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

Yubao Liu, Yuewei Liu, Gregory Roux, Jason Knievel
National center for Atmospheric research

Dragan Zajic and John Pace
US Army Dugway proving ground

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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 provide 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**

- **WRF-LES**: A capability introduced since WRF 3.0
- **WRF-RTFDDA-LES**: Simultaneous nested-down simulation from synoptic scales ($DX \approx 10s \ km$) to VLES ($DX \approx 100s \ m$) and LES ($DX \approx 10s \ m$) 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
Experimental RT runs began in May 2012

~160x180km²
Two “Natural” Questions

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 $\Delta$ are of the same order)?
Validate VLES with LES

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

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Weather Case Simulated

Wind Speed (m/s)

00Z 06Z 12Z 18Z 00Z 12Z
5/4/2012 5/5 5/5

TWR-2m TWR-8 TWR-16 TWR-32

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Nocturnal Stable Period

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

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

TWR 8,16,32m Wind

Current Time: 250
Current bottom_top_stag: 2
Frame 1 in File wrfout_d06_2012-05-04_08:20:00
Comparison with range sfc wind obs

D1: DX=8.1 km

D2: DX=2.7 km

D3: DX=0.9 km

D4: DX=300 m

D5: DX=100 m

D6: DX=33 m

20120504 12:00 UTC

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

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

TWR 8,16,32m Wind
Comparison with 32m Tower Obs

Wind Speed (m/s)

D1 (8.1km)
D2 (2.7km)
D3 (900m)
D4 (300m)
Tower obs at 16m

Wind Speed (m/s)

00Z 06Z 12Z 18Z 00Z 06Z 12Z
5/4/2012 5/5 5/5

5/4/2012
Comparison with 32m Tower Obs

Wind Speed (m/s)

- Tower obs at 16m
- D4 (300m)
- D5 (100m)
- D6 (33m)

00Z 06Z 12Z 18Z 00Z 06Z 12Z
05/04/2012 05/05
Summary

1. New advances in computing allow regional NWP down to 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!