

# STATE OF THE CLIMATE IN 2004

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which was above the climatological median of 26 (75th percentile, 29.5 NSs). The nine tropical storms in 2004 equaled the climatological median, and four of these tropical storms were not officially named (01W, 02W, 05W, 21W). Twenty-one tropical cyclones reached typhoon intensity, which was well above the climatological median of 17.5 (75th percentile, 20 TYs), and the highest number since the El Niño year of 1997, when 23 typhoons developed. Seven of these typhoons became supertyphoons, which was above the 75th percentile of the climatological mean of six (the median is four). During the period 1971–2000, 62% (13%) of the named tropical cyclones reached typhoon (supertyphoon) intensity; while in

2004 the percentage was 70% (23%). The long-term data suggest that more frequent and intense tropical cyclones are characteristic of El Niño years in the western North Pacific basin (Camargo and Sobel 2004), and tropical cyclone–intensity indices are correlated with the Niño-3.4 and Niño-4 indices in the western and central tropical Pacific (Camargo and Sobel 2005). According to both the NOAA and International Research Institute for Climate Prediction (IRI) definitions, a weak El Niño occurred in 2004 with anomalous warming in the central tropical Pacific (see section 4.a), which likely contributed to such an active season in 2004.

Overall, only 50% of the named storms occurred between July and October in 2004, compared to the clima-

## “FENOMENO CATARINA:” THE SOUTH ATLANTIC’S FIRST HURRICANE?—M. RUSTICUCCI<sup>35</sup> AND M. A. FORTUNE<sup>17</sup>

The rapid development on 27 March 2004 of a strong cyclone with hurricane-force winds in the South Atlantic Ocean, and its westward propagation and landfall along the southern coast of Brazil, astonished the meteorological community (Gusso 2004). As such an unusual event, there was widespread disagreement whether the cyclone was tropical, extratropical, or a “hybrid” system. NOAA’s National Hurricane Center (NHC) classified Catarina as a

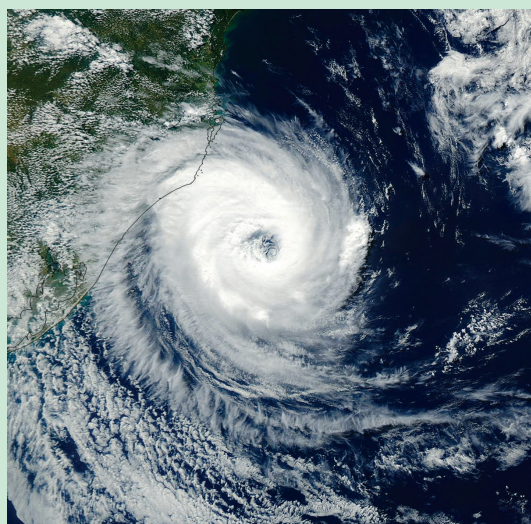
“category 1” hurricane, while specialists in both Brazil’s national meteorological service [Instituto Nacional de Meteorologia (INMET)] and the Weather Forecasting and Climate Studies Center [Instituto Nacional de Pesquisas Especiais (INPE) Centro de Previsão de Tempo e Estudo Climáticos (CPTEC)] classified it as a “fenomeno” (phenomenon in Portuguese). Initial observations suggested that it appeared to be a hybrid of a tropical

and an extratropical cyclone (Silva-Dias et al. 2004). The maximum recorded wind speed and surface pressure during landfall were 147 km h<sup>-1</sup> (~79.4 kt) and 993 hPa at Siderópolis, Brazil, respectively, at 0300 (LST) on 28 March.

Atmospheric conditions associated with Catarina at times differed from those of a tropical cyclone, because it developed both barotropic and baroclinic characteristics during its life cycle (Mattos and Satyamurty 2004). Initially, it was observed as a low pressure disturbance that developed along a cold front over the South Atlantic Ocean, but in 2 days it acquired the typi-

cal characteristics of a tropical cyclone, with rain- and cloud bands cyclonically converging into a well-defined eye. Catarina mostly resembled both Mediterranean lows (Reale and Atlas 2001), and hurricane-like vortices that develop between Australia and Tasmania. These are considered “hybrid systems” that originate as extratropical, cold core vortices, but develop a warm core due to latent heating in the convectively active center. Cyclone Catarina developed a clearly visible “eye” and an associated wall cloud of very intense convection where the strongest winds were observed (Fig. 4.11). In the eye region, initializations of two models [NCEP’s Aviation (AVN) model and the Regional Atmospheric Modeling System (RAMS)] exhibited a warm core, surrounded by the extensive cold core air mass (Bonatti et al. 2004; Menezes and Silva-Dias 2004).

As the cyclone intensified over the South Atlantic Ocean, Brazilian authorities were notified and measures were taken to minimize the possible loss of human life. Sampaio-Calearo et al. (2004) considered the results “very satisfactory,” considering the minimal loss of life and the lack of local experience in forecasting an event such as this one. However, damages on the southern coast of Santa Catarina state and the northern coast of Rio Grande do Sul state were extensive, and reached approximately 330 million U.S. dollars.



**FIG. 4.11.** Satellite image at 1630 UTC on 24 Mar 2004 of cyclone “Catarina” over the South Atlantic Ocean, from the afternoon overpass of NASA’s Moderate Resolution Imaging Spectroradiometer (MODIS) on board the *Terra* satellite.

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