金星周回軌道投入一周年をむかえたあかつき

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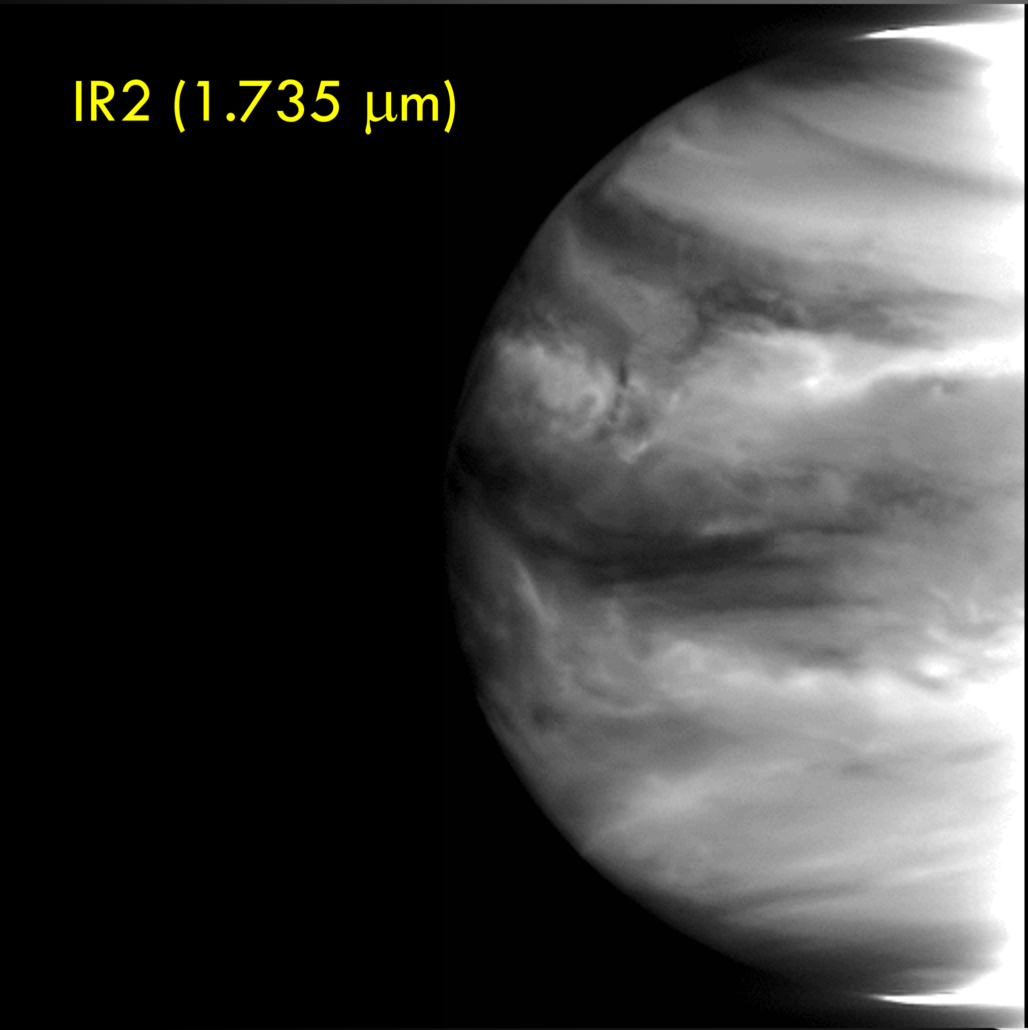
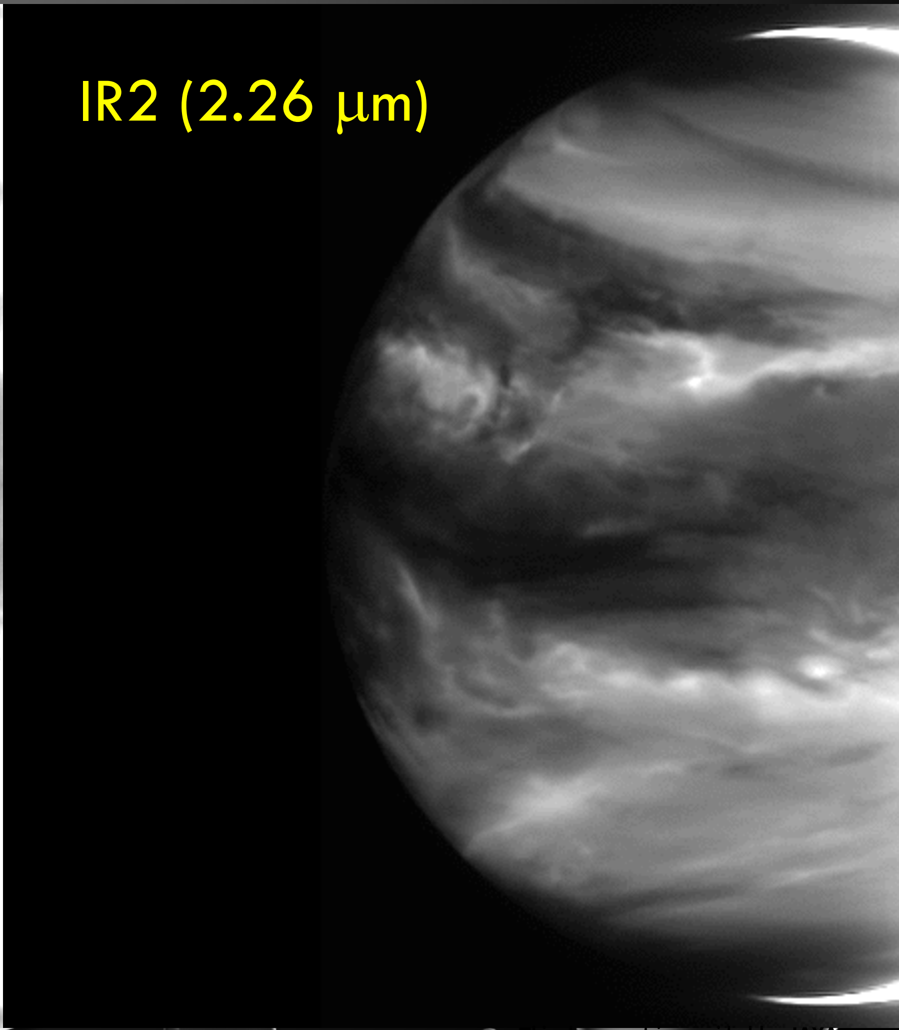
VOI-R1 ON DECEMBER 7, 2015

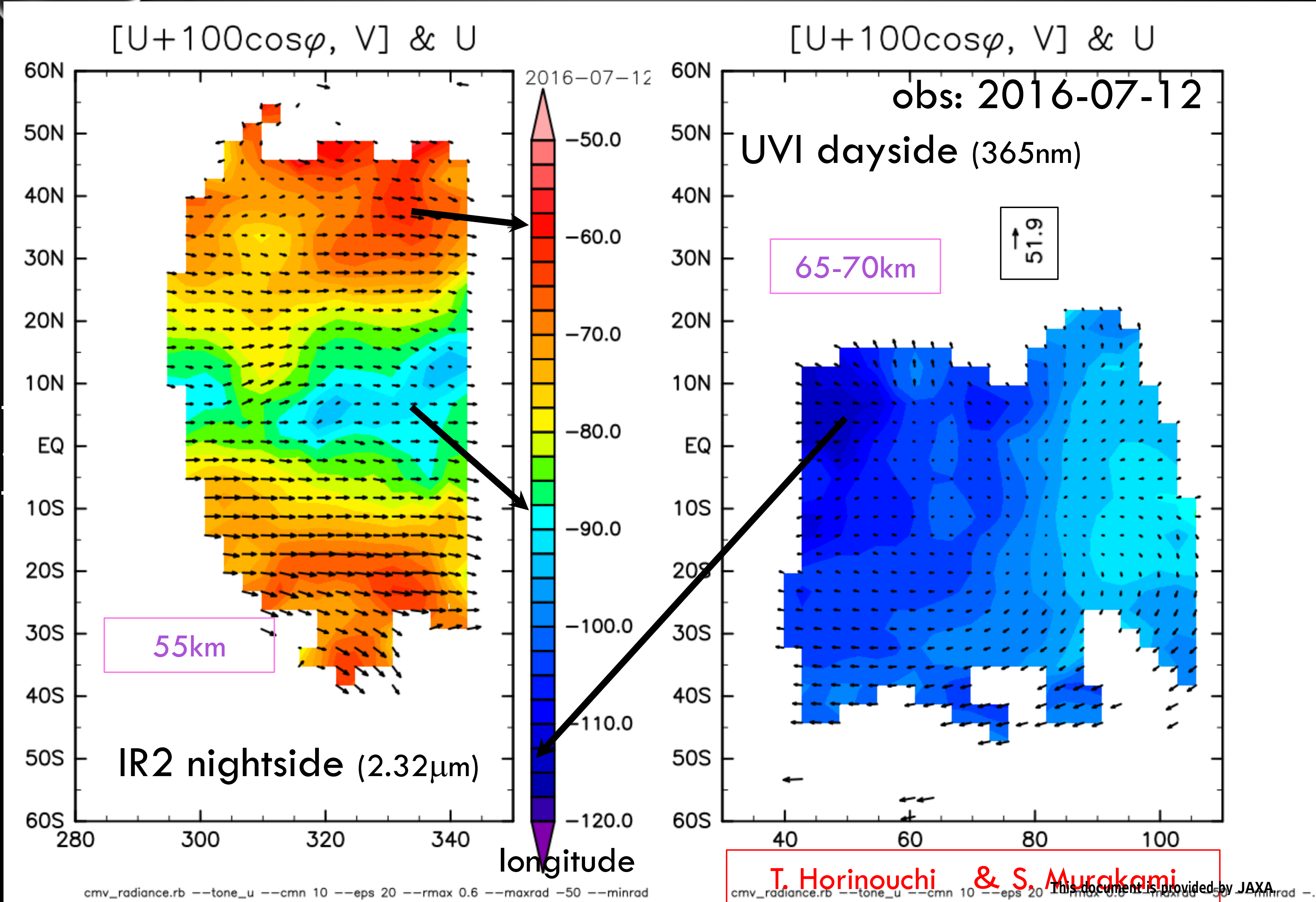
IR2 : Six-hour movies on night side (13 AUG 2016 @ ~0.12 M km)

T. Satoh





Cloud tracking "Day vs. night" comparison



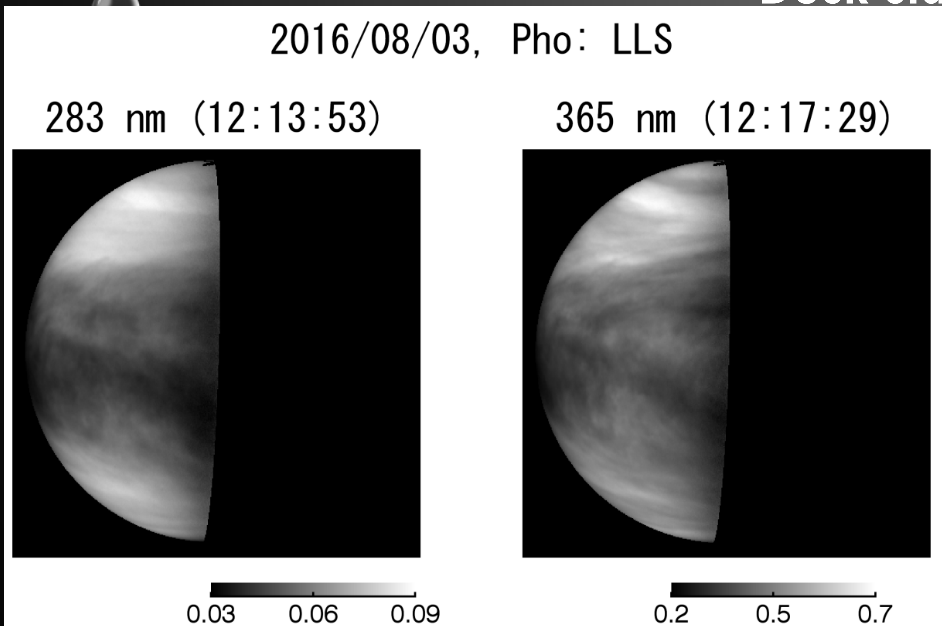
Notable dates

- VOI-R1 (DEC 7, 2015)
  - Period: 13 days, apocenter altitude: 0.44 million km
- VOI-R2 (DEC 20, 2015)
  - Period: 10.5 days, apocenter altitude: 0.36 million km
- COMMENCE OF REGULAR OBSERVATIONS (APR 1, 2016)
- PC1 (APR 4, 2016)
  - Period: 10.8 days, apocenter altitude: 0.37 million km
- SUPERIOR CONJUNCTION (JUN 7, 2016)
  - Solar corona observation (RS)
- ONE VENUS YEAR IN ORBIT (JUL 19, 2016)
- ONE TERRESTRIAL YEAR IN ORBIT (DEC 7, 2016)

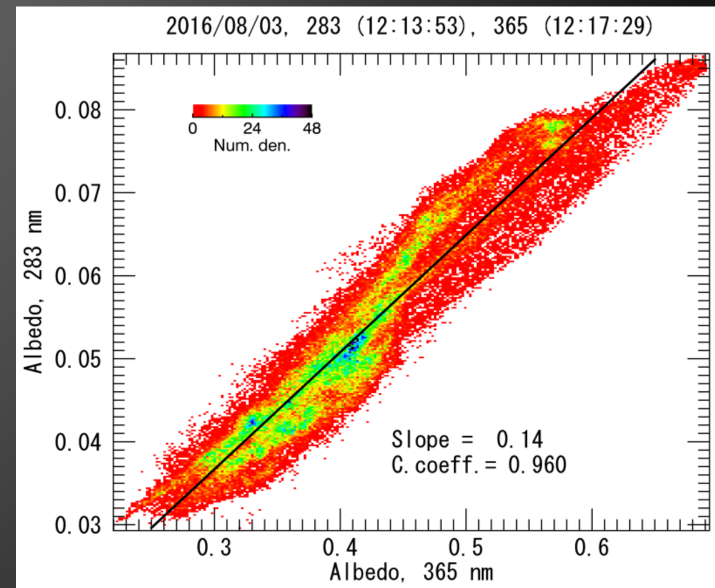
UVI compares SO_2 and “unknown” absorber

An example of high correlation cases

Dusk side (Sub S/C: 17LT)



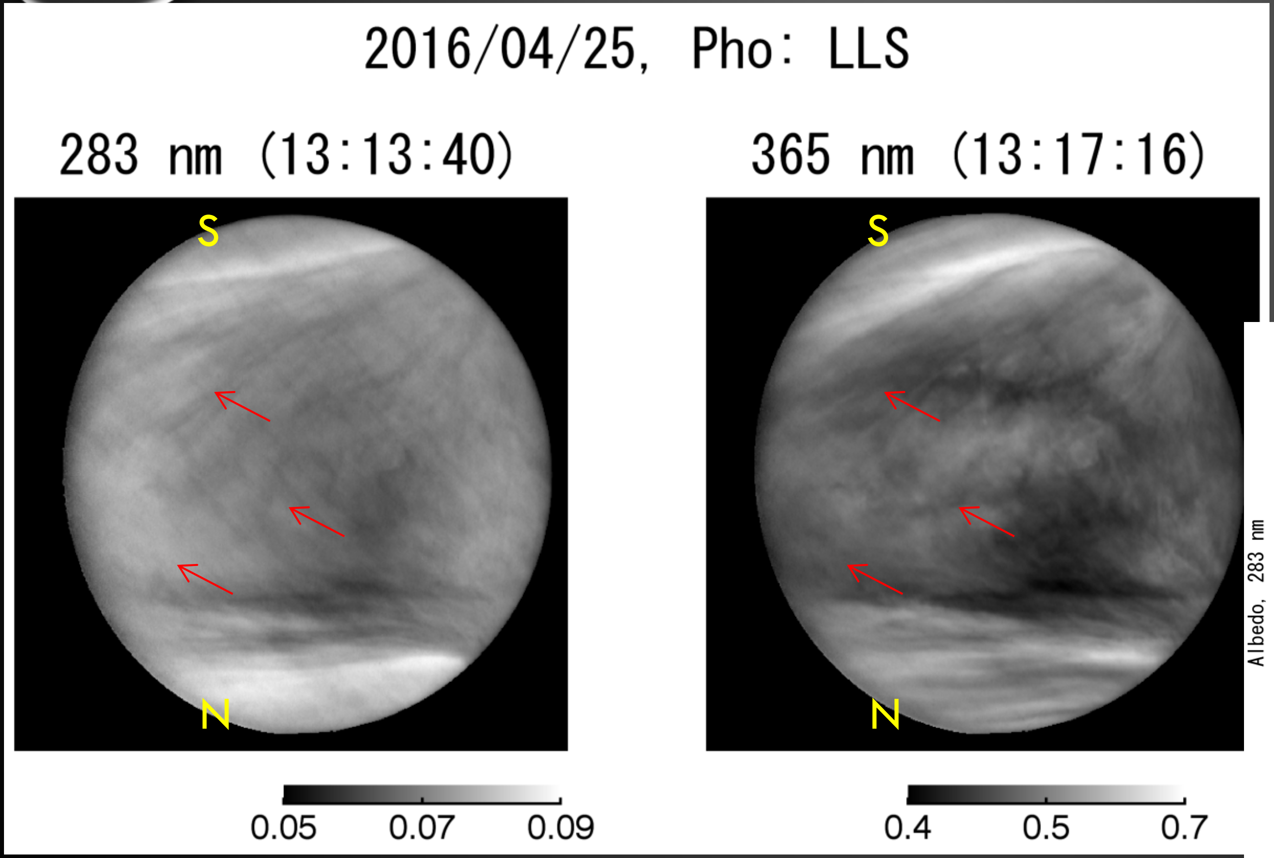
C.Coeff. = 0.960



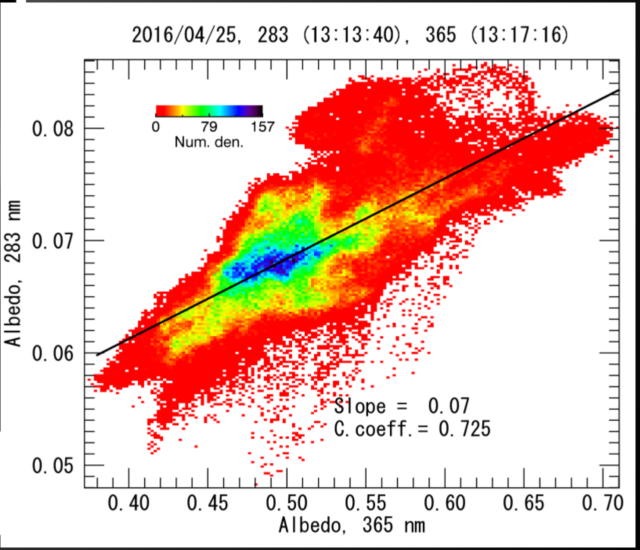
With 283-nm and 365-nm filters, UVI compares spatial distribution of albedos of SO_2 and “unknown” UV absorber to study the transport of SO_2, relation to dynamics and cloud formation.

- Total number of pairs used: 387
  periods: 2015-12-07 to 2016-08-11
- They compared albedo, which is the ‘radiance factor’ obtained by photometric correction using the Lambert and Lommel-Seeliger law.

An example of low correlation cases



C.Coeff. = 0.725



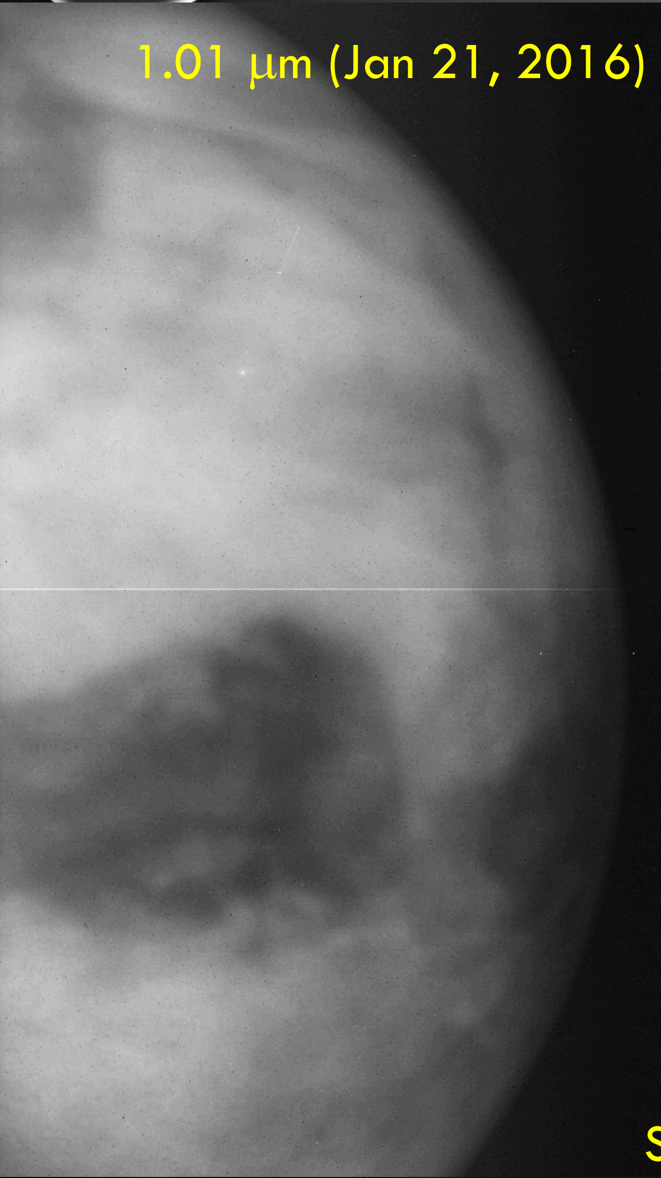
- Both high and low correlation cases exist for the comparison between 283 and 365 nm images. In low correlation cases, we typically observe either of the following cases:

  (1) dark 283 nm & bright 365 nm over afternoon side

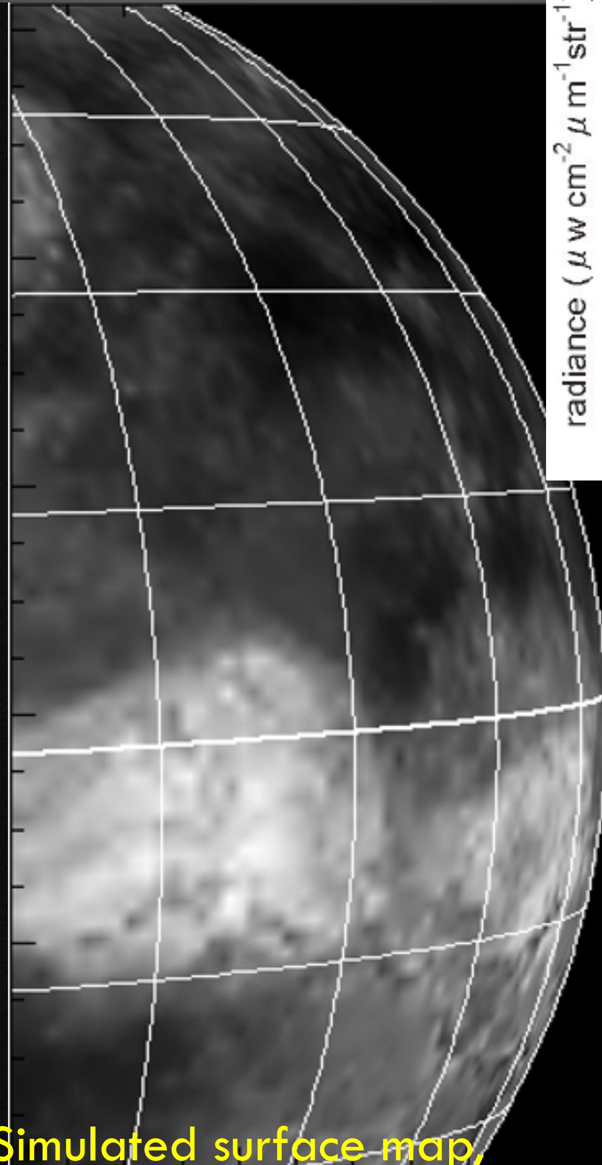
  (2) bright 283 nm & dark 365 nm over morning side

- The albedo used in these slides needs to be updated in the future study

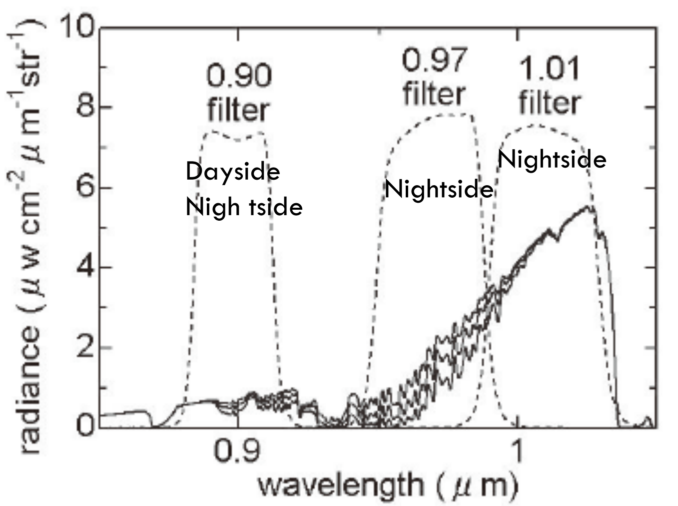
IR1: Imaging surface through clouds



1.01 μm (Jan 21, 2016)



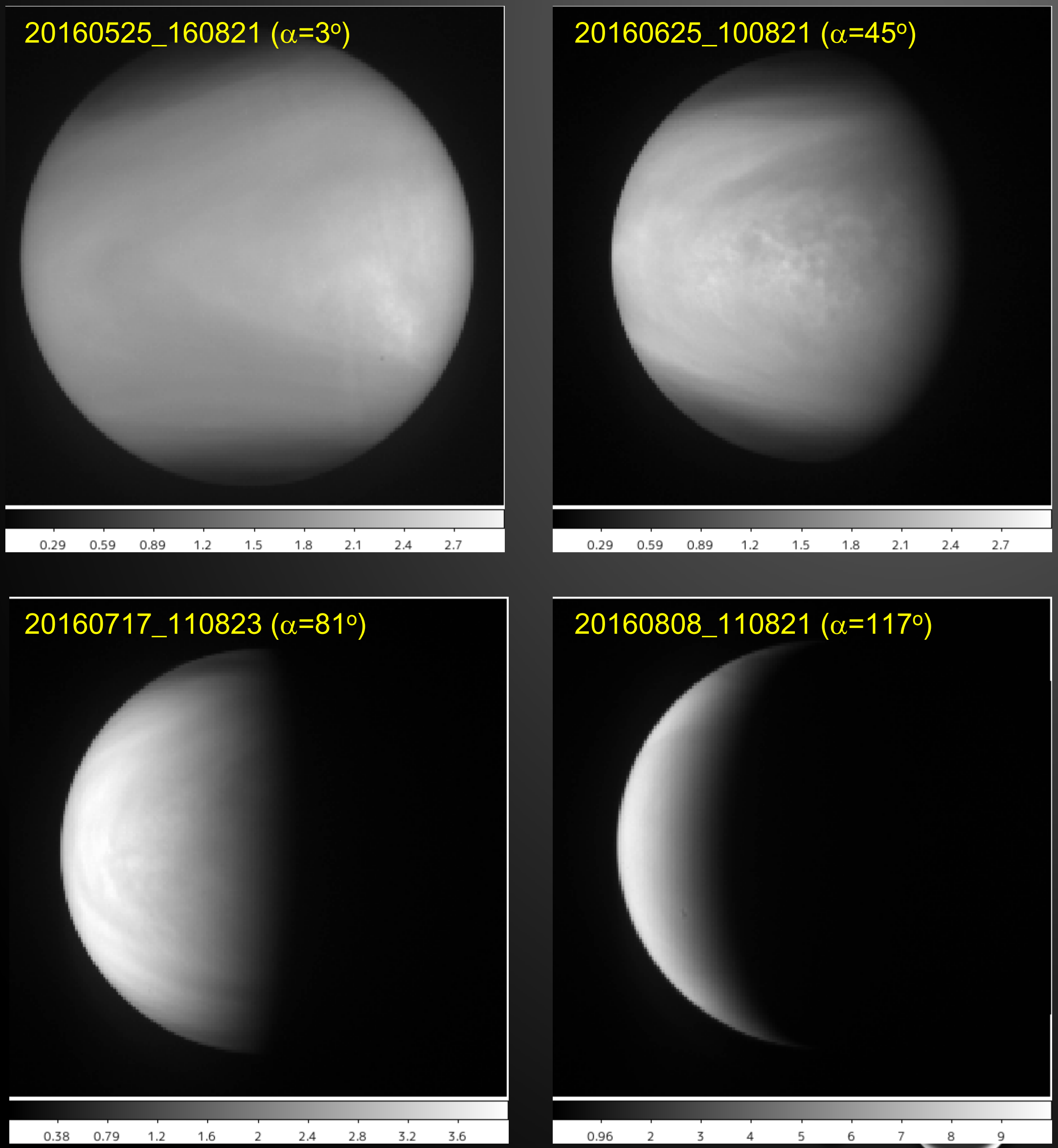
Simulated surface map, courtesy of T. Kouyama



This IR1 image at 1.01μm demonstrates its ability to map thermal emissions from the surface. Aphrodite terra appears an E-W elongated low-temperature region, well compared to MAGELLAN altitude map.

IR2 : 2.02-μm dayside images for altimetry

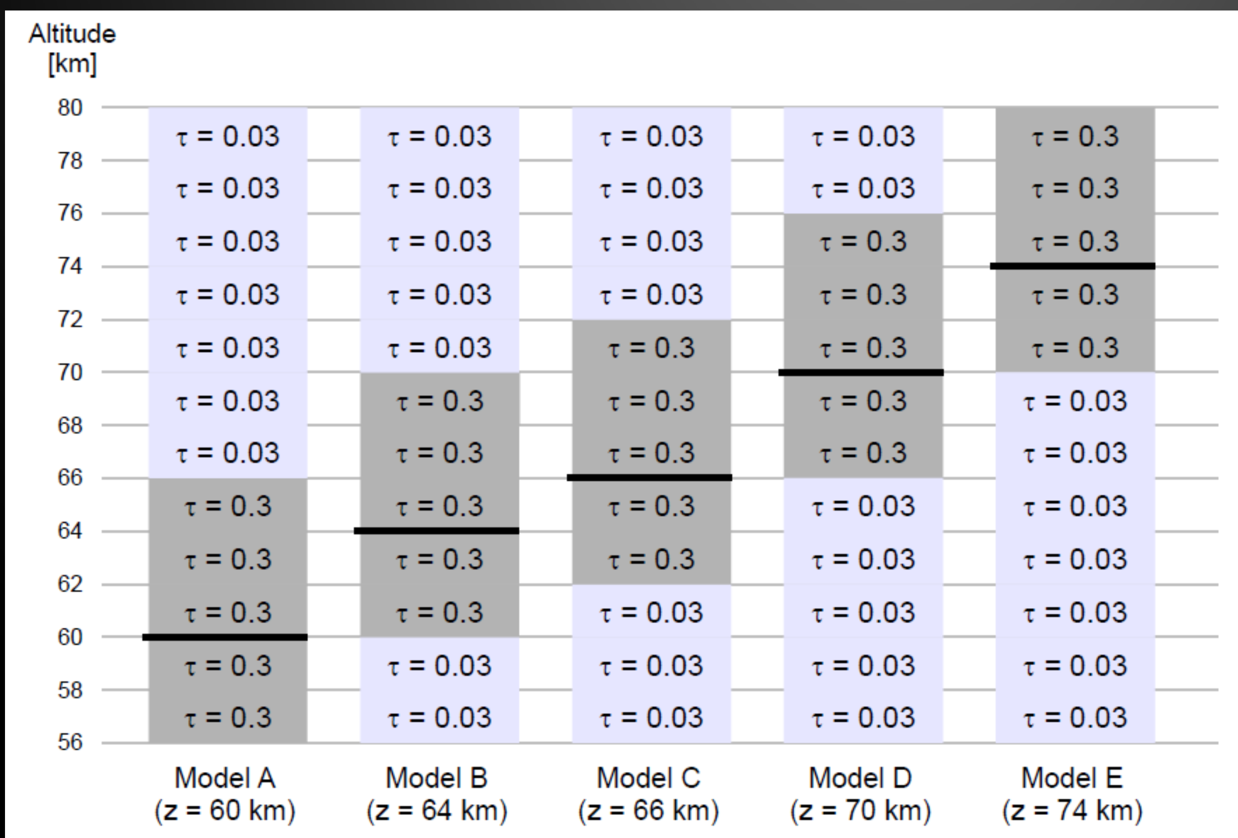
T. Satoh, et al.



- Four representative phase angles (α) are chosen to demonstrate preliminary 2.02-μm cloud-top altimetry.
    - Images acquired from near apoapsis are used for two reasons:
        - To reduce the number of pixels (currently 200 x 200 pixels area is analyzed).
        - To examine as wide background as possible for image deconvolution.

Cloud model

- Cloud models are rather simplified:
  - A layer with 1.5 optical thickness aerosol over 10 km vertical extent. Each model is labeled with the altitude of the cloud optical thickness 0.9 (see figure)
  - Above the cloud top is filled with tenuous haze.
- An adding-doubling code is used to compute multiply-reflected sunlight from Venus atmosphere.
  - Absorption coefficients are pre-computed for each altitude layer.



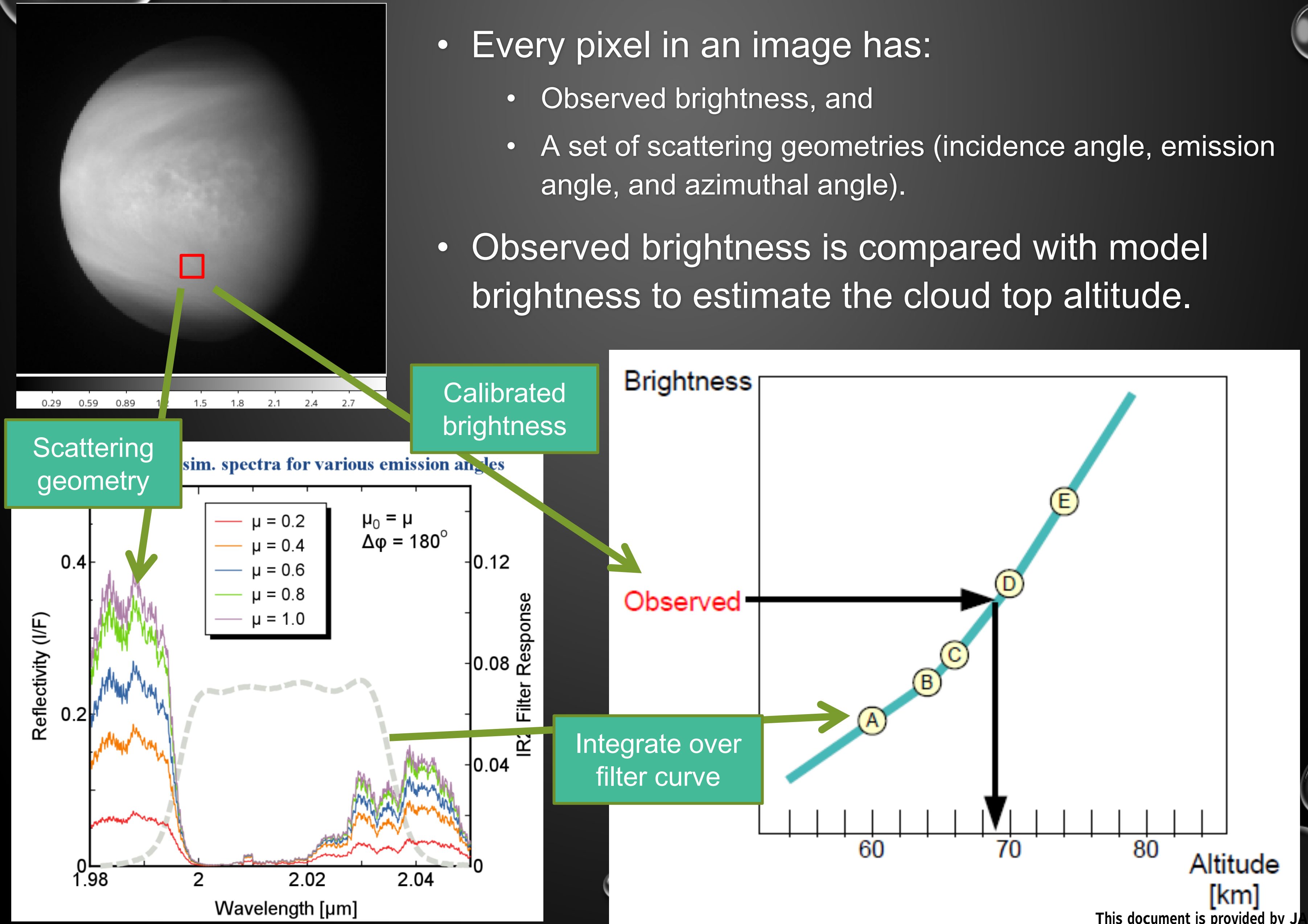
Molecules:
CO_2 (HITRAN, first 4)
N_2 (HITRAN)
H_2O (HITEMP, first 4)
HCl (HITRAN, first 4)

Wavenumber range:
4800 – 5100 cm^{-1}

Line profile:
Voigt (cutoff at 120 cm^{-1})

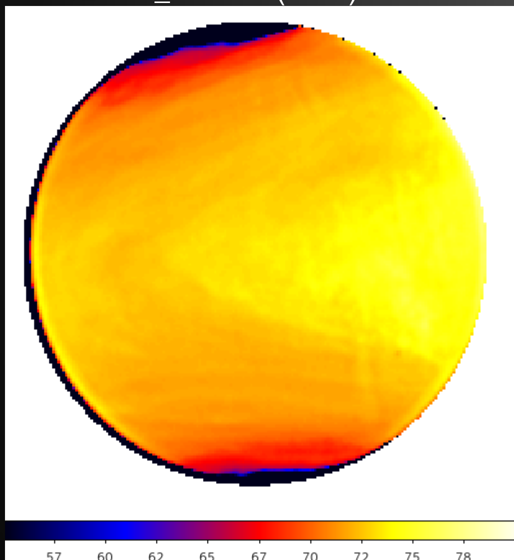
Comparison of the model and observation

- Every pixel in an image has:
  - Observed brightness, and
  - A set of scattering geometries (incidence angle, emission angle, and azimuthal angle).
- Observed brightness is compared with model brightness to estimate the cloud top altitude.

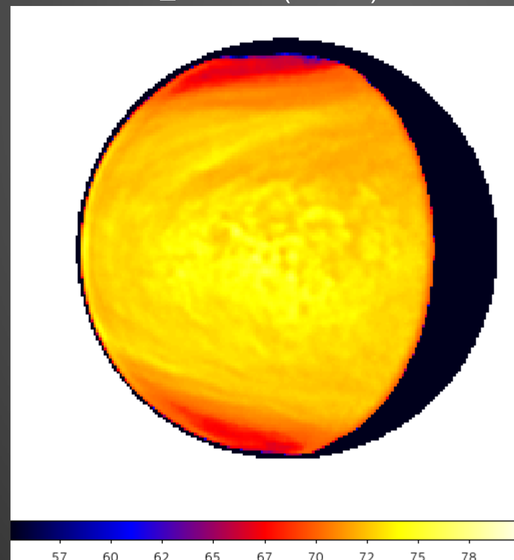


Derived altitude maps

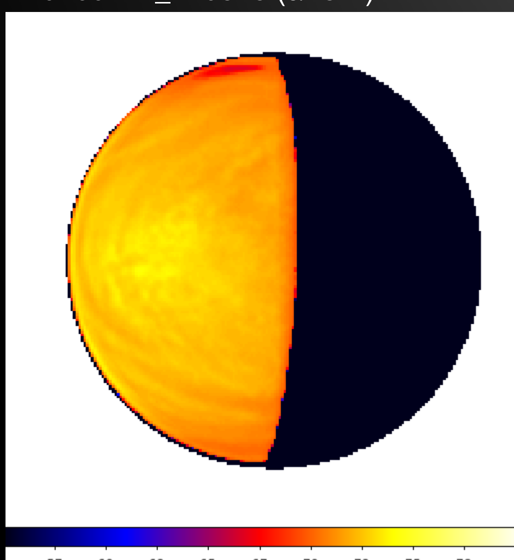
20160525_160821 (α=3°)



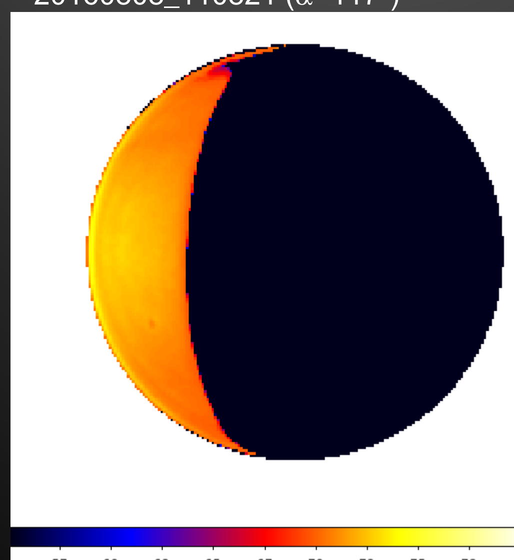
20160625_100821 (α=45°)



20160717_110823 (α=81°)



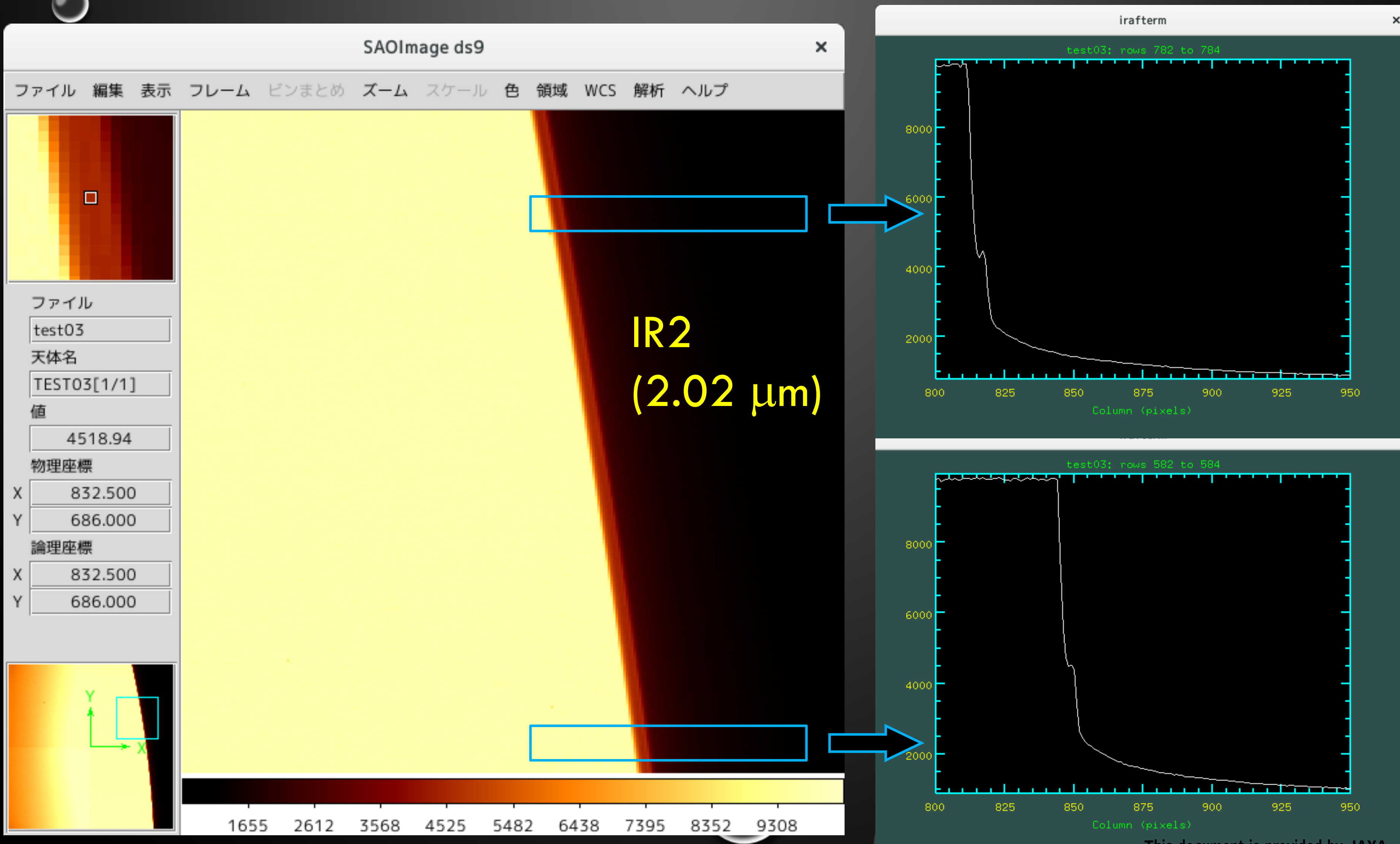
20160808_110821 (α=117°)



- For all 4 phase angles, almost consistent cloud top altitudes (nearly flat from the limb to the terminator) are derived. This may be indicating that the assumed upper cloud structure is adequate.
- Cloud top altitudes for polar regions vary from deeper (small α) to higher (large α) systematically, suggesting that the cloud structure for these regions may be somewhat inappropriate.

IR2 : Fine-resolution limb imaging
(30 OCT 2016 @ ~8240 km)

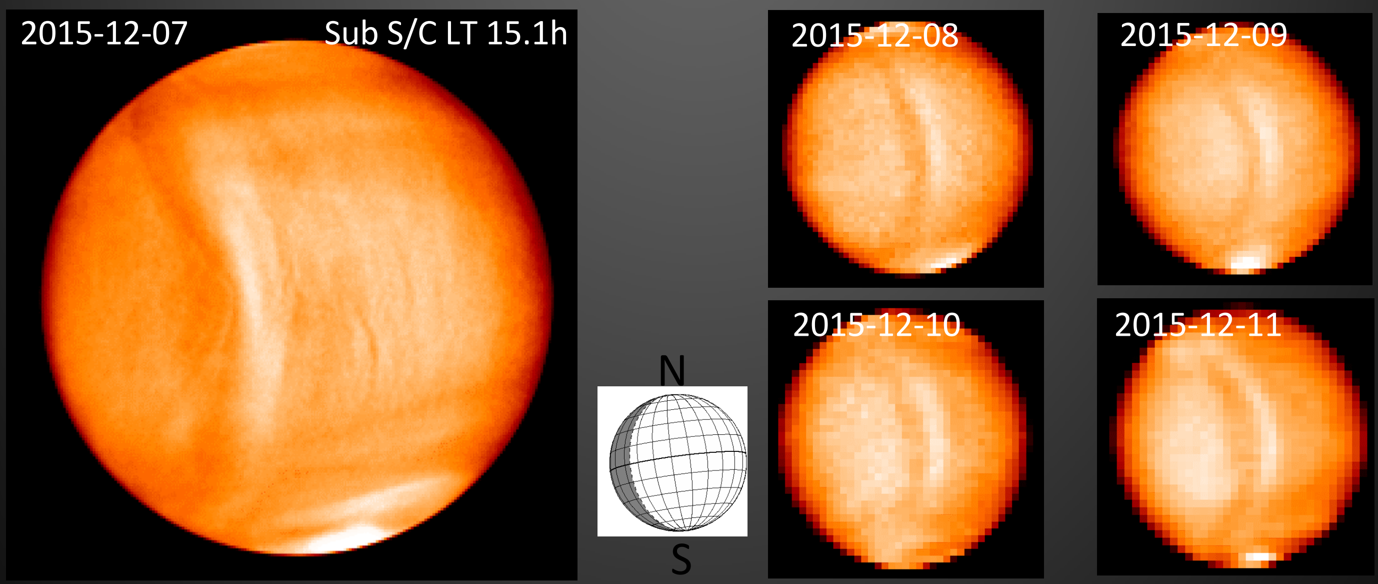
T. Satoh, et al.



LIR : A huge bow-shaped thermal feature

Fukuhara et al., Huge stationary gravity wave in the Venus atmosphere , submitted to Nature Geoscience

First light after VOI-R1

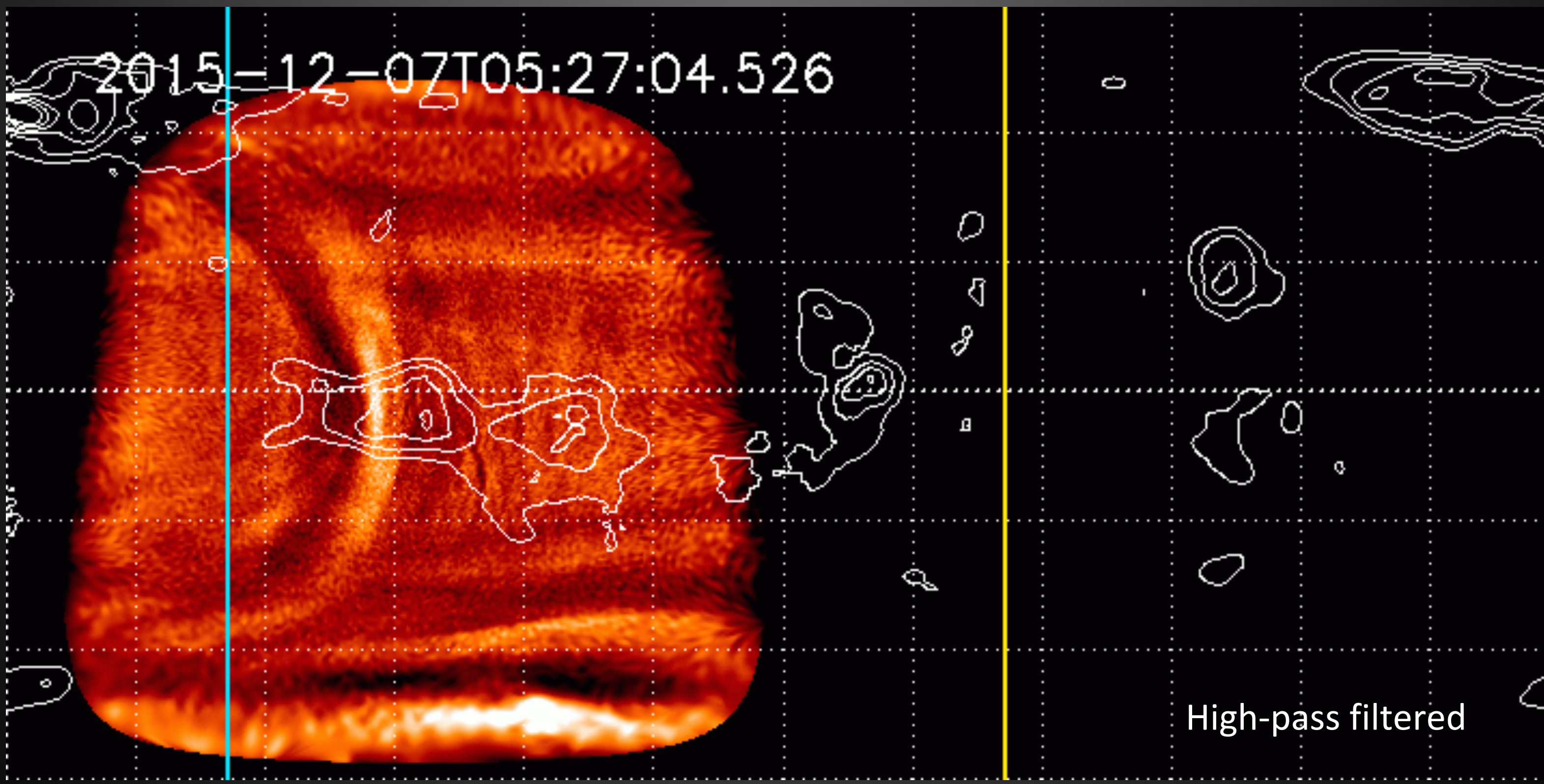


- A huge bow-shaped thermal structure extending from the northern high latitudes to the southern high latitudes was found in the dayside afternoon sector.
- Its end-to-end distance is longer than 10,000 km, and existed in the same region for 4 days at least.
- Its highest and lowest temperatures are 230-231 k and 225-226 k, respectively.
- Filament-like small bow-shaped structures are also identified in the lower latitudes.

M. Taguchi, T. Kouyama, et al.

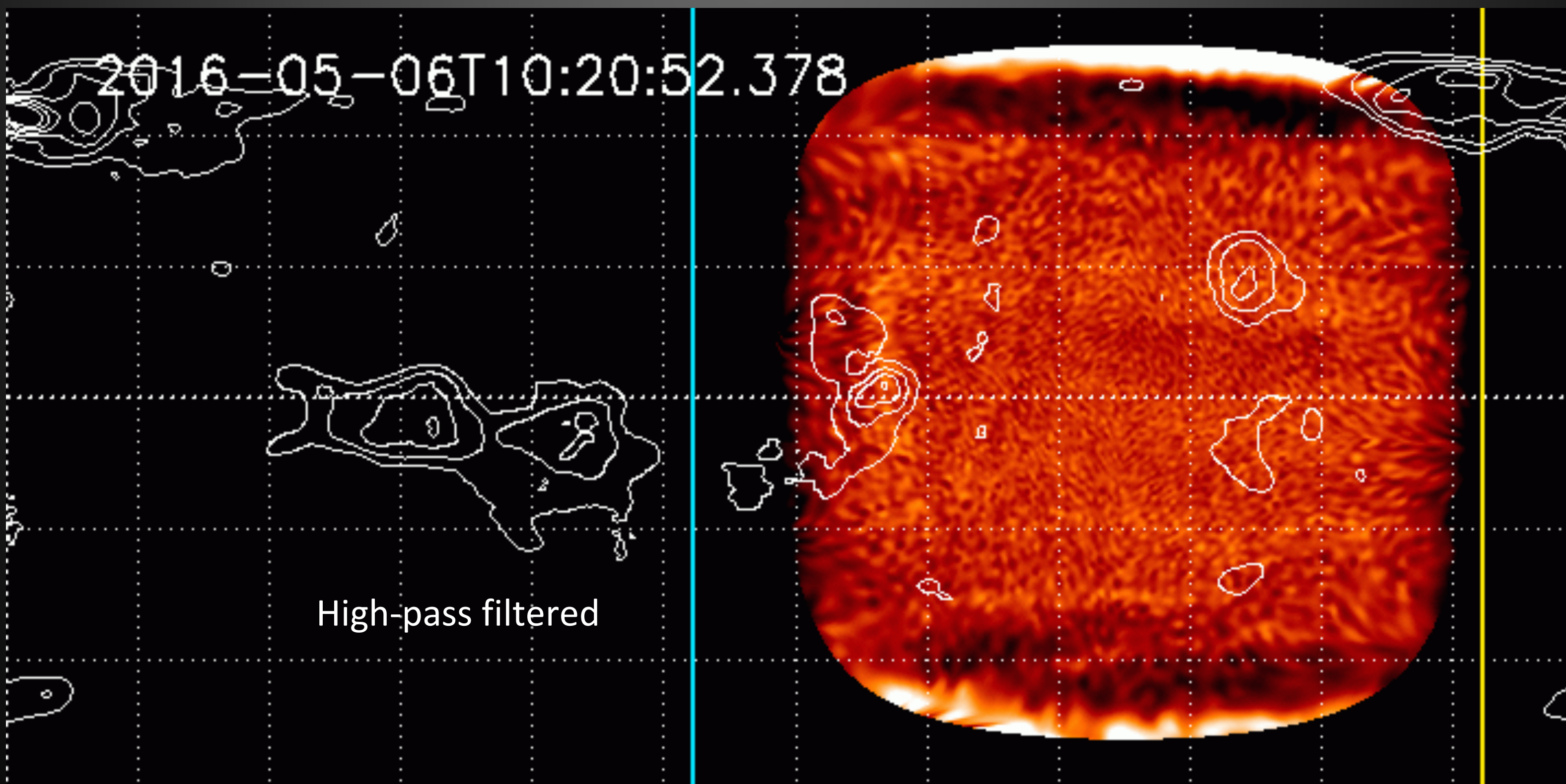
blue line: evening terminator

yellow line: morning terminator



- longitude of the boundary between high and low temperature regions of the bow shape at the equator: $\lambda_B \approx 80° \sim 84°$
- angular velocity of the boundary: $\omega_B \approx 0.6 \pm 0.2\,[\mathrm{deg/day}]$
- rotation speed of Venus to the sun: $\omega_R \approx -3.1\,[\mathrm{deg/day}]$
- the bow-shaped structure looks to be fixed not to local time but on the ground.

blue line: evening terminator   yellow line: morning terminator

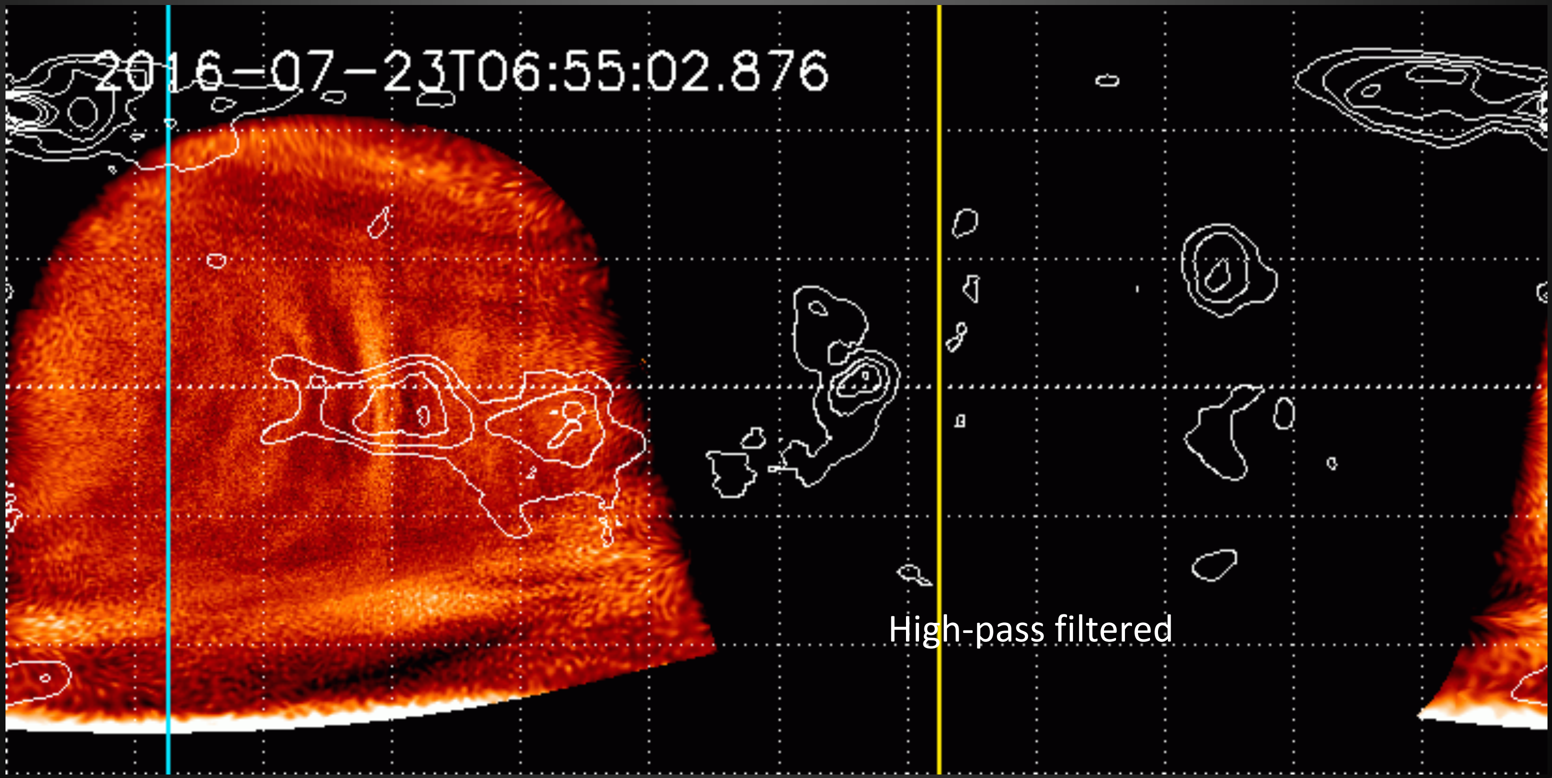


- A weak bow-shaped structure appeared around 200° in longitude above the eastern highland of Aphrodite terra on may 6.
- Two faint bows are identified in April but in different longitudes and local times.

Bow-Shaped Structure in Jul./Aug.

Blue line: evening terminator

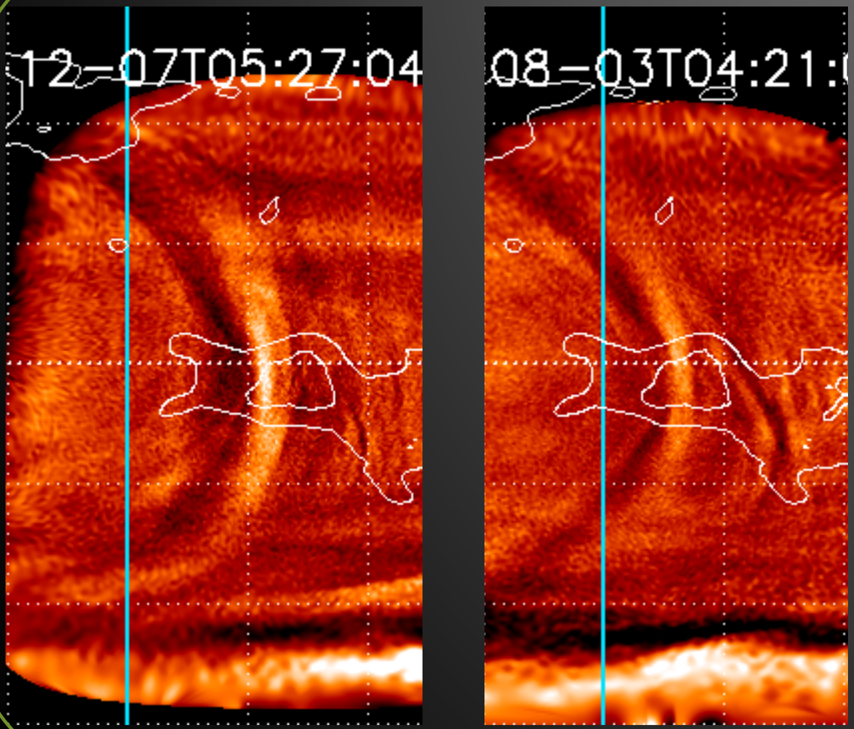
Yellow line: morning terminator

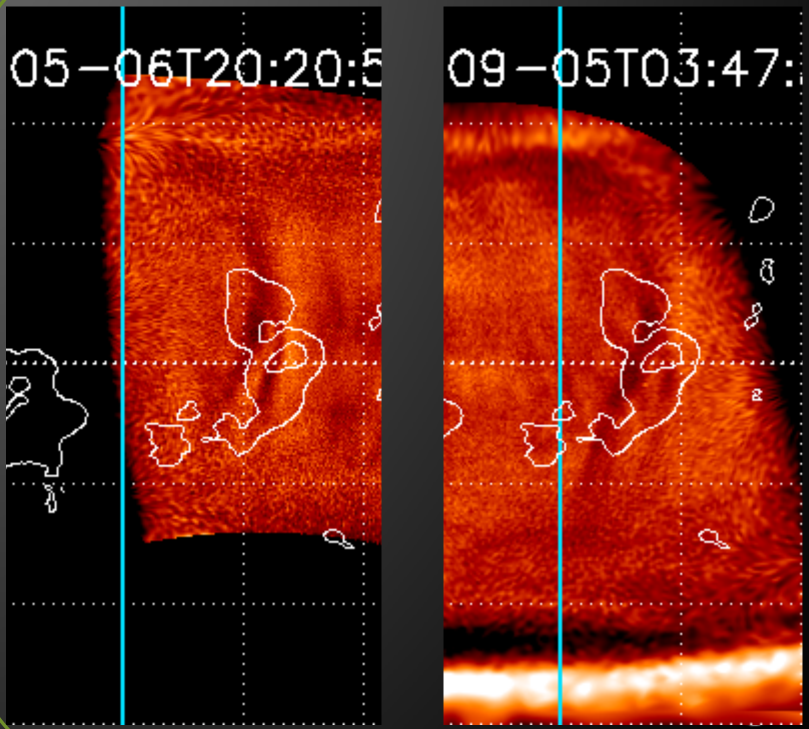


- Another prominent bow-shaped structures appeared in late July, lasting to the end of August.
- Their centers were located around 90° and 130° in longitude above the western highlands of Aphrodite Terra in the equatorial region.

Stationary feature events

- Same location with Same appearance





Stationary feature events

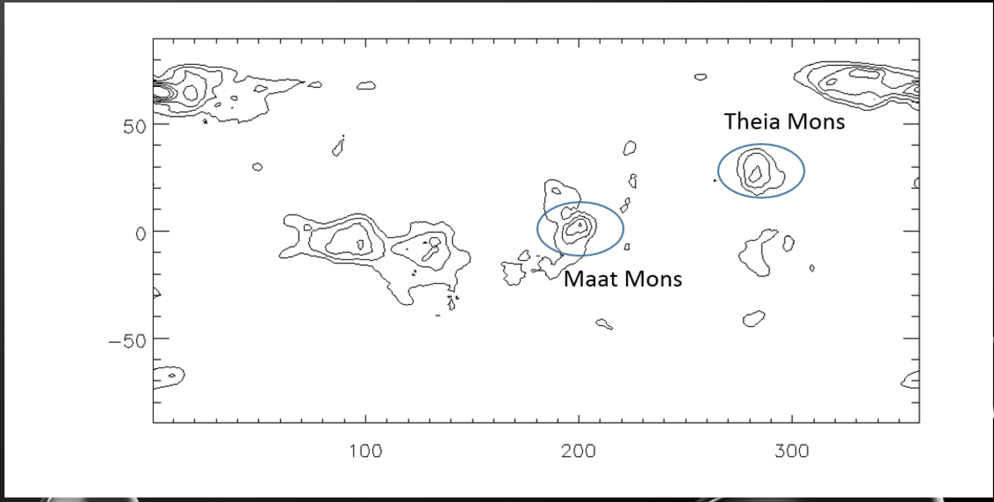
Event date	Location (place name)	Confirmed Local time
2015.12.07-12.11	Aphrodite Tera	~16h
2016.05.06	Maat Mons	~15h
2016.05.16	Theia Mons	~12h
2016.07.23 – 08.25	Aphrodite Tera	15h – 19h
2016.09.05	Maat Mons	~17h

・These events mainly occurred above huge mountains in low latitudes

・Periodical: Same location has same feature-events at same local-time

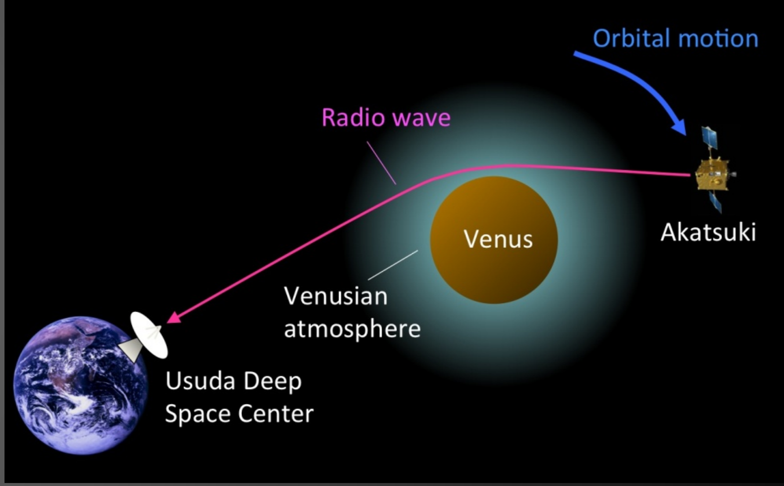
=> Daily events of Venus

・The features became clearer in evening region.

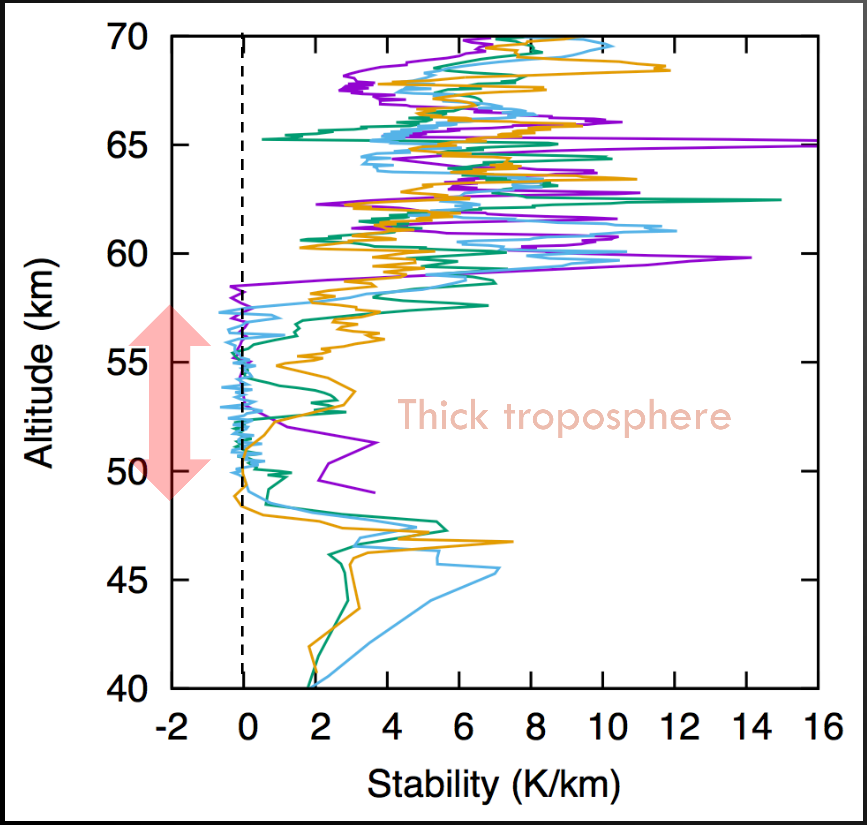


RS: vertical scan of atmosphere

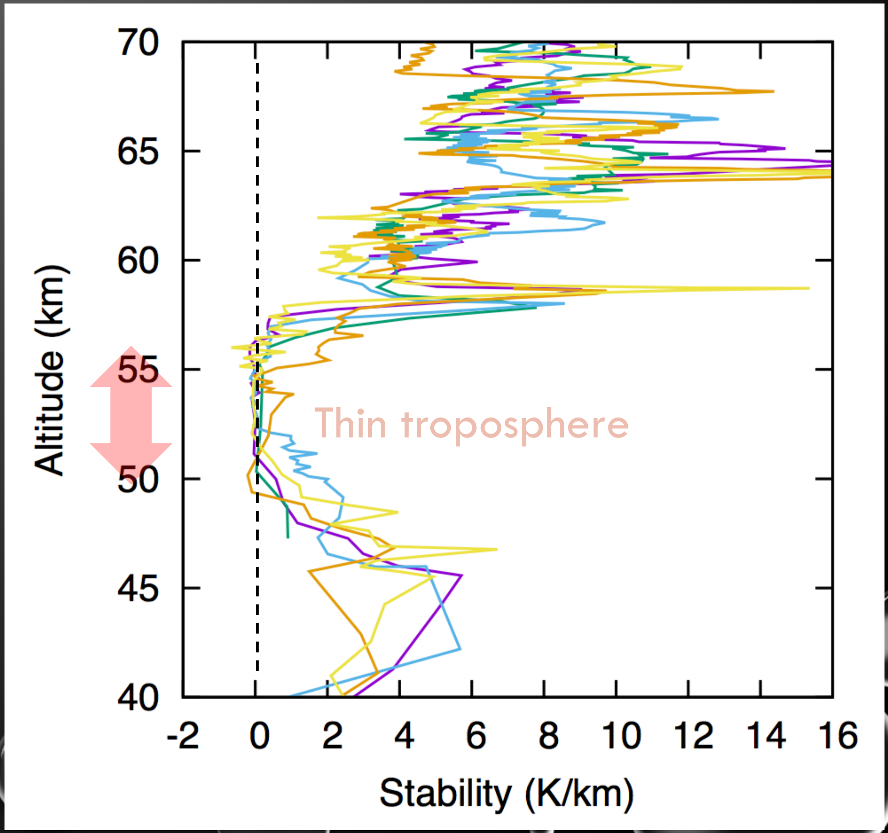
T. Imamura & H. Ando



Dawn (LT = 4.7–5.5)



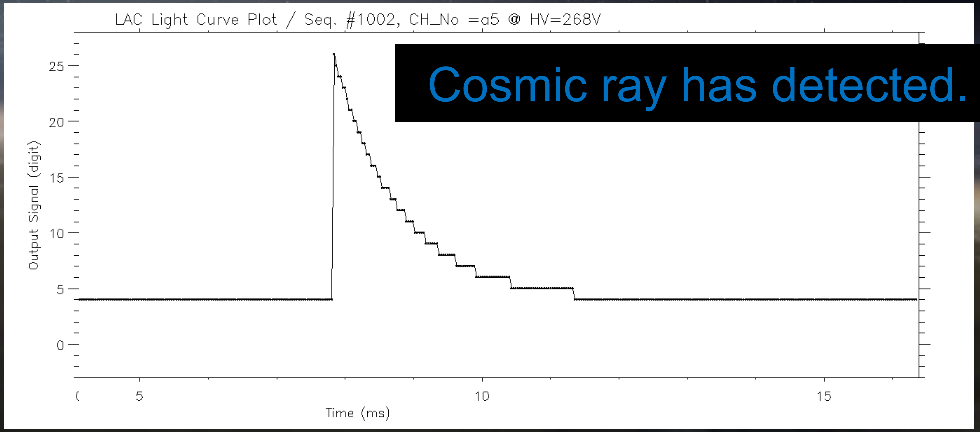
Dusk (LT = 16.2-17.5)



LAC: Now ready to start lightning observation

- The instrument is quite healthy, and HV level has reached nominal level.
- Lightning has not detected yet.

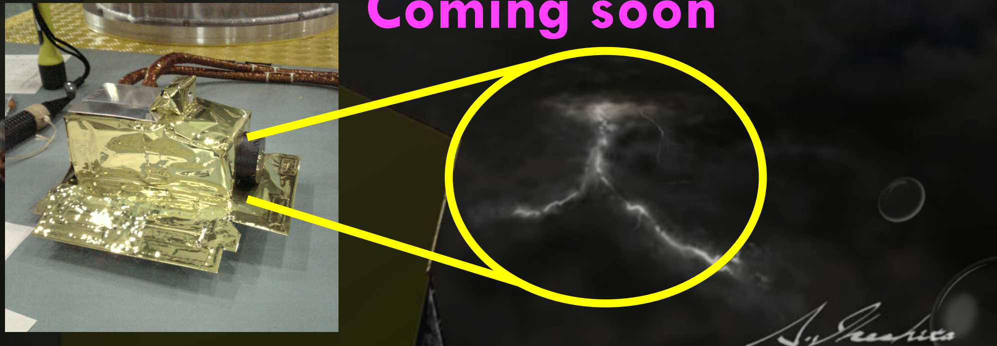
FOV	16 × 16 deg
Lens	Single 25 mm diameter
Sensor	8 × 8 multi-anode SiAPD
Pixel size	2 mm × 2 mm
Bit rate	10 bit/pixel for lightning
Sampling time	32 μsec sampling



~ LAC Observation Schedule ~

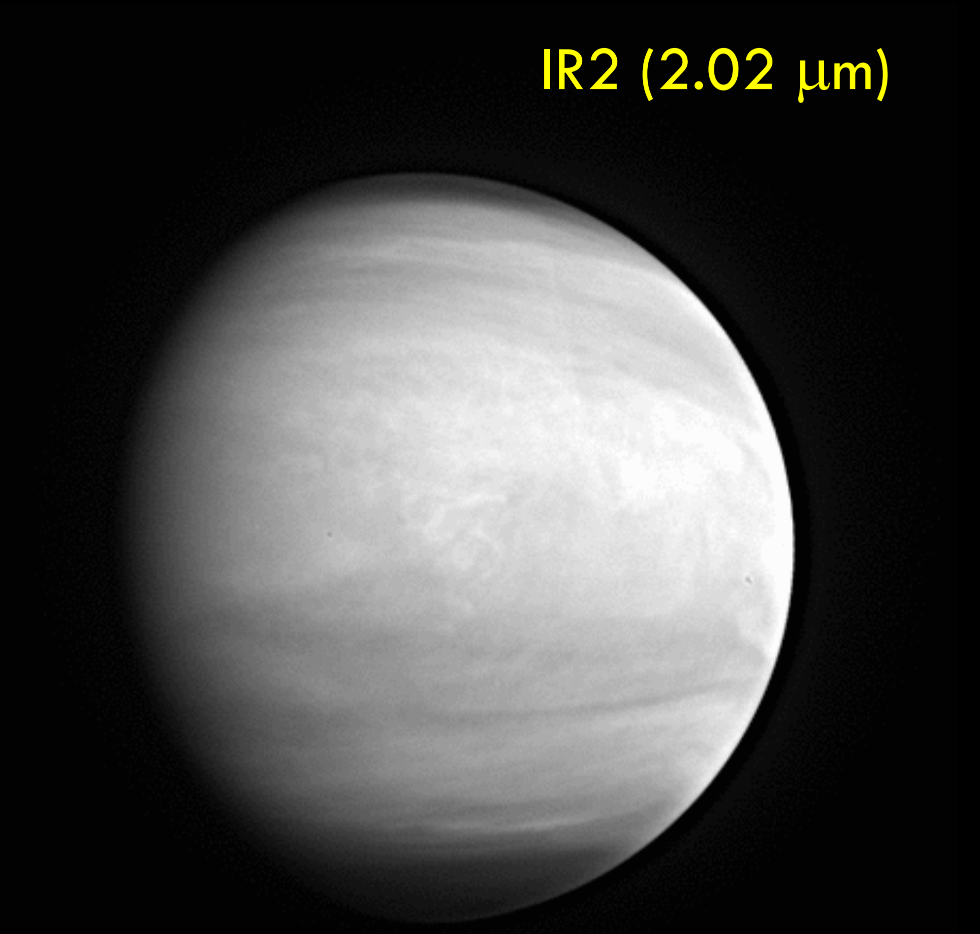
2016/08/02 (**not detected**)
2.5 min. exposure, HV = 270 V
2016/11/09 (**not detected**)
20 min. exposure, HV = 280 V
2016-11-20 (under analysis)
22 min. exposure, HV = 290 V
2016-12-01
11 min. exposure, HV = 300 V (<u>nominal</u>)
...

Coming soon



Summary

- AKATSUKI was successfully inserted in Venus orbit, and on-board science instruments are acquiring high-quality Venus data.
- Although the orbit is more elongated than envisioned, benefit of being in the equatorial plane to study dynamics is obvious.
- The science team expects to achieve all success criteria in the nominal mission period (the end of march 2018).



2 July 2016 @ 0.175-234 M km