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First 3D measurements of temperature fluctuations induced by gravity wave with the infrared limb imager GLORIA

Isabell Krisch (1), Peter Preusse (1), Jörn Ungermann (1), Felix Friedl-Vallon (2), and Martin Riese (1)

(1) Institut für Energie und Klimaforschung - Stratosphäre (IEK-7), Forschungszentrum Jülich, Jülich, Germany, (2) Institut für Meteorologie und Klimaforschung, Karlsruher Institut für Technologie, Karlsruhe, Germany

Gravity waves (GWs) are one of the most important coupling mechanisms in the atmosphere. They couple different compartments of the atmosphere. The GW-LCYCLE (Gravity Wave Life Cycle) project aims on studying the excitation, propagation, and dissipation of gravity waves. An aircraft campaign has been performed in winter 2015/2016, during which the first 3D tomographic measurements of GWs were performed with the infrared limb imager GLORIA (Gimballed Limb Observer for Radiance Imaging of the Atmosphere).
GLORIA combines a classical Fourier Transform Spectrometer with a 2D detector array. The capability to image the atmosphere and thereby take several thousand spectra simultaneously improves the spatial sampling compared to conventional limb sounders by an order of magnitude. Furthermore GLORIA is able to pan the horizontal viewing direction and therefore measure the same volume of air under different angles. Due to these properties tomographic methods can be used to derive 3D temperature and tracer fields with spatial resolutions of better than 30km x 30km x 250m from measurements taken during circular flight patterns.
Temperature distributions measured during a strong GW event on the 25.01.2016 during the GW-LCycle campaign over Iceland will be presented and analyzed for gravity waves. The three dimensional nature of the GLORIA measurements allows for the determination of the gravity wave momentum flux, including its horizontal direction. The calculated momentum fluxes rank this event under one of the strongest 1% observed in that latitude range in January 2016.
The three dimensional wave vectors determined from the GLORIA measurements can be used for a ray tracing study with the Gravity wave Regional Or Global RAy Tracer (GROGRAT). Here 1D ray tracing, meaning solely vertical column propagation, as used by standard parameterizations in numerical weather prediction and climate models is compared to 4D ray tracing (spatially three dimensional with time varying background) for the presented event on the 25.01.2016. Here it is shown, that in the 1D case the GWs are filtered at lower altitudes, whereas in the 4D case the rays were able to propagate to altitudes of above 30km.
Besides the forward propagation up to higher altitudes, also the backward propagation to the source region can be study with GROGRAT. Here the mountains of Iceland could be clearly identified as the source region of the measured GWs.