8th International Conference on Fog, Fog Collection and Dew
Taipei, Taiwan, 14–19 July 2019
IFDA2019-138-1

Valleys fog events: relative importance of local and non-local processes during radiative/advective fog formation

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In regions of complex terrain, during nightime stable conditions, important heterogeneities on temperature and dynamics could be found between valleys and surrounding elevated areas. Furthermore, thermally driven circulations, such as drainage flows, can lead to modifications on valley thermodynamical conditions, highly variable in time and space and depending on valley geometry. This study proposes to investigate the effect of such circulations on valley fog formation according to different valley configurations during the LANFEX campaign (Price et al., 2018).

In this way, observations from the LANFEX campaign were used in addition with the numerical approach using the Meso-NH research model (Lac et al., 2018). Sites situated in valleys with different geometries have been widely instrumented in order to understand why a same airmass could lead to different fog behaviours, or the absence of fog, from a valley to another one. The present study focuses on the IOP 12 of LANFEX, where a stratocumulus passage during the night gives the opportunity to study two formation stages. The numerical modelling consists in a 100-m resolution simulation with a nested downscaling approach from the AROME operational model, and uses a 2 moment microphysics with a prognostic representation of a multimodal aerosol population (Vié et al., 2016). It aims to analyze local and non-local contributions to fog formations in the different valleys.

The model succeeds to reproduce the occurrence of fog before and after the cloudy interlude and the differences between sites. Important features, such as drainage flow in narrow valleys and associated thermodynamical characteristics, are well represented. It appears that the fog forms through local processes (i.e. condensation) across narrow valleys floor, and is partially balanced by non-local processes (i.e. advection) within drainage flow. Such balance is variable depending on the valley geometry : basins are likely to experiment denser fog through a prevalence of local formation and reduced non-local destruction, while lateral contraction induces a balance between advection and local contribution. Advective fog events occur at basin apertures when basin fog overflows downstream in the valley, associated with a strenghtening of valley circulation because of the valley narrowing. The largest valleys, opened to tributary valleys and surrounding plains, are subjected to numerous circulations with different impacts on fog conditions, more complex than in narrow valleys. Even if both local and non-local processes in the largest valleys are favorable to the fastest fog growth, subtle interactions between different flows with different origins lead to modulate the fog behaviour which is highly variable from an event to another one.

Lastly, a sensitivity test is conducted between 2-moment and 1-moment microphysical schemes and shows a positive impact of the 2-moment approach when the radiative impact of the droplet concentration is taken into account.