8th International Conference on Fog, Fog Collection and Dew
Taipei, Taiwan, 14–19 July 2019
IFDA2019-167

Spring Fog over Taiwan Strait: Formation and Model Prediction Capability

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Fog is a low-level stratus cloud with dense water or ice droplets which can reduce visibility and affect the air, marine, and land transportations and cause huge economic losses. The prediction of fog in global and regional models is still a challenge since its formation and dispersion depend on the complex interactions among thermodynamics, dynamics, and microphysical processes. The East China Sea accommodates intense human activities, but the air and marine transportations are frequently influenced by fog events especially in late winter and spring. Although some studies have addressed the modeling capability of fog simulation over the Yellow Sea, scare studies focus on the Taiwan Strait, which hosts busy marine and airborne transportations. In this study, a two-moment mixed-phase bulkwater cloud microphysical parameterization (NTU1) incorporated into the NCAR Weather Research and Forecasting (WRF) model was used to understand the fog formation processes and tested for fog prediction. Fog events during the spring of 2010-2012 were simulated, and the results were evaluated with visibility observation from the coastal meteorological stations. Simulations of fog events using different microphysical schemes showed that the NTU1 scheme obtained higher TS and POD scores, however, it also showed slightly over-forecast. All microphysical schemes that tested performed relatively well at Kinmen, but failed to simulate fog formation at Matsu and Pengjiayu in some cases. A notable difference among different microphysical schemes can be found in cloud number concentration and the particle size. Compared with the MODIS effective radius, the RMSD predicted by MYJ and NTU1 schemes are smaller than predicted by WDM6 and Morrison schemes. The correlation between simulated and MODIS cloud optical thicknesses were about 0.5 for MYJ, WDM6 and Morrison schemes, but over 0.8 when using the NTU1 scheme. The POD of all schemes is lower than 0.3.