HMI Local Helioseismology Data: Status and Prospects

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Local Helioseismology Data Products

series	module	cadence (sec/rec)	size (MB/rec)	Description
hmi.V_avg120	*datavg*	396000	60	1/3 rotation averages of Dopplergrams with orbital velocity removed, for detrending
hmi.rdVtrack_fd05	*mtrack*	12	18	mosaics of tracked mapped data cubes from data in series hmi.V_45s
hmi.rdVtrack_fd15	*mtrack*	340	472	
hmi.rdVtrack_fd30	*mtrack*	2500	1000	
hmi.tdVtrack_synopHC	*mtrack*	993	250	
hmi.rdVpspec_fd05	*pspec3*	12	12	mosaics of the power spectra of the tracked tiles in the series hmi.rdVtrack_fd*, with 1-to-1 mapping of most parameters
hmi.rdVpspec_fd15	*pspec3*	340	324	
hmi.rdVpspec_fd30	*pspec3*	2500	648	
hmi.rdVavgpspec_fd15	*datavg*	8400	324	mosaics of full-rotation averages of power spectra of tracked tiles in series hmi.rdVpspec_fd*
hmi.rdVavgpspec_fd30	*datavg*	34400	648	
hmi.rdVfitsf_fd05	*ringfitf*	12	0.02	mosaics of the "fast" ("dynamics") fits to the power spectra in series hmi.rdVpspec_fd*
hmi.rdVfitsf_fd15	*ringfitf*	340	0.09	
hmi.rdVfitsf_fd30	*ringfitf*	2500	0.2	
hmi.rdVfitsc_fd05	*ringfitc*	12	0.1	mosaics of the "slow" ("structure") fits to the power spectra in series hmi.rdVpspec_fd*
hmi.rdVfitsc_fd15	*ringfitc*	2500	0.7	
hmi.rdVfitsc_fd30	*ringfitc*	10000	0.9	
hmi.tdVtimes_synopHC	*travel_times*	993	22	mosaics of travel time fits to the data in series hmi.tdVtrack_synopHC
hmi.rdVflows_fd15_frame	*rdvinv*	98000	2.25	flow inversions of the fits in all records for a given analysis time in series hmi.rdVfitsf_fd*
hmi.rdVflows_fd30_frame	*rdvinv*	196000	0.57	
hmi.tdVinvrt_synopHC	*invert_td_hr*	248	11	flow and sound-speed inversions of the travel time fits in in series hmi.tdVtimes_synopHC

Tracked Doppler data - common input for *most* local helioseismology analysis

Ring-diagram tiles at three size scales: 32°, 16°, and 5°.12 "squares"

(Uniform apodization to: 30°, 15°, and 5° circles)

Time-distance tiles: 30°.72 "squares"

R-D tile spacings: ~15°, 7°.5, and 2°.5 in arc; T-D tile spacings 24° in latitude and longitude

R-D Latitude spacing uniform, with tiles centered at 0, ±s, ±2s, ...

R-D Longitude spacing depends on latitude, same as latitude spacing at equator, and subject to constraint of integer divisor of 360°

4 additional T-D tiles at 20° spacings from edges on equator and meridian

Mapping with Postel's projection at scale of 0°.04 / pxl (5° and 15° tiles), 0°.08 / pxl (30° tiles), and 0°.06 / pxl (T-D tiles)

R-D regions tracked while within 80° of disc center

Three different sets, depending on heliographic latitude of SDO

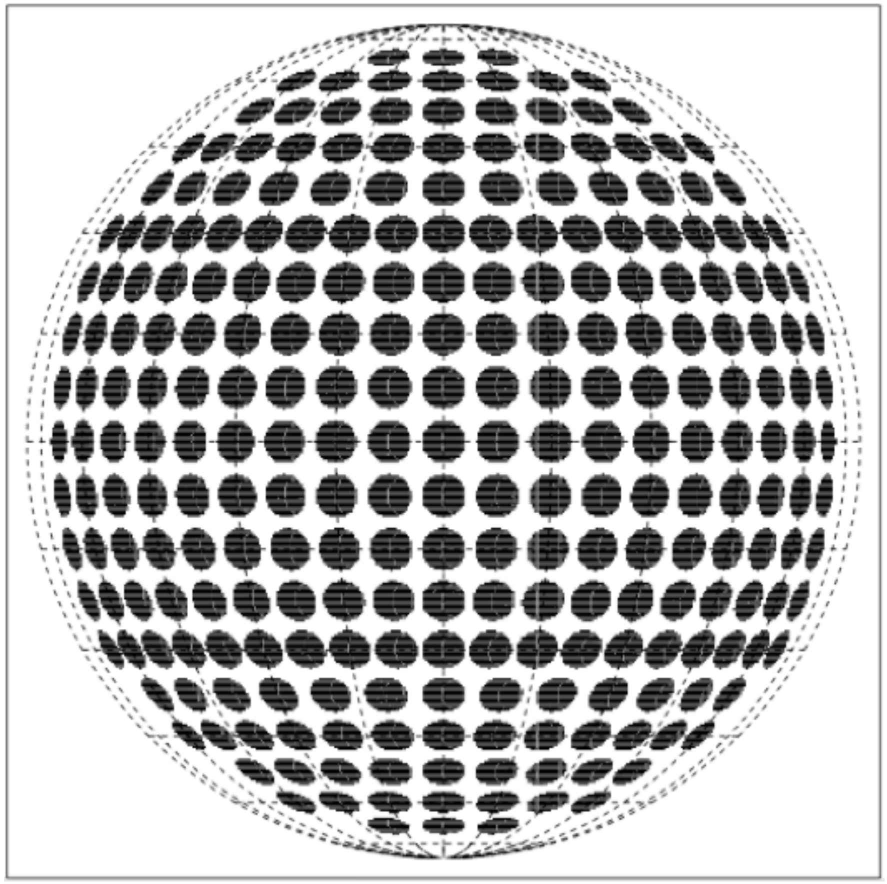
R-D regions tracked at Carrington rate

Maximum photospheric zonal velocity 260 m/s at 50°

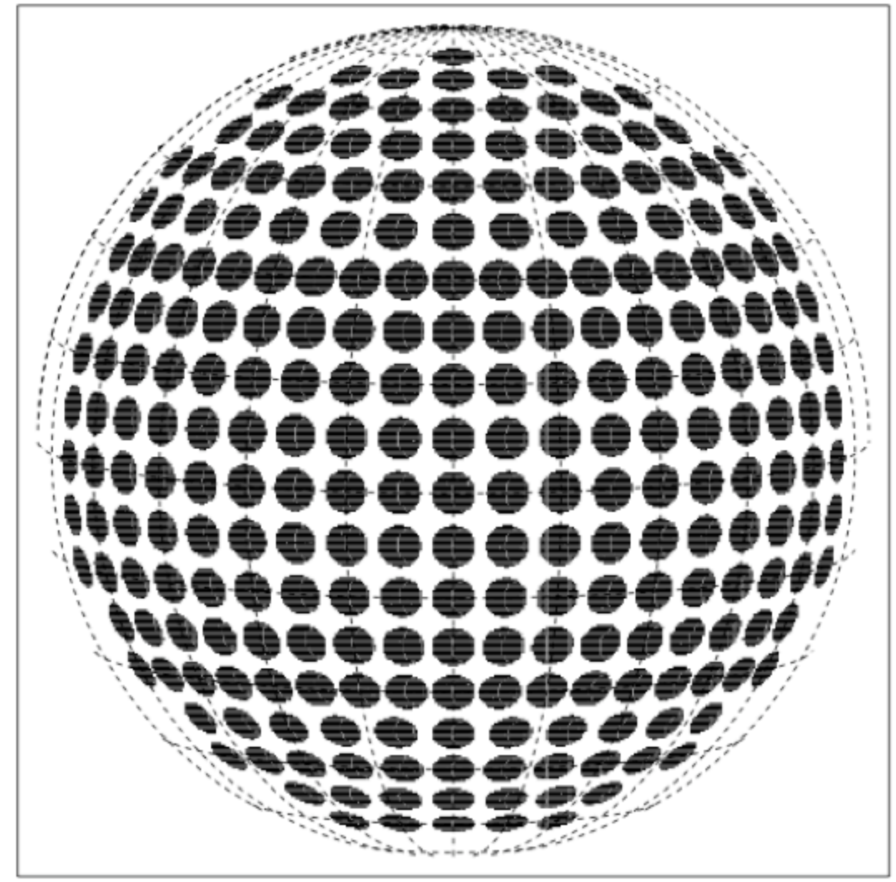
Maximum photospheric drift rate 4°.34 / day at poles

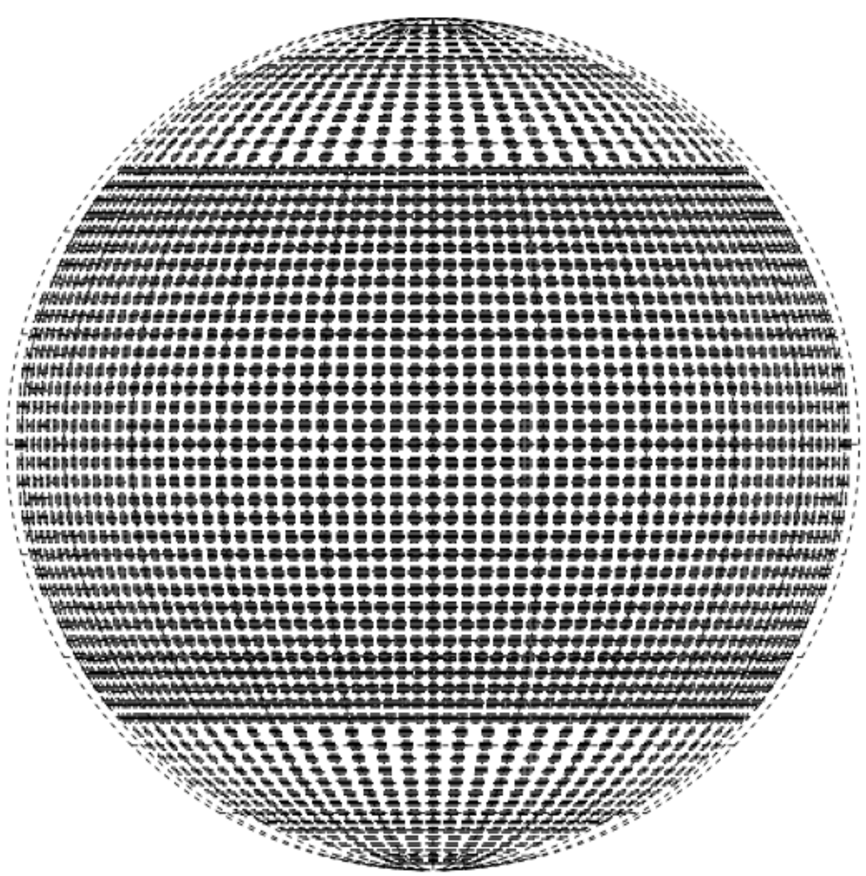
T-D regions tracked at nominal photospheric Doppler rate at center of region

Distribution of Ring-diagram Target Regions

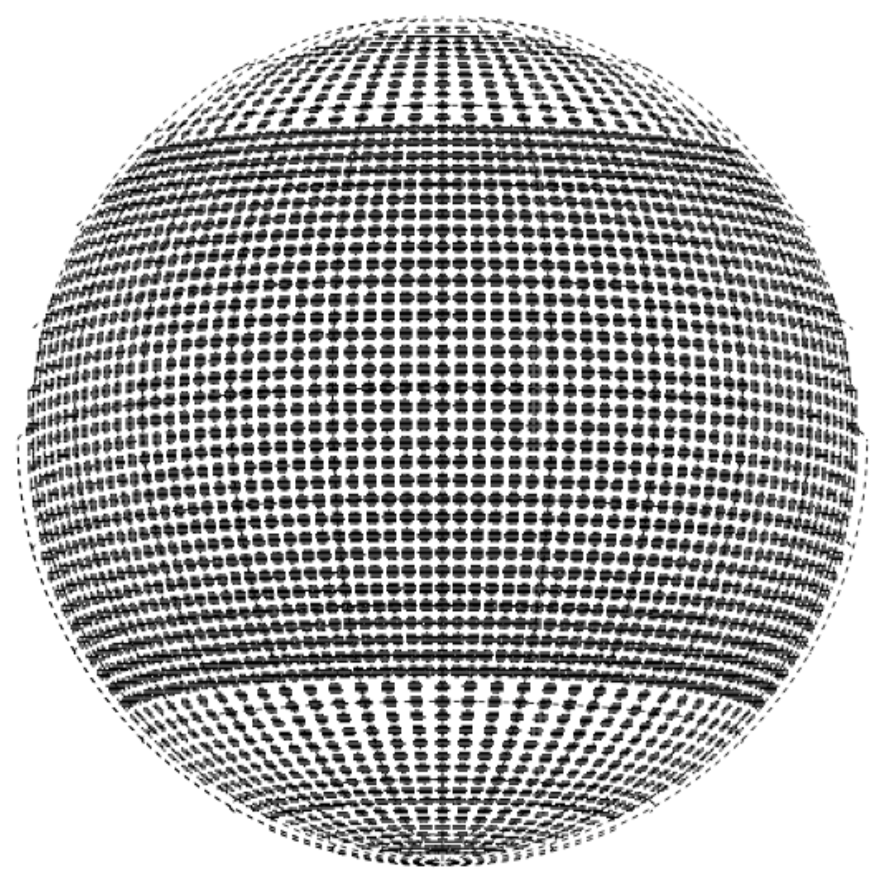


15°



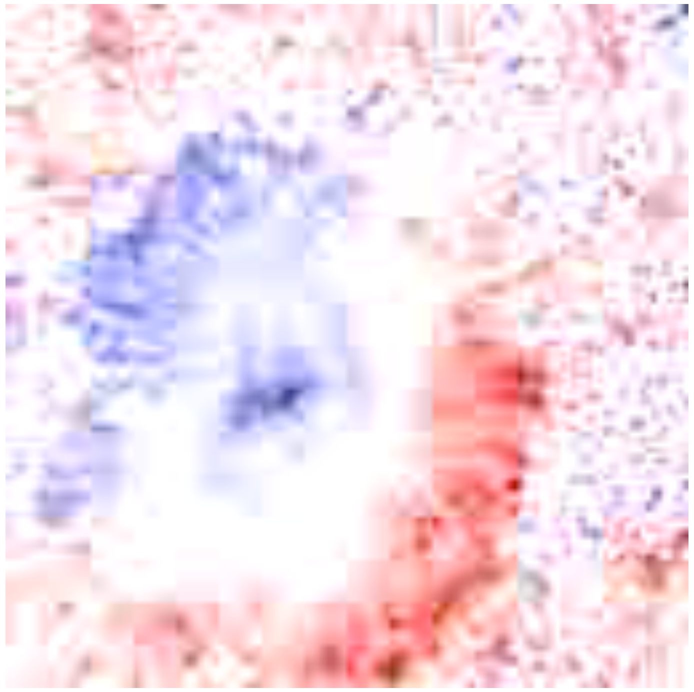


5°

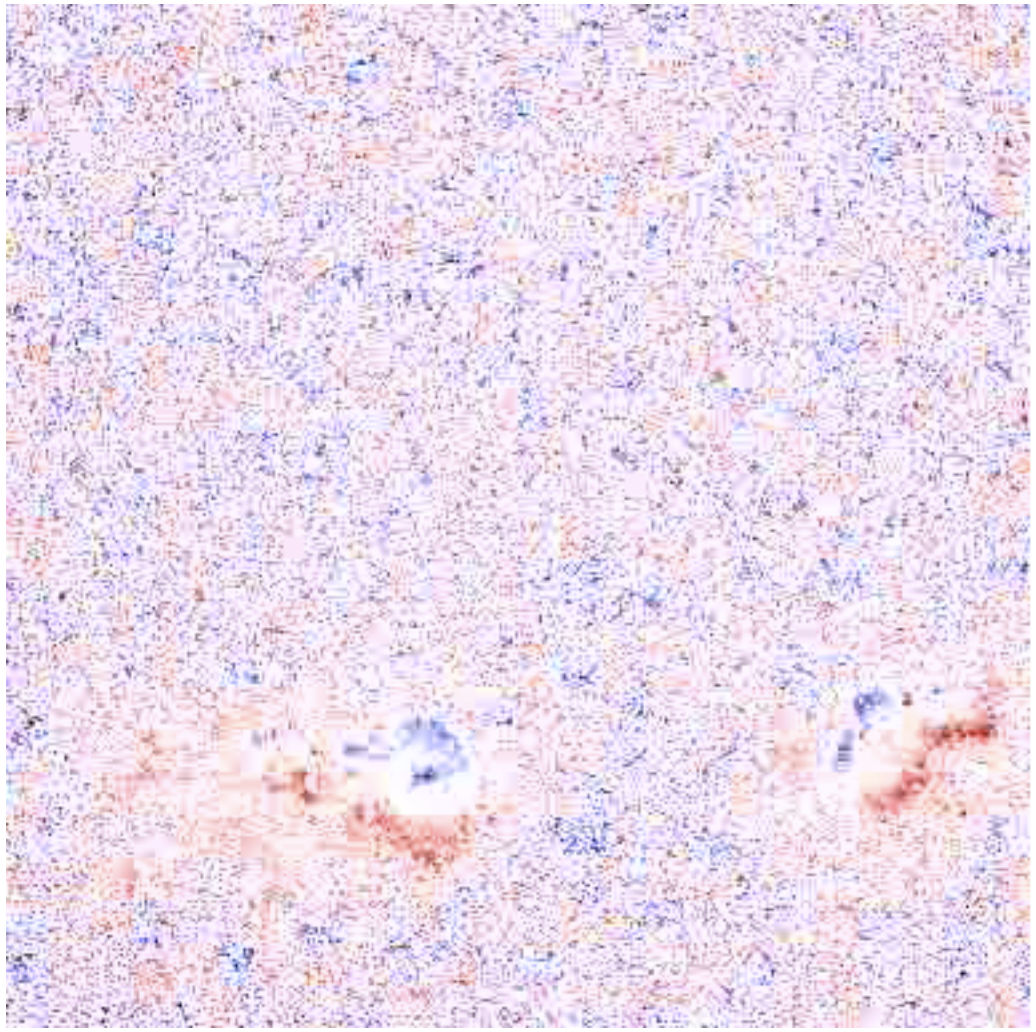


Tracked Doppler data cubes, centred at 2152:210 (2014.07.09_08:45)

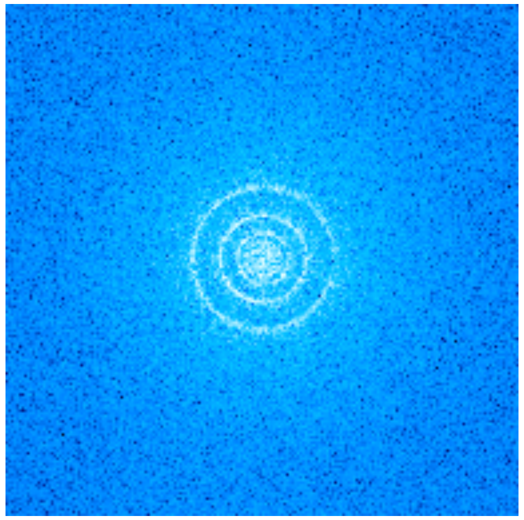
5° @ 12.5W07.5S



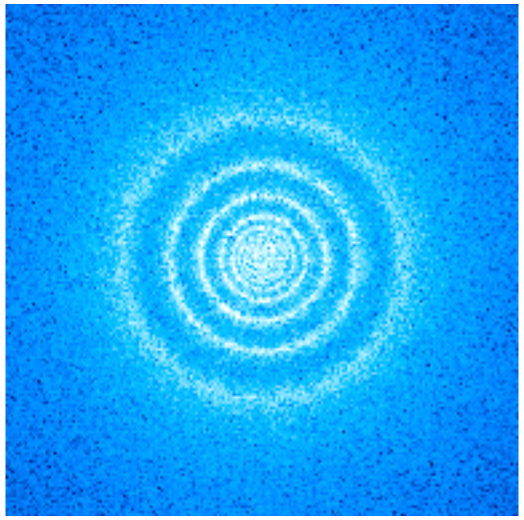
30° @ 15.0W00.0N



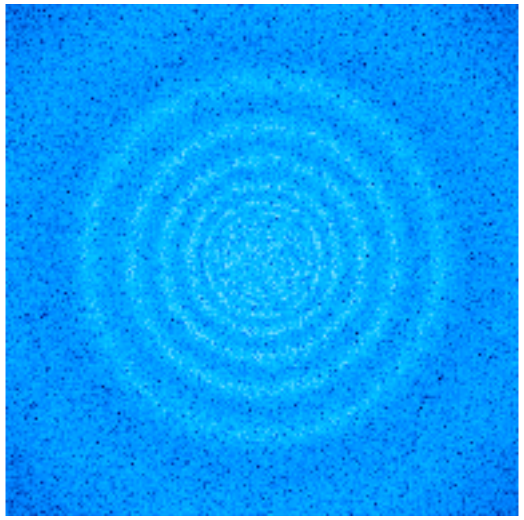
15° power spectrum, 2151:240 (2014.06.09_21:36), 00.0W00.0N



2.5 mHz

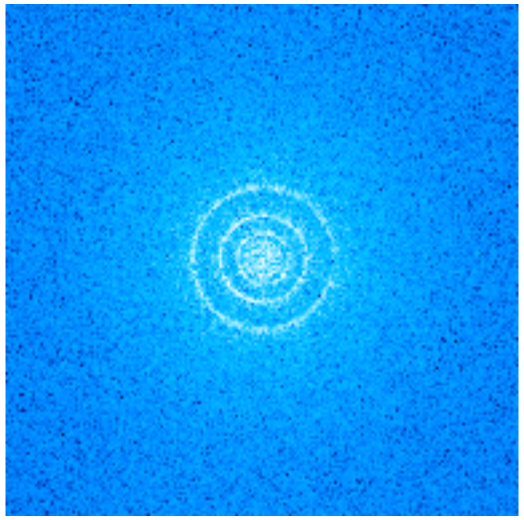


3.5 mHz

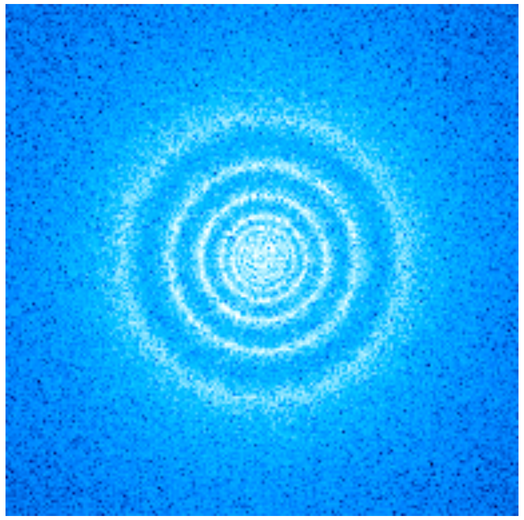


5.0 mHz

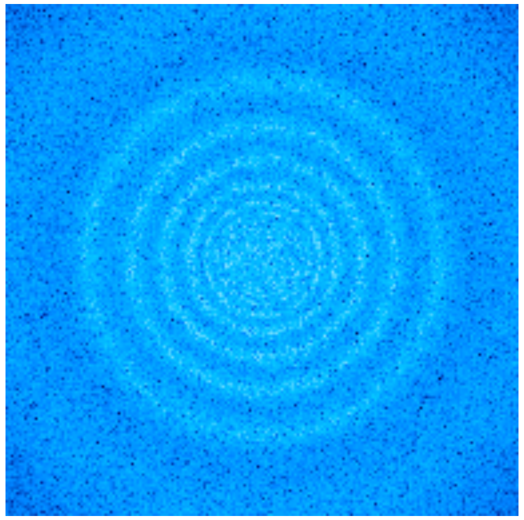
15° power spectrum, 2151:240 (2014.06.09_21:36), 00.0W00.0N



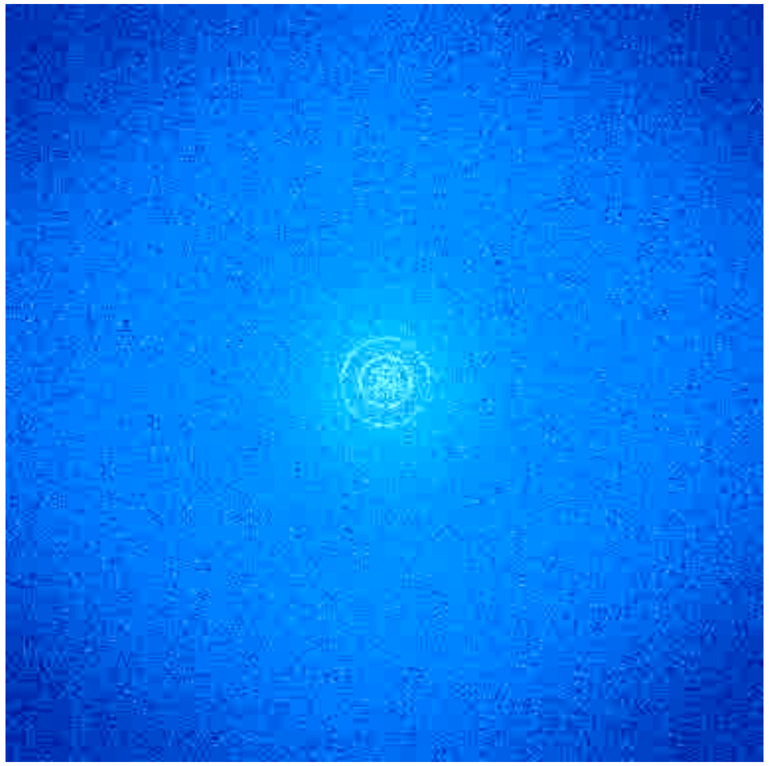
2.5 mHz



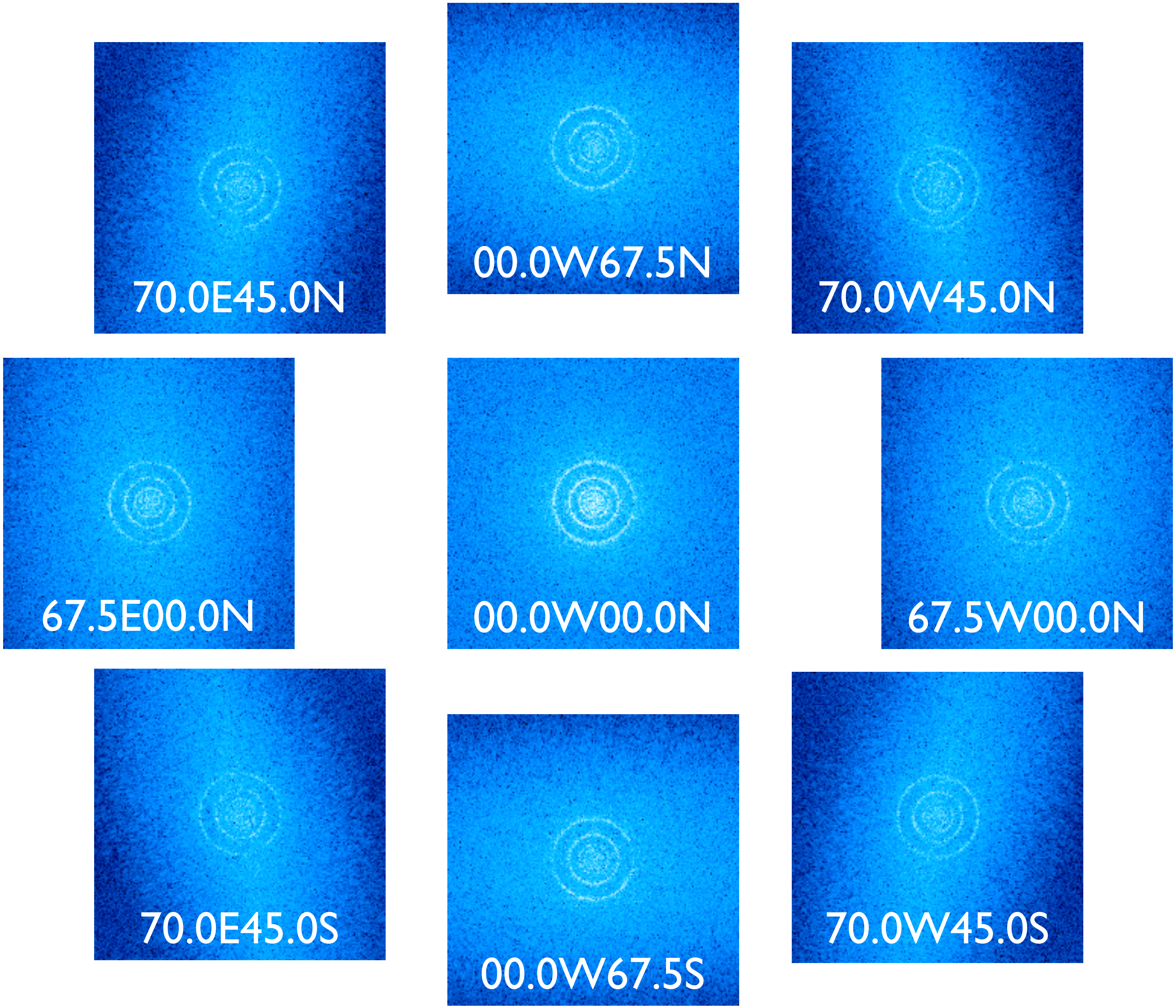
3.5 mHz



5.0 mHz

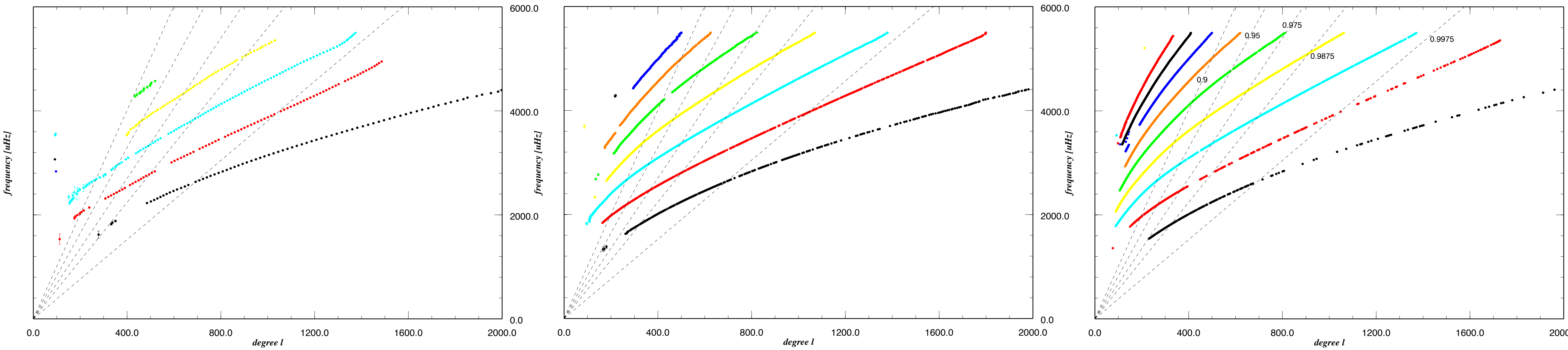


15° power spectra cuts @ 2.5 mHz around disc

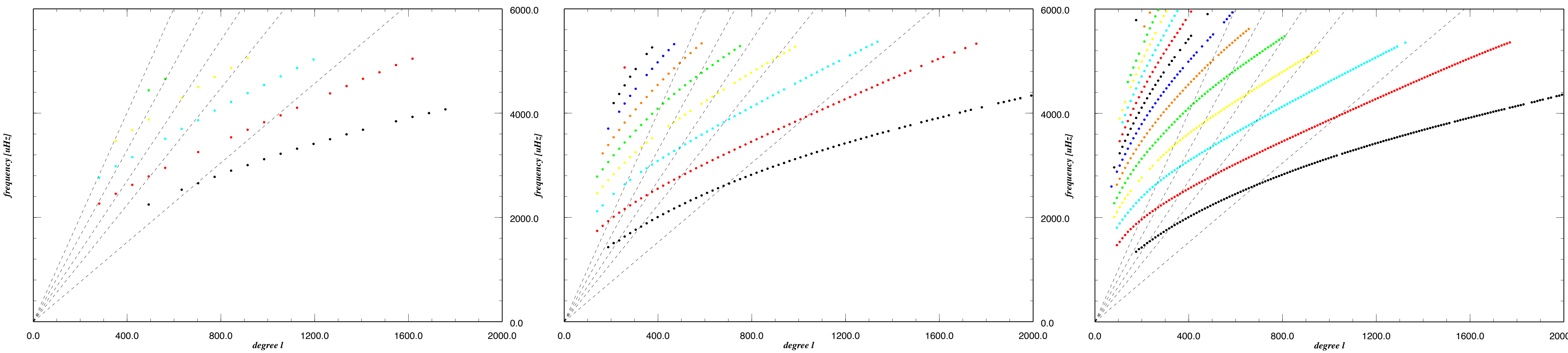


l-ν for ring-diagram fits to power spectra, 2151:240, 00.0W00.0N

5° | 15° | 30°

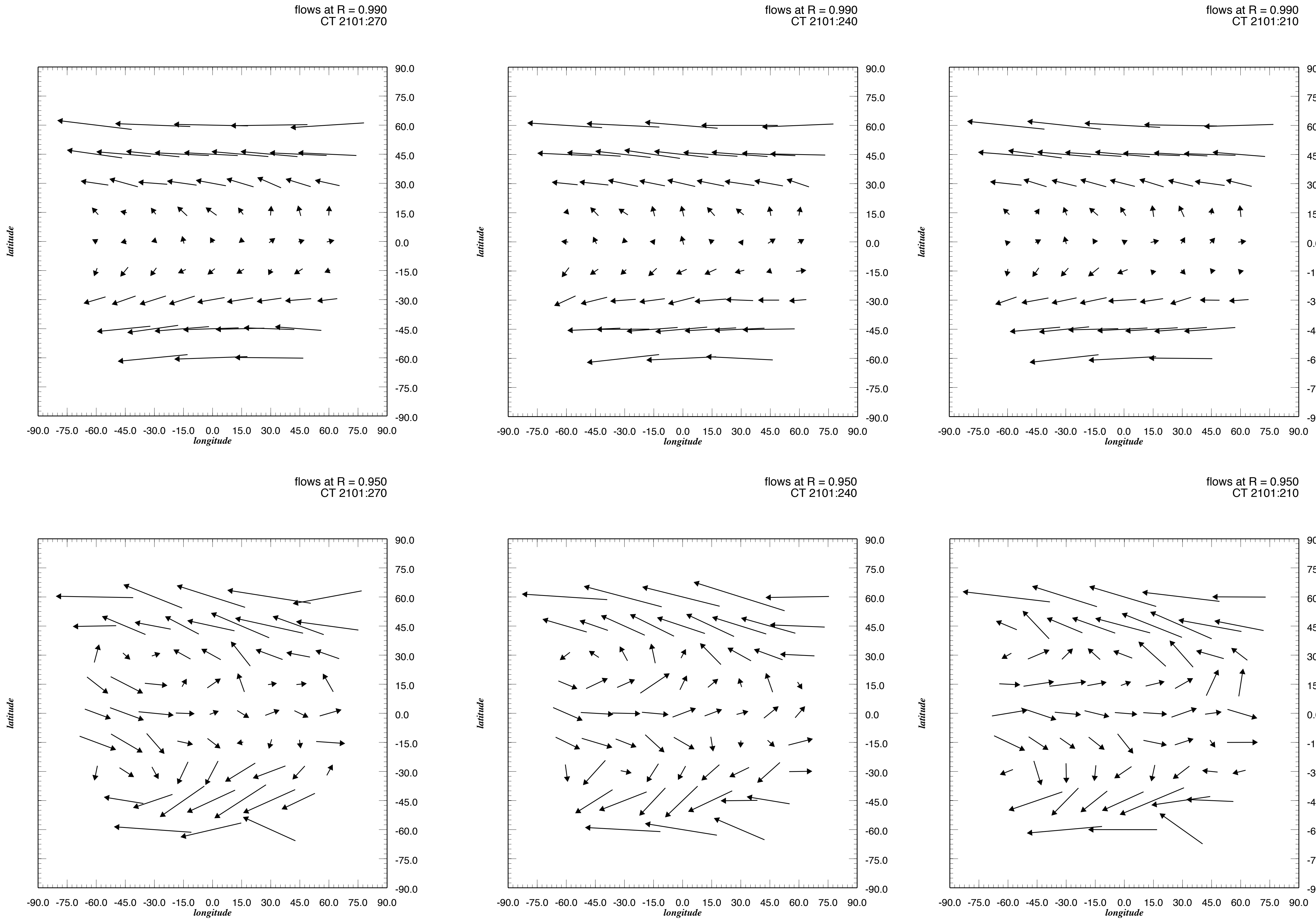


rdfitc



rdfitf

Sample flow inversions over the disc at different depths, 2101:240



Time-Distance Sound-Speed Inversions

2014.07.09_12:00

Gabor Wavelet

Target Depth [Mm]

Fitting Method

Gizon-Birch

Inversion Method

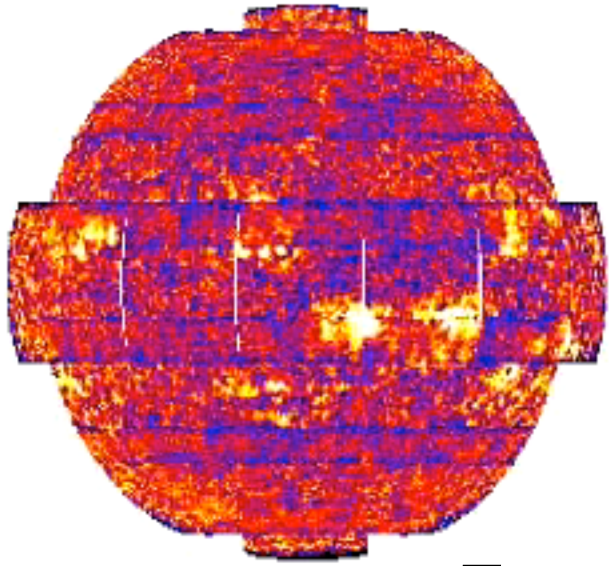
Born Approx

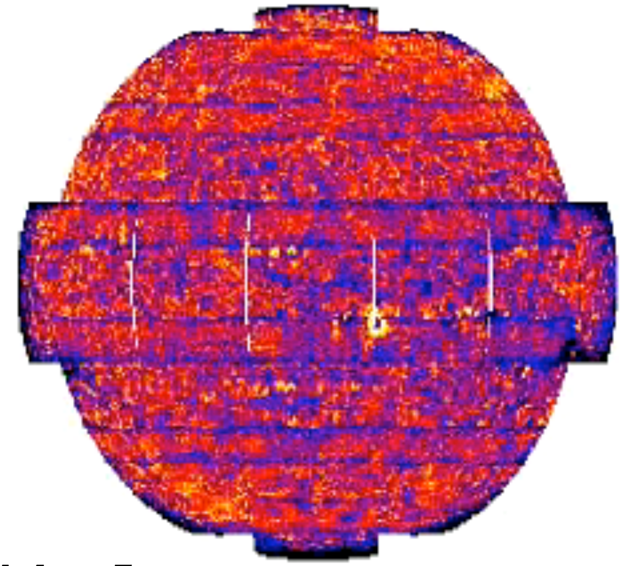
Ray Path

Time-Distance Sound-Speed Inversions

2014.07.09_12:00

Gabor Wavelet



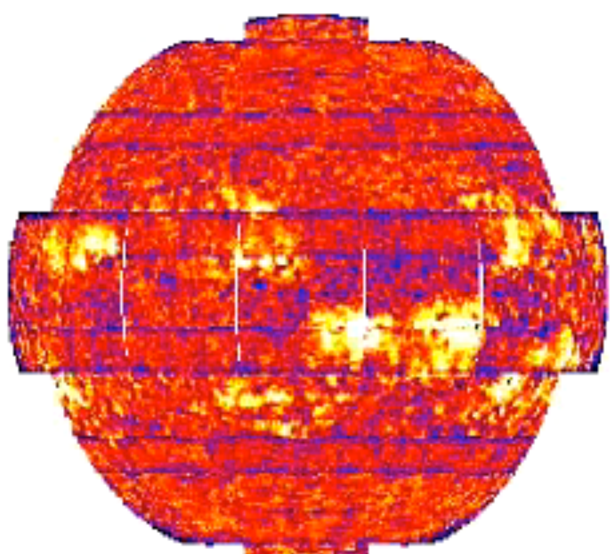


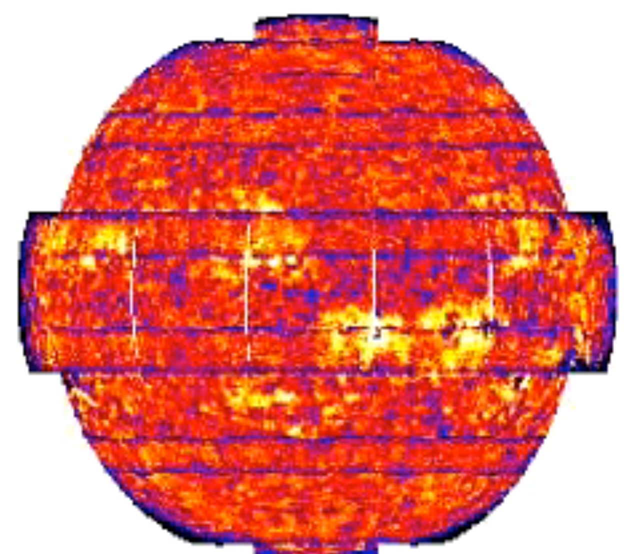
Target Depth [Mm]

Fitting Method

0.5

Gizon-Birch

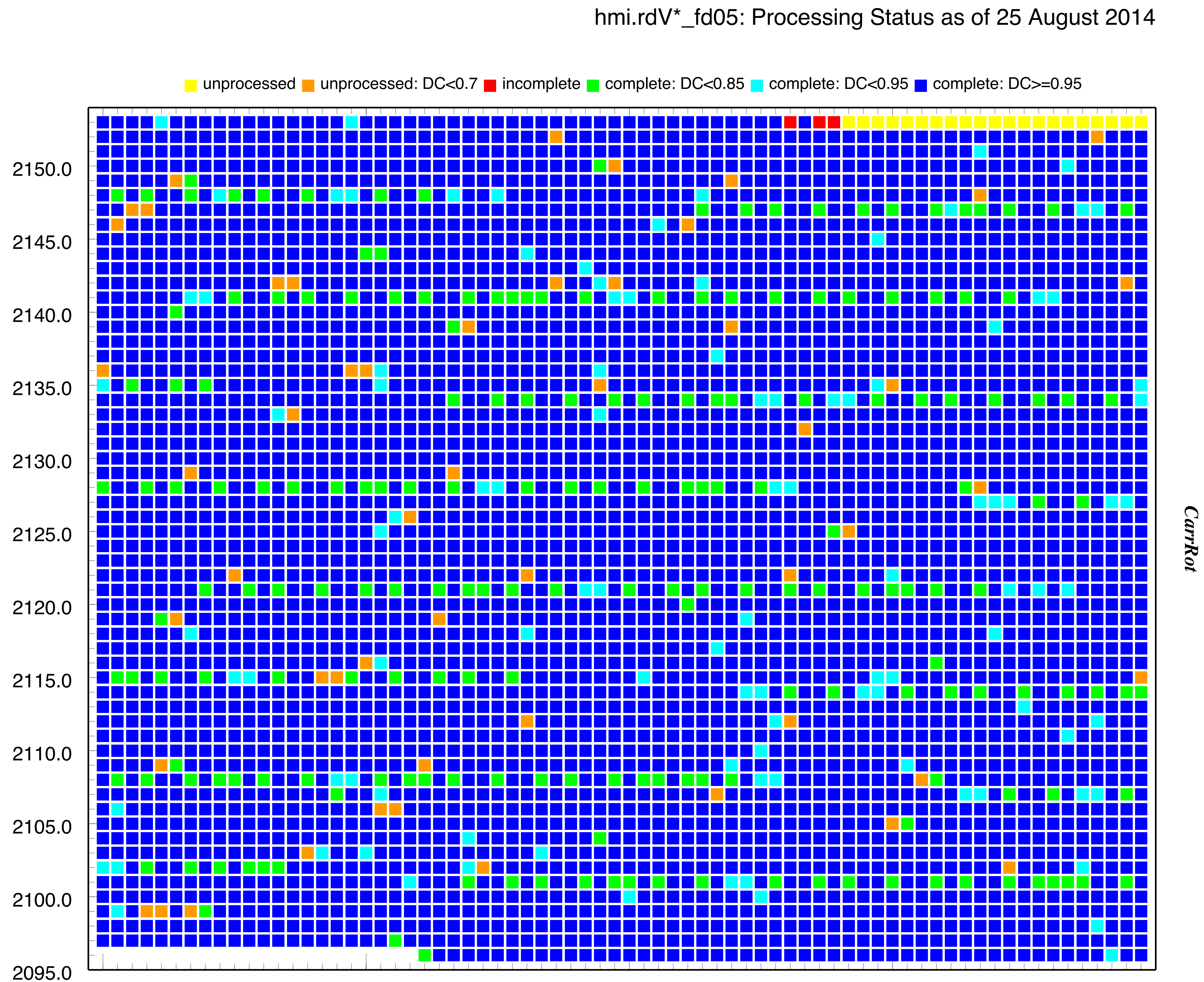




Inversion Method

Born Approx

Ray Path

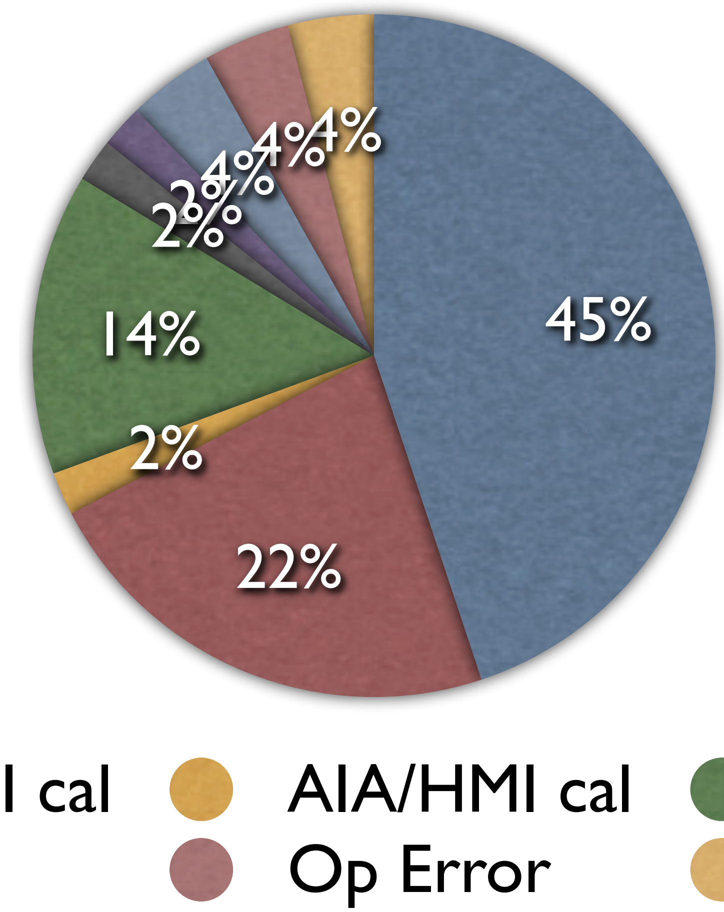

hmi.rdV*_fd05: Processing Status as of 25 August 2014
unprocessed
unprocessed: DC<0.7
incomplete
complete: DC<0.85
complete: DC<0.95
complete: DC>=0.95
2150.0
2145.0
2140.0
2135.0
2130.0
2125.0
2120.0
2115.0
2110.0
2105.0
2100.0
2095.0
CarrRot

Local Helioseismology Data Recovery

During 57 rotations, 2096:250 – 2153:255 (2010.05.01 – 2014.08.02):

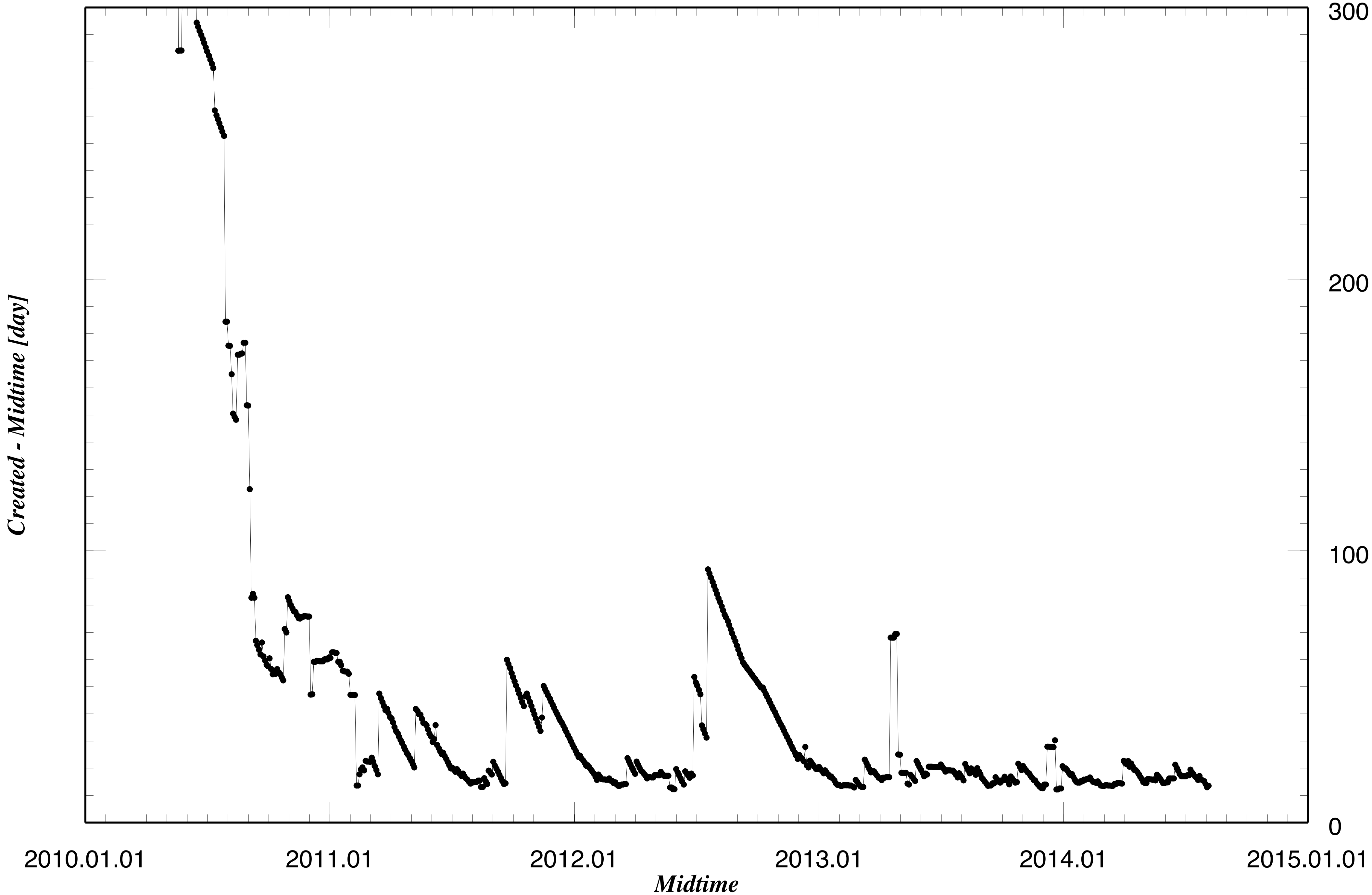
series	*window*	*opportunities*	*threshold*	*missed*	*recovery*
5º ring diagrams	9:36	4104	0.7	51	0.988
15º ring diagrams	28:48	1368	0.7	4	0.997
30º ring diagrams	57:36	684	0.7	0	1.000
time distance	8:00	4572	0.5	36	0.992

Principal causes of lost 5° ring diagram data



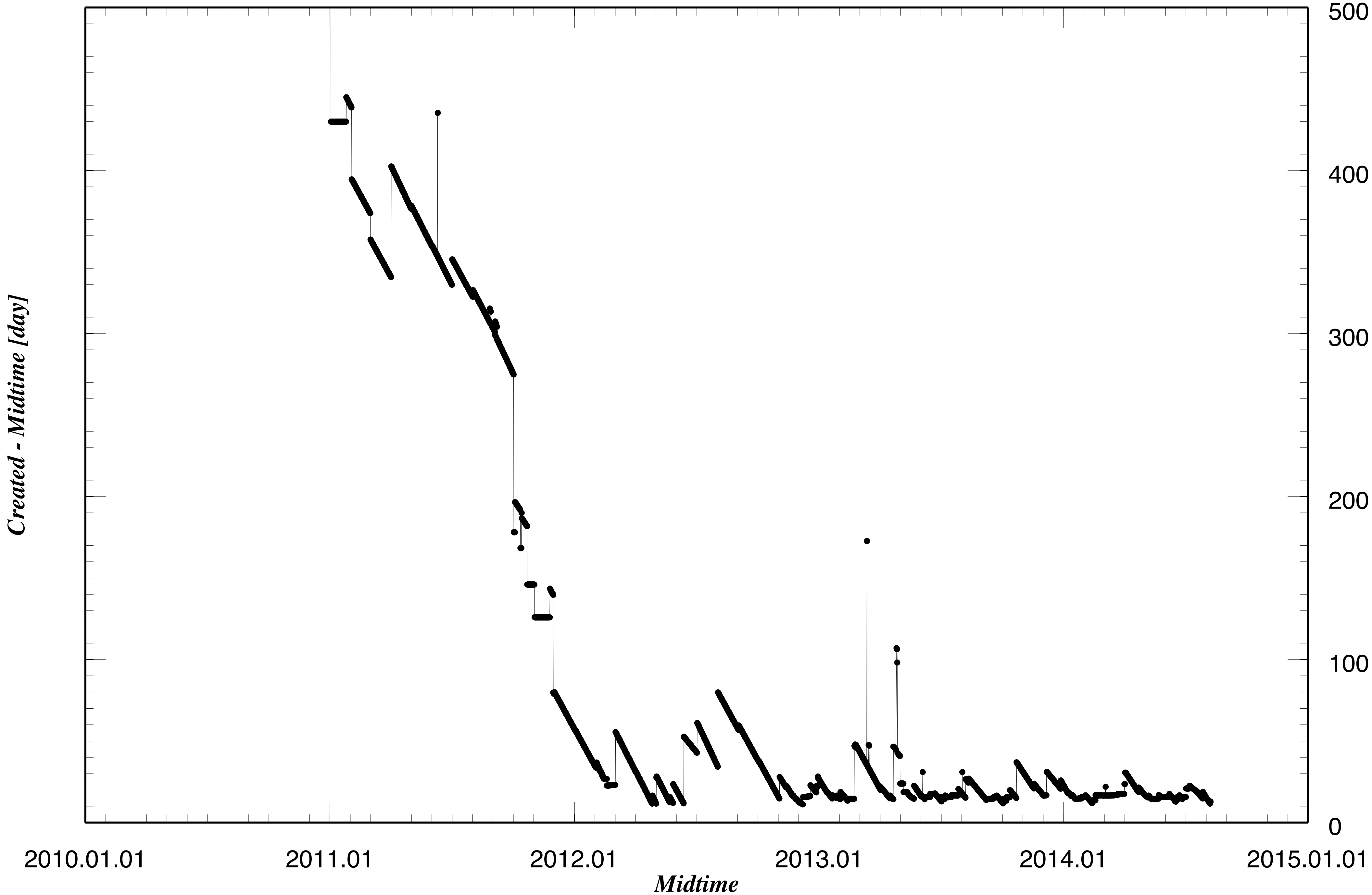
Ring-diagram Data Products

Delay between Observation and Completion of Processing



Time-distance Data Products

Delay between Observation and Completion of Processing



Prospects

More of Same

Identical analysis (almost) applied to MDI, GONG, and Mt Wilson data sets

Ring-Diagrams

Addition of multi-ridge fit code to pipeline

Full-disc fitc fits for 15° tiles

Improved fitting procedures to account for spatial variations

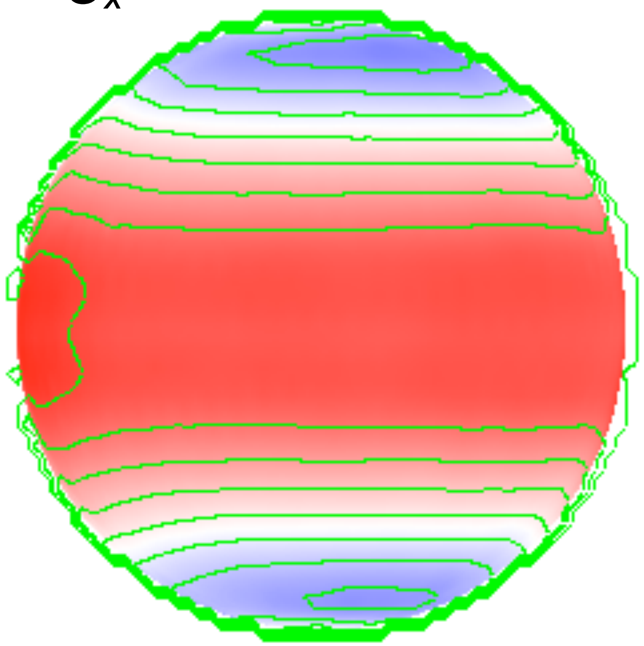
Time-Distance

???

Spatial Distribution of Averaged mode-fit Parameters

n = 1–3, 0.9875 < r_T < 0.9975

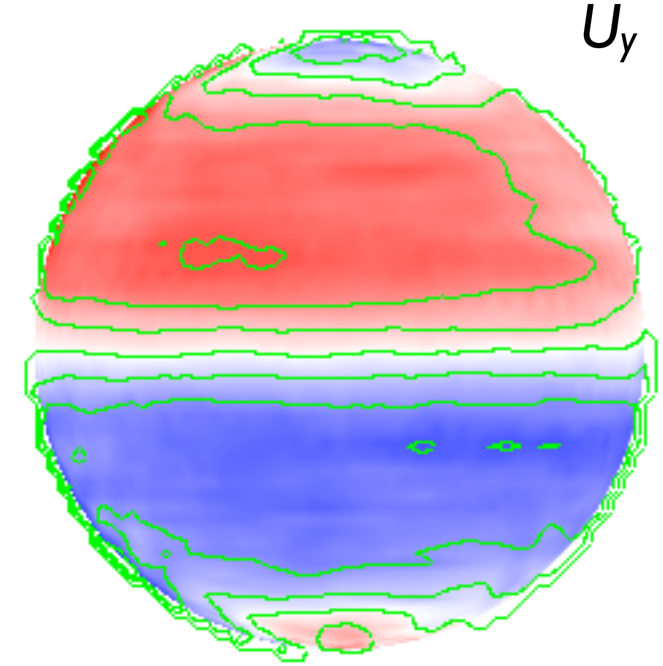
U_x



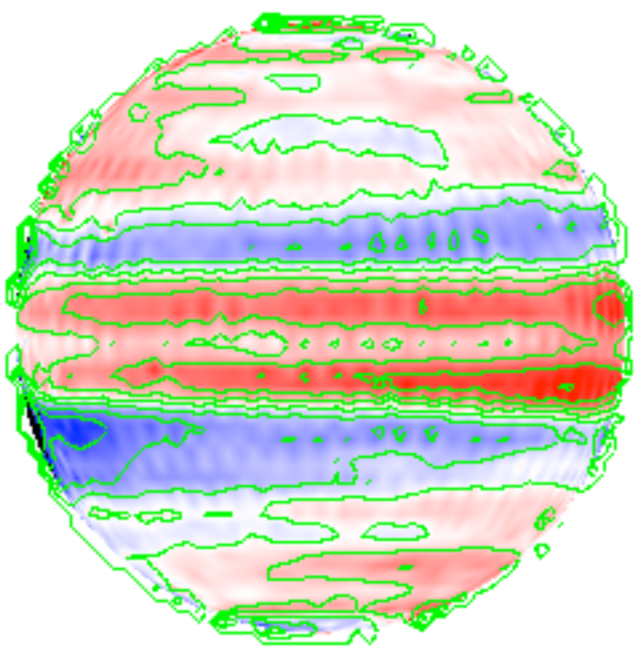
(25 m/s contours)

4-year mean 5° *rdfitc*
CR 2096:250–2149:050
(2010.05.01_02:12–2014.04.30_19:59)

U_y

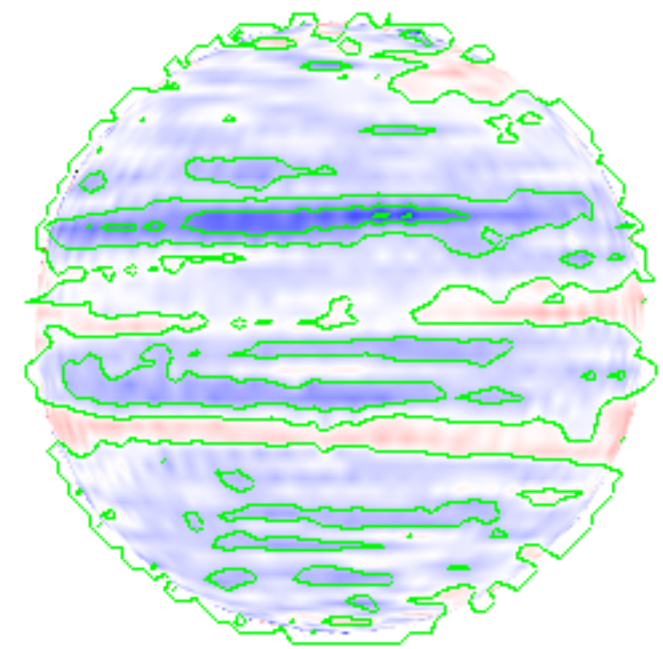


(5 m/s contours)



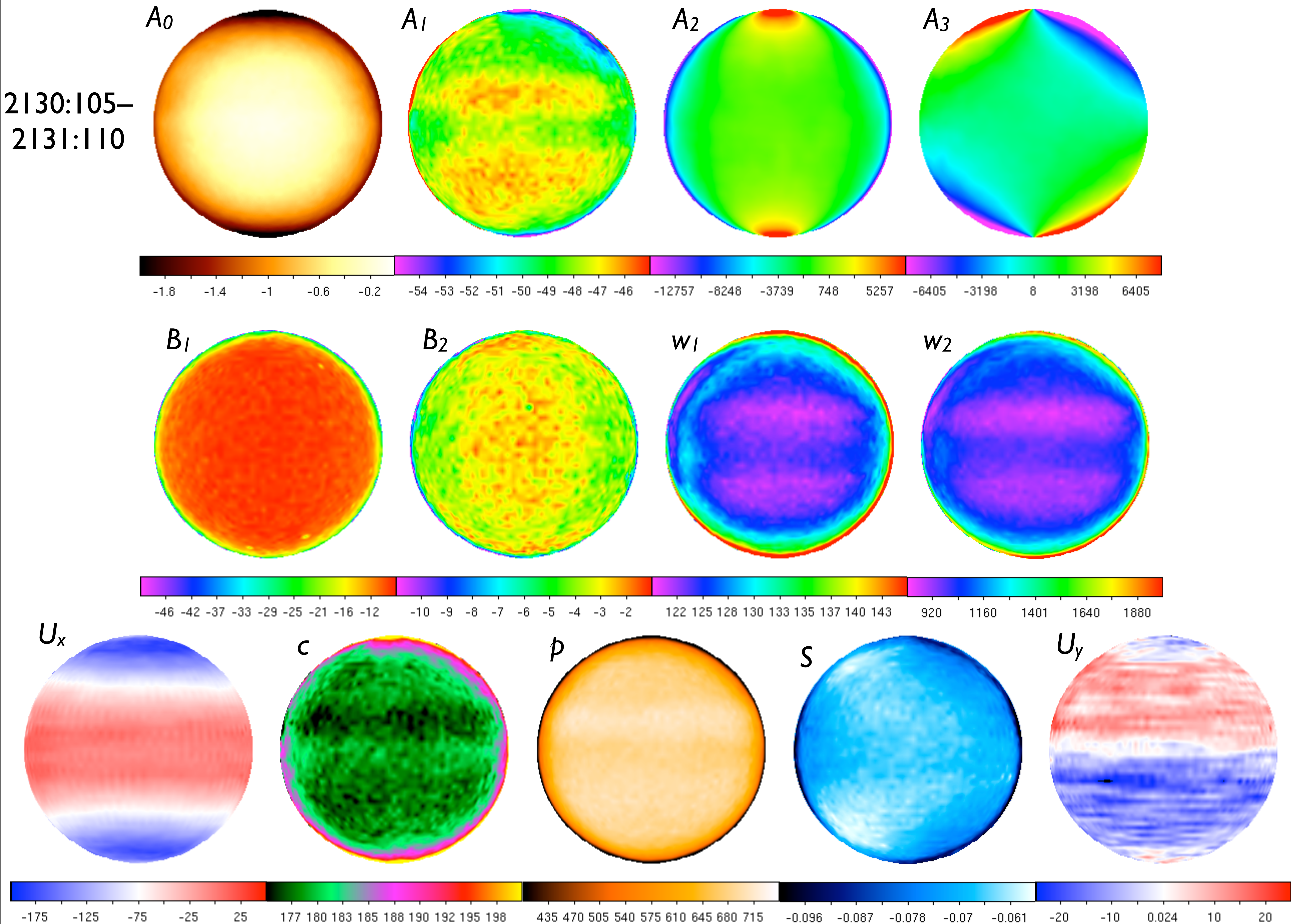
(2.5 m/s contours)

last 2 yrs minus first 2 yrs 5° *rdfitc*
CR 2123:330–2149:050 -
CR 2096:250–2123:335

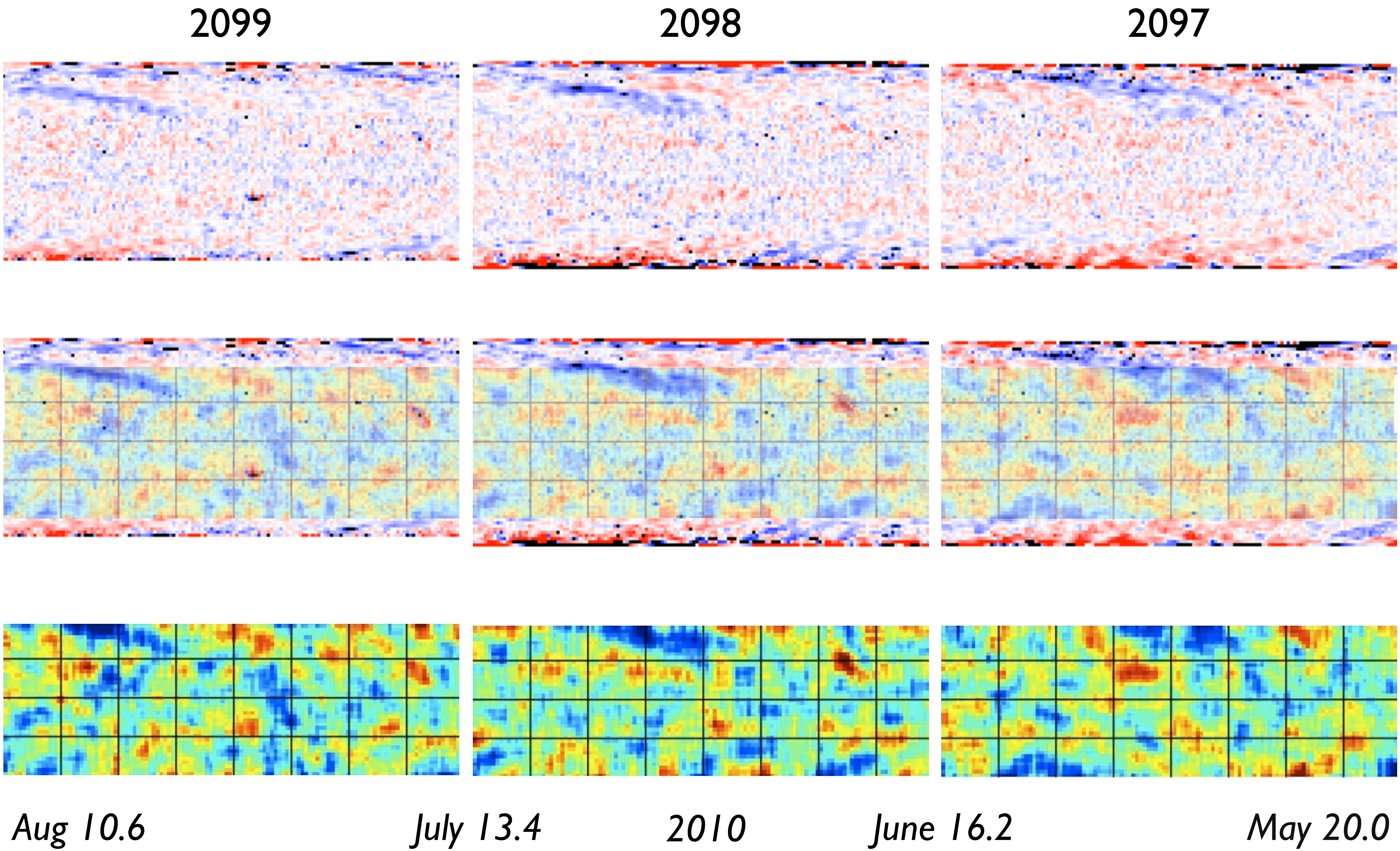


(2.5 m/s contours)

(

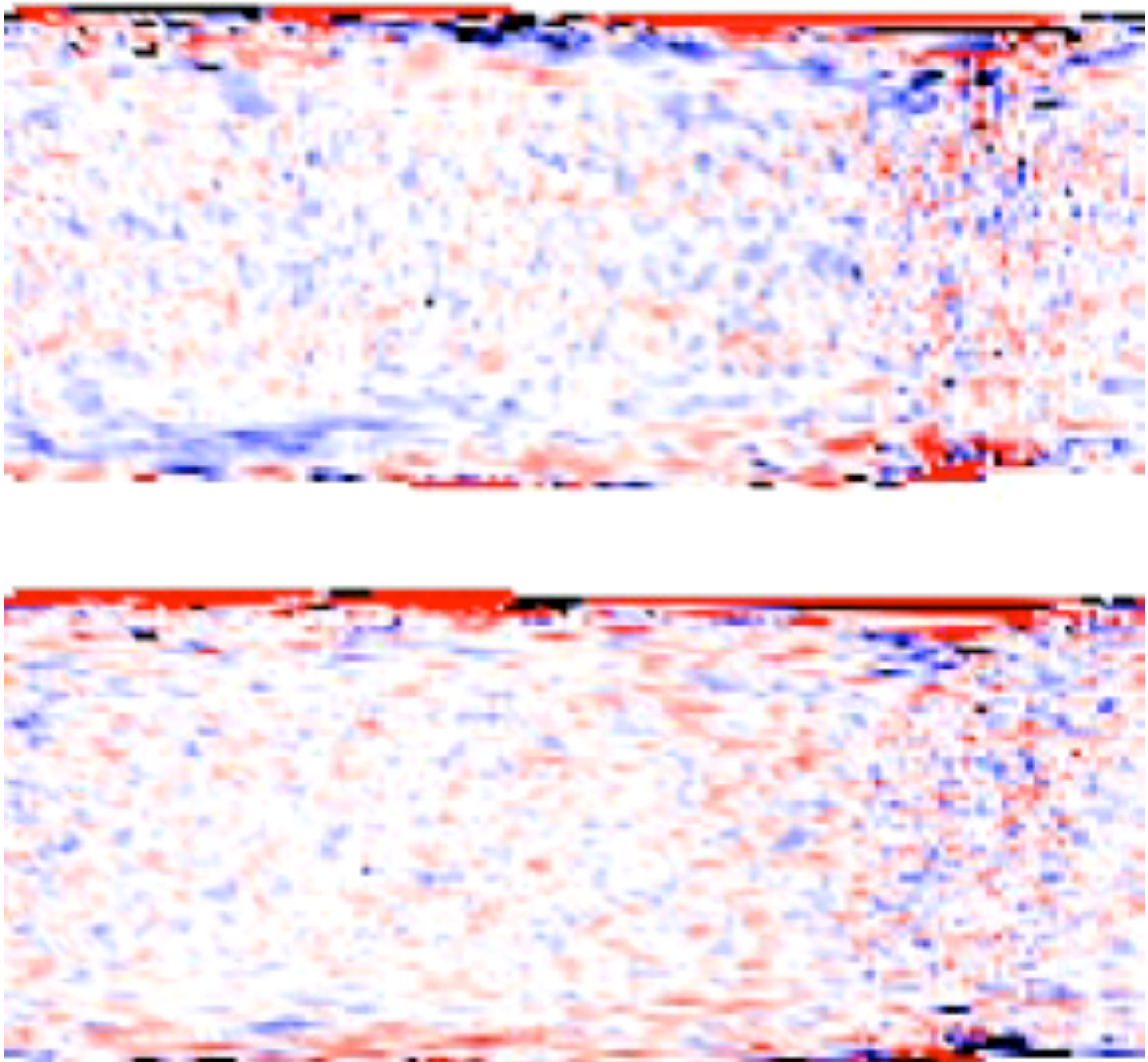

2130:105–
2131:110
A0
A1
A2
A3
-1.8 -1.4 -1 -0.6 -0.2
-54 -53 -52 -51 -50 -49 -48 -47 -46
-12757 -8248 -3739 748 5257
-6405 -3198 8 3198 6405
B1
B2
w1
w2
-46 -42 -37 -33 -29 -25 -21 -16 -12
-10 -9 -8 -7 -6 -5 -4 -3 -2
122 125 128 130 133 135 137 140 143
920 1160 1401 1640 1880
Ux
c
p
S
Uy
-175 -125 -75 -25 25
177 180 183 185 188 190 192 195 198
435 470 505 540 575 610 645 680 715
-0.096 -0.087 -0.078 -0.07 -0.061
-20 -10 0.024 10 20

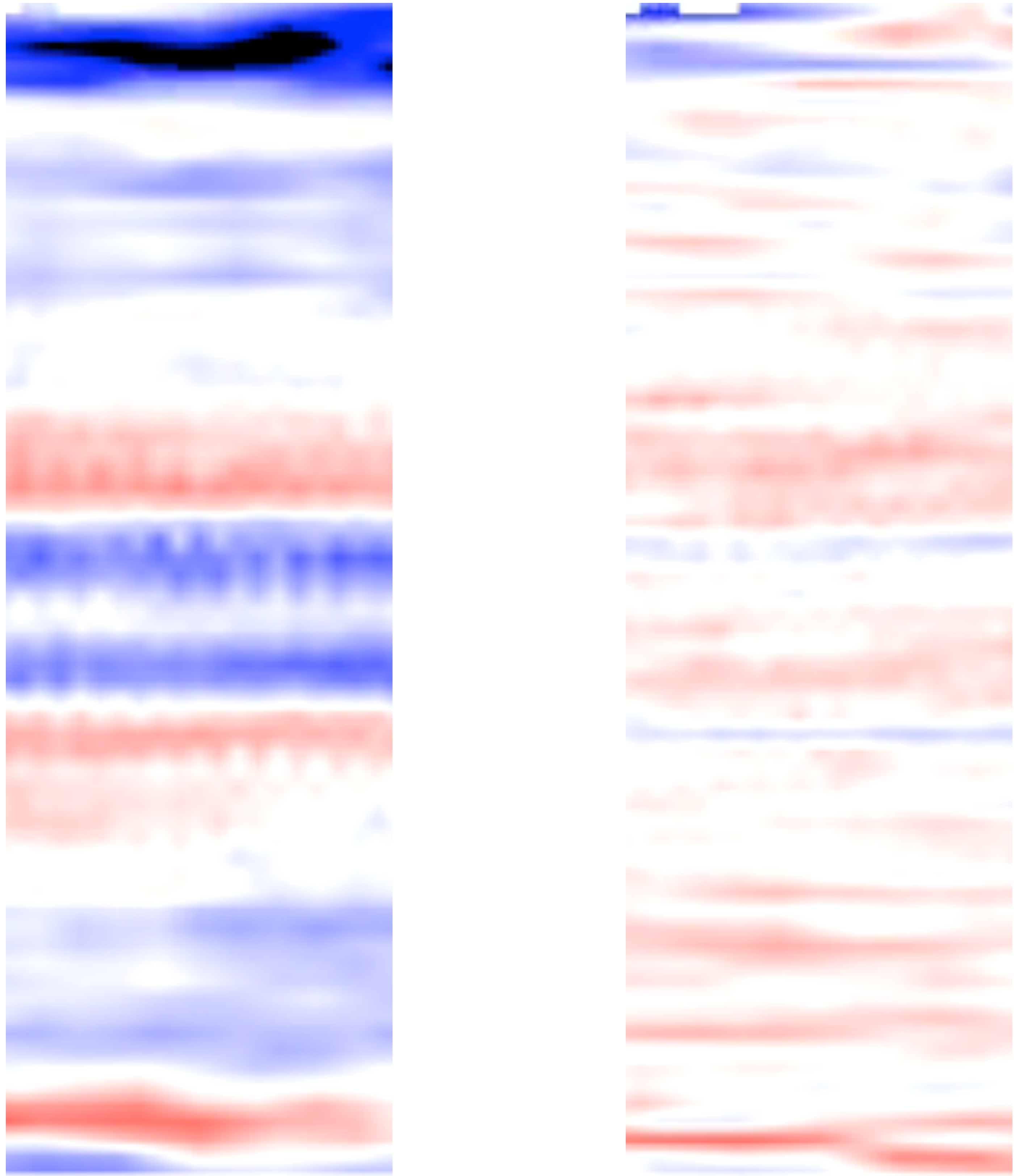
Comparing Ring-Diagram and Time-Distance Zonal Flow Anomalies
(Depth 3–6 Mm)

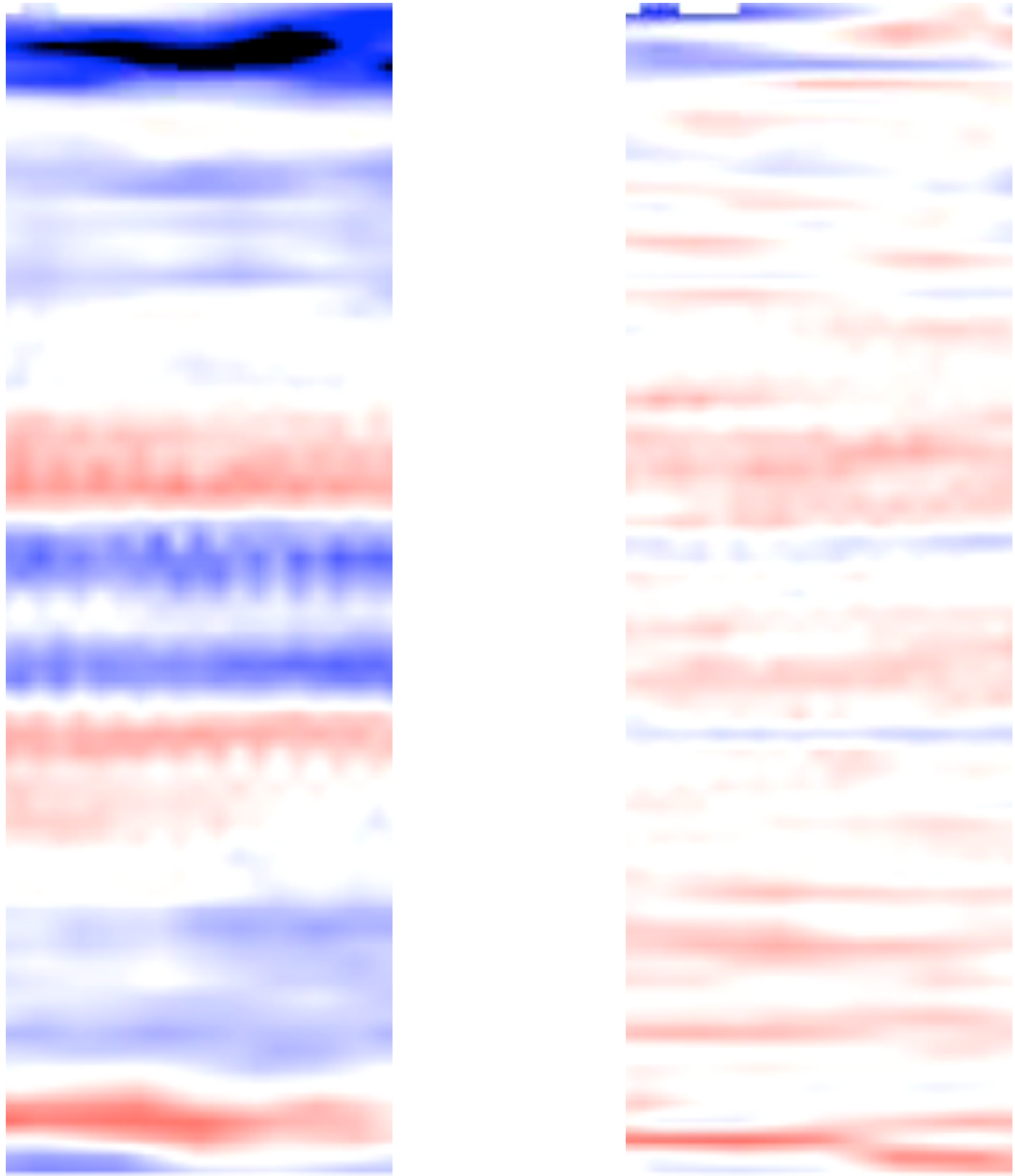


Evolution of the Flow Anomaly Patterns, 5.2010 – 5.2014

Evolution of the Flow Anomaly Patterns, 5.2010 – 5.2014

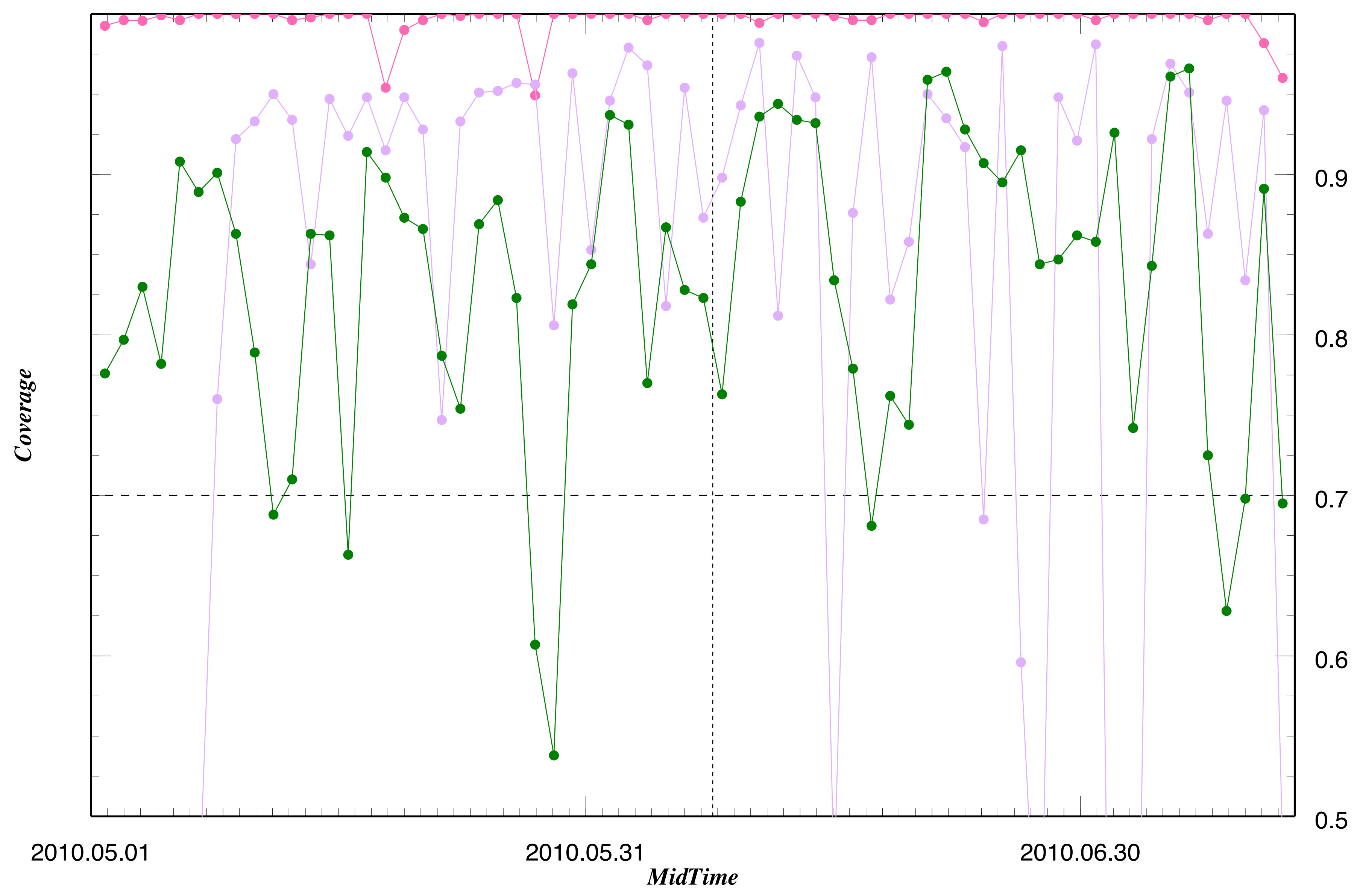






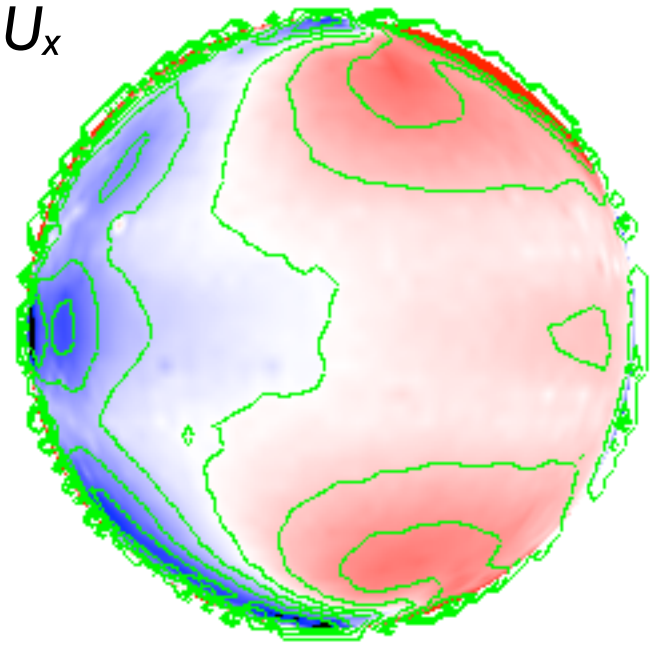
HMI, MDI, & GONG Coverage during Comparison Interval

2096:240 – 2098:015 (2010 05.01–07.12)



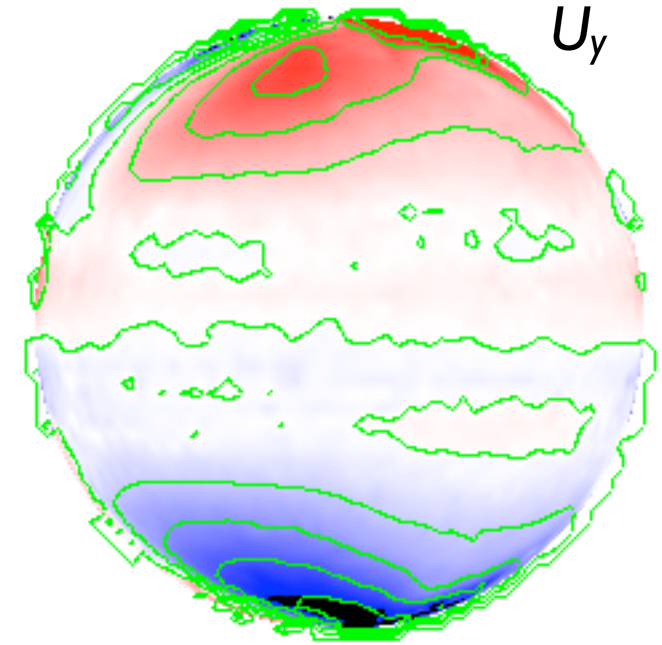
Differences in 4-year means of *rdfitf* and *rdfitc* flow parameters

U_x

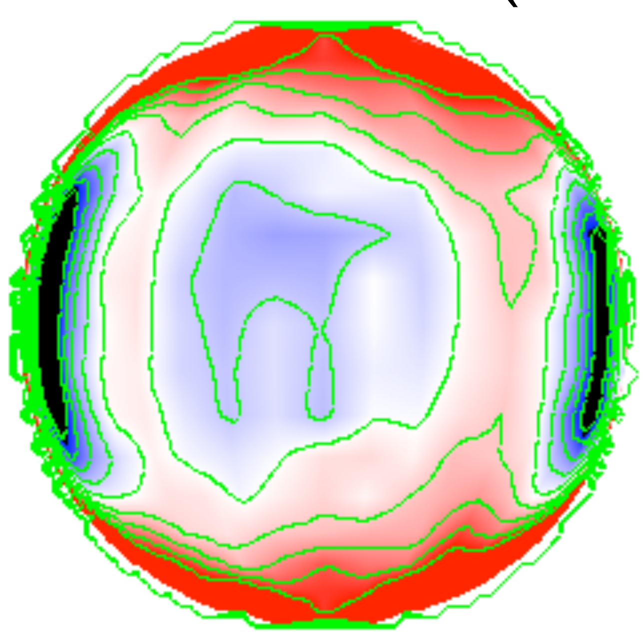


(2.5 m/s contours)

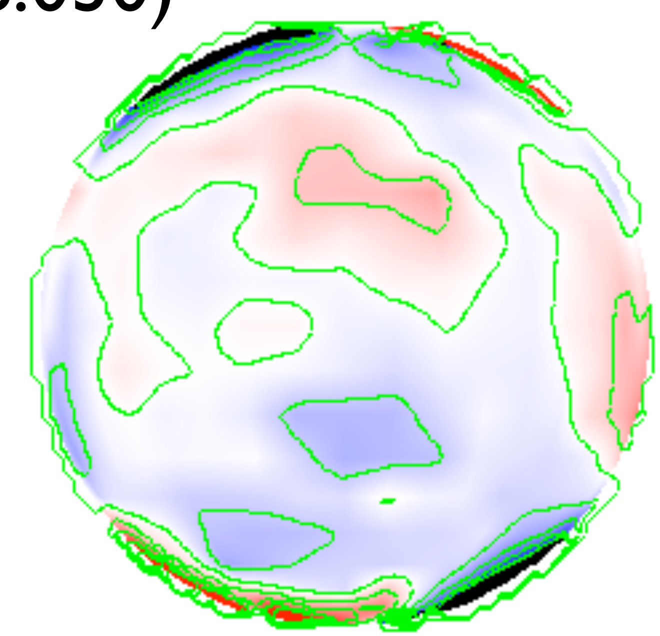
U_y



Differences in 2.5-month means of *rdfitm* and *rdfitc* flow parameters (MDI data, 2096:150–2098:030)



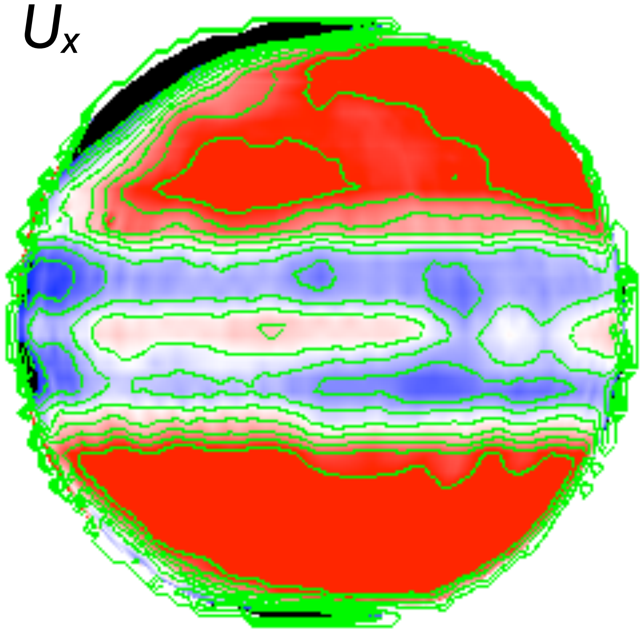
(5 m/s contours)



But...

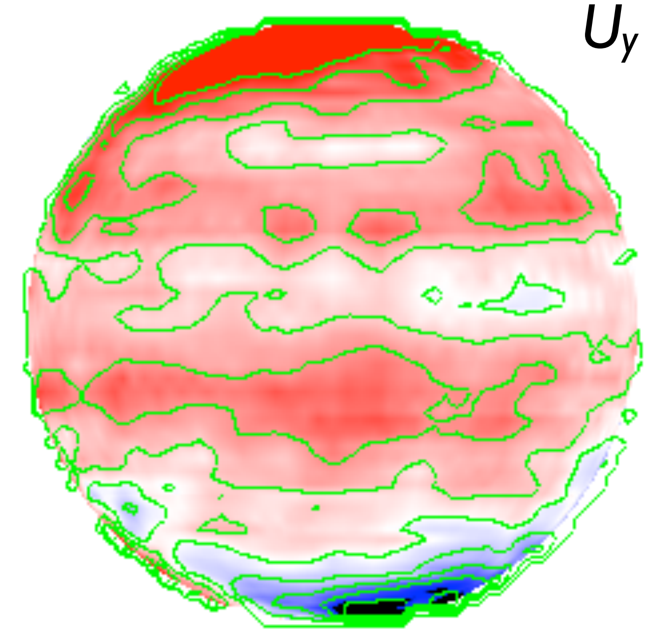
Differences in 1-rotation means of 15° and 4-yr means of 5°

U_x



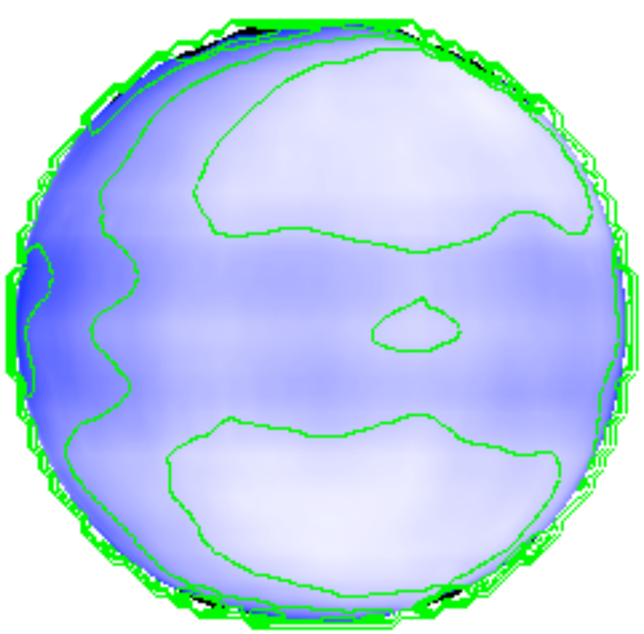
(2.5 m/s contours)

U_y

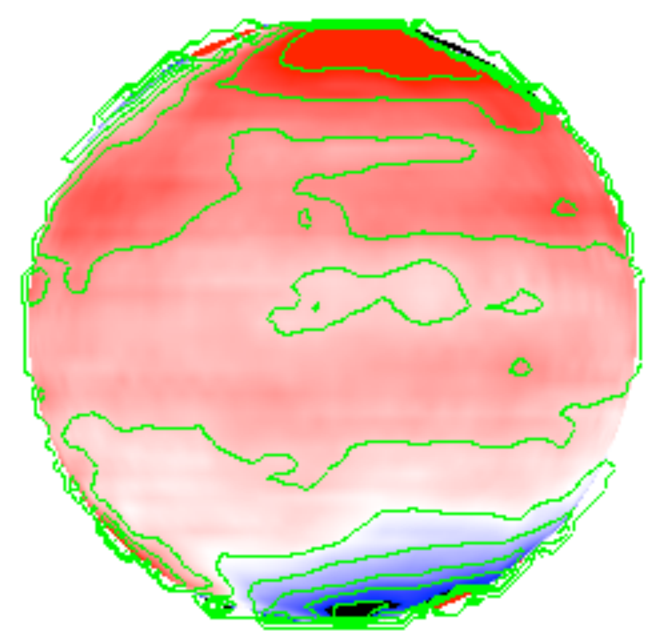


And...

Differences in 2.5-month means of MDI 15° and 4-yr means of HMI 5°



(20 m/s contours)



(5 m/s contours)