SOFIE Gravity Waves

v0.0, 10 December 2015

The gravity wave (GW) data files provide the user with gravity wave amplitude and potential energy for each temperature profile (*if there are at least 12 profiles per day). The method to derive GW information from temperature data is described below.

Method:

- Estimate background temperature (To): The temperature profiles (T) are sorted in ascending longitudes and fitted with a least squares fit (LSF, Thurairajah et al., 2014). The fitted temperatures are used to calculate the daily zonal mean temperature (wave number 0) and planetary wave (wave number 1-7) components. To is the sum of the zonal mean temperature and planetary wave components. Only daily data with at least 12 daily T profiles are used. *Since we are subtracting the wave number 6 and 7 components, if the 13,14, and/or 15th profiles are missing they are calculated by averaging the previous five temperature profiles. But the GW information for the missing temperature profiles is not reported in the final data file.
- Calculate temperature perturbation (T' = T - To): The background temperature is subtracted from the temperature profiles to get the perturbation temperature. This removes the contribution from planetary waves and tides and T' is interpreted as fluctuation due to gravity waves (GWs).
- Three dominant vertical wavelengths restricted between 4-30 km are determined from wavelet analysis of the perturbation temperature.
- The perturbation temperature profile is reconstructed by harmonic fitting with a 10 km sliding window using the estimated vertical wavelengths.
- The reconstructed perturbation temperature is used to calculate the GW potential energy. The harmonic fitting provides the amplitude of the GWs

GW data products are given in amplitude [K] and potential energy [J/kg]. Due to the 10 km sliding window used to the harmonic fitting the GW parameters are reported only from 20-90 km. The temperature and reconstructed perturbation temperature are also included in the netcdf file.

The SOFIE GW amplitudes are smaller than the previously reported SABER GW amplitudes (e.g. Yamashita et al., 2013 and references therein). One reason could be that we subtract all 7 planetary wave components, compared to the first five components in the SABER analysis. Subtracting only the wave numbers 1-5 components sometimes results in the perturbation temperature being contaminated with the higher wave number planetary waves.

The precision of SOFIE temperature measurements is 0.5 K. Users are encouraged to use caution when using amplitudes with values less than 0.5 K. Also, the GW amplitudes are expected to increase with increasing altitudes. However we sometimes observe a decrease in amplitude with height in the ~40-60 km altitude range. We are further investigating this issue.

More information about SOFIE GW potential energy and the calculation of the LSF and T' can be found in Thurairajah et al. (2014). SOFIE GWs have also been reported by Liu et al. (2014). Harmonic fitting to estimate wave amplitudes has been used to calculate GW amplitudes from SABER temperature profiles (e.g. Yamashita et al., 2013 and references therein).

References:

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Thurairajah, B., S. M. Bailey, C. Y. Cullens, M. E. Hervig, J. M. Russell III (2014), Gravity wave activity during recent stratospheric sudden warming events from SOFIE temperature measurements, *J. Geophys. Res. Atmos., 119*, 8091-8103, doi:10.1002/2014JD021763.

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