Impact of Nesting Methods on Model Performance

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Model

- Use of a multi-scale meteorological and chemistry transport model system: mesoscale (METRAS,MECTM) in different resolutions and microscale (MITRAS,MICTM): maps of atmospheric and concentration fields available on different scales
- Coupling meteorology - chemistry transport:
  - off-line
  - no interface needed: same grid, model physics and parameterisations

Motivation

- Lenz et al. (2000): concentrations of NO_x and O_3 more sensitive to the description of meteorological fields at the boundaries than to the concentration fluxes
- Fields at the boundaries as realistic as possible

Method

- Coupling between different scales by one-way-nesting
- Nesting: spatial and temporal interpolation
- Meteorology-chemistry coupling: temporal interpolation

- => Nesting of METRAS in METRAS with coarser resolution: control of results

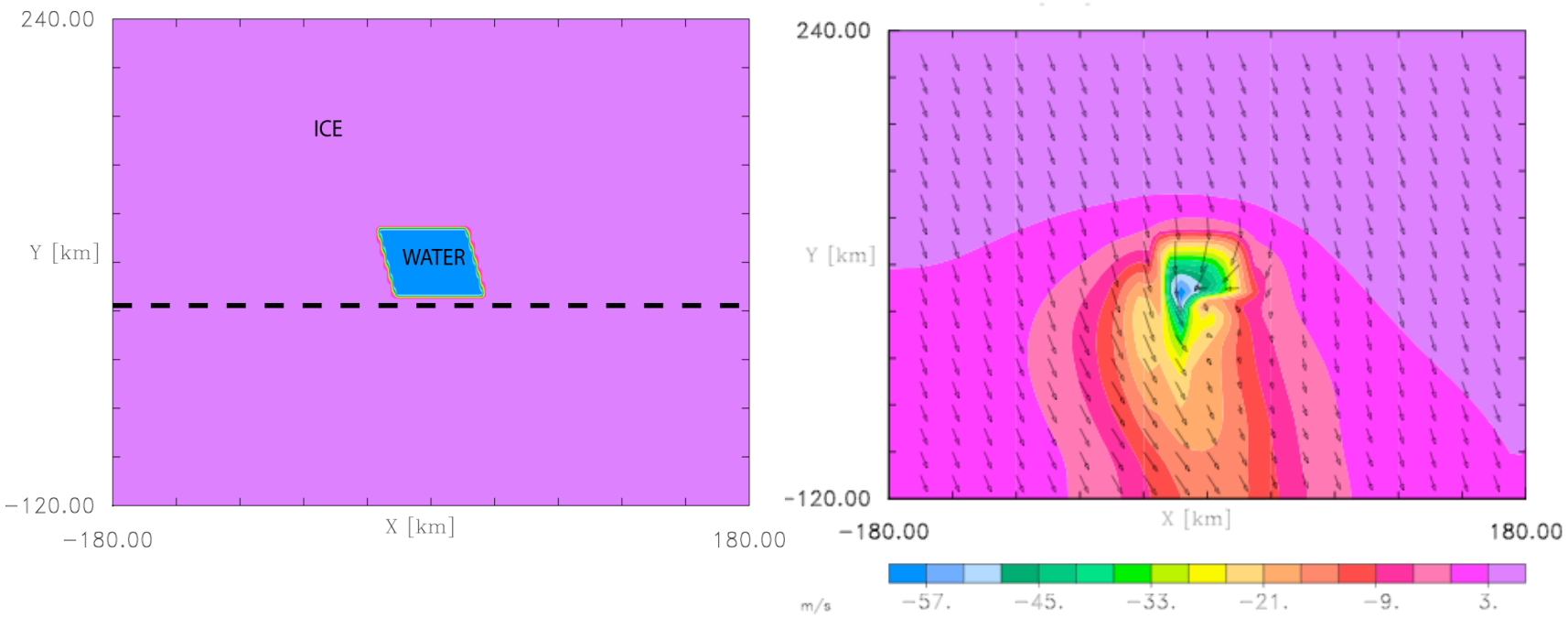
- Which time interval is needed?
- Continous reduction of time intervall - realy necessary?

  => online-writing of results = forcing data for nested run

Method

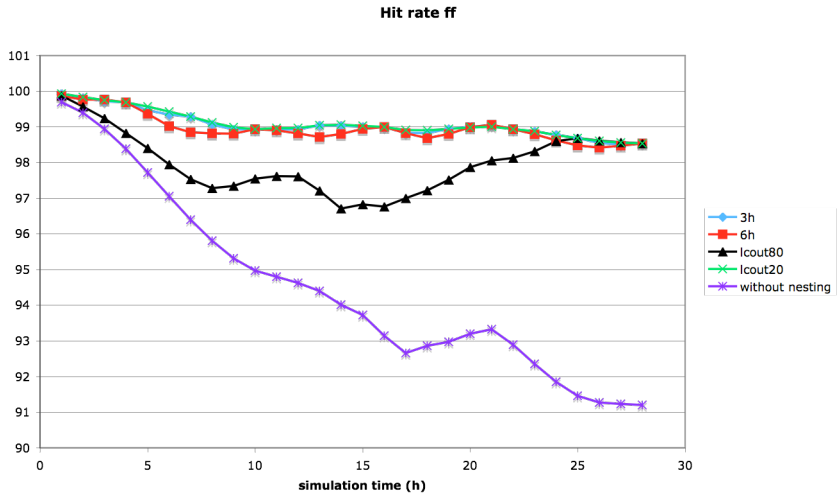
- Regular writing: 3h/6h vs. online writing:
- Control fields: velocity components
- 20/80% of grid points with significant changes: lcout20/lcout80

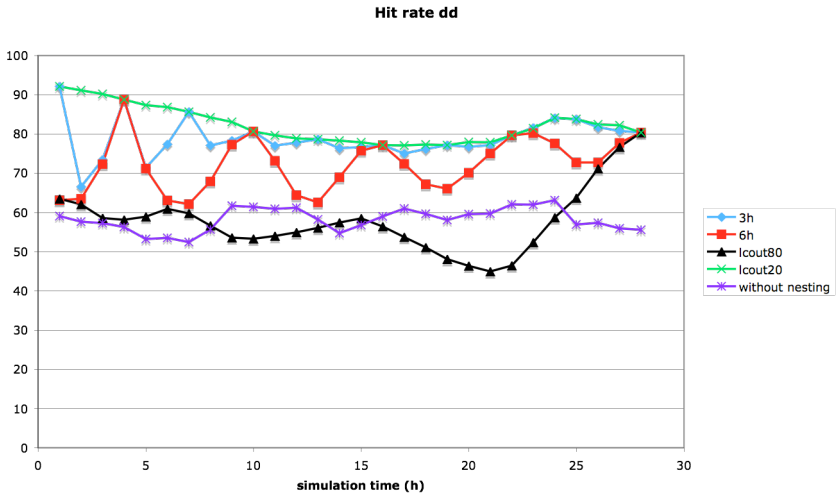
Idealized case

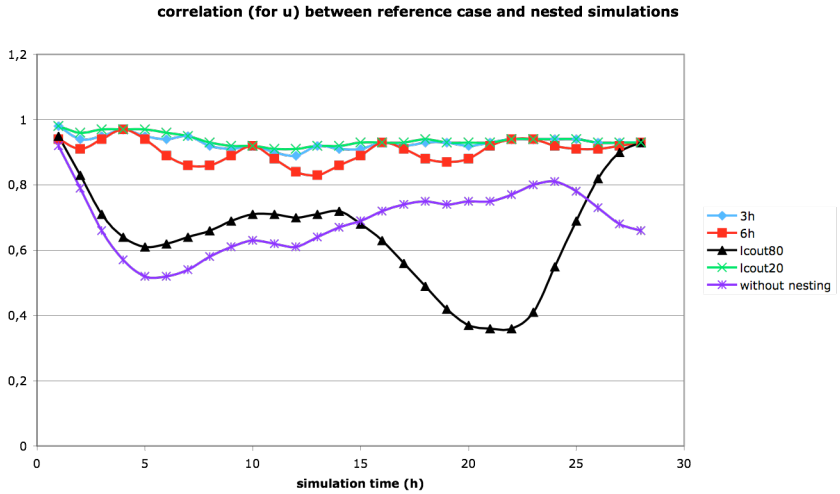


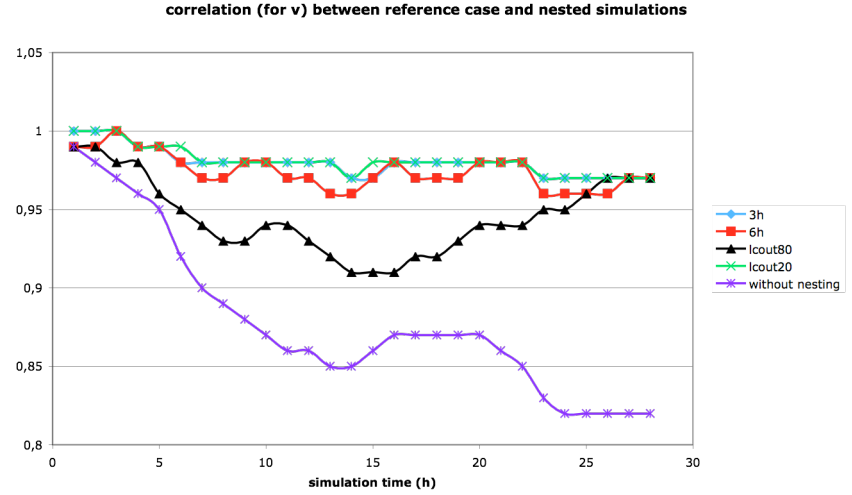
- Large gradients in turbulent fluxes: small cyclonic vortex forming
- Resolutions: 6km and 2km, coarse grid runs with different output intervals
- High resolution case as reference

Idealized case

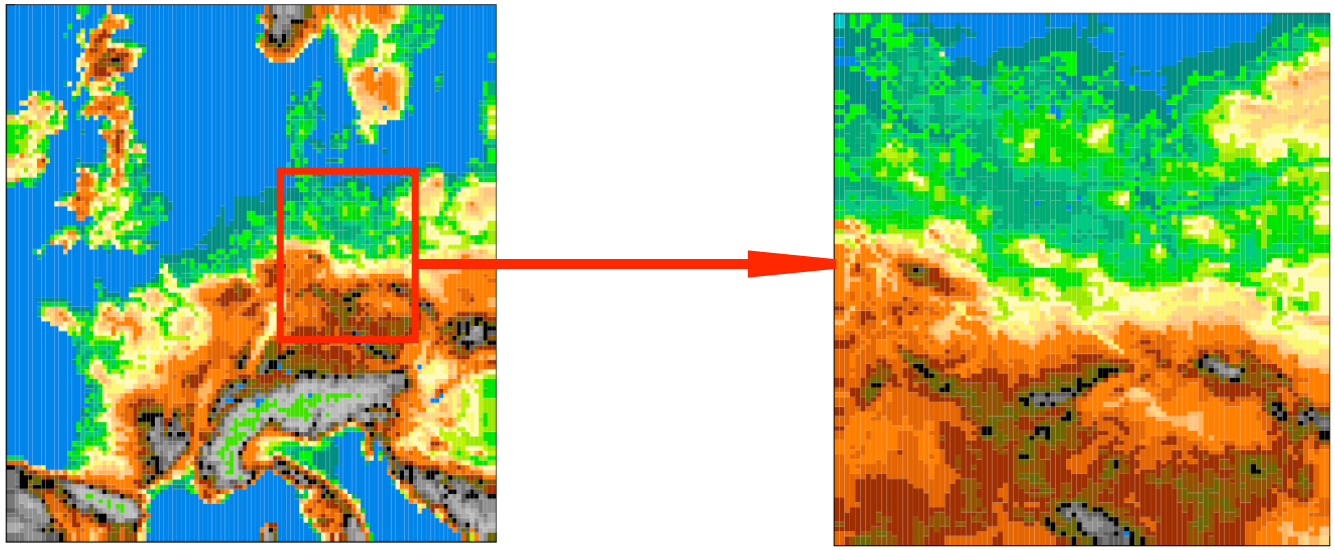








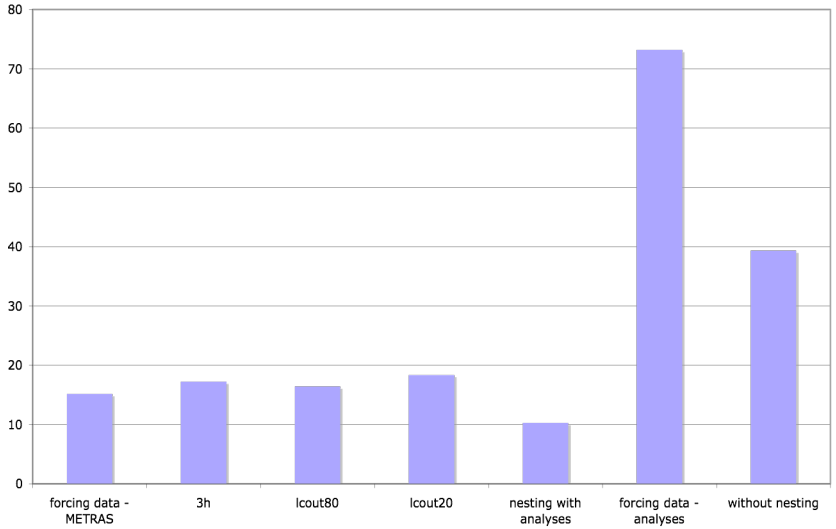
Realistic case

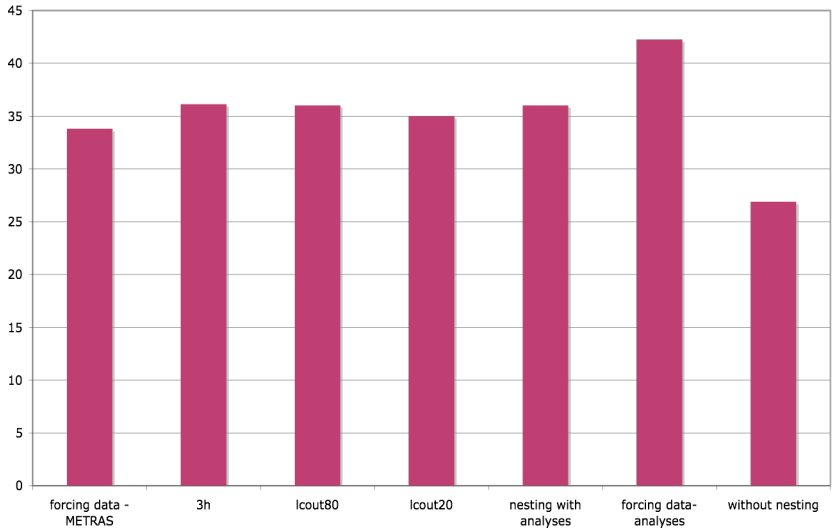


- Central Europe, 28 to 31 August 2003: low pressure system
- Resolutions: 18km and 6km
- Without nesting/ nested in analyses/nested in coarse METRAS-runs with different update-intervals
- Model performance: Comparison with measurements

Central Europe, August 2003: Hit rates

dd: ±30°



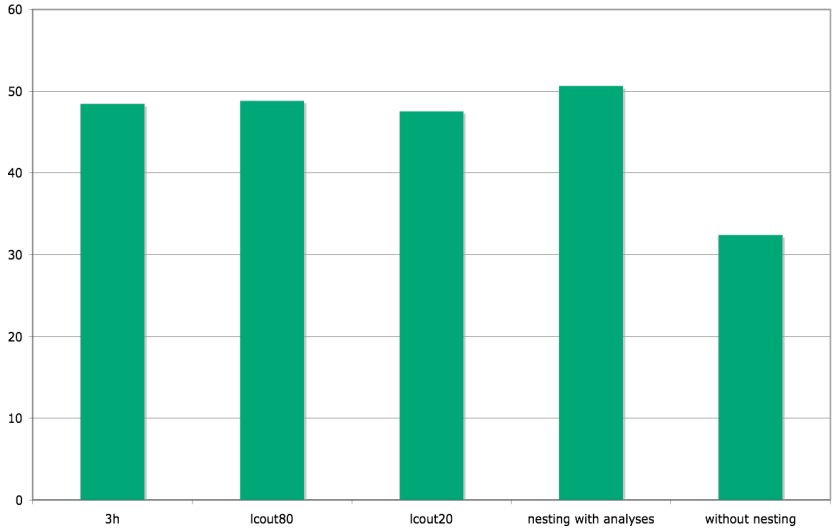


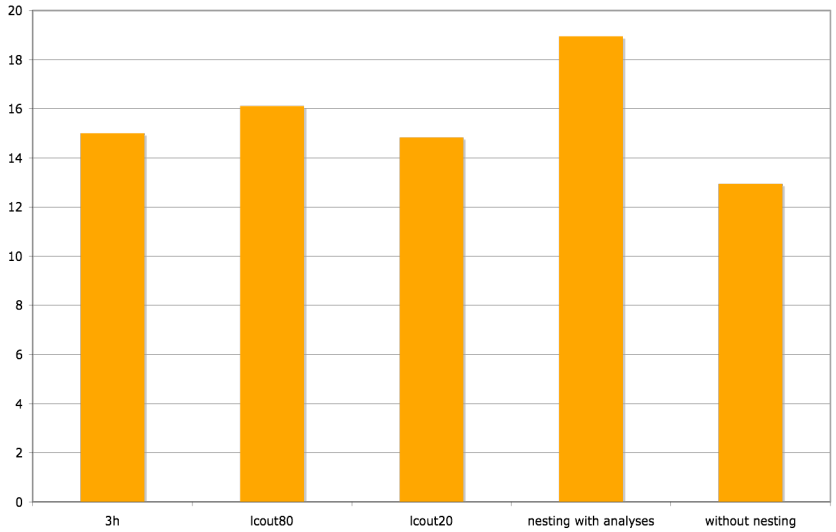
ff: ±1m/s

- Without nesting better for wind direction, but not for wind speed
- Analyses as forcing data: highest hit rates
- Forcing data from coarser grid: slightly below nested runs
- lcout80: same intervals as analyses, but better performance for the nested run and better than 3h-nested run

Central Europe, August 2003: Hit rates

T: ±2°C





Tdew: ±2°C

- Without nesting: lowest performance
- lcout80: highest performance for the runs forced by METRAS on coarser grid

Conclusion and Outlook

- Maps on several scales and with different resolutions available
- Nesting leads to better model performance
- Adaptive update-intervals of forcing data can improve model performance
- Under which conditions?
- 20 or 80 %: a general solution possible?

References:

Trukenmüller A., Grawe D. and Schlünzen K. H. (2004): A model system for the assessment of ambient air quality conforming to EC directives. Meteorol. Zeitschrift, Vol.13, No.5, 387-394.

Lenz C.-J., Müller F. and Schlünzen K. H. (2000): The sensitivity of mesoscale chemistry transport model results to boundary values. Env. Monitoring and Assessment, 65, 287-298.

Thank you for your attention!

Motivation

- High variability of meteorological and concentration fields
- Concentrations dependent on resolution (Trukenmüller et al. 2004)
- Meteorological and concentration fields: large scale + local effects
- High resolution -> high computational costs