Impact of resolution on the representation of polar lows in the Weather Research and Forecasting Model

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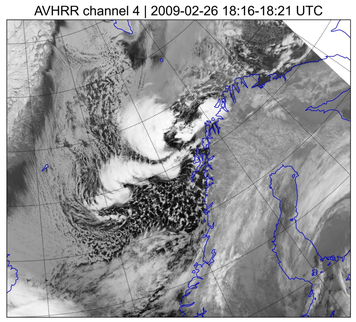
Introduction

- Polar lows are intense mesoscale cyclones that develop over the ocean at high latitudes during marine cold air outbreaks.
  - Lifetime: 3–36 h
  - Diameter: 200–1000 km (typically 250–450 km)
  - Maximum V_{10m} > 15 m/s
  - SST- T_{500} > 43 K
- Global climate models can be a useful tool to study the future climatology of polar lows and their impact on the ocean circulation, but they are too coarse in spatial resolution to represent many of them.



Question

- What is the impact of the atmospheric model horizontal resolution on the representation of polar lows?

→ The results of this project will shed light on the cost/benefit of increasing the resolution of atmospheric models to better capture polar lows.

Methods

Simulations with WRF → **Polar low tracking** → **Comparison of polar lows across simulations**

- Period: Winter 2008-2009
- Resolution: 50 km, 25 km, 12.5 km
- Vertical levels: 40
- Driven by: ERA5 (hourly)
- Spectral nudging of temperature and wind in top half of model domain

1. Interpolation of fields to the Equal-Area Scalable Earth 2 (EASE2) grid.
2. Cyclone detection and tracking algorithm: Crawford et al. (2021).
3. PL criteria: ocean fraction, lifetime, size, intensity, marine cold air outbreak index.

- Track
- Lifetime
- Size
- Maximum V_{10m}
- Minimum SLP
- Propagation speed
- …

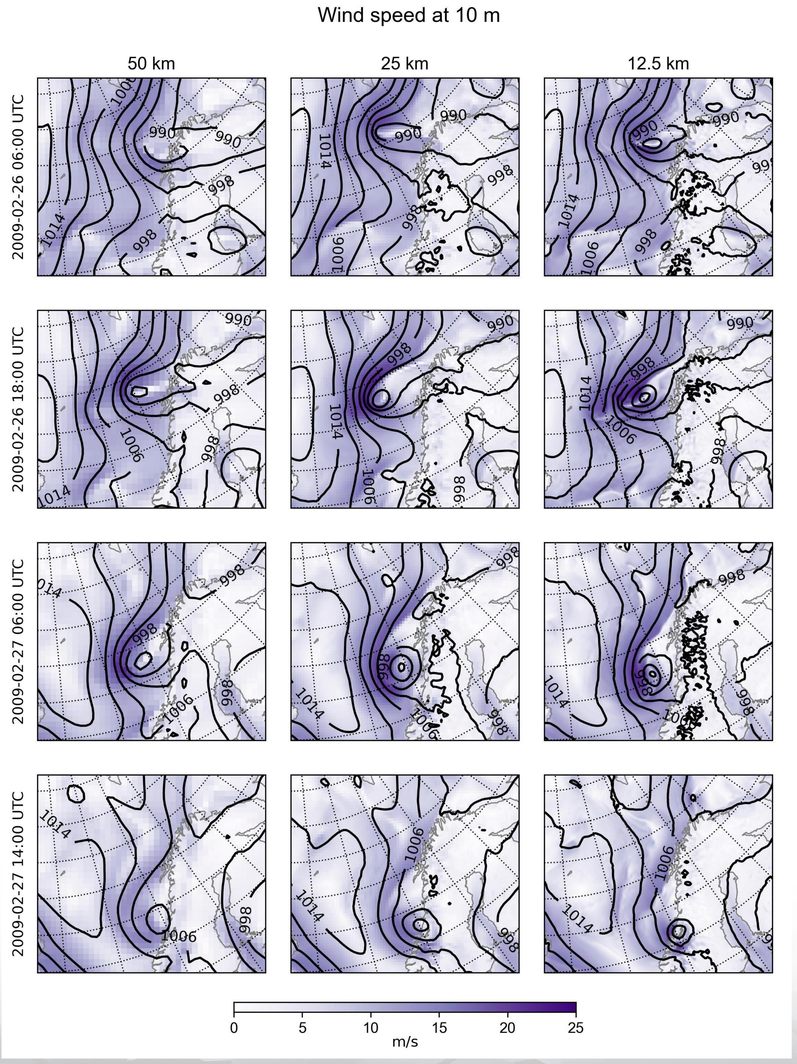
Verification

Monthly means of atmospheric fields	Polar lows
• ERA5 reanalysis. • CERES Energy Balanced and Filled (EBAF) data product.	• Subjective climatologies. • Objective climatologies.

Results

POLAR LOW DEVELOPED ON 26-27 FEBRUARY 2009

The track and size of the polar low is similar across the three simulations.



- *Genesis stage*
  The higher the grid resolution, the earlier the polar low starts to develop.

- *Mature stage*
  The polar low is weaker in the 50-km grid simulation compared to the higher-resolution simulations.

Resolution	Maximum wind speed at 10 m	Minimum SLP
50 km	22.4 m/s	988.9 hPa
25 km	24.3 m/s	985.8 hPa
12.5 km	24.1 m/s	984.4 hPa

- *Dissipation stage*
  The polar low dissipates earlier in the 50-km grid simulation than in the higher-resolution simulations.

Acknowledgments

MMI was supported by the CIRES Visiting Fellows Program, funded by NOAA Cooperative Agreement NA22OAR4320151