Relating Forest Damage Data to the Wind Field from High Resolution RCM Simulations: Case study of Anatol Passing Sweden in December 1999

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Photo: Peter Schlyter

The storm Anatol 3rd of December 1999

In December 1999 three severe storms, nicknamed Anatol, Lothar and Martin, passed over Europe. Together they caused 170 deaths, and vast damage to forests, infrastructure, and further impacted upon society at a total cost over 180 bn Euro.

The first storm, Anatol, passed over southern Scandinavia causing vast damage to the forests in Denmark. In Demark, more than 1 year of timber production was lost. Likewise, locally the forests in Scania, the southernmost province of Sweden, were uprooted and totally destroyed. In total 5 million cubic metre timber were damaged in southern Sweden (Nilsson et al., 2004). Observations of maximum wind speed at Falsterbo, in Scania, rated Anatol the most violent storm since 1967.

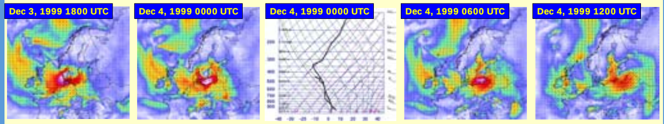


Fig. 1. HIRLAM reanalysed windfields from BALTEX/BRIDGE (Fortelius et al., 2002), and radiosounding from Copenhagen provided by University of Wyoming.

The centre of the low-pressure system developed west of Ireland on the 2nd of December, passed Scotland, and further deepened over Jylland, Denmark on the 3rd at 1900 UTC with an associated core pressure of 953 hPa. The radiosounding shows a strong low-level jet in the 700-900 hPa layer. During the evening the system moved in over southern Sweden (Fig. 1) before fading over Latvia and Russia the next day

Aim

The aim of this study is to relate the pattern of simulated wind fields using outputs from a high Regional Climate Model to the forest wind damage distribution, as a first step towards analysing the effect of wind storms on Swedish forests. For this purpose, the host model is the Canadian RCM (CRCM). The HIRLAM outputs is also used for comparison.

Methods

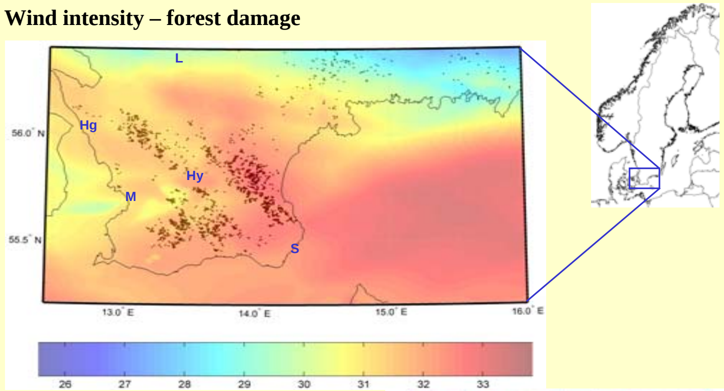
1. Simulation of the wind field over Scania on 3-4 December 1999 at 2 km using the non-hydrostatic nested CRCM including a gust parameterisation (Goyette et al., 2001; 2003).
2. Analysis of simulated maximum wind speed and direction, topography and land-use in relation to wind damaged forests.

Photo:Carin Nilsson

Data

- The simulated CRCM wind field at 920 hPa is displayed to the right (poster B).
- Regional Forestry Board records of urgent clearing of damaged forest stands.
- Wind data from the SMHI network.

Wind intensity – forest damage



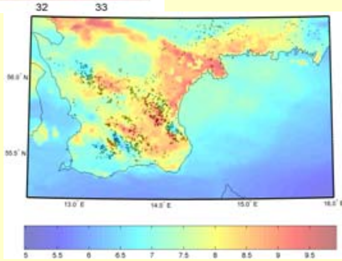


Fig. 2. Maximum wind speed at 10 m (above) and standard deviation of wind speed (right) during the Anatol storm as simulated by 2 km CRCM wind gust parameterisation over the period December 3-4, 1999. Dark dots are forest damage locations, and letters (above) refer to the station time series in Fig. 3.

Maximum wind speed

- Simulated maximum wind speed generally reaches above 30 m s^{-1} in Scania except at the northern boundary.
- In the eastern part the simulated maximum winds peak at 33 m s^{-1} approximately where the station "S" is located.
- The time evolution of the wind field simulated with CRCM (Poster B to the right) is very similar to the HIRLAM reanalysis (Fig. 1).
- The simulated maximum winds captures observations in realistic manner although the peak wind in point observations (Fig. 3) is underestimated by up to about 5 m s^{-1}.
- Standard deviation of the wind indicates the maximum wind speed variability which has some connection with the topographical features of the region as well as with forest damage areas.

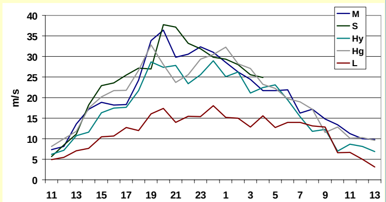
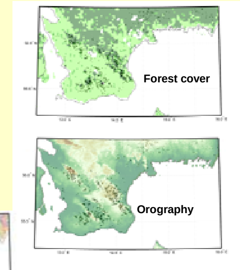


Fig. 3. Gust wind speed measured at SMHI automatic stations during the period December 03 11 UTC — 04 13 UTC. Station letters refer to Fig. 2.

Forest damage – land cover – orography

- In open land, storm damage may occur to any scattered forest stand.
- In forested areas damage mainly occurs on windward slopes and on hill crests.
- On lee-side slopes damage occurs due to increased turbulence behind the hills.



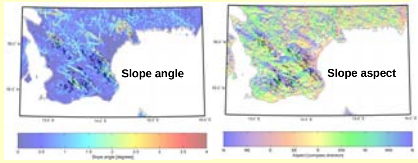


Fig. 4. Forest area, orography, slope aspect and angle. Dark dots are forest damage locations.

Conclusions

- CRCM with gust parameterisation successfully captures essential features of the maximum surface wind field when forced by NCEP reanalysis data in a nested setup.
- The distribution of recorded storm damage locations is consistent with the maximum and standard deviation of the simulated gust wind fields.
- The storm damage distribution can be explained by maximum wind speed, forest cover and wind direction in combination with topography.
- Detailed information regarding the maximum wind field is necessary but not sufficient for explaining wind damage to forests. Other factors are wind exposure, forest stand age and condition, and other site specific factors.

Future work

- A more detailed analysis of the time evolution of the wind field with the focus on the exchange of momentum between different levels in relation to orography.
- With high resolution initial and boundary data one or two of the nesting steps can be omitted. This should further improve the result.
- Simulation of the January 2005 hurricane Gudrun, that passed over a forested part of the country and destroyed 70 million cubic metre timber, will enable us to analyse the relationship between maximum winds and windthrow in more detail.

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