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Dispersion model uncertainty simulation using a limited area ensemble model

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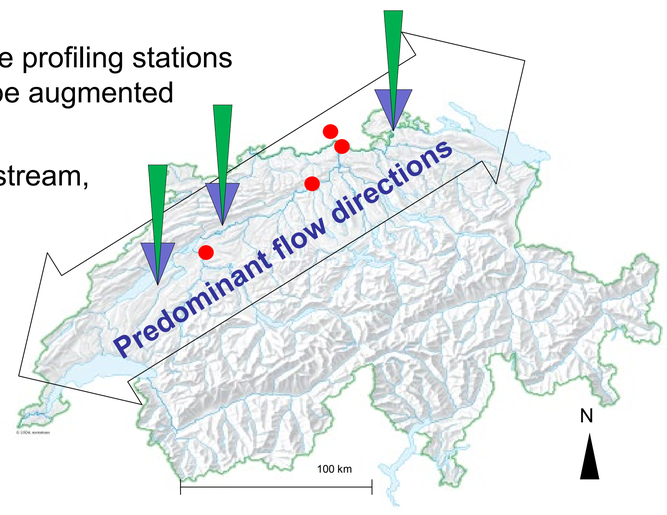
Introduction

- Uncertainty in the meteorological fields is a significant contributor to the total uncertainty of dispersion model results.
- Decision makers need to know the uncertainty of a dispersion simulation.
- The MeteoSwiss integrated analysis and forecasting system *EMER-Met* (Emergency Response Meteorology) features three remote-sensing sites equipped with wind profilers and microwave radiometers, which will soon be augmented with Doppler lidars.
- Meteorological uncertainty is obtained from the COSMO limited-area ensemble model of MeteoSwiss, which is nested in the ensemble model ENS of ECMWF.
- Dispersion forecast uncertainty is obtained by calculating a dispersion ensemble based on the meteorological ensemble model results with FLEXPART-COSMO.
- We are searching for the best way to provide uncertainty information to end users as easily interpretable graphics.

Enhanced Measurement Network

- During EMER-Met StArt (2019-2021), the profiling stations with radiometers and wind profilers will be augmented with Doppler lidars.
- The measurements sites are located upstream, downstream, and in the center of the Swiss Plateau region containing the Nuclear Power Plant sites.



● Nuclear power plant site

Wind profiler optimized for 500 m agl – 8000 m agl

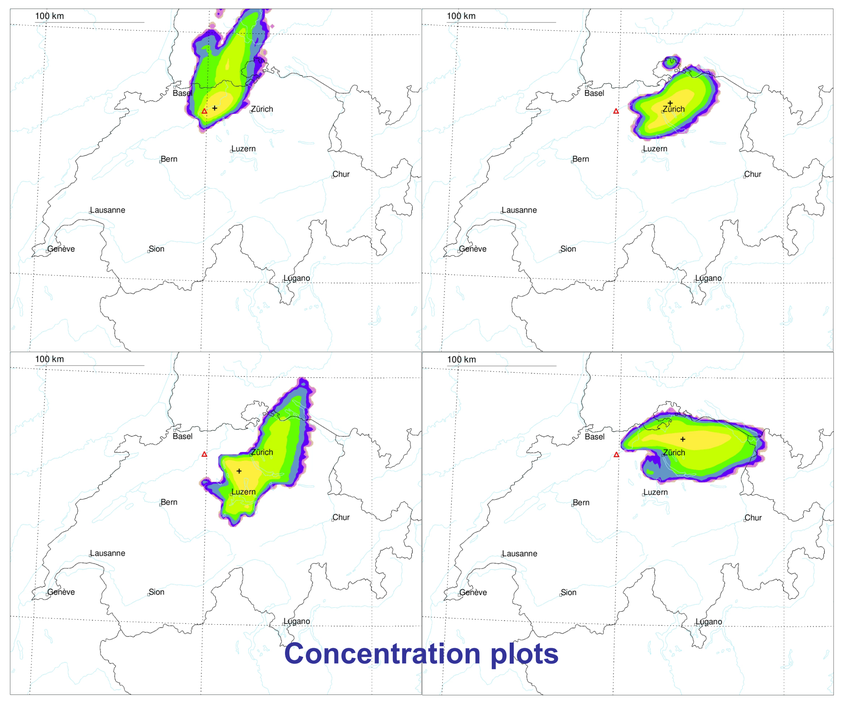
Doppler-lidar optimized for 0 m agl – 1000 m agl

Dispersion Ensemble with FLEXPART-COSMO

- The Lagrangian particle dispersion model FLEXPART-COSMO is applied to all members of the NWP ensemble.
- An example for 2017-08-08 is shown here (case with large spread), with a source active between 6:00 and 9:00 UTC.
- The four most disparate ensemble members are shown.
- Colors represent the concentration at 11:00 UTC (5 hours after start of release, with factor 10 between levels; actual values not of interest here).

COSMO Ensemble

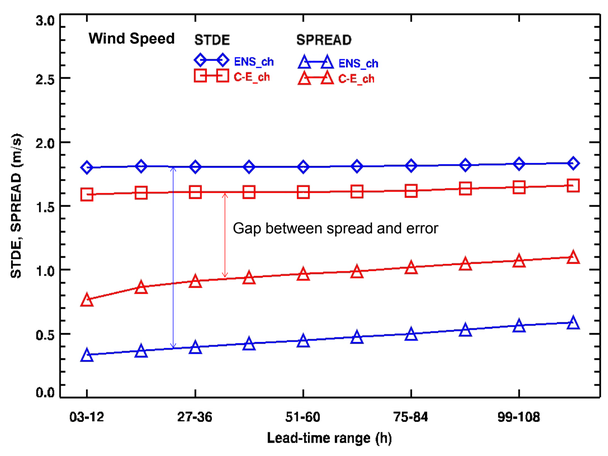
Flexpart



A case with large uncertainty: Concentration plots based on the four most diverse NWP ensemble members (identical source term and simulation time).

The Ensemble NWP Model COSMO-E

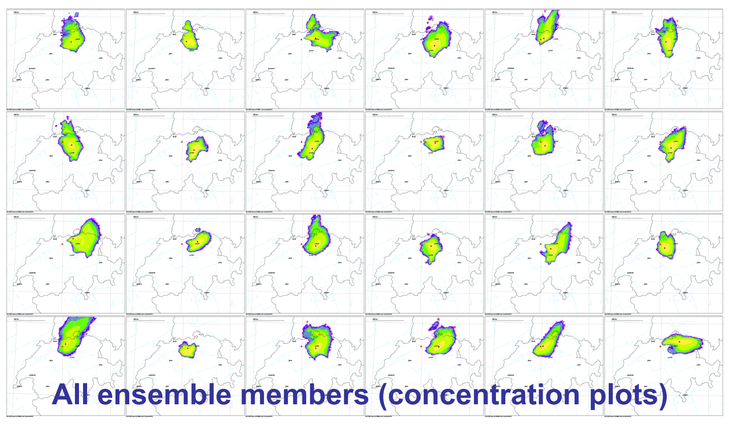
- The challenge for a short-range numerical weather prediction (NWP) ensemble is to achieve sufficient spread to fully represent the uncertainty.
- Methods to enhance the spread are applied (SPPT, ACI).
- This results in a smaller gap (↕) between spread and error over Switzerland in the limited area model COSMO-E (C-E_ch) than in the driving global model IFS ENS (ENS_ch).
- The ensemble will be expanded in 2020 (see table below):
  - COSMO-1E: higher resolution
  - COSMO-2E: 4 daily updates (now 2)



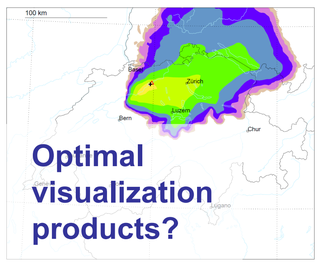
Resolution (Grid spacing)	Forecast Length	Current Type	Future Update Frequency	Future Ensemble Size	Future Name
1.1 km	33 hours	Deterministic	3-hourly	11 Members	COSMO-1E
2.2 km	120 hours	Ensemble	6-hourly	21 Members	COSMO-2E

Visualization

- The full ensemble information (example below) is difficult to interpret: The information needs to be condensed!
- The average of all members (as in the example below) is probably not the best way of presenting the information — probabilities or quantiles might be more useful.
- Unfortunately, there are no established standard products for concentration or deposition ensembles.
- A tailoring is needed to different users such as experts, emergency response specialists, and decision makers.



All ensemble members (concentration plots)



Optimal visualization products?

MeteoSwiss