On the development of water level, ocean surface wave and wind climate extreme indices

Xiaolan L. Wang, Y. Feng, and Val R. Swail

Climate Research Division, Environment Canada, Toronto, Canada

With comments/discussions from

Kevin Horsburgh

Scott Woodruff

ETCCDI meeting, 6-8 July 2015, UNESCO, Paris, France

JCOMM Interests/Expected Outcomes (from August 2012 JCOMM letter)

- "Integrated efforts for socially-relevant indicators and extremes in particular, such as occurrences of high waves, gale force winds, and marine air and sea surface temperatures - through using high-quality hindcast wind-wave data sets, GLOSS data, and ICOADS data".

- Current JCOMM ETCCDI members: Kevin Horsburgh, Xiaolan Wang, Scott Woodruff

At ETCCDI sub-group ad hoc meeting

(10-12 March 2014, Egmond aan Zee, The Netherlands)

- JCOMM ETCCDI members proposed to develop and operationalize (as practical) a set of impacts-relevant marine climate extreme indices (MarClimEX), thereby expanding the coverage of existing ETCCDI extreme indices to selected near-coastal and open-ocean areas

Presented a list of MarClimEX for discussion at CLIMAR-4 Workshop

(Asheville, USA, June 2014)**, including**

- ocean wave and wind indices using buoy/reanalysis data,
- water level and storm surge indices using tide gauge data
- ~~Marine surface air temperature (SAT) indices~~
- ~~Sea surface temperature (SST) indices~~

The consensus among the CLIMAR community was that

(1) Ocean wave indices should be developed; and indices related to the storm surge might be of interest

(2) analysis of winds should not be pursued at the same time, since there are potential issues with using reanalysis winds (serious inhomogeneity issues)

(3) the available data sources for marine SAT and SST were unsuitable for calculation of indices related to extremes

(4) some SST-based indices which might be beneficial in a broader sense – e.g. thermal stress anomaly – which might be considered in a JCOMM-only set of indices

(5) there was little or no value in trying to merge the surface marine analysis for coastal regions to neighbouring land areas, as had been proposed at the last ETCCDI meeting

a. Extreme water level indices (use GLOSS tide gauge data)

ID	Indicator name	Definitions	Units
WlMx	Monthly max water level	Monthly maximum value of water level (Wl)	m
WlMn	Monthly min water level	Monthly minimum value of water level (Wl)	m
WlAx	Annual max water level	Annual maximum value of water level (Wl)	m
WlAn	Annual min water level	Annual minimum value of water level (Wl)	m
fWl90p	Frequency of extreme high water level days	Annual percentage of days when Wl > 90th percentile	%
fWl10p	Frequency of low water level days	Annual percentage of days when Wl < 10th percentile	%
HWlDl	High water level spell duration indicator	Annual count of days with at least 2? consecutive days when daily max Wl > 90th percentile of base period (1961-1990 or 1981-2010)?	days

Percentile seasonality? No.

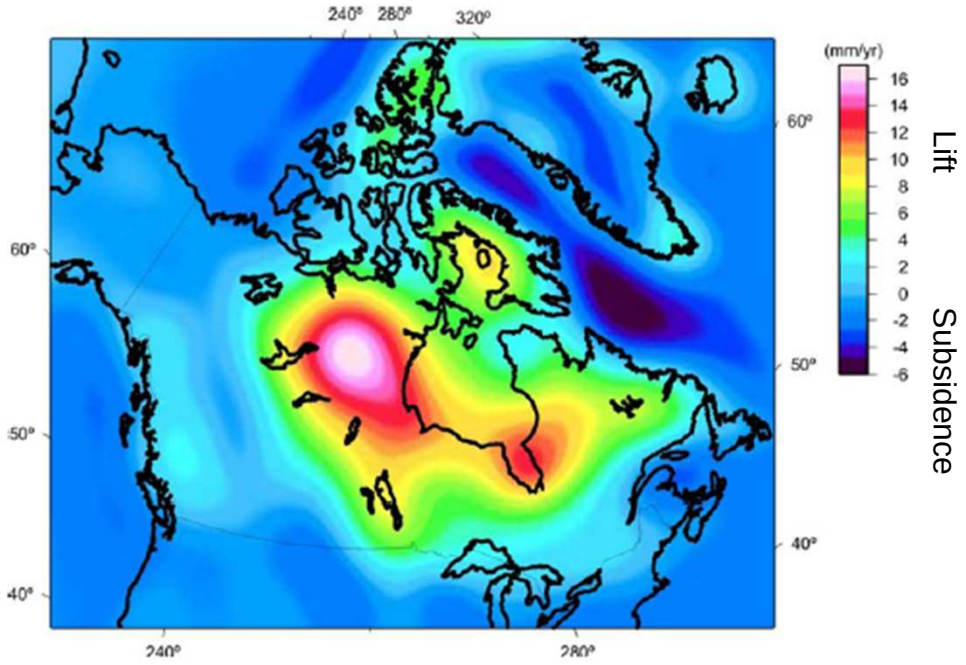
Start with the long-term tide gauge stations in the East and West Coasts of Canada

Shown next are
relative water level change
(observed/experienced relative to a fixed land site)

= absolute change + vertical land motion →

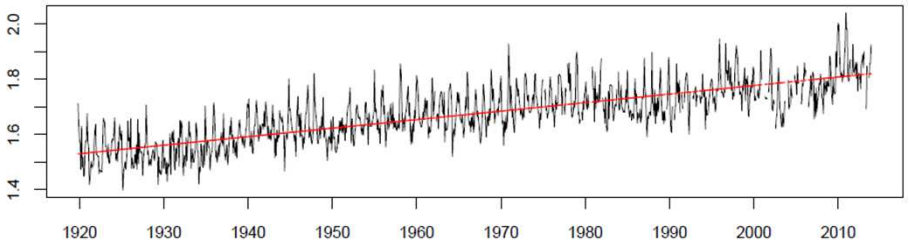
(referred to the Earth's centre)

generated by glacial isostatic adjustment (Peltier, 2004)

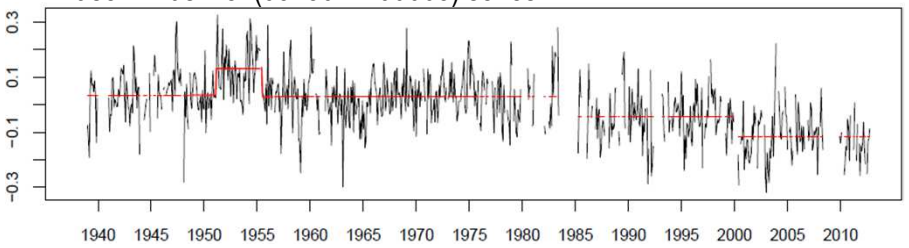


Homogenization of water level data

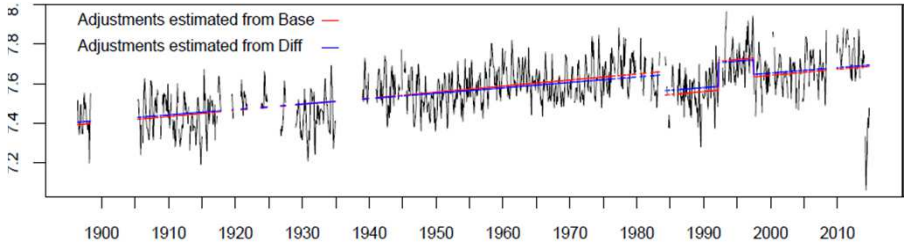
Ref. series (00490 – Halifax monthly mean of daily max. - homogenous)



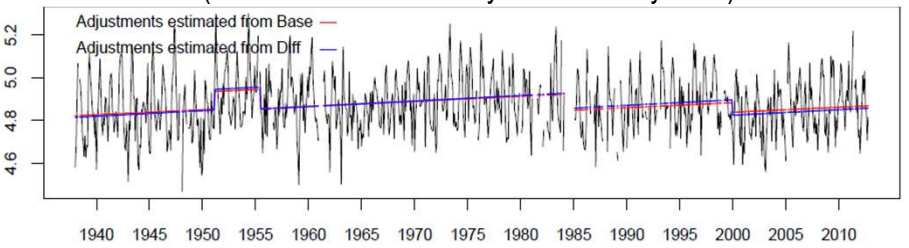
Base-minus-Ref (03250 - H00065) series



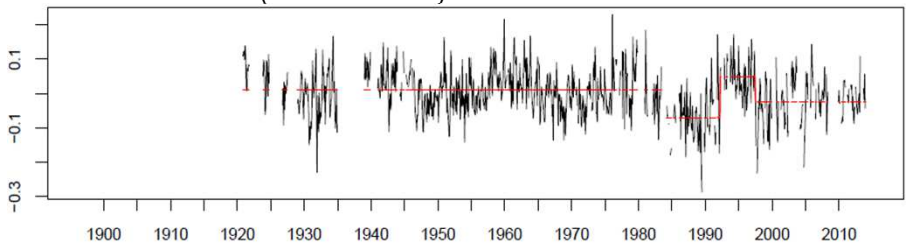
Base series (00065 – Saint John monthly mean of daily max.)



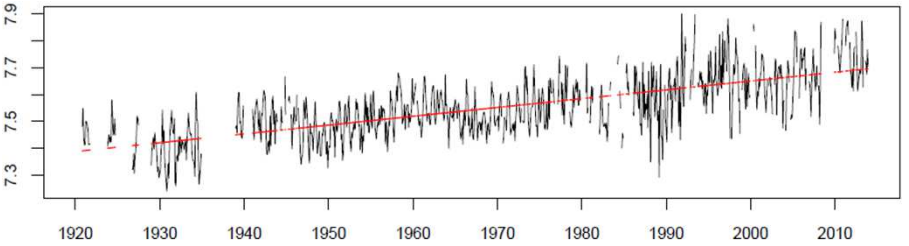
Base series (03250 – Lauzon monthly mean of daily max.)



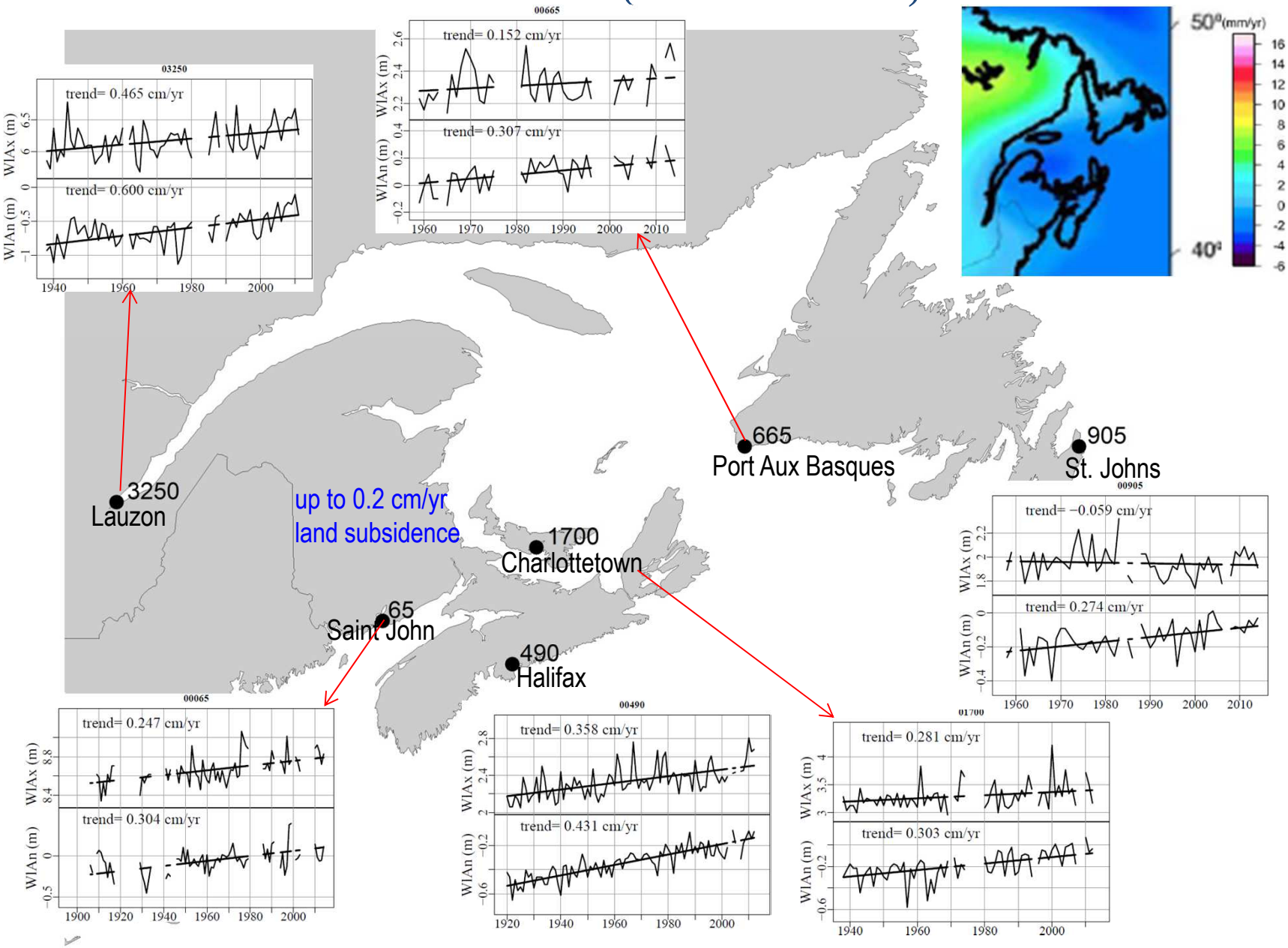
Base-minus-Ref (00065 - 00490) series



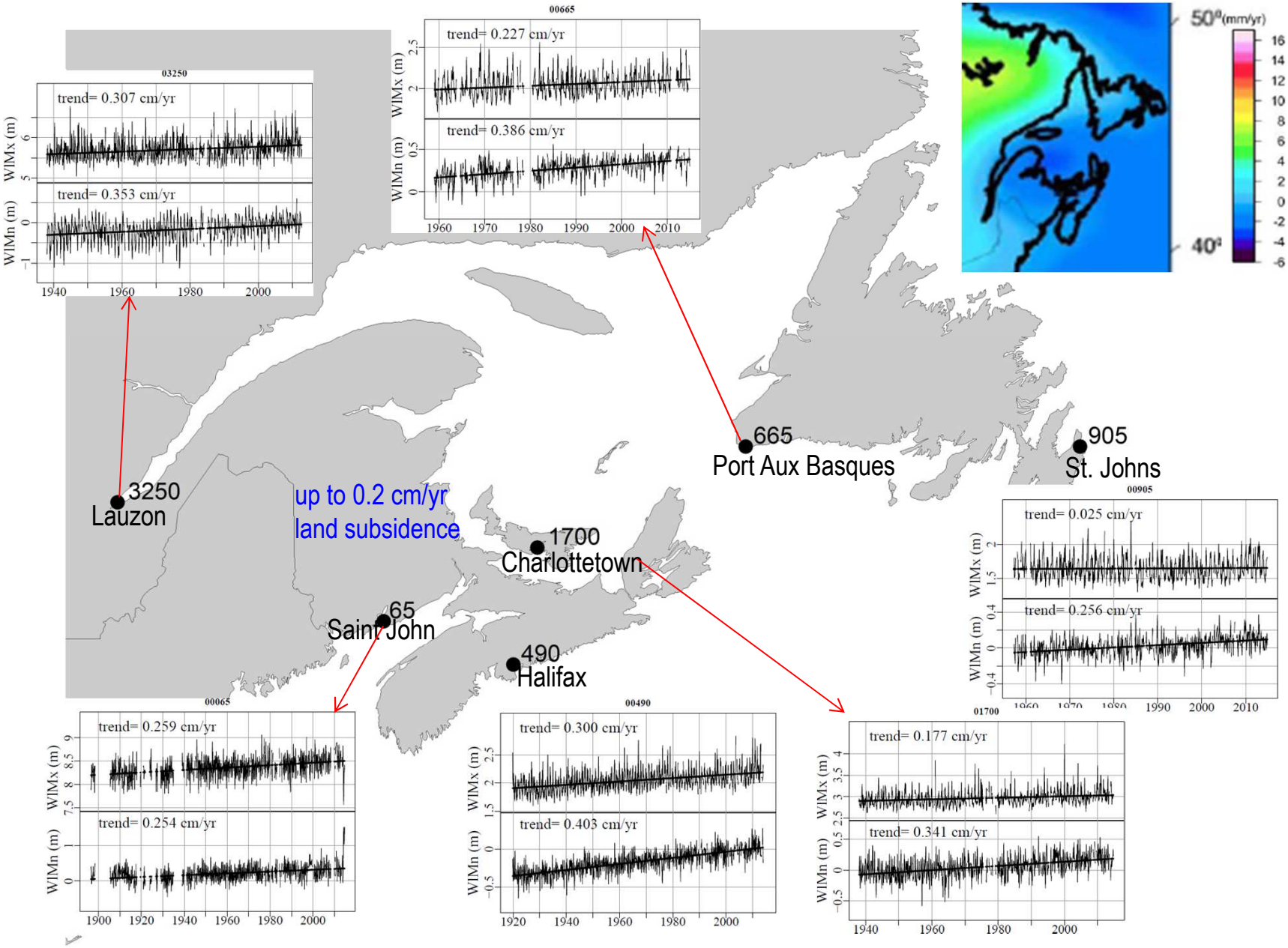
Ref. series (H00065 – Homog'd Saint John monthly mean of daily max.)



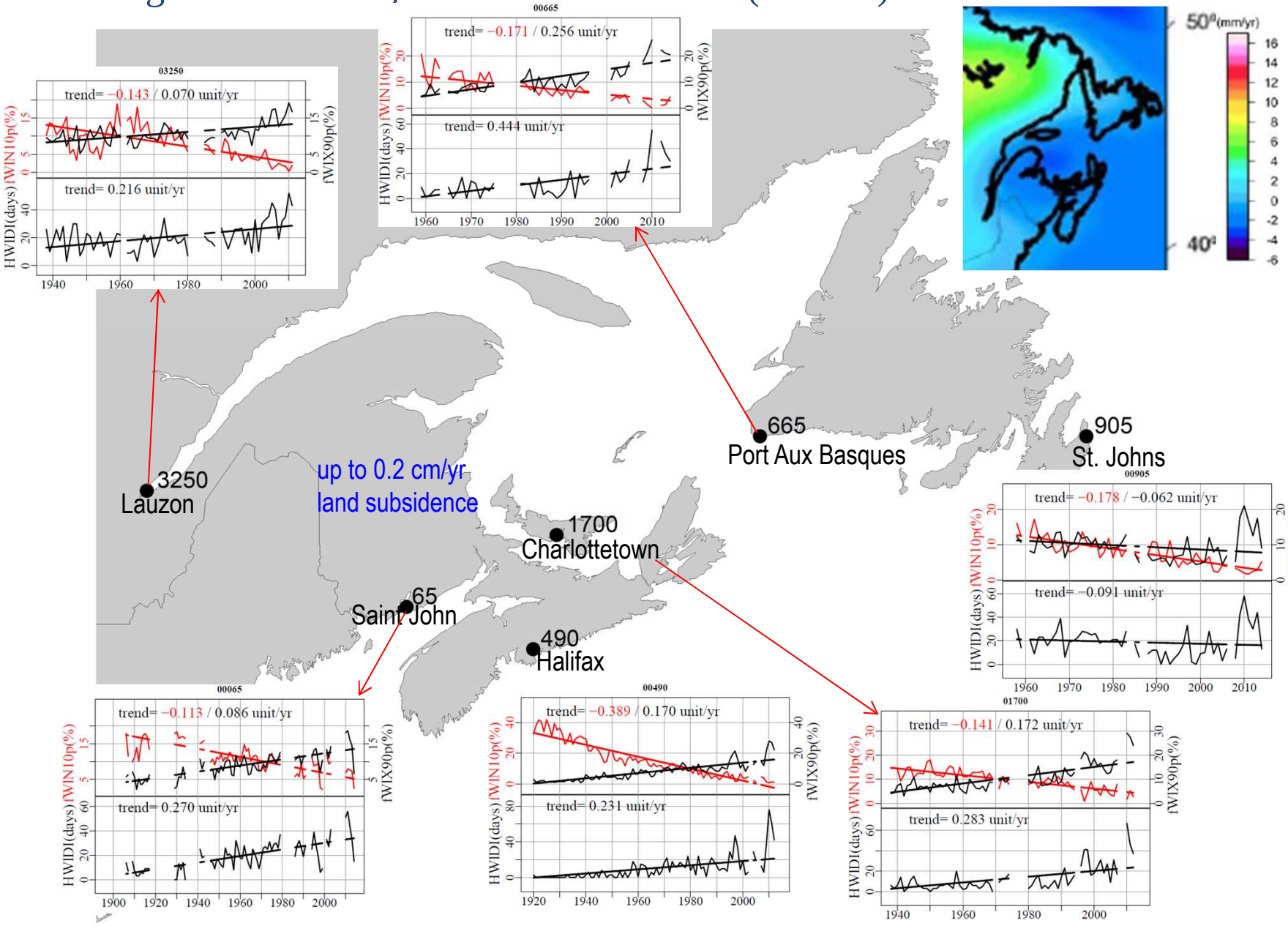
Annual max. and min. water level (WlAx and WlAn)



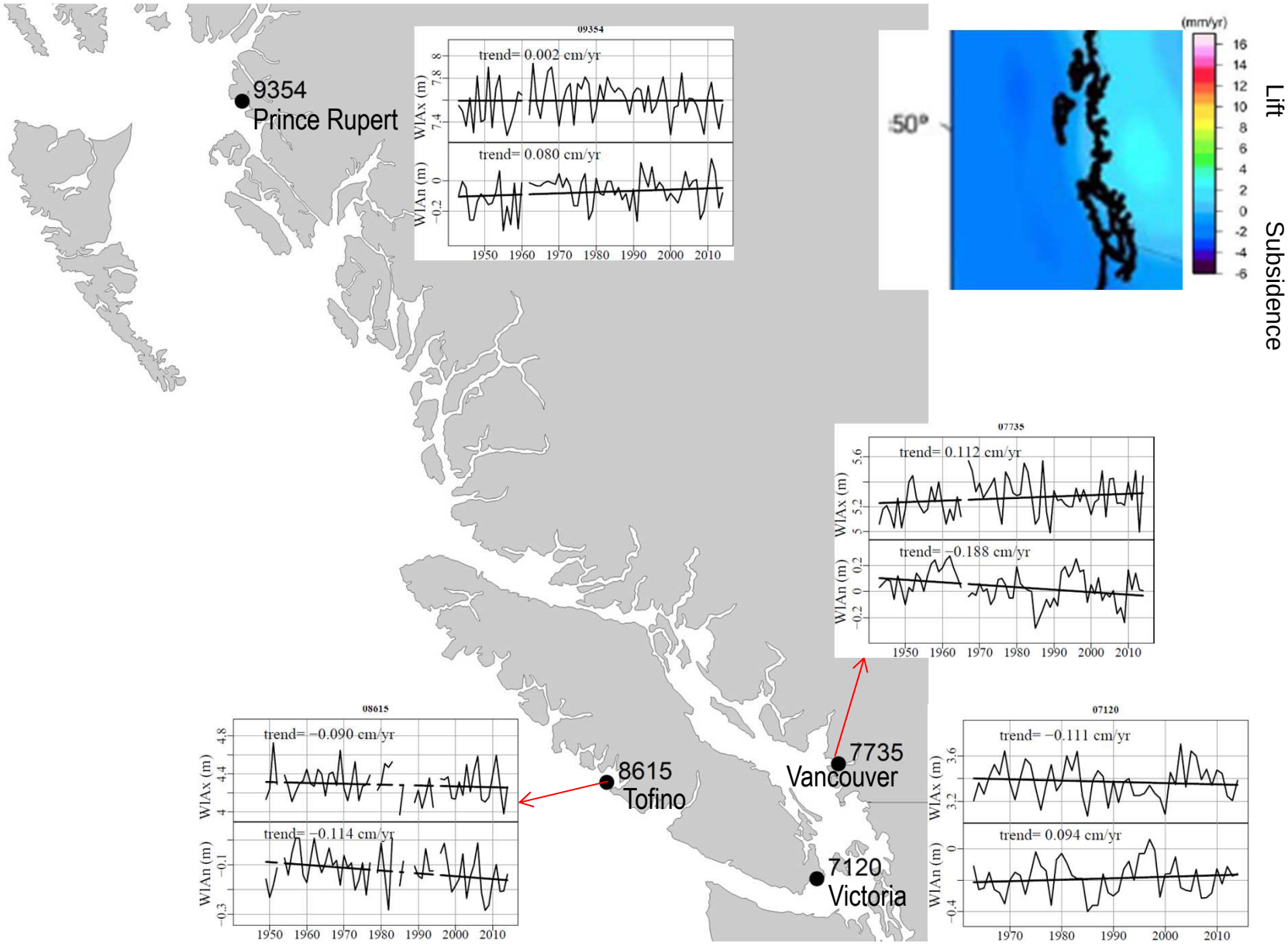
Monthly max. and min. water level (WlMx and WlMn)



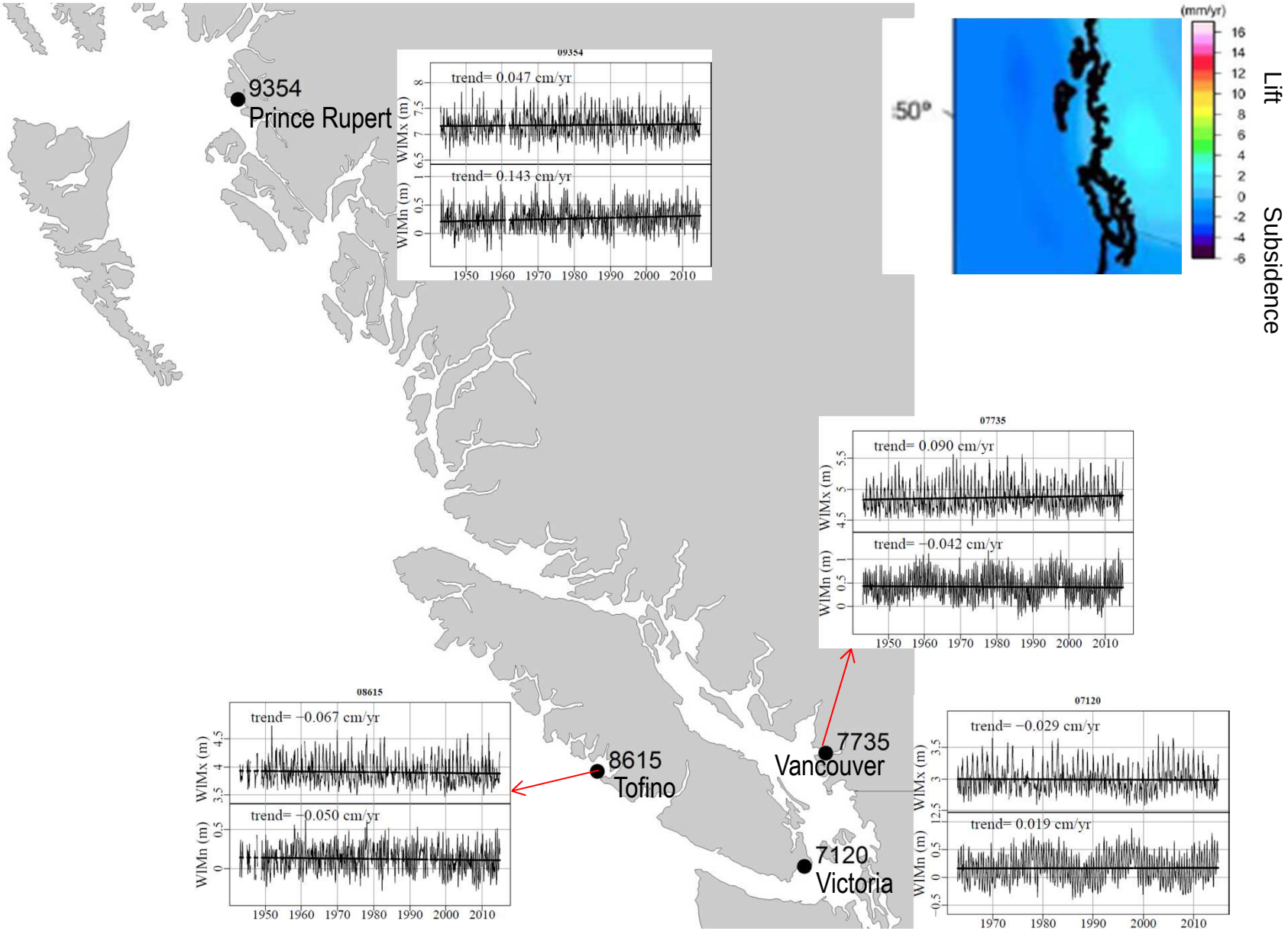
Frequency of extreme high and low water level (fWl90p and fWl10p), and high water level spell duration indicator (HWlDI)



Annual max. and min. water level (WlAx and WlAn)



Monthly max. and min. water level (WlMx and WlMn)



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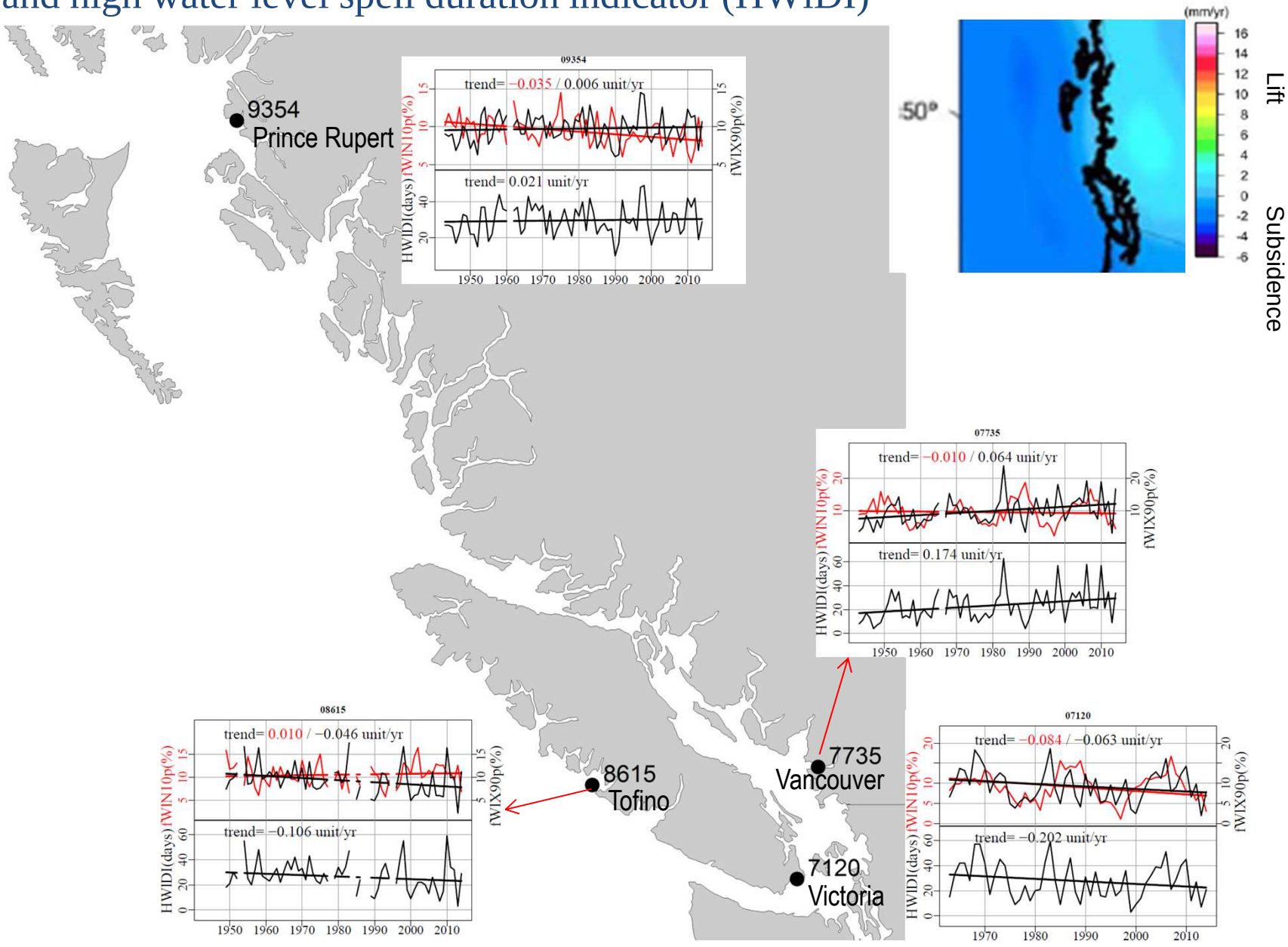

b. Extreme wave height indices (use ERA-Interim wave reanalysis data now, moored buoy and climate model data later)

ID	Indicator name	Definitions	Units
HsMx	Monthly max Hs (one for each month)	Monthly maximum value of significant wave height (Hs)	m
HsAx	Annual max Hs	Annual maximum value of significant wave height (Hs)	m
HsRo	Rough wave days	Annual count of days when daily max Hs > 2.5 m	days
HsHi	High wave days	Annual count of days when daily max Hs > 6 m	days
fHsRo	Rough wave day frequency	Annual percentage of days when daily max Hs > 2.5 m	%
fHsHi	High wave day frequency	Annual percentage of days when daily max Hs > 6 m	%
fHs90p	Top decile wave day frequency	Annual percentage of days when daily max Hs > 90th percentile	%
fHs10p	Low decile wave day frequency	Annual percentage of days when daily max Hs < 10th percentile	%
HHsDI	Top decile wave spell duration indicator	Annual count of days with at least 2? consecutive days when daily max Hs > 90th percentile	days

Other Hs indices?

Percentile seasonality?

- all calendar days share the same percentiles

or each calendar day has its own percentiles?

Like precipitation, Hs is non-negative and non-Gaussian. Treat it like precipitation

c. Extreme wind speed indices (use ERA-Interim wave reanalysis data now, moored buoy and climate model data later)

ID	Indicator name	Definitions	Units
WsMx	Monthly max wind speed	Monthly maximum value of wind speed (Ws)	m/s
WsAx	Annual max wind speed	Annual maximum value of wind speed (Ws)	m/s
WsB0	Calm wind days (very few days – drop it or change threshold?)	Annual count of days when daily max Ws < 0.514 m/s (1 Knot, Beaufort Scale 0)	days
WsB7	Near gale-force wind days	Annual count of days when daily max Ws > 14.403 m/s (Beaufort Scale 7)	days
WsB8	Gale wind days	Annual count of days when daily max Ws > 17.222 m/s (Beaufort Scale 8)	days
WsB9	Strong gale-force wind days	Annual count of days when daily max Ws > 20.833 m/s (Beaufort Scale 9)	days
WsB10	Storm-force wind days (very few days – drop this index?)	Annual count of days when daily max Ws > 24.722 m/s (Beaufort Scale 10)	days
fWsB0	Calm wind day frequency (drop it?)	Annual percentage of days when daily max Ws < 0.514 m/s (1 Knot,Beaufort Scale 0)	%
fWsB7	Near gale-force wind day frequency	Annual percentage of days when daily max Ws > 14.403 m/s (Beaufort Scale 7)	%
fWsB8	Gale-force wind day frequency	Annual percentage of days when daily max Ws > 17.222 m/s (Beaufort Scale 8)	%
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fWsB10	Storm-force wind day frequency (drop it?)	Annual percentage of days when daily max Ws > 24.722 m/s (Beaufort Scale 10)	%
fWs90p	Top decile wind day frequency	Annual percentage of days when daily max Ws > 90th percentile	%
fWs10p	Low decile wind day	Annual percentage of days when daily max Ws < 10th percentile	%
HWsDI	Top decile wind spell duration indicator	Annual count of days with at least 2? consecutive days when daily max Ws > 90th percentile	days
LWsDI (keep?)	Low decile wind spell duration indicator	Annual count of days with at least 2? consecutive days when daily max Ws < 10th percentile	days

← added by XW

Percentile seasonality? No.

Ws is also non-negative & non-Gaussian.

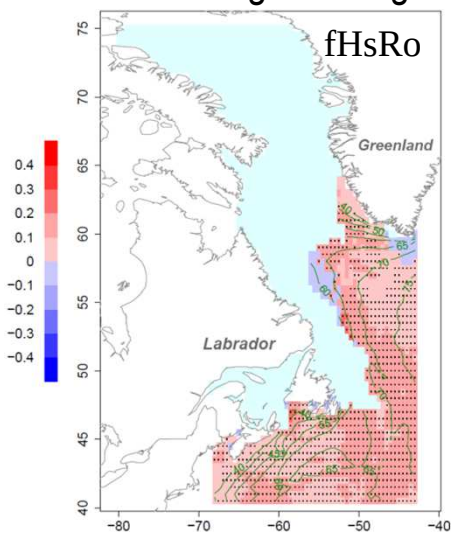
Treat it like Prcp

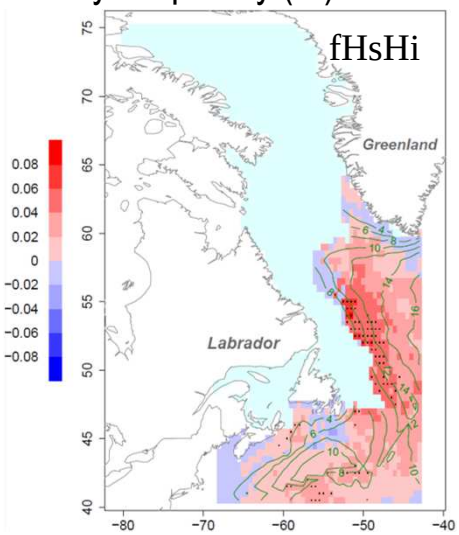
Other Ws indices?

Trends in extreme wave height indices (MSC50 reanalysis for 1954-2013)

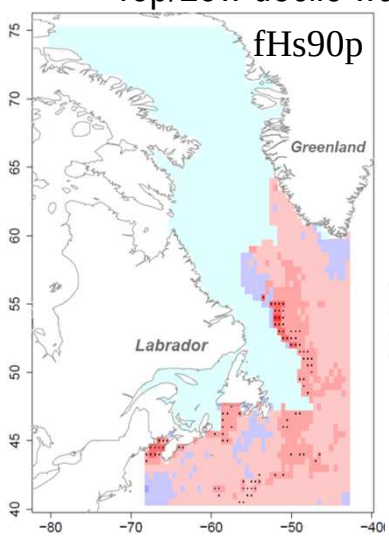
Waves over areas that are ice-free during the baseline period 1981-2010

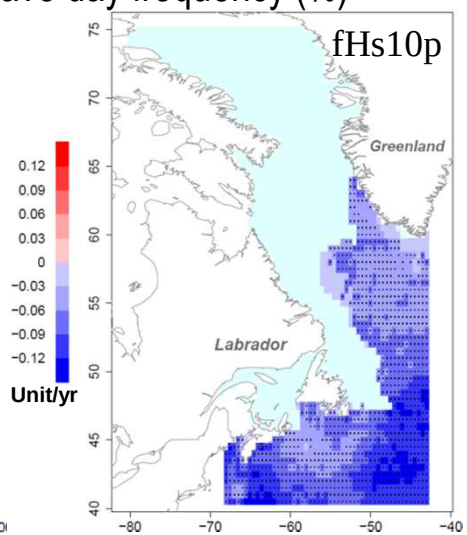
Rough and high wave day frequency (%)



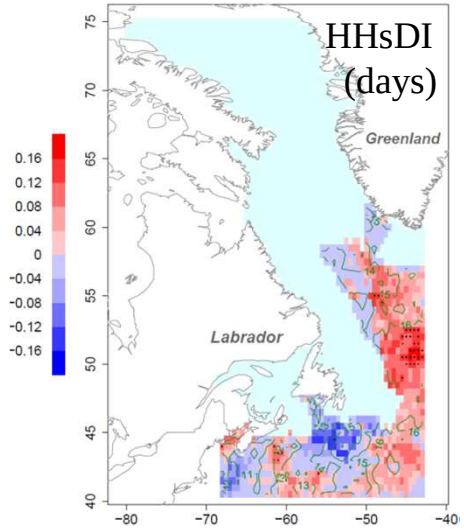


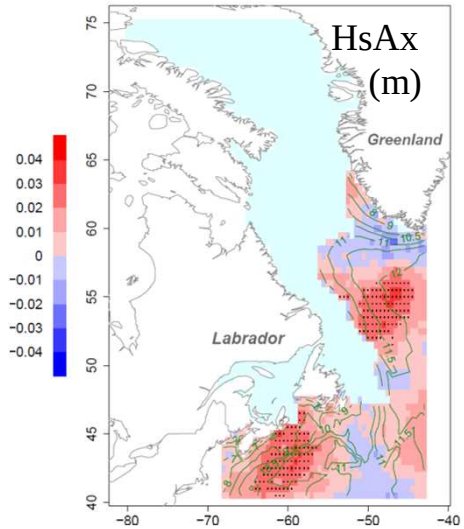
Top/Low decile wave day frequency (%)

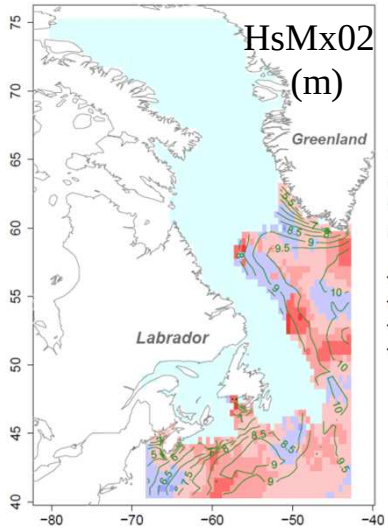


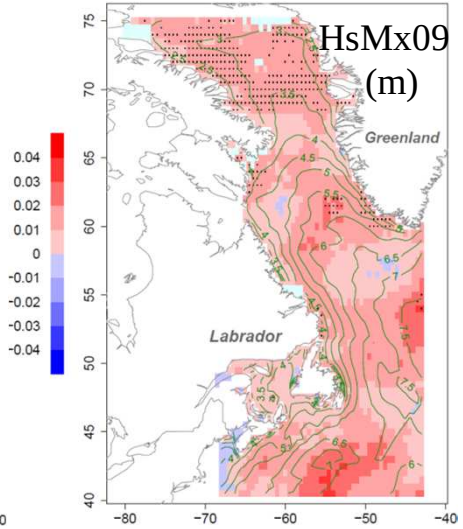


Stippling – 5% significance or higher



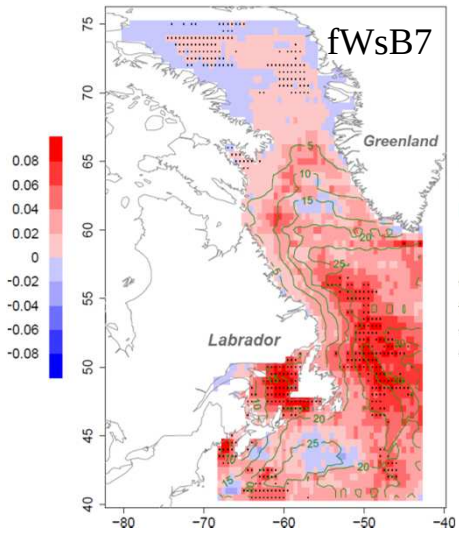


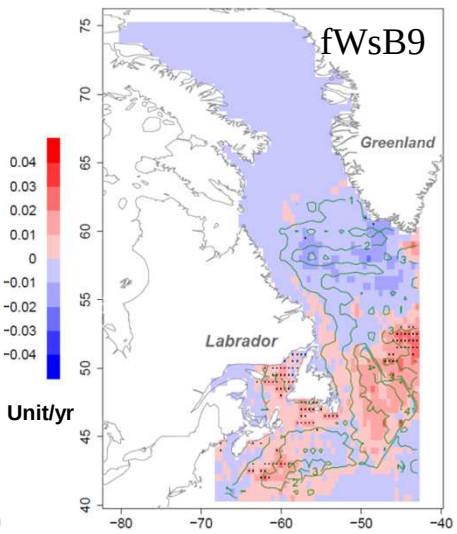




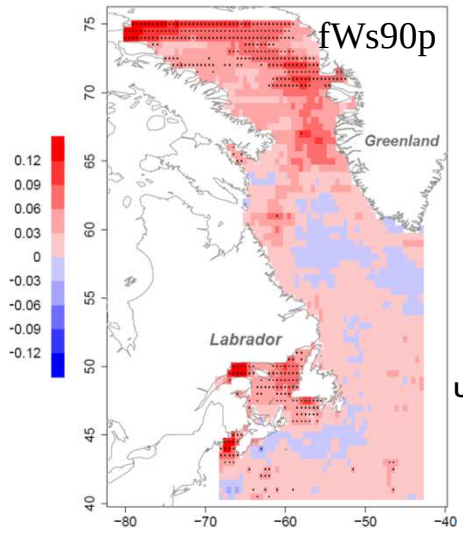
Trends in extreme wind speed indices (MSC50 for 1954-2013 – based on NCEP1)

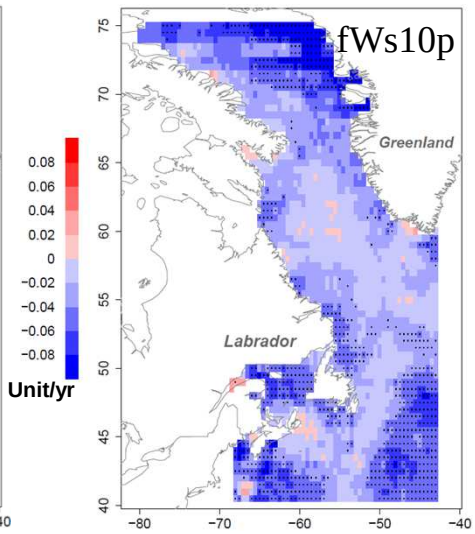
Near-gale and strong gale wind day frequency (%)



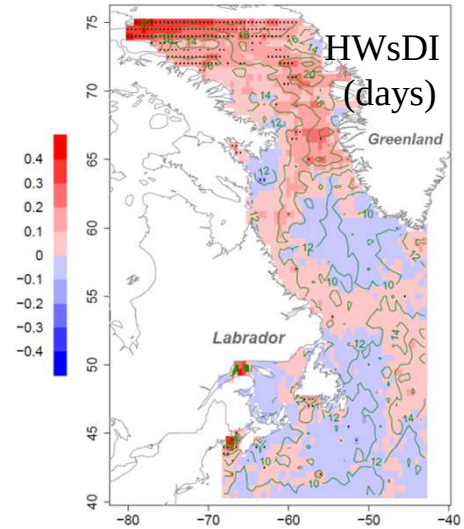


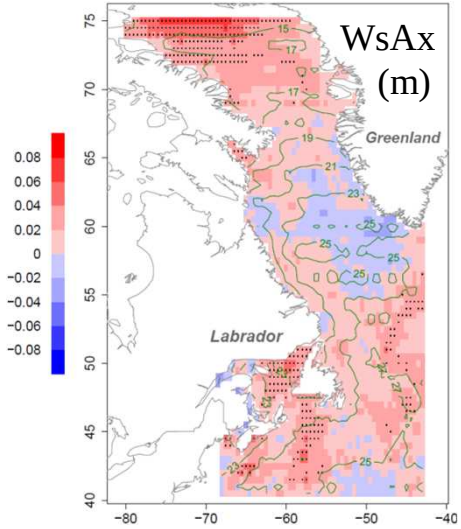
Top/Low decile wave day frequency (%)

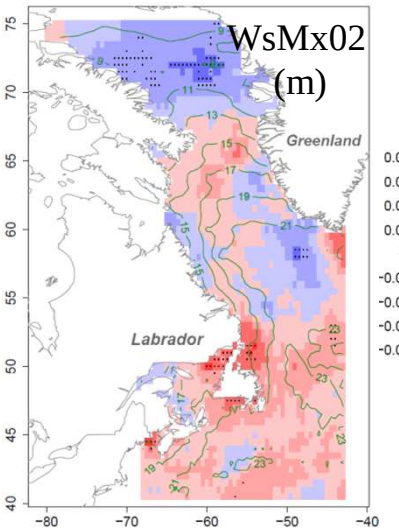


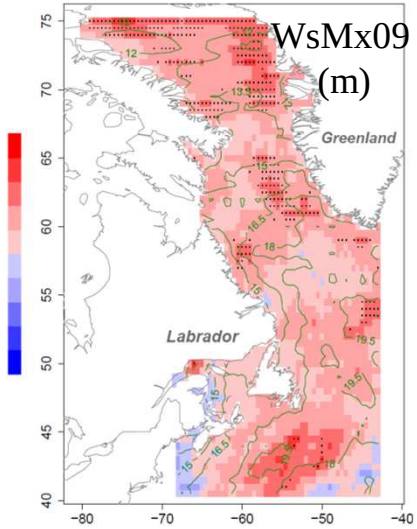


Stippling – 5% significance or higher





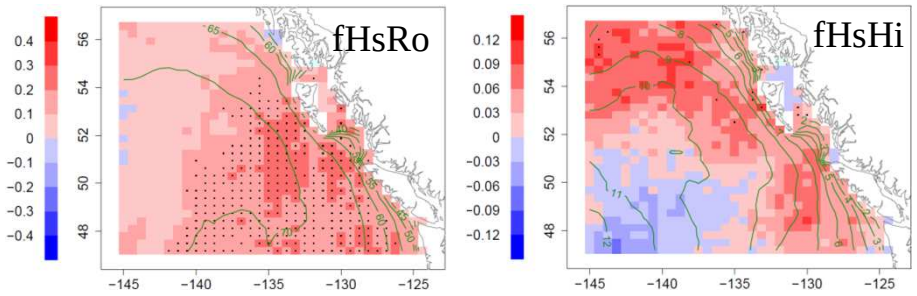




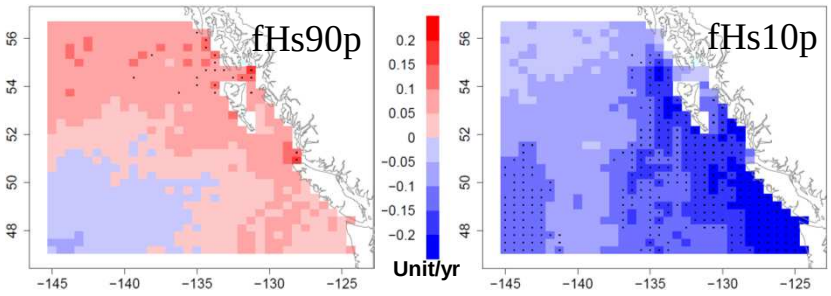
Trends in extreme wave height indices (GROW reanalysis for 1980-2011)

baseline period: 1981-2010

Rough and high wave day frequency (%)



Top/Low decile wave day frequency (%)



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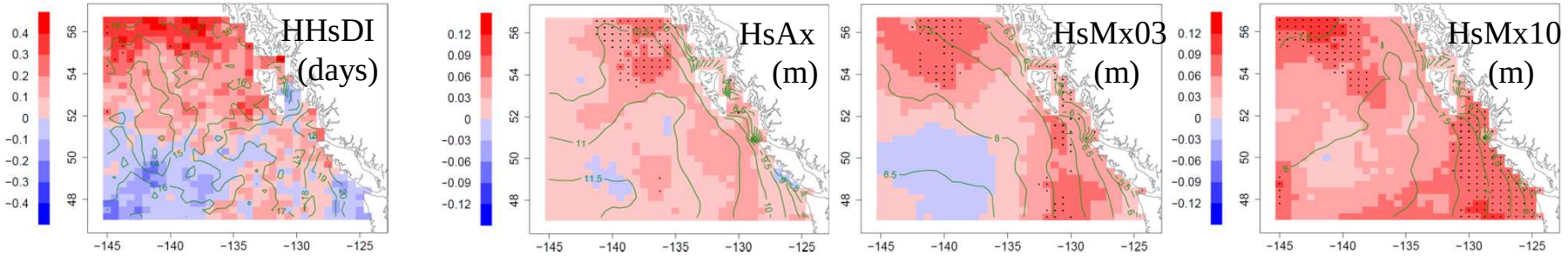
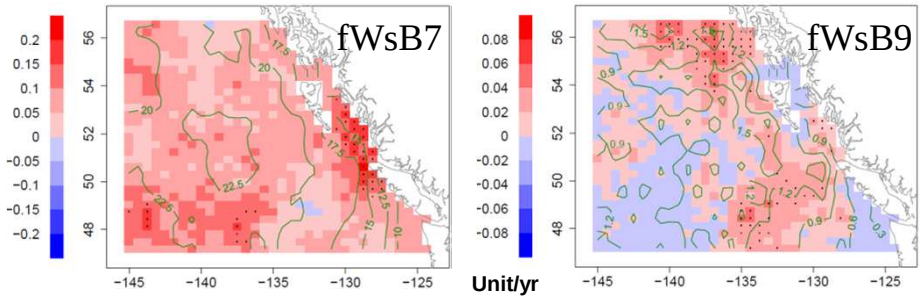


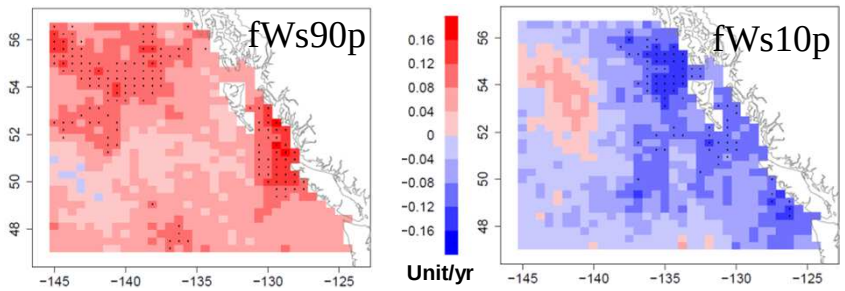
Trends in extreme wind speed indices (GROW for 1980-2011 – based on NCEP1?)

baseline period: 1981-2010

Near-gale and strong gale wind day frequency (%)



Top/Low decile wave day frequency (%)



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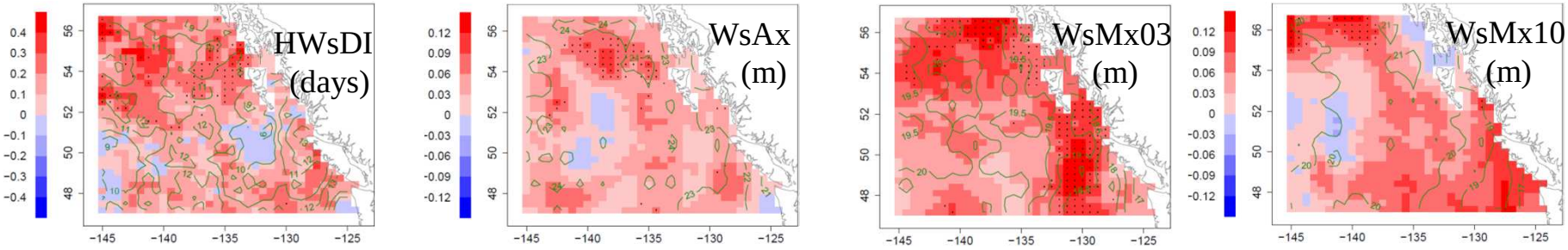

d. Storm surge indices (requires further development; data sources – tide gauge data?)

ID	Indicator name	Definitions	Units
SSSMx	Monthly max skew storm surge*	Monthly maximum skew storm surge (skew storm surge is the simple difference between observed high water and the tidal prediction in that same tidal cycle)	?
SSSMe	Monthly mean skew storm surge*	Monthly mean skew storm surge	?
SSSAx	Annual max skew storm surge*	Annual maximum skew storm surge	?
SSSAe	Annual mean skew storm surge*	Annual mean skew storm surge	?
SSS90p	all-time 90 percentile skew surge	???	?
???	Humidity indices (e.g. wet bulb or dew point temperatures)	???	

Kevin/Cathy to lead?