GMS-5 IR and Visible Imagery for November 1996-February 1997 from the ARM External Data Center

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Introduction

The El-Nino Southern Oscillation (ENSO) and Madden Julian Oscillations (MJO) are strongly influenced by radiative and other associated cloud processes in the Tropical Western Pacific (TWP). ENSO and MJO events in turn are important to global climate. The Geostationary Meteorological Satellites (GMS) capture the cloud and radiative processes by providing approximately hourly images of the TWP. Use of the satellite data by the research community is facilitated when the data is processed and made available in convenient data formats and media. Motivated by the success of the GMS-4 infrared (IR) satellite imagery CD-ROM produced by the Meteorological Research Institute (MRI 1994), the Atmospheric Radiation Measurement Program's External Data Center (ARM-XDC) has produced a complementary data set on a CD-ROM covering the period from November 1996 to February 1997.

Dataset Content and Format

ENSO warm event conditions for November 1992 to February 1993 were documented by hourly GMS-4 IR 0.1° (~11 km) resolution images distributed on CD-ROM by the MRI (1994). The images cover 130°E-180°E and 15°N-15°S with 500 x 300 pixels for each image. The ARM-XDC CD-ROM GMS-5 satellite images cover exactly the same region (130°E-180°E and 15°N-15°S) at the same resolution [~11 km (0.1°) and 500 x 300 pixels]. In addition to the IR images, the ARM-XDC CD-ROM also contains GMS-5 visible images (VIS) at ~11 km resolution and 500 x 300 pixels for the same region. The time period covered by the ARM-XDC CD-ROM with approximately hourly images is December 1996 to February 1997, an ENSO cold event.

There are 2277 IR images and 1186 VIS images on the ARM-XDC CD-ROM (Table 1). Each image consists of a 500-byte header which lists the date, time and type of image. The data contents of the file are 500 x 300 bytes with one byte representing one pixel. The 500 x 300 bytes are arranged by row major, i.e., from west to east and north to south. The byte value +100 represents the brightness temperature in Kelvin for the IR images. In the VIS images the (byte value) *0.5 is the albedo (%) normalized for solar zenith angle. The CD-ROM files are arranged in directories for each month with subdirectories for IR and VIS images. The filename for each image consists of the last two digits of year, month, day, hour format (yymmddhh) with either .vis or .IR2 suffix to distinguish VIS and IR images. Further documentation and file lists are contained in the *docs* directory of the CD-ROM. The *misc* directory contains Interactive Data Language (IDL) routines to view the data set contents.

Table 1. Number of images.

	IR	Vis
November 1996	544	288
December 1996	577	276
January 1997	572	309
February 1997	584	313
Total	2277	1186

Averages and Comparison with 1992/1993 Conditions

The mean brightness temperature of all the GMS-5 IR images on this CD-ROM (November 1996 to December 1997) was 268.03° K and the average brightness temperature of images only for the daylight hours [21:00 Greenwich Mean Time (GMT) to -4:00 GMT] is 268.74° K

(Figure 1a and 1b). There appears to be lesser spatial extent of cold temperatures and, hence, deep convection around the "maritime continent" (Ramage 1968) during the daylight hours. It is not clear whether this difference is due to different spatial distribution of cold cloud or the prevalence of warmer surface temperature during daytime hours. The average brightness temperature of all GMS-4 IR images during the 1992-1993 boreal winter was 272.73° K (Figure 1c). The average temperature of images during the daylight hours of 1992-1993 was 273.41° K (Figure 1d). The average IR values indicate that there is less convection and fewer cold clouds during 1992-1993 El-Nino conditions compared to 1996-1997 La-Nina conditions. However, examination of the images indicates there is a greater spatial extent of cold temperatures during the El-Nino of 1992-1993 compared to the La-Nina conditions of 1996-1997 (Figure 1a-d). It is possible that these differences are due to the very cold cloud tops associated with the very intense deep convection prevalent over land in comparison to the weaker less intense deep convection over the ocean (Miller and Fritsch 1991). It is also possible that the calibration of the satellite sensors of the GMS-4 and GMS-5 are different. Further investigation would be necessary to explain increased spatial extent of cold temperatures and associated higher average temperatures for 1992-1993 in comparison to the smaller spatial extent of cold temperatures and associated lower temperatures of 1996-1997.

Average albedo for the visible images for the 1996-1997 daylight hours (21:00 GMT to 4:00 GMT) was 21.3%. The average albedo image was remarkable in accentuating the land masses including small islands (Figure 2). The albedo over the islands during the daylight hours appeared to be over 70% and over the ocean less than 60% (Figure 2). Higher albedo over the small islands and differences with the surrounding ocean appeared to be greatest in the region containing the coldest temperature and hence greatest deep convection (Figure 2). In contrast, the greatest island ocean differences in brightness temperatures were found during minimal convective activity or cloud cover (Barr-Kumarakulasinghe et al. 1998). These differences probably reflect the differences in sampling of a diurnal cycle, with albedo being sampled only during daylight hours, and brightness temperatures throughout the day. These rather contrary results of island ocean differences in brightness temperature and albedo under-enhanced or diminished convective activity underscore the importance of complete sampling throughout the diurnal cycle to prevent biased results.

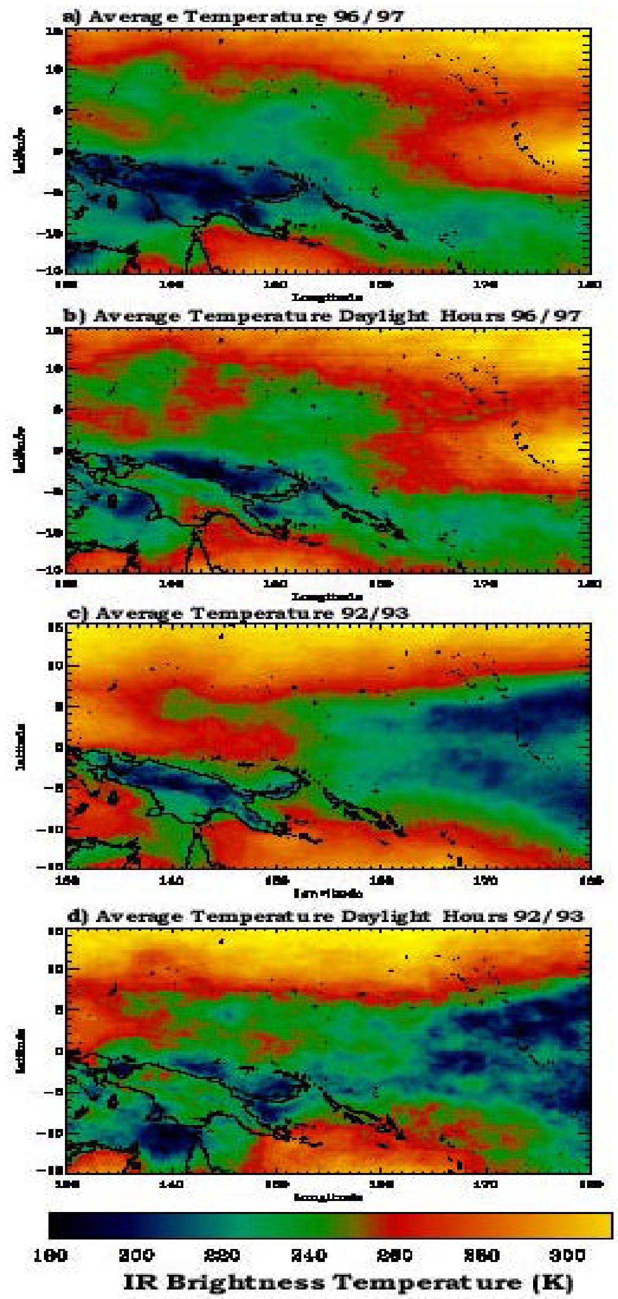

Figure 1. a) Average of all GMS-5 IR images from the ARM-XDC CD-ROM for November 1996 to February 1997 b) Average of all daytime GMS-5 IR images from the ARM-XDC CD-ROM for November 1996 to February 1997 c) Average of all GMS-4 IR images from the MRI (1994) CD-ROM for November 1992-February 1993 d) Average of all daytime GMS-5 IR images from the MRI (1994) CD-ROM for November 1992 to February 1993. (For a color version of this figure, please see *http://www.arm.gov/docs/documents/technical/conf_9803/barr-98.pdf*.)

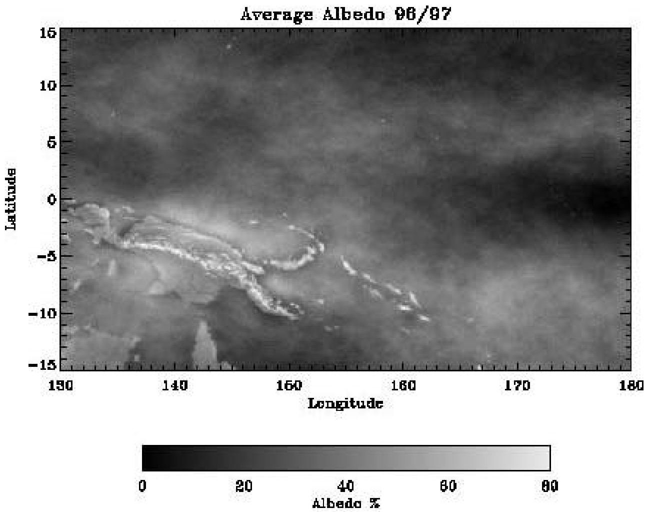

Figure 2. Average of all GMS-5 VIS images from the ARM-XDC CD-ROM for November 1996 to February 1997.

Conclusion

We hope the dataset will facilitate further investigations into the differences in El-Nino, La-Nina cloud cover (e.g., Fu et al. 1990, Chen and Houze 1997), deep convective cloud perimeter and area relationships to upper tropospheric humidity (Barr-Kumarakulasinghe and Lwiza 1998), and cloud type and size variations (Fu et al. 1990; Machado and Rossow 1993, Liu et al. 1995). We envisage producing a similar dataset on CD-ROM for December 1997 to February 1998 to document the 1997-1998 warm event. Details and plots of datasets with higher spatial resolution, greater temporal coverage can be obtained from the ARM archive at http://archive.arm.gov/. Information on updates, quick looks of satellite data can be found at http://ww.xdc.arm.gov/.

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