Tom's Research in Desert Meteorology

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The Warner Memorial Symposium, Boulder, 2 December 2011

JOURNAL OF APPLIED METEOROLOGY

VOLUME 39

Multiscale Local Forcing of the Arabian Desert Daytime Boundary Layer, and Implications for the Dispersion of Surface-Released Contaminants

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(Manuscript received 6 January 1999, in final form 20 April 1999)

ABSTRACT

Four 6-day simulations of the atmospheric conditions over the Arabian Desert during the time of the 1991

funded by the Department of Defense's Office of the Special Assistant for Gulf War Illnesses

Gulf War Illnesses

- In 1990s, more than 10% of the of the 1991 Gulf War have report muscular and neurological ailm a result of exposure to toxins a their service.
- Analysis of atmospheric transpont material released from the Kha weapons bunker in March 199 War.
- T&D of toxic materials are large the planetary boundary layer (wind speed within PBL (ventila)



Impacts of multi-scale interactions on PBL structures near Khamisiyah, Iraq. Six-day (9-15 March 1991) MM5 simulations



FIG. 1. Geographic extent of the three computational grids. Grid 1 has a grid increment of 30 km, grid 2 has a grid increment of 10 km, and grid 3 has a grid increment of 3.3 km. The locations of surface (plus signs) and upper-air (circles) observations also are shown.

Large-scale PBL Variability

WARNER AND SHEU



Large gradients along coastlines of the Red Sea and the Persian Gulf

Deep PBL over the mountains (> 2 km)

Lowest PBL over the Tigris– Euphrates Valle (< 1.5 km)

FIG. 12. Average daily maximum PBL depth (m) for the 6-day simulation period over grid 1. Isopleths are plotted at an interval of 300 m.

6-day average maximum daily PBL depth





FIG. 16. Vertical velocity along the cross section of the Tigris-Euphrates Valley defined by line C-C' in Fig. 3 for 1200 UTC 10 Mar 1991 (1500 LT). The isotachs are plotted at an interval of 2 cm s⁻¹. Dashed isotachs correspond to downward vertical velocities. The top of the PBL also is plotted (heavy line).

C

Downdraft in the valley at low levels.

Weak subsidence above 800 mb, and the western high terrains is the source of FML over the valley, which suppresses the PBL growth.

local-scale PBL Variability

Land-cover contrast in 3.3km grid





FIG. 19. Depth of the PBL on grid 3 at 1000 UTC 10 Mar 1991. Isopleths are plotted at an interval of 100 m. Shading indicates land cover characteristics, with white being barren desert, light gray being desert with scattered vegetation, and dark gray being "other" (see Fig. 2).

Some relationship between PBL depth variability and desert vegetation: deeper (~ 100s meters) PBL depths over the partially vegetated area.

This research breaks new ground in using mesoscale ensembles for reanalysis and for coupling atmospheric and dispersion models.



Using MM5 to drive Secondorder Closure Integrated Puff (SCIPUFF).

The 12 members of the ensemble model gave very different predictions for plume dispersal. Each box shows the predicted plume trajectory over time. The Department of Defense opted to use a single simulation from RAP, rather than the full ensemble data, in drafting its final report. A seven-member presidential board concluded in December 2000 that "research has not validated any specific cause of [Gulf War] illnesses," and that "stress is likely a primary cause of illness in at least some Gulf War veterans."

- Bob Henson, "UCAR Staff Note", April 2001

RIFE ET AL.

Mechanisms for Diurnal Boundary Layer Circulations in the Great Basin Desert

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(Manuscript received 6 April 2001, in final form 6 September 2001)

ABSTRACT

The purpose of this observation- and model-based study of the Great Basin Desert boundary layer is to illustrate the variety of locally forced circulations that can affect such an area during a diurnal cycle. The area of the Great Basin Desert (or Great Salt Lake Desert) that is studied is located to the southwest of Salt Lake City, Utah. It is characteristic of the arid "basin and range" province of North America in that it contains complex terrain, varied vegetation and substrates, and high water tables associated with salt-encrusted basin flats (playas). The study area is especially well instrumented with surface meteorological stations operated by the U.S. Army's West Desert Test Center and a collection of cooperating mesonets in northeastern Utah. The study period was chosen based on the availability of special radiosonde data in this area.

One of the processes that is documented here that is unique to desert environments is the salt breeze that forms around the edge of playas as a result of differential heating. The data and model solution depict the diurnal cycle of the salt breeze, wherein there is on-playa flow at night and off-playa flow during daylight. There is also a multiplicity of drainage flows that influence the study area at different times of the night, from both local and distant terrain. Finally, the lake-breeze front from the Great Salt Lake and Utah Lake progresses through the complex terrain during the day, to interact with early mountain drainage flow near sunset.

Model grid configuration



Observations of Great Basin Desert salt breeze

Observed diurnal cycle of 2m temperature at the US Amy West Desert Test Center



Observations of salt breeze for 14 July 1998. 10-m AGL winds and 2-m potential temperature (°C).



Modeling challenge



- Increase playa
 surface albedo
- Raise the water table close to surface
- Increase thermal conductivity



Model control simulation for 1400 LT 14 July 1998. Displayed are 10-m wind and topography.

Desert Meteorology



"...to date there has been no comprehensive reference volume or textbook dealing with the weather processes that define the character of the desert areas. Desert Meteorology fills this gap by treating all aspects of the desert weather..." Journal of the American Water Resources Association

"The text is enjoyable to read. Not only will this book be extremely useful to meteorologists, environmental scientists and applied biologists interested in desert meteorology and its processes, but also to anybody seeking general information about these challenging environments." **Royal Meteorological Society**

"Desert Meteorology is a comprehensive and extraordinary book on desert ecosystems, and should be read, referred to, or even browsed through by everyone interested in and concerned with the fate of our planet." Esmail Malek, Bulletin of the AMS

Men of Desert

"Wind, Sand and Stars" by Antoine de Saint-Exupery

I shall never be able to express clearly whence comes this pleasure men take from aridity, but always and everywhere I have seen men attach themselves more stubbornly to barren lands than to any other. Men will die for a calcined, leafless, stony mountain. The nomads will defend to the death their great store of sand as if it were a treasure of gold dust. And we, my comrades and I, we too have loved the desert to the point of feeling that *it was there we had lived the best years of our lives.*