STATE OF THE CLIMATE IN 2009

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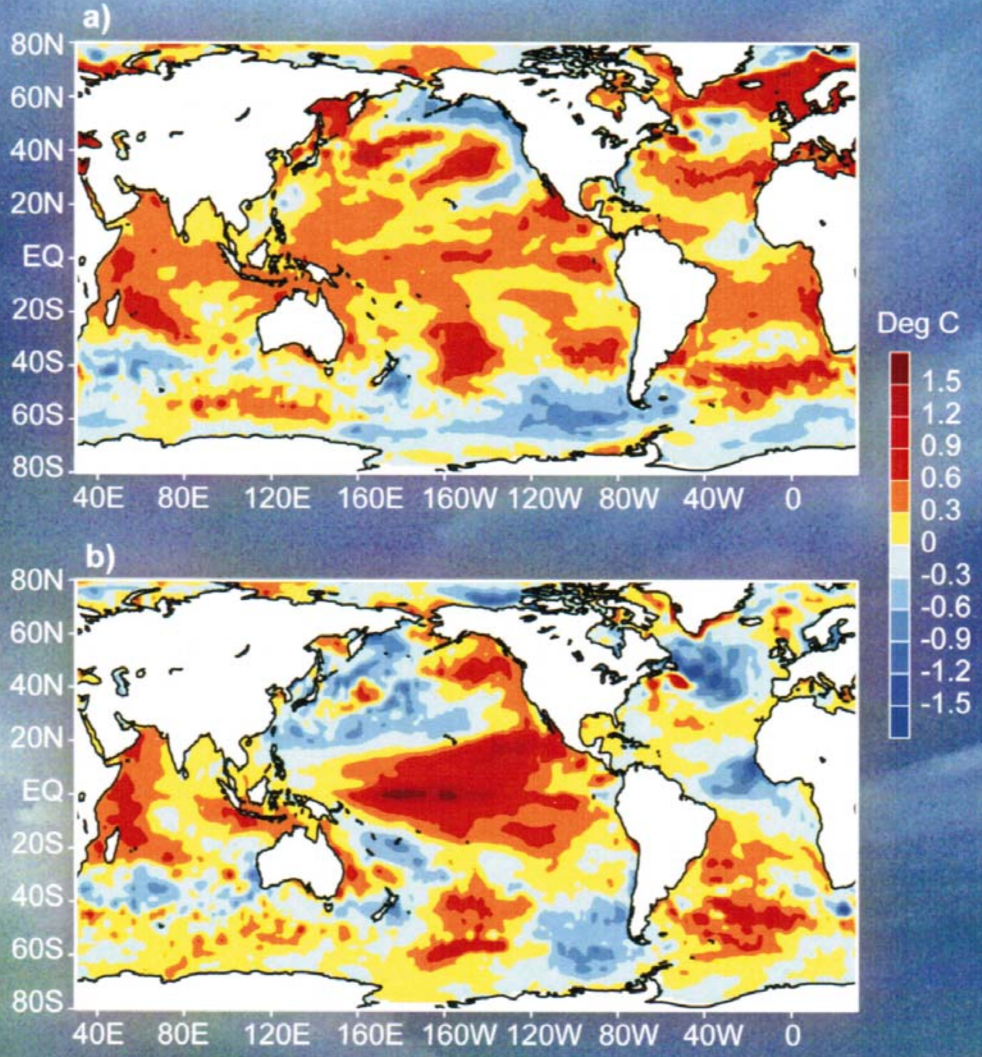

(a) Yearly mean sea surface temperature anomalies (SSTA) in 2009 and (b) SSTA differences between 2009 and 2008. Anomalies are defined as departures from the 1971-2000 climatology. Refer to Chapter 3, Figure 3.1 for a more detailed description.

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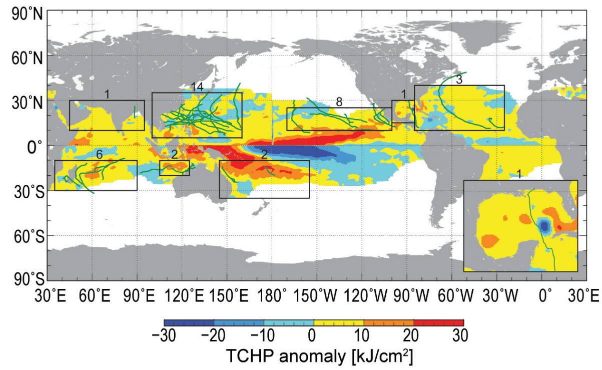

Fig. 4.26. Global anomalies of TCHP corresponding to 2009 computed as described in the text. The boxes indicate the seven regions where TCs occur: from left to right, Southwest Indian, North Indian, West Pacific, Southeast Indian, South Pacific, East Pacific, and North Atlantic (shown as Gulf of Mexico and tropical Atlantic separately). The green lines indicate the trajectories of all tropical cyclones reaching at least Cat- 1 (1-minute average maximum wind ≥119 km hr^{-1}) and above during November 2008–December 2009 in the Southern Hemisphere and 2009 in the Northern Hemisphere. The numbers above each box correspond to the number of Cat- 1 and above cyclones that travel within each box. The Gulf of Mexico conditions during June–November 2009 are shown in detail in the insert shown in the lower right corner.

The fourth landfalling system of the season was Dominic, a Cat- 2 system (maximum gusts 75 kt, maximum sustained winds 55 kt, minimum central pressure 976 hPa) which made landfall near Onslow, Western Australia on 27 January. As for the Queensland systems, the principal impact was flooding, with daily rainfall totals of 243 mm at Thevenard Island and 238 mm at Onslow Airport. Of those TCs that did not make landfall, the most intense was Ilsa, which peaked at Cat- 3 intensity (maximum gusts 125 kt, maximum sustained winds 90 kt, minimum central pressure 958 hPa) on 19 March when more than 1000 km off the Western Australian coast, near 16°S, 107°E.

e. *TC heat potential (TCHP)*—G. J. Goni, J. A. Knaff, and I-I Lin

TCHP is discussed here for the seven TC basins previously documented as a way to summarize that activity from a slightly different perspective. The TCHP, defined here as the ocean heat content contained between the sea surface and the depth of the 26°C isotherm, has been shown to be more closely linked than SST to intensity changes (Shay et al. 2000; Goni and Trinanes, 2003; Lin et al., 2008, 2009), provided that atmospheric conditions are also favorable. The TCHP shows high spatial and temporal variability associated with oceanic mesoscale features that can be globally detected with satellite altimetry TCHP (Goni et al. 2009). In general, the real-time forecast of TC intensity is highly dependent on track forecasts and many of the errors introduced in the track forecast are translated into the intensity forecast (Mainelli, et al. 2008). Clearly, areas with high values of TCHP may be important only when TCs travel over them.

To examine the interannual variability of TCHP with respect to TCs, TCHP anomalies are computed during the months of TC activity in each hemisphere: June through November 2009 in the Northern Hemisphere and from November 2008 through April 2009 in the Southern Hemisphere. Anomalies are defined as departures from the mean TCHP calculated during the same months for the period 1993 to 2009. These anomalies show large variability within and among the TC basins (Fig. 4.26).

The WNP basin exhibits the anomalies from the El Niño conditions, which have been in place in the equatorial Pacific Ocean since June 2009. Similar to the conditions during 2008, the South Pacific basin showed mostly positive anomalies. The NIO basin exhibited positive values in the Bay of Bengal and in the Arabian Sea. The Gulf of Mexico (Figs. 4.26, 4.27) showed mostly positive values except for a small region of negative values, which was probably due to a different location of the Loop Current. The tropical Atlantic exhibited mostly positive values, which is also observed in sea height and SST fields (http://www.aoml.noaa.gov/phod/regsatprod/atln/index.php).

The ENP season was very active although the first named storm of the season did not develop until late in June, being the latest start of the ENP

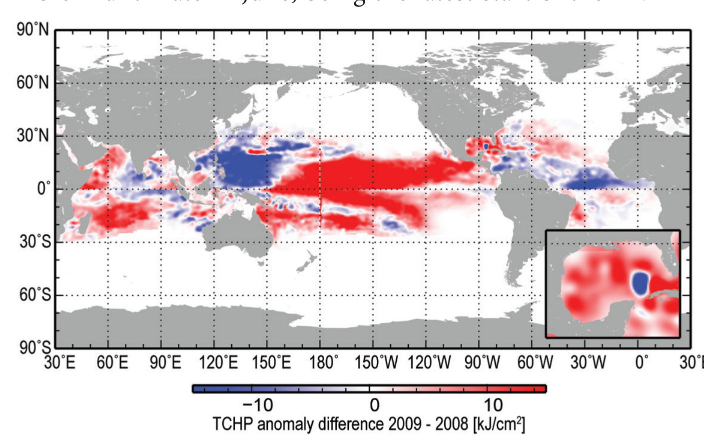

Fig. 4.27. Differences between the TCHP fields in 2009 and 2008.

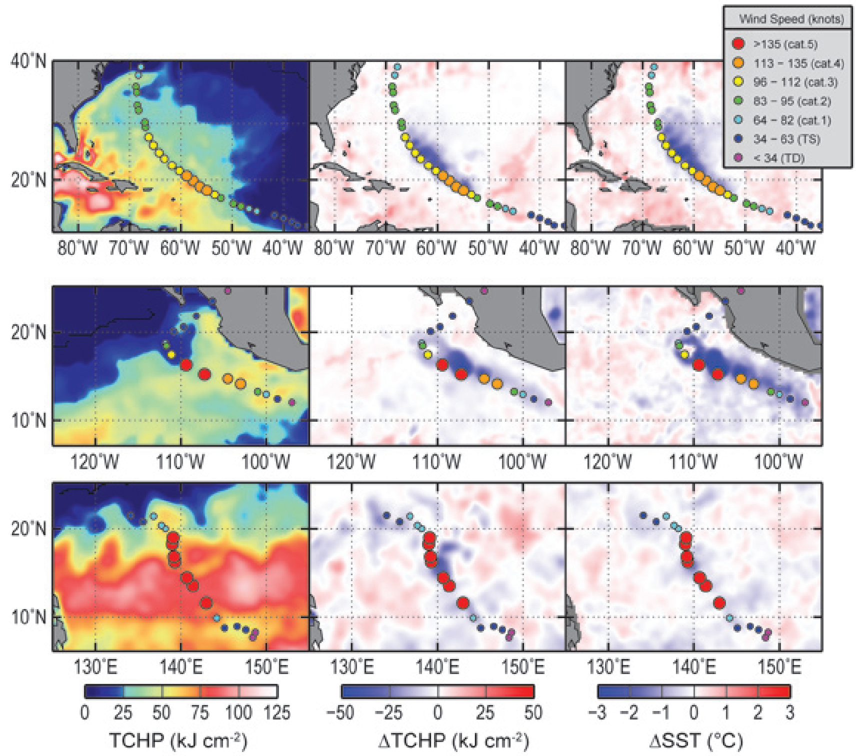

Fig. 4.28. (Left) TCHP, and surface cooling given by the difference between post- and pre-storm values of (center) tropical cyclone heat potential and (right) sea surface temperature, for (from top to bottom) Hs Bill and Rick, and TY Nida.

hurricane season in 40 years. H Rick reached Cat-5 in mid-October, and became the first Cat-5 ENP H since Kenna in 2002 and the second strongest ENP hurricane on record, behind Linda in 1997. H Rick intensified from Cat- 2 (85 kt, 975 hPa) to Cat- 5 (150 kt, 914 hPa) in one day. Six hours later Rick reached a maximum intensity of 155 kt just off the southern coast of Mexico (Fig. 4.28). This rapid rate of intensification occurred while traveling over a region of very high TCHP (above 70 kJ cm^{-2}) and in a favorable atmospheric environment. This TC weakened as quickly as it intensified under the influence of strong upper-level southwesterly wind associated with an amplified short-wave trough (Cangialosi and Avila 2010).

The WNP TY season was calmer than average in the early part of the season (June–August) but became very active during the later part of the season (September to November). During these three months, five Cat- 4 and 5 TYs developed, as compared to two in 2008. This happened despite the general cooling tendency of TCHP due to El Niño (Figs. 4.26 and 4.27) in the western Pacific in 2009. Although the TCHP in the western Pacific decreased by about 10–15 kJ cm^{-2} with respect to the average conditions and to 2008 (Figs. 4.26 and 4.27), this was only a small decrease compared to typical TCHP values (Lin et al. 2008). In the WNP, especially between the 10°N and 20°N latitudinal belt, the TCHP values are typically around 100–160 kJ cm^{-2} (Lin et al. 2008). Therefore, even with a 10–15 kJ cm^{-2} decrease, the resultant TCHP in 2009 was still around 85–140 kJ cm^{-2} (Lin et al. 2008), sufficient to keep the TY's self-induced ocean cooling negative feedback small during the intensification (Lin et al. 2009).

TY Nida was a Cat- 1 storm on 24 November and intensified into a Cat- 5 STY on 25 November, reaching peak winds of 160 kt, according to the preliminary JTWC best tracks. The track of this TY travelled from a region of high (~50 kJ cm^{-2}) TCHP values to over a region of extremely high (above 100 kJ cm^{-2}) values. The strength of this TY is also independently revealed by its large 10-minute sustained winds of 115 kt estimated at the same time in the final best track produced by RSMC Tokyo, the greatest intensity since TY Jangmi in 2008. However, the cooling produced by this TY was only of approximately 1°C, probably because of the very deep warm and stable surface layer (Fig. 4.28).

f. Intertropical Convergence Zones (ITCZ)

1) Pacific—A. B. Mullan

There are two prominent convergence zones in the Pacific: the ITCZ in the Northern Hemisphere, lying approximately parallel to the Equator with a slight poleward tilt on its eastern end and varying in position from around 5°N–7°N in February–May to 7°N–10°N in August–November; and the SPCZ, which extends diagonally from around the Solomon Islands (10°S, 160°E) to near 30°S, 140°W and is most active in the November–April half-year. A southern branch of the ITCZ can also occur but is only apparent in the January–May period and is strongest in La Niña years.

Figure 4.29 shows 20°N to 30°S transects of quarterly rainfall in the Pacific, as derived from the 0.25