Agronomy 406
World Climates

April 17, 2018

Changes to variables important for climate impacts.

Fact sheets due next class (April 19). Both printed and PDF versions. (Posters are NOT due this date.)

Poster session next week, during regular class time:

- Agronomy Commons (2nd floor of Agronomy Hall).
- Arrive a few minutes early to set up your poster.
- See schedule of presentations in Pages section on Canvas.

Predicted changes to variables important for climate impacts

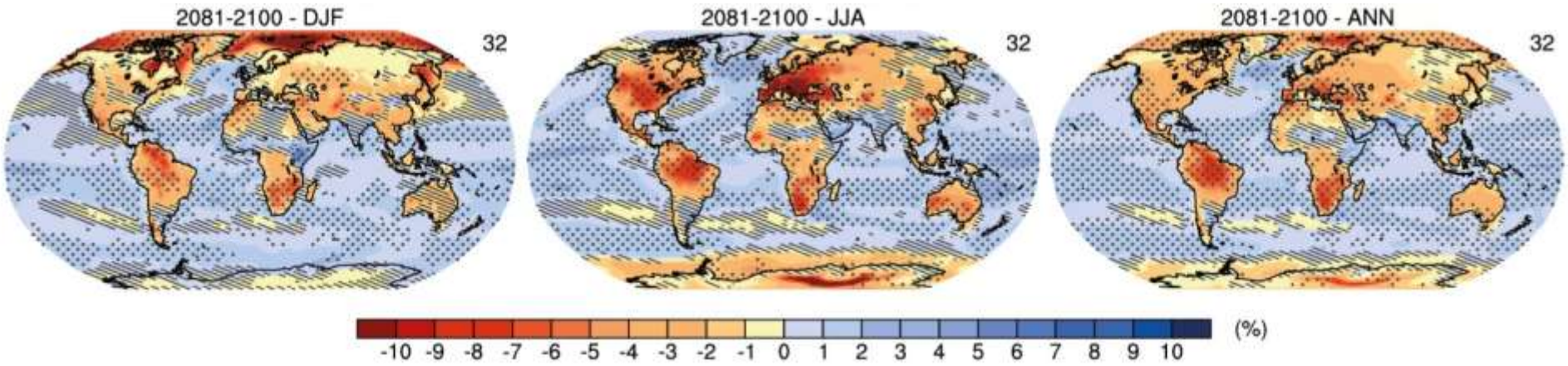
Temperature and precipitation are important, but other variables are important as well:

humidity, sea level rise, soil moisture...

Crops and human health often are sensitive to **extremes** or to specific **thresholds** of temperature and moisture (e.g., frost, or limiting high temperature for heat stress).

Predicted mean relative humidity change at 2081-2100 in RCP8.5

Dec-Jan-Feb | June-July-August | Annual



Dotted regions are where changes are large with high model agreement. Cross-hatched areas are where change is small compared to natural variability.

IPCC Fifth Assessment Report, Fig. 12.21

Relative humidity

Look at Fig. 12.21 in the "Excerpts from chapter 12" link from the course schedule:

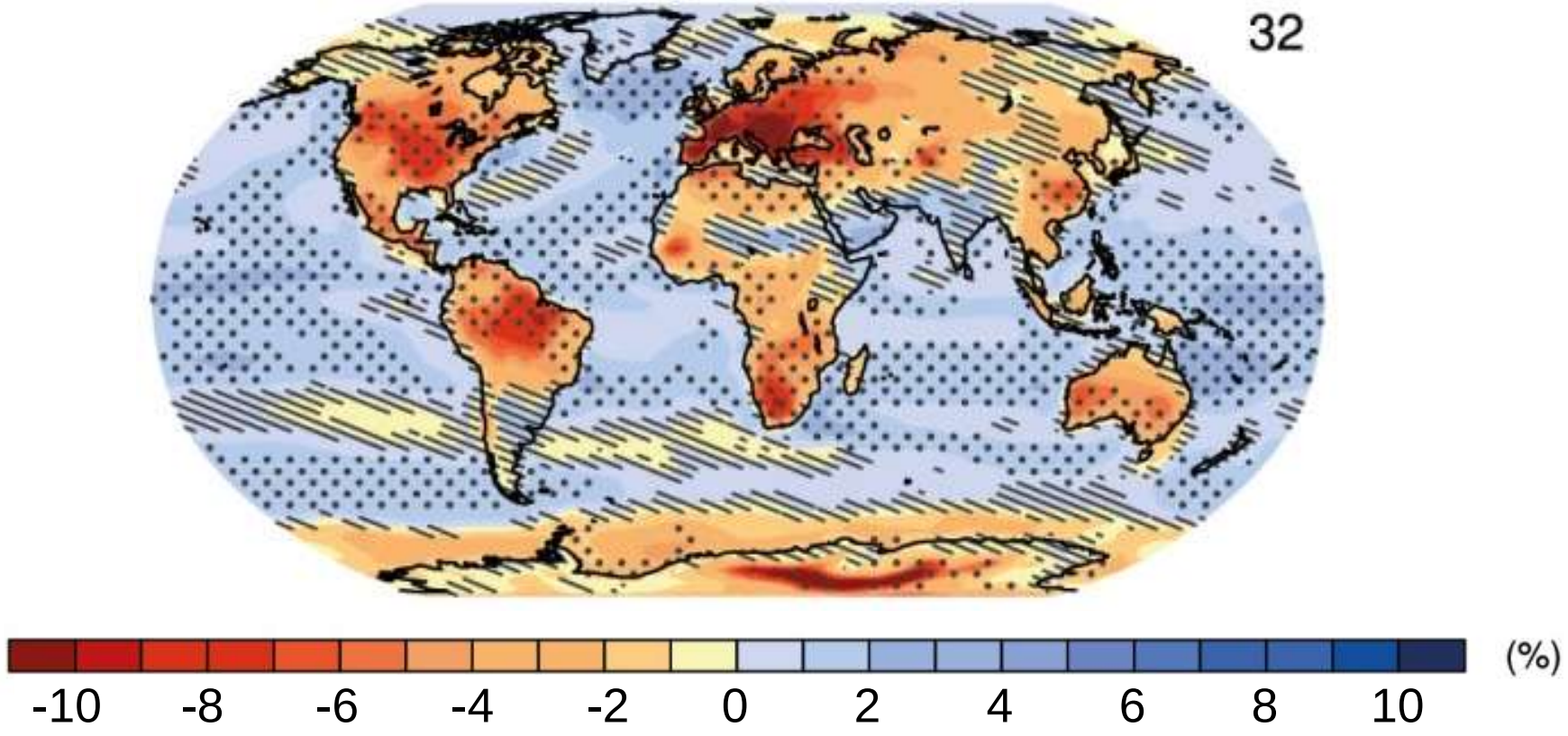
Where is NH summer relative humidity expected to increase?

Where is NH summer relative humidity expected to decrease?

What effects do you think a humidity increase or decrease would have on agriculture or human health?

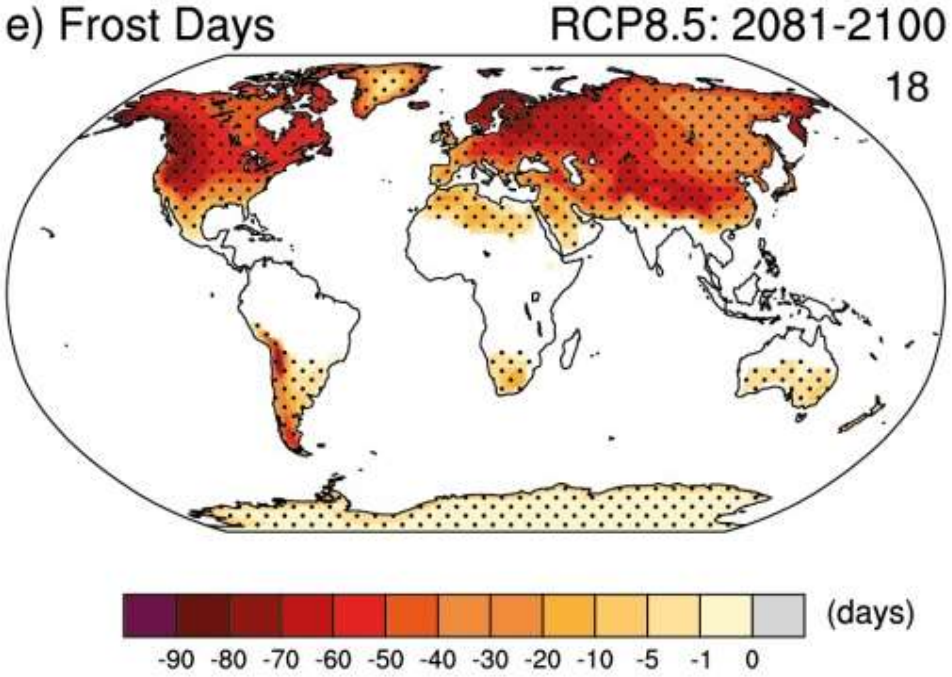
Predicted changes in NH summer relative humidity at 2081-2100

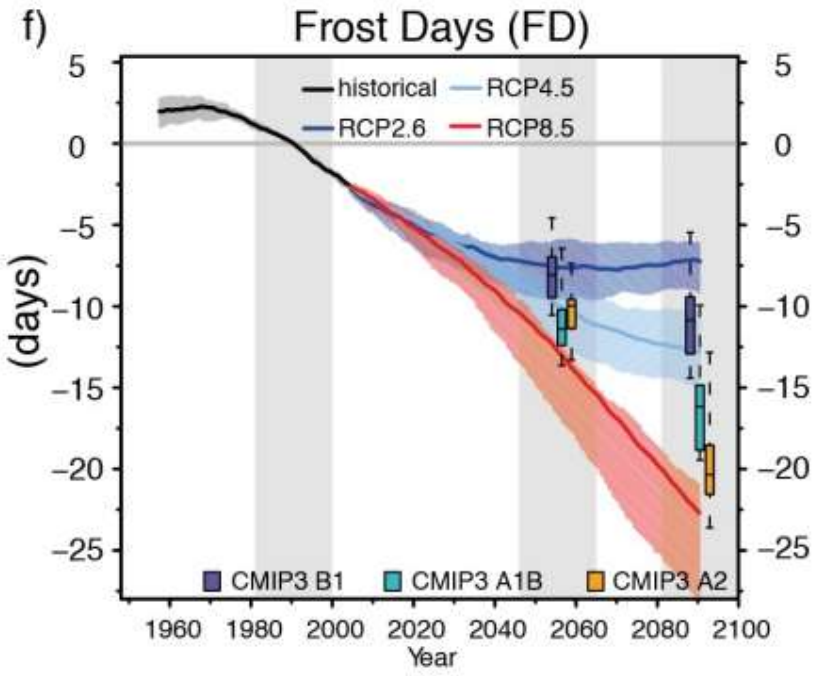
June-July-August



IPCC Fifth Assessment Report, Fig. 12.21

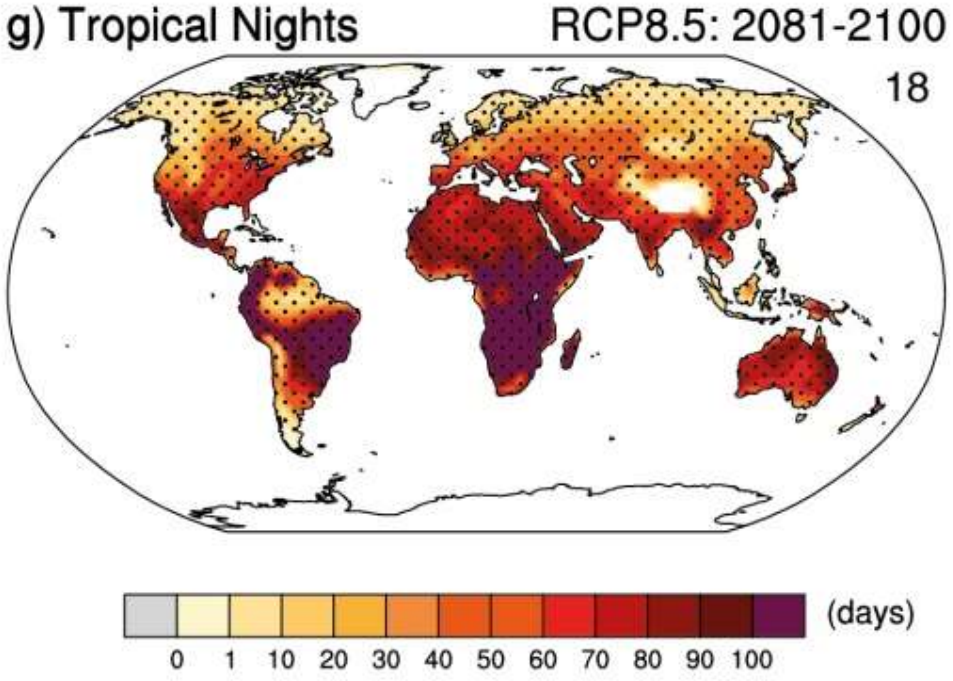
Projected change in number of days with temperature below freezing

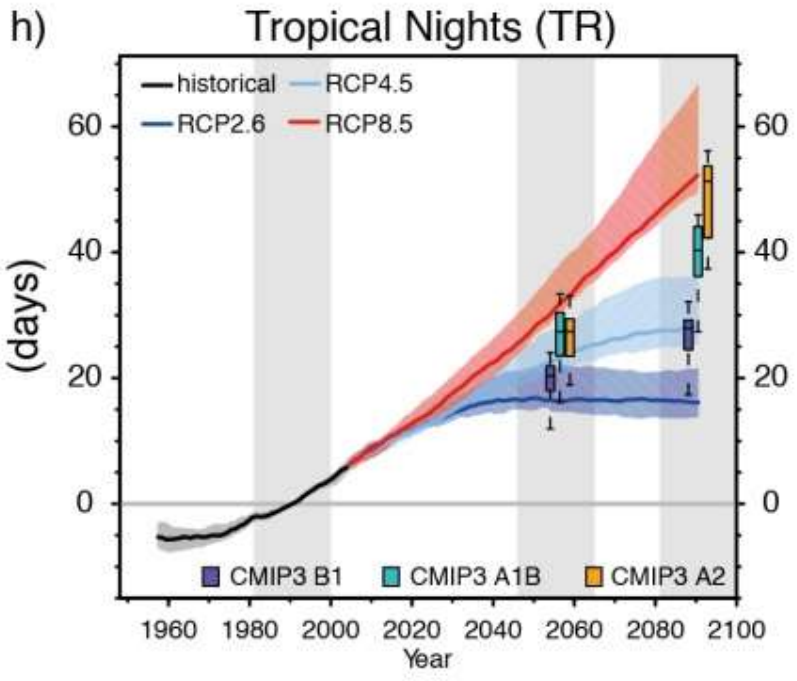




IPCC Fifth Assessment Report, Fig. 12.13

Projected change in number of "tropical nights" (daily minimum temperature 20ºC/68ºF or higher)





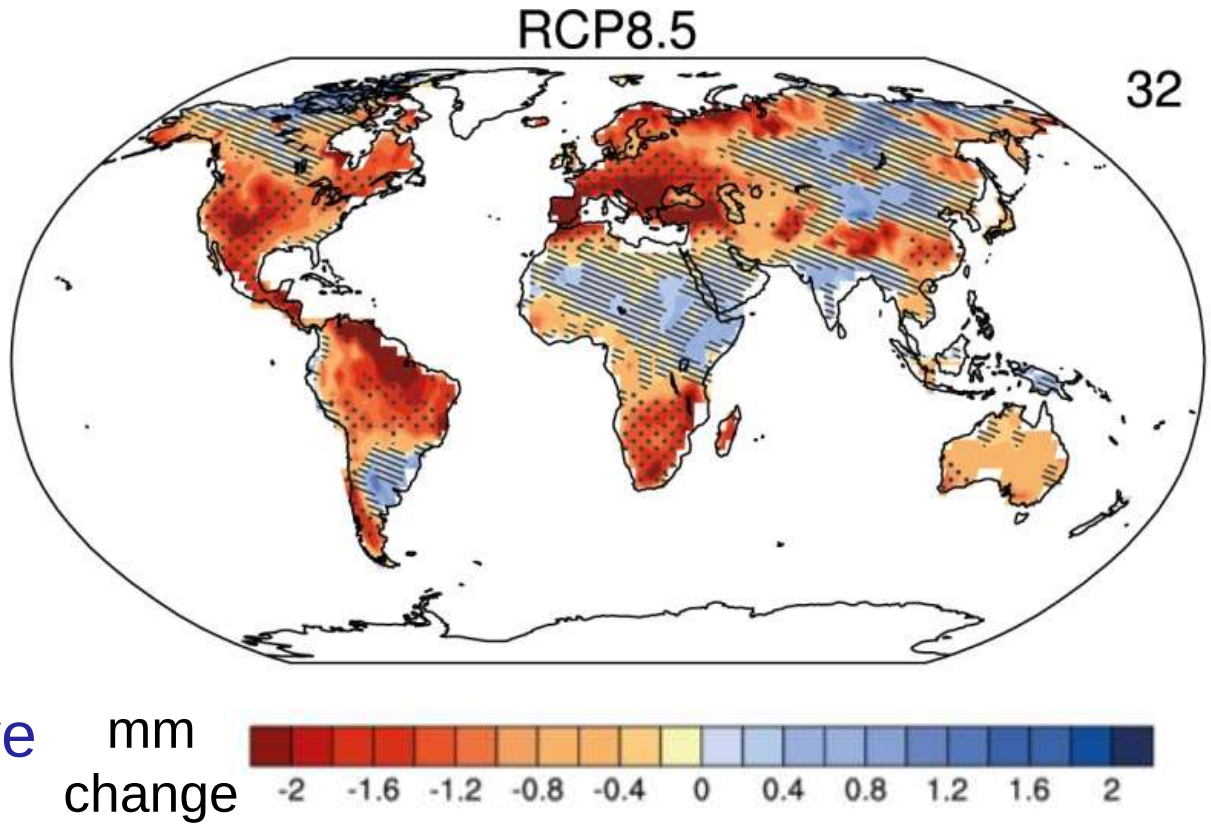
IPCC Fifth Assessment Report, Fig. 12.13

Projected change in annual mean soil moisture in the upper 10 cm (4 inches) of the soil

Where are soils projected to become **drier?**

Where are soils projected to become **wetter?**

Is there a relation to the patterns we saw for NH summer relative humidity? Explain.



IPCC Fifth Assessment Report, Fig. 12.23

Changes to extremes

Changes to extremes require different approaches than looking at changes to averages.

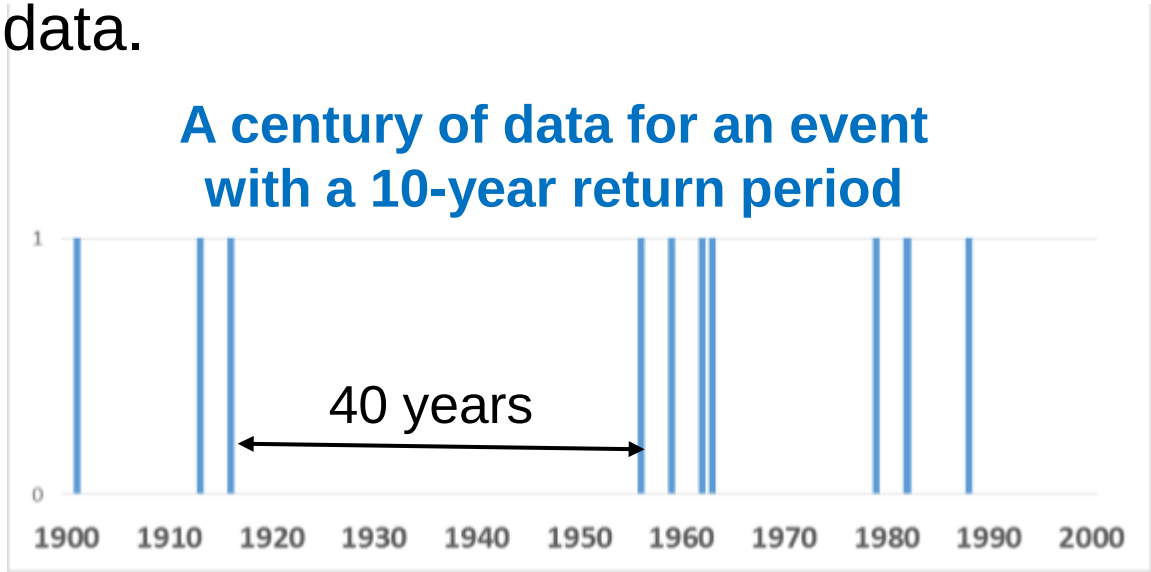
One method often used for extremes is to look at the **return period.**

Return period

The **return period** for an event is how long **on average** between each occurrence of the event.

This does **not** mean that the event always occurs every so many years!

Notice the apparent clustering of events in **purely random** data.



Occurrences generated **randomly** using Microsoft Excel RAND() function.

Return period for heavy precipitation

In the "Managing the risks of extreme events…" report, look at Fig. SPM.4B. Read the caption.

Note the report on extremes was published before the Fifth Assessment Report and uses an older set of scenarios. The scenarios correspond as follows:

A2 is between RCP6.0 and RCP8.5

A1B is comparable to RCP6.0

B2 is between RCP4.5 and RCP6.0

Roughly, A2, A1B, and B2 are high, medium and low.

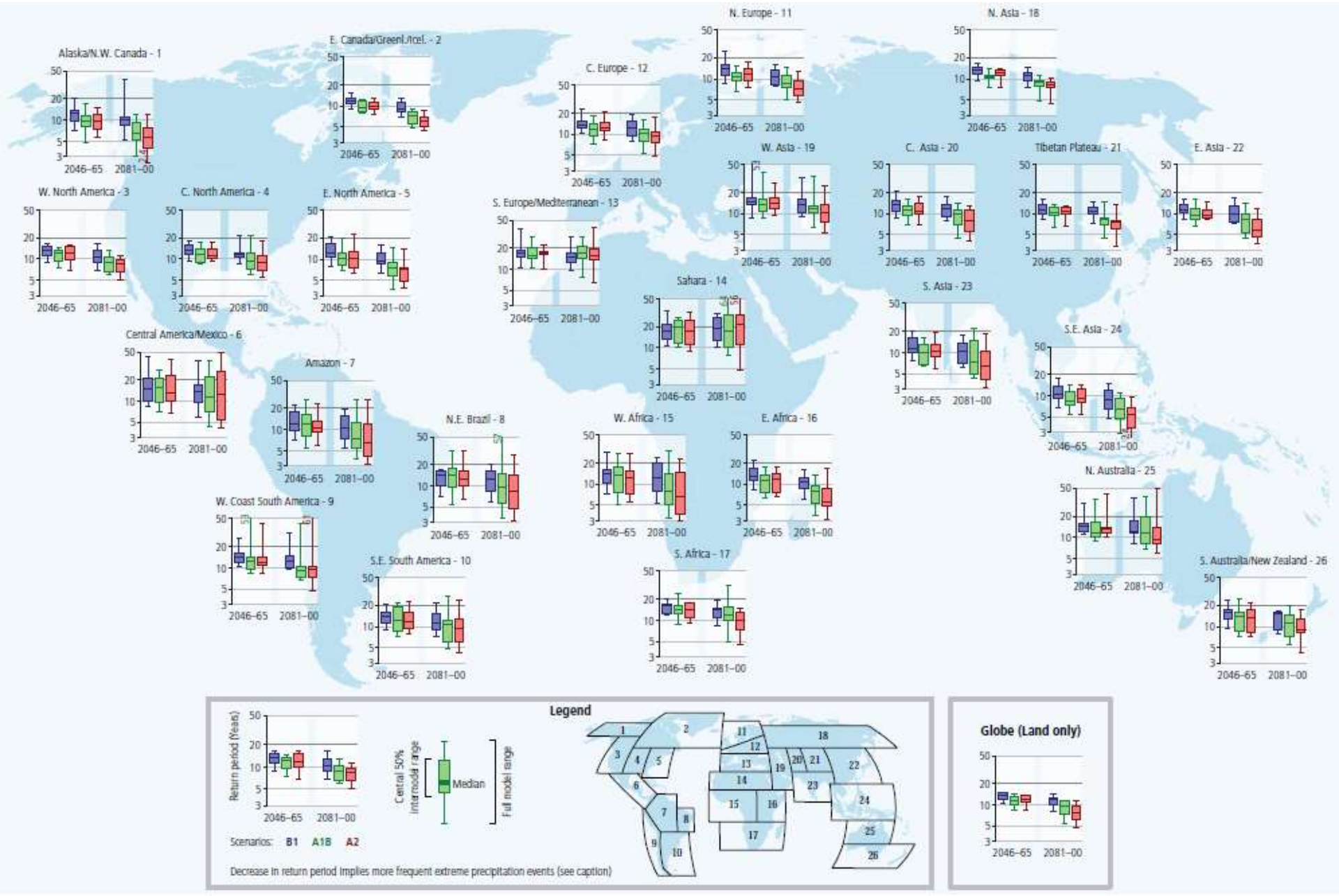
Return period for heavy precipitation

In the "Managing the risks of extreme events…" report, look at Fig. SPM.4B.

A **heavy precipitation** event that occurred on average every 20 years in 1981-2000 is predicted to occur on average every how many years in 2081-2100? Assume the A1B scenario (medium emissions).

Find values for these locations:

- Central Europe
- Central America and Mexico
- Central North America
- Eastern North America


Alaska/N.W. Canada - 1
E. Canada/Greenl./Icel. - 2
N. Europe - 11
N. Asia - 18
C. Europe - 12
W. Asia - 19
C. Asia - 20
Tibetan Plateau - 21
E. Asia - 22
W. North America - 3
C. North America - 4
E. North America - 5
S. Europe/Mediterranean - 13
Sahara - 14
S. Asia - 23
S.E. Asia - 24
Central America/Mexico - 6
Amazon - 7
N.E. Brazil - 8
W. Africa - 15
E. Africa - 16
N. Australia - 25
W. Coast South America - 9
S.E. South America - 10
S. Africa - 17
S. Australia/New Zealand - 26
2046–65
2081–00
Legend
Return period (Years)
Central 50% Intermodel range
Median
Full model range
Scenarios: B1 A1B A2
Decrease in return period implies more frequent extreme precipitation events (see caption)
Globe (Land only)

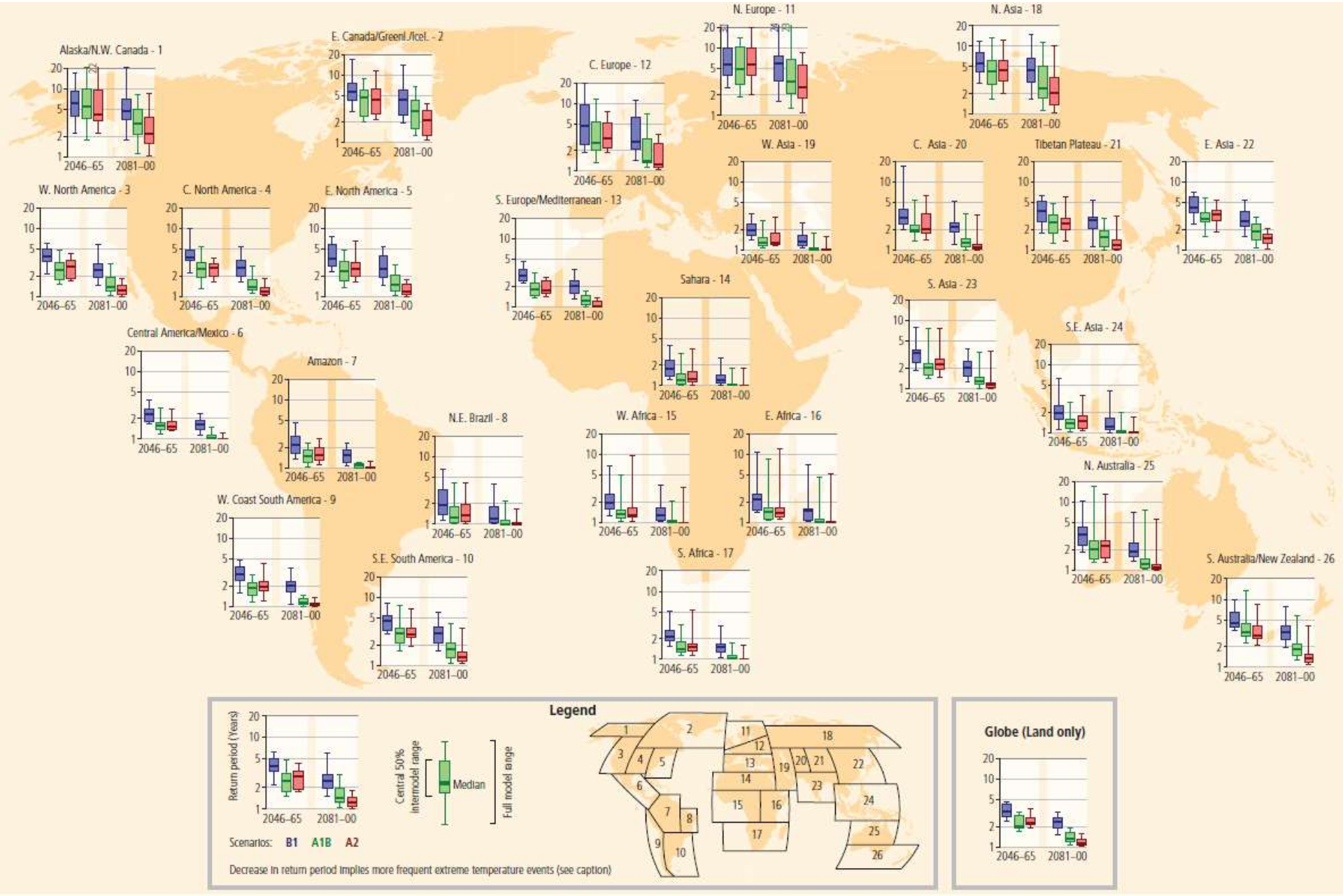
Return period for extreme high temperatures

Now look at Fig. SPM.4A in the "Managing the risks of extreme events" report.

A **high temperature** that occurred on average once every 20 years in 1981-2000 is predicted to occur every how many years on average in 2081-2100?

Find values for these locations:

- Central Europe
- Northern Europe
- Central North America
- Western Africa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E. Asia - 22
W. North America - 3
C. North America - 4
E. North America - 5
S. Europe/Mediterranean - 13
Sahara - 14
S. Asia - 23
S.E. Asia - 24
Central America/Mexico - 6
Amazon - 7
N.E. Brazil - 8
W. Africa - 15
E. Africa - 16
N. Australia - 25
W. Coast South America - 9
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S. Australia/New Zealand - 26
2046–65
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Legend
Return period (Years)
Central 50% Intermodel range
Median
Full model range
Scenarios: B1 A1B A2
Decrease in return period implies more frequent extreme temperature events (see caption)
Globe (Land only)

Sea level rise

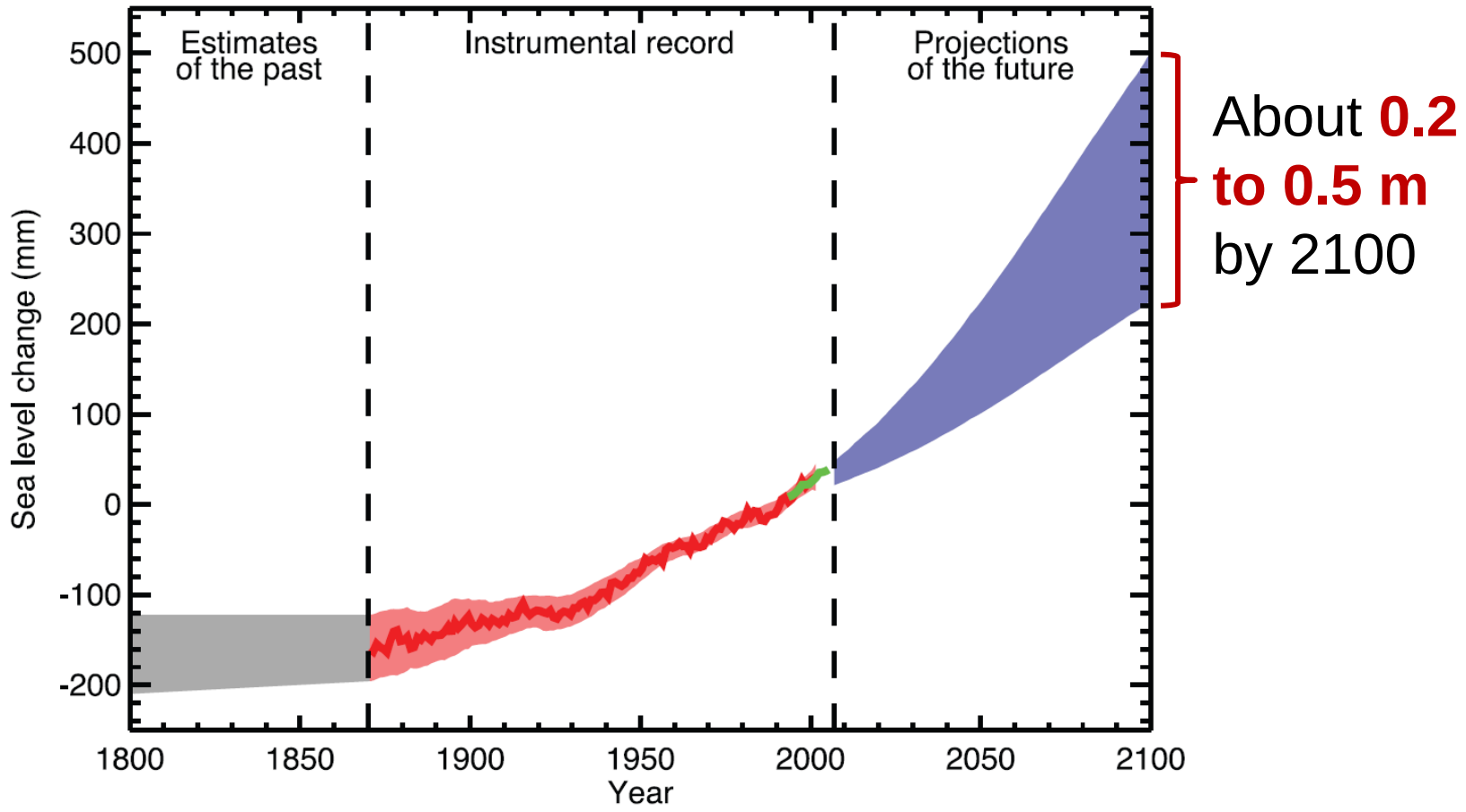
Changes in sea level are affected by changes in several parts of the climate system:

- ocean (gains or loses water)
- cryosphere (gains or loses water)
- atmosphere (**transfers** water – gains/losses are very small)

Sea level changes have two main causes:

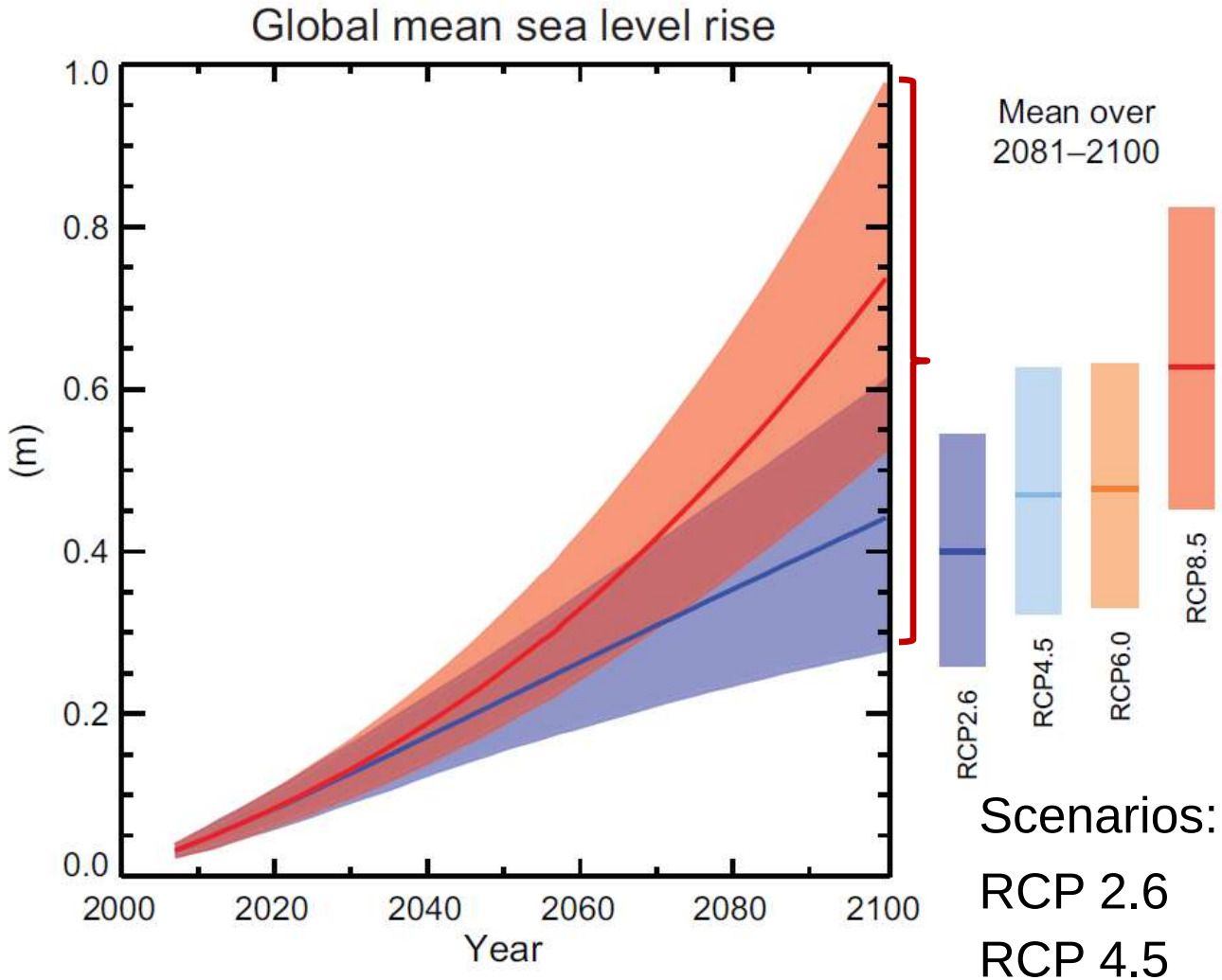
- **Sea water expands as it warms** (thermosteric sea level rise).
- Transfer of ocean water to or from other parts of the Earth. Mostly glaciers, but also groundwater withdrawal and other transfers.
- Both of these change as the climate changes.

Sea level rise in the previous IPCC report (4th Assessment Report, 2007)



from IPCC (2007)

The most recent IPCC report projects sea level rise about double the earlier report



About **0.3 to 1 m** by 2100 depending on model and scenario.

Scenarios:

RCP 2.6

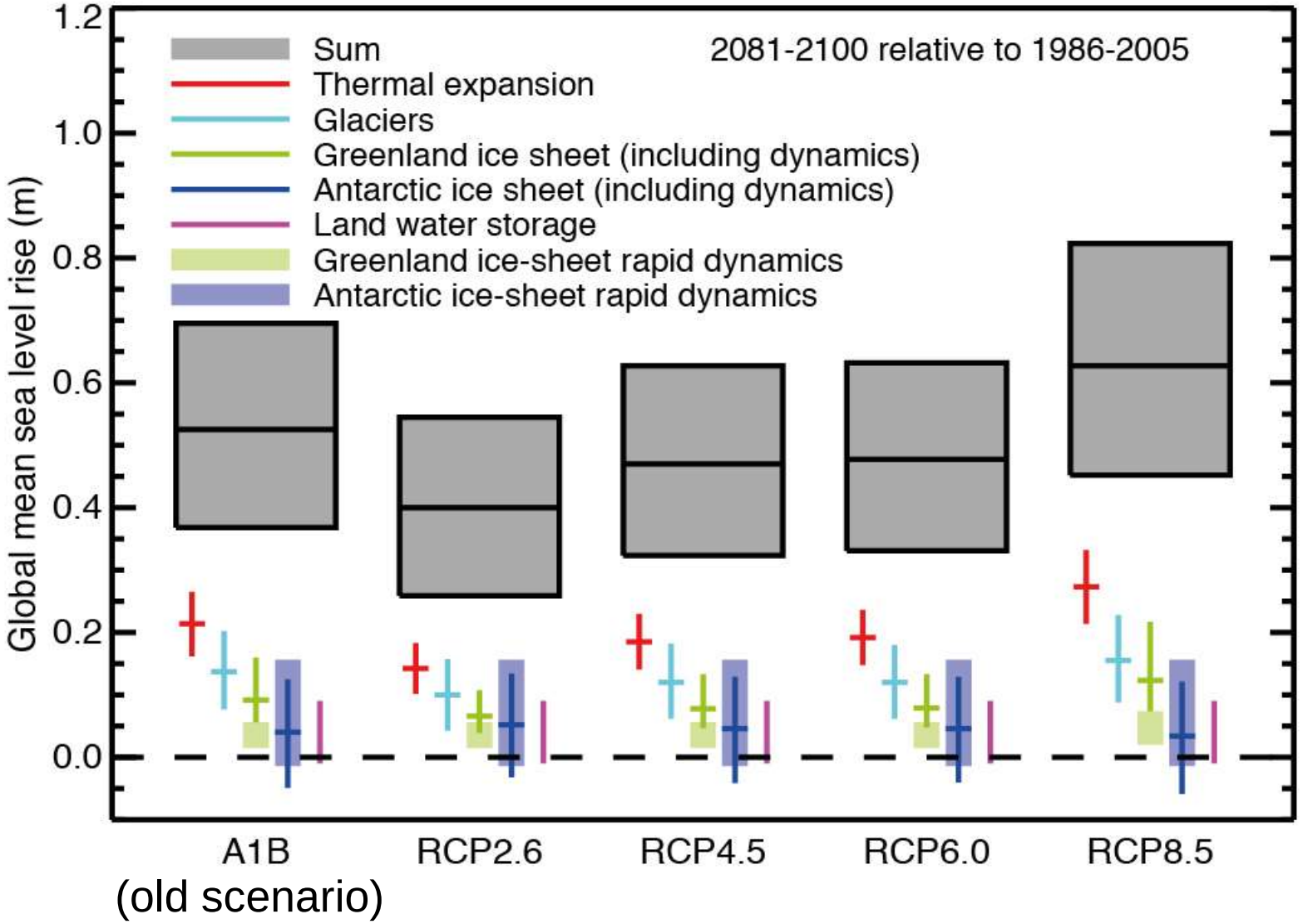
RCP 4.5

RCP 6.0

RCP 8.5

from IPCC (2013)

Thermal expansion of sea water is the leading cause of projected sea level rise



(old scenario)

IPCC Fifth Assessment Report, Working Group I, Fig, 13.10

Class exercise: Sea level rise

Go to either the "Pages" section on Canvas, or the AGRON 406 Schedule page.

In the Pages section or the schedule entry for today, follow the link for "Sea level rise simulator."

Set sea level to its present value:

Select **0 m** in the box labeled "Sea level rise" in the upper-left corner.

Sea level rise from IPCC scenarios

Zoom in on the area around New Orleans and the Mississippi River delta.

If we assume no major changes to ice sheets, the high-end IPCC estimate for sea level rise over the next century is close to 1 m. What changes do you see?

Select **+1 m** in the "Sea level rise" box.

Many scientists think this estimate is too low, because there is evidence that ice sheets are changing faster than expected.

Select **+2 m** in the "Sea level rise" box. Zoom in more closely on the New Orleans area to see the effects in detail.

Sea level rise: a more extreme scenario

If all of the Greenland ice sheet melted, sea level would rise about 7 meters.

Enter +7 m in the "Sea level rise" box.

Check the New Orleans area again. Also zoom out to look at southern Florida.

Even more extreme

If the Antarctic ice sheet were to melt entirely, sea level would rise about 60 meters. What effect would this have on the coast of the southeast United States?

Enter +60 m for sea level rise. Zoom out to see the entire East Coast and Gulf Coast of the U.S.

Also look at northern Europe.

Even with the highest emissions scenarios this will not happen any time soon!