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SIGNIFICANT CHANGE FROM LAST BULLETIN ON THIS SUBJECT NO. 353

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This bulletin, prepared by Mr. Lawrence D. Burroughs of the National Meteorological Center (NMC), describes the automated Santa Ana forecast guidance system, which was first implemented in 1985. The system forecasts the presence or absence of Santa Ana conditions and the associated winds at the following stations: Naval Air Station Point Mugu, Calif. (NTD); Marine Corps Air Station Santa Ana, Calif. (NTK); Catalina Ridge Buoy (46025); Naval Facility San Nicolas Island, Calif. (NSI); and Naval Air Facility San Clemente Island, Calif. (NUC). The wind forecasts for the Santa Ana Forecast System and the Coastal Wind Forecast System are made with modified perfect prognosis (MPP) equations, while the Santa Ana regime forecast equations are perfect prognosis (PP) equations.

The changes described in this bulletin were implemented on December 12, 1990. Users were notified of the change in National Technical Information Message (NTIM) 90-8, which was issued on December 10, 1990. The AFOS product identifier for the NTIM is WSHPNSNMC and the WMO header is NOFS10 KWBC.

Technical Procedures Bulletin No. 353 is now operationally obsolete.

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FORECAST GUIDANCE FOR SANTA ANA CONDITIONS

by Lawrence D. Burroughs[1]

1. INTRODUCTION

The Glossary of Meteorology (Huschke, 1959) defines a Santa Ana as a "... hot, dry, foehn-like desert wind, generally from the northeast or east, especially in the pass and river valley of Santa Ana, Calif., where it is further modified as a mountain gap wind...". Actually, all of southern California is affected. Wind speed and direction on the California coast depend on synoptic scale events, interaction of the Santa Ana circulation with the sea breeze circulation, and topography. Intensity and duration of Santa Ana conditions are also dependent on synoptic forcing, mesoscale interaction, and topographic effects (Rosenthal (1972) and Richardson (1973)). Additional details, particularly about the vertical structure of Santa Anas, are given by Fosberg et al. (1966). The season for Santa Anas is generally from October through May. They have been known to occur as early as mid-September or as late as mid-June. The centrally produced forecast guidance is available from October through May.

The Santa Ana is generally thought of as a fire weather problem; however, it can also be a marine weather problem. This is particularly true for the San Pedro and Santa Barbara Channels and for the boat harbor at Avalon, Santa Catalina Island. The Santa Ana forecast system forecasts the presence or absence of Santa Ana conditions and the associated winds at NTD, 46025, NTK, NSI, and NUC (see Fig. 1).

There are three major synoptic events which, when they occur simultaneously, normally give rise to Santa Ana conditions over southern California. These are the development of high pressure over the Great Basin, the passage of fronts through southern California, and the development of a 500-mb wave centered near the west coast of the United States, such that air flows from the Northeast over the coast range of mountains in southern California. There is a fourth synoptic event that rarely occurs but which gives rise to some of the most intense Santa Ana winds at the coast. This event is the development of a surface low off the southern California coast in addition to the above conditions. The resulting Santa Ana is often associated with showery, unstable conditions and winds of gale, or even storm, strength.

According to Fosberg et al. (1966), the Santa Ana is primarily a lee wave phenomenon, and air flow is nearly isentropic. When the amplitude of the waves is large, they reach the earth's surface (this is often referred to as surfacing.); when the amplitude is small, they don't. There are periodic and aperiodic components in the surfacing. The periodic effects are associated with the interaction of localized circulations, such as the sea breeze, with the mountain waves. The aperiodic effects are determined by the static stability and wind structure upwind of the mountain barrier and are the prime factors in the surfacing.

The following definitions are made to distinguish between the conditions that bring about the formation of mountain waves associated with Santa Ana weather and the conditions that result from the surfacing of the mountain waves:

Santa Ana Burst - A single period of continuous Santa Ana surface winds (averages 6 to 8 hours in length).

Santa Ana Regime - An overall synoptic scale event usually lasting 36 hours and consisting of more than one burst separated by less than 24 hours between bursts.

1 Ocean Products Center Contribution No. 36

Since 1985, several events have occurred or are planned to occur which made it necessary to redesign the Santa Ana Forecast System. These events include the closing of one station; the addition of two new buoy stations; and the withdrawal of the Limited-area Fine-mesh Model (LFM) from the NMC operational job stream sometime in 1992. As a result of these events, a new Santa Ana Forecast System has been designed. The overall size of the new system has increased from 5 to 6 stations. The bulletin format for the wind forecasts has changed from forecasts at 3-h intervals out to 48 hours to forecasts at 6-h intervals out to 48 hours because it was not possible to derive equations at 3-h intervals. Additionally, the Santa Ana Forecast System has been converted from an LFM-based package to an Regional Analysis and Forecast System (RAFS)-based package.

The system forecasts the presence or absence of Santa Ana conditions and the associated winds at the following stations: NTD, NTK, 46025, NSI, and NUC. When a strong Santa Ana is forecast, special equations are used to make the wind forecasts at these stations. When no Santa Ana or a weak Santa Ana is forecast, the coastal wind forecast equations (NWS, 1991) are used at these stations. Wind forecasts at Point Conception Buoy (46023) are also included because it is located in the area covered by the Santa Ana wind bulletin. The winds at 46023 are rarely affected by Santa Ana conditions, so only forecast equations from the Coastal Wind Forecast System are used to make forecasts for it.

The new forecast equations were implemented in conjunction with the redesigned Coastal Wind Forecast System on December 12, 1990. Users were notified of the change in National Technical Information Message (NTIM) 90-8, issued on December 10, 1990. The AFOS product identifier for the NTIM is WSHPNSNMC and the WMO header is NOFS10 KWBC.

2. METHOD

A single station approach based on the MPP technique was used to derive new wind forecast equations which are used when strong Santa Anas are forecast. A set of equations was developed for each site. The MPP approach uses LFM initialization (00) and 6-h model (06) projection as though they were perfect analyses and relates them to the appropriate observed data. Two sets of equations were derived - one for each cycle. These special equations are only valid during the Santa Ana season from October through May. To derive the 0000 UTC cycle 00-h equation (eq 1), predictors from the LFM 0000 UTC initialization were related to the observed u-wind and v-wind components and to the observed wind speed at 0000 UTC. Likewise, predictors from the LFM model 06-h projection on the 0000 UTC cycle were related to the observed winds at 0600 UTC (eq 2). Predictors from the LFM 1200 UTC cycle initialization were related to observed winds at 1200 UTC (eq 3). Predictors from the LFM model 06-h projection on the 1200 UTC cycle were related to the observed winds at 1800 UTC (eq 4). RAFS model output are then used with these equations to produce forecasts at each projection from 6 - 48 hours as shown in Table 1.

RAFS PROJ	RAFS 0000 UTC CYCLE	RAFS 1200 UTC CYCLE
06	Eq 2	Eq 4
12	Eq 3	Eq 1
18	Eq 4	Eq 2
24	Eq 1	Eq 3
30	Eq 2	Eq 4
36	Eq 3	Eq 1
42	Eq 4	Eq 2
48	Eq 1	Eq 3

Table 1. The application of the modified perfect prognosis forecast equations to each cycle and projection of RAFS output. Equation identification is given by equation number (eq) as explained in the text.

The PP technique was used to develop forecast equations for Santa Ana conditions at the coast. The potential predictors were taken from a subset of grid-point data from LFM initializations on both the 0000 and 1200 UTC cycles for the years 1978 through 1988. Categorical predictand data were developed for the same period. Categories are no Santa Ana, weak Santa Ana,