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Quantification of flux components generated by near surface gravity waves, one option of Eddy Covariance Measurements during polar night conditions

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Though the polar night is in almost all points inappropriate for good quality Eddy Covariance flux measurements in common ways (first of all because the turbulence is very limited till not existing), there can be made diverse scientific findings and understandings in consideration of the special circumstances. For example and first of all, the behaviour of the measurement instruments under extreme climatic conditions can be observed. The knowledge of this behaviour can lead to qualitative conclusions about the turbulent fluxes in polar regions.

In August/September 2010 an Eddy Covariance System was installed next to Ny – Ålesund on Spitzbergen at N 78° 55.287', E 011° 54.851'. The main goal in doing so is to get more knowledge about the momentum, sensible and latent heat flux during stable conditions and to achieve as exact as possible parameterizations of the fluxes. Here, one small point of the polar flux behaviour shall be presented.

In common the sensible heat fluxes during polar night conditions are negative (directed to the surface), because there is no heating by atmospheric shortwave radiation and the longwave radiative loss at the interface soil – atmosphere is quite big, so the temperature at the soil surface is much lower than in a certain height. Nevertheless, under typical conditions, gravity waves can lead to positive sensible fluxes about 50 – 100 Wm^{-2}.

By varying the flux averaging time (typically the fluxes are averaged about 30 minutes to get the complete turbulence spectrum) the occurrence of gravity waves under specific circumstances can be detected.

In our case, there was made a comparison between 30 minutes middled sensible heat fluxes and 60 minutes middled sensible heat fluxes. The 30 minutes middled fluxes were added and divided by 2 and then compared with the 60 minutes middled fluxes. Under specific conditions, the values of the 60 minutes middled fluxes are considerable higher than the 60 minutes fluxes calculated from the 30 minutes fluxes. There are long wave components, which leads to measuring positive fluxes under specific conditions, if you middle over 60 minutes or more. The range of wave motion is given in all cases by the Brunt – Väisälä frequency ($N = \sqrt{\frac{g}{\theta} \cdot \frac{d\theta}{dz}}$), which describe the oscillation frequency of a vertical linked mass element in a static system.

The occurrence of the measured positive flux components is coupled with always the same behaviour of different scalars. First of all, the longwave radiative loss at the interface soil – atmosphere is big, the sky is clear, there is no radiative heating by shortwave radiation. Second, the wind velocity is getting much lower before the occurrence of gravity waves; it has to be quite calm, turbulent mixing processes by the wind have to be disabled. Third, the 2 meter temperature signal of the standard meteorological measurements shows the wave motion very clearly. The frequency of the waves here is about 0.5 to 1 per hour. The amplitude can be about 5 Kelvin and more.

So, the intent is to use 60 minutes (or more, the investigations here are still running) middle time for flux determination in common in case of wave motion during polar night conditions to detect the complete spectrum for making qualitative remarks on the energy balance in polar regions for this cases. A possible goal could be, to develop and develop further as exact as possible criterias for the occurrence of gravity waves at this polar site and furthermore all polar sites.