Evaluating errors due to unresolved scales in convection permitting numerical weather prediction

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Abstract

In numerical weather prediction (NWP), observations and models are quantitatively compared for the purposes of data assimilation and forecast verification. The spatial and temporal scales represented by the observation and model may differ and this results in a scale mis-match error which may be biased and correlated. Here we investigate the structure of representation error in convection-permitting NWP models for four meteorological variables: temperature, specific humidity, zonal and meridional wind. We use high resolution data from the experimental Met Office London Model (approximately 300 m grid-length) to simulate perfect observations and lower resolution model data. The scale mis-match error and its bias, variance and correlation are calculated from the perfect observation and low-resolution model equivalents. Our new results show that the scale mis-match bias is significant in the boundary layer for temperature and specific humidity, whereas the variance is significant in the boundary layer for all analysed variables. Furthermore, they are shown to be related to the mismatch in the high- and low-resolution orography. Contrary to previous studies using low-resolution, (km-scale) data, horizontal correlations are shown to be insignificant. However, all variables exhibit considerable vertical representation error correlation throughout the boundary layer; for temperature a significant positive vertical correlation persists for all model levels in the troposphere. Our results suggest that significant biases and vertical correlations exist that should be accounted for to give maximum observation impact in data assimilation and for fairness in model verification and validation.

Keywords: Observation uncertainty, Representation error, Uncertainty quantification

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