Dry Forest Ecosystems

and the

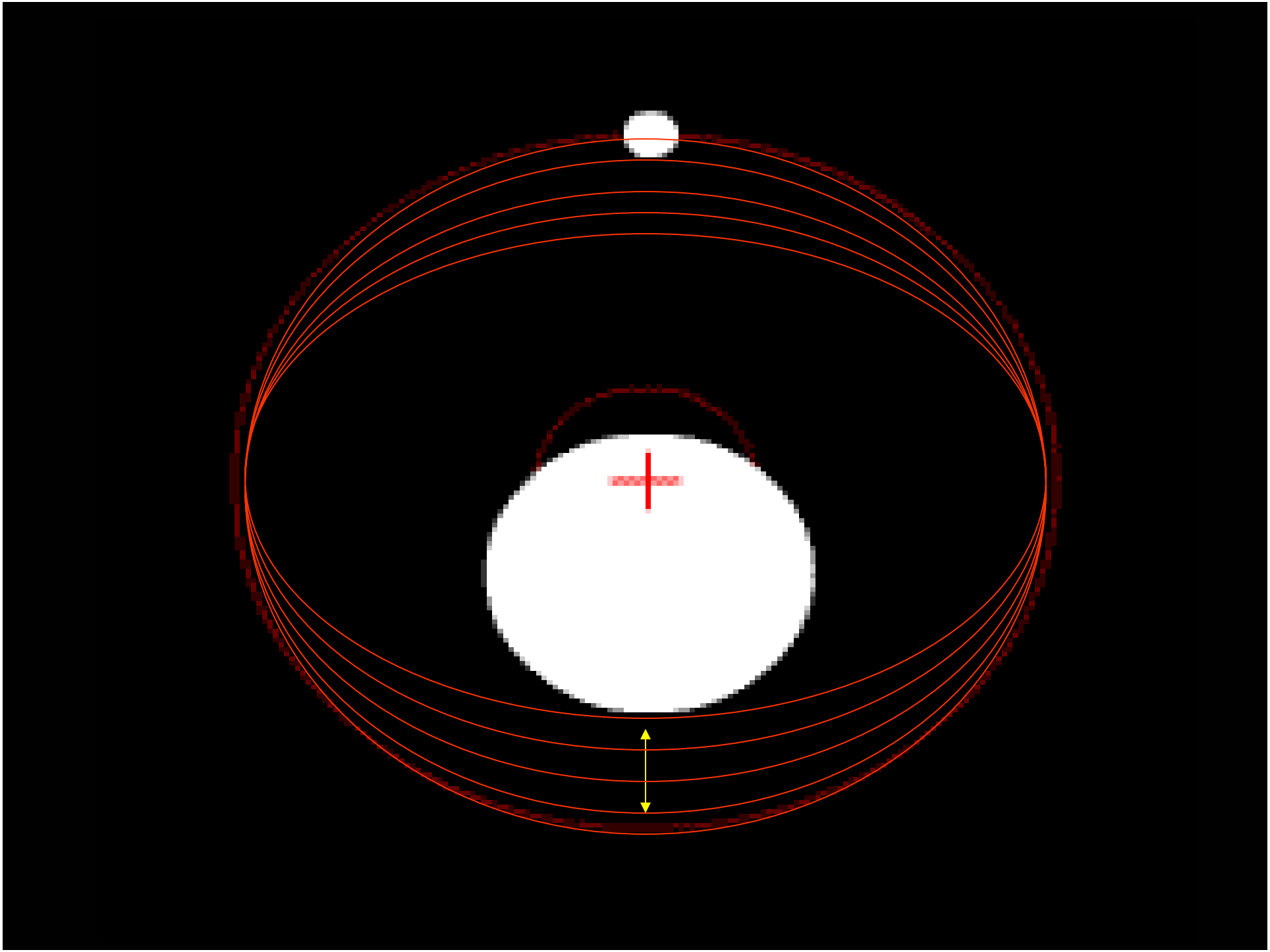
Klamath Province

Dry Forest Characteristics

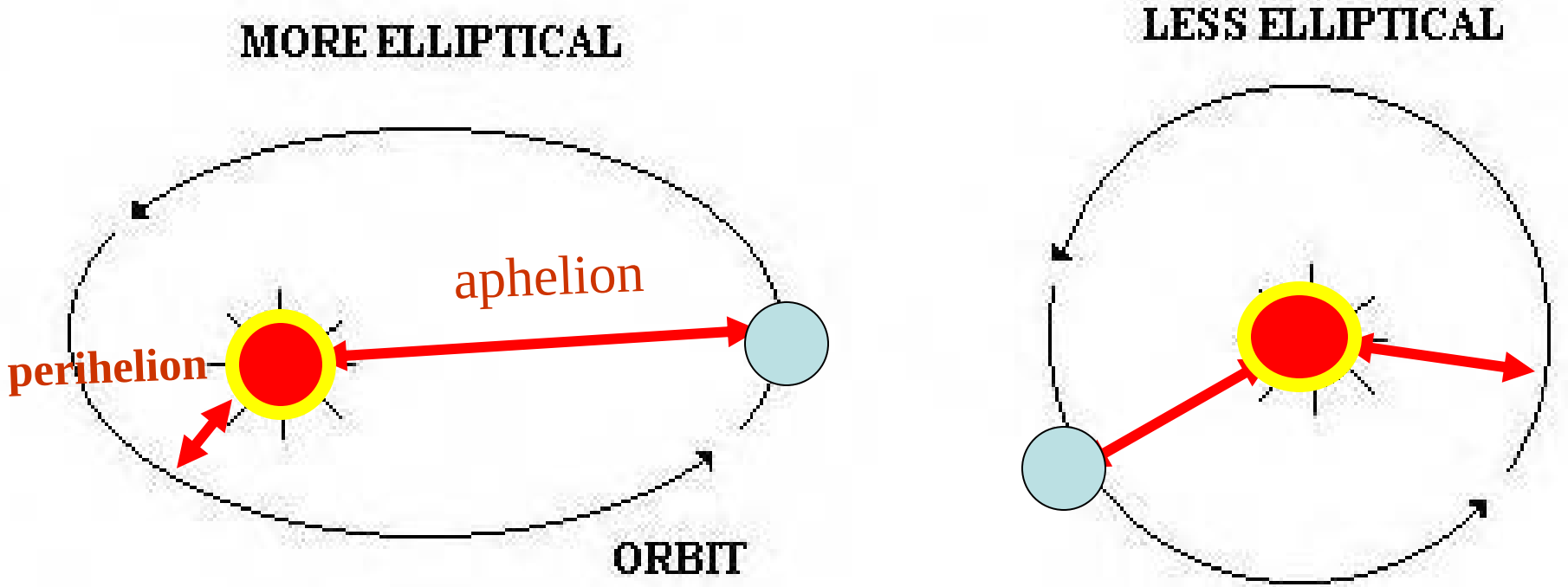
- **Extend periods of little precipitation (>140 days)**
- **< 2.5” precipitation per dry period. Total precipitation less important**
- **Net primary productivity limited by environment**
- **Fringe habitats**
- **Highly dependent on natural processes**
- **Environmental stratification creates high diversity**
- **Ephemeral habitats**
- **Sensitive to natural cycles- Susceptible to small environmental perturbation**
- **Most threatened ecosystem**

Threatened Dry Forest of the World

- Costa Rica
- Hawaii
- Madagascar
- Puerto Rico
- South America
- Australia
- Ecuador
- Mexico
- Peru
- Bolivia
- Panama
- Nicaragua
- West Africa
- India



Eccentricity Cycle

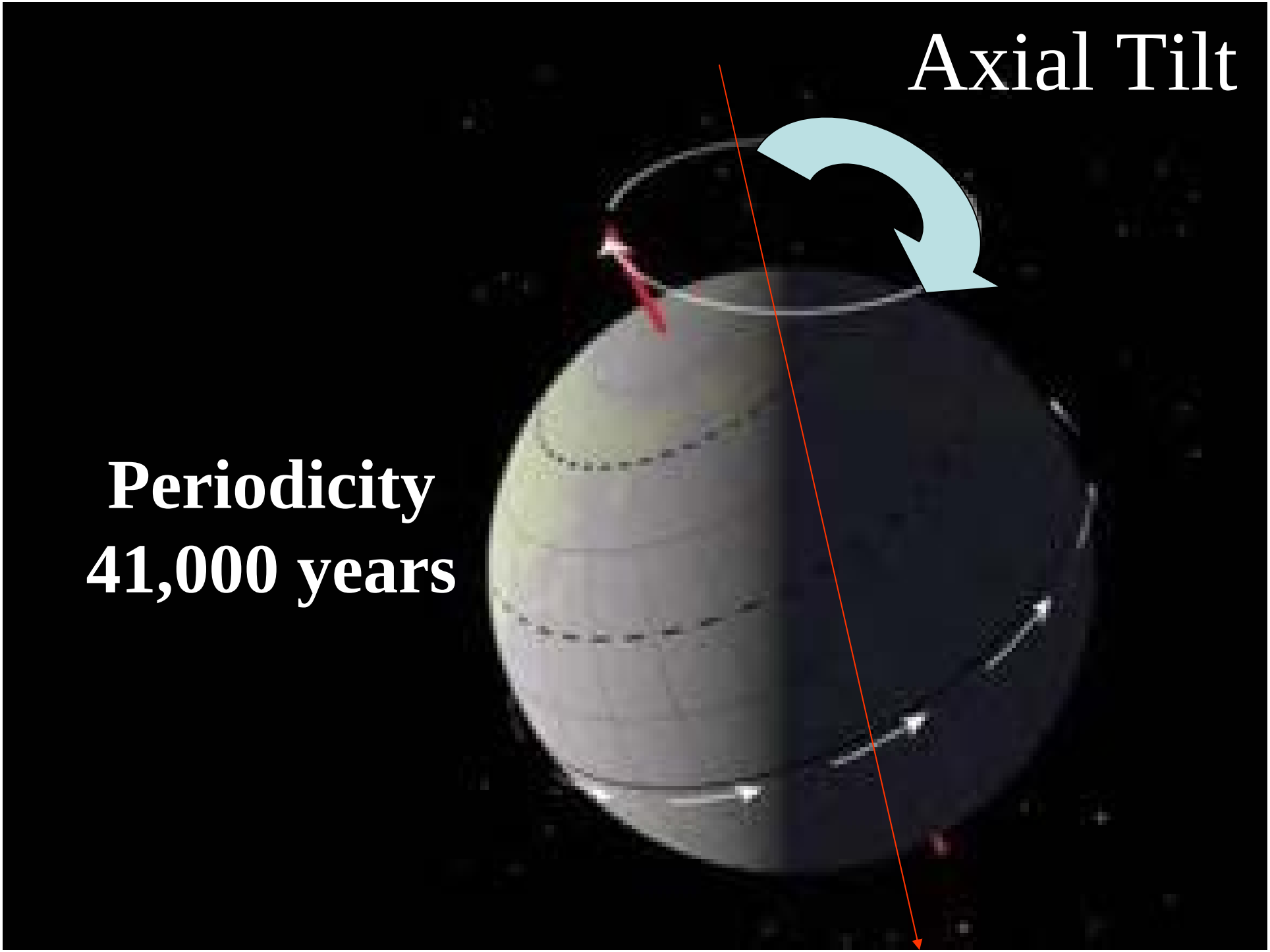


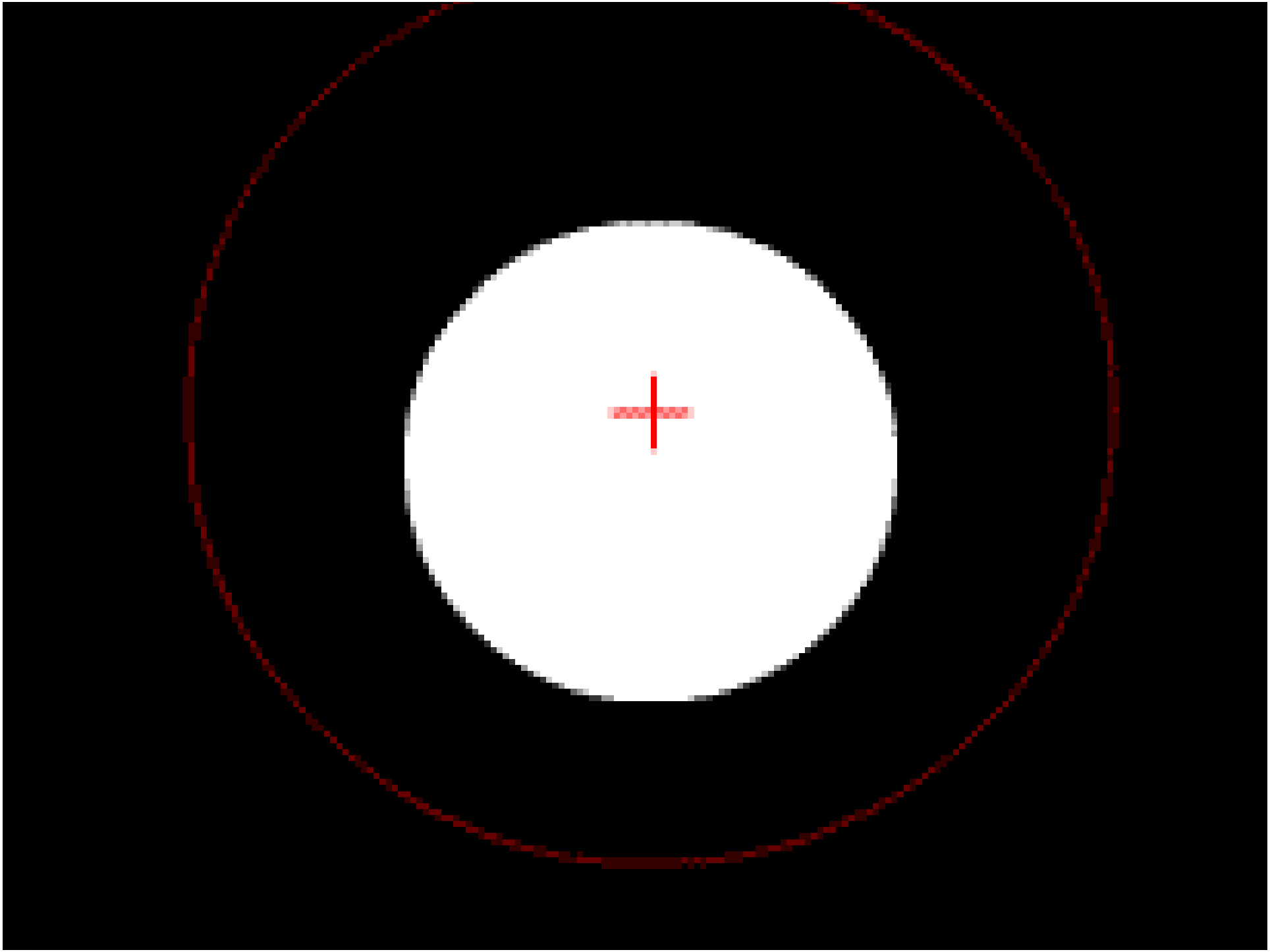
30% difference in solar radiation

6% difference in solar radiation

PERIODICITY:

100,000 YEARS


Axial Tilt
Periodicity
41,000 years



Axial Tilt

Obliquity of the Ecliptic

Periodicity
41,000 years

23.5^0 Today

(going toward less tilt)

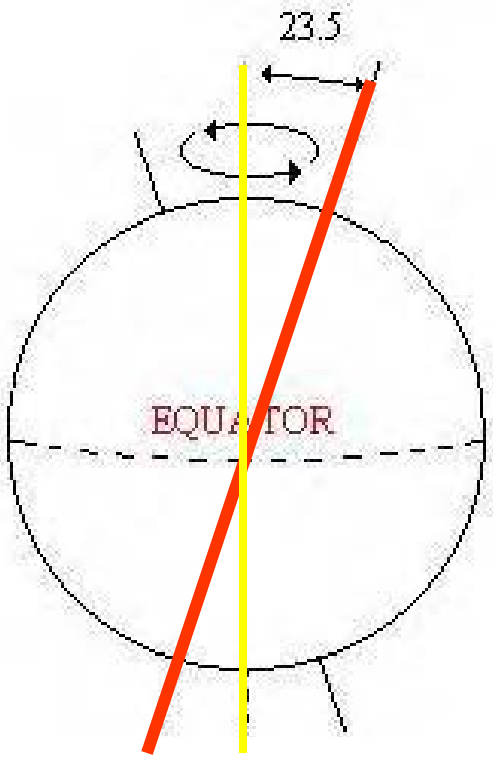
Less to more tilt increases and decreases the radiation difference between equator and poles

Cooler summers – Less melting

Increased moisture – Greater snow fall

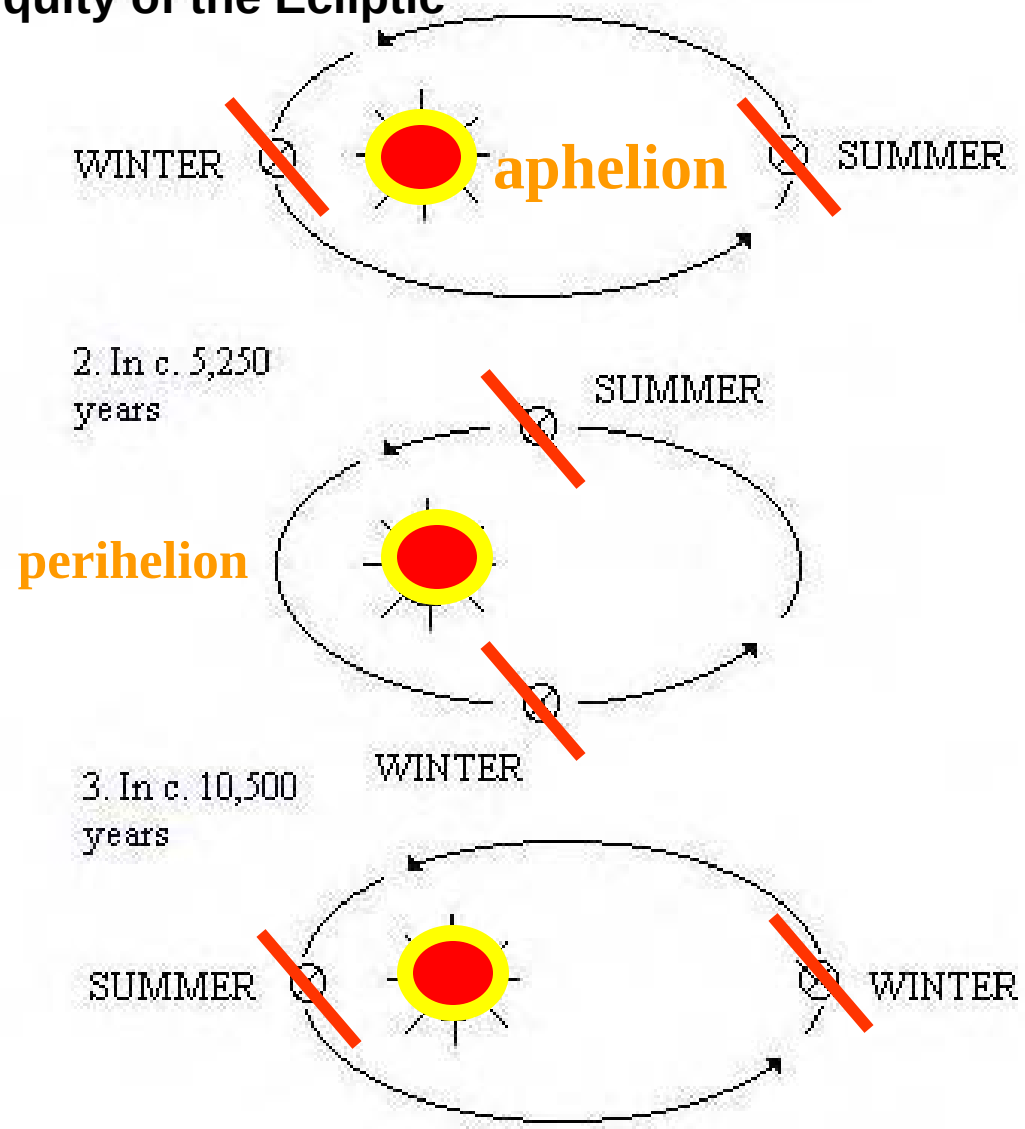
Precession Cycle

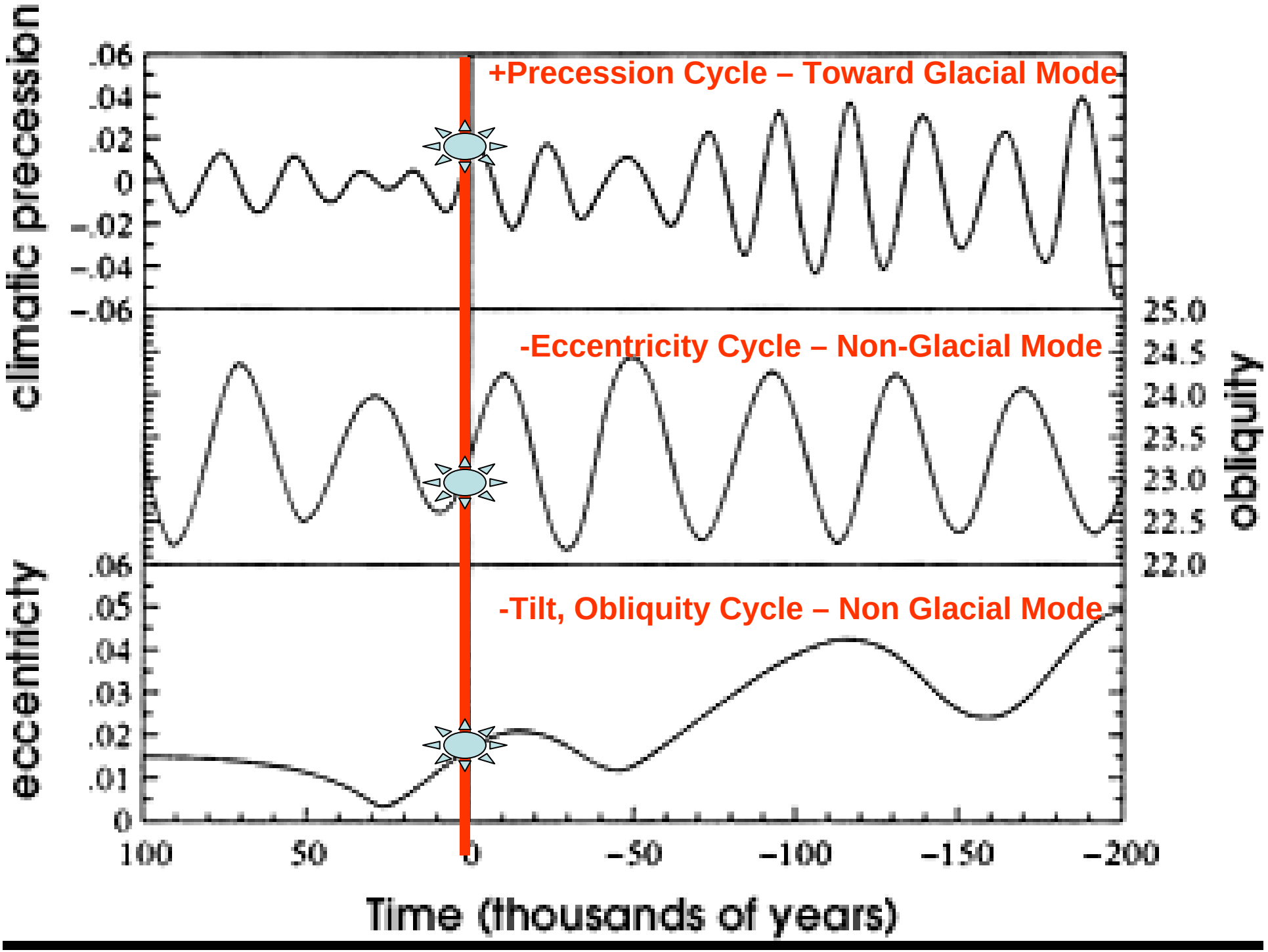
Precession relative to Obliquity of the Ecliptic

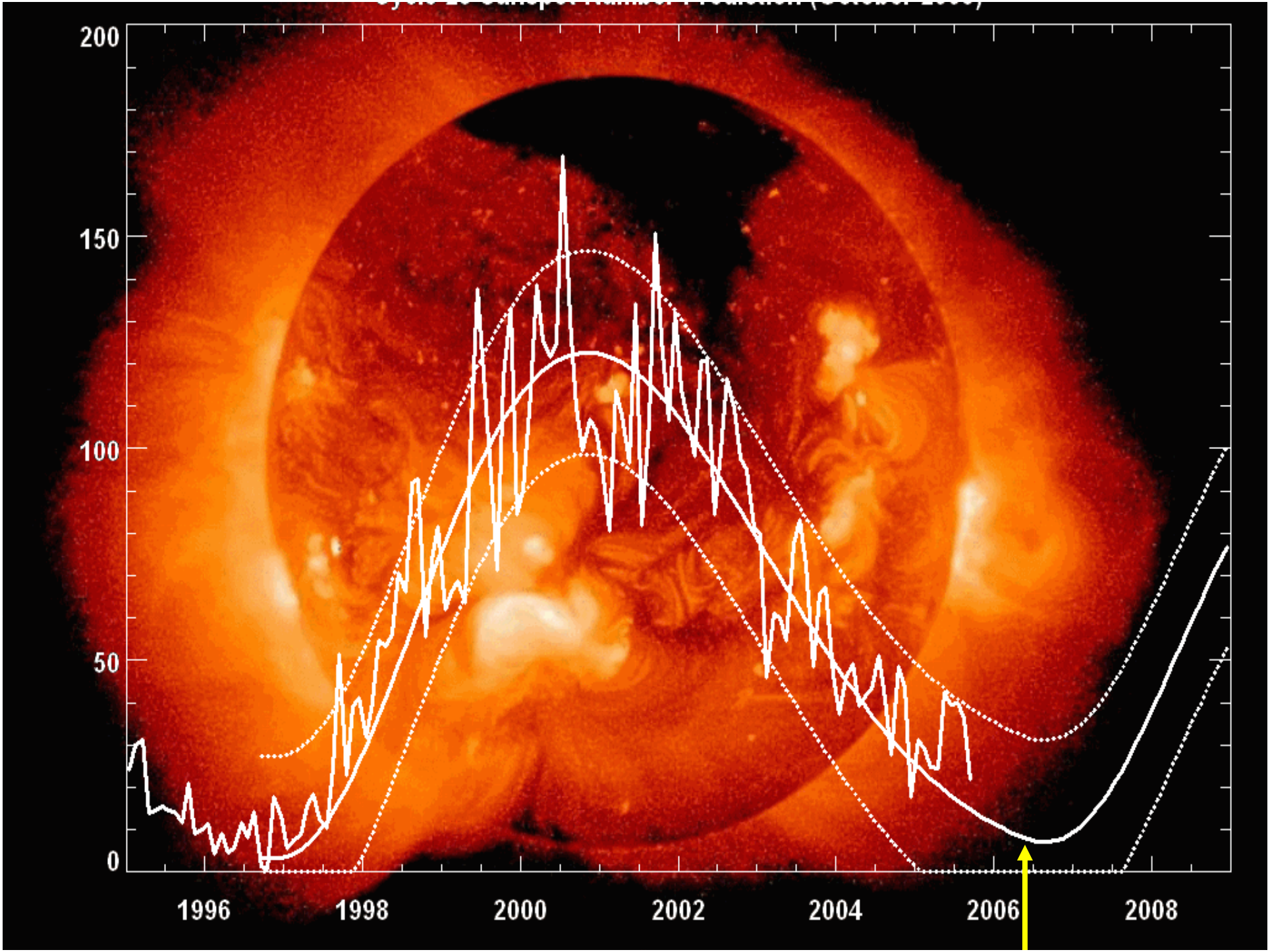


Periodicity

25,800 Years

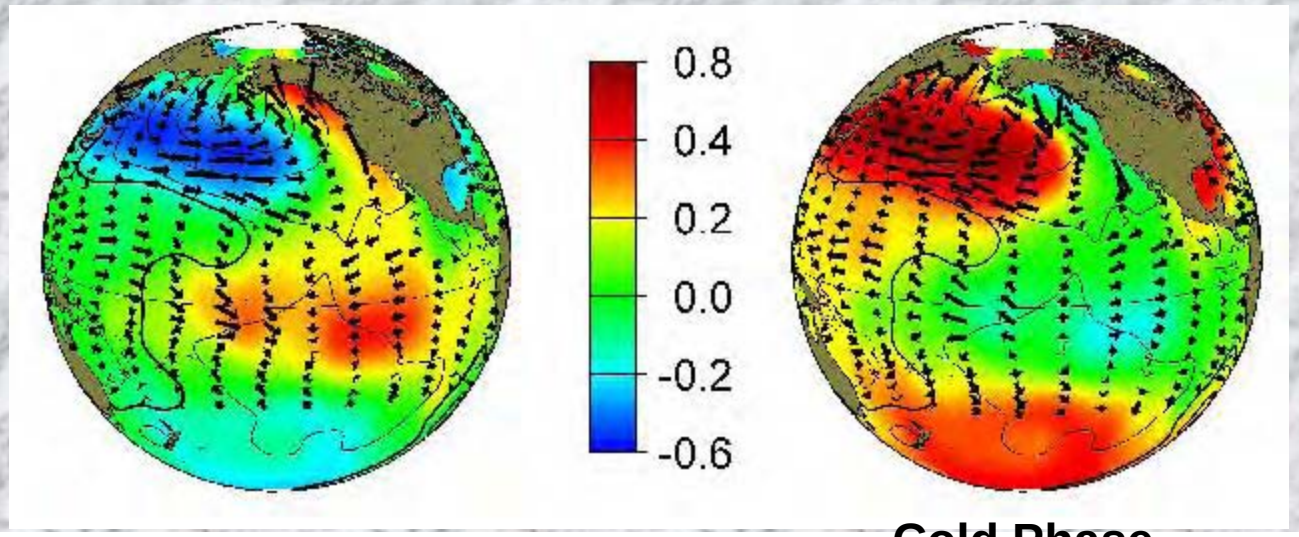


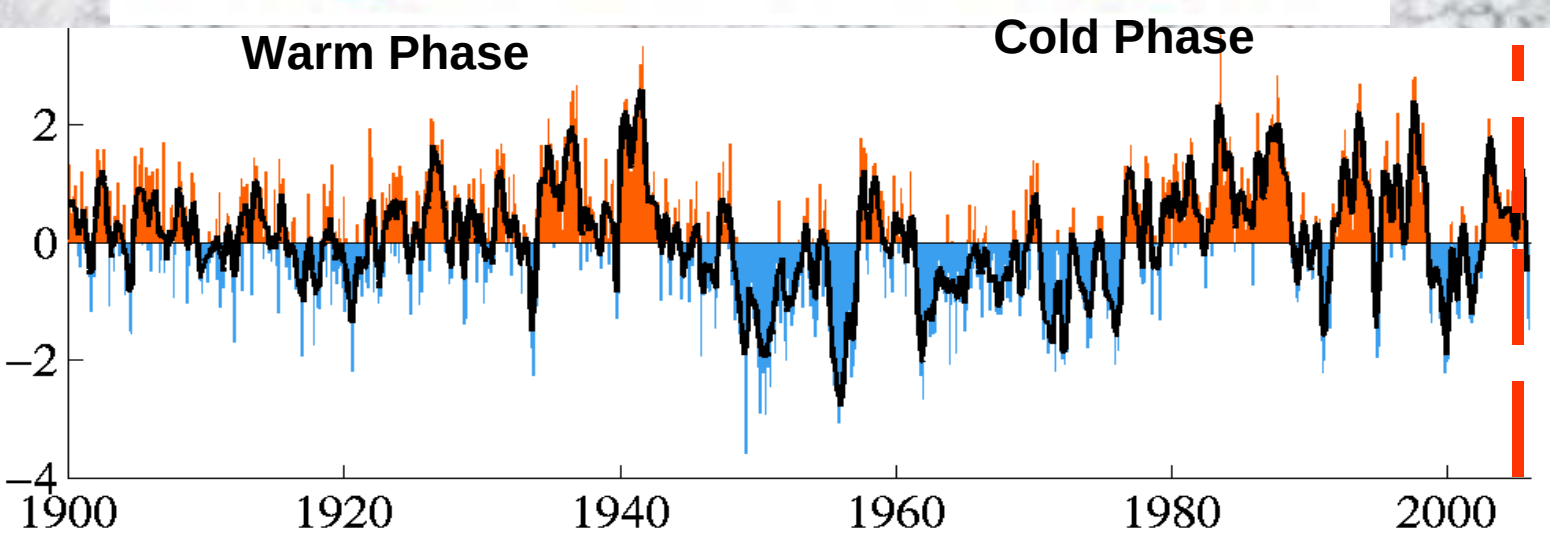

+Precession Cycle – Toward Glacial Mode
-Eccentricity Cycle – Non-Glacial Mode
-Tilt, Obliquity Cycle – Non Glacial Mode
climatic precession
.06
.04
.02
0
-.02
-.04
-.06
eccentricity
.06
.05
.04
.03
.02
.01
0
obliquity
25.0
24.5
24.0
23.5
23.0
22.5
22.0
100
50
0
-50
-100
-150
-200
Time (thousands of years)

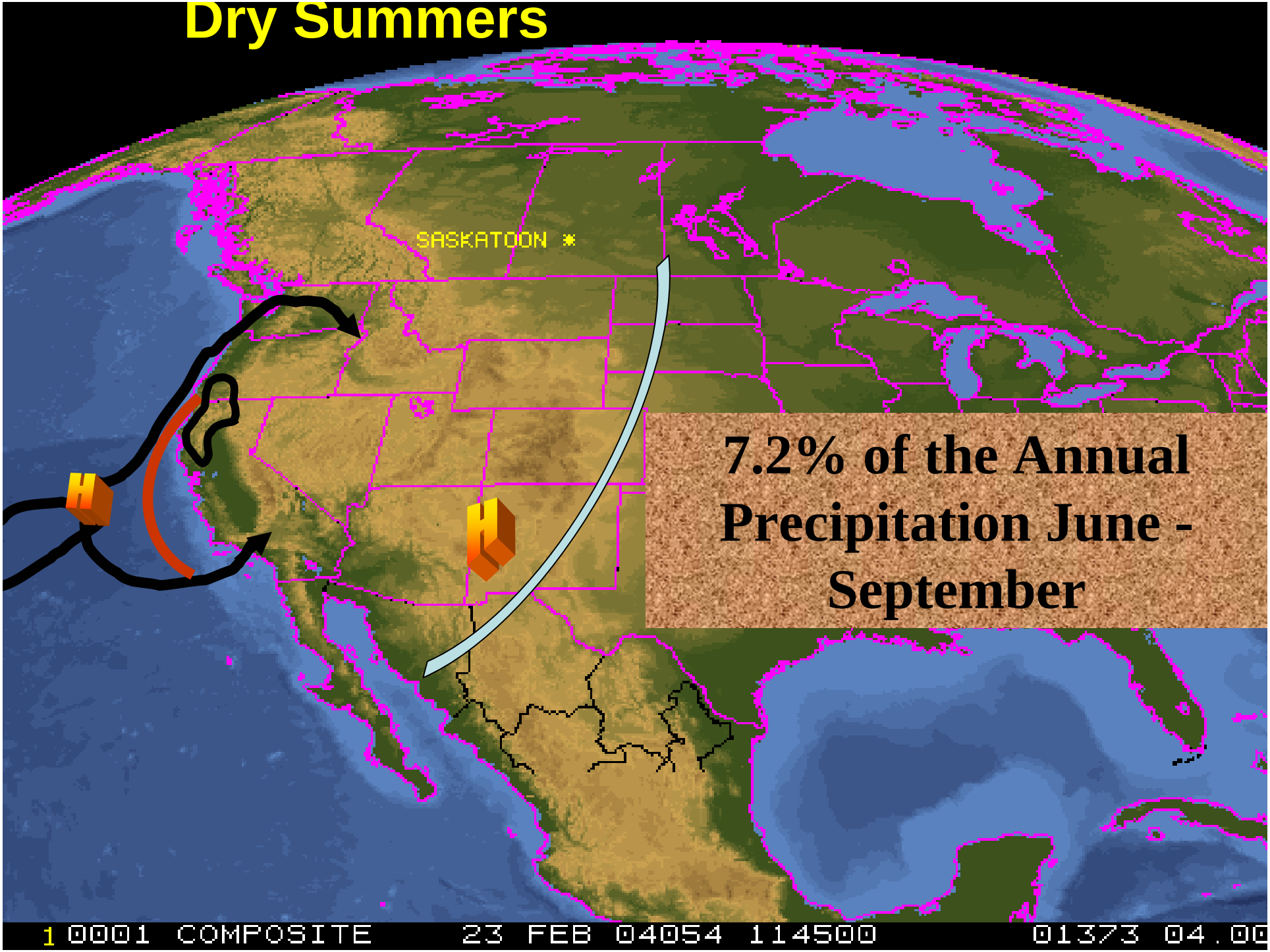

200
150
100
50
0
1996
1998
2000
2002
2004
2006
2008

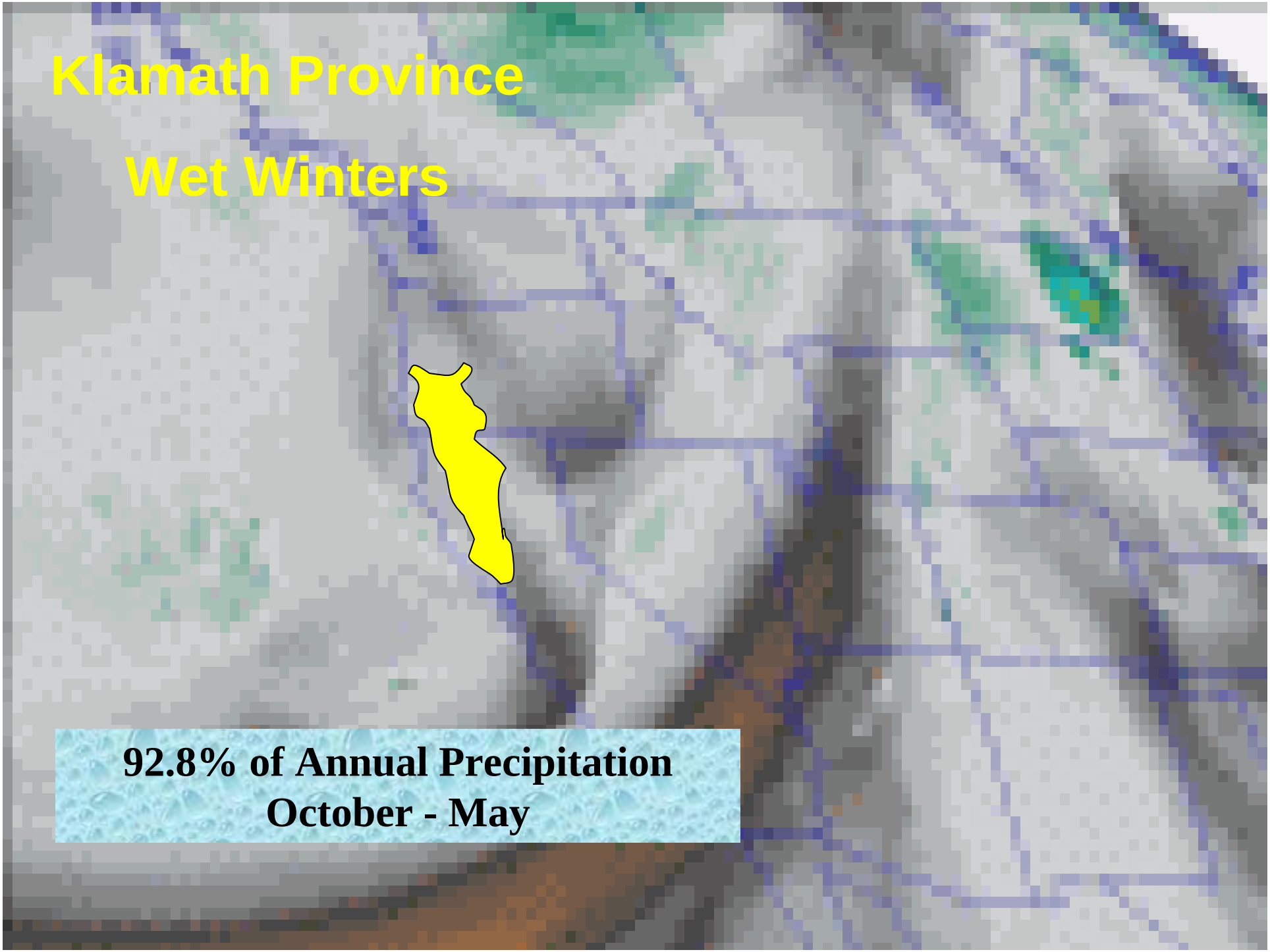
The Pacific Decadal Oscillation (PDO)

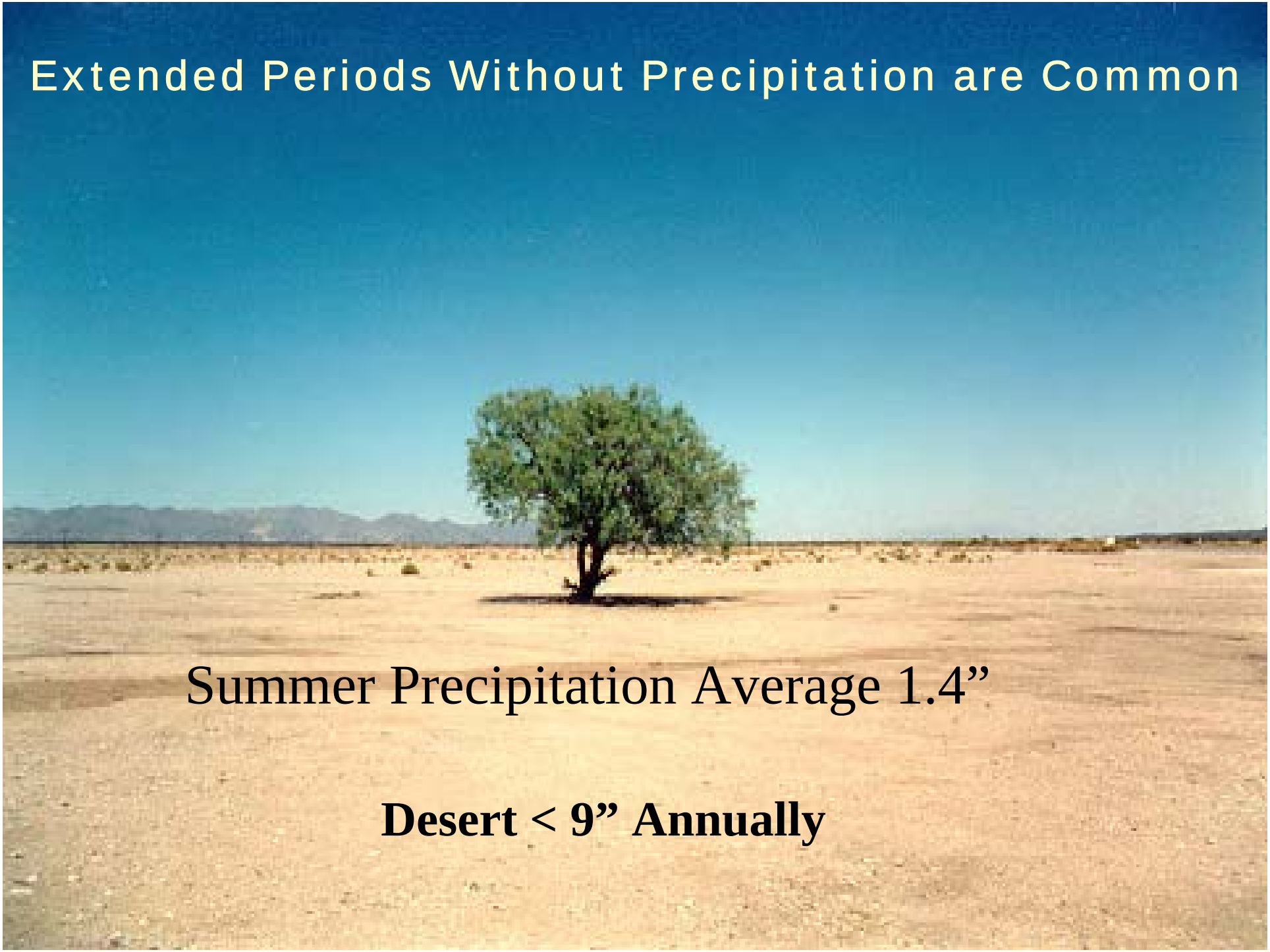
-Typical wintertime Sea Surface Temperature (colors)
-Sea Level Pressure (contours)
-Windstress (arrows)






Dry Summers
SASKATOON
H
H
7.2% of the Annual Precipitation June - September
1 0001 COMPOSITE 23 FEB 04054 114500 01373 04.00


Klamath Province
Wet Winters
92.8% of Annual Precipitation
October - May

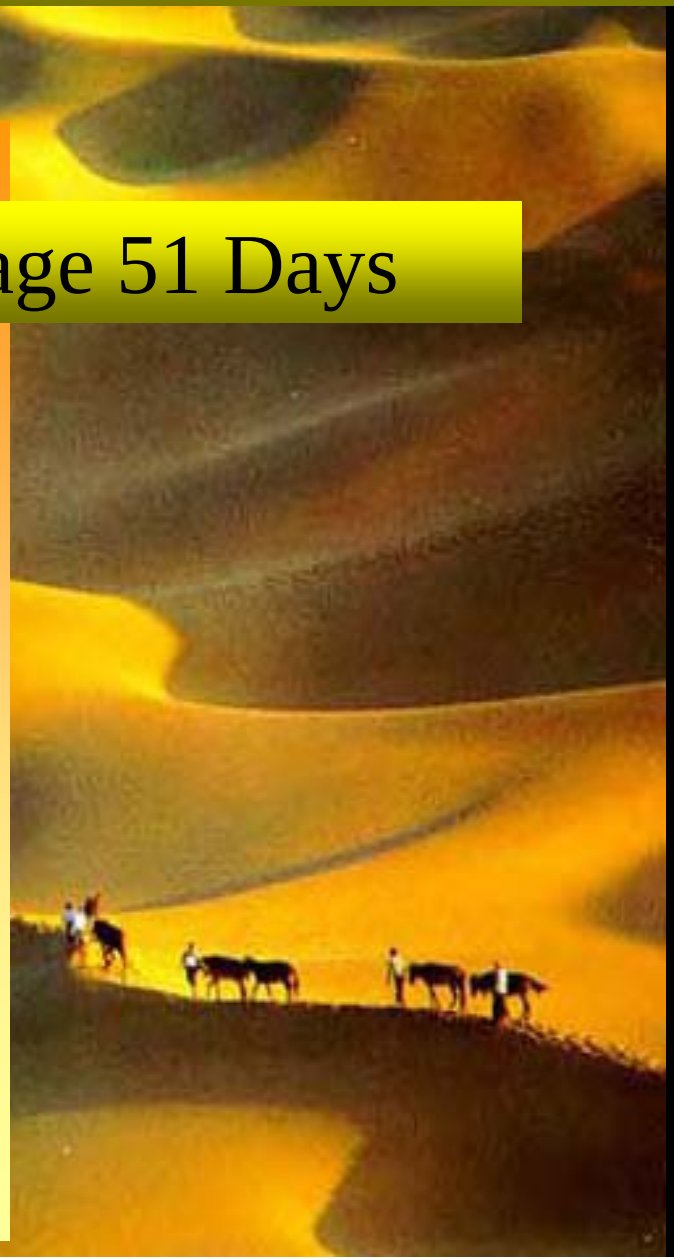

Extended Periods Without Precipitation are Common
Summer Precipitation Average 1.4”
Desert < 9” Annually

Extended Periods Without Precipitation are Common

Consecutive Days Without Precipitation

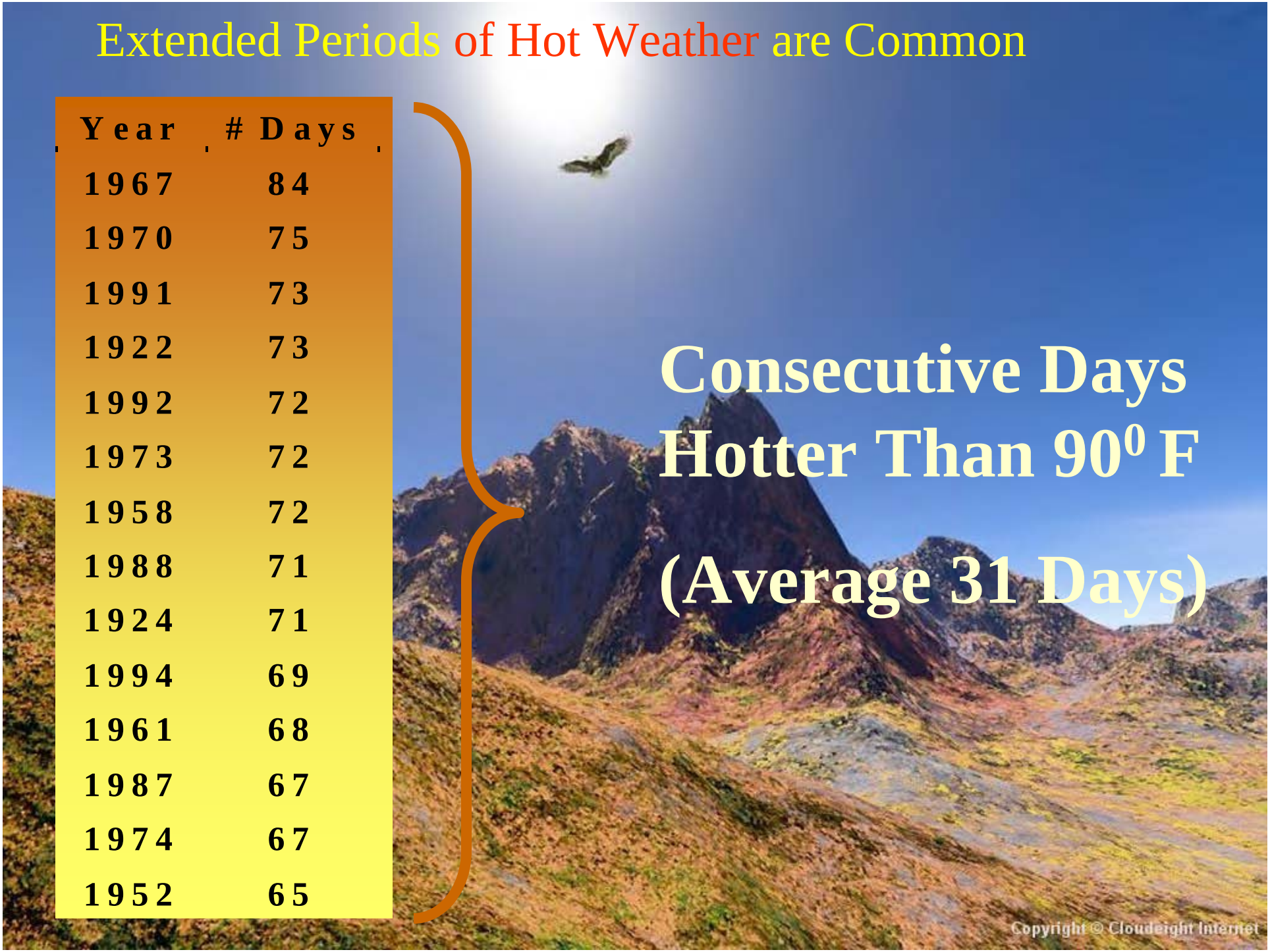
Year	# Days	Date	
1929	112	Jun 16	Oct 5
1951	107	May 14	Aug 28
1974	102	Jul 9	Oct 19
1949	99	Jun 1	Sep 7
1987	98	Jul 25	Oct 31
1998	93	Jun11	Sep24
1950	91	Jun 17	Sep 15
2003	81	May 13	Aug 1

Average 51 Days



Extended Periods of Hot Weather are Common

Year	# Days
1967	84
1970	75
1991	73
1922	73
1992	72
1973	72
1958	72
1988	71
1924	71
1994	69
1961	68
1987	67
1974	67
1952	65



Consecutive Days Hotter Than 90^0 F

(Average 31 Days)

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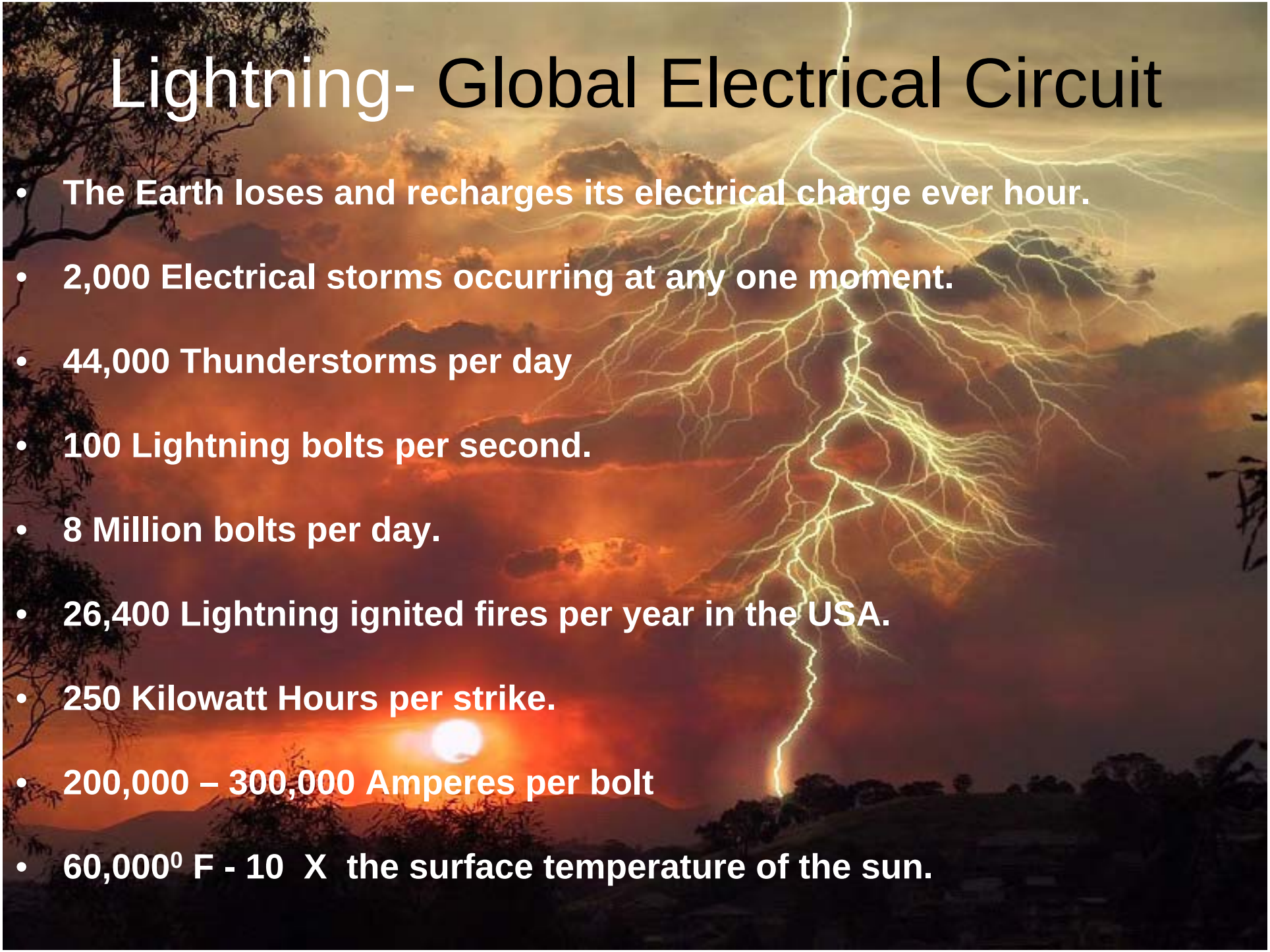
Short-Term Klamath Province Cycle

- Mild Winters, Higher Winter Precipitation
- Extended Hot Summers, Increasing
- Increasing Winter Temperatures
- Increasing Lightning Ignition
- Less Favorable for Coniferous Forest
- Shift to Early Seral Habitat
- Drying of Klamath Dry Forests
- Global Warming ?

Electrical
Gradient
Differential

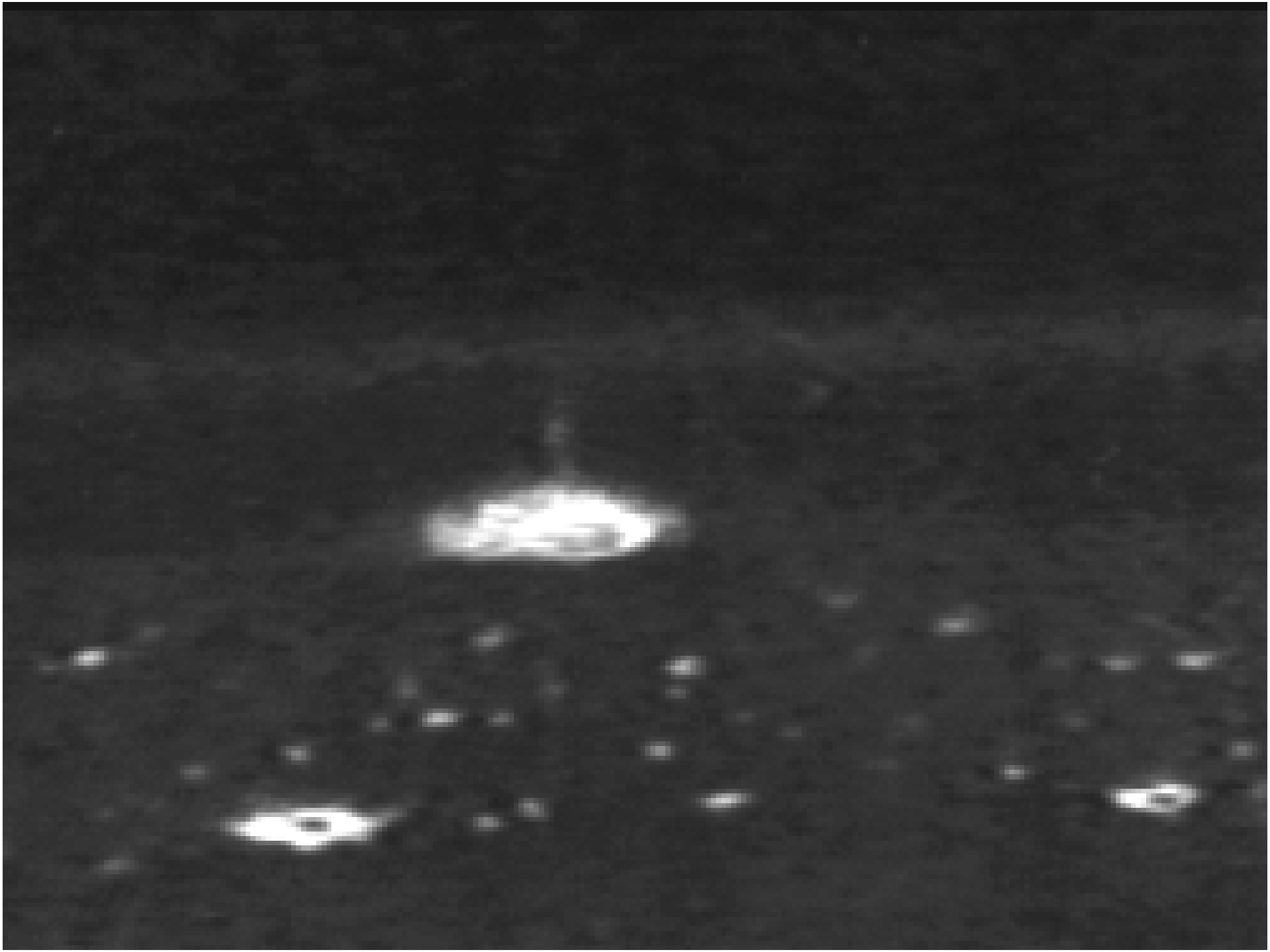
Electrification

Fire
an Ecological Force

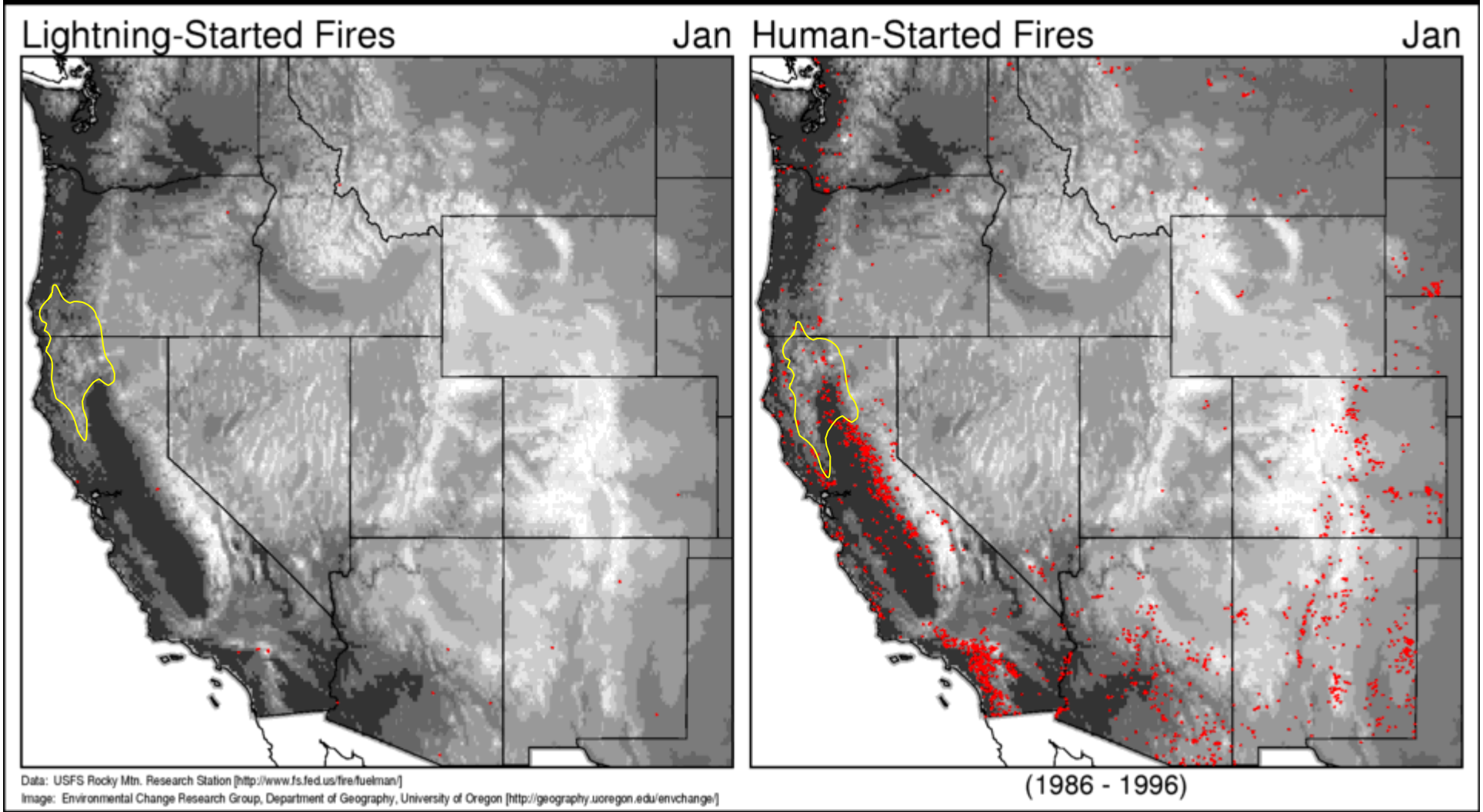


Lightning- Global Electrical Circuit

- **The Earth loses and recharges its electrical charge ever hour.**
- **2,000 Electrical storms occurring at any one moment.**
- **44,000 Thunderstorms per day**
- **100 Lightning bolts per second.**
- **8 Million bolts per day.**
- **26,400 Lightning ignited fires per year in the USA.**
- **250 Kilowatt Hours per strike.**
- **200,000 – 300,000 Amperes per bolt**
- **60,000^{0} F - 10 X the surface temperature of the sun.**



On earth, every 56 min. lightning generates enough electrical energy to propel the worlds largest ship around the earth



Data: USFS Rocky Mtn. Research Station [http://www.fs.fed.us/fire/fuelman/]
Image: Environmental Change Research Group, Department of Geography, University of Oregon [http://geography.uoregon.edu/envchange/]

Forest Type	Total Fire[1] Records	Total Fire[2] Scars	Trees Recording Single Scars	Trees Recording Multiple Scars	Composite[3] Fire Interval From Total Scars	Grouped Composite[4] Fire Interval From Total Scars Grouped +/- 3yrs	Point Frequency[5] Fire Interval From Individual Trees w / Multiple Scars	3 Longest Fire Free Periods From Total Scars Grouped +/- 3yrs	% of Decades Recording Fire From Total Scars Grouped +/- 3yrs
Cascade - mixed conifer	Complete History	Complete History	Complete History	Complete History	From 1700	From 1700	Complete History	From 1700	From 1700
			55	13	5 (1-20)		50 (22-114)	20,15,15	
			99	19	3 (1-16)		43 (19-155)	16,11, 9	
			42	8	8 (1-30)		(33-203)	30,17,14	
			22	2	10 (3-24)		(40-47)	24,17,16	
Willow Creek	24	29	32	6	9 (1-22)		(20-103)	22,19,16	
total	246	441	23	3	9 (1-29)		6 (106-180)	29,19,18	
	ave. 41	**ave. 73**	273	51					
	SE 10.0	SE 21.8	**ave. 45**	**ave. 8**	**ave. 7yrs**	**ave. 11yrs**	**ave. 69yrs**	**Range**	
			SE 11.8	SE 2.6	SE 1.1	SE 0.9	SE 16.2	9 to 30	SE 8.5
Siskiyou - mixed evergreen									
Glade Creek	55	134	78	17	4 (1-13)		45 (12-309)	15,12,12	
			53	6	5 (1-25)		46 (17-98)	25,18,17	
			32	4	6 (1-32)		5 (14-53)	22,21,13	
			72	9	5 (1-26)		4 (15-82)	26,20,19	
			44	3	5 (1-27)		9 (25-47)	27,27,24	
	18	31	21	4	6 (2-27)		43 (22-72)	35,29,13	
total	201	443	300	43					
	ave. 35	**ave. 73**	**ave. 50**	**ave. 9**	**ave. 6yrs**		**ave. 39yrs**	**Range**	
	SE 19.8	SE 16.5	SE 9.1	SE 2.2	SE 0.7	SE 0.8	SE 3.2	12 to 35	SE 7.3
Mid-Coast - tanoak/Douglas-fir									
Dulog Creek	11	16	12	2	17 (4-42)		30 (20-39)	51,21,22	
			33	7	8 (1-38)		56 (17-161)	38,22,14	
			19	3	7 (1-5)		80 (5-152)	50,16,14	
			37	7	7 (1-2)		31 (17-49)	19,18,18	
			35	14	5 (1-2)		45 (11-140)	21,15,11	
	35	83	57	12	6 (1-28)		63 (15-145)		
total	164	319	193						
	ave. 27	**ave. 53**	**ave. 32**			12yrs	**ave. 51yr**		
	SE 3.9	SE 9.0	SE 6.4			1.8	SE 7.9		

Cascade

11 yrs

67 %

Siskiyou

12 yrs

68 %

Mid-Coast

12 yrs

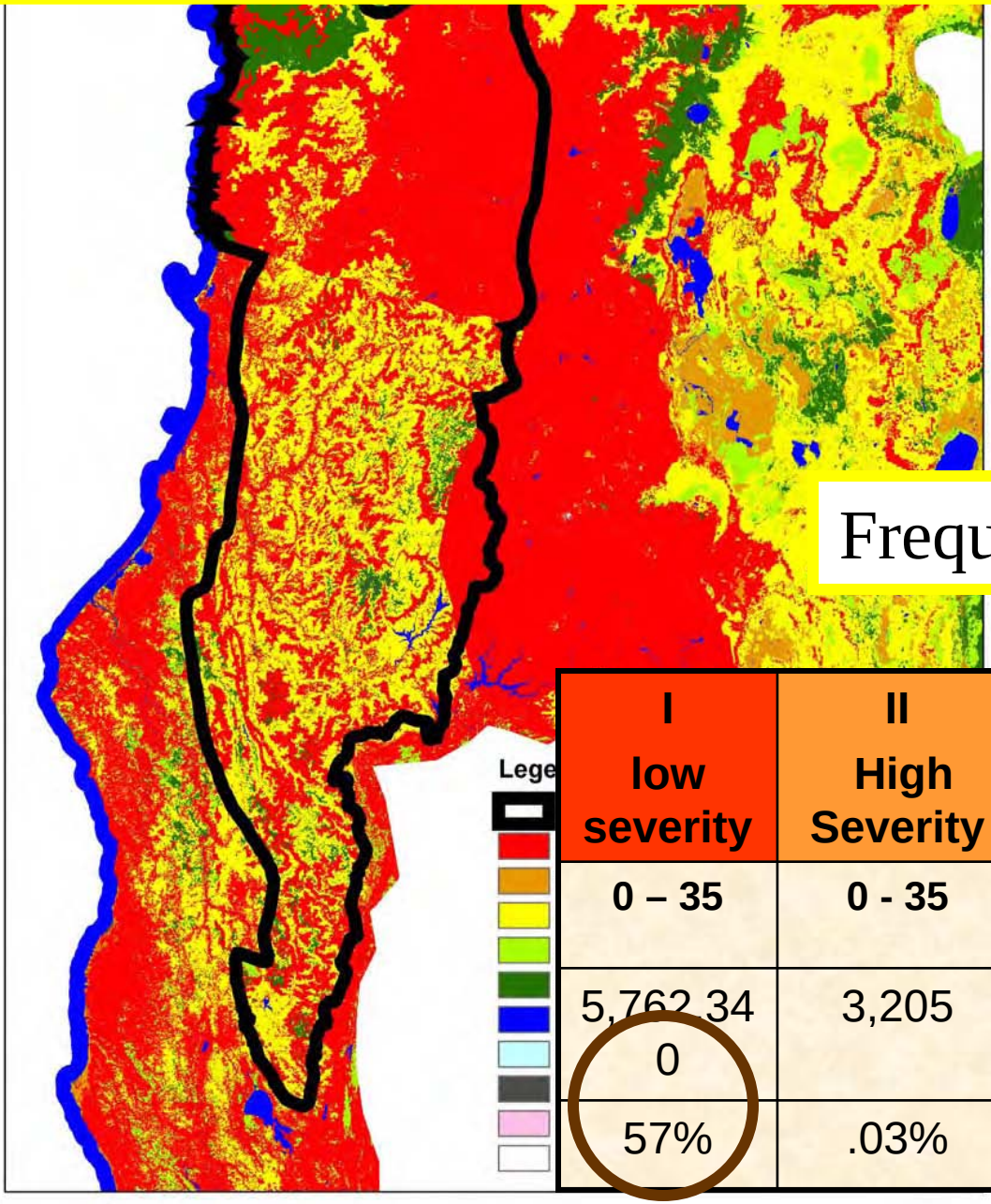
63 %

Fire History

Fire in Old-Growth Averaged 12 Years

Fire in Old-Growth 65% of the Decades

Klamath Province Historic Fire Regimes



10,089,703 acres

Frequency in Years

I low severity	II High Severity	III	IV	V
0 – 35	0 - 35	35 -100	35 – 100+	200 - +
5,762,340	3,205	3,551,674	52,710	645,745
57%	.03%	35%	.52%	6.4%

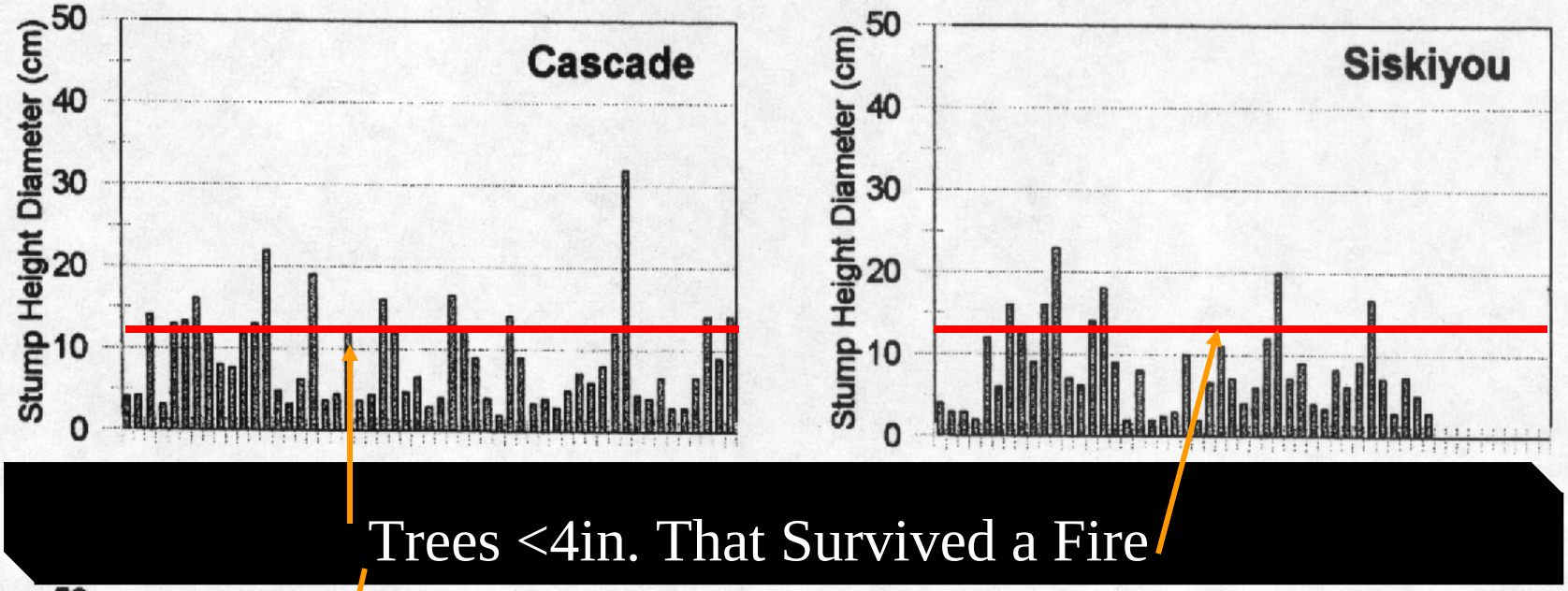
Klamath Province
Temperate Coniferous Forest

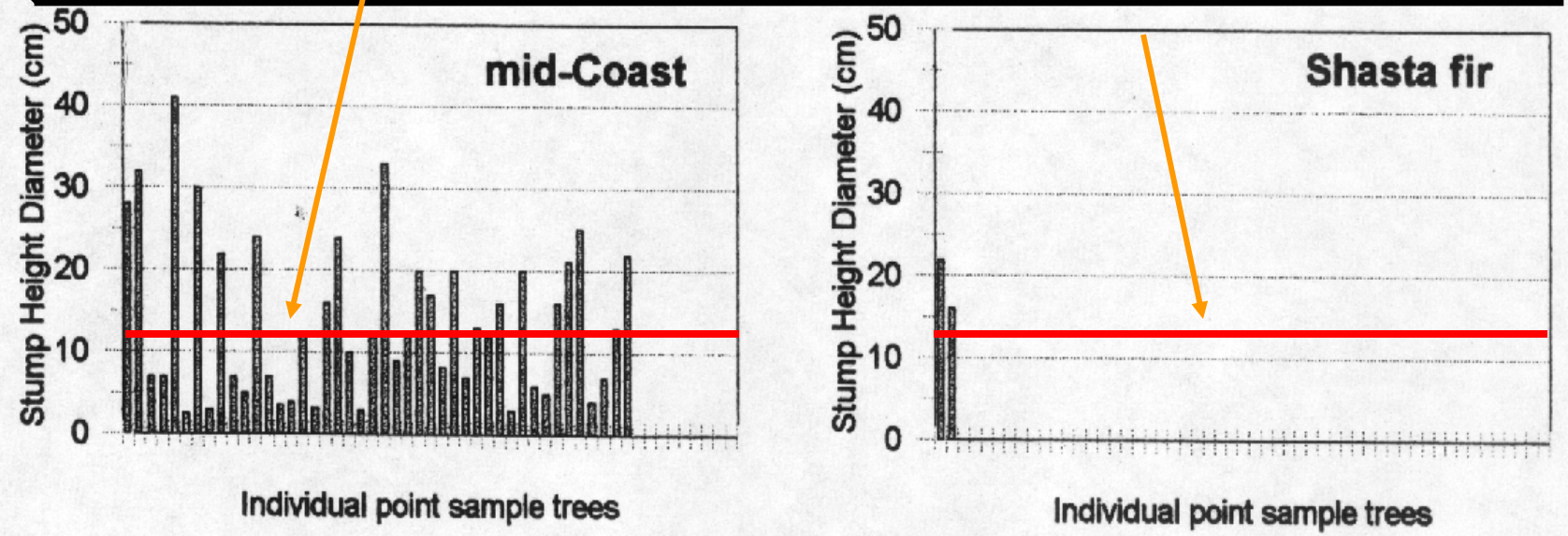
- **3,500 native plants species**
- **280 Plant Species Endemic to Klamath-Siskiyou**
- **4th richest temperate coniferous forests in the world (Sichuan, China, Russian Far East)**
- **85 Serpentine Plant Species**
- **30 Conifer Species (17 tree species in one sq. mi)**
- (world record occurs in Amazonian 473 tree species on a single hectare)

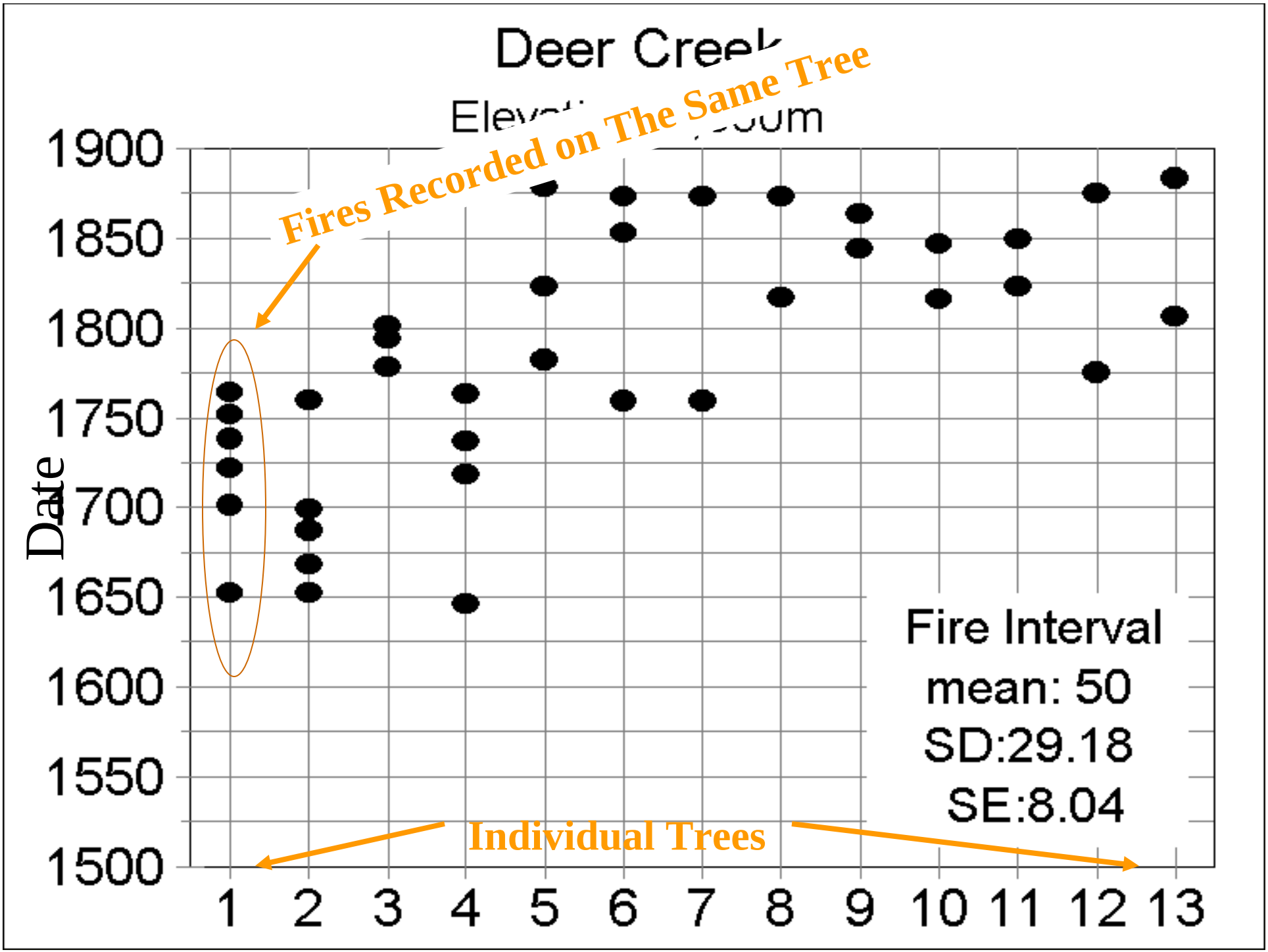
Notable Species

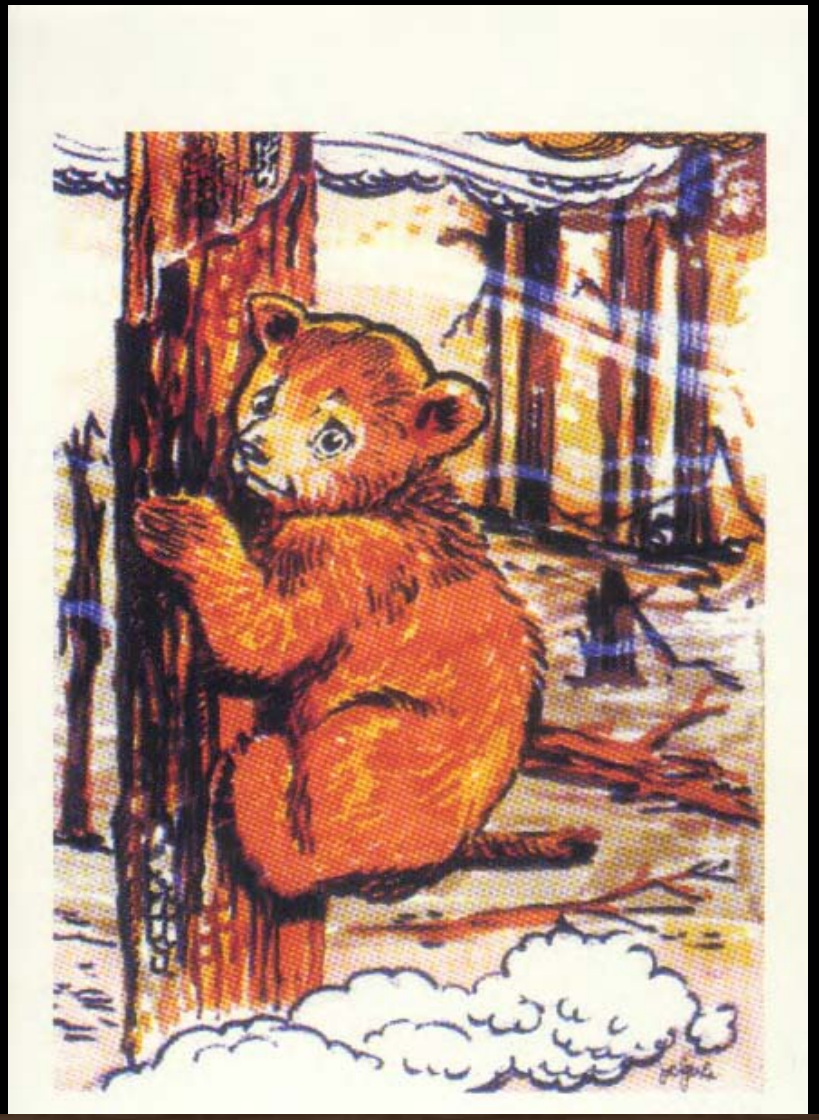
- Bald eagle
- Marbled murrelet
- Northern goshawk
- Coho salmon
- Tailed frog
- Pacific fisher
- Freshwater mussels.
- Pine marten
- Lost River sucker
- Short-nose sucker
- Miller Lake lamprey (extinct ?)
- Numerous rare snails

Size of Trees Surviving Multiple Fires At The Time Of First Fire

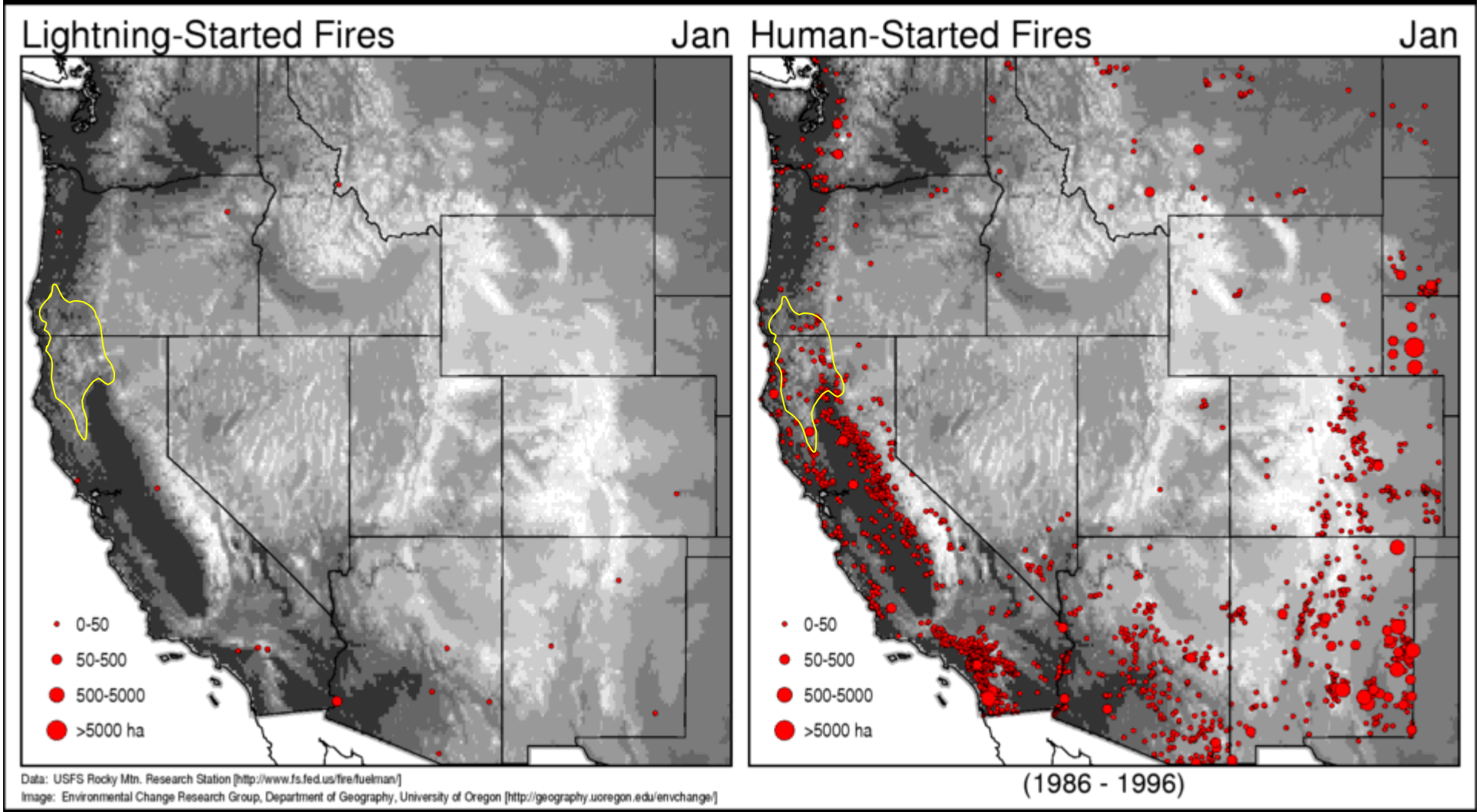


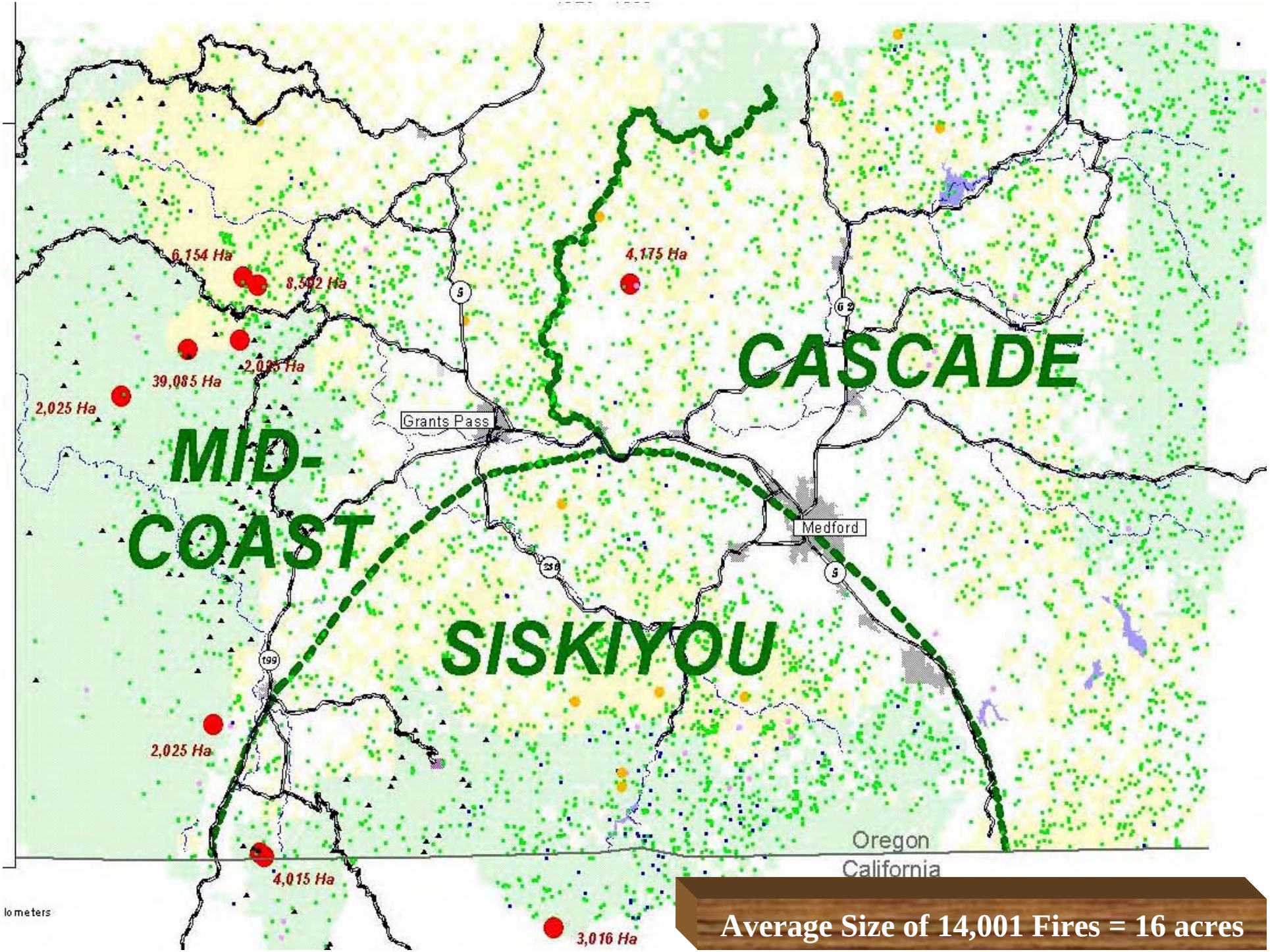



Deer Creek
Fires Recorded on The Same Tree
Date
1900
1850
1800
1750
1700
1650
1600
1550
1500
1 2 3 4 5 6 7 8 9 10 11 12 13
Individual Trees
Fire Interval
mean: 50
SD:29.18
SE:8.04



Active fire suppression began in about 1900 and has been extremely effective.

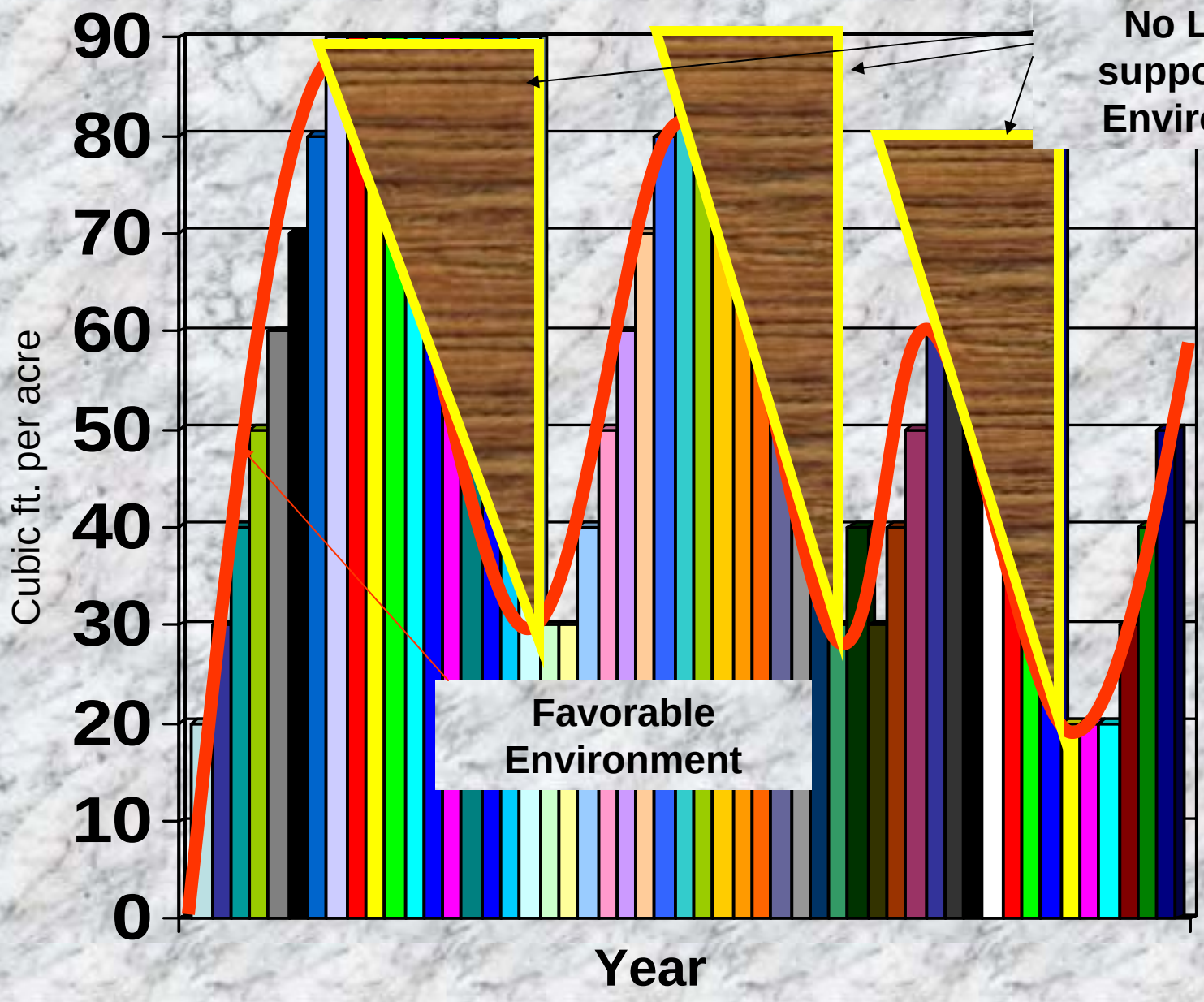

Lightning-Started Fires
Jan
0-50
50-500
500-5000
>5000 ha
Human-Started Fires
Jan
0-50
50-500
500-5000
>5000 ha
(1986 - 1996)
Data: USFS Rocky Mtn. Research Station [http://www.fs.fed.us/fire/fuelman/]
Image: Environmental Change Research Group, Department of Geography, University of Oregon [http://geography.uoregon.edu/envchange/]



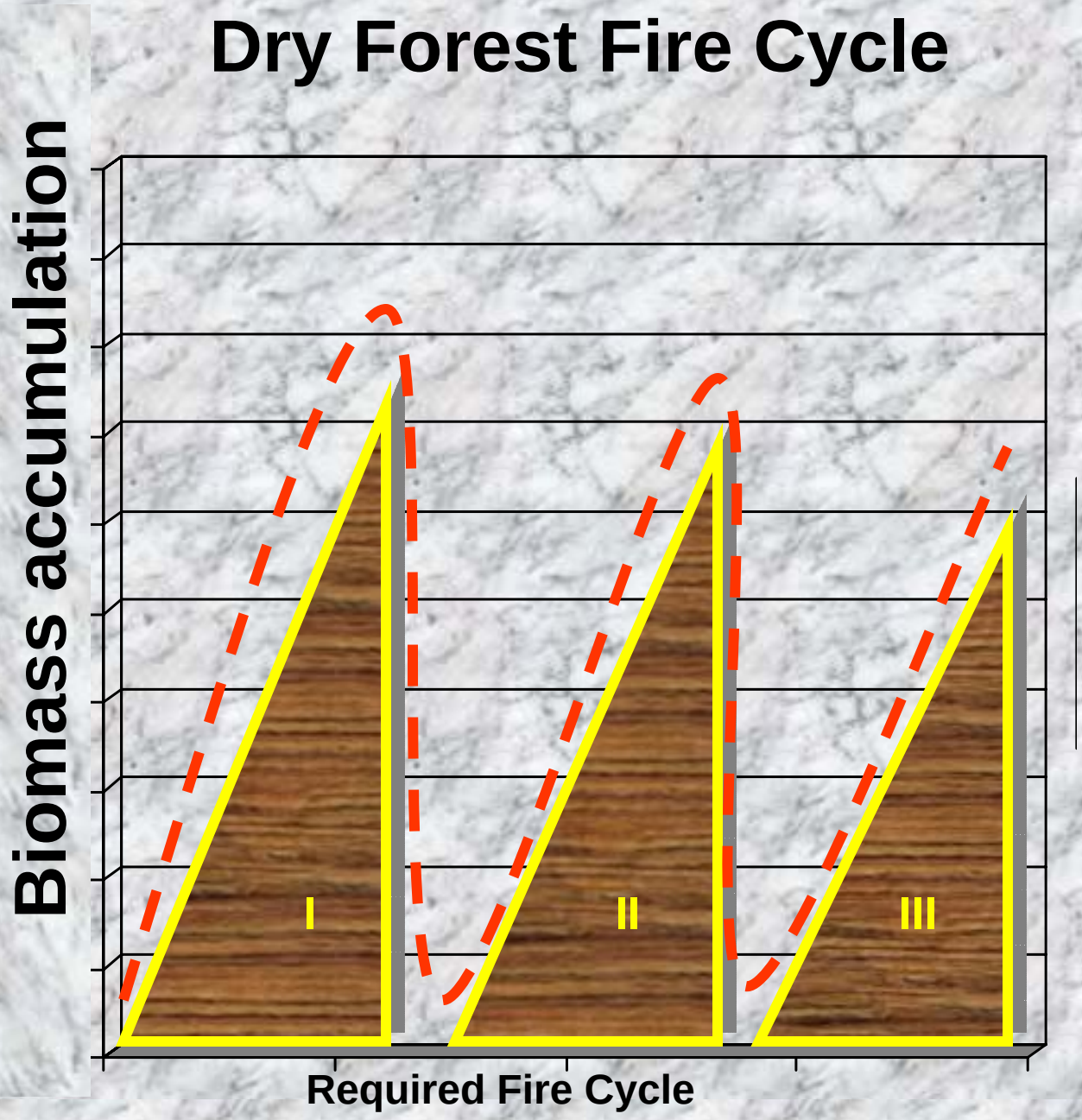
Average Size of 14,001 Fires = 16 acres

Dry Forest

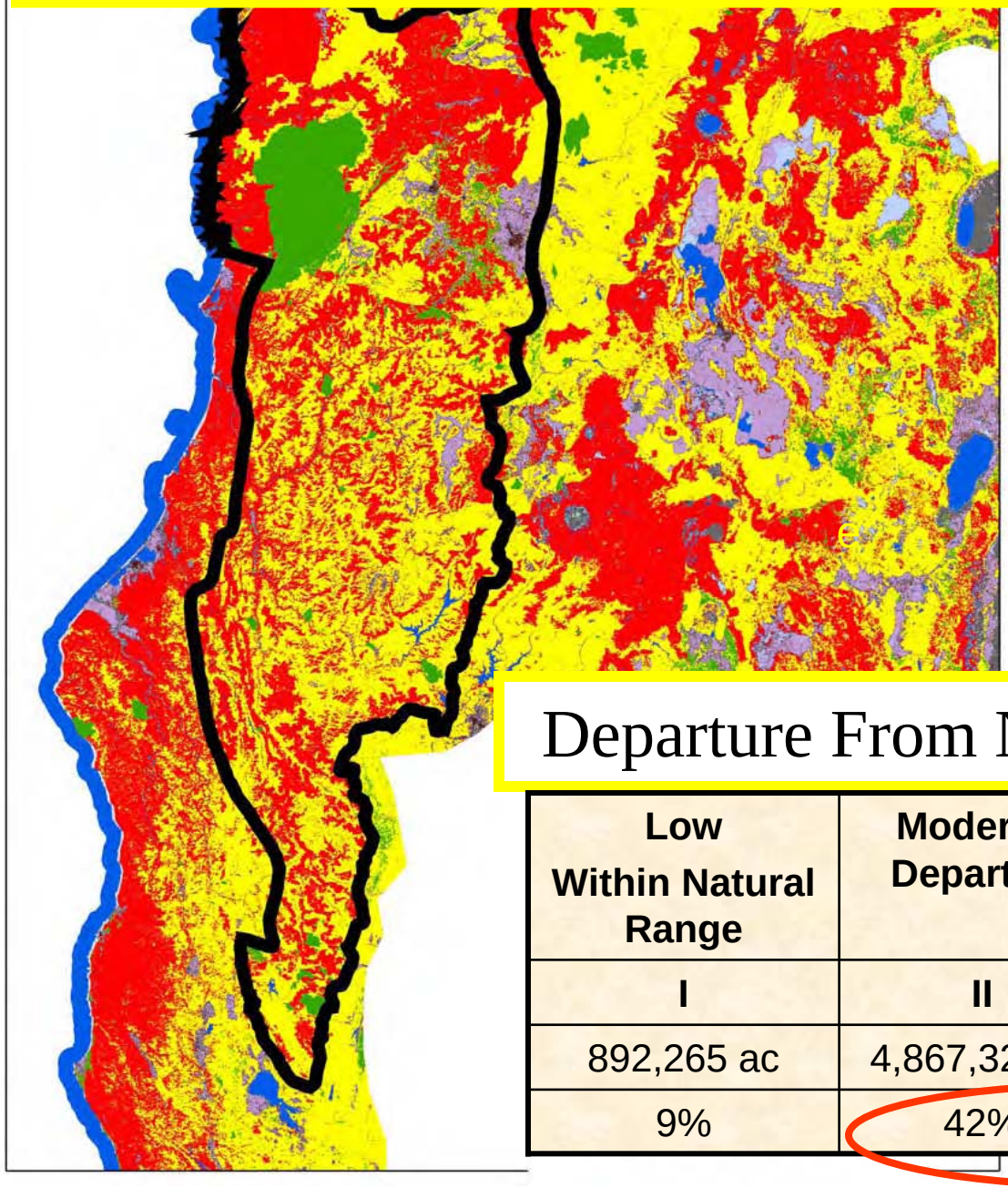
Cycles in Productivity Force Out Biomass in pulses



Dry Forest Fire Cycle



Klamath Province Fire Regime Condition Class



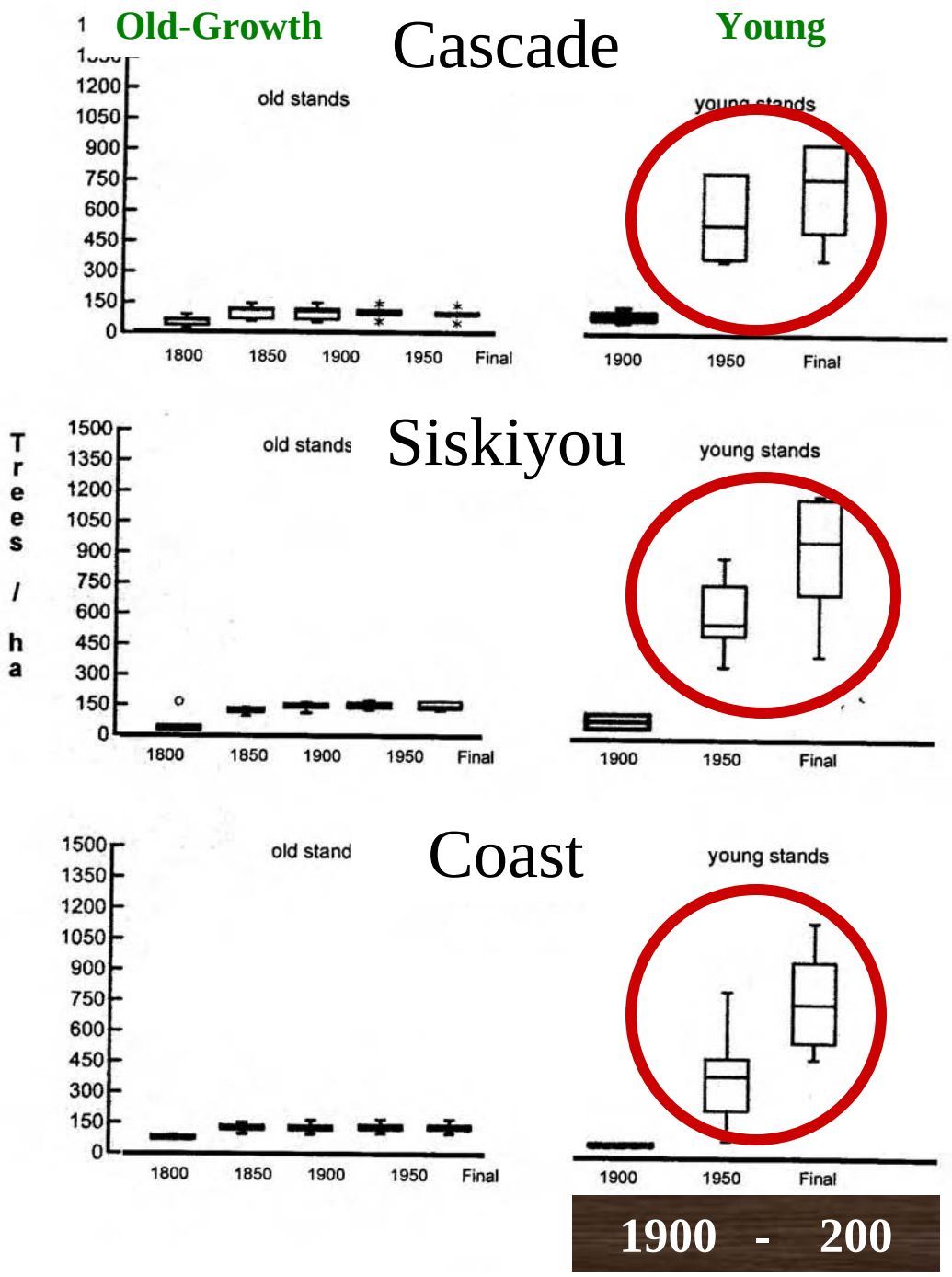
10,089,703 acres

8.8 Million Acres in I & II

Departure From Natural Range

Low Within Natural Range	Moderate Departure	High Departure
I	II	III
892,265 ac	4,867,327 ac	3,919,286 ac
9%	42%	39%

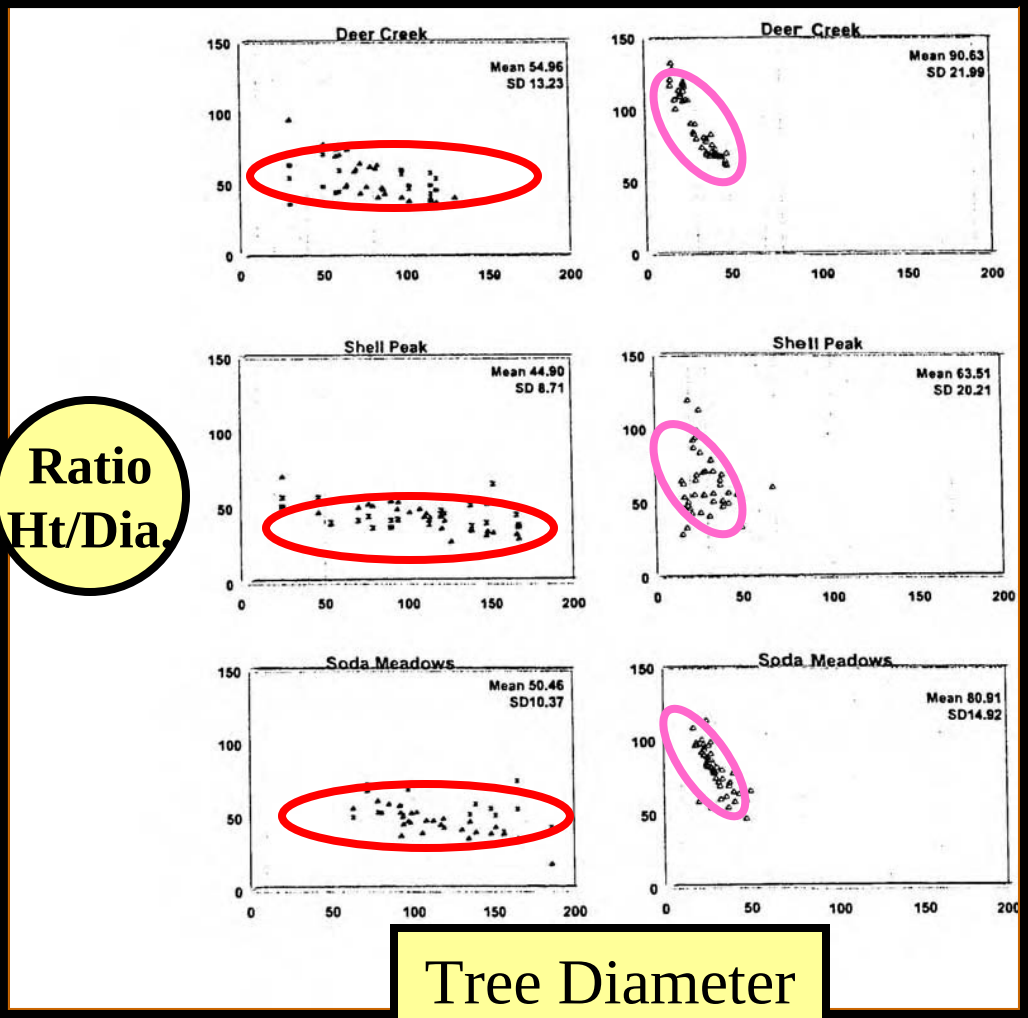
Old-growth

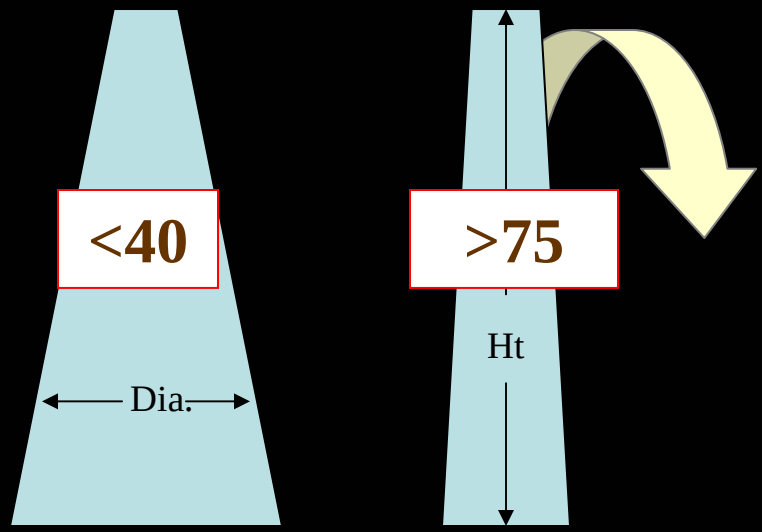


Trees per Hectare

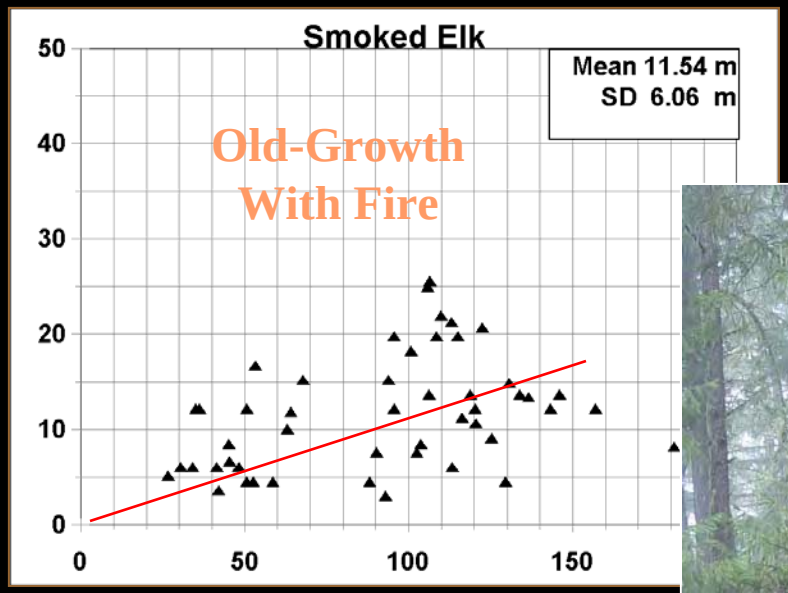
When Did The Forests Become So Dense ?

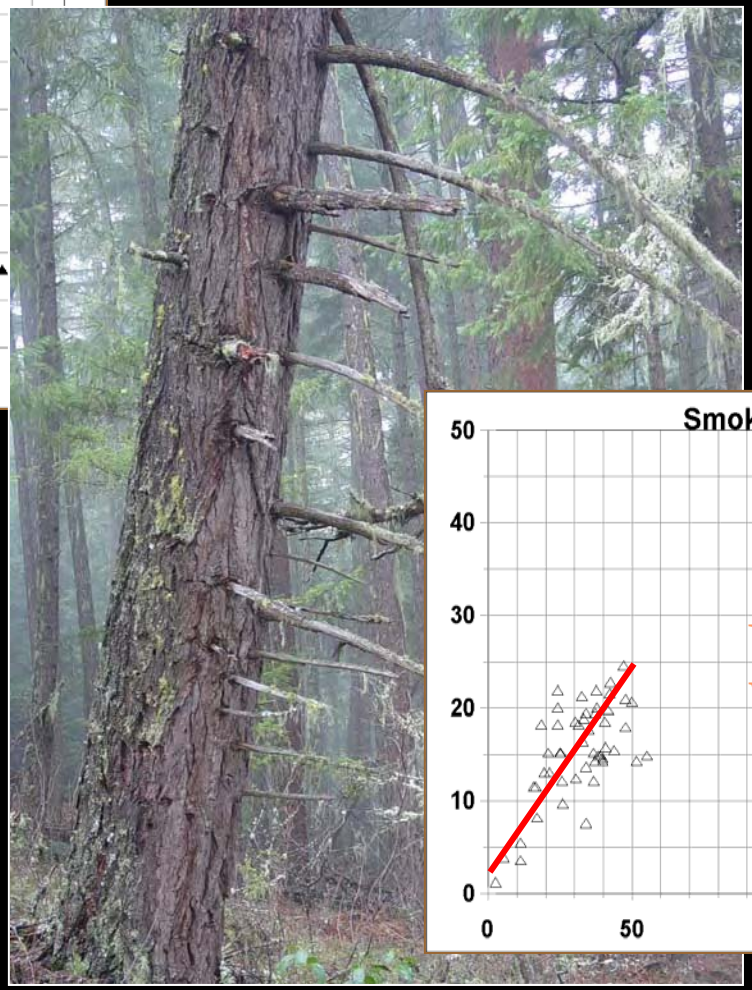
Ratio of Tree Height to Diameter

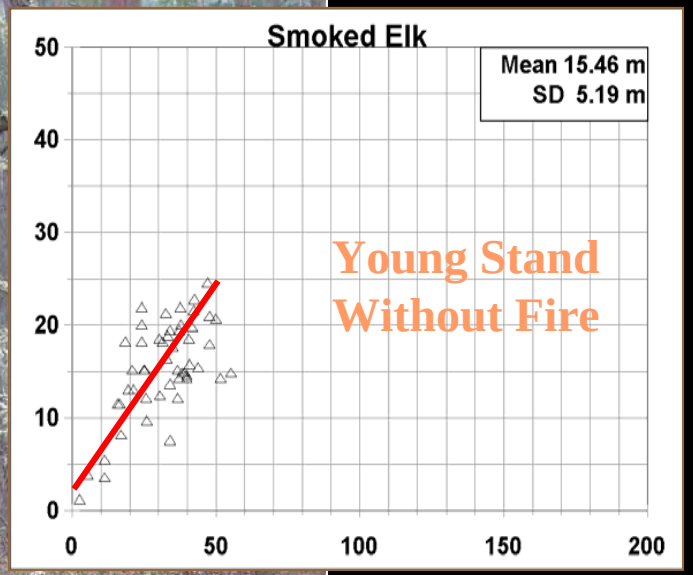




Height of the Lowest Live Limb

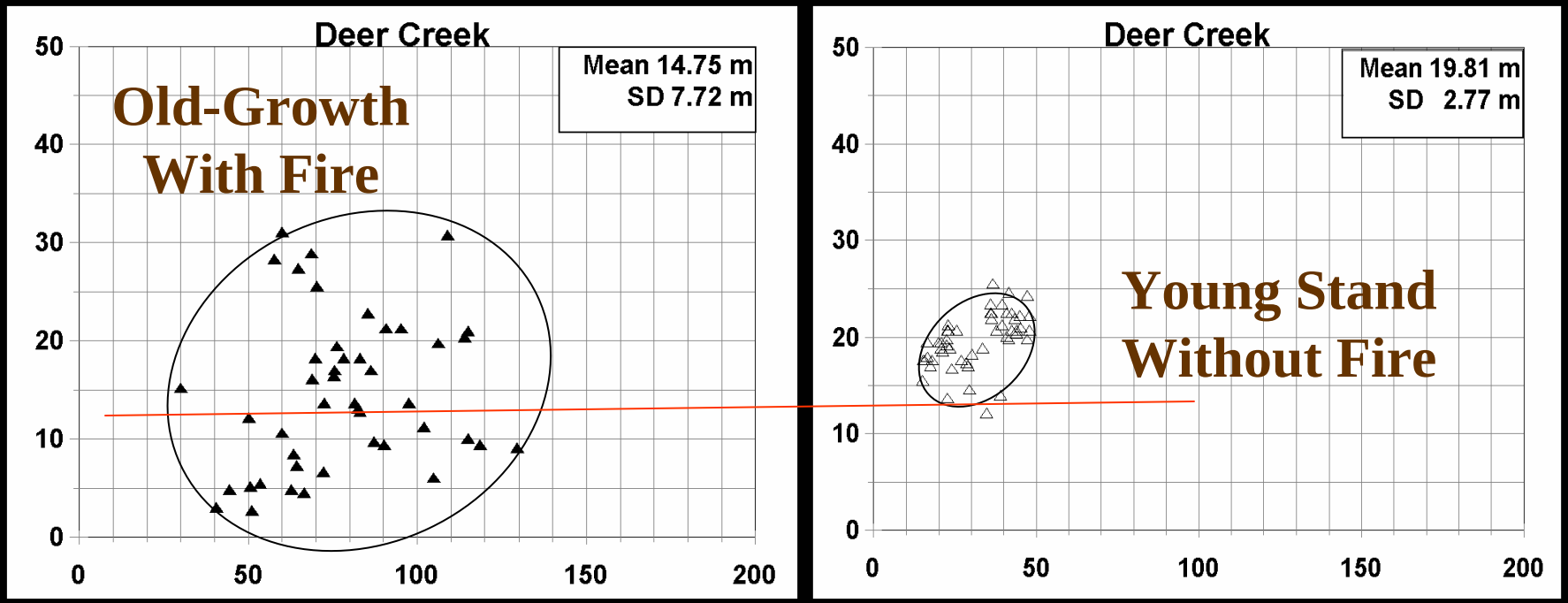






Structural Diversity

Distribution of Lowest Live Limb



Tree Age

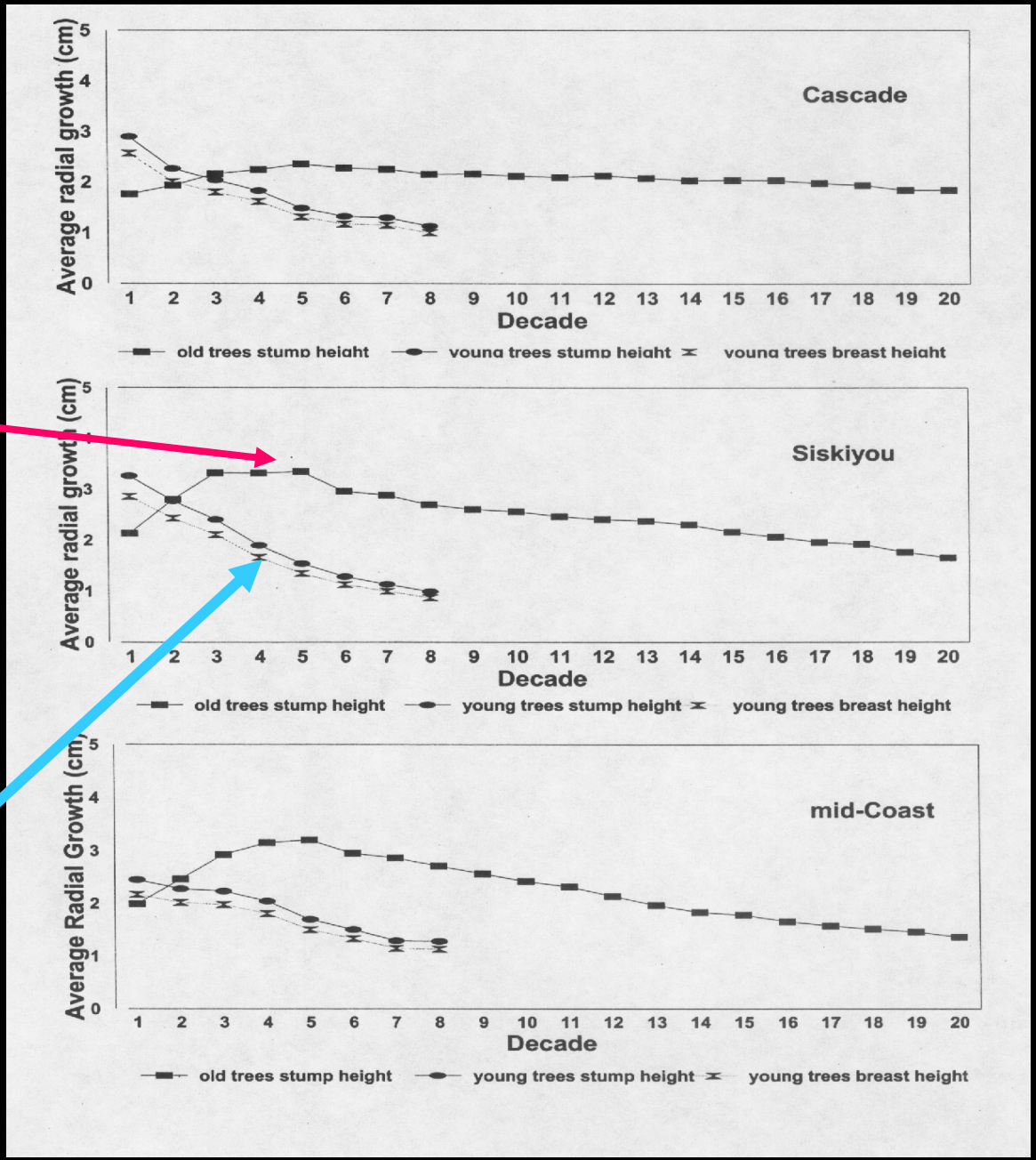
Relict Species

A fire-scarred white oak snag signals a shift in plant community structure.

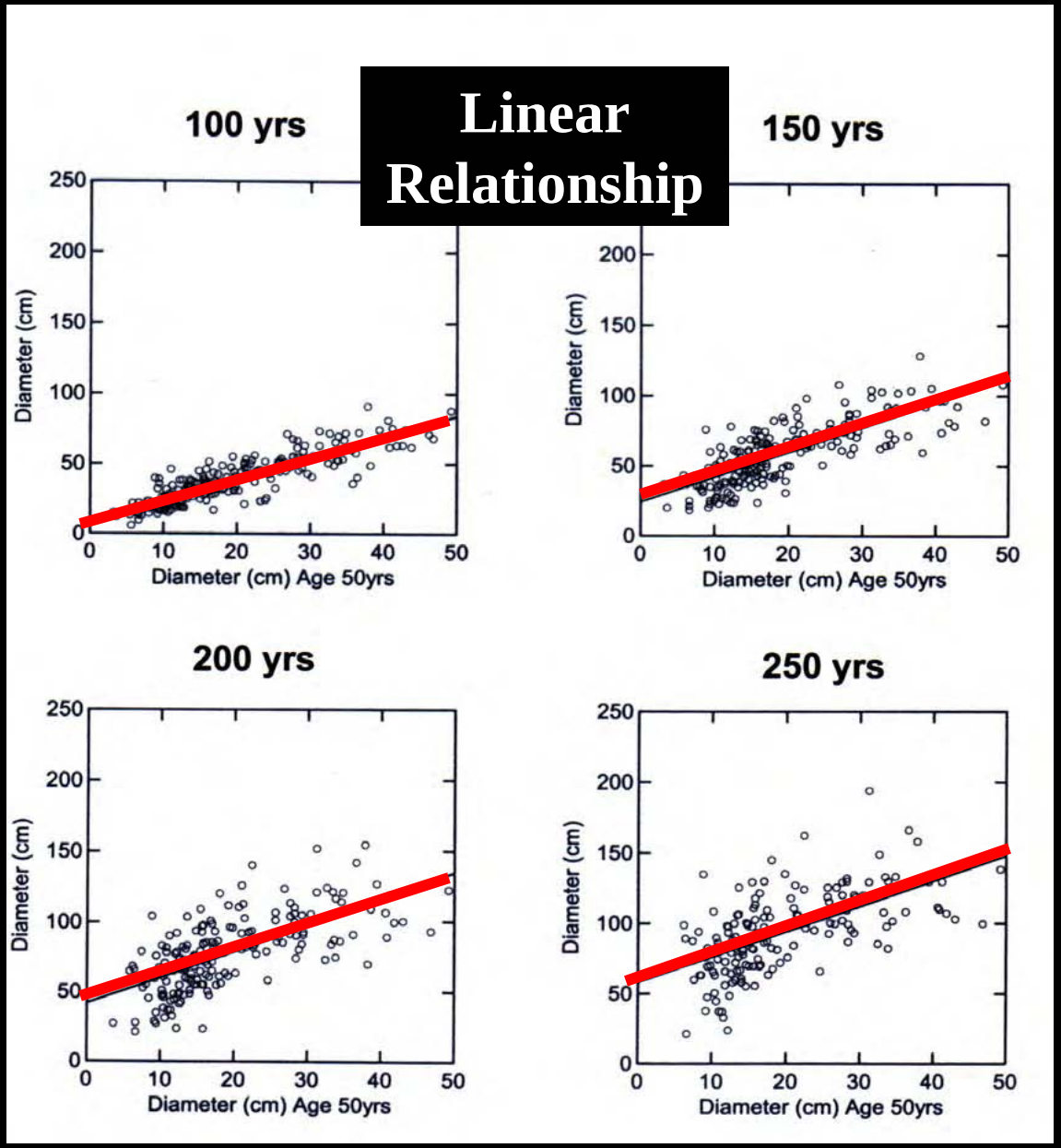
Historic Radial Growth of Old-Growth Trees

Old-Growth Trees

Young-Growth Trees



Relationship of Tree Size From Age 50yrs – 250yrs



The likelihood of a tree becoming an old-growth tree is generally determined early in the tree's life.