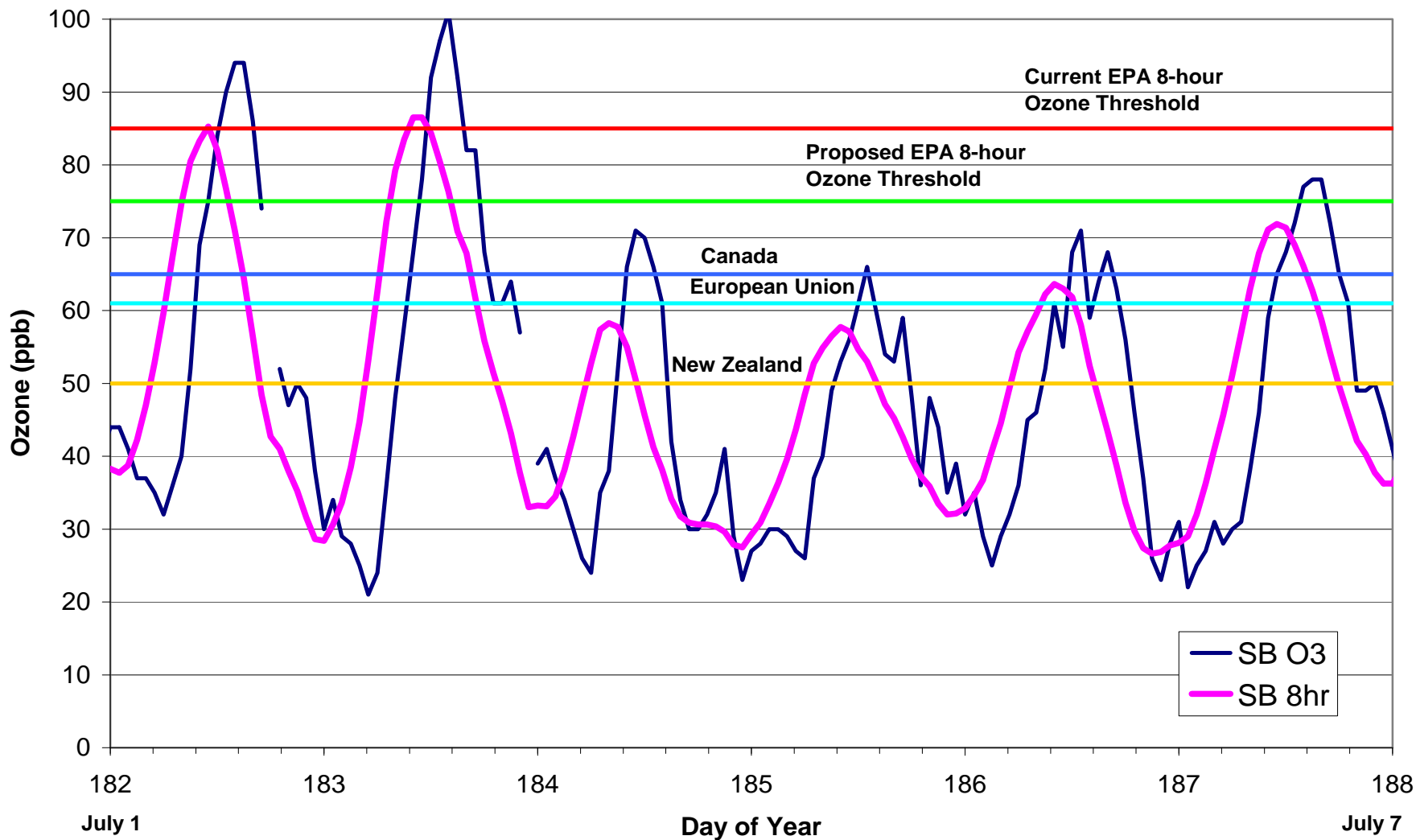


South Boulder Creek Station 2007



Ozone Chemistry and Transport Along a 2000 m Altitude Gradient in the Colorado Front Range from 12 Surface Sites and Balloon Sonde Observations

Molly Brodin, Detlev Helmig, Sam Oltmans, Bryan Johnson, and many others



**US
EPA**

Ozone Chemistry and Transport Along a 2000 m Altitude Gradient in the Colorado Front Range from 12 Surface Sites and Balloon Sonde Observations

Ozone Everywhere !

Molly Brodin, Detlev Helmig, Sam Oltmans, Bryan Johnson

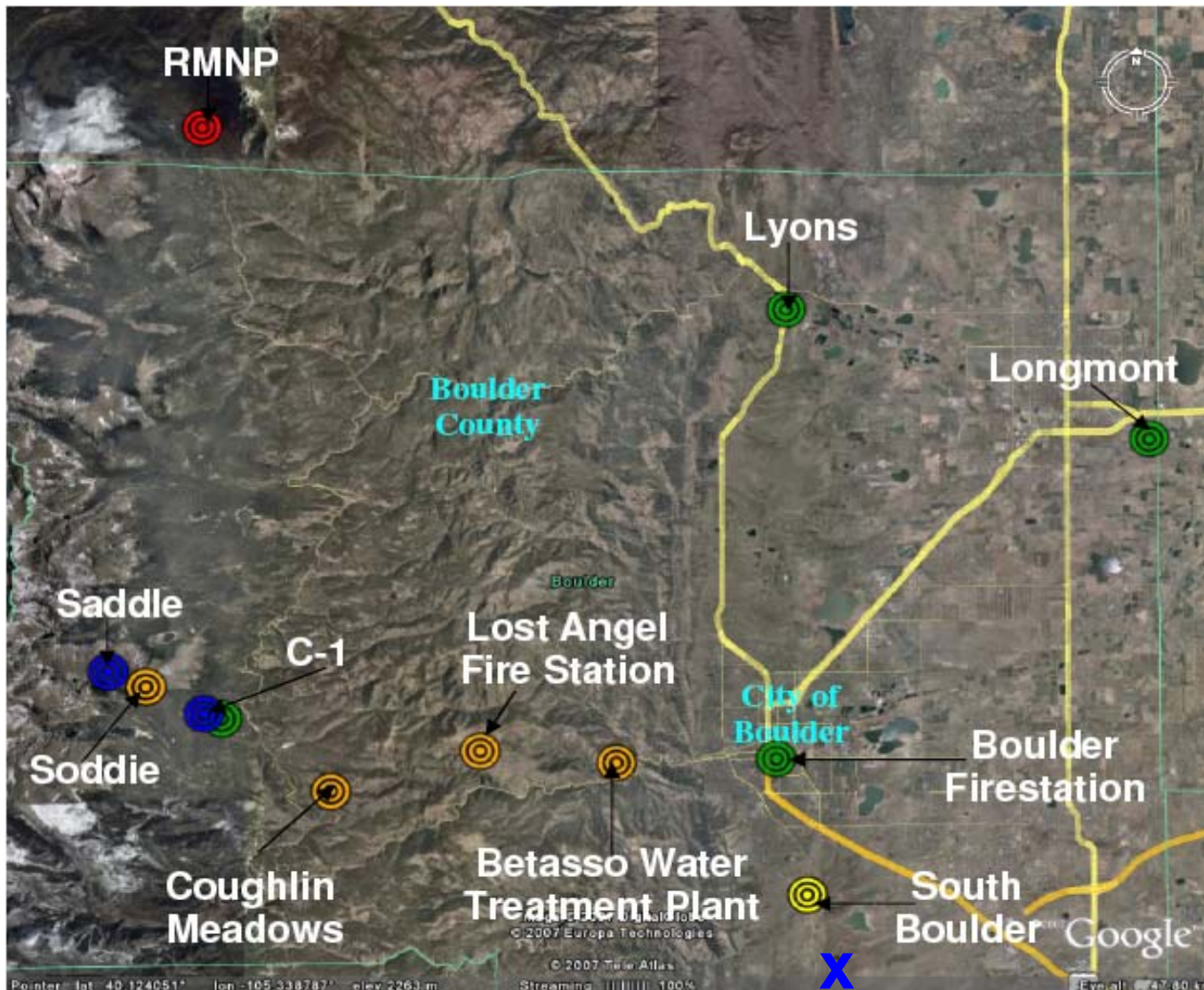


US
EPA

Colorado Front Range Surface Ozone

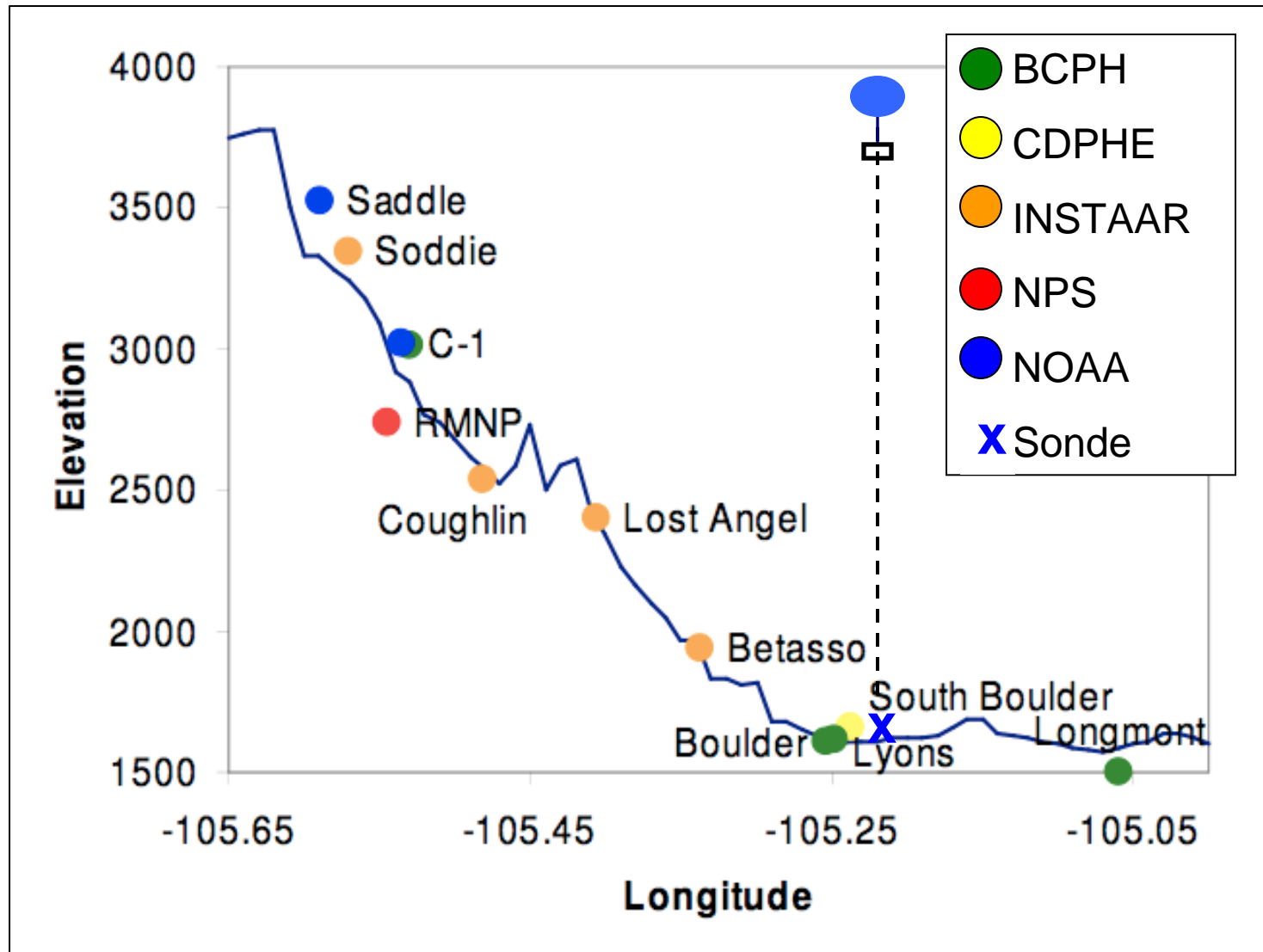
- The location of a large urban area in a Mountain-Plains transition zone.
 - Downslope transport from the Continental Divide
 - Transport of polluted air from the Denver Metro Area
 - Weekly ozone-sonde launches make possible a comparison of ozone along the elevation gradient with free troposphere levels.
- Opportunity to study ozone sources and transport with high spatial and elevation resolution.

Site Locations

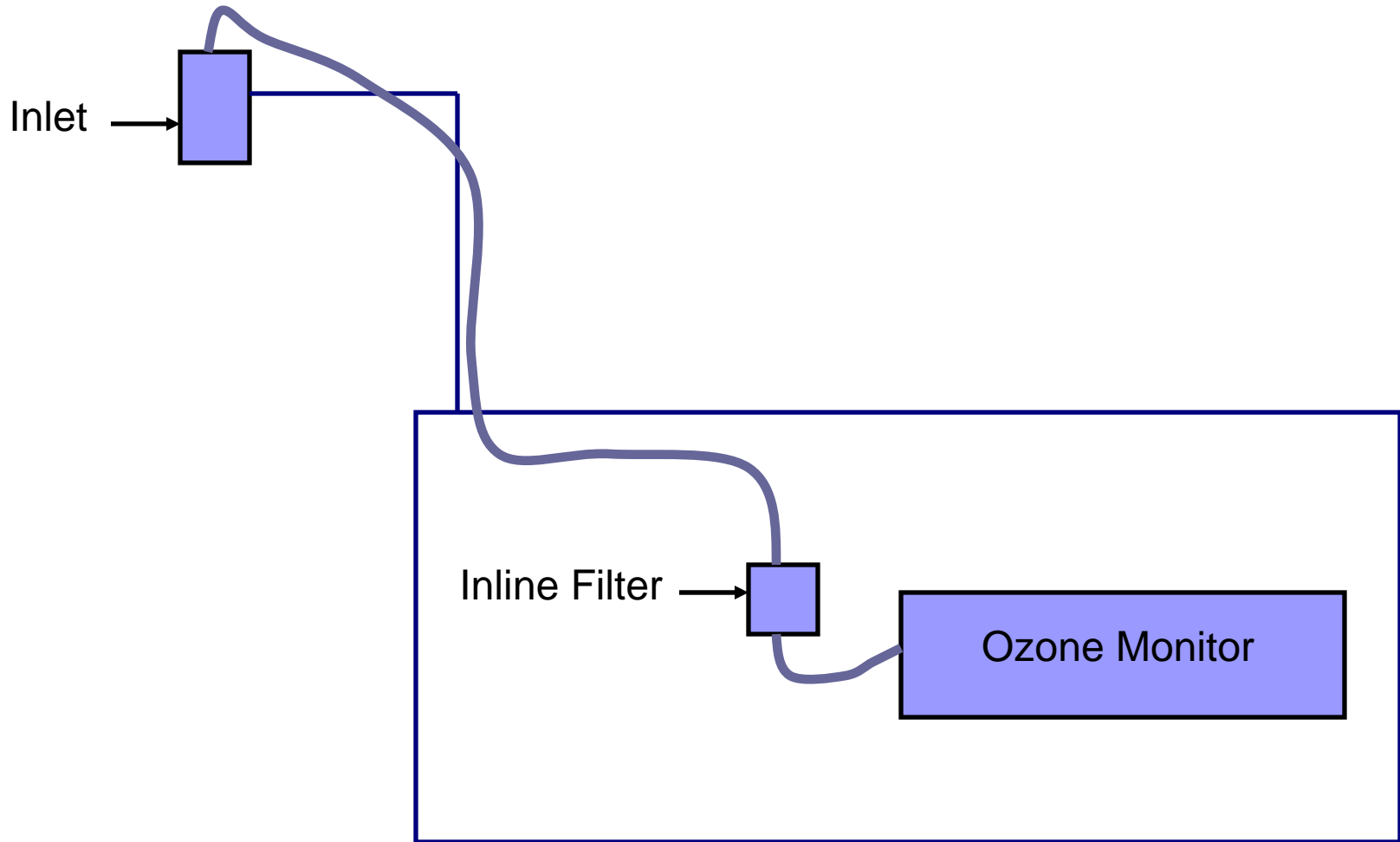


- BCPH
- CDPHE
- INSTAAR
- NPS
- NOAA
- ✕ Sonde

Ozone Sites Elevation Profile



Experimental Setup



Monitoring Sites - Lyons



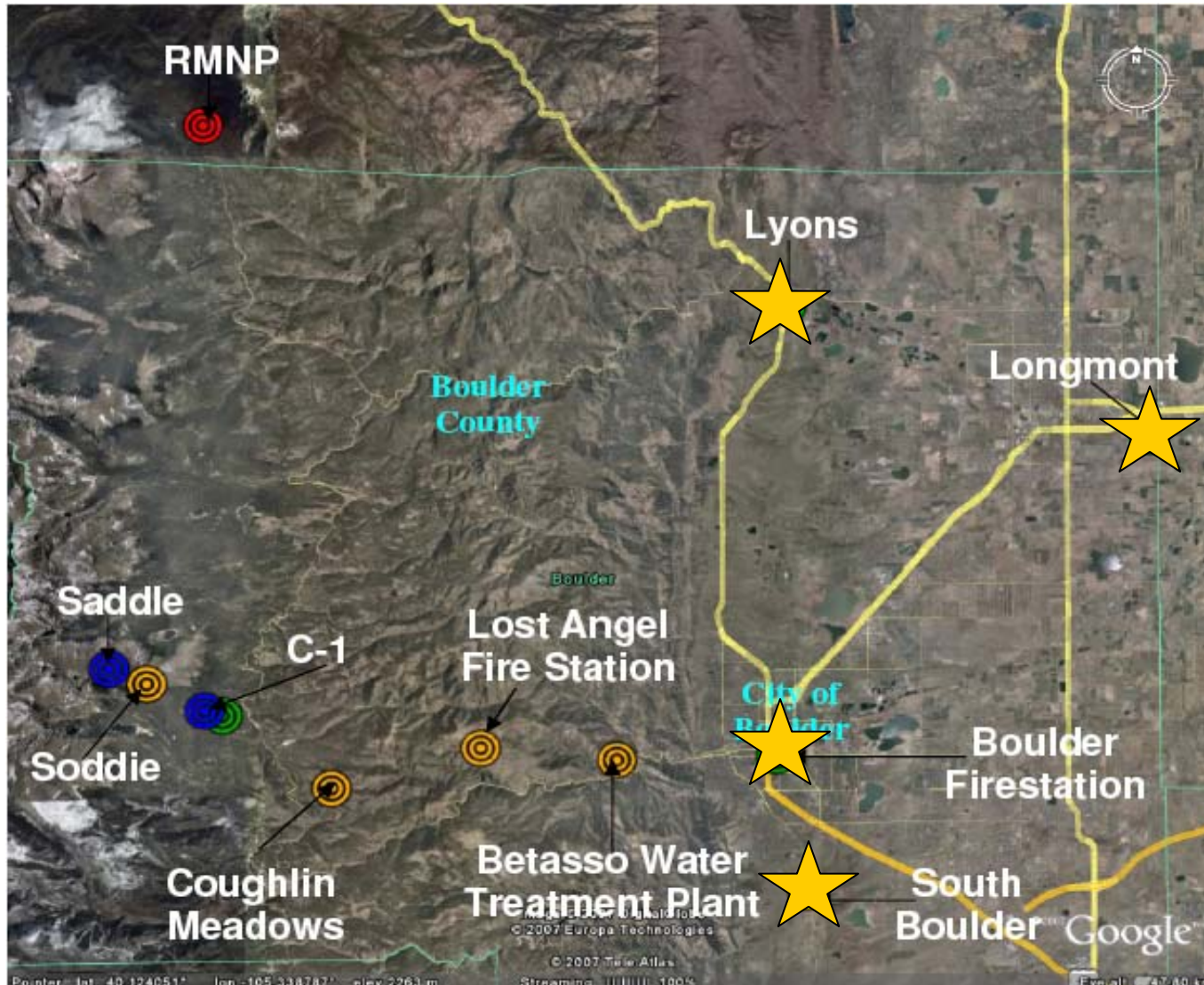
Monitoring Sites - Niwot Ridge Soddie Site



Monitoring Sites - Niwot Ridge Tundra Lab (Saddle)

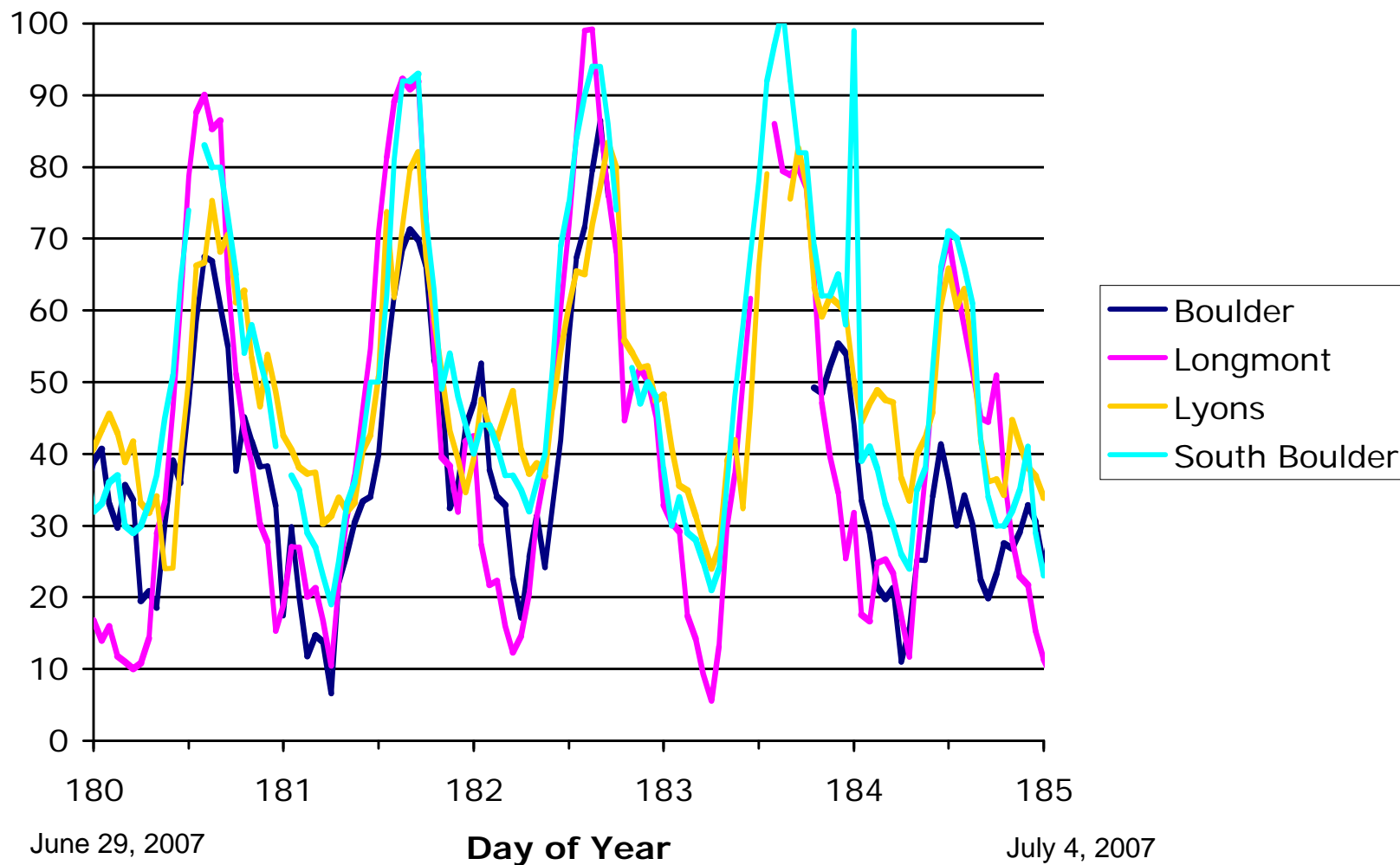


Time Series - Plains Sites

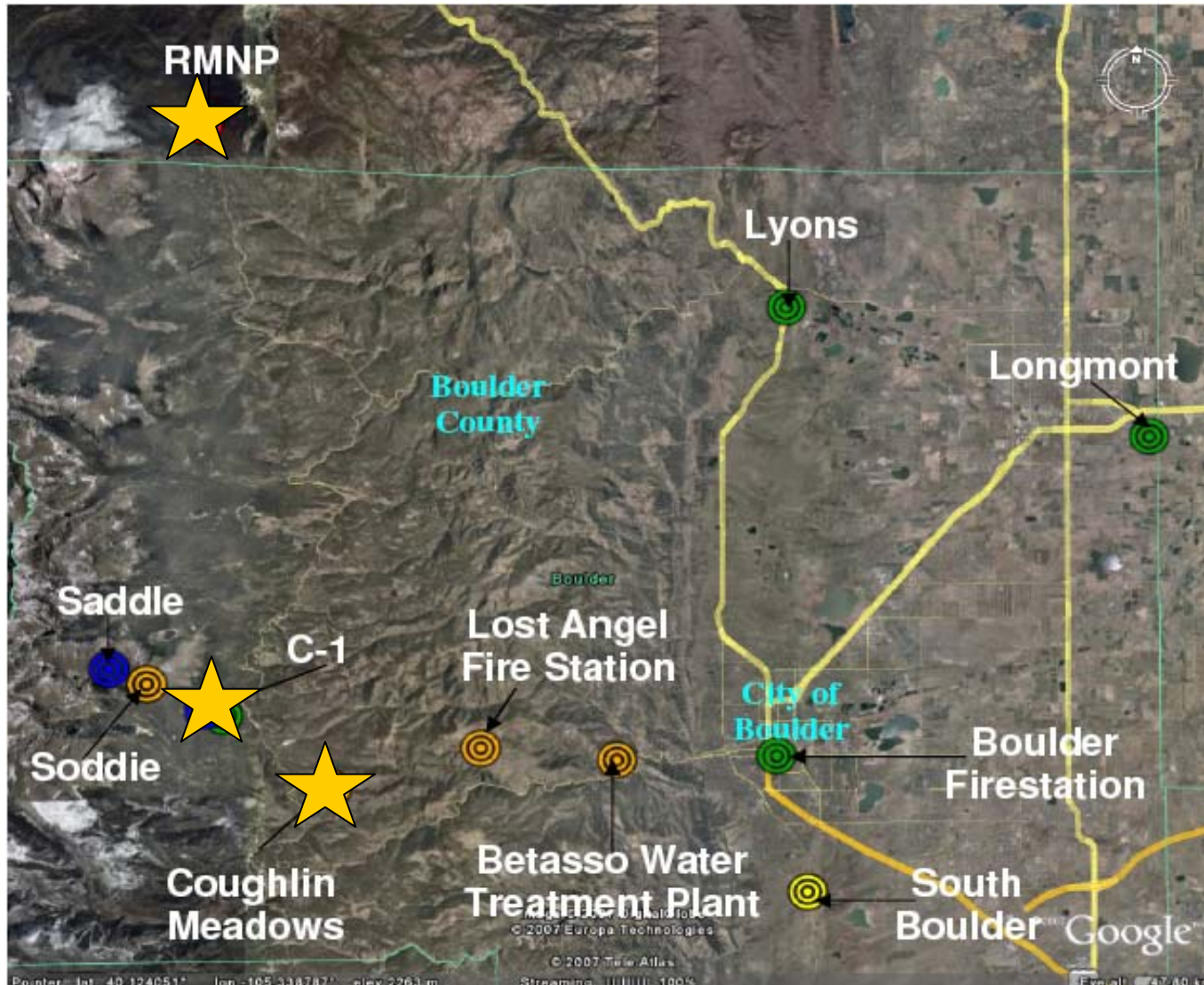


Time Series - Plains Sites

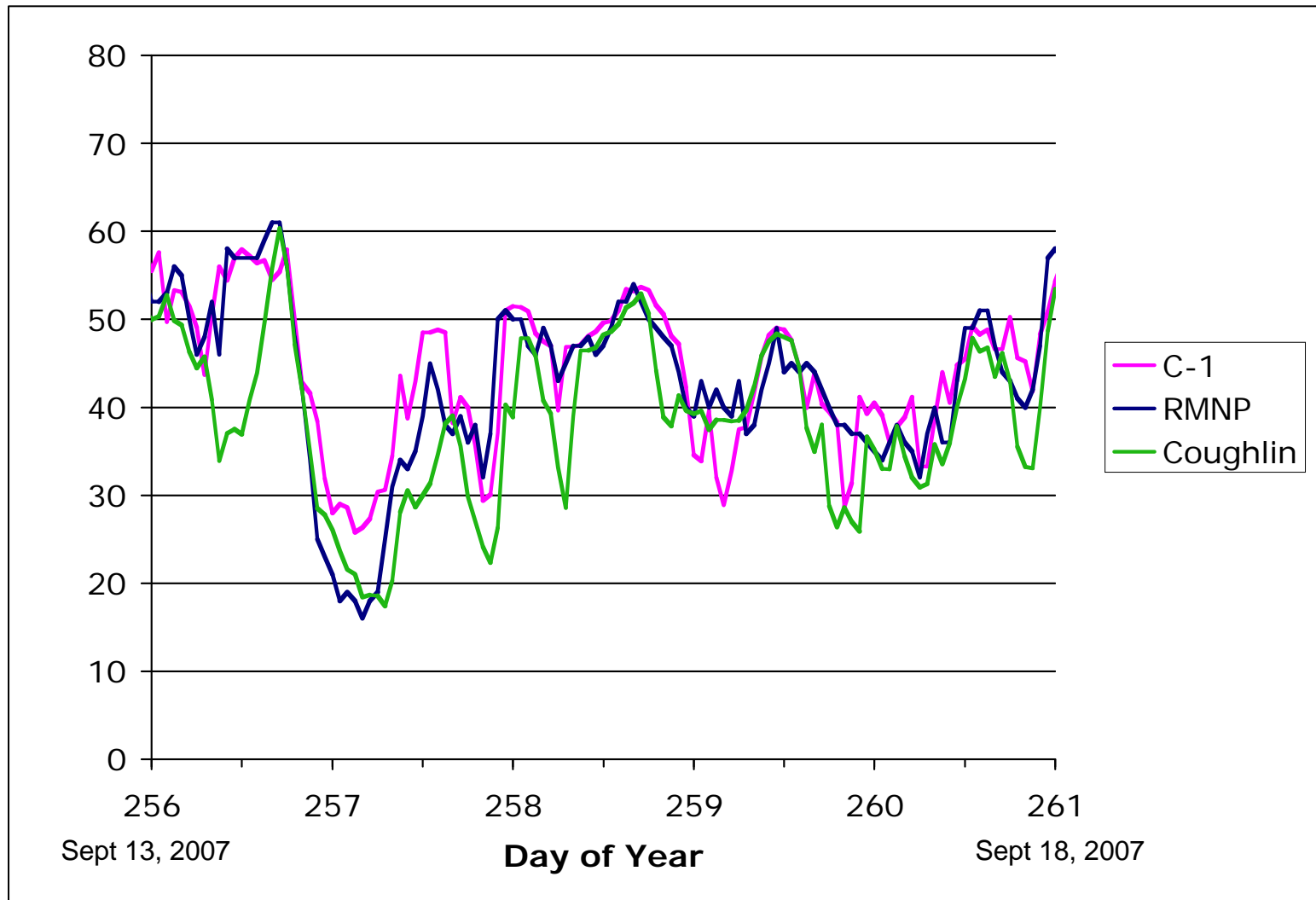
Ozone (ppbv)



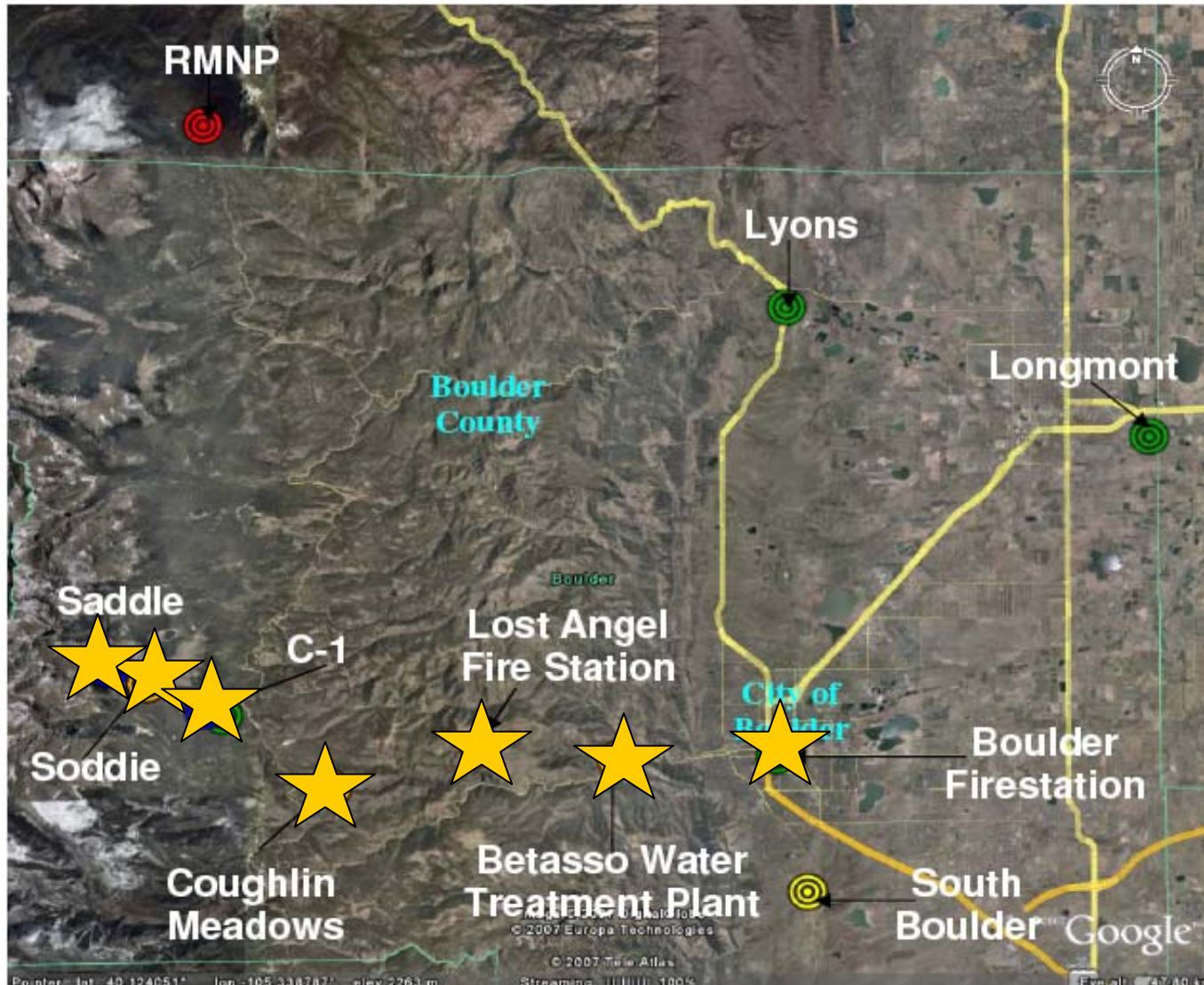
Time Series - Peak-to-Peak Sites



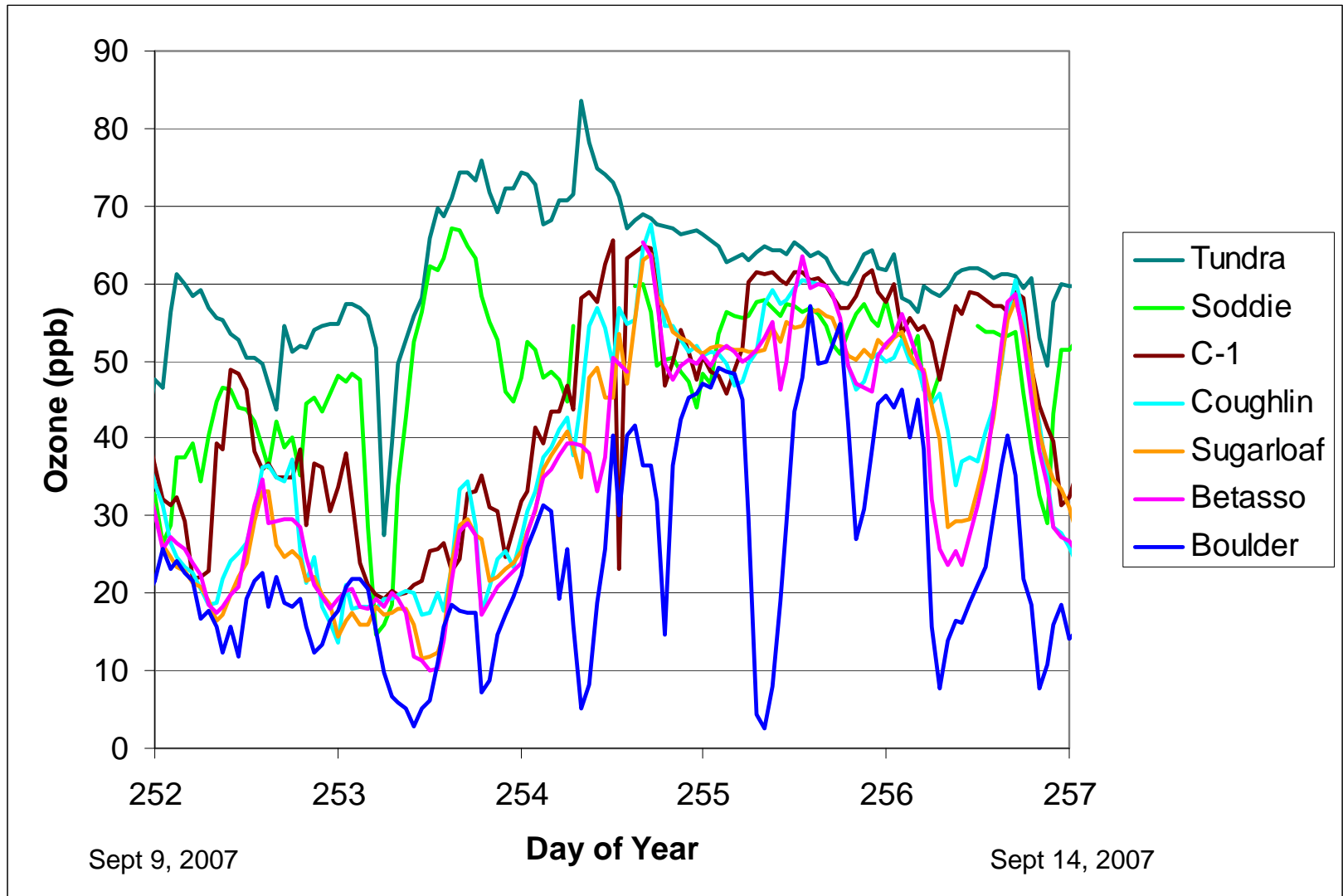
Time Series - Peak-to-Peak Sites



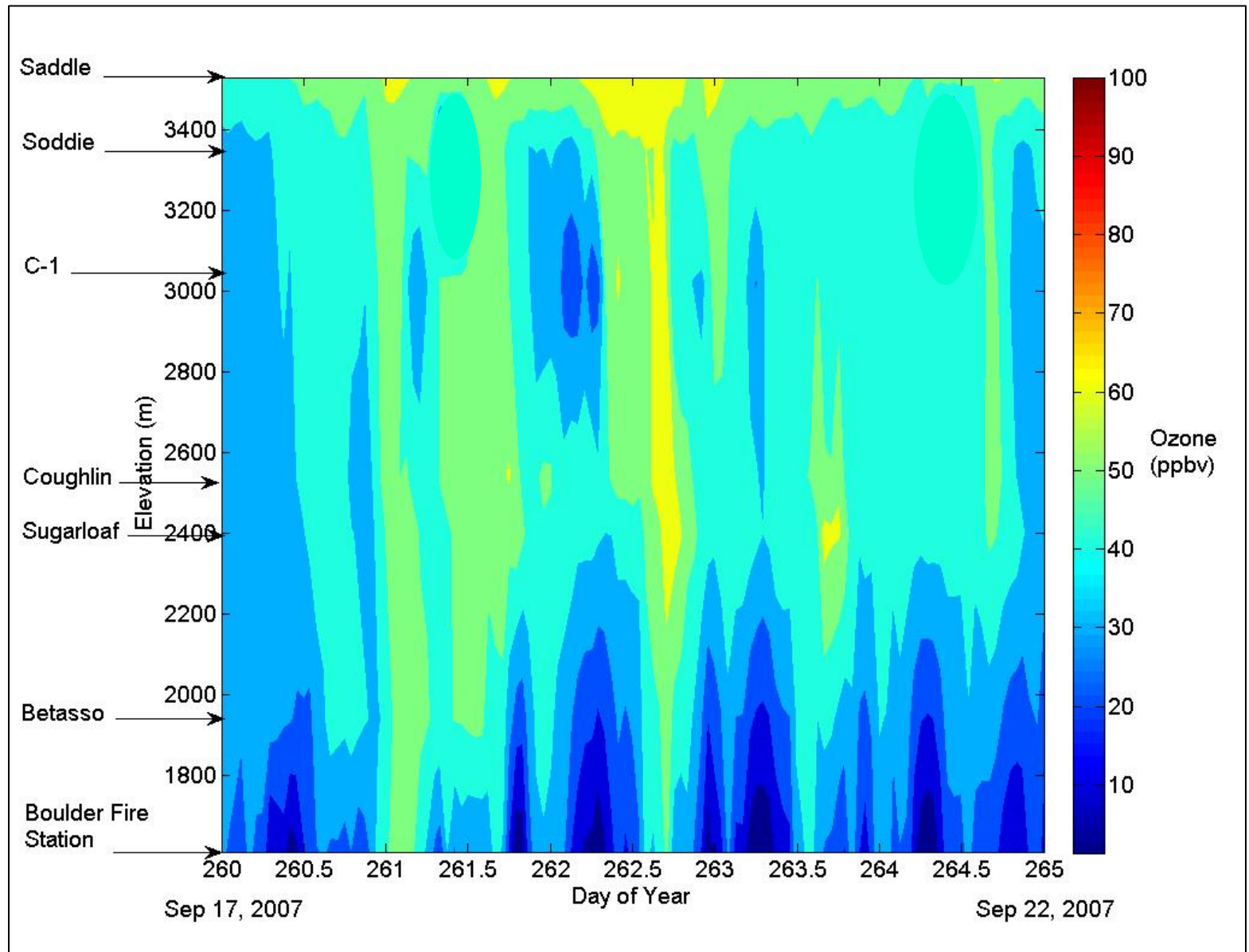
Time Series – Elevation Profile Sites



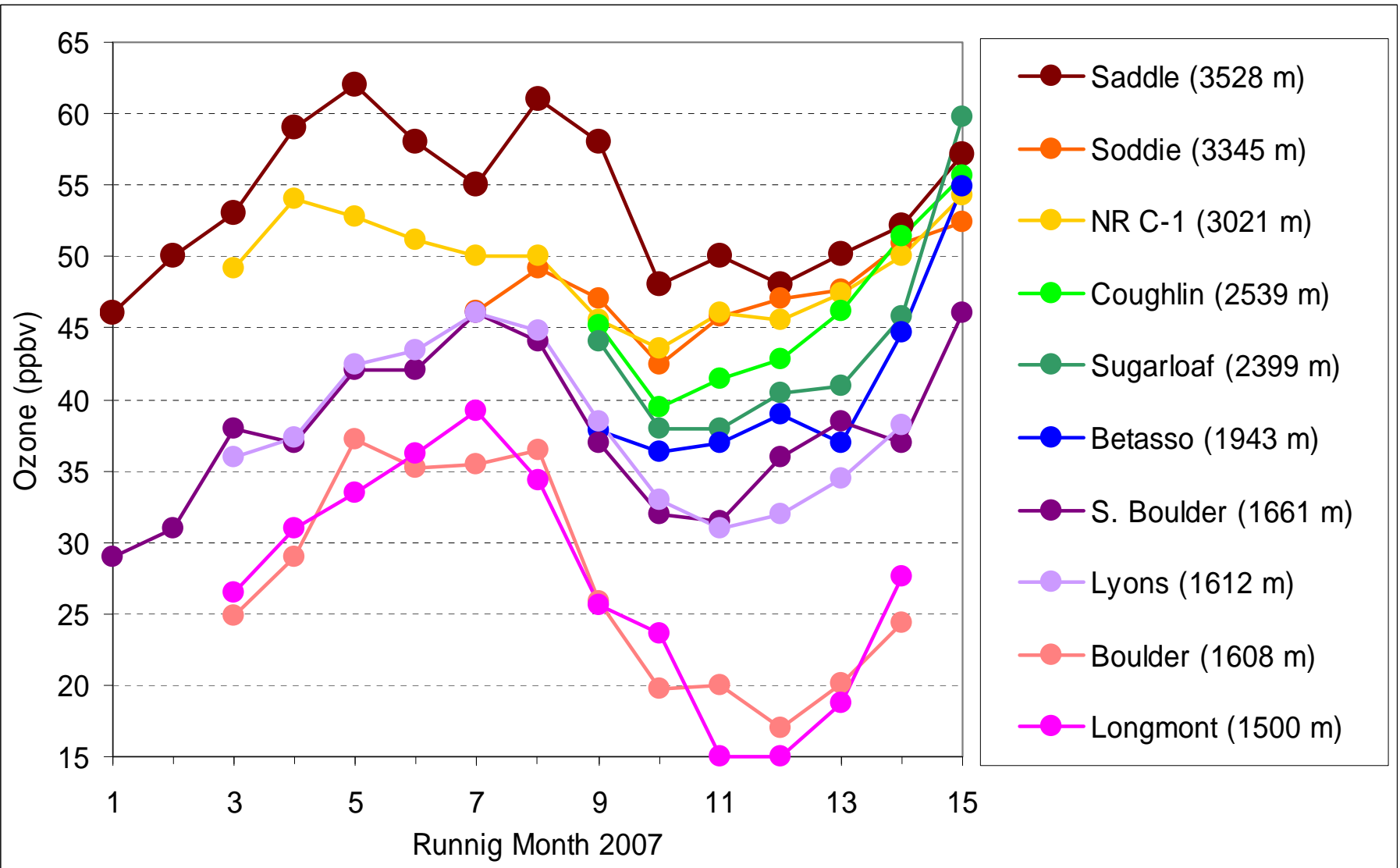
Time Series – Elevation Profile Sites



Ozone Contour Data

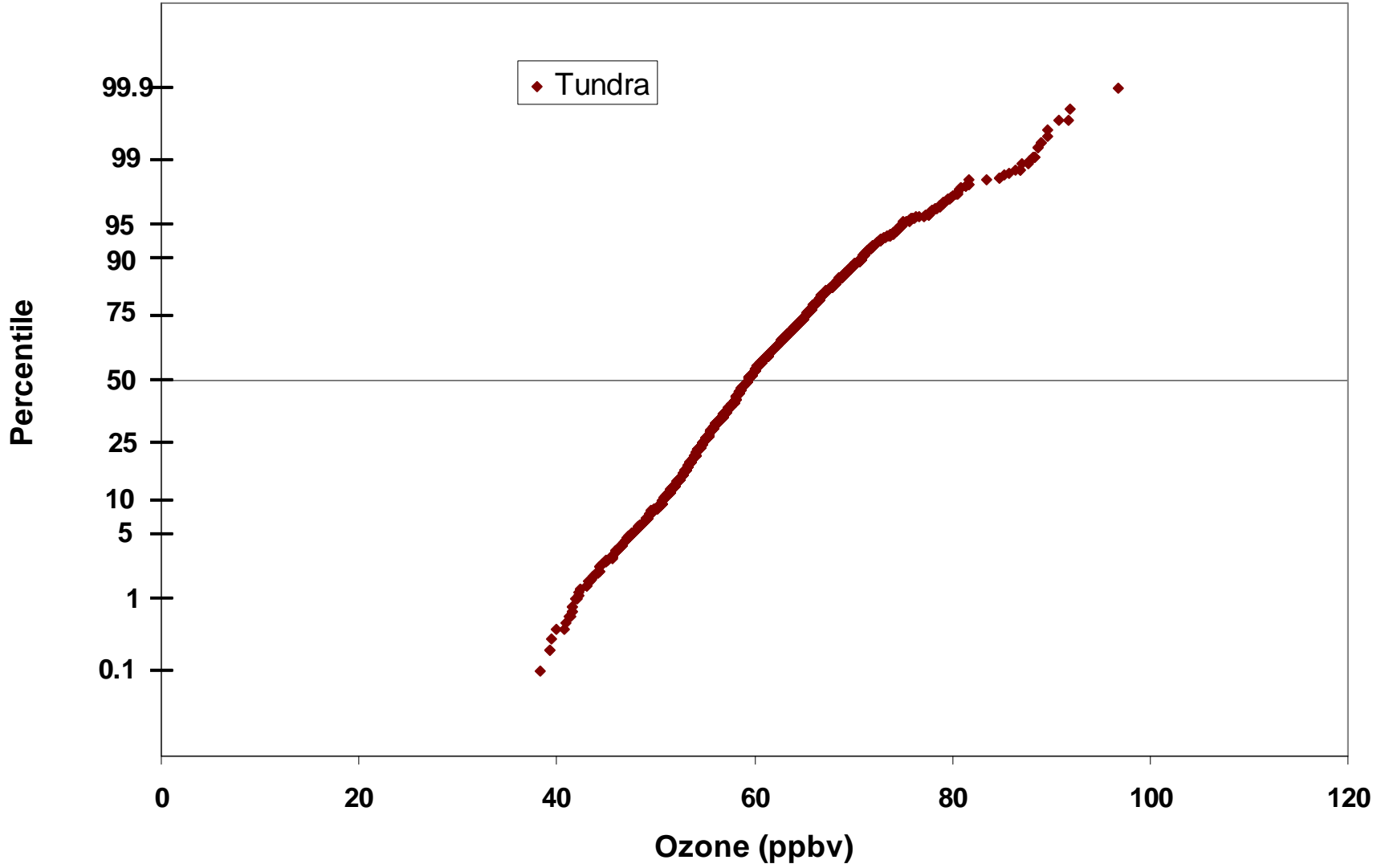


Monthly Median Ozone

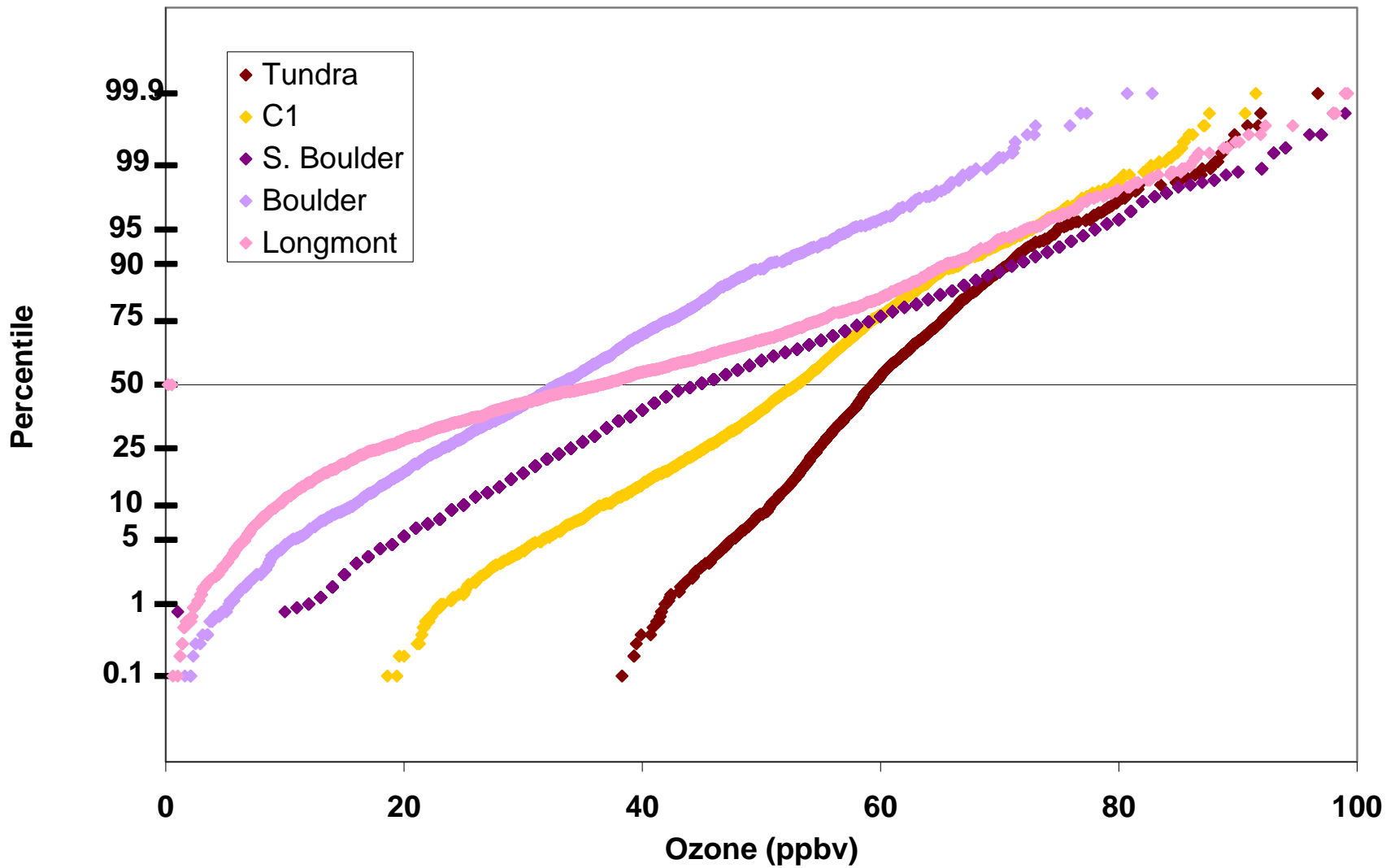


Cummulative Distribution Plot

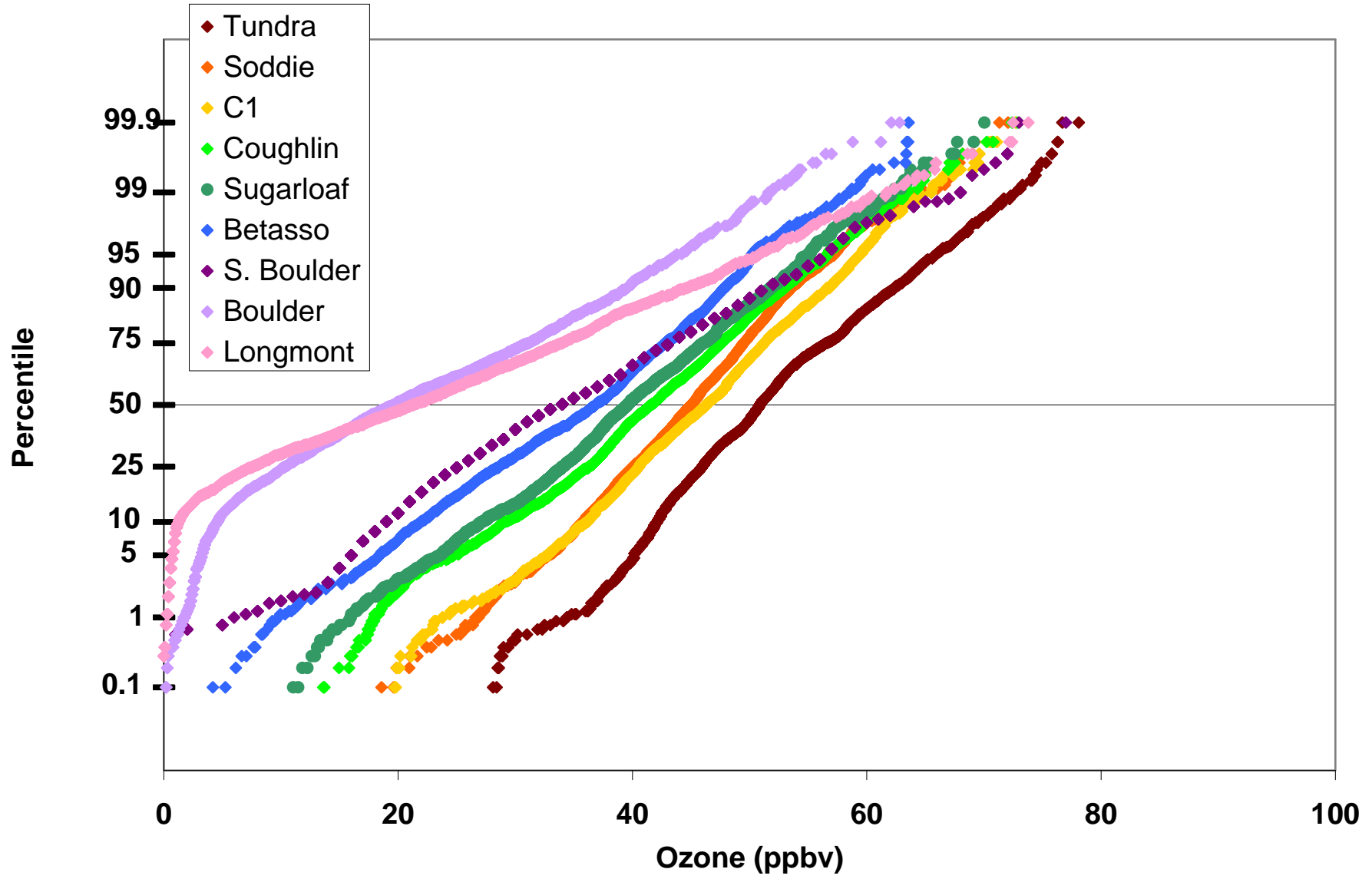
Tundra Lab, Summer 2007 (June, July, Aug)



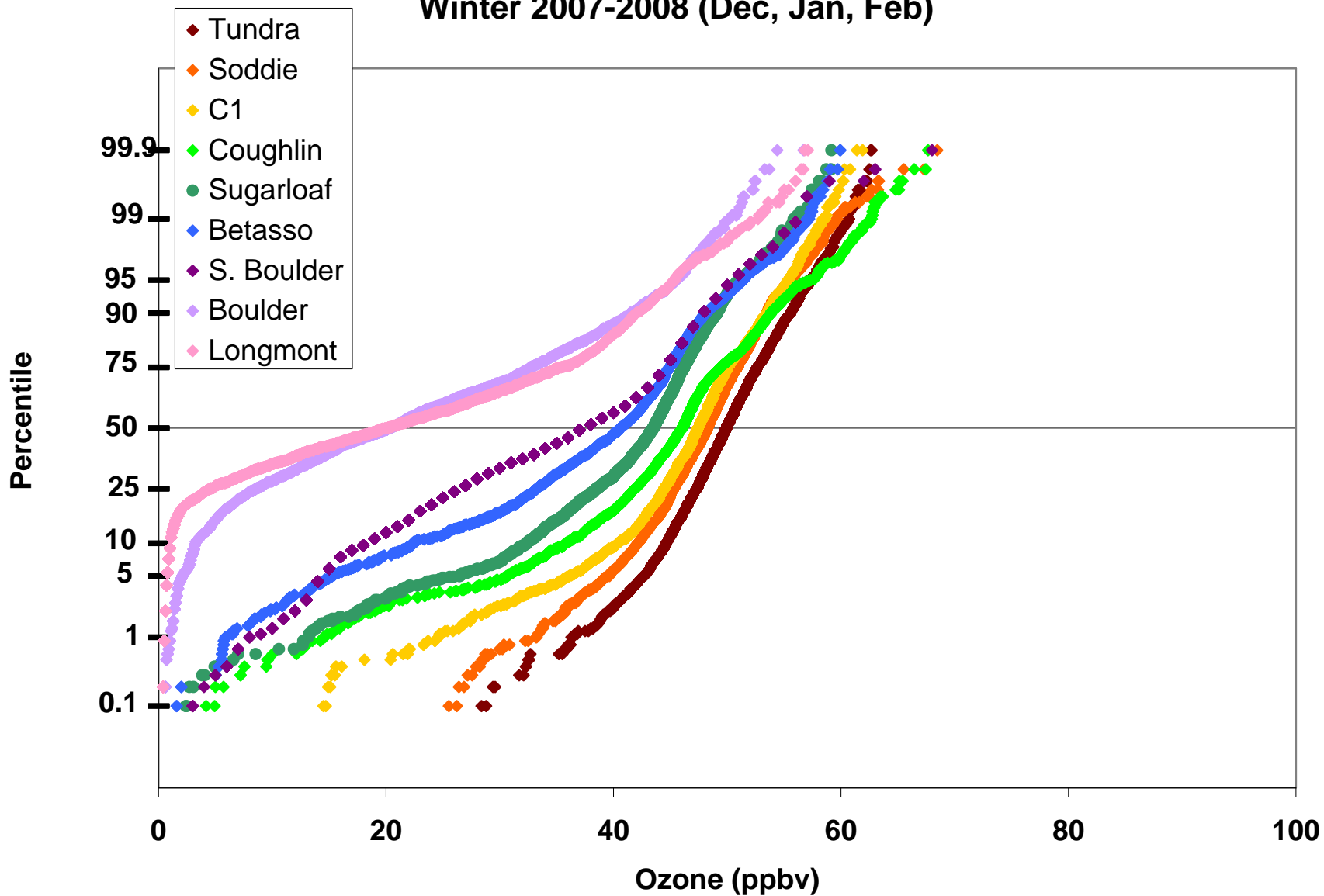
Summer 2007 (June, July, Aug)



Fall 2007 (Sep, Oct, Nov)



Winter 2007-2008 (Dec, Jan, Feb)



Ozone Pollution Index

(mean daily Max divided by Min, weekly averages)

Week 2007

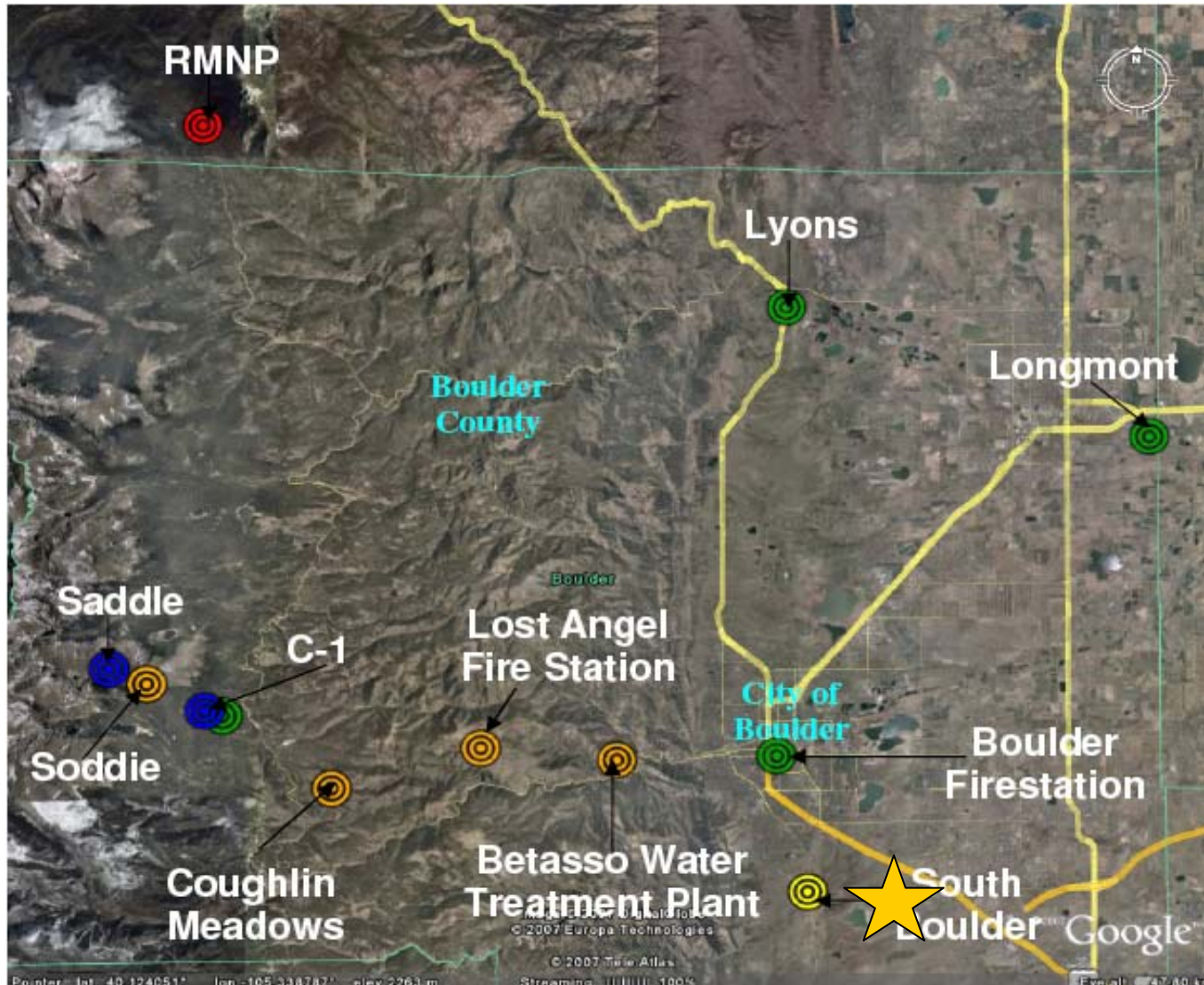
	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Saddle	1.2	1.4	1.2	1.3	1.4	1.4	1.2	1.3	1.2	1.1	1.3	1.3	1.3	1.2	1.3	1.1	1.2	1.2
Soddie	1.8	1.8	1.4	1.4	1.6	1.5	1.3	1.4	1.4	1.1	1.3	1.4	1.3	1.3	1.4	1.3	1.2	1.2
Niwot Ridge C1	1.8	1.8			1.4	1.5	1.4			1.1	1.3	1.3	1.3	1.3	1.6	1.2	1.3	1.2
Coughlin	1.8	2.3	1.6	1.6	1.6	1.8		1.5	1.6	1.4	2.7	1.3	1.5	1.6	1.9	1.3	1.3	1.3
Sugarloaf	1.6	1.9	1.5	1.6	1.5	1.6	1.6	1.6	1.7	1.4	1.4				1.9	1.3	1.3	1.3
Betasso		2.1				1.9	1.7	1.7	2.0	1.6	1.7	1.7	2.0	2.3	2.5	1.5	1.8	1.8
South Boulder	2.8	2.8	2.6	2.6	2.0	2.3	2.2	1.9	3.1	2.0	2.1	1.8	2.6	2.3	2.4	2.0	2.3	1.8
Boulder Firestation	10	8.6	23	16	5.4	8.3	4.3		7.7	9.8	12	4.9	9.7	6.7			16	5.0
Longmont	14		7.9	11	15	8.5	4.5	7.2	112	55	45	13	28	7.8	14	70	9.9	6.3

Week 2008

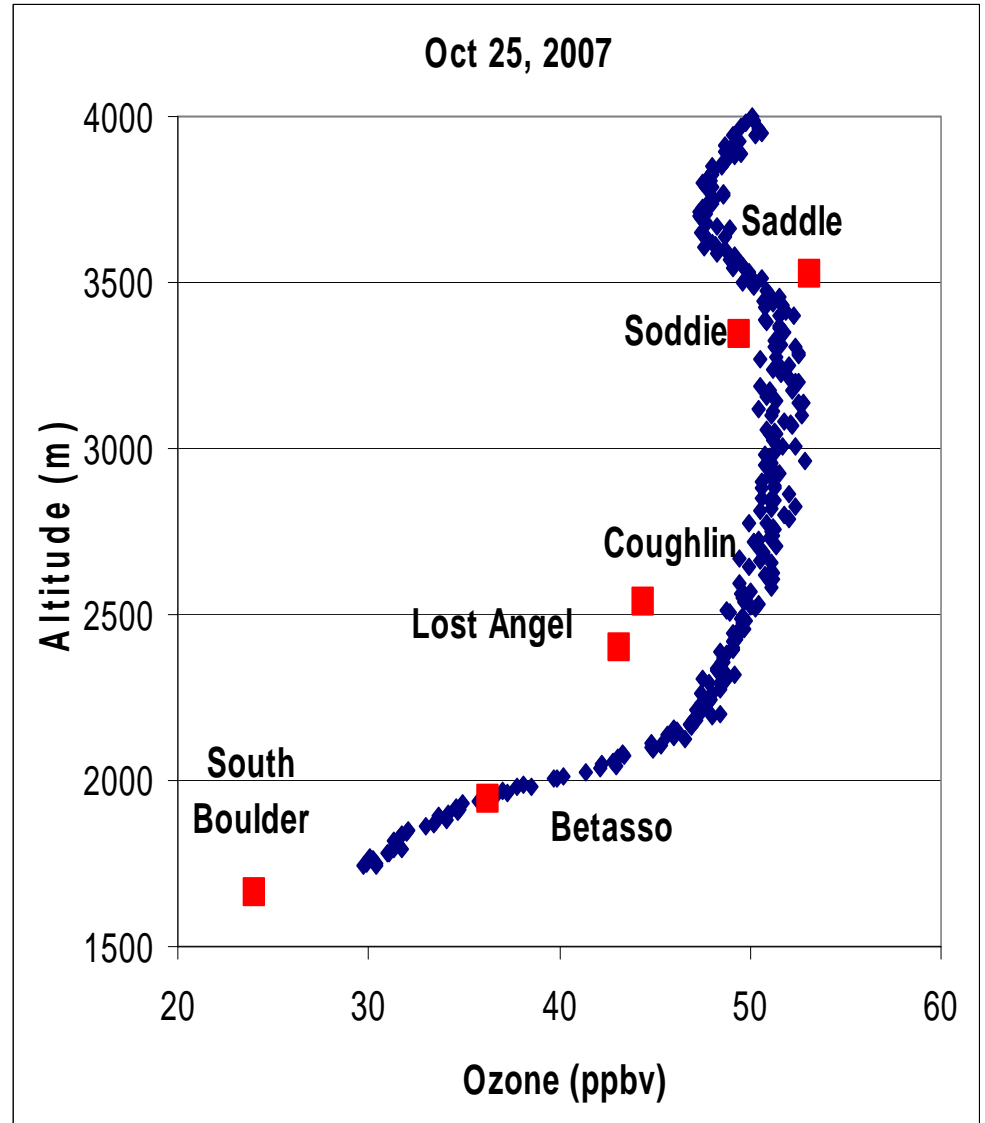
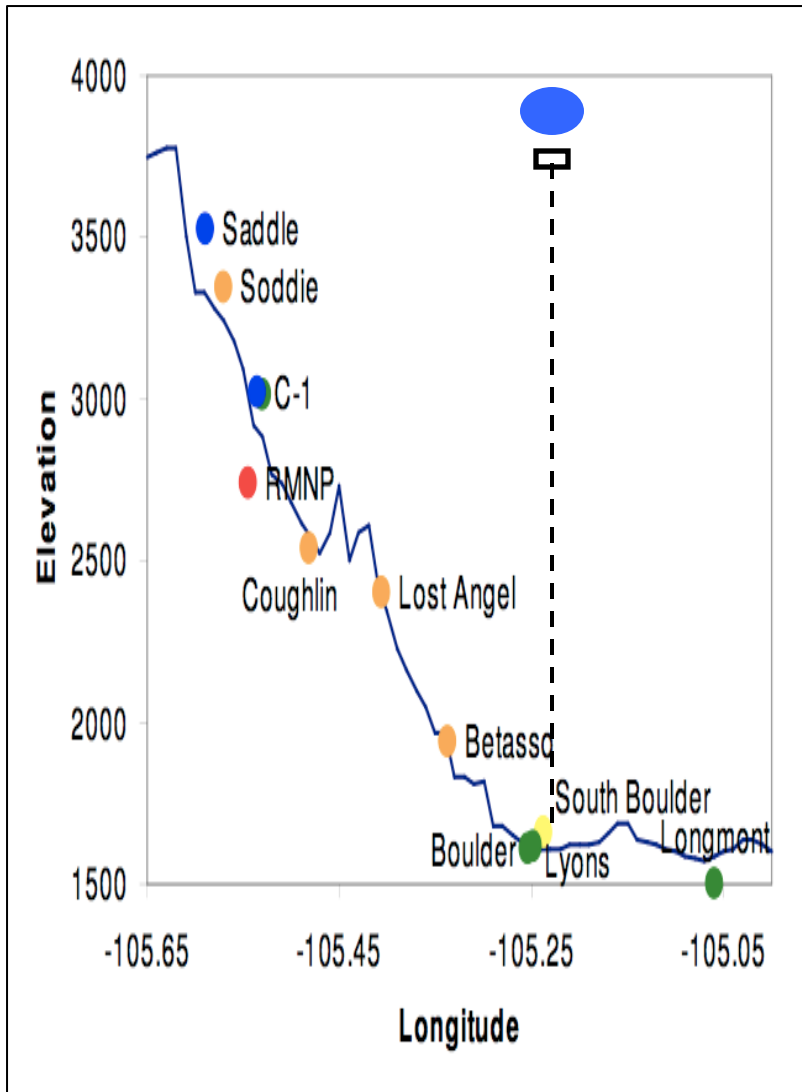
	1	2	3	4	5	6	7	8	9	10	11	12
Saddle	1.2	1.2	1.2	1.3	1.2	1.2	1.2	1.2	1.2	1.1	1.2	1.2
Soddie	1.2	1.2	1.2	1.3	1.3	1.2	1.4	1.2	1.9	1.3	1.3	1.2
Niwot Ridge C1	1.2	1.1	1.1	1.3	1.3	1.2	1.2	1.3	1.2	1.2	1.3	1.2
Coughlin	1.3	1.3	1.9		1.3	1.2	1.3		1.2	1.2	1.4	1.4
Sugarloaf	1.3	1.3	1.6	1.3	1.3	1.3			1.3			
Betasso	2.5	1.6	1.6	1.4	1.5	1.5	1.6	1.7	1.4	1.4	1.5	1.5
South Boulder	1.9	2.1	2.9	1.6	3.3	3.1	3.6	2.4	1.8	1.7	2.1	2.0
Boulder Firestation	9.0	6.9	7.1	3.8	4.0	4.2	8.0	7.4				
Longmont	16	20	11	6.4	9.6	4.9	39	18				

< 1.4 clean, unpolluted
2- 10 rural
>10 polluted

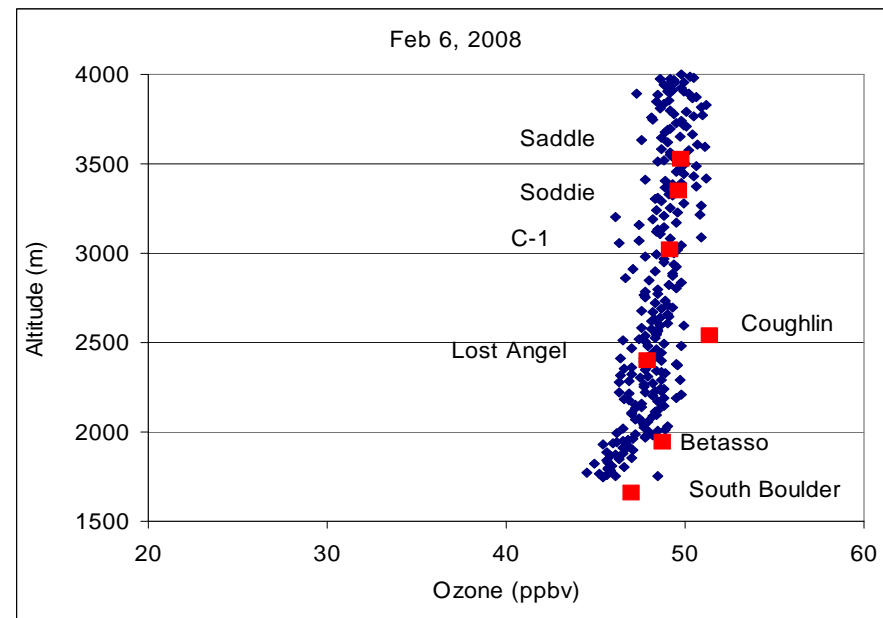
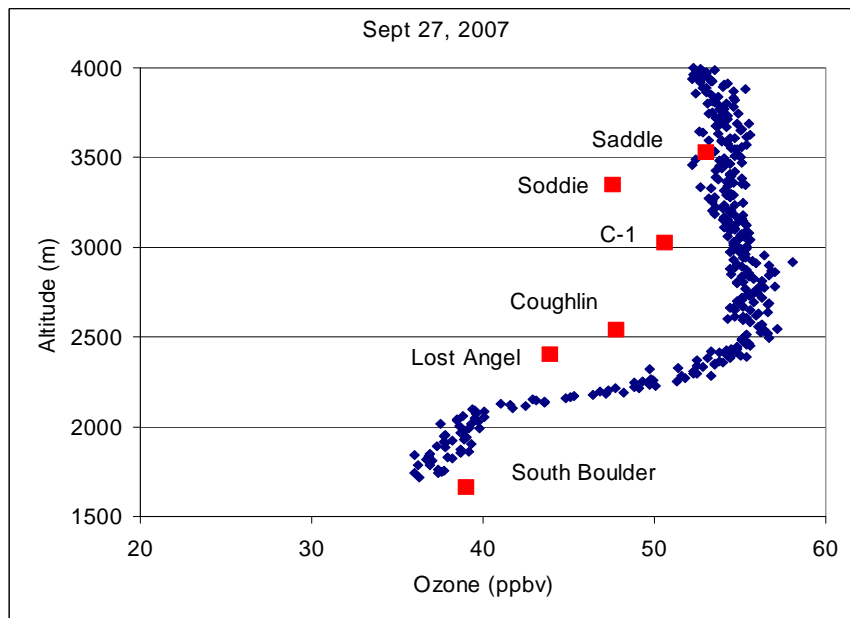
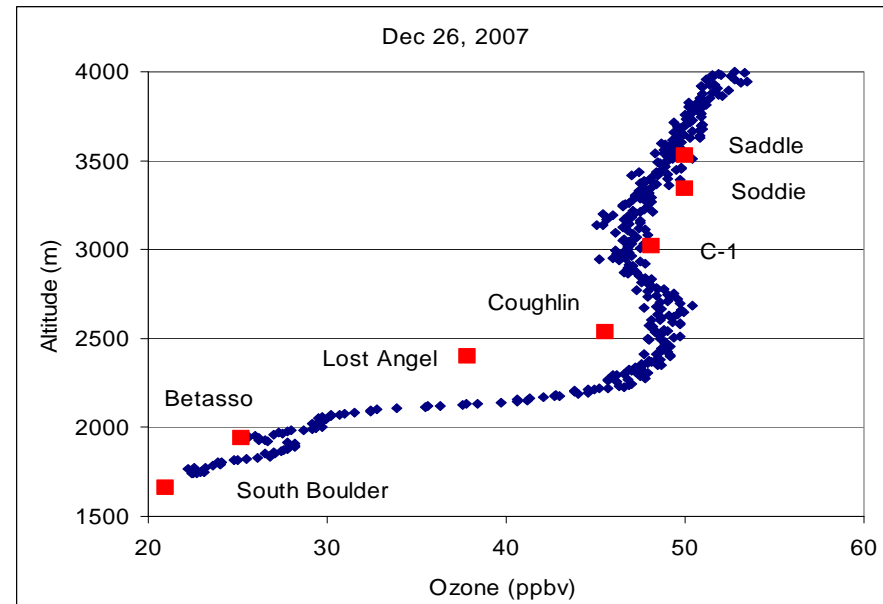
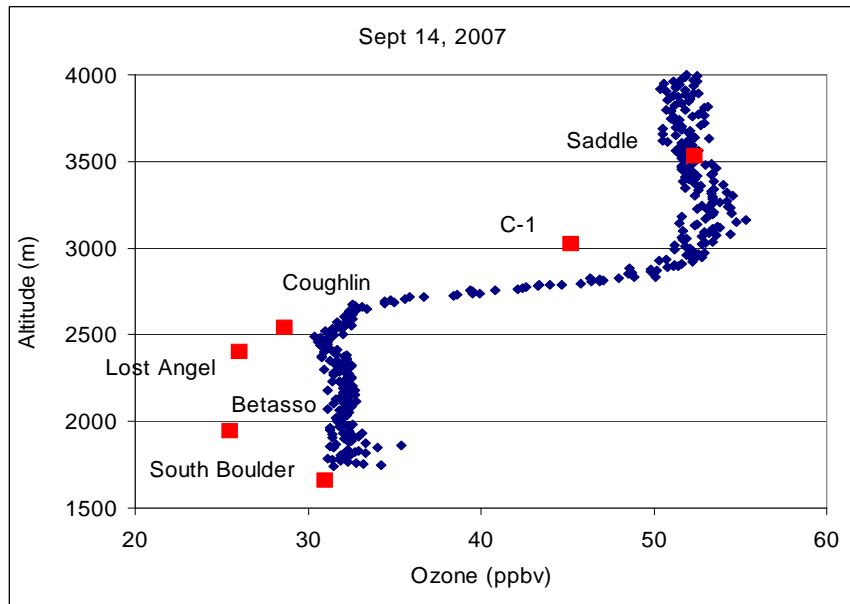
Ozone Sonde Comparison



Surface Site - Ozone Sonde Comparison



Surface Site - Ozone Sonde Comparison

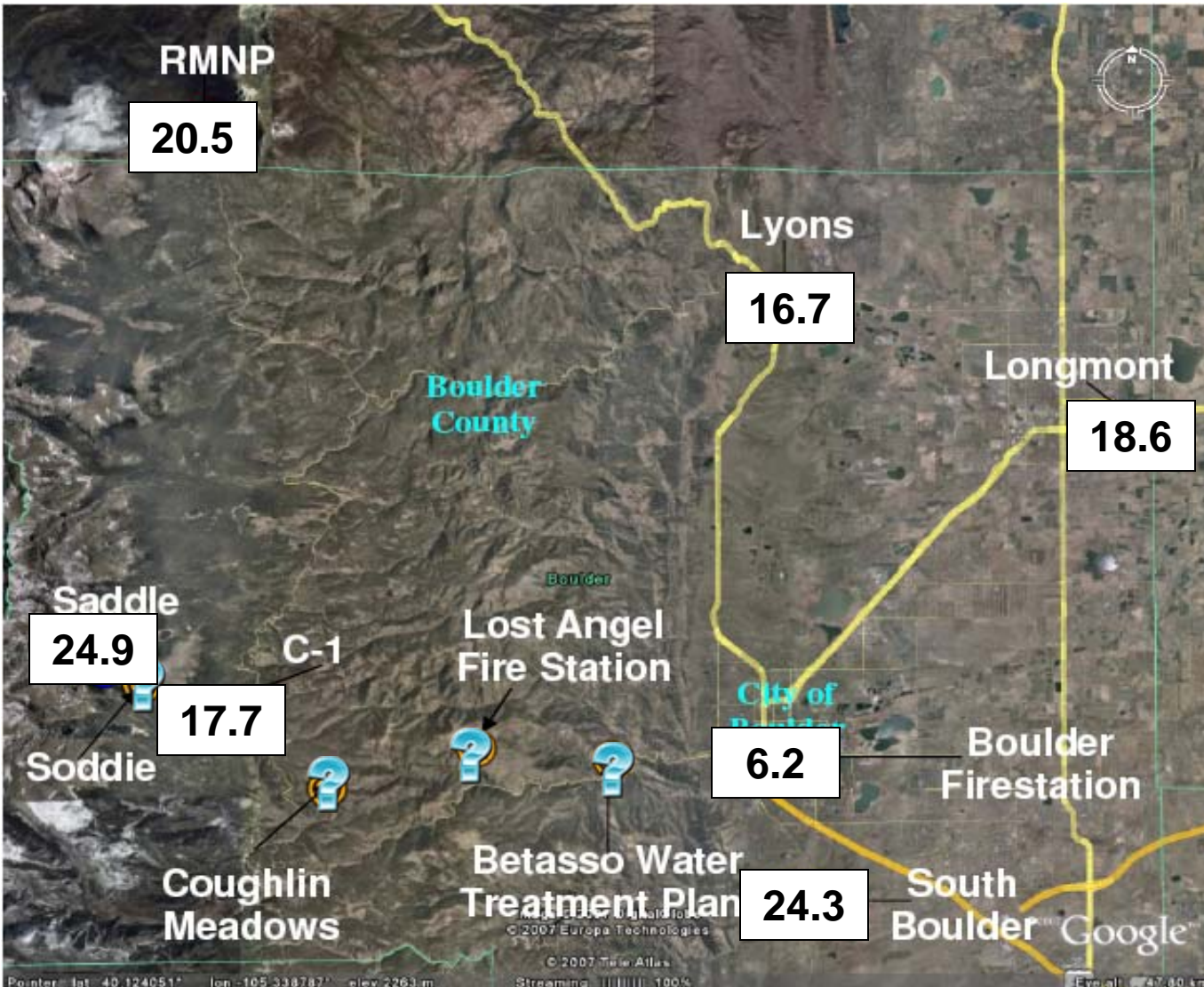


Highlights

- Colorado Front Range regularly experiences surface ozone levels that exceed U.S. air quality standard
- High spatial variability at foot of the mountains, more uniform at higher elevation
- Much higher temporal variability at the Plains sites
- Generally increasing ozone with elevation
- Ozone sonde data most times 0-5 ppbv higher than surface data at same elevation
- Plans are to run study through fall 2008

.....much more data analysis on the horizon – happy to share data

June-August 2007 W126 (3 mo)



September 2007 W126 (1 mo)

