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Operational Convective-Scale Ensemble Data Assimilation at MeteoSwiss

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Objectives

In May 2016, MeteoSwiss introduced a new, convection permitting NWP EPS system consisting of an Ensemble Data Assimilation (KENDA) based on the Local Ensemble Transform Kalman Filter (LETKF) and a Forecasting System (COSMO-E).
Here, we show selected pre-operational results and the benefit of additional ways to account for model uncertainty: Stochastic Perturbations of Physical Tendencies and Soil Moisture Perturbations

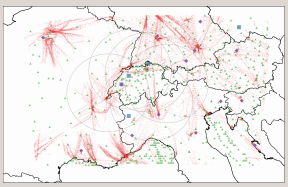
KENDA Setup

COSMO model (Δx=2.2km, 60L) (Baldauf et al., 2011)
- 40 analysis members, 20 forecast members
- Additional deterministic analysis and forecast
- Hourly analysis cycle
- Forecasts out to +12h

LETKF (Hunt et al., 2007, Schraff et al., 2016)
- Adaptive localization
- Adaptive multiplicative covariance inflation
- Relaxation to prior perturbations (RTTP)

Lateral Boundary Conditions
- ECMWF IFS ENS and HRES

Observations



- Radiosondes
- SYNOP (p_s only)
- Windprofiler
- Aircrafts
- Radar (with Latent Heat Nudging)

Model domain and geographical distribution of active observations measured during one month

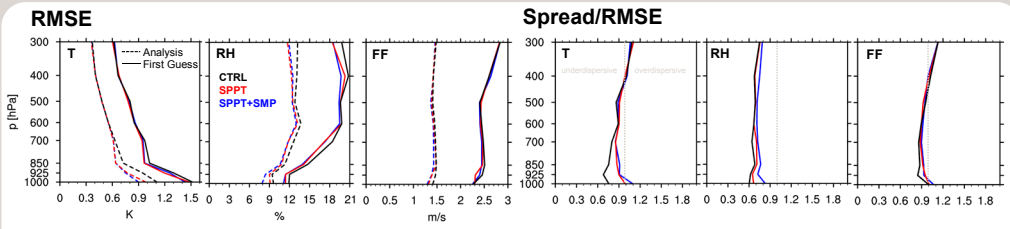
Test Periods

Summer: 17.07.2015 – 28.08.2015
Winter: 08.12.2015 – 14.01.2016

Experiments

CTRL	LETKF as used pre-opr
SPPT	LETKF with Stochastic Perturbations of Physical Tendencies (Buizza et al., 1999; Maurer et al., 2014)
SPPT+SMP	LETKF with SPPT and Soil Moisture Perturbations (Schraff et al., 2016)
Nudging	Old operational DA

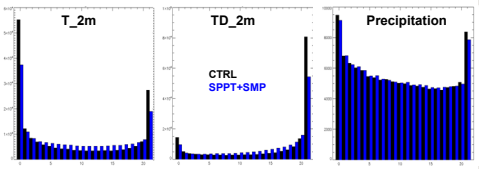
Analysis Performance



Summer period RMSE and Spread/RMSE ratio for temperature, relative humidity and wind speed from LETKF analyses and first guess, evaluated against radiosonde observations. The RMSE in the Spread/RMSE ratio is corrected with the observation error.

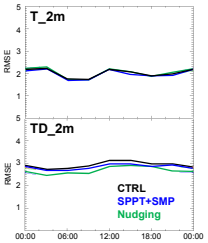
Forecast Performance

Benefit of Additional Perturbations

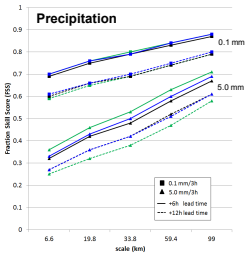


Summer period rank histograms of T_2m, TD_2m and hourly precipitation sums from COSMO-E forecasts, evaluated against SYNOP obs. Average over all leadtimes

Comparison of LETKF with Nudging

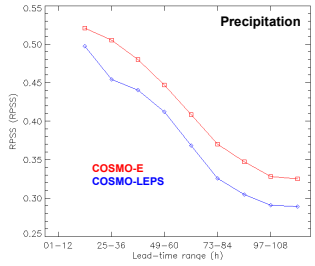


Summer period daily cycle of T_2m and TD_2m RMSE from deterministic forecasts, evaluated against SYNOP obs



Summer period Fraction Skill Scores of 3h precipitation sums from deterministic forecasts, evaluated against gauge-corrected radar obs

COSMO-E outperforms COSMO-LEPS



Spring (MAM) 2016 period Rank Probability Skill Score (RPSS) of 12h precipitation sums from COSMO-E and COSMO-LEPS forecasts

Conclusions

- KENDA deterministic analyses and forecasts similar to nudging analyses and forecasts
- KENDA still slightly worse than nudging for summer TD_2m and precipitation
- SPPT and SMP consistently improve KENDA, benefit larger in summer than in winter period

Outlook

- Assimilation of T_2m and TD_2m
- Deterministic analysis with Δx=1.1km
- Assimilation of more remote sensing observations (Radar, Lidar, Radiometer, Satellites)

References

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