Spatial Distribution of Precipitation for Winter Storms in Northern California

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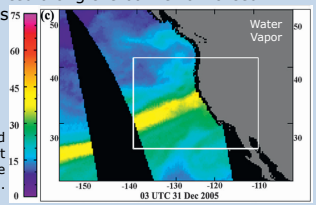
I. Introduction

Purpose

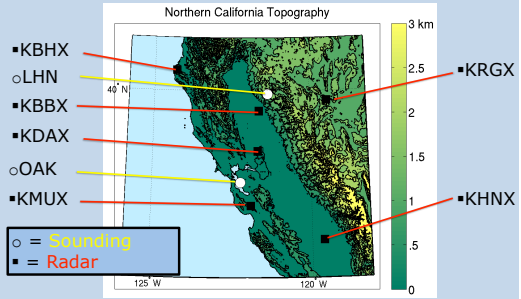
To better understand the interaction between land-falling atmospheric rivers (ARs), which are narrow bands of air with enhanced low level moisture, and the terrain in Northern California. When air flow encounters high elevation terrain, the air can either be diverted along the barrier or forced upward through a process called orographic lifting. This process can lead to enhanced precipitation and, in some cases, regional flooding.



SSM/I Satellite integrated water vapor measurement [mm][1]. The yellow band is the AR for the Dec 31 2005 storm.

Study Domain

◆ Six National Weather Service radars (red) and two sounding sites (yellow) are used to observe AR storms.

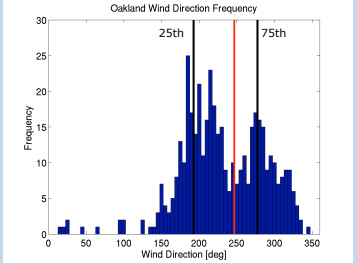


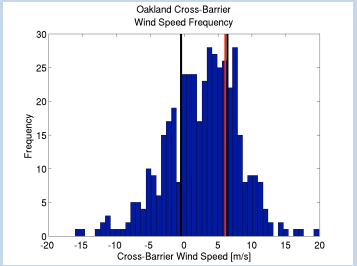
Datasets

Sounding Location and Date	Number of Soundings	Time Distribution of Data
Oakland (OAK) from Oct. 1997 – Apr. 2011 during all AR storms	439	Every 12 hours
Lincoln (LHN) from Dec. 2010 – Mar. 2011	68	Launched intermittently (~ every 4 hours during events)

NWS WSR-88D Radar Locations	Number of Volumes and Dates	Time Distribution of Data
Sacramento (KDAX), Beale Air Force Base (KBBX), San Joaquin Valley (KHNX), Eureka (KBHX), San Francisco (KMUX), and Reno, Nevada (KRGX)	~ 1080 at each location from Dec 29 2005 to Jan 01 2006	1 sweep every 4-6 minutes during the storm

II. Environment





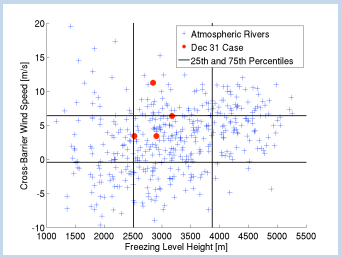
The 29-31 December 2005 storm caused major flooding along the Russian, Napa, and Truckee Rivers, several mudslides, and flooding in the streets of San Francisco and Reno.

◆The Dec 31 2005 (red line) storm had a southwesterly wind typical for AR storms.

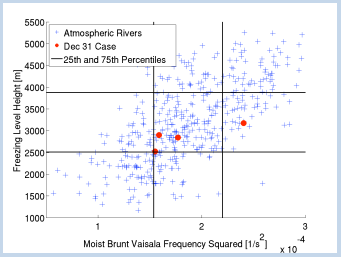
◆ The Dec 31 2005 storm (red line) had wind speeds in the 75th percentile of wind speeds for AR storms.

Black lines indicate the 25th and 75th percentile values.

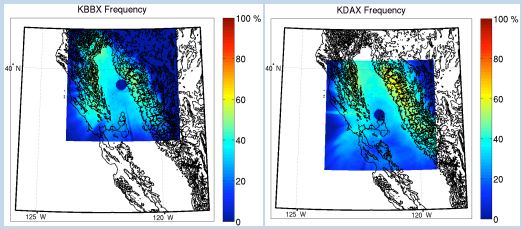
◆ The Dec 31 2005 storm had typical freezing level heights and cross-barrier wind speeds that ranged from typical to high compared to other AR storms.
◆ Most high (4000+ m) freezing level heights occur when cross-barrier winds are greater than the 25th percentile.



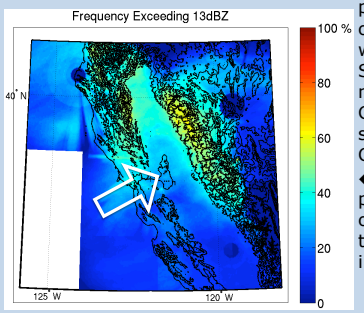
◆ The Dec 31 2005 storm had stable low level air.
◆ Higher stability is associated with higher freezing level in AR storms.



III. Composite



◆ Radar reflectivity frequency of values exceeding 13 dBZ (~ 0.2 mm hr^{-1}) was found at each grid point for each of the six radar locations (two shown above).
◆ The six images were then combined onto one image by finding the maximum frequency at each grid point shown below).



◆ Frequent precipitation occurs on the windward slope of Sierra Nevada north of Petaluma Gap and leeward slope of North Coastal Range.
◆ Less frequent precipitation occurs south of the Petaluma Gap in the Sierras.

◆ Arrow indicates air flow through the Petaluma gap.

Conclusions

◆ Low level moisture is carried through the Petaluma Gap and across the Sierra Nevada range.
◆ Some moisture is also carried northward along the base of the Sierra Nevada, resulting in stronger precipitation north of the Petaluma Gap.

Future Work

◆ Relative calibration adjustments need to be made to the radar data to smooth out discontinuities.
◆ Additional storms need to be examined.

Acknowledgements

◆ [1]Smith, et al., 2010: Water vapor fluxes and orographic precipitation over Northern California associated with a land-falling atmospheric river. Mon. Wea. Rev., 138, 74-100.
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◆ Thanks to A. Hall, J. Cunningham, N. Hardin, M. Miller, and D. Kingsmill for their assistance and advice.
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