High-Resolution Simulations of Fog with the 2-Moment Microphysical Scheme LIMA

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LANFEX CAMPAIGN

The Lanfex campaign (Price et al. 2018) was conducted by the UK MetOffice to study the impact of complex orography and surface heterogeneities on fog formation, life cycle and dissipation. Several instrumented sites sampled fog conditions in different Shropshire valleys.

➔ What processes drive the fog life cycle over complex terrain?
➔ What are the relative contributions from local and advective processes?
➔ What is the impact of microphysics on fog life cycle?

FOG IN A NARROW VALLEY: PENTRE

Fog conditions at Pentre supersite:
• Stratocumulus are observed at 0 UTC on 2015/10/2 and prevent fog onset until 5 UTC.
• Stratocumulus are 2 hours late in the simulation. Therefore, thin fog forms at 0:30 UTC on 2015/10/2 in the simulation, and dissipates by 2 UTC due to the longwave forcing by the stratocumulus. Fog forms again at 6 UTC (~1 hour too late), and has a correct height and lifetime.

Simulation of fog onset at Pentre, between 1 UTC and 2 UTC:
• Easterly synoptic flow on hilltops
• Westerly drainage current in the valley, associated with a positive advection of potential temperature
• Fog forms in the bottom of the Pentre valley (positive condensation tendency)
• Advection counterbalances the local formation of fog in the valley
• Fog at Pentre (located on the side of the valley) is mostly due to advection, and experiences evaporation locally
• The opposite effects of local (condensation) and non-local (advection) processes lead to thin fog in the narrow valley of Pentre

FOG IN A LARGE VALLEY: JAY BARNES

Fog conditions at Jay Barns supersite:
• Thin, intermittent fog is observed starting at 23 UTC on 2015/10/1, and dissipates when stratocumulus pass over the site at 0 UTC on 2015/10/2. Fog forms again at Jay Barns under clear sky conditions between 3 and 9 UTC.
• Stratocumulus are 2 hours late in the simulation. Fog forms after 22 UTC in the simulation (~1 hour too early), and transitions to deep fog while stratocumulus are not simulated. Fog dissipates around 3:30 UTC due to the stratocumulus longwave forcing, and forms again under clear sky conditions.

Simulation of fog onset at Jay Barns, between 22 UTC and 23 UTC:
• Northeasterly synoptic flow on hilltops
• Northwesterly flow from adjacent valleys in the northwest, northerly flow in the north, and very low wind in the south of the valley
• Local conditions are favourable to fog formation by condensation in most of the valley.
• Low advection in the south does not compete with condensation, which results in fog deepening and thickening at Jay Barns.
• Jay Barns is close to the convergence area, where the NW flow from adjacent valleys interacts with the weak S flow in the valley. Non resolved turbulence cloud explain that fog at JB is more intermittent/patchy than simulated.

CONCLUSION

High-resolution simulation of fog with Meso-NH:
➔ Good representation of small-scale circulations in most valleys
➔ LIMA – realistic representation of fog, with droplets activated at the top
➔ Using prognostic N_r and r_c to compute cloud optical properties yields best results

In narrow valleys (Pentre):
• Condensation happens at the bottom of the valley
• Opposite effect from advection and condensation/evaporation – thin fog

In large valleys (Jay Barns):
• Weak advection does not compete with local condensation – thick fog
• Conflict zone between drier advection and local condensation – intermittent fog
• Higher resolution simulations are needed to better represent small-scale flows in the narrowest valleys, and turbulent processes associated with flows interactions

REFERENCES

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