

## Beyond Hurricanes: Marine Analysis and Forecasting at the Tropical Prediction Center

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### 1. INTRODUCTION

The most widely known function of the Tropical Prediction Center (TPC)/National Hurricane Center (NHC) is to issue forecasts and warnings for tropical cyclones (TC). However, the TPC has year-round responsibilities beyond those associated with TC consisting of TPC/NHC outreach, applied research and development by the Technical Support Branch, and marine-based forecasts/warnings issued by the Tropical Analysis and Forecast Branch (TAFB). TAFB issues 104 daily marine and tropical weather-based products which include a suite of text and graphical forecasts, subtropical and tropical surface analyses, tropical weather discussions, and satellite-based rainfall estimates. The TAFB is also an integral part of the NHC and provides operational and forecast support during the hurricane season including TC forecast support, satellite-derived TC position and intensity estimates, radar fixes, media support, and general operational support. Additionally, the unit is actively involved in an outreach program and many of the forecasters participate in TPC research and development. This paper provides an overview of the operations of the TAFB, the suite of year-round forecast products, and current research/development projects by the unit.

### 2. TAFB OPERATIONS

Unlike the NHC, which is fully staffed for operations during the hurricane season, the TAFB is staffed 24 hours a day, 365 days per year and has at least three meteorologists working at all times. The TAFB comprises three operational desks (Atlantic Marine Forecast Desk, Pacific Marine Forecast Desk, and the Tropical Analysis and Forecast Desk) and consists of seventeen full-time employees (five lead forecasters, nine forecasters, two forecaster development interns, and a branch chief). TAFB meteorologists are highly experienced in tropical and marine meteorology and are normally rotated through each of the three desks to maintain proficiency in all areas. The TAFB area of responsibility covers approximately 13,700,000 square nautical miles containing the subtropical and tropical North Atlantic and Eastern Pacific, SE Pacific, Caribbean Sea, and Gulf of Mexico. The large area of responsibility includes both subtropical and tropical regions, and the interaction of mid-latitude and tropical weather systems presents a unique and interesting challenge. In fact, there are two peak periods for TAFB

operations, the summer (tropical storms/ hurricanes) and winter (non-tropical gales/storms). Figure 1 shows the yearly distribution of warnings and indicates that warnings are split almost equally between non-tropical gales/storms and tropical storms/hurricanes. Additionally, the TAFB area of responsibility includes topography-induced gap winds such as those observed within the Gulf of Tehuantepec, Gulf of Papagayo, and Gulf of Panama. These mesoscale phenomena can produce winds to hurricane force and are very challenging to forecast. TAFB shares boundaries and extensively coordinates with other National Weather Service (NWS) offices such as the Ocean Prediction Center (OPC), Hydrometeorological Prediction Center, and coastal NWS Weather Forecast Offices (WFO). Additionally, the TAFB serves as backup to the Aviation Weather Center, OPC, and the Honolulu WFO.

### 3. TAFB TEXT PRODUCTS

Text-based products issued by the TAFB consist of high seas marine forecasts (HSF), offshore marine forecasts (OFF), tropical weather discussions (TWD), a marine weather discussion (MWD), a Pan-American temperature and precipitation table, and satellite rainfall estimates. The HSF is issued every six hours and contains information on current and forecast wind and significant wave heights through forty-eight hours including marine warnings for gale, storm, or TC conditions. The HSF is tailored for large trans-oceanic vessels with a threshold of 20 knots and 8 feet for wind and significant wave heights respectively.

The OFF is tailored more towards smaller vessels thus containing more detailed wind, sea, and weather information. There are no thresholds for wind or sea heights, and the OFF extends to five days. The MWD compliments the OFF by summarizing significant marine weather, operational numerical weather prediction evaluation, current or anticipated changes in the forecast and/or reasoning, recent data, and other marine information. In essence, the MWD is similar to the area forecast discussions issued by the WFO or the TC discussion issued by the NHC.

The TAFB issues a TWD for both the eastern Pacific and Atlantic basins. The TWD is a narrative of significant surface and upper-level weather features such as fronts, troughs, ridges, jets, cyclones, anticyclones, TC, tropical waves, and tropical disturbances. The TWD also includes descriptions of significant convection and the location of the intertropical convergence zone. The Atlantic TWD covers the area between western Africa and 100°W longitude including the Caribbean Sea, Gulf of Mexico, northern portions of South America, Central America,

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and Mexico. The eastern North Pacific TWD includes the area between 80°W and 140°W longitude including portions of Central America and Mexico. The Atlantic TWD is generally more detailed with more focus on middle to upper-level features than the East Pacific TWD. Both are issued every six hours. Additional text products include a Pan-American Temperature and Precipitation Table issued twice daily and satellite-based rainfall estimates issued when a TC or convective system threatens land.

#### 4. TAFB GRAPHICAL PRODUCTS

The TAFB issues a suite of graphical forecast products including the Atlantic and Pacific wind/wave forecast charts, surface forecast charts, an Atlantic sea-state analysis, peak wave period/primary swell direction forecast charts, a TC danger graphic, a high wind/wave graphic, and surface analyses over the tropics and subtropics.

The surface analysis is a wide-area tropical and subtropical synoptic-scale surface pressure analysis issued four times daily (every six hours) at the synoptic times. The surface analysis includes all significant surface features such as troughs, fronts, highs, lows, tropical waves, tropical disturbances, and TC. Current and anticipated marine warnings as well as 24-hour forecast positions and intensity (pressure) for lows, highs, and TC are also depicted. The surface analysis is one of the more time-consuming products issued by TAFB requiring extensive coordination with other forecast offices/centers. The analysis is started at the synoptic times (0000, 0600, 1200, and 1800 UTC) and generally takes between 2.5-3 hours to complete. Additionally, the TAFB produces limited area intermediate analyses at 0300, 0900, 1500, and 2100 UTC which are utilized by the HPC.

The Atlantic sea-state product includes significant wave heights (contoured every three feet) along with primary swell direction and is issued twice daily, at 0000 and 1200 UTC. The analysis is based upon latest ship observations, remotely sensed data where available, and numerical model guidance. The wind/wave forecast charts are issued for both the Atlantic and eastern Pacific regions and include wind vectors (direction and magnitude) along with significant wave height contours (every 3 feet). For the Atlantic basin, 24, 48, and 72-hour forecasts are produced. The 24-hour forecast graphic is issued 4 times daily while the 48 and 72 hour graphics are issued twice daily. For the Pacific, a nowcast is included with the 24-hour forecasts as a two-panel chart and is updated every 6 hours. The 48-hour forecast is issued twice daily while the 72 hour forecast is issued once daily. The peak wave period and primary swell direction chart distinguishes the locally generated wind waves (in cases with strong local winds) from the larger period waves (swells) that typically propagate large distances from their generation/source region. A 48-hour forecast graphic is issued twice daily and a 72-hour forecast is issued once daily for both the Atlantic and East Pacific.

A TC danger and high wind/wave graphic outlines areas of current or anticipated hazardous weather. The TC danger graphic is issued from May 15 through November 30. Current TC forecast track and danger areas for each active system are depicted as a shaded region within the graphic. Danger area is determined by adding 100-200-300 nautical miles to the 24-48-72 hour forecast position and maximum 34 knot wind radii respectively. The values used in determining danger areas are based on the latest 10-year average error in forecast tracks issued by the NHC. Additionally, the TC danger graphic depicts areas of possible TC formation/development. The high wind/seas graphic is issued from December 1 to May 15. The high wind/seas graphic outlines areas of high wind (greater than 25 knots) along with corresponding sea/wave heights. Information depicted on the high wind graphic is taken from the latest text high seas forecast.

#### 5. TAFB OUTREACH AND RESEARCH

In addition to providing year-round operational marine and tropical forecasts, the TAFB also participates in NWS outreach aimed at informing the public on both marine and general weather hazards. Past events include numerous boat shows, Coast Guard meetings and conferences, sailing/yacht club meetings, fishing shows, ocean/dive shows, youth fairs, and school career days. Many of these events offer tremendous visibility given the large amount of attendees. Additionally, TAFB forecasters edit and/or publish manuscripts on boater/marine safety and general marine/tropical weather. The TAFB routinely publishes seasonal weather summaries and general weather articles within the *Mariners Weather Log* and aids in the production of NHC post-storm reports. Many TAFB forecasters are also involved in research, applications development, and verification. Recent research topics include analysis of Gulf of Tehuantepec events, new satellite-derived tools and applications, TC forecasting and numerical weather prediction, climatology, and seasonal TC forecasting. The wide scope of weather features affecting the TAFB area and the numerous TAFB research and outreach activities, make the TAFB an exciting and busy TPC unit year-round.

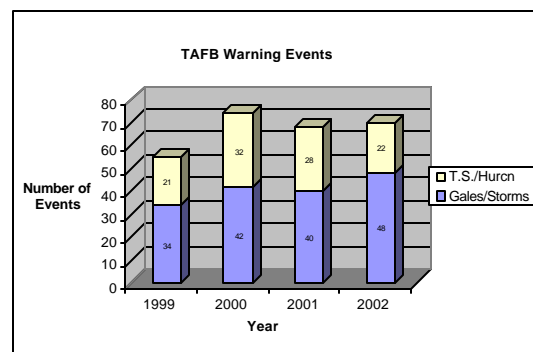


Figure 1. Yearly distribution of TAFB warning events by category (storm/gale versus tropical storm/hurricane).