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Case study of wave breaking with high-resolution turbulence measurements with LITOS and WRF simulations

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Gravity waves in their final stage produce turbulence and dissipation. In the stratosphere only few studies of this phenomenon exist because the observation is technically challenging. In order to precisely infer energy dissipation rates, the viscous subrange has to be covered, which in the stratosphere lies at scales of centimetres and below. With our balloon-borne instrument LITOS (Leibniz-Institute Turbulence Observations in the Stratosphere), which has a vertical resolution below 1 mm, measurements were performed from Kiruna (68°N, 21°E) as well as from Kühlungsborn (54°N, 12°E). To characterise the atmospheric background conditions, WRF simulations driven by ECMWF reanalysis data were performed for the times of the flights.

Averaged dissipation rates observed by LITOS are connected to wave signatures seen in the model. Particularly, larger dissipation rates correlate to larger amplitudes seen in the horizontal divergence or vertical winds in the model and vice versa. For one flight, a very pronounced maximum in dissipation is observed below the tropopause. It is connected to a wind reversal and dynamic instability. In the corresponding WRF simulation, turbulent kinetic energies (TKE) and amplitudes in horizontal divergence are enhanced in this region. For the other flights, no such pronounced maximum in dissipation but also no enhanced values of TKE outside of the boundary layer are observed. That means that low and moderate turbulence is not resolved in WRF, but is observed by LITOS throughout all altitudes.