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Propagation of gravity waves in the vicinity of the polar night jet

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Atmospheric gravity waves cause perturbations of wind and temperature. In an atmosphere at rest the relation between the quantities is simple. For example the time evolution of a vertical profile of temperatures gives enough information to deduce upward and downward energy and momentum transport. In a situation with atmosphere motions, eventually changing with altitude and time, the relation between wind and temperature perturbations is more complicated. Nonetheless, combined temperature and wind observations enable characterization of inertia-gravity waves (IGW) using the phase relations between the different quantities.

In this work we use the hodograph method that makes use of the phase relation between both zonal and meridional wind components, and temperature. We apply this method to single profiles of a larger dataset. The method is based on localized linear theory of gravity waves and has been used to determine the intrinsic frequency, propagation direction, and phase velocity of IGW. The hodograph is a unique method to derive these IGW characteristics unambiguously from ground-based observations. The main challenge for this method is the identification of nearly monochromatic waves. We developed an approach that isolates one dominating wave in a limited altitude range. Thus, in one altitude profile several waves can be identified. This allows analyzing IGW individually and subsequently applying different averaging according to selected IGW-properties.

We show measurements performed at the ALOMAR research station in northern Norway (69°N, 16°E) during January 2016. These observations were performed while the polar-night jet introduced a large shear above the lidar station leading to a complicated but striking situation for up and downward propagating gravity waves. Our analysis gives insight to gravity wave parameters, for example regarding propagation directions.