HMI Data Analysis Software

Plan for Phase-D
JSOC - HMI Pipeline

HMI Data

- Filtergrams
  - Doppler Velocity
    - Tracked Tiles Of Dopplergrams
  - Heliographic Doppler Velocity maps
    - Spherical Harmonic Time series To l=1000
      - Mode frequencies And splitting
  - Ring diagrams
  - Time-distance Cross-covariance function
  - Egression and Ingression maps
  - Line-of-sight Magnetograms
    - Vector Magnetogram Fast algorithm
    - Vector Magnetogram Inversion algorithm
    - Tracked full-disk 1-hour averaged Continuum maps
      - Solar limb parameters
      - Brightness feature maps
  - Stokes I,V
  - Stokes I,Q,U,V
  - Continuum Brightness
    - Tracked Tiles
    - Full-disk 10-min Averaged maps
    - Tracked Tiles

Processing

- Filtergrams
- Heliographic Doppler Velocity maps
- Spherical Harmonic Time series To l=1000
- Mode frequencies And splitting
- Ring diagrams
- Time-distance Cross-covariance function
- Egression and Ingression maps
- Line-of-sight Magnetograms
- Vector Magnetogram Fast algorithm
- Vector Magnetogram Inversion algorithm
- Tracked full-disk 1-hour averaged Continuum maps
- Solar limb parameters
- Brightness feature maps

Data Product

- Internal rotation \( \Omega(r,\Theta) \) (0<r<R)
- Internal sound speed, \( c_s(r,\Theta,\Phi) \) (0<r<R)
- Full-disk velocity, \( v(r,\Theta,\Phi) \), And sound speed, \( c_s(r,\Theta,\Phi) \), Maps (0-30Mm)
- Carrington synoptic \( v \) and \( c_s \) maps (0-30Mm)
- High-resolution \( v \) and \( c_s \) maps (0-30Mm)
- Deep-focus \( v \) and \( c_s \) maps (0-200Mm)
- Far-side activity index
- Line-of-Sight Magnetic Field Maps
- Vector Magnetic Field Maps
- Coronal magnetic Field Extrapolations
- Coronal and Solar wind models
- Brightness Images
Global helioseismology

Filtergrams

Doppler Velocity

Heliographic Doppler velocity maps

Spherical Harmonic Time series To l=1000

Mode frequencies And splitting

Internal rotation \( \Omega(r,\Theta) \) (0<r<R)

Internal sound speed, \( c_s(r,\Theta) \) (0<r<R)

Code: project J. Schou
Status: ready to port

Code: qdotprod J.Schou
Status: ready to port

Code: med-l peak bagging J.Schou
High-l ridge fitting, E. Rhodes
Status: needs improvements

Code: sound-speed inversions A.Kosovichev
Status: ready to port

Code: rotation inversion J.Schou R. Howe
Status: ready to port

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Ring Diagrams

Doppler Velocity

Filtergrams

Tracked Tiles Of Dopplergrams

Ring diagrams

Local wave frequency shifts

Full-disk velocity, $v(r,\Theta,\Phi)$, and sound speed, $c_s(r,\Theta,\Phi)$, maps (0-30Mm)

Carrington synoptic $v$ and $c_s$ maps (0-30Mm)

Code: fastrack
R.Bogart, J.Toomre, D. Haber, B. Hindman
Status: needs improvements

Code: power spectrum
R.Bogart
Status: ready to port

Code: ring fitting
S.Basu, F.Hill, J.Toomre, D.Haber, B.Hindman
Status: needs improvements

Code: sensitivity kernels
A.Birch
Status: in development

Code: inversions
J.Toomre, D.Haber, B.Hindman
Status: needs improvements

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Time-Distance Helioseismology

Filtergrams → Doppler Velocity → Tracked Tiles Of Dopplergrams → Time-distance Cross-covariance function → Wave travel times

- Full-disk velocity, v(r,Θ,Φ), And sound speed, c_s(r,Θ,Φ), Maps (0-30Mm)
- Carrington synoptic v and c_s maps (0-30Mm)
- High-resolution v and c_s maps (0-30Mm)
- Deep-focus v and c_s maps (0-200Mm)

Code: fastrack
R.Bogart, T.Duvall J.Zhao
Status: needs improvements (remapping issues)

Code: cross-covariance
T.Duvall J.Zhao
Status: needs improvements

Code: travel time fitting
T.Duvall J.Zhao S.Couvidat
Status: needs improvements

Code: sensitivity kernels
A.Kosovichev J.Zhao A.Birch
Status: needs improvements

Code: inversions
A.Kosovichev J.Zhao A.Birch S.Couvidat J.Toomre B.Hindman
Status: needs improvements

Code: deep-focus maps
T.Duvall A.Kosovichev J.Zhao
Status: needs substantial development

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Acoustic Holography

Filtergrams

Doppler Velocity

Tracked Tiles Of Dopplergrams

Egression and Ingression maps

Wave phase shift maps

Inversions

High-resolution v and $c_s$ maps (0-30Mm)

Far-side activity index

Code: fastrack
R. Bogart
D. Braun
C. Lindsay
Status: needs improvements (field-effect corrections)

Code: egression-ingression
D. Braun
C. Lindsay
Status: needs improvements

Code: phase shifts
D. Braun
C. Lindsay
Status: needs improvements (showglass corrections)

Code: sensitivity kernels
A. Birch
Status: in development

Code: holographic inversions
A. Birch
Status: in development

Code: Far-side imaging
P. Scherrer
C. Lindsay
D. Braun
Status: needs improvements
Magnetic Fields

Filtergrams

Stokes I,V

Stokes I,Q,U,V

Line-of-sight Magnetograms

Full-disk 10-min Averaged maps

Tracked Tiles

Vector Magnetograms Fast algorithm

Vector Magnetograms Inversion algorithm

Line-of-Sight Magnetic Field Maps

Vector Magnetic Field Maps

Coronal magnetic Field Extrapolations

Coronal and Solar wind models

Code: Stokes I,V, Lev0.5 V & LOS field
J. Schou
S. Tomczyk
Status: in development

Code: Stokes I,Q,U,V
J. Schou
S. Tomczyk
Status: in development
Line-of Sight Magnetic Field

Filtergrams

Stokes I,V

Line-of-sight Magnetograms

Line-of-Sight Magnetic Field Maps

Synoptic Magnetic Field Maps

Magnetic Footpoint Velocity Maps

Code: LOS magnetograms
J. Schou
S. Tomczyk
R. Ulrich (cross calib)
Status: in development

Code: LOS magnetic maps
T. Hoeksema
R. Bogart
Status: in development

Code: Synoptic Magnetic Field Maps
T. Hoeksema
X. Zhao
R. Ulrich
Status: in development

Code: Velocity Maps of Magnetic Footpoints
Y. Liu
G. Fisher
Status: in development

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