Effects of Climate Change on Water Resources

Cristiane Queiroz Surbeck, P.E., Ph.D.
Assistant Professor
Department of Civil Engineering
The University of Mississippi

Global Warming course

February 18, 2009

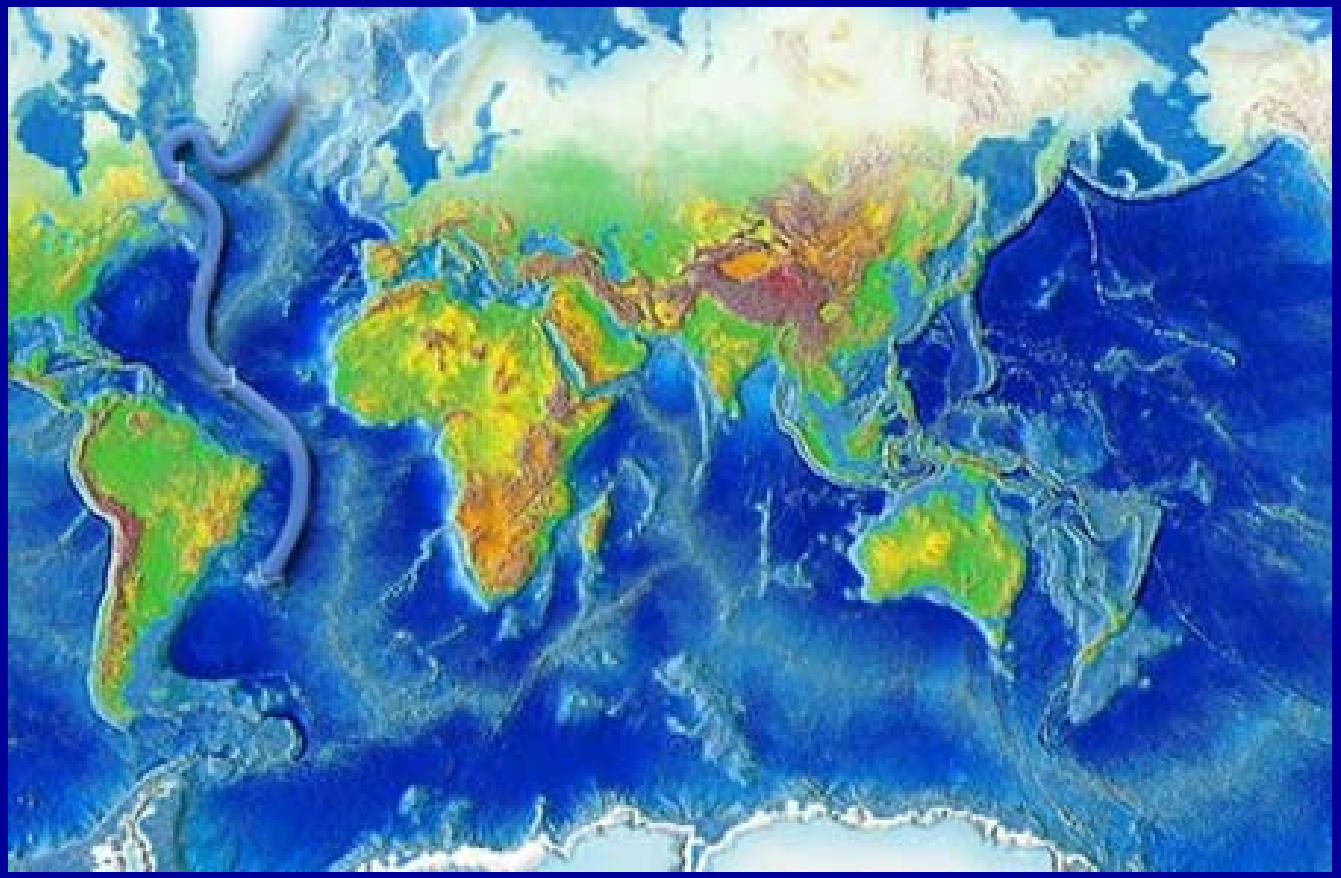
Outline

- The Global Perspective
- The Watershed Perspective
- The Water Budget
- Rainfall Analysis

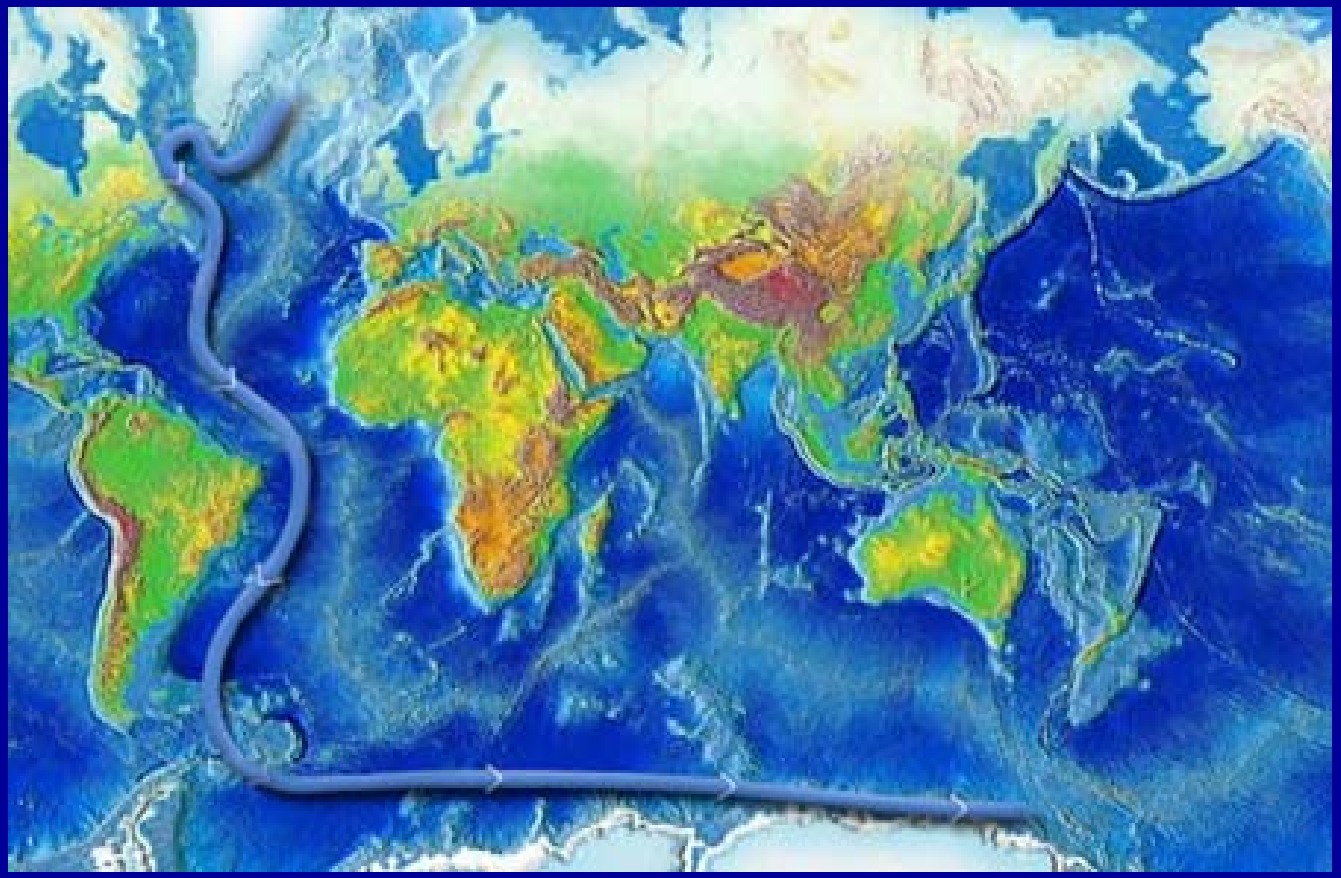
The Global Conveyor Belt

- Thermohaline circulation
- Water is chilled in the North Atlantic, gets saltier (more dense), sinks
- Deep water moves south then splits towards the Indian Ocean and the western Pacific
- The two branches warm and rise, then return to North Atlantic
- Deep sea currents: base of food chain

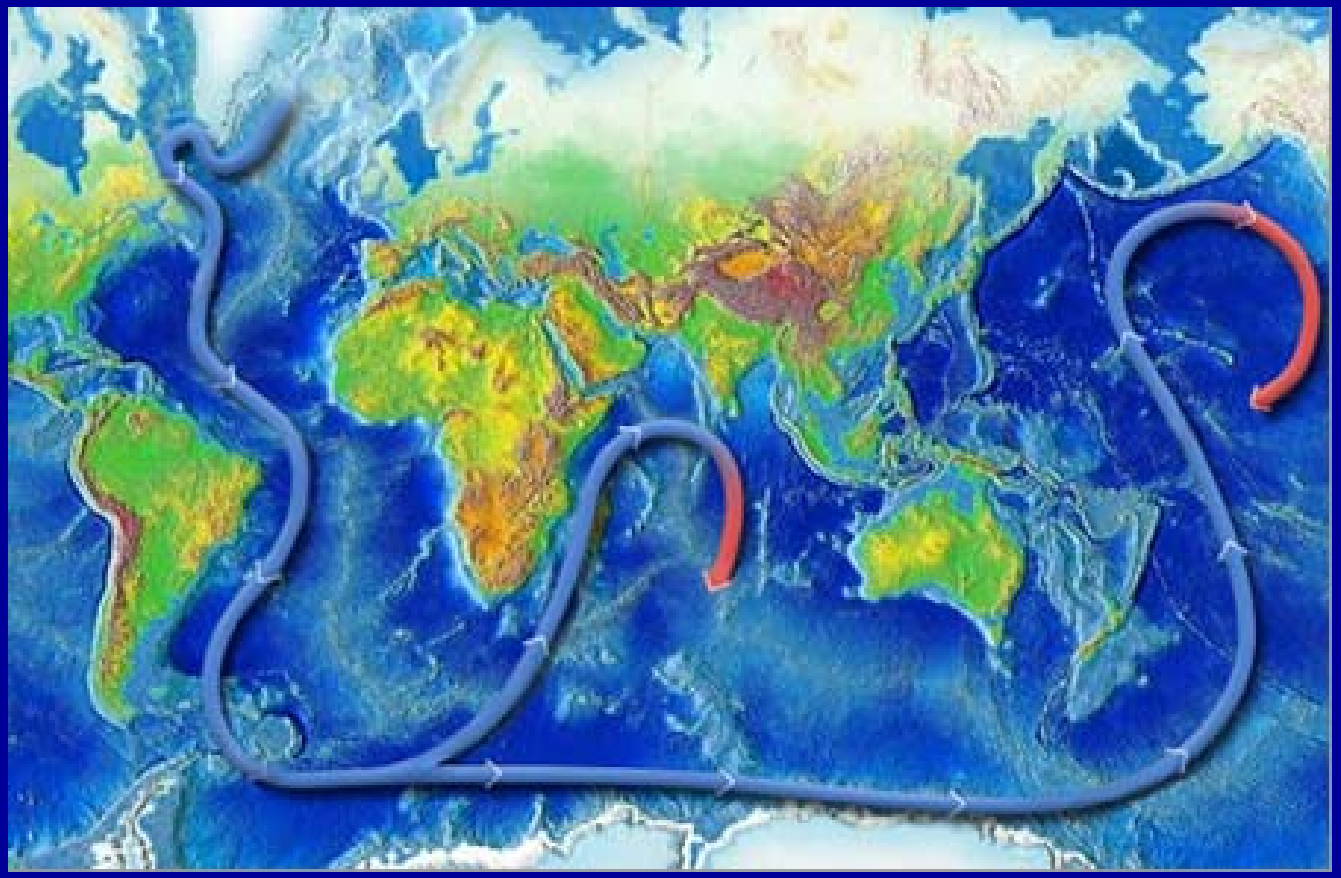
The Global Conveyor Belt



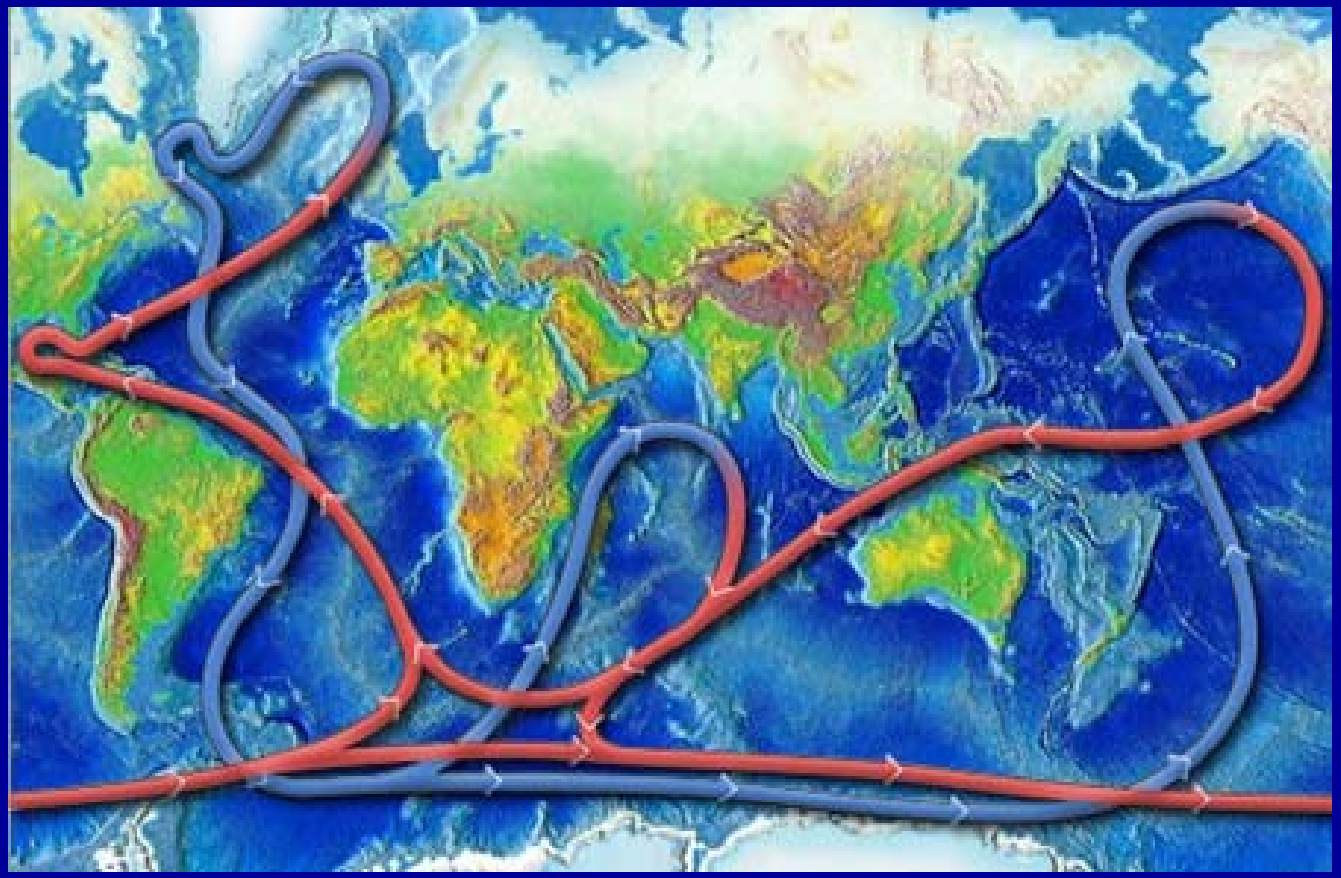
The Global Conveyor Belt



The Global Conveyor Belt



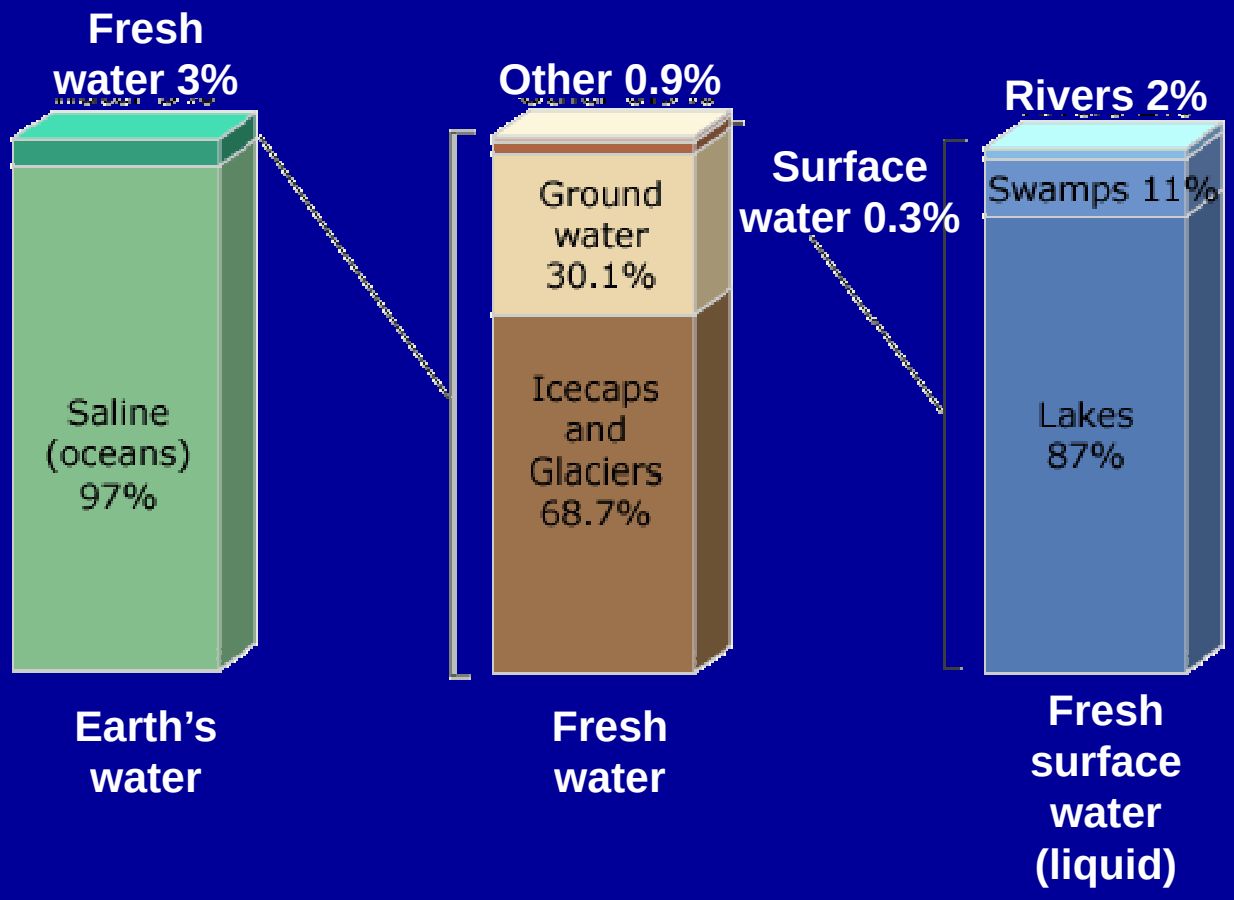
The Global Conveyor Belt



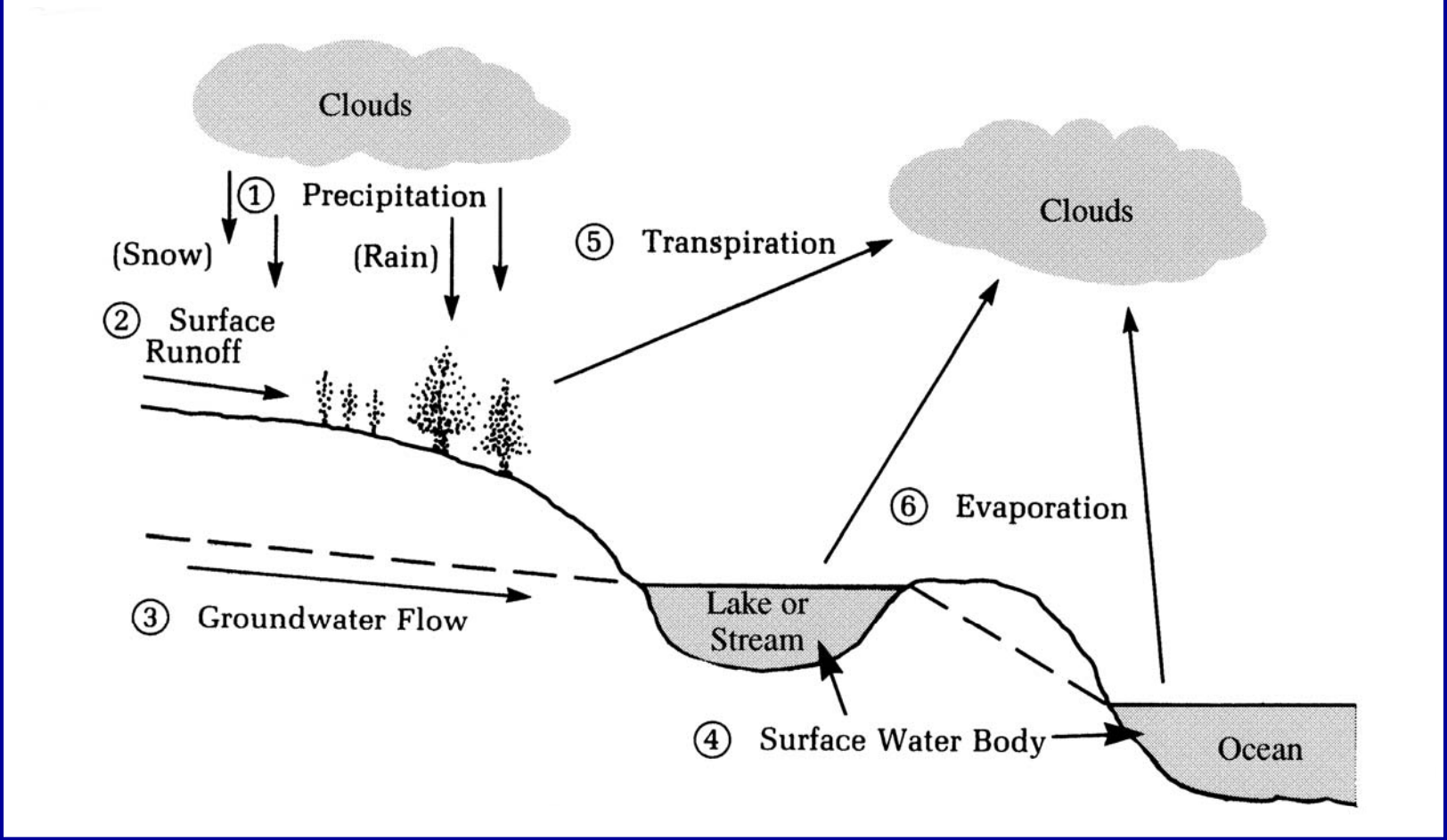
Effect of Global Warming on Ocean Conveyor Belt

- Warmer, less dense water, won't sink
  - Change in currents
  - Decreased salinity
  - Ecosystem
- Rise in sea levels

Distribution of Earth's Water



The Hydrologic Cycle



Effects of Climate Change on Water Resources

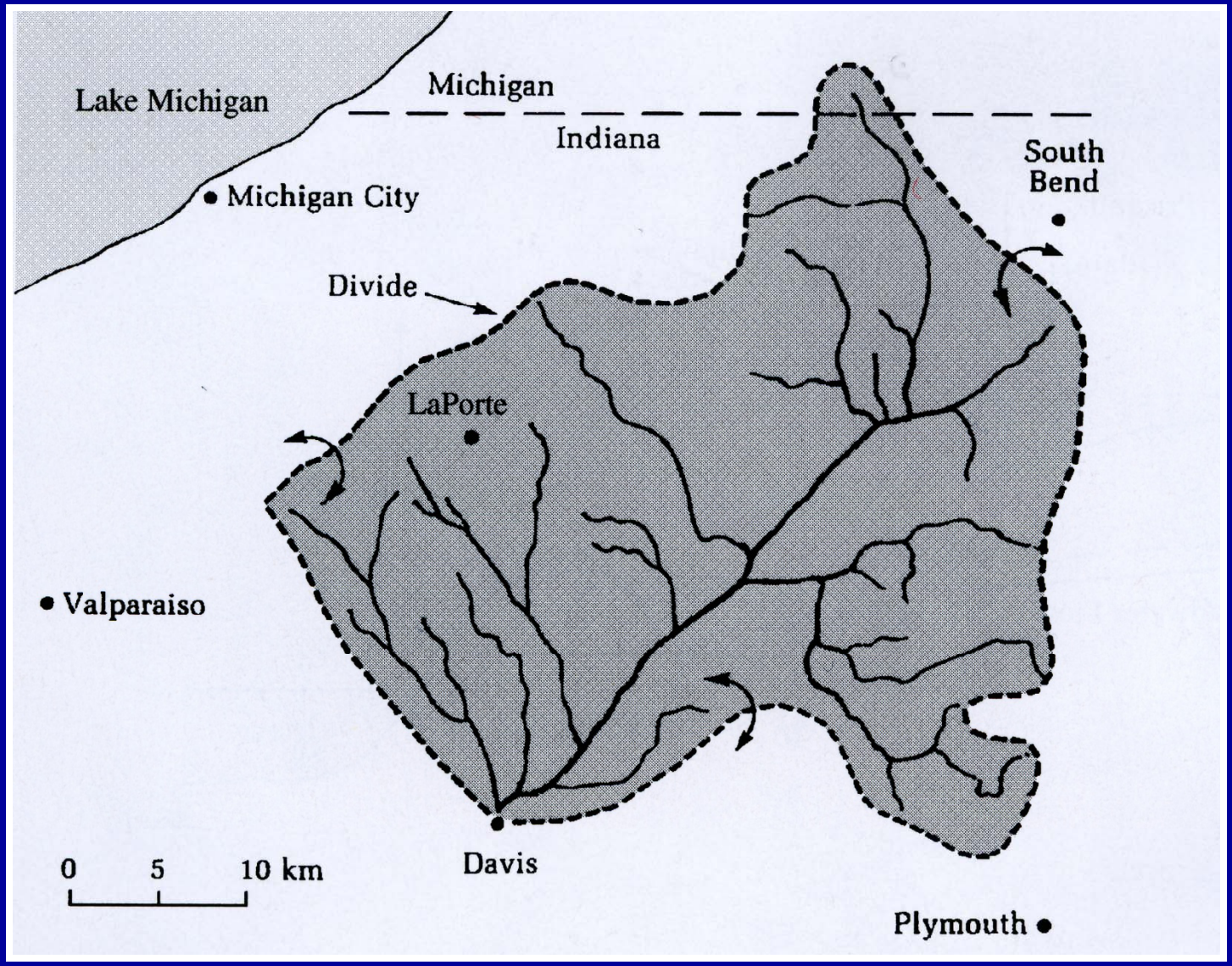
- An increase in net solar radiation or temperature speeds up the processes within the hydrologic cycle
- More evaporation (loss of water), droughts
- Earlier snowmelt, more streamflow, earlier peak discharges
- Lower dissolved oxygen levels (effect on aquatic life)
- Different climate effects throughout globe

Effect of Climate Change on Water Quality

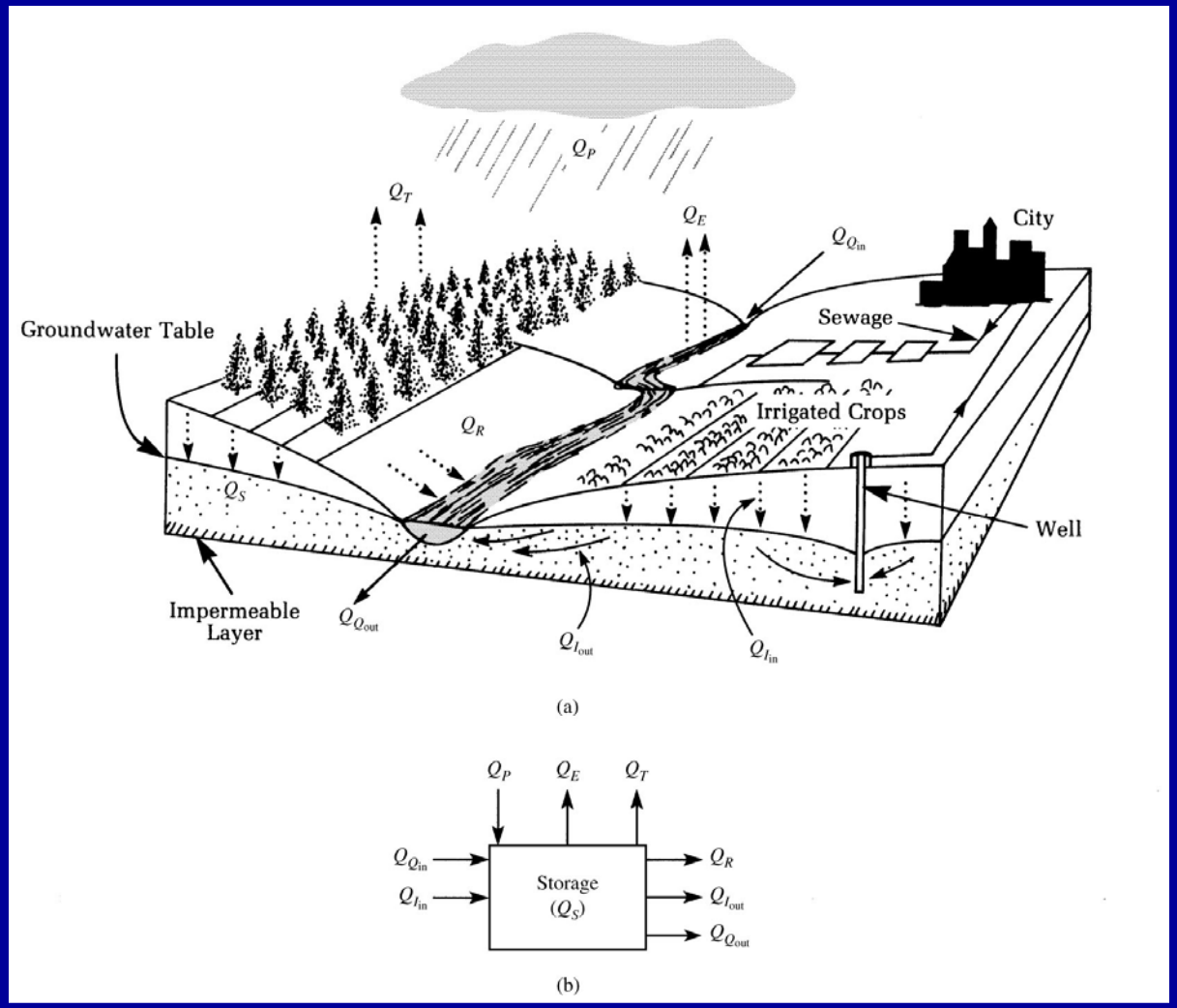
- Reduced dissolved oxygen levels
- Less dilution of pollutants during droughts
- Increased pollution and sedimentation during increased rainfall
- Increased salinity in coastal water bodies

Effects of Climate Change on North America

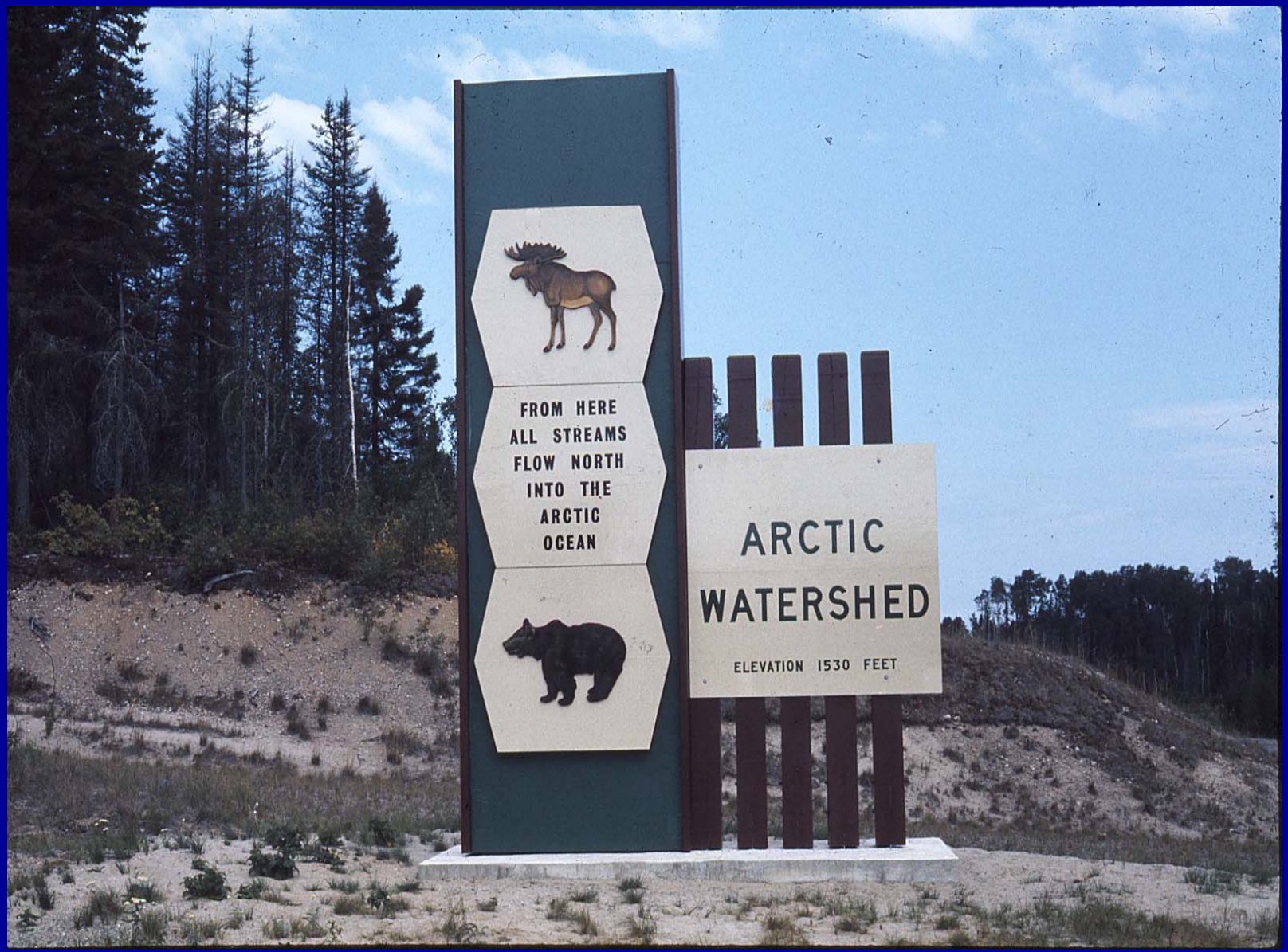
- Alaska, Yukon, and Coastal British Columbia
  - Increased flooding
  - Increased stress on salmon
- Southeast, Gulf, and Mid-Atlantic
  - Risk of extreme precipitation events, hurricanes
  - Possible longer droughts
  - River flow variability
- Varying effects in other regions
- http://www.epa.gov/climatechange/effects/water/northamerica.html



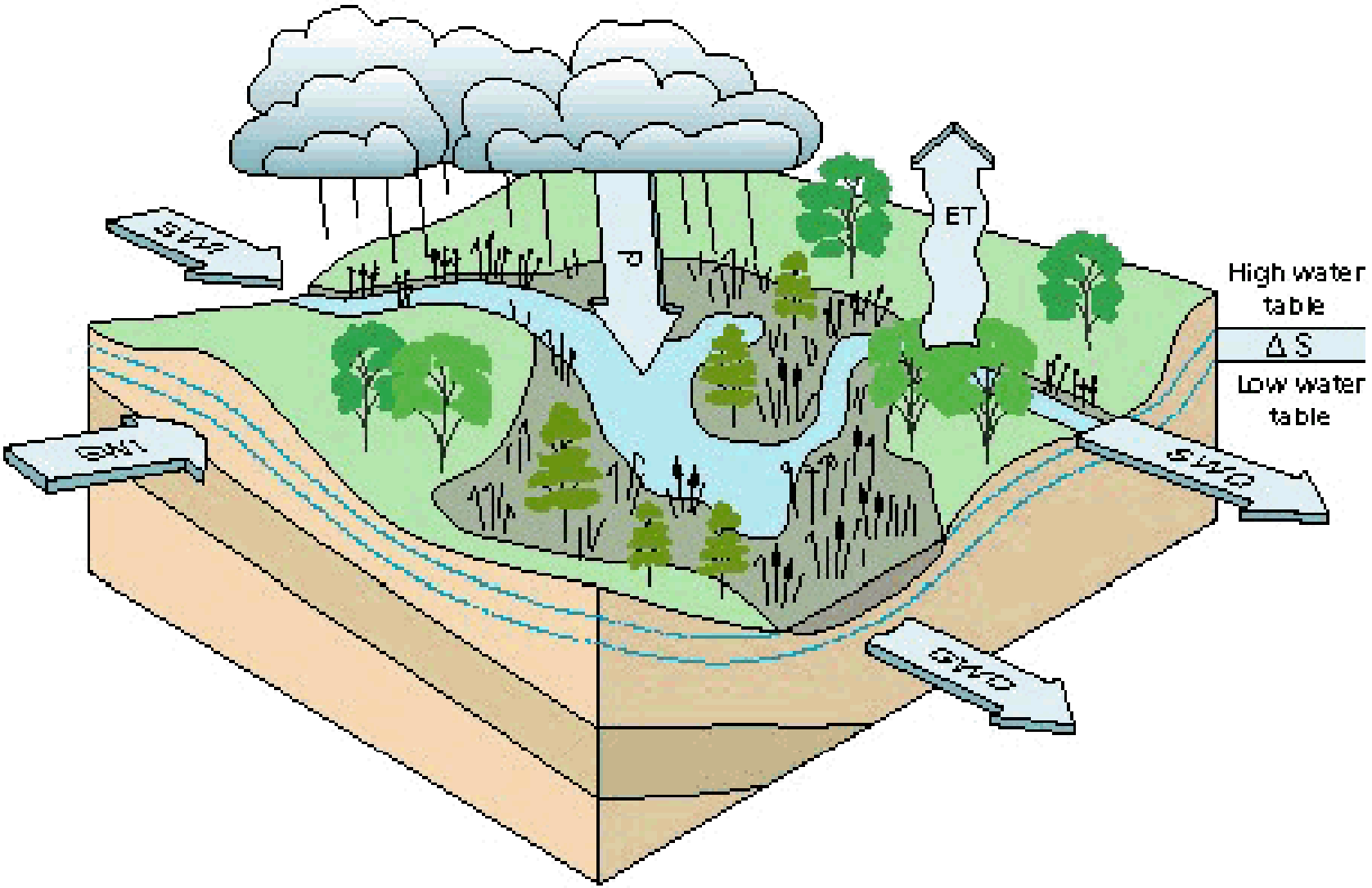
The Kankakee River Basin above Davis, IN. The dashed lines divide the watershed



(a) Schematic diagram of a hydrologic system, (b) mass balance diagram of a hydrologic subsystem

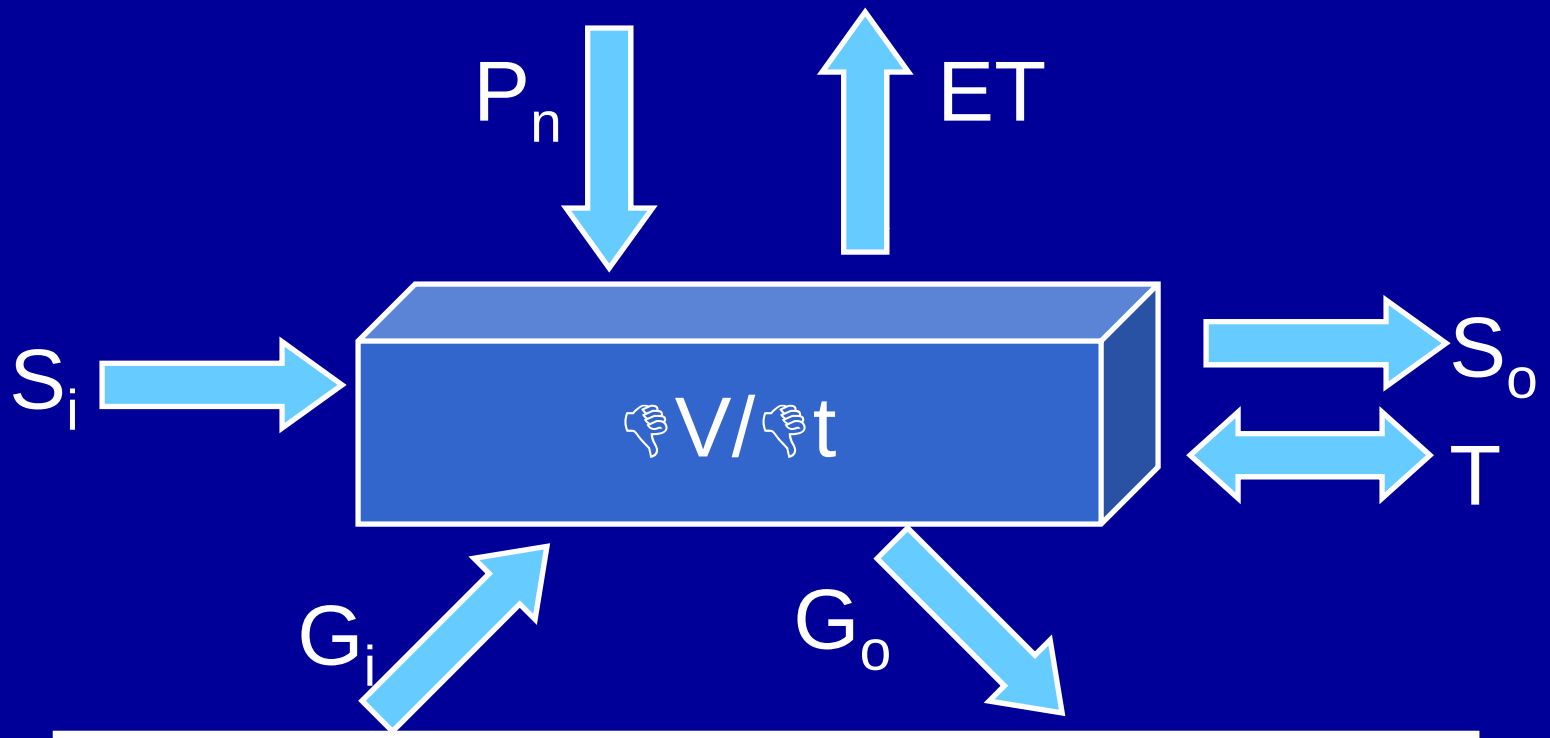

FROM HERE
ALL STREAMS
FLOW NORTH
INTO THE
ARCTIC
OCEAN
ARCTIC
WATERSHED
ELEVATION 1530 FEET

Hydrologic Water Budget



Hydrologic Water Budget

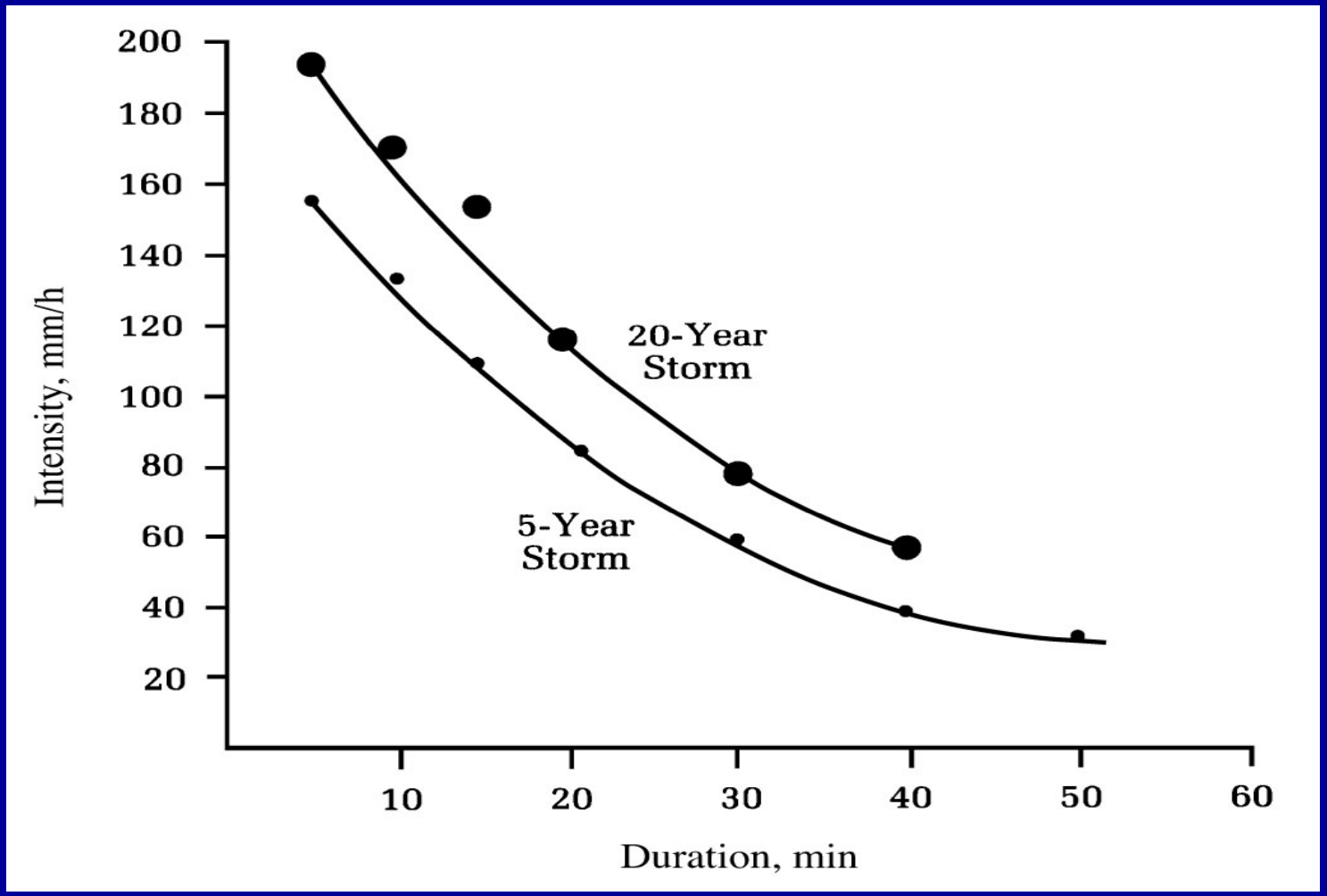
Mass balance of inflows and outflows



$$\frac{\Delta V}{\Delta t} = P_n + S_i + G_i - ET - S_o - G_o \pm T$$

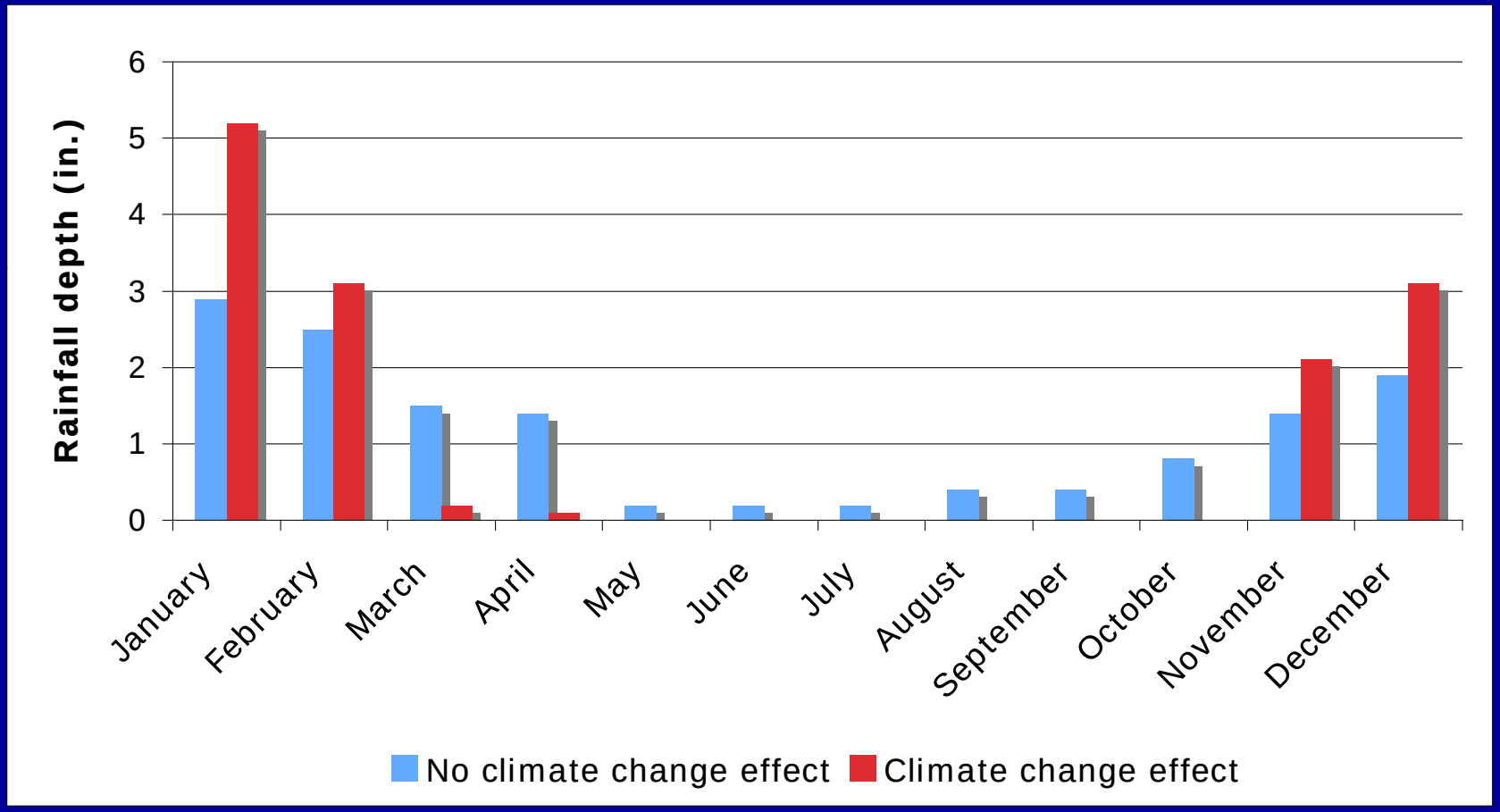
Rainfall Analysis

- Intensity (rainfall depth/time)
- Duration (time)
- Frequency (1/time) or return period (time)



Intensity-duration-frequency curves

Possible climate change effect on annual rainfall distribution



Total annual rainfall in both cases: 13.8 inches

1975 Flood at East Lansing, MI
Return Period (T) = 40 years

Return Period (T)

- T = 1/P
- P = exceedence probability
- Return period: the average lengthof time between events that have the same depth and duration
- Exceedence probability: the probability that an event having a specified depth and duration will be exceeded in one time period (usually one year).

Conclusions and Questions