Turbulence structure in the daytime boundary layer around an isolated mountain from in-situ airborne measurements

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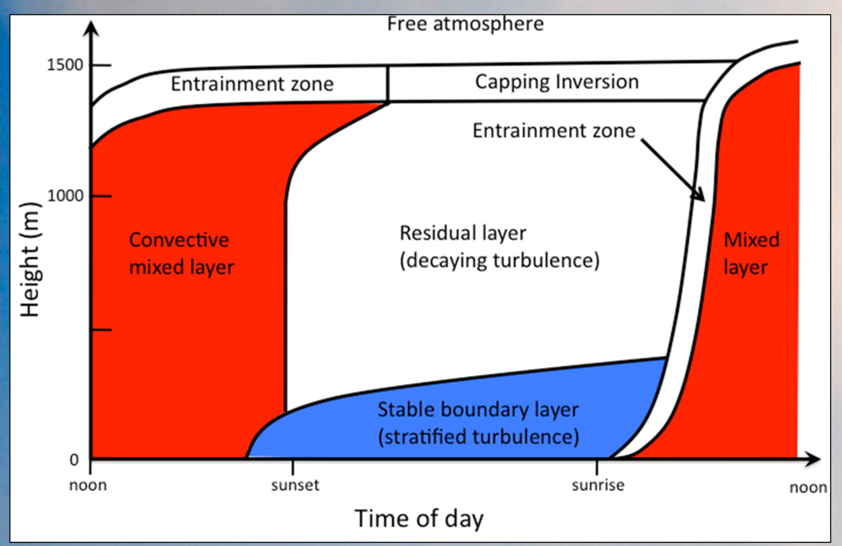
1. Introduction

Diurnal evolution of the boundary layer



Terrain induced cloud formations

Motivation

The scientific community requires insight into how atmospheric flow and complex terrain interact and how these flows impact boundary layer development and turbulence structure over complex terrain .

MATERHORN

During the first field experiment of the Mountain Terrain Atmospheric Modeling and Observations (MATERHORN) campaign between September 24th and October 25th of 2012, a Navy Twin Otter research aircraft was deployed to collect high spatial-temporal *in situ* and Doppler lidar measurements of various atmospheric state variables around the isolated Granite Mountain, Utah. In this poster, initial analyses of aircraft *in situ* data from the Navy Twin Otter aircraft are presented with the major goal to investigate the daytime boundary layer turbulence structure over complex terrain during a fair weather day.

Objectives

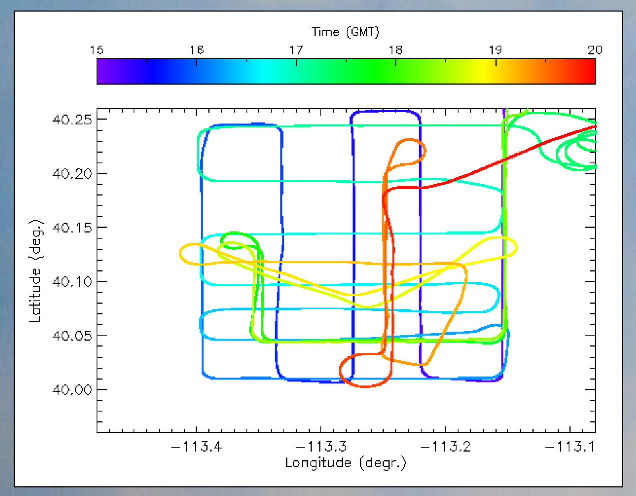
1. Investigate the spatial variability of turbulence measurements of potential temperature, mixing ratio and vertical velocity.
2. Characterize the turbulence structure by analyzing fluctuations in vertical velocity and potential temperature

2. Twin Otter *in situ* Aircraft Measurements

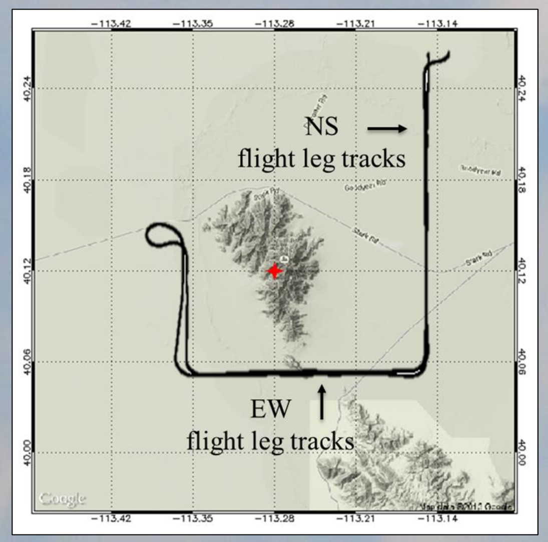
Navy Twin Otter Aircraft

Granite Mountain, Utah

Navy Twin otter Aircraft: Airspeed = 50 m/s; measurements of vertical velocity, ambient temperature, wind speed, wind direction, dew point, and relative humidity at 10 hz .



Flight legs on the morning of Oct. 10th 2012

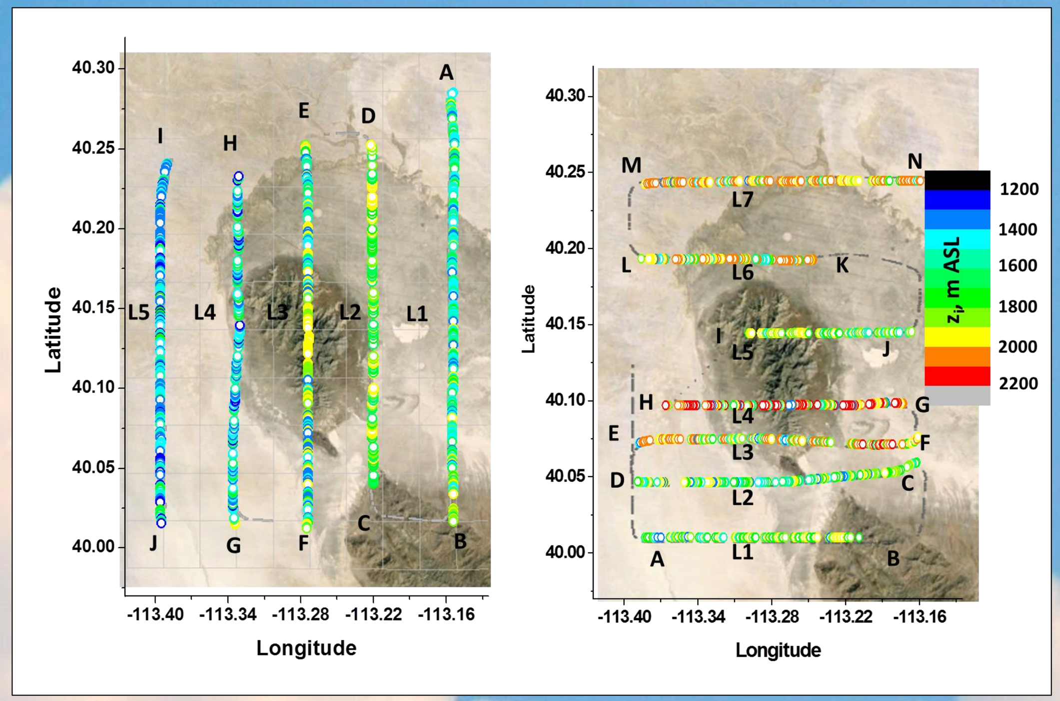


Selected NS flight legs

Leg Name	Time (GMT) start	Time (GMT) end	Altitude m ASL (z)	Length km	BL height m ASL (zi)	Inside/outside BL
NS Leg 1	17:50	17:57	1890	19.93	1700	outside
NS Leg 2	18:15	18:20	1760	18.81	1700	outside
NS Leg 3	18:21	18:28	1620	22.06	1700	inside

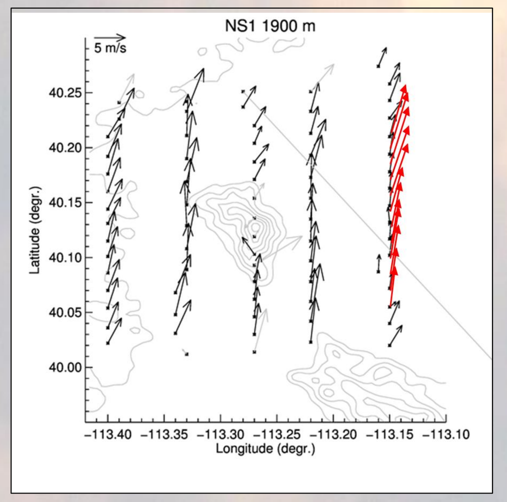
Table of selected NS flight leg characteristics on Oct. 10th

3. 2D field of zi and horizontal wind

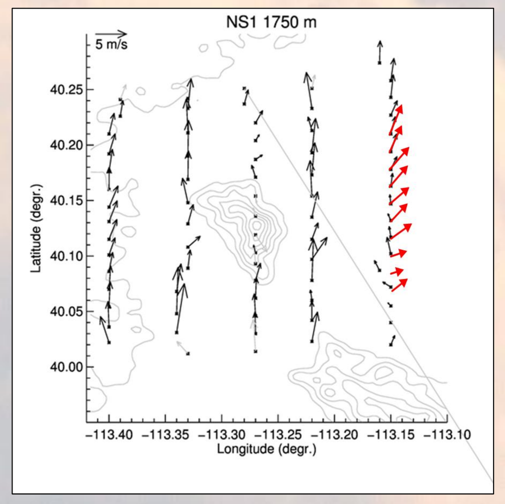


Observed BL top (zi) variability along the north-south **[left]** and the east-west flight legs [right] on the morning of 10 October 2012. BL height ranged from 1600-2200 m ASL.

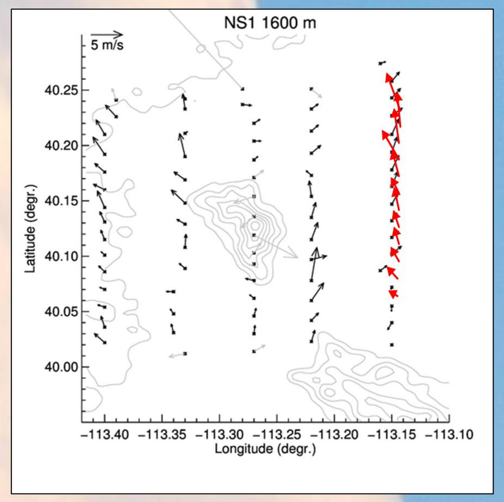
1900 m ASL



1750 m ASL



1600 m ASL

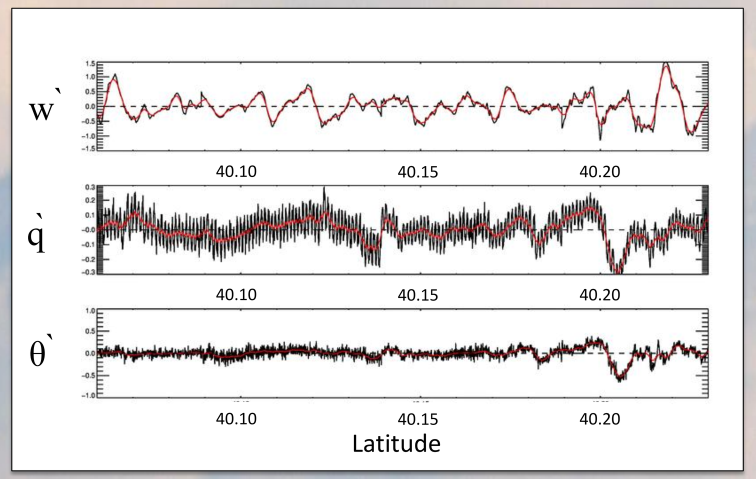


Horizontal winds measured by Twin Otter Doppler wind lidear (Black) overlaid with in situ aircraft wind measurements (Red) from selected NS flight legs

w`=0

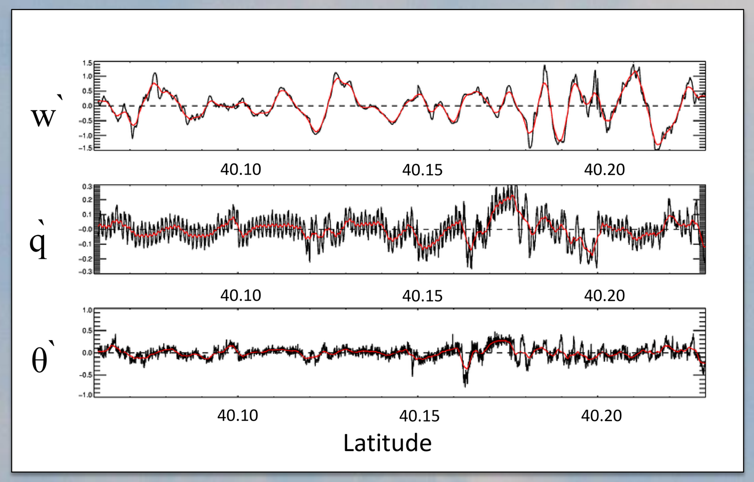
4. Turbulence Measurements

NS Leg 1

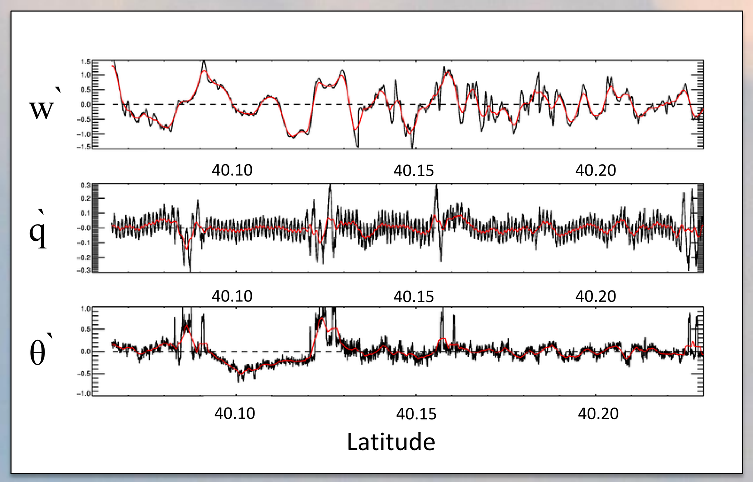


Raw aircraft *in situ* data was detrended using a linear fit. Fluctuations are calculated by subtracting detrended data from *in situ* measurements..

NS Leg 2

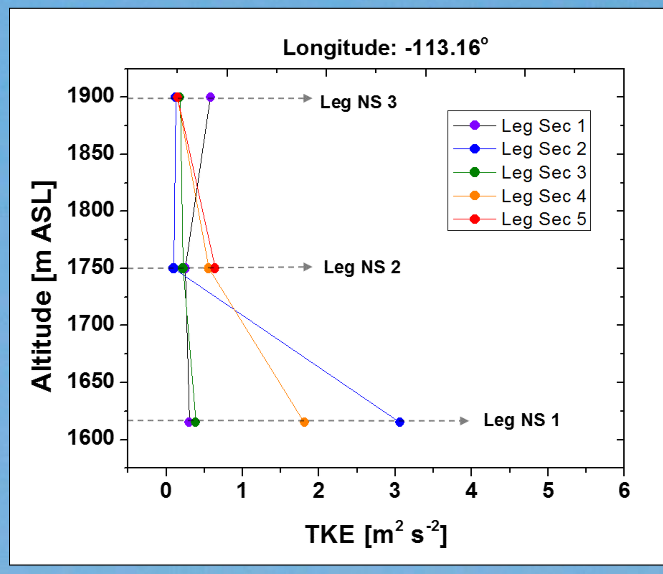


NS Leg 3

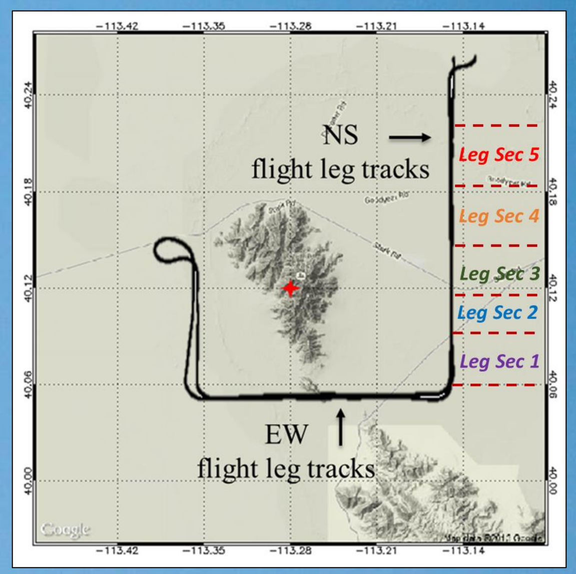


Spatial variability of vertical velocity (w'), specific humidity (q'), and potential temperature (θ') perturbations for selected flight legs.

5. Turbulence Kinetic Energy

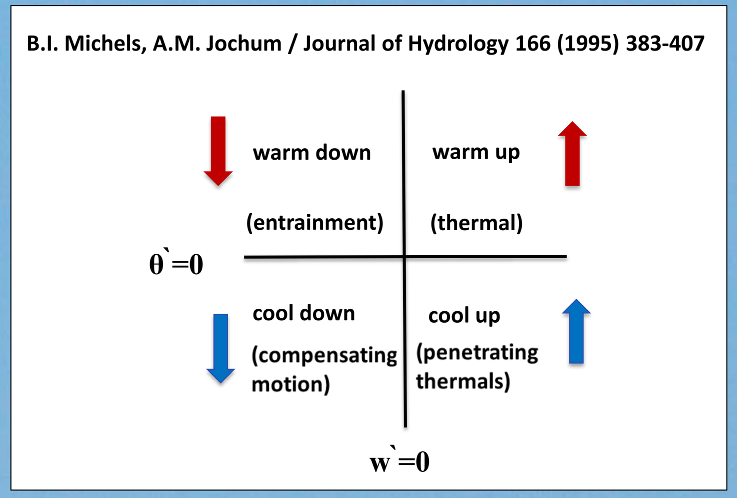


Spatial variability of turbulent kinetic energy (TKE).



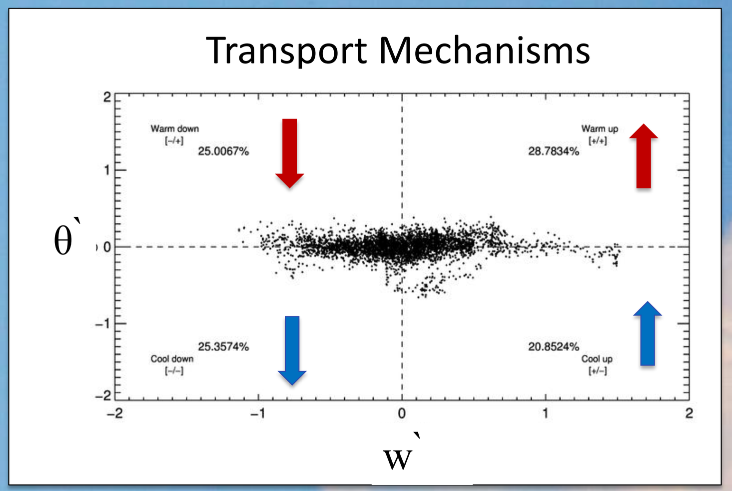
Five sections of each leg [approx.. 2-3 km in length]

6. Quadrant Analysis of Turbulence

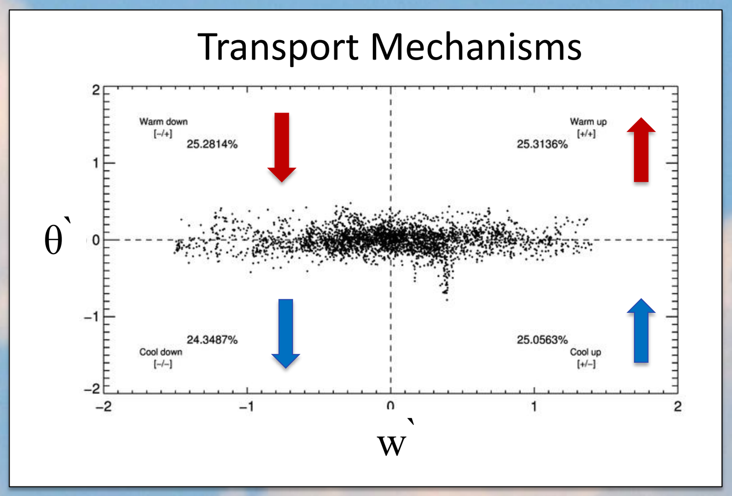


Example of quadrant analysis

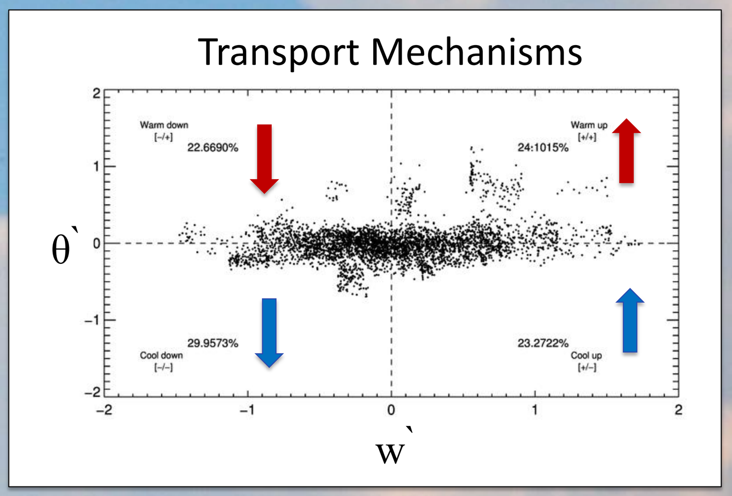
NS Leg 1



NS Leg 2



NS Leg 3



Quadrant analysis of selected NS flight legs on 10 October 2012

6. Key Findings

- Doppler lidar and *in-situ* measurements of horizontal winds agree reasonably well.
- Horizontal variability of turbulence measurements increases with altitude.
- Quadrant analysis explains the majority of the eddies at 1600 m ASL and 1750 m ASL are characterized by warm-up and cool-down thermals.
- Vertical variability illustrating a decrease in TKE with height
- Future research will investigate the linkage between ABL turbulence structure and organized convective structures in the experimental area.

Acknowledgements

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