Comparison of aircraft observations and PWRF simulations in the Canadian tundra

**Motivation of the study**

In July 2012, the campaign AirMeth of AWI and GFZ (Potsdam, Germany) collected meteorological data in the Mackenzie delta (NW Canada). The Polar5 (P5) aircraft measured temperature, wind vector and methane concentration along horizontal flight tracks in low altitudes and along steep ascends and descends through the boundary layer.

On July 4th, a reversal in wind direction on the horizontal flight track was observed during two hours (three overpasses). The instruments also recorded a local increase in methane concentration.

It was assumed that a small vortex had formed, which was not resolved in the synoptic weather charts.

**Model configuration**

We use the PolarWRF (Version 3.4.1) of NCAR/OSU in three domains of 24, 8, and 2.87 km resolution (two-way nesting).

Starting time of the innermost domain is 2012/07/04 00 UTC, with each parent domain starting 6 hours earlier.

Boundary layer scheme is QNSE (Sukoriansky et al. 2005). As vertical resolutions, we use:

- a) 55 vertical levels total, 7 in the lower 1km.
- b) 47 vertical levels total, 14 in the lower 1km.

**Wind vortex in the model**

The model simulations (QNSE-a) show the development of a wind vortex. The vortex is most pronounced around 19 UTC (local time zone is UTC - 6). The reversal of the wind direction has been observed by the aircraft also at earlier times.

The north-easterly wind at the coast is deflected southwards by the mountain range.

**Comparison of P5 and PWRF data**

Aircraft data (coloured line) and a subset of PWRF data (QNSE-a) at matching vertical model level. Shown is a selected flight track from south to north, 18:00 to 18:30 UTC, at 100 m mean height a.s.l.

**Statistics for low horizontal flights**

Statistics are shown for horizontal flight tracks in chronological order (16 – 20 UTC) and in increasing heights (51, 25, 55, 102, 284, 495, 503m) as bias (PWRF - P5, first row) and root mean square error (RMSE, second row). Big dot for flight track shown before (4).

- warm bias of PWRF exhibited on every flight track
- simulated wind speed mostly higher than observed
- direction of PWRF-wind often turned clockwise as compared to P5-wind
- no scheme (QNSE-a or b) has the lowest RMSE for all tracks or all shown quantities, so none can be preferred

**Vertical profiles of temperature**

Vertical profiles of potential temperature from P5 aircraft (descending flight) and PWRF (gridpoint of mean horizontal flight) at 17:45 UTC. PWRF surface data are compared with aircraft data.

- different vertical model resolutions (a, b) are relevant near the coast
- unstable boundary layer in the north is not captured in PWRF data
- sharp temperature increase at 350 or 500m height is only seen in P5 data

**Summary**

The observed wind vortex is resolved in the high-resolution PWRF simulations. The position of the vortex is well matched, but wind speed and temperature show some deviations. The selected vertical resolution significantly influences the results, as also does the selected PBL scheme (not shown). All in all, no configuration can be preferred.