Hans-Ertel-Centre for Weather Research
DATA ASSIMILATION BRANCH

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ON THE LIMITS OF PREDICTABILITY OF CONVECTIVE PRECIPITATION: IMPACT OF OROGRAPHY

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1. BACKGROUND

Lorenz (1969) stated two aspects of predictability:

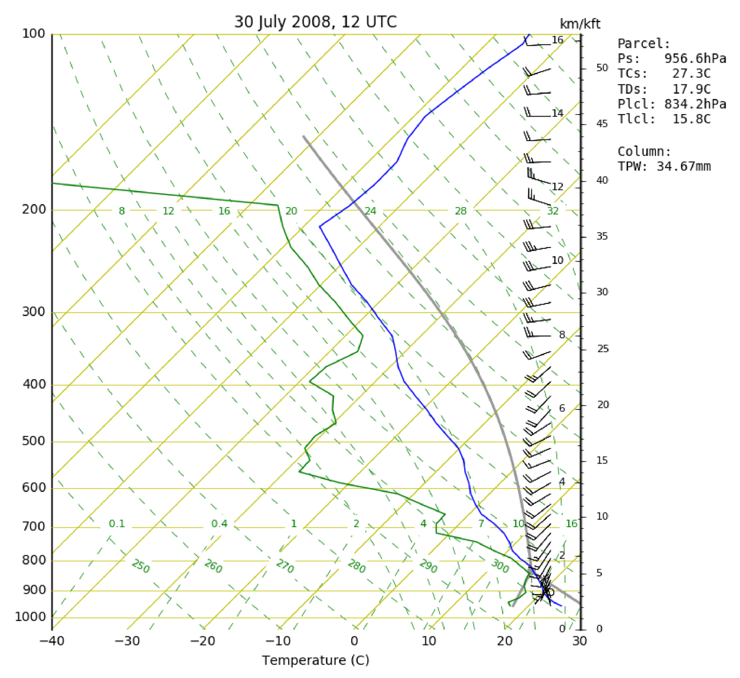
Intrinsic predictability: *'the extent to which prediction is possible if an optimum procedure is used'*
Practical predictability: *'the ability to predict based on procedures and available model error representations currently available'*

- Predictability of convective weather lies in the range of tens of minutes to one hour (Lilly, 1990)
- Surface inhomogeneities (e.g. orography) and weather regime influence predictability (Anthes, 1986)

Research Question:
What impact do various forcing elements, like orography, have on the limit of practical predictability of convective precipitation?

2. IDEALIZED COSMO-KENDA

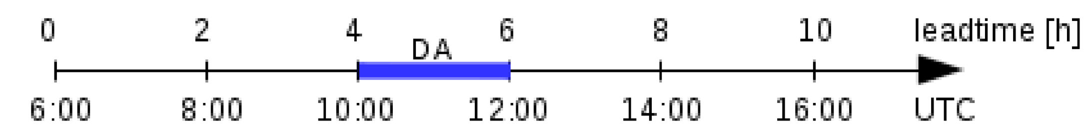
COSMO:
Convection-permitting 50 member EPS (Δx = Δy = 2km)
Domain 400 x 400km with periodic boundaries
Radiation
Surface friction
Horizontal homogeneous conditions:
sounding of Payerne allowing
for organized convection (CAPE=2200 J/kg)
Initial condition perturbations:
temperature: 0.02 K
vertical velocity: 0.02 m/s



Orography:
Gaussian mountain: Δz = 500m,
10.000m half width at (50km, 50km)

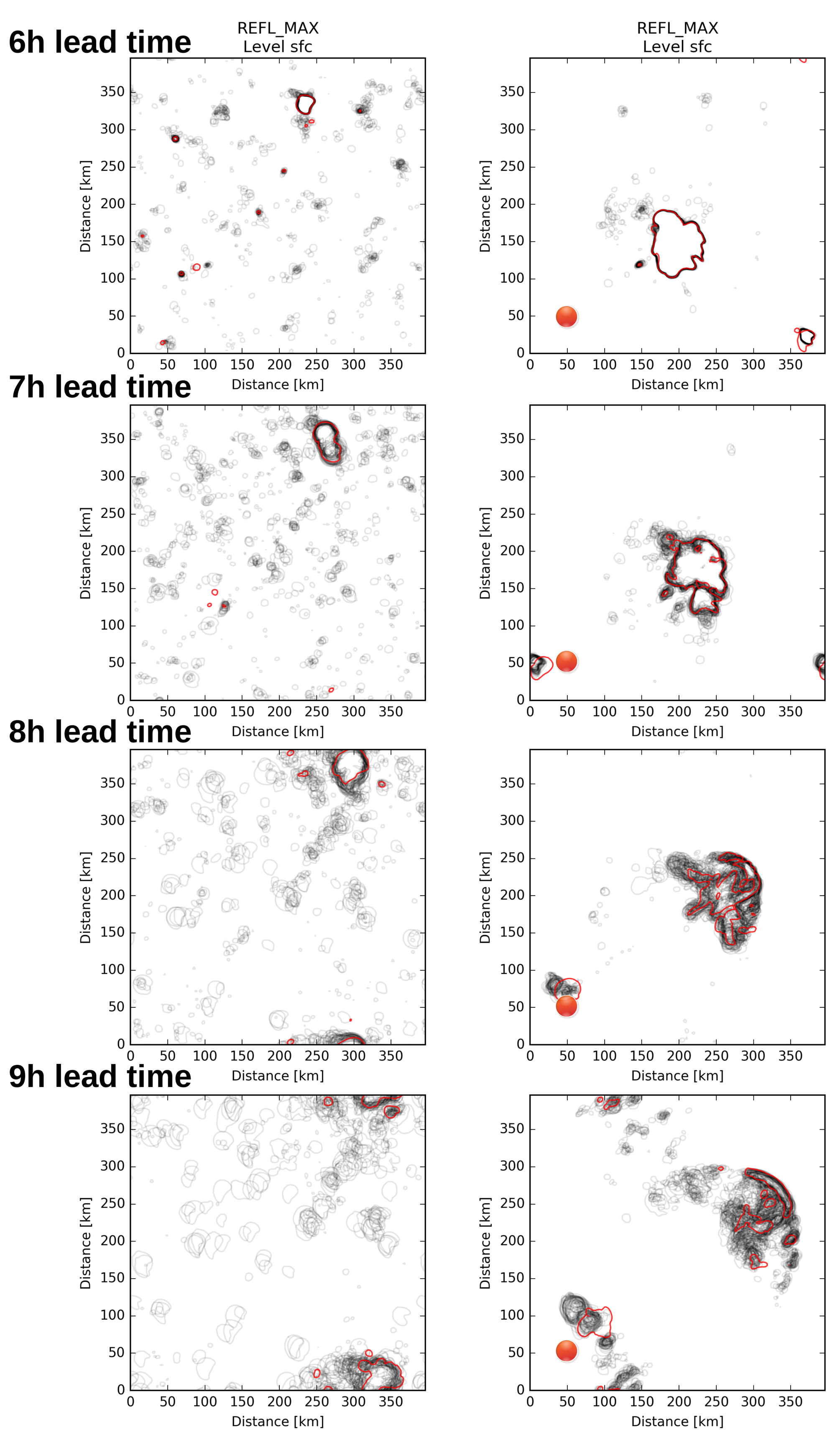
KENDA:
Kilometer-scale ensemble data assimilation based on a Local Ensemble Transform Kalman Filter (LETKF)

Assimilation of synthetic radar observations (REFL and u) masked with a threshold of 5 dBz
(horizontal localization = 8km, superobservation = 4km, cycling = 15min)



3. ENSEMBLE MEMBERS W AND W/O OROGRAPHY

Comparison of the 25dBz isoline of reflectivity (nature run in red) in the domain with and without orography depicts significant diferences:



Without orography:

high variability even directly after the DA cycling

many smaller cells in addition to the main cell

Locations of the small-scale convection diverge over course of the simulation

With orography:

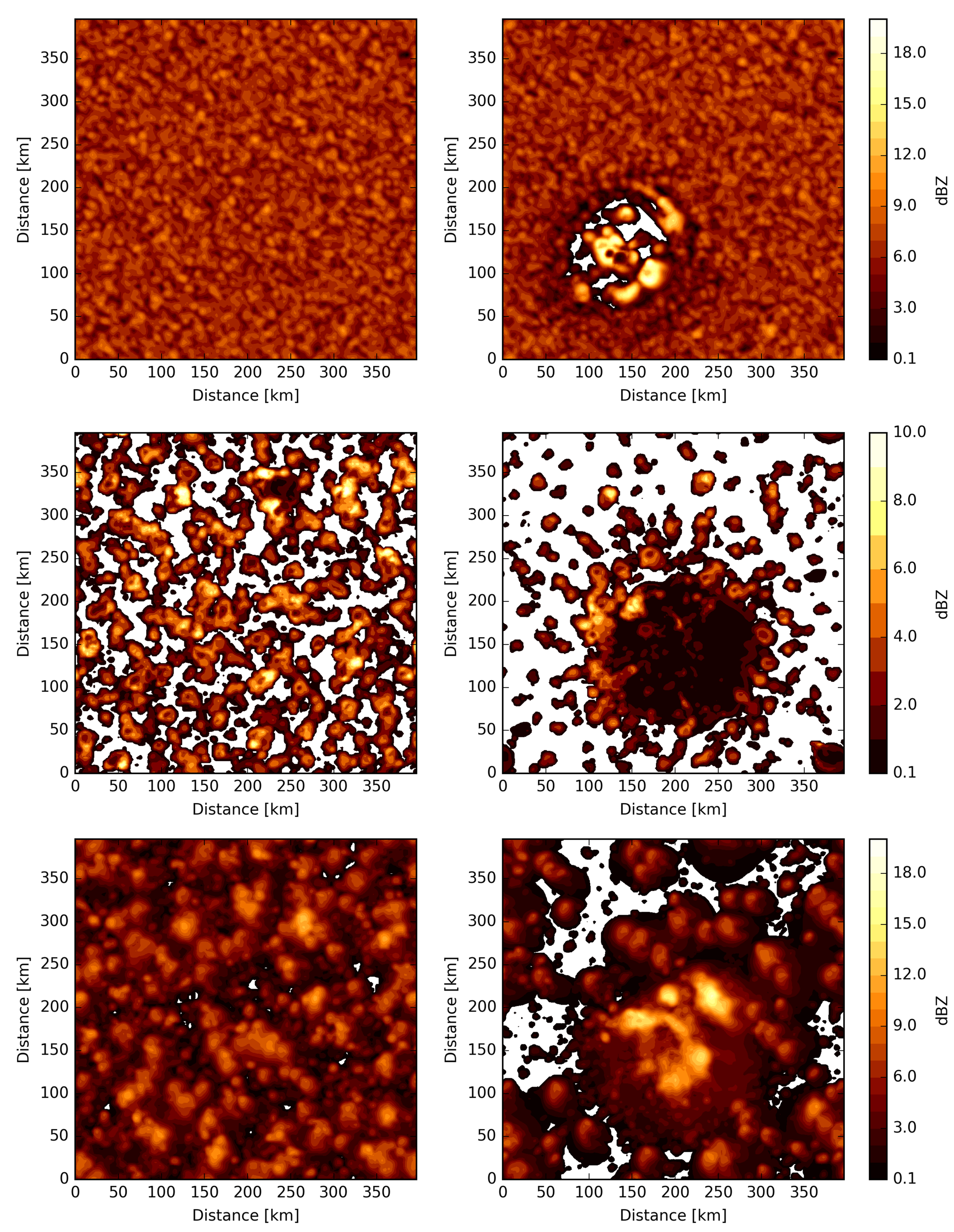
Orography triggers convection in its lee

therefore decreases the spatial variability drastically

Almost no small-scale convection in the first 3 hours after DA cycling

The orography also initiates convection about two hours earlier and increases strength and organization of the cell.

4. ENSEMBLE SPREAD OF REFLECTIVITY



4h lead time: begin of DA

Homogeneous spread increased in the lee of the orography due to earlier onset of convection

6h lead time: end of DA

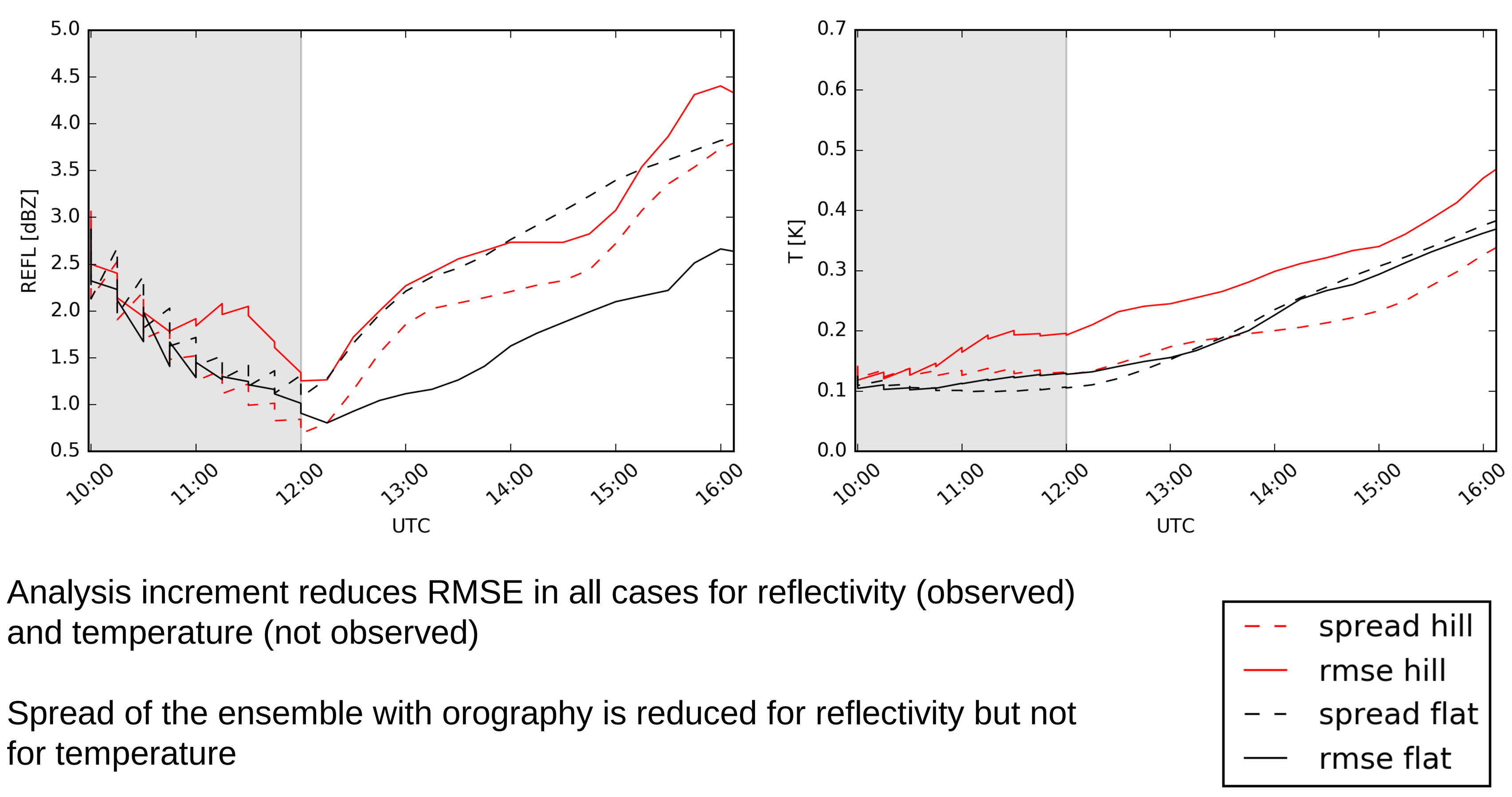
Drastically reduced spread

Different stages of development of convection visible

6h lead time: no DA, free fct

Larger spread especially in the lee of the mountain

5. TIME SERIES OF SPREAD AND RMSE



Analysis increment reduces RMSE in all cases for reflectivity (observed) and temperature (not observed)

Spread of the ensemble with orography is reduced for reflectivity but not for temperature

6. OUTLOOK

- Sensitivity studies with different soundings representing different convective environments
- Analysis of the impact of orography on location and amplitude of precipitation using spatial measurements (FSS, DAS)
- Influence of height and shape of the orography on predictability
- Impact of synoptic forcing (convective vs. baroclinic instability)

7. REFERENCES

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