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Creating an icing climatology using representative periods

Petra Thorsson, Hans Bergström, Stefan Söderberg, Esbjörn Olsson and Per Undén

Vindforsk project V-313

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Outline of presentation

- First part will be on using five consecutive years to construct climatologies for temperature, wind speed and icing
- The second part will be on a different approach to construct climatologies using representative months

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The need of an icing climatology

- Information on icing could be a huge benefit to any investments in cold climate
- For the wind power industry the location of turbines can be optimized and the need for anti- or de-icing can be evaluated
- Unfortunately icing has not been measured for a long time or at many locations – which makes it hard to construct a trustable climatology

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Test of five consecutive years

- Modelling 30 years with the required resolution would be very costly and an alternative is needed
- Here consecutive five year periods are tested to see if they could represent the long term climate
- This has been tested on a WRF dataset with 9×9 km grid of NCEP/NCAR downscaled reanalysis data
- All results in presentation for November

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Method – Modelling of icing

- The ice load is modelled using the Makkonen equation: $$\frac{dM}{dt} = \alpha_1 \alpha_2 \alpha_3 w_L V D$$

  M - mass, t - time, $\alpha_1, \alpha_2, \alpha_3$ - collections efficiencies, w_L - liquid water content, V - wind speed and D - diameter of accreted ice. For ice accreting on a rotating cylinder

- This equation is commonly used to model icing, since icing is not commonly a parameter in Numerical Weather Prediction (NWP) Models
- Note that icing here is % of time in a month with active icing

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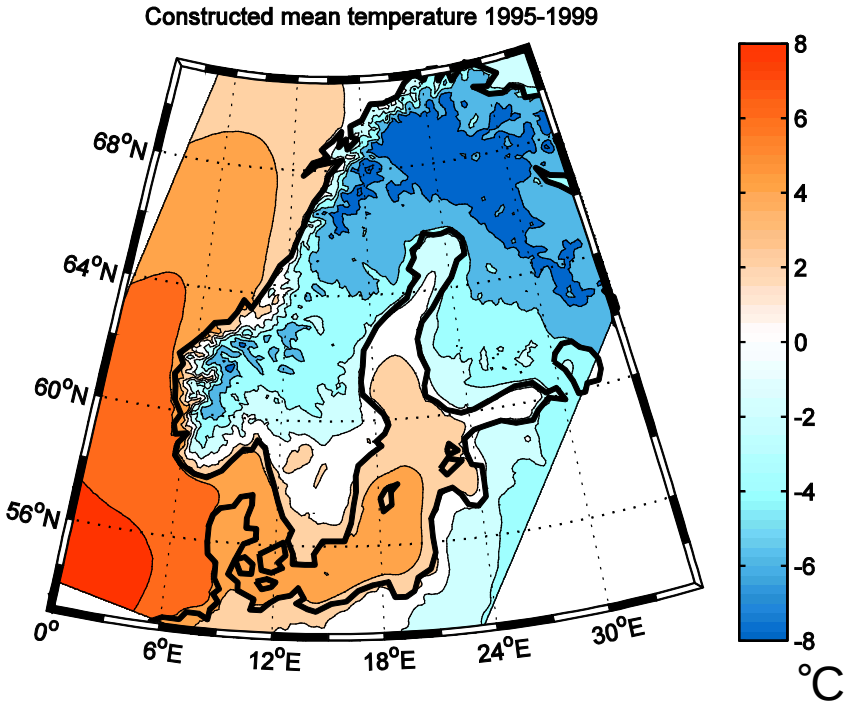
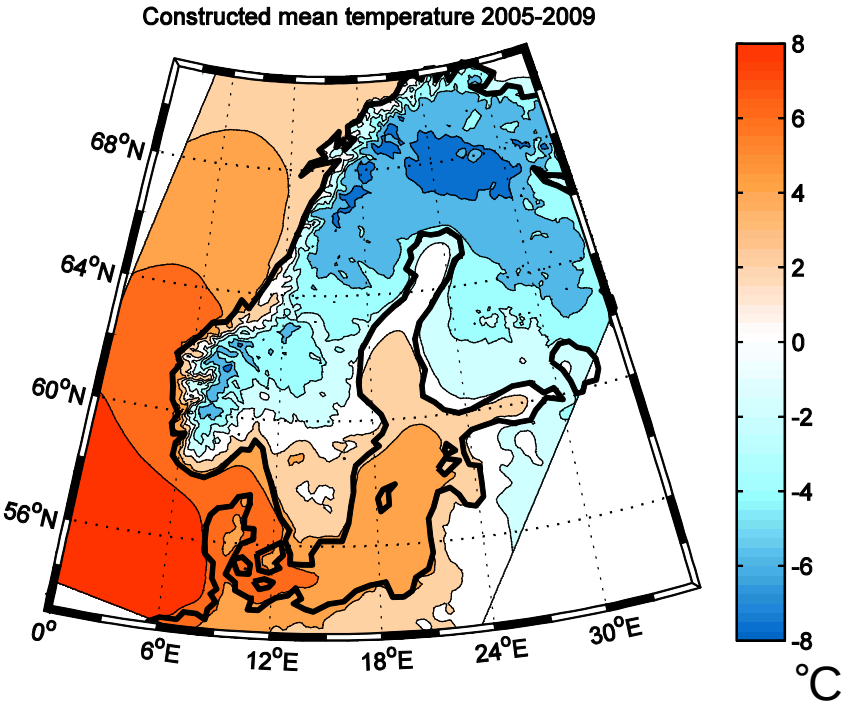
Comparison between two five year periods Mean temperature (November)

Mean temperature 1995-1999



Mean temperature 2005-2009



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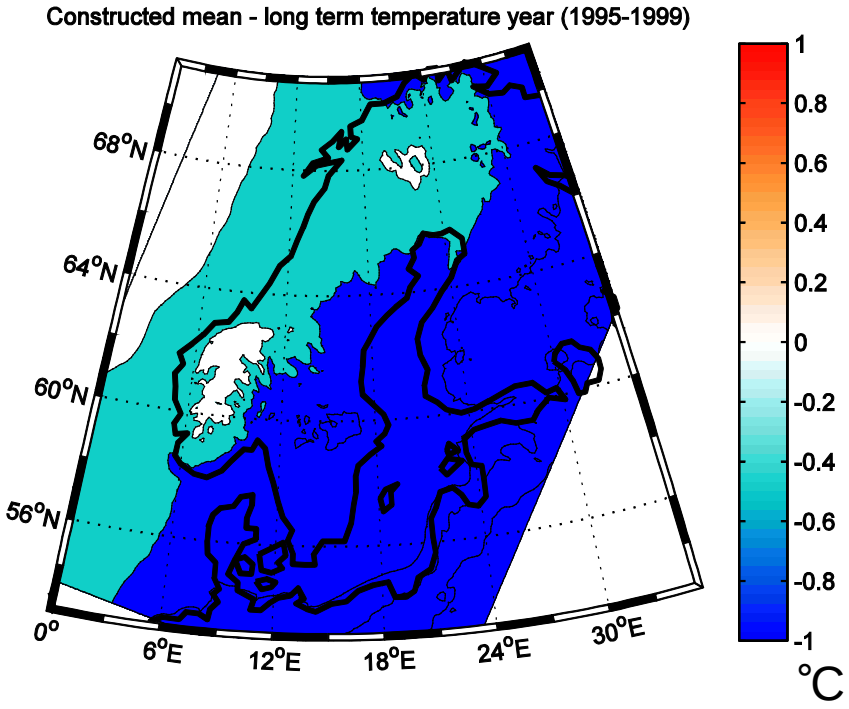
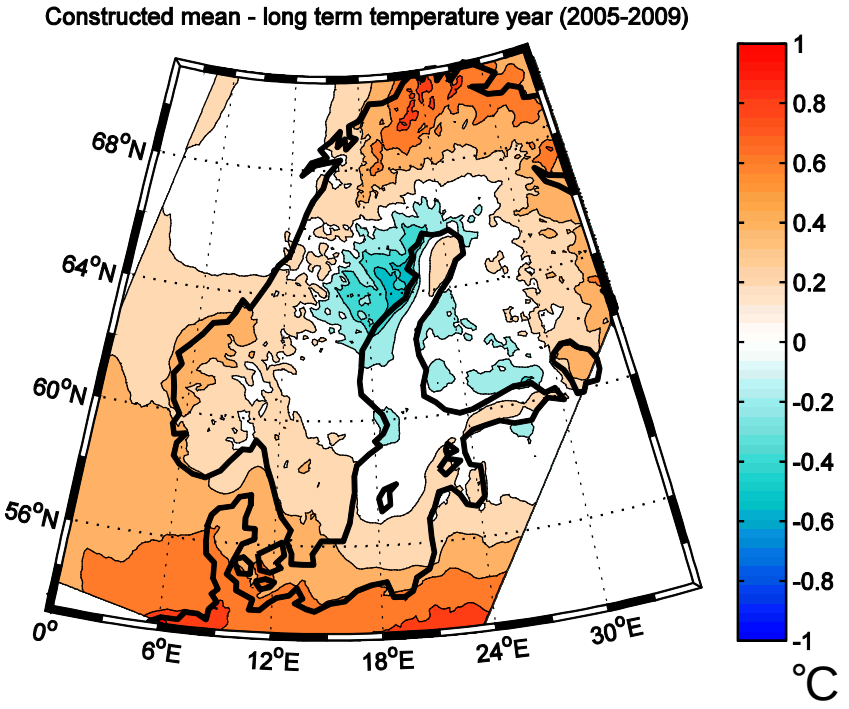
Temperature difference between long term mean and five year periods

1995-1999 temperature – long term temperature



2005-2009 temperature – long term temperature



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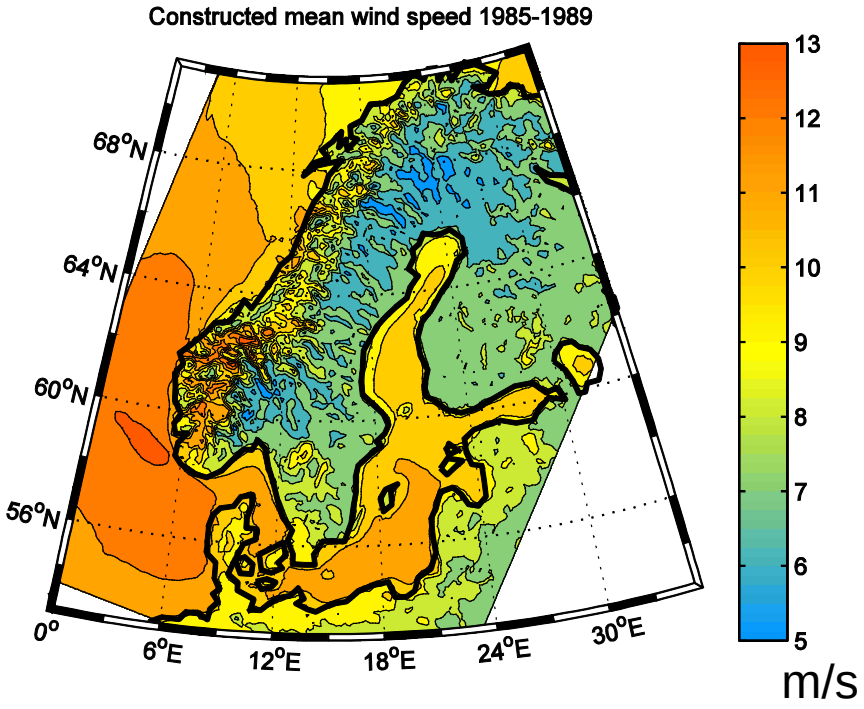
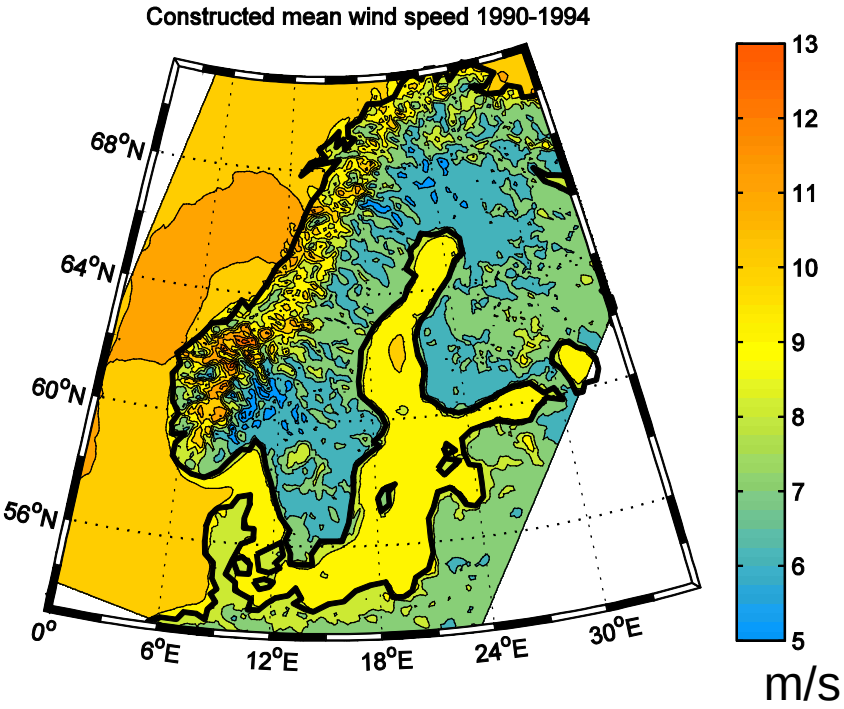
Comparison between two five year periods
Mean wind speed (November)

Mean wind speed 1985-1989



Mean wind speed 1990-1994



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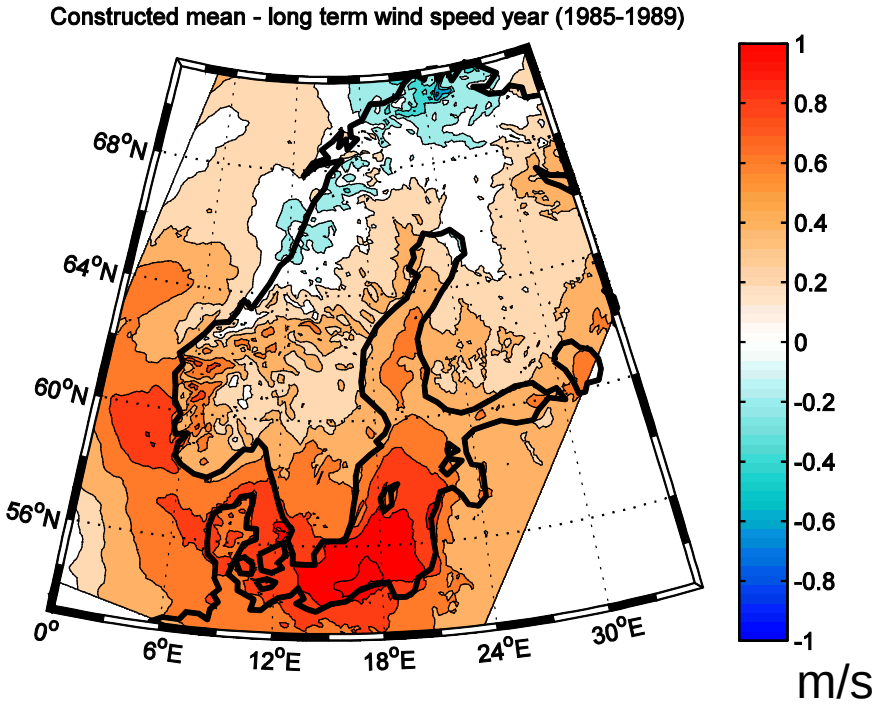
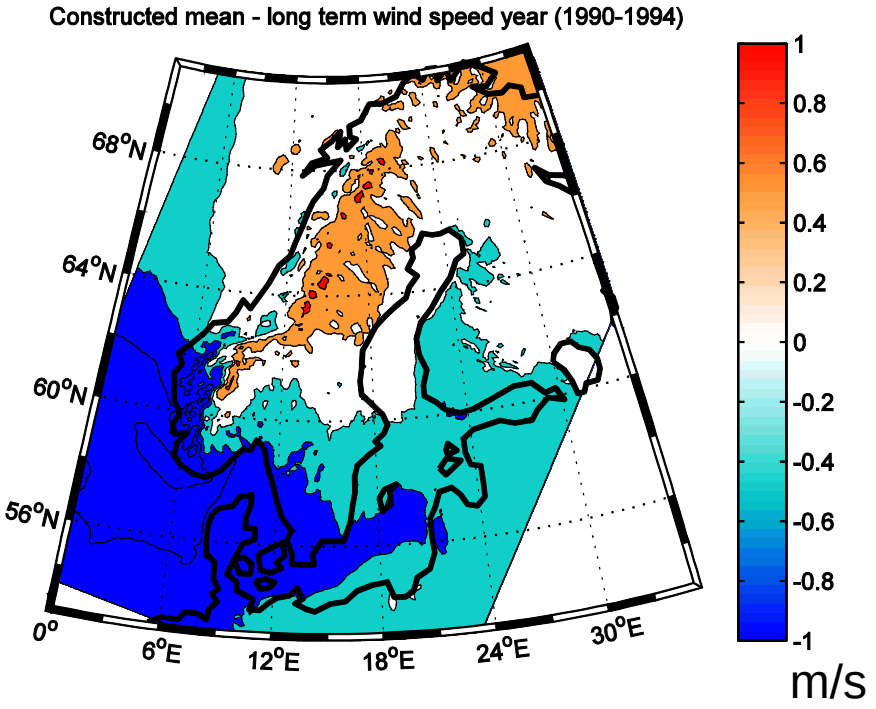
Wind speed difference between five year periods and long term mean

1985-1989 wind speed – long term wind speed

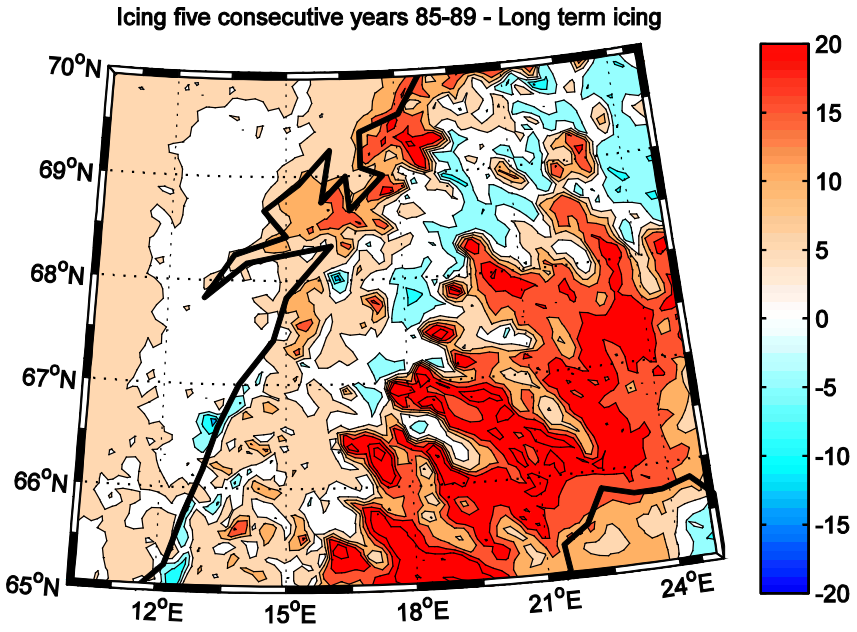


1990-1994 wind speed – long term wind speed

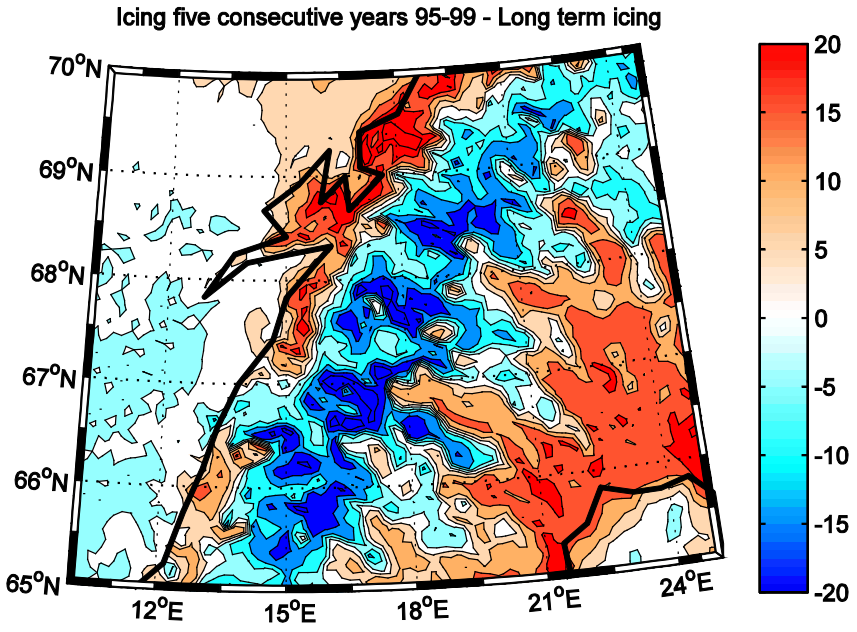


Icing – difference between five year periods and long term mean

1985-1989 icing – long term icing



1995-1999 icing – long term icing



Difference in percentage points. For some areas here there is a difference of over 30 percentage points between the two five year periods.

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Conclusions on using consecutive years

- Using five consecutive years cannot construct a good climatology for either temperature, wind speed or icing
- There are large differences between the five year periods for all of the parameters. There can in some areas be 2 m/s difference between the wind speeds from two five year periods
- For icing there are large differences between two five year periods, very large differences for some areas

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How to find representative years

- To test if the long term climate can be estimated with a shorter number of years a “best fit” approach is tested on the data set
- This test was done on a low resolution dataset to find the five best fits. ERA Interim reanalysis dataset for the Scandinavian area was used
- Then the method was tested on the WRF dataset (same dataset as used before)

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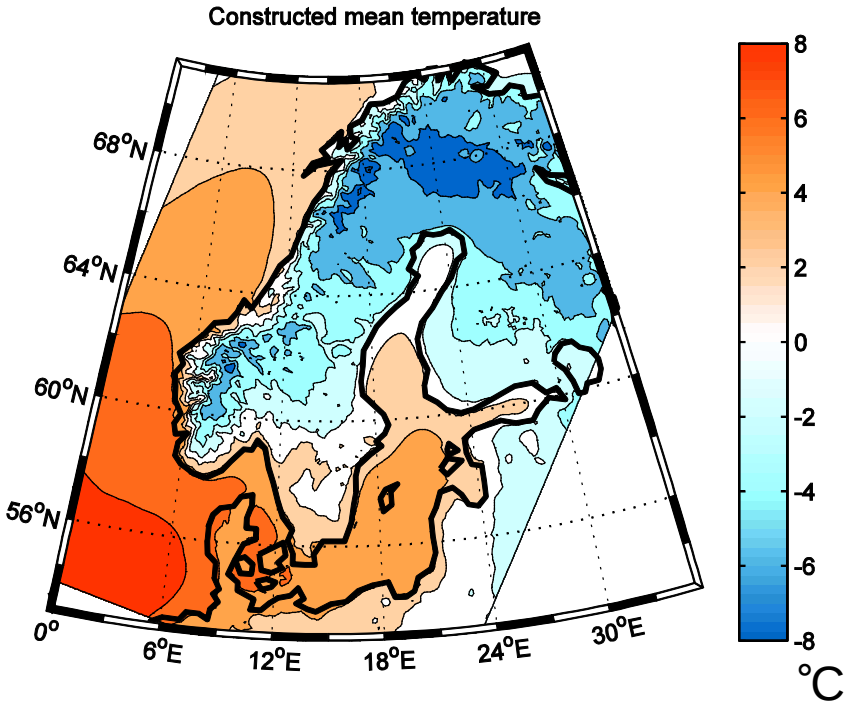
How to find representative years

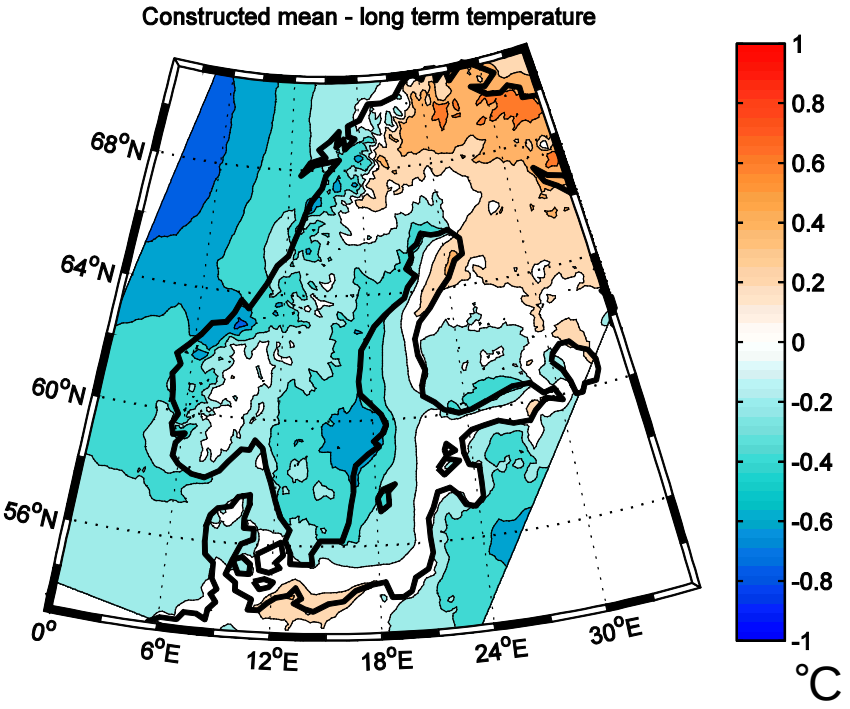
- We used 30 years to find the five best fits of the monthly means of temperature and wind speed to the long term means
  1. Comparing the monthly means of the parameters to the long term means
  2. Use a number of best fits as an estimation of long term climate
- Here we use wind speed and temperature and the five best fits
- This method will be called the best fit method

Temperature
Best fit of temperature and wind speed

Constructed mean temperature



Difference, Constructed temp - long term temp



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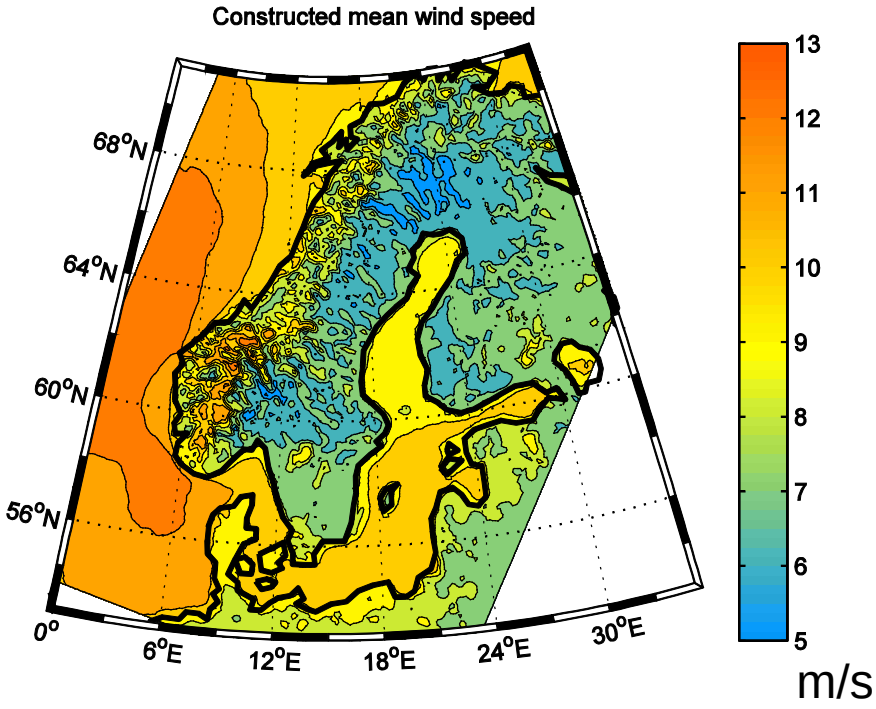
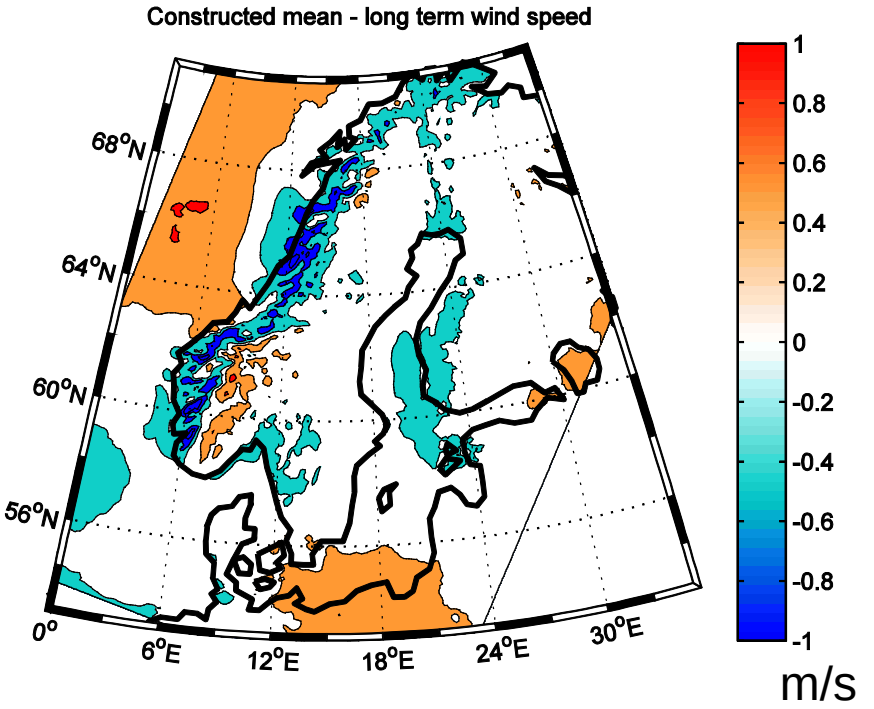
Wind speed
Best fit of temperature and wind speed

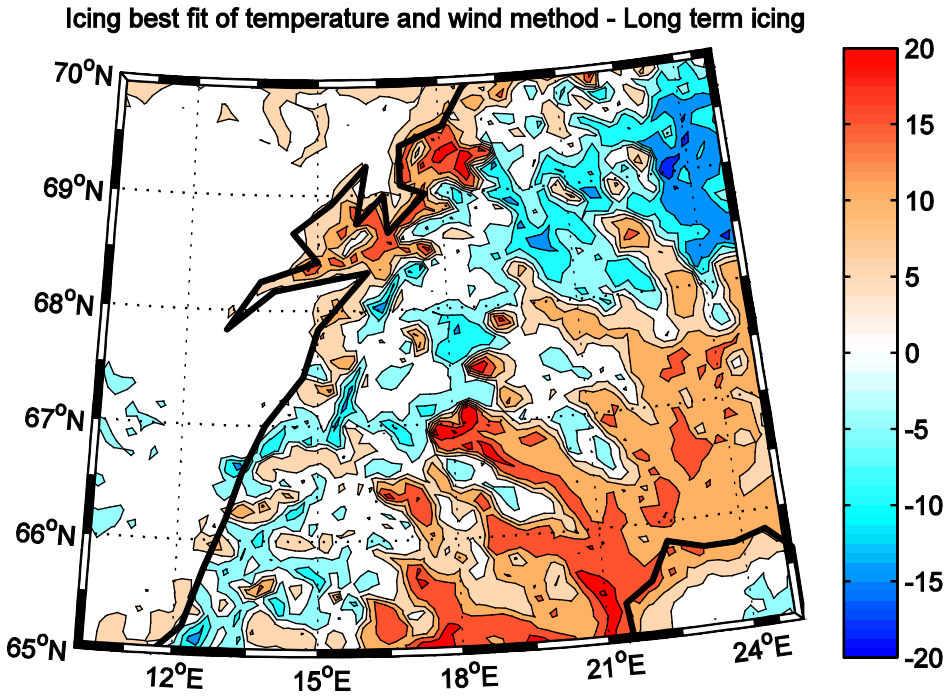
Constructed mean wind speed



Difference, Constructed wind speed – long term wind speed



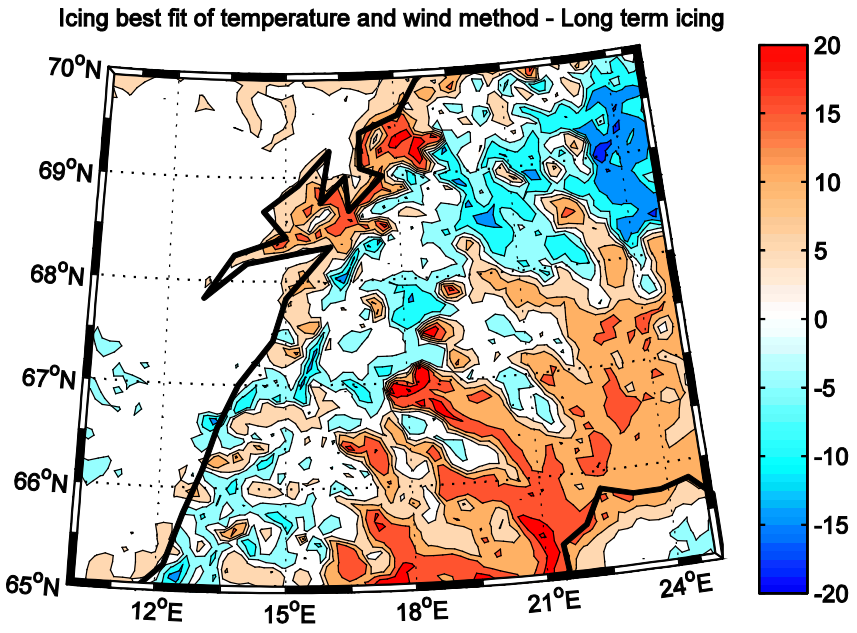
Icing
Best fit of temperature and wind speed



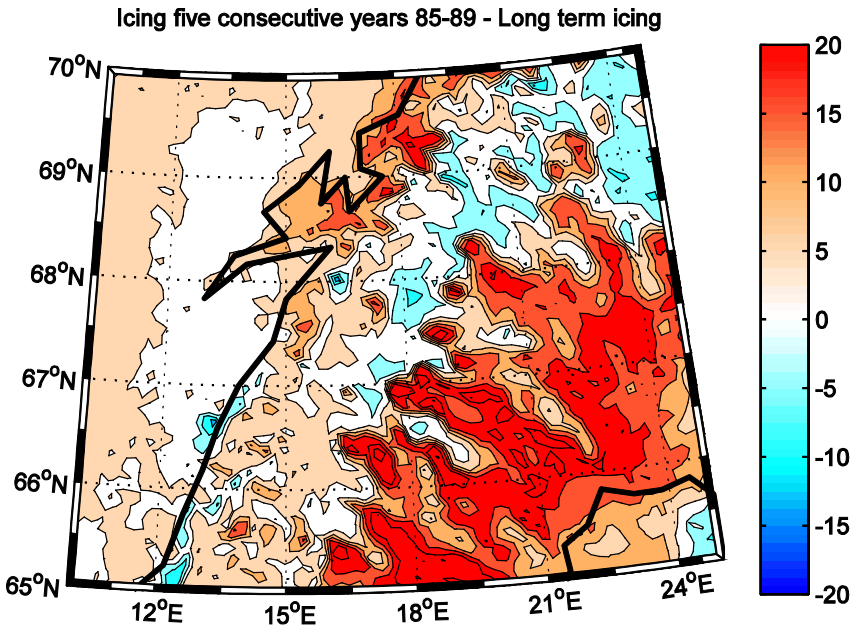
Difference between icing calculated using the best fit of temperature and wind speed method and long term icing. Difference in percentage points.

Comparison between icing with the different methods

Icing best fit method – Long term icing



Icing 1985-1989 – Long term icing



Difference in percentage points

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Conclusions

- Using the best fit to the long term mean ensures a better results for some parameters
- This method will be investigated further on a smaller area with a higher resolution
- Using five years to estimate the climate is very risky, the five consecutive years method is not recommended

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Future work

- To test the methods on other areas and compare with measurements and on PIREPs
- Comparing the methods with downscaling
- And using a higher resolution dataset (1×1 km grid) and smaller areas

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Thank you for your attention!

Contact information:

Petra Thorsson
petra.thorsson@geo.uu.se

Hans Bergström
hans.bergstrom@met.uu.se

Stefan Söderberg
stefan.soderberg@weathertech.se

Esbjörn Olsson
esbjorn.olsson@smhi.se

Per Undén
per.unden@smhi.se

A great thanks to Vindforsk III and the Vindpilot projects for financing and sponsoring!