Hindcasts and realtime predictions with WRF LES in support of the 2018 ISARRA Flight Week

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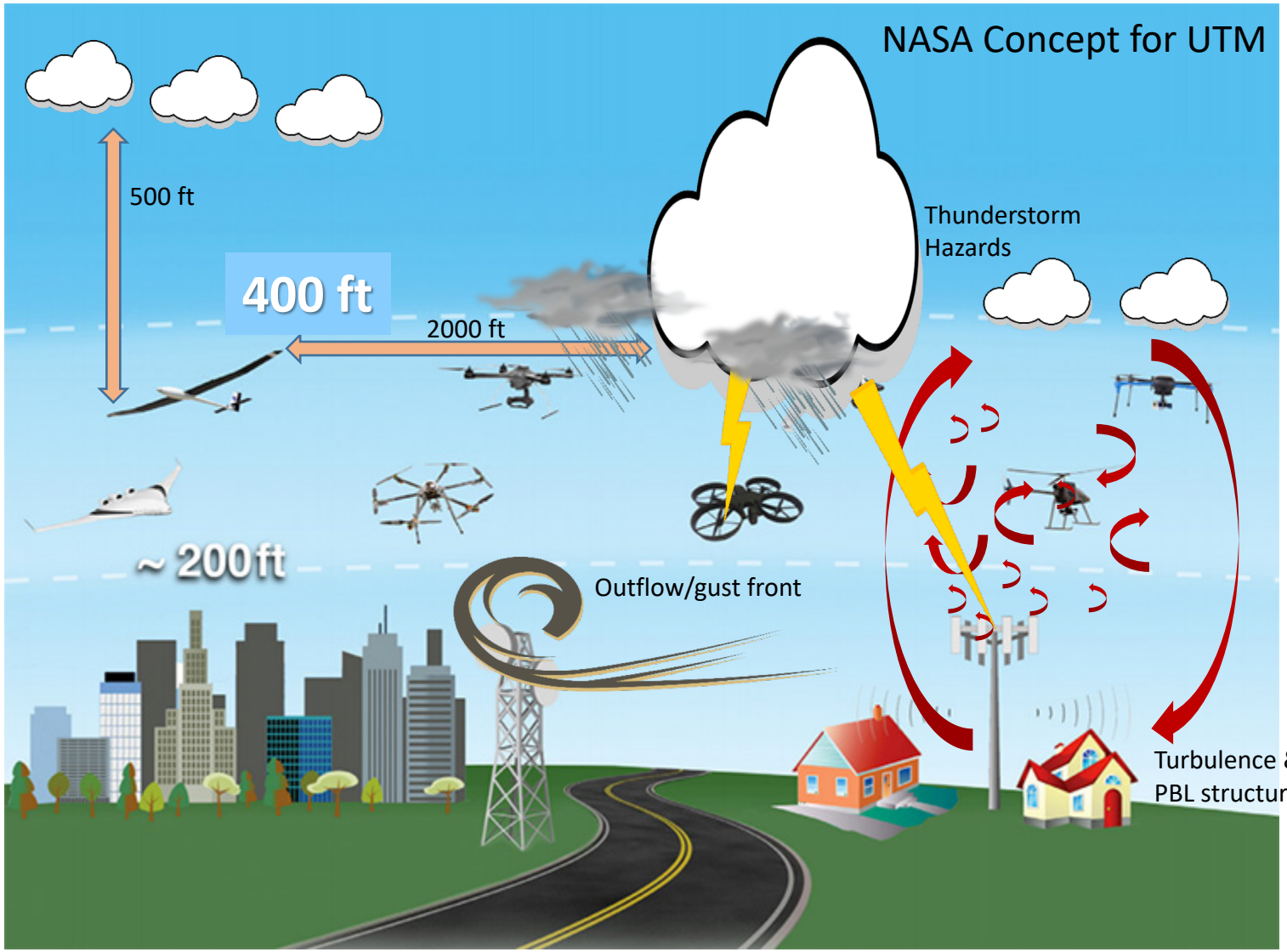
Motivation/Goal



Courtesy: https://utm.arc.nasa.gov/images/utm-airspace.jpg

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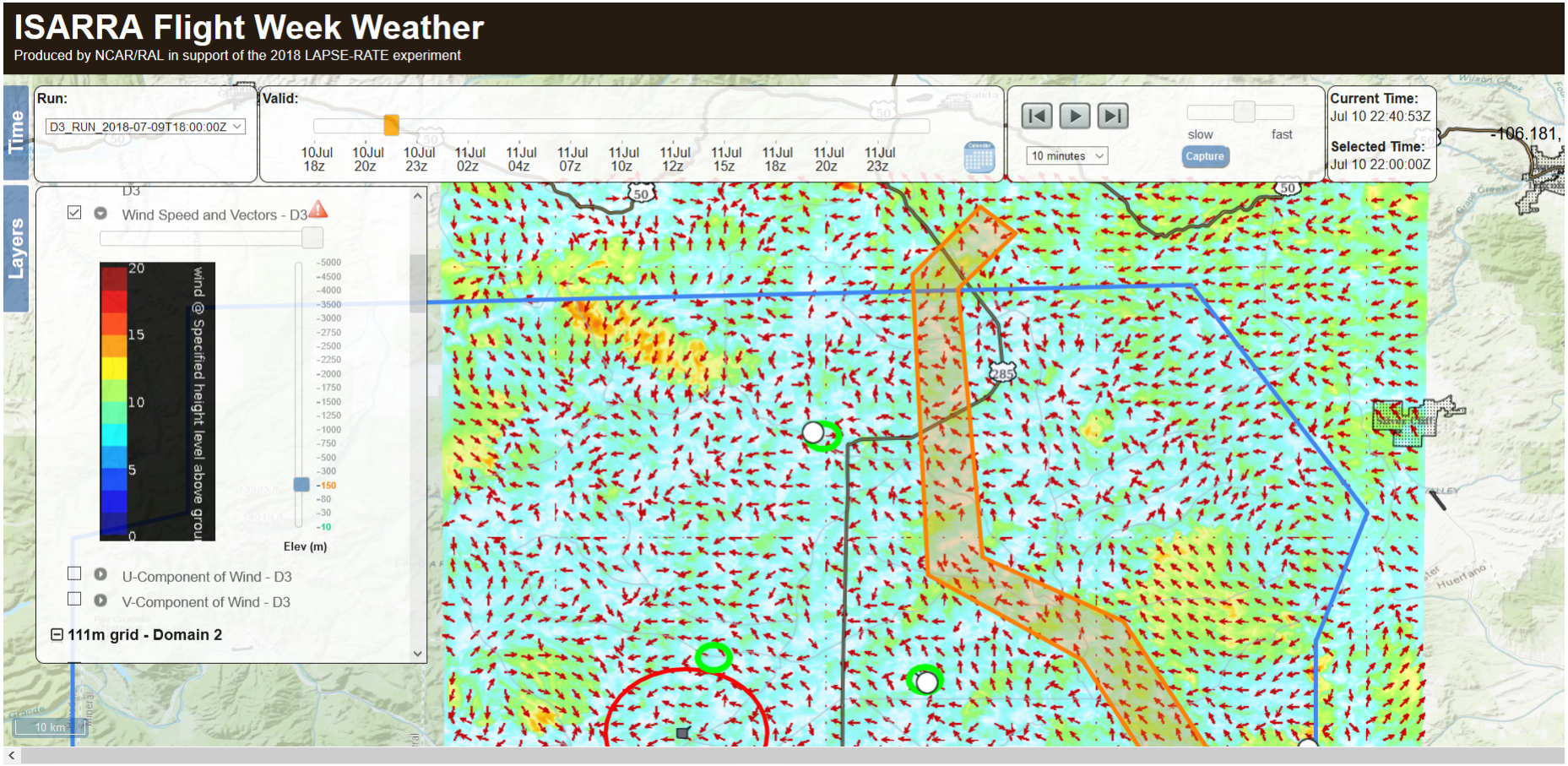
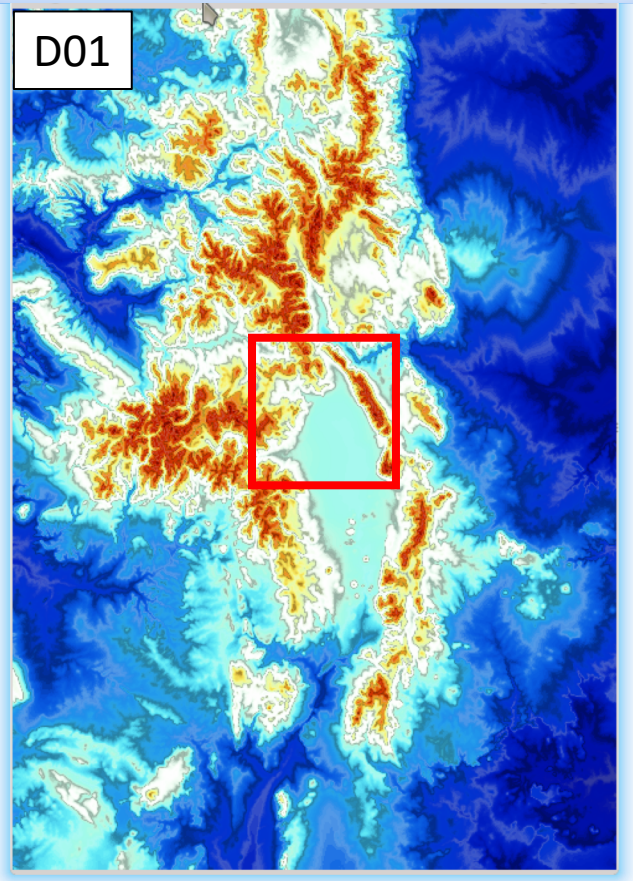
Initial Steps: Developing a UAS Weather Program at NCAR



Model Configuration

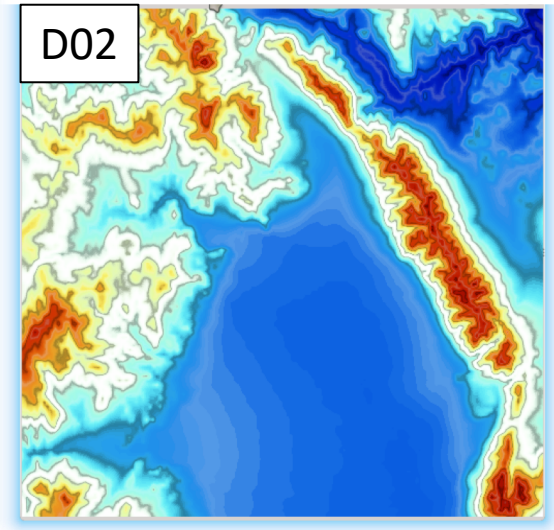


Domain 1

- 1 km resolution
- 487 x 637 x 45 gps

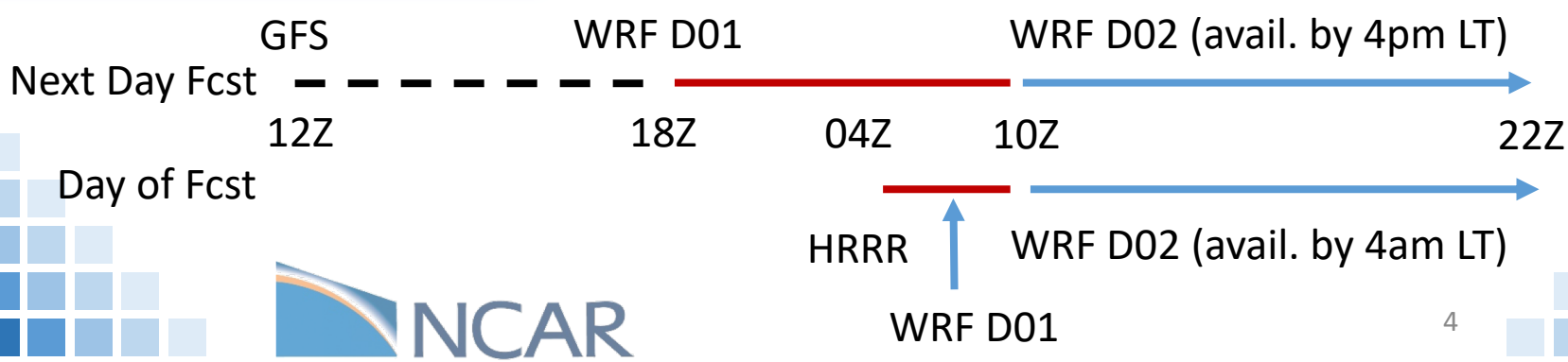
Domain 2

- 100 m resolution
- 1008 x 972 x 45 gps



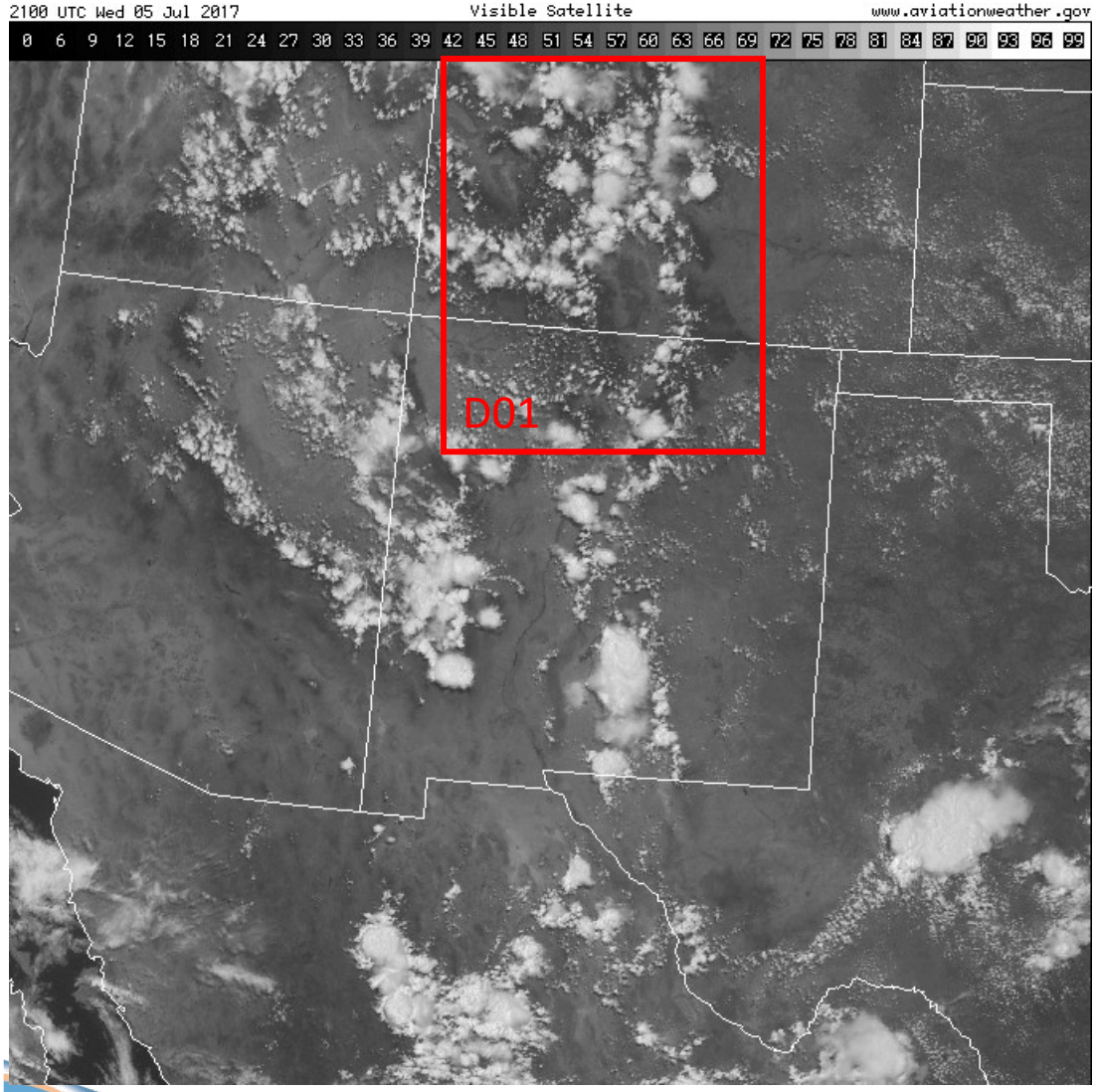
Model Physics

- WSM Microphysics
- MYNN2 PBL – D01 Only, D02 = WRF_LES
- NOAH LSM
- Builds on Munoz-Esparza et al 2017, 2018



Clear Sky/Weakly Forced Drainage Flows

Hindcast: 5 July 2018



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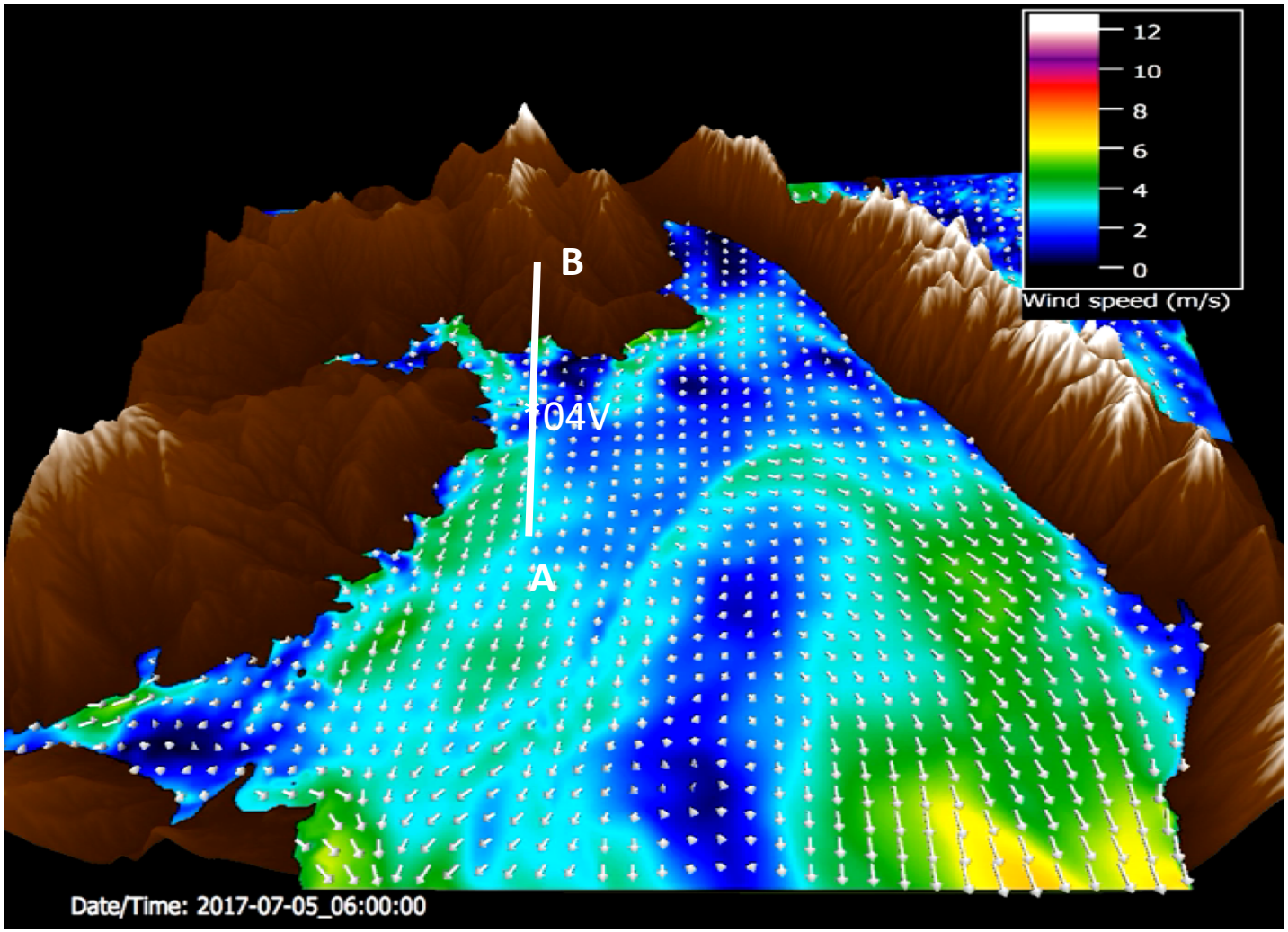
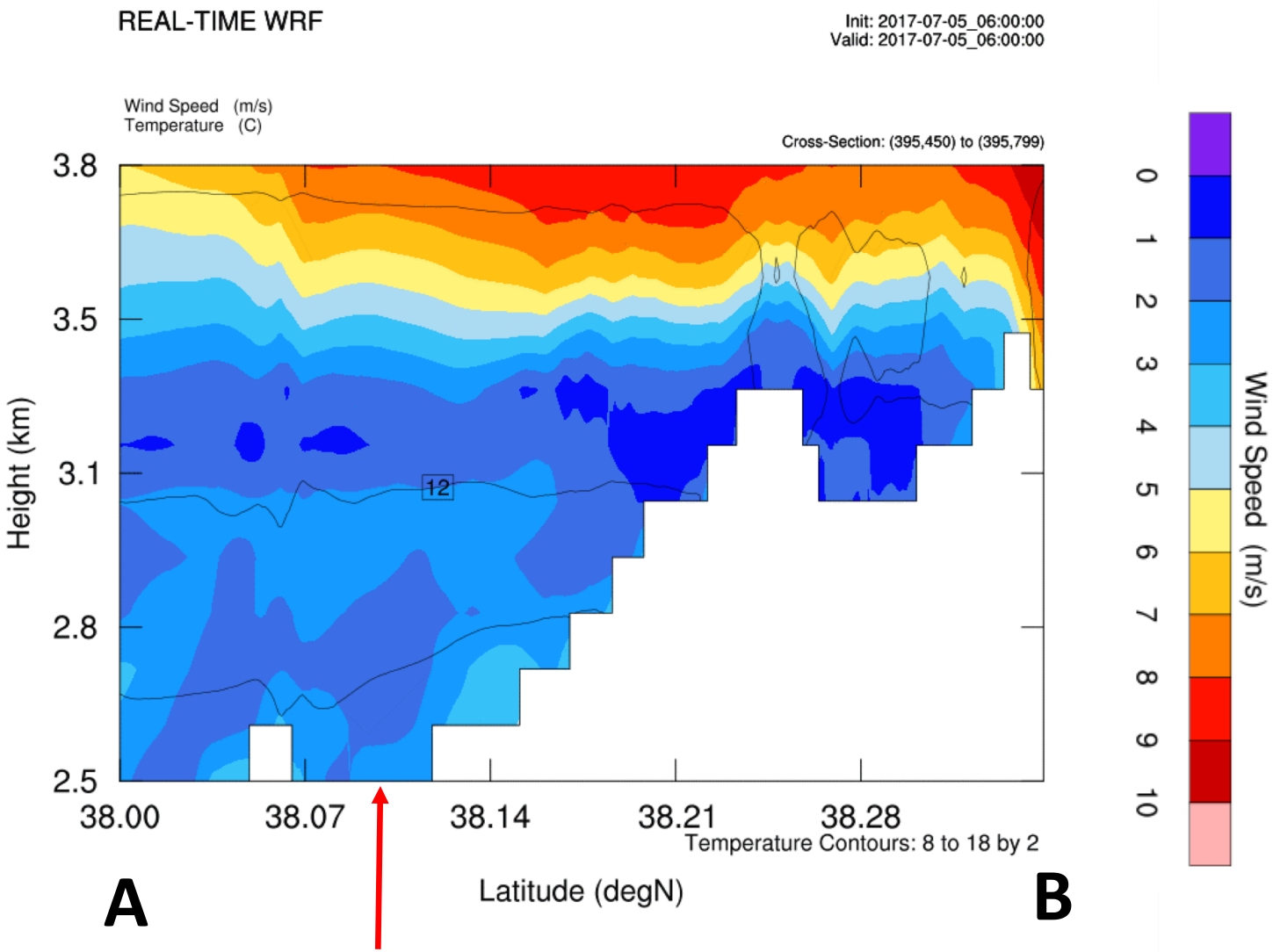
Evolution of Winds in San Luis Valley

12 hour run valid: 06:00 – 18:00 UTC (00:00 – 12:00 LT)



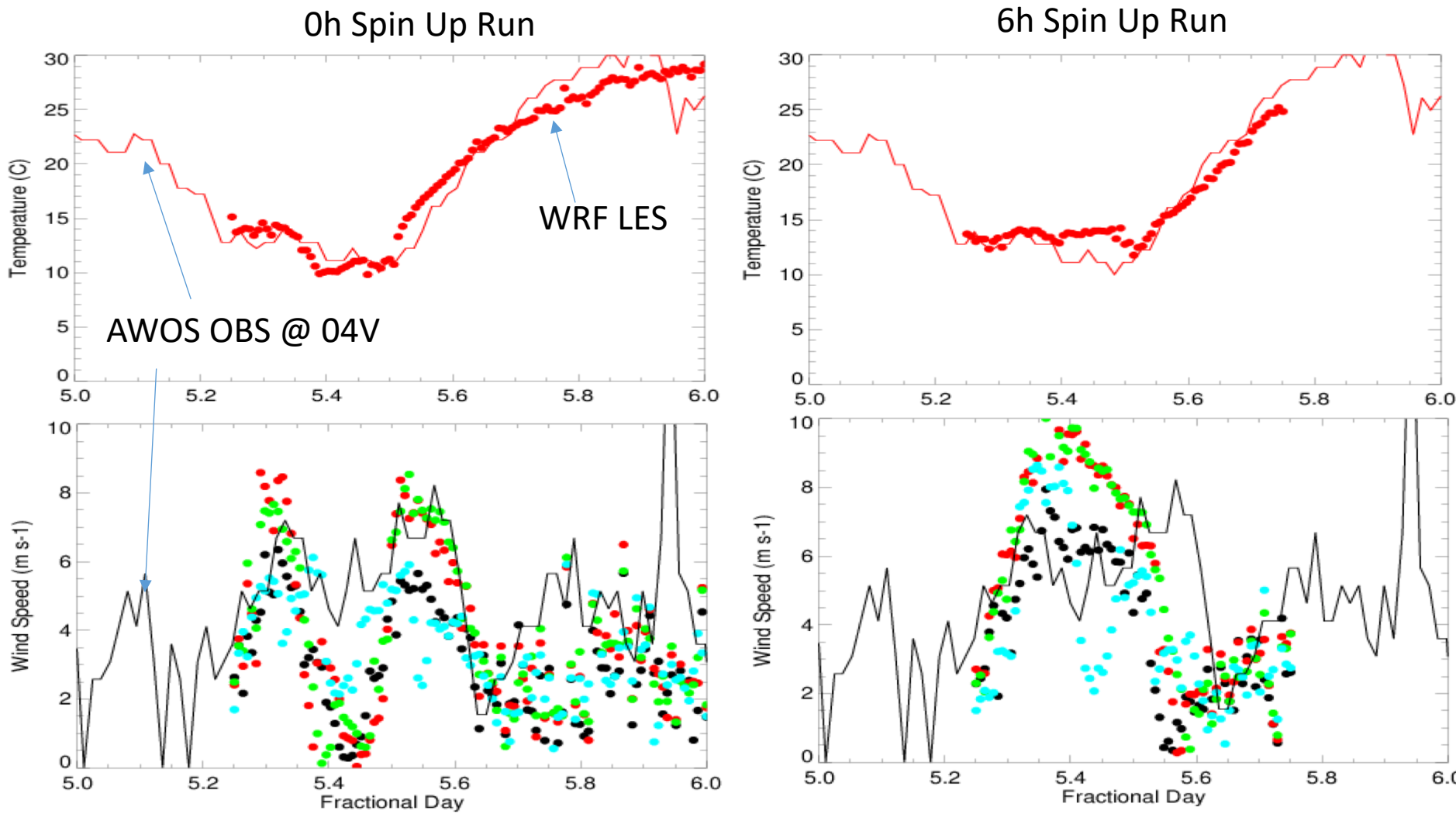
5 July 2018 case: ~300 m AGL

Evolution of Saguache Canyon Drainage Flow



04V: Saguache Municipal Airport

Evaluation of WRF LES Sensitivity to Spin-Up Period

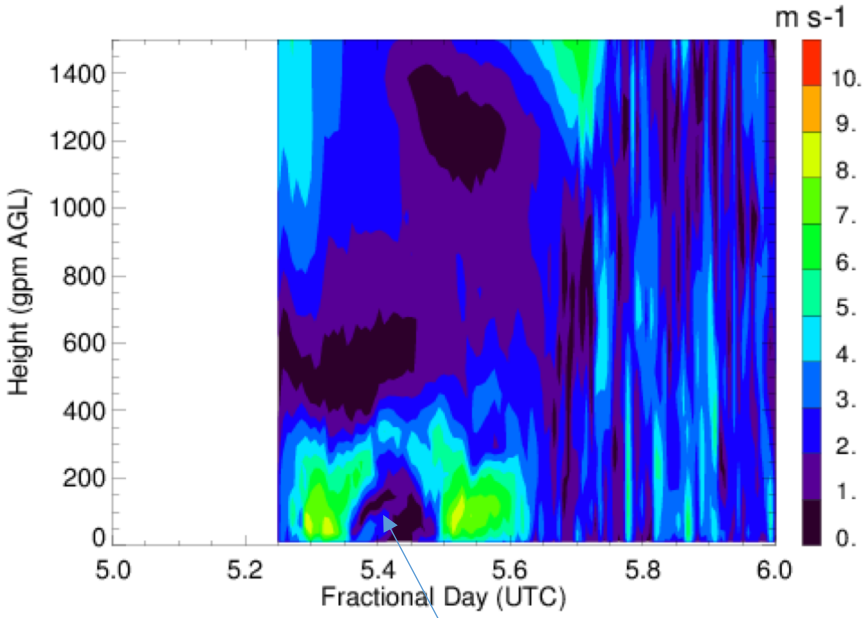


(UTC)

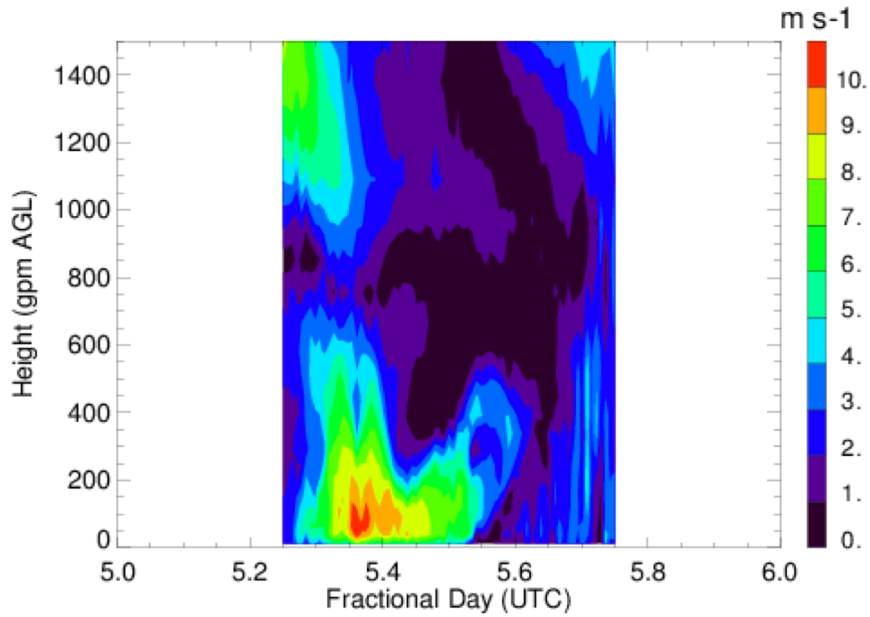
WRF LES Wspd: 10 60 120 240 m

Time-Height Cross Section of Wind Speed @ 04V

Using 0 h spinup D01 Initialization



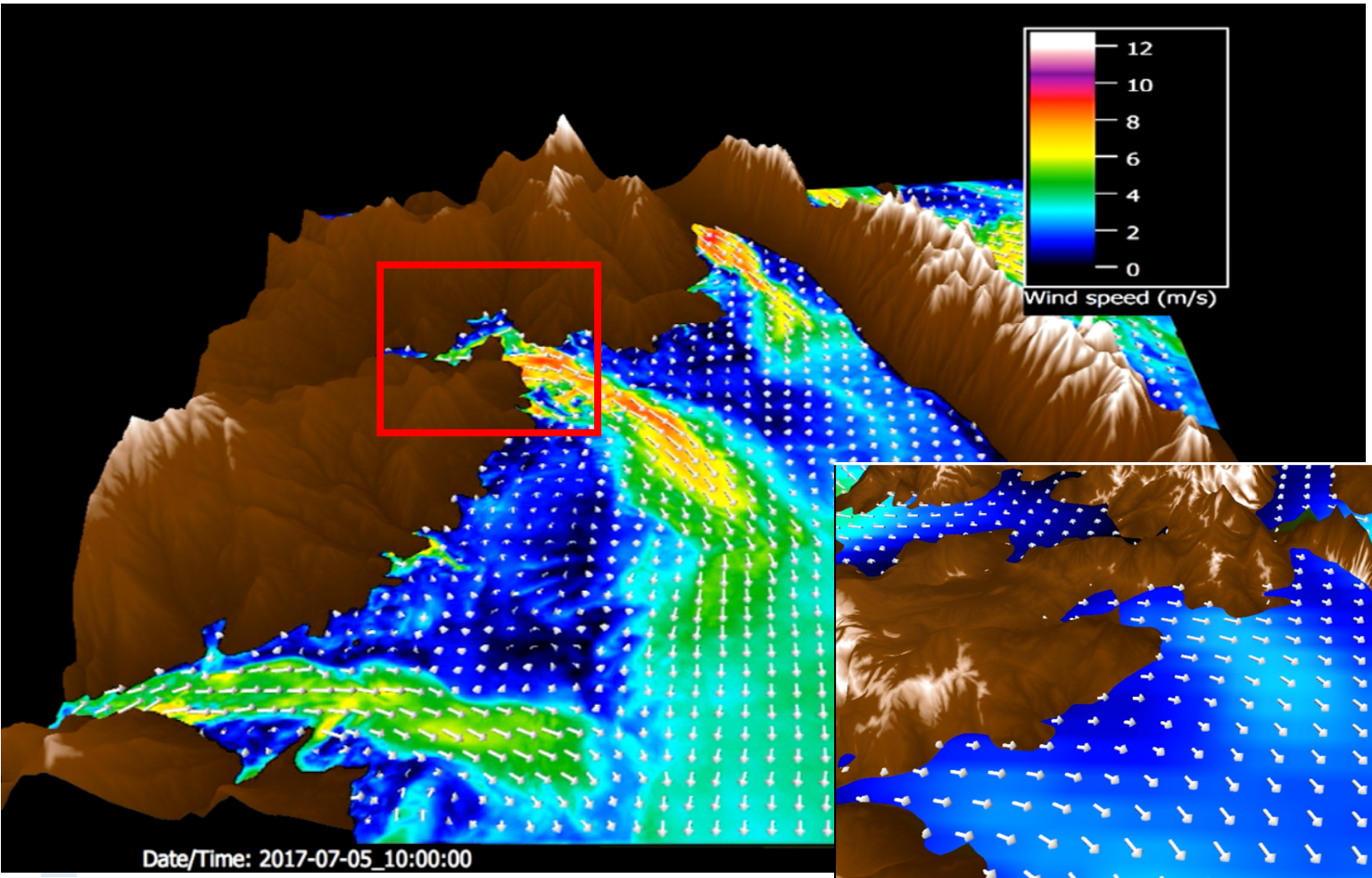
Using 6 spinup D01 Initialization



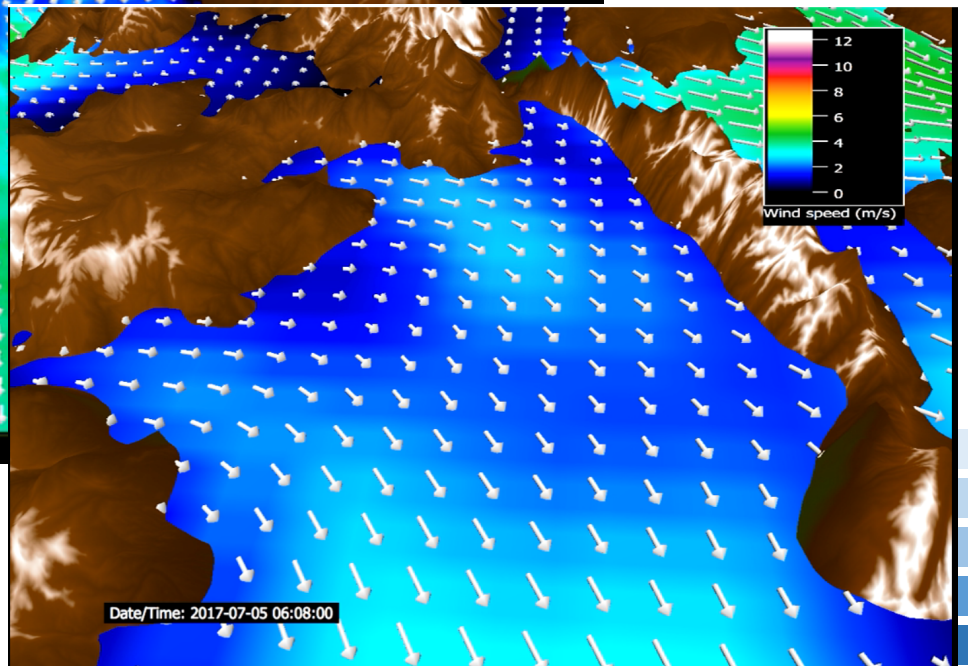
Lull in strength of drainage flow was caused by spurious wave that propagates off Sangre De Cristos

Comparison of WRF LES and HRRR

WRF LES Forecast Valid 10:00 UTC



HRRR Forecast
Valid 14:00 UTC



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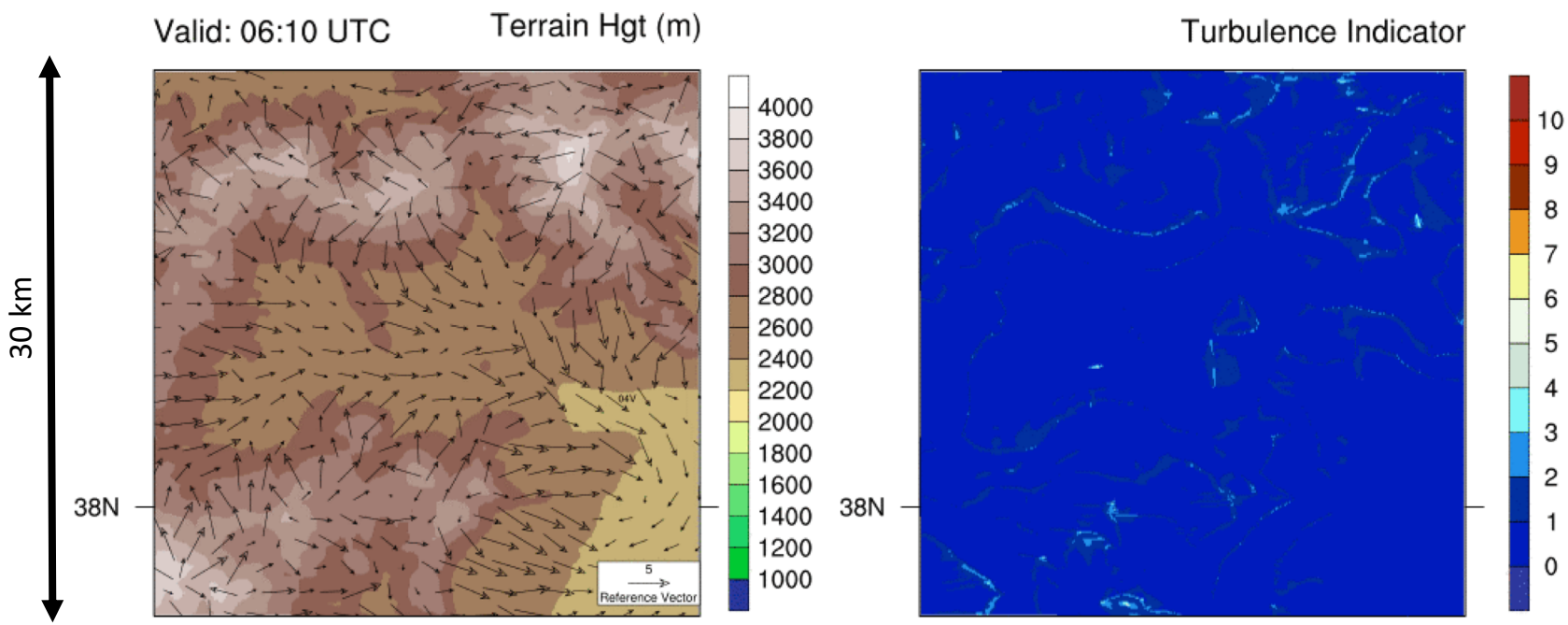
Detailed Predictions of Terrain Flows

Movie of Winds and Turbulence over the Saguache River Canyon Region



Resolves: Slope flows, gap flow, and TKE associated with resolved (~5Δx = 500 m) eddies.

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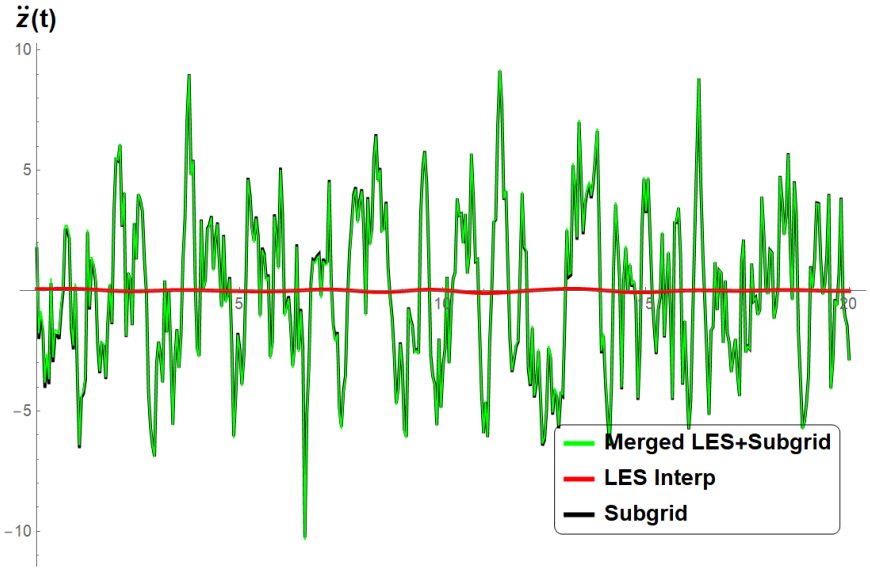
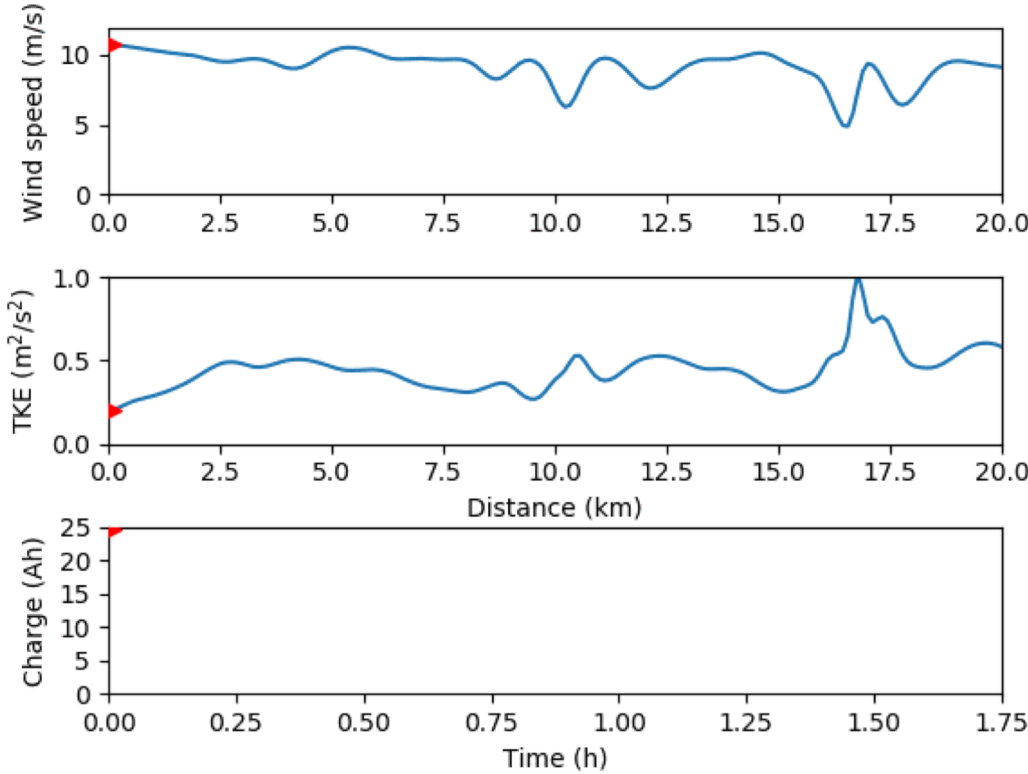
Impacts Translation Modeling

UAS

Vertical Acceleration Response



Assumes subgrid turbulence is isotropic.



Turbulence impacts

Summary Points

- Meso-to-microscale modeling can provide sensible weather (winds, turbulence intensity) at space and time scales needed for small UAS.
- Finescale spatial measurements are needed for model assessment/development.
- ISARRA flight week provides an unprecedented opportunity!

Acknowledgements: This work was funded by NSF and NASA grants.

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Questions?

Backup

Variables Planned for Display

- 2D Variables:
  - rain_rate, composite reflectivity, OLR
  - Ceiling and visibility
  - Q2, T2, PSFC
  - U10m, V10m, max windspeed10m
  - low-level wind shear
  - maximum upward vertical velocity

- 3D Variables: P,U,V,W,T,Q,TKE
  - Output at 9 flight levels
    - 30, 80, 150, 300, 450, 600, 1200, 2400 m, 5000m AGL
  - Output on sigma levels

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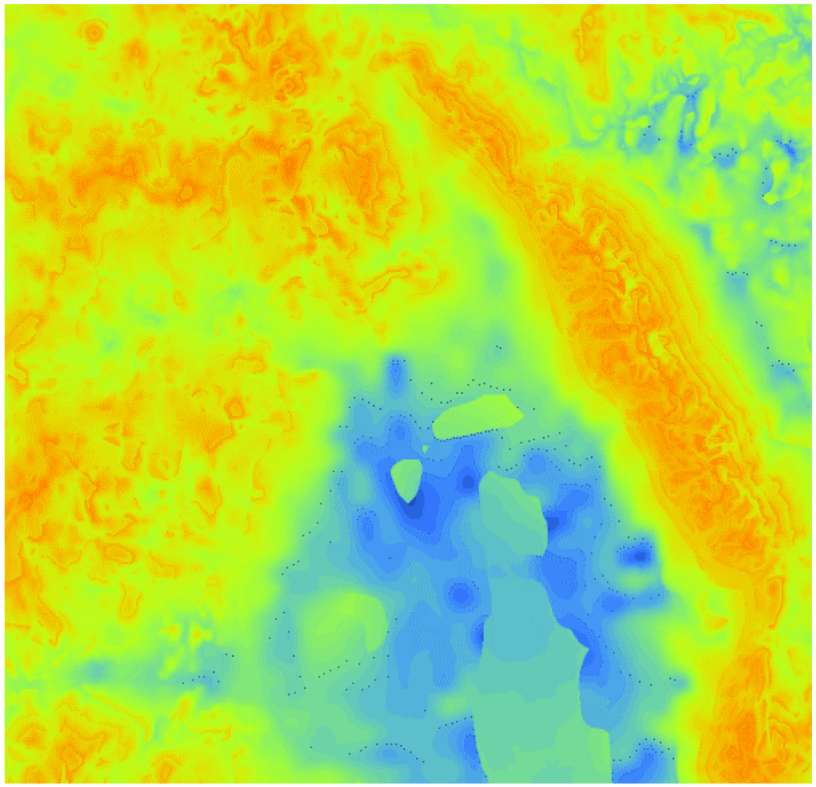
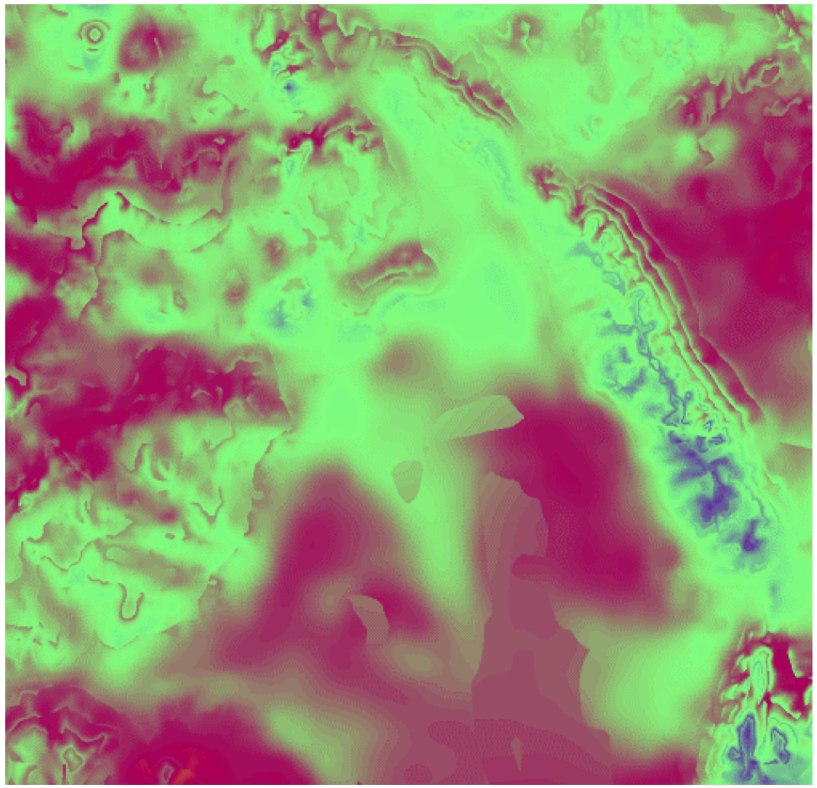
Impact of Gravity Wave on Drainage Flows

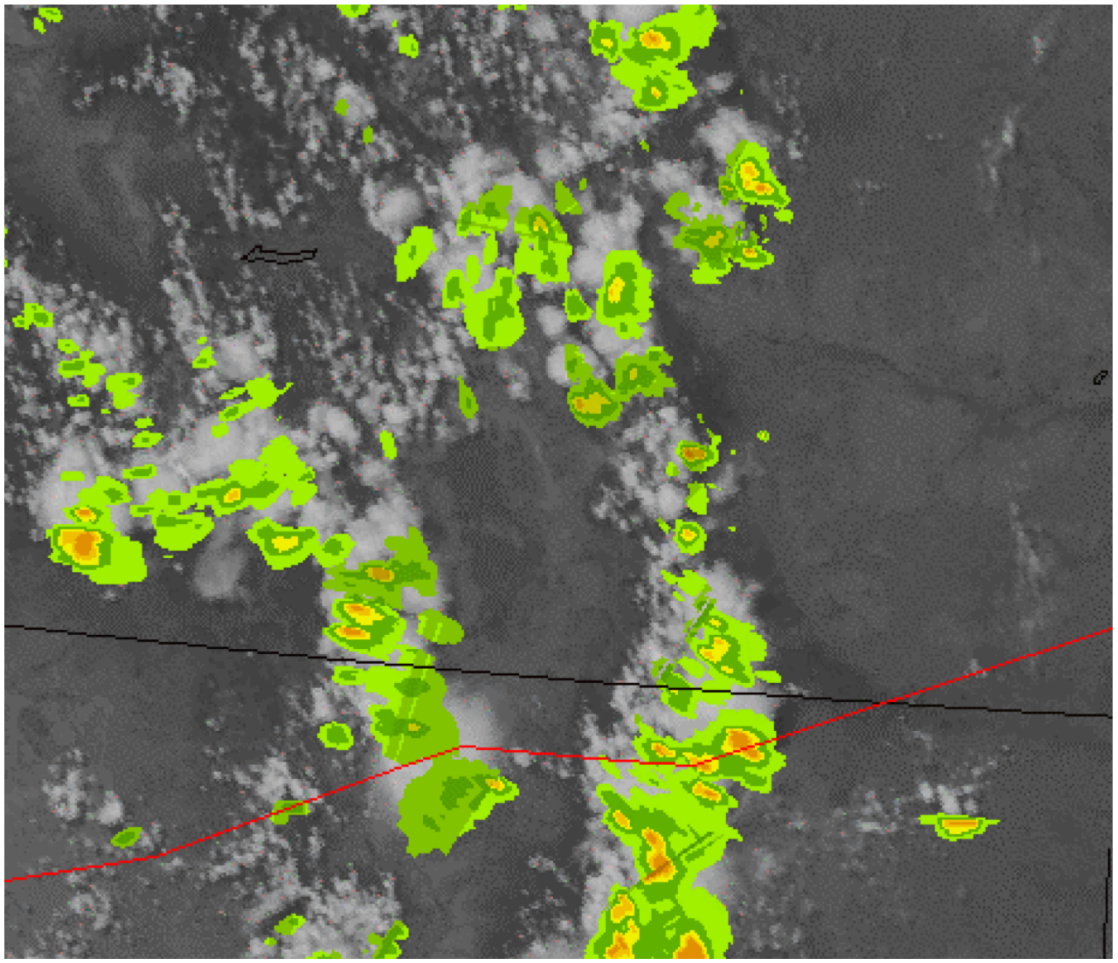
Temperature – level1



V-component – level2



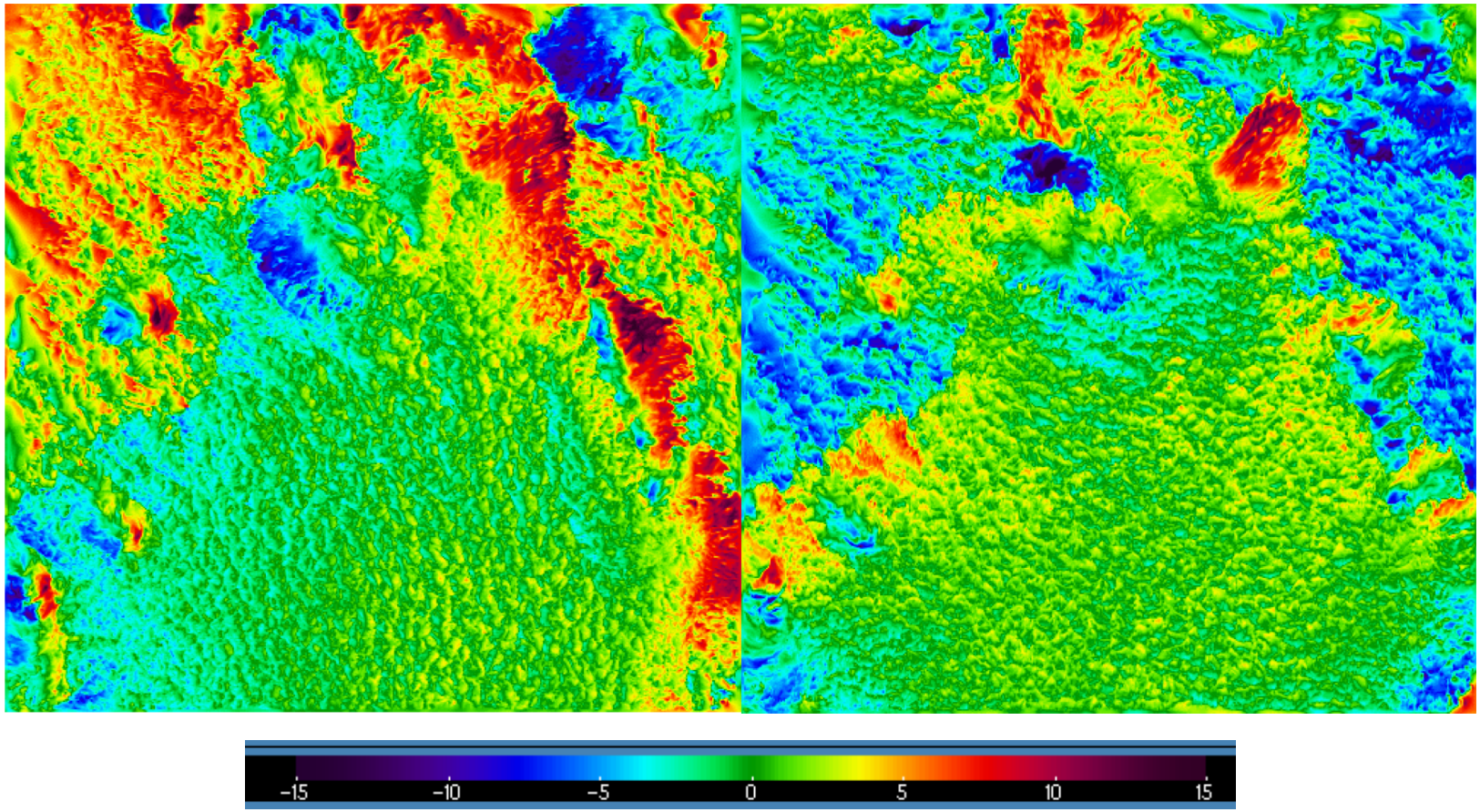
San Luis Valley CI : 8 July 2017



CI in valley @ 22:00 UTC
(16:00 MST)

U-wind – level 4

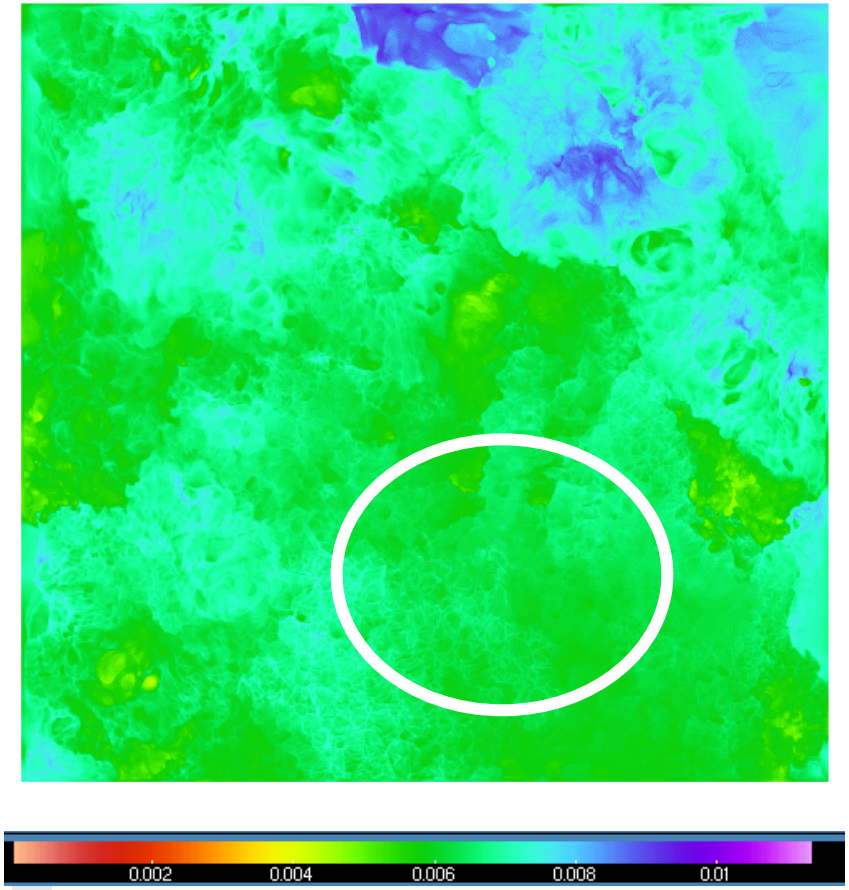
V-wind – level 4



17:40-20:50 UTC
11:40-14:50 MDT

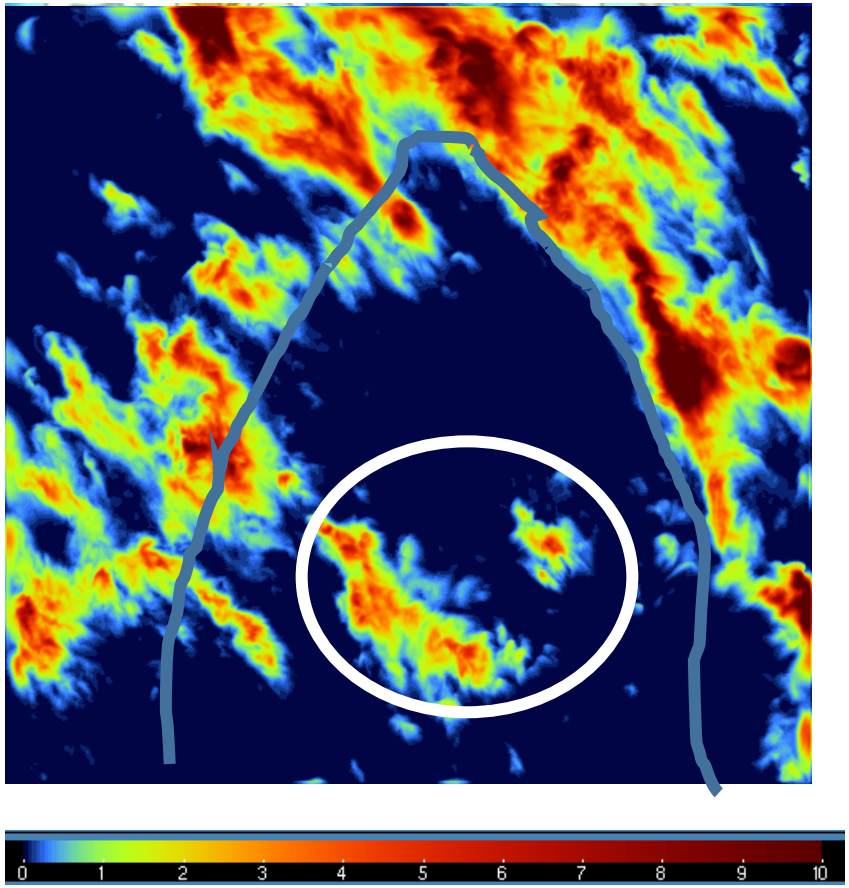
Case #2: CI in center of San Luis Valley (8 JUL 17)

Water Vapor Mixing Ratio (near sfc)



19:20-20:50 UTC

Accumulated Precip (mm) through 21:00 UTC



Circled: rainfall between 20:00-21:00 UTC

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