The use of differencing to remove spurious correlations in models of geostationary 2 MeV electron flux: comparison to spectral subtraction

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ML-Helio 2022

- Periodicity is common in space weather data. -- Cycles range from diurnal to the 27 day and 11 year solar cycles
- Removing common cycles reduces spurious correlations
- Diurnal cycles can be removed from electron flux and a ULF index using either a bandstop filter or a differencing transformation ($y_t - y_{t-24}$)
- Differencing is more useful as it removes both the 24 hour noise signal and the 27 day solar cycle
- With common cycles removed, correlations between these parameters are more valid, but lower (≤ 0.11) than previously published values

One Approach: Bandstop filter to remove 24 hour signal

Using an FIR equiripple bandstop filter, we successfully remove both the 24 hour and 12 hour noise signals from electron flux data (LANL satellite at geosynchronous orbit)


24 hour cycle visible

After filtering, cycles are removed
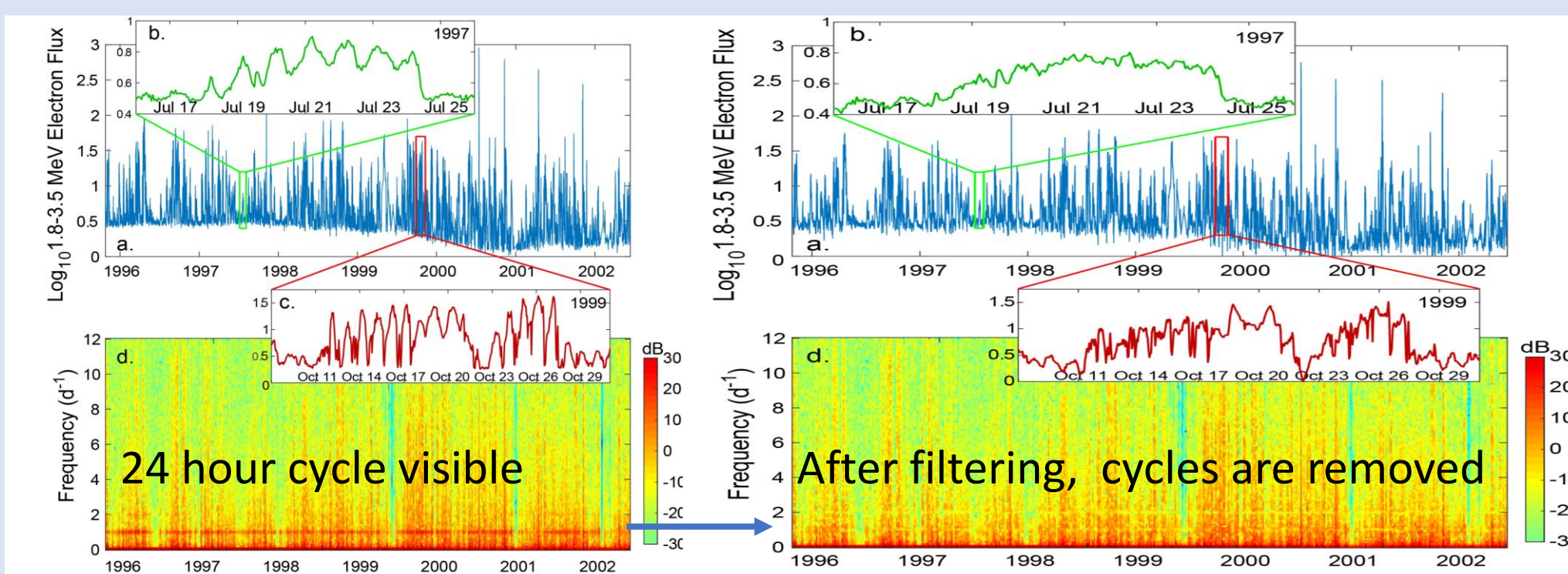
Second Approach: Difference transformation ($y_t - y_{t-24}$) removes both the 24 hour signal and the 27 day solar cycle

Subtracting the flux 24 hours previous from every observation removes the 24 h frequency as well as higher frequencies
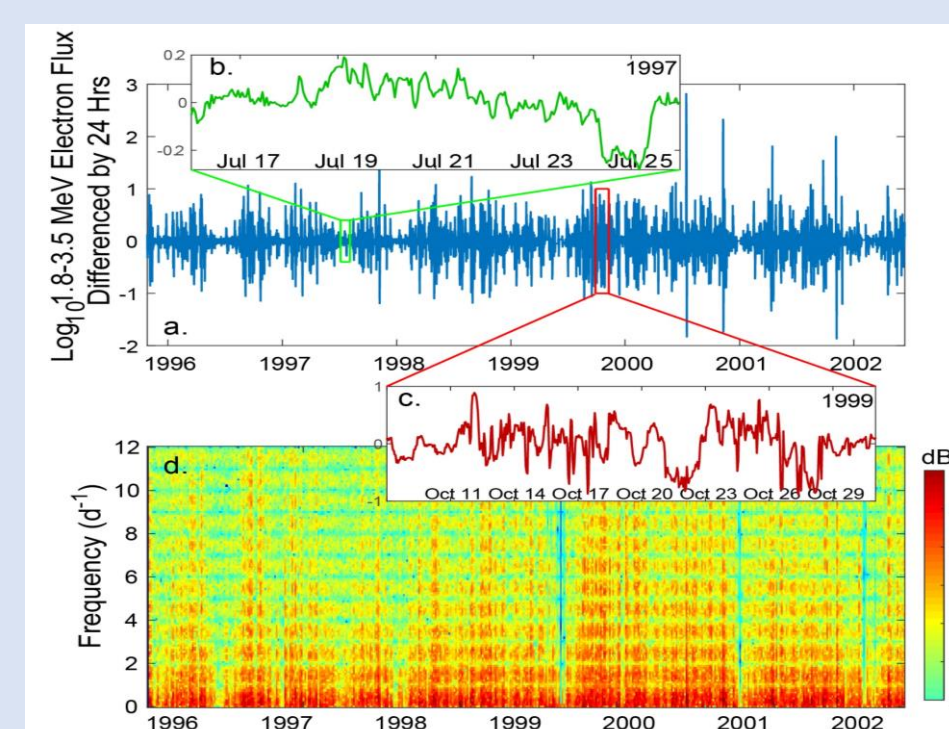
Differencing also removes longer cycles, including the 27 day solar cycle

27 day cycle

27 day and 24 cycles removed by differencing
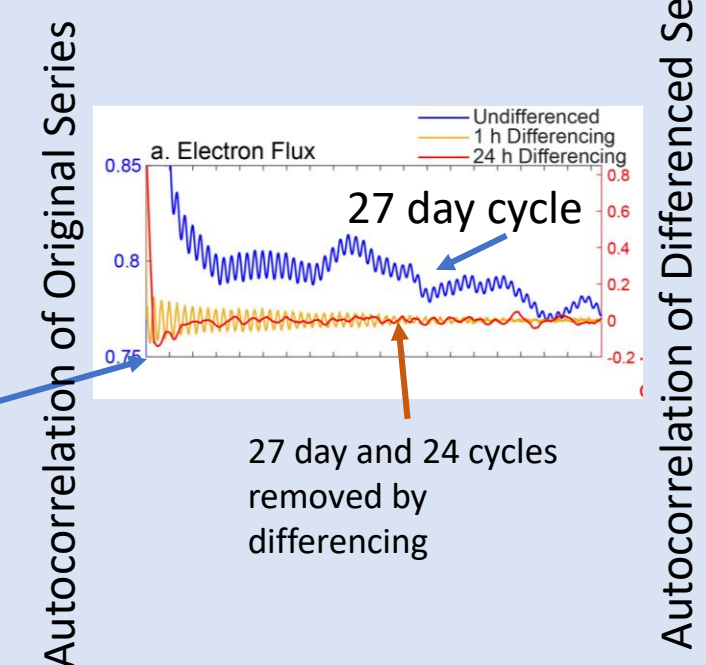
- Correlations between electron flux, a ULF index, and solar wind velocity (V) are all lower if common cycles are removed using the difference transformation ($y_t - y_{t-24}$)
- Spectral subtraction removes 24 cycle but not 27 day cycle: higher correlations are result of this longer cycle not being removed
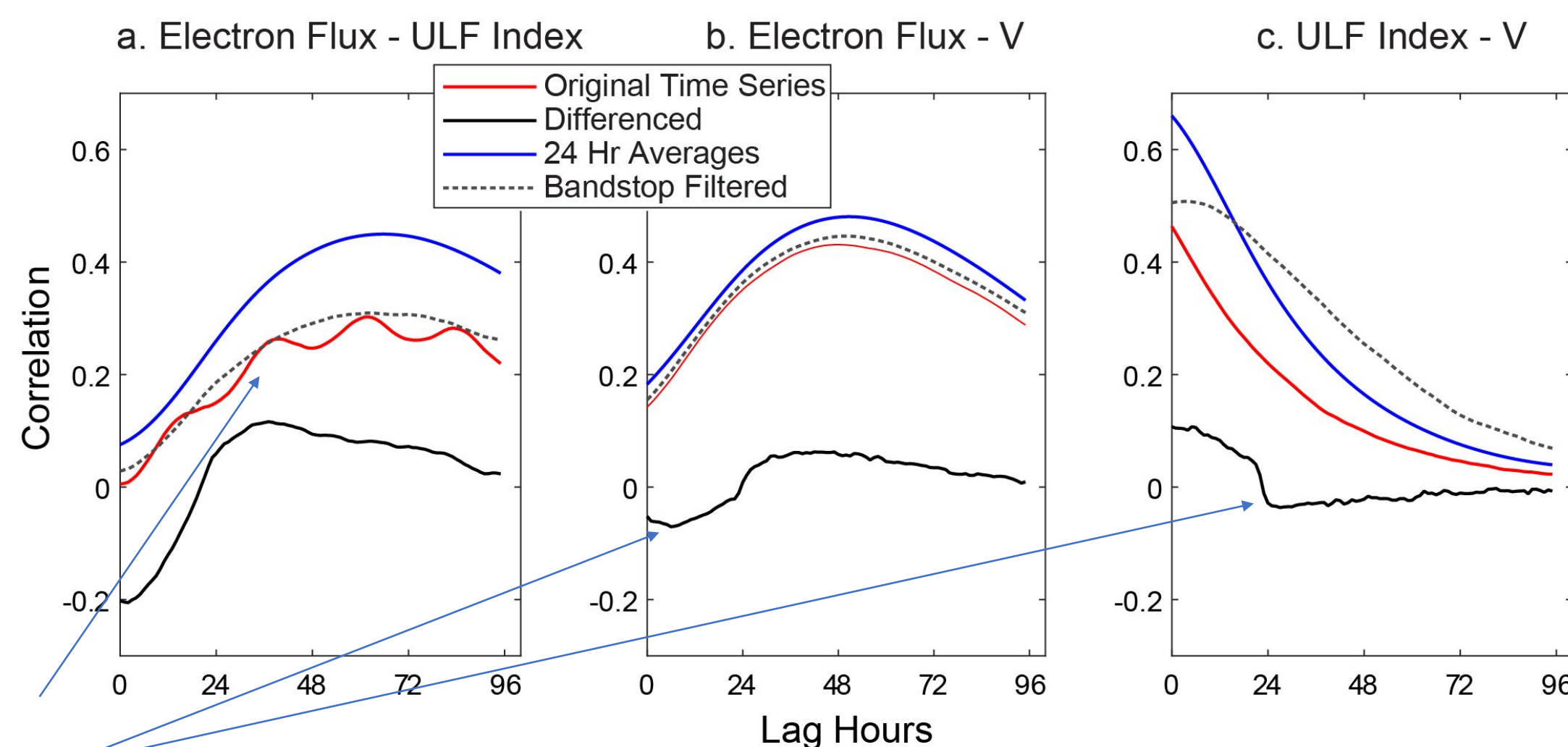
- Differenced correlation is the most valid as cycles are removed
- Differenced correlation is also the lowest
- Most of the correlation between electron flux and the ULF index is therefore due to common cycles
- Previously published high correlations suggested a strong physical relationship between these variables over these long time periods. With cycles removed, these associations are no longer as strong

Correlations of Differenced Series Are Lower – Because Common Cycles Are Removed