Koninklijk Nederlands
Meteorologisch Instituut
Ministerie van Infrastructuur en Milieu

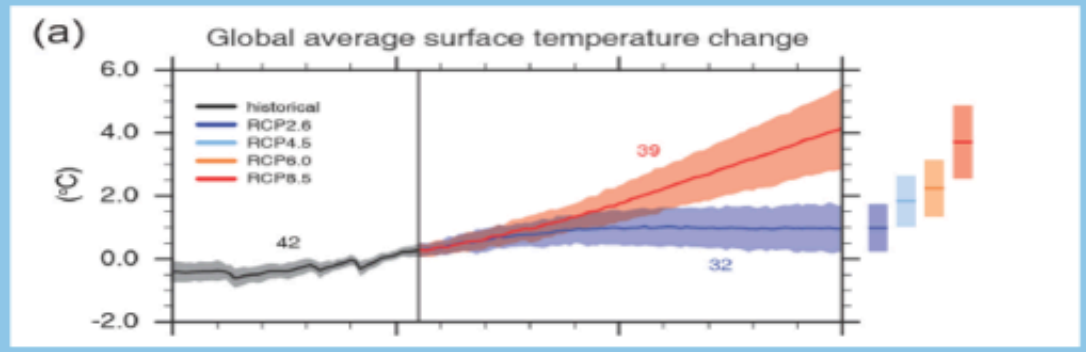
Exploiting the climate archives for meaningful events

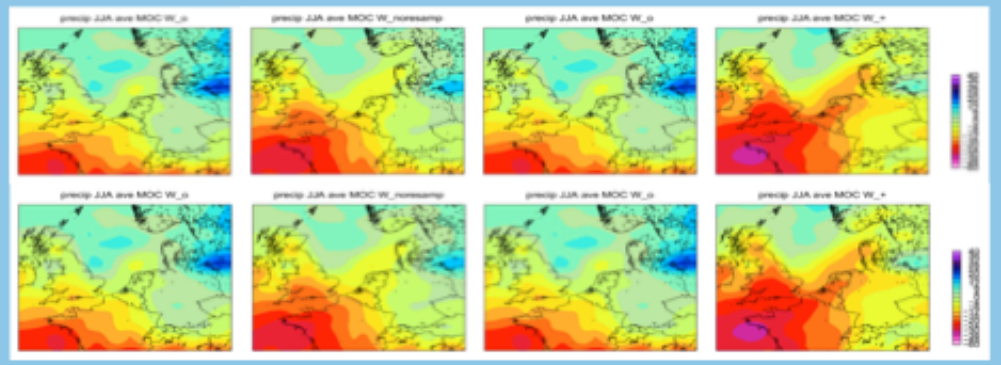
Bart van den Hurk (KNMI)
Jakob Zscheischler (ETH)

acknowledging Ted Shepherd
(U. Reading)

The "IPCC" approach

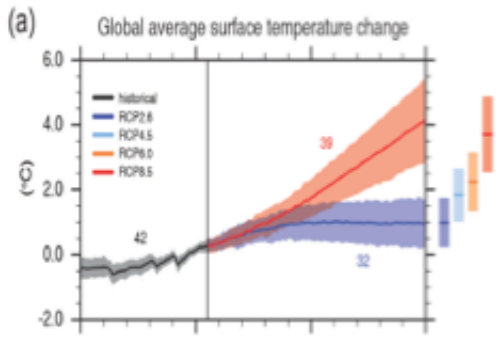
- Future conditions are mapped using a scenario framework
  - complex GCMs as major mapping tool
  - Regional downscaling to generate "locally relevant" information
  - Detailled impact modelling to generate sector/region specific information





Local "actionable" scenarios

- (1) Synthesis of the large ensemble
- (2) A local interpretation of this summary



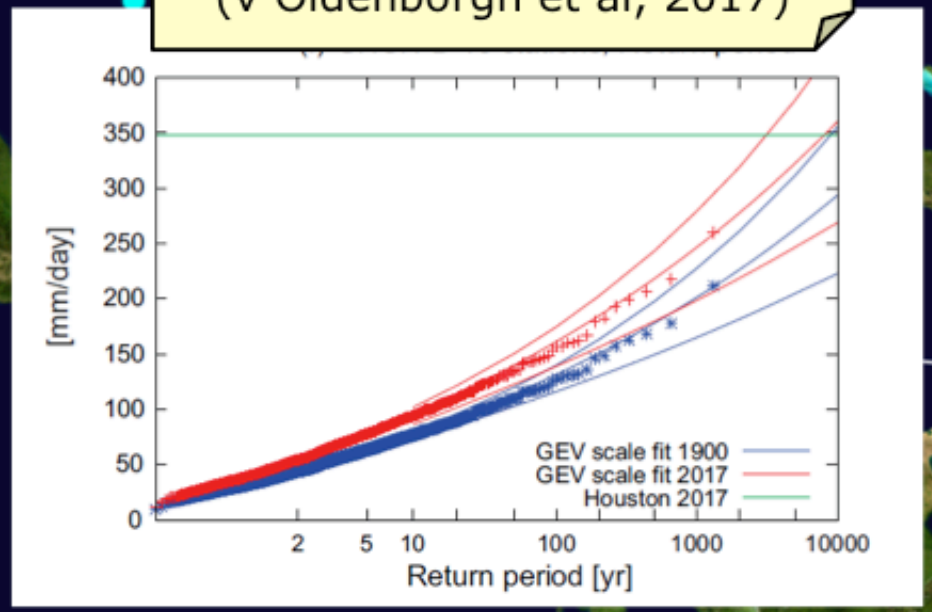
- Well embedded in Dutch water management design

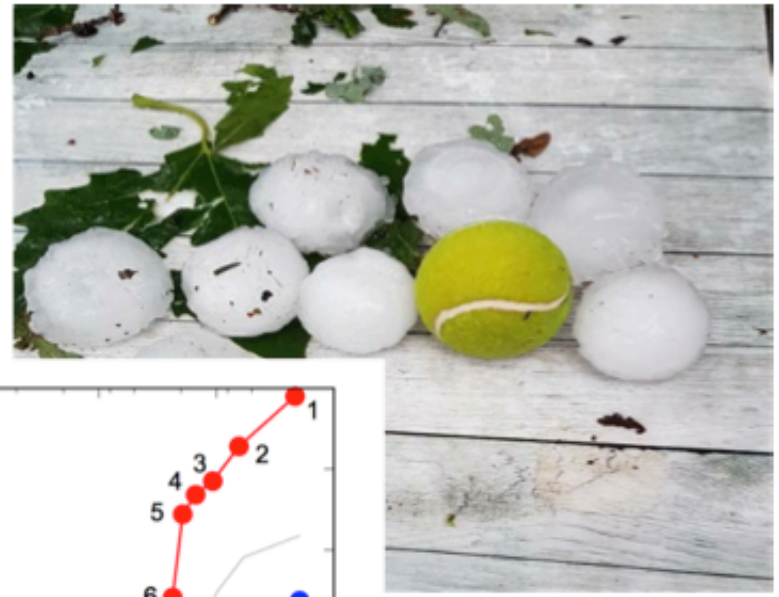
Scenario change values for the climate around 2050 (2036-2065)				Scenario change values for the climate around 2085 (2071-2100)				Natural variations averaged over 30 years[1]
G_L	G_H	W_L	W_H	G_L	G_H	W_L	W_H	
+1 °C	+1 °C	+2 °C	+2 °C	+1.5 °C	+1.5 °C	+3.5 °C	+3.5 °C	
Low value	High value	Low value	High 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								
+0.6								
-3								
-5								
+								
+4.5								
+								
-0.3								
+9.5								
-1.								
-								
-1.4								
+0.9								
+4.5								
+1.0								
+3.5								
+0.9								
+1.1								
+0.9								
+1.4								
+2								
+0.5								-
+1.2								▲9.2%
+2.1 to +								-
+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%

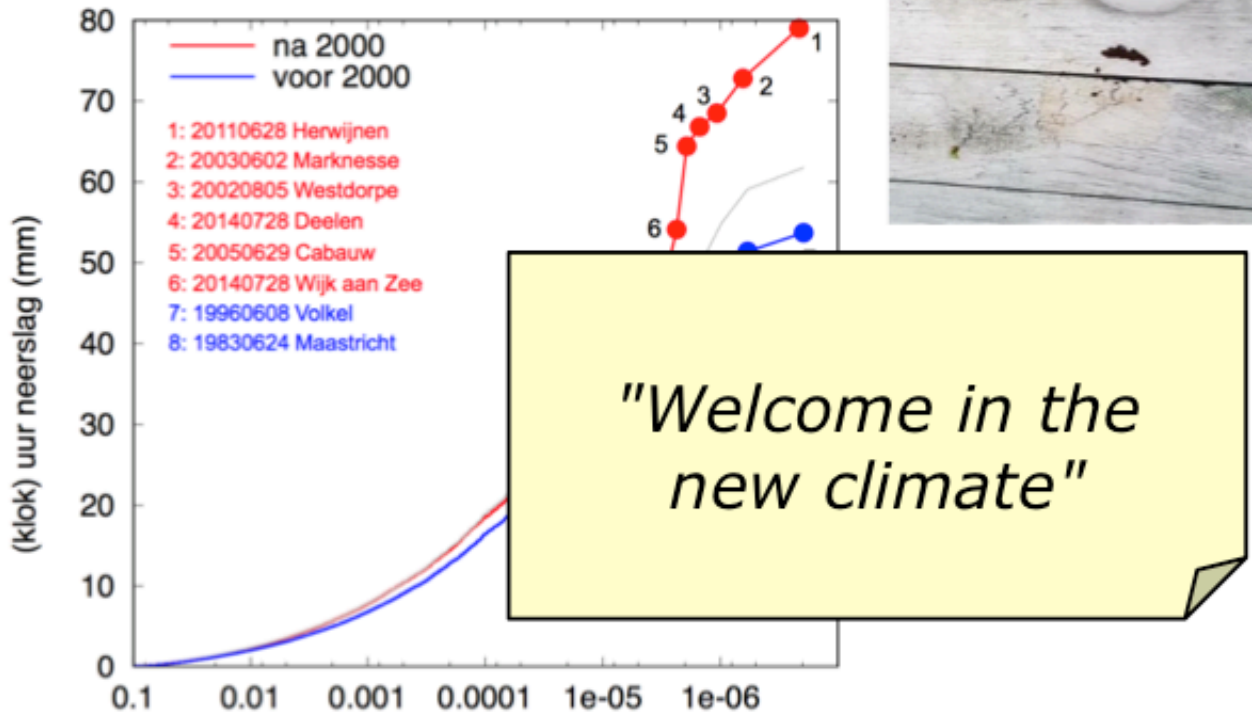
But a lot of **essential information** on weather, disasters, remote impacts, compounding effects etc. is hidden

Events triggering discussions...

a 1/9000 yrs event
(v Oldenborgh et al, 2017)

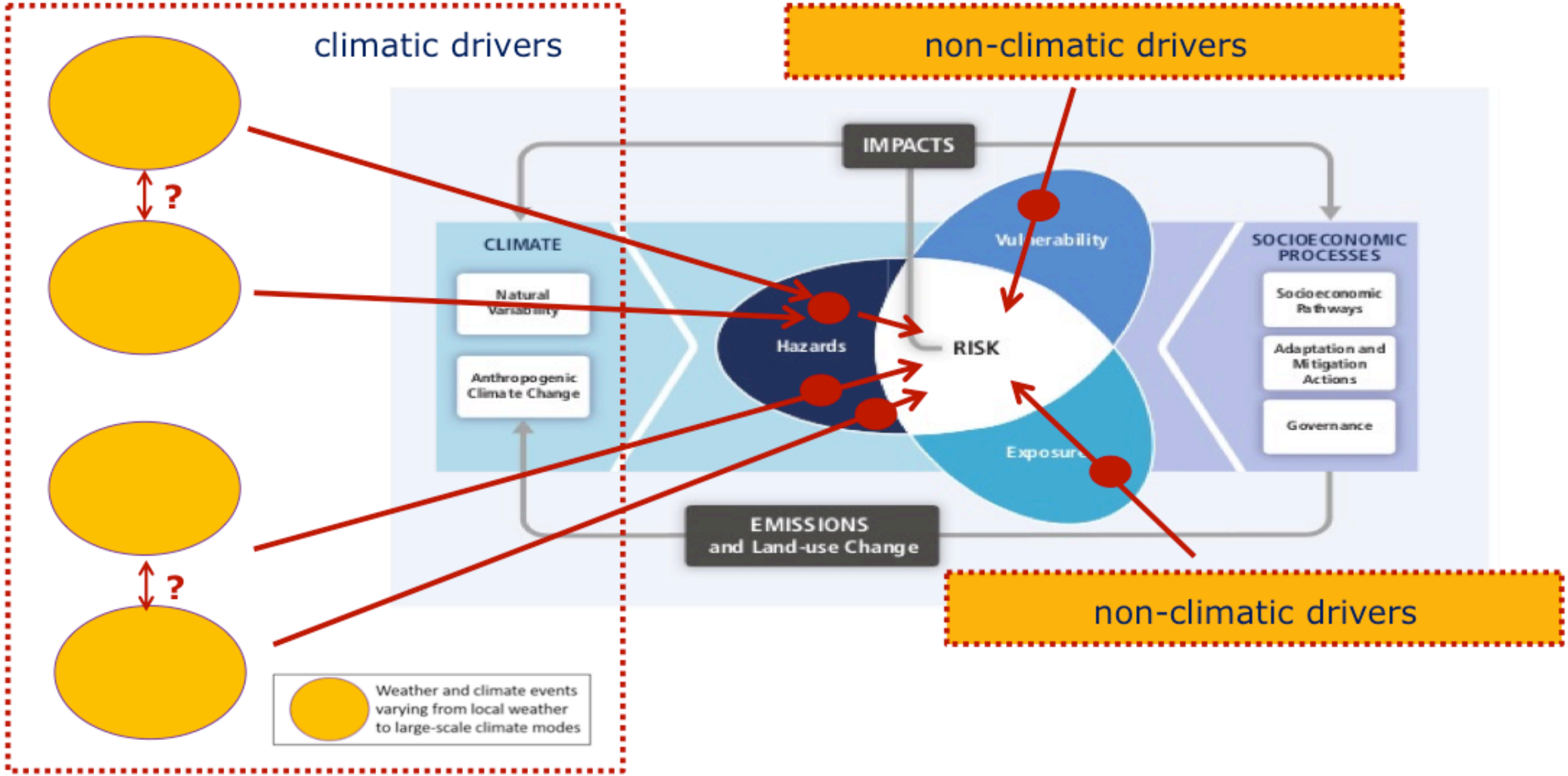






"Welcome in the new climate"

The concept of risk



Compound events

Compound weather/climate events refer to the ***combination*** of ***multiple*** drivers and/or hazards that contributes to societal or environmental ***risk***.

DispatchDate: 26.04.20

nature climate change

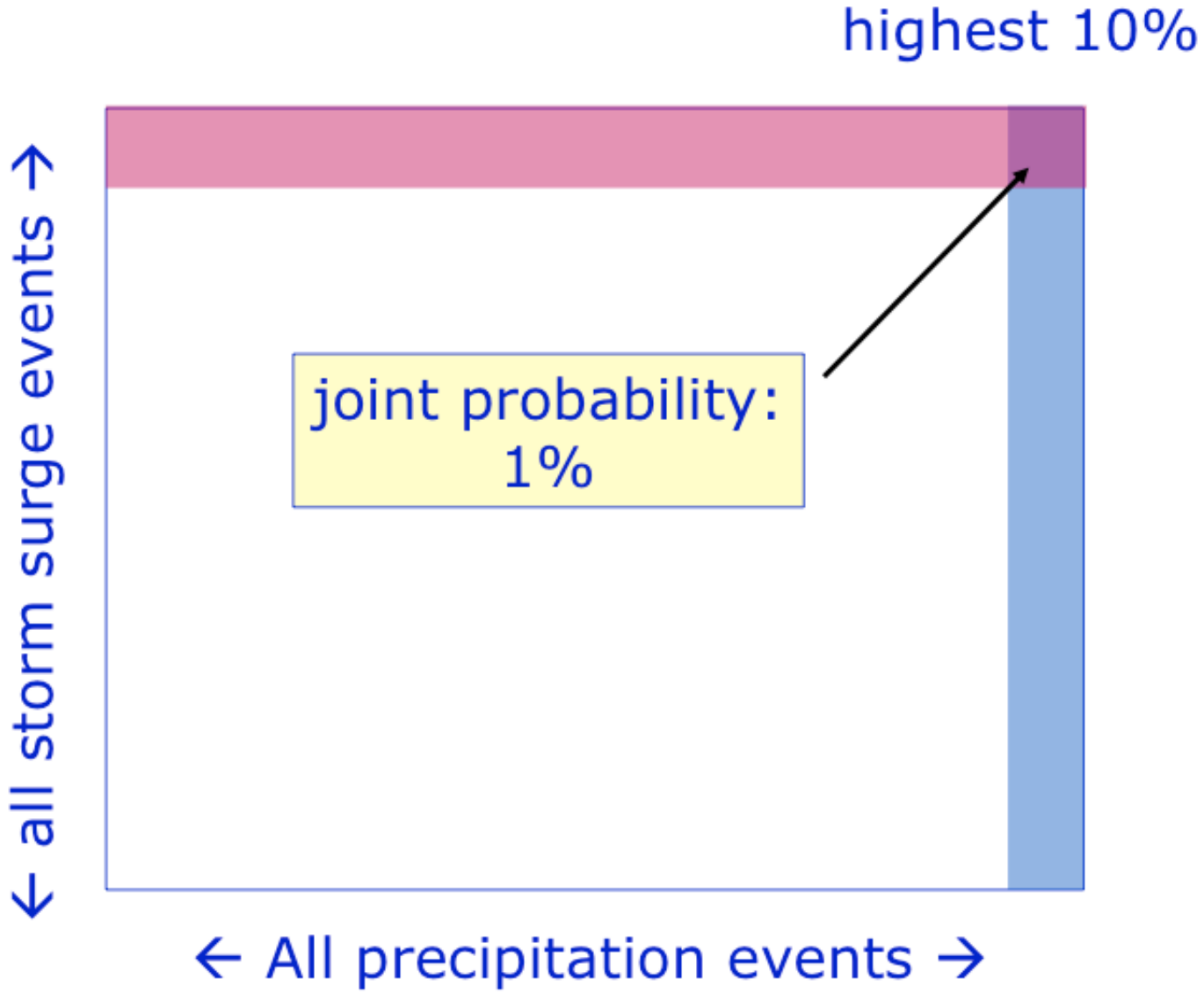
Future climate risk from compound events

Jakob Zscheischler[1*], Seth Westra[2], Bart J. J. M. van den Hurk[3,4], Sonia I. Seneviratne[1], Philip J. Ward[4], Andy Pitman[5], Amir AghaKouchak[6], David N. Bresch[7,8], Michael Leonard[2], Thomas Wahl[9] and Xuebin Zhang[10]

Floods, wildfires, heatwaves and droughts often result from a combination of interacting physical processes across multiple spatial and temporal scales. The combination of processes (climate drivers and hazards) leading to a significant impact is referred to as a 'compound event'. Traditional risk assessment methods typically only consider one driver and/or hazard at a time, potentially leading to underestimation of risk, as the processes that cause extreme events often interact and are spatially and/or temporally dependent. Here we show how a better understanding of compound events may improve projections of potential high-impact events, and can provide a bridge between climate scientists, engineers, social scientists, impact modellers and decision-makers, who need to work closely together to understand these complex events.

Zscheischler et al, NCC 2018

The concept of compound events



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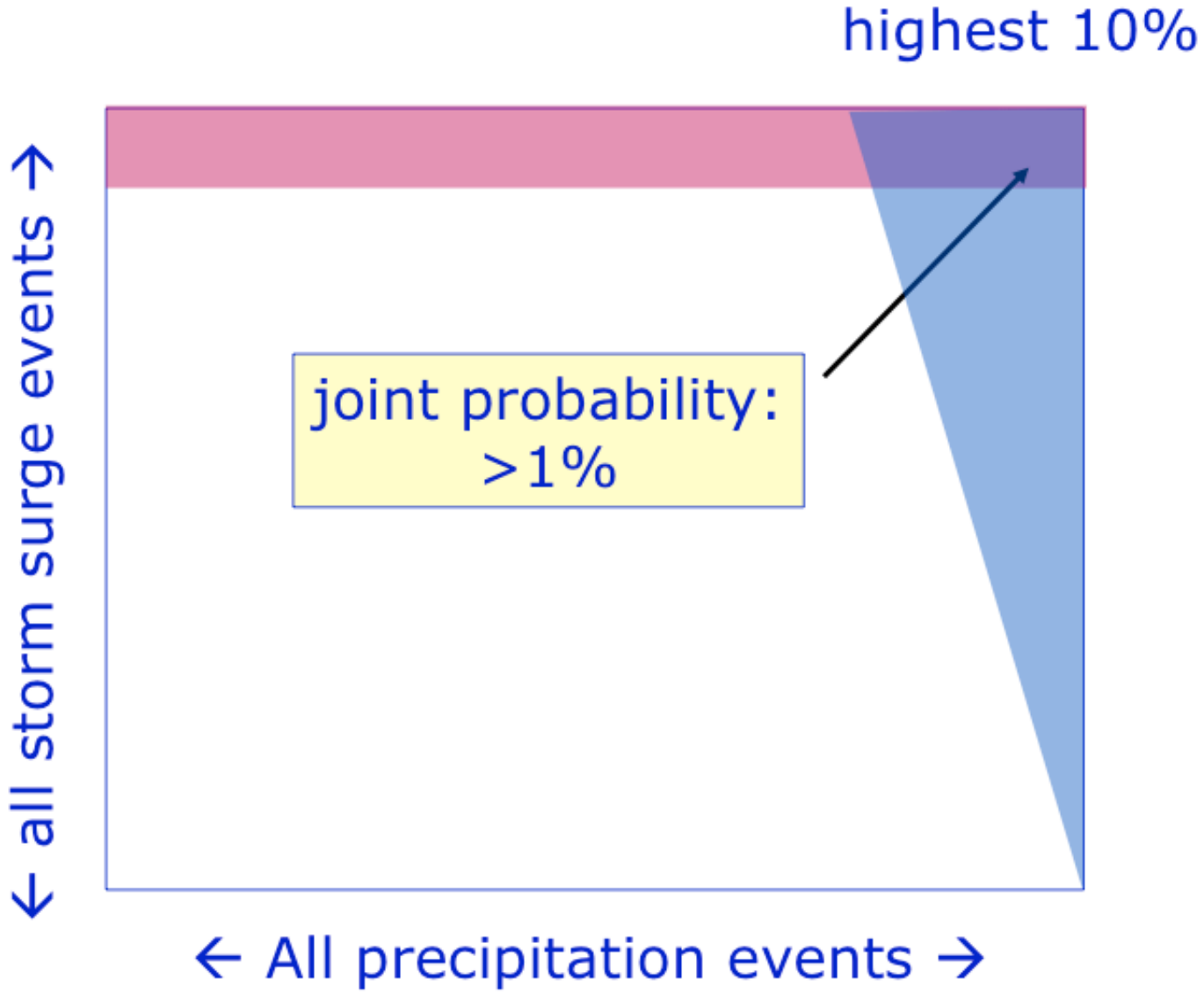
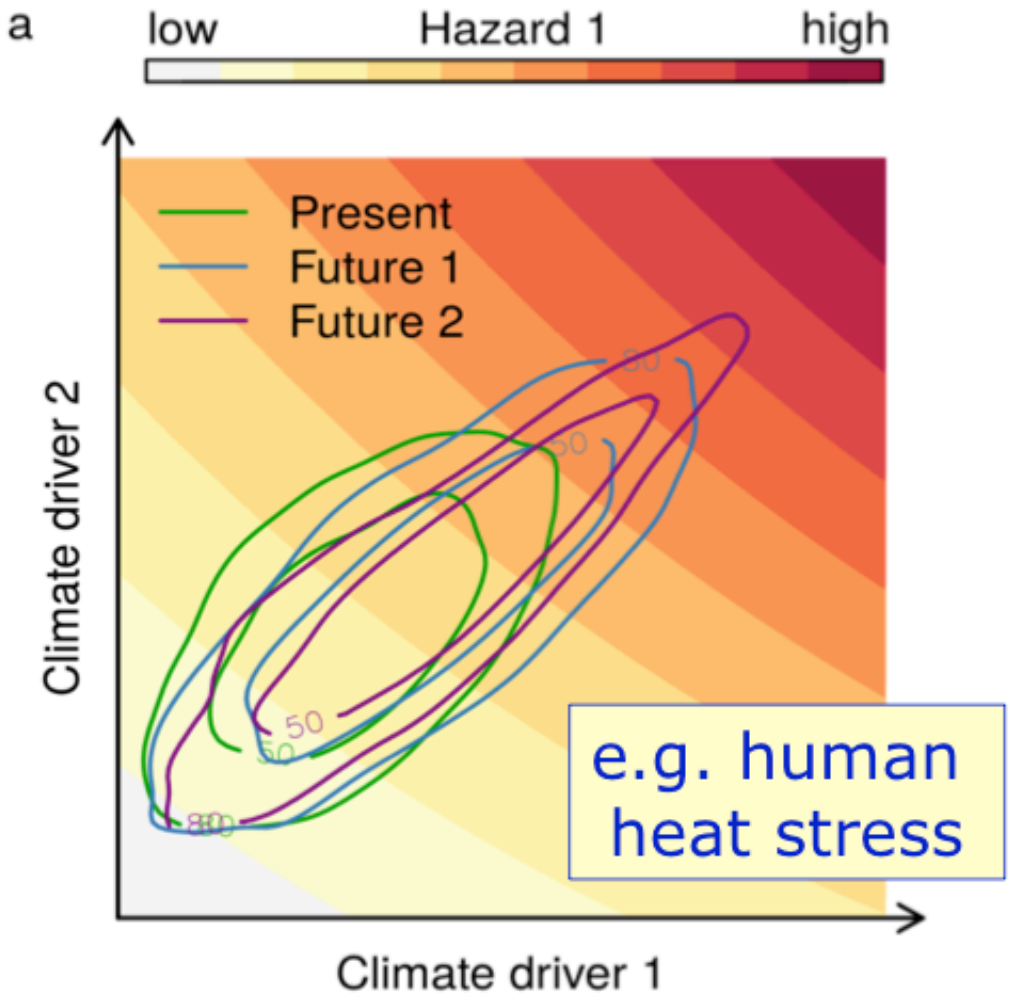


Examples

Drought	Precipitation, evapotranspiration, historic evolution of soil moisture, temperature
Heat stress	Diurnal cycle of temperature, humidity
Fire risk	Temperature, precipitation, relative humidity, wind, lightning
Coastal flooding	Storm surge, precipitation, discharge
Concurrent phenomena	wind, precipitation, temperature, air pollution, ...

Impact varies with combination of drivers



The challenge of compound events

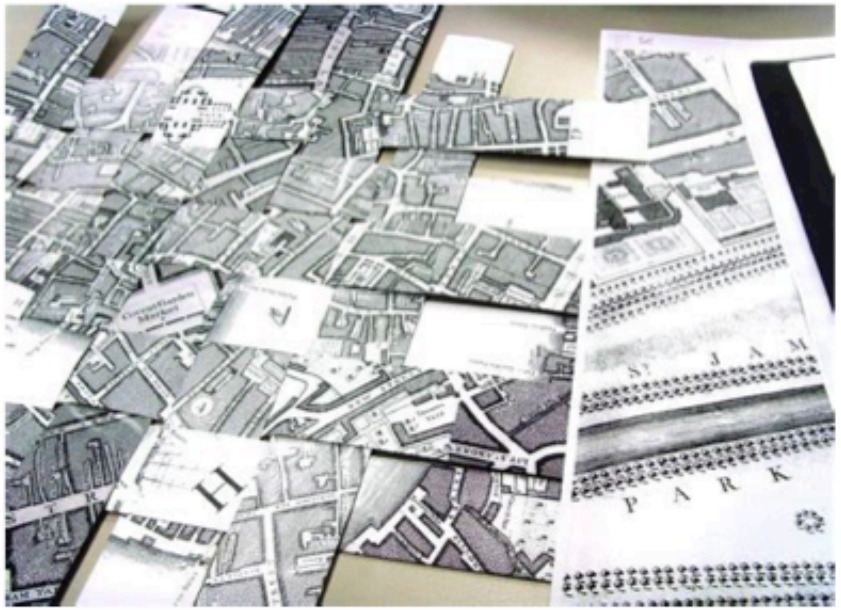
- **Document:**
  - Which climate variables?
  - What do we know ab
  - Do we have sufficien
- **Understand:**
  - What governing proc
  - What spatial and tem
  - Do they change in re
- **Attribute:**
  - Can we identify causes?
  - Can we use current modelling tools to do attribution?
- **Simulate:**
  - Are models reliable enough?
  - How do we know?
  - Can they project effects of change in climate or other drivers well?

European COST action just approved

(to be lead by Jakob Zscheischler – ETH)

Storylines

- **An alternative approach to representing uncertainty in physical aspects of climate change**



Shepherd at al, Clim.Dyn (under revision)

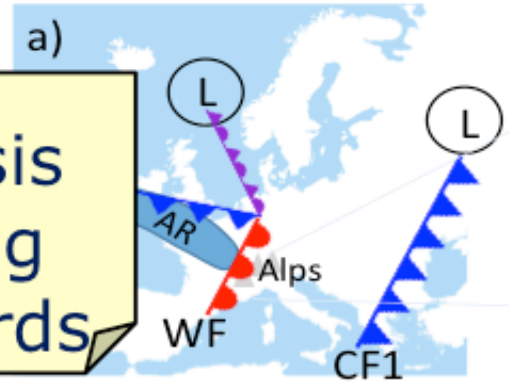
- Storyline = a physically **self-consistent** unfolding of past events, or of plausible future events or pathways.
- **No *a priori* probability** of the storyline is assessed; emphasis is placed instead on **understanding** the driving factors involved, and the **plausibility of those factors**

Reasons to use storylines

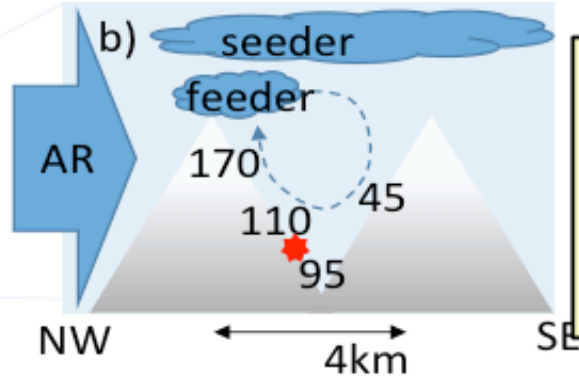
Swiss Alps, 8-10 Oct 2011

Physical basis for exploring climate records

Synoptic-scale flow



Local precipitation and circulation



Exploring boundaries of plausibility

Increasing risk awareness

Impacts

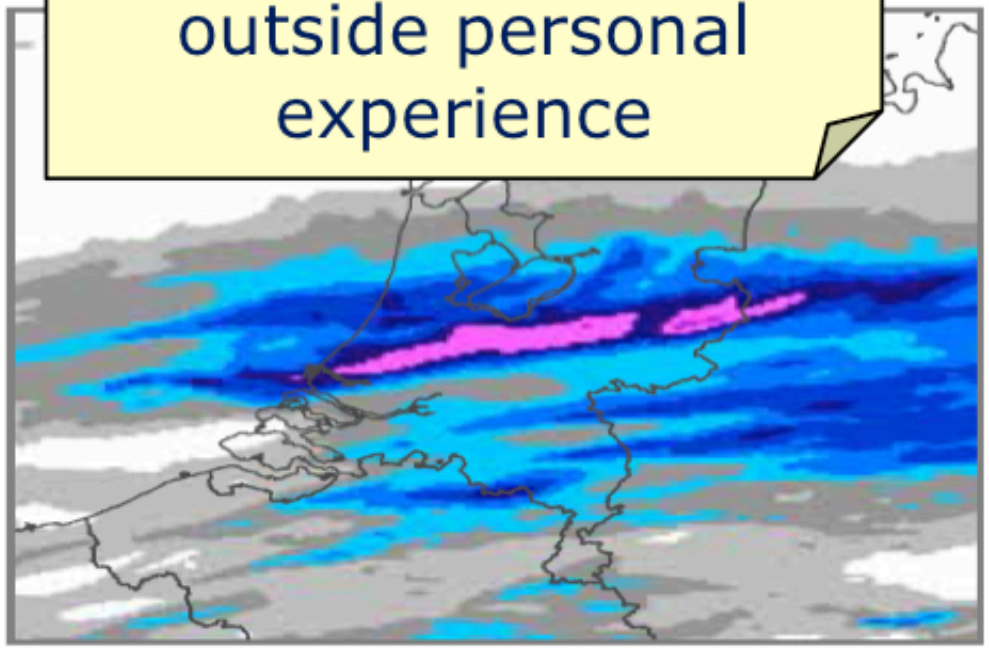
Adaptation measures

Improved decision making

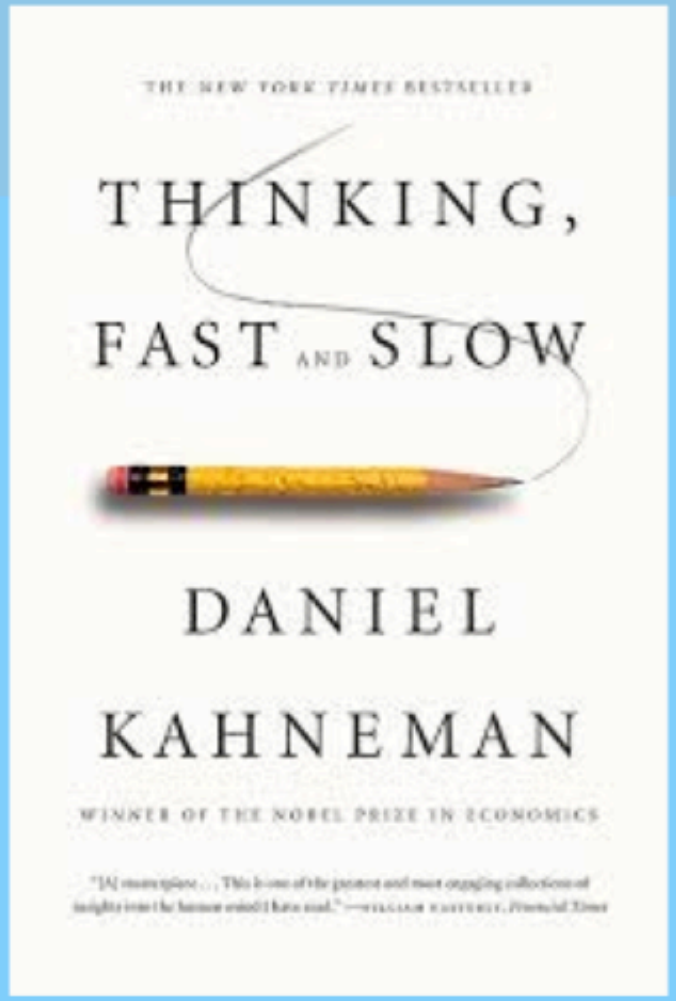
Shepherd at al, Clim.Dyn (under revision)

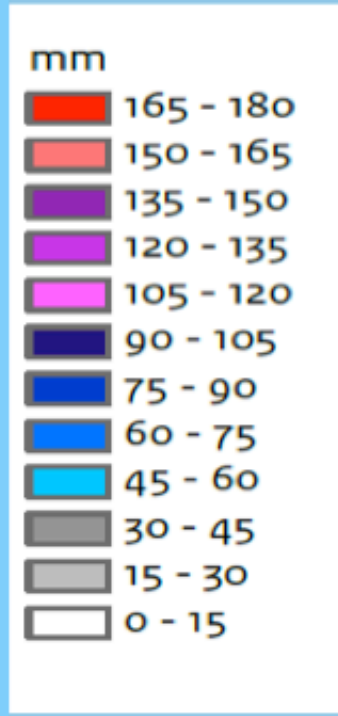
Increasing risk awareness

Difficult to respond rationally to events outside personal experience

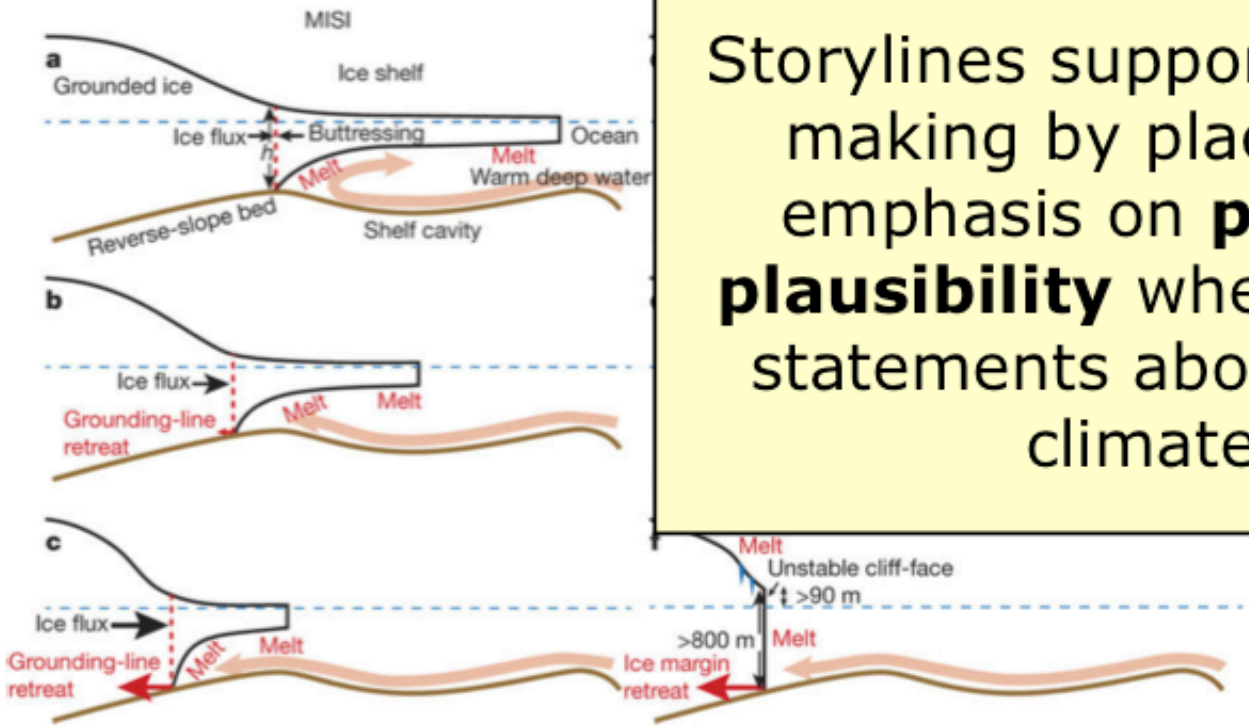


Attema et al, ERL 2014

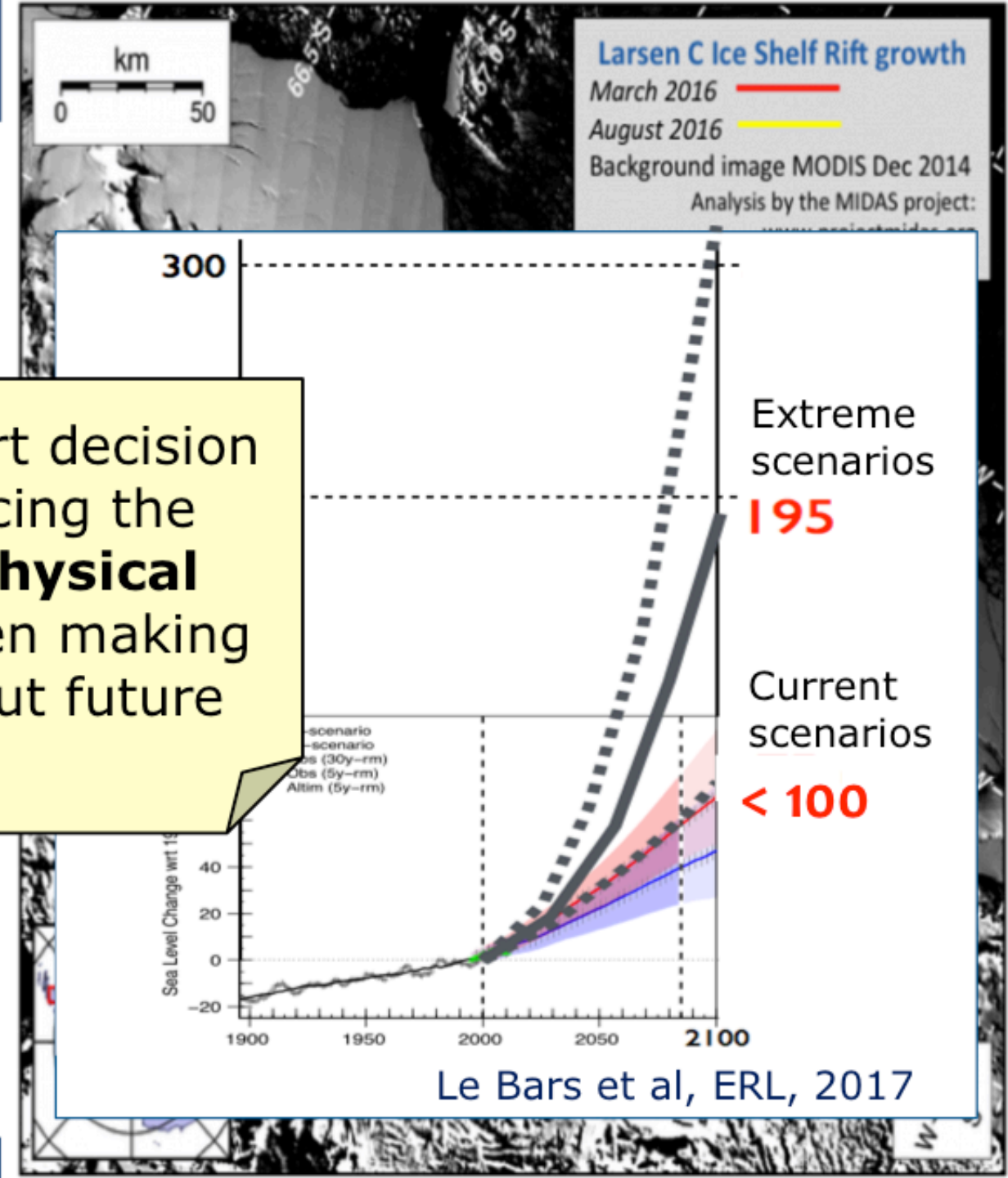




Plausible boundaries



DeConto and Pollard, Nature 2016

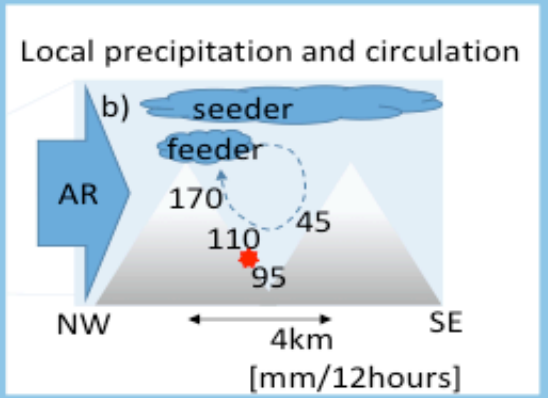


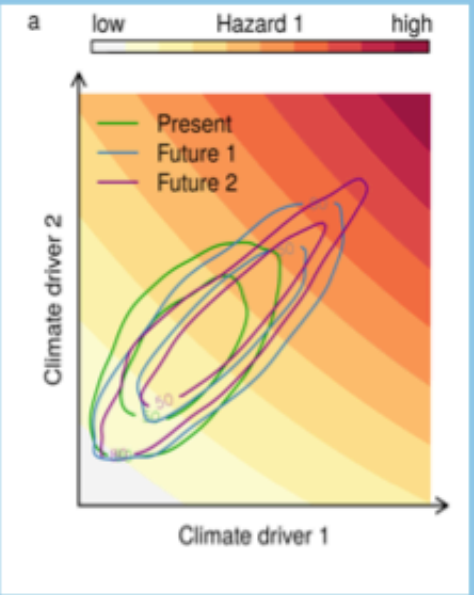
Storylines support decision making by placing the emphasis on **physical plausibility** when making statements about future climate

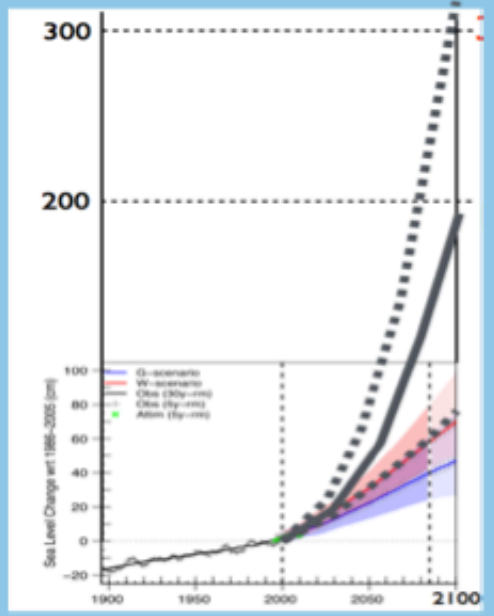
Le Bars et al, ERL, 2017

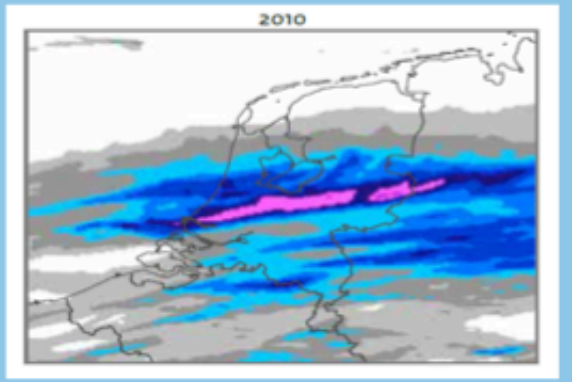
Conclusions

- Top down scenario analyses need to be accompanied by bottom-up event analyses
- Many events have compounding drivers
- Storytelling helps develop new climate assessments
- Changes our interrogation of climate records
- Emphasises (physical) plausibility next to probability

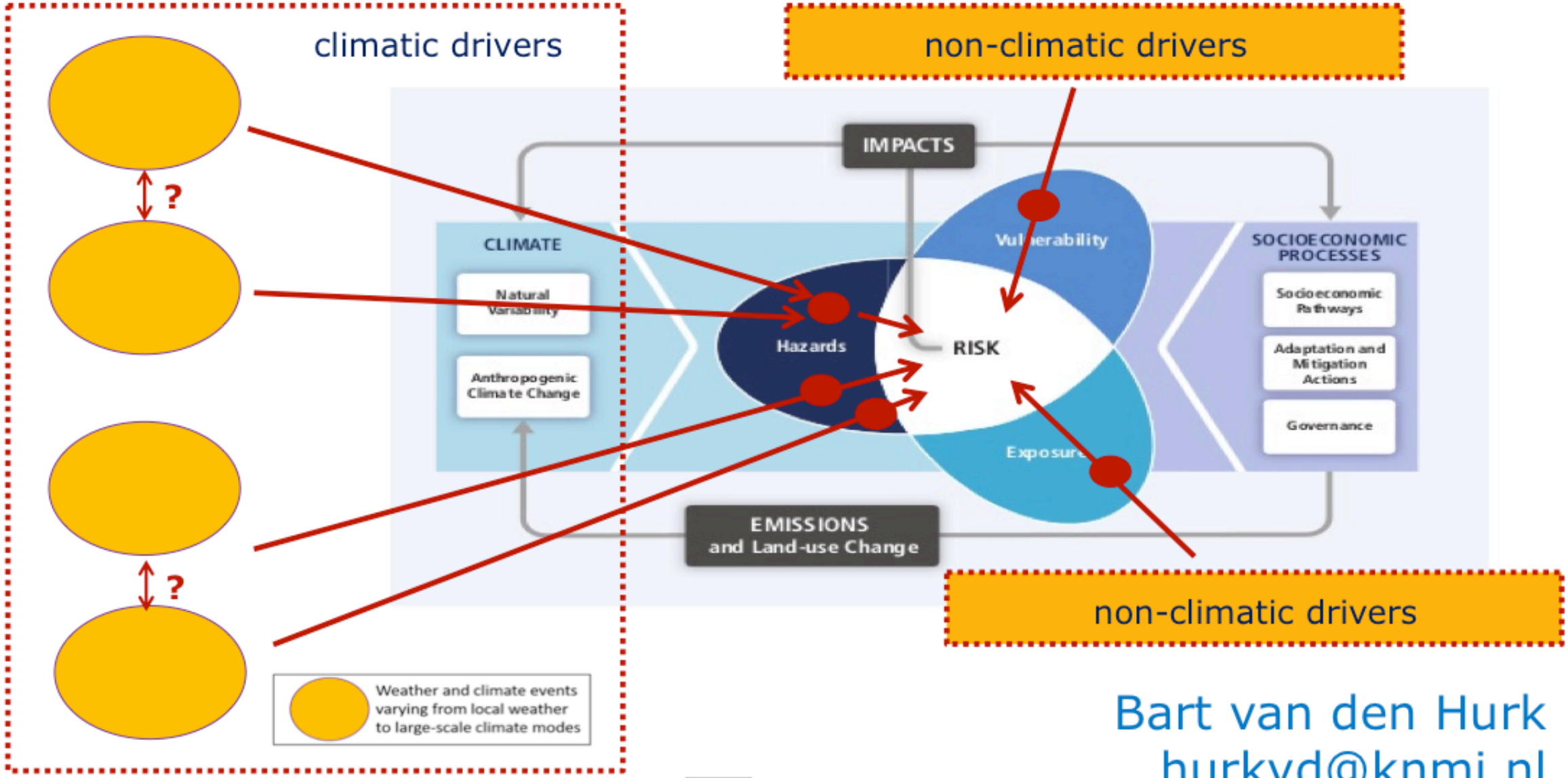








Thank you



Bart van den Hurk
hurkvd@knmi.nl