ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Application of radar wind observations for wind atlas validation

Joint HIRLAM ASM ALADIN workshop
15.4.2010, Cracow

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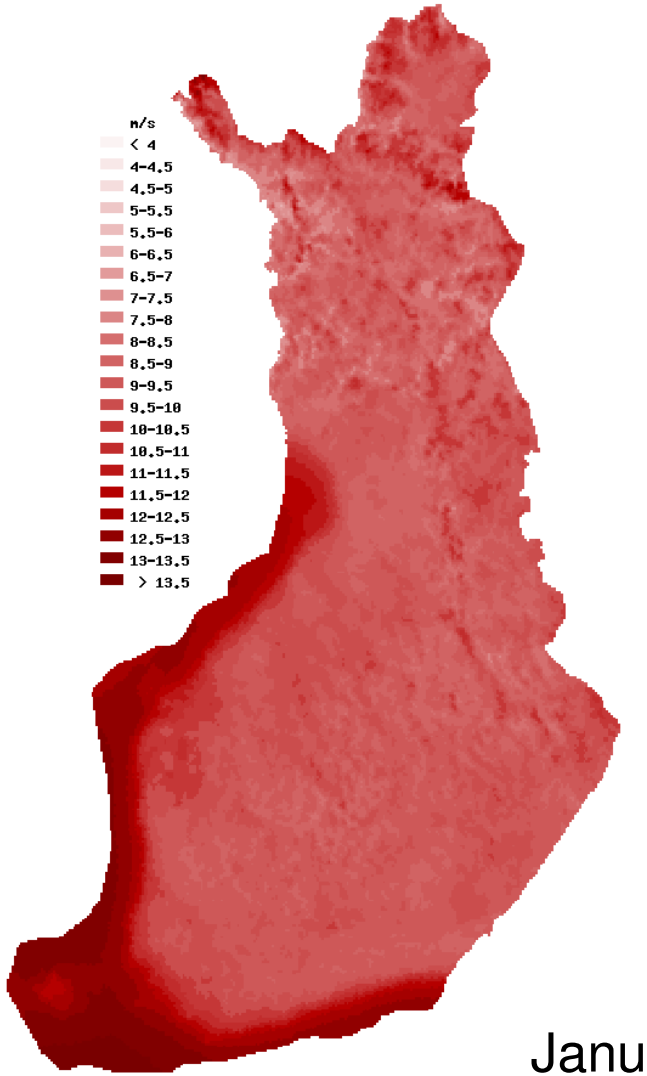
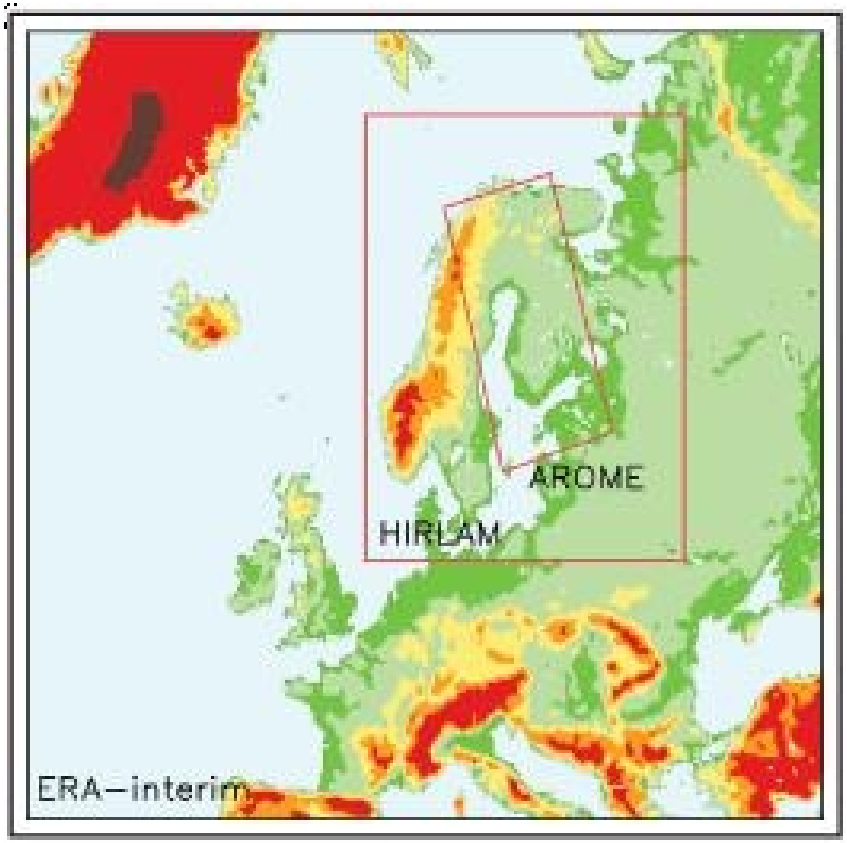
The Finnish wind atlas



January, 200 m

- Many countries focus on complementing traditional energy sources with renewable sources.
- Wind atlas provides detailed information about the wind speed and direction the annual and seasonal averages.
- It enables planners to reserve areas that are highly suitable for wind power generation.

The Finnish wind atlas

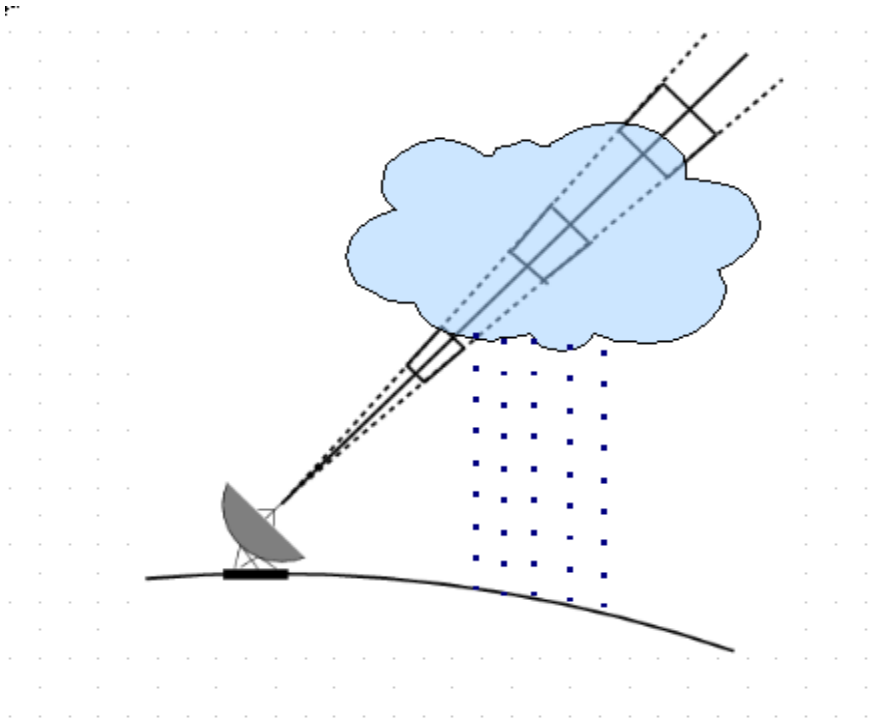


- NWP model based:
  - AROME NWP model
  - WAsP statistical model
- Wind conditions are given with 2.5 km resolution, along coasts and other windy areas even with 250 m resolution.
- 6 years, 72 months of simulations to produce the wind climatology.

Wind atlas validation

- Wind observation sources
  - Mast observations (up to ~300 m height)
  - Radiosoundings (upper atmosphere)
  - Radar wind observations (available from few hundred meters up to ~6 km height)

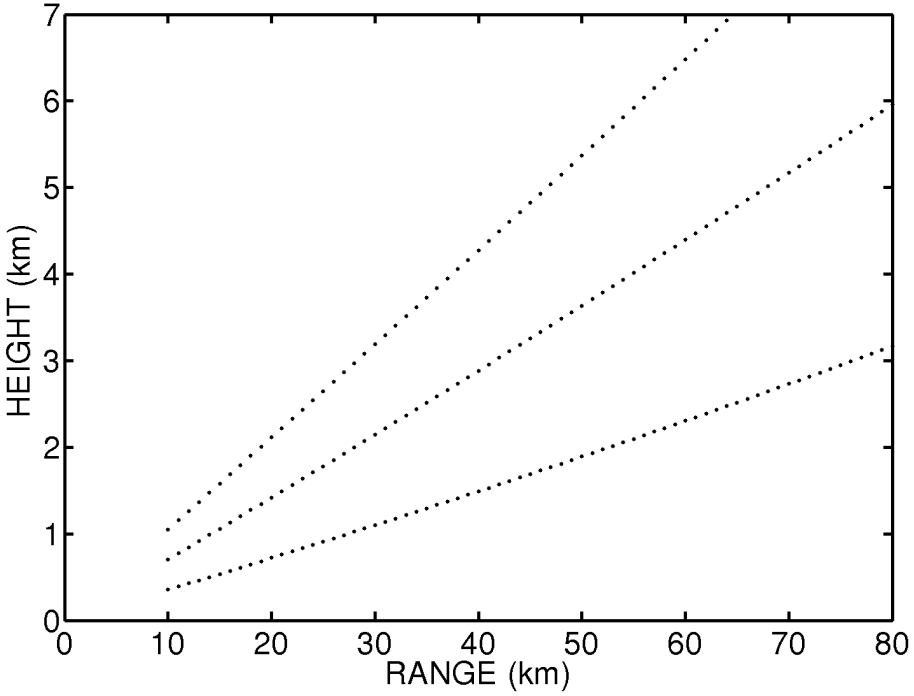
Doppler radar radial wind observation

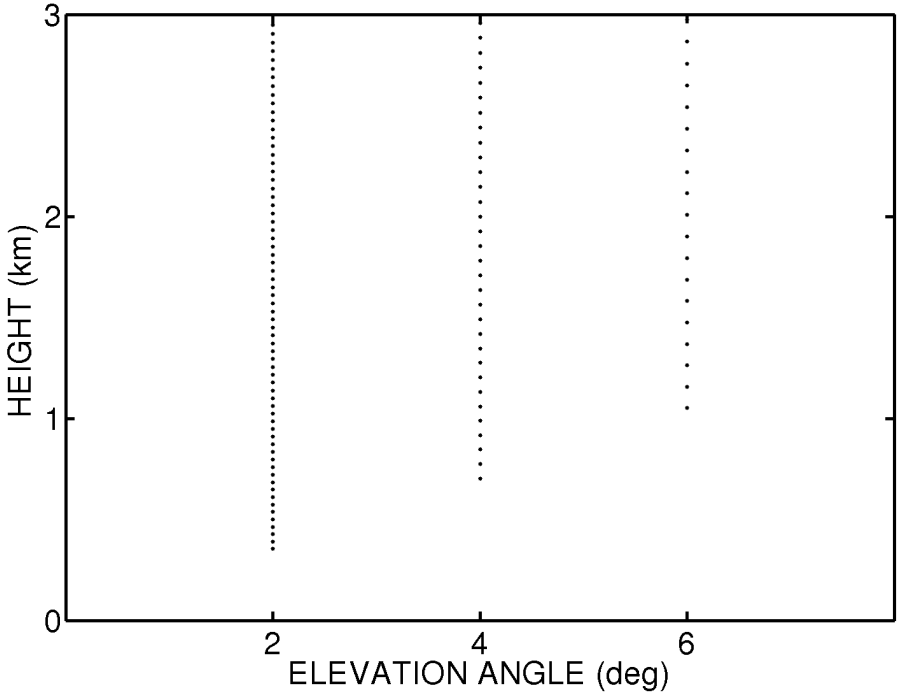


- Radar emits electromagnetic pulses which backscatter from atmospheric hydrometeors.
- The scattering hydrometeors are in three-dimensional motion.
- The radial velocity is determined from the phase shift between the back-scattered returns from successive radar pulses.

Spatial resolution

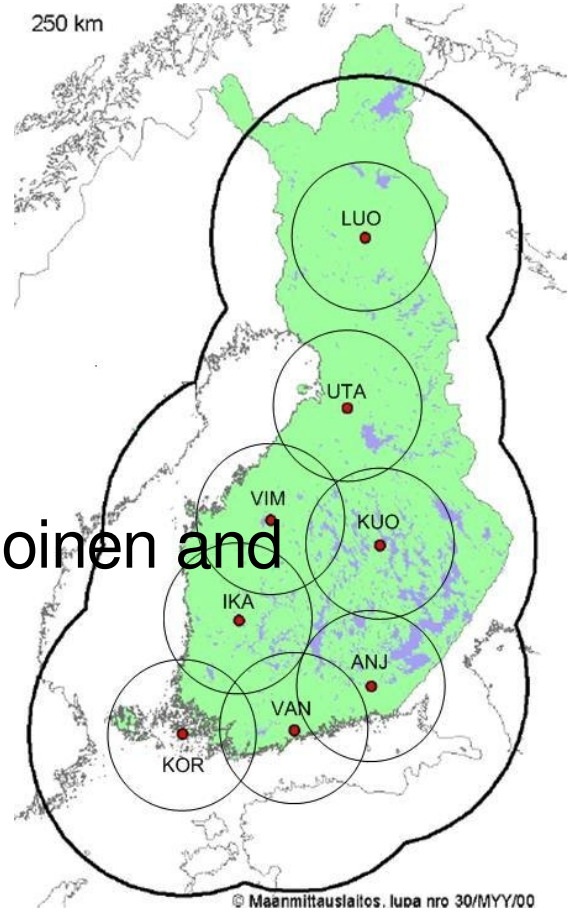
- Spatial resolution 1 km, corresponds to approximately 35 m resolution in height when elevation angle is 2°.



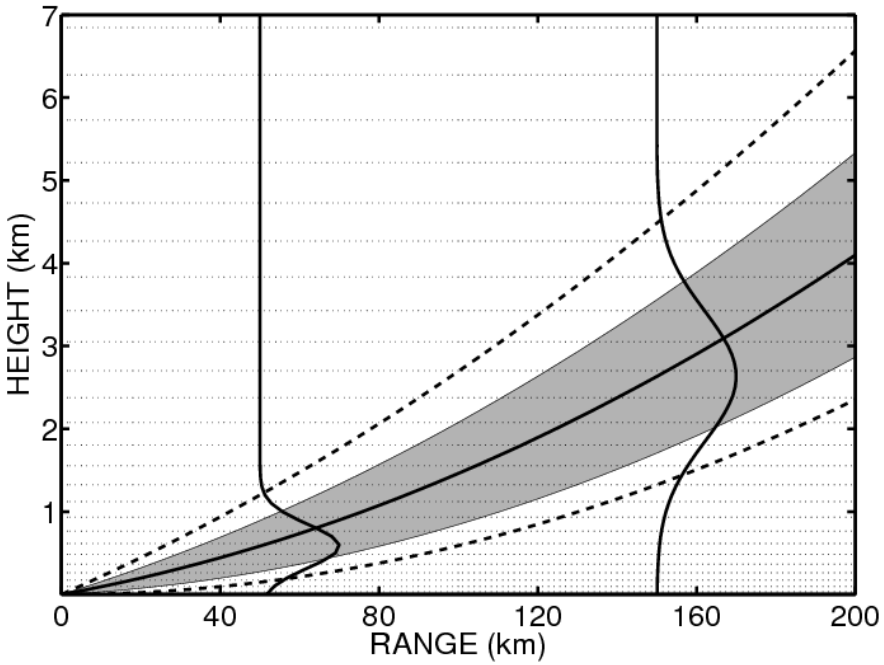


How the validation has been done

- Seasonal validation of operational AROME 6 and 12 hour forecasts for:
  - July – August 2008
  - September – November 2008
  - December 2008 – February 2009
  - March – May 2009
- Radiosoundings Jyväskylä 06 UTC, Jokioinen and Sodankylä 12 UTC.
- Radar data from 8 FMI radars.



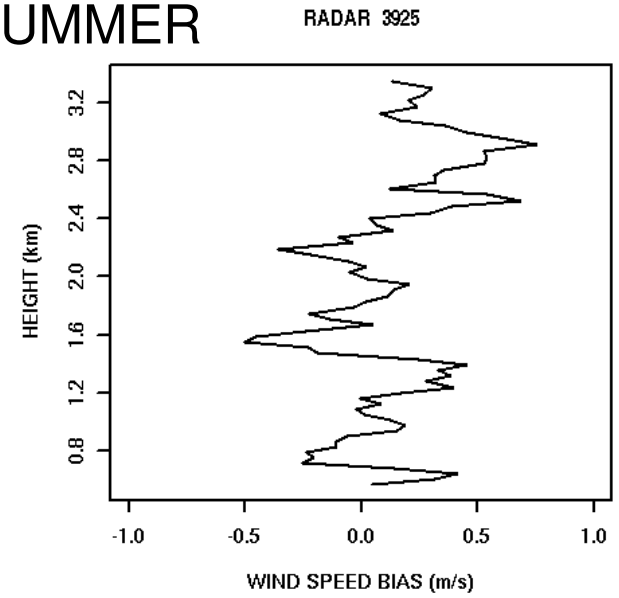
How the validation has been done



- Model counterpart for radar radial wind observation is calculated with a specific observation operator.
- Observation operator takes into account the radar beam broadening and bending.
- Validation statistics: wind speed and direction bias, radial wind std.

Vimpeli: wind speed bias

SUMMER



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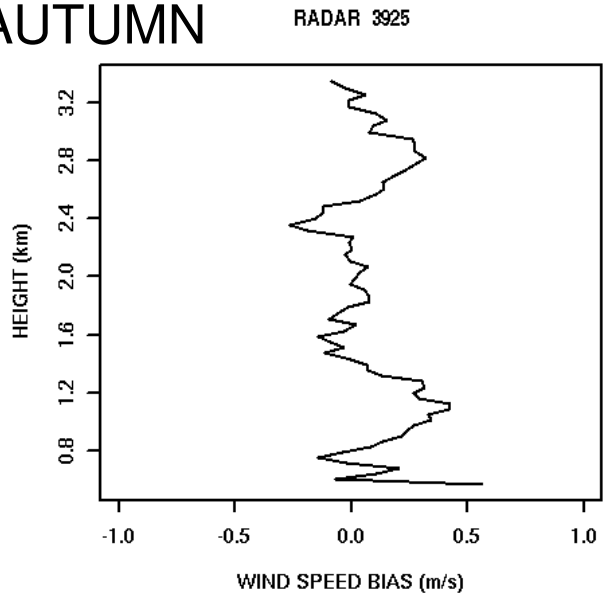
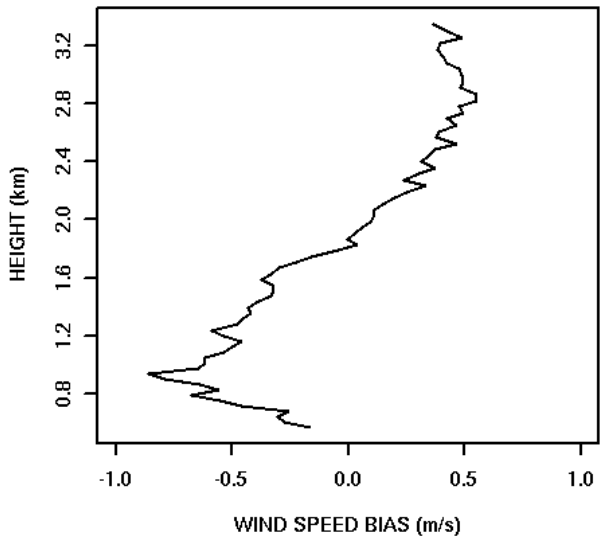


WINTER



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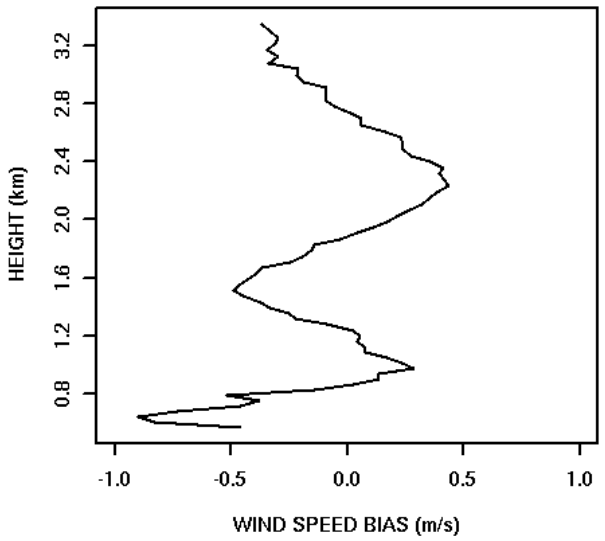
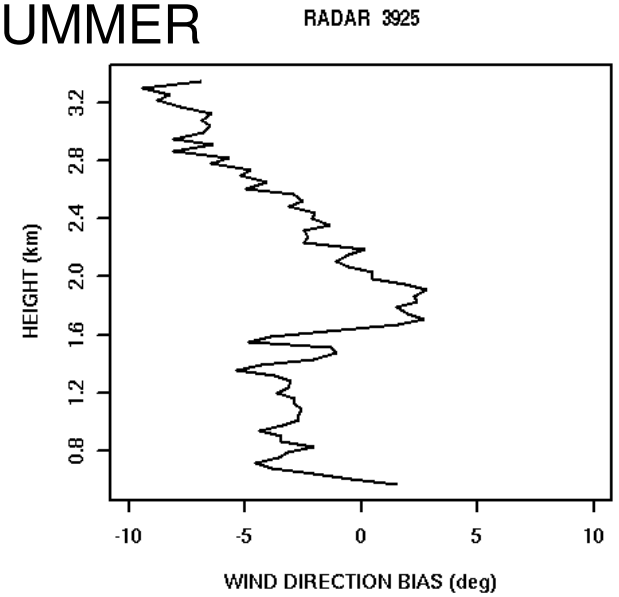


Vimpeli: wind direction bias

SUMMER



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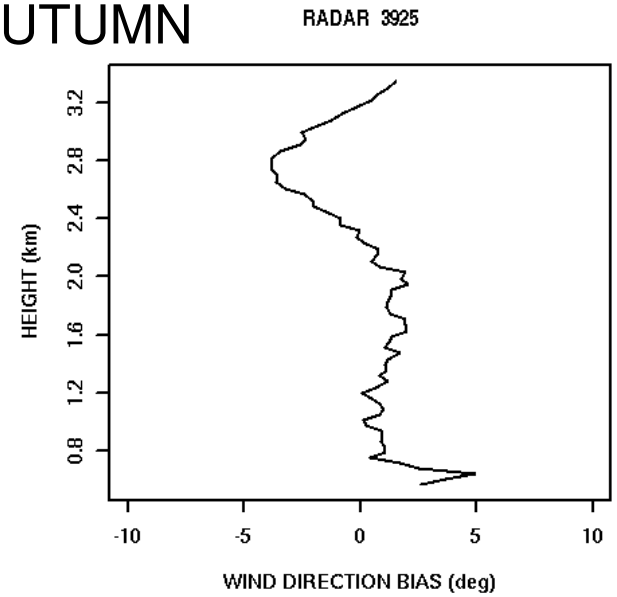

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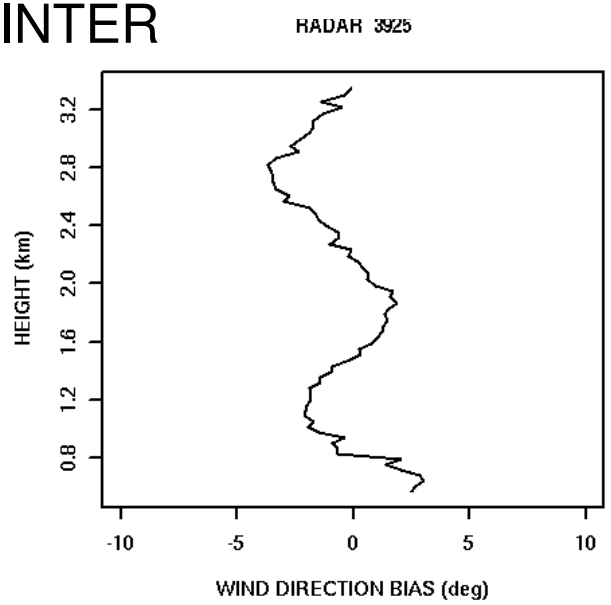

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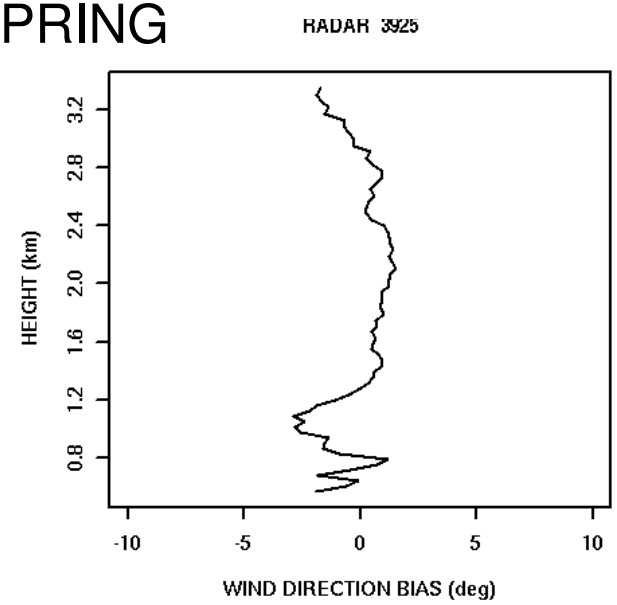
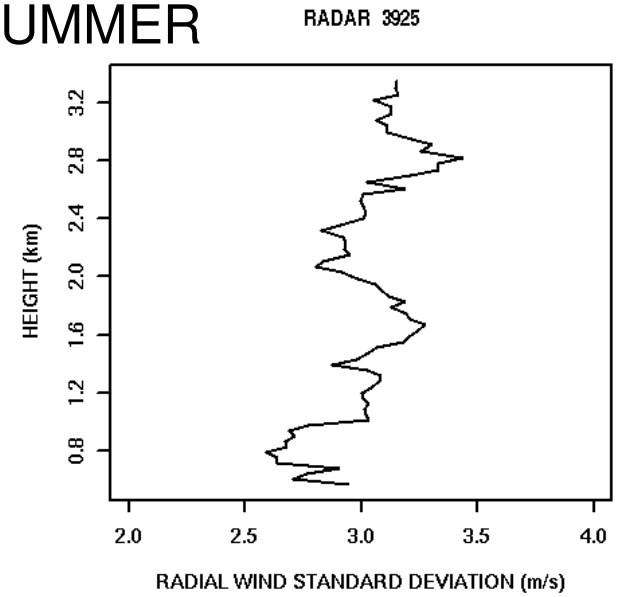


Vimpeli: radial wind speed std

SUMMER



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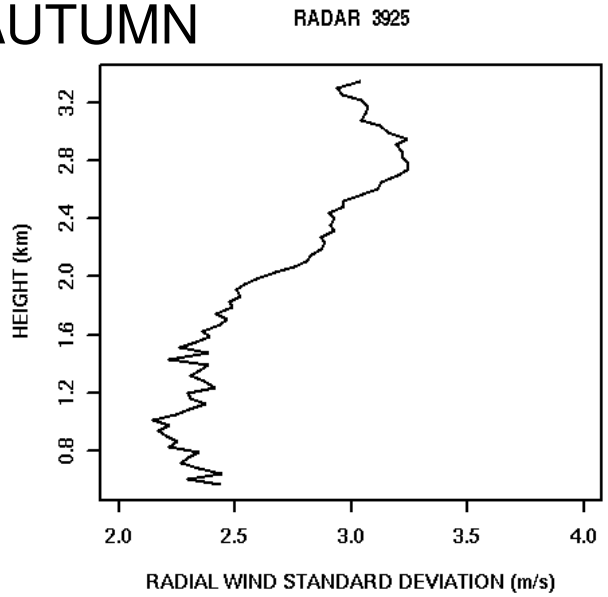

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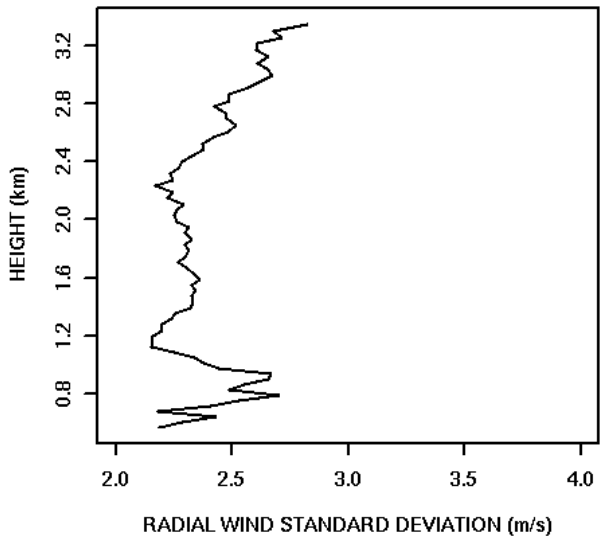

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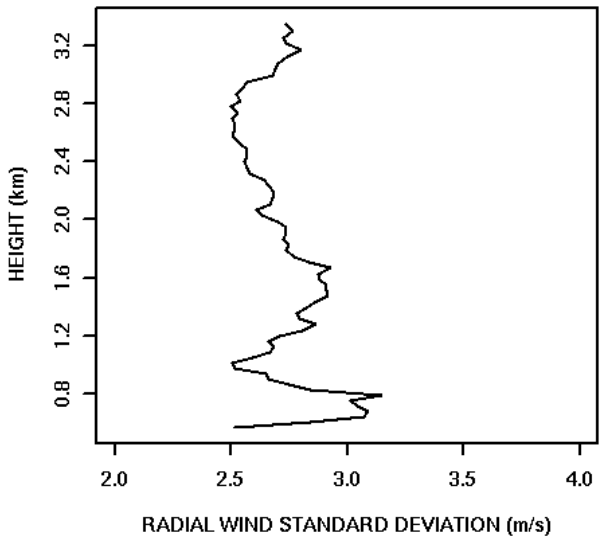

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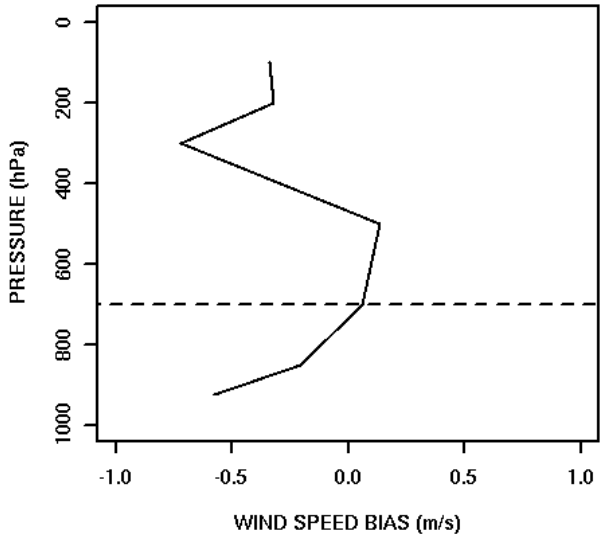
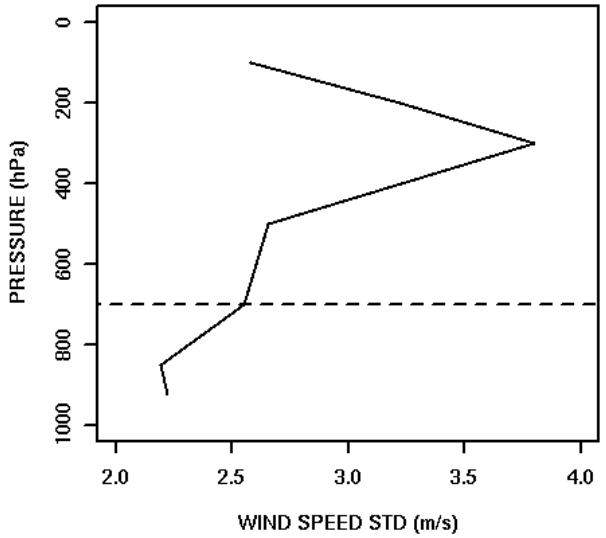
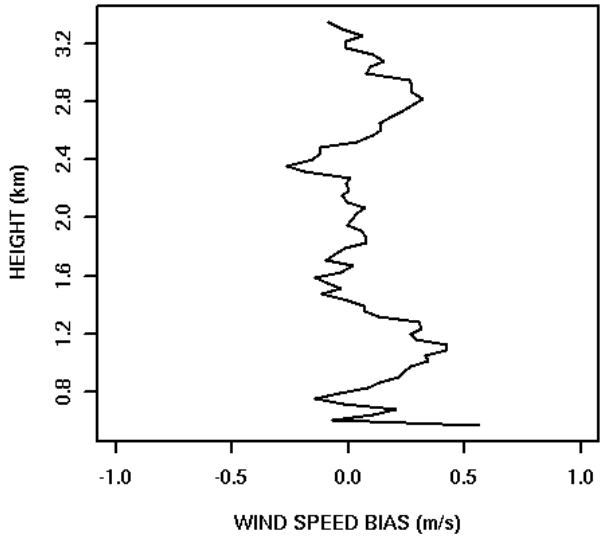
Comparison to radiosoundings

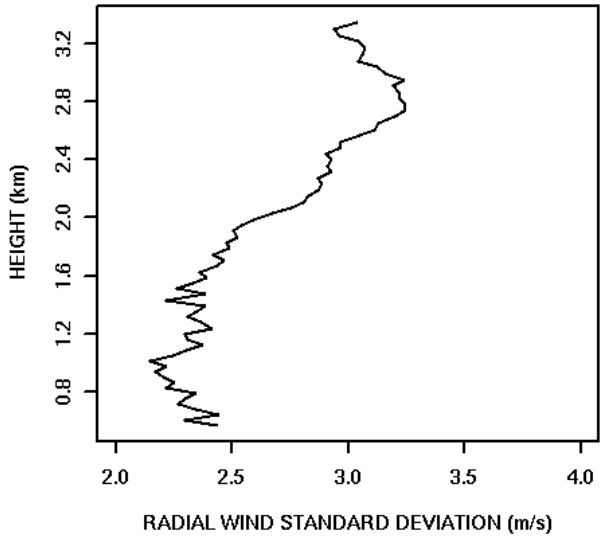
JYVÄSKYLÄ, AUTUMN





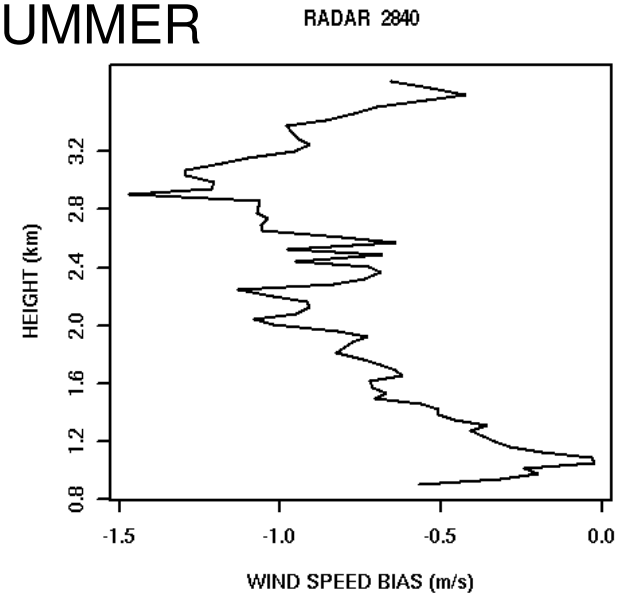
VIMPELI, AUTUMN





Luosto: problems with data quality

SUMMER



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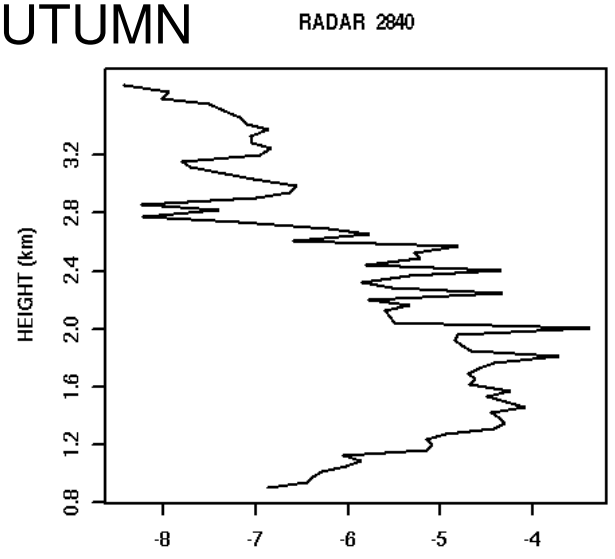

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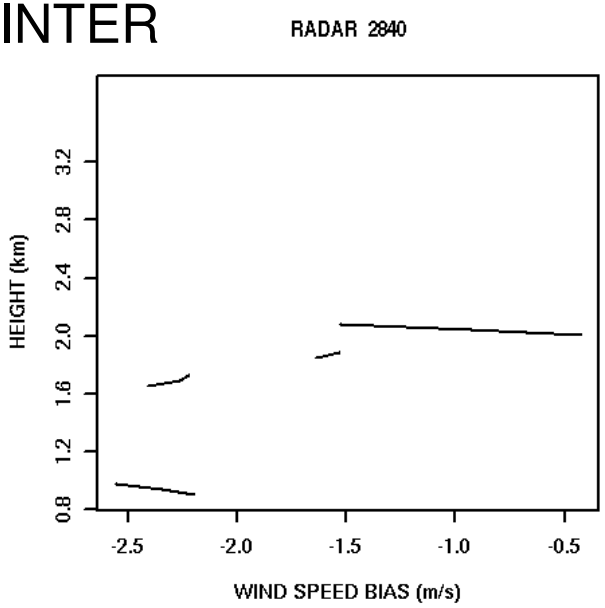

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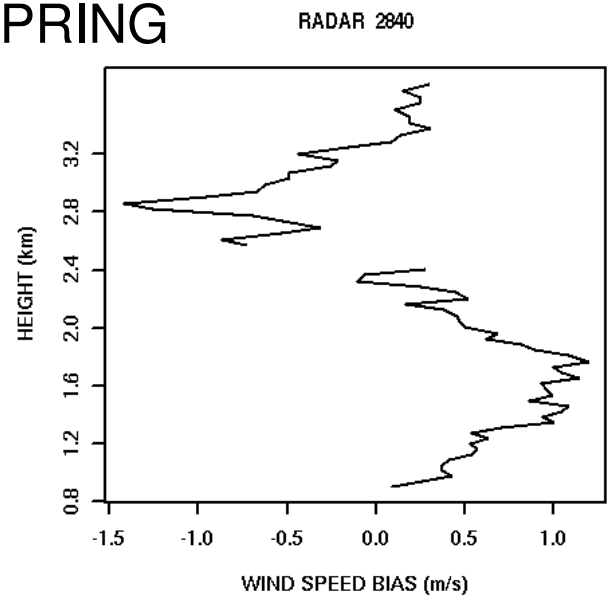

Conclusions

- Radar wind data is very valuable for low level wind forecast validation.
- Validation against radar data benefits from large number of observations (in this study 1200 times more radar observations than radiosounding observations).
- One needs to be careful with data quality.