SAMI3 ECLIPSE STUDIES

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MODELED ECLIPSES

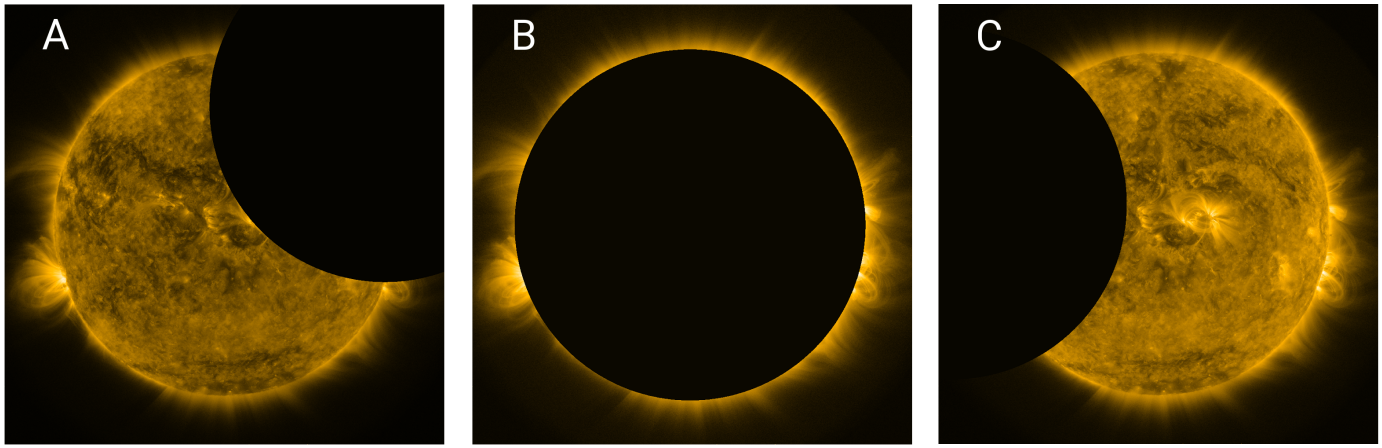
- 21 August 2017 (the great American eclipse)

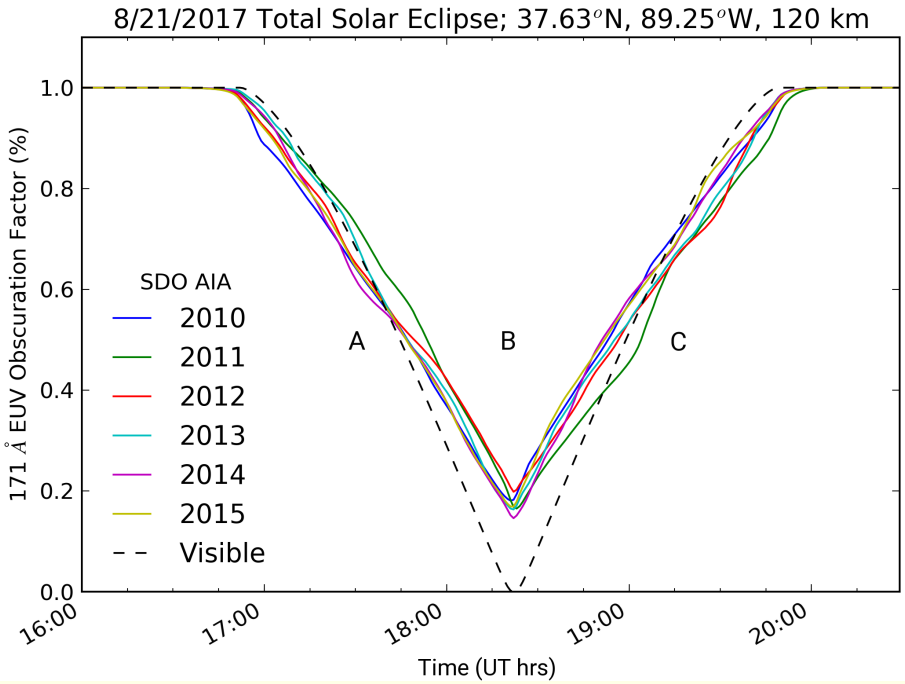
  Huba and Drob, SAMI3 prediction of the impact of the 21 August 2017 total solar eclipse on the ionosphere/plasmasphere system, GRL, 2017 3
- 26 December 2019 (over asian sector)

  Senapati et al., Change in Total Electron Content During the 26 December 2019 Solar Eclipse: Constraints From GNSS Observations and Comparison With SAMI3 Model Results, JGR, 2020
- 4 December 2021 (over southern polar cap)

EUV OBSCURATION

uses Solar Dynamics Observatory (SDO) data and NOVAS (Huba and Drob, GRL, 2017)





EUV MASK (SIMPLISTIC)

used in SAMI3 for the 2017 great American eclipse

$$M(r,t) = \begin{cases} 1 & |r - R_e(t)| \geq R_o \\ 0.15 + 0.85|r - R_e(t)|/R_o & |r - R_e(t)| < R_o \end{cases}$$

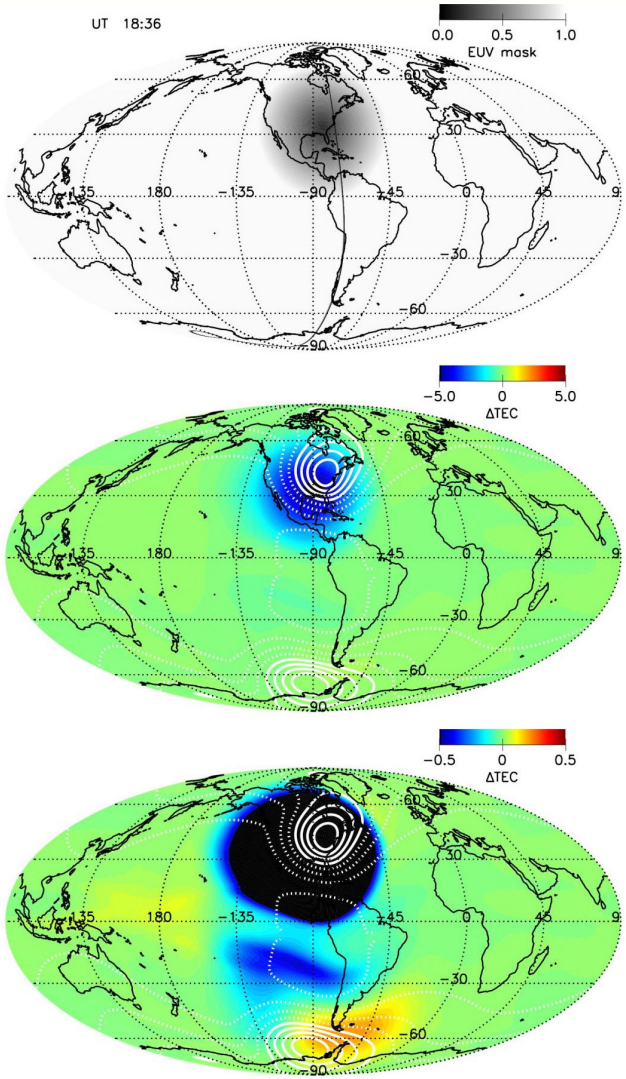
where r is the position of a SAMI3 grid point projected onto the surface of the earth and R_e is the position of the total solar eclipse on the earth

radius of obscuration $R_o \sim 4000$ km

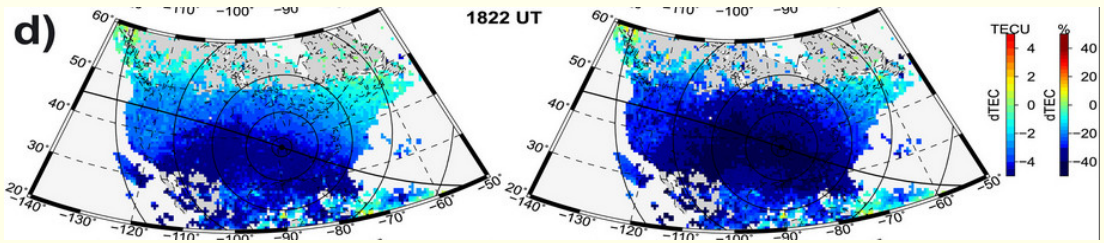
21 AUGUST 2017

the great American eclipse

21 AUGUST 2017

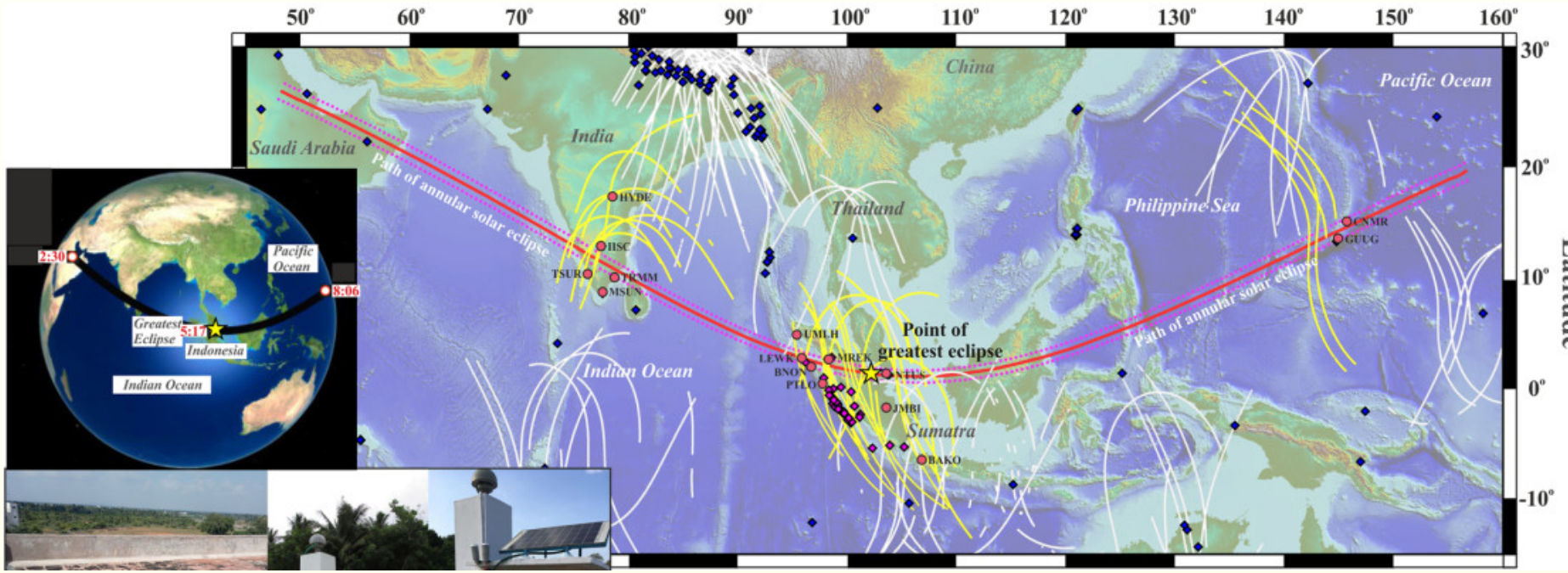


- eclipse mask (top)
- dTEC = TEC(eclipse) - TEC(no eclipse) middle/bottom panels
- contours of the potential also shown eclipse modification of the conductances affects the ionosphere electric field
- aside from TEC decrease over the USA there is also a ‘conjugate’ effect albeit small
- below, TEC data from Cherniak and Zakharenkova (GRL, 2018)

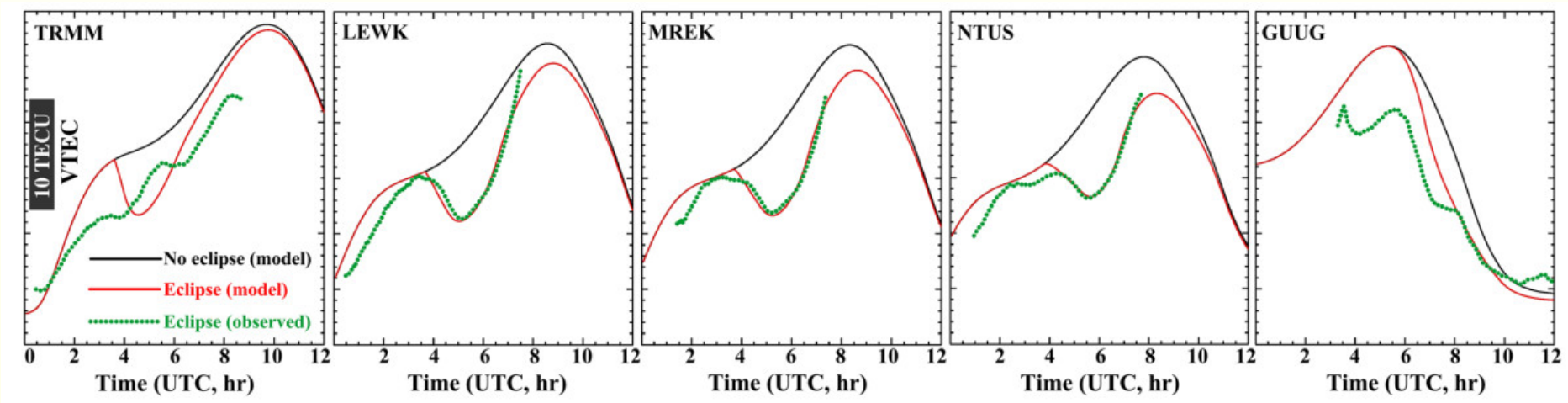


26 DECEMBER 2019

asian sector

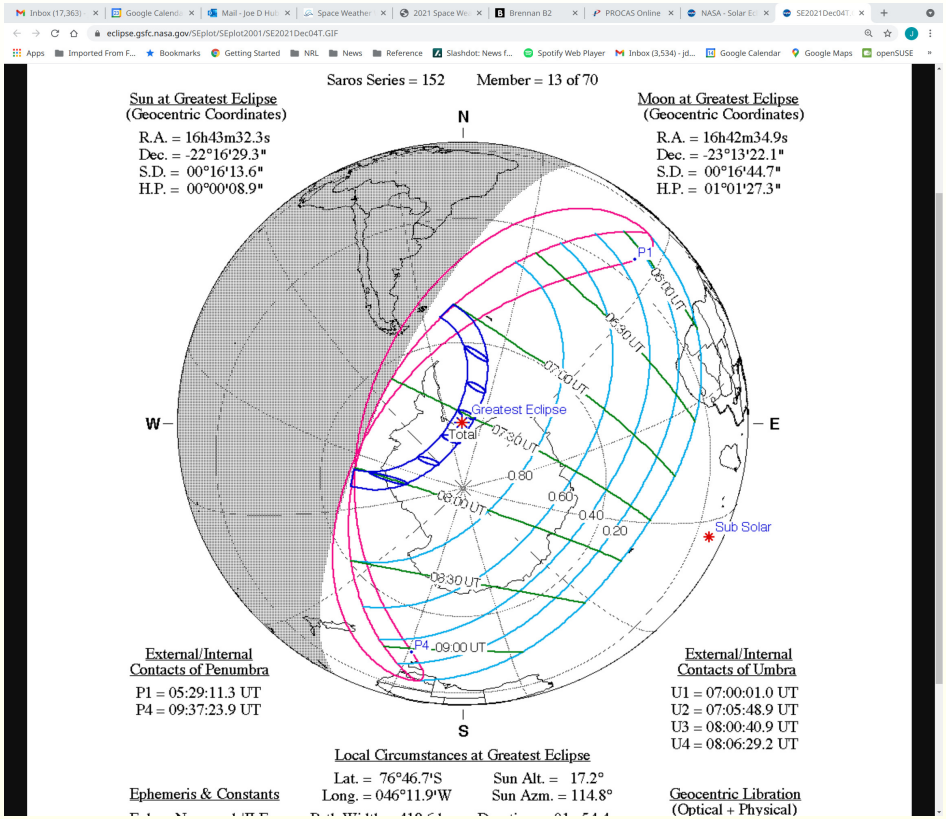


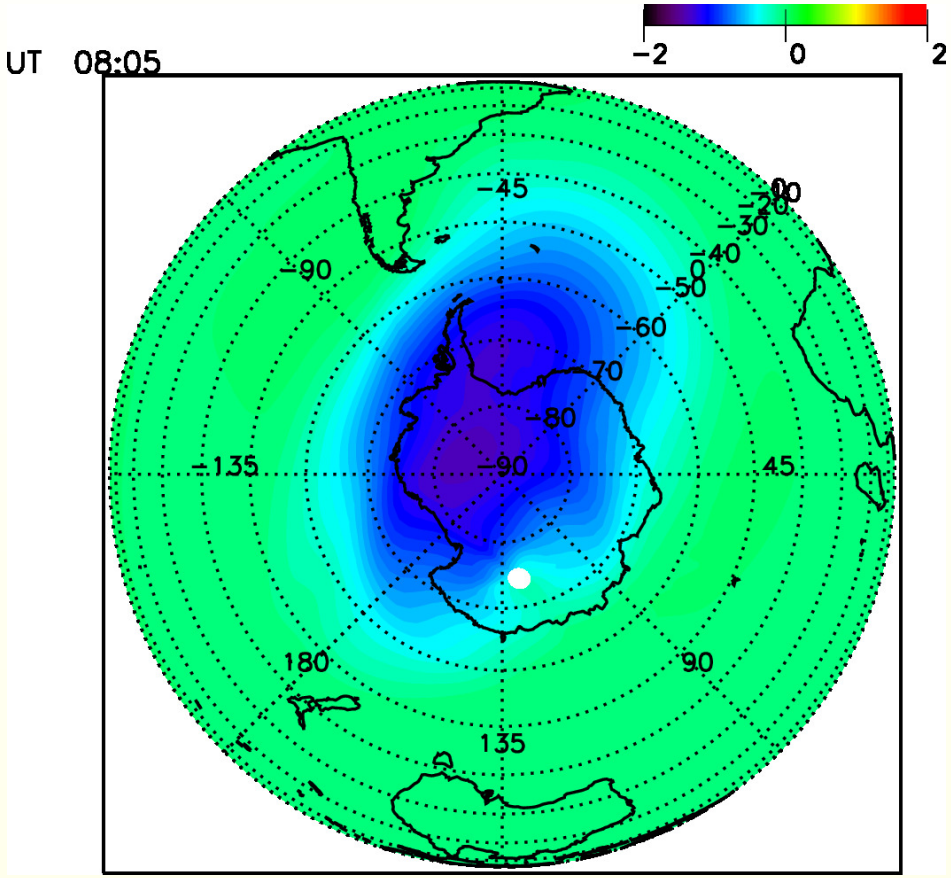
- comparison of TEC observed at several sites in the Asian sector and SAMI3 results
- comparison is surprisingly good
- below, from Senapati (JGR, 2018)



4 DECEMBER 2021

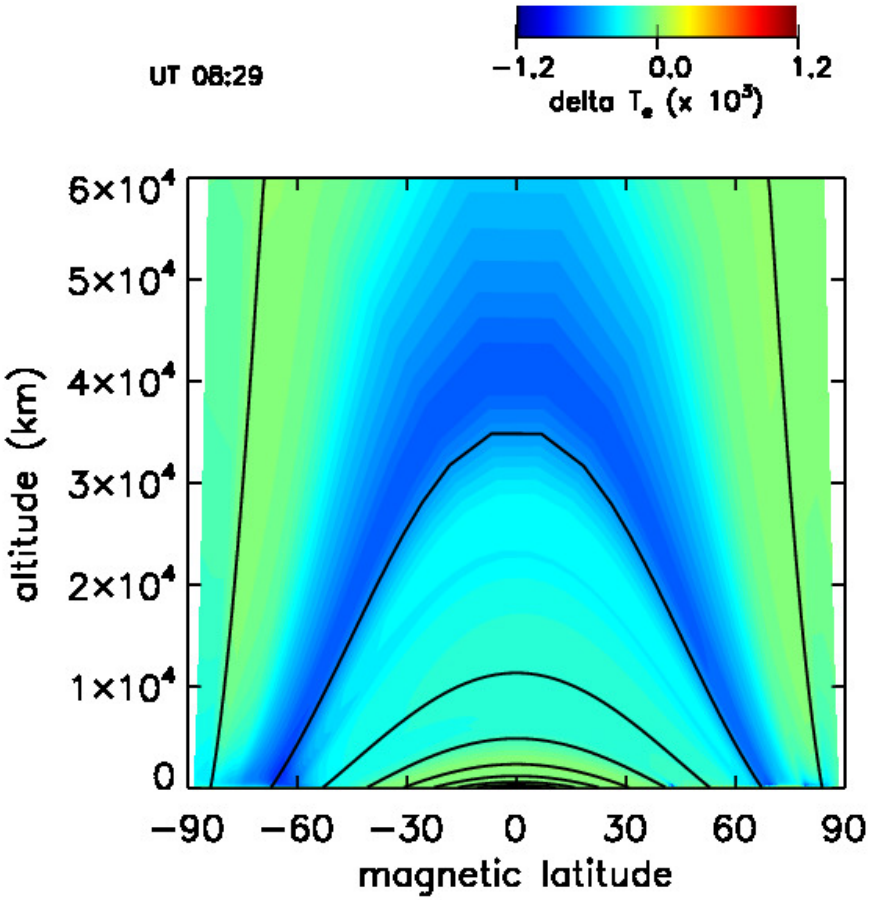
southern polar cap

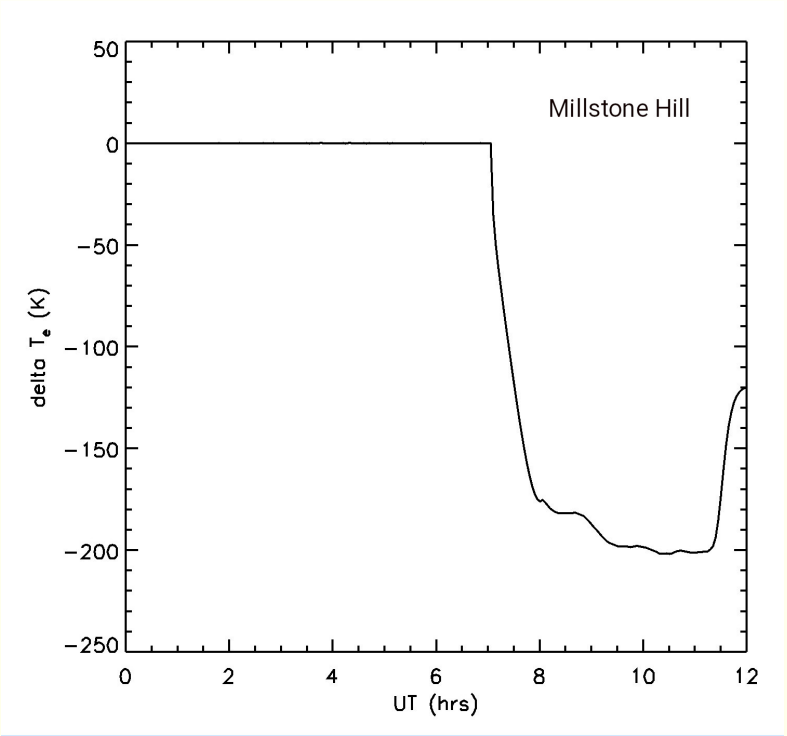




ELECTRON TEMPERATURE: CONJUGATE EFFECTS

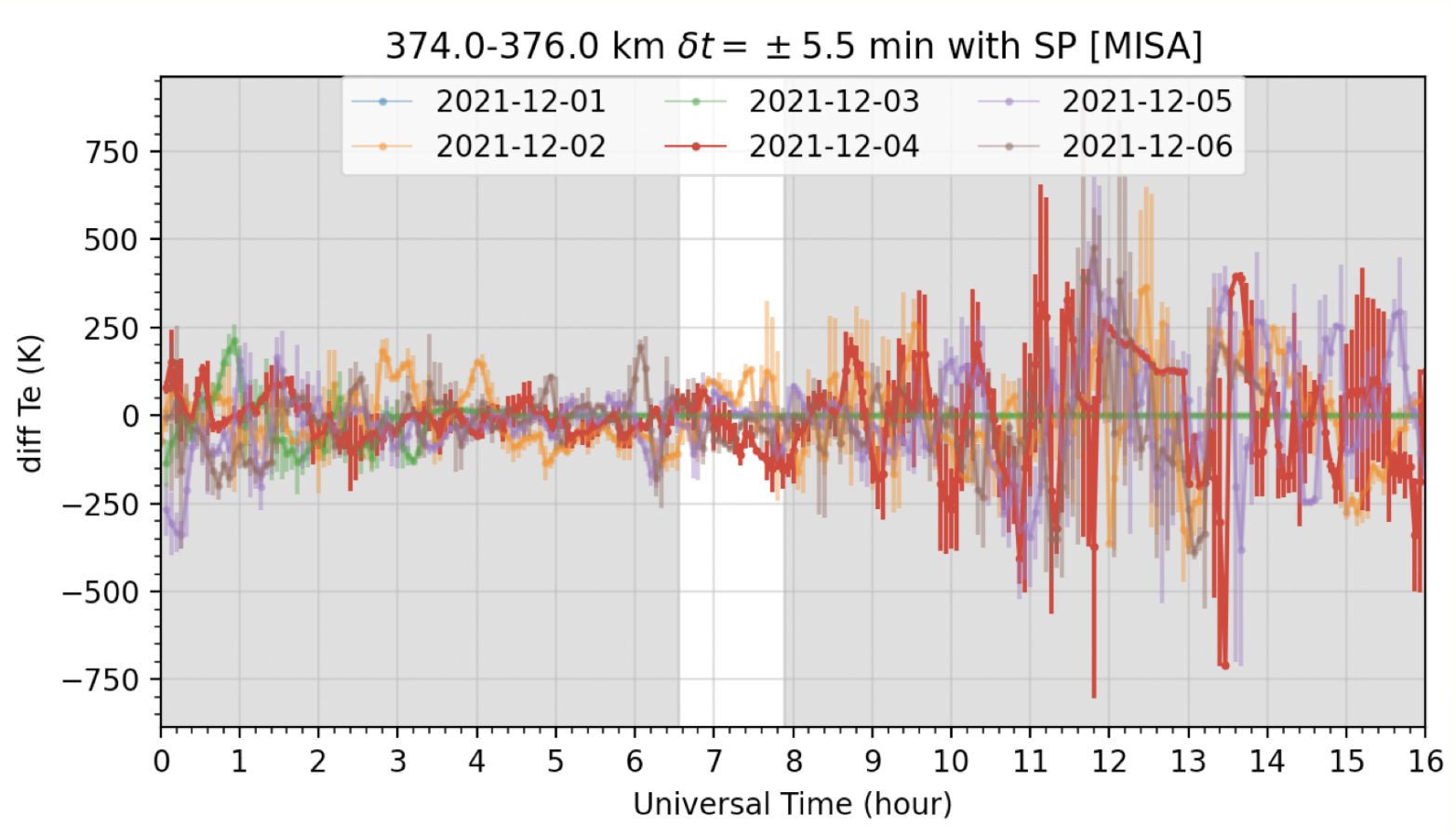
cooling of plasmasphere: 100s K and at Millstone Hill





ELECTRON TEMPERATURE: MILLSTONE HILL

courtesy of Shun-Rong Zhang



DISCUSSION

- SAMI3 has been used to model several eclipses
- generic TEC decrease (e.g., change in TEC) is captured reasonably well for 21 Aug 2017 and 26 2019; but not subsequent increase for 21 Aug 2017
- predicted a drop in the electron temperature over Millstone Hill during the 4 Dec 2021 eclipse over the southern polar cap: kinda observed ...
- issues that should be addressed in future modeling
  - design a more realistic EUV mask that takes into account differences in spectral bands and geometric factors (e.g., altitude, eclipse path)
  - thermosphere response (e.g., TIEGCM/TIMEGCM)