Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2021-594

Anton Beljaars (Referee)

Referee comment on "Constant flux layers with gravitational settling: links to aerosols, fog and deposition velocities" by Peter A. Taylor, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-594-RC1, 2021

This paper extends traditional surface layer similarity to fog and aerosol layers where the particles have a constant gravitational settling velocity (Vg). Neutral and stable situations are considered. The result is a correction to traditional Monin-Obukhov (MO) profiles, which consist of a logarithmic profile + a stability function dependent on z/L, where z is height above the surface and L is the Obukhov length. A new dimensionless number Vg/(k u*) is introduced, where kappa is the vonKarman constant and u* is the friction velocity. This number characterises the relative importance of gravitational settling and turbulent flux. The merit of this paper is that it provides analytic solutions for profiles of liquid water content or aerosol concentration in the surface layer. They do not only depend on z/L as in traditional MO-similarity but also contain a dependency on Vg/(k u*). Although the analysis is limited to neutral and stable situations, the work is highly relevant for practical application in numerical weather prediction, because advection of fog over water with flow from warm to cold SST, leads to stably stratification and to fog formation once the air becomes saturated. The work is also highly relevant for aerosol modelling not in the least because it provides a framework to put widely used schemes for deposition velocity in the framework of MO similarity. The idea as presented in this paper is innovative, and will not only help to analyse data from profile measurements in fog and aerosols, but it will also help to formulate surface transfer laws in models. Surface transfer of fog droplets and aerosols is a highly sensitive component of models, but at the same time very uncertain. I therefore welcome this paper as it will inspire observational work and provide a framework for the analysis of observations. This is the only way forward to reduce uncertainty in models.

I have no hesitation to recommend this paper for publication in its current form. The paper is innovative, well written, well embedded in relevant literature, and highly relevant for practical applications. Turbulent deposition of fog droplets is largely ignored in models (by lack of supporting science), so I hope it will inspire the science community to pay more attention to turbulent deposition of droplets and aerosols.

Minor comments:

1. Line 240
Reference is made to radiation fog over land as an example of fog with stable stratification. It would be good to mention advection fog over water where fog forms in a transition from warm to cold SST.