MASCS/VIRS geometry update

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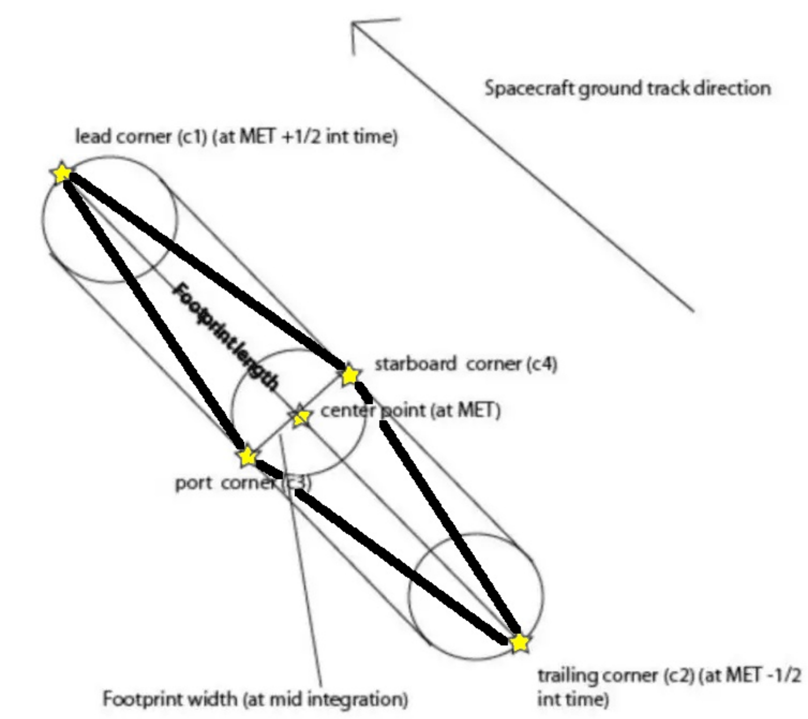
Introduction – MASCS FOVs



Adapted from Figure 4
MASCS VIRS Software Interface Specification

The points I tried to address:

1. PDS data contains only center, trailing, leading and lateral points of the elongated Field Of View (FOV).

2. PDS paramters are calculated only at the central point.

3. PDS data contain some geometrical paramters, but omit useful one like i.e. local time (useful proxy for the surface temperature).

4. PDS data were calculated approximating Mercury to an ellipsoid. I used a SPICE DTM derived from MESSENGER Mercury Laser Altimeter (MLA) to 7 pixels per degree data processed and generated by ESA SPICE Service (ESS)

ESA have a more detailed tiled version at full 665m resolution, but it is harder to use (SPICE limits to 8M polygons per model file)

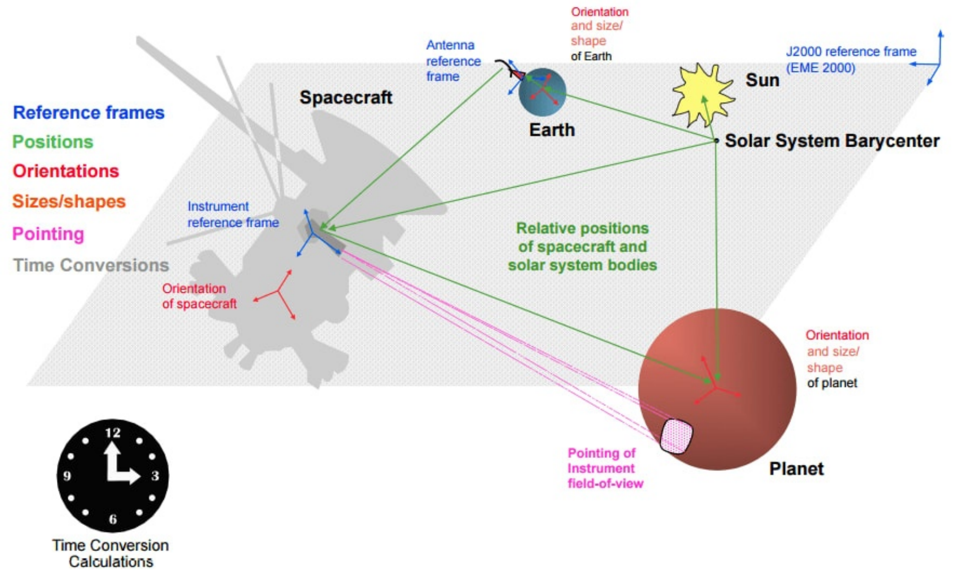
Thanks to Alfredo Escalante Lopez and Thomas Cornet (ESA).

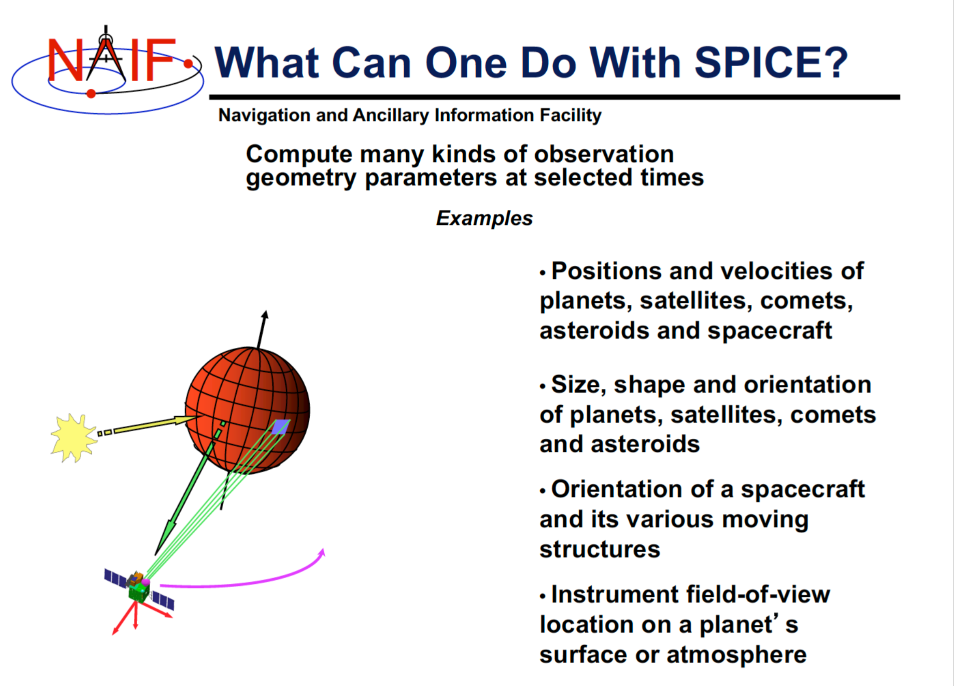
Original data from USGS > Mercury MESSENGER Global DEM 665m v2

SPICE Toolkit

The Navigation and Ancillary Information Facility (NAIF), acting under the directions of NASA's Planetary Science Division, has built an information system named "SPICE" to assist NASA scientists in planning and interpreting scientific observations from space-borne instruments, and to assist NASA engineers involved in modeling, planning and executing activities needed to conduct planetary exploration missions.

Further reading material is available at SPICE Tutorials.

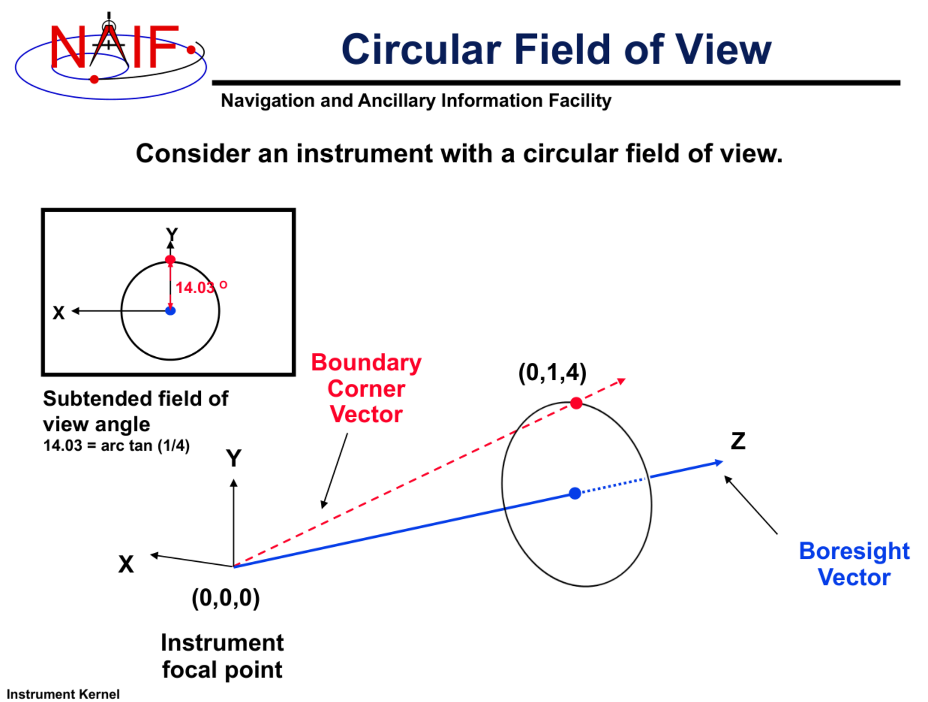


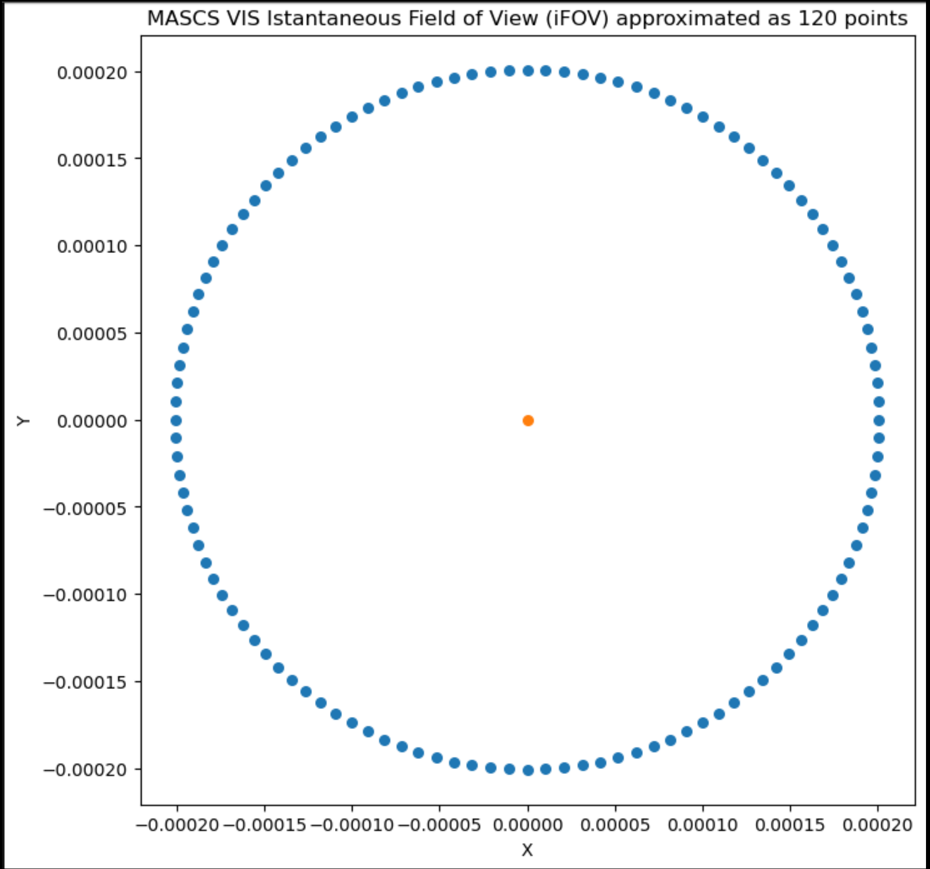


I used the *unofficial* pyton package SpiceyPy 5.1.2 created, documented and maintained by Dr Andrew Annex (thanks!)

My code is publicly available on github at mariodamore/MESSENGER-MASCS-VIRS-geometry-calculator

Define the iFOV

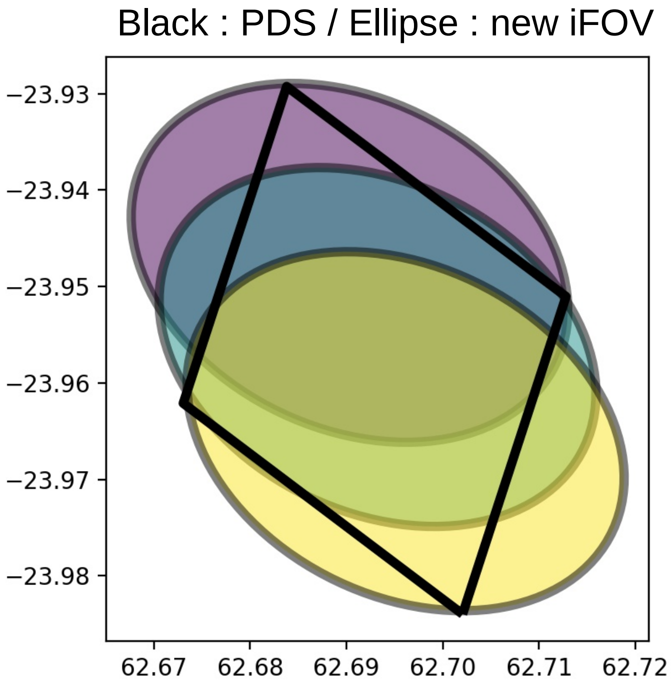


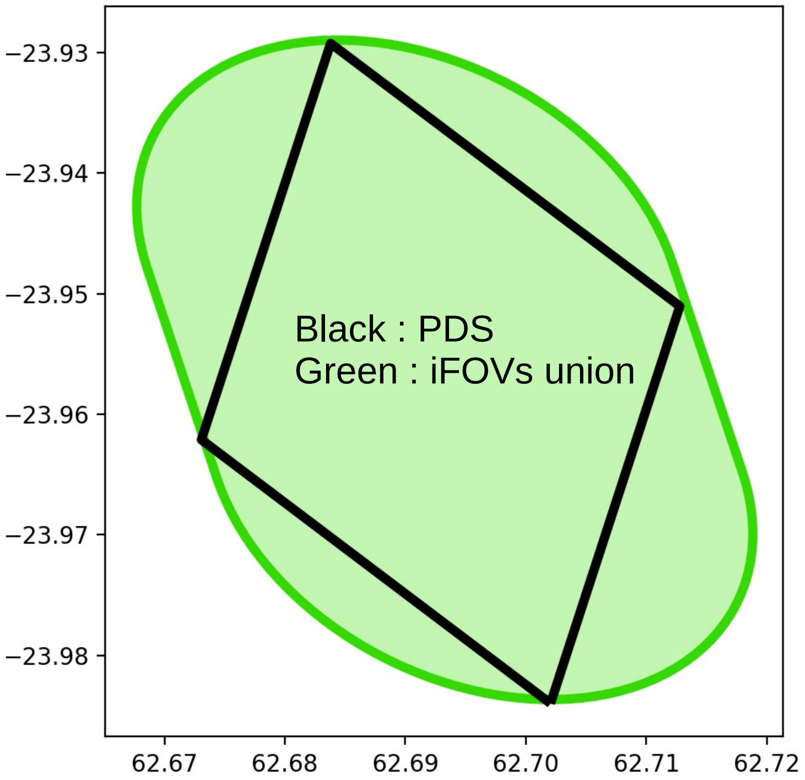


25_ik : The subsystem that deals with instrument field of view size, shape and orientation

Calculate the new FOV

Interpolate iFOVs between start and stop time

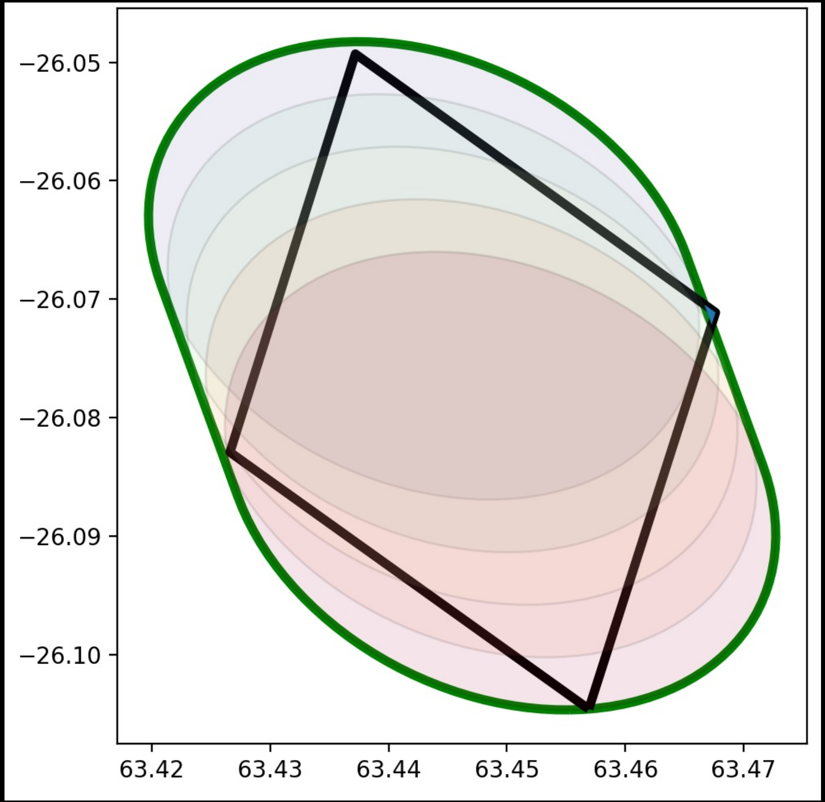




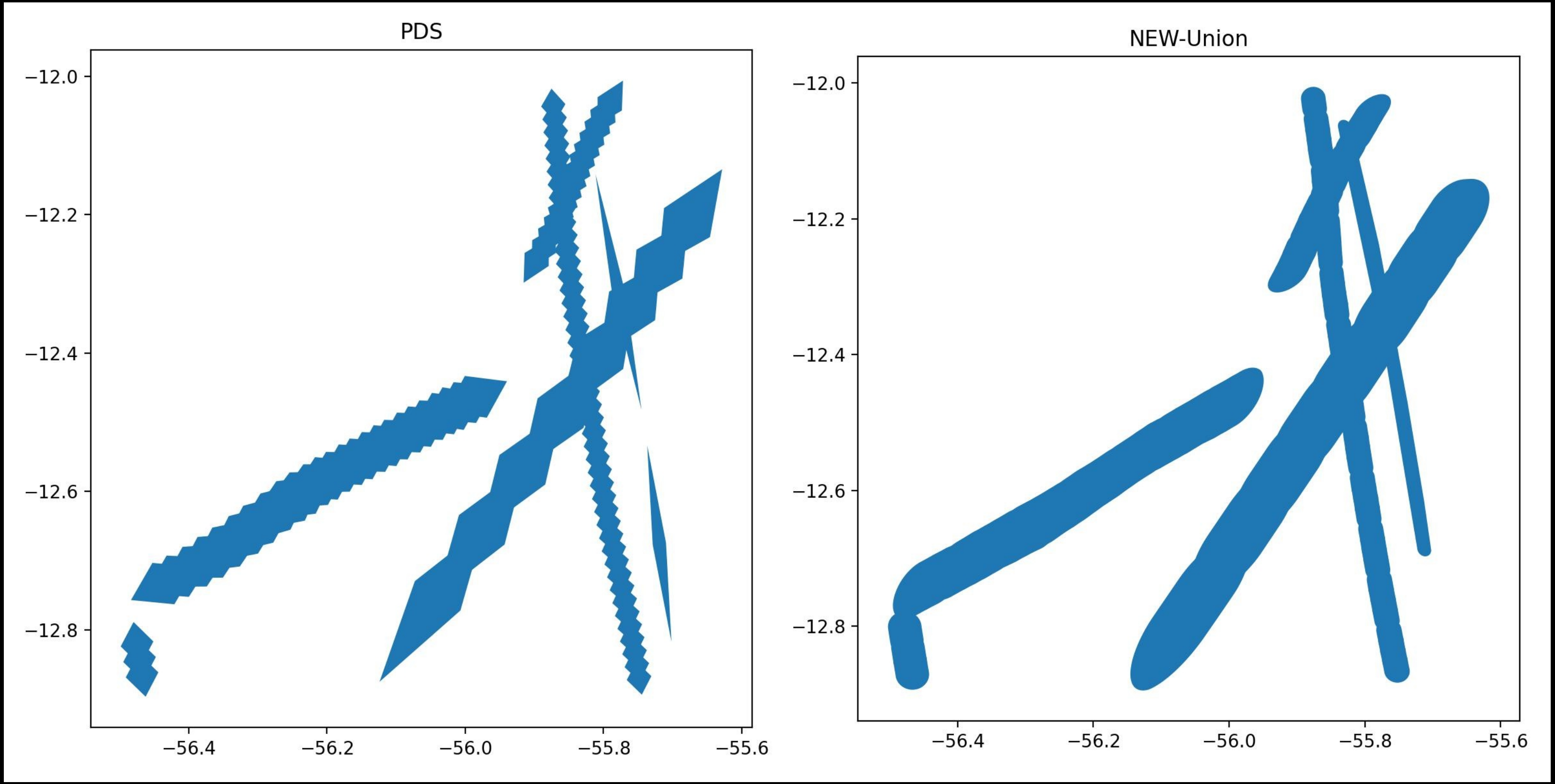
Calculate the new FOV

Number of iFOV per measurements :

Default 5, automatically increase to fill up the measurement.



Example output : Hopper crater



Calculated paramter

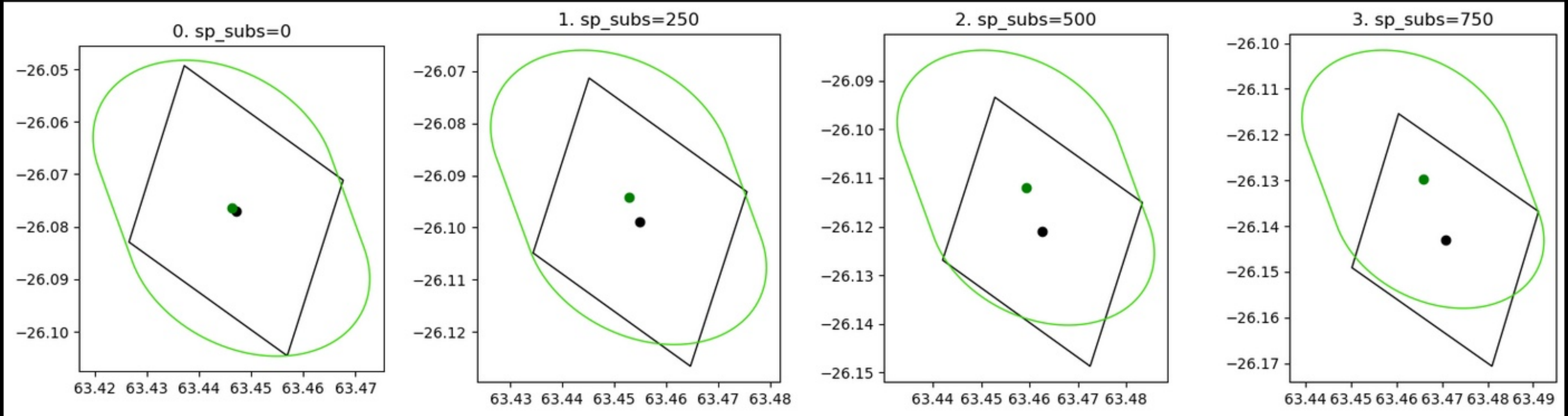
mean and standard deviation available for all parameters

- **trgepc** : epoch (time) at target, this is to take in account light time and stellar aberration.
- **tarlon** : target (intersection) lontgitude
- **tarlat** : target (intersection) latitude
- **taralt** : target (intersection) local altitude (DTM)
- **tardis** : target distance from spacecraft
- **tarang** : target angular diameter from spacecraft
- **trgenpc** : epoch (time) at target, this is to take in account light time and stellar aberration.
- **phase** : phase angle at target
- **incdnc :** incidence angle at target
- **emissn** : emission angle at target
- **hr** : hour at target (part of the local time)
- **mn** : minute at target (part of the local time
- **sc** : second at target (part of the local time
- **sublon** : sub-spacecraft point longitude
- **sublat** : sub-spacecraft point latitude
- **subalt** : sub-spacecraft point altitude (DTM)
- **sunlon** : sub-solar point longitude
- **sunlat** : sub-solar point latitude
- **sunalt** : sub-solar point altitude (DTM)

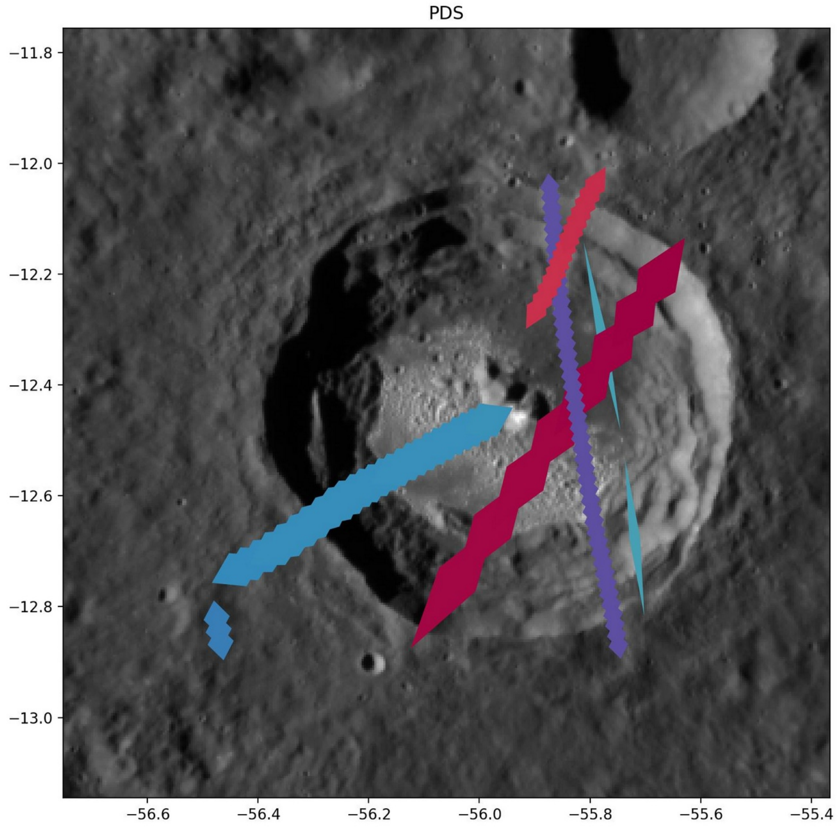
Problems (?)

From **MASCS VIRS Software Interface Specification**

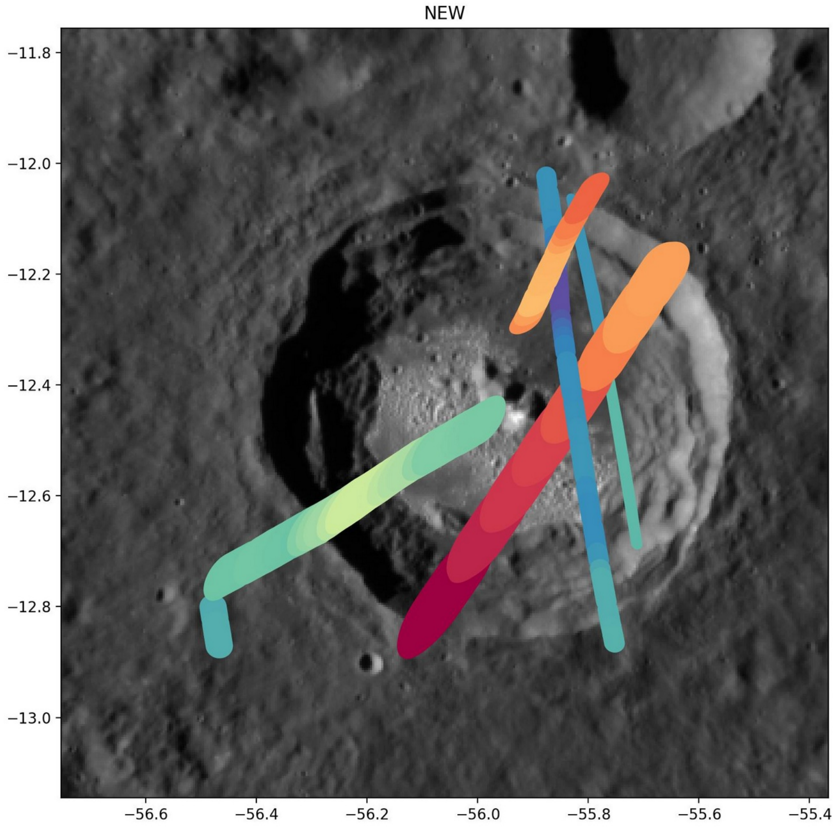
- **SPECTRUM_MET**: mission elapsed time (in seconds) since launch (for partition 1) or since reset (for partition 2) at the start of an individual VIRS spectrum.
- **SPECTRUM_SUBSECONDS** : The calculated subsecond time in milliseconds that a VIRS integration was started. For each VIRS integration, SPECTRUM_MET plus SPECTRUM_SUBSECONDS gives the spacecraft time of the start of that integration.



Hopper

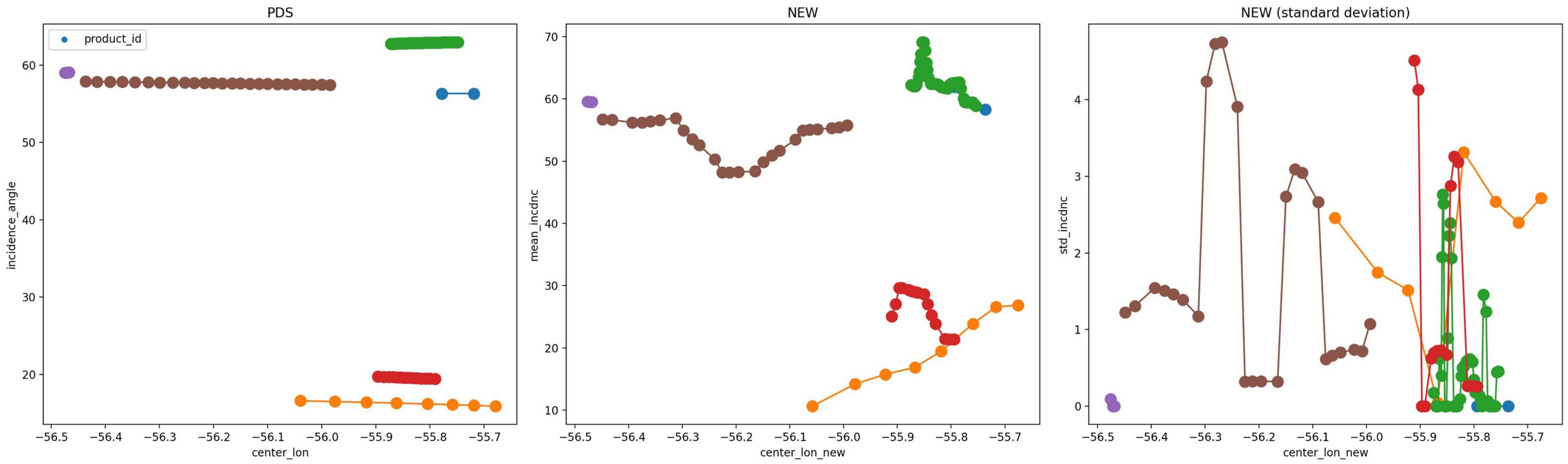


PDS
−11.8
−12.0
−12.2
−12.4
−12.6
−12.8
−13.0
−56.6
−56.4
−56.2
−56.0
−55.8
−55.6
−55.4



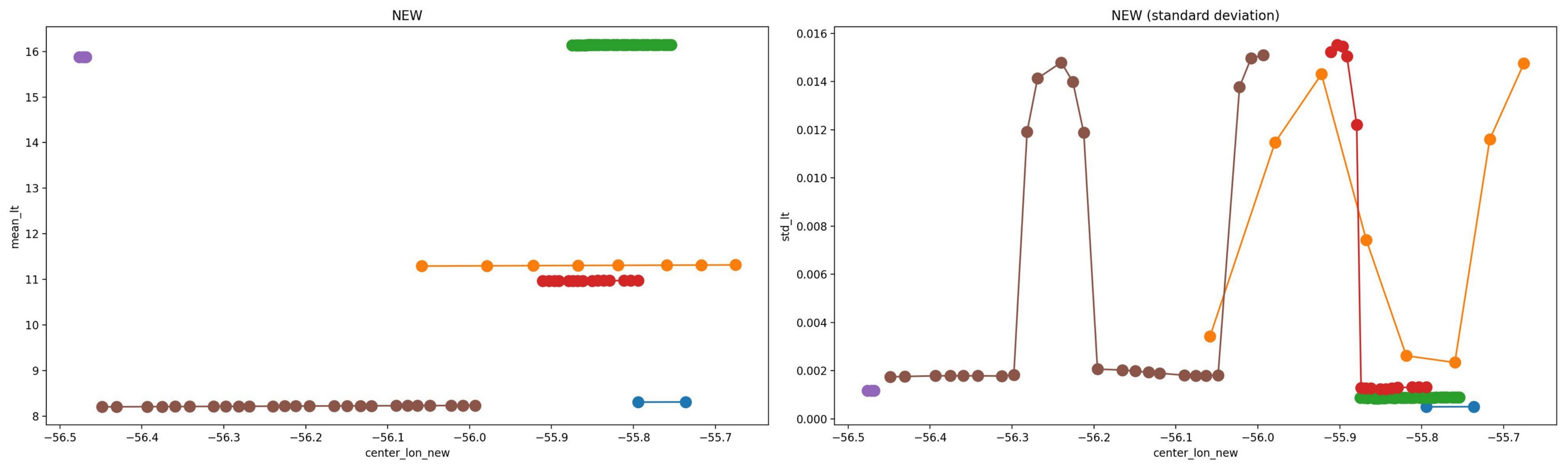
NEW
−11.8
−12.0
−12.2
−12.4
−12.6
−12.8
−13.0
−56.6
−56.4
−56.2
−56.0
−55.8
−55.6
−55.4

Hopper

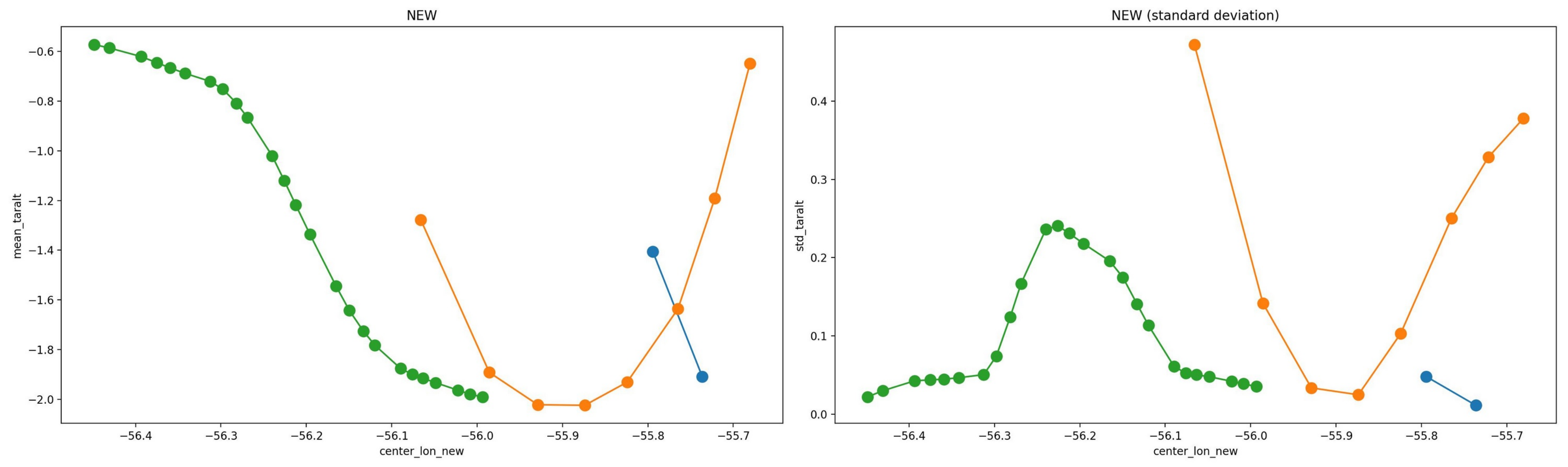


PDS
product_id
incidence_angle
center_lon
NEW
mean_incdnc
center_lon_new
NEW (standard deviation)
std_incdnc
center_lon_new

Hopper

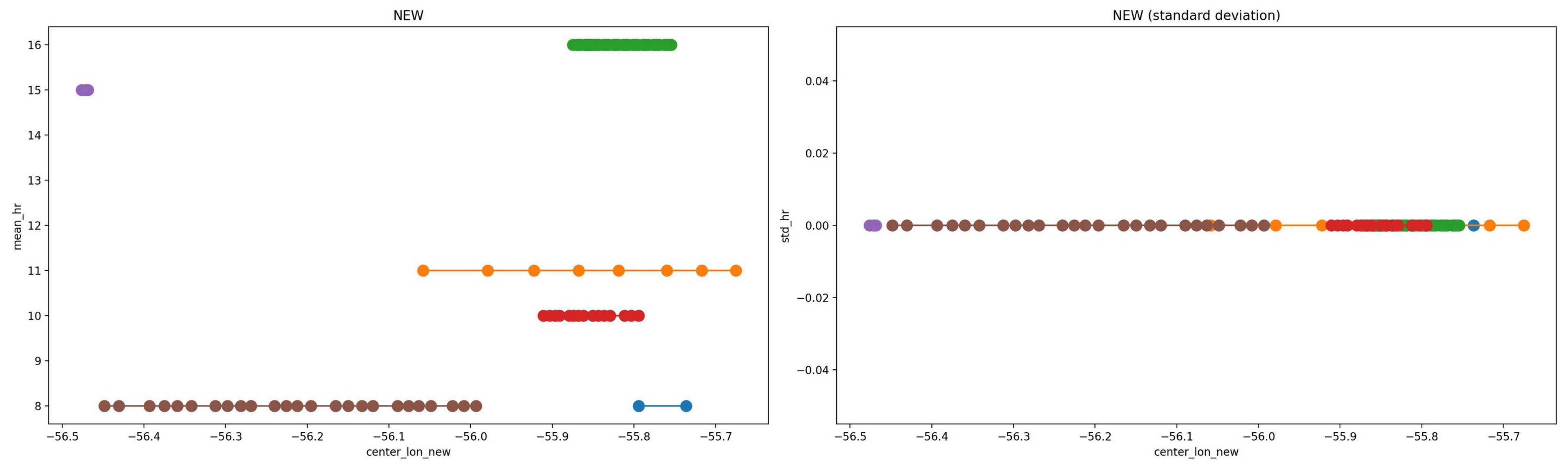

NEW
mean_lt
center_lon_new
NEW (standard deviation)
std_lt
center_lon_new

Hopper

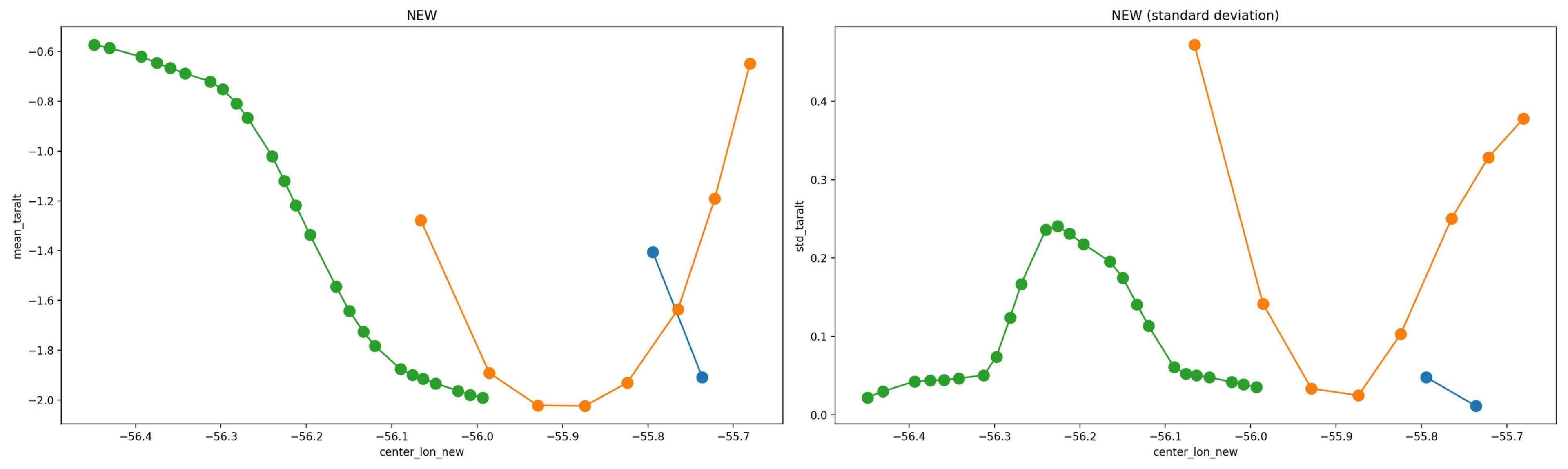


NEW
mean_taralt
−0.6
−0.8
−1.0
−1.2
−1.4
−1.6
−1.8
−2.0
−56.4
−56.3
−56.2
−56.1
−56.0
−55.9
−55.8
−55.7
center_lon_new
NEW (standard deviation)
std_taralt
0.4
0.3
0.2
0.1
0.0
−56.4
−56.3
−56.2
−56.1
−56.0
−55.9
−55.8
−55.7
center_lon_new

Hopper

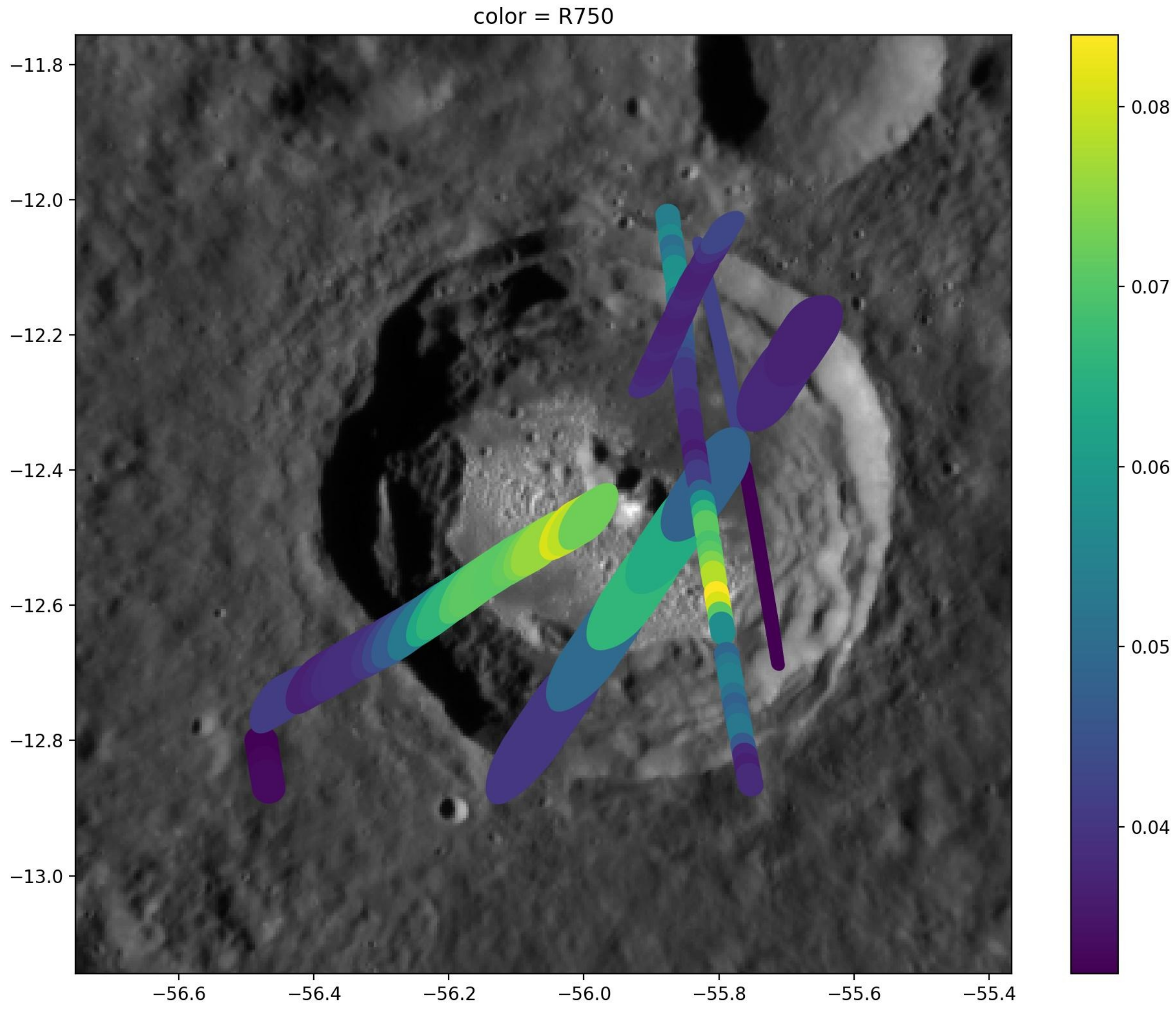

NEW
mean_hr
16
15
14
13
12
11
10
9
8
−56.5
−56.4
−56.3
−56.2
−56.1
−56.0
−55.9
−55.8
−55.7
center_lon_new
NEW (standard deviation)
std_hr
0.04
0.02
0.00
−0.02
−0.04
−56.5
−56.4
−56.3
−56.2
−56.1
−56.0
−55.9
−55.8
−55.7
center_lon_new

Hopper



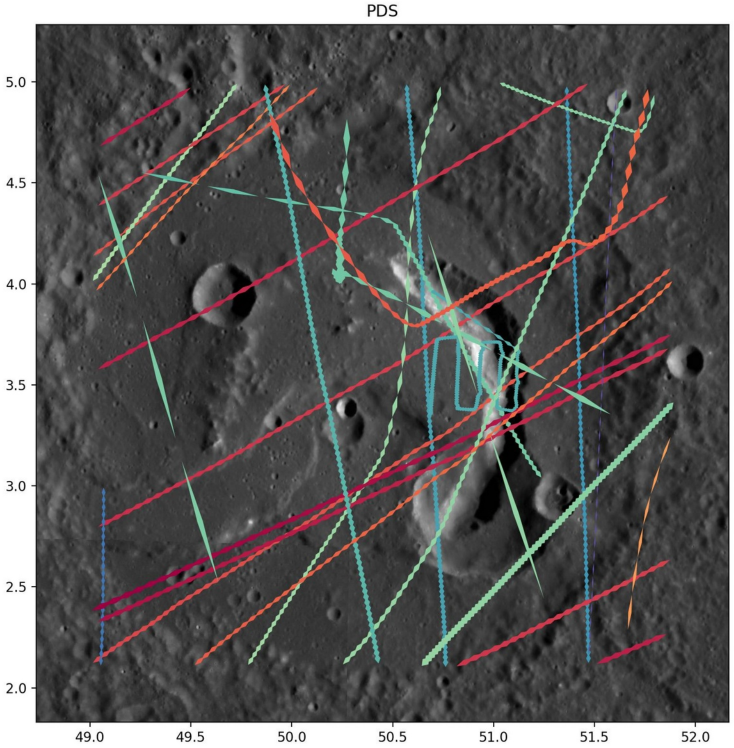
NEW
mean_taralt
−0.6
−0.8
−1.0
−1.2
−1.4
−1.6
−1.8
−2.0
−56.4
−56.3
−56.2
−56.1
−56.0
−55.9
−55.8
−55.7
center_lon_new
NEW (standard deviation)
std_taralt
0.4
0.3
0.2
0.1
0.0
−56.4
−56.3
−56.2
−56.1
−56.0
−55.9
−55.8
−55.7
center_lon_new

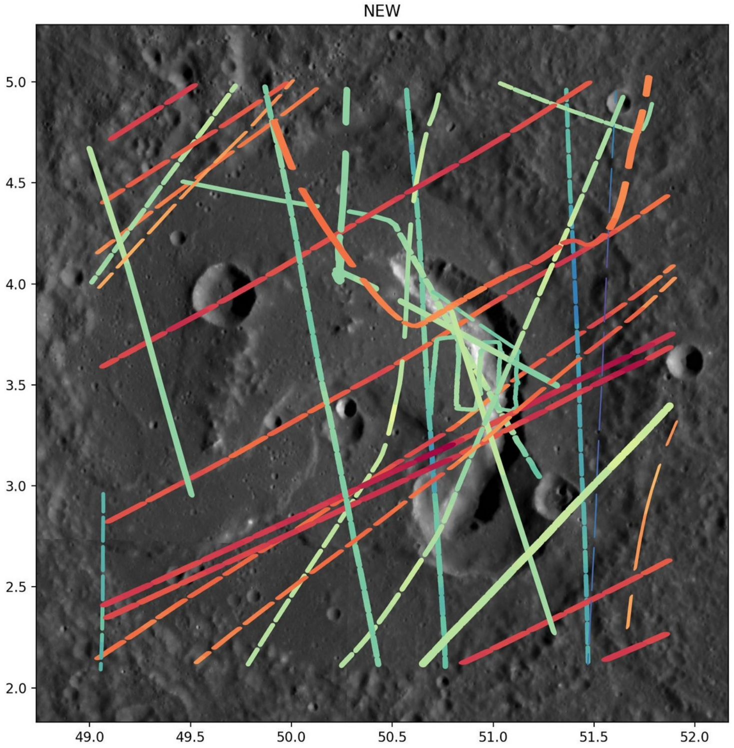
Hopper



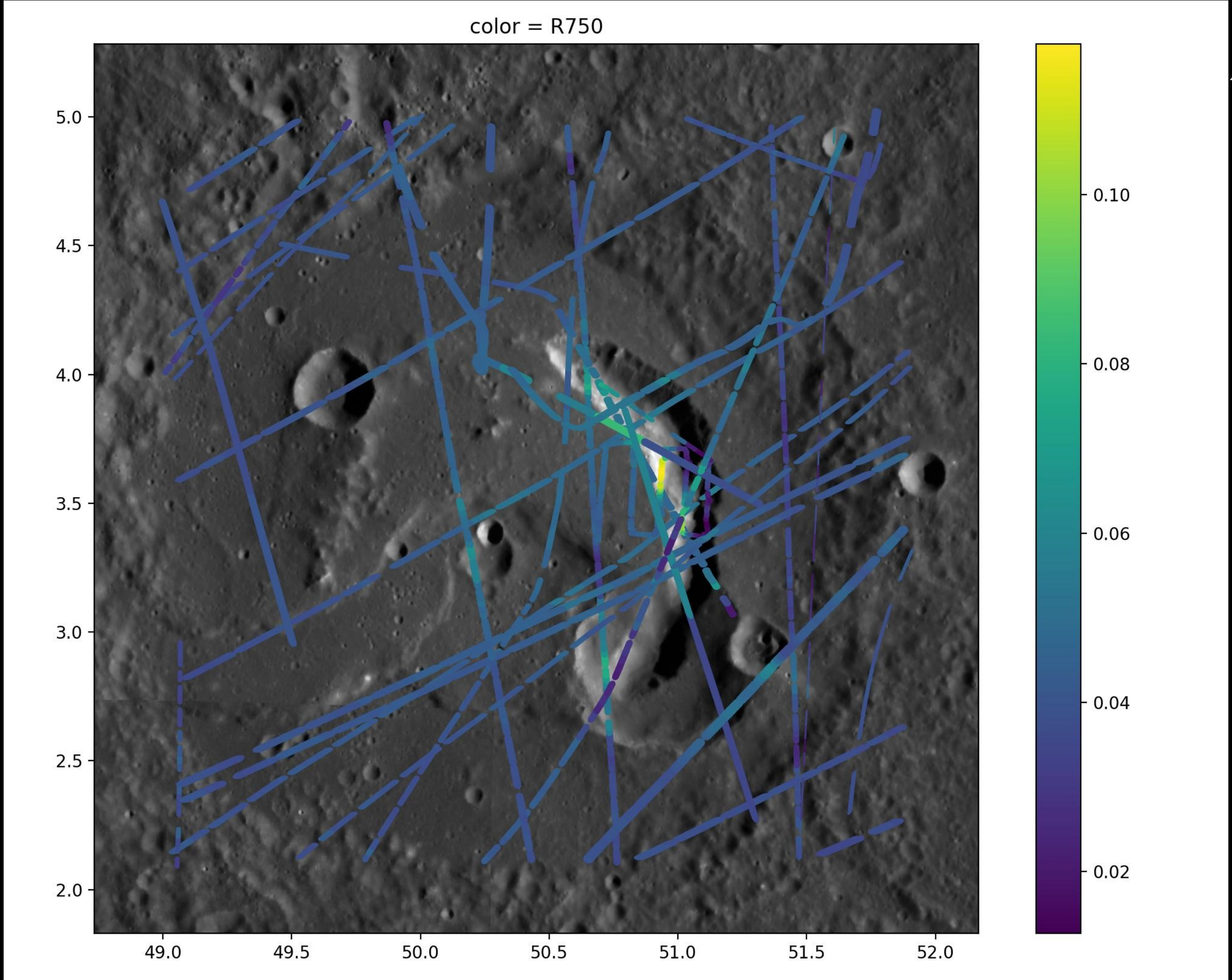
color = R750
−11.8
−12.0
−12.2
−12.4
−12.6
−12.8
−13.0
−56.6
−56.4
−56.2
−56.0
−55.8
−55.6
−55.4
0.08
0.07
0.06
0.05
0.04

Picasso

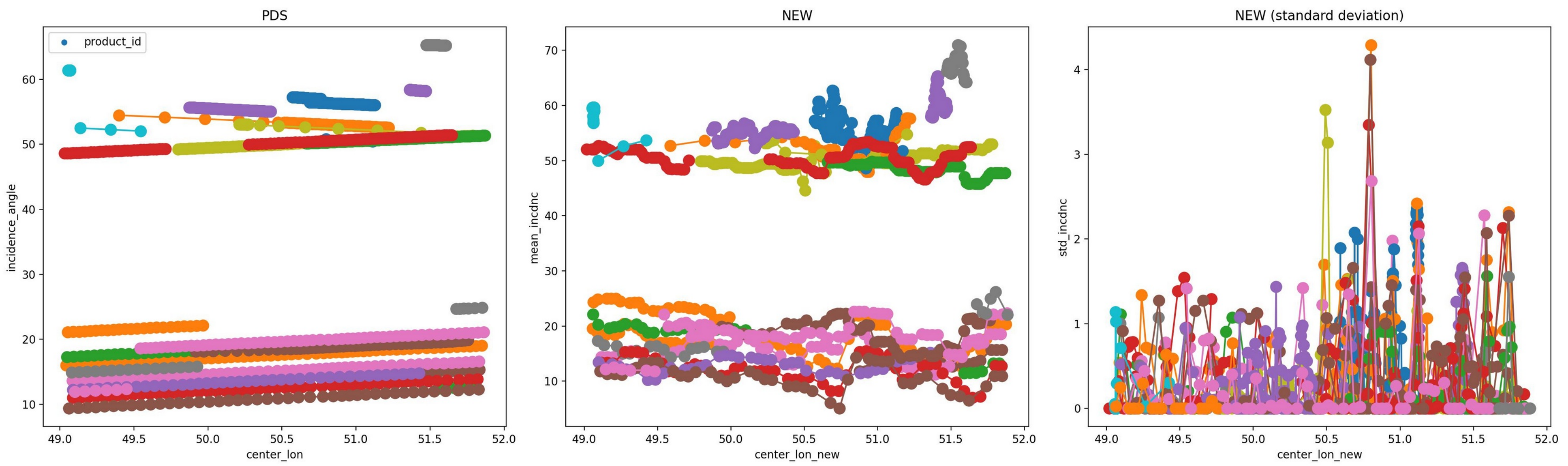

PDS
5.0
4.5
4.0
3.5
3.0
2.5
2.0
49.0
49.5
50.0
50.5
51.0
51.5
52.0


NEW
5.0
4.5
4.0
3.5
3.0
2.5
2.0
49.0
49.5
50.0
50.5
51.0
51.5
52.0

Picasso

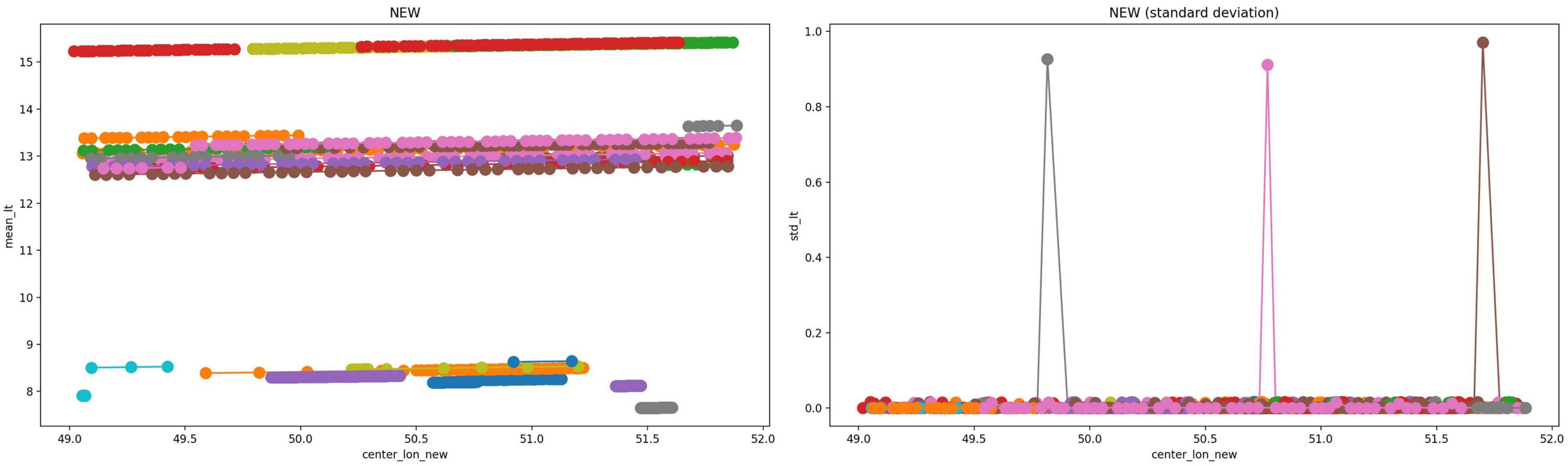

color = R750
5.0
4.5
4.0
3.5
3.0
2.5
2.0
49.0
49.5
50.0
50.5
51.0
51.5
52.0
0.10
0.08
0.06
0.04
0.02

Picasso



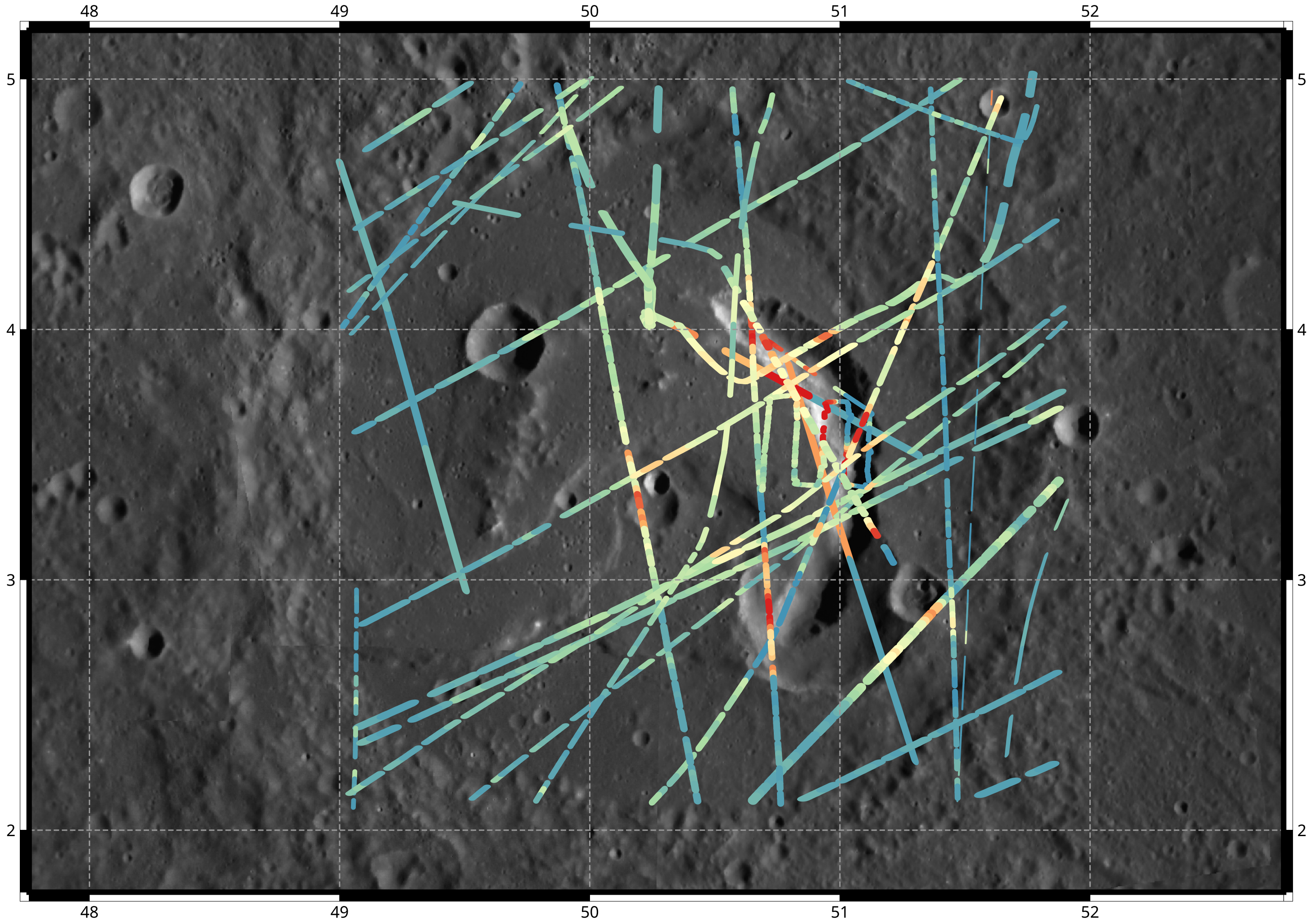
PDS
product_id
incidence_angle
center_lon
NEW
mean_incdnc
center_lon_new
NEW (standard deviation)
std_incdnc
center_lon_new

Picasso

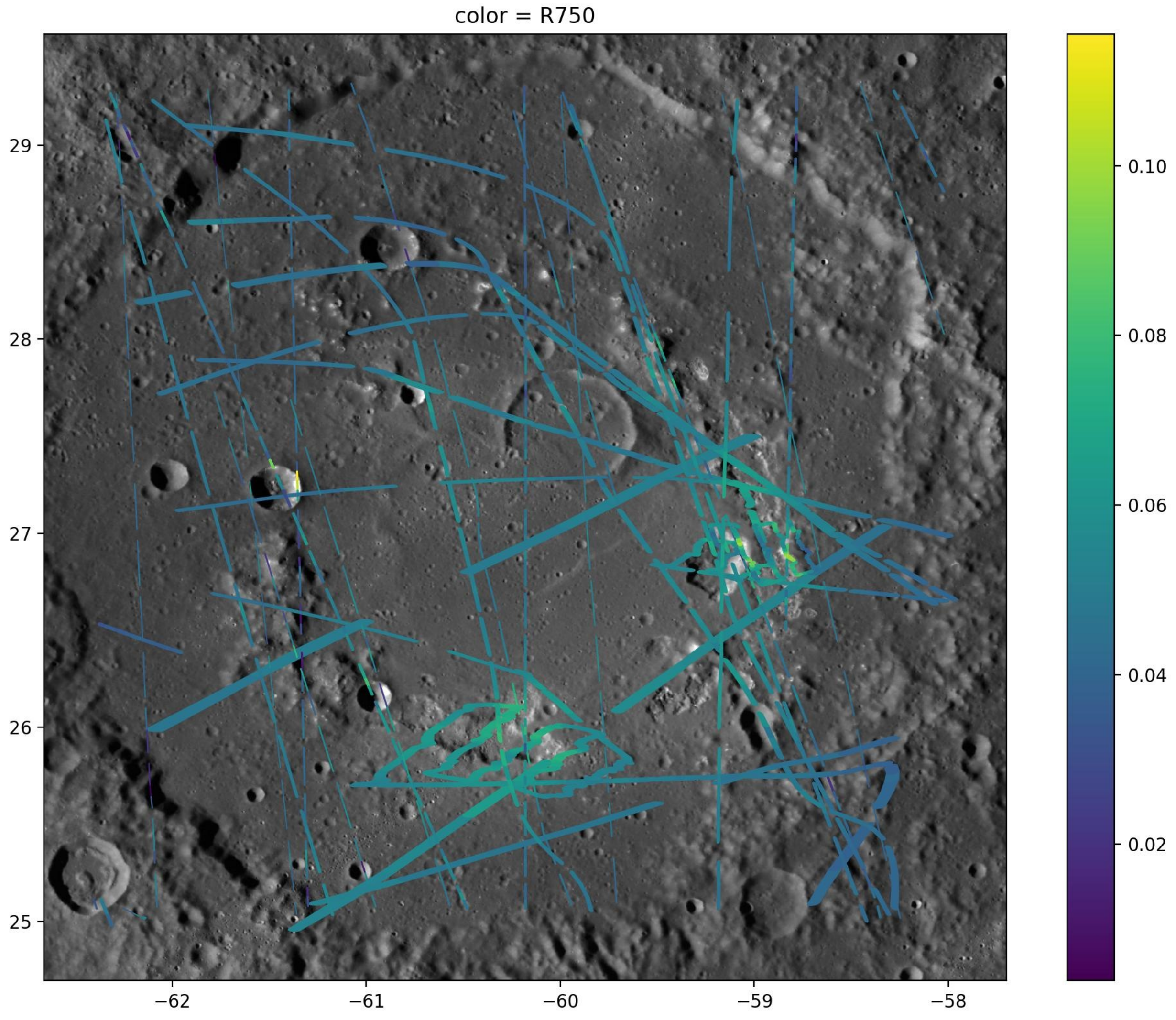

NEW
mean_lt
center_lon_new
NEW (standard deviation)
std_lt
center_lon_new

Picasso

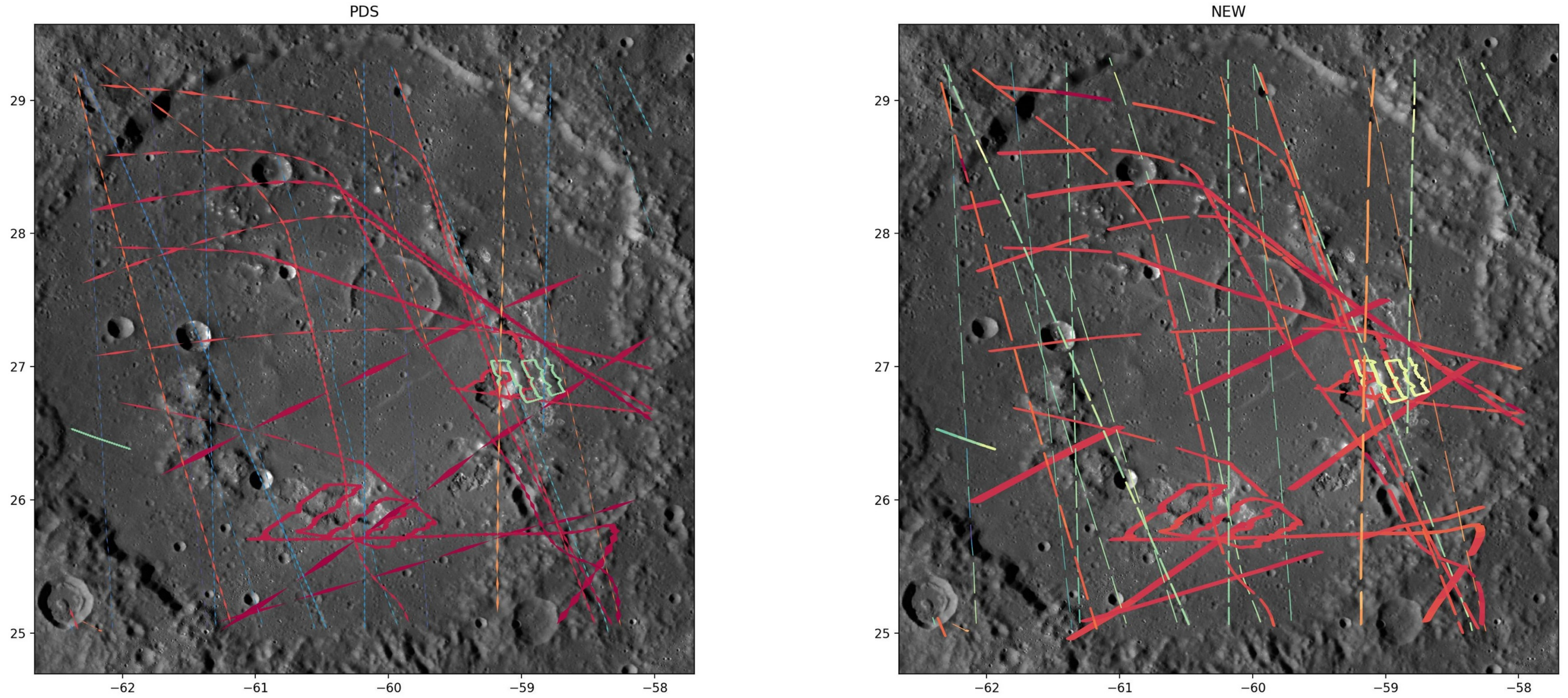
Using QGIS and GeoJson output



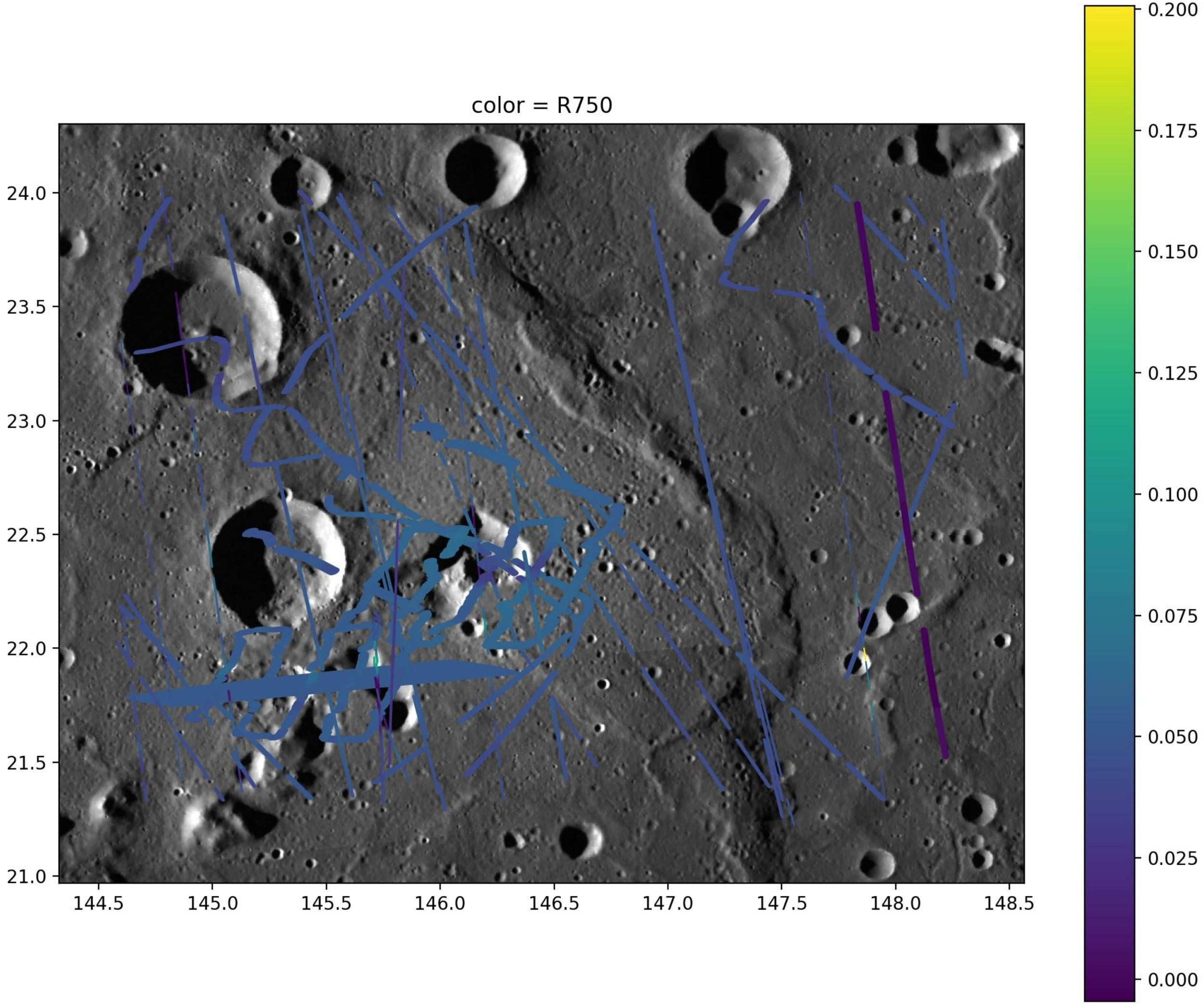
Orm



Orm

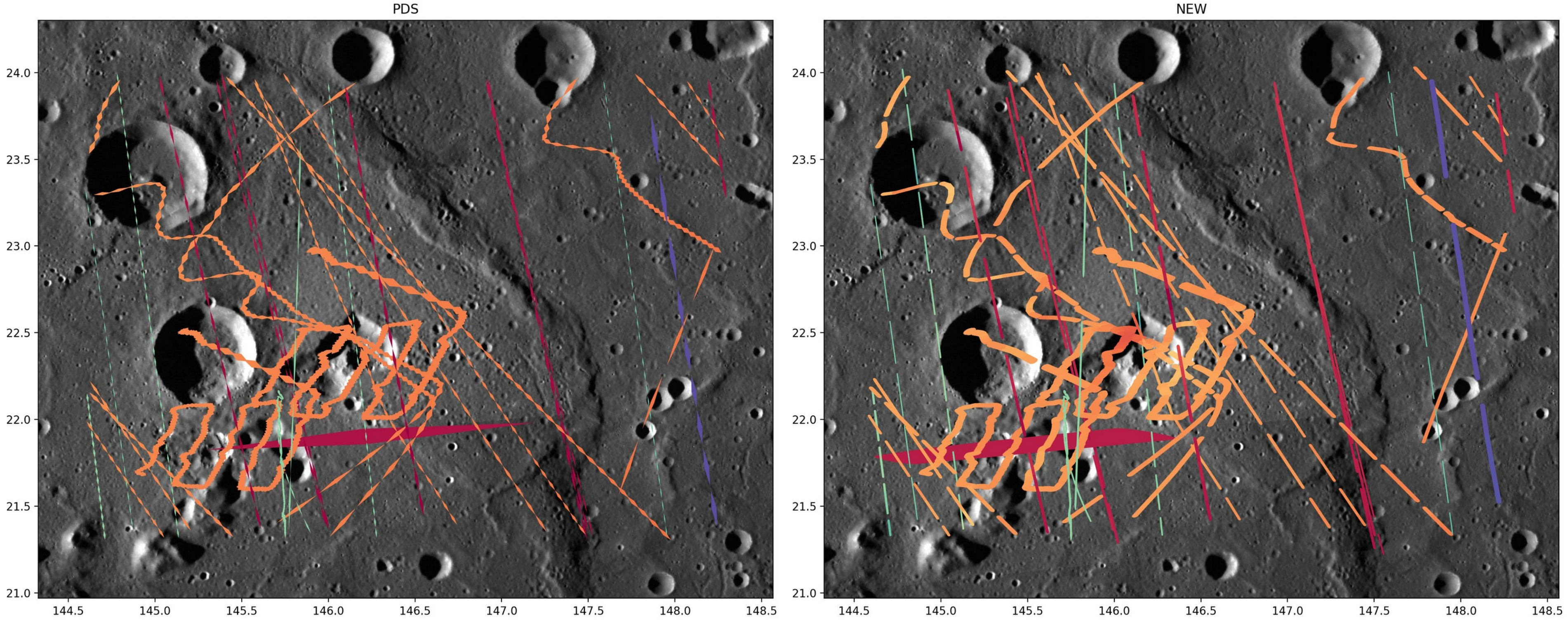


Agwo



color = R750
24.0
23.5
23.0
22.5
22.0
21.5
21.0
144.5
145.0
145.5
146.0
146.5
147.0
147.5
148.0
148.5
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000

Agwo


PDS
NEW
24.0
23.5
23.0
22.5
22.0
21.5
21.0
144.5
145.0
145.5
146.0
146.5
147.0
147.5
148.0
148.5

Summary

Outputs for al ROIs (Agwo, Hopper, Orm-Faculae-SW, Picasso)

1) **MASCS-Hopper.csv.zip** : PDS MASCS data (contains spectra too).
2) **MASCS-Hopper_NEW-iFOV.csv.zip** : New instantaneous FOVs.
3) **MASCS-Hopper_NEW-FOV-union-convex.csv.zip** : New merged FOVs (comparable with PDS data)
4) **Hopper.geojson** : Union of 1) and 2) ready for GIS (no spectra, only parameters)

Open questions

- how to verify this?
- Subsecond dependance: it is true?
- „holes“ in tracks : are those real?