Renewed observation plan of Akatsuki

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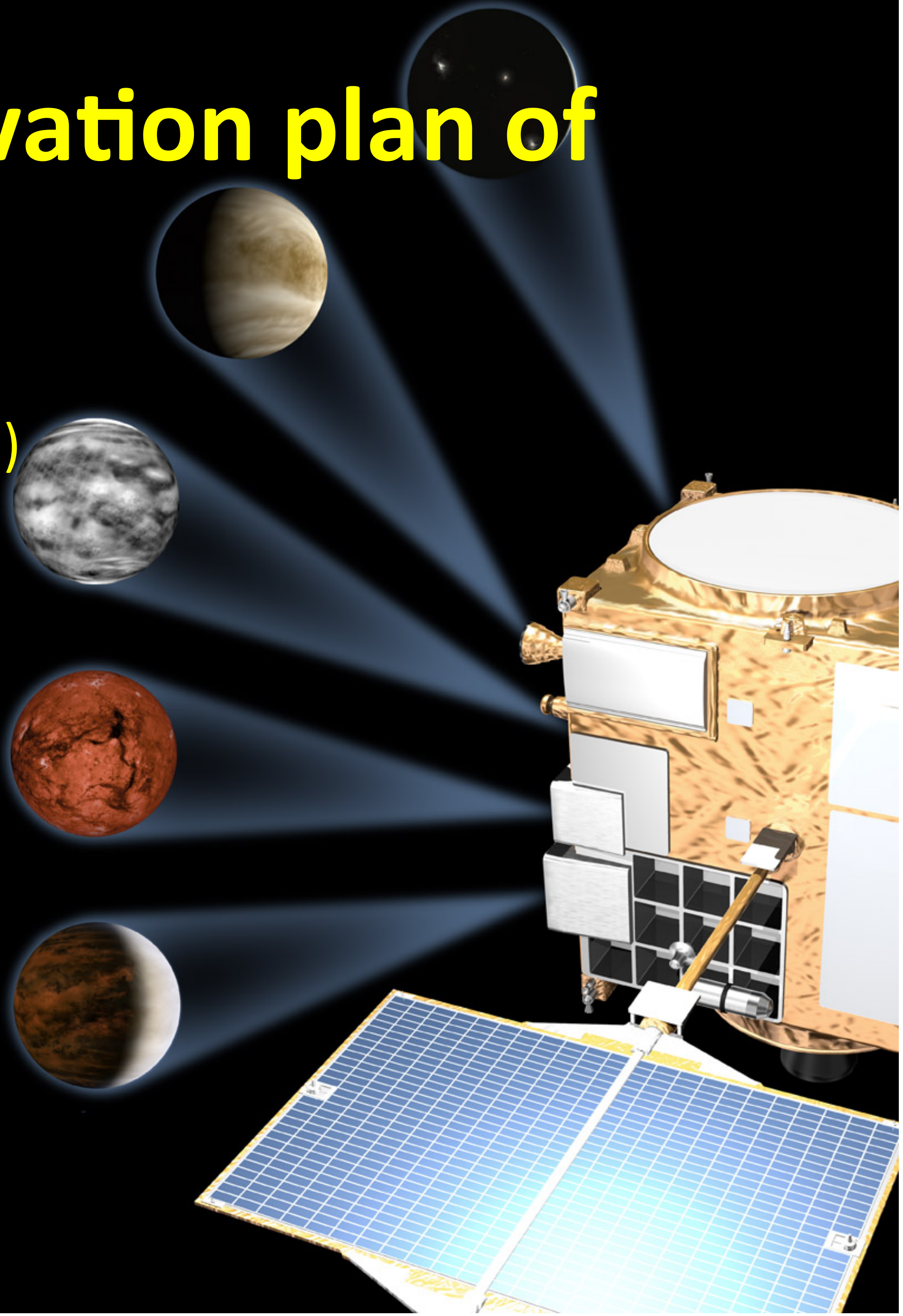
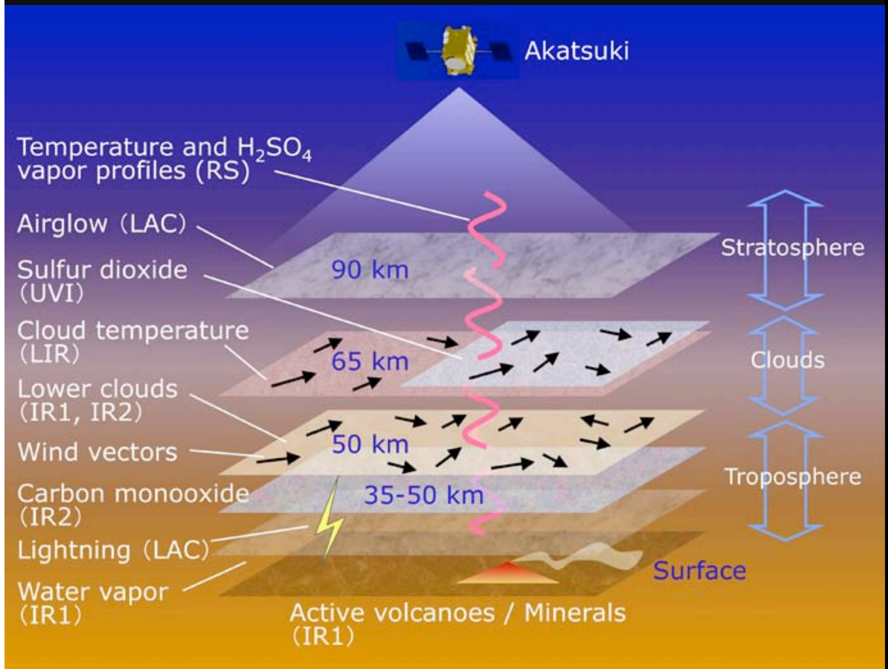
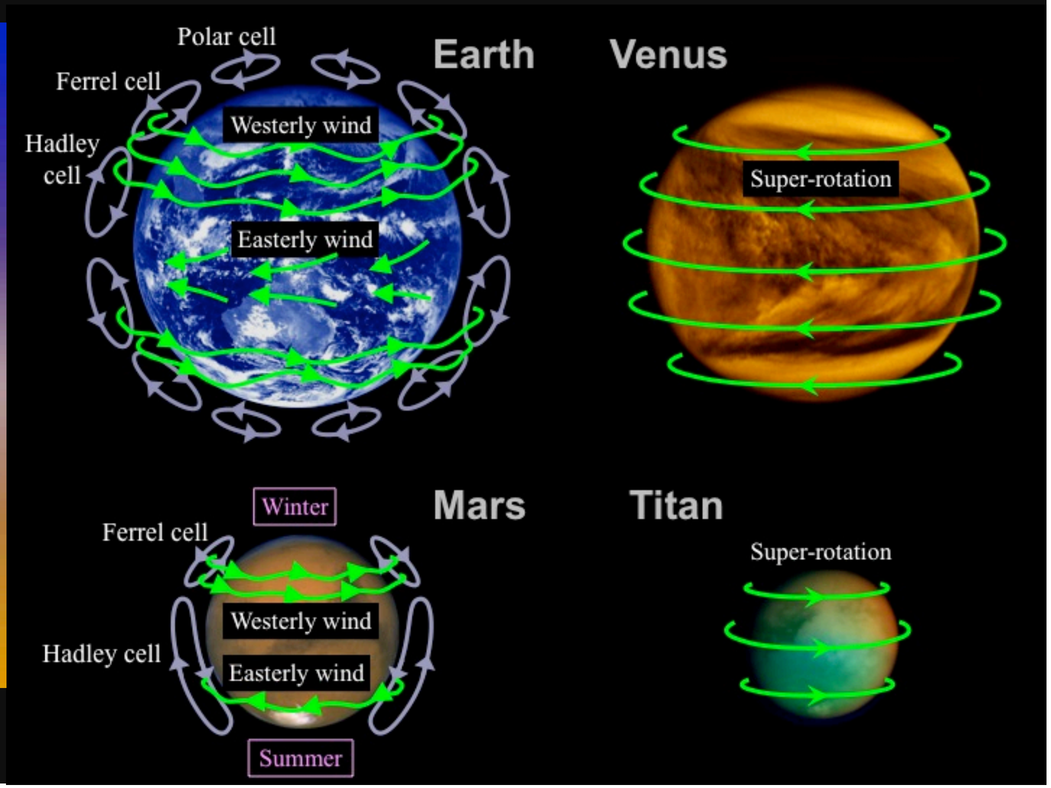
Akatsuki project team



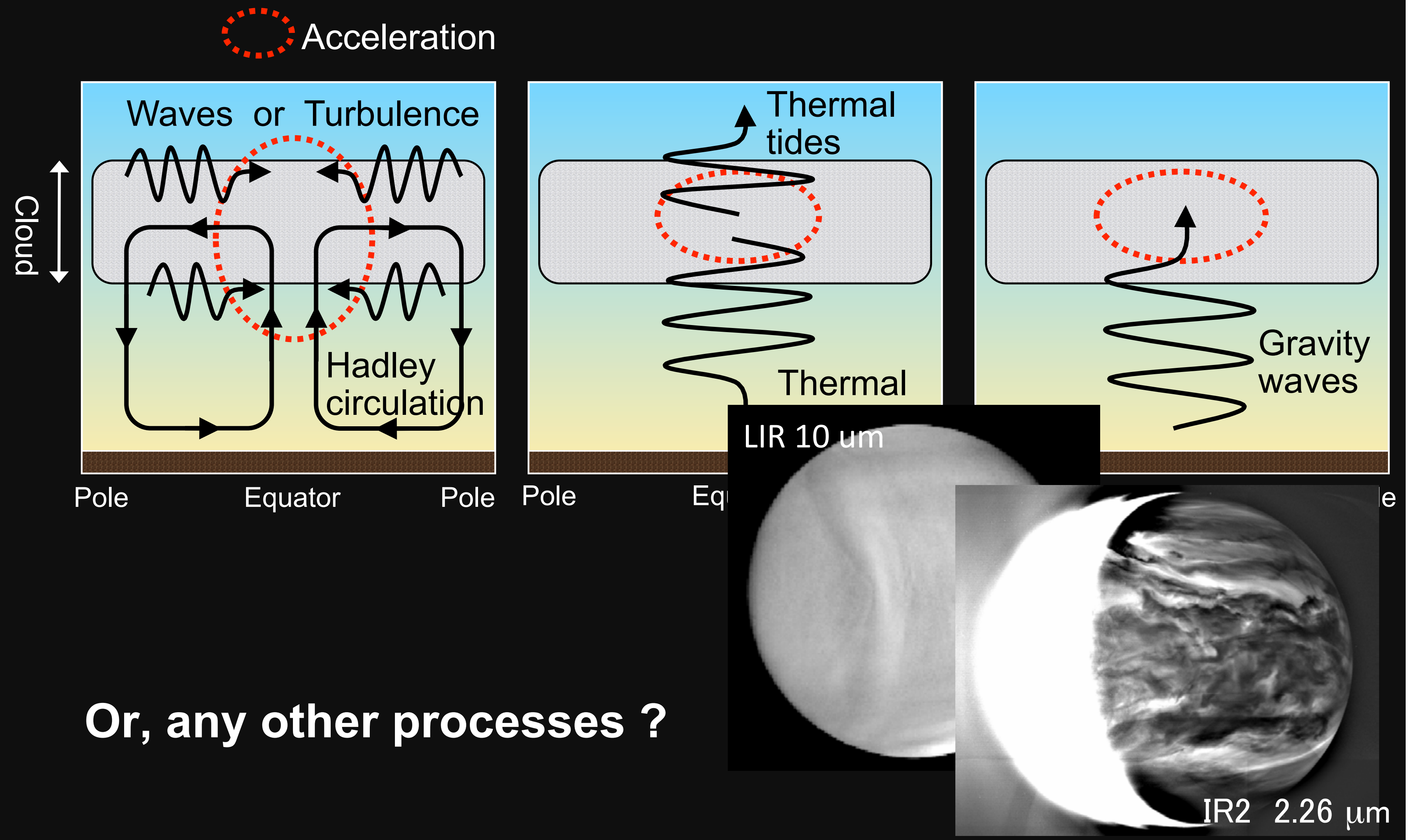
Toward the understanding of Venusian climate

- Mechanism of super-rotation : roles of eddies and meridional circulation
- Structure of meridional circulation : direct/indirect/stacked cells
- Meso-scale processes : convection, gravity waves, instabilities
- Formation of clouds : transport of SO_2, chemical/dynamical production
- Lightning : spatial/temporal distribution
- Active volcanism, surface material : spatial/temporal variation of NIR flux



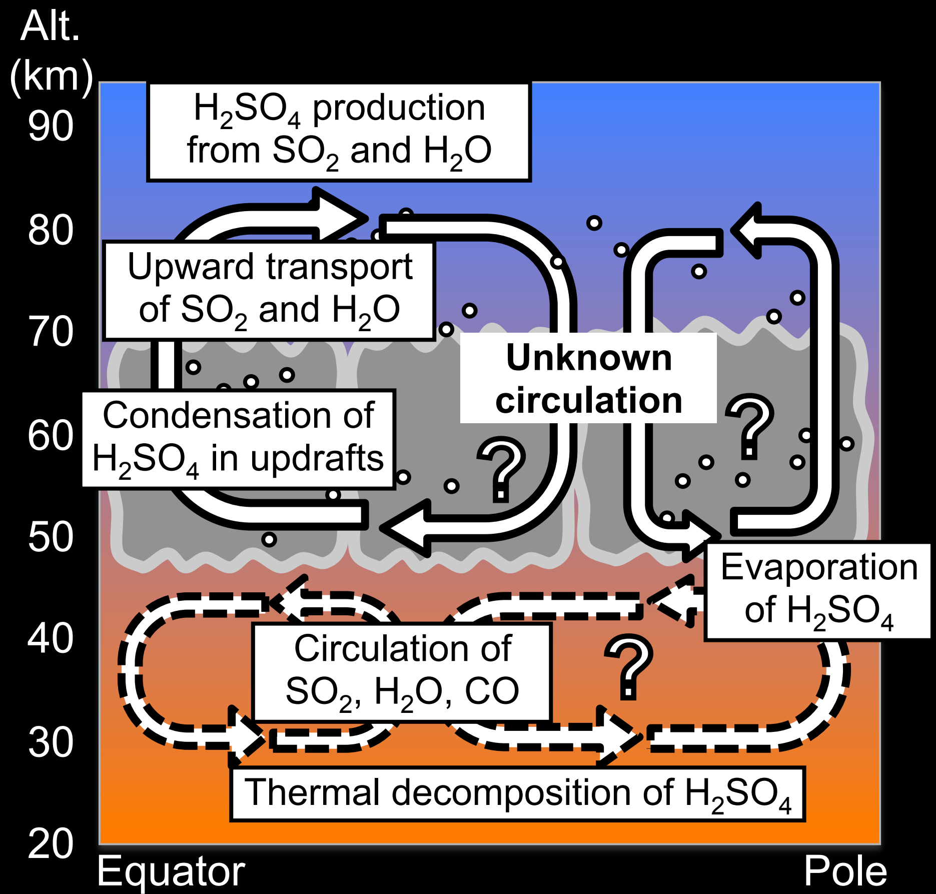


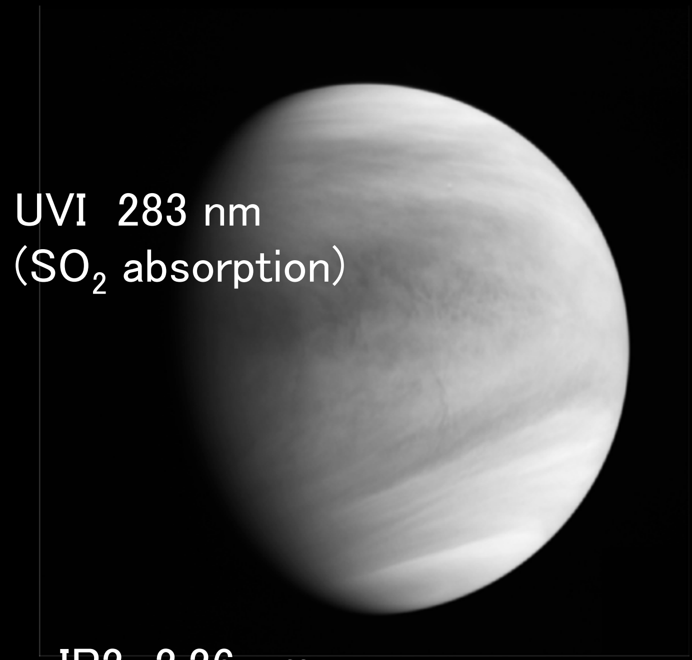
Candidate mechanisms of super-rotation



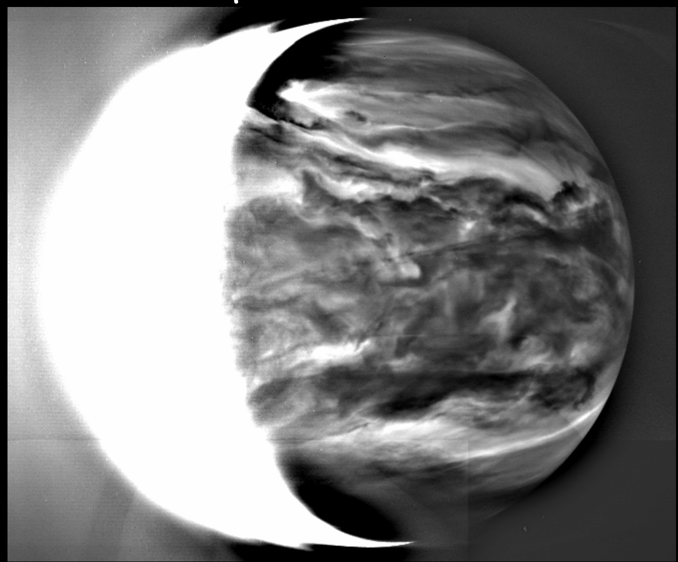
Or, any other processes ?

Cloud-formation processes

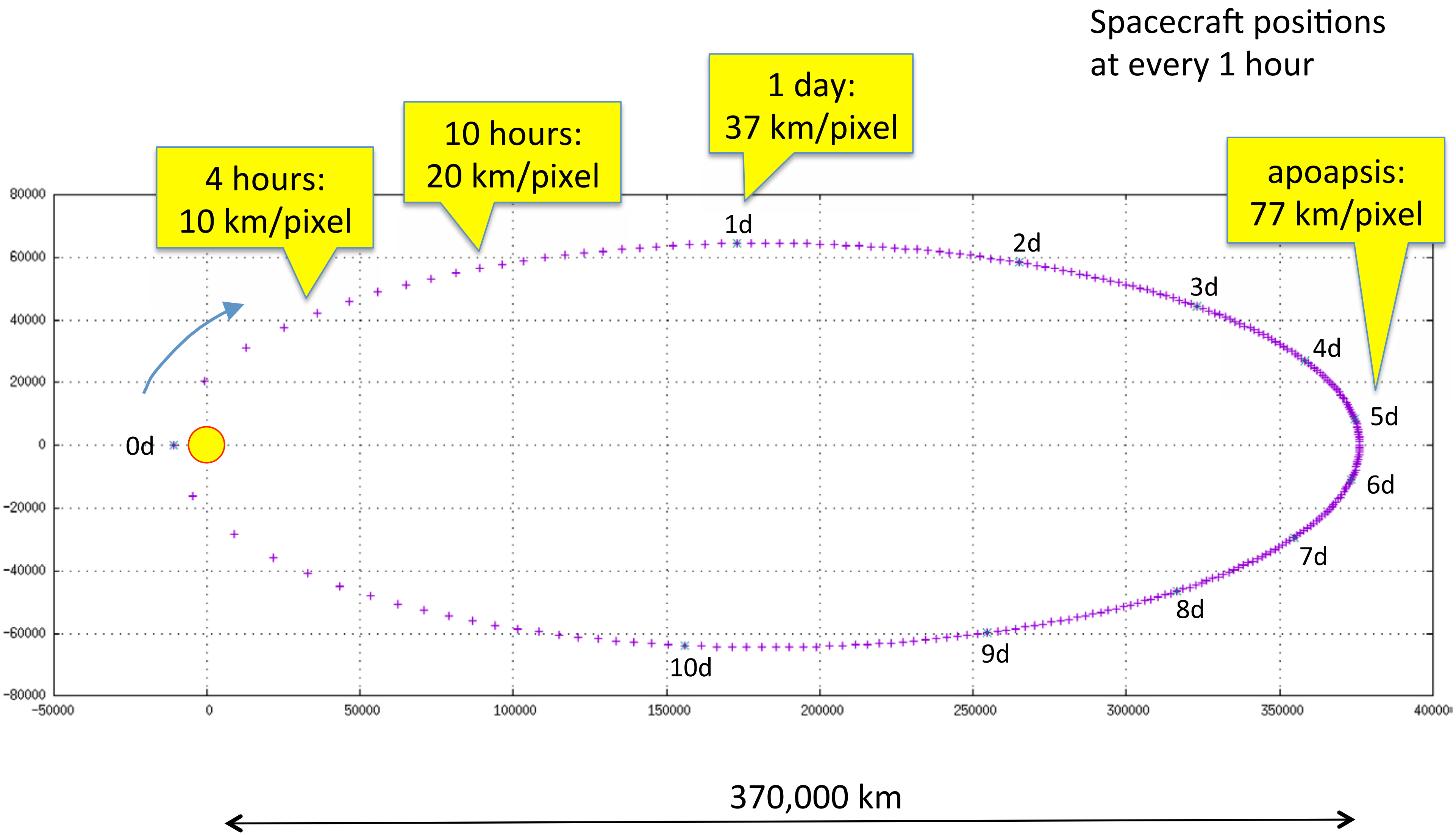




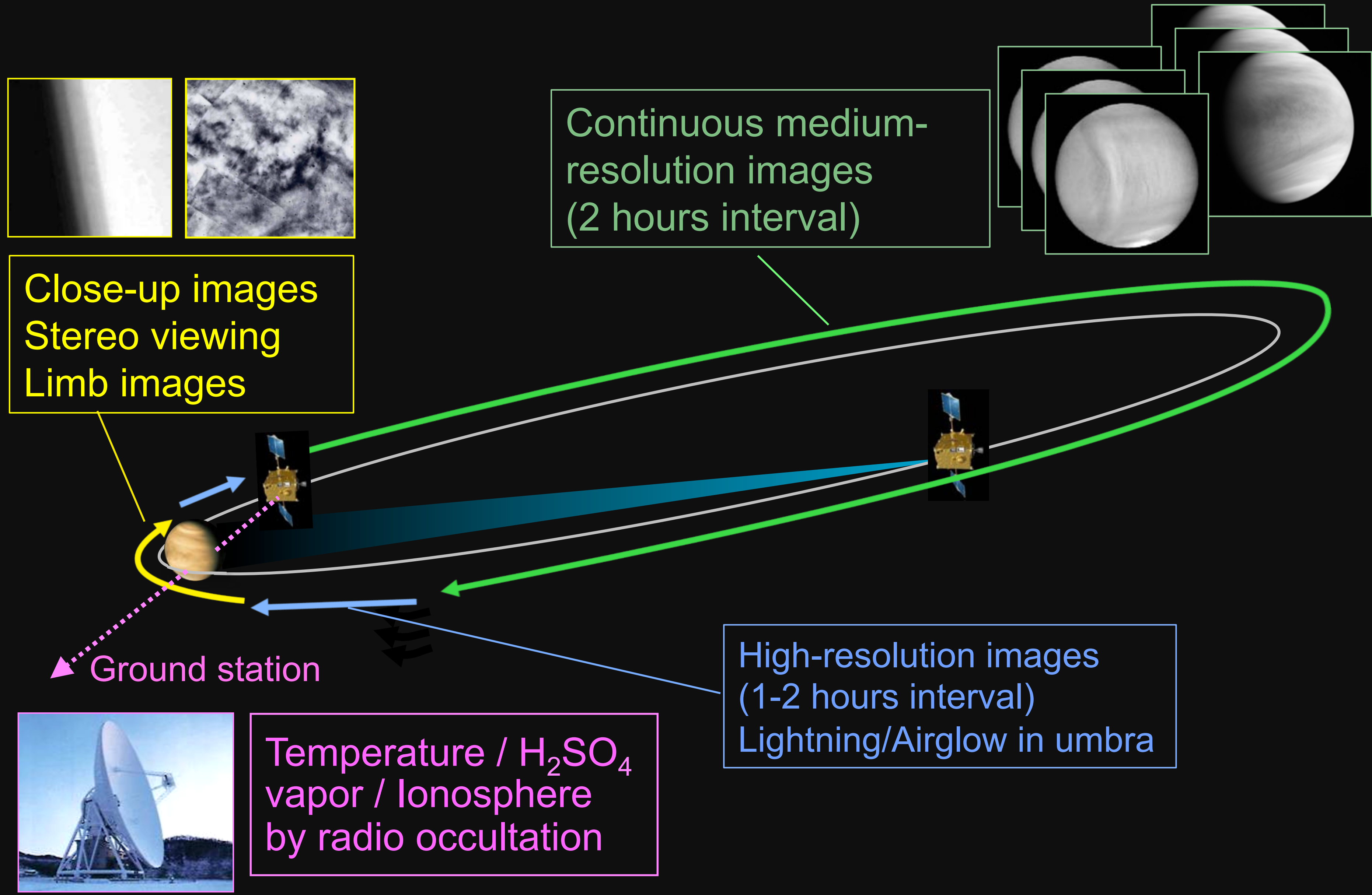
IR2 2.26 μm



Dynamical processes responsible for cloud formation seem to be much more complicated than expected.


Spacecraft positions
at every 1 hour
4 hours:
10 km/pixel
10 hours:
20 km/pixel
1 day:
37 km/pixel
apoapsis:
77 km/pixel
0d
1d
2d
3d
4d
5d
6d
7d
8d
9d
10d
80000
60000
40000
20000
0
-20000
-40000
-60000
-80000
-50000
0
50000
100000
150000
200000
250000
300000
350000
370,000 km

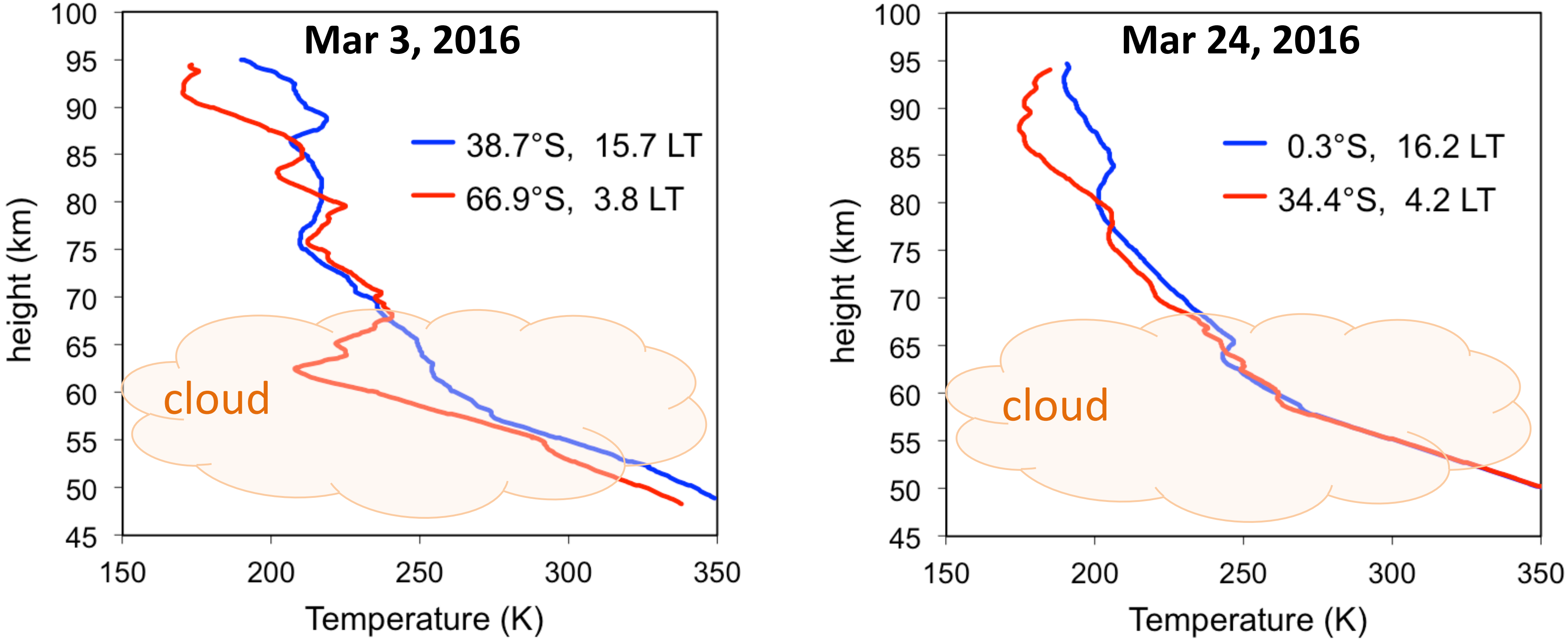
Observation sequence



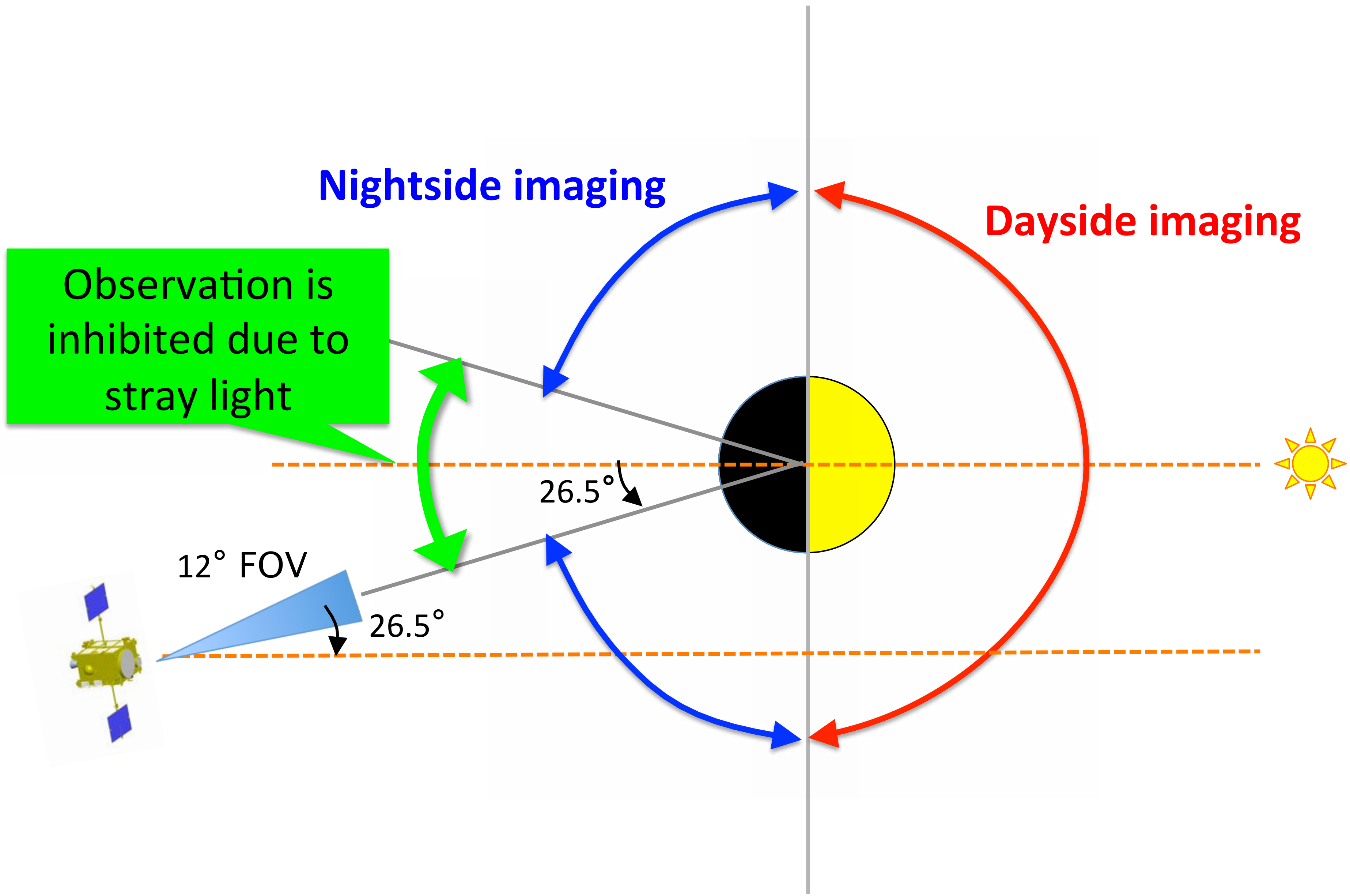
Radio occultation observation

- To complement imaging observations by vertical sounding with resolution of <1 km
- Atmospheric temperature, H_2SO_4 vapor, ionospheric electron density
- Use of an ultra-stable oscillator enables sampling of both entry and exit occultations

First results of Akatsuki's radio occultation temperatures



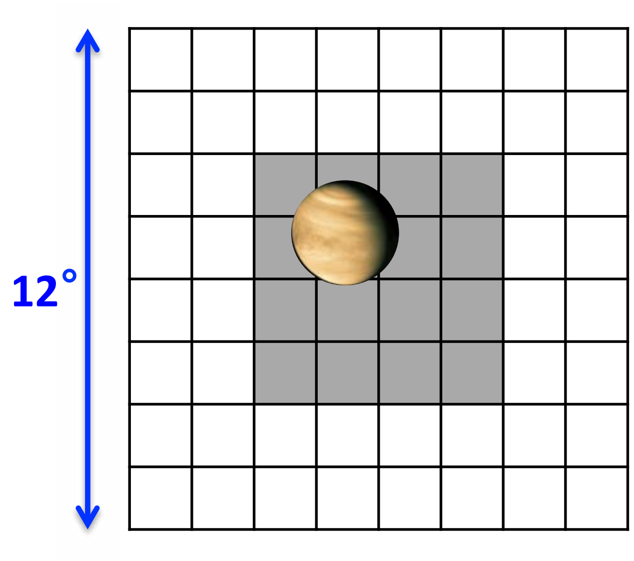
Imaging on dayside and nightside



Onboard instruments

Instrument	FOV	Detector	Filters	Width	Targets
1-μm Camera **IR1**	12°	Si-CSD/CCD 1024 x 1024 pix	1.01 μm (night)	0.04 μm	Surface, Clouds
			0.97 μm (night)	0.04 μm	H_2O vapor
			0.90 μm (night)	0.03 μm	Surface, Clouds
			0.90 μm (day)	0.01 μm	Clouds
2-μm Camera **IR2**	12°	PtSi-CSD/CCD 1024 x 1024 pix	1.735 μm (night)	0.04 μm	Clouds, Particle size
			2.26 μm (night)	0.06 μm	
			2.32 μm (night)	0.04 μm	CO below clouds
			2.02 μm (day)	0.04 μm	Cloud-top height
			1.65 μm (cruise)	0.3 μm	Zodiacal light
UltraViolet Imager **UVI**	12°	Si-CCD 1024 x 1024 pix	283 nm (day)	15 nm	SO_2 at cloud top
			365 nm (day)	15 nm	Unknown absorber
Longwave IR Camera **LIR**	12.4X 16.4°	Bolometer 248 x 328 pix	10 μm (day/ night)	4 μm	Cloud-top temperature
Lightning & Airglow Camera **LAC**	16°	8 x 8 APD (50kHz sampling in lightning mode)	777.4 nm (night)	4.2 nm	OI lightning
			552.5 nm (night)	4.7 nm	O_2 HerzbergII ariglow
			557.7 nm (night)	3.1 nm	OI airglow
			630.0 nm (night)	3.5 nm	OI airglow
Ultra-stable oscillator for Radio Science **RS**			X-band (8.4GHz)		Vertical prifiles of T, H_2SO_4 (g), Ne

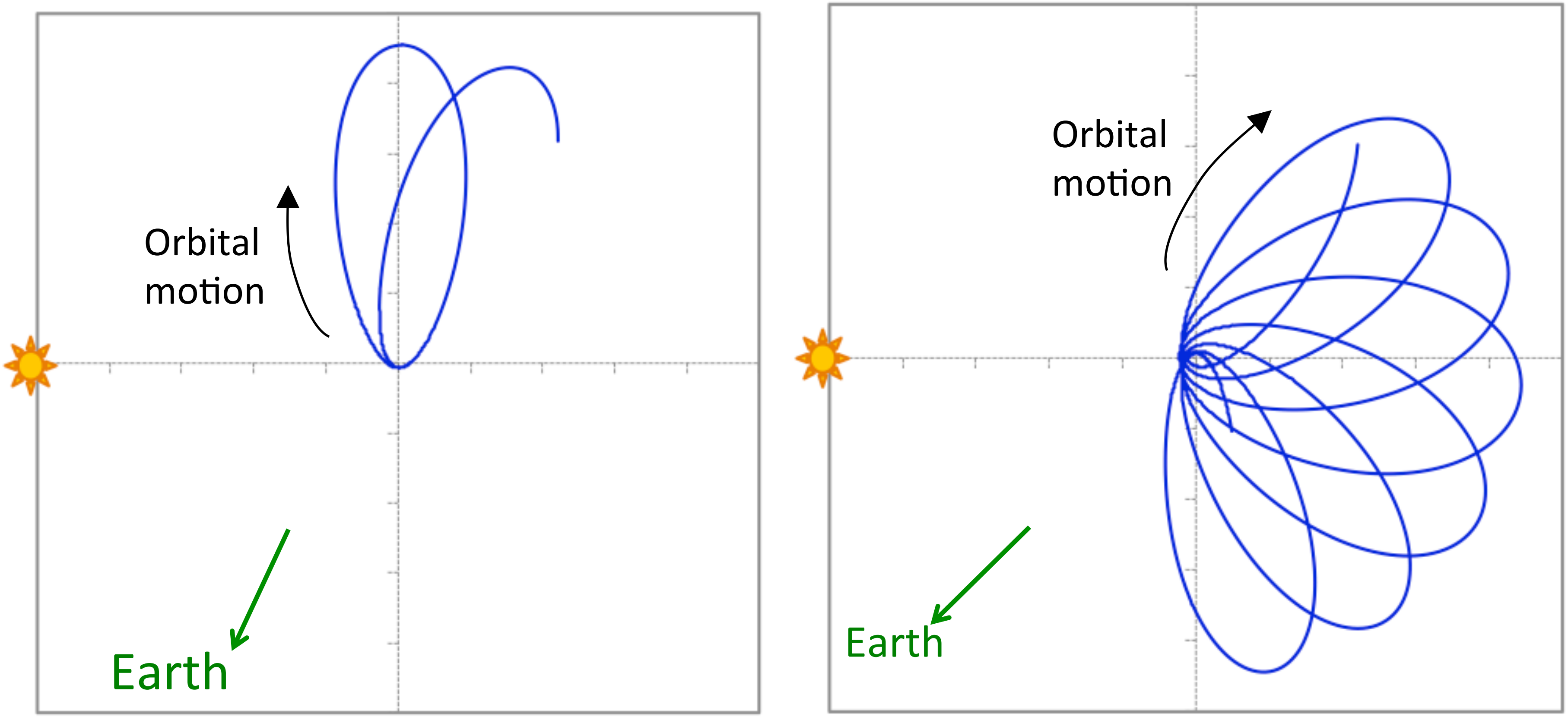
ROI (region of interest) function



- The angular diameter of Venus is 1.9° near the apocenter.
- Images composed of 1024x1024 pixels are divided into 8x8=64 “tiles” before compression. The “ROI (region of interest)” function of the onboard data processing unit (DE) can extract a limited number of tiles to reduce the data volume.
- ROI function was newly installed on the processing unit just before VOI. Introduction of this function to the ground system is ongoing.

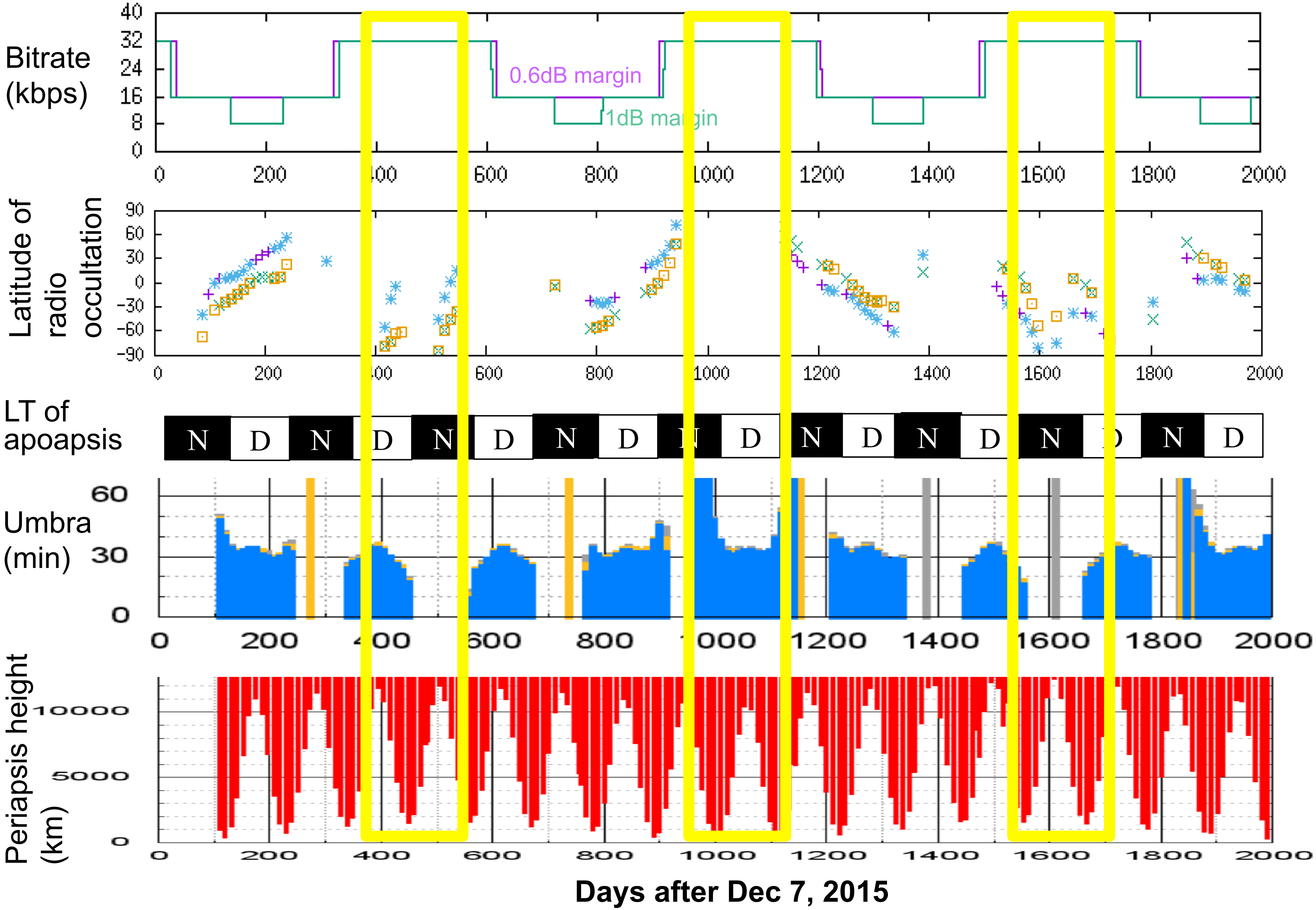
Dec 7, 2015 (VOI) to Dec 31, 2015
Initial checkout

Jan 1, 2016 to Mar 31, 2016
Initial C/O → Regular obs



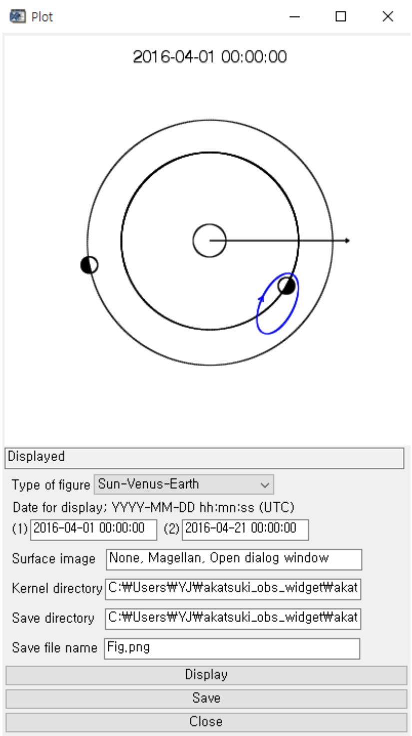
Trajectory of Akatsuki in a frame fixed to Venus and Sun
(Center: Venus)

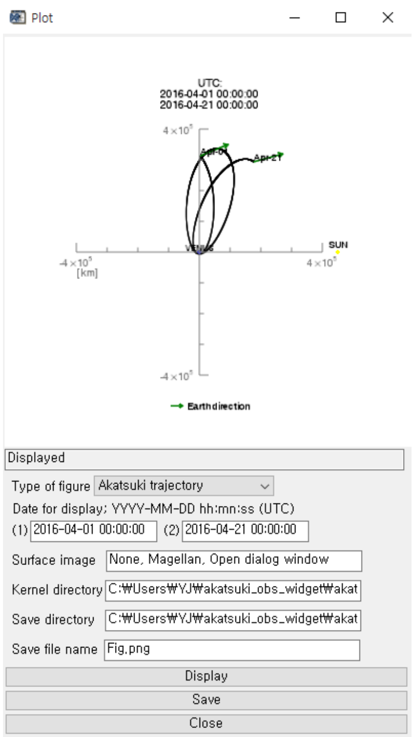
Observation conditions in next 2000 days

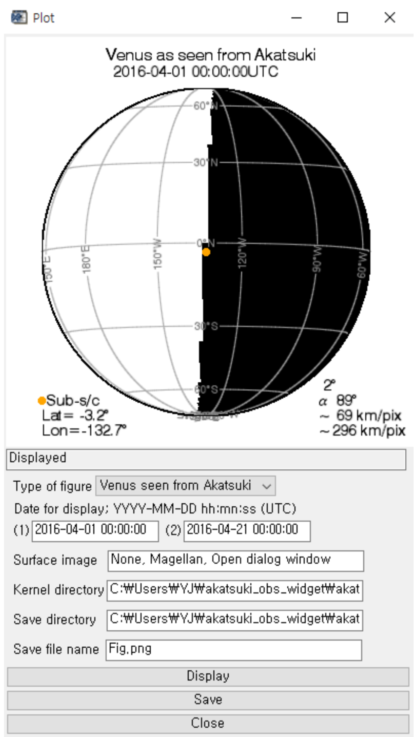


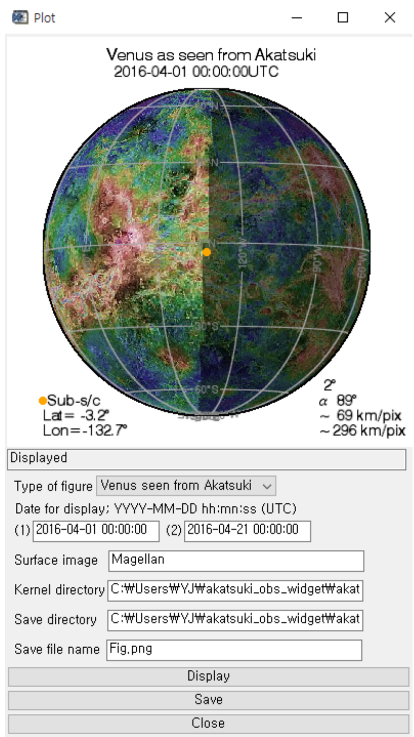
A simple tool, visualizing the observational condition of Akatsuki (by Yeon Joo Lee)

- Periods: 2015 Dec. 9th – 2020 Apr.
- Method and data: IDL, SPICE-ICY, and the predicted trajectory of Akatsuki









Data processing pipeline

Level 0 : Uncompressed images

Level 1 : Calibrated images with FITS header

Level 2 : Calibrated images with FITS header, including geometry information (to be released in PDS)

Level 3 : Brightness (and cloud-tracked vectors*) on longitude-latitude grids in netCDF format

* Cloud-tracked vectors will be newly defined as “Level 4”.

Summary

- ✓ Initial results demonstrated Akatsuki's ability to unveil yet-to-be-discovered phenomena in the atmosphere. Near-regular observations have partly started. Development of schemes to calibrate brightnesses and the optical alignment is ongoing. Regular production of science data will start soon.
- ✓ Science goals and observation strategies are almost unchanged from the original plan developed before 2010. In addition to the continuous global imaging with 1-2 hours interval, lightning/airglow observation, radio occultation measurements and close-up/limb imaging are conducted at close distances.
- ✓ Although the spatial resolution near the apoapsis is much worth and the frequencies of radio occultation and lightning search are much lower than those in the original plan, high-resolution images taken at close distances and the possible mission extension might make up for these weaknesses.
- ✓ Coordination with ground-based observations is important for comprehensive understanding of Venus's atmosphere because Akatsuki is specialized to continuous imaging of the cloud layer.