ICON Documentation: Parameterization of wind gusts

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1   Wind gusts

The gust parameterization of ICON consists of two components: turbulent gusts and convective gusts. The diagnosis of turbulent gusts has been taken over from the COSMO model (Schulz, 2003, 2008). Turbulent gusts at $10\,\mathrm{m}$ above ground are derived from the turbulence state in the atmospheric boundary layer, using the absolute speed of the mean wind at $10\,\mathrm{m}$ above ground U_{10} and its standard deviation σ.

$$U_{10\,\mathrm{gust,turb}} = U_{10} + \alpha\,\sigma \tag{1}$$

Following Panofsky and Dutton (1984), the standard deviation σ can be approximated as

$$\sigma \approx 2.4\,u_\star$$

with $u_\star$ denoting the friction velocity. Using the relationship $u_\star = \sqrt{C_D}\,U_{10}$, where C_D denotes the drag coefficient for momentum, we arrive at

$$U_{10\,\mathrm{gust,turb}} = U_{10} + \alpha\,2.4\sqrt{C_D}\,U_{10} \tag{2}$$

The tuning parameter α has been estimated to $\alpha = 3$. Note that for computing $u_\star$, the wind speed at the lowest model level is used rather than U_{10}.

Equation (2) asesses the gustiness in the boundary layer, however it does not take into account gusts due to strong convective events. Therefore, a convective contribution is added to the turbulent wind gusts in the presence of deep convection. The parameterization follows Bechthold and Bidlot (2009) where the convective gusts are simply estimated as proportional to the low level wind shear:

$$U_{10\,\mathrm{gust,conv}} = C_{conv}\max\left(0, U_{850} - U_{950}\right) \tag{3}$$

with the convective mixing parameter C_{conv} and $U_{850} - U_{950}$ the difference between $850\,\mathrm{hPa}$ and $950\,\mathrm{hPa}$ wind speeds. This contribution is computed only in regions where deep convection is active, as identified by the convection scheme (*ktype=1*). Thus, the total gustiness $U_{10\,\mathrm{gust}}$ becomes:

$$U_{10\,\mathrm{gust}} = U_{10\,\mathrm{gust,turb}} + U_{10\,\mathrm{gust,conv}} \tag{4}$$

The parameter $U_{10\,\mathrm{gust}}$ is computed every fast-physics time step and its 6-hourly maximum (preliminary) is written to disk.

1.1   Computation of U_{850} and U_{950}

References

Bechthold P, Bidlot J. 2009. Parameterization of convective gusts. *ECMWF Newsletter* **119**: 15–18.

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