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Wetter und Klima aus einer Hand

Comparing observed and modeled radar reflectivities at different spatial scales

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Aim of the work

At the Deutscher Wetterdienst, the SINFONY Project aims at developing a new seamless prediction system for very short range convective-scale forecasting. Products of Nowcasting and Numerical Weather Prediction (NWP) are complemented, further developed and interlocked in such a way that a seamless representation of the atmospheric state and weather phenomena from now until +6/+12 h is possible.

Model outputs in observation space, in particular the **reflectivities** simulated by the Radar Forward Operator EMVORADO (Zeng et al., 2016) included in the COSMO model, allow seamless combination of Nowcasting and NWP into combined products for the forecasters. Furthermore, reflectivity can be used for the verification of the developed products. This method is chosen to be able to compare, and then combine, “apples with apples”.

But is the reflectivity simulated by the model really similar to the observed one? Or are they more like “apples and pears” ?

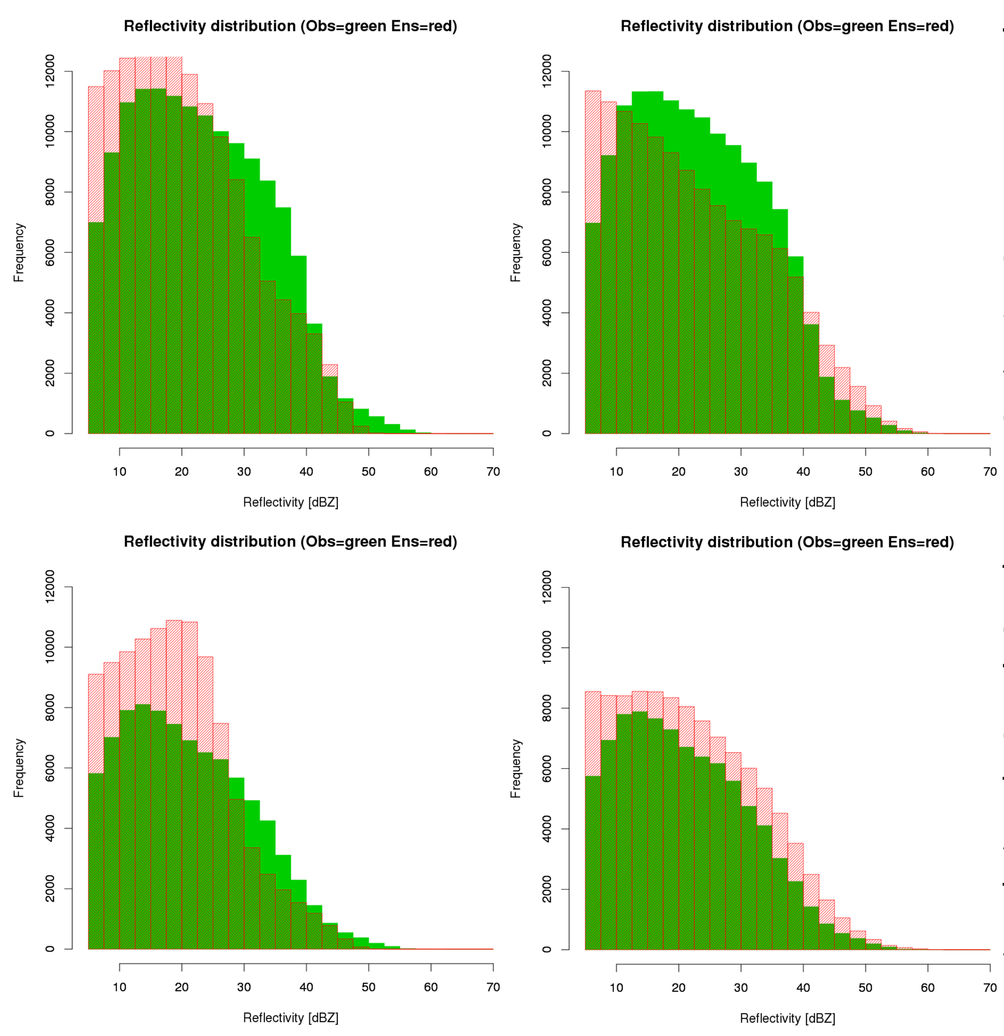
Purpose of this work is to analyse the two reflectivity fields and to assess their characteristics and their degree of (dis)similarity, with particular emphasis on the spatial scales represented by the two fields. This analysis aims to contribute to the design of appropriate methods for the combination of Nowcasting and NWP products and for their verification.

Data used

Observed reflectivities are obtained from the German radar network, while the simulated ones are from the **COSMO-DE-EPS** ensemble of DWD, run at 2.8 km over Germany, with 20 members.

A period of seven days is analysed, **from 27th of May to 2nd of June 2016**, when several convective events occurred over Germany. The ensemble was run every day at 15 UTC for 6 hours.

Frequency distribution of the reflectivity values



The distributions of the reflectivities observed by the **radar** (**green**) and simulated by the **model** (**red**) during the events of the 29th (top row) and 31st of May (bottom row) are shown. All the 6 hours contribute to the distributions. For the ensemble, all the members are included (and the frequency is normalised by dividing by 20).

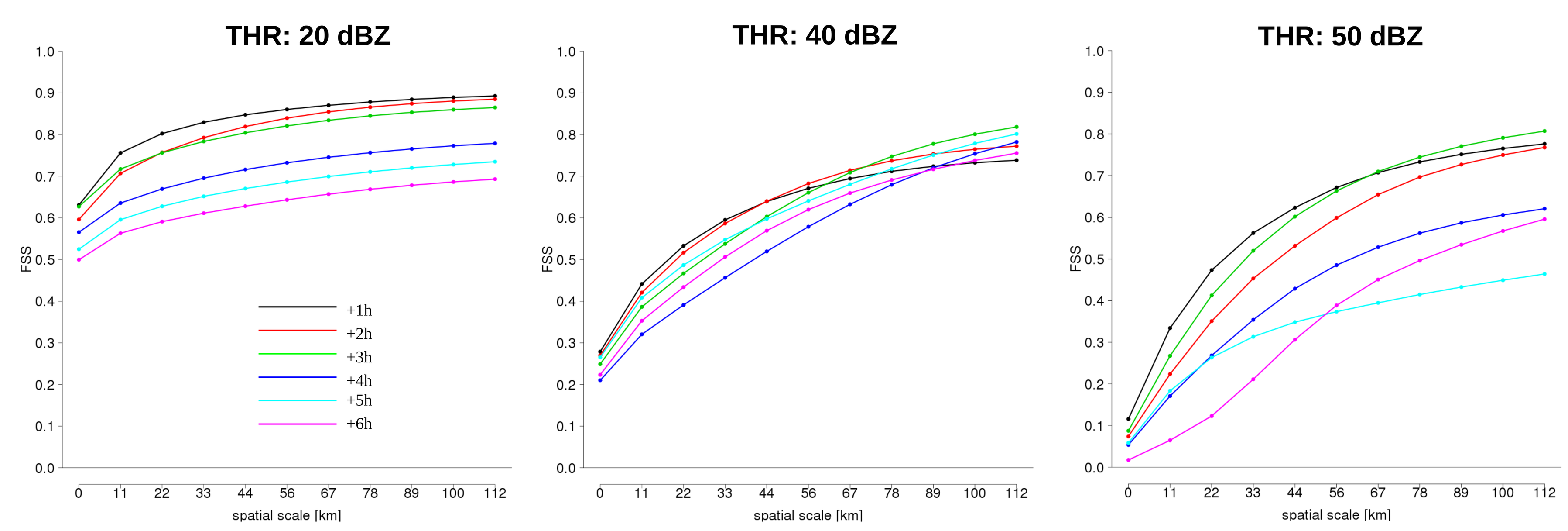
The ensemble is run in 2 configurations: COSMO using the 1-moment microphysics scheme (left panels) and using the 2-moment microphysics scheme by Seifert and Beheng (2006) (right panels).

The model tends to produce too many low reflectivity values.

Intermediate reflectivity values are sometimes underestimated by the model, also in the 2-moment configuration.

In all cases it is found that the distribution of the high reflectivity values (above 50 dBZ) is better represented by the 2-moment scheme.

Degree of similarity at different spatial scales



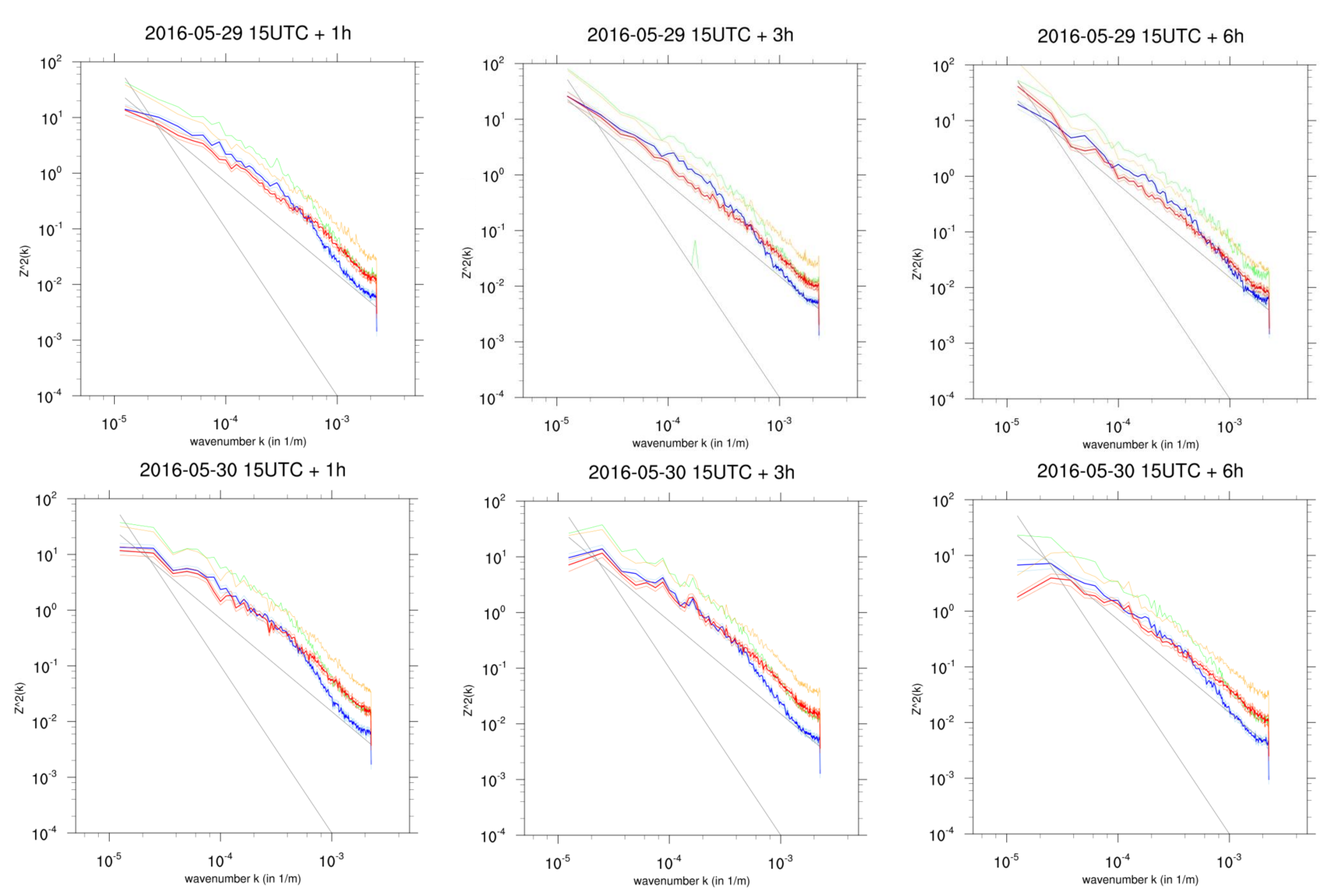
In order to evaluate the degree of similarity between the modeled reflectivties and the observed ones in dependence of the spatial scale, the Fraction Skill Score (FSS, Roberts and Lean, 2008) was computed for the ensemble, for spatial scales up to about 100 km.

The FSS is shown for the event of the 29th of May, for the 2-moment configuration. Three thresholds are considered: 20, 40 and 50 dBZ. The 6 forecast hours are plotted separately (different colours), representing here the evolution of the phenomenon more than the forecast range.

It is not possible to establish an optimal scale of aggregation for all intensities, since the simulated reflectivities have different degree of similarity to the observed one for low, moderate and high intensities.

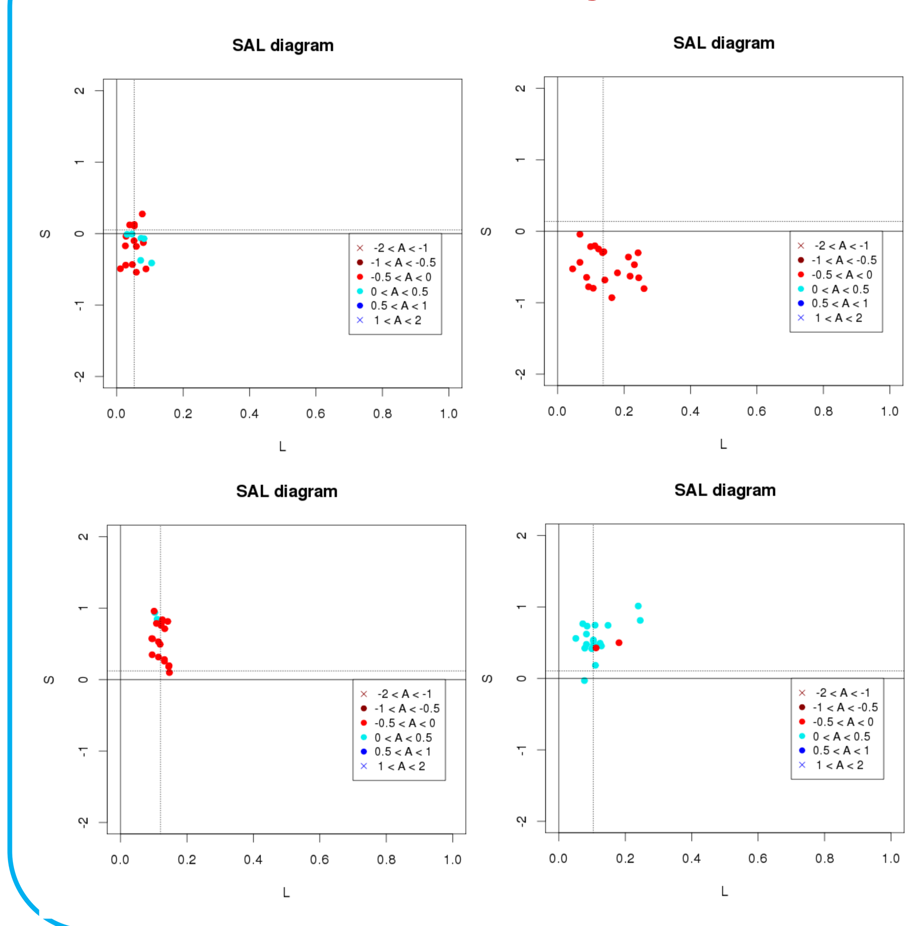
Reflectivity spectra

Spectra of the reflectivities, from **radar** (**red**) and **model** (**blue**), were computed, following the method of Skamarock (2004). The events of the 29th (top row) and 30th (bottom row) of May are shown, for the hours +1, +3 and +6.



In most cases it is found that below a wavelength of about 15 km (k about 4×10^{-4} m^{-1}) the simulated reflectivities do not follow the spectrum of the observation anymore.

Variability of the ensemble members



In order to assess the variability among the ensemble members in simulating the reflectivities, the SAL method is used (Wernli et al., 2008). Structure (S), Amplitude (A) and Location (L) components were computed for all the members.

The events of the 29th (top row) and 30th of May (bottom row) are shown, for the forecast range +2h (left panels) and +5h (right panels).

While in the first event the ensemble tends to produce structures too peaked (S<0), in the second event they are too flat (S>0). Differences in location error are also visible along the x axis.

References

Roberts, N. M. and H. W. Lean, 2008: Scale-selective verification of rainfall accumulations from high-resolution forecasts of convective events. *Mon. Wea. Rev.*, **136**, 78-97.

Seifert, A. and K. D. Beheng, 2006: A two-moment cloud microphysics parametrization for mixed-phase clouds. Part 1: model description. *Meteorol. and Atmos. Phy.*, **92**, 45-66.

Skamarock, W. C., 2004: Evaluating mesoscale NWP models using Kinetic Energy spectra. *Mon. Wea. Rev.*, **132**, 3019-3032.

Wernli, H., M. Paulat, M. Hagen and C. Frei, 2008: SAL - A novel quality measure for the verification of quantitative precipitation forecasts. *Mon. Wea. Rev.*, **136**, 4470–4487.

Zeng, Y., U. Blahak and D. Jerger, 2016: An efficient modular volume-scanning radar forward operator for NWP models: description and coupling to the COSMO model. *Q. J. R. Meteorol. Soc.*, **142** (701), 3234-3256.

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