HErZ-DA: Research Group for Data Assimilation

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Project goals

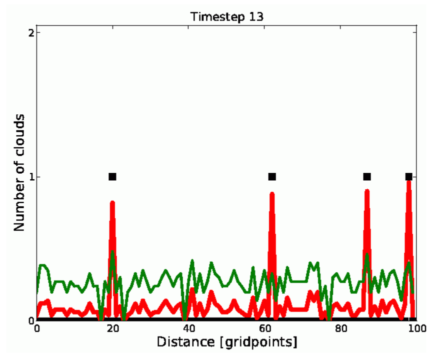
- Finding suitable methods for convective-scale data assimilation and testing promising methods in a hierarchy of idealized models
- Estimating the contribution of observations to the analysis and forecast accuracy (observation impact)
- Using additional non-standard satellite observations
  - MSG VIS+NIR reflectance to improve the representation of clouds
  - CALIPSO lidar observations to correct AMV heights
- Improved representation of uncertainty in the ensemble system (investigating current, EnDA and stochastic BL-scheme perturbations)

Current team

Lead **Post-Docs** **PhD students** **Additional supervisors**

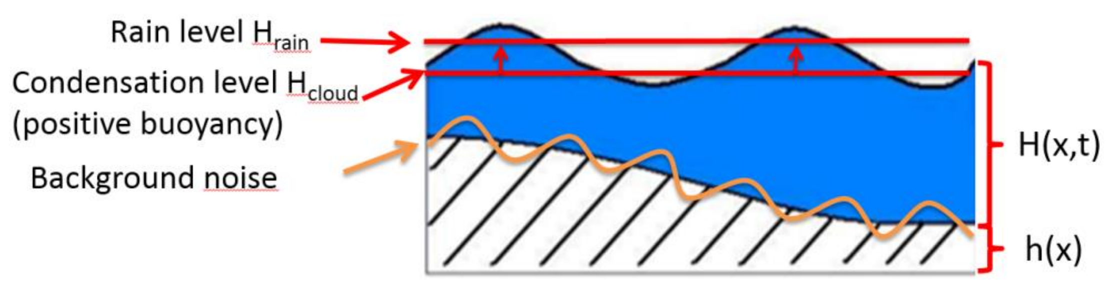
Testing data assimilation methods in a hierarchy of idealized models

Stochastic cloud model



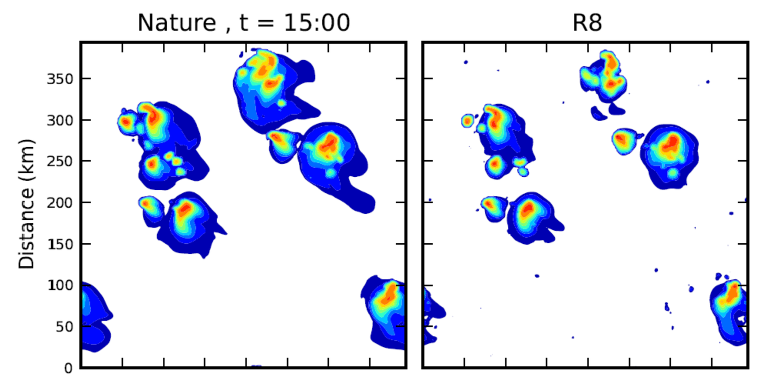
- 1D model, clouds appear and disappear randomly following poisson birth-death process
- The comparison of ETKF, particle filter (SIR) and efficent particle filter shows advantage of particle filtering for this non-Gaussian problem for both short and long lived clouds
- More details in ***Craig and Würsch 2013***

Modified shallow-water model



- SW model with additional upward force when "condensation level" is exceeded and downward force when "rain level" is exceeded
- Resembles life cycle of convection
- Tests with ETKF and efficient particle filter with nudging
- More details in ***Würsch and Craig***

Idealized NWP system

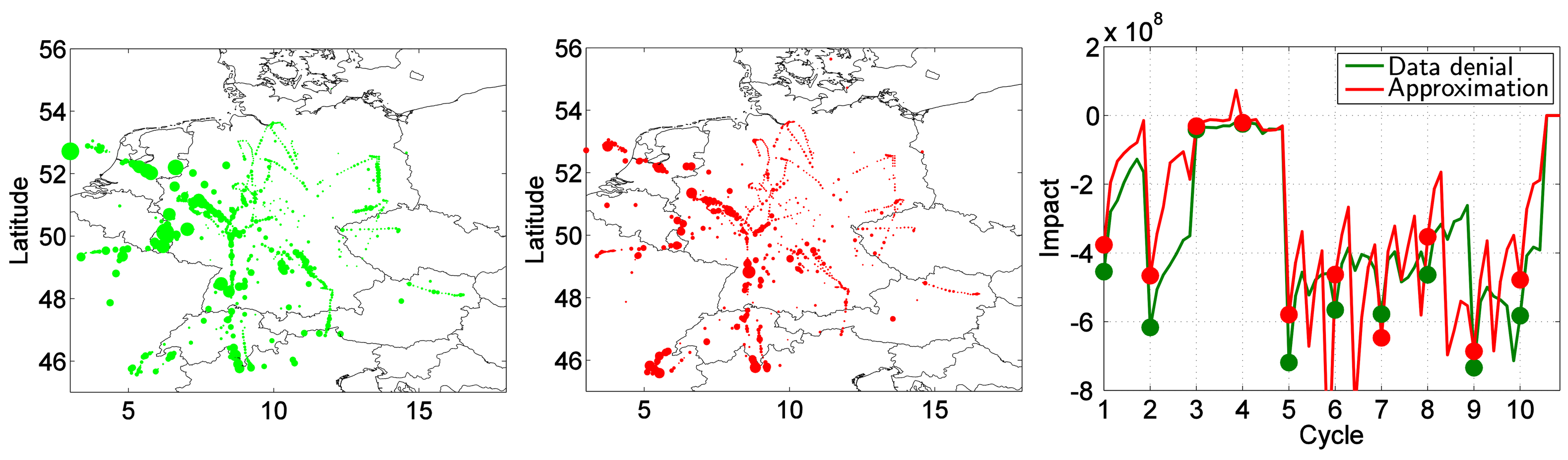


- Non-hydrostatic, convection-permitting NWP model COSMO with idealized initial conditions
- Nature run → simulated observations → analysis
- Testing different data assimilation setups for idealized radar data assimilation within DWD LETKF (KENDA)
- More details in ***Lange and Craig***

References

- Craig, G. and M. Würsch, 2013: The impact of localization and observation averaging for convective-scale data assimilation in a simple stochastic model. Q. J. R. Meteorol. Soc., **139**, 515-523.
- Weissmann, M., K. Folger and H. Lange, 2013: Height correction of atmospheric motion vectors using airborne lidar observations. J. Appl. Meteor. Climatol., **52**, 1868–1877.
- Kühnlein, C., C. Keil, G. Craig, C. Gebhardt: The impact of downscaled initial condition perturbations on convective-scale ensemble forecasts of precipitation. Q. J. R. Meteorol. Soc., accepted.
- Keil, C., F. Heinlein and G. Craig: The convective time-scale as indicator of predictability of convective precipitation. Q. J. R. Meteorol. Soc., accepted.
- Kostka, P., R. Buras, B. Mayer, O. Stiller, M. Weissmann: Observation operator for visible and near-infrared satellite reflectivities. Submitted to J. Appl. Meteor. Climatol.
- Würsch, M. and G. Craig: A simple dynamical model of cumulus convection for data assimilation research. Meteorol. Z., submitted.
- Sommer, M., M. Weissmann: Observation impact in a convective-scale localized ensemble transform Kalman filter. Q. J. R. Meteorol. Soc., submitted.
- Folger, K., M. Weissmann: Height correction of atmospheric motion vectors from CALIPSO. Geophys. Res. Lett., submitted.
- Lange, H., G. C. Craig: On the benefits of a high resolution analysis for convective data assimilation of radar data using a local ensemble Kalman filter, Mon. Wea. Rev., in preparation.

Estimating observation impact



Observations with negative (green) and positive (red) impact *AIREP impact*

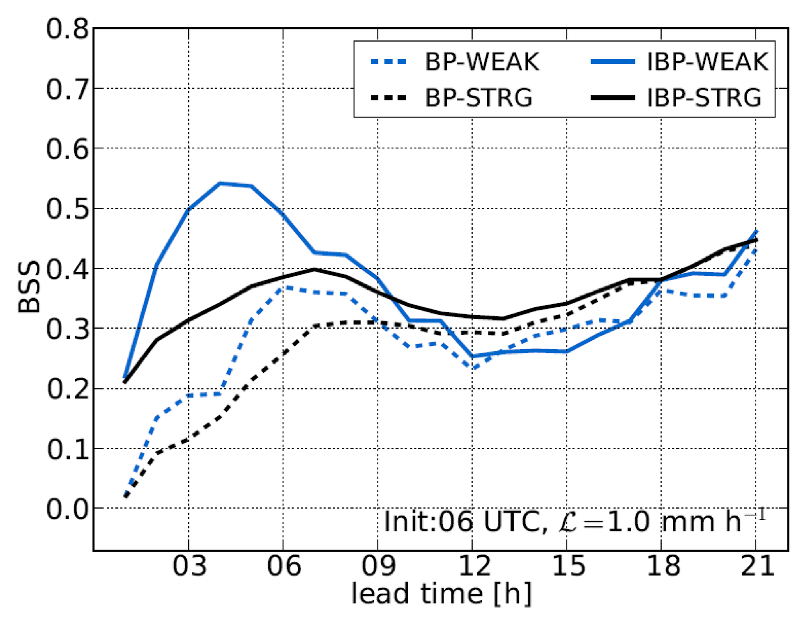
Goal
Assessing the contribution of observations to the reduction of forecast error (observation impact) in a convective-scale data assimilation and forecasting system

Approach
Observation impact is estimated in a computationally inexpensive way using analysis perturbations from the KENDA (Km-scale ENsemble Data Assimilation) system and forecast perturbations from an ensemble of COSMO runs

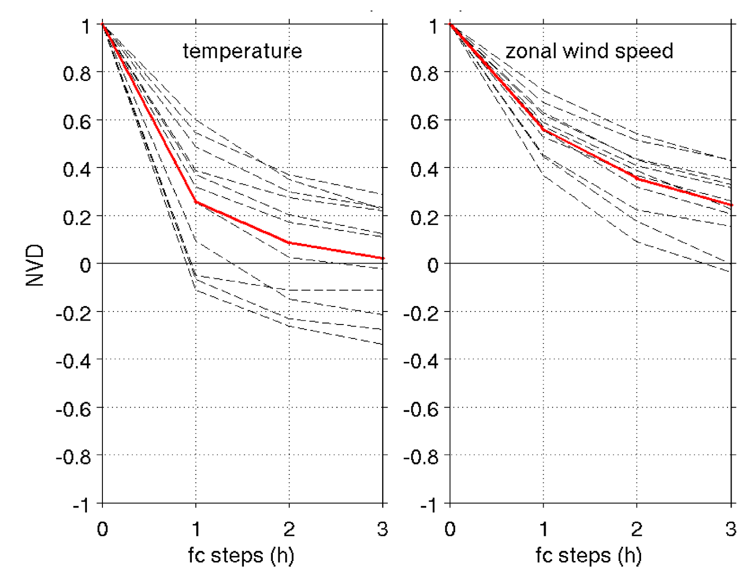
Results
- Observation impact can be efficiently estimated
- The differences of the approximation to data denial results are not significant
- Groups of observation with suboptimal impact can be identified

More details in ***Sommer and Weissmann***

Representation of uncertainty in ensembles

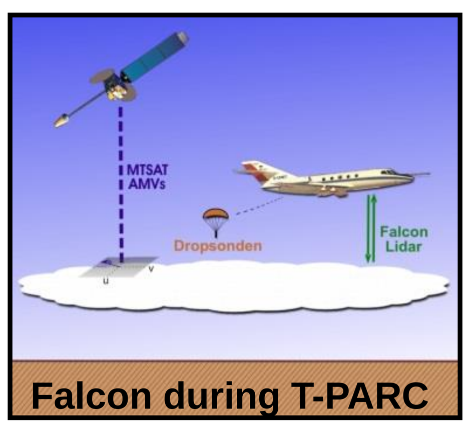


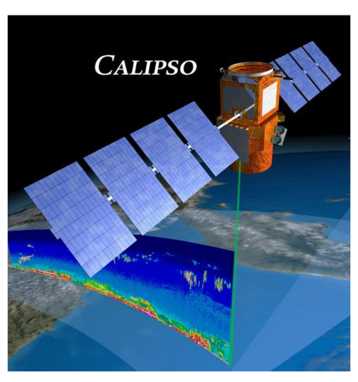
- Brier Skill Score of IBP ensemble vs deterministic COSMO-DE is significantly positive
- COSMO-DE-EPS outperforms deterministic forecast in probabilistic terms
- Current initial condition perturbations add variance and skill up to ~6h, particularly during weak forcing
- Predictability depends on weather regime classified with time-scale of convective adjustment (not shown)
- More details in ***Kühnlein et al.*** and ***Keil et al.***

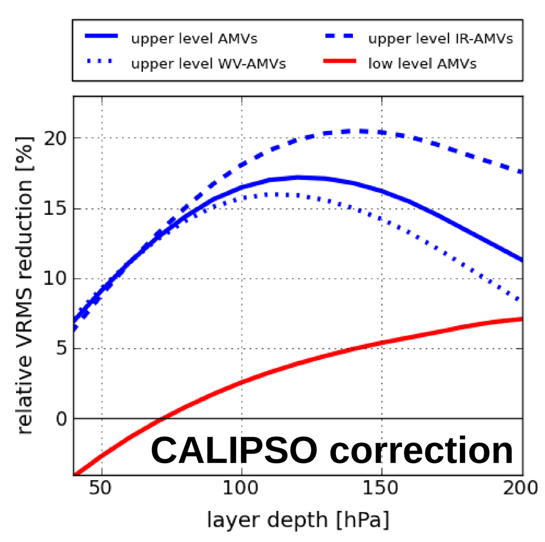


- Normalized variance difference (NVD) for lower troposphere and surface variables is increased using KENDA initial condition perturbations compared to COSMO-DE-EPS
- Ensemble forecasts are less under dispersive
- Neutral impact for mid- to upper-tropospheric variables

AMV height correction



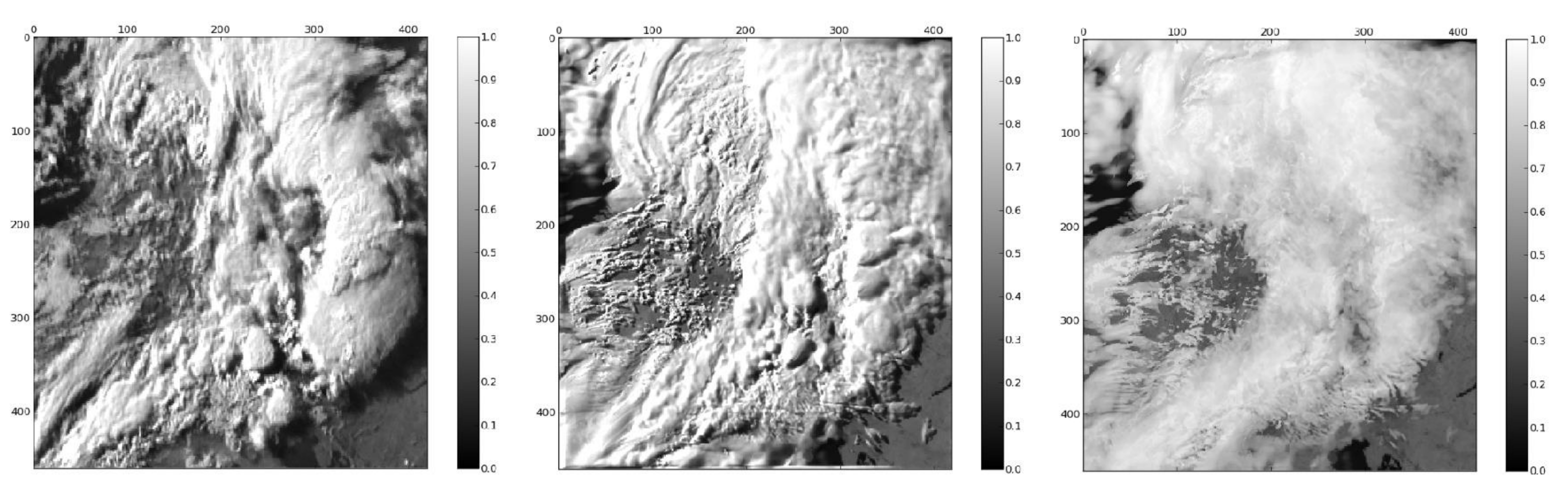




Motivation
- AMVs are the only wind information in many regions
- Height assignment issues are responsible for up to 70% of their error
- Significant error correlation causes rigid thinning of data in NWP
- Lidars provide accurate information on cloud top heights

Approach and results
- Method for lidar correction developed based on T-PARC airborne lidar obs.
- Significant error reduction when AMV heights are corrected with CALIPSO or airborne lidar observations
- AMVs represent wind in a vertical layer
- More details in ***Weissmann et al. 2013*** and ***Folger and Weissmann***

Assimilation of MSG VIS+NIR reflectances



SEVIRI observation **3D simulation** **1D simulation**

Goal: Improved representation of clouds in regional analysis (KENDA-COSMO) by directly assimilating MSG VIS+NIR reflectance

Approach:
- Developing forward operator
- Accuracy assessment
- Assimilation experiments

Results:
- Operator accuracy better 6% (validated with 3D operator)
- First direct assimilation in NWP model technically successful
- Systematic differences of model and obs. need investigation

More details in ***Kostka et al.***