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NCEP/NCAR reanalysis surface wind field assessment in the circum-polar Arctic

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Abstract

The prevalence and wide potential applicability of data from the US National Center for Environmental Prediction (NCEP) and National Center for Atmospheric Research (NCAR) Reanalysis project make careful consideration of strengths and weaknesses from this dataset essential. Much derived work (e.g. ice model, coastal geomorphology) depends upon surface winds, thus it was of interest to determine how NCEP/NCAR reanalysis surface wind data compare with observed for the climatically sensitive circum-Polar region. Surface windspeed and direction fields from the NCEP/NCAR reanalysis 6 hourly data set were compared with observed hourly wind data from three major datasets over the period 1950-2000: terrestrial weather stations, including 124 coastal stations in Russia, Norway, Greenland, Canada and Alaska and 59 stations from the Canadian interior; ice island/ice breaker observations, consisting of 600 marine grid sites; and Beaufort Sea oil platform observations, consisting of 65 individual time series. Vector and Pearson correlations were performed for direction and speed components, respectively, between each station point and the nearest reanalysis grid point. Correlations were performed for various temporal periods, including annual and calendar seasons, and for two speed categories, "low speed" (station speed <10 m/s), and "high speed" (station speed >= 10m/s). For each temporal period and speed category a single mean correlation was determined for the circum-polar region. Spatial and temporal patterns in the correlations are presented and contrasted with data availability and teleconnection indices. In general, results indicated that reanalysis surface wind direction is reliable while speed is not. These patterns are exaggerated for the higher speed category. The regular nature of the discrepancies, however, suggests corrective work can be reasonably performed. Temporal trends indicate a degree of data dependency, although there is a coincidental suggestion of influence by inter-annual pressure oscillations (e.g. AO, PNA).

INTRODUCTION

The NCEP/NCAR Reanalysis project (NCEP: National Centre for Environmental Prediction; NCAR: Prediction/National Centre for Atmospheric Research) was undertaken to give to the science community accurate, high-resolution data sets for climatological work. The data sets produced by this project, and other similar efforts (such as the European Center for Medium Range Weather Forecasting reanalysis project), are known generally as "reanalysis data". The Reanalysis project combines an NCAR weather forecasting model and observational data from various sources. The distribution of climate observing sites over the earth is non-uniform, however, which means the influence exerted by the model on the final reanalysis data result is variable.

The objective of this project is therefore to compare reanalysis data back to observed station data and to assess its ability to reproduce the observed record. This is especially important if the reanalysis data are to be used as the basis of analyses conducted in remote, data sparse regions, or if they are to be used as input to other models to derive secondary parameters, such as wave heights. Other studies that have assessed reanalysis data have found that the NNR wind speeds are often too low during times of observed high-magnitude events, such as storms.

This paper presents partial results from a detailed comparison of NNR 6-hourly 10 mhag (meters height above ground) winds with observational hourly wind data from weather stations located throughout the circum-Arctic coastal region.

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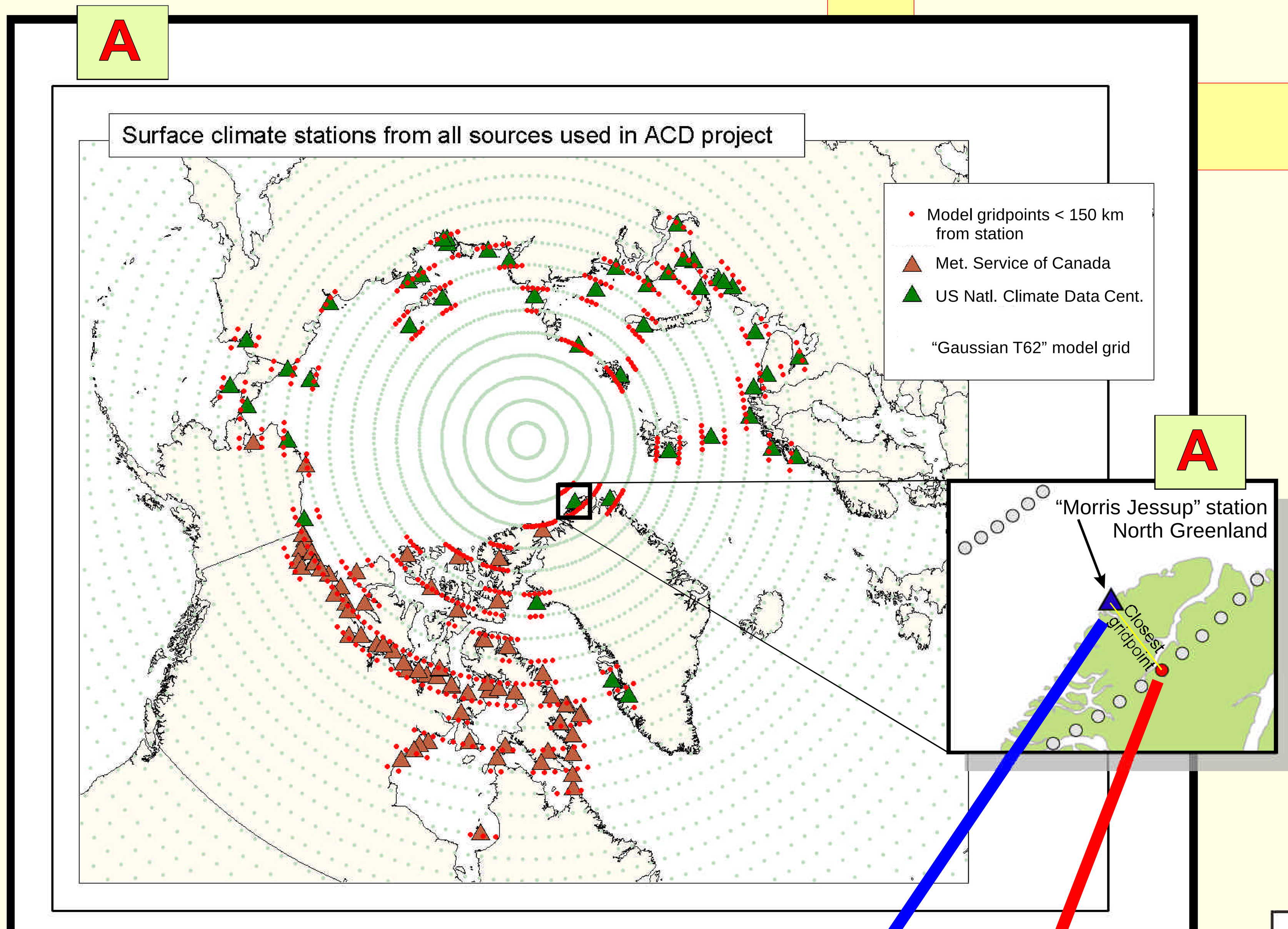
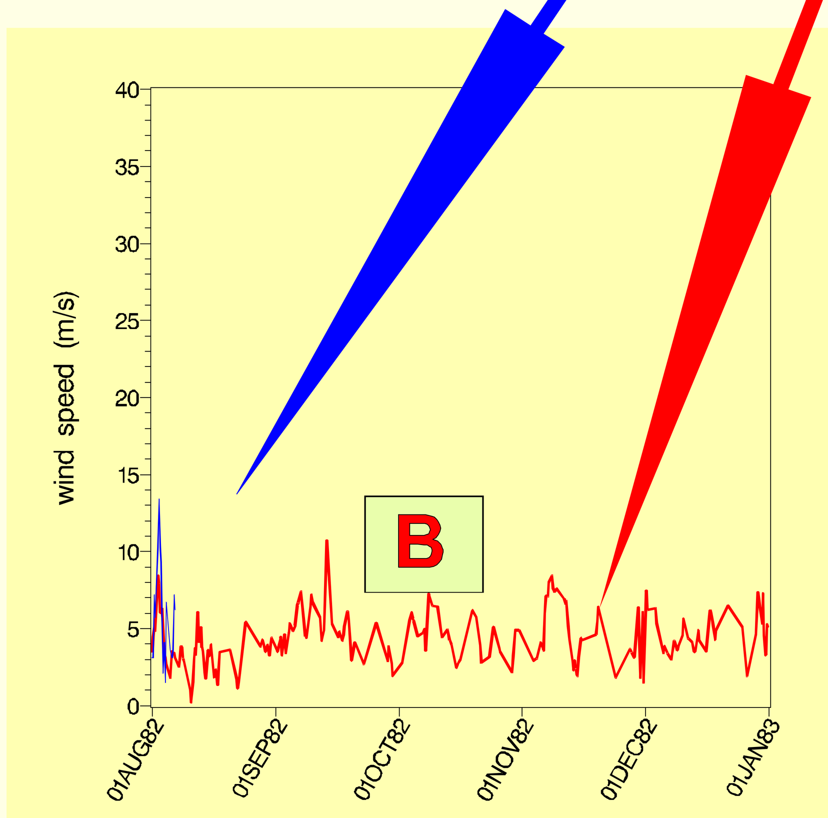


METHOD

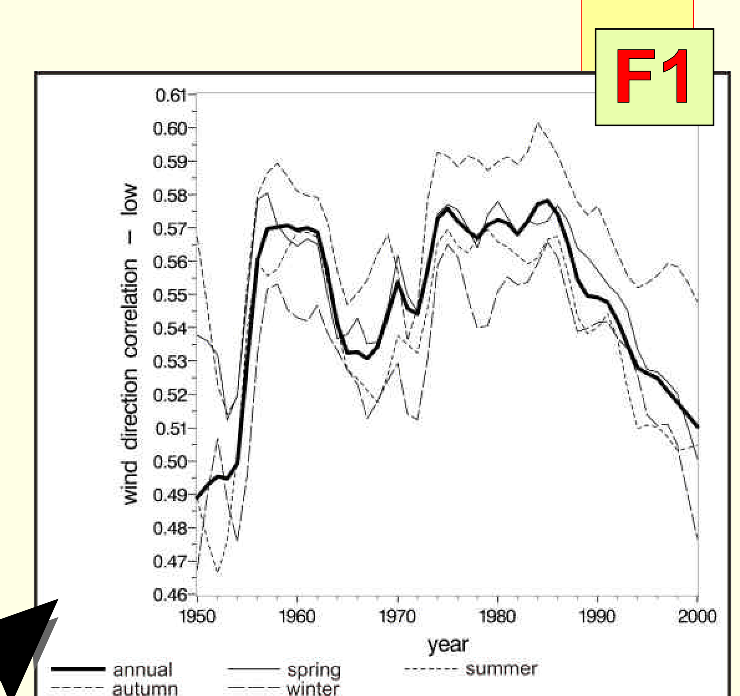
Method consists of the following steps:
A: closest reanalysis grid point to each station identified
B: Data from both sources retrieved
C: Correlations on wind speed and direction performed
D1: Correlations are averaged by station OR
D2: averaged by year
E1: Spatial plots by speed category showing wind speed correlations, AND
E2: wind direction correlations
F1: Time series plots to examine trends AND
F2: to compare against modes of variability

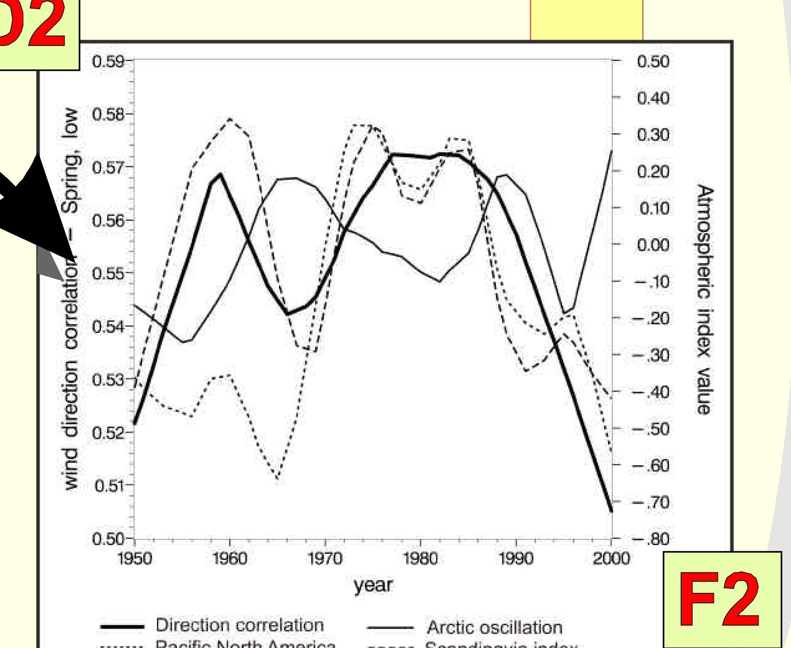


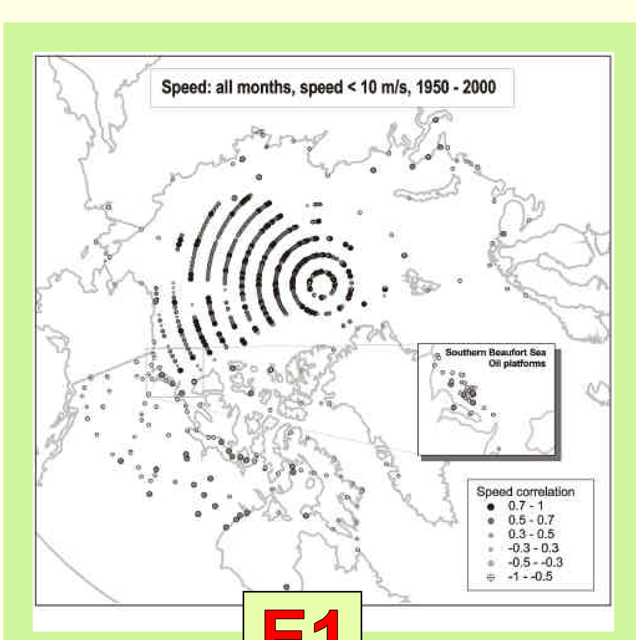
C
Correlation = 0.47 between these two wind speed series

D1 Average by station

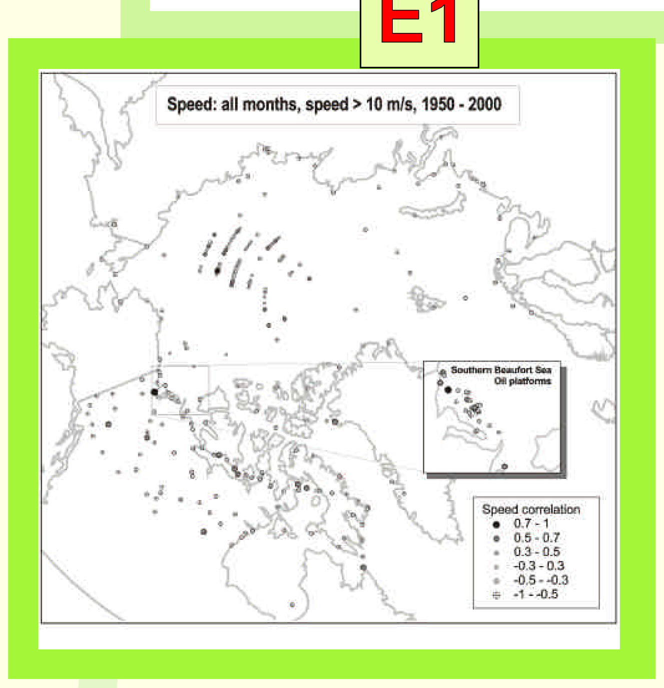
D2 Average by time



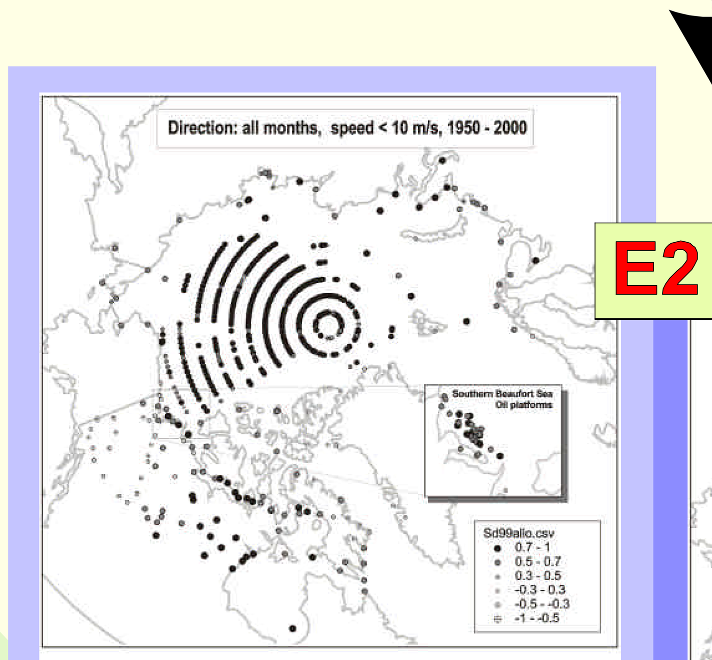


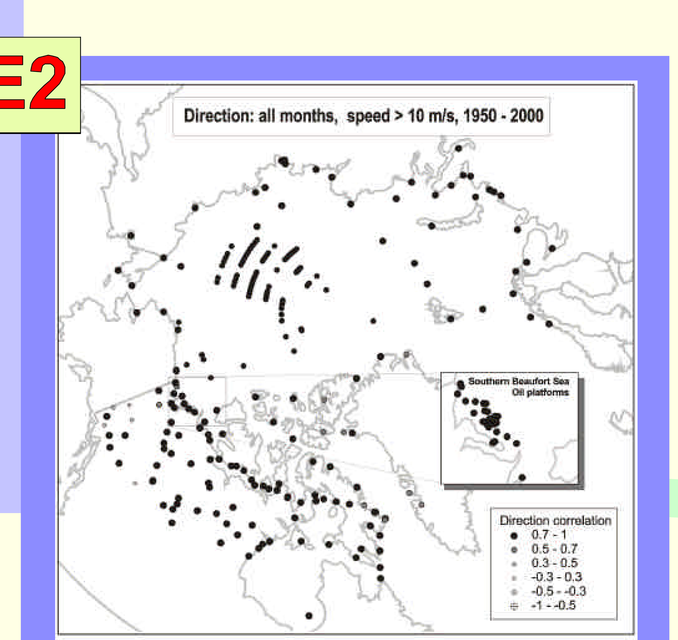


E1



E2





DISCUSSION

The following observations were made about the NCEP/NCAR reanalysis surface 6-hourly wind fields in the circum-arctic region. First, accuracy with respect to observed was dependent on the wind speed magnitude. For lower wind speeds, below 10 m/s, wind speed correlations often exceeded 0.5, while direction correlations ranged widely and were highly variable spatially. For higher wind speeds (> 10 m/s) however, speed correlations dropped markedly for almost all stations, while direction correlations increased and inter-station variability decreased. Regarding time series correlations of region-wide averages of all correlations by year, both direction and speed correlations were found to vary with patterns and trends that showed coherency with a number of standard northern hemisphere pressure-pattern indices.

The behaviour in the spatial correlation patterns may be explained as follows. During conditions of low wind speed local topographic influences exert a strong control over the wind direction, causing it to decouple from the prevailing flow, which the reanalysis data are representing. Speed, however, is generally adequately captured for the low-speed magnitude regime, and correlates reasonably well. Higher speed regimes are usually indicative of storminess, and during such events local influences are overwhelmed by the strong large-scale flow, which explains the improvement in direction correlation accuracy. The reanalysis data have difficulty fully resolving storms, however, and speed is not adequately captured, resulting in the observed drop in speed correlation. It must be noted that, although the reanalysis did not usually fully capture the large-magnitude events in terms of speed, there was still an indication of timing, which has been used to apply a correction, with limited success. Regarding the time series plots, the fact that they often showed some coherency with various indices of atmospheric variability suggests the reanalysis model is sensitive to some parameter captured by this, perhaps a variability in storm frequencies that the indices are describing, or a shift in the mean strength of the near-surface flow.

In general the major drawback of the reanalysis surface wind field is its poor ability to reproduce large-magnitude events. This is not an insurmountable problem, however, and is amenable to correction.

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