Scale-Dependent Forecast Sensitivity to Observational Density

Accurate weather forecasts depend on atmospheric observations that constrain the initial conditions of numerical weather prediction (NWP) models. However, observational coverage is highly uneven across the globe, particularly for in situ observations.

A unique set of forecast experiments performed with the ICOsahedral Nonhydrostatic (ICON) model is available in which the density and quality of assimilated pseudo-observations (PSOs) were systematically varied. Previous analyses using spatially averaged metrics showed that increasing observational density generally improves forecast skill, particularly at short lead times, whereas observational quality has a considerably smaller impact. Forecast improvements were also found to saturate more rapidly in the tropics than in the extratropics.

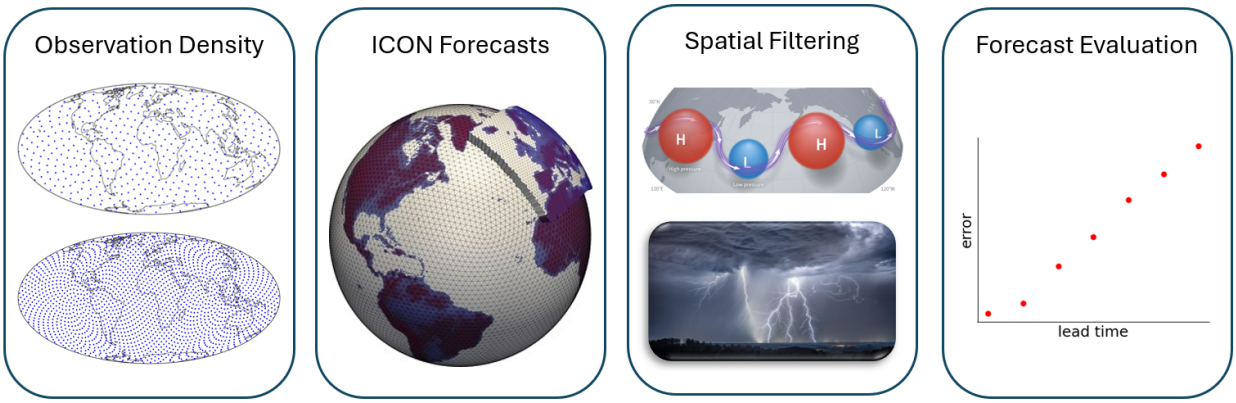

Figure 2: *Conceptual illustration of a possible analysis workflow for investigating the scale-dependent response of forecast skill to observational density.*

Globe with ICON grid adapted from DWD, rossby wave illustration adapted from climate.gov, and thunderstorm image adapted from wallpaperaccess.com.

This thesis extends the previous analysis by investigating how the response of forecast skill to observational density depends on spatial scale. Spatial filtering techniques will be applied to separate large-scale, synoptic-scale, and mesoscale variability, allowing forecast skill to be assessed for individual scale ranges. In a second step, equatorial wave filtering techniques (e.g. Yang et al., 2003) will be used to examine the representation of tropical wave modes such as Kelvin waves and Equatorial Rossby waves.

Possible research questions include:

- At which spatial scales does observational density have the largest impact on forecast skill?
- How rapidly do forecast improvements decay with lead time at different spatial scales?
- Can scale-dependent forecast sensitivities explain the contrasting behaviour of forecast skill in the tropics and extratropics?
- How does observational density affect the representation of equatorial waves?

The work will involve processing meteorological datasets in Python and applying spatial and equatorial wave filtering techniques.

Interested? Please contact cedric.froidevaux@kit.edu or peter.knippertz@kit.edu