

Notes on the HMI Pipeline filtering code comparison

Junwei retrieved a full-disk datacube of the quiet Sun obtained with MDI, and tracked it with fastrack. From this cube, he produced 3 datacubes: the original one, a cube that has been phase-speed filtered for the distance 14.6 Mm, and a cube that has been phase-speed filtered for the distance 32.1 Mm.

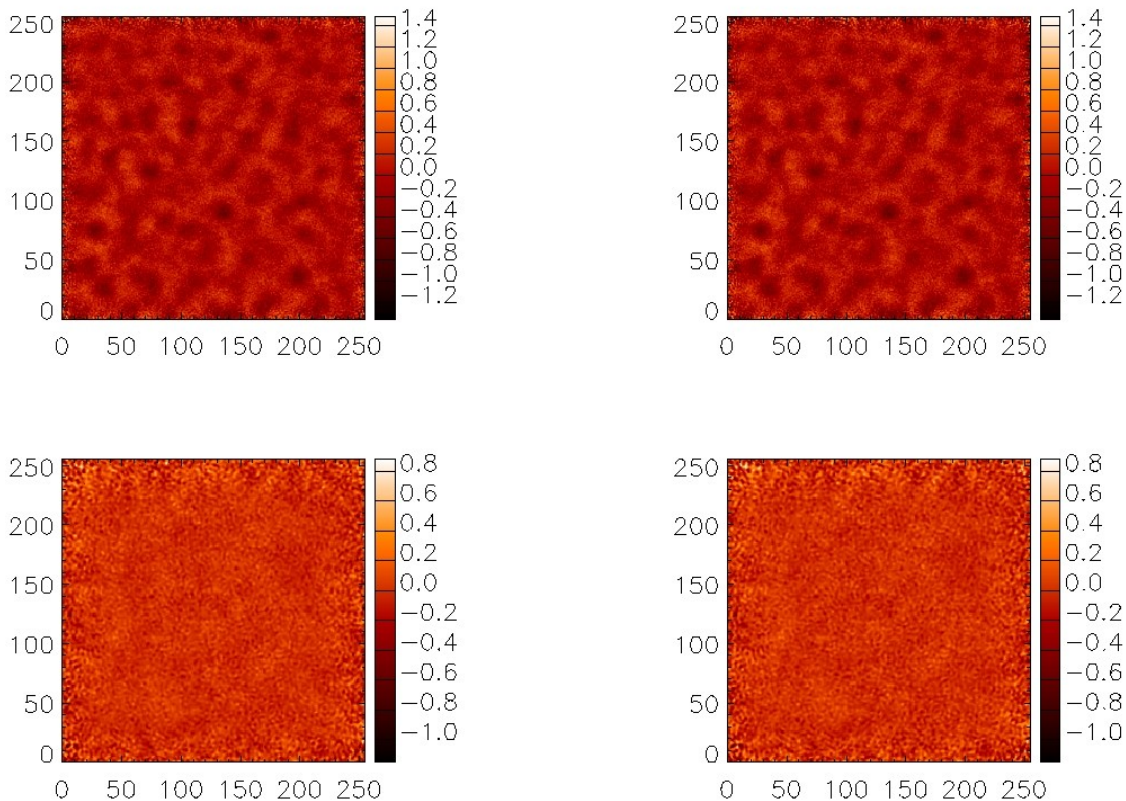
All phase-speed filter parameters and corresponding distances were provided by Tom. Then, using Junwei's original datacube, Tom and I applied our travel-time codes: we phase-speed filtered the cube, computed the cross-covariances, and derived the travel-time maps. We also derived travel-time maps from the datacubes already phase-speed filtered by Junwei.

After several rounds (allowing us to correct for minor differences in the way we filter), the computation of the correlation coefficients between the travel-time maps obtained with Junwei's original cube (and filtered by Tom and I) and the maps obtained with Junwei's filtered cubes, give the following result:

Distance source-receiver	outgoing travel times	ingoing travel times
14.6 Mm	0.988	0.990
32.1 Mm	0.927	0.926

These coefficients are very good, and show that only minor discrepancies remain (probably due to difference in the f-mode ridge removal). The way we define filter width and central phase speed are the same.

The following figure shows the travel-time difference maps (in minutes) for 14.6 Mm (upper panels) and 32.1 mm (lower panels), and obtained with my filtering code (left panels) and Junwei's filtering code (right panels). Both sets of maps look very similar.



The phase-speed filter at wavenumber k and angular frequency w ($w=2\pi f$) is defined as:

$$F(k,w) = \sqrt{[\exp(-(w/k-v_0)^2 / [2(\text{FWHM}/2.35482)^2])]}$$

and is applied in the Fourier domain. The f-mode ridge is also removed. For the different distances between source and receiver (in heliographic degrees), the values of v_0 , the central phase speed of the filter, and FWHM, the full-width at half maximum, retained for the HMI pipeline are:

Distance min-max (in °)	V_0 (km/s)	FWHM (km/s)
0.6-0.96	15.8044	5.65879
1.08-1.32	21.3801	5.49698
1.44-1.8	28.8275	9.39779
1.92-2.4	36.4804	5.90805
2.4-2.88	40.6173	5.12964
3.12-3.84	47.3257	8.28702
4.08-4.8	55.9407	8.94736
5.04-6.0	64.9492	9.07418
6.24-7.68	74.3514	9.72139
7.68-9.12	83.6705	8.91675
9.12-10.56	93.1295	10.0013
11.04-12.48	102.951	9.63831
12.48-14.4	113.915	12.2884
14.4-16.32	126.120	12.1222
17.28-19.2	138.960	13.5566
19.2-22.08	153.365	15.2534
22.08-24.0	168.858	15.7344

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