

# Projections for Climate Change

Projection graphs and figures in this exercise are taken from the IPCC Technical Summary  
<http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-ts.pdf>

## I. Projected Global Average Surface Warming and Sea Level

Table TS.6. Projected global average surface warming and sea level rise at the end of the 21st century. {10.5, 10.6, Table 10.7}

Case	Temperature Change (°C at 2090-2099 relative to 1980-1999) <sup>a</sup>		Sea Level Rise (m at 2090-2099 relative to 1980-1999)
	Best estimate	Likely range	Model-based range excluding future rapid dynamical changes in ice flow
Constant Year 2000 concentrations <sup>b</sup>	0.6	0.3 – 0.9	NA
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

Notes:

<sup>a</sup> These estimates are assessed from a hierarchy of models that encompass a simple climate model, several Earth Models of Intermediate Complexity (EMICs), and a large number of Atmosphere-Ocean Global Circulation Models (AOGCMs).

<sup>b</sup> Year 2000 constant composition is derived from AOGCMs only.

This table summarizes the projected global average surface warming and sea level rise at the end of the 21<sup>st</sup> century. Data are from six different GCMs (general climate models).

Do all models show a projected increase in temperature? Is this significant?

What is the high, low and average projected change in global average temperature by the end of the century?

High = \_\_\_\_\_ °C      Low = \_\_\_\_\_ °C      Average = \_\_\_\_\_ °C

What is the high, low and average projected change in sea level rise by the end of the century?

High = \_\_\_\_\_ m      Low = \_\_\_\_\_ m      Average = \_\_\_\_\_ m

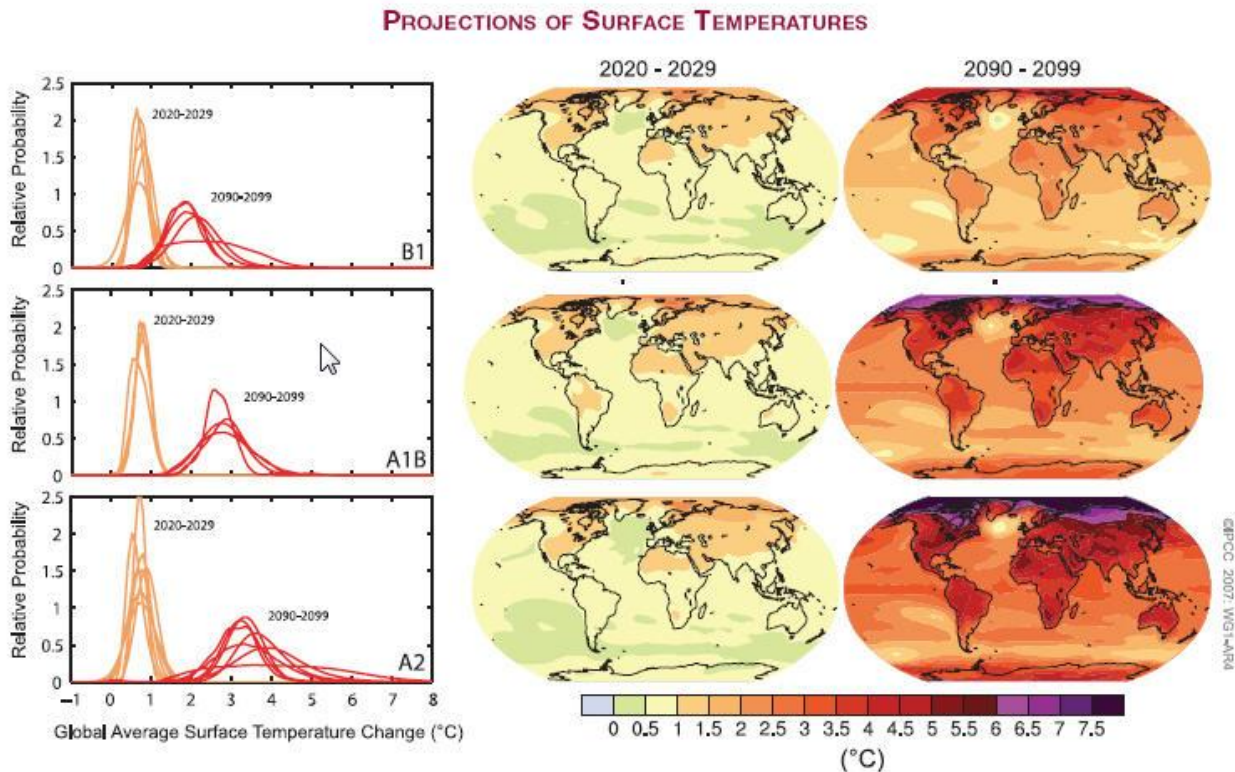
These are global averages; how is this significant?

How do the temperature and sea level projections relate to the Keeling Curve (atmospheric CO<sub>2</sub>)?

Given these projections what are the potential consequences due to temperature and sea level changes around the world? Pick three locations (2 outside the US) to discuss, use the map provided.

# Projections for Climate Change

## II. Projections of Surface Temperatures



This figure shows projected surface temperature changes for the early and late 21<sup>st</sup> century relative to the period 1980 to 1999. The center and right panels show model averages for three different scenarios. The left hand panels show uncertainties, probabilities and estimated changes in the near future and the end of the century.

For **2020-2029**:

Where are the projected increases **highest**?

What is the expected change in temperature? \_\_\_\_\_ °C

Why is this area undergoing more significant change?

Where are the projected increases the **lowest**?

What is the expected change in temperature? \_\_\_\_\_ °C

Why is this area undergoing less significant change?

For **2090-2099**:

Where are the projected increases **highest**?

What is the expected change in temperature? \_\_\_\_\_ °C

Why is this area undergoing more significant change?

Where are the projected increases the **lowest**?

## Projections for Climate Change

What is the expected change in temperature? \_\_\_\_\_ °C

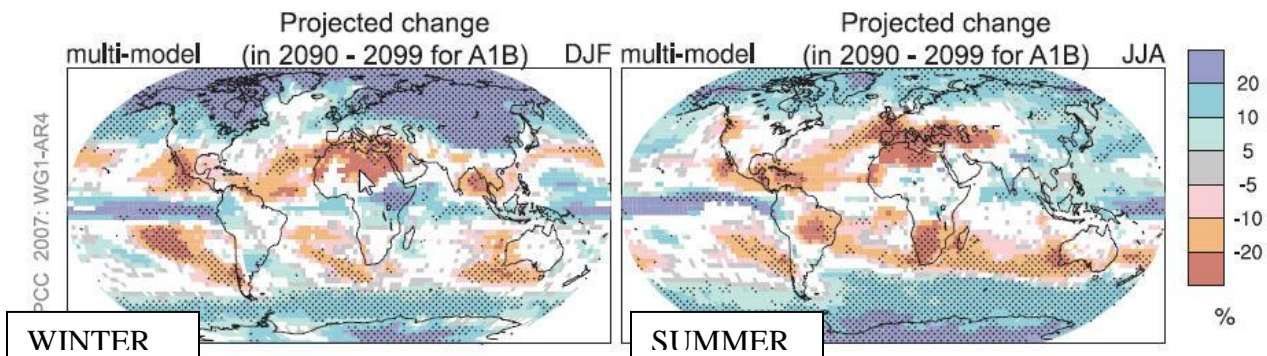
Why is this area undergoing less significant change?

How might these predictions influence the circulation of ocean water in the north Atlantic?

How are these projections of sea surface temperature likely to impact global food productions?

# Projections for Climate Change

## III. Projections of Changes in Precipitation



This figure shows projected changes in seasonal mean precipitation rate (in mm/day) for the end of the century. December to February are on the left and June to August are on the right. Projections are where more than 60% of the models agree on the changes. Stippled areas indicate areas where more than 90% of the models agree.

Please comment on any **general patterns** for each climate zone giving latitudinal locations for each of the following:

**Tropical**

**Sub-tropical/desert**

**Temperate**

**Polar**

Describe/comment on summer conditions in the Mediterranean/Europe, southern Africa, and Brazil specifically.

Describe any changes in Michigan winters and summers. Include absolute amounts if possible.

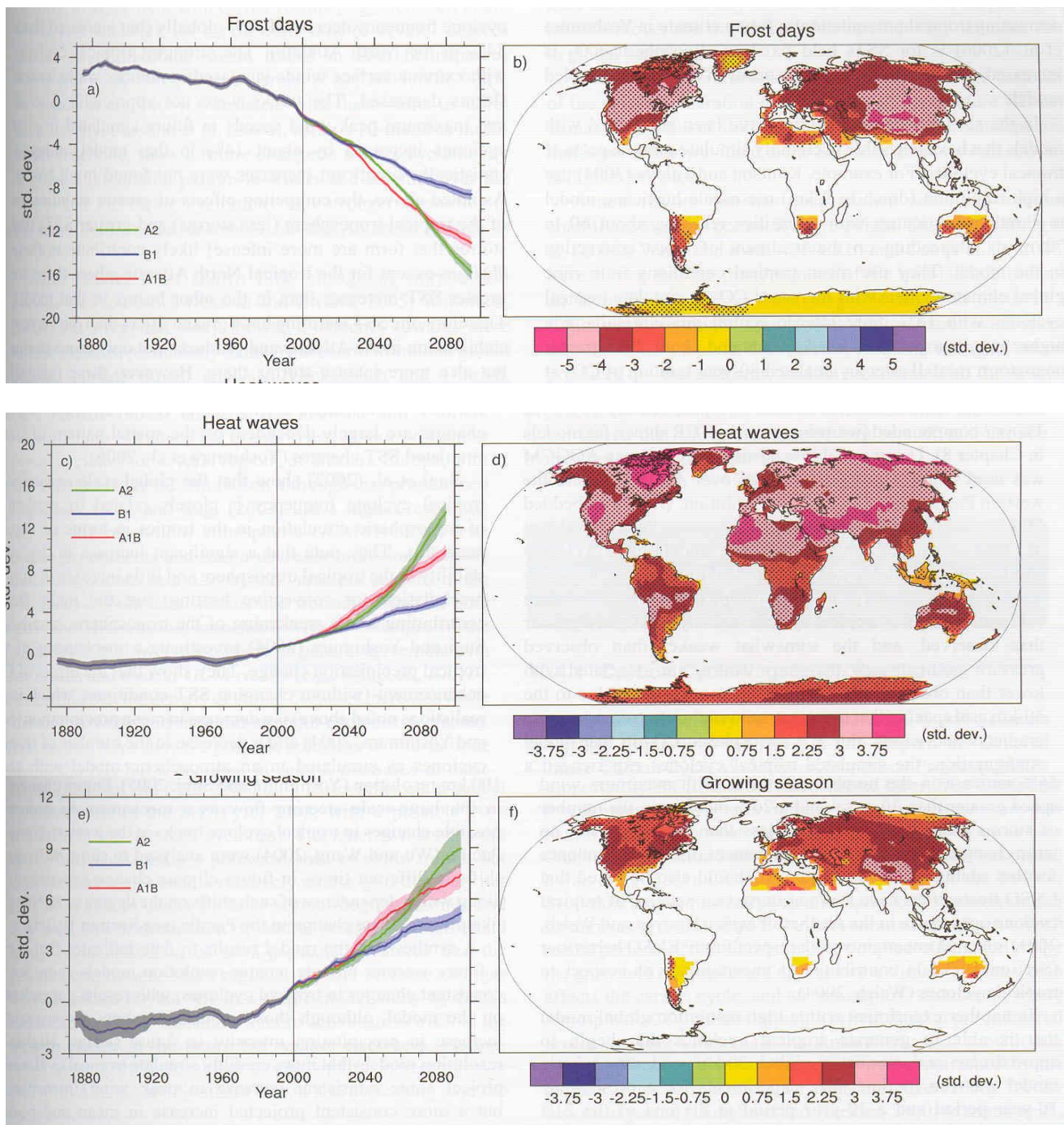
How are overall warming patterns shown in the previous section coupled with changes in precipitation?

Speculate on how these changes might influence on global food production.



# Projections for Climate Change

## IV. Projections of Changes in Frost, Heat, and Growing Days



Is the number of frost days likely to increase or decrease by 2080-2099?  
What regions will be most affected by the resulting frost days by 2080-2099?

Is the potential for heat waves likely to increase or decrease by 2080-2099?

## Projections for Climate Change

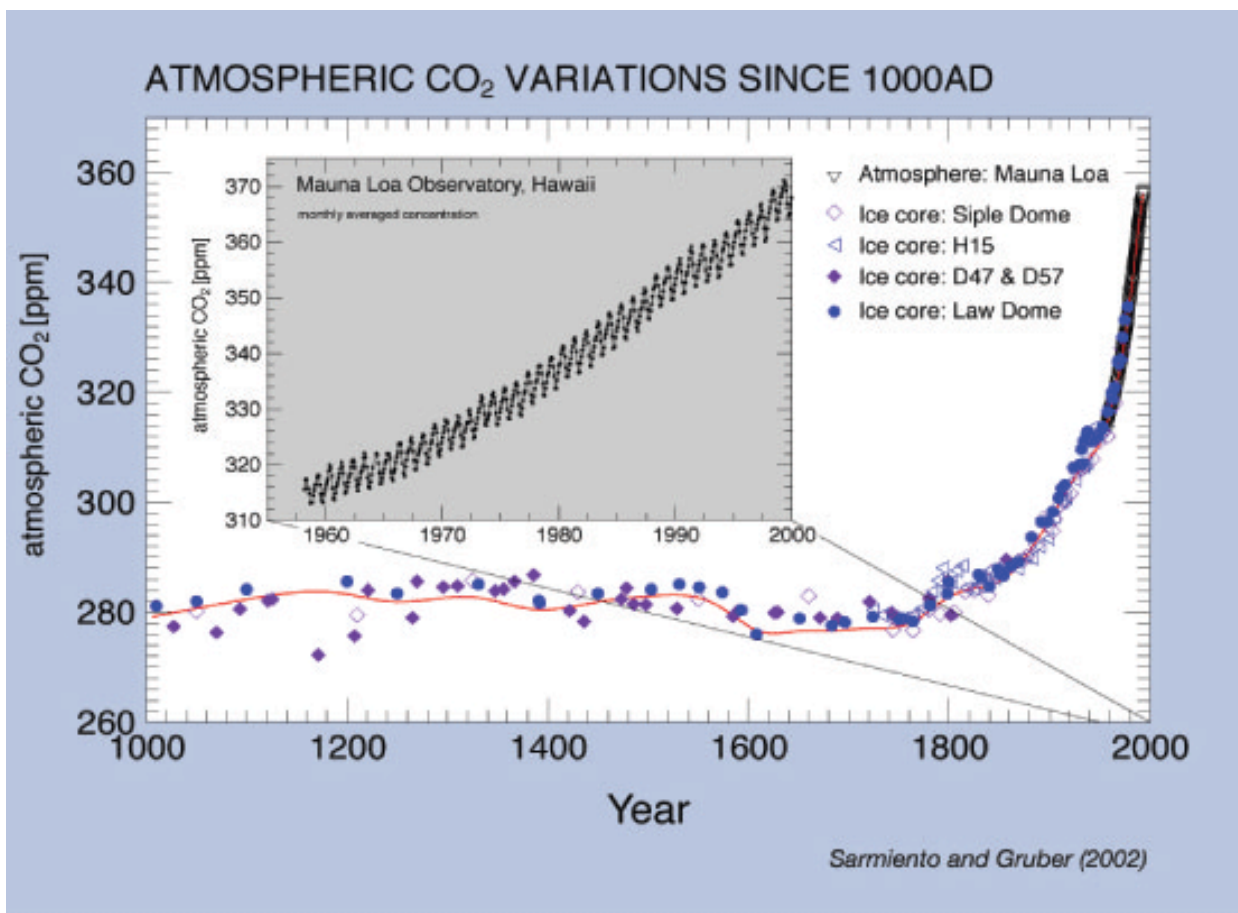
What regions will be most affected by the resulting heat days by 2080-2099?

How do these compare to the projections for growing days?

How do these projections influence oranges in Florida? Blueberries in Michigan? Wine in France?

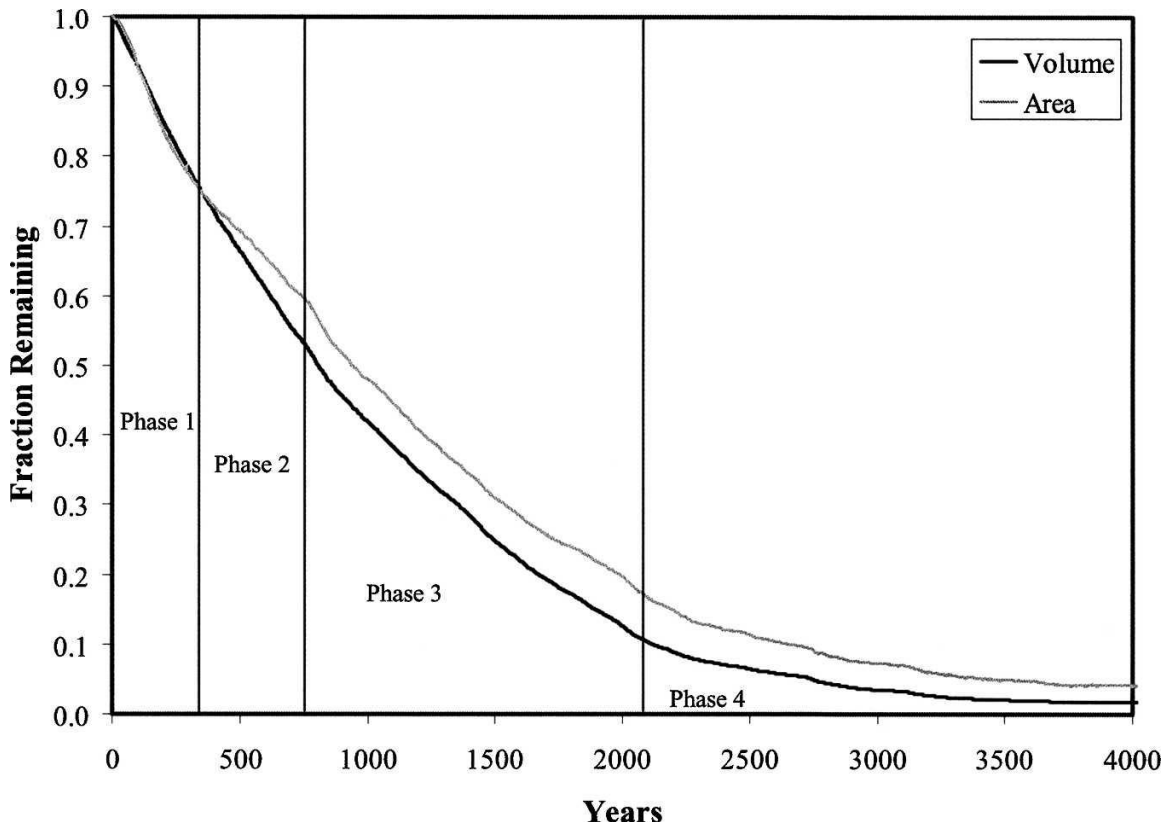
---

### v. Projections of Changes in Greenland



Ridley and others, 2005, Elimination of the Greenland Ice Sheet in a High CO<sub>2</sub> Climate, *Journal of Climate*, p. 3409-3427.

## Projections for Climate Change



Ridley and others focused a climate model on a narrow region that included Greenland. Their model considered ice mass changes in the ice sheet that, in turn, can alter the future climate through changes in orography (shape of the ice or land surface), surface albedo, and freshwater input to the model ocean.

Ridley et al. assumed  $\text{CO}_2$  level at 4 times the pre-industrial level. What would this concentration be?

At the current rate of  $\text{CO}_2$  increase how long would it take to reach this level?

Once the stated conditions are reached, how long does it take for 50% of the ice sheet to melt?

How long does it take for nearly all of the ice sheet to melt?

Speculate on how would the climate near Greenland change as this change progressed?  
Try to be as detailed as possible.

How would this scenario influence global ocean circulation?

# Projections for Climate Change

## VI. Where to live at the end of this century?

Based on projections for global average temperatures and changes in precipitation, describe the trends and rate the following 10 locations using all the evidence provided for the year 2099 by most climate changes to least climate changes.

1. Mt. Kilimanjaro, Africa
2. Anchorage, AK
3. South Australia
4. Indonesia
5. Miami, FL
6. Brazil along Amazon river delta
7. Greenland
8. Northern coast of Russia
9. Michigan
10. San Francisco, CA