Bingham Canyon Mine Experiment

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Topography of the Bingham Canyon Mine

- Mine bottom: 1373 m ASL, Depth 600 m
- East gap: 2078 m ASL, Depth 705 m
- Lowest gap: 1973 m ASL, Depth 600 m
- Low elevations outside: 1700 m ASL
- Mining extends to elevations of 2500 m ASL, Depth > 1100 m
- Diameter ~ 3000 m

Photo provided by Rio Tinto / Kennecott Utah Copper
Objectives

- What are the differences in the development of the atmospheric boundary layer structures within the mine basin and within the adjacent valley?

- What are the physical processes responsible for these differences?
Experimental design

Observe, within the basin of the Bingham Canyon Mine & in the Salt Lake Valley:

1. Temperature (& Humidity) profiles

1. Wind profiles

2. Exchange of air between basin and valley

➤ Combine experiment with PCAPS!
Instrumentation – 1) Pseudo-vertical profiles

- Inexpensive automatic temperature data-loggers (“Hobo”; Onset Computers)
- Thermistor with ~3 min response time (& Hygristor)
- Mounted in radiation shields (R.M. Young 6-plate)
- Fastened to fence posts
- Well tested in previous studies
- Data collection by ‘sneaker-net’
- 85 HOBOs available
- 5 minute resolution
- Instrument all 50-m elevation contours up to 2500 m
- West and East slope of the Salt Lake valley (Harker’s vs. Grandeur Line)
- Northern and Southern part of the valley (Harker’s vs. Kennecott Line)
- Kennecott Line has an inner and outer segment.
Kennecott Line, low point (1327m) on Jordan River
Kennecott Line, 1398 m
Grandeur Line, 2450 m ASL
Harker's Ridge Line
How good are these pseudo-vertical profiles?

Comparison with Radiosonde data

2010/12/12 00:00 UTC
2010/12/11 17:00 MST

Grandeur Line
Kennecott Line
Radiosonde
Spatial variations in vertical profile of the valley atmosphere exist and are resolved.
Instrumentation – 2) Wind LiDAR

- Access is limited due to 24/7 active mining operations
- Mine pit is well sheltered, filled with aerosols
LiDAR observations (mid - February – April)

Halo Photonics Streamline
Scanning Doppler Wind LiDAR
Eye safe, Range: 90 m to 7.5 km
Instrumentation – 3) Automatic Weather station

- In the low pass 1973 m along mine access road
- Flows through the gap?
- Export / Import of cold air?
Mine instrumentation - Summary

- Hobo Temperature Data Logger
- Automatic Weather Station
- Doppler Wind LiDAR
Initial results / data examples

A) Largest & Mean Valley-Mine temperature differences

B) Wind break-ins into Mine atmosphere (Mix-out event)

C) Gap flows – Air exchange through lowest pass: Export / Import of cold air?

D) A diurnal cycle
A) Temperature differences between valley and basin atmospheres

7 - 8 January 2011: shallow cold-air pool in Salt Lake Valley. PCAPS - IOP5
A) Temperature differences between valley and basin atmospheres

7 - 8 January 2011: shallow cold-air pool in Salt Lake Valley. PCAPS IOP5

Typical for inversion situations
## Basin – Valley Temperature Differences

<table>
<thead>
<tr>
<th>Height (m ASL)</th>
<th>Dec 2010-April 2011</th>
<th>PCAPS - IOP 5 (1-9 Jan 2011)</th>
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</table>
B) Mix-out case, 14-15 February 2011

- Aerosols higher backscatter
- Winds penetrating into mine, gusts >10 m/s
- Stagnant air, u >2 m/s
C) Flow through saddle

Outflow
SW

Inflow
NE

02 Jan 2011 0500 MST

03 Jan 2011 0600 MST
D) Diurnal cycle – Clear night of 31 March - 1 April

Weak winds throughout the 24-hour period.
D) Diurnal cycle – Clear night of 31 March - 1 April
Conclusions

- Pseudo-vertical profiles of temperature and humidity can be used to evaluate spatial and temporal variations in the boundary layer structure of valleys and basins.

- The atmospheres of the mine basin and adjacent valley behave differently. Valley and basin atmospheres are identically stratified only when they are well mixed (top-down convection or strong wind conditions).

- Flow in the low pass can be controlled by the exchange of cold air.

- The basin of the Bingham Canyon Mine behaves different from other enclosed basins. Nighttime cooling is generally weaker than in the adjacent Salt Lake Valley.

  - This suggests radiative exchange with the overlying atmosphere is inhibited due to the steep sidewalls.
Acknowledgements

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- National Forest Service (Carol Majeske)
- All PCAPS participants and volunteers
Valley – NE Side

Mine

Valley