Earth's Temperature History – How do we know?

Climate System Review

Temperature History Review

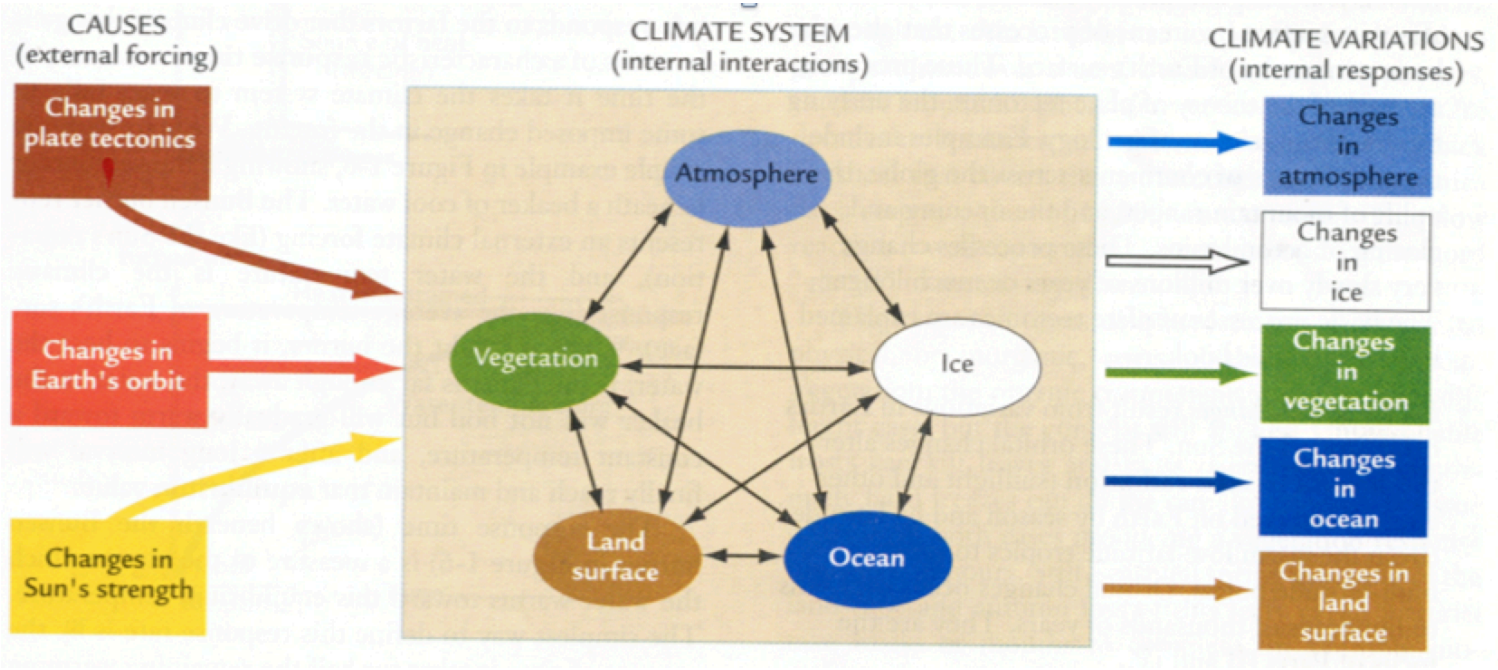
Temperature Proxies

Ice Core Activity

Climate Change

Climate System

- external forcings (plate tectonics, orbit, solar input, volcanoes & man)
- internal interactions (air, sea, land, ice, vegetation)
- internal responses (changes in climate system)

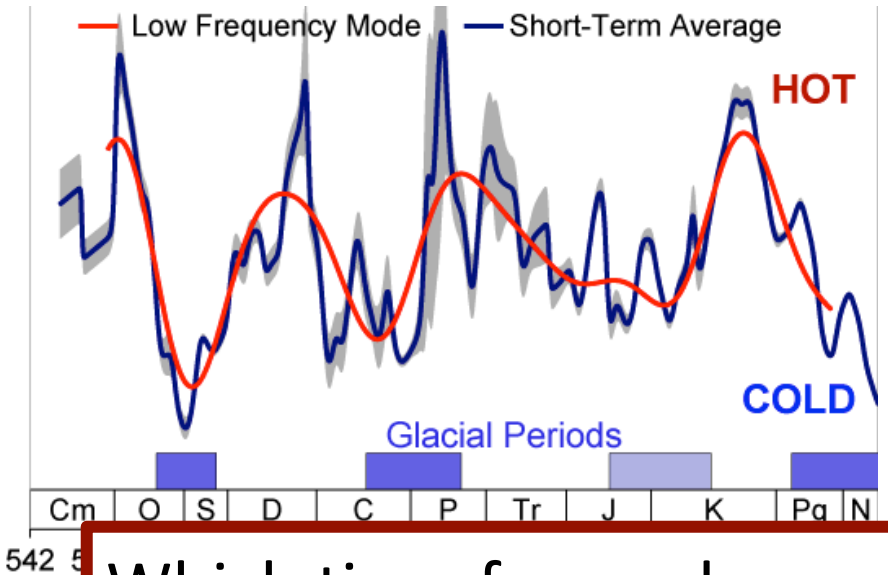


Causal Chains

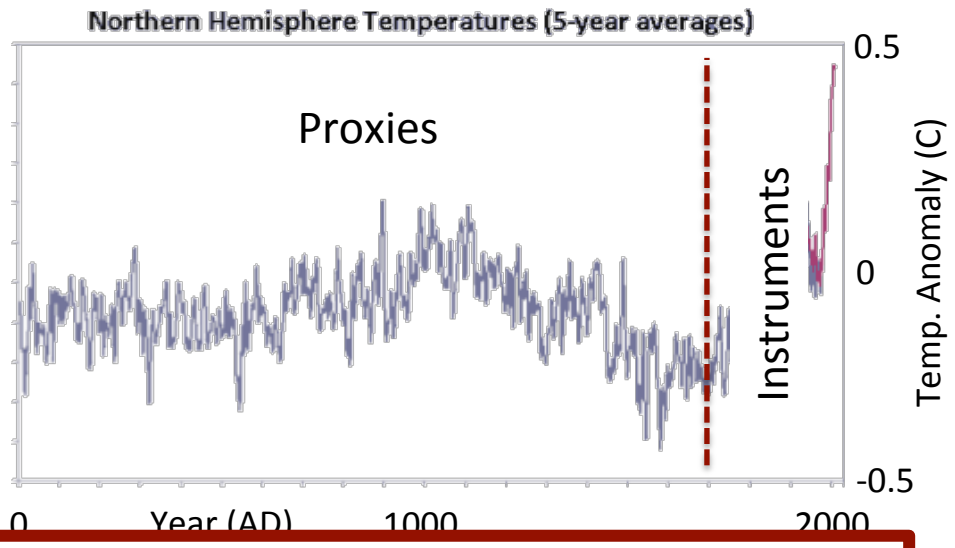
More sunspots => global warming => melts ice => sea level rises => land area decreases
=> less room for land plants ……

Temperature History Review

Plate Tectonics (Millions of Years)

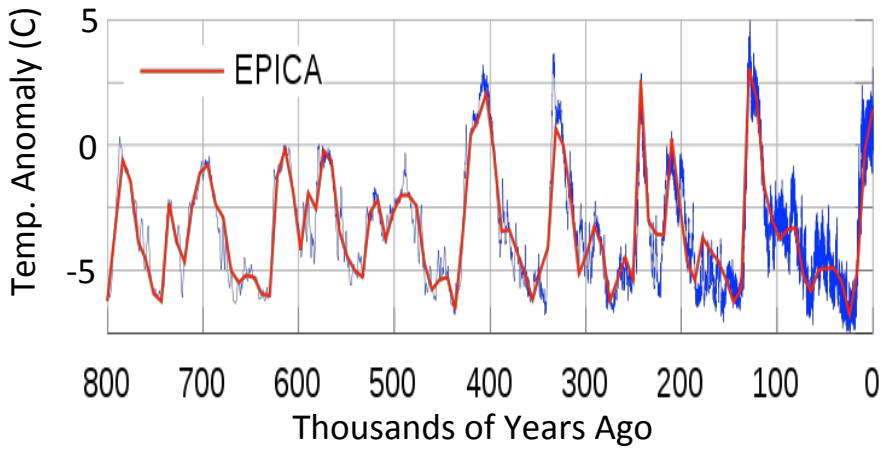


Sunspots/Volcanoes (10-100s of Years)

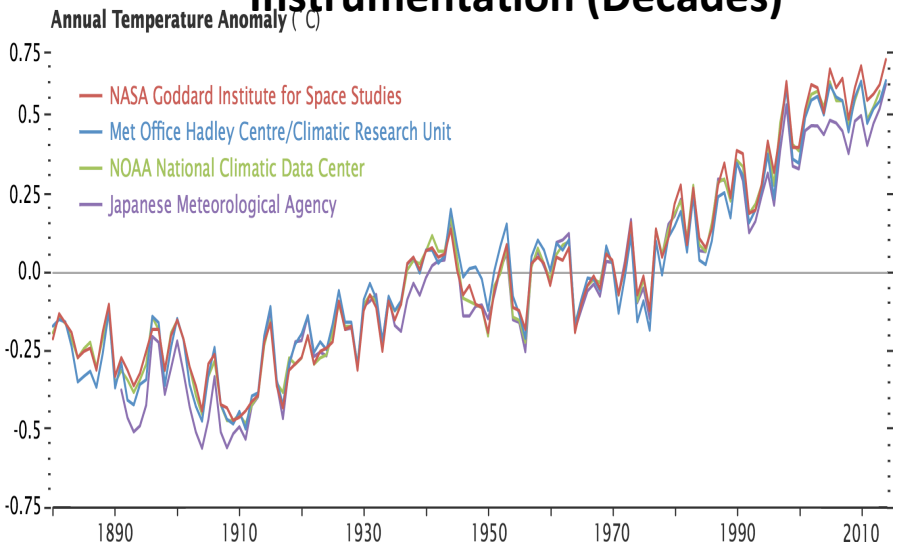


Which time-frame do you believe is the most accurate?

Orbital Patterns (Thousands of Years)



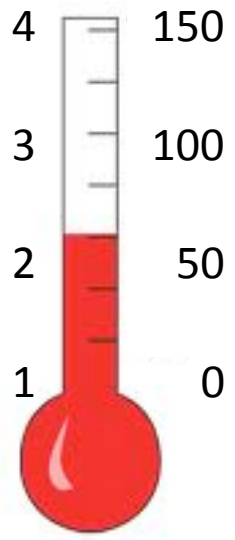
Instrumentation (Decades)

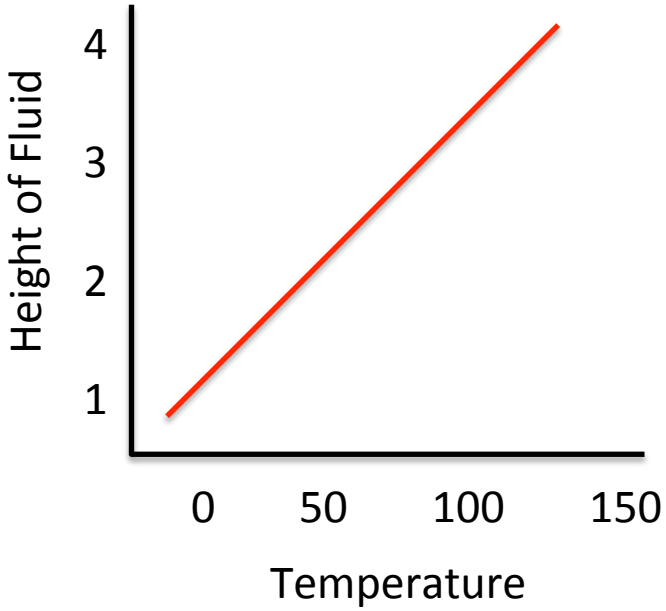


Temperature Proxy

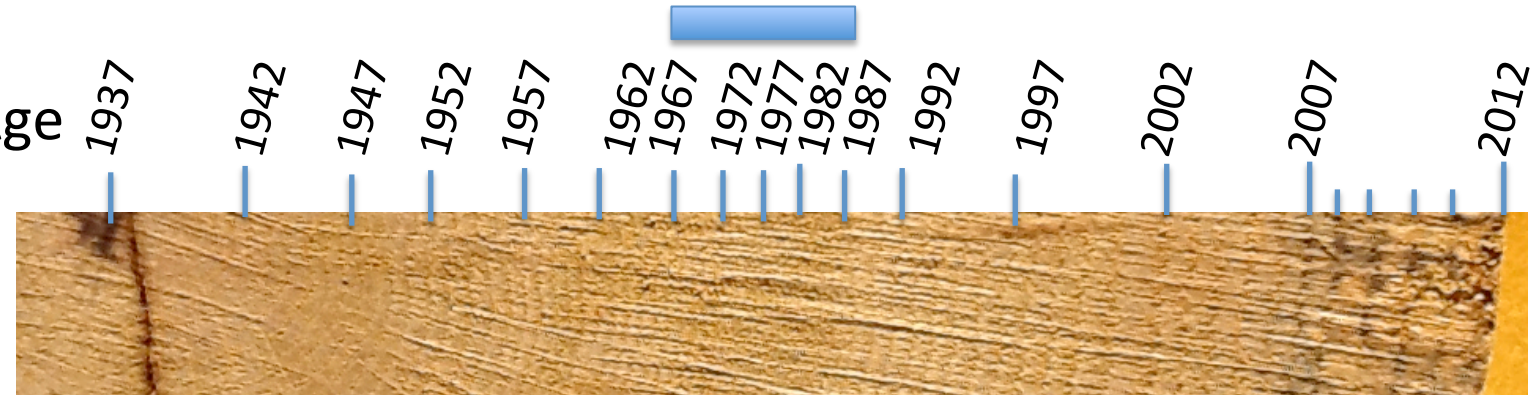
Temperature Proxy –

- preserved physical characteristic (e.g., tree ring)
- that can be used as a measure of past temperature
- if properly calibrated.

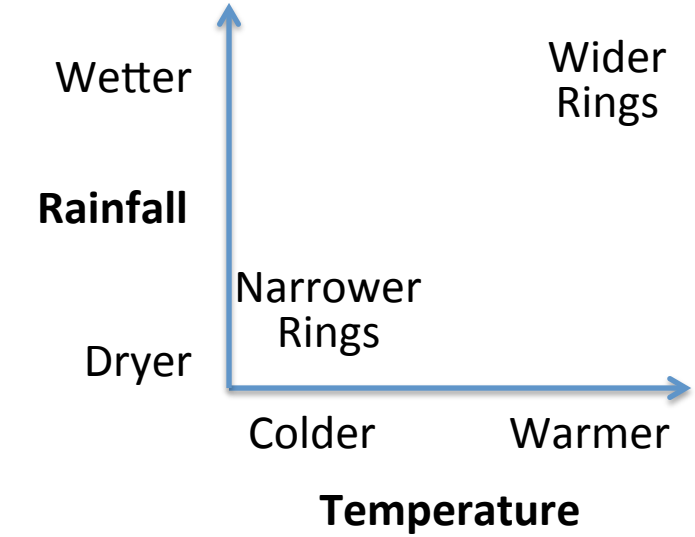


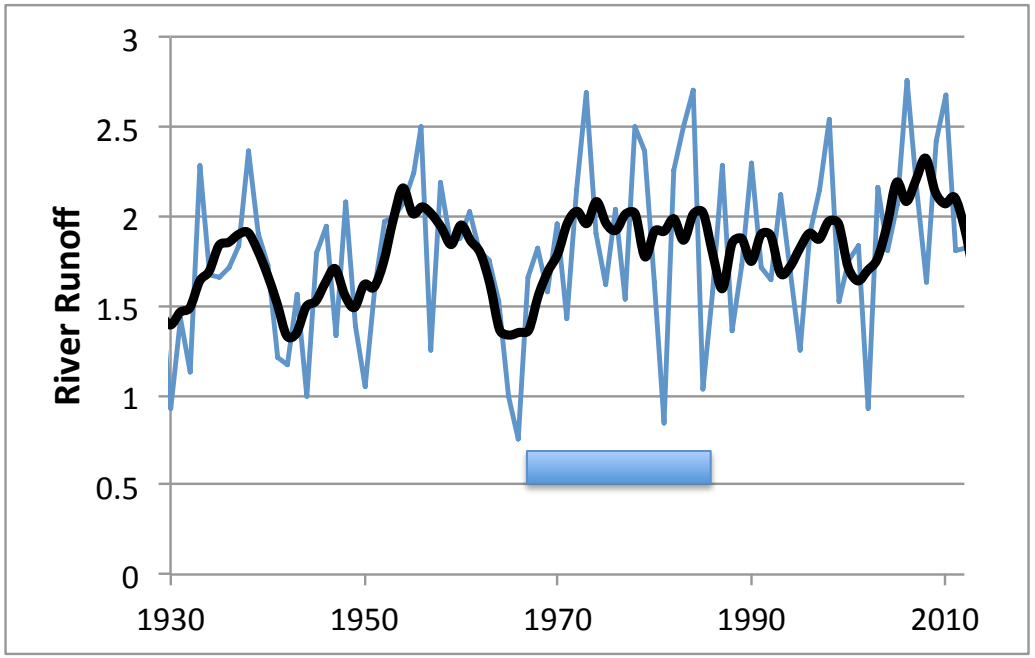


Temperature Proxy – Tree Rings

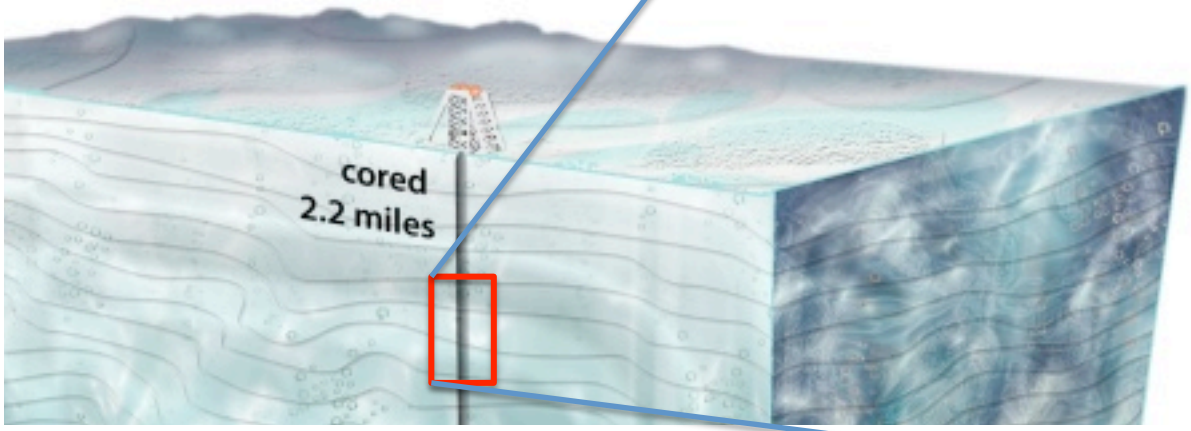


Growing Conditions?

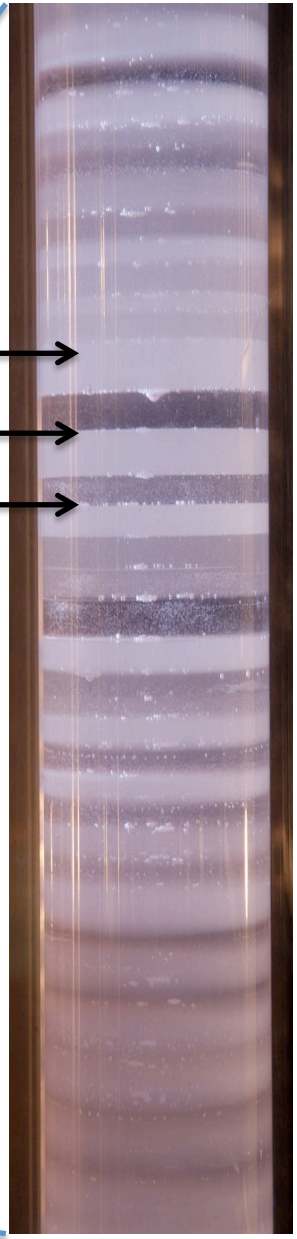




Temperature Proxy – Ice Cores

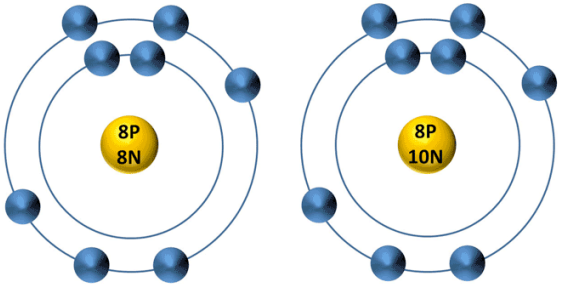


Annual
Rings



Temperature Proxy – Ice Cores

Oxygen Isotopes



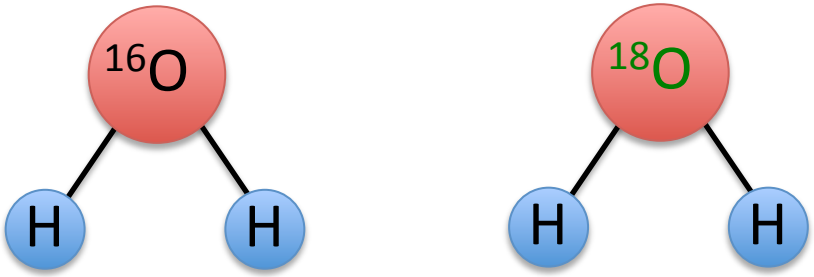
^{16}O

Lighter

^{18}O

Heavier

Water Molecules



Lighter

Heavier

Warmer Temps.

Ice enriched in ^{18}O

Ice depleted in ^{16}O

$^{18}O/^{16}O$ increases

Cooler Temps.

Ice depleted in ^{18}O

Ice enriched in ^{16}O

$^{18}O/^{16}O$ decreases

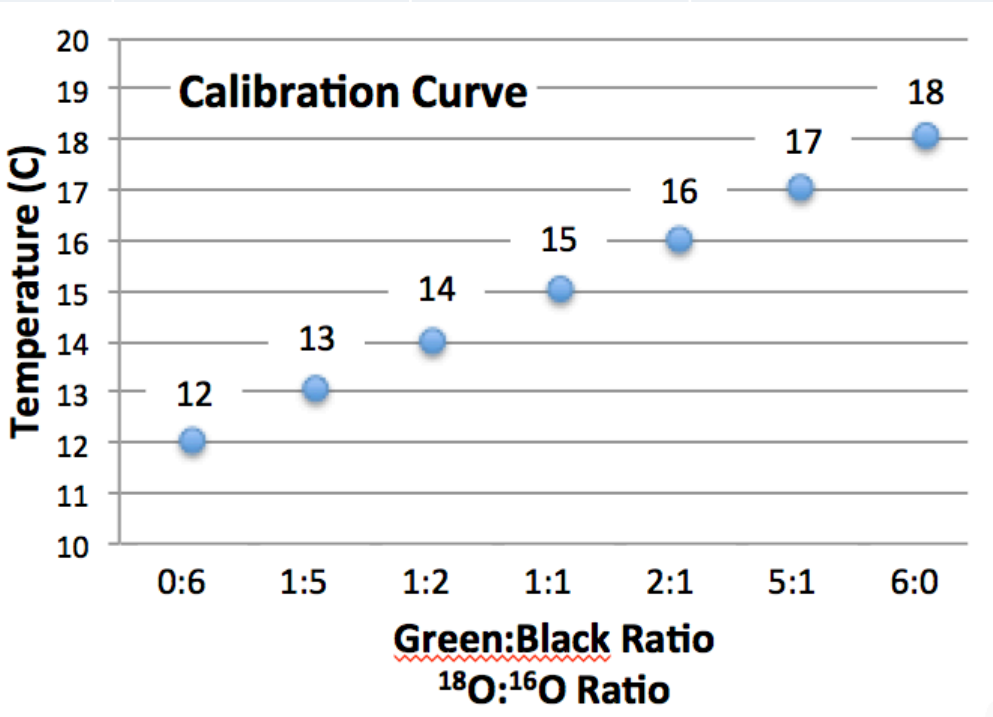
Split Ice Cores

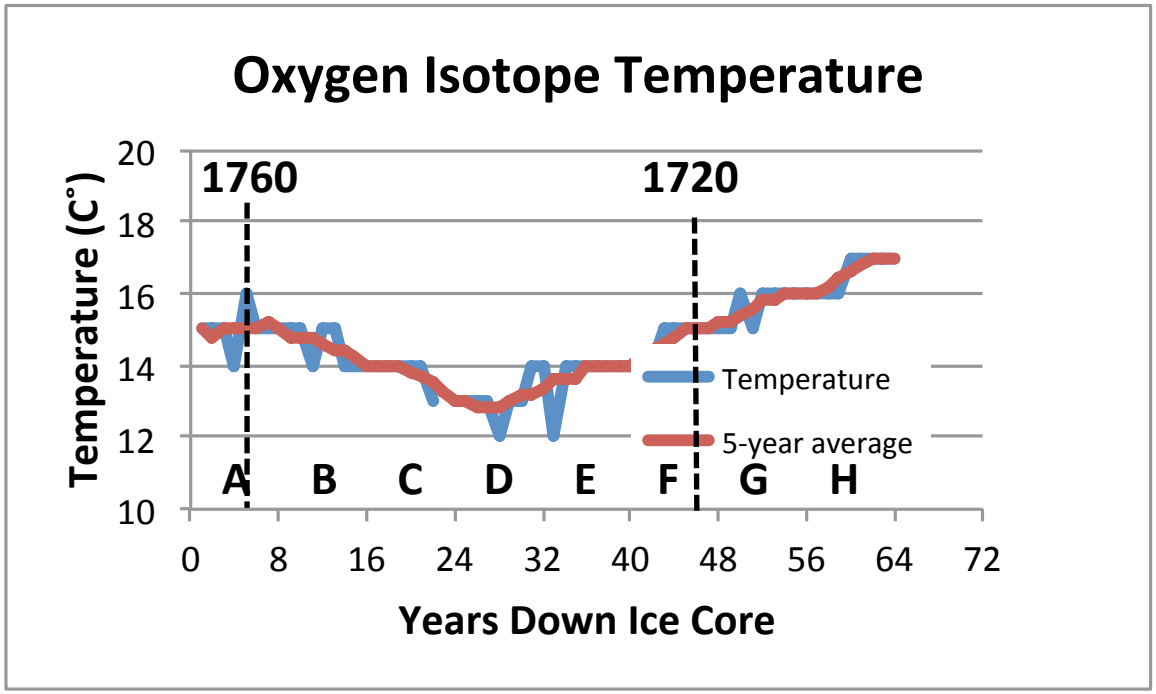
Archive Working

Split Ice Tray

Green Beads (^{18}O)	Black Beads (^{16}O)	Green:Black Ratio	Temperature
5	1	5:1	17

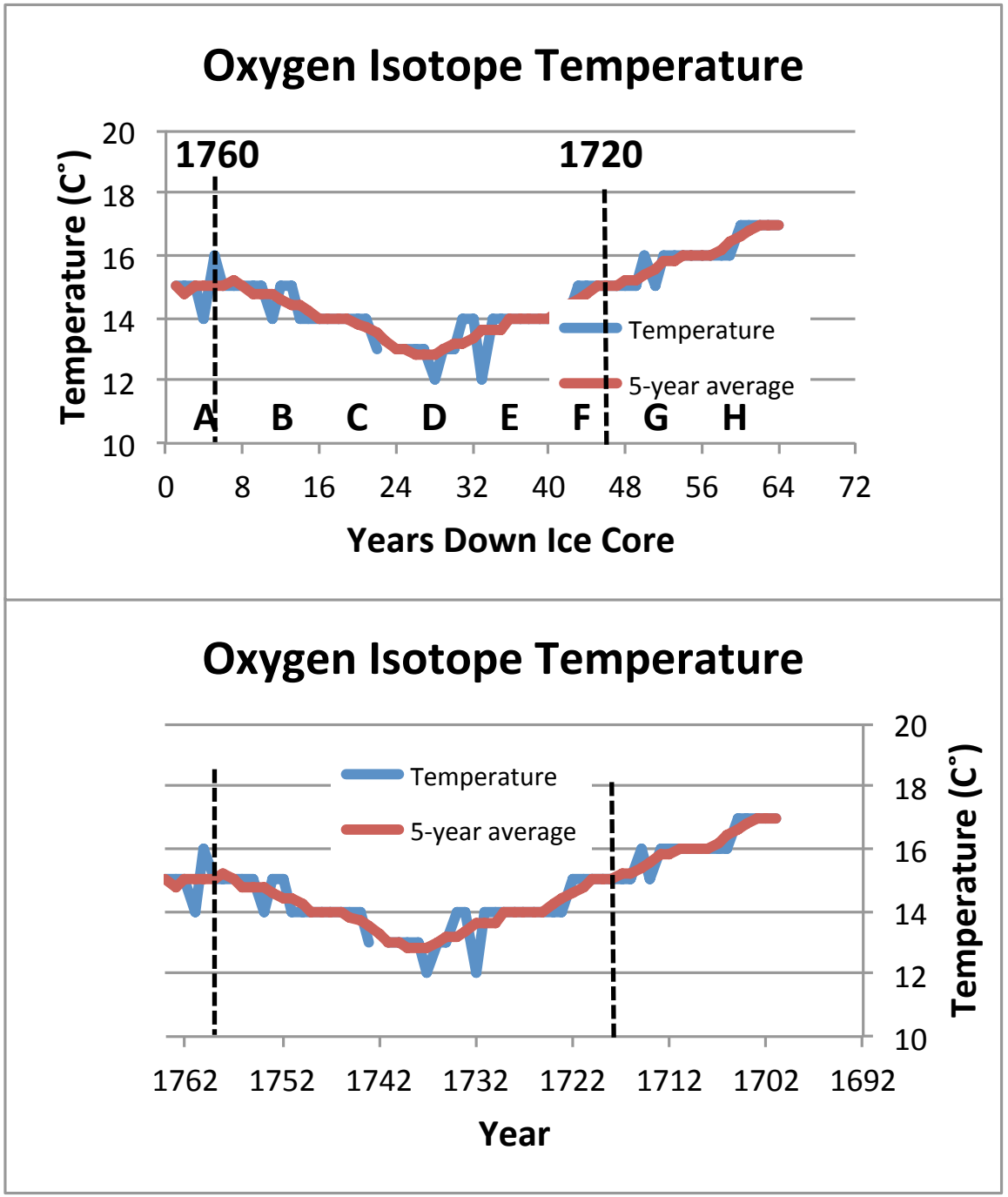
1) Count Number of Green Beads (^{18}O)
2) Count Number of Black Beads (^{16}O)
3) Calculate Ratio (Green/Black)
4) Use "Look-up Table" to obtain temperature





Volcanic Eruptions
- 1720
- 1760


ABCDEFGH
Top


Oxygen Isotope Temperature
Temperature (C°)
20
18
16
14
12
10
1760
1720
A
B
C
D
E
F
G
H
Temperature
5-year average
0
8
16
24
32
40
48
56
64
72
Years Down Ice Core
Oxygen Isotope Temperature
Temperature
5-year average
20
18
16
14
12
10
Temperature (C°)
1762
1752
1742
1732
1722
1712
1702
1692
Year


A
B
C
D
E
F
G
H

Ice Core Results