Validation of WRF and WRF LES Simulations of the Dispersal of Ground-generated AgI Nuclei

Xia Chu[1], Lulin Xue[2], Bart Geerts[1], Bruce Boe[3], Roy Rasmussen[2] and Dan Breed[2]

1. Department of Atmospheric Science, University of Wyoming, Laramie, Wyoming
2. Research Applications Laboratory, National Center for Atmospheric Research, Boulder, Colorado
3. Weather Modification Incorporated, Fargo, North Dakota

1. Introduction

➢ *The dispersion of aerosol, released at a point source, across a mountain range is of interest to weather modification because most operational cloud seeding programs over mountains use ground-based generators of the seeding material*

➢ *The purpose of this study is to validate the modeled dispersion of aerosol from a ground-based source over the complex terrain by means of airborne measurements.*

➢ *Cloud microphysical processes removing the AgI nuclei from the atmosphere are not simulated in this study: by design the observations were made on cloud-free days.*

2.Measurements and model design

➢ *Target weather was:*

(a) a sky devoid of low-level orographic clouds and snowfall, to allow an aircraft to fly under visual meteorological conditions close to the terrain

(b) substantial flow over the mountain

➢ *Nested 2.5 km and 500 m resolution non-LES and 100 m resolution LES to capture the turbulence and terrain-driven eddies.*

➢ *Initial data: NARR*

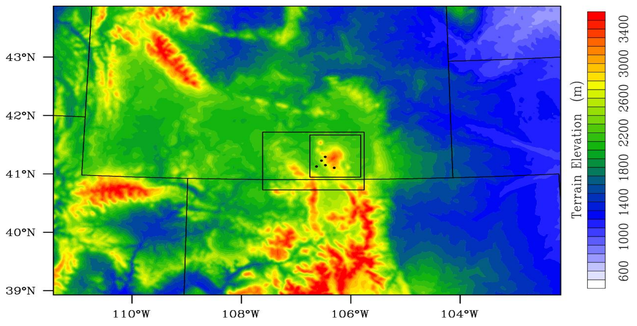


Fig. 1: Domains and generator locations for the WRF simulations. The resolutions in the 3 domains are 2.5 km, 0.5 km (both WRF ARW v3.2 non-LES), and 100 m (in LES mode).

3. Vertical structure

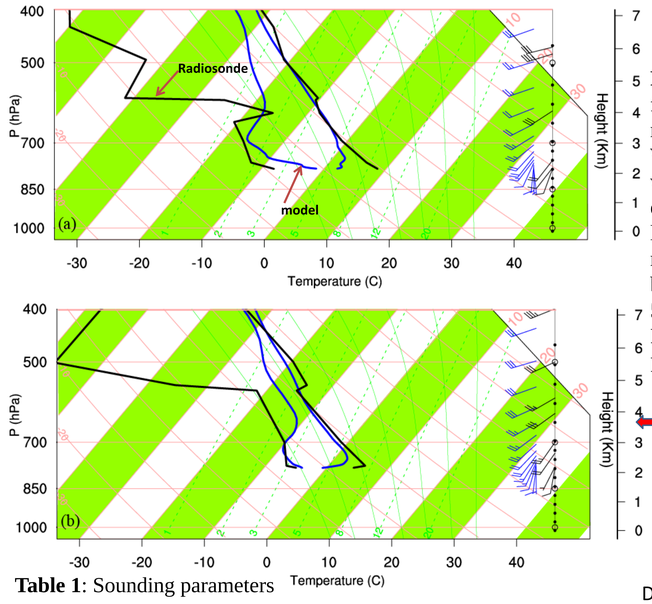


Fig. 2: Soundings from 500m WRF model and observation. Wind barbs are in m s^{-1} with a full barb equaling 5 m s^{-1}. Black lines represent radiosonde data and blue lines are WRF 500 m run data. a) 16 Feb at 22 UTC; (b) 17 Feb at 01 UTC.

Mountain top height: 3642 m MSL

Table 1: Sounding parameters

Variable	N_{ds}	Fr	LCL
Units	10^{-2} s^{-1}	-	m MSL
02/16 @22 UTC			
Radiosonde @ SAR	0.4	3.02	4272
500m WRF @ SAR	4.6	0.2	3116
100m LES @ upwind side	1.3	0.86	3649
02/17 @01 UTC			
Radiosonde @ SAR	1.4	1	3598
500m WRF @ SAR	4.6	0.23	3081
100m LES @ upwind side	5	0.24	3247

Developing inversion in model, surface layers over the valley become decoupled in model, not in reality. The model is too humid near the surface, at least in two soundings. Also, the model did produce cloud, but no precipitation, so it can still be called a "dry case.

4. AgI nuclei concentration-by-altitude (CFAD) comparison

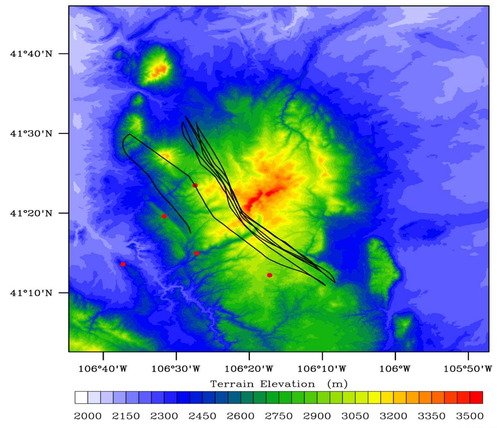
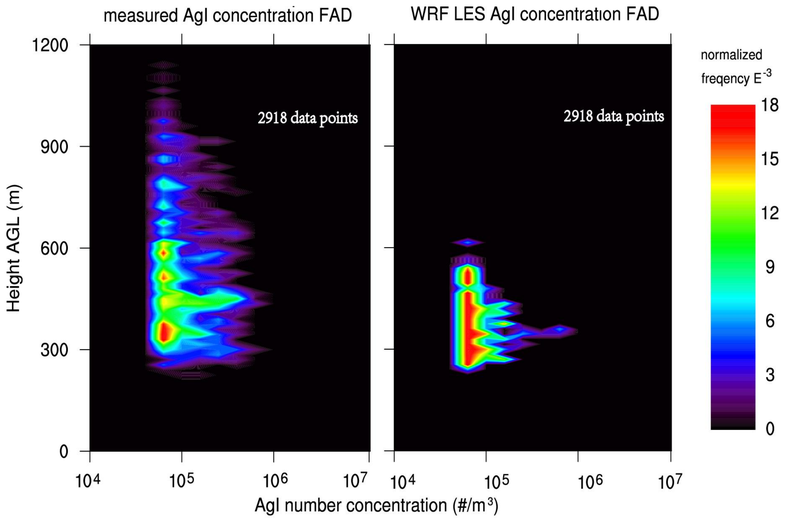


Fig. 3: Flight tracks (black lines) and generator locations (red dots) over 100 m LES terrain map

Fig. 4: CFAD of AgI concentration using all WRF LES AgI concentration data along the flight tracks. WRF LES data is limited to the observable range.



5. Compare with a case in which AgI nuclei are depleted by cloud and precipitation processes

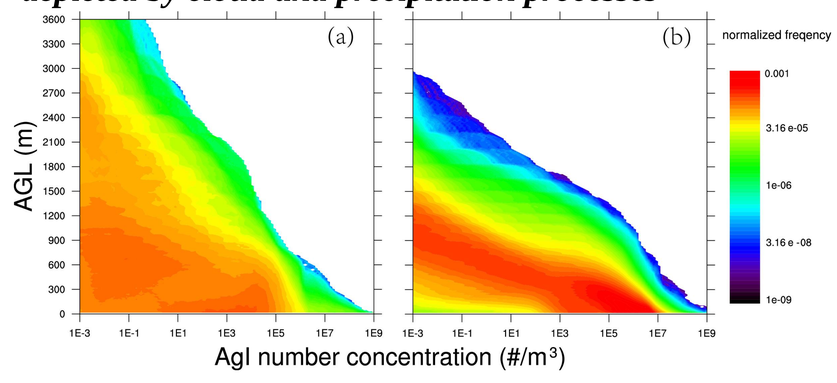


Fig. 5: Comparison of CFADs of AgI concentrations between the "dry case" the "cloudy case"

6. Conclusion

➢ *The WRF LES "dry case" simulated a* ***more stable*** *condition than the radiosondes indicated, leading* ***higher stratification*** *of the WRF LES atmosphere in the lowest few 100 m AGL.*

➢ *The model simulation is pretty good under 600m AGL*

➢ *The simulation near surface (ex. humidity and wind direction) needs to be further improved.*

Reference:

AgI Plumes in WRF LES Simulations Versus Airborne Measurements. Xue, L.; Rasmussen, R; Breed, D. W. American Geophysical Union, Fall Meeting , 2011, abstract #A53B-0342

Implementation of a Silver Iodide Cloud Seeding Parameterization in WRF. Part I: Model Description and Idealized 2D Sensitivity Tests. Xue et al., 2013, JAMC, in revision

Implementation of a Silver Iodide Cloud Seeding Parameterization in WRF. Part II: 3D simulations of actual seeding events and sensitivity tests. Xue et al., 2013, JAMC, in revision

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