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

James Pinto, Matthias Steiner, Pedro Jimenez, Branko Kosovic, Domingo Munoz-Esparza, Anders Jensen, Tracy Hertneky and Arnaud Dumont
NCAR/RAL

Cory Dixon
Integrated Remote and In Situ Sensing (IRISS), University of Colorado – Boulder

Gijs de Boer
Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado - Boulder
Motivation/Goal

Outflow/gust front

Thunderstorm Hazards

NASA Concept for UTM

Turbulence & Organized PBL structures

500 ft

2000 ft

400 ft

~ 200 ft

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

Next Day Fcst
- GFS 12Z
- WRF D01 18Z 04Z
- WRF D02 (avail. by 4pm LT) 10Z 22Z

Day of Fcst
- HRRR
- WRF D02 (avail. by 4am LT)
- WRF D01
Clear Sky/Weakly Forced Drainage Flows

Hindcast: 5 July 2018
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

REAL-TIME WRF

Wind Speed (m/s)
Temperature (°C)

Cross-Section: (395,450) to (395,799)

Height (km)

Latitude (degN)

Temperature Contours: 8 to 18 by 2

04V: Saguache Municipal Airport

Wind Speed (m/s)

0 1 2 3 4 5 6 7 8 9 10
Evaluation of WRF LES Sensitivity to Spin-Up Period

0h Spin Up Run

AWOS OBS @ 04V

WRF LES

6h Spin Up Run

WRF LES Wspd: 10 60 120 240 m

NCAR
NATIONAL CENTER FOR ATOMIC RESEARCH
Lull in strength of drainage flow was caused by spurious wave that propagates off Sangre De Cristos
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 (~5\(\Delta x = 500\) m) eddies.
Impacts Translation Modeling

UAS
Vertical Acceleration Response

\[ \ddot{z}(t) \]

Assumes subgrid turbulence is isotropic.
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.
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
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)

Accumulated Precip (mm) through 21:00 UTC

19:20-20:50 UTC

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