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Retrieval of intrinsic gravity wave parameters from lidar and airglow temperature data and radar wind data

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Momentum transport by atmospheric gravity waves represents an important coupling mechanism in the middle atmosphere with strong effects on the energy budget and circulation. Till now the behavior of discrete GWs has been investigated by applying bandpass filters to temperature time series of lidar and airglow temperature data and extracting observed periods. The resulting temperature perturbations have been interpreted as wave packets, where changes in amplitude were considered as a sign of either gravity wave breaking or the wave packet moving out of the observation volume. This interpretation is certainly valid in some cases, but not necessarily true in general. We show that Doppler shifting of intrinsic wave periods caused by variations in the background wind (e.g. tides) can result in disappearance of large scale wave packets in bandpass filtered time series.

We use co-located lidar temperature, airglow imager and meteor radar observations acquired from Sodankylä, Finland, during the winter 2015/16, as a part of the GW-LCYCLE2 campaign and derive intrinsic gravity wave parameters as well as propagation directions. Assuming that retrieved intrinsic parameters change slowly with height, time and geographic location, we calculate the Doppler shift as a function of space and time. Using this information, we adapt the passband of our spectral filter to follow the Doppler shift at each point in space and time. This new analysis method allows us to identify single wave packets in lidar and airglow data which undergo strong Doppler shifting and therefore show up as multiple wave packets using traditional filtering methods.

Using our new analysis method we see fewer wave packets which however persist over longer times. Our conclusion is that wave packets in the upper mesosphere are more coherent in space and time than previously thought. This may have an impact on the expectable intermittency of gravity waves and their parameterizations in circulation models.