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The Moon as a Diagnostic Tool for Microwave Sensors

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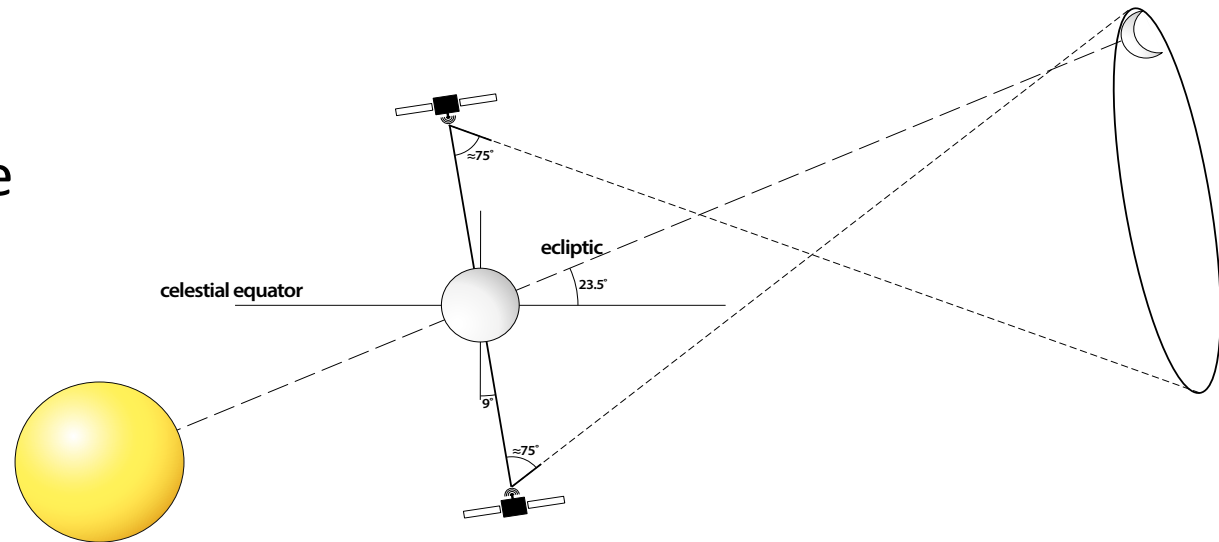


The Moon Supports Calibration

- Ground-based observing program with robotic telescope (Stone & Kieffer, 2002)
- Sophisticated model for visible and near-infrared wavelengths: ROLO
- No such model of disk-integrated flux at longer wavelengths
- Main advantage – unchangeable surface – also useful for stability checks in MW range

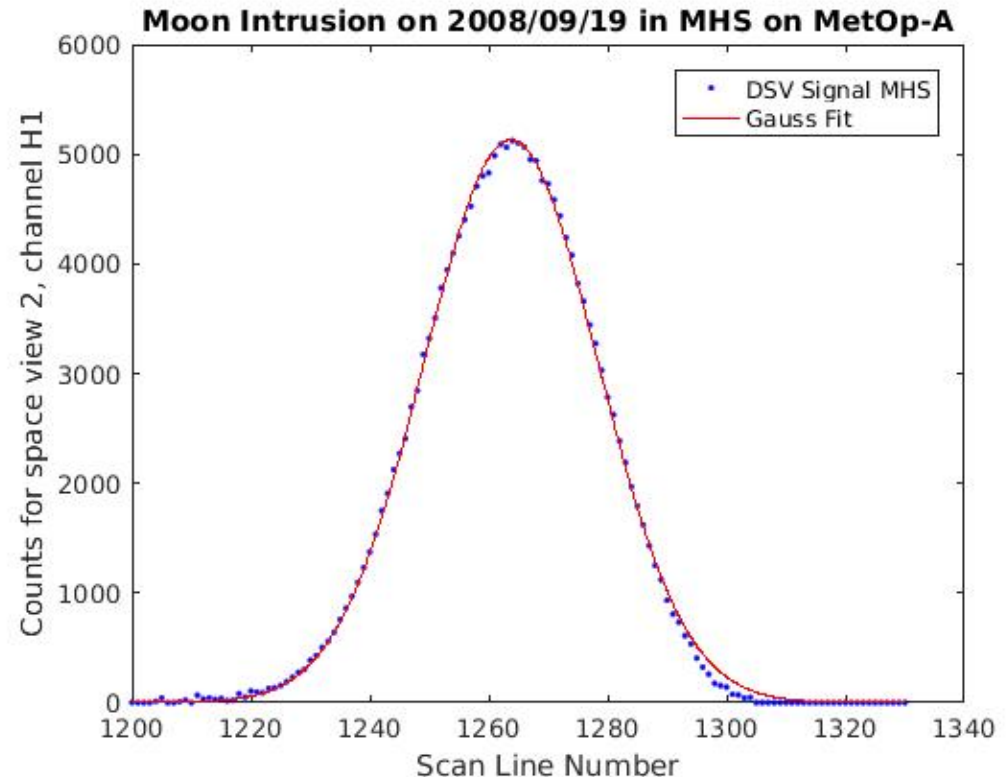
The Moon Seen by Microwave Sounders

- Pointing direction of DSV describes circle in the sky
- Moon crosses circle from time to time
- Several months each year with Moon intrusions during routine operations
- Pairs of groups of orbits with Moon intrusions



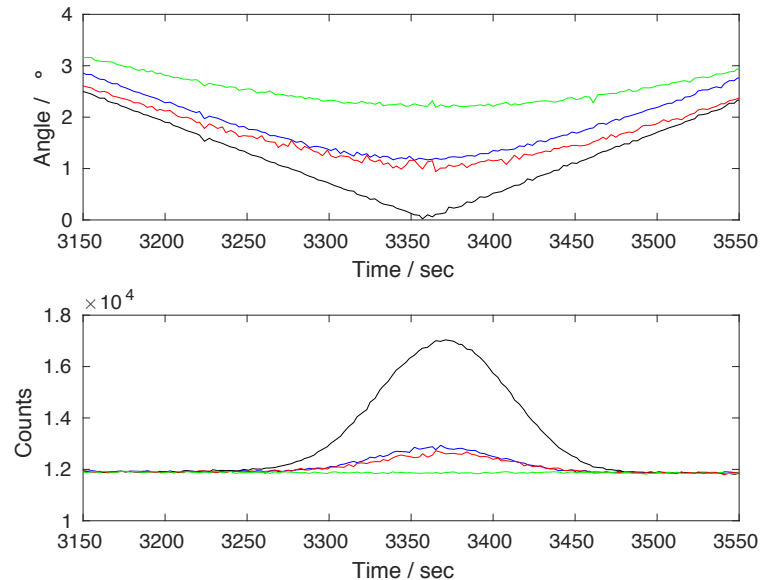
The Moon Produces an Additional Signal in the DSV

- The closer the Moon to the DSV direction, the stronger the signal
- Light curve resembles a Gaussian
- $1\sigma(a_1) / a_1 \approx 0.002$
- Maximum signal $\approx (0.5^\circ / \text{FWHM}_{\text{beam}})^2$
- Duration of intrusion = $f(\text{pos. angle}_{\text{DSV}})$



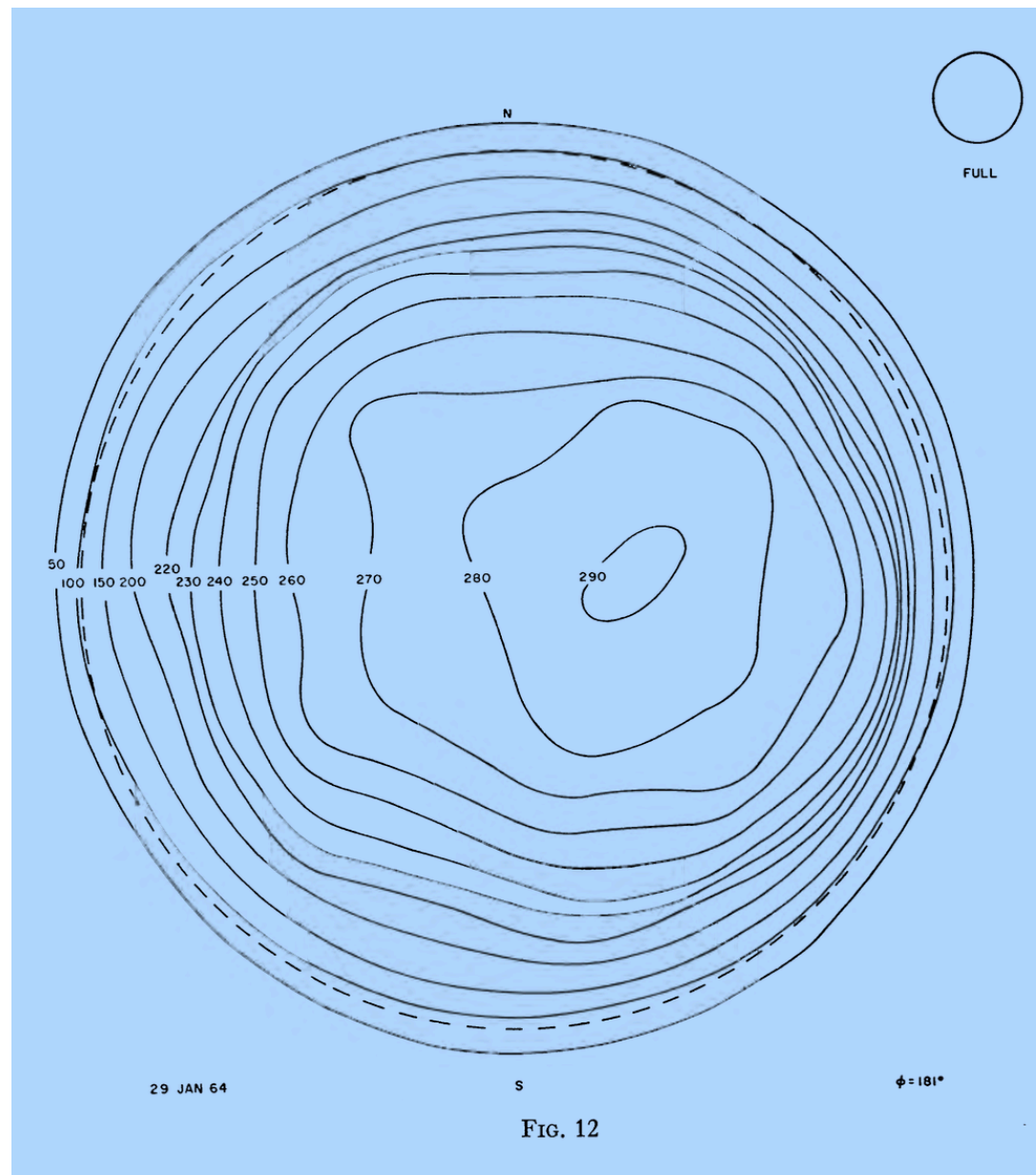
Check Pointing Accuracy With the Moon

- Angle between moon and space views in Level 1b Record
- Measured counts give the real picture
- ATBD for MHS claims uncertainty of 0.3°
- Seems to be 95% confidence bounds



Check Beam Size With the Moon

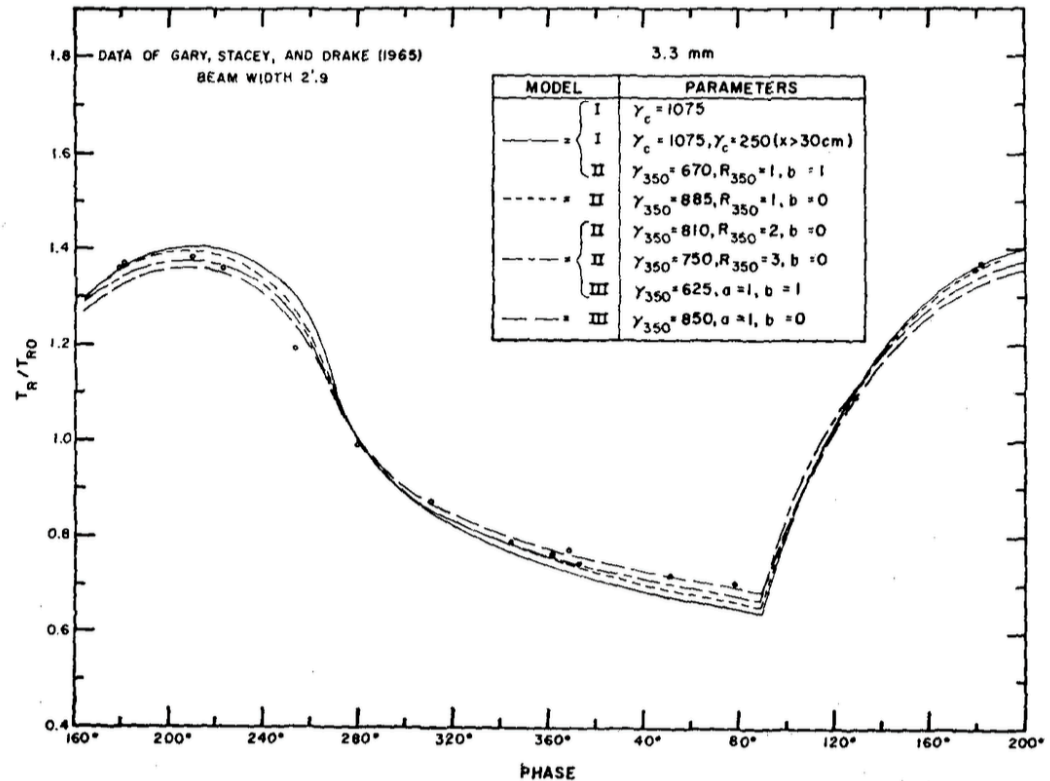
- DSV direction moves over Moon
- Width of light curve is proportional to beam size
- Beam size of MHS ch. 1 on N18 2% larger than on N19 – barely significant
- Anomalies found with MHS on MetOp-A



Gary et al. (1965)

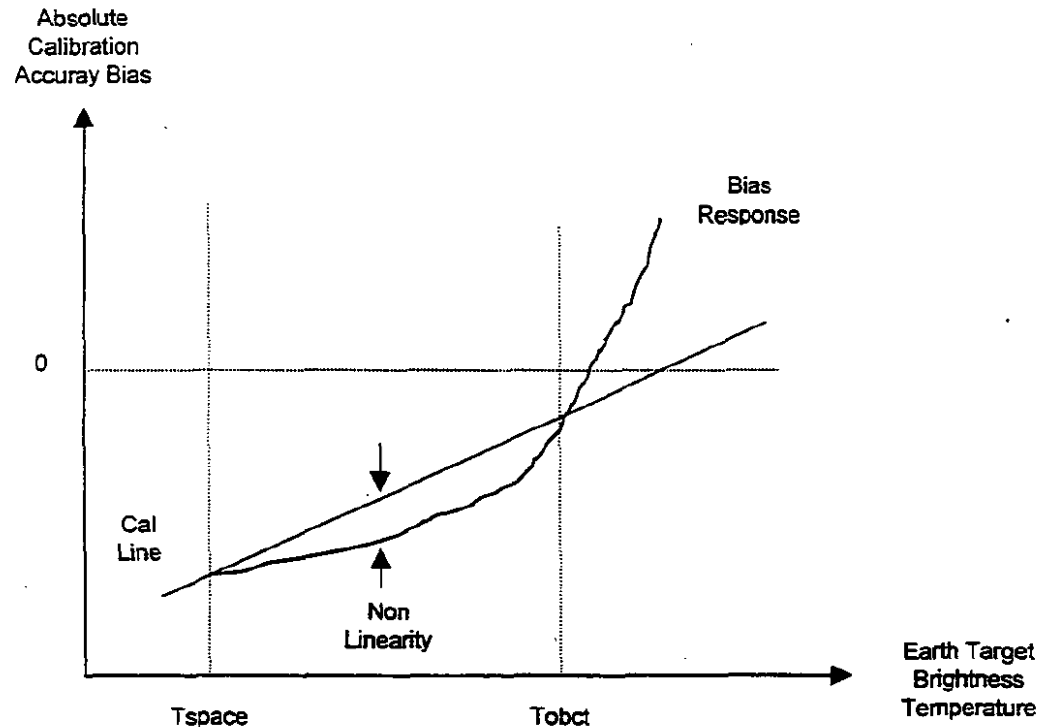
Check Photometric Stability With the Moon

- Moon is a calibration standard in radio astronomy
- Radio telescopes have $\theta_{mb} \ll D_{Moon}$
- Need accurate separation angle Moon – space view
- Correct for phase angle with Mo & Kigawa (2007)
- Accuracy $\approx 2\%$



Check Non Linearity Correction With the Moon?

- Non Linearity correction is zero at T_{space} and T_{obct}
- $Q = 4 Q_{\text{max}} (x - x^2)$
- Maximum at 140 K
- $\frac{3}{4} \times \text{max}$ at 70 K
- Non Linearity is typically ≤ 0.1 K
- Compare different instruments



The Moon and MW Sounders

- Moon intrusions in the DSV happen with every microwave sounder
- They contain information about pointing accuracy, beam pattern, photometric calibration, and maybe even non-linearity
- Best suited to investigate stability and inter-calibration over arbitrary time periods
- Will become more accurate with smaller beam size and dedicated S/C maneuvers