CIPS Level 3e Ground Station Summary Files

Last Updated May 2020

I. Introduction

This document describes the contents of the CIPS Level 3e data files, otherwise known as the ground station summary files. It is intended to provide the user with information on the construction of this data product and guidance in interpreting the contents of the CIPS 3e files. These files are designed as a convenient way for users to access CIPS Level 2 data that is spatially coincident with a specific ground station location throughout the season. The CIPS Level 3e data are pulled directly from the Level 2 NetCDF data files, with no additional processing being done on the data. They contain Level 2 retrieval products and associated auxiliary data for a subset of pixels overlapping a particular station, as defined by the coincidence criteria for that station (see description below). Each 3e file contains data corresponding to a single ground station over an entire PMC season. The file format is ASCII text. Level 2 data for each orbit are screened for all pixels that satisfy the desired coincidence criteria; only orbits containing coincident CIPS measurements are included in the Level 3e file.

Table 1 contains a list of all the ground stations currently being tracked, along with the latitude and longitude coordinates of the station and a description of the coincidence criteria used for that station. Two distinct types of coincidence criteria are used in constructing the 3e product. The most common coincidence definition (Type 0) uses a simple fixed geographical distance from the station location. The maximum distance can in principle vary from station to station but currently all are set to 100 km. The second coincidence definition (Type 1) uses a fixed reference coincidence region, defined by set latitude/longitude ranges. These boundaries may or may not contain the actual ground station location, but are constructed to encompass the known ground-based observation space. This type of criterion is used for ground observations that are not looking directly in the zenith, the most common example being ground-based photography of noctilucent clouds where the camera is typically pointed towards the horizon. There are 22 stations in total, 18 of which are in the Northern Hemisphere (NH) and 4 in the Southern Hemisphere (SH). Figure 1 shows the location of the stations in each hemisphere.

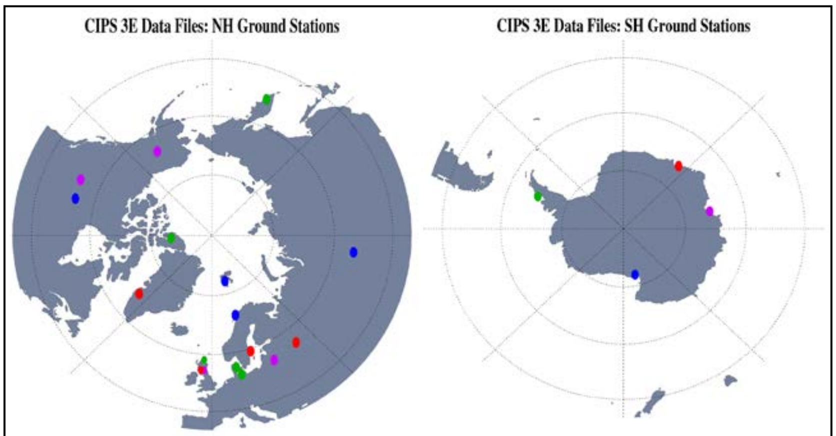

Figure 1. Location of all ground stations for which a 3e file is produced. NH (SH) stations are in the left (right) panels.

Table 2 contains a description of the variables contained in the 3e files. These quantities are provided for each CIPS orbit included in the file. The complete file contains all orbits in the season for which coincident measurements exist. There are essentially two types of information included for each orbit. A single summary line contains definitive information about the orbit, including AIM orbit number, date, time, number of coincident pixels, cloud fraction in the coincidence space, and so forth. Also included in this line are mean cloud parameters (albedo, radius, ice water content and cloud fraction) averaged over all pixels within a 500-km radius of the station. This is meant to give the user additional information about the morphology of the cloud field in the larger general vicinity of the station. (Note that we do not calculate mean cloud parameters for the coincident pixels themselves, but leave that to the user, who may want to apply their own data screening to this averaging process – see hints below). Following this summary line are multiple lines containing detailed information about each coincident pixel, including geolocation information and the CIPS Level 2 cloud parameter retrievals. A default value of 0.0 for the cloud parameters is used to indicate that no cloud is present. Each file contains an extensive header that includes the station name, location, coincidence criteria used and a complete description of the data variables in the file (essentially reproducing the information in Table 2).

Users are strongly encouraged to read the Level 2 data product documentation for a description of the Level 2 products and guidance in their interpretation. One data quality issue involves cloud pixels where a particle radius less than 20 nm is retrieved. As discussed in the Level 2 documentation, there are strong physical arguments why CIPS should not be sensitive to particles this small, and therefore these retrievals are thought to be erroneous, probably due to errors in the background Rayleigh subtraction. Because the retrieved particle radius and ice water content (IWC) are considered unreliable for these pixels, they are screened in the Level 3e summary file. The CLD_MAP value (see Table 2) remains at 1 for these pixels, indicating credible cloud detection, however the radius and IWC values are set to a default -999. Note that this is consistent with the data screening employed in the CIPS Level 3c latitude-binned summary files.

II. Sample results

In this section we show sample results of CIPS coincident data for two ground stations in the NH 2010 season. These two stations were chosen because they represent the two different types of coincidence criteria described above. Figure 2 illustrates CIPS coincidences with the Alomar station (Station #1) for a single orbit on July 8 2010. The small, solid black circle indicates the ground station location. The grey shaded area represents all CIPS Level 2 pixels for this orbit (within the limited range of this plot – obviously the orbit swath extends much farther both north and south of this range). The green area represents the CIPS pixels within the 100-km coincidence criterion for this station, whereas the blue pixels indicate the larger 500-km radius used to calculate the average cloud parameters surrounding the coincident measurements (see Table 2). All CIPS pixels for which clouds were detected are colored red, to give an idea of the cloud morphology on this orbit. The

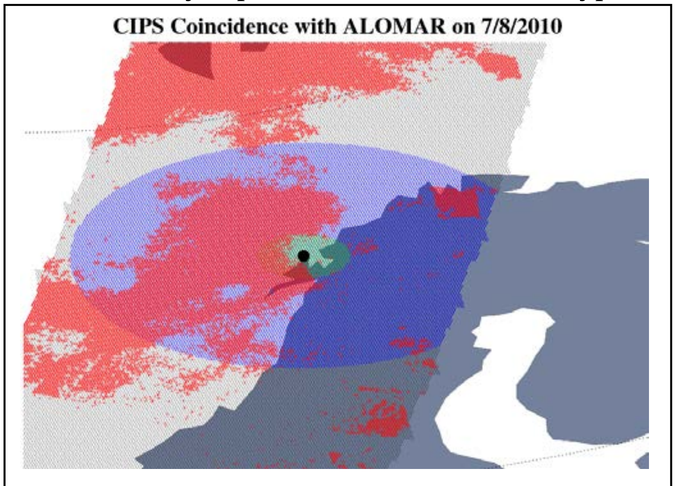

Figure 2. Example of the CIPS sampling for a coincidence with the Alomar station in 2010. The station location is represented by the black dot. Background grey pixelated area shows all CIPS level 2 pixels for this section of the orbit, with cloud pixels shown in red. The green (blue) areas show pixels within 100 km (500 km) of the station.

cloud fraction detected by CIPS within the coincidence region is 40.2% (and a slightly smaller 36.4% within the 500-km region).

This example is typical for stations using the 100-km coincidence criteria (Type 0) when the coincidence area is fully contained within the CIPS orbit swath. (The resolution of the CIPS v5 Level 2 pixels is 56 km^2, so a 100-km radius area should contain $\pi \bullet 100^2/56 \approx 560$ pixels.) This particular example is an optimal coincidence in that the station is close to the center of the CIPS orbit swath. Figure 3 illustrates the distribution of the number of pixels (NPIX) in the coincidence area for this station over the entire 2010 PMC season. This figure was made with v4 data, for which the pixel size was 25 km^2, so the # of coincident pixels per orbit (independent variable) should be multiplied by 25/56 to arrive at the corresponding values for v5 data. Note that all NPIX values up to the maximum allowable (~1,250 for v4; ~560 for v5) are represented in the distribution, but by far the most common occurrence (> 60% of all orbits) is when the full coincidence space is sampled.

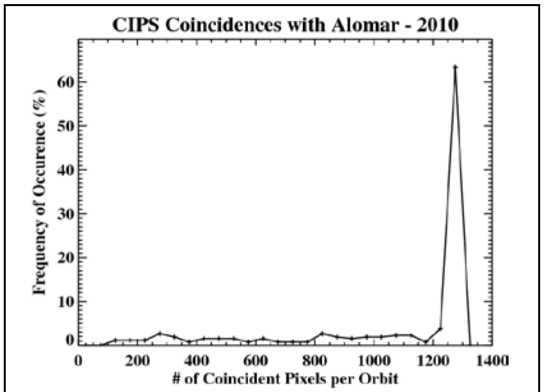

Figure 3. Distribution (occurrence frequency) of the NPIX parameter (number of coincident pixels per orbit) for the Alomar station in the 2010 season.

Finally, Figure 4 provides an example of the CIPS sampling characteristics that can occur for ground stations with the Type=1 coincidence criterion. This plot illustrates a coincidence with the MISU station in Stockholm on July 26, 2010. The meaning of the different colored pixels is the same as for Figure 2. Here we can see visually how the defined coincidence area (green) is offset from the actual ground station location. In this case it is shifted to the north and west, as the ground-based camera is pointed north, towards higher latitudes, and west to observed noctilucent clouds at sunset. Another important characteristic of the Type 1 coincidence criterion is that the defined coincidence area is generally much larger than the 100-km radius used for Type 0 stations. Thus they will on average contain far more CIPS pixels, assuming they are largely contained within the orbit swath. Note also that the coincidence area need not be contained entirely within the standard 500-km loose criterion radius. In this particular case the CIPS cloud fraction within the coincidence region is 9.7% and within the 500-km radius is only 2.5%.

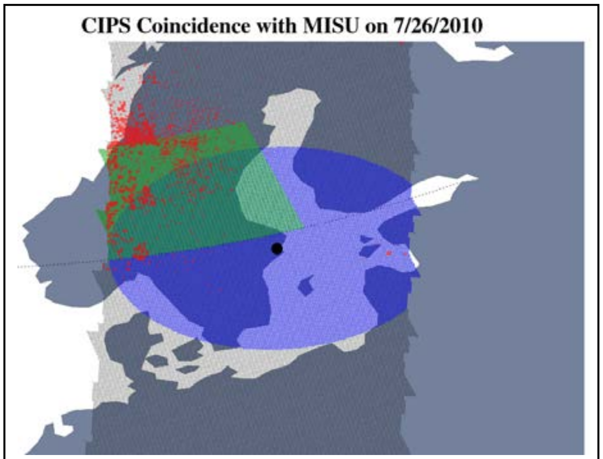

Figure 4. Same as Figure 2, but for a coincidence with the MISU station (Stockholm) on July 26, 2010. In this case, instead of the coincidence region (green) being defined as within 100 km of the station, it is defined by a set latitude/longitude range according to the ground station camera field of view.

Table 1. CIPS Level 3e ground station list.

#	Name	Latitude	Longitude	Coincidence Type	Max Distance (type=0)	Latitude Range (type=1)	Longitude Range (type=1)
1	**Alomar**	69.278	16.009	0	100		
2	**IAP**	54.117	11.772	0	100		
3	**SvalSat**	78.230	15.395	0	100		
4	**Sondrestrom**	66.997	-50.615	0	100		
5	**Poker Flat**	65.117	-147.461	0	100		
6	**Eureka**	80.00	-86.25	0	100		
7	**Davis**	-68.574	77.976	0	100		
8	**Rothera**	-67.568	-68.123	0	100		
9	**McMurdo**	-77.847	166.671	0	100		
10	**Syowa**	-69.000	39.583	0	100		
11	**Andoya**	69.294	16.020	0	100		
12	**MISU**	59.365	18.058	1		[60,65]	[8,20]
13	**Royal**	55.920	-3.190	0	100		
14	**Thurso**	58.600	-3.530	0	100		
15	**La Ronge**	55.1	-105.3	0	100		
16	**Port**	55.93	-4.68	1		[56,61]	[-15,-2]
17	**Athabasca**	54.73	-113.32	1		[56,61]	[-124,-
18	**Kamchatka**	53.07	158.62	1		[56,61]	[148,161]
19	**Novosibirsk**	54.87	83.10	1		[56,61]	[73,85]
20	**Moscow**	56.00	37.48	1		[56,61]	[27,40]
21	**Vilnius**	55.00	26.00	1		[56,61]	[16,28]
22	**Aarhus**	56.17	10.20	1		[56,61]	[0,12]

Table 2. Definition of variables in CIPS Level 3e Ground Station summary file (per orbit).

Variable Name	Units	Type/Dimension	Description
ORBIT	NA	INTEGER/SCALAR	AIM orbit number
DATE	NA	LONG/SCALAR	Date in YYYYMMDD format
UT	Hours	REAL/SCALAR	Mean UT time of coincident measurements
LTIME	Hours	REAL/SCALAR	Mean local time of coincident measurements
NPIX	NA	INTEGER/SCALAR	Number of coincident pixels.
NCLD	NA	INTEGER/SCALAR	Number of pixels where ice is detected.
CLD_PRES	NA	INTEGER/SCALAR	PMC present anywhere in the coincident pixels (0=no, 1=yes)
CLD_FRAC	%	REAL/SCALAR	Fraction of coincident pixels containing ice. [0.,1.]
ALB_LOOSE	10^{-6} sr^{-1}	REAL/SCALAR	Median albedo within 500 km of station (cloud pixels only)
RAD_LOOSE	nm	REAL/SCALAR	Median particle radius within 500 km of station (cloud pixels only)
IWC_LOOSE	g/km^2	REAL/SCALAR	Median ice water content within 500 km of station (cloud pixels only)
FRAC_LOOSE	%	REAL/SCALAR	Cloud fraction within 500 km of station.
LAT	Degrees	REAL(NPIX)	Latitude of each pixel. [-90,90]
LON	Degrees	REAL(NPIX)	Longitude of each pixel. [0,360]
SZA	Degrees	REAL(NPIX)	Solar zenith angle of each pixel.
DIST	km	REAL(NPIX)	Distance of each pixel from ground station location.
RADIUS	nm	REAL(NPIX)	Retrieved particle mode radius in each pixel (if cld_map = 1)
ALBEDO	10^{-6} sr^{-1}	REAL(NPIX)	Retrieved cloud albedo in each pixel (if cld_map = 1)
IWC	g/km^2	REAL(NPIX)	Retrieved cloud ice water content in each pixel (if cld_map = 1)
AIR ALBEDO	10^{-6} sr^{-1}	REAL(NPIX)	Cloud albedo in each pixel (if cld_map = 1) derived from AIR analysis (Thomas et al., 2018)
AIR IWC	g/km^2	REAL(NPIX)	Ice water content in each pixel (if cld_map = 1) derived from AIR analysis (Thomas et al., 2018)
QF	NA	INTEGER(NPIX)	Level 2 QUALITY_FLAG value for each pixel. Indicative of data quality (see Level 2 documentation).
CLD_MAP	NA	INTEGER(NPIX)	Identifies cloud pixels (1 = cloud, 0 = no cloud)

References:

Thomas, G., C. E. Randall, J. D. Lumpe, and C. Bardeen (2019). Albedo-Ice regression method for determining ice water content of Polar Mesospheric Clouds using ultraviolet observations from space, *Atmospheric Measurement Techniques*, 12, 1755-1766, doi:10.5194/amt-12-1755-2019.

Created by Jerry Lumpe 30 May 2012