Example: plothmi

[Example Data] https://pan.baidu.com/s/1nwsIcDr (pswd: s5re)

```
# %load_ext autoreload
# %autoreload 2
%matplotlib notebook

from __future__ import division, print_function
from astropy.coordinates import SkyCoord
import astropy.units as u
import matplotlib.pyplot as plt
import numpy as np
import sunpy.map
from copy import deepcopy

import sys
sys.path.append('../modules')
from usr_sunpy import read_sdo, plot_map, plot_vmap, image_to_helio

print('Python version: %s' % sys.version.split('(')[0])
print('SunPy version: %s' % sunpy.__version__)
```

```
Python version: 3.6.5 |Anaconda, Inc.|
SunPy version: 0.9.0
```

Read data

```
fnames = ('data/hmi.B_720s.20150827_052400_TAI.field.fits',
          'data/hmi.B_720s.20150827_052400_TAI.inclination.fits',
          'data/hmi.B_720s.20150827_052400_TAI.azimuth.fits',
          'data/hmi.B_720s.20150827_052400_TAI.disambig.fits')
```

```
mapb = read_sdo(fnames[0])
mapi = read_sdo(fnames[1])
mapa = read_sdo(fnames[2])
mapd = read_sdo(fnames[3])
```

```
hmi.B_720s.20150827_052400_TAI.field.fits [4096, 4096]
hmi.B_720s.20150827_052400_TAI.inclination.fits [4096, 4096]
hmi.B_720s.20150827_052400_TAI.azimuth.fits [4096, 4096]
hmi.B_720s.20150827_052400_TAI.disambig.fits [4096, 4096]
```

```
# Disambiguate
mapa.data[mapd.data > 3] += 180.
```

```
mapbx = deepcopy(mapb)
mapby = deepcopy(mapb)
mapbz = deepcopy(mapb)
mapbx.data[:] = mapb.data * np.sin(np.deg2rad(mapi.data)) * np.cos(np.deg2rad(mapa.data + 27
0.))
mapby.data[:] = mapb.data * np.sin(np.deg2rad(mapi.data)) * np.sin(np.deg2rad(mapa.data + 27
0.))
mapbz.data[:] = mapb.data * np.cos(np.deg2rad(mapi.data))
```

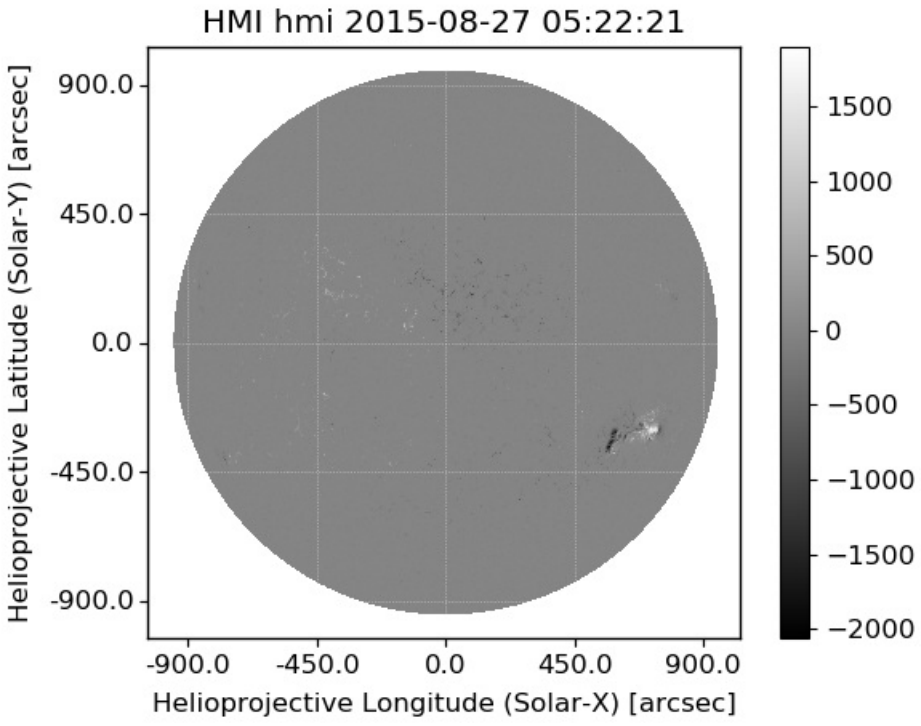
```
# Rotate(CCW)
order = 1
# Suppress metadata warnings if sunpy >= 0.9.0:
mapbx.meta['hgln_obs'] = 0.; mapby.meta['hgln_obs'] = 0.; mapbz.meta['hgln_obs'] = 0.
print('Correcting image axes...')
# Suppress warnings of NaNs:
with np.errstate(invalid='ignore'):
    mapbx = mapbx.rotate(order=order)
    mapby = mapby.rotate(order=order)
    mapbz = mapbz.rotate(order=order)
print('Rotation angle = %f deg (CCW)' % -mapb.meta['crota2'])
```

```
Correcting image axes...
Rotation angle = -180.013600 deg (CCW)
```

```
# Check the center ('crpix1', 'crpix2') - First pixel is number 1.
pcenter = ((mapbz.meta['crpix1'] - 1) * u.pix, (mapbz.meta['crpix2'] - 1) * u.pix)
center = mapbz.pixel_to_world(*pcenter)
print('[Image_center] (%.3f, %.3f) pixel = (%7.4f, %7.4f) arcsec  (lon, lat) = (%8.5f, %8.5f
) deg' %
      ((mapbz.dimensions.x.value-1.)/2., (mapbz.dimensions.y.value-1.)/2.,
        mapbz.center.Tx.value, mapbz.center.Ty.value,
        mapbz.center.heliographic_stonyhurst.lon.value, mapbz.center.heliographic_stonyhurst
.lat.value))
print('[ Disk_center] (%.3f, %.3f) pixel = (%7.4f, %7.4f) arcsec  (lon, lat) = (%8.5f, %8.5f
) deg' %
      (pcenter[0].value, pcenter[1].value, center.Tx.value, center.Ty.value,
       center.heliographic_stonyhurst.lon.value, center.heliographic_stonyhurst.lat.value))
print('[ Observation] (lon, lat, radius) = (%g deg, %g deg, %g m)' %
      (mapbz.heliographic_longitude.value, mapbz.heliographic_latitude.value, mapbz.observer
_coordinate.radius.value))
```

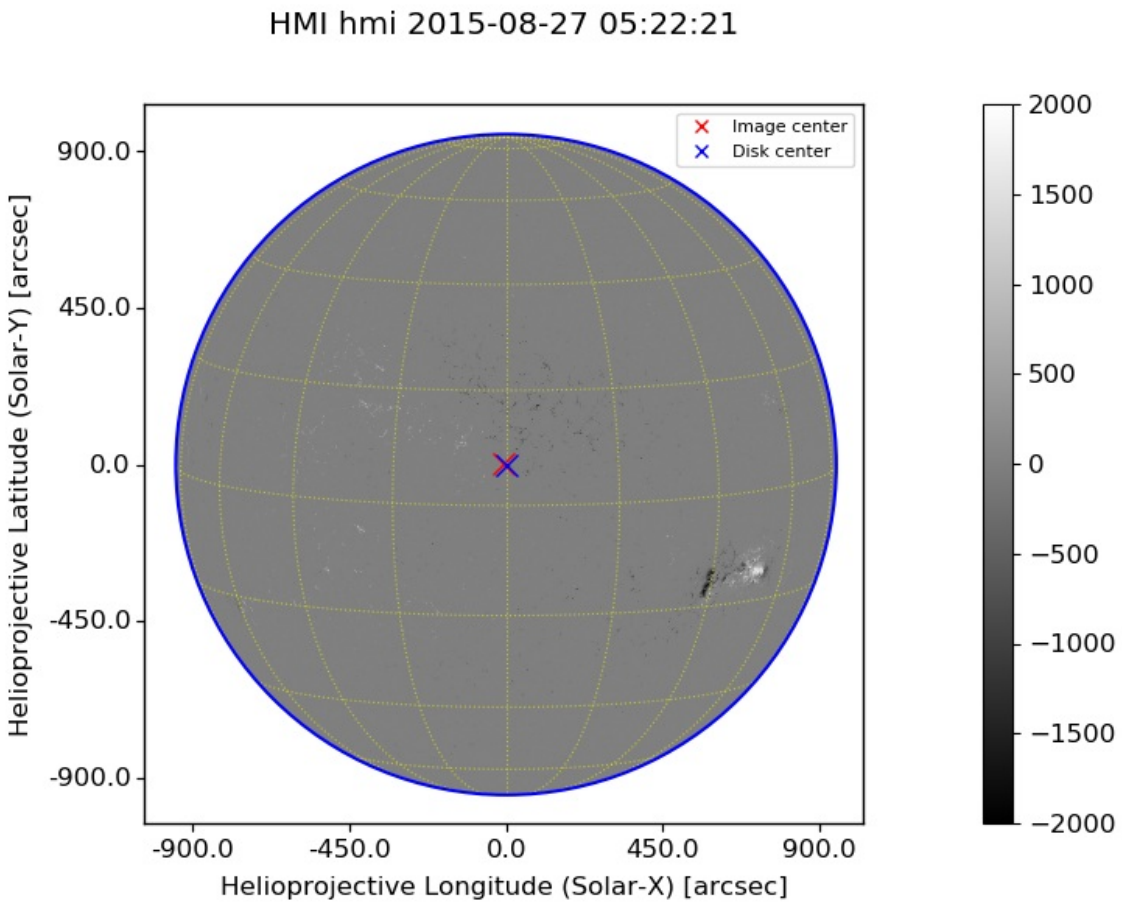
```
[Image_center] (2048.500, 2048.500) pixel = (-7.1497,  2.8244) arcsec  (lon, lat) = (-0.4329
2,  7.25845) deg
[ Disk_center] (2063.175, 2043.400) pixel = ( 0.0000,  0.0000) arcsec  (lon, lat) = ( 0.0000
0,  7.08900) deg
[ Observation] (lon, lat, radius) = (0 deg, 7.089 deg, 1.51197e+11 m)
```

```
# A quick look
mapbz.peek()
```



Plot

```
fig1 = plt.figure(figsize=(8, 6), dpi=100)
ax1 = fig1.add_subplot(111, projection=mapbz)
plot_map(ax1, mapbz)

# Properties
mapbz.draw_grid(axes=ax1, grid_spacing=20*u.deg, color='yellow', linestyle=':')
mapbz.draw_limb(axes=ax1, color='b', linewidth=1.5)
ax1.plot_coord(mapbz.center, 'rx', markersize=10, linewidth=1.5, label='Image center')
ax1.plot_coord(center, 'bx', markersize=10, linewidth=1.5, label='Disk center')
# ax1.set_title(mapbz.latex_name, y=1.05);
plt.clim(-2000., 2000.)
ax1.legend(loc='upper right', fontsize=8, markerscale=0.6);
# fig1.savefig('example_plothmi_disk.png', dpi=200)
```

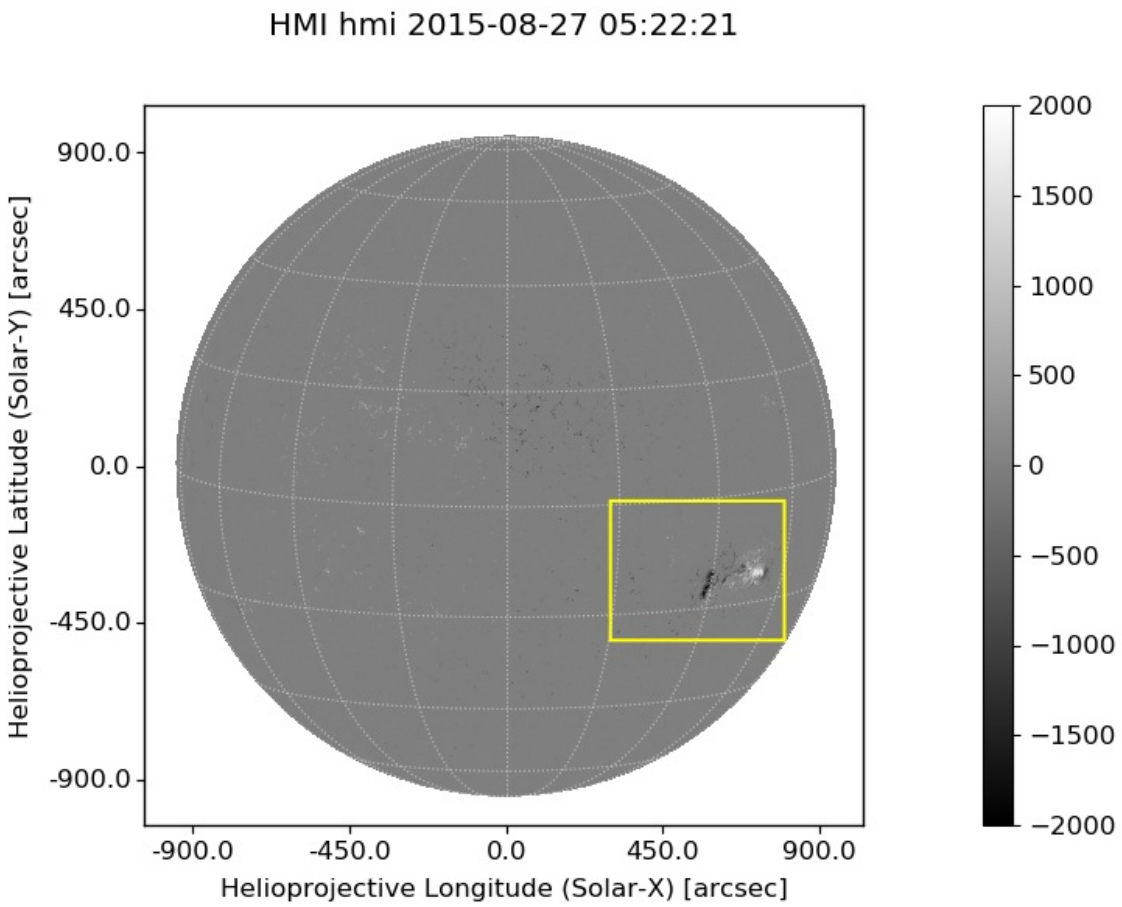


Submap

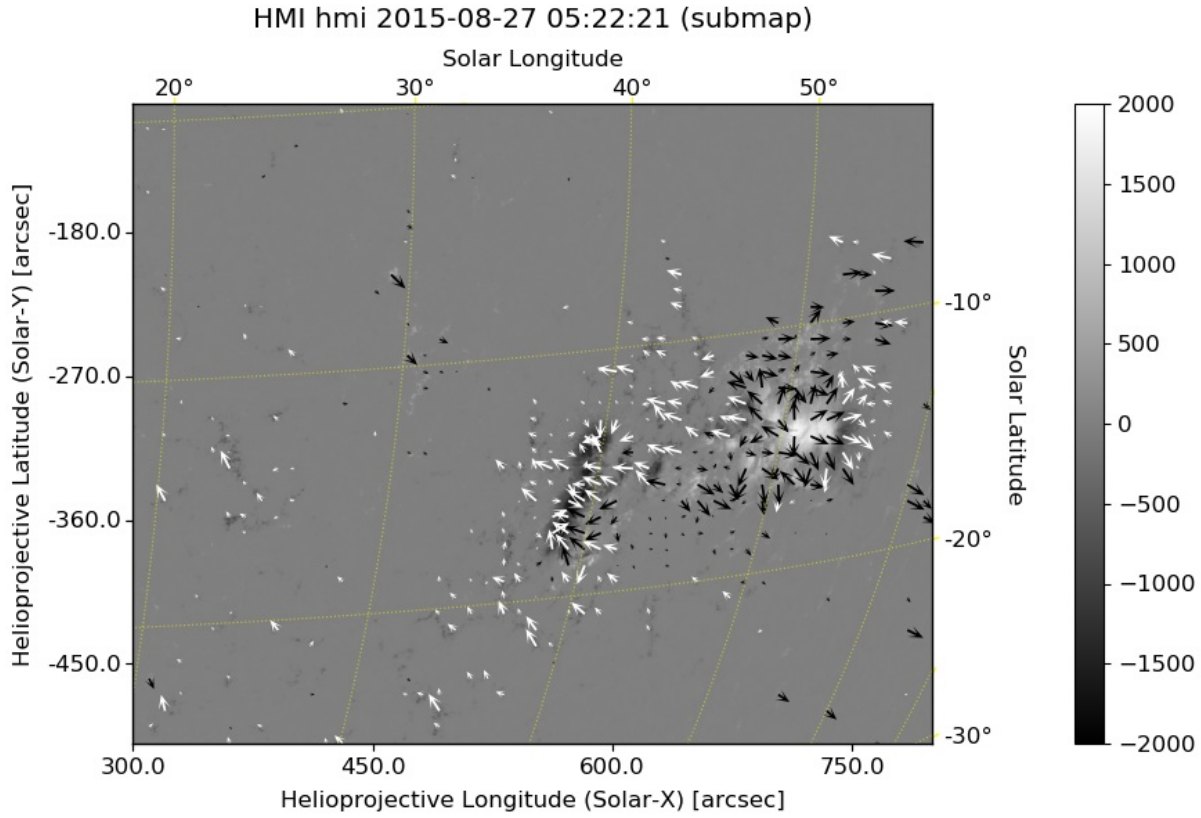
```
xmin, xmax = (300., 800.)  # arcsec
ymin, ymax = (-500., -100.)

bl = SkyCoord(xmin*u.arcsec, ymin*u.arcsec, frame=mapbz.coordinate_frame)
tr = SkyCoord(xmax*u.arcsec, ymax*u.arcsec, frame=mapbz.coordinate_frame)
smapbx = mapbx.submap(bl, tr)
smapby = mapby.submap(bl, tr)
smapbz = mapbz.submap(bl, tr)
print('Submap: %s = %s arcsec' % (tuple(map(int, u.Quantity(smapbz.dimensions).value)), ((xm
in, xmax), (ymin, ymax))))
```

```
Submap: (992, 793) = ((300.0, 800.0), (-500.0, -100.0)) arcsec
```

```
fig1 = plt.figure(figsize=(8, 6), dpi=100)
ax1 = fig1.add_subplot(111, projection=mapbz)
plot_map(ax1, mapbz)

# Properties
mapbz.draw_grid(axes=ax1, grid_spacing=20*u.deg, color='w', linestyle=':')
mapbz.draw_rectangle(bl, (xmax-xmin)*u.arcsec, (ymax-ymin)*u.arcsec, axes=ax1, color='yellow
', linewidth=1.5)
# ax1.set_title(mapbz.latex_name, y=1.05);
plt.clim(-2000., 2000.)
```



```
iskip, jskip = (20, 20)

fig2 = plt.figure(figsize=(9, 6), dpi=100)
ax2 = fig2.add_subplot(111, projection=smapbz)
im2 = plot_map(ax2, smapbz)
plot_vmap(ax2, smapbx, smapby, smapbz, iskip=iskip, jskip=jskip, cmin=20., vmax=500., cmap='
binary',
          scale_units='xy', scale=1/0.05, minlength=0.02)

# Properties
smapbz.draw_grid(axes=ax2, grid_spacing=10*u.deg, color='yellow', linestyle=':')
ax2.set_title(mapbz.latex_name+' (submap)', y=1.1);
plt.subplots_adjust(right=0.8)  # Reduce the value to move the colorbar to the right
im2.set_clim(-2000., 2000.)
```



Without disambiguation:

```
iskip, jskip = (20, 20)

fig2 = plt.figure(figsize=(9, 6), dpi=100)
ax2 = fig2.add_subplot(111, projection=smapbz)
im2 = plot_map(ax2, smapbz)
plot_vmap(ax2, smapbx, smapby, smapbz, iskip=iskip, jskip=jskip, cmin=20., vmax=500., cmap='
binary',
          scale_units='xy', scale=1/0.05, minlength=0.02)

# Properties
smapbz.draw_grid(axes=ax2, grid_spacing=10*u.deg, color='yellow', linestyle=':')
ax2.set_title(mapbz.latex_name+' [no disambiguation] (submap)', y=1.1);
plt.subplots_adjust(right=0.8)  # Reduce the value to move the colorbar to the right
im2.set_clim(-2000., 2000.)
```