

Wyoming Department of Environmental Quality  
(WYDEQ)

Visibility & Air Quality Monitoring Network

Durango, Colorado

September 6, 2007

John V. Molenaar  
Air Resource Specialists, Inc.

# http://www.wyvisnet.com/

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Wyoming Visibility Monitoring Network



## Live Sites

Boulder  
Carnegie County  
Cloud Peak  
Daniel South  
Jordan  
Murphy Ridge  
North Pass  
Thunder Basin  
Wamsutter  
All Sites

## Image Gallery

Bridger Wilderness  
Cloud Peak Wilderness  
Teton Wilderness  
Yellowstone National Park

Boulder  
Carnegie County  
Cloud Peak  
Daniel South  
Green River Basin  
Jordan  
Thunder Basin

## Welcome to the Wyoming Visibility Monitoring Network

The Wyoming Department of Environmental Quality - Air Quality Division (AQD) brings you live air quality data and images from our Visibility Monitoring Network.

WYVISNET.com also provides tools to better understand air quality and visibility in Wyoming. Image galleries from state and federal sites show examples of good and poor visibility and unique events. The Air Quality info page provides more detailed information about various air quality topics. Links guide you to other web cams, air quality sites and agencies around the state.

The Air Quality Division is involved in many programs to protect and improve visibility in Wyoming and Class I areas. Please visit the Air Quality info page to find out more about the Wyoming Visibility Monitoring Network, including the Green River Basin Visibility Study, Northeast Wyoming Visibility Study, and the IMPROVE Visibility Monitoring Program.



Access live or gallery images data by selecting a site of interest from the map or the list in the left-hand frame.

# WYDEQ Monitoring Sites



# Jonah Basin Aerial Shot

## Proposed Jonah Infill Drilling Project:

Up to 3100 new gas wells would be drilled and developed, with associated ancillary facilities, on up to 16,200 acres of new surface disturbance.

Well spacing is expected to range from the current 16 wells per 640-acre section (40-acre spacing) to 128 wells per section (5-acre well spacing).





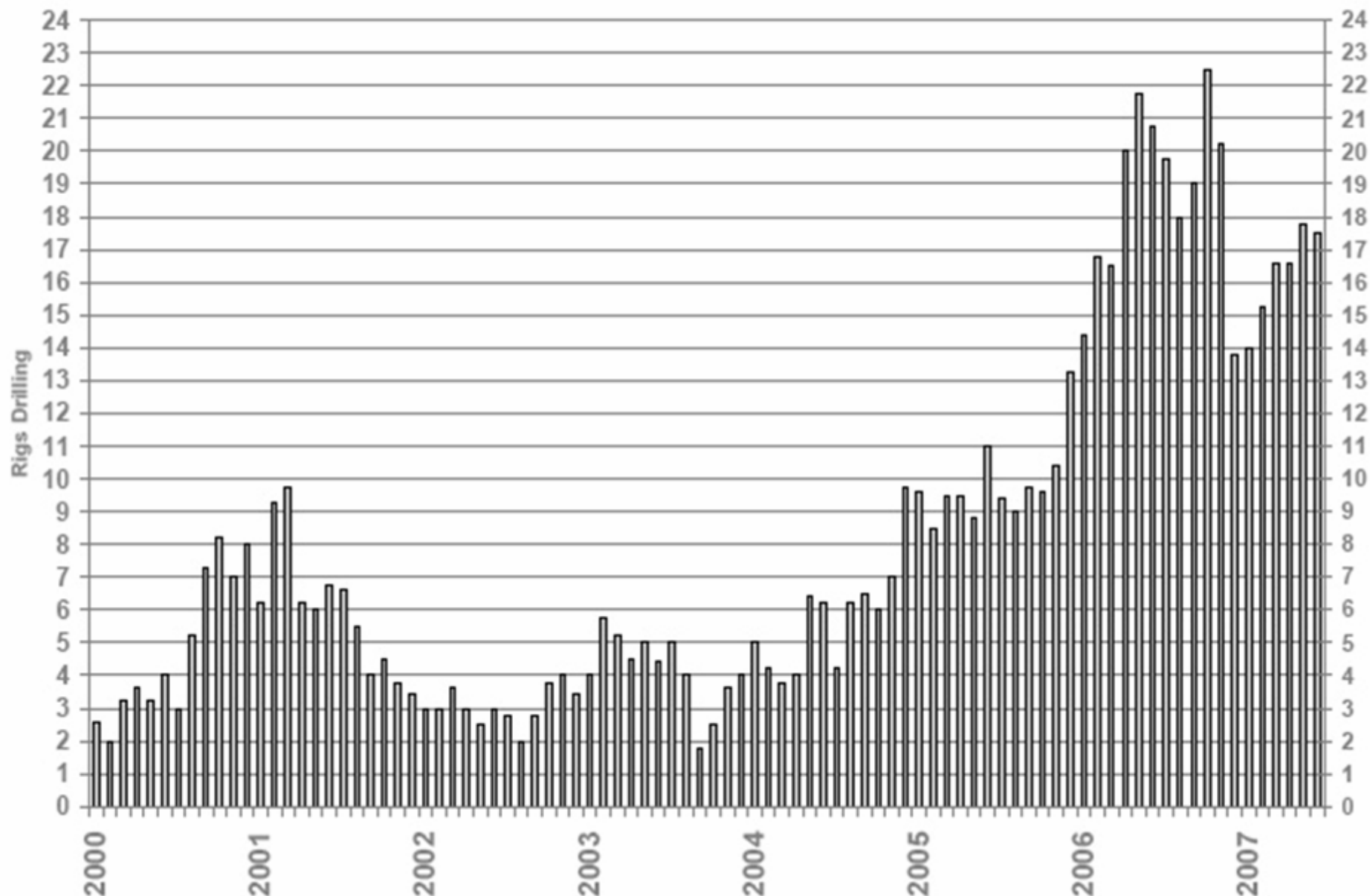
# Wind River Mts. & Drill Rig



# Rigs Drilling in the Jonah Field by Month 1/1/00 - 7/1/07

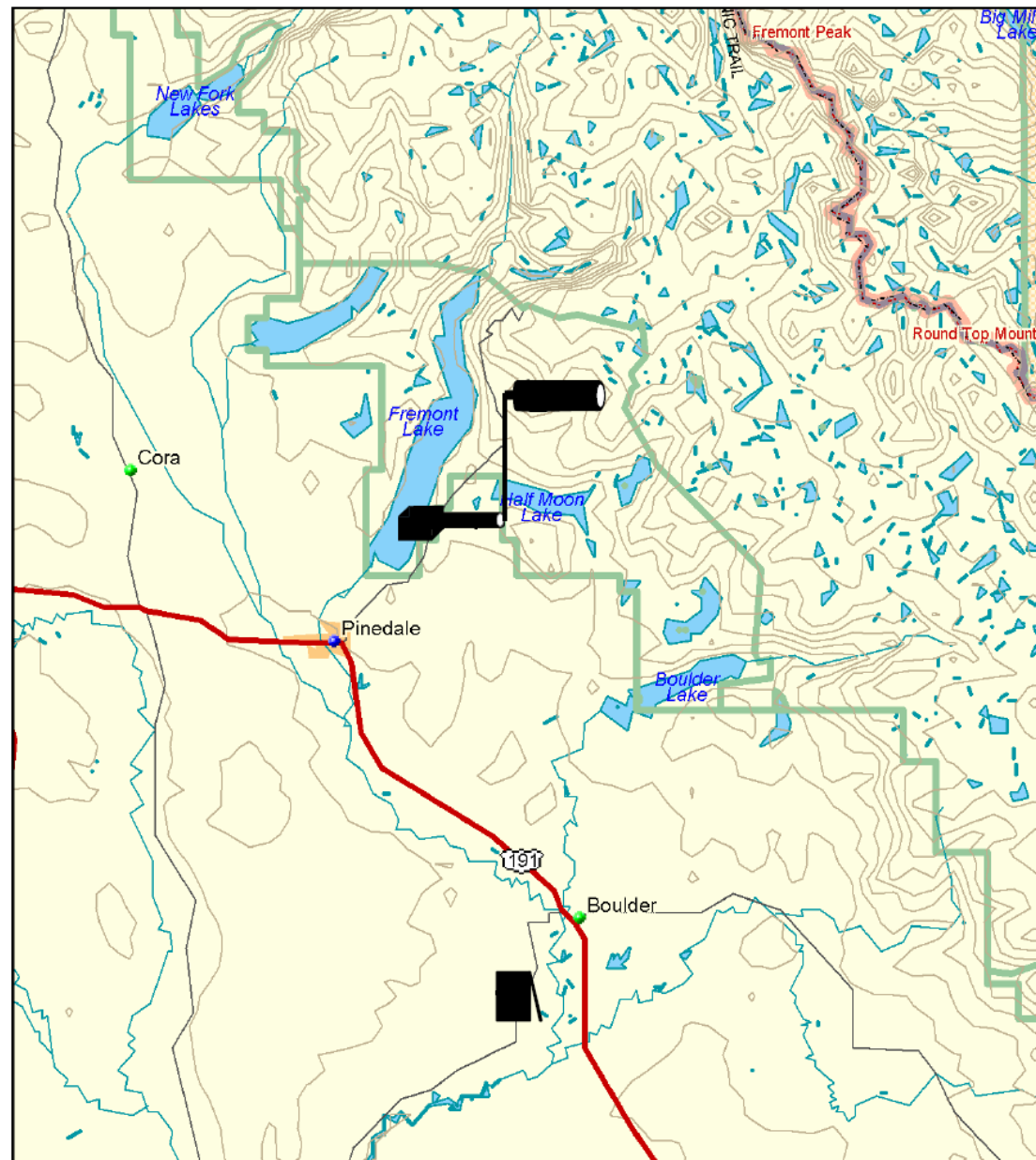
Source: Divestco Inc.

Compiled By: Jeffrey Jacquet | [www.sublette-se.org](http://www.sublette-se.org)



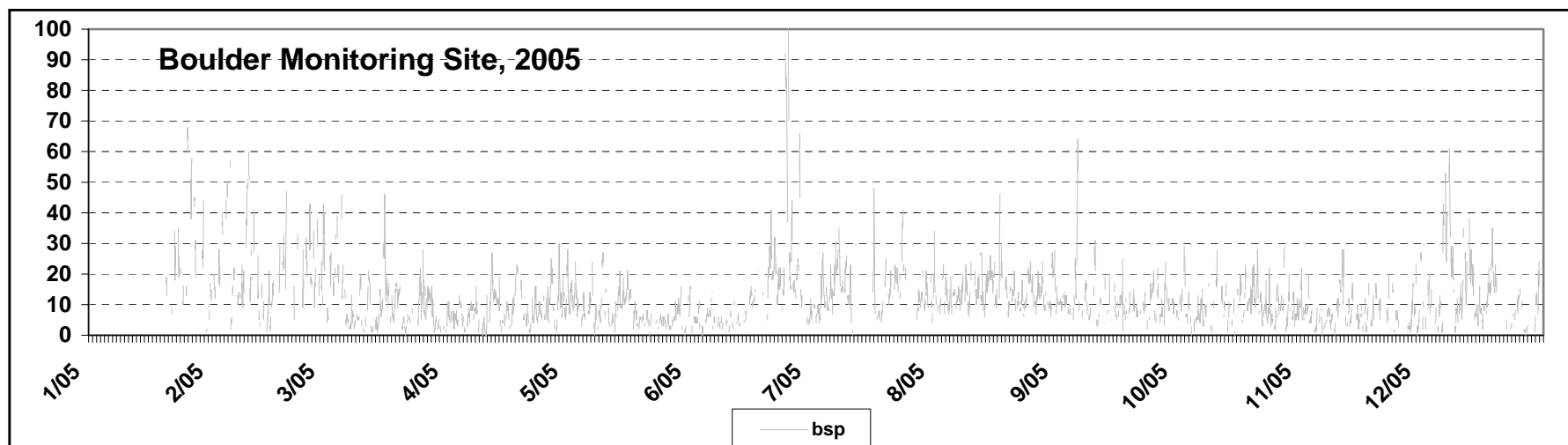
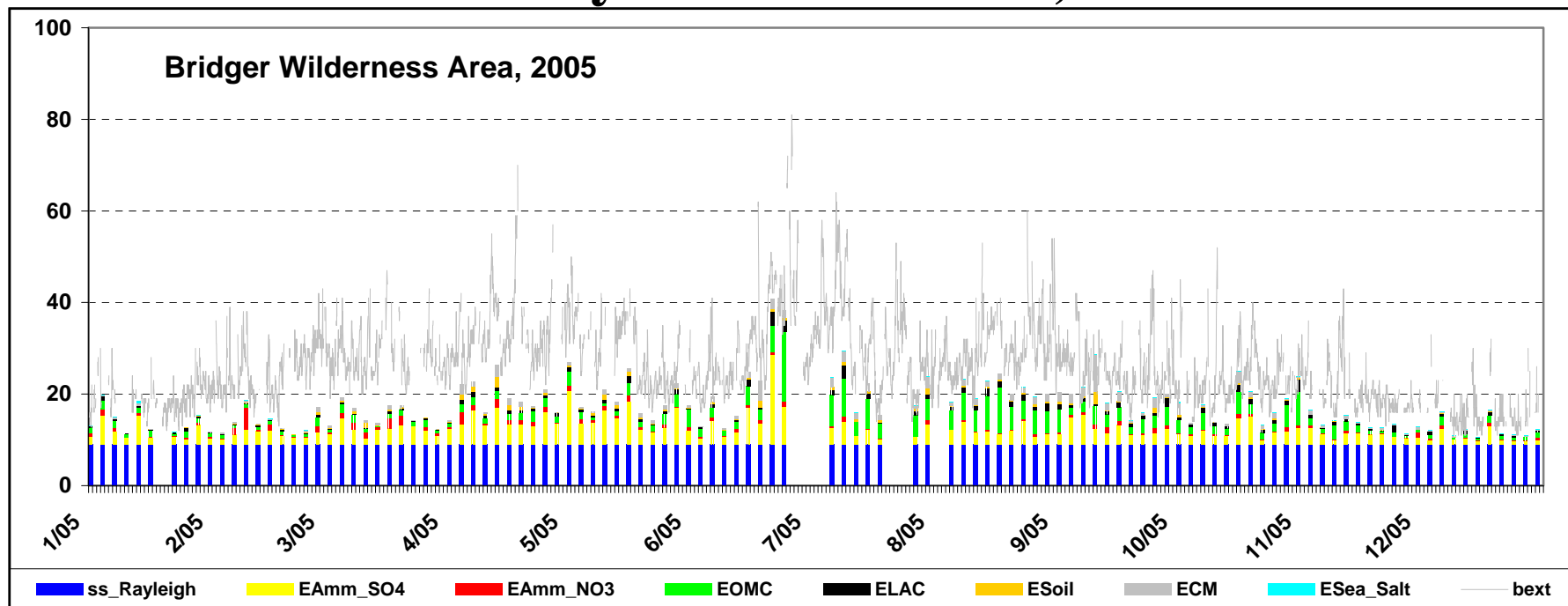
## Western WY Visibility Measurements:

- **Bridger Transmissometer (continuous)**
- **Bridger IMPROVE Monitor (every third day)**
- **Boulder Nephelometer (continuous)**



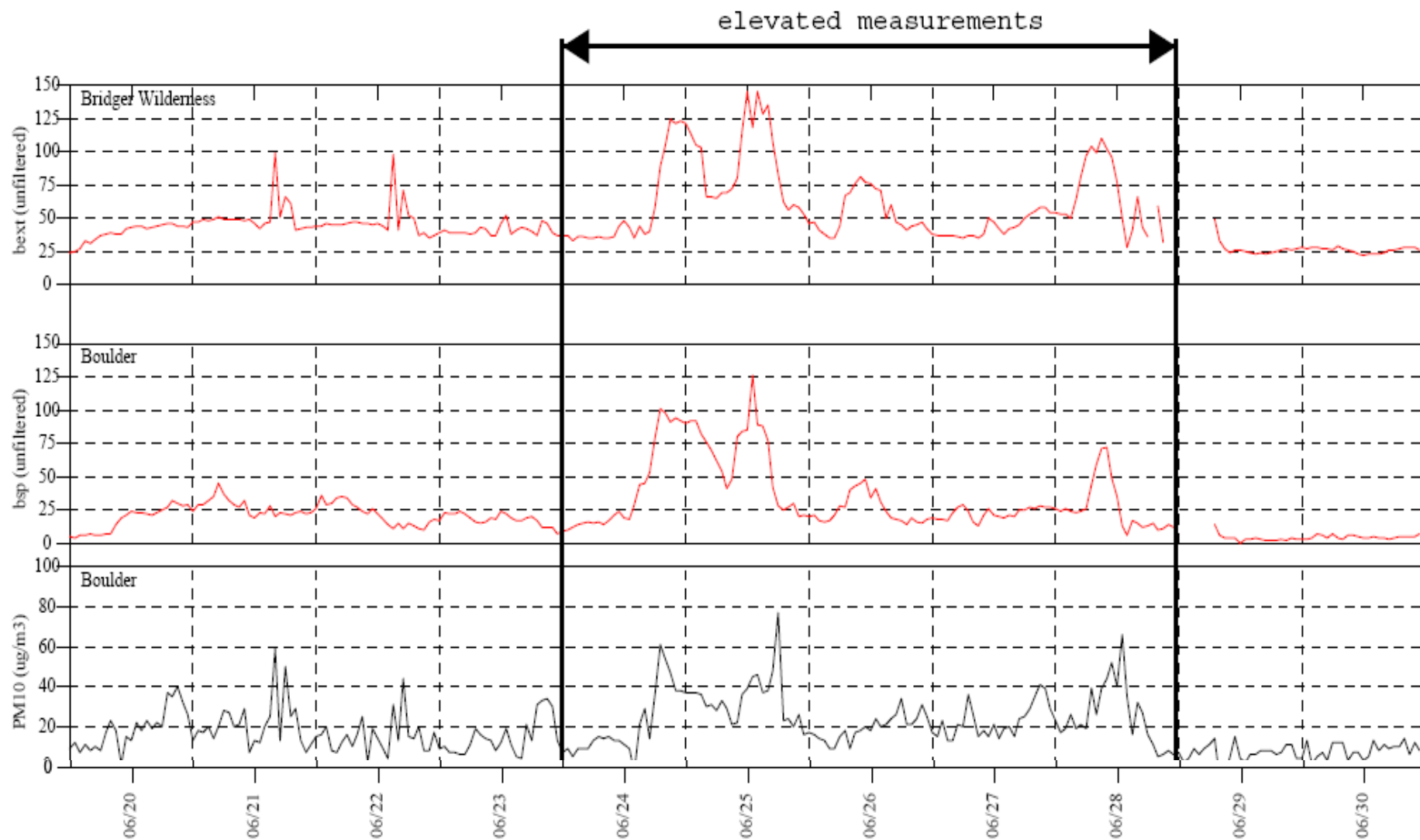
- = Nephelometer
- ▭ = Transmissometer Receiver
- ▭ = Transmissometer Transmitter

# Visibility Measurements, 2005





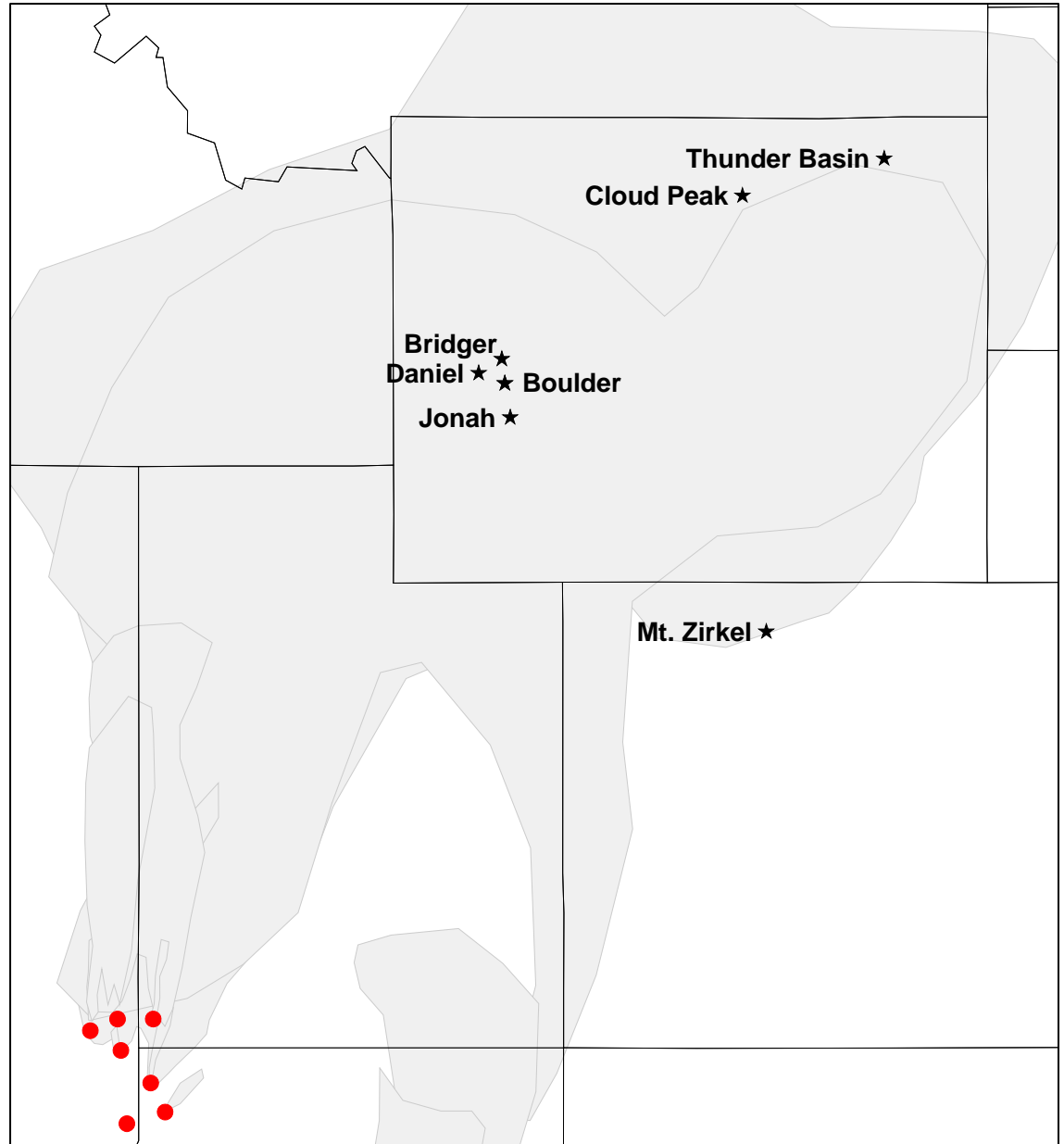
# Visibility Measurements, 2005



# HMS Analyzed Smoke on June 25, 2005

- Red dots indicate HMS detected hotspots

- Grey masses indicate analyzed smoke.

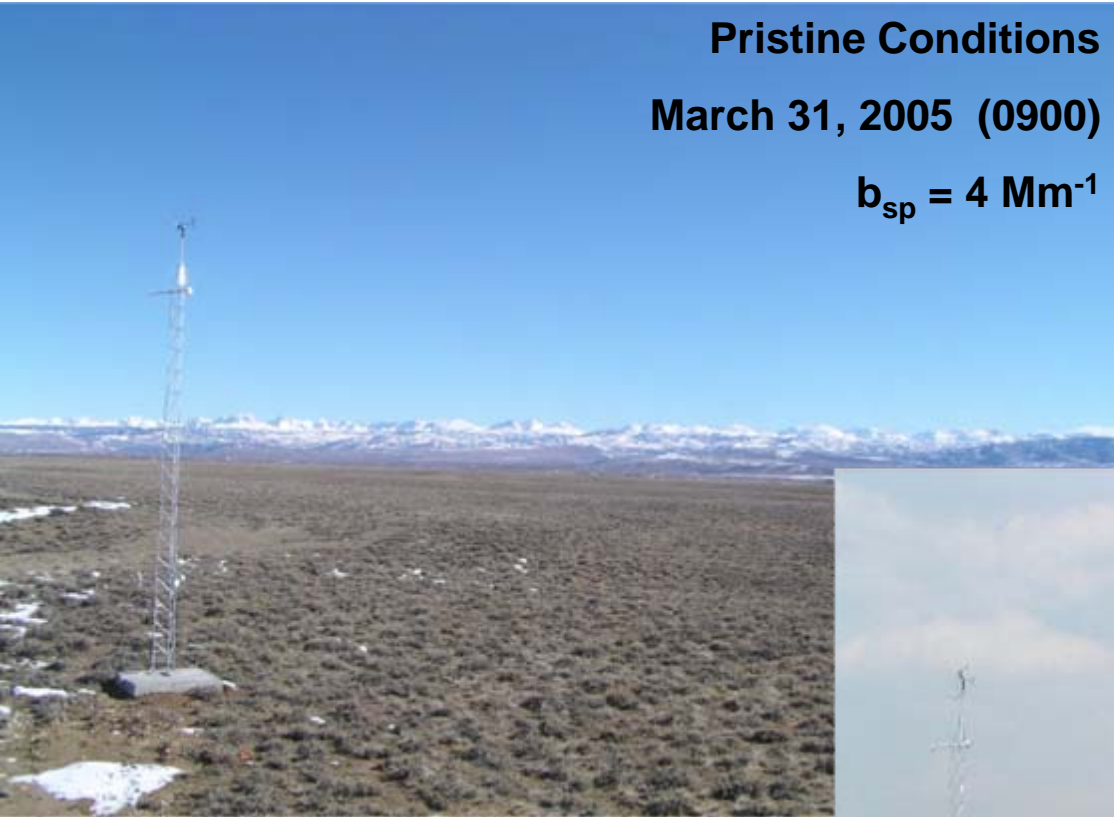


# Boulder Monitoring Site

**Pristine Conditions**

**March 31, 2005 (0900)**

$$b_{sp} = 4 \text{ Mm}^{-1}$$



**Hazy Conditions**

**June 25, 2005 (1300)**

$$b_{sp} = 125 \text{ Mm}^{-1}$$



**Boulder Monitoring Site**  
**September 20, 2005 (1630)**





# Camera Images, Summer 2006

**Jonah**

**July 25, 2006 (0900)**

**Smoke visible between 0900 and 1000**



# Ammonia Monitoring at Boulder Site

Funded by Shell Oil and Gas

# Why is Shell interested in Ammonia?

- Initial CalPuff modeling of  $\text{NO}_x$  emissions from Shell drilling rigs indicated visibility impacts in Bridger Wilderness from Nitrates
- Default background value in CalPuff is 1.0 ppb
- Shell wants to use actual  $\text{NH}_3$  concentrations in future CalPuff modeling
- Pilot study 12/2006 – 3/2007
- Funded full year of monitoring April, 2007 – March, 2008

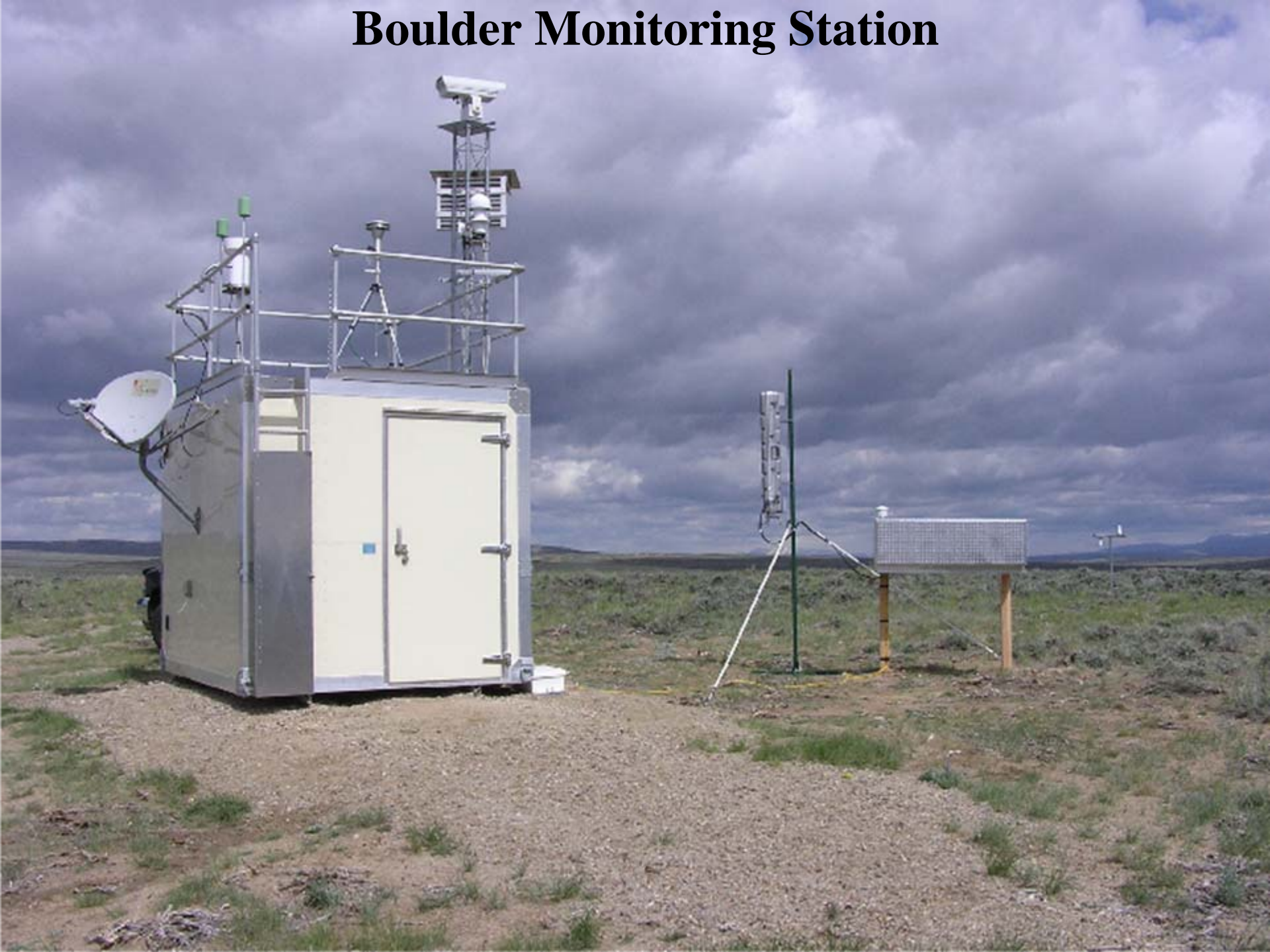
A dual channel URG denuder/filter-pack sampler is used to collect twice weekly samples ( 3 day & 4 day) of ambient trace gas ( $\text{NH}_3$  and  $\text{HNO}_3$ ) and  $\text{PM}_{2.5}$  aerosol species ( $\text{NH}_4^+$ ,  $\text{NO}_3^-$ ,  $\text{SO}_4^{2-}$ ) concentrations.

Sampler installation was coordinated by Air Resource Specialists (ARS) and Colorado State University (CSU). Sample train preparation, extraction, and analysis is performed by CSU. Sampler operation is performed by a local site operator, with supervision from CSU and ARS.

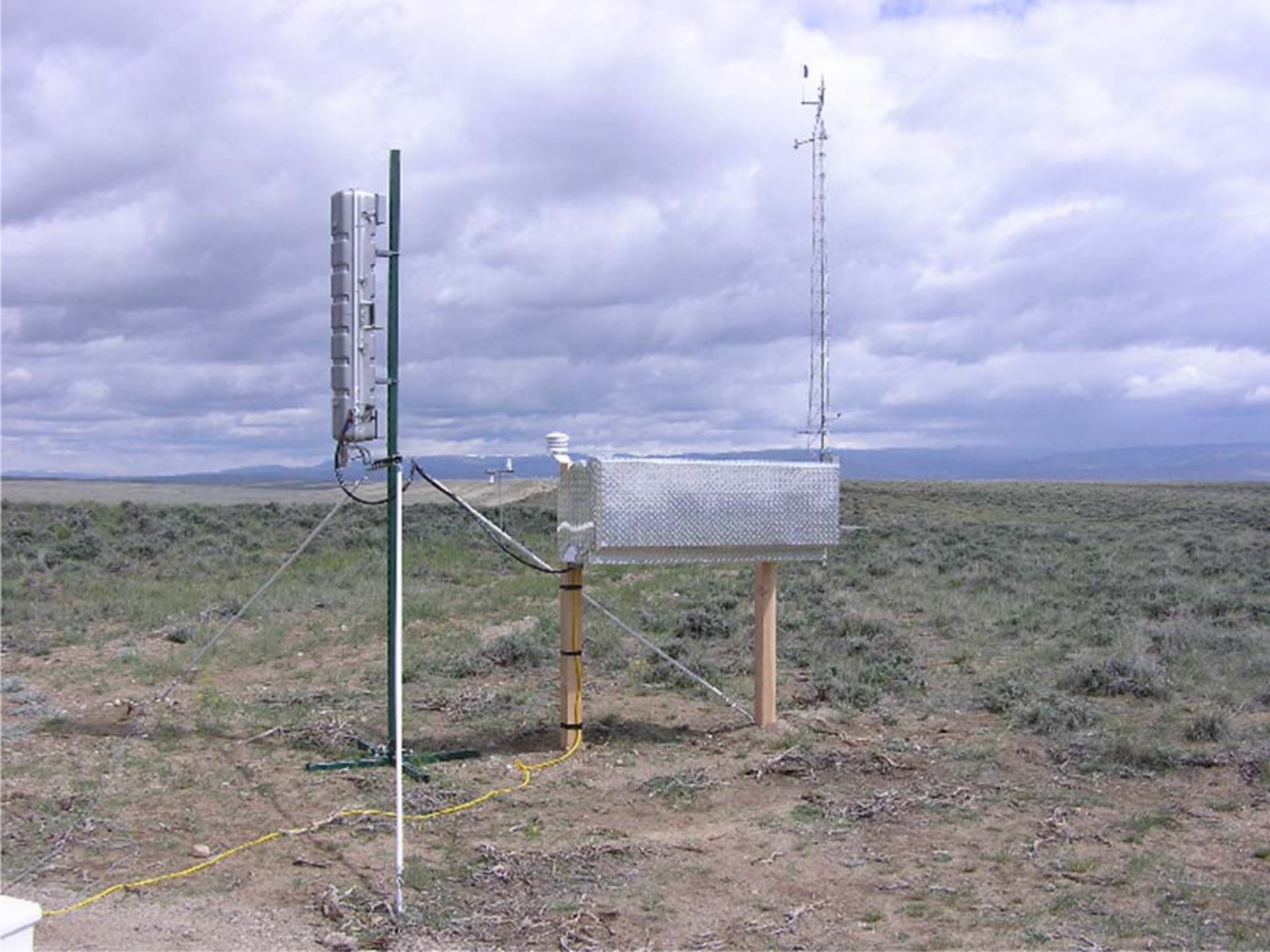
Sampling began 12/15/2006 and will continue until March 31, 2008



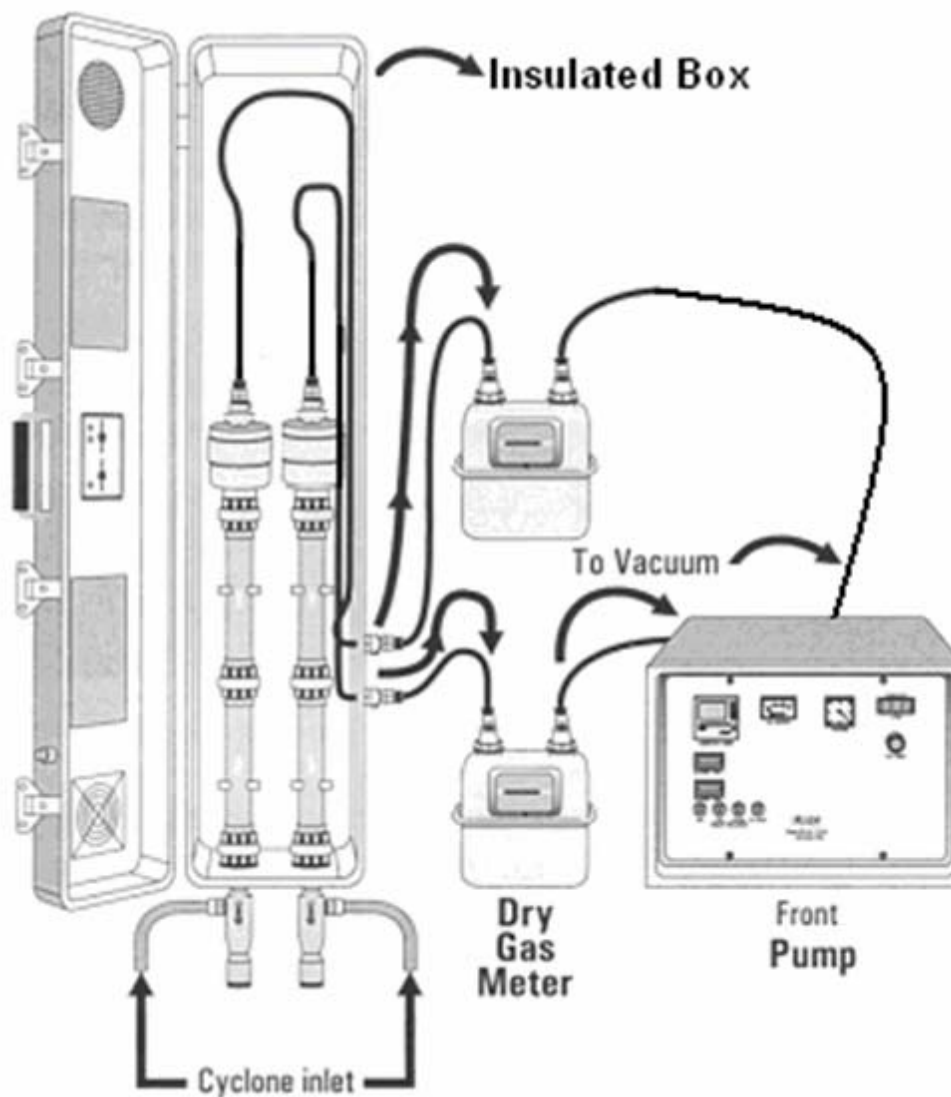
# Boulder Monitoring Station



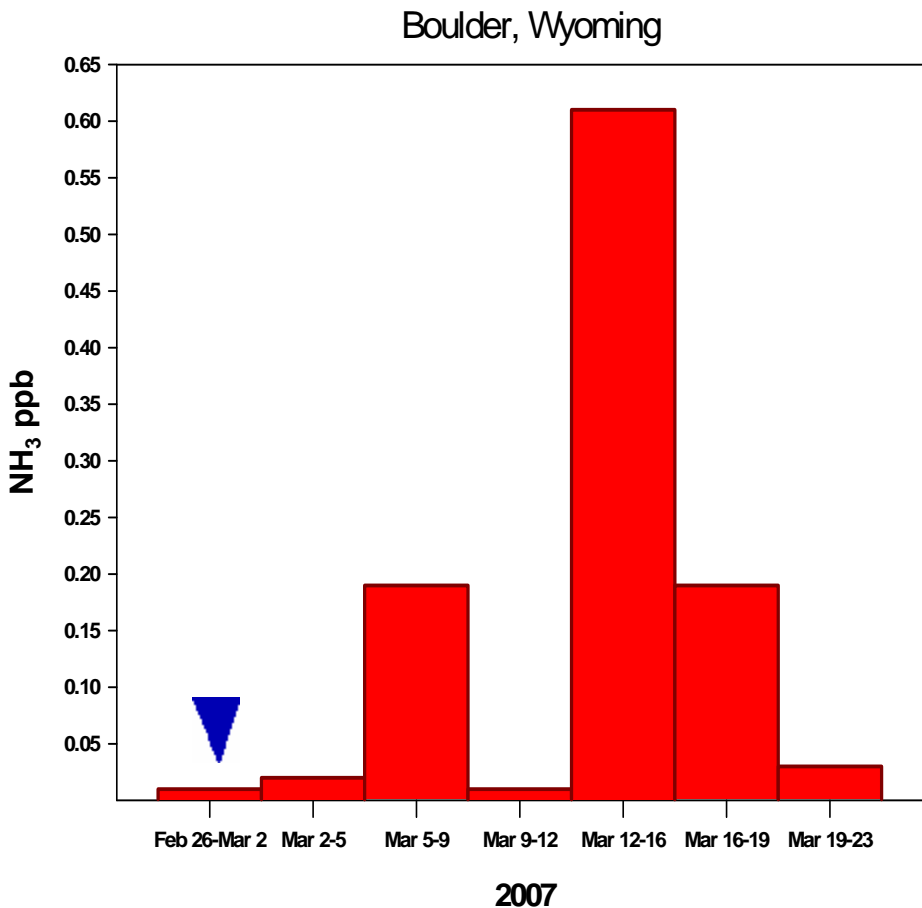




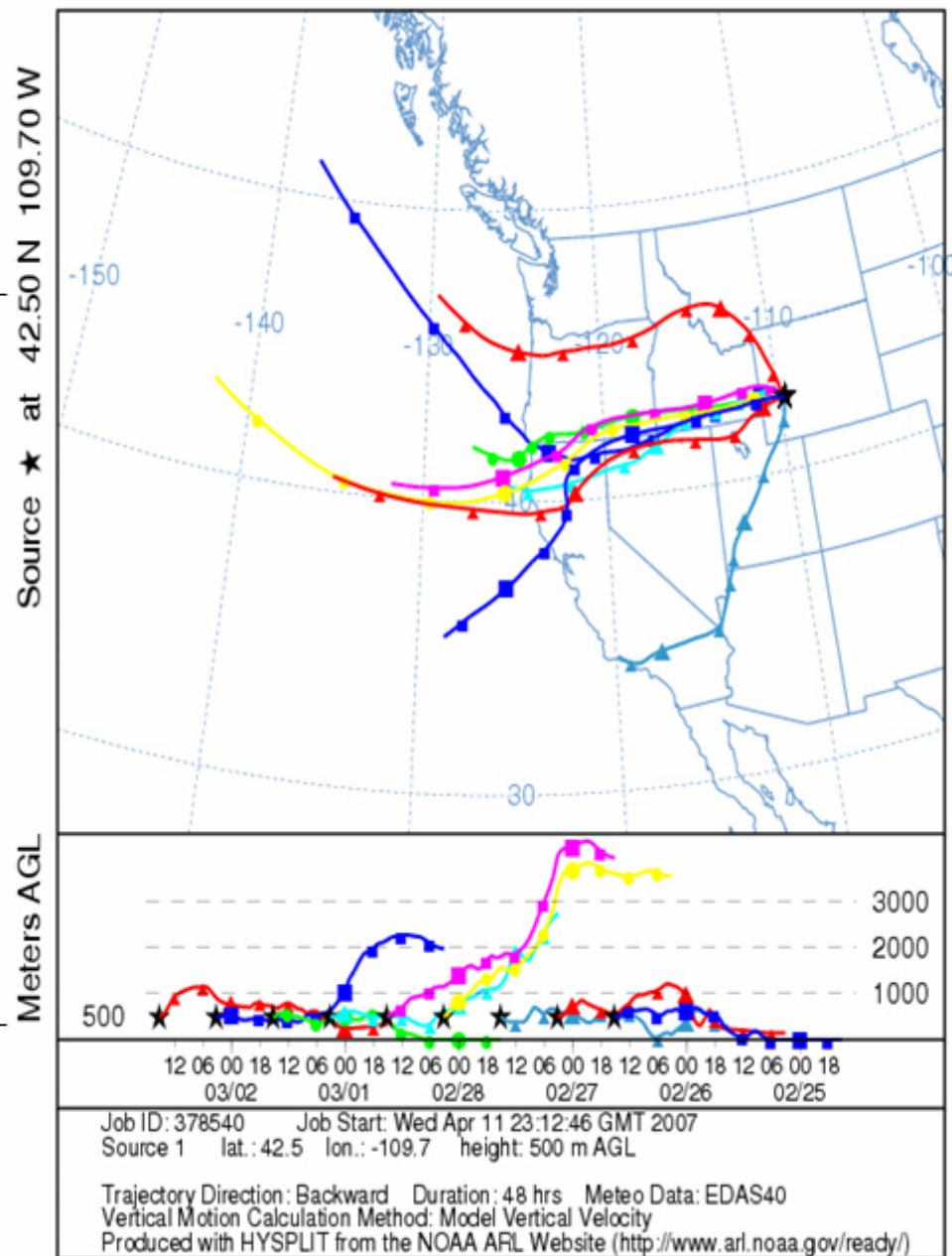
## Schematic of a dual channel URG annular denuder/filter pack system



# Feb 26- Mar 5, 2007



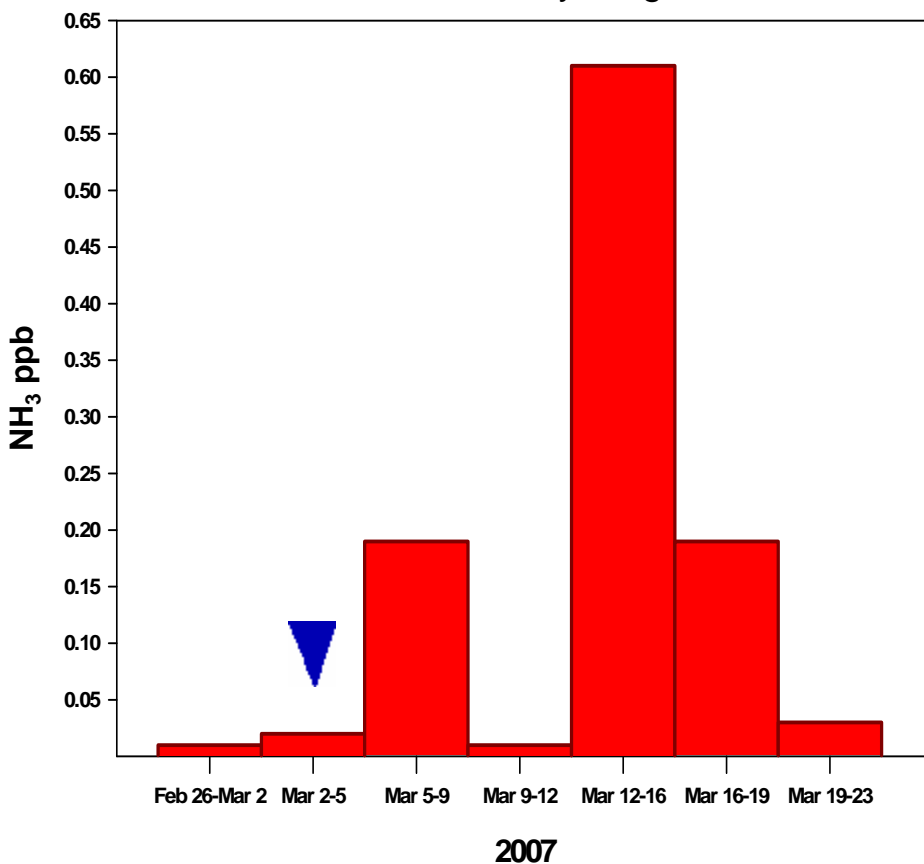
NOAA HYSPLIT MODEL  
Backward trajectories ending at 15 UTC 02 Mar 07  
EDAS Meteorological Data



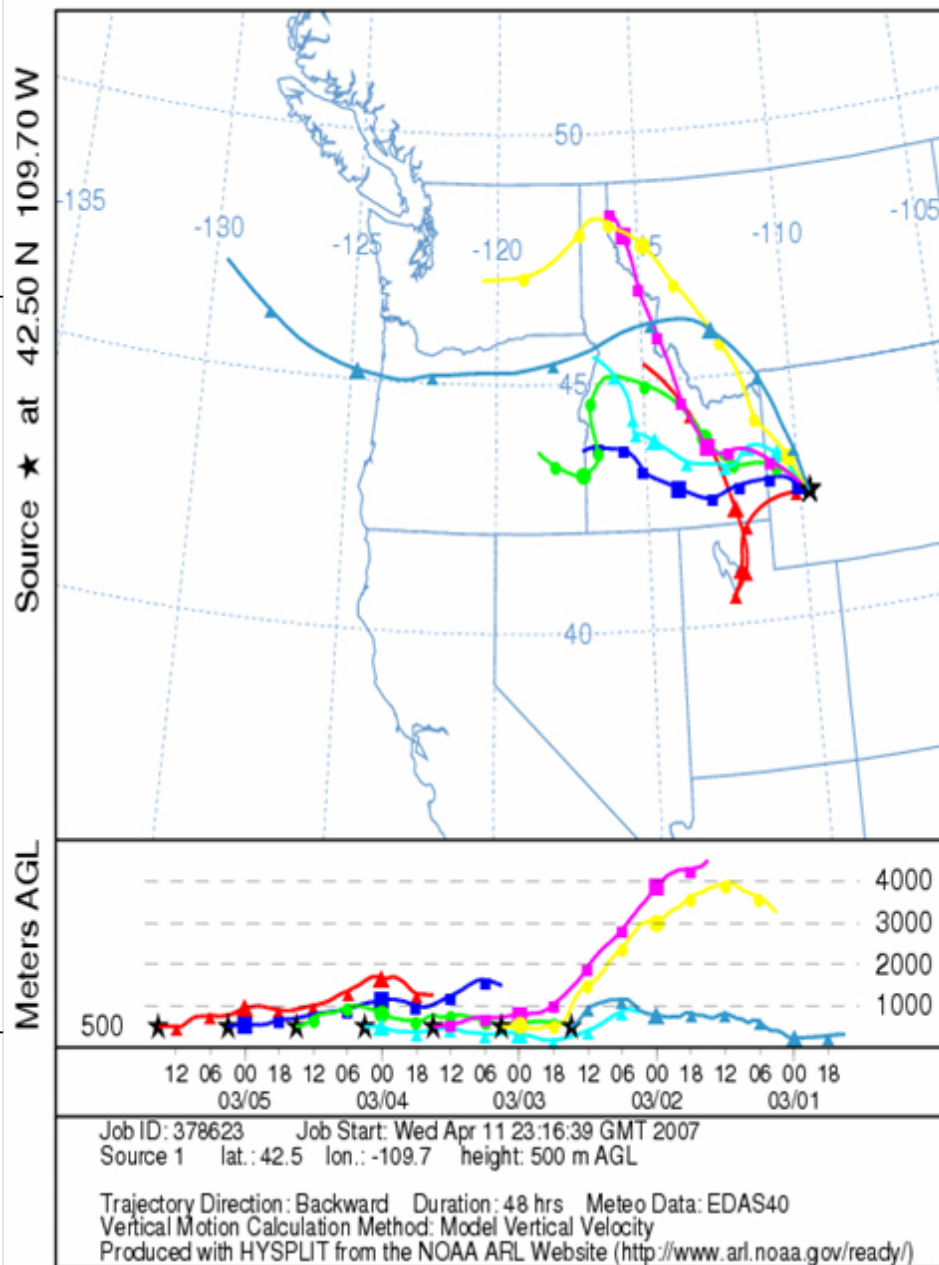


# March 2-5, 2007

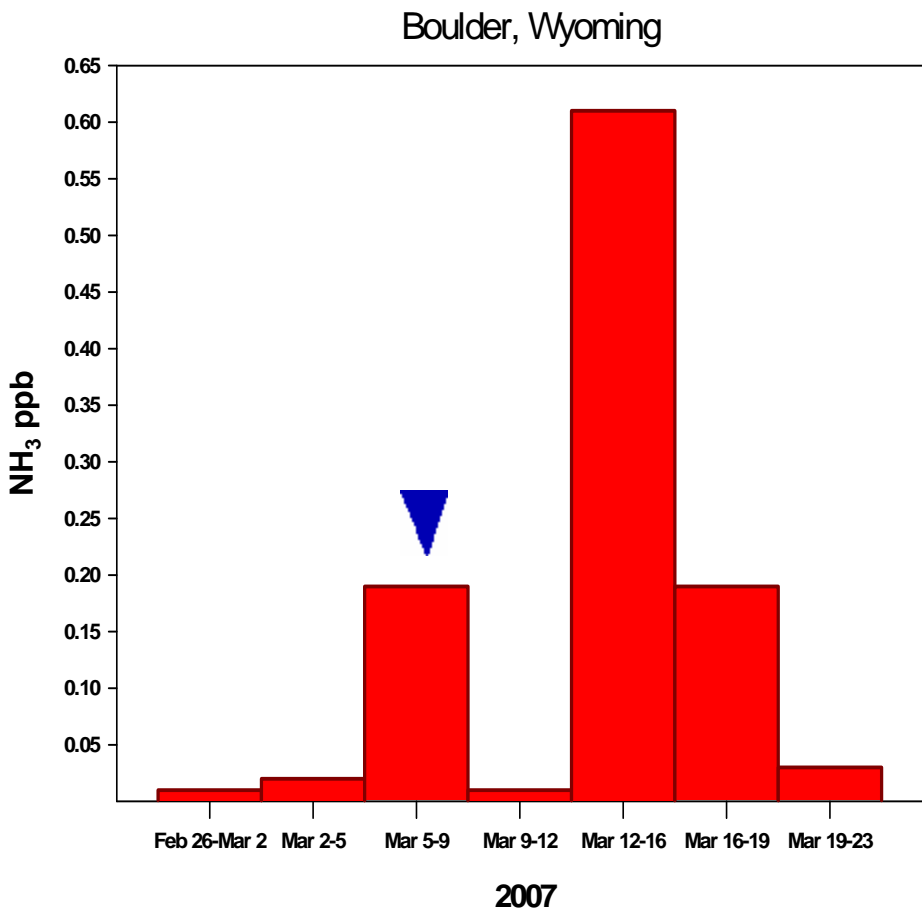
Boulder, Wyoming



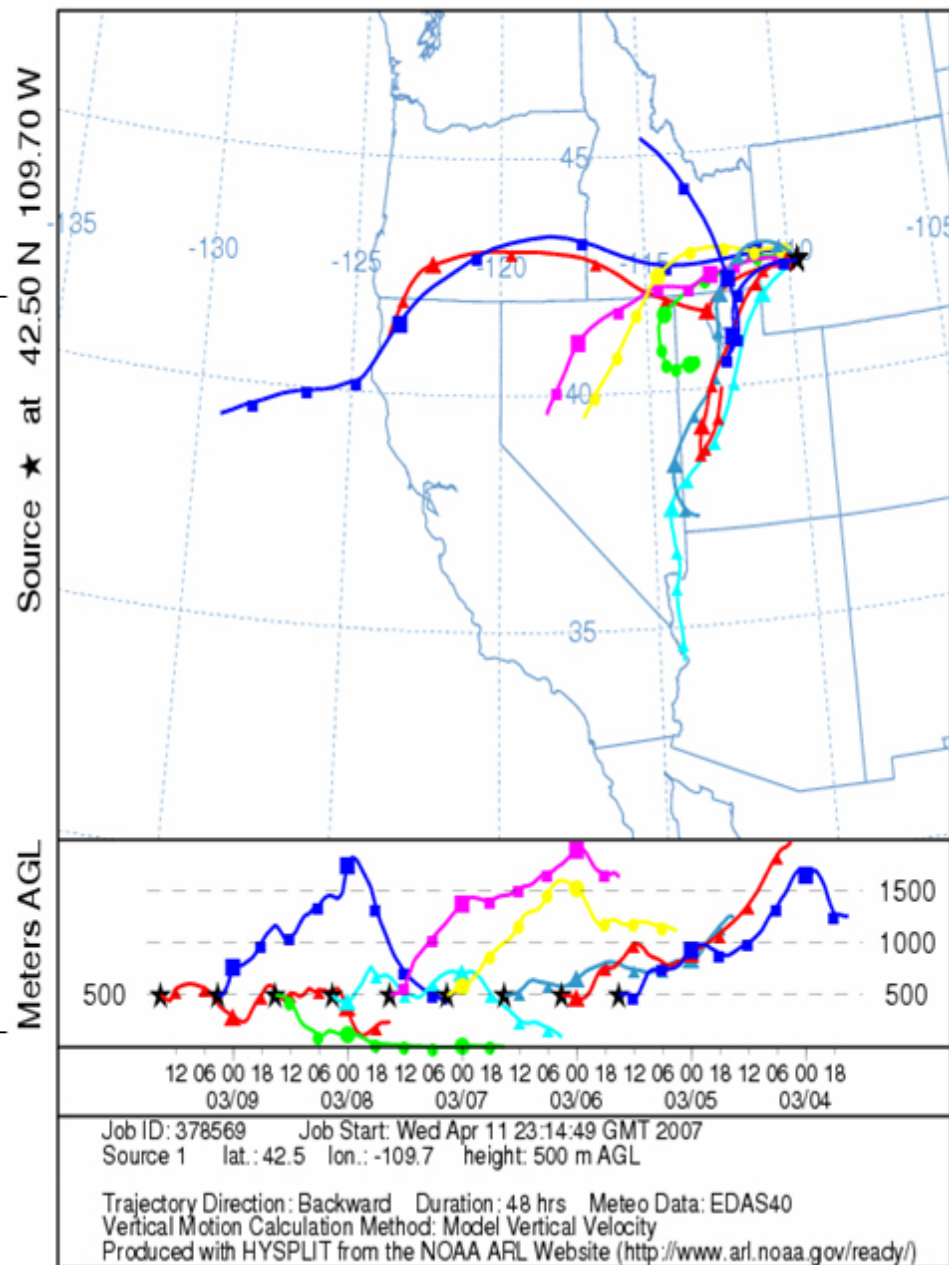
NOAA HYSPLIT MODEL  
Backward trajectories ending at 15 UTC 05 Mar 07  
EDAS Meteorological Data



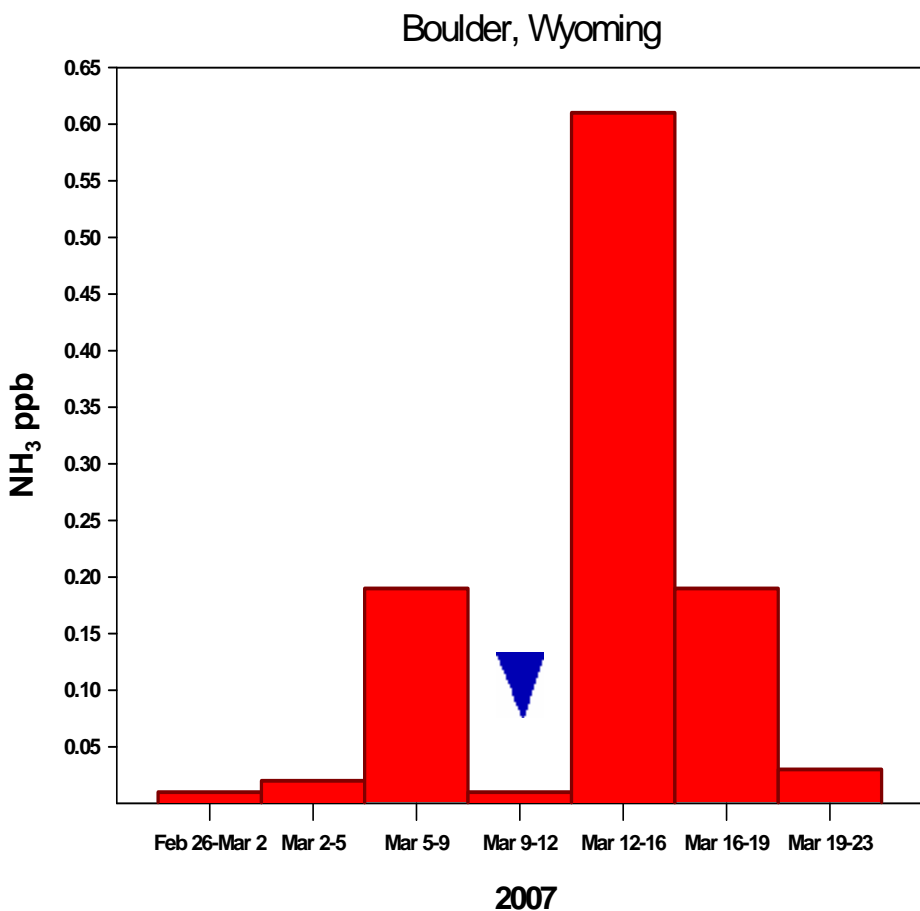
# March 5-9, 2007



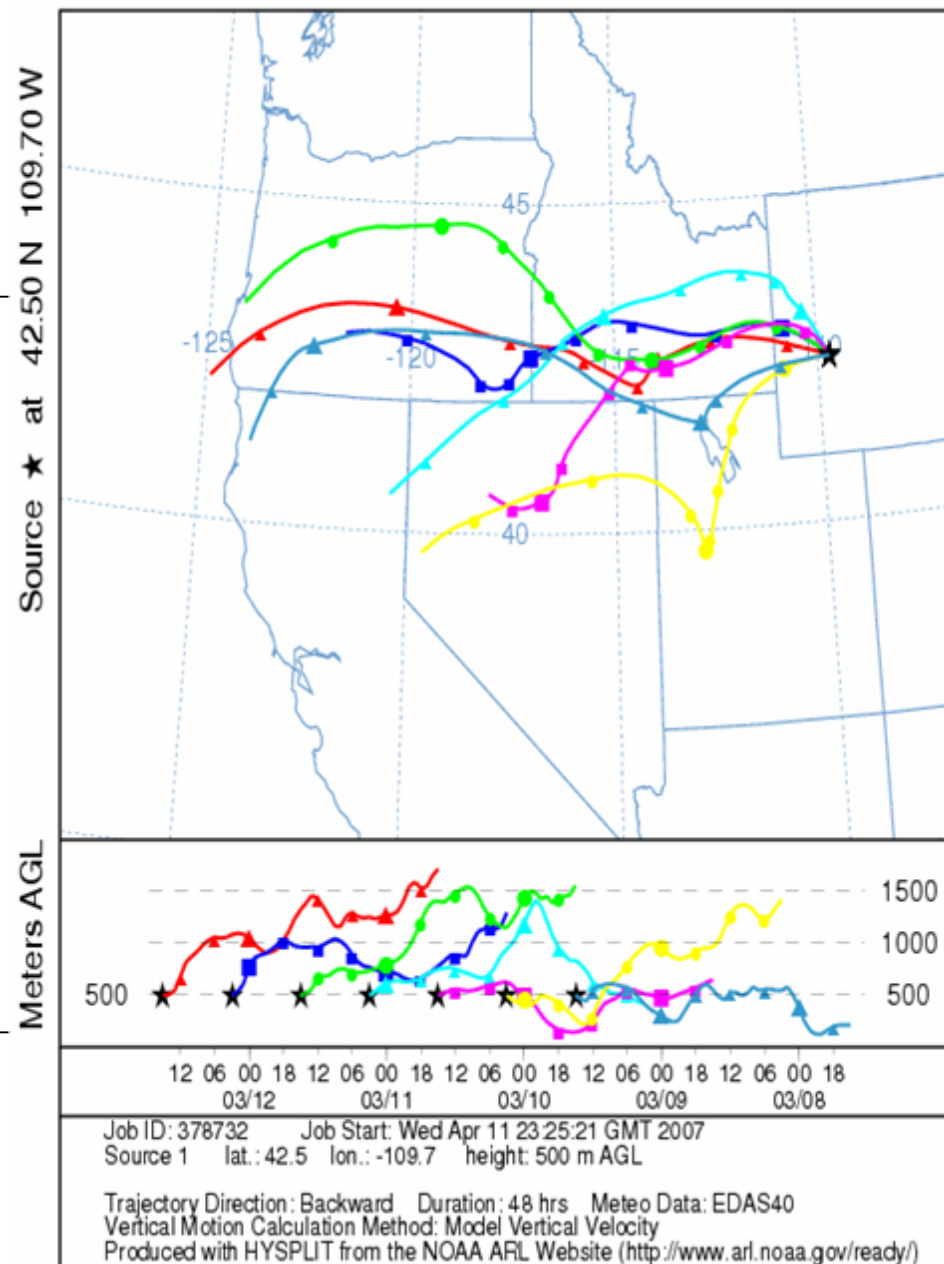
NOAA HYSPLIT MODEL  
Backward trajectories ending at 15 UTC 09 Mar 07  
EDAS Meteorological Data



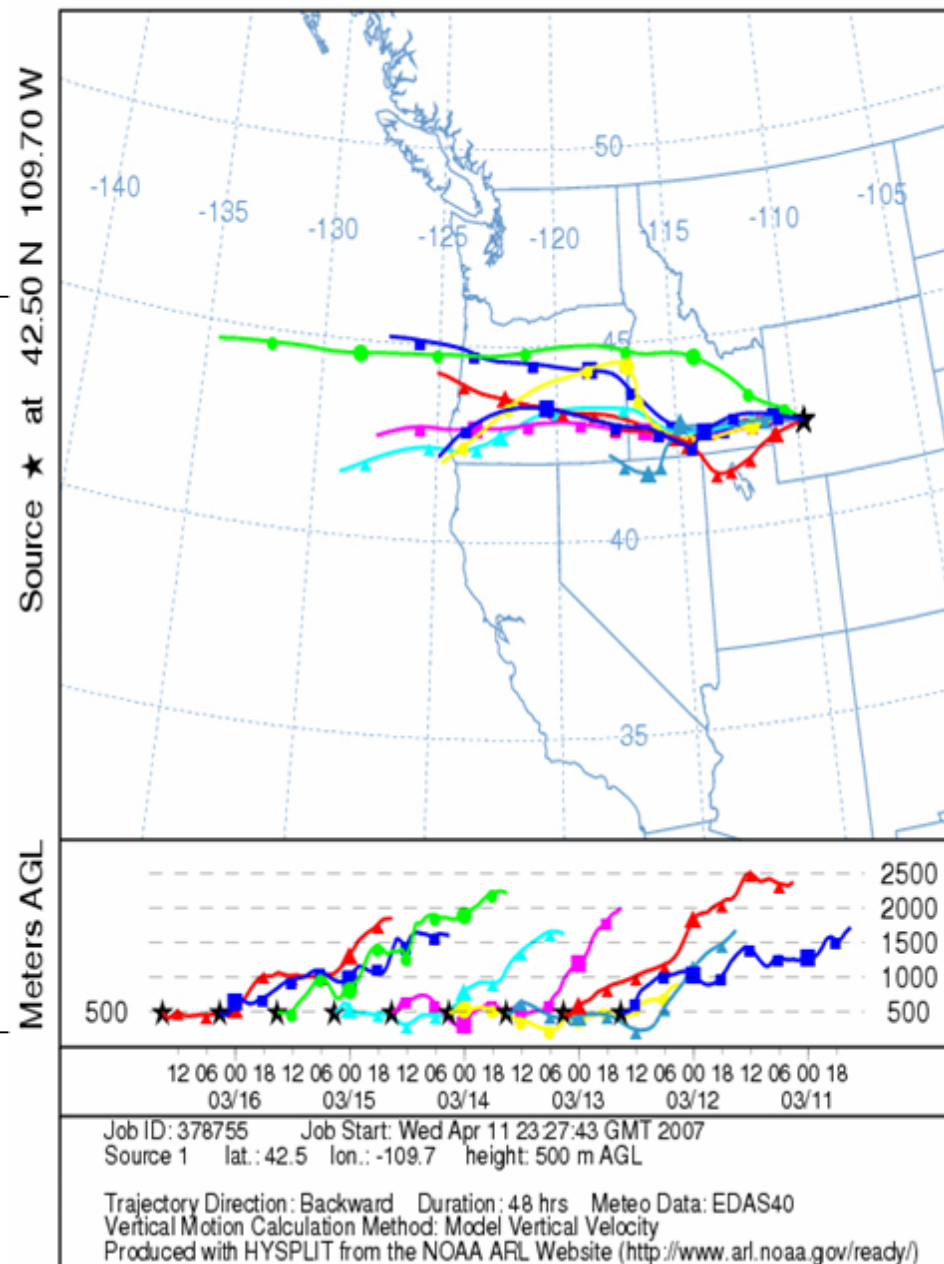
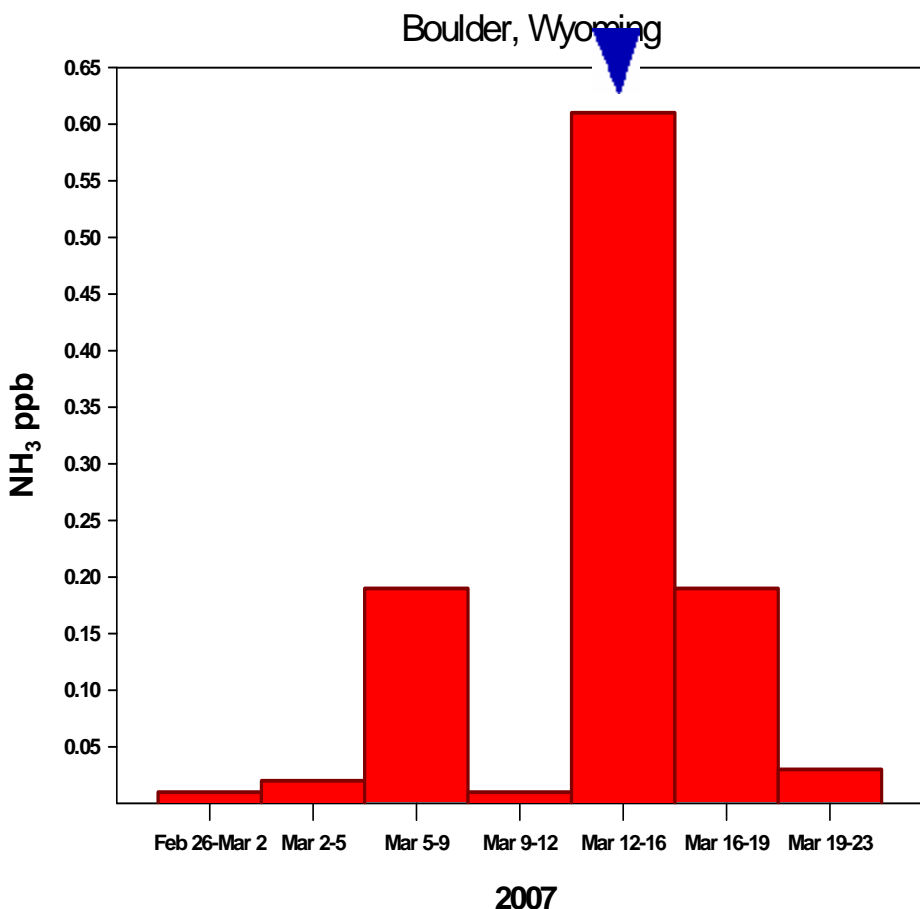
# March 9-12, 2007



NOAA HYSPLIT MODEL  
Backward trajectories ending at 15 UTC 12 Mar 07  
EDAS Meteorological Data

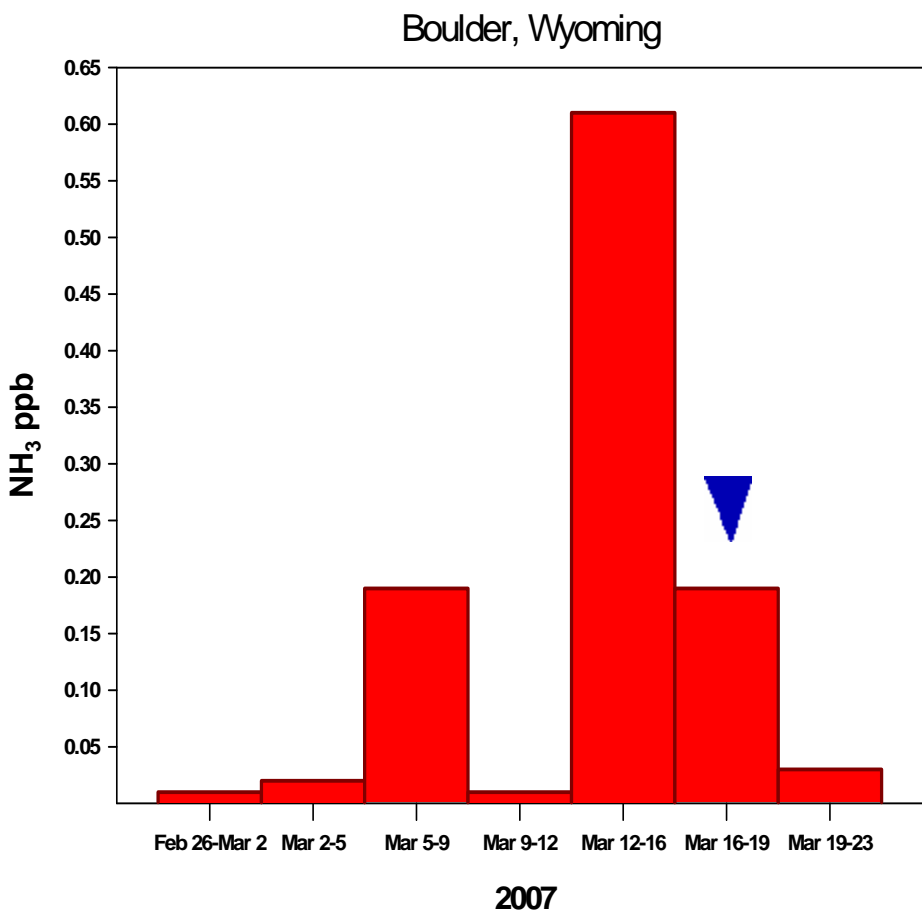


# March 12-16, 2007

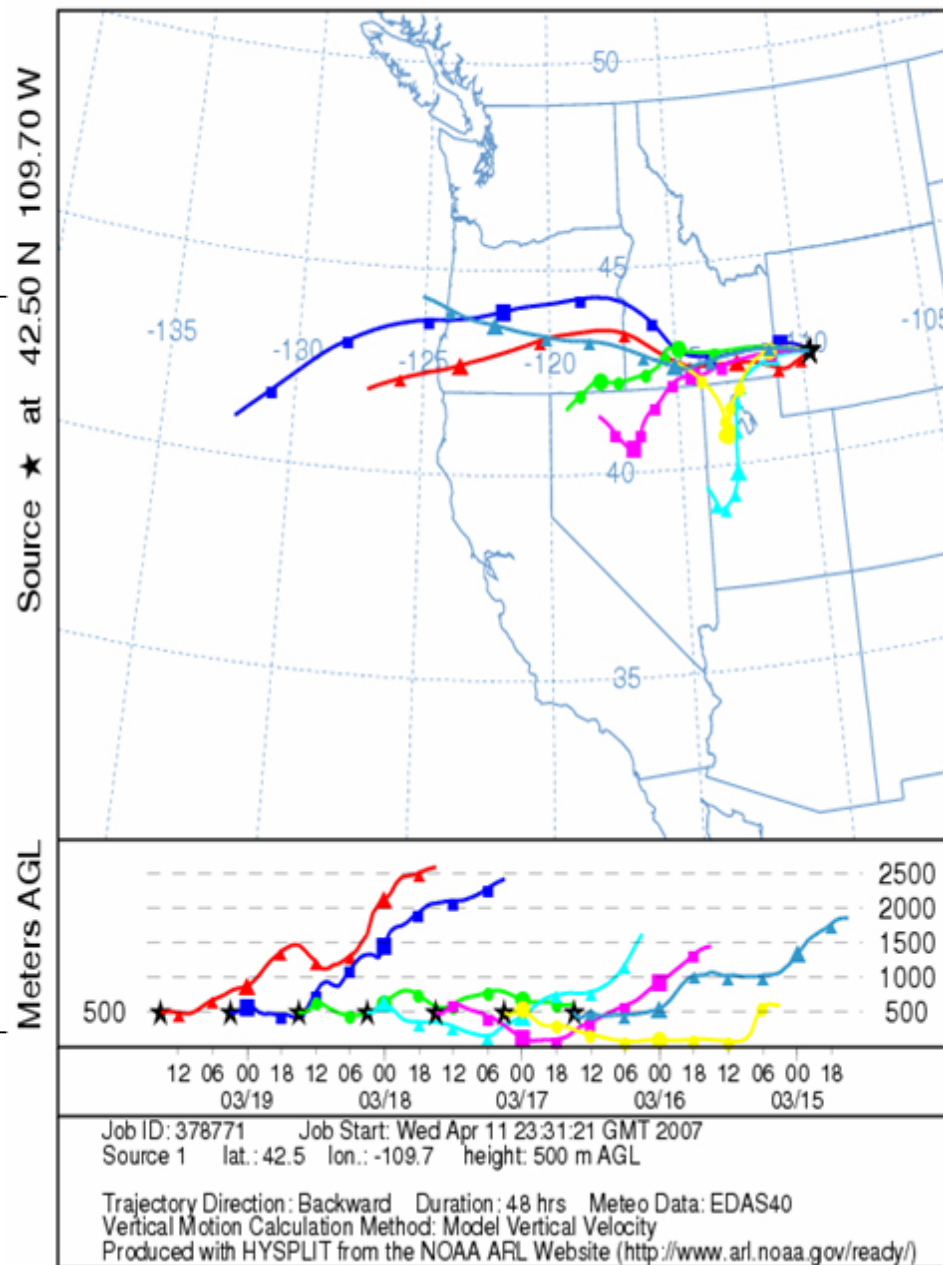




# March 16-19, 2007

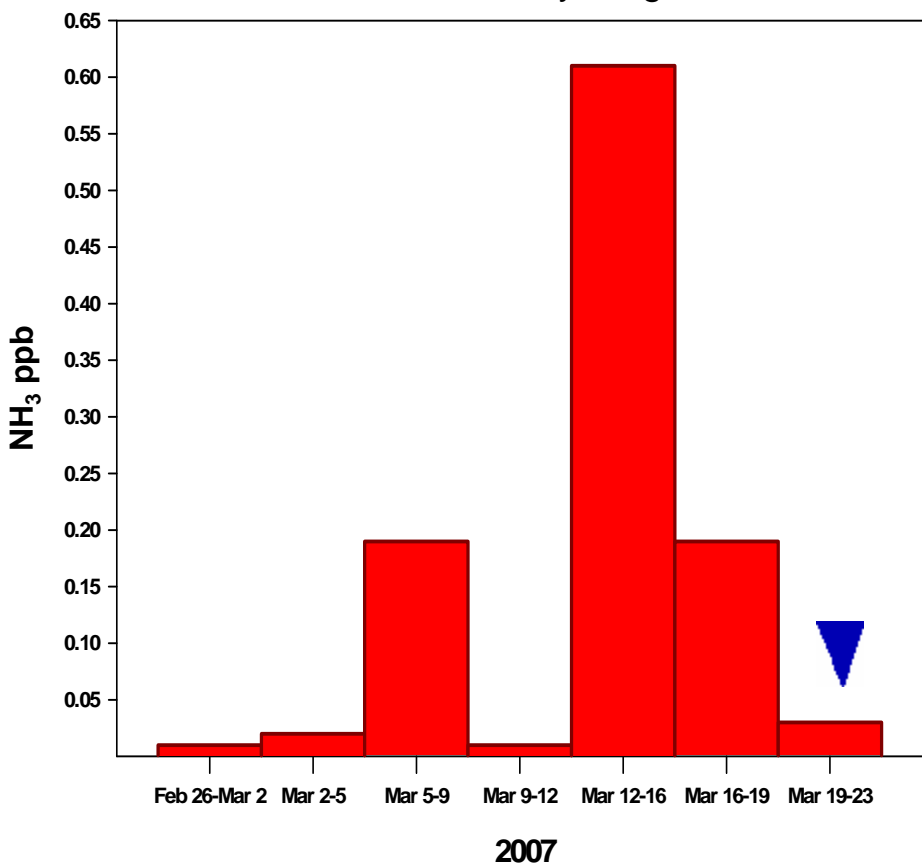


NOAA HYSPLIT MODEL  
Backward trajectories ending at 15 UTC 19 Mar 07  
EDAS Meteorological Data

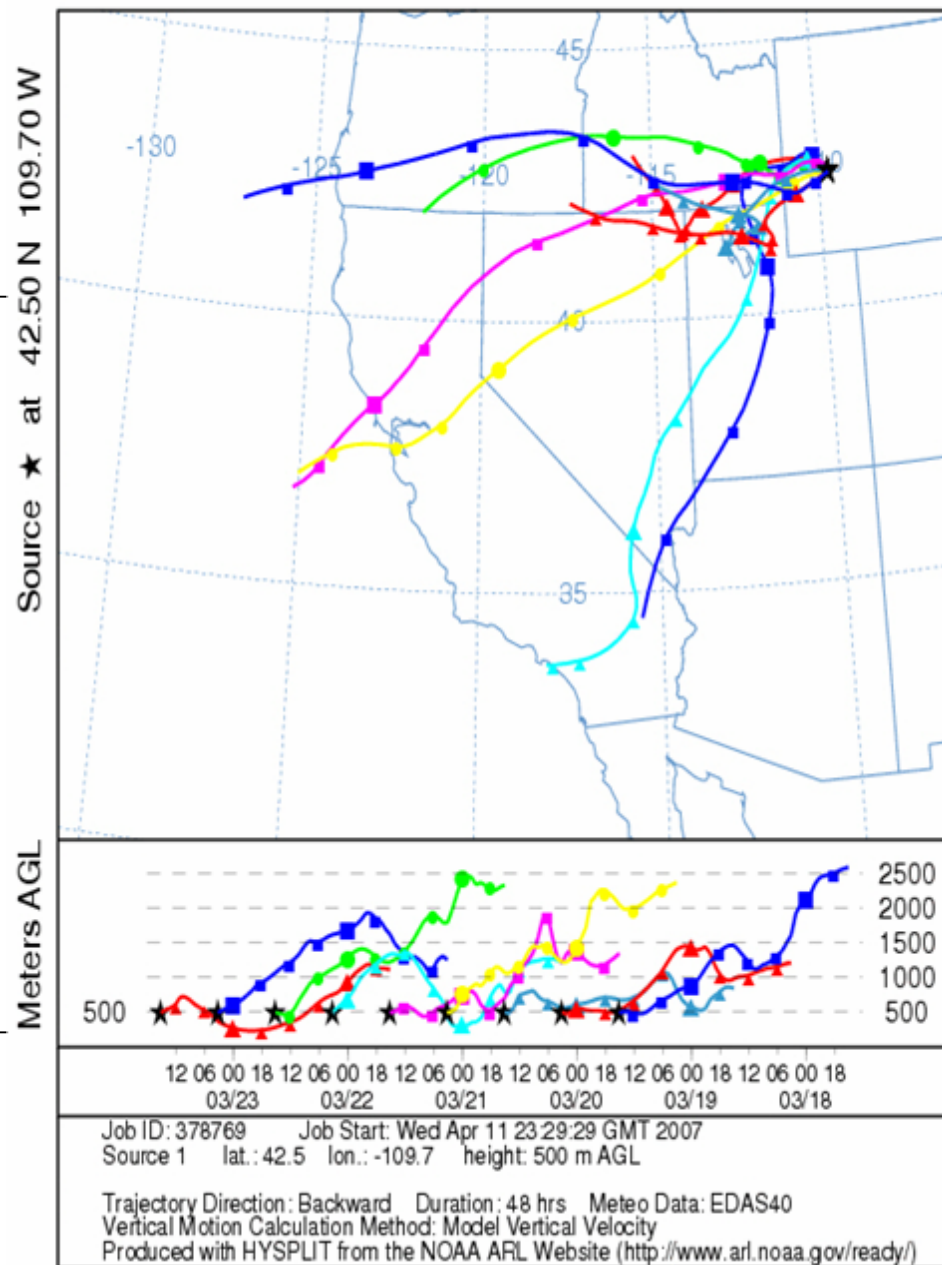


# March 19-23, 2007

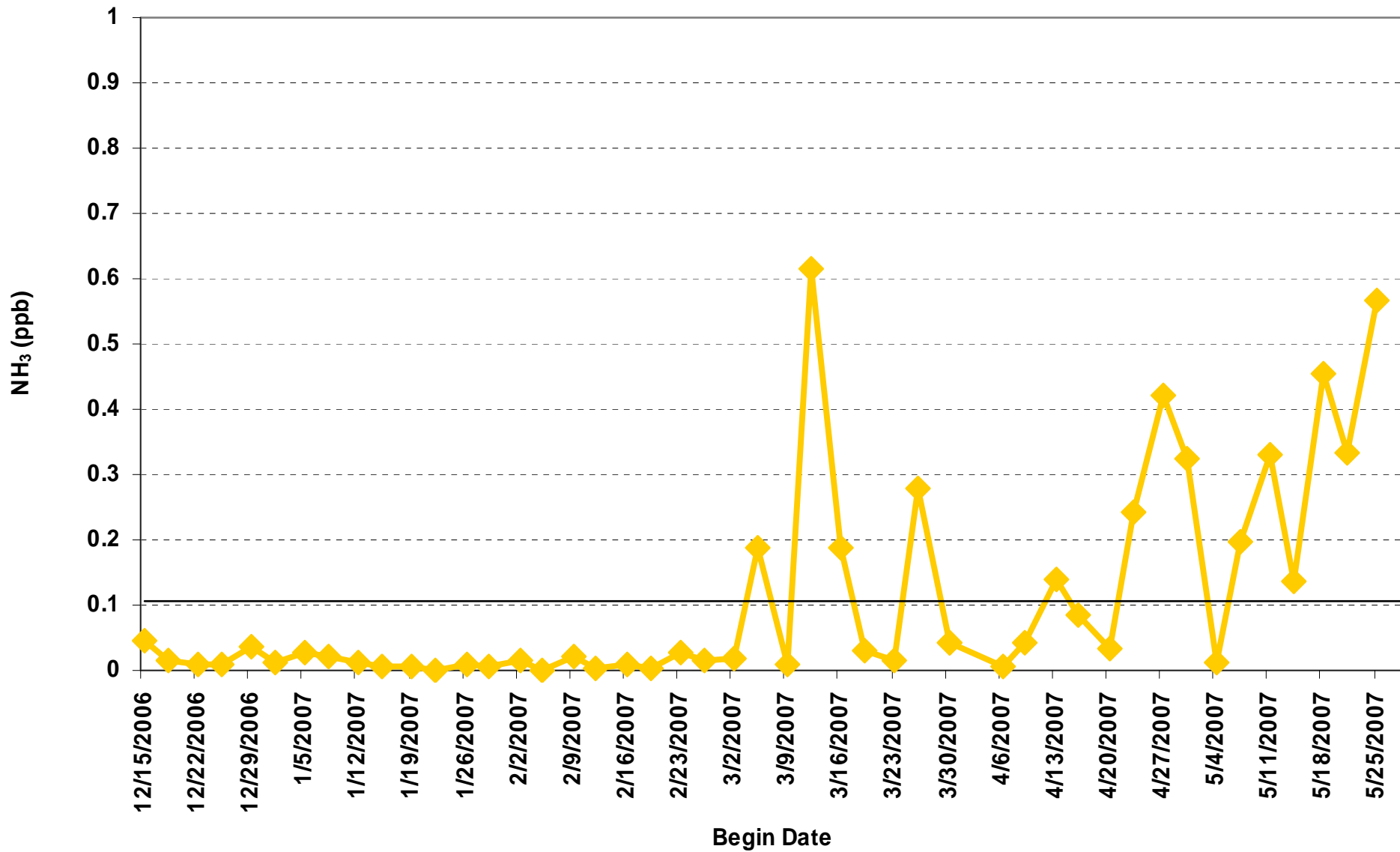
Boulder, Wyoming



NOAA HYSPLIT MODEL  
Backward trajectories ending at 15 UTC 23 Mar 07  
EDAS Meteorological Data

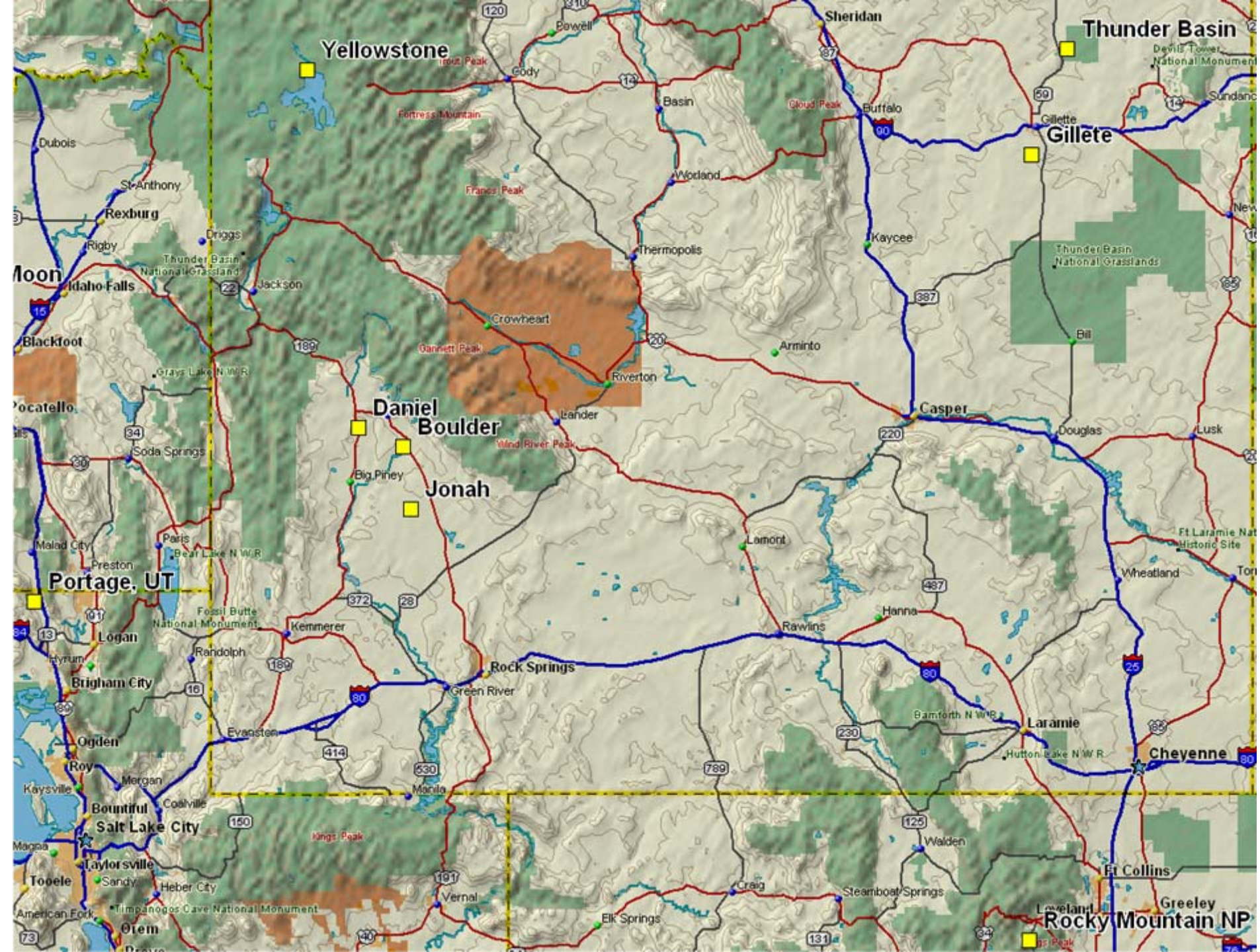


# Boulder, WY Ammonia Study



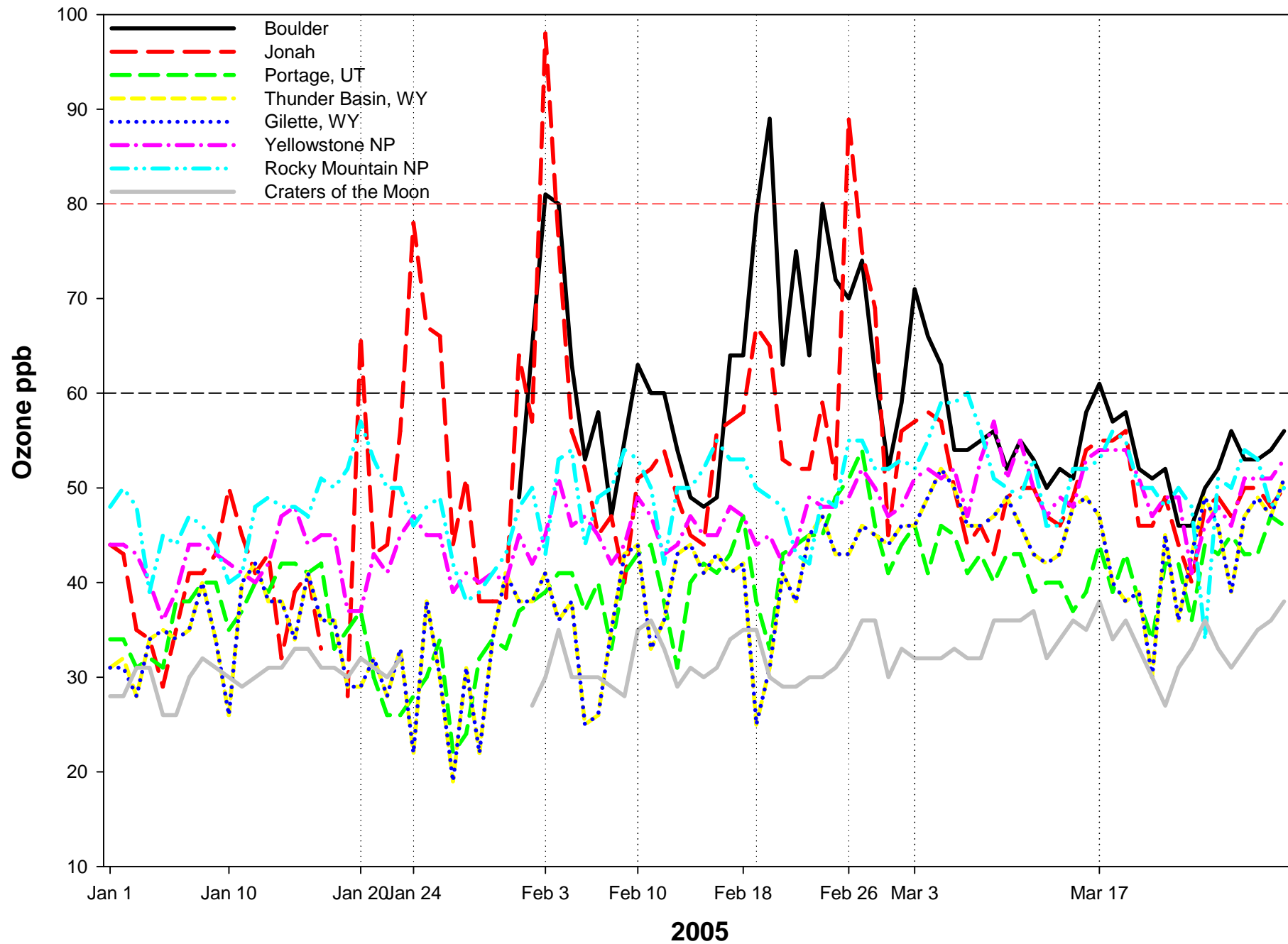
Investigation of Elevated Ozone Events During Late  
Winter – Early Spring in the Jonah-Pinedale  
Anticline Area





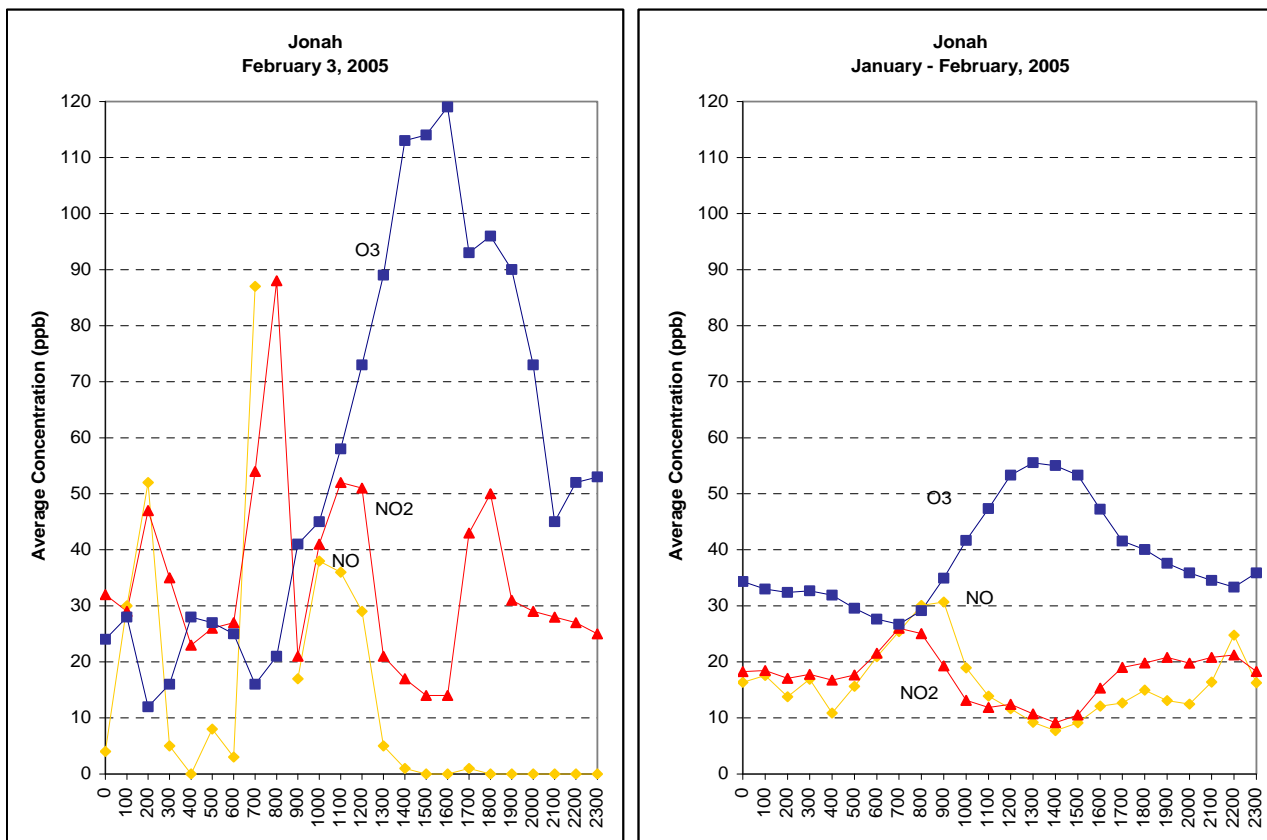


# Max 8hr Ozone Concentration



# February 3, 2005

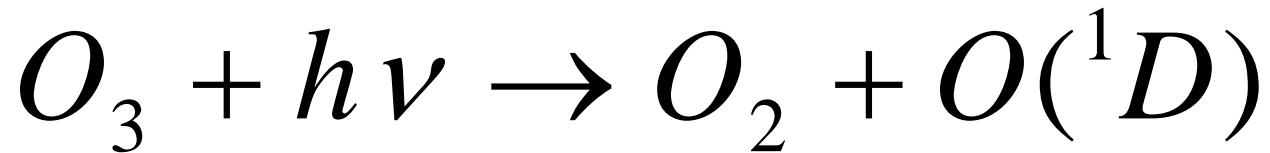
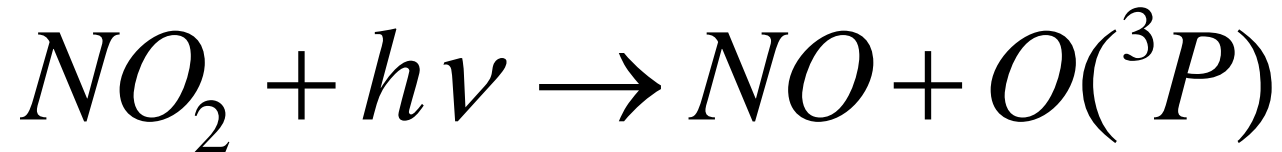
## NO-NO<sub>2</sub>-O<sub>3</sub> Hourly Data



# Possible Explanations

- Malfunctioning ozone analyzers
- Interference from some other atmospheric species
- Long range transport
- Stratospheric-Troposphere Exchange (STE)
  - ozone injection
- Enhanced  $\text{O}_3$ - $\text{NO}_x$ -VOC Photochemistry

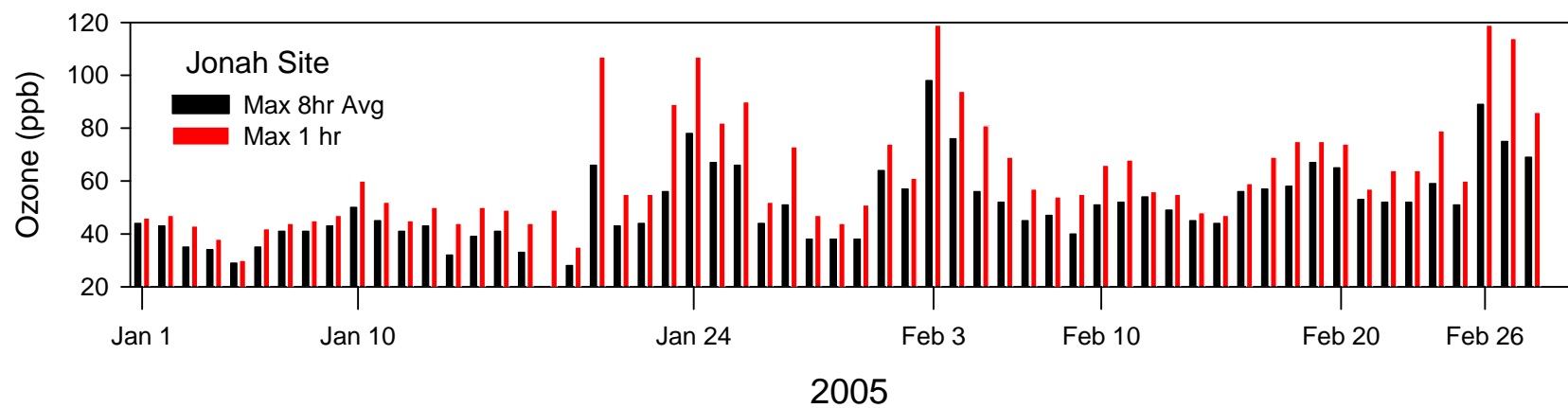
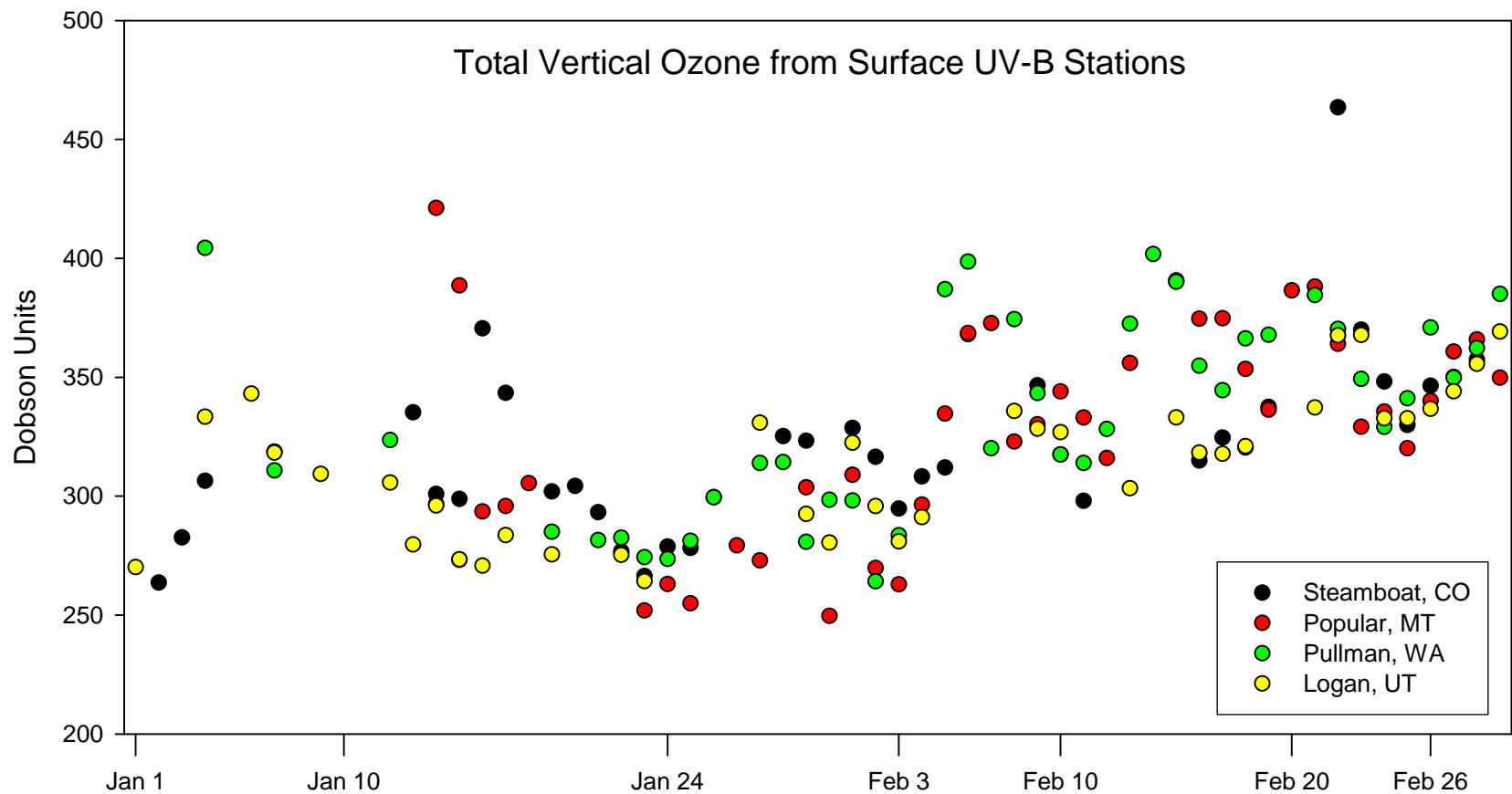
# Primary Photolytic Reactions



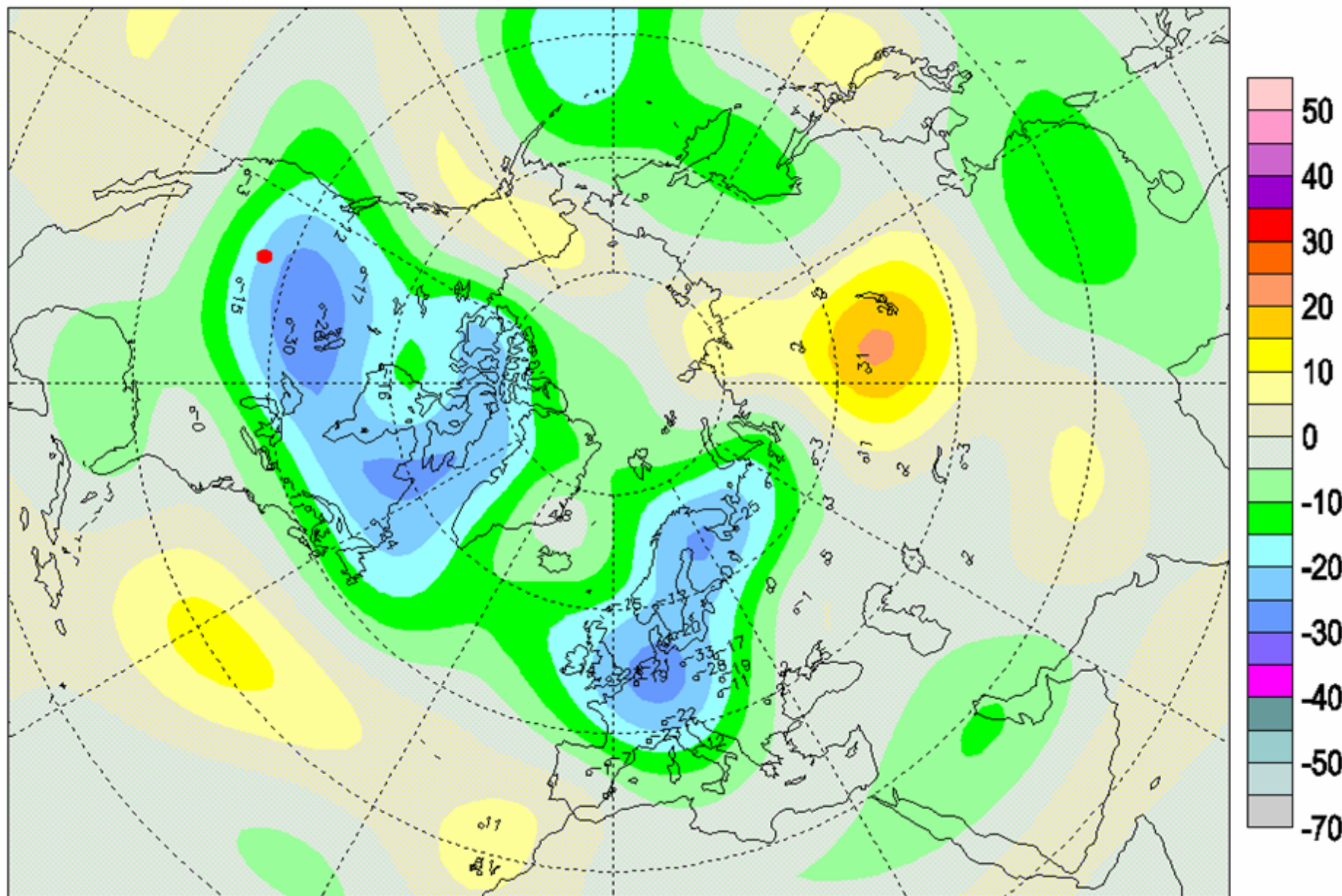
# Hypothesis

- Low total vertical ozone results in increased UV-B radiation reaching surface
- High albedo surface reflects radiation back enhancing UV-B flux
- High  $\text{NO}_x$  and VOC in shallow inversion layer with enhanced UV-B results in increased photochemical production of Ozone even during late Winter early Spring periods



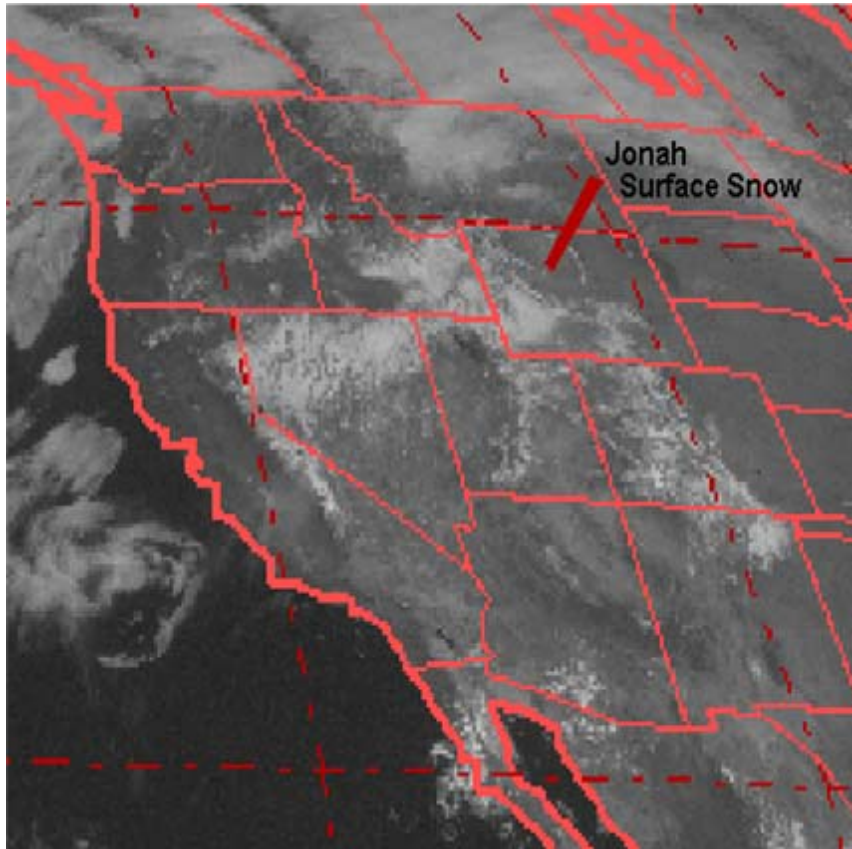


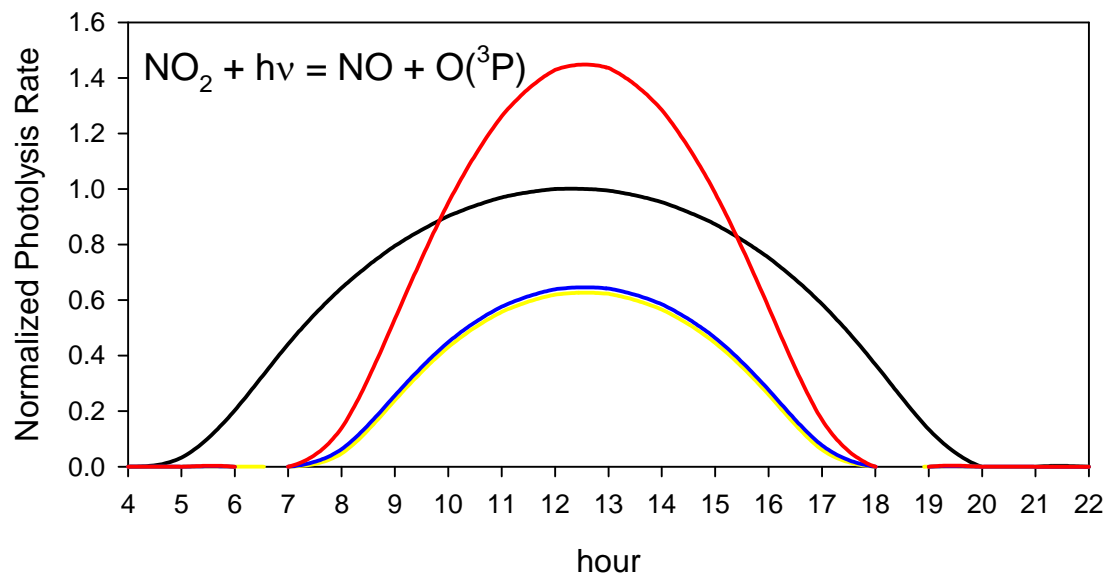
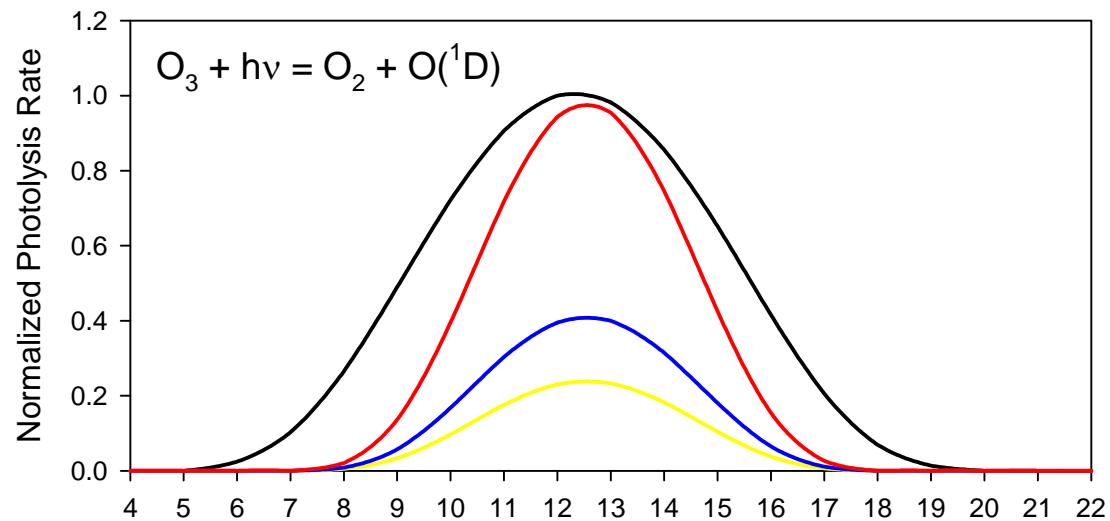
# Deviations (%) / Ecart (%) , 2005/02/03



# February 3, 2005

## Visible Satellite and Surface Images



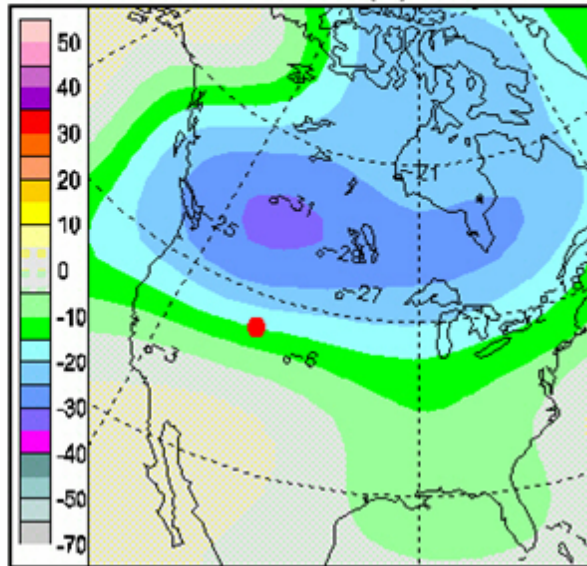


- June 21, 2005    Surface albedo = 0.1    Vertical  $\text{O}_3$  = 350 Dobson units
- February 3, 2005    Surface albedo = 0.1    Vertical  $\text{O}_3$  = 350 Dobson units
- February 3, 2005    Surface albedo = 0.1    Vertical  $\text{O}_3$  = 250 Dobson units
- February 3, 2005    Surface albedo = 0.9    Vertical  $\text{O}_3$  = 250 Dobson units

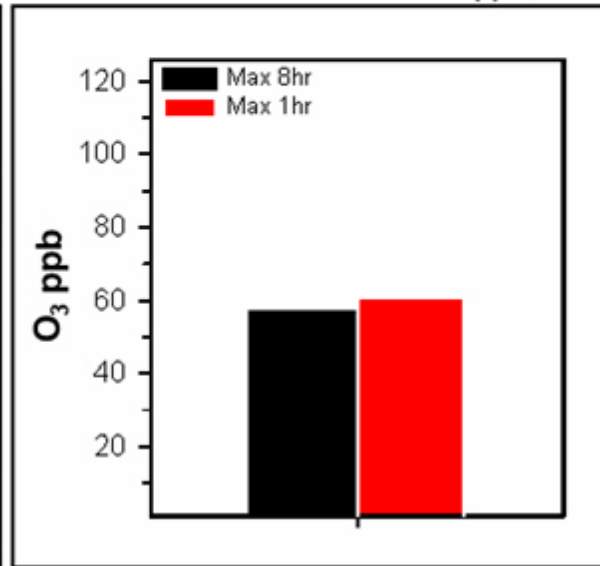


February 02, 2005

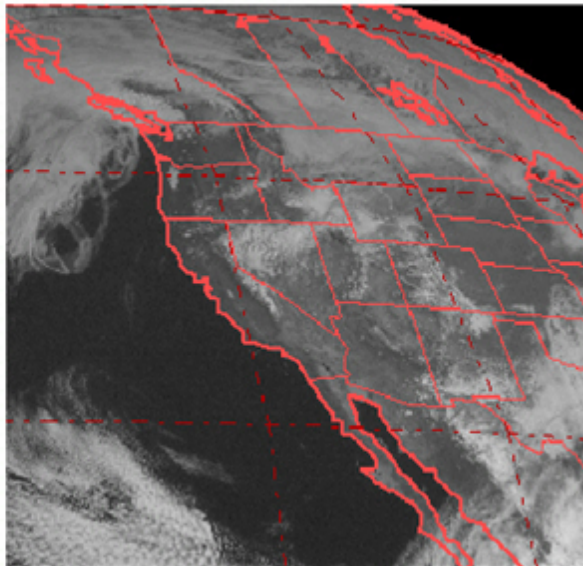
Vertical Ozone Deviation (%) from Normal



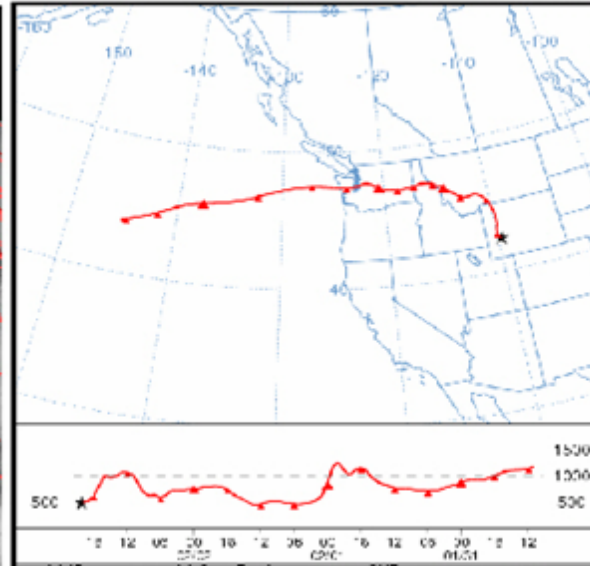
Jonah Surface Ozone ppb



GOES 20Z Visible Image



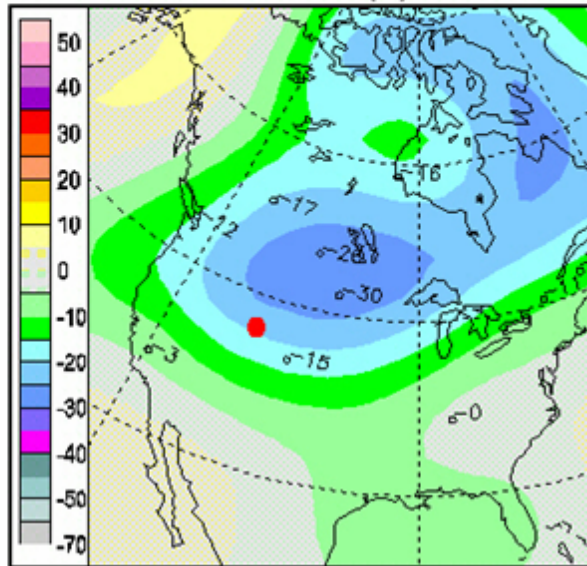
Hysplit 20Z - 5 Day Back Trajectory



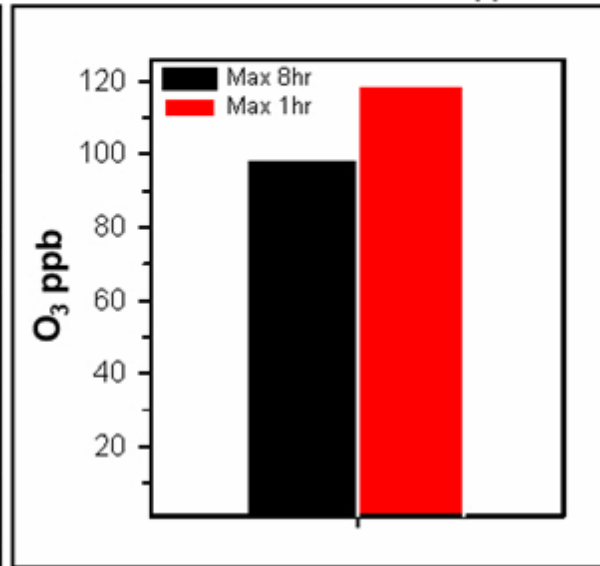


February 03, 2005

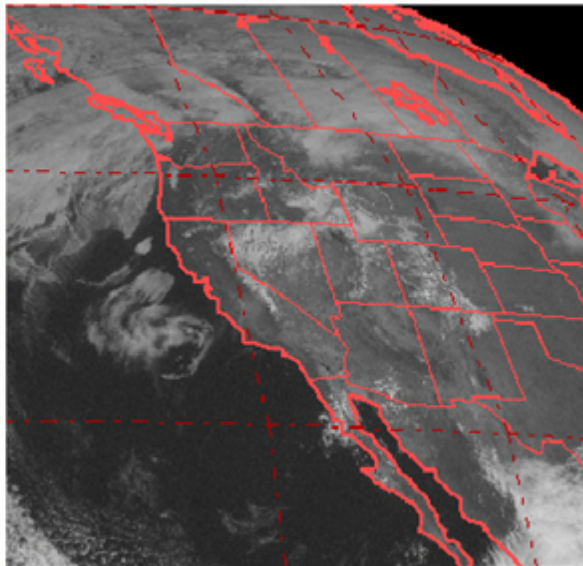
Vertical Ozone Deviation (%) from Normal



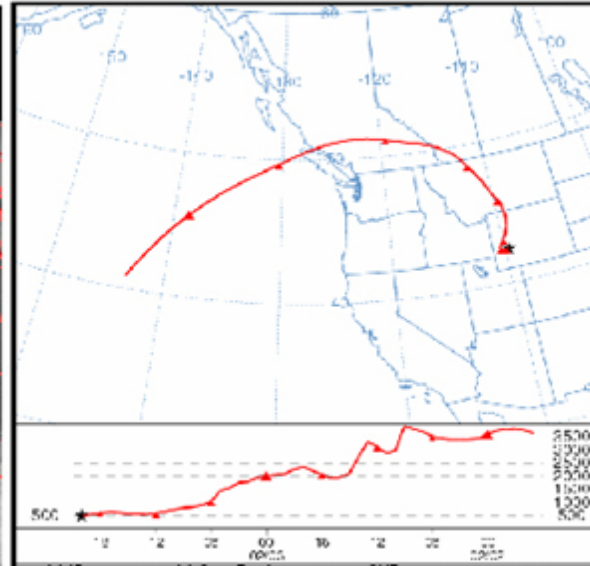
Jonah Surface Ozone ppb



GOES 20Z Visible Image

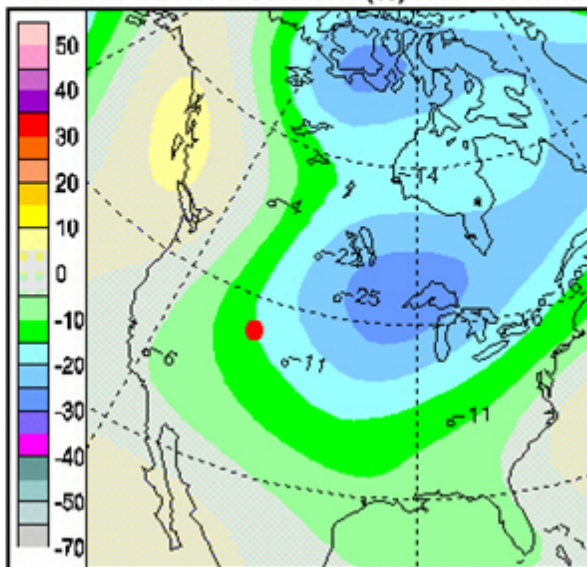


Hysplit 20Z - 5 Day Back Trajectory

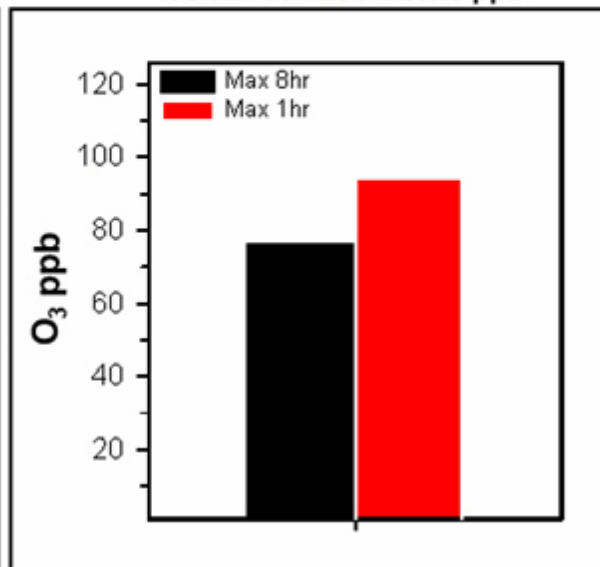


**February 04, 2005**

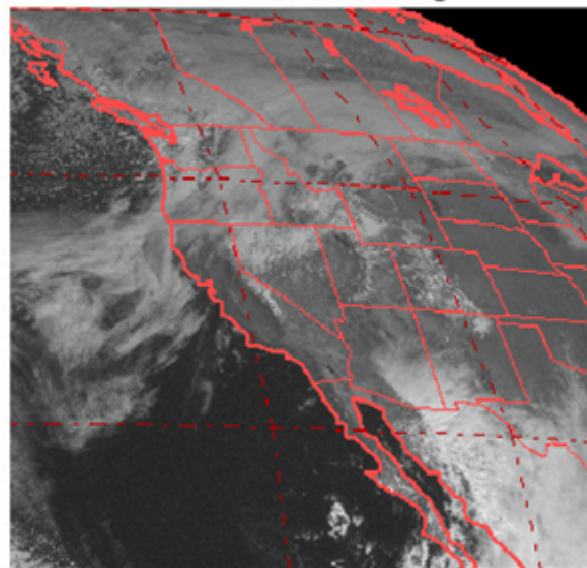
### Vertical Ozone Deviation (%) from Normal



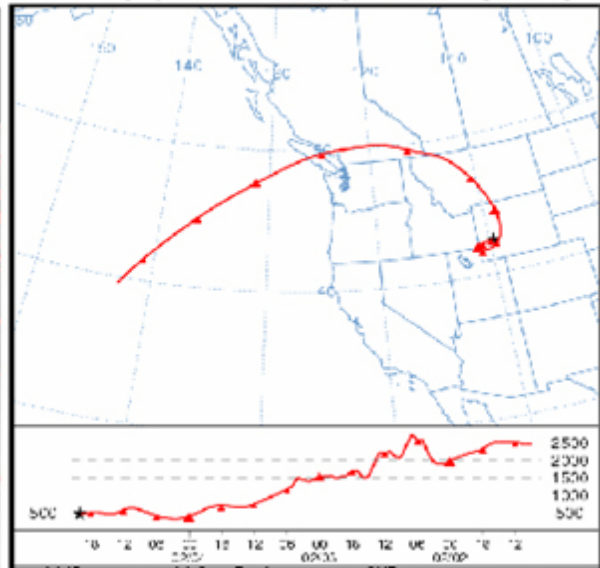
Jonah Surface Ozone ppb



GOES 20Z Visible Image

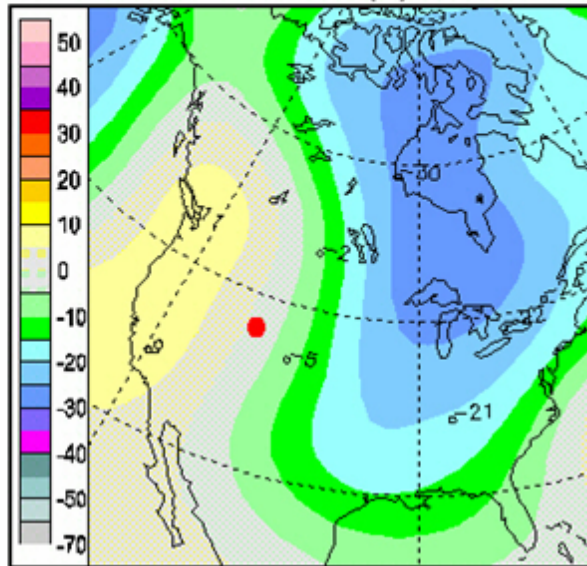


### Hysplit 20Z - 5 Day Back Trajectory

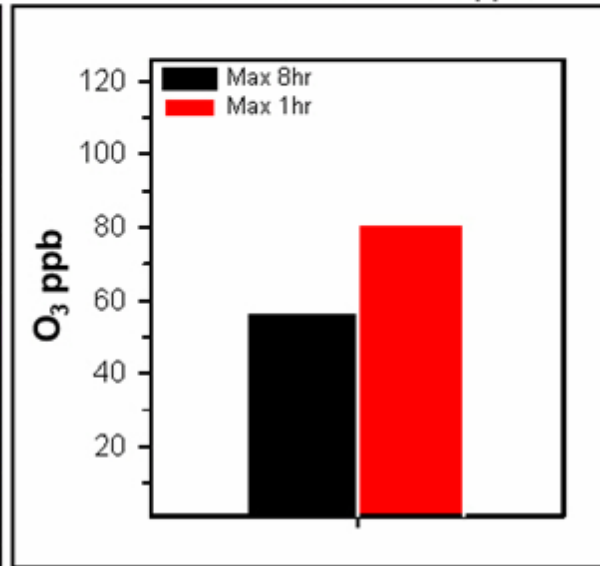


February 05, 2005

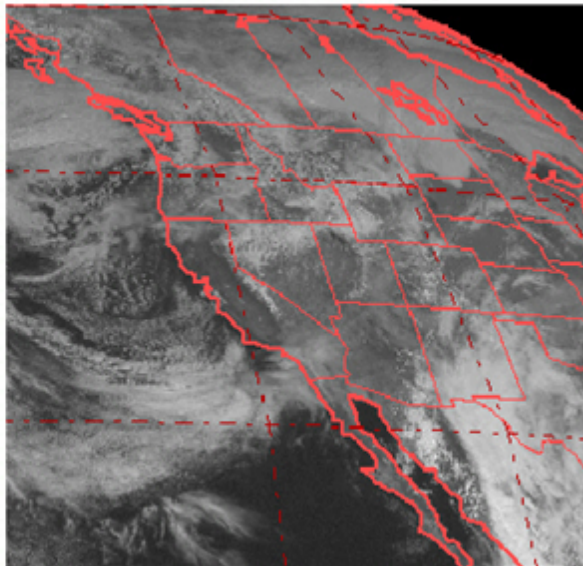
Vertical Ozone Deviation (%) from Normal



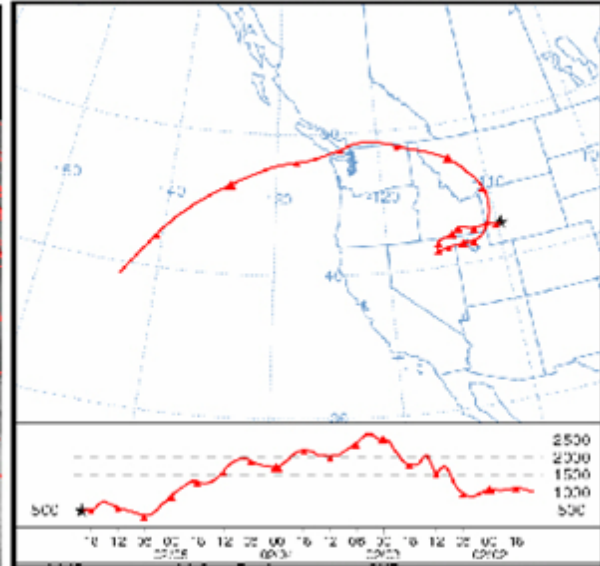
Jonah Surface Ozone ppb



GOES 20Z Visible Image



Hysplit 20Z - 5 Day Back Trajectory





# WYDEQ Monitoring Sites

