Longitudinal, Seasonal and Solar Cycle Variation of Lunar Tide Influence on Equatorial Electrodynamics?

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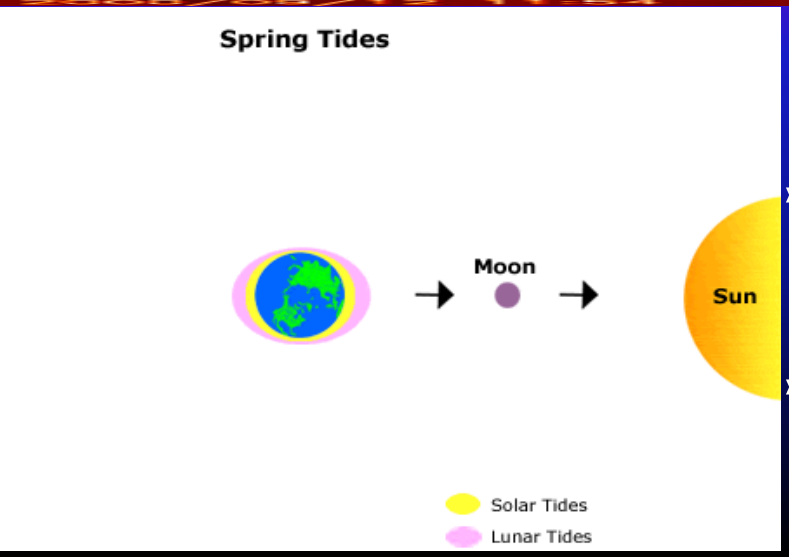
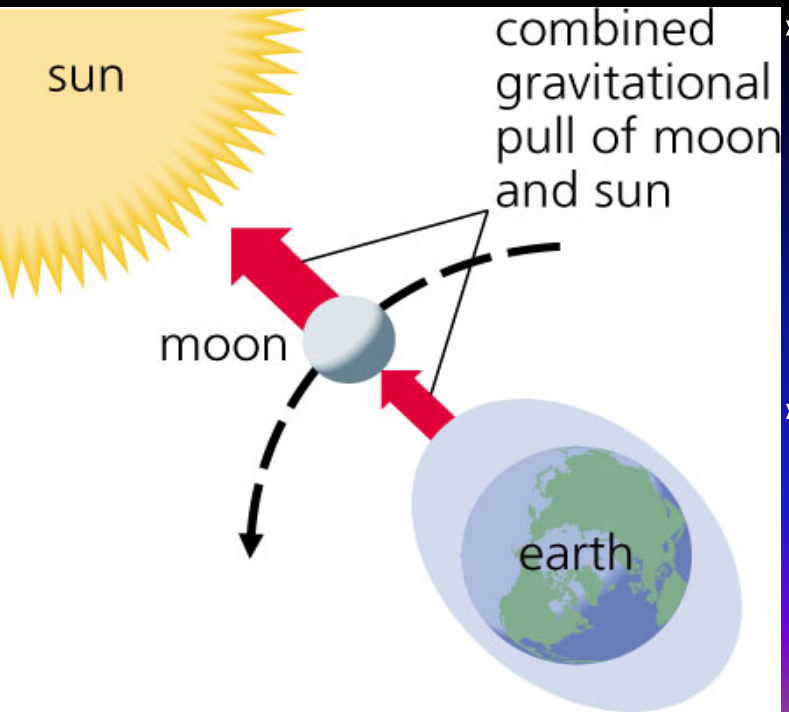
Outline



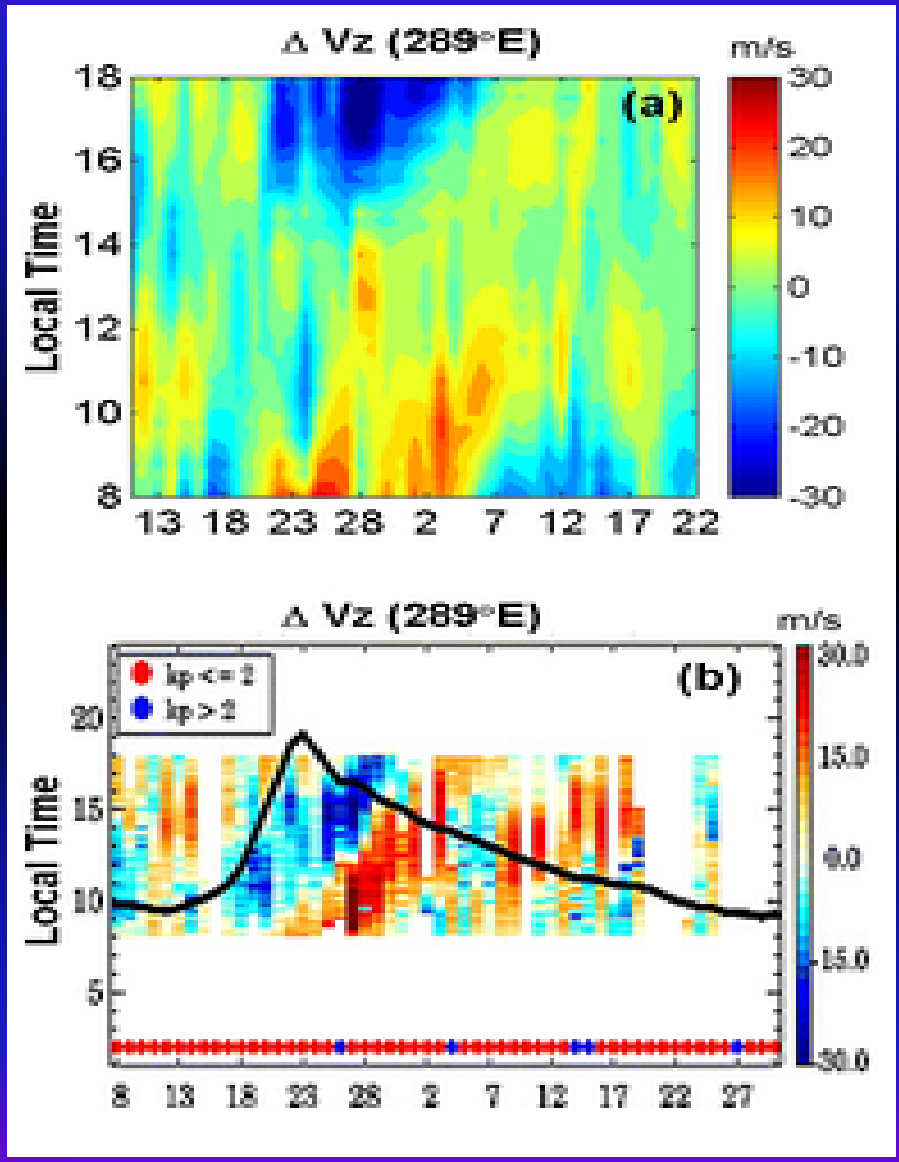


- Why do we care about lunar tide?
- Lunar tide extraction procedures
- Is lunar tidal wave Longitudinal, Seasonal, and Solar Cycle dependence?
- Summary

Why do we care about lunar tide?

- Lunar The lunar tidal wave propagates from the surface up into the E-region, generate an electrostatic field through dynamo action and modulate equatorial electrodynamics.

- Its influence gets intensified around noon, primarily during new and full Moon periods

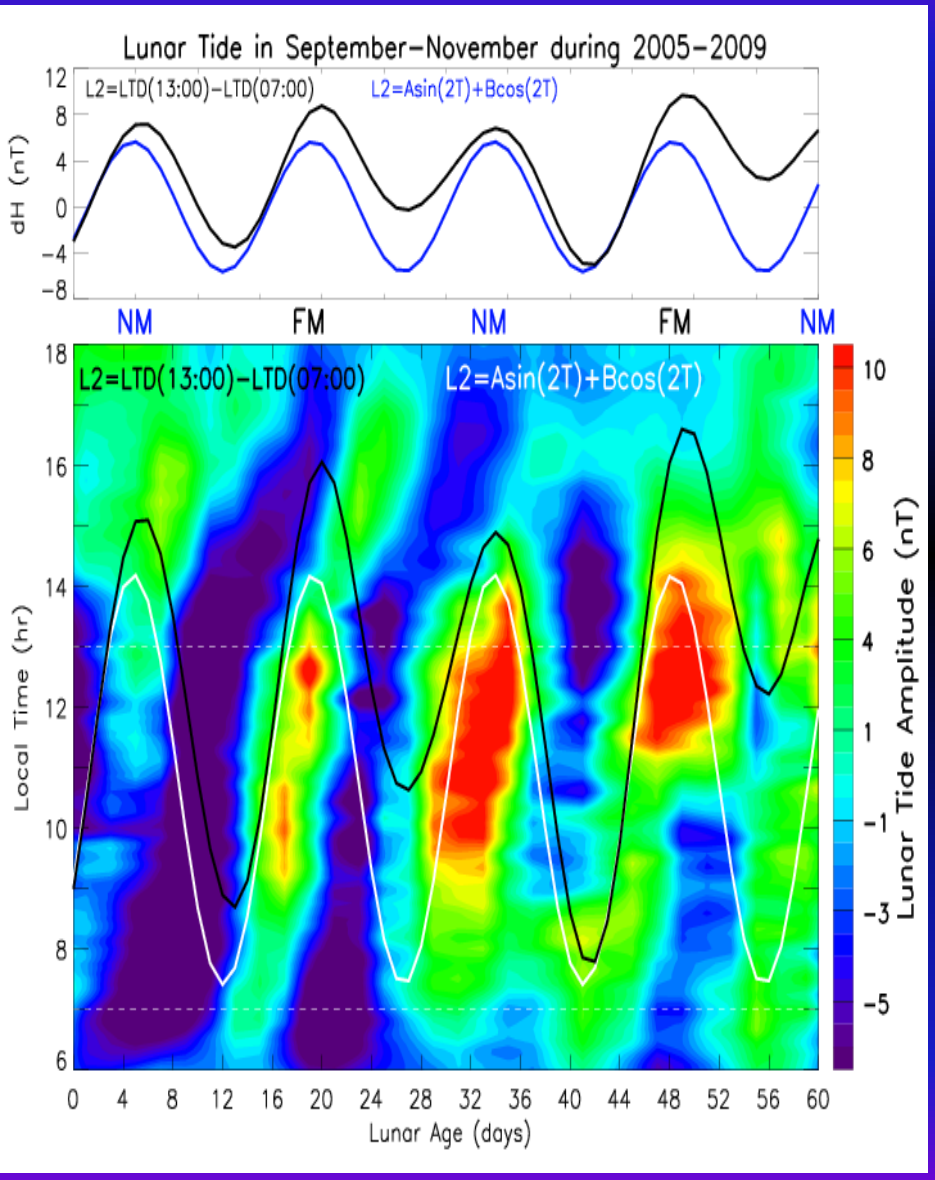


Fang et al., JGR, 2012

How can lunar tide amplitude be extracted from magnetometer data?

- Exclude observations taken during active periods (Kp > 3)
- Remove the background field
- Remove the Sq and ring current contributions
- Separate and subtract the geomagnetic solar tides that are generated by two kinds of atmospheric solar tides
  - Solar diurnal tide (forcing from below due to the local solar heating); removed by subtracting Sq
  - Solar semidiurnal tide (thermal forcing due to the absorption of solar radiation); removed by subtracting the 90day average value
- Noncyclic change subtracted on the daily bases.
- Finally, the residuals are rearranged as function lunar day and solar local time

Lunar tidal wave signature on EEJ



- The semi-diurnal (12 h for lunar day or 14 days for lunar month) lunar tide is the dominant component; and can be represented mathematically

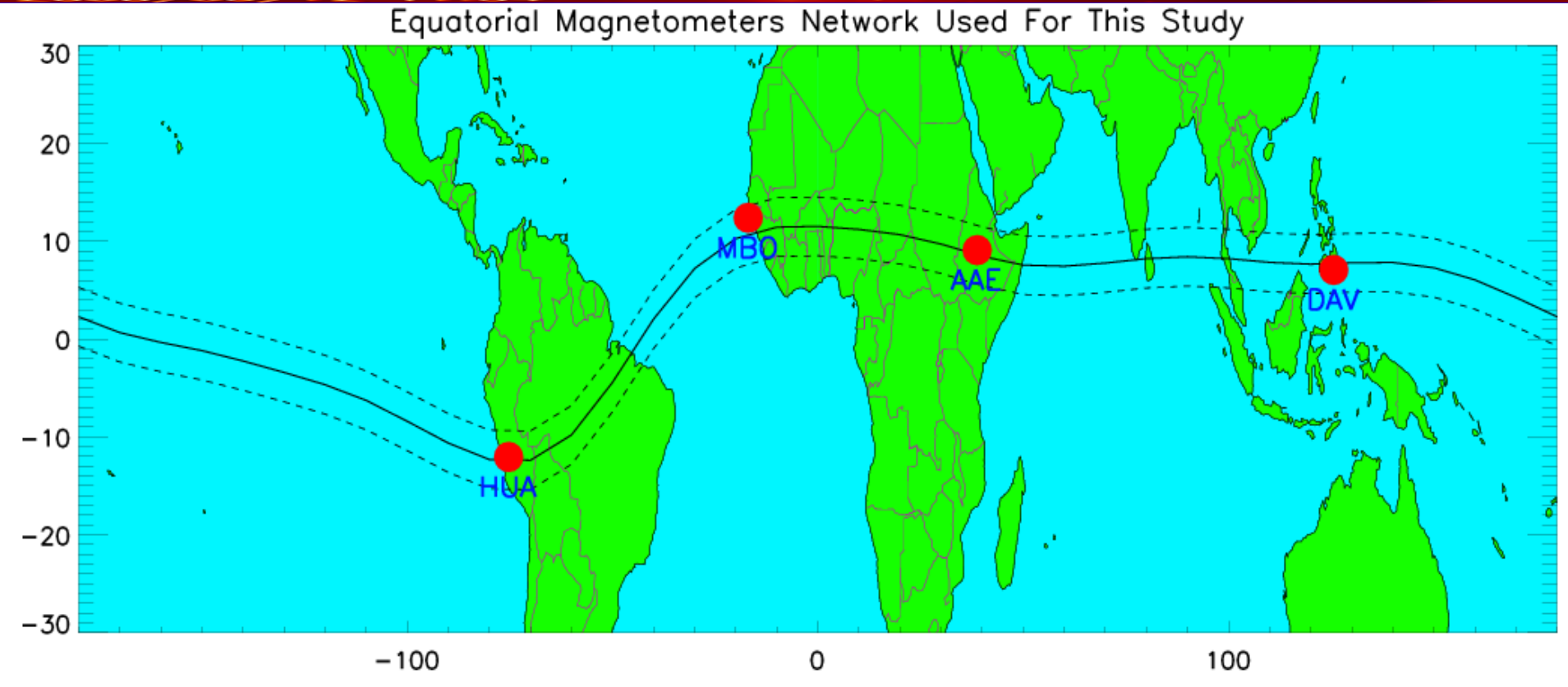
$$L_2 = A\sin(2\tau) + B\cos(2\tau)$$

A and *B* are coefficients determined using the technique described in (*Winch,1970*).

- **Is the lunar tide impact has longitudinal dependence?**

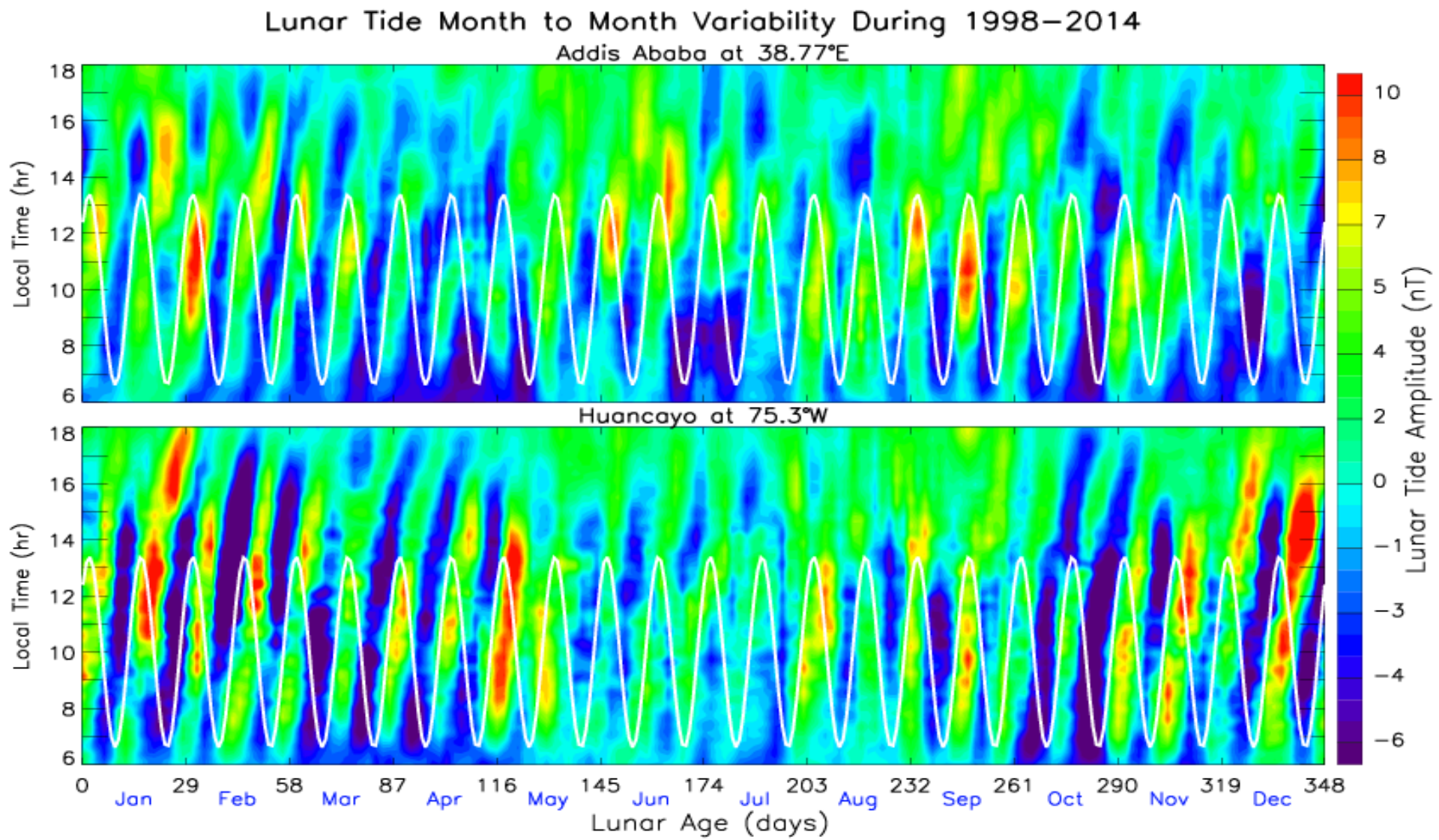
Yizengaw and Carter, AG, 2017

Data sources



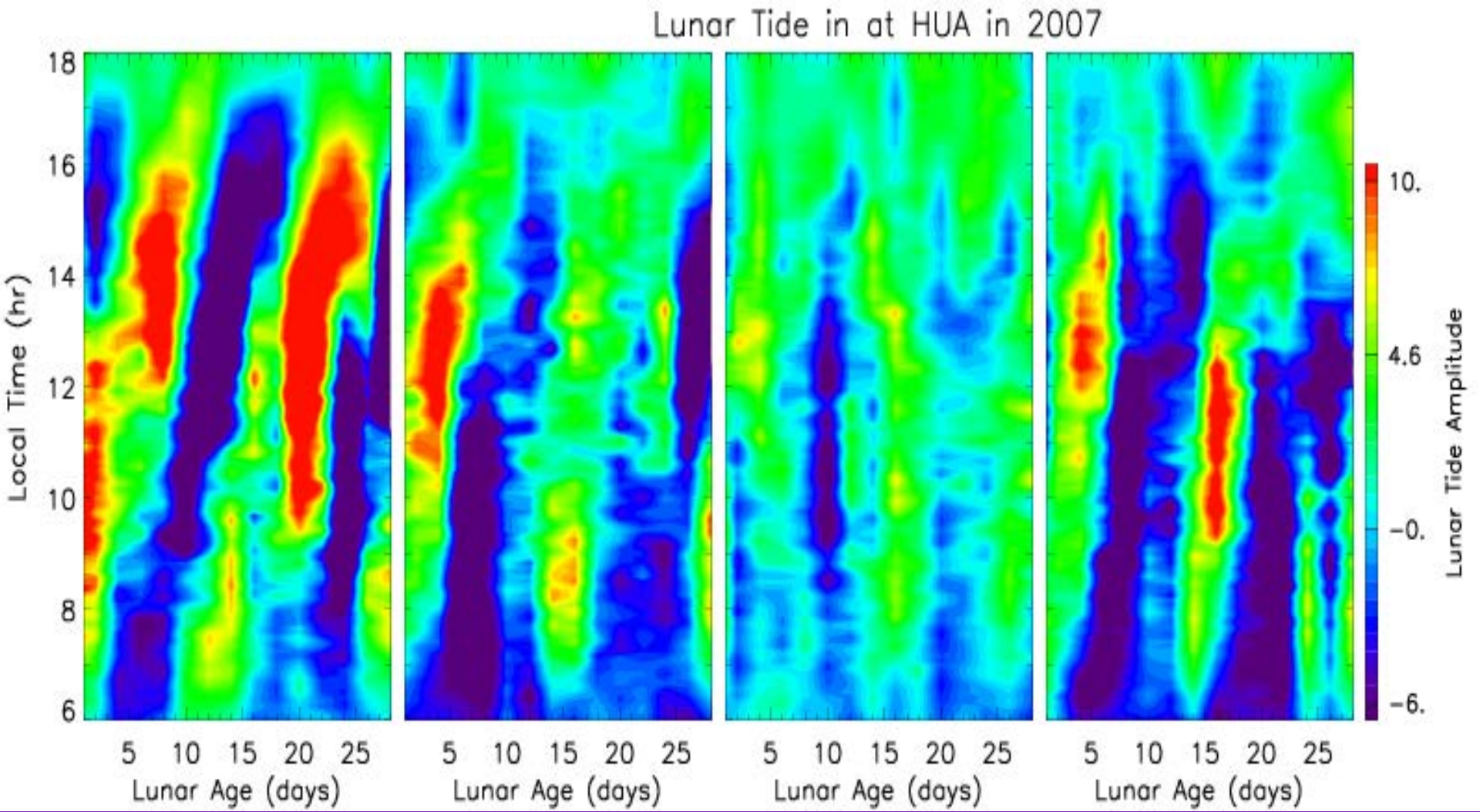
- 17 years (1998–2014) of extensive magnetometer observations at four longitudinal have been analyzed.
- Magnetically active periods (Kp> 3) observations have been excluded to eliminate storm contributions to the geomagnetic field variation at the geomagnetic equator.

Lunar Tidal wave Longitudinal Dependence

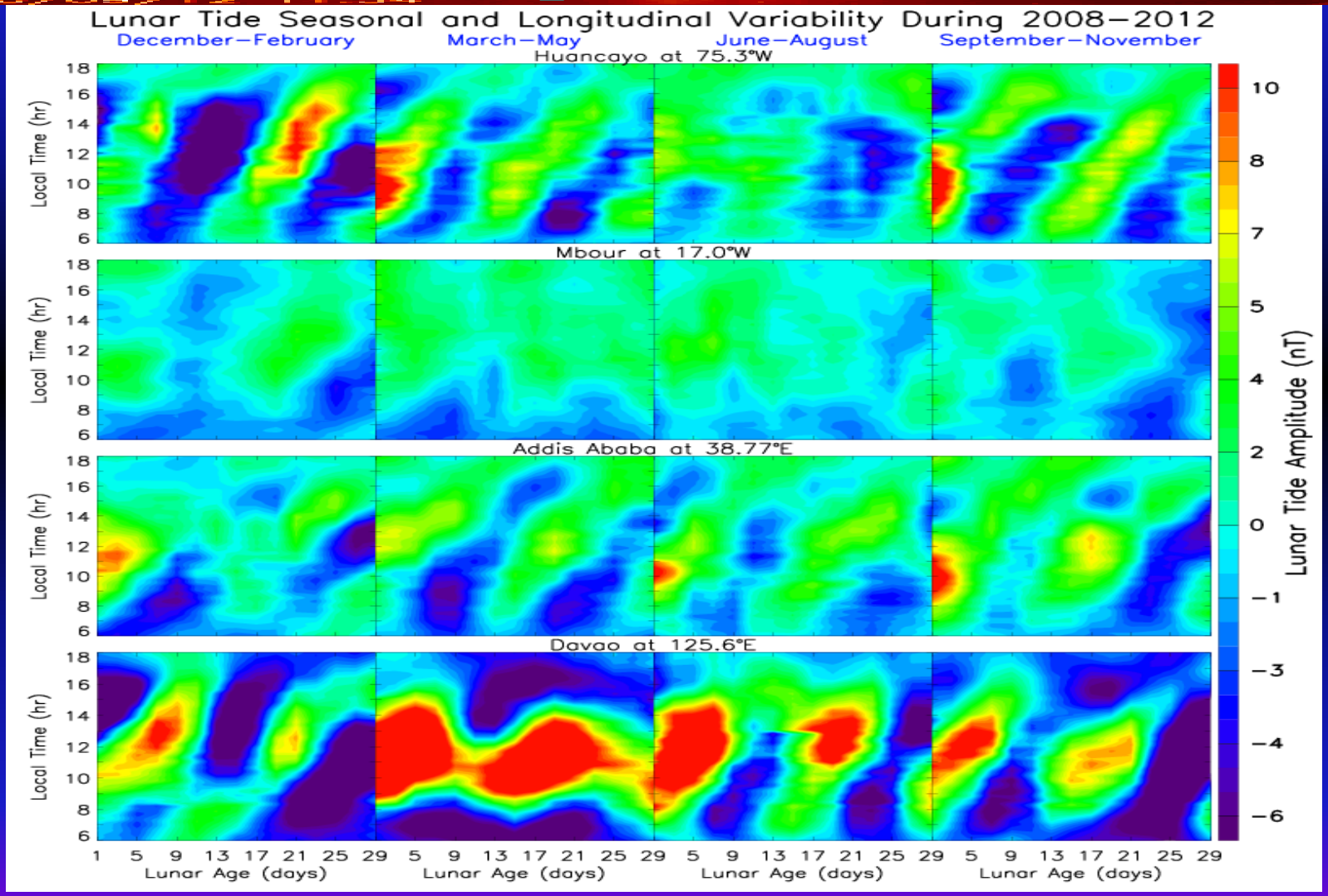


Lunar Tidal wave Seasonal Dependence

December-February | March-May | June-August | September-November



Lunar Tidal wave Seasonal Dependence



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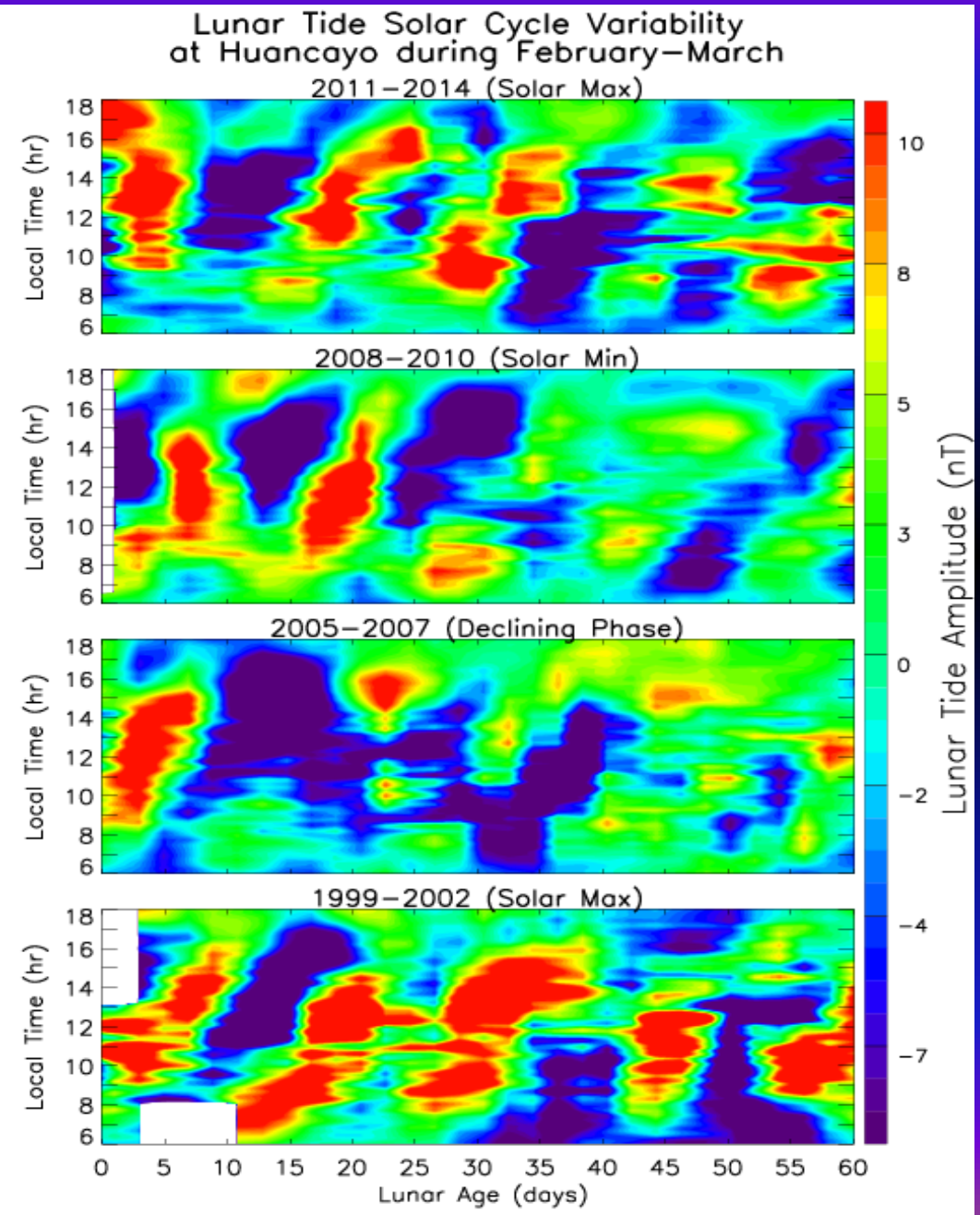
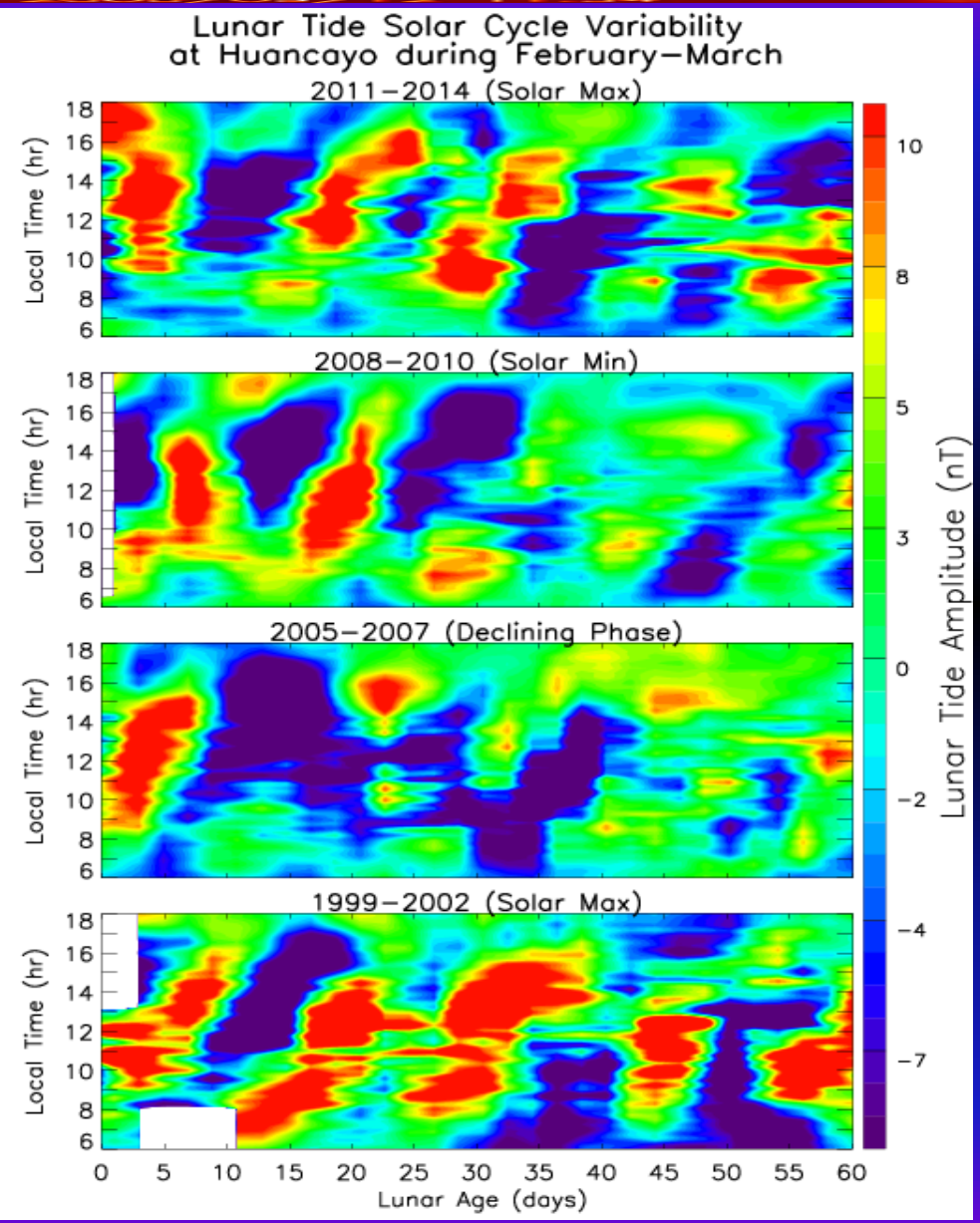
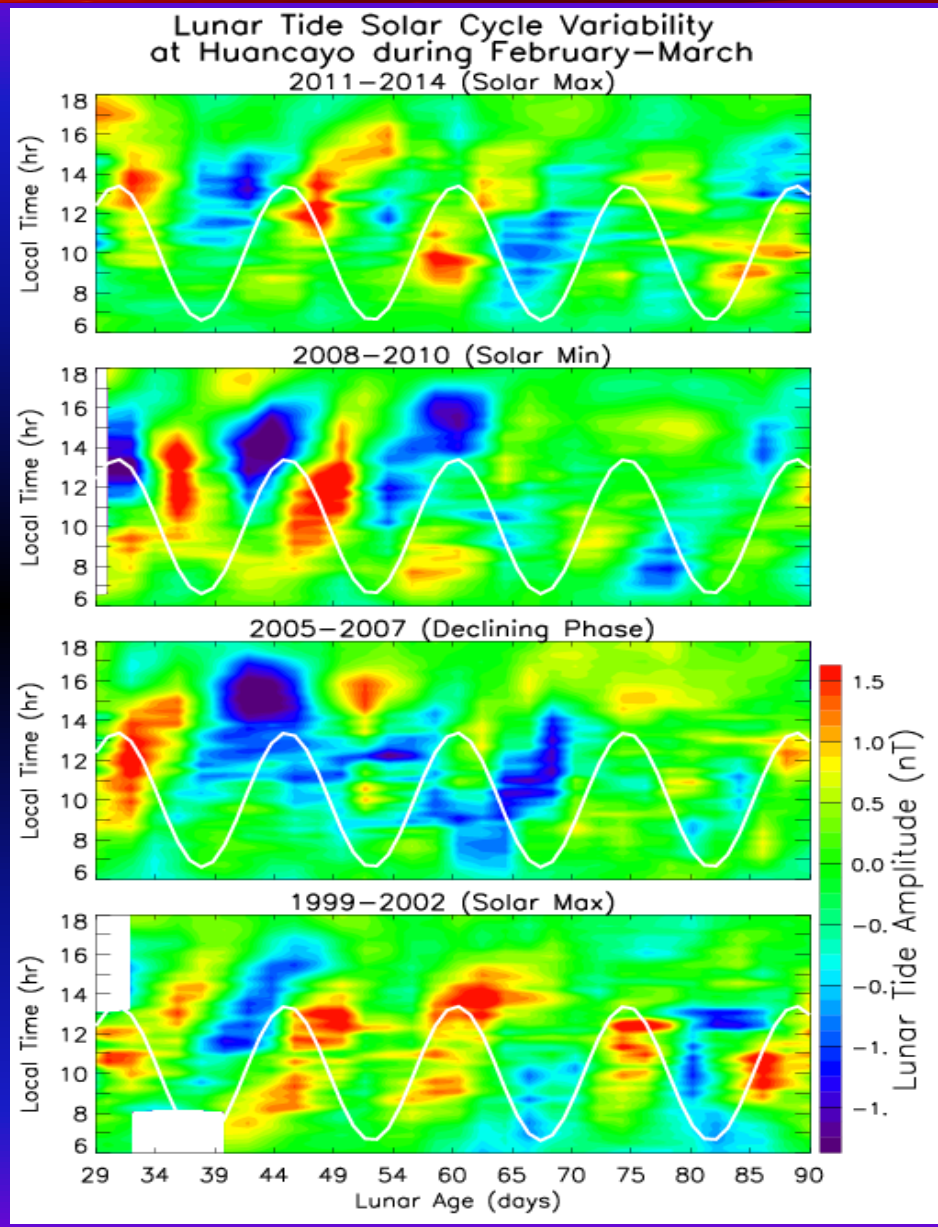
Lunar Tidal wave Solar Cycle Dependence



- The question is, why lunar tide is solar cycle dependent?
- Since ionospheric density is dependent to ionospheric conductivity, lunar tide amplitude is also dependent on ionospheric conductivity.
- Normalize the residuals by square root of the daily average value of F107 and F107A

Lunar Tidal wave Solar Cycle Dependence





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Summary

- The Longitudinal variability of lunar tide could be due to:
  - The longitudinal variability of the EEJ.
  - Longitudinal variability is the non-migrating tidal effect.
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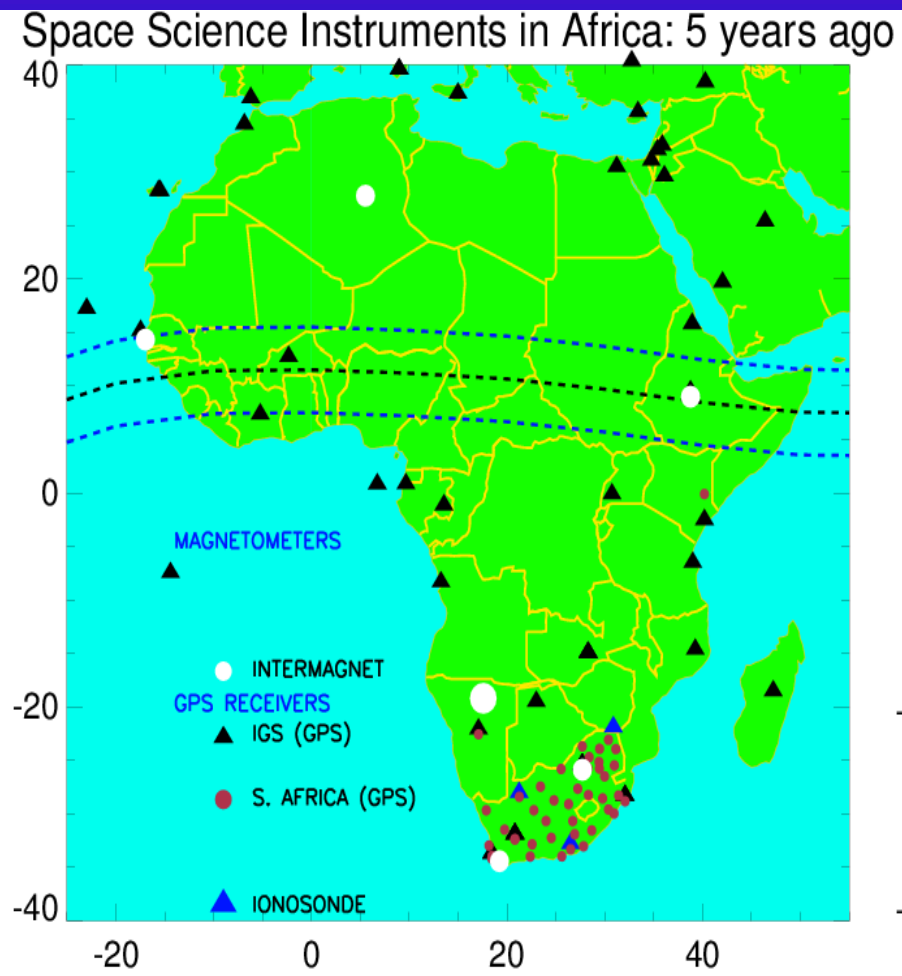
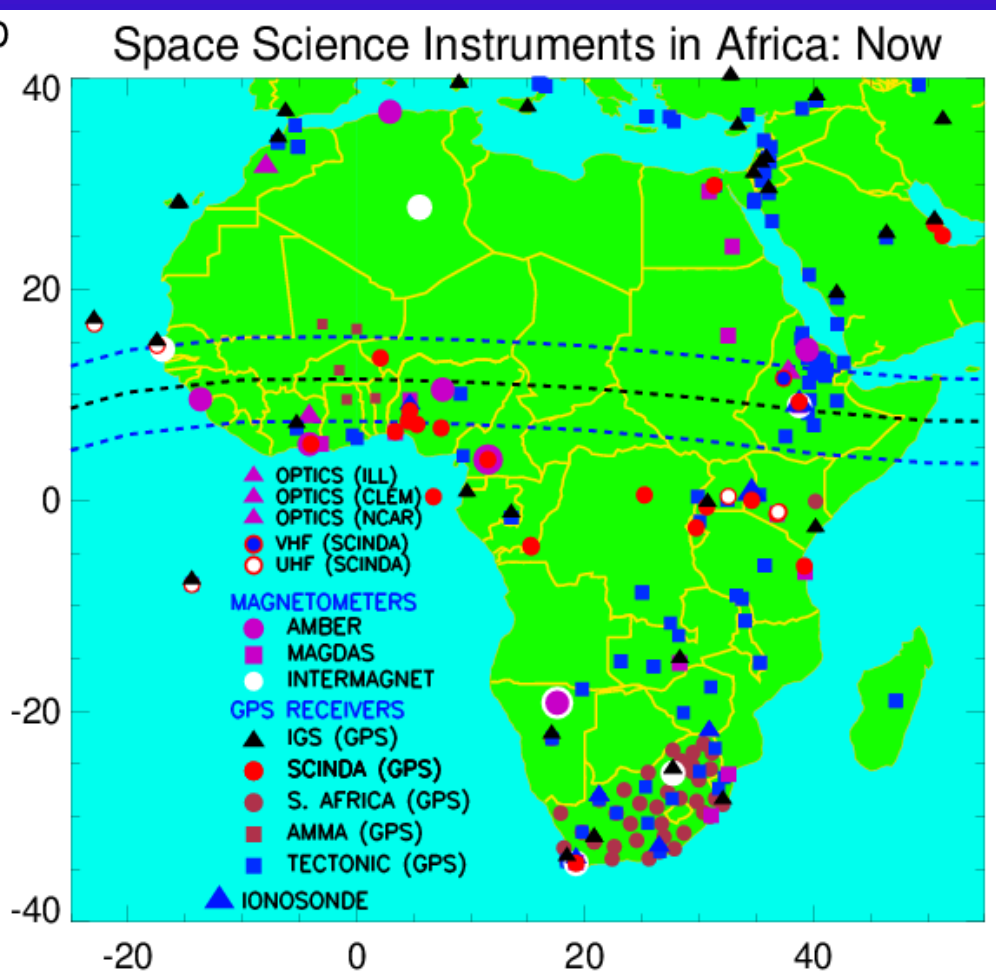
- The possible reasons for the seasonal variability of lunar tide
  - The differences in the distance between the Earth and the Sun (crossest in January and farthest in June) may contribute in part to the seasonal variation in the lunar tide
  - SSW may also amplify the tidal amplitude in winter
- The potential reasons for solar cycle dependency of lunar tide
  - It may not be due to the atmospheric tidal changes but to ionospheric conductivity difference that enhances ionospheric currents during solar maximum periods

Thank You!

General Instrumentation in Africa





In 2007 **In 2015**

Thank You!