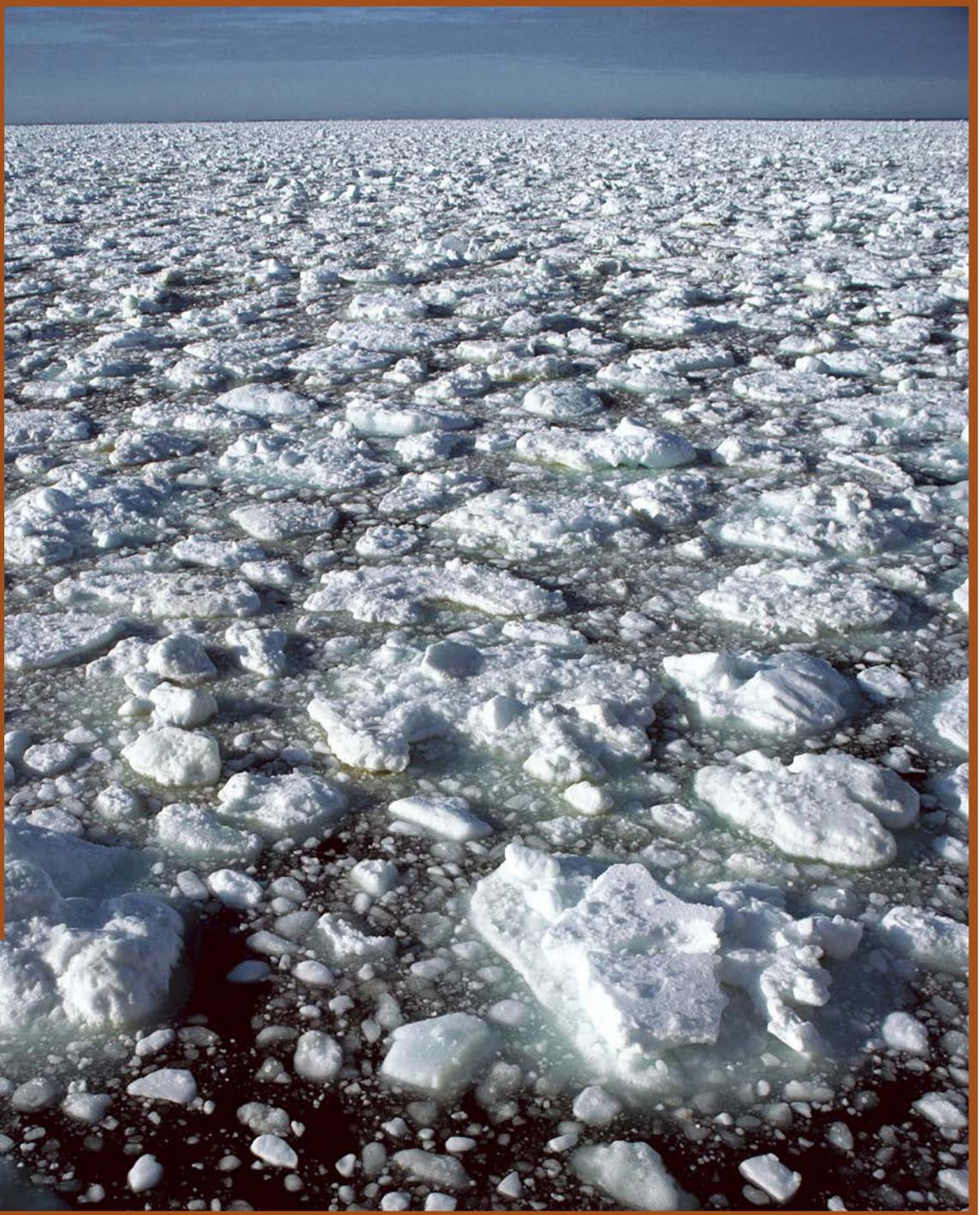


E

Earth Science  
Standard  
E.4.c.



# The Greenhouse Effect on Natural Systems

## **California Education and the Environment Initiative**

Approved by the California State Board of Education, 2010

### **The Education and the Environment Initiative Curriculum is a cooperative endeavor of the following entities:**

California Environmental Protection Agency  
California Natural Resources Agency  
California State Board of Education  
California Department of Education  
Department of Resources Recycling and Recovery (CalRecycle)

### **Key Partners:**

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### **Office of Education and the Environment**

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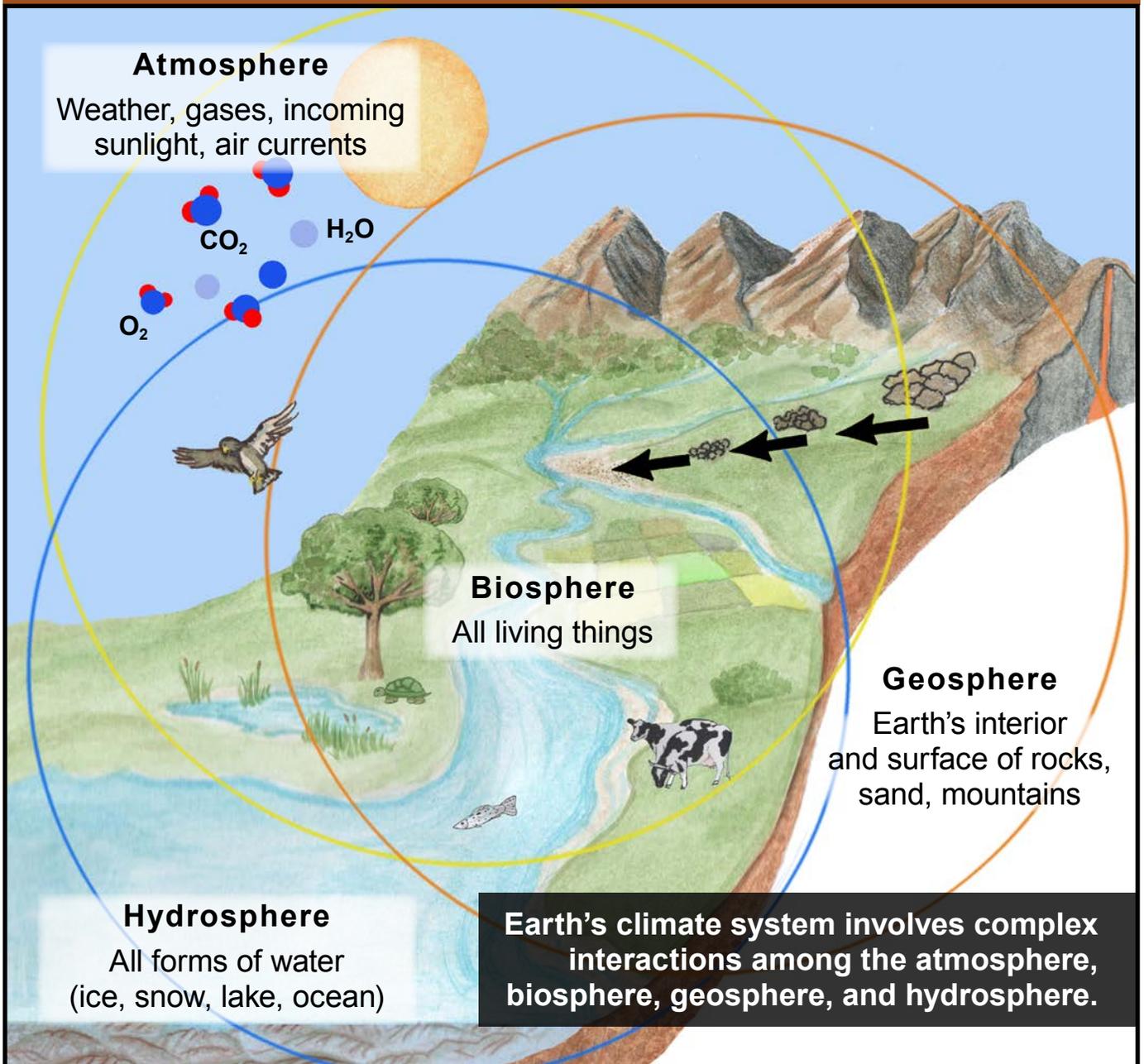
## **Lesson 6 Deciding About the Atmosphere**

None required for this lesson.

## VA #1 California 18,000 Years Ago



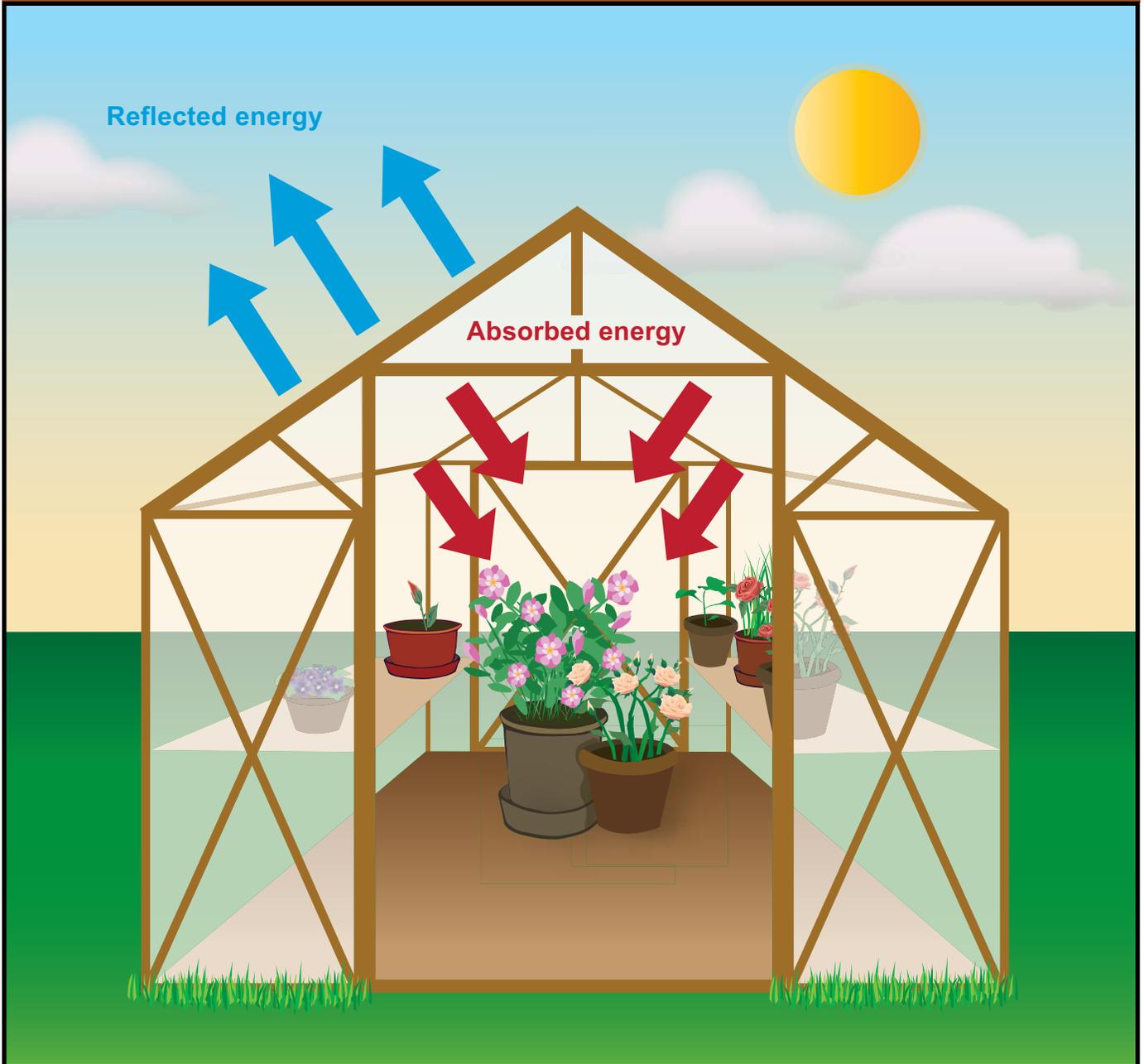
## VA #2 Earth's Climate System



## VA #3 Atmospheres of Earth, Venus, and Mars

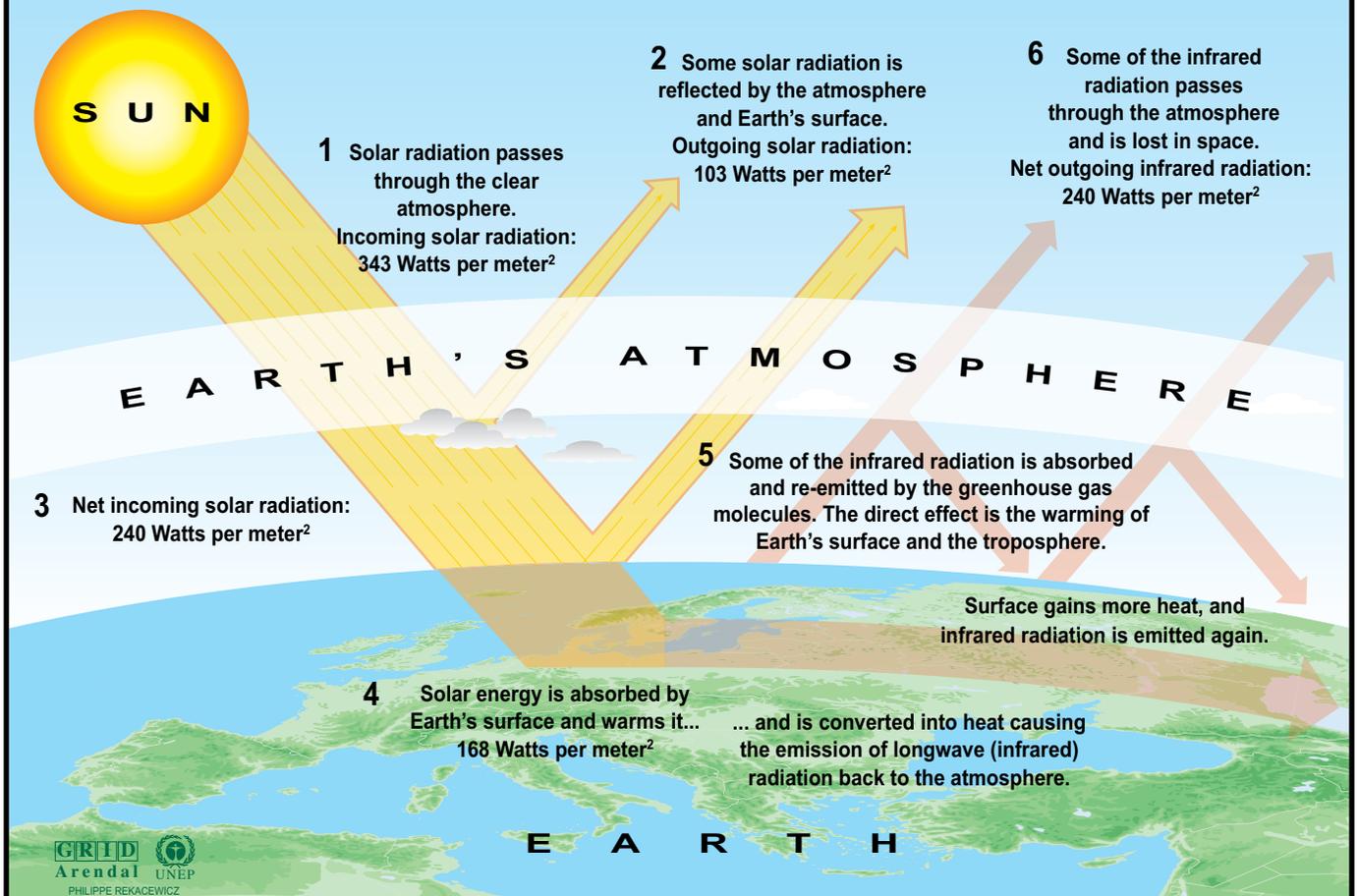
	Earth	Venus	Mars
			
<b>Carbon Dioxide (CO<sub>2</sub>)</b>	0.030 %	96.500 %	95.000 %
<b>Nitrogen (N<sub>2</sub>)</b>	78.000 %	3.500 %	2.700 %
<b>Oxygen (O<sub>2</sub>)</b>	21.000 %	Trace	0.130 %
<b>Argon (Ar)</b>	0.900 %	0.007 %	1.600 %
<b>Methane (CH<sub>4</sub>)</b>	0.002 %	0 %	0 %
<b>Nitrous Oxide (N<sub>2</sub>O)</b>	Yes	No	Yes
<b>Water Vapor</b>	Yes	No	No

### VA #4 A Greenhouse



## VA #5 Earth's Greenhouse

## The Greenhouse Effect



## VA #6 San Luis Reservoir, California



## VA #7 Other Greenhouse Gases

**Chlorofluorocarbons (CFCs, HCFCs)**  
**Hydrofluorocarbons (HFCs)**  
**Perfluorocarbons (PFCs)**



Found in aerosol sprays (spray paint, cooking spray), dry cleaning fluids, air conditioning, refrigeration, and medical supplies.

**Sulfur hexafluoride (SF<sub>6</sub>)**  
**Nitrogen trifluoride (NF<sub>3</sub>)**

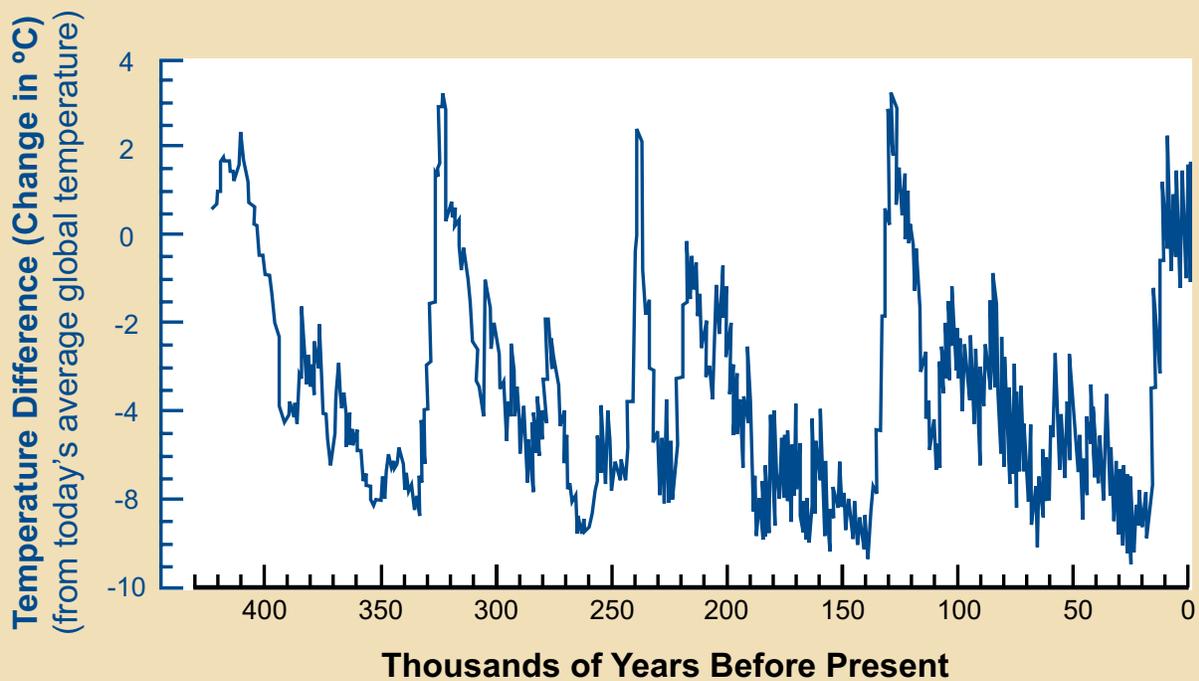


Used in electronics, as well as processing and manufacturing of semiconductors, like solar panels.

**Sources of these GHGs: Human activity (only)**

**Sinks of these GHGs: The atmosphere (only)**

## VA #8 Temperature Change on Earth Over Time

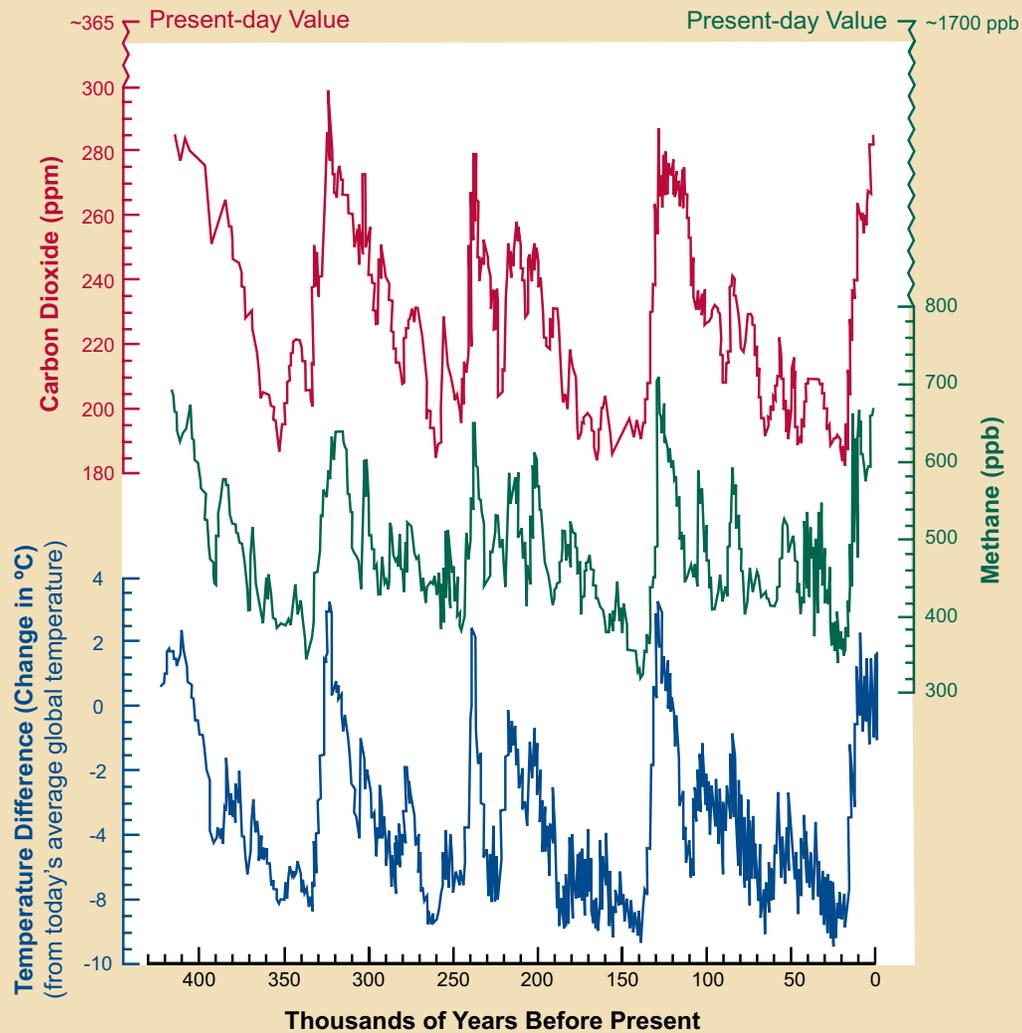


*Notes: These are the values measured in the ice cores.*

*0 on the Y-axis indicates the average temperature over time, not the actual temperature.*

*Other numbers on the Y-axis indicate the difference from the average temperature.*

## VA #9 Vostok Ice Core Data



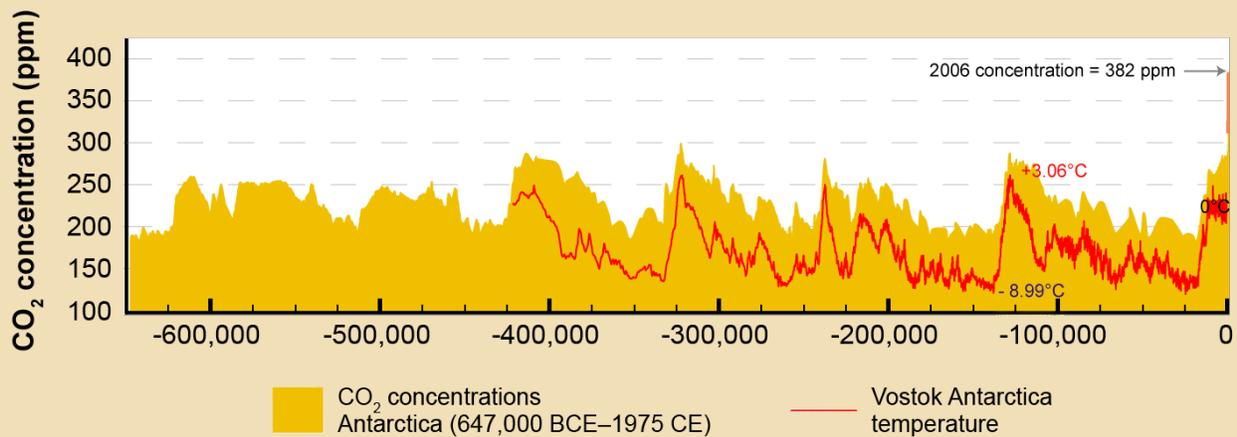
Notes: These are the values measured in the ice cores.

0 on the Y-axis indicates the average temperature over time, not the actual temperature.

Other numbers on the Y-axis indicate the difference from the average temperature.

VA #10 Antarctic Temperatures and Atmospheric CO<sub>2</sub>

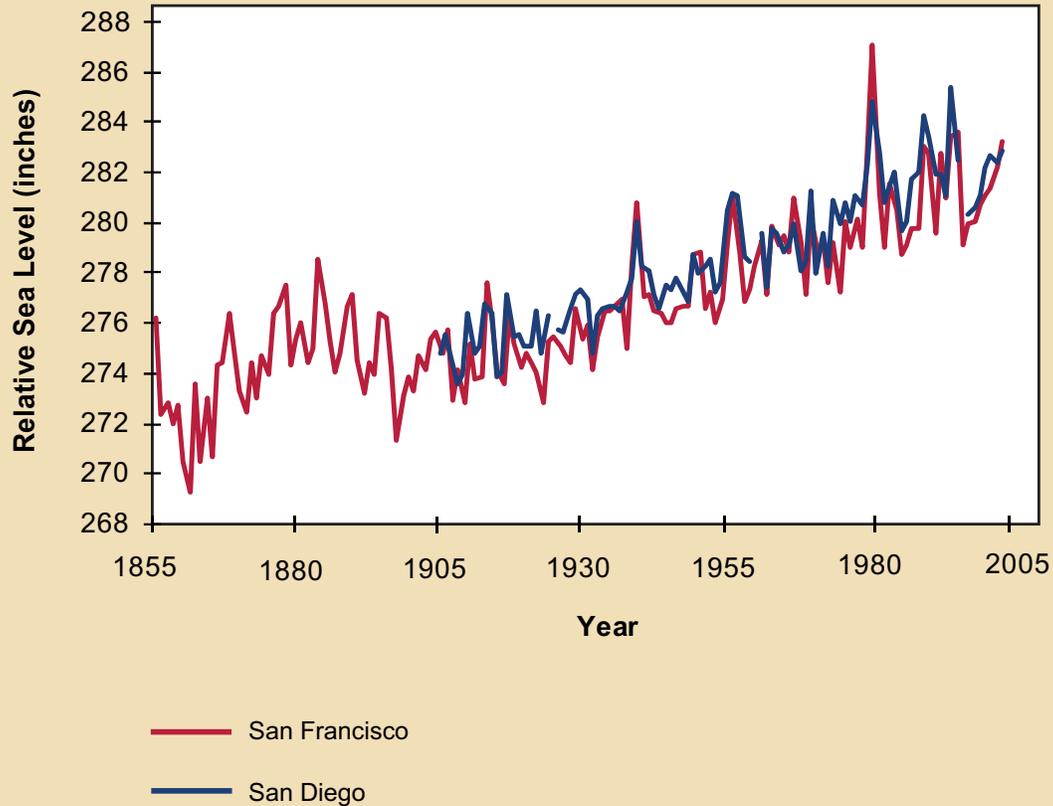
CO<sub>2</sub> concentrations 647,000 BCE to 2006 CE  
Antarctic temperature 421,000 BCE to 2000 CE\*



\*Antarctic temperature is measured as the change from the average conditions for the period 1850 CE–2000 CE

Source: U.S. Environmental Protection Agency (2009) <http://www.epa.gov/climatechange/science/pastcc.html>

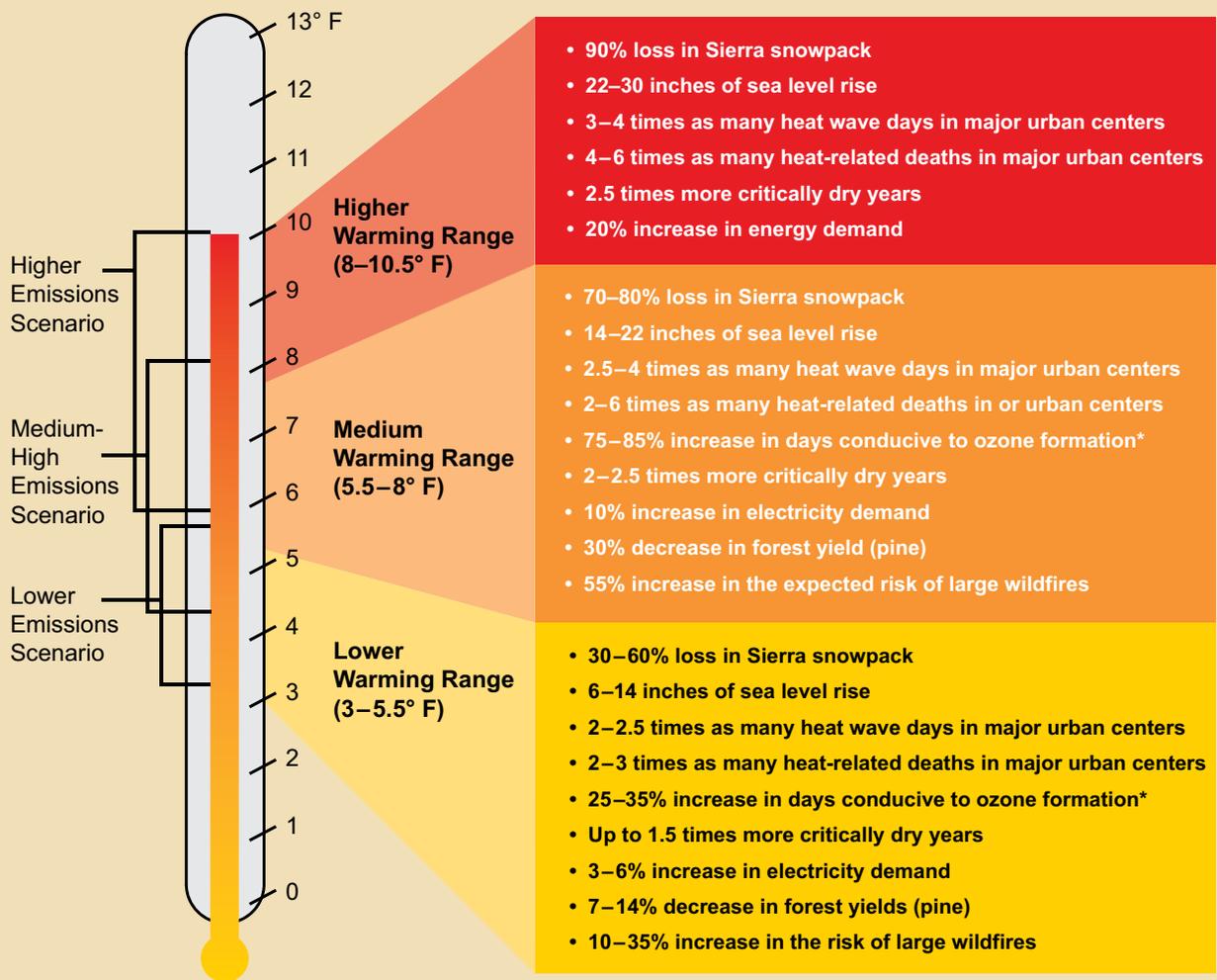
## VA #11 Historical Sea-Levels for San Francisco and San Diego



Source: Susie Moser, Guido Franco, Sarah Pittiglio, Wendy Chou, Dan Cayan, 2009. *The Future Is Now: An Update on Climate Change Science Impacts and Response Options for California*. (California Energy Commission, PIER Energy-Related Program, CEC-500-2008-071)

## VA #12 Projected Global Warming Effects in California

### Summary of Projected Global Warming Effects, 2070–2099 (as compared with 1961–1990)



\*For high ozone locations in Los Angeles (Riverside) and the San Joaquin Valley (Visalia)

Source: Union of Concerned Scientists (2006) [http://www.climatechoices.org/impacts\\_overview/](http://www.climatechoices.org/impacts_overview/)











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