Windvén–SSA

Single spectrum analysis and forecasting of interplanetary magnetic field data

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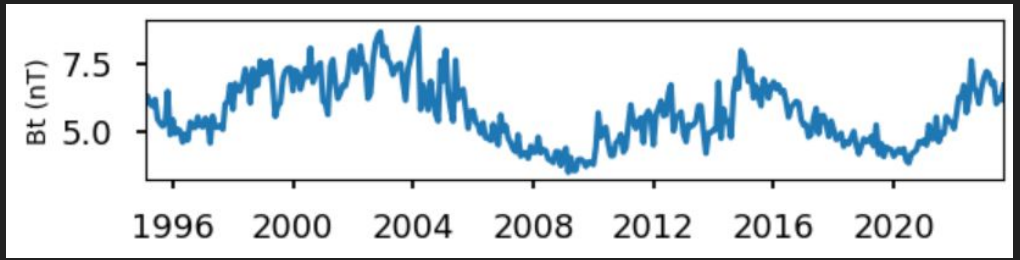
Magnetic Reconnection Challenge

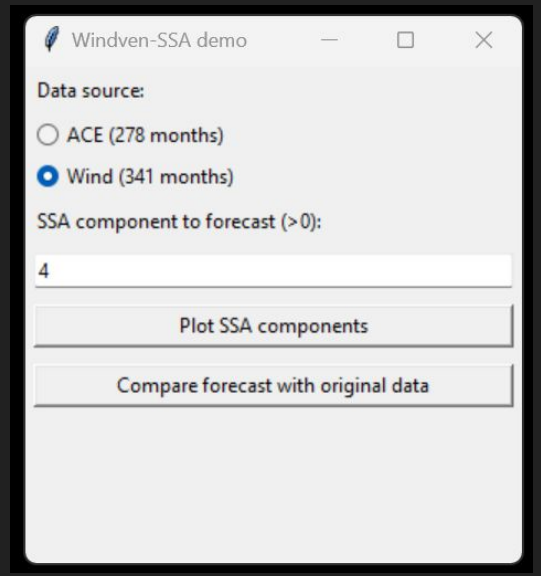
- Q: *How often does magnetic reconnection occur? How to present this?*
- Conditions for magnetic reconnection:
  - The magnetic field vector should be antiparallel with Earth's magnetic moment
  - **The magnetic field strength should be large** (we will focus on this aspect)
- Magnetic field data recorded by ACE and **Wind** (both are used):



Monthly averaged magnetic field strength data from Wind

Solution

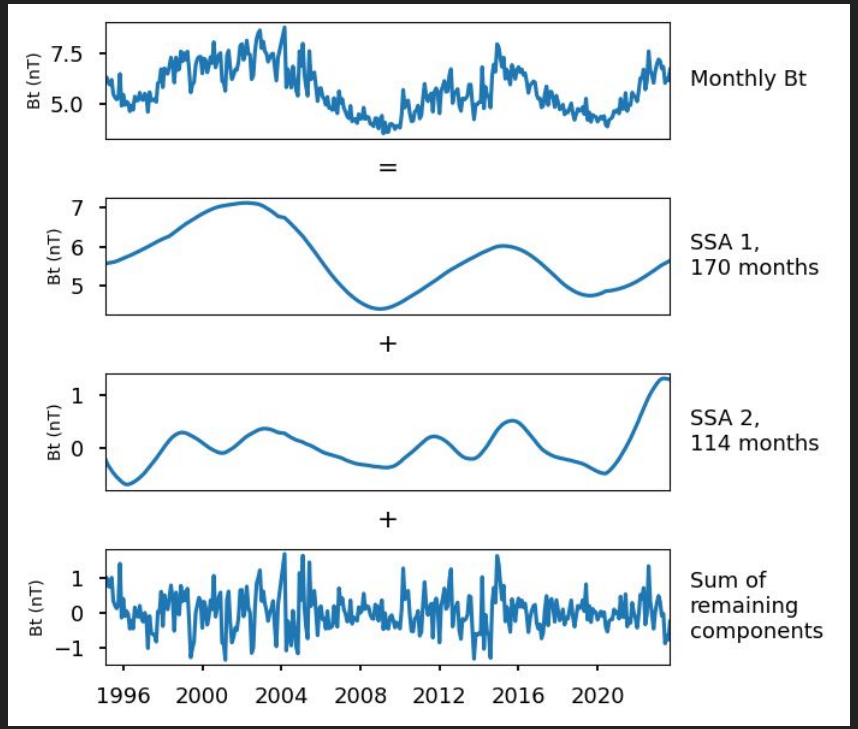
- Break up the complicated and noisy magnetic field time series data into components using single spectrum analysis (SSA)
- The components will be easier to analyze and make sense of to the general public
- Allow forecasting so that users get a better understanding of periodic variations
- Implement basic GUI (see figure on right)



Single spectrum analysis

- Decomposes the original magnetic field data into components
- Components are not necessarily sinusoidal (like in Fourier analysis)
- Analysis can be done with ACE or Wind data

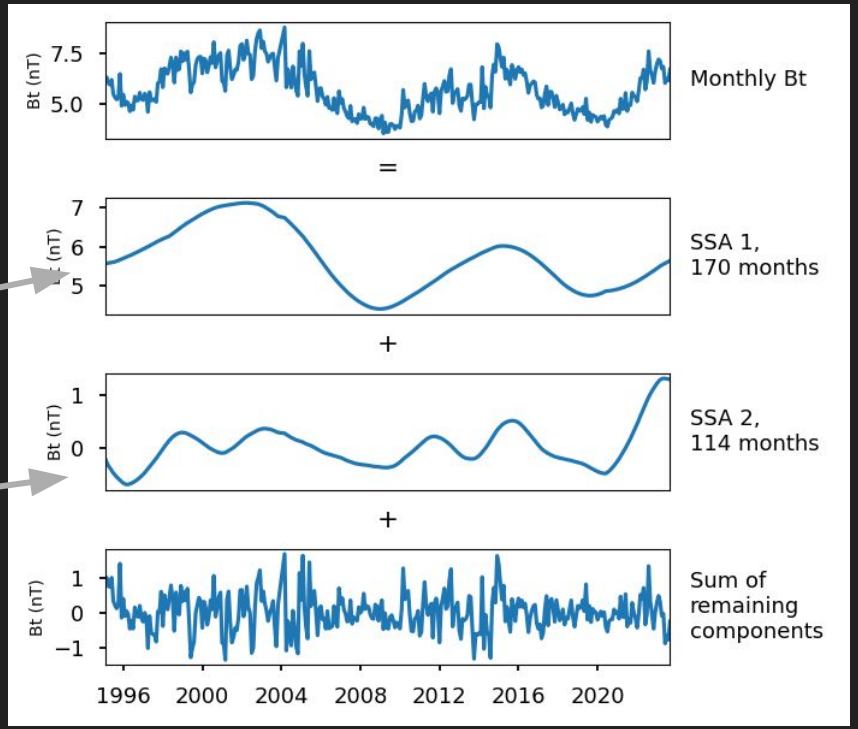
SSA of Wind data



Interpretation of SSA

- The SSA components coincide with cycles in the Sun's activity
- For example:
  - ~11 yr. solar activity cycle
  - Hemispheric asymmetry in the solar activity cycle

SSA of Wind data

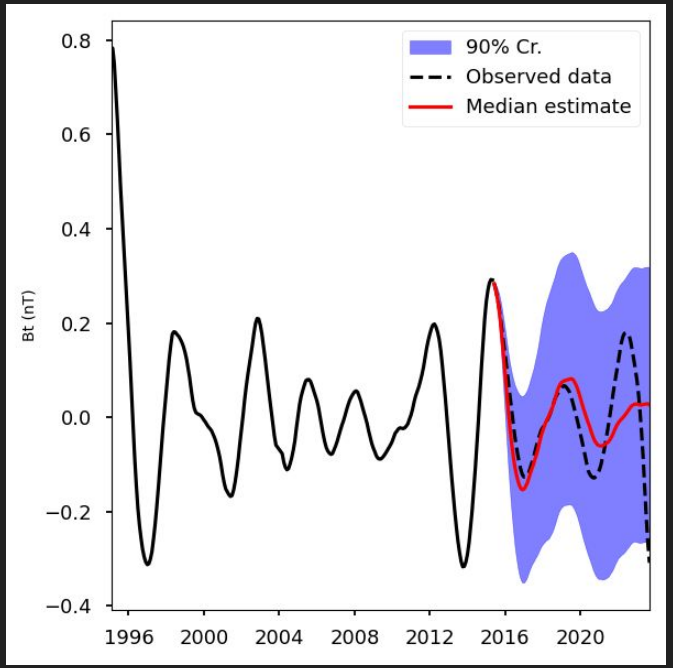


Forecasting

- Forecasting is done with **maximum entropy spectral estimation** of the individual SSA components

- Allows users to forecast the magnetic field strength for these components and compare with existing data

Example forecast using the 2nd SSA component of Wind data



Conclusion

- Two functions:
  - Allows a general audience to see the components that make up the magnetic field strength and how they vary in time
  - Allows users to forecast these components

- Target audience:
  - General public — they can inspect the SSA components to learn about solar cycles
  - Academics — SSAs are of interest to those looking to model and forecast this magnetic field data