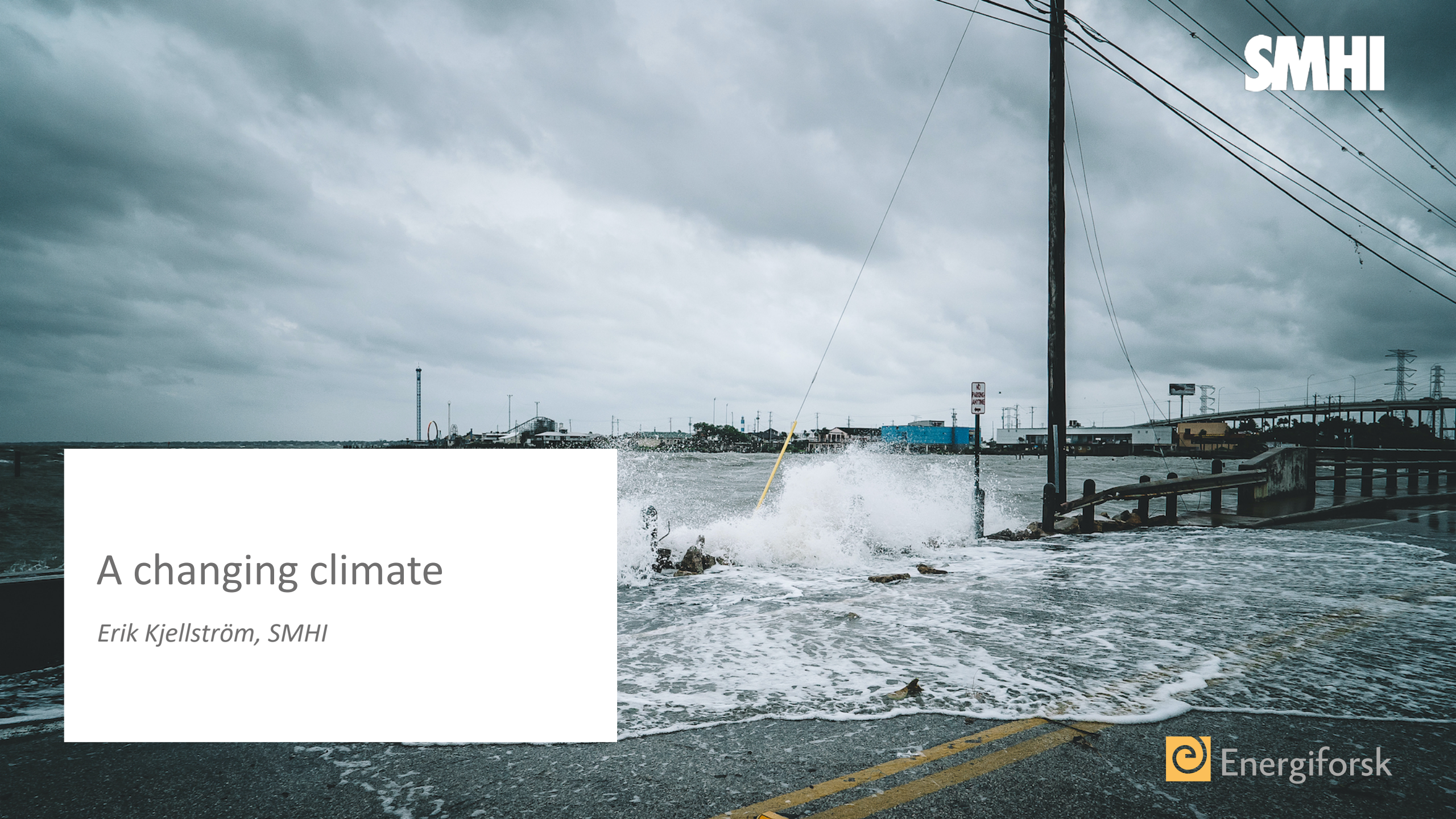


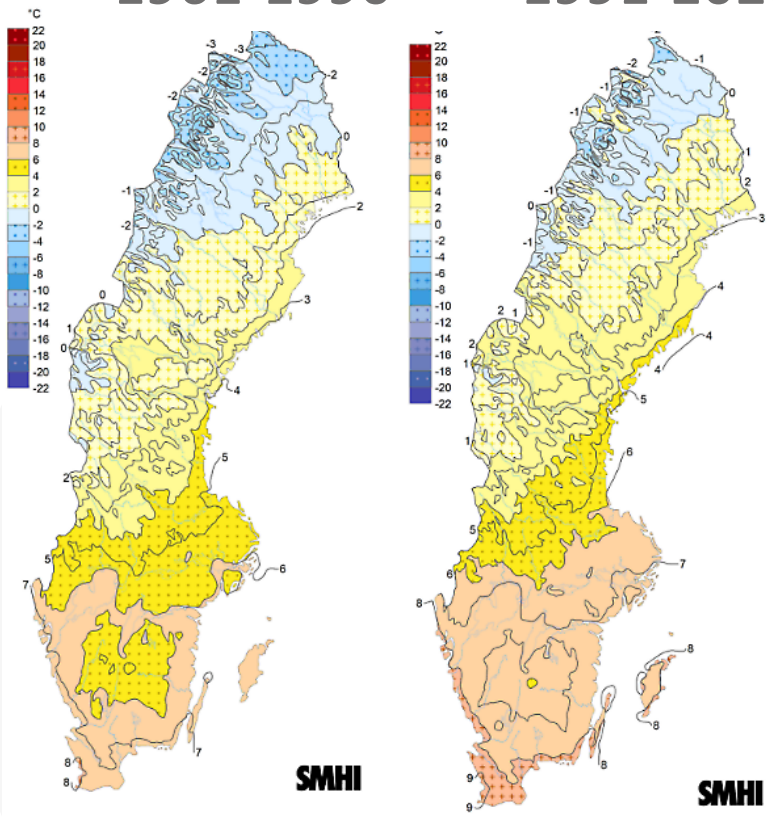
A changing climate

Erik Kjellström, SMHI

Strong ongoing change

- Higher temperatures in all seasons
- Longer and warmer summers
- Shorter season with snow / less sea ice
- Increasing precipitation
- Changing extremes

1961-1990 1991-2020



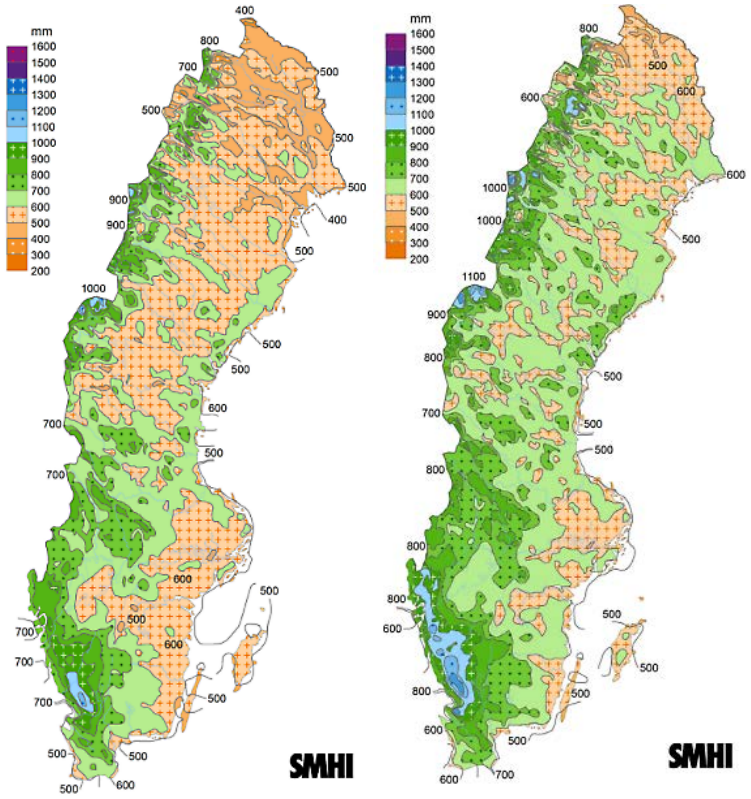
Annual mean temperature

+1,1°C

+8%

Annual precipitation

1961-1990 1991-2020



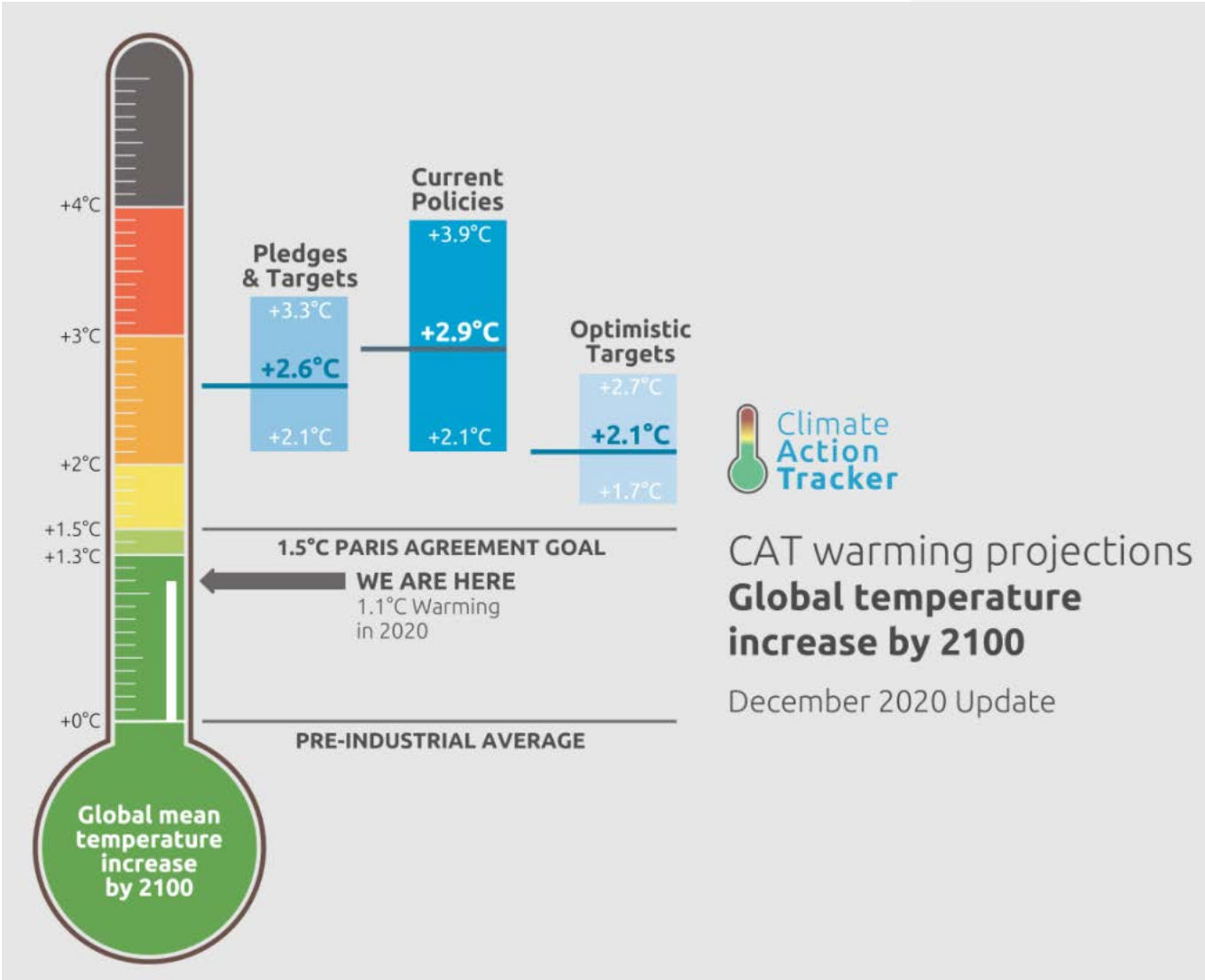
http://www.smhi.se

Continued strong warming ahead of us

How much?

- Current rate of warming c. 0,2°C per decade
- Will reach +1,5°C in c. 20 years
- Will reach +2°C in another c. 25 years

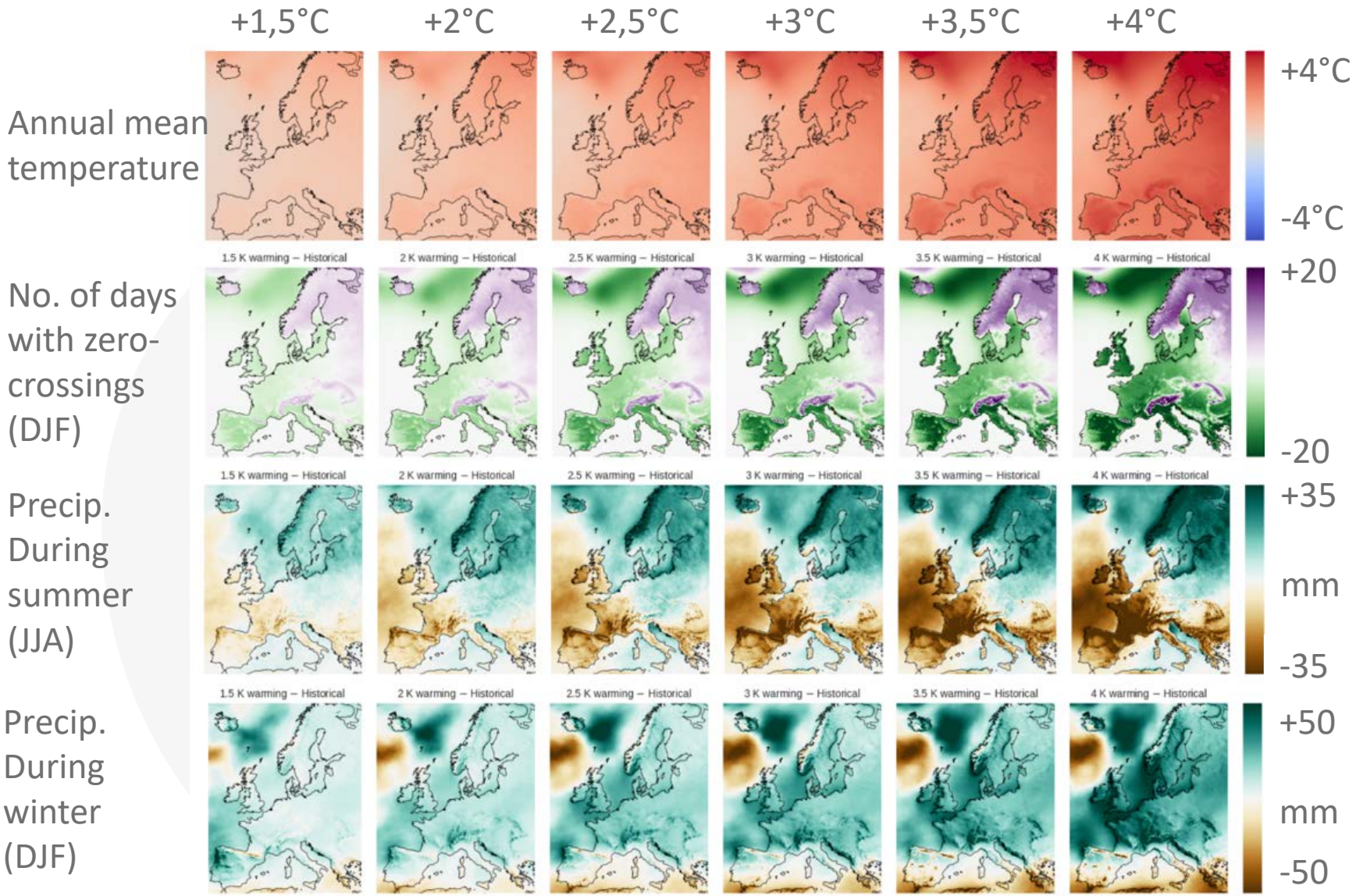
Uncertain how large the change will be towards the end of the century



https://climateactiontracker.org/

Gradual change

- Warmer, especially in the north during the winter period
- Shift of seasons
- Shift of character of seasons
- Generally more precipitation in the North, with a larger fraction from rain

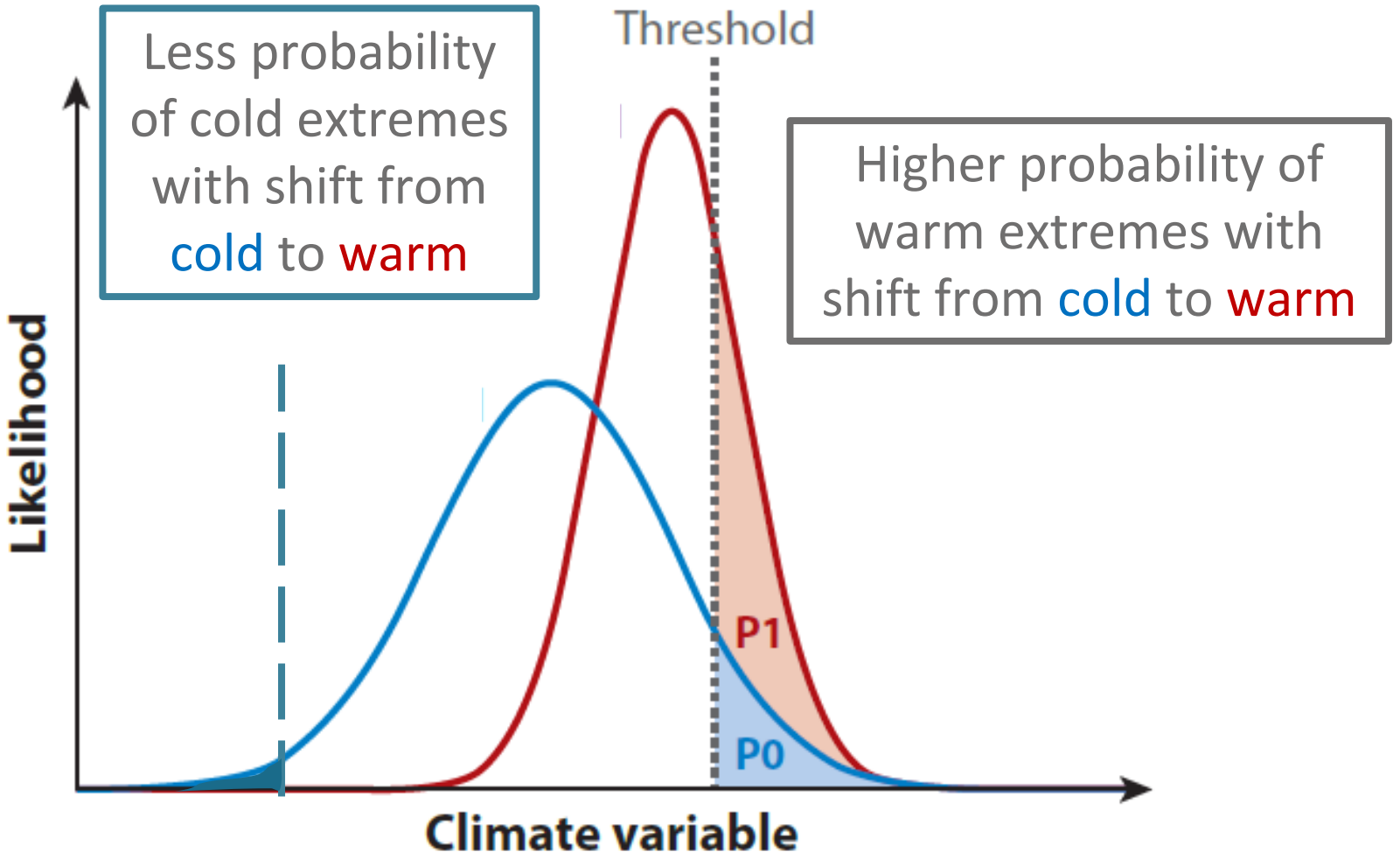


Based on > 65 Regional Climate Model projections from EURO-CORDEX at 12.5 km grid resolution

Changing extremes

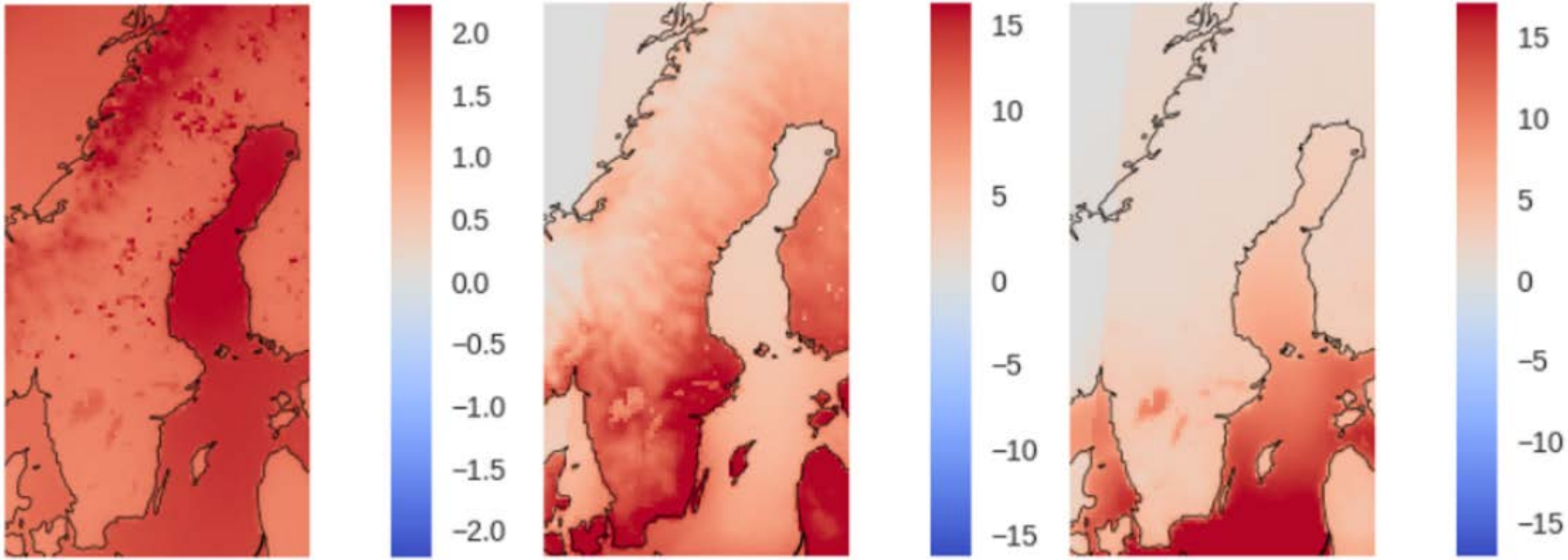
- Very rare events are usually not observed!
- Assessments of changes in rare events are highly uncertain
- Assessments of changes in compound events are generally highly uncertain

- More warm and less cold extremes
- More wet and more dry extremes
- Changes in wind extremes not expected
- More likely with higer sea level extremes



Indices relevant for warm extremes in summer

- At +2°C increase in maximum temperature (left), number of consecutive warm days June-August (middle), number of tropical nights (right)

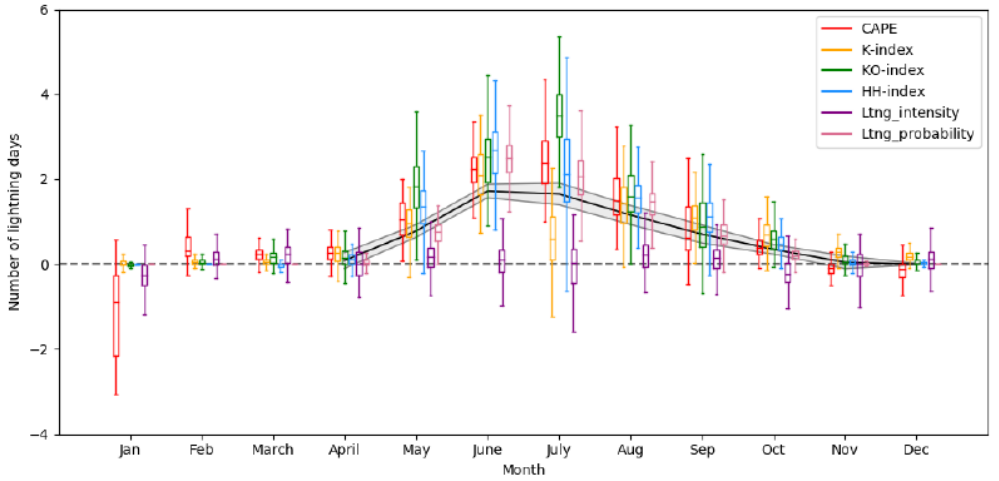


Of relevance for atmospheric and sea water temperatures

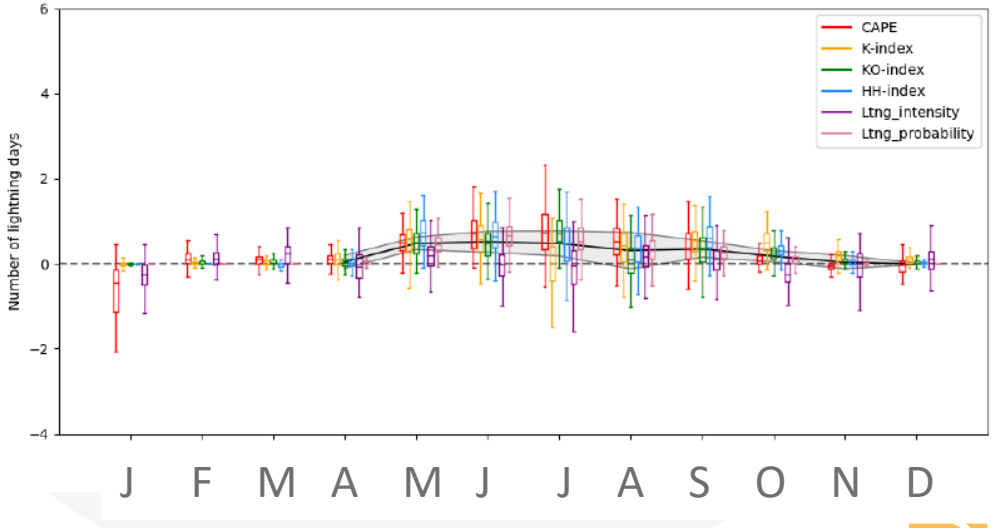
Will there be more lightning?

- Competing effects
  - Warmer and more humid conditions in favor of lightning
  - Warmer clouds with less cloud ice can reduce risk of lightning
- Results indicate longer season with risk for deep convective clouds (incl. lightning, hail, heavy rain, tornadoes)
- Risk for more intense events

Change in number of days with risk for deep convection



Change in number of days with risk for lightning



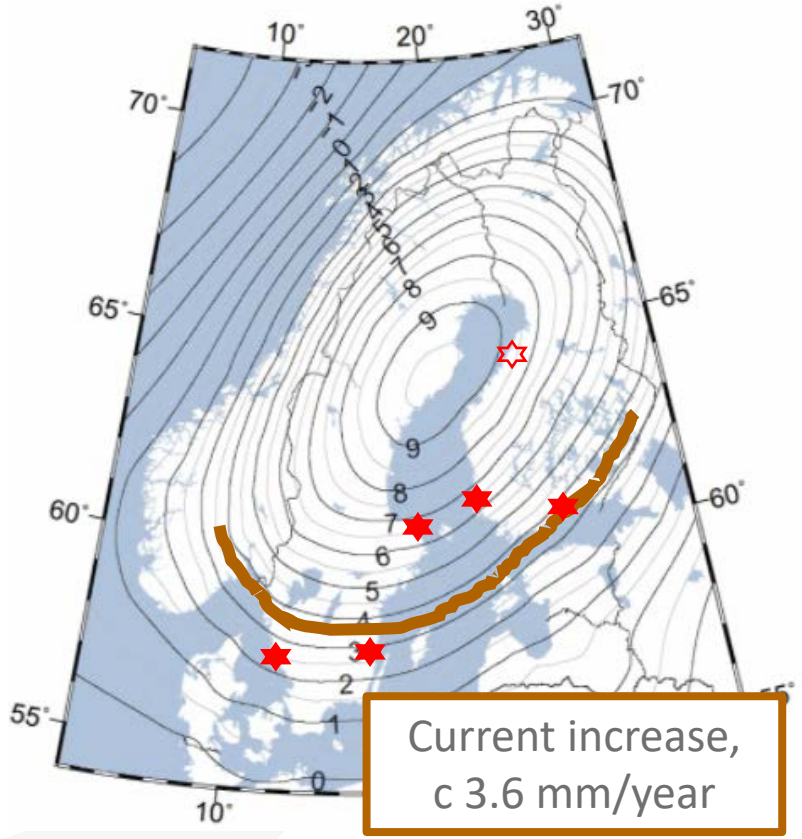
De Ridder (2020), student paper,
Dept. Meteorology, Stockholm University

Sea level changes

1. Global sea level rise counteracted by land uplift

17th-83rd percentiles as given by the IPCC

	RCP2.6		RCP8.5	
	2050	2100	2050	2100
Ringhals (Varberg)	16 (3 to 30)	19 (-7 to 46)	21 (8 to 35)	63 (28 to 99)
Oskarshamn (Oskarshamn)	20 (5 to 36)	20 (-6 to 46)	25 (11 to 39)	64 (30 to 99)
Forsmark (Östhammar)	3 (-11 to 18)	-17 (-36 to 3)	8 (-3 to 19)	29 (-4 to 63)



2. Extreme high levels associated with wind storms etc.

	100 yrs	200 yrs	1000 yrs	10000 yrs	No of years of observations
Ringhals	1,60	1.67	1,82	2,0	46
Oskarshamn	1,02	1.05	1,10	1,14	55
Forsmark	1,39	1.45	1,56	1,67	40

Hieronymus and Kalén (2020)

Summary

- We have already seen strong changes in the climate
- Expected continued gradual change
- Warmer, changing seasons
- More intense hydrological cycle – more precipitation but also increased risk of droughts
- More, and changed extremes
  - More intense heat waves including sea water temperature
  - Decreased risk for cold extremes, less snow fall and less sea ice
  - Increased risk for strong convection with impacts for heavy rainfall, hail, lightning, tornados
  - Increasing sea level with increased risk of flooding
- Lack solid information about future heavy rainfall, lightning, compound events

Extra material

- Description of how we assessed future climate change in the project

Energiforsk

Information about the future climate in this project

Starting point from global warming levels: +1,5°C, +2°C, +2,5°C, +3°C etc.

> 60 EURO-CORDEX regional climate models

The climate models has been applied with 12.5 km grid spacing for all Europe

A large number of climate indices describing mean temperature, lenght and intensity of heat waves, number of days with zerocrossings, heavy rainfall etc.

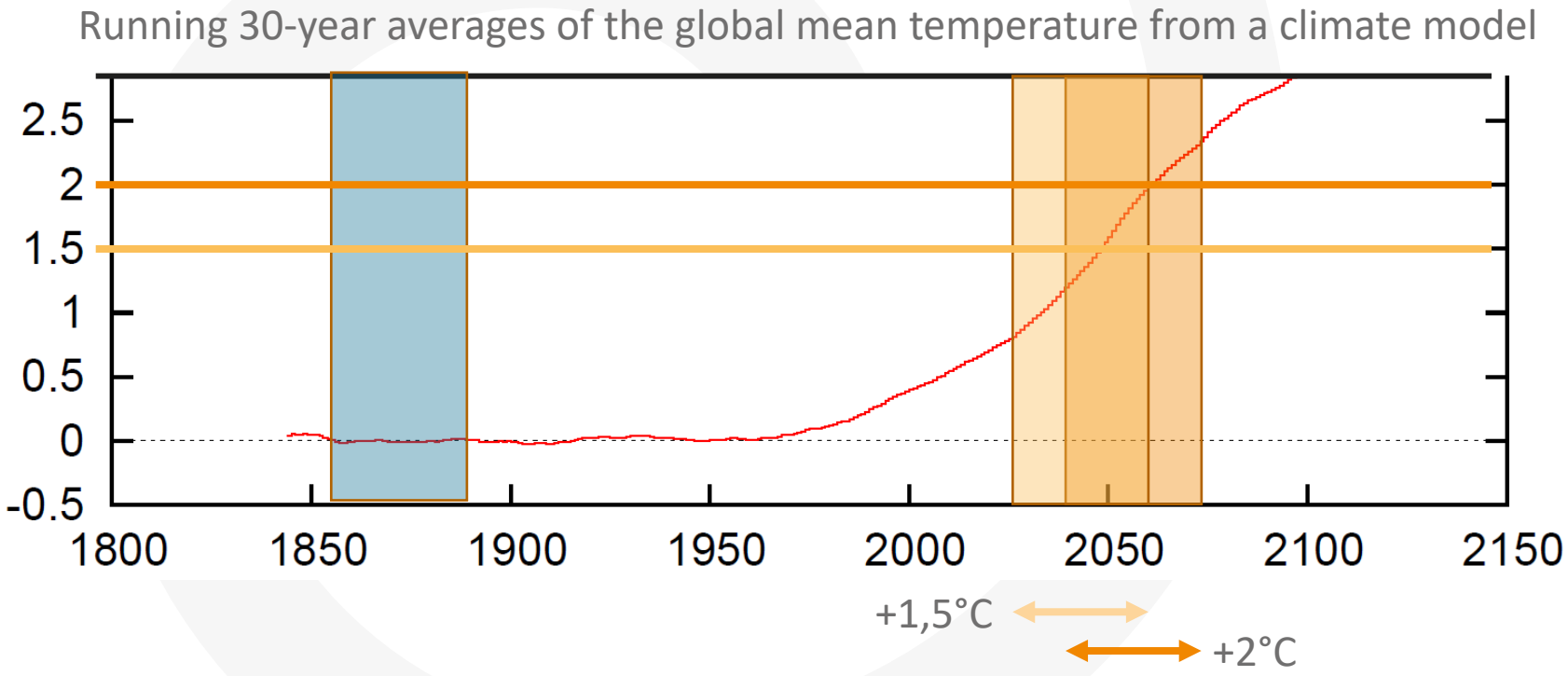
The indicies have been chosen to be representative for different energy sectors

Energiforsk

What are the warming levels: +1,5°C? +2°C?

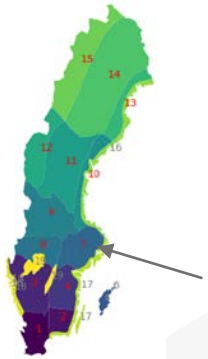
First 30-year period when the average temperature reach +1,5°C over the preindustrial level

- Periods are partly overlapping
- Climate is not stationary
- Uncertain at longer time scales



Calculations of climate indices

- Different combinations of emission scenarios, global and regional climate models
- > 60 climate indices for temperature, precipitation, wind, SW radiation, soil conditions, combinations
- Daily data



Ex: Start of the vegetation period (T>5°C) i ”Östra Svealand”