

ICON Data Product 4.1: HME The Lower Boundary for TIE-GCM

This data product contains the lower boundary of TIE-GCM including zonal wind, meridional wind, temperature, and geopotential height. Tidal structures obtained from ICON-MIGHTI observations are fitted to Hough Mode Extension (HME). Global tidal perturbation field are reconstructed using ICON-HME at 97 km. ICON-MIGHTI winds and temperature from 94 km to 102 km in the latitude range of 10°S-40°N and SABER in the latitude range of 5°S-50°S are used to fit to the HME. To cover all local time for tidal analysis, ICON-MIGHTI and SABER data are accumulated with a 45-day window and a 60-day window, respectively. HME has been widely used and tested before, and detailed HME methodologies are summarized in Forbes et al. [1994] and Oberheide et al. [2011]. HME for ICON and application to TIEGCM simulation is summarized in Forbes et al. [2017] and Maute [2017], respectively, and sensitivity study of HME fitting to the data coverage can be found in Cullens et al. [2020].

History

v01: Released in 2021, C. Y. Cullens

v02: In order to have enough data points for continuous tidal analysis, a window size is changed from 35 days to 45 days. In addition, 10-day running smooth is applied to tidal amplitudes before fitting HME for better TIE-GCM simulations. Released in 2022, C. Y. Cullens

V03: Updated Version 5 MIGHTI winds data and Version 5 MIGHTI temperature data are used for V03 HME product. Furthermore, to constrain semi-diurnal tides better in the Southern Hemisphere, SABER temperature data is added from 5°S to 50°S in addition to ICON-MIGHTI data from 10°S-40°N for HME fitting. Released in 2023, C.Y. Cullens

V04: Version 6 MIGHTI winds and temperatures are used in the V04 HME product. The V04 HME product includes TW3 (westward-propagating terdiurnal tides with zonal wavenumber 3).

Dimensions

NetCDF files contain variables and the dimensions over which those variables are defined. First, the dimensions are defined, then all variables in the file are described. The dimensions used by the variables in this file are given below, along with nominal sizes.

Dimension Name	Nominal Size
lat	74
lon	144
time	24
mtimedim	3

Variables

Variables in this file are listed below.

Variable Name	Description	Unit	Dimension
UN	Reconstructed zonal wind tidal structure at 97 km. Reconstructed field contains both diurnal tides (DW2 to DE3), semi-diurnal tides (SW4 to SE3) and ter-diurnal tide (TW3)	m/s	lon, lat, time
VN	Reconstructed meridional wind tidal structure at 97 km. Reconstructed field contains both diurnal tides (DW2 to DE3), semi-diurnal	m/s	lon, lat, time

	tides (SW4 to SE3), and ter-diurnal tide (TW3).		
TN	Reconstructed temperature tidal structure at 97 km. Reconstructed fields contains both diurnal tides (DW2 to DE3)), semi-diurnal tides (SW4 to SE3), and ter-diurnal tide (TW3).	K	lon, lat, time
Z	Reconstructed geopotential height tidal structure at 97 km. Reconstructed field contains both diurnal tides (DW2 to DE3)), semi-diurnal tides (SW4 to SE3), and ter-diurnal tide (TW3).	m	lon, lat, time
lat	Latitude	degree	lat
lon	Longitude	degree	lon
time	Hours since 0 UT		time
UT	Universal Time		time
year	Year		time
day	Day of year		time
mtime	[Day, hour, min]		time, mtime

Acknowledgement

This is a data product from the NASA Ionospheric Connection Explorer mission, an Explorer launched at 21:59:45 EDT on October 10, 2019, from Cape Canaveral AFB in the USA. Guidelines for the use of this product are described in the ICON Rules of the Road (<http://icon.ssl.berkeley.edu/Data>).

Responsibility for the mission science falls to the Principal Investigator, Dr. Thomas Immel at UC Berkeley: Immel, T.J., England, S.L., Mende, S.B. et al. Space Sci Rev (2018) 214: 13.

<https://doi.org/10.1007/s11214-017-0449-2>

Immel, T.J., England, S.L., Harding, B.J. et al. Space Sci Rev (2023) 219: 41.

<https://doi.org/10.1007/s11214-023-00975-x>

Responsibility for the validation of the L1 data products falls to the instrument lead investigators/scientists.

EUV: Dr. Martin Sirk and Dr. Eric Korpela : <https://doi.org/10.1007/s11214-023-00963-1>, and

<https://doi.org/10.1007/s11214-017-0384-2>

FUV: Dr. Harald Frey : <https://doi.org/10.1007/s11214-023-00969-9>, and <https://doi.org/10.1007/s11214-017-0386-0>

MIGHTI: Dr. Christoph Englert : <https://doi.org/10.1007/s11214-023-00971-1>,

<https://doi.org/10.1007/s11214-017-0358-4>, and <https://doi.org/10.1007/s11214-017-0374-4>

IVM: Dr. Roderick Heelis : <https://doi.org/10.1007/s11214-017-0383-3>

Responsibility for the validation of the L2 data products falls to those scientists responsible for those products.

* Daytime O/N2 ratio : Dr. Robert Meier : <https://doi.org/10.1007/s11214-018-0477-6>

* Daytime (EUV) O+ profiles: Dr. Andrew Stephan : <https://doi.org/10.1007/s11214-022-00933-z>, and <https://doi.org/10.1007/s11214-017-0385-1>

* Nighttime (FUV) O+ profiles: Dr. Farzad Kamalabadi : <https://doi.org/10.1007/s11214-018-0502-9>

* Neutral Wind profiles: Dr. Brian Harding : <https://doi.org/10.1007/s11214-017-0359-3>, and

<https://doi.org/10.1029/2020JA028947>

* Neutral Temperature profiles: Dr. Michael Stevens : <https://doi.org/10.1007/s11214-022-00935-x>, and <https://doi.org/10.1007/s11214-017-0434-9>

* Ion Velocity Measurements : Dr. Roderick Heelis : <https://doi.org/10.1007/s11214-017-0383-3>

Additional theoretical work in support of these products was supported by Dr. Robert Meier

Daytime O/N2 product : <https://doi.org/10.1029/2020JA029059>

Daytime (EUV) O+ profiles : <https://doi.org/10.1029/2023JA031533>

Additional validation work was performed by Dr. Jonathan Makela, Dr. Gilles Wautelet, and Dr. Yen-Jung (Joanne) Wu:

Neutral wind profiles : <https://doi.org/10.1029/2020JA028726>

Nighttime (FUV) O+ profiles : <https://doi.org/10.1007/s11214-023-00970-2>

Daytime (EUV) O+ profiles : <https://doi.org/10.1007/s11214-022-00930-2>

Ion Velocity Measurements : <https://doi.org/10.1007/s11214-023-00993-9>

Responsibility for Level 4 products falls to those scientists responsible for those products.

* Hough Modes : Dr. Chihoko Cullens : <https://doi.org/10.1186/s40645-020-00330-6> and <https://doi.org/10.1007/s11214-017-0401-5>

* TIEGCM : Dr. Astrid Maute : <https://doi.org/10.1007/s11214-017-0330-3>

* SAMI3 : Dr. Joseph Huba : <https://doi.org/10.1007/s11214-017-0415-z>

Pre-production versions of all above papers are available on the ICON website.

<http://icon.ssl.berkeley.edu/Publications>

Overall validation of the products is overseen by the ICON Project Scientist, Dr. Scott England.

NASA oversight for all products is provided by the Mission Scientist, Dr. Jeffrey Klenzing (2018-2022), Dr. Ruth Lieberman (2022-2025) and Dr. Douglas Rowland (2025-2026).

Users of these data should contact and acknowledge the Principal Investigator Dr. Immel and the party directly responsible for the data product (noted above) and acknowledge NASA funding for the collection of the data used in the research with the following statement : "ICON is supported by NASA's Explorers Program through contracts NNG12FA45C and NNG12FA42I".

These data are openly available as described in the ICON Data Management Plan available on the ICON website (<http://icon.ssl.berkeley.edu/Data>).