Understanding the Role of Aerosols Distribution in the Thompson Microphysics Scheme for Marine Fog

Piyush Teeloku, Student ID: 216561771

November 2023

I will be reading and documenting both Thompson microphysics schemes and how they treat cloud water droplets in the Weather and Forecasting (WRF) model.

For the Thompson microphysics scheme, it is assumed that each aerosol (except for snow) follows a generalized gamma function instead of the exponential distribution.

$$N(D) = \frac{N_t}{\Gamma(\mu+1)}\lambda^{\mu+1}D^{\mu}e^{-\lambda D} \tag{1}$$

In equation 1, N_t is the total number of particles in the distribution, D is the particle diameter, λ is the distribution's slope, and μ is the shape parameter [1].

From the Thompson aerosol-aware scheme paper, it is noted that aerosols play a role in cloud formation and microphysics through heterogeneous nucleation of cloud and ice particles. When aerosol concentration increases, liquid water content increases and will often lead to a larger number of liquid droplets which are smaller in size, resulting in an increase in cloud albedo which is called the first indirect effect. Then, as the cloud droplet size becomes smaller, the precipitation process can potentially be delayed and the amount of rain reduced, known as the second indirect effect. This can be more favorable for fog formation over the sea [2].

Therefore, I can run the Thompson microphysics scheme (mp-physics= 8 on WRF) and modify the different parameters such as N_t or μ to better suit the distribution of cloud water over maritime conditions. Also, I can try to find out how to change the distribution of aerosols like sea salts in the Thompson aerosol-aware scheme (mp-physics=28) to see any effects of fog formation and growth.

I will use the paper "Surface Deposition of Marine Fog and its Treatment in the Weather Research and Forecasting (WRF) Model" and add to the modifications made in the plots in Figure 1. My goal is to try to minimize the liquid water content of fog which is often over-estimated in weather prediction models [3].

References

[1] G. T. et al., “”explicit forecasts of winter precipitation using an improved bulk microphysics scheme. part ii: Implementation of a new snow parameterization”,” *AMETSOC*, vol. 136, no. 12, p. 5095–5115, 2008. [Online]. Available: https://doi.org/10.1175/2008MWR2387.1

[2] G. Thompson and T. Eidhammer, “A study of aerosol impacts on clouds and precipitation development in a large winter cyclone,” *AMETSOC*, vol. 71, no. 12, p. 3636–3658, 2014. [Online]. Available: https://doi.org/10.1175/JAS-D-13-0305.1

[3] P. T. et al., “Surface deposition of marine fog and its treatment in the weather research and forecasting (wrf) model,” *ACP*, vol. 21, no. 19, p. 14687–14702, 2021. [Online]. Available: https://doi.org/10.5194/acp-21-14687-2021