In-Flight Characterization of Microwave Sounders With the Moon

Martin Burgdorf, Imke Hans,

Marc Prange, Theresa Lang,
Stefan A. Buehler

Universität Hamburg

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

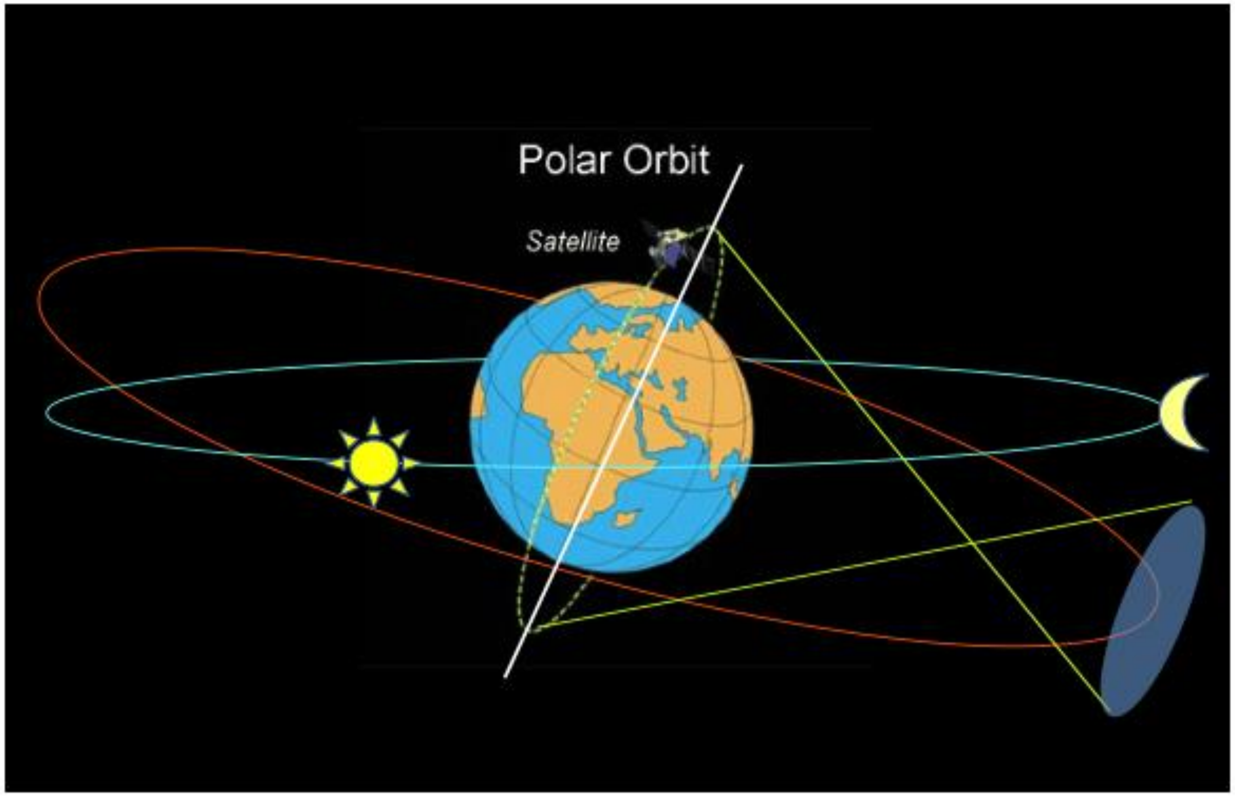
Fiduceo

Talk Structure

- Moon Intrusions in the DSV
- Properties of the Light Curve
- The Moon as Reference
- Example: Bias of AMSU-B on N16
- Conclusions

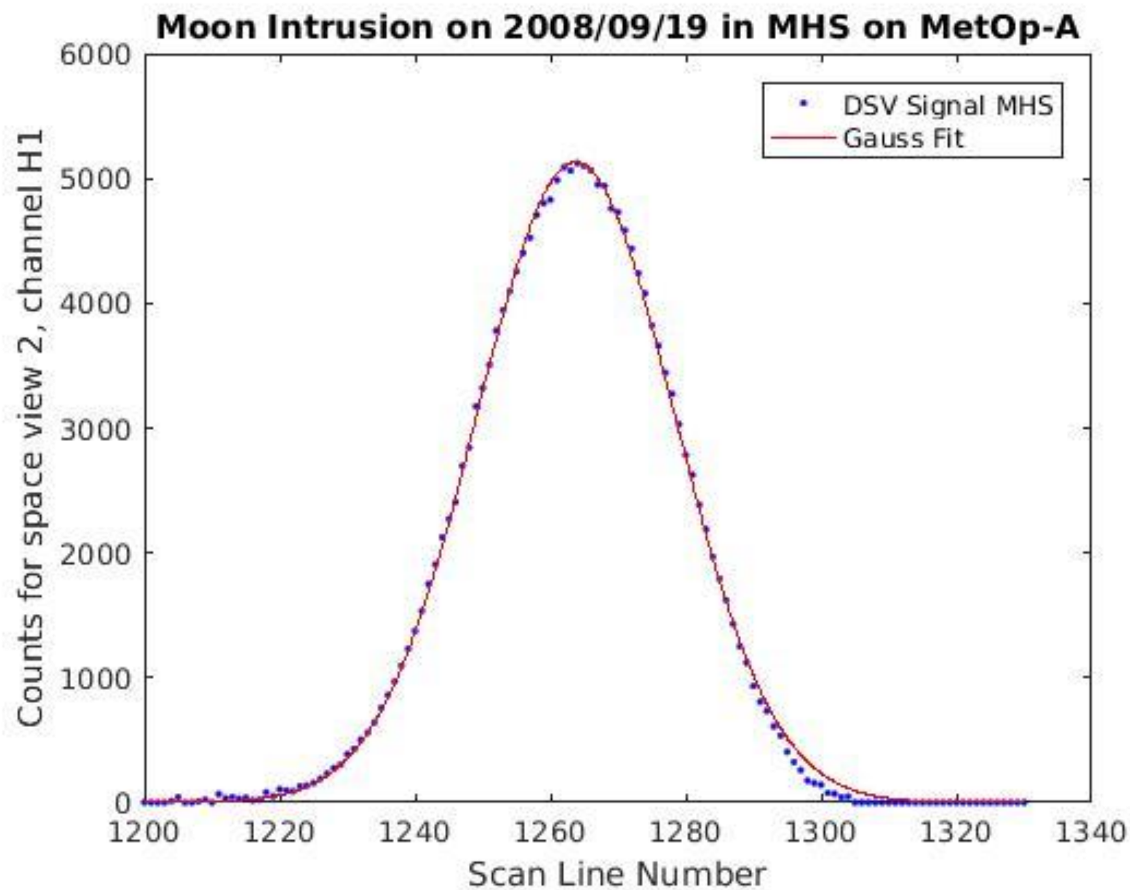
Moon Intrusions in the DSV

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



Light Curve

- The "light" curve of the Moon in the DSV follows closely a Gaussian.
- A Gaussian has three parameters:
  - Scan number of strongest signal => pointing accuracy (Bonsignori, 2017)
  - Width => beam size
  - Maximum signal => photometric stability – accuracy ≈ 0.3 %

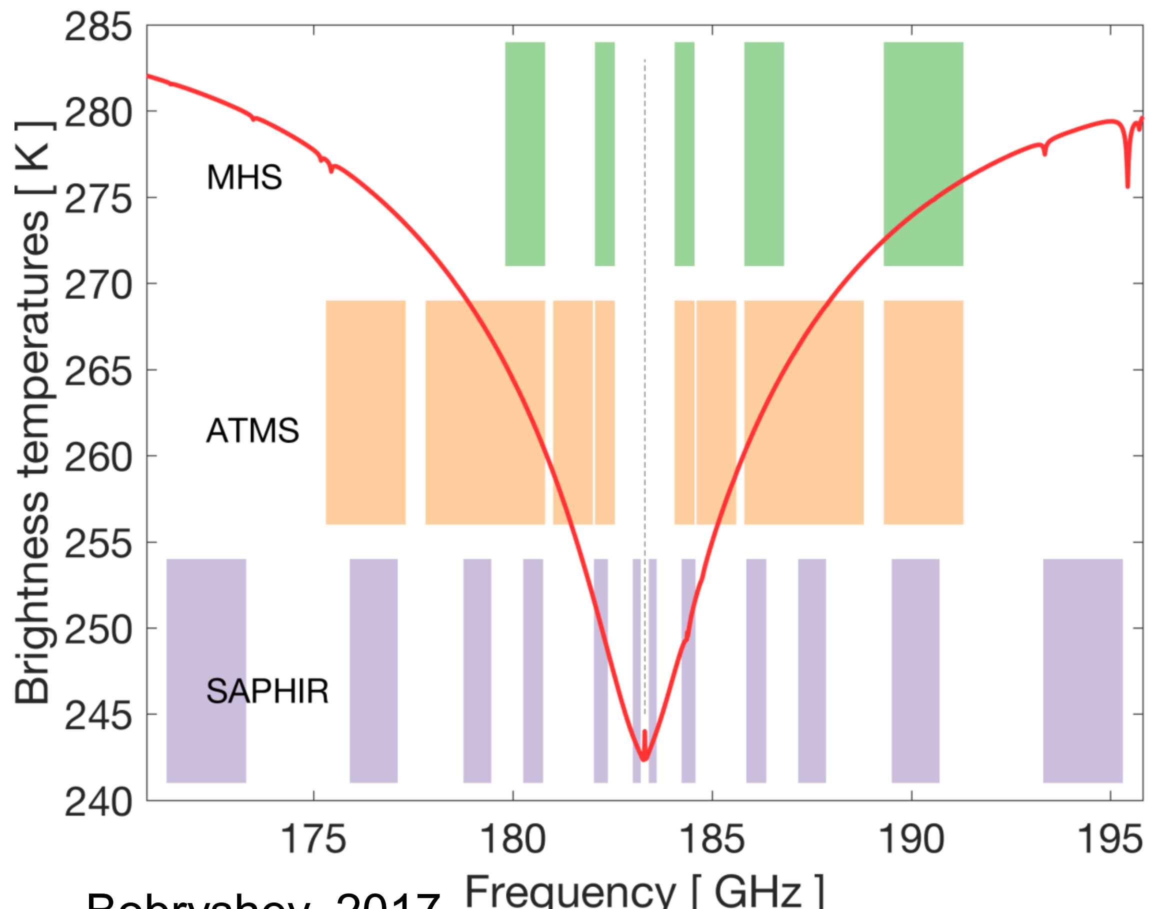


Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

FIduceo

The Moon as Reference (I)

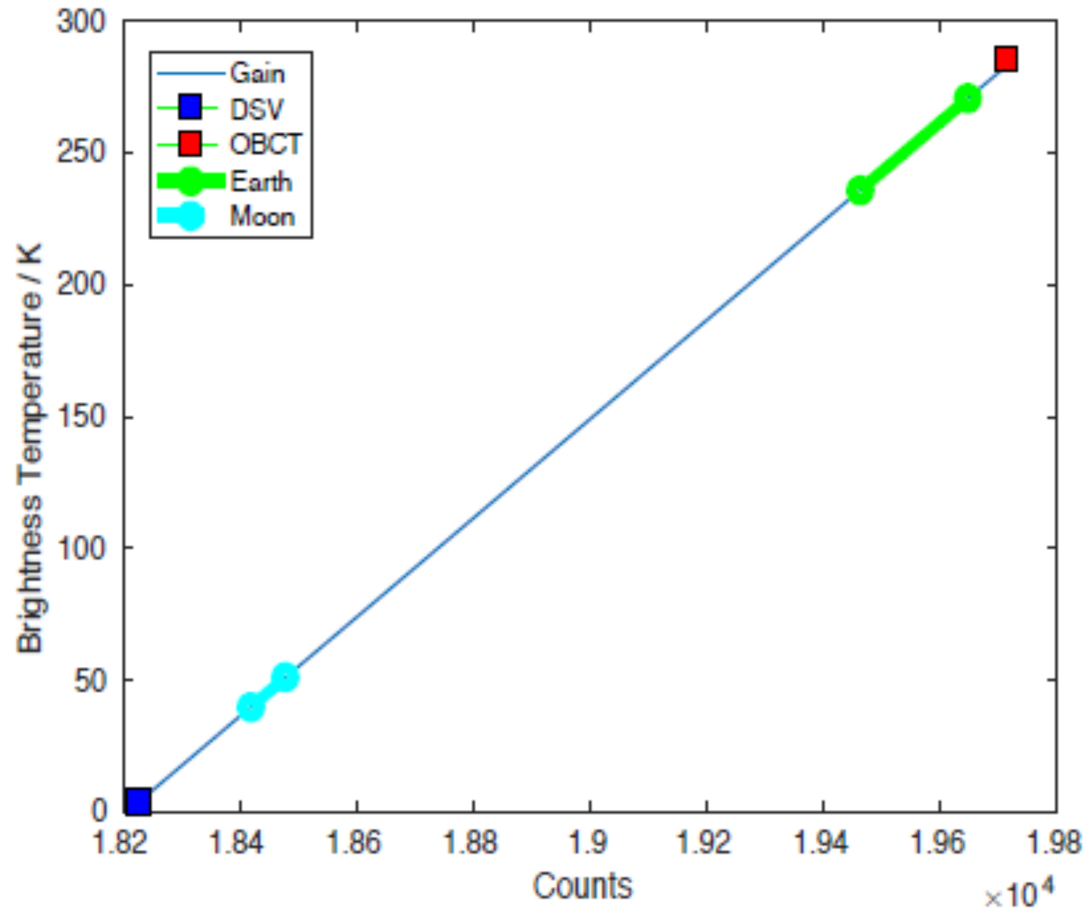
- Common reference for all satellites, past, present, and future
- Potential replacement of SNO for inter-calibration
- No atmosphere => no spectral lines => channels with the same central ν get the same R_ν



Bobryshev, 2017

The Moon as Reference (II)

- The Moon does not fill the beam of the instrument
- $R^{moon} << R^{earth\ scene}$
- Bias between satellites different for Earth and Moon
- Derive constraints on uncertainties of instrumental constants

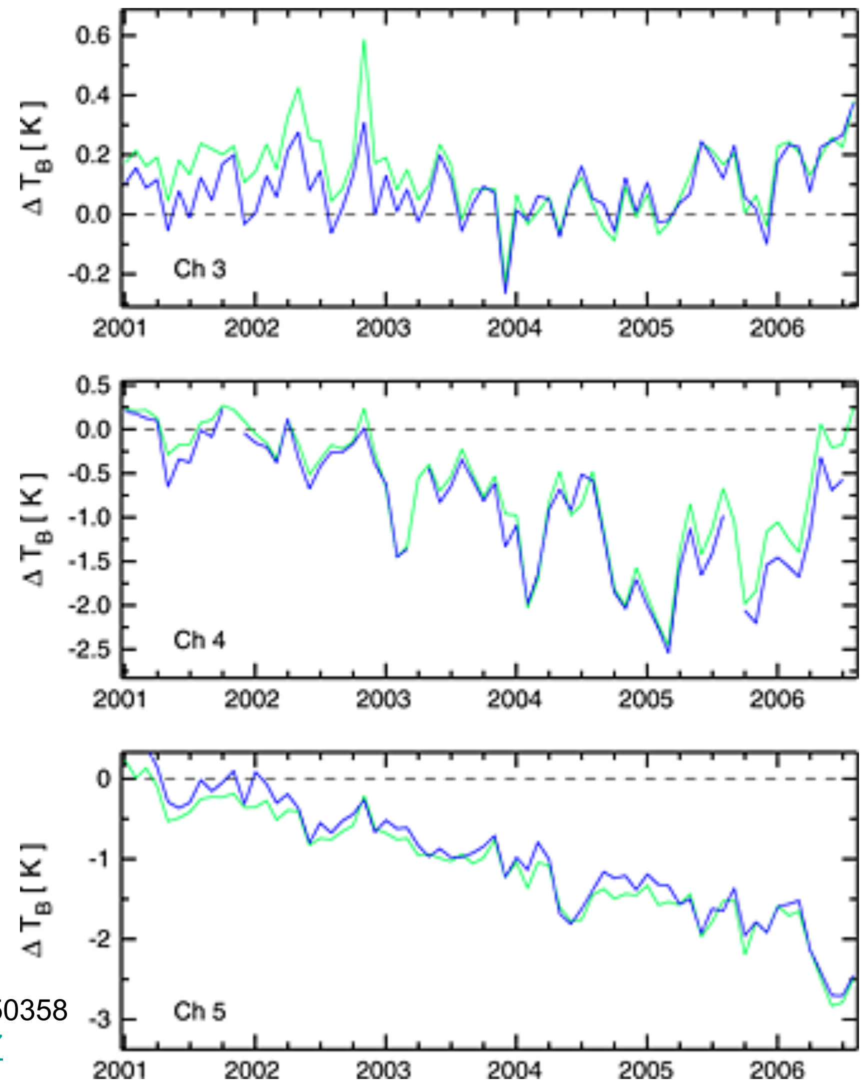


Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

FIduceo

Example: Bias of AMSU-B/N16 (I)

- "Channel 5 on N16 shows […] the largest bias which reaches 10 K by the end of 2010." (John et al., 2013)
- The 3 sounding channels give the same signal when observing the Moon.
- Bias due to non-linearity?
- Q proportional to $(C_E - C_{ICT}) \times (C_E - C_C)$
- $Q^{moon} = 9 \times Q^{tropical\ ocean}$, but no such discrepancy found



John et al., Journal of Geophysical Research: Atmospheres
Volume 118, Issue 10, pages 4906-4918, 20 MAY 2013 DOI: 10.1002/jgrd.50358
http://onlinelibrary.wiley.com/doi/10.1002/jgrd.50358/full#jgrd50358-fig-0007

Example: Bias of AMSU-B/N16 (II)

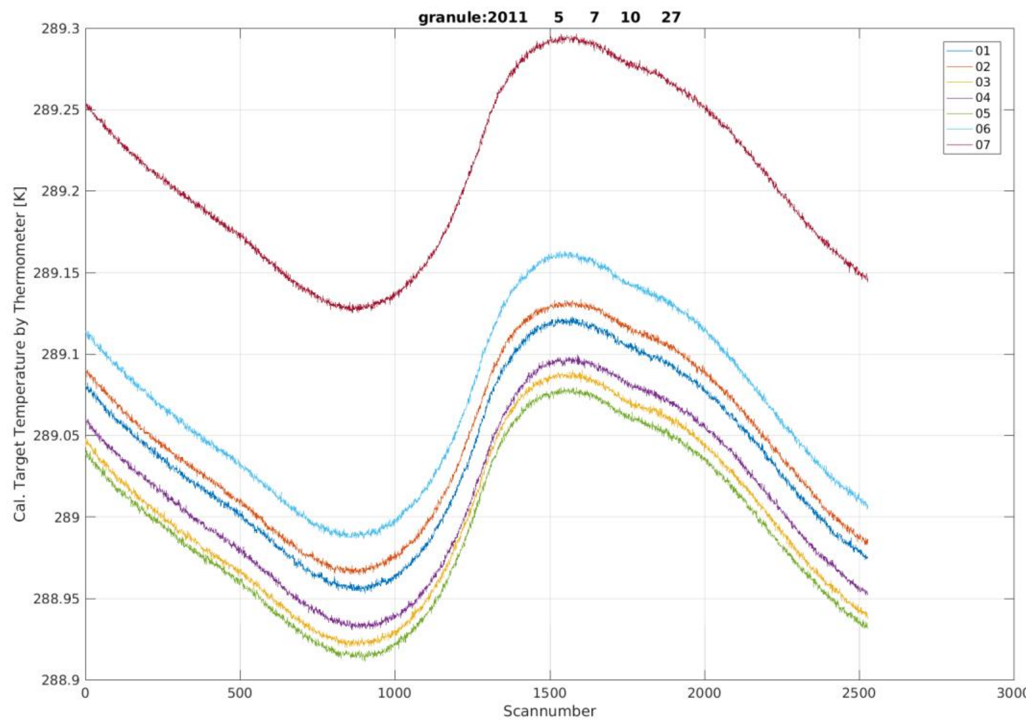
- Bias due to cold space temperature bias correction?

$$R_{ME} = R_{MS} + \frac{R_{MICT} - R_{MS}}{\overline{C}_{ICT} - \overline{C}_S} \times (C_E - \overline{C}_S) + DR_{nl}(C_E)$$

- $\delta R^{moon} = 39 \times \delta R^{tropical\ ocean}$, no such discrepancy found

- ICT OK, so instrumental constants in measurement equation are not to blame.

- Frequency shift can be ruled out (common LO)



Conclusions

- Observations of the Moon offer unique possibilities to check the stability and uniformity of sounding channels and to determine the cause for inter-satellite bias.
- No knowledge of the brightness temperature of the Moon is necessary.
- A few suitable Moon intrusions per year
- Smaller beam size of ICI and MWI => Moon no point source, but better SNR

View publication stats