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METEOROLOGY AND AIR QUALITY

Confronting the WRF and RAMS mesoscale models with innovative boundary-layer observations in the Netherlands

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Conclusions

- To represent a correct thermodynamic profile in the daytime boundary layer, the mesoscale models need (much) more heat input than given by the observations
- Both RAMS and WRF overestimate friction velocity and near surface wind speed
- In WRF: MRF entrains more than YSU; absorption of solar radiation in ABL underestimated for low resolution as well as underestimation of long wave radiation absorption

Introduction

Mesoscale limited area models as WRF and RAMS are widely used for high resolution weather forecasting, air quality forecasting, regional climate studies, and for inversion modelling of CO_2 and other species. A correct representation of the atmospheric boundary layer (ABL) is crucial for these applications. Here we evaluate the mesoscale models RAMS and WRF for 2 contrasting clear episodes (i.e. windy and calm) against tower and ceilometer observations at Cabauw and surface fluxes as recorded by eddy covariance and scintillometry.

Scintillometry

A scintillometer is an instrument with a light transmitter and a receiver separated at a distance of ~100 m -10 km. The degree of attenuation of the air's refraction index by turbulence is used to derive the *area-averaged* turbulent heat fluxes via Monin-Obukhov similarity theory (Meijninger et al., 2002).

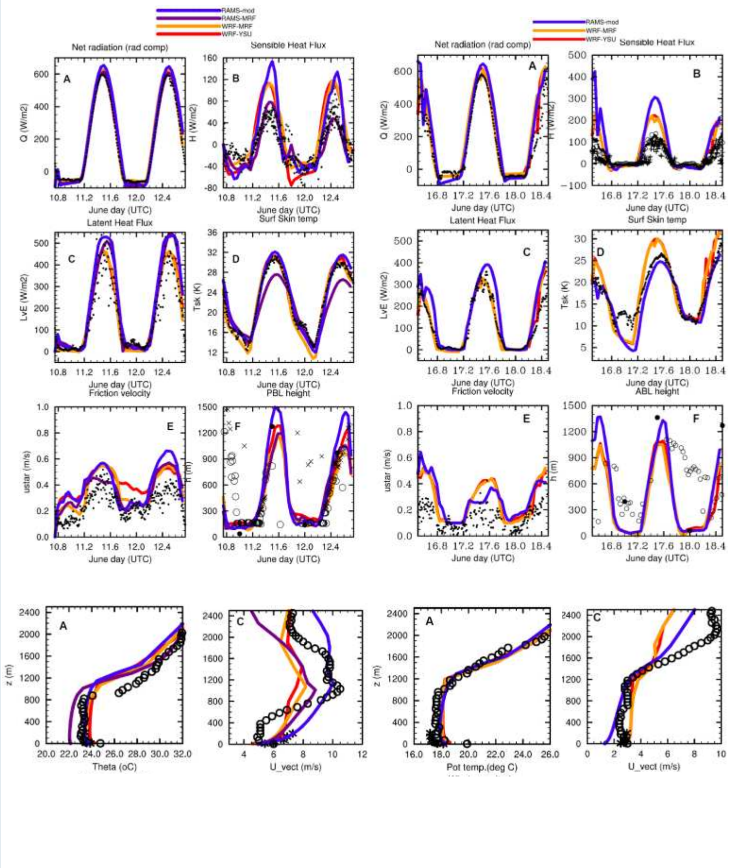
A ceilometer is a lidar system that detects the ABL height on the sharp decrease in aerosol backscatter at the ABL top.

Analysis

- The RAMS reference version shows a cold and moist bias
- RAMS improves with tuning a) vegetation fraction from 0.7 to 0.9
  b) critical bulk Ri number from 0.5 to 0.25
  c) minimal stomatal resistance from 100 to 200 sm^{-1}
- Amplitude diurnal cycle underestimated by RAMS, while overestimated by WRF for calm case.
- Tuned RAMS still overestimates PBL height for windy conditions.
- Tuned RAMS confirms improvement for calm case.
- Latent heat flux larger in RAMS than in WRF

To represent the observed thermodynamic structure, both RAMS and WRF require a larger surface sensible heat input than observed by scintillometry and eddy-covariance observations.

Windy episode: 11+12 June 2006 | A calm episode: 17 June 2006



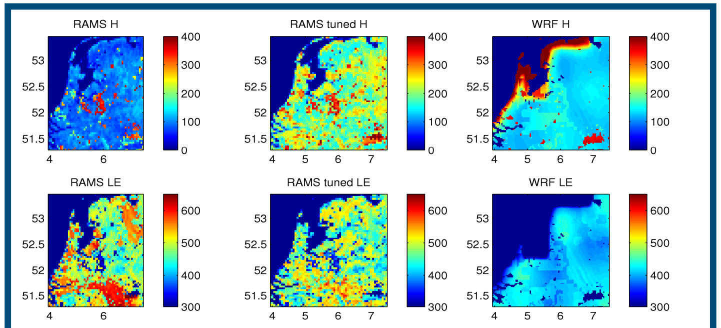


Fig 3: Modelled spatial distribution of sensible and latent heat flux with RAMS, RAMS-tuned, and WRF.

Some heat budget features in WRF

- WRF underestimates near surface longwave radiative tendency.
- WRF underestimates solar heating compared to "pseudo observations"
- MRF entrains more than YSU in the early morning

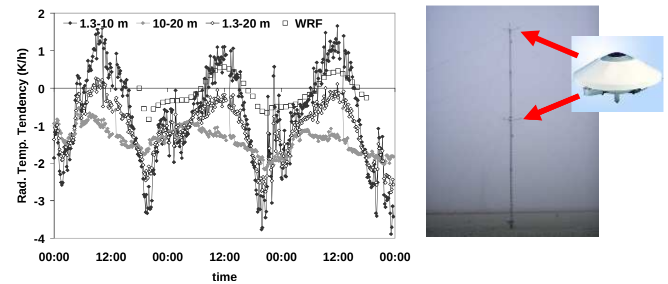


Fig 4: Modeled (WRF) and observed longwave near surface heating for 10-12 June 2006 (A). B): Experimental set-up.

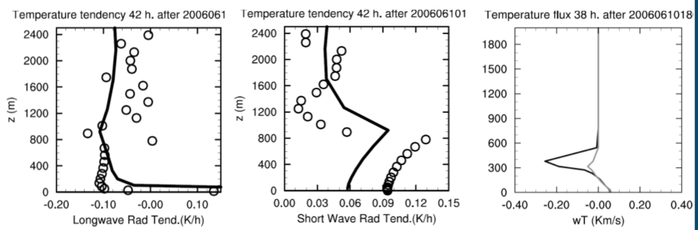


Fig 5: Modelled (WRF) and observed longwave and shortwave heating (a, b) for 12 June 2006, 12 UTC, and modelled heat flux profile 12 June 2006, 8 UTC

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