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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Gap filling and noise reduction of unevenly sampled data by means of the Lomb-Scargle periodogram" *by* K. Hocke and N. Kämpfer

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Dear Referee 3,

Thank you for your detailed comments which we will use for improvement of our study. We were not aware of the study by Hernandez et al. (1999) which is a good reference for appropriate usage and limitations of the Lomb-Scargle periodogram.

We agree with you that we should extend our article by a better description of the limitations and errors of the proposed method. Knowing the limitations, we may better optimize and apply the method.

The main purpose of our study is the exploration of a new method which can be used for

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gap filling of atmospheric and geophysical time series or fields. It is good that you put forward the question if gap filling is meaningful for scientific purposes? A good method of gap filling is necessary for any kind of climate change study where parameters are averaged (e.g., global mean of parameter X, annual average of parameter Y at location Z, ...). If the instrument provides more data gaps during the winter season, the average will be systematically biased towards the summer values. So one should close the gaps by linear interpolation before computing the average. Just taking the average of the available data would induce a larger error of the estimated mean state. Though 'linear interpolation' makes a good job, we guess that there might be better methods which are waiting for exploration. Actually, most scientists have a bad conscience if they fill data gaps by linear interpolation, and many referees raise a plea when gaps are filled by linear interpolation. We are skeptical if multiple linear regression and 'trend models' do a good job in case of data series where the data gaps are not randomly distributed.

We tried the way via the Lomb-Scargle periodogram and were strongly disappointed when we got the reconstructed series in Figure 4 where the gaps are just filled with the average of the time series. The Lomb-Scargle periodogram generates some false spectral components or noise which are responsible for the undesired filling of the gaps by the mean value (variance of the reconstructed series at the places of the gaps becomes zero). So we need to remove the false spectral components from the spectrum, and this leads to the better reconstructions shown in Figures 2, 6 and 7. Possibly this approach only works for time series which are superpositions of stationary sine waves and random noise.

It remains a challenge to find a gap filling method which is better than 'linear interpolation' if the time series are not superpositions of stationary sine waves. For the revision, we consider a comparison of our reconstruction method versus linear interpolation. We plan a further test with a complete measurement series and want to introduce realistic data gaps from another instrument into the complete series. (It is not easy to find a

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complete measurement series but it has the advantage that the true mean is known in this case.) Further we intend to search for characteristics of the undesired spectral components (e.g., behaviour of theta phase values). The chances of success are not great but it also would improve the Lomb-Scargle spectrum in general.

Finally we like to add a paragraph to the article where we describe the scientific need of gap filling methods for improved detection and quantification of climate change processes.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 4603, 2008.