Can a Good Climate Go Bad?

Understanding the Diagnosis

PART 2:
Climate vs. Weather
Understanding Past Climate

Presented by
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National Center for Atmospheric Research

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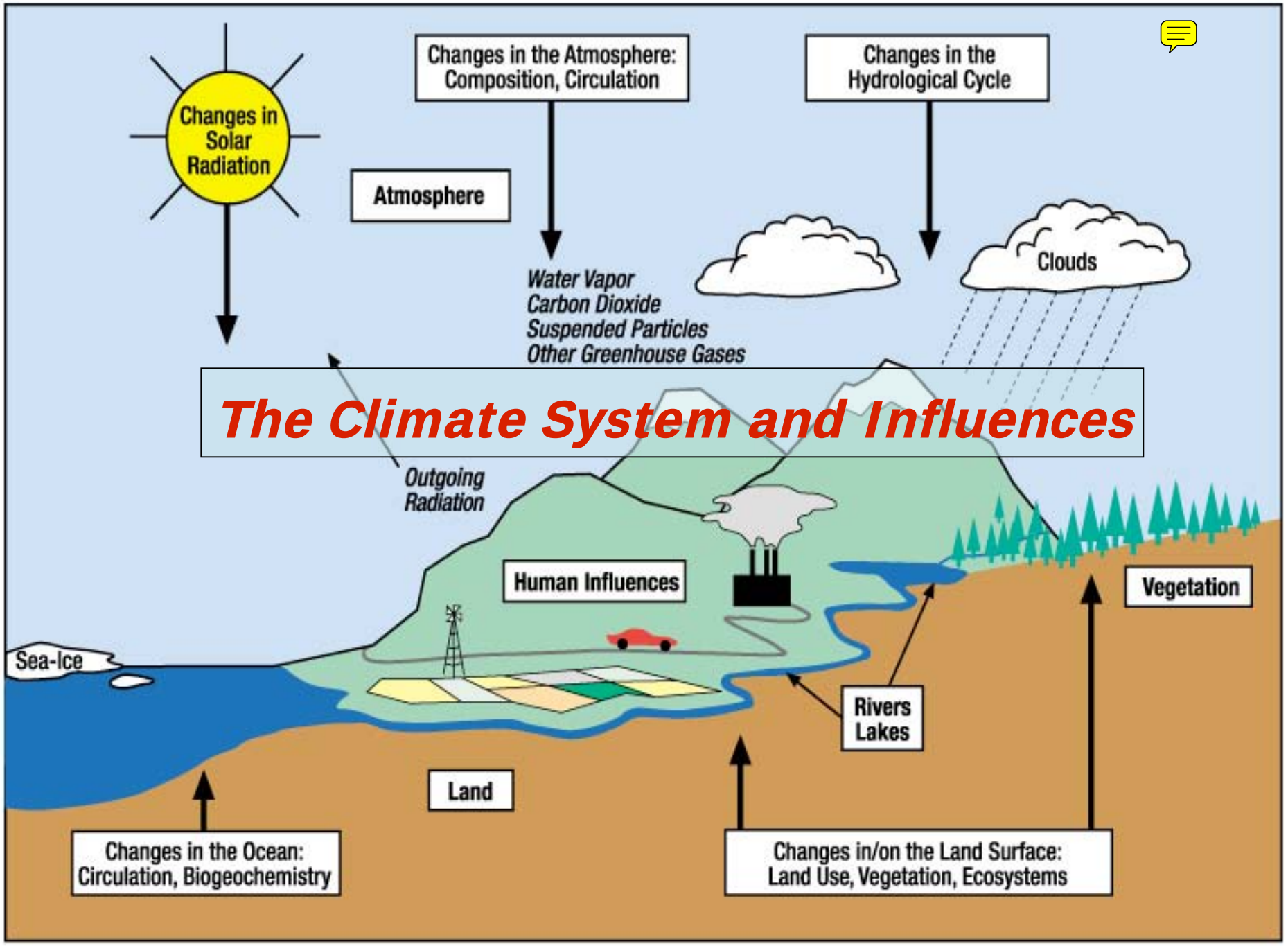
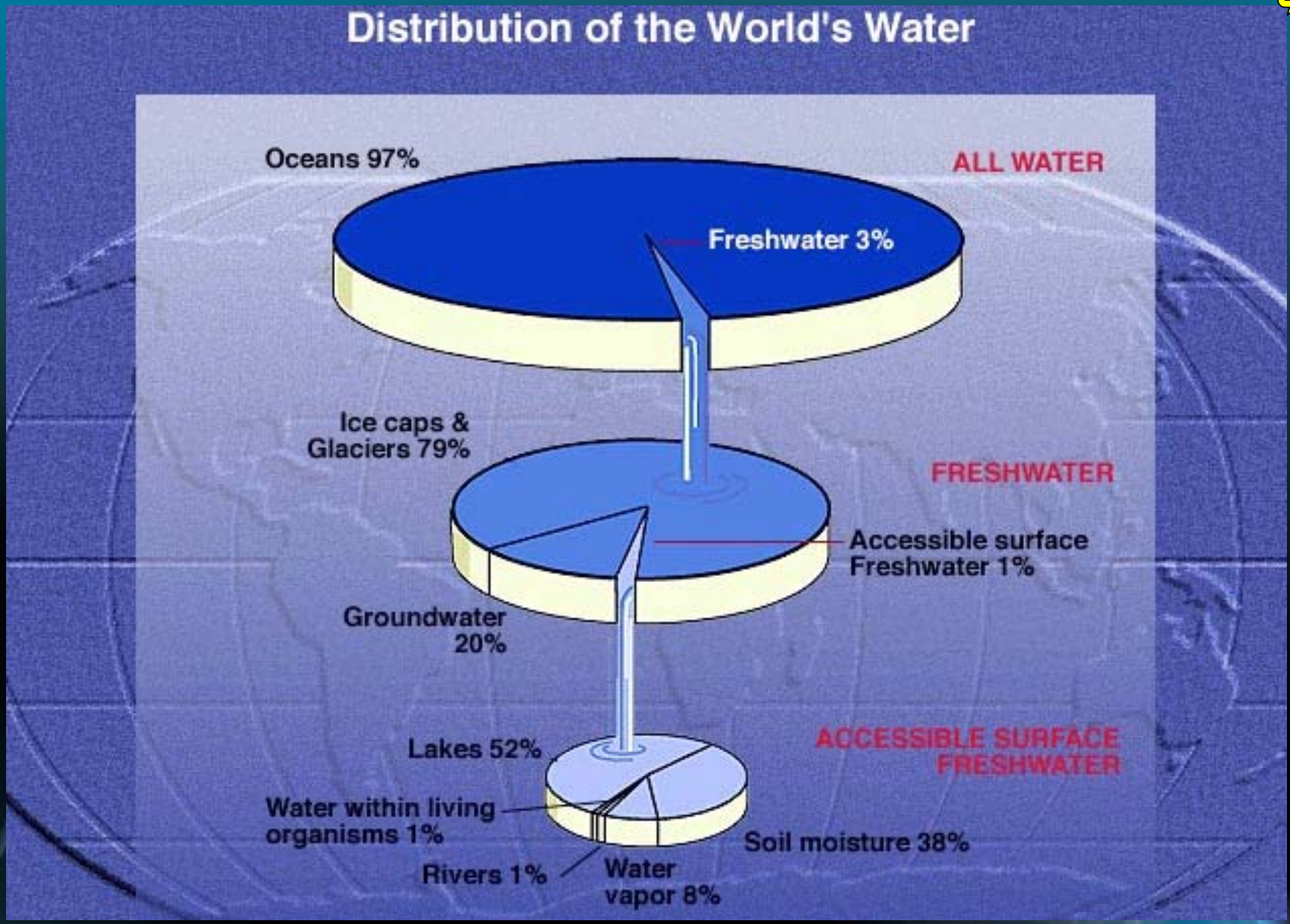
6th Annual Environmental Health Sciences Summer Institute for K-12 Educators
University of Texas, Austin


Changes in Solar Radiation
Changes in the Atmosphere: Composition, Circulation
Changes in the Hydrological Cycle
Atmosphere
Clouds
Water Vapor
Carbon Dioxide
Suspended Particles
Other Greenhouse Gases
The Climate System and Influences
Outgoing Radiation
Human Influences
Vegetation
Sea-Ice
Rivers
Lakes
Land
Changes in the Ocean: Circulation, Biogeochemistry
Changes in/on the Land Surface: Land Use, Vegetation, Ecosystems

The Global Conveyor Belt or… the Thermohaline Circulation of our Ocean System

Source: NASA Jet Propulsion Laboratory


Distribution of the World's Water
Oceans 97%
ALL WATER
Freshwater 3%
Ice caps & Glaciers 79%
FRESHWATER
Accessible surface Freshwater 1%
Groundwater 20%
Lakes 52%
ACCESSIBLE SURFACE FRESHWATER
Water within living organisms 1%
Soil moisture 38%
Rivers 1%
Water vapor 8%

What is Climate?
Climate vs Weather Activity

- **Weather is** the current conditions in the atmosphere (temperature, precipitation, wind, humidity) at a particular time and place.

- **Climate is** the general weather patterns that you'd expect in an area (sometimes based on the 30-year average weather).

***Climate** tells you what clothes to buy,*

*but **weather** tells you what clothes to wear.*

Question:

What is causing current climate change?

Response:

Warren Washington, NCAR Scientist, and other NCAR Scientist

CLUES TO EARTH'S PAST
PALEOCLIMATOLOGY

What Role Did CO_2 Play in Climates of Long Ago?
Are CO_2 Levels Responsible For Climate Change Throughout Time?

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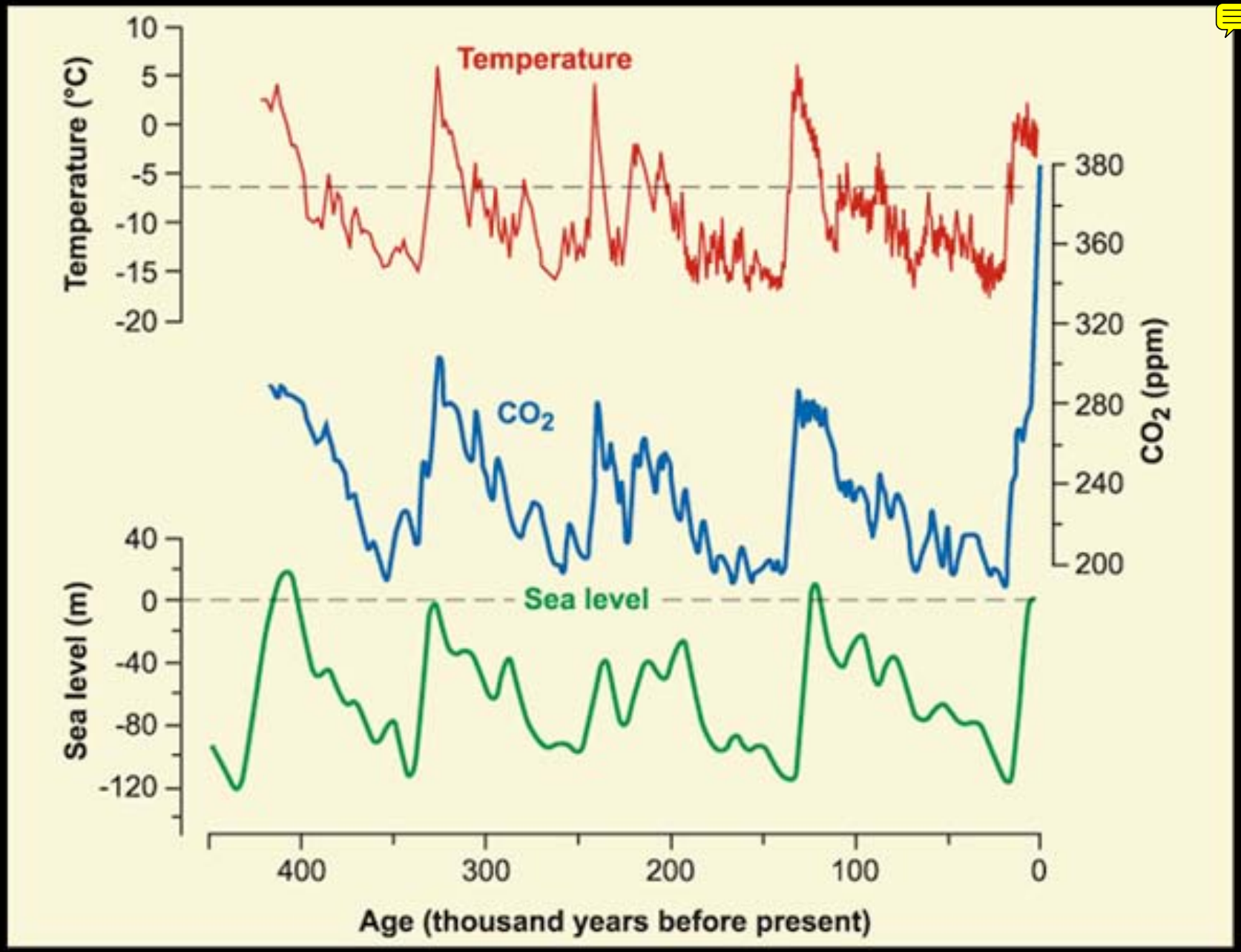
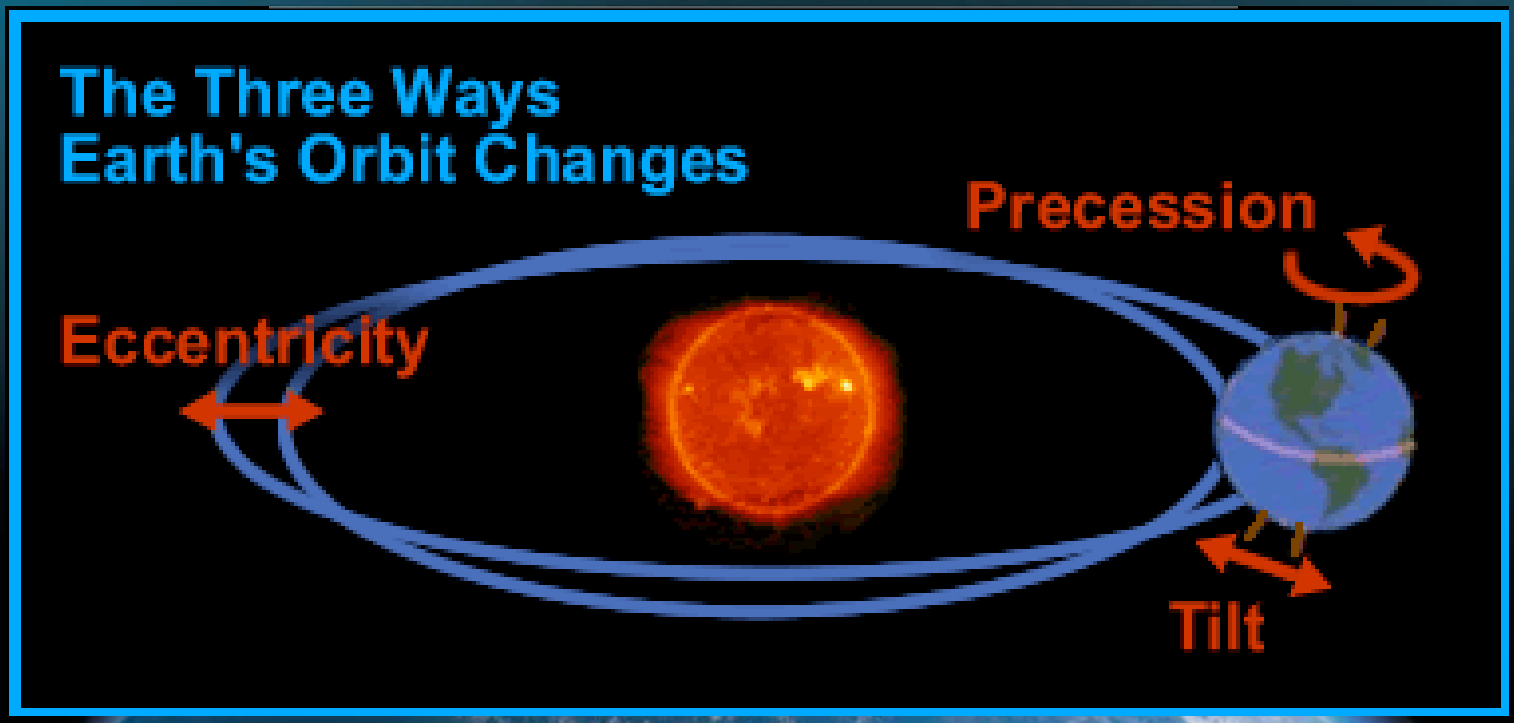

Temperature
Temperature (°C)
10
5
0
-5
-10
-15
-20
CO2
CO2 (ppm)
380
360
320
280
240
200
Sea level
Sea level (m)
40
0
-40
-80
-120
400
300
200
100
0
Age (thousand years before present)

Milankovitch Cycles



Precession (wobble): every 23,000 years

Tilt of Earth: every 41,000 years

Eccentricity (Orbit): 100,000 years

Question:

How is past climate studied?

Video Response:

Casper Ammann, NCAR Paleoclimatologist

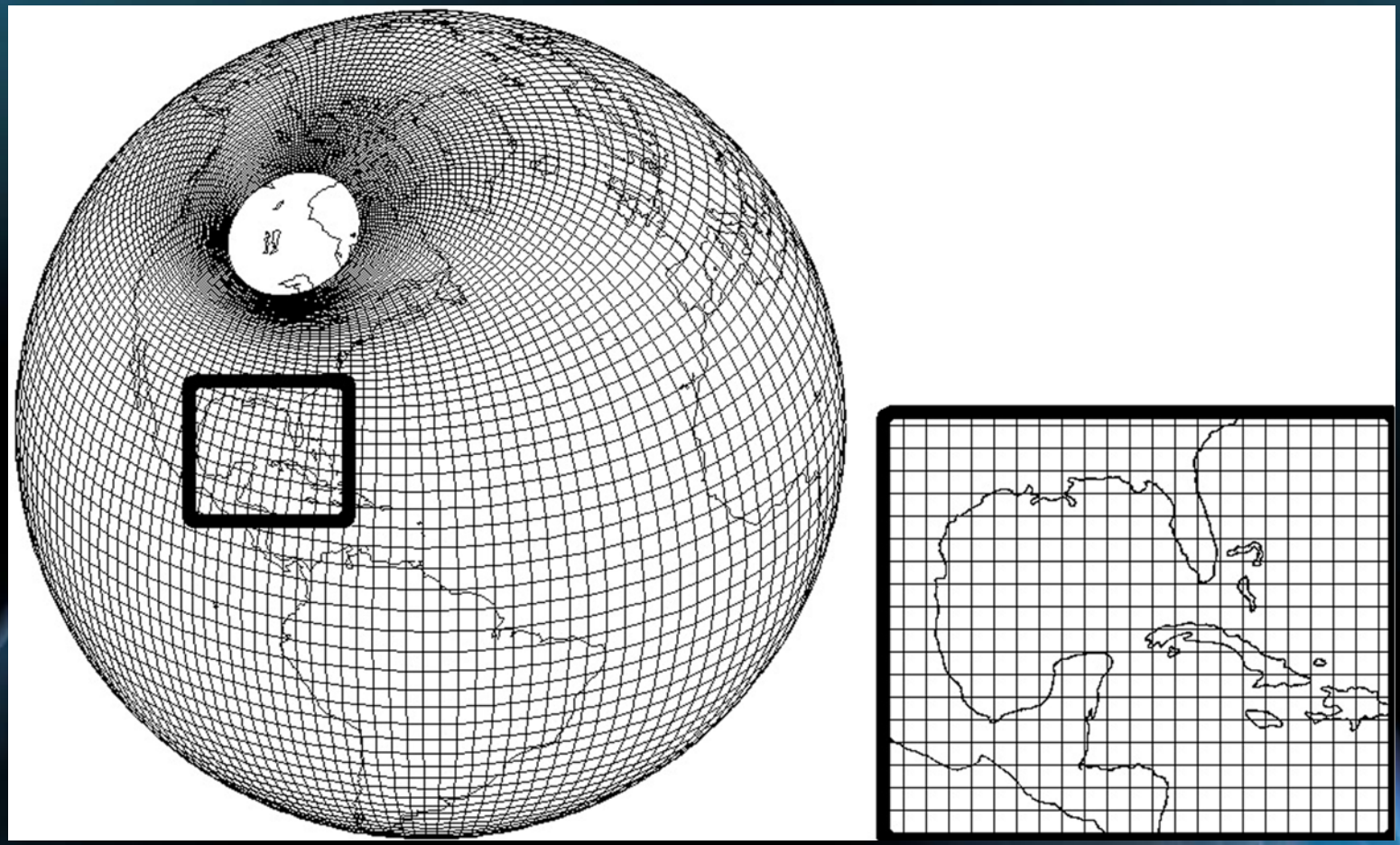
How do you study ancient climates?

- Models
- Proxy records (the clues that are left behind!)

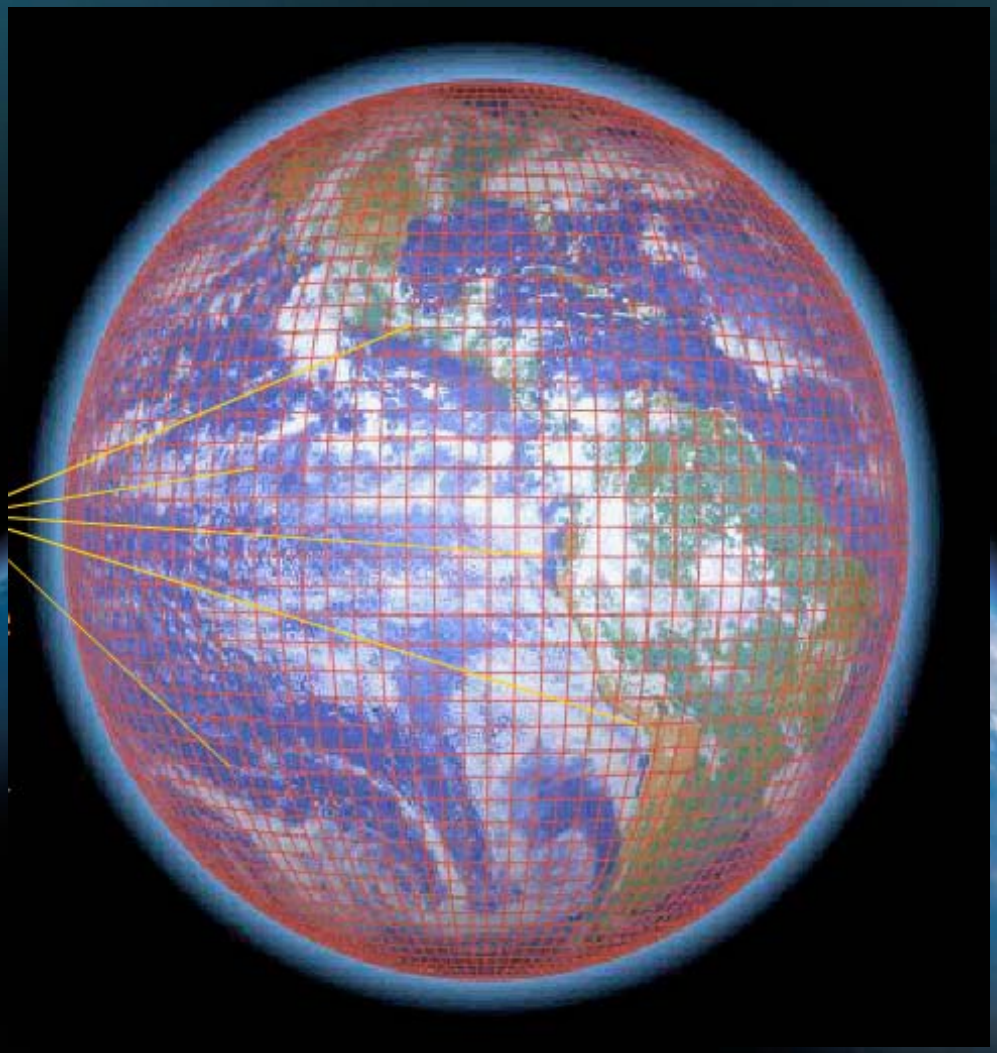
What Is the Item On Your Table?

- How is it like and unlike the “real” thing?

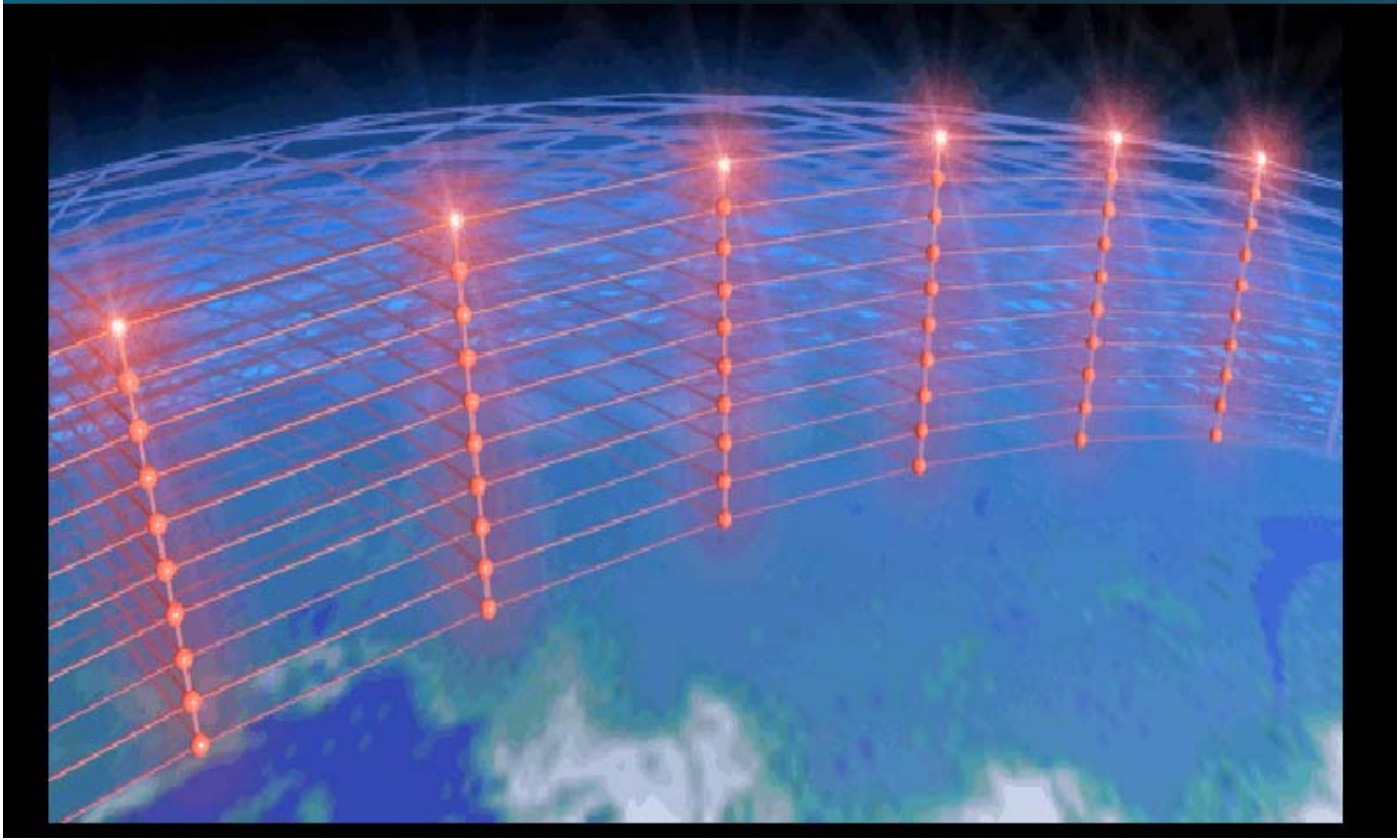
What is a Climate Model?



A Grid Model for our Atmosphere

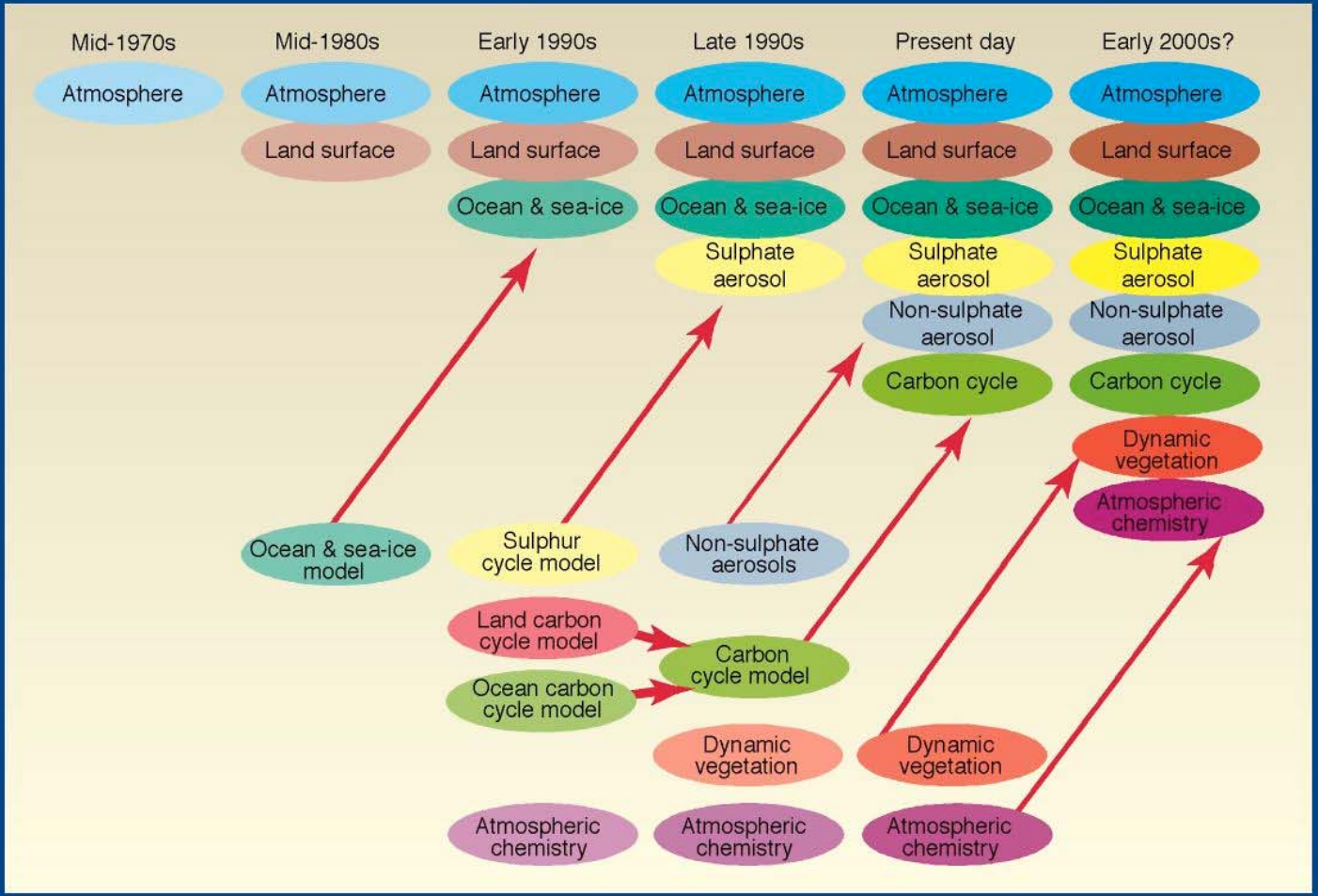


Model Grids Are Multi-Layered



Evolution of Climate Models

The development of climate models, past, present and future



WG1 - TS BOX 3
FIGURE 1

And… Come In Various Resolutions

What Do You Think It Is Now?

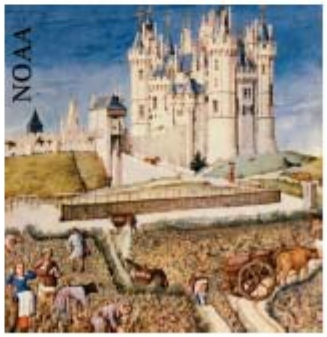
Is It the “Real” Thing?

Proxy Records:
Clues to Past Climate

Tree rings:
Yearly records of variability in temperature and water

When seasons change:
Records of when trees flower and when lakes freeze

Ice Cores:
Yearly variations in volcanic ash, temperature as recorded by isotope ratios



Food!
Records of harvest production, celebrations, and the cost of food

More Clues to Past Climates…

Pollen:
Indicates what plants grew where. If we know their growing conditions, we can interpret climate of the area.

Ocean and lake sediments:
Records of plankton, isotopes, color, decomposition, etc.

Artwork:
Paintings and photographs of people and places provide records of climate.

When Climates Change… Environments Change!

Global climate changes cause:

- Global changes in ecosystems and the distribution of species
- Changes in sea level

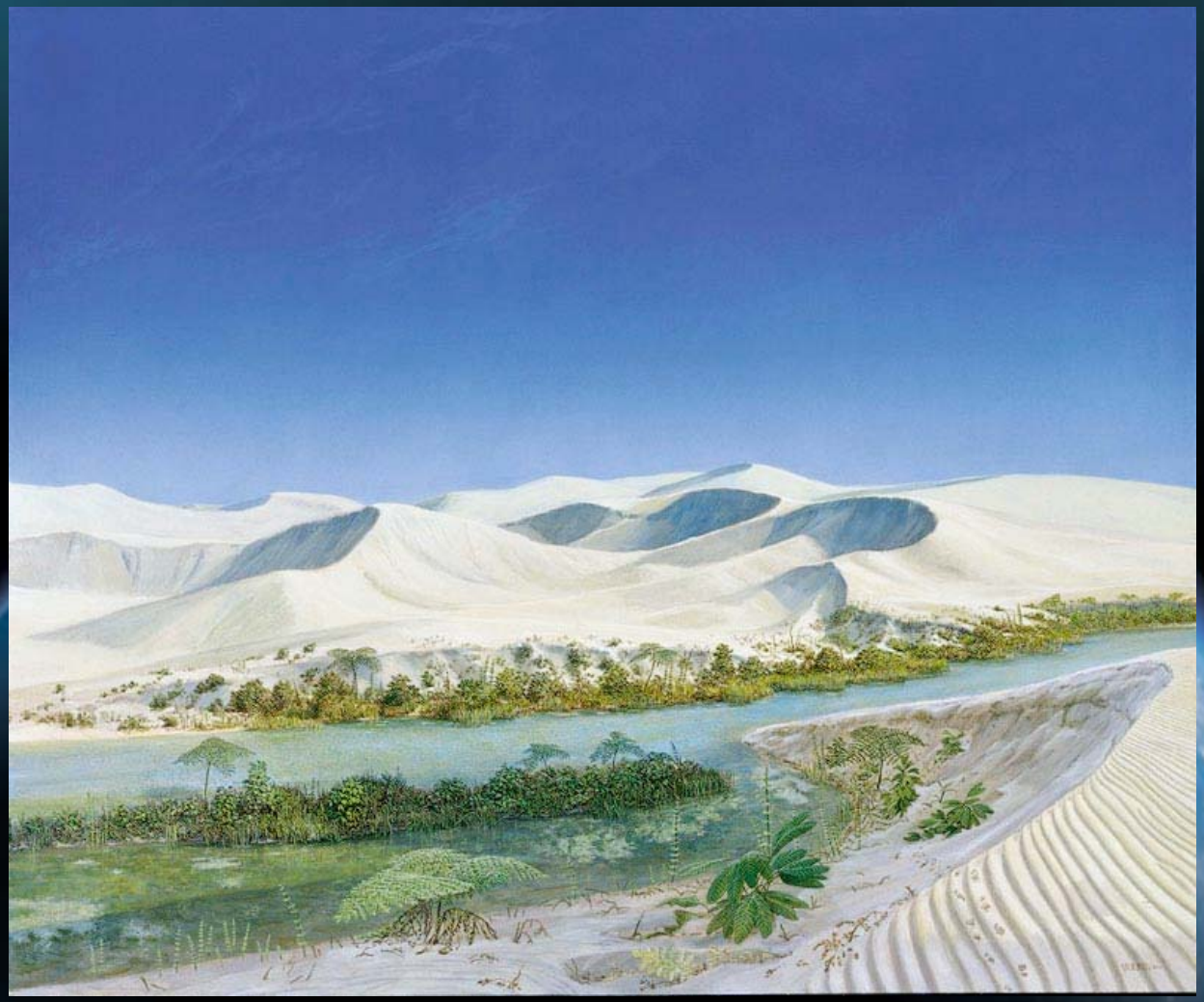
Regional climate changes cause:

- Regional changes in ecosystems

How Has Climate Changed in Denver?

300 Millio

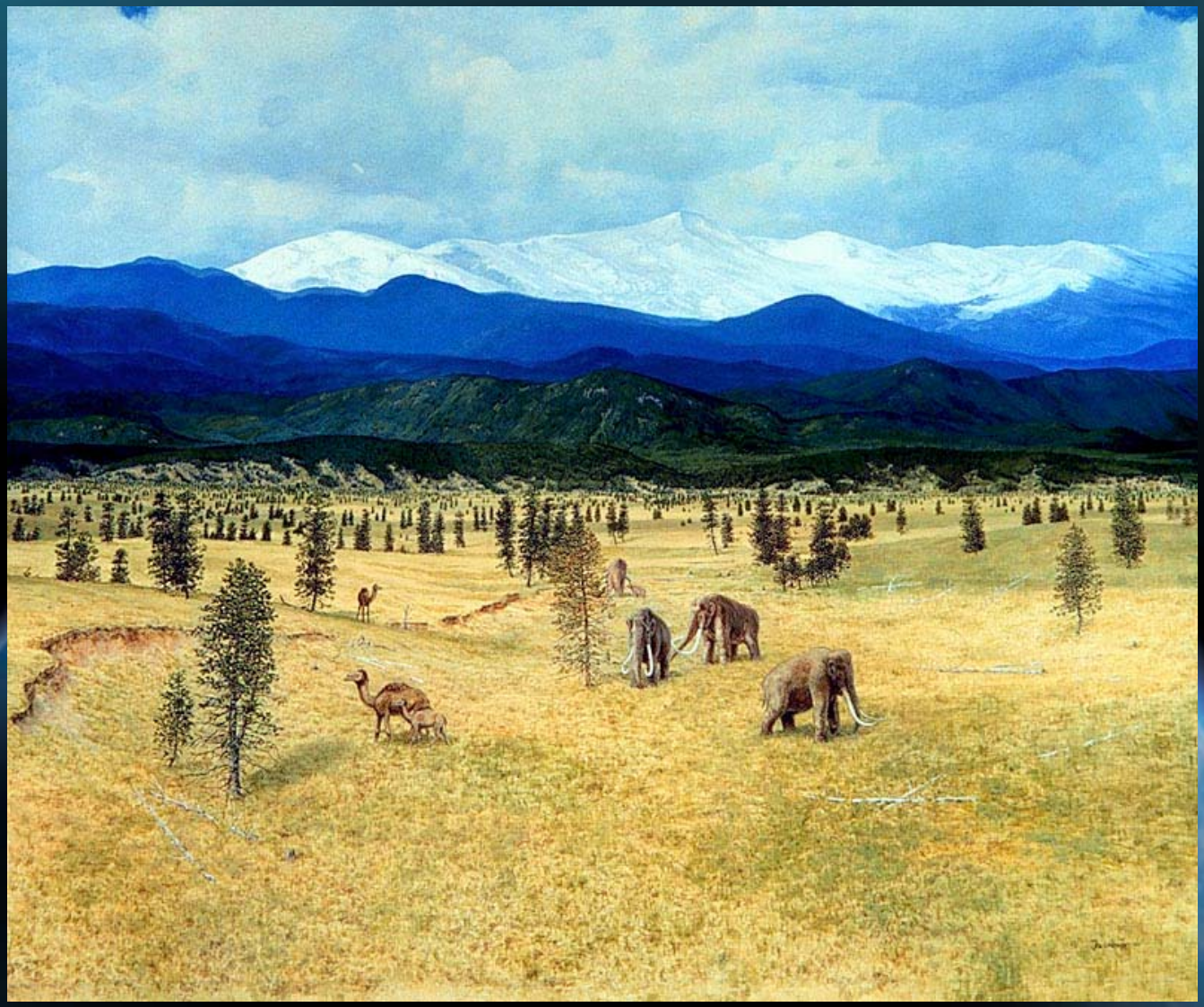
280 Million Years Ago



66 Million Years Ago

55 Million Years Ago

16,000 Years Ago



Today

When Climate Changes in a Location

…The Plant Species Able to Live There Change

Paleoclimates and Pollen Activity

Materials for each group:

- Sample of each 'sediment' layer (1 – 5)
- Plate and toothpicks
- Student Handout sheet

Low-growing shrub at high altitude, cold sites.

Mixed meadow species found in areas of warm summer temperatures and summer drought.

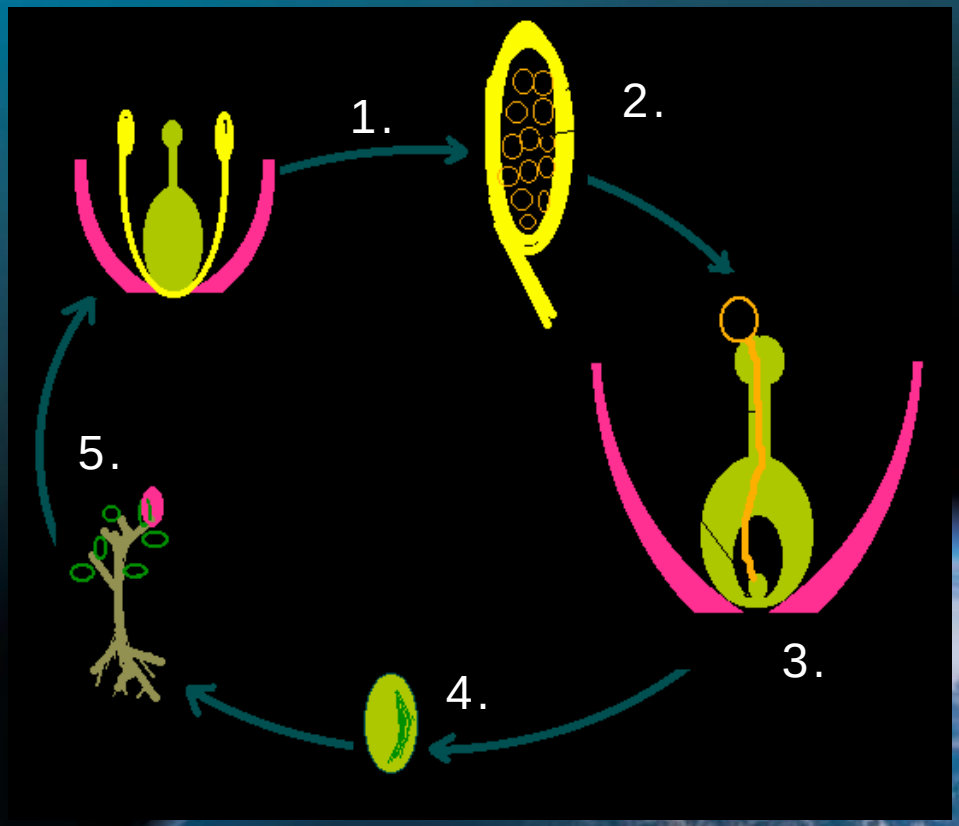
Oak tree found in warm, temperate sites characterized by dry, warm summers.

- Above center, Alder tree, prefers abundant water and can grow in cool climates. Widespread in the Pacific Northwest.
- Above right, grasses found in very cool alpine/subalpine meadows that are cool in summer, harsh in winter, with short growing season.
- Above left: Engelmann spruce is found in cold, usually sub-alpine sites.

At right: Western Cedar found only in temperate, very moist climates.

At left: Douglas Fir prefers moderately cool to warm sites & grows best in temperate, somewhat moist conditions.

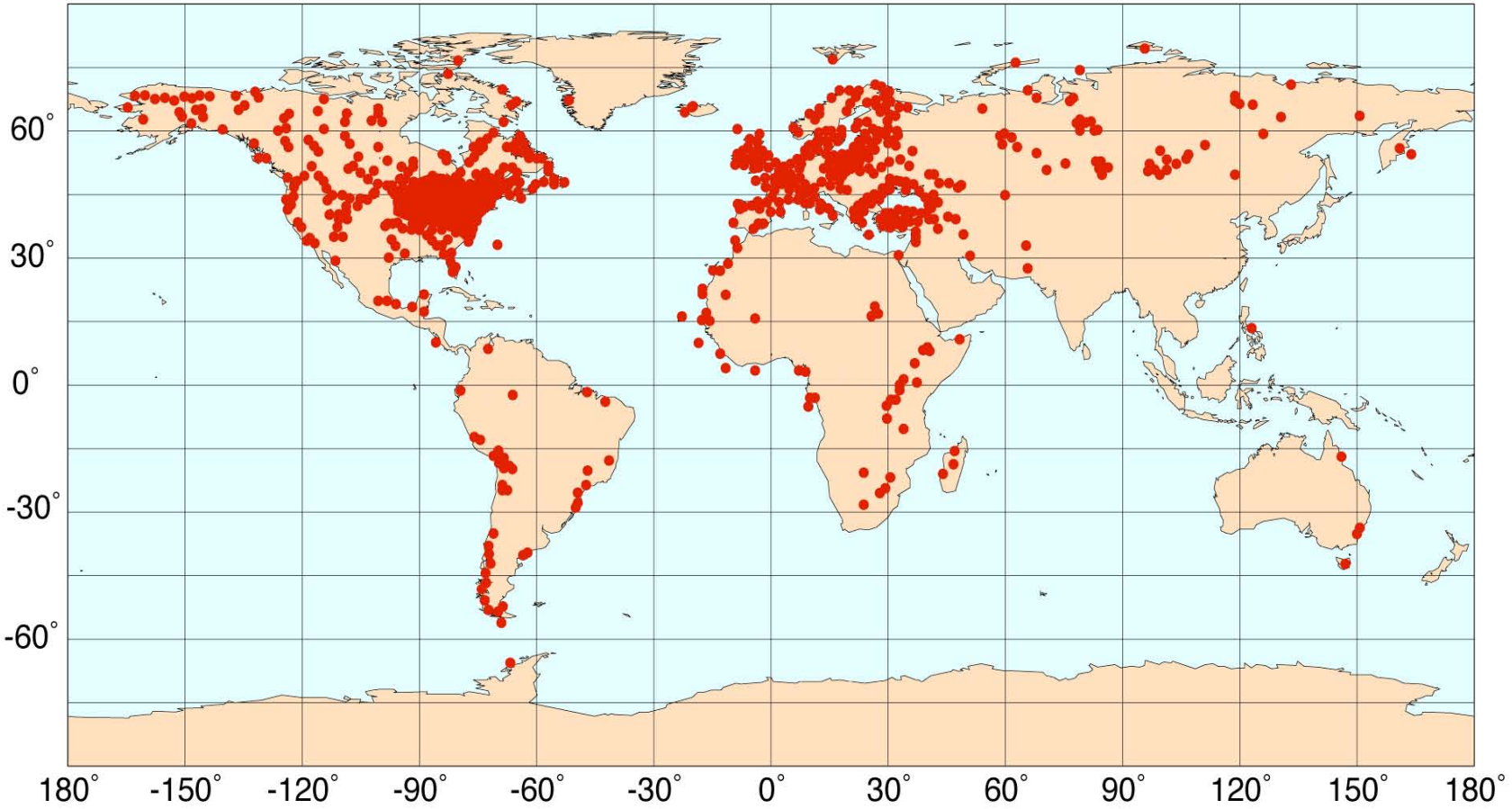
Lodgepole Pine found in very cool climates often at high altitudes (above 3500) at present.



1. Stamen - Mitosis produces egg and sperm
2. Pollen grains contain sperm nuclei in the anther
3. Pollen, stigma, ovary, egg, petal
4. Fertilized egg becomes embryo of seed
5. Seed germinates to produce plant, which will produce flower

Pollen grains are an outrageous invention of the seed plants, which first appeared over 300 million years ago.

Distribution of 1551 Sites with Fossil Pollen Data that are Available Globally



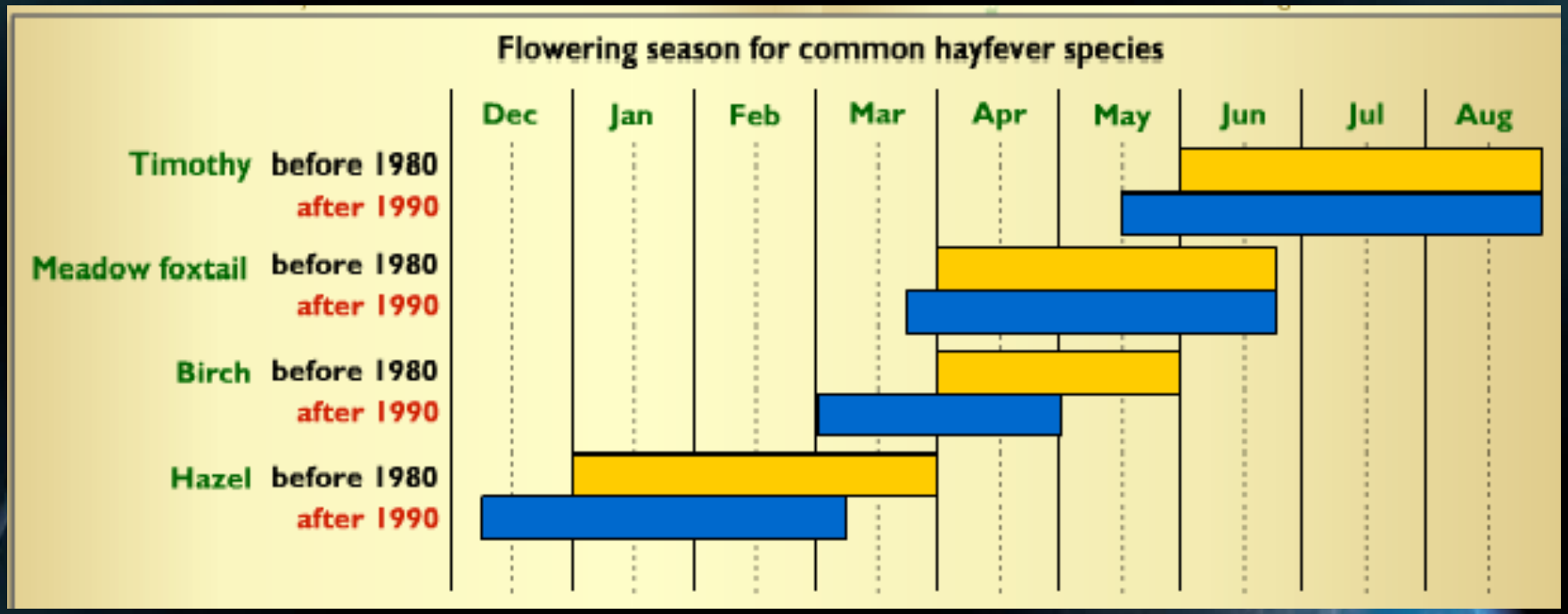
GLOBAL CHANGE
I G B P

Paleoclimate, Global Change and the Future
Alverson, Bradley and Pederson eds., 2002

Chapter 5: J. Overpeck et al., fig. 5.5, p. 87

PAGES
PAST GLOBAL CHANGES

Phenology records show that flowering dates for some common hay fever species have been getting earlier over the last few decades. Warmer spring temperatures are encouraging earlier flower development and pollen production.



When climate change causes changes to plant species or habitat…

The animals that are best adapted to the new conditions survive.

Source: BBC

Source: NOAA

Source: BBC, A. Kirby

Toucan

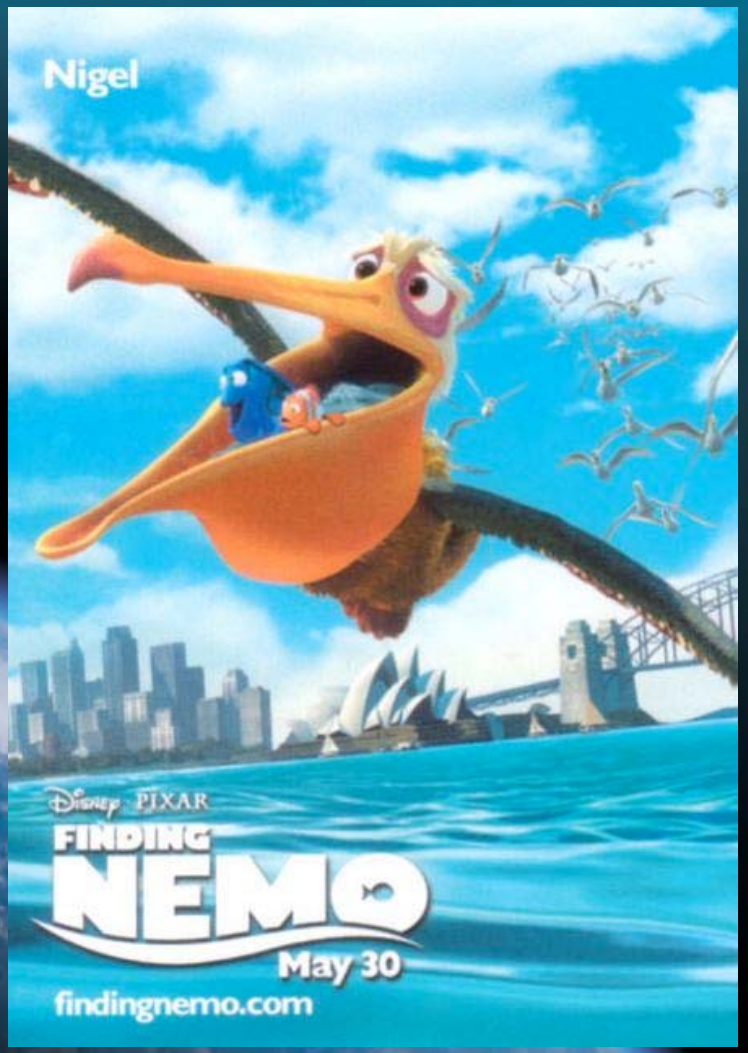
- The toucan's beak, strong like a nutcracker, is adapted to grab and crush fruit and nuts.

Hummingbird

- A hummingbird's long thin beak can get to the nectar in flowers.

Pelican

- The pelican's beak is adapted to scoop up fish to eat.



(Note: Only in cartoons do pelicans use their beaks to transport fish to safety.)

Adaptation Investigation Activity

- **What you will need:**
  - **One beak** *(straw, spoon, tweezers, toothpick, or clothespin)*
  - **One bird stomach** *(a plastic cup)*
  - **One plate of "bird food"** *(rice, seeds, marbles, marshmallows)* **to share with 1 or 2 other birds**
- **What you will do:**
  - In 30 seconds, collect as much food as you can into your cup using only your beak. One hand behind your back.

Adaptation Investigation: Round 2

- The climate has changed.
- Many plants species can no longer survive here.
- Only rice remains as a food source.
- ***Which birds will survive?***

Now it's time to ask yourself…

"Can a Good Climate Go Bad?"