P62 Dynamical conditions of ice supersaturation in convective systems: A comparative analysis between in-situ airborne observations and WRF simulations.

D'Alessandro, John, Minghui Diao, *San Jose State University/Department of Meteorology and Climate Science*, Ming Chen, *National Center for Atmospheric Research/Mesoscale and Microscale Meterology Laboratory (NCAR/MMM)*, Chenglai Wu, Xiaohong Liu, *University of Wyoming/Department of Atmospheric Science*, Hugh Morrison, Aaron Bansemer, *NCAR/MMM*, and Trude Eidhammer, *NCAR/Research Applications Laboratory*

Ice crystal formation requires a prerequisite condition known as ice supersaturation (ISS), i.e., relative humidity with respect to ice (RHi) greater than 100%. The magnitude of ice supersaturation has large impacts on the initiation and subsequent formation of ice crystals. To examine the representation of ice supersaturation in the Advanced Weather Research and Forecasting model (WRF), comparisons between the WRF realistic case simulations and in-situ observations from NSF/NCAR Gulfstream-V aircraft in the NSF Deep Convective Clouds & Chemistry (DC3) campaign (May – June 2012) have been conducted in this work. The WRF simulations were run at 2.4 km horizontal resolution with the Morrison (Morrison et al., 2009), Thompson (Thompson et al., 2008), and Thompson: Aerosol-aware (Thompson and Eidhammer, 2014) double-moment microphysics schemes. The in-situ airborne observations are at 1 Hz (~250 m horizontal scale).

Comparisons on the distributions of RHi with respect to temperature are conducted for clear-sky and in-cloud conditions at temperature below -40°C. Here we define in-cloud conditions where model output and in-situ observations show ice water content (IWC) ≥ 3.8×10-5 g m-3, which is the lowest IWC measured by the Fast-2DC probe in the DC3 campaign. The remaining regions are defined as clear-sky conditions. For in-cloud conditions, distributions of RHi at various temperatures show similar ranges of ISS between WRF simulations and in-situ observations, both of which peak around RHi = 100%. However, for clear-sky conditions, RHi reaches up to 108%, 125%, and 160% for Morrison, Thompson, and the Aerosol-aware schemes, respectively, compared with RHi up to 150% in observations.

One of our main goals is to examine whether vertical velocity (w) is the main determinant factor on ISS magnitudes (e.g., ISS of 10% versus 30%) for in-cloud conditions. Based on in-situ observations, we found that as IWC increases, the average w values also increase within regions where ISS coexists with ice crystals, suggesting higher vertical velocities are generally required for maintaining ISS at high IWC. However, such correlation between w and in-cloud ISS is found to be much stronger in the simulations, especially for relatively higher IWC values (i.e., IWC > 0.1 g m-3).

Consistent results have been found when analyzing the probabilities of ISS occurrence at various vertical velocity magnitudes for in-cloud conditions. In the observations, when ISS coexists with ice crystals at higher IWC (i.e., IWC > 0.1 g m-3), all magnitudes of ISS have slightly higher probabilities of occurring at relatively higher updraft speeds (i.e., > 1 m s-1) than those at lower updraft speeds (i.e., 0–1 m s-1). The probabilities of ISS differ by ~0.5–1.5 orders of magnitude between higher and lower updraft speeds for ISS < 20% and ISS ≥ 20%, respectively. In comparison, simulations show much higher probabilities of ISS associated with higher updraft speeds than those associated with lower updraft speeds, which differ by ~2–3 orders of magnitude. Thus, we found a stronger dependence of ISS on updraft speed at IWC > 0.1 g m-3 in the simulations than in the observations, indicating that high updraft speeds are a more dominant factor for generating and/or maintaining ISS at in-cloud conditions in the simulations than in the observations. One potential explanation for our finding is that the spatial heterogeneities of cloud-scale (~1 km) water vapor may not be resolved by the simulations, and water vapor spatial variabilities have been previously reported to be the dominant contributor to variabilities of RHi at both clear-sky and in-cloud conditions (Diao et al., 2014). Future work will investigate whether other factors besides high updraft speeds are contributing to the coexistence between ISS and ice crystals