Analysis of mesoscale rapidly occluding storm causing severe atmospheric anomalies in Southern California on February 28th, 2014

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Abstract

There are always good compliments on California's weather because no matter the season of the year a pleasant atmosphere usually prevails, until an alarming event changed the life course of 22 million of Southern Californians. On February 28th, 2014, Southern California experienced the largest thunderstorm since the storms of December 2010. The continuous progressivity of a strong and rapidly-occluding storm off the coast of California roaring from the Pacific Ocean led to flash flooding including mud and debris flows in certain zones. In order to understand the tough effect this storm had upon the zone, time-series of 125 NWS and RAWS weather stations are tested including at least 80% of hourly observations for a period of 72 hours. The substantial amounts of extreme precipitation were along the southern slopes of the San Bernardino County mountains, with Yucaipa Ridge reaching 11.11 inches, Lytle Creek with 9.67 inches and Cedar Glen with 9.10 inches. The occluding storm off Southern California's cost led to continuous flash flooding and winds of up to 77mph in different zones. An indication of the strength of the storm was the high amount of GOES-15 sounder Total Column Ozone associated with its circulation, which reached levels as high as 440-450 Dobson Units. Additional numerous arc-shaped mesospheric airglow waves in the storm circulation suggest that a 140-knot jet streak propagated them vertically in the southward direction.

Motivation

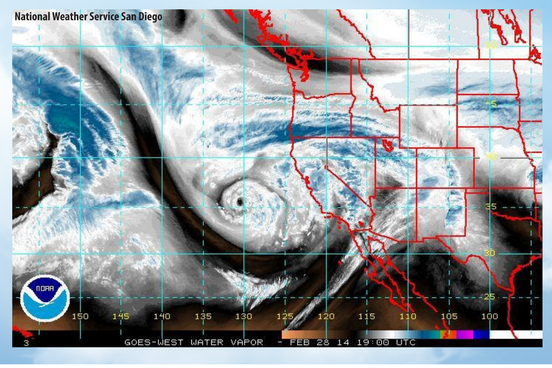
The goal of this research project was to increase understanding of how a mesoscale occluding storm can affect Southern California as it moves rapidly in a matter of hours.

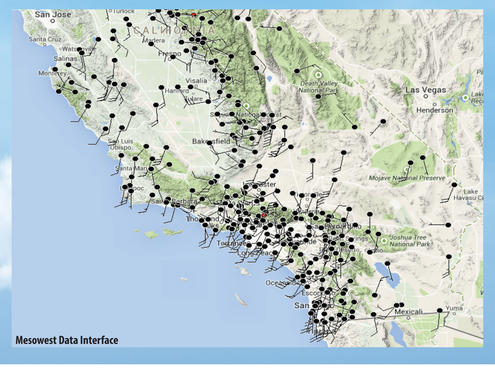
This information can be used to analyze the strongest storm of Southern California during 2014 since the Winter of 2010.

Methods

- Chose 125 weather stations consisting of Remote Automatic Weather Stations (RAWS) and National Weather Service (NWS) stations.
- Observed stations in Southern California during a period of 72 hours from February 28th to March 2nd, 2014. They were tested to measure the amount of hourly precipitation.
- Created a database of the total storm precipitation and plotted the orographic effect of the storm's precipitation in relation to the stations' elevation.
- Collected reports from the storm's effects including high winds, fash flooding and mud and debris flows in different zones of Southern California.
- Visually compared the water vapor channel in relation to total column ozone product, cloud-top IR brightness, cloud-to-ground lightning strikes through the Advanced Weather Interactive Processing System (AWIPS) image of Geostationary Operational Environmental Satellite (GOES-15).
- Analyzed additional Suomi NPP VIIRS Day/Night Band to observe the airglow waves produced by storm.

Results

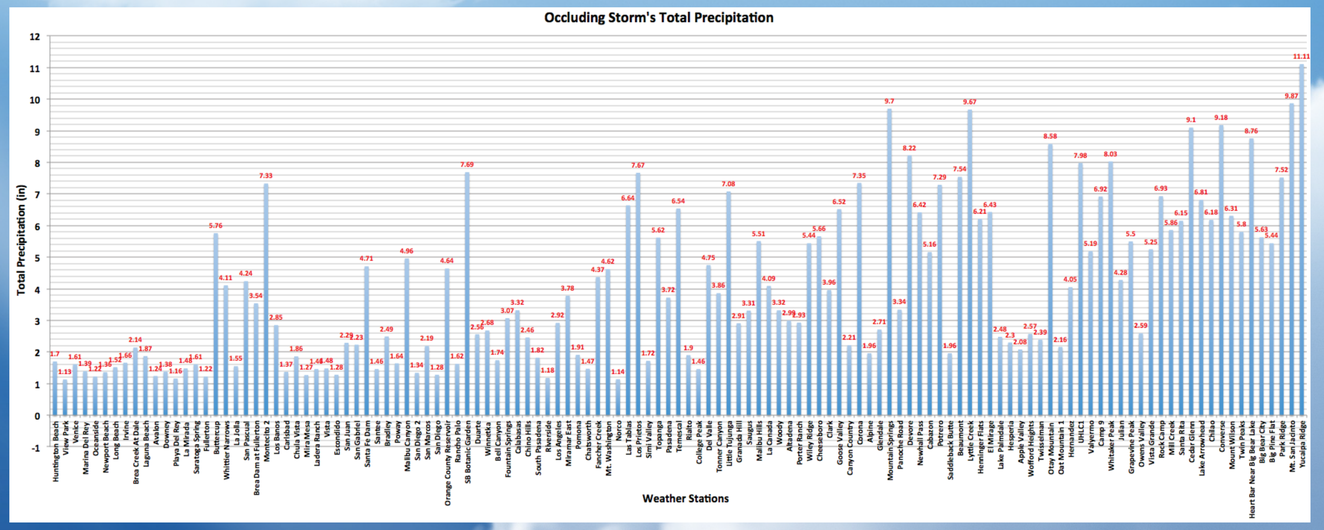


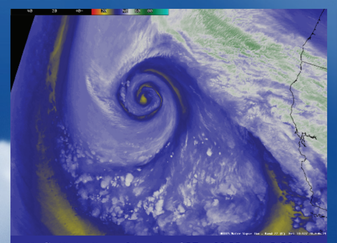


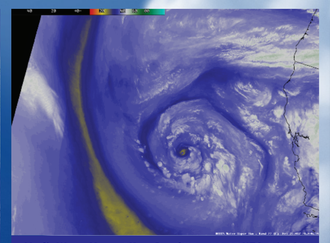
Left satellite image shows the winter storm with 970mb central pressure which pushed bands of rain into Southern California on February 28th, 2014.

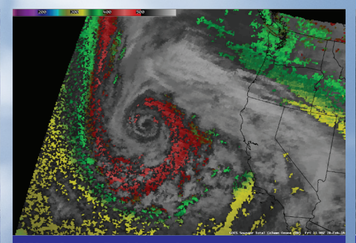
Map on right shows the NWS and RAWS weather stations' locations.

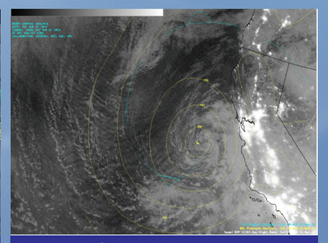
Bottom plot shows the orographic effect of the occluding storm's total precipitation in relation to the elevation of 125 stations.

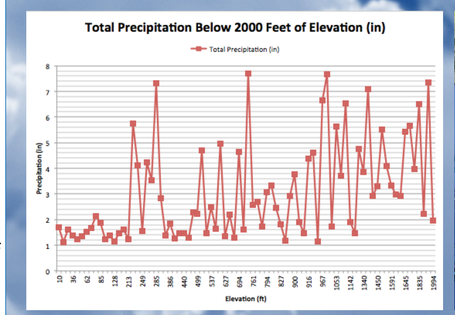


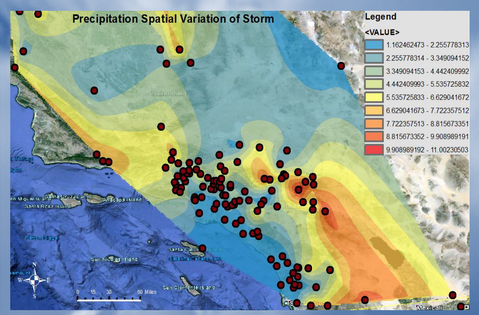

Modis Water Vapor 1Km - Band 27 10:32 UTC 2/28/14

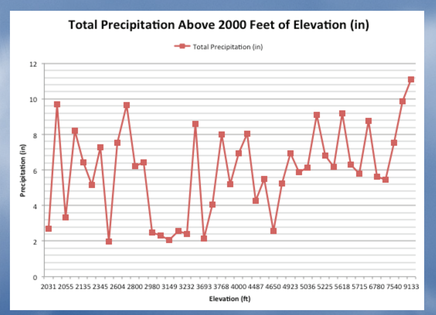

Modis Water Vapor 1Km - Band 27 21:40 UTC 2/28/14


GOES-15 Sounder Total Column Ozone product 16:00 UTC 2/28/14


Suomi NPP VIIRS 0.7 Âµm (DNB) MSL Pressure Analysis 10:22 UTC 3/1/14







Discussion/Future Work

- Look closer at wind speeds, sea level pressure, solar radiation and atmospheric pressure variations of every station in response to the storm's progressivity.
- Examine possible weather trends why a strong storm had not occurred such as this one since 2010.
- Look at other cases that were a product of this occluding storm effects such as in Northern California and other parts of the West Coast.

Conclusions

- When comparing storm total precipitation, there was a correlation between elevation and the total precipitation obtained from weather stations. Overall, the lower the elevation, the less total precipitation that was recorded and the higher the elevation, the higher total precipitation that was recorded.
- There was no true correlation between total precipation and time intervals as the highest precipitation widely varied from station to station in different zones.
- The occluded storm had 970 mb central pressure which weakened on February 28th, 2014 but its effects brought strong gusty winds, flash flooding, debris flows, heavy rain and flooding to all Southern California.
- The average precipitation of the storm for the 125 weather stations tested was of 4.05 in. The average precipitation for stations below 2000 ft of elevation was of 3.03 in, while the average precipitation for stations above 2000 ft of elevation was of 6.00 in.
- The high amounts of GOES-15 sounder Total Column Ozone associated with the circulation show that the storm reached levels as high as 440-450 Dobson Units indicating that the dynamic tropopause was below the 480 hPa pressure level.
- A comparison of Suomi NPP VIIRS 0.7 Âµm Day/Night Band (DNB) and 11.45 Âµm IR channel images revealed the presence of numerous arc-shaped mesospheric airglow waves in the western semicircle of the storm circulation on the DNB image

Acknowledgements

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