Multi-wavelength Helioseismology with the Solar Dynamics Observatory

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SDO data courtesy SDO (NASA) and the AIA and HMI consortia.
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Synopsis

- Introduction
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  - Phase and Coherence
  - Mode Parameters
- Local Analysis
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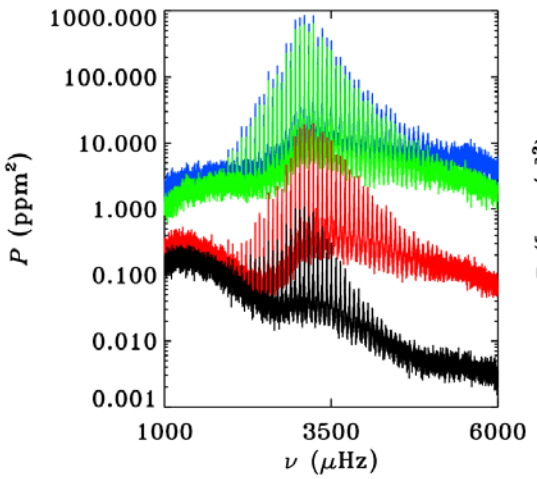
  - Phase and Coherence Maps
  - 3d Spectra
- Conclusions

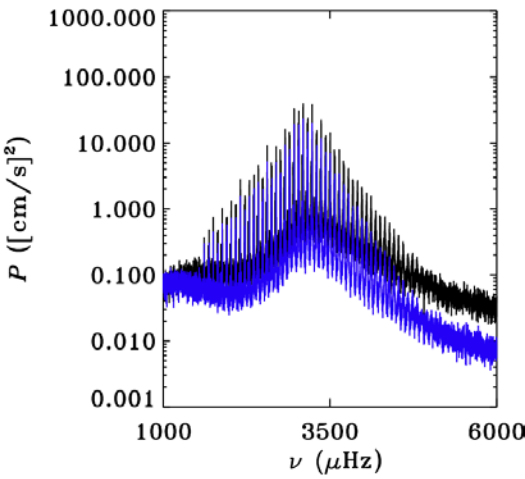
Introduction

- HMI observes Doppler velocity, Continuum Intensity, Line Depth in 6173 Angstrom line (20-270 km) at 45s cadence
- AIA provides 1700 (360 ±385 km) and 1600 (480 ± 185 km) Angstrom bands, usually at 24s cadence.
- Both have (almost) continuous full-disk coverage since May 2010.
- This provides scope for detailed helioseismic probing of atmospheric layers at both global and local scales.

Sun-as-a-Star

- Use keywords (DATAMEAN) from JSOC database to form time series.
- Line Core = Continuum-Line Depth
- Compare HMI Velocity with BiSON.
- All data interpolated to 45s cadence

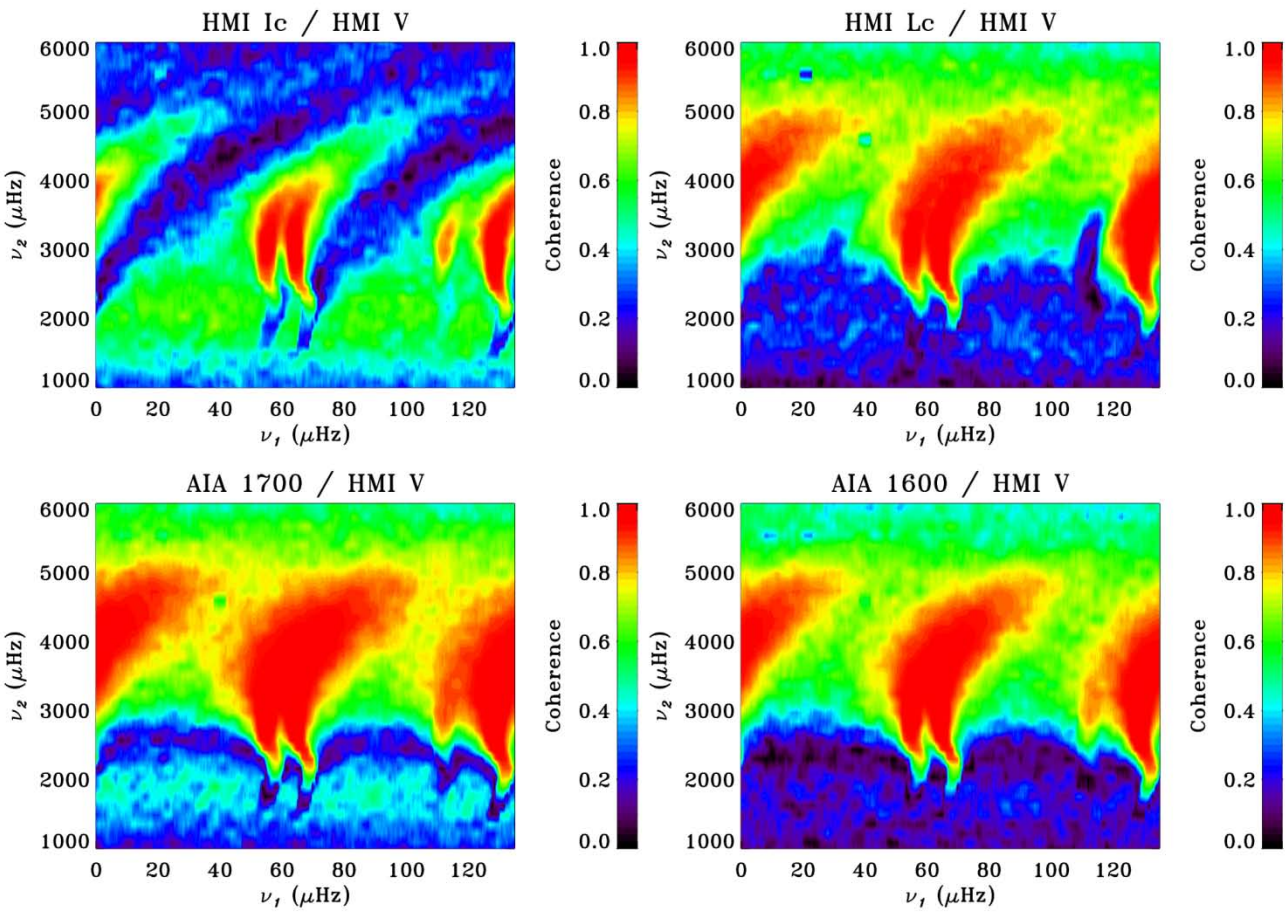




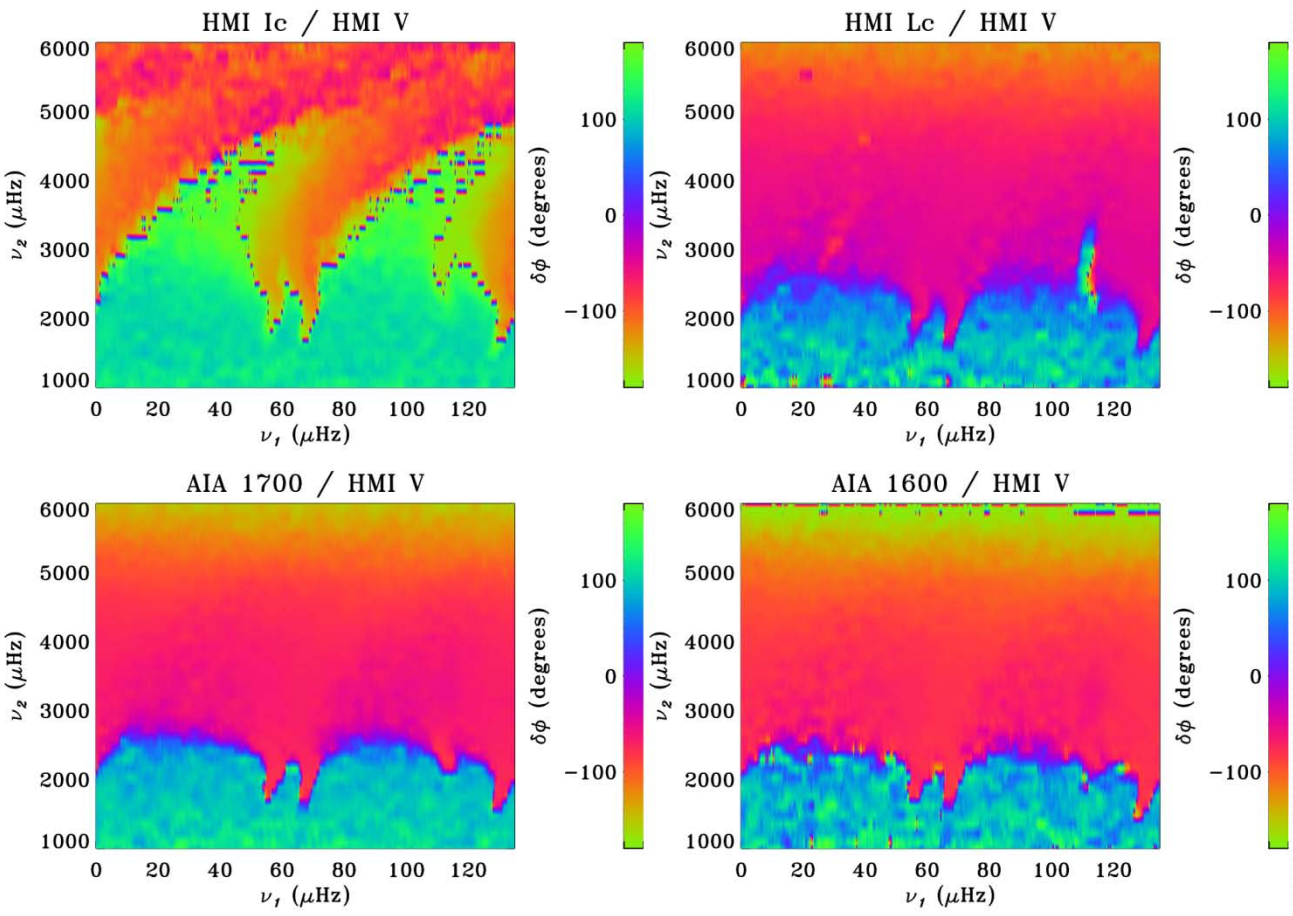
HMI Continuum
HMI Line Core
AIA 1600
AIA 1700

BiSON Velocity
HMI Velocity

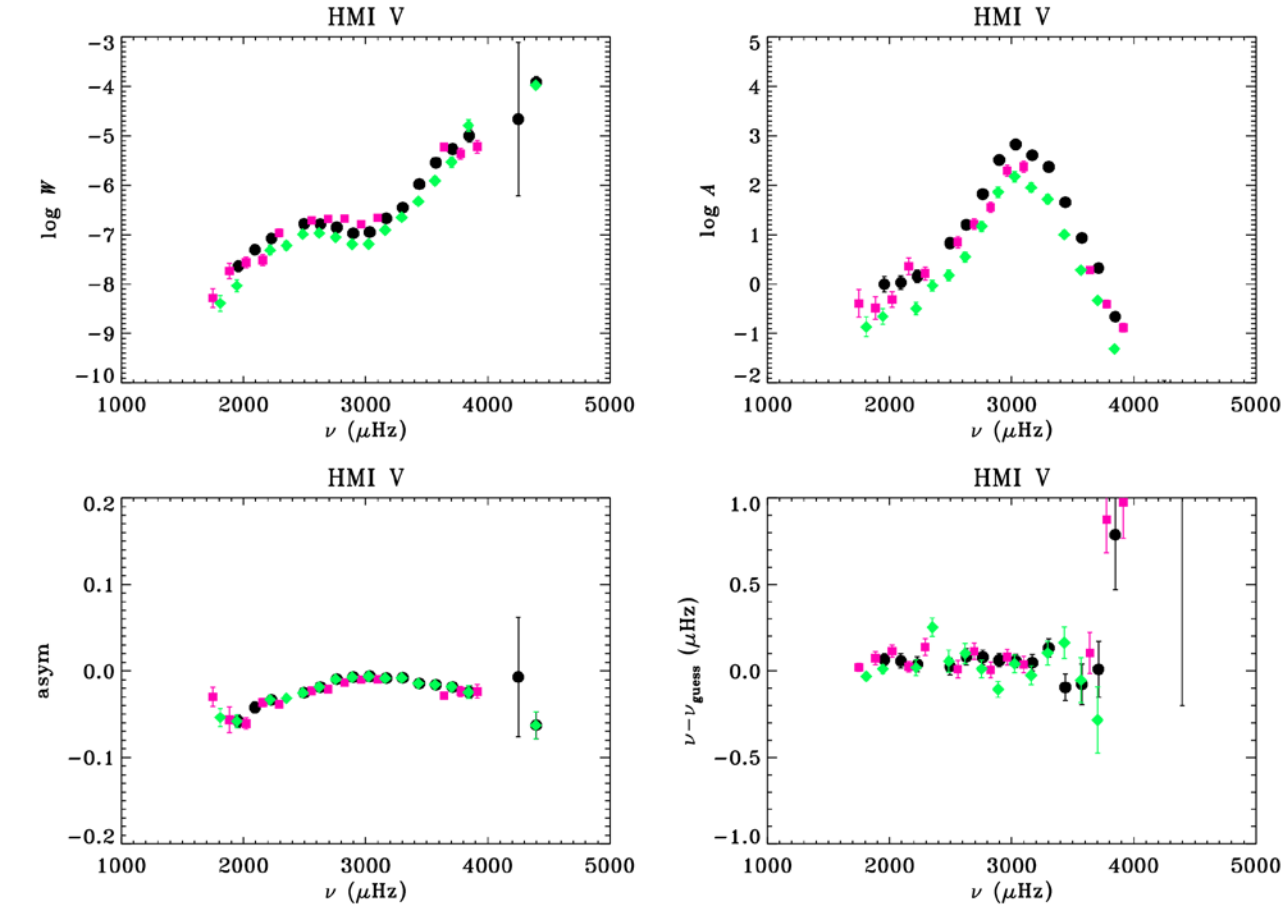
Coherence with HMI V



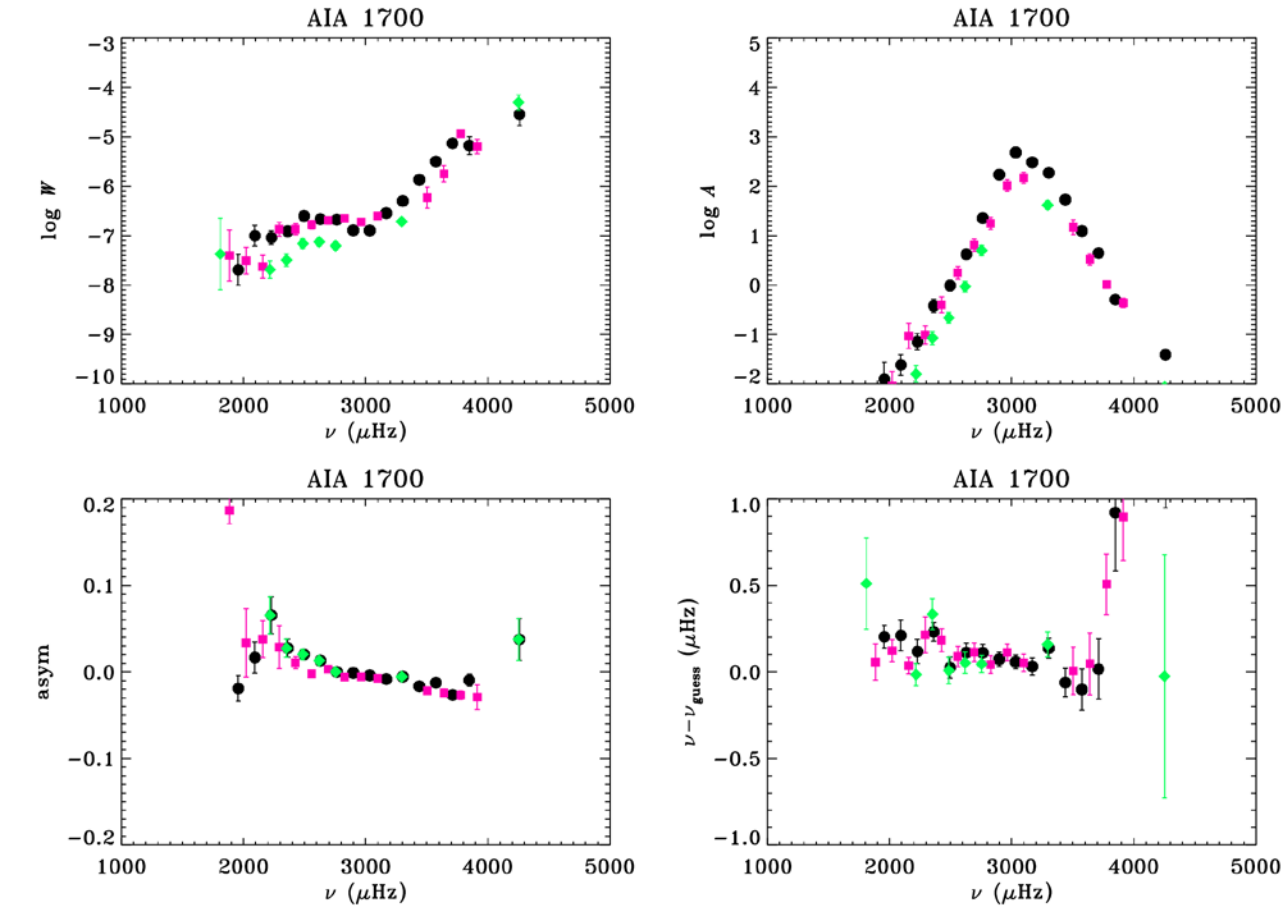
Phase relative to HMI V



0-d p-mode fits (HMI V)

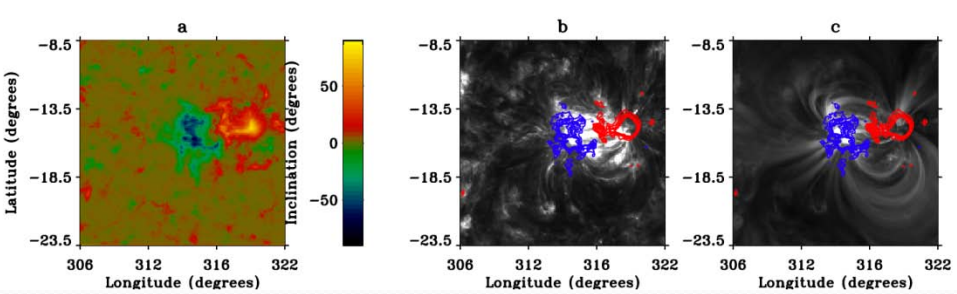


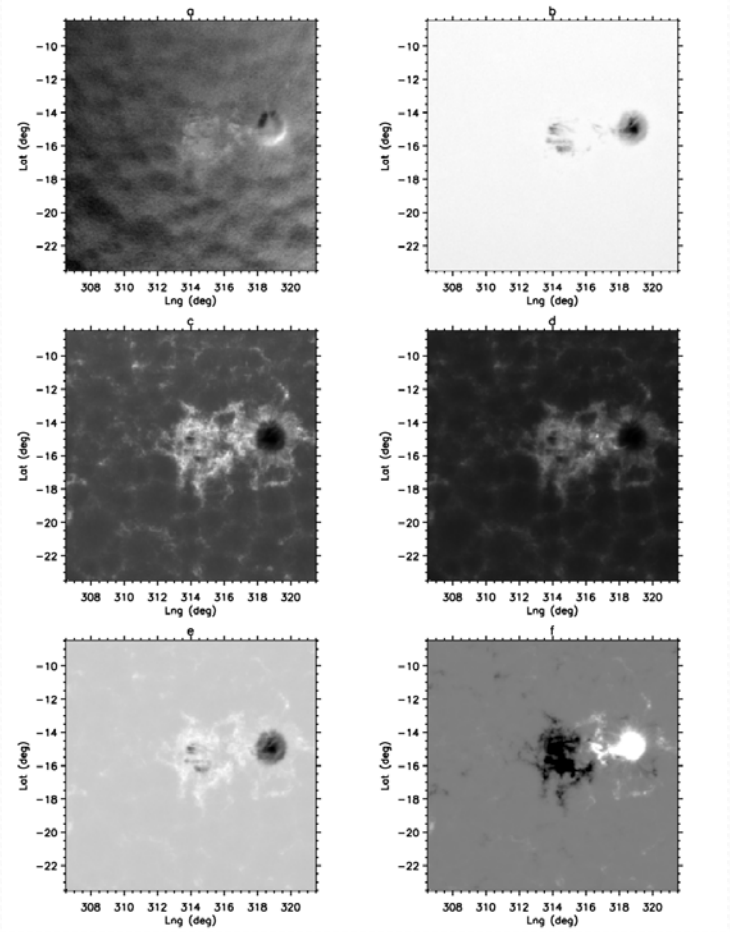
0-d p-mode fits (AIA 1700)



Local Analysis

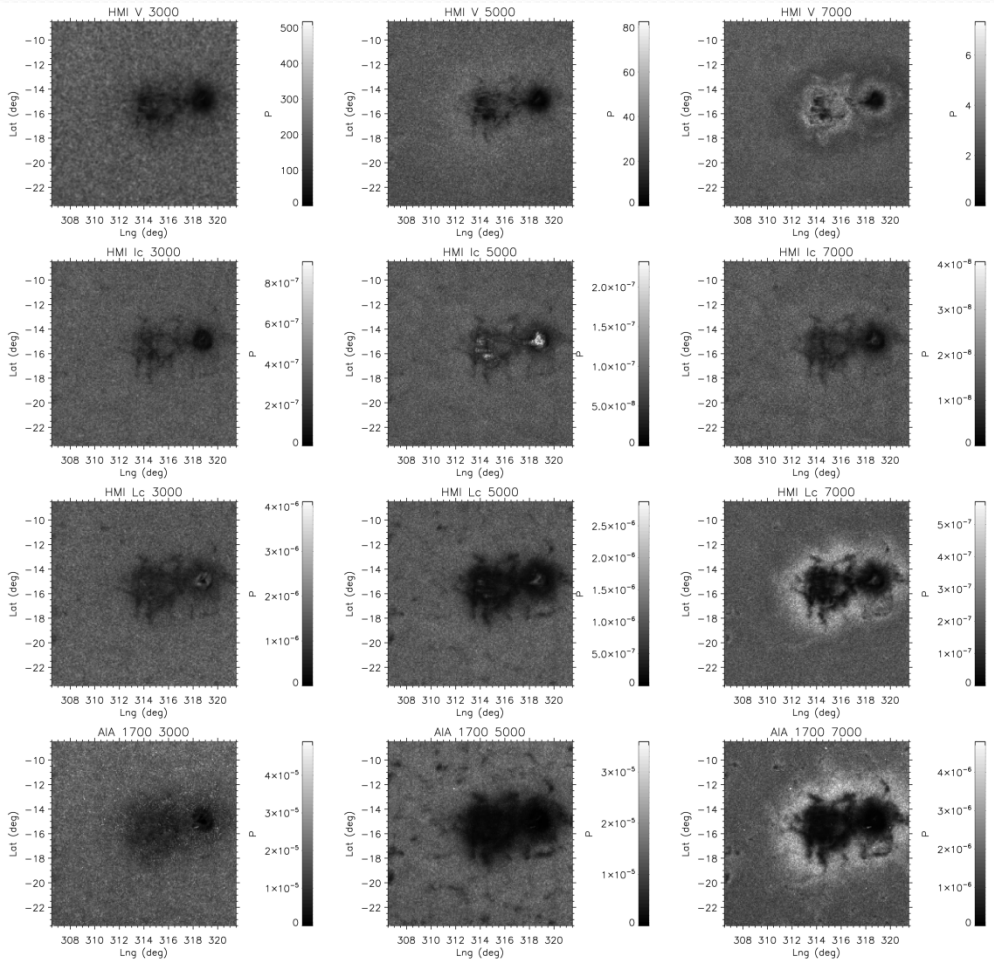
- 15-degree square patch, tracked for 24hr at rotation rate and remapped to uniform grid in heliographic latitude and longitude
- Active region 11072 on 2010-May-23





Power Maps

3mHz 5mHz 7mHz



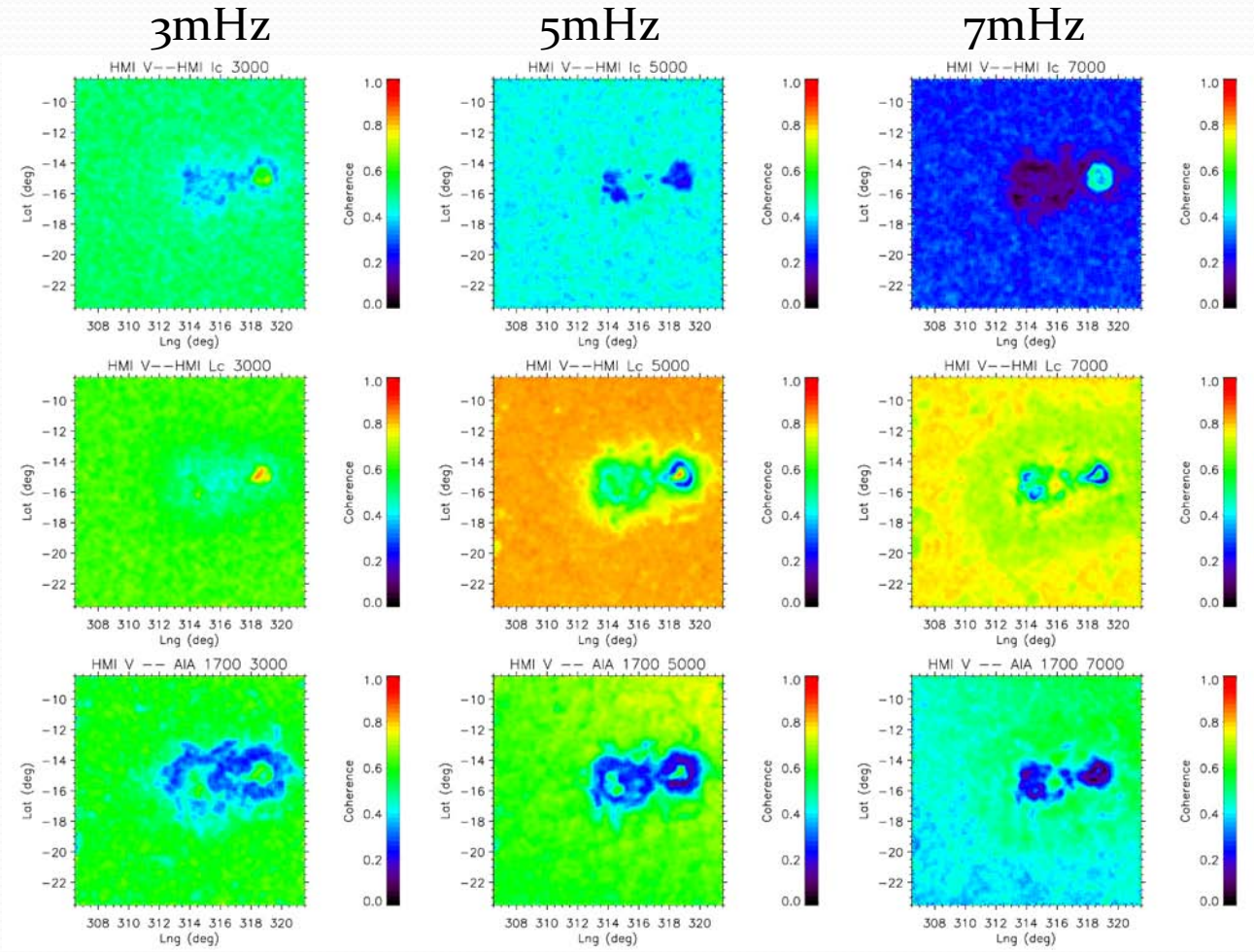
HMI V

HMI Ic

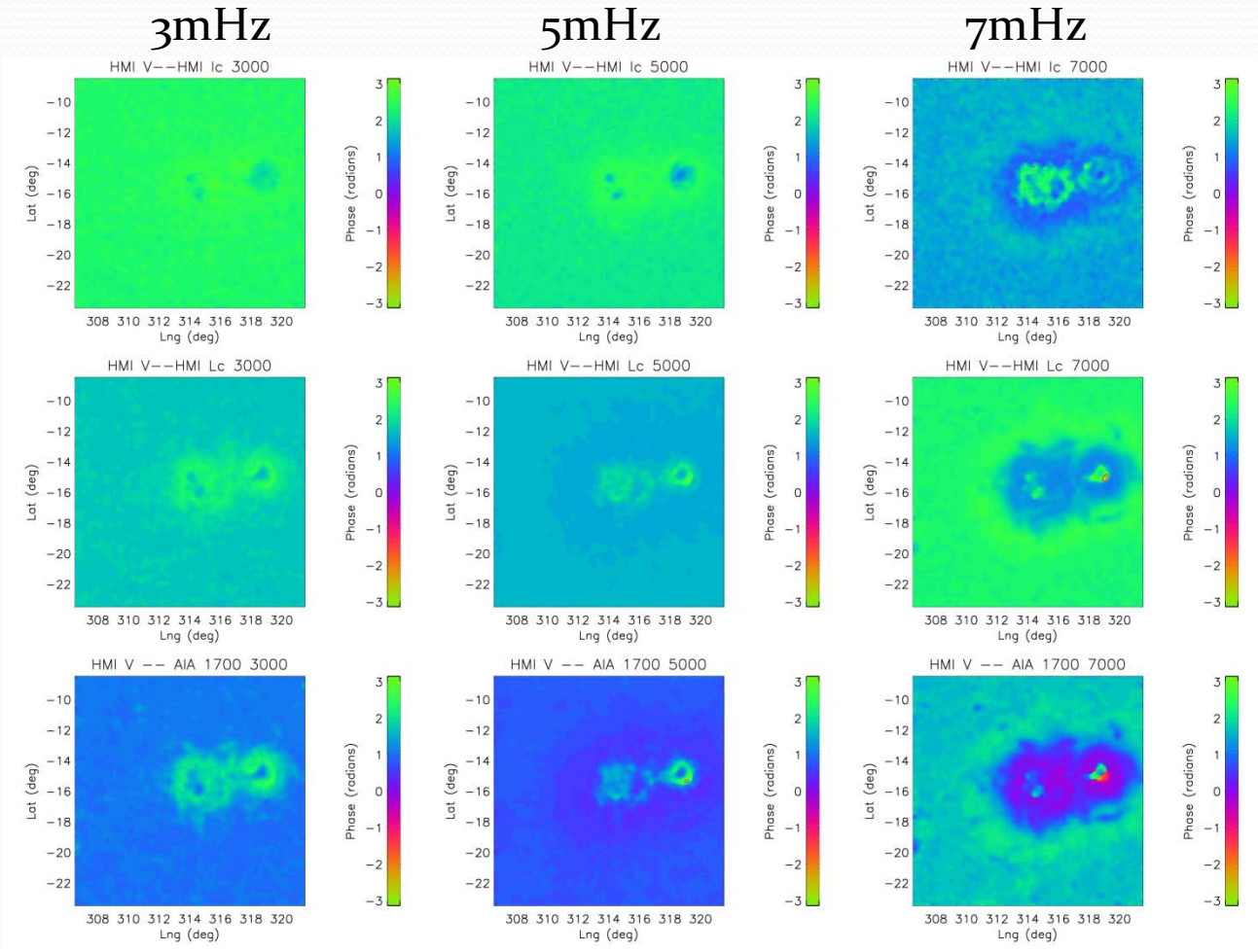
HMI Lc

AIA 1700

Coherence with HMI V



Phase with HMI V



Conclusions

- AIA UV bands offer potential for probing the solar atmosphere with helioseismic techniques
- Strong 5-minute signal – good for asteroseismology?
- UV bands exhibit phase behaviour similar to HMI line core; not surprising given formation heights.
- Active regions change phase and amplitude of acoustic modes, particularly beyond the acoustic cutoff.
- HMI line core and UV show strong power halo at 7mHz around active region.
- Influence of active regions extends well beyond the surface field, doesn't necessarily match coronal loops.