

## A decadal satellite record of gravity wave activity in the lower stratosphere to study polar stratospheric cloud formation

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Atmospheric gravity waves yield substantial small-scale temperature fluctuations that can trigger the formation of polar stratospheric clouds (PSCs). Here we introduce a new satellite record of gravity wave activity in the polar lower stratosphere to investigate this process. The record comprises observations of the Atmospheric InfraRed Sounder (AIRS) aboard NASA's Aqua satellite during January 2003 to December 2012. Gravity wave activity is measured in terms of detrended and noise-corrected 15 micron brightness temperature variances, which are calculated from AIRS channels that are most sensitive to temperature fluctuations at about 17-32 km altitude. The analysis of temporal patterns in the data set revealed a strong seasonal cycle in wave activity with wintertime maxima at mid and high latitudes. The analysis of spatial patterns indicated that orography as well as jet and storm sources are the main cause of the observed waves. Wave activity is closely correlated with 30 hPa zonal winds, which is attributed to the AIRS observational filter. We used the new data set to evaluate explicitly resolved temperature fluctuations due to gravity waves in the European Centre for Medium-Range Weather Forecast (ECMWF) operational analysis. It was found that the analysis reproduces orographic and non-orographic wave patterns in the right places, but that wave amplitudes are typically underestimated by a factor of 2-3. Furthermore, in a first survey of joint AIRS and Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) satellite observations nearly 50 gravity wave-induced PSC formation events were identified. The survey shows that the new AIRS data set can help to better identify such events and more generally highlights the importance of the process for polar ozone chemistry.

### References:

Hoffmann, L., Spang, R., Orr, A., Alexander, M. J., Holt, L. A., and Stein, O.: A decadal satellite record of gravity wave activity in the lower stratosphere to study polar stratospheric cloud formation, *Atmos. Chem. Phys.*, 17, 2901-2920, <https://doi.org/10.5194/acp-17-2901-2017>, 2017.

Spang, R., Hoffmann, L., Höpfner, M., Griessbach, S., Müller, R., Pitts, M. C., Orr, A. M. W., and Riese, M.: A multi-wavelength classification method for polar stratospheric cloud types using infrared limb spectra, *Atmos. Meas. Tech.*, 9, 3619-3639, <https://doi.org/10.5194/amt-9-3619-2016>, 2016.