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Partners or Cooperative Project: Partners

Project Title: Improving Severe Downslope Winds and Lee Wave Rotors Forecasts using GOES-R Proving Ground Products and High-Resolution Modeling

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Section 1: Summary of Project Objectives

1.1 The project plans to: 1) improve the predictability of severe downslope winds, lee waves, and rotors using the GOES-R proving ground products as well as high resolution modeling perspective; and 2) to establish a real-time downslope winds monitoring website for the county warning area of the WFO Las Vegas (e.g., Owens Valley, CA and Las Vegas Valley, NV). Two rotor events (April 27, 2010 and March 20, 2011) were selected. The WRF-ARW was employed to conduct numerical experiments for these two cases. Some simulation results were presented at the 2013 AMS annual meeting.

1.2 The NWS Las Vegas office provides observational datasets (satellite images, soundings and weather discussions). SJSU performs numerical simulations. The synthetic WRF product for March 20, 2011 event was provided by the Cooperative Institute for Research in the Atmosphere (CIRA). The synthetic imagery is a Proving Ground Product because it replicates how actual features will appear in GOES-R ABI bands.

Section 2: Project Accomplishments and Findings

The real-time WRF-ARW 4 km forecasts over the Las Vegas WFO County and Warning Forecast Area is available at http://www.met.sjsu.edu/weather/models/wrf_vegas.html

In addition to the real time products, two severe rotor/downslope wind events affecting the entire County and Warning Forecast Area (CWFA) were investigated in this project using the WRF-ARW model. The focal point of this study is to conduct microphysics sensitivity tests to better forecast rotors events in the Las Vegas area. Rotors and severe downslope wind events have been well documented. However, very few have tested the effects of thermodynamics on these events in the United States. The results of the 1-km grid spacing resolution WRF model was validated

using the Remote Automated Weather Stations (RAWS) in the area. The parameters of temperature, wind speed, and wind direction were used to evaluate WRF model performance in forecasting rotors and severe downslope winds. Figure 1 shows the 1 km resolution domain and surrounding RAWS stations in the area were adopted in the evaluation for April 27, 2010 and March 20, 2011 events, respectively.

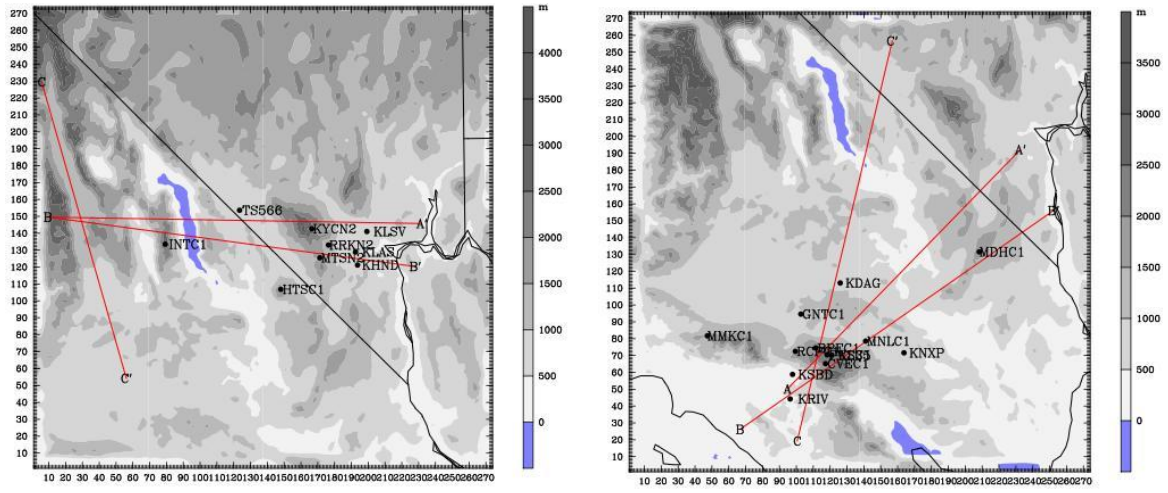

Figure 1: The 1 km resolution domain for (a) April 2010 event and (b) March 2011 event, respectively.

The simulation results show that the WRF-Single-Moment 3 class (WSM3) performed best with wind speed and temperature for the April event (Table 1). However, the March event contained no significant microphysics scheme that best fit the event (Table 2). The stations in complex terrain have lower correlation values.

Figure 2 shows WSM3 performance in forecasting rotor clouds formation during the event, which indicated the possibility of using the model results to future evaluate the GOES-R proving ground products. Unfortunately, the GOES-R proving ground products such as the Overshooting Top Detection product, the Tropopause Folding Turbulence Prediction product and the Downslope Mountain Wave Turbulence product are not available at this moment.

The preliminary results show that the rotor formation and severe downslope winds are recaptured well from the high resolution simulations. The model performs well in forecasting wind speeds and temperatures for the April event. However, the majority of the March event's model run was under forecasted with low correlation values except for the stations located in lower terrain. This is most likely due to most of the stations location in or around the mountain range. Further studies will investigate temperature inversions in complex terrain and the formulation of an ensemble forecast model.

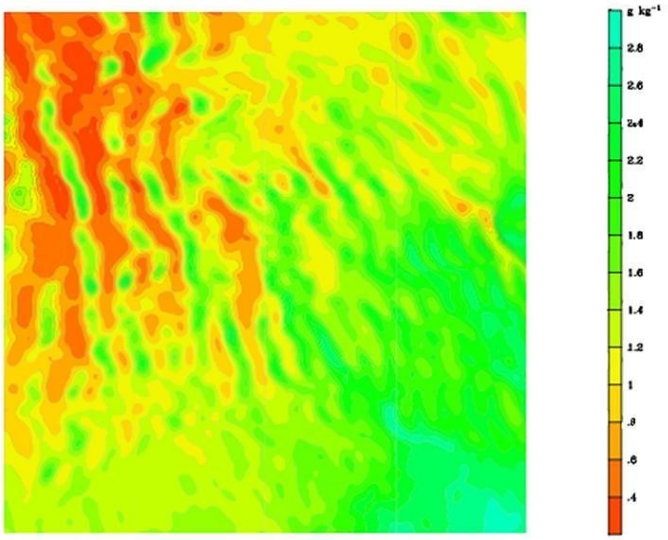

Figure 2: April event horizontal water vapor mixing ratio over the 1 km domain at 00 Z from WSM3 simulation.

Table 1: April Event Microphysics Correlation			
Station ID	Wind direction	Wind speed	Temperature
HTSC1	KESSLER	WSM6 0.71	KESSLER 0.84
KHND	NAN	WSM3 0.81	WSM3 0.95
KLAS	NAN	WSM3 0.79	WSM5 0.95
KLSV	NAN	WSM5 0.91	WSM3 0.96
KVGT	NAN	WSM3 0.86	WSM3 0.97
KYCN2	WSM5	WSM3 0.91	WSM6 0.80
MTSN2	THOMPSON	WSM3 0.91	WSM3 0.87
RRKN2	WSM6	WSM3 0.77	WSM3 0.75
TS566	WSM3	WSM3 0.93	WSM3 0.96

Table 2: March Event Microphysics Correlation			
Station ID	Wind direction	Wind speed	Temperature
BPFC1	WSM6	WSM6 0.62	WSM3 0.64
CVEC1	WSM3	WSM6 0.39	THOMPSON 0.51
FWSC1	LIN	LIN 0.74	THOMPSON 0.64
GNTC1	WSM3	WSM3 -0.25	WSM6 0.73
KDAG	NAN	LIN 0.37	LIN 0.80
KL35	NAN	WSM6 0.50	WSM6 -0.07
KNXP	NAN	WSM6 -0.43	LIN 0.67
KRIV	NAN	WSM6 0.79	KESSLER 0.84
MDHC1	WSM6	WSM5 0.30	THOMPSON 0.71
MNLC1	WSM3	WSM3 0.69	LIN 0.79
RCPC1	WSM3	KESSLER 0.82	WSM6 0.80

Section 3: Benefits and Lessons Learned: Operational Partner Perspective

Partnerships between university researchers and the NWS operational forecasters are of paramount importance. It is with these relationships that develop new operational strategy to better forecast and model our high impact weather. Specifically, the relationship between the San Jose State and the NWS Las Vegas has fostered a study to investigate the effects topography has on downslope wind and lee waves may locally affect the weather across the county warning areas and surrounding areas. That said, further investigation and better, high-resolution modeling could be employed to identify the effect of downslope wind events in the Las Vegas Valley.

Further studies, such as rotors, may help to identify the causative effects specific wind flow patterns may initiate, assisting operational forecasters with advancing lead time on those high impact weather events.

Section 4: Benefits and Lessons Learned: University Partner Perspective

The collaboration between SJSU and the WFO Las Vegas office provides an important benefit to advance our understanding of the processes of fine scale orographic related hazardous weather phenomena (i.e., downslope winds and rotors) over the Las Vegas valley and the adjacent areas. Our past modeling efforts we have provided model output to the operational staff at a temporal resolution of 1-hour. The local WRF-ARW model has aided in the timing and expected areal coverage of rotors, downslope wind events in the Las Vegas Valley. This high temporal and spatial resolution modeling effort may provided additional forecaster confidence in the timing of such frontal passages and that has been reflected in the Terminal Area Forecasts for North Las Vegas (KVGT) and McCarran International (KLAS).

Two graduate students, Angela Reside and Arthur Eiserloh, were partially supported by this project. Ms. Reside is planning to finish her M.S. thesis in May 2013. Through the onsite visit; we were able to further understand the needs from the operational perspective. In the near future, we will further evaluate different model resolution in terms of forecasting hazardous events in the Las Vegas valley. The partnership indeed provides my institution the opportunity to contribute to our discipline in a significant way.

Section 5: Publications and Presentations

Conference Presentation

Reside, A., S. Chiao, S. Czyzyk, 2013: WRF Mircophysics Performance in Forecasting Rotor Events in Las Vegas, The 12th Annual AMS student conference, Austin, TX, Jan 6-10, 2013.

Thesis (working in progress)

Reside, A., 2013: Evaluating WRF Mircophysics Performance in Forecasting Rotor Events in Las Vegas. San Jose State University.

Section 6: Summary of University/Operational Partner Interactions and Roles

The Meteorology department at San Jose State University and the WFO Las Vegas office interacted on this project constantly. An onsite visit was conducted in December 2012. We presented the findings from this research as well as to discuss the strategy about the next stage modeling tasks, which is one important tasks of this project. In addition to onsite visit, we were able to present results at the American Meteorological Society annual meeting (see Section 5). The graduate student who was partially supported by this grant will be defending her M.S. thesis in May 2013. A manuscript is under developing and will be submitted to the Journal of Applied Meteorology and Climatology. Both university and operational partner share the authorship of

these publications. The partnership of SJSU and WFO Las Vegas will lead to better understand the fundamental scientific as well as forecasts issues in simulating high impact weather events.