

## Motivations

- GLOW model is widely used but includes outdated versions of atmospheric (MSIS-00), ionospheric (IRI-90) and magnetic (POGO68) models.
- Airglow measurements are often wide-field and include slant observations.
- GLOW model is 1-D, calculating altitude profiles of volume emission rate (VER)

## Approach

- Update 1-D GLOW model to use MSIS-2.1 (thermosphere), IRI-2020 (ionosphere) and IGRF-14 (magnetic field).
- Extend 1-D GLOW model to 2 dimensions:
  - Arbitrary observation geometry.
  - Account for local solar position and earth curvature.

## GLOW Model Inputs

- Neutral: Altitude profiles of O, O<sub>2</sub>, N, N<sub>2</sub>, NO densities, T<sub>n</sub>.
- Ions: Altitude profiles of electron density, T<sub>i</sub>, T<sub>e</sub>.
- F10.7-scaled solar EUV flux (EUVAC or Hinteregger model).

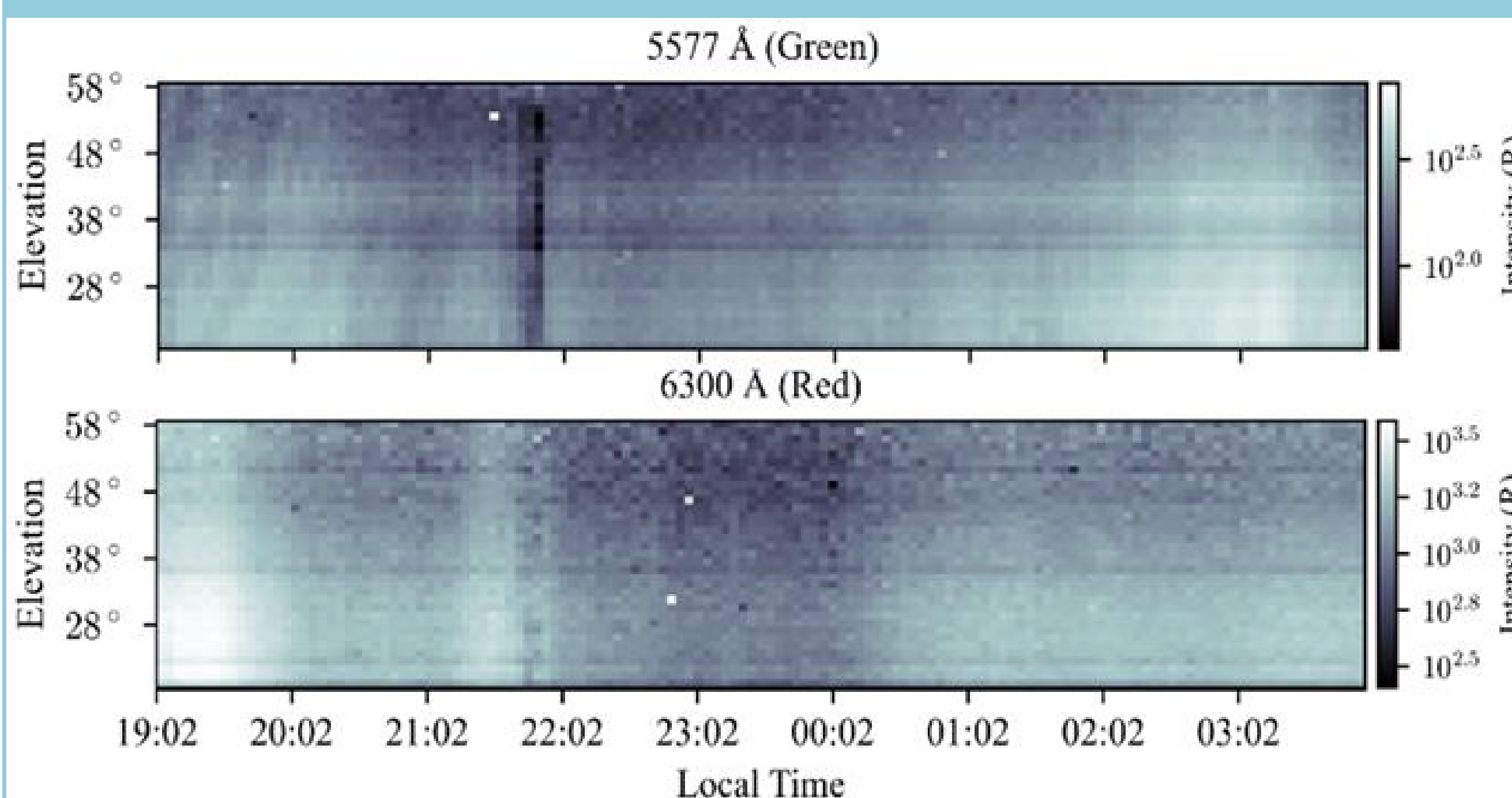
## Forward Modeling

- Generate ionosphere and thermosphere with F10.7 and A<sub>p</sub>.
- Equate model ionosphere TEC to GNSS-measured TEC.
- Calculate intensities for HiT&MIS (wide-field imaging spectrograph, Chakrabarti et. al. 2012) observation geometry.

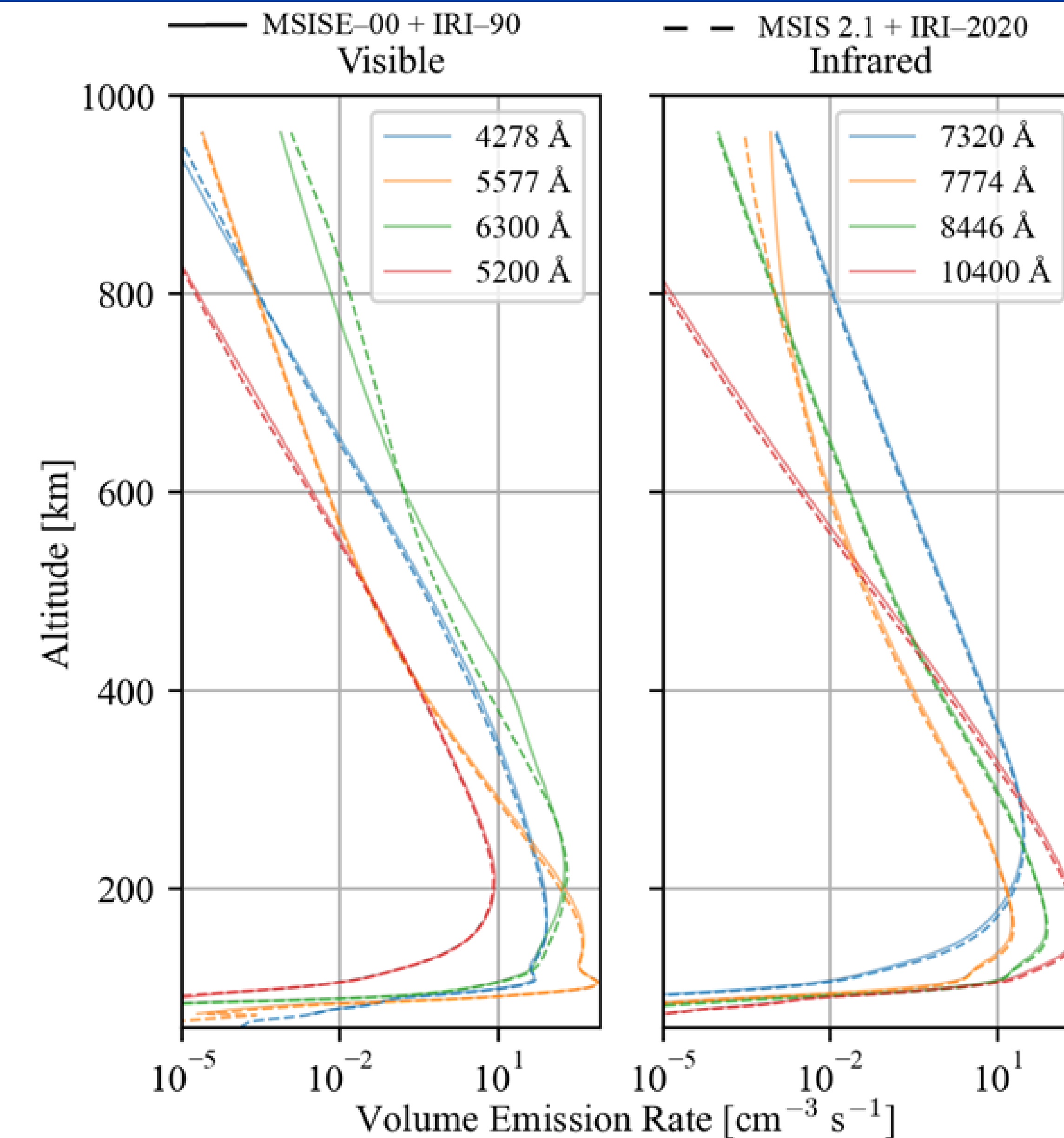
## Intensity Fitting

- Generate ionosphere and thermosphere with F10.7 and A<sub>p</sub>.
- Adjust neutral and electron densities.
- Calculate intensities for HiT&MIS observation geometry.
- Repeat until model intensities match observations.

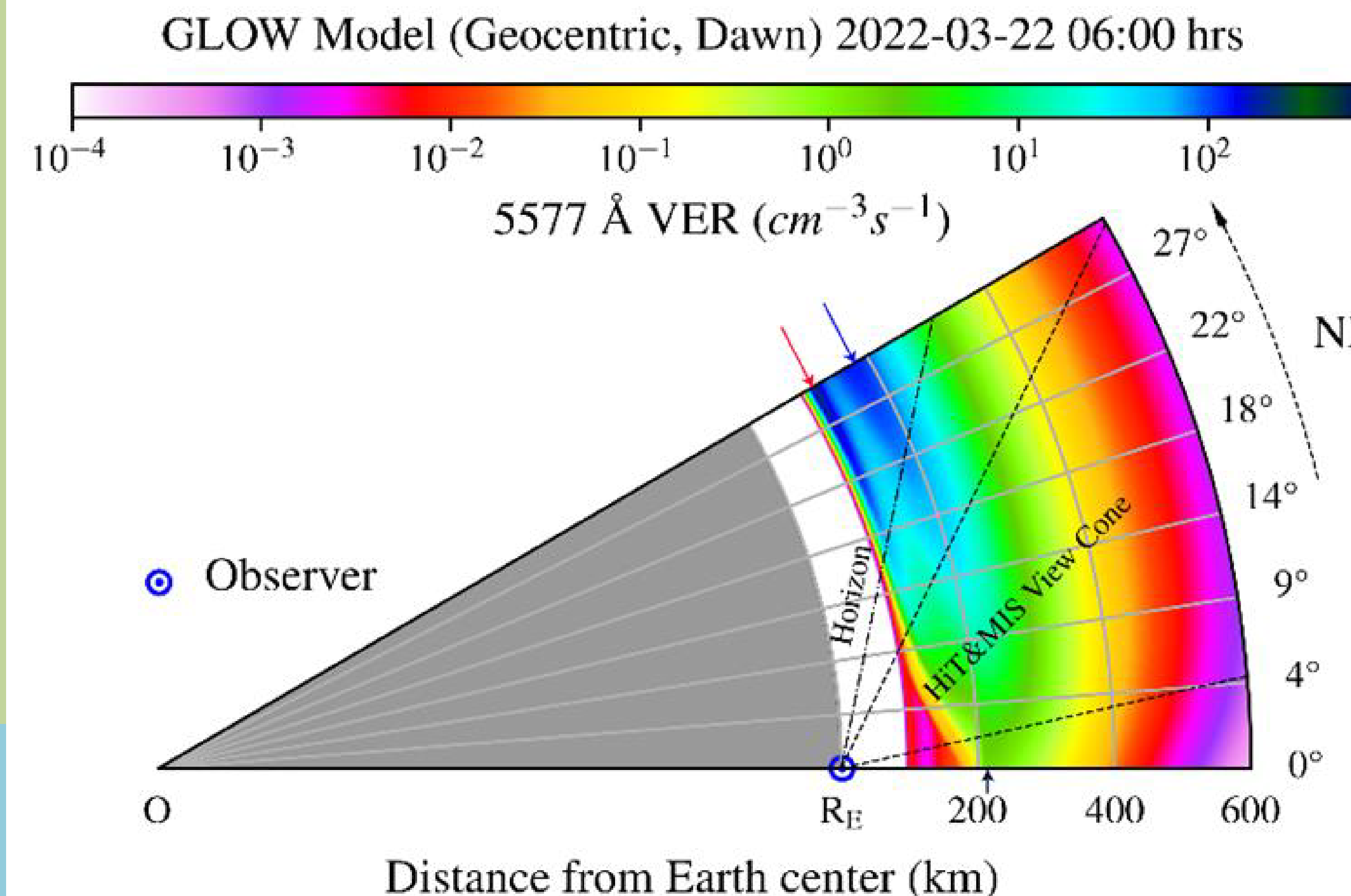
## Observations



**F1: HiT&MIS Nighttime Keogram**



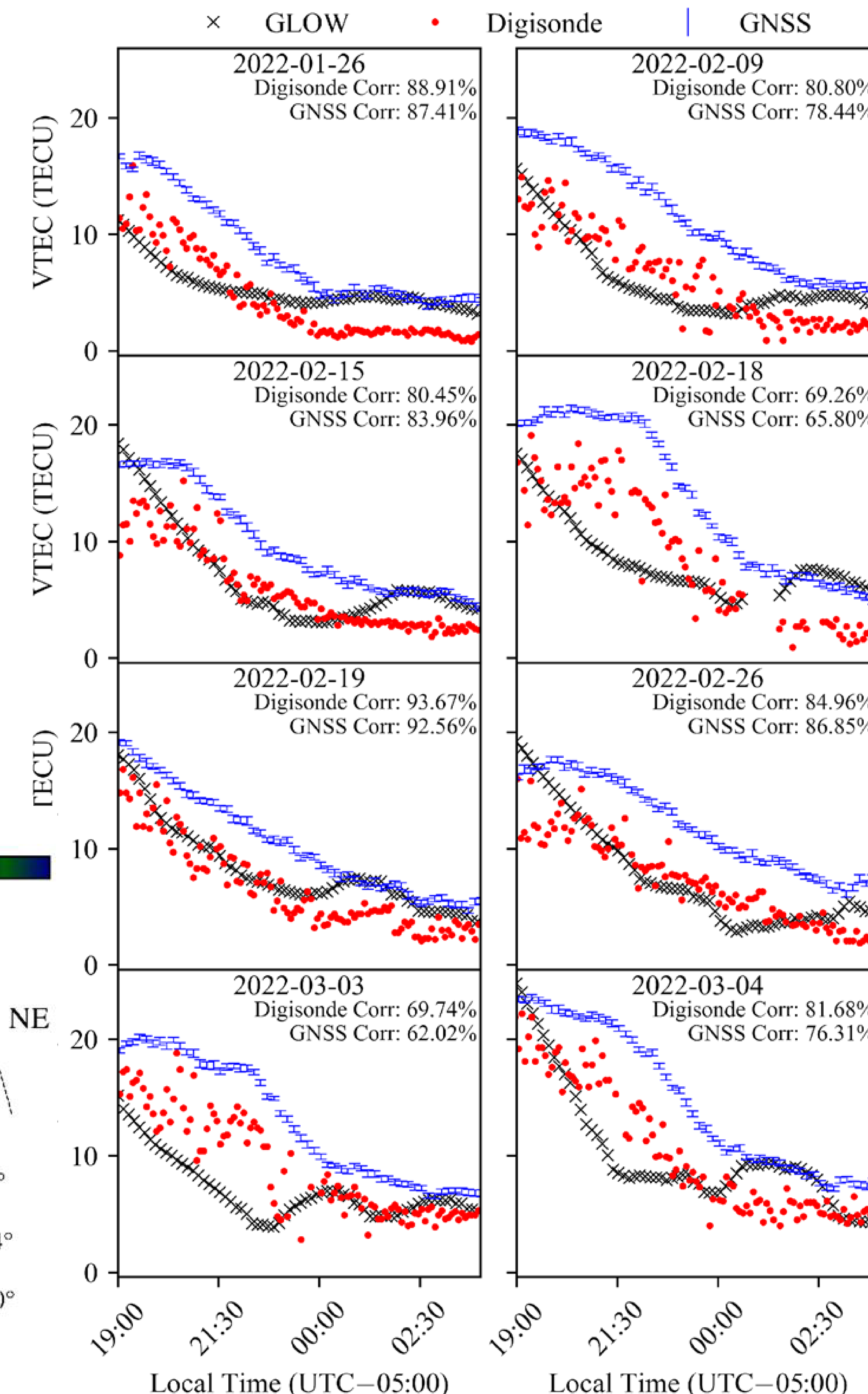
**F2A: 1-D GLOW VER comparison b/w different IT models**



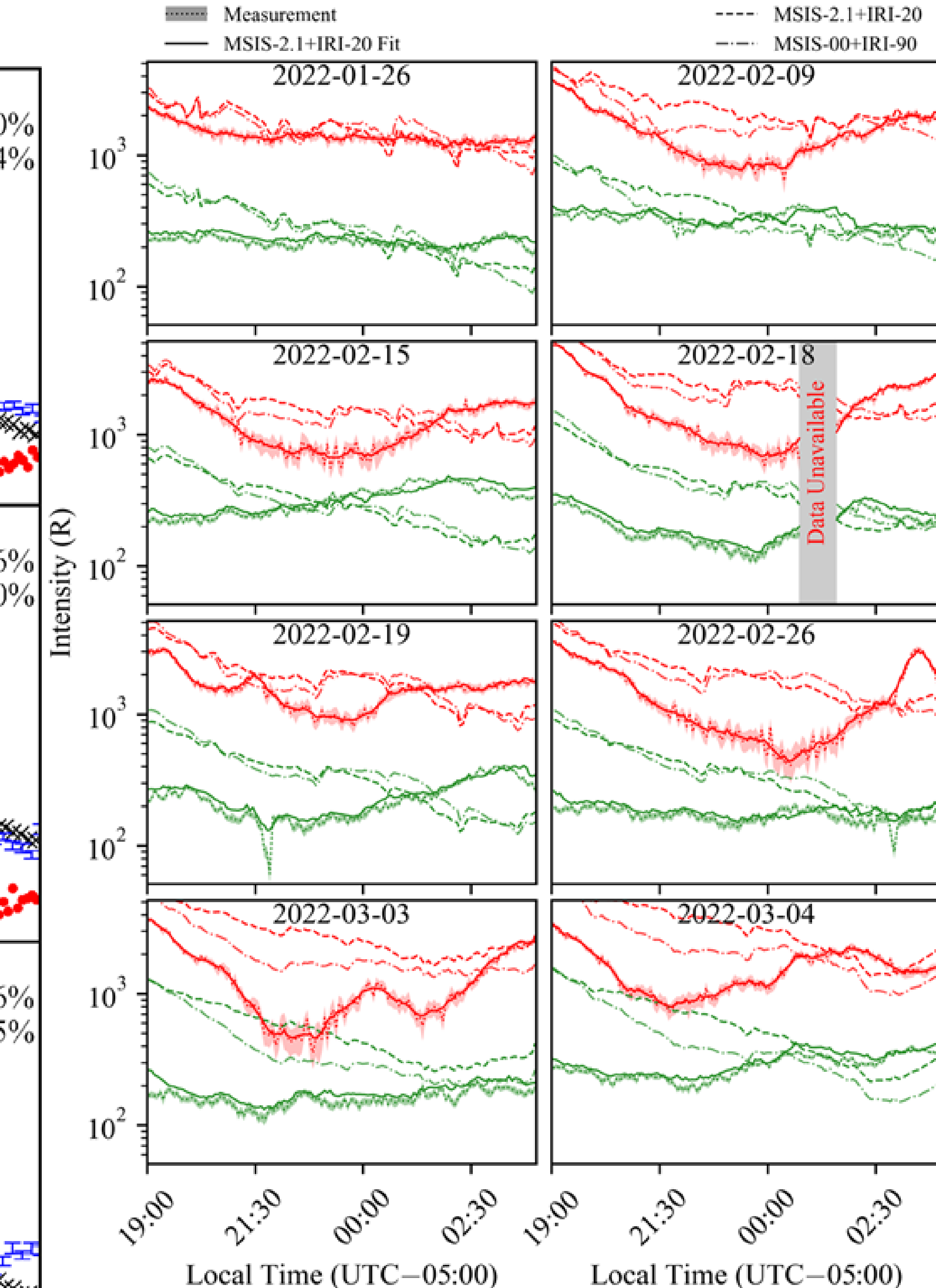
**F2B: 2-D GLOW VER for east-looking geometry (geocentric)**

## Results

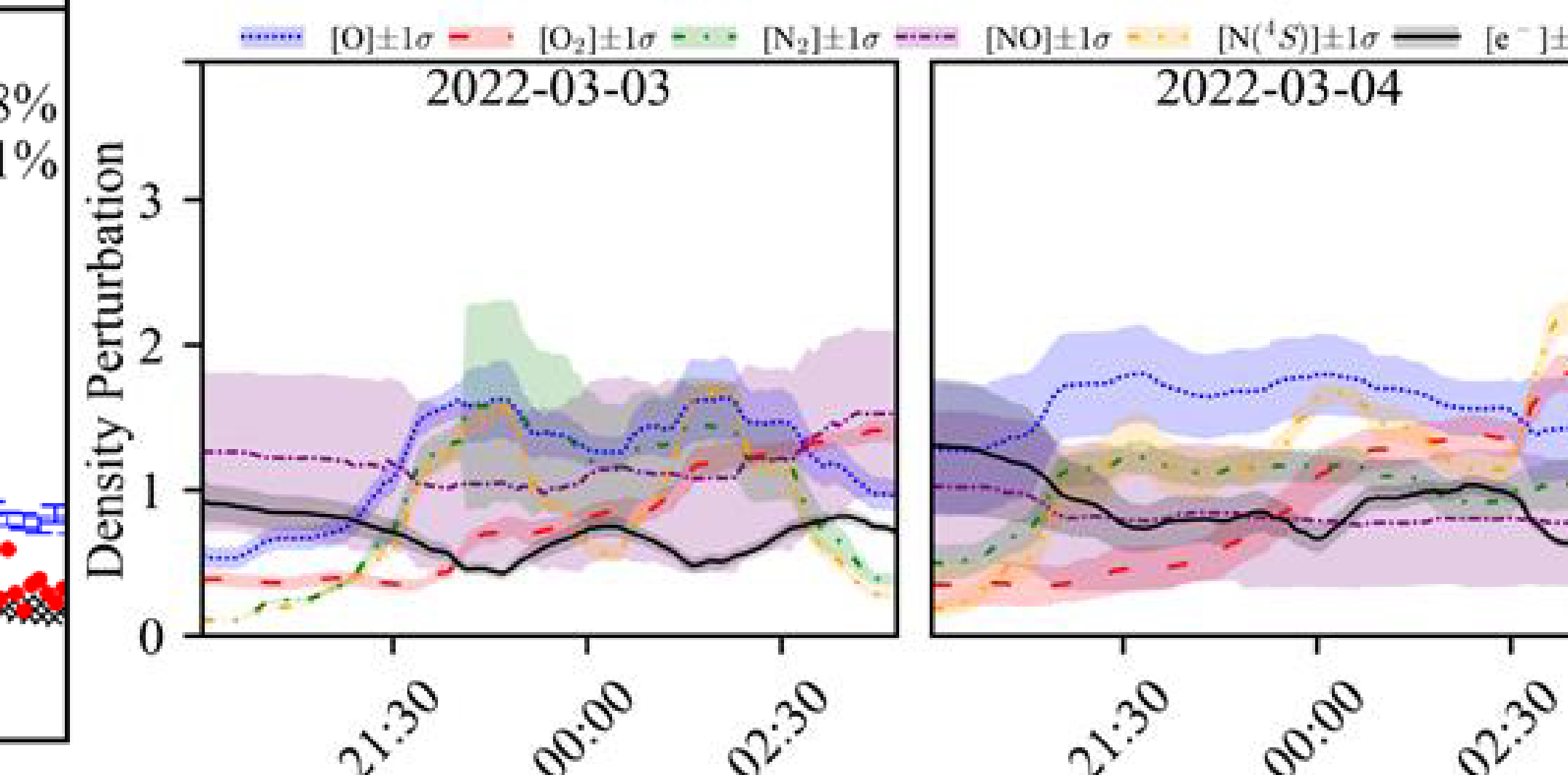
- Forward modeling intensities do not match measured intensities.
- Intensity fitting approach fits the red line intensity almost exactly.
- Green line intensities have short term spatio-temporal features not captured by model (F4).
- TEC (F3) from intensity constrained e<sup>-</sup> densities are correlated with TEC measured by Millstone Hill Digisonde<sup>4</sup> (geomean 74% [old] and 79% [new]).
- Geomean correlation with GNSS network TEC 71% [old] and 77% [new].



**F3: Measured and derived TEC**



**F4: Measured and modeled intensities**



**F5: Density modification over time.**  
NO density less constrained, e<sup>-</sup> density anticorrelated with O, O<sub>2</sub>, N, N<sub>2</sub>.

## Products

- GLOW model with selectable MSIS-2.1+IRI-2020, IGRF-14 models as well as MSISE-00+IRI-90 and POGO68.
- A 2-D framework around the GLOW model for line-of-sight intensity calculations for arbitrary observations.
- GLOW model outputs are compared between the older and newer models (F2A).
- Intensity fitting approach examined with new input models.

GLOW model repository

GLOW-2D repository

Community contributions welcome!

