CHECKING THE RADIOMETRIC STABILITY OF CRIS WITH THE MOON

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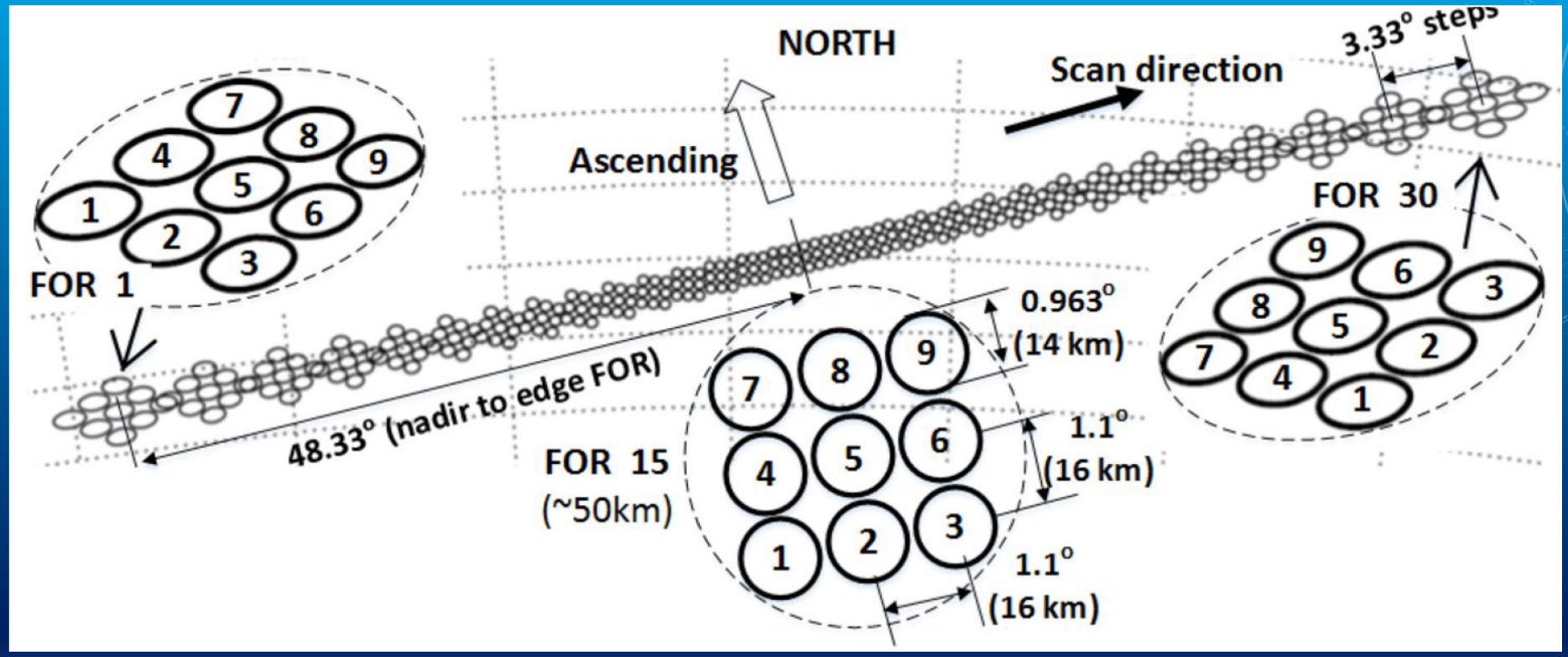
INTRODUCTION

- The Moon was used for the characterisation of HIRS in flight (Burgdorf et al., 2020, Seibert, 2022)
- A model for the disk-integrated thermal infrared is available (Müller et al., 2021)
- Many disk-integrated spectra of the Moon provided by Y. Chen
- What opportunities for (inter-)calibration do they offer?

AVAILABLE INFRARED OBSERVATIONS OF THE MOON

- Thousands of *spectra* with CrIS on SNPP and NOAA-20 (3.9 - 4.6μ, 5.7 – 8.3μ, 9.1 – 15.4μ)
- SNPP since Oct 2011, NOAA-20 since Nov 2017
- 667 events with SNPP, 326 events in NOAA-20
- No direct SNOs or matchups => Moon is common target

CROSS-TRACK INFRARED SOUNDER SCAN PATTERNS

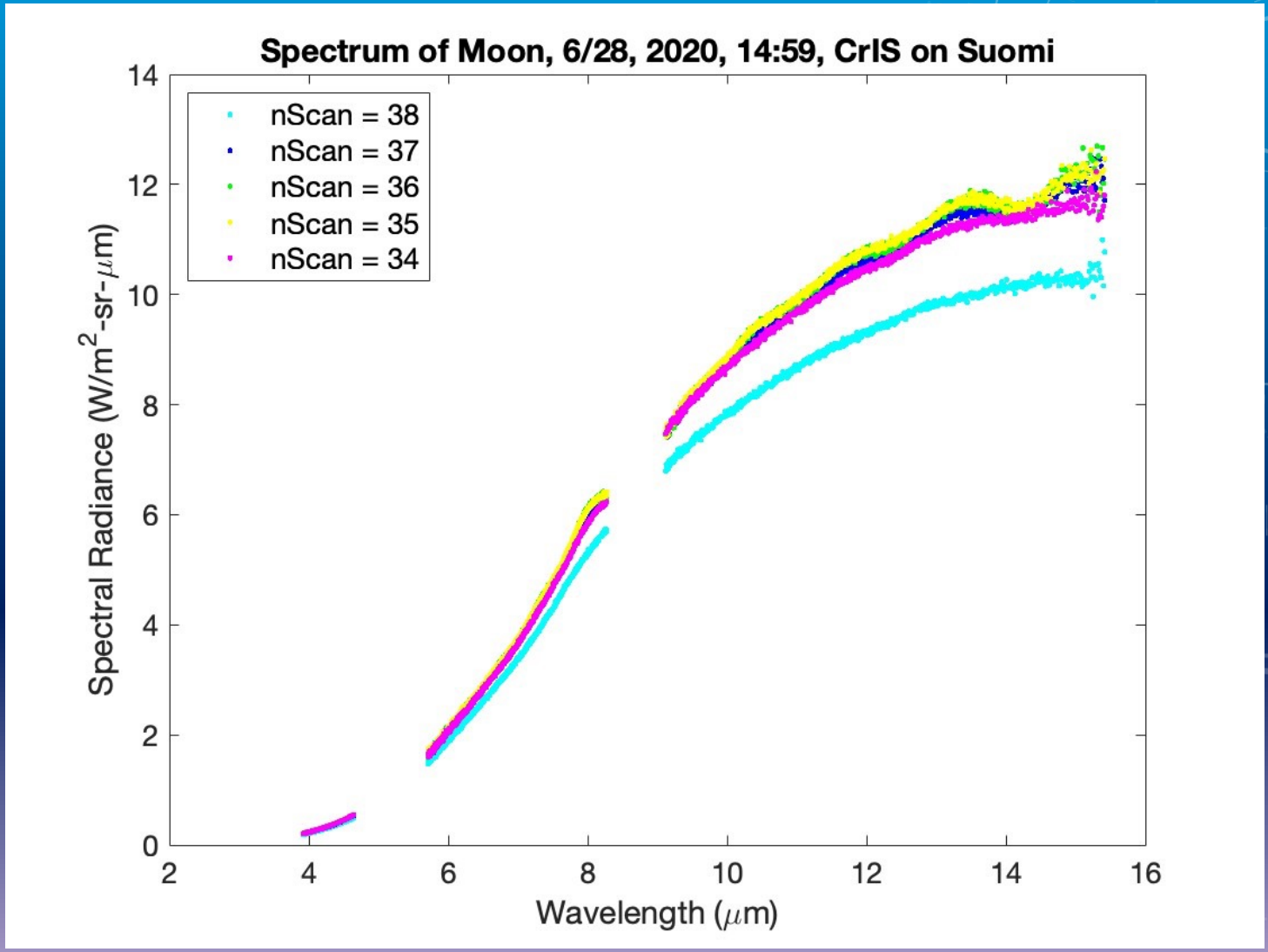


- 9 FOVs with 2 sweep directions.
- The 9 FOVs form one FOR. Each scan includes 30 FORs.
- 3 wavenumber ranges: 650 – 1095 cm^{-1}, 1210 – 1750 cm^{-1}, 2155 – 2550 cm^{-1}
- 3 x 3 14 km (0.963°) IFOV, sampling distance: 16 km at nadir.
- A typical CrIS lunar event has several observations in two to four FOVs.

From Yong Han et al. (2014)

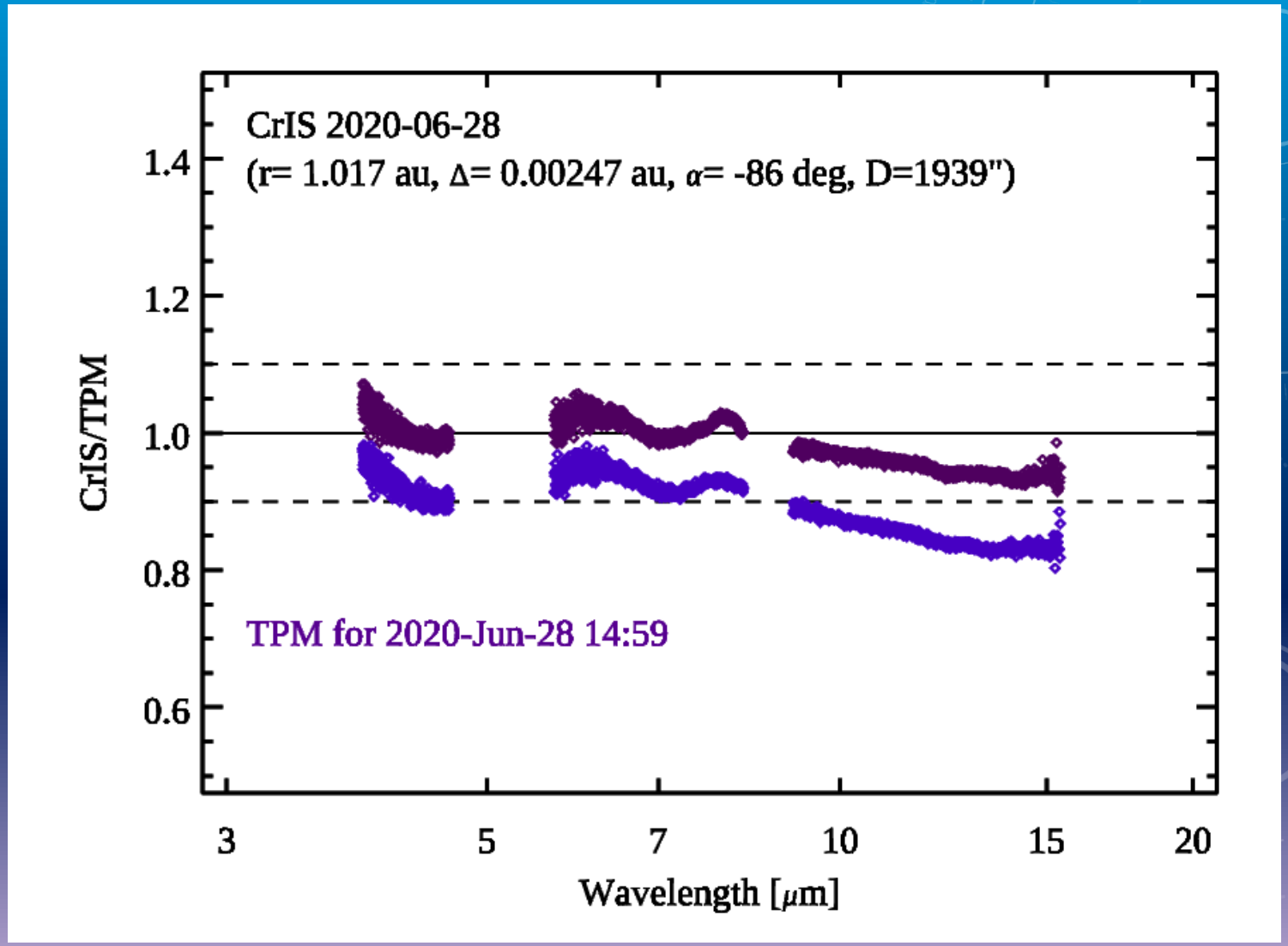
SPECTRA OF THE MOON FROM CONSECUTIVE SCANS

- 8 sec between consecutive scans
- Moon in center of FOV 5 for scan 36
- (Almost) no artefacts in scan 38 (and 34)



COMPARISON BETWEEN LUNAR MODEL AND OBSERVATION

- Reflected sunlight at shortest wavelengths
- Moon not fully included in FOV
- Spectral features in mid-IR

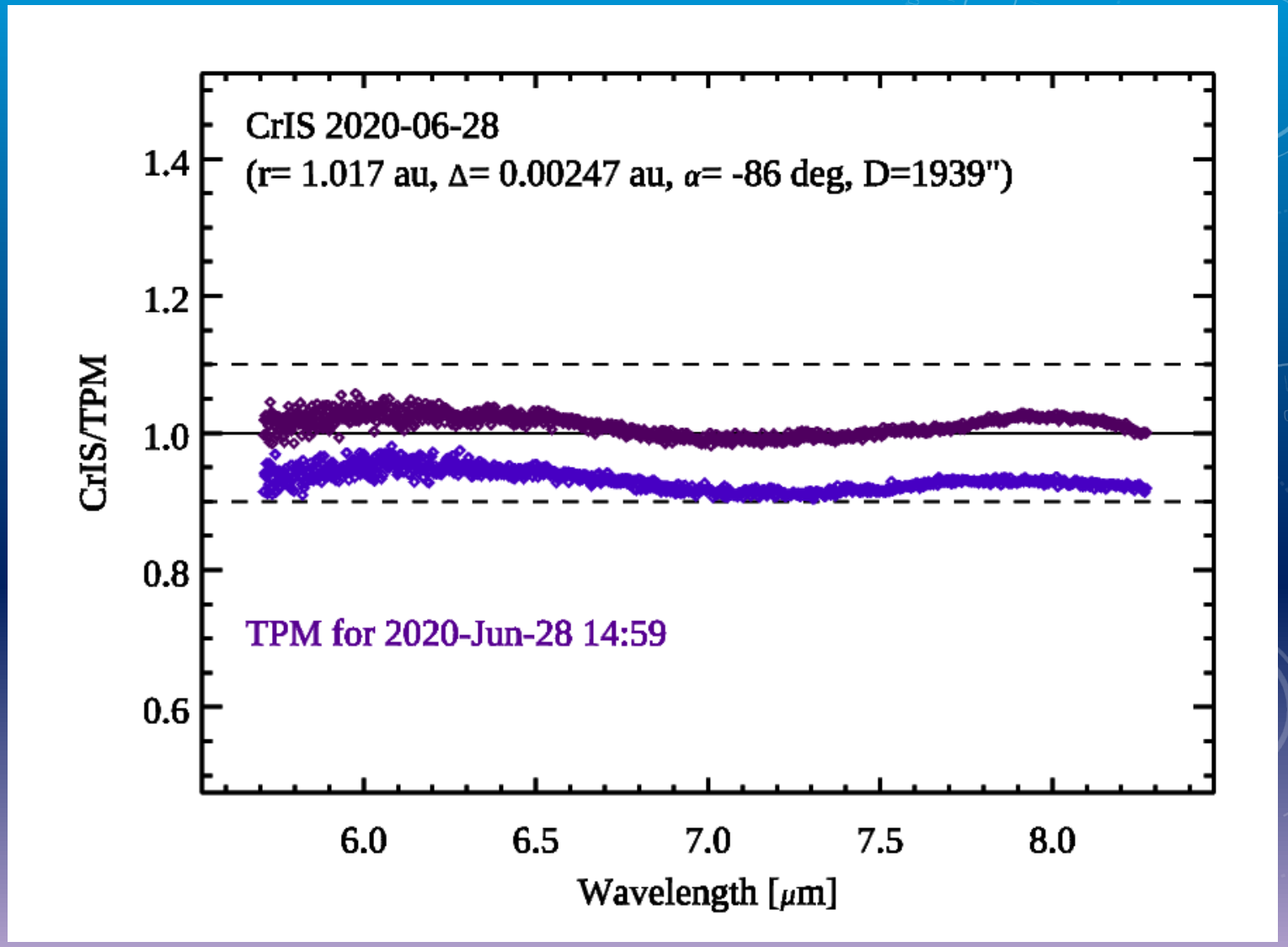


COMPARISON BETWEEN LUNAR MODEL AND OBSERVATION: MID-INFRARED

- Christiansen feature at

≈7.9μm ⚡ Diviner predict. 8.2 μm

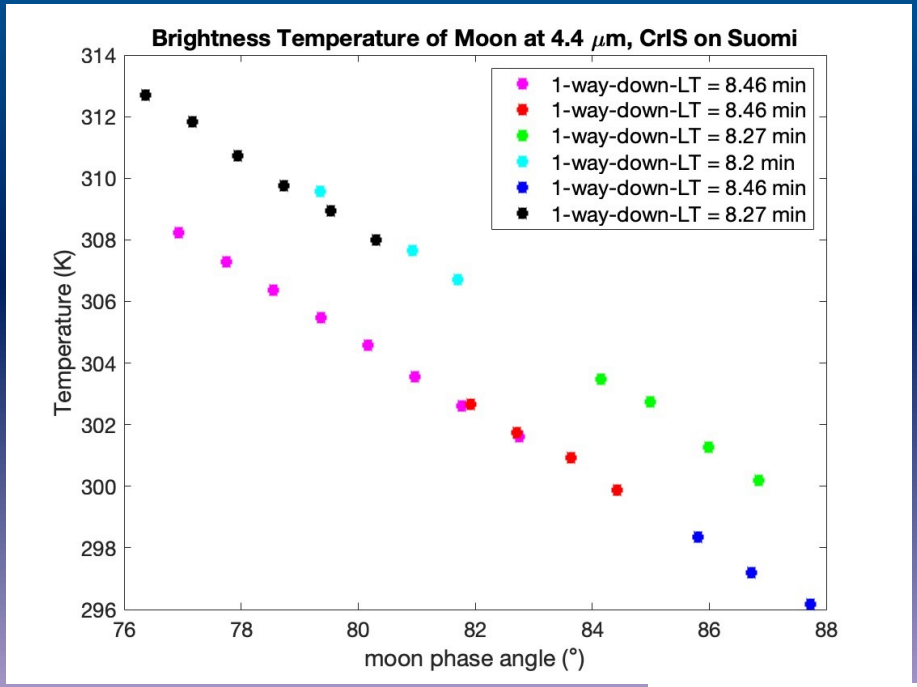
- Broad feature at 5.8 – 6.8 μm
  ⚡ SOFIA emission 5.9 – 6.3 μm
- Consider only range 7 – 7.3 μm



BRIGHTNESS TEMPERATURE = F(DISTANCE🌞🌜)

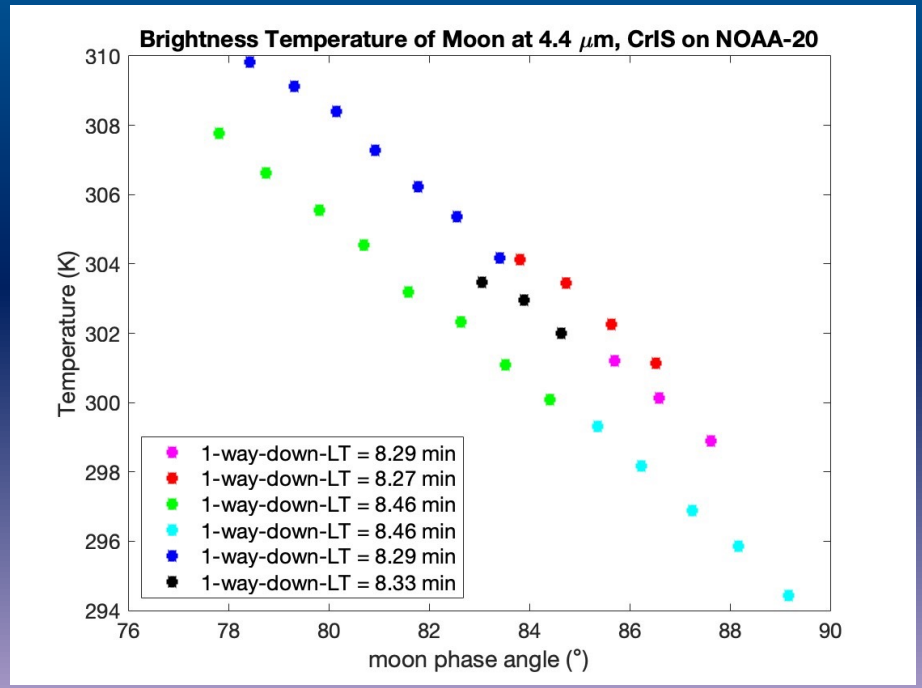
Δ Dist. Sun-Moon = 0.26 light-min (3%)

Δ Brightness Temp. = 4.0 ± 0.1 K



Fewer observations with CrIS on N-20

$T = f(\varphi)$ => standard obs. conditions



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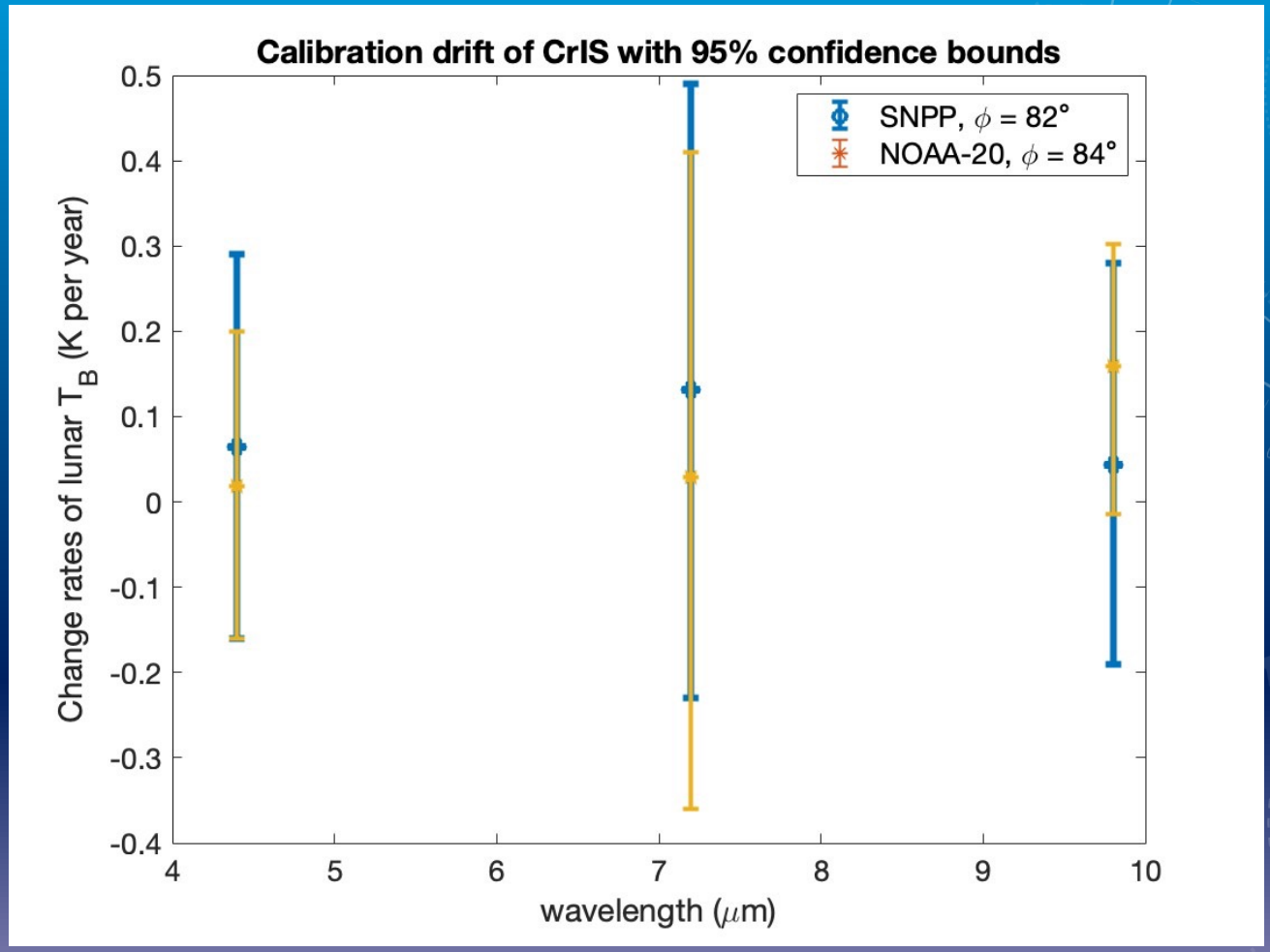
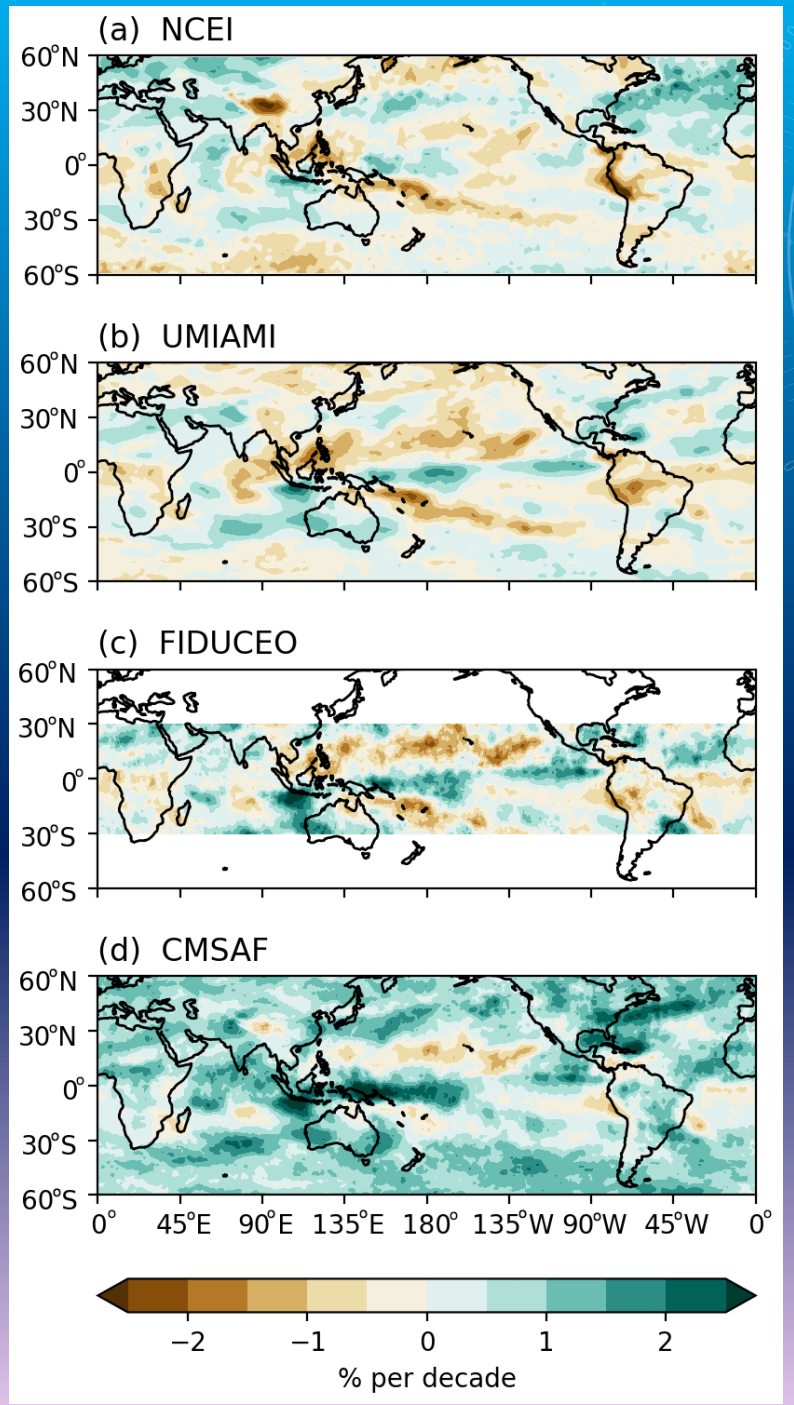
RADIOMETRIC STABILITY

- Compare lunar T_B at identical ϕ and d_{Sun} from different years
- Longwave channel on N-20 ≠0
- All 6 calibration drifts are ✚
- Mean drift: 0.075±0.024 K/yr



RELEVANCE FOR UTH

- NCEI UTH $\propto e^{(a-bT)}$
- ΔT = -0.075 K => ΔUTH = 0.86%
- Humidity increases for CMSAF, NCEI (HIRS-based) decreases.
- Sign and size suggest similar cal. Drift as found for CrIS



Shi et al., 2022

SUMMARY OF RESULTS

- Model in good agreement with spectrum from CrIS, except for two lunar features in the midwave infrared channels
- Consecutive orbits have Moon at phase angles differences < 1° => accurate interpolation
- Several observations of Moon near perihelion/aphelion available with similar phase angles
- Possibly differences in diameter of FOVs
- Reason for systematic difference in lunar radiance between SNPP and NOAA-20?
- Slight indication of the existence of a calibration-drifting error

PERSPECTIVES

- Open questions –
  - What are the differences in diameter of the 9 × 3 FOVs?
  - Significant impact from lunar libration?
  - Why are the water and Christiansen features not as expected in the midwave IR channels?
- Bias between SNPP and NOAA-20?
- More precise calibration-drifting errors – dependence on radiance (non-linearity)?
- Next steps -
  - Pipeline processing of all 993 observations of the Moon
  - Compare to other instruments (IASI? HIRAS?)
  - Calculate and publish calibration trends of all channels (and consequences for UTH)

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