NetCDF Variable Reference

ICON_L3-1_Wind_Temperature_2019-12-07_v06r001.NC

Generated: Thu Apr 23 14:41:40 2026

20 variables | 2 dimensions | ICON_L3-1_Wind_Temperature_2019-12-07_v06r001.NC

This L3.1 dataset combines the cardinal winds from ICON/MIGHTI (Data Product L2.2, v06) with the neutral temperatures from ICON/MIGHTI (DP L2.3, v06) so that they are all on the same vertical and longitudinal grid, as specified by L2.2 green line vector winds. v06r001 updates, M.H. Stevens 23 April 2026: 1) Reverse Local-Vertical Local-Horizontal (rLVLH) ICON orbits now included in L3.1 (2021/165-178 and 2022/100-104). Temperatures only. 2) Some missing days added, occasionally with temperatures only. 3) Red line winds appended to green line winds at 174 km. 4) Red line winds are paired with green line winds with nearest neighbor in time approach.

Variables

Variable Name	Type	Units	Notes
Epoch	LONG64	ms	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).

Variable Name	Type	Units	Notes
ICON_L31_Altitude	float64	km	A one-dimensional array defining the altitude dimension of the data grid (the other dimension being time). Altitude is defined using the WGS84 ellipsoid. The L22 grid for MIGHTI Green line results is used below 174 km and the L22 grid for MIGHTI Red line results is used above 174 km.Red line wind profiles are appended at 174 km to the green line wind profile that is the closest in time. Conjugate maneuvers and zero wind maneuvers are avoided. There are overlapping altitudes where both Green line and Red line winds are available and the interested user should see the MIGHTI L22 files for those results.
ICON_L31_Zonal_Wind	float64	m/s	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. to
ICON_L31_Zonal_Wind_Precision	float64	m/s	See L2.2 documentation for more extended discussion on vector wind uncertainties. This error is uncorrelated across time lags larger than 24 hours. Errors are slightly correlated across small altitude gaps. Errors in day mode and night mode are nearly uncorrelated.

Variable Name	Type	Units	Notes
ICON_L31_Zonal_Wind_Accuracy	float64	m/s	Various sources of error in MIGHTI winds are quantified with 1-sigma estimates and organized by their temporal persistence. These error sources are nearly uncorrelated with each other and can thus be added in quadrature. Users are encouraged to contact the MIGHTI team for assistance with error propagation. to The "Accuracy" variable quantifies the error introduced by the zero-wind phase estimate. It is strongly correlated across time lags of days to weeks and becomes increasingly decorrelated for time lags longer than 2 precession cycles (96 days). This error is estimated from the discrepancy between various techniques of determining the zero-wind phase. This error source is irrelevant for most users studying perturbations from the mean (e.g., tides, waves), but may be important for studies of zonal mean winds, point comparisons with other data sets, and seasonal/long-term trends thereof. Errors are moderately correlated across small altitude gaps. Errors in day mode and night mode are nearly uncorrelated, implying there could be different offsets for day mode and night mode. This could be important for error propagation of odd-numbered migrating tides (e.g., DW1).

Variable Name	Type	Units	Notes
ICON_L31_Meridional_Wind	float64	m/s	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. to
ICON_L31_Meridional_Wind_Precision	float64	m/s	See L2.2 documentation for more extended discussion on vector wind uncertainties. This error is uncorrelated across time lags larger than 24 hours. Errors are slightly correlated across small altitude gaps. Errors in day mode and night mode are nearly uncorrelated.

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ICON_L31_Wind_Quality	float64	--	The quality can take values of 0 (Bad), 0.5 (Caution), or 1 (Good). to The quality can take values of 0 (Bad), 0.5 (Caution), or 1 (Good).

Variable Name	Type	Units	Notes
ICON_L31_Temperature	float64	K	Derived temperatures from the O2 A-band by altitude for the MIGHTI-A detector. Temperatures from the MIGHTI-B detector are not included in this L3 product but can be found in the MIGHTI L2.3 product. MIGHTI-B typically observes the same volume of air as MIGHTI-A about 9 minutes later, which is driven by the requirement for the cardinal wind observations. Comparisons between MIGHTI-A and MIGHTI-B temperatures are within about 6 K between 90-105 km and those comparisons can be found in Stevens et al. [Space Sci. Rev., 218:67, https://doi.org/10.1007/s11214-022-00935-x, 2022]. Fundamentally, temperatures are retrieved from the rotational distribution of emission lines in the O2 A band. The MIGHTI measurement is made at 5 spectral channels, each about 2 nm in width. 3 channels measure the A band (760, 763, and 765 nm) and 2 others on either side of the band (754 and 780 nm) measure a background, which is very small but nonetheless subtracted from the 3 signal channels (see Stevens et al. for more details). An entire altitude profile is imaged simultaneously. An onion-peeling inversion is used on the raw observations to remove the near and far field effects from the integration along the line of sight. O2 A band spectra are pre-calculated from 100-400 K in 20 K increments based on the HITRAN 2016 database [Gordon et al., JQSRT (2017), 203:3-69.https://doi.org/10.1016/j.jqsrt.06.038] and smoothed filter functions with FWHM of ~2.0 nm. The filter functions are based on Gaussian fits to laboratory measurements and are a function of channel, row (altitude), and column. The fits are separately done for each pixel as a function of peak wavenumber (wavelength), width, and transmittance. For each of the three signal channels the fitted Gaussians are co-added over 51 pixels where the transmittance is largest for a representative filter function for that channel. The transmittances are not absolutely calibrated in photometric units, but the relative transmittance between channels and between detectors is maintained, which allows for the retrieval of temperature at the tangent altitude.More recently, polynomials are fit to the temperature vs. transmittance for each channel to ensure that the variation with temperature within each channel is smooth. See L2.3 var notes for more details.

Variable Name	Type	Units	Notes
ICON_L31_Temperature_Precision	float64	K	Statistical uncertainties (one sigma) in derived temperatures by altitude. This uncertainty is driven by the signal to noise ratio in the three signal channels for the MIGHTI A-band observations. The precision for an image is typically smaller than the accuracy.
ICON_L31_Temperature_Accuracy	float64	K	Estimated bias uncertainties in derived temperatures by altitude; aka systematic uncertainties. These uncertainties are present in each temperature profile and are primarily due to 1) uncertainty in the common shift applied to pre-flight laboratory determined filter positions. This uncertainty is determined by comparing MIGHTI-A and MIGHTI-B temperature retrievals for the same day at 90 km and averaging the absolute difference over 3 different days. a derived fixed uncertainty of 3 K is propagated at all altitudes and 2) the lack of measurements above the top altitude sampled, and altitude dependent, with the topmost altitudes of the retrieval affected the most. The temperature bias uncertainty is found by a root sum square of these two. At most altitudes the estimated bias uncertainty is dominated by the uncertainty in the common shift. The systematic bias is the same at all altitudes for daytime images or nighttime images. However, the bias can be different for daytime images and nighttime images.
ICON_L31_Latitude	float64	deg	The latitude of the data grid, where the latitude is referenced to 100 km. The latitude varies only slightly (a few deg) with altitude. Latitude is defined using the WGS84 ellipsoid. It should be noted that while a single latitude value is given for each profile, the observation is inherently a horizontal average over many hundreds of kilometers.

Variable Name	Type	Units	Notes
ICON_L31_Longitude	float64	deg	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.
ICON_L31_Magnetic_Latitude	float64	deg	The magnetic quasi-dipole latitude of the data grid. The magnetic latitude varies only slightly (a few deg) with altitude, and magnetic latitudes are referenced to 100 km. 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).
ICON_L31_Magnetic_Longitude	float64	deg	The magnetic quasi-dipole longitude of the data grid. The magnetic longitude varies only slightly (a few deg) with altitude, and magnetic longitudes are referenced to 100 km. 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).
ICON_L31_Local_Solar_Time	float64	hour	Local solar time at each point in the grid, calculating using the equation of time. The local times are referenced to 100 km.

Variable Name	Type	Units	Notes
ICON_L31_Solar_Zenith_Angle	float64	deg	Angle between the vectors towards the sun and towards zenith, for each point in the grid. The solar zenith angles are referenced to 100 km.
ICON_L31_Aperture_Setting_MIGHTI_A	byte	--	Aperture Position 1: 0=OPEN, 1=CLOSED, 2=15% OPEN, 3=UNKNOWN. Note that when OPEN (0) the integration time is 60 s for nighttime observations and when 15% OPEN (2) the integration time is 30 s for daytime observations.
ICON_L31_UTC_Time	string	--	This variable is the same as Epoch but is formatted as a human-readable string. Missing grid points are labeled with empty strings.