Why Believe in Helioseismology?

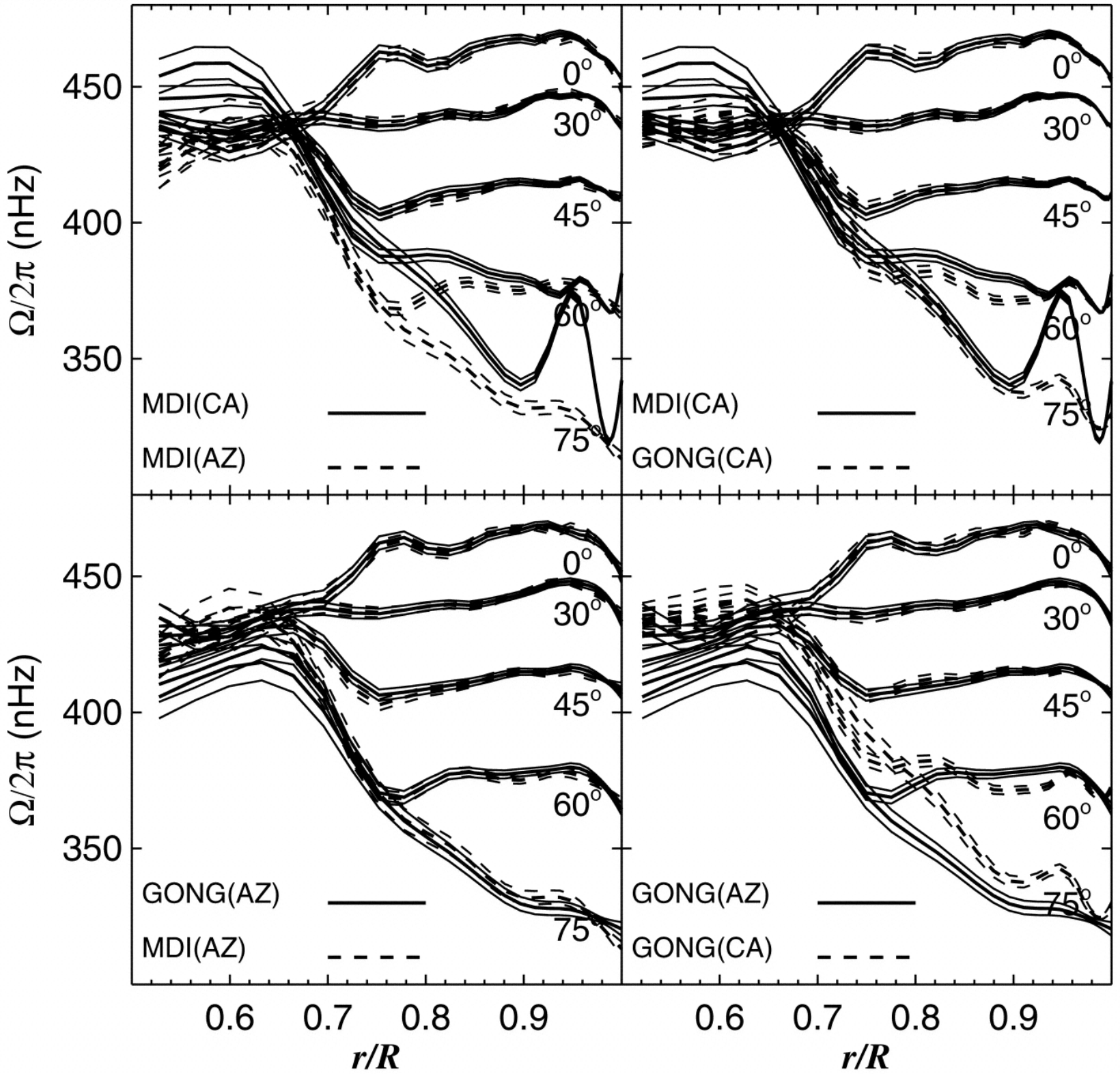
Tying Up the Loose Ends

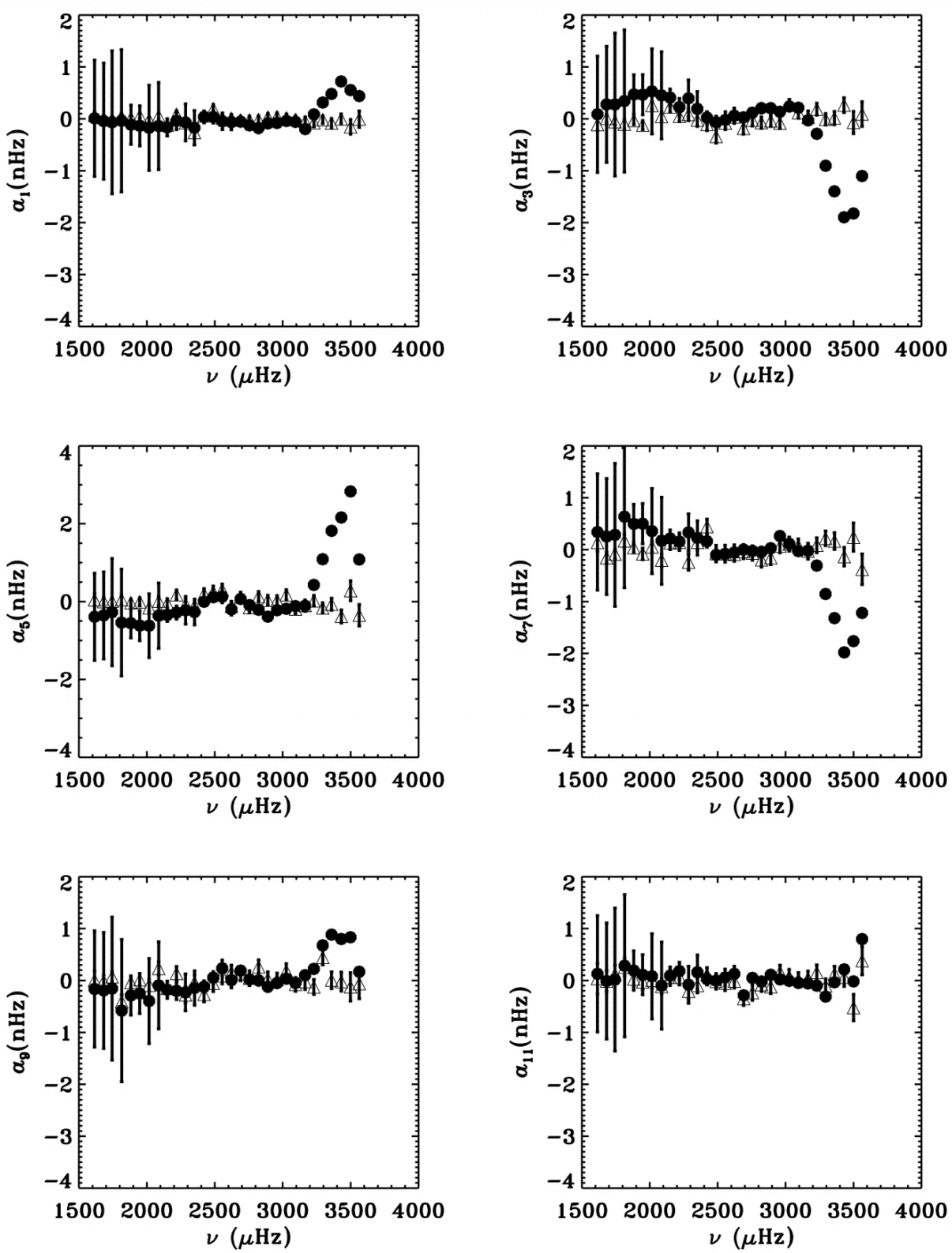
Tim Larson
tplarson@sun.stanford.edu

thesis discussion

Introduction

- What is Global Helioseismology?
  - Equations
  - History
- Motivation
  - Discrepancies
  - Improvements


Ω/2π (nHz)
450
400
350
0°
30°
45°
60°
75°
MDI(CA)
MDI(AZ)
GONG(CA)
GONG(AZ)
0.6
0.7
0.8
0.9
r/R


a_1(nHz)
a_3(nHz)
a_5(nHz)
a_7(nHz)
a_9(nHz)
a_{11}(nHz)
ν (μHz)
1500 2000 2500 3000 3500 4000

Data

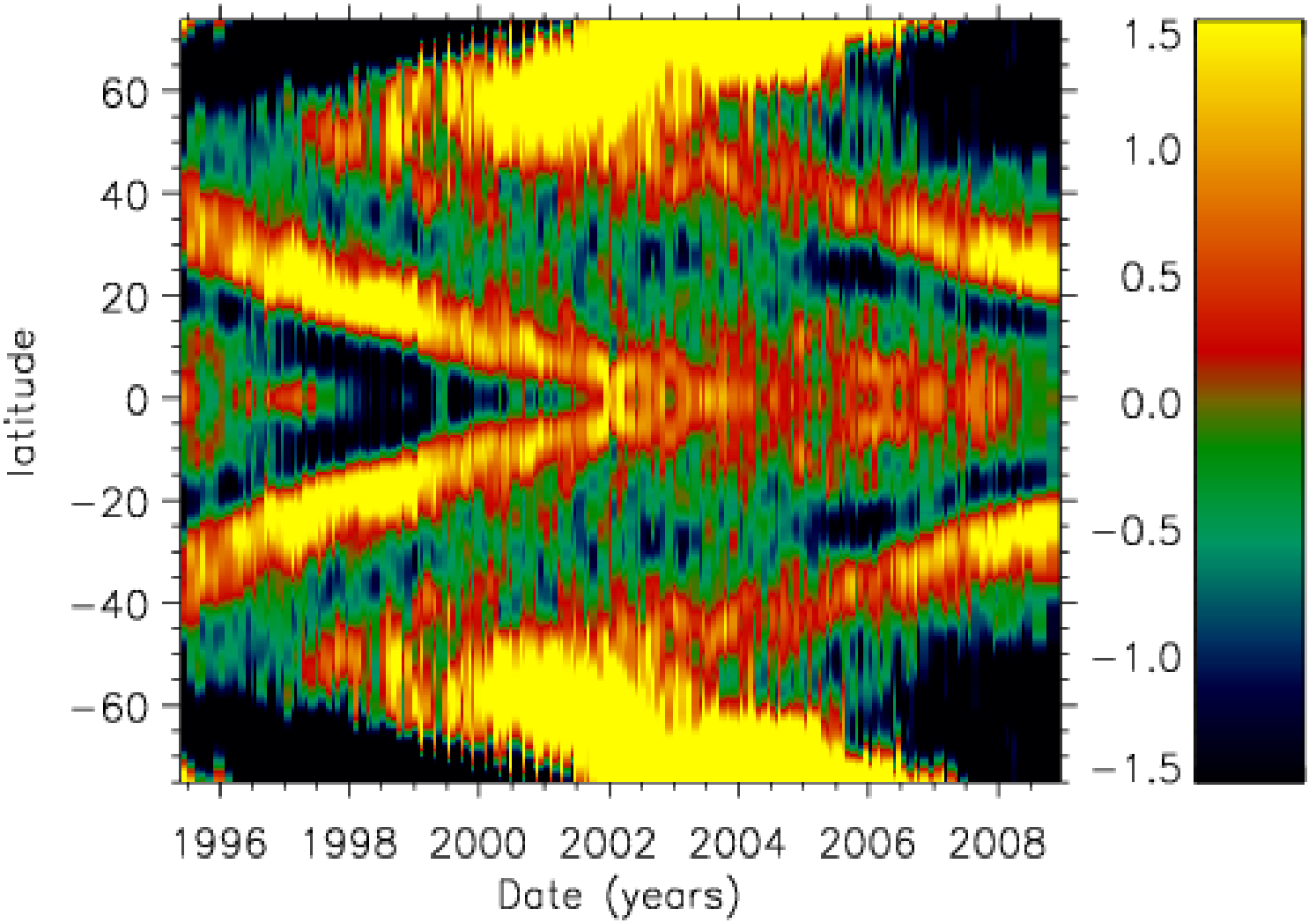
- Mount Wilson Observatory (MWO)
- Michelson Doppler Imager (MDI)
- Global Oscillation Network Group (GONG)
- Helioseismic and Magnetic Imager (HMI)
- Others

Processing Pipeline

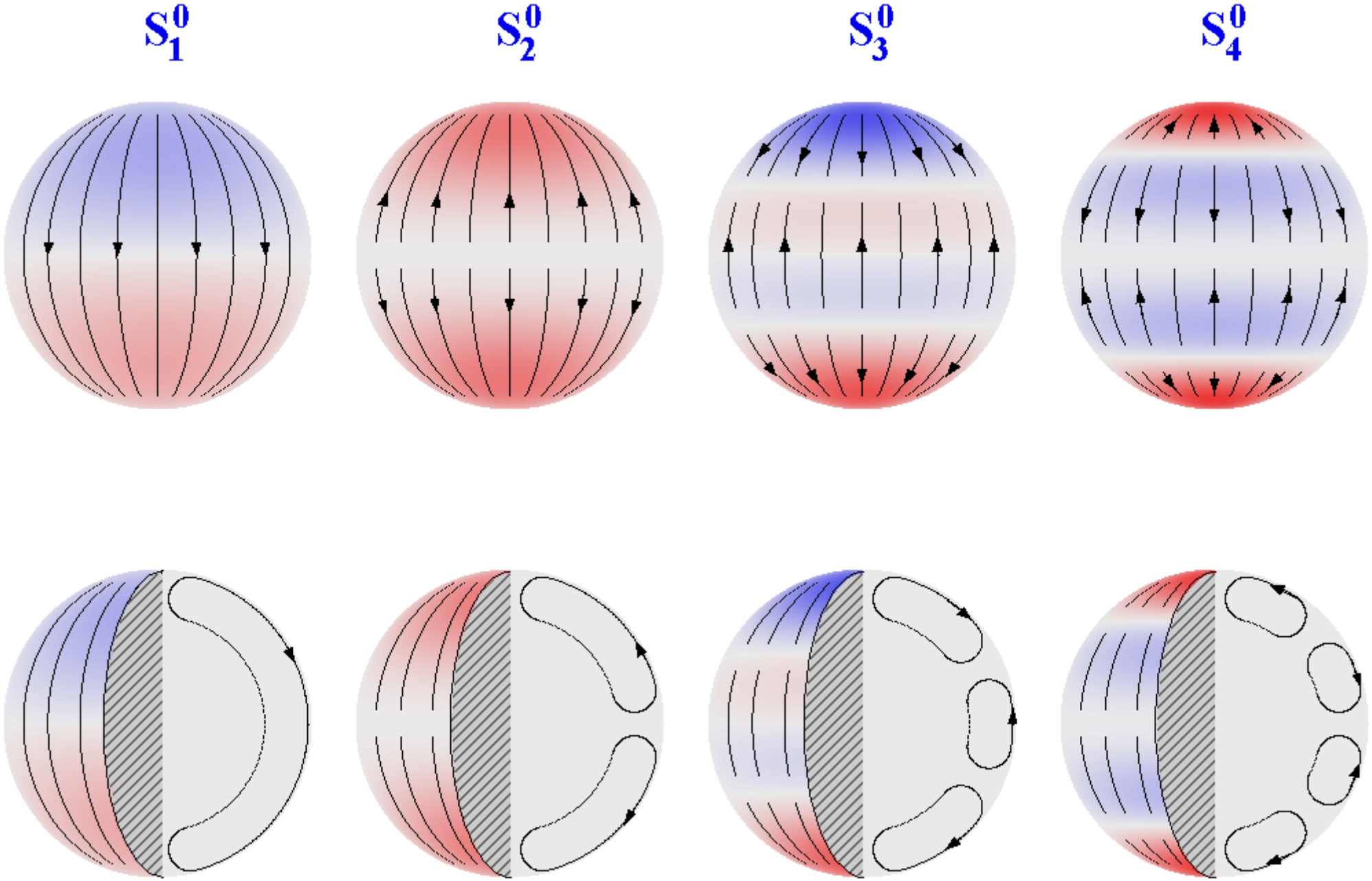
- Filtergrams to Observables
- Spherical Harmonic Decomposition
  - Leakage
- Detrending and Gapfilling
- Fitting Mode Parameters
- Inversion

Observations

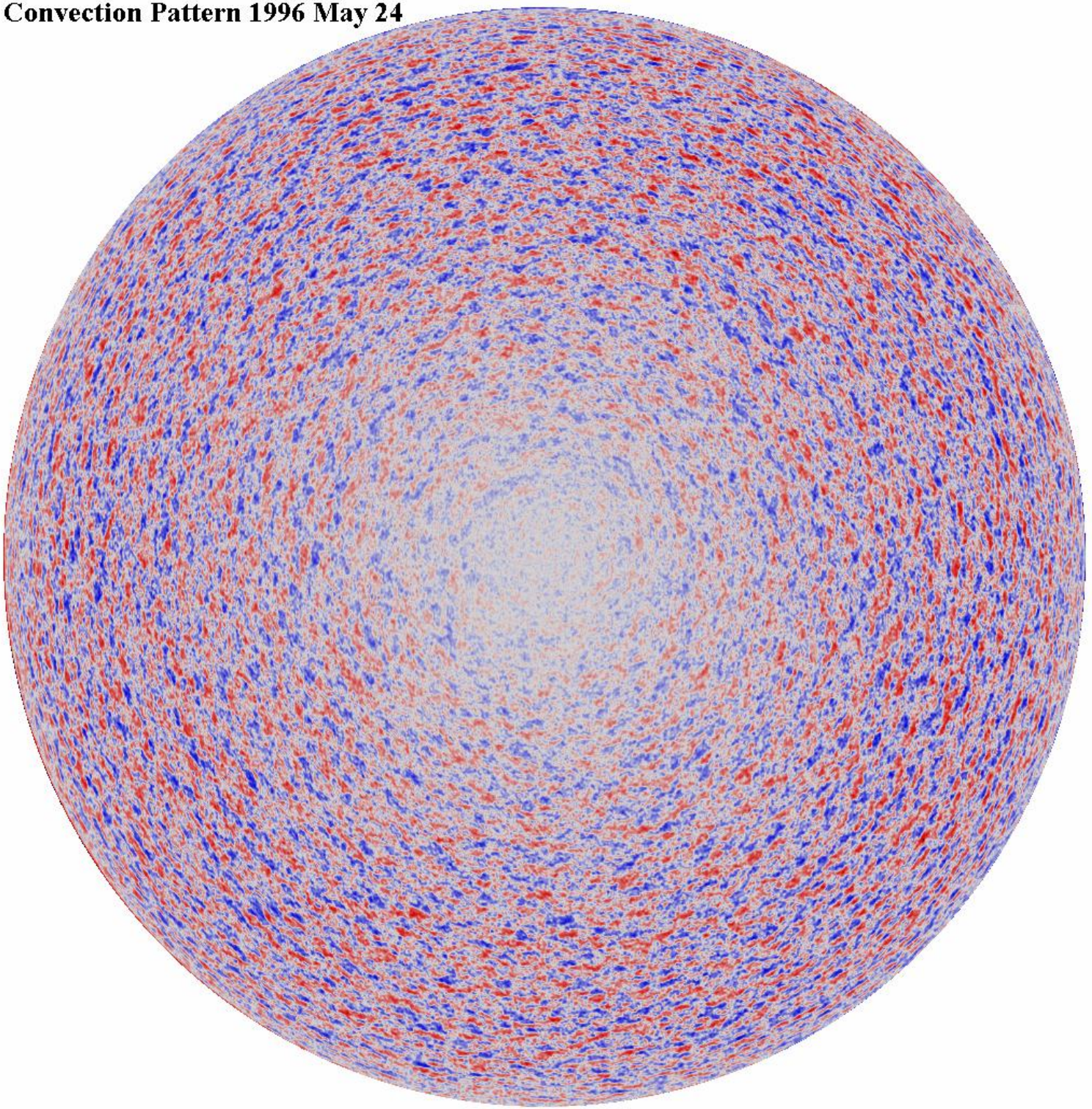
- Solar Cycle Variations
- Differential Rotation and Torsional Oscillation
- Meridional Flows
- Supergranulation


latitude
60
40
20
0
−20
−40
−60
1996
1998
2000
2002
2004
2006
2008
Date (years)
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5

MERIDIONAL FLOW COMPONENTS

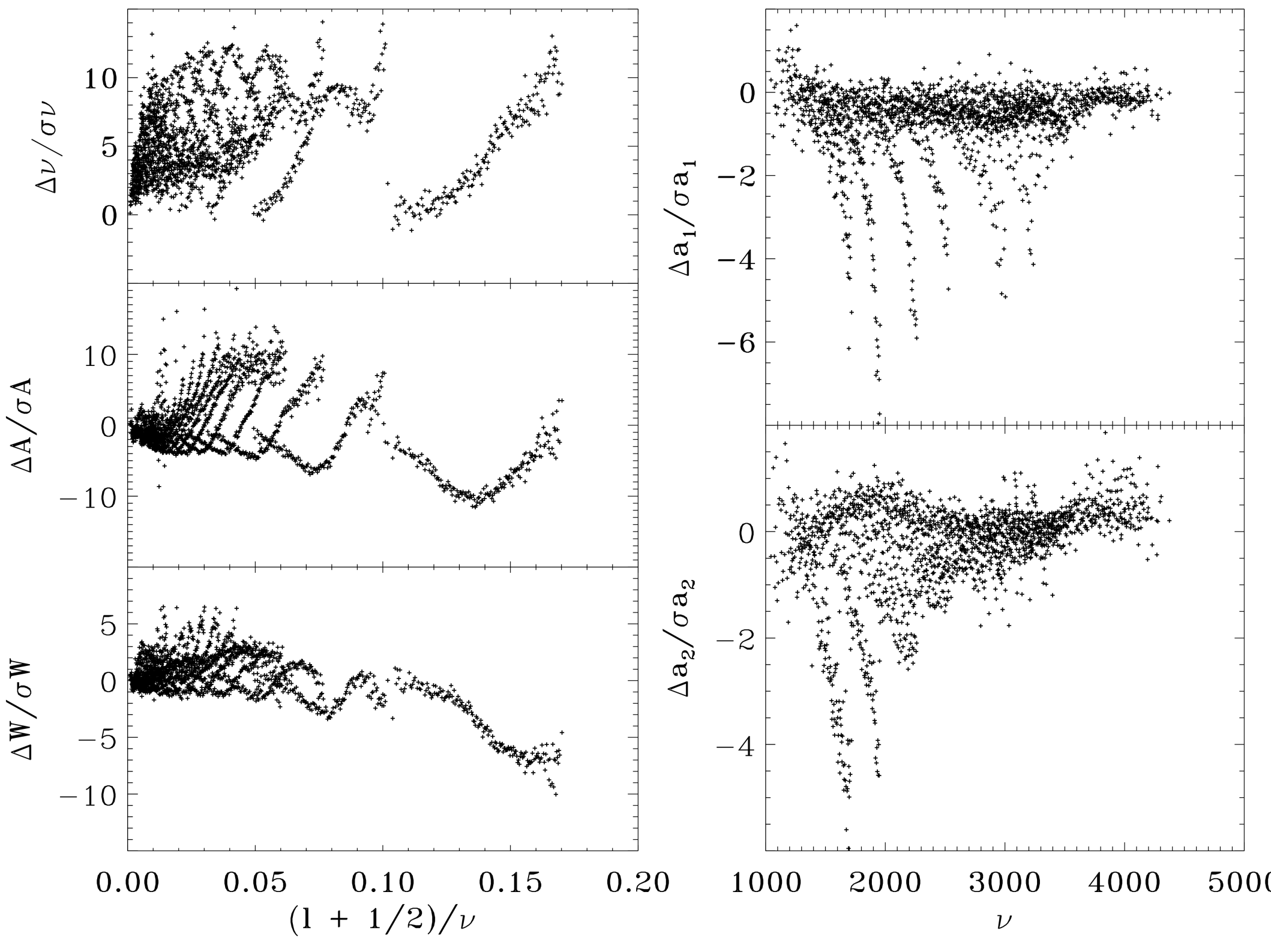


Convection Pattern 1996 May 24



Variations

- Corrections in Remapping
- Timeseries Processing
- Fitting Methods
  - Different Line Profiles
- Leakage Matrices


$\Delta\nu/\sigma\nu$
$\Delta A/\sigma A$
$\Delta W/\sigma W$
$\Delta a_1/\sigma a_1$
$\Delta a_2/\sigma a_2$
$(l + 1/2)/\nu$
ν

Comparisons

- Between Datasets
- Between Fitting Methods
- Simulations

New Ideas

- Simultaneous Fitting of Multiple Observables
- Fitting for the Leakage Matrix
- Information from Other Mode Parameters
- Using Magnetic Field Data

Discussion

- What Have We Learned?
- Future Work