

## CIPS Level 3a Data: Daily Daisies

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### **1. Introduction**

This document gives a brief overview of the CIPS level 3a data, which are daily PMC maps that are informally referred to as "daily daisies". At the time of this writing, the current level 3a data version is v4.20, revision 05. The level 3a data are provided for qualitative assessments of the global PMC cloudiness on any particular day. A complete description of the algorithms for all data levels is currently in preparation. See Bailey *et al.* [2008], Benze *et al.* [2008; 2011], McClintock *et al.* [2008], Merkel *et al.* [2008], and Rusch *et al.* [2008] for descriptions of the instrument and observation technique, as well as preliminary evaluation and use of the data. The level 3 data are based directly on level 2 data, so users of the level 3a data are strongly encouraged to read the level 2 documentation for information on issues related to data quality ([http://lasp.colorado.edu/aim/cips/data/repository/docs/cips\\_level2.pdf](http://lasp.colorado.edu/aim/cips/data/repository/docs/cips_level2.pdf)).

#### *Level 3a NetCDF files*

One level 3a NetCDF file (~15 MB) is produced for each day; it contains the level 3a cloud albedo (radiance/solar irradiance in units of  $10^{-6} \text{ sr}^{-1}$ ) for that day on a standard latitude/longitude grid with  $25 \text{ km}^2$  resolution. Table 1 at the end of this document defines the variables in the level 3a data files. Note that the individual NetCDF files do not contain the actual latitude/longitude grid points; rather, they contain bounding box information that enables calculation of the grid. IDL users can download the "read\_cips\_file" read tool for the NetCDF files, which incorporates the latitude/longitude calculation. Users of other software tools should download separate NetCDF files with the latitude/longitude grid points (one file per hemisphere; the grid is constant with time). All data files and read tools are available at <http://lasp.colorado.edu/aim/download-data.html>.

The v4.20 daisies are made by combining the measured albedo values from all of the individual orbit strips (level 2 data) on a given day into a single image covering the summer polar region. Where pixels from different orbits overlap, which occurs poleward of about  $75^\circ$  latitude in each hemisphere, the brightest pixel (not the average) is used unless the data quality flags (QF – see the level 2 documentation) of the overlapping pixels are different. If the QF values are different, the pixel with the lowest (best) QF value is used. Note also that both the ascending and descending node data are combined in the level 3 data product, so local times are not meaningful.

The decisions to use the brightest of overlapping points and to combine data from both nodes were made with the philosophy that the level 3a data are intended for qualitative use. These data quickly show users where PMCs are present each day, provide an overall morphology on any given day, and show how PMCs change over the season. Users interested in diurnal variations or any other quantitative analysis are encouraged to use the CIPS level 2 data (note, however, that at the current time, as described in the level 2 documentation, there are some uncertainties regarding possible ascending/descending node biases).

Just as in the level 2 data, the level 3a cloud albedos that are reported are normalized to a nadir ( $0^\circ$ ) view angle and  $90^\circ$  scattering angle. The view angle correction is accomplished by removing the  $\sec(\theta)$  geometry factor to account for the view angle dependence in path length (where  $\theta$ , the

view angle, is the angle between the satellite and zenith directions, as measured from the scattering volume). The scattering angle correction is accomplished by obtaining the best fit of the observed phase function (albedo vs. scattering angle) to a set of assumed scattering phase functions that are constrained by lidar data. Here we make the assumptions that the ice particles have an axial ratio of 2 and a distribution width that varies approximately as  $0.5 \times \text{radius}$ . The albedo at  $90^\circ$  scattering angle from that best fit is the value to which the view angle correction is applied. (See more description in the level 2 algorithm document; also see Hervig *et al.* [2009] and Baumgarten *et al.* [2010]).

Users should also be aware of the data screening applied to the level 3a data. The albedo for any measurement with  $QF > 1$  (see the level 2 documentation) is set to zero. As illustrated below, this results in sharp transitions between zero and positive albedo values at the cross-track edges of the individual orbit strips, which gives rise to a characteristic pattern in maps of the cloud albedo.

#### *Level 3a png files*

In addition to the NetCDF files with the numerical data, one png file ( $< 1\text{MB}$ ) is produced for each day; this png file shows a polar projection map of the cloud albedo using a blue/white color scale. These files are produced primarily as a "quick-look" or "browse" data product. Each individual png file map uses a color scale appropriate for that day. The scale is defined with a lower threshold of  $2 \times 10^{-6} \text{sr}^{-1}$  (note that while the png files do not show albedo values less than this threshold, all data are included in the NetCDF files). The upper threshold is set at a value of  $m + 2\sigma + 2 \times 10^{-5} \text{sr}^{-1}$ , where  $m$  is the median of the distribution of albedo measurements on that day, and  $\sigma$  is the standard deviation. Since these color scales change from day to day, it is not appropriate to use the level 3a png files to compare cloud brightness from one day to the next. For that purpose, the level 3a NetCDF files (or the level 2 data) should be used. At the current time the png file maps employ a low-latitude cut-off of  $50^\circ$ .

#### *Level 3b Data*

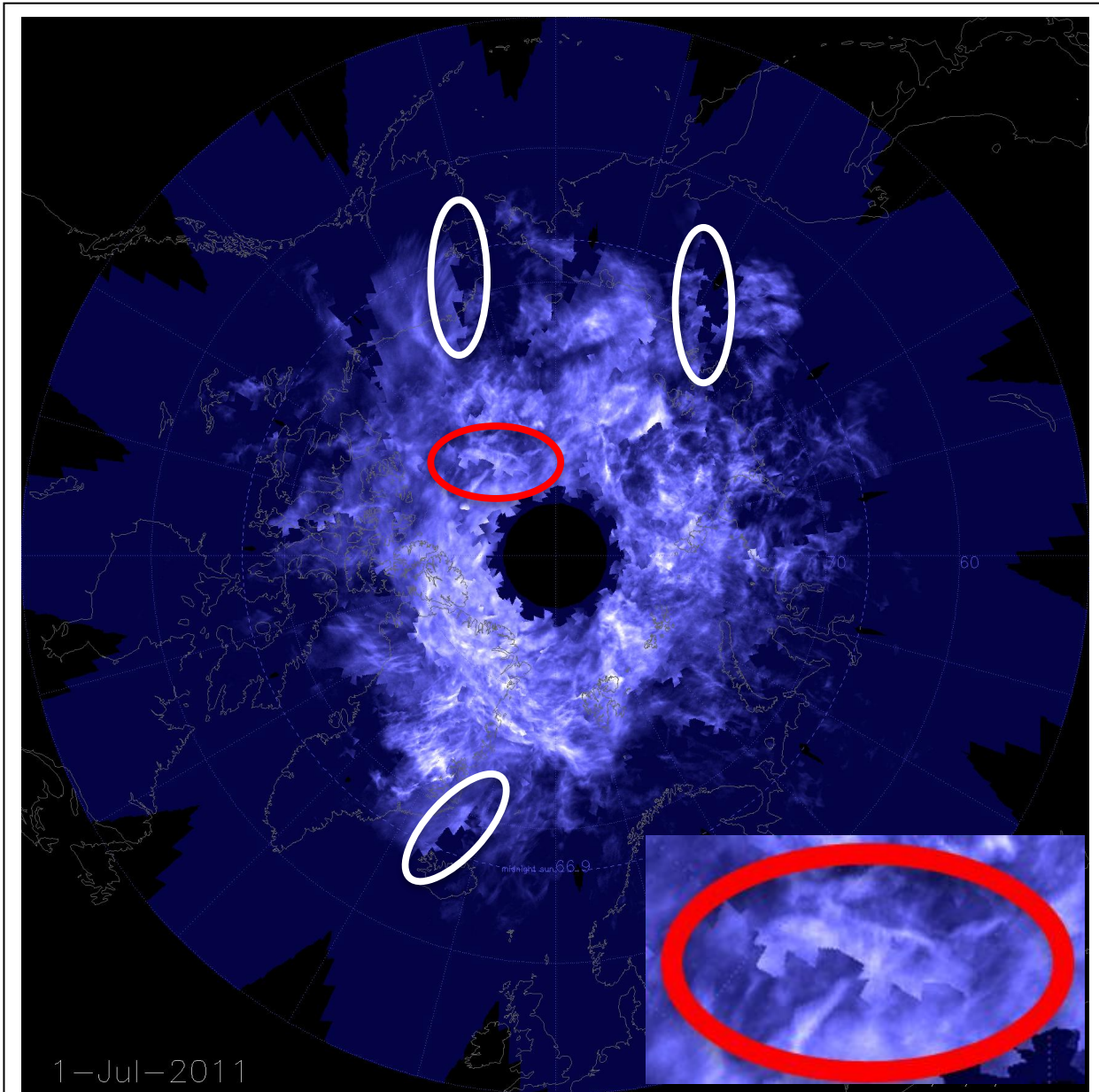
The CIPS level 3b data product consists of seasonal movies of the daily daisies. In contrast to the level 3a png files the movies use a single color scale for all days so that they can be compared to one another. This color scale uses a lower bound of  $2 \times 10^{-6} \text{sr}^{-1}$ , and an upper bound that is based on the entire data set for the season. Thus variations in image brightness in the movies, whether from day to day or over the course of a season, represent real changes in PMC brightness.

## **II. Daily Daisy Maps**

In this section we show examples of the daily daisies to illustrate normal behavior as well as some anomalies. The level 2 documentation describes a number of artifacts that appear in the CIPS level 2 orbit strip images; these of course will also appear in the daisy maps, and are thus not repeated entirely here. There are a few characteristics that are worth emphasizing, so we highlight these here.

### *"Normal" Daisy*

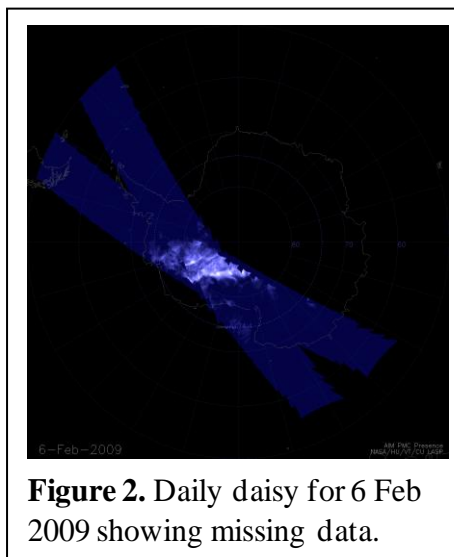
Figure 1 shows an example of a daisy that we consider to be "normal"; i.e., lacking in any obvious artifacts. This daisy is for 1 July 2011. The dark blue background shows the locations that CIPS observed on this day (regardless of QF value); black areas represent no data. Relative cloud brightness is represented by different shades of blue, ranging from the dimmest clouds in dark blue to the brightest in white. There is a wealth of structure in the clouds on this day, most of which is geophysical. The white ovals show clearly defined patterns that represent the edges



**Figure 1.** Level 3a "daily daisy" for 1 July 2011. White ovals highlight patterns that define the edges of regions in individual orbits where  $QF < 2$ . The inset shows a magnified version of the region on the full daisy marked by the red oval to highlight the expected behavior when PMCs change from one orbit to the next.

separating regions in individual orbits where  $QF = 0$  or  $1$  (included in level 3a) and  $QF = 2$  (for which the cloud albedo is defined to be zero in level 3a; these regions are thus included in the dark blue background). Clouds were likely present in the dark blue regions surrounding these edges; i.e., there was probably not an actual edge to the clouds as shown here.

The red oval in Figure 1 highlights a characteristic that is common to most of the daisies. Inside the oval there is a noticeable pattern that looks somewhat like the edges of jigsaw puzzle pieces. This results from the fact that clouds change from orbit to orbit and does *not* indicate an error in the retrievals. The jigsaw puzzle shape is simply the outline of the locations at the edge of an orbit strip beyond which  $QF > 1$ . Since PMCs will often change during the ~90 minutes between orbits, the same geographic location can be brighter or dimmer on successive orbits, depending on the changes that occur. Thus it is expected that at the edges of orbits, the data from one orbit to the next will not merge smoothly. This characteristic is enhanced by the decision to include the brightest, rather than the average, of the overlapping pixels. However, using the brightest pixel maximizes the number of clouds that are plotted (since using the average will, for the dimmest clouds, result in albedo values below the lower plotting threshold).



#### *Missing Data*

Some daisies are missing individual images or even entire orbits, leading to large black areas in the maps. Missing data can occur because of a number of reasons, including downlink issues, calibration issues and satellite pointing errors. Figure 2 shows an example of missing data on 6 February 2009. In this case, AIM went into a safe hold after getting only 2 orbits on this date.

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**Table 1.** Variables in the CIPS level 3a data files. Fill value is NaN.

Variable Name	Units	Type/Dimension	Description / Example*
Latitude	Degrees	Double / [xdim,ydim]	Latitude of each grid point, where xdim and ydim are the number of grid points in the (arbitrary) x and y directions. Same for all daisies. / [1953,1953], range: 24.52 to 90.0
Longitude	Degrees	Double / [xdim,ydim]	Longitude of each grid point, where xdim and ydim are the number of grid points in the (arbitrary) x and y directions. Same for all daisies. / [1953,1953], range: -180.0 to 179.94
UT_Date	yyyymmdd	Long / 1	UT Date / 20100702
Version		String / 1	Retrieval version number / 04.20
Product_Creation_Time	yyyy/doy-hh:mm:ss	String / 1	String containing UT time at which data file was produced / 2011/042-22:26:35
Dependent2a Version		Byte / [norbits]	Version of lower level 2 data used to produce this data set. One value per orbit (Each orbit forms a "petal" in the daisy.) / Byte array of 15 elements, all equal to 4.
Hemisphere		String / 1	N (north) or S (south) / N
Center_Longitude	Degrees	Float / 1	Center longitude of the grid / 4.15392
Petal_Start_Time	microseconds	Double / 1	GPS start time of each orbit (microseconds from 0000 UT on 6 Jan 1980) / [15], range: 9.6206507e14 to 9.6214616e14
First_image_start	microseconds	Float / 1	GPS start time of first orbit (seconds from 0000 UT on 6 Jan 1980); redundant with first element in petal_start_time, but floating point / 9.62065e+014
Km_Per_Pixel	km	Float / 1	Linear dimension of square pixel occupying area of CIPS resolution element / 5
BBox	Index	Long / [4]	Bounding Box: Bottom-Left and Top-Right indices of the smallest rectangle which both circumscribes a set of cells on a grid and is parallel to the grid axes / [300, 300, 2252, 2252]
Orbit_Numbers		Integer / [norbits]	Number of each orbit / [15], range: 17344 to 17358
Quality_Flags		Byte / [xdim,ydim]	Indicator of data quality. For each pixel, this is the QF value of the data point plotted. In v4.20 QF is determined by NLayers as follows: NLayers > 5, QF=0. NLayers = 4 or 5, QF=1.

			NLayers < 4, QF=2. For level 3a only valid data with QF = 0 or 1 are selected. All other pixels have the default value 255/ [1953,1953], range: 0 to 255.
<b>Albedo</b>	$10^{-6} \text{ sr}^{-1}$	Float / [xdim,ydim]	Cloud albedo / [1953,1953], range: 0.0 to 68.45
<b>Delta_Flat_File</b>		String / 1	Name of the data file containing calibration information. Currently null in publicly available data.
<b>Delta_Flat_Normalization_PX</b>		Float / 1	Normalization factor for PX camera. Currently set to 0 in publicly available data.
<b>Delta_Flat_Normalization_PY</b>		Float / 1	Normalization factor for PY camera. Currently set to 0 in publicly available data.
<b>Delta_Flat_Normalization_MX</b>		Float / 1	Normalization factor for MX camera. Currently set to 0 in publicly available data.
<b>Delta_Flat_Normalization_MY</b>		Float / 1	Normalization factor for MY camera. Currently set to 0 in publicly available data.

\* Examples are from cips\_sci\_3a\_2010-183\_v04.20\_r04.nc.

## References

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