



MOUNTAIN TERRAIN ATMOSPHERIC MODELING AND OBSERVATIONS (MATERHORN) PROGRAM

by

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and

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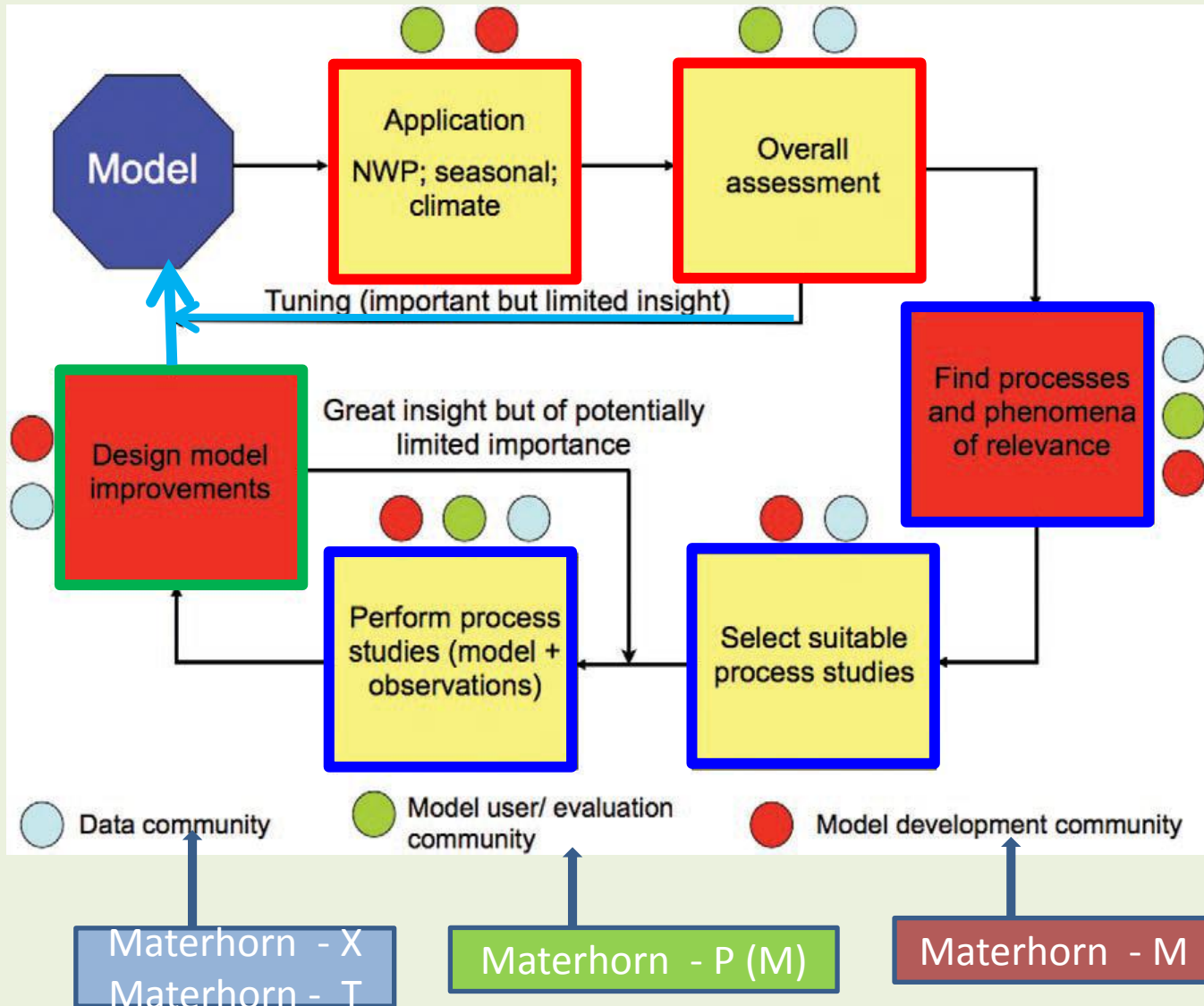
ONR FY 2011 MURI TOPIC #7: Improved Meteorological Modeling in Mountain Terrain

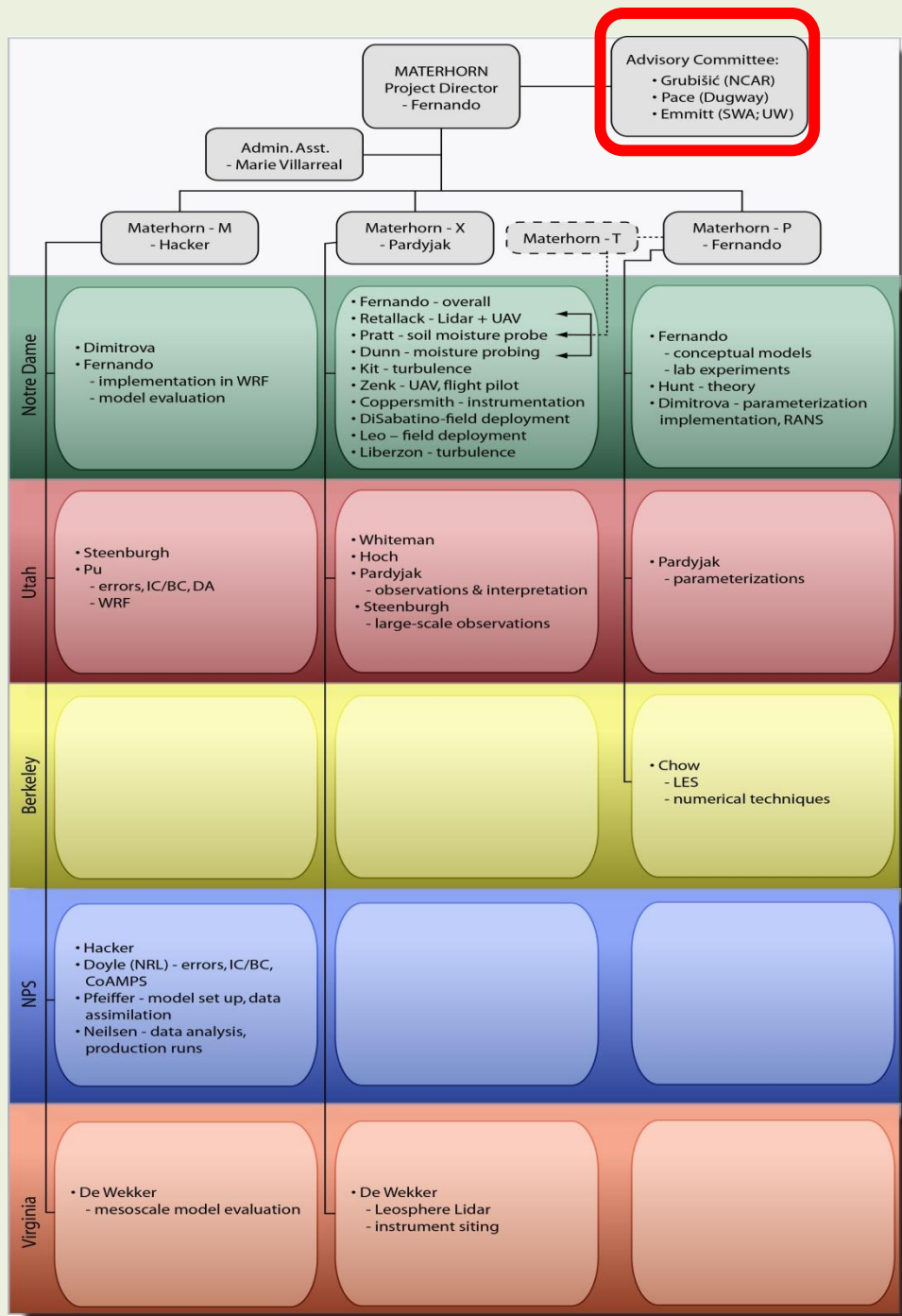


MATERHORN Goals

- identify and study the limitations of current state-of-the-science mesoscale models for mountain-terrain weather prediction
- develop scientific knowledge and tools to help realize leaps in predictability
- Cull a group of skilled researchers with synergy - atmospheric scientists, fluid dynamicists, numerical/theoretical analysts, engineers and applied mathematicians
- Embrace all methodologies - integrate systematically - new paradigm?

Approach





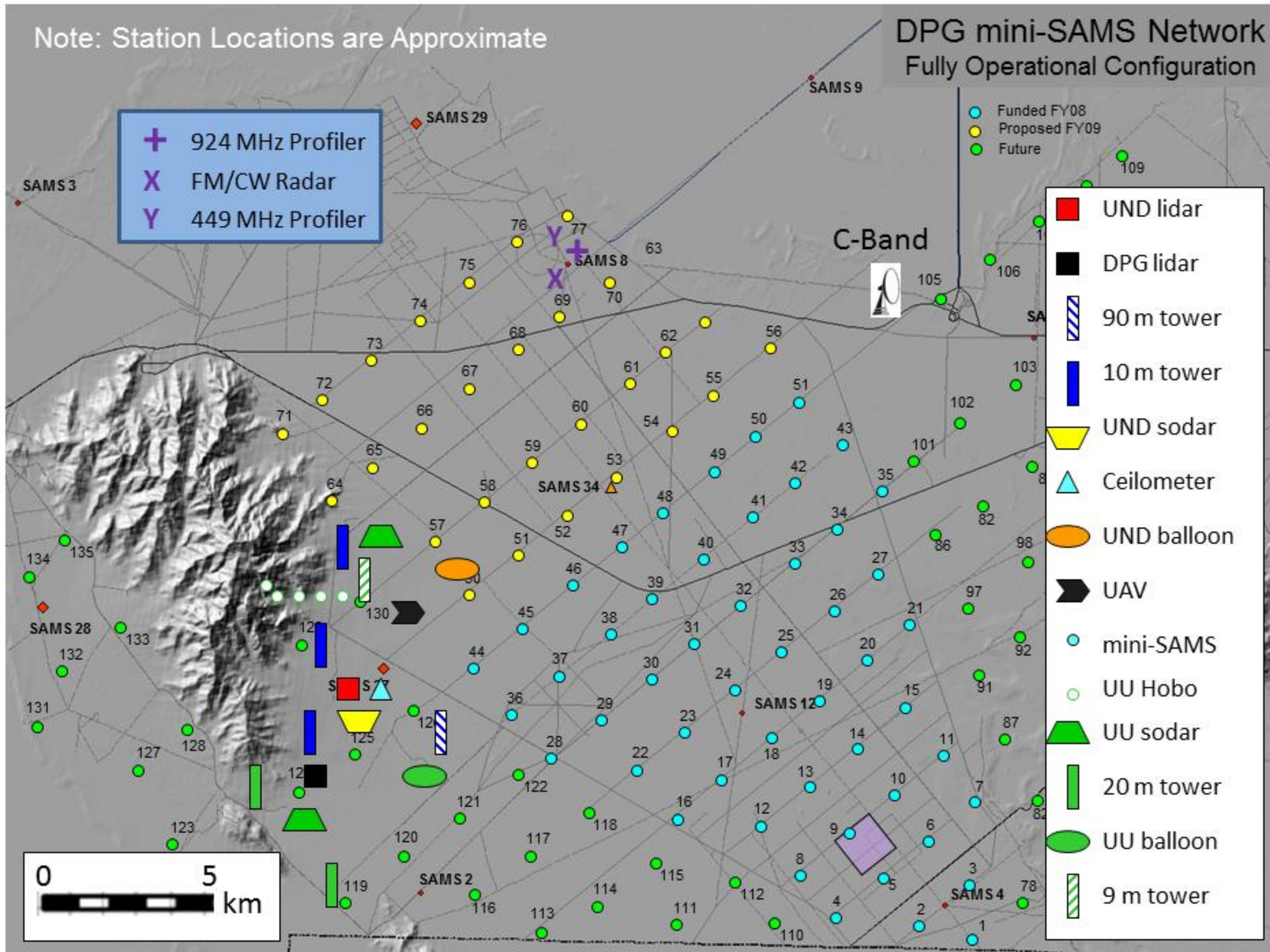
Participants and Administrative Structure

www.nd.edu/~dynamics/materhorn

List serve – Dan Liberzon

Note: Station Locations are Approximate

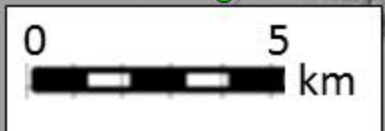
DPG mini-SAMS Network Fully Operational Configuration



- + 924 MHz Profiler
- X FM/CW Radar
- Y 449 MHz Profiler

- Funded FY08
- Proposed FY09
- Future

- UND lidar
- DPG lidar
- 90 m tower
- 10 m tower
- UND sodar
- Ceilometer
- UND balloon
- UAV
- mini-SAMS
- UU Hobo
- UU sodar
- 20 m tower
- UU balloon
- 9 m tower



Timeline

Special Session on Complex Terrain (DeWekker & Chow) – AGU Fall SF

Special session on Atmospheric Observations and Modeling in Complex Terrain (Fernando) – AMS Annual Meeting NO



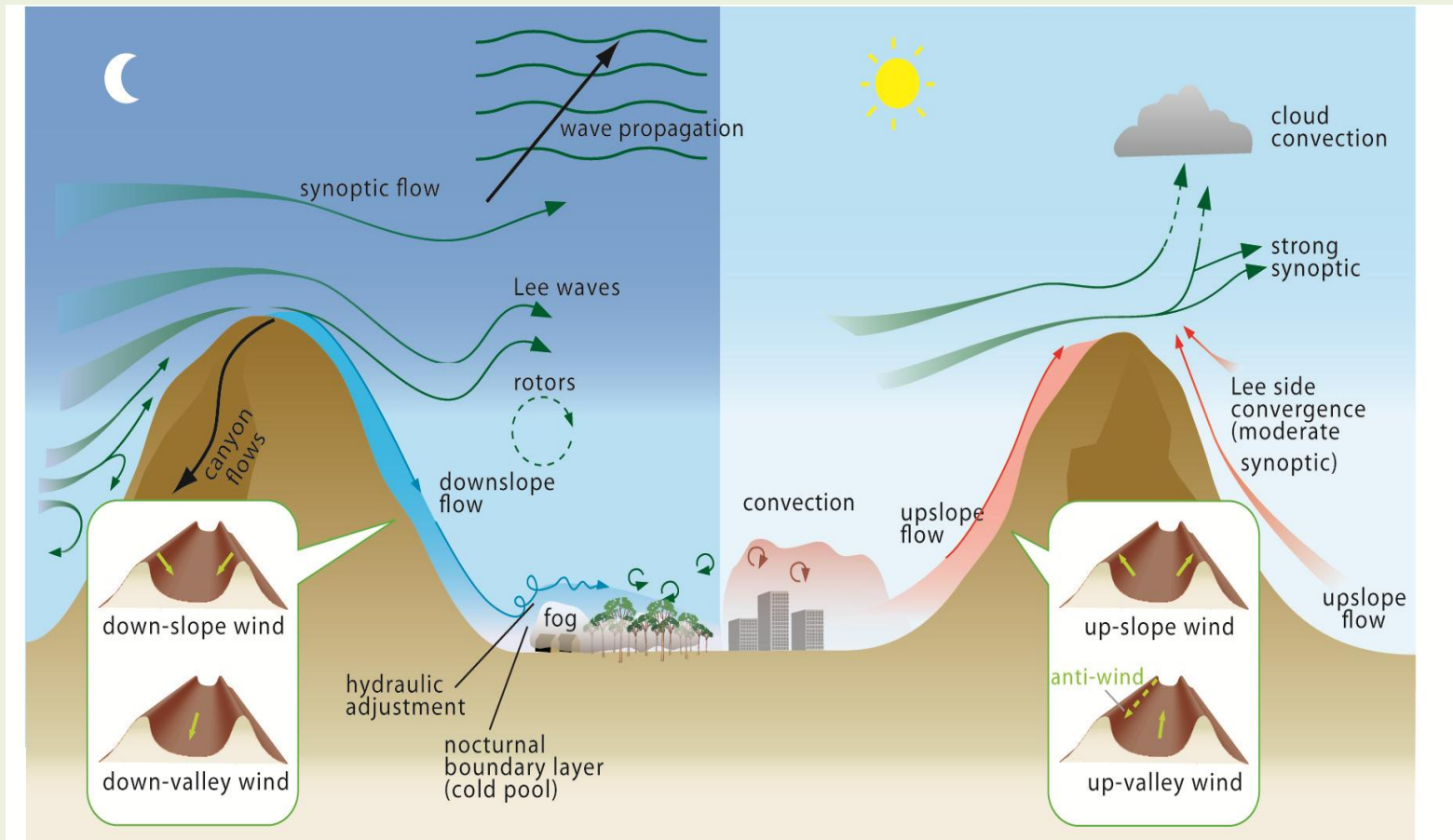
Reviews of 2009 MURI (Aug 24-26, 2011)

12 minute presentation; overseen by Assistant Secretary of
Defense

1. What is the MURI project trying to accomplish (scientific objective and technical approach)?
2. A listing of MURI team members and their professional qualifications, institutions and numbers of post docs and graduate students
3. Project Scientific Issues: Underlying scientific principles, prior state-of-the-art advances that favored a multidisciplinary approach, scientific barriers, potential scientific advances.
4. Scientific accomplishments to date and what we have learned?
5. Do you foresee any potential breakthroughs in this research?
6. Why is this an important area of research?
7. Overall budget dollars, year by year (planned or actual).
8. Dates, locations, overall results of major reviews or meetings.

Presence of the government program manager (PM) at the review is highly desirable and will provide an opportunity for inter-Service scientific coordination.

Mountain terrain processes



Air Quality Applications

Hazardous cloud

Crews contain acid leak in Laveen; 200 residents evacuated



Mike Rynearson/The Arizona Republic

From the *Arizona Republic*

Chemical Spills in Mountainous Terrain

Phoenix Brown Cloud

Purple haze, unhealthy days



Christine Keith/Staff photographer

From the *Arizona Republic*

Applications

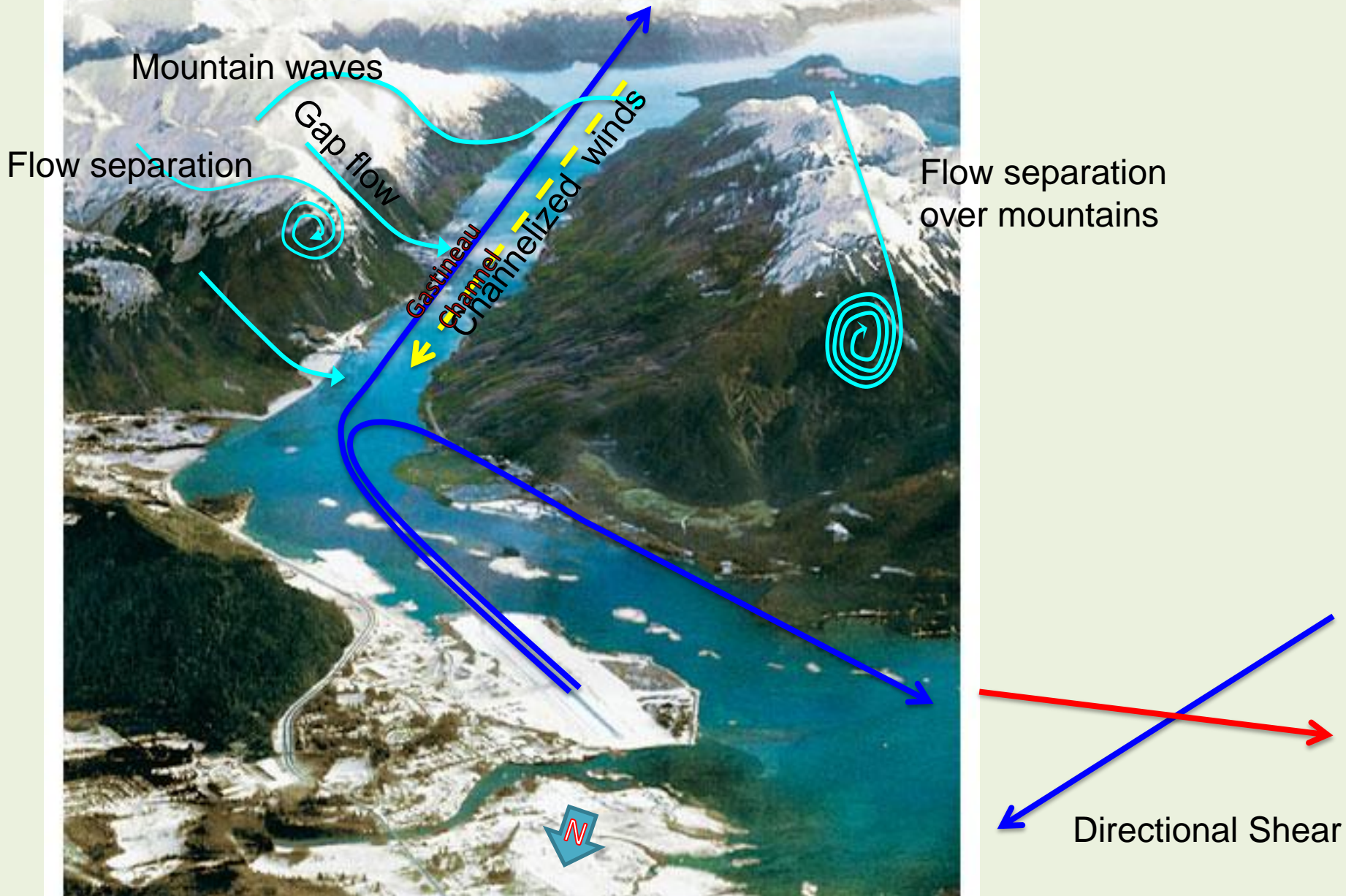


Applications



The Juneau Terrain-Induced Turbulence Alert System

Politovich et al., BAMS, March 2011



Notre Dame Personnel

Senior Personnel

- Joe Fernando (PI)
- Pat Dunn (co-PI)
- Tom Pratt (co-PI)
- Mike Zenk (co-PI)
- Renetal Dimitrova (RAP)
- Charles Retallak (Post doc)
- Dan Liberzon (Post doc)
- Laura Leo (Post doc)
- Scott Coppersmith (R. Eng)
- Eliezer Kit (Tel Aviv)
- Silvana DiSabatino (Lecci)
- Julian Hunt (Cambridge)

Junior Personnel

- Chris Hocut (PhD student)
- Zach Silver (PhD student)
- Stipo Sentic (PhD student)
- Margaret Bellon (undergrad)
- Kristin Stryker (undergrad)
- Mike Higginson (undergrad)
- Matthew Daye (undergrad)

At ND: June 1 – September 1, 2011

- An exploratory field experiment (12 July – August 1, 2011) – Preparation for Materhorn-1, instrument calibrations, student training; ABL Collapse (science) – DiSabatino/Leo
- New instrumentation designs
 - UAV – miniature circuits/flight (Coppersmith/Zenk)
 - Combo – anemometry system (Kit/SC)
- Laboratory experiment (Hocut/Liberzon)

Research Status

- WRF Simulations
Dimitrova
- Fog Aerosol Sampling System (FASS)
Pat Dunn/Charles Retallack
- Remote polarimetric sensing of moisture
Tom Pratt

Pre-Materhorn Experiment: 12 July-03 August 2011

- 15-day field experiment ; Whitefield, Notre Dame
- Heterogeneous flat terrain site with scattered trees; HP, dry and moist
- ABL Collapse
- DiSabatino, Leo, Sentic, Hocut, Silver Retallack, Liberzon, Fernando, Zenk, **Huq, Markfort**



Pre-Materhorn Experiment (12 July-03 August 2011)

A complete suite of instruments was deployed, including ...



Sodar/RASS

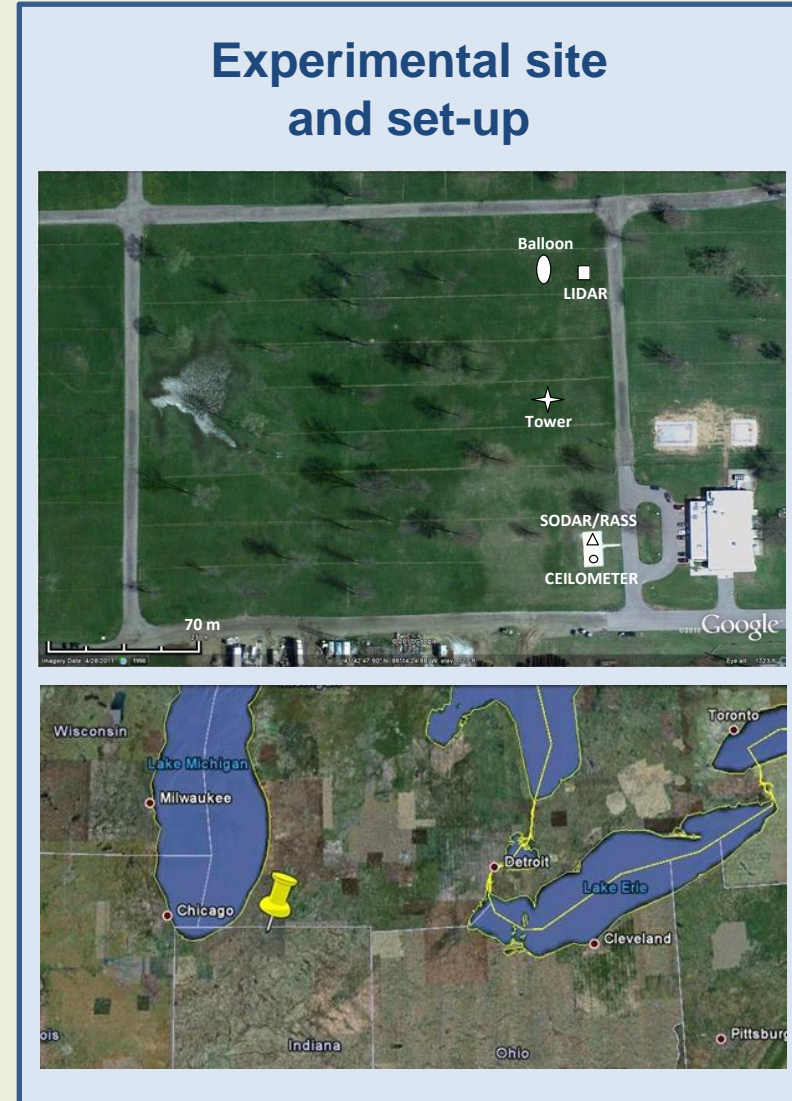


Doppler Lidar

Vaisala
Ceilometer



Tethered
Balloon



Experimental site
and set-up

Tower Set-up

10 m

10 m

Sonic Anemometer
Young



10 m

10 m

thermocouple type
K 1, relative
humidity probe

RH probe
Net
radiometer



Thermocouple 6 m

6 m

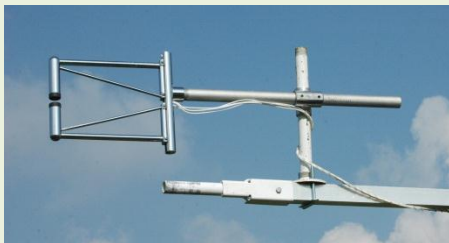
Sonic Anemometer
Young



3 m

3 m

Hygrometer
Thermocouple



CR5000 datalogger
Pressure sensor



Sonic Anemometer
CSAT
COMBO SYSTEM



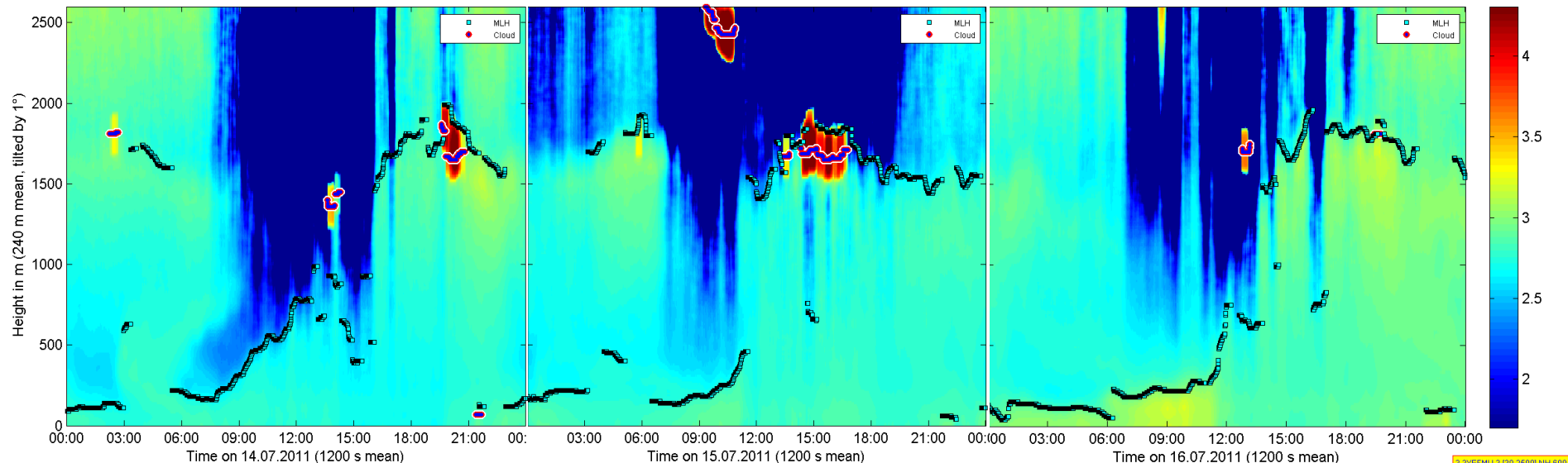
Ceilometer Data Analysis

14-15-16 July

whitefield \log_{10} of backscatter with MLH on 14.07.2011 in $10^{-9} \text{ m}^{-1} \text{ sr}^{-1}$

whitefield \log_{10} of backscatter with MLH on 15.07.2011 in $10^{-9} \text{ m}^{-1} \text{ sr}^{-1}$

whitefield \log_{10} of backscatter with MLH on 16.07.2011 in $10^{-9} \text{ m}^{-1} \text{ sr}^{-1}$

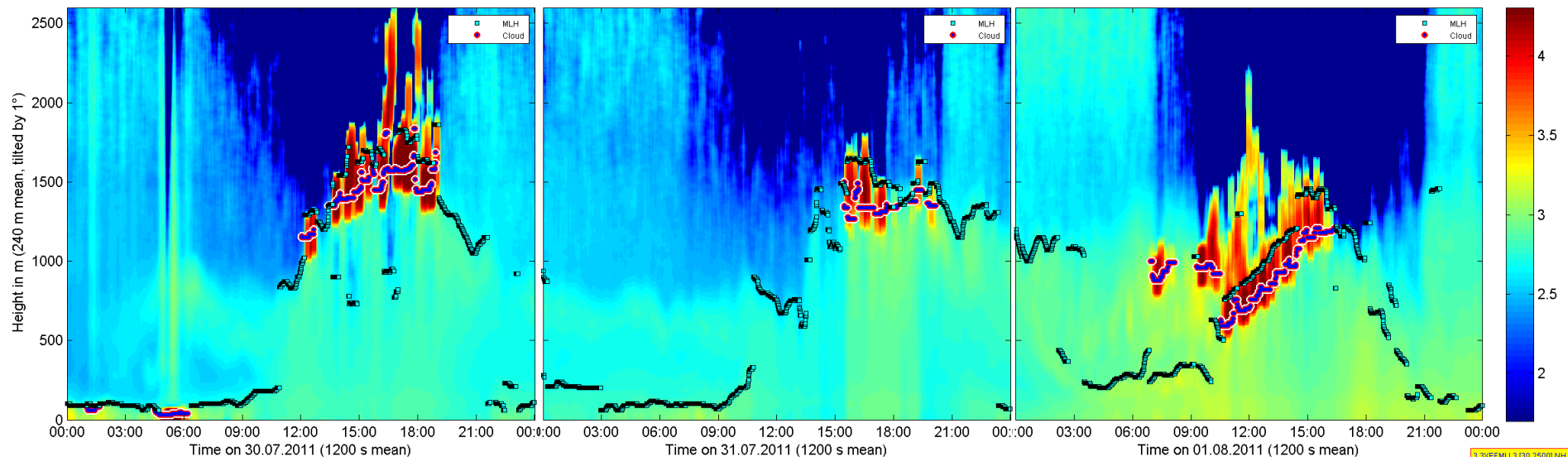


30-31 July-01 August

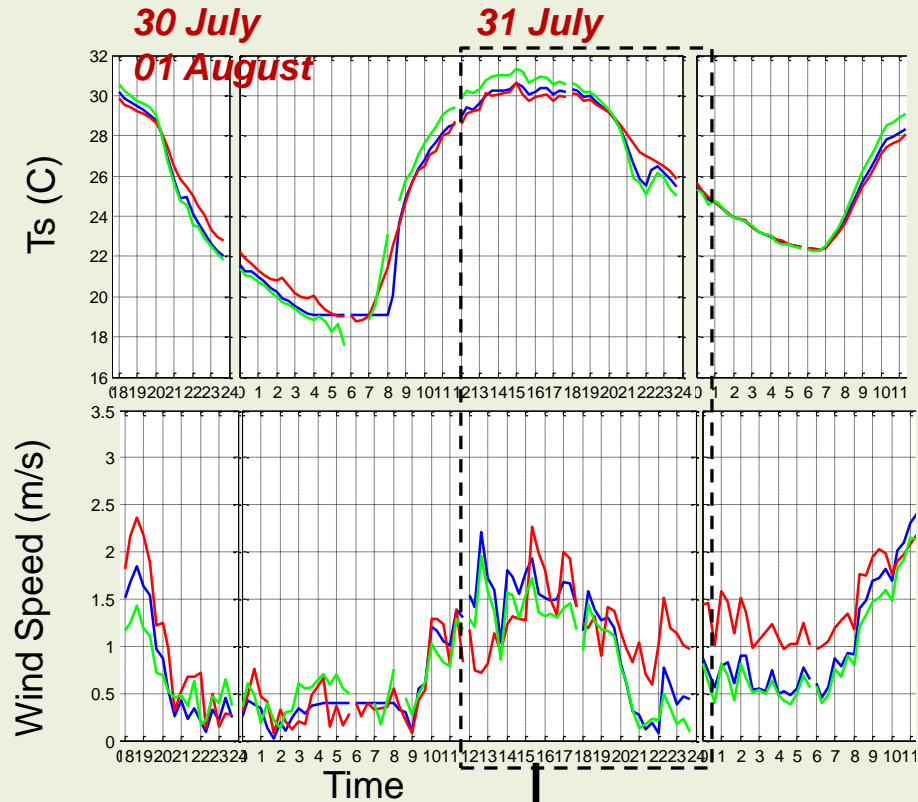
whitefield \log_{10} of backscatter with MLH on 30.07.2011 in $10^{-9} \text{ m}^{-1} \text{ sr}^{-1}$

whitefield \log_{10} of backscatter with MLH on 31.07.2011 in $10^{-9} \text{ m}^{-1} \text{ sr}^{-1}$

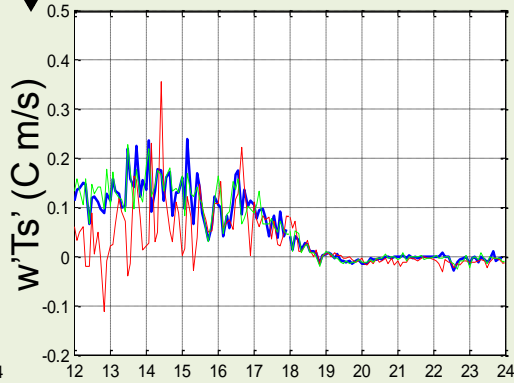
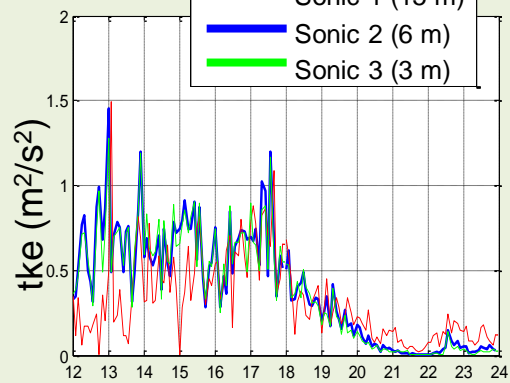
whitefield \log_{10} of backscatter with MLH on 01.08.2011 in $10^{-9} \text{ m}^{-1} \text{ sr}^{-1}$



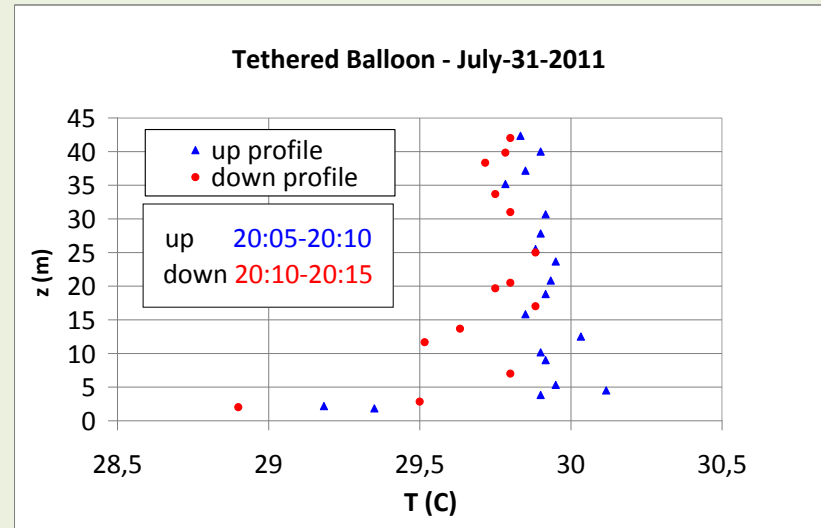
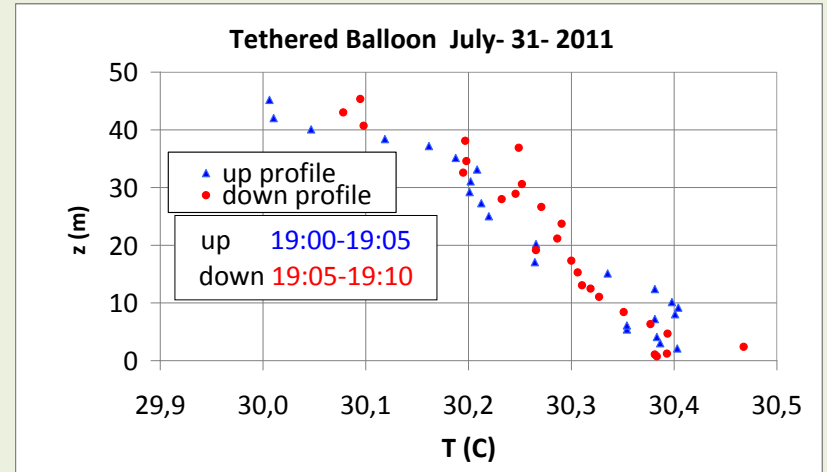
Sonics Data Analysis



— Sonic 1 (15 m)
— Sonic 2 (6 m)
— Sonic 3 (3 m)



Balloon Data Analysis

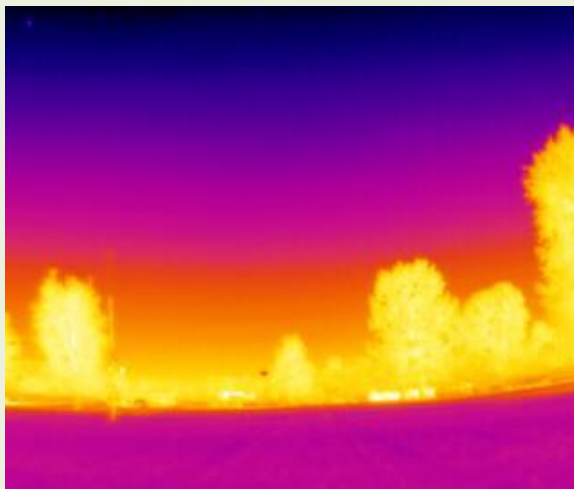


IR images

18:45



21:10



31 August

23:30

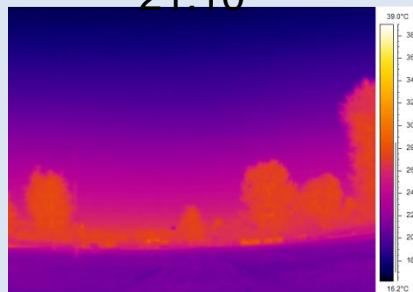


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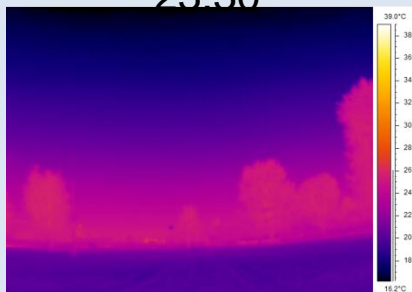


Same Color Palette

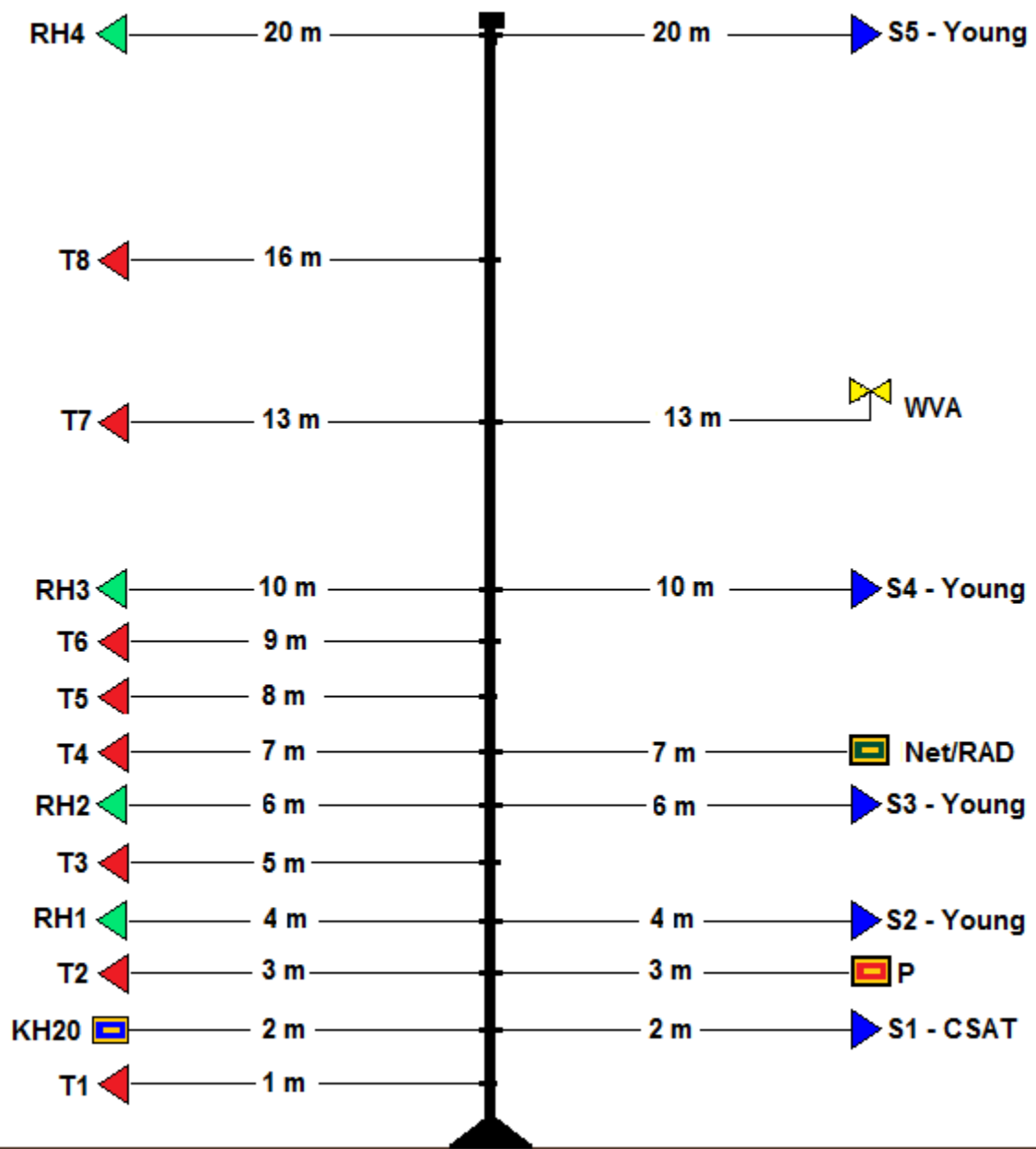
21:10



23:30

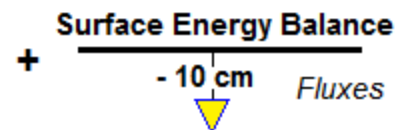


Tower One (Main Tower)

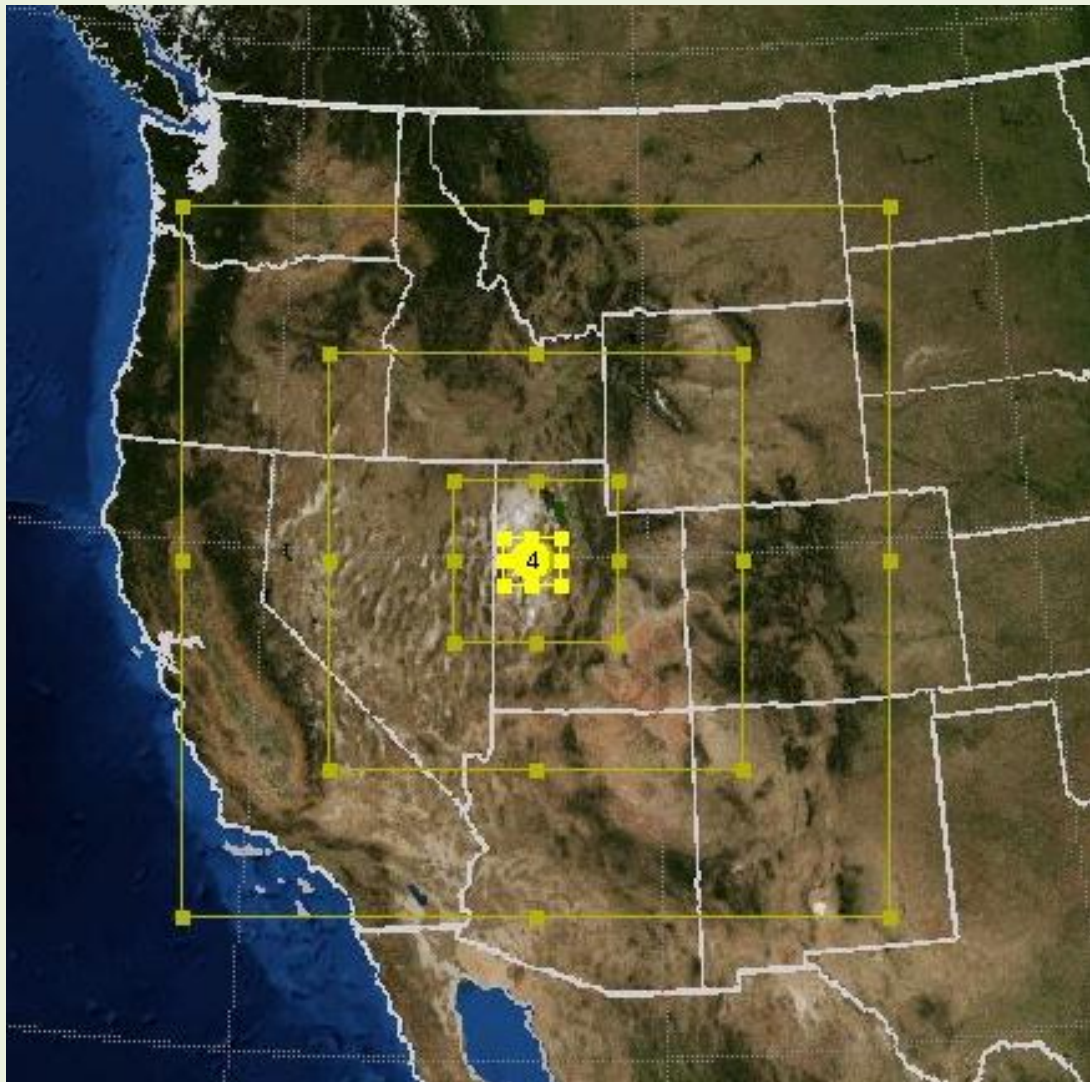


RH		Relative Humidity Sensors
T		Shielded Termocouples
S		Ultrasonic Anemometers
Net/RAD		Net Radiometer
KH20		K-Hygrometer
P		Barometer
WVA		Wind Vane Anemometer

Materhorn -1



Weather Research and Forecast Model Simulations



WRF (two-way nesting)

Domains:

D1: 25x25 - 64km

D2: 57x57 - 16km

D3: 89x89 - 4km

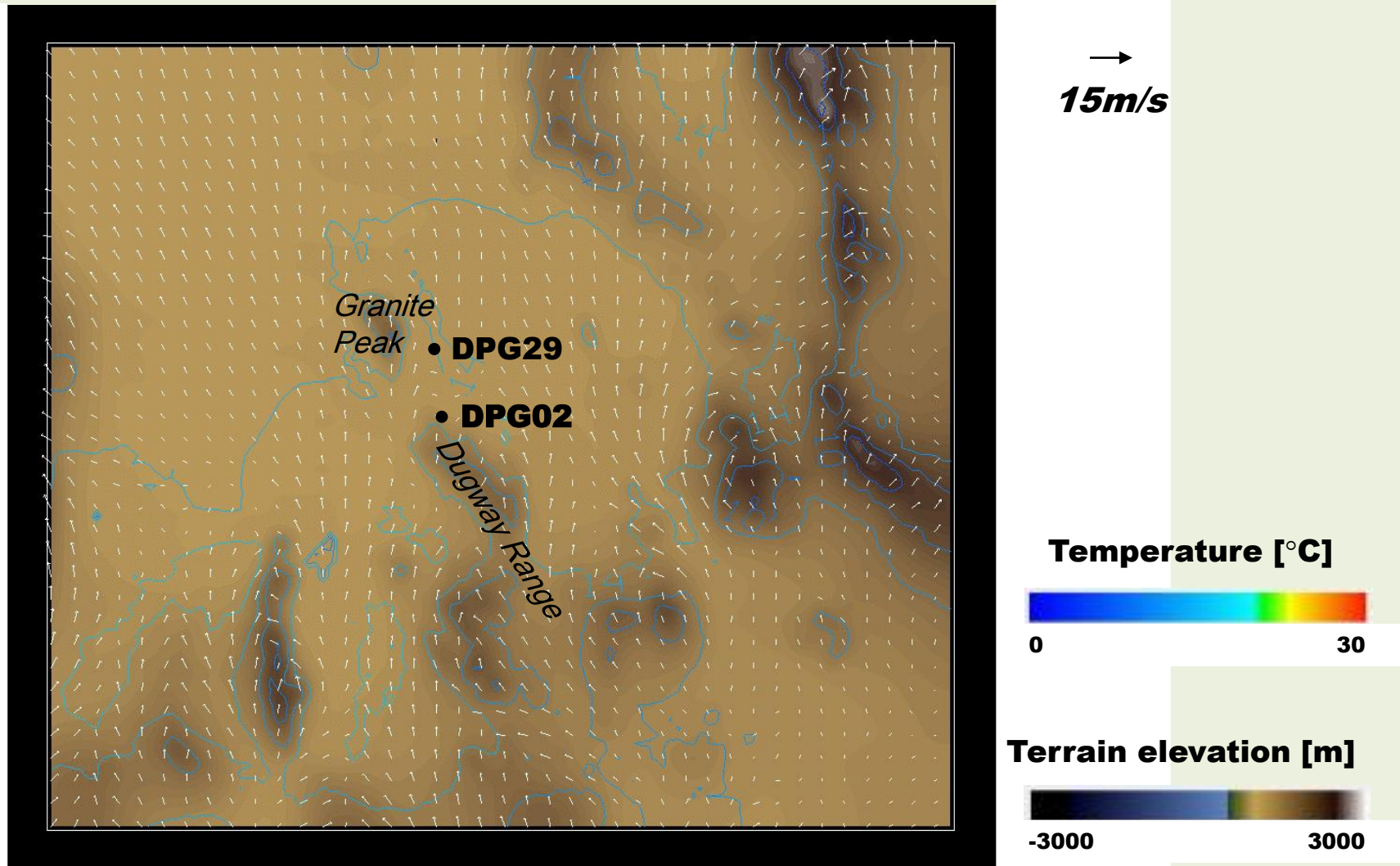
D4: 121x105 - 1km

37 vertical levels

Physics Options:

- **MODIS land-cover**
- **Noah land surface model**
- **Longwave Rad. RRTM**
- **Shortwave Rad. Dudhia**
- **WRF Single-Moment 6-class microphysics**
- **YUS (non-local-K scheme)**
- **MM5 similarity surface layer**

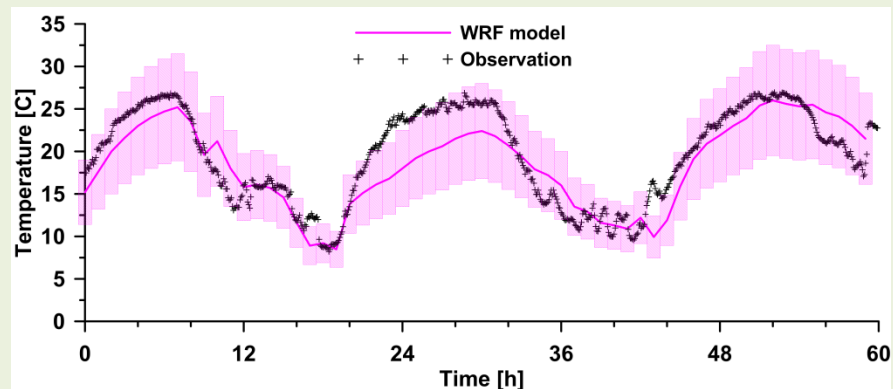
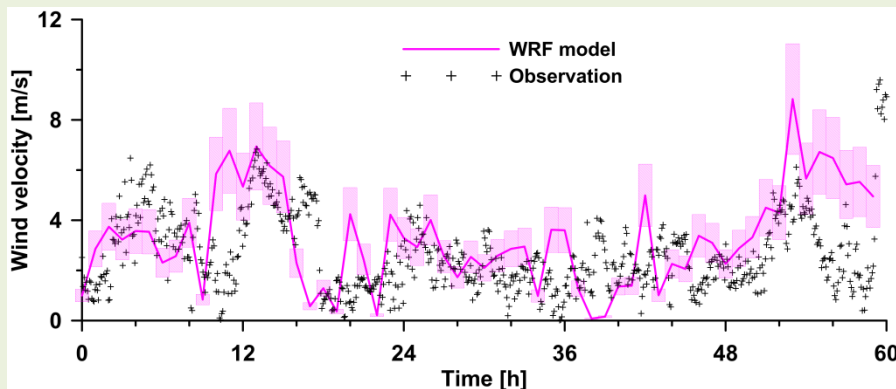
Wind vectors and temperature contours May 5-7, 2011



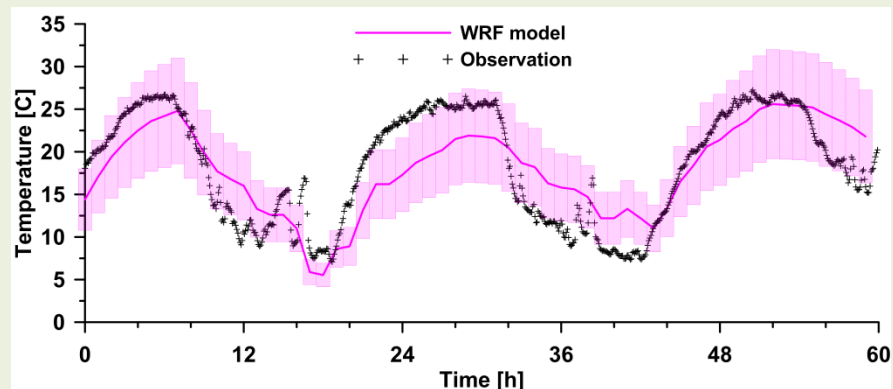
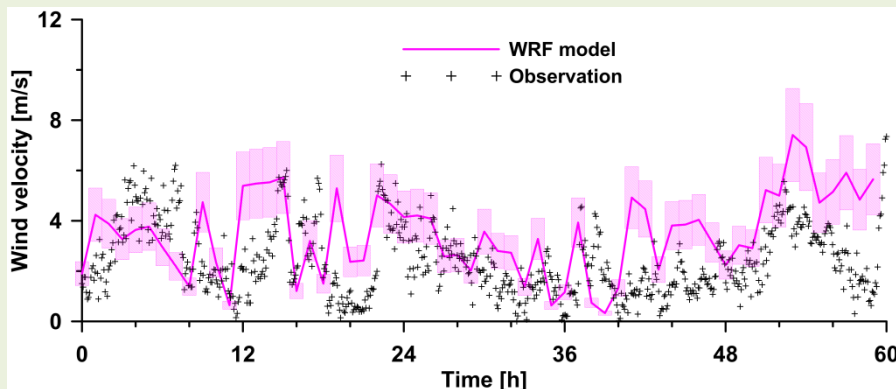
11:00:00 May 5, 2011

Model data compared with the measurements

DPG02 (May 5, 11:00:00 - May 7, 23:00:00)



DPG29 (May 5, 11:00:00 - May 7, 23:00:00)



Laboratory Experiments







Thank you