The Thorpex polar low analysed with AROME-Arctic

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\textbf{Research questions}

1) How well does AROME-Arctic simulate the Thorpex polar low?
2) How does the Thorpex polar low develop?
3) How sensitive is this polar low to the sea-surface temperature?

1) \textbf{The Thorpex polar low}

In February and March 2008, in connection to the International Polar Year (IPY) - The Observing System Research and Predictability Experiment (THORPEX) - several flight missions were conducted in the European Arctic. Three flights were going through a polar low that developed 3-4 March 2008 in the Norwegian Sea - commonly referred to as the Thorpex polar low.

2) \textbf{Intensity evolution}

The evolution of the polar-low intensity is compared between the control experiment (CTR, also presented in Fig. 2) and sensitivity experiments with suppressed surface sensible heat flux (noTH), latent heat flux (noQH), both surface flux components (noFLX) and condensational latent heat release (noCondens).

2a) Intensity evolution

![Image 1](image1.png)

![Image 2](image2.png)

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{The evolution of the intensity of the polar low centre (shown e.g. in Figure 1) in different experiments. The intensity is here given by the filtered 850 hPa relative vorticity of the centre (Gaussian filter with 100 km radius) and the maximum near-surface wind speed in the vicinity of the vorticity centre (within 400 km radius).}
\end{figure}

- Sensible heat flux and latent heat release have a comparable influence on intensification of the near-surface wind speed.
- Condensational heat release has only a small effect on the vortex intensification.

2b) Baroclinicity

![Image 3](image3.png)

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure3.png}
\caption{The evolution of the maximum baroclinicity (\(\nabla \theta\)) in the vicinity of the polar-low centre (within 400 km radius) of the experiments presented in Fig. 2.}
\end{figure}

- In the initial phase the polar low builds up baroclinicity, which is first maintained and then consumed in the baroclinic phase.
- Sensible heat flux and latent heat release contribute equally to the baroclinic phase.

2c) Heat fluxes

![Image 4](image4.png)

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure4.png}
\caption{The surface sensible and latent heat fluxes and condensational latent heat release around the polar-low centre (means within a radius of 300 km). Note that the western eyewall, the area of strongest surface heat fluxes, is just outside the domain after 04 March 6 UTC.}
\end{figure}

- In the convective mature phase condensational latent heat release maintains the polar low.
- In that stage less than half of the consumed latent heat is locally produced.

3) \textbf{Sensitivity to sea-surface temperature}

Sensitivity experiments with perturbed sea-surface temperatures (SST) are performed.

![Image 5](image5.png)

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5.png}
\caption{The evolution of the maximum baroclinicity (\(\nabla \theta\)) in the vicinity of the polar low centre in ms\(^{-1}\). The orange number depicts the maximum wind speed within 400 km of the PL centre in ms\(^{-1}\).}
\end{figure}

- The intensity of the polar low increases non-linearly for incrementally increased SSTs.
- The maximum wind speed increases by 1-2 m/s per 1K increase in SST.
- For highly increased SST a second polar low centre develops.

\textbf{AROME-Arctic}

AROME-Arctic (Applications of Research to Operations at MEsoscale for the European Arctic) is the operational weather-prediction model of the Norwegian Meteorological Institute since the end of 2015. The model has a horizontal model-grid resolution of 2.5 km and 65 vertical hybrid levels, from which 32 are below 3 km. Due to its fine resolution, it includes convection-permitting physics and non-hydrostatic dynamics. The model is operationally utilized for prediction of polar lows.

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