CHARACTERIZATION FOR IR AND MICROWAVE INSTRUMENTS WITH SOLAR SYSTEM OBJECTS

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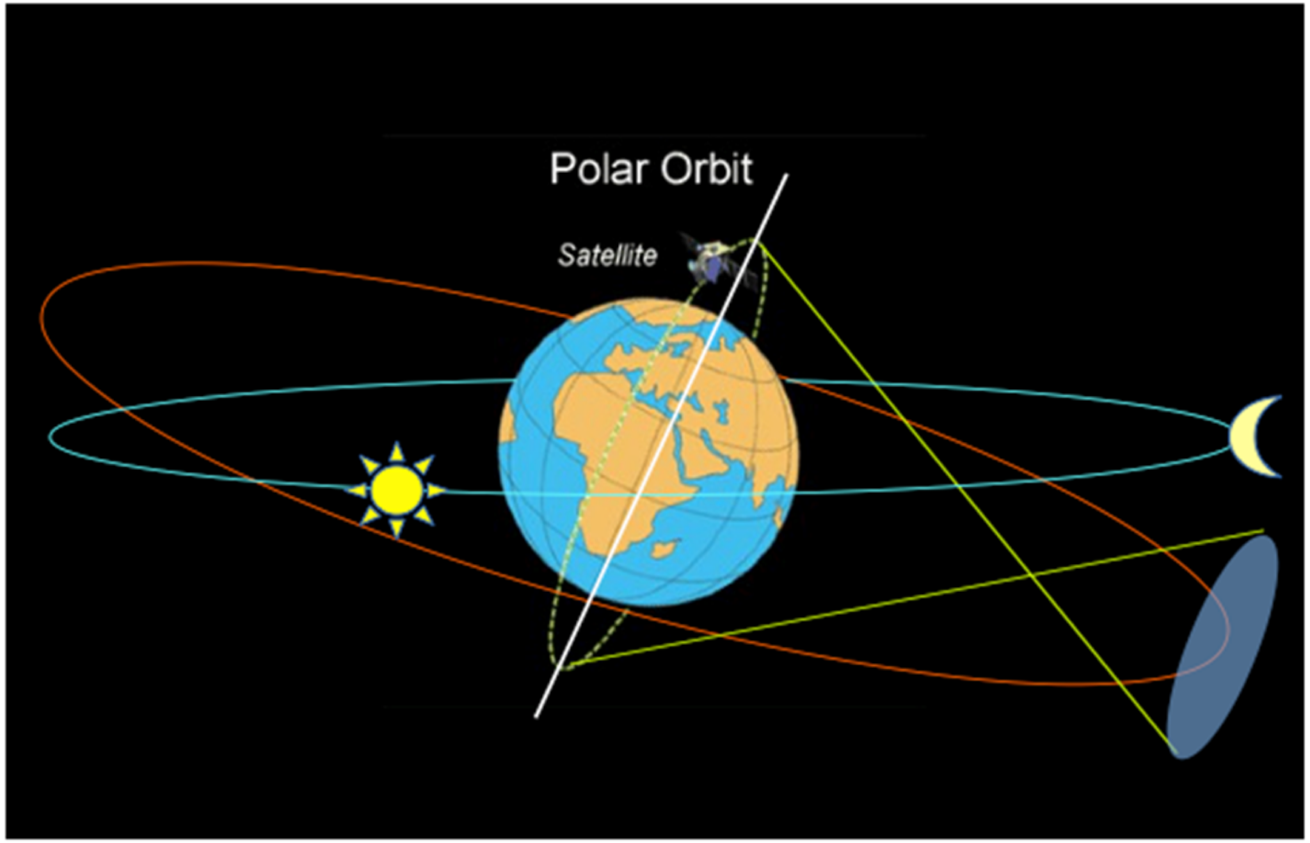
INTRODUCTION: WHAT USE ARE CELESTIAL OBJECTS?

- Serendipitous obs. of well-known objects in flight during mission
- Geometric calibration: position well known, object < FoV
- Checks ground characterization in flight
- Radiometric calibration: surface not changing, disk-integrated
- Check photometric stability, alternative to vicarious cal. / SNO
- How accurate are the observations of celestial objects?

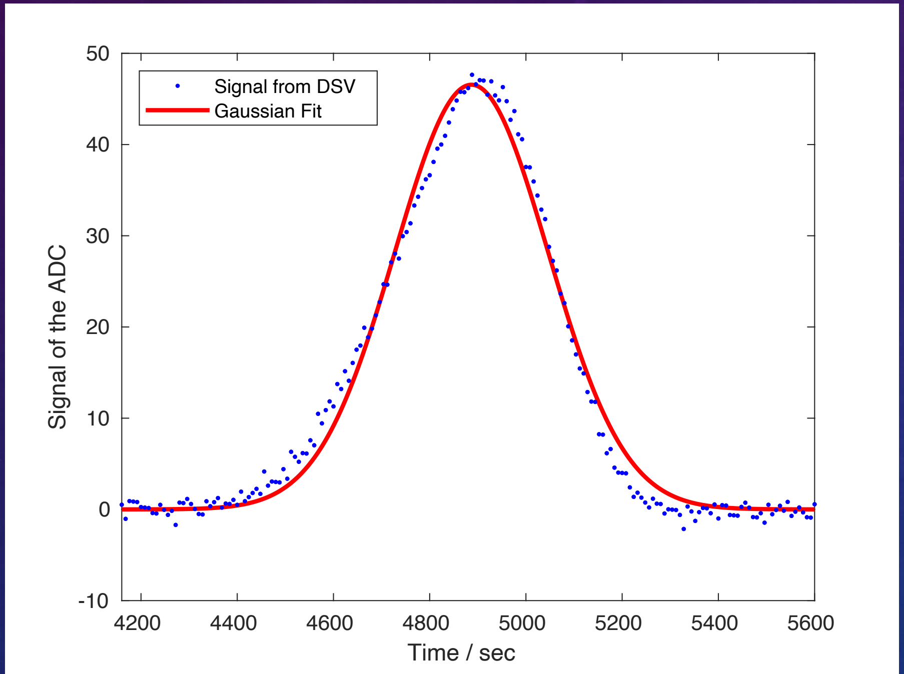
OBSERVING THE MOON WITH AMSU-B AND MHS

- DSV: circle close to celestial equator
- Moon close to ecliptic
- Moon moves through the DSV circle.
- Bigger circle => more intrusions
- Bigger beam => longer intrusions

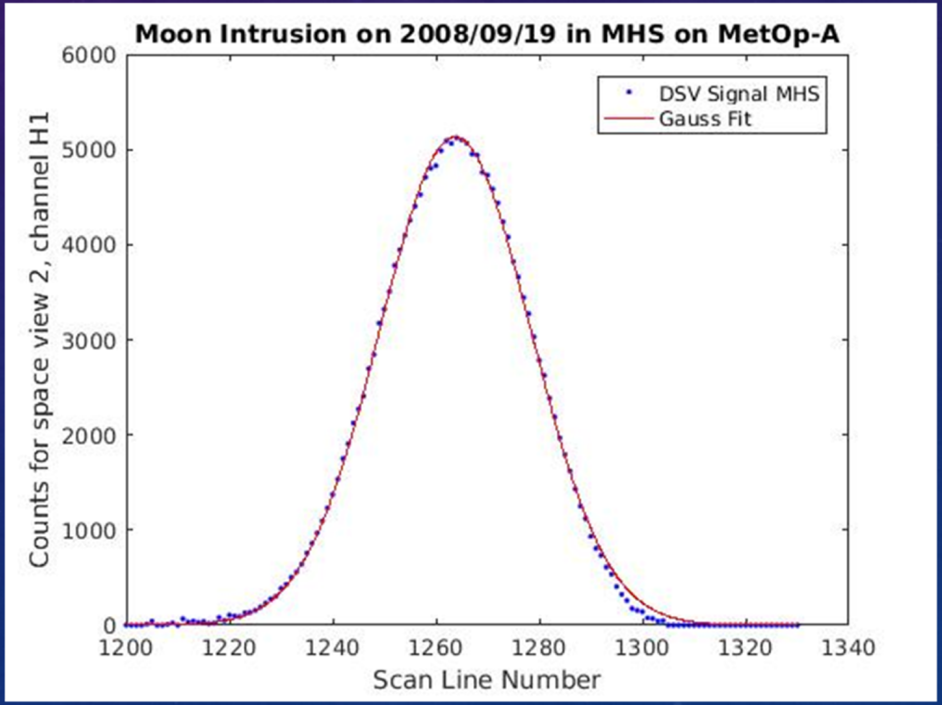


SIGNAL FROM THE MOON IN THE DEEP SPACE VIEW

AMSU-A

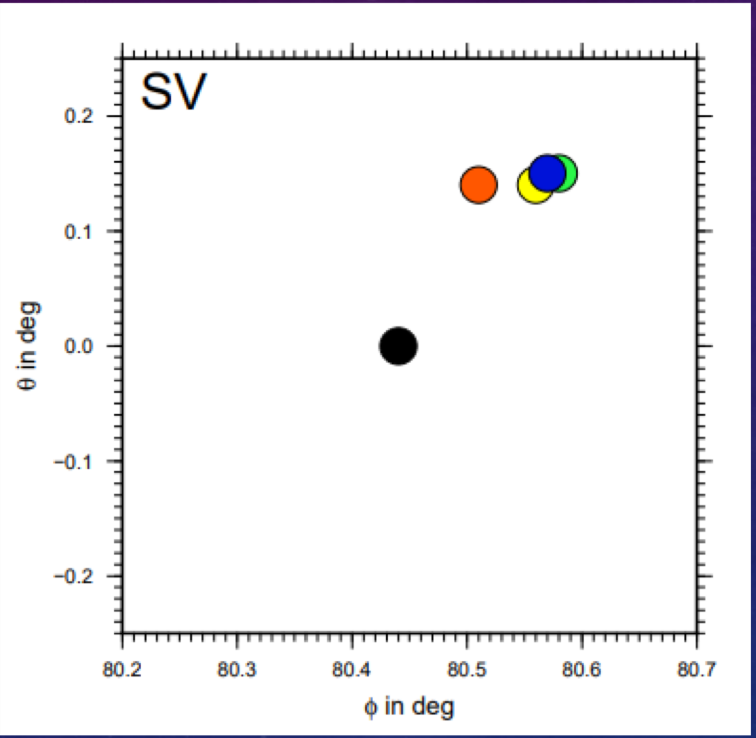


AMSU-B

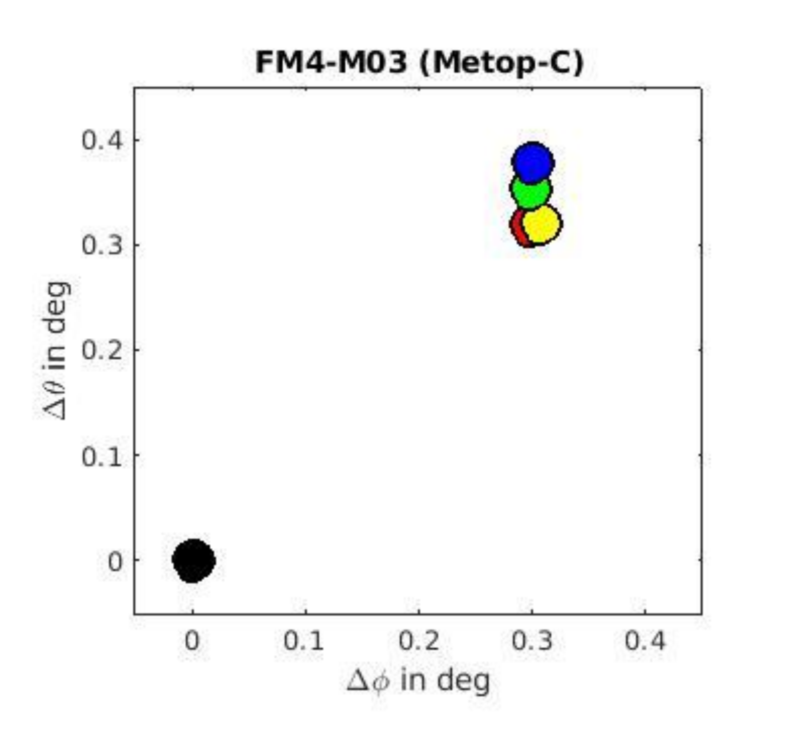


POINTING ACCURACY AND CO-ALIGNMENT

Ground Test (Airbus Defense & Space)



In-Flight From Moon in the DSV



MEAN HALF POWER BEAMWIDTH - AMSU-B AND MHS

Sat.	$(16/H1)_{gr}$	$(16/H1)_{op}$	$(17/H2)_{gr}$	$(17/H2)_{op}$	$(18-20/H3-4)_{gr}$	$(18-20/H3-4)_{op}$	$H5_{gr}$	$H5_{op}$
N15	1.12	1.199 ± 0.005	1.03	1.293 ± 0.011	1.05	1.207 ± 0.006		
N16	1.12	1.212 ± 0.006	1.05	1.338 ± 0.014	1.08	1.227 ± 0.009		
N17	1.16	1.210 ± 0.010	1.00	1.239 ± 0.010	1.00	1.093 ± 0.007		
N18	1.09	1.172 ± 0.004	1.03	1.067 ± 0.006	1.05	1.221 ± 0.004	1.05	1.241 ± 0.005
N19	1.10	1.178 ± 0.003	1.15	1.141 ± 0.003	1.12	1.271 ± 0.008	1.12	1.260 ± 0.003
M-A	1.11	1.177 ± 0.036	1.17	1.158 ± 0.037	1.07	1.215 ± 0.025	1.08	1.263 ± 0.041
M-B		1.120 ± 0.031		1.066 ± 0.029		1.140 ± 0.021		1.182 ± 0.033
M-C		1.245 ± 0.066		1.223 ± 0.062		1.278 ± 0.05		1.308 ± 0.073

RADIOMETRIC CAL.: OBSERVATION AND MODEL

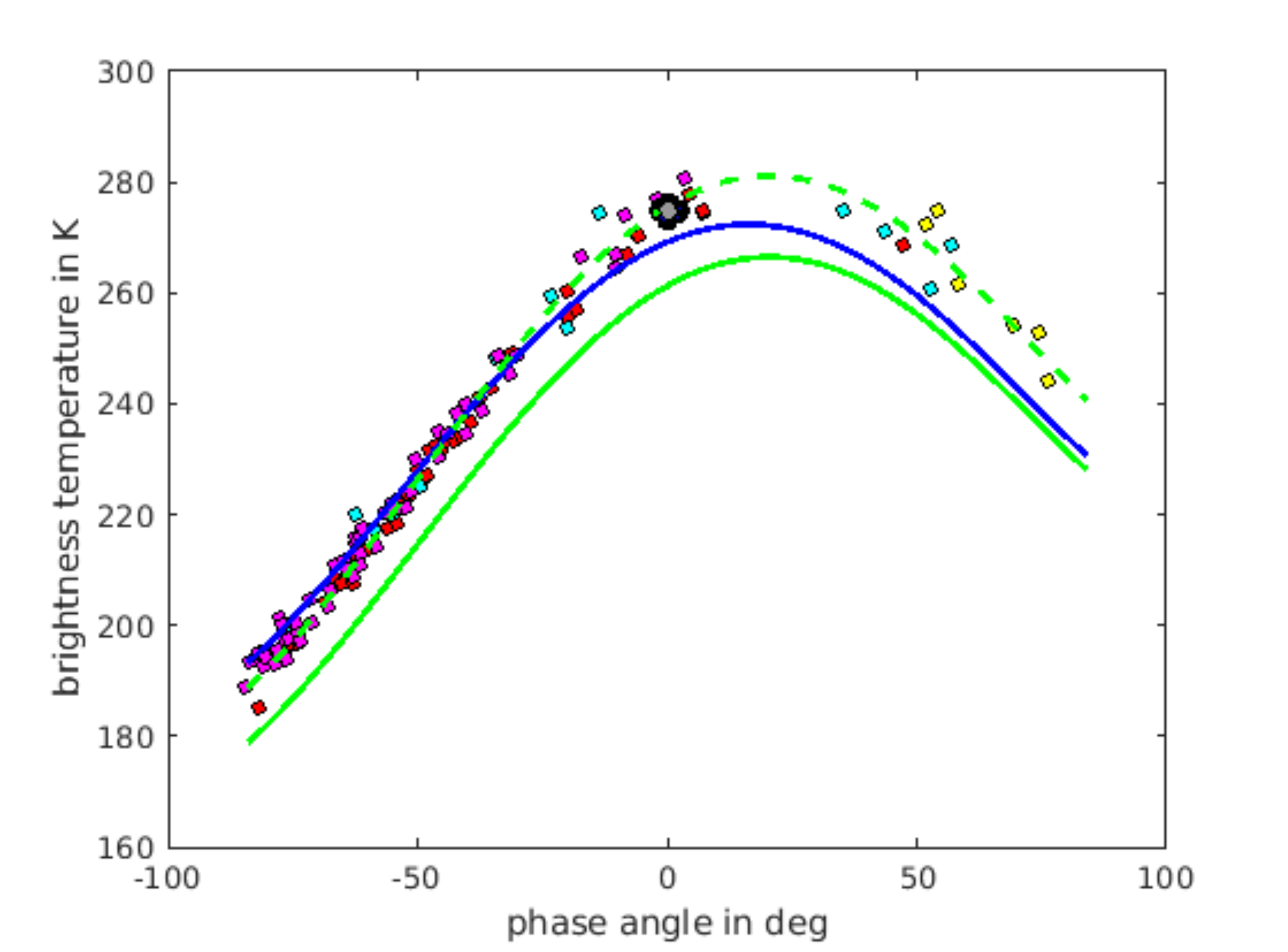
The measured T_B of the Moon at 89 GHz

Cyan: AMSU-B on NOAA-16
Yellow: NOAA-17

Red: MHS on NOAA-18
Magenta: NOAA-19

Grey dot: NOAA-20 ATMS.

Blue: Keihm (1984)
Green: Liu & Jin (2020).

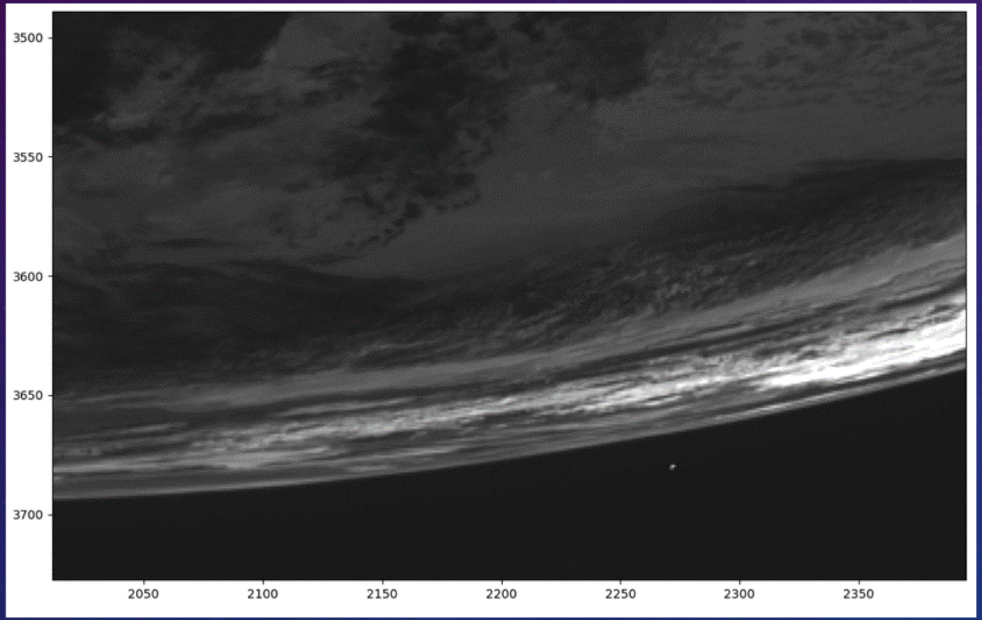


SUMMARY – MICROWAVE SOUNDERS

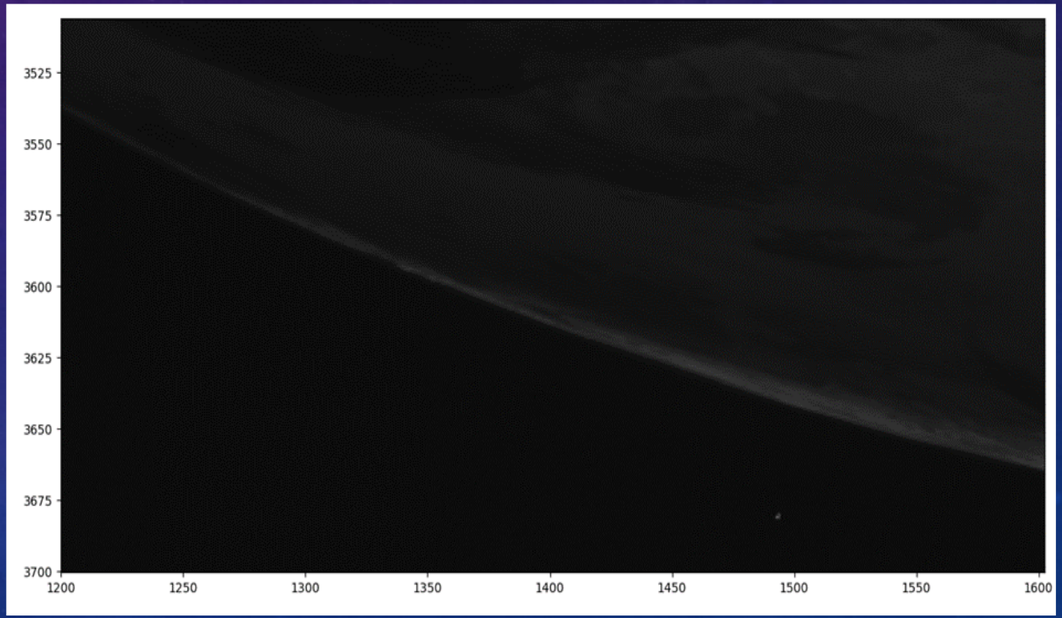
- Pointing accuracy at DSV
  - Requirement: ±0.1° for AMSU-B, ±0.09° for AMSU-B
  - Not compliant in 1/3 of the cases, more than ±0.3°
- Beamwidth at DSV
  - Requirement: 1.1° ± 10%
  - Not compliant in half of the sounding channels, discrepancies to ground tests ≥ ten sigma
- Radiometric calibration
  - Need to take distance of Moon to Sun and Observer and phase angle into account
  - Scatter around Liu & Jin‘s model of 2 K for MHS, absolute level 5.5% off

CONSECUTIVE OBSERVATIONS OF MERCURY (SEVIRI) I

Meteosat-10 at 3.92 μm on
5/15, 2017, 22:15

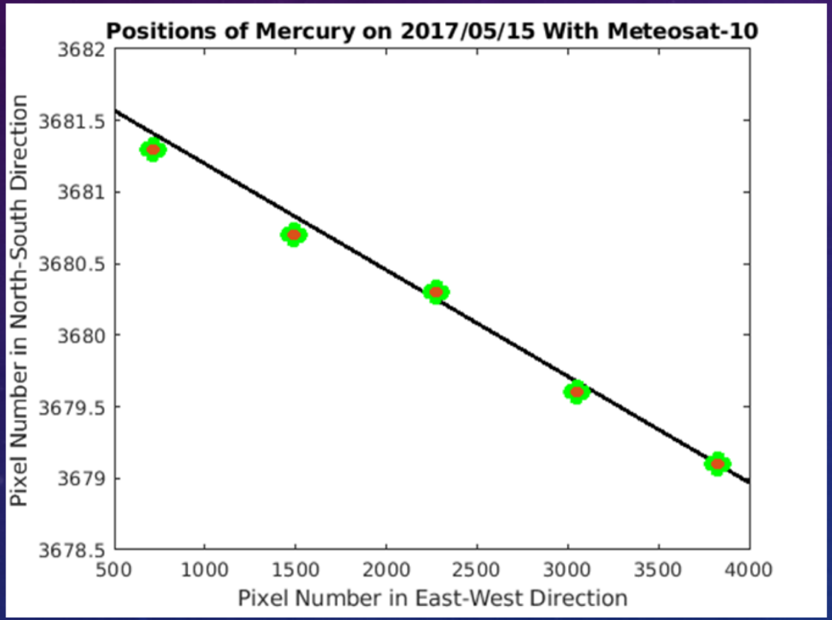


22:30

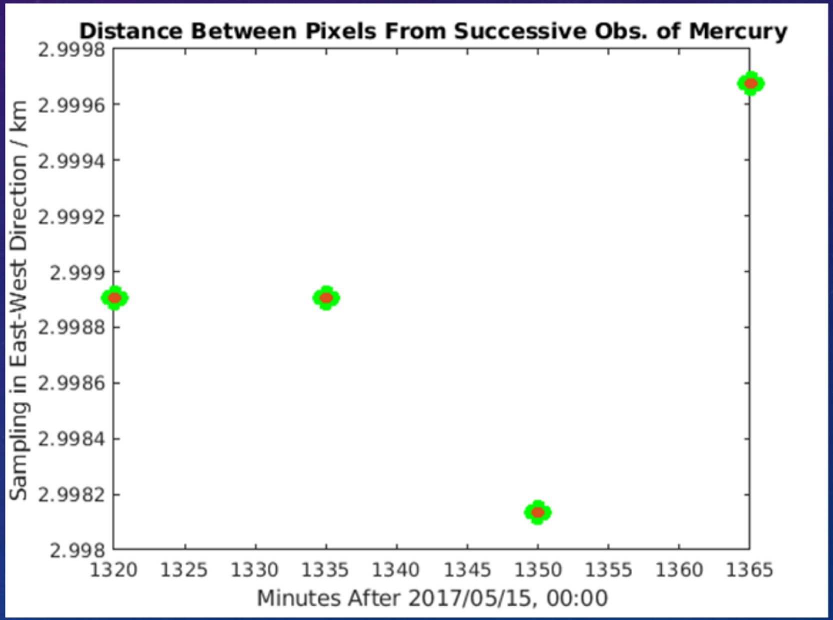


CONSECUTIVE OBSERVATIONS OF MERCURY (SEVIRI) II

Movement in North-South direction agrees with obs.



Sampling is accurate within a fraction of a ‰ over one hour.

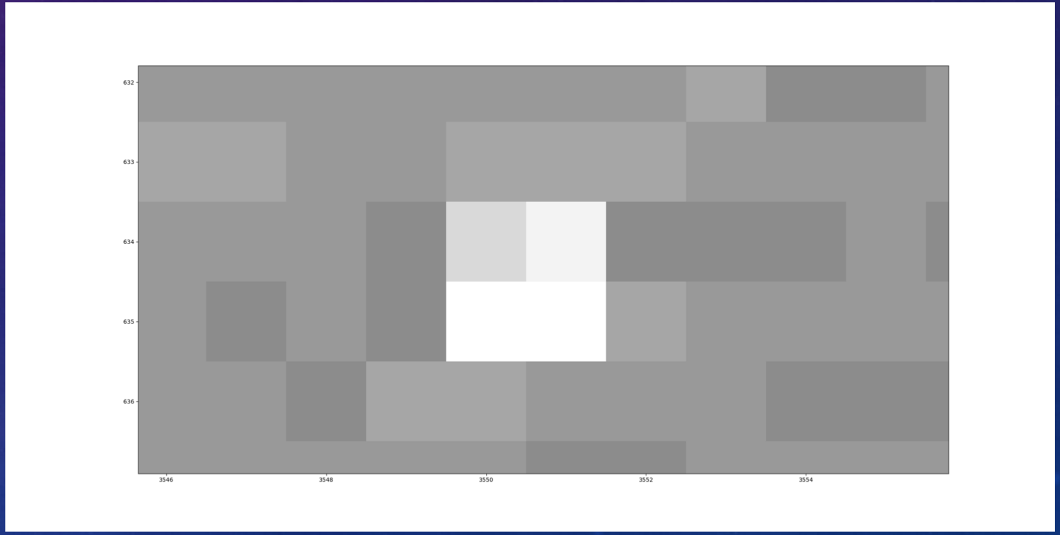


CHANNEL CO-REGISTRATION WITH SEVIRI

Venus at 800 nm on 9/30, 2019

Venus at 6200 nm on 9/30, 2019

Distance IR-VIS channels: 1.4 km



A MODEL FOR RADIOMETRIC CALIBRATION

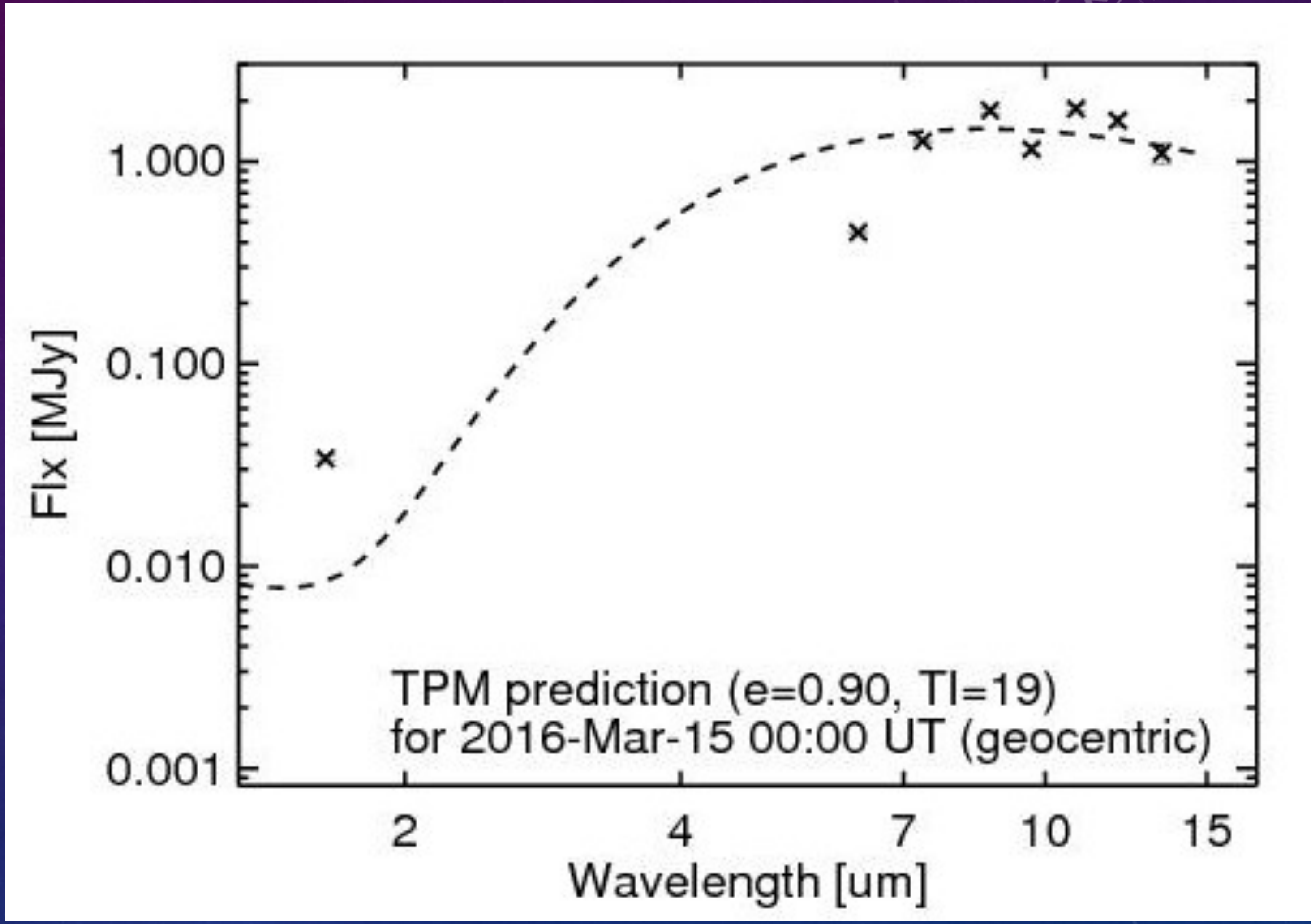
The disk-integrated flux of Mercury compared to a model.

Problem: IFOV > sampling

Feature at 6.25 μm?

Feldspar at 9.66 μm?

For VIS use Venus or Procyon.



Model by Thomas Müller, MPE

SUMMARY – SEVIRI ON METEOSAT

- Geometric calibration
  - Relative accuracy tested over 18.3° (> diameter of Earth) and consecutive images
  - Mis-registration between VIS/NIR and IR/WV focal planes confirmed for Meteosat-11
- Radiometric calibration
  - Short-term radiometric error requirements fulfilled for WV channels
  - Measurement uncertainties in VIS/NIR similar to vicarious calibration (single obs.)
- Problems with VIS/NIR
  - Venus not a point source, might be variable
  - ABI, AHI, and AMI have ten times smaller IFOV at 640 nm, use Procyon instead

CONCLUSIONS

- Moon intrusions in the deep space view are helpful for characterising MW sounders in flight.
- Performance of quasi-optics not compliant with ground tests and requirements in several cases
- Check of radiometric stability has accuracy of 2 K for a single observation with MHS.
- Mercury in the corners of the image is helpful for characterising SEVIRI's IR channels in flight.
- For VIS/NIR imagers with small IFOV: star close to celestial equator => make raw data available.