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Bundesamt für Meteorologie und Klimatologie MeteoSchweiz

Challenges for a new ensemble prediction system for 5 day-forecasts at MeteoSwiss

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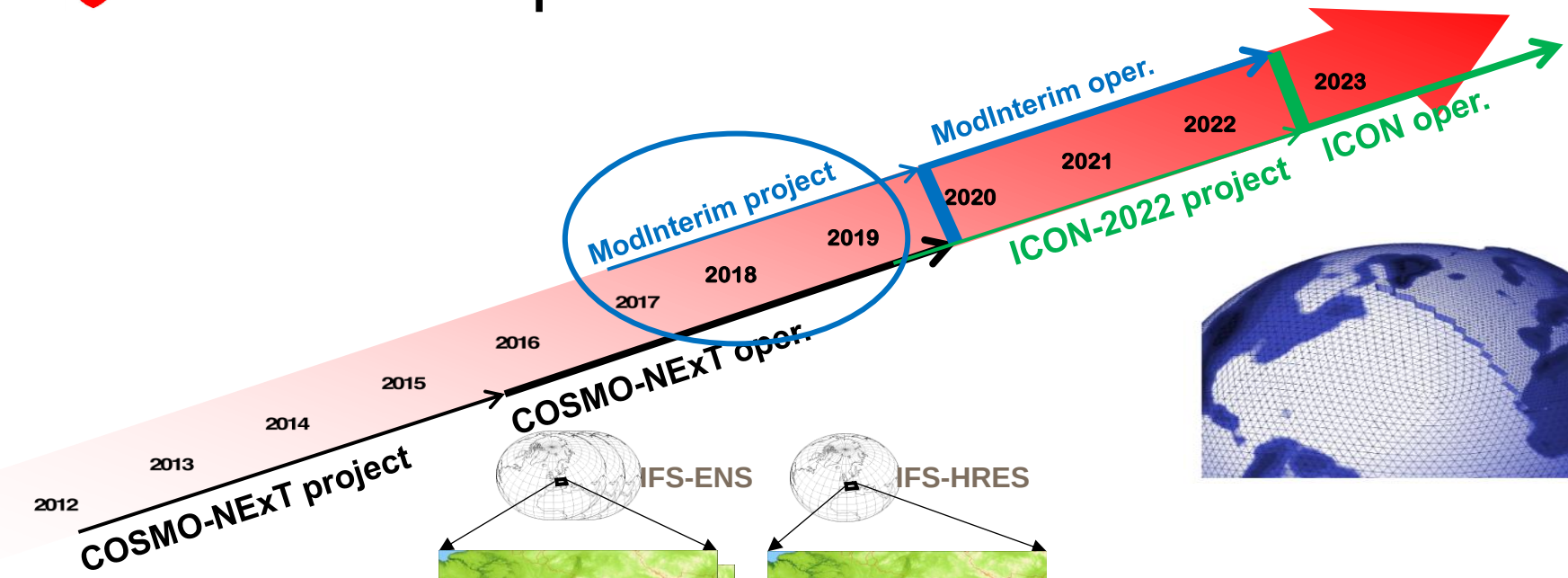
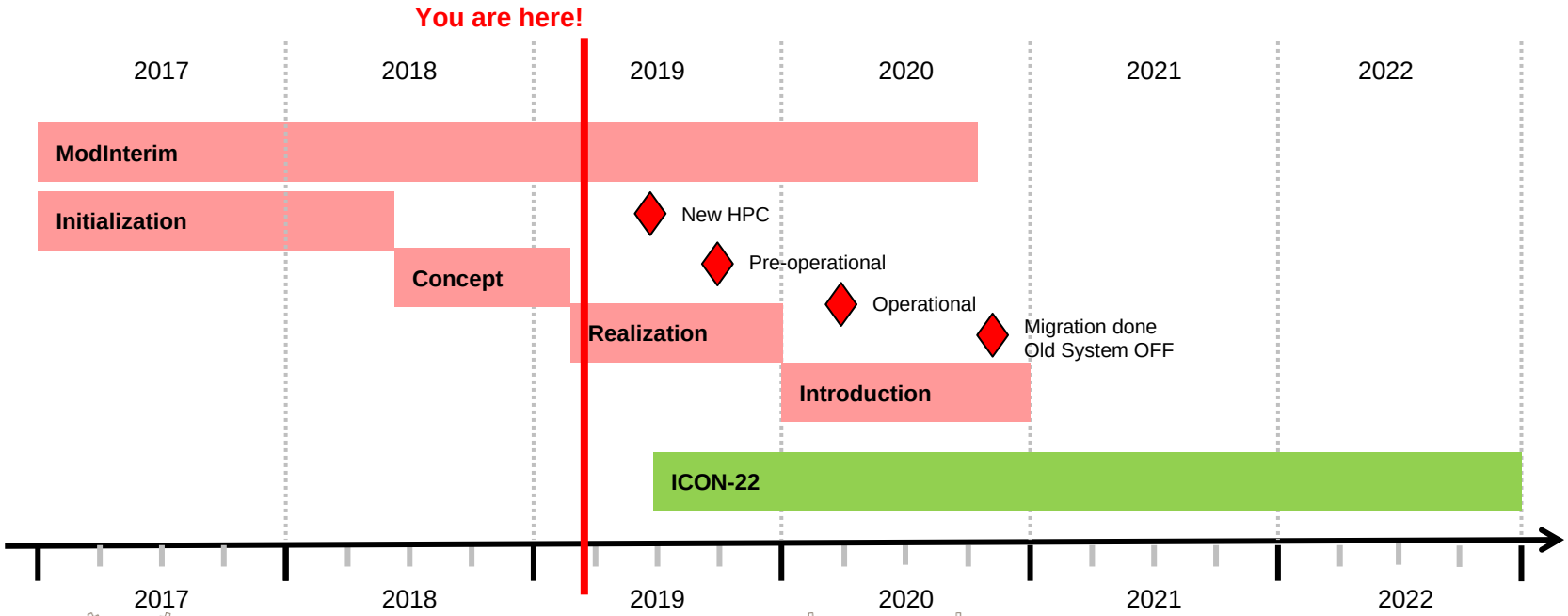
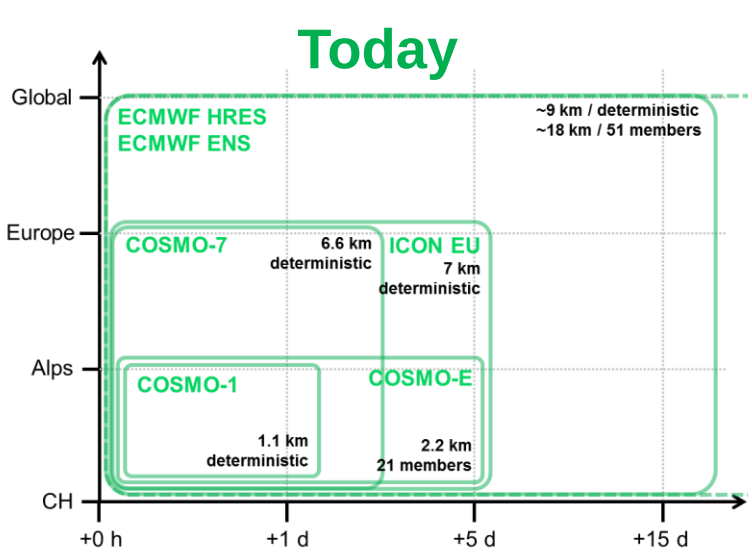
Roadmap Models

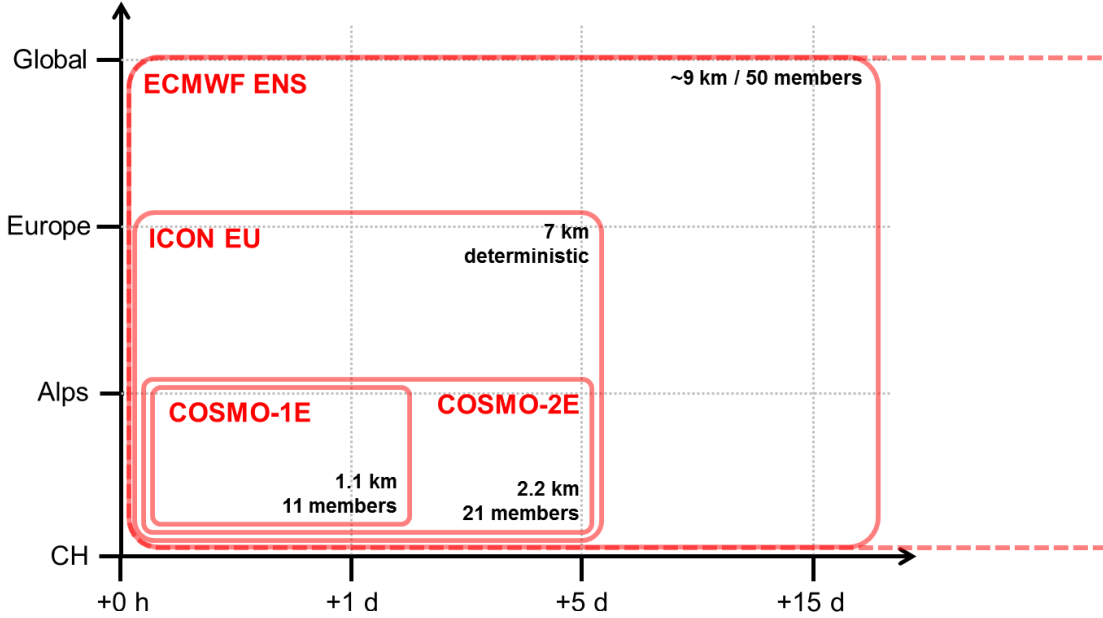


Where are we?


You are here!
2017
2018
2019
2020
2021
2022
ModInterim
Initialization
Concept
Realization
Introduction
ICON-22
New HPC
Pre-operational
Operational
Migration done
Old System OFF
2017
2018
2019
2020
2021
2022

What's new in **ModInterim**? 1/2





➡ Only **ensembles** for COSMO and IFS

➡ **Data Assimilation** (KENDA) **only** at 1.1km

What's new in **ModInterim**? 2/2

- Analysis **without** nudging
  - KENDA @ 1.1km with 40 members
  - **Upscaling** to 2.2km for COSMO-2E
- **Short range**: **COSMO-1E**
  - 8x per day (00, 03, 06, 09, 12, 15, 18, 21 UTC)
  - Lead time to **+33h** (03 UTC to **+45h**)
  - Aim: products between 1:15h and 2:30h/2:45h after initialization
- **Early medium range**: **COSMO-2E**
  - **4x per day** to **+120h**=+5d
  - Aim: products between 2:10h and 3h after initialization
  - Use ICON-EU for certain products and switch off COSMO-7
- **Late** medium range: **IFS-ENS** @ ~9km for some members
  - **2x per day** to **+15d**

What is “seamless” ?

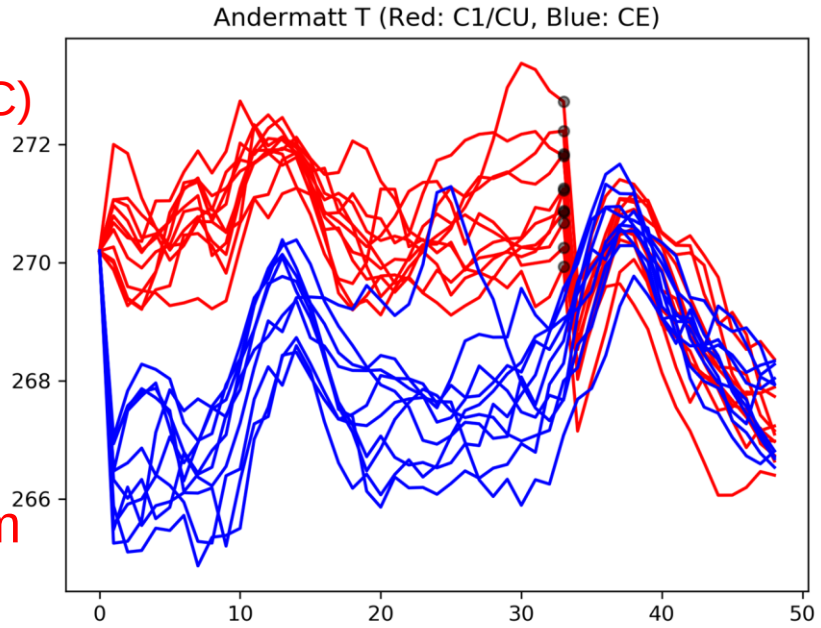
- In the concept phase, we planed to have a seamless solution between 1.1 and 2.2 km resolution models.
- Requirements for seamless ModInterim products:
  - No spin-up after upscaling (ok)
  - Same **bias** in 1.1 and 2.2 km members (?)
    → seamless across resolution
  - **Bias** remains the same after upscaling (?)
    → seamless across lead-time

Seamless across resolution…

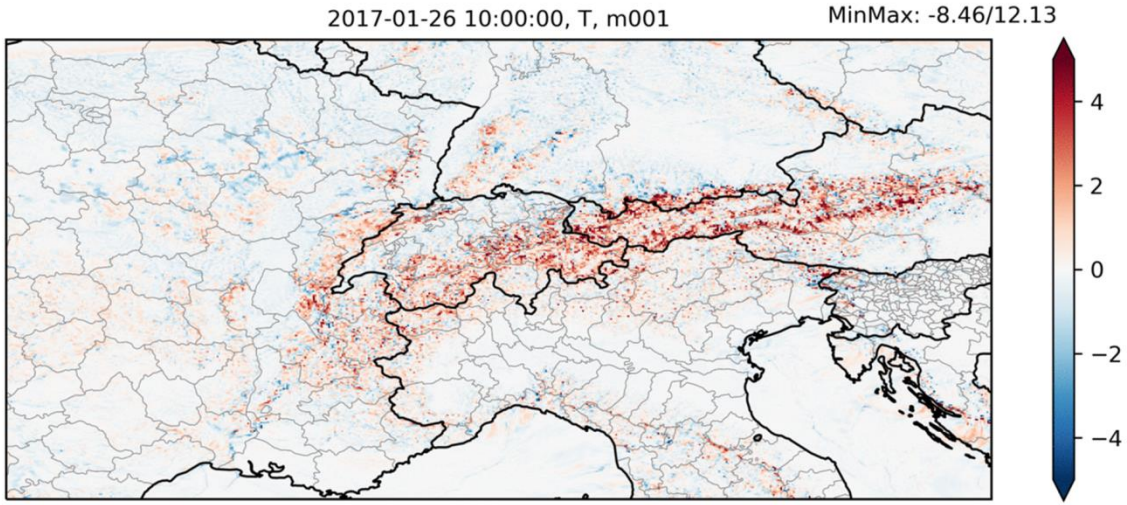
- Test with:
  10 Members @1km +0h to +33h (9UTC)
  10 Members @2km +33h to +120h (upscaled)
  11 Members @2km +0h to +120h

➢ not fulfilled at several stations in **complex topography**

➢ 2 clusters clearly visible until 1.1 km members are upscaled to 2.2 km



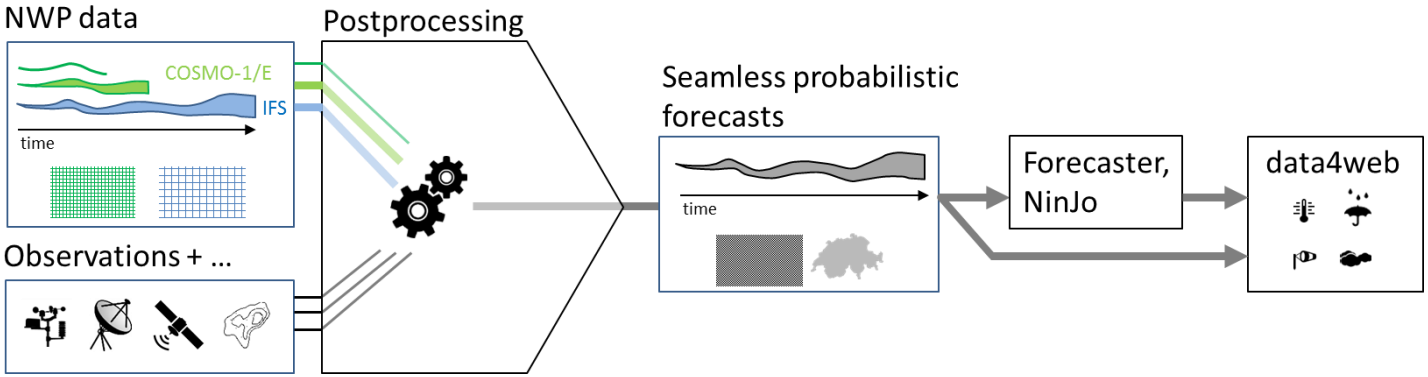
Seamless across lead-times…



Grid points with large temperature difference of up to 12 K between 1.1 and 2.2 km run 1h after upscaling (10 UTC)

➡ Move seamless option to another project

Seamless as part of «PostprocVeri» project



- Postprocessing of 2D, probabilistic, seamless forecasts for basic variables (temperature, dew point, precipitation, clouds, wind)
- Replacement of legacy postprocessing (Kalman-Filter)
- Implementation into existing production chain (data4web)
- Introduction of systematic verification of the whole production chain
- Recommendation of new headline scores

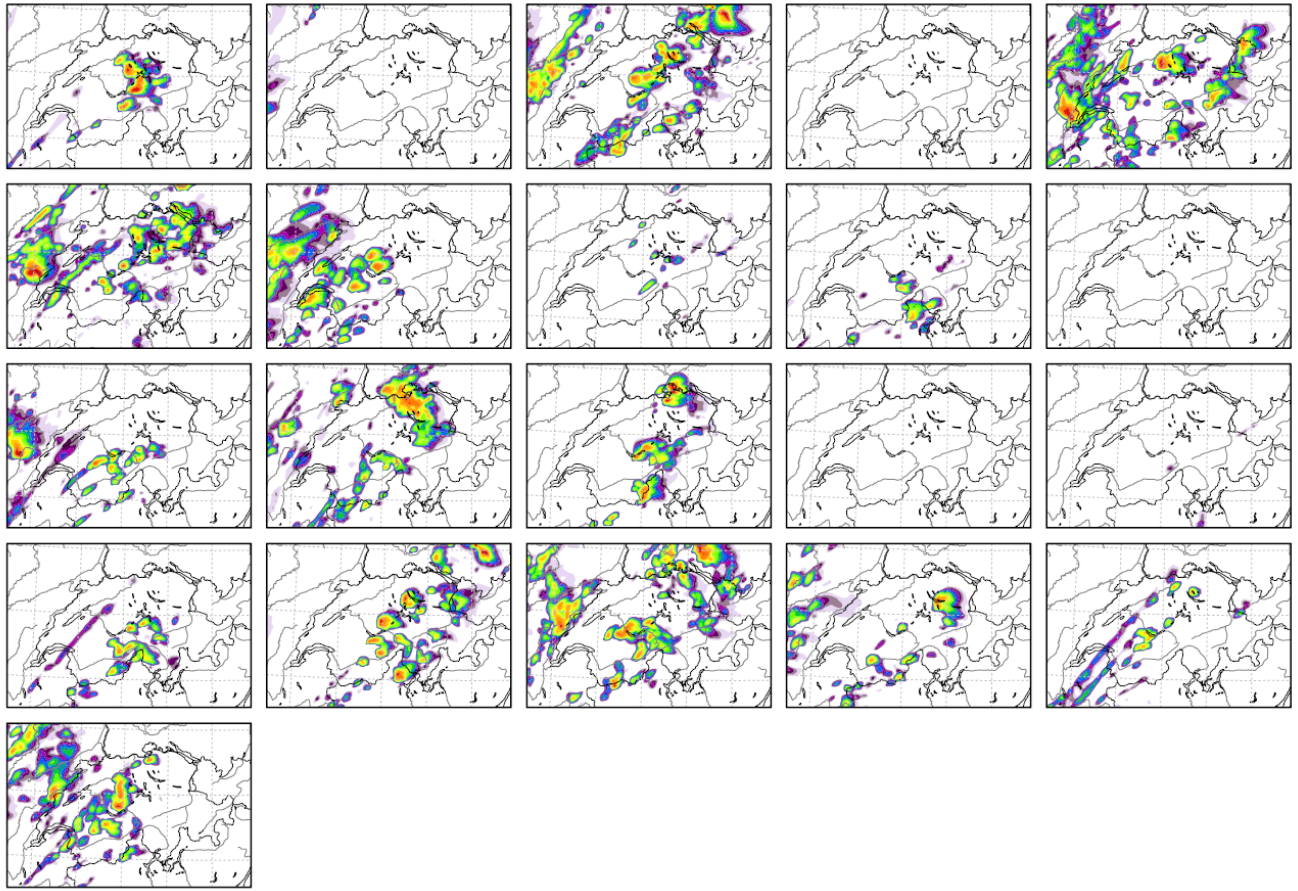
From M. Liniger, Chr. Spirig

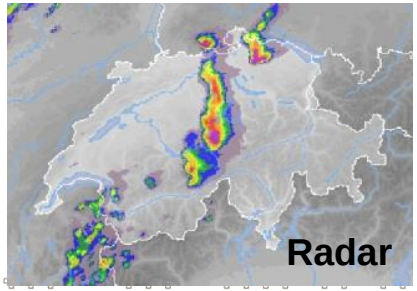
1.1 km vs. 2.2 km Ensemble

Case study 1.8.2017

Reference 2.2km with SPPT

Snapshot at 16UTC (+16h)



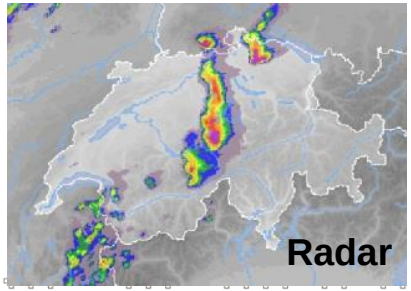


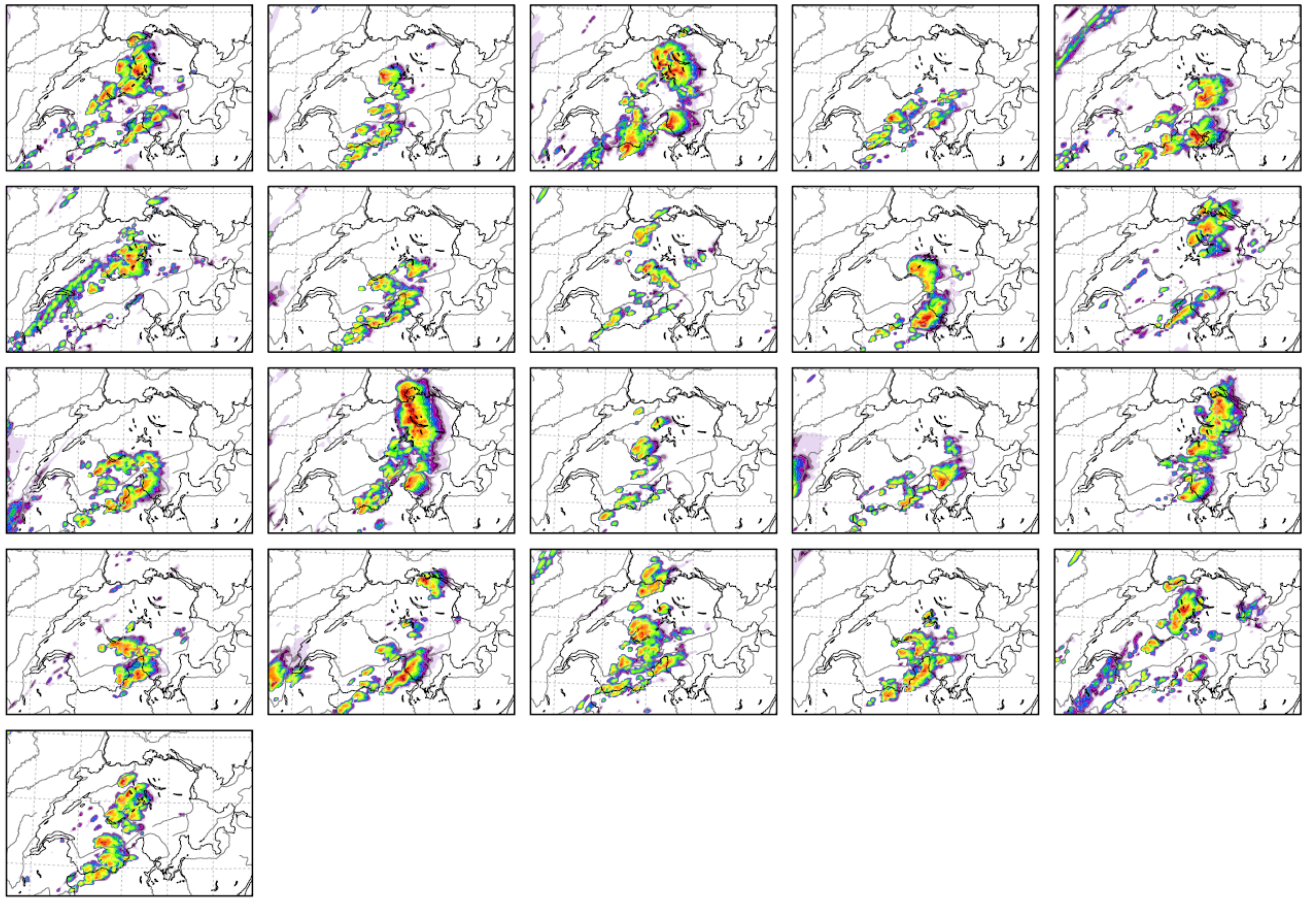
1.1 km vs. 2.2 km Ensemble

Case study 1.8.2017

Experiment 1.1km without SPPT

Snapshot at 16UTC (+16h)

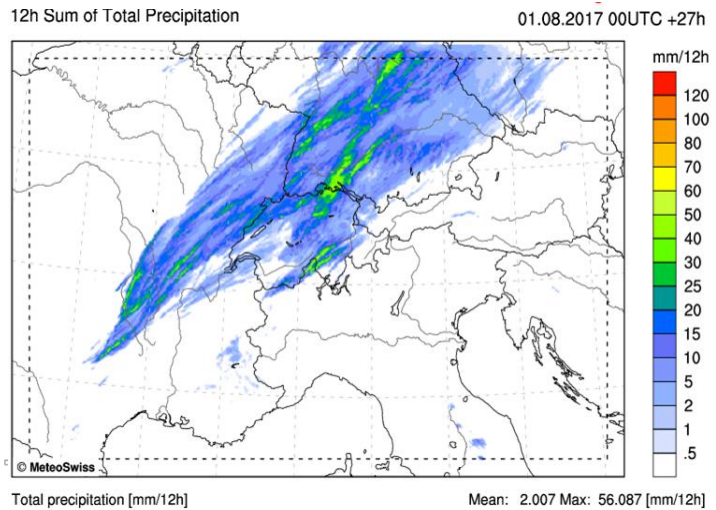




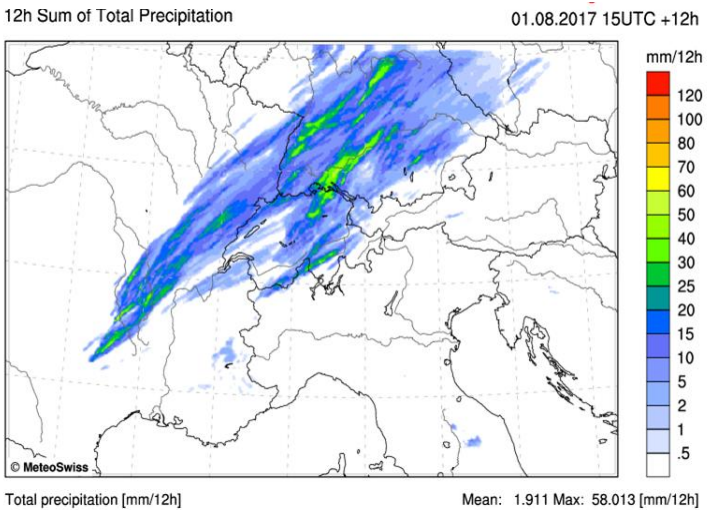
Upscaling Experiment

- Reference: 1.1km Forecast
- Experiment: Forecast started from an upscaled 1.1km forecast (here at 15UTC)
- Works well for many variables, but problems with T2m as shown on slide 7

Reference (1.1km)



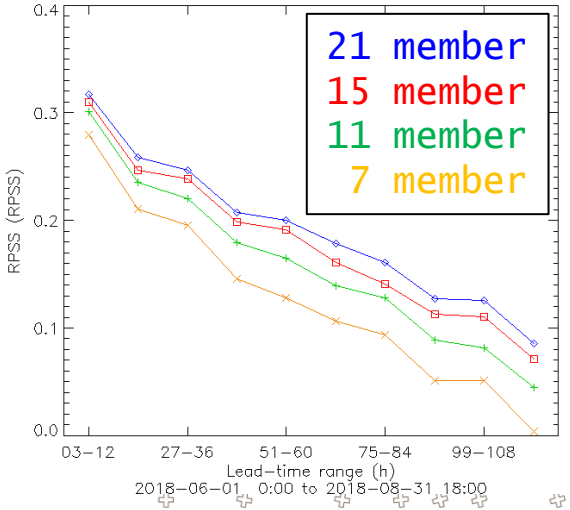
Experiment (2.2km)



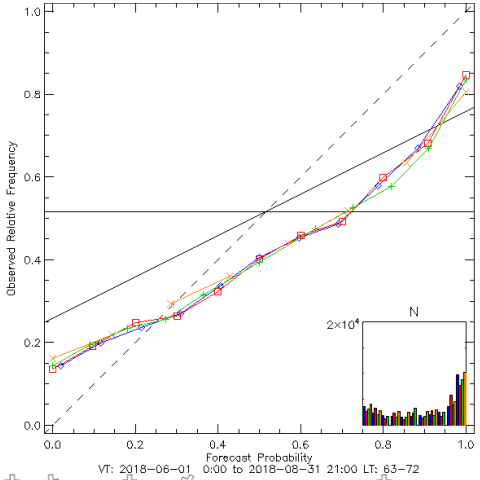
Number of Ensemble Members

- Verification experiment with operational COSMO-E
- Using first 7, 11, 15 and 21 members

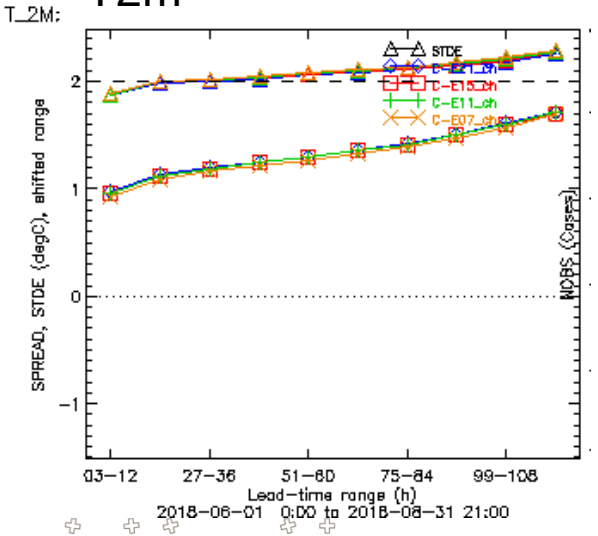
Precipitation



Clouds @ +63-72h

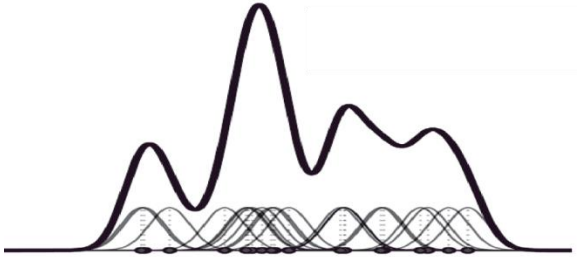


T2m



Probabilities from small ensembles

- Since the COSMO-1E ensemble has 11 members only, probability forecasts can potentially be **improved** by **statistical methods** (below) or by using the time lagged forecasts (**LAF**) members.



- Approach:
  - consider an ensemble as merely a source of information rather than possible scenarios of reality
  - derive a **kernel density estimation** (KDE) from the individual ensemble members
- Benefit for Gaussian parameters like temperature (e.g. Broeckner et al., 2008)
- However, KDE for non-Gaussian parameters like precipitation not straightforward

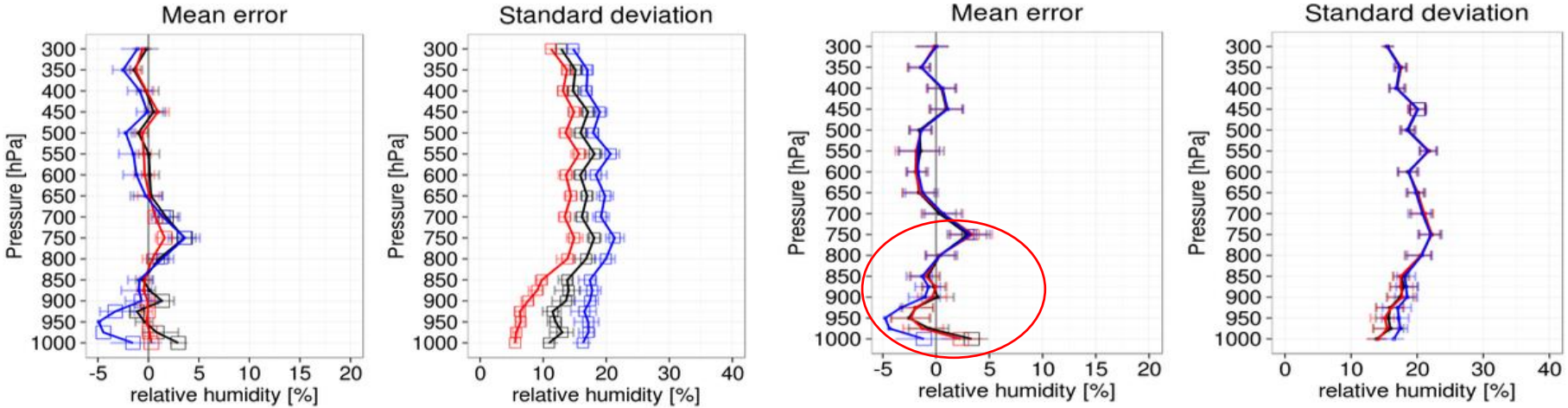
Data Assimilation

- Change from **Nudging** at 1.1 km to **KENDA**
  - Nudging draws model closer to observations, but quality of +12 h forecasts similar
  - Additive Covariance Inflation (ACI, operational since 16.10.2018)
  - First Guess Check (operational since 20.12.2018)
  - Retuning of Observation errors (on going) and Mode-S aircraft data (soon)
- **New observations**:
  - Temperature and humidity (T2m and RH2m) and from :
    - Raman lidar (profiles)
    - Microwave radiometer (Brightness Temperature)
    - MeteoDrones (profiles)

KENDA vs. Nudging

COSMO-E CTRL and Nudging Forecast verification against Radiosondes

Winter 2018/2019 Relative Humidity



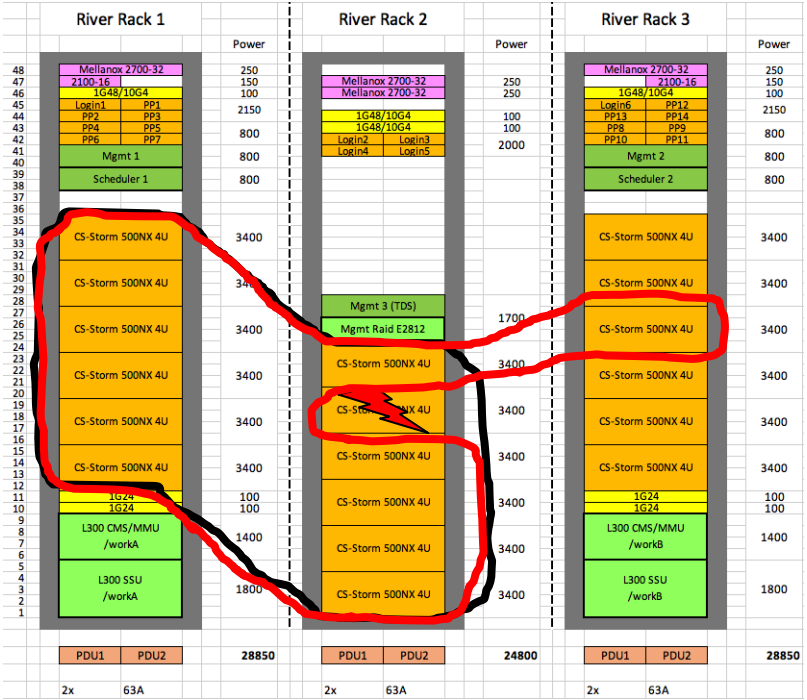
KENDA OPR

Nudging

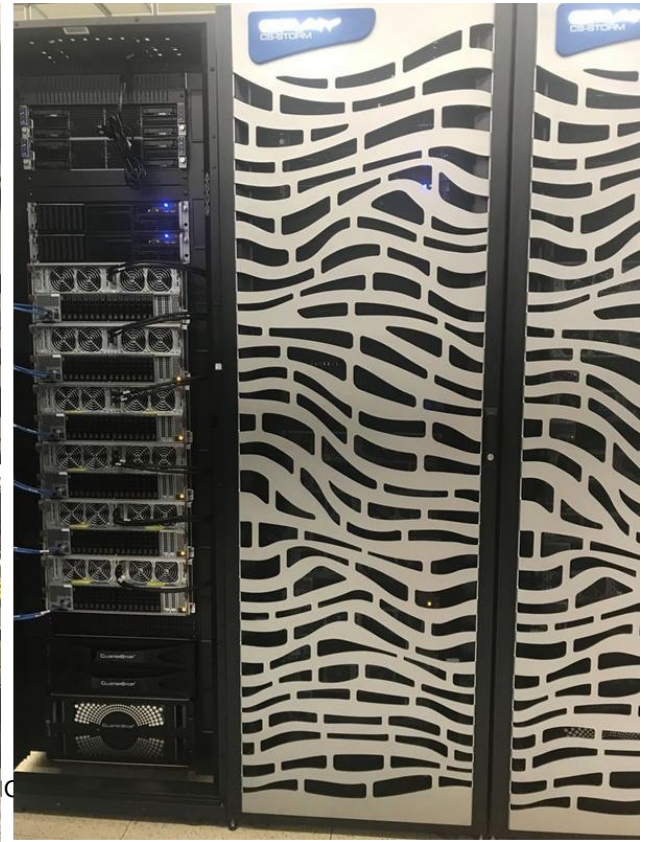
No-Obs

Lifecycle High Performance Computer CSCS

- Upgrade dimensioned to solution:
  - Cray CS Storm with **3 racks**
  - 18 compute nodes with each
    2 INTEL Skylakes CPU and
    8 NVIDIA V100 GPU (32GB)
  - **Latest Tesla Generation**
  - 14 PP and 6 login nodes with
    2 INTEL Skylakes CPU
- **Redundant** system:
  - Only 50% redundancy for compute nodes
  - New Failover-Procedure



New Computer has arrived @ CSCS



Next steps

- Q2 2019 Finish HPC system installation at CSCS
- Q3 2019 Pre-operational phase
- Q3 2020 Operational
- Q4 2020 Removal of old system

Conclusions

- **All lead times are probabilistic !**
- **No COSMO-7**
- **No Nudging** but **KENDA** (1**K**m scale **EN**semble **D**ata **A**ssimilation) (no alternative to produce an ensemble)
- **Ensemble analysis @ 1km** every hour
- A lot of work to migrate: new system, production, products and clients, etc.

Thank you for your attention and **questions**?