Simulation of snow bands in the Baltic Sea area with the coupled atmosphere-ocean-ice model COSMO-CLM/NEMO-Nordic

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Snowband or lake effect

- Fetch over water surface has to be at least 100km
- Temperature difference water – atmosphere at least 13K
- Orographic slope at the coast
- Main season: late autumn and winter
- Infrequently observed, rare events

- Heavy snowfall in snowbands
- Cold and dry air
- Evaporation
- Relatively warm SST
- Baltic Sea
## Snowband events

<table>
<thead>
<tr>
<th>Dates</th>
<th>Location</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-07.01.1985</td>
<td>Gulf of Finland to Kalmar, Sweden</td>
<td>Andersson &amp; Nilson, 1990</td>
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<tr>
<td>11.01.1987</td>
<td>Gulf of Finland</td>
<td>Andersson &amp; Gustafsson, 1994; Gustafsson et al., 1998</td>
</tr>
<tr>
<td>17-18.01.2006</td>
<td>Gulf of Finland</td>
<td>Savijaervi, 2012</td>
</tr>
<tr>
<td>30.11.2010</td>
<td>Coast of Germany</td>
<td>Witterungsreport Express, Deutscher Wetterdienst (11.2010)</td>
</tr>
</tbody>
</table>

Pham et al., Met Z, submitted 2015
Satellite image from Terra MODIS at 1015 UTC 30.11.2010
Coupled ocean-atmosphere model

COSMO-CLM
- EURO-CORDEX domain
- Approx. 25km horizontal resolution (0.22°)
- Vertical resolution: 40 vertical levels
- ERA-Interim reanalysis as input data

NEMO-NORDIC
- Horizontal resolution: approx. 3km
- Vertical resolution: 56 layer
Sea level pressure

CCLM

Event on 11th January 1987
Snowband event on Jan 11th 1987

**CCLM**

**CCLM-NEMO**

**CCLM-fixSST**

Sensible heat flux (W/m²)

Precipitation (mm)
Snowband event of Dec 7th 1998

CCLM

CCLM-NEMO

CCLM-fixSST

$\Delta T$: SST – T(850hPa)

Precipitation (mm)
Decadal coupled simulations

CCLM:
- Boundary conditions from MPI-ESM and SST of NEMO

Nemo:
- Initialisation with fields from ERA40 simulation

Hindcasts in five decades:

Decadal coupled simulations

Added Value

- Real Added Value (rAV) (Di Luca et al. 2013):

\[ rAV = (X_{UNCoup} - X_{EOBS})^2 - (X_{Coup} - X_{EOBS})^2 \]

\( X \) is the temporal mean value over the decade
Positive values: coupled model has added value compared to uncoupled model

Large areas with added value
**Conclusions**

**Snowbands**

- COSMO-CLM with 25km resolution captures the snowbands well
- CLM-fixSST has a lower capability to simulate snowbands, thus
  - As a lower boundary condition, data with high resolution ERA-Interim or (NEMO-Nordic) is needed to simulate snowband events reasonably well
- In some case, the coupled simulations are better than the stand-alone ones
- For future projections, a coupled ocean-atmosphere model is inevitable

**Decadal predictions**

- the coupled simulations show an added value compared to the atmosphere standalone simulations
Technical improvements

- COSMO-CLM was switched to the new recommended version
- CLM-Community development of an interface to couple different models to COSMO-CLM
- OASIS3-MCT2, the parallel coupling interface, is now used

Cooperation with the group of Bodo Ahrens at Goethe University and Ha Hagemann at HZG

- Coupling North and Baltic seas as well as Mediterranean Sea to COSMO-CLM in the EURO-CORDEX region
- Including a river runoff model
- Improvement of lateral boundary conditions