Interstellar Boundary Explorer

Data Release 16

Eleven Years of Imaging the Global Heliosphere with IBEX

- **Click Here to download a Zip File of all Data Release 16 Data (1.69GB)** (https://drive.google.com/file/d/1kUFa_tGXSUkHtRAzQ29V5MqwJnn4YQLs/view?usp=sharing)

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The Interstellar Boundary Explorer (IBEX) has now operated in space for a full solar activity cycle (Solar Cycle 24) and returned nearly continuous observations that have led to scientific discoveries and reshaped our entire understanding of the outer heliosphere and its interaction with the local interstellar medium. This data release extends prior work by adding comprehensive analysis of 2016-2019 data for the first time and improving prior correction methods. The data, maps, and documentation provided here represent the sixteenth major release of IBEX data, providing a complete eleven year set of Energetic Neutral Atom (ENA) observations from ~0.1 to 6 keV.

To download the entire data release as a zip file click the link above. To learn more about the structure and content of the files contained within the release, a detailed description follows. For questions about this or any other release, please email (ibex_datareleases@lists.sr.unh.edu)**ibex_datareleases@lists.sr.unh.edu** (mailto:ibex_datareleases@lists.sr.unh.edu).

A detailed description and initial analysis of these maps is presented in McComas et al. 2020 (ApJS). **Click here to access the paper.** (https://iopscience.iop.org/article/10.3847/1538-4365/ab8dc2)

Data Directory Structure and Naming Conventions

The data in this release are separated into six-month and one-year segments, which represent the following IBEX orbits and dates:

The 6-month and annual allsky maps are representative of the following IBEX orbits and dates:

Year	Skymap Name	Start-End Orbits or Arcs	Dates
1	Map2009A	11-34	12/25/2008 – 06/25/2009
1	Map2009B	35-58	06/25/2009 – 12/25/2009
2	Map2010A	59-82	12/25/2009 – 06/26/2010

2	Map2010B	83-106	06/26/2010 – 12/26/2010
3	Map2011A	107-130a	12/26/2010 – 06/25/2011
3	Map2011B	130b-150a	06/25/2011 – 12/24/2011
4	Map2012A	150b-170a	12/24/2011 – 06/22/2012
4	Map2012B	170b-190b	06/22/2012 – 12/26/2012
5	Map2013A	191a-210b	12/26/2012 – 06/26/2013
5	Map2013B	211a-230b	06/26/2013 – 12/26/2013
6	Map2014A	231a-250b	12/26/2013 – 06/26/2014
6	Map2014B	251a-270b	06/26/2014 – 12/24/2014
7	Map2015A	271a-290b	12/24/2014 – 06/24/2015
7	Map2015B	291a-310b	06/24/2015 – 12/23/2015
8	Map2016A	311a-330b	12/24/2015 – 06/23/2016
8	Map2016B	331a-351a	06/24/2016 – 12/26/2016
9	Map2017A	351b-371a	12/26/2016 – 06/24/2017
9	Map2017B	371b-391a	06/25/2017 – 12/25/2017
10	Map2018A	391b-411b	12/25/2017 – 06/28/2018
10	Map2018B	412a-431b	06/29/2018 – 12/26/2018
11	Map2019A	432a-451b	12/27/2018 – 06/27/2019
11	Map2019B	452a-471b	06/28/2019 – 12/26/2019

Along with each set of individual maps, we provide the 11-year combined map for that category, as well as a combined set of ENA maps in equatorial and galactic coordinate systems for the broader astrophysical community.

Map directories are named using keywords that indicate the type of data they contain:

- **cg** - Compton-Getting corrections have been applied to the data to account for the speed of the spacecraft relative to the direction of arrival of the ENAs.
- **tabular** - survival probability corrections have been applied to the data to account for the loss of ENAs due to radiation pressure, photoionization and ionization via charge exchange with solar wind protons as they stream through the heliosphere. This correction scales the data out from IBEX at 1 AU to ~100 AU.
- **noSP** - no survival probability corrections have been applied to the data.
- **ram** - data was collected when the spacecraft was ramming into the incoming ENAs.
- **antiram** - data was collected when the spacecraft was moving away from the incoming ENAs.
- **yyyyA/B** - identifies a particular set of orbits spanning 6 months in year yyyy (A - Jan - June, B - July - Dec).

- **yyyy** - identifies a particular set of orbits spanning year yyyy.
- **single** - data was collected over the course of the entire eleven-year span.

Filename Description

Data and map files are named using additional keywords that indicate the type of data they contain:

- **hide** - IBEX-Hi direct events
- **hi-n** - data from the nth energy bin of IBEX-Hi
- **trp** - triple coincidence
- **mono** - Compton-Getting corrected data
- **flux** - flux data
- **fsnr** - signal/noise data
- **ener** - energies data
- **numb** - samples per pixel
- **fexp** - total time exposure data
- **cnts** - total counts data
- **fraw**- raw orbit data
- **fvar**- flux variances

File Headers

The first number in the first line of each data file gives the number of lines taken up by the header followed by the number of rows times the number of columns in the data (i.e. 30X60 indicates 30 rows of declination by 60 columns of right ascension values). Row 1 corresponds to the South Ecliptic Pole, while row 30 corresponds to the North Ecliptic Pole. The columns start at ecliptic longitude 0 and step through to ecliptic longitude 360; the values of the first and last columns in each map are identical. The layout of the columns corresponds to Solar Ecliptic East Longitude, right to left as seen outward by IBEX. The keyword “h_title” gives the description of the data and the units used.

Calculation Notes for Users to Combine Multiple Maps:

Combining different maps is done by accounting for the statistical uncertainties and time exposure weighting. Below is an example of combining three different maps.
ENA Exposure times for the three ENA maps: tau1, tau2, tau3;
ENA fluxes for the three ENA maps: flux1, flux2, flux3;
ENA flux variances for the three ENA maps: var1, var2, var3;
We now calculate the weights from the exposure times as,
wt1=tau1/(tau1+tau2+tau3)
wt2=tau2/(tau1+tau2+tau3)
wt3=tau3/(tau1+tau2+tau3)
Combined fluxes and propagated variances are then determined using:
combined_flux=flux1*wt1 + flux2*wt2 + flux3*wt3
combined_var=var1*(wt1)^2 + var2*(wt2)^2 + var3*(wt3)^2