Analysis of 12 years of IMPROVE data in the Columbia River Gorge

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Photo from the Wishram IMPROVE site. Photo courtesy of IMPROVE/CSU website (http://vista.cira.colostate.edu/improve)

Goals

1. Use IMPROVE particulate data from Wishram, Washington and HYSPLIT back-trajectories to evaluate possible sources for worst air quality days in CRG.
2. Use IMPROVE data to evaluate chemical composition for worst air quality days in CRG.
3. Use IMPROVE data to evaluate whether air quality in CRG is improving or deteriorating.

Phase 1 of this project was funded by the Yakima Nation between Aug.-Dec. 2006. A final report was presented to the Yakima Nation in December. This presentation reflects information in that report, but is considered "Preliminary" in that it has not been submitted for peer-review.

Why focus on IMPROVE data?

- IMPROVE is a national network of air quality monitors to evaluate visibility, especially in National Parks and other class I areas.
- IMPROVE uses a standard protocol and all samples are analyzed in a central lab.
- IMPROVE conducts continuous QC and data evaluation.
- IMPROVE is the only long-term record of air quality in the CRG (1993-present)
- Samples collected approximately 2x per week.

Approach

- Identify the 50 worst air quality days (PM2.5 or "fine mass") in the CRG between 1993-2004.
- For each of these 50 days, calculate a set of HYSPLIT backward trajectories to evaluate the most probable sources of pollutants for that day.
- Based on the trajectories, classify each day by the source region.
- Examine the aerosol chemistry for each airmass type.
- Examine trends in the long-term data.

May 27th, 2003
Fine mass = 5.1 ug/m3

Image courtesy of USFWS Air Quality Image website:
http://www.fsvisimages.com/

November 7th, 2002
Fine mass = 34.7 ug/m3

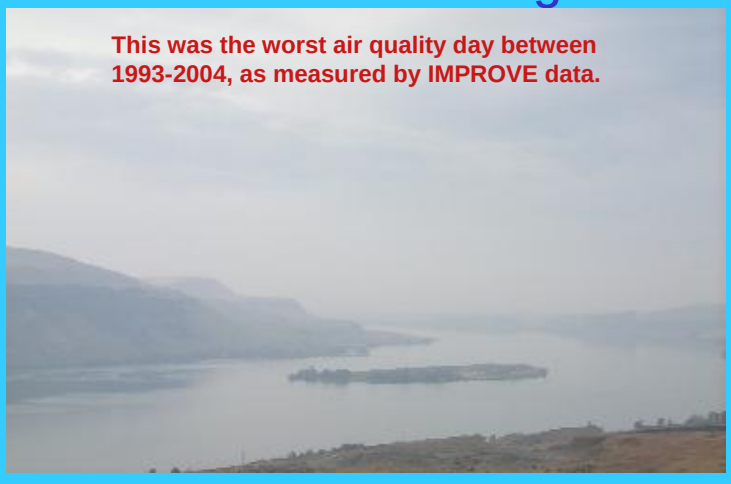


Image courtesy of USFWS Air Quality Image website:
http://www.fsvisimages.com/

Overview of Wishram data

Dates	June 1993-Dec 2004
Number of days with valid PM2.5 data	1139
Average PM2.5-all days	5.9 ug/m^3
Average PM2.5 for the 50 highest days	18.3 ug/m^3
Highest PM2.5	34.7 ug/m^3 (Nov 7, 2002)

Note: Proposed new PM2.5 standard is 35 ug/m3 for a 24 hour average.

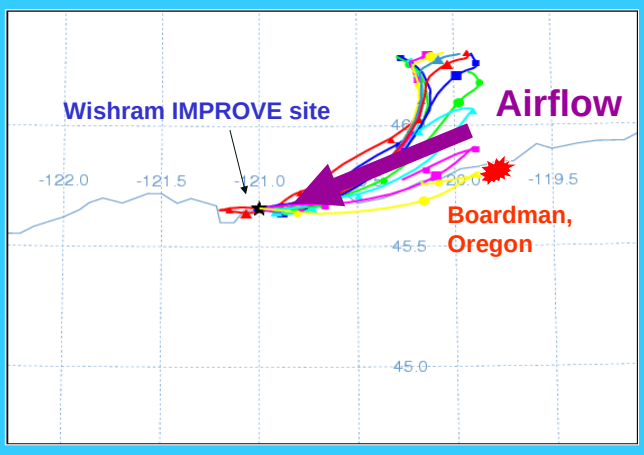
Distribution by month of 50 worst days

Jan	3
Feb	3
March	0
April	1
May	0
June	1
July	8
Aug	4
Sept	3
Oct	6
Nov	**18**
Dec	3

Atmospheric trajectories 101

- Trajectories give an estimate of the center of mass of a diffusing airmass.
- Trajectories are only as good as the meteorological data and models on which they are based. Grid resolution is an important consideration in regions of complex terrain.
- Trajectories can not be used to quantitatively assign source contribution.
- Trajectories can identify a likely source in one direction, compared to an alternate source in another direction.

Back-trajectories to Wishram for November 8th, 2004



Measured PM 2.5 on this date = 26.0 ug/m3

Distribution of 50 worst air quality days by trajectory type

Category	Number	Average PM2.5 (ug/m^3)
1- West Gorge	5	14.8
2-West Gorge possible	4	17.7
3-Unassigned or other	22	17.5
4-East Gorge possible	4	20.1
5-East Gorge	15	20.5
All others	1089	5.3

~40% of the worst air quality days are associated with transport from the East end of the CRG and these days tend to have higher PM2.5 concentrations.

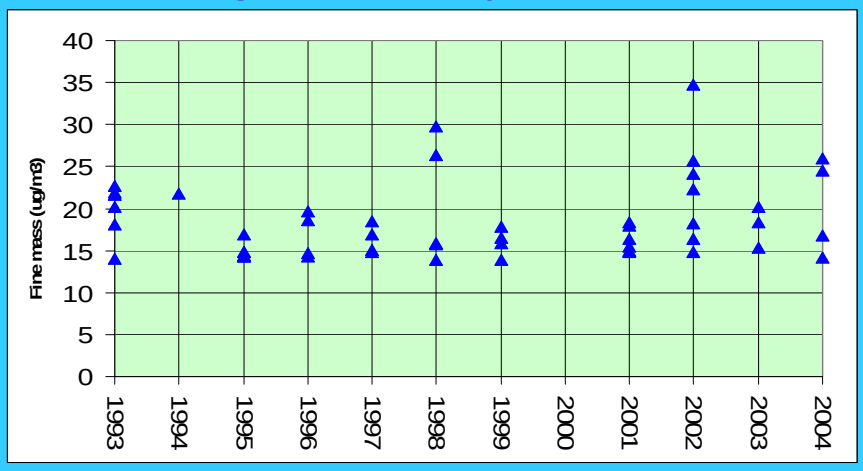
Note that the chemical composition of category # 5 days appears to be quite different from other days, with about 30% aerosol mass due to nitrate aerosol, compared with other airmass types that have only 11% as nitrate. For details, refer to final project report.

Comparison with "Causes of Haze" study

- The "Causes of Haze in the Gorge (CoHaGo)" study (Green et al., 2006), identified sources east of the gorge as significant contributors (Green et al., 2006);
- Our analysis also confirms that sources in the Boardman vicinity are significant contributors to particulate matter on the worst air quality days (Jaffe 2006).

Is Air Quality in the CRG Improving?

50 Highest PM2.5 days at Wishram



But, possible problems with IMPROVE nitrate data between 1997-1999 (McDade 2004). Even considering this effect, we see no evidence for improvements in CRG air quality from this point of view.

Conclusions

- While data from the Wishram IMPROVE site have an overall low average PM2.5 concentration (5.9 ug/m3) on some days, concentrations are much higher.
- I evaluated the most likely sources for the 50 worst air quality days (highest PM2.5) for the period 1993-2004 using HYSPLIT back-trajectories.
- For ~40% of the worst days, sources on the east end of the CRG appear to be primarily responsible (mean PM2.5 = 20.4 ug/m3) This is consistent with results presented in the CoHaGO study (Green et al 2006).
- For ~20% of the worst days, sources on the west end of the CRG (Portland) appear to be primarily responsible (mean PM2.5 = 16.1 ug/m3)
- While the annual mean PM2.5 concentration in the CRG shows some evidence of a decline, the frequency of bad air quality days does not appear to be changing. Many of the worst air quality days have occurred in the past 5 years.

Next steps-Phase 2

- Start: September 2007.
- Tasks:
  - Relate IMPROVE data with PGE Boardman data on plant shutdowns.
  - Use of Nitrogen isotopes (15/14) to quantify N sources in CRG (Ron Sletten).
  - Sampling of potential sources to establish N isotopes (Boardman Coal, Threemile Canyon Farm ammonia, etc)

Backup slides:

HYSPLIT trajectories

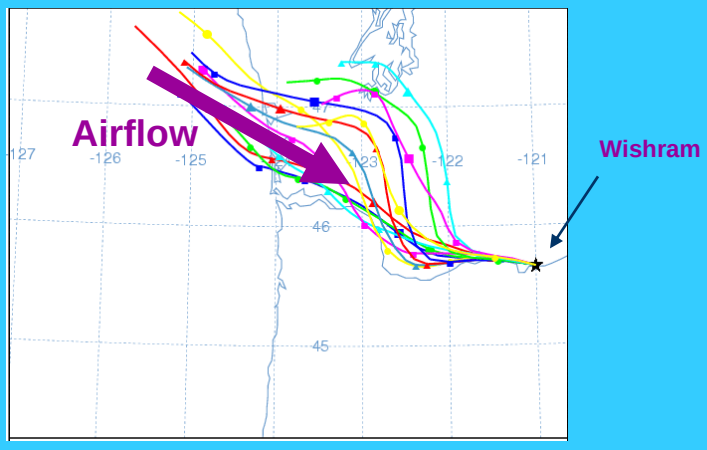
- Back-trajectories calculated using NOAA-HYSPLIT model http://www.arl.noaa.gov/ready
- Calculated for 0, 100 and 500 meter arrival height (agl) at Wishram
- For each date, best available meteorological data used (40, 80 or 250 km grid resolution, depending on date)
- For each 24 hour sample, trajectories were calculated at 2-hour intervals for a total of 13 trajectories per sample.
- Each case was classified based on consistency of all trajectories.

Wishram, Washington IMPROVE site

Google Earth map from: http://earth.google.com/

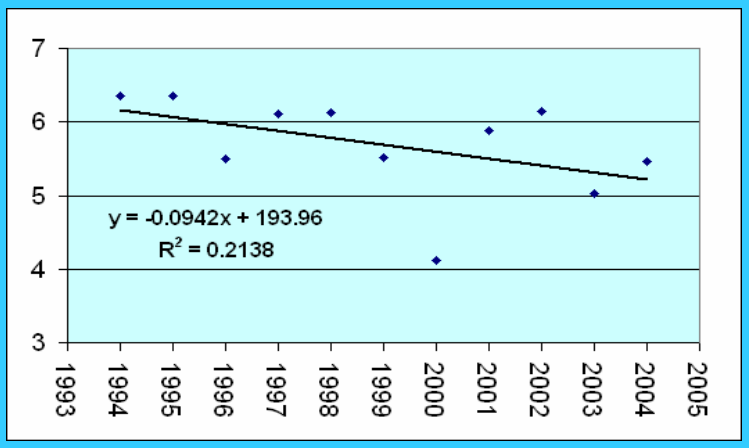
Back trajectories for July 30, 2004

13 trajectories calculated at 2-hour intervals



Measured PM2.5 at Wishram = 14.2 ug/m3

Is air quality getting better or worse in the CRG?

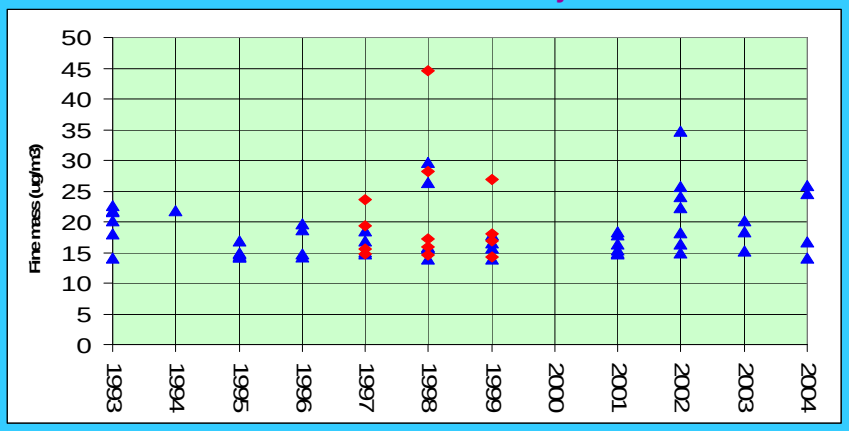


Annual average PM2.5 concentration at Wishram

Some improvement in annual average, but result is not statistically robust.

50 Highest PM2.5 days at Wishram

With and w/o nitrate adjustment



- **PM2.5 levels adjusted based on measured nitrate plus best estimate by IMPROVE of nitrate error (MdDade 2004).**
- **Frequency of "bad air days" is not changing and the peak concentrations are not improving.**