Koninklijk Nederlands Meteorologisch Instituut
Ministerie van Infrastructuur en Waterstaat

Deltares
Enabling Delta Life

Aggregated climate change scenarios for the Netherlands: their construction and stakeholder uptake

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Why develop climate scenarios?

- translation of IPCC findings to national context
- potential **indicators** of climate change and their **uncertainties**
- plausible and consistent **images of the future**
- potential **impacts** and key **vulnerabilities**

Cascade of scenario assumptions

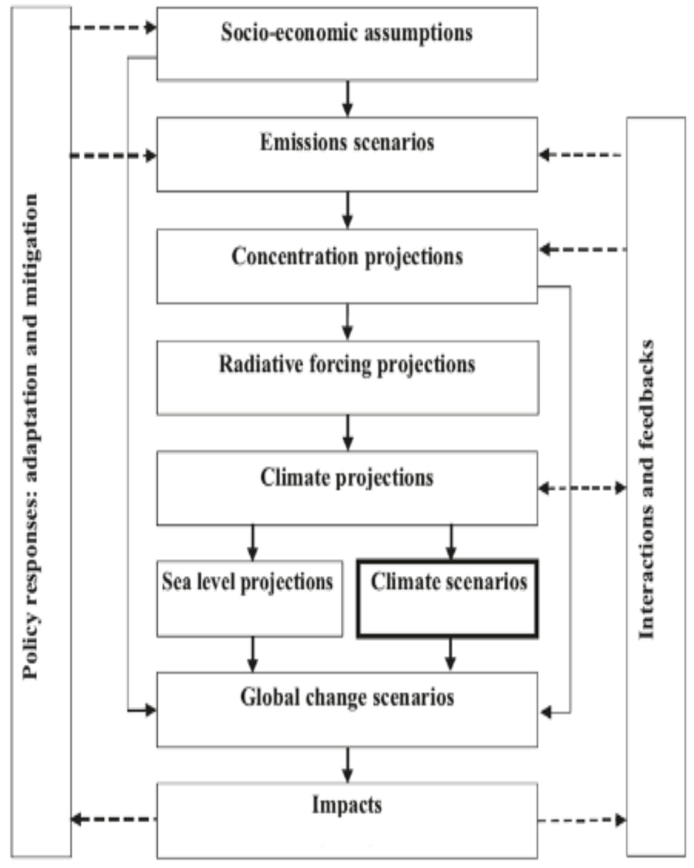
Socio economic scenarios

Emission scenarios

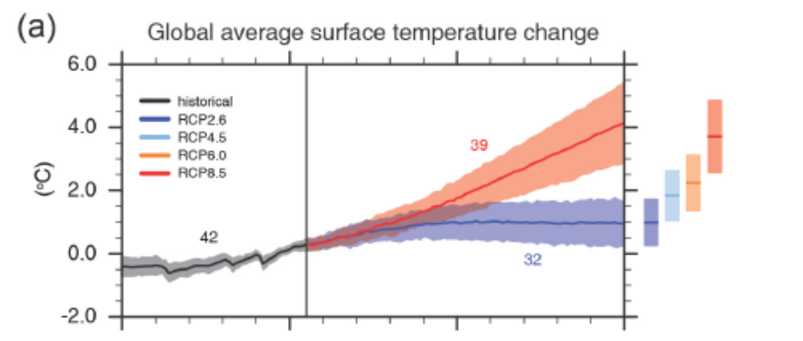
Concentration scenarios

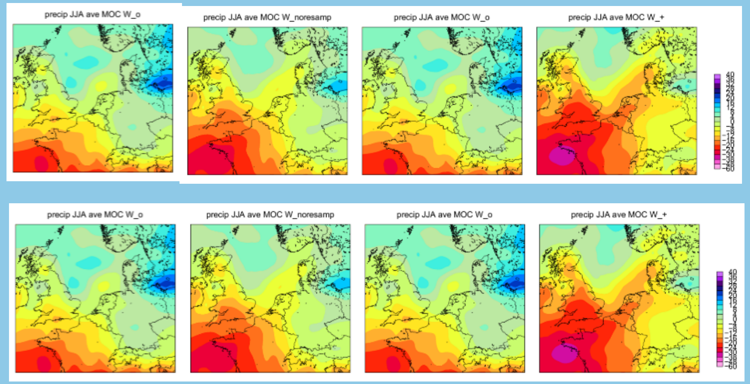
Climate change scenarios

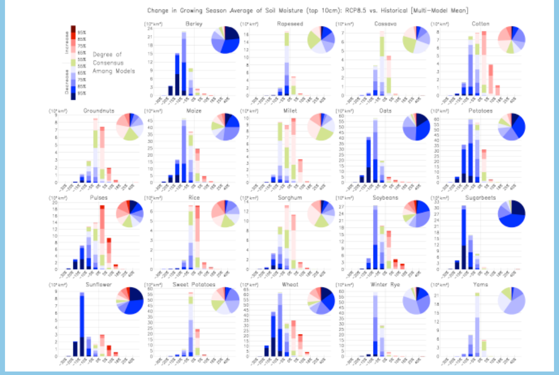
Climate impact scenarios



Source: After IPCC, AR3, WG 1 (2001), Chapter 13, Fig. 13.2

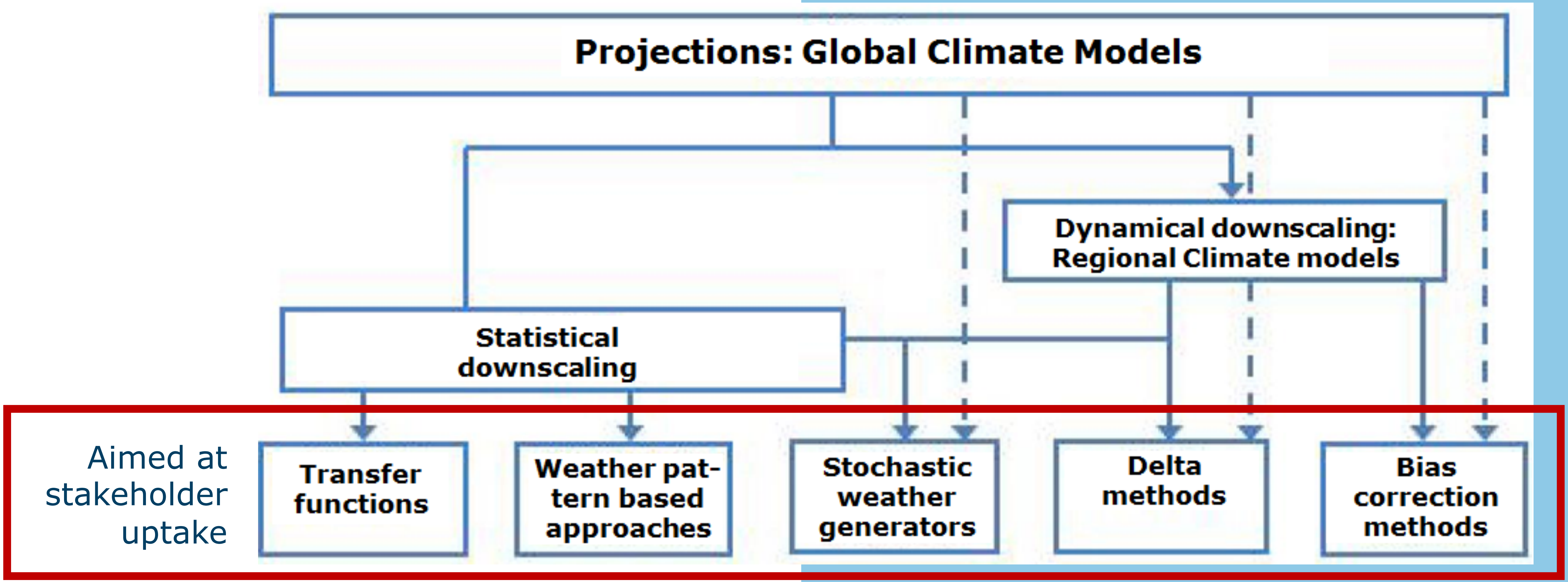






Downscaling and bias correction methods

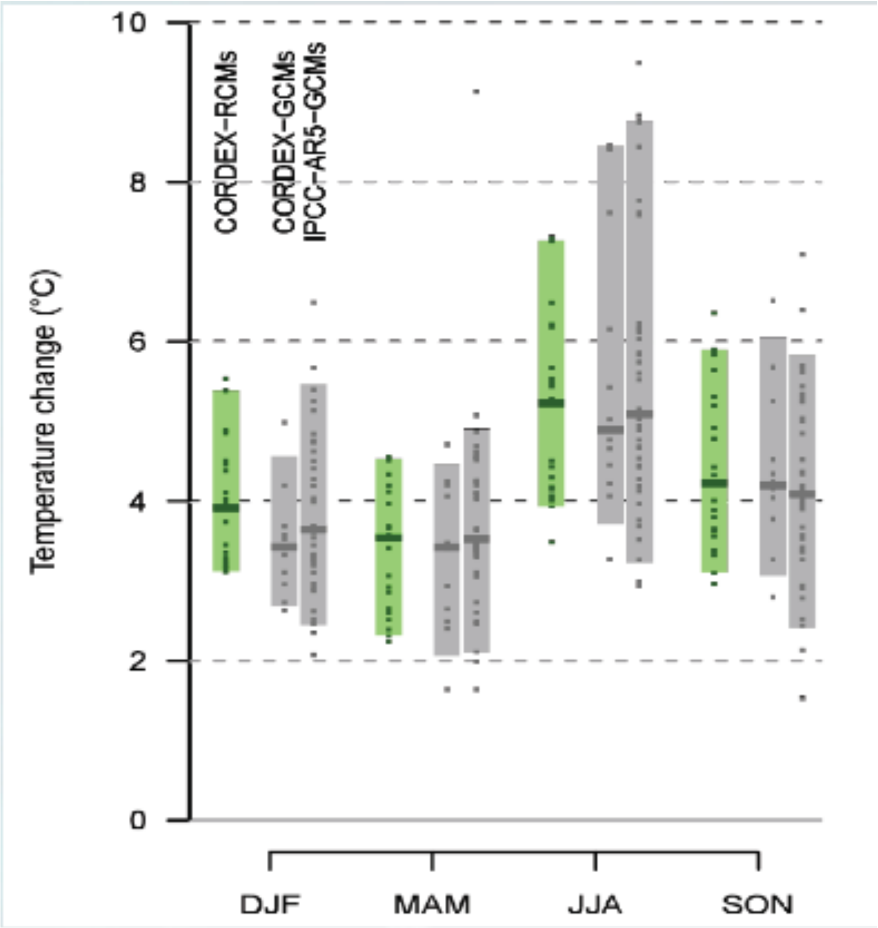
- statistical and dynamical downscaling methods
- often dynamical downscaling with the help of RCMs used



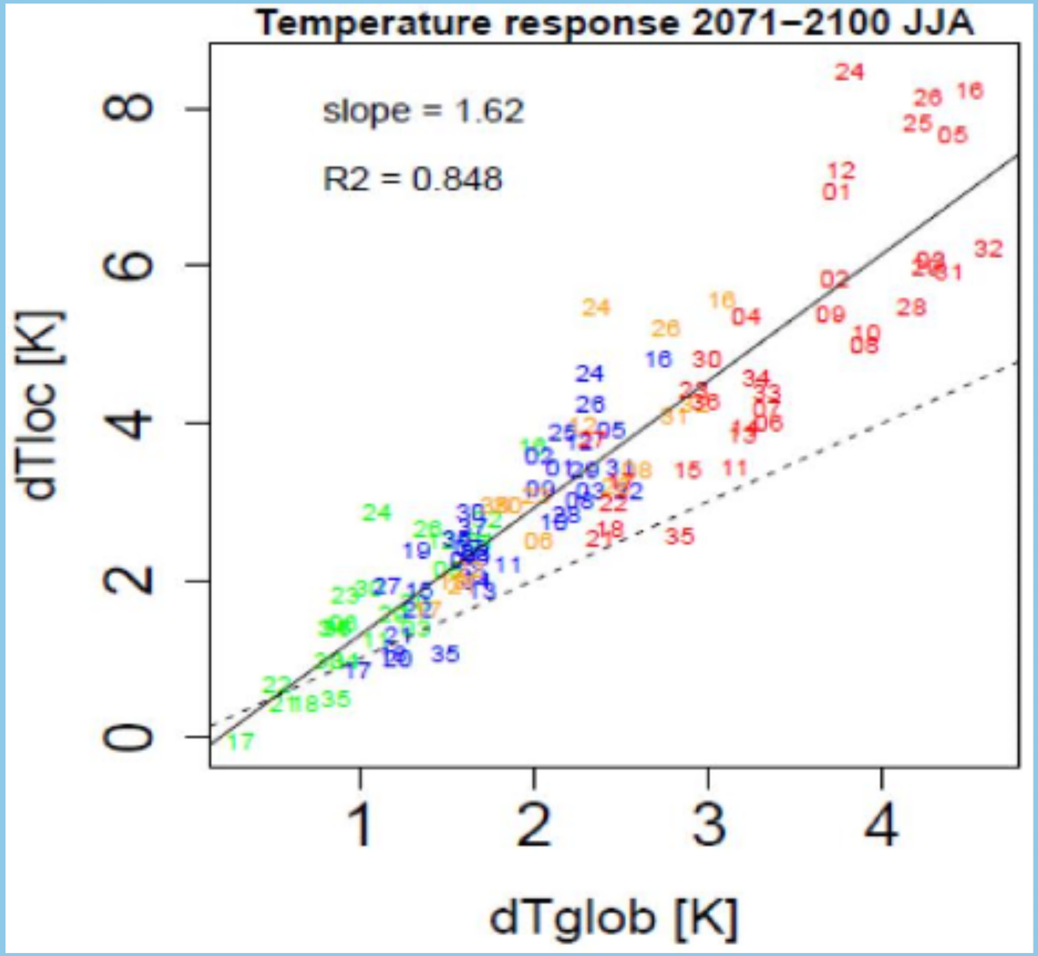
Large collection of European national climate scenarios

Country	Reference period	Time horizons	RCPs or emissions scenarios	Year publication
Austria	1971-2000	2021-2050, 2071-2100	4.5, 8.5	2015
Belgium	Not defined explicitly	30, 50 and 100 years ahead	Low, medium, high (4.5 + 8.5)	2015
Denmark	1986-2005	2046-2065, 2081-2100	2.6, 4.5, 6.0, 8.5	2014
France	1976-2005	2021-2050, 2041-2070, 2071-2100	2.6, 4.5, 8.5	2014?
Germany (Kliwas)	1961-1990	2021-2050, 2071-2100	Range of models (A1B)	2015
Ireland	1971-2000	2021-2050, 2071-2100	2.6, 8.5 (4.5)	2018
Netherlands	1981-2010	2016-2045, 2036-2065, 2071-2100	4.5-8.5	2014
Norway	1971-2000	2031-2060, 2071-2100	4.5, 8.5	2017
Portugal	1971-2000	2011-2040, 2041-2070, 2071-2100	4.5, 8.5	2015?
Spain	1961-1990, 1961-2000	2046-2065, 2081-2100	4.5, 6.0, 8.5	2014?
Sweden	1971-2000	2011-2040, 2041-2070, 2071-2100	2.6, 4.5, 8.5 (A1B)	2014
Switzerland	1981-2010	2020-2049, 2045-2074, 2070-2099	2.6, 4.5, 8.5	2018
United Kingdom	1981-2010, 1961-1990	2020-2039 to 2080-2099 (20-year periods)	2.6, 4.5, 6.0, 8.5	2018

Dutch approach a bit different



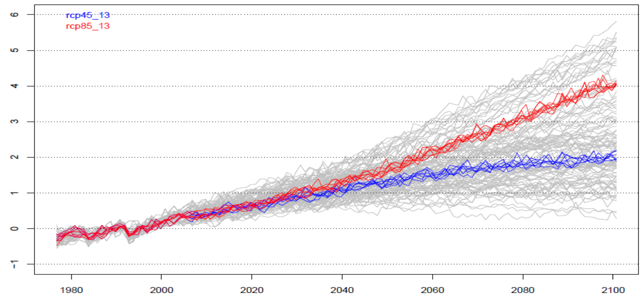
Switzerland: downscaling chain

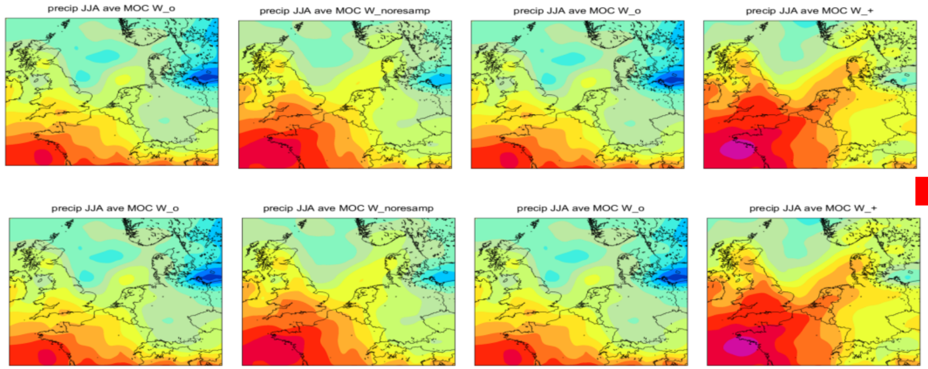


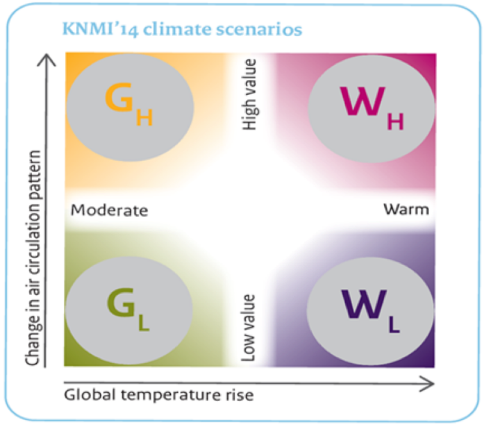
Netherlands: decomposition of ensemble between **global** response and **local** feedback

What are (KNMI'14) climate scenarios?

› (1) A comprehensive summary of large ensemble of climate projections







What are (KNMI'14) climate scenarios?

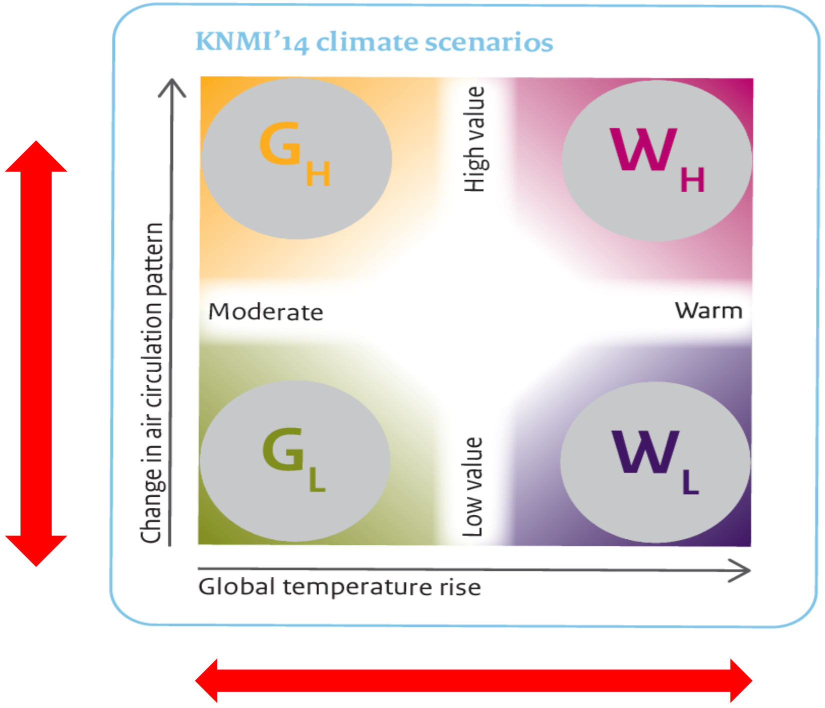
› (1) A comprehensive summary of large ensemble of climate projections

Separating two important drivers:

– Global temperature change

– Anomalies related to variations in

- regional atm. circulation (precipitation, extremes)
- ice cap dynamics (sea level rise)



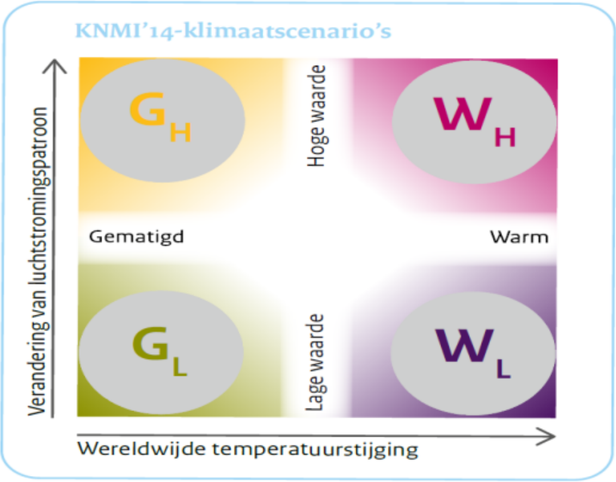
Local feedback may be different for different regions/climate zones

(monsoon, snow or land surface feedback, local SST patterns, …)

› Aggregation … locally relevant scenarios

What are (KNMI’14) climate scenarios?

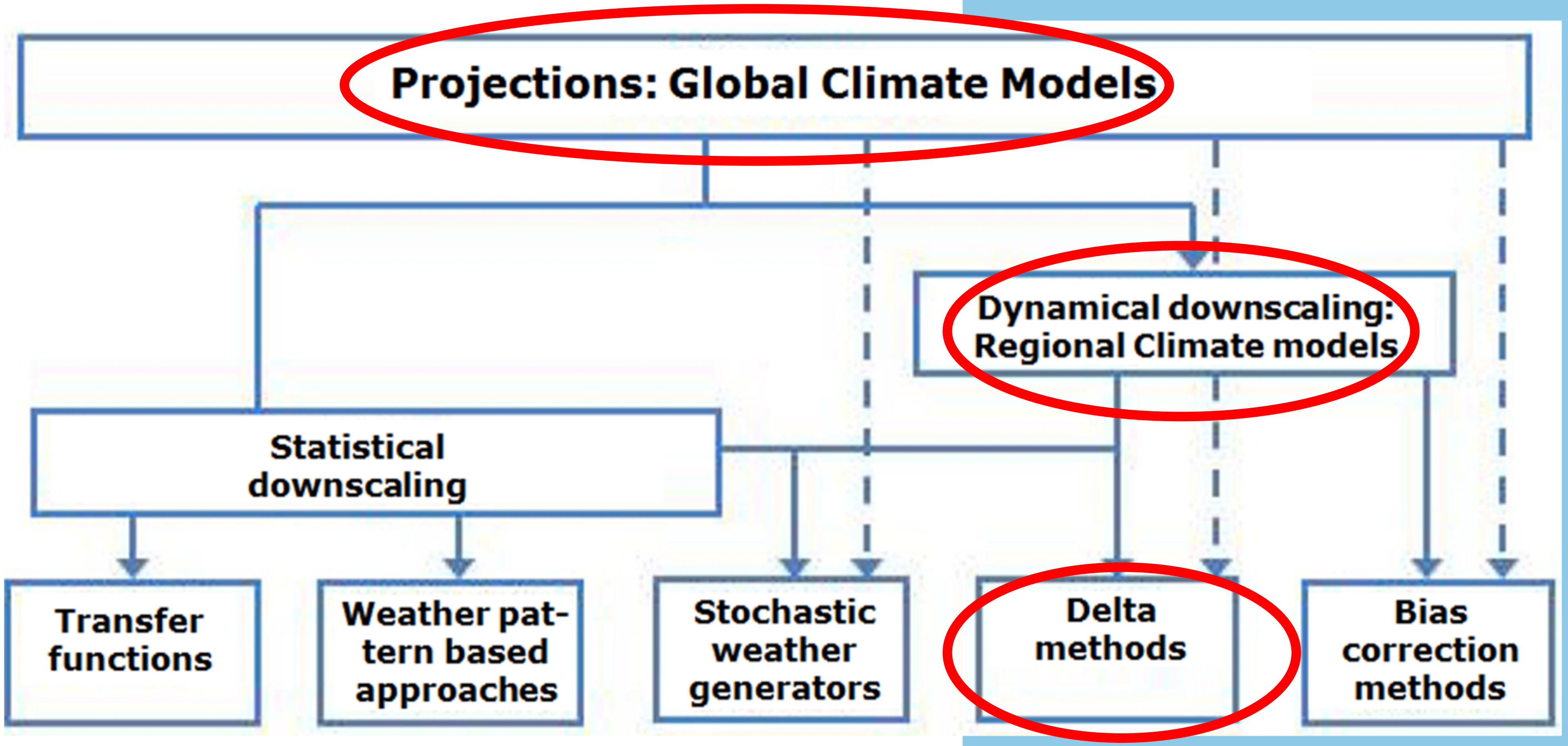
› (2) A local interpretation of this summary



Scenario change values for the climate around 2050 (2036-2065)				Scenario change values for the climate around 2085 (2071-2100)				Natural variations averaged over 30 years
G_L	G_H	W_L	W_H	G_L	G_H	W_L	W_H	
+1 °C	+1 °C	+2 °C	+2 °C	+1.5 °C	+1.5 °C	+3.5 °C	+3.5 °C	
Low value	High value	Low value	High value	Low value	High value	Low value	High value	
+15 to +30 cm	+15 to +30 cm	+20 to +40 cm	+20 to +40 cm	+25 to +60 cm	+25 to +60 cm	+45 to +80 cm	+45 to +80 cm	±1.4 cm
+1 to +5.5 mm/year	+1 to +5.5 mm/year	+3.5 to +7.5 mm/year	+3.5 to +7.5 mm/year	+1 to +7.5 mm/year	+1 to +7.5 mm/year	+4 to +10.5 mm/year	+4 to +10.5 mm/year	±1.4 mm/year
+1.0 °C	+1.4 °C	+2.0 °C	+2.3 °C	+1.3 °C	+1.7 °C	+2.8 °C	+3.7 °C	±0.16 °C
+4%	+2.5%	+5.5%	+5%	+5%	+5%	+6%	+7%	±4.2%
+0.6%	+1.6%	-0.8%	+1.2%	-0.5%	+1.1%	-0.8%	+1.4%	±1.6%
+3%	+5%	+4%	+7%	+2.5%	+5.5%	+6%	+10%	±1.9%
-110 hours	-110 hours	-110 hours	-110 hours	-120 hours	-120 hours	-120 hours	-120 hours	±39 hours
+1.1 °C	+1.6 °C	+2.1 °C	+2.7 °C	+1.3 °C	+2.0 °C	+2.8 °C	+4.1 °C	±0.48 °C
-8%	-16%	-13%	-20%	-10%	-17%	-13%	-24%	-
+1.0 °C	+1.6 °C	+2.0 °C	+2.5 °C	+1.2 °C	+2.0 °C	+2.7 °C	+3.8 °C	±0.46 °C
+1.1 °C	+1.7 °C	+2.2 °C	+2.8 °C	+1.4 °C	+2.1 °C	+3.0 °C	+4.4 °C	±0.51 °C
+2.0 °C	+3.6 °C	+3.9 °C	+5.1 °C	+2.7 °C	+4.1 °C	+4.8 °C	+7.3 °C	±0.91 °C
+0.6 °C	+0.9 °C	+1.7 °C	+1.7 °C	+1.0 °C	+1.2 °C	+2.4 °C	+3.1 °C	±0.42 °C
-30%	-45%	-50%	-60%	-35%	-50%	-60%	-80%	±9.5%
-50%	-70%	-70%	-90%	-60%	-80%	-80%	< -90%	±31%
+3%	+8%	+8%	+17%	+4.5%	+12%	+11%	+30%	±8.3%
+4.5%	+9%	+10%	+17%	+6.5%	+12%	+14%	+30%	-
+6%	+10%	+12%	+17%	+8%	+12%	+16%	+25%	±11%
-0.3%	+1.4%	-0.4%	+2.4%	+0.3%	+1.0%	-0.9%	+3%	±4.7%
+9.5%	+19%	+20%	+35%	+14%	+24%	+30%	+60%	±14%
-1.1%	+0.5%	-2.5%	+0.9%	-2.0%	+0.5%	-2.5%	+2.2%	±3.6%
-3%	-1.4%	-3%	0.0%	-2.0%	-0.9%	-1.8%	+2.0%	±3.9%
-1.4%	+3%	-1.7%	+4.5%	-1.6%	+6.5%	-6.5%	+4%	±6.4%
+0.9 °C	+1.1 °C	+1.8 °C	+2.1 °C	+1.2 °C	+1.5 °C	+2.4 °C	+3.1 °C	±0.24 °C
+4.5%	+2.3%	+11%	+9%	+8%	+7.5%	+13%	+12%	±8.0%
+1.0 °C	+1.4 °C	+1.7 °C	+2.3 °C	+1.2 °C	+1.7 °C	+2.7 °C	+3.7 °C	±0.25 °C
+3.5%	+7.5%	+4%	+9.5%	+5%	+9%	+6.5%	+14%	-
+0.9 °C	+1.4 °C	+1.5 °C	+2.3 °C	+1.0 °C	+1.7 °C	+2.6 °C	+3.8 °C	±0.35 °C
+1.1 °C	+1.3 °C	+1.9 °C	+2.2 °C	+1.4 °C	+1.7 °C	+2.9 °C	+3.7 °C	±0.18 °C
+0.9 °C	+1.1 °C	+1.6 °C	+2.0 °C	+1.0 °C	+1.4 °C	+2.3 °C	+3.1 °C	±0.43 °C
+1.4 °C	+1.9 °C	+2.3 °C	+3.3 °C	+2.0 °C	+2.6 °C	+3.6 °C	+4.9 °C	±0.52 °C
+22%	+35%	+40%	+70%	+30%	+50%	+90%	+130%	±13%
+0.5%	+0.6%	+1.4%	+2.2%	+0.9%	+1.2%	+4.5%	+7.5%	-
+1.2%	-8%	+1.4%	-13%	+1.0%	-8%	-4.5%	-23%	±9.2%
+2.1 to +5%	-2.5 to +1.0%	+1.4 to +7%	-4 to +2.2%	+1.2 to +5.5%	-2.5 to +1.9%	-0.6 to +9%	-8.5 to +2.3%	-
+1.7 to +10%	+2.0 to +13%	+3 to +21%	+2.5 to +22%	+2.5 to +15%	+2.5 to +17%	+5 to +35%	+5 to +40%	±15%
+5.5 to +11%	+7 to +14%	+12 to +23%	+13 to +25%	+8 to +16%	+9 to +19%	+19 to +40%	+22 to +45%	±14%
+0.5%	-5.5%	+0.7%	-10%	+2.1%	-5.5%	+4%	-16%	±6.4%
+4.5 to +18%	-4.5 to +10%	+6 to +30%	-8.5 to +14%	+5 to +23%	-3.5 to +14%	+2.5 to +35%	-15 to +14%	±24%
+2.1%	+5%	+1.0%	+6.5%	+0.9%	+5.5%	+3%	+9.5%	±2.4%
-0.6%	-2.0%	+0.1%	-2.5%	0.0%	-2.0%	-0.6%	-3%	±0.86%
+4%	+7%	+4%	+11%	+3.5%	+8.5%	+8%	+15%	±2.8%
+4.5%	+20%	+0.7%	+30%	+1.0%	+19%	+13%	+50%	±13%
+5%	+17%	+4.5%	+25%	+3.5%	+17%	+14%	+40%	-
+1.1 °C	+1.3 °C	+2.2 °C	+2.3 °C	+1.6 °C	+1.6 °C	+3.3 °C	+3.8 °C	±0.27 °C
+7%	+8%	+3%	+7.5%	+7.5%	+9%	+5.5%	+12%	±9.0%

- Long table of relevant climatological indicators and their change
- Table is based on stakeholder consultations
- Well embedded in Dutch water management design

Downscaling and bias correction methods



Potential range of change

More detailed info for the Netherlands

Time series for the future

Transformation of time series for rainfall

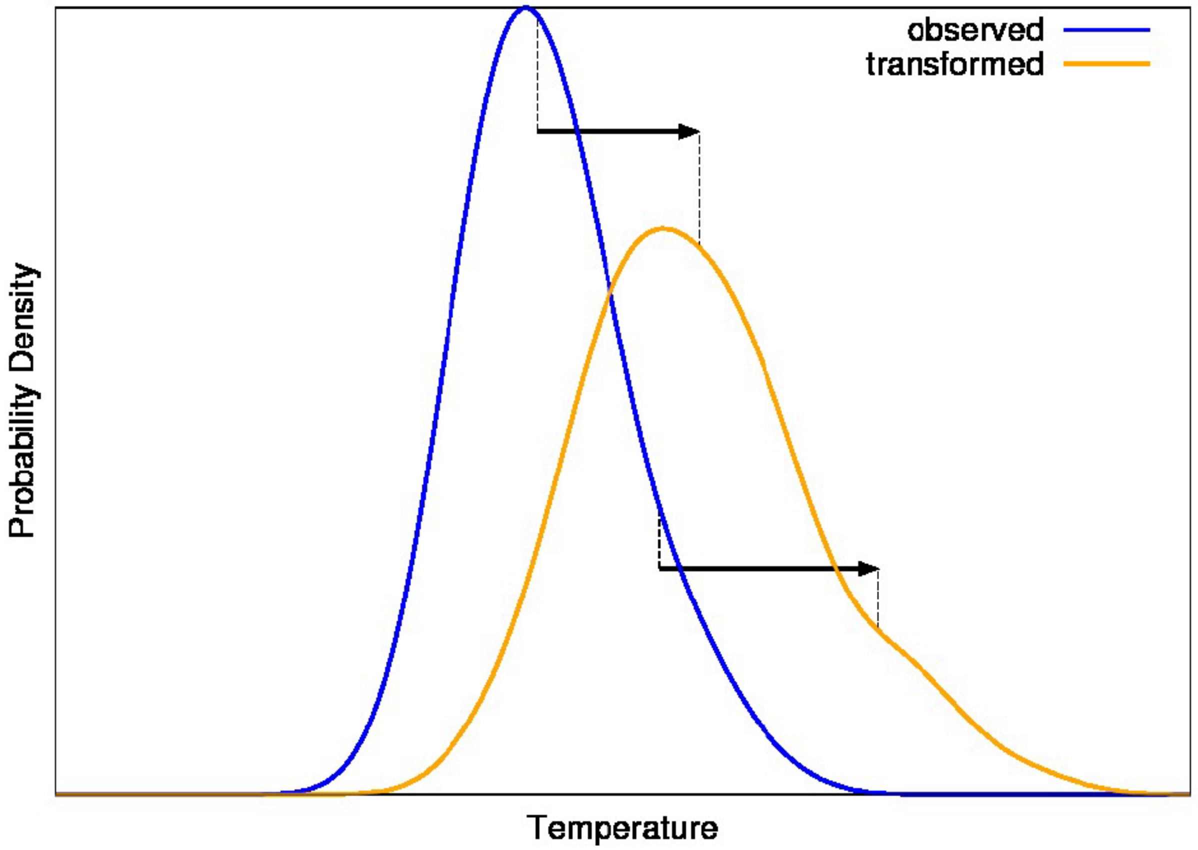
Add/subtract change from climate model projections to observed climate time series

Advantage:

- Local observations (also used for current-day system analyses) act as baseline
- Relatively simple procedure

Disadvantage:

- Operation can become complex (change in mean ≠ change in extreme)
- Historical sequence of events is inherited from baseline record (not all changes can be applied)



Transformation time series for 2050 rainfall

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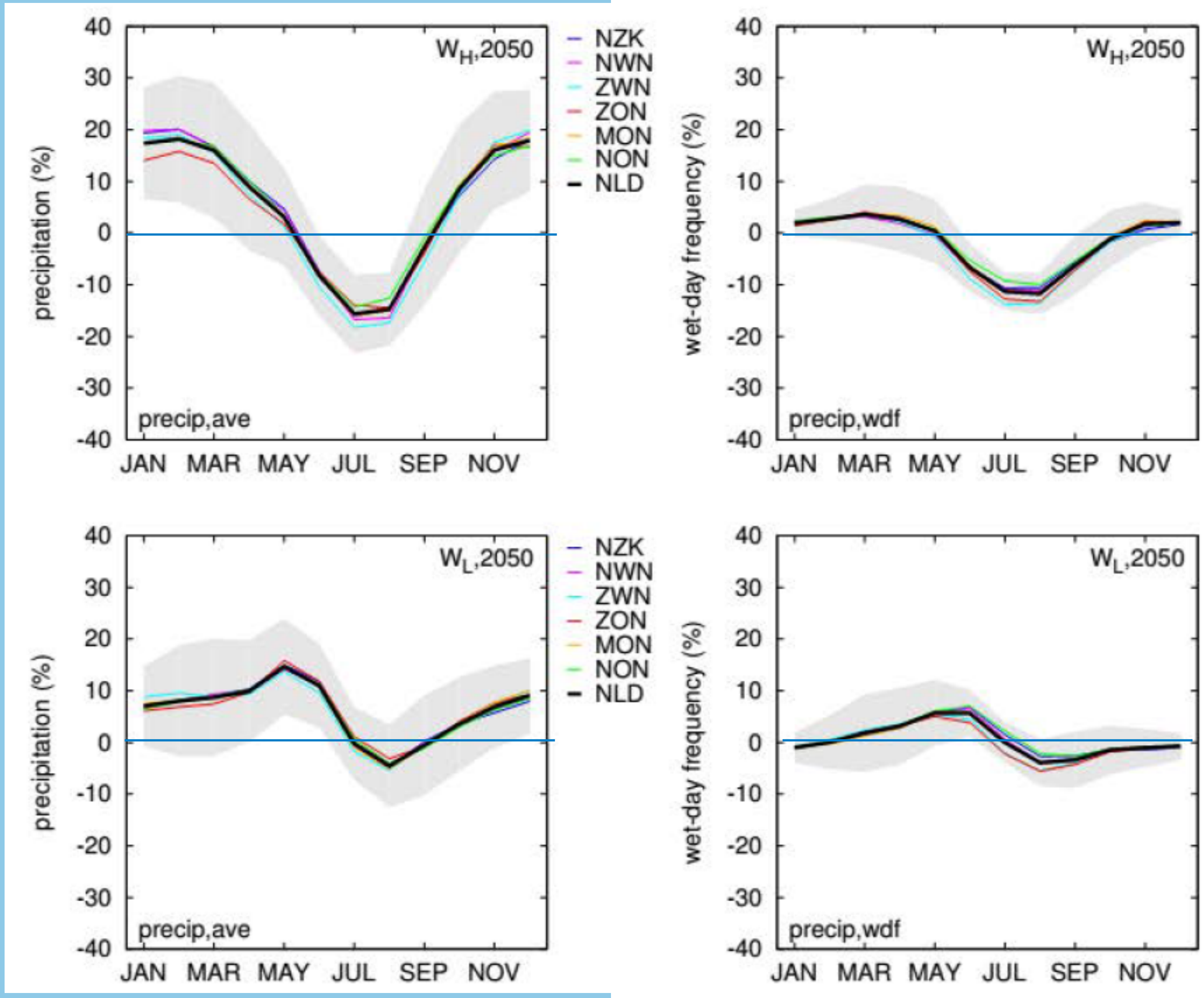
Scenario W_H

Average rainfall

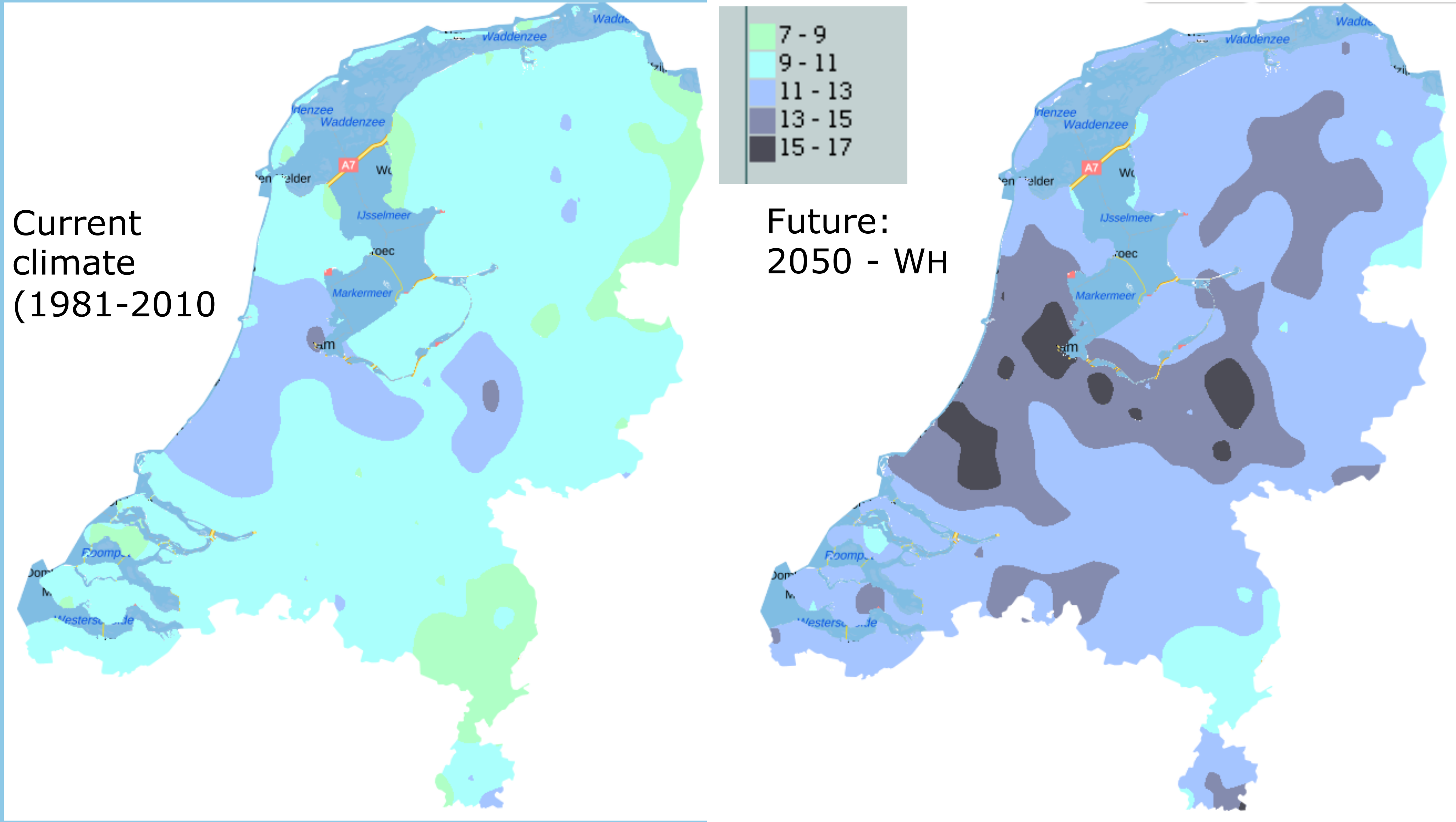


Wet day frequency

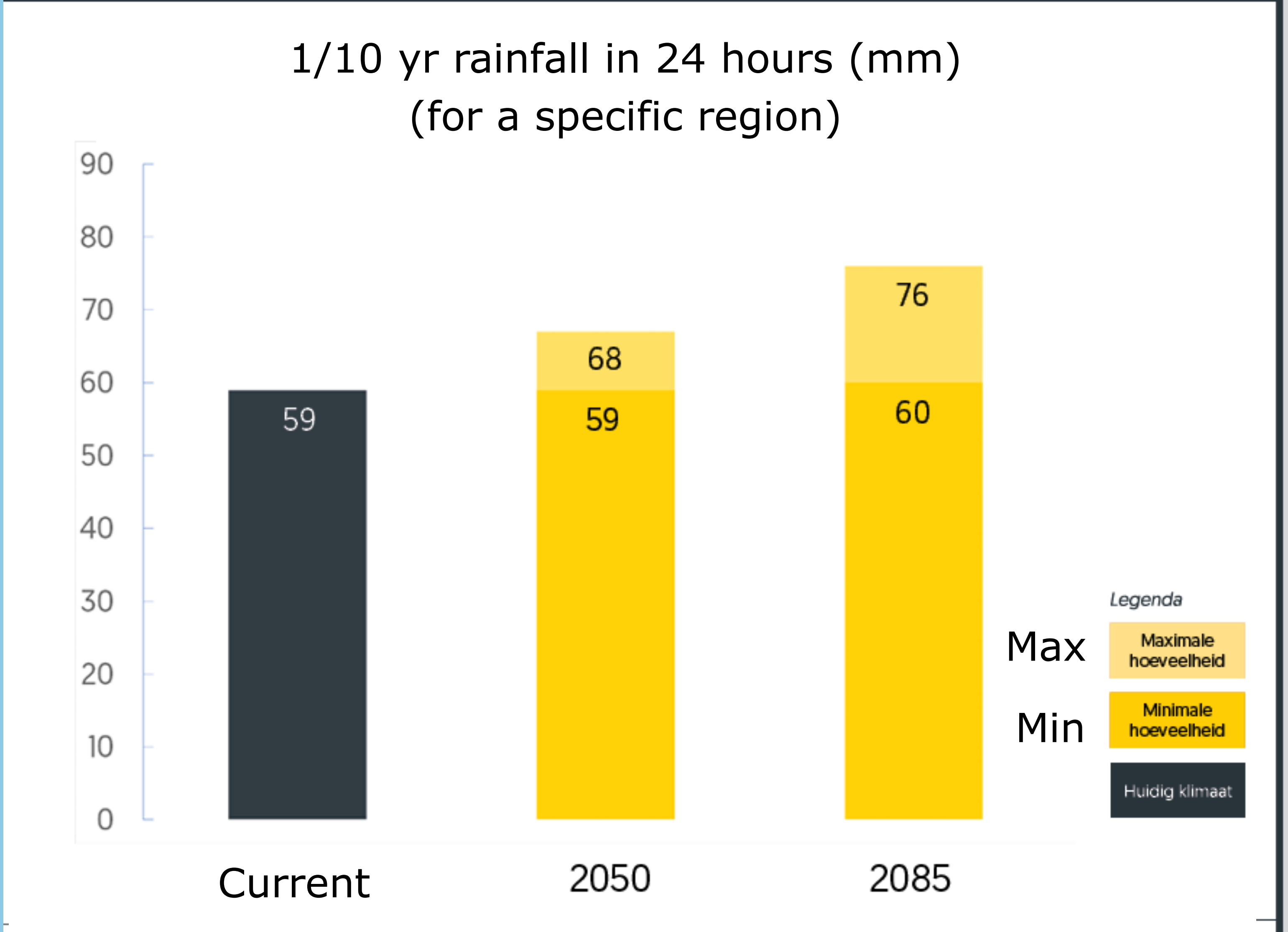
Scenario W_L

Climate Impact Atlas

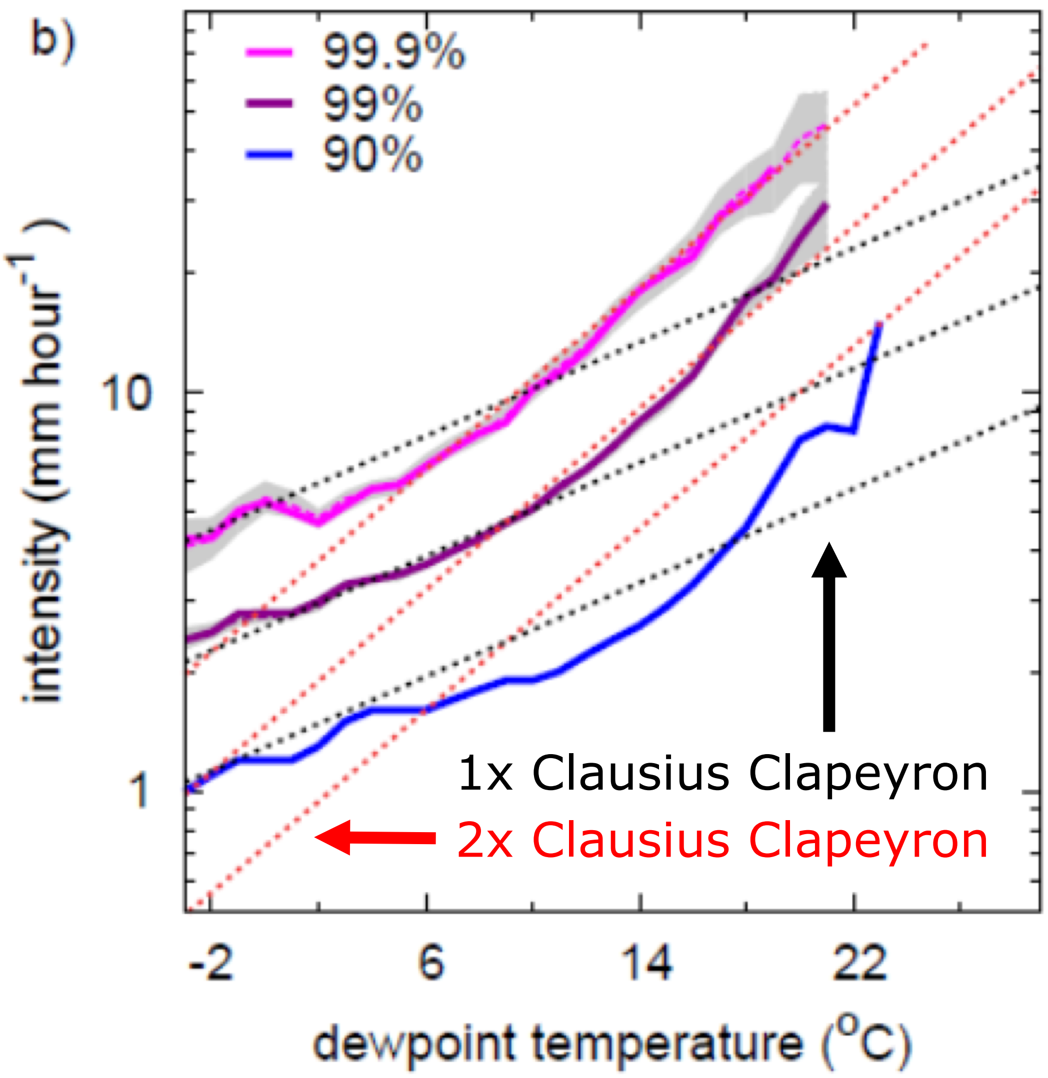
Days per year with ≥ 15 mm



Climate Impact Atlas



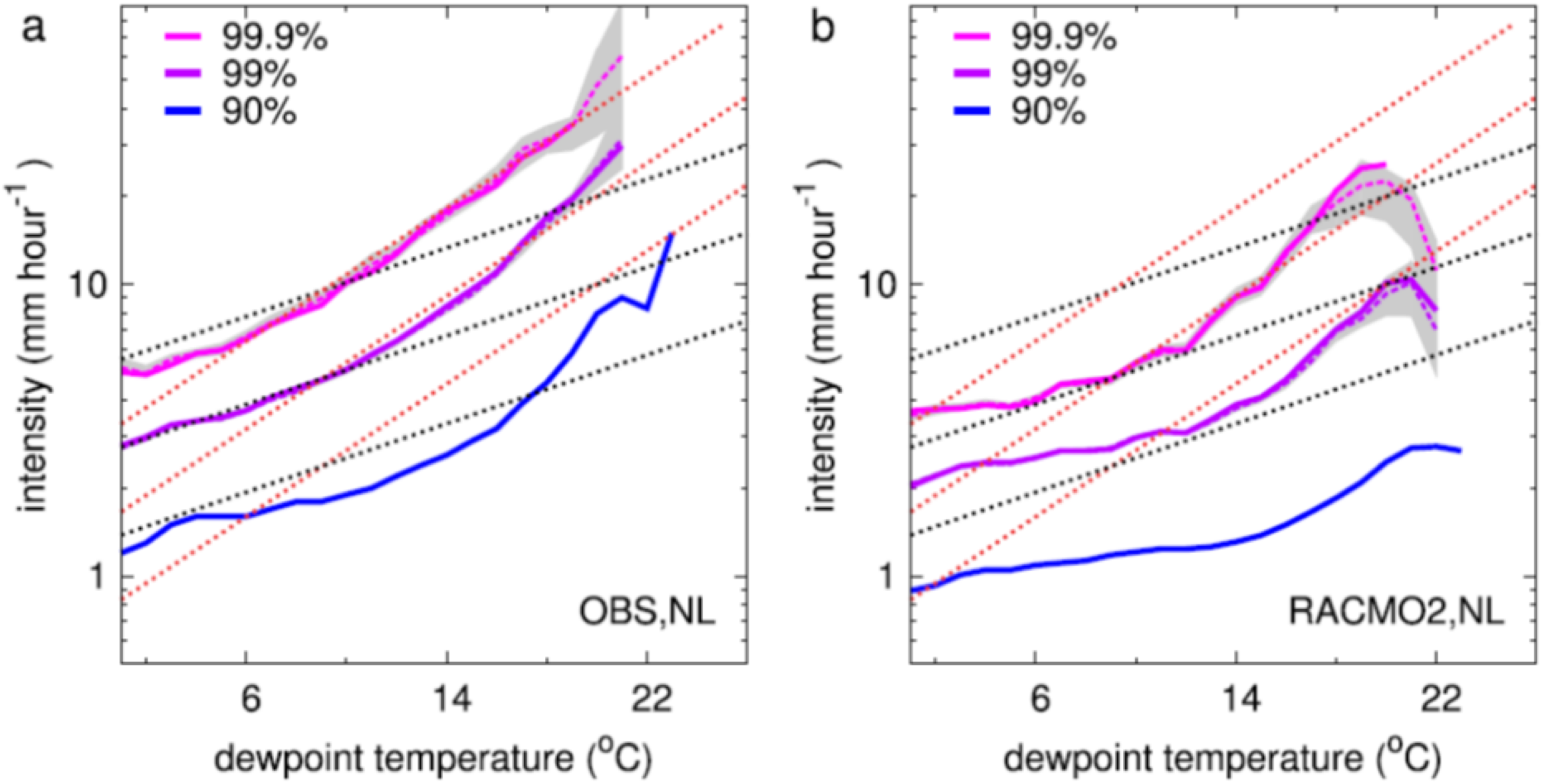
Short duration rainfall extremes



In observations:

- At higher temperatures faster increase of hourly rainfall extremes than Clausius Clapeyron

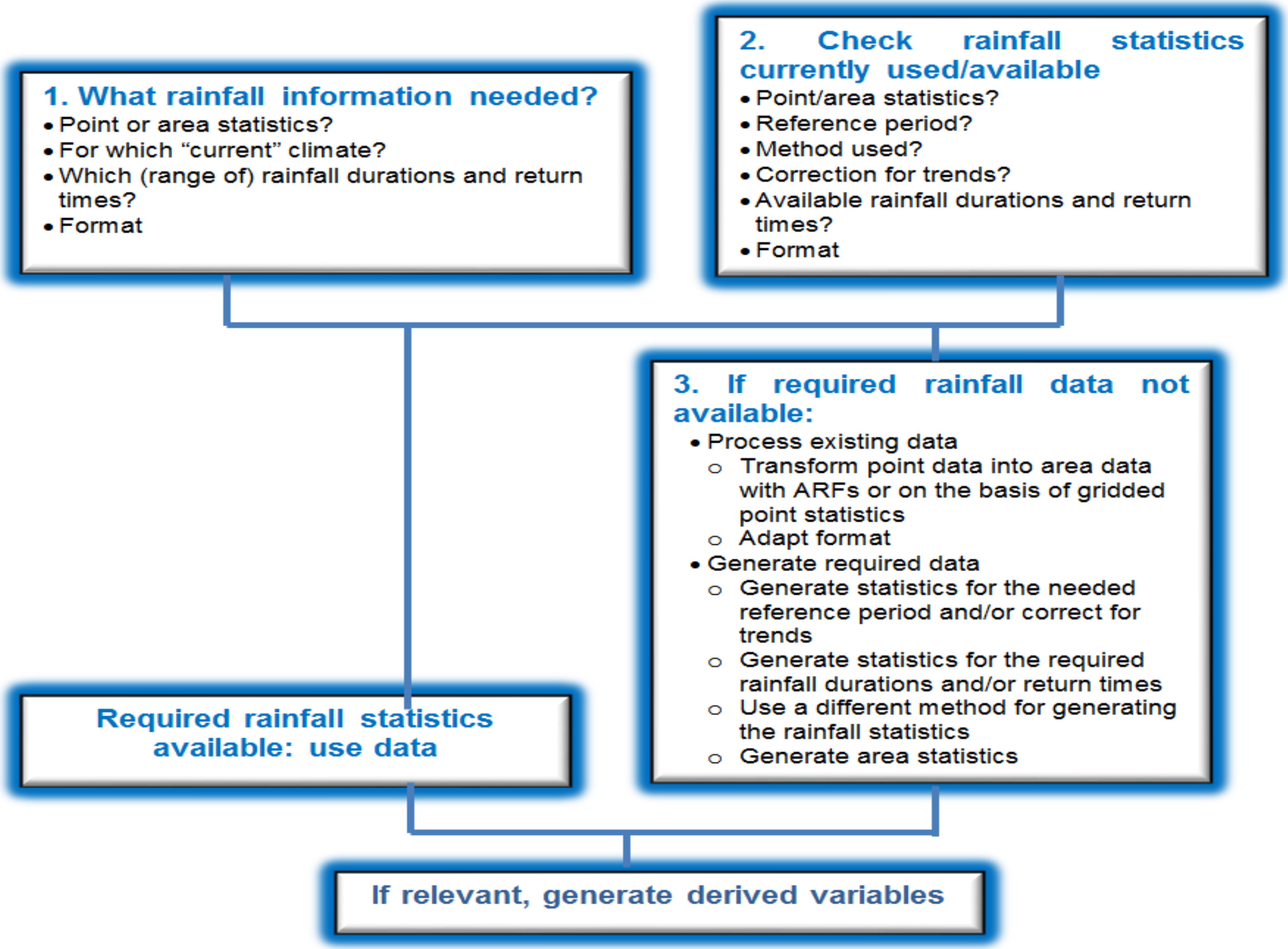
Short duration rainfall extremes



- Most current climate models do not simulate convective rainfall well
- High resolution models perform better

Protocol extreme precipitation information

Systematic survey of required and currently available information and methods to close gaps



Take home messages

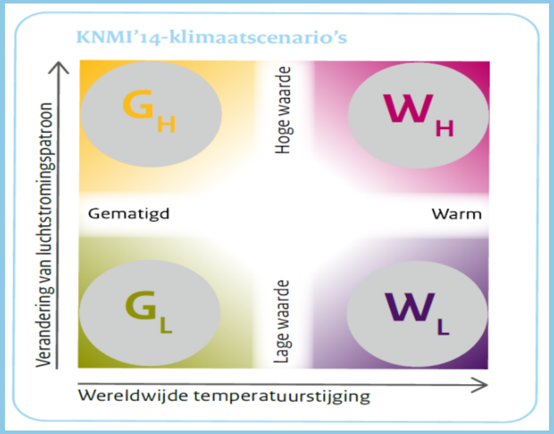
Climate scenarios need to

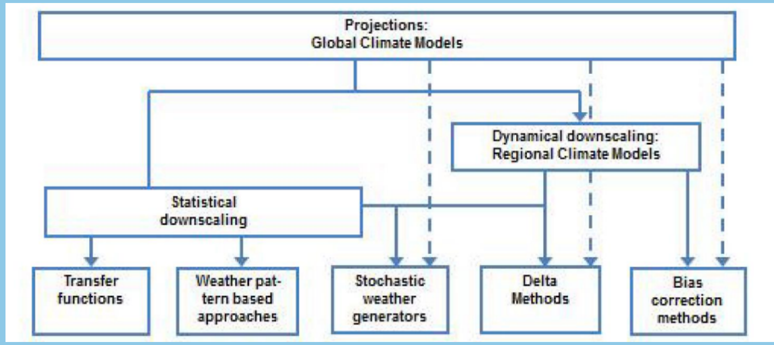
- **Aggregate** uncertain information
- Relate to **impacts**

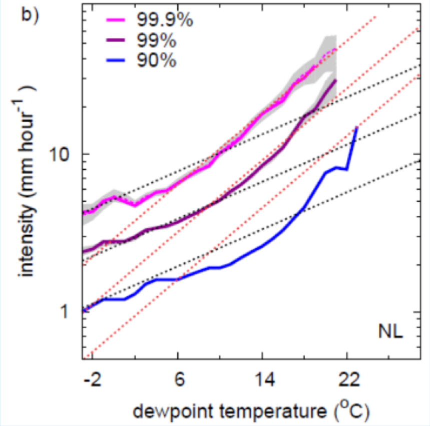
Multiple (downscaling) steps are required

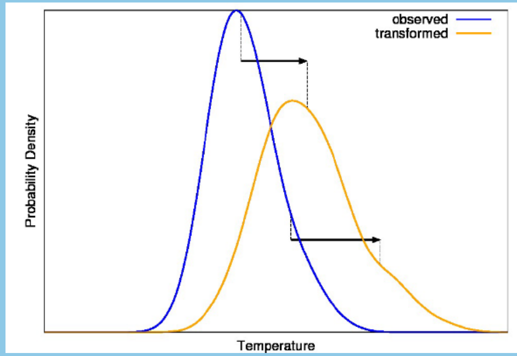
Local uptake of scenario information requires

- A good **physical** narrative
- A simple procedure to **ingest** scenario information to local applications
- Long-term interaction with users









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