CIPS Level 1a Data

Last Updated 2 May 2011

I. Introduction

CIPS data are currently being released as version 4.20 for all data levels; the previously released version was 3.20. The largest changes in going from v3.20 to v4.20 occurred in the level 2 retrieval algorithms, and are thus not relevant to this level 1a document. The main change to the level 1a data was an improved calibration. The v4.20 level 1a processing codes implement a new algorithm for characterizing and removing the dark count background in the data, and for calculating the camera-to-camera normalization.

CIPS Level 1a data are calibrated and geolocated registered images. Image spikes have been removed, and the data have been converted to albedo (observed radiance divided by solar irradiance, in units of 10^{-6} sr^{-1}). The calibration process includes corrections for detector dark current, flat field, electrical offset, nonlinearity and degradation, and intensifier gain and temperature (see calibration documentation). Each nadir pixel in a level 1a file is ~2 km^2; pixel sizes increase to ~15 km^2 toward the leading edge of the sunward ("PX") camera and trailing edge of the anti-sunward ("MX") camera [McClintock et al., 2009]. Four level 1a files are saved per orbit (one per camera). The level 1a data are not a publicly released product. At this point, users should read this document to understand the extent to which the CIPS level 1a data have been evaluated, and to become aware of issues that might propagate into the higher-level science data products.

The CIPS team has developed a method by which PMC presence is detected in level 1a data with a procedure similar to that used for the Solar Backscatter Ultraviolet (SBUV) instruments [DeLand et al., 2003; 2006]. A description of the SBUV-type algorithm as applied to CIPS can be found in Benze et al. [2009; 2011]. This technique allows us to evaluate the CIPS data by direct comparison with SBUV data. Here we summarize some of the main results.

The SBUV (which is taken here to include SBUV/2) instruments measure back-scattering with a 150-km^2 nadir field of view. For comparison, we have identified PMCs in CIPS data by applying the SBUV-type PMC detection algorithm described by DeLand et al. [2003; 3006] to a 150-km^2 footprint in the CIPS "PY" nadir camera. Figure 1 shows the results of this comparison for the NH 2007 & 2008 as well as SH 2007-2008 and 2008-2009 seasons, for both version 3.20 (top) and 4.20 (bottom). The figure compares daily CIPS cloud frequency and mean cloud albedo, as well as mean background (Rayleigh scattering) albedo to coincident SBUV measurements of these parameters. Details of the comparisons for v3.20 can be found in Benze *et al.* [2011]. Figure 1 shows that the fundamental CIPS measurements of cloud frequency and albedo are robust, and that the v4.20 changes had only a small influence on the level 1a data.

The comparison of the Rayleigh scattering background albedo in Figure 1 shows a systematic bias that depends on hemisphere: in the NH the background albedo from CIPS is lower than from SBUV; in the SH the CIPS background albedo is higher than from SBUV. This is true for both versions 3.20 and 4.20, but there are small differences between the versions. In particular, the background albedo in v4.20 is systematically lower than in v3.20, so that on average the magnitude of the differences with respect to SBUV are now larger (more negative) in the NH

and smaller in the SH. At the current time, this hemisphere-dependent bias is not completely understood. Differences between the CIPS and SBUV orbit geometry likely play a role because the two instruments sample slightly different solar zenith angles (SZAs). Even after accounting for this difference, however, a small discrepancy in the background albedo measurements persists. Understanding the source of this discrepancy is a topic of future research.

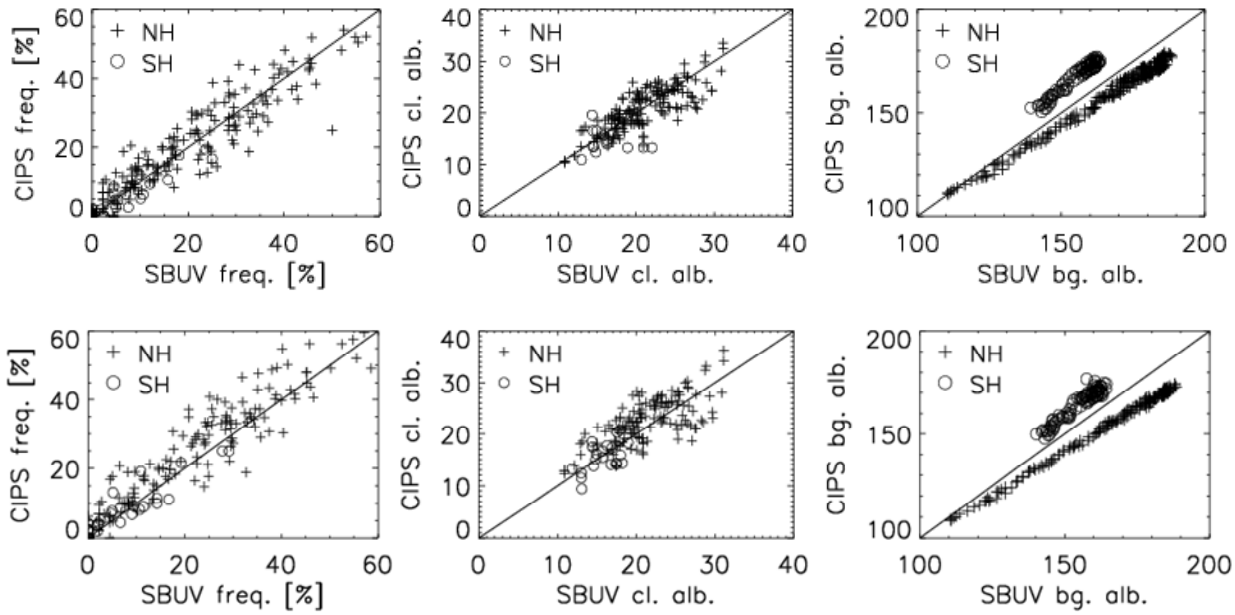

Figure 1*: Scatter plots of coincidence results for NH 2007 to SH 2008 in the NH (plus symbols) and in the SH (open circles) for CIPS version 3.20 (top, from Benze et al. [2011]) and version 4.20 (bottom). Left: occurrence frequency; middle: cloud albedo; right: background albedo. Albedo units are 10^{-6} sr^{-1}. Coincidences are found at latitudes of 80° ± 3° in both descending and ascending node data.*

II. Cautions for the User

While the comparisons in Figure 1 show excellent agreement, there are issues with the data of which users should be aware, and which are currently under investigation.

"Sawtooth" Feature

In principle, the SBUV-type algorithm can be applied to CIPS data at its native resolution, enabling us to use level 1a data to detect clouds with smaller extent than is possible with the 150-km^2 footprint. This high resolution, level 1a analysis is currently compromised, however, by what we call a "sawtooth" feature in the images. The origin of this feature is described in the calibration documentation that is also posted on the web site, and is related to an apparent slope in sensitivity across each camera that we do not yet understand. We describe here how this feature is manifested in the SBUV-type analysis of level 1a data. As mentioned below, although this feature is present in both v3.20 and v4.20 level 1a data, improvements to the level 2 v4.20 cloud retrieval algorithm mitigate its effects on the level 2 cloud products.

To illustrate the "sawtooth" feature, Figure 2 shows v3.20 and v4.20 NH data from the PY camera for all 24 images acquired during a single orbit on 24 May 2007; note that there is very

little difference between the versions. Only data points with view angles between 21° and 22° are included, because the SBUV-type analysis can only be applied to a narrow range of view angles at one time. May 24 is before the start of the NH 2007 season, so no clouds should be detected. There is a systematic variation in albedo over each image, which we refer to as the "sawtooth" effect; it is present in both v3.20 and v4.20. The right hand side of Figure 2 shows the result when a 4th order polynomial is fit to this pre-season, full resolution data. Black and red colors distinguish between points that are identified as non-cloud and (false) cloud points, respectively; the green line is the 4th order polynomial. The red false cloud detections are emphasized by a larger symbol size. Clearly, on this pre-season day, the tips of the "sawteeth" are falsely detected as clouds. Whereas these false cloud detections could be avoided by using a higher detection threshold, this would lead to underestimating actual cloud occurrences during the season. For this reason the SBUV-type analysis of full resolution data using all pixels in one or several cameras has been put on hold for now.

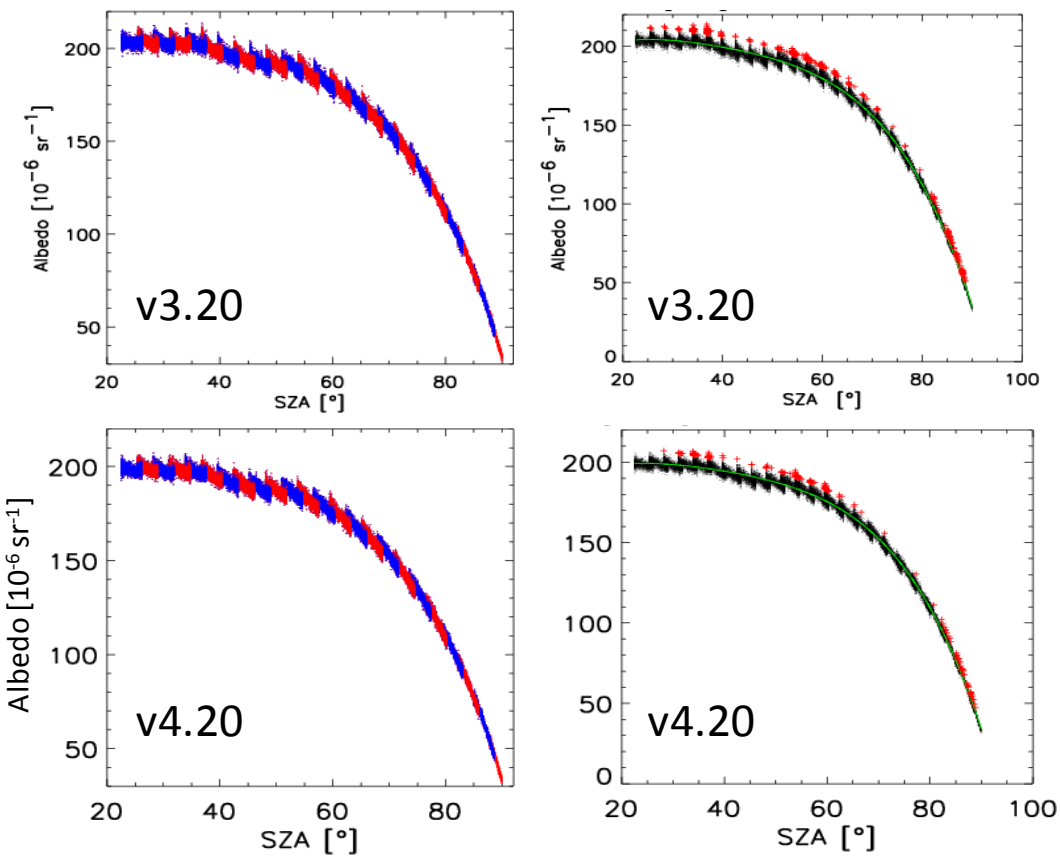

Figure 2*: Illustration of the "sawtooth" feature in v3.20 (top) and v4.20 (bottom). Left: Albedo vs. SZA for view angles between 21° and 22° from 24 May 2007, orbit 423, for every 20th point in the PY camera. Adjacent images are separated by red and blue colors. Right: Same as left, but adjacent images are not colored differently. Red denotes points that are incorrectly detected as clouds after applying an SBUV-type analysis to the high resolution data; the green line is the 4th order polynomial fit to the Rayleigh background. For clarity, false cloud points are plotted with a larger symbol size than non-cloud points (black). Note that the "clouds" are simply the tips of the sawteeth.*

As noted above, the level 2 retrieval algorithm has been improved so that v4.20 level 2 data will not be significantly affected by the sawtooth feature. This is because, unlike in v3.20, the level 2 retrieval algorithm performs the background Rayleigh removal by binning data in 0.25-degree SZA bins. Because this bin size is significantly finer than the "sawtooth" structure, the artifact is mapped into the retrieved C/σ background parameters and effectively removed from the data. See the level 2 data and algorithm documentation for more details.

Miscellaneous Issues

A number of small issues can occasionally affect the data if not flagged properly. For instance, on day 26 of 2008 there was a solar eclipse, which led to anomalously low albedo values. Immediately after a safehold, the spacecraft can come back up pointing in the opposite hemisphere, so it is prudent to always check the latitudes. There are also occasional spikes (low and high) in albedo that are unexplained but clearly anomalous, and sometimes anomalously low albedo values at low SZA that are also currently unexplained. For these reasons, users are encouraged to inform the CIPS team if anything peculiar appears in the higher level science data, since it may reflect issues with the lower level products that have not yet been flagged.

References

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