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Progress of the COSMO-NExT Project

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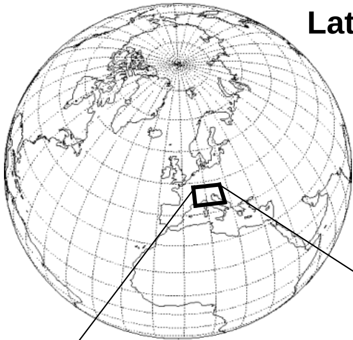
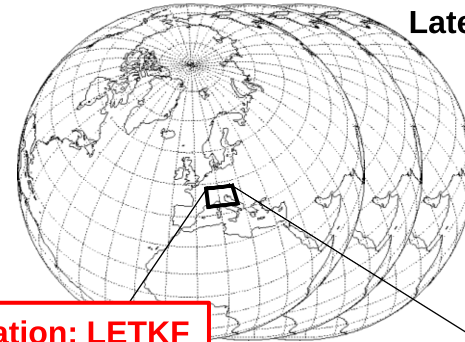
for the COSMO-NExT project team

Swiss COSMO User Workshop
January 18, 2016

COSMO-NExT: The two NWP Systems



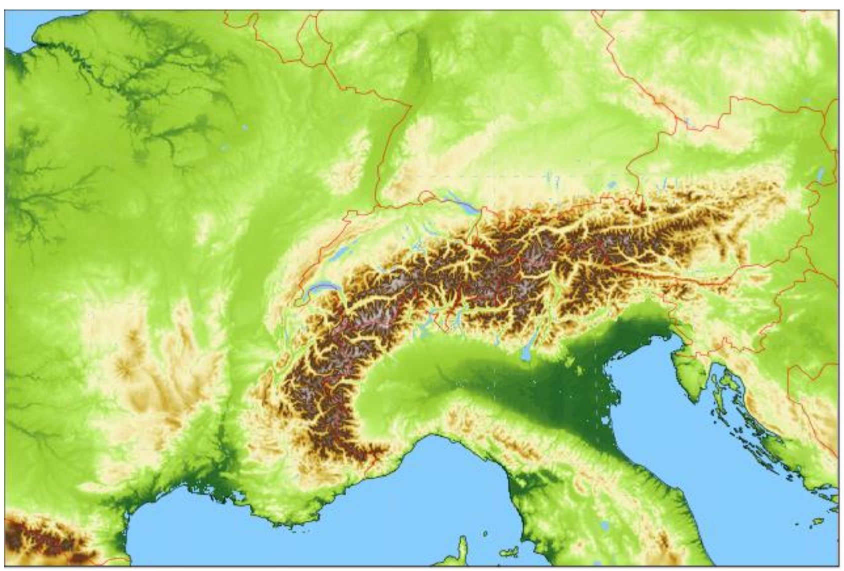
Lateral boundary conditions:
IFS-HRES
9km
4x per day



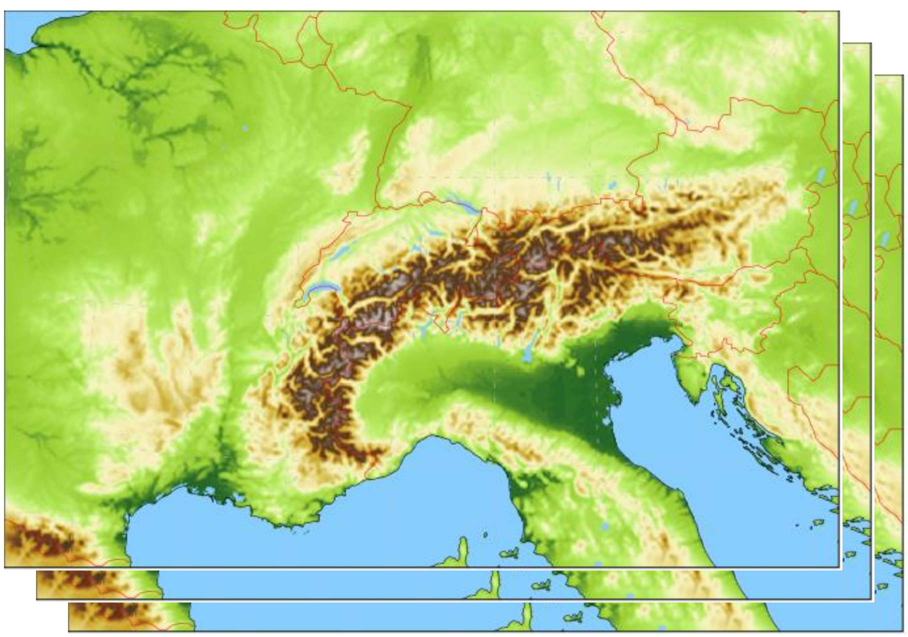
Lateral boundary conditions:
IFS-ENS
18km
4x per day

ensemble data assimilation: LETKF

COSMO-1: 33 hour forecasts, 8x per day
1.1km grid size (convection permitting)



COSMO-E: 5 day forecasts, 2x per day
2.2km grid size (convection permitting)
21 ensemble members



Project Overview and Status

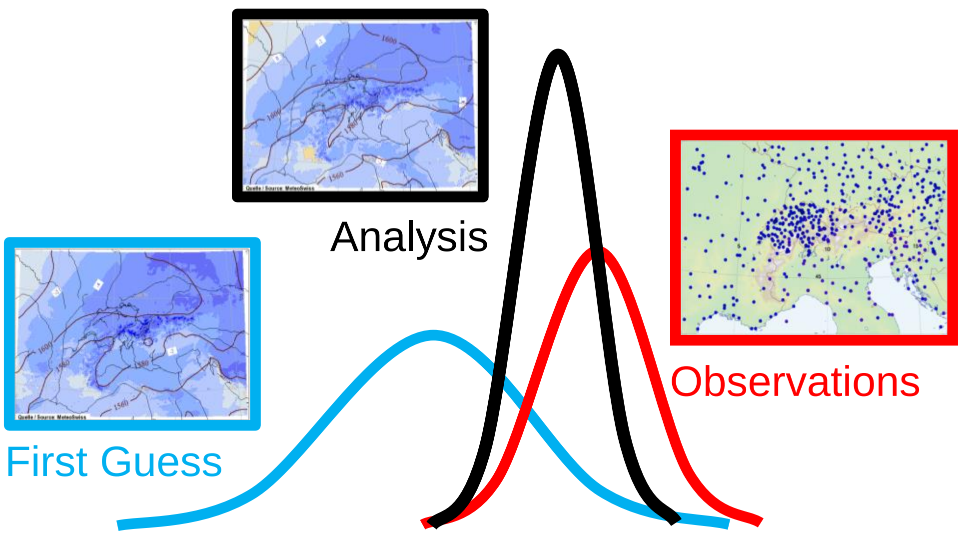
- KENDA (Ensemble Data Assimilation)
  - Provides 2.2km ensemble initial conditions for pre-operational COSMO-E since Dec 2015

- COSMO-1
  - Pre-operational deterministic 1.1km forecasts since Sept 2015

- COSMO-E
  - Pre-operational 2.2km ensemble forecasts since Dec 2015
  - see also talk by Christina

KENDA:
km-scale ensemble data assimilation

Replace current COSMO nudging assimilation system with a new, state-of-the-art Ensemble Kalman Filter (**LETKF**: **L**ocal **E**nsemble **T**ransform **K**alman **F**ilter)

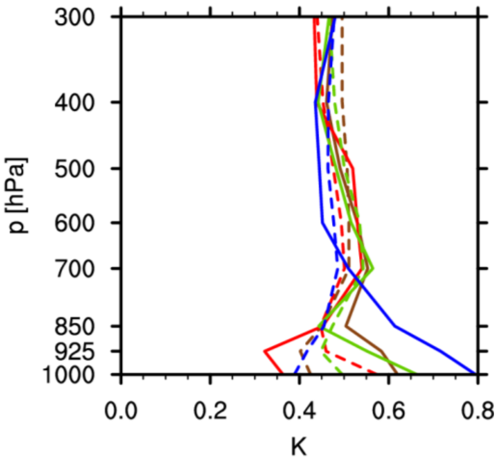


Better analysis through

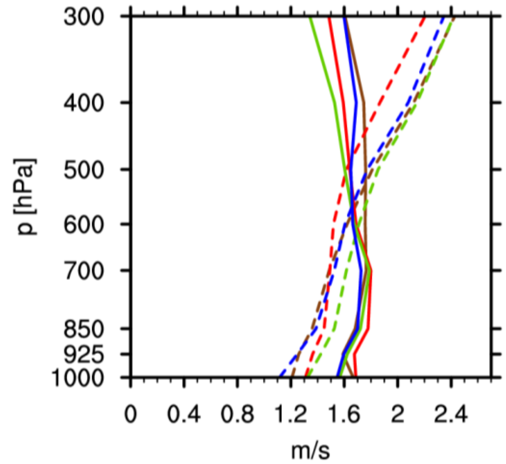
- optimal combination of model and observations based on error statistics;
- flow-dependent background error statistics based on ensemble;
- much more flexibility in using new observations!

Seasonal Spread-Skill Relation

Temperature (AIREP)

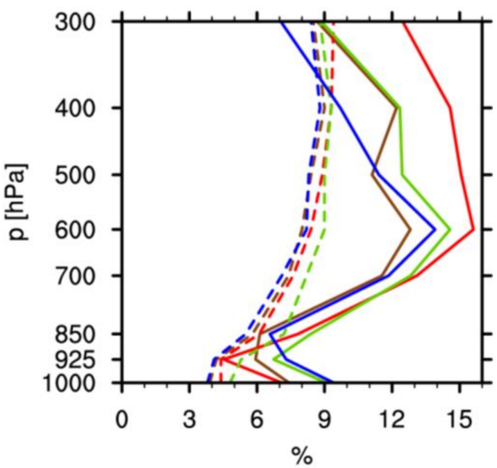


Wind speed (AIREP)

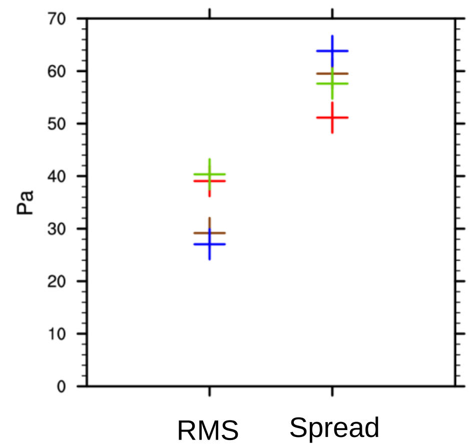


---- Spread
—— RMS

Humidity (TEMP)



Ps (SYNOP)

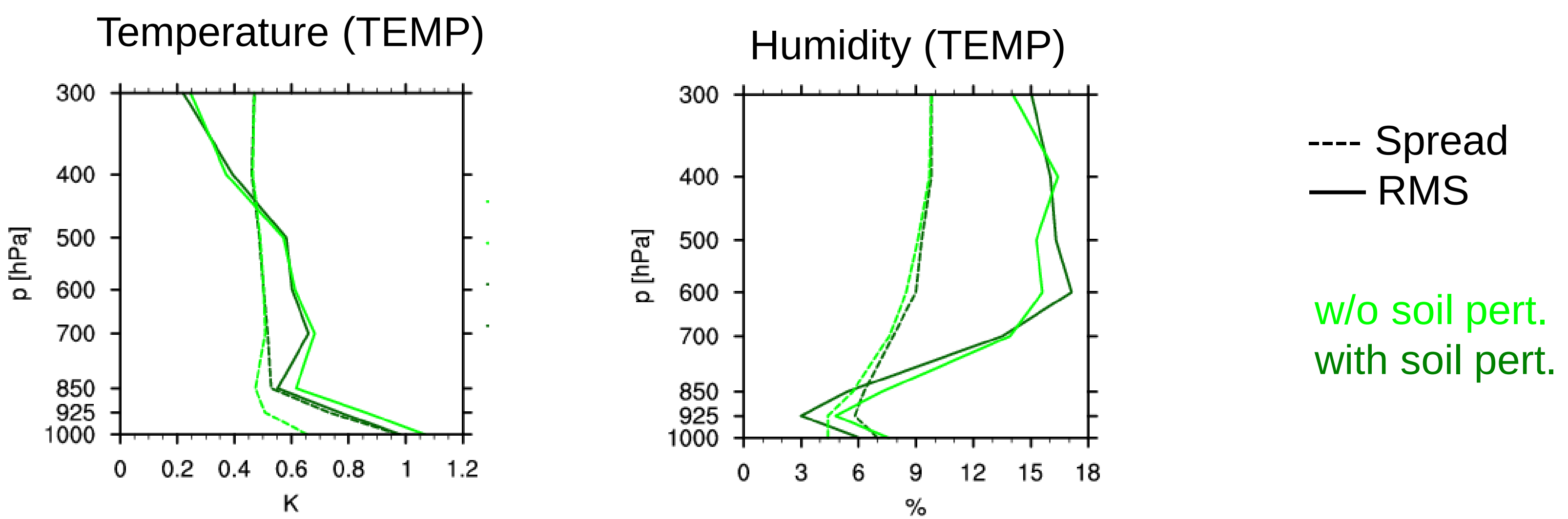


Winter (DJ)
Spring (MAM)
Summer (JJA)

Obs error is taken into account in RMS !

Soil Moisture Perturbations

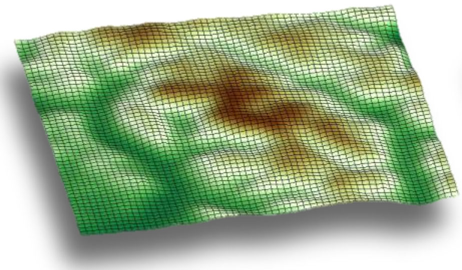
- Insufficient spread in PBL
- Soil moisture perturbations help to increase near-surface spread
- Near-surface observations get more weight in analysis

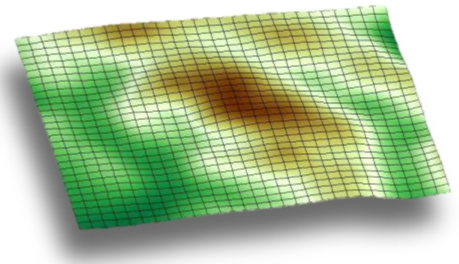


KENDA: Next steps

- Compare stochastic physics in assimilation cycle with soil moisture perturbations to account for model errors
- Investigate performance of COSMO-1 deterministic analysis (comparison against current nudging analysis)
- Include more observations in analysis
  - 2m temperature and humidity (see talk of Tobias)
  - Mode-S aircraft obervations
  - Temperature and humidity profiles from radiometer / lidar
  - Radar radial winds and volume reflectivity
  - Satellite radiances

COSMO-1



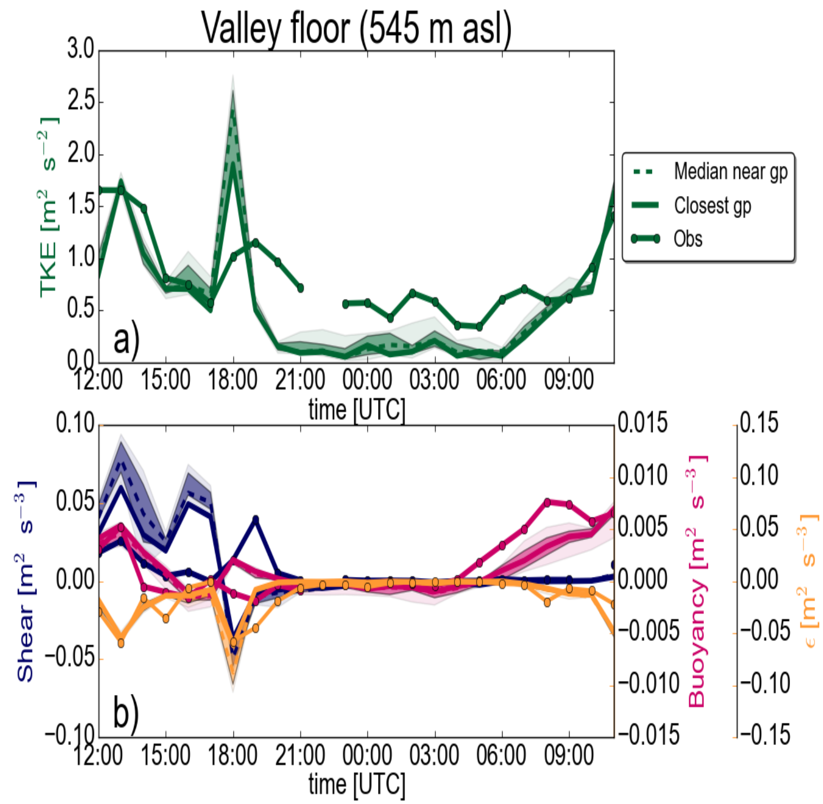


- **Deterministic forecasts** with convection-permitting resolution (1.1 km mesh-size)
- **Rapid update cycle** with new forecast every 3 hours
- On demand mode for key clients
- Elapsed **time on new GPU machine**: 34min for +33h forecasts
- Skill is **better than or equal to COSMO-2** in most parameters and seasons

Turb-i-Box Project

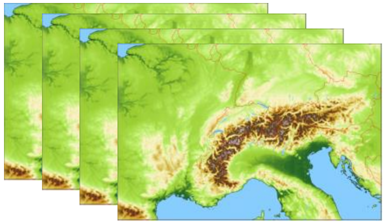
- Comparison of COSMO-1 with ground measurements in the Inn Valley and Payerne
- collaboration with Prof. M. Rotach from University of Innsbruck
- COSMO-1 underestimates overall TKE, but catches well the TKE budget terms

Case study of 11.6.2014



Brigitta Goger, Uni Innsbruck

COSMO-E



- COSMO: convection-permitting resolution (2.2 km mesh-size, 60 vertical levels); 21 members
- perturbations
  - initial conditions: from ensemble data assimilation system
  - lateral boundary conditions: from IFS-ENS
  - model error: Stochastic Perturbation of Physical Tendencies (SPPT)
- provides “best estimate” and forecast uncertainty
- Elapsed time on new GPU machine: 100min for +120h forecasts
- Skill is clearly better than COSMO-LEPS and at least as good as COSMO-2 in most parameters and seasons

Summary

- Locally **more detailed and more accurate deterministic forecasts**: **COSMO-1**
- **probabilistic forecasts providing information on forecast uncertainty**: **COSMO-E**
- **better data assimilation system**, eventually including more observational data (e.g., satellites) and resulting in more accurate analyses and forecasts: **KENDA**
- all systems planned to be operational in Q2 2016 discontinuation of COSMO-2 in Q4 2016

Current and former COSMO-NEXT People

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