



Global-scale data-model comparison of the July 2nd, 2019 total solar eclipse's thermospheric effect

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GOLD Observation vs Model



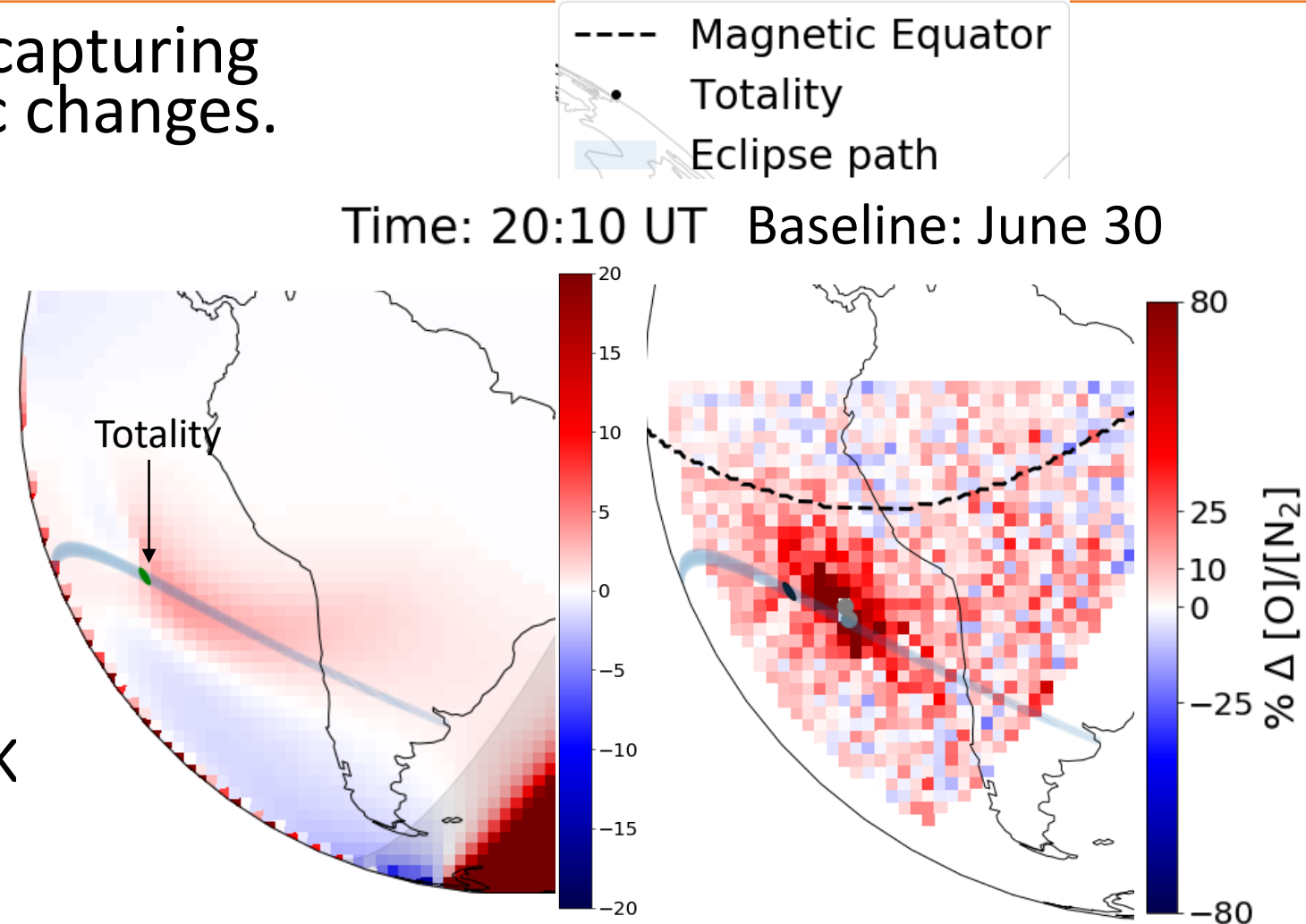
➔ Model appears inadequate in capturing eclipse induced thermospheric changes.

➔ Eclipse enhanced O/N_2 ratio by >80% near totality.

Model enhancement: ~20%
Baseline: ~ 1

➔ Eclipse temperature reduction: 200K (preliminary). Model reduction: ~ 30K. Baseline ~ 650K

➔ Morphological differences southward of totality (see images to the right)

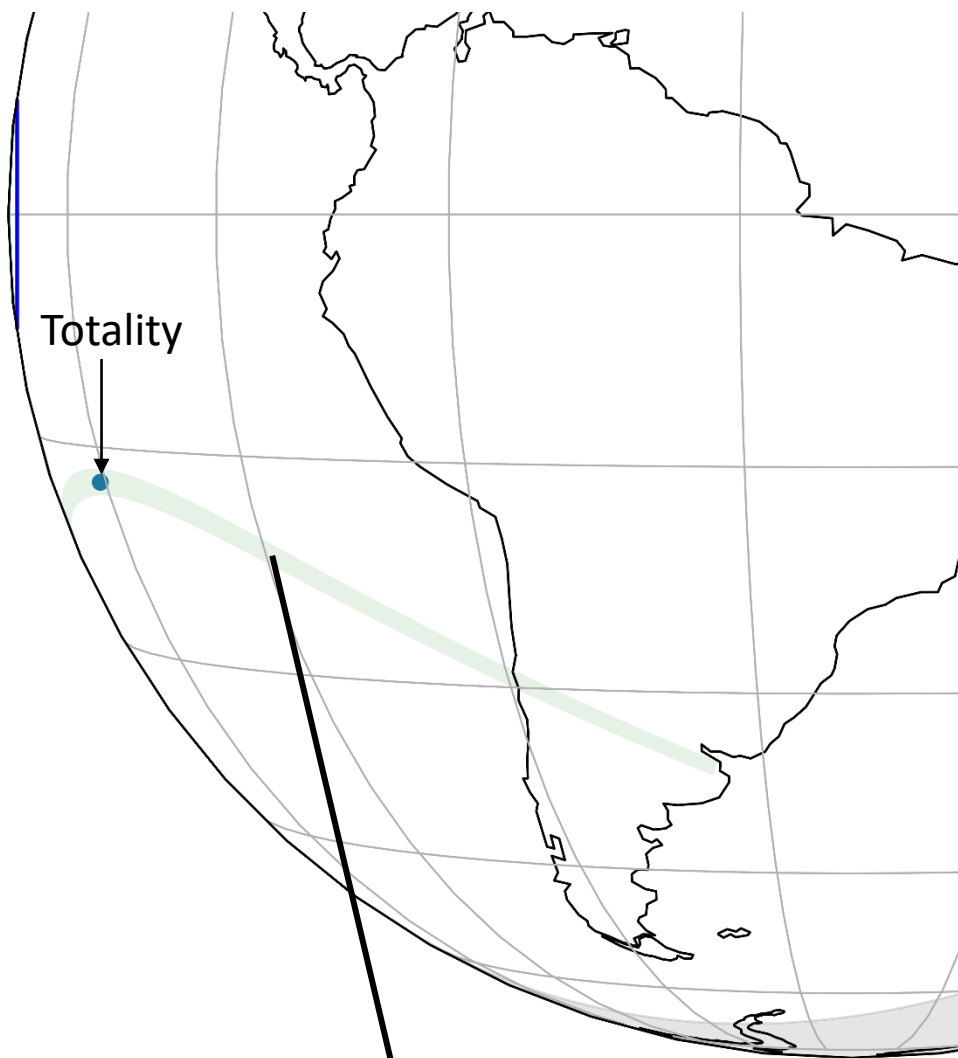


Model: TIEGCM+ GLOW Data: GOLD's observation

The July 2, 2019 Eclipse



- Eclipse start (partial) ~ 17 UT at 37S, 158W, Total: 18 UT
- Greatest eclipse: 17S, 109W around 19:25 UT
- Greatest duration: 17S, 108.6 W
- Totality: about 5 minutes



July 2, 2019 eclipse's path in GOLD's field of view

GOLD Spatial-Spectral Imaging



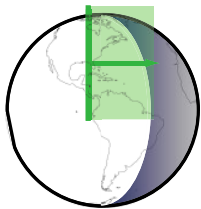
Technique

- Telescope equipped with a scan mirror images the I-T system onto the slit of an imaging spectrograph
- *Binned day disk resolution is ~ 125 by 125 km at Nadir*

Adapted from Eastes et al., 2017

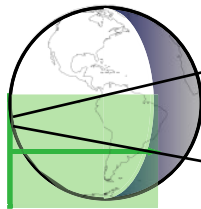
Dayside Disk Imaging Temperature & O/N₂ Ratio

3a



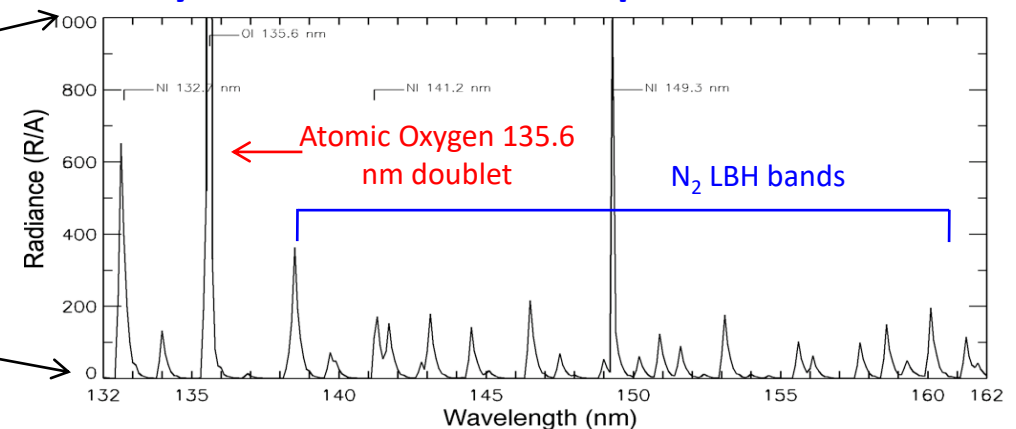
Return to HR scan location
LIMB/HR slit in place
HR scan, N hem. day, W to E

3b



HR scan, S hem. day, W to E

Daytime Far-Ultraviolet Spectrum

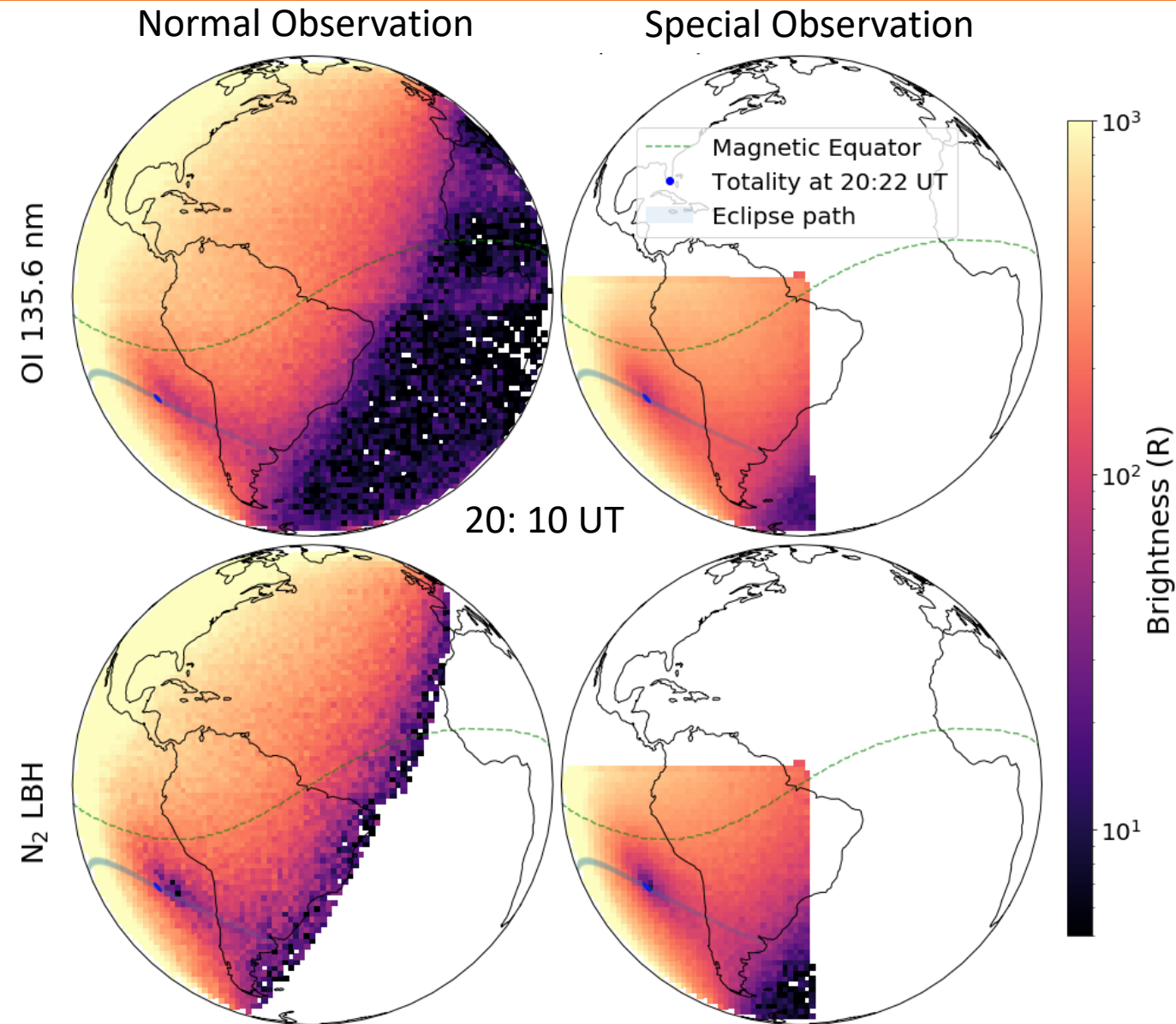


The spectrograph records spectra as a function of slit height at each point on the disk.

GOLD's Day Disk Observation Modes



- Full disk observation, ~30 Minutes cadence:
 - ~15 Minutes North and South scans
 - ~15 minutes delay in the southern scan
- South-west quarter of western hemisphere, 30 minutes cadence



Modeling: TIEGCM+GLOW



- TIEGCM: Thermosphere Ionosphere Electrodynamics General Circulation Model

Qian et al., 2014

- Three-dimensional model: momentum, energy and continuity equations for neutral and ion species at each time step
- One run to simulate eclipse condition (using EUV Mask)
- Baseline: Exact geophysical condition as the eclipse condition but no EUV mask

- GLOW (Global airglOW): Airglow calculation model

Bailey et al., 2002; Solomon & Abreu, 1989; Solomon et al., 1988

- TIEGCM outputs used as input into GLOW for photo-chemical and electron transport calculations, with and without the eclipse mask
- EUV mask from TIEGCM used as attenuation factor to account for photo-electron flux reduction

O/N₂:During the Eclipse



- Data: > 80 % (factor of 1.8) increase in O/N₂ near totality

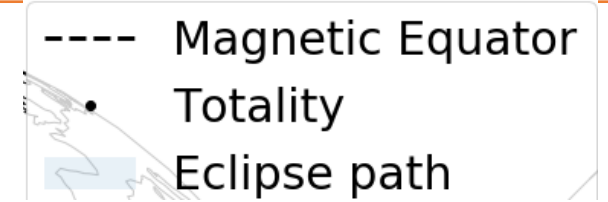
- Model: ~ 20 % increase (factor of 1.2) in 135.6/LBH ratio
- Some morphological differences near totality

Baseline for data: June 30

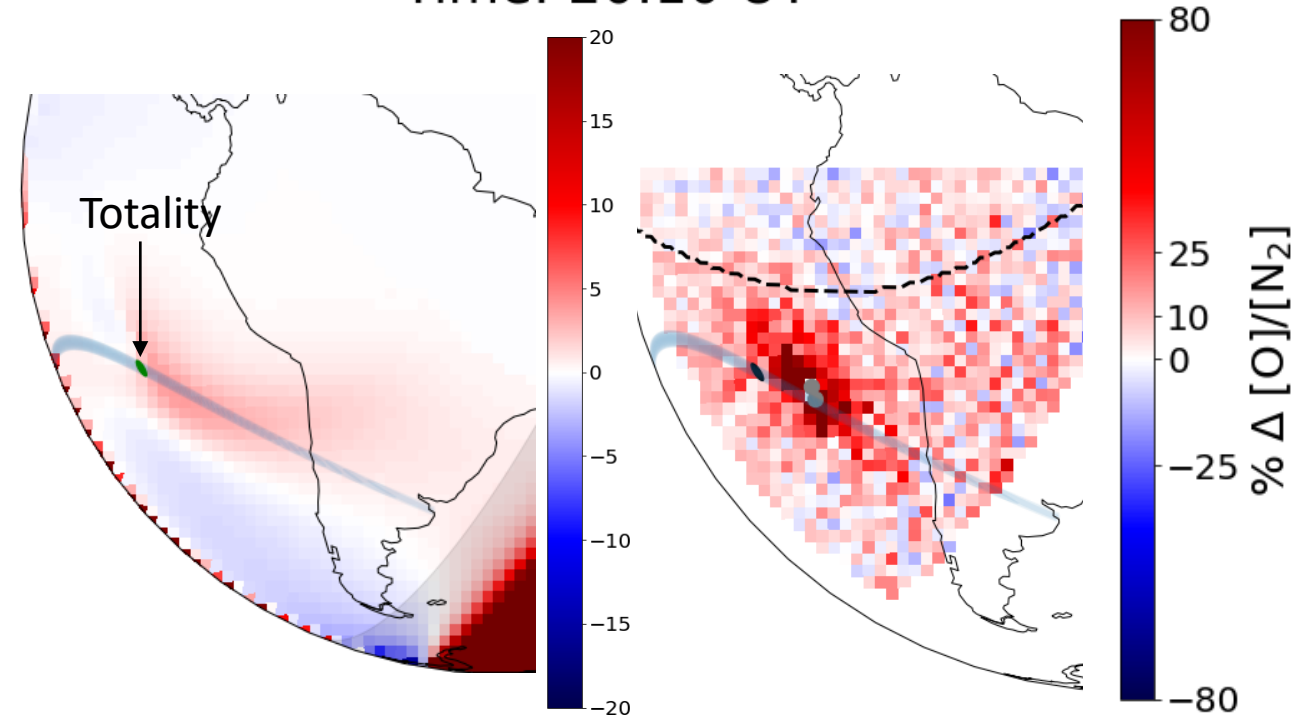
Both days:

Kp < 4

F10.7 ~ 67



Time: 20:10 UT



Model: TIEGCM+ GLOW

From Aryal et al., JGR, under review

Temperature Change: Preliminary

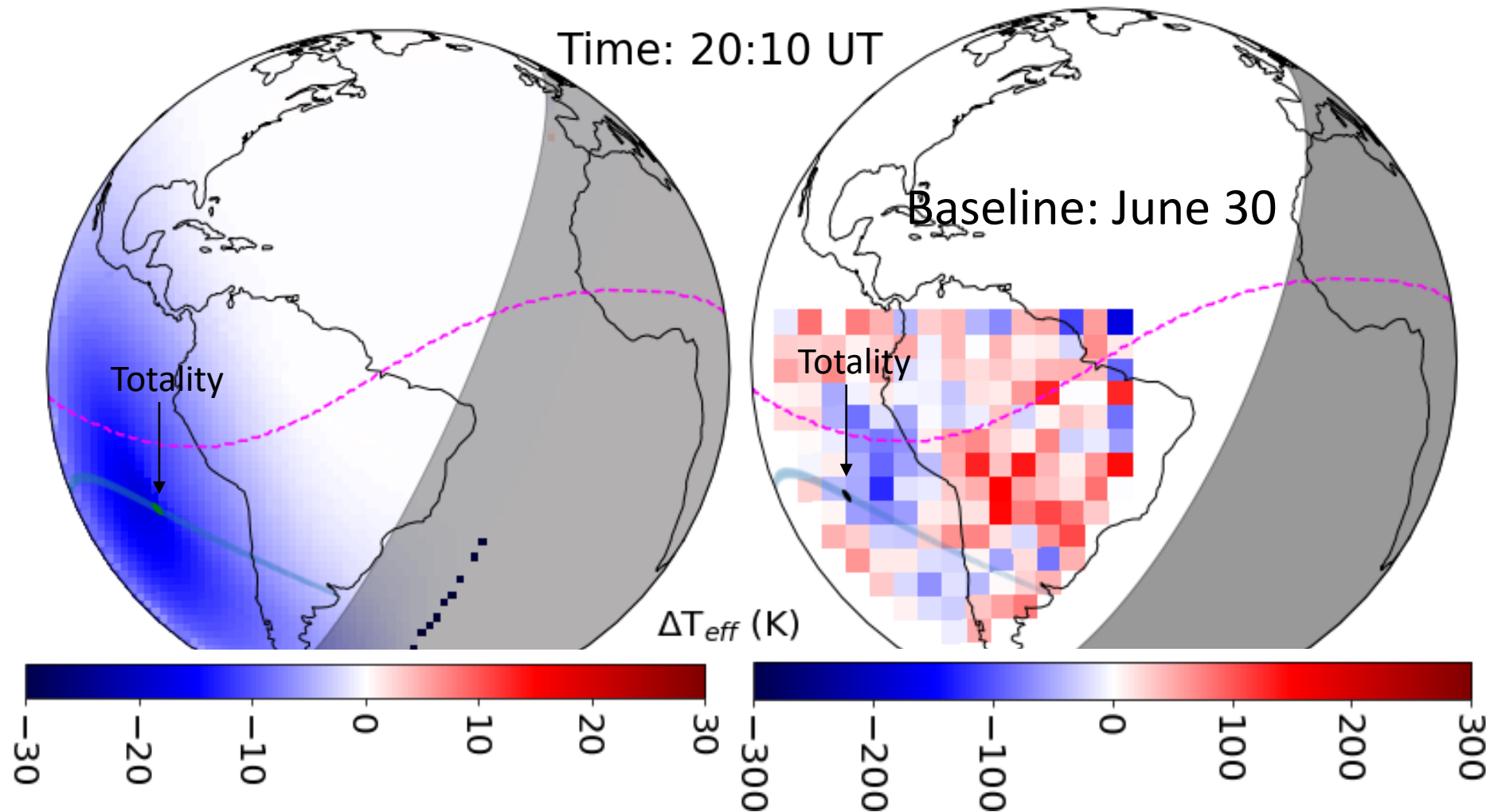


- Data: ~ 200 K decrease near totality (preliminary)

2 by 2 binning

- Model: ~ 30 K

- Baseline: ~ 650 K



Summary/Future Work



- TIEGCM+GLOW modeling not capturing eclipse induced thermospheric changes.
- Eclipse induced changes provide information on thermospheric response to impulsive events: test for current models.
- Future: December 14, 2020 eclipse over South America. Eclipse will be within GOLD's field of view for almost its entire duration.