# Intense Decadal Variation of Venus' 365-nm Albedo & its Impacts on the Atmosphere

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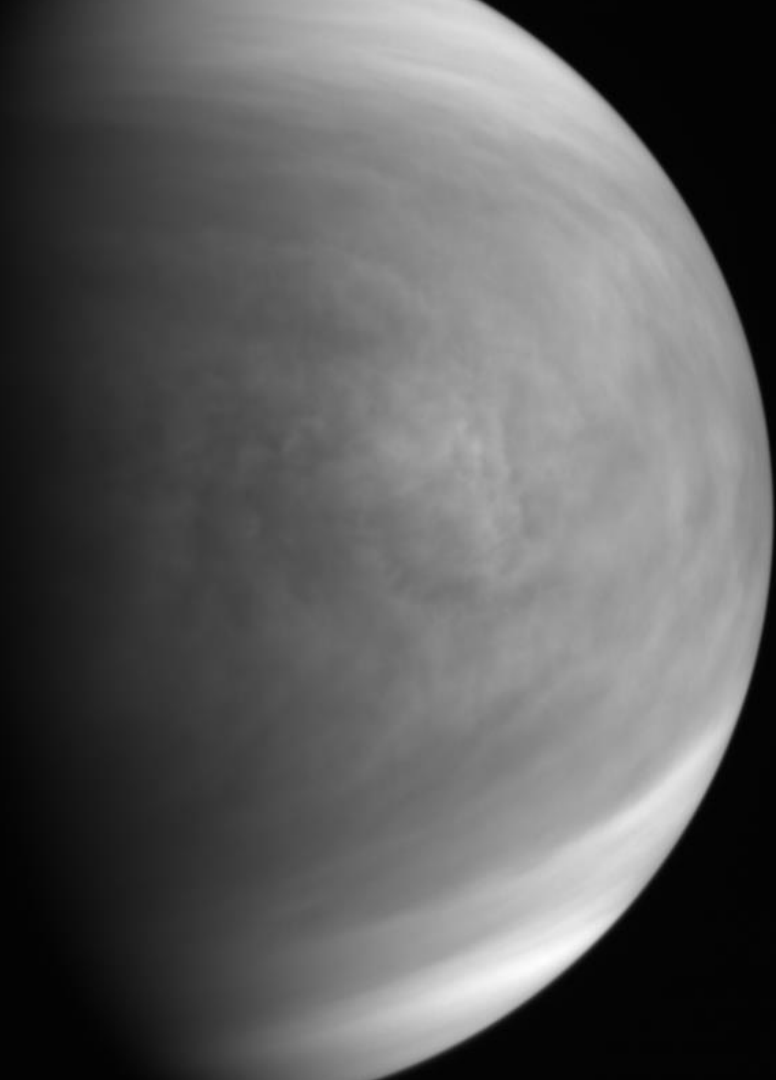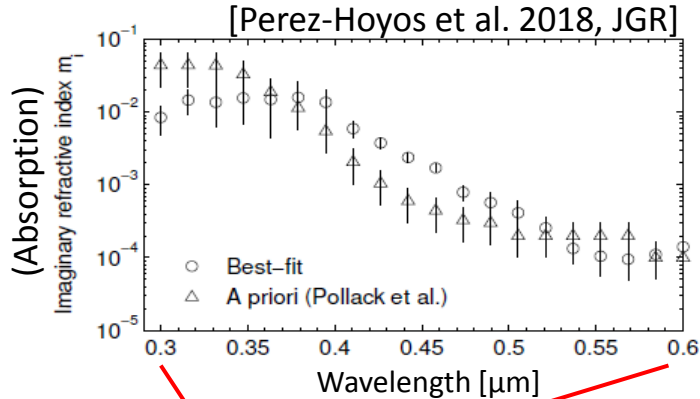
Venus in UV

365 nm UVI Akatsuki

$H_2SO_4 \cdot H_2O$ clouds *+ Unknown Absorber*

The broad absorption spectrum of the unknown absorber

[Perez-Hoyos et al. 2018, JGR]

50% of solar heating is due to the unknown absorber [Crisp 1986]

30-60% of solar heating is due to the unknown absorber [Lee et al. 2015]
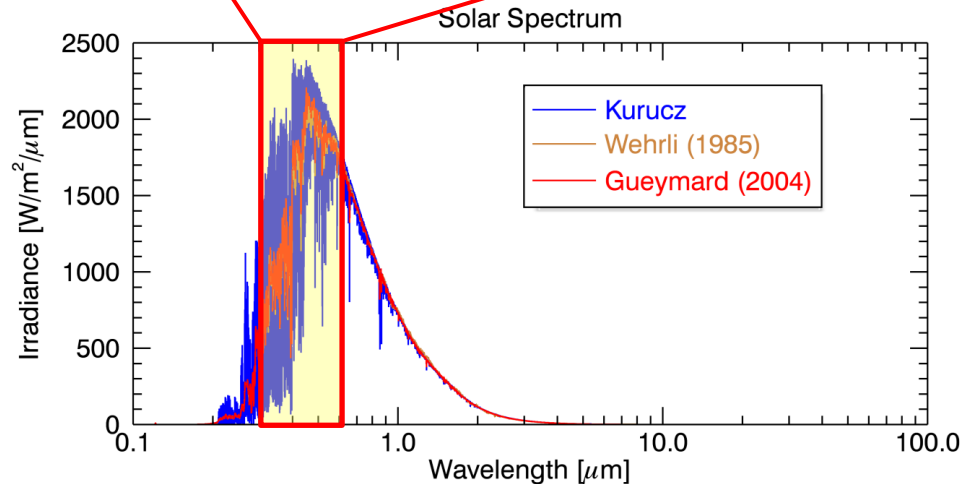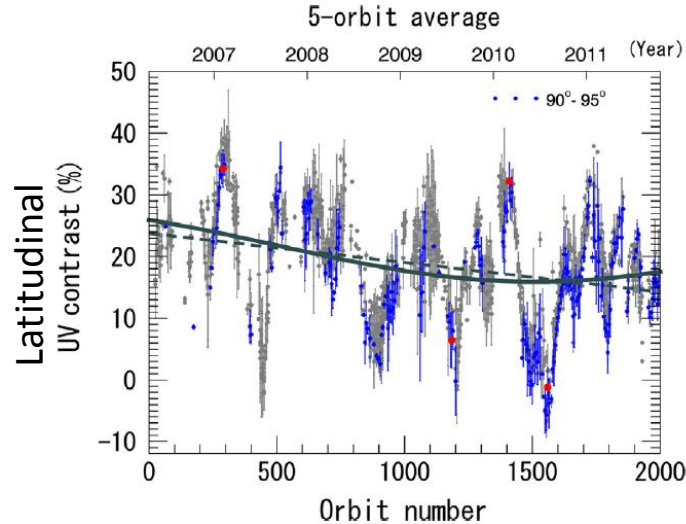
Previous studies at 365-nm (VMC/Venus Express)

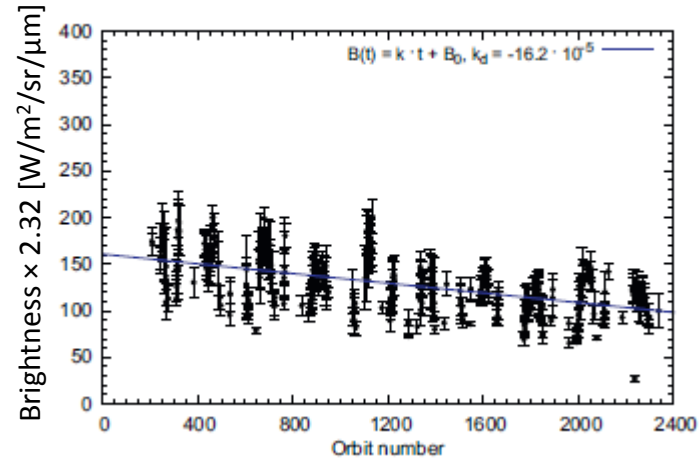Difficulties to distinguish between

"Venusian nature" and **"instrumental artifact"**

[Lee et al. 2015, Icarus]

[Shalygina et al. 2015, PSS]

→ **Cross-comparison** of independent UV instruments is necessary to understand the natural signal of Venus

UV observation data used in this study

- **Global UV images of VMC**/Venus Express (**2006-2014**)
- **Southern low-lat UV spectra of MASCS**/MESSENGER, Venus flyby in **2007**
- **Southern low-lat UV spectra of STIS**/Hubble Space Telescope (HST) in **2011**
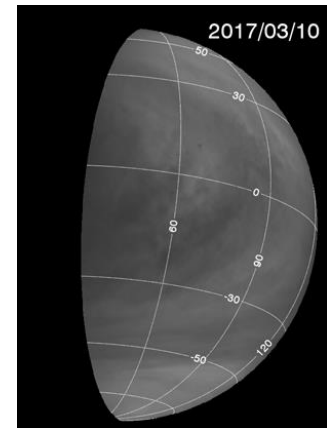- **Global UV images of UVI**/Akatsuki in **2011**, and **Dec 2015-May 2017**

Star obs.

VMC
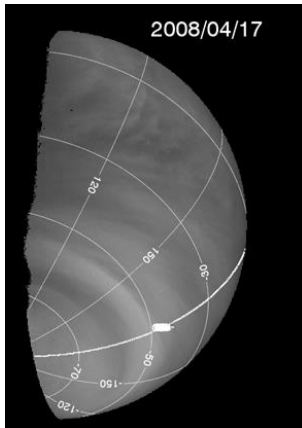
Venus seen from MESSENGER
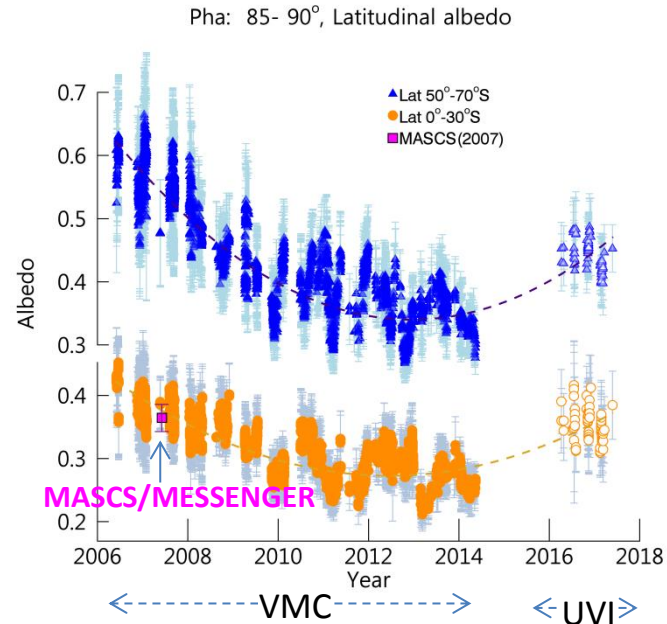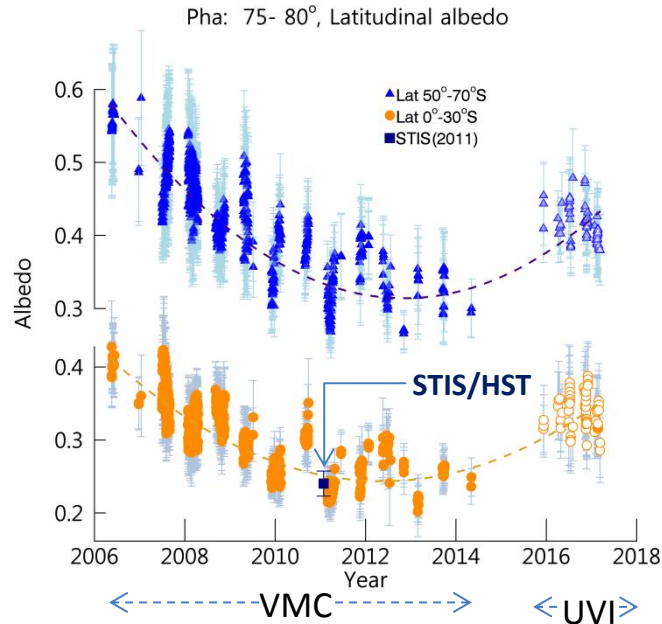2007-06-05 23:00:00

Venus seen from HST
2011-01-27 16:05:00
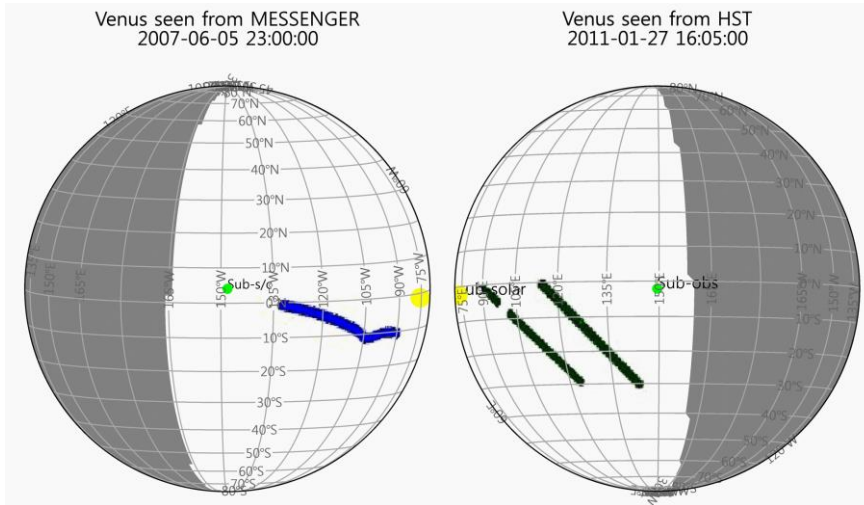
UVI

# Cross-comparison of UV data: updating VMC's calibration

- Venus' **low (0-30°S)** and **high (50°S-70°S)** latitudinal mean albedos of disk-resolved data. Photometric correction is applied [Lee et al. 2015, 2017], using the Lambert and Lommel-Seeliger law.
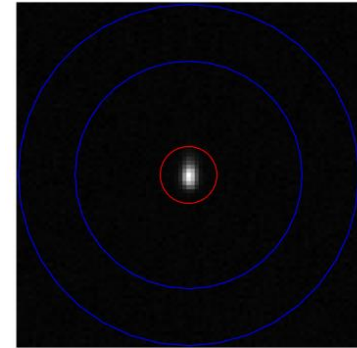

[Lee et al. submitted]

Validation of the updated VMC's data

- Whole-disk (disk-integrated) albedo of Venus.
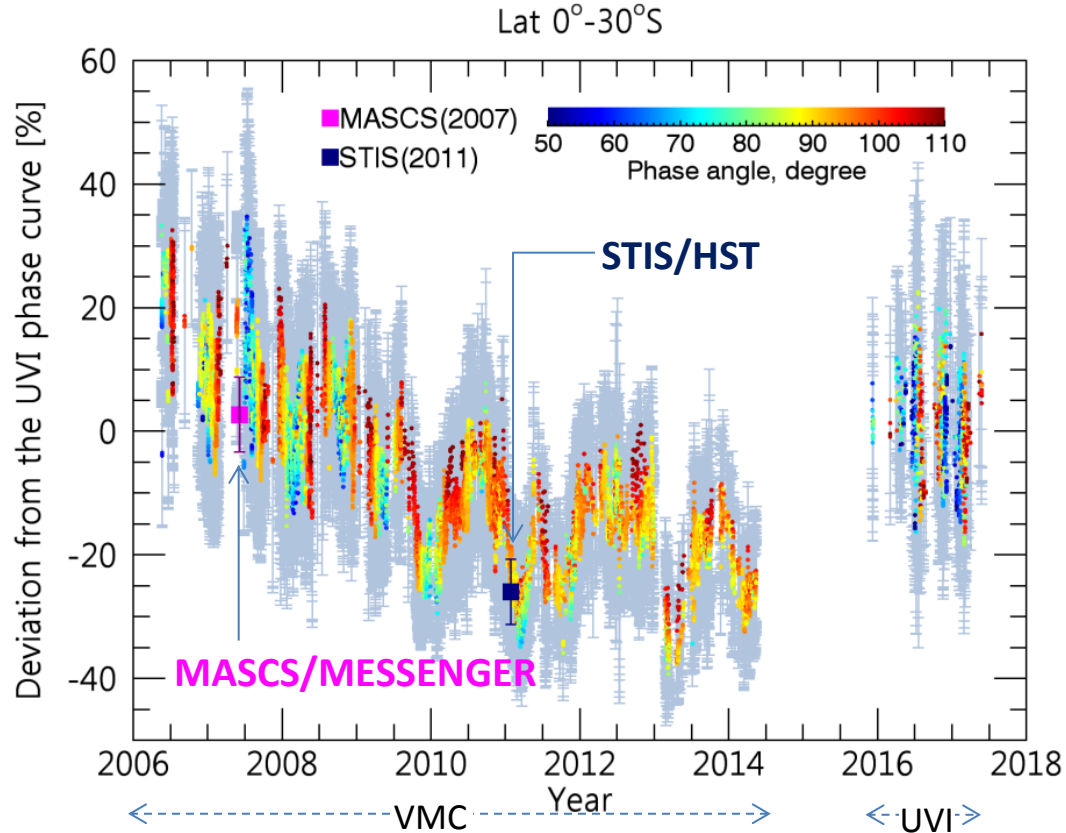 VMC's new calibration correction factor is applied.
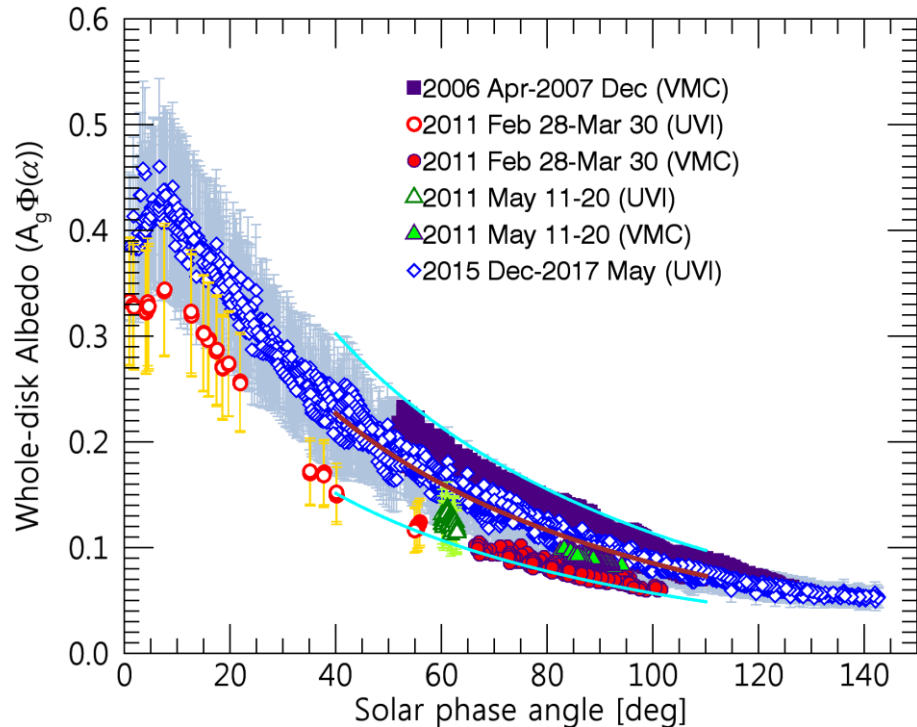
UVI (2011)

Results: observed long-term 365-nm albedo

- Relative temporal variations of low-latitudinal mean albedo.

Lat 0°–30°S

MASCS(2007)
STIS(2011)

Phase angle, degree

STIS/HST

MASCS/MESSENGER

Deviation from the UVI phase curve [%]

Year

VMC   UVI

[Lee et al. submitted] Error bars are standard deviations.

Results: observed long-term 365-nm albedo

- Relative temporal variations of whole-disk albedo.

Whole-disk albedo ($A_g\Phi(\alpha)$)
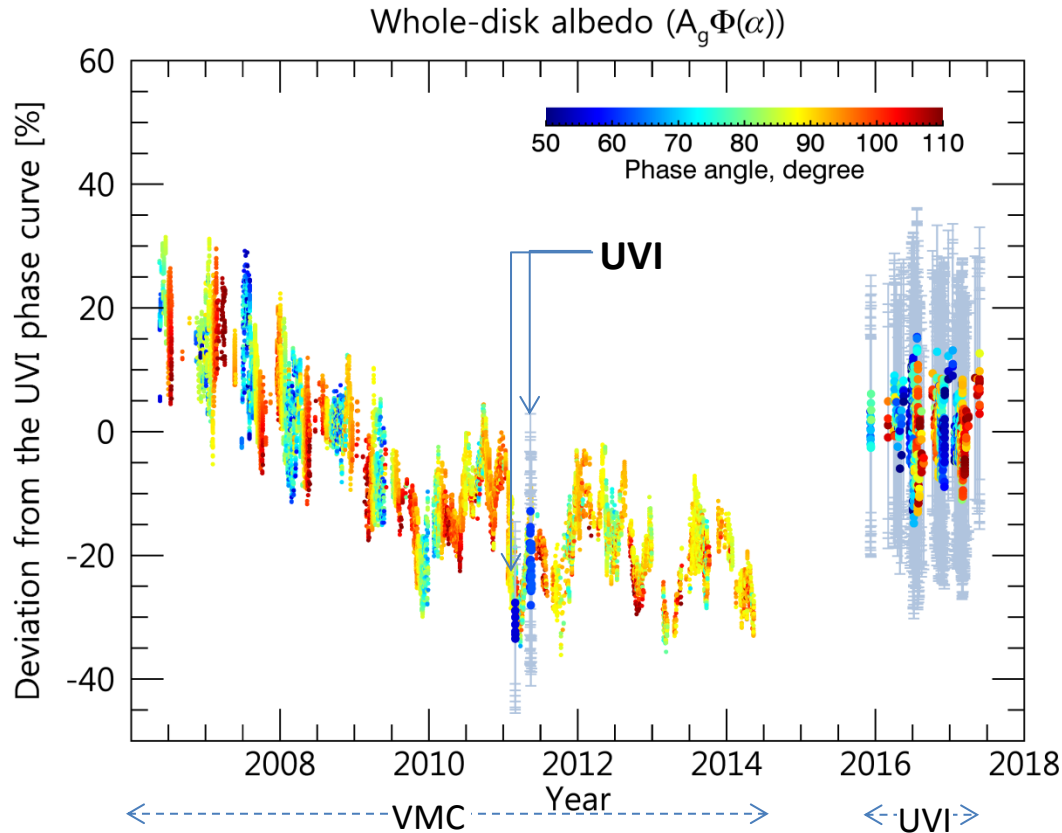
[Lee et al. submitted]
Error bars of UVI indicate the uncertainties of star flux measurements, 18%.
That of VMC is omitted (82%).

Direct influence on solar heating rates

- Solar heating rate calculations in a 1-D radiative transfer model (0-100 km, 0.2-5 μm, Lee et al. 2015&2016), using Crisp(1986)'s assumptions on the unknown absorber (57-71 km) and the vertical structure of clouds.
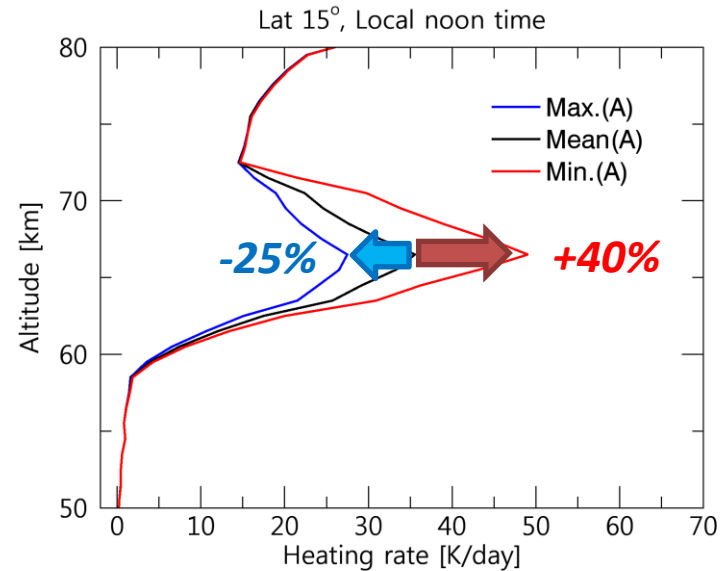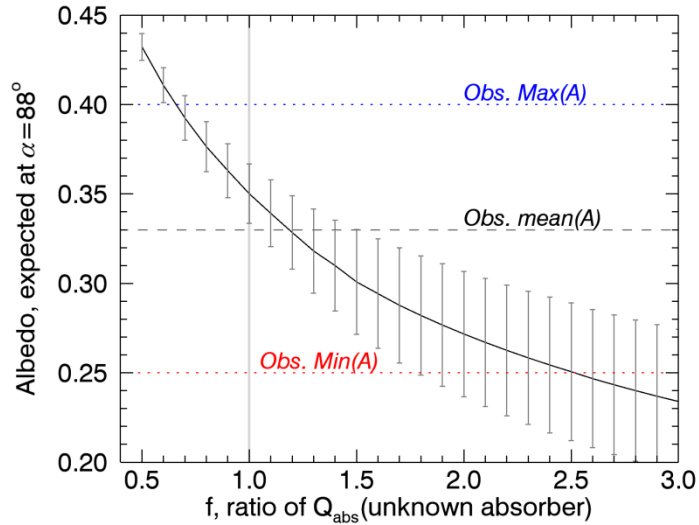
f = a factor, multiplied to the initial abundance of the unknown absorber (Crisp, 1986)
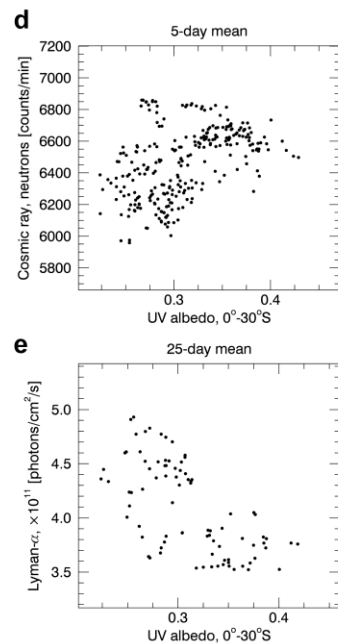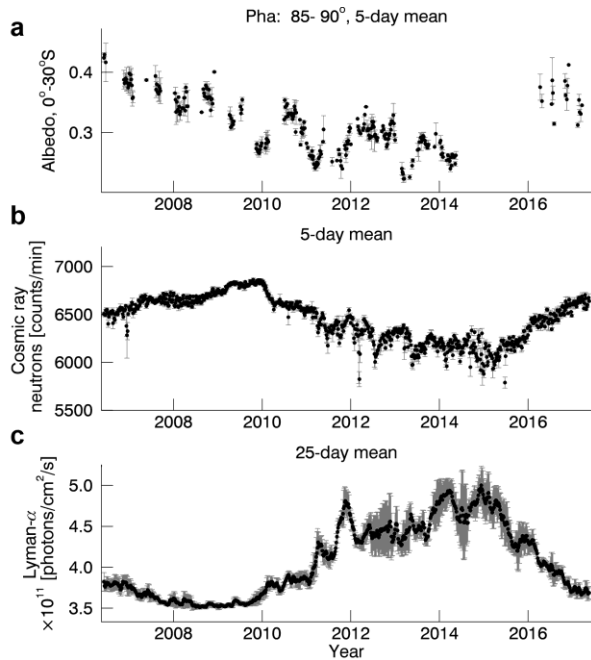
Possible influences on the zonal wind speed

- IPSL-Venus GCM (Garate-Lopez & Lebonnois 2018)
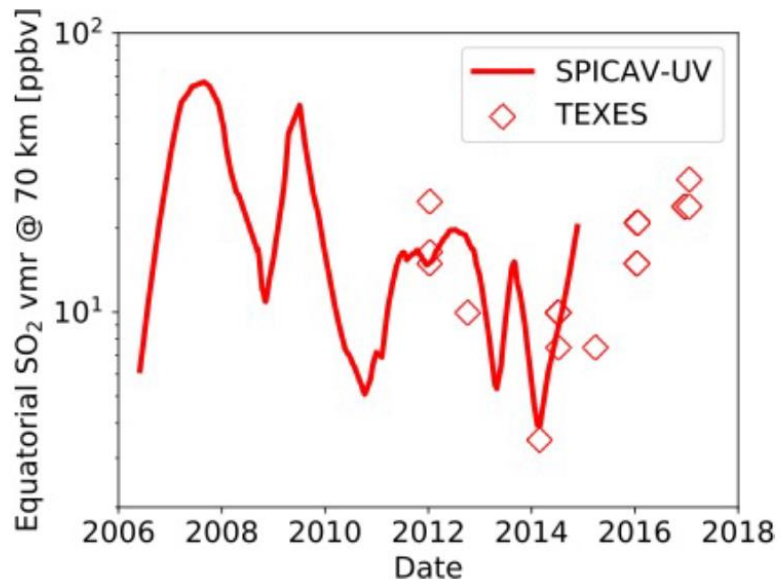 - The reference solar heating rate is reduced by 40% during ~6 years

[Khatuntsev et al. 2013]

[Horinouchi et al. 2018]
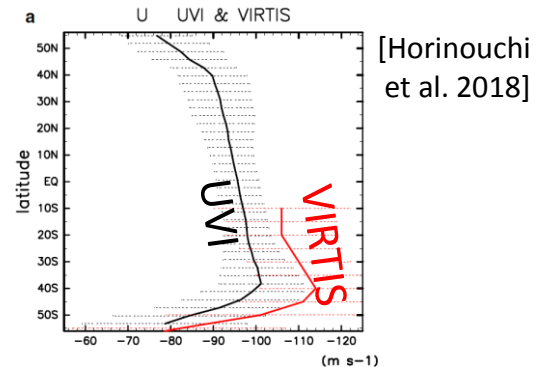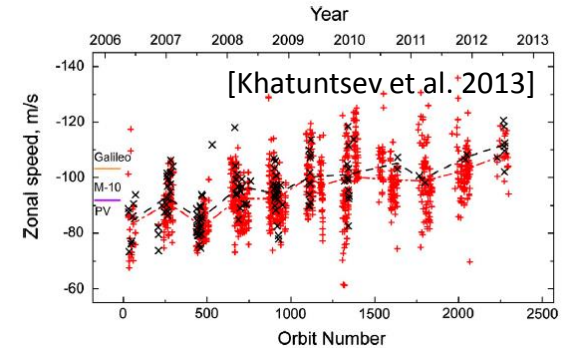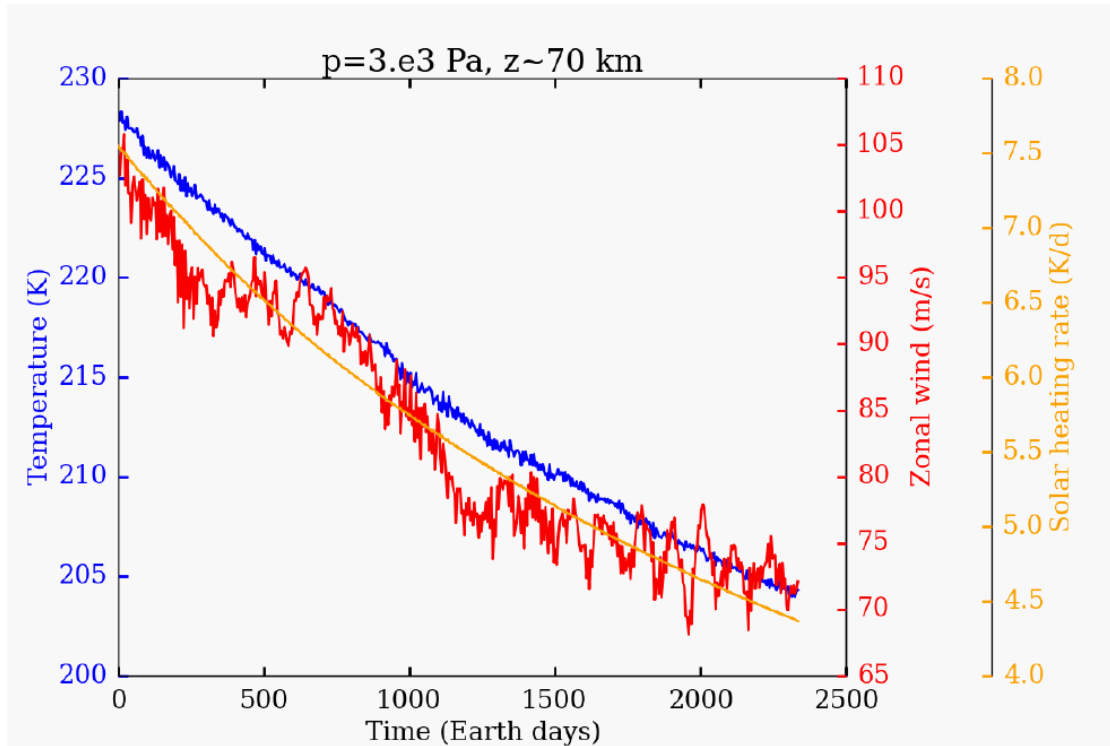
Reasons of the 365-nm albedo variations

- Solar activities: Solar EUV and/or cosmic-ray?
- SO_2 gas abundance above the clouds?

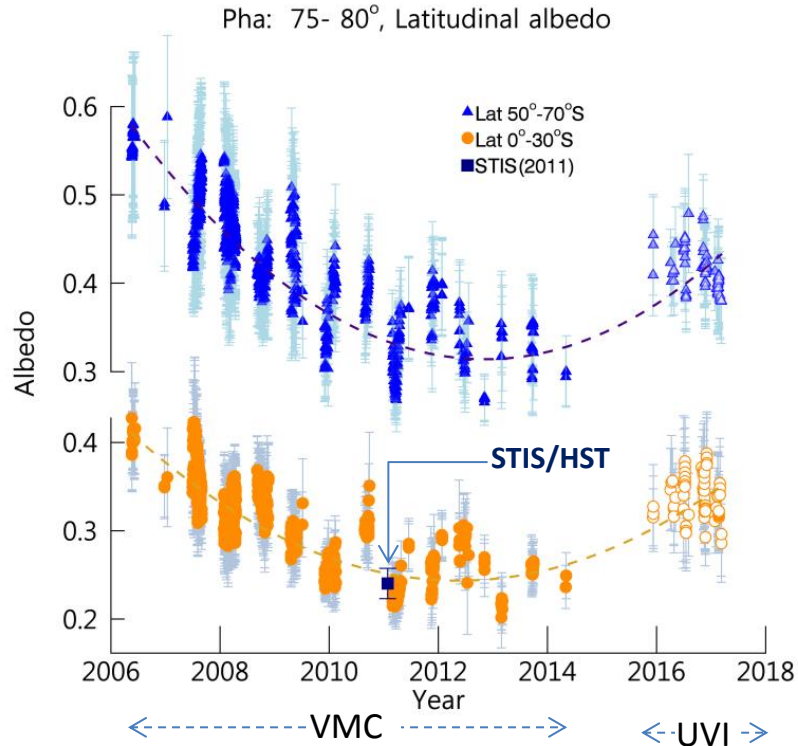
[Lee et al. submitted]

[Encrenaz et al. 2019]
[Marcq et al. 2019]

Intense decadal 365-nm albedo variations on the current Venus!

Pha: 75- 80°, Latitudinal albedo

365-nm albedo has been varied by **a factor of 2** in the recent decade.

This can directly control **solar heating rate**.
This may **affect zonal winds speed**.

→ Ongoing climate change on Venus?