Using ICON data to drive ionosphere/thermosphere models from below: TIEGCM-HME

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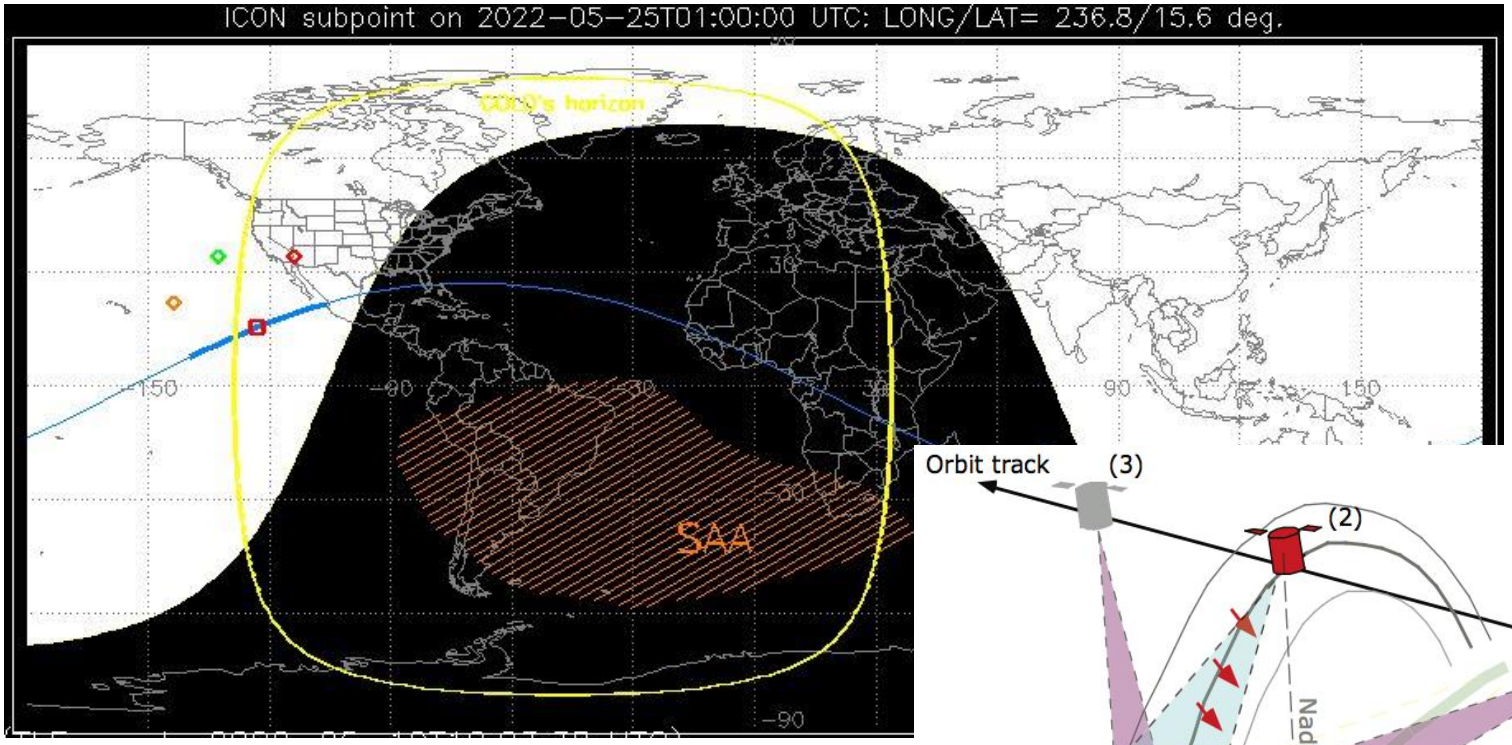
Overview

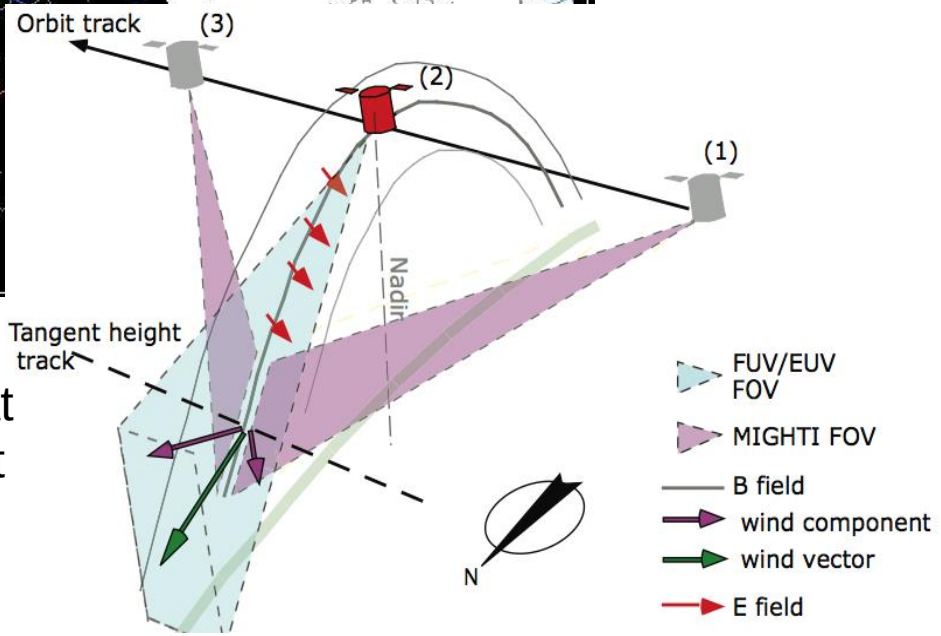
Goal is to learn about the available TIEGCM-HME simulation output

- ❑ ICON mission
- ❑ HME data product
- ❑ TIEGCM-HME data product
- ❑ Where to find the data products

Ionospheric Connection Explorer (ICON)



ICON was launched Oct 2019 and orbits at 600km woth a 27^{o} inclination. To construct the lower boundary for the TIEGCM we use the vector winds & temperatures measured by MIGHTI-A and MIGHTI-B.

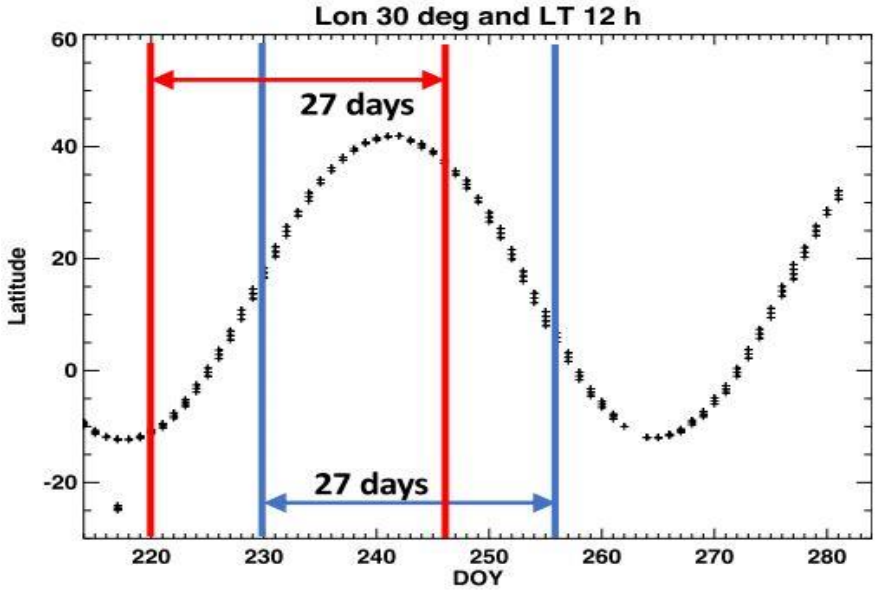


[Immel et al., 2017]

Global tides via Hough Mode Extension (HME)

- HME are fitted to MIGHTI neutral wind and temperature between 10°S-40°N from 94-102 km.
- HME-V01 is using a 35-day data window for fitting.

Latitudes of ICON sampling for 12 SLT



[Cullens et al., 2020]

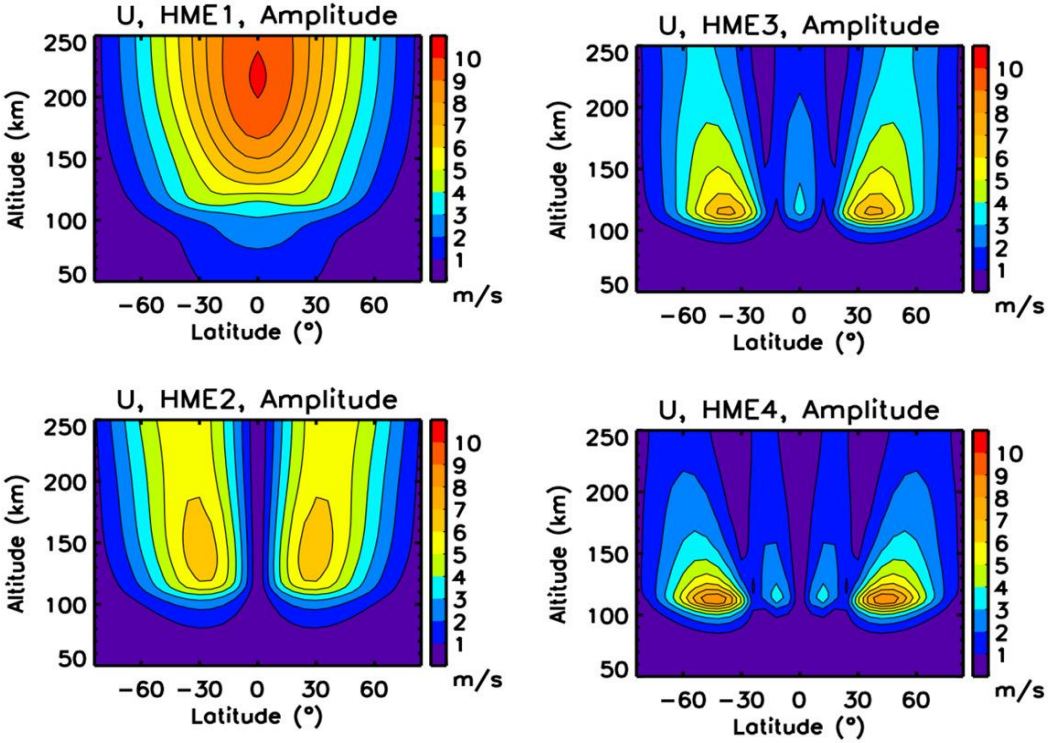
Forbes et al., Space Sci Rev. (2017)

Cullens et al., Earth Planetary Science (2020)

Global tides via Hough Mode Extension (HME)

- HME data product L4.1 is provided between 0-400km and capture the effect of upward propagating tides but no in-situ excitation e.g., tide-tide and tide-ion drag forcing.

First 4 HME of SE2 for zonal wind



[Forbes et al., JGR, 2022]

hme_tiegcm-lower-boundary

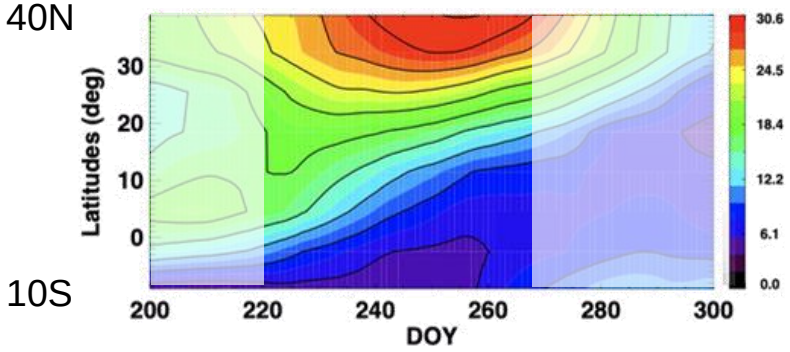
- L4-1 "hme_tiegcm-lower-boundary" product is used at the lower boundary of the Thermosphere-Ionosphere-Electrodynamics- GCM (TIEGCM). The LB HME varies in latitude and longitude (no altitude) and are reconstructed at 97 km from the HME fit (amplitude, phase).
- hme_tiegcm_lower boundary is V2.0.
- The following tidal components are included Diurnal DW2 – DE3 and Semidiurnal SW4 – SE3

  Number is the zonal wave number

  E for east-, W for westward

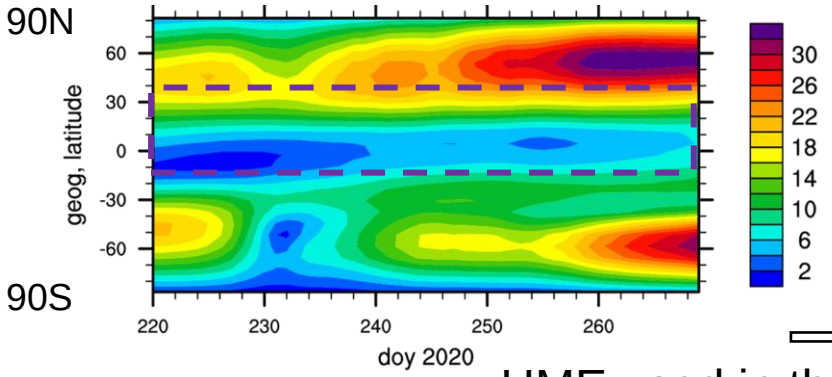
Tidal forcing via Hough Mode Extension (HME) in TIEGCM – example of SW2

SW2 in **MIGHTI zonal wind** [m/s] at 96km



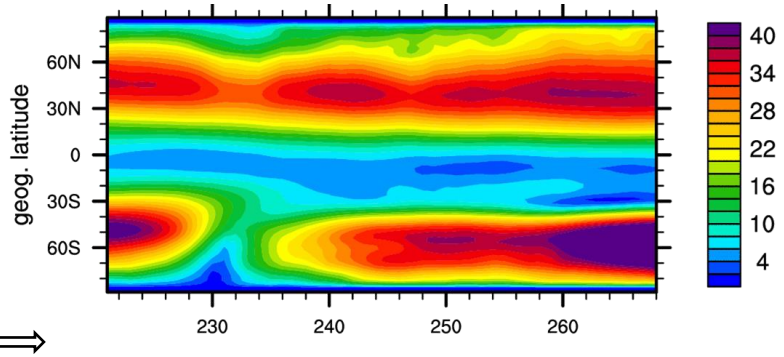
Tidal components in MIGHTI data is extended globally using HME and then used as lower boundary for the TIEGCM

SW2 zonal wind [m/s] at 96km from **HME fitting**



MIGHTI observing latitudes

SW2 zonal wind [m/s] at 110km from **TIEGCM-HME**



HME used in the TIEGCM lower boundary

TIEGCM-HME and TIEGCM-noHME

Two TIEGCM simulations are available

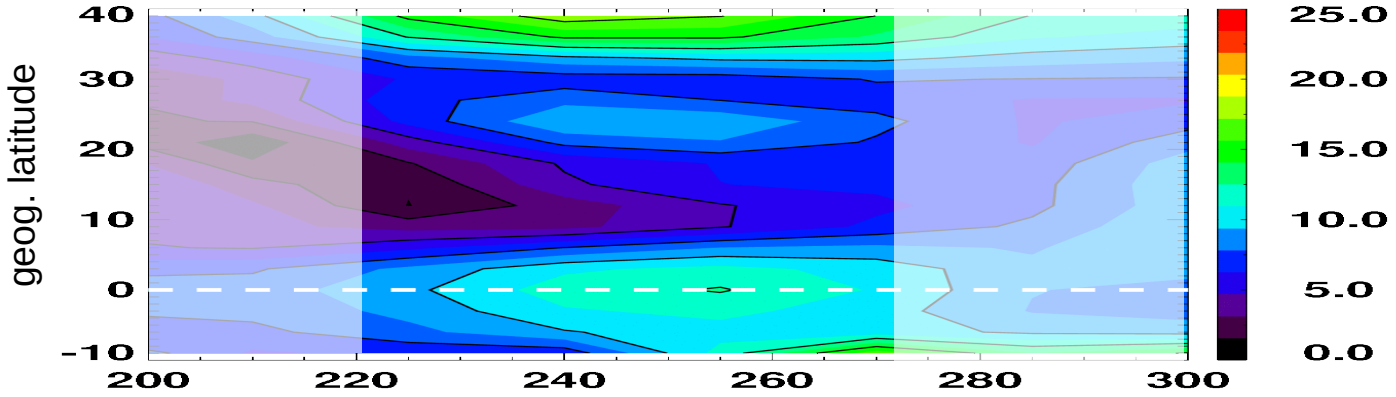
- **TIEGCM simulation with tidal HME forcing (TIEGCM-HME)**
- **TIEGCM without any tidal forcing (TIEGCM-noHME).**

The difference between these simulations isolate the effect of upward propagating tides on the thermosphere-ionosphere system.

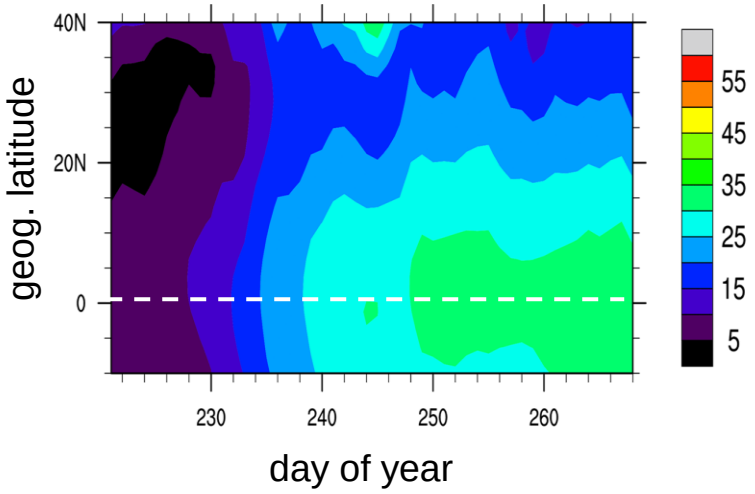
- TIEGCM is forced with Weimer ion convection driven by 5 min solar wind data. The default analytical particle precipitation model with its parametrization is used.
- LB background is based on HWM & MSIS (Jones Jr., 2014)
- E-region plasma densities are increased according to Fang et al. (2008)

SW2 amplitude zonal wind [m/s] at 250km based on MIGHTI & TIEGCM-HME

MIGHTI SW2 zonal wind amplitude [m/s] at 250km



TIEGCM-HME SW2 zonal wind amplitude [m/s] at 250km



SW2 zonal wind amplitude in TIEGCM-HME is larger than the MIGHTI SW2 amplitude.

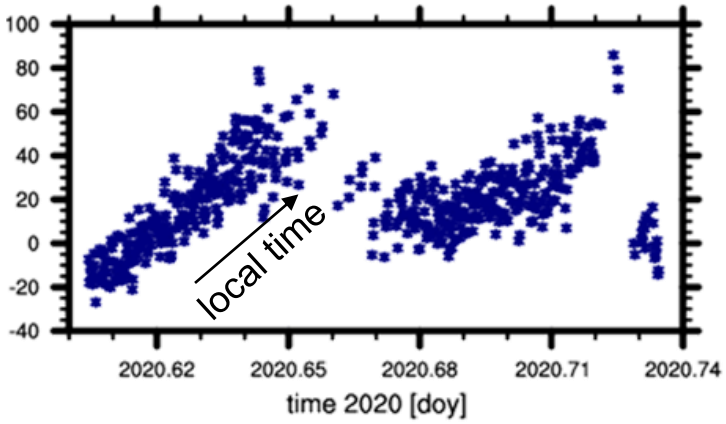
There are similarities in both with increasing amplitudes over time and a maximum at the equator.

SW2 MIGHTI based up to 45-day window

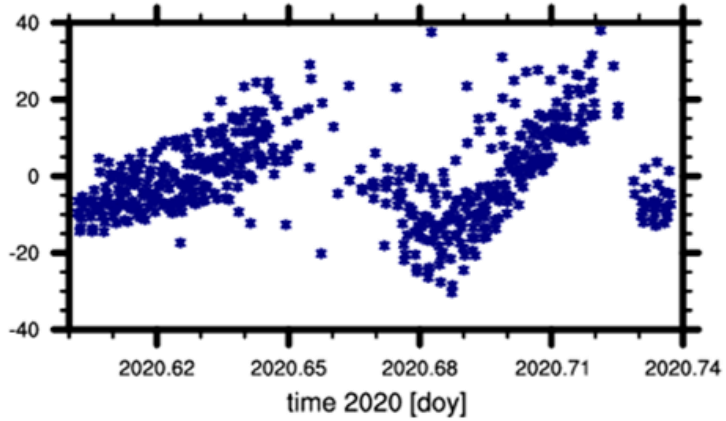
SW2 TIEGCM-HME based on 2-day window

IVM-A ion drift & ExB TIEGCM-HME

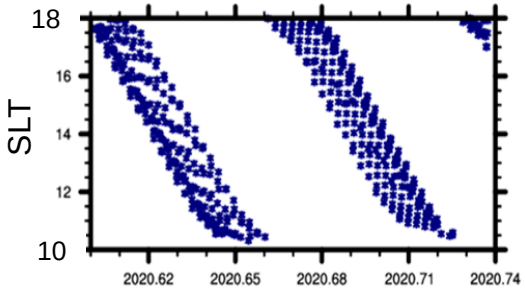
ICON mag. upward drift [m/s]



TIEGCM-HME mag. upward drift [m/s]



Comparison of magnetic upward drift (perpendicular to the geomagnetic field line) for 10-18 solar local time and magnetic latitude $|\lambda_m|<5^o$



(IVM-A V06 only good data quality; for vertical drift a 24h mean is removed; TIEGCM-HME at 588km)

Where to find data at UC Berkeley

- ICON website at UC Berkeley https://icon.ssl.berkeley.edu/ with links to the data and publications; data product matrix https://icon.ssl.berkeley.edu/Data/Data-Product-Matrix

Data Product Matrix

ICON Level 4 data products are available online at ftp://icon-science.ssl.berkeley.edu/pub/LEVEL.4. These are higher level products that provide global specification of atmospheric tides (4.1) and all other key parameters (4.3) in this environment measured by ICON .

Level 4 Product	Version	Notes
Hough Mode Extension	1.0	Includes Tidal Components and TIEGCM boundary specification. Described at this link and this link
ICON-TIEGCM	1.0	Full TIEGCM runs that include the HME boundary specification derived from MIGHTI winds and temperatures. Described at this link

- Note that for the ICON-TIEGCM we used HME-V2
- Available from Dec. 2019 to Dec 2021.

Where to find the data at NASA SPDF

- ICON data at NASA https://spdf.gsfc.nasa.gov/pub/data/icon/
- The Level 4 data includes the HME L4.1 product and TIEGCM L4.3 product

Index of /pub/data/icon/l4/tiegcm/2020

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icon_l4-3_tiegcm_2020-01-12_v01r000.zip	2022-04-04 17:34	1.5G

- So far only TIEGCM-HME is uploaded not TIEGCM-noHME.
- ICON_L4-3_TIEGCM_v01 description missing and can be found on Berkeley website

Questions?