



High-Resolution Satellite-Derived Ocean Surface Winds in the North Atlantic

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Florida State University
Support from the NASA OVVST**



Nordic Seas Region

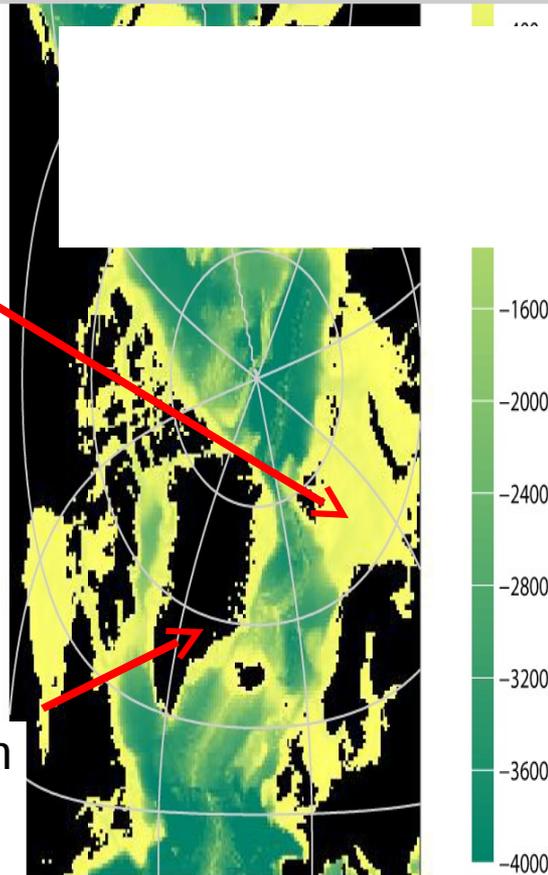
Water mass transformation and production of high-density water in the Barents Sea through cooling and brine rejection during ice freezing

Shelf-derived dense water contributes to the Arctic Ocean halocline and deep water (*Aagaard, 1981; Cavalieri and Martin, 1994; Jones et al., 1995*)

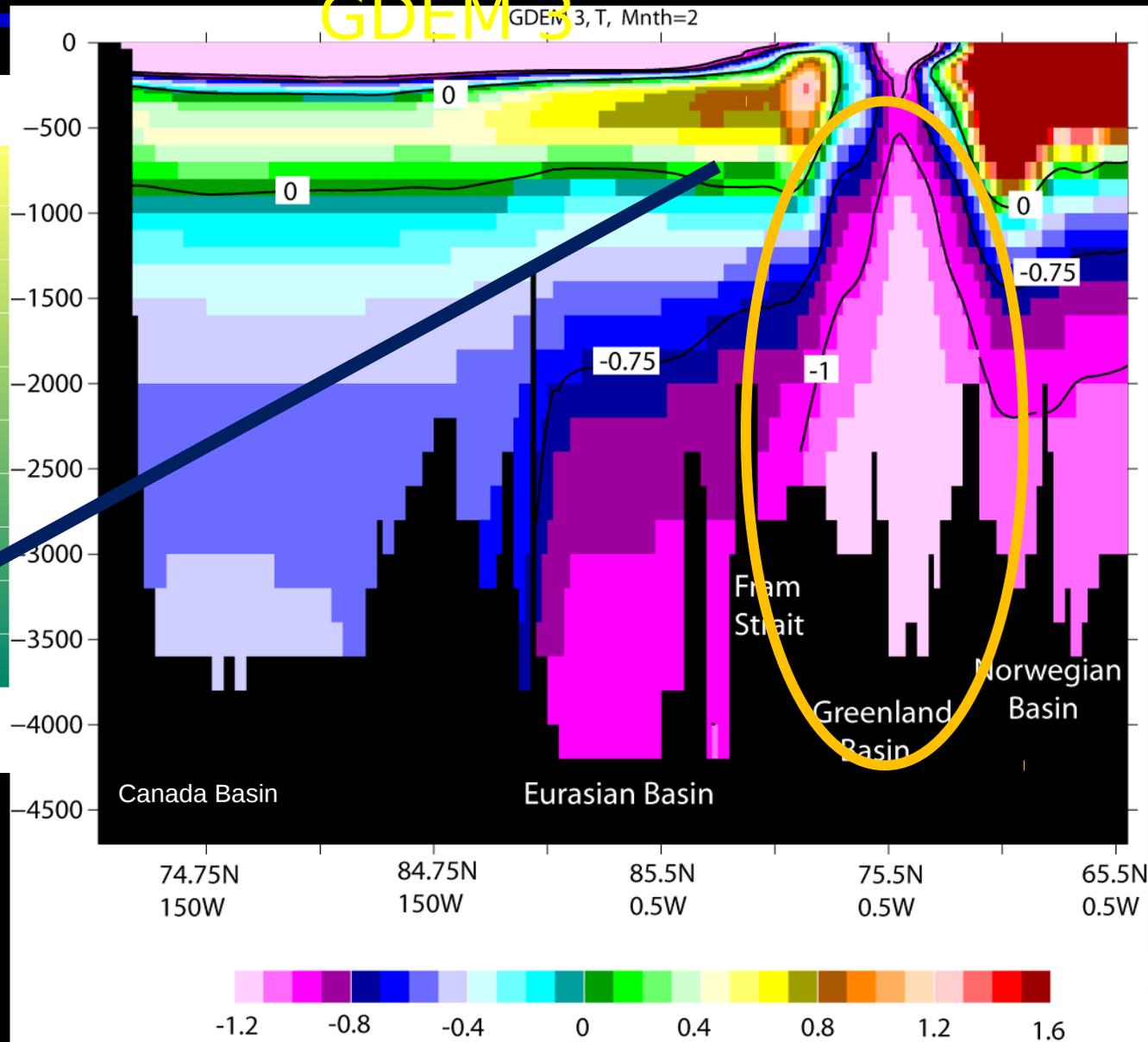
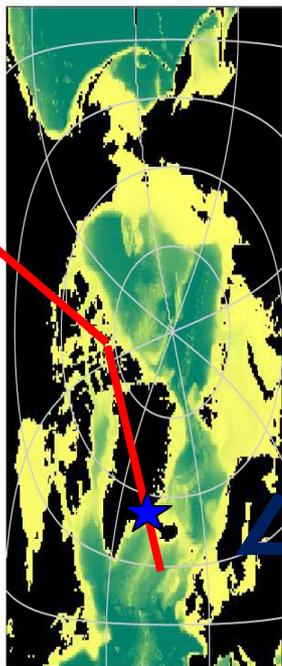
Atlantic Water undergoes modifications in the Greenland Sea through cooling and mixing with Arctic water masses

A very dense water mass is formed in the Greenland Gyre. It overflows the Denmark Strait sill contributing to the bottom North Atlantic water.

Monthly average net fluxes can exceed **400 W/m²** during winter (*Hakkinen and Cavalieri, JGR, 1989*)

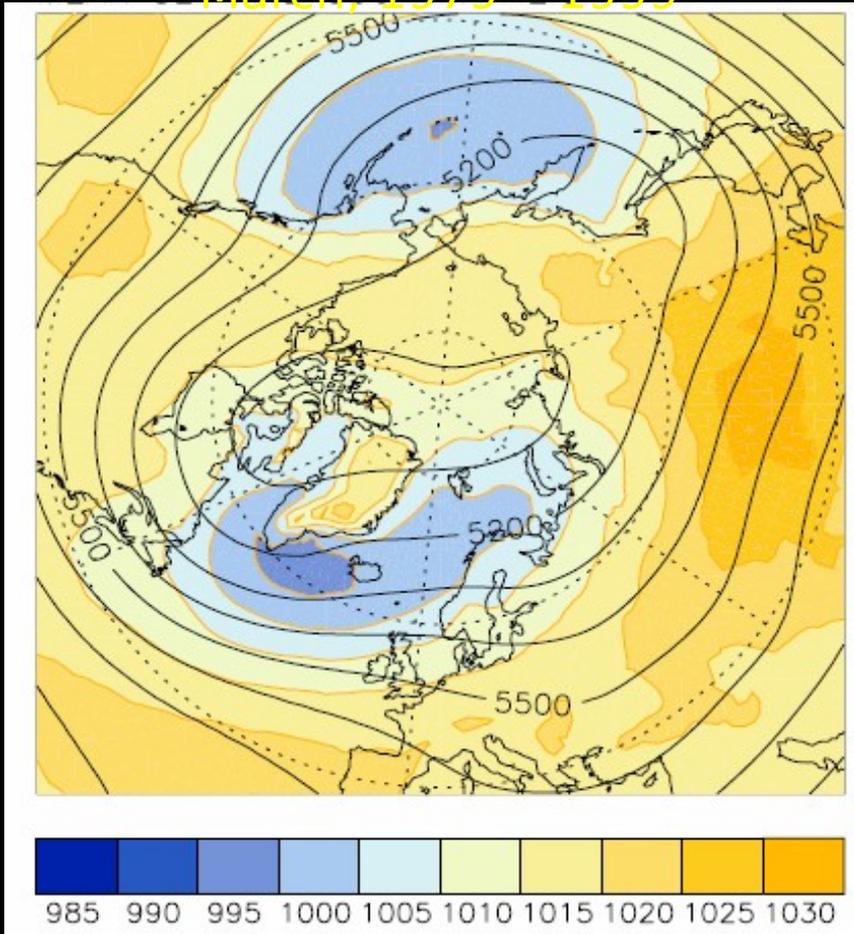


Vertical Temperature Profile, February, GDEM 3



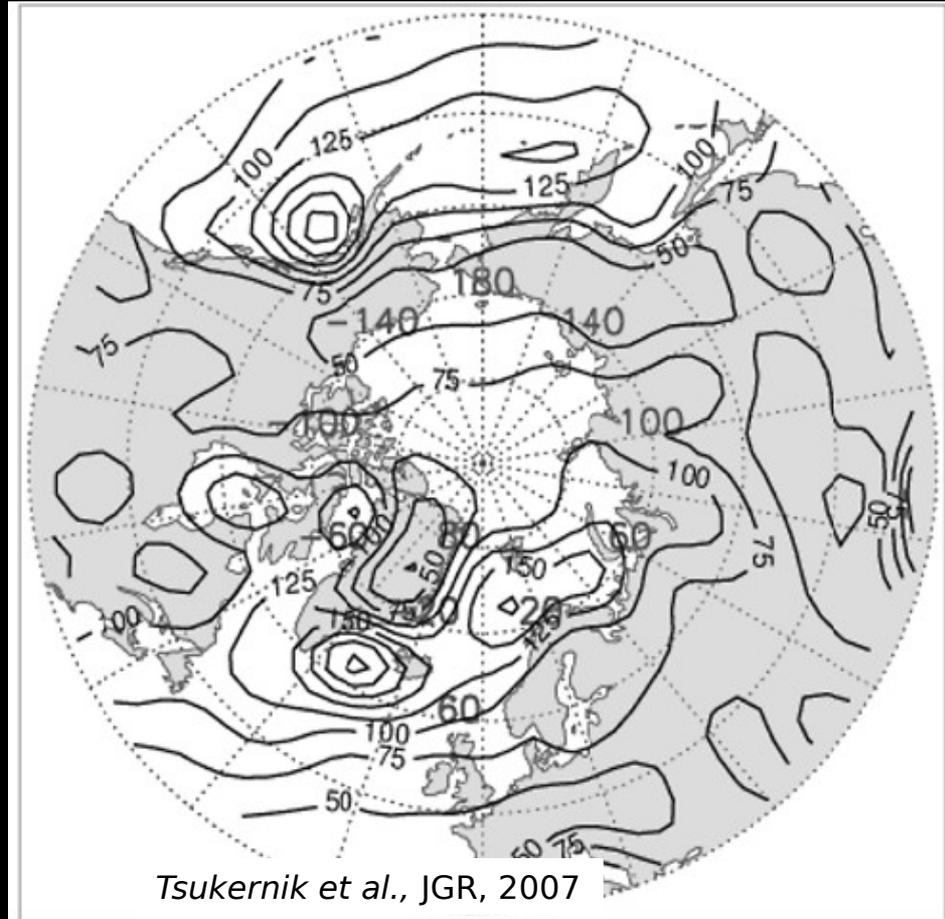
Cyclones in the Nordic Seas

Distribution of mean SLP and mean 500 hPa height (contours) fields, November - March, 1979 - 1999



Tsukernik et al., JGR, 2007

Total winter cyclone count (November – March), 1979 - 1999





Cyclone Classification

Large-scale low-pressure systems:

Spatial scale: $O(1e3)$ km

Time scale: days-week

Meso- & small-scale low pressure systems (e.g., Polar Lows):

Spatial scale: $O(100)$ km

Time scale: hours – day

Very strong winds (>17 m/s)

Polar Low over the Barents Sea in NOAA satellite image

NOAA 04:33 UTC 20 December, 2002

blizzards over much of eastern Britain as well as over large parts of Holland and Belgium (figure 7) [?]. At some locations on the east coast of England, wind speeds reached force 10!

From that afternoon chaos reigned throughout Great Britain. Stanstead Airport was closed while thousands of travellers were delayed at Heathrow Airport as flights were cancelled; the London underground came to a halt; schools were closed; many workers trying to make their way home after work found themselves in traffic gridlock for many hours; thousands suffered power cuts; snowploughs struggled to keep roads open, with many short journeys taking hours and there were numerous road accidents as up to 15 cm of snow fell in many places. Yet in the corresponding NOAA-17 image the following day, only a tenuous streamer, possibly a remnant of the cyclone's 'comma' tail, remained to tell the tale (figure 8).

References and Further Reading

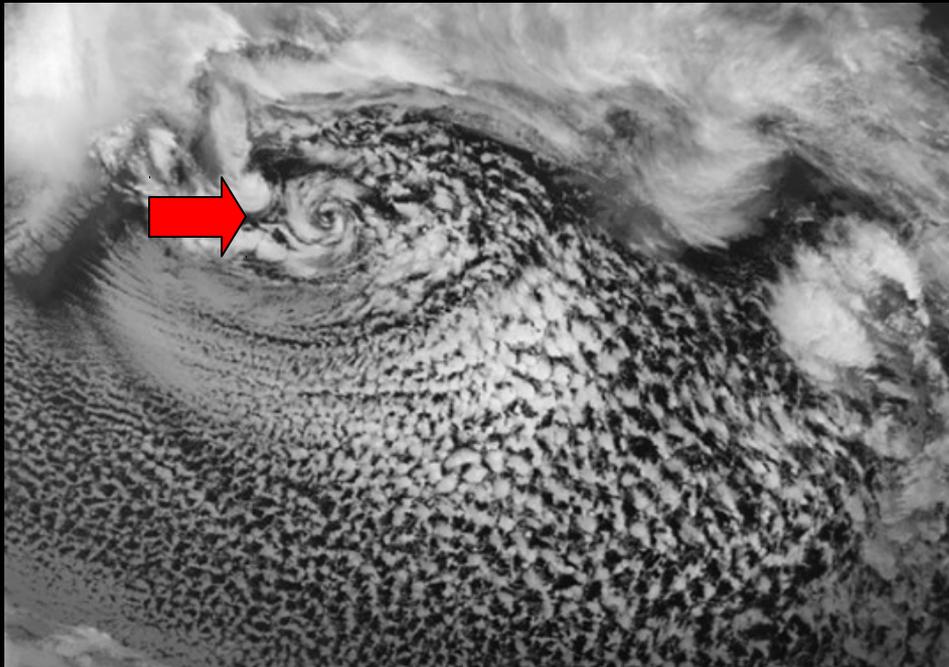
1. The European Polar Low Working Group
<http://www.meteo.uni-bonn.de/mitarbeiter/GHeinemann/eplwg/eplwgop.htm>
2. 'Polar low' boven zuidelijke Noordzee
<http://www.knm...>
3. Weather Online

From: L. Hamilton, The European Polar Low Working Group, 2004

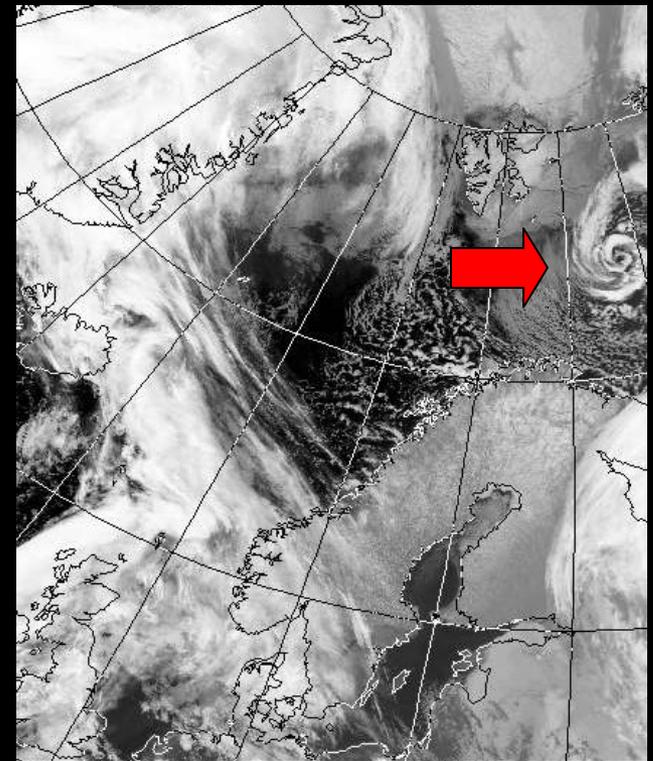


Are Small-Scale Cyclones Represented in the Wind Fields?

“Yet owing to their small scale, polar lows are poorly represented in the observational and global reanalysis data <...>”. Zahn & von Storch, Nature (467), 2010



A polar low embedded in a large cold air outbreak on 2 March 2009. Greenland in the top left corner and Iceland is partly covered by a cloud in the upper right quadrant (<http://polarlows.wordpress.com/>)

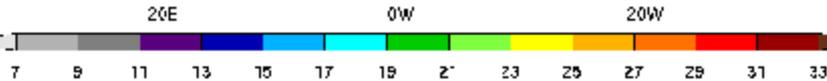
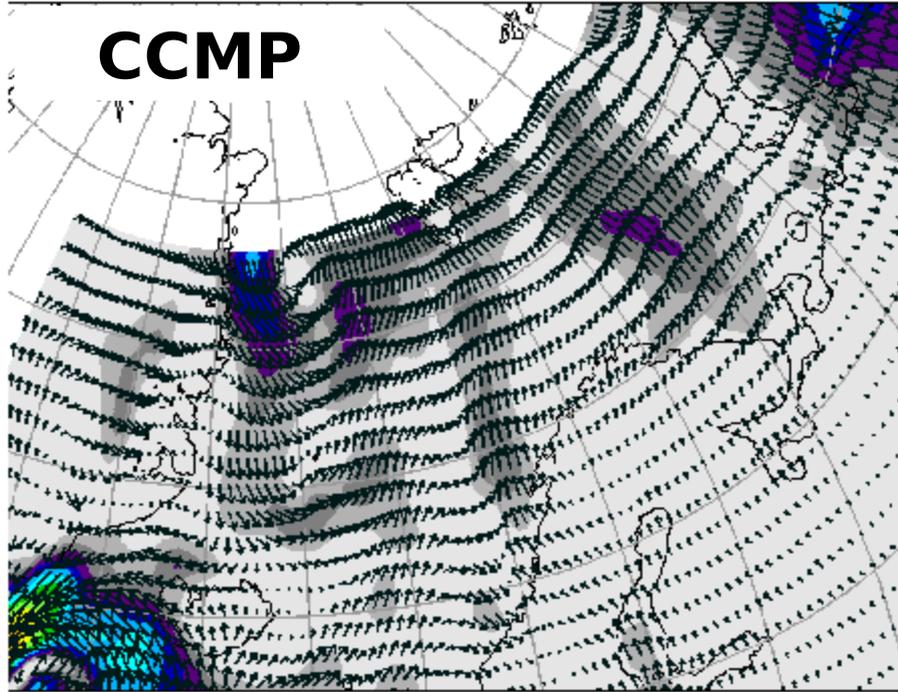


A classic Barents Sea polar low, February 9, 2011



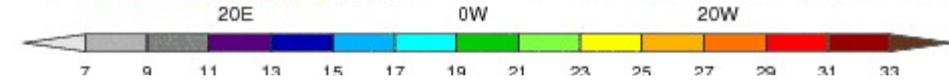
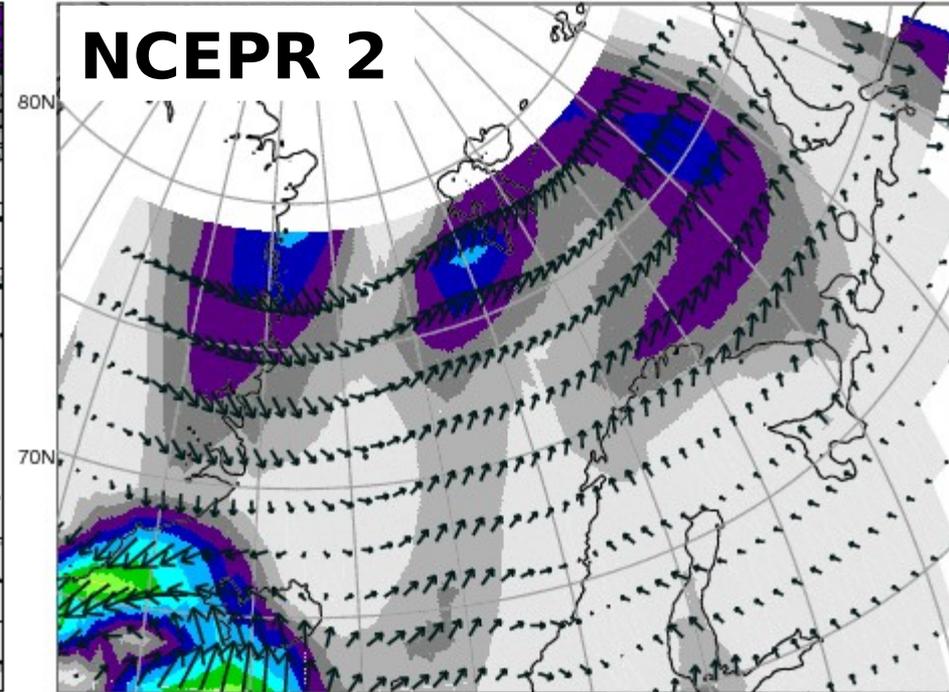
Surface Winds from Cross-Calibrated Multi-Platform Ocean Surface Wind Components (CCMP) and National Center for Environmental Prediction Reanalysis 2 (NCEPR 2), October 2007 - April 2008

CCMP - Level 3.0 Winds, 01-Oct-2007 00:00:00



- Period covered: July 1, 1987 - December 31, 2008; 0.25° resolution, 6hr fields
- The data set combines data derived from several scatterometer satellites
- Satellite data are assimilated into the ECMWF Operational Analysis fields

NCEPR 2 Winds, 01-Oct-2007 00:00:00



- Period covered: 1891 - present;
- Assimilated observations: surface pressure, sea surface temperature and sea ice distribution, **scatterometer winds (since 2002)**
- Products include 3- and 6-hourly data on ~1.9 x 1.9° global grid, monthly, daily averages

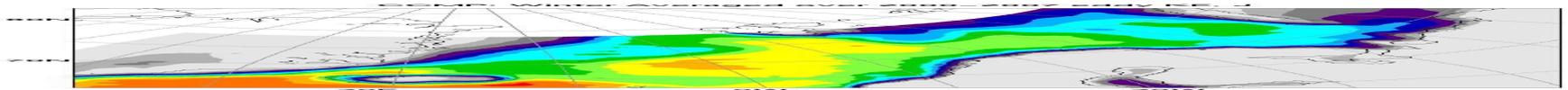
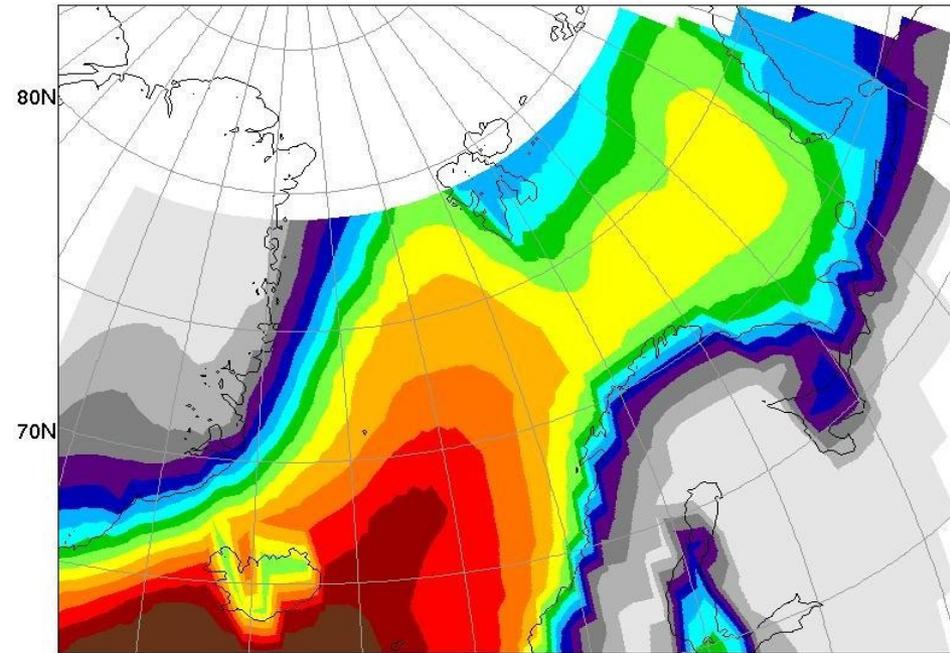
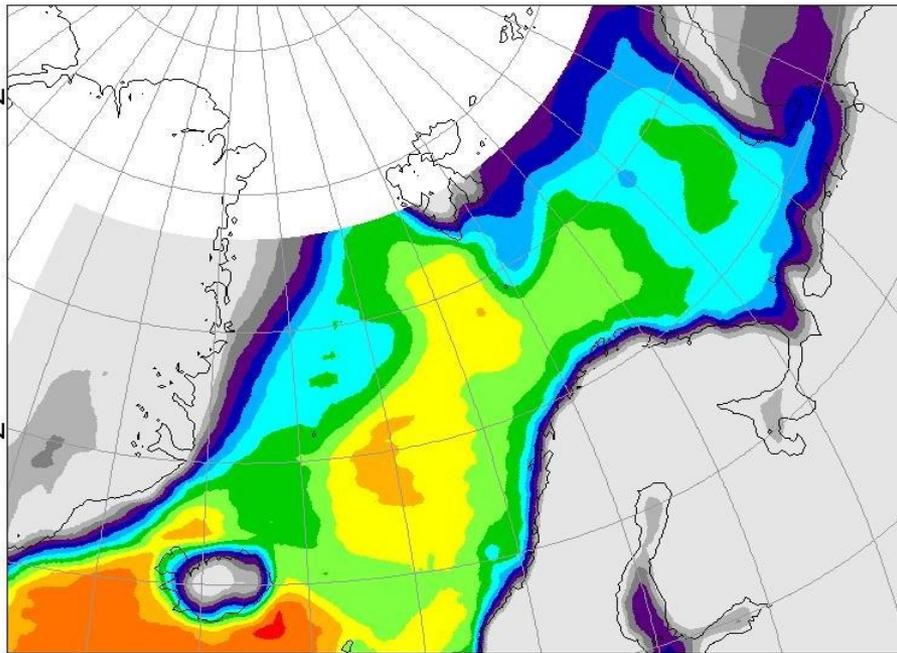
Winter Mean EKE (2000 - 2007)

CCMP

NCEP R 2

CCMP: Winter Averaged over 2000-2007 eddy KE, J

Winter Averaged over 2000-2008 eddy KE, J



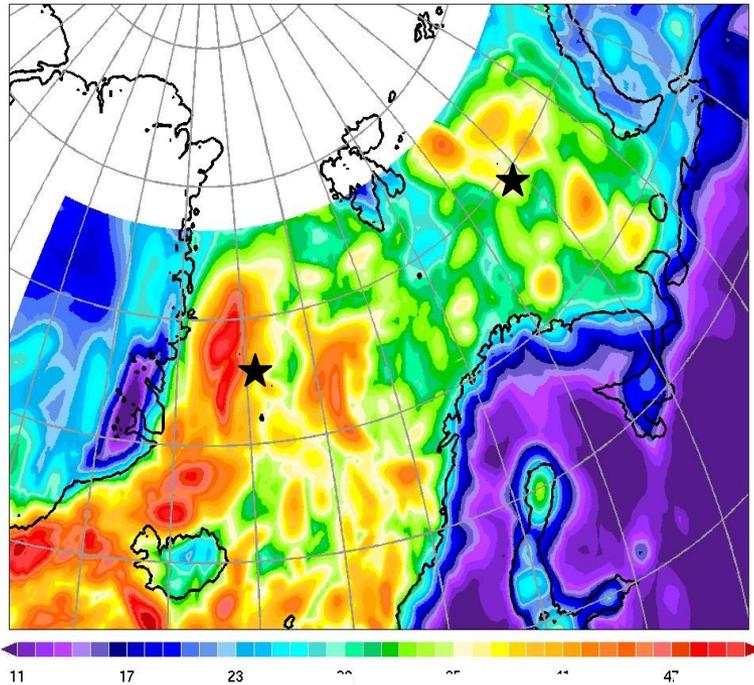
EKE (J)

Maximum Wind Speeds, Winter 2000-2007

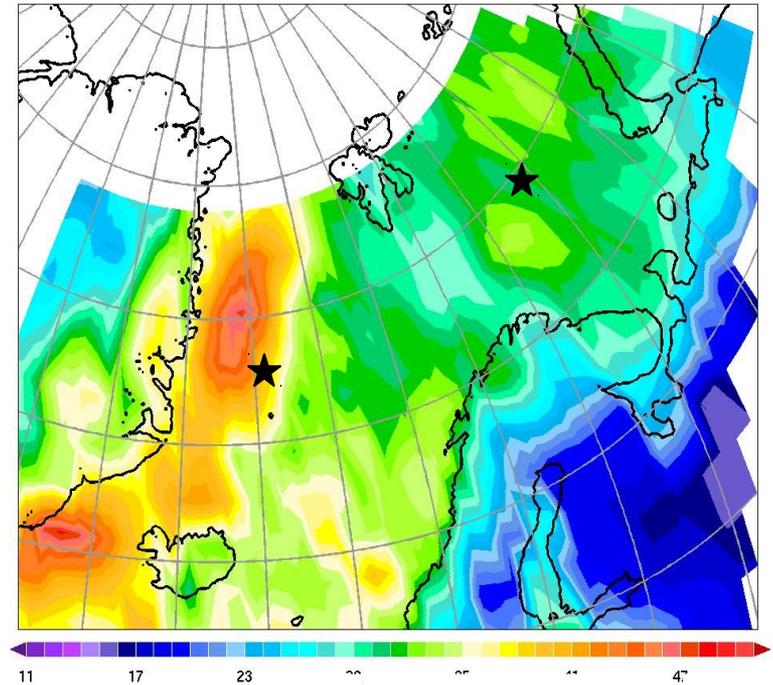
CCMP

NCEP R 2

Maximum Wind Speed, winter, CCMP, 2000-2007

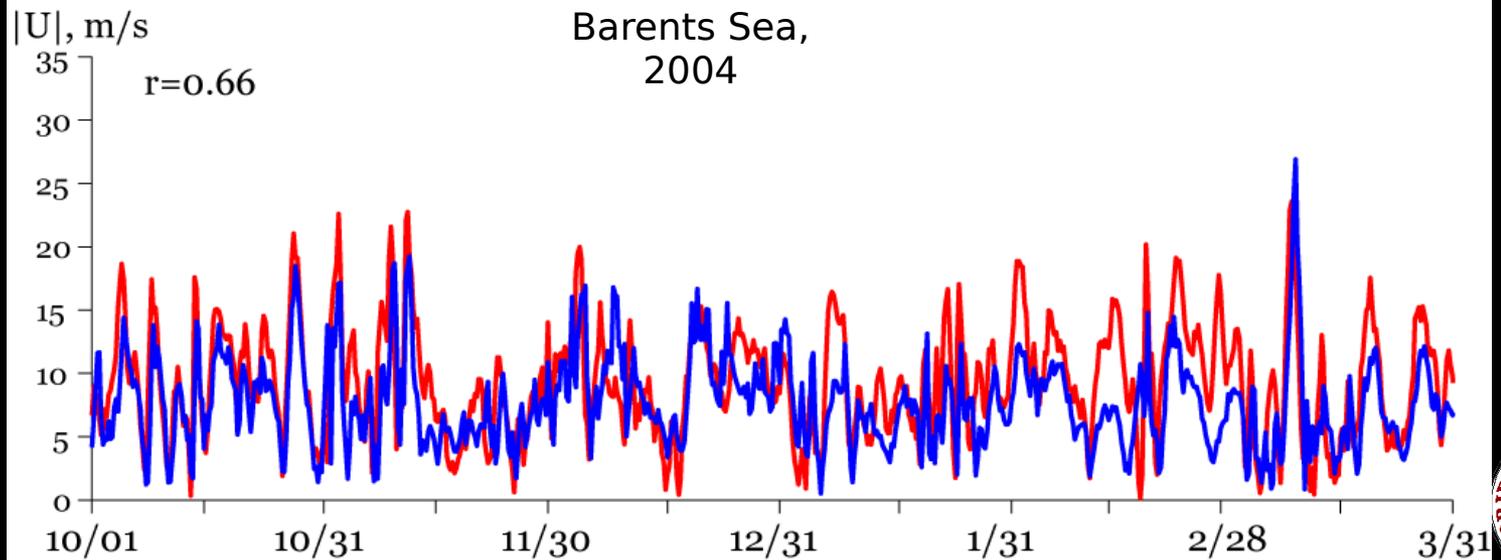
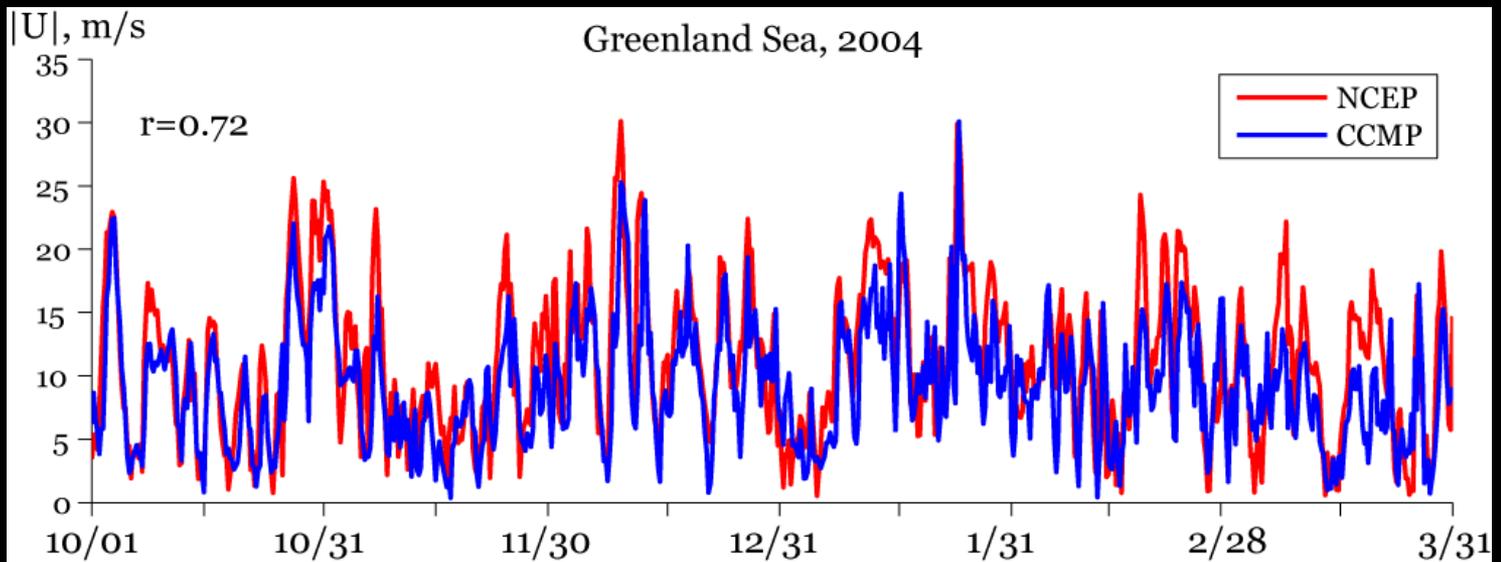


Maximum Wind Speed, winter, NCEP, 2000-2007

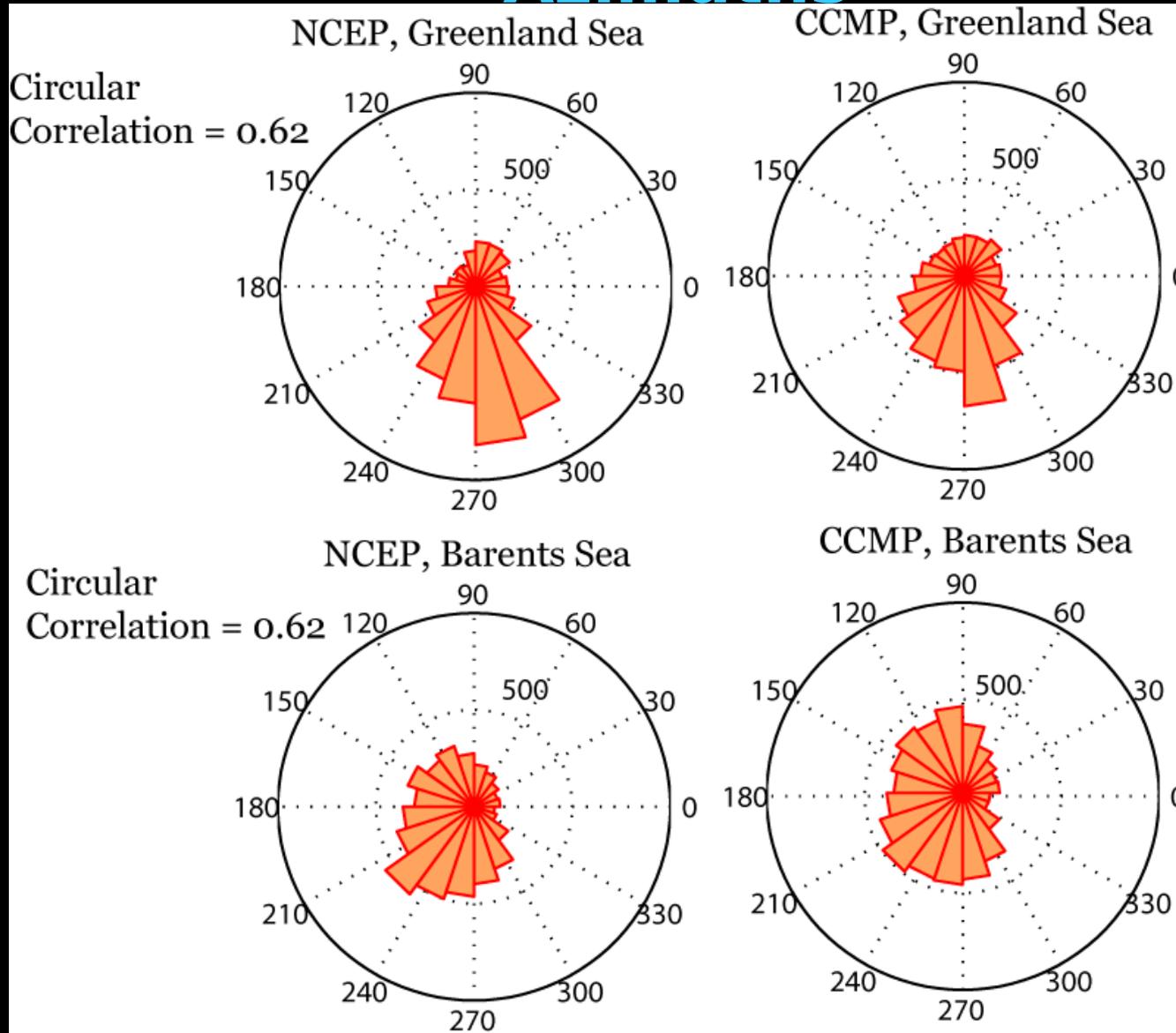




Time Series of Wind Speed, Winter 2004-2005

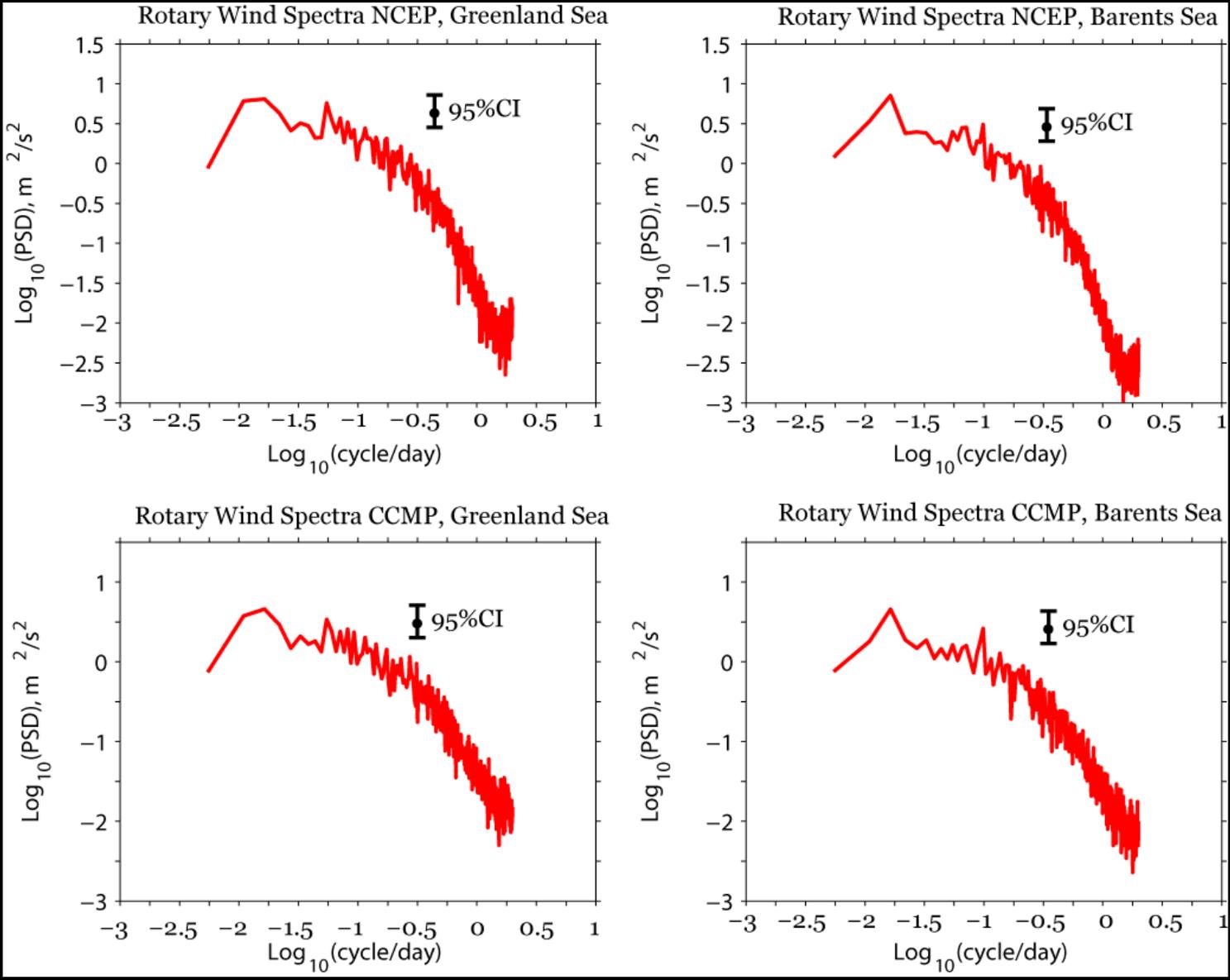


Circular Histograms of Wind Azimuths





Rotary Wind Spectra

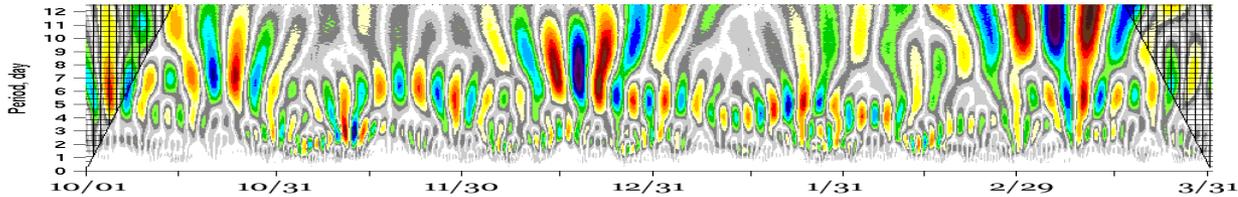




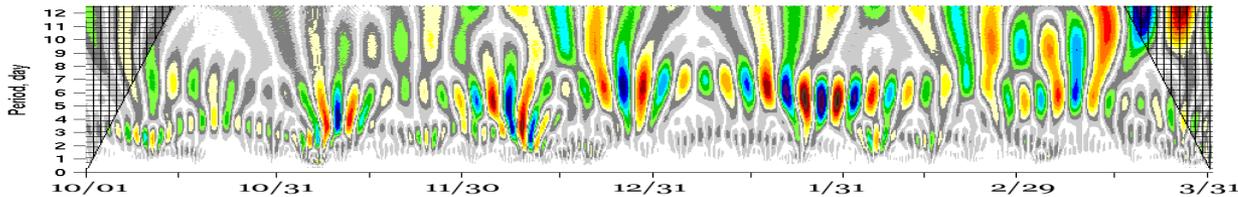
Coefficients of Morlet Wavelet Transformation of Wind Speed Time Series, Greenland Sea, winter 2004-2005

NCEP

Coefficients of Morlet Wavelet Speed Anomaly in Time, 2004, NCEP, Greenland Sea

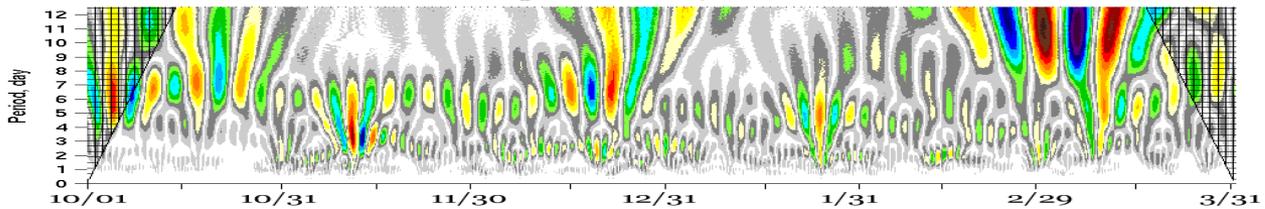


Coefficients of Morlet Wavelet Speed Anomaly in Time, 2004, NCEP, Barents Sea

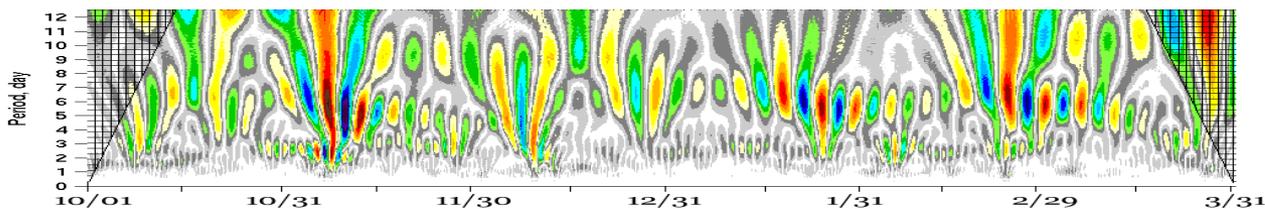


min **CCMP^o** max

Coefficients of Morlet Wavelet Speed Anomaly in Time, 2004, CCMP, Greenland Sea



Coefficients of Morlet Wavelet Speed Anomaly in Time, 2004, CCMP, Barents Sea

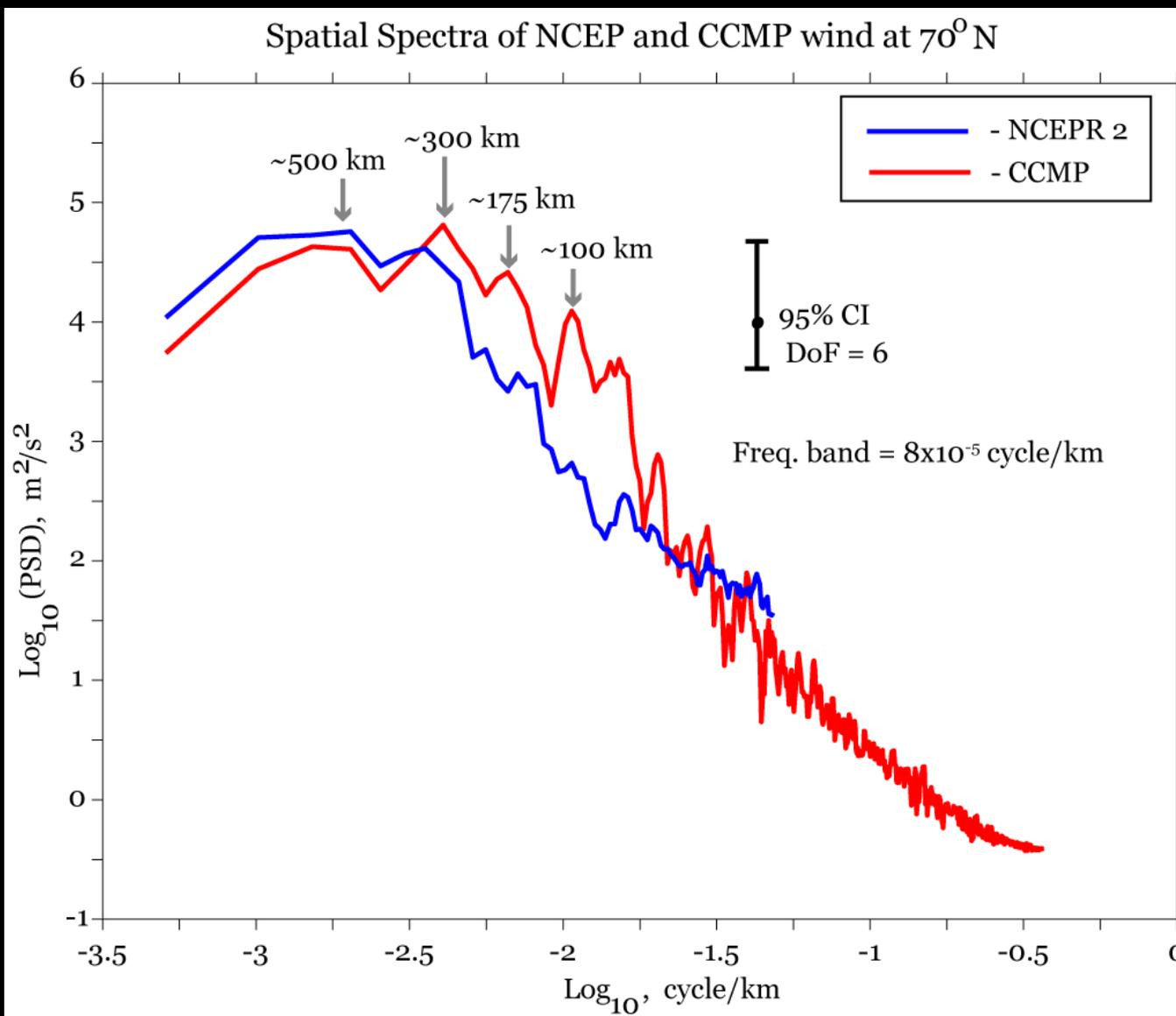


min 0 max





Spatial Spectra of the Wind Data





Flux Estimates on the Basis of CCMP and NCEPR 2 and SST from HYCOM/CICE (ARCc0.08 - NRL SSC)

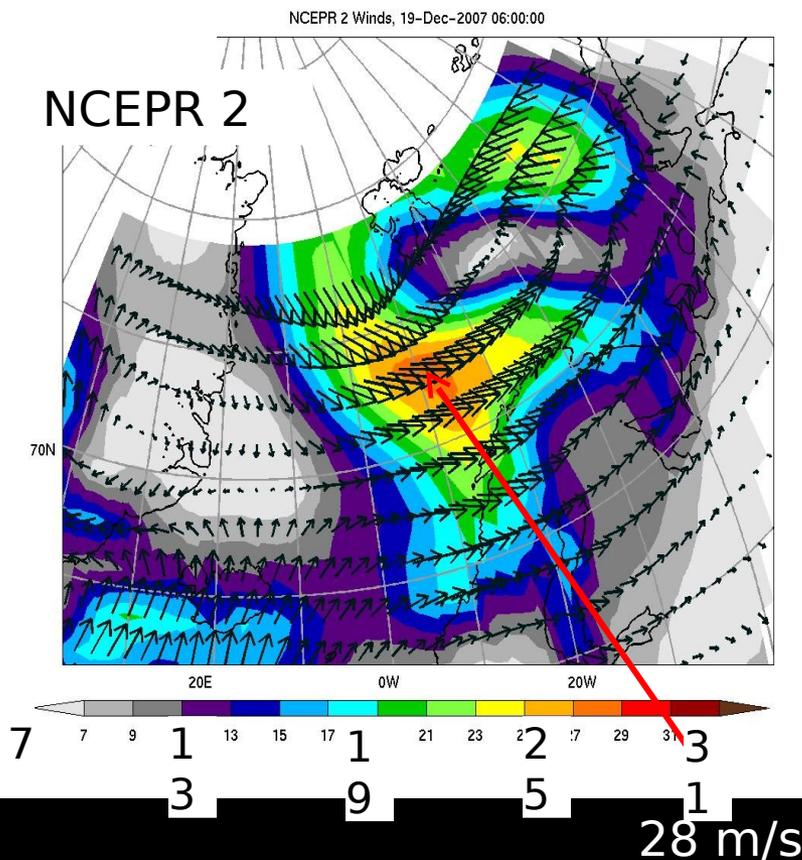
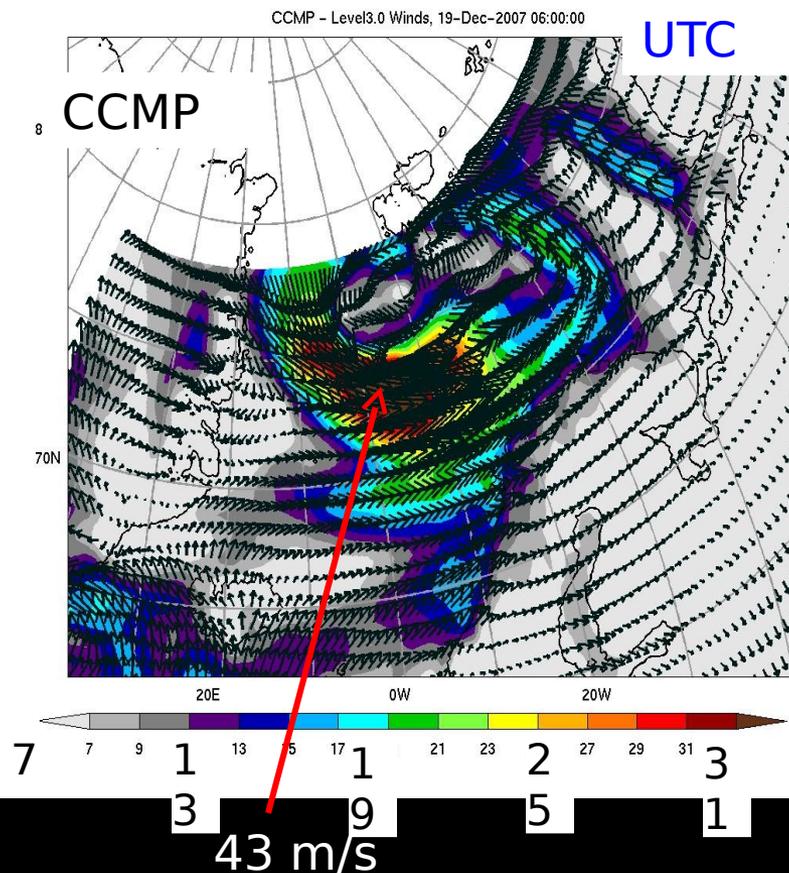




Winds on 12-19-2007

features

19-12-2007, 6:00
UTC



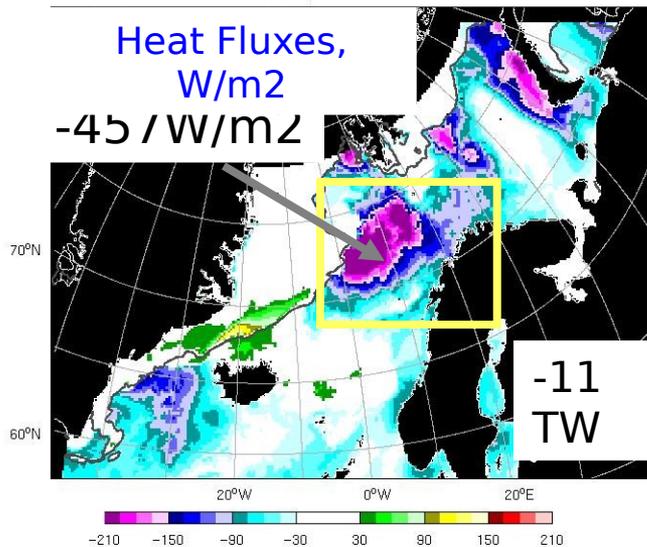
Category 2 Hurricane
on Saffir-Simpson scale



Heat and Momentum Fluxes, December 19, 2007 6:00

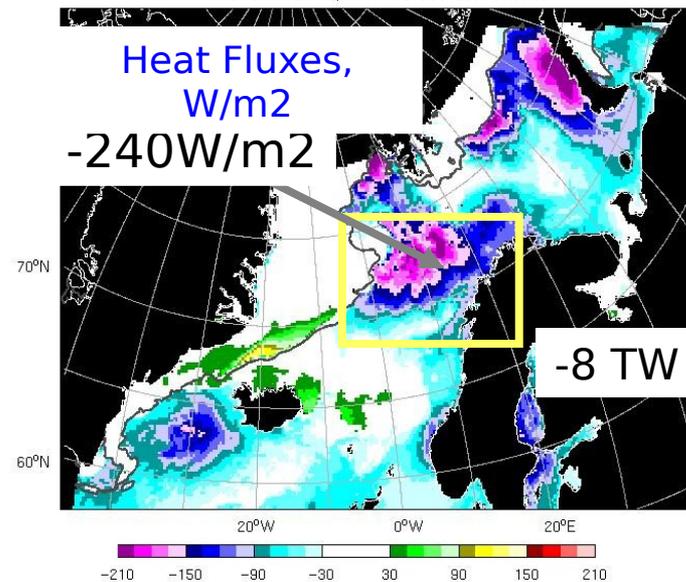
CCMP winds

Turbulent Heat Flux, W/m^2 19-Dec-2007 06:00:00

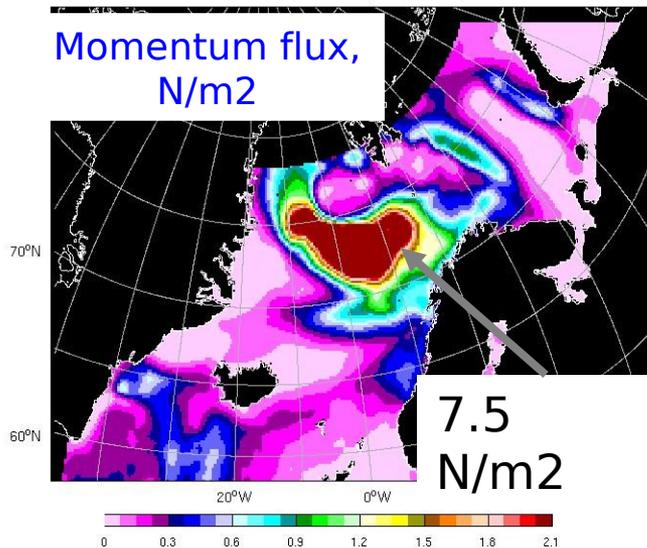


NCEP 2 winds

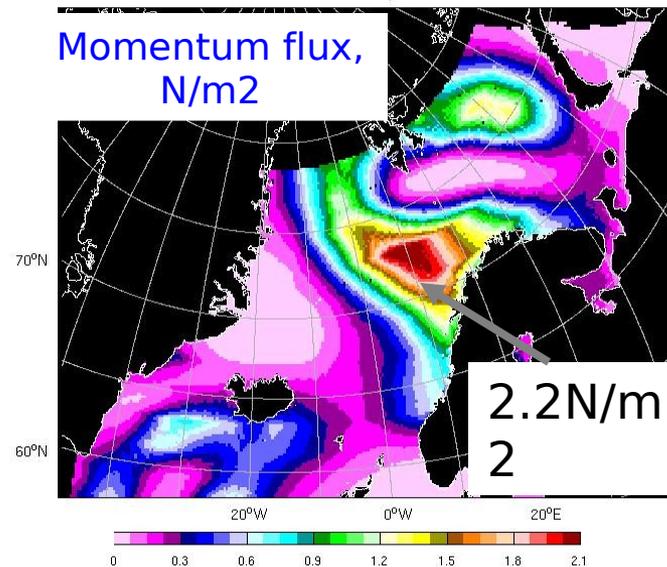
Turbulent Heat Flux, W/m^2 19-Dec-2007 06:00:00



Absolute value of the Momentum Flux, N/m^2 19-Dec-2007 06:00:00



Absolute value of the Momentum Flux, N/m^2 19-Dec-2007 06:00:00





Summary

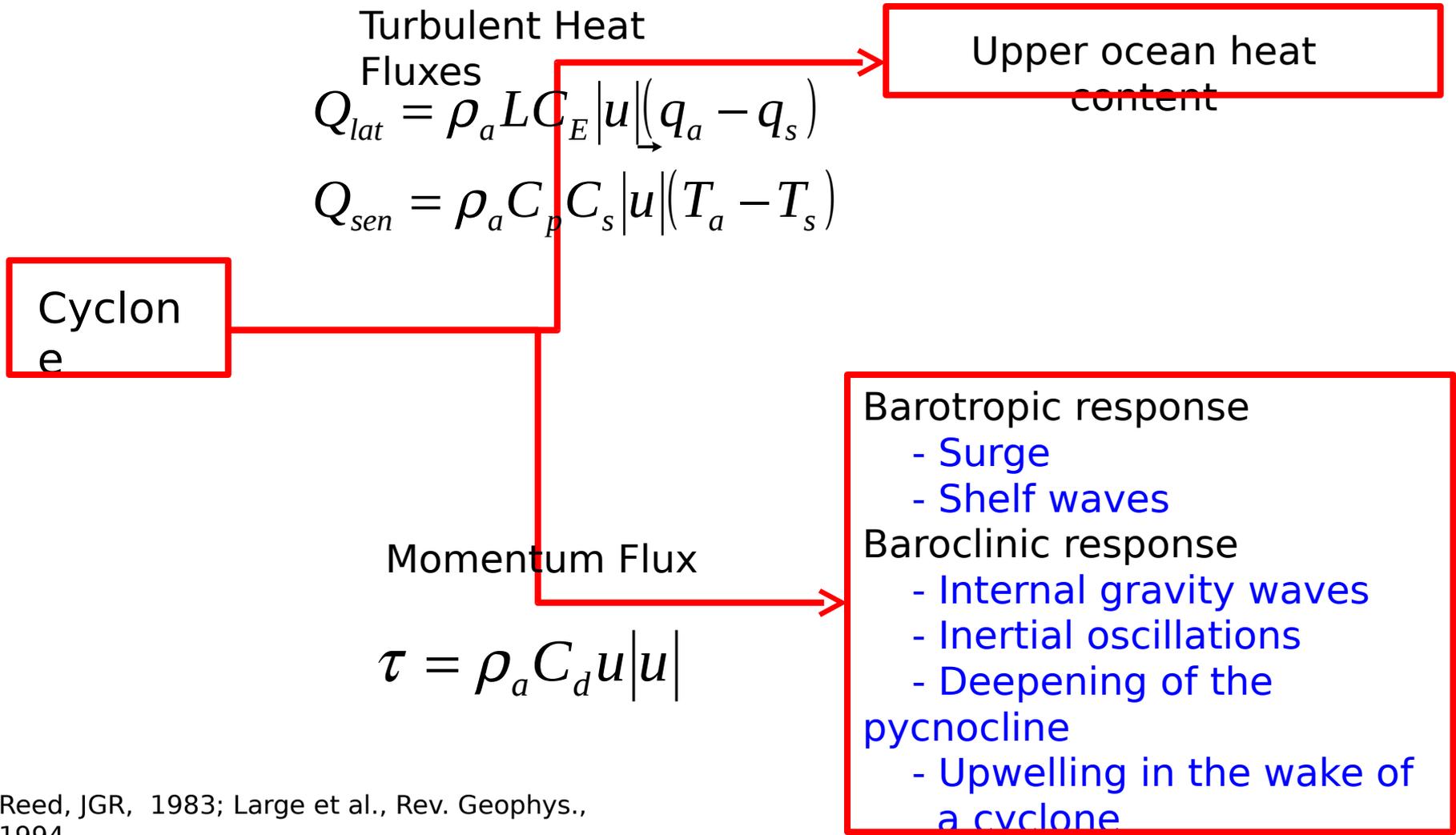
- (1) **Large-scale atmospheric circulation:**
 - (§) the CCMP and NCEP data generally agree
 - (§) discrepancies between the two wind products :
 - ⊙ wind direction
 - ⊙ location, size, and timing of storms
 - ⊙ on average, the NCEP winds have higher speeds compared to the CCMP winds
 - ⊙ in storms, the CCMP winds have higher peak values than the NCEP winds
- (2) **Meso- and small-scale cyclones are not resolved in the NCEP data.**
- (3) **Time spectra of the NCEP and CCMP winds look similar. Wavelet transform reveals discrepancies between the two wind time series in the frequency/time space.**
- (4) **Spatial spectra indicates noticeable differences in dominant length scales of the NCEP and CCMP winds.**
- (5) **Ocean response to the CCMP and NCEP winds is anticipated to be different**







Ocean Response to a Cyclone





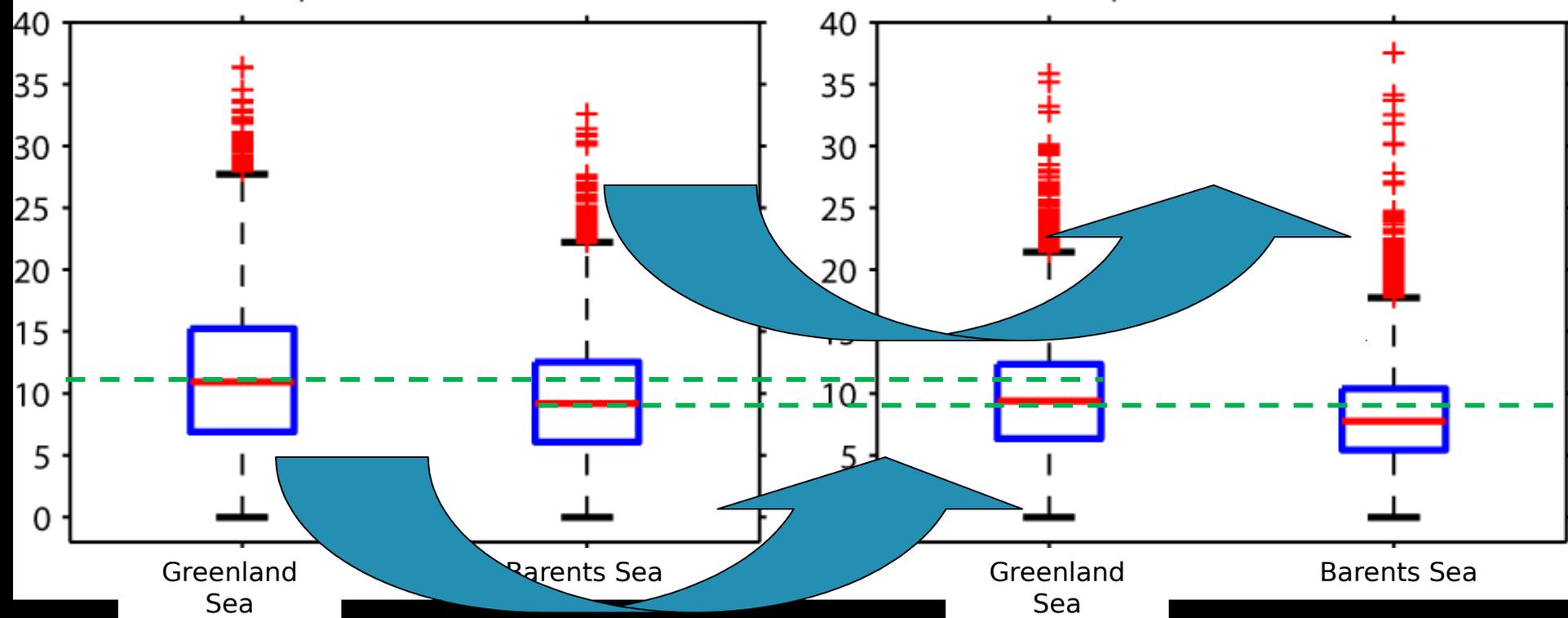
Winter Wind Speed, 2000-2007

NCEP

CCMP

NCEP wind speed, winter, 2000–2007

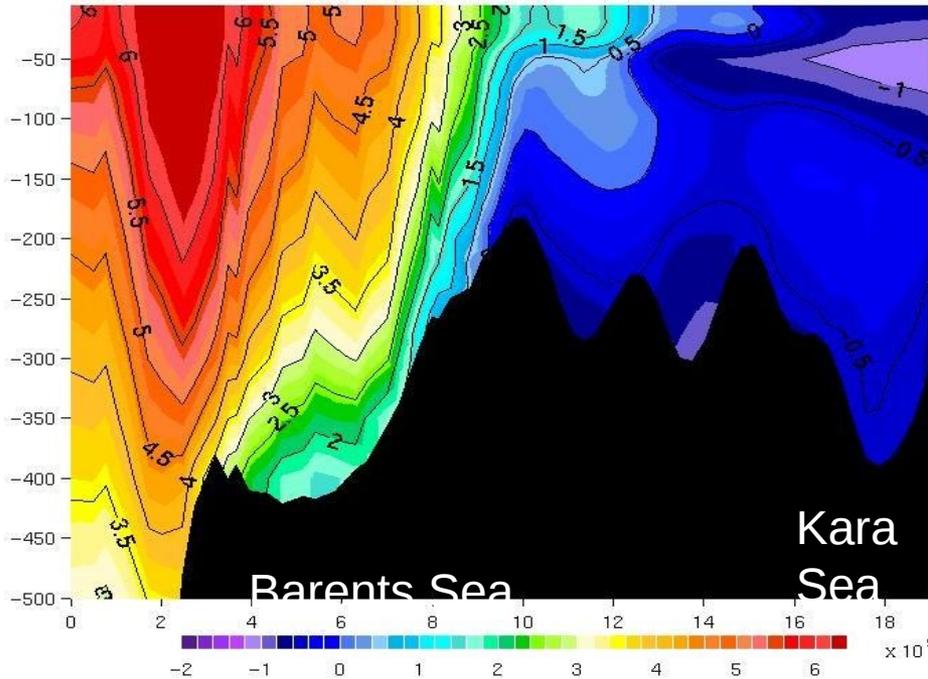
CCMP wind speed, winter, 2000–2007



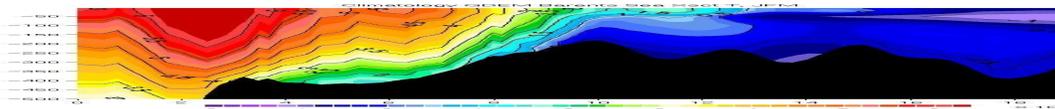
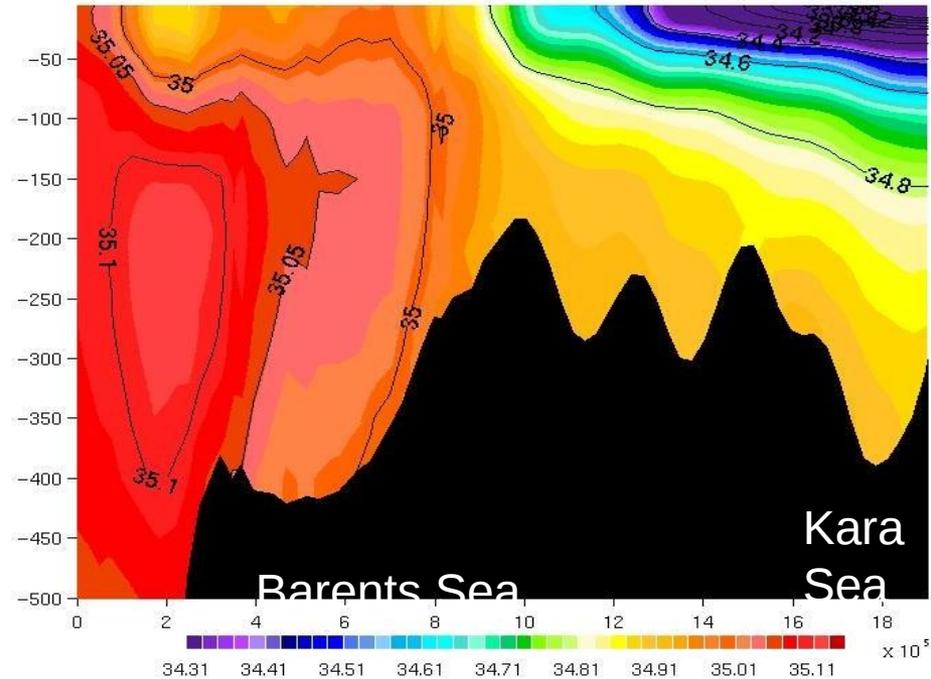


T/S Sections in the Barents Sea, GDEM 3, October - December

Climatology GDEM Barents Sea Xsct T, JFM



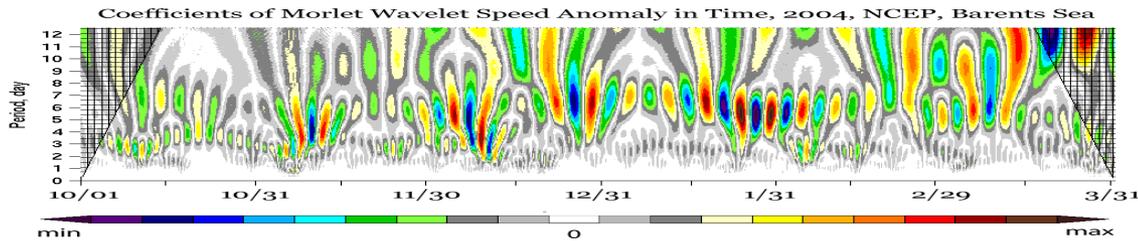
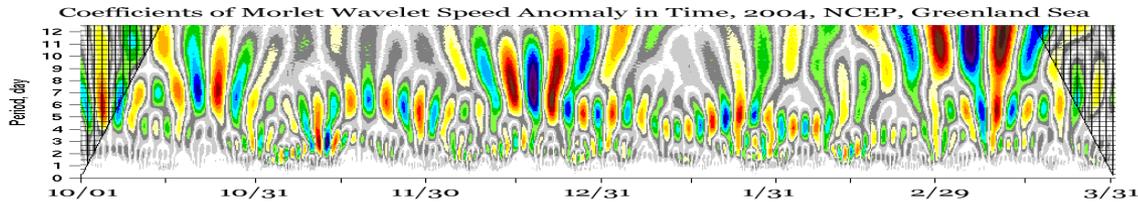
Climatology GDEM Barents Sea Xsct S, JFM



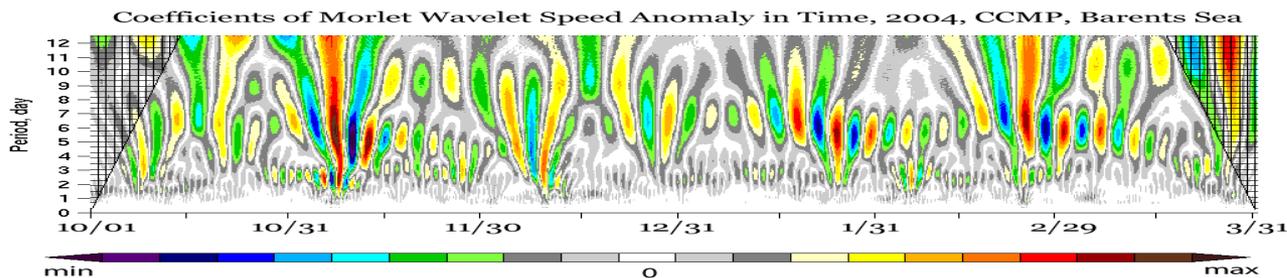
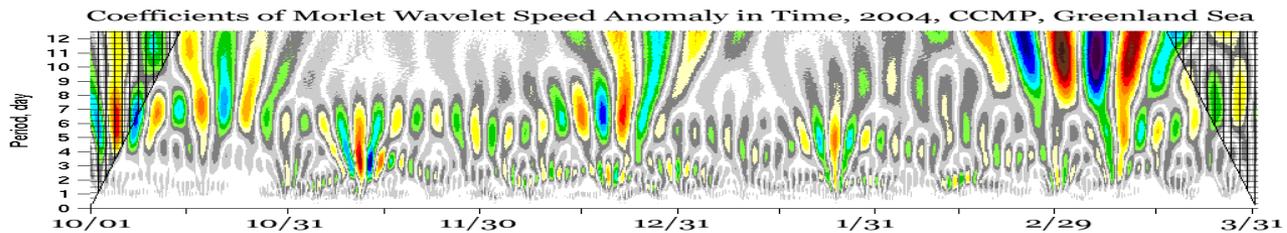


Coefficients of Morlet Wavelet Transformation of Wind Speed Time Series, Barents Sea, winter 2004-2005

NCEP



CCMP





CCMP winds vs NCEPR 2 winds

Cross-Calibrated Multi-Platform Ocean Surface Wind Components (CCMP)

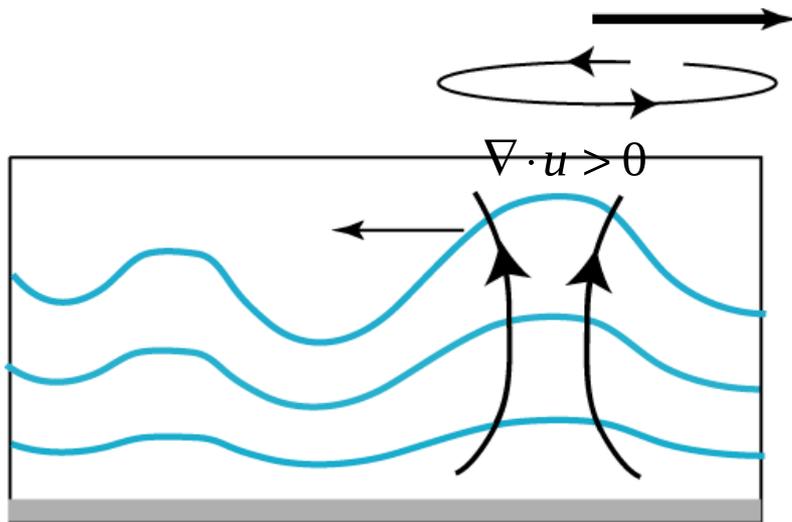
- Project is funded by NASA
- Gridded data set of ocean surface vector winds at 0.25° resolution
- Period covered: July 1, 1987 – December 31, 2008
- The data set combines data derived from several scatterometer satellites
- Satellite data are assimilated into the ECMWF Operational Analysis fields

National Center for Environmental Prediction Reanalysis (NCEPR 2)

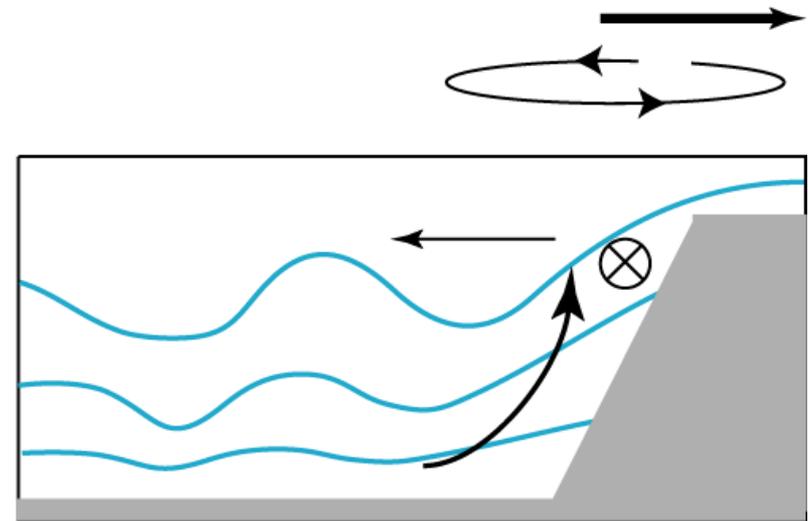
- The Twentieth Century Reanalysis Project, supported by the Earth System Research Laboratory Physical Sciences Division from NOAA and the University of Colorado CIRES/Climate Diagnostics Center
- Global climatological data reconstruction from 1891
- The product is obtained by assimilating surface observations of synoptic pressure, sea surface temperature and sea ice distribution
- Products include 3- and 6-hourly data on $\sim 2 \times 2^\circ$ global grid, monthly, daily averages, etc.
- Fields: SST, SSS, atmospheric temperature, precipitation, heat flux, radiation, ...



Internal



Baroclinic topographic





Water Mass Transformation in the Nordic Seas

Water mass transformation and production of high-density water in the Barents Sea through cooling and brine rejection during ice freezing

Shelf-derived dense water contributes to the Arctic Ocean halocline and deep water (Aagaard, 1981; Cavalieri and Martin, 1994; Jones et al., 1995)

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A very dense water mass is formed in the Greenland Gyre. It overflows the Denmark Strait sill contributing to the bottom North Atlantic water.

Largest Map Store. - Mozilla Firefox

Map of Arctic

Arctic Ocean Floor Map 1971 by N...

Polar Discovery :: Arctic Location and G...

Overview : AOMIP

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ARCTIC OCEAN FLOOR

panning controls: Pan East

Appearing in the October 1971 issue of the National Geographic Magazine, this Arctic Ocean Floor map has been reproduced from its original cartography in order to bring to life a beautiful poster previously only seen in National Geographic. This reproduction holds true to the high standards that Geographic Maps are known for.

Customs duties/brokerage fees upon arrival. This cost is not included in the product or shipping charges.

This map requires 2 business days to print and laminate prior to shipping.



Schematic representation of high-density shelf plume sinking down the continental slope

