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UND NACHHALTIGKEIT (CEN)

Inter-Calibration of Infrared Imagers Using Observations of Venus

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Agenda

- “Third Point“ for Calibration of Infrared Imagers
- What about Venus?
- First Results From Inter-Calibration
- Conclusions

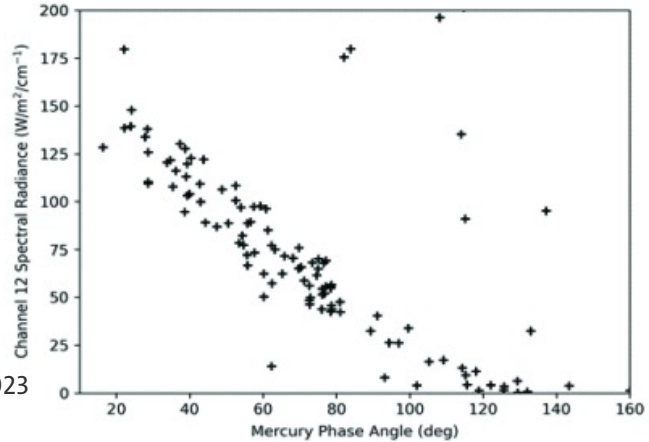
Celestial Targets Considered Fit for Calibration

Moon (Used With Solar Bands)

- Temperatures 100 - 400 K on surface
- Model needed close to New ☾
- Inconsistent spatiotemporal sampling in data stitching

Mercury (Bremer, SPIE, 2010)

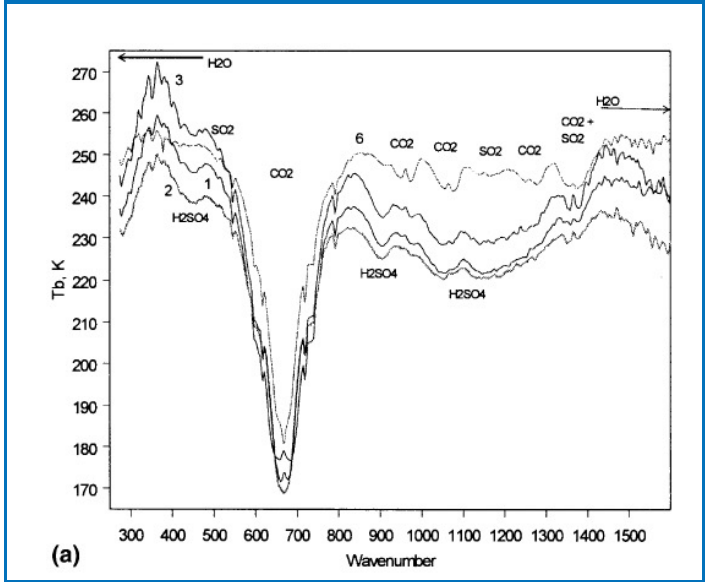
- Large dynamic range needed
- Exact knowledge of PSF and pointing essential



Fulbright et al., 2023

Venus: a Possible Radiometric Calibrator?

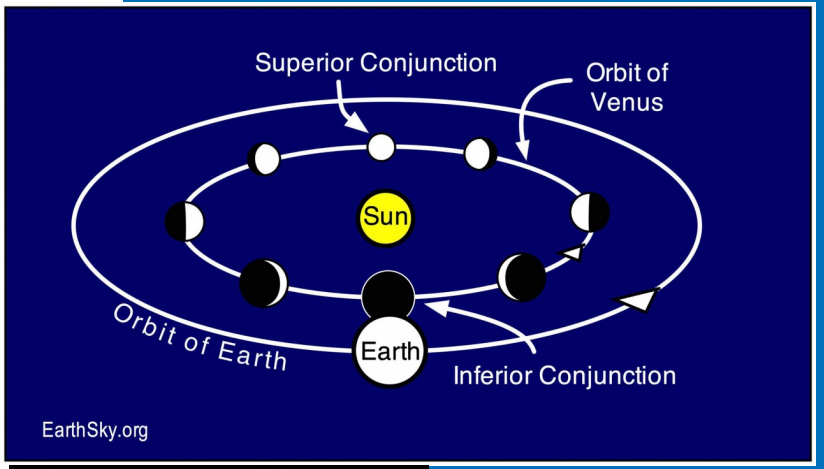
- Venus has an atmosphere, so
- Q: Its T_b is variable
- A: Reproducible diurnal variations?
- Q: There are spectral features – availability of model?
- A: No model needed for inter- and cross-calibration!
- Q: Spatial variations?
- A: Average over large fraction of disk!

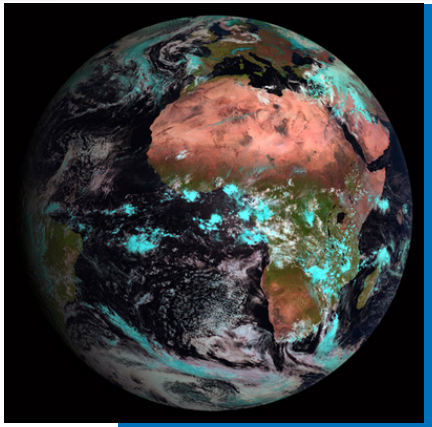


Zasova et al. (2004)

Observing Strategy: Inferior Conjunctions of Venus

Date and Time	Dec	Diameter
2007 Aug 18	+5°	60“
2009 March 27	+10°	59“
2015 Aug. 15	+6°	58“
2017 March 25	+9°	59“
2023 Aug. 13	+7°	58“
2025 Mar 23	+8°	60“





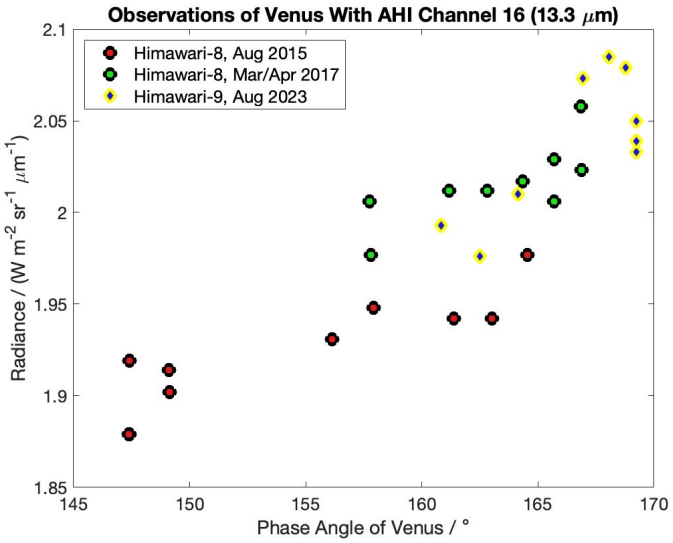
Inter-Calibration of SEVIRI on METEOSAT-8…-11

Satellite	Date	Phase Angle	Counts (13.4 μm)
METEOSAT-11	2023/08/13	L169°	207.4±1.8
METEOSAT-10	2023/08/30	L143°	205.2±1.7
METEOSAT-10	2017/03/30	L164°	203.9±0.7
METEOSAT-9	2017/04/02	L159°	204.1±0.9
METEOSAT-9	2015/08/21	L163°	203.5±0.5
METEOSAT-8	2017/04/11	L144°	207.5±1.3

Counts (raw data) change by less than 0.7% in radiance or 0.4 K in brightness temperature.

Inter-Calibration of AHI on Himawari-8 and -9

- Example: AHI Channel 16 (13.3 μm)
- Phase angle range 155° - 165° covered three times
- Himawari-8 in 2015: 1.948 $\pm$ 0.008 W m^{-2} sr^{-1} μm^{-1}
- Himawari-8 in 2017: 2.005 $\pm$ 0.007 W m^{-2} sr^{-1} μm^{-1}
- Himawari-9 in 2023: 1.993 $\pm$ 0.01 W m^{-2} sr^{-1} μm^{-1}
- Agreement between Himawari-8 and -9
- Calibration drift of ≈1 K with Himawari-8 after launch?
- Radiance at 13.3 μm with max. at local midnight?



Summary and Conclusions

- Venus‘ night side: a homogeneous extended source with a radiance slightly lower than Earth
- STDEV in radiance < 1% at $\lambda > 8$ μm => Venus is suitable for vicarious calibration
- Spot checks of radiometric stability in different years: SEVIRI on METEOSAT-9 and -10 better than 0.5 K *on counts level*.
- Inter-calibration of Himawari-8 and -9: agreement within 0.5% in radiance or 0.3 K in brightness temperature, six years apart.
- Venus‘ only drawback is the low frequency of inferior conjunction