



Koninklijk Nederlands
Meteorologisch Instituut
Ministerie van Infrastructuur en Milieu

Wind en regen in de toekomst - wat zeggen de KNMI'14 scenario's?

Andreas Sterl (KNMI)

- wind
- hurricanes (orkanen)
- regen
- zicht + mist
- weer van de toekomst

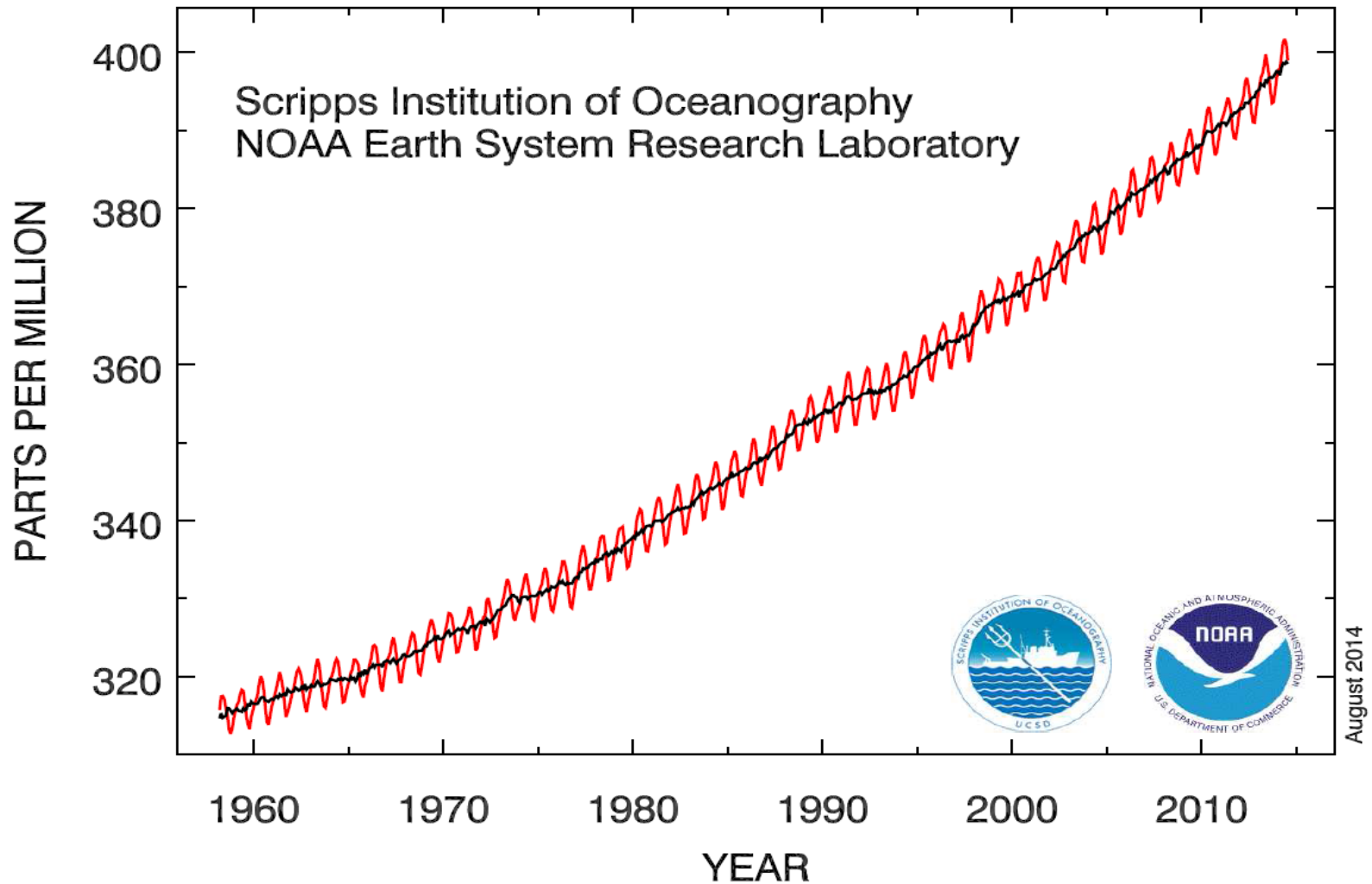


Achtergrond: CO₂ en temperatuurstijging

Stijging CO₂



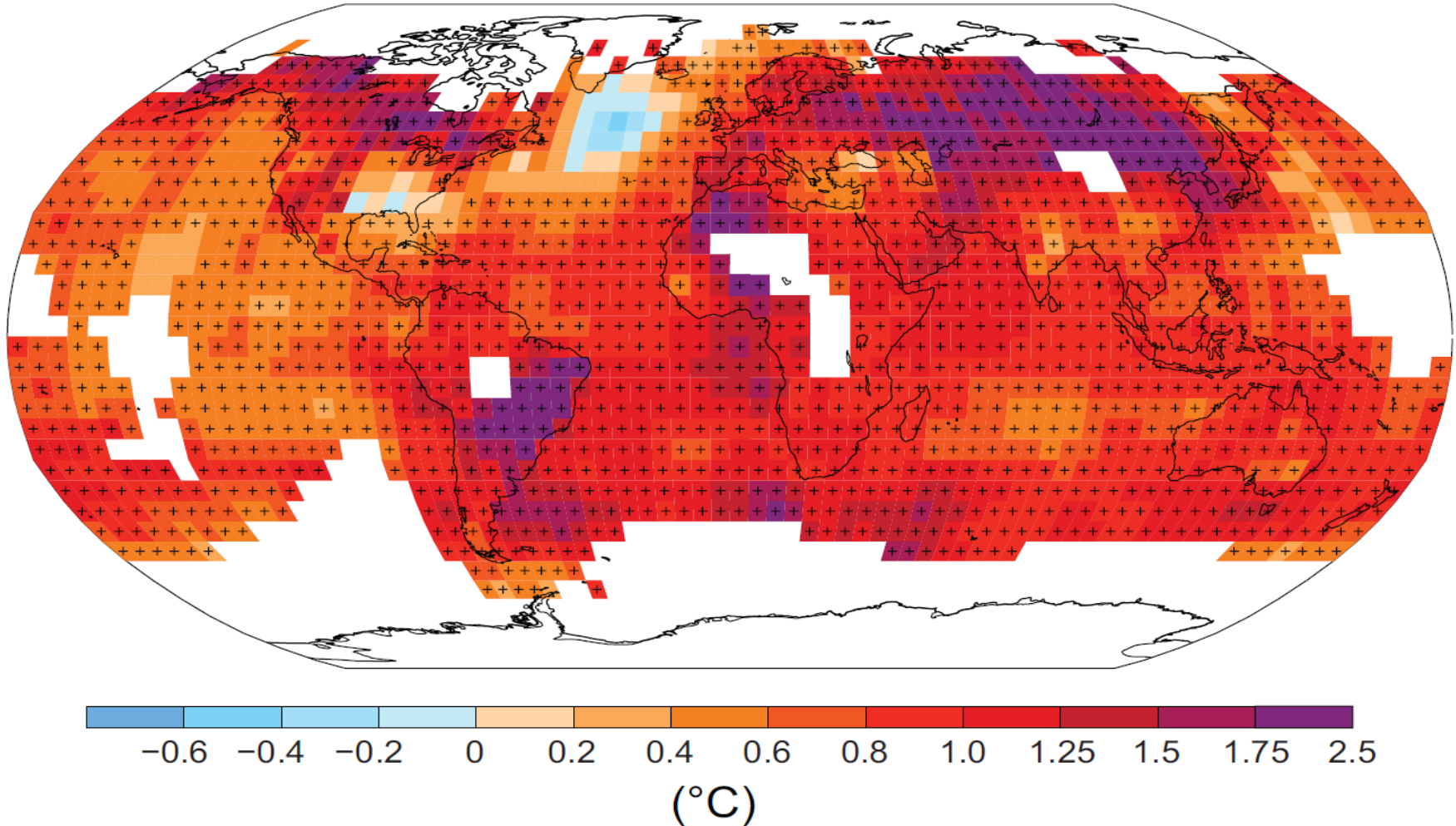
Atmospheric CO₂ at Mauna Loa Observatory



Temperatuur

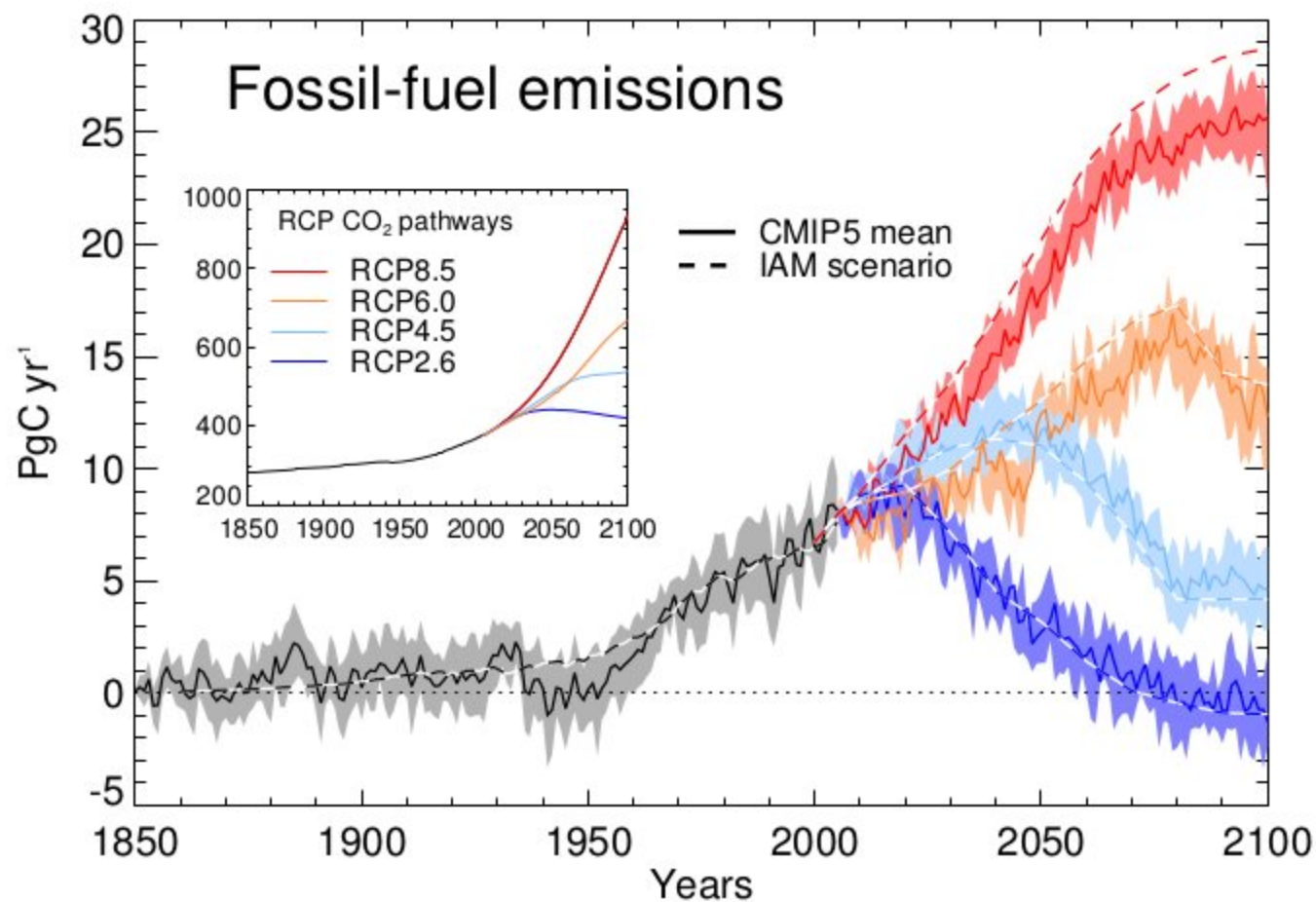


Observed change in surface temperature 1901–2012





Carbon emissions for the four AR5-scenarios





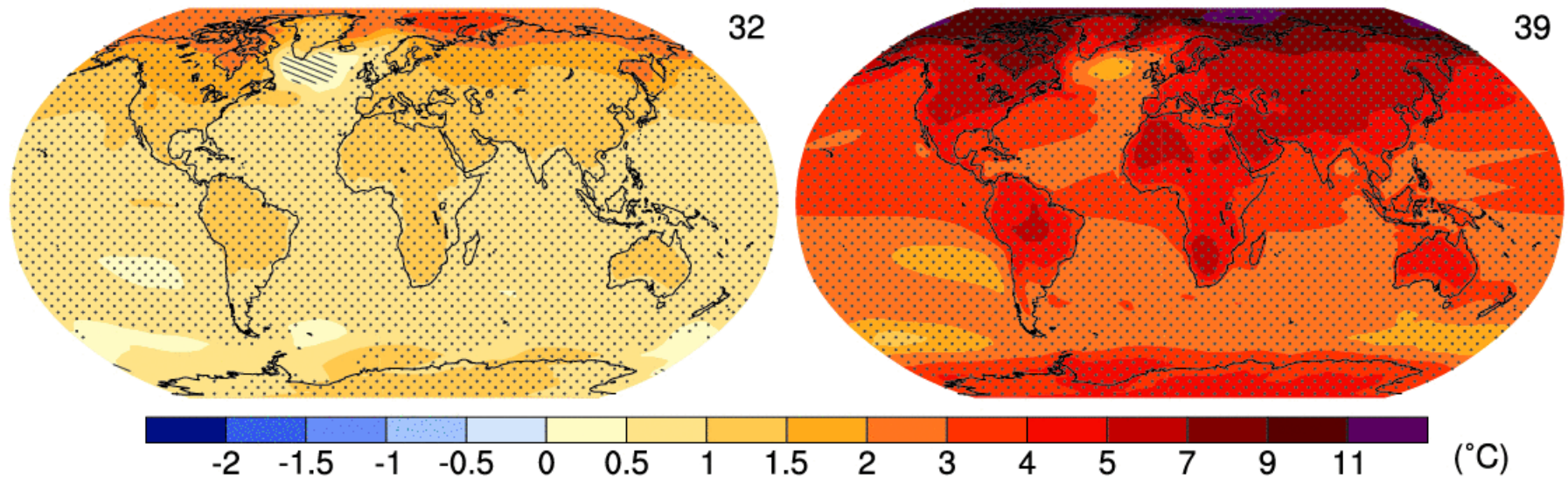
Temperatuur: projecties

RCP2.6

RCP8.5

(a)

Change in average surface temperature (1986 - 2005 to 2081 - 2100)



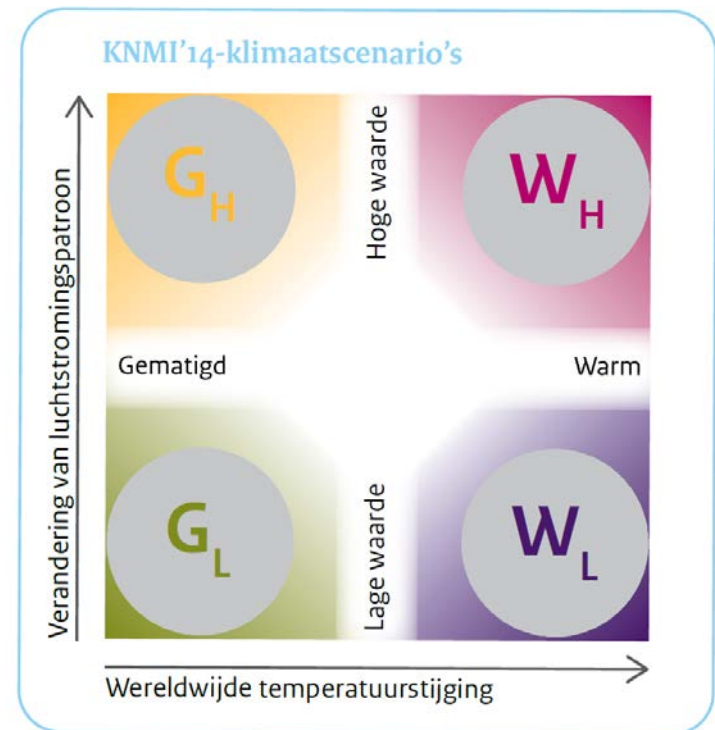
hatching: signal/noise $< 1\sigma$

stippling: signal/noise $> 2\sigma$ + 90% agree on sign



KNMI'14 klimaatscenario's voor Nederland

- vertaling globale resultaten naar lokale/regionale schaal
- mogelijkheden voor toekomstig klimaat
- globale temperatuurstijging
 - **G**ematigd
 - **W**arm
- circulatieverandering
 - **L**aag
 - **H**oog



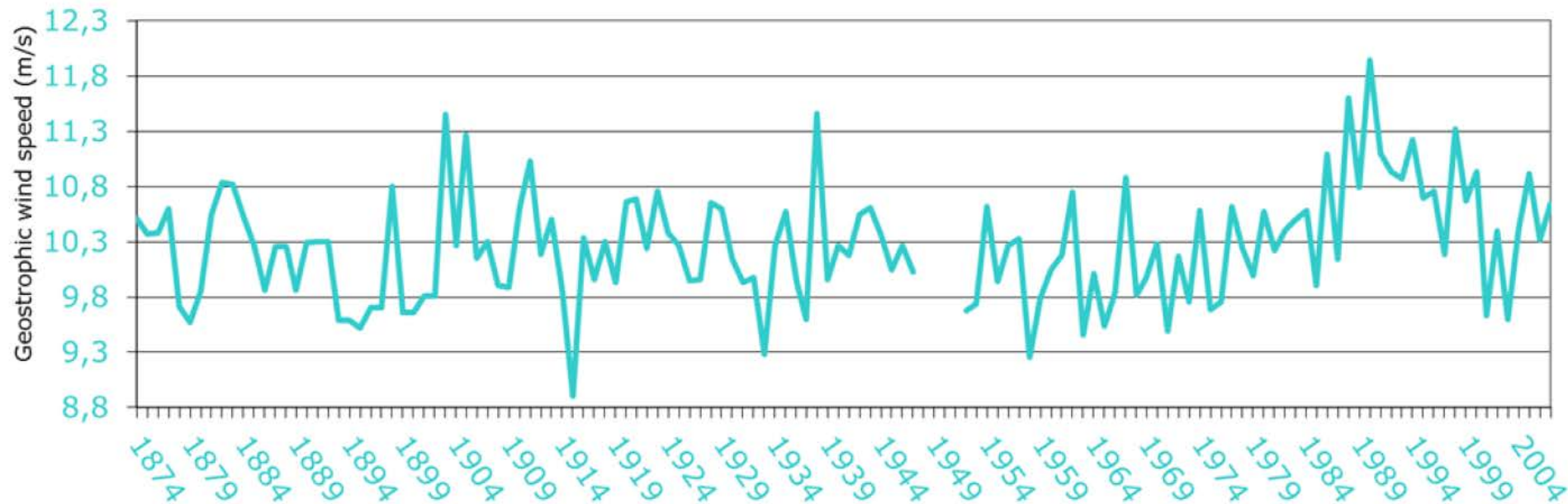


Wind



Geostrophic winds - observed

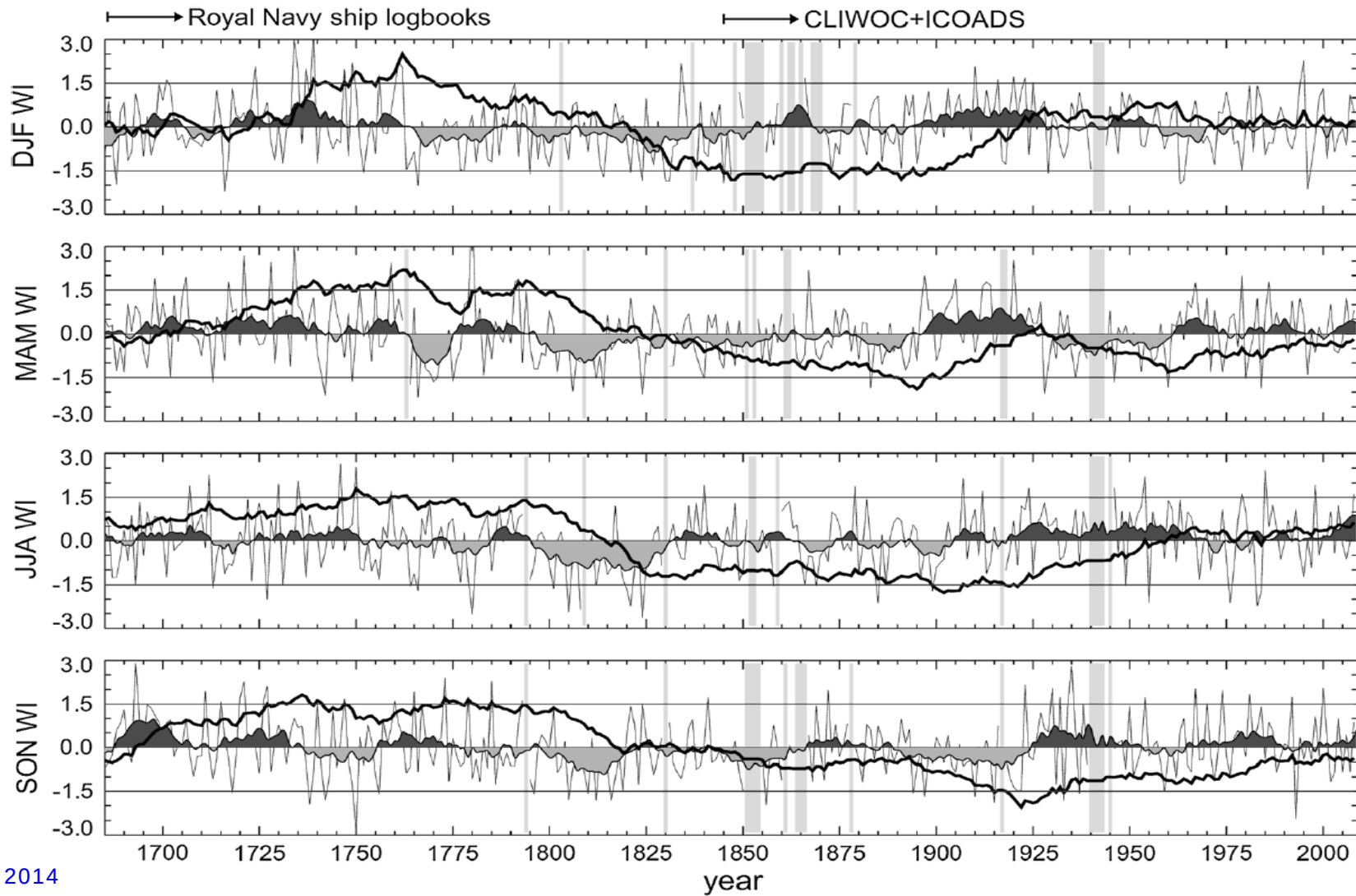
pressure triangle
Aberdeen-Tyborøn-De Bilt



=> large variability, no trend



westerly wind index in English Channel



Barriopedro et al. 2014



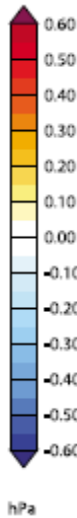
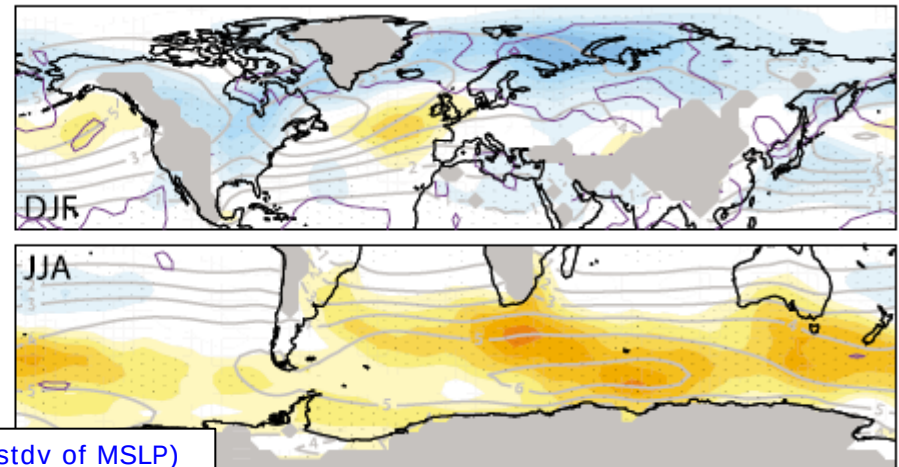
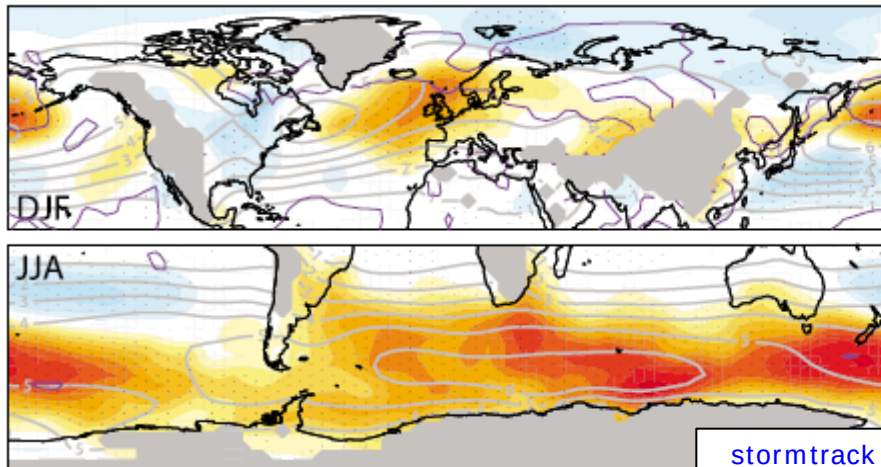
CMIP5 - literature

- Harvey et al. (2012) and Chang et al. (2012):
 - Storm tracks (= stdv of 2-6 days bandpassed SLP)
 - No changes over Europe
 - Chang et al. (2012) find hints of changes higher up in the atmosphere
- Mizuta (2012): small changes in cyclone no + growth rate; differ between models
- Eichler et al. (2013): decrease of storm frequency + increase of intensity in Natl, but not North Sea
- Zappa et al. (2013): decrease in cyclone no. + frequency over most of Natl and Eur, but small (< 1% !) increase over British Isles
- **general: insignificant changes of either sign**



CMIP3 Mean response: SRESA1B-20C3M

CMIP5 Mean response: RCP45-20C



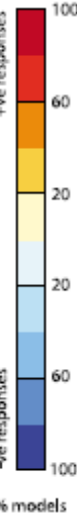
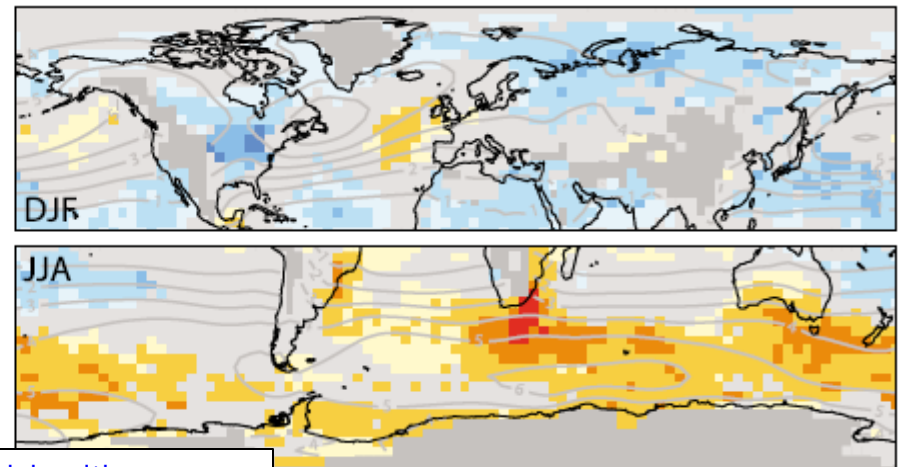
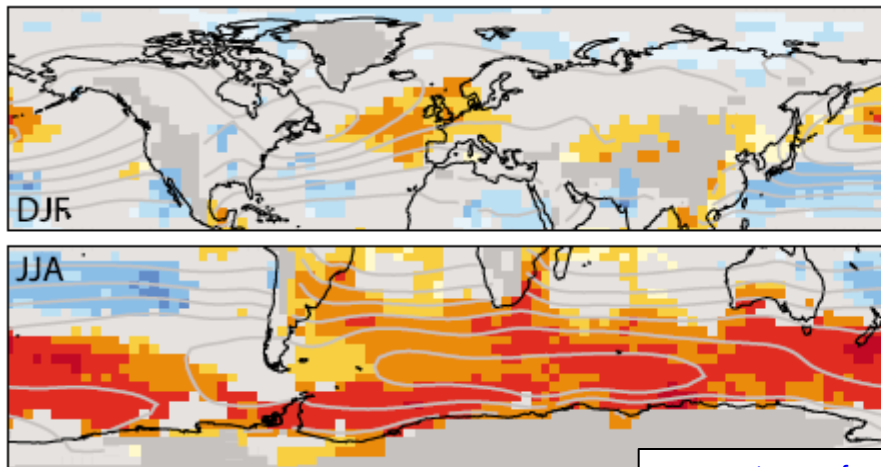
20C3M: 19 models (31 ens members), SRESA1B: 19 models (27 ens members)

20C: 19 models (46 ens members), RCP45: 19 models (30 ens members)

stormtrack (stdv of MSLP)

CMIP3 Consensus: SRESA1B-20C3M

CMIP5 Consensus: RCP45-20C



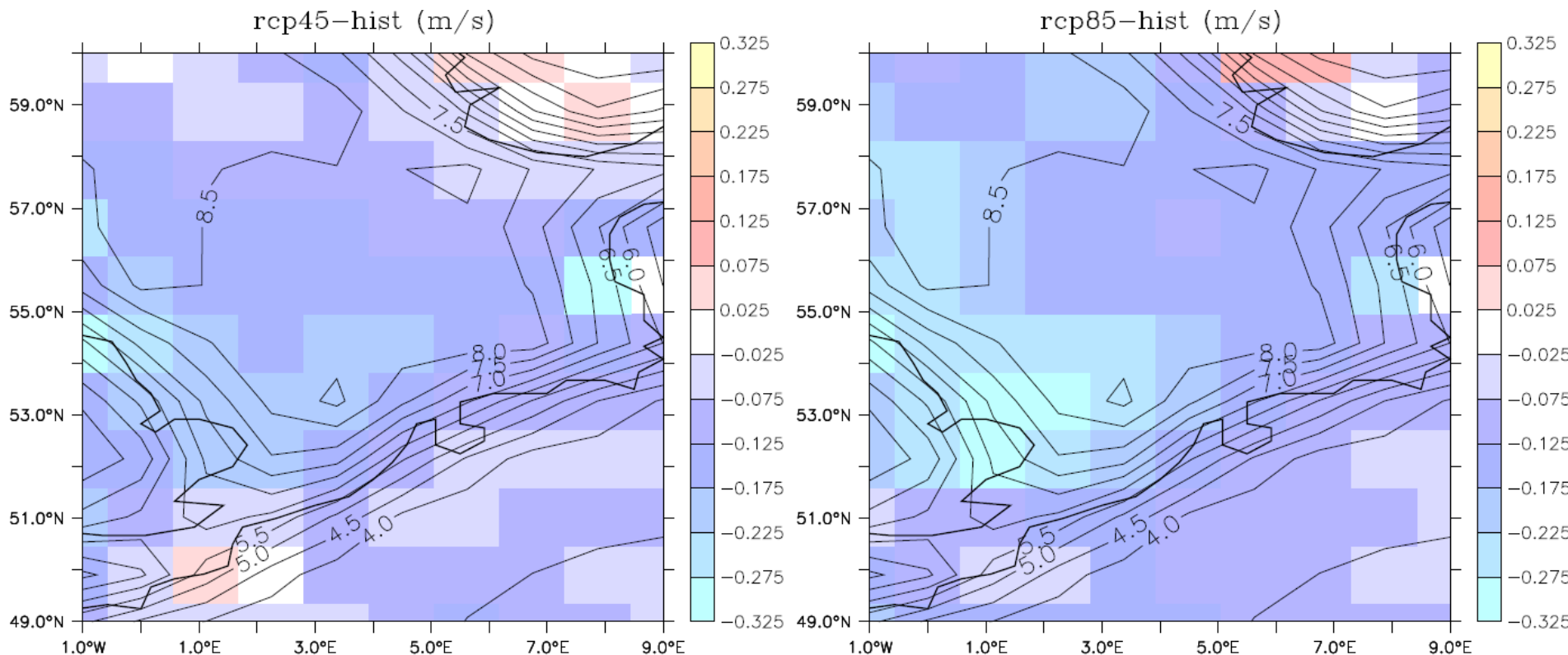
20C3M: 19 models (31 ens members), SRESA1B: 19 models (27 ens members)

RCP45: 19 models (30 ens members)

percentage of models with response
> 0.5 inter-ann. stdv



EC-Earth: projected change ann. mean Wspd

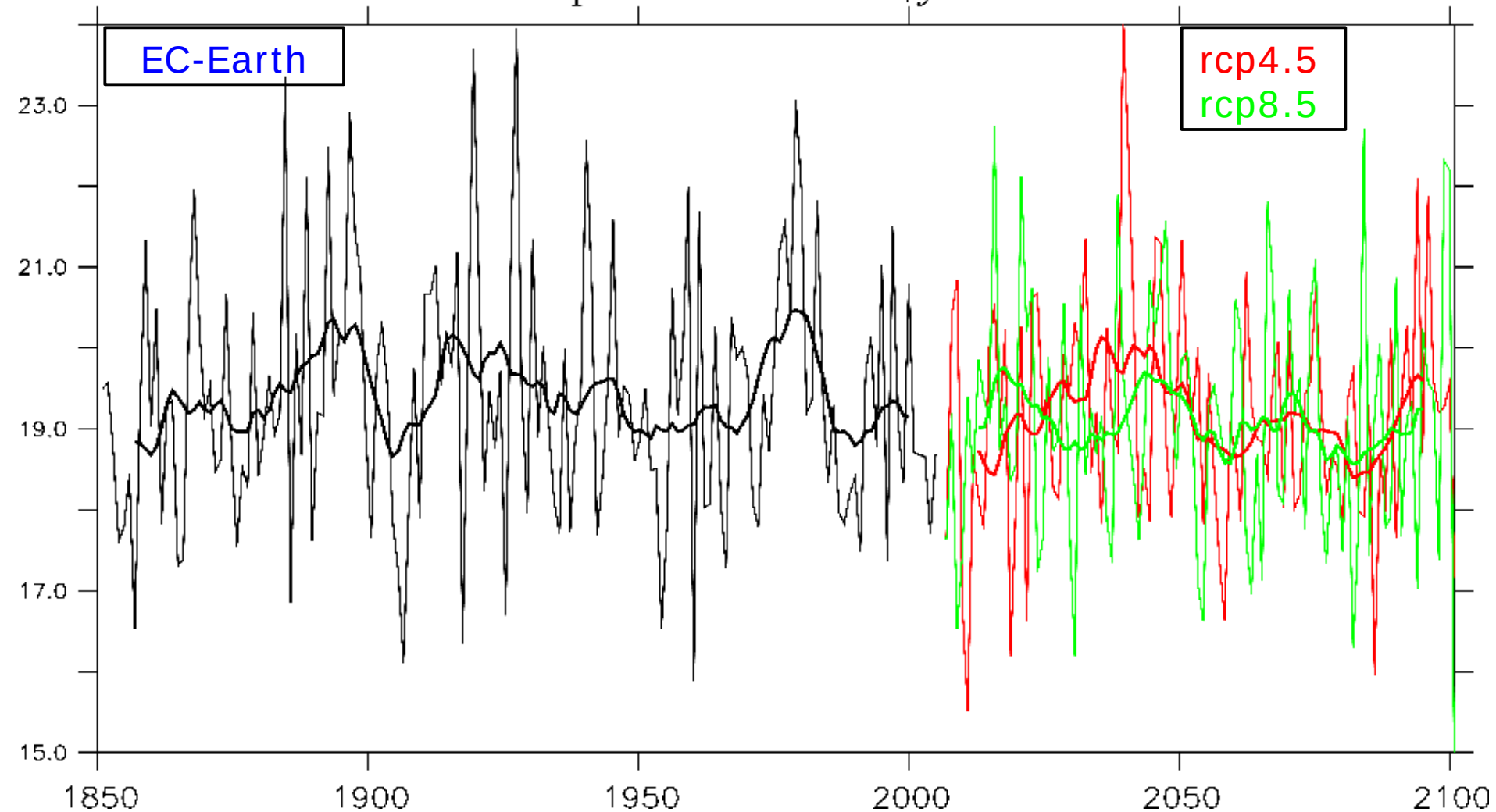


2071-2100 – 1976-2005 (col); 1976-2005 (contours). decrease, but statistically not significant

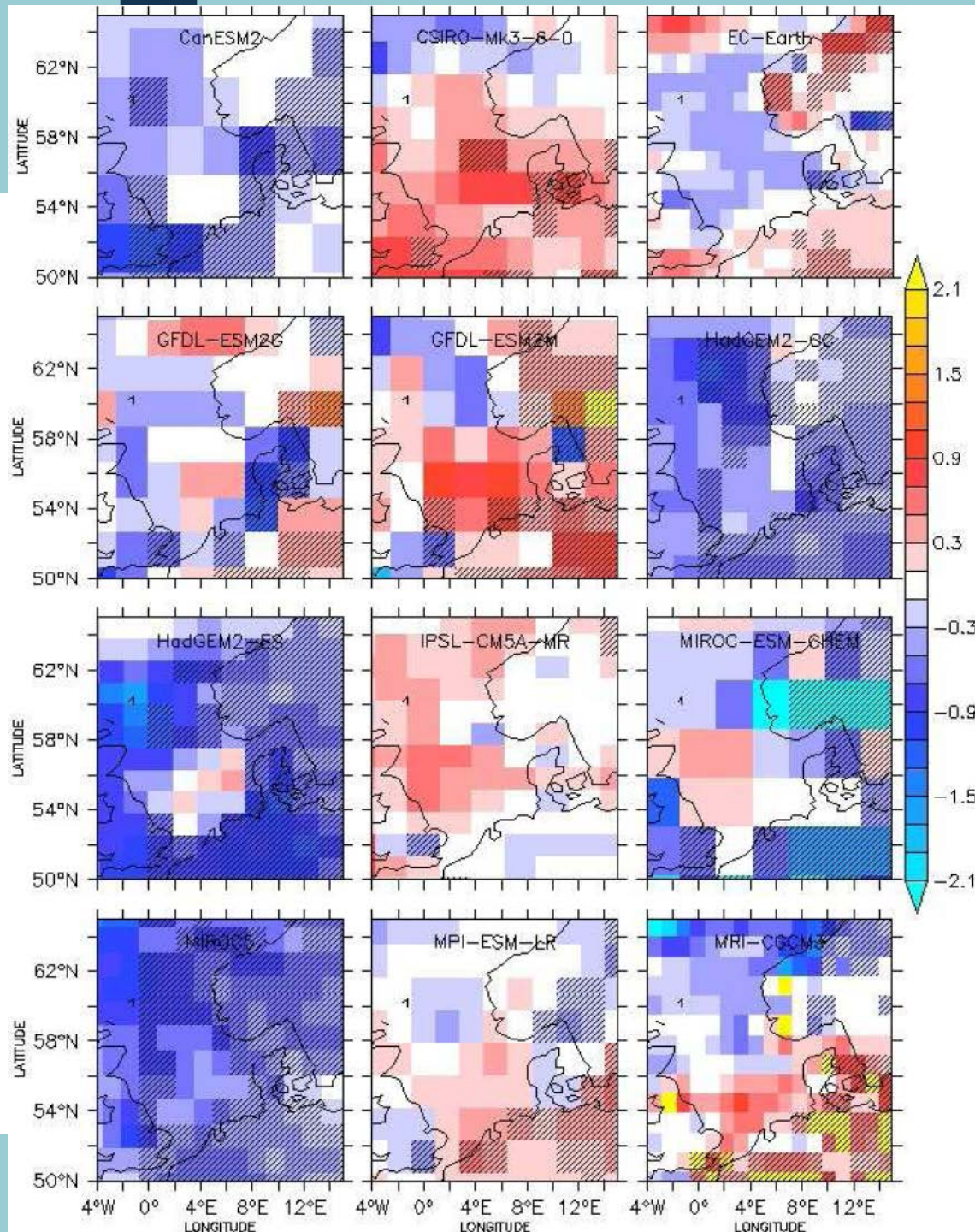
High winds



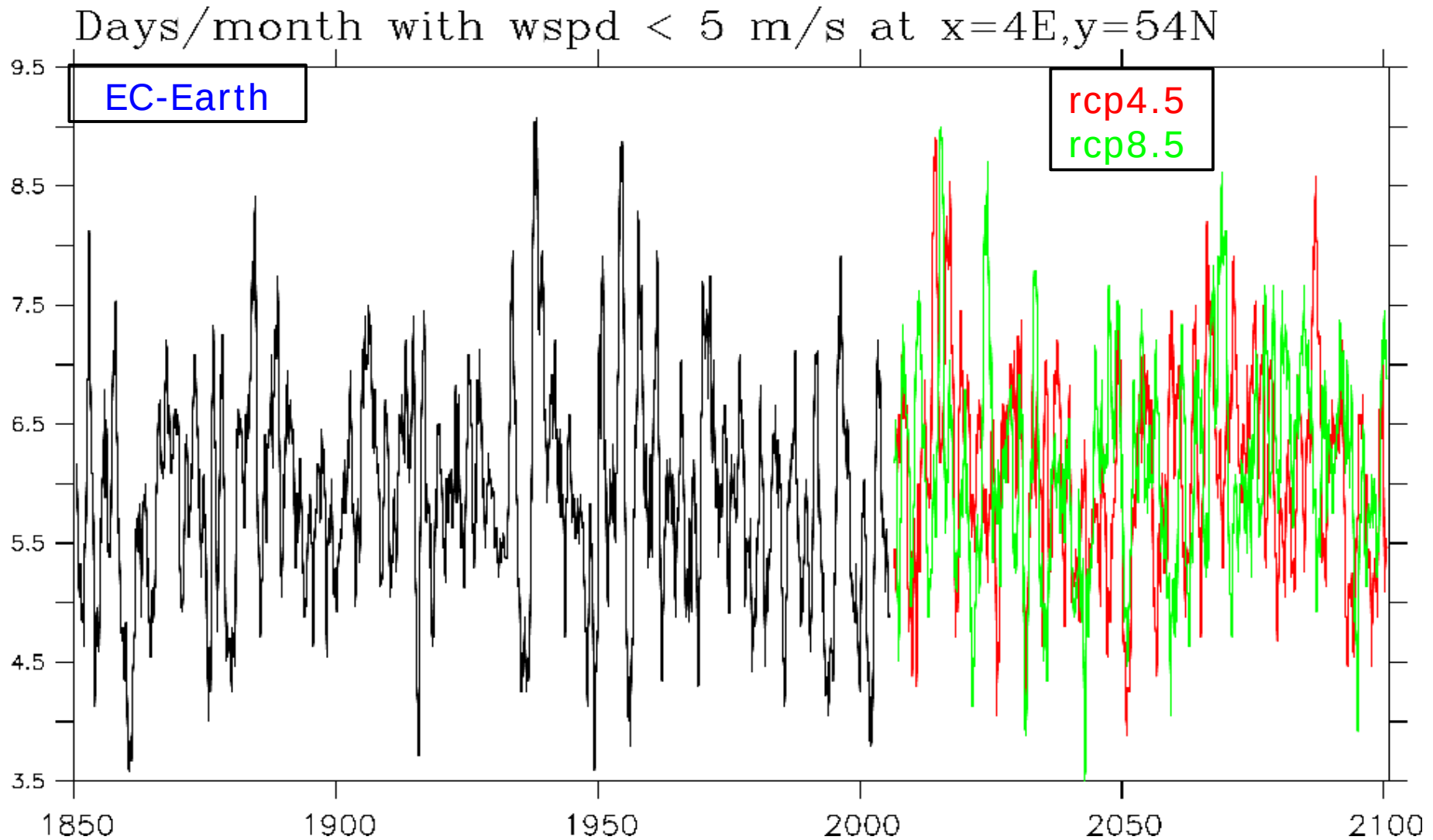
Annual max wind speed at $x=4E, y=54N$



Verandering
jaar-maxima
van de
dagelijks
gemiddelde
windsnelheid
gedurende
21de eeuw
(rcp8.5)



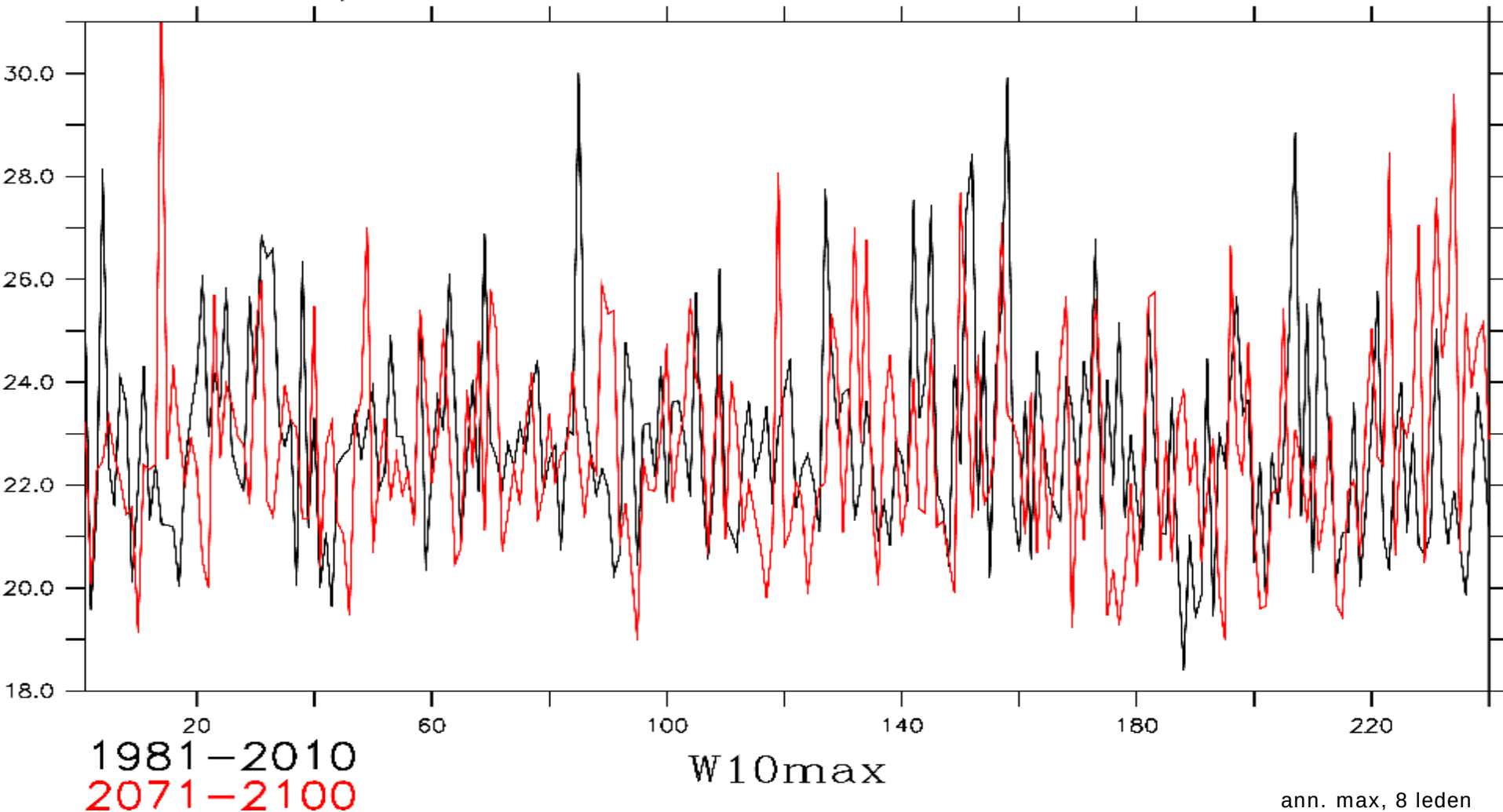
Low winds



Downscaling



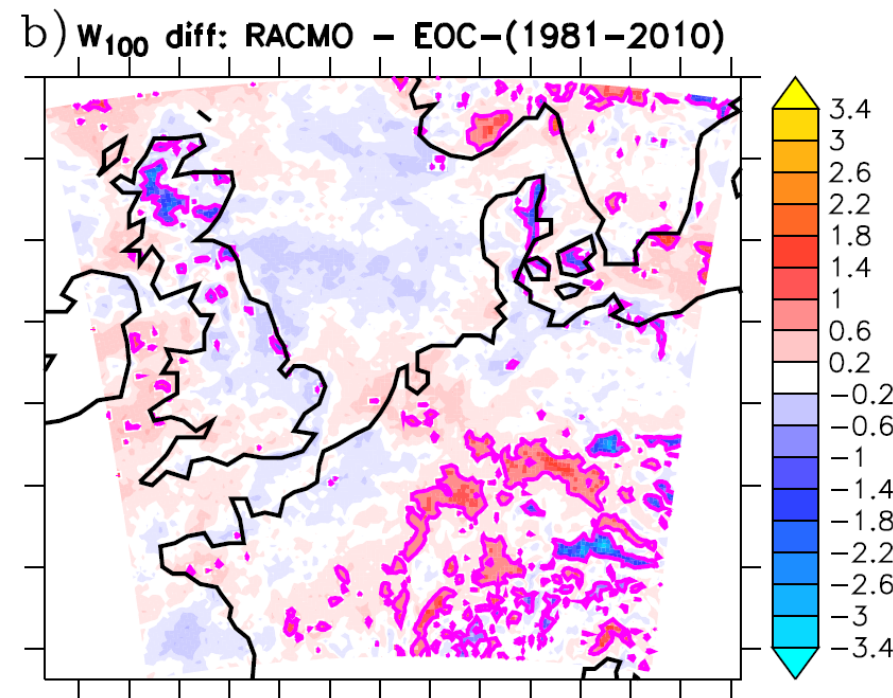
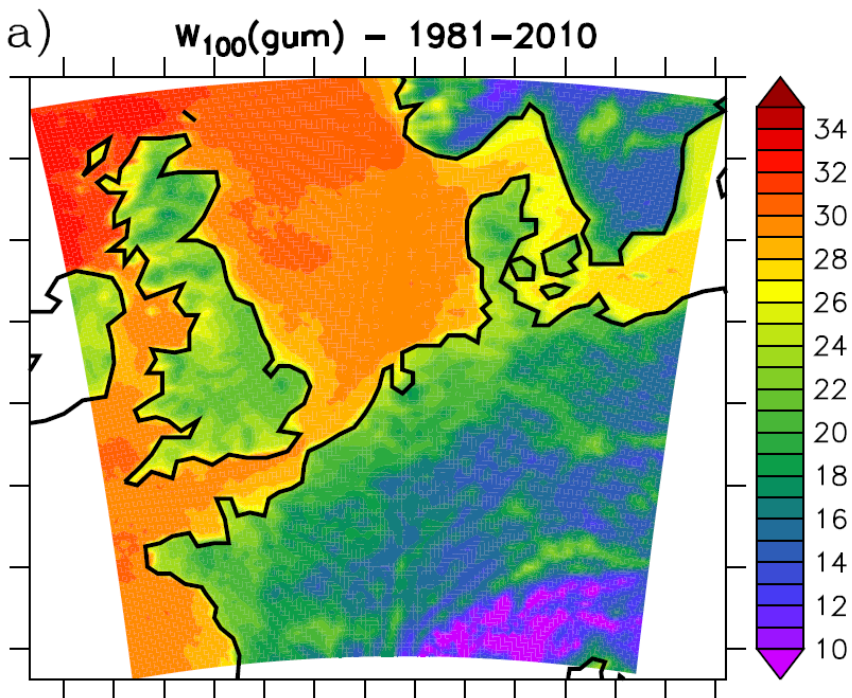
4.158984E, 53.94318N





RACMO - W_{100}

daily-max wspd



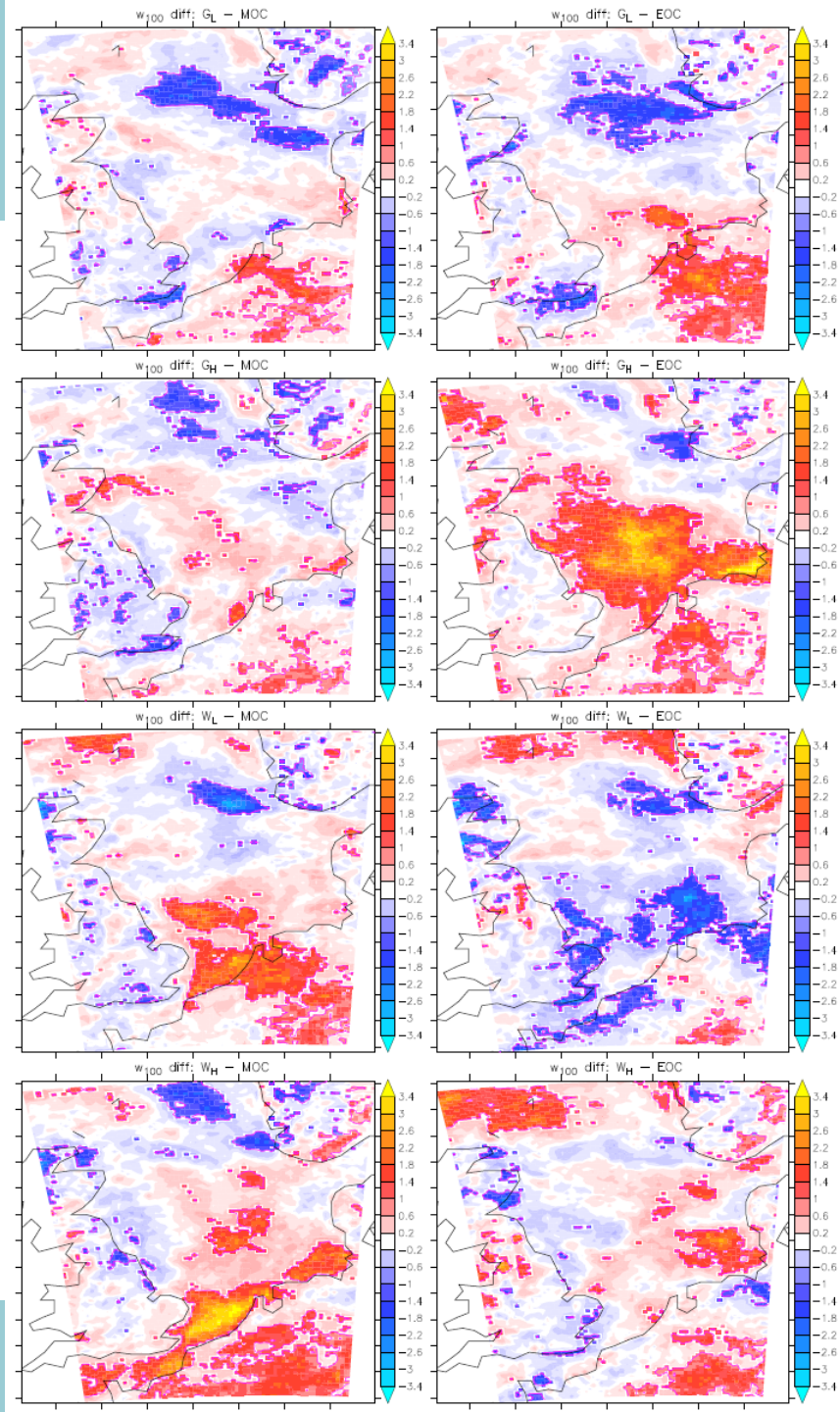
differences in general not significant

Re-sampling

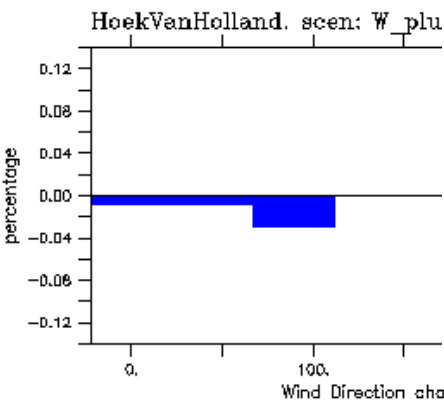
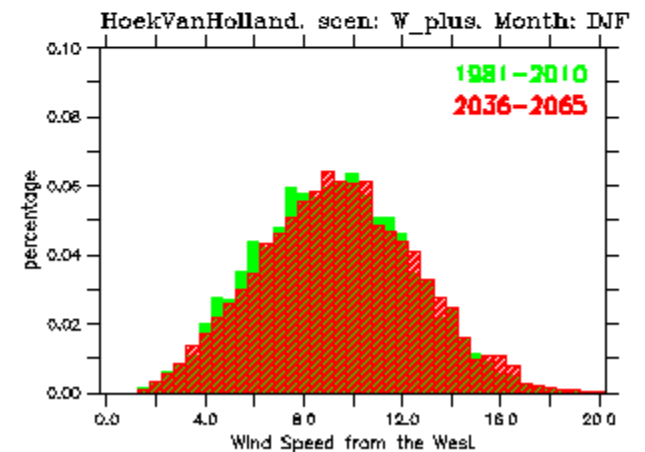
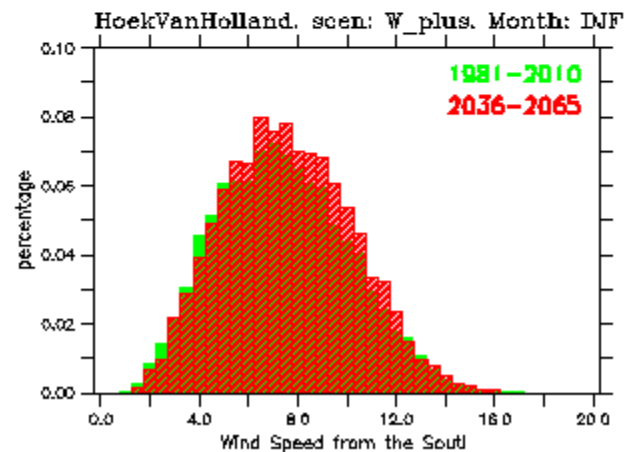
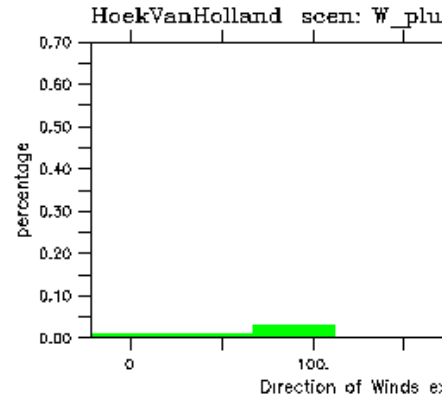
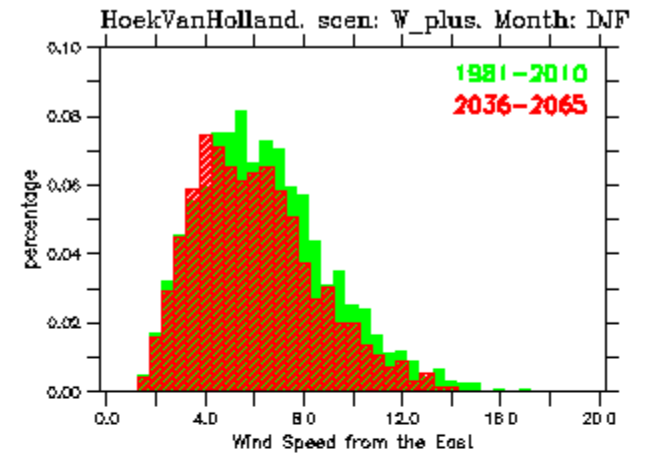
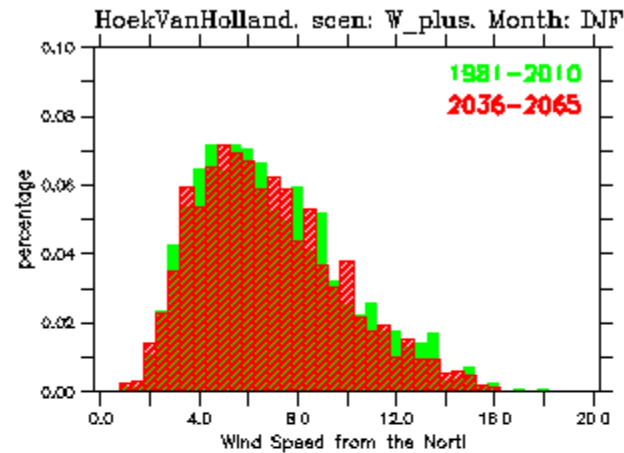
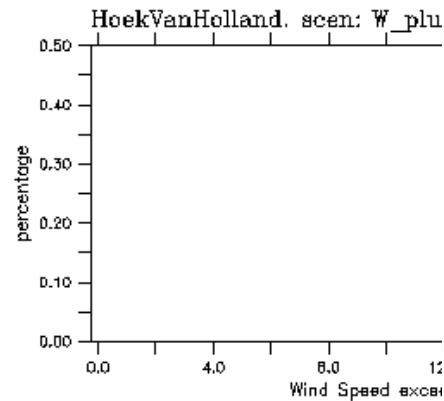
changes of W_{100} (daily-max) for
the 4 scenarios and 2 time
horizons

=>

- not consistent between scenarios
- mostly not significant



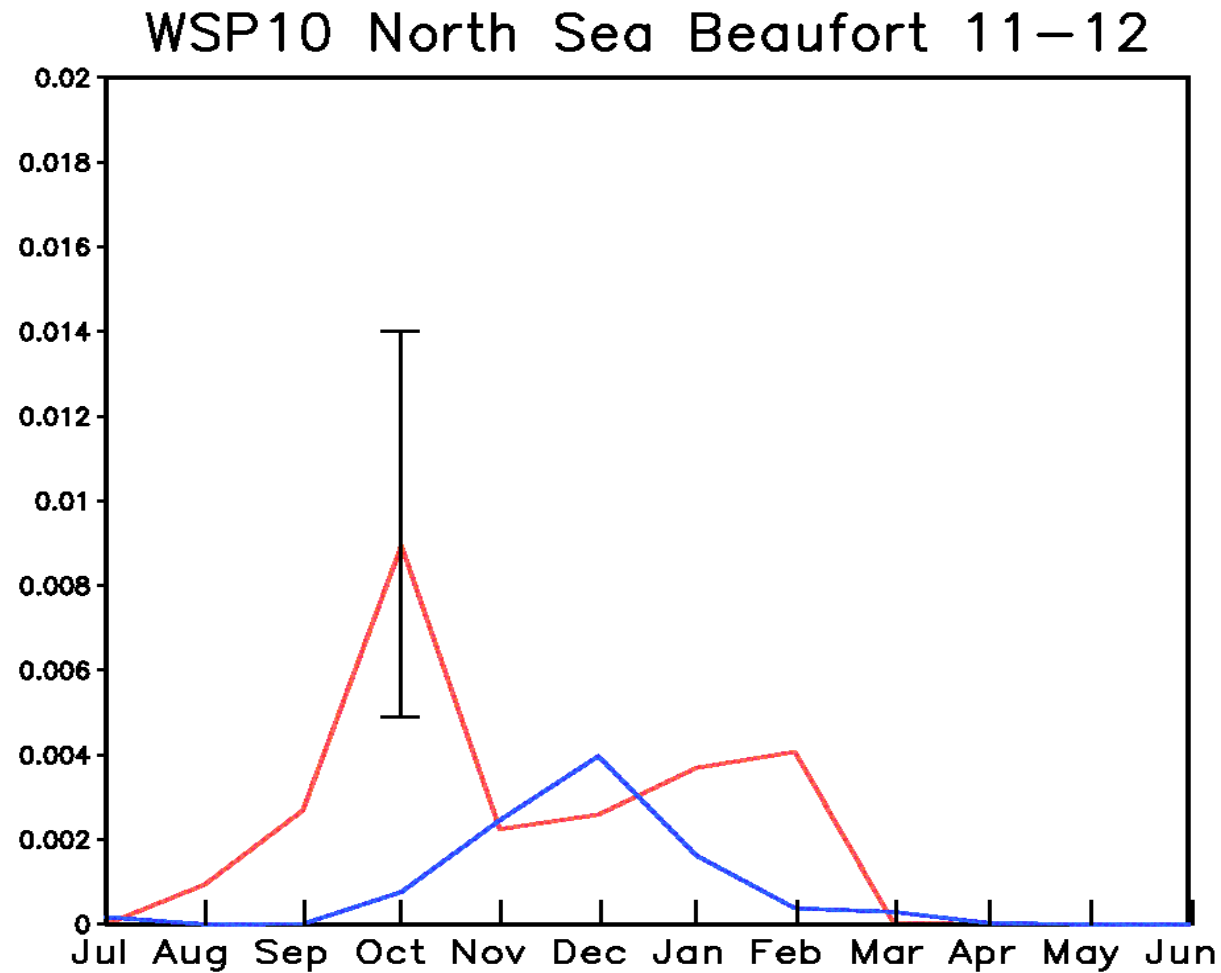
Wind directions





Maar ...

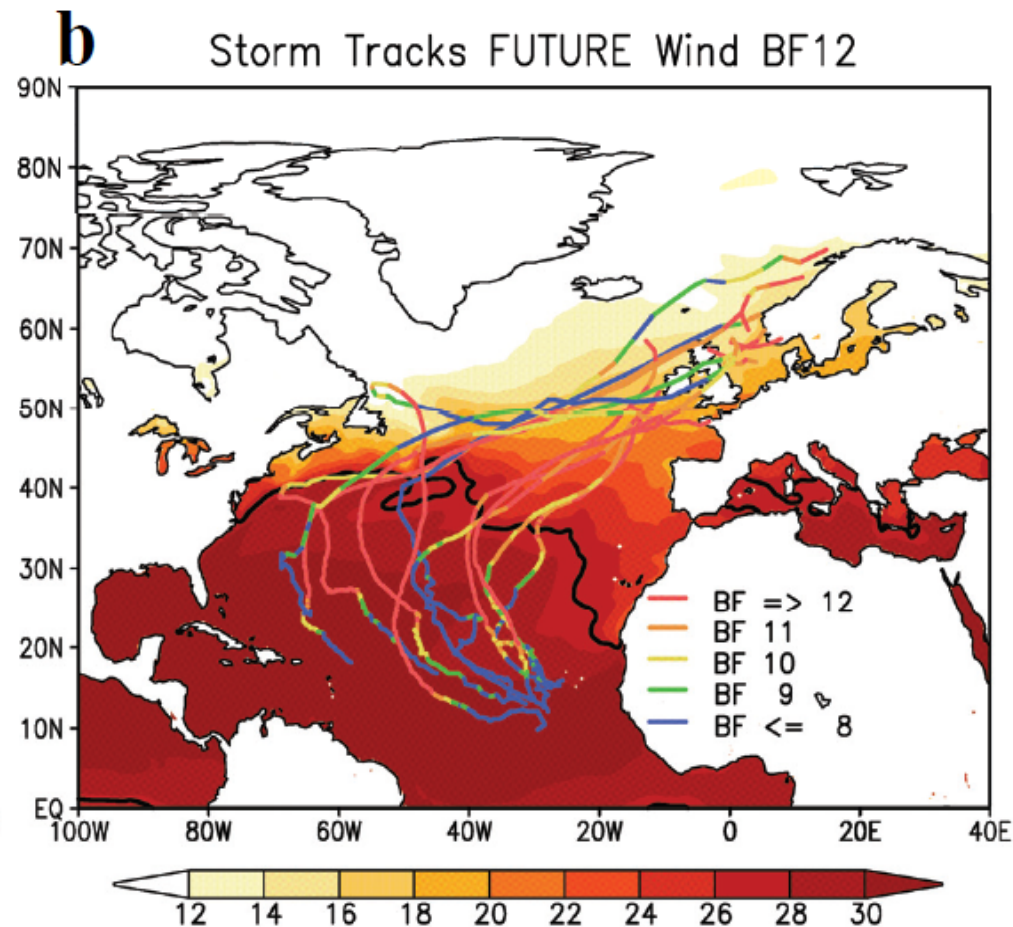
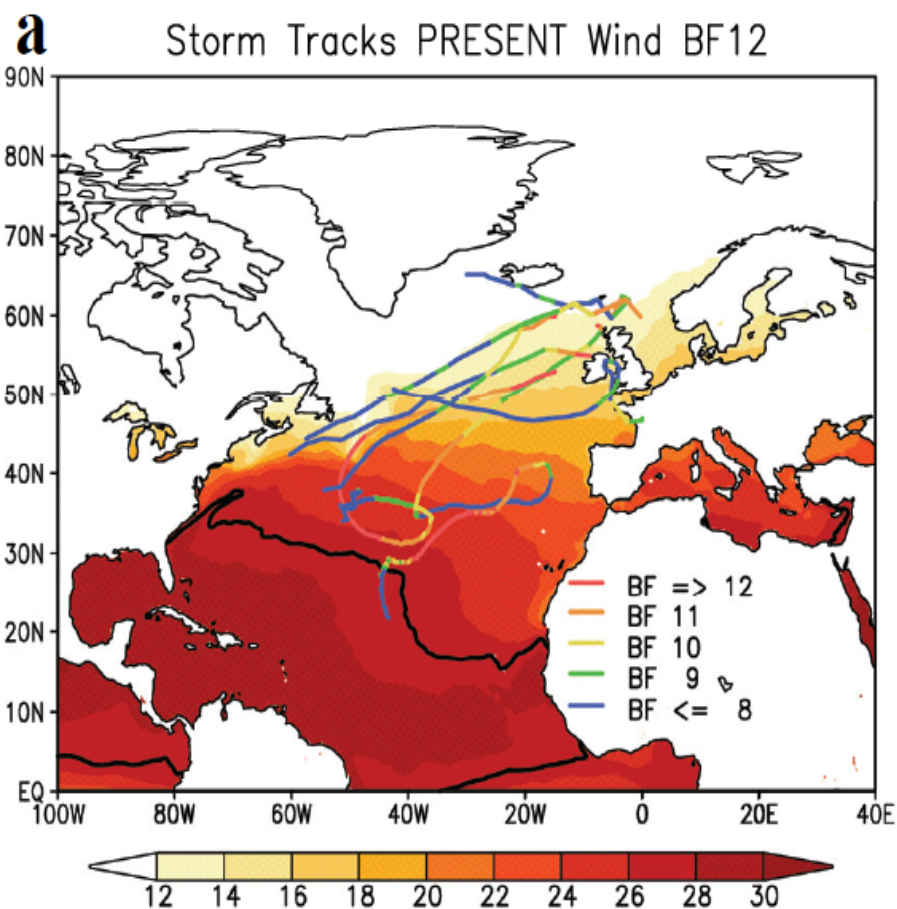
EC-Earth run bij hoge
resolutie (25km),
maar ongekoppeld:
Toename van zware
stormen, met name in
het vroege najaar



Frequency distribution of 3-hourly 10m windspeed



Tropische stormen op de Noordzee?





Summary

Wind

- Large variability (inter-annual, inter-decadal)
- No systematic changes in future for “ordinary” mid-latitude storms in GCM output or in downscaled RCM output
- Slight indication of less winds from the Northeast, more from the Southwest
- **But**: possible new source of storms: hurricanes!



Neerslag

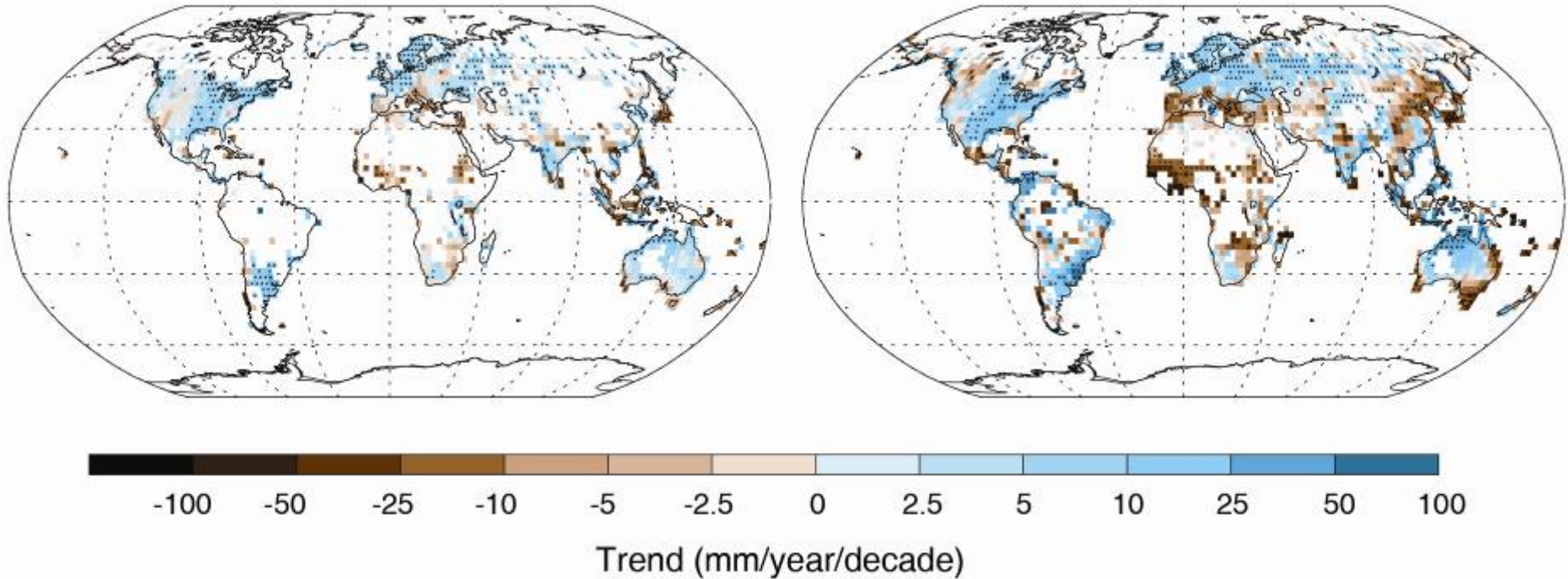
Neerslag



Observed change in precipitation over land

1901–2010

1951–2010



Incompleet beeld door incompleet
waarnemingnetwerk



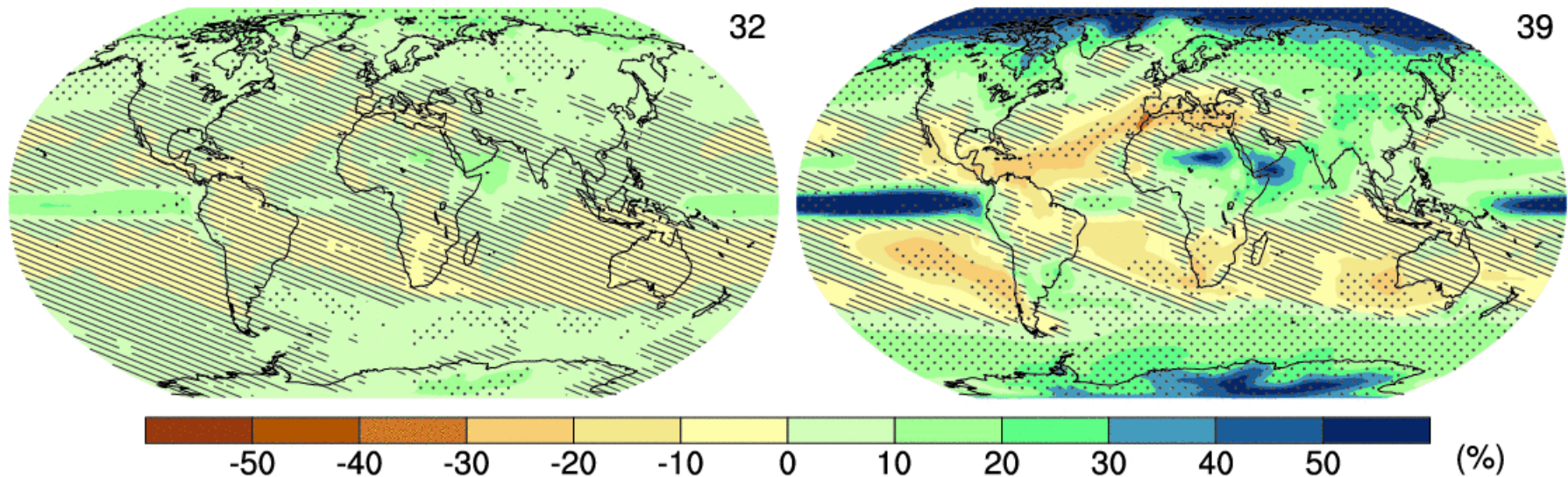
Neerslag: projecties

RCP2.6

RCP8.5

(b)

Change in average precipitation (1986 - 2005 to 2081 - 2100)

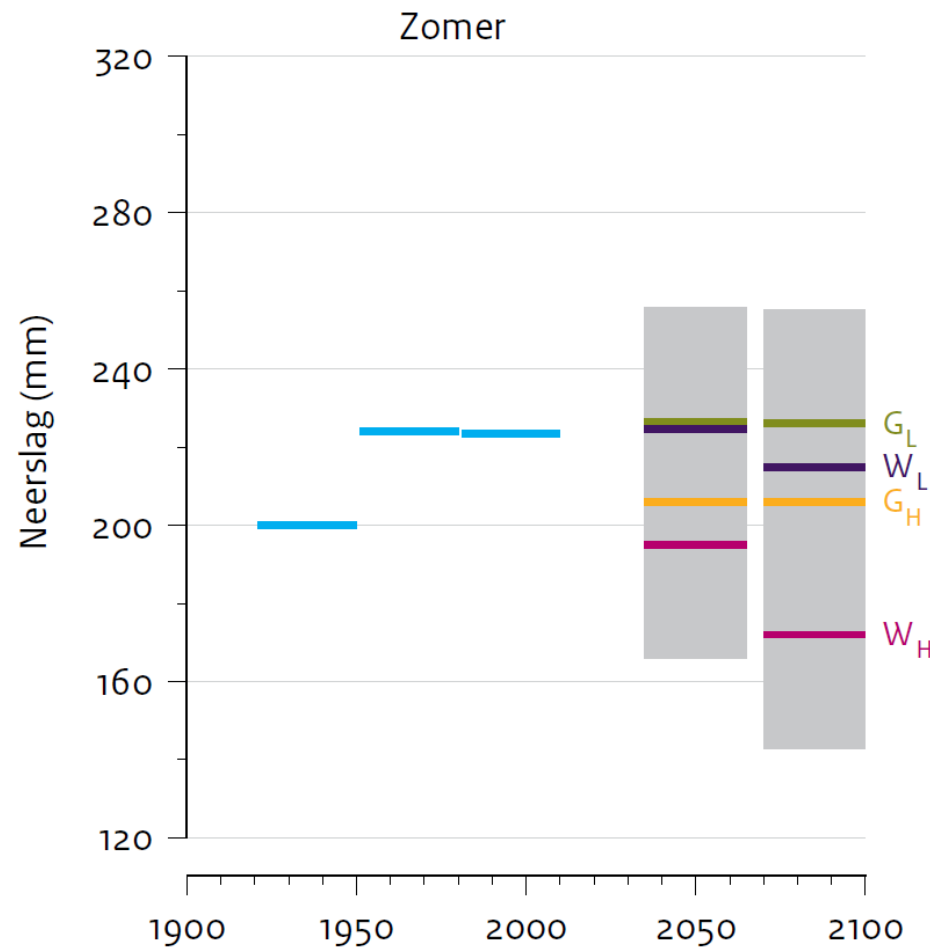
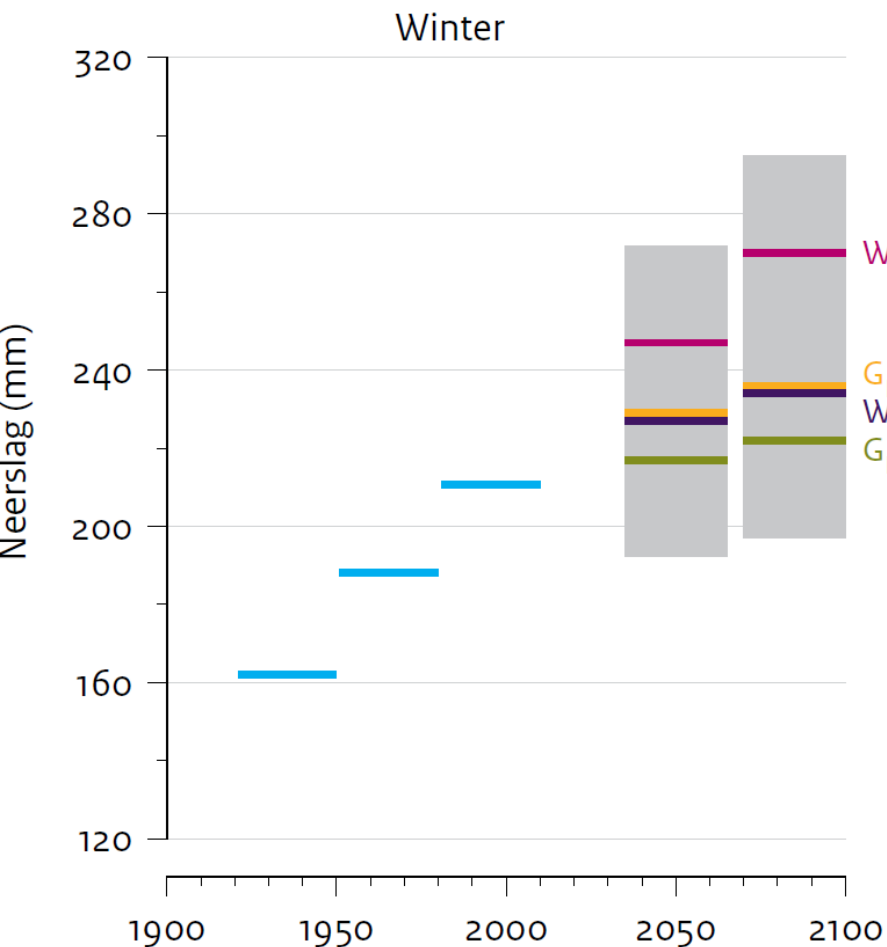


Hatching: signal/noise $< 1\sigma$

stippling: signal/noise $> 2\sigma$ + 90% agree on sign



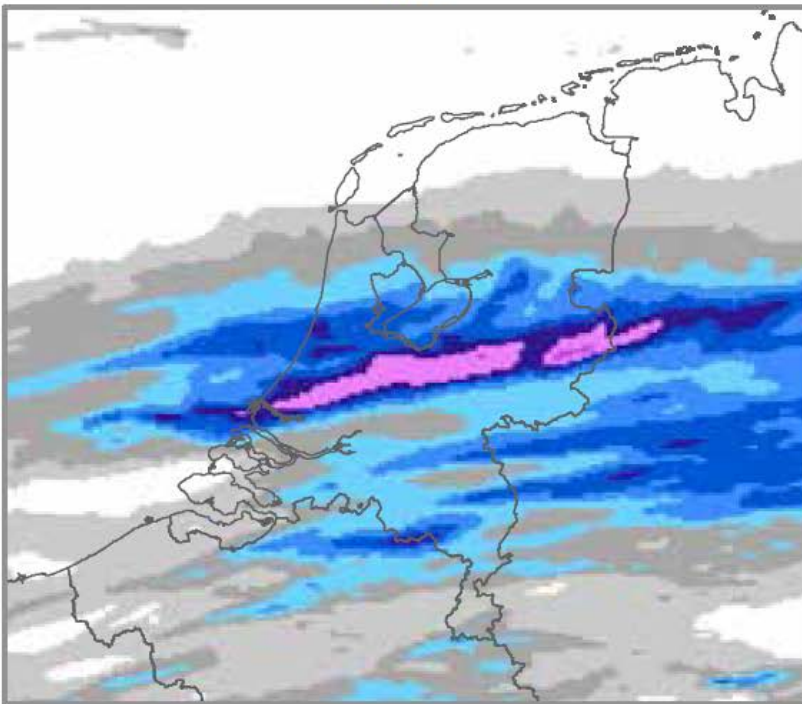
Neerslagprojectie Nederland





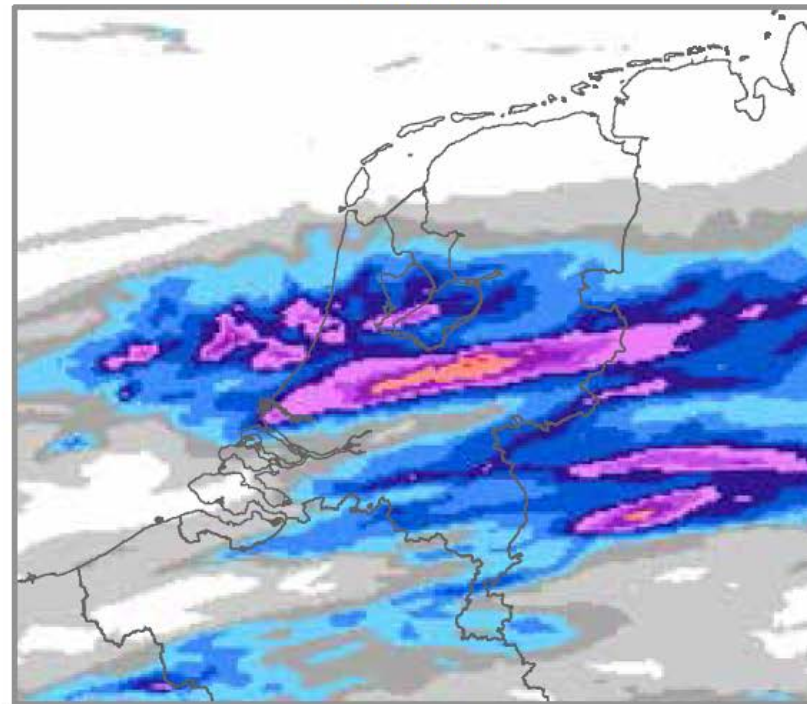
Hevige neerslag nu en straks

2010



neerslag binnen 2 dagen
("Hupsel")

Toekomst



2 graden warmer klimaat



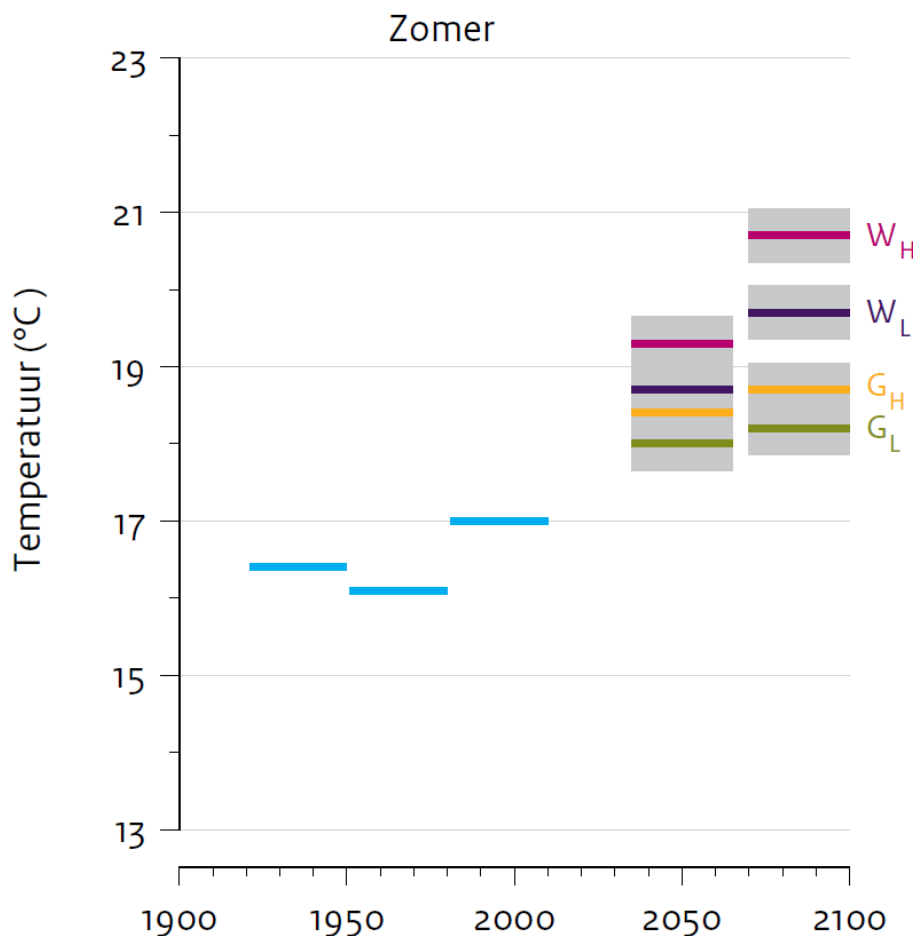
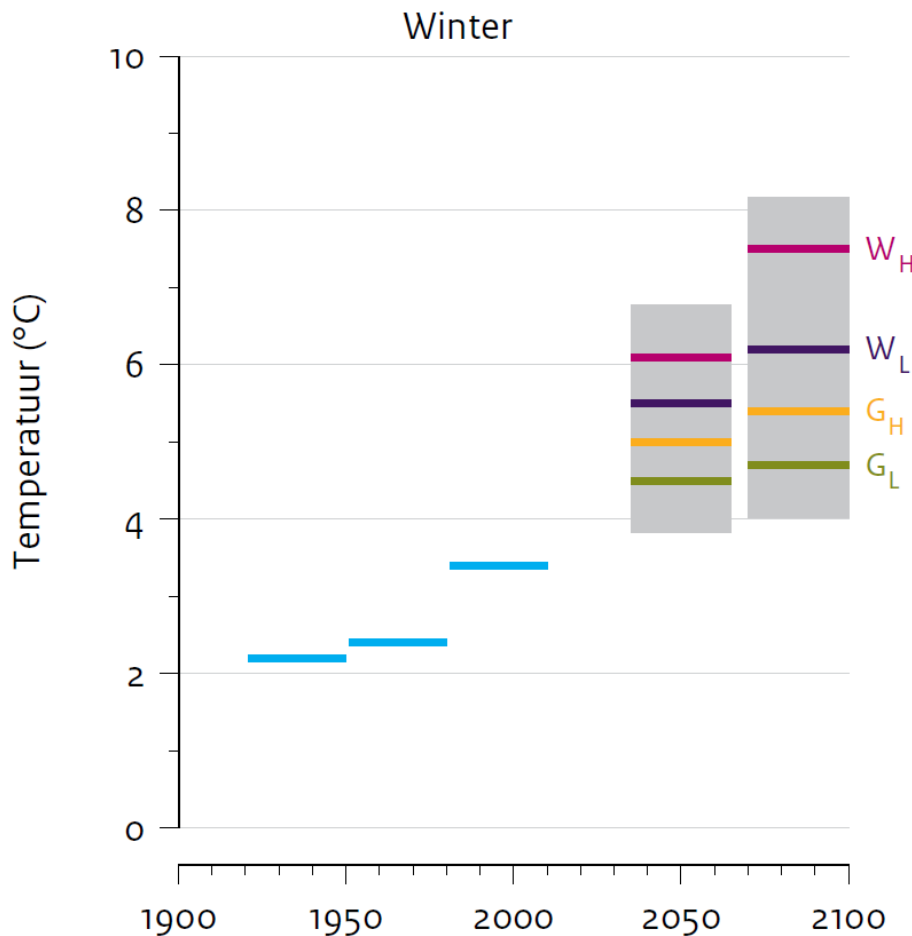


Andere weerelementen

zicht	lichte toename	iets minder luchtverontreiniging
mist	lichte afname	iets minder luchtverontreiniging
verdamping	toename	warmer
droogte	toename	meer verdamping, minder zomer neerslag
hagel + onweer	toename	meer vocht => meer latente warmte
bewolking	afname in zomer in H-scenario's	meer droge oostenwind



Temperatuurscenario's



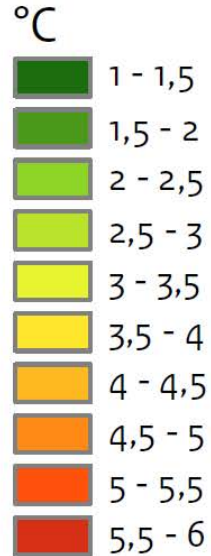
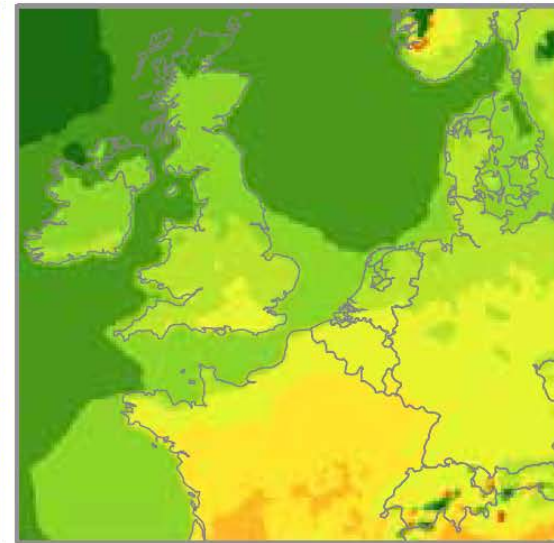
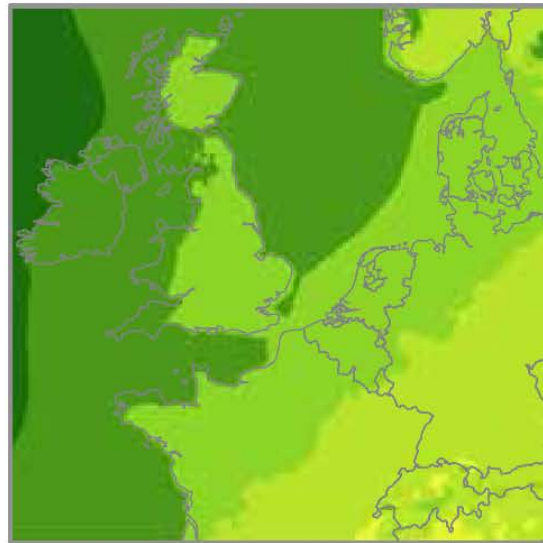
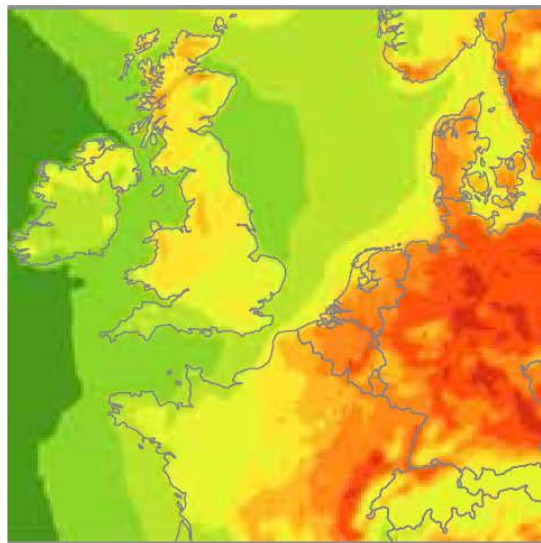


Temperatuurveranderingen

Koudste winterdagen

Jaargemiddelde

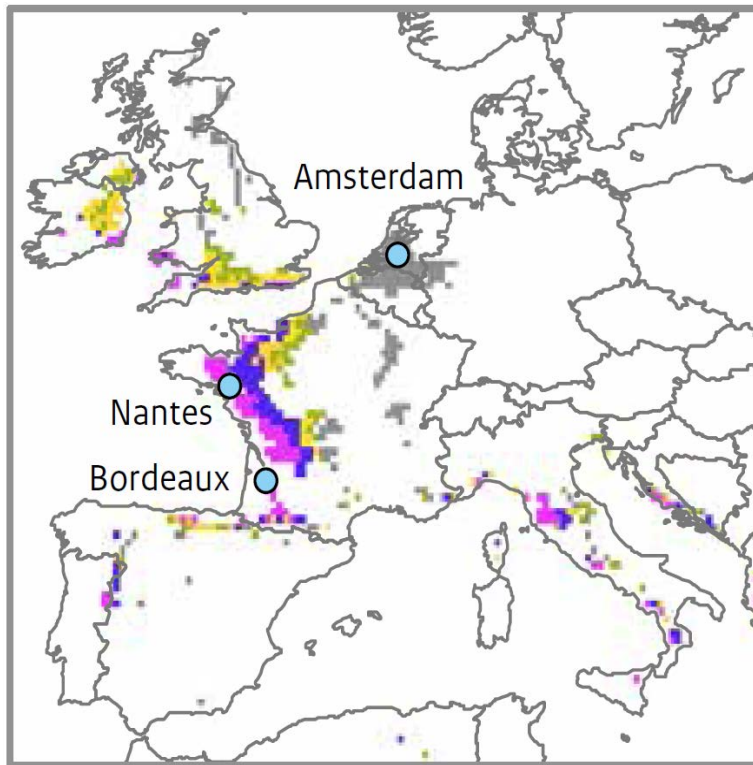
Warmste zomerdagen



WH, 2050

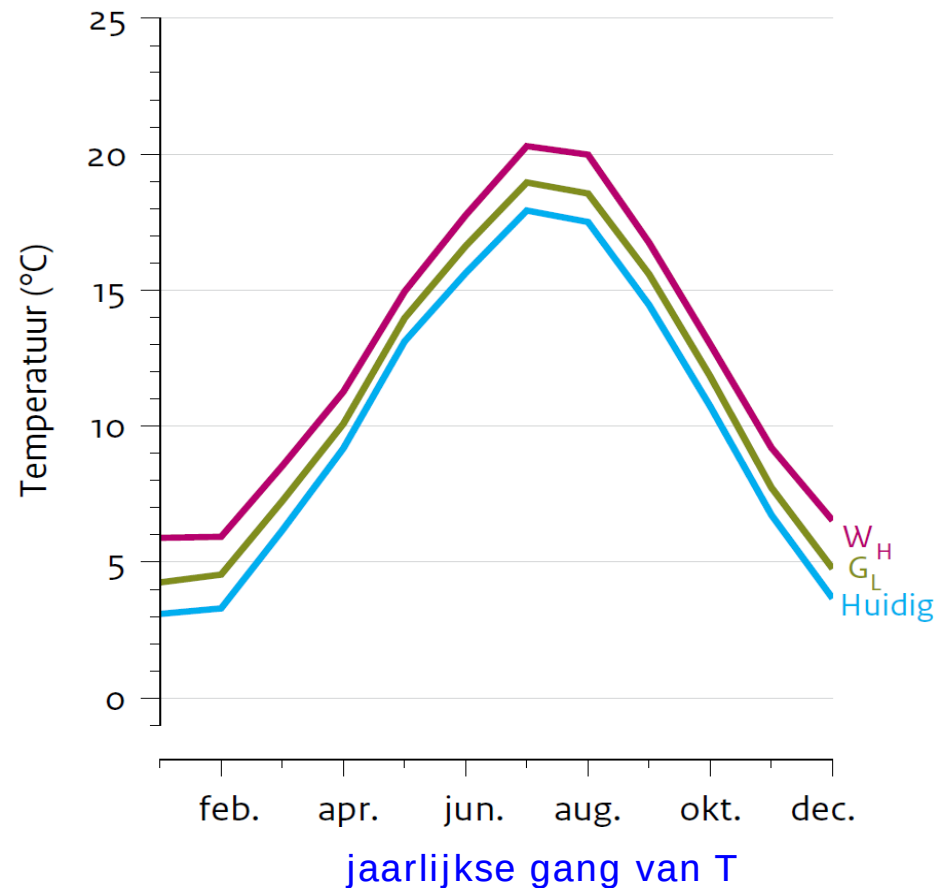


Weer van de toekomst (2050)



Huidig / G_L G_H W_L W_H

winter (T en P)



Algemene veranderingen

- de temperatuur blijft stijgen
- zachte winters en hete zomers komen vaker voor



- de neerslag en extreme neerslag in de winter nemen toe
- de intensiteit van extreme regenbuien in de zomer neemt toe
- hagel en onweer worden heviger



- de zeespiegel blijft stijgen
- het tempo van de zeespiegelstijging neemt toe



- de veranderingen in windsnelheid zijn klein



- het aantal dagen met mist neemt af en het zicht verbetert verder
- de hoeveelheid zonnestraling nabij het aardoppervlak neemt licht toe



Scenario verschillen en natuurlijke variaties

- temperatuurveranderingen zijn verschillend voor de vier scenario's
- veranderingen in 2050 en 2085 zijn groter dan de natuurlijke variaties op de 30-jaar tijdschaal



- meer droge zomers in twee (G_H en W_H) van de vier scenario's
- natuurlijke variaties in neerslag zijn relatief groot, zodat de scenario's minder van elkaar verschillen



- het tempo van de zeespiegelstijging hangt sterk af van de wereldwijde temperatuurstijging
- geen verschil tussen scenario's met verschillend luchtstromingspatroon



- 's winters vaker westenwind in twee (G_H en W_H) van de vier scenario's
- het wind- en stormklimaat vertoont grote natuurlijke variaties



- natuurlijke variaties zijn verschillend voor de verschillende klimaatvariabelen

