Section Sciences et Ingénierie de l'environnement
Design Project 2024 (semestre de printemps)

Proposition n°50

Performance analysis
of a new precipitation forecast product in the Alps

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Descriptif du projet

Alpine regions are particularly vulnerable to floods due to their complex topography. In Switzerland, a number of recent flooding events has highlighted the need for more reliable forecasting systems to mitigate flood impacts. Since 2013, the CREALP (research center on alpine environment) is operating a real-time flood forecasting system for the upper Rhone River basin and is continuously improving it since then (Foehn, 2019). This system relies on numerical weather forecast provided by MeteoSwiss. Among the different variables of interest, precipitation forecasts in complex terrain remain a major challenge.

For several years now, MeteoSwiss is operating high-resolution numerical weather models, COSMO-1 and COSMO-2, covering the Alps and its surroundings with a resolution of 1 km and 2 km respectively. In early 2024, the Icosahedral Nonhydrostatic Weather and Climate Model (ICON) will replace the COSMO forecasting model. As mentioned by MeteoSwiss, one of the main advantages of this new model is the following:

While COSMO uses a regular geographical (latitudinal/longitudinal) grid, the ICON concept is based on a triangular (icosahedral) grid. The advantage of this is that the grid elements no longer differ in their actual size, thus avoiding any grid distortion due to the meridians converging towards the Earth's poles. ICON also enables better reproduction of the complex and detailed Alpine topography of Switzerland. The new formulation of the flow equations allows the use of steeper mountain slopes than the COSMO model could cater for. The resulting, more detailed modelling of the surface also helps to improve the model predictions.

As user of these forecasts in an operational system, CREALP is interested in analyzing the quality of these new forecasts more closely and see if ICON model will bring an added-value compared to COSMO.

Objectif et buts

The students will analyze the quality of precipitation forecasts provided by this new ICON model in Wallis. In particular, they will focus on weather situations that are critical for floods of the Alpine Rhone river, in which the topography of the Alps plays a crucial role. The aim of this analysis is twofold: on the one hand, to quantitatively assess the absolute quality of ICON forecasts compared to ground truth; on the other, to analyze the quality of ICON forecasts compared to the ones provided by COSMO models.

To perform such analysis, the students will need a reference dataset to compare with. There are mostly two independent datasets available in Wallis: the CombiPrecip product, which combines radar data and rain gauges and SwissMetNet station observations both provided by MeteoSwiss.

Descriptif tâches

During the first month of the project, the students will perform a literature review, collect and prepare the data for the next step. They will then perform the performance analysis on selected events, potentially in collaboration with MeteoSwiss Geneva. The results will be analysed, compared with COSMO outputs and validated against state-of-the-art data (CombiPrecip, SwissMetNet stations). During this phase, they should also annotate carefully their code/work to facilitate any future use. Finally, the students will write a report with their main findings and potential problems.

Divers

The students must be interested in numerical modeling tools. They should also be comfortable with programming (R, Python) and with handling large files.

Foehn Alain, Radar-rain gauge merging and discharge data assimilation for flood forecasting in Alpine catchments, PhD dissertation, 2019, EPFL.