Historical changes in the Davis Strait Baffin Bay surface winds and waves, 1979-2016

Xiaolan L. Wang[1], M. Casas-Prat[1], Y. Feng[1], A. Crossby[2], V. R. Swail[1]

[1]Climate Research Division
Science and Technology Branch

[2]Oceanweather Inc., CT, USA

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Outline

- Introduction - the EC Davis Strait Baffin Bay (EC-DSBB) wave reanalysis
- Trend analysis methods
- Results - changes in surface winds and waves
- Summary

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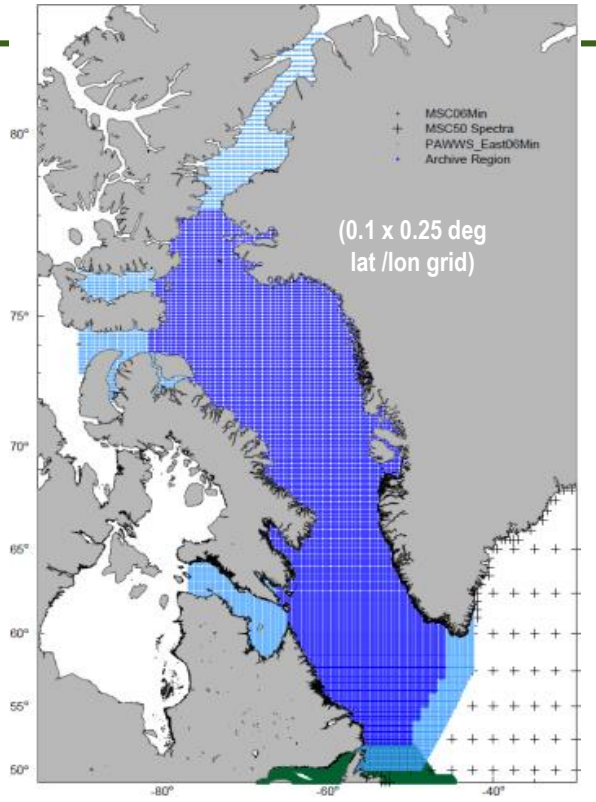
EC Davis Straight-Baffin Bay wave reanalysis (EC-DSBB)

- done for 1979-2013 in 2015; updated to 2016

NCEP CFSR surface winds were used to drive the OWI-3G wave model, with MSC50 waves as boundary conditions

Sea ice concentration:

- a blend of CFSR and Canadian Ice Service gridded data
- ice concentration of >50% was treated as land



Trend analysis methods:

- carried out the analysis for the months of May – December, because these are the months of a significant ice-free area in the domain.
- characterized trends in three ways:

  climatological mean changes, linear trends in regional mean time series, and maps of linear trends.

- the analysis was done for each month, separately, because the ice-free area changes from month to month in May-December

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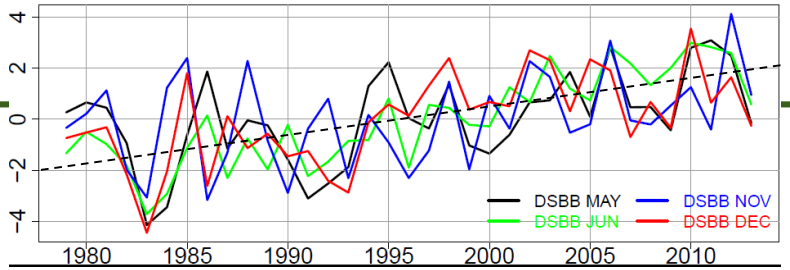
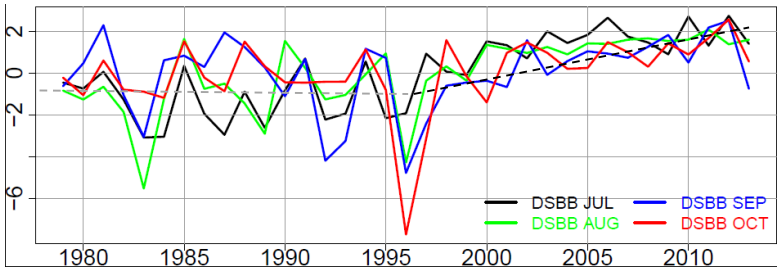
Normalized time series of the open water area in each month:

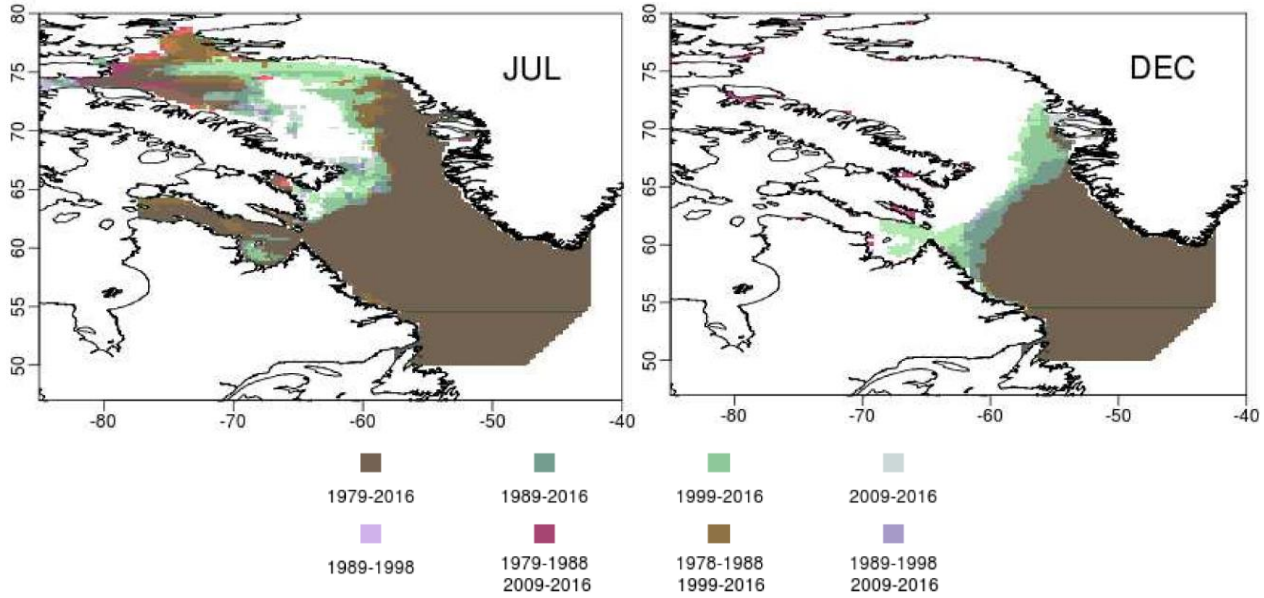




steady increases in the transition months (May, Jun, Nov., Dec.), most notably in June.

In July-October, the increase started in 1997, with reduced inter-annual variability

Climatological mean open water areas in July and December:



Greenish colors show the new water areas

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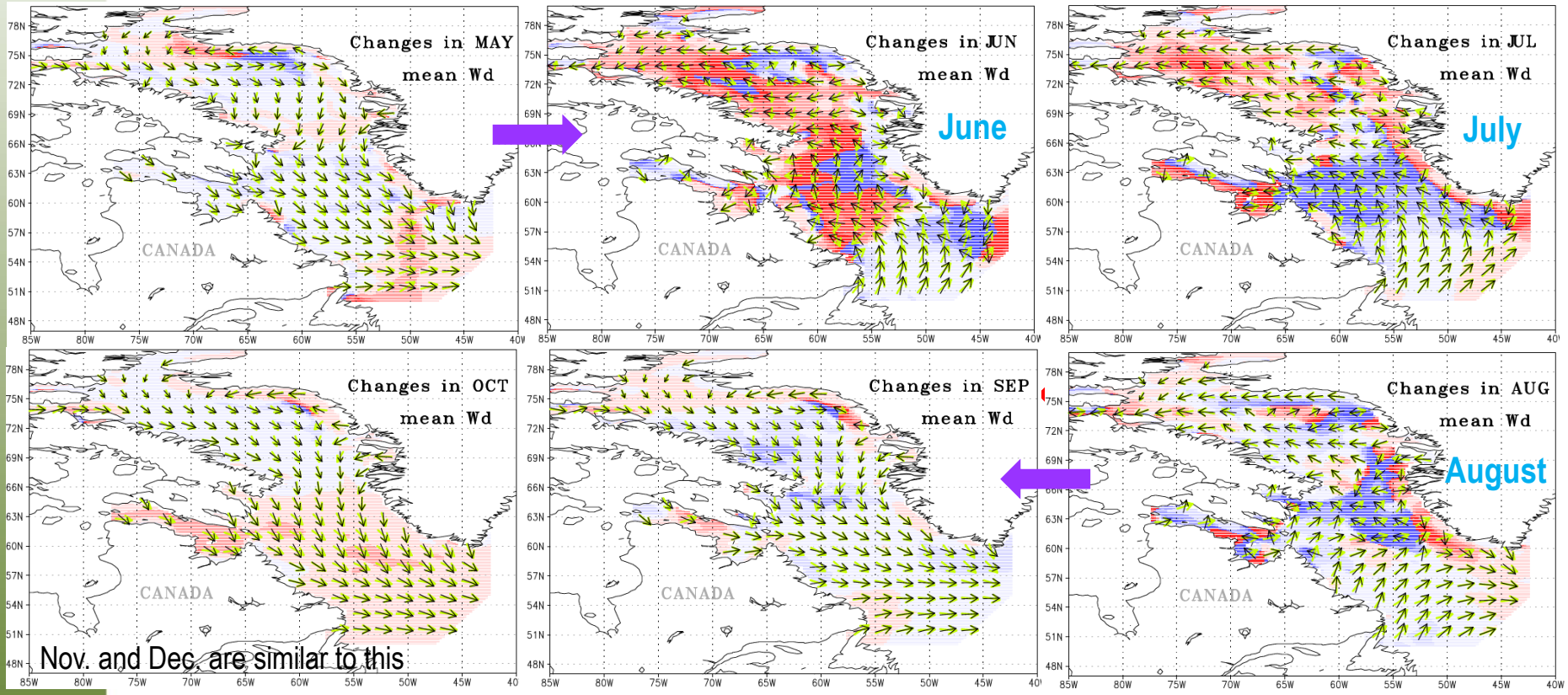
Climatological mean wind direction (Wd) for these two periods: 1979-1988 and 2007-2016, and the changes between the two periods

Black arrows: 2007-2016
Green arrows: 1979-1988

Changes: −120 −90 −60 −30 0 30 60 90 120 °
Anti−clockwise Clockwise



Notable seasonal variations of mean wind direction, particularly May to June and August to September.

The most significant changes are seen in June-August, especially in June.

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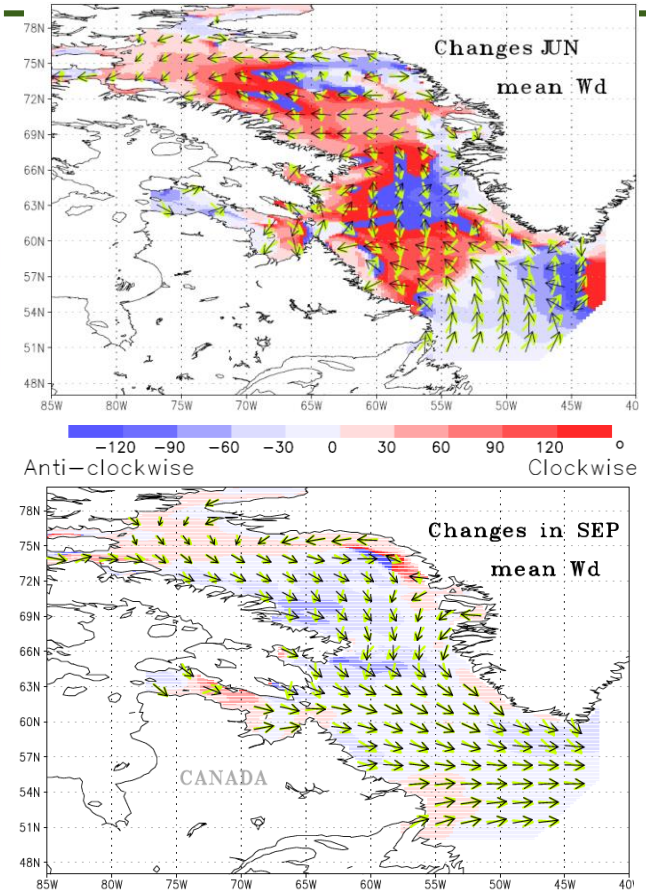
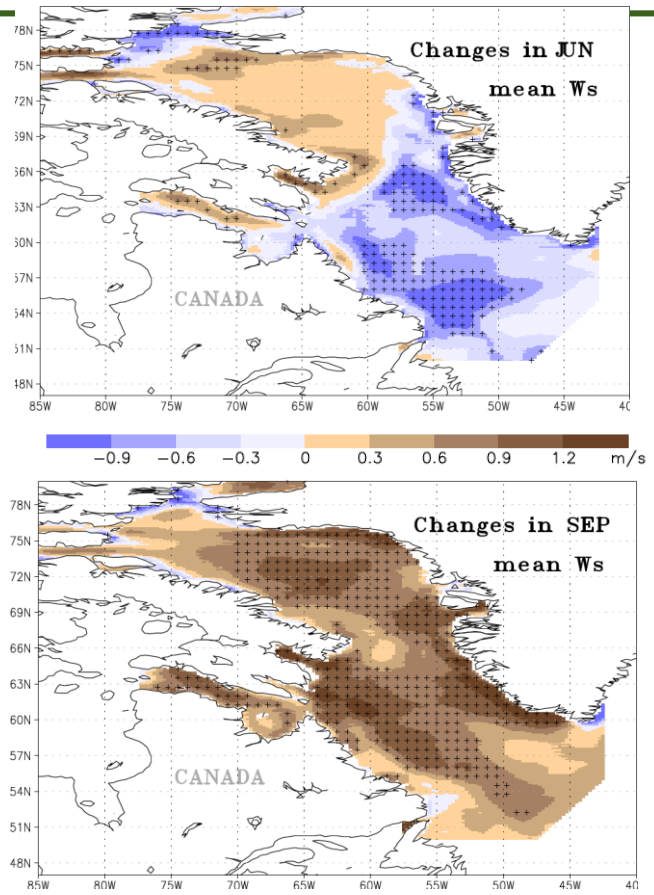
Wind climate and changes

Ws – wind speed (stippling - 5% significance)

Mean wind direction:



Mean wind speed: 2007-2016's minus 1979-1988's

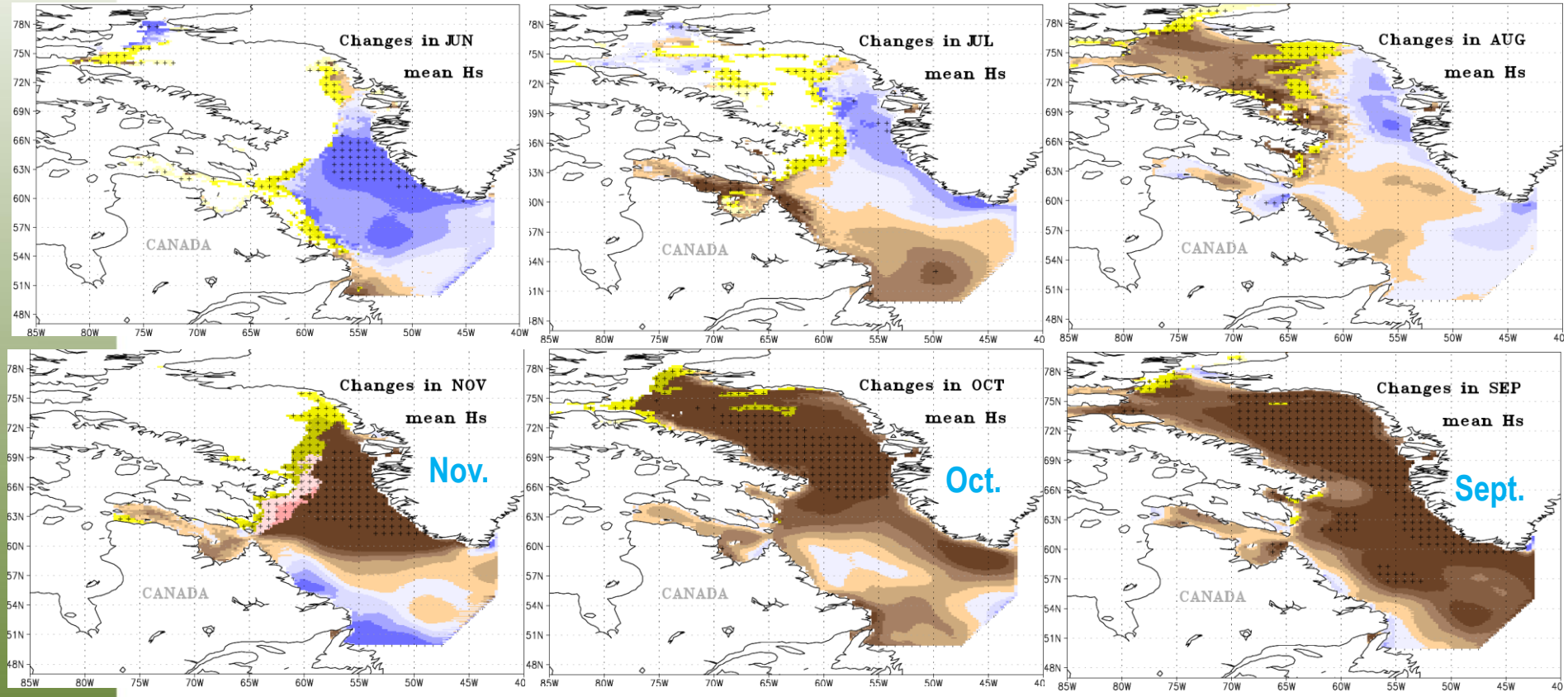


The changes in June wind speed features significant decreases in the south.

The most significant changes in wind direction are seen in June, but the most extensively significant changes in wind speed are seen in September, showing significant increases over most area of the domain.

Changes in the climatological mean Hs between these two periods: 1979-1988 and 2007-2016

The most extensively significant changes are the increases in Sept.-Nov., especially in Sept.

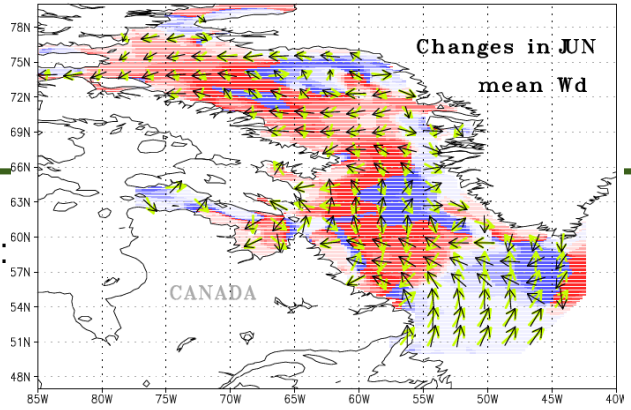


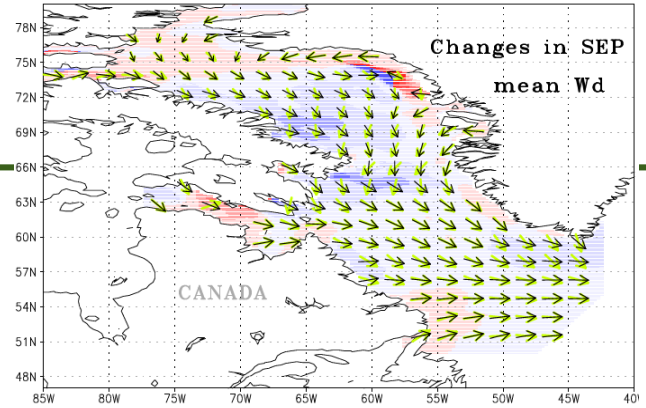
Changes in wind speed dominate changes in mean Hs:

June

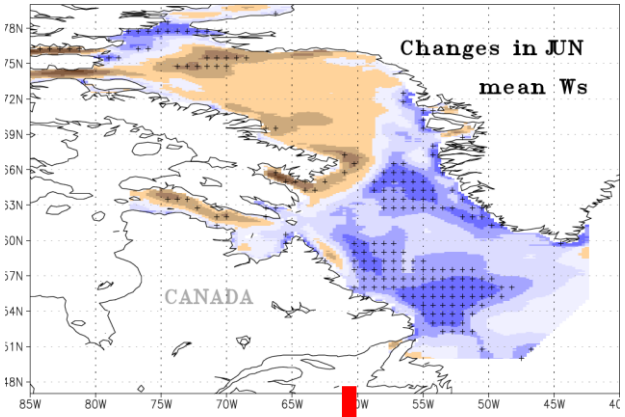
September

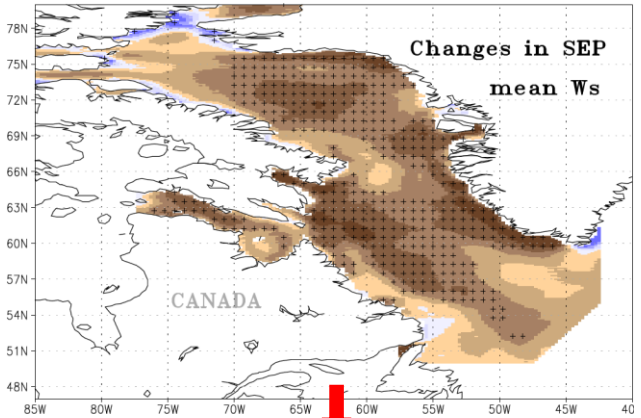
wind direction:



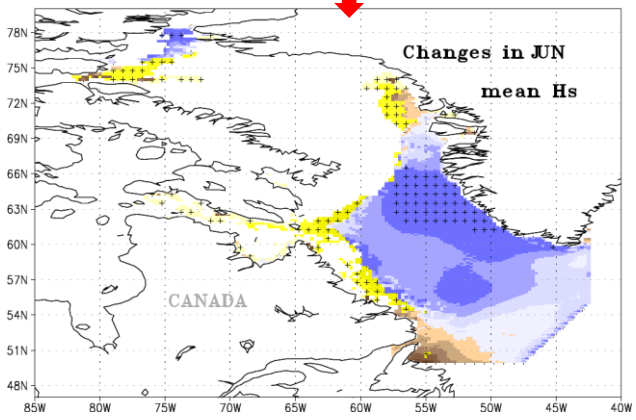


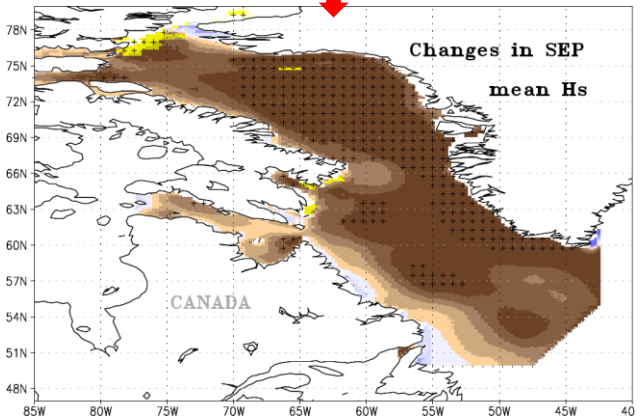
wind speed:





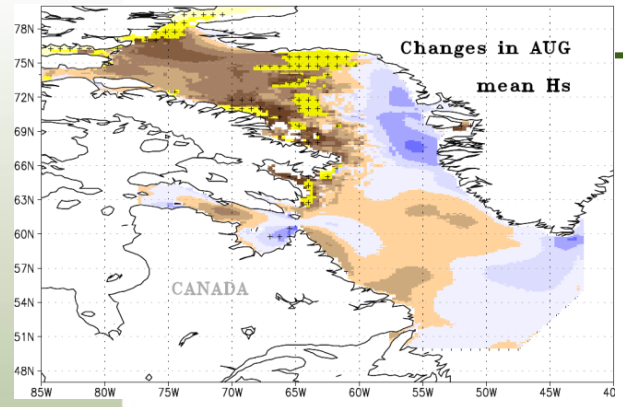
mean Hs:

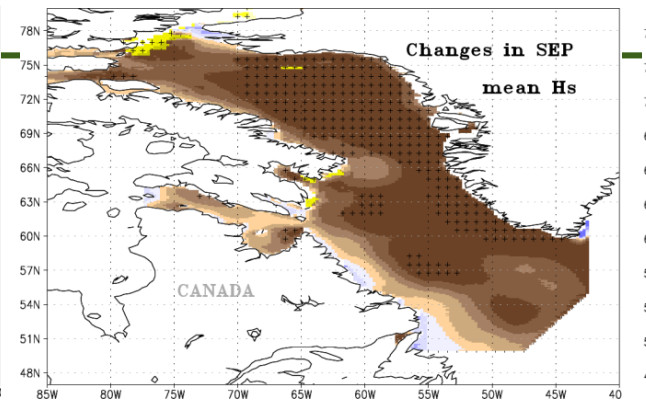


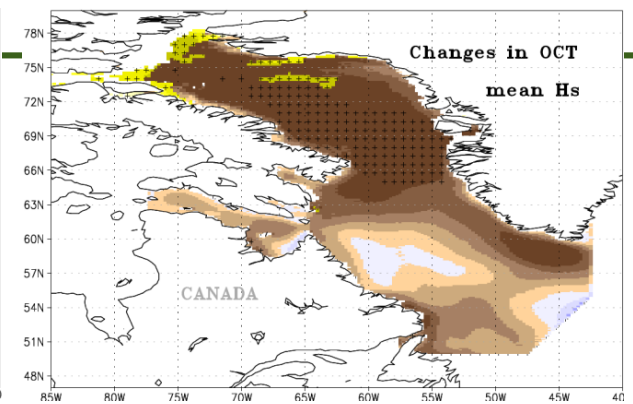


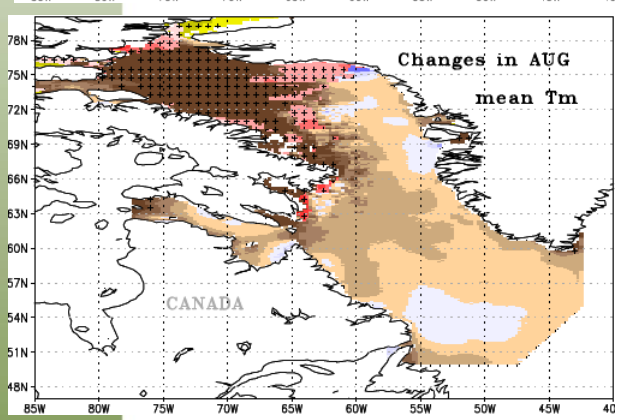
(stippling - 5% significance)

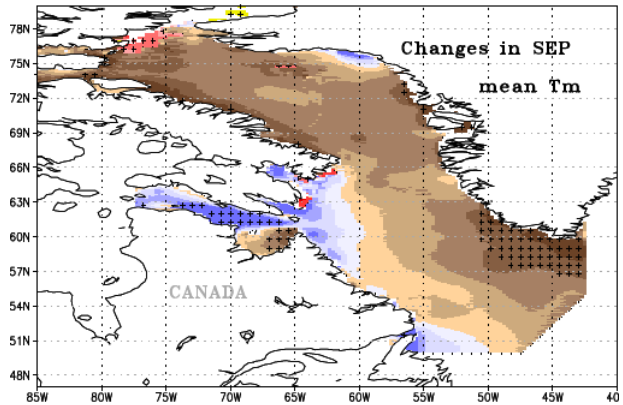
Changes in the climatological mean Hs and Tm are different in significance, but sharing similar patterns:

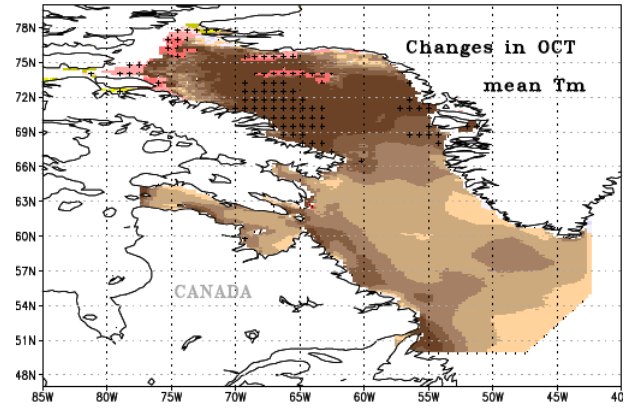












In August, insignificant wave height increases with significant mean wave period increases are seen in the North.

But the opposite is seen in September.

More similarity between the two variables is seen in October.

Stippling - 5% significance

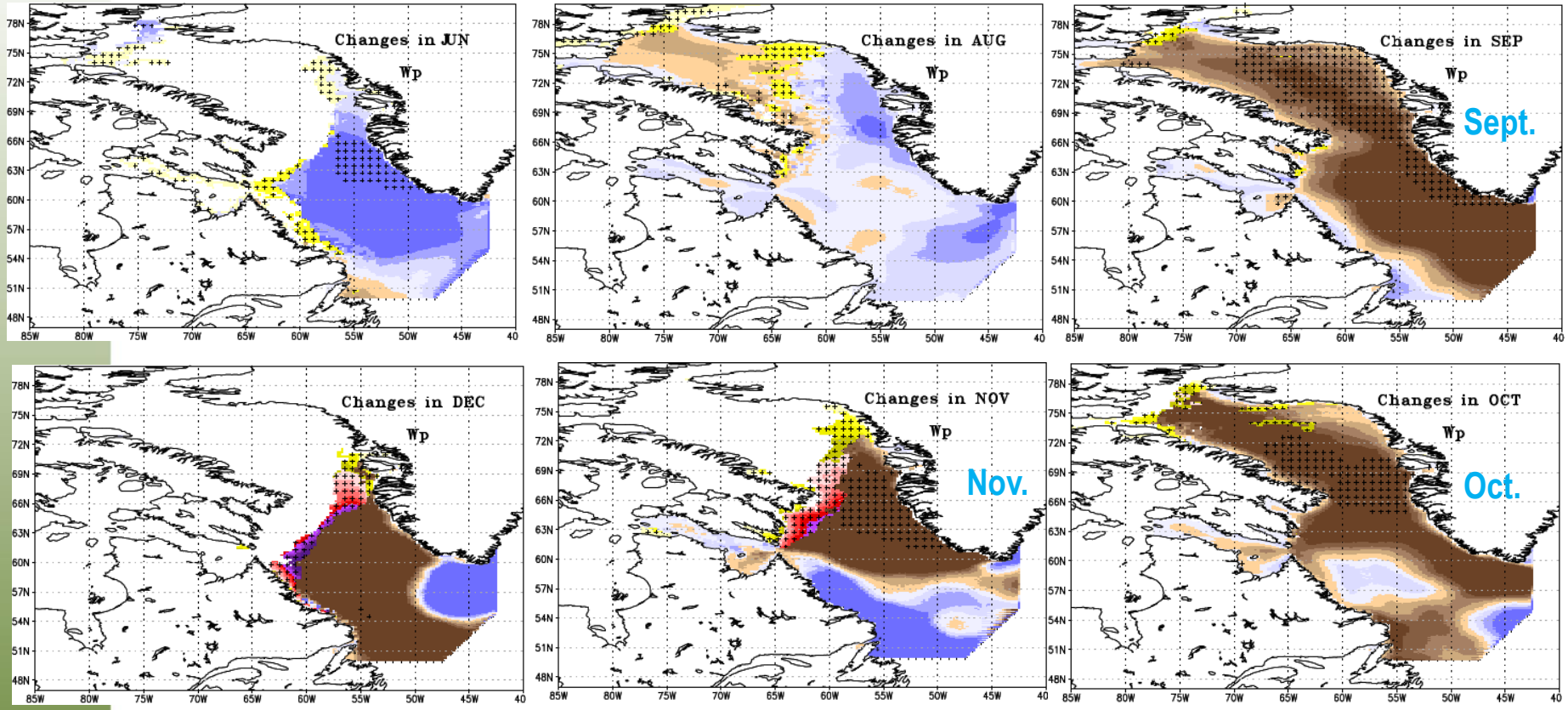
Changes: 3 3.4 3.8 4.2 4.6 5 5.4 5.8 6.2 6.6 7 7.4 s

Climatol.: −0.18 −0.12 −0.06 0 0.06 0.12 0.18 0.24 s

(shown for new open water area)

Changes in the climatological mean wave power between these two periods: 1979-1988 and 2007-2016:

$$(Wp = 0.491 \cdot Hs^2 \cdot 1.14Tm)$$



The most extensively significant changes are seen in Sept.-Nov.; with no significant changes in Jul.-Aug. and Dec. except in the new open water areas.

Stippling - 5% significance

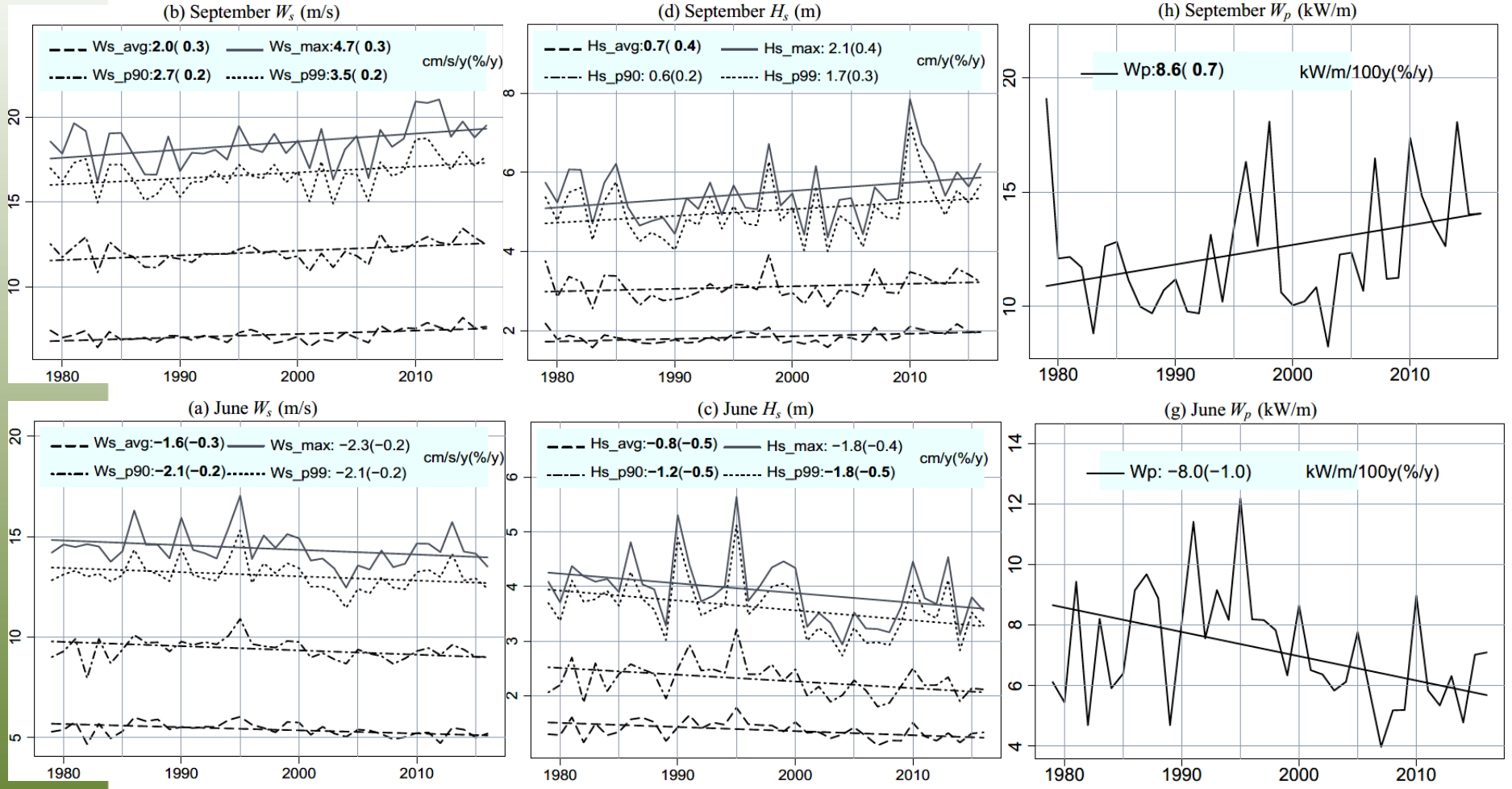
Changes: −12 −9 −6 −3 0 3 6 9 12 15 20 30 40kW/m/100y

Climatol.: −1 −0.5 0 0.5 1 1.5 2 2.5 kw/m

(shown for new open water area)

avg – mean
p90 – 90th percentile
p99 – 99th percentile
max - maximum
bold - 5% significance

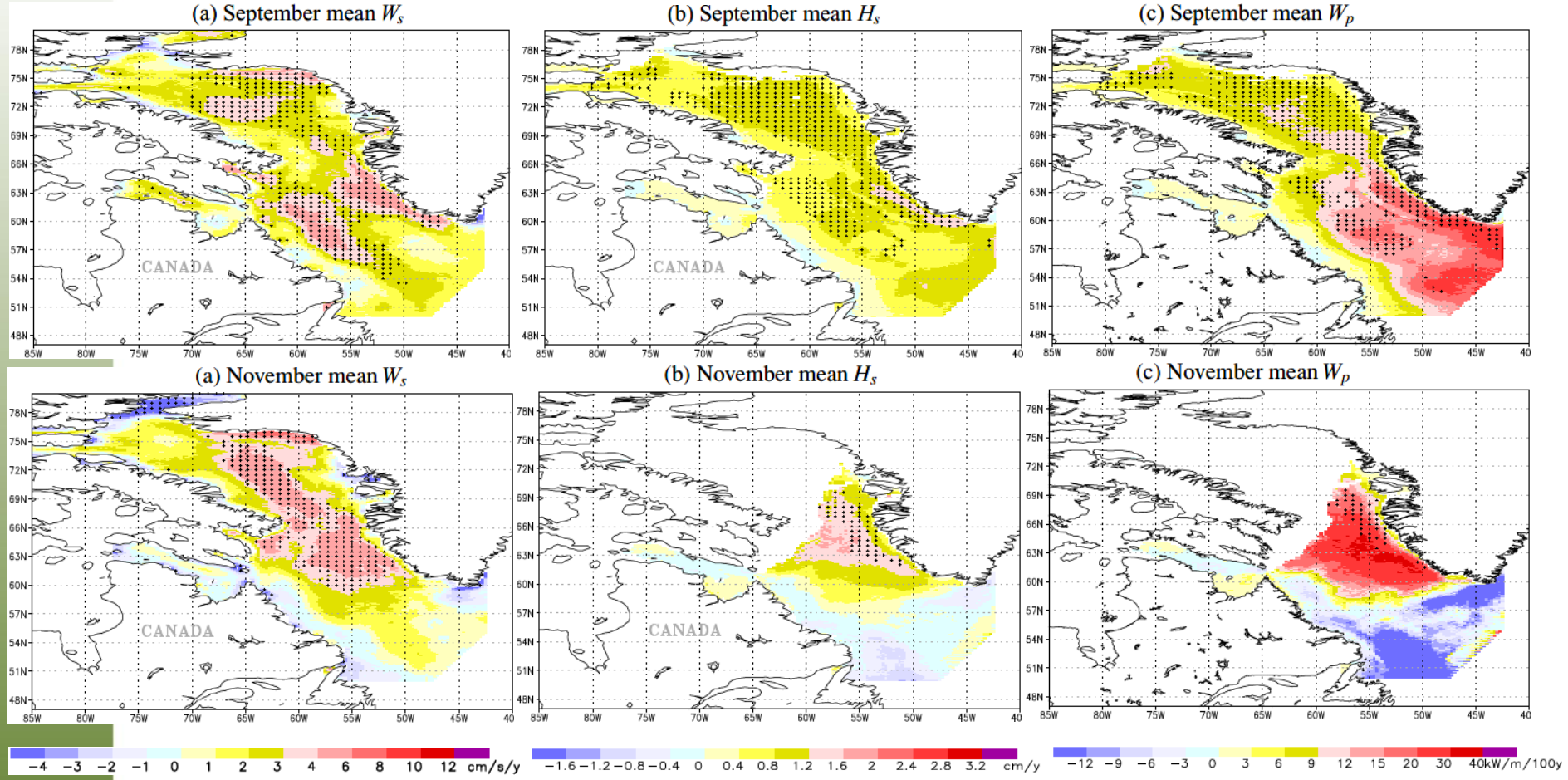
Regional mean time series of Ws, Hs, and Wp for June and September



An increase is seen in September in all quantities of wind and waves analyzed here, with a decrease in June, although the changes are not always statistically significant at 5% level.

Maps of the 1980-2016 linear trends in monthly mean Ws, Hs, and Wp for Sept. and Nov.

Wind speed | Significant wave height | Wave power



(stippling - 5% significance)

For the other months, the linear trends in wave height or wave power are mostly insignificant at 5% level.

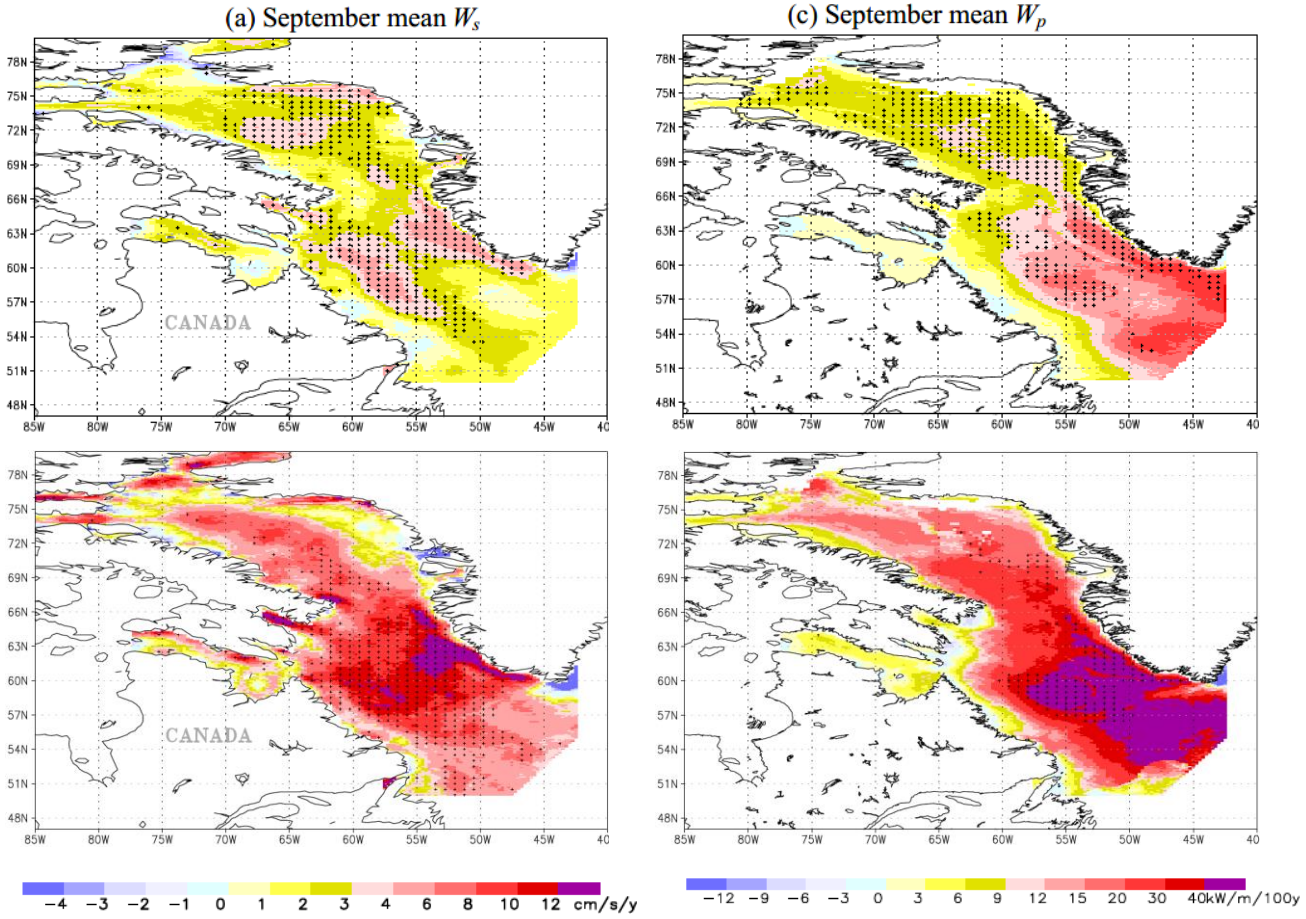
The increasing trends were estimated to have intensified during the last decade, e.g.:

Wind speed

Wave power

1980-2016 trends:

1997-2016 trends:



(stippling - 5% significance)

Summary

- Wind speed has increased significantly in most areas of the domain in Sept.-Dec., with some significant decreases over the open water area in June and July. The increases are most extensive in September.
- The mean wind direction shows notable seasonal variations, with the most notable changes being seen in June.
- Wave height and wave power have increased significantly in most areas of the domain in Sept.-Dec., but decreased in June.
- In terms of the regional mean, the September wave power has increased at a rate of 7% per decade; but the June wave power decrease is statistically insignificant although of high rate (10% per decade).
- In Sept. – Dec., the wind speed increases are the main driver for the wave height and wave power increases.

Thank you very much for your attention!

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