Ulugh Beg Astronomical Institute of the Uzbek Academy of Sciences

6th Maidanak Users meeting

A POTENTIAL TOOL FOR STELLAR ACTIVITY ANALYSIS

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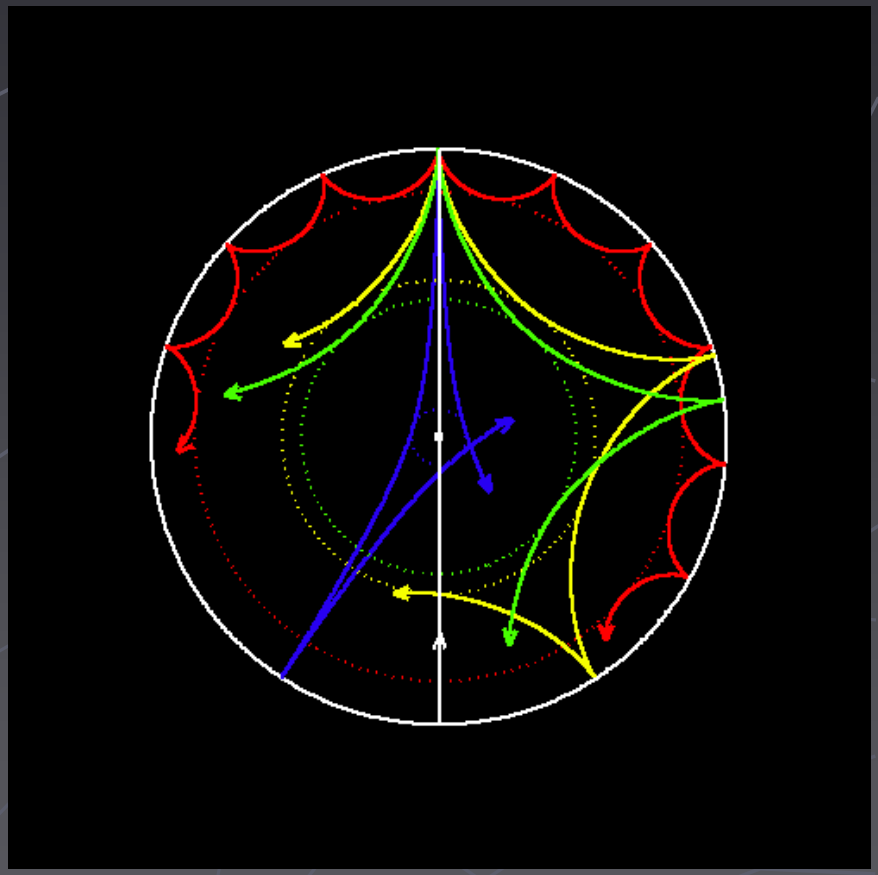
Outline

- Introduction
- Time-distance analysis
- Acoustic radius measurements
- Data: GONG, MDI, HMI
- Comparison between instruments
- “Quiet Sun” measurements
- Conclusions

Helioseismology is the study of the internal structure of stars through the interpretation of their oscillation frequencies

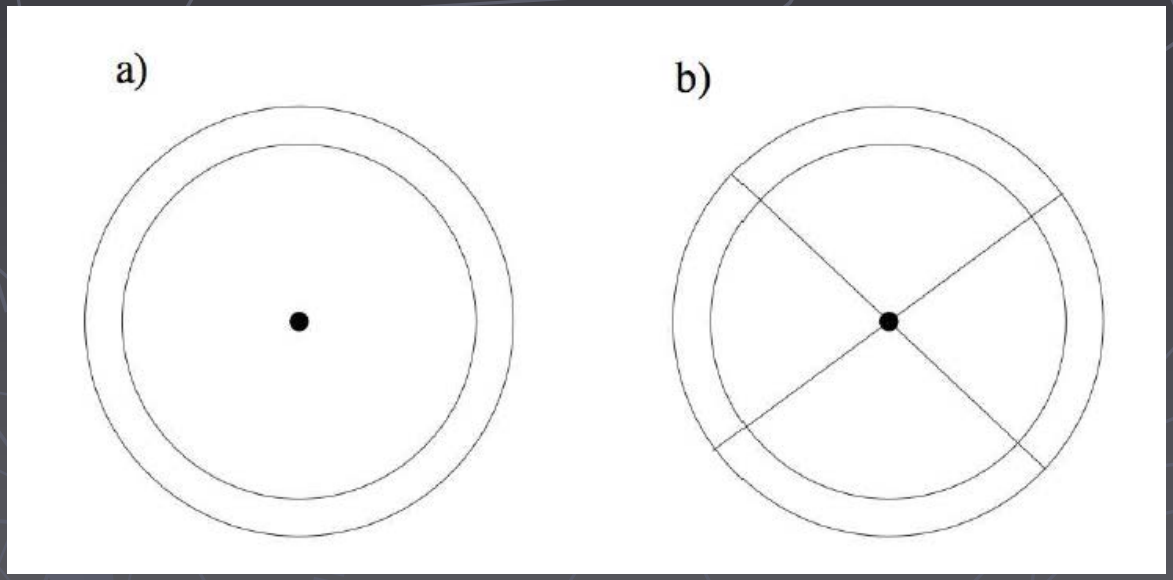
The oscillations are standing sound waves that are reflected within a cavity

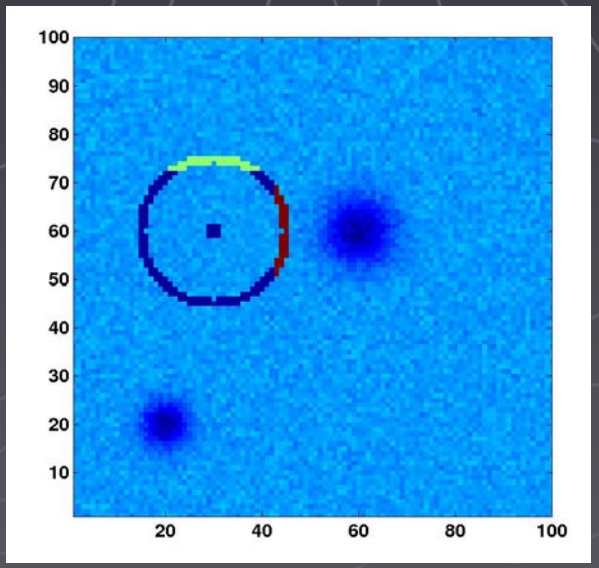
Different oscillations penetrate to different depths and hence probe different layers



Time-distance helioseismology

(Duvall et.al. 1993)





measures travel times of acoustic waves propagating between different surface points through the interior

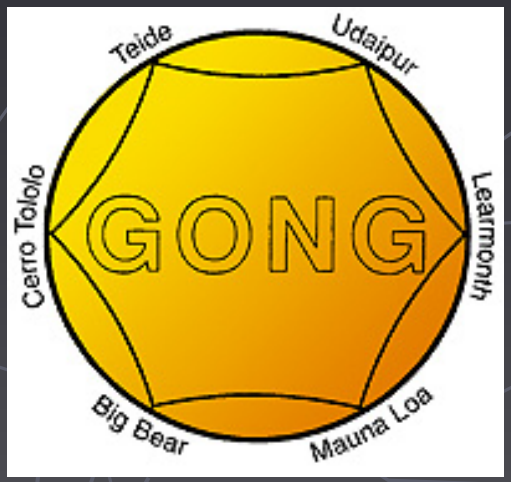
Determination of the size of the Sun – important astronomical problem

In contrast, acoustic radius measurements
provided by helioseismic methods are quite consistent

Acoustic radius measurements

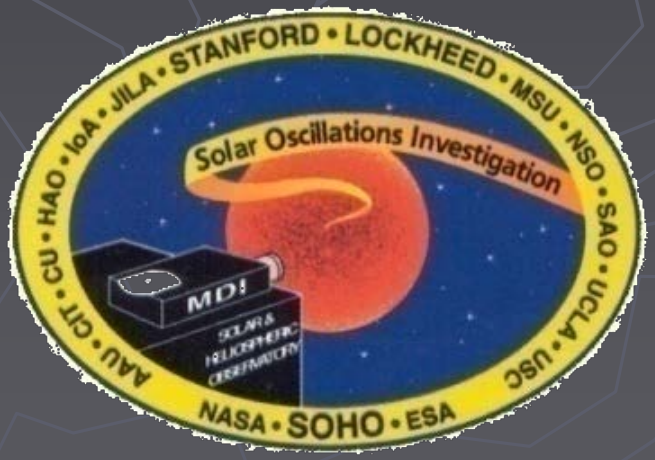
the acoustic radius (*T) of the Sun multiplied* by four owing to the propagation of the wave through the Sun from the observation point to the far side and back, traveling a distance of four radii. The units of *T are seconds,* as it is expressed as the sound travel time.

DATA



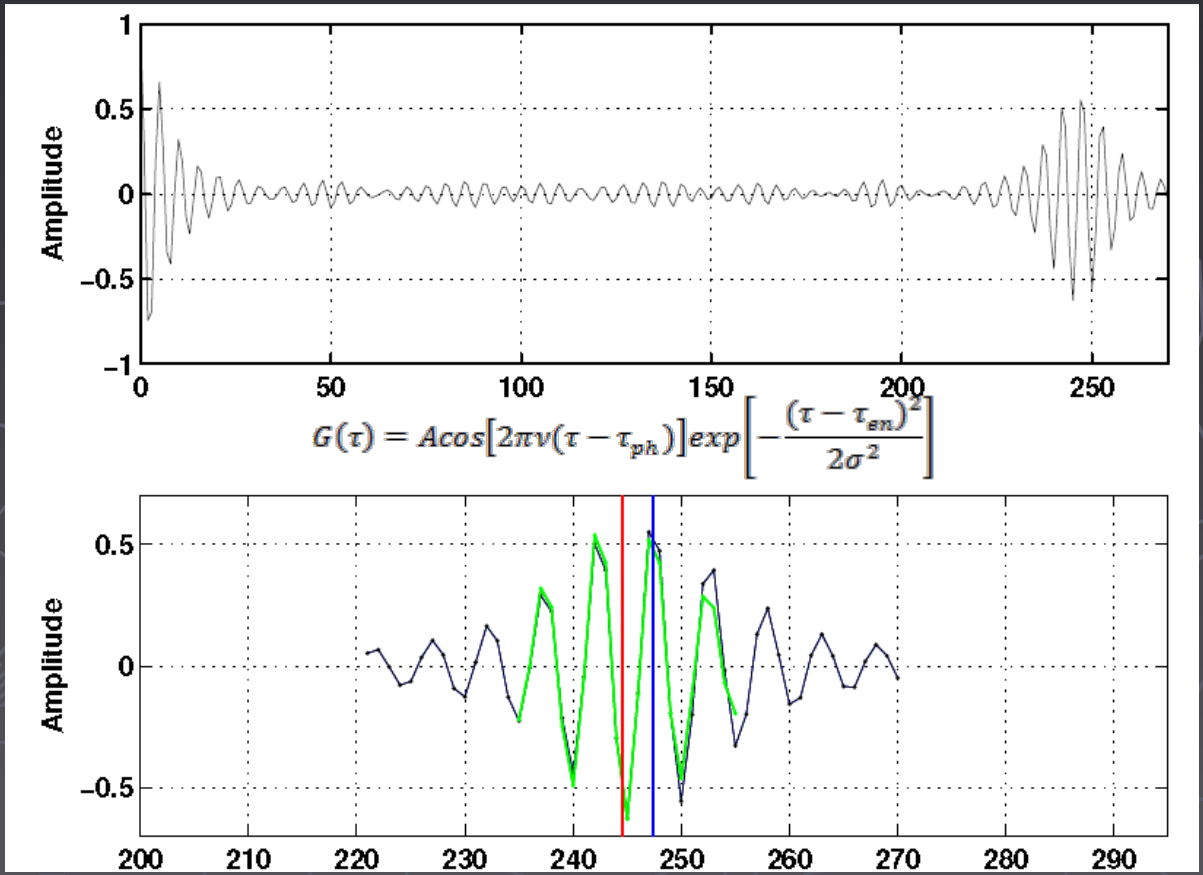
1995-2018

1996-2011



2010-2018

ACF and its Gabor wavelet fitting

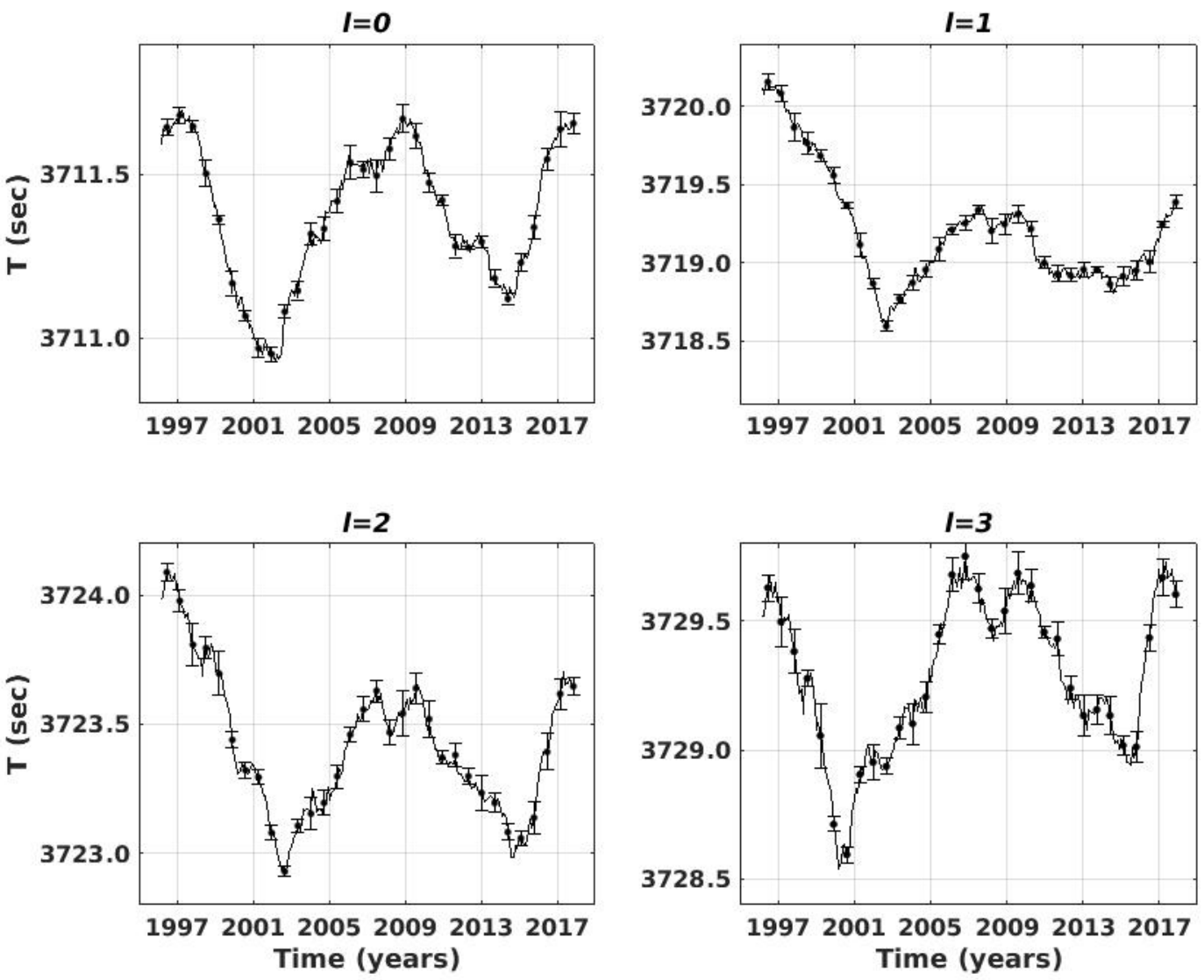


We investigate the temporal ACF of global solar oscillations

Top panel shows a typical ACF function computed from 10 days of GONG *(l=0)* SH time series.

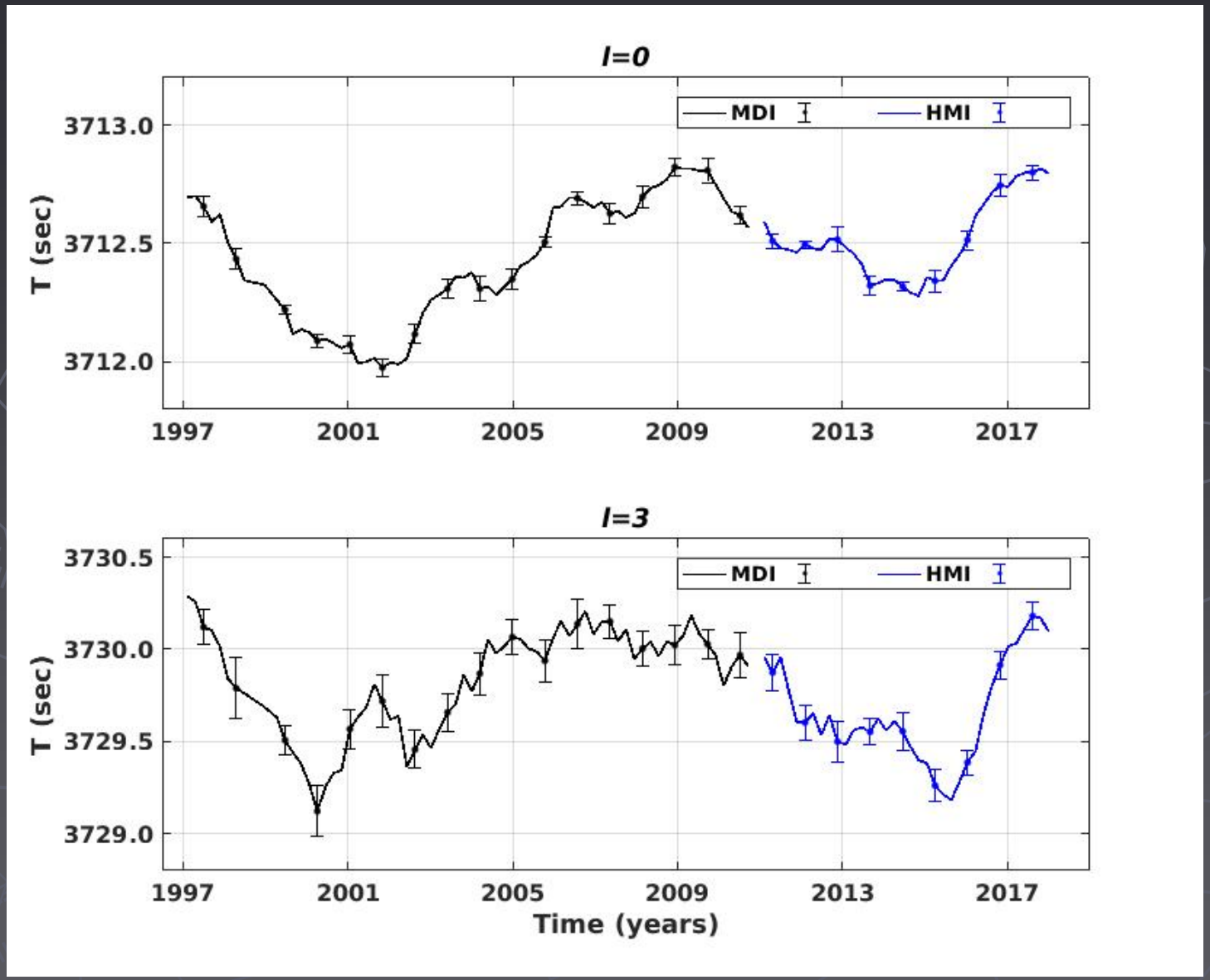
The first dominant peak around T=247 (this time lag is the inverse travel time of sound wave through the Sun from observation point to the far side and back, traveling a distance of four radii)

Solar acoustic radius variability



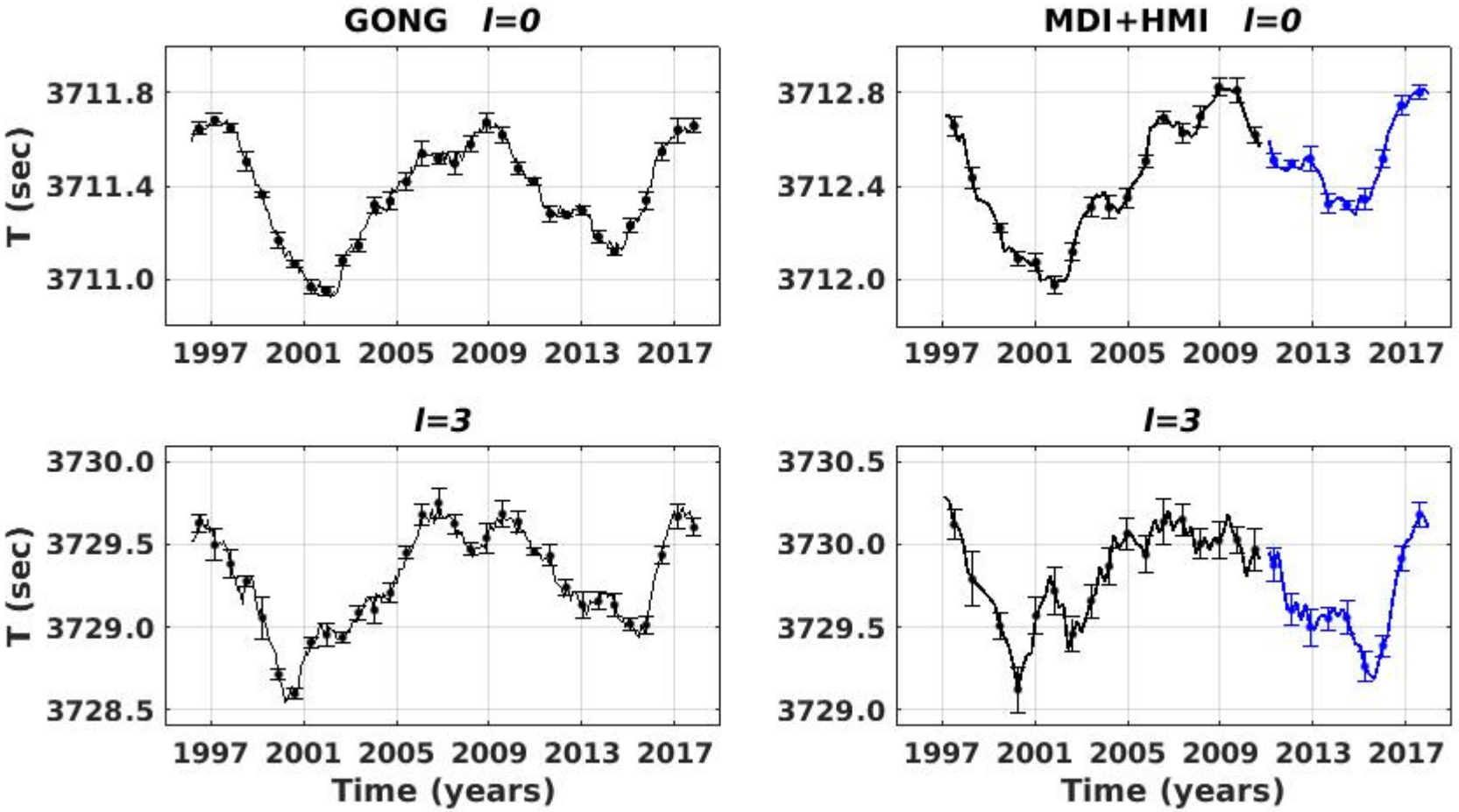
Solar acoustic radius as a function of time from GONG

Solar acoustic radius variability



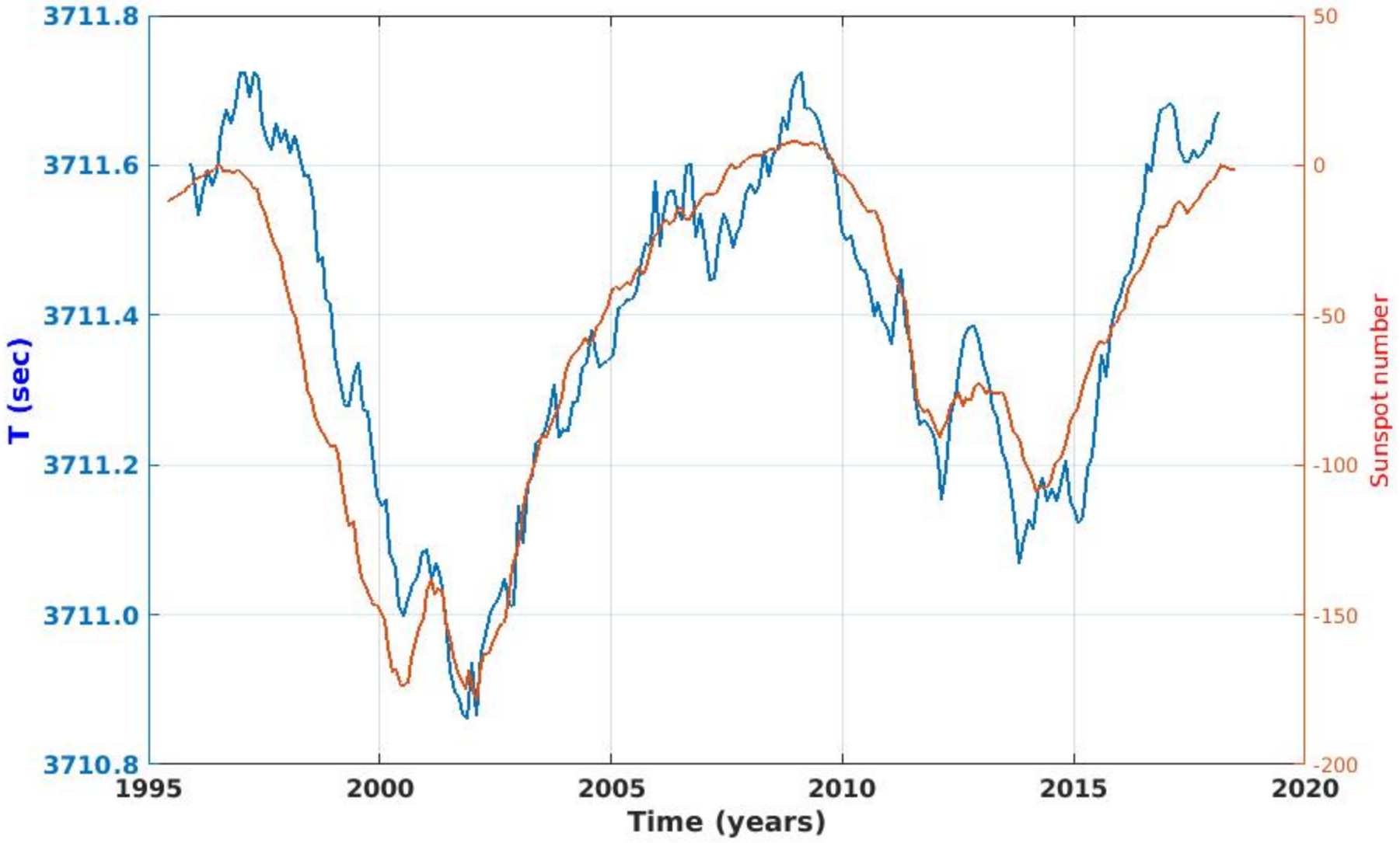
Solar acoustic radius as a function of time from MDI (black) and HMI (blue)

Comparison between ground based and space based data

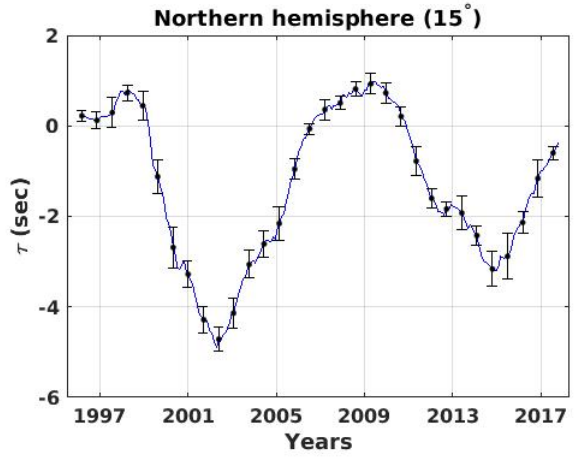


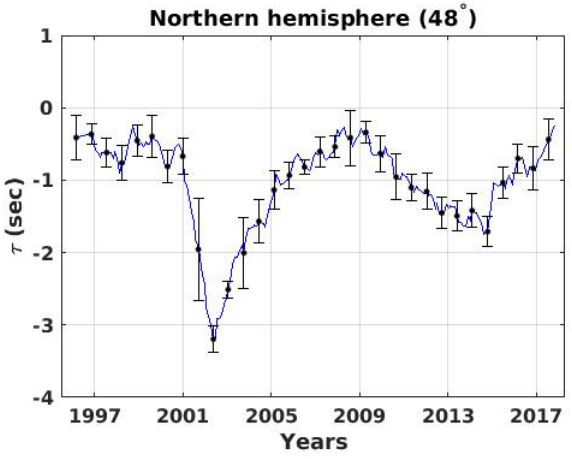
Solar acoustic radius as a function of time

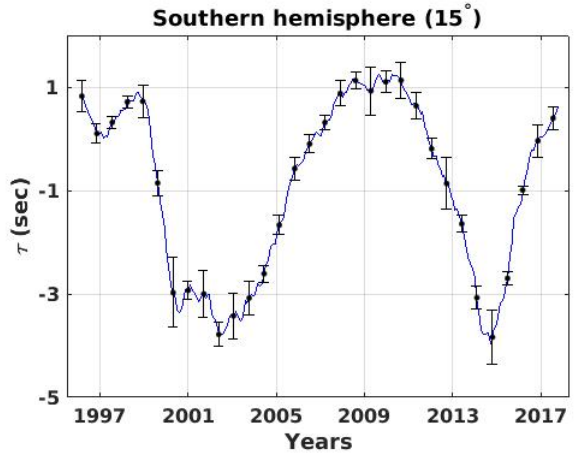
Solar acoustic radius and solar activity

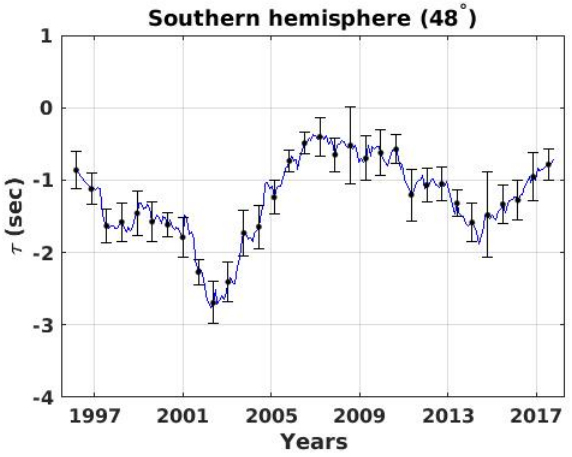


“Quiet Sun” measurements









AR have an evidence of global change
and does not depend on change occuring on the surface of the Sun

- **Summary**
- measurements from both, ground based and space located instruments show similar behavior and well anticorrelation with the solar activity cycle
- variations of solar acoustic radius have an evidence of global change and does not depend on changes occurring on the surface of the Sun
- **Applicable to stellar activity**
- Kepler measurements
- long term observations of stars at MAO

Maidanak night sky