Unhealthy Air in the Salt Lake Valley -  
A discussion of an upcoming field project to improve understanding of wintertime air pollution episodes

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Photo Credit: Tom Smart, Deseret Morning News
Personal Control of the Weather-

Whatever the field project is about, expect the opposite to take place

VORTEX2 was the largest field project ever to understand tornadoes (over 100 scientists and over 40 vehicles participated during May/June 2010 @ $10 million)

GRIP was conducted to better understand how tropical storms form and develop into major hurricanes from 15 August – 30 September 2010

Salt Lake Tribune Headline
February 1 2011???

UU Scientists Still Waiting For Pollution Episode
Mission: Discover, advance, and disseminate knowledge about weather and climate for the benefit of the people of Utah and the wider international community

Blue Ribbon Advisory Council on Climate Change
Report to Governor Jon M. Huntsman, Jr.
October 3, 2007

Climate Change and Utah: The Scientific Consensus
September 2007
Fine Particulate Matter: PM2.5

• Primary sources: homes and businesses; construction; cars; industry
• Photochemical reactions result in secondary particulates not attributable to particular sources
Health Impacts of PM 2.5

• can lodge deeply into the tissue of the lung and are not easily dispelled

• cause respiratory and cardiac illness
Northern Utah air worst in nation

Weather » A storm expected Wednesday could help clean air.

By Lindsay Whitehurst
The Salt Lake Tribune

Updated: 01/11/2010 06:19:49 AM MST

The air quality in northern Utah was the worst in the nation Sunday, according to the U.S. Environmental Protection Agency.

The news gets worse: The dirty soup isn't expected to lift until mid-week, according to regulators and forecasters.

Sunday was a red-air quality day in every county the Division of Air Quality monitors. They include Salt Lake, Davis, Utah, Weber and Cache counties. And air quality for today and Tuesday is predicted to be the same.

"Essentially, what we need is we need a really good storm," said Donna Spangler, spokeswoman for the Utah Department of Environmental Quality. A storm would break up the "lid" of warm air hanging over the valley and trapping pollutants.

The best the area will get, however, is a weak storm expected to move through the area Wednesday.

"It may improve things a bit," said National Weather Service Meteorologist Mike Conger. Another weak system is expected for the weekend, which should continue a gradual improvement.

On Sunday, the EPA's national pollution map, which offers a snapshot of key pollutants at any given time, singled out northern Utah and a small swath of southern Idaho as having the only "red," or unhealthy, air quality in the country.

Salt Lake's air quality index for Sunday was 142, compared with 29 in Las Vegas, 23 in Denver and 47 in Phoenix, according to the EPA air quality Web site. The San Francisco Bay area recorded air quality unhealthy for sensitive groups, at 67 on the index. In New York it
Realtime Monitoring of PM2.5

Environmental Protection Agency
& Local/State Air Quality Agencies

Daily Average PM$_{2.5}$ AQI
Sunday, January 10, 2010

Hawaii

Good   Moderate   USG   Unhealthy   Very Unhealthy   Hazardous   ! Action Day
Salt Lake Tribune Articles

December 28, 2001--Bad Air Is No (Dirty) Joke - N. Utah winter inversion brings health warnings, no burn advisories

January 9, 2004--Inversion causes officials to post red burn alert

December 13, 2005--Breathless in N. Utah - Mild storms, expected today, could bring some relief; Wind, snow the only hope for better air

December 09, 2006--Weather: Air gunk lingers, should lift today

January 28, 2007--When will winter storm cough out valley smog?

January 3, 2008--A lungful of crud: Red alert issued for Wasatch air quality

January 22, 2009--Unhealthy air

January 12, 2010--Breathing poison
Improving Air Quality is A National Issue
Improving Air Quality is A National Issue
Who is Responsible for Salt Lake’s Air Pollution?
Improving Air Quality in the Salt Lake Valley Requires Planning

- Weather
- Terrain
- Public Policy Decisions
- Emissions
- Personal Decisions

Air Quality
“But, do we really need another study of the weather associated with air pollution?”
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public and personal decisions during the winter to mitigate air quality require accurate weather forecasts of onset, duration, and termination of cold-air pool events.
Persistent cold-air pool

• A ground-based or elevated temperature inversion that is confined by topography, is colder than the air above, and lasts at least 24 hours

• Usually forms in winter when solar radiation input is weak and in high-pressure weather situations

• The cold pool air is quiescent; moisture and air pollutants tend to build up in it over time
CAP Effects

- Cold conditions
- Suppressed diurnal temperature cycle
- Often fog, stratus clouds and air pollutants build up in pool
- If below freezing, rain or drizzle may fall into the pool, producing freezing rain or freezing drizzle; icing
- Affects air and ground transportation
- Difficult to forecast onset and cessation of pool

Forecasting difficulty with operational models

Resolution of topography
Resolution of wind and temperature structure
Physics
Basins and air pollution

Austria’s Klagenfurt basin

Salt Lake Basin, Utah

©Helmut Ditsch

Whiteman photo

Vail, Colorado

Whiteman (2000)
Stratus or pollution?

Jan 2004

20 Jan 2005

Erik Crosman photo
Complexities of Salt Lake Valley Cold-Air Pools

Snow cover
Cloud cover
Evaporation
Moisture advection

Clear Temperature Profile

Cloudy Temperature Profile

Bathtub ring
Climatological analysis

Twice daily rawinsonde sounding data from SLC Airport, 50+ yrs.

![Diagram showing atmospheric profiles and distribution of cold-pool events](image)

- **Cold-pool events ≥ 12 hours**
  - 1956-2010

- **Cold Pool Duration (8K Threshold) 1956-2010**
  - Number of Events vs. Cold Pool Duration
Objectives

• Identify meteorological processes leading to development, maintenance, and breakup of persistent inversions.

• Determine meteorological processes affecting air pollution transport and diffusion.

• Determine how meteorological models can be improved to provide more accurate simulations of persistent inversions.
Field Program

• Objectives
  – Document processes that involve temporal and spatial scales ranging from the ground up to the mid-troposphere and from the microscale to the scale of the entire Western United States
  – Document 3-D nature of CAPs in unprecedented detail

• Measurement Strategy
  – Continuous automated measurements over the entire period
  – Intensive Observing Periods during inversion events
Measurement Sites

Salt Lake Basin

Great Salt Lake

Wasatch Mountains

Oquirrh Mountains

Traverse Range

Airport
ISFS
ISS

AWSes
NCAR/EOL
Integrated Sounding System

Rawinsonde Set
Possible: Laser ceilometer
449 MHz RWP

915 MHz radar wind profiler with RASS

SODAR with RASS
NCAR/EOL Integrated Surface Flux System

Flux-PAM tower
Additional Measurement Sites
University of Utah
Department of Atmospheric Sciences

Mini-SODAR

Temp data logger lines

Mobile weather station

Additional:
2 rawinsonde sets
5-10 AWSes
Time-lapse cameras
Other Participants

• Other UU scientists (Bowling, Pardyjak & Silcox)
• San Jose State University
• San Francisco State University
• Utah DAQ & DOT
• NOAA/NWS WR & SLC Forecast Office
• Dugway Proving Ground
• International collaborators
Maximizing the benefits from a field project run on a shoe string

- Improved Understanding
- Feedback to NWS & DAQ
- Student & Public Involvement
PCAPS will provide input on atmospheric conditions useful for future DAQ modeling efforts.
Simulating and Validating Air Quality Models for the Salt Lake Valley

State implementation plans required to meet EPA air quality standards will be based in part on model simulations run by DAQ.
Opportunities for students/public NOT limited to ATMOS majors

• We need volunteers to launch balloons carrying instrument packages
• Hands-on science
• Participate in the planning, designing, & running of the field study
• ATMOS 5910 course during first half of spring semester
Next Steps

• Want to help? Let us know today or contact one of us later (dave.whiteman@utah.edu, john.horel@utah.edu)

• Want to be informed about the field project?
  • Webpage: http://pcaps.utah.edu
  • Facebook page: search for the group “PCAPS”
Other Avenues for Involvement

Utah Moms for Clean Air

CLEAR THE AIR CHALLENGE
Drive Down Your Miles

Utah Physicians for Healthy Environment
For Current and Background Info on Salt Lake Air Quality:
Utah DAQ
GLOBAL WARMING IS A HO...

Ho...

Hoh Hoh Hoh Hoh

INVERSION SEEMS PRETTY REAL.

GASP!

Bagley, Salt Lake Tribune. Jan 7, 2009