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Representation of surface subgrid heterogeneity in ICON using tiles – Impact on forecast quality

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With the advancing progress of supercomputer power, operational global numerical weather prediction models are now heading toward mesh sizes on the order of $10\,\mathrm{km}$. This resolution, however, is still much too coarse to adequately resolve the characteristics of the land surface, which can vary on the order of meters. Homogeneous surface representations, like the one so far implemented in the NWP models of DWD, take into account only the spatially dominant land surface type in a grid cell. This can lead to significant forecast errors and biases in the land-atmosphere interactions.

To improve the representation of subgrid heterogeneity in DWD's global model ICON (**Ico**sahedral **N**onhydrostatic), a tile-approach has been implemented. The basic idea is to partition the grid cell into homogeneous subregions ("tiles"), each representing a specific surface type. Patches of the same surface type occurring within a grid cell are gathered into a single tile. Since ICON makes use of the GlobCover 2009 land cover database, up to 23 land surface types/tiles are possible. The surface energy balance, soil temperatures and soil water contents (from the surface down to the lower boundary in the soil) are then computed separately for each tile, using surface type specific parameters. Atmospheric parameters, however, are assumed constant over the grid cell, i.e. the blending height is located at the lowest atmospheric model level. The grid-averaged atmospheric forcing is then computed by weighting the contributions from the different tiles according to their fraction on the total cell area.

For the sake of computational efficiency, in each grid cell of the ICON model only n dominant surface types are selected to be represented by tiles, where n is a small adjustable number usually around 3. For this purpose, the tiles in each grid cell are ranked according to the fractional area they cover. As a consequence, the full spectrum of surface types provided by the GlobCover 2009 dataset is retained globally, while being restricted to the n dominant ones locally. Beyond the dominating land tiles, each grid cell can have an additional lake-, ocean-, and seaice tile, to adequately represent coastal regions and fractional seaice cover.

We will present details on the technical implementation in ICON and assess the potential impact on forecast quality. For this purpose, ICON was run in both "tiled" and "homogeneous" mode with a realistic quasi-operational setup.