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METEOROLOGICAL EXAMPLES OF GLD360 EVENTS

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1. INTRODUCTION

Improved GLD360 data have become available in recent months. In the course of monitoring and examining the data, especially interesting events have been noted that show the value of GLD360 data over remote regions. In addition, many features are well defined due to the high detection efficiency and location accuracy of GLD360.

2. SOUTH AMERICA IN SUMMER

Figure 1 shows a one-day map of GLD360 strokes ending late on 06 January 2012. A number of interesting features are shown on this summer day in South America.

GLD360 shows lightning over the Amazon basin and other regions, as well as a separate line from NNW to SSE along the west coast. During the day, low-level moisture is pulled westward toward higher elevations and is the fuel for thunderstorms over the mountains, and to their east, but not on the west side. The spatial accuracy of GLD360 allows the strokes to be correctly plotted over and east of the mountains, but not to the west. The lack of coastal lightning in Figure 1 is due to cool to cold water on the west side of continents at low latitudes. This feature prohibits deep convection from forming, along with subsiding air aloft. This mountainous region is not covered by meteorological radars, and shows how GLD360 can identify lightning in remote locations.

An additional feature on this map is an east-west line of lightning over the tropical Atlantic in upper right Figure 1. These strokes are in the equatorial trough located in this region in January. Of interest are the lack of motion and short lifetimes of the storms in the line, and the somewhat cellular nature of the convection. While visible and infrared satellite imagery identifies the general region of storm complexes in the equatorial trough, not all of the satellite-detected cloudiness at any given time is active with respect to updrafts and other conditions necessary to produce lightning. It should be mentioned that lightning in this area has not been well located by detection systems due to its remoteness, but GLD360 has a very extended detection range.

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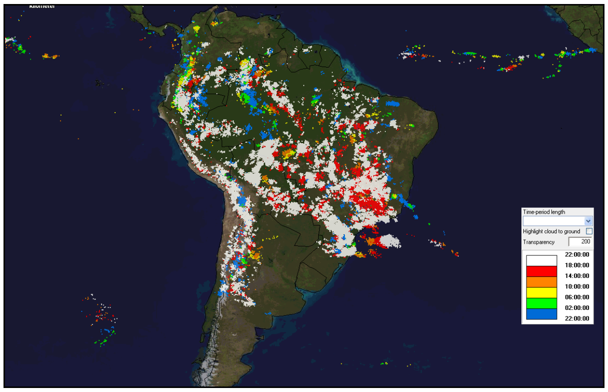

FIGURE 1. Map of 247,014 Global Lightning Dataset GLD360 strokes for 24 hours ending at 2157 UTC on 06 January 2012. Strokes are color coded by six-hour intervals according to the scale on the right.

3. TROPICAL CYCLONE YASI

One of the strongest tropical cyclones to affect Australia in many years came inland on 02 February 2011. Yasi entered the northeast coast near Cairns in northern Queensland. Figure 2 shows the track in light blue with positions located at 0000 and 1200 UTC on 01 and 02 February 2011 as Yasi moved from east-northeast to west-southwest. GLD360 lightning data show 76,437 strokes over the map area during the 24-hour period ending at 2000 UTC on 02 February.

Four general features of the cyclone are apparent in Figure 2 that can be compared with the satellite image at 1132 UTC on 02 February:

- Several small clusters of strokes are located within 100 km of the eyewall along the latter portion of the track at 0000 and 1200 UTC 02 February. These and other features have been identified in studies using prior Vaisala long-range lightning data in tropical cyclones by Demetriades and Holle (2005), Demetriades et al. (2006), Demetriades and Holle (2008 a,b), Demetriades et al. (2010), Molinari et al. (2006), and Squires and Businger (2008).
- There are curved lines at the top center of the image that are feeder bands flowing toward

the center of the cyclone as it moved to the west-southwest.

- There is almost no lightning along the track where the past studies mentioned above have shown a nearly complete lack of lightning in the large central dense overcast shield containing the strongest winds of a tropical cyclone that is not undergoing any rapid changes.
- Finally, there are several large clusters over Australia that have very frequent lightning to the northwest through southwest of the center as it makes landfall just after 1200 UTC on 02 February 2011. These clusters are located on the western edge of thick upper clouds from the outflow of Yasi, in the humid air where thunderstorms developed during daytime heating. The GLD360 data are able to identity all four of these features - eyewall, feeder bands, lightning-free central dense overcast, and outer edge of the cyclone. GLD360 identifies these locations and times of strong updrafts and associated convective weather threats over the entire region in one seamless view.

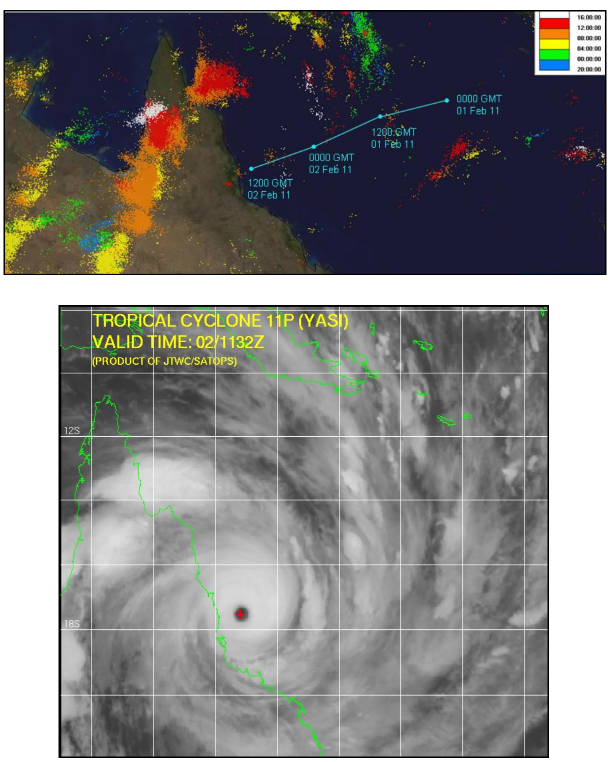

FIGURE 2. Tropical cyclone Yasi. Top: Map of Global Lightning Dataset GLD360 strokes for 24 hours ending at 2000 UTC on 02 February 2011. Strokes are color coded by six-hour intervals according to the scale on the right. Bottom: Infrared satellite image at 1132 UTC on 02 February 2011.

4. LIGHTNING INCREASES IN SOUTH AMERICAN SUMMER

Lightning in South America persists all year near the equator and in the northern Amazon basin. To the south over the continent, however, cold fronts bring cooler and drier air from the south in winter months. As spring arrives, lightning expands steadily southward (Figure 3). The top panel for June 2011 has 1,963,061 strokes across the continent while there are winter storms to the south, and some activity in the northwest. The middle panel for August 2011 shows 1,775,087 strokes, but there is very infrequent lightning to the south. By the start of summer in August, there are 8,867,458 strokes spread over the same area.

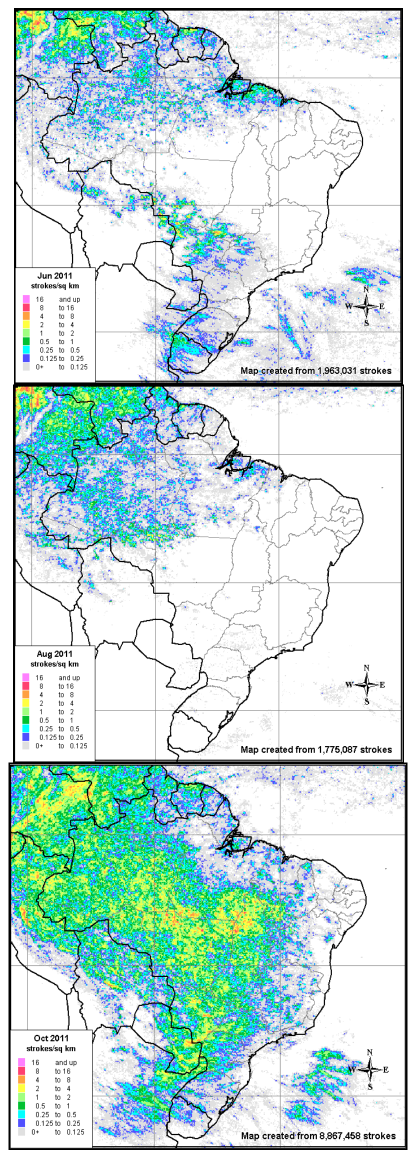

FIGURE 3. Monthly GLD360 strokes detected over South America in June, August, and October 2011.

5. GLD360 ACCURATELY LOCATES LIGHTNING IN REMOTE AREAS

The Global Lightning Dataset GLD360 is able to locate lightning in areas of the world where some of the typical meteorological observations may be lacking. Among the most difficult areas are islands that sometimes do not have local meteorological radars. Meteorological satellite data are usually not available at high temporal and spatial sampling rates in such areas, so timely updates on convection and thunderstorms are often lacking. Two examples are considered with GLD360 data.

The mountainous island of New Guinea, divided between the countries of Papua New Guinea and Indonesia, is near the equator and surrounded by warm oceans. These factors result in a lightning maximum over the island during daytime when the land is heated relative to the surrounding oceans. Figure 4 shows that GLD360 data from August through November 2011 locate lightning strokes very well over the main island, while there is a lower stroke frequency over water. The map also shows maxima over nearby islands to the northeast. Lightning frequencies over the higher terrain of New Guinea indicate that the annual total equals or exceeds the Florida annual frequency. Without information from radar and other sensors in this country, GLD360 lightning data can be used to identify areas of concern for aviation, defense, maritime, and other interests.

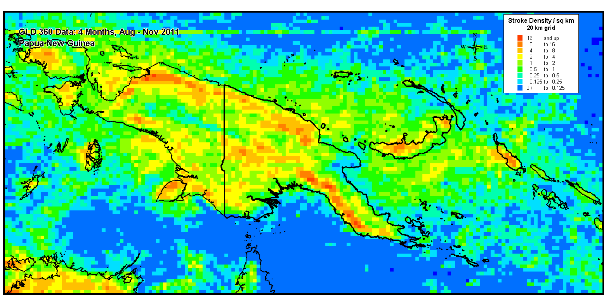

FIGURE 4. Map of GLD360 strokes over New Guinea and surrounding ocean from August through November 2012.

An additional GLD360 view in Figure 5 shows features over islands and coastlines in southeast Asia. Most of the higher lightning frequencies are over land, especially coastal China. In addition, there are maxima in stroke density along the coasts and higher elevations of Japan. GLD360 is able to view this large region due to its very good location accuracy and detection efficiency due to minimal spatial variations.

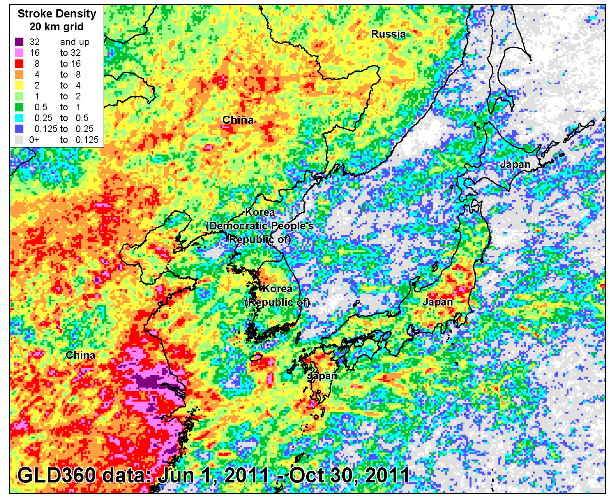

FIGURE 5. Map of GLD360 strokes over southeast Asia from 01 June through 30 October 2011.

6. SUMMARY OF GLD360-DETECTED FEATURES IN ONE DAY

Many of the features shown in the previous figures can be shown in one day. A daily Global Lightning Dataset GLD360 map has a large number of interesting meteorological features in Figure 6 on 23 June 2011. It shows lightning activity under a large range of conditions in several regions, starting from the northwest corner of the map.

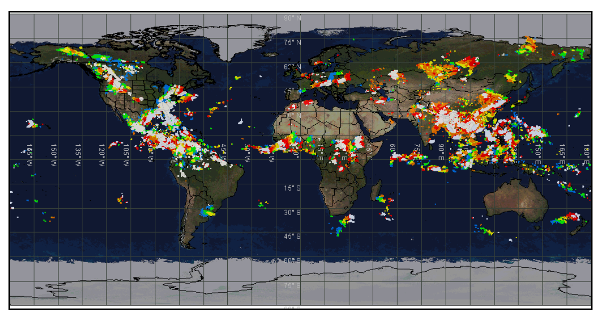

FIGURE 6. Map of 2,399,593 strokes detected by GLD360 for 24 hours ending 2102 UTC 23 June 2011. Most recent four hours in white, followed by red for previous four hours, until oldest four hours in blue.

- Lightning in thunderstorms in Alaska and Canada's Northwest Territories are quite far north, but this is the time of year when high-latitude storms can be expected.
- The monsoon over Mexico is beginning to move northward along the Pacific coast. Lightning activity in this region is frequent around the mountains of Mexico, and eventually reaches the southwest U.S. in July and August (Murphy and Holle 2005).

- A lightning-producing storm is moving west to east in Argentina in a typical location during this time of early winter.
- The equatorial trough in the Atlantic is active from a starting position in West Africa, as storms move westward over the ocean. This is the genesis area for tropical cyclones later in the year.
- Lightning in eastern Russia on this day is quite far to the north as expected during the warmest months of the summer.
- A variety of small storms in the westerlies are evident in the Southern Hemisphere where it is winter.

Acknowledgments

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