Geophysical Research Abstracts
Vol. 21, EGU2019-3010, 2019
EGU General Assembly 2019

Wavelet analysis of eddy covariance measured methane emission time series from an alpine peatland on the Qinghai-Tibetan Plateau

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The Eddy Covariance (EC) method provides not only a direct signal of the ecosystem-atmospheric CH4 exchange, but also continuous CH4 fluxes which are perfectly suited for time series analysis. Continuous wavelets are robust to noise, which makes it a more powerful tool for analyzing time series with nonstationarity than the Fourier analysis. The Morlet wavelet has a real and an imaginary part, which allows the investigation of amplitude and phase respectively. Using the Continuous Wavelet Transform (CWT) with the Morlet wavelet, we examined the temporal variation of ecosystem CH4 exchange and its correlations with the environmental factors within the growing season of an alpine peatland on the eastern Qinghai-Tibetan Plateau. Diurnal variations in ecosystem CH4 exchange were not consistent throughout the growing season, and limited to periods from mid-May to June, late July to early August, mid-August and late September. The spectral energy peak at the daily scale was clear for CH4 fluxes, soil temperature at 25 cm below the surface (ST-25), fraction velocity, vapor pressure deficit (VPD), and water table level. However, the spectral energy peak of water table level at the daily time scale is much lower than that of friction velocity, CH4 fluxes, VPD and ST-25. The presentation of the local CH4 wavelet power spectrum in the time-frequency domain revealed additional shorter periods of high variation in ecosystem CH4 exchange that occurred at timescales of 28-30 days. Patterns of correlation with ecosystem CH4 exchange in the time-frequency domain were similar for air temperature at 200 cm above the surface (AT200), soil temperature at 10 cm below the surface (ST-10), ST-25, and soil temperature at 40 cm below the surface (ST-40). However, the phase shift pattern was different, especially on smaller timescales. All the temperature variables exhibited significant correlation with CH4 fluxes on a daily time scale, but only AT200 was in phase with the fluctuations in CH4 exchanges.