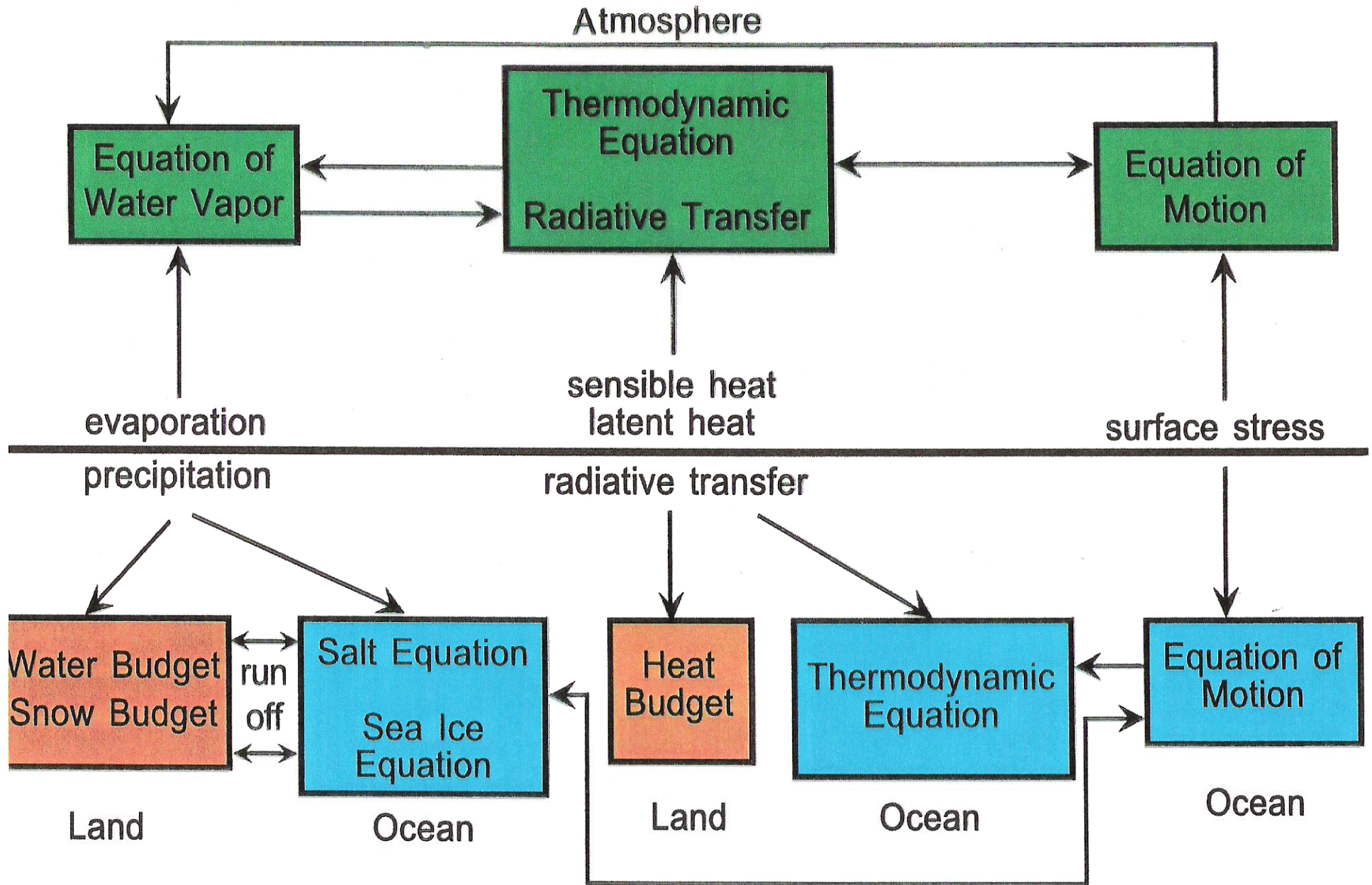


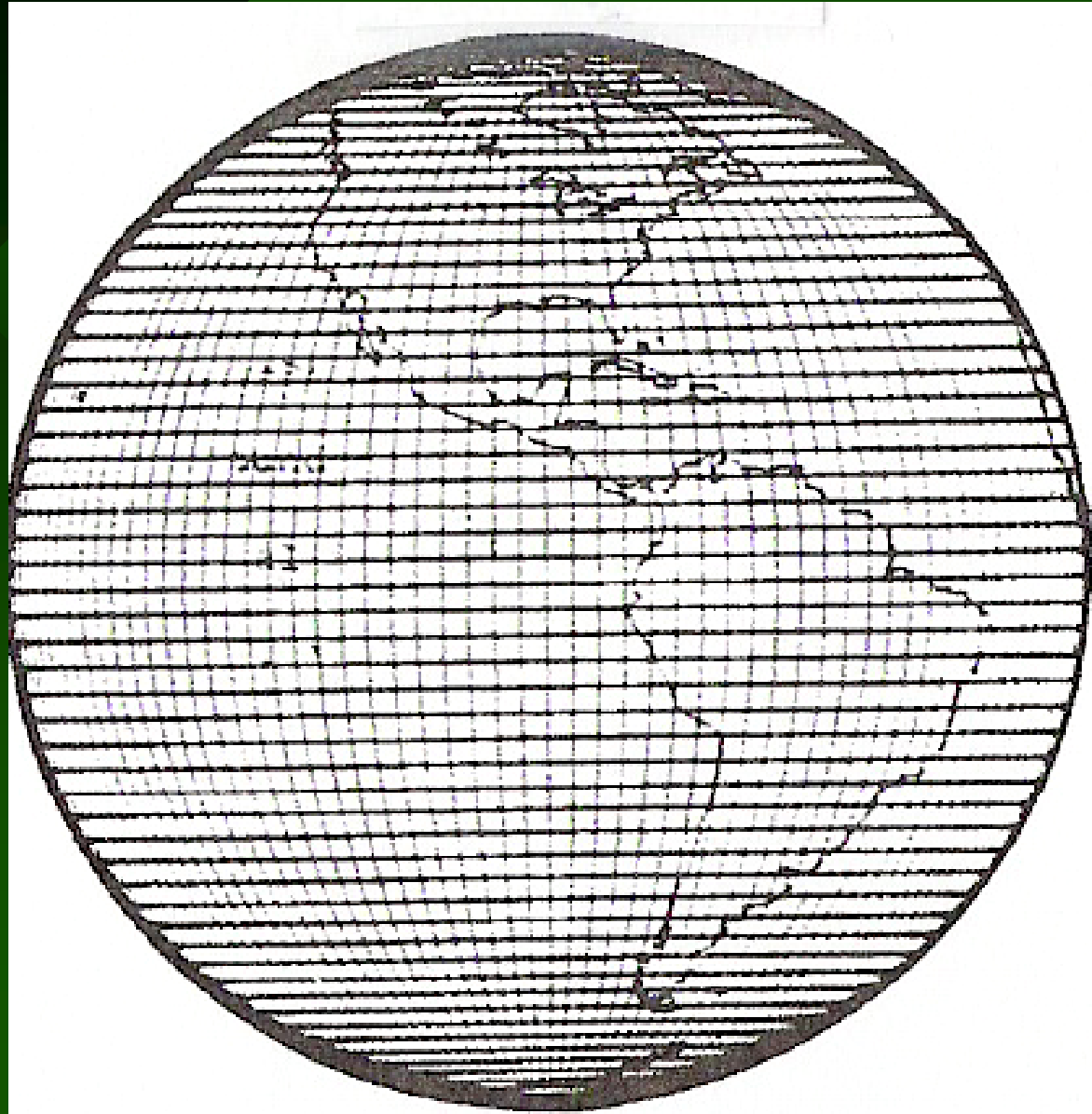


**Global Warming
and
Water**

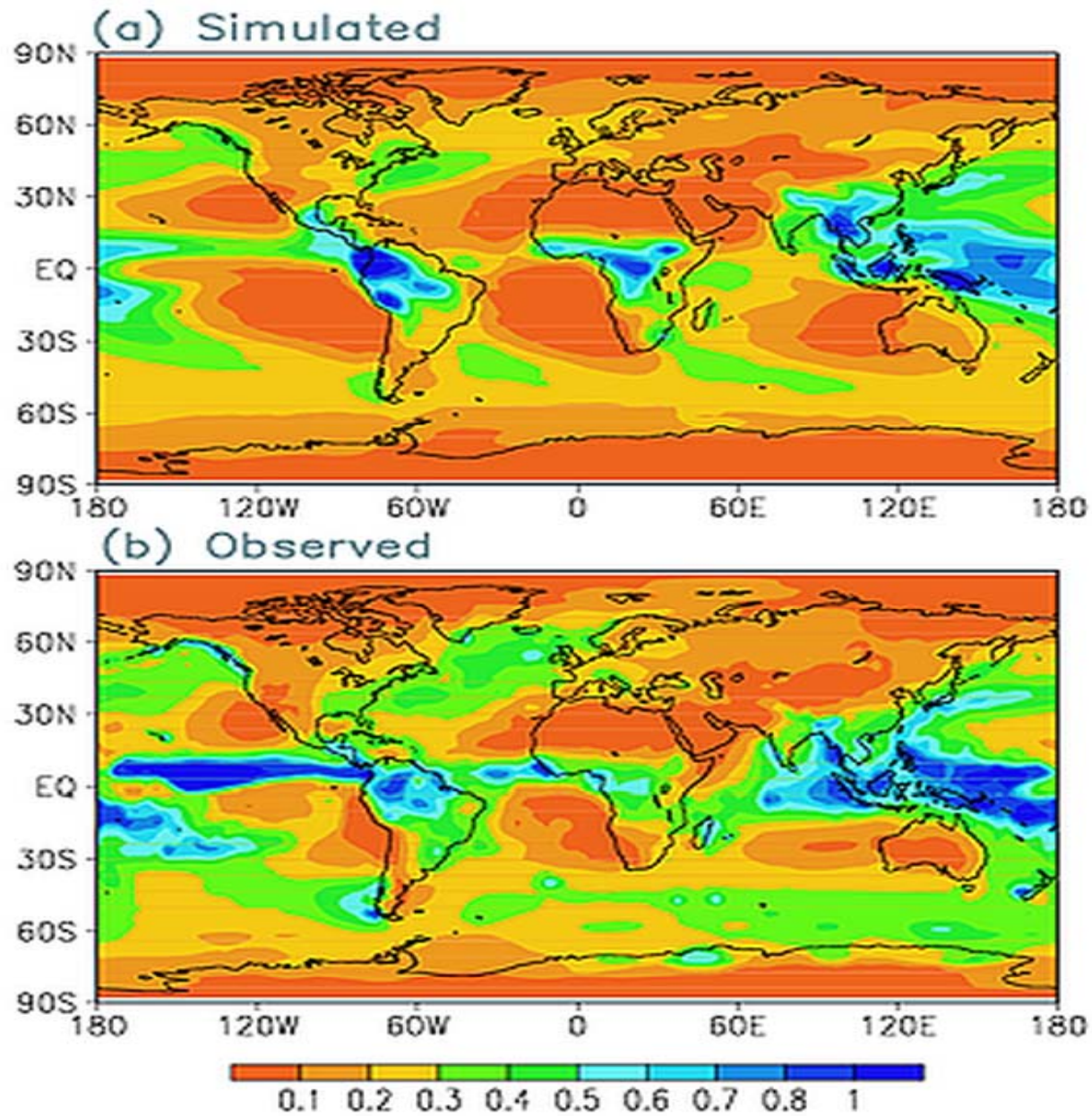
Coupled Ocean-Atmosphere-Land Model



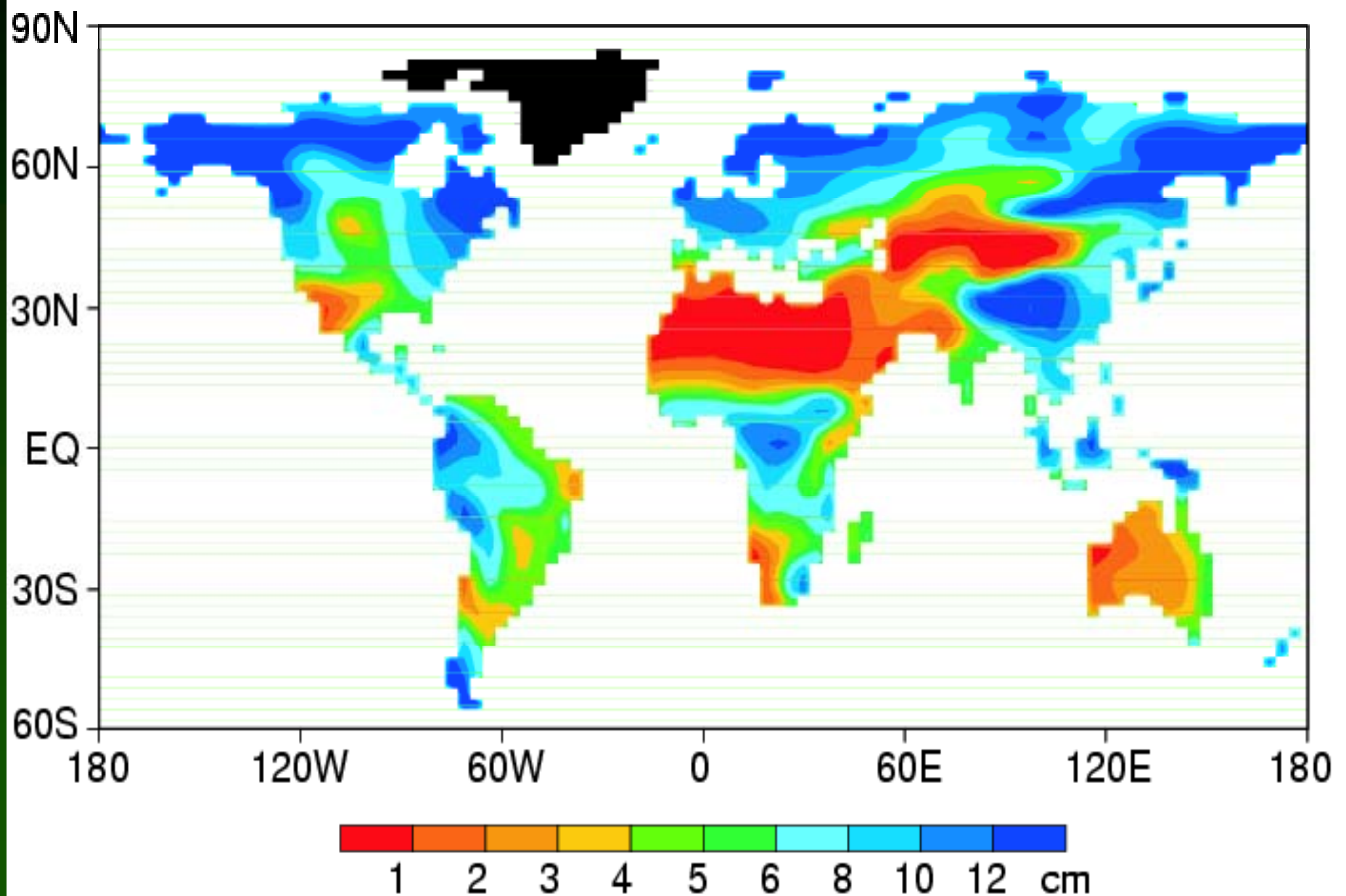
Global Grid System



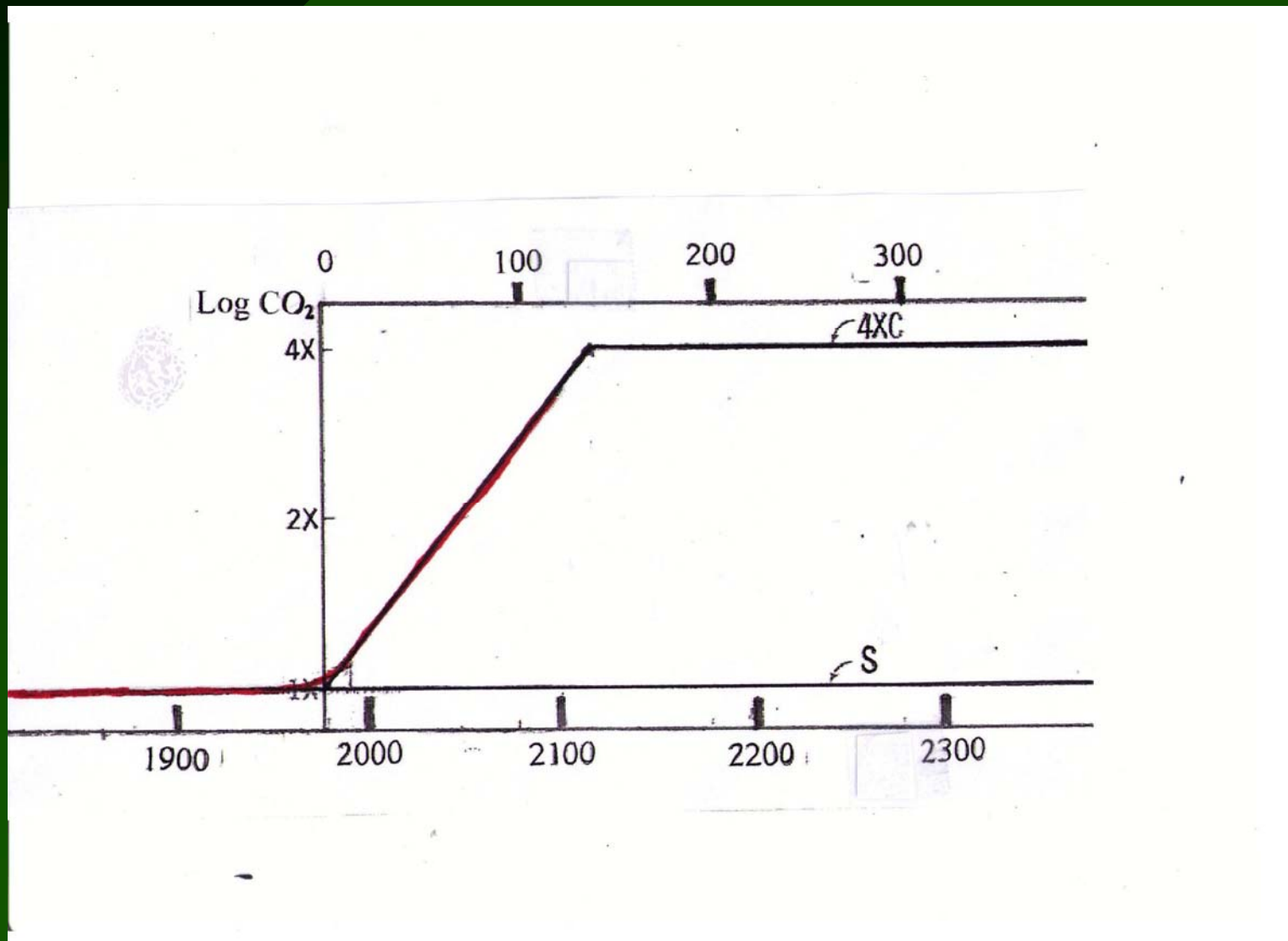
Annual Mean Precipitation, cm/day



Annual Mean Soil Moisture, Simulated



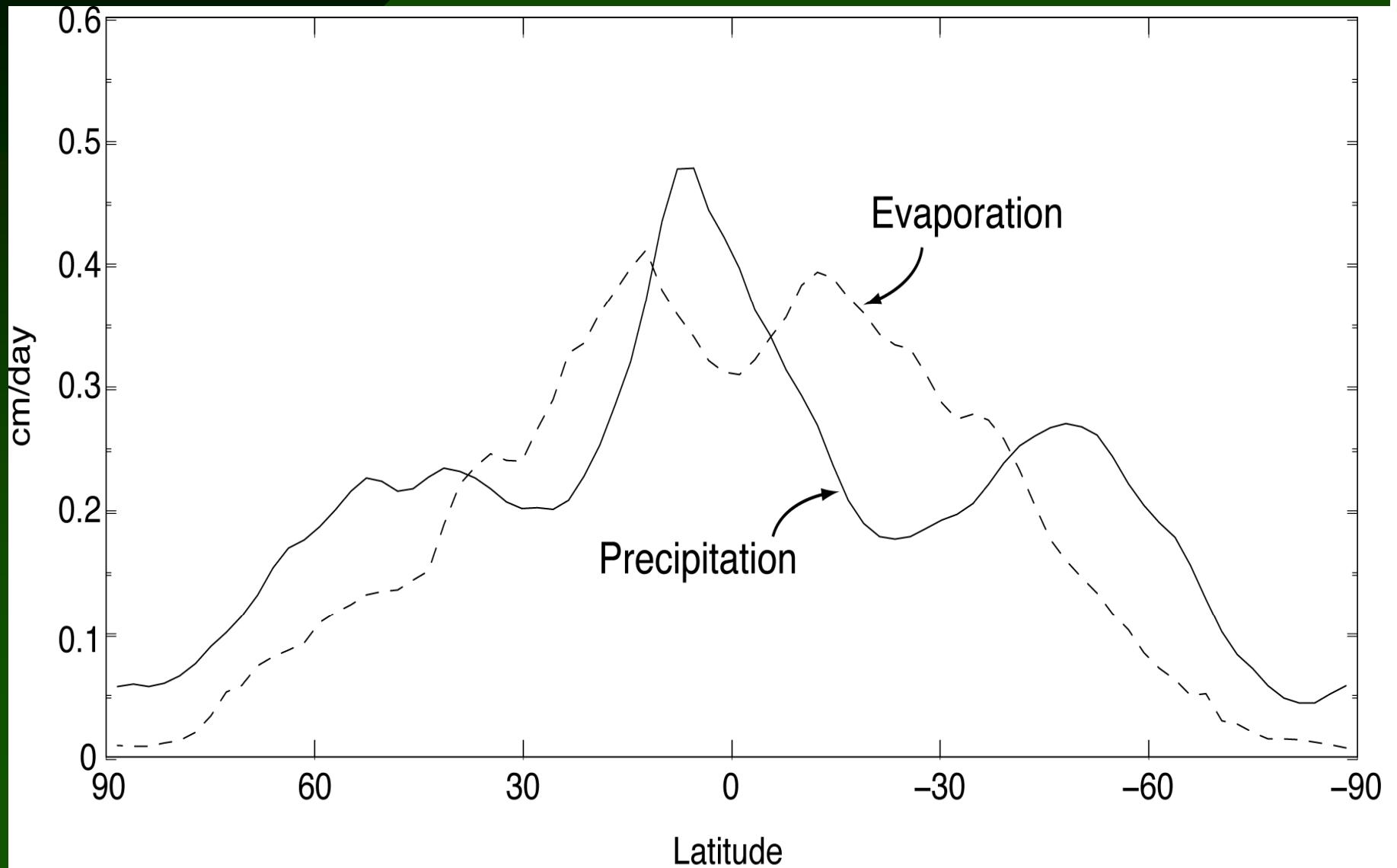
CO₂ Concentration ~ Time

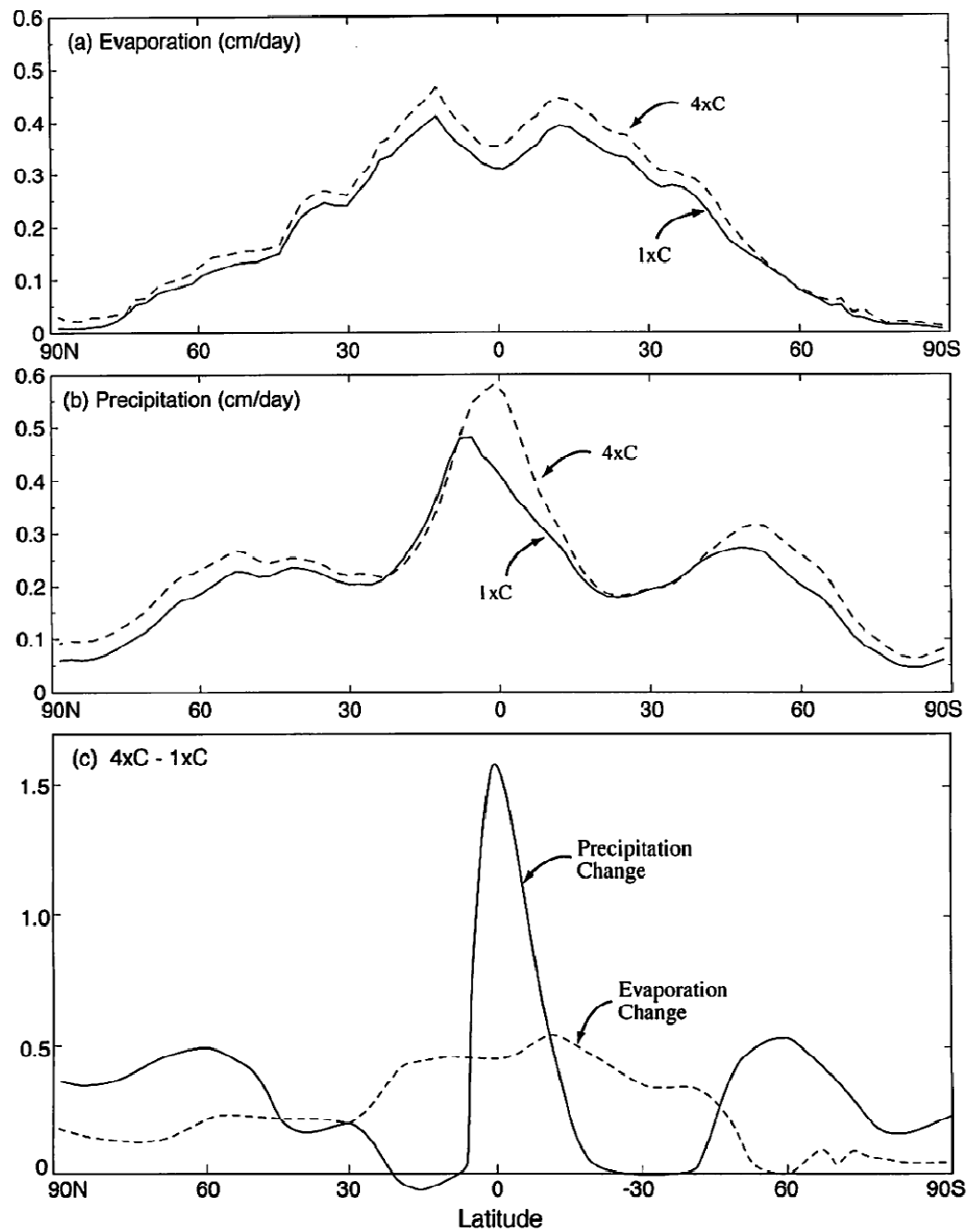


Global Mean Changes

	ΔT_s^G	$\Delta \text{Precip.} = \Delta \text{Evap.}$	ΔRunoff
2050	+2.3°C	+5.3%	+7.3%
4xC	+5.5°C	+12.7%	+14.8%

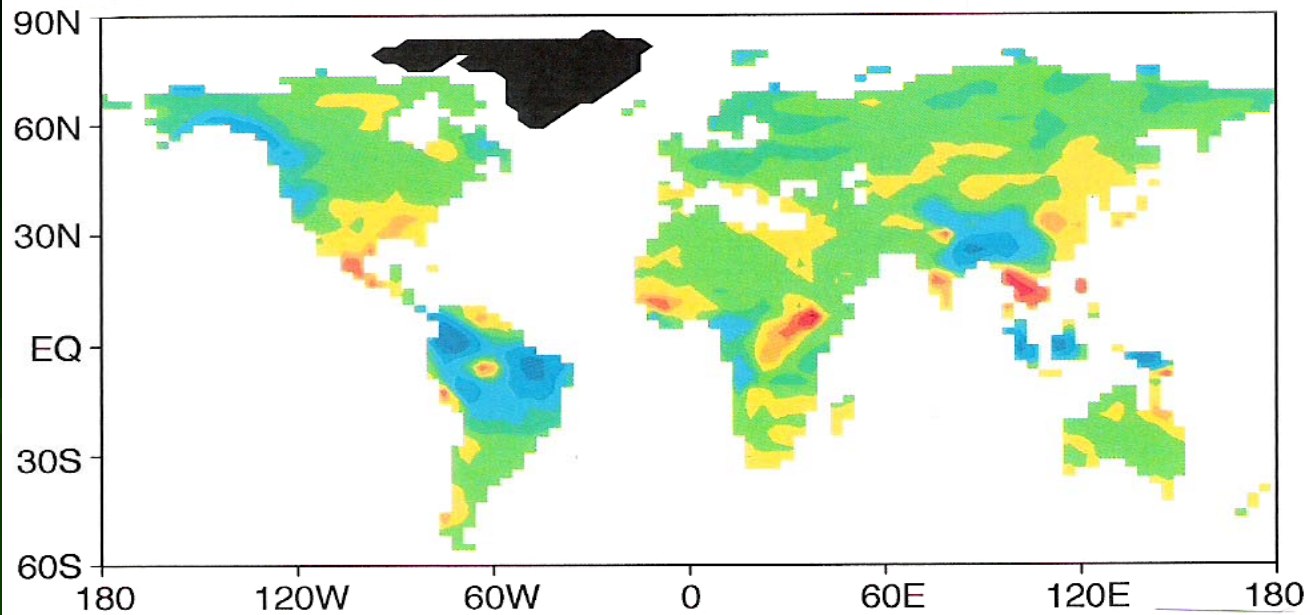
Latitudinal Profiles: P & E





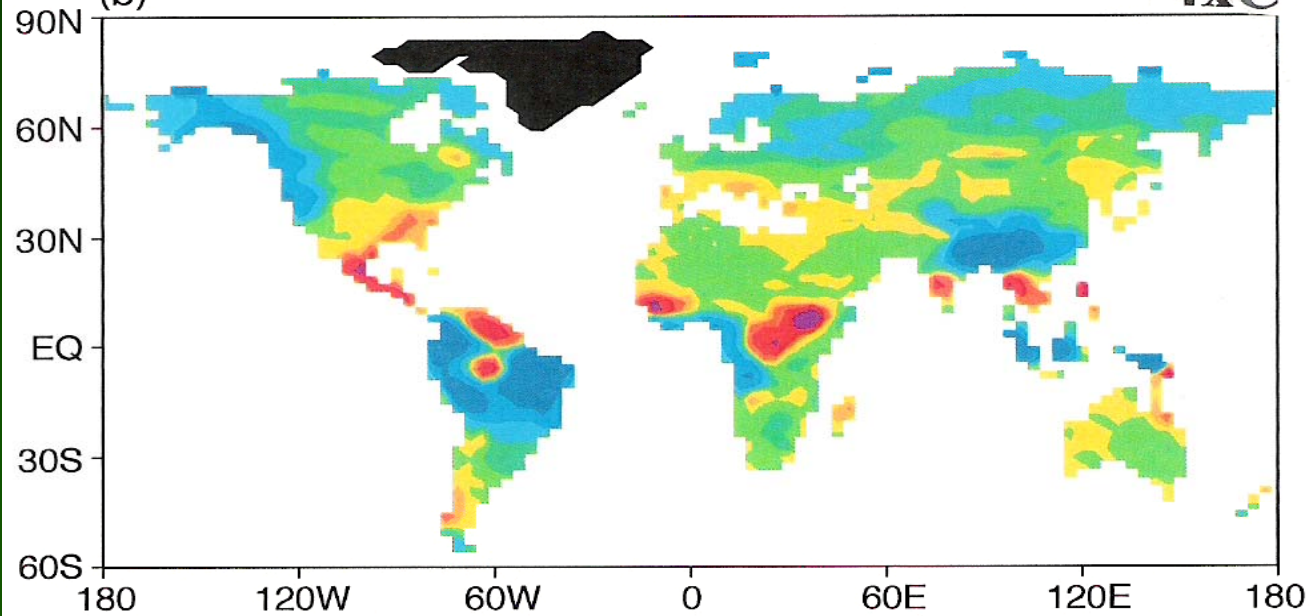
Change in Annual Runoff

2050



(b)

4x CO_2



River Discharge ($10^3\text{m}^3\text{s}^{-1}$)

High Latitudes, Europe & NW-region of N. America

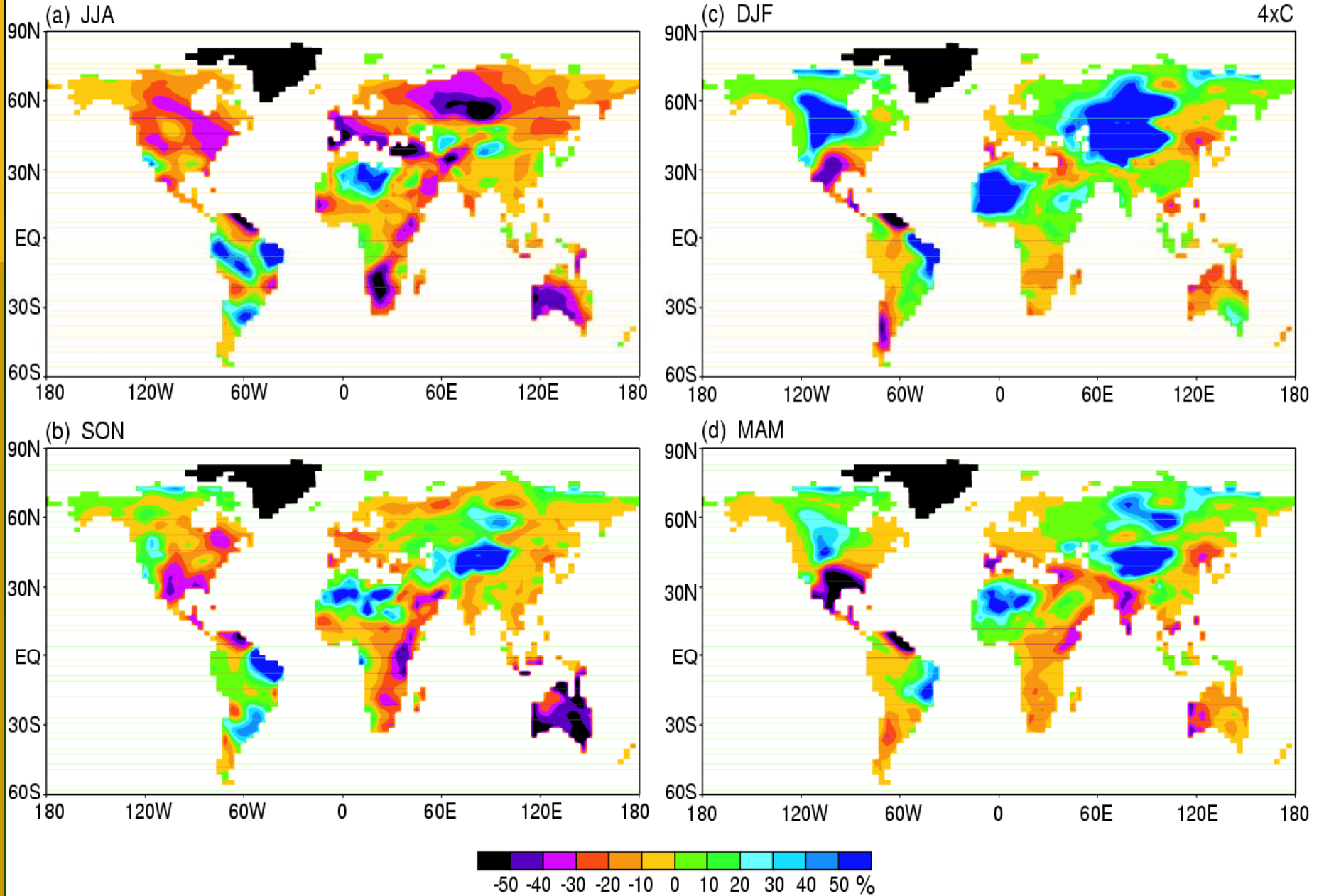
	Rate	Change	Change
Name	S. (Obs.)	2050	4xC
Yukon	10 (7)	+21%	+ 47%
Mackenzie	9 (9)	+21%	+40%
Yenisei	13(18)	+13%	+24%
Lena	15(17)	+12%	+26%
Ob'	6(13)	+21%	+42%
Subtotal	53(63)	+16%	+34%
Rhein/Elbe/-	3(4)	+25%	+20%
Volga	5(8)	+25%	+59%
Danube/-	7(9)	+21%	+9%
Columbia	6(5)	+21%	+47%
Subtotal	21(26)	+23%	+34%

River Discharge ($10^3\text{m}^3\text{s}^{-1}$) (Low Latitudes)

	Rate	Change	Change
Name/River	S.(Obs.)	2050	4xC
Amazonas/Jari/ Maicuru/	234(194)	+11%	+23%
Ganga/ Bramaputra	49(33)	+18%	+49%

Percentage Change
in Soil Moisture: $\Delta W / W$

Soil Moisture Change (%), 4xC



Summary

Water-Rich Regions

- Increased Runoff
- Increased Flood Frequency

Water-Poor Regions

- Reduced Soil Moisture / Runoff
- Increased Drought Frequency

High Elevation

- Reduced Snow pack

Improved Water Management

Through

- Desalinization of Sea Water
- Filtering / Recycling of Used Water
- Increased Storage (i.e., dams and lakes)
- Transport through Pipeline
- Conservation
- Change in Agricultural Practice
- Biotechnology

Signal to Noise Ratio

Signal: Global Warming

Noise: Natural Variability

- The signal to noise ratio decreases with decreasing space/time scale
- At local scales, natural variability overwhelms global change particularly the change in rainfall

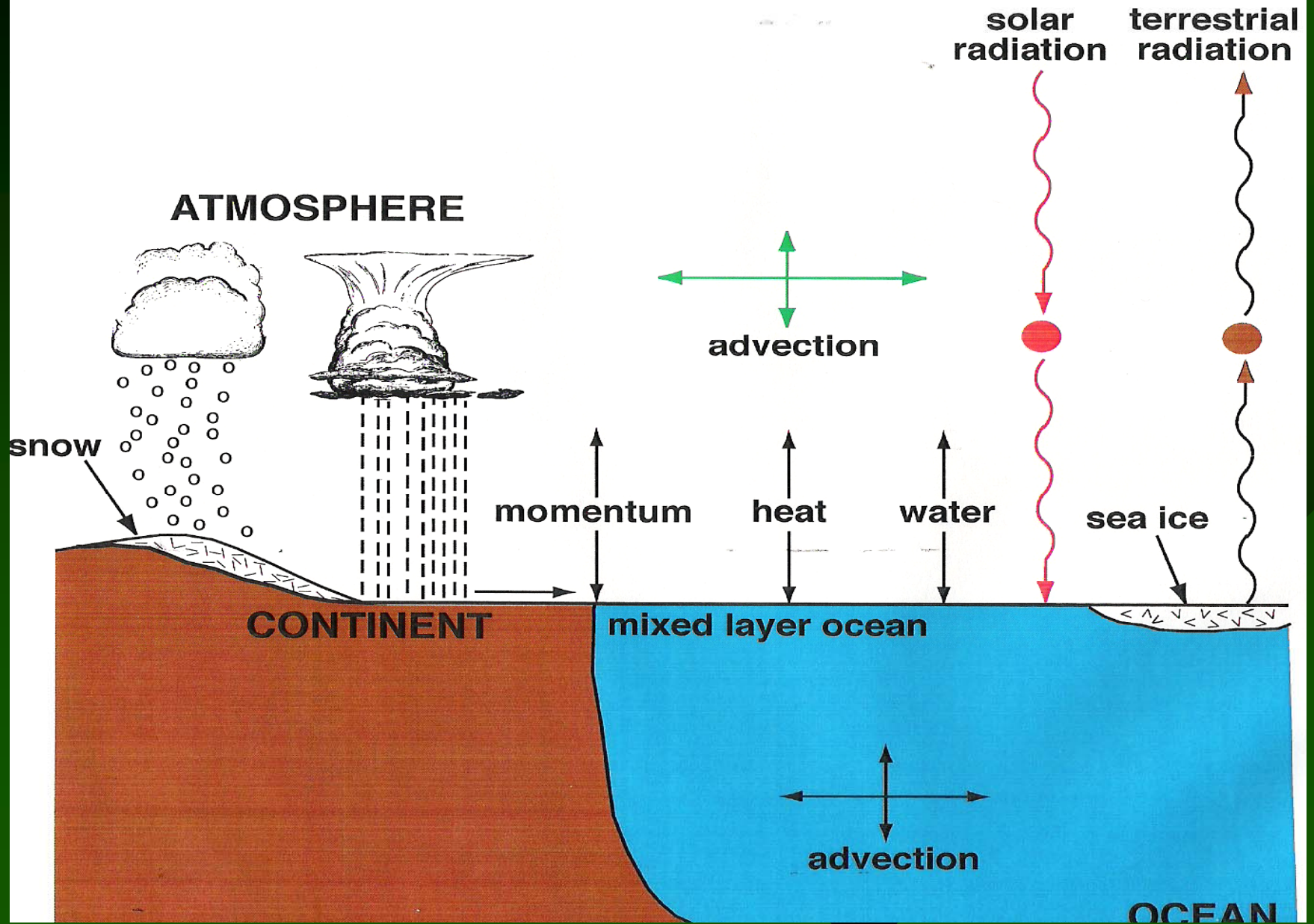
In-situ & Satellite Monitoring of the Following Variables

- Large-scale distribution of rainfall
- Frequency distribution of rain intensity (averaged over large area)
- Discharges from major rivers
- Continental-scale aridity
- Vegetation
- Snow cover and mountain glaciers

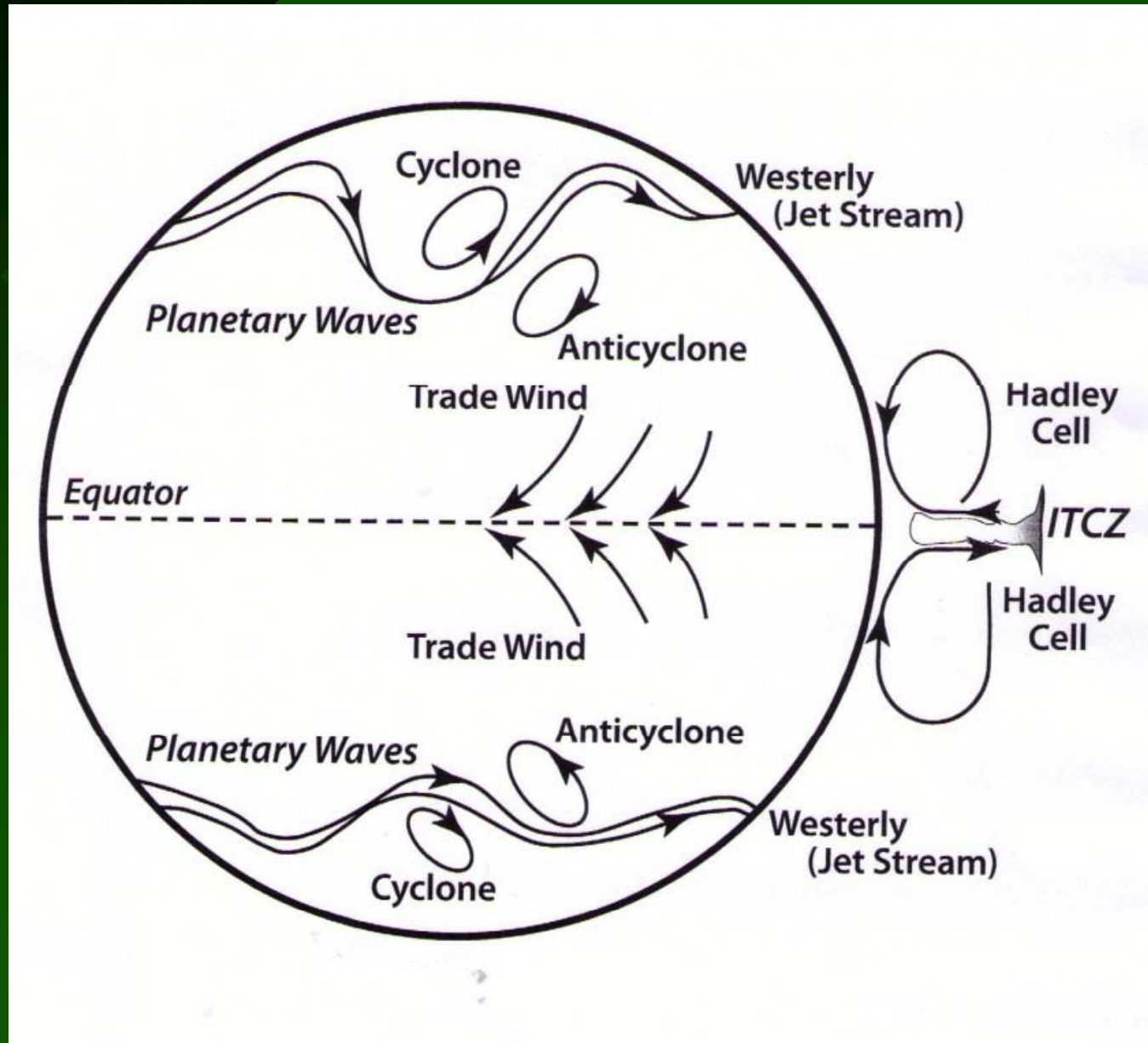
The slide features a dark green background with a large, lighter green diamond shape in the center. A vertical yellow bar is on the left side. The text "End of Presentation" is written in yellow in the upper left area.

End of Presentation

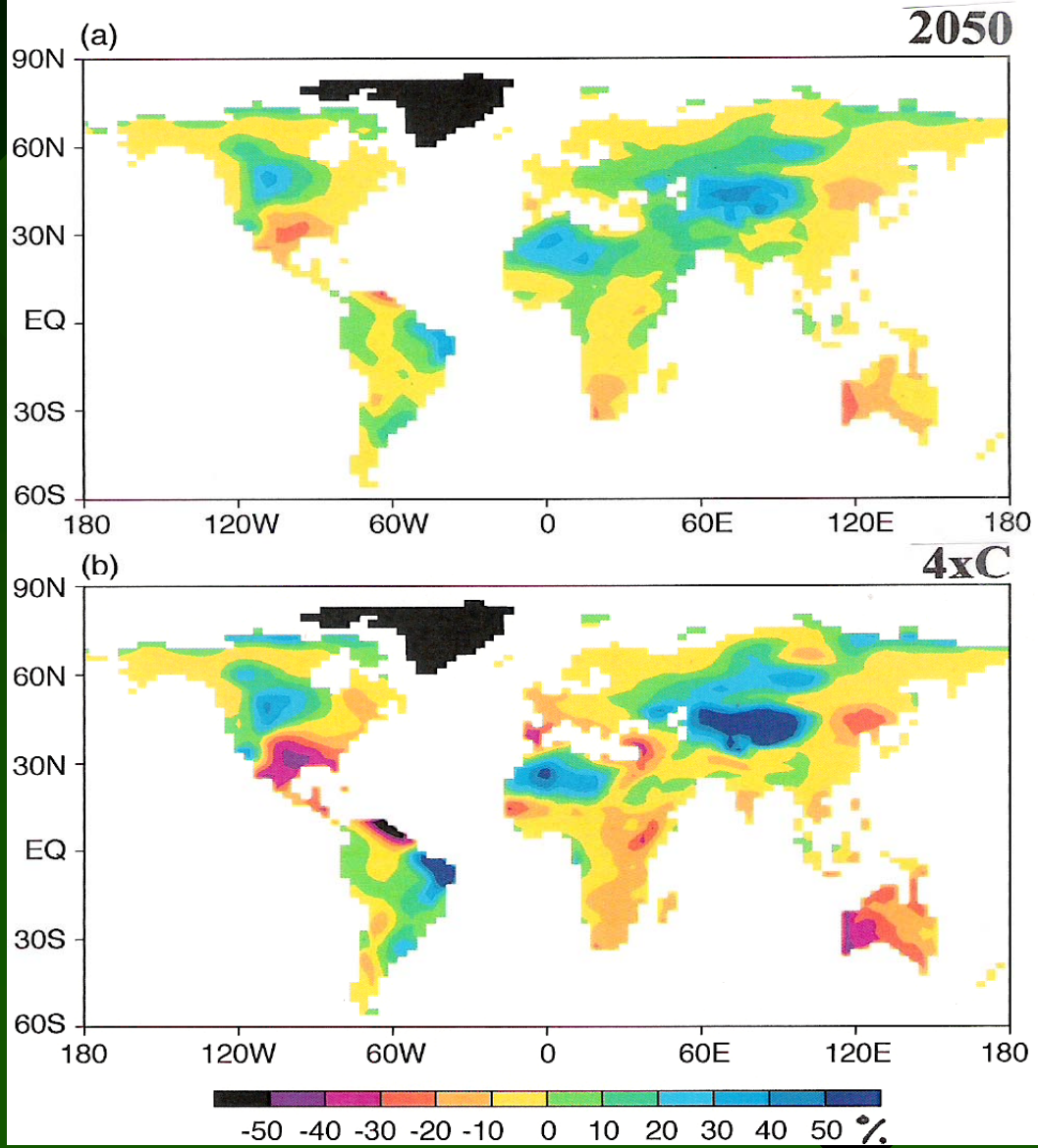
Physical Processes in a Model



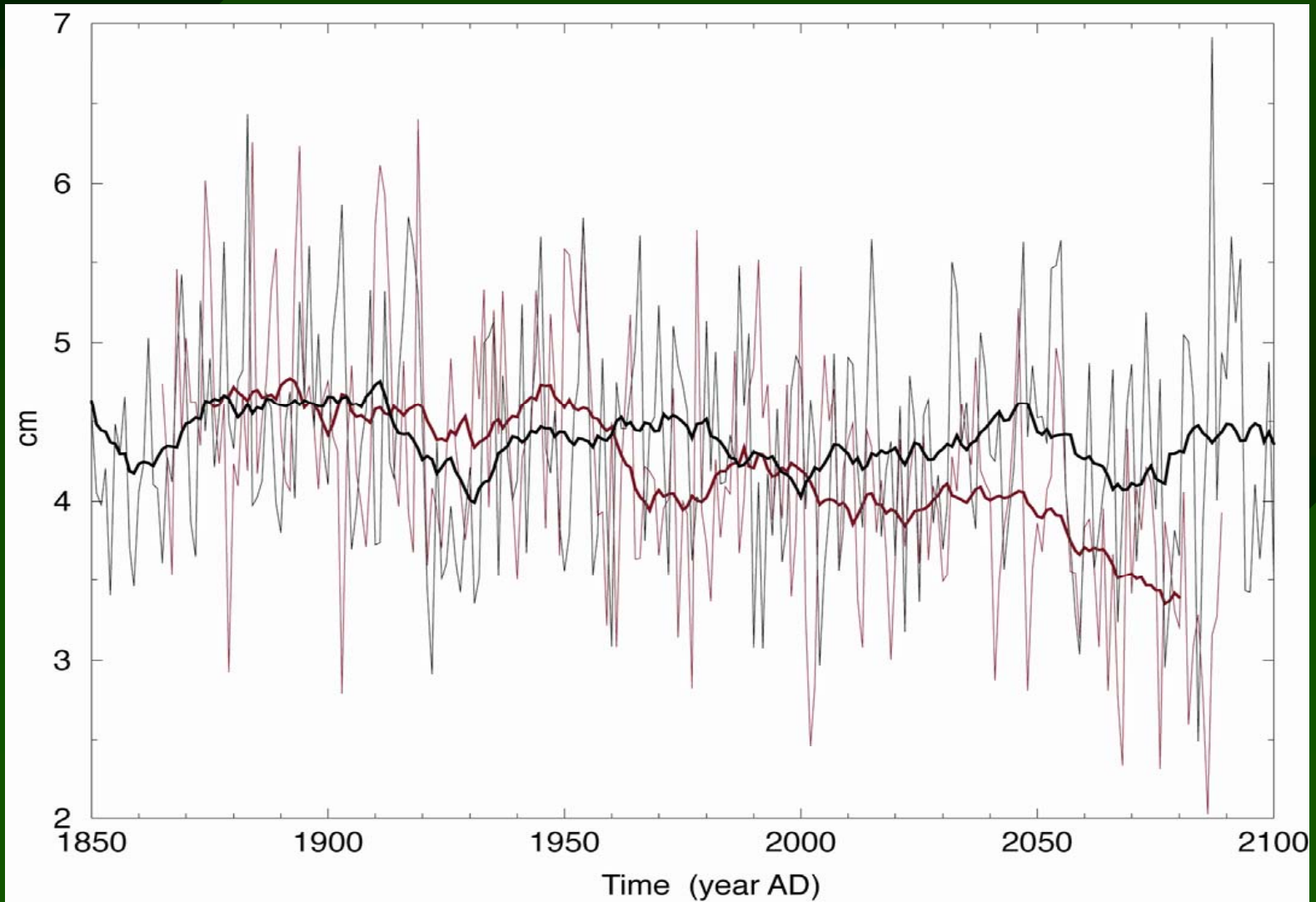
Atmospheric Circulation



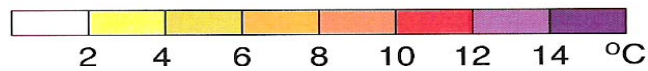
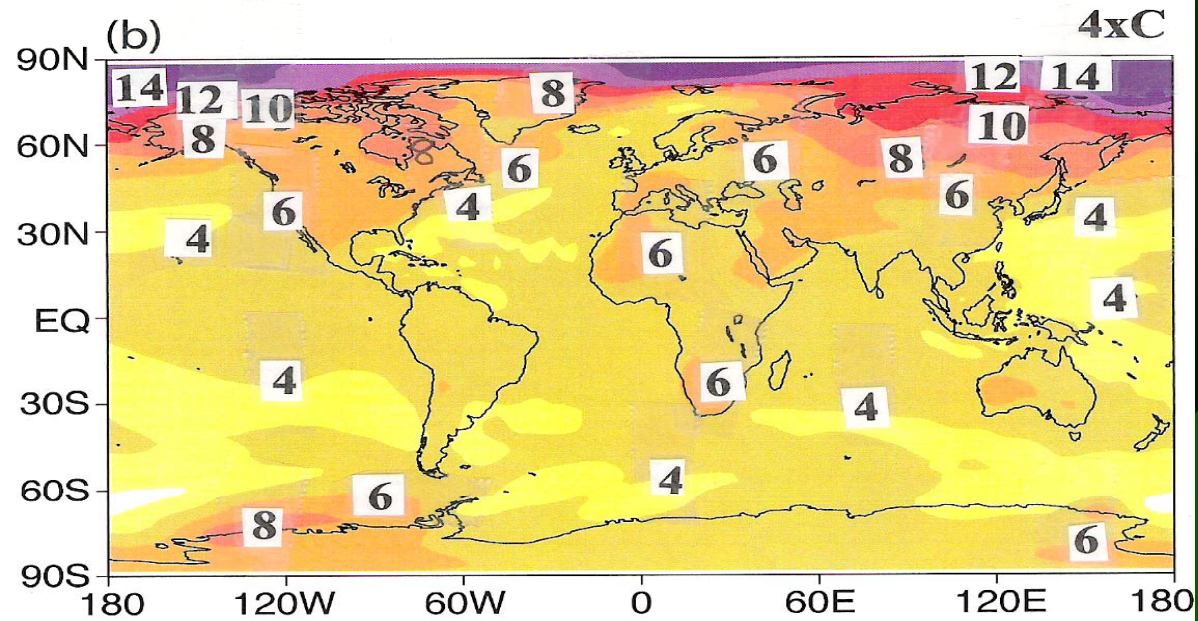
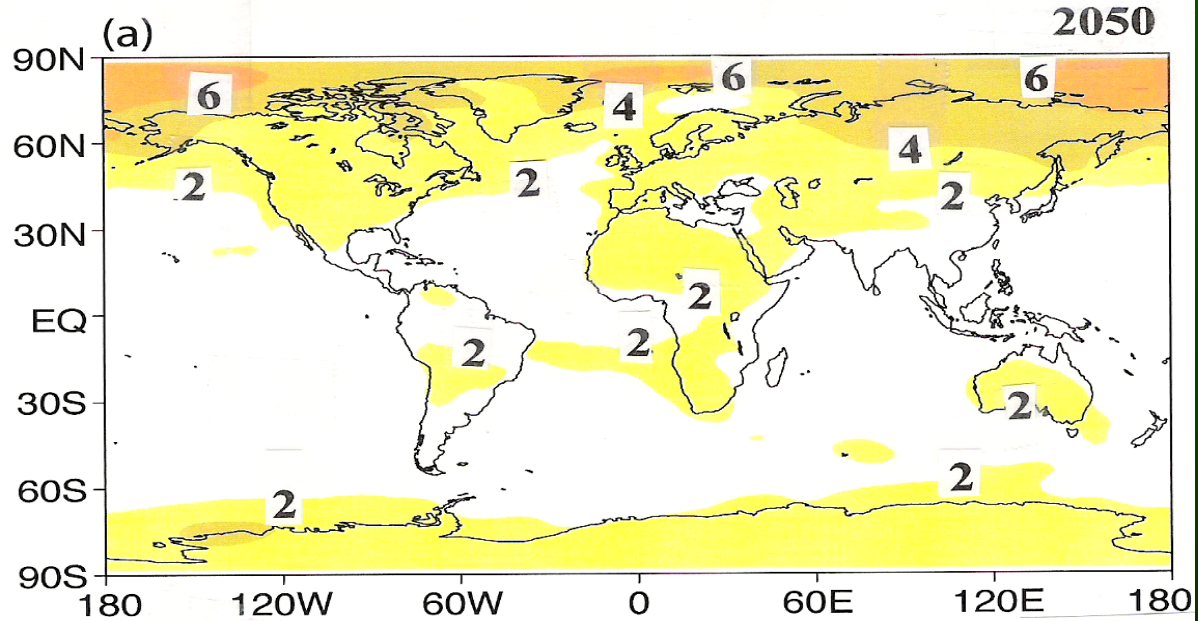
% Change in Annual Mean Soil Moisture



Time series of annual mean soil moisture in southwestern region of North America



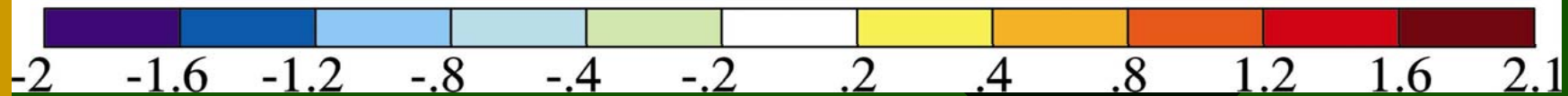
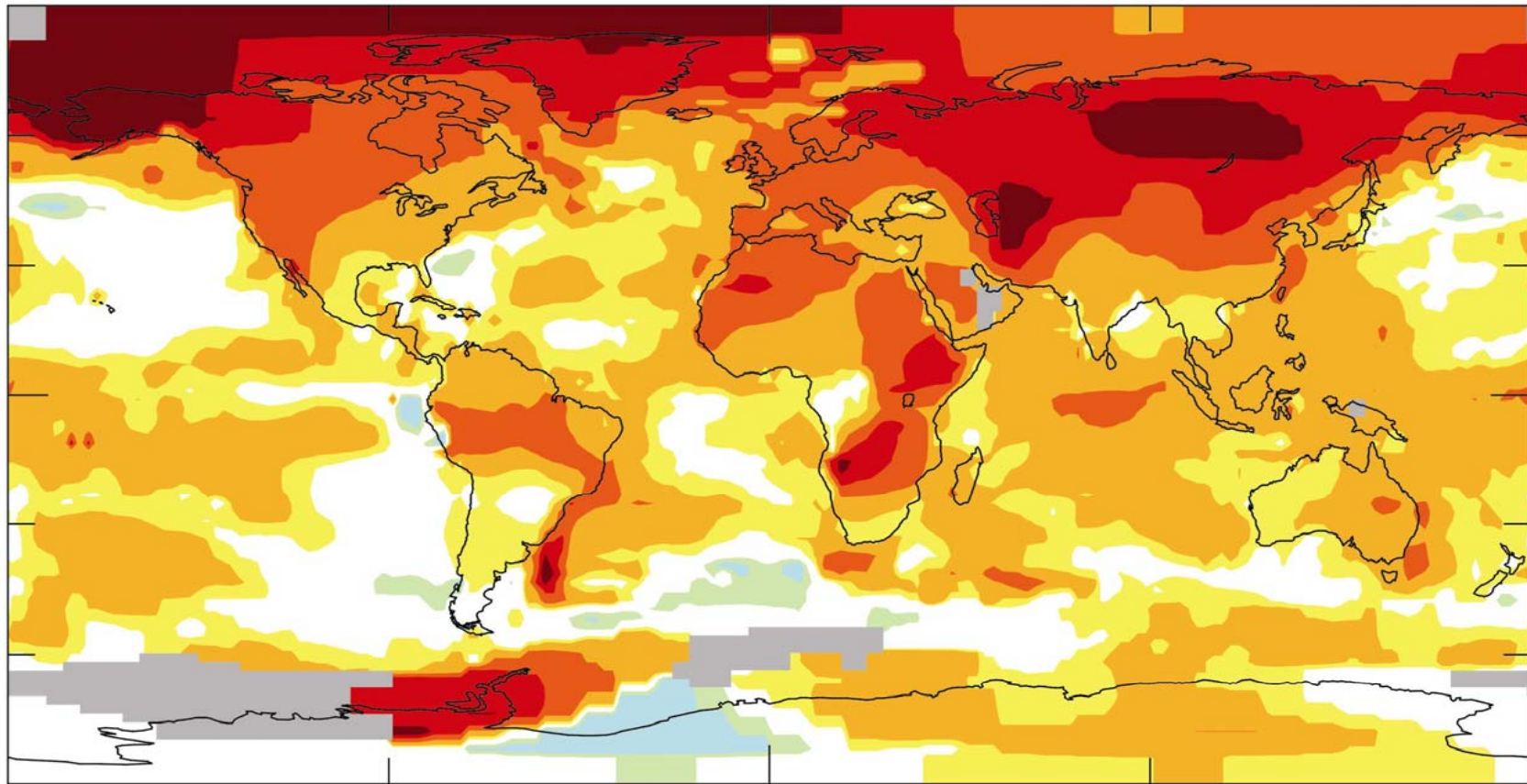
Annual Mean Surface Air Temperature Change



2001-2005 Mean Surface Temperature Anomaly ($^{\circ}\text{C}$)

Base Period = 1951-1980

Global Mean = 0.53



Soil Moisture Change (%) by 2050

