

Can we forecast radiation fog using meso-scale models?

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Rationale

The occurrence and development of radiation fog is still one of the unresolved topics in meteorology (Van de Velde et al. 2010).

For three fog episodes, this study evaluates the performance of two state-of-the-art atmospheric meso-scale models, WRF and Harmonie in forecasting the onset and development of radiation fog at the Cabauw measurement facility.



Figure 1: airport in the fog

Case studies

24 and 25 November 2004: widespread fog developed under high pressure conditions with clear skies, light winds and low temperatures.

5 and 6 October 2005: wide spread fog in the Netherlands, with light winds and relatively warm temperatures.

9 April 2009: fog in southwestern Netherlands due to clear skies and very light winds.

Observations

Cabauw measurement facility: incoming short and long wave radiation, friction velocity and temperature and humidity measurements taken at 2 m.

Simulations

WRF 3.2.1 – ARW setup

- Resolution: 41x41, 41x41, 61x61 grids with 25, 5, 1 km resolution (episode November 2004), 61x61, 101x101 grids with 16, 4 km resolution (other episodes),
- 27 vertical layers
- NCEP-FNL boundary conditions
- PBL: YSU scheme
- Microphysics: WSM3 (bulk)
- Land: NOAH with 4 soil layers

Harmonie 36h1.2 setup

- Resolution: 2.5 km, 300 x 300 grid points
- 60 vertical layers
- ECMWF boundary conditions
- PBL: TKE-1 scheme
- Shallow convection: EDMF
- Deep convection: mass flux
- Microphysics: ICE3
- Land: Surfex

Results I – 24 and 25 November 2004

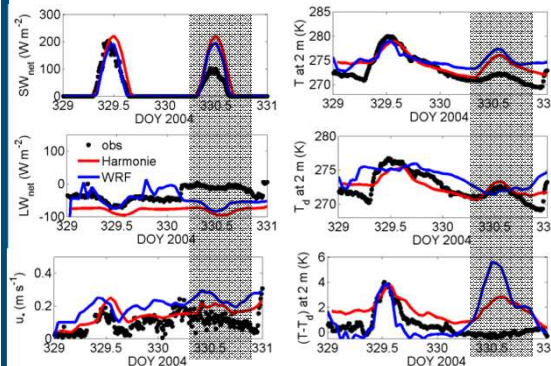


Figure 2: time series of observed and modeled (red: Harmonie, blue:WRF) short and long wave radiation, u^* , 2 m temperature, 2 m dew point temperature and 2 m dew point depressions for 24 and 25 November 2004 (marked areas give radiation fog episodes)

Results II - 5 and 6 October 2005

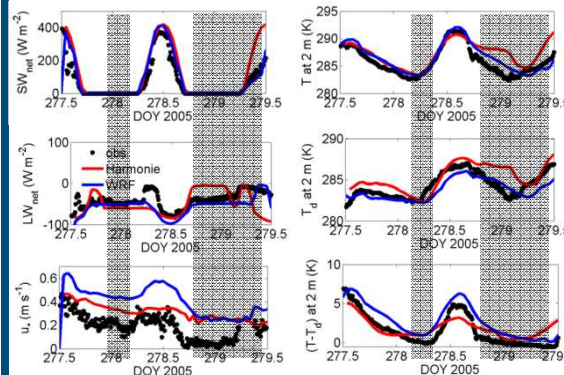


Figure 3: idem as figure 2, but for 5 and 6 October 2005

Results III – 8 and 9 April 2009

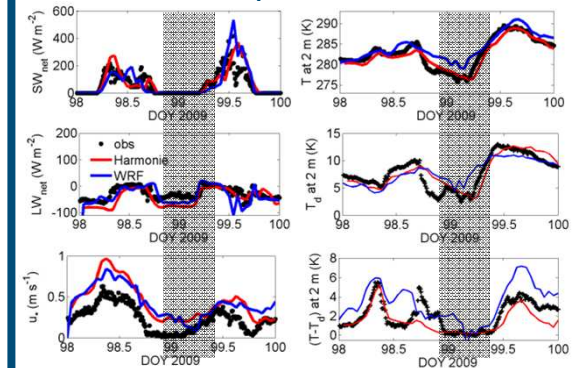


Figure 4: idem as figure 2, but for 8 and 9 April 2009

Discussion and conclusion

24 and 25 November 2004

- WRF forecasts an onset of fog that is too early and breaks up too fast in the morning.
- Harmonie does not forecast fog on 24 and 25 November 2005

5 and 7 October 2005

- WRF forecasts the onset of fog on time, but predicts a too fast dissolving of the fog.
- Harmonie does forecast the onset of fog, but it either overestimates (5 October 2005) or underestimates (6 October 2005) the duration of the fog layer.

8 and 9 April 2009

- WRF forecasts an onset of fog that is too late and which duration is too short
- Harmonie has a moist bias and forecasts a fog layer that starts slightly too early and extends slightly too long.

References

Van de Velde, G.J. Steeneveld, B.G.J. Wichers Schreur, and A.A.M. Holtslag, 2010: Modeling and forecasting the onset and duration of severe radiation fog under frost conditions. Mon. Wea. Rev., 138, 4237-4253