Performance analysis of a new precipitation forecast product in the Alps

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Context and Objectives :

This project delivers a performance analysis of ICON, a new forecast model, in comparison to COSMO, the established model in Switzerland. Thanks to parameters produced by those models, the weaknesses and strenghts of each model can be seen and assessed. Motivated by Crealps' interest, this study focuses on the Valais region. Forecasts and the understanding of atmoshperic processes are essentials as weather guides our everyday lives and the future of the planet.

1. Identify the models' strengths and weaknesses based on 6 parameters of interest
2. Compare the models and find if there is an added value from ICON
3. Determine the influence of replacing COSMO with ICON on forecast accuracy and reliability

Methodology :

NetCDF files provided by MétéoSwiss and CREALP :

ICON | COSMO | Combi Precip

Visualisation : Conversion of the data on a uniform grid : ESPG 2056 projection

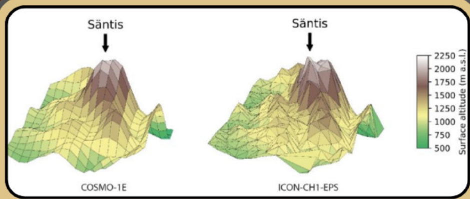
Data extraction : python code to isolate each realization per model and compare it with CombiPrecip

Data Analysis :

Two analysis over 6 events of high-intensity precipitations on the Wallis region.

Metrics Analysis :
- hit rates
- bias
- false alarms
- correct rejections

Error Analysis :
- comparison ICON vs CombiPrecip
- comparison COSMO vs CombiPrecip

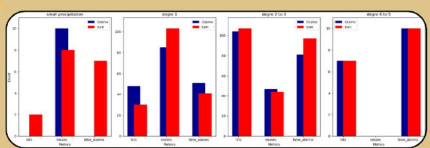


The difference in the grid explains how ICON can be more precise for various altitudes

Thresholds	For 48h events	For 72h events
Small Precipitations	[0-10] mm	[0-15] mm
Degree 1	[10-30] mm	[15-45] mm
Degree 2-3	[30-120] mm	[45-130] mm
Degree 4-5	<120 mm	<130 mm

Thresholds used for these measures

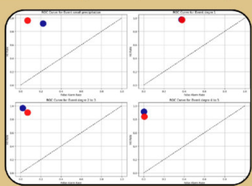
Results : Metrics for reliability and accuracy



Bar charts showing number of hits, misses and false alarms for different thresholds

The histogram shows that ICON is better for forecasting small precipitations and a bit under COSMO for important degrees.

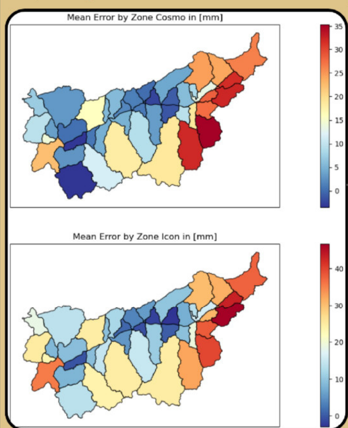
The graph on the right show hits rates according to false alarm rates. A point on the line means the model has no skill. As we can see ICON underpeforms relatively to COSMO when it comes to very high precipitation events.



Relative Operating Characteristics for different thresholds

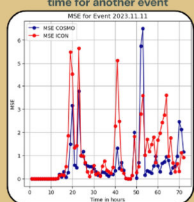
Results : Measurements on errors associated with the forecasts

Map showing the mean error across different Watersheds

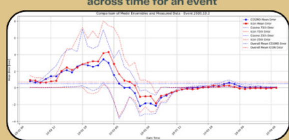


These 2 maps show different errors across the watersheds of the Valais Region. These outline 3 important points :
- Both models clearly overestimate the total precipitations that will occur
- ICON overestimations are larger than COSMO
- All the regions over the Alps are associated with high errors from both models

Mean Squared Error across time for another event



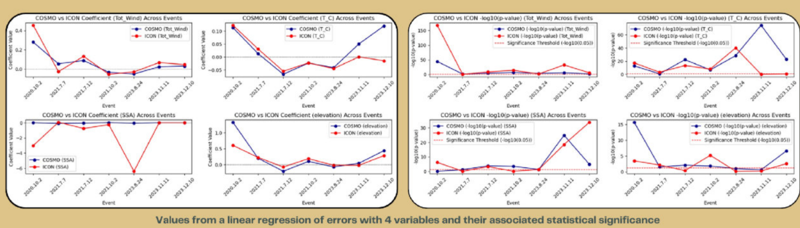
Mean 75th and 25th quartile errors across time for an event



These graphs show respectively the mean squared error and the mean error across 2 different events.

The graphs below represent respectively coefficients associated with a linear regression of errors (on Temperature, wind intensity, elevation and snow amount) and their associated p-values. Values below the thresholds are considered statistically significant. Except for the elevation coefficients, we do not find statiscally significant variables. The betas show that errors seem to increase with altitude and total wind

To plot these we used the ensemble forecast median predictions. The first graph exhibits a larger error for COSMO at a specific time but for the entire event, ICON seems to be the underprefoming model. As for the second graph, we can see that ICON also overestimates precipitations slightly more than COSMO. On this event it can be noted that both models missed by a few hours the timing of the precipitation event.



Values from a linear regression of errors with 4 variables and their associated statistical significance

Conclusion :

The comparison between COSMO and ICON for high precipitation events demonstrates that both models can effectively forecast weather, though they tend to slightly overestimate precipitation. The analysis also uncovered a correlation between errors and altitude. While COSMO shows slightly higher precision overall, ICON performs better for significant precipitation events.