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Addressing near-surface biases in global NWP

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Over the last 10 years there has been a substantial reduction of the random error in global NWP forecasts of near-surface quantities. Trends in the systematic error component have been more mixed, however. While increased horizontal resolution has reduced the representativeness mismatch between model grid-point values and point observations, and improved boundary-layer physics as well as a better representation of low clouds has reduced some of the systematic errors, large-scale biases persist in 2 m temperature and humidity, and 10 m wind speed. These biases exhibit diurnal and annual cycles and are typically a function of latitude and/or surface type as well as continentality. Often they are conditional biases, becoming more pronounced in a specific meteorological setting, such as clear-sky conditions over a snow surface. Interestingly, biases significantly differ between global models. It is shown how conditional verification helps in the diagnosing of systematic errors and contributes to process understanding. For 2 m temperature, for example, conditioning the verification on orography, distance from the coast, snow cover, cloudiness and wind speed, provides a much clearer picture of the actual issue and possible underlying causes. This approach is combined with boundary-layer sensitivity studies, where the physically meaningful range of bias changes (e.g. in 2 m temperature) is explored by varying less well constrained parameters, such as in the vertical diffusion parameterization. A complementary approach investigates the role of atmosphere-surface coupling as a contributing factor to near-surface biases. Results indicate that identifying compensating systematic errors in NWP models is crucial for making further progress in this area.