PROSNOW

Provision of a prediction system allowing for management and optimization of snow in Alpine ski resorts

Document description	
WPs	WP5
Type	Report – Deliverable D5.4
Title	**Report on dissemination and exploitation of results** (full version)
Dissemination	Public / Internal / **Confidential**
Version, Date	V1, 04/09/2020
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Related files	- PROSNOW Deliverable D5.1

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Objective of the document

The objective of this document is to report on the dissemination and exploitation of PROSNOW results. It brings together information and data generated throughout the project with respect to market interest, added value for professionals, willingness to pay, costs of service provision, etc. and presents the thereof derived suggestions for the PROSNOW business model(s). The document outlines the developed and agreed strategy for exploiting the results of the PROSNOW project, reports on the dissemination and exploitation activities undertaken throughout the project, and presents the plans for post-project dissemination and exploitation activities.

1. Introduction

Ski resorts nowadays face various challenges with respect to snow management. They need to meet the high demands of their customers towards snow reliability and quality, while ongoing climate change puts them under significant pressure to adapt to changing environmental conditions. Examples include the recent series of challenging early winter situations (2014/15, 2015/16, and 2016/17) with poor conditions of natural snow and too high temperature for technical snow production throughout the entire Alps (Morin et al. 2018). Against this backdrop of climatic vagueness and increasing quality demands, together with the need to control operating costs, snow management has become a crucial issue for the ski resort industry. A series of technical solutions has been developed in recent years and decades to support snow management in ski resorts, promising reductions and savings in resources and operating costs[1] (e.g. GPS-based snow height measurements in grooming vehicles, software for snowmaking control, etc.). However, the lack of anticipatory power on the upcoming meteorological and snowpack conditions remains a significant threat in terms of waste of money and resources. This lack of anticipatory power may result in premature melting of produced snow on the one hand or overproduction with snow left over after the end of the season on the other hand.

The PROSNOW project aimed at increasing the anticipatory power of ski resorts by building a demonstrator of a meteorological and climate prediction and snow management system, that provides improved anticipation capabilities at all time-scales, spanning from days to the seasonal scale of several months. Such a system holds significant potential to increase the resilience of socio-economic stakeholders and support their real-time adaptation potential. The document at hand presents the strategy followed by the project team in order to maintain and exploit the developed system after project end by transferring it to the market. In addition, it reports on the activities undertaken throughout the project to prepare for market exploitation.

Objective and overall strategy

The overarching dissemination and exploitation objective of the PROSNOW project was to pave the way for a commercial forecasting service that helps Alpine ski resorts to optimize the management of snow, based on adequate monitoring and forecast of snow conditions on ski slopes. The project team aimed to achieve this by

- tailoring the service to the actual needs of intermediate and end-users by an intensive co-design process,

- having leading suppliers of snow management equipment and services within the project consortium for maximizing the chance of integrating PROSNOW forecasts into their products and services,

- ensuring the compatibility of PROSNOW API (aka webservices) for a future convergence of different services,

- assessing the added value of using PROSNOW not only under "laboratory conditions", but also demonstrating and documenting it by means of the real-time testing in pilot ski resorts,

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[1] See e.g. product folders of SNOWsat and TechnoAlpin:
https://www.pistenbully.com/fileadmin/content_pistenbully/modul_8_download/pistenbully_snowsat_09_2014_en.pdf;
https://www.snowsat.com/fileadmin/content_snowsat/downloads/WEB_11589_SNOWsat_brosch_en_04.pdf;
https://www.technoalpin.com/smc/e215037b68385ac3afcdf6c07242b2e08a9cf858.pdf

- making PROSNOW and its added value known among professionals and further target groups,

- engaging in awareness raising, teaching and training activities among professionals,

- managing the created IP in a way that best supports commercial exploitation,

- disseminating results (deliverables, documentation, software, and datasets) in coordination with the exploitation strategy within and/or outside the project consortium to enable their reuse by internal and/or external organisations,

- and providing best possible support for partners – or alternatively third parties – interested in a commercialization of PROSNOW.

Relation to other work packages

Important input and support for preparing PROSNOW's market exploitation came from almost all work packages (see also Figure 1). By means of assessing market interest, added value for professionals, and willingness to pay, WP2 provided crucial input for elaborating the business plan(s). With the development and implementation of the PROSNOW demonstrator, WP3 laid the foundation and starting point for up-scaling and future exploitation. WP4 aimed at exploiting the PROSNOW demonstrator in real time at the pilot ski resorts, thereby contributing to the potential for market replication. This included basic training on how to use the PROSNOW demonstrator as well as continuous technical support. Evaluations of the real time testing in the pilot ski resorts provided additional insights on PROSNOW's added value and ski areas' willingness to pay. WP6 supported the preparation for market exploitation with a customized communication strategy and coordinated the scientific dissemination of results.
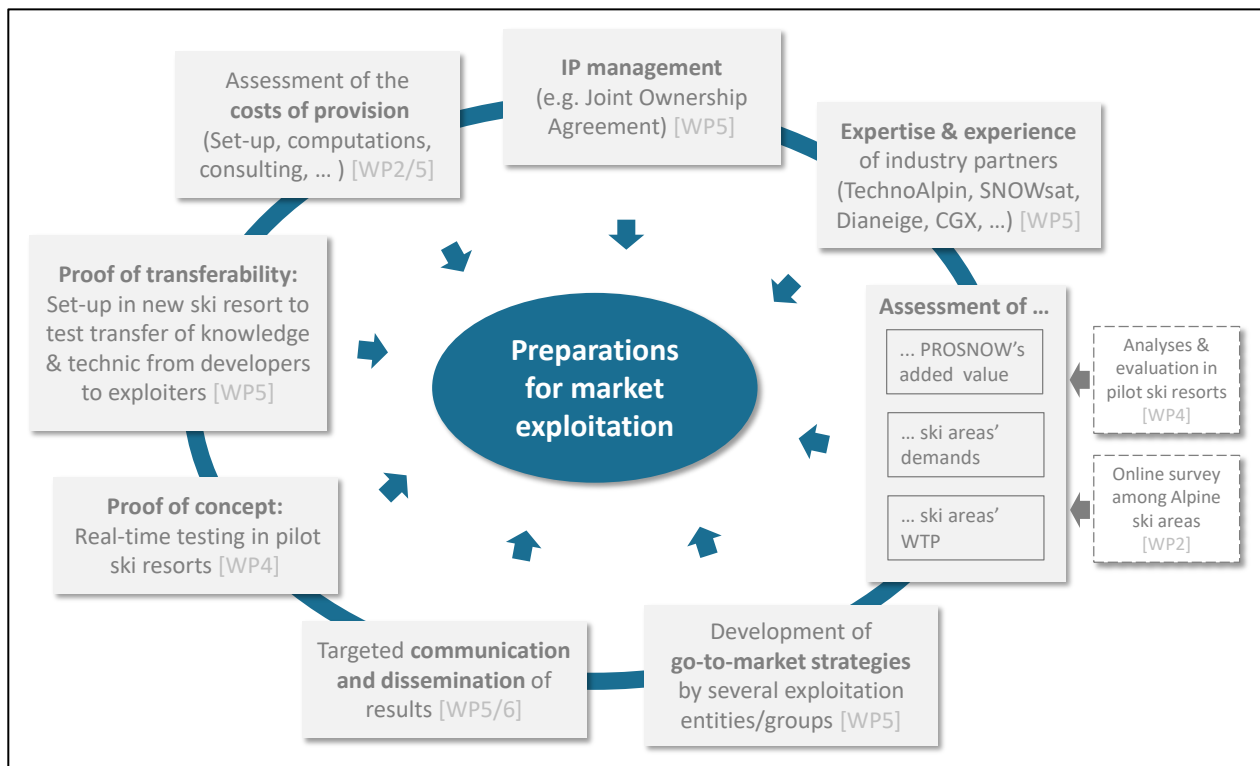

Figure 1: Overview on main inputs from different WPs to prepare for market exploitation

Structure of the document

The present document is structured as follows. Chapter 2 gives an overview on the exploitable results and the exploitation-relevant insights gained from different PROSNOW WPs throughout the project.

Chapter 3 introduces the PROSNOW exploitation entities that have emerged during the project together with their go-to-market strategies and business plans. Each of these exploitation entities consists of one or several members of the PROSNOW consortium and plans to exploit PROSNOW results commercially in the near future. Chapter 4 reports on the dissemination and exploitation activities carried out by the PROSNOW consortium throughout the project. Moreover, it outlines the activities planned for the post-project period. Chapter 5 finally provides some conclusions.

2. Exploitable results and exploitation-relevant insights from the project

In this section, we summarize the exploitation-relevant results and insights generated throughout the PROSNOW project. This includes the main exploitable results, but also data and information that formed the basis for developing PROSNOW's exploitation and go-to-market strategy and deriving the business model(s).

Main exploitable results

Table 1 gives an overview of generated PROSNOW results that are of particular relevance for (commercial) exploitation.

Table 1: Listing of exploitable results generated within PROSNOW (the focus is on non-scientific exploitation)

Exploitable result	Short description	Exploitation-relevant notes
PROSNOW concept / workflow	Concept and workflow for a meteorological and climate prediction system tailored to the management and optimization of snow in Alpine ski resorts. The PROSNOW concept uses (i) daily to seasonal meteorological forecasts, downscaled to sub-units of a ski resort, (ii) in-situ observations, (iii) snowpack models, and (iv) a scenario-based approach to infer the probability range of consequences of daily tactical snow management choices (where, when and how much snow to produce; where and when to groom). For details on the workflow, see D1.2 (*Report on modelling chain*) and D3.2 (*Central data server and demonstrator*).	Jointly developed by the PROSNOW partners. The PROSNOW concept / workflow forms the basis of the planned commercial services. It is also publicly available through public deliverables (e.g. D1.2 *Report on modelling chain*; D1.6 *Report on the real-time implementation of the model chains*) and scientific papers (e.g. Morin et al. 2018).
Central Data Server	The Central Data Server organizes all data flows needed to provide PROSNOW forecasts, including initialization data from ski resorts, met forecast data, snow-modelling data, and PROSNOW outputs (see	Jointly developed by several PROSNOW partners with main responsibility at INRAE and hosted by INRAE during the project period. The structure, related software and documentation are stored on two

Exploitable result	Short description	Exploitation-relevant notes
	D3.2 *Central data server and demonstrator* for details). It brings together data providers and data users and includes a series of software elements to map input data of various origins into the database structure (e.g., SRU definition). An authorization system manages the access rights.	access-restricted software repositories ("Gitlab" for developers and "Zenodo" for transfer to exploiters). Accessibility and terms of use are settled in the Joint Ownership Agreement (see also chapter 4): Access will be restricted to exploiting consortium members for 3 years after the end of the project. As of 31st August 2023, the code will be made open to external entities via the Zenodo platform.
API	Application programming interface for normalized data exchanges (push/get data) with the Central Data Server (see D3.2 *Central data server and demonstrator* for details). The API transforms http and JSON requests into standard SQL. Access and rights are restricted by an authentication system.	Developed by INRAE with input from most partners. The structure and documentation are stored on two access-restricted software repositories ("Gitlab" for developers and "Zenodo" for transfer to exploiters). Accessibility and terms of use are settled in the Joint Ownership Agreement (see also chapter 4): Structure and documentation will be made publicly accessible via the Zenodo platform as of 31st August 2020.
Demonstrator V1 / user-facing tool	Data visualization interface: Webmapping tool with a limited set of features and a simple, not secured, access (see D3.3 *Demonstrator and documentation V1* for details).	Developed by INRAE with input from several PROSNOW partners. The Demonstrator V1 was used within the Local Working Groups (LWGs) for illustrative purposes and to define future features of the second version. Thus, it mainly served as basis for the development of the Demonstrator V2. It was also exploited for communication purposes.
Demonstrator V2 / user-facing tool	Data visualization interface: User-friendly, easy-to-deploy open-source application for data visualization (see D3.4 *Demonstrator and documentation V2* for details). The second version of the Demonstrator is more robust with respect to massive data and offers expandable functionalities. It is fully connected and compatible with the Central Data Server and the related API.	Developed by INRAE with input from several PROSNOW partners. The structure, related software and documentation are stored on two access-restricted software repositories ("Gitlab" for developers and "Zenodo" for transfer to exploiters). Accessibility and terms of use are settled in the Joint Ownership Agreement (see also chapter 4): Access will be restricted to exploiting consortium members for 3 years after the end of the project.

Exploitable result	Short description	Exploitation-relevant notes
		As of 31st August 2023, the code will be made open to external entities via the Zenodo platform.
Improvements in snowpack models	Improvements and enhancements in the three snowpack-models AMUNDSEN, Crocus, SNOWPACK/Alpine3D and harmonization of some core functionalities, such as handling of snow management and model input/output variables (see D1.3 *Report on snowpack modelling* for details). In the case of SNOWPACK/Alpine3D, for instance, a module for the simulation of snow management processes was implemented.	The improvements will be exploited in subsequent deployments of the snowpack models, i.e. in other research projects, but also when deployed for commercial purposes. SNOWPACK/Alpine3D (developed by SLF) and SURFEX (developed by Météo-France and incorporating the Crocus snowpack model) have already been open source software. Software updates are released one to two times per year. The latest releases already include model improvements thanks to PROSNOW. The terms of use are settled in the respective free software license agreements[2]. An open source version of the AMUNDSEN model is currently under development (see also chapter 4).
Standardization	PROSNOW has defined a common input and output data format and generated a procedure to bring all used data into this common format. Data formats used are NetCDF and JSON (incl. GeoJSON). See D3.2 *Central data server and demonstrator* for further details. Co-designed with industry partners (e.g. Technoalpin, SnowSAT, CGx) and building on existing "soft" de-facto standards, the new standard is intended to foster data exchanges between snow management software systems (e.g. transfer of snow depth observations, snowmaking information, meteorological forecasts, snow cover forecasts).	Making the new standard in the form of the API public as soon as possible (i.e. as of 31st August 2020) will help to establish PROSNOW as a core player in the snow management industry, making it possible to establish linkages between existing and upcoming services. In addition, the strong involvement of project partners in other big research and application projects will further foster the usage and spread of the common data format defined in the PROSNOW project.
Algorithm to define SRUs (default option)	Approach that automatically discretizes a ski resort to SRUs[3] (**S**ki	Developed mostly by INRAE and part of the software elements included in

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[2] SURFEX: https://www.umr-cnrm.fr/surfex/IMG/txt/licence_cecill_c_v1_en.txt
SNOWPACK/Alpine3D: https://www.gnu.org/licenses/lgpl-3.0.de.html

[3] PROSNOW provides forecasting information at the level of "**S**ki resort **R**eference **U**nits" (SRUs), i.e. areas or sections of slopes within which the snowpack is considered similar (depth, mass, snow management).

Exploitable result	Short description	Exploitation-relevant notes
	resort **R**eference **U**nit), based on the local topography (elevation, aspect and slope) and the presence of snowmaking. (See D1.3 *Report on snowpack modelling* and D3.2 *Central data server and demonstrator* for details).	the Central Data Server to map input data of various origins into the database structure. For accessibility and terms of use, see the information on the Central Data Server.
Protected brand	Since 23/5/2019, PROSNOW has been a registered EU trademark.	The registered EU trademark PROSNOW is collectively owned by all consortium members and expires in 2029. The terms of use, i.e. the requirements to be fulfilled for using the PROSNOW brand, are set in the Joint Ownership Agreement (see also chapter 4).

Components needed for an operational service

Figure 2 illustrates the supply chain of the PROSNOW service. It can be split into two main parts:

- ***Generation of the forecasting data***:
  This first part of the supply chain is made up of several steps: (i) import of local observational data, (ii) downscaling of meteorological and seasonal forecasts, (iii) simulation of the snowpack evolution, and (iv) post-processing of the generated data. Besides these concrete steps in generating the forecasting data, this first part also includes the general management of the Central Data Server.

- ***Exploitation of the forecasting data by downstream services***:
  Downstream processes may include, for instance, the visualization of the forecasting data by the stand-alone web-based PROSNOW user-interfacing tool, the integration of PROSNOW forecasts into existing tools and services or the use of the forecasting data as input for consulting activities.

Both parts of the service supply chain can be handled by one single company or split between several companies. The crucial point for service maintenance after project end is having one or several organisations running the first part of the supply chain (i.e. generation of forecasting data). In chapter 3 and 0 of this document, the strategy agreed upon by the PROSNOW consortium to set up commercial service provision is introduced in detail.
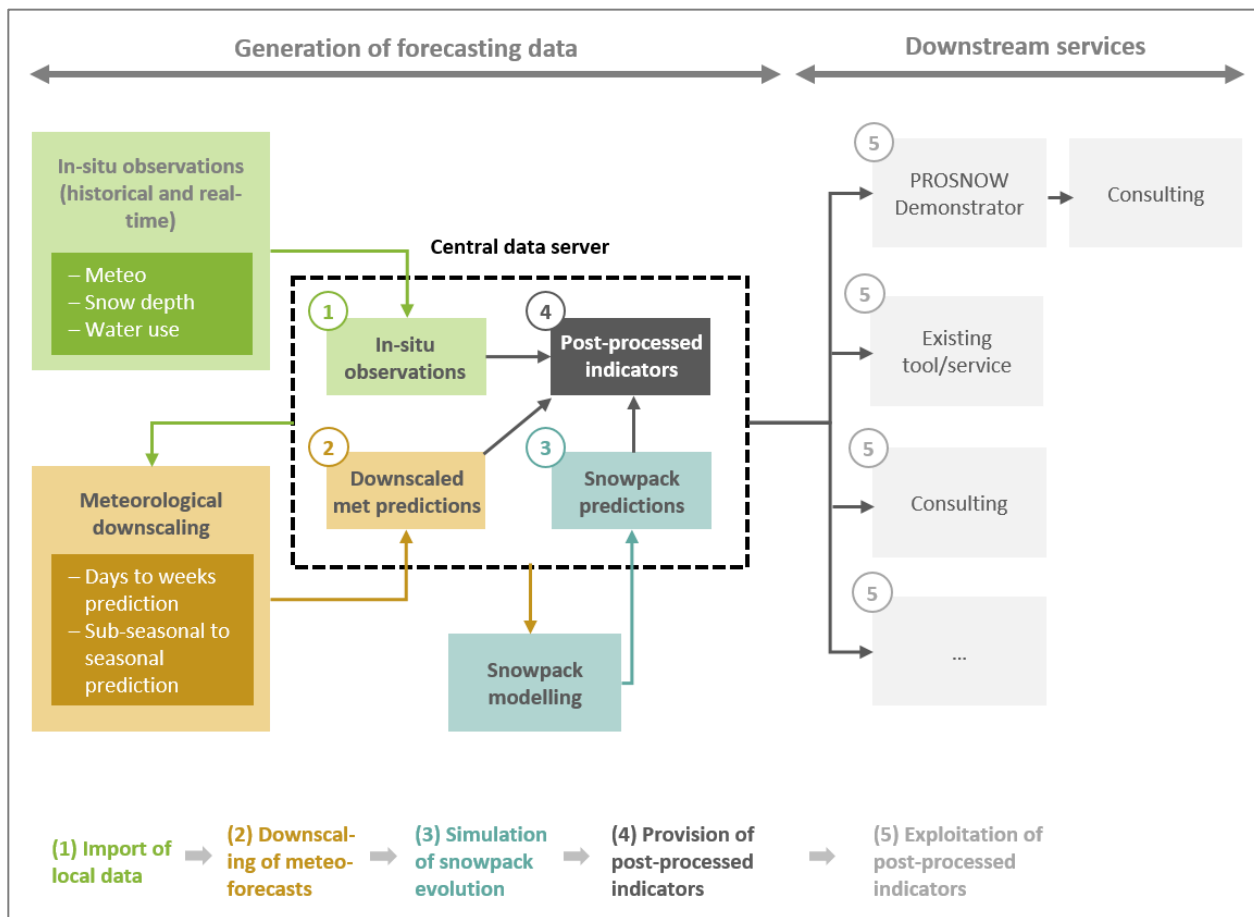
Figure 2: PROSNOW service supply chain (based on Morin et al. 2018)

What we know about the potential (end-)users

Ski resorts represent the main end-user group of PROSNOW services. Maximizing the chances for actual up-take and use of the PROSNOW service by ski resorts requires a good understanding of their needs and a clear demonstration of the service's added value. These issues were particularly addressed in WP2 and WP4. This included collecting the needs of ski resorts with respect to snow management, investigating the costs associated to snow management and potential cost reduction levers, assessing the economic benefits of using the PROSNOW service and analysing the ability as well as the willingness of potential users to pay for such a service. Different means and methods were deployed for this purpose. They included (i) literature reviews, (ii) interviews, surveys, and workshops in the local working groups[4] (LWGs) of the pilot ski resorts, (iii) surveys based on the real-time testing of the PROSNOW demonstrator in the pilot ski resorts, (iv) interviews with providers of snow management tools and services, and (v) an online survey targeted at Alpine ski areas. Below, the exploitation-relevant insights gained in WP2 and WP4 are summarized.

Snow management operating costs:

Operating costs are a sensitive issue for ski areas and they are usually quite reserved in providing related data. That is why only little information is publicly available. An assessment based on data from some of the PROSNOW pilot ski resorts suggested snowmaking costs to be rather negligible compared

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[4] For each pilot ski resort within PROSNOW, a local working group (LWG) was established. Each LWG comprises at least one representative from the resort technical management team, a technical and science partner and all stakeholders directly concerned with the use of data.

to the ski resorts' turnover (see deliverable D2.1 *Review of ski resorts operating costs and market analysis*). Nevertheless, the results of the Alpine-wide online survey conducted in spring 2019 showed that snow management could account for a considerable fraction of a ski area's total operating costs. In the ski areas that responded to the survey, this fraction ranged from 5 % to 40 % (with a mean of 21 %) and mainly consisted of grooming and snowmaking (see deliverable D2.4 *Report on interviews and surveys with European Alps stakeholders*).

The uncertain nature of upcoming weather and snow conditions usually animates snow managers to produce some sort of "snow safety buffer" (see also the paragraph below on "*Snowmaking strategies, risk attitudes and handling of uncertainties*"). This uncertainty surcharge currently seems to account for a noticeable fraction in total snow production and related water consumption as well as in total snow management operating costs, at least in the PROSNOW pilot ski resorts. They expect that perfect knowledge would reduce the amount of technical snow needed by up to 45 %, the amount of water needed by up to 40 %, and total snow management operating costs by up to 20 % (see D4.4 *Report on the perceived added-value of the service from a users' experience and quantification of the added-value based on economic indicators*). Simulations with the PROSNOW snowpack models for the last winter seasons confirm this potential for savings (see D2.6 *Economic analysis of PROSNOW products*). Hence, there is obviously room for a service that is able to enhance the ski resorts' current anticipatory capabilities. This observation also goes in line with the observed interest of Alpine ski resorts in a forecasting service like PROSNOW (see the paragraph below on "*Interest in a service like PROSNOW by Alpine ski resorts*").

Services and tools currently used for snow management:

According to the Alpine-wide online survey from spring 2019, the use of weather forecasts in planning technical snow production is very common and their importance for snow management is rated high (see deliverable D2.4). This is a good starting base for PROSNOW, which intends to go some steps further than common weather forecasts by providing a seamless snow prediction system that covers all relevant time scales from a few days to several months. For the actual uptake of PROSNOW services by ski resorts, it is however crucial to clearly demonstrate the added value over currently used – and most often freely available – weather forecasting products (see below for details on how the pilot ski resorts perceived PROSNOW's added value).

Besides weather forecasts, the majority of survey respondents also indicated to use tools and services for snow depth recording, grooming management and/or snowmaking in their ski area. Ski areas in the uppermost size-class (more than 150 slope-km) show the highest usage rates of tools and services for snow management. For them, PROSNOW forecasts integrated into the tools and services they already use are expected to be more appealing than a stand-alone system. The opposite is true for ski areas not making use of sophisticated snow management tools at the moment. That is why most of the PROSNOW exploitation entities plan to provide both, forecasts integrable into already existing tools and forecasts visualized by the stand-alone user-interface developed during the project (see chapter 3 for further details).

Snowmaking strategies, risk attitudes and handling of uncertainties:

Particularly at season start, the widespread and risk-avoiding strategy in the light of uncertain upcoming conditions is to produce snow whenever possible and independent of (forecasted) natural snowfall or melting events. Both, discussions in the LWGs and the results of the Alpine-wide online survey showed that many ski areas decide for a no-risk or low-risk strategy when it comes to building a basic snow cover in the pre-seasonal period. Nevertheless, some fraction also seems willing to consider somewhat uncertain information on subsequent conditions when deciding about the exploitation of potential snowmaking hours. One reason might be limited water resources and the corresponding necessity to avoid the risk of waste. In any case, it is crucial to demonstrate, where and how even uncertain

information can be of added value for decision making. Although the pilot ski resorts' real-time testing of PROSNOW in the winter season 2019/20 already provided some preliminary insights, collecting illustrative examples and best practice cases on the most optimal use of uncertain information for decision making will also remain a task for the PROSNOW exploitation entities in the years to come.

Regarding the added value of seasonal forecasts, analyses within WP1 showed that although the predictability of atmospheric parameters is poor, snowpack variables have a good predictability, thanks mainly to the knowledge of initial conditions. For the operational use, there seems no systematic added value of using seasonal forecasts compared to climatology (i.e. the use of historical scenarios) as forcing for the snowpack models. The use of seasonal forecasts could, however, be recommended in case of specific situations, where climate experts identity enhanced predictability due to a specific context (for instance, El Niño/La Niña years, or good consistency between seasonal forecasting models). Then, seasonal forecasting could help to reduce uncertainty.

Interest in a service like PROSNOW by Alpine ski resorts:

The majority of participants to the Alpine-wide online survey in spring 2019 showed interest in a forecasting service like PROSNOW and regarded it important and useful for snow management in their ski area, particularly for optimizing water use. Forecasting reliability, however, is mentioned as an important aspect for actual uptake and usage.

Added value of PROSNOW services as perceived by the pilot ski resorts:

In the winter season 2019/20, the nine PROSNOW pilot ski resorts tested the developed demonstrator in real-time. Although only a few of the pilot ski resorts already observed positive impacts (e.g. resource or cost savings, facilitations in planning and decision-making, etc.) during the real-time testing[5], a clear majority was very positive that PROSNOW could in principle be of help to save resources and costs or to facilitate planning and decision-making. Areas of application for which PROSNOW is considered useful by the pilot ski resorts particularly include snowmaking decisions for the upcoming hours and days, the optimization of water and energy use, resources planning in general, avoidance of snow overproduction, and internal/external communication. Based on their experience from the testing season, some pilot ski resorts expect to be able to save up to about 16 % of current snow management operating costs by using PROSNOW (see also D4.4).

Willingness to pay (WTP):

The PROSNOW pilot ski resorts' WTP was assessed after their real-time testing of the demonstrator in the winter season 2019/20. Even though some pilot ski resorts experienced problems with the demonstrator, the majority indicated to be willing to pay a non-zero price for the PROSNOW service in its current form. Directly stated WTP ranged from 2 500 € to 10 000 € per season, without any further conditions. Some resorts indicated to be even willing to pay at least 11 500 € under particular conditions (e.g. refunding of the price in case of the exceedance of a predefined forecasting inaccuracy, completion of a completely successful testing season, etc.). Deriving respondents' WTP indirectly by systematically varying selected product attributes in a limit conjoint analysis resulted in maximum chargeable prices between 7 400 € and 12 700 € for the respondents' most preferred product packages. The limit conjoint analysis also showed that the preference structures of the pilot ski resorts with respect to the product attributes *number of SRUs*, *type of support*, *forecast horizon*, and *price* are quite heterogeneous. For some of them, the price plays the most important role in determining their total utility or benefit from the product, whereas for others the number of SRUs or the forecast horizon is of highest relative importance. Such heterogeneous preference structures suggest using a modular

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[5] Note that for some pilot ski resorts, the PROSNOW demonstrator was not fully operational in time, which limited the period available for full and extensive testing. In addition, taking full advantage of the PROSNOW forecasts will take time, both in terms of confidence building and adapting common practices.

product design, where customers can choose to add modules of predefined types of support or additional SRUs to their base package.

Due to the small sample size, the results on WTP are not necessarily representative for Alpine ski resorts in general. Nevertheless, the figures provided PROSNOW exploitation entities with some basic support in determining the pricing schemes for their planned commercial PROSNOW products (see chapter 3).

Need for training:

The second round of LWGs, where the first version of the web-based demonstrator was presented, and the real-time testing in the season 2019/20 both confirmed the high importance of providing training and assistance to the ski-resorts' staff. The web-based user-facing tool provides a huge amount of information. Although most graphs and variables are self-explaining for a scientific or well-trained audience, some of the provided information is new or unfamiliar to many ski resort actors. Most often, they are for example not used to the interpretation of quantiles (e.g. quantitative treatment of probabilities), which are applied in the user-facing tool to display the uncertainty associated to the snow forecasts. The same holds true for the interpretation of the climatology. Hence, even the most experienced stakeholders will need a proper training in order to exploit the user-facing tool to its full potential themselves (see D4.2 *Synthesis note on the performance of the Demonstrator deployment* and D4.3 *Report describing the assessment of the continuous exploitation of the Demonstrator*). This has been considered by the PROSNOW exploitation entities when defining their commercial PROSNOW offers (see chapter 3).

What we know about the costs of service provision

To get an idea about the costs of providing PROSNOW forecasts and services, a survey among the project partners involved in data collection, generation, preparation, management and visualization was conducted in summer 2019. They were asked to provide cost estimates for tasks related to the provision of PROSNOW forecasts and services, differentiating between three different categories:

- Setup costs for a new ski area
- Running costs for one additional ski area per season/year (i.e. marginal costs)
- General/fixed running costs per season/year

Table 2 presents the cost estimates consolidated from inputs of several PROSNOW partners.

Further experiences on the costs of setting up the model chain in a commercial environment were gained by the implementation of the full model chain for an entirely new ski resort located in Andorra (Grandvalira). This test, carried out by out by CGx, Dianeige and Météo-France (one of the PROSNOW exploitation entities; see chapter 3), with support from INRAE and interactions with TechnoAlpin for the provision of water consumption, demonstrated that the full model chain can be transferred to another resort under acceptable costs, enabling PROSNOW exploitation entities to engage in commercial exploitation of PROSNOW results (see chapter 3 for further details).

Table 2: Estimation on the cost of providing PROSNOW forecasts and services

Cost category	Included tasks / costs	Estimate (€)
Setup costs for a new ski area	Personnel, travel & material costs: - Meeting with ski resort before (defining customer needs and expectations) and after set up (training session on use and interpretation) - Data collection & preparation - Snowpack model setup - Integration of ski resort in PROSNOW software elements (central data server, user-facing tool, API)	12 500 - 18 500
Running costs for one additional ski area per season/year	Personnel costs: - Daily running of the simulation chain (MET forecasts, snowpack forecasts, …), including setup for automatic provision, checks and problem solving - Continuous consulting	5 500 - 16 000
General/fixed running costs per season/year	Personnel, travel and material costs: - Server costs and maintenance - Personnel - General expenses (travel, energy, insurance, etc.)	21 000 - 39 000

Some simulations on costs, revenues and earnings of a PROSNOW service

Autumn 2019 represented a crucial phase for exploitation. In order to refine and nail down PROSNOW's commercial exploitation strategy, in-depth discussions took place in a dedicated WP5 meeting in Grenoble and the subsequent third General Assembly in Davos. The aim was to clarify whether there was enough interest among the partners to push for consortium-internal commercial exploitation or whether the efforts in finding external operators for future commercial PROSNOW services needed to be increased. In preparation for these in-depth discussions on commercial exploitation, we updated the initial simulations on costs, revenues and earnings presented in D5.1 (*Initial strategy for dissemination and exploitation of results*). The purpose of this update was to give partners with a potential interest in commercial exploitation a more concrete idea about whether there was room for a profitable exploitation of PROSNOW. The results of these simulations already highlighted the main points of attention for future PROSNOW services from an exploiter's point of view.

To simulate the costs, revenues and earnings of a commercial PROSNOW service, we used an Excel tool with macros that generates financial accounts and simulates a real business. The underlying assumptions are based on the idea that an independent single company is exploiting PROSNOW. Note however, that the main conclusions do not change significantly if service provision is split between several companies, which represents the path that was finally agreed on and followed by the PROSNOW consortium in their autumn 2019 meetings (see chapter 3 for further details). The main assumptions are summarized in Box 1. They were fed by assessments of the modelling teams on the efforts needed for setting up and running PROSNOW forecasts (see the previous sub-section on the

costs of service provision) and expert judgments of the industry partners, particularly TechnoAlpin, who is the world leader of snowmaking infrastructure and a renowned IT service provider for ski resorts.

Box 1: Assumptions underlying the cost/revenue/earning simulations

Business model

Independent PROSNOW company that offers data and consultancy to ski resorts in Europe

Offers (and selling prices)

	Prices
1. Model set up and interface	€ 17 500
2. Annual subscription for daily data provision (meteo & snowpack forecasts)	
a. Standard (data for 1 point in the ski area)	€ 1 500
b. Premium: Small resort (data for several SRUs)	€ 1 500
c. Premium: Big resort (data for several SRUs)	€ 5 000
3. Consultancy based on PROSNOW data	
a. Small resort	€ 3 000
b. Big resort	€ 10 000

Number of clients

It is assumed to have 90 resorts in standard subscription and 100 resorts (50 small, 50 big) in premium subscription by 2027, with 35 also using the consultancy service.
It is assumed that after 7 years (2027) the maturity level is reached and the company stops investing money into getting new clients.

Staff

The company starts with 4 people (1 admin, 2 commercials and 1 technician), increases to 9 and goes down again to 7 when reaching maturity in 2027.

Royalties

Royalties for using the PROSNOW results, proportional to the number of subscriptions, are taken into account.

Further assumptions

	EUR
Seed capital (100 k€ cash, 700 k€ loan)	€ 700 000
Annual investments	€ 25 000
Annual equipment costs	€ 8 000
Annual costs for research (part time contract, whereof 30 % are covered by CIR)	€ 23 000
Costs of data processing and provision (per premium subscription)	€ 1 800
Costs of daily IT process running per resort	€ 12

Table 3 and Figure 3 to Figure 5 show the main results of the cost, revenue and earning simulations. Personnel costs represent the by far largest cost category. Total costs reach a first maximum after 4 years and a second one at the end of the simulation period (see Table 3 and Figure 3). Revenues from

new model set-ups are decreasing over time, as fewer new ski resorts need to be acquired under the assumption that ski resorts once acquired remain to be clients (see Table 3 and Figure 4). Based on the underlying assumptions, an equilibrium between costs and revenues is reached after 3 to 4 years. At maturity, i.e. after 7 years, the EBITDA equals 8 % of net revenues (see Table 3 and Figure 5).

Table 3: Simulated evolution of costs, revenues and EBITDA (earnings before interest, taxes, depreciation and amortization)

| Costs (€)	2020	2021	2022	2023	2024	2025	2026	2027
Personnel Costs	288 876	354 036	495 216	514 764	460 464	427 884	397 476	397 476
Rent and Utilities	26 500	26 500	26 500	26 500	26 500	26 500	26 500	26 500
Marketing Costs	40 000	25 000	20 000	20 000	20 000	20 000	20 000	20 000
Other Administrative Costs	23 000	25 100	26 200	28 300	31 400	33 500	35 600	38 700
Data processing	12 000	25 000	40 000	50 000	60 000	70 000	90 000	100 000
Data acquisition	9 600	20 000	32 000	40 000	48 000	56 000	72 000	80 000
Royalties	6 000	12 500	20 000	25 000	30 000	35 000	45 000	50 000
Revenues (€)	2020	2021	2022	2023	2024	2025	2026	2027
Set up	210 000	175 000	350 000	262 500	262 500	175 000	87 500	87 500
Standard subscription	15 000	30 000	60 000	82 500	105 000	120 000	127 500	135 000
Premium subscription	39 000	81 250	130 000	162 500	195 000	227 500	292 500	325 000
Consultancy / reporting	32 500	65 000	97 500	162 500	195 000	227 500	227 500	227 500
EBITDA	2020	2021	2022	2023	2024	2025	2026	2027
EBITDA (€)	-115 406	-137 981	-28 141	-35 214	79 386	81 266	48 724	61 524
EBITDA (% of revenue)	-39 %	-39 %	-4 %	-5 %	10 %	11 %	7 %	8 %
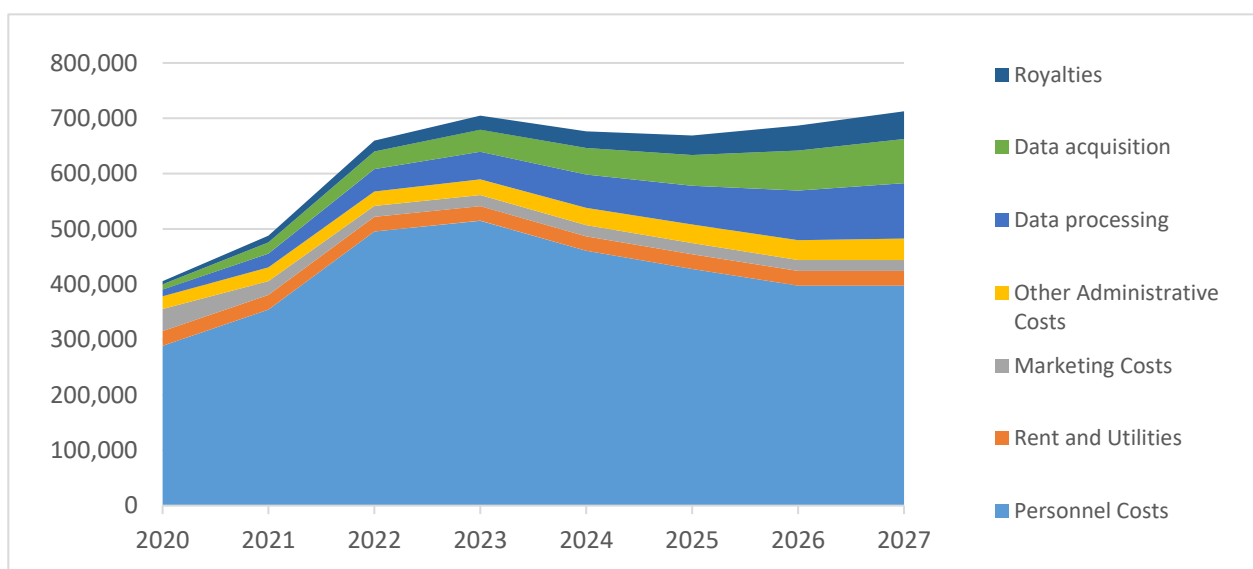
Figure 3: Simulated evolution of costs
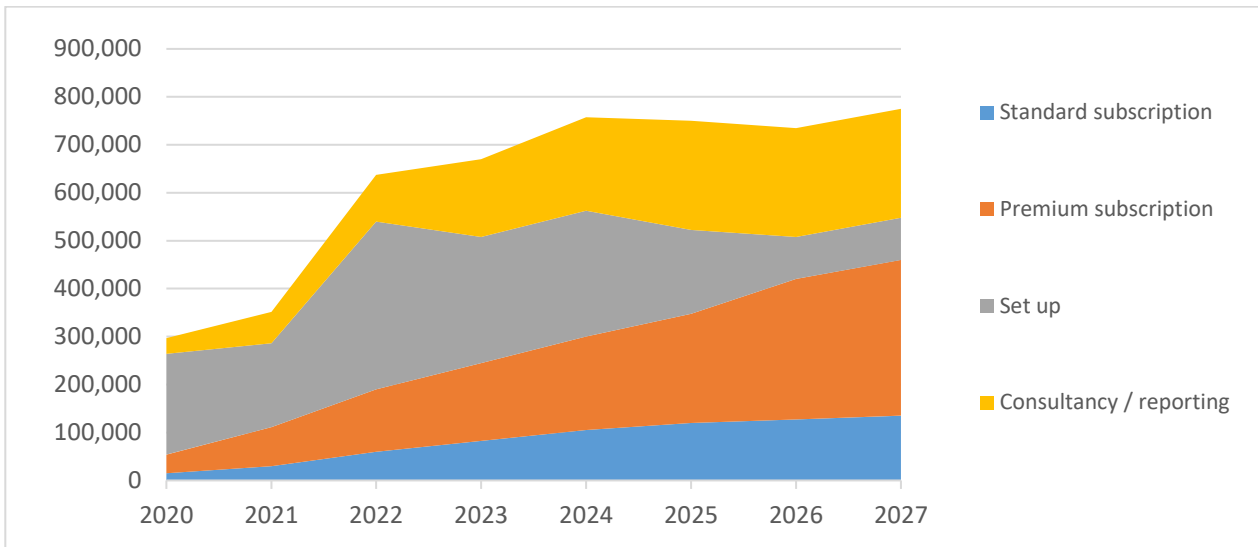
Figure 4: Simulated evolution of revenues
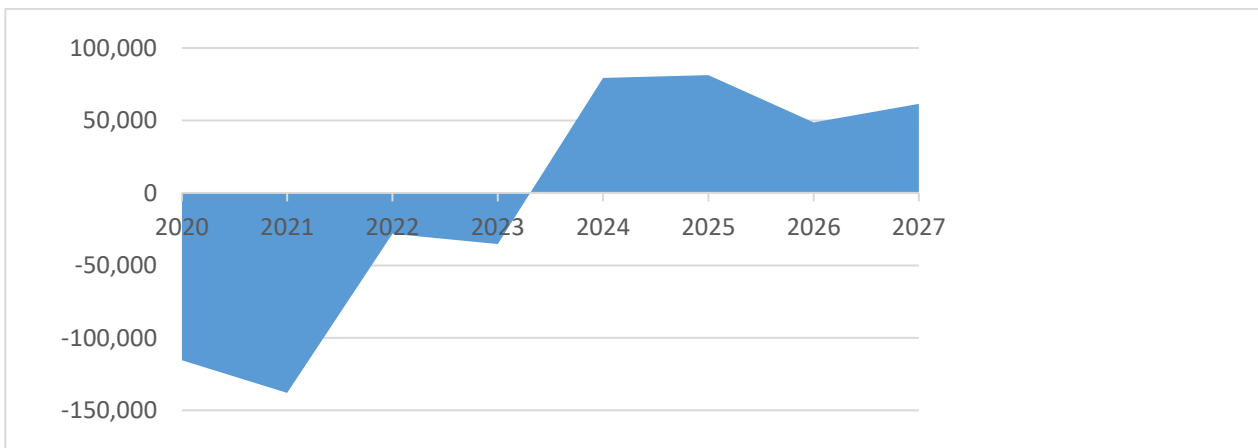
Figure 5: Simulated evolution of EBIDTA (earnings before interest, taxes, depreciation and amortization)

The main conclusion is that there seems to be room for a profitable exploitation. However, the assumption on the number of clients gained after 7 years is quite high. The simulations show that the cost or time of computation is critical. Profitability can only be reached with optimization. Hence, it might be necessary to limit the number of modelled snow management configurations and SRUs (see D1.3 *Report on snowpack modelling* for details on configurations and SRUs) in order to be profitable.

Based on these results, some of the final PROSNOW exploitation entities plan for service simplifications in order to reduce the costs of provision (see chapter 3). Moreover, by placing highest priority on favourable conditions for exploitation in a context where the commercial sustainability of a PROSNOW service is not guaranteed, the consortium finally agreed not to implement any royalties for exploiting jointly owned PROSNOW results (see chapter 4).

3. PROSNOW exploitation entities & their business plans

As mentioned before, autumn 2019 represented a crucial phase for setting the course of PROSNOW's commercial exploitation. There were several in-depth discussions among project members to clarify whether there was enough interest among the partners to push for consortium-internal commercial exploitation or whether the efforts in finding external operators of future commercial PROSNOW

services needed to be increased. During these discussions, several project partners expressed strong interest in contributing to the commercial exploitation of PROSNOW results, including:

- **Météo France (MF)**, the French national operator for weather and climate. Besides large-scale numerical weather prediction, seasonal prediction and climate modelling activities, Météo France also observes and models snowpack in mountain regions. In addition to its institutional duties, Météo-France provides commercial services to a wide range of sectors.

- **Alpsolut**, a start-up company providing state-of-the art scientific products for practitioners and the public to tackle their problems related to snow. Alpsolut offers services for snow-avalanche risk management and avalanche danger evaluation, performs snow cover simulations and is active in snow-applied research.

- **CGx**, an SME that develops, integrates, distributes, implements and helps to operate geographical information systems dedicated to aviation, defence and civil security, and ski resorts. CGx equips many ski resorts in Europe and has a recognized expertise in information systems and development of bridges between the different applications in ski resorts (in the form of plugins).

- **Dianeige**, an SME that advises and supports clients in their projects of development of mountain tourism activities in an environmental-friendly way. Dianeige also supports clients to optimize their snowmaking strategies and grooming technics. The company exports its knowledge and skills in more than 20 countries all over the world.

- **SNOWsat**, a company that provides solutions for unified, digital control of the processes in the ski area. This comprises professional slope and fleet management with snow depth measurement, snow management, GIS data management, etc.

- **TechnoAlpin**, the worldwide leader of snowmaking systems with snow producers installed in more than 1,800 ski resorts in almost 50 countries. TechnoAlpin designs, manufactures and markets snowmaking devices, machine rooms and control software for a fully automatic snow production. Their automatic control software ATASSplus and LIBERTY include snow depth management and a weather forecast.

- **UIBK (University of Innsbruck) and Schneezentrum**, two partners planning to found a spin-off company to exploit PROSNOW results. UIBK has strong experience in modelling snow conditions in mountain regions. Schneezentrum aims at generating new technology and management methods, which help to green and economize technical snow production. The planned spin-off company represents a potential partner for commercial exploitation.

Different scenarios and constellations were discussed, including the founding of one big PROSNOW-company or joint venture operating on the European (or even worldwide) market. The latter was favoured by project-internal solution providers operating on a European or worldwide scale, as it would have avoided being part of or cooperating with several entities in order to receive PROSNOW forecasts for ski areas all over Europe (or worldwide). However, it turned out that the complexity of such a broad constellation, including all partners interested in commercial exploitation, would have made its coordination difficult and the scenario quite risky in terms of actual implementation. This applied all the more as some partners intend to limit their activities to particular countries. Météo France, for instance, plans to avoid providing meteorological forecasts for countries traditionally served by their own national meteorological services.

Hence, rather than forming one big "PROSNOW company" serving ski areas all over Europe and beyond, the consortium decided on an alternative path with a higher chance for actual implementation: forming several – potentially concurrently operating – exploitation entities, each consisting of a smaller number of involved organizations and aiming at smaller (initial) target markets. Four promising

exploitation entities emerged at the third General Assembly in Davos in October 2019. Each of these entities appointed a "lead facilitator" among the involved partners to coordinate and push the development and elaboration of the entity's go-to-market strategy and business model. The project's overall dissemination and exploitation strategy (including IP management and terms of use, internal transfer of technical know-how, etc.) was further fine-tuned and adapted to best support the PROSNOW-internal exploitation entities (see chapter 4 for details). Table 4 gives an overview on the PROSNOW exploitation entities as of August 2020, with further details following below the table. The exploitation entities are at different stages of maturity and readiness with respect to actually going to the market. Entity A, the group with the highest readiness level, plans to provide its commercial service starting with the upcoming winter season 2020/21. The other three exploitation entities, by contrast, need at least one more year of preparation before going to the market, with different hurdles to overcome first. Note, that exploitation entity B2 represents an extended version of exploitation entity B1, both with respect to the partners involved and the geographical spread of the target market.

Table 4: Overview of the PROSNOW exploitation entities

	Entity A	Entity B1	Entity B2	Entity C
Lead facilitator	MF	Alpsolut	Alpsolut	UIBK
Organizations involved and their roles	**CGx**: managing the Central Data Server (incl. maintaining the API and the user-facing tool) **MF**: running meteorological and seasonal forecasts; running snowpack simulations **Dianeige**: consultancy based on the forecasts provided by MF; marketing	**Alpsolut**: running the whole model chain	**Alpsolut**: managing a cloud-based central data server, owned by all partners involved; maintaining the API and the user-facing tool; running snowpack simulations **TechnoAlpin**: input data (water use); intermediate user of forecasts **SNOWsat**: input data (snow depth measurements); intermediate user of forecasts	**Spin-off UIBK/Schnee-zentrum**: running snowpack simulations; consultancy **To be defined**: cooperation with one of the other initiatives (e.g. entity B1/2) to use their server infrastructure and the maintained user-facing tool
Form of cooperation	Over-the-counter contract	-	Joint Venture	Spin-off, tbd
PROSNOW IP used	- Concept (i.e. simulation chain) - Central Data Server - User-facing tool - API - Brand	- Concept (i.e. simulation chain) - Central Data Server - User-facing tool - API - Brand (probably)	- Concept (i.e. simulation chain) - Central Data Server - User-facing tool - API - Brand	- Concept (i.e. simulation chain)* - Central Data Server* - User-facing tool* - API* - Brand

	Entity A	Entity B1	Entity B2	Entity C
	- Improvements in snowpack model Crocus	- Improvements in snowpack model SNOWPACK/Alpine3D - Knowledge	- Improvements in snowpack model SNOWPACK/Alpine3D - Knowledge	- Improvements in snowpack model AMUNDSEN ------------------------- * in cooperation with another entity
Target market	**First:** Ski resorts (& local partners) in France, Spain, and Andorra **Later:** Rest of Europe and even outside Europe	**First:** Ski resorts in Italy and Switzerland **Later:** Ski resorts in the Alpine range	**First**: Ski resorts in the Alpine range (existing customers of TechnoAlpin and SNOWsat) **Later**: Worldwide	**First**: PROSNOW pilot ski resorts in Tyrol and South-Tyrol **Later**: Ski resorts in Austria and South-Tyrol
Main challenges or risks	- Aversion to commercial risk requires a high degree of certainty about the potential success of this commercial exploitation - Ensuring a fully-fledged integration of the local observations (SNOWsat, Leica) into the modelling chain. The issue has been solved technically, but in practice it's up to those service providers to make the data available daily during winter.	- Further developments needed before going to the market (e.g. simplifications in the visualization tool) - Providers of local meteorological and seasonal forecasts needed (discussions have started)	- Missing profound skills to generate local seasonal forecasts within the joint venture - COVID-19 pandemic has interrupted and slowed down preparations for going to the market	- Re-structuring and re-coding of AMUNDSEN for a clear IP situation - The spin-off company does not yet exist - Provider of local meteorological and seasonal forecasts needed (in contact with ZAMG)
Status quo (as of August 2020)	- Plan: offer service from 2020/21 on - Technical and legal issues resolved - Focus on client recruiting	- Will need (at least) one more year of preparation before going to the market - Considerations about offering another testing	- Will need (at least) one more year of preparation before going to the market	- Will need (at least) one more year of preparation before going to the market - Re-structuring and re-coding of

	Entity A	Entity B1	Entity B2	Entity C
		season for selected pilot ski resorts (Livigno, Lenzerheide)		AMUNDSEN in progress - Foundation of spin-off in preparation

Details on exploitation entity A

CGx | Météo France | Dianeige

Development status. Ready to go to the market.

Organizations involved and their roles. Entity A involves three of the project partners interested in contributing to the commercial exploitation of PROSNOW. CGx will manage the central data server as well as the maintenance of the API and the user-facing tool. Météo France will provide location-specific meteorological and seasonal forecasts and run the snowpack model (Crocus). Dianeige will be responsible for service delivery to the end-users (consultancy based on the forecasts provided by Météo France) and for marketing. In addition, entity A will collaborate with one other external partner, INRAE, for initial technical support. A more detailed listing of all tasks and the respective contributions of the involved organizations is shown in Table 6 in Annex A.

Form of cooperation. The cooperation will be defined by an over-the-counter contract between CGx, Météo France and Dianeige. This contractual form is flexible, which fits with the size of the consortium, the nature of the parties (two of them are SMEs), and the estimated duration. A draft version of the contract has already been agreed upon. A final version is planned to be ready and signed by October 2020.

After the first testing phase (season 2020/21) it is also planned to set up an IP management structure composed of (i) an IP management committee and (ii) an exploitation manager. The IP management committee will be in charge of legal procedures such as licensing, legal dispute and resolution. This committee will also be the interface to the PROSNOW co-owners, in compliance with the Joint Ownership Agreement. The exploitation manager will be the main contact for exploiting the IP.

Providers of local input data (water consumption, snow height measurements, etc.) are not directly involved in the organizational structure of entity A for running the service. As the quality of the forecasts however greatly benefits from such local input data, some form of cooperation with such suppliers[6] will be needed to gather local observation data from ski resorts.

PROSNOW IP used. It is planned to make use of the PROSNOW concept and workflow (see Table 1), the user-facing tool and the related database, the Central Data Server, the API, the PROSNOW trademark, and the improvements in the snowpack model Crocus. The necessary technical know-how on the API, the Central Data Server and the user-facing tool has already been transferred from INRAE to CGx. This transfer has been done in the course of setting up PROSNOW for a new ski resort in Andorra (Grandvalira), which served as a kind of testing case that provided the proof for the technical transferability of the PROSNOW code.

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[6] Potential suppliers include TechnoAlpin and SNOWsat, both part of the PROSNOW consortium, but also data providers external to PROSNOW, such as Leica, PowerGIS, ARENA PistenManagement, etc. The cooperation with parties outside the PROSNOW consortium was tested by the example of the pilot ski resort Arosa-Lenzerheide. In Arosa-Lenzerheide, in-situ snow depth from grooming machines are produced by a third party company, Leica, which does not belong to the PROSNOW consortium. It was thus used as a test case to check the barriers and enablers in cooperating with external data suppliers.

Target market. Ski resorts in France, Spain, and Andorra and their local partners, such as local authorities, tourism offices, etc., will represent the initial target market (~ 160 ski areas with at least 10 slope-km; see Table 9 in Annex B). Extension to Eastern Alps and Eastern Europe as well as Nordic countries (and even outside Europe) can be envisioned at a later stage, depending on circumstances such as the existence or not of a sister service provider similar to PROSNOW, the relationship with weather/climate service providers, etc.

Offered product(s)/service(s). It is planned to offer three types of services:

(A) Access for ski resorts to the web-based user-facing tool (similar to what the pilot ski resorts access currently).

(B) Access for ski resorts to PROSNOW forecasts through existing management tools (e.g. TechnoAlpin, SNOWsat software) by means of APIs. Note that this service requires some form of cooperation with the suppliers of existing management tools.

(C) Real-time consultancy for ski resorts, with or without direct access for the ski resorts to the web-based user-facing tool.

For the upcoming winter season 2020/21, prices for service A – including the set-up, one day of consulting at the beginning of the season and a support hotline during the winter – will range from 7.5 k€ to 12.5 k€, depending on the size of the resort (see Table 7 in Annex A for further details and the splitting of the revenues between partners). There is no detailed pricing scheme for service B yet, since it is not planned to be offered in the upcoming winter season. Service C will be tailored to the needs of each resort, with a wide range of options and hence prices.

The French PROSNOW pilot ski resorts La Plagne and Les Saisies, who have already agreed to continue using PROSNOW in the upcoming season 2020/21, will be granted discount fares for their efforts in co-developing the services.

Path to customer. Dianeige exhibits a strong and long-established presence in the market of Alpine and Pyrenean ski resorts. A relationship of trust is already established between the SME Dianeige and the potential customers targeted by entity A.

Competitors. A screening showed that no similar external service providers currently operate on the market. If more than one sub-consortium emerges from the PROSNOW project, this will respect competition law and no antitrust practice will be willingly done.

Cost structure. The main costs will be personnel costs (managing and maintaining the server and software elements, providing meteorological and seasonal forecasts, running the snowpack model, consulting) and computing/storage costs.

Go-to-market strategy. An important pre-step before going to the market was porting the software elements (Central Data Server, user-facing tool, API) from main developer INRAE to CGx and make them suitable for commercial exploitation. This transfer of technic and knowledge took place in the course of setting up the PROSNOW demonstrator from scratch for a new ski resort (Grandvalira, Andorra) in spring 2020. The setup was carried out by exploitation entity A with support from INRAE and TechnoAlpin (see chapter 4 for further details).

For going to the market, the already existing channels of Dianage and the contacts gained within PROSNOW will be exploited. Over the last months of the PROSNOW project, the developed demonstrator and the upcoming service offers of exploitation entity A have already been presented to a range of (French) ski resorts in order to gain first customers for the winter season 2020/21 (see chapter 4 for further details on these activities).

Key risks. The main risk pertains to the ability of partners to engage sufficiently (resources such as manpower in particular) for the operation of the service after the end of the PROSNOW H2020 project (risks must be taken to support the first months/years of operations). A further challenge is to ensure

a fully-fledged integration of local observations (SNOWsat, Leica) into the modelling chain. The issue has been solved technically, but in practice it's up to those service providers to make the data available daily during winter. Another risk – at least in the short term – could be related to the difficulties the resorts have encountered (and maybe will encounter again in the coming months) due to the COVID-19 pandemic. In these complicated and uncertain times, some resorts prefer not to engage with new services whose full potential has still to be proved to them.

Action plan. (i) Finalize transferring the knowledge about the Central Data Server, the web-based user-facing tool, and the API from INRAE to CGx. (ii) Make the Central Data Server appropriate for commercial use. (iii) Adapt the PROSNOW code that automatically runs the daily snow simulations to the new Météo-France supercomputer (this ongoing work will take several weeks) (iv) Ensure that both SNOWsat and Leica measurements are properly integrated into the modelling chain.

During summer 2020, PROSNOW and the upcoming services by exploitation entity A have been presented (through videoconferences) to 11 French, Andorran and Spanish resorts (see also chapter 4). A wider audience will be reached on October 1-2, when PROSNOW and exploitation entity A's offers will be officially presented at the annual assembly of the French ski-resorts (http://congresdsf.fr/). The goal is to register 5-10 customers before November 2020 in order to run the service for the winter season 2020/2021.

For an illustration of entity A's Business Model Canvas see Figure 7 in Annex A.

Details on exploitation entity B1

Alpsolut

Development status. Exploitation entity B1 will need (at least) one more year of preparation before going to the market.

Organizations involved and their roles. Scenario B1 only involves PROSNOW partner Alpsolut. Alpsolut already has a server infrastructure that is compatible with the PROSNOW simulation chain and performs snowpack simulations with the model SNOWPACK/Alpine3D.

PROSNOW IP used. It is planned to make use of the PROSNOW concept and workflow (see Table 1), the user-facing tool, the Central Data Server, the API, possibly the trademark, the improvements in the snowpack model SNOWPACK/Alpine3D (e.g. the module for simulating snow management processes), and further knowledge gained in the PROSNOW project. This includes: (i) the operational needs of the customers; (ii) capabilities and limitations of the meteorological and seasonal forecasts; (iii) needs and processes required for integrating climatic and numerical weather models with snowpack models for operational use.

The transfer of the necessary technical know-how and software elements related to the Central Data Server, API, and user-facing tool from main developer INRAE to Alpsolut has already started and is planned to be completed in September 2020.

Target market. Ski resorts in Italy and Switzerland will represent the initial target market (~ 250 ski areas with at least 10 slope-km). Extension to other Alpine countries can be envisioned at a later stage, depending on circumstances such as the existence of sister service providers similar to PROSNOW, the cooperation with providers of weather and climate data, etc.

Offered product(s)/service(s). It is planned to offer two types of services:

(A) Access for ski resorts to the web-based user-facing tool (similar to what the pilot ski resorts access currently). This also includes basic information/training on how to use the products supplied. Optionally, customers can order extra consultancy services tailored to their specific needs.

(B) API or HTML products for allowing the integration of the simulation results into third-party interfaces (e.g. TechnoAlpin platforms).

Prices, most likely ranging between 4 000 € and 10 000 €, will depend on the required degree of detail, i.e. they will increase with the number of SRUs.

Path to customer. See the go-to-market strategy.

Competitors. According to an initial screening, there are no competitors offering similar services. However, other partners involved in PROSNOW could develop their own services and being much stronger on the market by using their leader position (e.g. TechnoAlpin, SNOWsat, etc.).

Cost structure. The highest costs are related to the maintenance of the server calculating the snow cover simulations and processing the data for the web-based user-facing tool. Alpsolut already has a server infrastructure compatible with the PROSNOW simulation chain. The costs will be a scalar, depending on the number of customers. Thus, there is no need for large investments. The running costs for a server able to run the API and the user-facing tool are estimated at 4 000 € to 6 000 € per year. Further costs will arise from purchasing weather forecast data. Depending on the total number of points and the number of updates per day, prices per point may vary from 30 € to 100 €.
Before going to the market, some investments will be needed for defining interfaces to integrate the simulations in already existing platforms (about 1 000 € to 2 000 €). In addition, some service simplifications might be needed in order to reduce the costs for service provision and thus the price of the service.

Go-to-market strategy. The way to the market will require at least one more year of further development (simplifications; interfaces for integration; etc.). At the moment, there are national and regional programs for funding the developments of innovative IT products. Alpsolut already was funded by a regional program for improving its IT infrastructure. It is planned to apply for further funding to support the developments needed to go to the market.
Preparations before going to the market also include the selection of a supplier of local meteorological and seasonal forecasts. Different suppliers have been contacted and their offers are evaluated at the moment. Simultaneously, Alpsolut is also building up know-how to insource the provision of local meteorological and seasonal forecasts in the long term. A first version of a high-resolution Numerical Weather Model has already been installed on Alpsolut servers.
It is planned to continue providing the PROSNOW service to the pilot ski resort Livigno, test and develop the final product, and then approach other customers in Italy and Switzerland. Alpsolut may use the opportunity provided by the Winter Olympic Games planned in Italy in 2026, as Livigno will host the Olympic village and will have high visibility during the games.

Key risks/challenges. In general, the investments required for providing the service are not high. However, the go-to-market process could be long and other competitors may approach the market in the meantime.
In addition, a provider for the meteorological and seasonal forecasts needs to be defined.

Action plan. (i) Complete the installation of the simulation chain (i.e. the setup of the user-facing tool, the data server and the API) at Alpsolut. (ii) Decide on a supplier of local meteorological and seasonal forecasts. (iii) Continue the process of installing a numerical weather model in order to reduce the costs of supplying the simulations (long term: 2 years).

Details on exploitation entity B2

Alpsolut | TechnoAlpin | SNOWsat

Development status. Exploitation entity B2 will need at least one more year of preparation before going to the market, with some degree of uncertainty in its actual implementation. The COVID-19

pandemic and its impacts resulted in short-time work at some of the involved organisations and shifted their setting of priorities. Thus, preparations for this commercialization path are more or less in stand-by mode at the moment.

Organizations involved and their roles. Entity B2 is an extended version of entity B1, including TechnoAlpin and SNOWsat in addition to Alpsolut. It is planned to have a cloud-based central data server, owned by all parties, but hosted and managed by Alpsolut. Alpsolut will also be the main responsible for maintaining the API and the user-facing tool, set up the service, and run the snowpack simulations using the model SNOWPACK/Alpine3D. TechnoAlpin and SNOWsat will provide location-specific input data (water use, snow depth), and sell the forecasts produced by Alpsolut as an integrated part of their own products. Moreover, they will use their position for introducing the product into the market.

Form of cooperation. Joint Venture[7]

PROSNOW IP used. Similar to entity B1.

Target market. Ski resorts in the Alpine range that are customers of TechnoAlpin and SNOWsat will represent the initial target market. In a later stage, resorts in the rest of Europe and even worldwide are planned to be approached.

Offered product(s)/service(s). It is planned to offer two types of services:

(A) Access for ski resorts to the web-based user-facing tool (similar to what the pilot ski resorts access currently). This also includes basic information/training on how to use the products supplied. Optionally, customers can order extra consultancy services tailored to their specific needs.

(B) PROSNOW forecasts as part of the existing management tools of TechnoAlpin and SNOWsat.

Prices will depend on the required degree of detail, i.e. they will increase with the number of SRUs. With respect to service (B), offering ski resorts the possibility of a free testing season is considered. An agreement on how to share the costs of such promotions between the partners of the joint venture still needs to be found.

Path to customer. TechnoAlpin and SNOWsat both exhibit a strong and long-established presence in the market of ski resorts. TechnoAlpin has their snow producers installed in more than 1,800 ski resorts. SNOWsat is present in 60 resorts.

Competitors. According to an initial screening, there are no competitors offering seamless predictions of snowpack evolutions on ski slopes for days to months, or products and services including such predictions. At the moment, the most advanced services for improving the management of snowmaking and grooming operations are already provided by some of the partners involved in the joint venture (i.e. TechnoAlpin and SNOWsat). The actually provided services are limited to weather forecasts; there are no simulations of the snow cover characteristics or projections of the actual snow situation on the market. Most of the existing tools are based on providing the most accurate now-casting situation. However, there might be competitors if more than one of the commercial exploitation initiatives materializes from the PROSNOW project.

Cost structure. The highest costs are related to the maintenance of the servers calculating the snow cover simulations and processing the data for the web-based user-facing tool (compare with entity B1). Costs for marketing and commercialization can be strongly reduced by using the commercial networks

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[7] The direct involvement of the local data providers TechnoAlpin and SNOWsat in the organizational structure does not necessarily exclude the involvement of third parties (e.g. Leica, PowerGIS, ARENA PistenManagement, etc.) as further providers of local input data.

of the partners involved in the joint venture. Costs will also be related to the purchase of weather forecast products.

Go-to-market strategy. Before going to the market, the joint venture needs to find one or several suppliers of weather and climate data (meteorological and seasonal forecasts, climatology) and/or invest into gaining knowledge for downscaling meteorological data. Data will be obtained by directly accessing open-source climatic products (e.g. Copernicus data) and/or by signing specific supply contracts with weather forecast providers that could be both, national or private (e.g. MeteoFrance, MeteoSwiss, ZAMG, Meteoblue). The choice of the weather data provider will be mainly based on commercial opportunities and the capability to ensure the same quality and results for all the different Alpine-wide/global customers. In the meantime, gaining the knowledge to run an own numerical weather model will be strategically important.

The currently ongoing set-up of the cloud-based data server, the API and the user-facing tool at a server within Alpsolut premises is planned to be finalized by the mid of September 2020. This will complete Alpsolut's know-how for running the whole modelling chain, as it has already been responsible for running the snowpack model SNOWPACK/Alpine3D within the project. However, further product developments towards service simplifications might be needed before going to the market in order to reduce the costs for service provision and thus the price of the service. In addition, the existing API will be extended in order to provide the weather forecasting data from the cloud-server to TechnoAlpin and SNOWsat and thus to the final customers in order to optimize the costs of the provided service.

For going to the market, it is planned to start with interested PROSNOW pilot ski resorts and to approach the existing customers of the companies involved in the joint venture (particularly TechnoAlpin and SNOWsat) subsequently.

Key risks/challenges. None of the involved partners can provide the necessary local meteorological and seasonal forecasts, at least in the short term. Hence, entity B2 needs to find one or several suppliers of local meteorological and seasonal forecasts and/or invest in gaining the knowledge for processing the required data on its own.

The main limitation seen so far are the high costs for running and maintaining the simulation chain, which may result in prices exceeding the end-users' willingness to pay. As mentioned above, further service simplifications might thus be needed to reduce the costs of provision.

Action plan. (i) Define the legal arrangements between the partners involved in the joint venture. (ii) Further elaborate on the business plan, the prices of the service and the selling strategies. (iii) Complete the installation of the simulation chain. (iv) Decide on one or several suppliers of local meteorological and seasonal forecasts.

Details on exploitation entity C

UIBK/Schneezentrum Spin-off Company (not yet founded)

Development status. The exploitation scenario of entity C is still in an early stage of development as a number of pre-steps need to be taken before getting more concrete on the go-to-market strategy and the business plan.

Organizations involved and their roles. Entity C involves a spin-off company, planned to be founded by UIBK and Schneezentrum. This spin-off company would run the snowpack simulations, using the model AMUNDSEN, and provide consultancy to ski resorts based on these snowpack forecasts. A cooperation with one of the other initiatives in order to use its server infrastructure and the maintained user-facing tool is under consideration. Corresponding discussions are, for instance, underway with Alpsolut.

PROSNOW IP used. It is planned to make use of the PROSNOW improvements in the snowpack model AMUNDSEN. Other PROSNOW IP, including concept and workflow, the API, the Central Data Server, and the user-facing tool is likely to be used as well through the cooperation with another PROSNOW exploitation entity.

Target market. The PROSNOW pilot ski resorts in Tyrol and South Tyrol would represent the initial target market, with subsequent extension to all ski resorts in Austria and South Tyrol.

Go-to-market strategy. Some pre-steps need to be taken before going to the market. First, due to its development history, the IP of the AMUNDSEN simulation model is spread over several institutions. UIBK is currently working on re-organizing and re-programming the model code such that the modelling tool can be appropriately used as kernel in a commercial PROSNOW service. Secondly, the spinoff company needs to be founded. Respective preparations are ongoing and concrete steps will be taken from September 2020 on. Thirdly, some form of cooperation with other PROSNOW exploitation initiatives is planned to be set up in order to use their server infrastructure and the maintained user-facing tool. Currently, there are corresponding discussions with Alpsolut. Fourthly, providers of the meteorological and seasonal forecasts need to be defined. For the Austrian market, UIBK is in contact with the National Weather Service (ZAMG), who is highly interested in a cooperation. Hence, the way to the market is expected to require at least one more year of preparation.
For going to the market, it is planned to start with interested PROSNOW pilot ski resorts in Austria and South-Tyrol. Furthermore, the already existing contacts and channels of Schneezentrum will be used to expand to further ski resorts in Austria and South-Tyrol.

Key risks/challenges. UIBK and Schneezentrum need to succeed in founding the – not yet existing – spin-off company. In addition, a provider of the meteorological and seasonal forecasts needs to be defined and a cooperation with other PROSNOW partners to be set up.

Action plan. (i) Complete the re-organization and re-programming of the AMUNDSEN code; (ii) Complete the foundation of the spin-off company; (iii) Define the cooperation with other exploiting PROSNOW partners; (iv) Define the cooperation with provider(s) of local meteorological and seasonal forecasts; (v) Work on a detailed go-to-market strategy and business plan based on the insights from PROSNOW.

4. Report on dissemination and exploitation activities

As mentioned in the introduction of this report, the overarching dissemination and exploitation objective of the PROSNOW project was to pave the way for a commercial forecasting service that helps Alpine ski resorts to optimize the management of snow, based on adequate monitoring and forecast of snow conditions on ski slopes. To reach this target, the project's general dissemination and exploitation strategy encompassed a range of activities listed below and described in further detail in the sub-sections of this chapter. Despite the clear focus on market exploitation, this also included activities and plans on non-commercial exploitation:

- Strategy development for commercial exploitation (including business model development)

- Identification of target groups for dissemination and exploitation

- Dissemination of PROSNOW results and promotion of PROSNOW services among the identified target groups (beyond the PROSNOW consortium)

- IP management (including IP protection, knowledge and technological transfer, etc.)

- Contributions to standardization

- Education and training

- Planning for non-commercial exploitation

Strategy development for commercial exploitation

As mentioned in chapter 2 of this document, the supply chain of the PROSNOW service can be split into two main parts: (i) generation of the forecasting data and (ii) exploitation of the forecasting data by downstream services (see Figure 2). The crucial part for service maintenance and commercial exploitation after project end is having one or several organisations running the first part of the supply chain. Deliverable D5.1 (*Initial strategy for dissemination and exploitation of results*) highlighted three different options on how to operate and commercialize the PROSNOW supply chain. They are summarized in Box 2.

Box 2: Main possibilities for commercialization as outlined in deliverable D5.1

> ### *Main commercialization possibilities*
>
> <u>*Option A*</u>**:** *One or several members of the PROSNOW consortium operate the data server and user-facing tool at the end of the project. This approach would maximize the efficiency of the transfer between the project phase and the subsequent operational phase. This would however require that during the project a legally binding agreement is signed between several members of the consortium regarding the conditions of operations. Input data should be sought by the operating consortium. In this situation, both the web-services provided by the data server and the user-facing tool would be commercialized by the operating consortium.*
>
> <u>*Option B*</u>*: One or several members of the PROSNOW consortium operate the data server only. Pending access to the necessary input data (similarly to Option A), this operating consortium would thus commercialize access to the web-services to a service provider which would integrate this information into its own suite of products targeting ski resorts. This option will be facilitated by the compatibility of APIs and web services for a future convergence of services.*
>
> <u>*Option C*</u>*: An organization not part of the PROSNOW consortium operates the data server and/or user-facing tool either for one region or country, or for the same geographical scope as the project itself. In such a case, given that the computer code of the data server and user-facing tool are open source, it would be required that this organization takes the lead in the maintenance and development of these software elements. In order to facilitate this option, the central data server is developed in a manner authorizing easy replication by external parties.*

Due to the interest of several consortium members in exploiting PROSNOW commercially – including the operation of the data server and the user-facing tool – the course was set for a somewhat mixed and adopted version of options A and B in autumn 2019. Consortium members interested in commercial exploitation grouped up into several PROSNOW exploitation entities, focusing on different initial target markets. As described in chapter 3, most of these entities plan to operate the data server and the user-facing tool (as in option A) or at least to make use of the related expertise. Besides the provision of PROSNOW forecasts through the user-facing tool, their business models also include the integration of PROSNOW forecasts into the products of existing service providers (as in option B).

Starting from autumn 2019, each of the PROSNOW exploitation entities has been working on its business model and go-to-market strategy (see chapter 3), making use of the insights gained from the market analysis (WP2) and the real-time testing of the PROSNOW demonstrator (WP4). These insights included information on user needs, the service's added value, willingness to pay of potential

customers, estimates on the costs of service provision, training needs by the potential users, etc. (see chapter 2). The project's overall IP management (including internal knowledge and technical transfer from developers to exploiters, terms of use, etc.) and dissemination strategy was adapted and fine-tuned to best support the PROSNOW exploitation entities. This, for instance, resulted in some temporally limited exclusivity on parts of the jointly owned PROSNOW IP granted to members of the PROSNOW consortium (see sub-section "*Intellectual property management*" for details). The temporally limited exclusivity, however, does not preclude external organizations from becoming part of a PROSNOW exploitation entity. Although the consortium agreed to prioritize internal partners over external organizations in commercial exploitation, external organizations may nevertheless become part of a PROSNOW exploitation entity if no consortium member is able or willing to overtake particular parts of commercial service provision. Météo France, for instance, plans to consider the provision of meteorological and climate data for locations outside of France only if the respective national weather service shows no interest in providing this data.

Identification of target groups for dissemination and exploitation

Dissemination and exploitation activities focused on particular target groups, with the type of actions tailored to each of these groups in order to maximize their effectiveness. Four target groups have been mainly addressed by PROSNOW[8]: (i) end-users, (ii) intermediaries/purveyors, (iii) service operators, and (iv) multipliers.

End-users: The target group *end-users* includes different kinds of actors, ranging from potential final users of PROSNOW services to potential final users of climate services in general:

- *Ski resorts (professionals in charge of ski management):* Ski resorts may use PROSNOW services in their daily snow management operations, but also for promotion, marketing and communication purposes. Regarding the latter, PROSNOW may, for instance, serve as scientific label for good snow conditions or snow guarantee (in case of corresponding forecasts).

- *Public institutions in charge of tourism promotion and development (e.g. local tourism offices):* Public tourism institutions may use PROSNOW services to adapt their marketing and communication to snow conditions. Similar to ski resorts, they may employ PROSNOW, for instance, as scientific label for good snow conditions or snow guarantee.

- *Other tourism stakeholders operating outside the ski industry domain*: For tourism stakeholders not related to the ski industry PROSNOW could serve as a best practice example, demonstrating the added value of climate services in the tourism sector and thus promoting the take-up of climate services in the tourism industry in general.

Several potential end-users have been integrated in the project through the partner ski resorts and the user advisory board (UAB). WP5 activities concentrated on reaching further potential end-users not linked to the project, with a particular focus on ski resorts as the main end-user group of PROSNOW services.

Intermediaries & purveyors: *Intermediaries and purveyors* represent the second PROSNOW target group. Depending on the type of intermediary or purveyor, this group may (i) use PROSNOW services to enlarge their own offers, (ii) use PROSNOW services as an input for other services or (iii) subscribe PROSNOW services for a group of end-users. Intermediaries or purveyors of PROSNOW services include the following actors:

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[8] Note that scientists are not listed as a target group here for the reason that they were addressed by WP6 activities on communication and dissemination.

- *Solution providers (e.g. providers of snow monitoring and snow management systems)*: PROSNOW services could enable solution providers to enlarge their offer to ski resorts with meteorological and snow forecast services.

- *Professional associations:* May subscribe PROSNOW services for their members.

- *Other re-users of snowpack modelling and forecasting*: PROSNOW services on snow(pack) modelling and forecasting may also be re-used as an input for other products in the fields of tourism (e.g. skier days or visitor forecasts), hydropower, natural hazards or public water services.

Several solution providers have been involved as partners in PROSNOW, including CGx, Dianeige, TechnoAlpin, SNOWsat, and Alpsolut. They have played a key role in the preparation for market exploitation. Further potential intermediaries beyond the project consortium were addressed by the dissemination and exploitation activities of WP5.

Service operators: Members of the PROSNOW consortium may not become the sole operators of potential PROSNOW services in the future. Thus, scientific and socio-economic stakeholders, who could be interested in running or contributing to PROSNOW services in the long-term, form a further target group. Since several project partners expressed strong interest in commercially exploiting PROSNOW results in autumn 2019, it was decided to temporally grant them advantages over potential third-party operators. Hence, during the project lifetime concrete efforts in reaching out to potential third-party service operators focused on organizations that could fill existing gaps in the PROSNOW exploitation entities, introduced in chapter 3. This, for instance, includes operators of meteorological services such as the Austrian National Weather Service (ZAMG)[9], which represents a potential meteorological partner for exploitation entity C.

Multipliers: The fourth target group is more diverse and includes so-called multipliers. These are actors who could further disseminate PROSNOW results via their networks to relevant stakeholders and thus multiply our efforts. This includes, for instance, related initiatives or projects with shared interest (e.g. Climateurope, Copernicus Climate Change Services, EUSALP, etc.). Multipliers have also strongly been targeted by WP6 (see D6.7 *Report on communication activities* and D6.9 *Report on cooperation activities*).

Table 5 gives an overview of the dissemination and exploitation objectives, contents and channels per target group. A more detailed description of the actual activities taken throughout the project follows in the subsequent sub-sections.

Table 5: Objectives, contents and channels per target group

Target group	Objectives / Activities	Contents transported	Channels / Tools
End-users	- Raise awareness about climate change and its impacts on the activities of ski resorts - Raise awareness about using climate services to foster operational decision making - Demonstrate the added value of PROSNOW services	- Functionality & features of the PROSNOW service / demonstrator (showcase access) - Added value of the PROSNOW service / demonstrator - Experience reports from the 8 pilot cases (user friendliness, saving potential, etc.)	- Professional and sector-specific events - Professional and sector-specific (e-)newsletter, magazines, websites - Existing relationships and channels of PROSNOW partners (particularly solution providers) to end-users

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[9] Note that the Austrian National Weather Service was also represented in the PROSNOW UAB.

	- Improve the understanding about seasonal forecasts - Enable broad use of PROSNOW forecasts by setting up a commercial service after project end	- Availability of and access to commercial PROSNOW services	- Individual meetings with potential end-users - Training courses on snow management - PROSNOW UAB
Intermediaries & purveyors	- Demonstrate the added value of PROSNOW services - Demonstrate the possibility to enlarge own offers with meteorological and snow(pack) forecast services - Consider intermediaries and purveyors in the PROSNOW business model(s), e.g. by enabling group subscriptions - Ensure compatibility of API/webservices for a future convergence of services through standardization	- Functionality & features of the PROSNOW service / demonstrator (showcase access) - Added value of the PROSNOW service / demonstrator - Experience reports from the 8 pilot cases (user friendliness, saving potential, etc.) - Availability of and access to commercial PROSNOW services (terms of use, standards for data exchange, …)	- Professional and sector-specific events (e.g. meetings of professional associations, etc.) - Professional and sector-specific (e-)newsletter, magazines, websites - Individual meetings with potential intermediaries and purveyors - Existing networks of PROSNOW partners - PROSNOW UAB - Project deliverables - Data and software repositories (Zenodo)
Service operators	- Demonstrate the added value of PROSNOW services - Share solutions and know-how - Develop viable business models and demonstrate estimates on the possible profitability of PROSNOW services	- Functionality & features of the PROSNOW service / demonstrator (showcase access) - PROSNOW business model and revenue stream simulations - Where, when, and how to access datasets, software, documentation, etc. - Terms of use of datasets, software, etc.	- Climate services events - Scientific events (WP6) - PROSNOW UAB - Existing networks of PROSNOW partners - Project deliverables - Data and software repositories (Zenodo)
Multipliers	- Trigger interest in further promoting and disseminating PROSNOW results - Demonstrate the added value of PROSNOW services	- Functionality & features of the PROSNOW service / demonstrator (showcase access) - Added value of the PROSNOW service / demonstrator	- Partners' networks - Events - Direct contacting

Dissemination of PROSNOW results and promotion of PROSNOW services among the identified target groups (beyond the PROSNOW consortium)

During the first phase of the project, the major dissemination aim was to make the PROSNOW concept known among potential end-users, intermediaries/purveyors, take-to-market partners and multipliers. With progressing project time, the focus more and more shifted to the demonstration of the developed

system and its added value as well as the promotion of the upcoming commercial services. For presenting and promoting PROSNOW products and results to target groups beyond the project consortium, we made use of different communication and dissemination channels[10]:

Professional fairs and sector-specific events: Beyond the small sample of PROSNOW pilot ski resorts, the objective was to reach a broader community of ski, snow and tourism professionals. In that perspective, rather than organising '*PROSNOW events*', we promoted and disseminated PROSNOW activities and results at ski, tourism and mountain professional events, but also at climate services events. Dissemination activities at these events included networking (i.e. identifying potential end-users, intermediaries and take-to-market partners), distributing PROSNOW materials, participating in round tables and discussions, and giving talks and presentations. We also rented a booth at the Mountain Planet fair 2020 in Grenoble to inform about the PROSNOW results, showcase the demonstrator and promote the upcoming commercial services of the French exploitation entity. However, the event was cancelled due to COVID-19. Table 11 in Annex B gives a non-exhaustive overview of sector-specific events, professional fairs and climate services events where PROSNOW was presented in the one or other form. It represents a broad mix of regional, national and international events. The table also includes an outlook on upcoming events after the end of the project, at which PROSNOW is planned to be presented.

(E-)newsletters, magazines and websites: Professional and sector-specific (e-)newsletters, magazines and websites were used as further channels to actively inform potential end-users, intermediaries, service operators and multipliers about the PROSNOW concept, results and upcoming services. Besides deploying existing e-newsletters and customer magazines of partners, solution suppliers and pilot ski resorts involved in the PROSNOW project, we also made use of sector-specific media channels outside the project consortium. Table 12 in Annex B gives an overview of the professional and sector-specific (e-)newsletters, magazines and websites where PROSNOW has been presented.

In addition, also the PROSNOW website (http://prosnow.org/) and the PROSNOW newsletter, both part of WP6, were used to disseminate PROSNOW results (see D6.7 for more details). All public deliverables and factsheets (http://prosnow.org/project-material/) as well as the showcase version of the PROSNOW demonstrator (http://prosnow.org/get-to-know-prosnow/) have been made accessible via the PROSNOW website.

Individual meetings: With progressing project duration, increased use was made of individual meetings with potential end-users and intermediaries/purveyors to present PROSNOW results and promote upcoming PROSNOW services. Due to the prospect of a commercial service for the season 2020/21 by the French exploitation entity (MF, CGx, Dianeige), a particular focus was laid on French ski resorts. Starting with November 2019, an initiative to present the PROSNOW results and the upcoming commercial service to ski resorts was launched under the lead of Dianeige. This initiative included several e-mailing campaigns to inform ski resorts about the possibility to get individual PROSNOW presentations. For this purpose, Dianeige also made use of existing customer relationships. Altogether, they organized more than 20 virtual and physical meetings with ski resorts – partly together with MF – with more than 90 participants. Table 13 gives a general overview of individual meetings with potential end-users and intermediaries/purveyors. Such individual meetings are planned to be continued after the end of the project by the PROSNOW exploitation entities.

Partners' networks: Existing networks of the PROSNOW consortium members were used to disseminate results to potential re-users outside the ski industry (e.g. hydropower, natural hazards, public water services, tourism). Potential re-users in the field of hydropower were addressed through

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[10] An action plan in the form of an Excel table, jointly managed by WP5 and WP6, was used to plan, monitor and report on all communication and dissemination activities.

the network of consortium member EURAC, potential re-users in the field of avalanches through the networks of MF and SLF.

Webinars: Due to COVID-19, several dissemination events had to be cancelled, including for example PROSNOW's presence at the Mountain Planet fair in Grenoble, but also the final PROSNOW event that had been planned to take place along with the final GA in June 2020 in Bolzano. The final PROSNOW event would have been hosted by TechnoAlpin, EURAC and Alpsolut and would have gathered scientist and professionals from the areas of snow management, mountain tourism, and climate services. As replacement for the dissemination activities cancelled due to COVID-19, a series of PROSNOW webinars – targeting at different audiences – was organized together with WP6. For more details on the PROSNOW webinars see D5.5 (*Report on the outcome of the final event*) and D6.7 (*Report on communication activities*).

User Advisory Board (UAB): Besides its consultative role, the UAB also served disseminating PROSNOW results to the professional community. That is, UAB members acted as multipliers. They, for example, helped promoting the Alpine-wide online survey conducted within WP2 and offered establishing contacts to the US skiing resort industry in case of a PROSNOW roll out in North America.

Data and software repository Zenodo: A great portion of PROSNOW results is made available via the long-term repository Zenodo. This includes the structure, software and documentation of the data server and the user-facing tool, the structure and documentation of the API, and all the datasets used in scientific publications. Access to some of these results (data server, user-facing tool) will, however, be restricted to project partners until three years after project end (see the section on IP management below). For further details, see also D5.3 (*Full data management plan*).

Intellectual property (IP) management

Table 1 of this document lists the main exploitable results of the PROSNOW project. Most of PROSNOW's key exploitable results represent joint developments of several PROSNOW partners. For these jointly developed PROSNOW results, a Joint Ownership Agreement (JOA) was set up. At the moment of report submission, the JOA was about to be signed by the project partners.

Joint Ownership Agreement (JOA): The JOA establishes and organizes the joint ownership of PROSNOW results and defines the rights and obligations of each Party with respect to these jointly owned results. That is, it settles the conditions of use and exploitation of the jointly owned IP (e.g. the data server, the user-facing tool, the PROSNOW brand, etc.) and its related management.

To ease the negotiations, an exploitation term sheet was developed in a pre-step to the JOA. It lists all the elements required for operating PROSNOW, describes the background and foreground of all these elements, and how to deal with the foreground. It defines, which of the technical elements to be part of the JOA, the conditions of use of these elements (including also the PROSNOW brand), and how to transfer the generated know-how to the exploiters. This term sheet was approved by the Steering Committee on April 6th and is included as an Annex in both, the JOA and deliverable D5.3 (*Full data management plan*).

Overall, the idea was to make it as easy as possible for partners of the PROSNOW project to exploit PROSNOW output commercially. Hence, the highest priority was put on favourable conditions for exploitation. This included abstaining from any royalties between consortium-internal exploiters and developers. In addition, access to some main elements required for operating PROSNOW services – in particular, the structure, related software and documentation of the central data server and the user-facing tool – will remain confidential to the project consortium for three years after project end. This shall give PROSNOW consortium members an advantage over potential competitors outside the consortium and maximize the chances of business development for project partners. After August 2023, the code will be made open also to external entities. Hence, in the first 3 years after project end, PROSNOW partners will primarily carry out commercial exploitation, with support from external

organizations where needed (e.g. in the provision of meteorological and seasonal forecasts outside of France). The structure and documentation of the API specifications, by contrast, will be published with project end (i.e. after August 2020), ensuring that PROSNOW services are interoperable. The aim is that the API will become and remain a standard for the industry, making it possible to establish linkages between existing and upcoming services. This is the reason for publishing it immediately after the end of the project.

In order to coordinate further evolutions of the PROSNOW software (i.e. API, central data server, and user-facing tool) and ensure its long-term sustainability, a PROSNOW software management body is installed with the JOA. It consists of the partners Alpsolut, CGX, Dianeige, INRAE, TEC-Ramboll, SNOWsat, TechnoAlpin, and WSL-SLF.

Code management & documentation: The structure, code and documentation of the jointly owned demonstrator system (API, Central Data Server, user-facing tool) is stored on Gitlab (for further development) and on a dedicated Zenodo platform (for internal/external transfer). The version on the Zenodo platform represents the established state of play of the PROSNOW API (open), central data server (access restricted to project partners for 3 years) and the user-facing tool (access restricted to project partners for 3 years) as of what has been achieved during the project's lifetime. For further details see also deliverables D3.4 and D5.3.

Snowpack models: The three snowpack models, that have been used and enhanced within PROSNOW, will continue to be managed by their host organisations Météo-France (Crocus), WSL-SLF (SNOWPACK), and UIBK (AMUNDSEN). Crocus (within the larger code SURFEX) and SNOWPACK were open source before PROSNOW, see e.g. http://www.umr-cnrm.fr/surfex/spip.php?rubrique8 for Crocus (Cecill-C licence) and https://www.slf.ch/en/services-and-products/snowpack.html for SNOWPACK (GNU-LGPL licence). AMUNDSEN, whose IP is spread across several institutions due to its development history, is progressively being converted into open source software, with support from PROSNOW. Its management is fully taken care of by PROSNOW partner UIBK.

Internal knowledge & technology transfer: The project team engaged in transfer and spreading activities of their results and findings to the consortium members that aim for commercialization of the PROSNOW service. This particularly included knowledge and technology transfer from INRAE (server/data platform, user-facing tool, API) and modeller partners like Météo-France (capabilities of forecasts, interpretation of results, etc.) to the industry partners (e.g. TechnoAlpin, Dianeige, CGx, etc.).

Setting up the PROSNOW demonstrator system for a ski resort in Andorra (Grandvalira) in spring 2020 served as first test case for proving the transferability of the PROSNOW software elements (API, central data server, user-facing tool) from main developer INRAE to future exploiters. The transfer was initiated by exploitation entity A, consisting of Météo-France, Dianeige, and CGx. As described in chapter 3, CGx will manage the central data server as well as the maintenance of the API and the user-facing tool within this exploitation entity. Hence, all PROSNOW software elements were installed on a server located within CGx premises and – with some support from INRAE and interactions with TechnoAlpin for the provision of water consumption data – exploitation entity A successfully implemented the full model chain for the Andorran ski resort Grandvalira. This first software transfer helped enhancing the documentation of the software components and the model chain, thus improving the transferability of the tool (see D5.3). Moreover, it further proved the feasibility of the implementation of the system for an extended range of ski resorts (beyond the PROSNOW pilot ski resorts) under acceptable costs. As of May 15th, the model chain for Grandvalira is running, with limited additional development required to deploy the tool to other ski resorts covered by exploitation entity A.

The second test case for transferring PROSNOW software elements from developers to future exploiters started in summer 2020, with the setup of the Central Data Server, the API and the user-

facing tool on a server located within Alpsolut premises. It is planned to be finalized by the mid of September 2020.

Brand protection & management: The brand "PROSNOW" has been protected at EU level by registering it as an EU trade mark (EUTM) at the European Union Intellectual Property Office (EUIPO)[11]. The trade mark is jointly owned by all PROSNOW project partners and will continue to be managed by Ghislain Dubois (TEC-Ramboll) after the end of the project. The brand manager will organize a meeting once per year in order to exchange information and views on the PROSNOW exploitation between the joint owners, foster fruitful exploitation and minimize regional or market overlaps by different PROSNOW exploitation entities. Exploitation services using the name PROSNOW in their denomination (such as "Based on PROSNOW", "Inspired by PROSNOW", "PROSNOWcompliant" etc.) need to fulfil the following requirements:

- Compliance with PROSNOW API.

- Production of forecasts spanning the ongoing winter season, based on ensemble forecasting methods, including meteorological and snow conditions on ski slopes, based on snowpack modelling, accounting for snow grooming and/or snowmaking.

- Explicit representation of the ski resort maps.

Contributions to standardization

Using existing standards and building new ones where needed was central to the project, as one of its goals was to have a system being capable of easily exchanging with other (existing) snow management systems. The PROSNOW API is a new standard for the snow management industry, co-designed with industry partners (e.g. TechnoAlpin, SNOWsat, CGx) and building on existing "soft" de-facto standards. Its open publication on Zenodo along with the start of the PROSNOW exploitation (i.e. with September 1st, 2020) is intended to foster data exchanges between different snow management software systems (e.g. transfer of snow depth observations, snowmaking information, meteorological forecast, snow cover forecast). This will help to establish PROSNOW services as core player in the snow management industry.

Education & training activities

The project team engaged in education and training activities. These activities served several purposes: (i) spreading the scientific and practical knowledge gained within the project, (ii) making PROSNOW known among professionals, i.e. potential future customers of commercial PROSNOW services, and (iii) contributing to the build-up/maintenance of skilled personnel for the commercial exploitation of PROSNOW. The activities included courses at university level, contributions to curriculums for professional snowmakers and trainings for snow managers, groomer drivers and snow patrollers. Table 14 in Annex B provides a non-exhaustive overview of education and training activities of PROSNOW project partners.

In addition, the project itself has generated highly-skilled personnel, in particular non-permanent staff hired by using resources from the project, who ideally fit the purpose of commercial exploitation. The PROSNOW exploitation entities are thus doing their best to provide them with meaningful employment opportunities since they are fully aware that the success of their business models strongly relies on hiring the relevant personnel (e.g., trained during PROSNOW and main contributors to PROSNOW developments).

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[11] https://euipo.europa.eu/eSearch/#details/trademarks/018013961

Planning for non-commercial exploitation

Despite the clear focus on market exploitation, non-commercial exploitation plays an important role as well. Non-commercial exploitation is especially, but not exclusively, relevant for the scientific partners in PROSNOW. This sub-section gives an overview of non-commercial exploitation activities already carried out during the project lifetime or planned for the post-project period.

Météo France. The French national operator for weather and climate, Météo France, plans to use PROSNOW results for portfolio of meteorological and climate services (avalanche forecasting, snow cover monitoring, etc.). Improvements in the snow cover model Crocus, which is part of Météo France's open source surface modelling platform SURFEX, are publicly available. Versions of Crocus improved through PROSNOW are already being used for the production of long-term climate change impact indicators relevant to the mountainous environment, under preparation and which should be provided on the French national climate services portal (Drias). This includes improvements on how snow management is described in Crocus, thereby providing relevant information for ski tourism at the time scales of long term climate change (Drias currently only contains projections for natural snow). Additional knowledge gained through PROSNOW is also increasingly used for training of Météo France employee, who are often asked, casually or formally, about snow in ski resorts at all time scales. Training courses organized by Météo-France for ski patrollers and snow cover observers in its collaborative snow observation network, also benefit from improved descriptions of snow on ski slopes and relevant management information, partly based on PROSNOW results. In terms of research, PROSNOW has contributed to maintaining and improving knowledge and tools used for atmospheric and snow cover observations and modelling at Météo-France, which will be used for upcoming research projects, at national or international scale, in the future, benefitting from the network of snow experts gathered in PROSNOW.

TEC-Ramboll. Ramboll France SAS provides expert advice on public health and environmental issues, including the field of climate policies. Ramboll would contemplate making use of PROSNOW outputs or the potential commercially-available PROSNOW service in future projects (vulnerability studies covering mountain regions, for instance). Ramboll will actively participate in promoting/calling attention to PROSNOW as an innovative climate service, within the scope of Ramboll's other work relevant to climate services.

UIBK. The research group Human-Environment Systems Research (MUS) at the Institute of Geography of the University of Innsbruck (UIBK) has a strong research focus and experience in modelling of hydrological and climatological surface processes in Alpine regions, including the interface to human-environment systems. Both the integration of snowmaking and snow management practices in numerical models and the integration of improved meteorological forecasts (seasonal predictions and short-term forecasts) are hence important research interests. The methods developed in PROSNOW and the improvements made in the methodology during the project will be further developed in future research projects by UIBK. Moreover, UIBK aims to continue the collaboration with the SNOWPACK and Crocus developer teams and closely follow the further developments in these models.
Together with **Schneezentrum**, **UIBK** plans to found a spin-off company to exploit PROSNOW in the best possible way (see also page 25f.). For that purpose, the AMUNDSEN simulation model code is currently re-organized and re-programmed such that the modelling tool can be appropriately used as kernel in a commercial PROSNOW service. The spin-off will focus on both scientific development work (further development of the snow modelling system), as well as commercial services and consulting.

INRAE (former IRSTEA). The National Research Institute for Agriculture and Environment (INRAE) conducts research and develops expertise to improve the knowledge and management of mountain ecosystems, socio-economics, and natural hazards. Within PROSNOW, INRAE's involvement ranged from the development of the Central Data Server, the API, and the user-interfacing tool to the co-design

process, the market analysis, and the economic evaluation.

(i) On the economic side, the European comparison of ski resorts within the Alps contributed to enlarge INRAE's point of view on management practices of ski resorts and thus directly contributed to the understanding of their dynamics. Snow management and economics are key issues for the adaptation of ski resort to climate change and PROSNOW helped a lot to understand the economic factors involved.

(ii) More than a physic issue, water appears to be a strategic resource and this finding led INRAE to reshape their research and to highlight climate change from a new perspective. A PhD thesis will begin in September 2020 to address the water issue not only as the ski resorts' impact on the ecosystem but also as a productive constraint driving their adaptation capacity. It will also deal with the local balance, which needs to be known for water allocation, adaptation, and decision-making in a locally integrated scope.

(iii) The use of European data sources encouraged INRAE to use such a material to expand the scope of their research and to reproduce what they have already done at the national level at the Alps scale (linked to the C3S MTMSI project with the application of the ADAMONT method to the UERRA5 grid to produce climate projection at the NUTS3 level).

(iv) The investigations about snow management and operations required to run a ski resort raised questions about investment strategies and highlighted new research perspectives. Together with some PROSNOW partners and enriched by additional knowledge and skills from further organizations, INRAE aims at setting up a new research project to investigate these questions about investment strategies.

(v) The technologies used to develop the PROSNOW demonstrator (API, Central Data Server, user-facing tool) contributed to a great improvement of INRAE's skills that will help the general effort of knowledge transfer or valorization of research outputs and will improve INRAE's capacity to create tools that help scientific collaboration. Similar technologies will thus be used to track wolf attacks and build a tool to spread information on climate risk for more than 2500 pastures in the French Alps.

EURAC. The private non-profit organization for advanced research and education contributes to PROSNOW through its Institute for Applied Remote Sensing, which focuses on research topics such as natural hazards and risks, climate change impacts and advanced remote sensing techniques. Within PROSNOW, EURAC has generated and provided time series of snow products based on Sentinel 2 imagery for each pilot ski resort. EURAC plans to engage in further topics related to PROSNOW thanks to the acquired know-how and networks and expects a larger use of remote sensing products in combination with physical-based models in future.

WSL-SLF. The Swiss research and service center WSL-SLF is an international leader in snow and avalanche research. It conducts research on snow, the atmosphere, natural hazards, permafrost and mountain ecological systems, and develops innovative products that translate their knowledge into practical applications. One of these products is the open-source snowpack model SNOWPACK/Alpine3D. Within PROSNOW, WSL-SLF has enhanced this model with a module that allows for the simulation of snow management processes. WSL-SLF will exploit these improvements in SNOWPACK/Alpine3D by using the model in future research projects. Moreover, additional advancements are planned in future research projects, such as understanding and modeling the impact of slope preparations on the snow cover.

Besides exploiting the model improvements on its own, WSL-SLF also enables every interested third-party exploiter to make use of the new features developed within PROSNOW: the latest public release of the newest SNOWPACK/Alpine3D version already includes the PROSNOW improvements.

WSL-SLF aims to continue the collaboration with the AMUNDSEN and Crocus developer teams and closely follow the further developments in these models.

BOKU. The HyWa institute of the University of Natural Resources and Life Sciences (BOKU), Vienna has a strong research focus on the water cycle including high alpine catchments encompassing all

hydrological components like precipitation, interception evapotranspiration, infiltration and runoff as well as water storage in groundwater, lakes/reservoirs and the snow cover. Within the PROSNOW project, BOKU has gained additional experience, insights and knowledge on snowpack simulations, particularly on technical snow management, and their coupling to meteorological and seasonal forecasts. BOKU aims to further exploit WSL-SLF's enhanced and open source models MeteoIO, SNOWPACK and Alpine3D and to continue collaborations and further research with PROSNOW partners (especially on modelling, in situ measurements and remote sensing) at different alpine sites and in particular at their research catchment Zugspitze, Germany.

JR. With its Centre for Climate, Energy and Society, the research organization Joanneum Research (JR) aims at supporting the transition to a low-carbon economy/society and providing tools and strategies to strengthen resilience to climate and weather risks. JR will use the insights, experience and knowledge gained in PROSNOW (i) within future research projects on climate services and/or the ski/winter tourism sector and (ii) for improving and enhancing its own weather and climate services (e.g. WEDDA®). JR also intends to use the established contacts for future research collaborations.

5. Conclusions

PROSNOW's overarching dissemination and exploitation objective was to initiate the commercial exploitation of the developed forecasting service at the end of the project. With a commercial PROSNOW service becoming available for French ski resorts in the upcoming winter season 2020/21 and preparations on commercial services for other Alpine countries continuing, this objective has been fully met.

The exploitation strategy finally followed by the PROSNOW project builds upon the interest of several consortium members to contribute to the commercial exploitation of PROSNOW results. Based on this interest, highest priority was placed on making it as easy as possible for project partners to exploit PROSNOW output commercially. This included abstaining from any royalties between consortium-internal exploiters and developers and keeping access to some main software elements restricted to the project consortium for three years after project end. The latter should give PROSNOW consortium members an additional advantage over potential competitors outside the consortium – apart from knowledge and experience advantages due to three years development work. It does however not exclude the involvement of project-external parties within PROSNOW exploitation entities.

Overall, the exploitation of PROSNOW results beyond the project lifetime is placed on a broad footing. Eight project partners have concrete plans on exploiting PROSNOW results and insights non-commercially. Four "PROSNOW exploitation entities" emerged in the course of the project and started preparing for commercial exploitation, with one of them ready to go to the French market in the upcoming winter season. At the moment, it is however still hard to anticipate how the COVID-19 pandemic will affect the success probability of the PROSNOW exploitation entities. For sure, it represents another challenge on the way to the market.

6. Bibliography

Morin, S., Dubois, G., the PROSNOW Consortium (2018). PROSNOW – Provision of a prediction system allowing for management and optimization of snow in Alpine ski resorts. Proceedings of the International Snow Science Workshop, Innsbruck, Austria, 2018. http://prosnow.org/wp-content/uploads/ISSW2018_P06.11.pdf

Vanat, L. (2019). 2019 International Report on Snow & Mountain Tourism – Overview of the key industry figures for ski resorts. https://www.vanat.ch/RM-world-report-2019.pdf.

A. Annex: Supplementary material on exploitation entity A

Table 6: Main tasks and the roles of the organisations involved in exploitation entity A
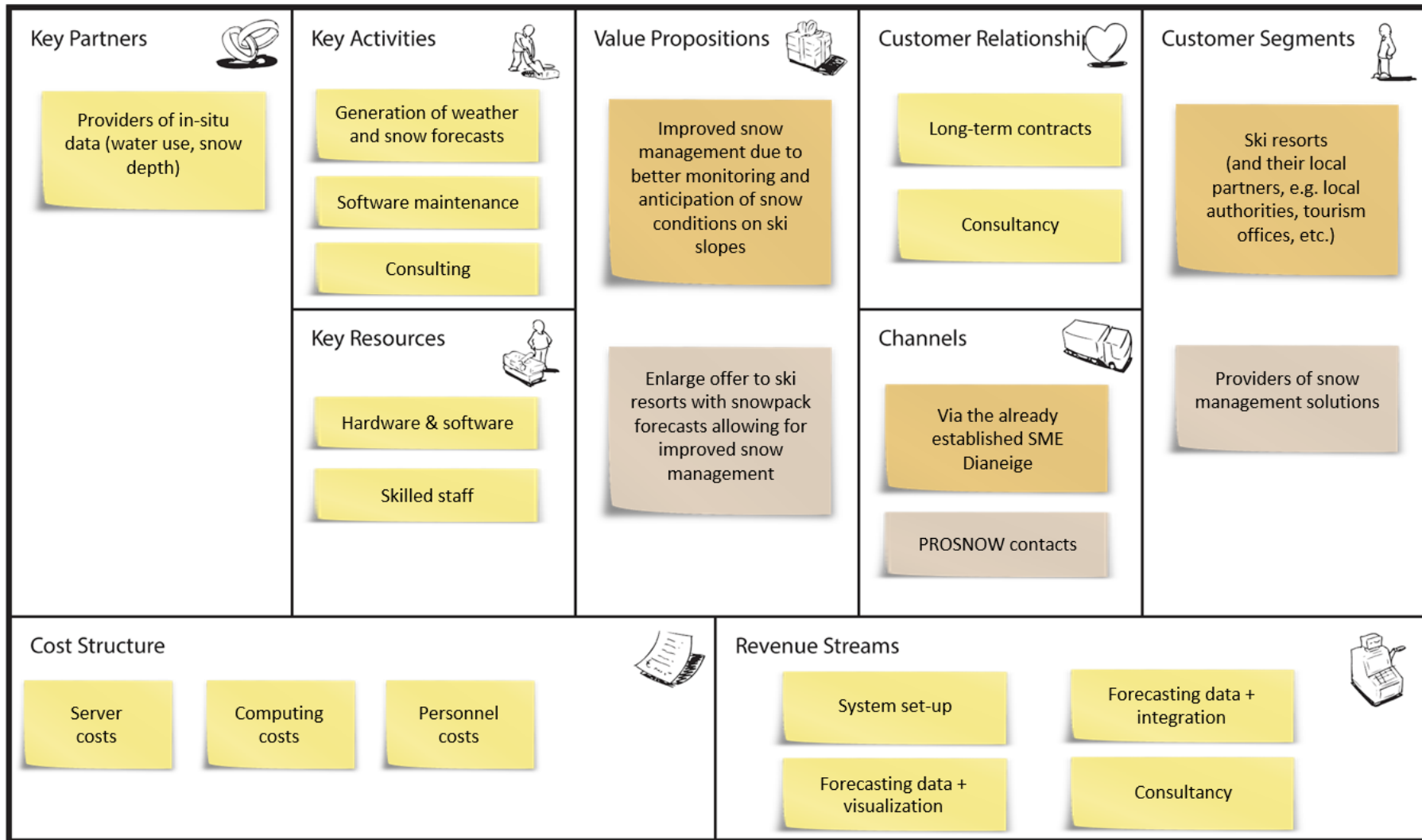
Task	Entity A			Other (INRAE, …)
	CGx	**Dianeige**	**MF**	
Data collection from resort		X		
Contact with resort		X		
Parameterization		X		
Data integration, server maintenance	X			
Weather forecast, snow simulations			X	
Commissioning at the resort		X		
Training, consulting		X		
Hotline (technical)	X			
Hotline (consulting)		X		
Software maintenance	X		X	X
Communication	X	X	X	
Business provider	X	X		
R&D	X	X	X	X
Contact with PROSNOW community	X	X	X	X

Table 7: Price of service A in the winter season 2020/21 and revenue splitting among entity A and external partners

	Small resort (< 100 ha)	Medium resort (100-250 ha)	Large resort (> 250 ha)
CGx	1 500 €	2 000 €	2 500 €
Météo-France (MF)	1 500 €	2 000 €	2 500 €
Dianeige	3 000 €	4 000 €	5 000 €
Others (INRAE, …)	1 500 €	2 000 €	2 500 €
Total (= price)	7 500 €	10 000 €	12 500 €

N°	Risk	Factor	Impact on the objectives	Impact	Probability	Criticality	Decision	Preventive measures	Corrective measures
1	Ability of partners to sufficiently engage human resources	Lack of financial resources to create a full-time position.	Impossible to provide a high quality service with an almost 7/7 presence to ski resorts.	5	2	10		Advocating for the creation of a full-time position for at least three years. This is currently under discussion and there is high confiderence in the effective creation.	
2	The server cannot support the amount of data processed.	Cheap server.	Lower quality of service providing.	4	3	12		Subscribing to an insurance. Being sure to have internal resources to manage such a case.	Idem. Maintenance costs are also provided for such a case.
3	Service unavailable	The server is hacked. Server issues.	Interuption of the service for an unknown period.	4	2	8		Planning, in the exploitation costs, to pay for a good security.	Idem.
4	The product is not as attractive as foreseen.	The cost is regarded as too high for the quality and proposed features.	This could end the commercialisation.	5	3	15		Go, but not for too long then. Anticipating ski resorts reactions, create a relation of trust.	Upgrade as soon as possible features. Offering discounts.
5	Negative financial balance due to not enough subscriptions.	Price is too high.	This could end the commercialisation.	5	3	15		Set a number of KPI aiming at following-up financial and after-sale aspects.	Offering discounts or upgrading asap the service, keeping the same price at a first stage. Thinking of ending or transferring the commercial exploitation.

Figure 6: Risk analysis for exploitation entity A

Key Partners
- Providers of in-situ data (water use, snow depth)

Key Activities
- Generation of weather and snow forecasts
- Software maintenance
- Consulting

Key Resources
- Hardware & software
- Skilled staff

Value Propositions
- Improved snow management due to better monitoring and anticipation of snow conditions on ski slopes
- Enlarge offer to ski resorts with snowpack forecasts allowing for improved snow management

Customer Relationship
- Long-term contracts
- Consultancy

Channels
- Via the already established SME Dianeige
- PROSNOW contacts

Customer Segments
- Ski resorts (and their local partners, e.g. local authorities, tourism offices, etc.)
- Providers of snow management solutions

Cost Structure
- Server costs
- Computing costs
- Personnel costs

Revenue Streams
- System set-up
- Forecasting data + integration
- Forecasting data + visualization
- Consultancy

www.businessmodelgeneration.com

Figure 7: Entity A's Business Model Canvas

B. Annex: Some facts and figures on the ski industry

Ski resorts represent the main potential end-users of future PROSNOW services. As described in detail in Vanat (2019), the Alps[12] are the world's biggest ski destination. They capture 44 % of all skier visits. With more than 10 000 lifts, they are the most intensely equipped region of the industry. Four of the major players of the world's ski industry are located in the Alps: Austria, France, Italy, and Switzerland (see Table 8).

Due to continuous investments, **Austrian** operators show the most updated lift infrastructure of the industry (Vanat, 2019). Since 2000, more than € 9 billion have been spent on the modernisation and comfort of the lift infrastructure and on snowmaking facilities[13]. Ski Service International (https://www.skiresort-service.com/) lists more than 400 Austrian ski areas, of which 158 offer at least 10 km of slopes (see Table 9). Vanat (2019) counts 254 ski areas with 5 lifts or more and 16 major resorts with more than 1 million skier visits per season (see Table 10). About 70 % of all ski slopes are covered with snowmaking[14].

France hosts the world's largest ski resort operator, i.e. the Compagnie des Alpes. It runs nearly all the major resorts in France. No other European country has such a dominant operator (Vanat 2019). Ski Service International lists 136 ski areas that offer at least 10 km of slopes (see Table 9). Vanat (2019) even reports 325 resorts with 5 lifts or more, of which 13 represent major resorts (see Table 10). About 32 % of all ski slopes are covered with snowmaking[15].

Other than the France ski industry, the **Italian** one is quite fragmented. There is no major operator. Some operators, like the Dolomiti Superski, provide a high level of infrastructure, state-of-the-art lifts, and snowmaking facilities, whereas evolution has been slower in some other areas (Vanat 2019). Ski Service International lists almost 260 ski areas, of which 127 offer at least 10 km of ski slopes (see Table 9). Vanat (2019) counts 349 ski areas with 5 lifts or more and 7 major resorts (see Table 10). About 87 % of all ski slopes are covered with snowmaking[15].

Switzerland used to be the most well-known ski destination in the world and the leader in terms of lift infrastructure. However, with investments slowed down for quite some time, unfavourable exchange rates, and a reputation as being expensive, part of Switzerland's attraction to foreign tourists has been lost. In addition, the industry is struggling with demographic changes in their customer base (Vanat 2019). Ski Service International identifies about 330 ski areas, of which 126 offer at least 10 km of ski slopes (see Table 9). Vanat (2019) counts 186 ski areas with 5 lifts or more and 5 major resorts (see Table 10). About 50 % of all ski slopes are covered with snowmaking[15].

Besides the Alps, another 10 % of the global market of skiers is attracted by the Northern, Southern and Western European non-alpine countries (Vanat 2019).

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[12] Vanat (2019) ranks Austria, France, Italy, Liechtenstein, Slovenia, and Switzerland among the Alps.

[13] https://www.wko.at/branchen/transport-verkehr/seilbahnen/ZahlenDatenFakten.html (as of October 2019).

[14] https://www.wko.at/branchen/transport-verkehr/seilbahnen/factsheet-beschneiung.pdf (as of May 2019).

[15] https://de.statista.com/statistik/daten/studie/167606/umfrage/kuenstlich-beschneite-skipisten-fuer-den-wintersport-in-europa/ (as of May 2019)

Table 8: Average seasonal skier days per country (2013/14-2018/19)

Country	Skier days [in million]	Skier days per inhabitant
USA	54.18	0.18
France	53.19	0.80
Austria	51.80	6.00
Japan	31.51	0.25
Italy	27.35	0.45
Switzerland	22.56	2.73
Canada	17.93	0.50
China	15.02	0.01
Germany	9.07	0.11
Sweden	8.86	0.90
Russia	7.43	0.05
Norway	7.23	1.40
Czech Republic	5.80	0.55
Spain	5.07	0.11
South Korea	5.02	0.10
Poland	5.00	0.13
Slovakia	5.00	0.92
Finland	2.52	0.46
Andorra	2.43	31.87
Australia	2.17	0.09
New Zealand	1.60	0.35
Argentina	1.50	0.03
Ukraine	1.40	0.03
Bulgaria	1.20	0.17
Turkey	1.20	0.02
Rumania	1.20	0.06
Slovenia	1.10	0.53

Sources: Statista 2019, EUROSTAT 2019, worldometers 2019

Table 9: Number of ski areas per country having information about slope-km at Skiresort Service International

Country	# of ski areas	# of ski areas (≥ 10 slope-km)	# of ski areas (≥ 50 slope-km)	# of ski areas (≥ 100 slope-km)	# of ski areas (≥ 200 slope-km)
Austria	432	158	30	16	3
France	247	136	53	29	12
Italy	259	127	29	12	1
Switzerland	331	126	34	12	3
Germany	703	31	0	0	0
Andorra	3	3	2	1	1
Norway	113	43	2	0	0
Sweden	119	35	1	0	0
Spain	34	23	6	4	0
Finland	68	14	1	0	0
Czech Republic	299	11	0	0	0
Slovakia	127	9	0	0	0
Slovenia	49	9	0	0	0
Greece	24	8	0	0	0
Poland	234	7	0	0	0
Great Britain	79	5	0	0	0
Romania	49	5	0	0	0
Bulgaria	12	5	1	0	0
Ukraine	33	3	1	0	0

Source: Skiresort Service International 2019 (as of May 2019)

Table 10: Number of ski areas per country according to Vanat (2019)

Country	# of ski areas (5 lifts or more)	# of major resorts (> 1 m skier visits)
Austria	254	16
France	325	13
Italy	349	7
Switzerland	186	5
Germany	498	0
Andorra	3	1
Norway	213	0
Sweden	228	2

Country	# of ski areas (5 lifts or more)	# of major resorts (> 1 m skier visits)
Spain	32	0
Finland	76	0
Czech Republic	191	0
Slovakia	107	0
Slovenia	44	0
Greece	22	0
Poland	182	0
Great Britain	10	0
Romania	45	0
Bulgaria	32	0
Ukraine	54	0

Source: Vanat (2019)

Potential intermediate users of future PROSNOW forecasts particularly include companies supplying services and equipment for snow management, such as snowmaking systems, fleet management systems, GPS-based snow height measurement, etc. Some important market players are listed below:

- **TechnoAlpin** (part of the PROSNOW consortium): Specialized in manual and fully automated snowmaking systems, TechnoAlpin is a major player in snowmaking with a strong market share in Europe, Asia, and North America. In collaboration with the private meteorological forecasting company MeteoGroup, they already have managed successfully to integrate meteorological forecast information into their snow management systems ATASSplus and LIBERTY.
  https://www.technoalpin.com/en.html

- **SNOWsat** (part of the PROSNOW consortium): The subsidiary of **Kässbohrer Geländefahrzeug AG** provides solutions for unified, digital control of the processes in the ski area. This comprises professional slope and fleet management with snow depth measurement, snow management, GIS data management, etc. SNOWsat is present in about 60 resorts in 11 countries all over the world.
  https://www.snowsat.com/aut/en.html

- **DEMACLENKO:** DEMACLENKO designs, develops, manufactures and sells turnkey snowmaking systems and system components. Within their fully automated operating software Snowvisual 4.0 they also provide a Meteo-app that shows the probability of the wet-bulb temperature for the following 10 days for determining the window of opportunity for snowmaking.
  https://www.demaclenko.com/en/information/index/1-0.html

- **Prinoth:** Together with Kässbohrer Geländefahrzeug AG, the Italian company Prinoth dominates the market of snow groomers. They offer snow groomers, fleet management systems and – in cooperation with **Leica Geosystems** – a satellite-based system to measure and visualize snow depth.
  https://www.prinoth.com/en/

- **MND Group:** The MND group is a leading industrial partner in the fields of mobility, safety and recreational activities. SUFAG, a global player in technical snow production, is part of the group. It offers turnkey snowmaking systems and system components and is present in nearly 50 countries.
http://www.mnd-group.com/en/; http://www.sufag.com/en/

- **Supersnow S.A.:** Supersnow is a company dealing with the design and production of comprehensive snowmaking systems. Supersnow's devices can be found in more than 30 countries in Europe, Asia, and America.
https://www.supersnow.com/

- **PowerGIS:** The Austrian company PowerGIS offers tailored solutions for slope management and geo-management, including snow height measurement, fleet management and GIS. They are serving clients in Austria, Switzerland and Italy.
https://www.pistenmanagement.at/en

C. Annex: List of activities

Table 11: Non-exhaustive overview of professional and sector-specific events with PROSNOW presence[16]

#	Event	Activities	Objectives
1	**Rencontres Climat Météo Montagne 2018** La Plagne (FR), 26/1/2018 Annual event, where French ski resort stakeholders meet for a two-day discussion on snow and science.	- [Presentation](#) of the PROSNOW concept by C. Carmagnola (MF) and M. Galvin (TechnoAlpin)	- Make the PROSNOW concept known to French-speaking professionals (end-users, purveyors, multipliers)
2	**winter sports congress 2018: "Alpine trends in changing times"** Kufstein (AT), 5-6/4/2018 B2B congress for the winter sports industry	- [Keynote](#) on "*Snow of tomorrow*" by M. Rothleitner (Schneezentrum)	- Make the PROSNOW concept known to German-speaking professionals (end-users, purveyors, multipliers)
3	**Mountain Planet Fair 2018** Grenoble (FR), 18-20/4/2018 One of the biggest international mountain professional trade shows	- [Presentation](#) of the PROSNOW project MF - 1st UAB meeting - Informal networking (MF, INRAE) - [Winning](#) the Jury's Special Prize at the 2018 Digital Mountain Awards	- Make the PROSNOW concept known to international professionals (end-users, purveyors, multipliers)
4	**Annual Austrian Ropeway Conference 2018** Zell am See (AT), 25/4/2018 Annual meeting of the members of the Austrian Cable Car Association	- [Presentation](#) of the PROSNOW concept within a broader talk on "*The climate and energy balance of technical snowmaking: a first step towards the climate-neutral winter holiday*" by F. Prettenthaler (JR)	- Make the PROSNOW concept known to Austrian professionals (end-users, purveyors, multipliers)
5	**6th Styrian Climate and Energy Forum: "Challenges of a tourism region under climate change"** Schladming (AT), 5/9/2018	- [Presentation](#) of the PROSNOW concept within a broader talk on "*Climate change and tourism: from the costs of inaction to the benefits of climate services*" by J. Köberl (JR)	- Make the PROSNOW concept known to regional tourism stakeholders in Austria (end-users, multipliers)

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[16] For PROSNOW's presence at more scientifically oriented events see D6.7.

#	Event	Activities	Objectives
6	**Annual congress of Domaines Skiables de France (DFS) 2018** Paris (FR), 1-2/10/2018 Annual meeting of the French association of ski area operators, which brings together all operators, suppliers, elected representatives and partners of the sector.	- Networking with key stakeholders of the sector and introducing the PROSNOW concept	- Make the PROSNOW concept known to French professionals (end-users, purveyors, multipliers)
7	**Rencontres Eau en Montagne** Annecy (FR), 18/10/2018 Meeting that brings together public and private stakeholders from the mountain water sector to foster sustainable water resources management.	- Presentation of the PROSNOW concept and initial results by C. Carmagnola (MF)	- Make the PROSNOW concept and first results known to public and private stakeholders from the mountain water sector (end-users, purveyors, multipliers)
8	**Rencontres Climat Météo Montagne (14th edition)** Les Menuires (FR), 14-15/12/2018 Annual event, where French ski resort stakeholders meet for a two-day discussion on snow and science.	- Presentation of the PROSNOW concept and first results by C. Carmagnola (MF), H. François (INRAE), and F. Bray (INRAE)	- Make the PROSNOW concept and first results known to French ski resorts stakeholders (end-users, purveyors, multipliers)
9	**Alpipro Fair** Chambéry (FR), 26/4/2019 Meeting place for suppliers to the mountain economy, ski area operators and mayors of mountain resorts	- Informal networking with potential end-users (MF) - Distribution of PROSNOW material (MF)	- Make the PROSNOW concept and first results known to potential end-users.
10	**Annual Austrian Ropeway Conference 2019** Innsbruck (AT), 8/5/2019 Annual meeting of the members of the Austrian Cable Car Association in the course of the Interalpin Fair 2019	- Participation of F. Prettenthaler (JR) in a panel discussion on the topics "sustainability" and "green mountain"	- Make the PROSNOW concept known to Austrian professionals and promote the upcoming presentation of the PROSNOW demonstrator V1 at the Interalpin
11	**Interalpin Fair 2019** Innsbruck (AT), 9/5/2019 One of the biggest international trade fairs for all key players in the Alpine technologies industry	- Presentation of the PROSNOW concept and the demonstrator V1 by S. Morin (MF) - Participation of F. Prettenthaler (JR) and M. Rothleitner (Schneezentrum) in a panel discussion organized by the magazine "SI Seilbahnen International" on "*How are we snowing the future?*" - Distribution of project material and informal networking (MF, TEC-Ramboll, JR, BOKU, INRAE, UIBK, SNOWsat) - 2nd UAB meeting	- Present the PROSNOW concept and the demonstrator to professionals from the ropeway and ski tourism industry and gather feedback

#	Event	Activities	Objectives
12	**ECCA 2019 – European Climate Change Adaptation Conference** Lisbon (PT), 28-31/5/2019 Biennial conference on climate change adaptation, addressing actors from academia, government, business and community	- [Presentation](#) of the PROSNOW concept and the latest developments in the context of a broader presentation on "*Climate services for climate resilient water resource management and adaptation in winter tourism*" by G. Dubois (TEC-Ramboll) - [Presentation](#) of the latest developments on the PROSNOW demonstrator in the context of a broader presentation on "*Participatory approaches to support the co-development of climate services in Europe*" by M. Terrado (TEC-Ramboll) - [Presentation](#) of the PROSNOW demonstrator by S. Bryère (TEC-Ramboll) - Informal networking and distribution of PROSNOW material (TEC-Ramboll, JR)	- Make actors from business, government and community (purveyors, multipliers) aware of the PROSNOW concept and the latest developments on the demonstrator
13	**Annual congress of Domaines Skiables de France (DFS) 2019** Besancon (FR), 1-2/10/2019 Annual meeting of the French association of ski area operators, which brings together all operators, suppliers, elected representatives and partners of the sector.	- [Presentation](#) of the latest PROSNOW results and developments by S. Morin and C. Carmagnola (MF) - [Participation](#) of S. Morin and C. Carmagnola (MF) in a round table on ski resorts' sustainability	- Make the French community of ski resorts aware of the latest PROSNOW developments.
14	**Making Climate Services a Reality in Europe** Tervuren (BE), 13-14/11/2019 Two-day conference that brought together climate researchers, policy-makers and industry experts as well as city and regional actors to showcase how climate data can serve cities, regions and businesses	- [Presentation](#) of the PROSNOW concept in the context of a broader presentation on "*The market for climate services in the tourism sector*" by J. Köberl (JR) - [Presentation](#) of the latest PROSNOW developments in the context of a broader presentation on "*From the forecast to the decision: C3S and PROSNOW, 2 examples of climate services focusing on displaying complex data*" by S. Bruyére (TEC-Ramboll)	- Make the PROSNOW concept and latest developments on the demonstrator known to policy-makers, industry experts, regional actors and climate researchers (multipliers) and exploit synergies with other EU-funded projects on climate services
15	**Climate Sprint: Accelerating Climate Solutions** Paris (FR), 13/11/2019 Innovation camp on how climate services (focus on sub-seasonal to seasonal	- [Presentation](#) of the PROSNOW concept and latest results in the context of a broader presentation on	- Make the PROSNOW concept and latest developments on the demonstrator known to decision-

#	Event	Activities	Objectives
	time scales) can support decision-making of actors from sectors such as energy, agriculture, insurance and tourism	"*Climate service tools in the operation & maintenance of skiing facilities*" by A. Damm (JR) - Informal networking and presenting the PROSNOW demonstrator by C. Carmagnola (MF)	makers in the tourism sector (and other sectors) and exploit synergies to other climate services projects
16	**FIS Mainau Environment Forum 2019** Island of Mainau in Lake Constance (DE), 21-22/11/2019 Forum for shaping the future strategy of the FIS (Fédération International du Ski) in the presence of climate change	- Invited presentation by M. Lehning (WSL-SLF)	- Make the PROSNOW concept and latest developments known to the FIS and support the FIS in shaping their future strategy
17	**Rencontres Météo Climat Montagne 2019** La Plagne (FR), 20-21/12/2019 Annual event, where French ski resort stakeholders meet for a two-day discussion on snow and science (Event was cancelled due to the upheavals in social activity in France with major disruption in national transport)	- Presentation of some first results from the real-time testing of PROSNOW in the nine pilot ski resorts by C. Carmagnola (MF), using the example of La Plagne	- Showcase the demonstrator and present first results from the real-time testing of PROSNOW to professionals, scientists and journalists
18	**Mountain Planet Fair 2020** Grenoble (FR), 22-24/4/2020 One of the biggest international mountain professional trade shows (Event was cancelled due to COVID-19)	- PROSNOW booth for presenting the PROSNOW demonstrator and the upcoming offers of the French exploitation entity - 1 hour PROSNOW presentation in a seminar room - 3rd UAB meeting	- Present the developed demonstrator to professionals (end-users, purveyors, multipliers) - Promote the upcoming service of the French exploitation entity and gain customers
19	**RDV Montagne** Virtual, 26-28/4/2020 Virtual business platform offered by the organizers of the Mountain Planet fair as some kind of substitute to the cancelled Mountain Planet fair	- Several virtual meetings with interested mountain stakeholders by L. Guily (Dianeige) and C. Carmagnola (MF), informing about PROSNOW and the upcoming services	- Present PROSNOW results and make French mountain stakeholders aware of the opportunity to order PROSNOW services in the upcoming winter season
20	**PLANNED: Annual congress of Domaines Skiables de France (DFS) 2020** Grenoble (FR), 1-2/10/2020 Annual meeting of the French association of ski area operators, which brings together all operators, suppliers, elected representatives and partners of the sector.	- Presentation of PROSNOW results and offers of exploitation entity A - Booth - Informal networking	- Present PROSNOW results and make French mountain stakeholders aware of the opportunity to order PROSNOW services in the upcoming winter season
21	**PLANNED: Symposium "Schnee von morgen" ["Tomorrow's snow"]** Austria, Autumn 2020	- Presentation of PROSNOW results and upcoming services for Austrian ski resorts	- Present PROSNOW results and upcoming possibilities for Austrian ski

#	Event	Activities	Objectives
	Symposium organized by Schneezentrum (subcontractor in PROSNOW), bringing together researchers, people from the ski industry (ropeway operators, solution providers, etc.), and public authorities.		resorts to make use of PROSNOW services

Table 12: Non-exhaustive overview of professional, sector-specific and regional media in which PROSNOW has been presented[17]

#	Medium	Content	Objectives
1	**Mountain Manager – Snowmaking special 2017** 17/7/2017 Professional journal for mountain tourism management and alpine technology	- Interview with M. Rothleitner (Schneezentrum), informing a.o. about the upcoming PROSNOW project and the PROSNOW concept (in German)	- Make the PROSNOW concept known to professionals (end-users, purveyors, multipliers)
2	**Online news magazine of pilot ski resort Livigno** 27/9/2017	- Article about the start PROSNOW project and the (in English and Italian)	- Make the PROSNOW concept known to sector-specific stakeholders (purveyors, multipliers) and the general public
3	**Montagna.tv** 28/9/2017	- Article about the PROSNOW project (in Italian)	- Make the PROSNOW project known to actors in the mountain sector (end-users, purveyors, multipliers) and the general public
4	**Cluster Montagne solutions website** 10/2017 The website features the latest French innovations in mountain development	- Brief presentation of the PROSNOW project (in French and English)	- Make the PROSNOW project known to professionals (end-users, purveyors, multipliers)
5	**Discovery Alps website** 5/10/2017 Online magazine that addresses the topics trekking, skiing, hiking, etc.	- Article about the PROSNOW project (in Italian)	- Make the PROSNOW project known to actors in the mountain sector (end-users, purveyors, multipliers)
6	**Tiroler Tageszeitung** 18/2/2018 Regional newspaper	- Interview with M. Rothleitner (Schneezentrum) about snow management, with references to the PROSNOW project and its aims to provide forecasts for an optimized snow management (in German)	- Make the PROSNOW project known to professionals (end-users, purveyors, multipliers) and the general public

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[17] For PROSNOW's presence in general (i.e. not sector-specific) media see also D6.7.

#	Medium	Content	Objectives
7	**T.A.I. Tourismuswirtschaft Austria & International** 23/2/2018 Professional journal (online and print) providing analyses, background stories and comments about the Austrian and international tourism sector	- [Article](#) about the PROSNOW project ("*Software for optimized snow*") (in German)	- Make the PROSNOW project known to professionals (end-users, purveyors, multipliers)
8	**Mountain Manager – Snowmaking special 2018** 31/7/2018 Professional journal for mountain tourism management and alpine technology	- Interview with M. Rothleitner (Schneezentrum), informing a.o. about the PROSNOW project and recent developments (in German)	- Make the PROSNOW concept and latest developments known to professionals (end-users, purveyors, multipliers)
9	**MyClimateServices website** 16/11/2018 Communication service of the H2020 CLARITY project	- [Interview](#) with G. Dubois (TEC-Ramboll) about the PROSNOW concept, including the models underlying PROSNOW and their importance to evolving Alpine snow cover conditions (in English)	- Make the PROSNOW concept known to actors interested in climate services (end-users, purveyors, multipliers)
10	**LE MAG de Domaines Skiables de France** 23/12/2018 Magazine of the association of all French ski resorts	- [Info box](#) about the PROSNOW project (in French) - [Article](#) about the new "Handbook for Snow managers" and the involvement of Météo France PROSNOW staff (C. Carmagnola) in the writing (in French)	- Inform professionals (end-users, purveyors, multipliers) about PROSNOW and the latest developments
11	**FdSnow (No. 53)** 12/2018 Professional journal for the ski sports	- [Article](#) by L. Lehning et al. about "*Snow and climate change in high mountain regions*", including prospects on results expected from the PROSNOW project (in German) - [Article](#) by U. Strasser et al. about "*The AMUNDSEN model*", including prospects on results expected from the PROSNOW project (in German)	- Inform professionals and the interested public about the PROSNOW concept and latest developments (end-users, purveyors, multipliers)
12	**Südostschweiz** 11/12/2018 Regional newspaper	- [Interview](#) with P. Ebner (SLF) about potential benefits of PROSNOW in terms of finances and resource management (in German)	- Inform professionals and the interested public about PROSNOW and its potential benefits
13	**LEAD Innovation website** 17/1/2019 Company that provides support in the structuring, planning and marketing of innovation	- Introduction to the PROSNOW project as part of [a blog](#) article about "the truth behind snow cannons" (in German)	- Make PROSNOW known to professionals and the general public

#	Medium	Content	Objectives
14	**L'Essor 38** 2/2/2019 Weekly newspaper of local and regional information	-[Article]() about the PROSNOW project, the latest developments (i.e. the first version of the demonstrator) and Irstea's involvement (in French)	-Inform professionals and the interested public about the PROSNOW concept and the latest developments (end-users, purveyors, multipliers)
15	**Newsletter of the Austrian Ropeway Association** 29/3/2019	-Article about the PROSNOW project, promoting the participation in PROSNOW's alpine-wide online survey and providing the link to the survey (in German)	-Inform professionals (end-users) about PROSNOW and animate them to participate in the PROSNOW online survey
16	**News-section on the website of partner SLF** 16/4/2019	-[Article]() about recent developments in PROSNOW (1st version of the demonstrator) and the roles of SLF and the pilot ski resort Arosa-Lenzerheide (in German, English, French, Italian)	-Inform interested stakeholders about recent developments
17	**Website of pilot ski resort Arosa-Lenzerheide** 16/4/2019	-[Article]() about the involvement of Arosa-Lenzerheide in PROSNOW and the benefits they expect from using the tool (in German)	-Inform professionals and the interested public about PROSNOW and the benefits expected by pilot ski resorts
18	**Montagne Leaders (No. 272)** 4/2019 Professional journal about mountains and ski resorts	-[Article]() about PROSNOW and the latest developments (release of the 1st version of the demonstrator, etc.) (in French and German)	-Inform professionals (end-users, purveyors, multipliers) about the latest project developments
19	**Mountain Manager – Anniversary Edition** 7/2019 Professional journal for mountain tourism management and alpine technology	-[Interview]() with M. Rothleitner (Schneezentrum), informing a.o. about the PROSNOW project and the latest developments (release of the 1st version of the demonstrator, etc.) (in German)	-Inform professionals (end-users, purveyors, multipliers) about the latest project developments
20	**France Montagnes website** 7/1/2020 Official website of the ski resorts in France	-[Information]() on the PROSNOW project (in French)	-Make PROSNOW known to professionals and the interested public
21	**RTBF (Radio-télévision belge de la Communauté française)** 10/2/2020 Public service broadcasting for the francophone population of Belgium	-[Report]() about PROSNOW and the testing of the demonstrator in the pilot ski resort La Plagne (in French)	-Make PROSNOW and the latest developments known the professionals and the interested public
22	**SRF (Schweizer Radio und Fernsehen)** 18/2/2020 Swiss radio and television	-[Report]() about PROSNOW and the testing of the demonstrator in the pilot ski resort Arosa-Lenzerheide in the telecast "10vor10" (in German)	-Make PROSNOW and the latest developments known the professionals and the interested public

#	Medium	Content	Objectives
23	**Groupe Ecomedia** 28/2/2020 Regional business news	- [Article](#) about the pilot ski resort Les Saisies and its efforts towards increased sustainability, including the testing of the PROSNOW demonstrator for snow management optimization (in French)	- Make PROSNOW and its added value known to professionals and the interested public (end-users, multipliers).
24	**News-section on the website of partner JR** 20/6/2020	- [Article](#) about the latest developments in PROSNOW, including a link to the showcase of the final demonstrator (in German and English)	- Make the showcase access to the final demonstrator known and available to the public.
25	**News magazine of "Techniques De L'Ingeneur"** 5/3/2020	- [Interview](#) with S. Morin (MF) about the PROSNOW project, the developed software and the testing in the French pilot ski resorts (in French)	- Inform professionals (end-users, purveyors, multipliers) about the latest project developments
26	**CAPA-EUSALP: Climate Adapt Platform for the Alps** 4/20/2020 Platform that provides knowledge about adaptation to climate change in the Alps	- [Record](#) about PROSNOW and the showcase access to the final demonstrator (in English)	- Make the showcase access to the final demonstrator known and available to potential end-users and actors interested in climate services (end-users, multipliers)
27	**Mountain Planet 2020 Exhibitor Catalogue** 21/7/2020 Despite the cancellation of the 2020 edition of the Mountain Planet fair due to COVID-19, the exhibitor catalogue was distributed online to nevertheless give companies in the mountain sector visibility	- [Record](#) on PROSNOW, including an image of the user-facing tool and a short description of the system (in French and English)	- Make PROSNOW and the developed demonstrator known to professionals (end-users, purveyors, multipliers)

Table 13: Non-exhaustive overview of individual meetings with potential end-users and intermediaries/purveyors

#	Activity	Objectives
1	**Stakeholder meeting at Val Thorens ski resort (FR)** 12/3/2019 Organisation of a two-hour stakeholder meeting by MF to present the latest version of the PROSNOW demonstrator	- Make the latest PROSNOW results known among potential end-users
2	**Meeting with Lumiplan (FR)** 3/4/2019 Discussion and feedback on the latest version of the PROSNOW web interface with S. Albrecht from Lumiplan (member of PROSNOW UAB). Lumiplan innovates to serve communities and ski park administrators and operators, to improve the experience for tourists and skiers.	- Make the latest PROSNOW results known among potential purveyors and gather feedback.

#	Activity	Objectives
3	**Stakeholder meeting at Méribel ski resort (FR)** 8/11/2019 Organisation of a two-hour stakeholder meeting by MF to present the latest version of the PROSNOW demonstrator	- Make the latest PROSNOW results known among potential end-users
4	**Stakeholder meeting at Avoriaz ski resort (FR)** 8/11/2019 Organisation of a two-hour stakeholder meeting by MF to present the latest version of the PROSNOW demonstrator	- Make the latest PROSNOW results known among potential end-users
5	**Stakeholder meeting at Mottaret ski resort (FR)** 8/11/2019 Organisation of a two-hour stakeholder meeting by MF to present the latest version of the PROSNOW demonstrator	- Make the latest PROSNOW results known among potential end-users
6	**Stakeholder meeting in Switzerland** 26/11/2019 Presentation of PROSNOW and upcoming services to potential end-users by Dianeige	- Make the latest PROSNOW results and plans on future services known to potential end-users
7	**Stakeholder meetings in France** 29/11/2019, 30/11/2019, 8/1/2020, 9/1/2020, 14/1/2020, 24/1/2020, 5/2/2020, 13/2/2020, 26/2/2020, 10/6/2020 Presentation of PROSNOW and upcoming services to potential end-users by Dianeige	- Make the latest PROSNOW results and plans on future services known to potential end-users
8	**Online meeting with Soldeu ski resort (FR)** 16/6/2020 Presentation of PROSNOW and upcoming services by the French exploitation entity to potential customers	- Gain customers for the winter season 2020/21
9	**Meeting with Courchevel ski resort (FR)** 1/7/2020 Presentation of PROSNOW and upcoming services by the French exploitation entity to potential customers	- Gain customers for the winter season 2020/21
10	**Meeting with Les Arcs ski resort (FR)** 1/7/2020 Presentation of PROSNOW and upcoming services by the French exploitation entity to potential customers	- Gain customers for the winter season 2020/21
11	**Meeting with Oz - Vaujany ski resort (FR)** 2/7/2020 Presentation of PROSNOW and upcoming services by the French exploitation entity to potential customers	- Gain customers for the winter season 2020/21
12	**Meeting with Domaines Skiables de France (FR)** 2/7/2020 Presentation of PROSNOW and discussion about the service rollout in France. Domaines Skiables de France (DSF) is the French association of ski area operators.	- Make the upcoming commercial service by the French exploitation entity known to potential purveyors

#	Activity	Objectives
13	**Meeting with Méribel Mottaret ski resort (FR)** 28/7/2020 Presentation of PROSNOW and upcoming services by the French exploitation entity to potential customers	- Gain customers for the winter season 2020/21
14	**Meeting with Peyragudes (FR)** 30/7/2020 Presentation of PROSNOW and upcoming services by the French exploitation entity to potential customers. Peyragudes is part of N'PY, a brand including eight Pyrenean ski resorts.	- Gain customers for the winter season 2020/21
15	**PLANNED: Meeting with Serre-Chevalier ski resort (FR)** 7/9/2020 Presentation of PROSNOW and upcoming services by the French exploitation entity to potential customers	- Gain customers for the winter season 2020/21

Table 14: Non-exhaustive overview of education and training activities

#	Activity	Audience
1	**Lecture at the University in Landeck (AT), 15/1/2019** Lecture on "Sustainable winter tourism" by UIBK and Schneezentrum, including results and insights from PROSNOW	- Students
2	**Training course, France, 22/1/2019** Eight hour training course on snow management, with a focus on new tools and services, at "Domaines Skiables de France" by MF	- Snow management professionals
3	**Contribution to technical manual for snowmakers, 22/1/2019** Contribution by MF to the new technical manual for snowmakers (edited by Domaines Skiables de France) in the form of a 35 page chapter on snow management, including a presentation of PROSNOW. The PROSNOW logo appears at the beginning of the chapter.	- Snowmakers
4	**Open-doors for high-school students, Grenoble (FR), 24/1/2019** INRAE and Météo-France have long organized an annual dedicated one-day event in Grenoble for high-school students with a school project on snow, avalanches and the mountain environment. This time, PROSNOW featured in this day with a presentation by C. Carmagnola	- Pupils
5	**ETH Zürich seminar, Zürich (CH), 1/3/2019** Presentation of PROSNOW "Provision of a prediction system allowing for management and optimization of snow in Alpine ski resorts" by M. Bernhardt (BOKU)	- Students, scientific community (20 people)

#	Activity	Audience
6	**BOKU seminar, Vienna (AT), 12/3/2019** Presentation of PROSNOW "Provision of a prediction system allowing for management and optimization of snow in Alpine ski resorts" by F. Koch (BOKU)	- Students, scientific community (20 people)
7	**Training for ski patrollers, Chamonix (FR), 3/4/2019** Two-hour presentation on snow management and PROSNOW at ENSA (Chamonix) by MF	- Ski patrollers (23 people)
8	**Training for professionals, AT, 6/11/2019** Training for skiing area professionals, including the presentation of the PROSNOW demonstrator capabilities and the PROSNOW background by UIBK	- Ski area professionals (14 people)
9	**Training for snowmakers, Saint-Jean-de-Waurienne (FR), 8/11/2019** Four-hour training course by MF on snowmaking, including a presentation of the newest version of the PROSNOW demonstrator	- Snowmaking recruits (6 people)
10	**Lecture on technical adjustments in ski areas in the context of climate change, Appenzell (CH), 8/11/2019** Presentation of PROSNOW as part of a lecture by WSL-SLF that took place at the General Assembly of the Ebenalp Horn ski areas	- Snow management professionals, ski are staff (100 people)
11	**Training for ski patrollers, Chamonix (FR), 14/11/2019** Two-hour presentation on snow management and PROSNOW at ENSA (Chamonix) by MF	- Ski patrollers (24 people)
12	**Training course, St. Gervais (FR), 22/11/2019** Training course by MF on snow on the ski slopes, with a presentation of the PROSNOW service	- Snow management professionals (6 people)
13	**Training course, France, 25/11/2019** Eight hour training course on snow management, with a focus on new tools and services, at "Domaines Skiables de France" by MF	- Snow management professionals (6 people)
14	**Training course, France, 28/11/2019** Eight hour training course on snow management, with a focus on new tools and services, at "Domaines Skiables de France" by MF	- Snow management professionals (8 people)
15	**Training for ski patrollers, Chamonix (FR), 29/11/2019** Two-hour presentation on snow management and PROSNOW at ENSA (Chamonix) by MF	- Ski patrollers (22 people)
16	**Training for groomer drivers, France, 9-15/12/2019** Several presentations on snow physics and snow management by MF, including a focus on PROSNOW	- Groomer drivers (12 people)
17	**Lecture on technical adjustments in ski areas in the context of climate change, Tschiertschen (DE), 27/1/2020** Presentation of PROSNOW as part of a public lecture about optimization options for technical snowmaking by WSL-SLF	- End-users, multipliers, public (50 people)
18	**6th Snow Science Winter School, Col du Lautaret (FR), 16-22/2/2020** Contributions in the form of lectures and content drawing on the outcome of the PROSNOW project by MF	- Students, scientific community
19	**Course on snow cover modelling, Italy, 18/6/2020** Course on snow cover modelling for professionals by Alpsolut, including insights and results from PROSNOW	- Professionals (15 people)

#	Activity	Audience	#	
20	**Contribution to technical manual for groomers, 27/8/2020** Contribution by MF to the new technical manual for snowcat drivers (edited by Domaines Skiables de France), including a short presentation of PROSNOW and the PROSNOW logo.	- Groomers		