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Determination of the Effective Resolution of Regional Climate Models

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The spatial resolution of numerical weather prediction and climate models is generally determined by their grid spacing (Δx) or spectral truncation and the numerical implementation of dynamical core and model parametrisations. For example features of the scale $2\Delta x$ and $3\Delta x$ are smoothed to avoid numerical instabilities (e.g., aliasing effects) and parameterisations in connection to advection, pressure gradient force, and subgrid-scale diffusion can only be well represented at dimensions of at least four times the grid spacing. Some parametrisations, however, generate energy at the grid-spacing scale. These multiple effects on the effective resolution of models are investigated in this study for three high resolution regional climate models (RCMs) in dependence of their grid spacing.

In order to determine the effective resolution variance spectra of the model results at various grid spacings are derived. The variance spectra are constructed by applying the Discrete Cosine Transform (DCT) on the model fields. This Fourier-type transform can, unlike many other methods, handle aperiodic fields. The variance is displayed in terms of scales (wavelengths) of the analysed atmospheric field.

Variance spectra of three non-hydrostatic high-resolution models (PSU/NCAR model MM5, its succesor WRF, and the German model of the national weather services CCLM) with three different grid spacings (1km, 3km, 10km) on two vertical levels (near the surface and at 700hPa) are compared. Furthermore, the model variance spectra are compared to variance spectra of highly resolved gridded observational-based data (1km grid spacing), the nowcasting system of the Austrian meteorological service (INCA) and a dense observation network in Eastern Styria, Austria (Wegener Net, www.wegenernet.org), and the Integrated Forecast System (IFS, $\approx$25km grid spacing) of the European Centre for Medium-Range Weather Forecasts (ECMWF). Preliminary results show that the effective resolution varies from $3\Delta x$ to $7\Delta x$, depends on the investigated parameter as well as on the model formulation, and is particularly sensitive to the distance from the surface. More results of this analysis are going to be discussed in detail.