

Community GOES-R Image Processing with *heregoes*

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2026-05-21

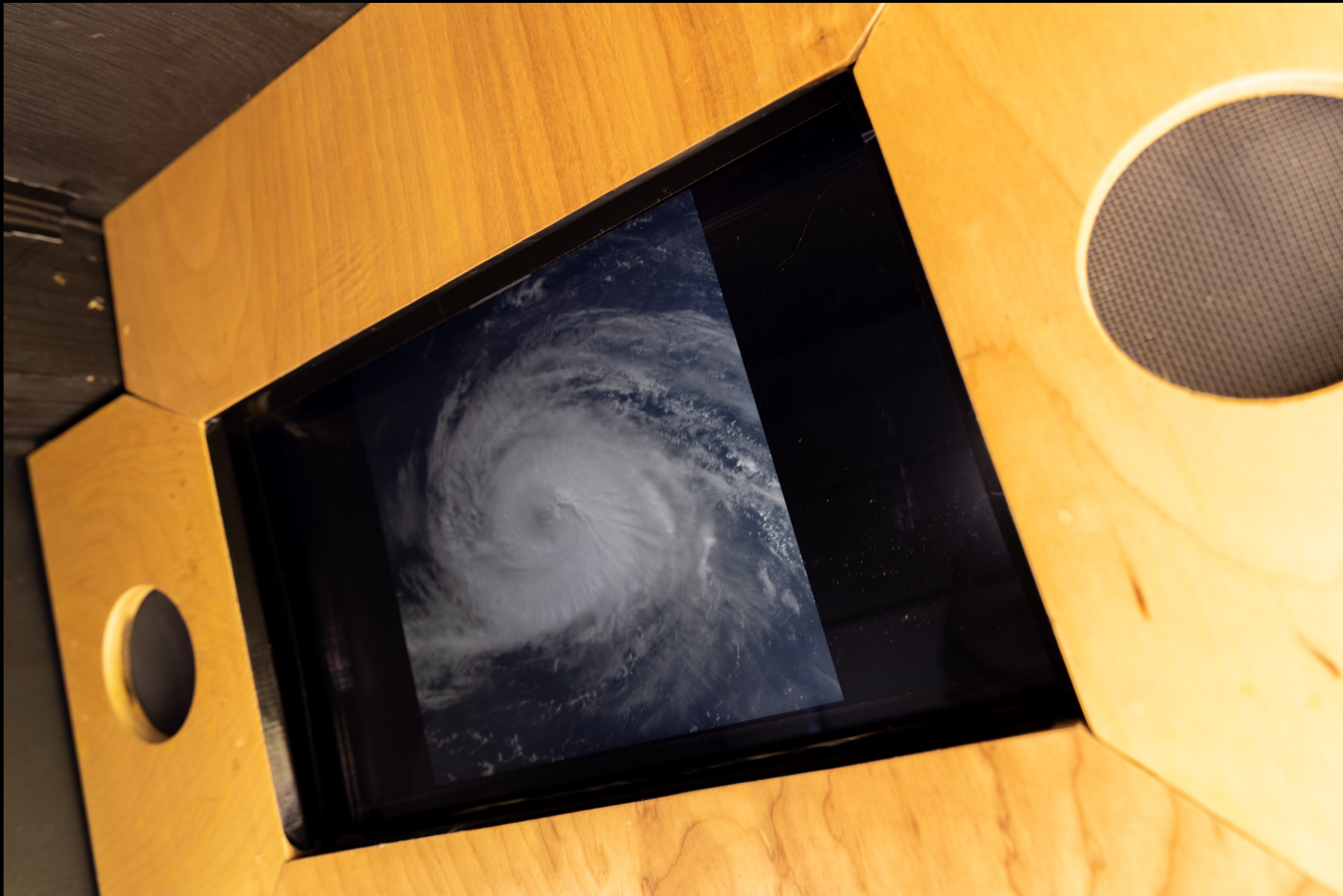
Here GOES Radiotelescope (2020)

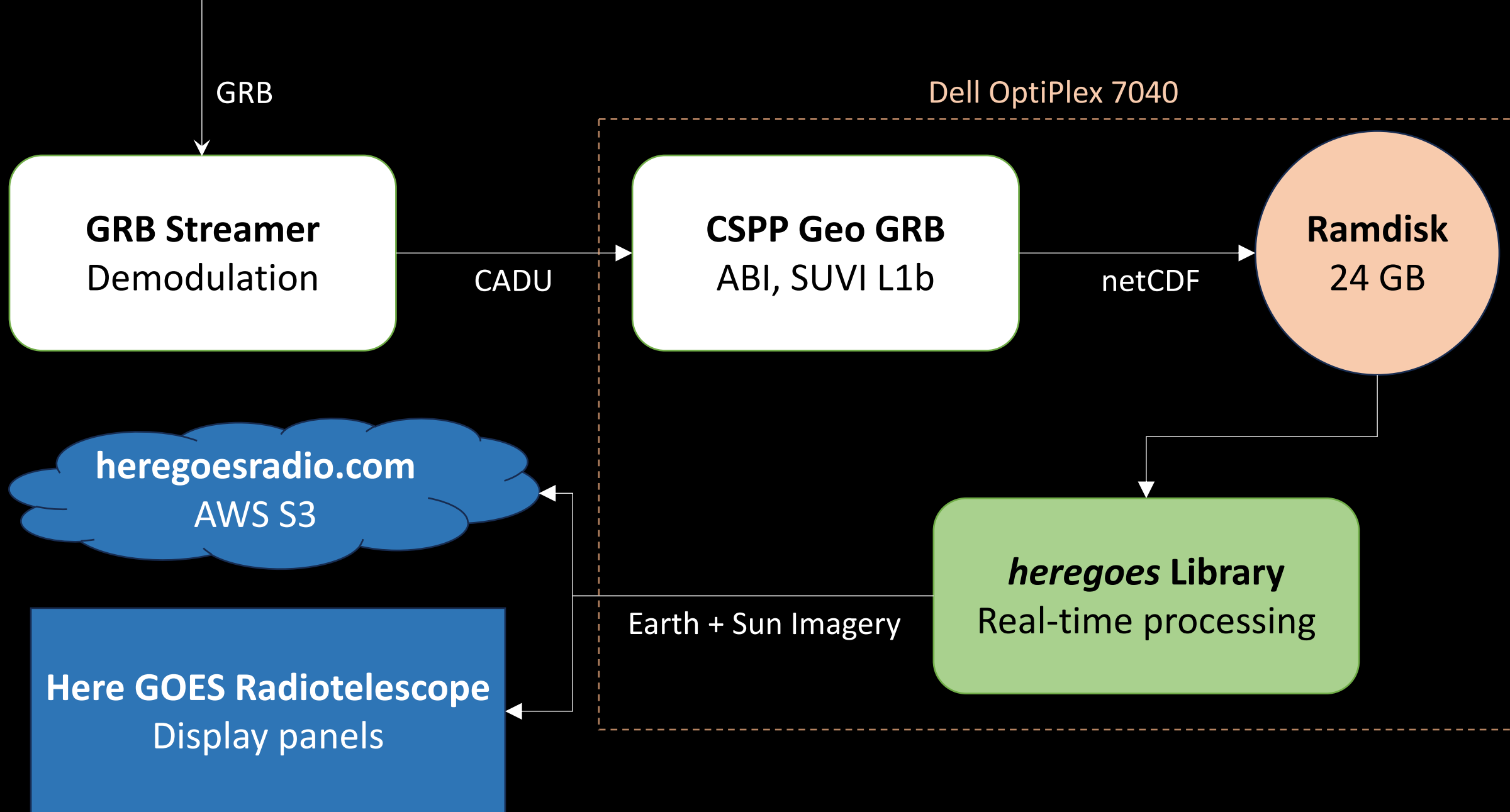
Here GOES Radiotelescope is...

- A sculptural installation at the Wave Farm arts center in upstate New York
- A collaboration with artist Heidi Neilson
- A GRB receive station for GOES-19









heregoes at SSEC

- Solar imagery (SUVI) from GRB for Geo Browser
- In production since 2023

 CIMSS Satellite Blog

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Geo-Browser Adds SUVI Images

By [Tim Schmit](#) • 13 July 2023



SSEC Geostationary Satellite Imagery

Satellite / Product:
SUVI GOES-19

End date / time:
14:57:00 UTC, 4 Feb

View (image / animation):
Animation: 120 images

Geographic Coverage:
Sun

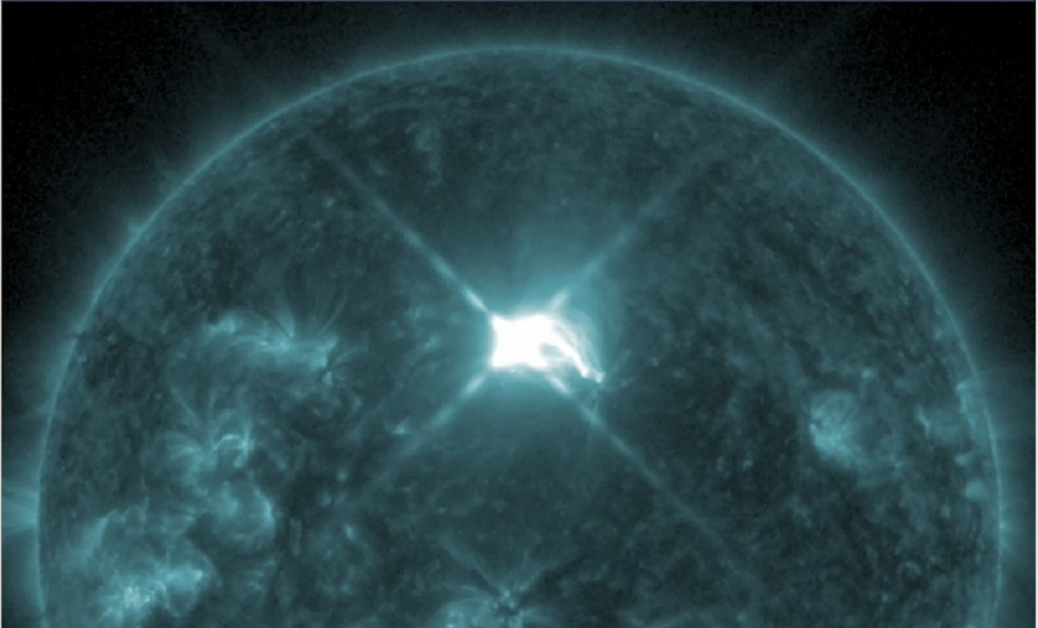
Channel:
Fe131 (131 Å)

Download:

SSEC Geostationary Satellite Imagery

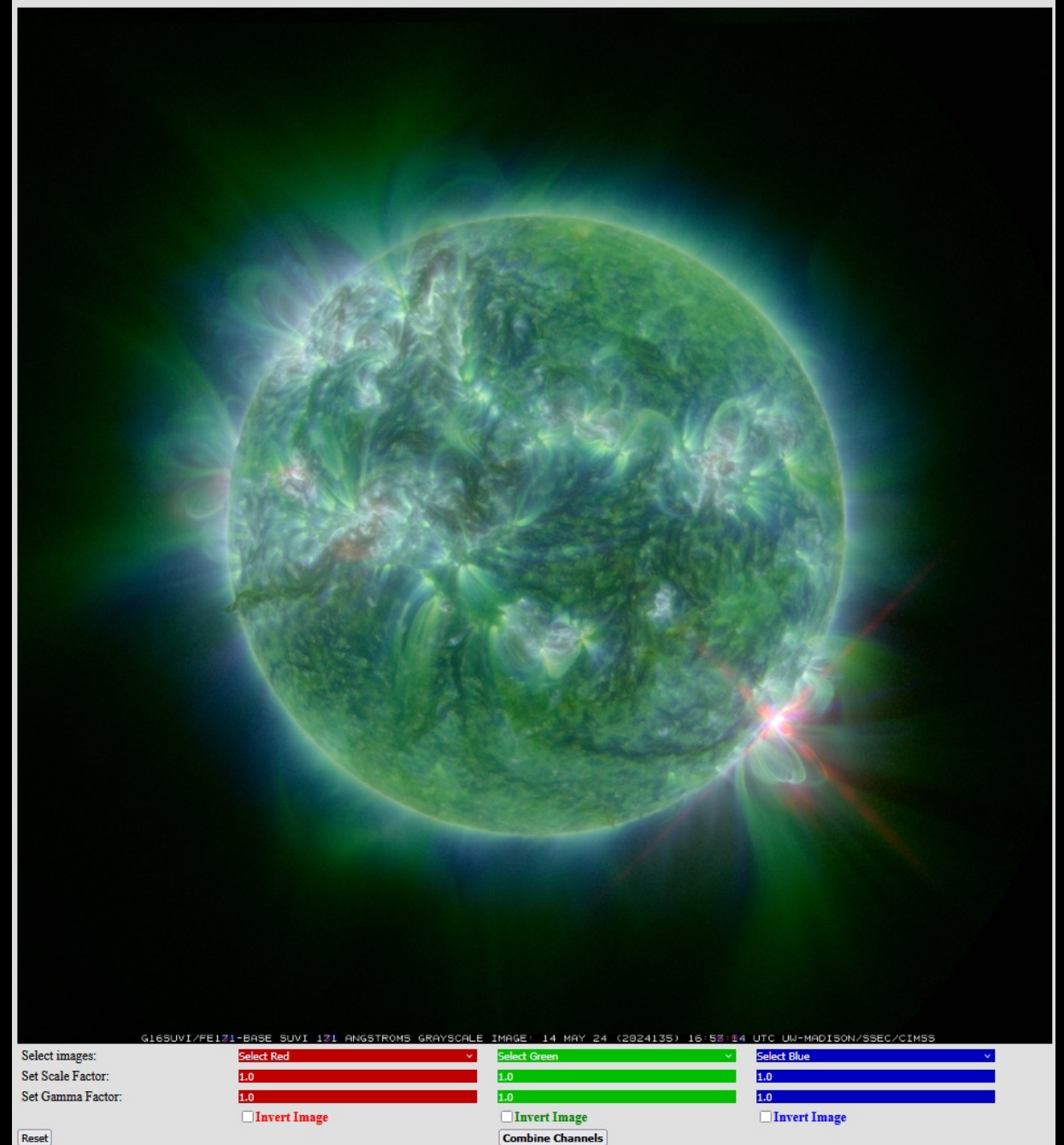
stop < > rock slow fast

2026-Feb-4 12:17 UTC (80/120)



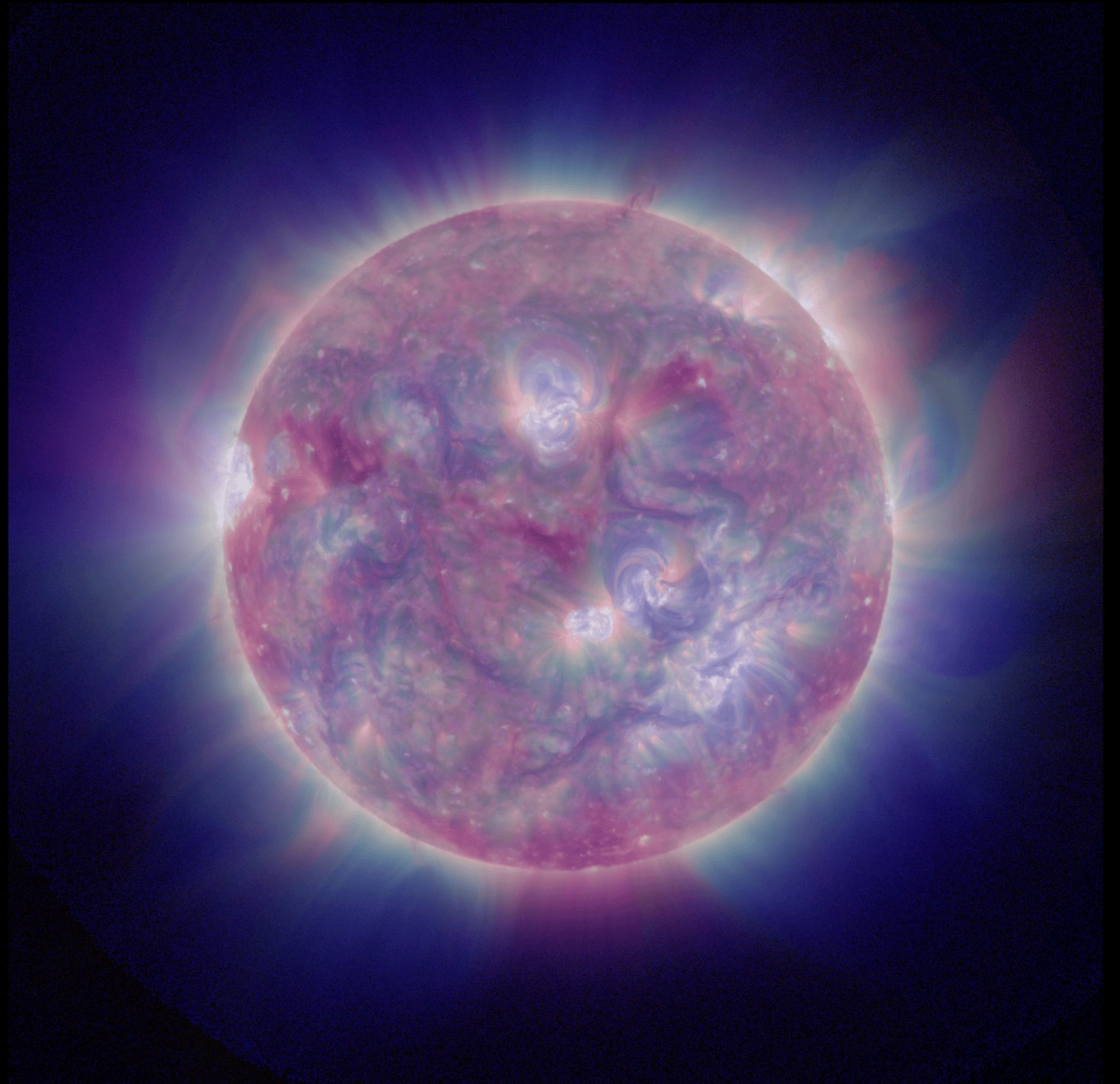
heregoes at SSEC

- SUVI RGB teaching tool
- http://cimss.ssec.wisc.edu/goes/webapps/satrgb/satrgb_suvi_grb_GOESEast_SSEC.html



SUVI RGB

```
from heregoes.image import SUVIImage, SUVIRGB  
  
red = SUVIImage("OR_SUVI-L1b-Fe171[...].nc")  
  
green = SUVIImage("OR_SUVI-L1b-Fe195[...].nc")  
  
blue = SUVIImage("OR_SUVI-L1b-Fe284[...].nc")  
  
rgb = SUVIRGB(red, green, blue)
```



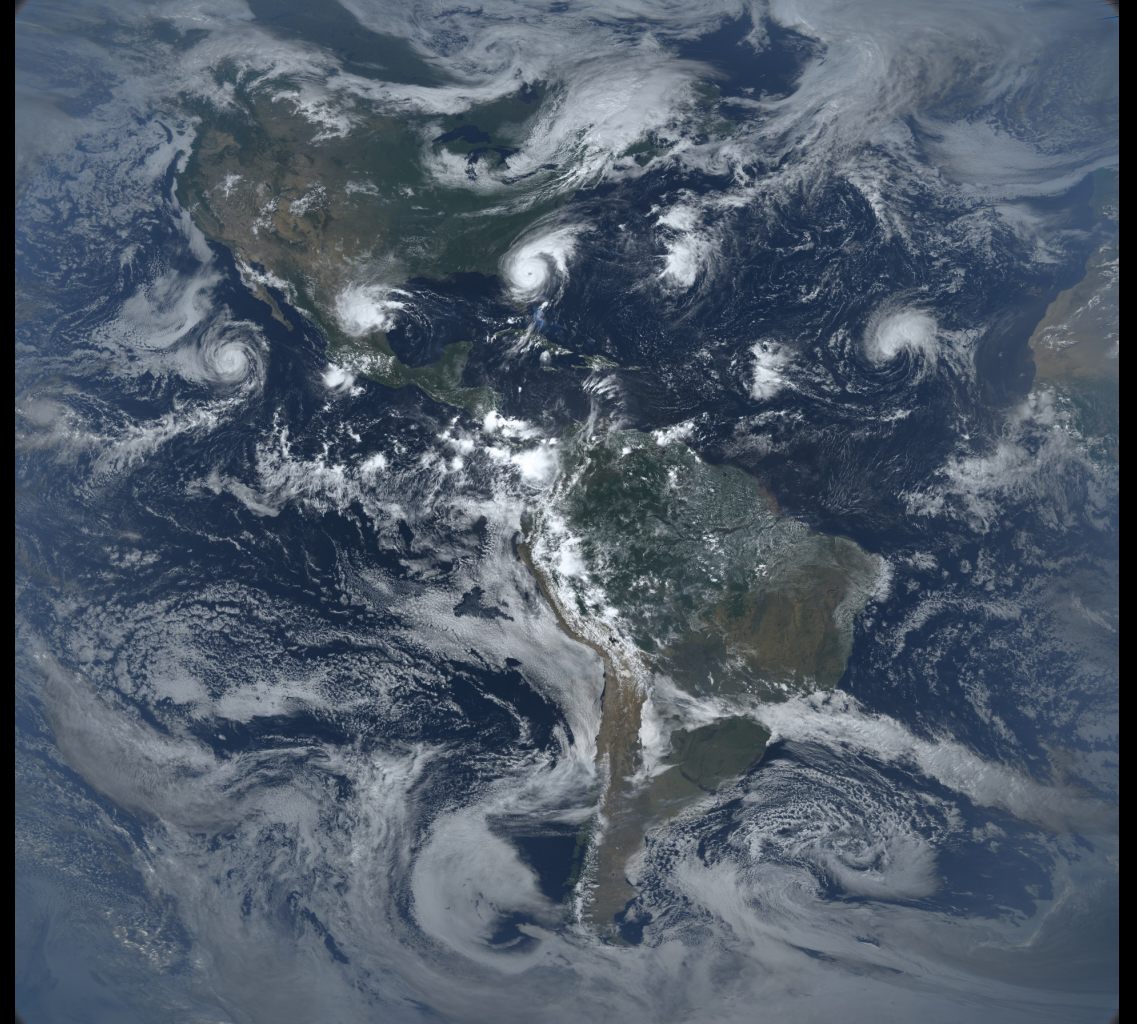
Advanced Baseline Imager

- Render Cloud Moisture Imagery (CMI) and RGB

```
from heregoes.image import ABIImage, ABINaturalRGB

img = ABIImage("OR_ABI-L1b-Rad[...].nc", gamma=2/3)
img = ABINaturalRGB(
    c02_nc, c03_nc, c01_nc,
    upscale=True,
)

img.save(ext=".jpg")
img.save(ext=".png")
img.resample2cog("abi-cloud-optimized-geotiff.tiff")
```



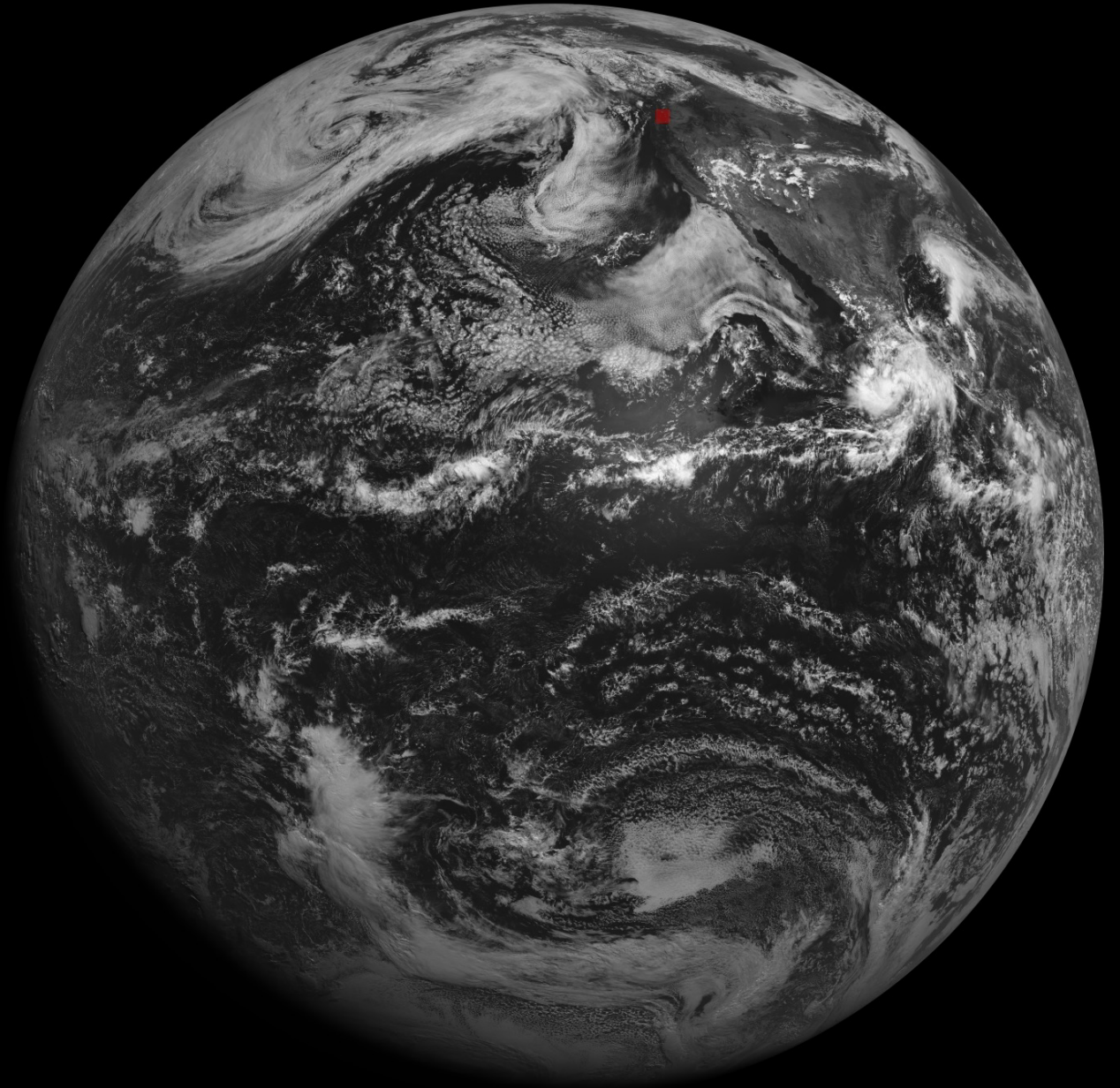
ABI Navigation Layer

- Support for L1b and L2 products
- Transparent access to metadata
- Lat/lon subsetting

```
from heregoes.image import ABIImage

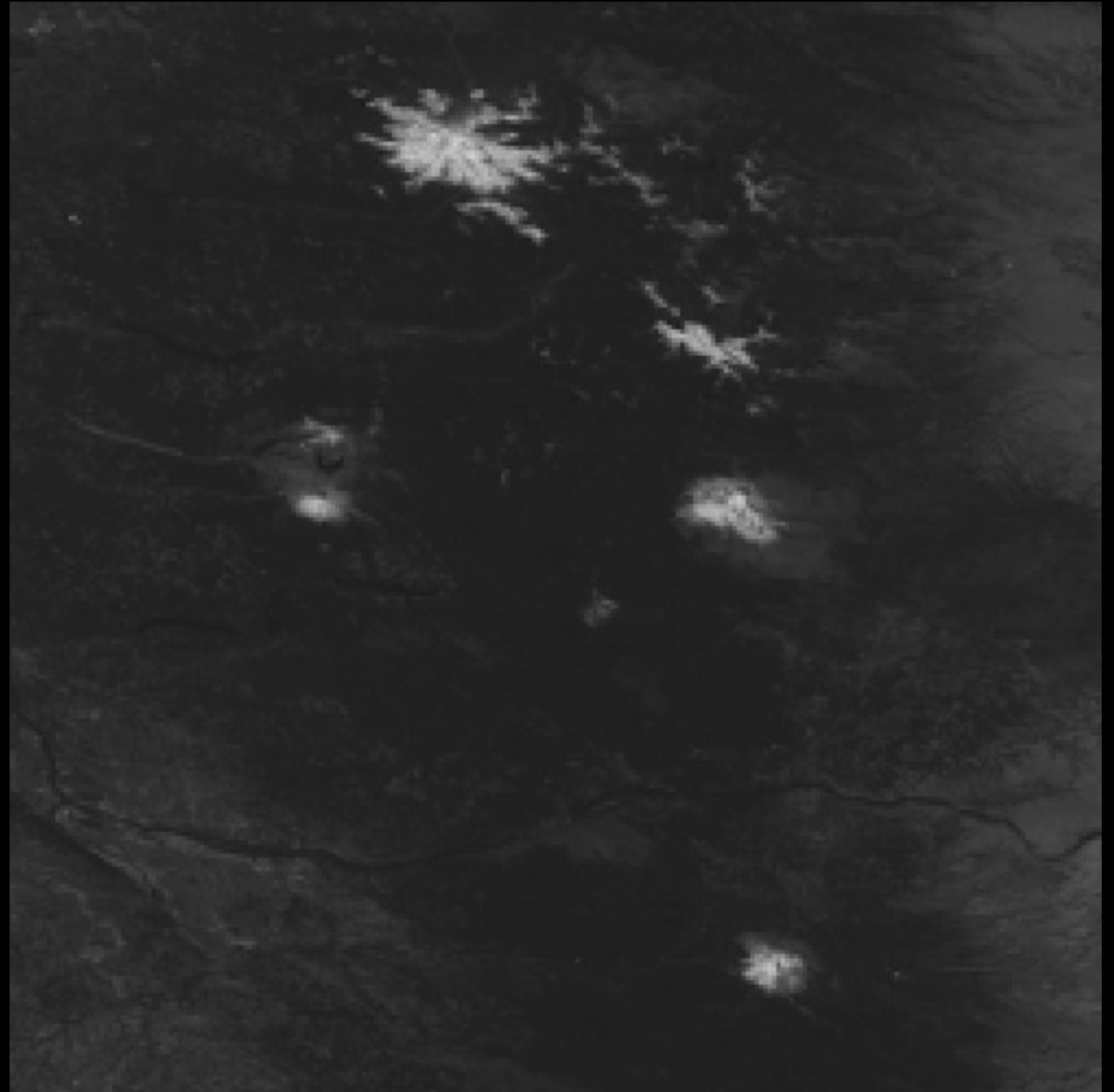
img = ABIImage("OR_ABI-L1b-Rad[...].nc")

img.y_rad, img.x_rad #image coordinates
img.lat_deg, img.lon_deg #Earth coordinates
img.area_m2 #effective ground coverage
img.sun_za, img.sun_az #Sun look angles
img.sat_za, img.sat_az #sat look angles
```



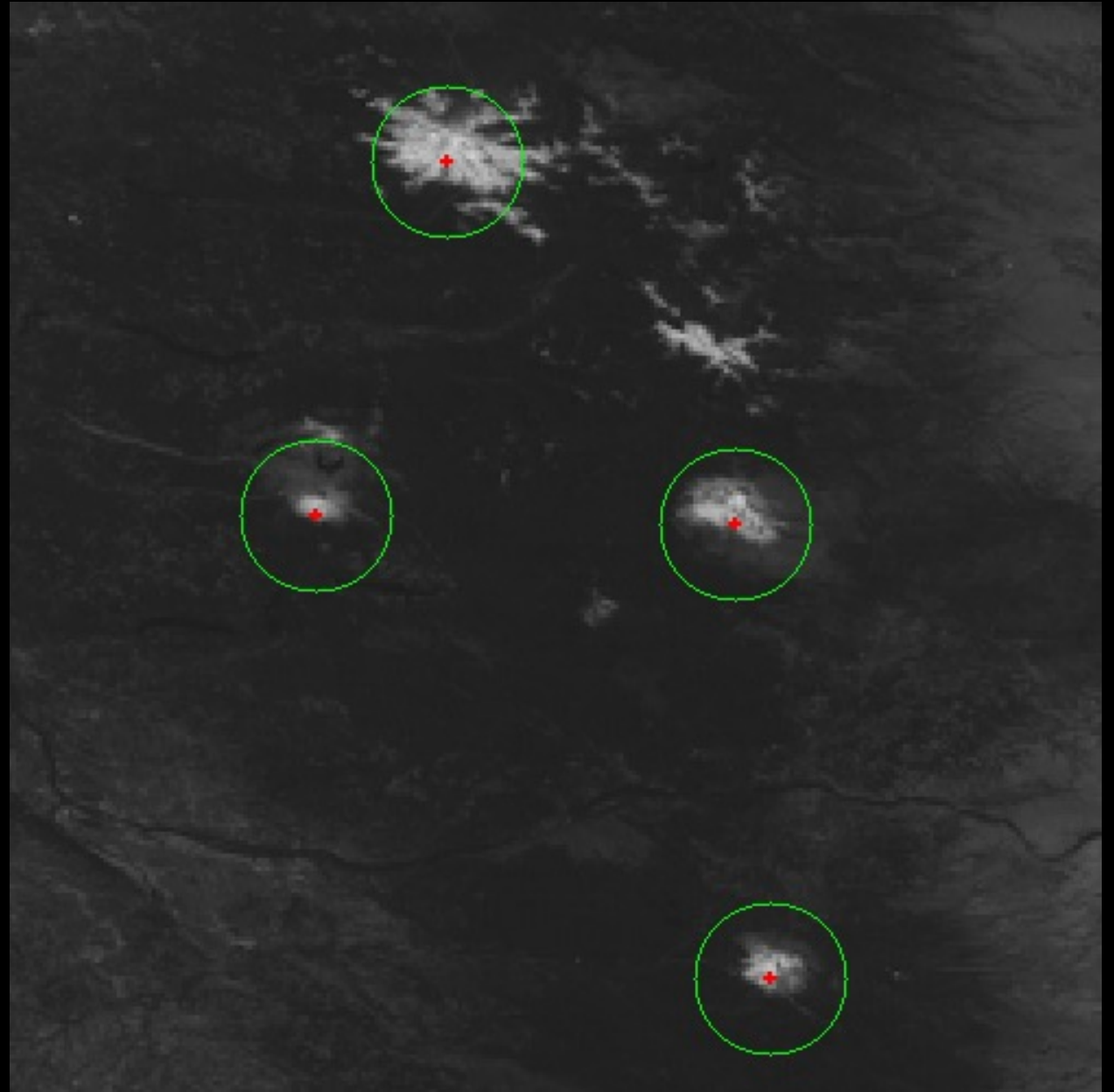
Terrain parallax

- Cascade mountain range in Pacific NW US
- Off-nadir mountains tilt away from GEO perspective



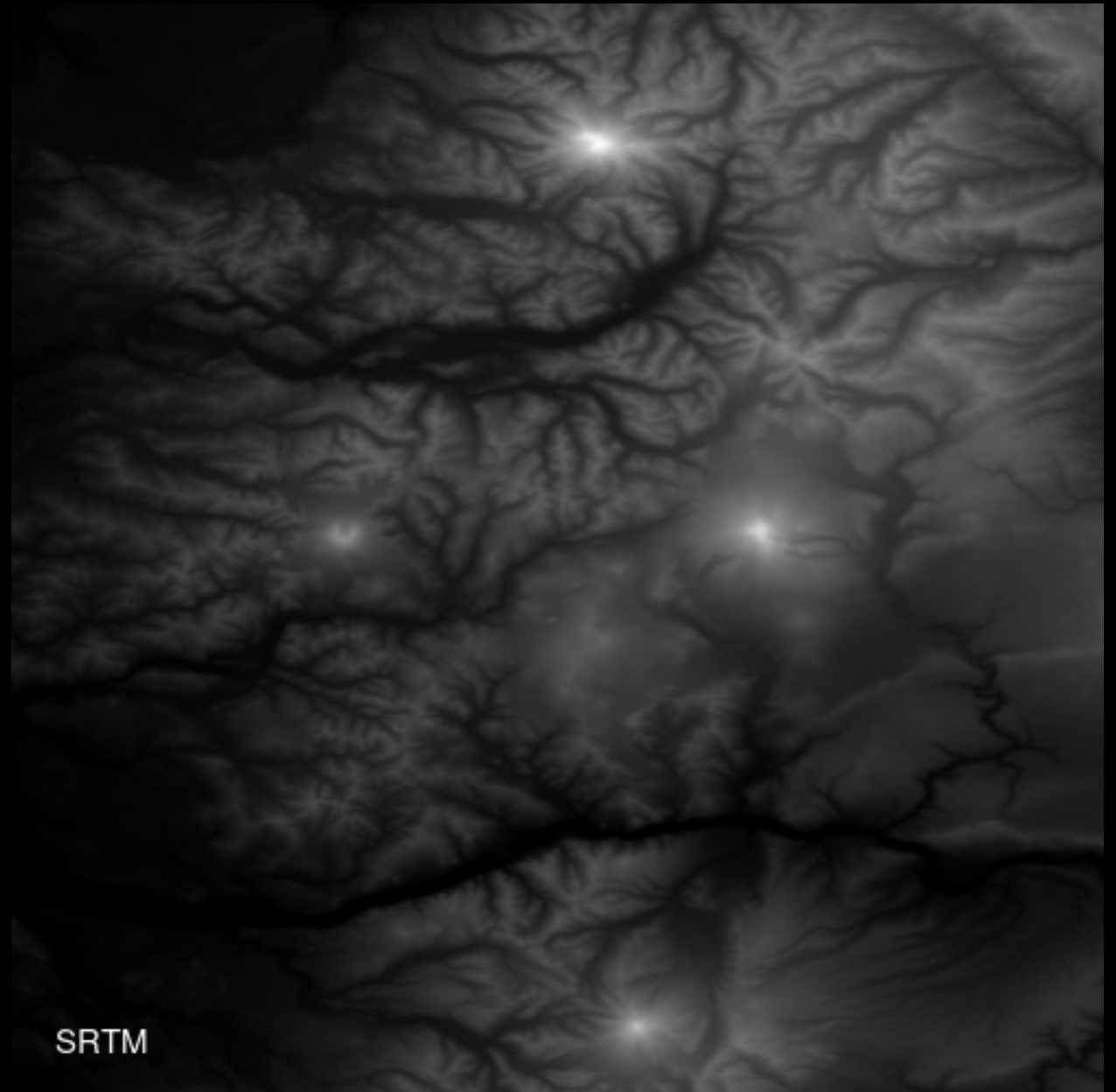
Geolocation error

- Geolocation of the mountain peaks is off by ~3-6 km
- *heregoes* can help!



Ancillary height data

- Shuttle Radar Topography Mission
- Import SRTM heights to correct for terrain parallax

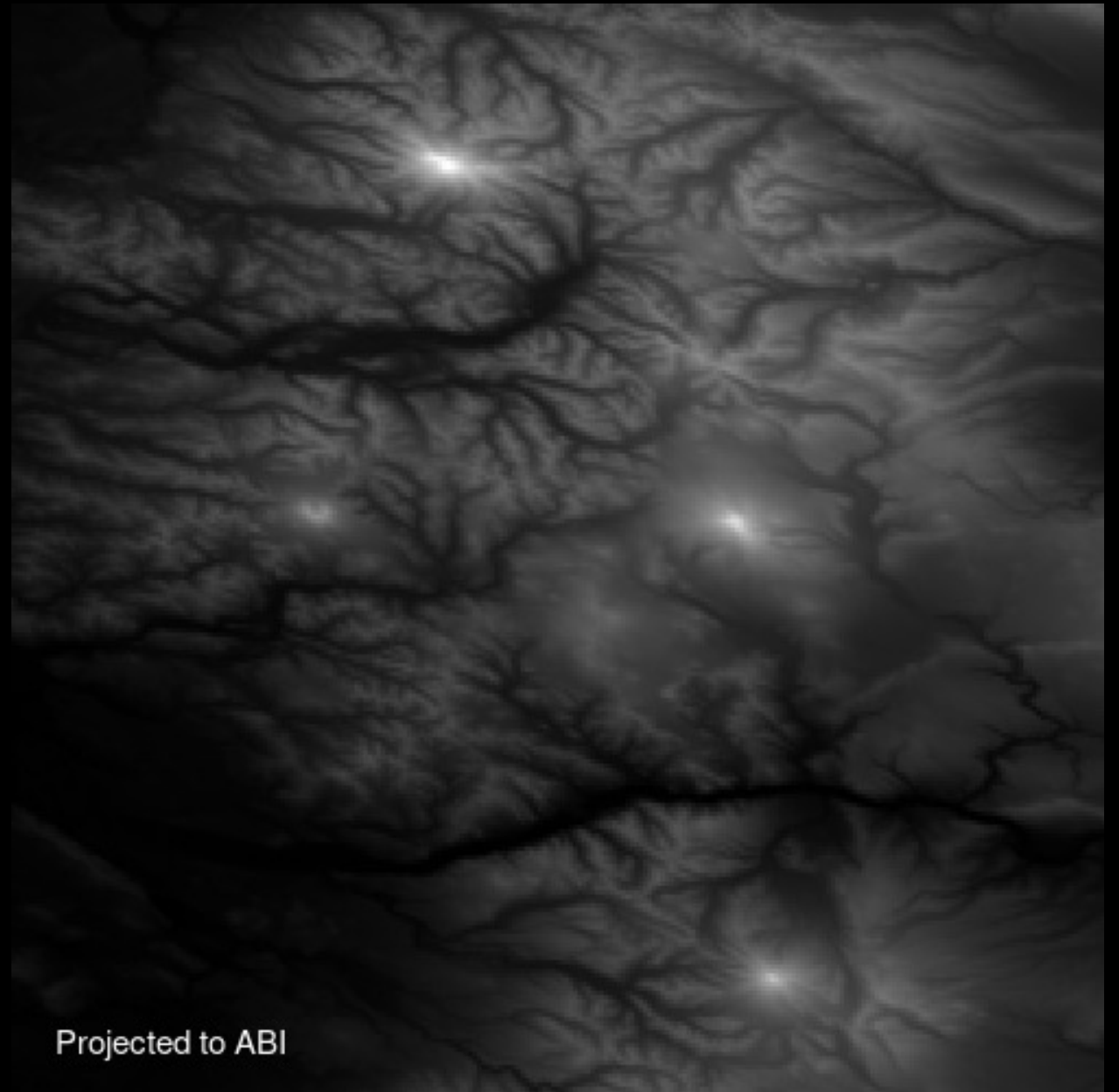


Reproject SRTM

```
from heregoes.projection import ABIProjection

abi_projection = ABIProjection(
    abi_nc_path,
    lat_bounds=lat_bounds,
    lon_bounds=lon_bounds,
    height_m=(ul_height, lr_height),
)

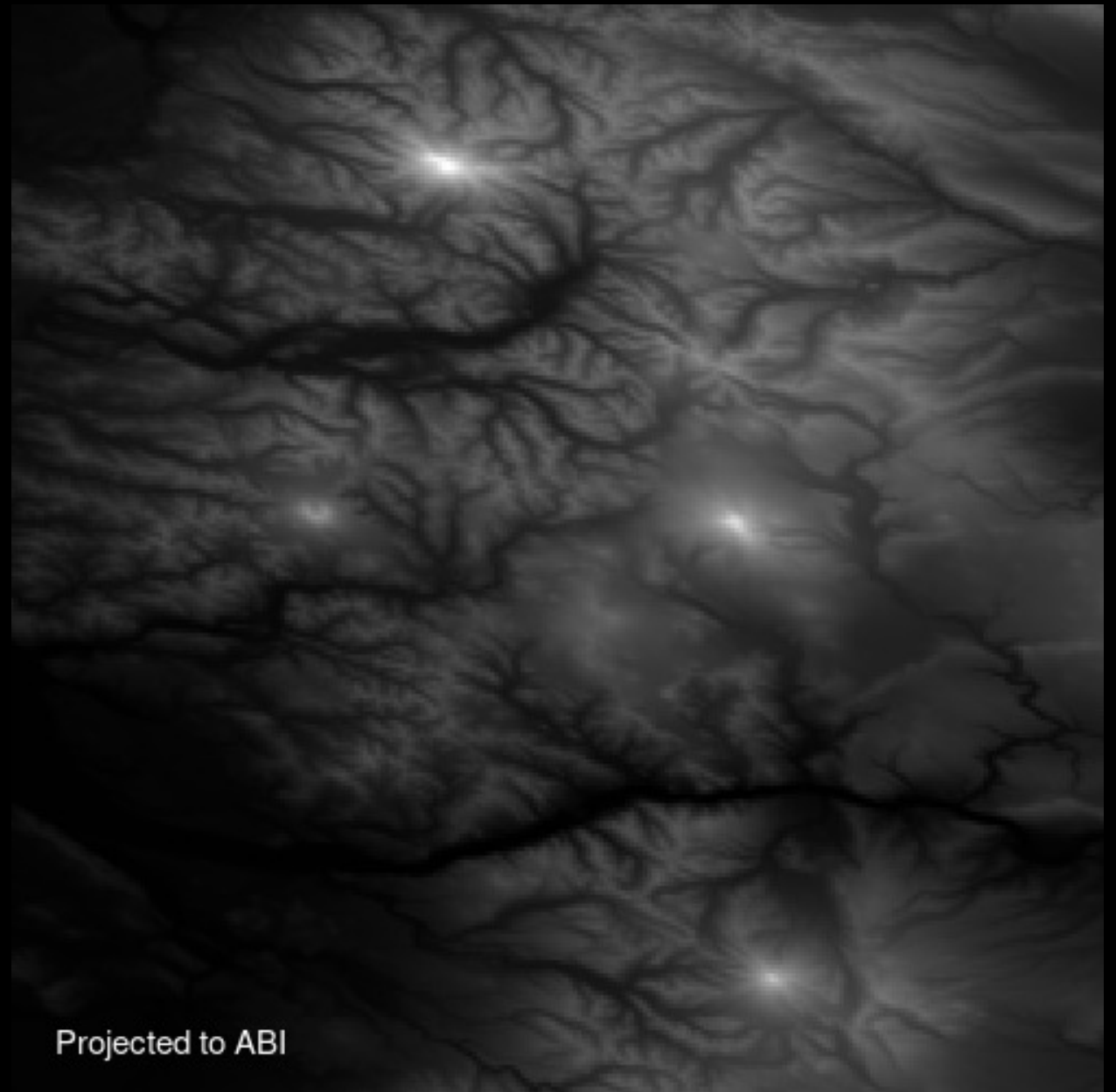
resampled_srtm = abi_projection.resample2abi(
    srtm_heights,
    lat_bounds=srtm_lat_bounds,
    lon_bounds=srtm_lon_bounds,
    resample_algo="max",
)
```



Nav correction

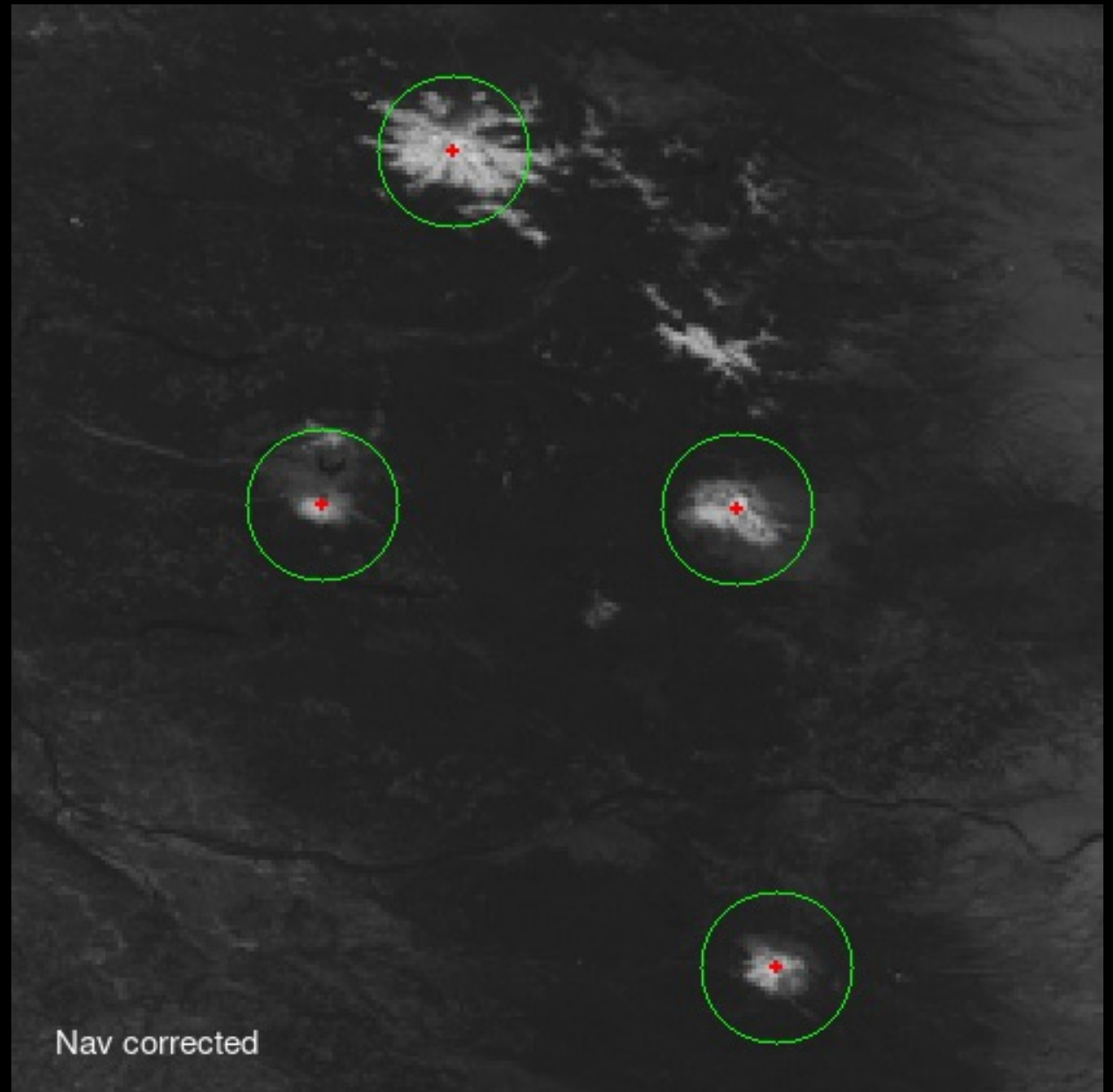
```
from heregoes.image import ABIImage

img_with_corrected_nav = ABIImage(
    abi_nc_path,
    gamma=abi_gamma,
    lat_bounds=abi_projection.lat_deg,
    lon_bounds=abi_projection.lon_deg,
    height_m=resampled_srtm,
    resample_nav=True,
)
```



Nav corrected

- Geolocation is corrected for terrain parallax
- *heregoes* recovers the parallax displacement vector with:
 1. Indirect ray-tracing
 2. Binary search ($O(\log n)$)

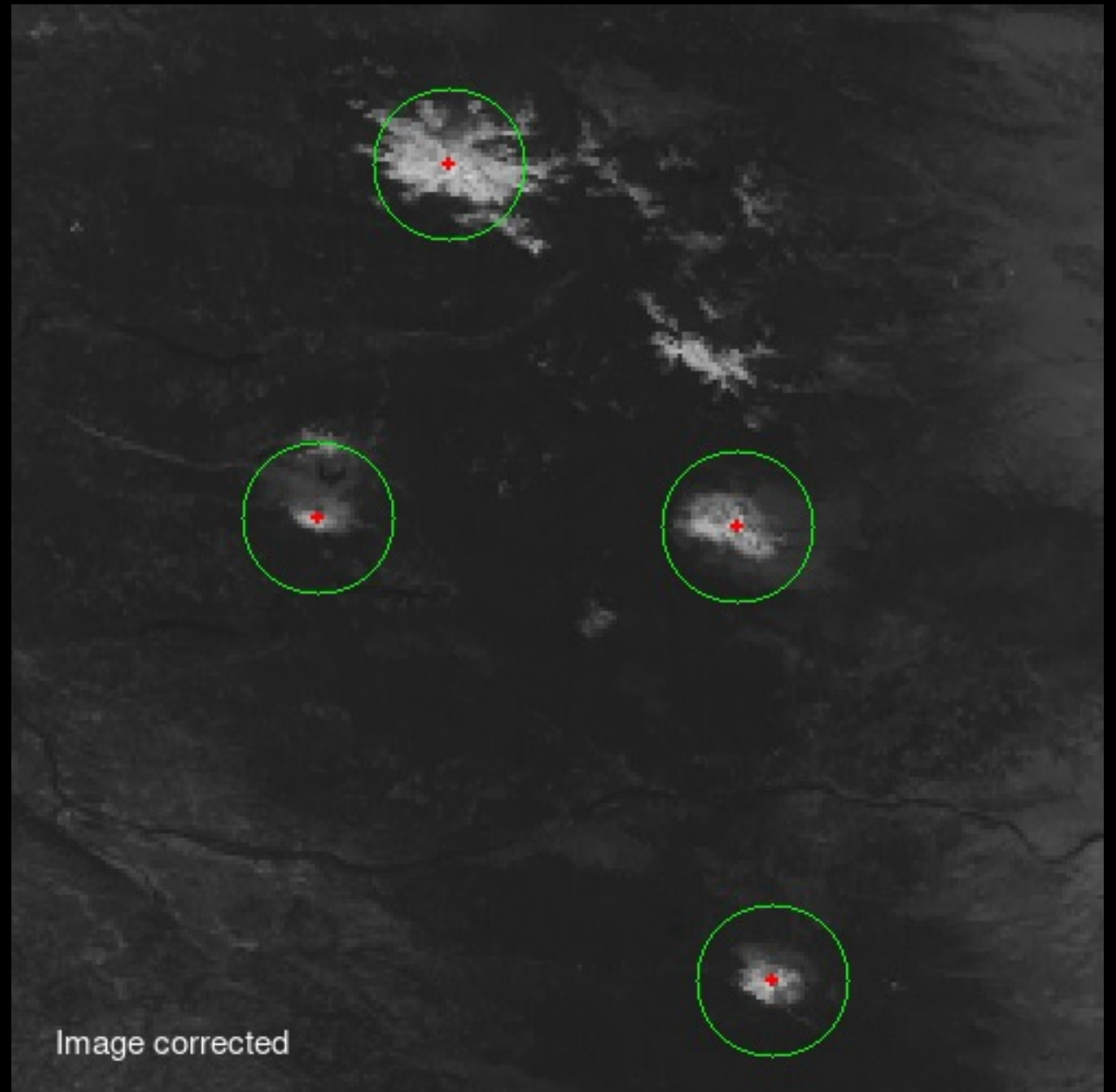


Orthorectification

- Corrects only elevated pixels, maintaining GEO projection

```
from heregoes.image import ABIImage

orthorectified_img = ABIImage(
    abi_nc_path,
    gamma=abi_gamma,
    lat_bounds=abi_projection.lat_deg,
    lon_bounds=abi_projection.lon_deg,
    height_m=resampled_srtm,
    resample_nav=False,
)
```



Unit testing for nav routines

- Hand-tested terrain correction against shorelines and ground features
- Needed bright targets to track automatically through transformations:
 - Reflections from greenhouses, solar power plants, slanted glass roofs...

```
import numpy as np

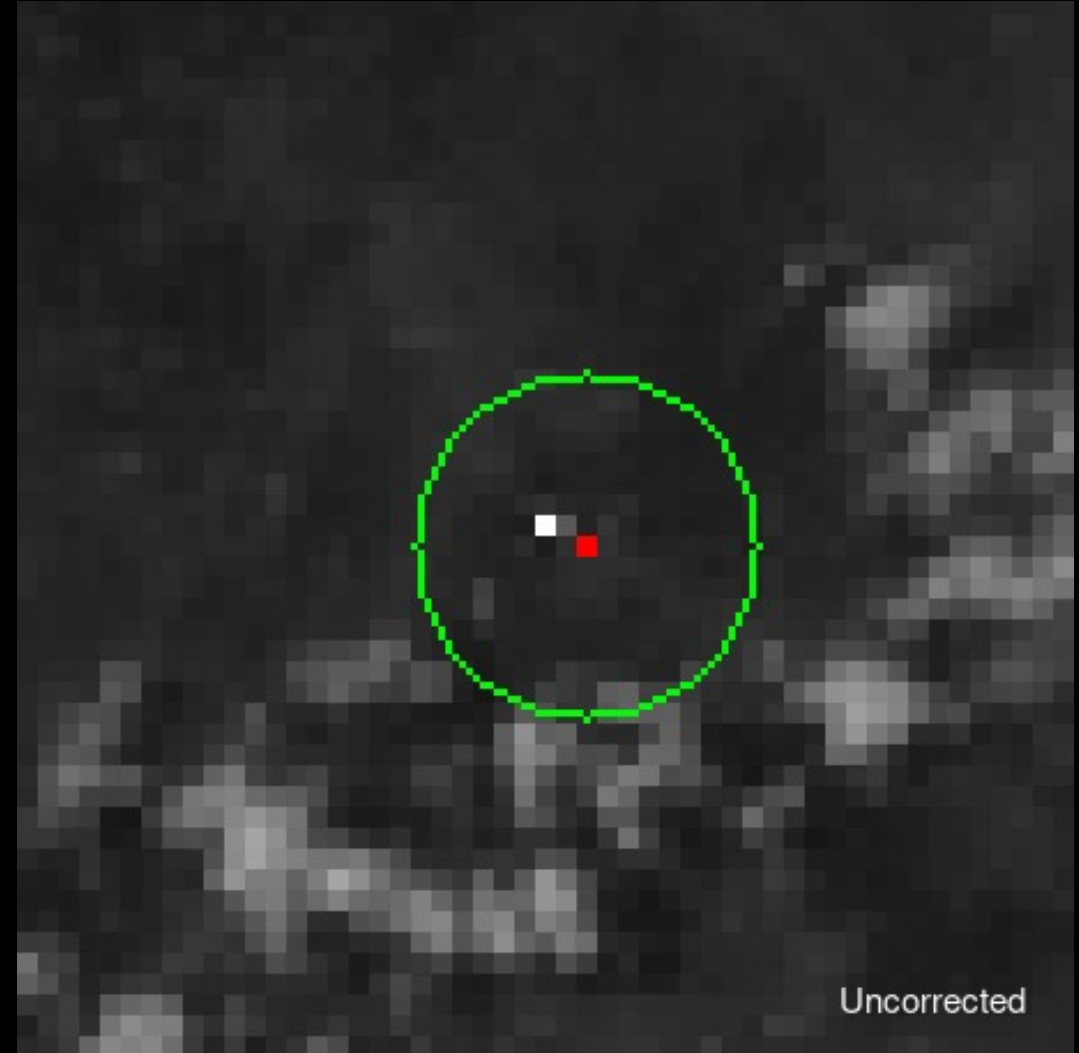
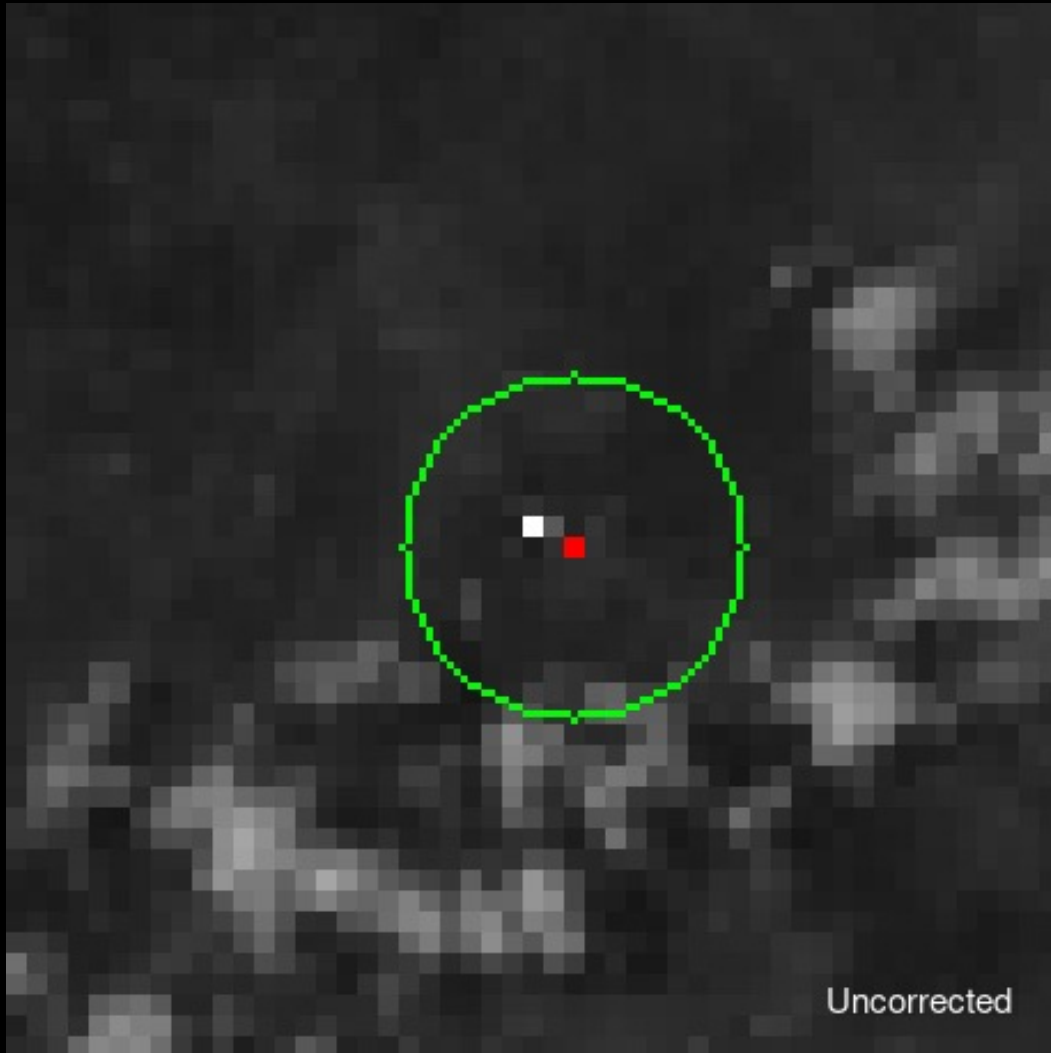
# get index of brightest pixel in the subset
subset = np.s_[213:474, 11:307]
brightest_idx = np.unravel_index(
    np.nanargmax(abi_img.cmi[subset]),
    abi_img.cmi[subset].shape,
)
```



Greenhouse in Durango, MX – 1,755 m



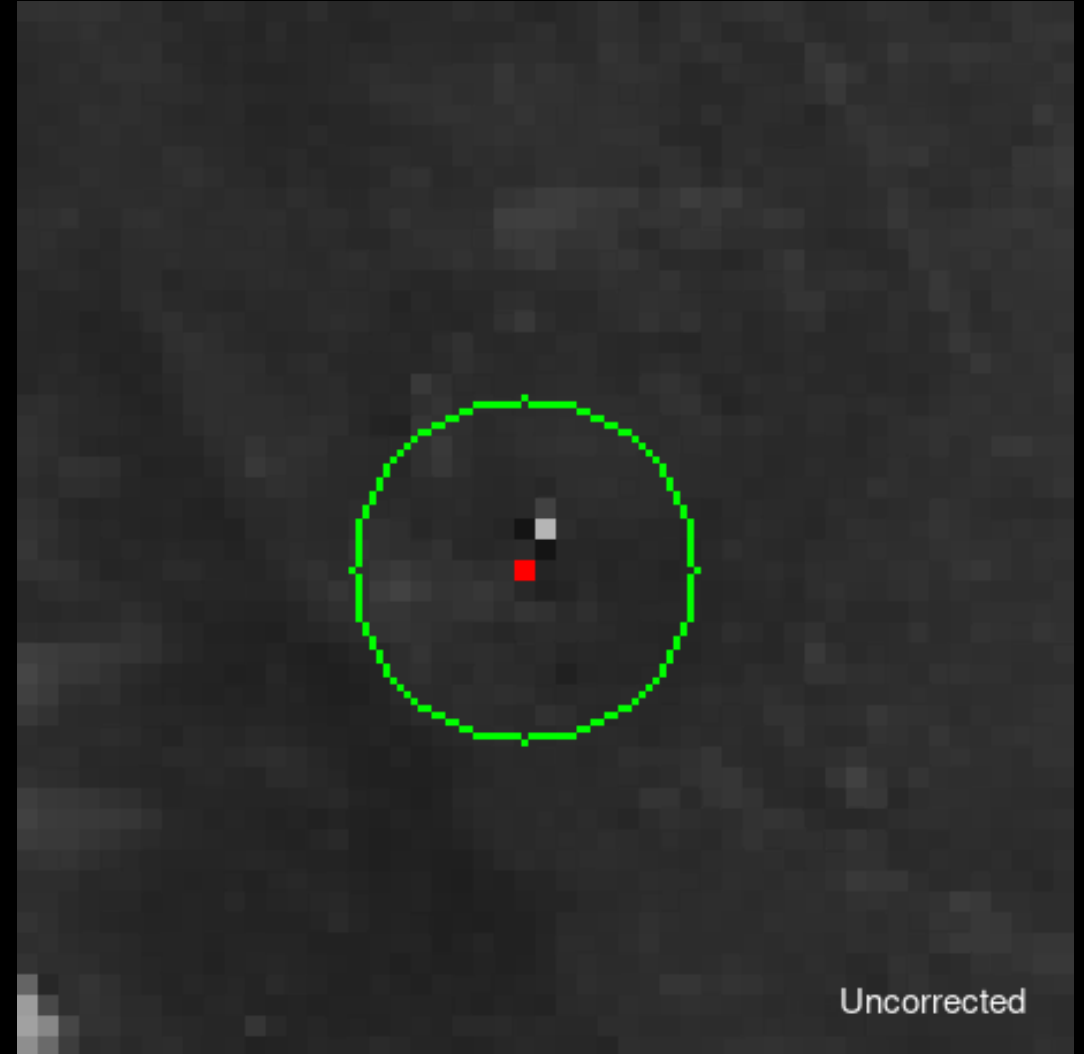
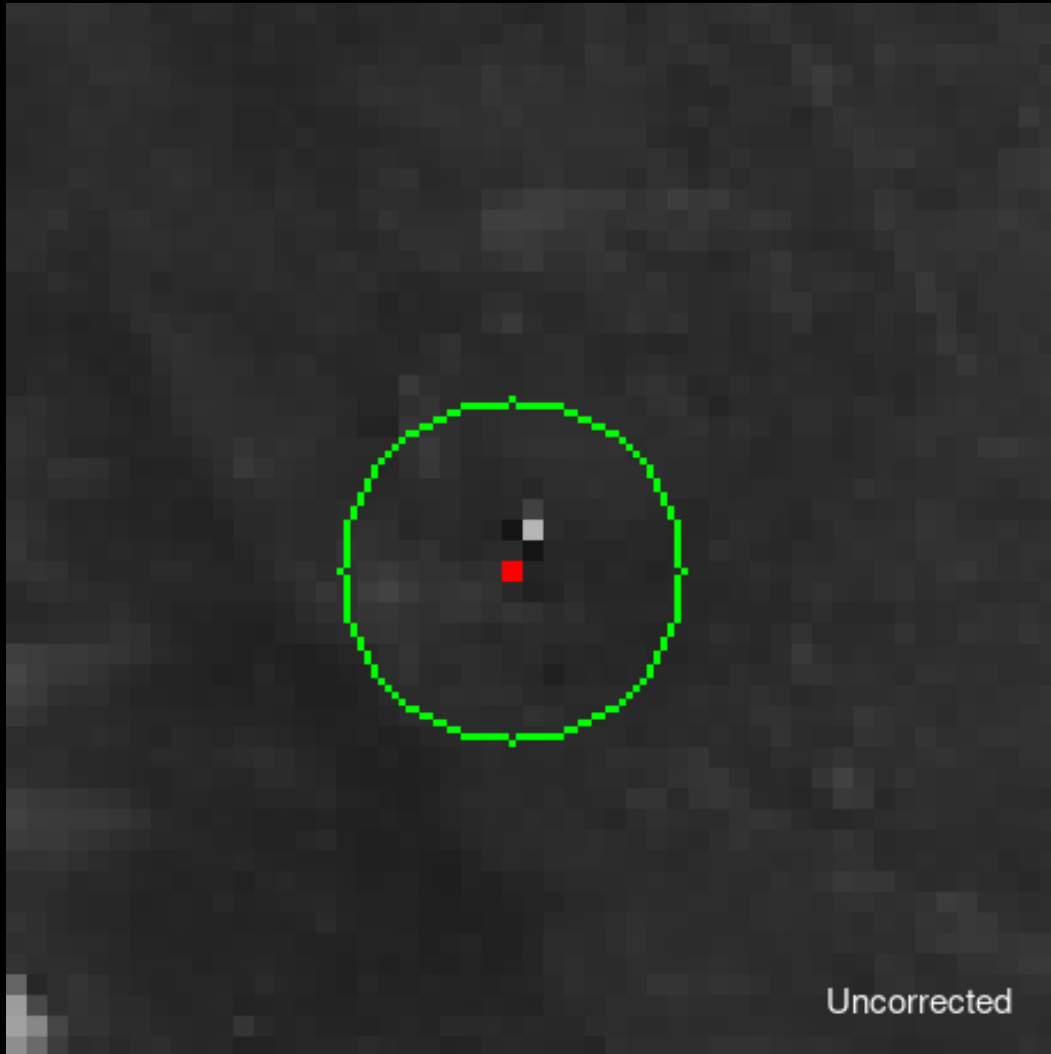
Greenhouse in Durango, MX – 1,755 m



PV solar plant in Colorado, US – 1,563 m



PV solar plant in Colorado, US – 1,563 m



heregoes Performance

- Recommended system specifications:
 - 24-32 GB RAM (16 GB minimum)
 - 8 logical CPUs
- Accelerated + parallelized with Numba JIT
- Below metrics from *Here GOES Radiotelescope* (i7-6700 + 24 GB RAM)

Product	<i>heregoes</i> Processing Time-to-upload (24 hr avg)
ABI Full Disk*	38.1 s
ABI CONUS (Conterminous United States)	6.9 s
ABI Mesoscale	2.5 s
SUVI Radiance Image	4.6 s

*The 500 m Full Disk image is ~471 megapixels and arrives every 10 min

What's next for *heregoes*?

- More to be done with ABI + prep for GeoXO
- Other ABI-class instruments or GEO imagers?
 - Himawari AHI, GEO-Kompsat AMI?
- We respond to GitHub feature requests!

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github.com/herergoesradio/herergoes
herergoesradio.com

Acknowledgements:

Wave Farm | wavefarm.org

Heidi Neilson | heidineilson.com