Report for 4th Snow Science Winter School, Col du Lautaret, France

The 4th Snow Science Winter School (SSWS) took place in Col du Lautaret, France, from 11. - 17. February 2018. Organized by the Snow study center (CNRM/CEN - Météo France/CNRS), WSL Institute for Snow and Avalanche Research SLF from Davos, Switzerland, the Station Alpine Joseph Fourier (SAJF), the Institut des Géosciences de l'Environnement (IGE/OSUG – CNRS / Grenoble INP / IRD / UGA), and the Finish Meteorological Institute FMI, the snow school aimed at teaching graduate students in modern snow measurement techniques. In addition to the lectures, all traditional and modern field instruments were available for the students to get hands-on experience in the field. The instruments ranged from hand lenses and crystal plates for traditional snow pits up to high-resolution penetrometers.

The schedule of the school consisted of lectures and by hands-on field training in measurement techniques. The covered subjects in lectures ranged from advances in snow quantification techniques to physical snow models and large scale applications. The SAJF facilities at Col du Lautaret allowed hosting the 24 students with direct access by foot to the field sites.

Lectures

A series of lectures on snow science were given to attendants, varying from 30 to 60 minutes. After a welcome, safety & introduction session, the following topics were covered.

Monday Feb 12

- Snow microstructure and basic metrics
- Alpine snowpack evolution
- Microstructure and macroscopic properties

Tuesday Feb 13

- Instruments presentations

Wednesday Feb 14

- Detailed snowpack modelling

Thursday Feb 15

- Impact of climate on the snowpack structure : the example of the Arctic
- A few snow climate feedbacks
- Snowpack hydrology, modelling and applications

Friday Feb 19.

- Comparing measurements and models
- Uncertainties in snowpack modelling

The rest of the day was devoted to an interactive session between students and lecturer where the students were asked to compare detailed snowpack model results (Crocus, provided) to their measurements in the field.

Field exercises

The main purpose of the school was to familiarize students with current and emerging techniques for objective characterization of the snowpack for various applications. Traditional methods for snow quantification were also covered. The teaching method adopted was a hands-on approach in a real environment, supported by introductory lectures on the first day of the school. For the field exercises and subsequent reporting, the students

were assigned to small groups of 3-4 people. The groups learned to study the snowpack at different locations with different instruments. After each field day, students were required to use time with their group to summarize their measurements and enter the observations in a common database.

The daily activities consisted of the following:

Monday Feb 15.
The first exercise consisted of an introduction to snowpack. Each group had to dig its own snowpit and performed the same really basic measurements (snow types, layering, depth, temperature). The exercise took place in the immediate vicinity of the SAJF facilities (but in real snow!).

Tuesday Feb 16.
For the second day of field work, students learned how to use the different instruments with devoted working groups in the field (one lecturer for each instruments, 45 minutes for each spots). The exercise also took place in the immediate vicinity of the SAJF facilities.

Illustration 3: Snow casting demonstration (Martin Schneebeli) on Tuesday (photo: Pascal

Wednesday Feb 17.
The day was a field trip near Col du Lautaret (1 hour walk with snowshoes). The students were split into two groups. The first group went to a place close to forest at the same elevation as the pass. The second group went a bit above the pass (roughly 2500 m altitude). For both groups, all instruments demonstrated the day before were provided and they were

asked to organize their measurements to be able to compare the results to a detailed snowpack model.

Thursday Feb 18.
The day was a repetition of Wednesday but at different locations.

Illustration 4: Field work on Thursday

Conclusion

61 students applied for the course, from which 24 were selected. Almost equal numbers in gender resulted. 4 were Post-Docs, 17 PhD-students, 2 advanced Master-students and 1 bachelor student from 11 European countries and 1 from the USA and 2 from Canada. The high number of applications showed the large interest in this subject.

The eight groups presented their results in written reports, which are in review by the lecturers. The presentations showed a good understanding of the applicability of the methods in different environments, their ease of use and limitations. The presentations will be made publicly available on the website of the Snow Science Winter School after final redaction.

All students were very positive about the winter school, and expressed their satisfaction with the program (a more formal survey will be done until end of April). Somewhat of a

concern was the splitting in two groups, which were felt to be too large for work. This will be taken into account for the next snow science school.

The fifth edition will take place in February 2019 in Finland, the overarching topic will be "snow on sea ice".

The lecturers are convinced that this snow school will form a well-educated base of snow scientist knowing about in depth about quantitative methods to measure snow properties. We think that this will be very important for the forthcoming research projects in snow-related topics.

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