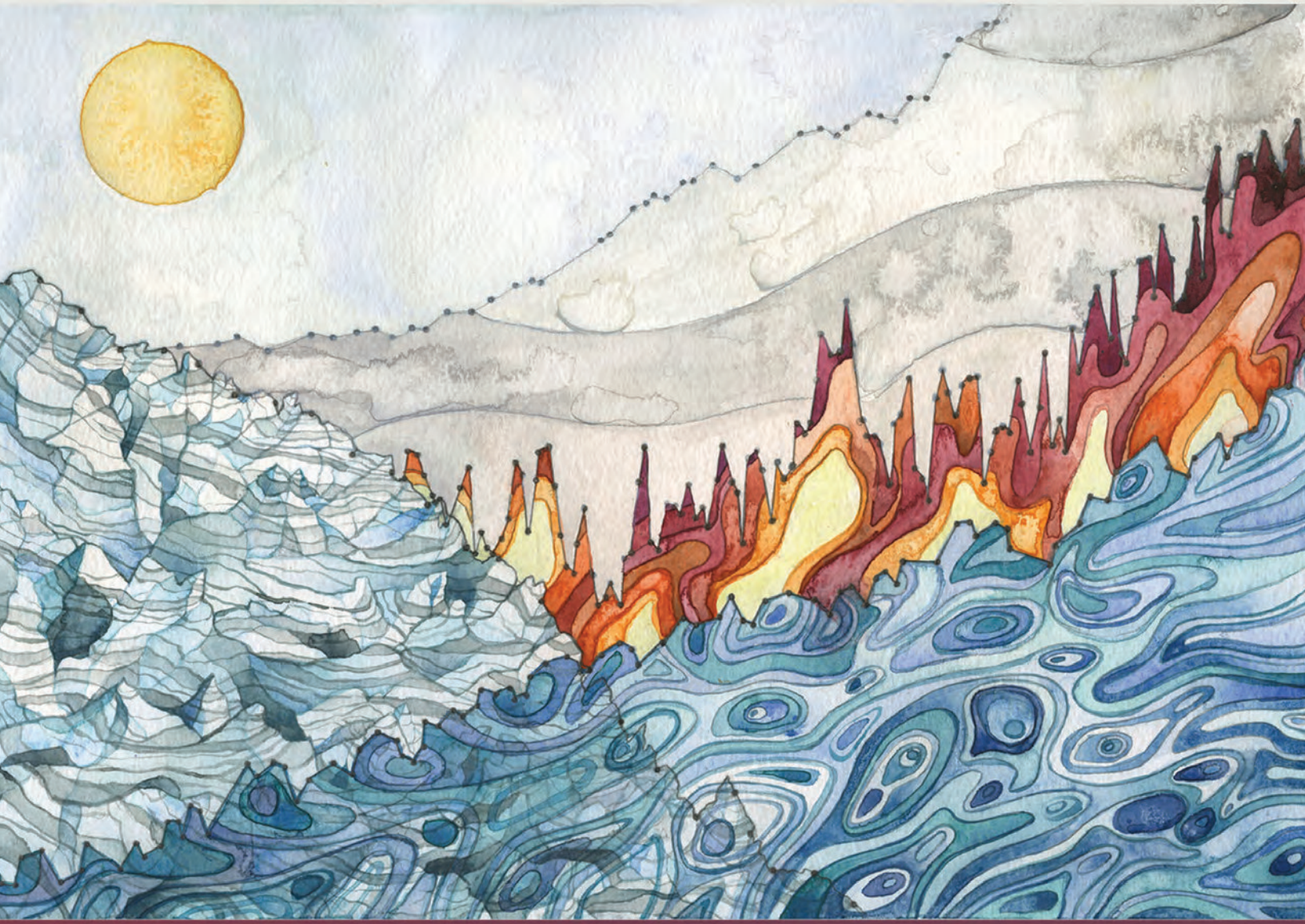
STATE OF THE CLIMATE IN 2015



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STATE OF THE CLIMATE IN 2015

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Landscape of Change uses data about sea level rise, glacier volume decline, increasing global temperatures, and the increasing use of fossil fuels. These data lines compose a landscape shaped by the changing climate, a world in which we are now living. (Data sources available at www.jillpelto.com/landscape-of-change; 2015.)

Salmon Population Decline uses population data about the Coho species in the Puget Sound, Washington. Seeing the rivers and reservoirs in western Washington looking so barren was frightening; the snowpack in the mountains and on the glaciers supplies a lot of the water for this region, and the additional lack of precipitation has greatly depleted the state's hydrosphere. Consequently, the water level in the rivers the salmon spawn in is very low, and not cold enough for them. The salmon are depicted swimming along the length of the graph, following its current. While salmon can swim upstream, it is becoming more of an uphill battle with lower streamflow and higher temperatures. This image depicts the struggle their population is facing as their spawning habitat declines. (Data sources available at www.jillpelto.com/salmon-populagtion-decline; 2015.)

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while 16.7% of the country, mainly in the northern regions, recorded hot days during July–September (much below the average of 29.6%).

(ii) Precipitation

Above-average rainfall was observed across the north-central region in 2015, while below-average conditions were present across northern Baja California, the South Pacific (coastal areas of Guerrero, Oaxaca, and Chiapas), Veracruz, and the northern Yucatan Peninsula (Fig. 7.7b). The 2015 national rainfall total of 872.0 mm (110.8% of normal) was the ninth highest annual total since national records began in 1941.

March was exceptionally wet. Two winter storms and four frontal passages led to the rainiest March since records began in 1941, with 69.6 mm of rain, providing 8.0% of the annual rainfall for the year compared to a normal contribution (14.7 mm) close to 2.0%. September, which climatologically provides the greatest amount to the annual rainfall total (18.5%), added 132.7 mm in 2015, which represents 15.2% of 2015 annual rainfall.

Nine hurricanes, which all formed in the eastern North Pacific basin (see section 4e3), impacted the nation's western coastal region, leaving, in most cases, significant rainfall. The most activity occurred in September when Tropical Storm Kevin, Hurricane Linda, Hurricane Marty, and Tropical Depression 16-E brought heavy rain to northwestern and southwestern parts of the nation.

Overall, Aguascalientes (central Mexico) and Colima (western Mexico) had their wettest year on record, while Baja California Sur and Chihuahua had their second wettest. Meanwhile, the rainfall deficits were remarkable along the South Pacific coast, with Oaxaca having its second driest year since national records began in 1941.

(iii) Notable events

An EF3 tornado struck Ciudad Acuña, Coahuila, on the morning of 25 May, causing at least 14 deaths and 290 injuries and destroying 750 homes. This was only the second tornado to reach EF3 intensity over the past 15 years, following the tornado in Piedras Negras on 24 April 2007, also in the state of Coahuila.

Hurricane Patricia was the strongest hurricane on record in the eastern North Pacific basin and one of the most intense to strike Mexico. It developed on 20 October and reached Category 5 hurricane strength on the Saffir–Simpson scale, with maximum sustained winds of 174 kt (88 m s^{-1}) and a minimum pressure of 879 mb (see section 3e4). Patricia was only the second tropical cyclone to make landfall in Mexico on the Pacific shores as a Category 5 storm since records began in the Pacific basin in 1949. The previous Category 5 landfall was in October 1959, when Hurricane No. 12 made landfall in the Tenacatita Bay, Jalisco, similar to Patricia's trajectory.

c. Central America and the Caribbean

1) Central America—J. A. Amador, H. G. Hidalgo, E. J. Alfaro, A. M. Durán-Quesada, and B. Calderón

For this region, nine stations from five countries were analyzed (Fig. 7.8). Stations on the Caribbean slope are: Philip Goldson International Airport, Belize; Puerto Barrios, Guatemala; Puerto Lempira, Honduras; and Puerto Limón, Costa Rica. Stations located on the Pacific slope are: Tocumen International Airport and David, Panama; Liberia, Costa Rica; Choluteca, Honduras; and Puerto San Jose, Guatemala. For 2015, the NOAA/NCEI GHCN daily precipitation dataset showed a considerable amount of missing data. For some stations, the daily rainfall amount was incomplete, whereas in other cases the value was flagged because it did not pass a quality control test. Precipitation historical records for the above-mentioned stations were recovered from Central American national weather services (NWS). The station climatology (1981–2010) and anomalies for 2015 were recalculated using NWS data by filling the gaps in the daily data records of the NOAA/NCEI database (especially those considered initially as zero based on the flags listed in the metadata of this database). In some stations (e.g., David and Choluteca), differences in precipitation totals between NWS data and the NOAA/NCEI dataset were as high as 420 and 560 mm, respectively, for 2015. In the station climatology, the largest differences were found in David and Liberia (490 and 820 mm, respectively). Previous years' station climatology from the NOAA/NCEI database and procedures used for all variables can be found in Amador et al. (2011).

(i) Temperature

Mean temperature (Tm) frequency distributions for the nine stations are shown in Fig. 7.8. Most stations, with the exception of Limon and Liberia, experienced a higher frequency of above-average daily mean temperatures in 2015. There was a near-normal negative skewness in Tm at Philip Goldson (Tm1) and Puerto Barrios (Tm2) on the Caribbean slope and a near-average number of cold surges during the winter months. Stations in Panama (Tm5 and Tm6) and Honduras (Tm8) show a shift to the right of the Tm distribution with a higher frequency of warm Tm values during 2015.

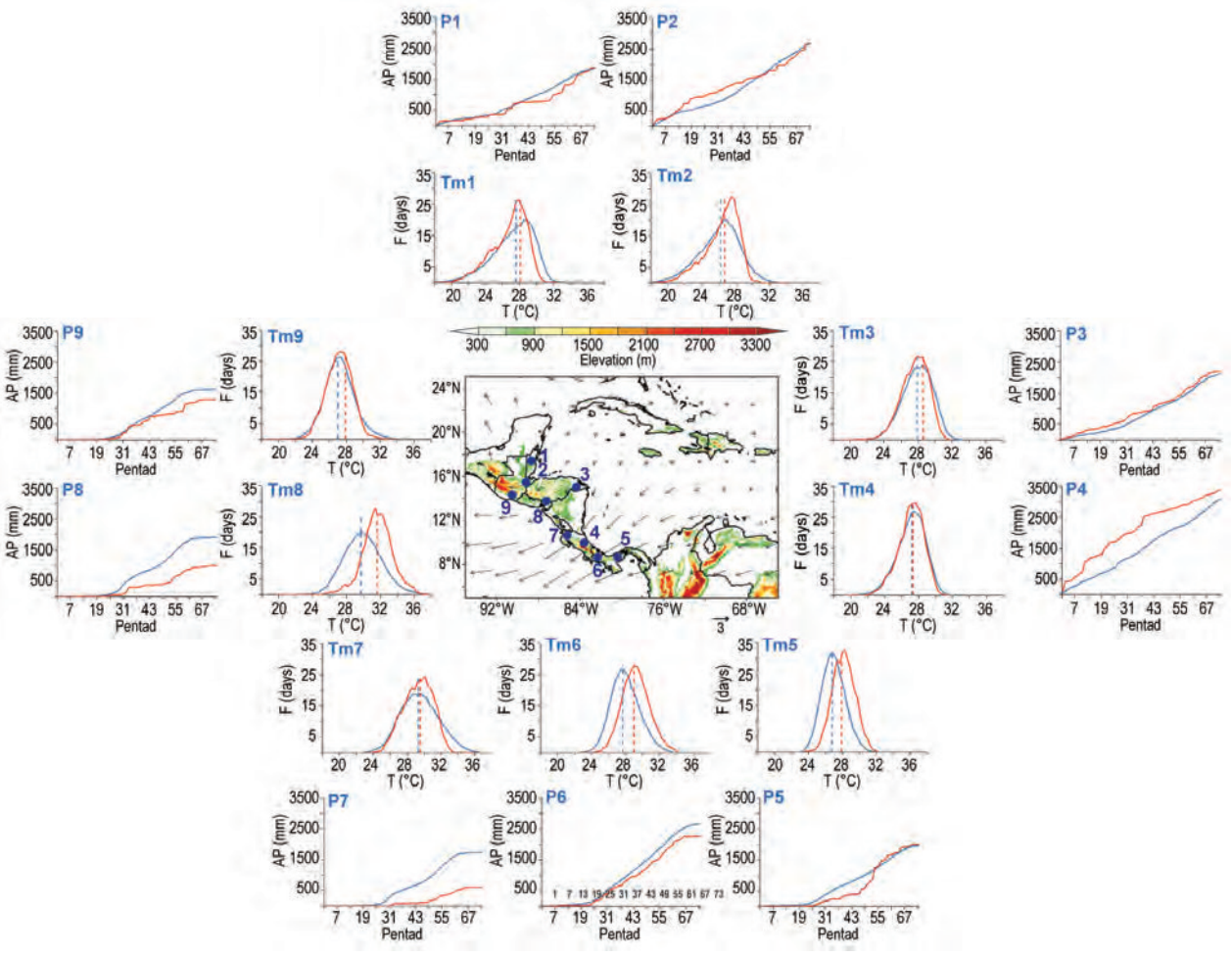

Fig. 7.8. Mean surface temperature (Tm) frequency (F; days) and accumulated pentad precipitation (P; mm) time series are shown for nine stations (blue dots) in Central America: (1) Philip Goldson International Airport, Belize; (2) Puerto Barrios, Guatemala; (3) Puerto Lempira, Honduras; (4) Puerto Limón, Costa Rica; (5) Tocumen International Airport, Panamá; (6) David, Panamá; (7) Liberia, Costa Rica; (8) Choluteca, Honduras; and (9) Puerto San José, Guatemala. The blue solid line represents the 1981–2010 average values and the red solid line shows 2015 values. Vertical dashed lines depict the mean temperature for 2015 (red) and the 1981–2010 period (blue). Vectors indicate July wind anomalies at 925 hPa (1981–2010 base period). Shading depicts regional elevation (m). (Source: NOAA/NCEI and Central American NWS.)

(ii) Precipitation

Annual precipitation totals were below normal at all stations on the Pacific slope (Fig. 7.8). At Liberia and Choluteca, the values were extremely low (in the tail of the distribution at the $p = 0.05$ level), and these areas experienced a long dry spell that extended past pentad 50 (beginning of September). Subsequent rains helped increase the accumulations later in the year, but they were not sufficient to move out of the "extremely dry" classification. A similar type of variation also occurred in Tocumen, where lack of precipitation caused an extremely dry condition until around pentad 47 (third week of August), but subsequent rains led to a close-to-normal annual total. The other stations in the Pacific slope (David and Puerto San Jose) showed no or little indication of this "late-rains" effect. Stations on the Caribbean slope observed relatively normal accumulations at the end of the year. Puerto Limon was extremely wet most of the time from the beginning of the year to pentad 40 (third week of July). A subsequent reduction of rainfall at this station resulted in moderately wetter-than-normal conditions for the year as a whole.

Low-level moisture appeared sensitive to ENSO conditions. Regional rainfall resembled conditions associated with the development of the El Niño event in 2015. Near-surface moisture flux convergence anomalies were computed based on ERA Interim reanalysis data. Results (not shown) reveal that wetter-than-normal conditions in late 2014 evolved into drier-than-normal after spring 2015.

Table 7.1. Summary of events and impacts, including number of fatalities (f), missing people (m), and affected people (a) by country and specific region. [(Sources for the Guatemala landslide in October 2015: www.redhum.org/documento_detail/17300 and the Pacific slope of Cenral America: OCHA-ROLAC (in Spanish: Oficina de Coordinación de Asuntos Humanitarios-Oficina Regional para América Latina y el Caribe, reliefweb.int/sites/reliefweb.int/files/resources/Crisis%20por%20sequia%20en%20America%20Central%20en%202015.pdf)]

Country(ies)	Dates (2015)	Hydrometeorogical Conditions	Fatalities (f) Missing People (m) Affected People (a)	Specific Region
Panamá	22 Sep	Extreme below-average rains	Unknown number of affected farmers, 2500 cattle died	Azuero Peninsula
Costa Rica	27–28 Oct	Floods	4f	Central Valley
	19 Nov	Floods	1f	Alajuela and Corredores
Nicaragua	2–14 Jun	Heavy rainfall and floods associated with low pressure systems	6f, 35 000a	Managua
El Salvador	15–20 Oct	Floods and landslides	4f, more than 210a	San Cayetano, Zaragoza, San Miguel, Luis de Moscoso
Honduras	07–15 Jun	Heavy rainfall, landslides and floods	2f, 2m, 300a	Tegucigalpa
	16–18 Oct	Floods	8f	Central Honduras
	7–8 Dec	Floods and landslides	3f	Northern Honduras
	15 Dec	Landslides	1f	Cuculmeca
Guatemala	7 Jun	Floods and landslides	8000a	Departments of Guatemala, Sacatepéquez, Santa Inés, and San Miguel Petapa
	8 Aug	Floods associated with a tropical wave	5f	Caribbean slope
	13 Oct	Landslides	274f, 353m	El Cambray II Community, and Santa Catalina Pinula
Pacific Slope of Central America	Up to 6 Oct	Extreme below-average rains	An estimated 3.5 million people affected, with more than 2 million in need of food, medical, and sanitary assistance	Azuero Peninsula, Panama; Guanacaste, Costa Rica; Pacific slopes of Nicaragua, El Salvador, Honduras, and Guatemala

(iii) Notable events

Tropical storm activity during 2015 was below average for the Caribbean basin (6°–24°N, 60°–92°W). There were three named storms: Danny, Erika, and Joaquin. Joaquin became a hurricane and reached major hurricane status in early October. No significant impacts were reported for Central America associated with any of these tropical systems. Stronger-than-average Caribbean low-level jet (CLLJ; Amador 1998), 925-hPa winds during July (vectors in Fig. 7.8) were consistent with El Niño (Amador et al. 2006). Central America experienced contrasting hydrometeorological conditions between the Pacific and Caribbean slopes from January to May. The impacts were severe, but different, across the region (Table 7.1).

2) Caribbean—T. S. Stephenson, M. A. Taylor, A. R. Trotman, S. Etienne–LeBlanc, A. O. Porter, M. Hernández, D. Boudet, C. Fonseca, J. M. Spence, A. Shaw, A. P. Aaron-Morrison, K. Kerr, G. Tamar, D. Destin, C. Van Meerbeeck, V. Marcellin, A. C. Joseph, S. Willie, R. Stennett-Brown, and J. D. Campbell

Prevailing El Niño conditions were associated with below-normal annual rainfall and above-normal annual mean temperatures over much of the region (Fig. 7.9). Abundant dry and dusty air from the Sahara Desert in Africa also contributed to the dry weather for the year, particularly during the first six months. The base period for comparisons is 1981–2010.

(i) Temperature

Some Caribbean countries, including Anguilla, Barbados, Cayman Islands, Cuba, Dominican Republic, St. Kitts and Nevis, St. Maarten, and St. Lucia, experienced above-normal to record temperatures during 2015. The average annual temperatures were the highest on record since 1951 for Cuba (26.6°C) and second highest since 1946 for Piarco, Trinidad (27.4°C). Other temperature extremes for Piarco include the highest mean maximum temperature since 1946 for October (33.6°C) and November (32.7°C) and the second highest for August (33.6°C). V. C. Bird International Airport, Antigua, recorded its second-highest maximum temperature of 34.6°C (on 30 September) since records began in 1971 and observed a high mean minimum temperature of 24.5°C for the year, tying the record set in 2001 and 2002. Sangster International Airport, Jamaica, recorded its highest mean maximum temperature for May (33.0°C) since 1973, and Crown Point, Tobago, set records for August (33.2°C), September (33.9°C), and November (33.0°C) since records began in 1969. During October–December, record high mean maximum temperatures were observed in Freeport, Bahamas (25.3°C), and Grand Cayman (31.3°C) since 1990 and 1971, respectively, and the highest absolute maximum temperature was observed for Dominica (35.5°C) in the 45-year record.

(ii) Precipitation

While annual rainfall for 2015 was below normal for most of the Caribbean, contrasting rainfall anomalies were observed in some territories during the first quarter of the year. The January–March rainfall was above normal for Dominican Republic, Grenada, Aruba, Barbados, and eastern Jamaica, and below normal for Anguilla, Antigua and Barbuda, and St. Maarten. St. Thomas, U.S. Virgin Islands, recorded its wettest February (339.1 mm) since 1953. The transition to drier conditions commenced in the second quarter for Aruba, Dominican Republic, and Jamaica, with Dominica, Guadeloupe, St. Kitts, and St. Lucia also recording very dry conditions.

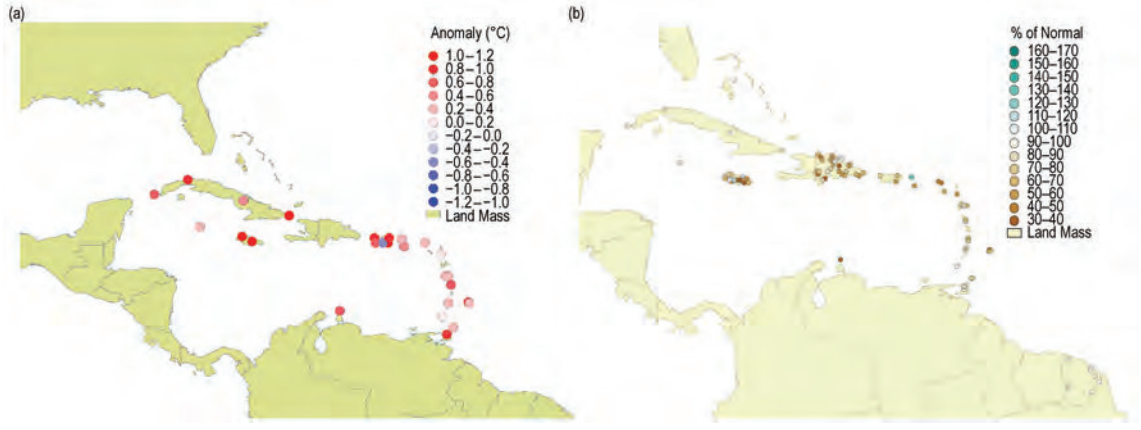

Fig. 7.9. Annual (a) temperature anomalies (°C) and (b) percent of normal (%) rainfall for 2015 across the Caribbean basin with respect to the 1981–2010 annual mean. (Source: Caribbean Institute for Meteorology and Hydrology and the Instituto de Meteorología de la República de Cuba.)