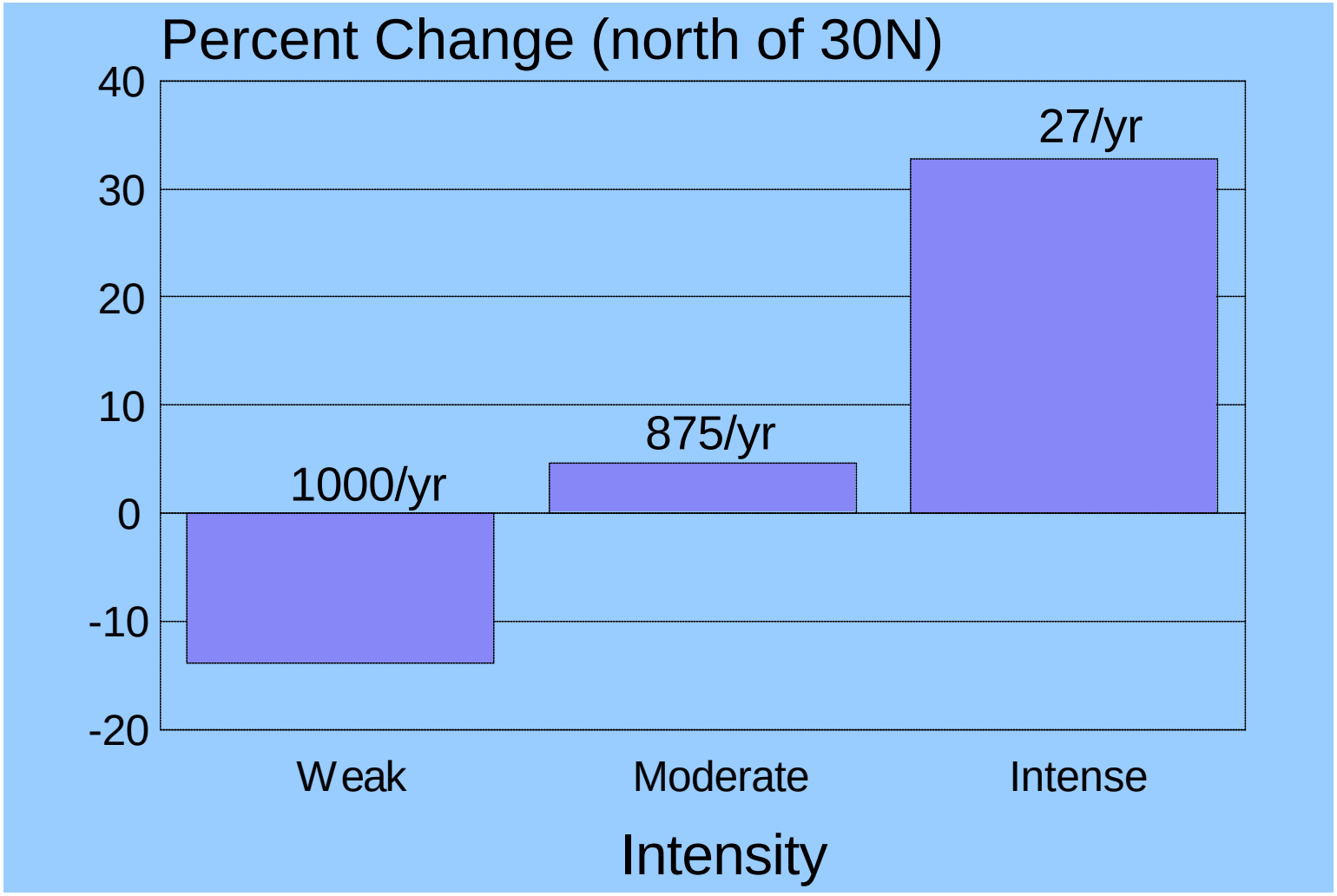
NW Atlantic wave estimates under global warming conditions

[1,2]Will Perrie, [1,3]Jing Jiang, [1,2]Zhenxia Long
[1]Bash Toulany, [1,2]Weiqing Zhang

[1]Bedford Institute of Oceanography, Canada
[2]Dalhousie University, Canada
[3]Nanjing University, China

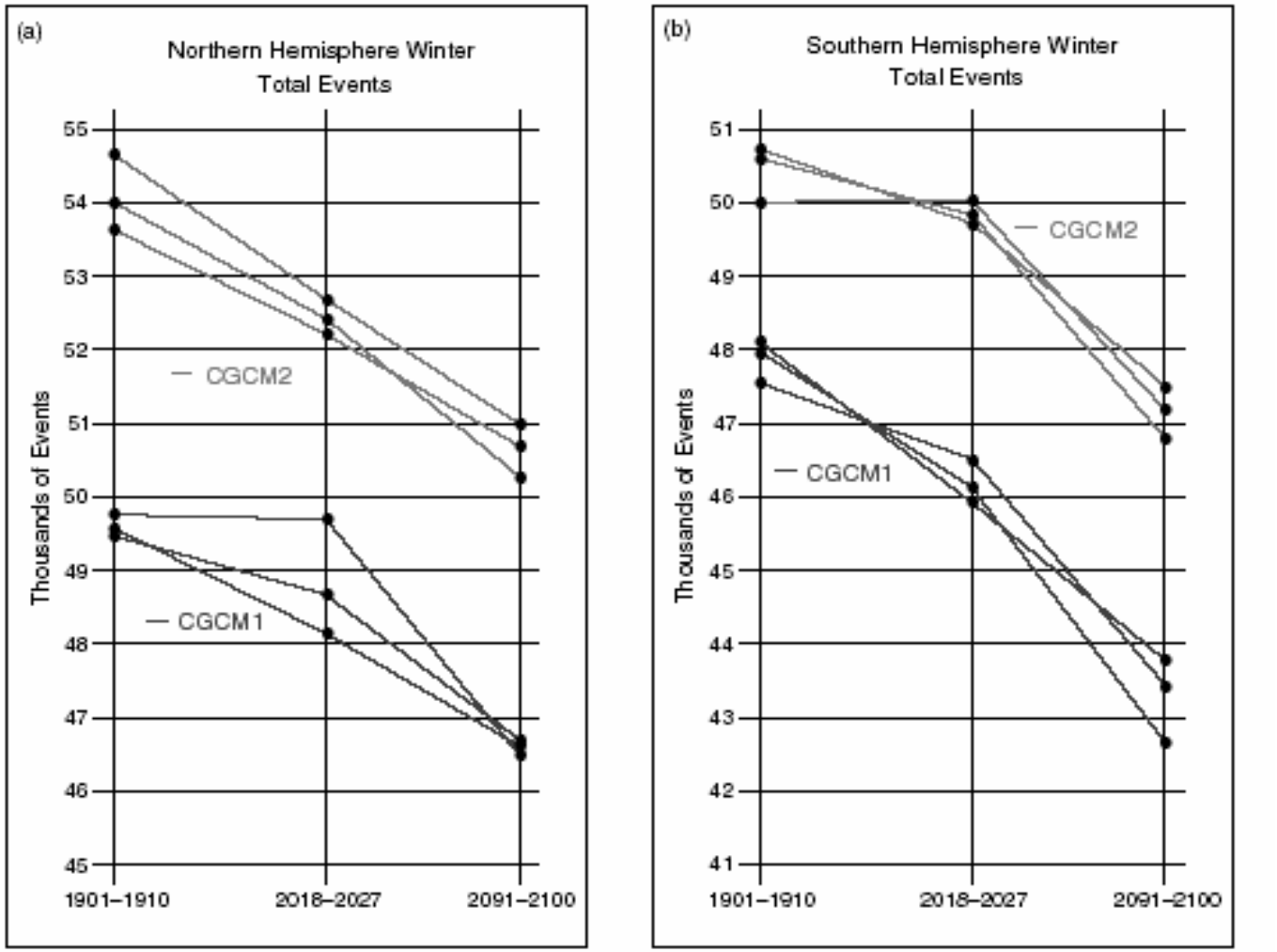
Winter Storms



Lambert 1995, 2004 using CCCma model CGCM1 and CGCM2 model outputs at 3°-4°

Numbers indicate number of storms/ yr and rates of change in GHG warmed scenarios

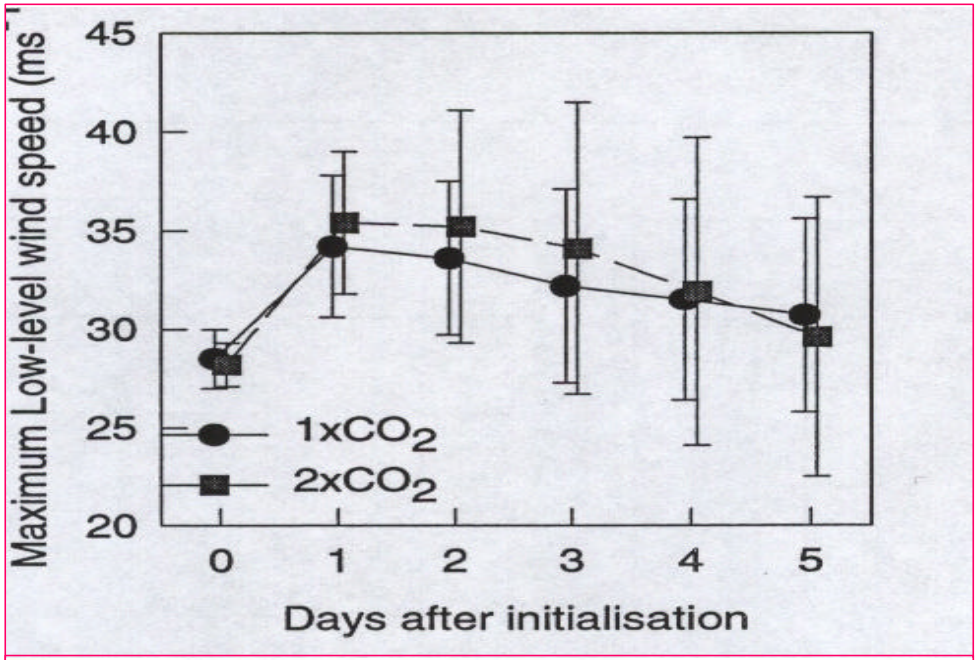
Winter Storms (con't)

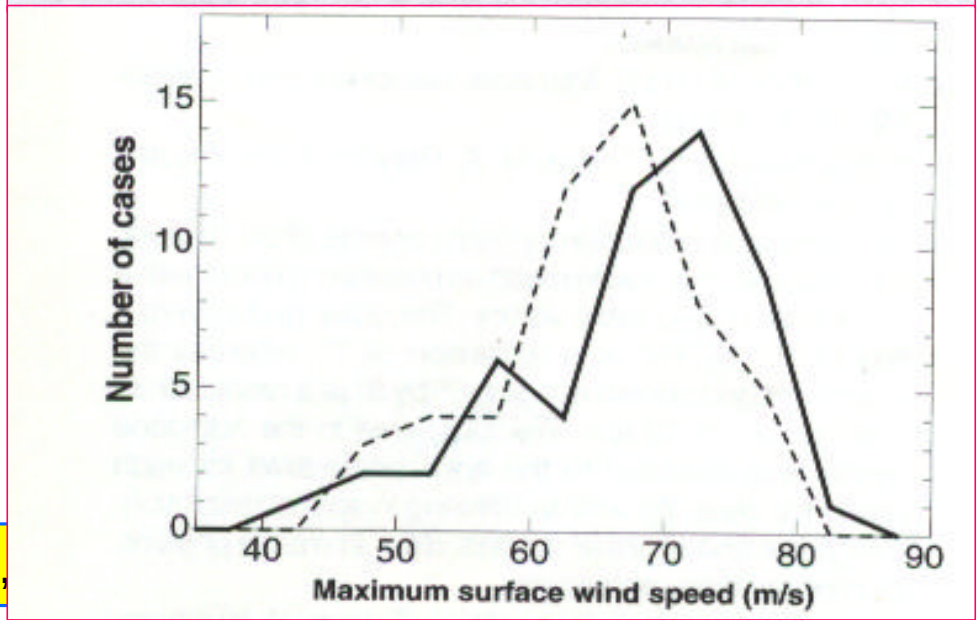


1. reduction of about 6% in the number of cyclone events in the Northern Hemisphere in GHG warmed scenarios
2. intense cyclones increased 6% for the northern hemisphere

Hurricanes

- Net increase in hurricane intensity
- Average max wind speeds increased by 6%
- Precip within 100km of centre of storm increased by 18%
- Warming slowly increases risk of highly destructive category 5 storms.





Knutson,T.R. and Tuleya,R.E. 2004,

Method A: Knutson: Princeton GFDL NOAA: J. Climate

1. Automatic selection software for autumn (September-October) storms, from GCM coarse resolution 3-4^{o} outputs for present (1975-94) and future change (2040-59).

2. Use the MC2 mesoscale atmospheric model to downscale winds to 25km for (72) present climate and (66) future climate storms.

Method B: Walsh: CSIRO/ U. Melbourne Australia: J. Climate

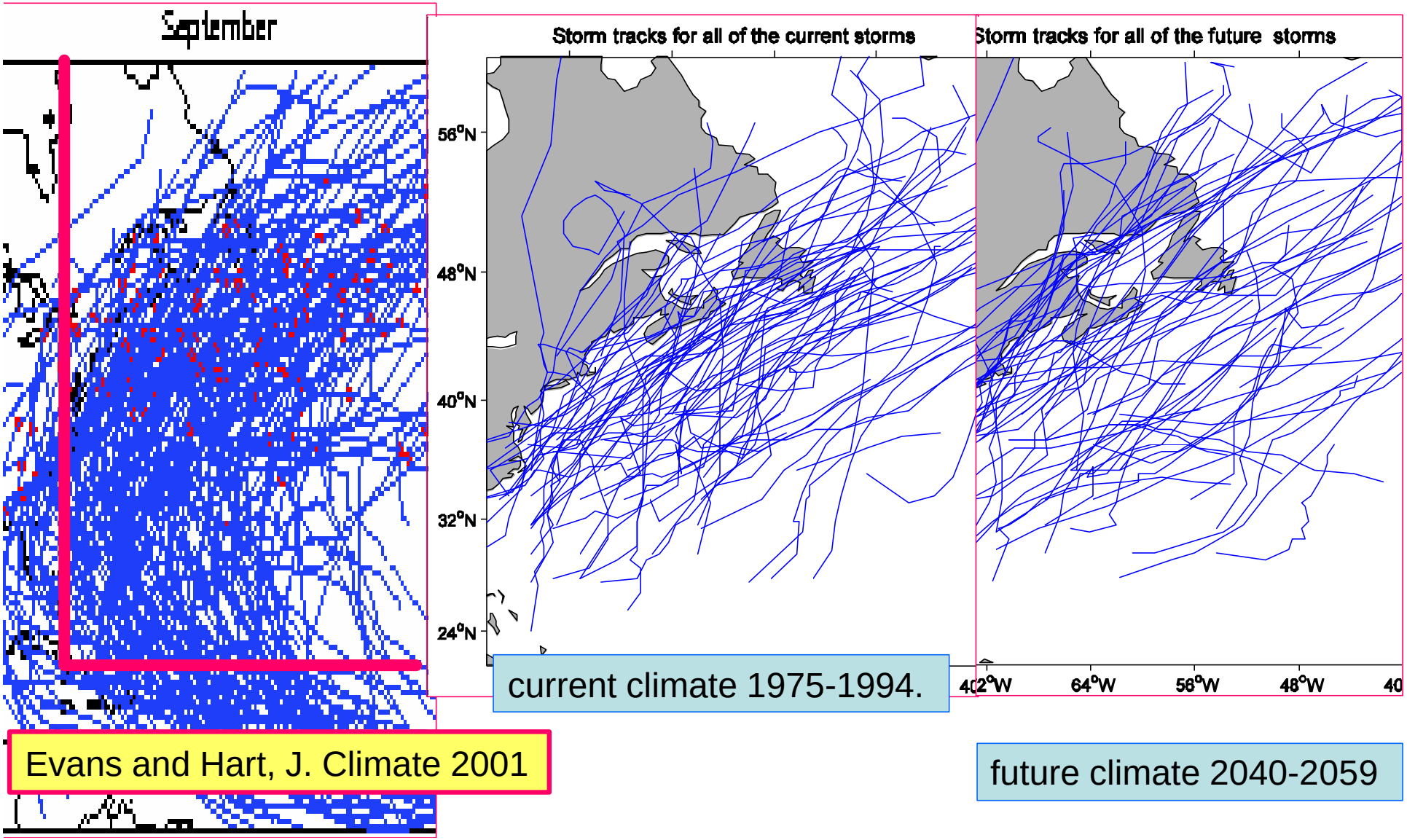
1. GCM to drive Regional Climate Model $\Rightarrow$ downscale winds to 0.25^{o} resolution for 20 winters (Dec. – Mar.) of present (1975-94) and future climate (2040-59).

2. Automatic selection software for severe winter storms $\Rightarrow$ 135 present climate, and 109 future climate storms. Criteria = MSLP and > 24h duration.

Use the winds to drive waves, and give climate change impacts on wave climate.

Method A: Autumn storms using GCM outputs to drive mesoscale atmosphere storm model at 0.25º resolution

Sept.-Oct.

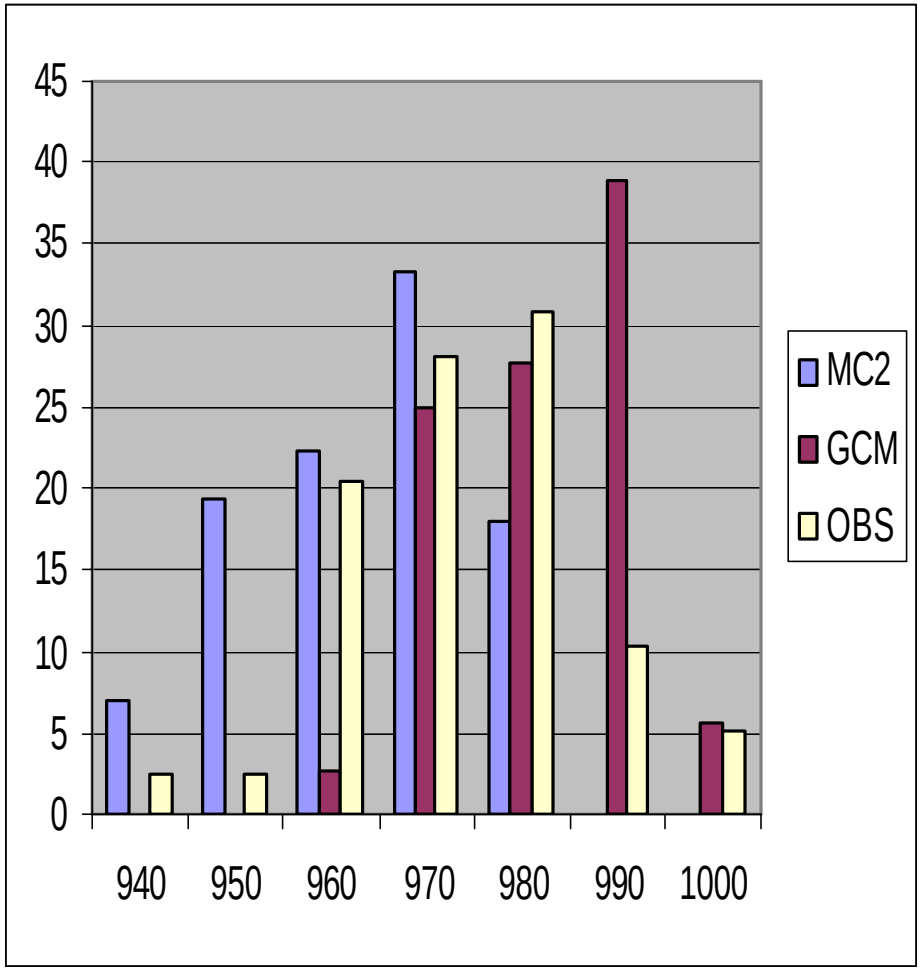


current climate 1975-1994.

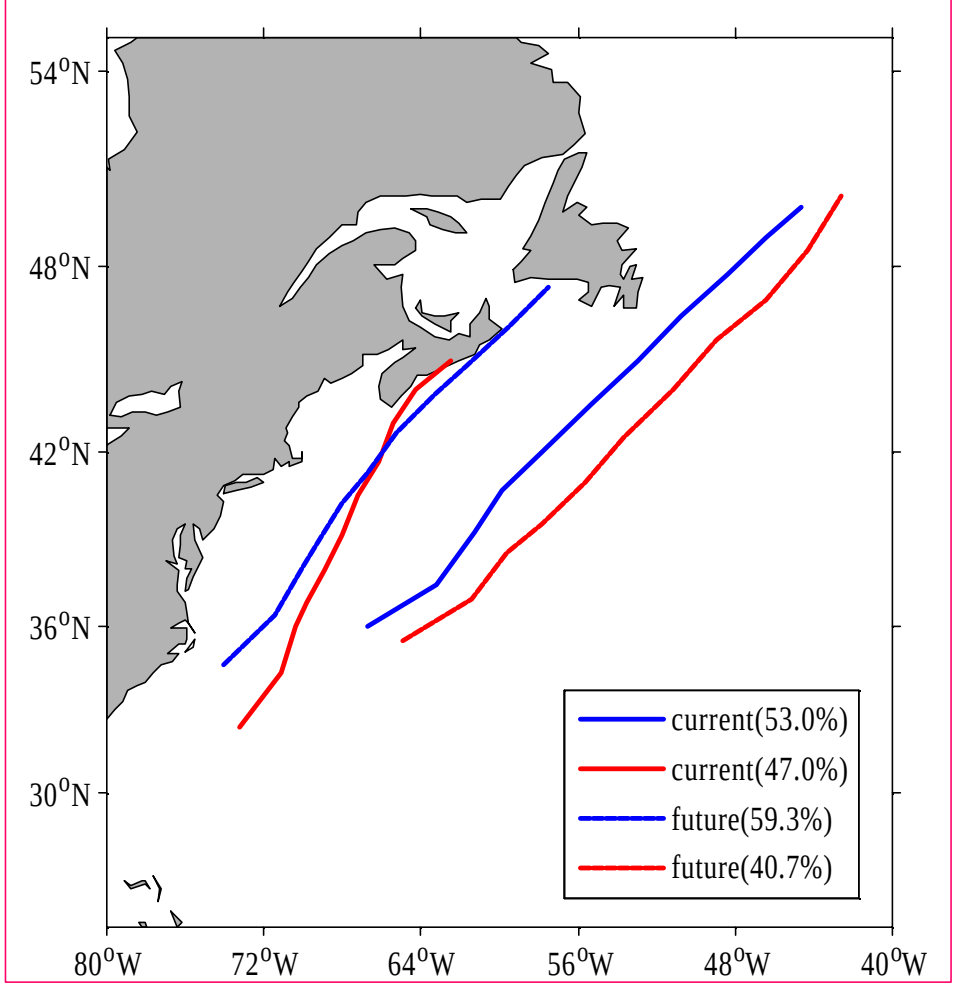
Evans and Hart, J. Climate 2001

future climate 2040-2059

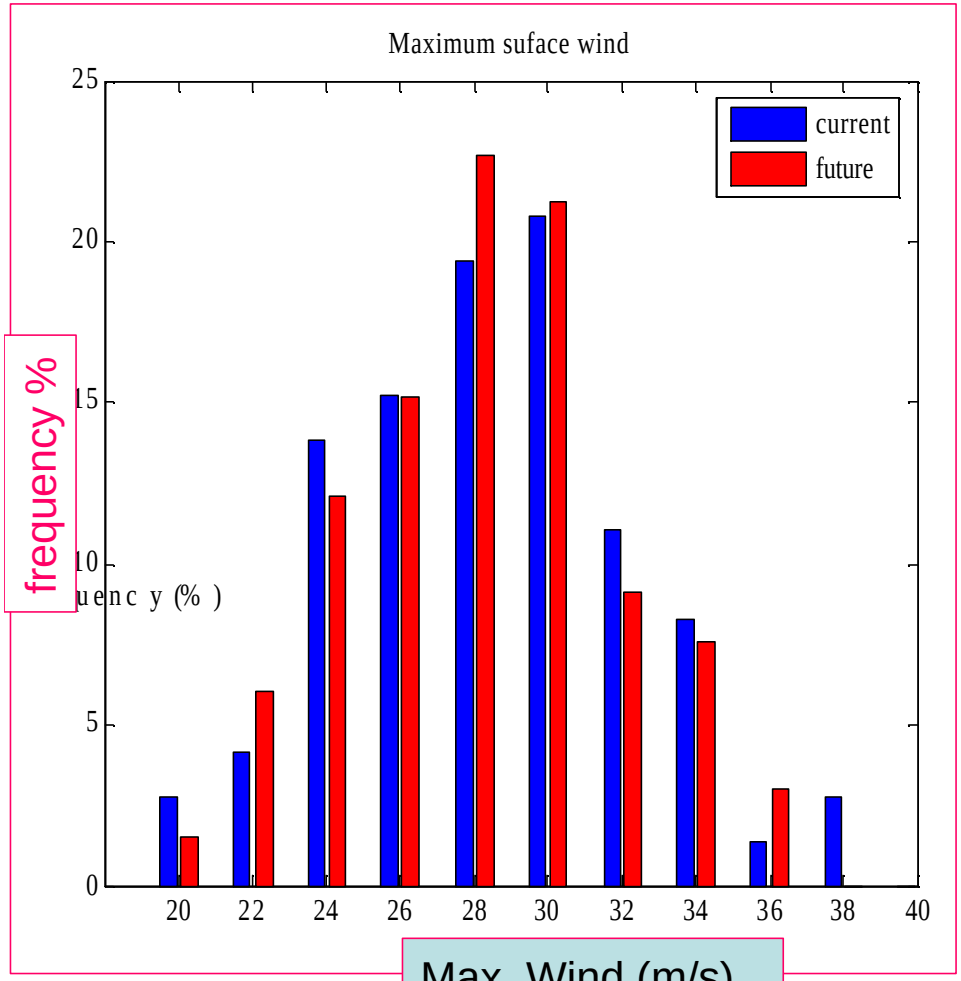
MC2 - GCM – obs

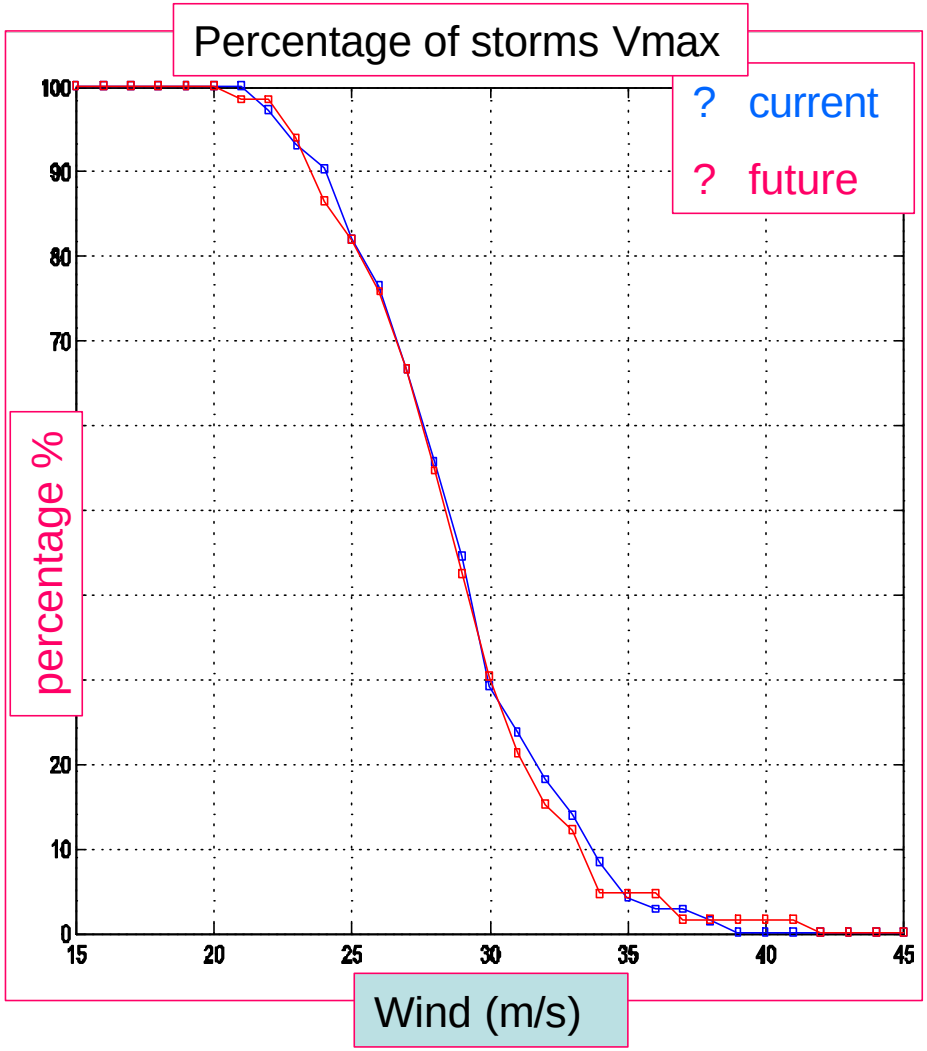


Dominant storm tracks

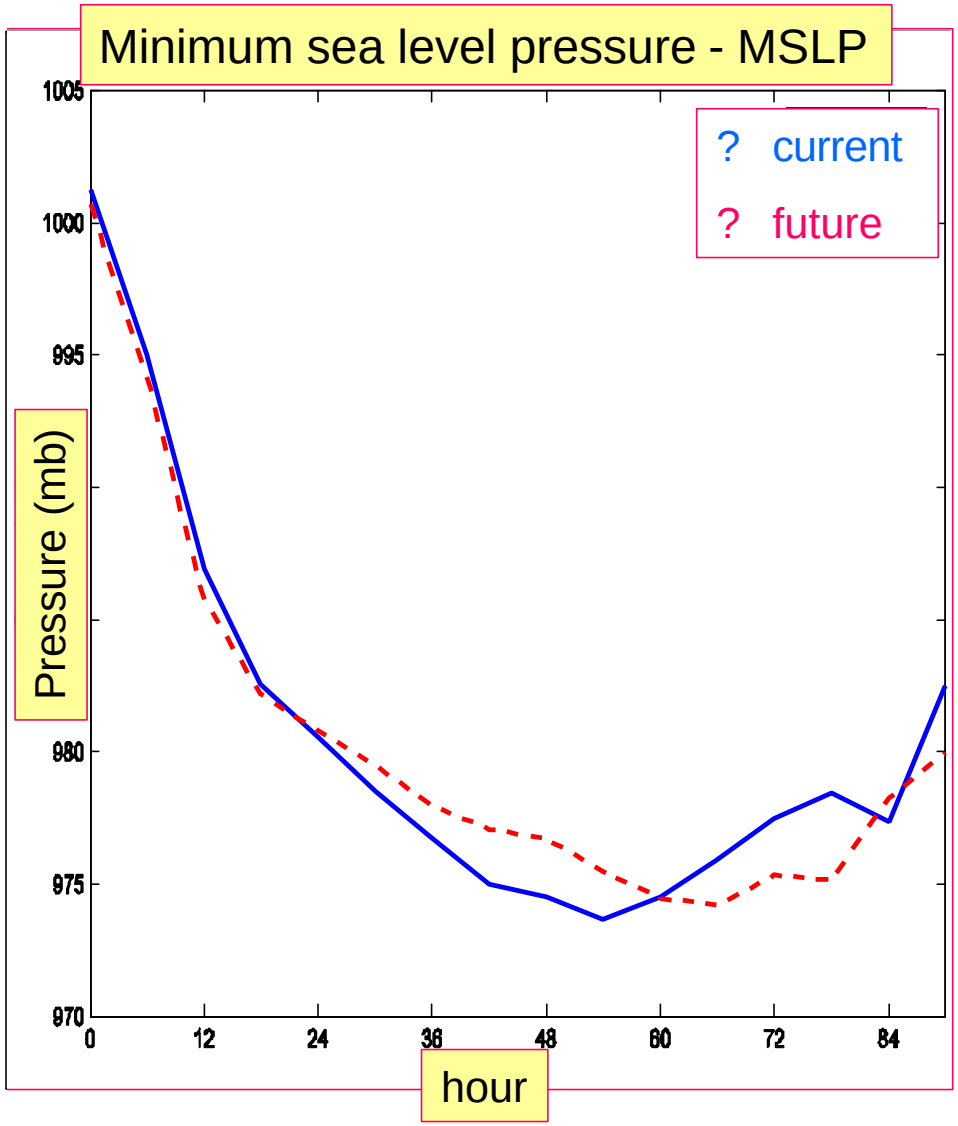


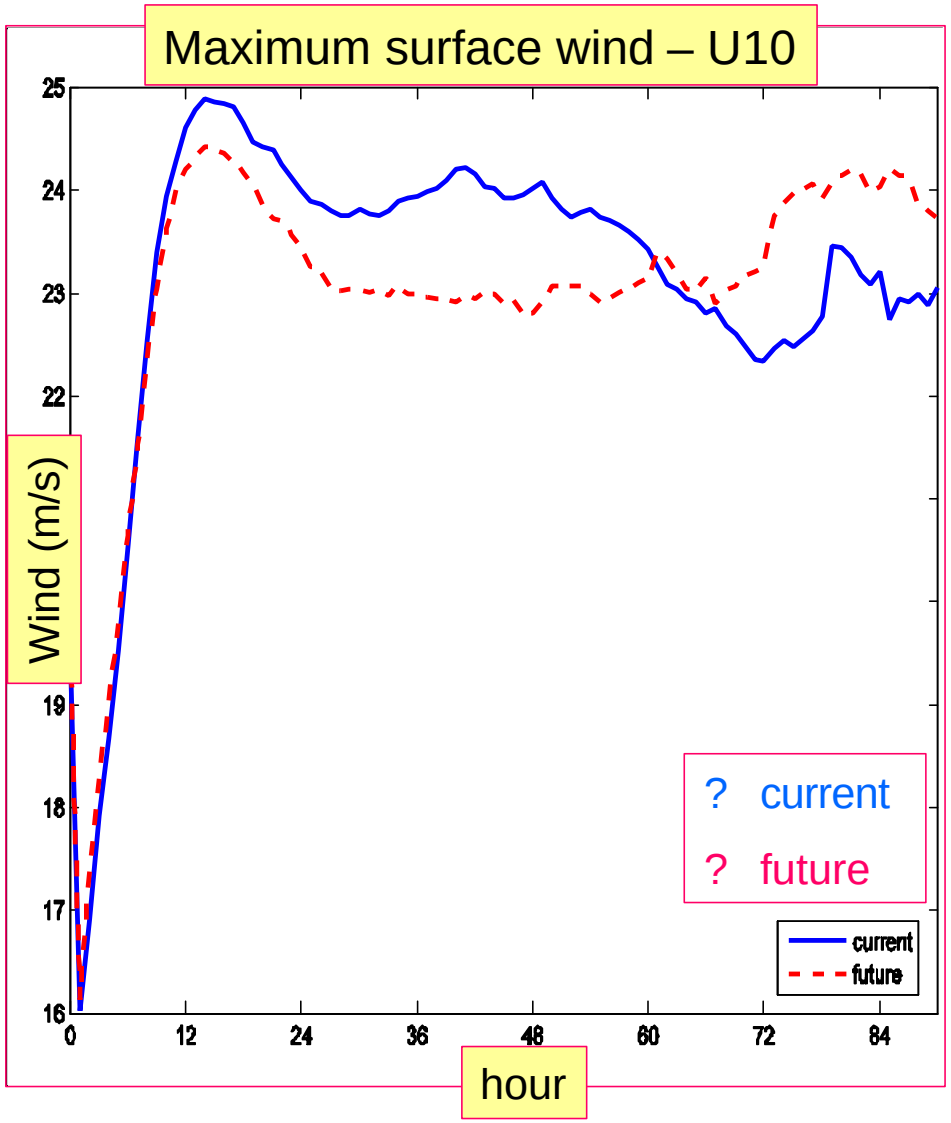
Climate change impacts ⇒ U10



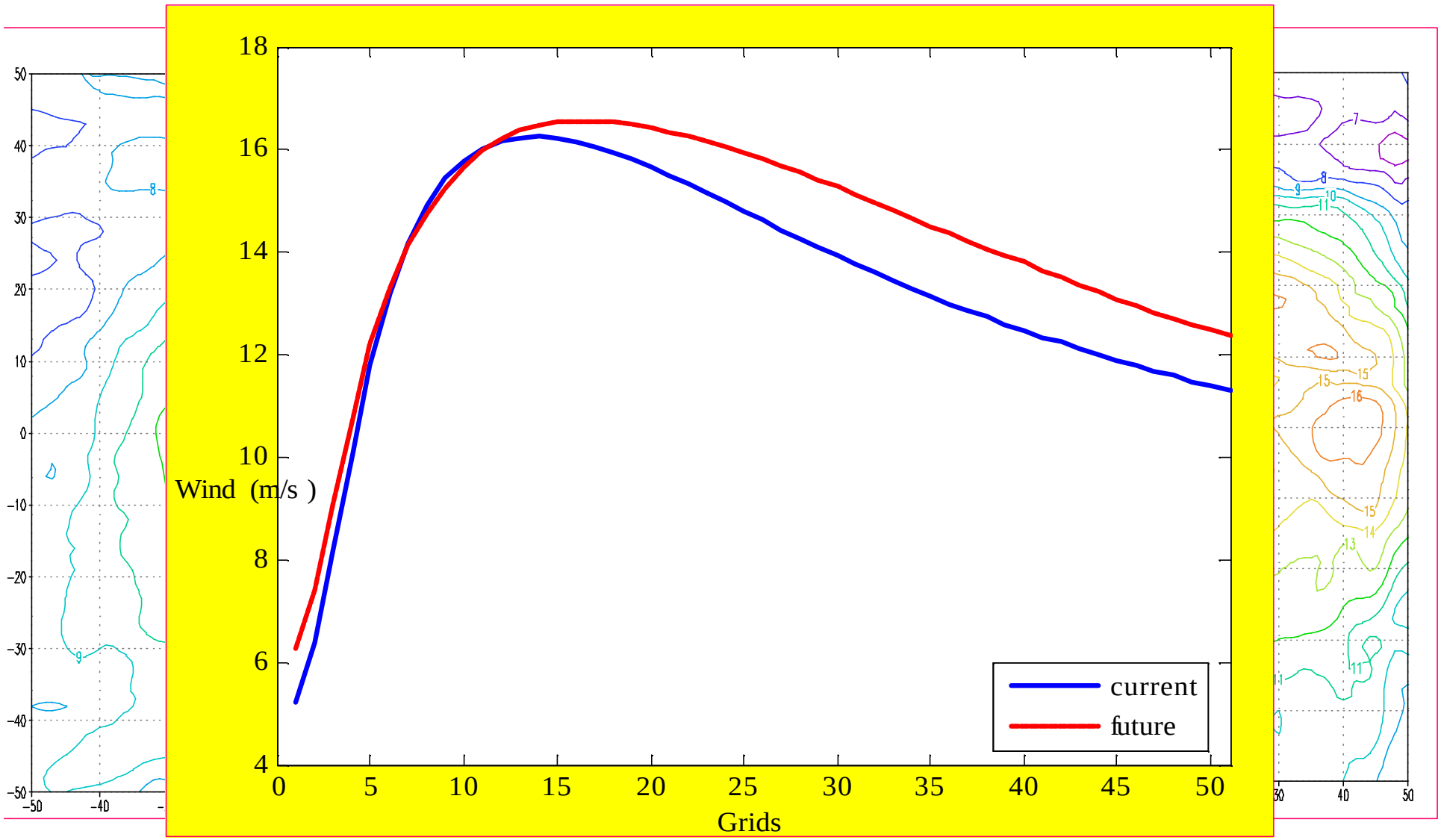


Climate change impacts ⇒ MSLP, U10



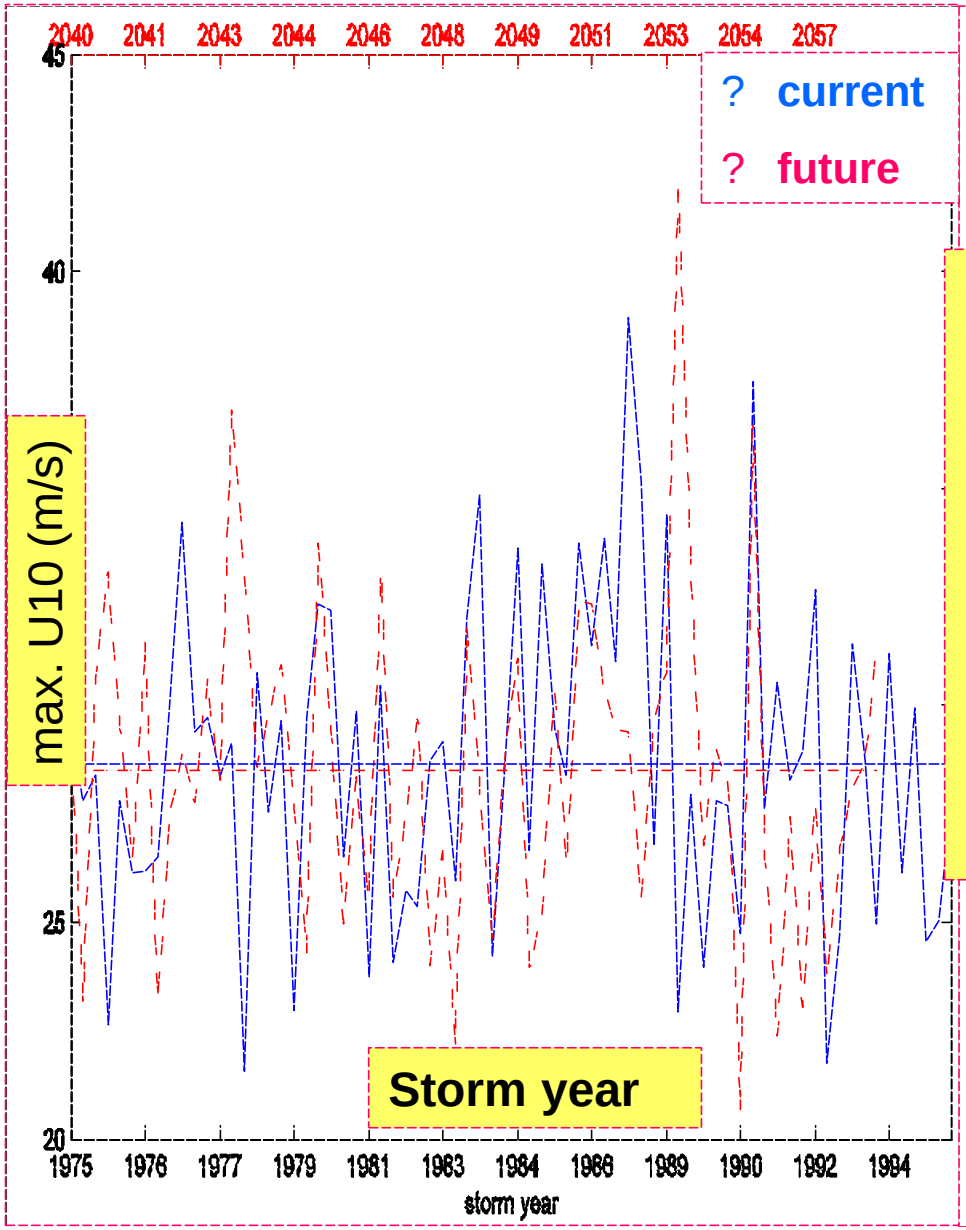


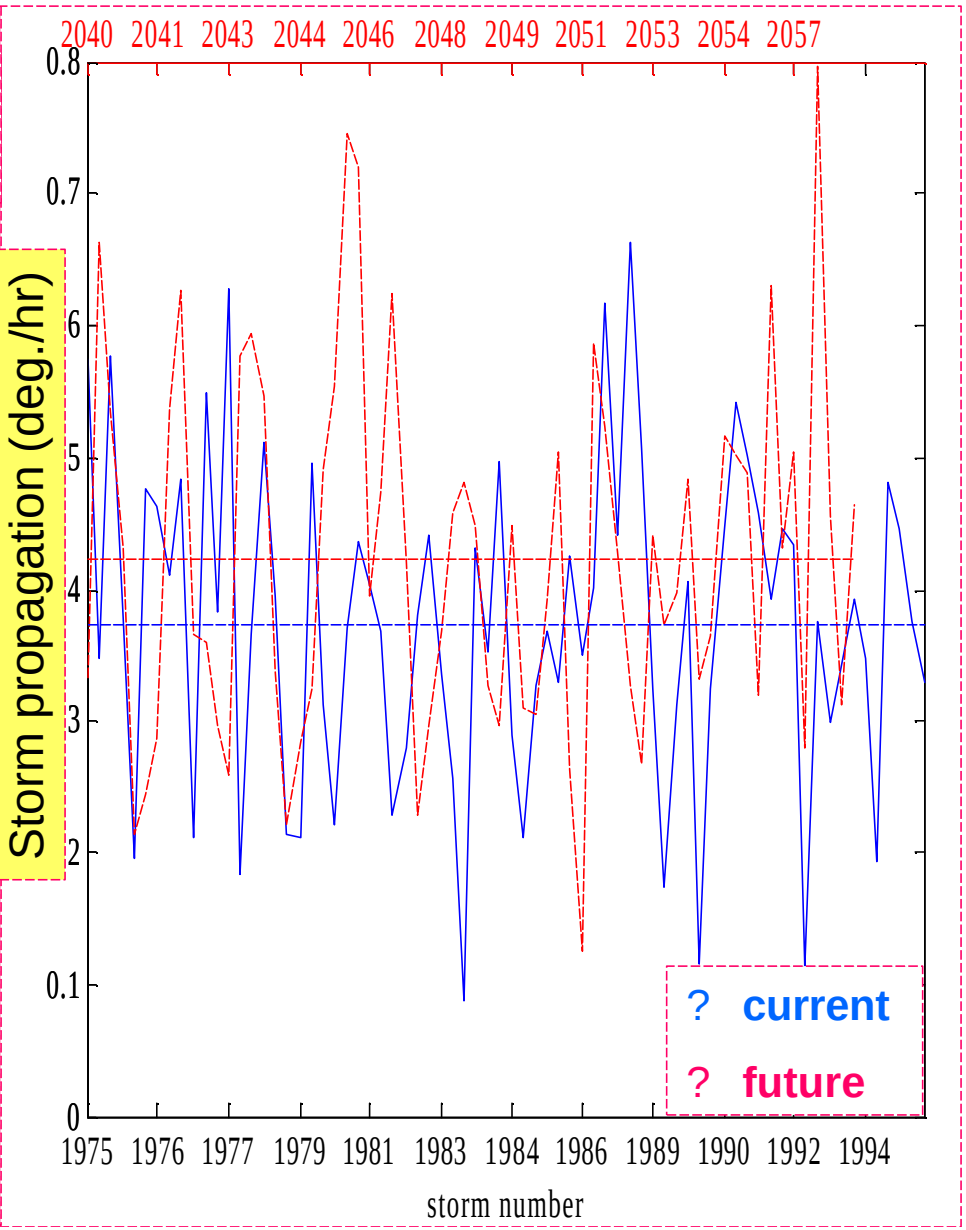
Climate change impacts ⇒ storm structure



Each grid is 0.25°

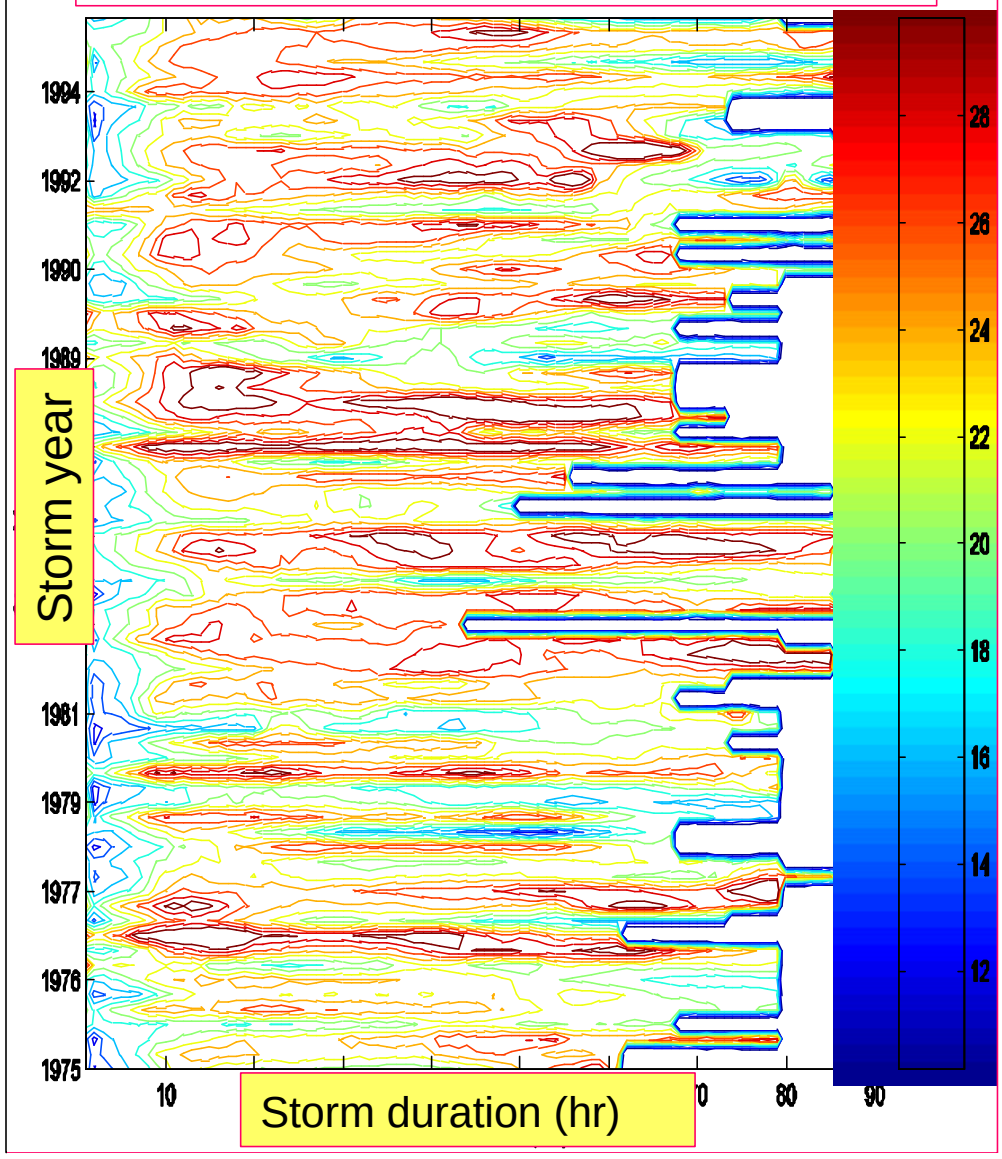
Climate change impacts ⇒ U10, storm speed



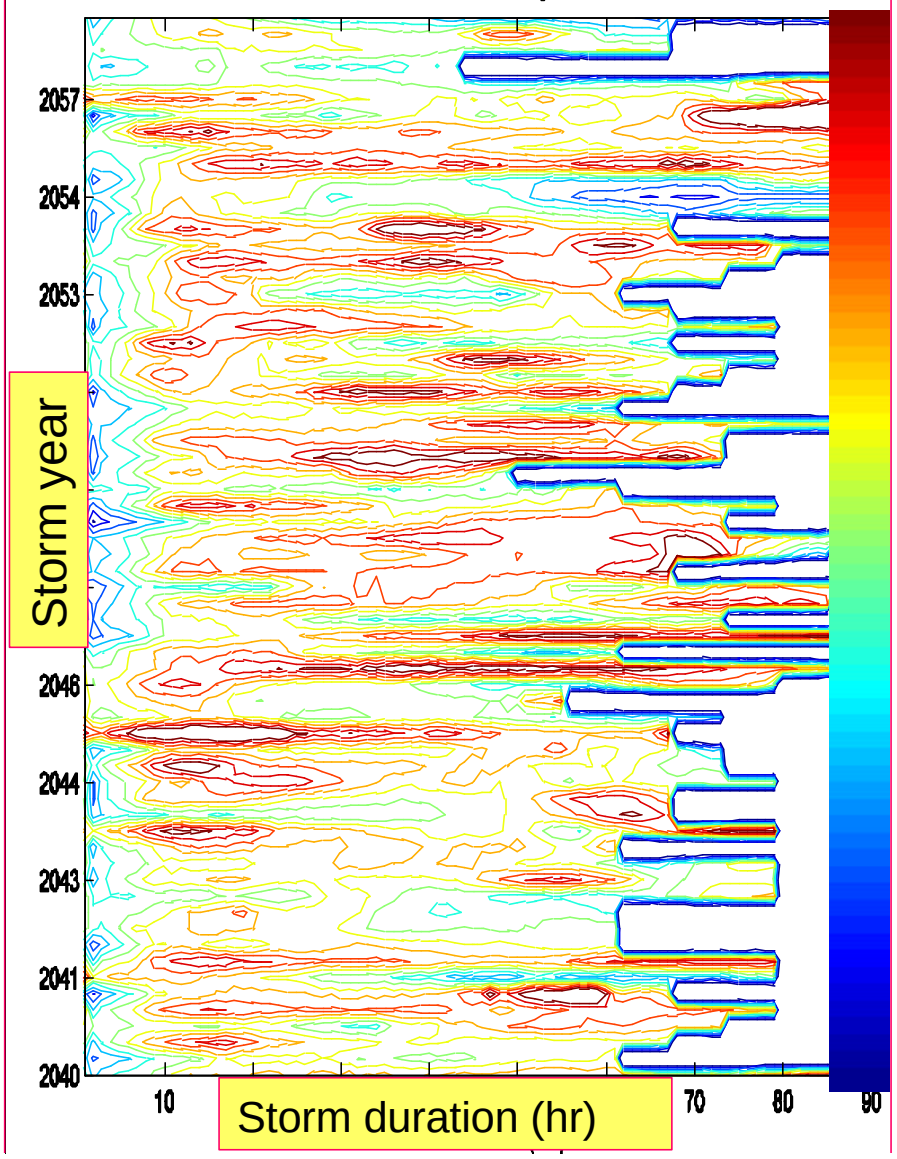


Climate change impacts ⇒ max. U10

Vmax vs. duration for **current** climate

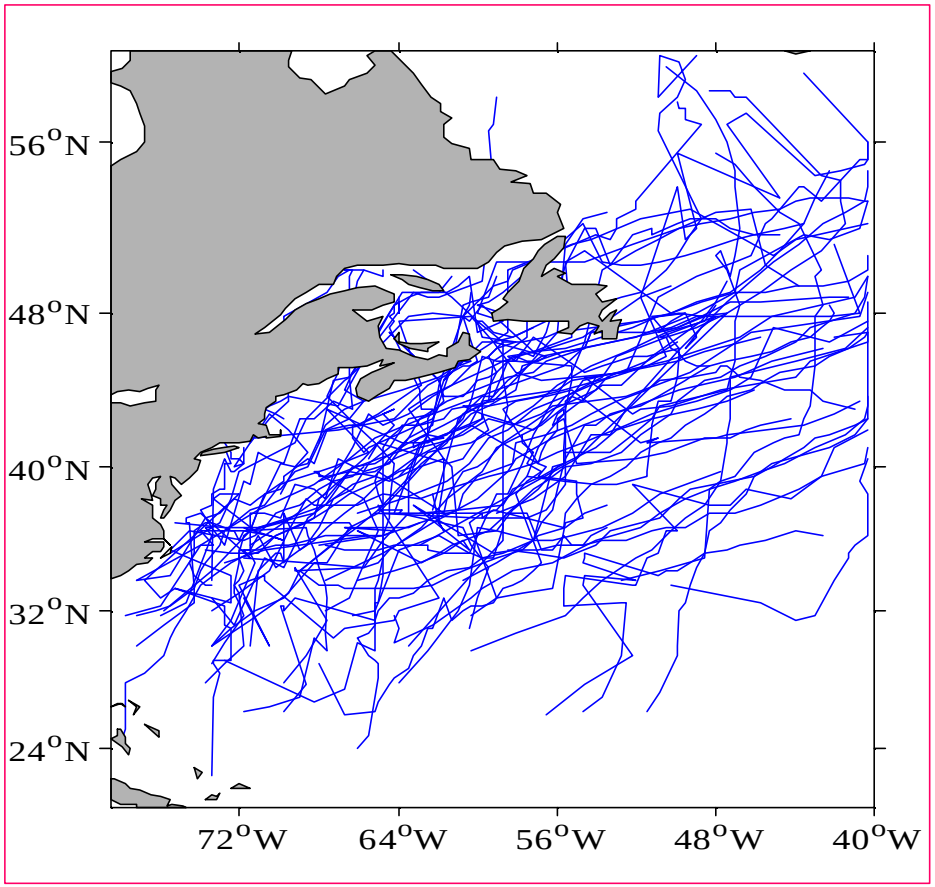


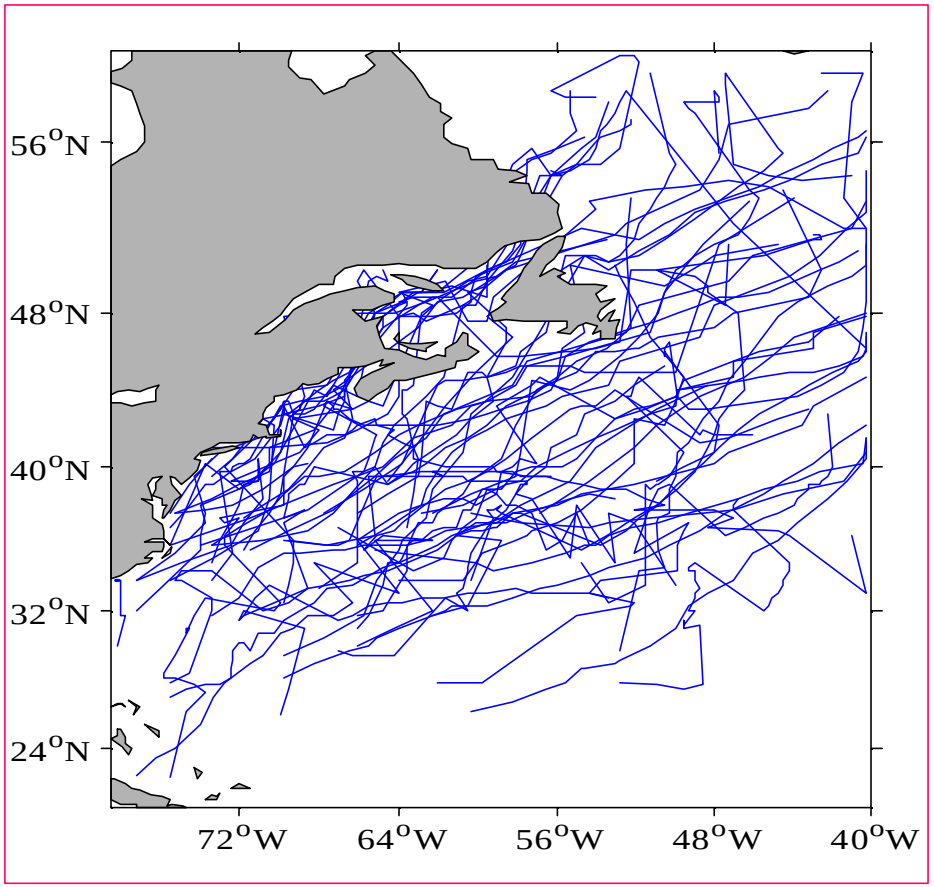
Vmax vs. duration for **future** climate



Oil Tanker “Prestige”Disaster

Impact of climate change on Hs





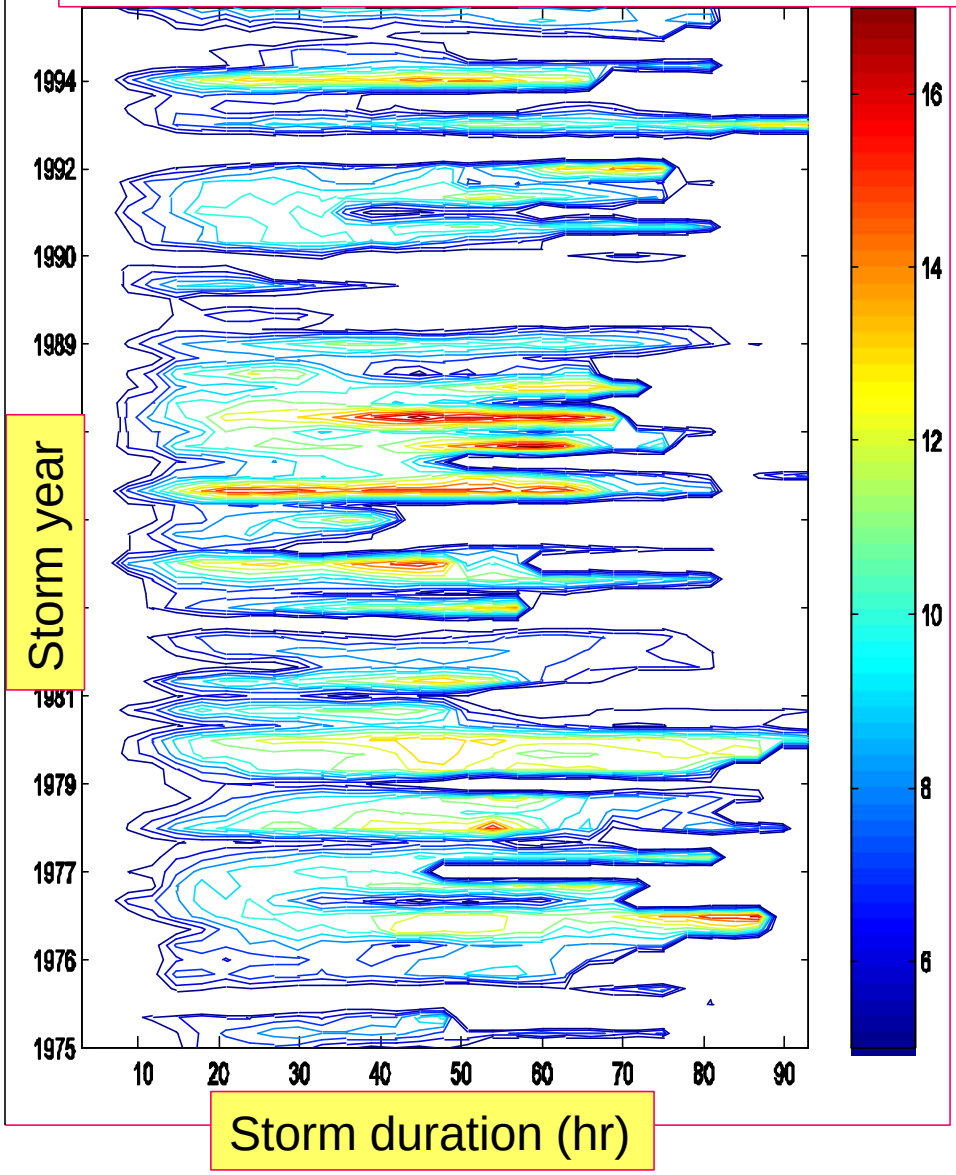
Tracks of maximum Hs for current climate 1975-1994.

Tracks of maximum Hs for future climate 2040-2059

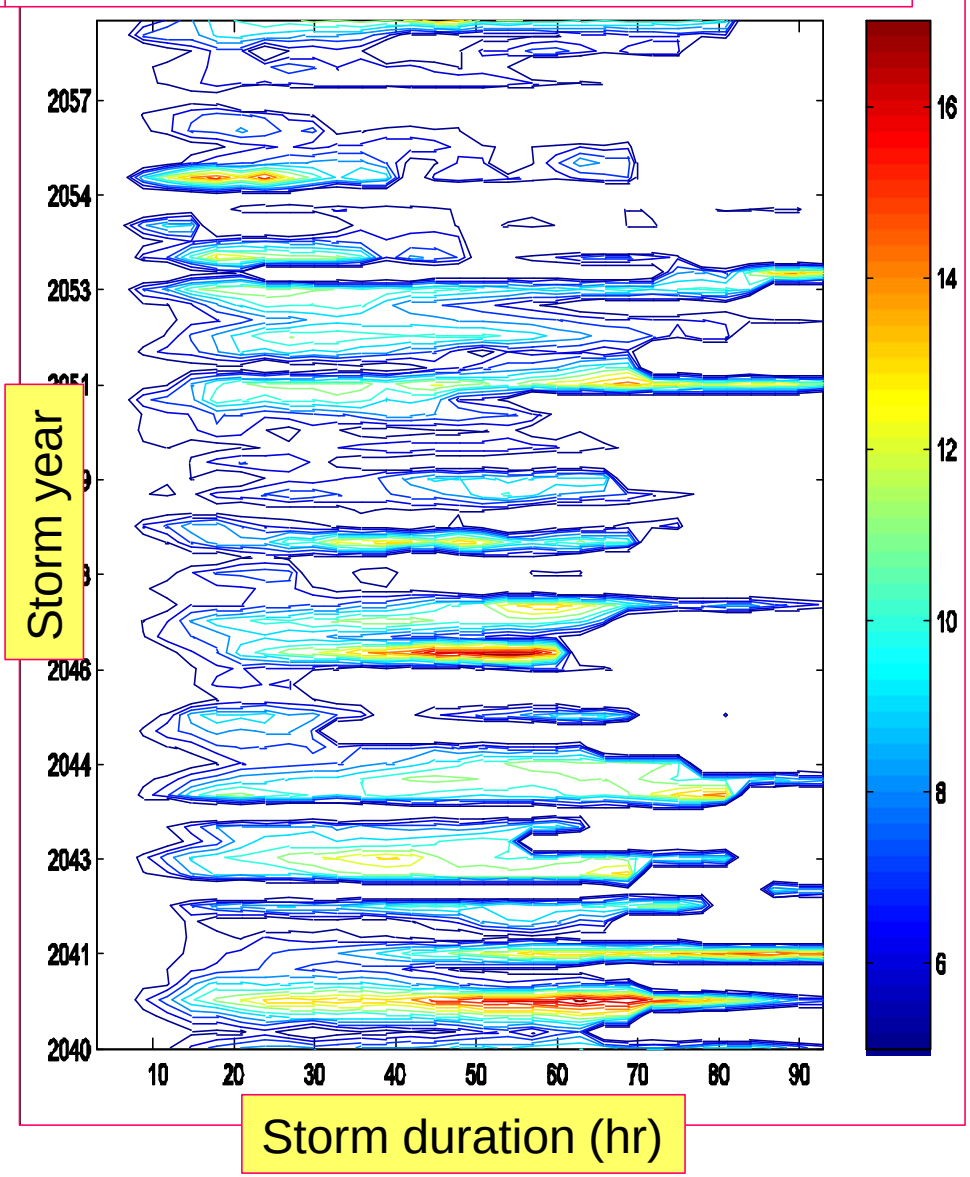
Hs – along storm tracks

Max. Hs along storm tracks - for all storms

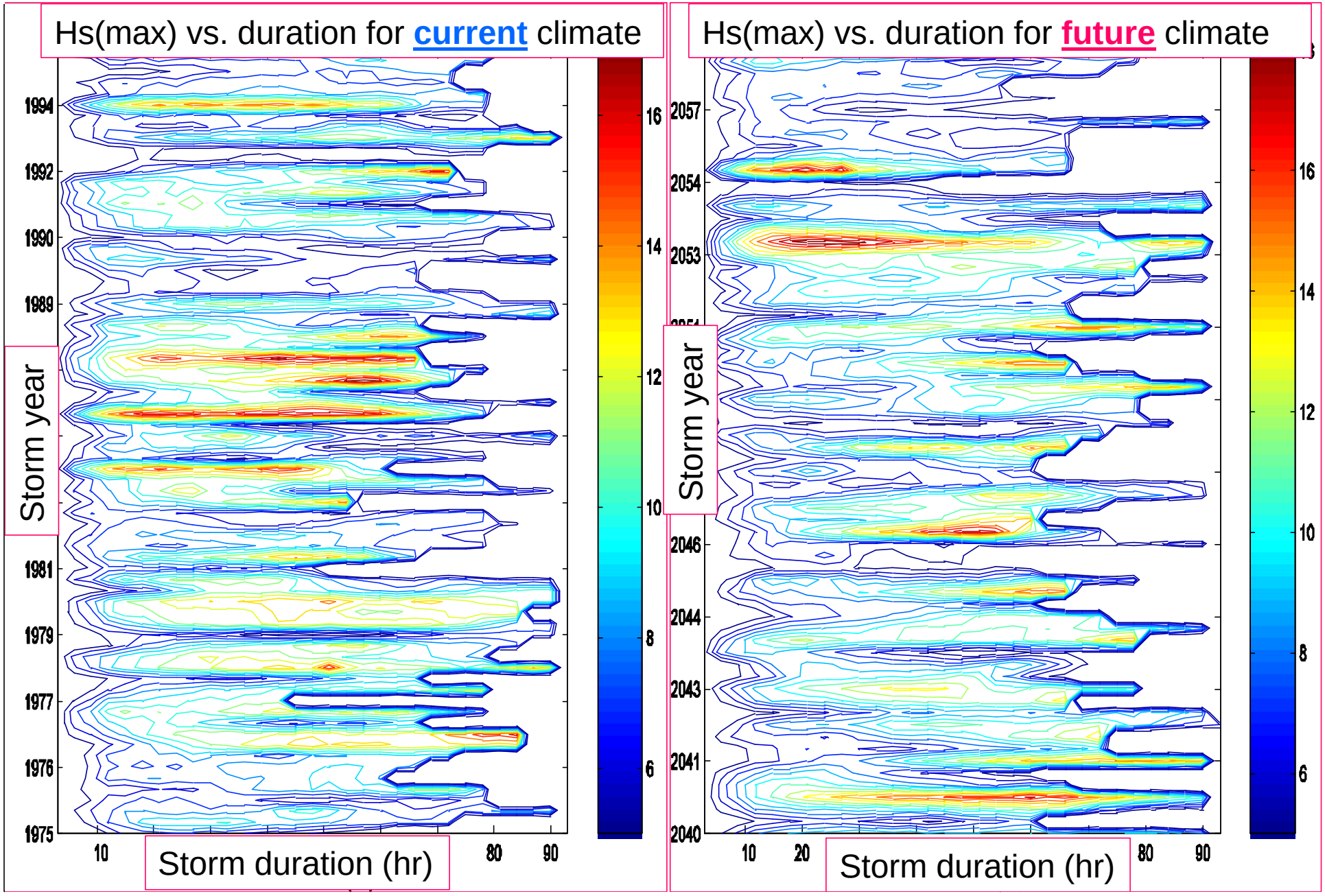
Hs(max) vs. duration for **current** climate



Hs(max) vs. duration for **future** climate

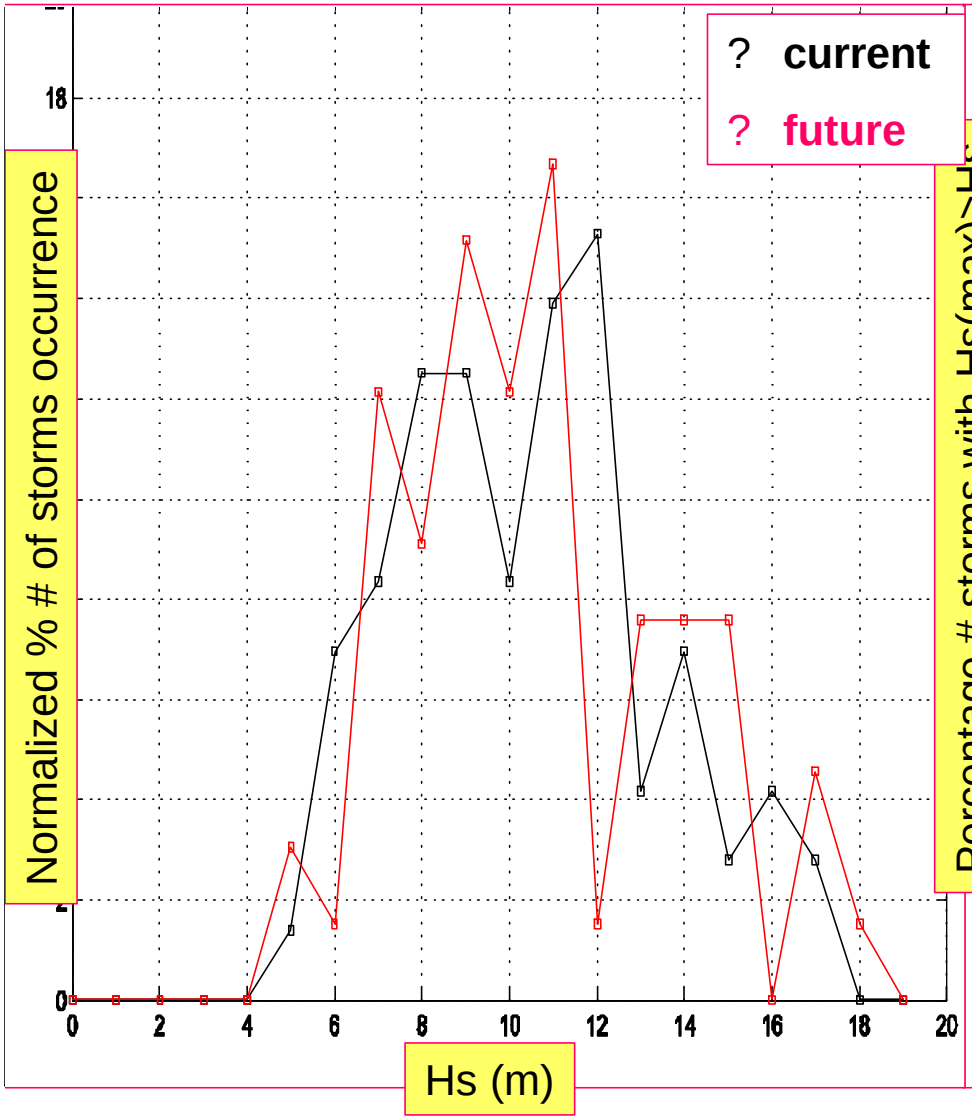


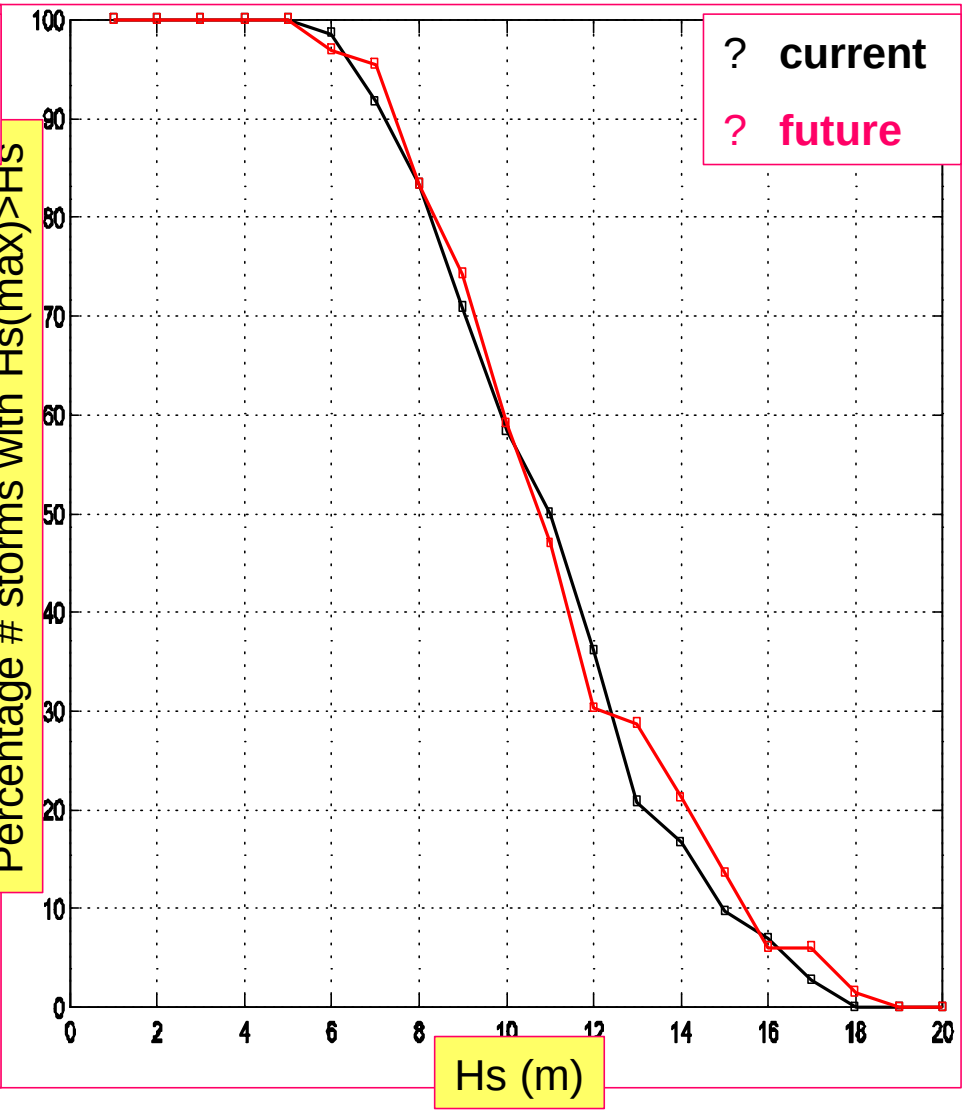
Global max. Hs - for all storms



Global max. Hs

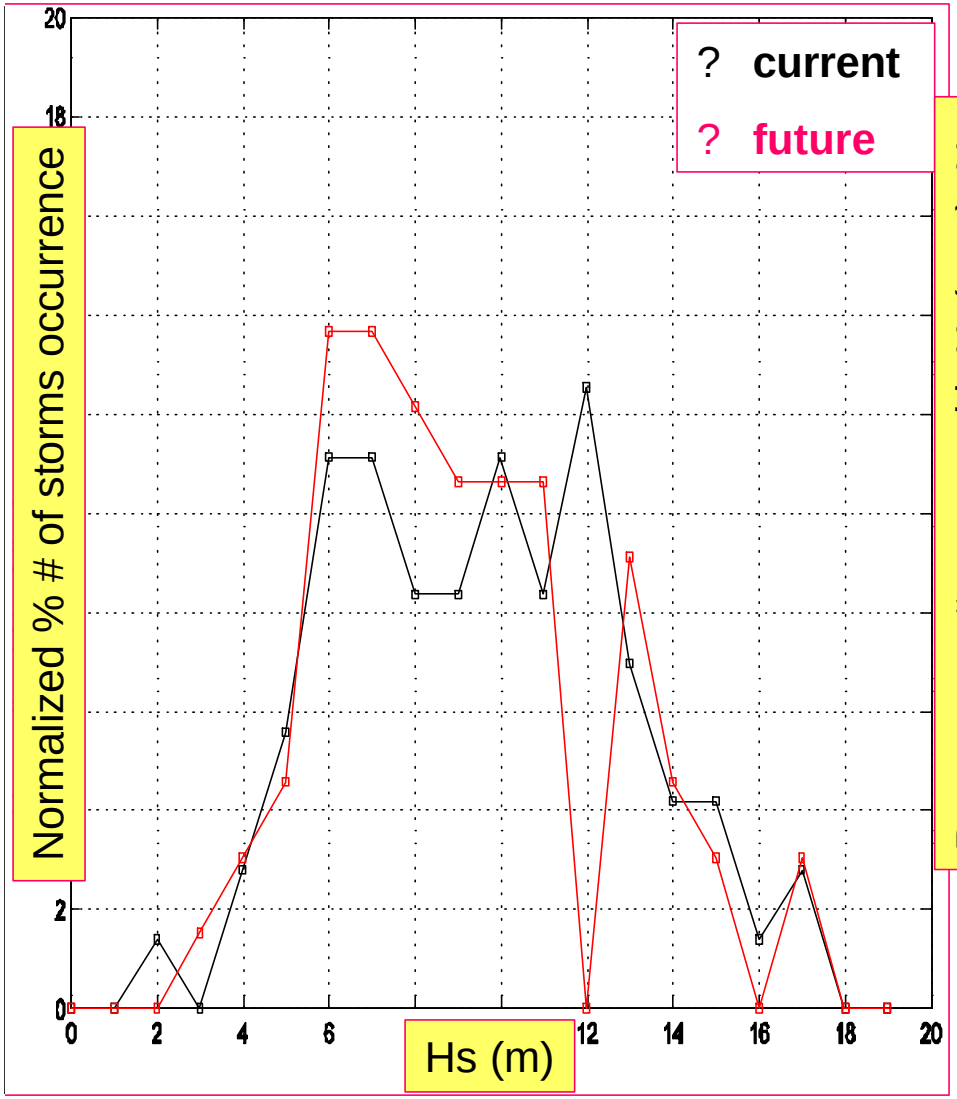
Percentage # storms with Hs(max)>Hs vs. Hs

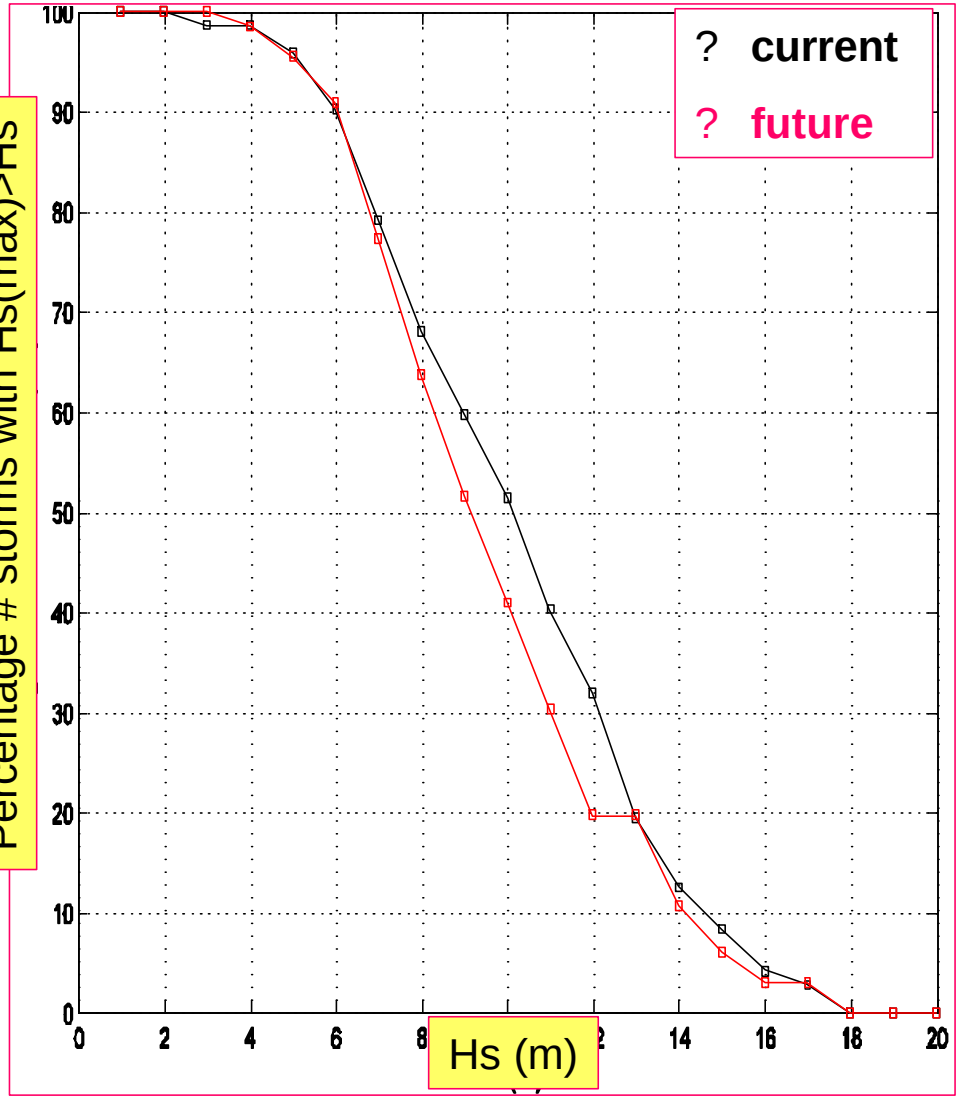




Max. Hs along storm tracks

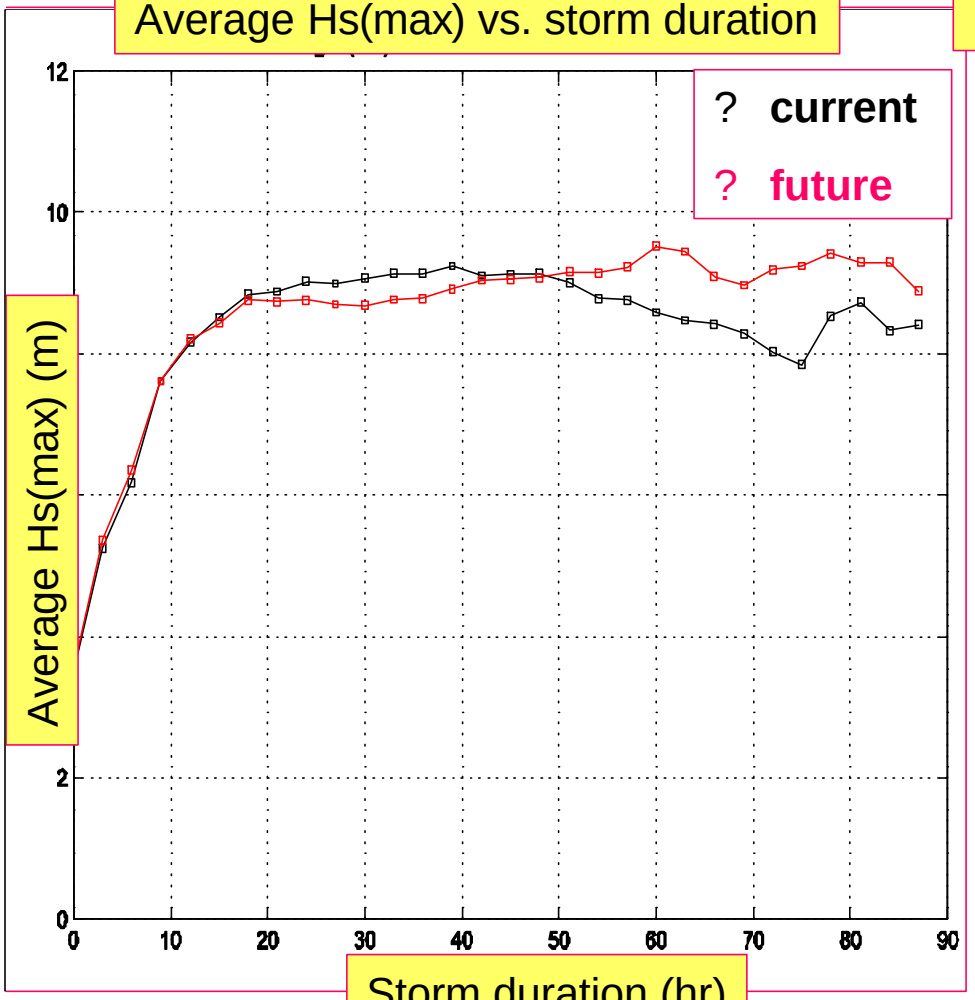
Percentage # storms with Hs(max)>Hs vs. Hs



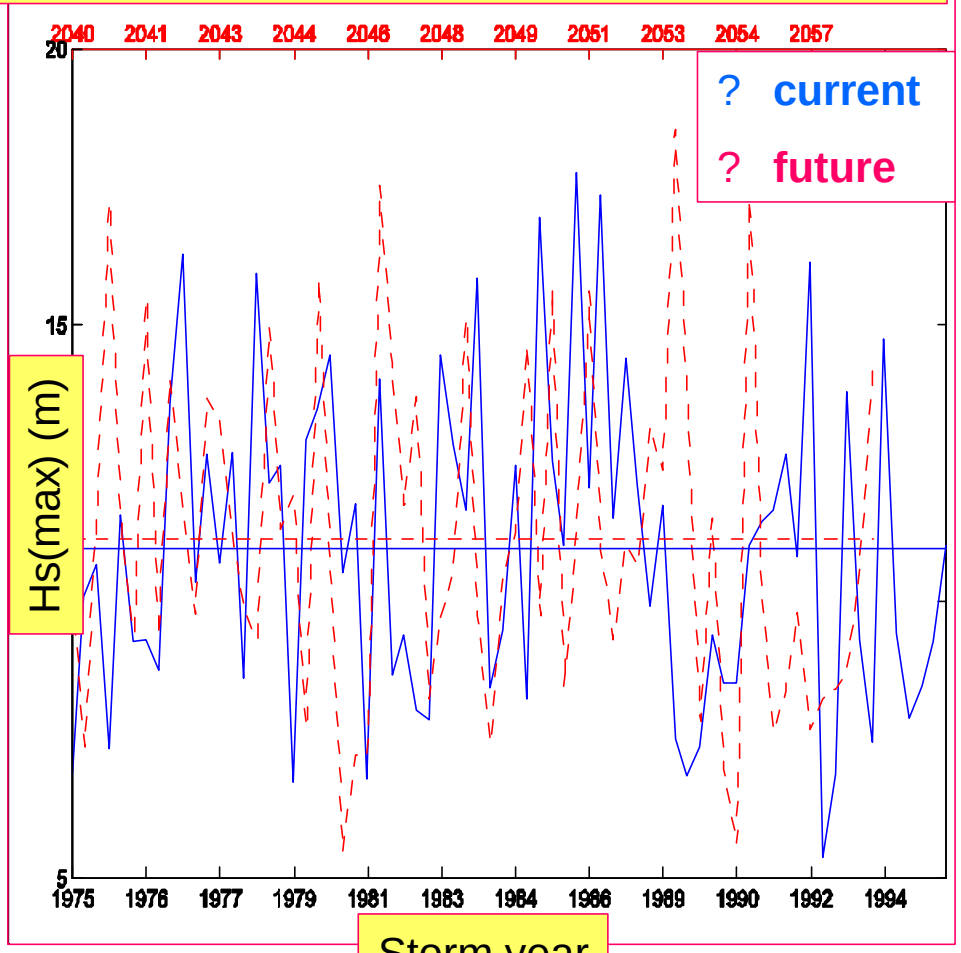


Global max. Hs - for all storms

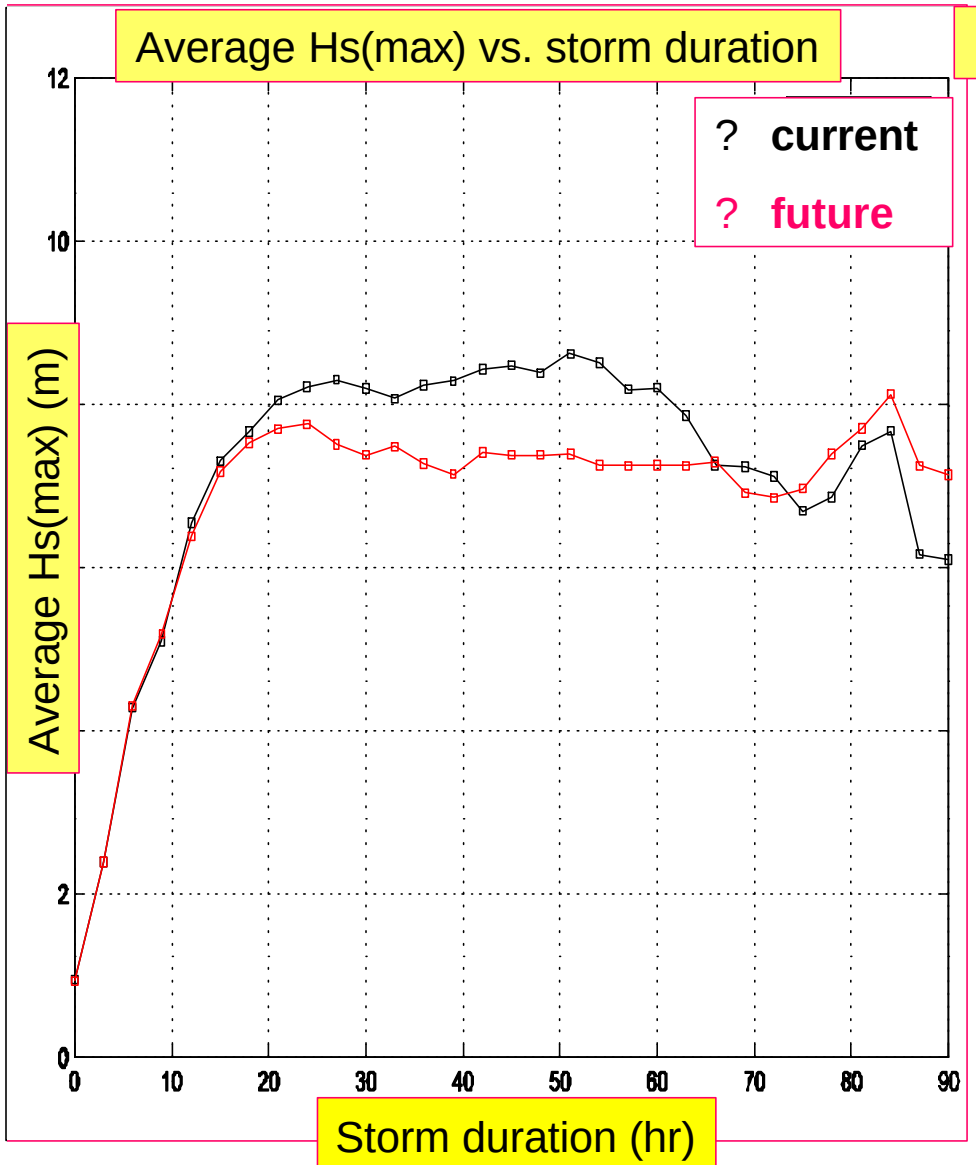
Average Hs(max) vs. storm duration

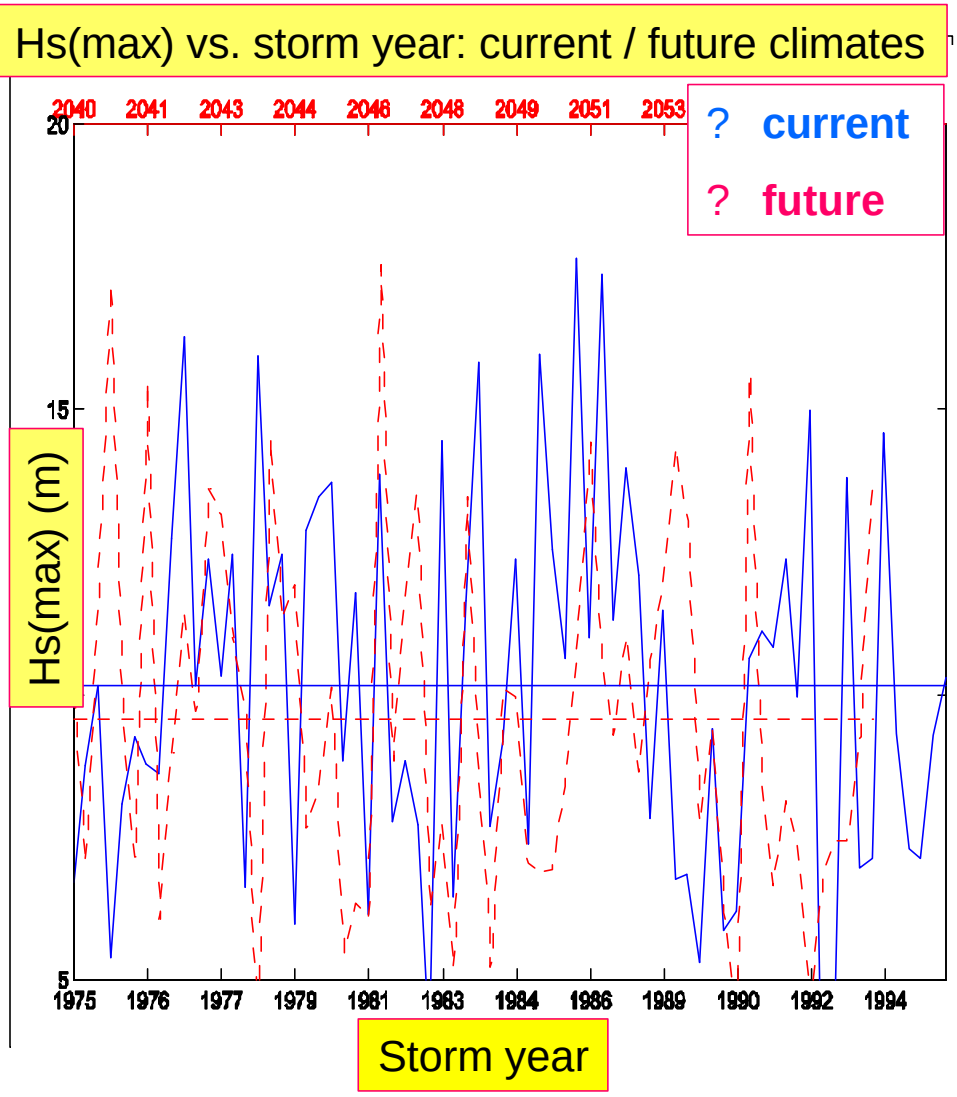


Hs(max) vs. storm year: current / future climates

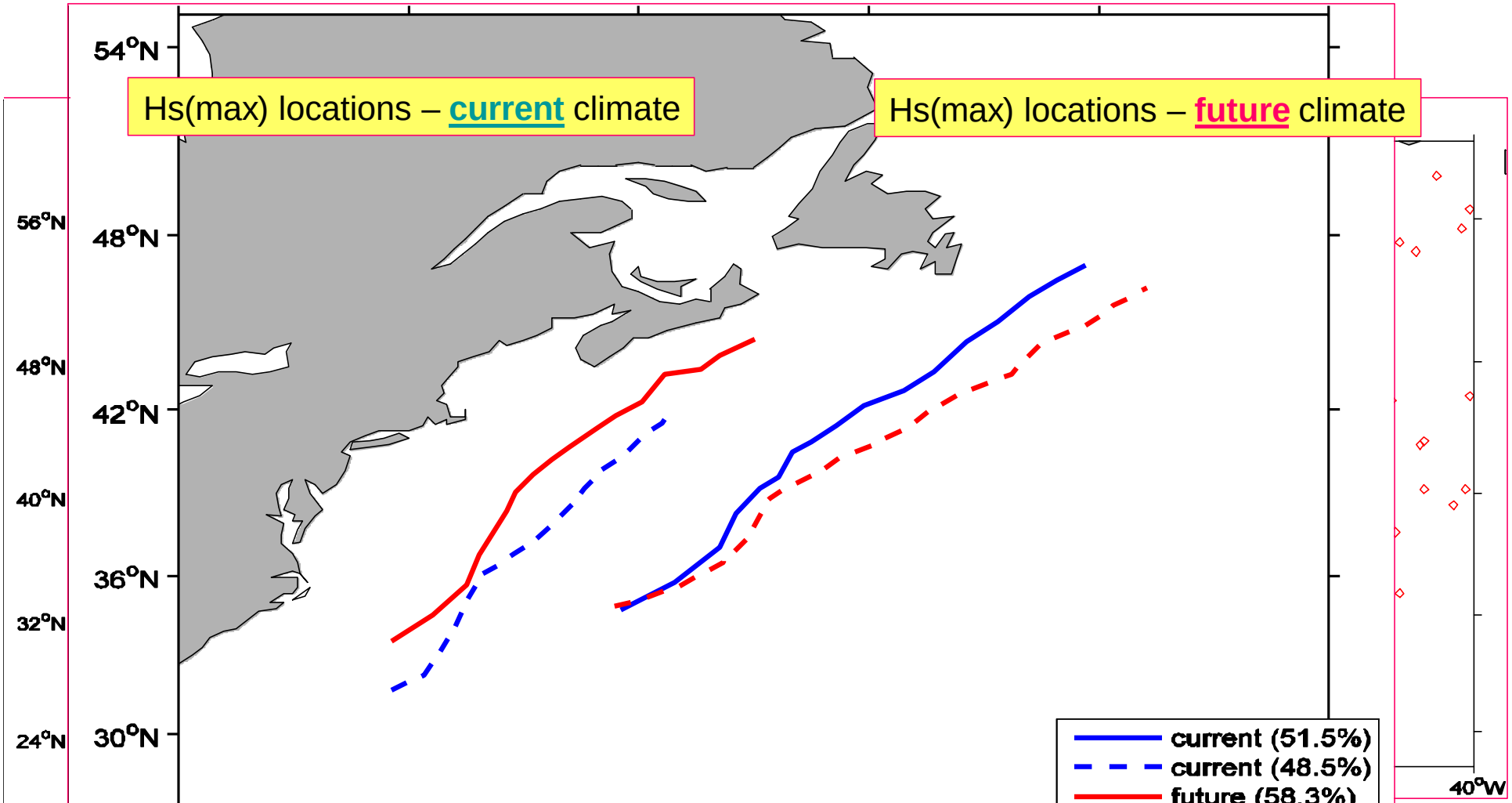


Max. Hs along storm tracks - for all storms



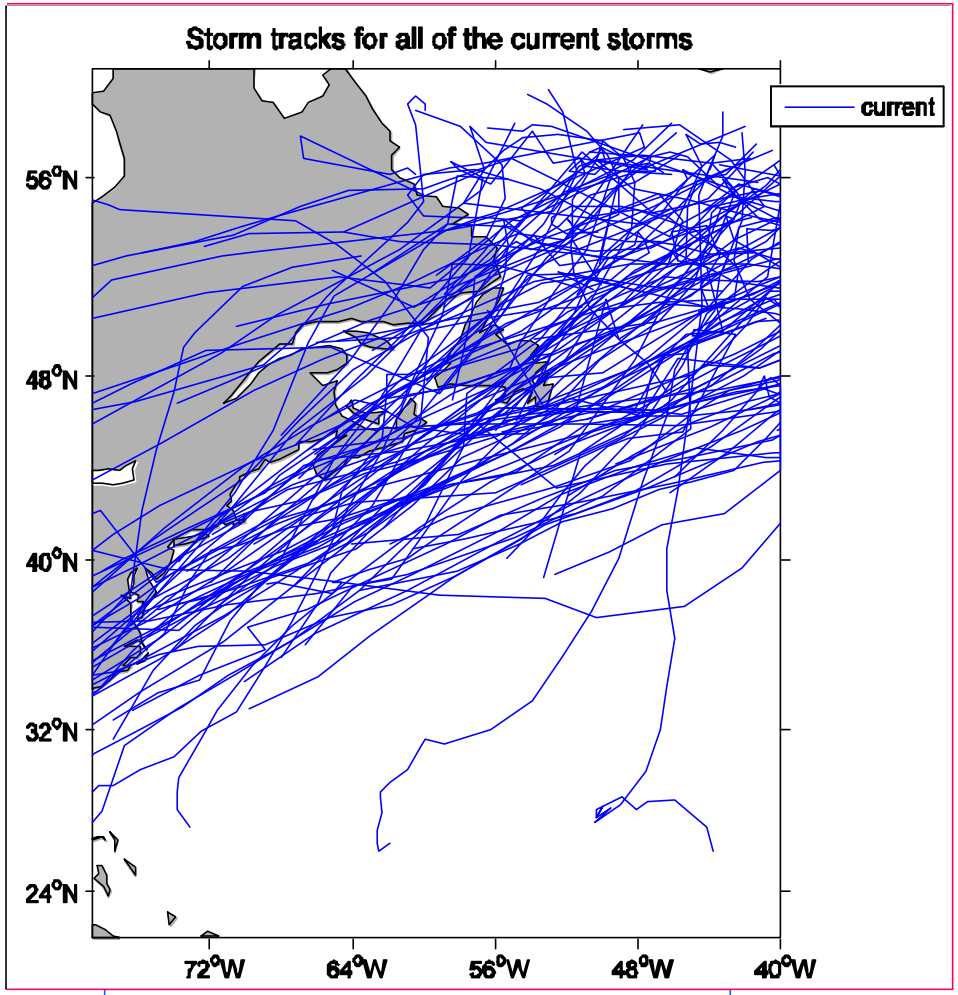


Hs(max): current / future climate

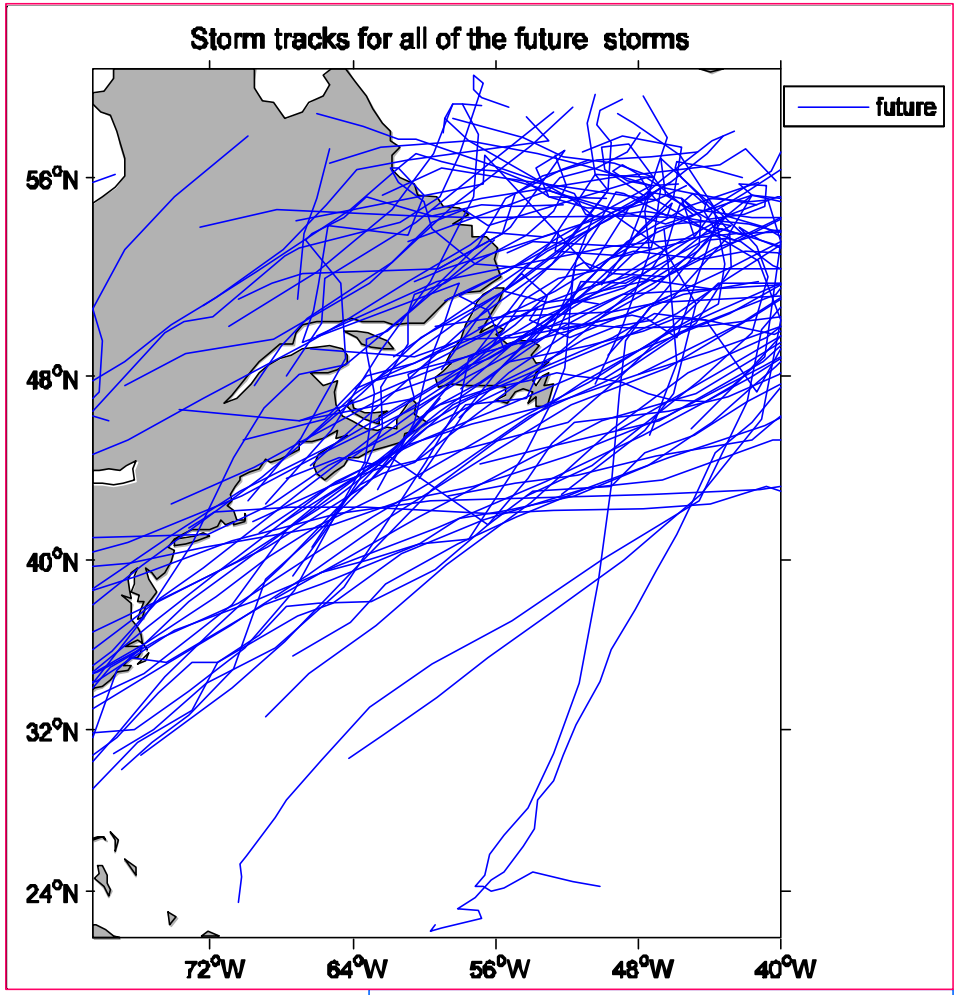


Method B: Winter storms using GCM outputs to drive regional climate model for storms at 0.25º resolution

Dec.-Mar.

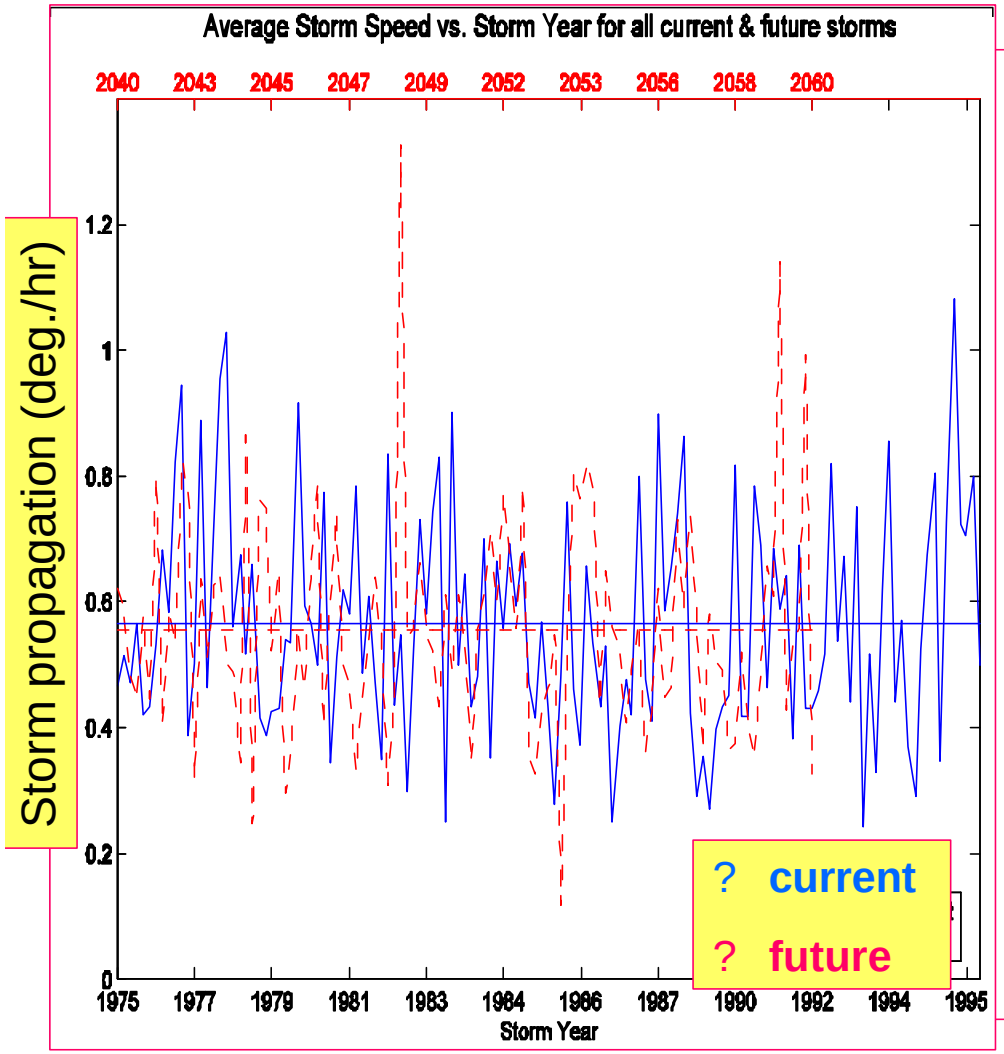


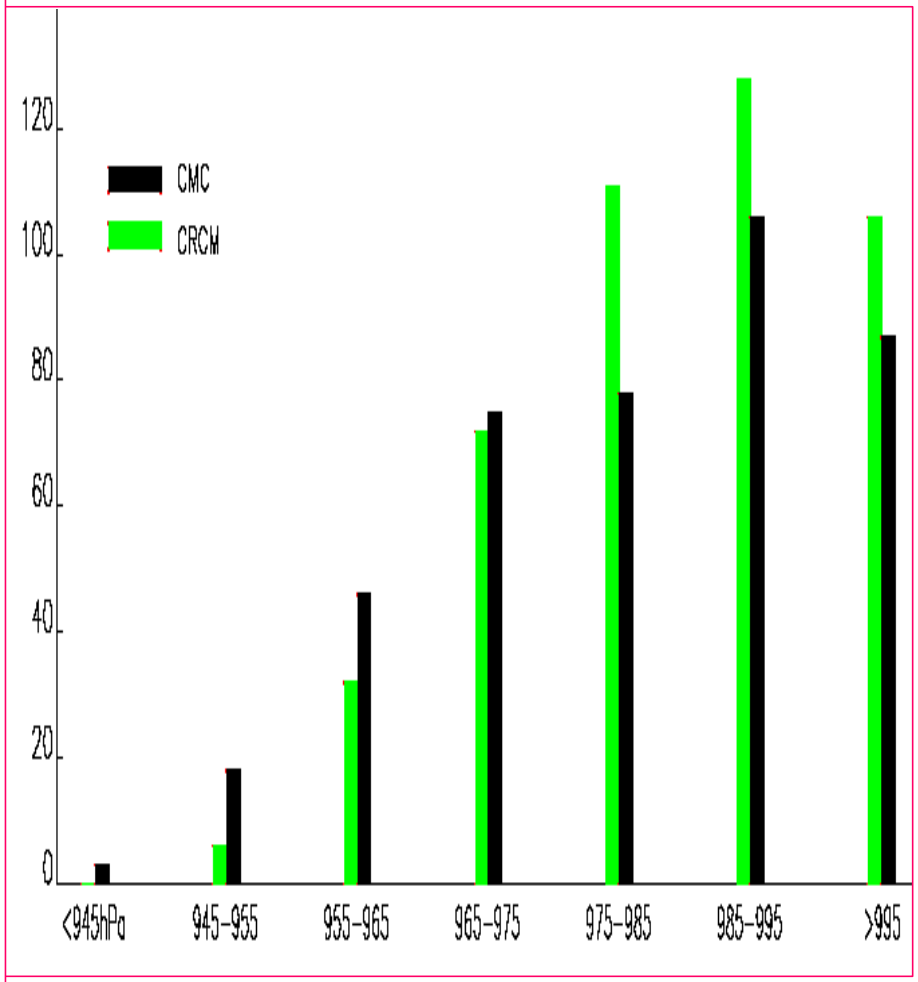
current climate 1975-1994.



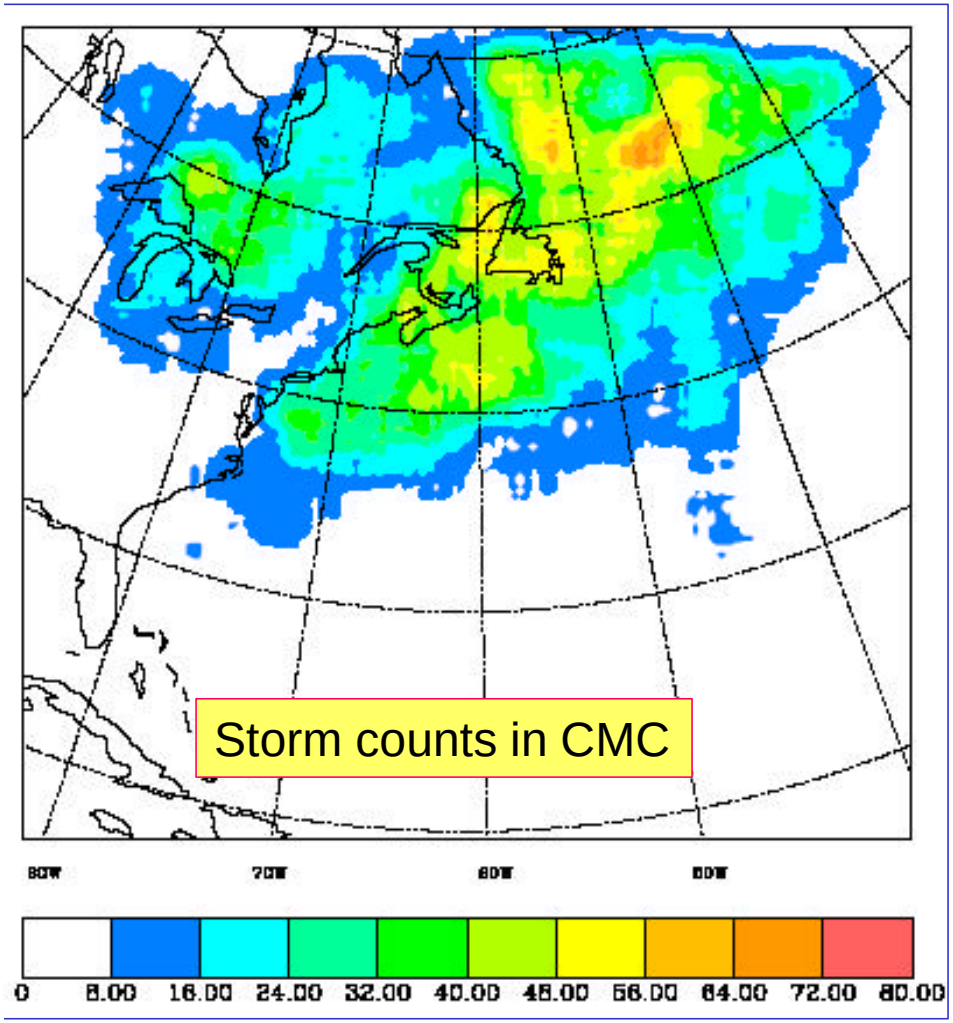
future climate 2040-2059

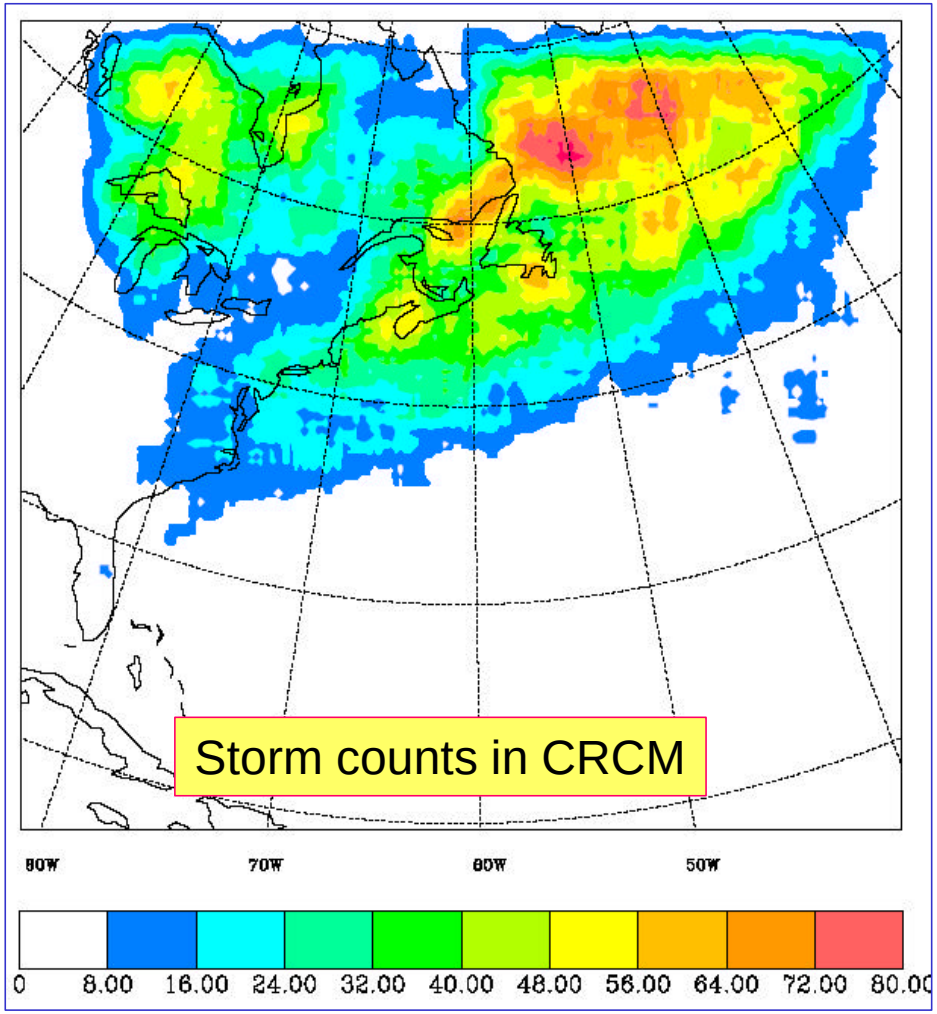
Climate change impacts ⇒ MSLP, storm speed



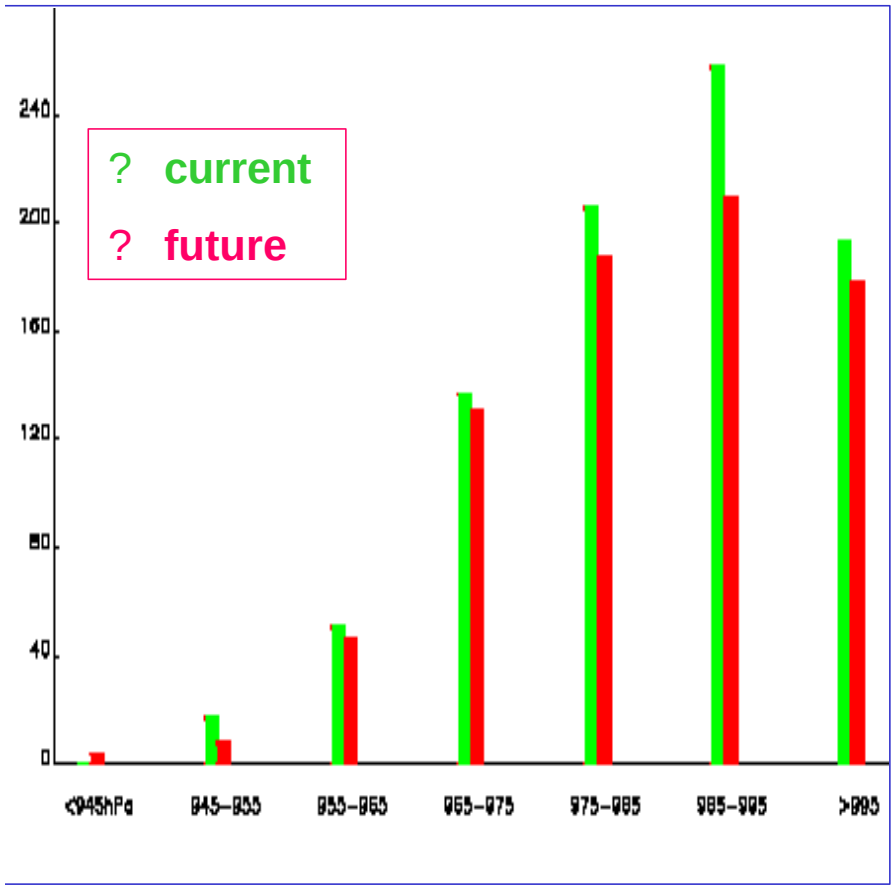


Storm count verification

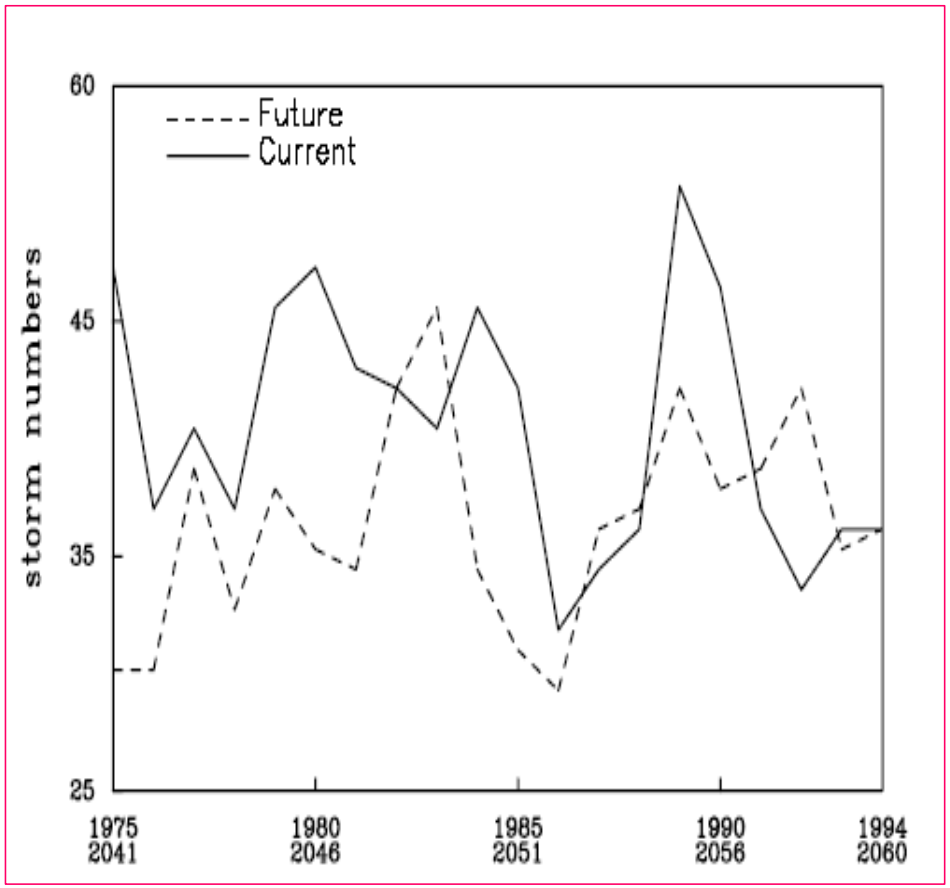




Current – future comparison: counts

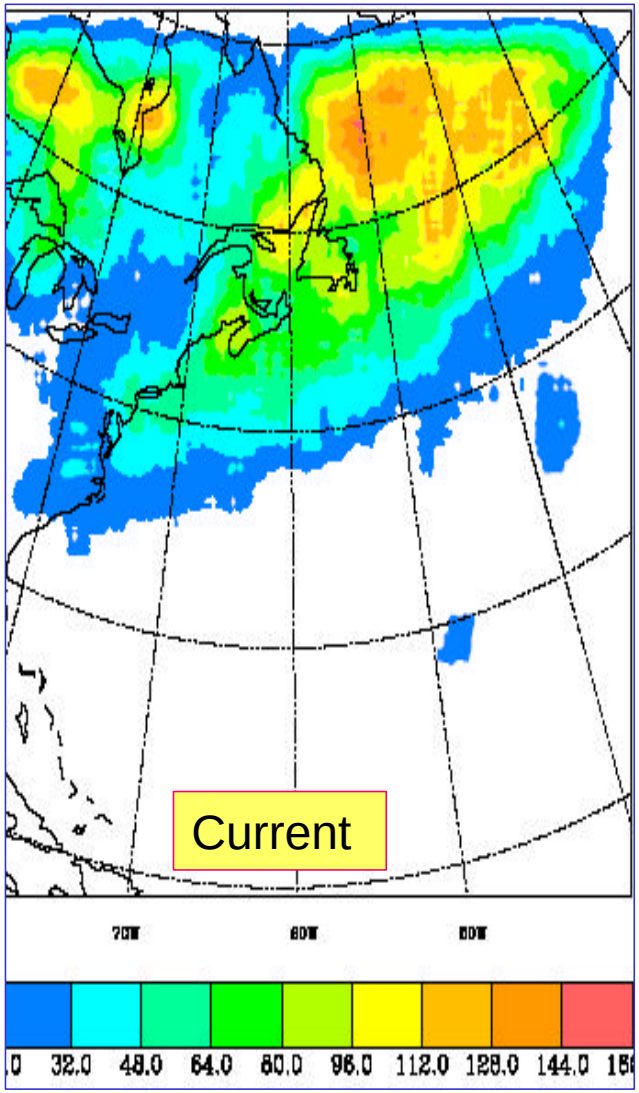


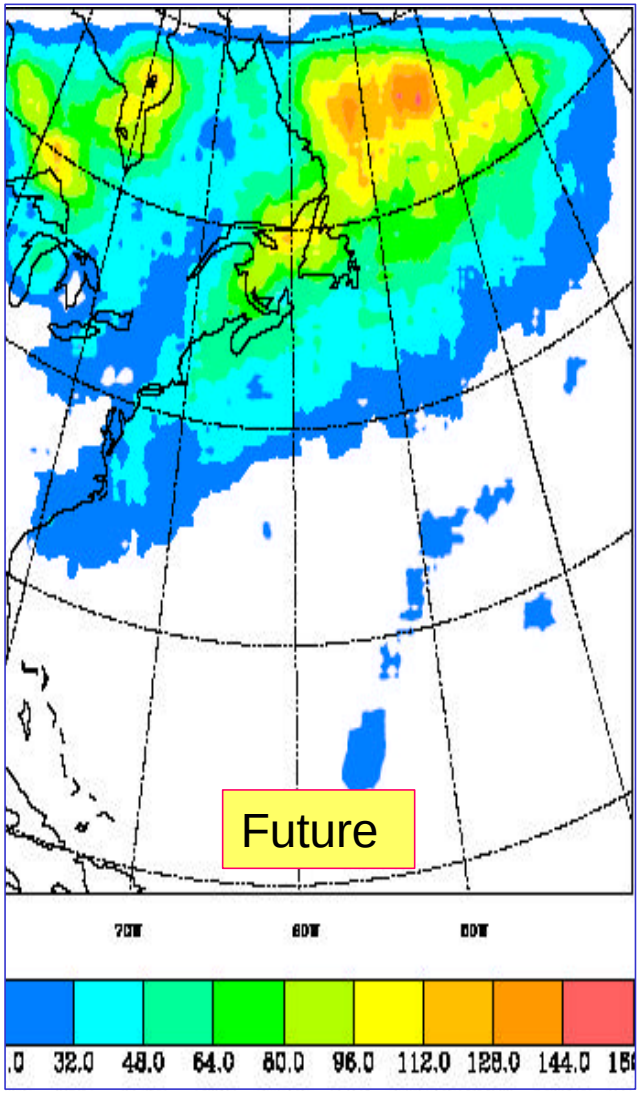
Winter storm counts

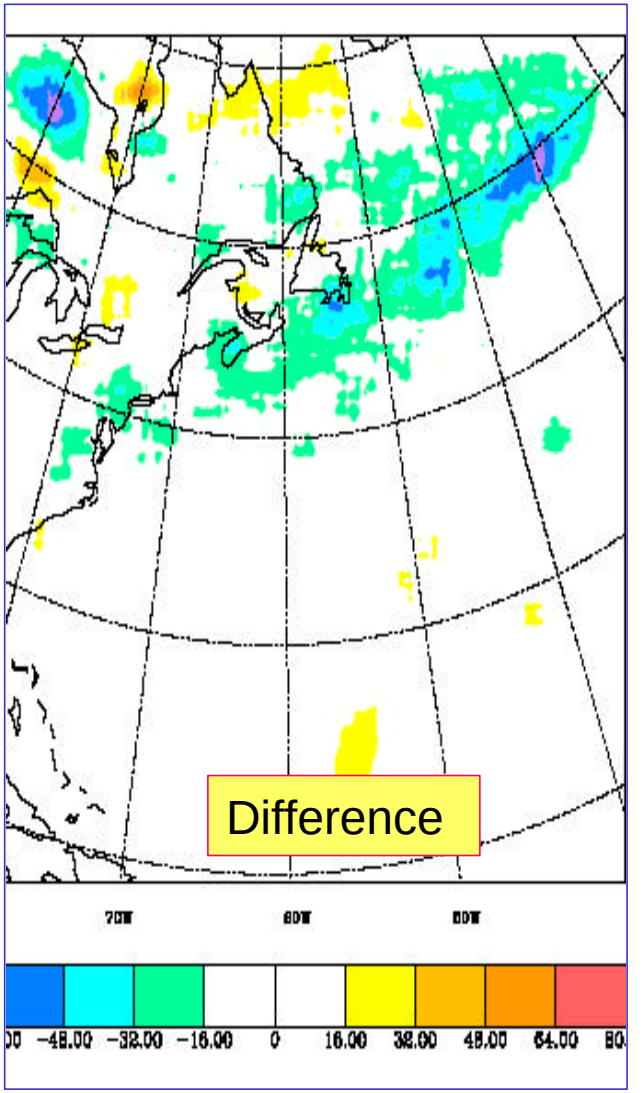


Total storm count in entire domain

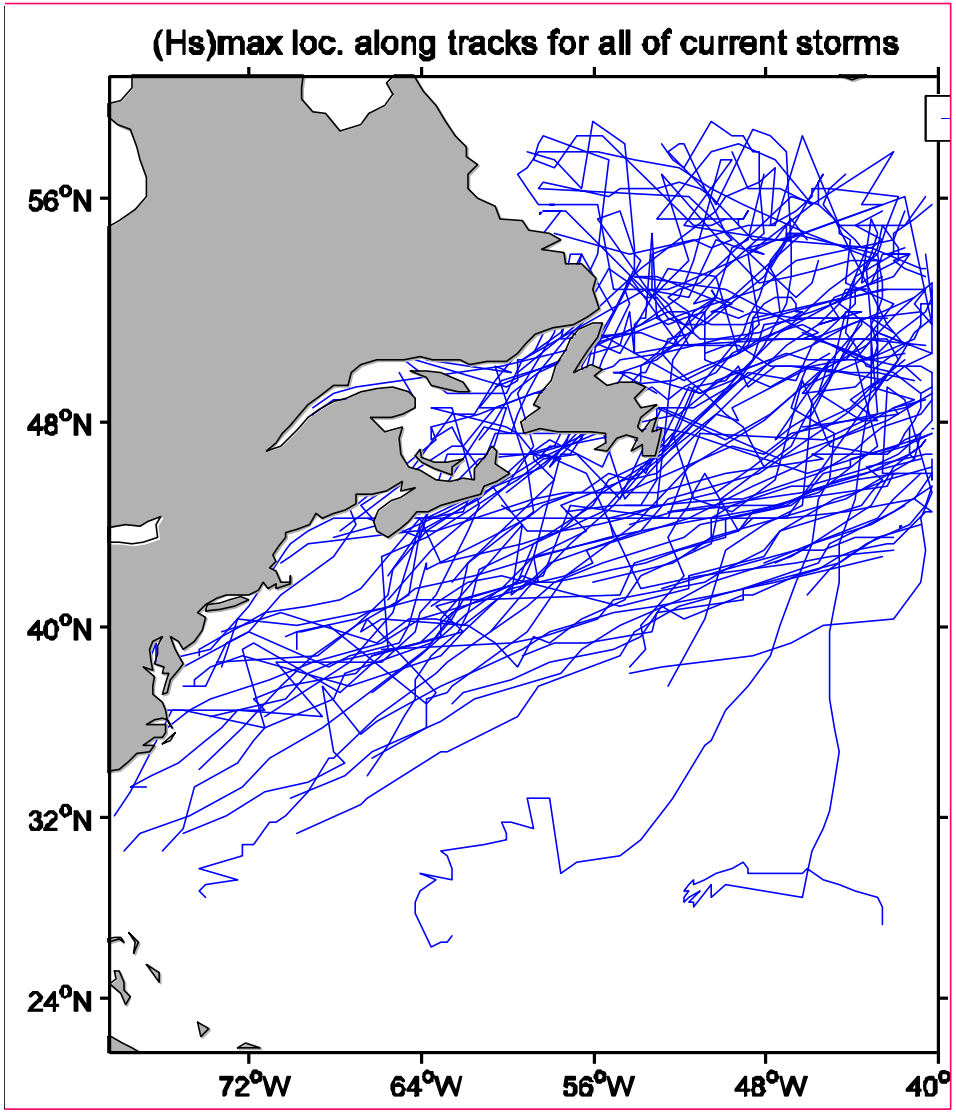
Storm counts

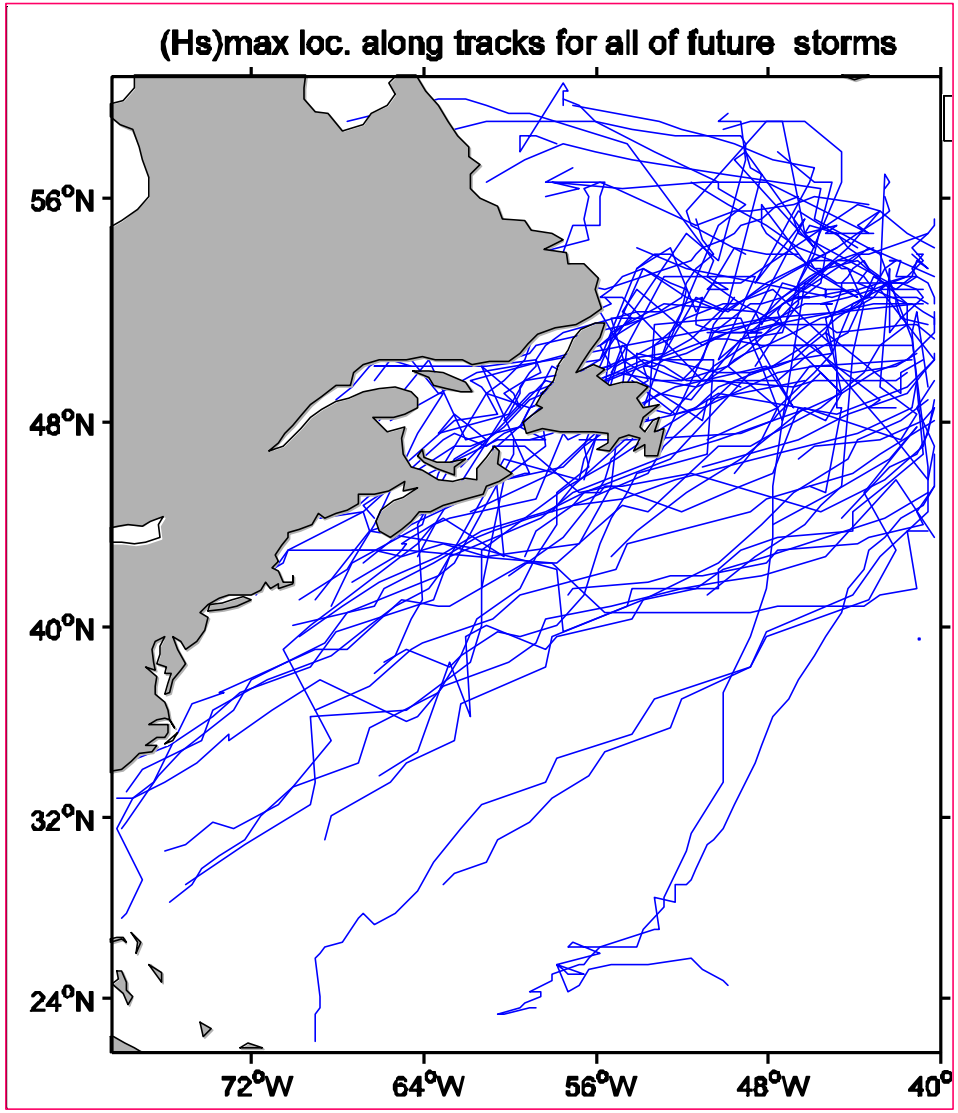




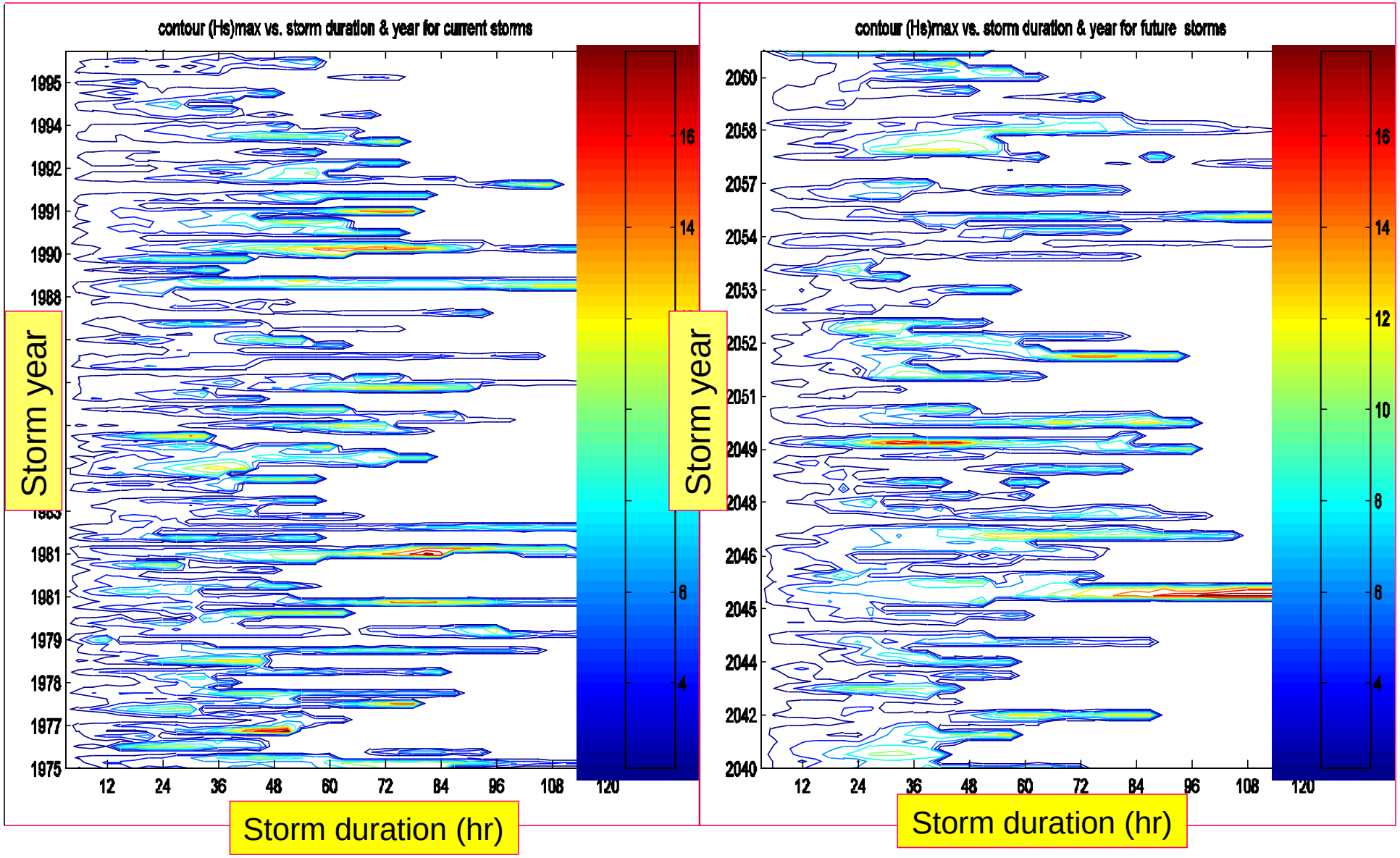


Impact of climate change on Hs

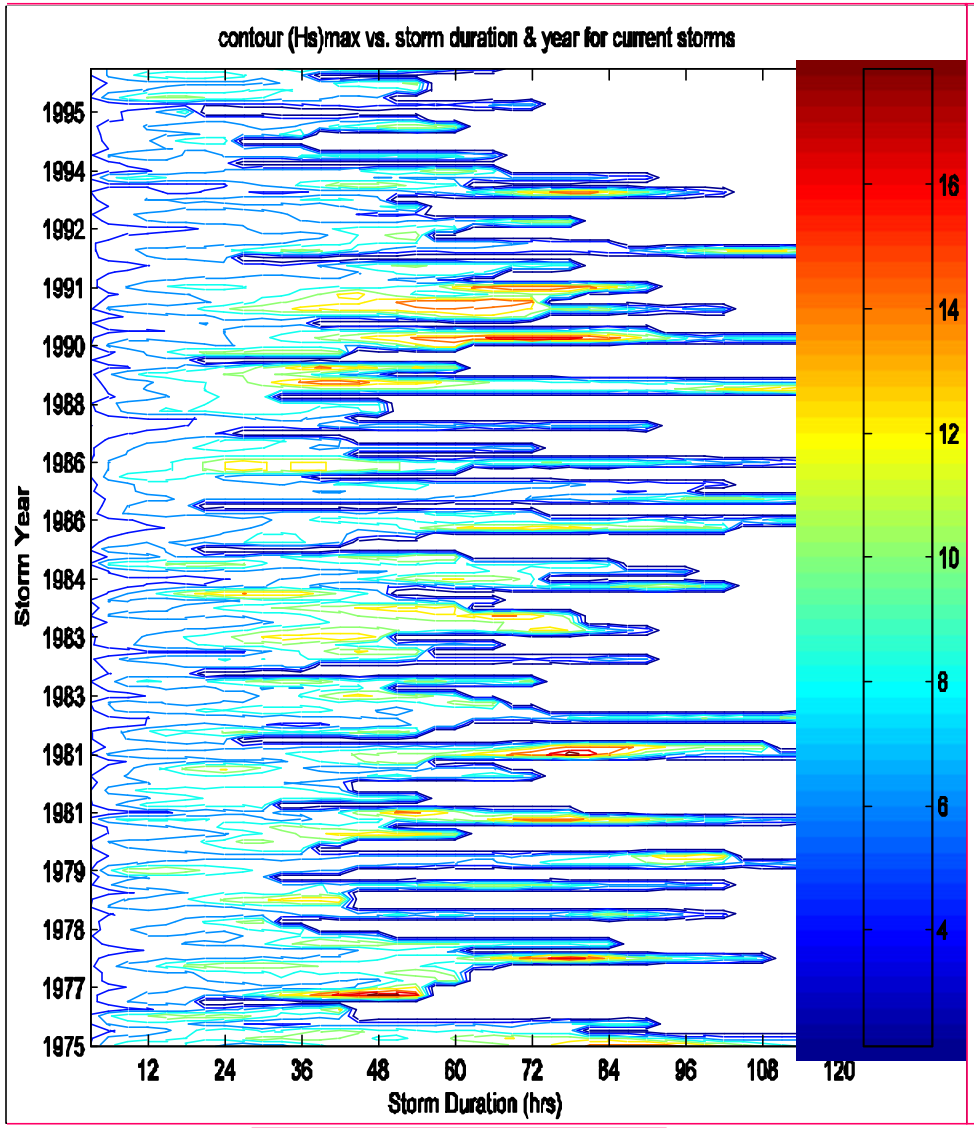




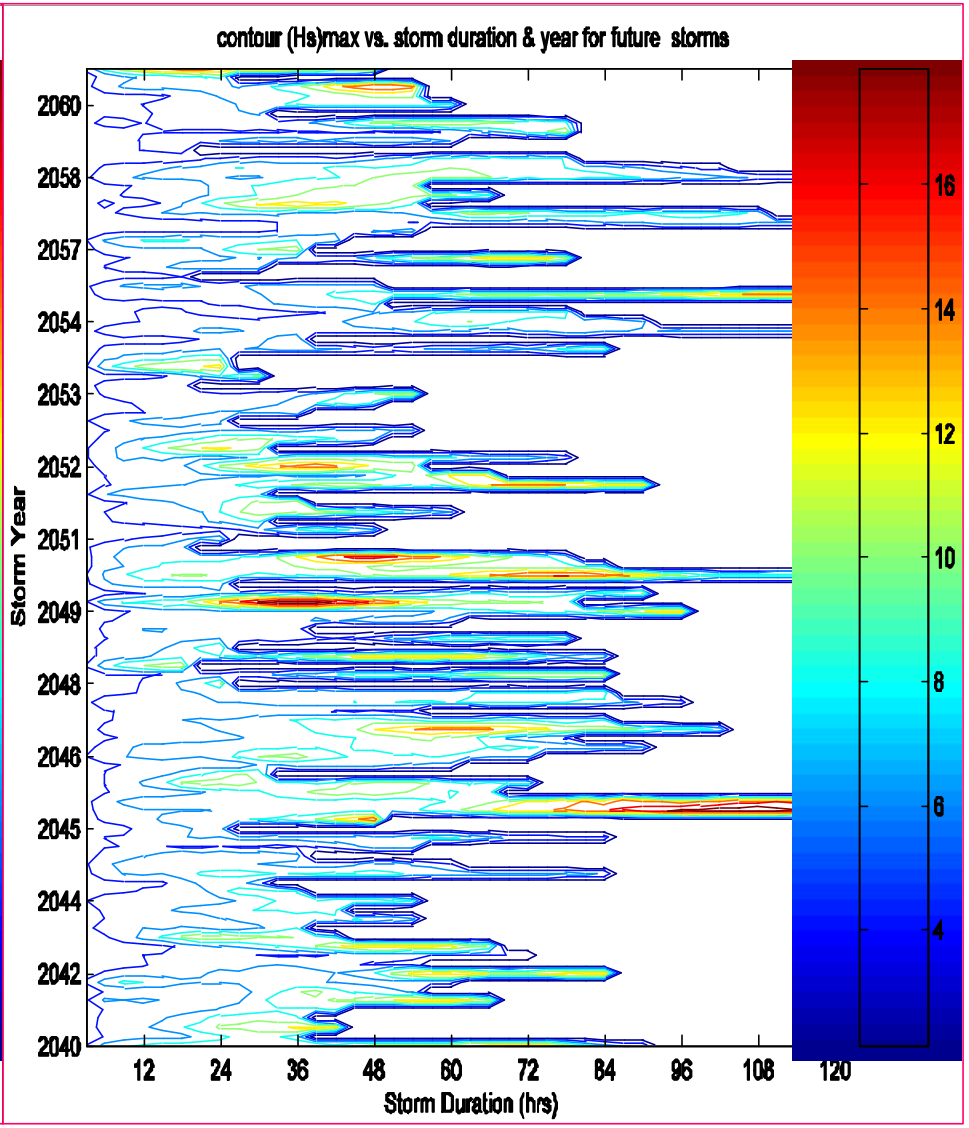
Max. Hs along storm tracks - for all storms



Global max. Hs - for all storms

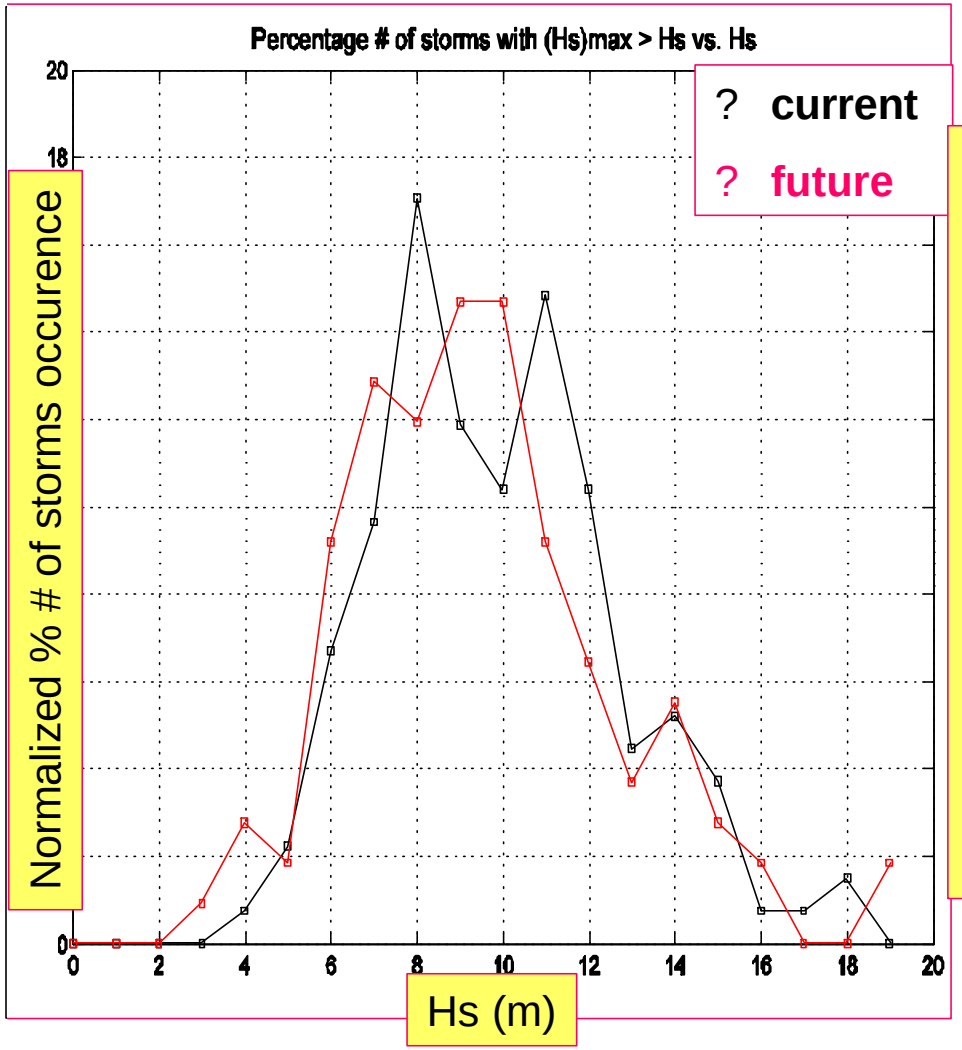


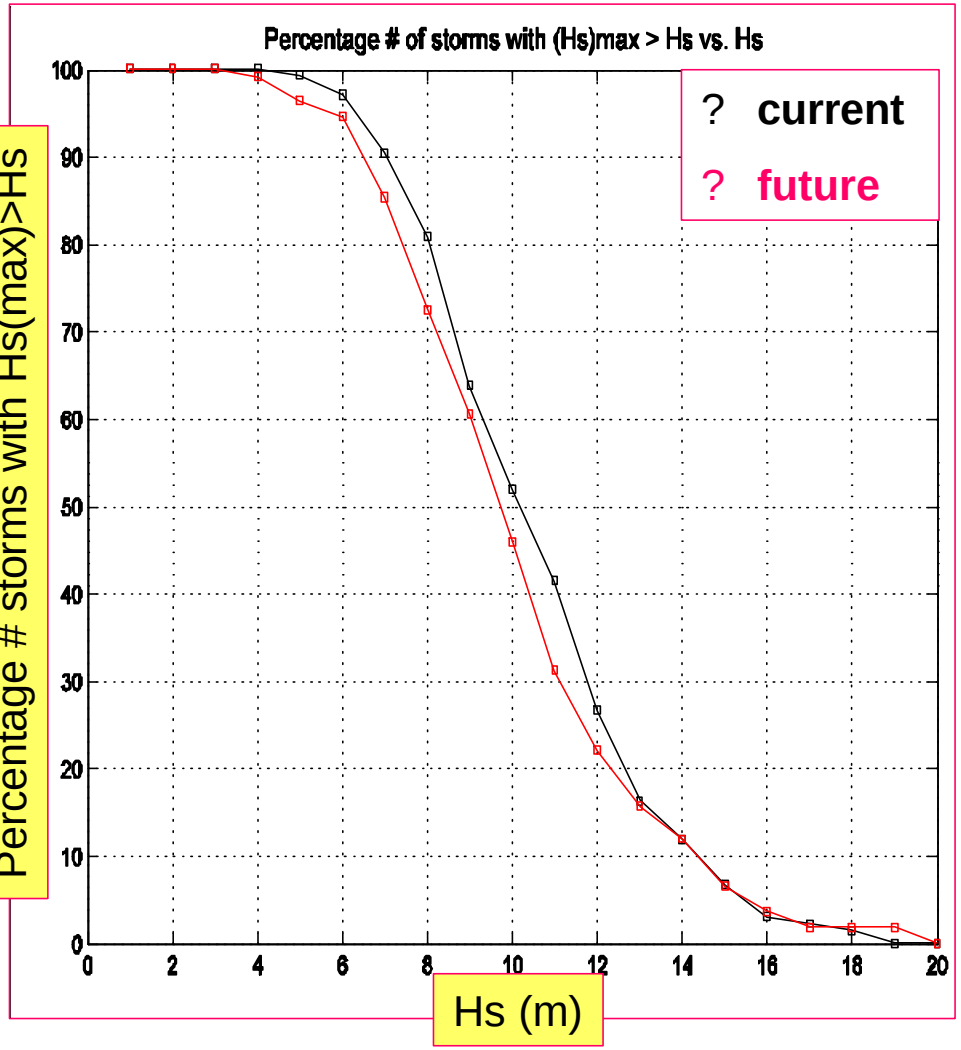
A: current climate



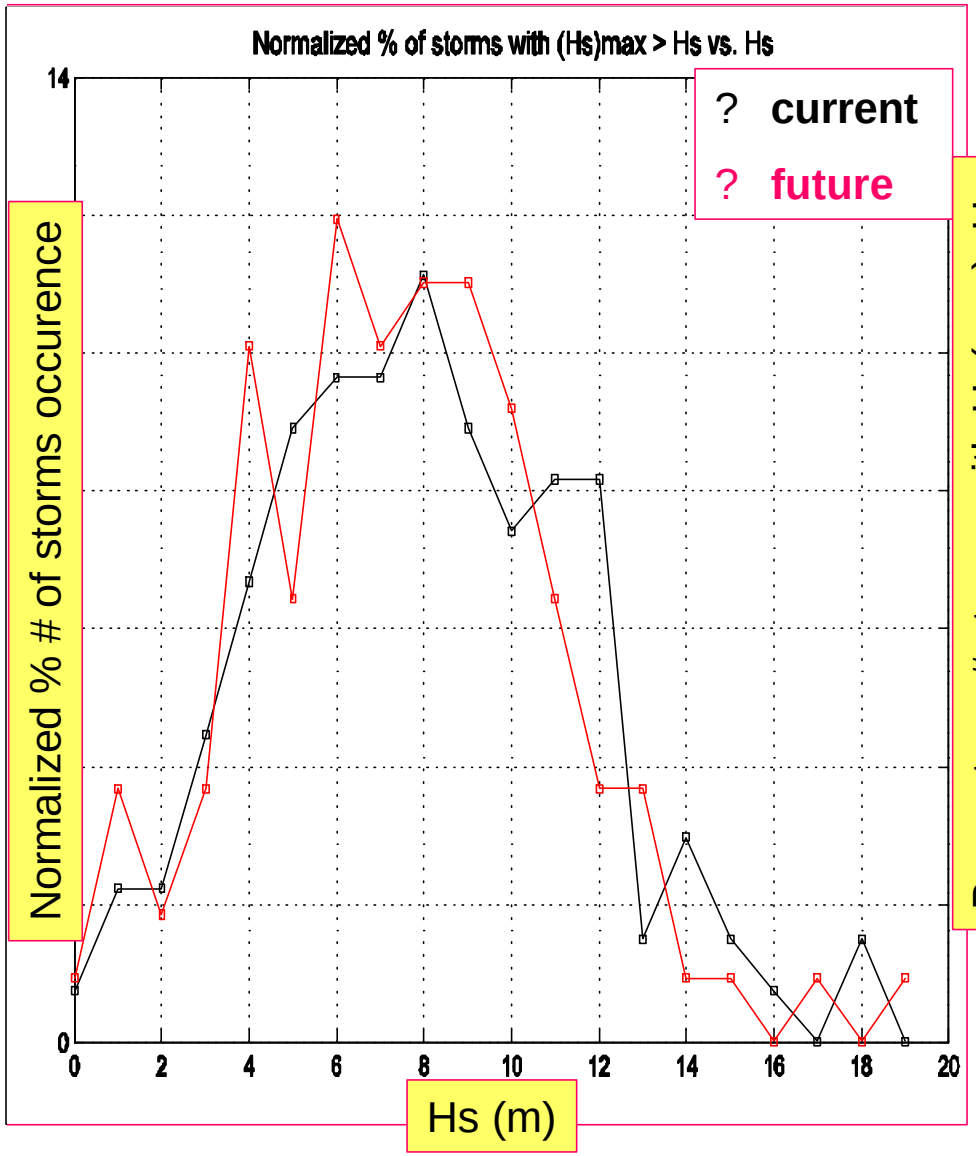
B: future climate

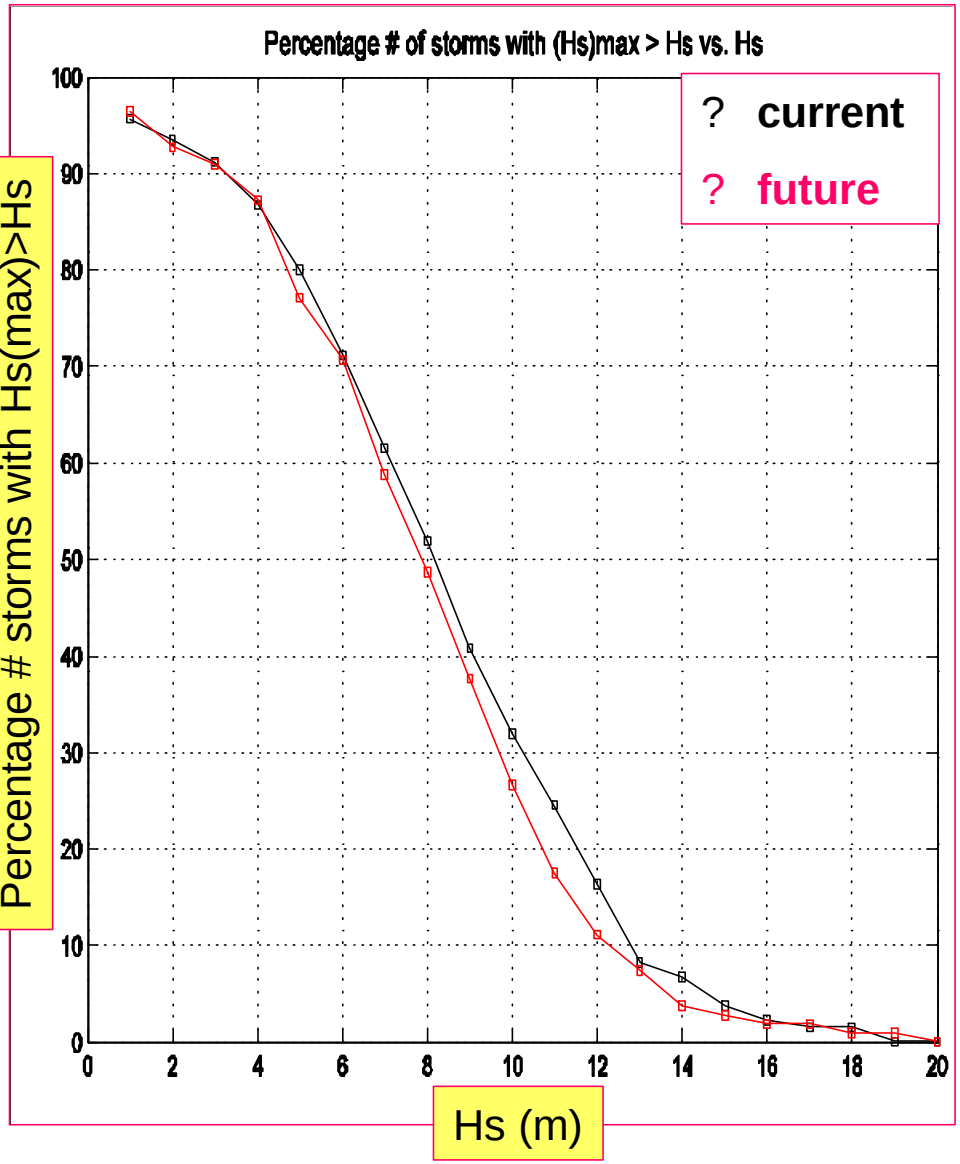
Global max. Hs - for all storms



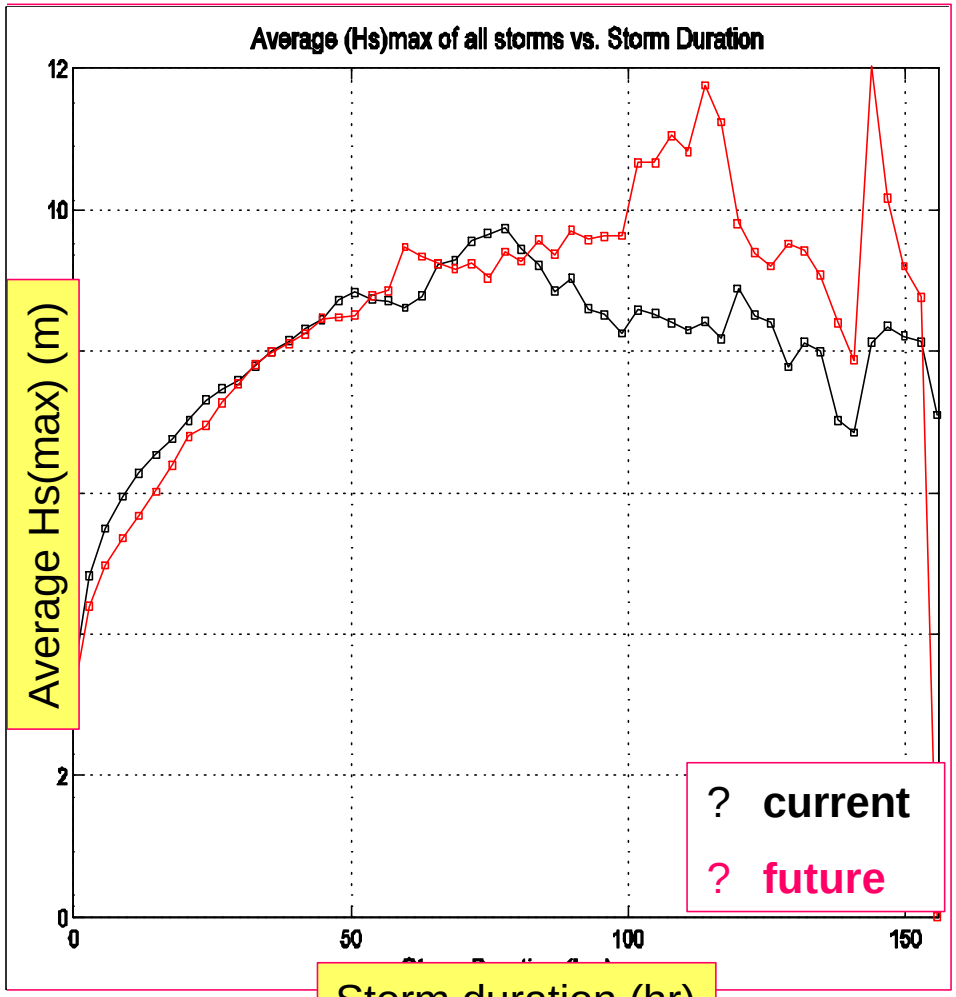


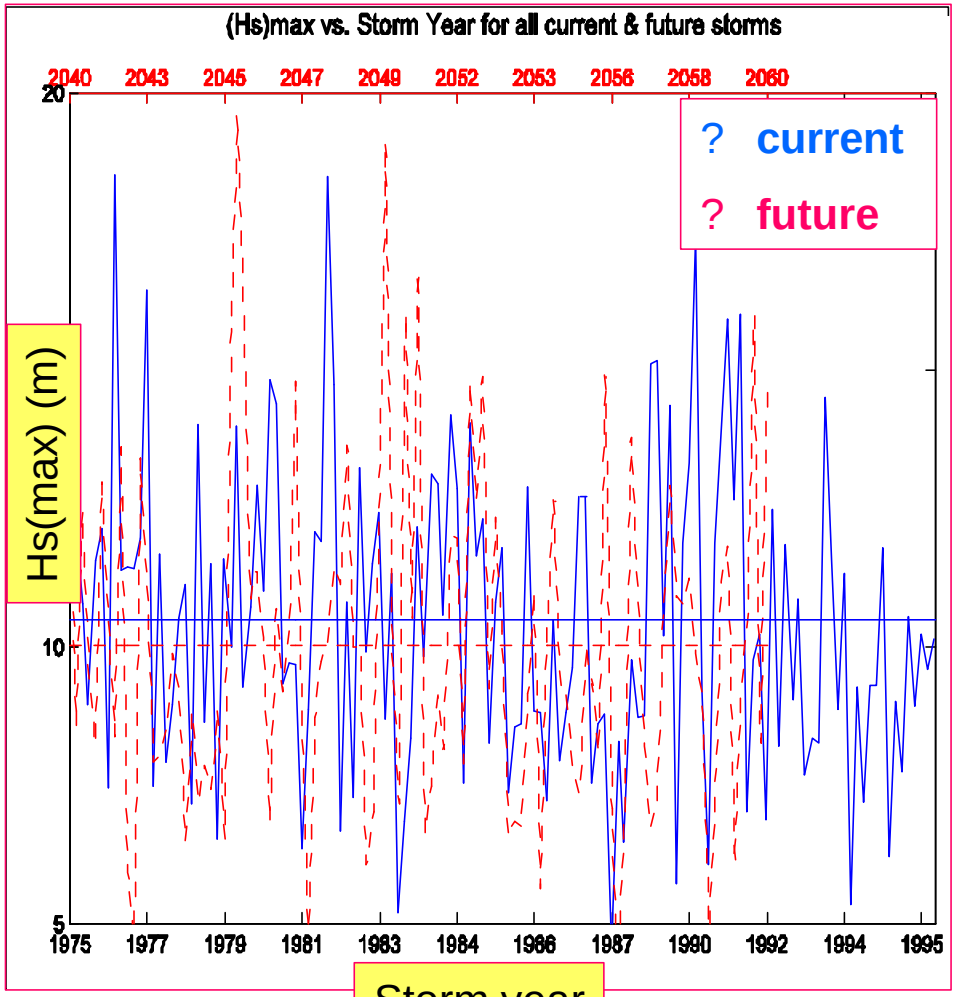
Max. Hs along storm tracks - for all storms



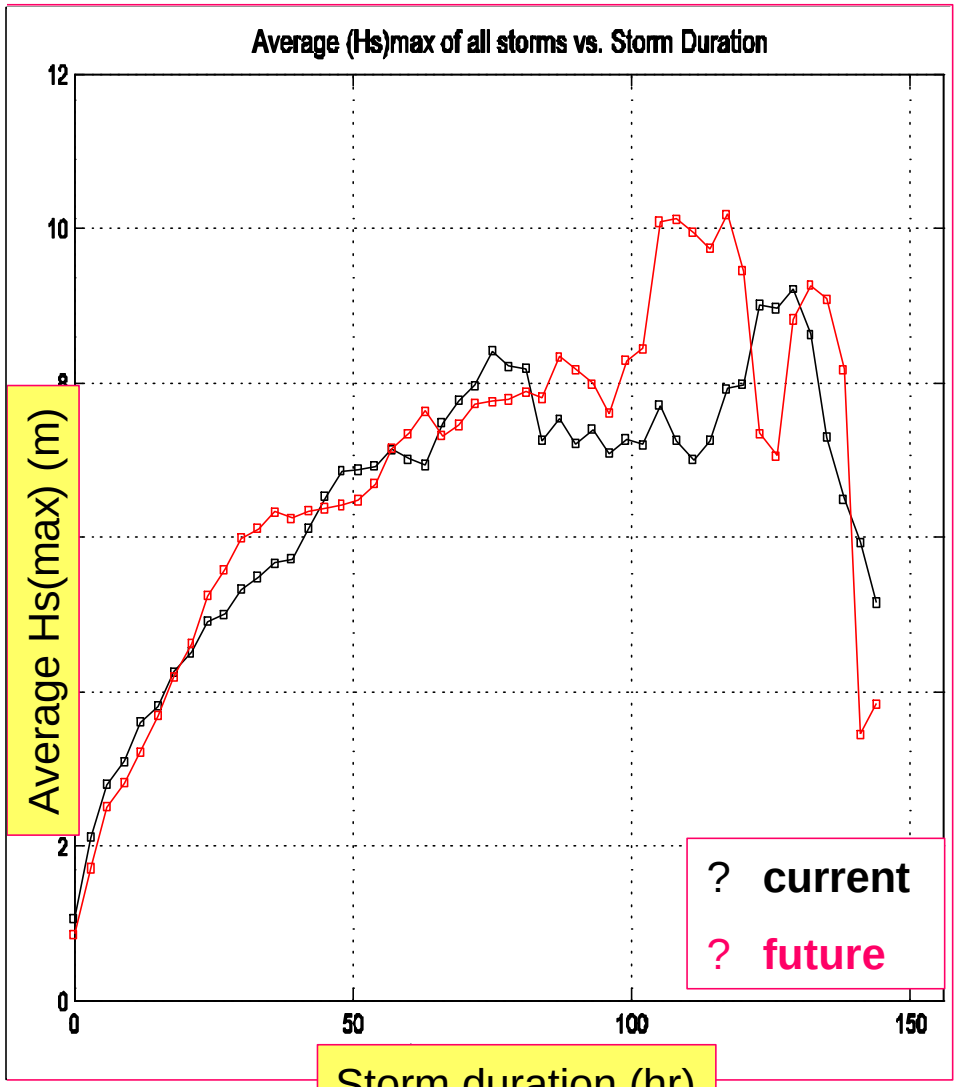


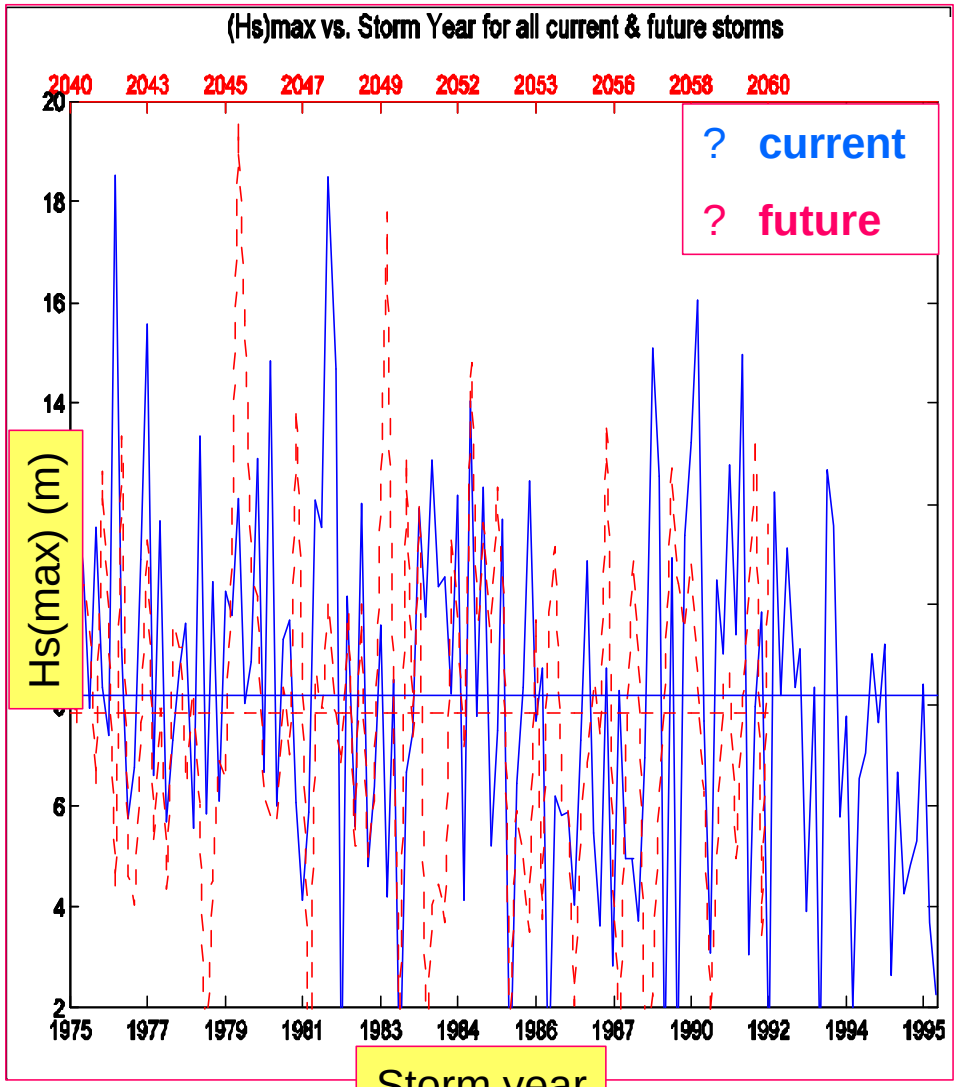
Global max. Hs - for all storms





Max. Hs along storm tracks - for all storms





conclusions

1. Downscaling GCM outputs with regional atmospheric model gives more intense storms

2. Indication of track shift, particularly with MC2 runs in climate change scenario, both for max winds, and waves

3. Indication of increased number of extreme storms in climate change scenario ⇒ higher winds and waves

4. Persistence of high wind and wave conditions ⇒ lengthening of storm tracks in duration, fetch (for autumn storms)

5. Indication that autumn storm propagation speed increases ⇒ impacts on wave growth along storm track