Propagation of mesoscale gravity waves above the Scandinavian Mountains as observed by GLORIA and AIRS

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Gravity waves (GWs) are one of the most important coupling mechanisms between the lower and upper atmosphere. Within the GW-LCYCLE (Gravity Wave Life Cycle) project, an aircraft campaign has been performed in winter 2015/2016 to study the propagation of gravity waves. During this campaign, the first 3D tomographic measurements of GWs were taken 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 75km x 30km x 500m from measurements taken during linear flight patterns.

Temperature distributions measured by GLORIA in the UTLS during a strong GW event on 28 January 2016 over Southern Scandinavia will be presented. The 3-D nature of the GLORIA measurements allows for the determination of 3-D wave vectors, including the horizontal directions, which is a novelty for limb instruments These 3-D wave vectors enable the use of the Gravity wave Regional Or Global RAy Tracer (GROGRAT) to study the propagation of these waves. The waves stay mainly above Scandinavia and propagate up to the model top at 45km. These propagated waves are compared with stratospheric measurements of the AIRS satellite instrument. This wave can barely be observed by AIRS due to the short vertical wavelength. Despite the limitations of the nadir geometry, a comparison including the AIRS observational filter yields a good agreement. Besides the forward propagation up to higher altitudes, also the backward propagation to the source region can be study with GROGRAT. Here the orography of the Scandinavian Mountains and spontaneous adjustment above the North Sea are identified as sources of the waves. This case study allows to investigate contributions and interaction of these two sources and the influence of the background winds on the resulting wave field.

Key words: gravity waves, remote sensing, aircraft campaign, ray-tracing, tomography