Using TOPCAT with sparse measurements on planetary surfaces

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What is TOPCAT ?

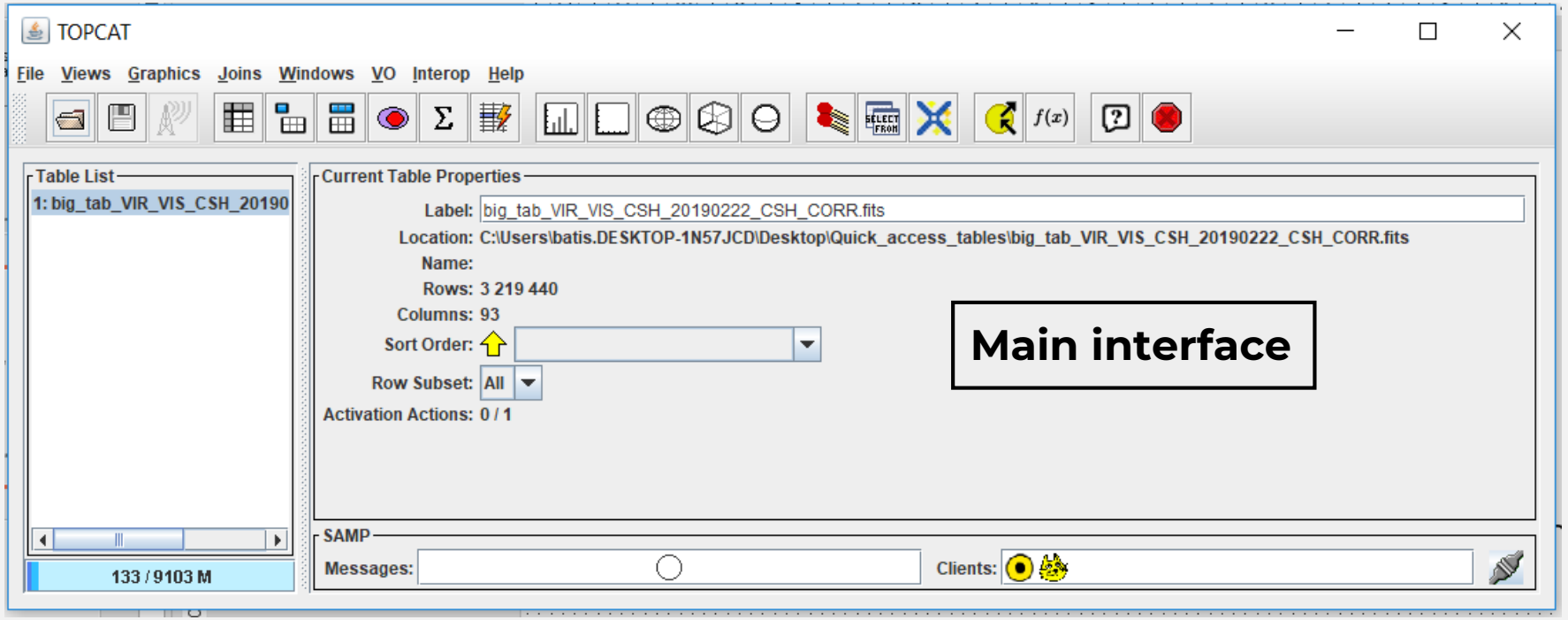
- **TOPCAT: Tool for OPerations on Catalogues And Tables**
  - Developed by Mark Taylor (Bristol University)

Free download, more information at: **www.starlink.ac.uk/topcat/**

What is TOPCAT ?

- **TOPCAT: Tool for OPerations on Catalogues And Tables**
  - Developed by Mark Taylor (Bristol University)

- Powerful VO tool to manage large tables of data.
- **Light, fast, interactive and multifunctional**. Active support. **Very easy to use**.



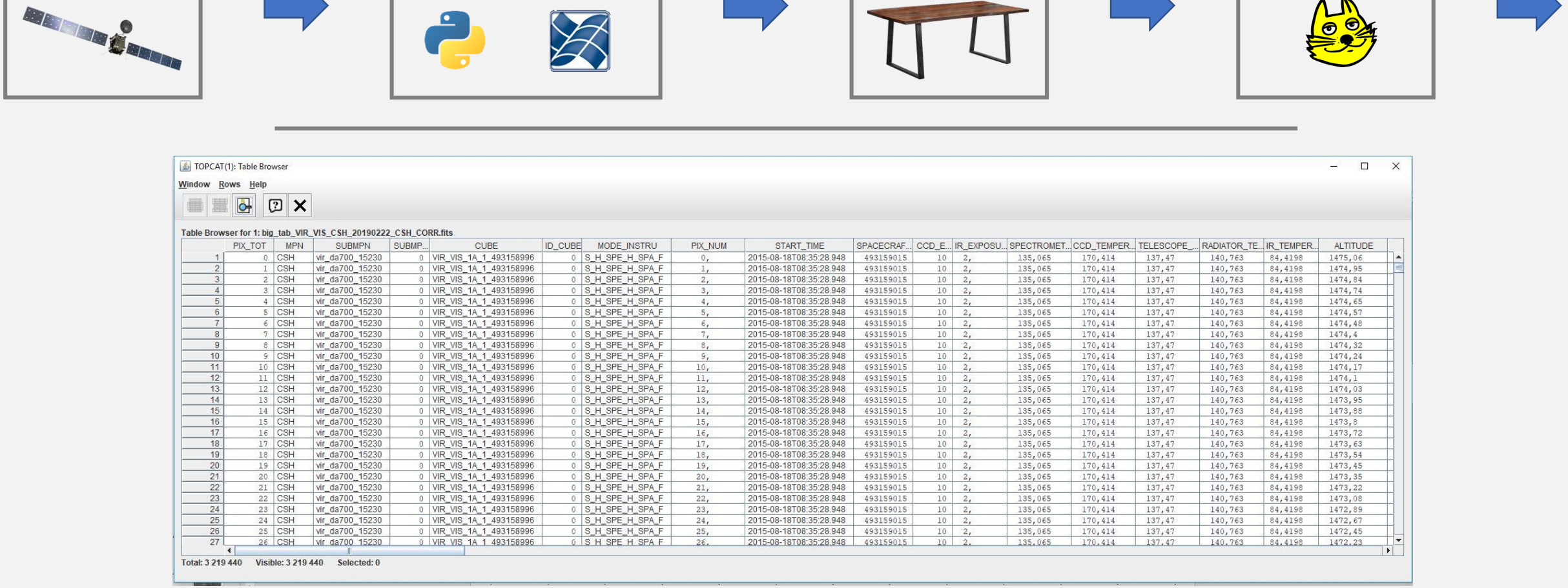
Free download, more information at: **www.starlink.ac.uk/topcat/**

TOPCAT & planetary science

Use TOPCAT in a workflow of remote sensing data processing

Central concept: 1 pixel or 1 hyperspectral image = 1 row

DATA → **PROCESSING** → **TABLE** → **TOPCAT** →



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7	6	CSH	vir_da700_15230	0	VIR_VIS_1A_1_493158996	0	S_H_SPE_H_SPA_F	6,	2015-08-18T08:35:28.948	493159015	10	2,	135,065	170,414	137,47	140,763	84,4198	1474,48
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9	8	CSH	vir_da700_15230	0	VIR_VIS_1A_1_493158996	0	S_H_SPE_H_SPA_F	8,	2015-08-18T08:35:28.948	493159015	10	2,	135,065	170,414	137,47	140,763	84,4198	1474,32
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25	24	CSH	vir_da700_15230	0	VIR_VIS_1A_1_493158996	0	S_H_SPE_H_SPA_F	24,	2015-08-18T08:35:28.948	493159015	10	2,	135,065	170,414	137,47	140,763	84,4198	1472,67
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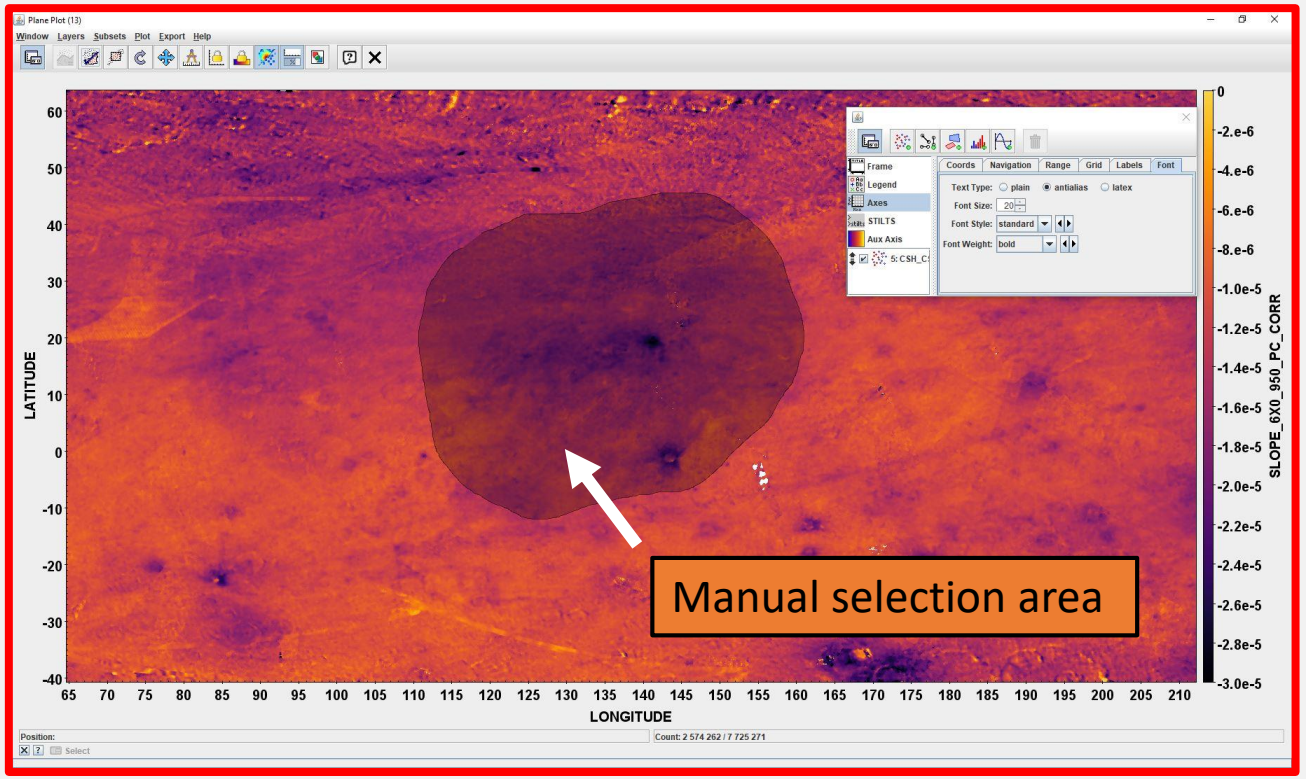
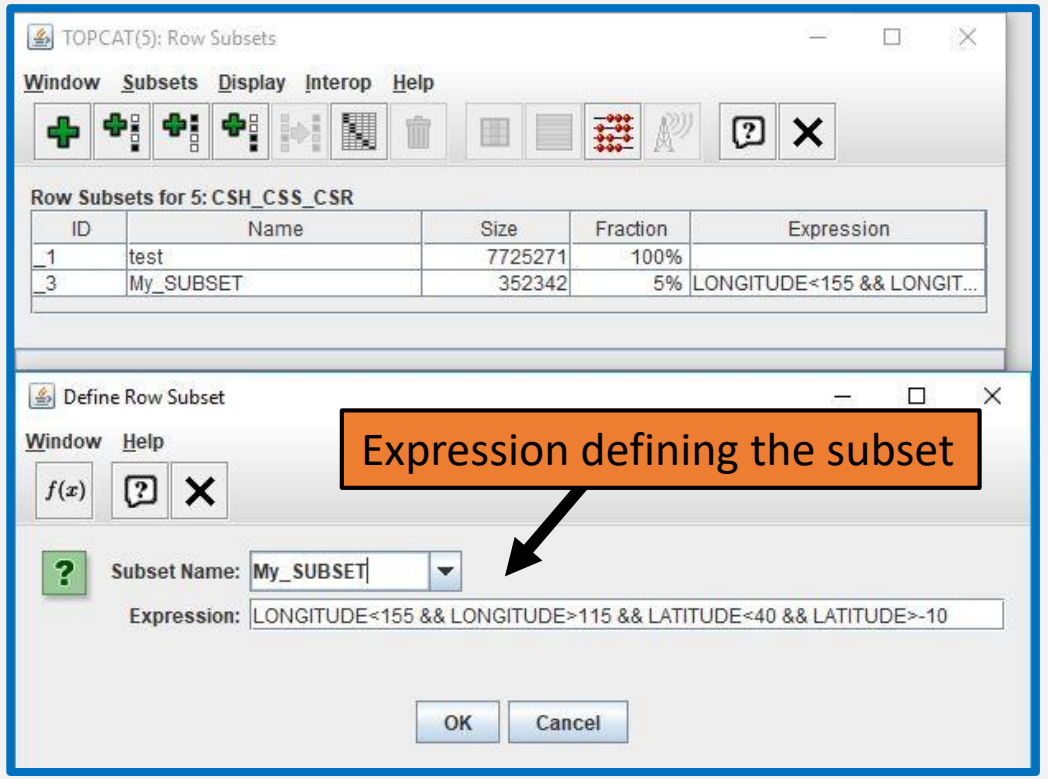
27	26	CSH	vir_da700_15230	0	VIR_VIS_1A_1_493158996	0	S_H_SPE_H_SPA_F	26,	2015-08-18T08:35:28.948	493159015	10	2,	135,065	170,414	137,47	140,763	84,4198	1472,23

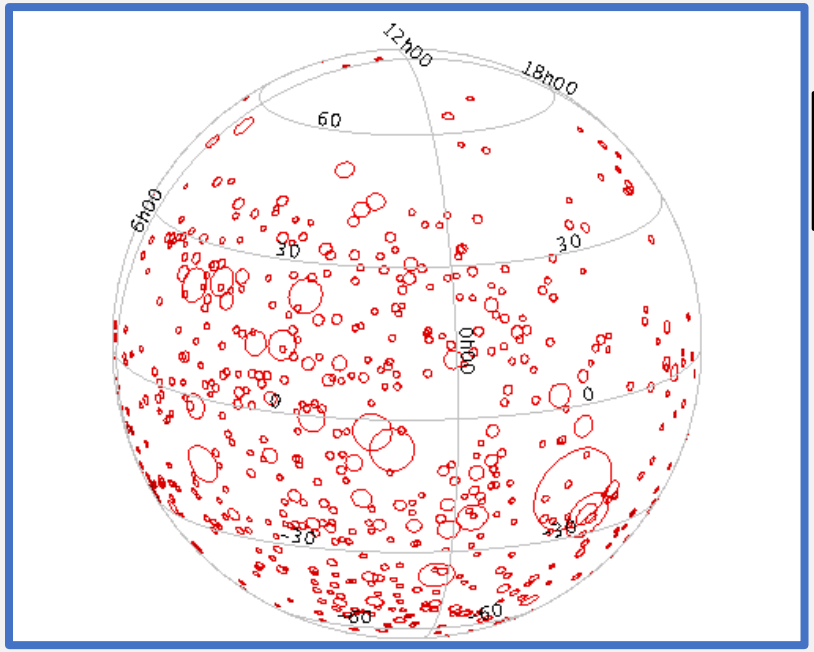
- Multiple formats: VOTable, FITS, ASC, TXT, CDF…
- Editing: cell, column, metadata
- **Powerful subset definition tool**: **from a graphic** (manually), **from an algebraic expression**
- Table concatenation
- Cross match
- Session export: back-up with defined subsets, format conversion





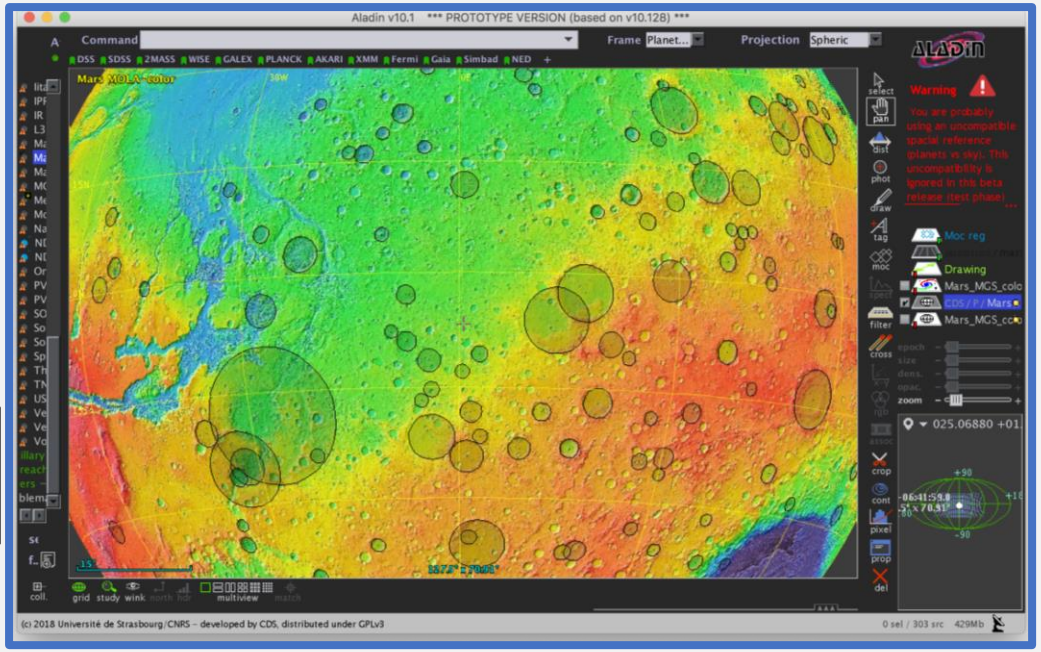
- One of the basic tools of the **Virtual Observatory** in astronomy
- **Query to distant databases**, result crossing, **data importation ; TAP protocol** support
- **EPN-TAP protocol** support in the framework of VESPA (50 services worldwide related to planetary science)

- **SAMP protocol**:
  - Transfer from the VESPA portal to TOPCAT
  - Data exchange between VO tools (Aladin, CASSIS)



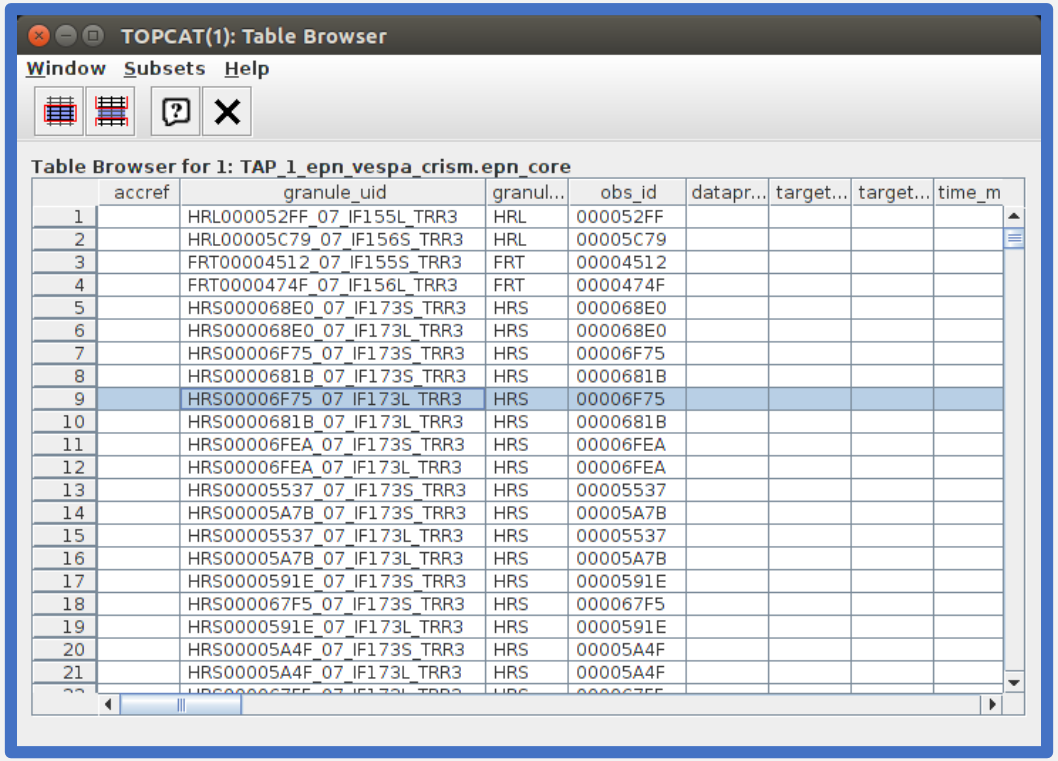
Mars crater footprints in TOPCAT…

…transferred to Aladin through the SAMP protocol



- Statistics, math function library, **histograms** (1D, 2D)
- **Automatic actions on row selection**: code execution, display image, open/download URL, send FITS image/VOTtable/spectrum…

- **Graphics**: 2D and 3D with numerous options:
  - Density, weighted, label, linear fit, vector, error bars, grid, contour… + personalisation (axis…)



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2		HRL00005C79_07_IF156S_TRR3	HRL	00005C79				
3		FRT00004512_07_IF155S_TRR3	FRT	00004512				
4		FRT0000474F_07_IF156L_TRR3	FRT	0000474F				
5		HRS000068E0_07_IF173S_TRR3	HRS	000068E0				
6		HRS000068E0_07_IF173L_TRR3	HRS	000068E0				
7		HRS00006F75_07_IF173S_TRR3	HRS	00006F75				
8		HRS0000681B_07_IF173S_TRR3	HRS	0000681B				
9		HRS00006F75_07_IF173L_TRR3	HRS	00006F75				
10		HRS0000681B_07_IF173L_TRR3	HRS	0000681B				
11		HRS00006FEA_07_IF173S_TRR3	HRS	00006FEA				
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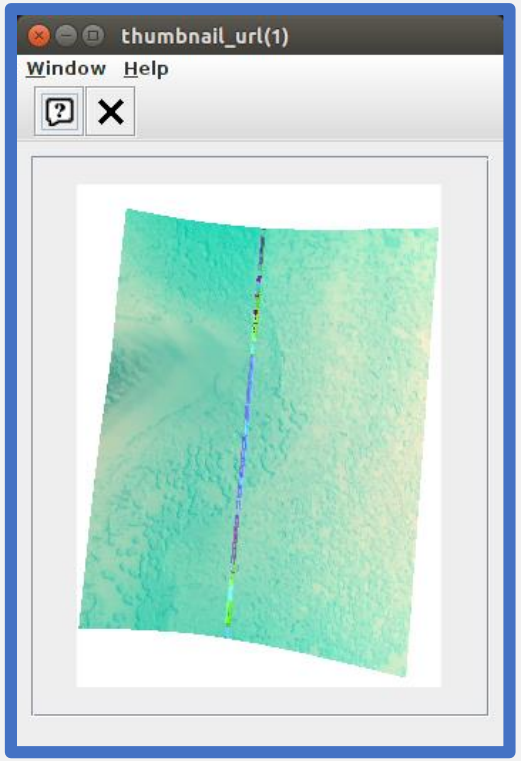
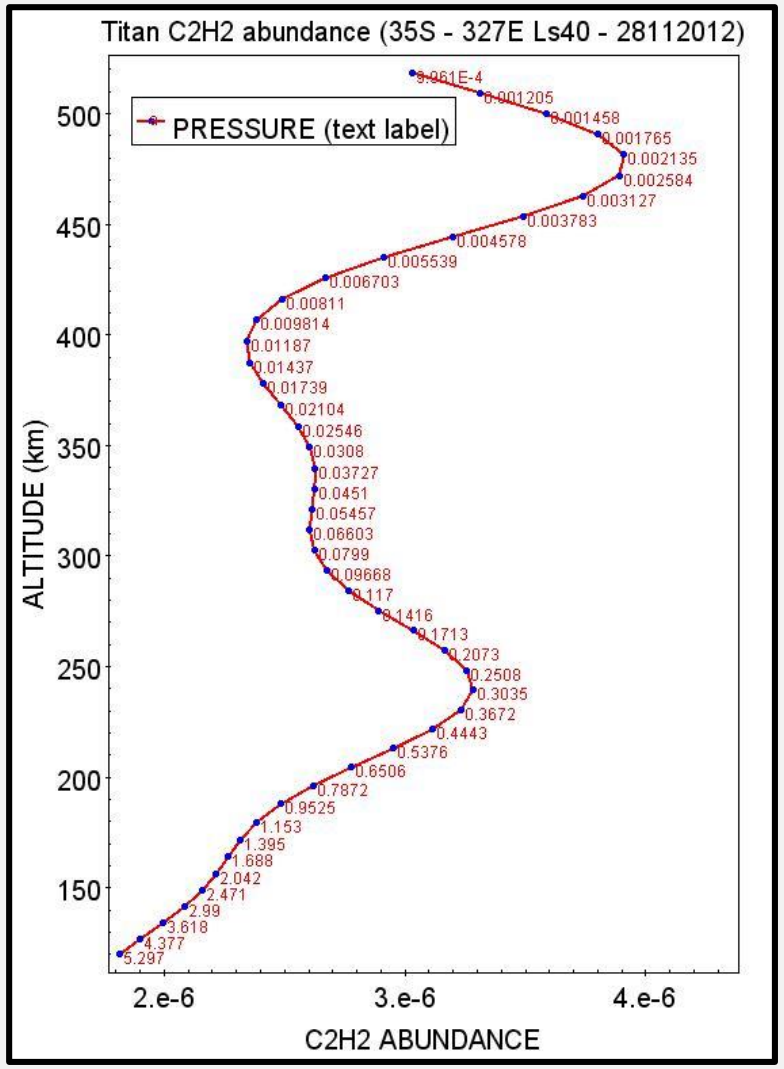


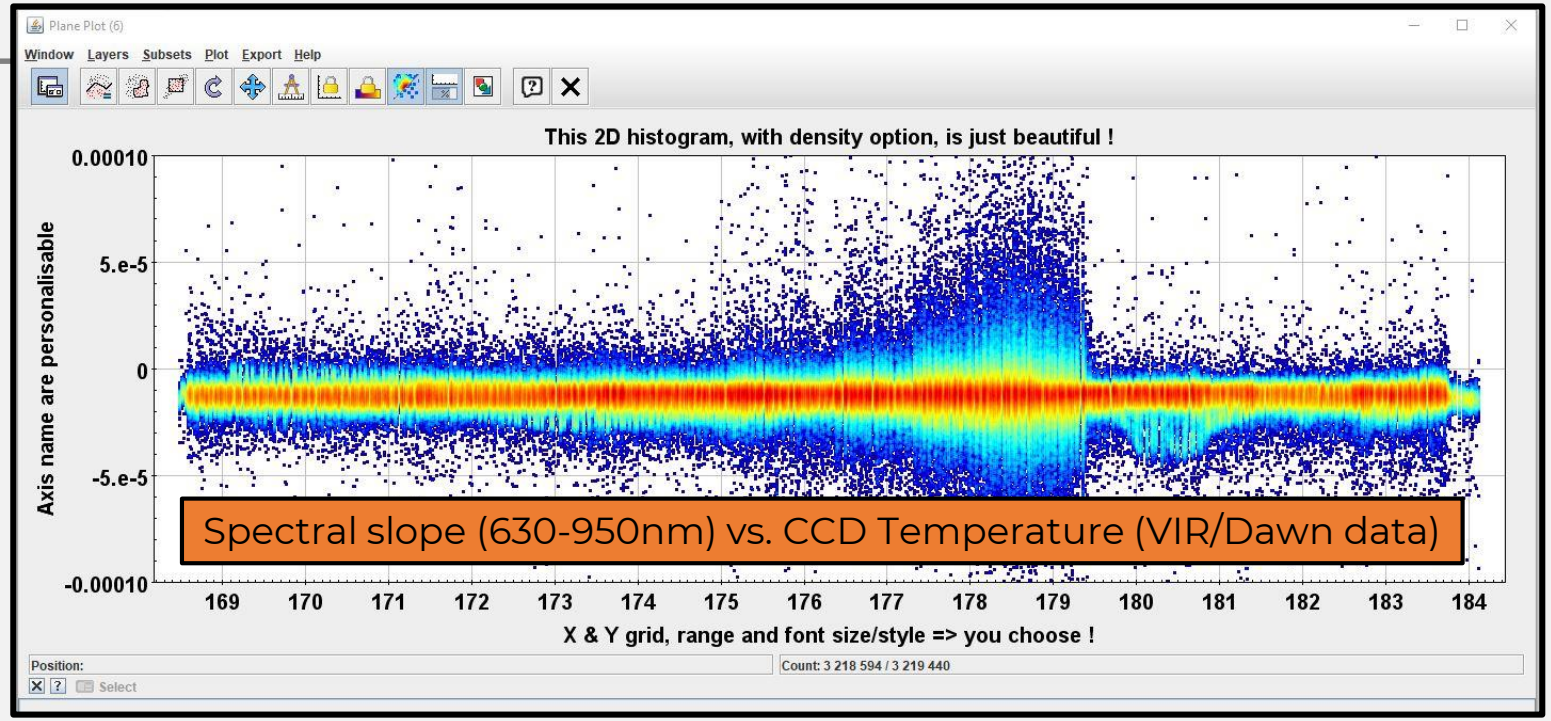
- **Automatic action example**:
  - Table with references of CRISM observations downloaded with distant query.
  - On row selection, a thumbnail can be opened to visualize the content.

https://github.com/epn-vespa/tutorials/blob/master/surfaces/jra-t4-EPN1-CRISM/jra-t4-EPN1-CRISM-Tutorial.md

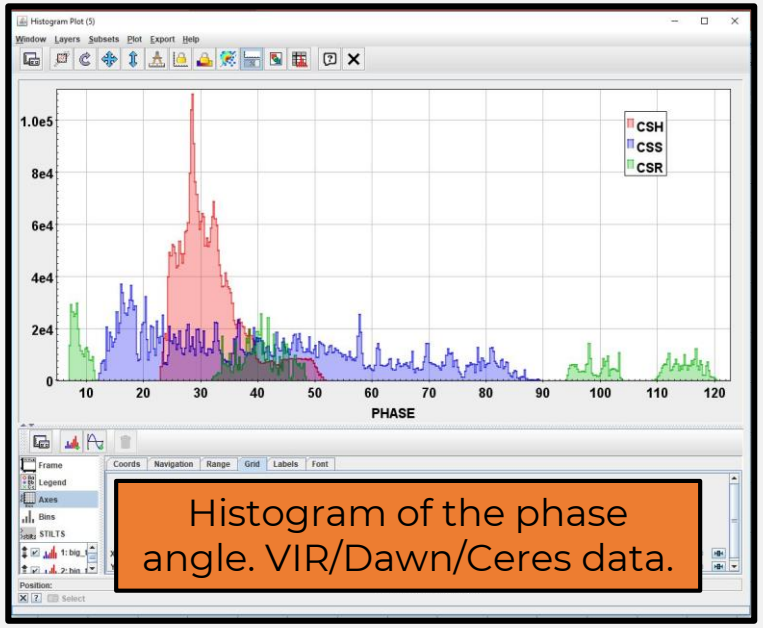
Graphic examples



C2H2 Titan atmospheric profile from Cassini/CIRS. Data downloaded from VESPA portal.

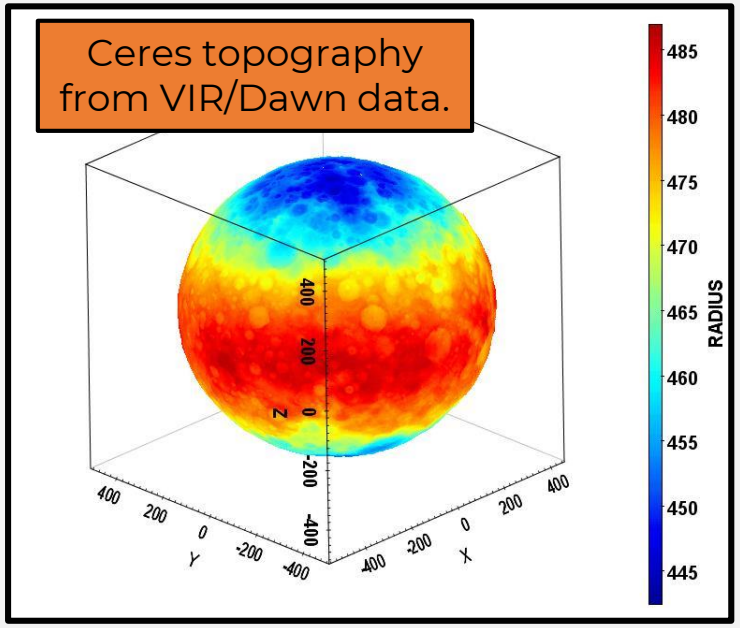


Spectral slope (630-950nm) vs. CCD Temperature (VIR/Dawn data)



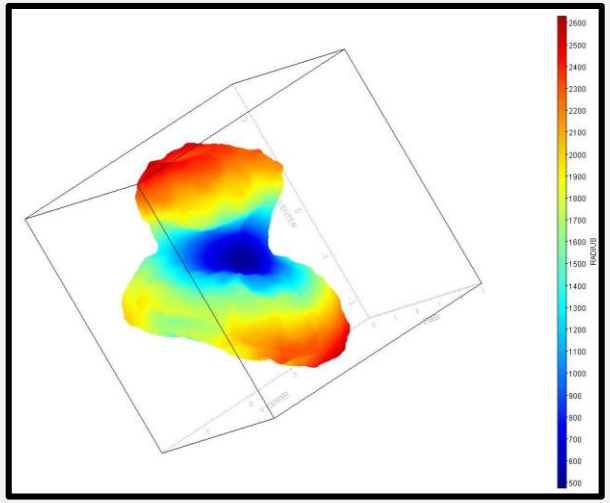
Histogram of the phase angle. VIR/Dawn/Ceres data.

Ceres topography from VIR/Dawn data.

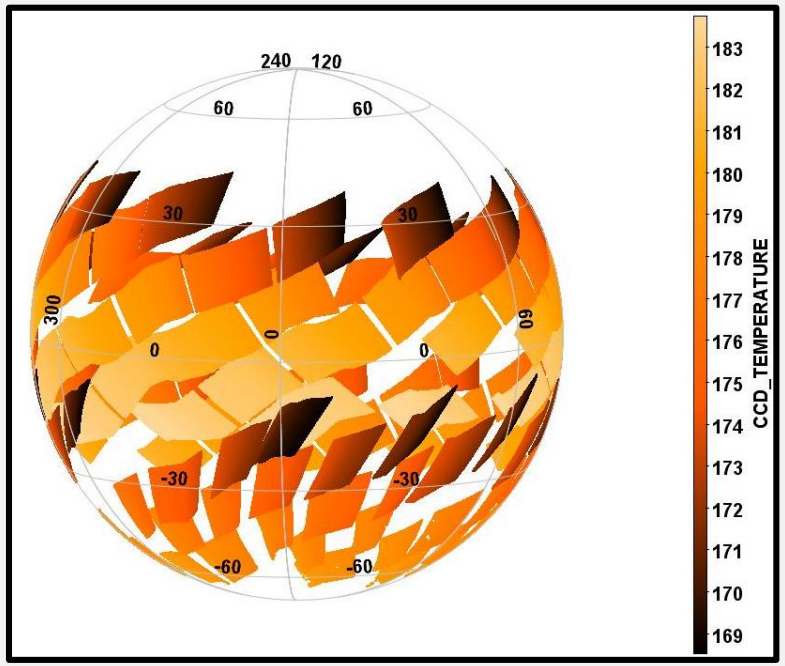


- "Sky plotting" with sinusoidal, Aitoff and plate carrée/equirectangular projections
- 3D plotting using cartesian or spherical polar coordinates
- Healpix functionnality

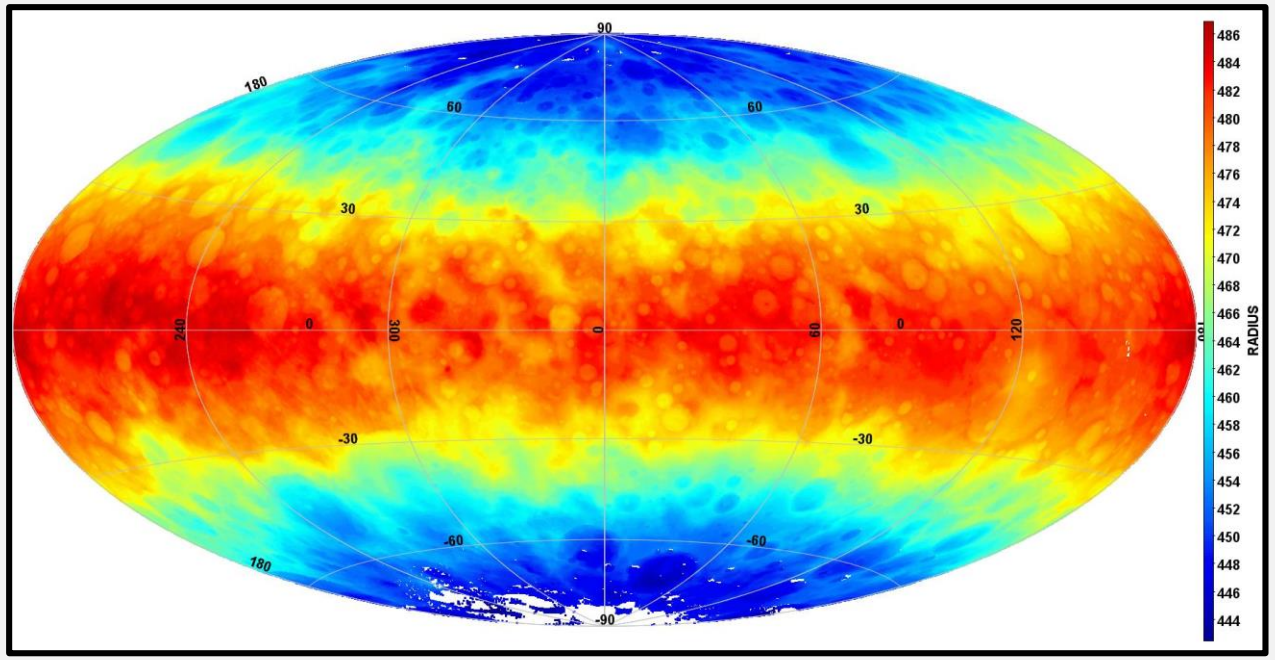
- **Global map with millions of pixels <u>in few seconds</u>**
- **New tool for pixel footprints** (polygon shape)



67P radius from VIRTIS/Rosetta data



VIR/Dawn hyperspectral images on Ceres. CCD temperature. 1 point=1 pixel.

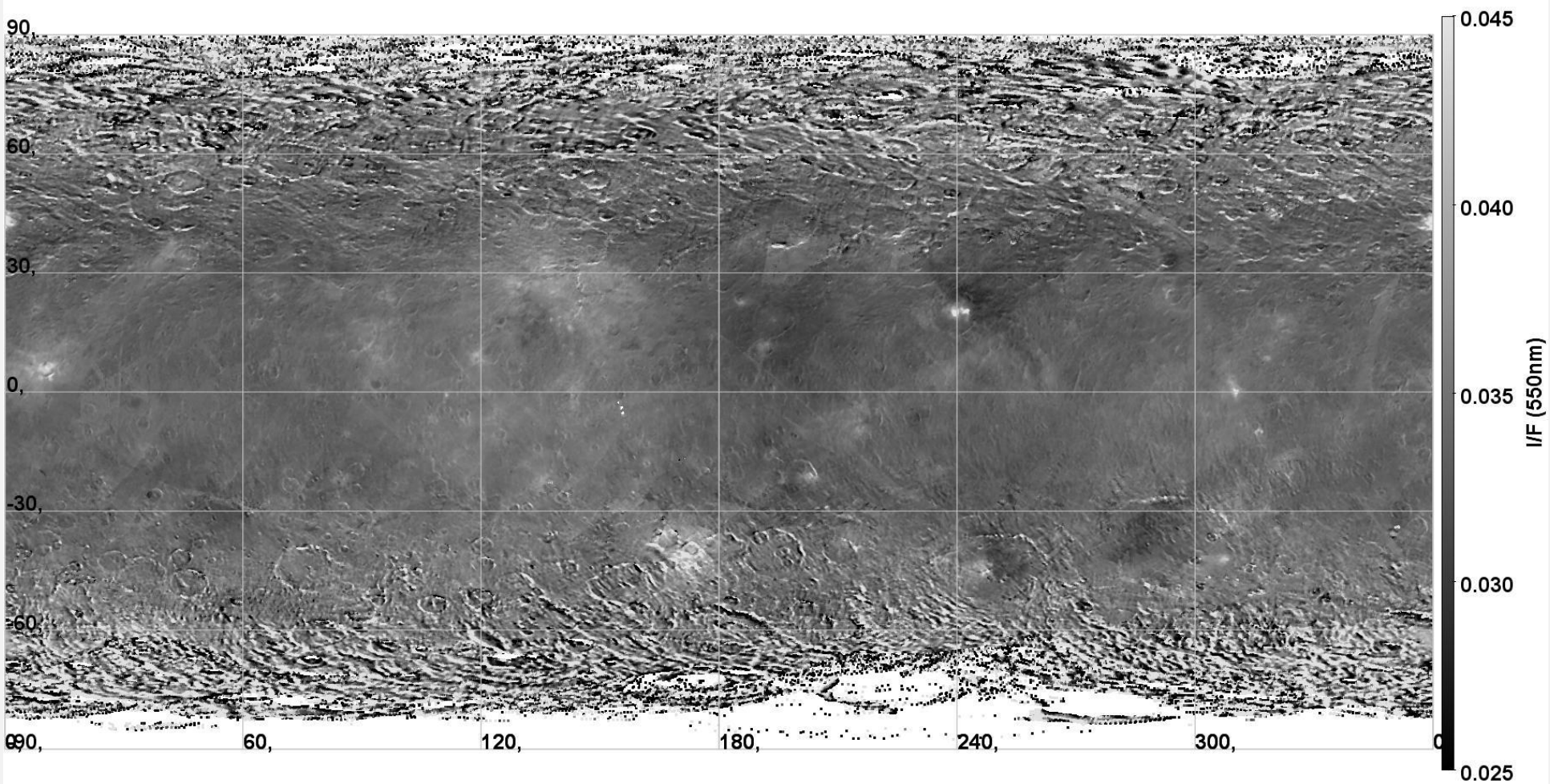


Ceres global radius map. 1 point = 1 pixel. Data from VIR/Dawn.

Mapping tool: global result with a large dataset

1 pixel = 1 point. **Map of 7,7M pixels…in few seconds**

The result for overlapping of data is customizable (mean, **median**, min, max, sum, stdev…).

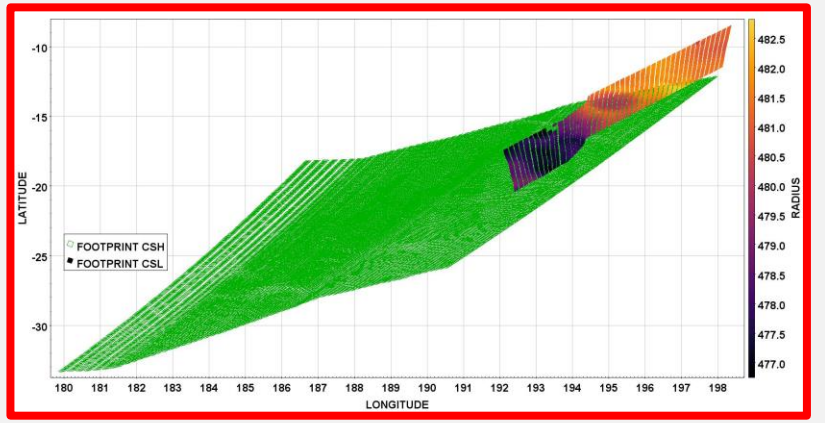


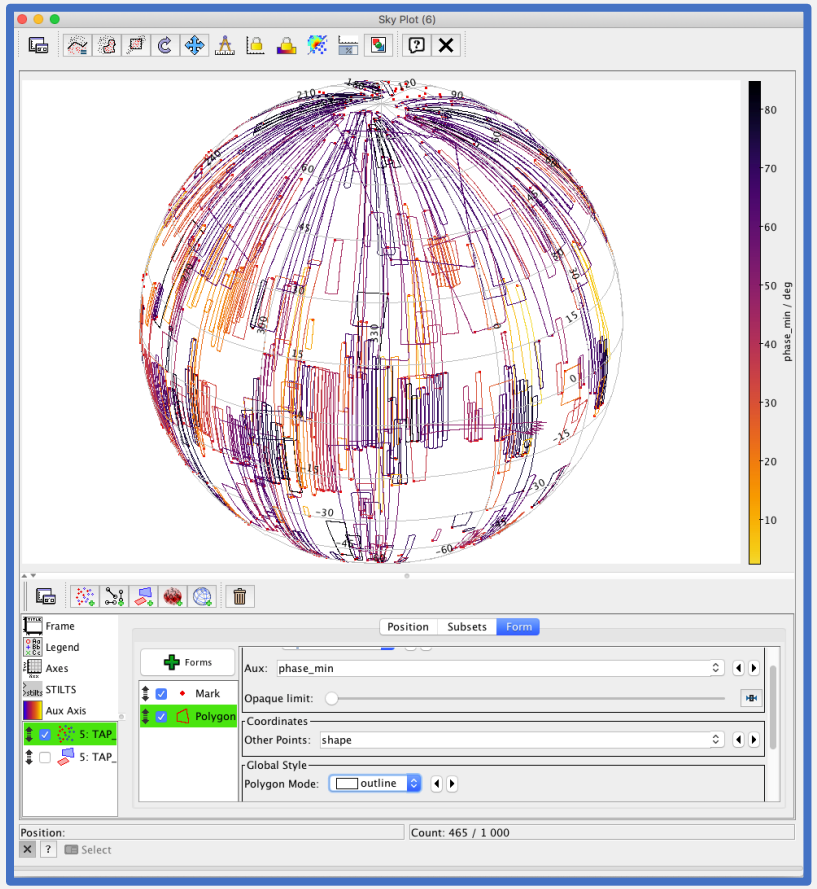
Ceres surface. Reflectance map (550nm). Data from the VIR imaging spectrometer

New POLYGON tool for pixel footprints

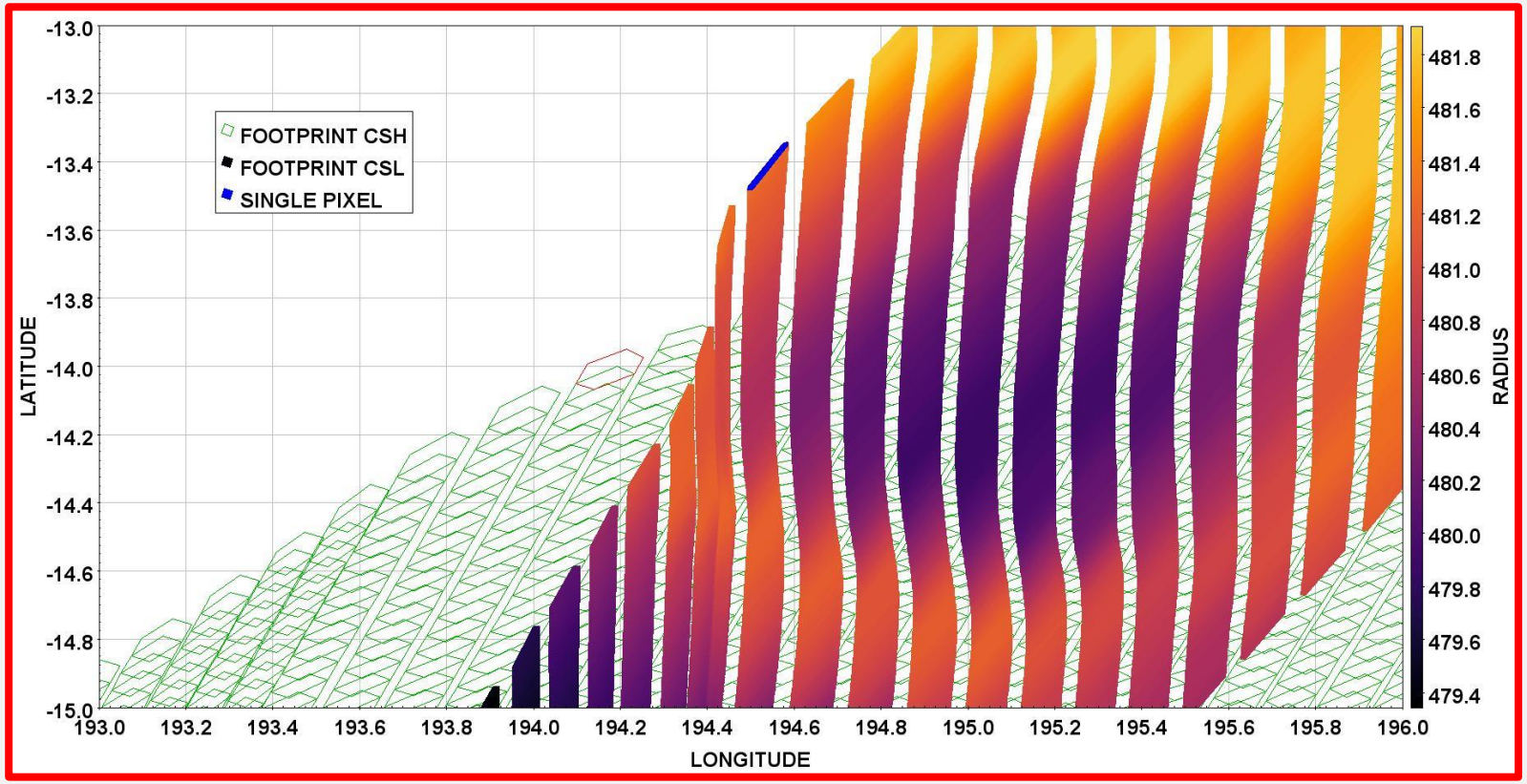
Use to draw the footprint of **pixels**, **cubes**...

Convenient for “local” mapping and to preserve a more realistic size of the projected pixel





HRSC image footprints (Mars)



Projected pixels of the VIR/Dawn imaging spectrometer (Ceres)

Conclusion

Multi-functionality. Interactivity. Flexibility. Speed. User-friendliness.

- TOPCAT is adapted and powerful to deal with remote sensing data in planetary science.

- Free download, more details and complete documentation at: **www.starlink.ac.uk/topcat/**

- Mark Taylor (developer) is open to suggestions from our community. Don't hesitate to contact him.

- Use cases: **www.europlanet-vespa.eu/tutos.shtml**

- More details, **live demo: come to see me** or contact me: batiste.rousseau@inaf.it