SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

The STSM applicant submits this report for approval to the STSM coordinator

Action number: ES1404
STSM title: Snowpack evolution - a comparision of field measurements and snowpack modelling results
STSM start and end date: 10/02/2018 to 17/02/2018
Grantee name: Dr Anna Seres

PURPOSE OF THE STSM/

(max.500 words)

My main research interest is numerical snowpack and avalanche risk modeling. During my PhD research at the University of Miskolc, I have developed a snowpack and avalanche risk model. Currently the model works on a specific study site and needs a lot of improvement in order to validate it and extend its geographical coverage. Unfortunately in Hungary snow and avalanche science is basically non-existent, posing a big challenge for me to advance in my career and gain more knowledge and experience in the topic. The purpose of this STSM was to gain such on-hands knowledge, acquire more understanding on the physics of the snowpack evolution, learn how detailed snowpack models work and learn more about and use some instruments designed for measuring different snowpack properties by attending the 4th Snow Science Winter School (11-17 February 2018, Col du Lautaret, France).The objective of the school is to teach state-of-the-art snow measurement techniques, understanding the physical processes responsible for the evolution of the snowpack and understanding vertically resolved snowpack models (Crocus, SNOWPACK) and larger scale land-surface models. In practice it gave the students the opportunity to learn about different instruments and methods describing the snow and to gather data from snow pits and use it to compare with the snow models based on meteorological inputs from the same days

My main purpose of attending the school was:

1) complementing my knowledge in snow science with state of the art field, lab and remote sensing snow measurement techniques - in order to improve my collaboration with field scientists who provide me with their data, deepen my understanding on their results and give me the ability to take part in conducting specific measurements in the future.
2) deepening my knowledge in modeling and snow physics - to be able to further improve my own numerical model and to use other, complementary models successfully. The school explains about vertically resolved snowpack models, like Crocus and SNOWPACK and AvalMap, a multi-layer snowpack model developed as my PhD research, is similar to these models. So learning more about Crocus and SNOWPACK and the source of the data they use, I could improve AvalMap, extend its geographical coverage and harmonise its results with the existing and frequently used models.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

(max.500 words)

During the school I attended lectures about different snow measurement techniques and snowpack models. On the field I learnt to use the following state-of-the art instruments, designed for measuring snow properties:

- federal snow sampler: for snow depth and SWE
- Denoth meter: for snow density or wetness
- box cutter and scale: for density
- NIR photo: for snowpack stratigraphy and specific surface area (SSA)
- SnowMicroPen: for hardness and density
- RammSonde: for hardness
- traditional stratigraphy: for layering, hand hardness, particle type and size
- IceCube/Dufiss: for SSA

After these introductory lectures and field presentations, we had two days of field work. Here the students had to make the organization and the measurements necessary to evaluate Crocus, to make comparisons between the properties measured in the field and modelled by Crocus.

The field measurements were: snow depth transects, RammSonde, SnowMicroPen, traditional stratigraphy, box cutter and scale, Denoth meter, NIR photography, IceCube/Dufiss. On the first day I made the traditional stratigraphy on two sides of the pit and on the second day I made the RammSonde and Denoth measurements. The measured data was then typed / copied into the computers and processed, using the softwares Niviz, SnowMicroPyn, ImageJ and Anaconda and shared between the students. As homework, each group (group of 3 people) had to make a scientific report about the comparison of the data measured in the field and data produced by Crocus with input of meteorological data from the beginning of December to the date of the field days for the nearest massif. My group handed in a report of 19 pages, titled: “Comparison of in-situ data with simulations from the Crocus snowpack model in the Col du Lautaret”, showing the study site, describing the measurement techniques and methods, making a detailed comparison of all the results and drawing conclusions. The compared snow properties were: grain type (classical and by sphericity), grain size, specific surface area, density, hardness, temperature.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

(max. 500 words)

The purpose of attending the school was achieved as I learnt about several instruments and measurement techniques, learnt about detailed snow models and made a comparison of field data and a detailed snow model data. Based on these, I will be able to make more precise measurements, to compare the results of my model with the measured data better, to validate and improve my model, to extend its geographical coverage and to harmonize its results with other models results.

Some of the main conclusion of the comparison are the following:

Grain type: grain type is generally well represented in the model runs on day 1. The model corresponds

well to the rounding trend from top to bottom and it also catches a more rounded few layers in the upper part of the snowpack. The most important three melt-freeze crusts and a buried surface hoar layer were all very well represented in all or most of the model runs. However, the very distinct ice layers present in the field were not produced by any of the model runs and the thick depth hoar layer at the bottom was also not really caught by the model. Grain size in general is also well represented by the model in the 0 - 1,2 mm range. Larger, surface and depth hoar grains, with diameter of 4-5 mm are not produced by the model. Grain types do not correlate well in case of day 2 measurements and model runs, the reasons of which are detailed in the report.

Specific surface area: Modelled SSA values show a very good representation of values measured by IceCube/Dufiss and data derived from NIR photo. The Dufiss measurements give about the same range of SSA values, show the top and bottom layers correctly and matches some of the melt-freeze crusts as well. Ice or melt-freeze layers, visible on NIR photos are also very well represented by the model results

Density: In general, the model does a good job in representing the general snow density profile but fails to simulate the lower density at the bottom of the snow pack. The SMP measurements indicates density values that are too high, compared to the Denoth and box cutter measurements.

Temperature: The measured and the modelled snow temperature profiles agree in the location of the lowest temperature and in the general pattern of temperature increase towards the ground level. The modelled temperature decreases towards the snow surface as well, which represents only the second, warmer day's temperature line. The first day the measured snow surface temperature was way below the modelled one.

Hardness: The depth, where the SMP overloads, matches with the ice layers indicated by the traditional stratigraphy's hand hardness measurements. The profile over that have the same qualitative properties. The RammSonde resolution is very low and results into significant differences with the SMP measurements.

FUTURE COLLABORATIONS (if applicable)

(max.500 words)

My participation in the 4th Snow Science Winter School could result in three possible collaborations:

1. After improving my snowpack model, AvalMap, a continued collaboration with the Slovakian Avalanche / Rescue Service is expected. Our aim is to make the model operational, to be able to use it in the Low Tatras and the West Tatras to help making the avalanche forecasts and depending on how well it works, to publish its results
2. Based on experiments from last two seasons, and the knowledge about NIR photography gained in this school, together with the Hungarian Ski Mountaineering Association, we are planning to construct a new type of field instrument, which would be able to measure stratigraphy and grain types. We already have two prototypes, which, after some additional change based on the knowledge from this school, we would like to test with the cooperation of the Slovakian Avalanche /Rescue Service.
3. After some discussion with one of the organizing institutes, SLF, we are planning to submit a Marie Curie proposal next year.