Forecasting fresh snow amounts in deep Alpine valleys under “cooling by melting” conditions

On June 8th 1956 Innsbruck (580 m above sea level) received 15 cm of snow, following a day with a maximum temperature of 27°C. The snow reached the valley floor, despite a freezing level in the range between 1200 m and 1500 m in the northern Alpine foreland. This is an impressive example of the “cooling by melting” phenomenon, that is, the cooling of an air mass by melting of falling snow or graupel. If the air mass is protected against exchange with the larger-scale airflow generating the precipitation, the air mass may be cooled until the snow reaches the ground. This phenomenon is most pronounced in deep mountain valleys, where the surrounding ridges tend to protect the valley atmosphere from the ambient winds. It is clear from the above example that this phenomenon can have a drastic impact on the local weather.

The forecasting of cooling by melting events in a numerical weather prediction (NWP) context is very challenging. Until recently most operational NWP models lacked the resolution to resolve the deep mountain valleys of interest. And even if the valley can be resolved, model errors related to steep topography often prevent an accurate forecast, in particular model errors related to numerical diffusion.

In this thesis, the predictability of historic cooling by melting events as a function of model resolution is investigated by means of real-case simulations using the ICON model of the German Weather Service (DWD). The modern numerics of the ICON model allows for simulations with steep topography and minimal numerical diffusion and thus the potentially skillful simulation of cooling by melting events. In a first step, high-resolution ICON simulations for a more recent cooling by melting event (Sep 19, 2011) are performed and the sensitivity of the forecast to model resolution is investigated. In a next step, further events may be simulated in order to investigate the predictability of more marginal events.

The work will consist of undertaking and analyzing simulations with the ICON model, including a detailed comparison against the available observations. This requires a solid background in computer programming and numerical weather prediction models.

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