

# Seven Years of Imaging the Global Heliosphere with IBEX

## IBEX Data Release 10

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The Interstellar Boundary Explorer (IBEX) has now operated in space for seven years 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 the 2014-2015 data for the first time and improving prior correction methods. The data, maps, and documentation provided here represent the tenth major release of IBEX data, providing a complete seven year set of Energetic Neutral Atom (ENA) observations from ~0.1 to 6 keV.

To download the entire data release as a zip file or to go to a table of plot directories and data selections for either IBEX-Lo or IBEX-Hi, click on one of the links below. 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](mailto:ibex_datareleases@lists.sr.unh.edu).

A detailed description and initial analysis of these maps is presented in McComas et al. 2017 (ApJS, In Press).

- [IBEX Data Release 10 archive download \(0.96Gb\)](#)
- [IBEX Hi Data and Plots](#)
- [IBEX Lo Data and Plots](#)

## 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 #	Start-End of Orbits or Arcs	Dates
1	Map1	11-34	12/25/2008 – 06/25/2009
1	Map2	35-58	06/25/2009 – 12/25/2009

2	Map3	59-82	12/25/2009 – 06/26/2010
2	Map4	83-106	06/26/2010 – 12/26/2010
3	Map5	107-130a	12/26/2010 – 06/25/2011
3	Map6	130b-150a	06/25/2011 – 12/24/2011
4	Map7	150b-170a	12/24/2011 – 06/22/2012
4	Map8	170b-190b	06/22/2012 – 12/26/2012
5	Map9	191a-210b	12/26/2012 – 06/26/2013
5	Map10	211a-230b	06/26/2013 – 12/26/2013
6	Map11	231a-250b	12/26/2013 – 06/26/2014
6	Map12	251a-270b	06/26/2014 – 12/24/2014
7	Map13	271a-290b	12/24/2014 – 06/24/2015
7	Map14	291a-310b	06/24/2015 – 12/23/2015

Along with each set of individual maps, we provide the 7-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.
- **mapx** - x identifies a particular set of orbits spanning 6 months.
- **yearx** - x identifies a particular set of orbits spanning one year.
- **single** - data was collected over the course of the entire seven-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
- **lode** - IBEX-Lo direct events
- **hi-n** - data from the nth energy bin of IBEX-Hi
- **lo-n** - data from the nth energy bin of IBEX-Lo
- **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). The keyword “h\_title” gives the description of the data and the units used.

## IBEX Hi Observing Energetic Neutral Atoms In a Higher Range of Energies

### Plots and Data Directories

<b>6-month Compton-Getting Corrected Maps</b>	<b>6-month Maps</b> These maps represent	<b>Yearly Maps, Ram Direction</b> These maps include data	<b>Yearly Maps, AntiRam Direction</b>
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<p>Compton-Getting maps adjust values after correcting for the speed of the spacecraft in relation to the direction of arrival of the ENAs.</p> <p>The data directories:</p> <p><a href="#">hvset_cg_single</a></p> <p><a href="#">hvset_cg_map1</a></p> <p><a href="#">hvset_cg_map2</a></p> <p><a href="#">hvset_cg_map3</a></p> <p><a href="#">hvset_cg_map4</a></p> <p><a href="#">hvset_cg_map5</a></p> <p><a href="#">hvset_cg_map6</a></p> <p><a href="#">hvset_cg_map7</a></p> <p><a href="#">hvset_cg_map8</a></p> <p><a href="#">hvset_cg_map9</a></p> <p><a href="#">hvset_cg_map10</a></p> <p><a href="#">hvset_cg_map11</a></p> <p><a href="#">hvset_cg_map12</a></p>	<p>the data before any corrections are made for speed of spacecraft or survival probability.</p> <p>The data directories:</p> <p><a href="#">hvset_single</a></p> <p><a href="#">hvset_map1</a></p> <p><a href="#">hvset_map2</a></p> <p><a href="#">hvset_map3</a></p> <p><a href="#">hvset_map4</a></p> <p><a href="#">hvset_map5</a></p> <p><a href="#">hvset_map6</a></p> <p><a href="#">hvset_map7</a></p> <p><a href="#">hvset_map8</a></p> <p><a href="#">hvset_map9</a></p> <p><a href="#">hvset_map10</a></p> <p><a href="#">hvset_map11</a></p> <p><a href="#">hvset_map12</a></p>	<p>recorded from times when the aperture was pointed towards the hemisphere of the spacecraft's motion. The maps do not include survival probability corrections.</p> <p>The data directories:</p> <p><b>Without Compton-Getting</b></p> <p><a href="#">hvset_noSP_ram_single</a></p> <p><a href="#">hvset_noSP_ram_year1</a></p> <p><a href="#">hvset_noSP_ram_year2</a></p> <p><a href="#">hvset_noSP_ram_year3</a></p> <p><a href="#">hvset_noSP_ram_year4</a></p> <p><a href="#">hvset_noSP_ram_year5</a></p> <p><a href="#">hvset_noSP_ram_year6</a></p> <p><a href="#">hvset_noSP_ram_year7</a></p> <p><b>With Compton-Getting</b></p> <p><a href="#">hvset_noSP_ram_cg_single</a></p> <p><a href="#">hvset_noSP_ram_cg_year1</a></p>	<p>These maps include data recorded at times when the aperture was pointed away from the hemisphere of the spacecraft's motion. The maps do not include survival probability corrections.</p> <p>The data directories:</p> <p><b>Without Compton-Getting</b></p> <p><a href="#">hvset_noSP_antiram_single</a></p> <p><a href="#">hvset_noSP_antiram_year1</a></p> <p><a href="#">hvset_noSP_antiram_year1</a></p> <p><a href="#">hvset_noSP_antiram_year2</a></p> <p><a href="#">hvset_noSP_antiram_year3</a></p> <p><a href="#">hvset_noSP_antiram_year4</a></p> <p><a href="#">hvset_noSP_antiram_year5</a></p> <p><a href="#">hvset_noSP_antiram_year6</a></p> <p><a href="#">hvset_noSP_antiram_year7</a></p> <p><b>With Compton-Getting</b></p> <p><a href="#">hvset_noSP_antiram_cg_single</a></p>
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<a href="#">hvset_cg_map13</a> <a href="#">hvset_cg_map14</a>	<a href="#">hvset_map13</a> <a href="#">hvset_map14</a>	<a href="#">hvset_noSP_ram_cg_year2</a> <a href="#">hvset_noSP_ram_cg_year3</a> <a href="#">hvset_noSP_ram_cg_year4</a> <a href="#">hvset_noSP_ram_cg_year5</a> <a href="#">hvset_noSP_ram_cg_year6</a> <a href="#">hvset_noSP_ram_cg_year7</a>	<a href="#">hvset_noSP_antiram_cg_year1</a> <a href="#">hvset_noSP_antiram_cg_year2</a> <a href="#">hvset_noSP_antiram_cg_year3</a> <a href="#">hvset_noSP_antiram_cg_year4</a> <a href="#">hvset_noSP_antiram_cg_year5</a> <a href="#">hvset_noSP_antiram_cg_year6</a> <a href="#">hvset_noSP_antiram_cg_year7</a>
<p><b>6-months, Compton-Getting and Survival Probability Corrected Maps</b></p> <p>Compton-Getting Tabular Maps adjust values after correcting for the speed of the spacecraft in relation to the direction of arrival of the ENAs and include adjustments taking into account ENA survival probability as they move from the outer heliosphere to 1 AU (location of IBEX).</p> <p>The data directories:</p> <p><a href="#">hvset_cg_tabular_single</a></p> <p><a href="#">hvset_cg_tabular_map1</a></p>	<p><b>Survival Probability Lookup Maps</b></p> <p>Survival Probability Maps account for the loss (extinction) of ENAs due to radiation pressure, photoionization and ionization via charge exchange with solar wind protons.</p> <p>The data directories:</p> <p><a href="#">hvset_tabular_single</a></p> <p><a href="#">hvset_tabular_map1</a></p>	<p><b>Yearly Maps, Survival Probability Corrected, Ram Direction</b></p> <p>These maps include survival probability corrected data recorded from times when the aperture was pointed towards the hemisphere of the spacecraft's motion.</p> <p>The data directories:</p> <p><b>With Compton-Getting</b></p> <p><a href="#">hvset_tabular_ram_cg_single</a></p> <p><a href="#">hvset_tabular_ram_cg_year1</a></p>	<p><b>Yearly Maps, Survival Probability Corrected, Antiram Direction</b></p> <p>These maps include survival probability corrected data recorded from times when the aperture was pointed away from the hemisphere of the spacecraft's motion.</p> <p>The data directories:</p> <p><b>With Compton-Getting</b></p> <p><a href="#">hvset_tabular_antiram_cg_single</a></p> <p><a href="#">hvset_tabular_antiram_cg_year1</a></p>

<a href="#">hvset_cg_tabular_map2</a>	<a href="#">hvset_tabular_map2</a>	<a href="#">hvset_tabular_ram_cg_year2</a>	<a href="#">hvset_tabular_antiram_cg_year2</a>
<a href="#">hvset_cg_tabular_map3</a>	<a href="#">hvset_tabular_map3</a>	<a href="#">hvset_tabular_ram_cg_year3</a>	<a href="#">hvset_tabular_antiram_cg_year3</a>
<a href="#">hvset_cg_tabular_map4</a>	<a href="#">hvset_tabular_map4</a>	<a href="#">hvset_tabular_ram_cg_year4</a>	<a href="#">hvset_tabular_antiram_cg_year4</a>
<a href="#">hvset_cg_tabular_map5</a>	<a href="#">hvset_tabular_map5</a>	<a href="#">hvset_tabular_ram_cg_year5</a>	<a href="#">hvset_tabular_antiram_cg_year5</a>
<a href="#">hvset_cg_tabular_map6</a>	<a href="#">hvset_tabular_map6</a>	<a href="#">hvset_tabular_ram_cg_year6</a>	<a href="#">hvset_tabular_antiram_cg_year6</a>
<a href="#">hvset_cg_tabular_map7</a>	<a href="#">hvset_tabular_map7</a>	<a href="#">hvset_tabular_ram_cg_year7</a>	<a href="#">hvset_tabular_antiram_cg_year7</a>
<a href="#">hvset_cg_tabular_map8</a>	<a href="#">hvset_tabular_map8</a>	<b>Without Compton-Getting</b>	<b>Without Compton-Getting</b>
<a href="#">hvset_cg_tabular_map9</a>	<a href="#">hvset_tabular_map9</a>	<a href="#">hvset_tabular_ram_single</a>	<a href="#">hvset_tabular_antiram_single</a>
<a href="#">hvset_cg_tabular_map10</a>	<a href="#">hvset_tabular_map10</a>	<a href="#">hvset_tabular_ram_year1</a>	<a href="#">hvset_tabular_antiram_year1</a>
<a href="#">hvset_cg_tabular_map11</a>	<a href="#">hvset_tabular_map11</a>	<a href="#">hvset_tabular_ram_year2</a>	<a href="#">hvset_tabular_antiram_year2</a>
<a href="#">hvset_cg_tabular_map12</a>	<a href="#">hvset_tabular_map12</a>	<a href="#">hvset_tabular_ram_year3</a>	<a href="#">hvset_tabular_antiram_year3</a>
<a href="#">hvset_cg_tabular_map13</a>	<a href="#">hvset_tabular_map13</a>	<a href="#">hvset_tabular_ram_year4</a>	<a href="#">hvset_tabular_antiram_year4</a>
<a href="#">hvset_cg_tabular_map14</a>	<a href="#">hvset_tabular_map14</a>	<a href="#">hvset_tabular_ram_year5</a>	<a href="#">hvset_tabular_antiram_year5</a>
Note: Survival probability correction procedures are documented in Appendix B in <a href="#">McComas et al. 2017</a> .	Note: Survival probability correction procedures are documented in Appendix B in <a href="#">McComas et al. 2017</a> .	<a href="#">hvset_tabular_ram_year6</a>	<a href="#">hvset_tabular_antiram_year6</a>
		<a href="#">hvset_tabular_ram_year7</a>	<a href="#">hvset_tabular_antiram_year7</a>
		Note: Survival probability correction procedures are documented in Appendix B in	Note: Survival probability correction procedures are documented in Appendix B in

		<a href="#">McComas et al. 2017.</a>	<a href="#">McComas et al. 2017.</a>
<p><b>ENA Maps in Equatorial and Galactic Coordinates</b></p> <p>These maps in equatorial and galactic coordinate systems are for the use of the broader astrophysical community:</p> <p><a href="#">hvset_tabular_ram_equatorial_single</a></p> <p><a href="#">hvset_tabular_antiram_cg_single</a></p> <p>Note: Survival probability correction procedures are documented in Appendix B in <a href="#">McComas et al. 2017.</a></p>			

**All Hi Data Directories**

[All IBEX Hi Data Directories](#)

**IBEX Lo Observing Energetic Neutral Atoms In a Lower Range of Energies**

**Plots and Data Directories**

<p><b>6-month Maps</b></p> <p>These maps represent the data before any corrections are made for speed of spacecraft or survival probability.</p>	<p><b>Survival Probability Lookup Maps</b></p> <p>Survival Probability Maps account for the loss (extinction) of ENAs due to radiation pressure, photoionization and ionization via</p>
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The data directories:

[lvset h single](#)

[lvset h map1](#)

[lvset h map2](#)

[lvset h map3](#)

[lvset h map4](#)

[lvset h map5](#)

[lvset h map6](#)

[lvset h map7](#)

[lvset h map8](#)

[lvset h map9](#)

[lvset h map10](#)

[lvset h map11](#)

[lvset h map12](#)

[lvset h map13](#)

[lvset h map14](#)

charge exchange with solar wind protons.

The data directories:

[lvset h tabular single](#)

[lvset h tabular map1](#)

[lvset h tabular map2](#)

[lvset h tabular map3](#)

[lvset h tabular map4](#)

[lvset h tabular map5](#)

[lvset h tabular map6](#)

[lvset h tabular map7](#)

[lvset h tabular map8](#)

[lvset h tabular map9](#)

[lvset h tabular map10](#)

[lvset h tabular map11](#)

[lvset h tabular map12](#)

[lvset h tabular map13](#)



[lvset h tabular map14](#)

Note: Survival probability correction procedures are documented in Appendix B in [McComas et al. 2017](#).

## All Lo Data Directories

[All IBEX Lo Data Directories](#)

## 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,

$$wt1 = \tau_1 / (\tau_1 + \tau_2 + \tau_3)$$

$$wt2 = \tau_2 / (\tau_1 + \tau_2 + \tau_3)$$

$$wt3 = \tau_3 / (\tau_1 + \tau_2 + \tau_3)$$

Combined fluxes and propagated variances are then determined using:

$$\text{combined\_flux} = \text{flux1} * wt1 + \text{flux2} * wt2 + \text{flux3} * wt3$$

$$\text{combined\_var} = \text{var1} * (wt1)^2 + \text{var2} * (wt2)^2 + \text{var3} * (wt3)^2$$