Sensitivity of the WRF Simulated Low-Level Winds in Central California to the Atmosphere and Soil Initialization

S.A. Michelson[1,2] J.-W. Bao[1]

[1]NOAA/Earth System Research Laboratory, Boulder, CO

[2]CIRES, University of Colorado and NOAA/Earth System Research Laboratory, Boulder, CO

(*email contact: Jian-Wen.Bao@noaa.gov*)

Motivation for the Study

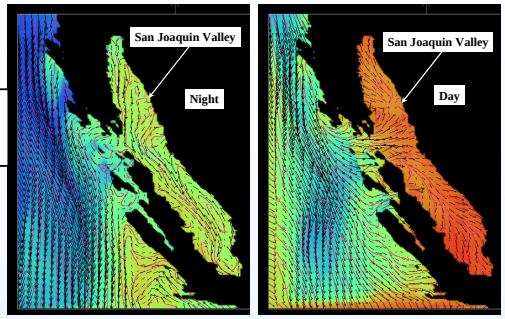
1. Assess the uncertainties of WRF in simulating the locally forced meteorological processes that influence air quality in the San Joaquin Valley, California.
2. Investigate the connection between the sensitivity to initial conditions and the meteorological processes that influence air quality in California.

Sensitivity Assessment

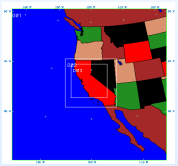
Scatter diagrams are used to illustrate the sensitivity. The abscissa is the prognostic variable from the AWIP simulation (see the permutation table), and the ordinate is the counterpart from a perturbed simulation (i.e., either the AWIP AIR ECMWF SOIL or the ECMWF AIR AWIP SOIL simulation).

The scatter diagrams can be interpreted using simple linear regression ($y = ax + b$), in which the slope parameter (a) indicates the linear response of the prognostic variable to the perturbation (either to the atmospheric initialization or to the soil initialization), and the intercept parameter (b) measures the overall bias of the prognostic variable from the perturbed simulation relative to the AWIP simulation. The coefficient of determination (R^2) provides a measure of the nonlinear response of the prognostic variable to the perturbation.

Simulated wind, temperature and streamlines at 300 m MSL



1-Way Nest Grid Configuration



36km grid 95x91

12km grid 91x91

4km grid 190x190

All have 50 layers, with 22 in lowest 1km

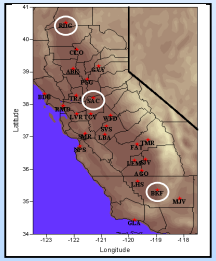
Physics Configuration of WRF 2.1.2

- the MYJ ABL and surface layer schemes
- the NOAH land surface model
- the Dudhia short-wave, RRTM long-wave radiation schemes
- the Lin et al. microphysics parameterization
- the Kain-Fritsch convective scheme (only on the 36 km and 12 km grids)

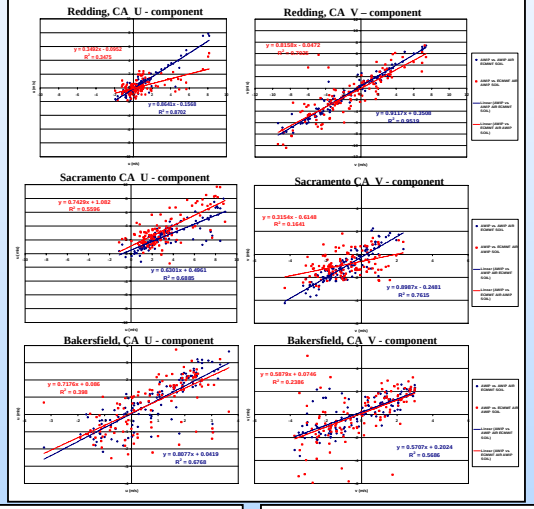
Permutation Table of Initialization

	ETA ATMOSPHERE	*ECMWF ATMOSPHERE*
ETA SOIL	AWIP	ECMWF AIR AWIP SOIL
ECMWF SOIL	AWIP AIR ECMWF SOIL	ECMWF

Sensitivity Assessment Locations



Scatter diagrams with linear regression information of the u- and v-components averaged over the lowest 300 m AGL for the AWIP run vs. AWIP ECMWF AIR AWIP SOIL run and AWIP run vs. AWIP AIR ECMWF SOIL run.



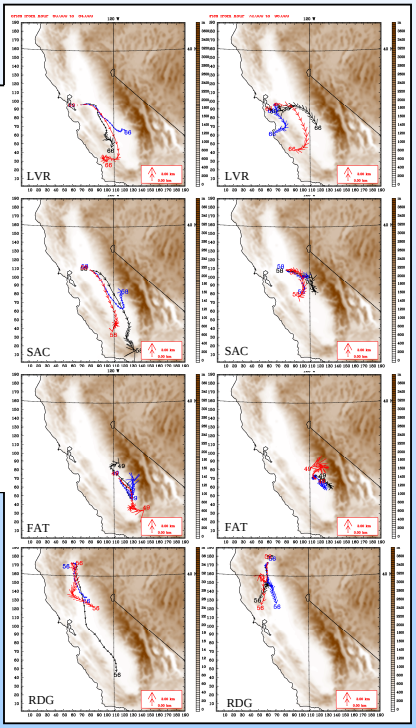
Simulated trajectories released at the lowest model level to demonstrate the sensitivity of transport to the atmosphere and soil initialization.

Forward trajectories released at 00 UTC 1 August 2000 and ending at 00 UTC 2 August are shown in the left column. Forward trajectories released at 12 UTC 1 August 2000 and ending at 12 UTC 2 August 2000 are shown in the right column.

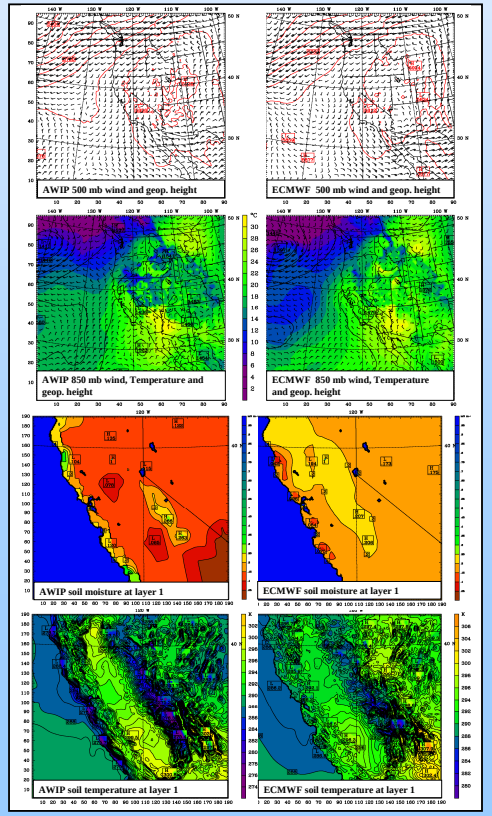
Black: AWIP run

Red: ECMWF AIR AWIP SOIL run

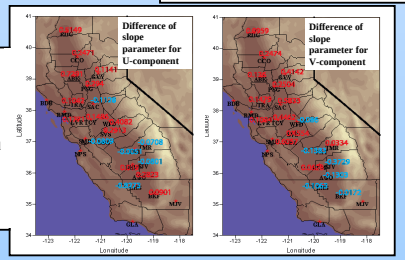
Blue: AWIP AIR ECMWF SOIL run

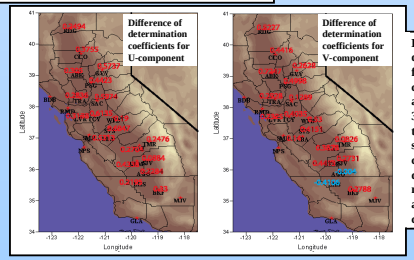


Initial Condition Valid at 1200 UTC 29 August 2000



Differences of the slope parameters for the u- and v-components (air – soil) averaged over the lowest 300 m AGL. Differences that are < 0 indicate more sensitivity to the soil initial conditions, while differences > 0 indicate more sensitivity to the atmosphere initial conditions





Differences of the determination coefficients for the u- and v-components (air – soil) averaged over the lowest 300 m AGL. Differences that are < 0 indicate more sensitivity to the soil initial conditions, while differences > 0 indicate more sensitivity to the atmosphere initial conditions

Conclusions of the Case Study

1. The WRF simulated low-level winds in the northern SJV are more sensitive to the initialization of the atmosphere than that of the soil.
2. The simulated low-level winds in the southern most part of the SJV are more sensitive to the soil initialization than they are in the northern SJV.
3. In the central SJV, where the winds are more directly impacted by the incoming marine flow, the winds are more equally sensitive to the atmosphere and soil initialization than in either the northern or the southern SJV.
4. The distribution of sensitivity indicates the important role that the incoming marine flow through the San Francisco Bay Area plays in controlling the local transport and dispersion of pollutants in the SJV.
5. Because of the interaction between the incoming marine flow and the locally forced flows, the atmospheric initialization on the large-scale and the soil initialization can both be important for meteorological models to accurately simulate the low-level winds and the overall transport and dispersion of pollutants in the San Joaquin Valley, CA.