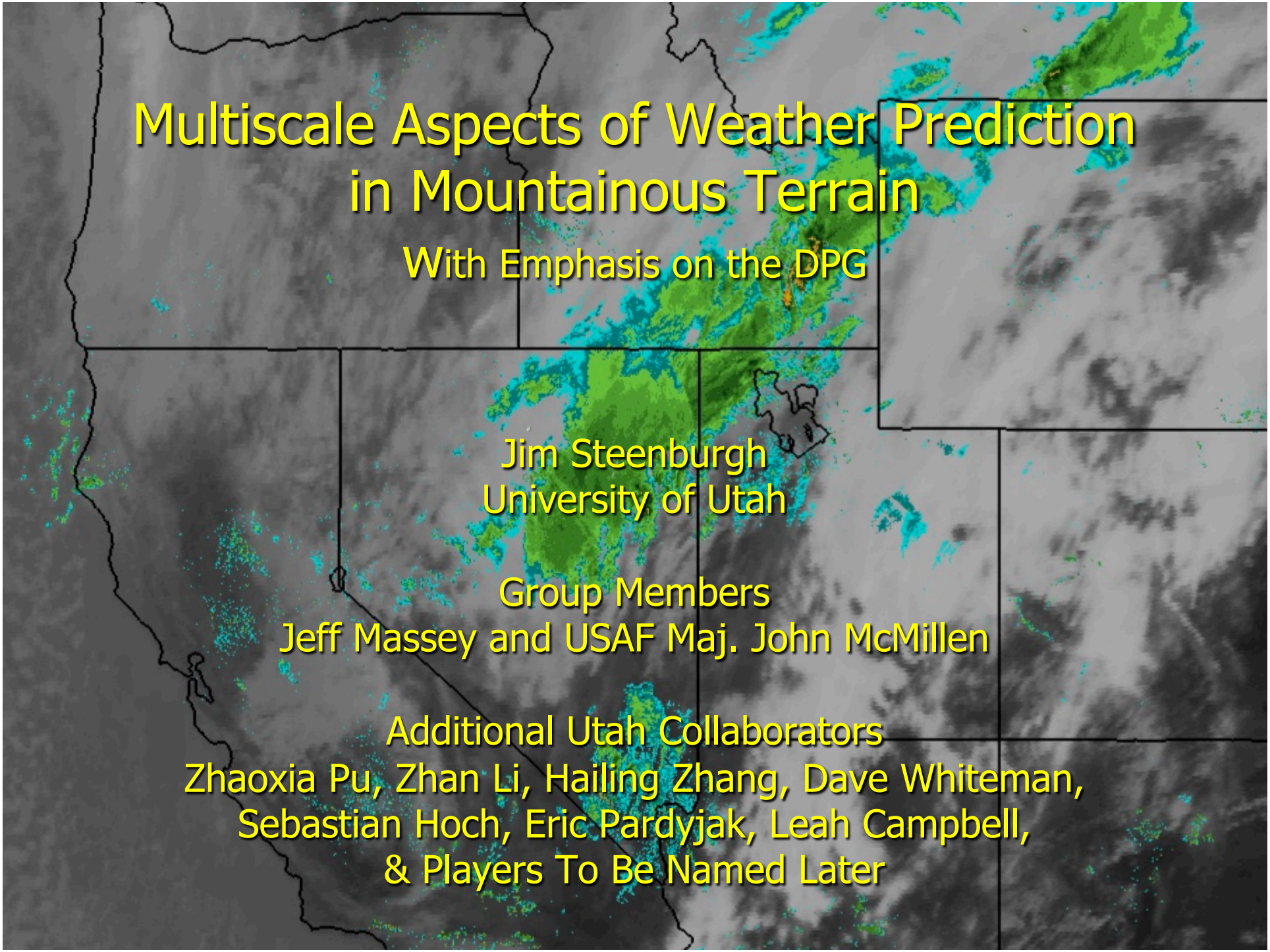

Multiscale Aspects of Weather Prediction in Mountainous Terrain

With Emphasis on the DPG

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University of Utah

Group Members
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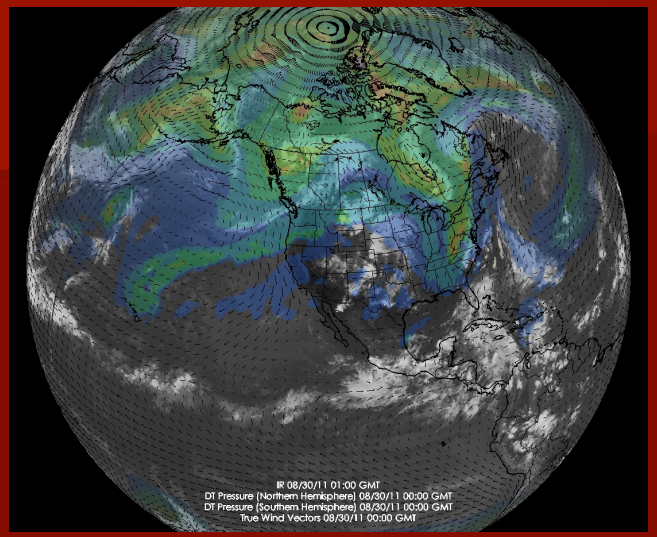
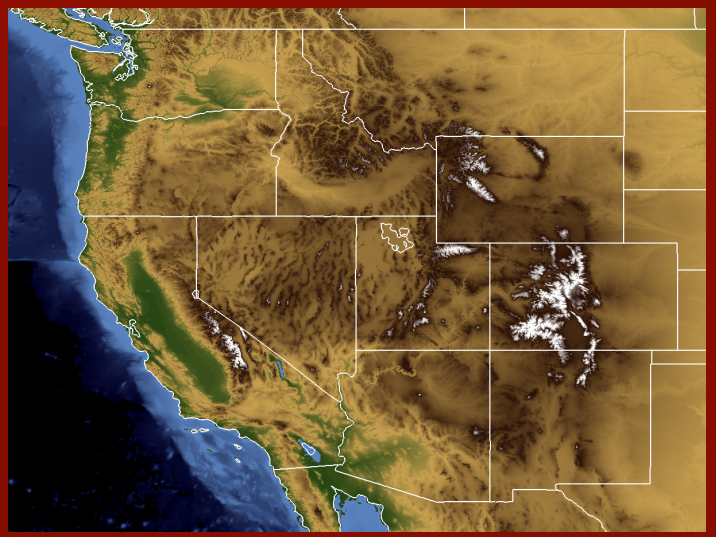
Additional Utah Collaborators
Zhaoxia Pu, Zhan Li, Hailing Zhang, Dave Whiteman,
Sebastian Hoch, Eric Pardyjak, Leah Campbell,
& Players To Be Named Later

DPG looks different to a….

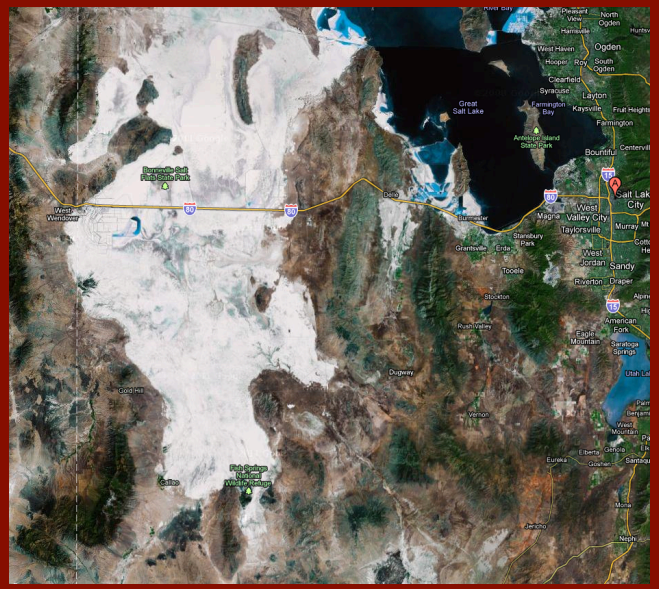
Large-Scale Dynamicist



Synoptic Meteorologist



Mesoscale Meteorologist



PBL Meteorologist

Forecasting Is a Multiscale Problem

- We know the topography but…
  - You can't get the local weather right if you can't get the larger scales right
  - You can't get the local weather right if you can't adequately resolve and model the smaller scale processes

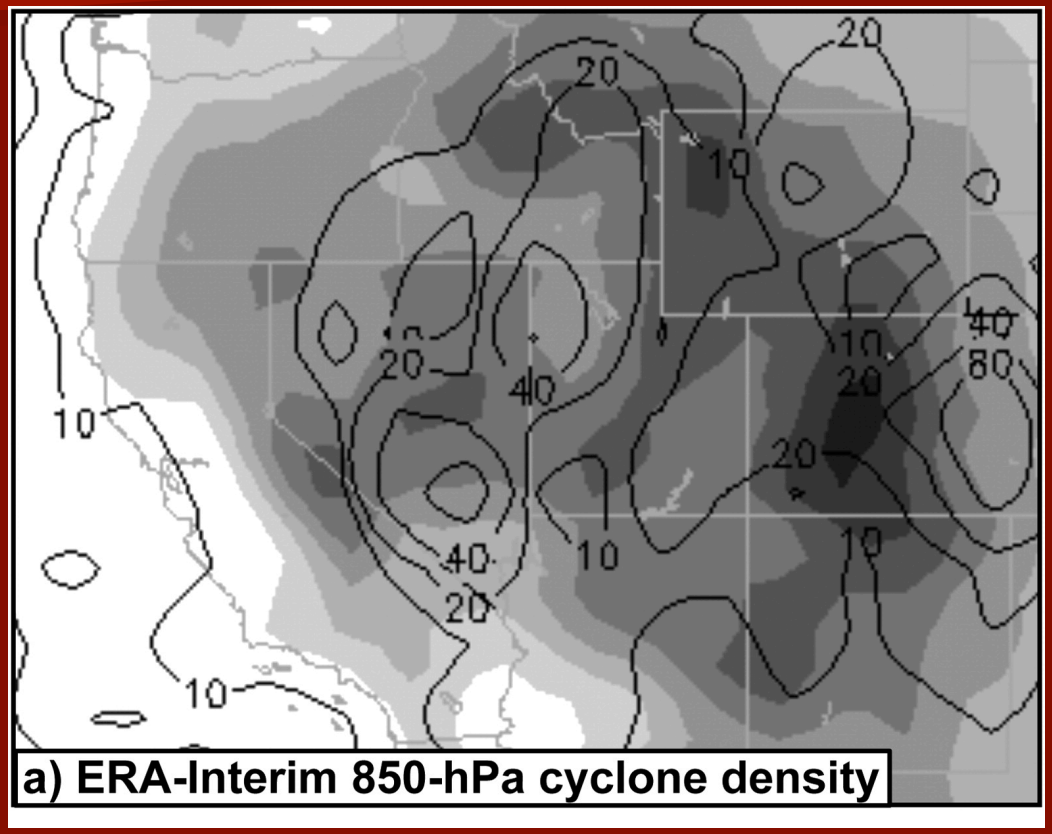
Forecasting Is a Multiscale Problem

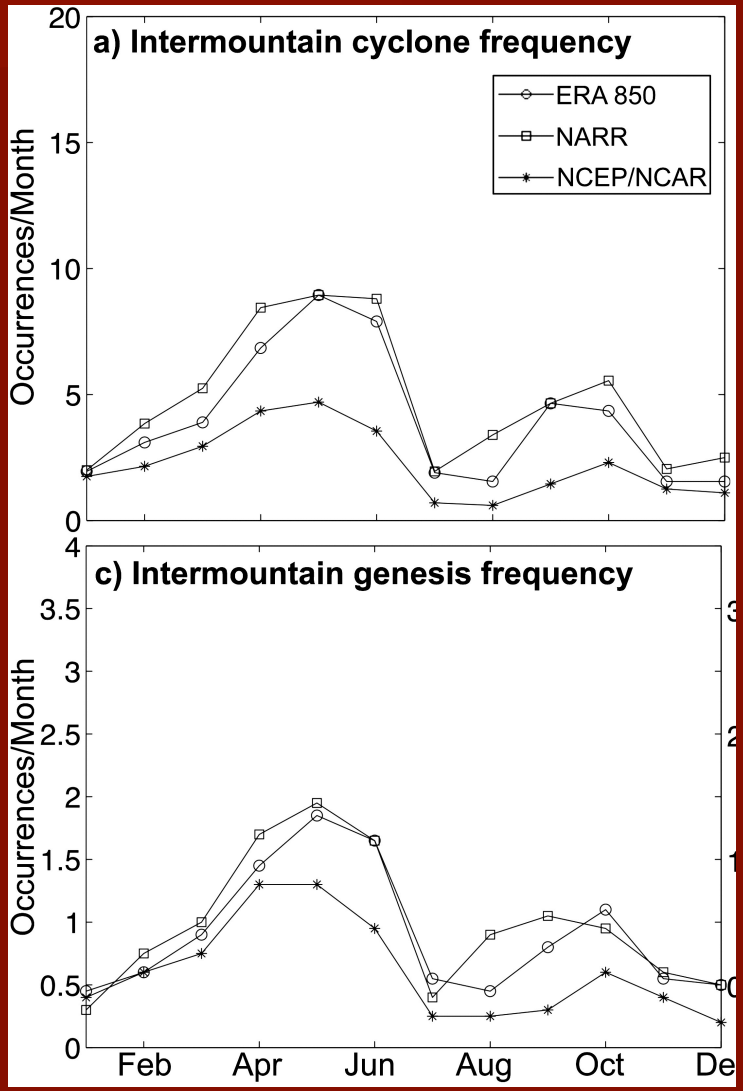
- Fundamental questions are not new, but remain inadequately answered (e.g., Paegle et al. 1990)
  - "Under what circumstances are flows in complex terrain dominated by the surface boundary conditions, as opposed to the initial state of the atmosphere?"
  - "Do the advantages of strong surface forcing outweigh uncertainties related to physical parameterizations and numerical resolution?"

Forecast Challenges @ DPG

- Orographic Cyclogenesis
- Front-mountain interactions on all scales
- Dust storms
- Cold pools (persistent & diurnal)
- Multiscale thermally driven flows
- Moist convection
- Garden variety weather

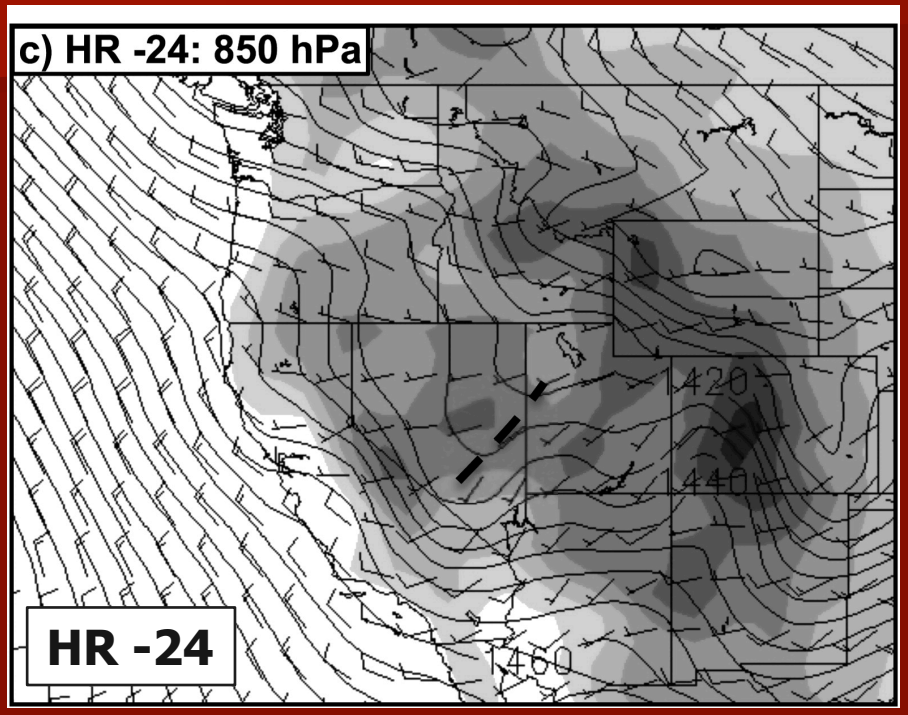
Orographic Cyclogenesis

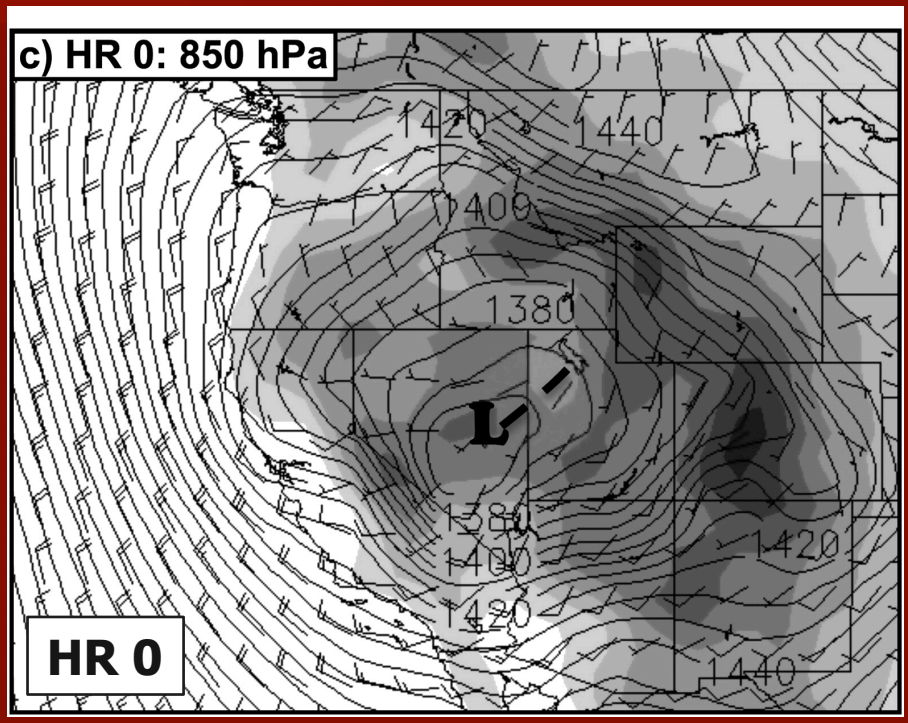




Jeglum et al. (2010)

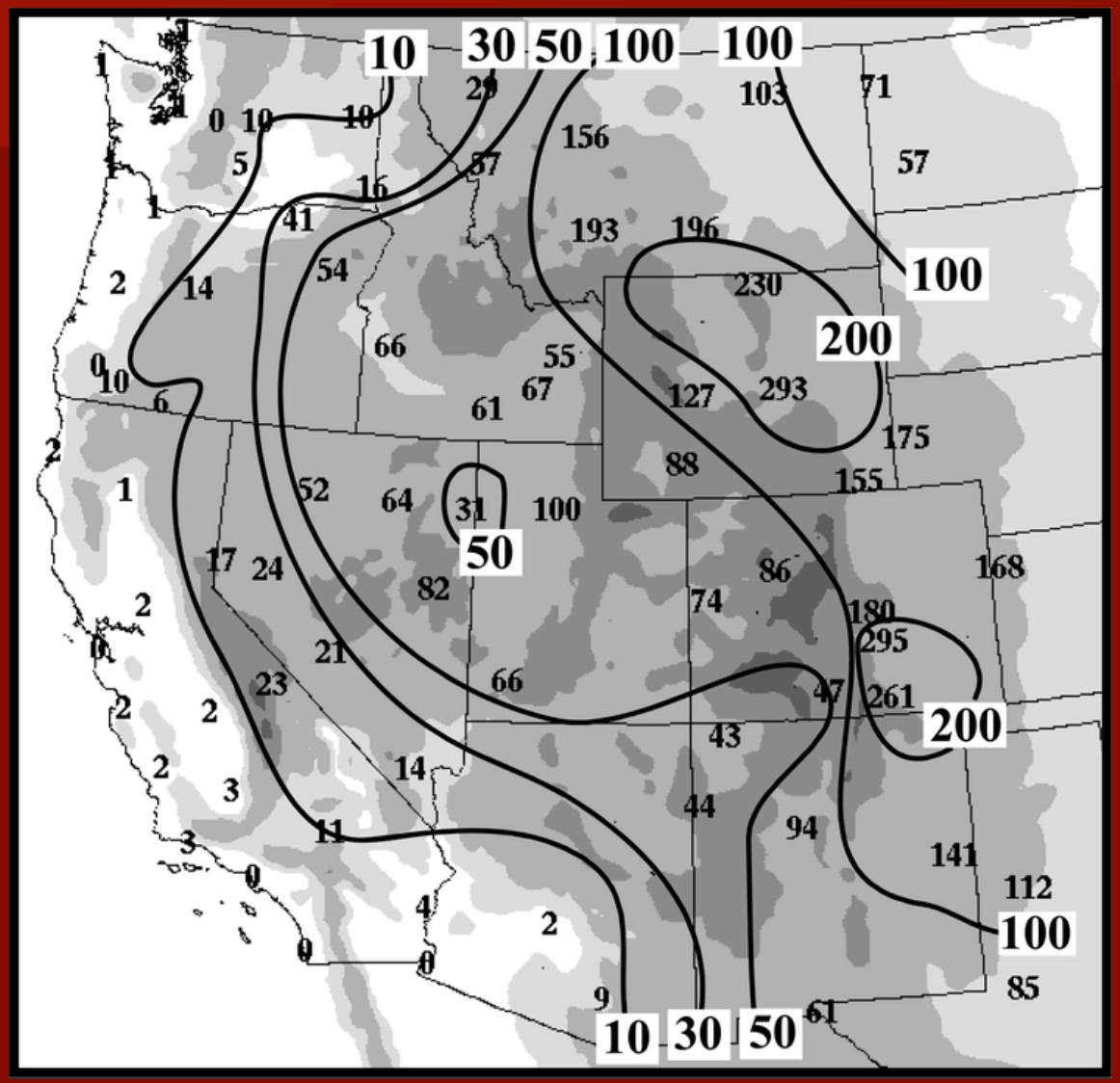
Orographic Cyclogenesis





Jeglum et al. (2010)

Front-Mountain Interactions

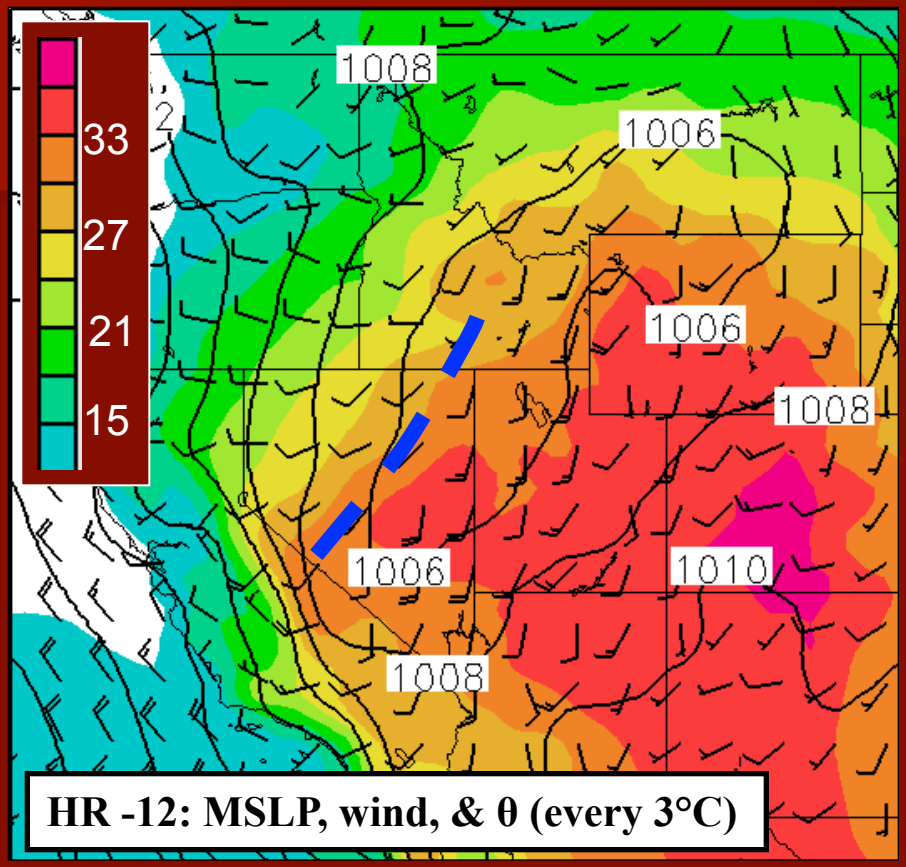


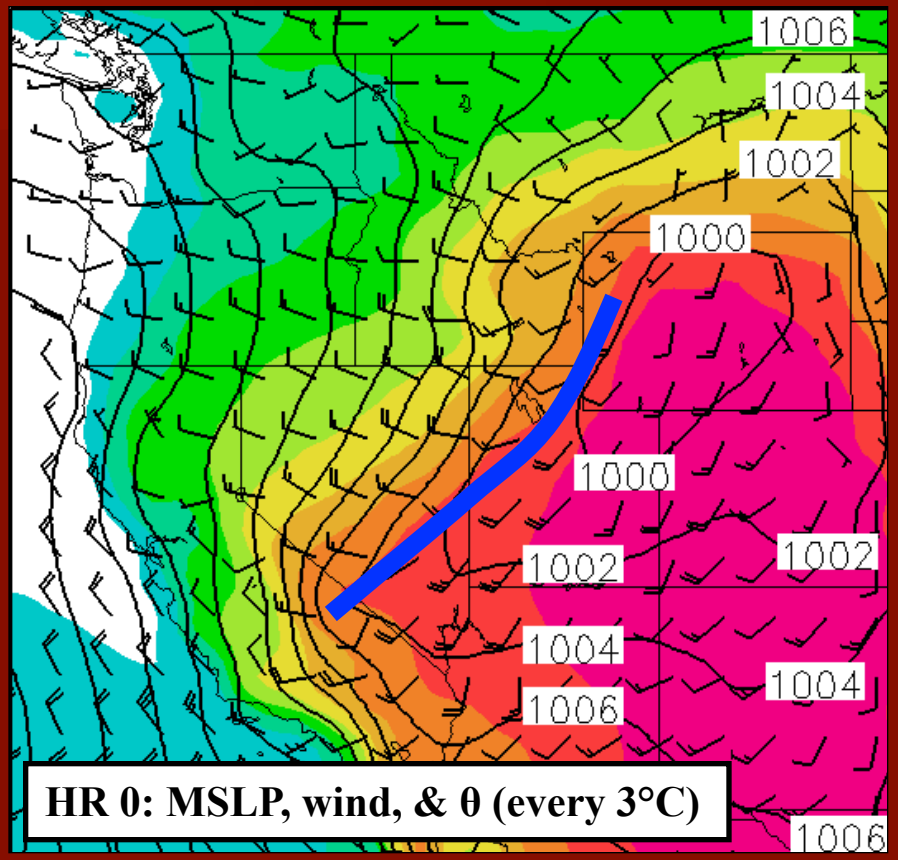
Strong Cold Fronts 79-03

- **> 7°C fall**
- **> 3 hPa rise**
- **> 6°C/500 km @ 700 mb**

Shafer and Steenburgh (2008)

Front-Mountain Interactions

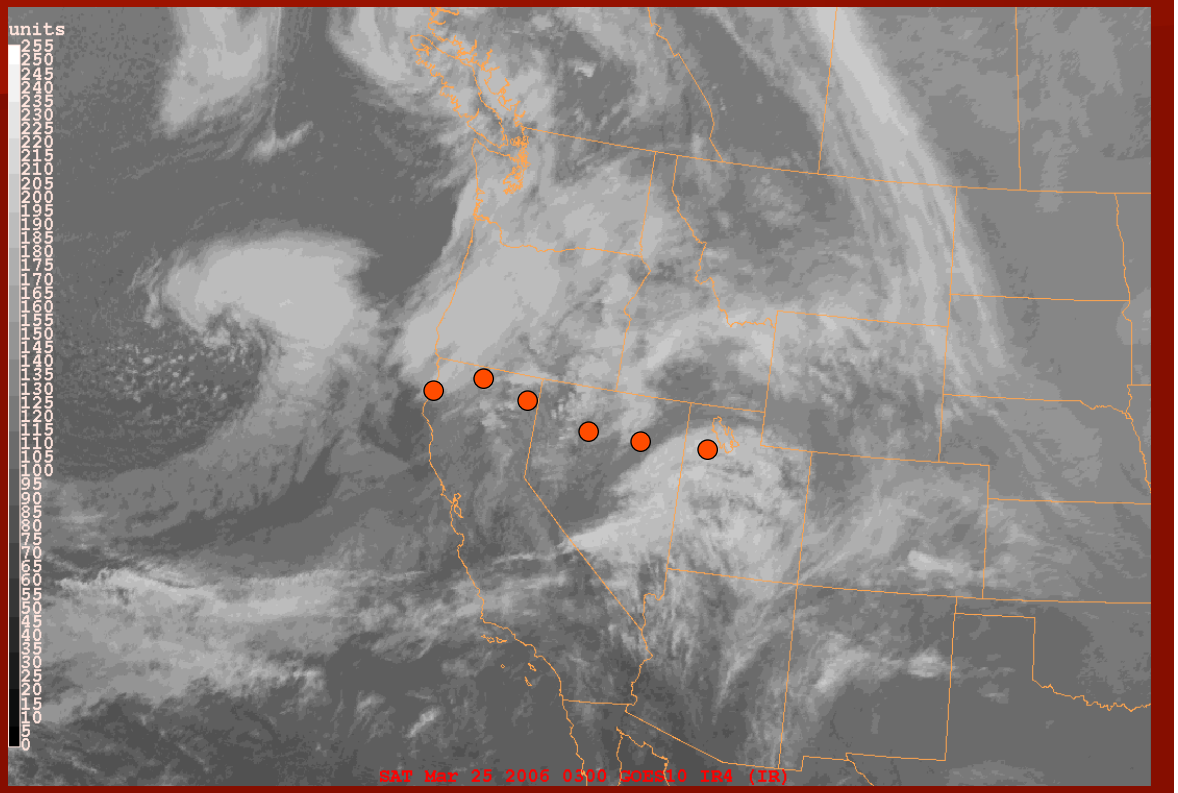




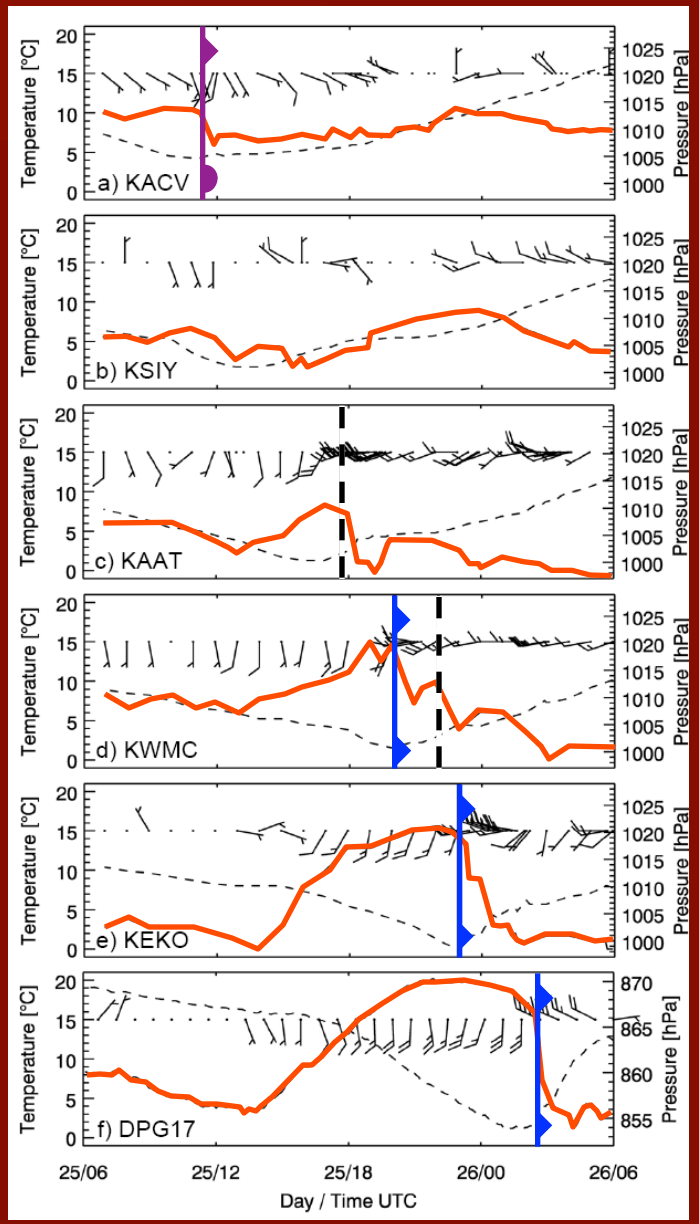
- Frontal development occurs along confluent flow in central Nevada
  - Forms boundary between warm, dry Intermountain air and cooler Pacific air
  - Location and intensity related to Nevada cyclogenesis and flow deflection around the Sierra

Shafer and Steenburgh (2008)

Front-Mountain Interactions

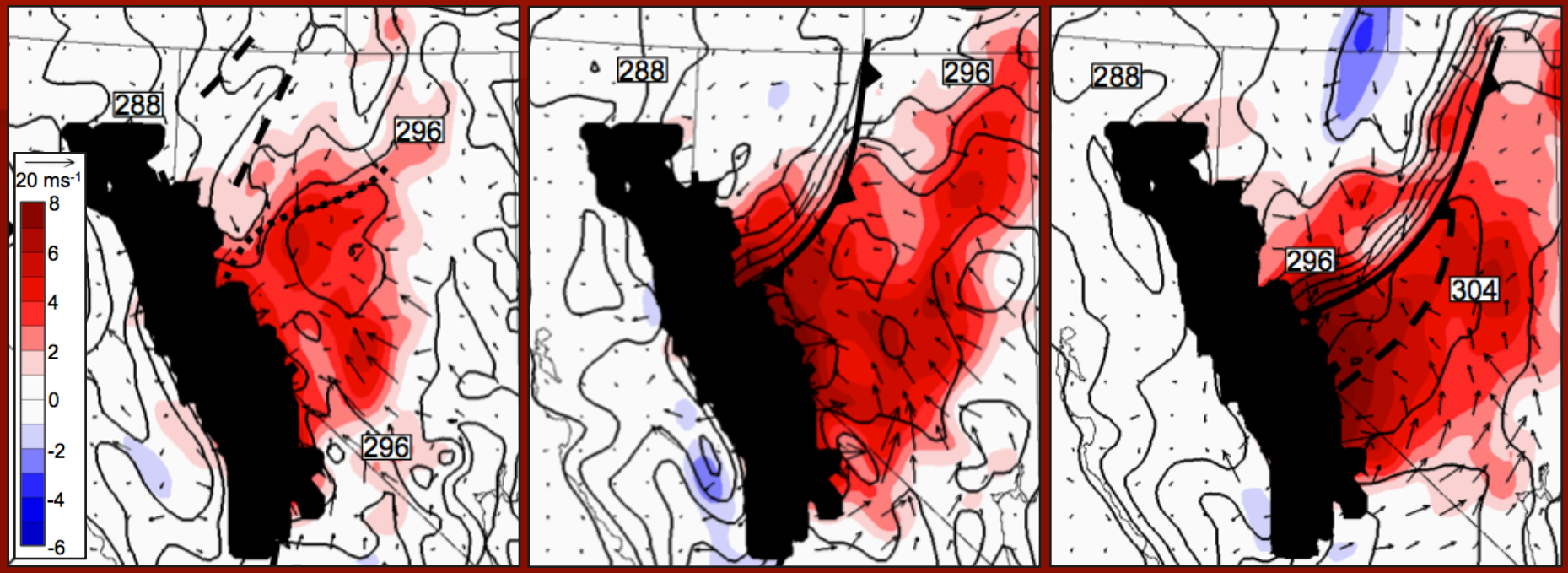


ACV to SLC
16 h
60 km/h



Steenburgh et al. (2009)

Front-Mountain Interactions

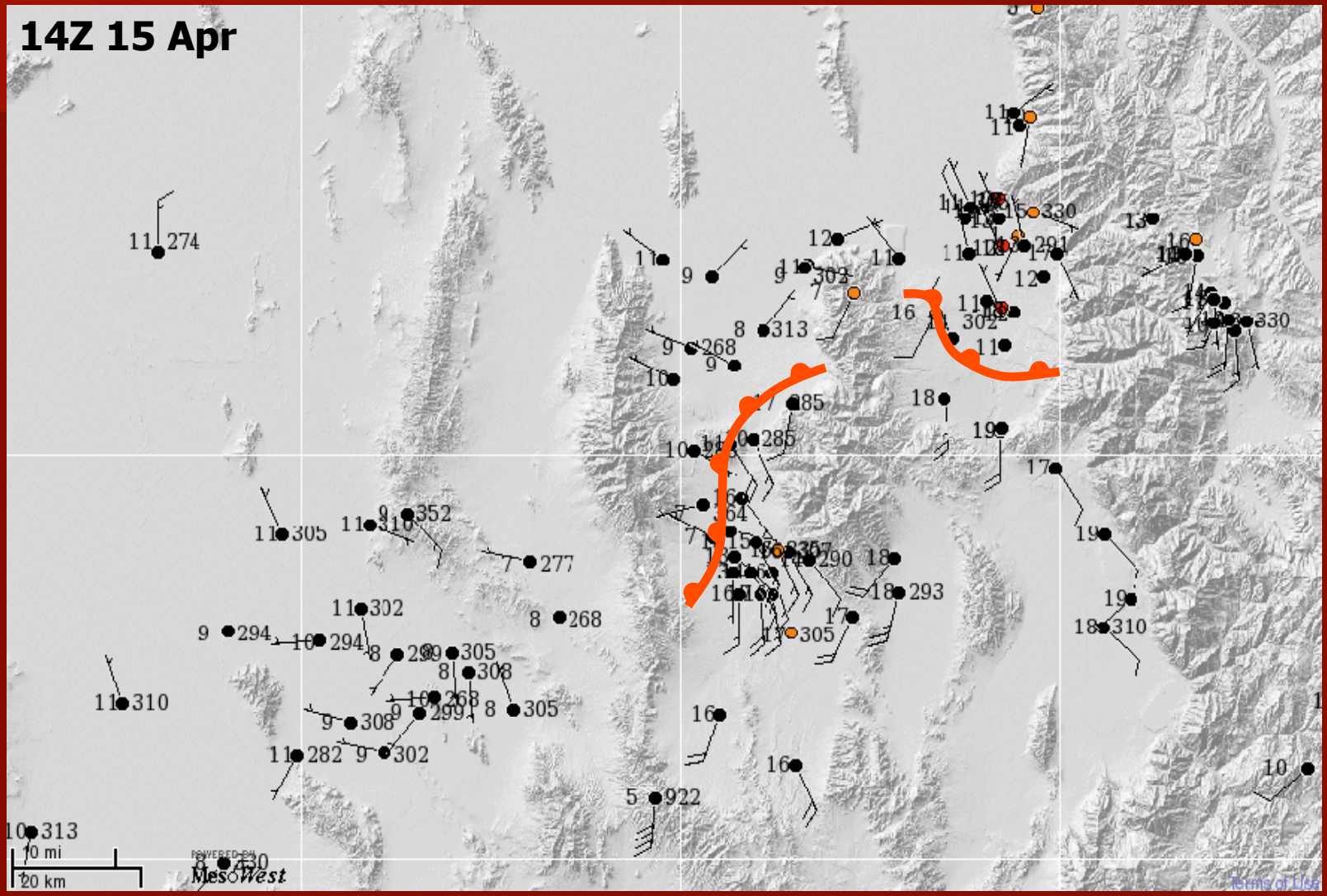


1500 UTC **1800 UTC** **2100 UTC**

FULLTER Lowest-Level Temperature
FULLTER-NOSIERRA Wind and Lowest-Level Pot. Temperature Anomalies

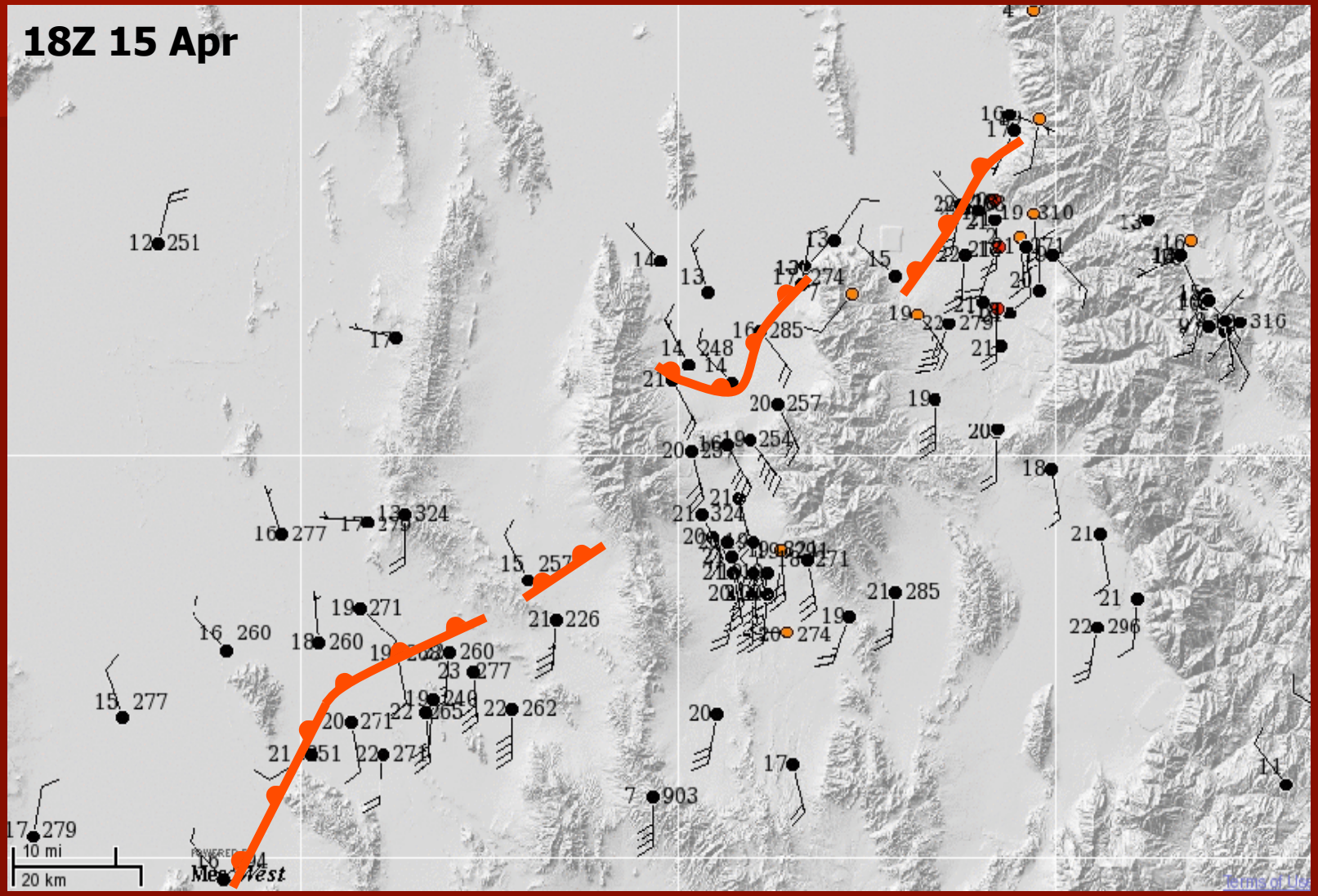
West and Steenburgh (2011)

Front-Mountain Interactions



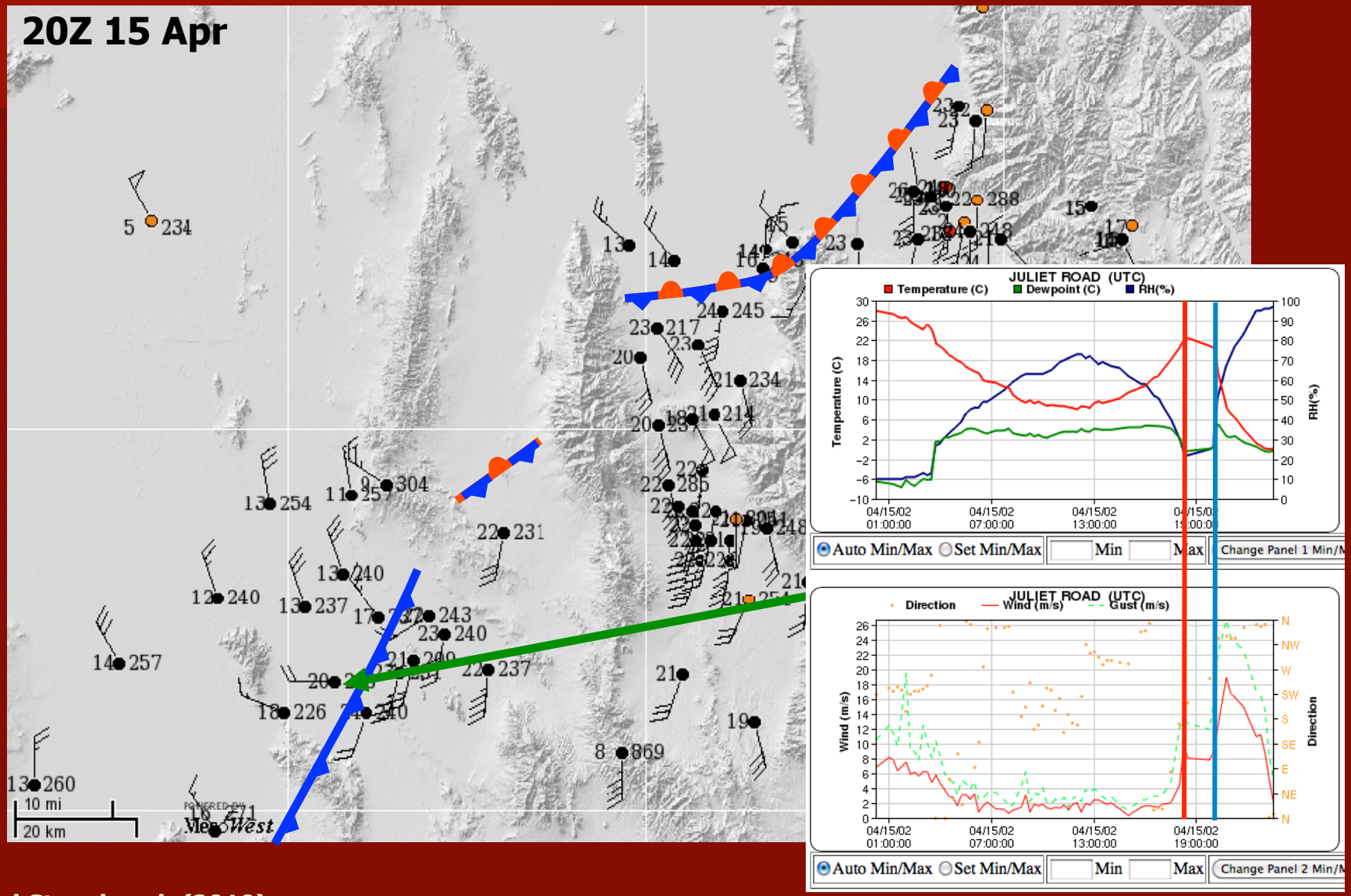
West and Steenburgh (2010)

Front-Mountain Interactions



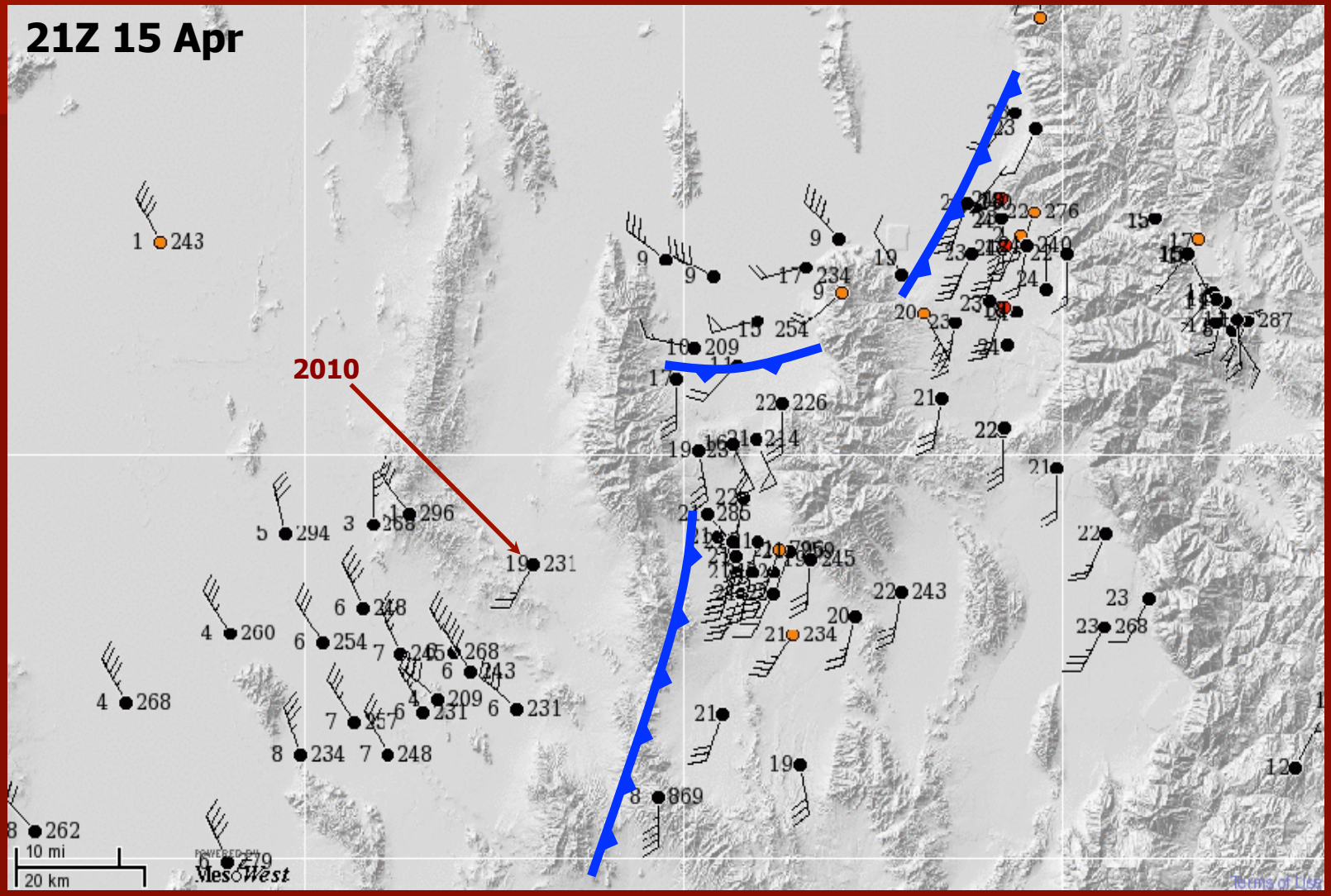
West and Steenburgh (2010)

Front-Mountain Interactions



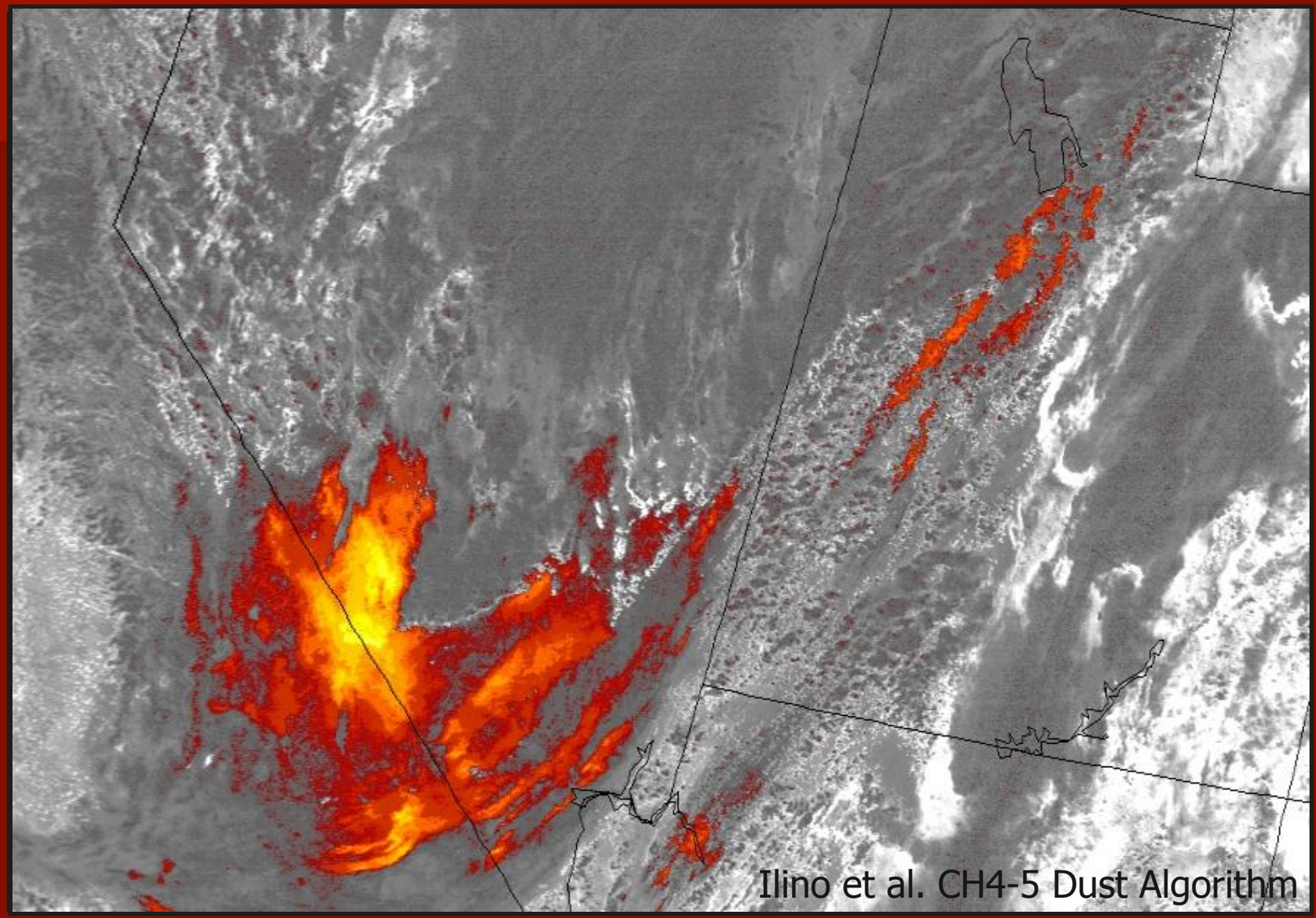
West and Steenburgh (2010)

Front-Mountain Interactions



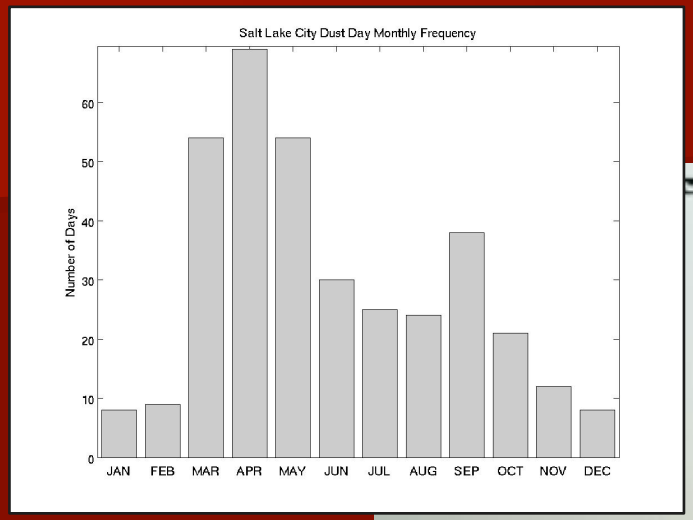
West and Steenburgh (2010)

Dust Storms



West and Steenburgh (2010); Steenburgh et al. (in prep)

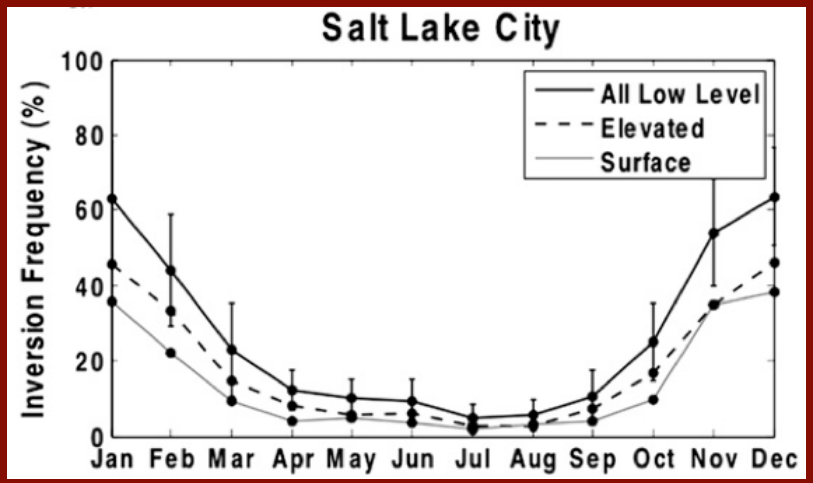
Dust Storms



Steenburgh et al. (in prep); Video: George Wilkerson

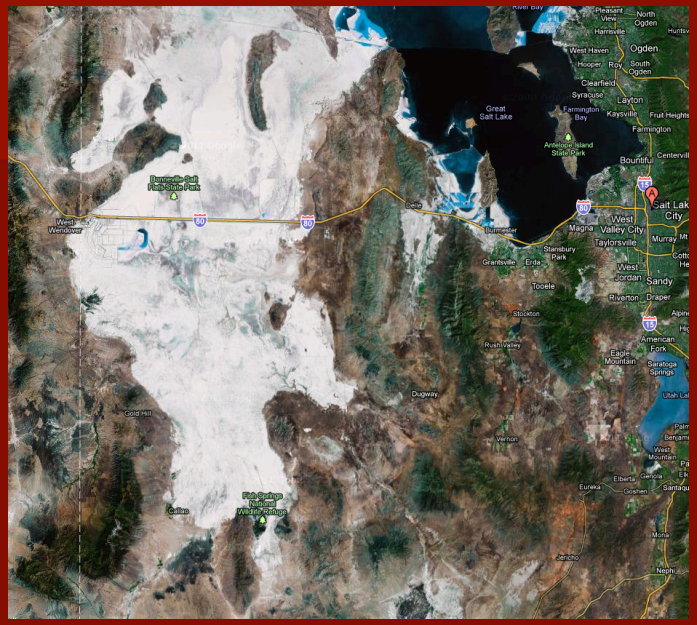
Cold Pools

DPG from Deseret Peak, Early Jan 2011



Bailey et al. (2011)

Multiscale Thermally Driven Flows



Superimposed upon each other over the study area, in this case, are:

1) the salt-breeze circulation with on-playa flow at night and off-playa flow during the day;

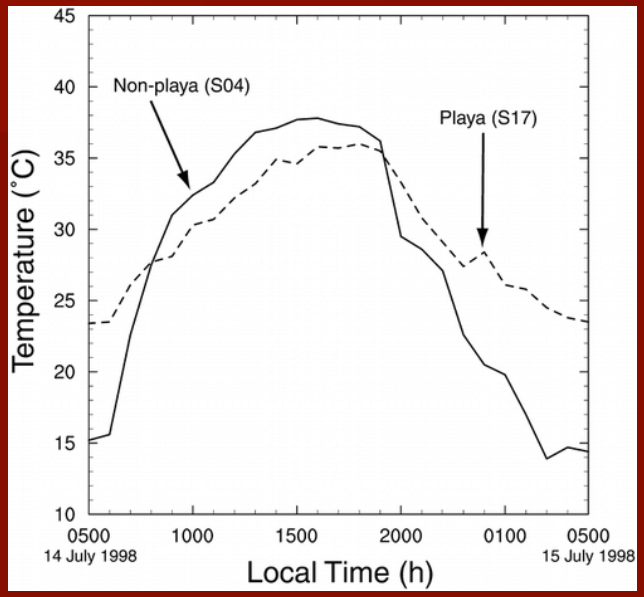
2) lake breezes originating 50–100 km away, and persisting well after the original daytime surface thermal forcing has ceased;

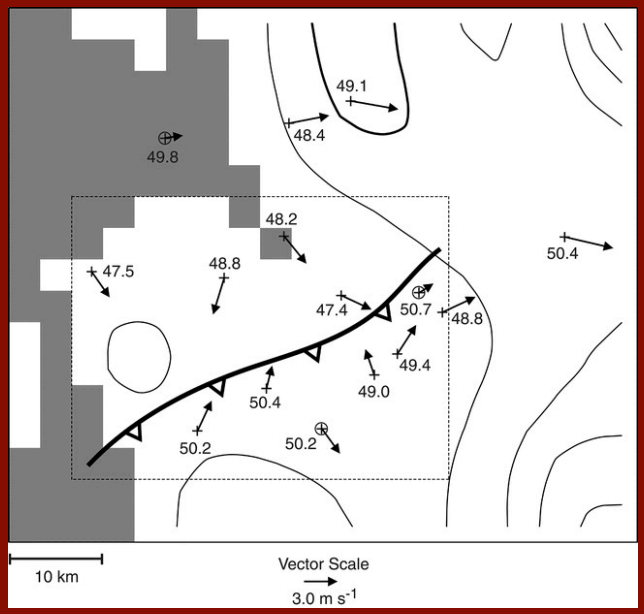
3) nocturnal drainage flows from nearby terrain that impart a signature in the wind field beginning early in the evening near sunset; and

4) cyclonic flows related to the surface trough that affect the northern and western part of the study area at night.

Rife et al. (2002)

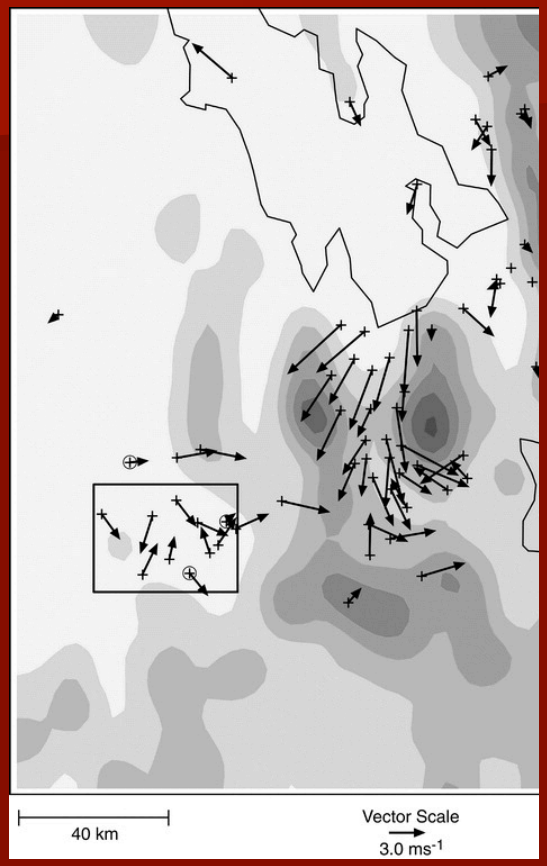
Regional Thermally Driven Flows



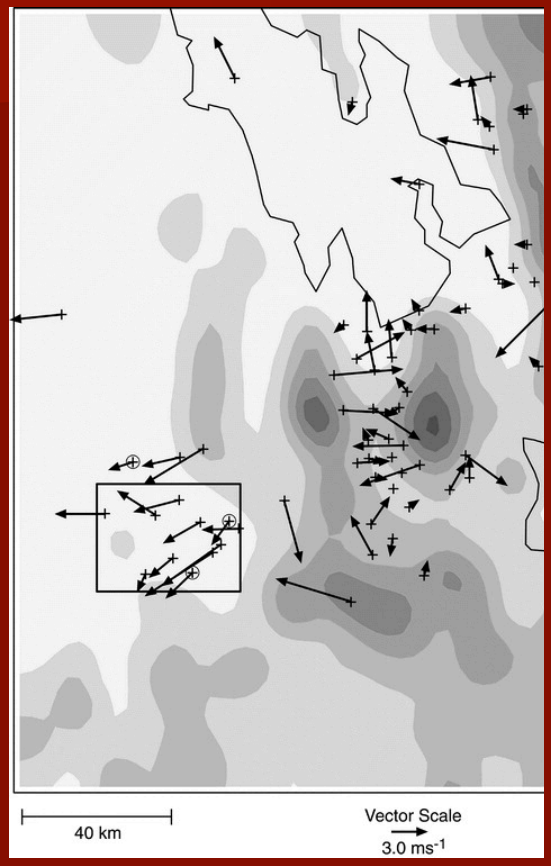


Rife et al. (2002)

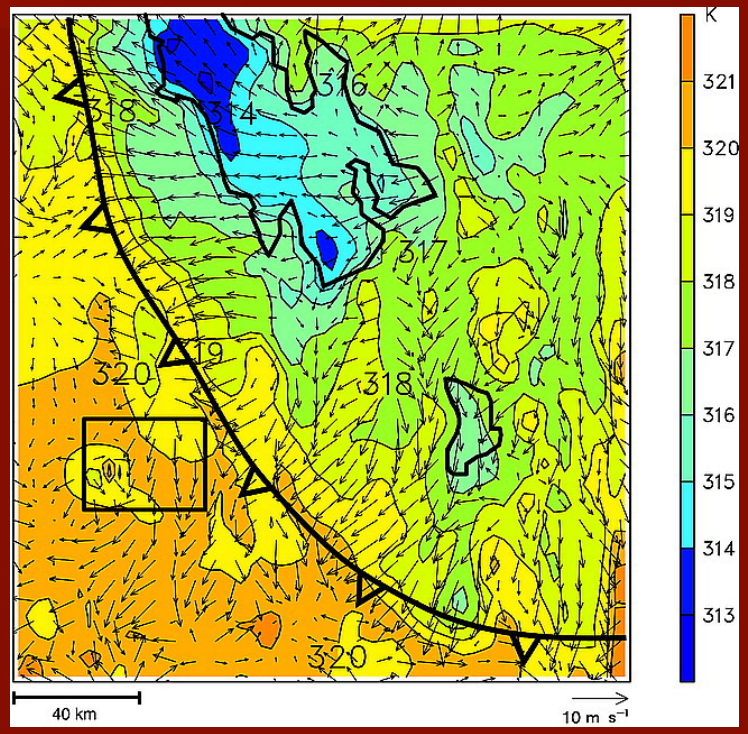
Regional Thermally Driven Flows



1400 LT 14 Jul



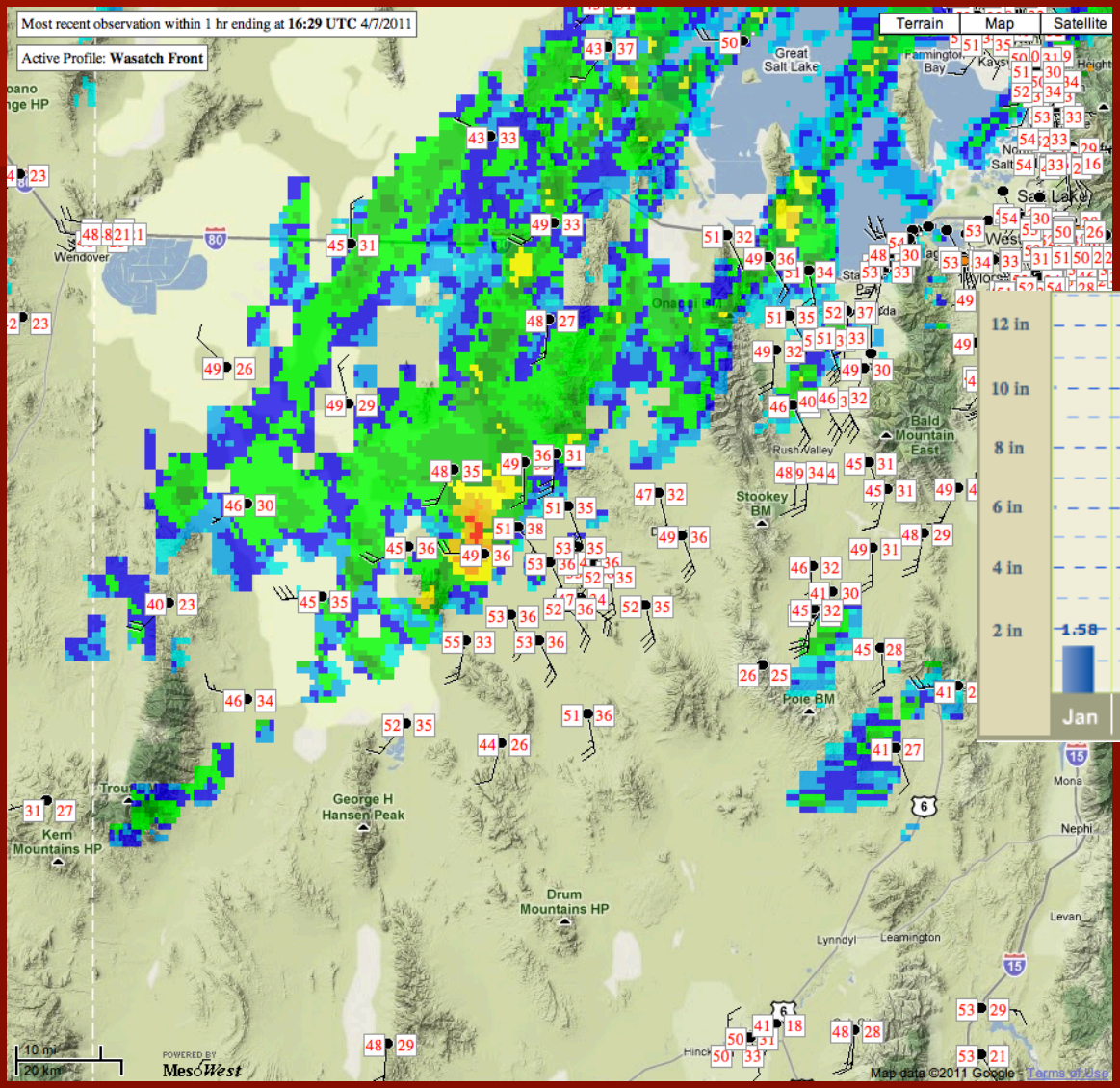
2200 LT 14 Jul



1900 LT 14 Jul

Rife et al. (2002)

Moist Convection



Climo for KSLC

Summary

- Local prediction in mountainous terrain is a multiscale problem
  - DPG provides many great examples
  - Mother Nature will decide what we get for Materhorn-X
- We are interested in better understanding interactions between larger scale flows, topographic forcing, and their implications for local weather prediction in complex terrain