P4.23

INTRODUCING THE GOES IMAGER CLEAR-SKY BRIGHTNESS TEMPERATURE (CSBT) PRODUCT

Anthony J. Schreiner *
Cooperative Institute for Meteorological Satellite Studies (CIMSS)
University of Wisconsin-Madison
Madison, WI

Timothy J. Schmit
NOAA/NESDIS, Office of Research and Applications, Advanced Satellite Products Team (ASPT)
Madison, WI

Christina Köpken
ECMWF (European Centre for Medium-Range Weather Forecasts)

Xiujuan Su
NCEP/EMC (Environmental Modeling Center)

Curtis Holland
NOAA/NESDIS, Office of Satellite Data Processing and Distribution
Camp Springs, MD

James A. Jung
Cooperative Institute for Meteorological Satellite Studies (CIMSS)

1. INTRODUCTION

Since November 2001 the Cooperative Institute for Meteorological Satellite Studies (CIMSS) has been determining Clear Sky Brightness Temperature (CSBT) information from the Geostationary Operational Environmental Satellite (GOES) –8 & -10 Imagers. These observed data are provided to the National Center for Environmental Prediction (NCEP) in Washington, D.C. and the European Centre for Medium-range Weather Forecasts (ECMWF) in England for assimilation into global weather prediction models. In order to take advantage of the diurnal capabilities of a geostationary platform, processing frequency is hourly and coverage is hemispheric. The goal is for this product to compliment the water vapor CSBT product from the European Meteorological Satellite (Meteosat) produced by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and assimilated operationally at ECMWF (Köpken et al., 2002).

2. DATA

Coverage for the CSBT extends from roughly 67S to 67N and 30W to 165E. The data are averaged over boxes of approximately 50 km. Each box consists of 187 (eleven rows by 17 columns) fields-of-view (fov's). For a given box a cloud detection algorithm (Schreiner et al, 2001) is used. This clear/cloudy mechanism is based on comparisons to brightness temperatures with its neighbors and surface information provided by hourly observations where available, the NCEP Global Forecast System (GFS) model numerical forecasts, and remotely sensed sea surface temperatures based on Advanced Very High Resolution Radiometer (AVHRR) observations.

For each 50 km box the average brightness temperature for each infrared (IR) band and the albedo for the visible band are calculated along with the average clear and cloudy brightness temperatures. Additional parameters are the number of clear and cloudy fov's, center latitude and longitude of the box, center local zenith and solar zenith angles of the box, land/sea

* *Corresonding author address:* Anthony J. Schreiner, Cooperative Institute for Meteorological Satellite Studies (CIMSS), University of Wisconsin-Madison, Madison, WI 53706; e-mail: Tony.Schreiner@ssec.wisc.edu

flag, standard deviation of the average clear and cloudy brightness temperatures, and two quality indicator flags. The quality indicator flags provide information on the likelihood of a particular observation being affected by sun glint and the relative quality of the Sea Surface Temperature observation. Processing is performed using the Man computer Interactive Access System (McIDAS) system (Young et al, 1998) and the output information is then transferred from a McIDAS Meteorological Data (MD) file into a Binary Universal FoRm (BUFR) file. Data have been produced near continuously since 24 October 2001 and are available via anonymous file transfer protocol (ftp). Data latency is generally 1.0 to 1.5 hours.

Besides the averaged output data, single fov information is also generated in the form of a McIDAS area file. Figure 1 is a composite image of the GOES-8 & -10 Imager for the 11.0 µm (Long Wave Window) band for 23 September 2002 at 18 UTC. Figure 2 is a CSBT single fov output image for the 11.0 µm (Long Wave Window) band for the GOES Imager. It is for the same day and time as Figure 1. The yellow to red colored portion of Figure 2 shows the clear fov brightness temperatures. The "gray mask" denotes the cloudy fov's. This single fov product can be useful in determining the effectiveness of the cloud detection algorithm. Figure 3 is a histogram of clear brightness temperatures of the 11.0 µm band for one twenty-four hour period (23 September 2002). It is a pictorial display of Table 1.

These averaged CSBT are currently being collected, decoded, evaluated, and for limited cases are being experimentally assimilated into global numerical weather prediction models. ECMWF and NCEP performed a preliminary evaluation of the GOES Imager CSBT and found the water vapor channel (band 3, 6.7 um) to be of good quality. Additional quality control tests by NCEP of the averaged CSBT for the infrared surface bands (band 2, 3.9 µm; band 4, 11.0 µm; band 5, 12.0 µm) indicated some deficiencies in the cloud detection algorithm. One example demonstrated how incorrectly identified clear fov's were slipping through, when in fact they were actually cloudy. This deficiency was remedied and the improved data versions were first made available on 1 July 2002. NCEP noted that quality of the "improved data" for the IR Window bands were change for the better.

Table 1. Frequency distribution of clear sky brightness temperatures for the Long Wave Window band for 23 September 2002 for GOES-8 & -10.

Temp. (K)	Land & Ocean	Land	Ocean
220	0	0	0
230	16	16	0
240	20	20	0
250	160	159	1
260	3227	3141	86
270	39252	25415	13837
280	177815	65384	112431
290	491970	93412	398558
300	18108	16423	1685
310	3645	3264	381
320	294	273	21
330	0	0	0

NCEP will investigate assimilating WV band data over land and ocean and the three IR bands over oceans only every six hours (Su et al, 2003). ECMWF uses the hourly CSBT of the WV band over land and ocean. ECMWF experiments indicate a positive impact with changes in upper level humidity being in agreement with other radiance observations and a small but positive impact on forecasts of the upper level wind and geopotential (Köpken et al, 2003).

Plans call for the CSBT processing system to be migrated to the NESDIS/ Office of Satellite Data Processing and Distribution (OSDPD) in Washington. D.C. This process has already begun and is expected to be ready soon. Pending approval of funding documentation for the CSBT processing system will also be included. Once processing begins in Washington, D.C., this data set will become one of the suites of real-time operational products resulting from the GOES Imager.

3. FUTURE WORK

In order to make these remotely sensed brightness temperatures more compatible for numerical weather modeling, upgrades in the processing system are planned. One is an improvement to the cloud detection technique. The current cloud detection technique will flag all bands for a particular fov. This may be true for the three "Window" bands (3.9 µm, 11.0 µm, and 12.0 µm), but the Water Vapor band may in fact be clear, especially with low-level clouds (i.e. cumulus level). The second upgrade is to possibly expand the product to include CSBT data from the western Pacific, along with the CSBT information already being operationally generated from the Meteosat data. This will result in a nearly global, hourly radiance product. Quality indicator flags will be expanded. These flags will focus on the quality or worthiness of the brightness temperature itself. Finally, an upgrade will focus on the effects the slightly modified suite of IR bands (for example there is no 12.0 μm band available) aboard the GOES-12 Imager (Schmit et al, 2001), and how these modified bands will affect the cloud mask. Revisiting the various thresholds used in determining whether a fov is considered clear or cloudy will be a major task in this upgrade.

As a result of these upgrades and by inserting hourly, globally produced CSBT data sets into numerical weather prediction models, improved global forecasts will result.

4. REFERENCES

Köpken, C., G. Kelly, and J.N. Thépaut, 2002: Monitoring and Assimilation of METEOSAT radiances within the 4DVAR system at ECMWF.

Köpken, C., G. Kelly, and J.N. Thépaut, 2003: Assimilation of water vapor radiances from geostationary imagers in 4DVAR, To be presented at the 12th AMS Sat. Con., Feb., 2003.

Schmit, T.J, E.M. Prins, A.J. Schreiner, and J.J. Gurka, 2001: Introducing the GOES-M Imager. *National Weather Digest*, Vol. 3,4.

Schreiner, A.J., T.J. Schmit, and W.P. Menzel, 2001: Observations and trends of clouds based on GOES sounder data. *Journal of Geophysical Research-Atmospheres*, **106**, 20,349-20,363.

Su, X., J.C. Derber, J.A. Jung, and Y. Tahara, 2003:The usage of goes imager clear-sky brightness temperatures in the NCEP global data assimilation system, To be presented at the 12th AMS Sat. Con., Feb., 2003.

Young, J.T., T.M. Whittaker, M.A. Lazzara and R.J. Fox, 1998: McIDAS - Its 25th anniversary. International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology, 14th, Phoenix, AZ, 11-16 January 1998. Boston, MA, American Meteorological Society, 1998. pp24-30.

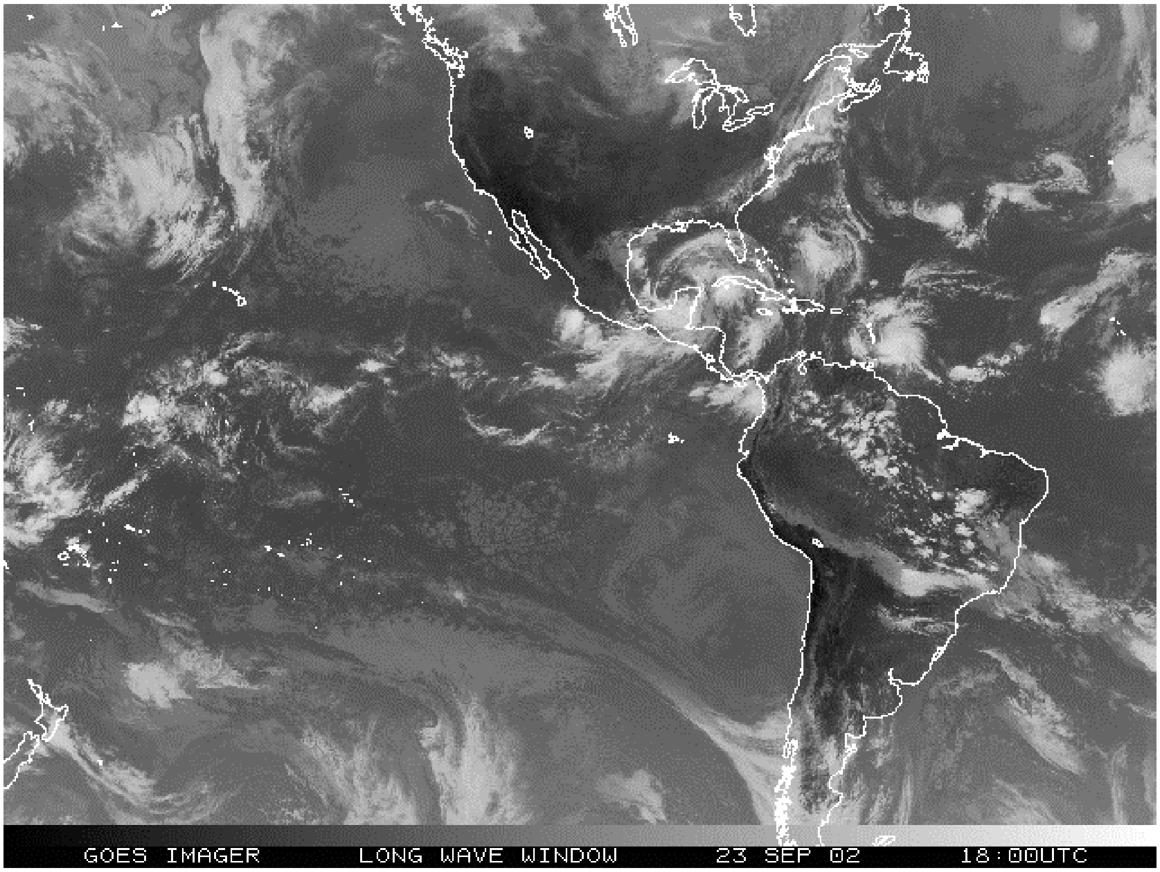

Figure 1. Combined GOES-8 & -10 Imager 11.0 µm (Long Wave Window) band for 12 March 2002 15 UTC.

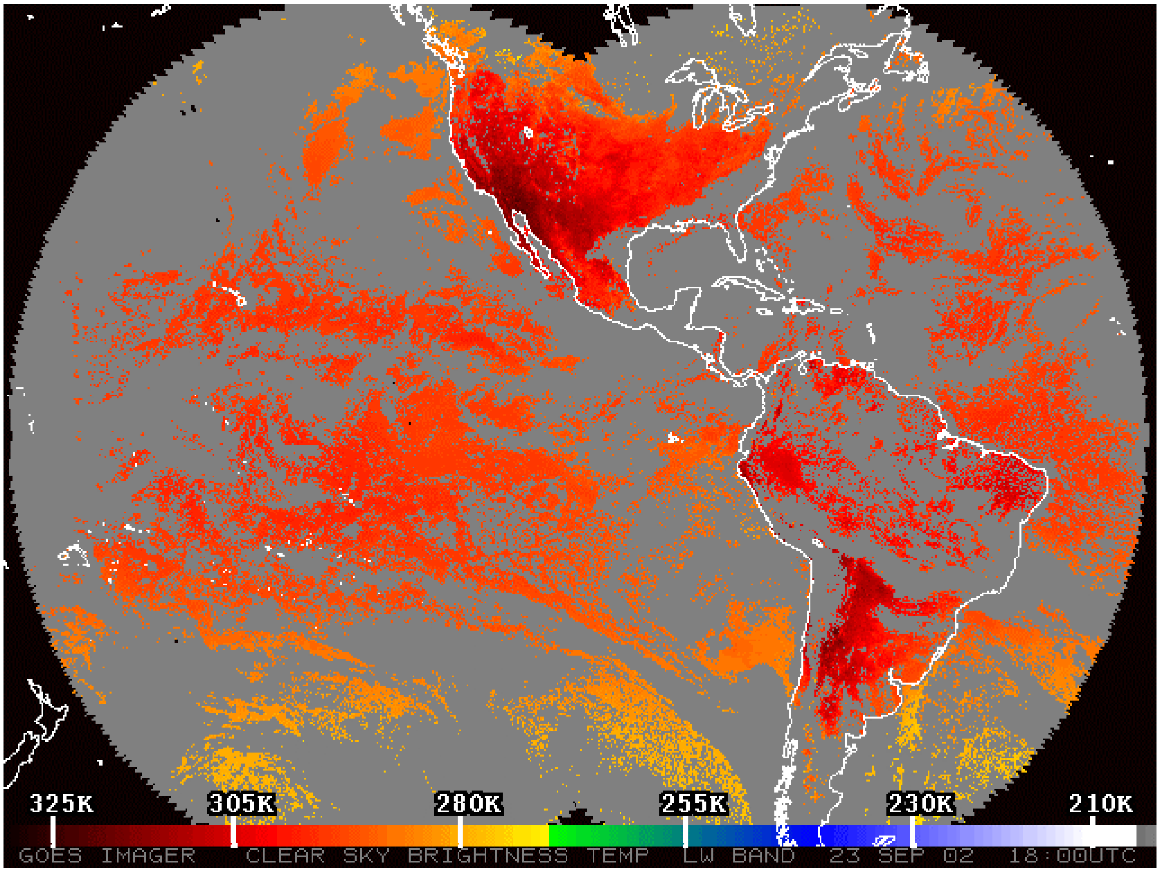

Figure 2. Combine GOES-8 & -10 Clear Sky Brightness Temperature image of the 11.0 µm (Long Wave Window) band for 12 March 2002 15 UTC. Grey indicates cloud and white through dark red indicate clear.

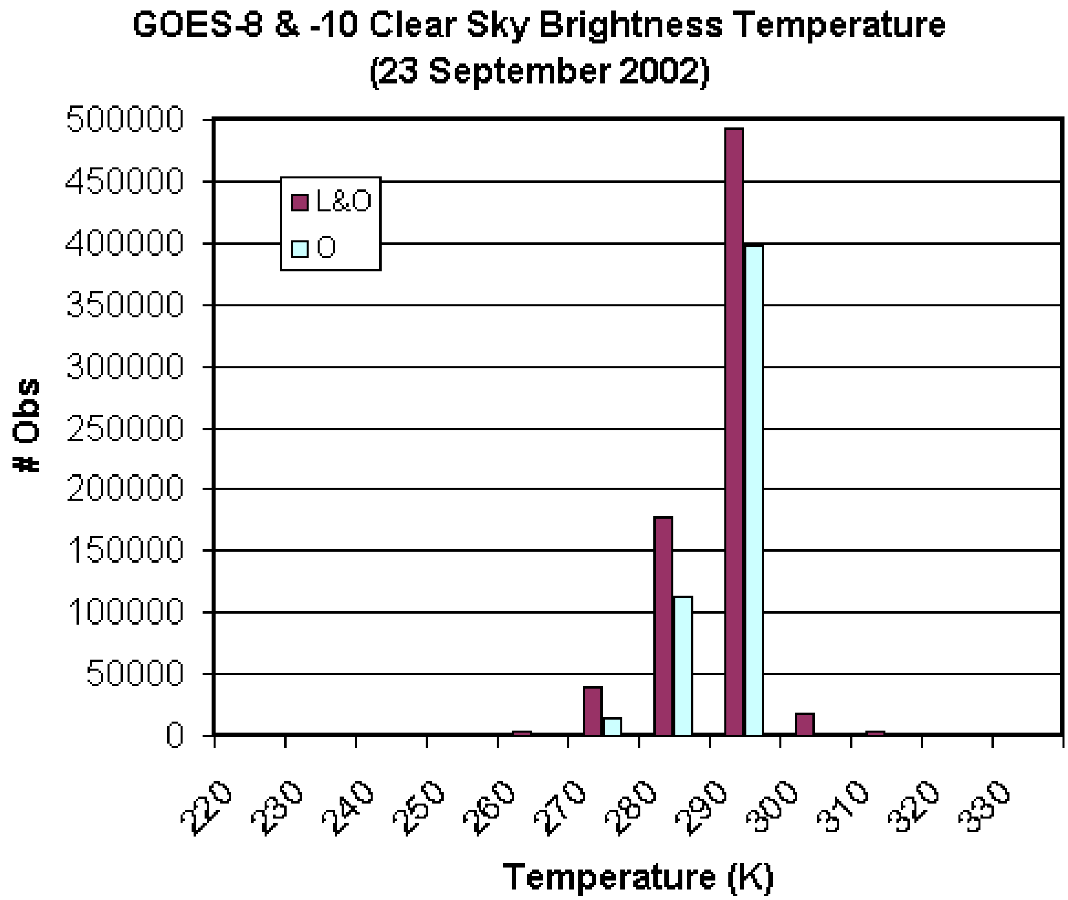

Figure 3. Histogram of the frequency of clear brightness temperatures for the Long Wave Window based on radiances from GOES-8 & -10 Imager. The observations are for a twenty-four hour period from 23 September 2002. L&O and O represent land & ocean and ocean only observations, respectively. This is a pictorial display of Table 1.