Effects of orographically induced low-level moisture convergence and inversion strength on upslope fog: a case study at Xitou

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Previous observational studies on the orographic fog at Xitou of Taiwan suggested that the upslope winds induced by topography is a key factor to the fog formation (Wey et al., 2016). However, the moisture supply associated with the upslope winds is not evident. The relationship between the synoptic environment and the variations of the fog duration is also unclear. In this study we applied a large eddy simulation framework called TaiwanVVM to explicitly simulate 3-dimensional flow structure and vertical turbulence processes in the valley boundary layer at Xitou. TaiwanVVM is a large eddy simulation framework with realistic land surface processes over complex topography of Taiwan. Wu et al. (2019) developed this framework and demonstrated that it is suitable to investigate the local phenomenon associated with the orographically induced circulation such as the afternoon thunderstorm. A series of idealized simulations are carried out under different prescribe temperature inversion strengths to understand the synoptic control on the duration of the orographic fog at Xitou. This is the first attempt to understand the local circulation associated with the formation of the orographic fog at Xitou using a high-resolution (500 m) cloud-resolving model. The results show that the effects of orographically induced low-level moisture convergence are the essential processes to supply moisture in Xitou valley, and the capping inversion helps the fog formation by limiting the development of convections and preserve moisture in the valley. With stronger capping inversion above Xitou valley, the moisture is trapped in the valley, and the duration of the orographic fog is consequently longer.

Key words: fog, upslope wind, orographic effect, cloud-resolving model, large eddy simulation

References

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