Simulation of the land-atmosphere exchange during persistent cold air pool events in Salt Lake Valley, Utah

Xia Sun, Heather A. Holmes

Atmospheric Sciences Program, Department of Physics, University of Nevada, Reno, NV

Introduction

- PCAPs are characterized by stable ABL conditions
- PCAPs are accompanied by elevated air pollution concentrations due to limited mixing and low PBLH
- WRF does not give satisfactory results
- Land-atmosphere interaction is pivotal for meteorology simulation (it might hold the key!)

Data and Methods

- The Persistent Cold Air Pool Study, 2010-2011, Utah (PI: Whiteman, UU)
- Three domains, dx/dy=0.48 km
- NAM reanalysis data (12km) with 3 hr forecasting dataset
- Three sensitivity experiments for two IOPs, using ACM2, YSU, MYJ, and MYNN PBL schemes

Conclusions

- The model performance in simulating surface energy fluxes degraded in the strong PCAP compared to the weak PCAP.
- The overestimated surface sensible and latent heat fluxes during the strong PCAP was related to the overestimated net radiation and soil moisture.
- The NAM_MYNN case produced the least bias in both net radiation and surface turbulent fluxes for the strong PCAP.
- The underestimation of non-dimensional vertical temperature gradient in stability functions based on the Monin-Obukhov theory was responsible for the CH discrepancies in the WRF model.

Surface Exchange Coeff.

\[ H = -\rho c_p c \left( \theta_a - \theta_0 \right) \]  \hspace{1cm} (1)

\[ CH = \ln \left( \frac{z}{S_{\theta}} \right) - \psi \frac{z}{S_{\theta}} \]  \hspace{1cm} (2)

- Major underestimation of \( \phi_s \) in the stability range of \( 0.025 < \zeta \leq 1.0 \)
- Almost inverse behavior of \( \phi_s \) versus \( \zeta \)
- Overall overestimation of \( CH \) in models

Spatial variation of the \( CH \) discrepancies