When the namelist variable, use_aero_icbc is false, the Thompson & Eidhammer (2014) scheme will assume all model horizontal grid points have the same vertical profiles of water nucleating aerosols (CCN, also known as number of water-friendly aerosols, NWFA) and ice nucleating aerosols (IN, also known as number of ice-friendly aerosols, NIFA). These profiles are controlled by parameter settings of variables at the top of phys/module_mp_thompson.F: naCCN0 (300 per cubic centimeter) is the near-surface value of CCN and naCCN1 (50 per cubic centimeter) is the free tropospheric value of CCN. A set of similar variables are used for IN. The vertical profile is terrain height dependent in a manner that was designed to fit the Continental U.S. in which the near-surface value is found to exist within an idealized boundary layer of approximately 200 to 1000 meters depending on starting elevation. The formulation was designed not to follow either height above ground nor height above sea level, because the so-called boundary-layer height isn't the same at the top of high mountains like Pikes Peak as it is in Denver or Houston. In effect, the formulation tries to account for a very thin idealized boundary layer height of tens of meters in high terrain above 2500 meters but closer to 1000 meters for grid points near sea level. An exponential decay of aerosol number from the higher numerical value in the boundary layer to the lower free tropospheric number is used to complete the vertical profile. These settings are done once at model initial time (inside subroutine thompson_init) regardless of land versus ocean or other potential geographic information. A future version could incorporate marine versus continental differences.

During model integration, the NWFA and NIFA variables are advected and diffused exactly as other scalars (e.g., cloud ice number concentration), and a zero-gradient lateral boundary condition also follows the other scalars. A fake surface aerosol emissions/flux/tendency is computed as a 2D field (computed in subroutine thompson_init and held in variable called nwfa2d) based on horizontal grid spacing and starting aerosol number concentration for the NWFA variable. No surface emission tendency is applied for NIFA as of this writing (April 2014). The 2D tendency field is added each time step to the first model vertical level NWFA value. Future versions are expected to use more appropriate aerosol emission inventories or other available data.

When the namelist variable, use_aero_icbc is true, the Thompson & Eidhammer (2014) scheme uses an auxiliary aerosol climatology file placed into WRF through the WPS program. Aerosol number concentrations were derived from multi-year (2001-2007) global model simulations (Colarco, 2010) in which particles and their precursors are emitted by natural and anthropogenic sources and are explicitly modeled with multiple size bins for multiple species of aerosols by the Goddard Chemistry Aerosol Radiation and Transport (GOCART) model (Ginoux et al. 2001). The aerosol input data we used included mass mixing ratios of sulfates, sea salts, organic carbon, dust, and black carbon from the 7-year simulation with 0.5-degree longitude by 1.25-degree latitude spacing. We transformed these data into our simplified aerosol treatment by accumulating dust mass larger than 0.5 microns into the ice nucleating, non-hygroscopic mineral dust mode, NIFA, and combining all other species besides black carbon as an internally-mixed cloud droplet nucleating, hygroscopic CCN mode, NWFA. Input mass mixing ratio data were converted to final number concentrations by assuming log-normal distributions with characteristic diameters and geometric standard deviations taken from Chin et al. (2002; Table 2).

Currently, the aerosol climatology data must reside on the same set of vertical (pressure) levels as the input meteorological data. Therefore, there exists, separate files for GFS, AWIP, and ERA data. The files are available for download at URL (http://www.mmm.ucar.edu/wrf/src/wps_files) and on the Yellowstone supercomputer at /glade/p/work/wrfhelp/WPS_files. The names of the files are: QNWFA_QNIFA_Monthly_AWIP.tar.gz2, (or GFS or ERA replaces AWIP).

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Thompson, G. and T. Eidhammer, 2014: A study of aerosol impacts on clouds and precipitation development in a large winter cyclone. *J. Atmos. Sci.,* **in press**.