ICON Data Product 2.2: Cardinal Vector Winds

This document describes the data product for ICON MIGHTI Cardinal Vector Winds (DP 2.2), which is in NetCDF4 format.

This data product contains cardinal (i.e., zonal and meridional) thermospheric winds obtained by combining Level 2.1 (line-of-sight winds) from MIGHTI A and MIGHTI B. The cardinal winds are given as a function of time (spanning 24 hours) and altitude (spanning nominally 90-300 km). In addition to the cardinal vector wind data and the corresponding ancillary data, such as time and location, this product contains supporting data, such as fringe amplitude profiles and relative volume emission rate profiles. Absolute calibration and MIGHTI-A/B cross calibration of these data is not necessary to obtain the wind data, and therefore any direct analysis of these supporting data requires caution. There is one file per emission color (red or green).

Cardinal wind observations are enabled by the ~90-degree offset between the two MIGHTI sensors. First, MIGHTI A measures a wind component along its line of sight. Five to eight minutes later, depending on tangent point altitude, the spacecraft has moved to a position such that MIGHTI B measures a nearly orthogonal wind component at approximately the same location. A coordinate rotation is performed on the two line-of-sight components to obtain the northward and eastward components reported in this file. The assumption is that the thermospheric wind has not changed during this time interval. Because the Level 2.1 data are naturally on an irregular grid, they are first interpolated to a regular, pre-defined grid of longitude and altitude before the coordinate rotation is performed. See Harding et al. [2017, doi:10.1007/s11214-017-0359-3] for more details of the Level 2.2 algorithm.

Known issues with the initial data release (labeled v03) are listed below. These issues are expected to be resolved in future data releases. In future releases, some data points may change by up to 50 m/s, but most changes are expected to be much smaller. Future updates to the "zero wind phase" (discussed in detail below, in the notes for the wind variable) will change the winds by a bulk offset, but most relative variations in time, latitude, longitude, and from day to day will remain.

Known issues with v03:
* Some artifacts from preliminary calibrations are present (e.g., thermal instrument drift, detector flat field, and fringe visibility correction). These manifest as artificial offsets that affect a single altitude or a single local solar time, persisting for an entire UT day.
* The quality flag indicating contamination by the South Atlantic Anomaly is too conservative, so some high-quality data points are given a lower quality factor.
* The reported wind error includes the effect of dark, read, and shot noise in the observations, but does not include calibration uncertainty. It is likely that a future release will revise the reported error upward by approximately 50%.
* The bottom two rows of data (corresponding to altitudes of ~88 and ~91 km) are masked out pending updated calibrations. These rows are near the edge of the field of view and not all columns are illuminated, which requires special consideration.
* Airglow brightness observations are not a required mission product, and no effort was yet made to absolutely- or cross-calibrate the brightness observations for MIGHTI-A and MIGHTI-B, and thus the Relative_VER variable should be treated with caution.
* A calibration lamp is used for one orbit per day to assess the periodic thermal drift of MIGHTI. This is used to correct all other observations that day. In v03 data, the thermal drift is ascribed entirely to interferometer drift, but some fraction is due to mechanical drift. This will be corrected by using the observed drift of the fiducial notches. The error in the current approach is estimated to be less than 10 m/s.
* During the one orbit per day when the calibration lamp is on, the wind data are noisier and a slight bias is evident. For this release, these orbits have been labeled with quality=0.5 (i.e., caution). Work is underway to remove this restriction.
* The top 3-5 rows of the red channel are experiencing a long-term drift relative to other rows. The error is estimated to be zero on 2020-02-01 and approximately 50 m/s on 2020-05-15, for both MIGHTI-A and MIGHTI-B. Users should use caution with data above 273 km. This artifact has been identified as an uncorrected drift in the phase distortion and will be corrected in a future release.

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.

Dimensions

The dimensions used by the variables in this file are given below, along with nominal sizes. Note that the size may vary from file to file. For example, the "Epoch" dimension, which describes the number of time samples contained in this file, will have a varying size.

Dimension Name	**Nominal Size**
`Epoch`	2195
`N_Flags`	34
`ICON_L22_Altitude`	84

Variables

Variables in this file are listed below. First, "data" variables are described, followed by the "support_data" variables, and finally the "metadata" variables. The variables classified as "ignore_data" are not shown.

data

Variable Name	Description	Units	Dimensions
`ICON_L22_Zonal_Wind`	Zonal component of the horizontal wind. Positive Eastward. The zonal (positive eastward) and meridional (positive northward) winds are the primary data product in this file. They are defined on a grid with dimensions of time and altitude, spanning 24 hours and nominally 90-300 km (150-300 km for the red channel). The altitude, time, latitude and longitude corresponding to each point in the grid are given by other variables in this file. It should be noted that while each measurement is ascribed to a particular latitude, longitude, altitude, and time, it is actually an average over many hundreds of kilometers horizontally and 2.5-30 kilometers vertically (depending on the binning). It also assumes stationarity over the 5-8 minutes between the MIGHTI-A and B measurements used for each point. See Harding et al. [2017, doi:10.1007/s11214-017-0359-3] for a more complete discussion of the inversion algorithm. Knowledge of the "zero wind phase" is needed for any instrument using Doppler shifts to determine winds. The zero wind phase is defined as the measured interference fringe phase that corresponds to the rest wavelength of the emission. For this initial data release, the zero wind phase has been determined by comparing a 60-day average of MIGHTI data to a 60-day average of the empirical Horizontal Wind Model 2014 (HWM14, Drob et al., 2015, doi:10.1002/2014EA000089), which is a fit to decades of previous wind measurements. At each time and location of a MIGHTI measurement, the MIGHTI measurement is simulated by integrating HWM14 along the line of sight, weighted by the observed volume emission rate as determined by the measured fringe amplitude profile. The 60-day-average difference between the measured and simulated phases is taken as the zero wind phase. This is done separately for each sensor (A and B), for each color (red and green), for each mode (day and night), and for each row (i.e., each altitude). This approach to determining the zero wind phase is analogous to the approach taken for the UARS/HRDI instrument (Hays et al., 1992, doi:10.1016/0032-0633(92)90119-9), which assumed that a long-term average of the meridional wind is zero. Although the long-term average altitude profile is constrained to match HWM14 in this initial MIGHTI data release, measured variations in time, latitude, longitude, and from day to day are retained using this approach. A future data release will leverage ICON's unique "zero wind maneuver" to determine an independent zero wind phase.	m/s	`Epoch, ICON_L22_Altitude`

Variable Name	Description	Units	Dimensions
ICON_L22_Meridional_Wind	Meridional component of the horizontal wind. Positive Northward. The zonal (positive eastward) and meridional (positive northward) winds are the primary data product in this file. They are defined on a grid with dimensions of time and altitude, spanning 24 hours and nominally 90-300 km (150-300 km for the red channel). The altitude, time, latitude and longitude corresponding to each point in the grid are given by other variables in this file. It should be noted that while each measurement is ascribed to a particular latitude, longitude, altitude, and time, it is actually an average over many hundreds of kilometers horizontally and 2.5-30 kilometers vertically (depending on the binning). It also assumes stationarity over the 5-8 minutes between the MIGHTI-A and B measurements used for each point. See Harding et al. [2017, doi:10.1007/s11214-017-0359-3] for a more complete discussion of the inversion algorithm. Knowledge of the "zero wind phase" is needed for any instrument using Doppler shifts to determine winds. The zero wind phase is defined as the measured interference fringe phase that corresponds to the rest wavelength of the emission. For this initial data release, the zero wind phase has been determined by comparing a 60-day average of MIGHTI data to a 60-day average of the empirical Horizontal Wind Model 2014 (HWM14, Drob et al., 2015, doi:10.1002/2014EA000089), which is a fit to decades of previous wind measurements. At each time and location of a MIGHTI measurement, the MIGHTI measurement is simulated by integrating HWM14 along the line of sight, weighted by the observed volume emission rate as determined by the measured fringe amplitude profile. The 60-day-average difference between the measured and simulated phases is taken as the zero wind phase. This is done separately for each sensor (A and B), for each color (red and green), for each mode (day and night), and for each row (i.e., each altitude). This approach to determining the zero wind phase is analogous to the approach taken for the UARS/HRDI instrument (Hays et al., 1992, doi:10.1016/0032-0633(92)90119-9), which assumed that a long-term average of the meridional wind is zero. Although the long-term average altitude profile is constrained to match HWM14 in this initial MIGHTI data release, measured variations in time, latitude, longitude, and from day to day are retained using this approach. A future data release will leverage ICON's unique "zero wind maneuver" to determine an independent zero wind phase.	m/s	Epoch, ICON_L22_Altitude

Variable Name	Description	Units	Dimensions
ICON_L22_Zonal_Wind_Error	Error in the zonal wind estimate. The statistical (1-sigma) error in the zonal wind, propagated from the error in the L2.1 (line-of-sight wind) files. This is usually dominated by shot noise in the detectors, but also includes the effects of dark and read noise, as well as calibrations errors (e.g., the zero wind calibration), and spacecraft pointing error (which affects the uncertainty in removing the spacecraft velocity from the observed velocity). Other systematic errors or biases may exist (e.g., the effect of gradients along the line of sight) which are not included in this variable.Errors in daily calibrations may create systematic patterns in winds that are constant for an entire 24 hour period (00:00 - 23:59 UT) but change from day to day.	m/s	Epoch, ICON_L22_Altitude
ICON_L22_Meridional_Wind_Error	Error in the meridional wind estimate. The statistical (1-sigma) error in the meridional wind, propagated from the error in the L2.1 (line-of-sight wind) files. This is usually dominated by shot noise in the detectors, but also includes the effects of dark and read noise, as well as calibrations errors (e.g., the zero wind calibration), and spacecraft pointing error (which affects the uncertainty in removing the spacecraft velocity from the observed velocity). Other systematic errors or biases may exist (e.g., the effect of gradients along the line of sight) which are not included in this variable.Errors in daily calibrations may create systematic patterns in winds that are constant for an entire 24 hour period (00:00 - 23:59 UT) but change from day to day.	m/s	Epoch, ICON_L22_Altitude
ICON_L22_Wind_Quality	A quantification of the quality, from 0 (Bad) to 1 (Good) A quantification of the overall quality of the wind data. While the intent is that the XXX_Wind_Error variable accurately characterizes the statistical error in the wind data, it is possible that systematic errors are present, or that the statistical error estimation is not accurate. If this is suspected to be the case, the quality will be less than 1.0. If the data are definitely unusable, the quality will be 0.0 and the sample will be masked. Users should exercise caution when the quality is less than 1.0. Currently, the quality can take values of 0 (Bad), 0.5 (Caution), or 1 (Good).		Epoch, ICON_L22_Altitude
ICON_L22_Fringe_Amplitude	Fringe Amplitude An approximate volume emission rate (VER) profile in arbitrary units, estimated by combining MIGHTI-A and MIGHTI-B data. Technically this is not the VER, but rather the amplitude of the fringes, which has a dependence on thermospheric temperature and background emission. Thus, it does not truly represent volume emission rate. However, it is a useful proxy. The units are arbitrary, as the fringe amplitudes are not calibrated. See also variables Fringe_Amplitude_Relative_Difference, Fringe_Amplitude_A, and Fringe_Amplitude_B.	arb	Epoch, ICON_L22_Altitude

Variable Name	Description	Units	Dimensions
`ICON_L22_Fringe_Amplitude_Error`	Error in the fringe amplitude estimate The statistical (1-sigma) error in the fringe amplitude estimate, propagated from error in the MIGHTI-A and MIGHTI-B inversions. The units are arbitrary, as the fringe amplitudes are not absolutely calibrated. Systematic errors, such as those arising from airglow gradients or cross-calibration, are not included in this variable, but are probably the dominant source of total error.	arb	`Epoch, ICON_L22_Altitude`
`ICON_L22_Relative_VER`	Relative volume emission rate The volume emission rate (VER) obtained by averaging the VER from MIGHTI-A and MIGHTI-B, which is obtained by scaling the fringe amplitude by a calibration factor, as described in Data Product 2.1. Pre-flight calibrations and on-orbit comparisons with ground-based instruments are used to determine the best possible calibration. The fringe amplitude has a dependence on temperature, which is corrected using the MSIS model. Because the on-orbit calibration is uncertain, and because the MSIS temperature correction is not perfect, caution should be exercised when absolute calibration is required, or when precise comparisons are being made between samples at very different temperatures. Please contact the MIGHTI team before performing any studies that require absolute calibration. The statistical (1-sigma) error for this variable is provided in the variable ICON_..._Relative_VER_Error, though it is expected that systematic calibration errors dominate the total error.	ph/cm^3/s	`Epoch, ICON_L22_Altitude`
`ICON_L22_Relative_VER_Error`	Error in VER estimate (statistical) The statistical (1-sigma) error in the relative VER estimate, propagated from error in the MIGHTI-A and MIGHTI-B inversions. This error arises mostly from shot noise. Importantly, it is expected that systematic errors (e.g., calibration errors) dominate the total error, but they are not included in this variable.	ph/cm^3/s	`Epoch, ICON_L22_Altitude`
`ICON_L22_VER_Quality`	A quantification of the quality, from 0 (Bad) to 1 (Good) A quantification of the overall quality of the VER data. While the intent is that the XXX_VER_Error variable accurately characterizes the statistical error in the VER data, it is possible that systematic errors are present, or that the statistical error estimation is not accurate. If it is suspected that this is the case, the quality will be less than 1.0. If the data are definitely unusable, the quality will be 0.0 and the sample will be masked. Users should exercise caution when the quality is less than 1.0. Currently, the quality can take values of 0 (Bad), 0.5 (Caution), or 1 (Good).		`Epoch, ICON_L22_Altitude`

Variable Name	Description	Units	Dimensions
ICON_L22_Magnetic_Field_Aligned_Wind	Magnetic field-aligned component of the wind The component of the wind in the direction of the magnetic field line, assuming vertical winds are negligible. This variable is calculated by taking the geographic zonal and meridional wind (the primary data products in this file) and expressing the wind vector in a local magnetic coordinate system defined using the Python package OMMBV (https://github.com/rstoneback/OMMBV). The coordinate system used here is orthogonal and is identical to the coordinate system used to express the ion drifts in the ICON IVM data product 2.7 (i.e., the variables ICON_L27_Ion_Velocity_Meridional, ICON_L27_Ion_Velocity_Zonal, and ICON_L27_Ion_Velocity_Field_Aligned).	m/s	Epoch, ICON_L22_Altitude
ICON_L22_Magnetic_Meridional_Wind	Magnetic meridional component of the wind The component of the wind in the magnetic meridional direction, assuming vertical winds are negligible. This variable is calculated by taking the geographic zonal and meridional wind (the primary data products in this file) and expressing the wind vector in a local magnetic coordinate system defined using the Python package OMMBV (https://github.com/rstoneback/OMMBV). The magnetic meridional unit vector is orthogonal to the magnetic field line but within the plane of the magnetic meridian (defined by the apex of the field line and its footpoint). At the magnetic equator, the meridional direction points up, while away from the equator it has a poleward component (north in the northern hemisphere, south in the southern hemisphere). Note that in some ion-neutral coupling models, a definition of magnetic meridional is often used that is horizontal (i.e., perpendicular to gravity) and generally northward. The definition used here is perpendicular to B and thus has primarily a vertical component at ICON latitudes. Note also that the definition of magnetic meridional and zonal used here differs from quasi-dipole and apex coordinate bases. The coordinate system used here is orthonormal and is identical to the coordinate system used to express the ion drifts in the ICON IVM data product 2.7 (i.e., the variables ICON_L27_Ion_Velocity_Meridional, ICON_L27_Ion_Velocity_Zonal, and ICON_L27_Ion_Velocity_Field_Aligned).	m/s	Epoch, ICON_L22_Altitude

Variable Name	Description	Units	Dimensions
ICON_L22_Magnetic_Zonal_Wind	Magnetic zonal component of the wind The component of the wind in the magnetic zonal direction, assuming vertical winds are negligible. This variable is calculated by taking the geographic zonal and meridional wind (the primary data products in this file) and expressing the wind vector in a local magnetic coordinate system defined using the Python package OMMBV (https://github.com/rstoneback/OMMBV). At the magnetic equator, the zonal direction points horizontally, while away from the equator it can have a slightly vertical component. Note that the definition of magnetic meridional and zonal used here differs from quasi-dipole and apex coordinate bases. The coordinate system used here is orthonormal and is identical to the coordinate system used to express the ion drifts in the ICON IVM data product 2.7 (i.e., the variables ICON_L27_Ion_Velocity_Meridional, ICON_L27_Ion_Velocity_Zonal, and ICON_L27_Ion_Velocity_Field_Aligned).	m/s	Epoch, ICON_L22_Altitude
ICON_L22_Orbit_Number	ICON orbit number The ICON orbit number corresponding to each grid point. This is usually an integer, but when samples from two different orbits are used, an interpolated (fractional) value is used.		Epoch, ICON_L22_Altitude
ICON_L22_Orbit_Node	ICON orbit ascending/descending flag A flag indicating whether ICON is in the ascending (0) or descending (1) part of the orbit. For some grid points, samples from MIGHTI-A are on the descending part of the orbit, while samples from MIGHTI-B are ascending. In these cases an interpolated value is used (between 0 and 1).		Epoch, ICON_L22_Altitude

support_data

Variable Name	Description	Units	Dimensions
Epoch	Sample time, average of A and B measurements. Number of msec since Jan 1, 1970. A one-dimensional array defining the time dimension of the two-dimensional data grid (the other dimension being altitude). This is the average of the MIGHTI-A and MIGHTI-B sample times, which differ by 5-8 minutes. Where MIGHTI-A or MIGHTI-B samples are missing, data are reported as missing, but gaps in Epoch are interpolated over to adhere to the netCDF4 standard that coordinate variables should have no missing values. The matchup between MIGHTI-A and B happens at slightly different times at different altitudes, a complication which is ignored by this variable. The effect is small (plus or minus 30-60 seconds), but in cases where it is important, it is recommended to use the alternative time variable Epoch_Full, which is two dimensional and captures the variation with altitude.	ms	Epoch
Epoch_Full	Sample time, midpoint of A and B measurements. Number of msec since Jan 1, 1970. See the notes for the variable Epoch. This variable is the same as Epoch but contains a second dimension, which captures the small (30-60 second) variation of time with altitude. For most applications this is expected to be negligible, and Epoch can be used instead of this variable. Also see the variable Time_Delta, which contains the difference between the MIGHTI-A and MIGHTI-B times that contributed to each point. Epoch_Full contains the average time.	ms	Epoch, ICON_L22_Altitude
ICON_L22_UTC_Time	Sample time, average of A and B measurements. This variable is the same as Epoch but is formatted as a human-readable string. Missing grid points are labeled with empty strings.		Epoch
ICON_L22_Altitude	WGS84 altitude of each wind sample A one-dimensional array defining the altitude dimension of the data grid (the other dimension being time). Altitude is defined using the WGS84 ellipsoid.	km	ICON_L22_Altitude
ICON_L22_Longitude	WGS84 longitude of each wind sample A two-dimensional array defining the longitude (0-360 deg) of the two-dimensional data grid. In the initial implementation, the longitude is constant with altitude, but this may change in the future to capture the slight (few deg) variation with altitude. Longitude is defined using the WGS84 ellipsoid. It should be noted that while a single longitude value is given for each point, the observation is inherently a horizontal average over many hundreds of kilometers.	deg	Epoch, ICON_L22_Altitude

Variable Name	Description	Units	Dimensions
ICON_L22_Latitude	WGS84 latitude of each wind sample A two-dimensional array defining the latitude of the two-dimensional data grid. The latitude varies only slightly (a few deg) with altitude, but this variation is included. Latitude is defined using the WGS84 ellipsoid. It should be noted that while a single latitude value is given for each point, the observation is inherently a horizontal average over many hundreds of kilometers.	deg	Epoch, ICON_L22_Altitude
ICON_L22_Magnetic_Latitude	Magnetic quasi-dipole latitude of each wind sample A two-dimensional array defining the magnetic quasi-dipole latitude of the two-dimensional data grid. The latitude varies only slightly (a few deg) with altitude, but this variation is included. It should be noted that while a single latitude value is given for each point, the observation is inherently a horizontal average over many hundreds of kilometers. Quasi-dipole latitude and longitude are calculated using the fast implementation developed by Emmert et al. (2010, doi:10.1029/2010JA015326) and the Python wrapper apexpy (doi.org/10.5281/zenodo.1214207).	deg	Epoch, ICON_L22_Altitude
ICON_L22_Magnetic_Longitude	Magnetic quasi-dipole longitude of each wind sample A two-dimensional array defining the magnetic quasi-dipole longitude of the two-dimensional data grid. The longitude varies only slightly (a few deg) with altitude, but this variation is included. It should be noted that while a single longitude value is given for each point, the observation is inherently a horizontal average over many hundreds of kilometers. Quasi-dipole latitude and longitude are calculated using the fast implementation developed by Emmert et al. (2010, doi:10.1029/2010JA015326) and the Python wrapper apexpy (doi.org/10.5281/zenodo.1214207). Quasi-dipole longitude is defined such that zero occurs where the geodetic longitude is near 285 deg east (depending on latitude).	deg	Epoch, ICON_L22_Altitude
ICON_L22_Solar_Zenith_Angle	Solar zenith angle of each wind sample Angle between the vectors towards the sun and towards zenith, for each point in the grid.	deg	Epoch, ICON_L22_Altitude
ICON_L22_Local_Solar_Time	Local solar time of each wind sample Local solar time at each point in the grid, calculating using the equation of time.	hour	Epoch, ICON_L22_Altitude
ICON_L22_Time_Delta	Difference between MIGHTI-A and B times contributing to each point To determine the cardinal wind at each point, a MIGHTI-A line-of-sight wind is combined with a MIGHTI-B line-of-sight wind from several minutes later. This variable contains this time difference for every point. During standard operations (LVLH Normal), this variable should be positive, but can potentially become negative during conjugate operations or when ICON is observing to the south (LVLH Reverse).	s	Epoch, ICON_L22_Altitude

metadata

Variable Name	Description	Units	Dimensions
ICON_L22_Fringe_Amplitude_A	Fringe Amplitude from MIGHTI-A See Fringe_Amplitude. This variable contains the fringe amplitude measured by MIGHTI-A, interpolated to the reconstruction grid. This is one of two variables used to create Fringe_Amplitude.	arb	Epoch, ICON_L22_Altitude
ICON_L22_Fringe_Amplitude_B	Fringe Amplitude from MIGHTI-B See Fringe_Amplitude. This variable contains the fringe amplitude measured by MIGHTI-B, interpolated to the reconstruction grid. This is one of two variables used to create Fringe_Amplitude.	arb	Epoch, ICON_L22_Altitude
ICON_L22_Relative_VER_A	Relative VER from MIGHTI-A See Relative_VER. This variable contains the VER measured by MIGHTI-A, interpolated to the reconstruction grid. This is one of two variables used to create Relative_VER. When A and B are significantly different, large horizontal gradients are suspected, and the quality is reduced.	ph/cm^3/s	Epoch, ICON_L22_Altitude
ICON_L22_Relative_VER_B	Relative VER from MIGHTI-B See Relative_VER. This variable contains the VER measured by MIGHTI-B, interpolated to the reconstruction grid. This is one of two variables used to create Relative_VER. When A and B are significantly different, large horizontal gradients are suspected, and the quality is reduced.	ph/cm^3/s	Epoch, ICON_L22_Altitude
ICON_L22_VER_Relative_Difference	Difference in MIGHTI A and B's VER estimates, divided by the mean The absolute value of the difference between Relative_VER_A and Relative_VER_B, divided by the average. Ideally, MIGHTI A and B should measure the same VER. When they do not, this is an indication of potential violations of the spherical symmetry assumption inherent to the inversion. This is the parameter used to determine if the spherical asymmetry flag is raised.		Epoch, ICON_L22_Altitude

Variable Name	Description	Units	Dimensions
ICON_L22_Quality_Flags	Quality flags This variable provides information on why the Quality variable is reduced from 1.0. Many quality flags can be raised for each grid point, and each flag takes values 0 or 1. More than one flag can be raised per point. This variable is a three-dimensional array with dimensions time, altitude, and number of flags. Each entry is 0 or 1. Most quality flags are passed through from the L1 and L2.1 algorithms (after interpolation to the L2.2 grid). Some additional quality flags are created in L2.2. The N_Flags dimension is defined below: * 0 : (From L1 A) SNR too low to reliably perform L1 processing * 1 : (From L1 A) Proximity to South Atlantic Anomaly * 2 : (From L1 A) Bad calibration * 3 : (From L1 A) Calibration lamps are on * 4 : (From L1 A) Unused * 5 : (From L1 A) Unused * 6 : (From L2.1 A) SNR too low after inversion * 7 : (From L2.1 A) Significant airglow above 300 km * 8 : (From L2.1 A) Line of sight crosses the terminator * 9 : (From L2.1 A) Thermal drift correction is uncertain * 10: (From L2.1 A) S/C pointing is not stable * 11: (From L2.1 A) Unused * 12: (From L1 B) SNR too low to reliably perform L1 processing * 13: (From L1 B) Proximity to South Atlantic Anomaly * 14: (From L1 B) Bad calibration * 15: (From L1 B) Calibration lamps are on NOTE: Var_Notes truncated. See NC file for full description.		Epoch, ICON_L22_Altitude, N_Flags

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

Responsibility for the validation of the L1 data products falls to the instrument lead investigators/scientists.
* EUV: Dr. Eric Korpela : https://doi.org/10.1007/s11214-017-0384-2
* FUV: Dr. Harald Frey : https://doi.org/10.1007/s11214-017-0386-0
* MIGHTI: Dr. Christoph Englert : 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 and N2 profiles: Dr. Andrew Stephan : https://doi.org/10.1007/s11214-018-0477-6
* Daytime (EUV) O+ profiles: Dr. Andrew Stephan : 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. Jonathan Makela : https://doi.org/10.1007/s11214-017-0359-3
* Neutral Temperature profiles: Dr. Christoph Englert : https://doi.org/10.1007/s11214-017-0434-9
* Ion Velocity Measurements : Dr. Russell Stoneback : https://doi.org/10.1007/s11214-017-0383-3

Responsibility for Level 4 products falls to those scientists responsible for those products.
* Hough Modes : Dr. Chihoko Yamashita : 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.

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).

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