Nested-grid simulation of complex terrain flows at US Army DPG with NCAR WRF-RTFDDA-LES

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Outline

1. Motivation
2. WRF-RTFDDA-LES
3. Model configuration
4. Validation and comparisons
5. Summary and future work

Motivation

- **Computing capability increases substantially**
  - Faster CPUs, more "cores", bigger storages …
- **These capabilities provides an exceptional opportunity to advance regional RT NWP:**
  - Ensemble DA and ensemble forecasting
  - **VLES-scale NWP at DX ~100 – 300m grids**
  - **LES NWP at DX ~10s m grids in near future**

*VLES – Very Large-Eddy Simulation

WRF-RTFDDA-LES

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- **WRF-LES:** A capability introduced since WRF 3.0
- **WRF-RTFDDA-LES:** Simultaneous nested-down simulation from synoptic scales (***DX~10s km***) to VLES (***DX~100s m***) and LES (***DX~10s m***) scales
- "Full-physics", including LES grids
- Realistic specification of detailed underlying forcing with LSM-physics
- RTFDDA provides highly-desirable, accurate, and dynamic and cloud "spun-up", ICs and LBCs to drive refined VLES/LES prediction

DPG RTFDDA-VLES NWP System

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smac-c4-int2.rap.ucar.edu/images/ens/GEDPGL/

4DWX

WDTC Meteorology Division
Dugway Proving Grounds, Utah

GEDPGL

NAM_WCTRL member - FDDA Image Viewer

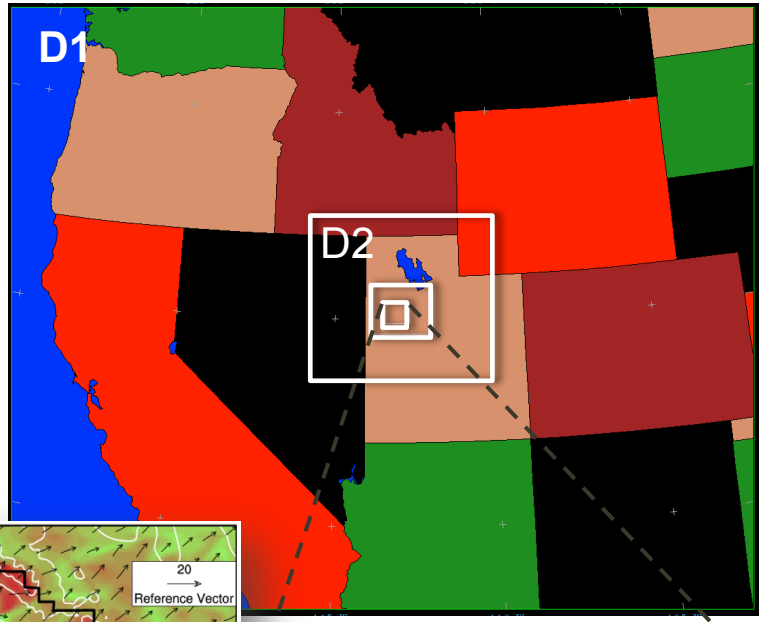
Observations

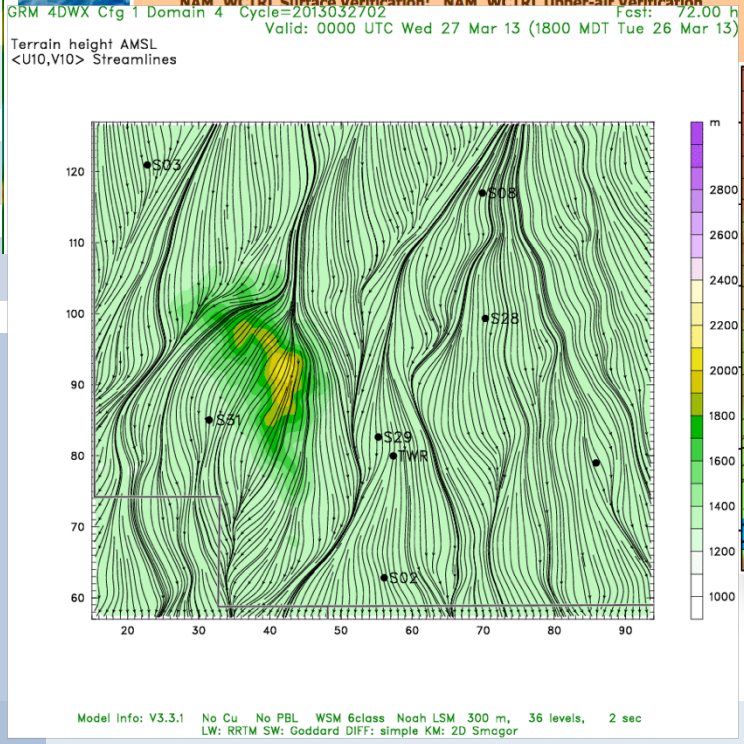
NAM_WCTRL Observations - Image Viewer

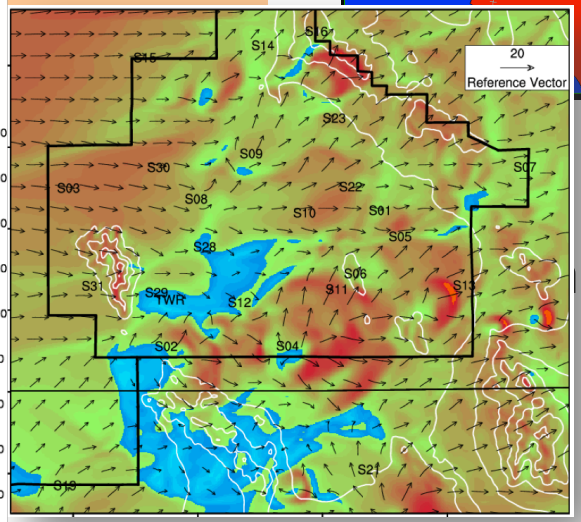
Cycle Verification Viewer

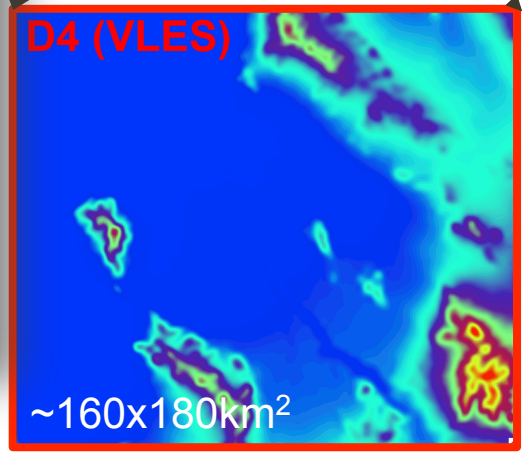
NAM_WCTRL Surface Verification: NAM_WCTRL Upper-air Verification

Experimental RT runs began in May 2012









Two "Natural" Questions

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A. Is WRF able to simulate realistic features of real weather with real terrain and land surface forcing when run at LES grid?

B. WRF-RTFDDA-VLES: The current computing capacity can support VLES-NWP (DX~100s m) operation. Is VLES practically valuable, or should we sit back, drink, wait, and skip this "Terra-Incognia" (i.e. *l* and Δ are of the same order)?

Validate VLES with LES

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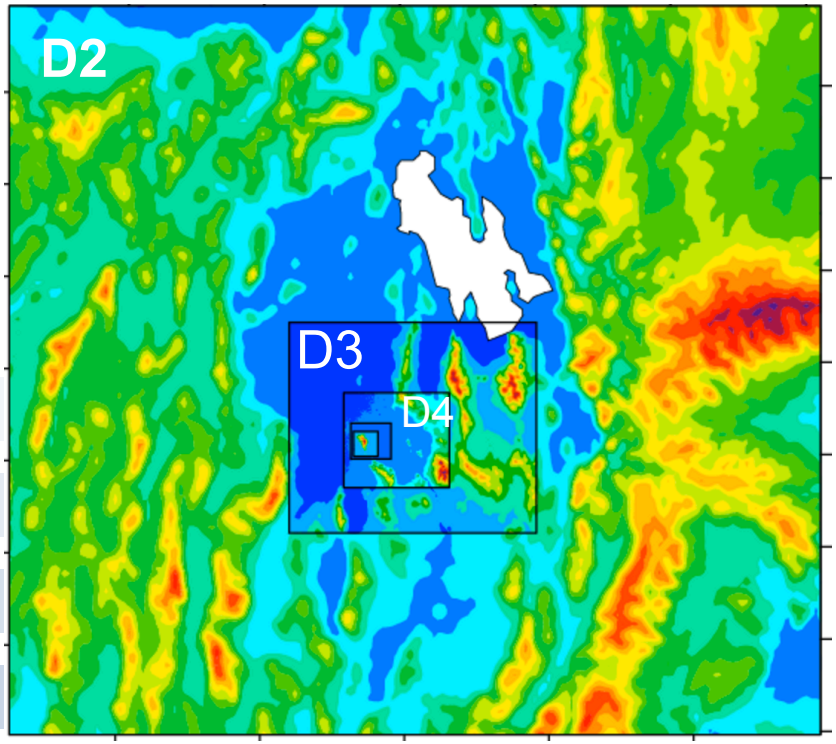
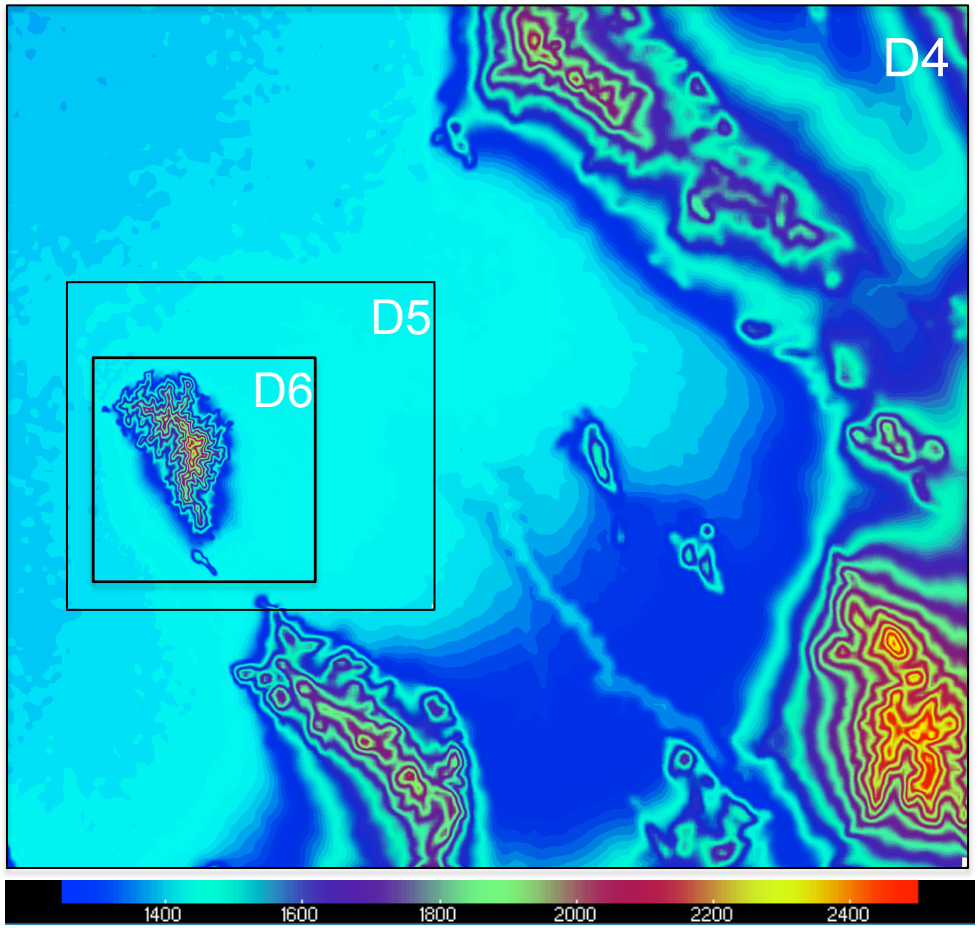
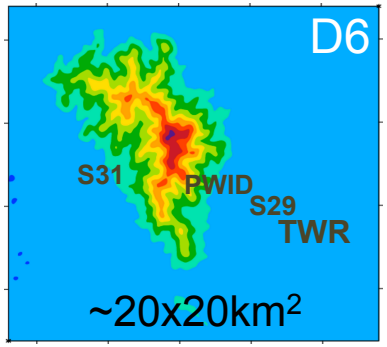


Six nested-grid domains, 48hrs

*(DPG RTFDDA-VLES: D1 – D4)



D1: DX=8.1km
D2: DX=2.7km
D3: DX=900m
D4: DX=300m
D5: DX=100m
D6: DX= 33m



"GM": Granite mountain

Weather Case Simulated

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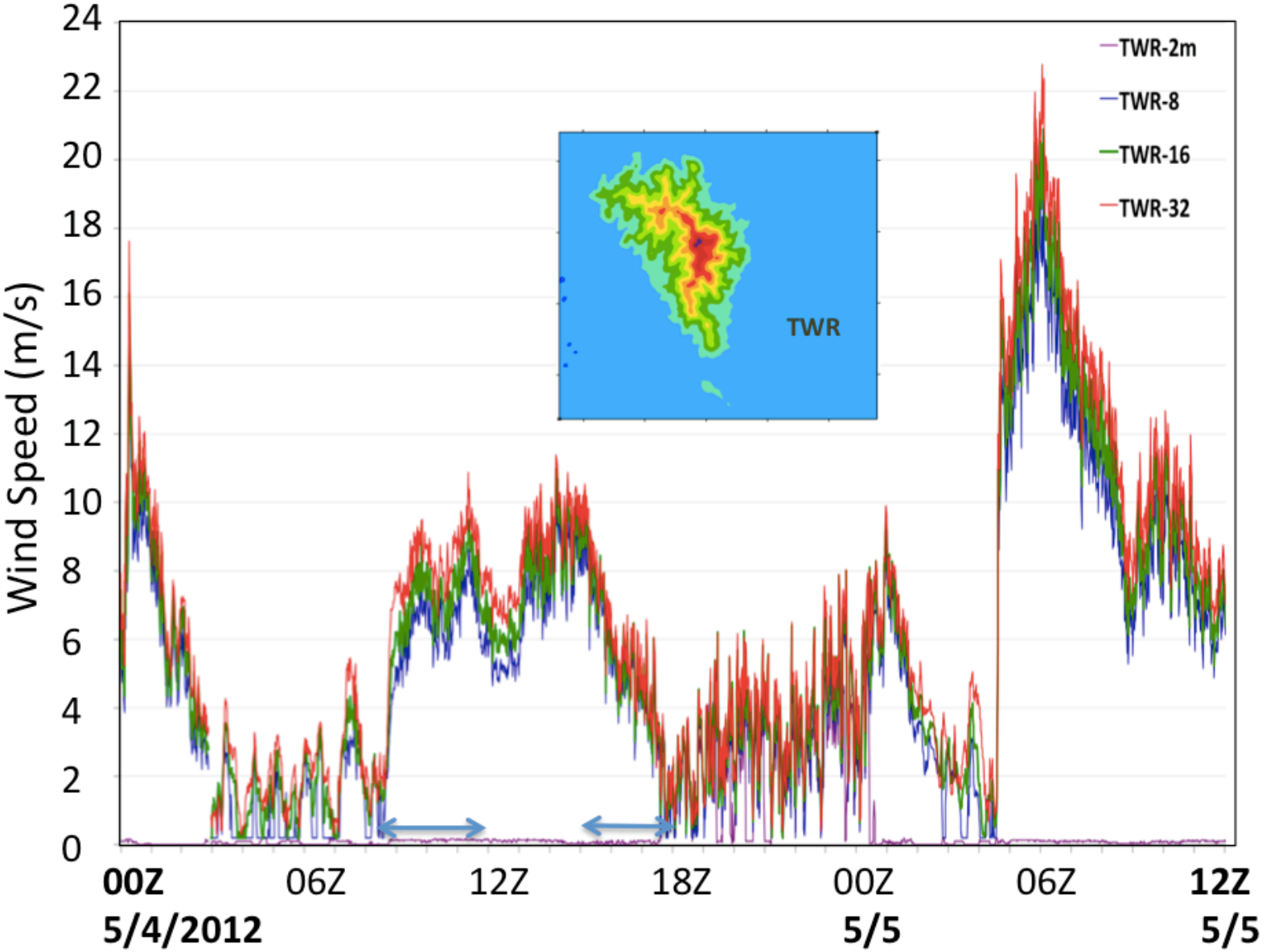

Nocturnal Stable Period

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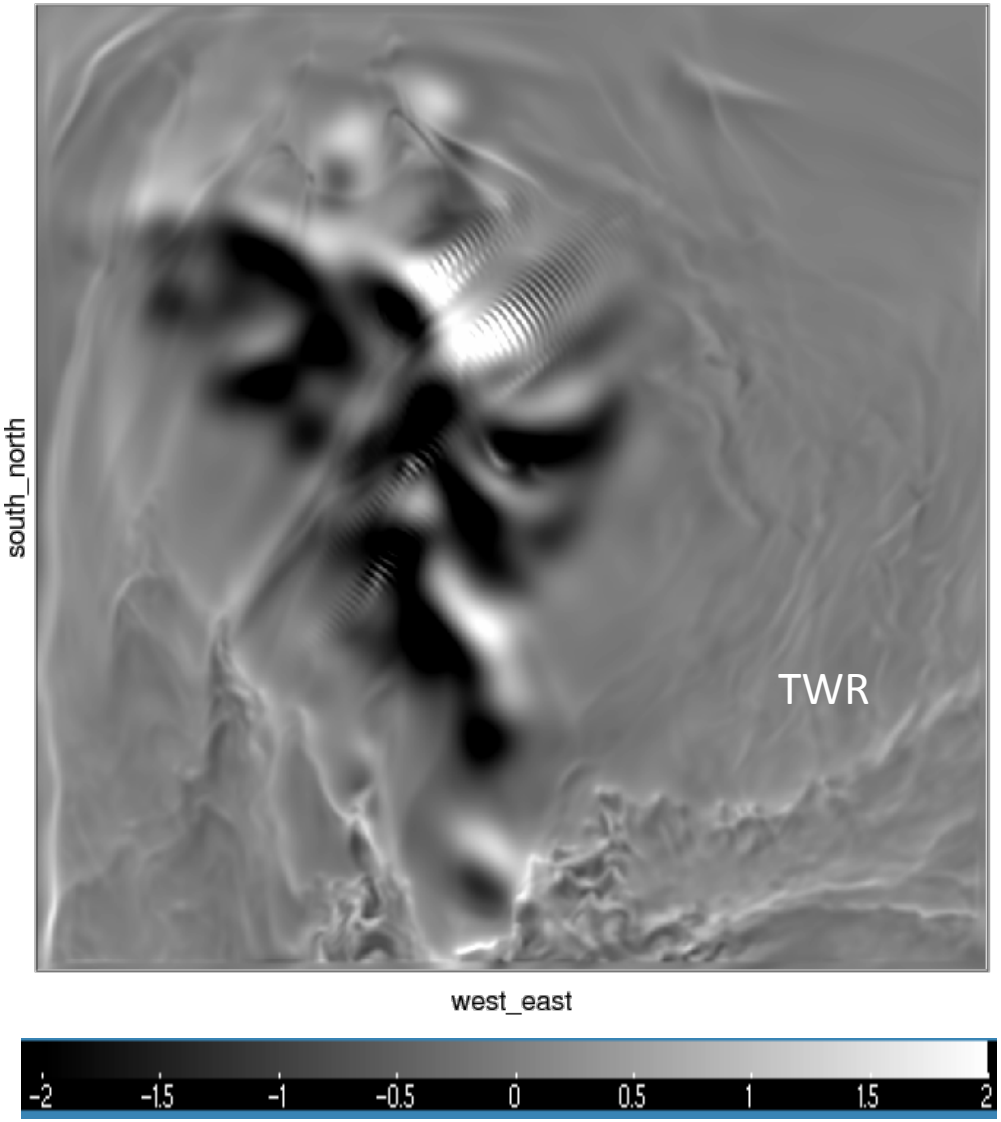
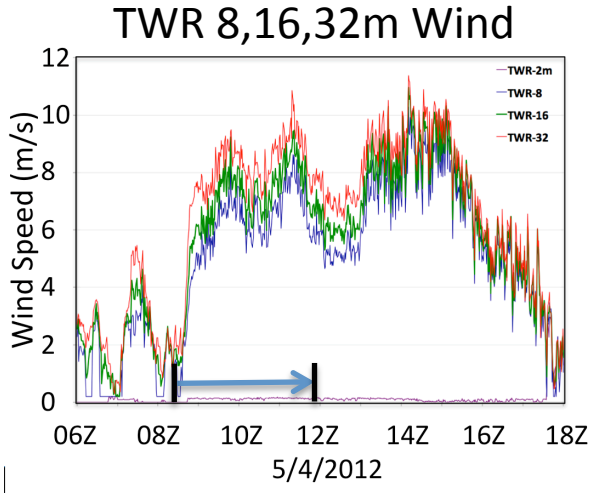
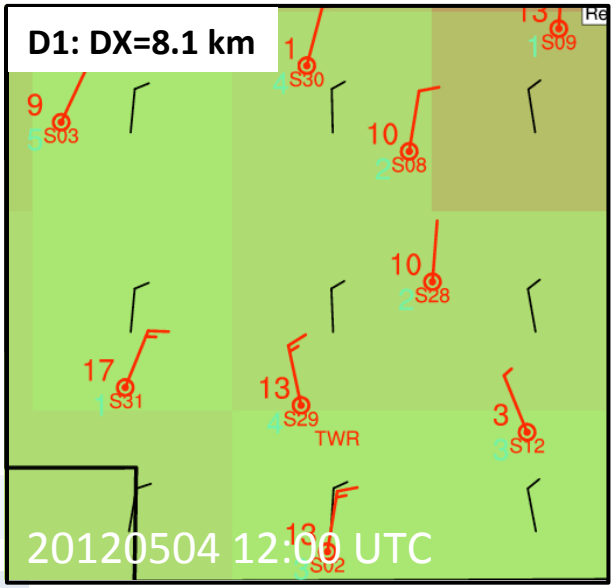


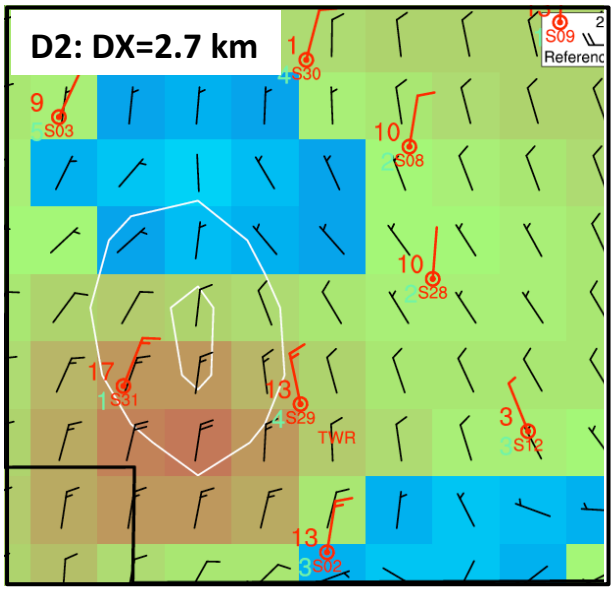
Dom 6 (DX=33m)
W (m/s)

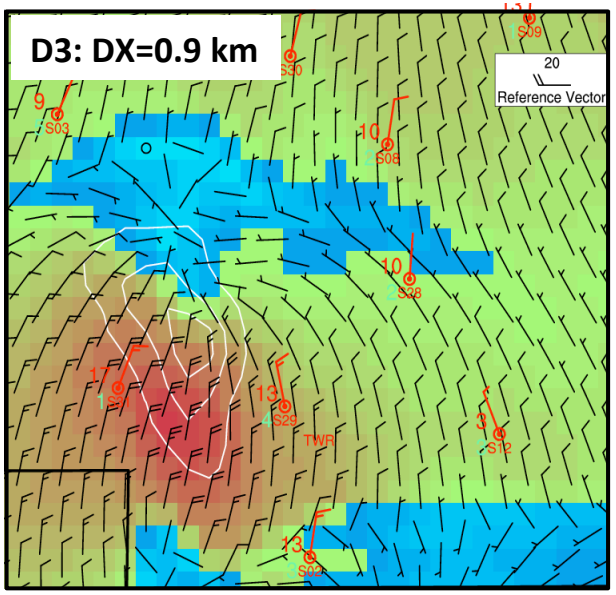
Animation from
08:20 – 11:50 UTC
4 May 2012;
Every 2 minutes

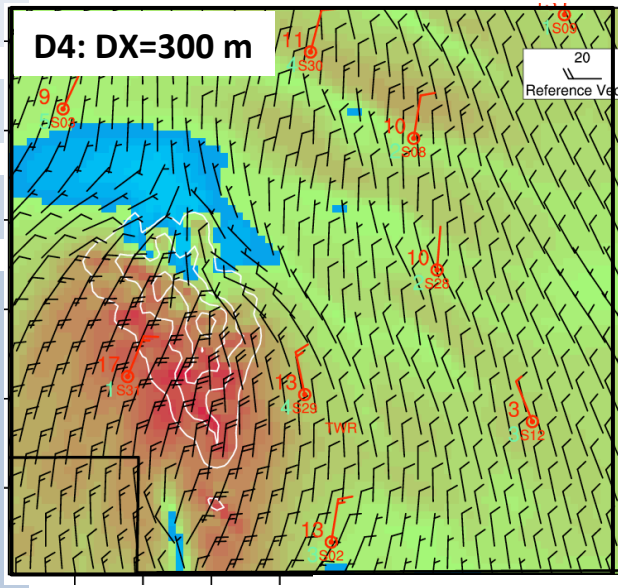


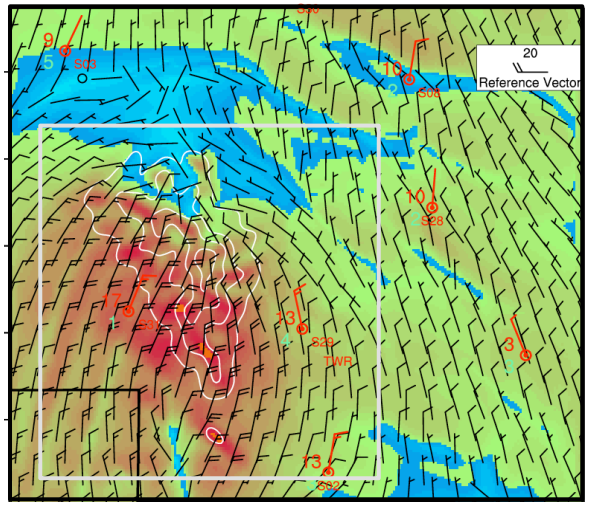
Comparison with range sfc wind obs

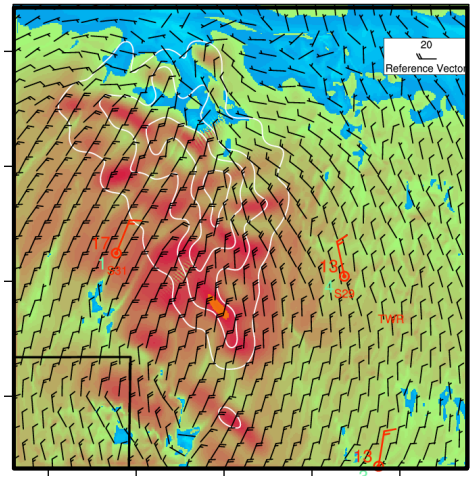












Morning Transition Period

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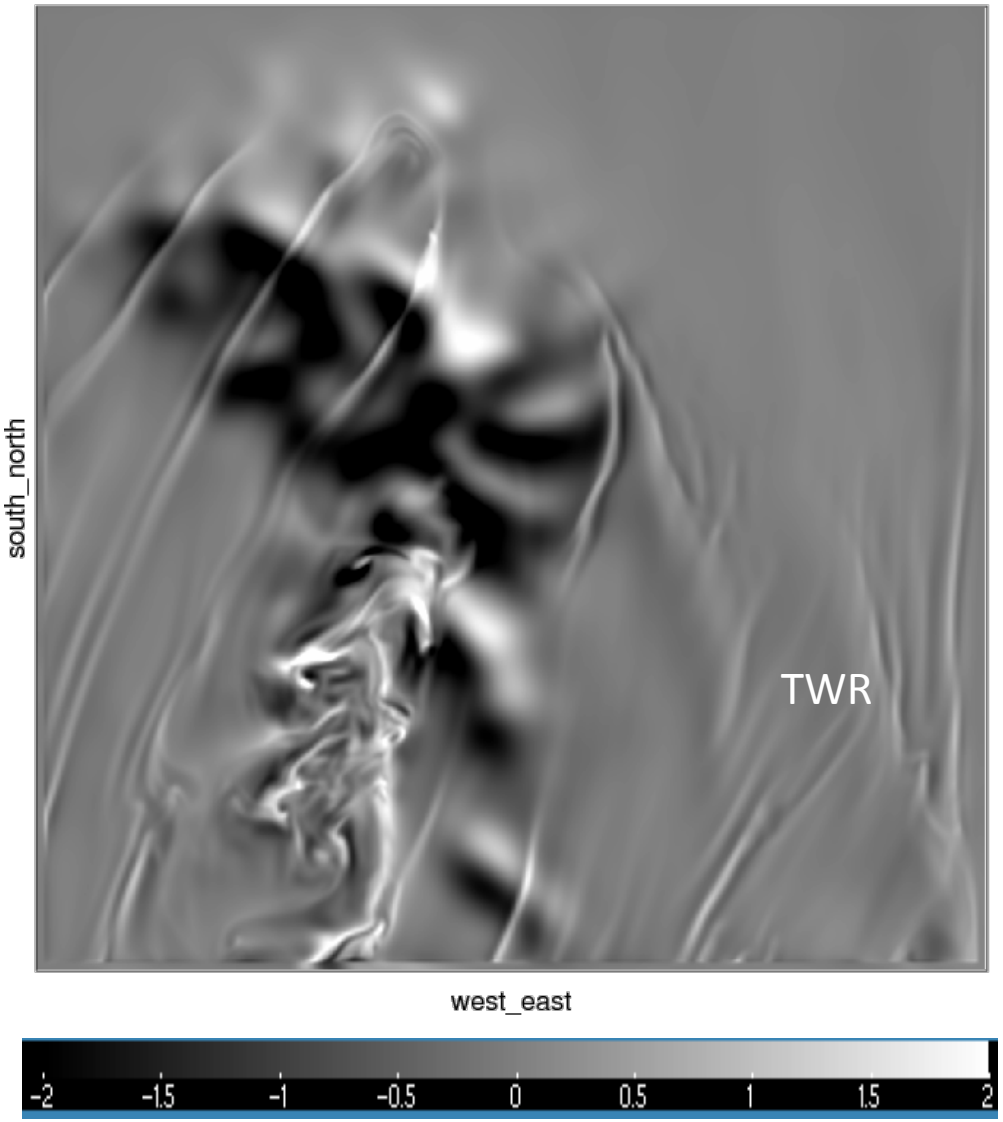
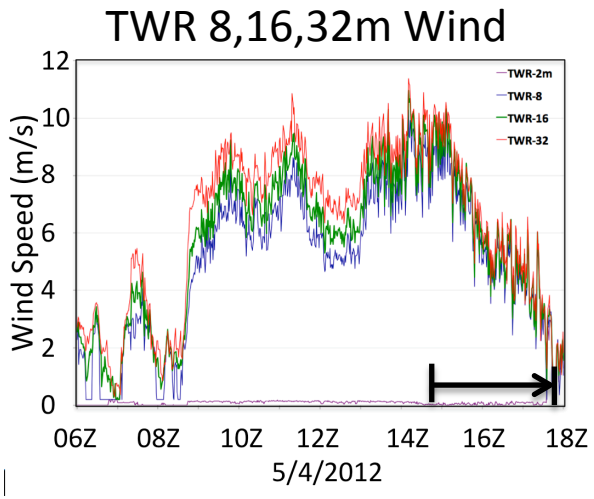


D6 (DX=33m)
W (m/s)

Animation from
14:50 – 17:50 UTC
4 May 2012;
Every 2 minutes



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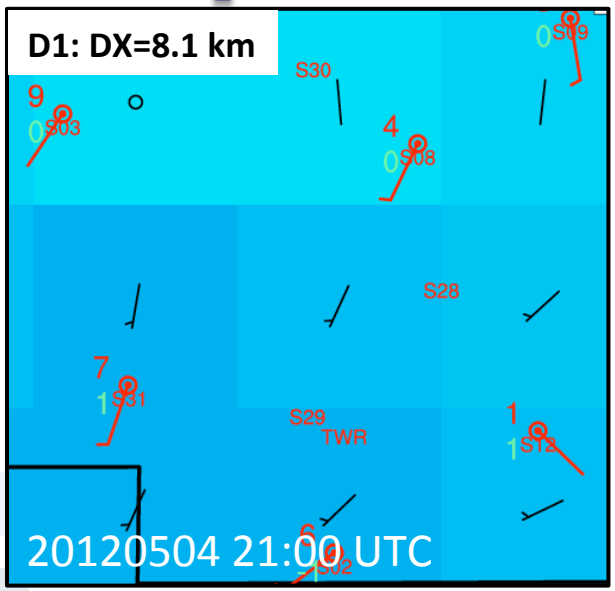

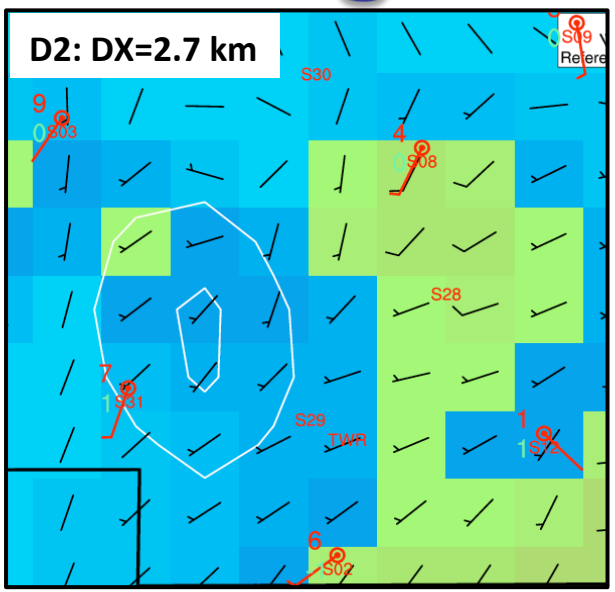

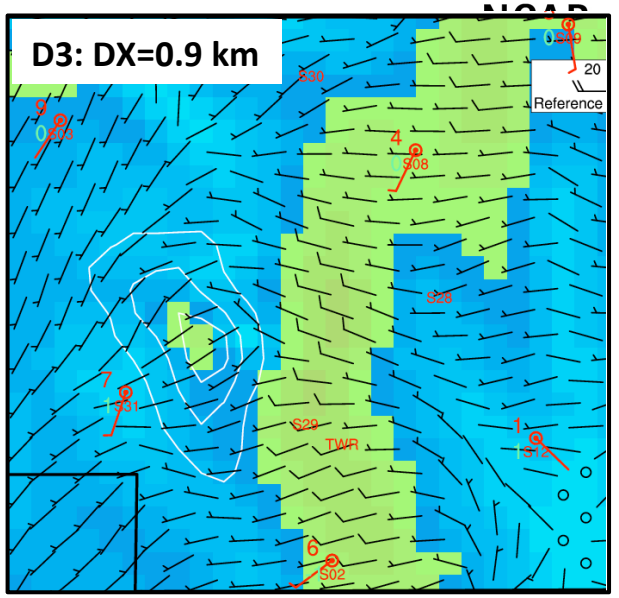

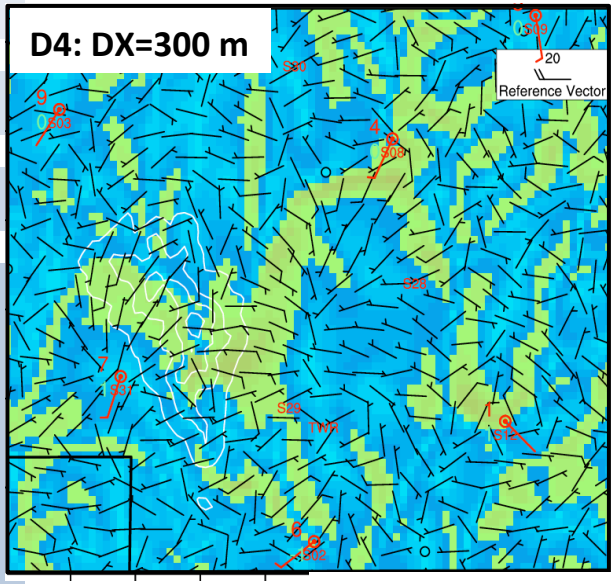

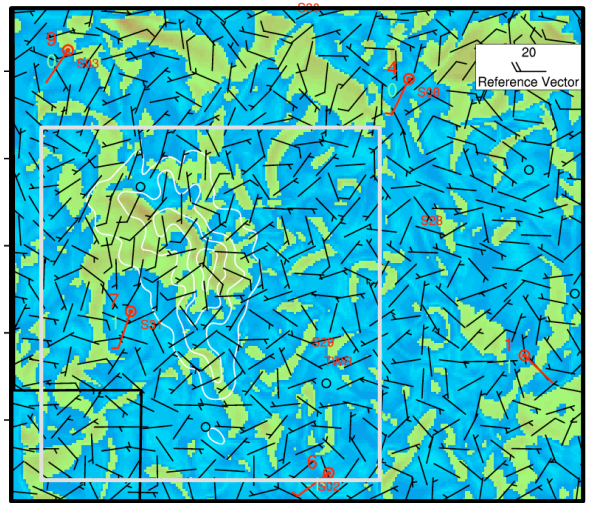

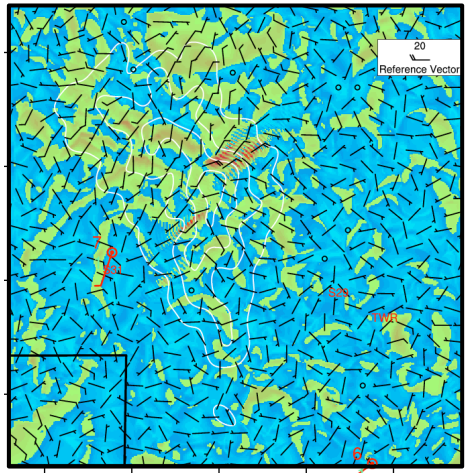

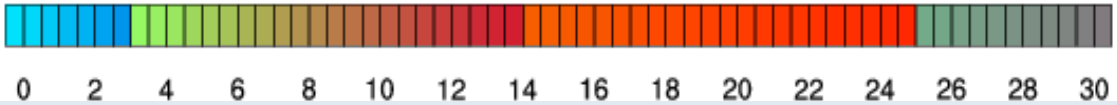

Comparison with 32m Tower Obs

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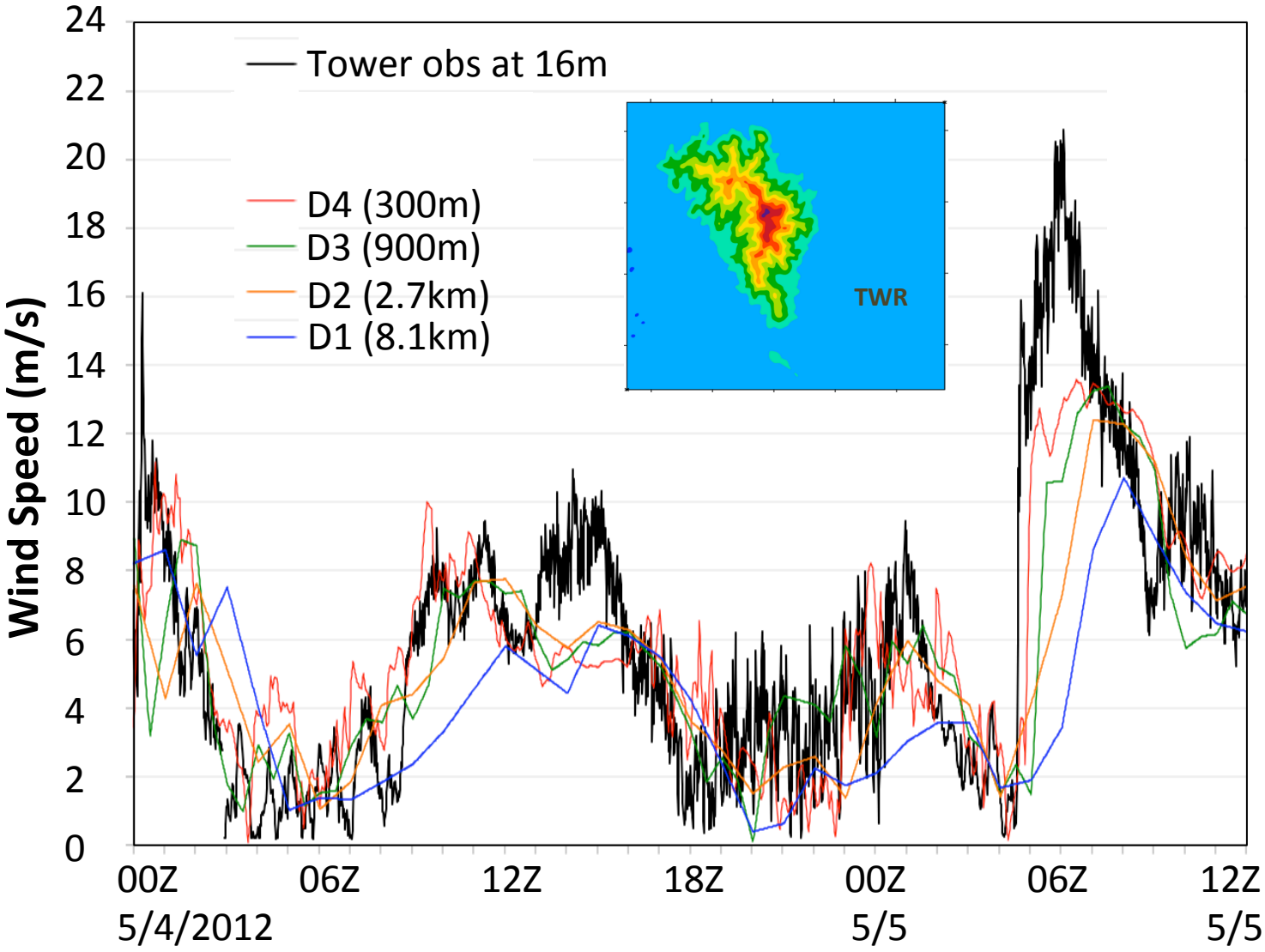

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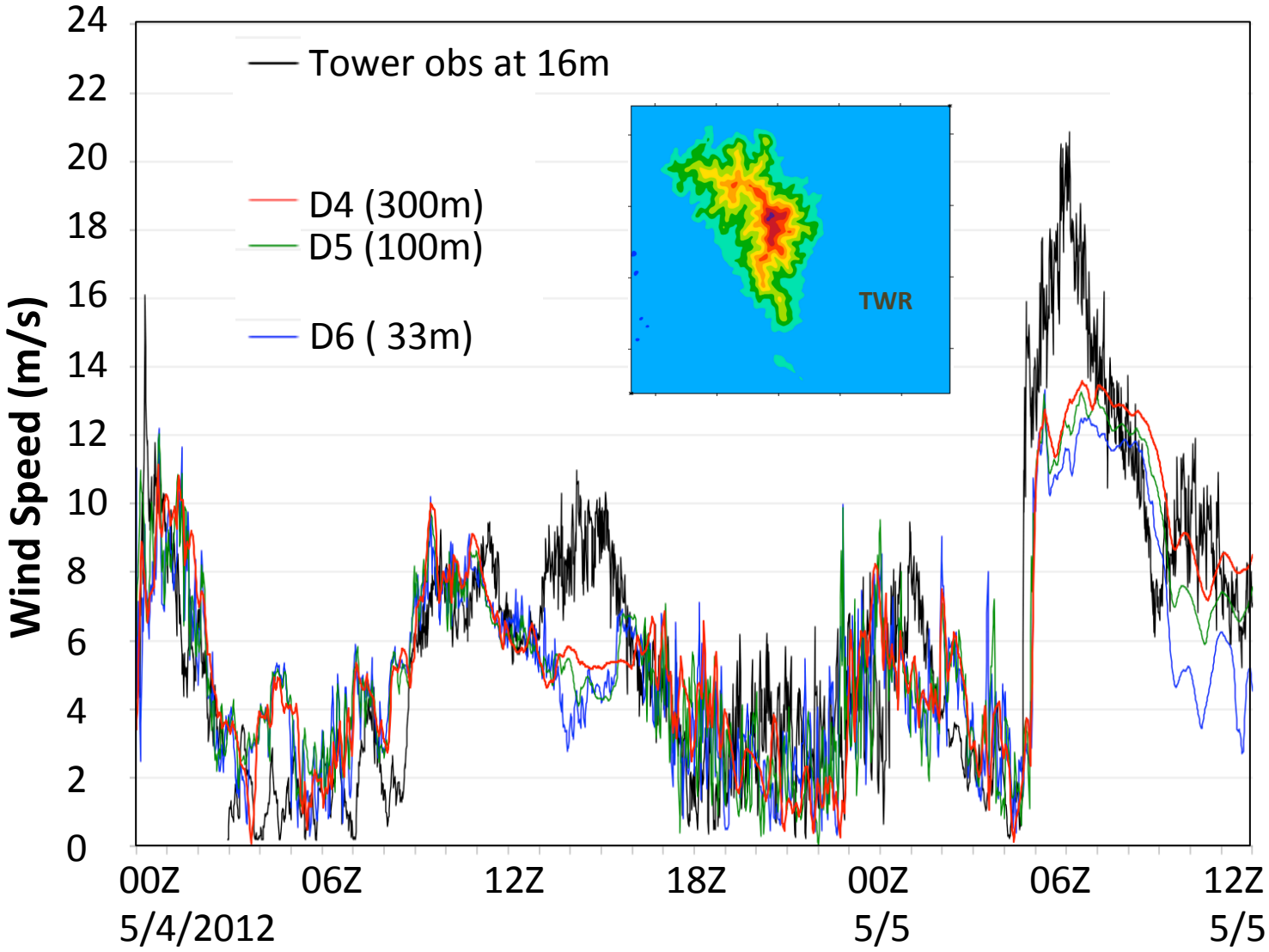
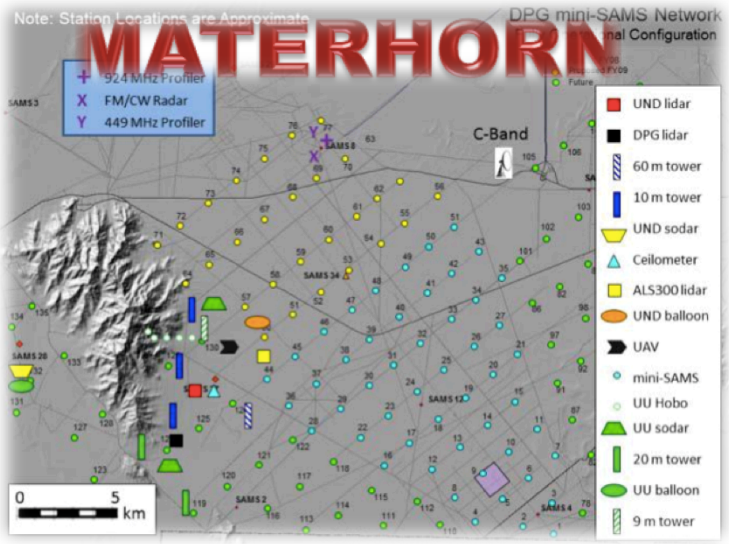


Summary

1. New advances in computing allow regional NWP downto VLES and LES scales.
2. NCAR has launched real-time WRF-RTFDDA-VLES system for US Army DPG, Utah.
3. VLES is proven valuable using LES simulation and verification through case study.
4. Many research works need to be done
   - How to verify
   - How to use
   - How to improve
   - DA on VLES grids



Thank you !