MATERHORN Fog-X 2015 Overview

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University of Notre Dame

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Motivation for Studying Fog in Complex Terrain

- Limit military operations
- Ground Transportation
- Air Travel
- Relationship to air quality

General difficulty in fog forecasting due to uncertainties and complexities, Gultepe et al. 2007

Review:

"Fog processes involve droplet microphysics, aerosol chemistry, radiation, turbulence, large/small-scale dynamics, and surface conditions (e.g., pertaining to the presence of ice, snow, liquid, plants, and various types of soil)"

MATERHORN Fog-X Goals

- Improved understanding of fog formation, evolution and dissipation mechanisms in complex terrain
  - Radiative cooling, surface moisture, aerosol size distribution, snow cover, turbulent intensity and turbulent flux divergences
- Produce a unique dataset to evaluate how improved/new turbulence parameterizations being achieved through MATERHORN will impact fog predictions and forecasting

MATERHORN Fog-X Participants

- University of Utah
- University of Notre Dame
- University of Virginia
- Environment Canada - Cloud Physics and Severe Weather Section
- Army Research Lab

Contributors

- Dugway Proving Ground
- NCAR

Fog-X Timeline

October 2014 through March 2015

- October/November 2014 – First instrument deployments
- January 2015 – Final Instrument deployments (Environment Canada)
- January 2015 – 11 Intensive Observational Periods (IOPs)
- April 2015 – final teardown of Heber site main tower
- June 2015 – final teardown of Salt Lake site main tower

- IOPs were selected based on the Fog climatology study conducted by the Pu group at the University of Utah

Fog-X Operations

- University of Utah (Jeglum and Pu) provided daily forecast briefings at the University of Utah
- During most of the IOPs operation duties UND/UofU/ARL
- Duration will be no more than 24 hours depending on the fog type (persistent versus short live diurnal fogs)

Fog-X IOP Summary

IOP	Dates/Time of IOP (MST)	RS	TB	Comment	Last Precip	Snow Cover
0	7 Jan 1500-8 Jan 1200	Heber	None	Ice fog/frost in Heber; fog in SLC+PCAP		SLC-No/Heb-Yes
1	8 Jan 1500-9 Jan 1200	Heber/SLC	Heber	Fog both sites		SLC-No/Heb-Yes
2	8 Jan 1400-10 Jan 1200	Heber/SLC	Heber	Fog both sites; weak & short in Heber		SLC-No/Heb-Yes
3	14 Jan 0500-14 Jan 1100	Heber	Heber		1/11-1/13	SLC-Yes/Heb-Yes
4	15 Jan 1500-16 Jan 1100	Heber/SLC	Heber	Thick ice fog in Heber		SLC-No/Heb-Yes
5	17 Jan 2015- Jan 18 0100	Heber	Heber	No Fog		SLC-No/Heb-Yes
6	20 Jan 0100–20 Jan 0900	Heber	Heber	No Fog	1/9 (trace)	SLC-No/Heb-Yes
7	22 Jan 1500- 23 Jan 0100	Heber/SLC	Heber	No Fog/Clear Sky		SLC-No/Heb-Yes
8	27 Jan 0300- 27 Jan 0900	Heber	Heber	No Fog		SLC-No/Heb-Yes
9	29 Jan 043 - 29 Jan 0900	Heber	Heber	Fog SLV only	1/28 (trace)	SLC-No/Heb-patchy
10	1 Feb 0400 - 01 Feb 1030	Heber	Heber	No		SLC-No/Heb-patchy

Fog-X IOPs

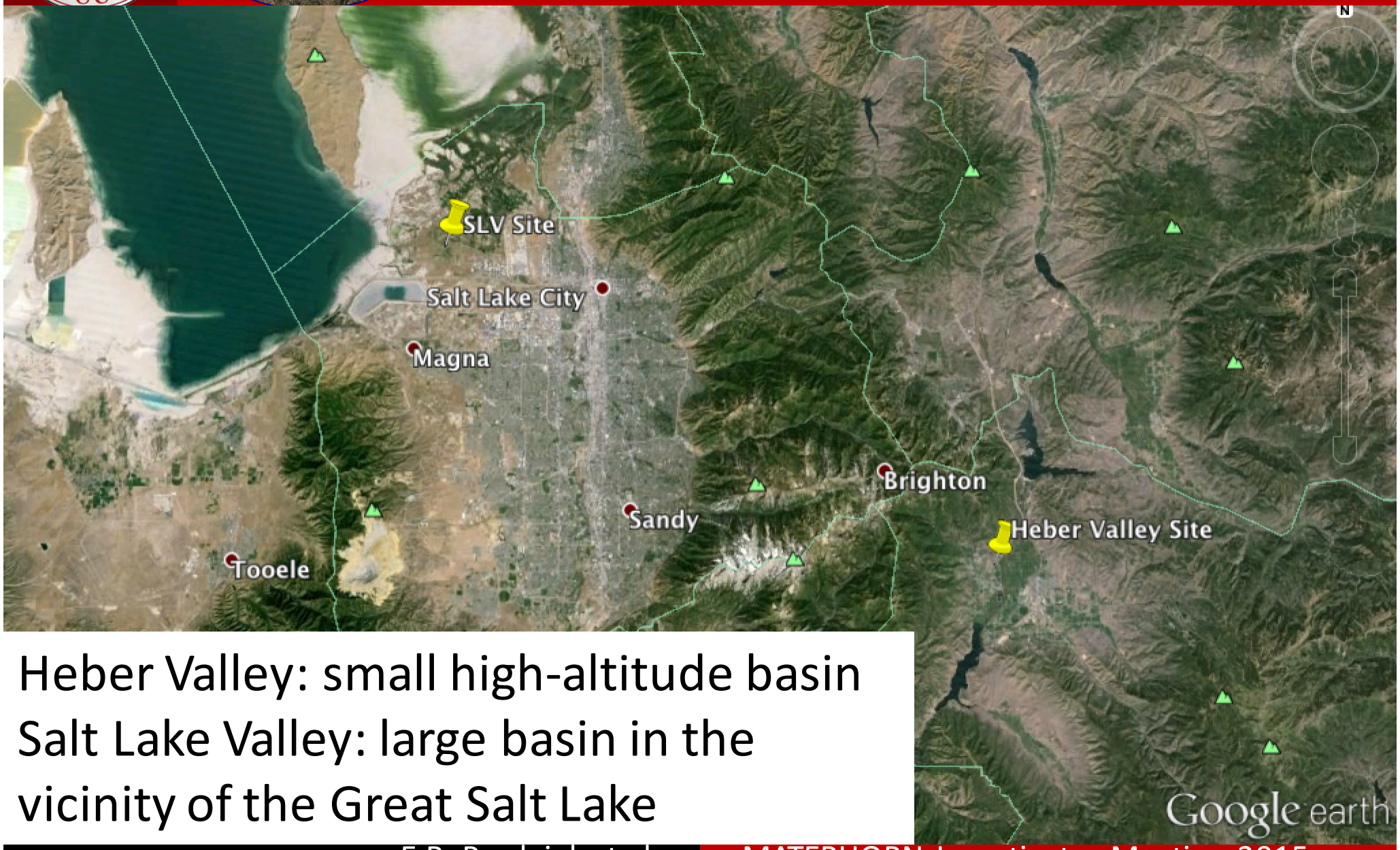
Missed IOP – January 30

- Fog forecast not high
- Power outage

Experiment Details

1. **Turbulence Tower Based Measurements (Both sites, UU, UND, DPG)**
   - Turbulence towers + FW mast
   - Detailed Radiation Balance
   - Flux divergences (sensible, latent, radiative)
   - Surface Energy Balance
2. **Meteorological Stations**
   - 14 LEM stations (UU)
   - 6 – 2D sonic weather stations (UVA)
   - Gultepe station (EC)
   - Existing mesonet
3. **Ground-Based Remote Sensing**
   - Wind LIDAR (UU)
   - SODAR (UU & ARL)
   - Ceilometers (Heber & SLV)
4. **Balloon Measurements (IOPs)**
   - Radiosonde launches
   - Tethered Balloon – Heber Valley only
5. **Fog Sensing Equipment (EC)**
   - Present weather station (Visibility, fog, rain)
   - LPM spectra (droplet size)
   - FMD fog droplet spectra sensor (<50 micron, 15 channels)
6. **Particulate**
   - Size segregated particle counter (MetOne, UVA/EC)
   - Nephelometers (NCAR)
7. **Other**
   - Soil moisture sampling
   - Snow depth (manual and ultrasonic)
   - Photos (UU, EC, NWS)

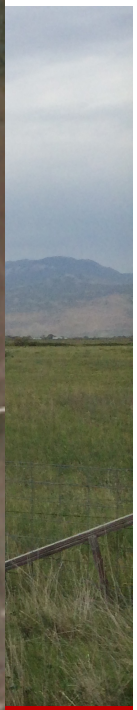
Planned Experimental Sites



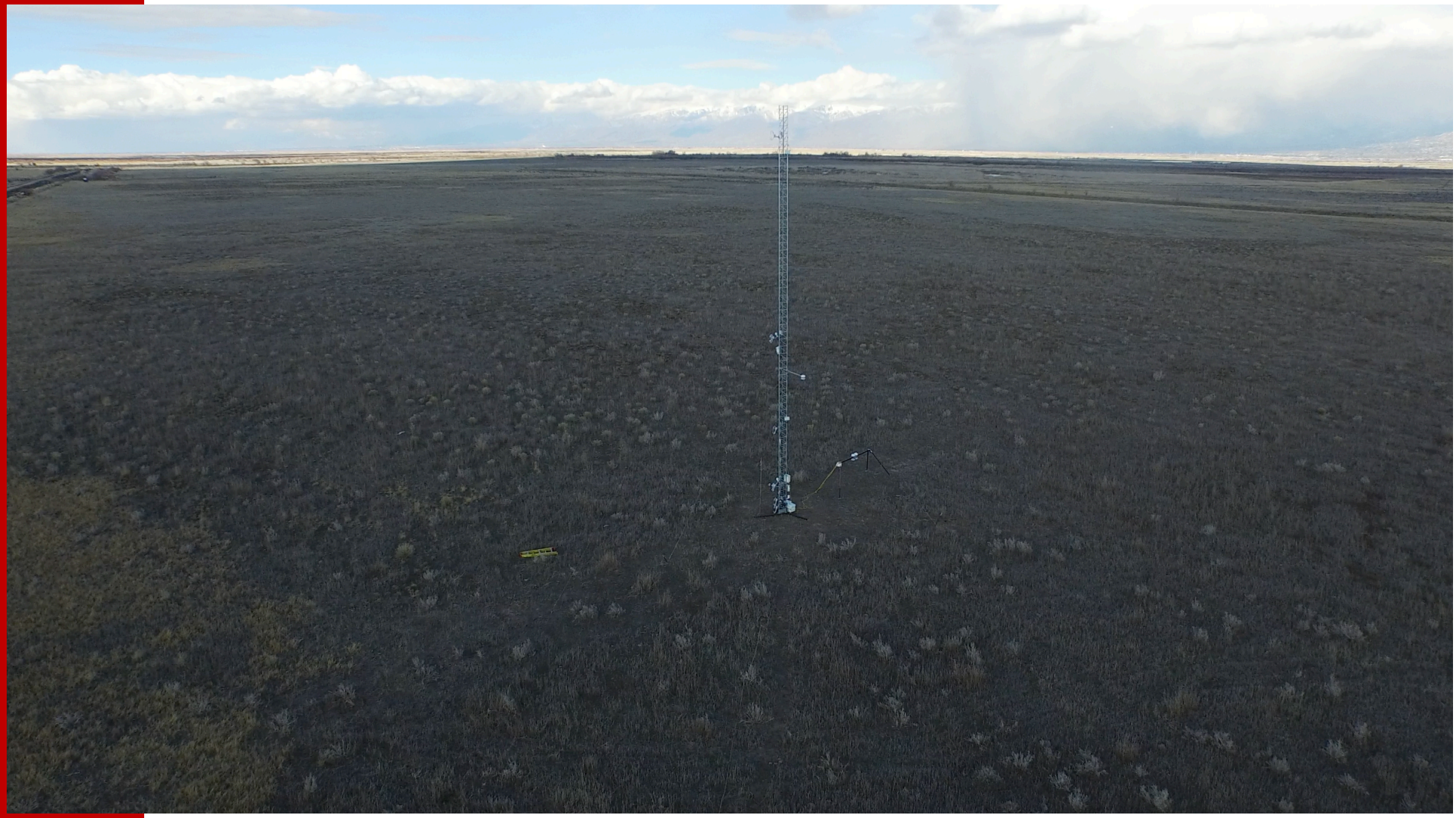
Heber Valley: small high-altitude basin

Salt Lake Valley: large basin in the vicinity of the Great Salt Lake

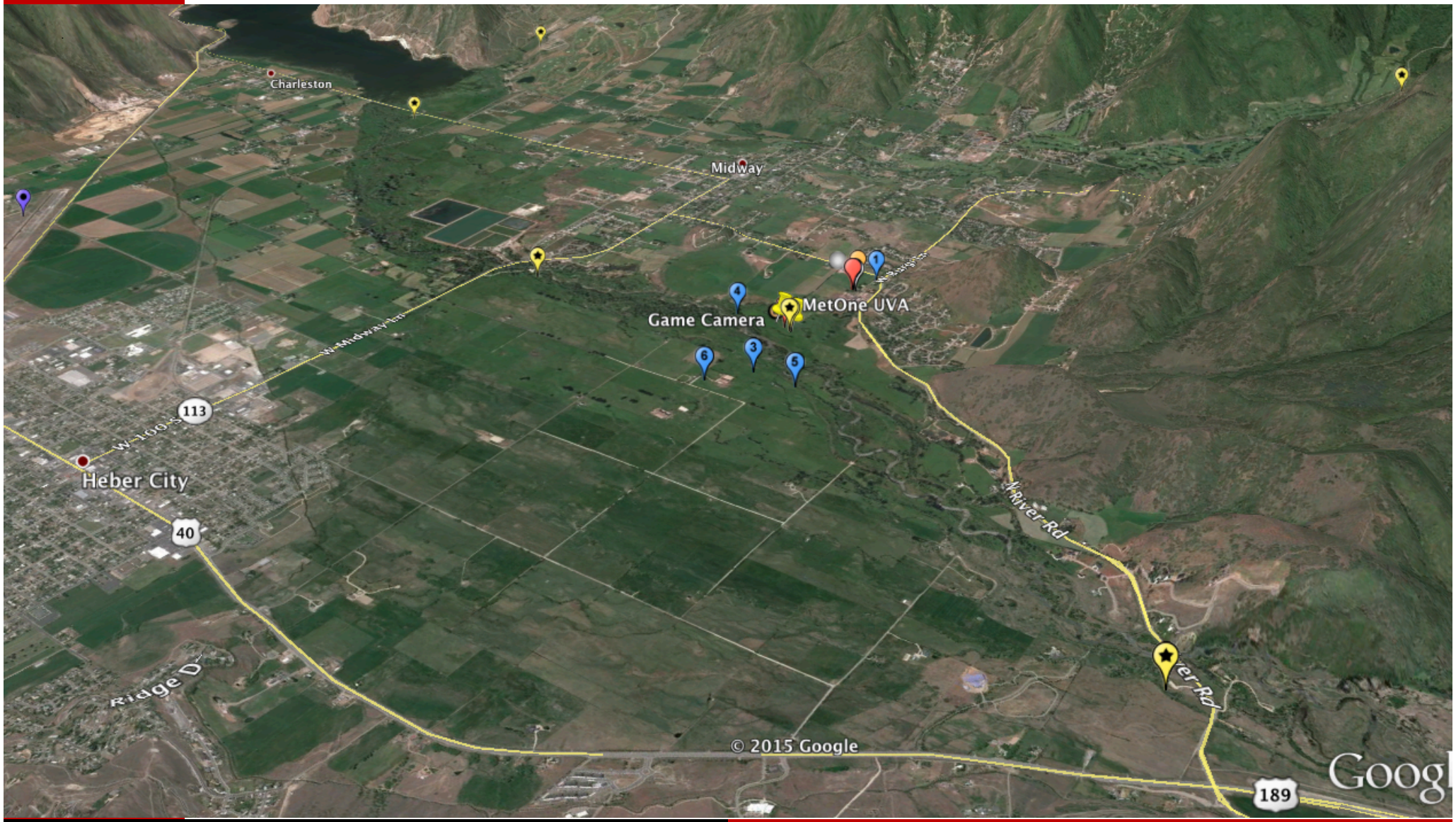

Baileys Lake
MetOne EC
Game Camera



Salt Lake City Site

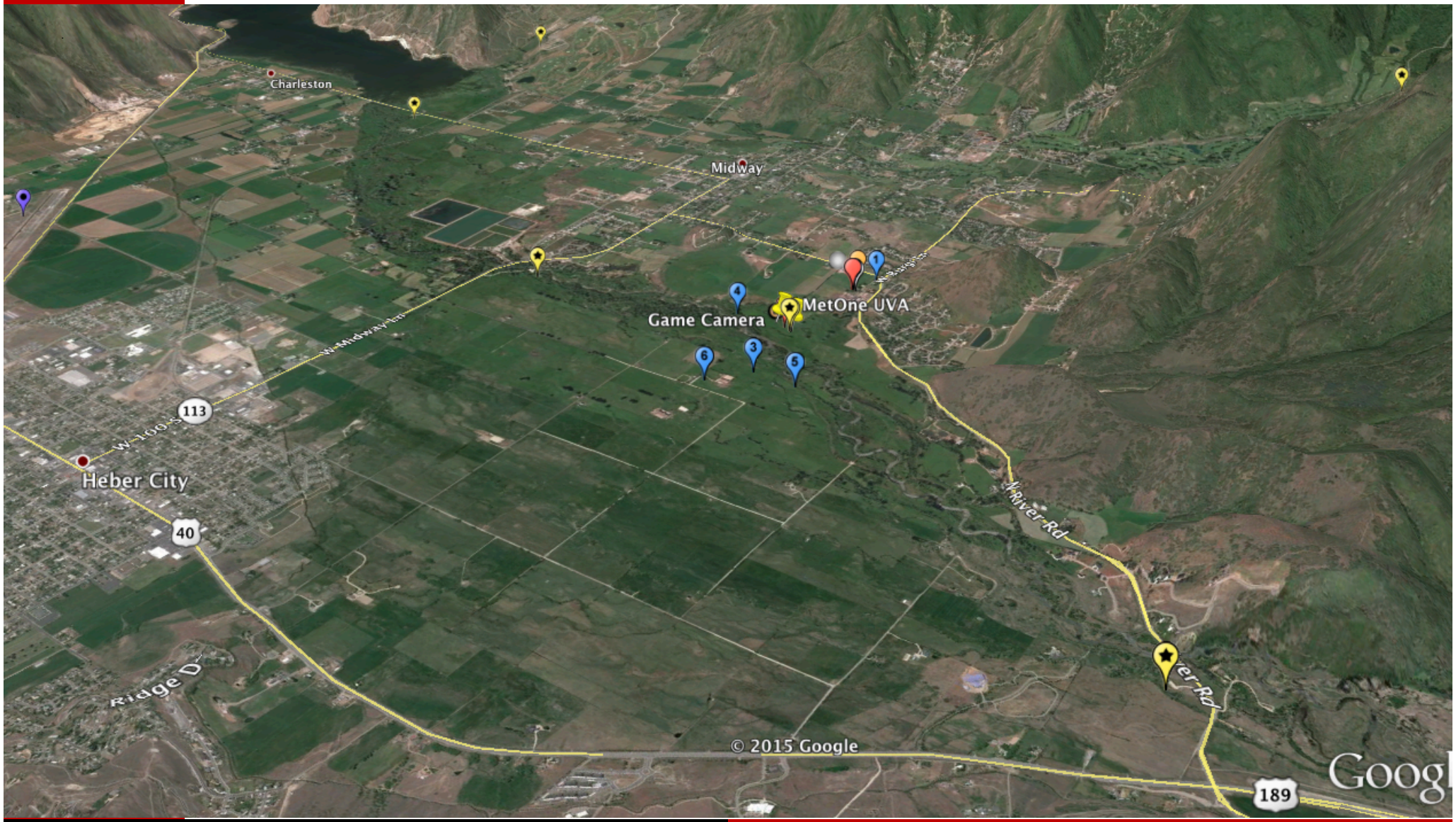


Heber Valley Site



Heber Valley Site

Heber Valley Site

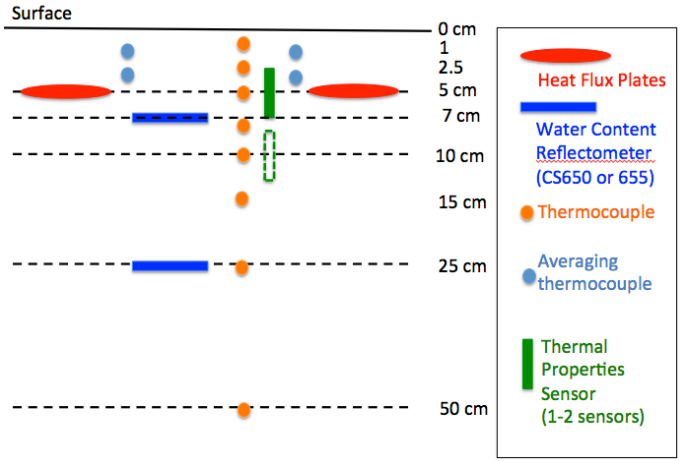


Experiment Details

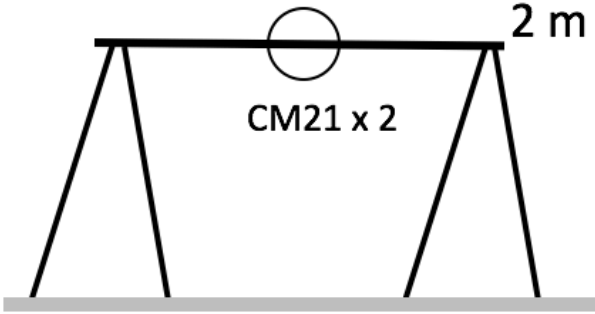
Intensive Fog Instruments – Environment Canada

Main SLV Site Towers: Experiment Details

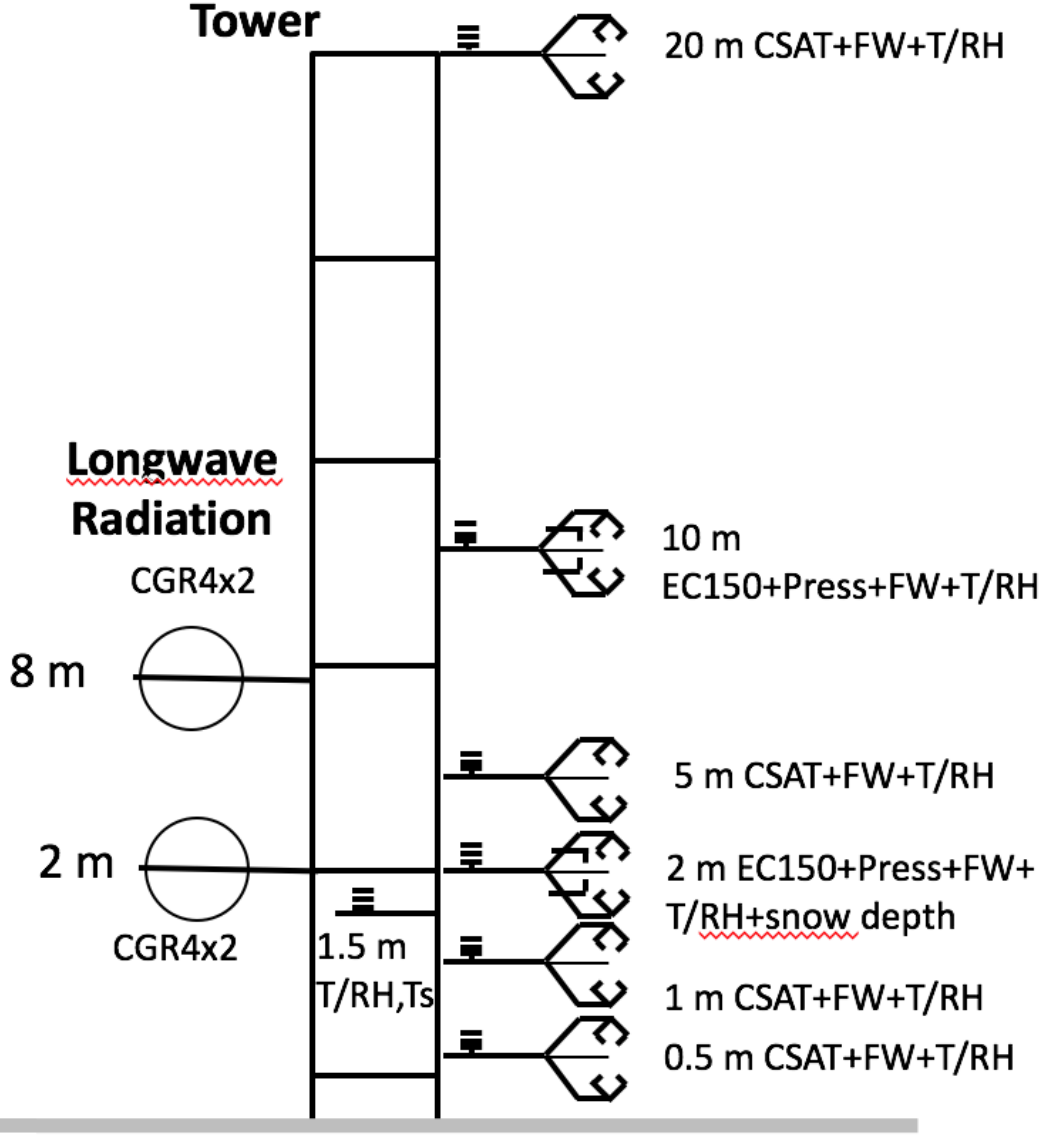
Subsurface



Shortwave Radiation Sawhorse

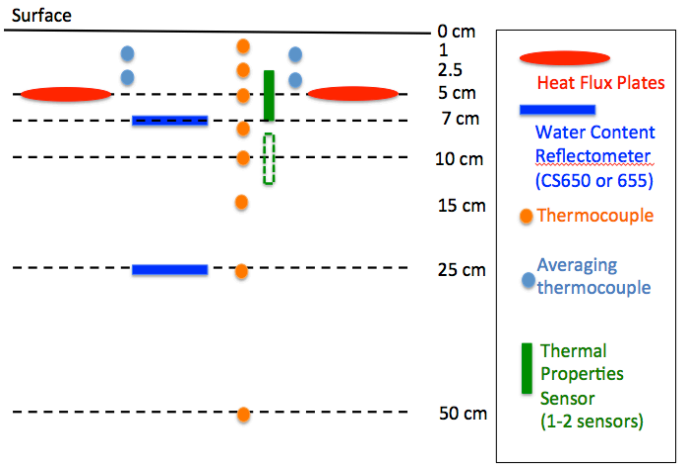


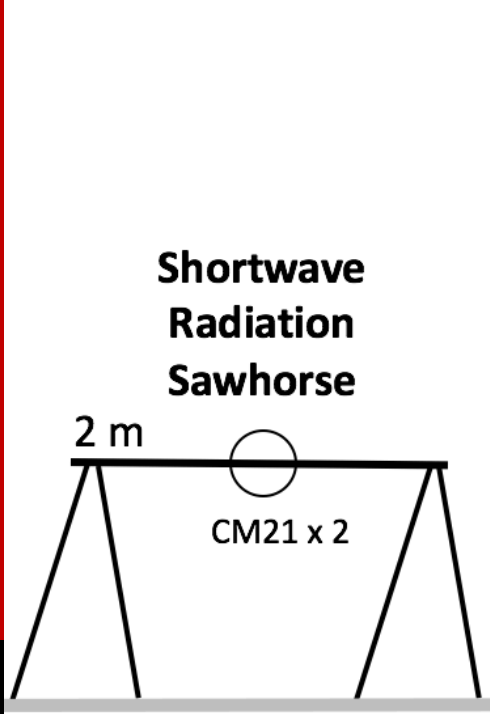
20-m Turbulence Tower

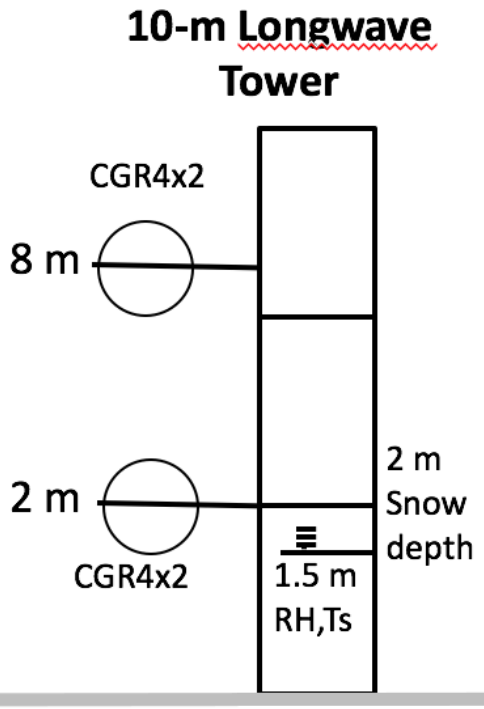


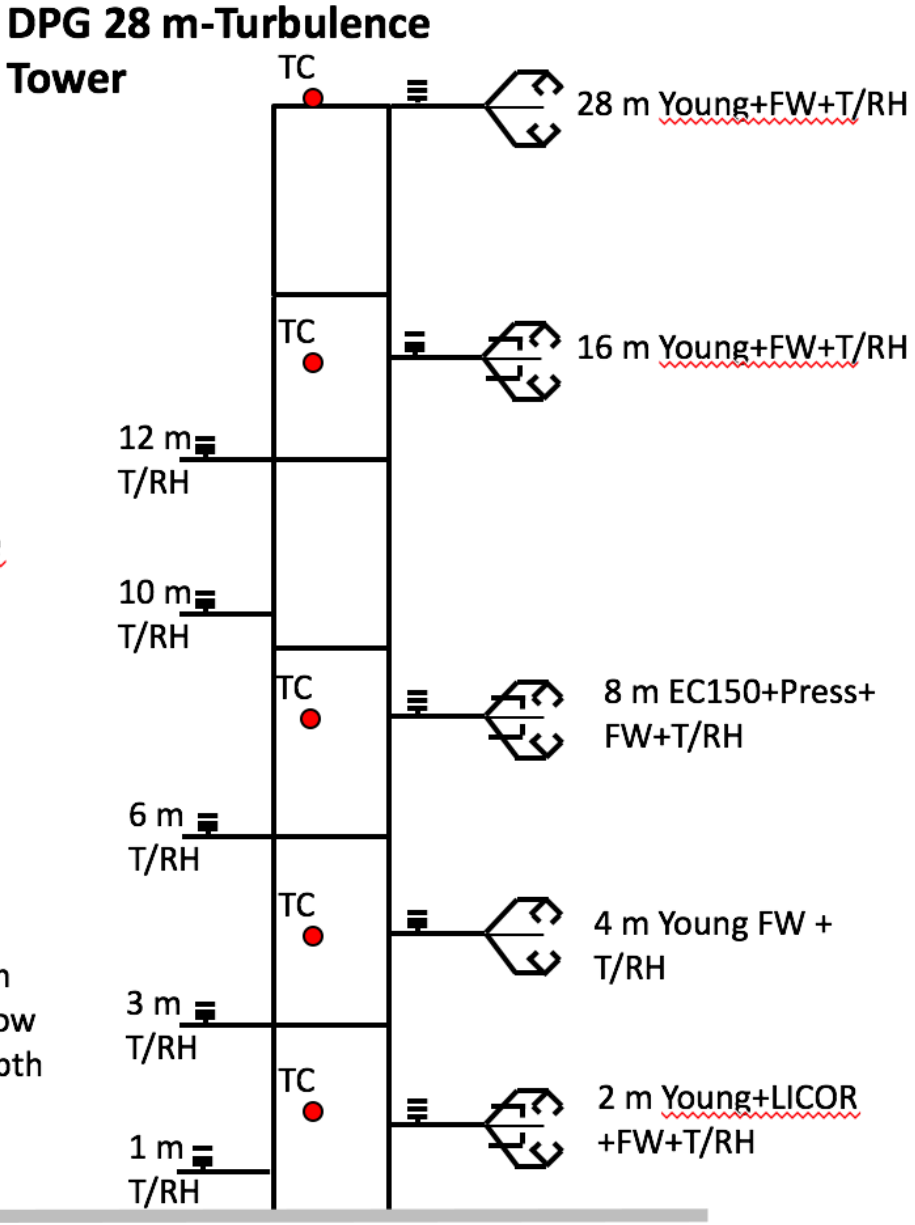
Main Heber Site Towers: Experiment Details

Subsurface



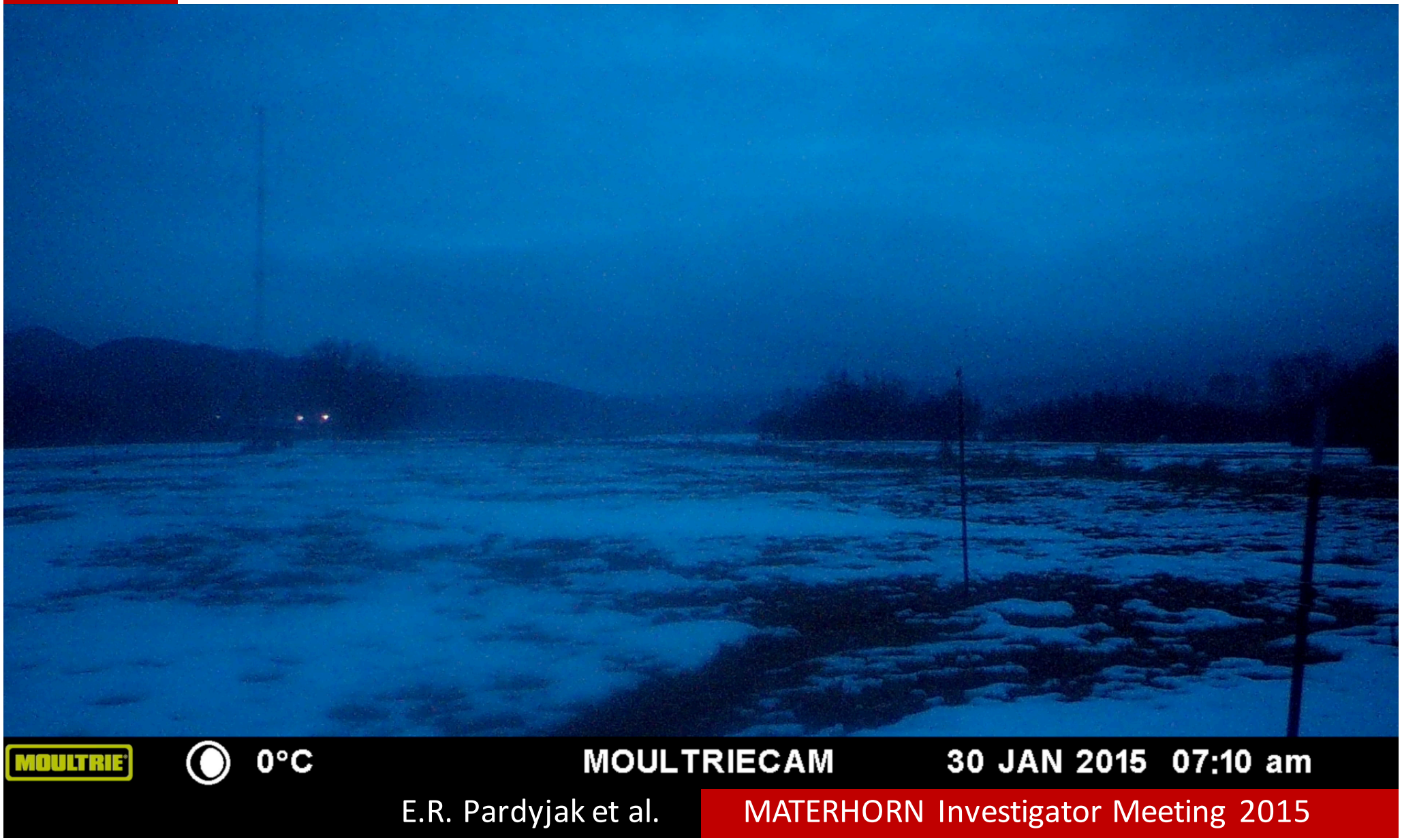






Heber Site Fog Event
9 January 2015

Heber Site Fog Event
30 January 2015



Continued MATERHORN FogX

- All notes are on Evernote in Team MATERHORN-X
- Notes include snow cover measurements, etc.
- University of Utah is finishing compiling the complete Fog-X dataset and will host one version. A second complete version will be sent to UND