Impact of radar data assimilation on the predictability of convection in the presence of orography

Kevin Bachmann, Christian Keil, Heiner Lange

kevin.bachmann@lmu.de

Hans-Ertel-Centre for Weather Research, Germany
Meteorological Institute Munich, LMU Munich, Germany

Orography as a source of predictability

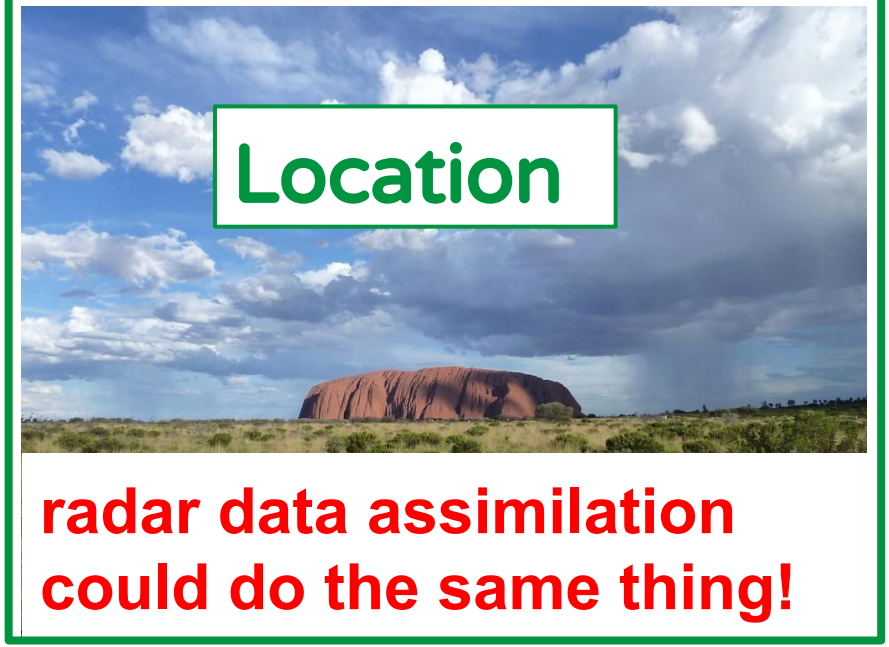
Joe, 23.5.2013, *Convection - Las Vegas, NV*
Retrieved from https://www.flickr.com/photos/tossmeanote/5788194264

Niccolò Ubalducci, 13.1.2013, *Supercell*
Retrieved from https://www.flickr.com/photos/meteopassione/14094200028

Orography as a source of predictability

Fraser Mummery, 12.2.2011, *Rain Seeks Uluru*
Retrieved from https://www.flickr.com/photos/73014677@N05/6591192289

Orography as a source of predictability

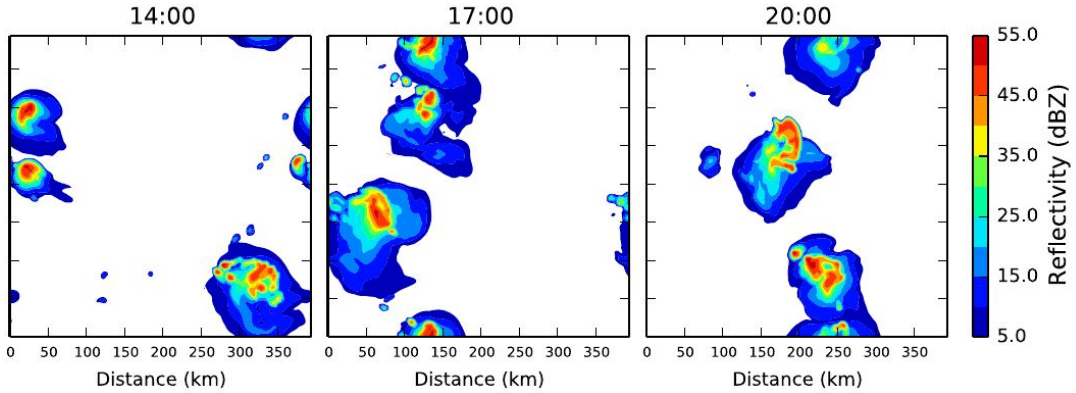


Research questions

- How is **predictability of convection** influenced by orography?
- On what **spatial** scales? Only on **convective** scales?
- What is the impact of **radar data assimilation**?

Idealized setup

COSMO-KENDA-SOFIA
20 member ensemble
512 x 512 km (Δx = Δy = 2 km)
Periodic boundaries
Diurnal cycle

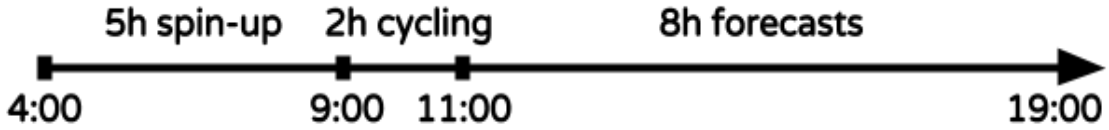


Lange and Craig (2014)

Gaussian mountain: height = 1000 m
half width = 10.000 m
at (64 km, 64 km)

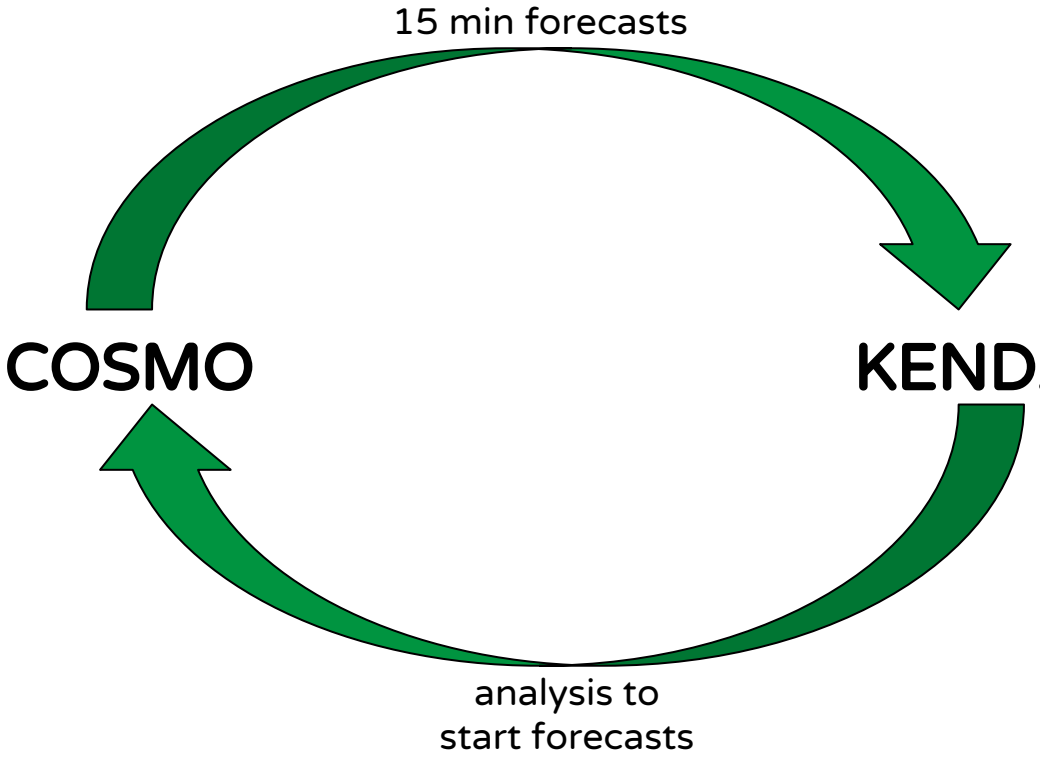
Initial conditions

horizontally homogeneous
Payerne sounding
    CAPE ~ 2200 J/kg
    vertical wind shear
white noise on **temperature**
    and **vertical velocity**

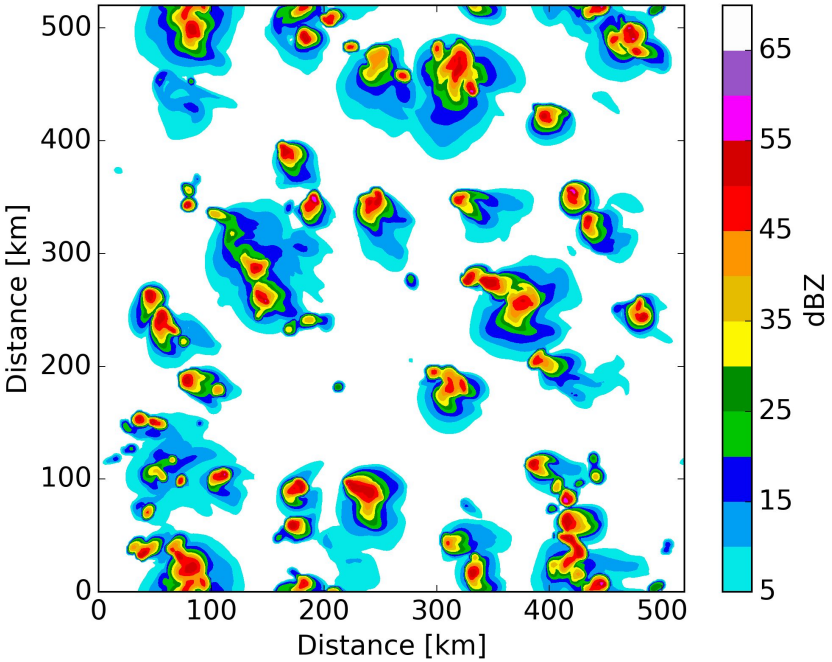


Data Assimilation **cycling** of synthetic radar observations,
REFLECTIVITY and **U**, every 15 min over a 2 hour period

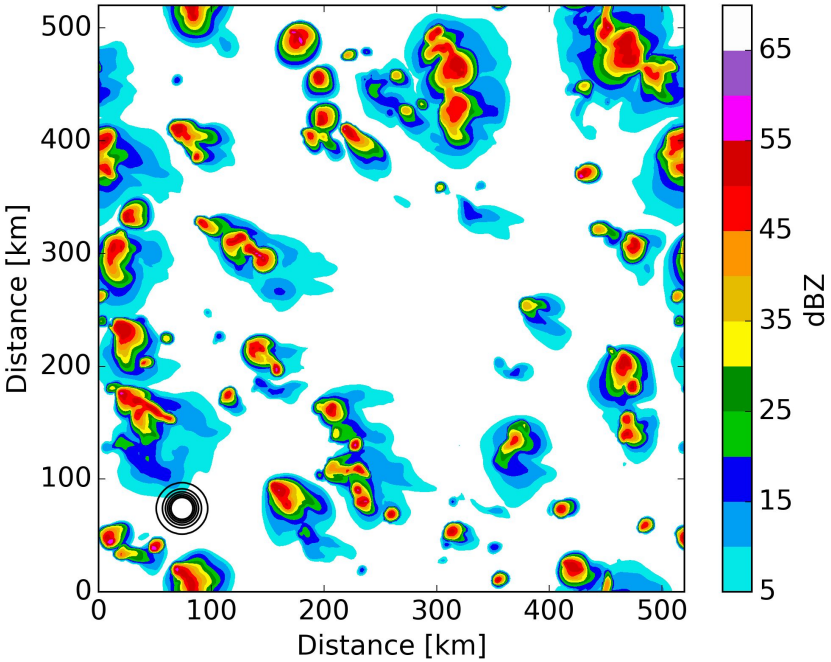
Cycling - COSMO-KENDA-SOFIA



Comparison of nature runs at 11 UTC

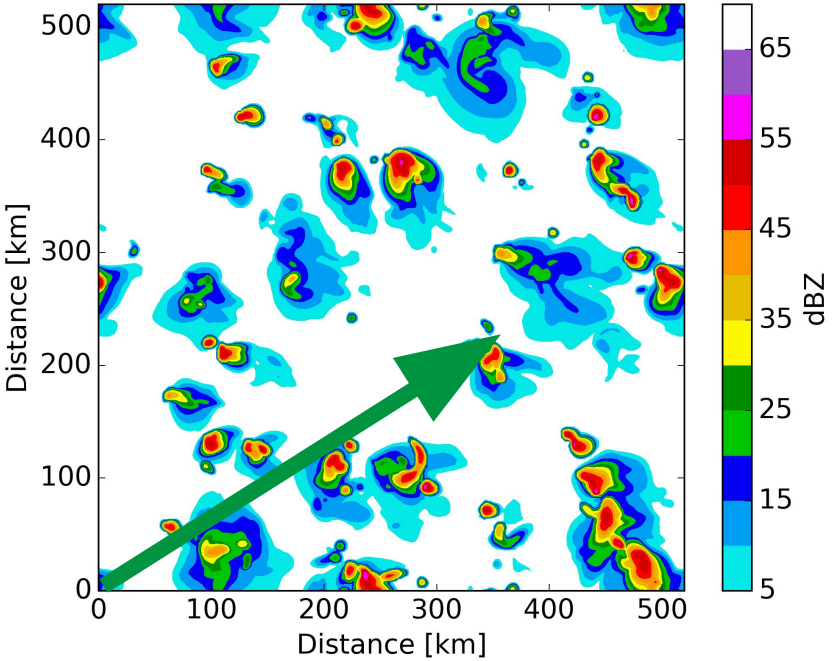


no orography

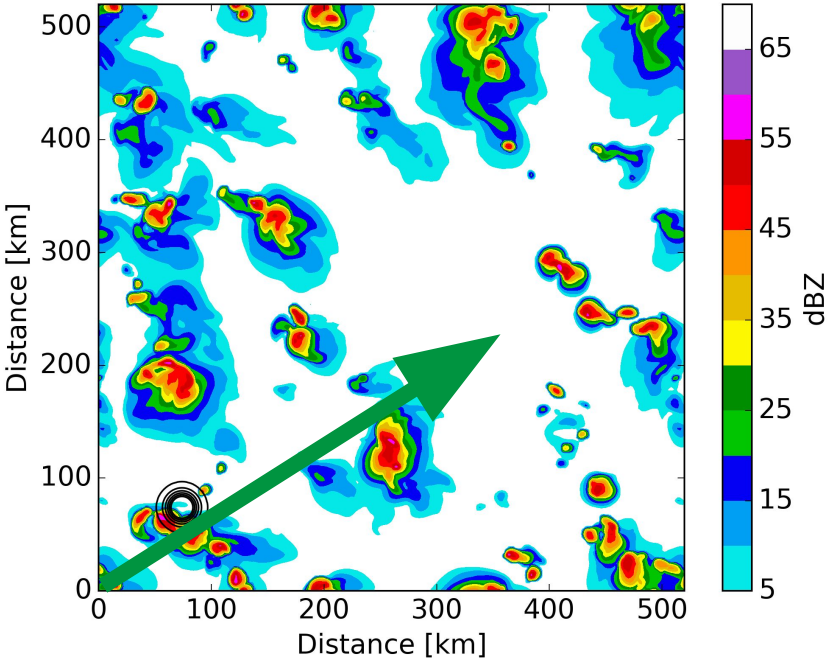


orography

Comparison of nature runs at 12 UTC



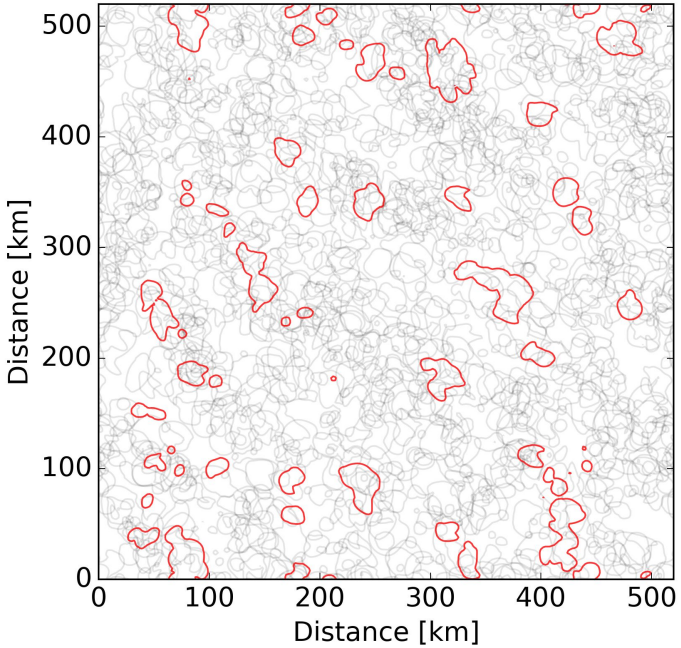
no orography

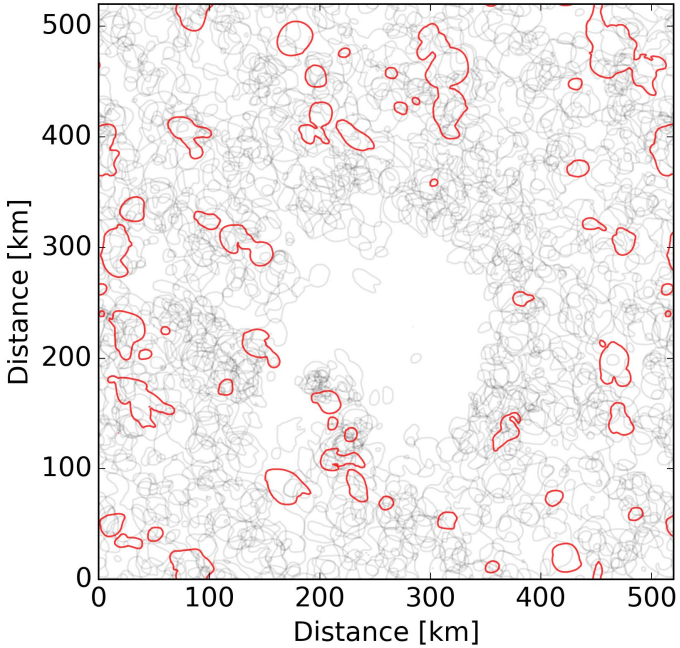


orography

Ensembles without DA at 11UTC

25 dBZ isolines





no orography

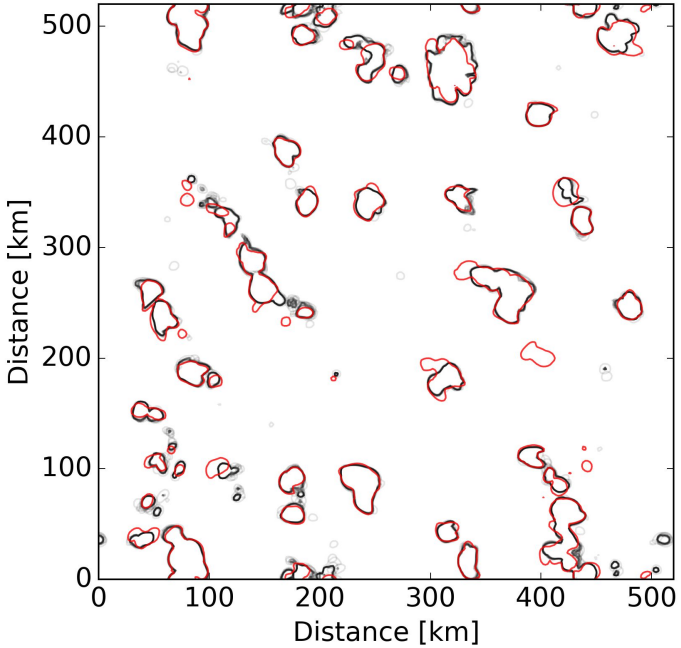
red ~ nature run

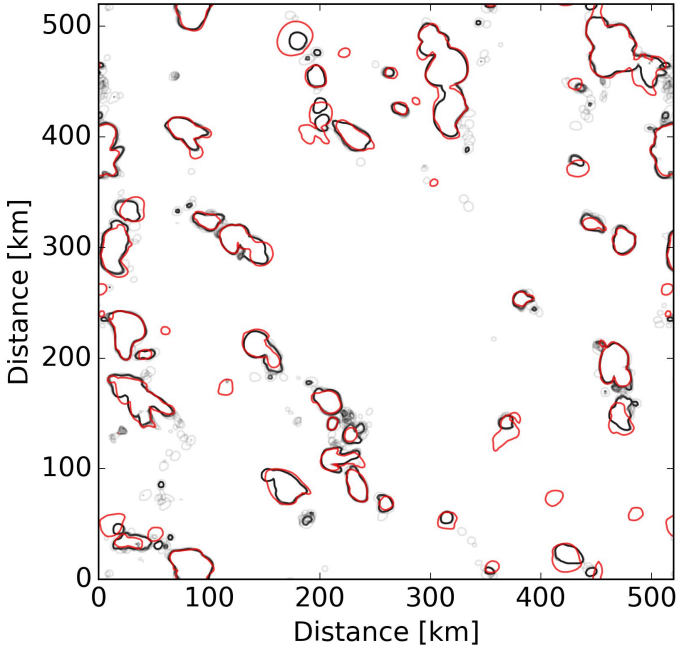
black ~ ensemble realizations

orography

Ensembles with DA at 11UTC

25 dBZ isolines





no orography

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orography

Ensembles with DA at 11UTC

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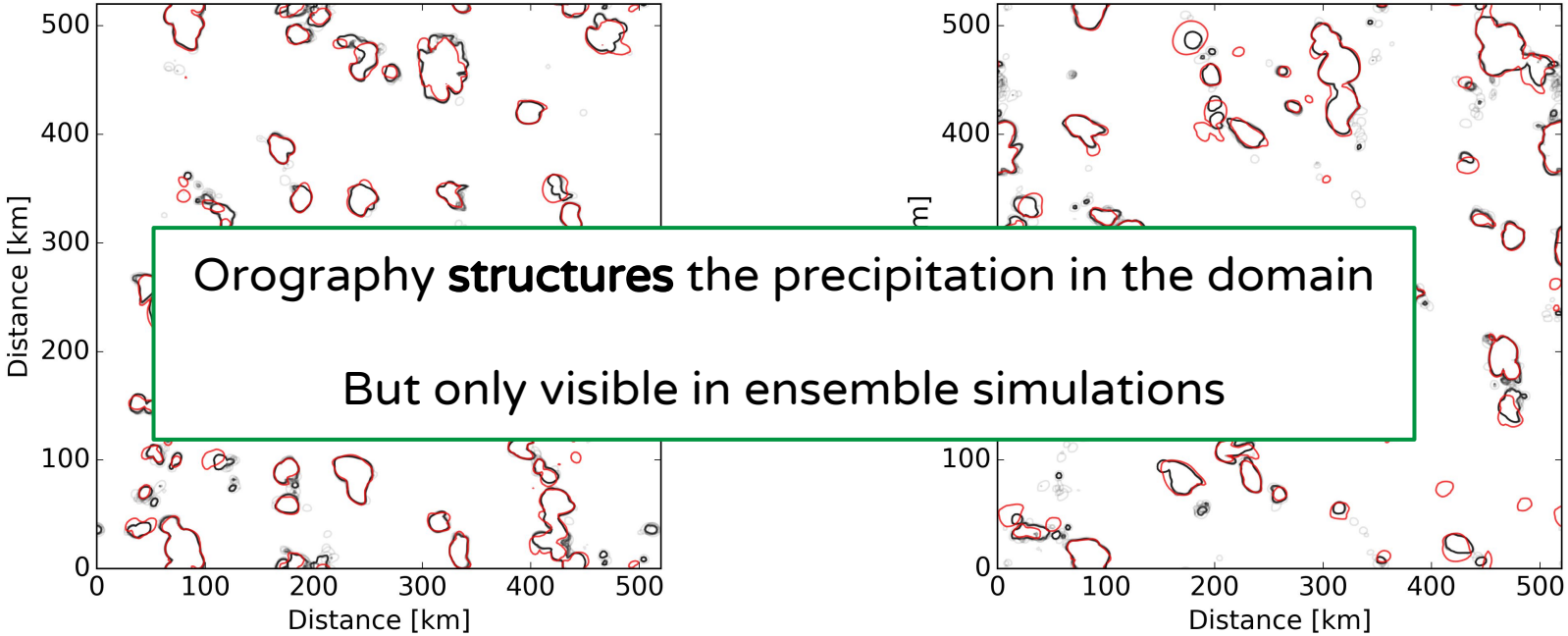


Orography **structures** the precipitation in the domain

But only visible in ensemble simulations

no orography

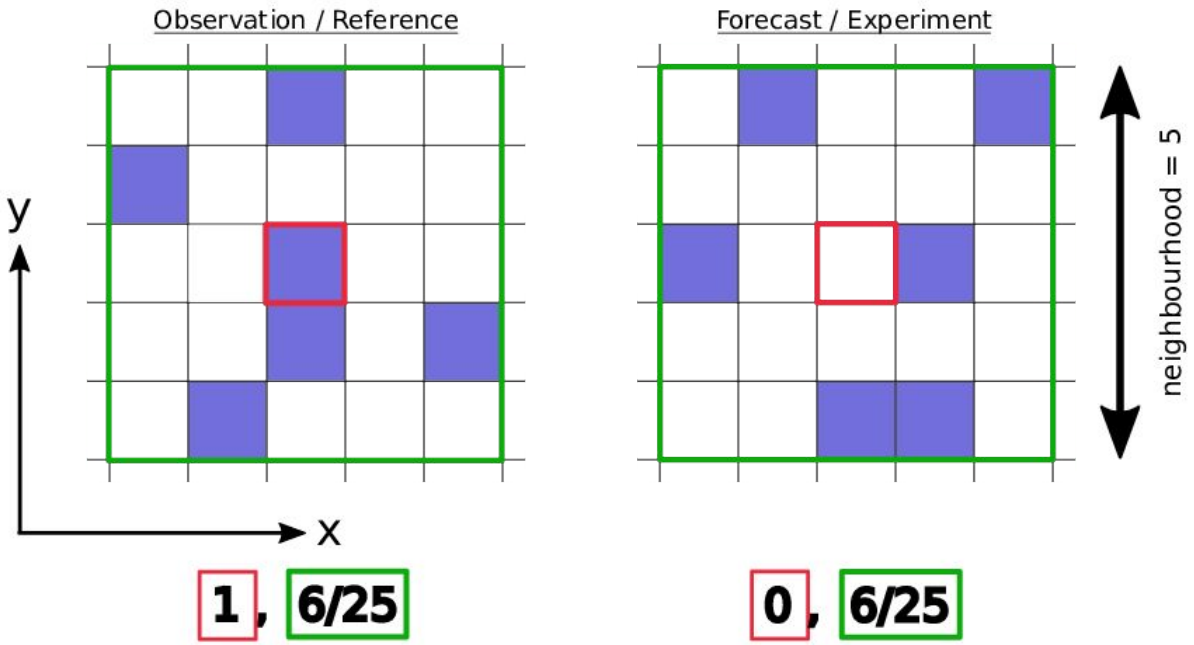
red ~ nature run

black ~ ensemble realizations

orography

Spatial Skill - Fractional Skill Score

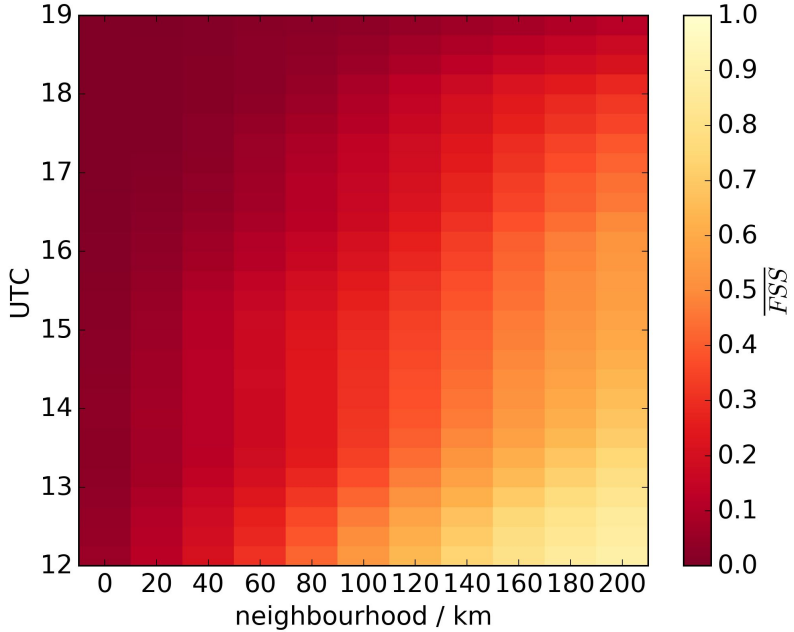
Create binary field
by applying threshold

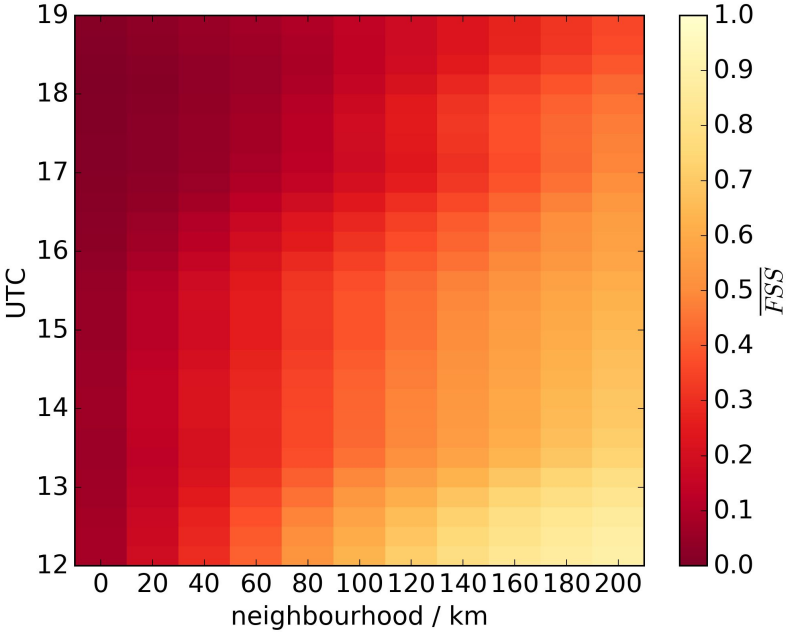


Grid-point: no skill
Upscaled: perfect

Roberts and Lean (2008)

FSS without radar DA





no orography

meanFSS
threshold 3 mm/h

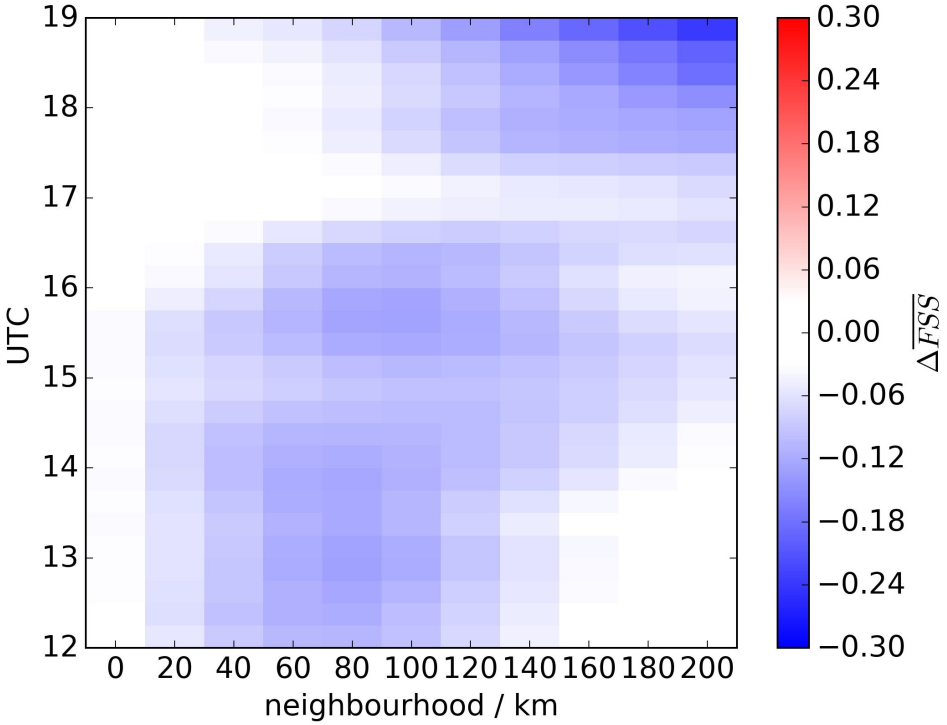
orography

FSS difference <u>without</u> radar DA

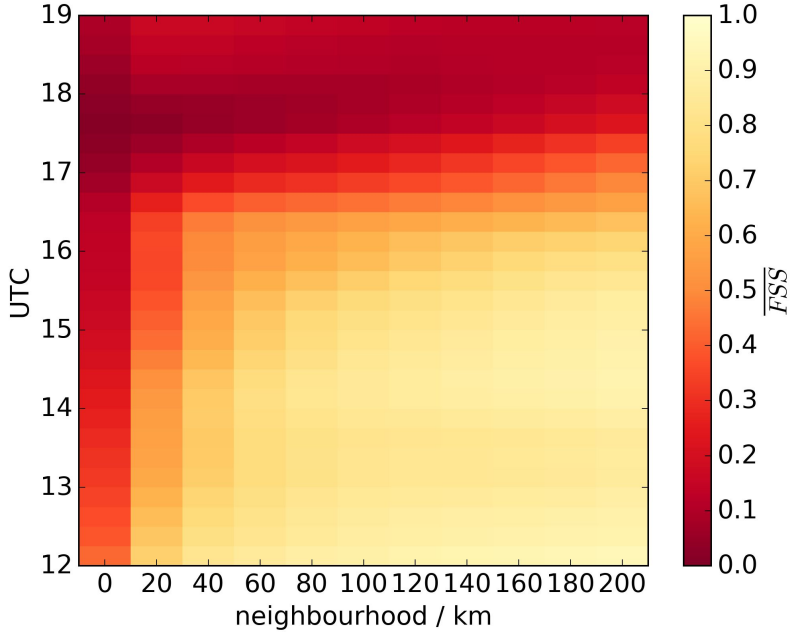
no orography

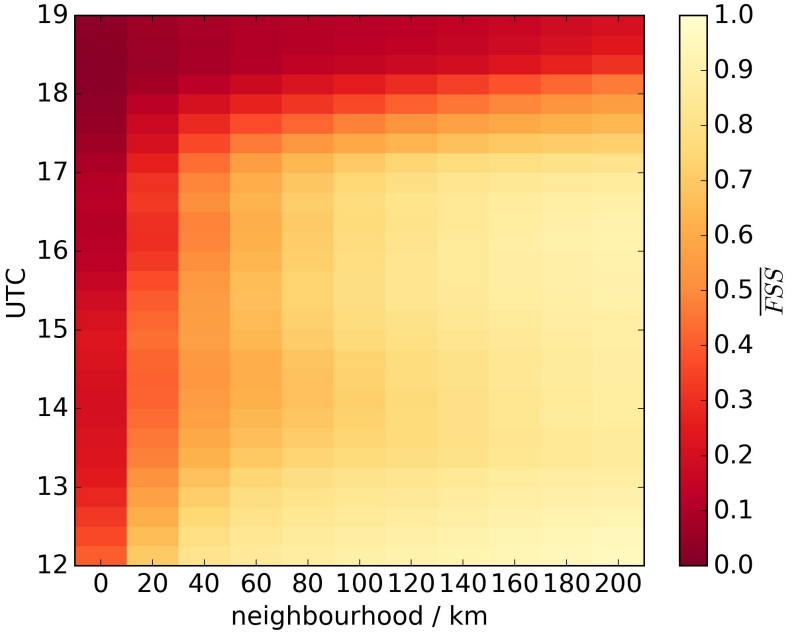
orography

Improved skill in the presence of orography throughout neighbourhoods and lead times



FSS with radar DA





no orography

meanFSS
threshold 3 mm/h

orography

FSS difference with radar DA

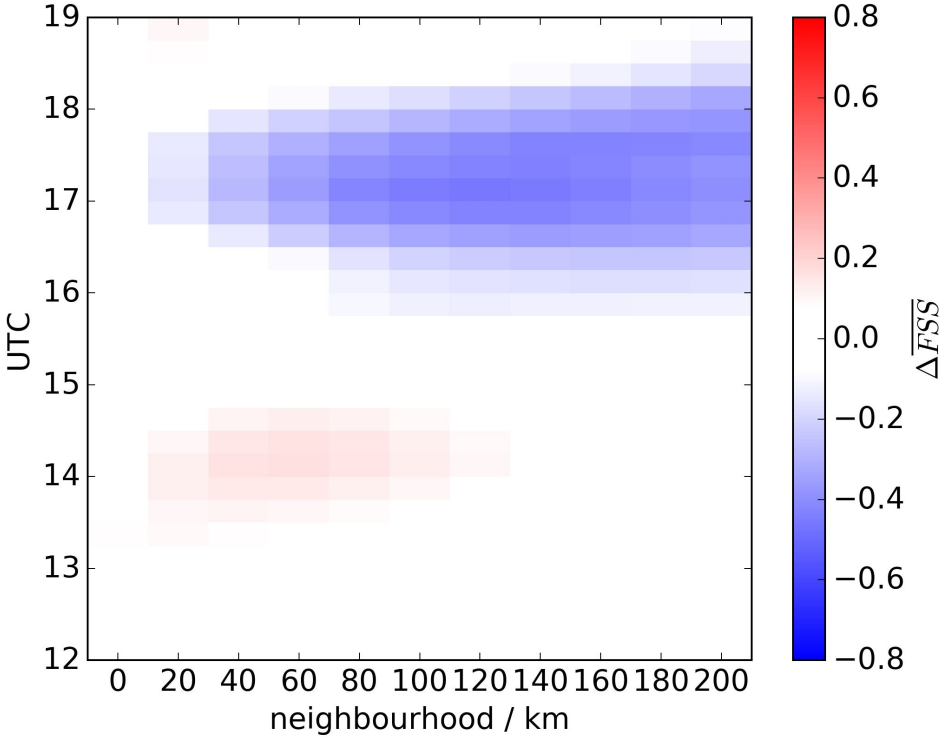
no orography

=

orography

=

No significant skill differences
for 5-6h after radar DA is applied



Decorrelation scale

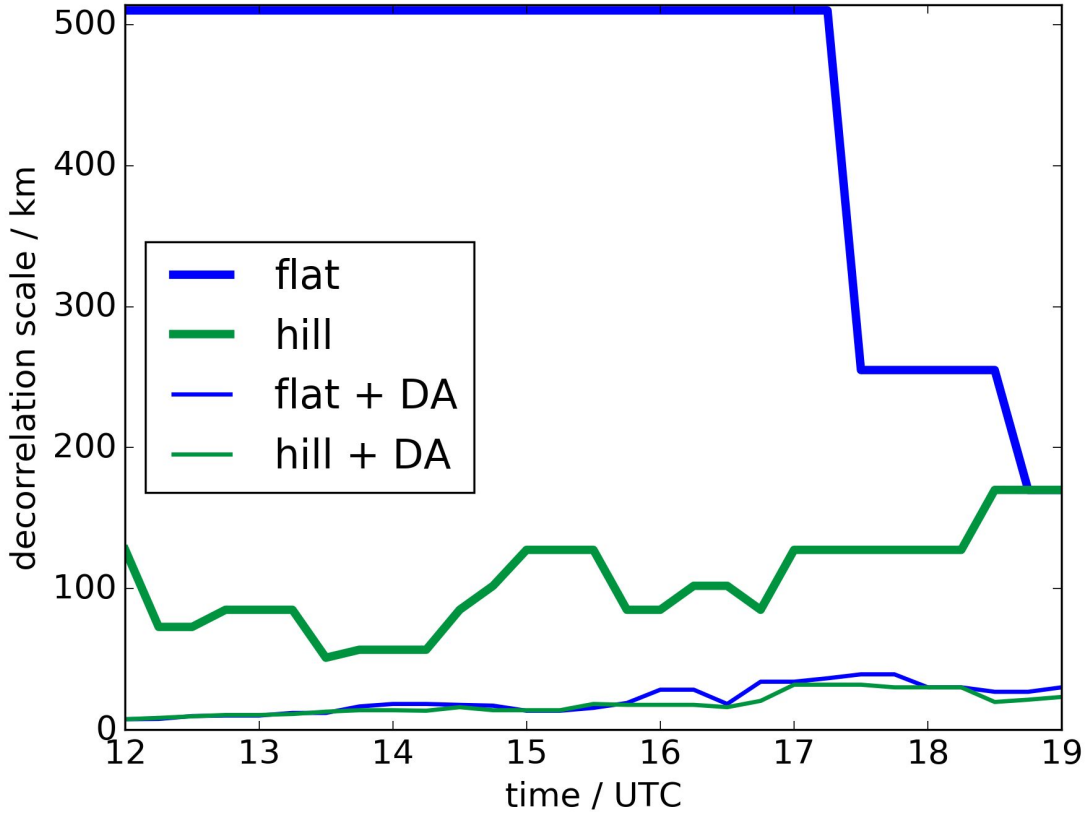
in a nonlinear system ensemble members with small initial condition errors diverge until they are as similar as random realizations

Smaller scales decorrelate earlier

Surcel (2015):

-> Compute largest **random/decorrelated scale** over time to identify **unpredictable** scales

Decorrelation scale - results



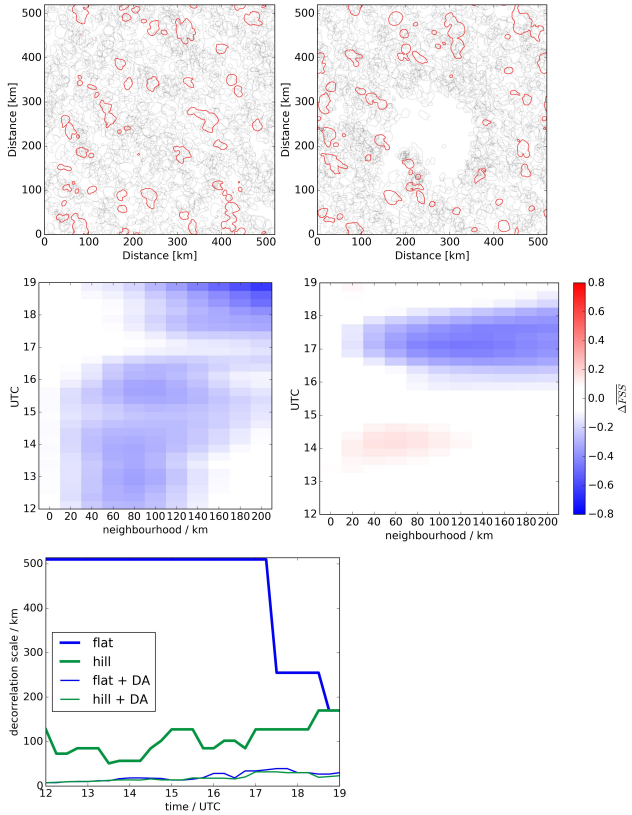
Orography enhances predictability

Radar DA compensates for the positive effect of the orography

no orography ~ blue

orography ~ green

Summary



- Orography structures the precipitation
- But ensemble visualization might be necessary

- Higher spatial skill with orography
- Radar DA improves skill drastically
- DA eliminates skill advantage of orography

- More predictable scales with orography
- But especially if radar DA is applied
- With radar DA identical predictability

Thank you for the attention…

Questions? Remarks?

References

Roberts, N. M., & Lean, H. W. (2008). Scale-Selective Verification of Rainfall Accumulations from High-Resolution Forecasts of Convective Events. *Monthly Weather Review*, *136*(1), 78–97. https://doi.org/10.1175/2007MWR2123.1

Lange, H., & Craig, G. C. (2014). The Impact of Data Assimilation Length Scales on Analysis and Prediction of Convective Storms. *Monthly Weather Review*, 140707140511002. https://doi.org/10.1175/MWR-D-13-00304.1

Surcel, M., Zawadzki, I., & Yau, M. K. (2015). A Study on the Scale Dependence of the Predictability of Precipitation Patterns. *Journal of the Atmospheric Sciences*, *72*(1), 216–235. https://doi.org/10.1175/JAS-D-14-0071.1

Surcel, M., Zawadzki, I., & Yau, M. K. (2015). The case-to-case variability of the predictability of precipitation by a Storm-Scale Ensemble Forecasting system. *Monthly Weather Review*, 151023111612004. https://doi.org/10.1175/MWR-D-15-0232.1