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MATERHORN IV Investigator Meeting ♦ Salt Lake City, Utah ♦ Thursday October 9, 2014

High Resolution Modeling for MATERHORN Field Campaign

Applications to Synoptically Driven Flow

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Overview

- Adjusted WRF model setup
- Application to MATERHORN-X-2
- Model comparisons with the Playa radiosonde data
- Model comparison to North West tower
- Applications to the smoke release / dividing streamline
- On going work

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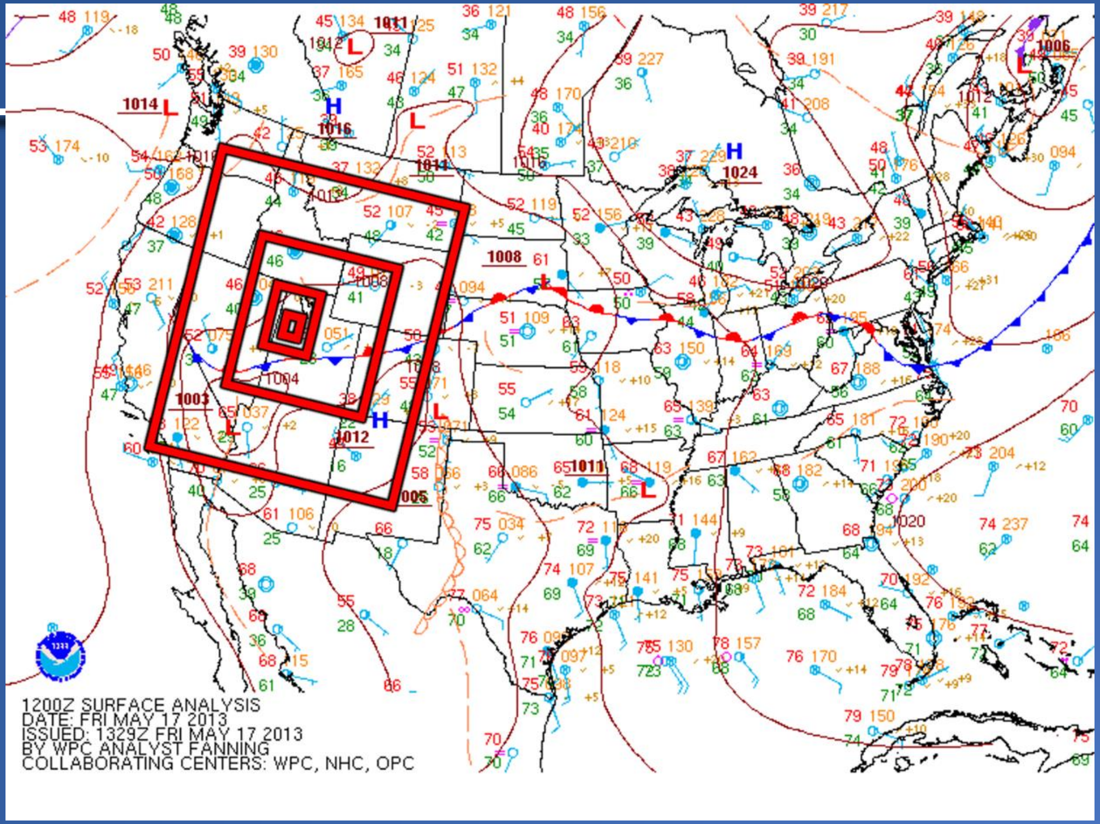
WRF-ARW v.3.4.1

Lambert projection Utah (113°W, 40°N)

Horizontal grids
D1: 32km (40x50)
D2: 8km (89x97)
D3: 2km (109x141)
D4: 0.5km (145x169)

Vertical grid
50 eta levels
22 below 600 m
first half level ~ 9 m

Level	Approximate Elevation	Level	Approximate Elevation
1	8 m	14	143 m
2	20 m	15	163 m
3	28 m	16	187 m
4	35 m	17	219 m
5	43 m	18	259 m
6	51 m	19	300 m
7	59 m	20	361 m
8	67 m	21	443 m
9	75 m	22	526 m
10	83 m	23	609 m
11	95 m	24	693 m
12	111 m	25	778 m
13	127 m	26	906 m



No data assimilation

IB: NCEP Final Analyses (http://rda.ucar.edu/datasets/ds083.2/)

Updated land-cover and terrain elevation; 33-category National Land Cover Database (playa, white sand, and lava soil texture classes); new parameterization of soil thermal conductivity in the Noah land-surface model for silt loam and sandy loam soils (J. Massey et al., 2013, J. Appl. Met. and Climatology)

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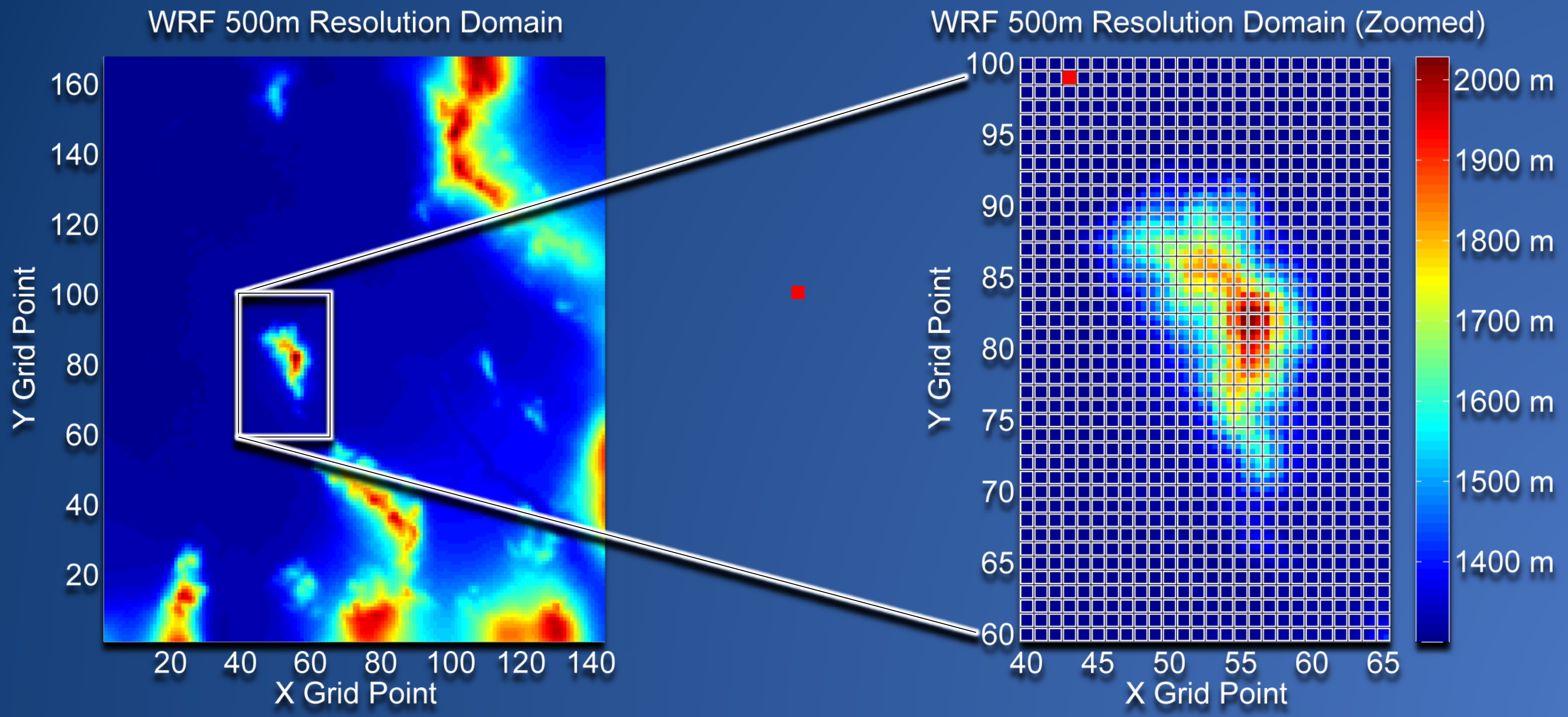
Inner most nest



Spring Field Study Dates

IOP - Spring	Start (MDT)	End (MDT)	Start (UTC)	End (UTC)	Classification	Wind speed
IOP 1	5/1/2013 14:00	5/2/2013 14:00	5/1/2013 20:00	5/2/2013 20:00	Moderate / Quiescent	<5 m/s – 10 m/s
IOP 2	5/4/2013 14:00	5/5/2013 14:00	5/4/2013 20:00	5/5/2013 20:00	Moderate	5 m/s – 10 m/s
IOP 3	5/7/2013 5:00	5/7/2013 17:00	5/7/2013 11:00	5/7/2013 23:00	Moderate	5 m/s – 10 m/s
IOP 4	5/11/2013 14:00	5/12/2013 14:00	5/11/2013 20:00	5/12/2013 20:00	Quiescent	<5m/s
IOP 5	5/13/2013 12:00	5/14/2013 12:00	5/13/2013 18:00	5/14/2013 18:00	Moderate / Transitional	5 m/s – 10 m/s
IOP 6	5/16/2013 12:00	5/17/2013 12:00	5/16/2013 18:00	5/17/2013 18:00	Moderate / Transitional	5 m/s – 10 m/s
IOP 7	5/20/2013 17:15	5/21/2013 14:00	5/20/2013 23:15	5/21/2013 20:00	Sandwich Quiescent	<5m/s
IOP 8	5/22/2013 14:00	5/23/2013 14:00	5/22/2013 20:00	5/23/2013 20:00	Moderate	5 m/s – 10 m/s
IOP 9	5/25/2013 10:00	5/26/2013 10:00	5/25/2013 16:00	5/26/2013 16:00	Moderate	5 m/s – 10 m/s
IOP 10	5/30/2013 14:00	5/31/2013 10:00	5/30/2013 20:00	5/31/2013 16:00	Moderate	5 m/s – 10 m/s

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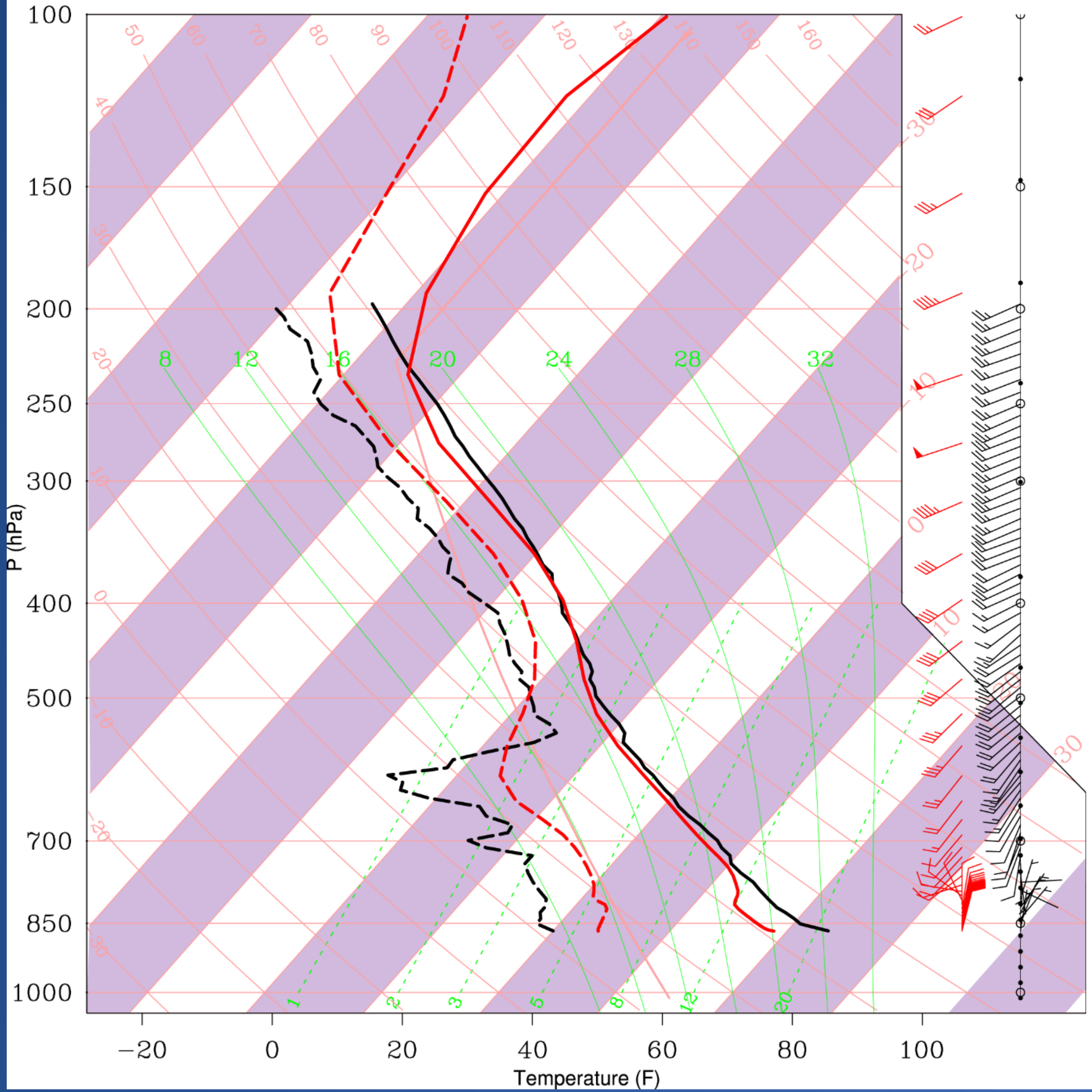
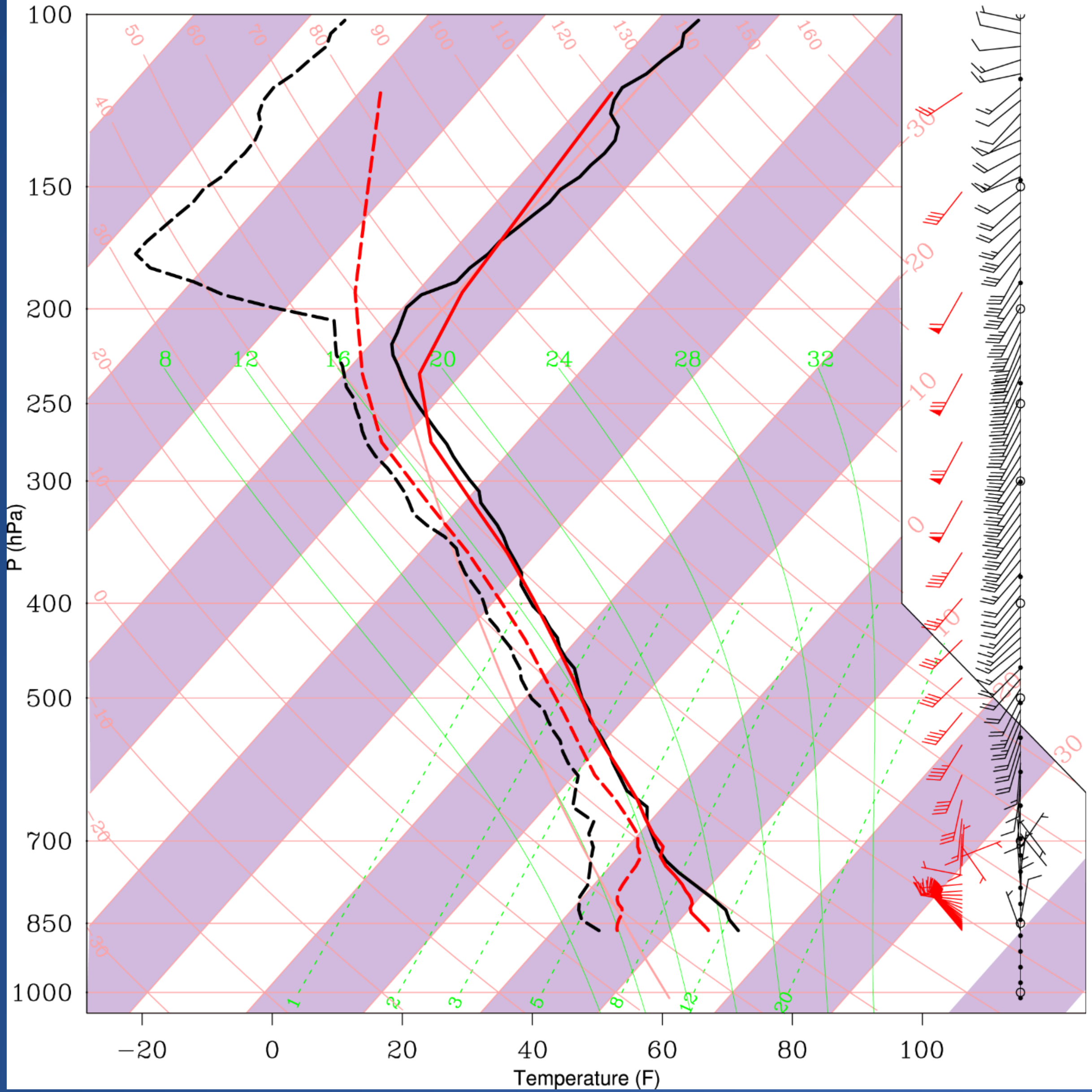
WRF to Playa Radiosonde Comparison May 16, 2013 at 1723UTC



- Playa Radiosonde
- WRF at (24,84)

WRF to Playa Radiosonde Comparison May 17, 2013 at 1114UTC



- Playa Radiosonde
- WRF at (24,84)

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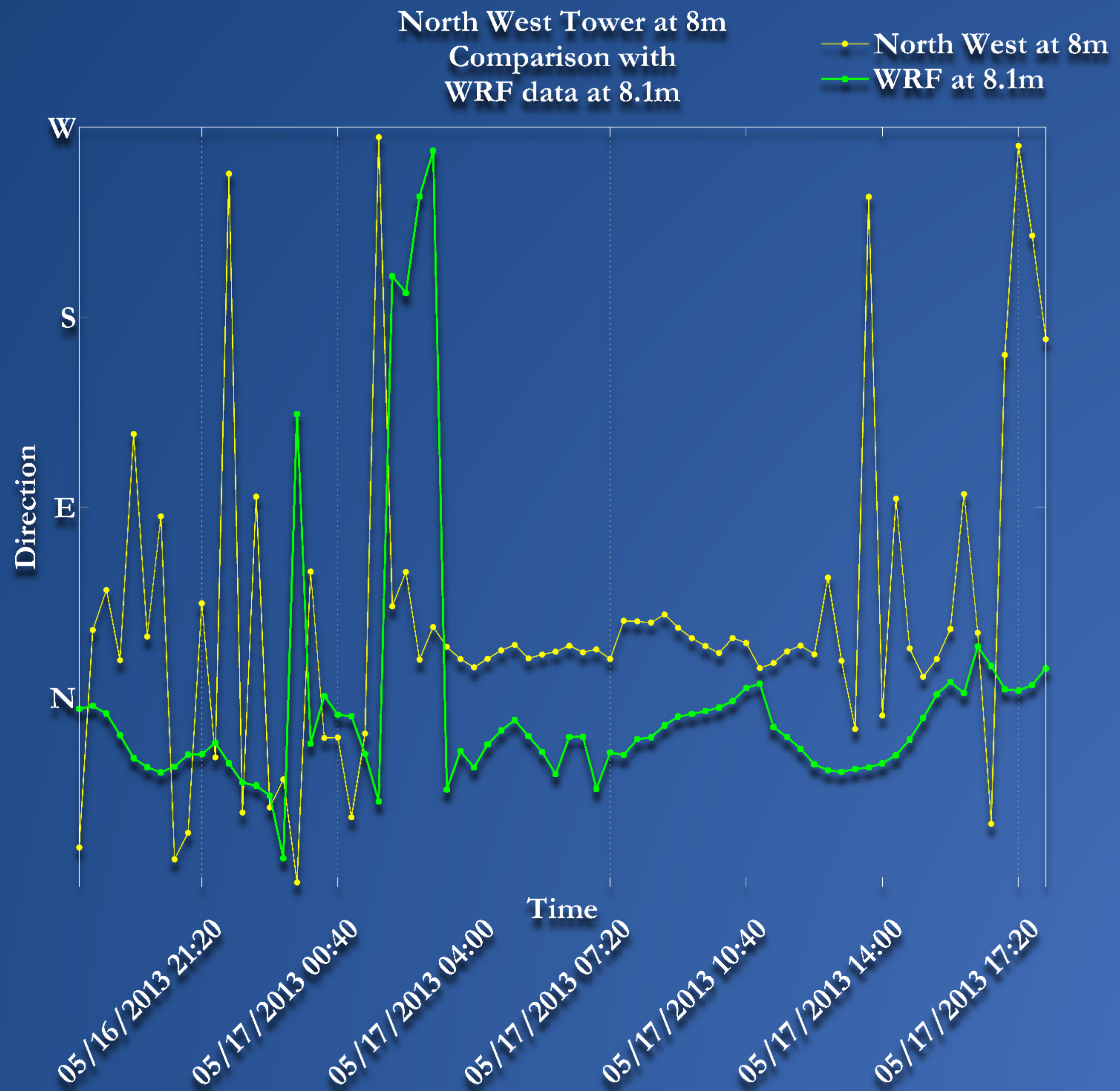

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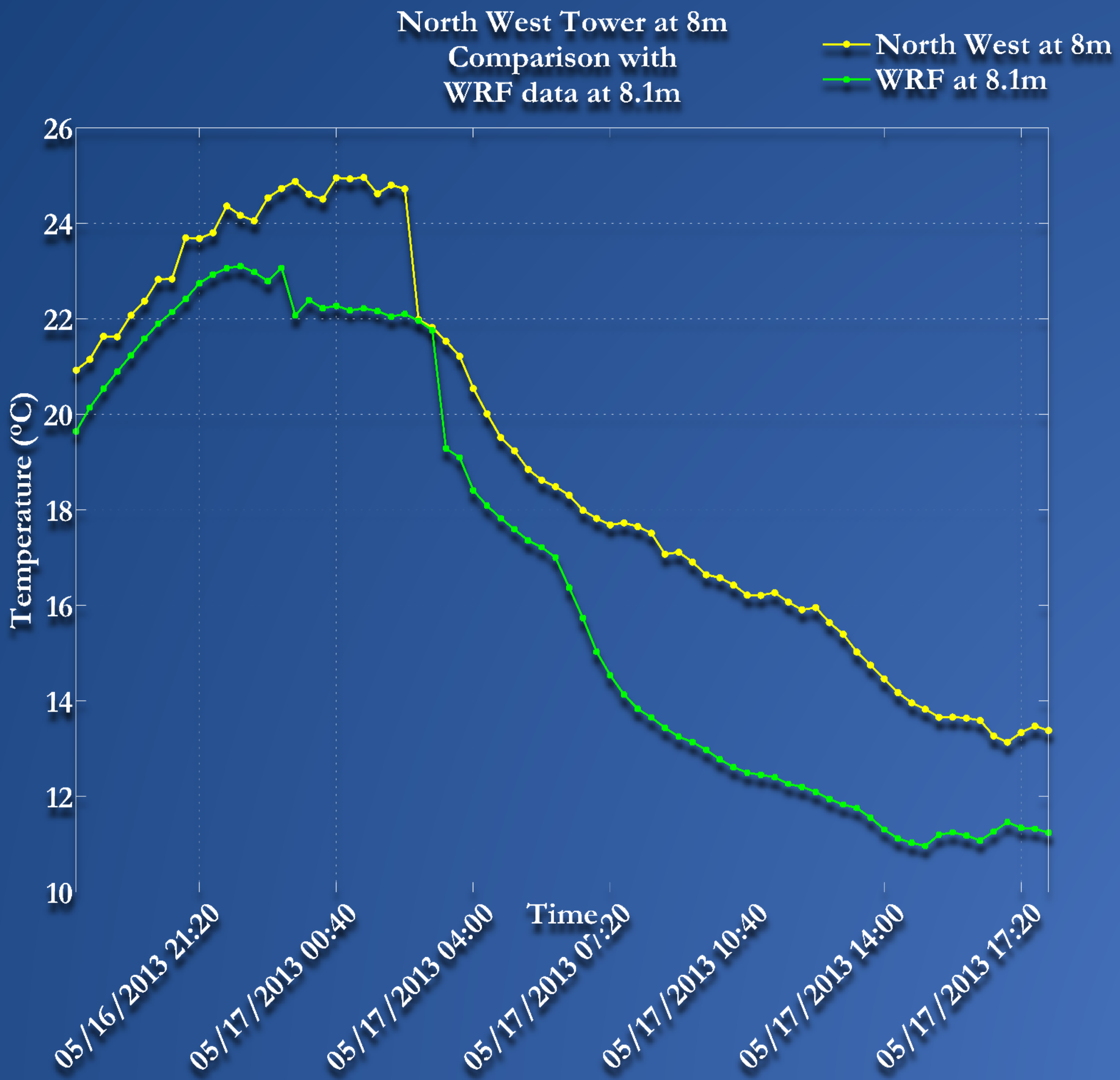

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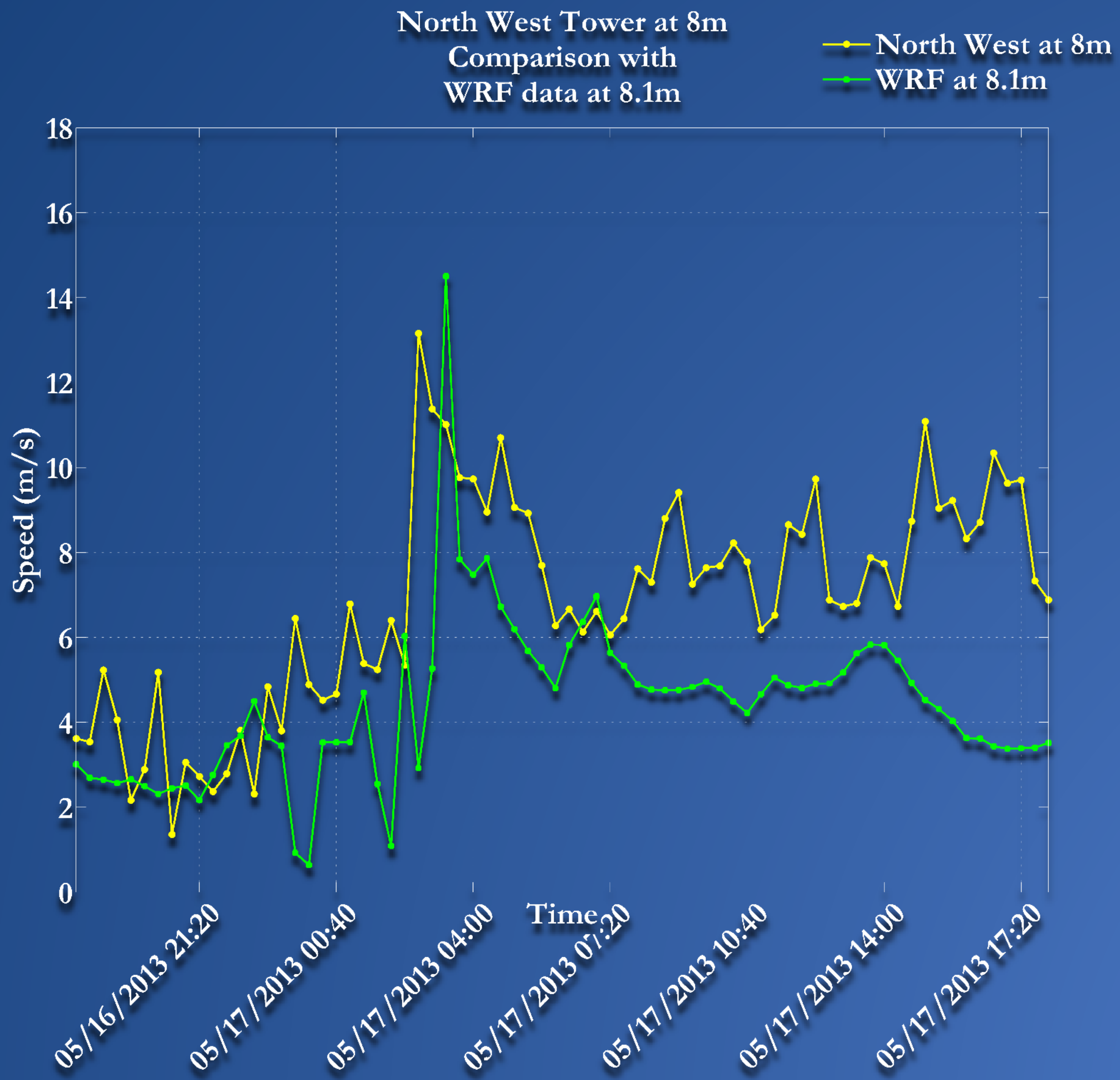
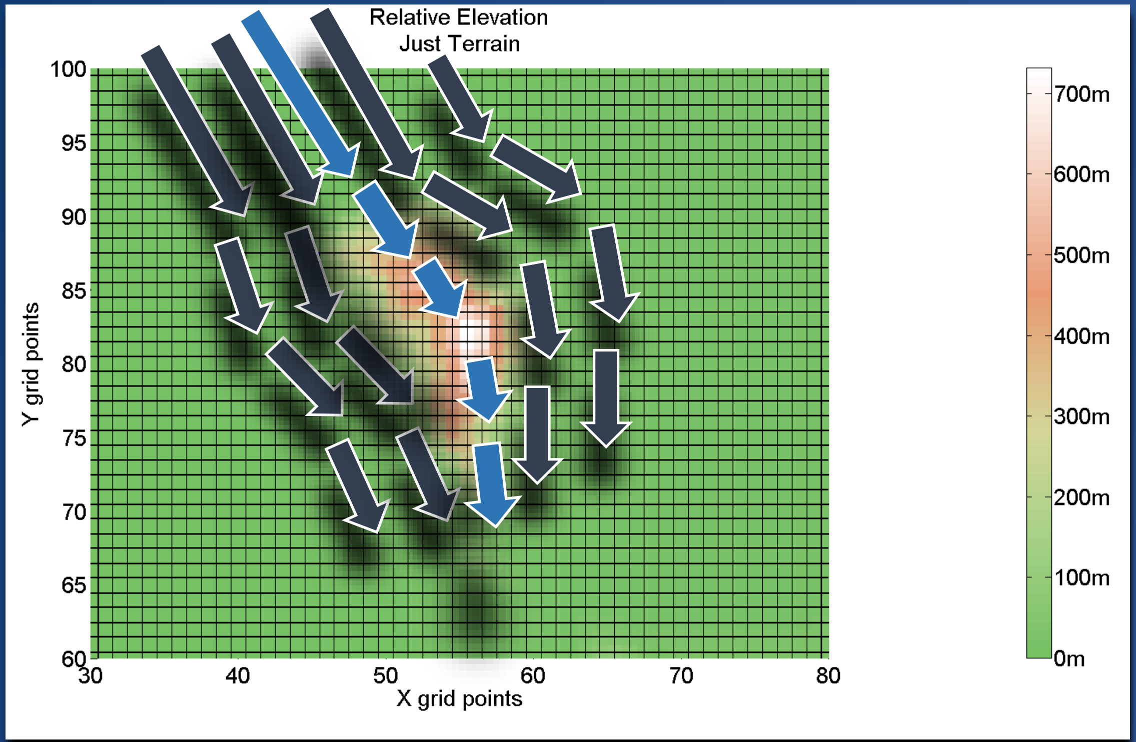
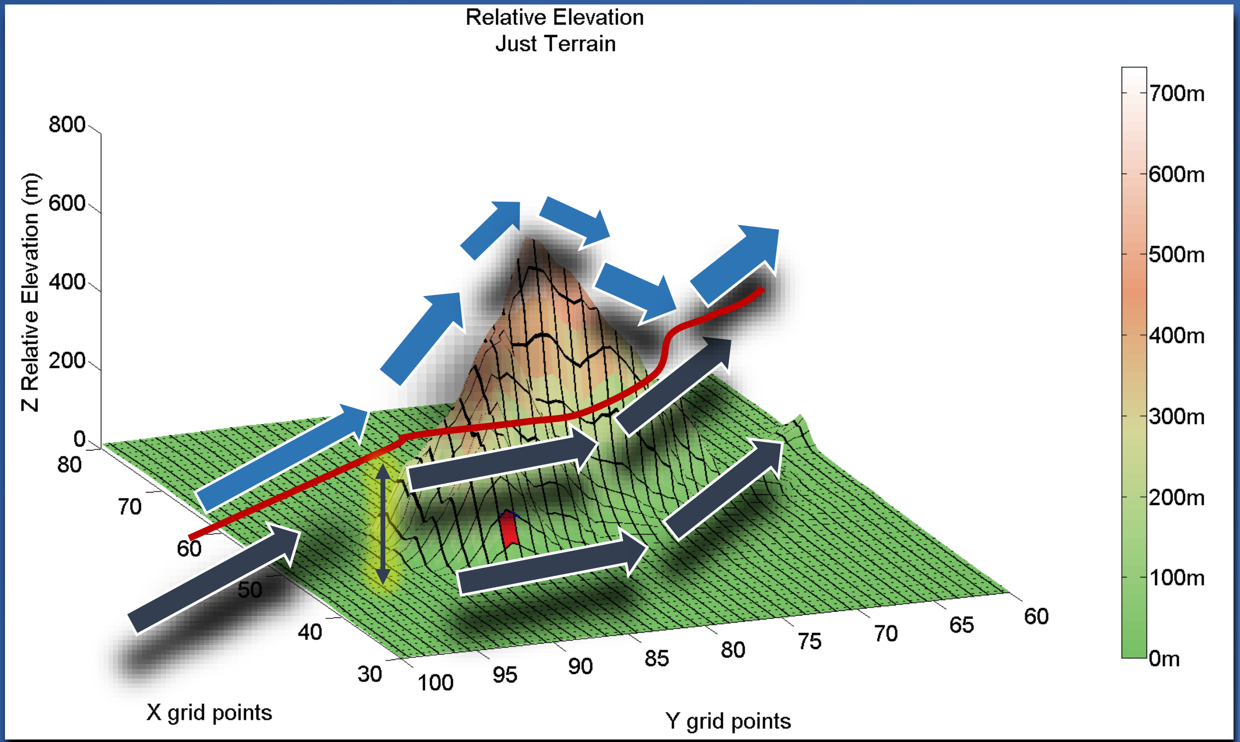


Expectations for the dividing streamline





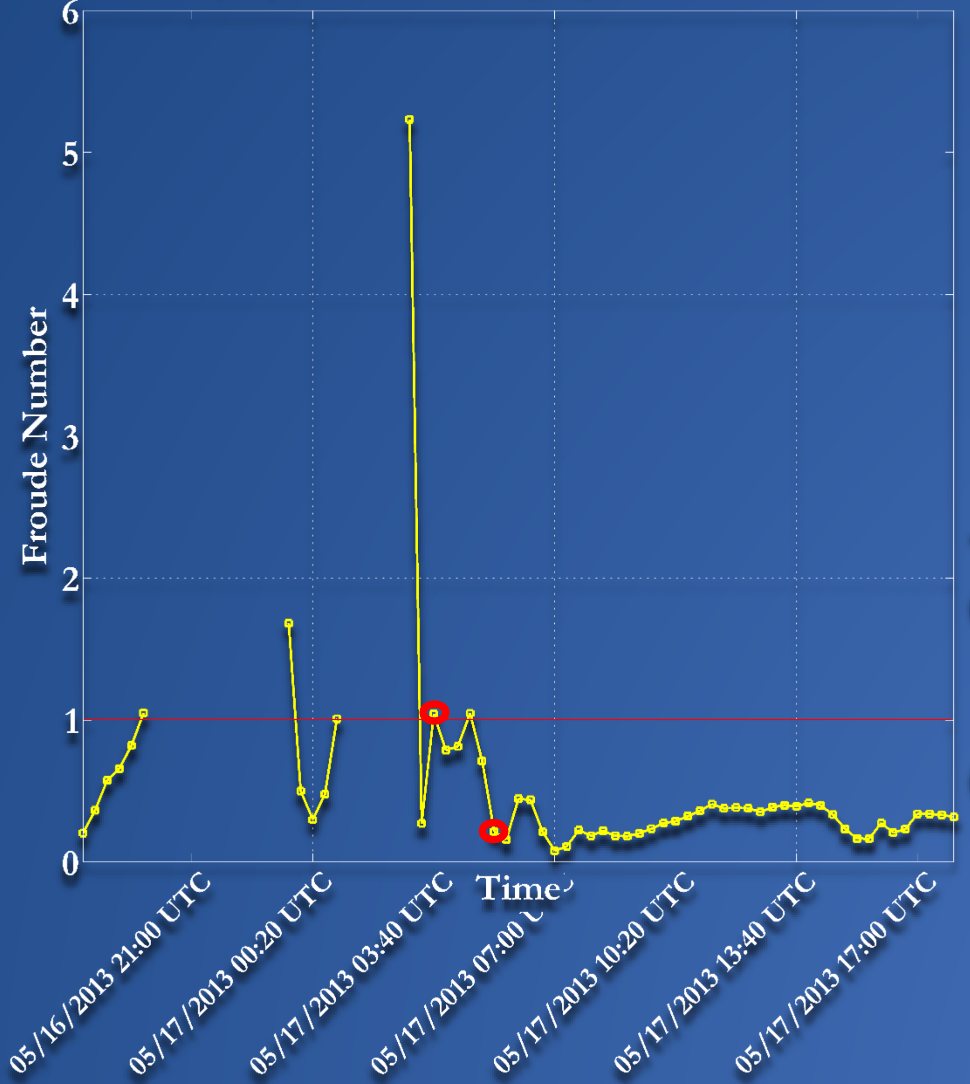
Froude number

- Foude Number: $\boldsymbol{F_r} = \frac{U/h}{N}$
  - U = wind speed (perpendicular)
  - h = mountain height
  - N = Brunt–Väisälä frequency

- Brunt–Väisälä frequency: $N = \sqrt{\frac{g}{\rho_0}\frac{\partial\rho(z)}{\partial z}}$, in the atmosphere $N = \sqrt{\frac{g}{\theta}\frac{\partial\theta}{\partial z}}$
  - g = *gravity*
  - $\partial\theta$ = potential temperature difference
  - θ = potential temperature
  - ∂z = change in elevation

[1] M. Muccilli, "Using the Froude Number to Improve Westerly Flow Upslope Snow Forecasts in the Green Mountains of Vermont." [Online]. Available: http://www.erh.noaa.gov/btv/mountain/profile/froude/. [Accessed: 29-Aug-2014].

Froude Number at Grid Cell x 43 and y 99
05/16/2013 18:00:00 to 05/17/2013 18:00:00 UTC
h equal to 540m and 26 vertical levels from 1315m to 2215m
05/16/2013 12:00 to 05/17/2013 12:00 MDT



Times that are circled:
05/17/2013 0340UTC
05/16/2013 21:40 MDT

05/17/2013 0340UTC
05/16/2013 23:20 MDT

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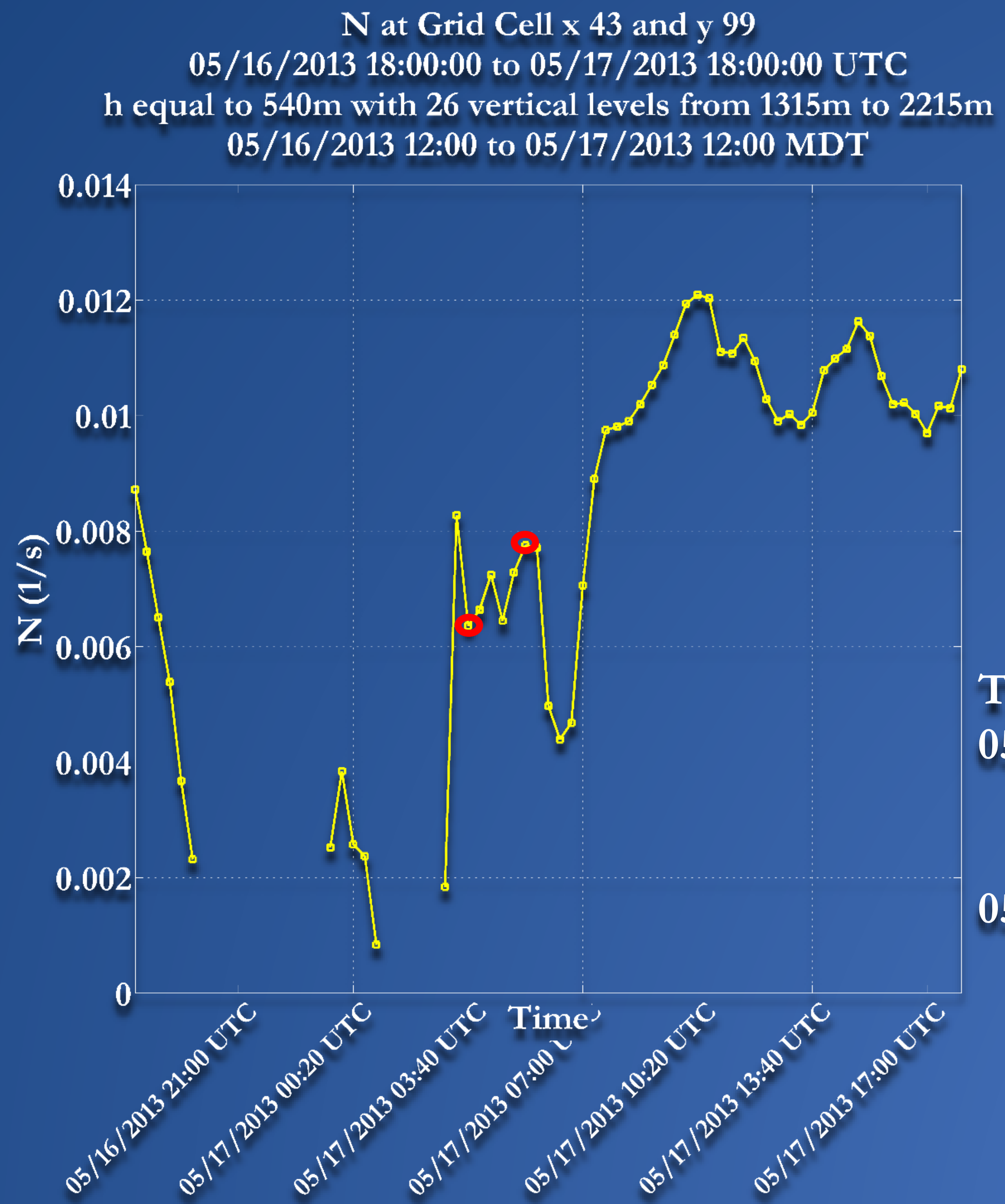

Times that are circled:

05/17/2013 0340UTC

05/16/2013 21:40 MDT

05/17/2013 0340UTC

05/16/2013 23:20 MDT

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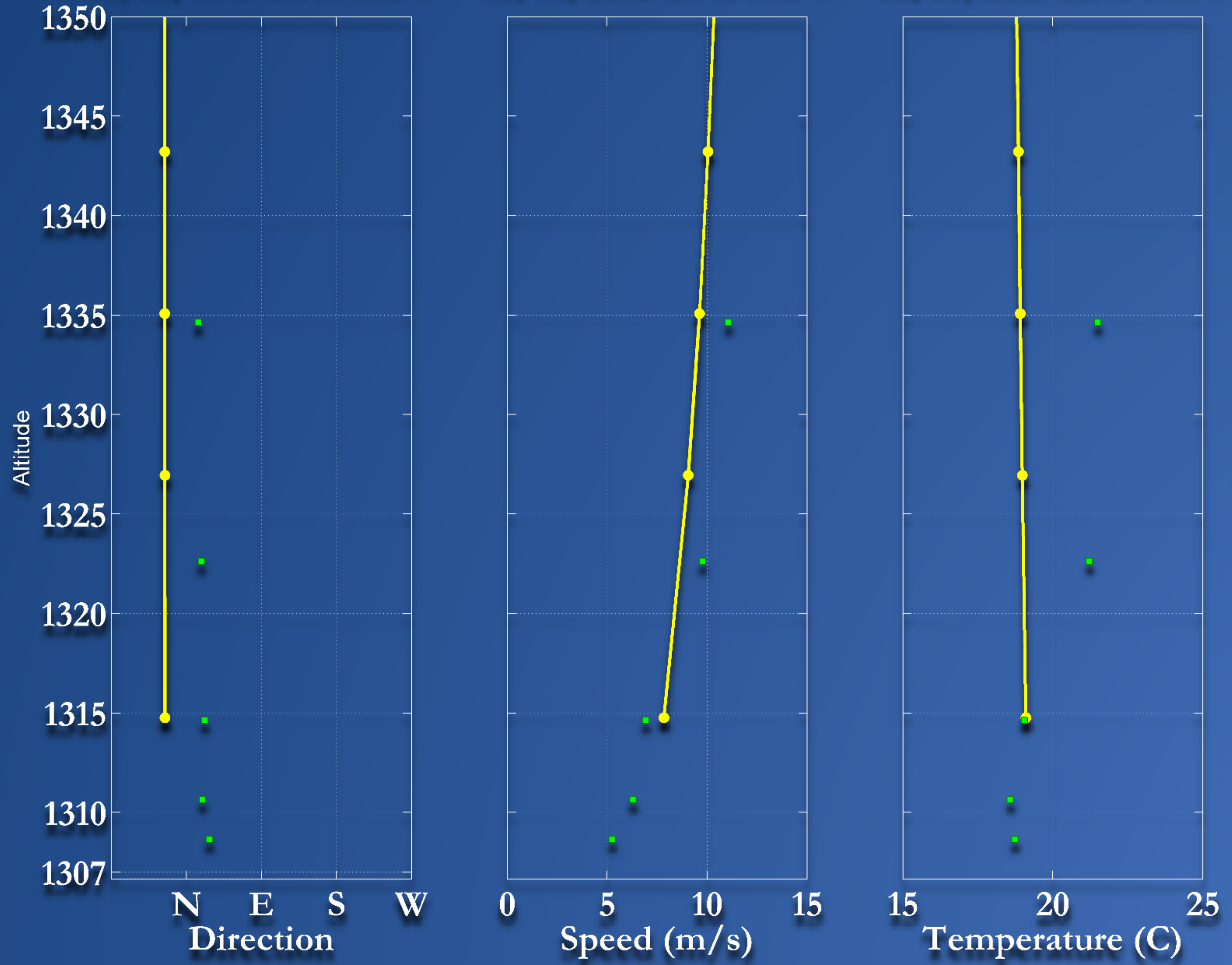
Direction Profile
Grid Cell (43,99)
05/17/2013 03:40 UTC
05/16/2013 21:40 MDT

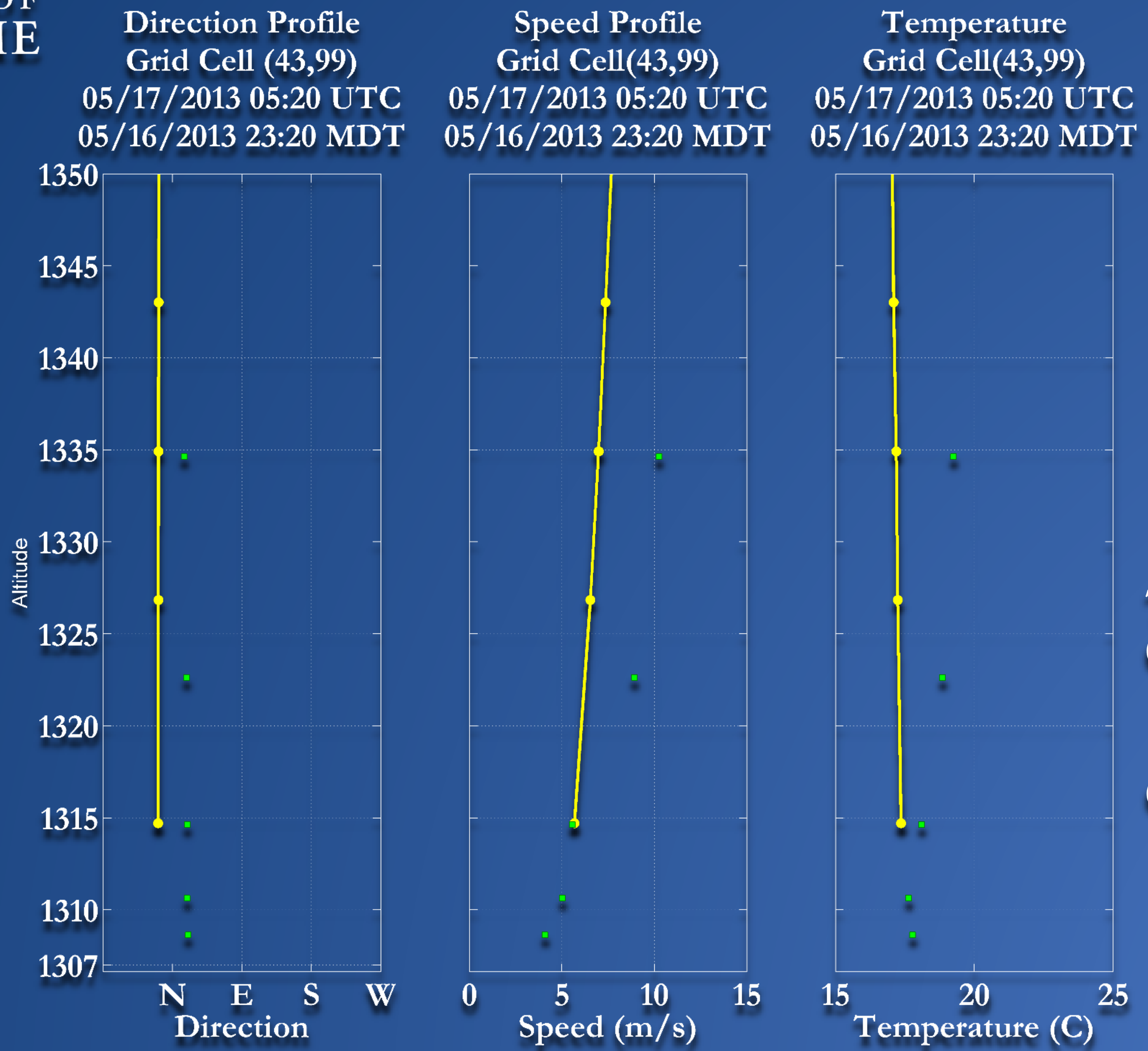
Speed Profile
Grid Cell(43,99)
05/17/2013 03:40 UTC
05/16/2013 21:40 MDT

Temperature
Grid Cell(43,99)
05/17/2013 03:40 UTC
05/16/2013 21:40 MDT



Times that will be shown:
05/17/2013 0340UTC
05/16/2013 21:40 MDT

05/17/2013 0340UTC
05/16/2013 23:20 MDT



Times that will be shown:

05/17/2013 0340UTC

05/16/2013 21:40 MDT

05/17/2013 0520UTC

05/16/2013 23:20 MDT

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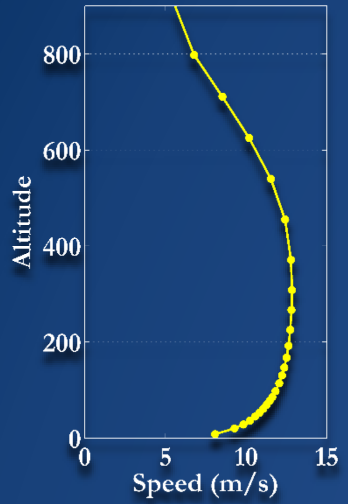
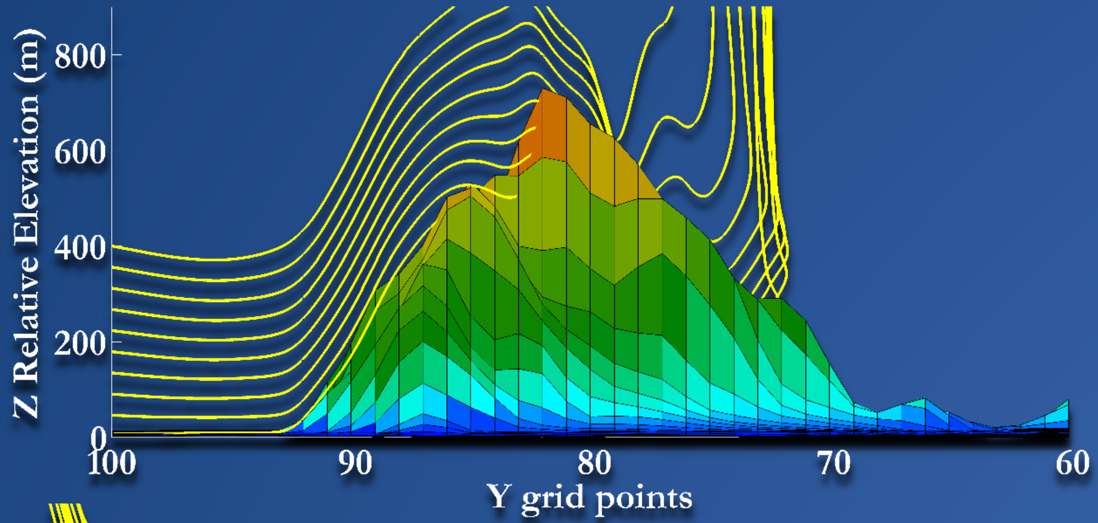
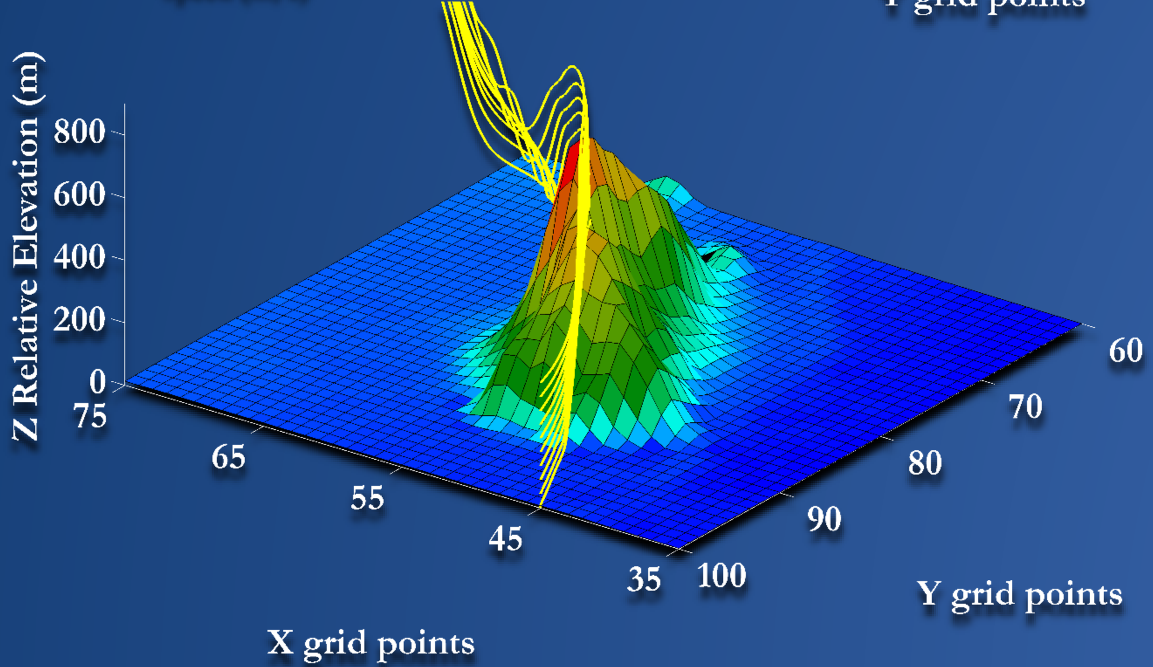
WRF Streamlines
05/16/2013 21:40:00 MDT
05/17/2013 03:40:00 UTC

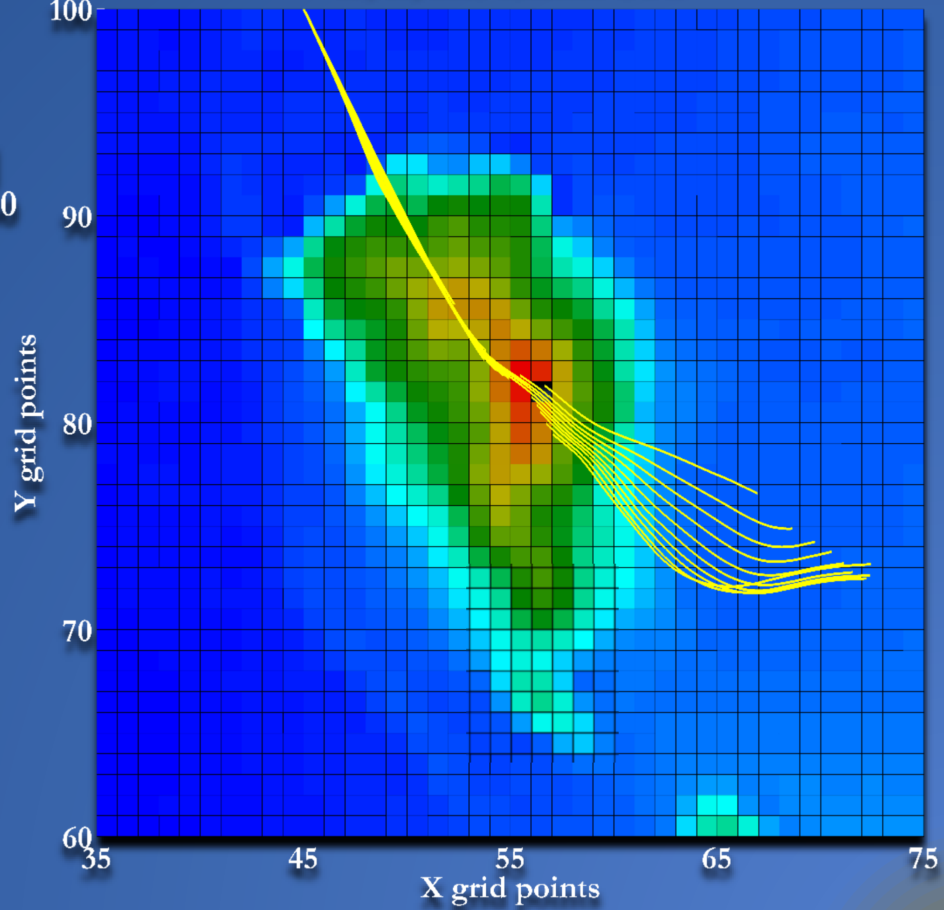






Streamlines originating from grid cell x = 45, y = 100

WRF Streamlines
05/16/2013 21:40:00 MDT
05/17/2013 03:40:00 UTC



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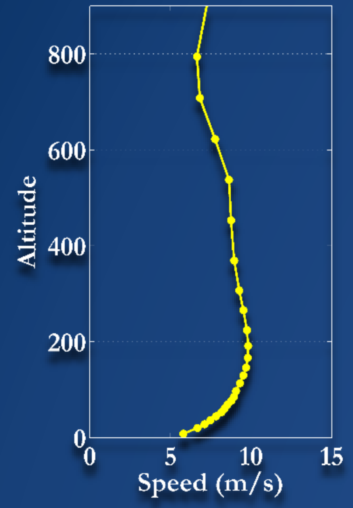
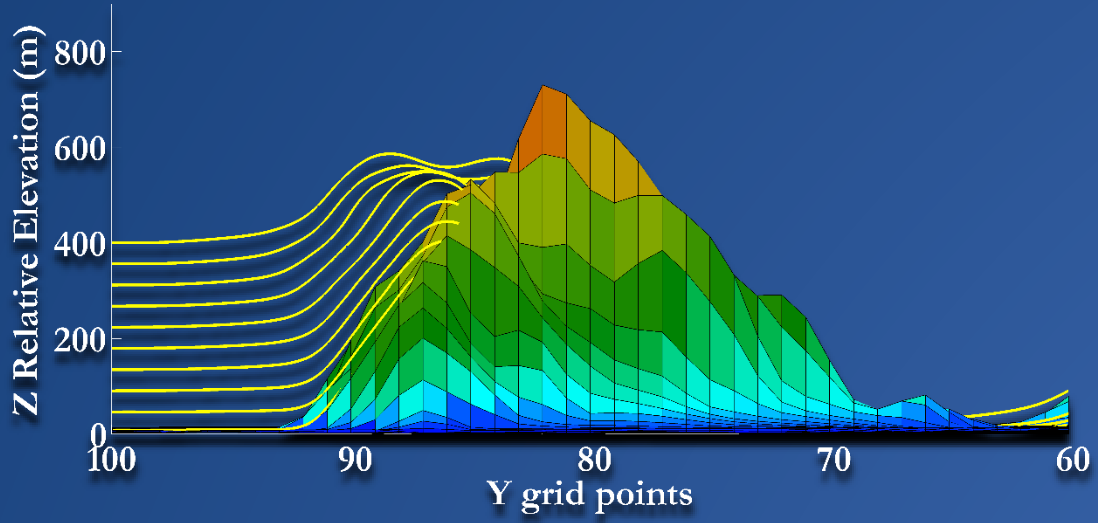
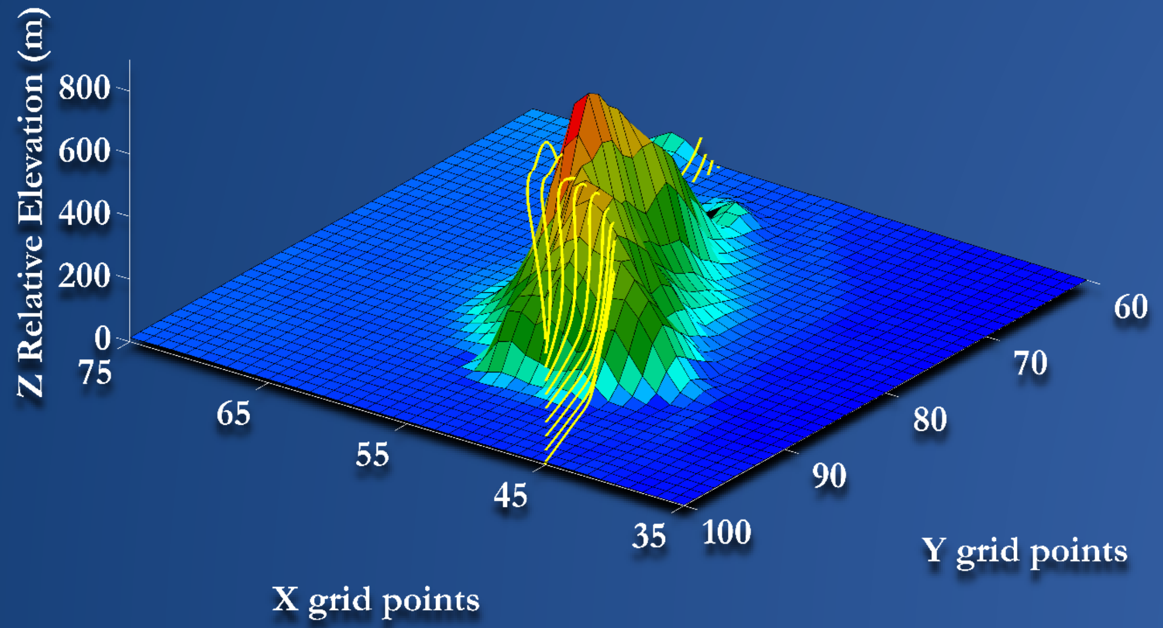
WRF Streamlines
05/16/2013 23:20:00 MDT
05/17/2013 05:20:00 UTC

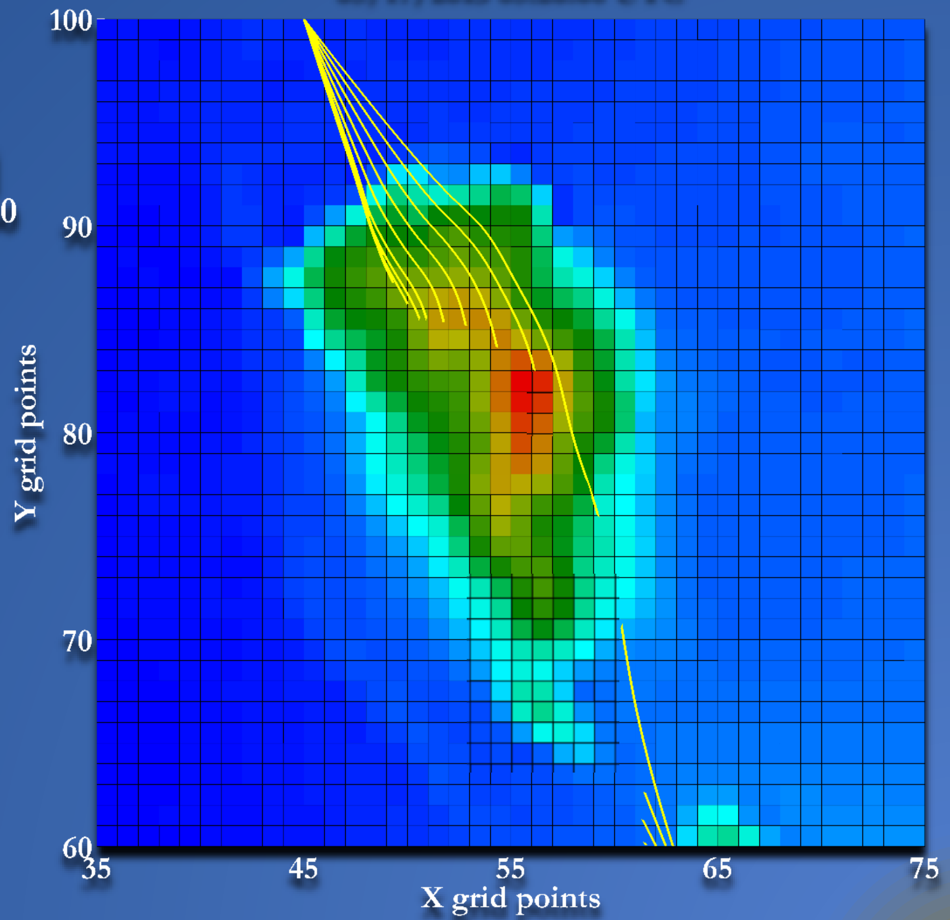






Streamlines originating from grid cell x = 45, y = 100

WRF Streamlines
05/16/2013 23:20:00 MDT
05/17/2013 05:20:00 UTC



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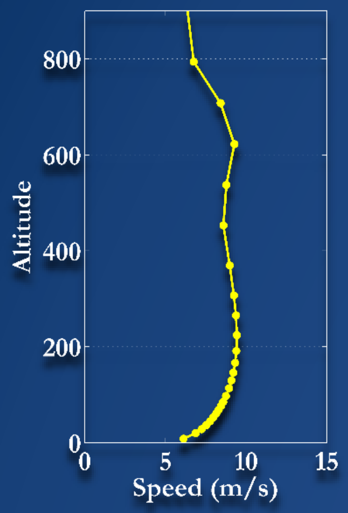
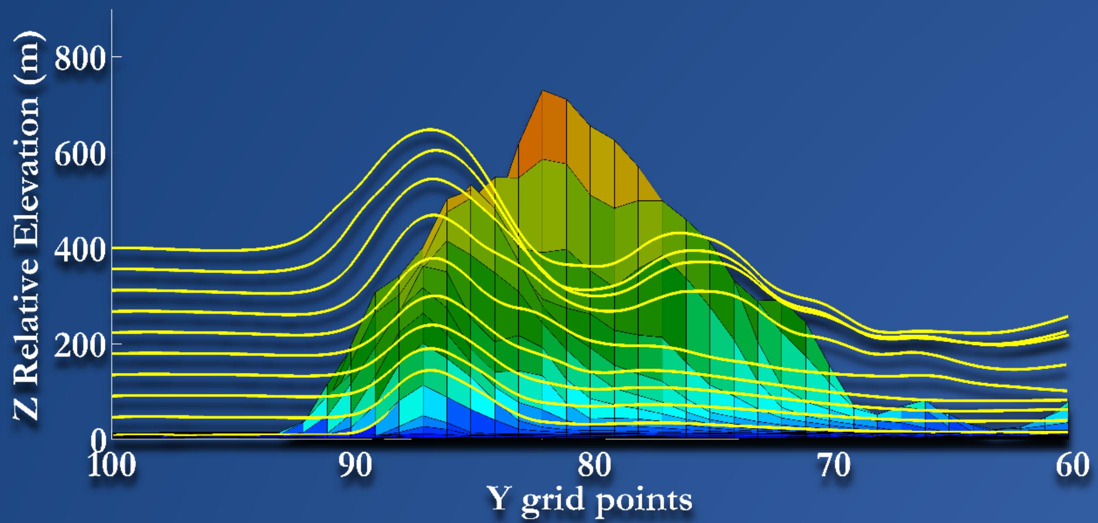
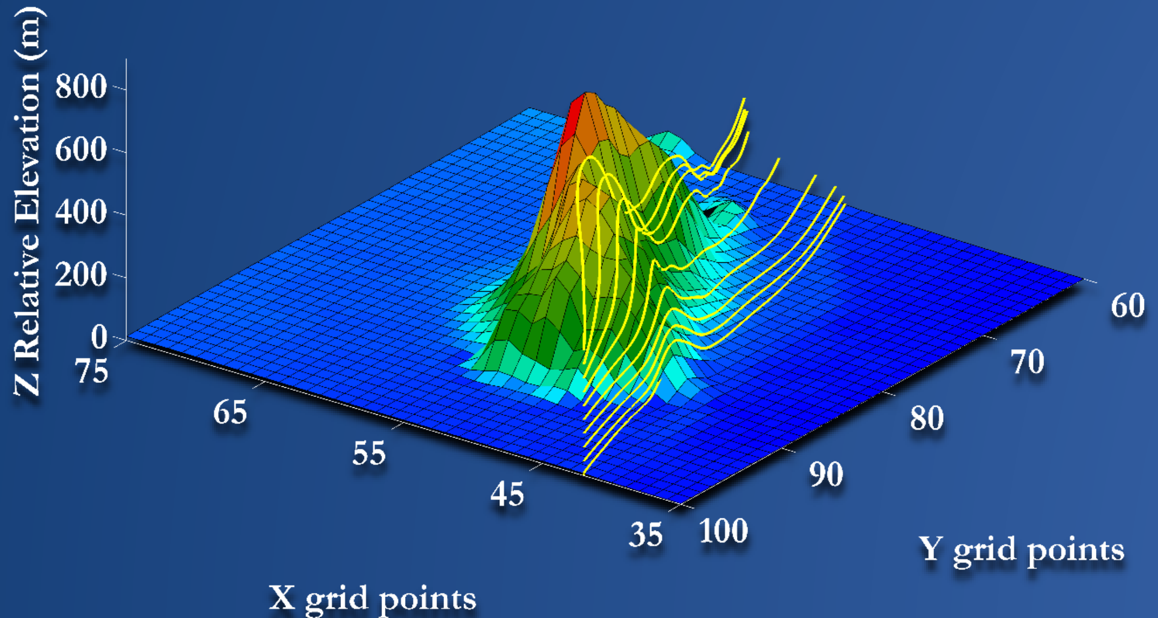
WRF Streamlines
05/16/2013 23:20:00 MDT
05/17/2013 05:20:00 UTC

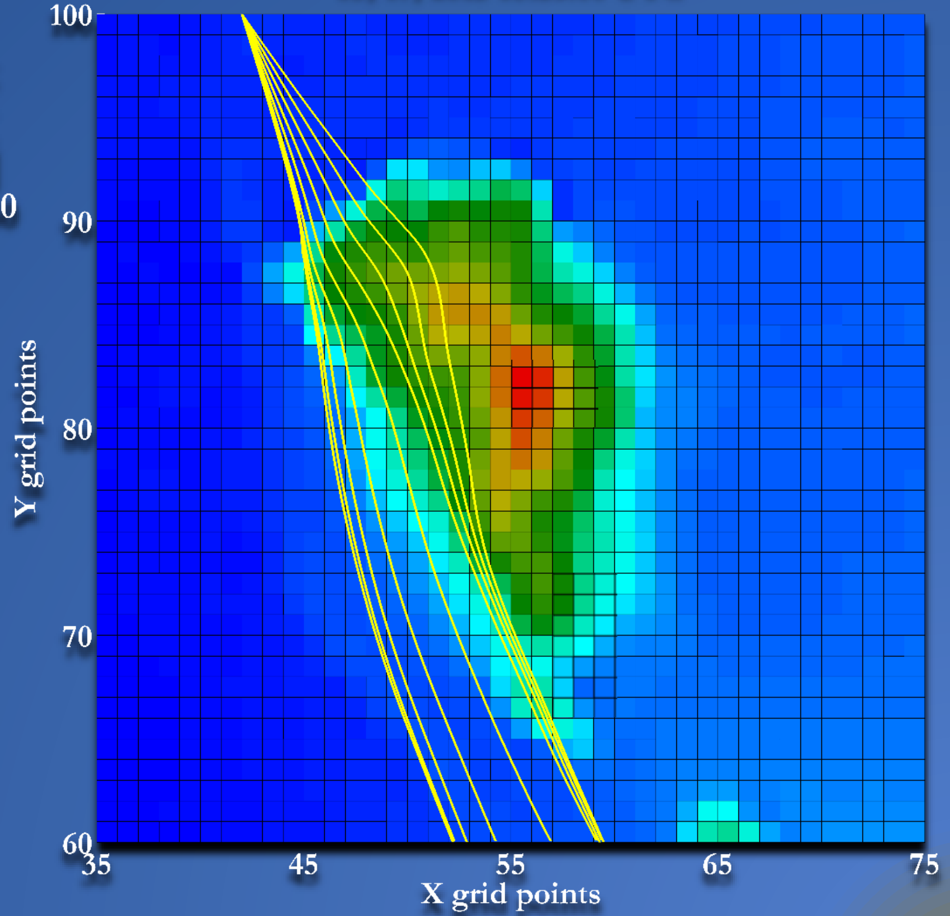






Streamlines originating from grid cell x = 39, y = 100

WRF Streamlines
05/16/2013 23:20:00 MDT
05/17/2013 05:20:00 UTC



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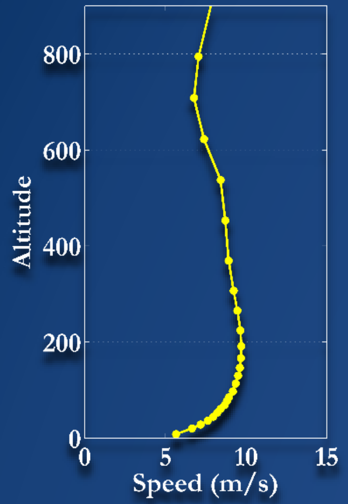
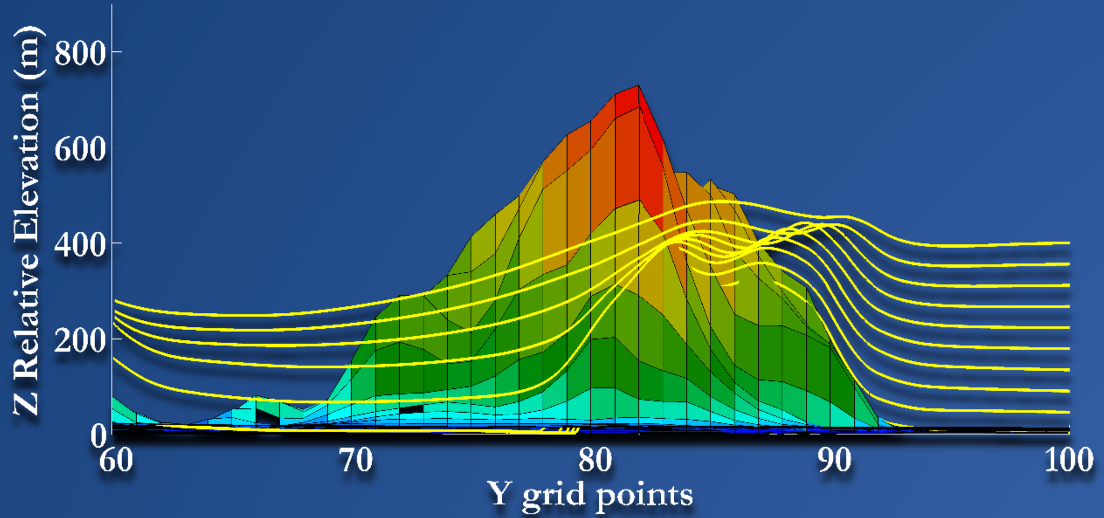
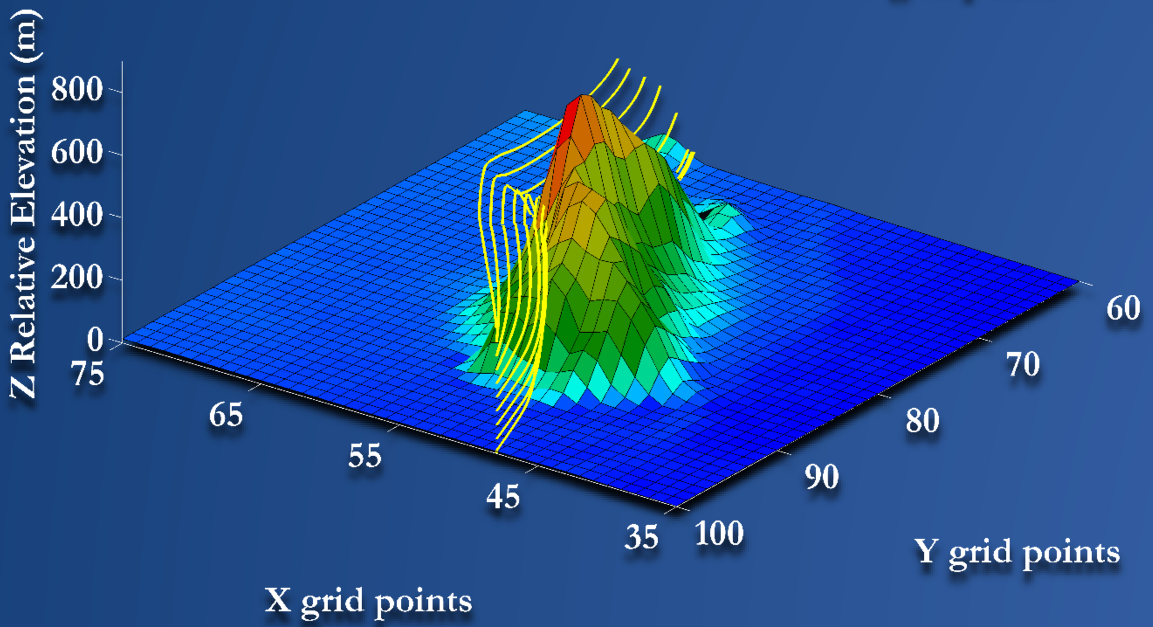
WRF Streamlines
05/16/2013 23:20:00 MDT
05/17/2013 05:20:00 UTC







Streamlines originating from grid cell x = 48, y = 100

WRF Streamlines
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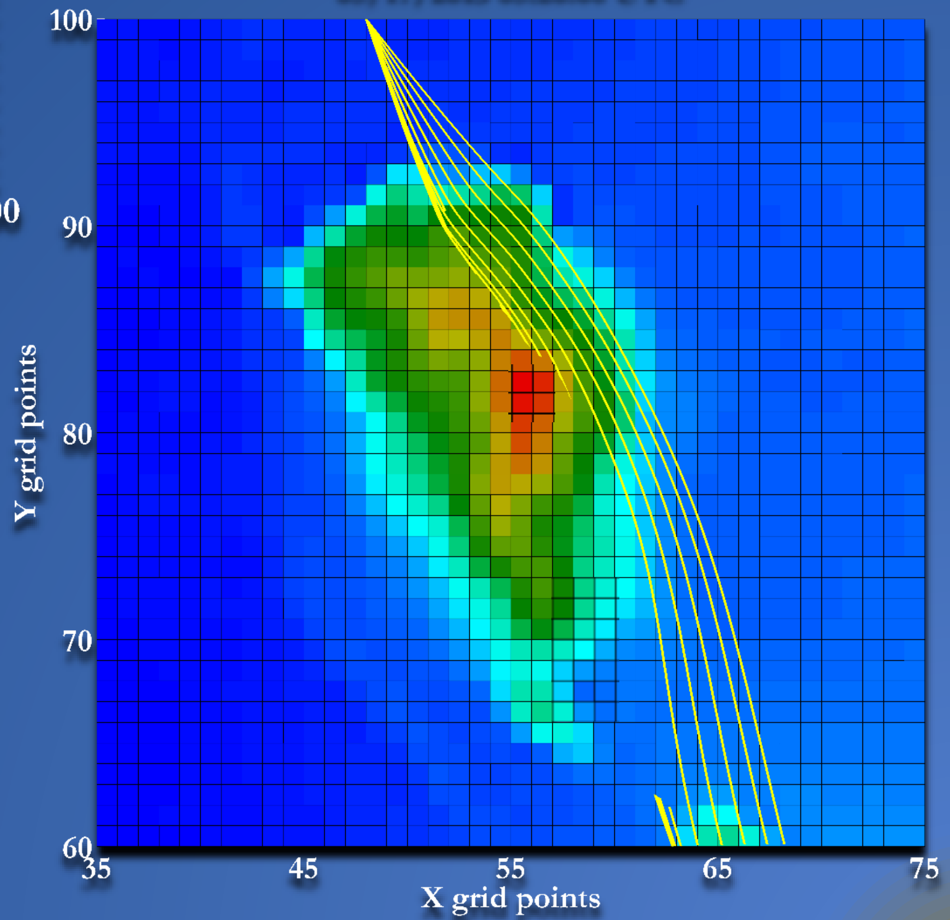
05/17/2013 05:20:00 UTC



Results and on going work

- The model captures synoptic conditions, however the ability for the model to capture the temperature and moisture conditions still needs to be addressed
- Flow features in the lee of the mountain that are expected can be captured, but further model to observation comparisons are on going
- Additional analysis is underway to identify how the model fits within the frame work of the dividing streamline theory

Acknowledgements

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Thank you!