Introduction

The large variations in terrain features in Southern California (mountain areas to over 11,000 feet MSL, desert areas below -200 feet MSL, and its proximity to the Pacific Ocean) creates significant difficulty for forecast models to accurately resolve weather features in Southern California (fig. 1). The High-Resolution Rapid Refresh (HRRR) model, NOAA’s real-time 3-km resolution, hourly updated, cloud-resolving atmospheric model, (initialized by 3-km grids with 3-km radar assimilation over a 1-h period) has been incorporated into the National Weather Service San Diego warning/forecast process in order to address this challenge. We have had some recent opportunities to examine the HRRR in action. One case was a cold front event with strong winds, which makes timing the front through the area a very critical part of an aviation forecaster’s “problem of the day.” Another case was a cold front event with strong winds in the desert, which can easily produce strong winds for hundreds of miles, reduce visibility, and sometimes creating additional thunderstorms when it encounters high terrain, terrain related flows, or the sea breeze flows, or the sea breeze (including gusts wind). Another case was a low pressure system as a “problem of the day”. Another case was a cold front event with strong winds, which the forecaster can determine when the crosswind is likely to develop as well as the potential drop in ceiling/visibility in heavy rain and fog.

Strong Cold Frontal Passage Case

During the morning of 12 December 2014 a strong cold front moved through Southern California. This brought strong winds associated with the front. The winds were from the south ahead of the front, which creates wind shear and crosswind issues as the runway orientations of the major airports are often east-west. When the crosswinds reach about 25 knots (29 mph), issues develop concerning landing of aircrafts. Also an airport weather warning is issued for events when wind gusts reach or exceed 30 knots (35 mph). The 0000 UTC 12 December 2014 run of the 3-km HRRR (fig. 2) did a fine job of showing the frontal position and wind strength, with 30 knot (35 mph) wind gusts in table 1, reasonably consistent with the 30 knot southerly wind in the model.

The 30-31 December 2014 Low Elevation Snow Event

On 30-31 December 2014 a very cold low moved into southern California. The 3-km HRRR 15 hour forecast of the Run-Total Accumulated Snow/Sleet using the 10:1 ratio (inches) valid the following morning at 1500 UTC 31 December 2014 (from the 0000 UTC 31 December 2014 run) shows snow/sleet across western Riverside County (including the valleys). Legend amounts in inches.

Thundershower Outflow/Gulf Surge Case

During the evening of 24 August 2015 through the morning hours of 25 August 2015, a strong cold front moved through Southern California. Convection along with surface pressure gradients allowed strong southerly wind gusts to reach Palm Springs International Airport (KPSP) and Thermal Airport [also known as Jacqueline Cochran Regional Airport (KTRM)]. The winds reached Thermal at around 1552 UTC on 25 August 2015 (Typically a late night and early morning phenomena). The model was able to capture this event (fig. 2 and Table 2).

Summary and Conclusions

Although some of the biggest winter storms, most unstable episodes, and the highest frequency of heavy rain events was shown to peak in February for the 1998-2005 period, [strongly skewed by the very strong El Niño Event of 1997-1998 (Small, 2007)], some fairly sizable events have already occurred during the early part of the 2015-2016 very strong El Niño (including flash flooding and severe weather). With February 2016 closing in, there is the potential for a similar pattern to set up to the south. Although the 12 December 2014 event was only one frontal case, it is anticipated that similar events will be caught by the 3-km HRRR during the 2015-2016 El Niño that will result in timely forecasts of frontal impacts in Southern California. Outflow boundary and gulf surge events have been tricky at best in the past when attempting to determine their impact in Southern California using the lower resolution models. Based on the 25 August 2015 case, this higher resolution 3-km HRRR model can indeed catch some of the subtle details surrounding such events, and should help to improve forecasts of blowing dust, shifting winds, and thunderstorms generated by "topographical updrafts" (outflows flowing up mountain slopes) in the future. In the 30-31 December 2014 low elevation snowfall case the HRRR showed that it can handle rare events, (for example, in this case when snow covered the valley area). There was also snow west of the mountains in what was at the time a "coastal area forecast zone" (snow was accumulating below 1500 feet MSL just east of Irvine).

References


Table 1. Table 1 is a snapshot of the MESOWEST surface observations for Lindbergh Field (KSAN). The weather elements of note are in red (strong wind gusts, crosswinds, low ceilings, and low visibilities). Note the wind shift from a southerly crosswind at 14:44 UTC to westerly winds (with little crosswind component remaining) by 15:22 UTC (7:22 am local time).

Table 2. Table of observations for Riverside March Air Reserve Base (KRIV). The field is only at about 1356 feet MSL.

Table 3. Table of observations for Impact Weather, the 89th American Meteorological Society Annual Meeting, Phoenix, AZ.