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Gap filling and noise reduction of unevenly sampled data by means of the Lomb-Scargle periodogram

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Abstract. The Lomb-Scargle periodogram is widely used for the estimation of the power spectral density of unevenly sampled data. A small extension of the algorithm of the Lomb-Scargle periodogram permits the estimation of the phases of the spectral components. The amplitude and phase information is sufficient for the construction of a complex Fourier spectrum. The inverse Fourier transform can be applied to this Fourier spectrum and provides an evenly sampled series (Scargle, 1989). We are testing the proposed reconstruction method by means of artificial time series and real observations of mesospheric ozone, having data gaps and noise. For data gap filling and noise reduction, it is necessary to modify the Fourier spectrum before the inverse Fourier transform is done. The modification can be easily performed by selection of the relevant spectral components which are above a given confidence limit or within a certain frequency range. Examples with time series of lower mesospheric ozone show that the reconstruction method can reproduce steep ozone gradients around sunrise and sunset and superposed planetary wave-like oscillations observed by a ground-based microwave radiometer at Payerne. The importance of gap filling methods for climate change studies is demonstrated by means of long-term series of temperature and water vapor pressure at the Jungfraujoch station where data gaps from another instrument have been inserted before the linear trend is calculated. The results are encouraging but the present reconstruction algorithm is far away from being reliable and robust enough for a serious application.

Final Revised Paper (PDF, 654 KB) Supplement (24241 KB) Discussion Paper (ACPD)

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