Lecture 4. Atmospheric Absorption of Radiation

- The atmosphere absorbs little (5%) of radiation in visible wavelengths
- Stratospheric ozone absorbs almost all UV radiation
- Water vapor, CO_2, methane, nitrous oxide, ozone, and CFCs all absorb some of the infrared radiation emitted by the earth, and are called greenhouse gases.

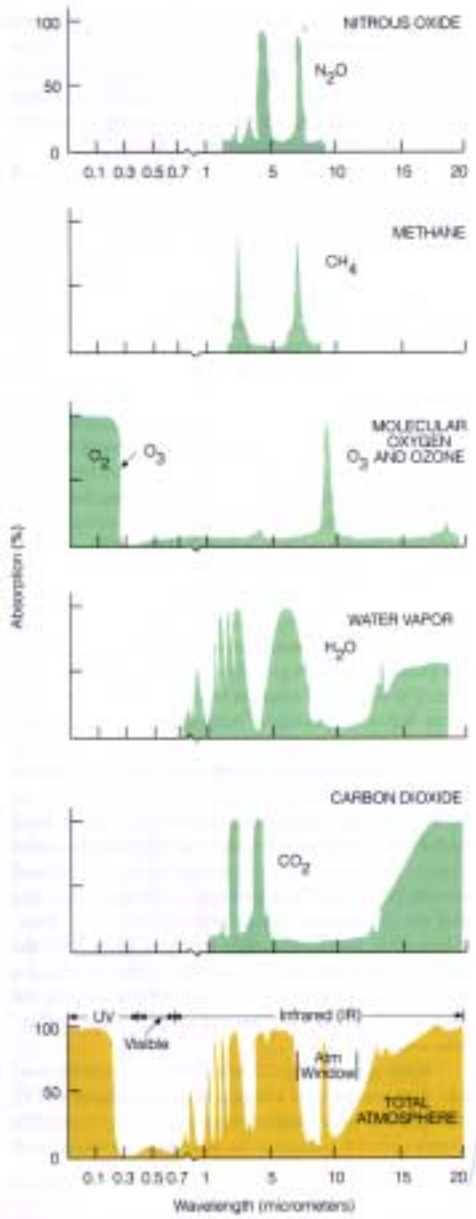
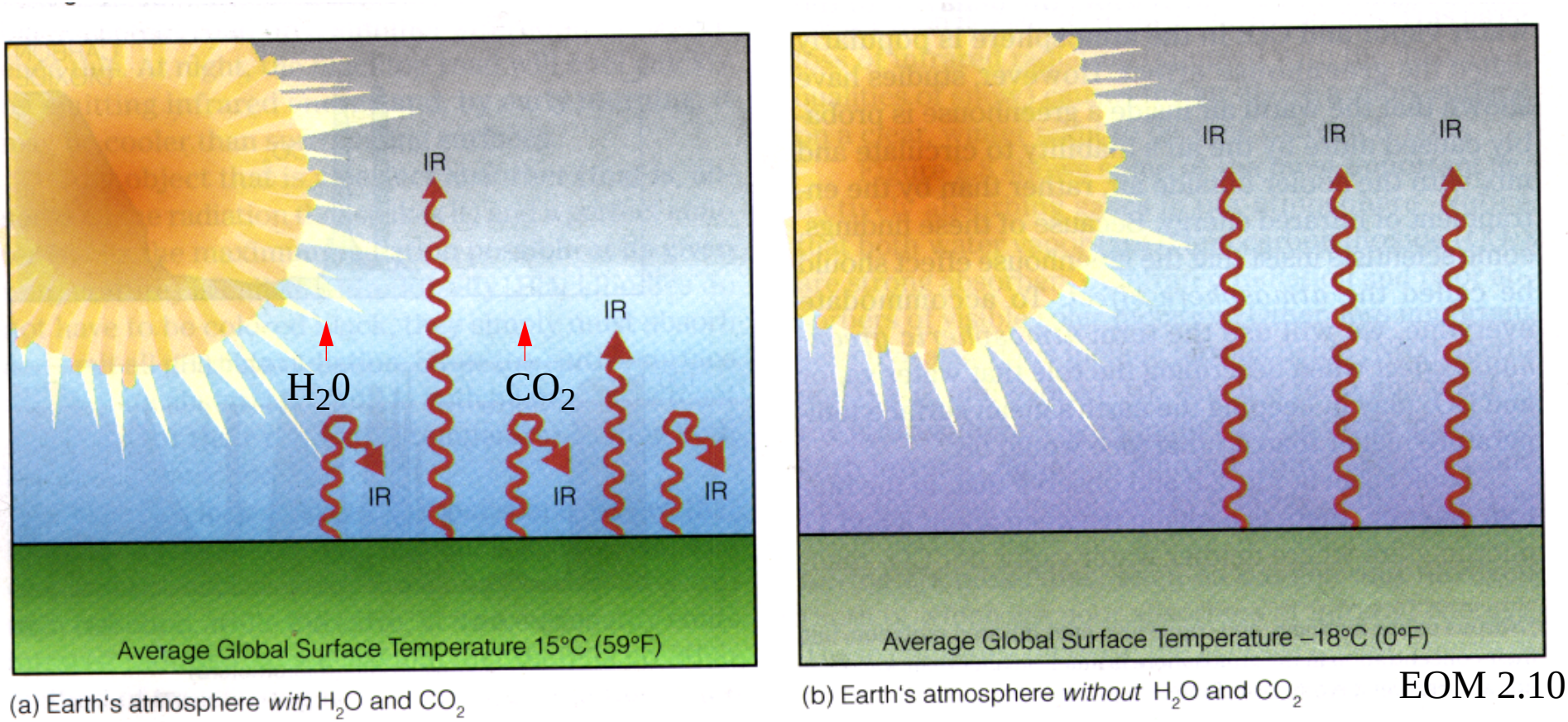


FIGURE 2.9
Absorption of radiation by gases in the atmosphere.

EOM 2.9

The Greenhouse Effect



(a) Earth's atmosphere *with* H_2O and CO_2

(b) Earth's atmosphere *without* H_2O and CO_2

EOM 2.10

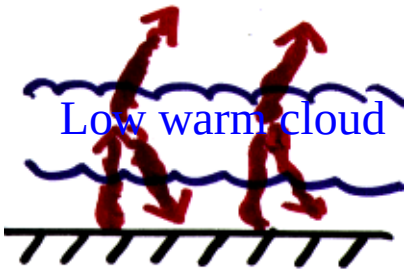
- Greenhouse gases absorb and emit infrared (IR, also called longwave) radiation. Some of this IR radiates downward, warming the surface.
- No greenhouse effect $\Rightarrow$ Earth's surface would average a frigid -18°C (0°F).
- Water vapor, clouds, and CO_2 (in that order) produce the most greenhouse warming, raising Earth's mean surface temperature to 15°C (59°F).

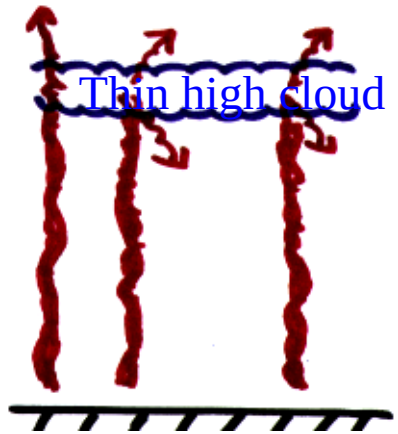
Clouds' Greenhouse Effect

- Cloud reflects visible light but strongly absorbs IR radiation, so also has greenhouse effect.

  Low, warm cloud radiates lots of IR groundward (and upward)⇒ large surface greenhouse effect

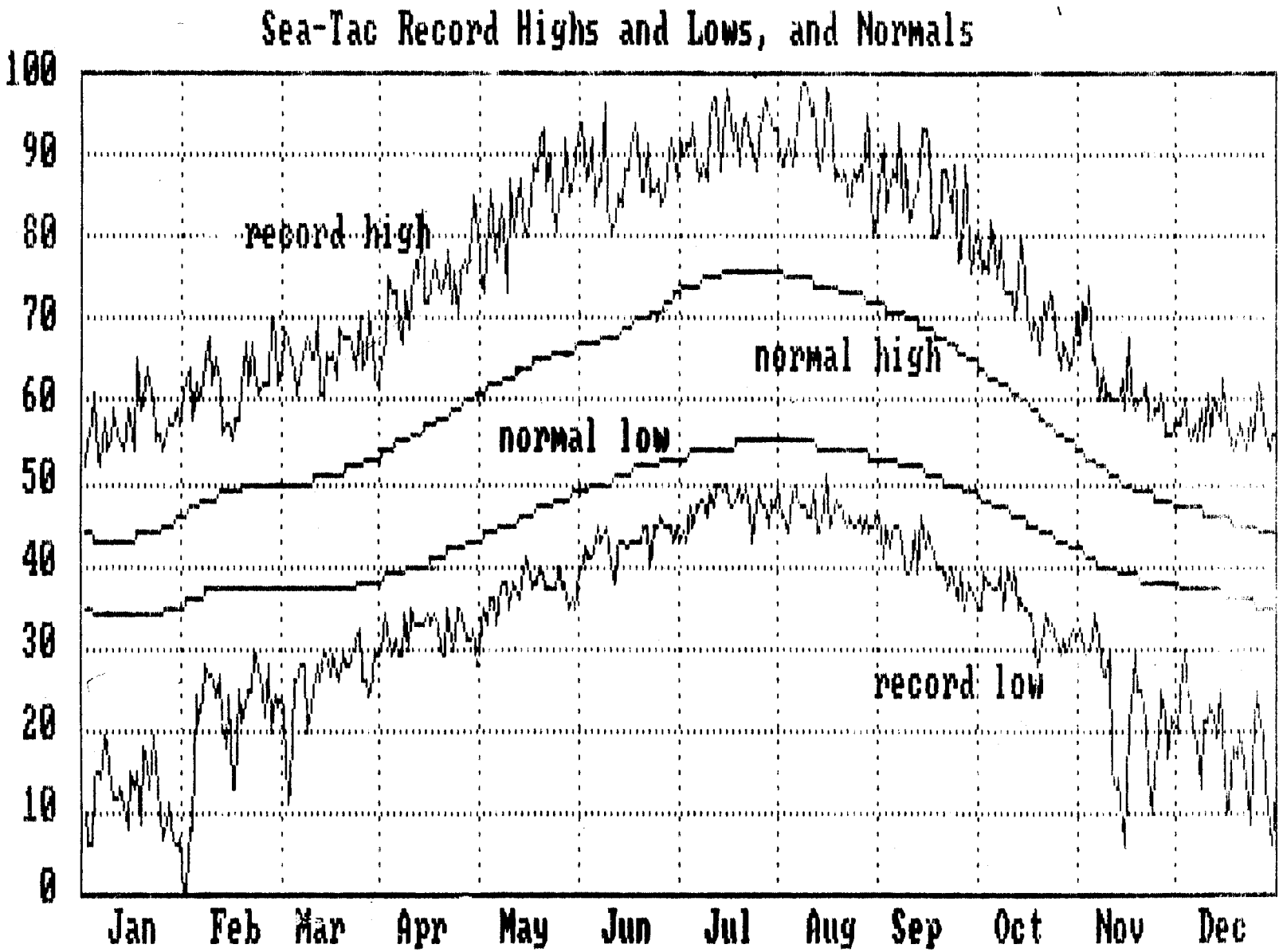
  High, cold cloud radiates less IR groundward (and upward)⇒ less surface greenhouse effect

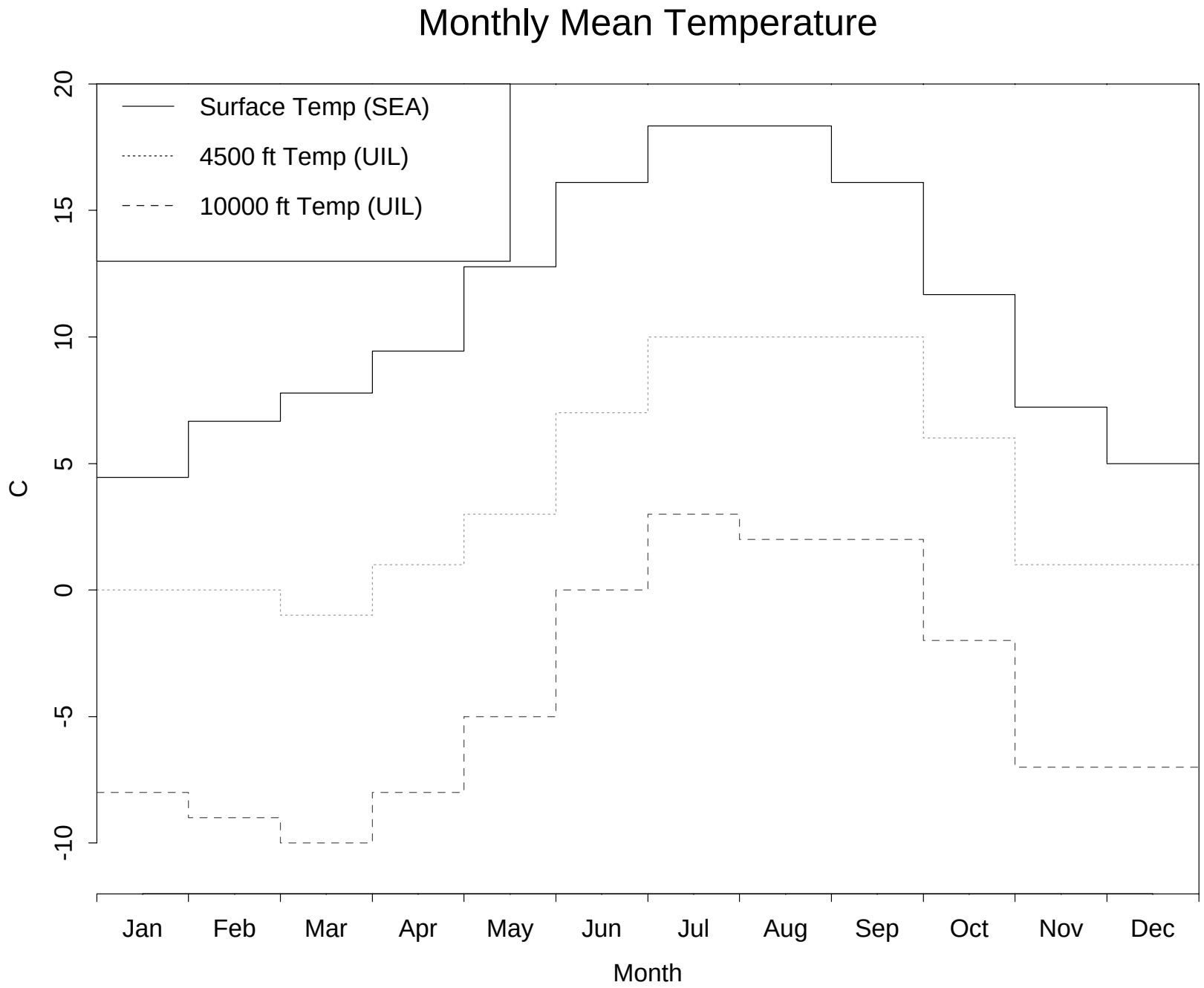




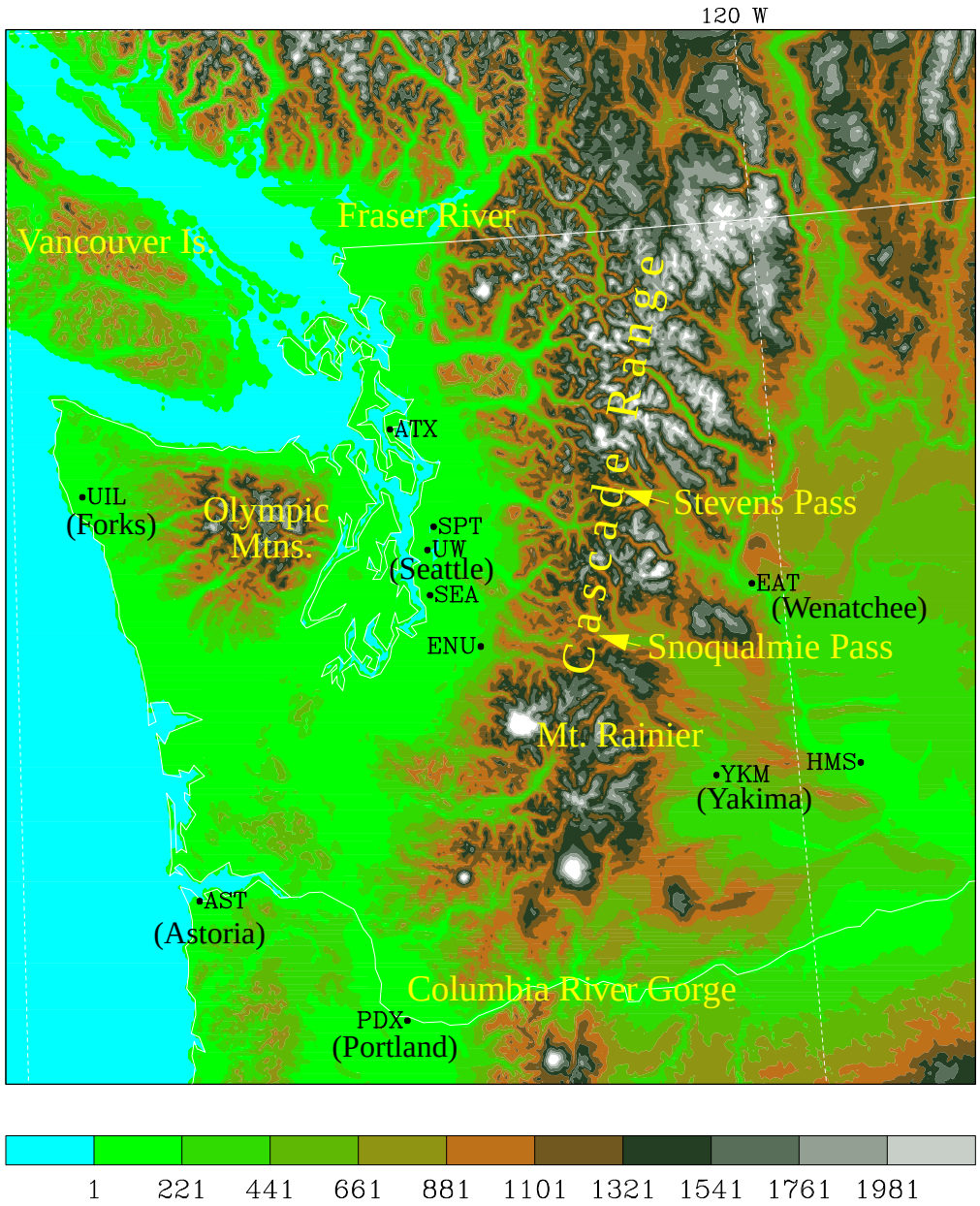
- Thus surface temperature tends to cool much less on a night with low or thick clouds.
- Note: Real greenhouses don't work like the 'greenhouse effect'! They trap absorbed heat by suppressing air exchange with the outside.
- IR satellite images show upwelling IR. White ⇒ low IR, i. e. high, cold cloud. Grey ⇒ low, warmer, cloud. Black ⇒ clear, can see surface (which is usually warmer than clouds).

Seattle Climatology




Monthly Mean Temperature
Surface Temp (SEA)
4500 ft Temp (UIL)
10000 ft Temp (UIL)
C
20
15
10
5
0
-5
-10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

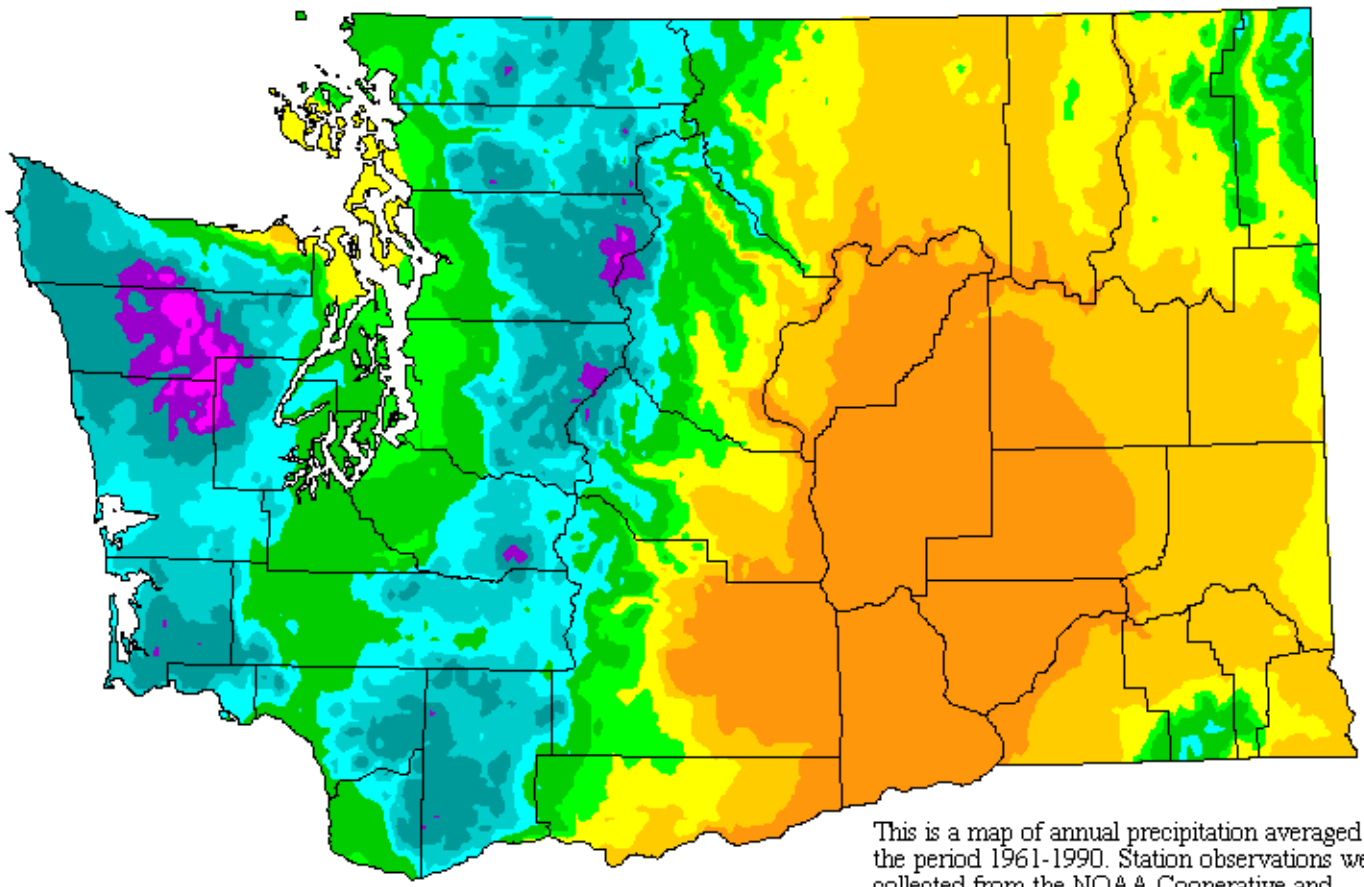
Western Washington topography



Average Annual Precipitation

Washington

1961-1990



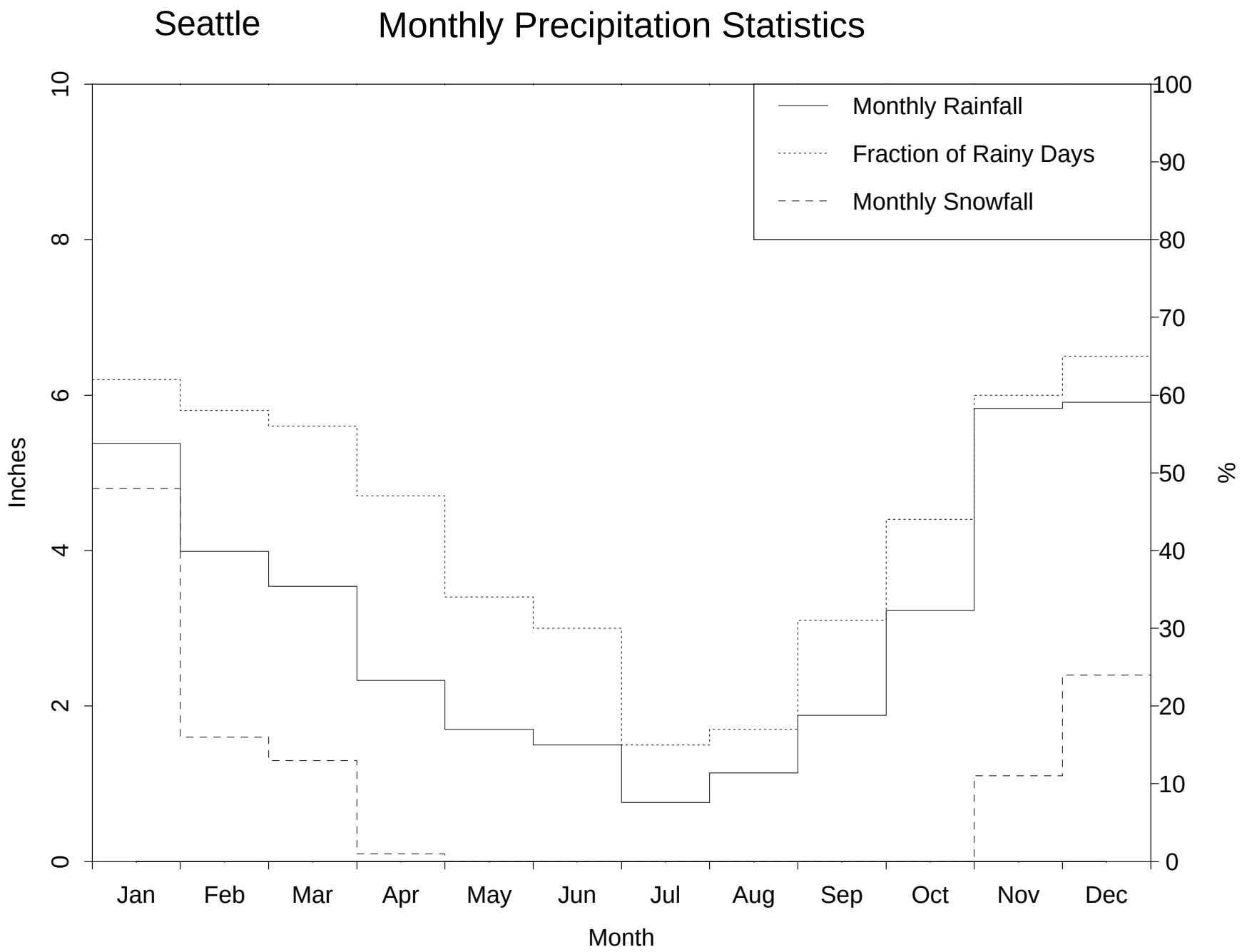
This is a map of annual precipitation averaged over the period 1961-1990. Station observations were collected from the NOAA Cooperative and USDA-NRCS SnoTel networks, plus other state and local networks. The PRISM modeling system was used to create the gridded estimates from which this map was made. The size of each grid pixel is approximately 4x4 km. Support was provided by the NRCS Water and Climate Center.

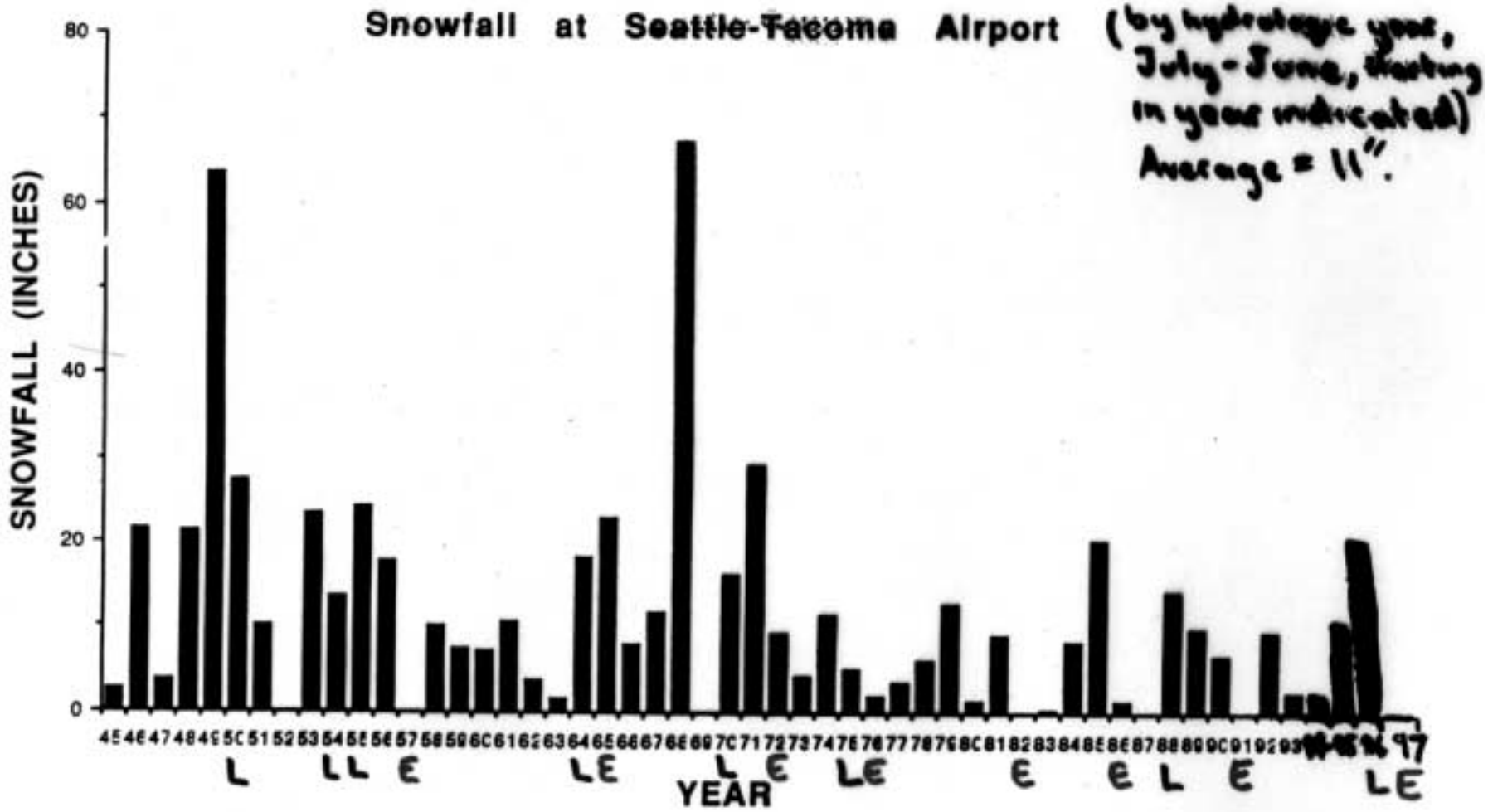
Legend (in inches)

Under 10	60 to 80
10 to 20	80 to 100
20 to 30	100 to 140
30 to 40	140 to 180
40 to 60	Above 180

For information on the PRISM modeling system, visit the SCAS web site at http://www.ocs.orst.edu/prism

The latest PRISM digital data sets created by the SCAS can be obtained from the Climate Source at http://www.climatesource.com

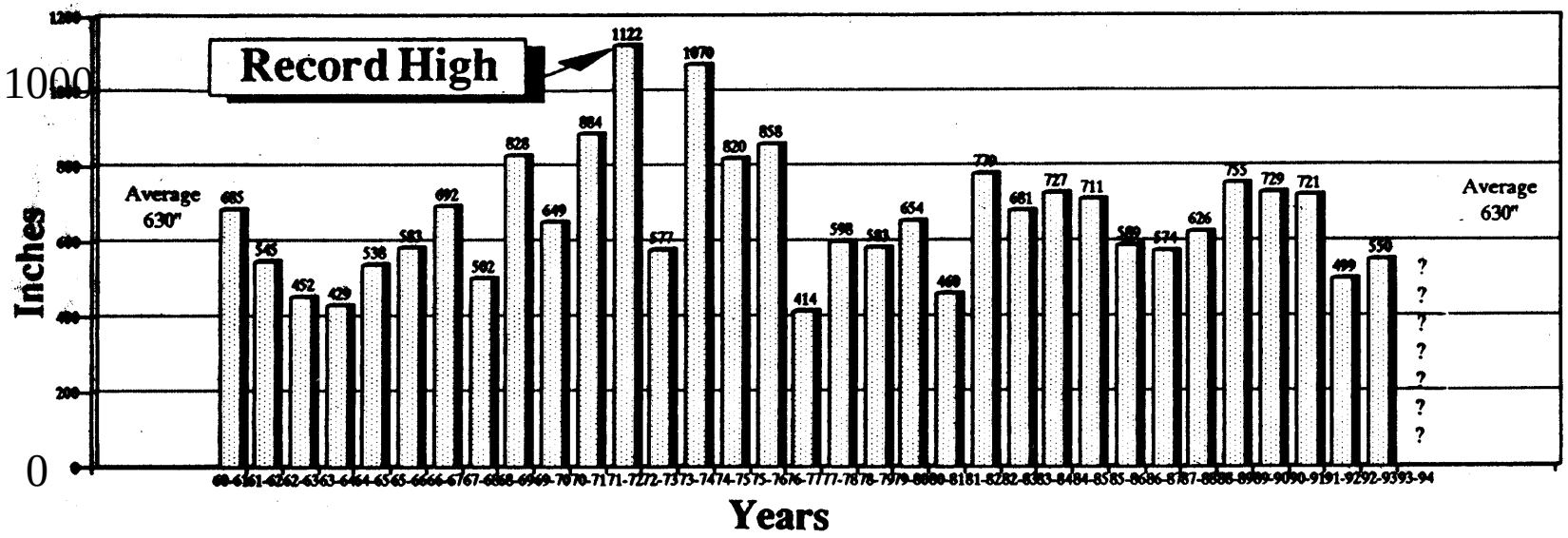

Seattle
Monthly Precipitation Statistics
Monthly Rainfall
Fraction of Rainy Days
Monthly Snowfall
Inches
%
0
2
4
6
8
10
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month



Snowfall tends to be low in El Nino years

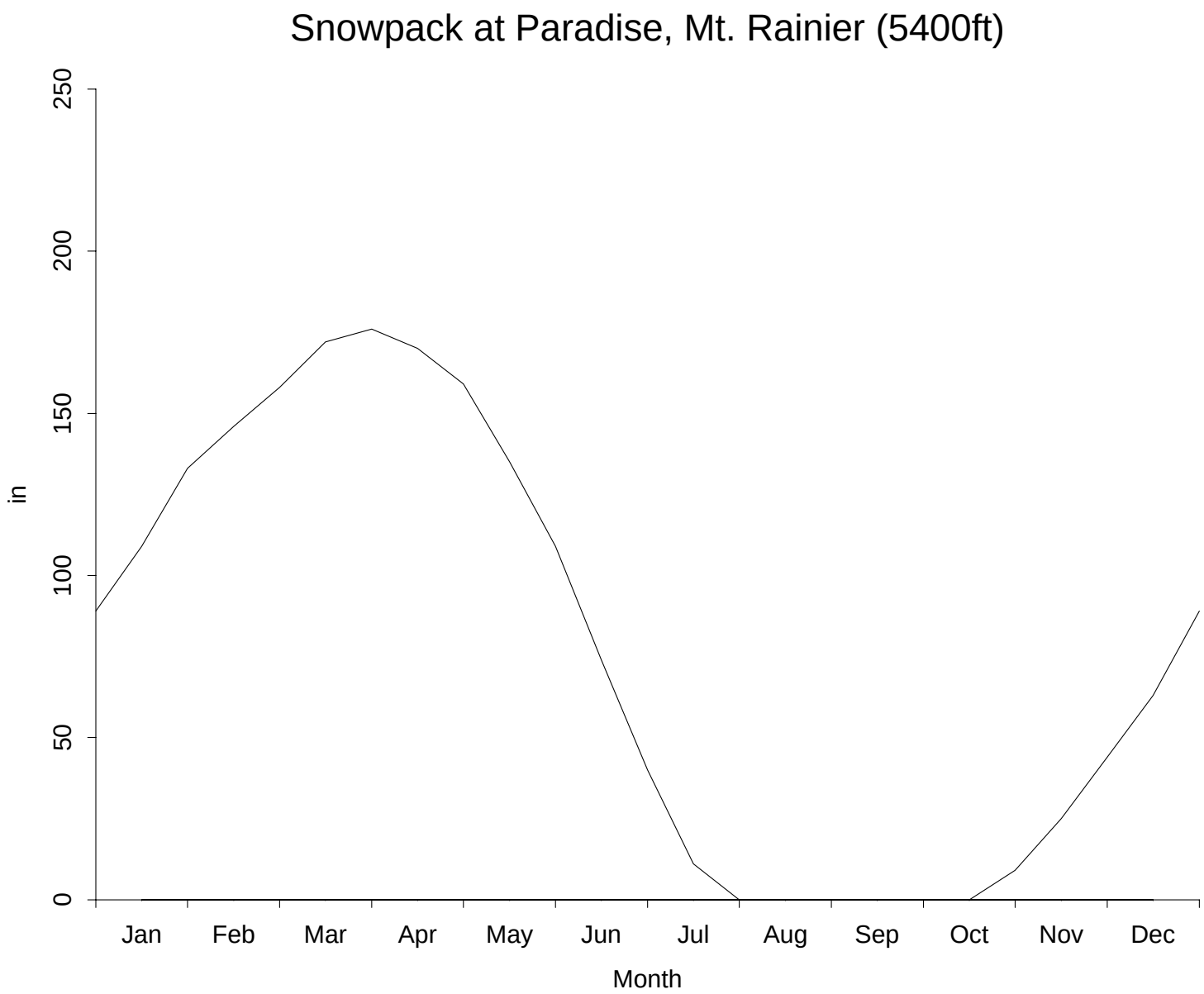
Snowfall has been lower since early 70s

Annual Snowfall at Paradise, Mt. Rainier (5400’)



Average = 630 in

Record = 1122 in (1971-72)


Snowpack at Paradise, Mt. Rainier (5400ft)
in
0
50
100
150
200
250
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month