Deborah Verfaillie[1], **Samuel Morin**[1], Matthieu Lafaysse[1], Michel Déqué[2], Nicolas Eckert[3], Yves Lejeune[1], Jean-Michel Soubeyroux[4]
[1]Météo-France - CNRS, CNRM UMR 3589, Centre d'Etudes de la Neige, Grenoble, France, [2]Météo-France - CNRS, CNRM UMR 3589, Toulouse, France, [3]Univ. Grenoble Alpes, Irstea, ETNA, Grenoble, France, [4]Météo-France, Direction de la Climatologie et des Services Climatiques, Toulouse, France

Long term records of Alpine meteorological and snow conditions are prominent indicators of ongoing climate change. However, there has been limited assessments of the impact of global air temperature levels on their local variations. Such approaches are particularly required at present time, because international scientific assessments, forming the basis of climate negotiations, have shifted into an era of global temperature targets rather than the traditional scenario based approach. Addressing local impacts of global temperature variations may better inform policy makers than scenario-based visualizations, because of the direct relationship, regardless of the lead time, between local climate impacts (required for local climate adaptation planning) and the global temperature targets (largely discussed and showcased in national and international public debates and negotiations).

This contribution introduces a method addressing the links between variations of global temperature and local indicators of meteorological (temperature, precipitation, snow/rain partitioning) and snow on the ground (mean snow depth, peak snow water equivalent, onset/melt-out date of the snowpack, number of days above selected snow threshold values) in mountainous areas. Past and future variations of these indicators were computed based on the SAFRAN reanalysis from 1958 to 2016, and using CMIP5/EURO-CORDEX GCM/RCM pairs spanning historical (1950-2005) and RCP2.6 (4), RCP4.5 and RCP8.5 (13 each) future scenarios (2006-2100). The adjusted climate model runs were used to drive the detailed snowpack model Crocus. While such an approach makes it possible to generate continuous scenarios of meteorological and snow conditions for the time period from 1950 to 2100, we specifically process the obtained results in order to highlight the local impacts of 1.5°C, 2°C, 3°C etc. global temperature increases since pre-industrial levels, based on 30 years average values of the indicators selected.

The method is introduced and illustrated for a representative location of the Northern French Alps, the Chartreuse massif (near Grenoble) at an altitude of 1500 m. In this case, regardless of the time period into the future, variations of local meteorological and snow conditions generally show significant linear correlation with global temperature variations, except total winter precipitation which does not show any significant relationship to global temperature. Global temperature levels on the order of 1.5°C above pre-industrial levels correspond to a 25 % reduction of winter mean snow depth (reference 1986-2005). Even larger reduction is expected for global temperature levels exceeding 2°C.

Beyond this illustrative example, this contribution provide in-depth analysis of the obtained results in the French Alps and in the Pyrenees and discuss how the method can address other sectorial indicators, in the field of hydropower, mountain tourism or natural hazards.

P5.15

ESTIMATION OF ACCUMULATION FROM SNOW AVALANCHES ON THE MOUNTAIN GLACIERS

Anton Lazarev[1], Alla Turchaninova[1], Yury Seliverstov[1], **Anton Komarov**[1], Sergey Sokratov[1]
[1]Lomonosov Moscow State University, Faculty of Geography, Moscow, Russian Federation

Avalanches redistribute snow from the top of the ridges down to the valley bottoms, often occupied by glaciers. The evaluation of snow avalanches' contribution into mountain glaciers' mass balance with a lack of direct observational data on snow avalanches is highly relevant task delivering the important knowledge of one of the least studied components of the glaciers mass balance under the climate change. We developed a new approach for the numerical estimation of snow avalanches contribution into accumulation on glaciers, without carrying out detailed terrestrial snow surveys, based on DEM and meteorological data analysis using GIS and numerical modeling of snow avalanches. Our approach consists of the following steps: DEM analysis; avalanche release zones identification; meteorological data analysis; indication of the active avalanche release zones and the corresponding snow fracture height during the analyzed winter periods; avalanches volumes assessment; numerical simulations of avalanches in three-dimensional terrain using avalanche dynamics program RAMMS; evaluation of the contribution of avalanches into the seasonal accumulation on the glacier. The developed approach was tested on the Batysh Sook Glacier, Tian Shan. A case study was realized for the 2015/2016 balance year based on the high-resolution DEM obtained from a drone in July 2016 and the data of regular meteorological observations at the nearest to the glacier meteorological station (Kumtor, Tien Shan). We estimated release zones that were most probably active during the winter season 2015/2016 based on the regional dependences of the avalanche activity on relief and climate characteristics. We performed numerical simulations of avalanches that were most probably released during the winter period 2015/2016 using RAMMS. RAMMS simulation results (run out distances and deposition heights) were compared with the field measurements, July 2016. The outlines of the avalanches deposits as well as the deposition heights were realistically reproduced by RAMMS using predicted input model parameters considering the time difference between the field measurements. The estimated total volume of avalanches-redistributed snow deposited on the Batysh

Sook Glacier during the winter season 2015/2016 was 75 000 m3. Thus, the snow avalanche accumulation on the Batysh Sook Glacier during the winter season 2015/2016 turned out to be 13 +/- 4% of the total accumulation.
We plan to test our approach for the mountain glaciers in other regions. The results of numerical assessment of snow avalanches contribution into glacier accumulation possess a high scientific significance due to high sensitivity of the components of glacial mass balance to the climate change. The approach can also be applied to the snow avalanche's contribution to the river runoff that adds even more practical significance to the research.

P5.16

EFFECTS OF SNOW COVER ON SEED GERMINATION FOR TWO SPCEIES IN IRON MINE TAILLING, COLD DESERT

Xiaoying Zhao[1], Luyao Wang[1]
[1]*Xinjiang Normal University, Urumqi, China*

Introduction: Germination responses and dormancy of soil seed in nature can reveal dynamics of soil seed bank and predict trend of population regeneration, and thus information is needed on this aspect of the seed biology of a species before it is selected for use in habitat restoration projects. Seriphidium gracilensces is a small shrub that is dominant species of vegetation and Chenopodium botrys is a nursery plant. They are important candidate species for revegetation in iron mine tailling, the cold deserts of northwest China.

Methods: We study impacts of snow cover on germination and dormancy of seeds in nature of the species for five months under snow cover in cold desert habitat. Fresh seeds were put on surface iron mine tailling in November 2017 after first snow and in a house without heater and window in Qinghe of Xinjiang, China. They were exhumed and tested germination in incubator in April 2018 after snow melting.

Results: Some seeds remain dormancy for two species. Final germination percentage of fresh seed are 80.7% and 94.0% respectly for Seriphidium gracilensces and Chenopodium botrys. During first two weeks, seed germinate 52.7% for fresh seed and 88.0% for storage in cold house and 87% and 92% for under snow cover to the two spceies. Seed under snow cover had higher germination percentage than in laboratry (dry and warm). Snow greatly improve germination. These results maybe result from cold stratification in snow cover during winter.

Conclusion: Snow cover improve dormancy breaking for the two species.

P5.17

GLOBAL WARMING REDUCES THE CONSEQUENCES OF SNOW-RELATED HAZARDS

Erik Hestnes[1], Christian Jaedicke[1]
[1]*Norwegian Geotechnical Institute, Oslo, Norway*

Changing weather pattern due to global warming cause shifts in the potential of natural hazards worldwide. Most recent publications dealing with consequences related to avalanches and slushflows state that their impact on mankind will increase. That is a highly debatable statement. Milder weather, shorter winters, less snow and rise of snowline will mainly shift their potential problem away from populated areas and infrastructure. It is unlikely that expansion of settlement and/or human activity into these areas will outweigh the hazard reduction, mainly because other types of rapid mass movements will increase in those areas and in general.
Surely are part of the Arctic and parts of cold continental and mountainous regions, subject to more snow and rain in winter due to the climatic change, and consequently to larger and more frequent avalanches and slushflows. It is, however, unlikely that the consequences to future activity in remote areas will exceed the reduction in consequences in more densely populated areas.
Global warming reduces the impact by snow-related hazards on mankind, but the general hazard potential worldwide will most likely increase.

P5.18

SNOW COVER AND CLIMATE CHANGES IN THE ITALIAN ALPS (1930-2018)

Mauro Valt[1,2], Paola Cianfarra[3]
[1]*ARPAV Avalanche Center, Arabba,* [2]*AINEVA, Trento,* [3]*Università Roma Tre - Department of Science - Geology Section, Roma*

The Fifth AR5 report of the working group of the Stockholm IPCC panel confirmed that the snow cover extent in the Northern Hemisphere has been gradually decreasing, and that in March and April high correlation exists between such decrease and anomalous temperature values.
Recent works have already proved that in the Italian Alps, too (6.6-13.7 E and 47.1-44.1 N) the snow cover extent and the amount of fresh snow have been gradually reducing, especially in March and April, at heights ranging between 800 and 1,500 m.
The present work instead analyzes temperature data, snowfalls and snow cover duration with more than 30 cm thickness (skiable snow) in the 1930-2018 period.
The analyses carried out highlighted, in the 1987-1988