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Climate of the Past Discussions

Interactive comment on "Solar modulation of flood frequency in Central Europe during spring and summer on inter-annual to millennial time-scales" *by* M. Czymzik et al.

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Czymzik et al. compare air pressure, precipitation and flood data from southern Germany with total solar irradiance (TSI, Lean et al. 2000) for the period 1926 - 2002. After finding significant correlations ($p < 0.001$) between the records, a flood record from Lake Ammersee in southern Germany is compared to a 10 Be record by Vonmoos et al. (2006) and a 14C record by Muscheler et al (2007).

The flood record is undoubtedly excellent. However, there are issues that should be addressed before publication.

In this paper a 5-year running mean is applied to TSI and air pressure, precipitation and flood time-series. Applying a 5-year running mean to a time-series induces temporal autocorrelation: adjacent data points within the smoothed time-series are no longer independent. The test used to assess significance of correlations between smoothed solar activity and air pressure time-series assumes independence of the data points within one time-series. As temporal autocorrelation is not taken into account, the reported p-value of $p < 0.0001$ for $r = -0.47$ is most probably overoptimistic. In addition to the lack of independence within data series, leads and lags of up to 5 years are tested and the procedure is applied to six time-series, resulting in a multiple testing problem.

There are several analytical ways to deal with these problems (e.g. Trenberth et al. 1984). There are also methods using simulated data to deal with the lack of independence in a time-series. A simple way is to apply methods used in a study (i.e. 5-year running mean and allowing for lags up to 5 years) to random data (e.g. white noise) and to compare the results obtained using random data to the results obtained using the data tested (in this case pressure data).

I generated 100000 series of white noise, applied a 5-year running mean to the white noise series and correlated (using lags of 0 to 5 years, but no leads) the smoothed white noise series with the TSI data by Lean et al. (2000). I then chose the maximum of the six correlations produced by one white noise series to generate a null distribution.

Using this procedure, about 10% of the randomly generated time-series have a correlation of $|r| > 0.47$ with TSI, i.e. $p = 0.1$. A correlation of $r = -0.47$ (the highest correlation found in this paper) is therefore not significantly ($p<0.05$) different from results obtained using random data (only allowing for lags up to two years, or only for lags between 1 and 3 years, $p = 0.06$).

In the analysis of the late Holocene flood record the data by Vonmoos et al. (2006) is used for comparison with the flood record. In the earlier paper by Czymzik et al. (2013) the flood record was compared to the record by Steinhilber et al. (2009).

Vonmoos et al. (2006) write: “The reconstructed Phi record displays a long-term trend. Inferring a varying solar activity on such long timescales is not possible as long as the mentioned uncertainties considering possible system effects of the 10Be record exist and geomagnetic field reconstructions during the Holocene exhibit such large errors. Within the uncertainties, the long-term changes in 10Be can be completely explained by the changes in the geomagnetic dipole field [Muscheler et al., 2005a; Wagner et al., 2000]. Taking into account the calculated errors of the Phi reconstruction, the long-term trend in Phi in fact turns out not to be significant, indicating that possible system effects on the 10Be flux would be small. Therefore the OBSERVED LONG-TERM TREND in the presented Phi record is MOST LIKELY CAUSED BY AN INCOMPLETE ELIMINATION OF THE GEOMAGNETIC FIELD INFLUENCE on the 10Be flux and/or a slight long-term change in the climate system. However, long-term changes in solar activity cannot be excluded either.”

As reviewer one states: “Although the analysis reveals highly significant results correlation is not the best choice for this task. It is very sensitive to long-term trends.” Looking at Fig 4 the significant correlation between the flood record and the record by Vonmoos et al. (2006) is probably caused by long term trends that are not reliable.

Regarding 10 Be and 14C records, Steinhilber et al. (2012) state: “A comparison with changes in the geomagnetic dipole field strength [. . .] shows that the geomagnetic dipole shielding is the main cause of the observed multimillennial variability”

In light of this information, providing further motivation for the use of the Vonmoos et al. (2006) record instead of the Steinhilber et al. (2009) or Steinhilber et al. (2012) record (or inclusion of the latter two records) would greatly improve the quality of this paper (Especially as the paper by Czymzik et al. (2013) used the Steinhilber et al. (2009) record for comparison).

References

Czymzik et al. 2013 QSR, 61.

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