



Update on Army Research Lab's Efforts to Establish a Meteorological Sensor Array at White Sands Missile Range

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and Ben MacCall

OFCM Session

21st Annual GMU Conference on AT&D Modeling

13 June 2017

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Outline

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Business/Laboratory Overview

Meteorological Sensor Array Progress

Field Campaigns

Other Research of Community Interest



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Mission

DISCOVER, INNOVATE, and TRANSITION Science and Technology to ensure dominant strategic land power



Making today's Army and the next Army obsolete

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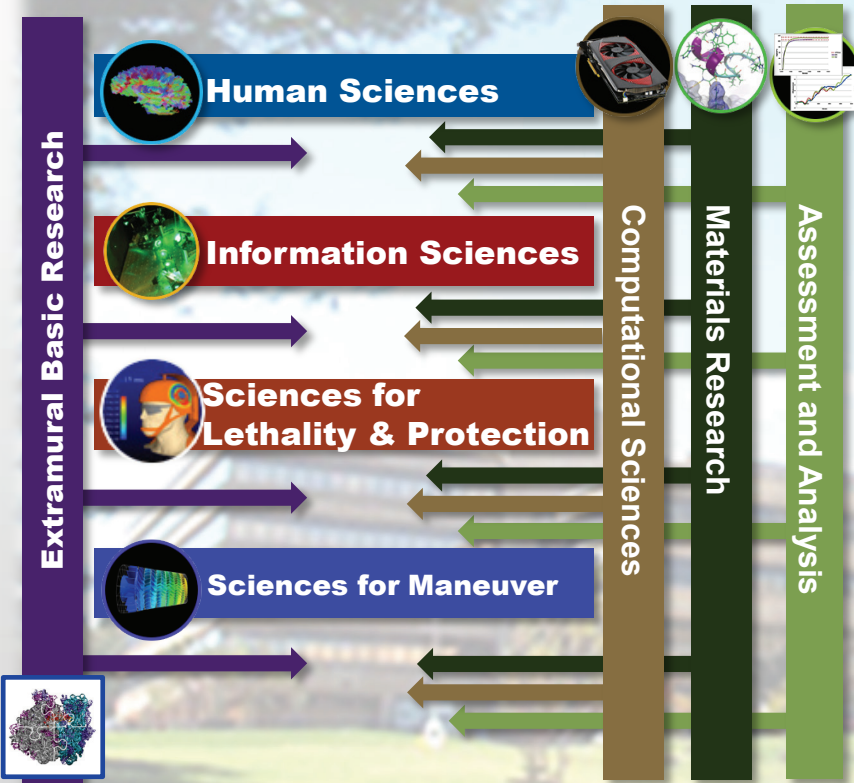


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S&T Campaign Plans



Open Campus Business Model



<http://www.arl.army.mil/publications>



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ARL's New Research Centers

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Adelphi, MD

- Cyber Research Center (CRC)
- Center for Extreme Batteries (CREB)
- Center for Semiconductor Materials and Device Modeling (CSDM)
- Intelligent Systems Center (ISC)
- Network Science Research Center (NSRC)
- Semiconductor Research Nanofab Center (SRNC)



**Cyber
Research
Center (CRC)**

**Center for Agile
Materials Manufacturing
Science (CAMMS)**

**Center for Semiconductor
Materials and Device
Modeling (CSDM)**

**Center for Research
in Extreme Batteries
(CREB)**

**Semiconductor
Research Nanofab
Center (SRNC)**

**Network Science
Research Laboratory
(NSRL)**

Aberdeen Proving Ground, MD

- Center for Agile Materials Manufacturing Science (CAMMS)
- Center for Adaptive Soldier Technologies (CAST)
- Novel Energetics Research Center (NERC)
- Center for Human Injury and Performance (CHIP)

Orlando, FL

- Center for Adaptive Instructional Sciences

EL Paso, TX

- Center for Cyber Analysis and Assessment

White Sands Missile Range, NM

- Atmospheric Sciences Center (ASC)



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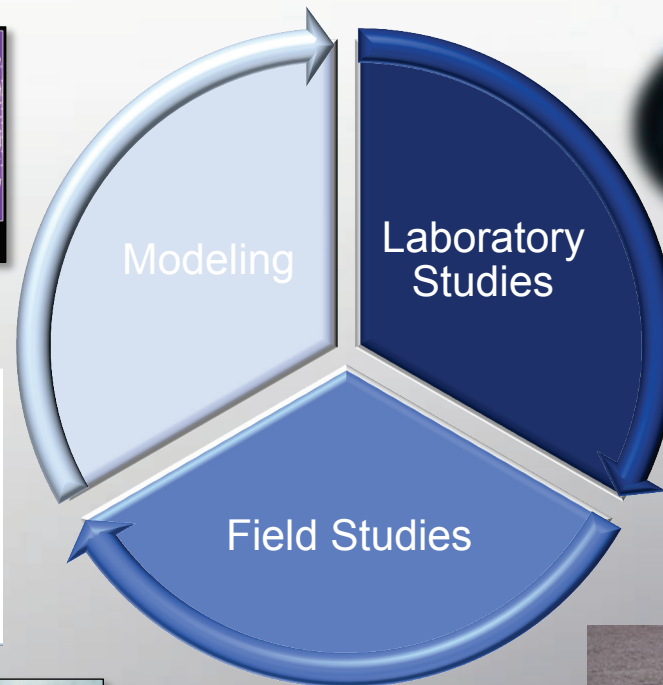
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Atmospheric Science Center

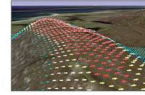
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Bring together government, industry, and academia to advance atmospheric science and its application to critical defense technologies through a collaborative, innovative research ecosystem.

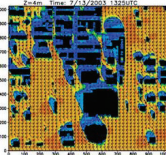


Askervine Hill (10m AGLwind)

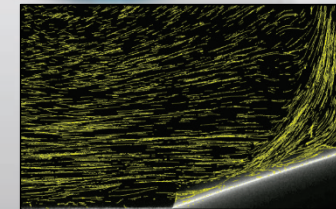
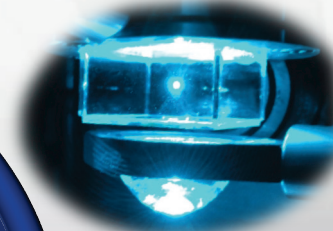
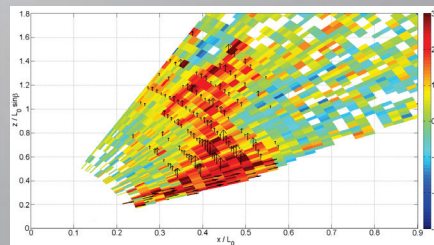
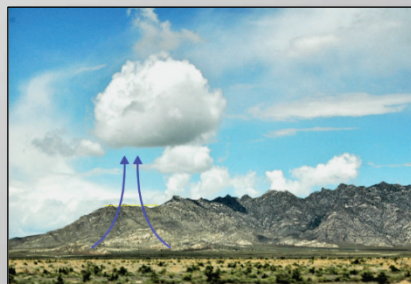
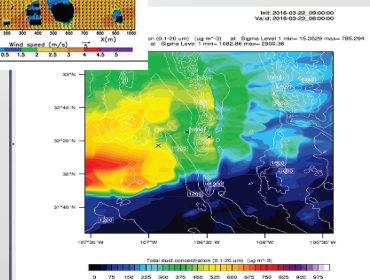
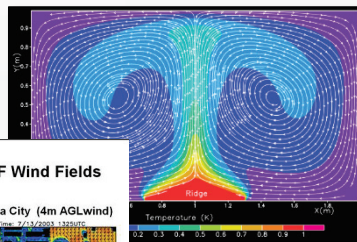
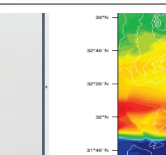


3DWF Wind Fields

Oklahoma City (4m AGLwind)



Kabul (20m AGLwind)



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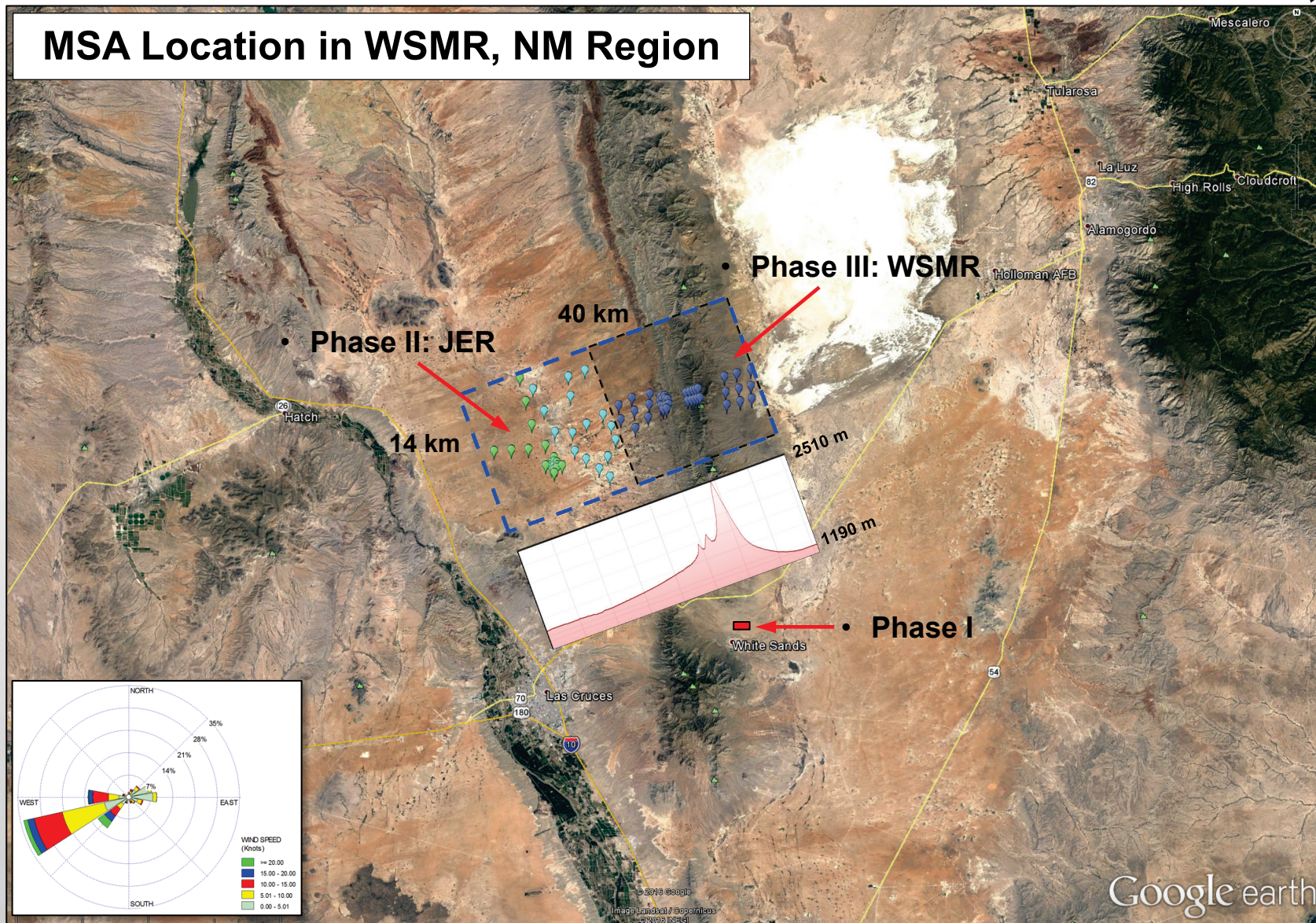
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MSA Update: New Location

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MSA Location in WSMR, NM Region



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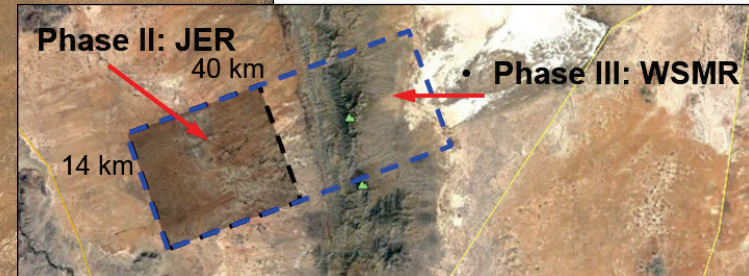
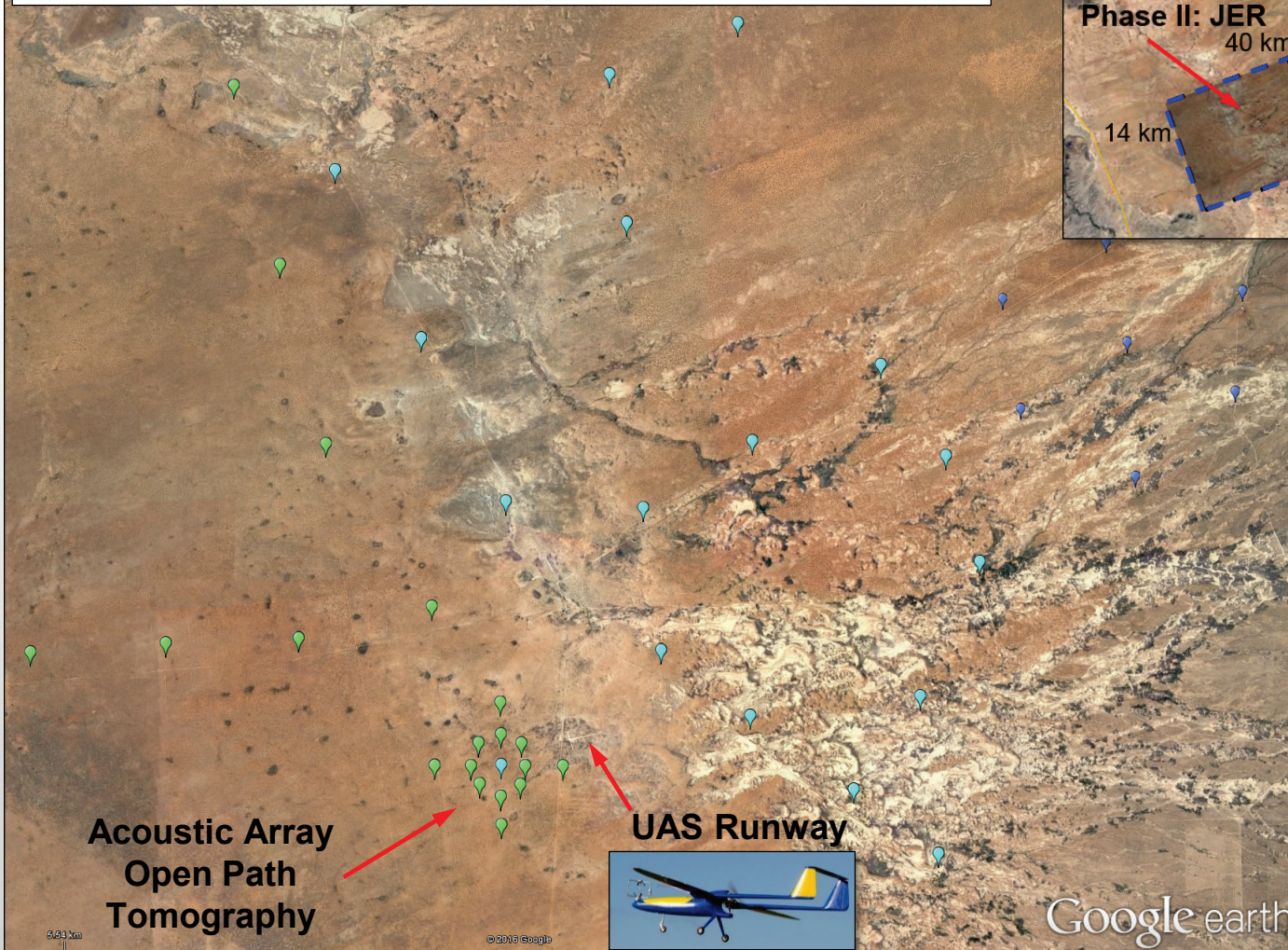
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MSA Update: Tower Installation

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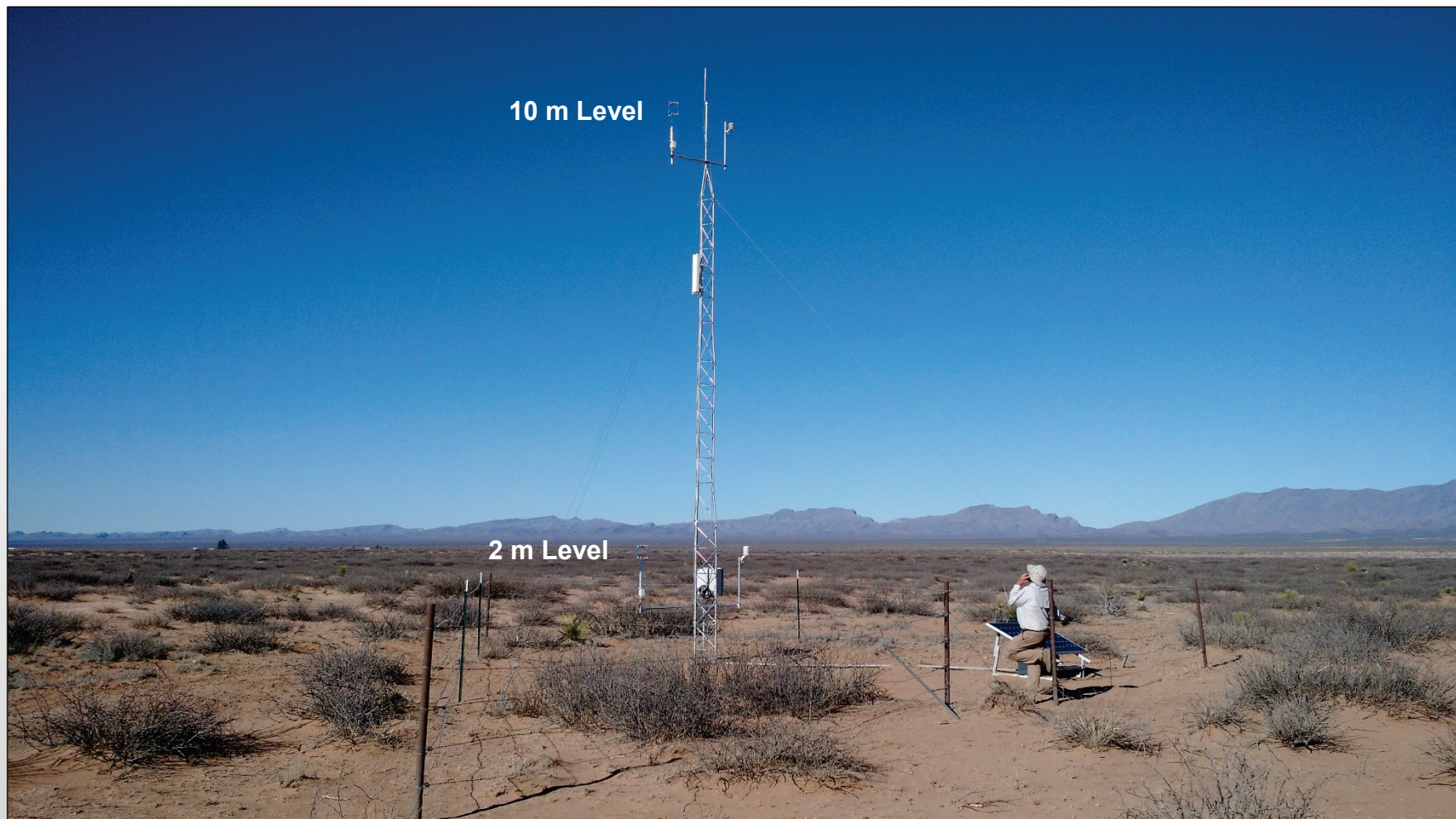
Phase II: Jornada Experimental Range (JER) (USDA/NMSU)



1st tower installed
1 Dec 2016

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MSA Update Instrumentation

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2 m Level: U, WD, T, RH, p
10 m Level: U, WD, T

Soil moisture probes at 5, 10, 25 and 50 cm,
rain gauge, pyranometer.



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MSA: Process Studies

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Phase III: JER / WSMR - San Andres Peak: 2510 m / 8235 ft

Microscale

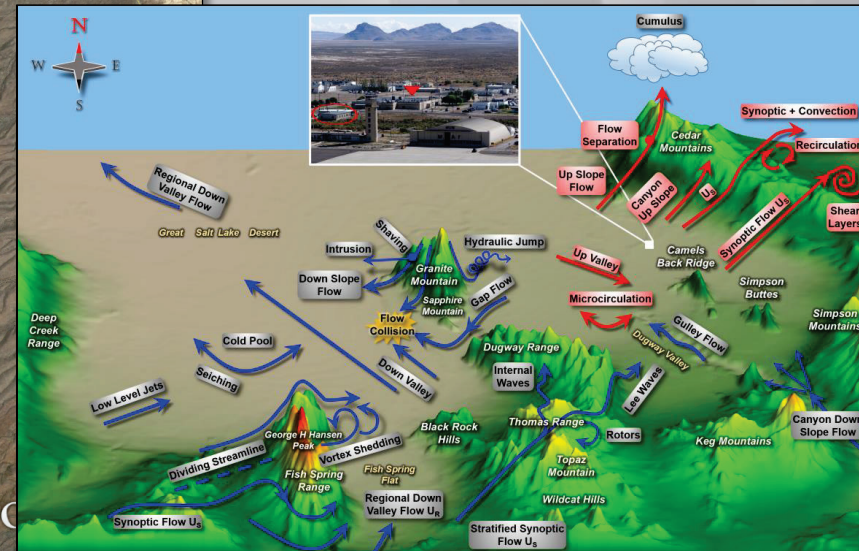
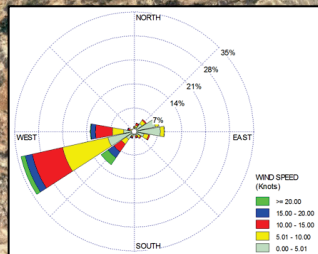
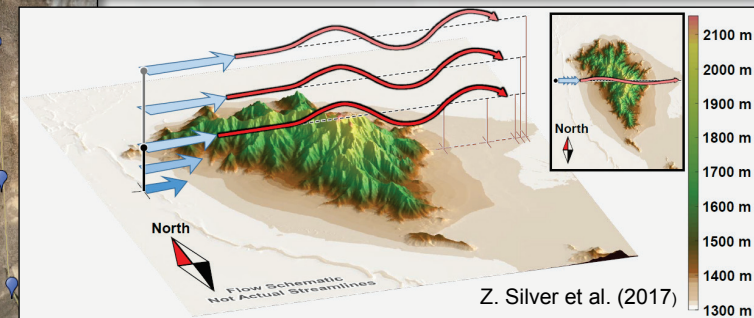


Phase II: JER

40 km

14 km

Phase III: WSMR





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- **Dust Transport Study**
- **Perdigão**

Other Research of Community Interest



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Field Campaign: Dust Transport Study

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National Wind Erosion Research Network

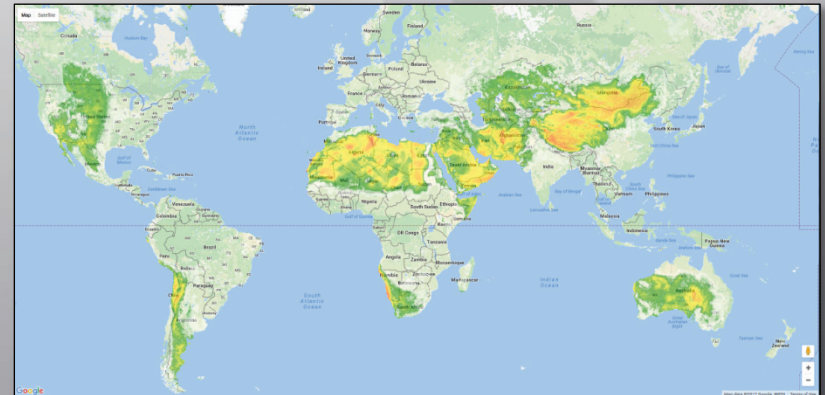
USDA-ARS Jornada Experimental Range

- Coordinating multi-partner National Wind Erosion Research Network.
- Basic and applied research into wind erosion and dust emission processes.
- Data assimilation for national and global modeling.
- 80,000 ha research facility with dedicated long-term ecological and dust monitoring.
- Jornada collaboration with ARL supporting data and knowledge sharing.



Jornada's National Wind Erosion Research Network Site

Horizontal sediment mass flux (2000 – 2014). Estimate produced using MODIS albedo-driven dust emission scheme with GLDAS. 500 m, 3 hr estimates. Model calibrated using Network data.



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Conservancy





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Field Campaign: Dust Transport Study

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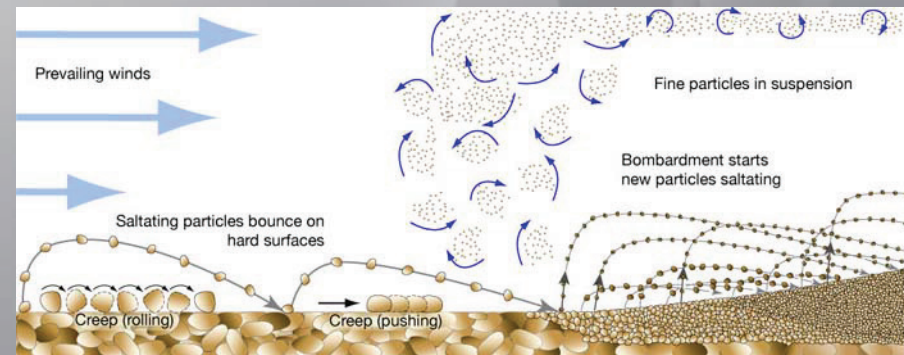


Dust Transport / Dust Characterization

Partnered with NRL to deploy an extensive network of rain gauges and soil moisture sensors throughout the JER MSA that supplement the USDA-ARS instruments to attain detailed spatial soil moisture measurements

Objectives:

- Improve the quantification of soil moisture in desert regions – soil moisture is critical for several important processes
 - Surface heat flux parameterizations for meso / microscale atmospheric models
 - Dust transport
- Investigate the effects of topography on satellite soil-moisture retrieval, satellite algorithm validation
- Determine the correlation between soil moisture variability and spatial aerosol concentration



http://www4.uwsp.edu/geo/faculty/lemke/geomorphology/lectures/11_aeolian.html

Collaborators: NMSU, USDA, NRL, UND



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WRF-Chem Dust Simulations

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Domain Configuration

- ARL is running daily WRF-Chem dust simulations
- Dust emitted based on friction velocity (u_*), land surface roughness length, and soil moisture
- 3-h atmospheric data assimilation followed by 24-h forecast
- Nested domains with 9-, 3-, and 1-km horizontal grid spacing
- Forecast WRF-Chem dust fields from one day used to initialize WRF-Chem dust fields for the next day's simulation (cycling)





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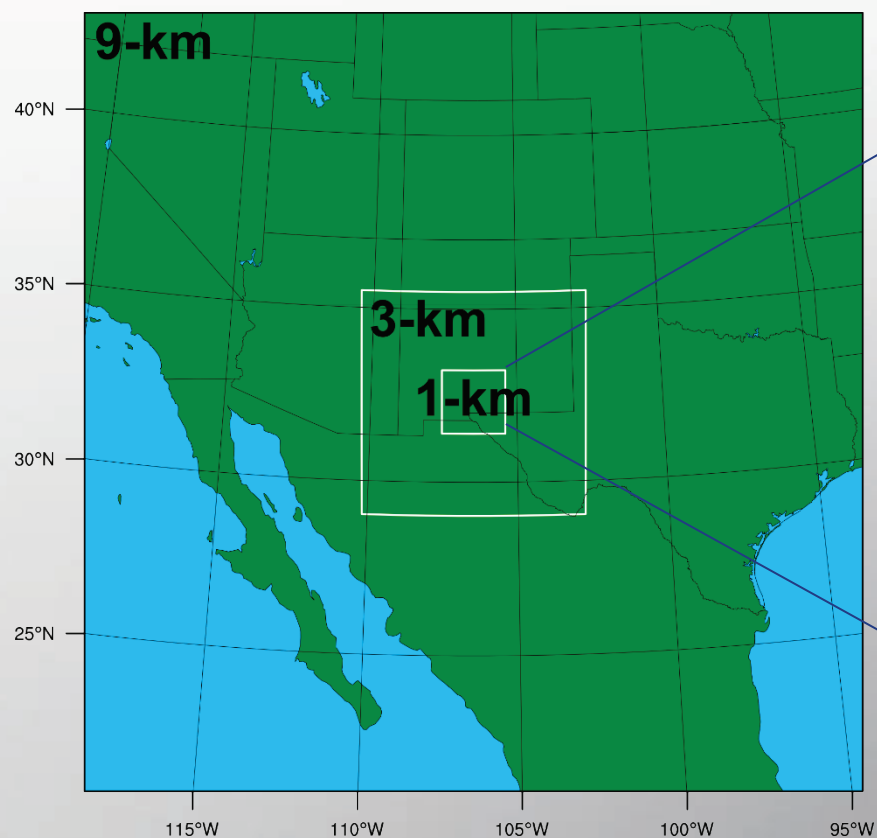
WRF-Chem Dust Simulations

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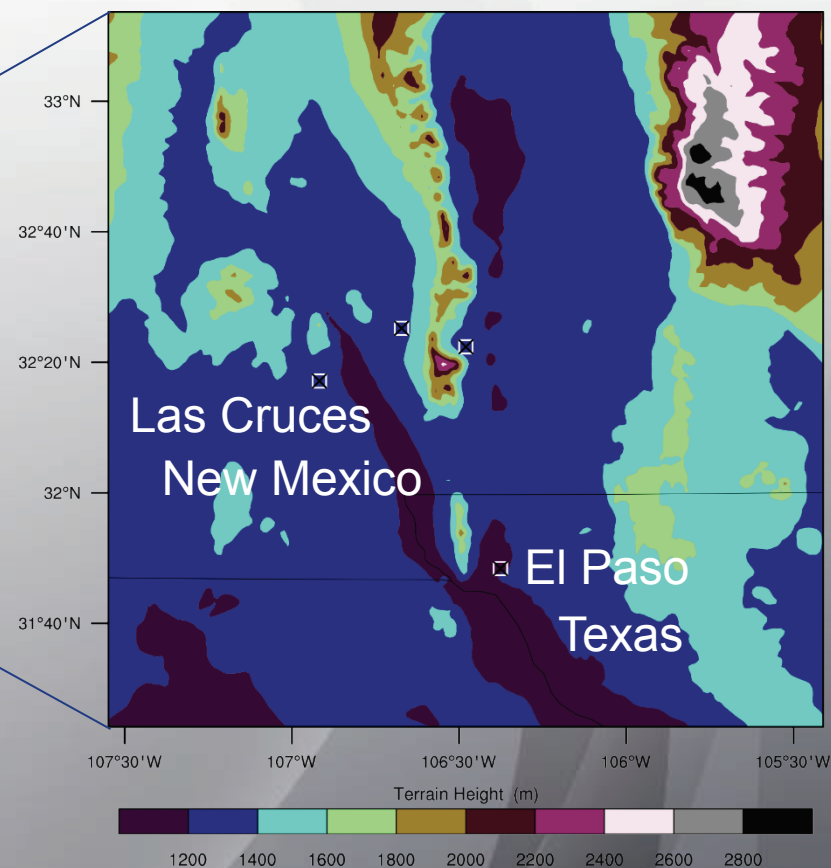


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Domain Configuration



Terrain Height on 1-km Horizontal Grid Spacing Domains



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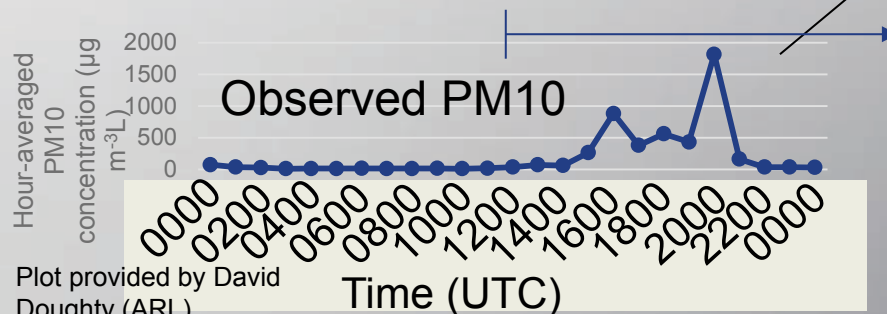
WRF-Chem Dust Simulations

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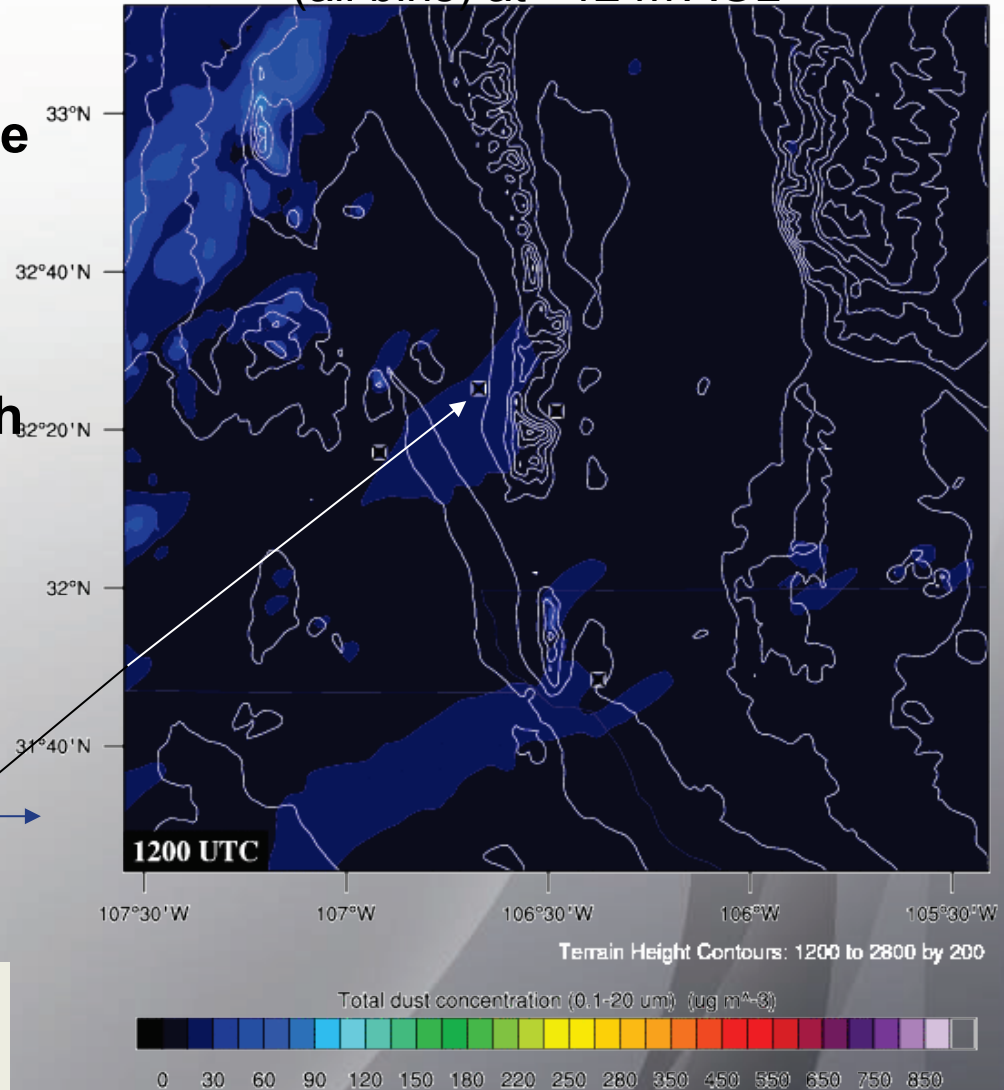


Sample Case: 17 December 2016

- Southwest-Northeast oriented line of convection moves southeast through the domain
- Model dust peaks at ~ 875 micrograms / m^3
- Model and observations both indicate strong winds
 - Model sustained winds peak at 73 MPH
 - Observed gusts peak at 110 MPH



WRF-Chem 1-km Forecast of Total Dust (all bins) at ~ 12 m AGL





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Model vs. Observed Dust: 1600 UTC

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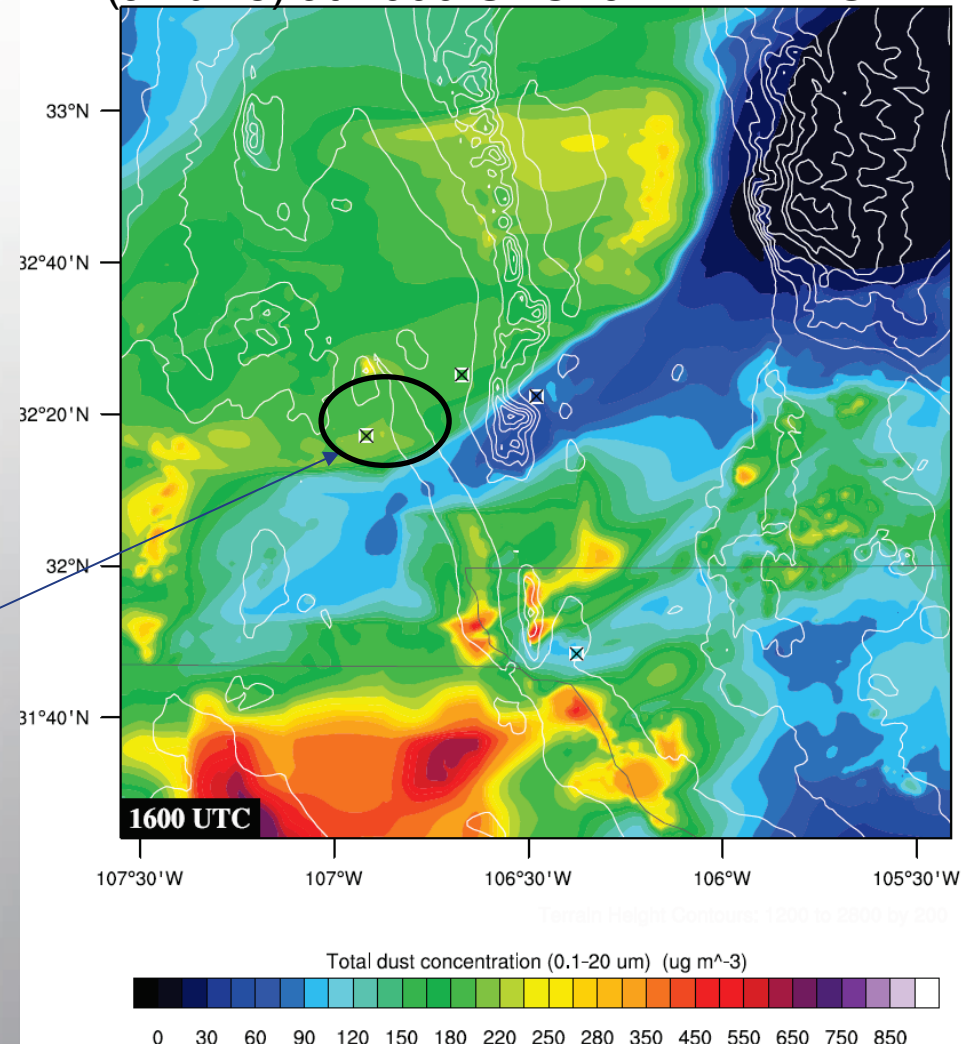
At 1600 UTC, WRF-Chem forecasted high dust concentrations in Las Cruces, NM, and a photograph taken here confirms visibility is obstructed at this time

Observation: Photograph at 1600 UTC in Las Cruces



From NM State Climatologist Twitter

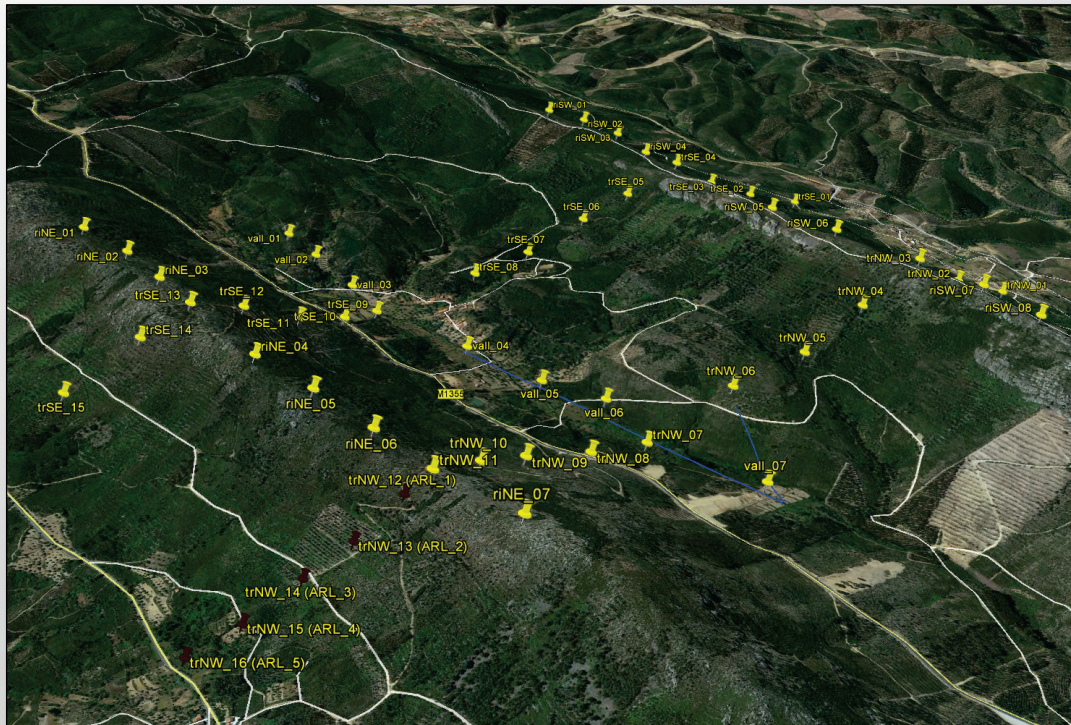
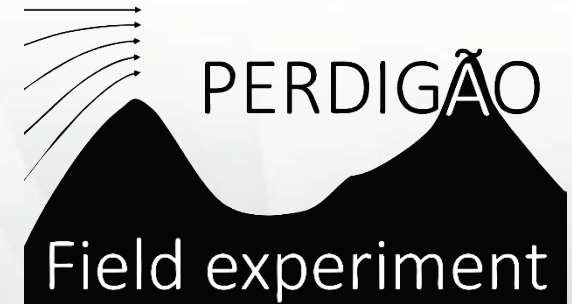
WRF-Chem 1-km Forecast of Total Dust (all bins) at 1600 UTC for ~12 m AGL



Perdigão, Portugal: 1 May – 15 June 2017

Collaborators: EU - DTU, Porto U., Inegi, DLR
US - UND, NCAR, CU, Cornell, U.C. Berkley,
Boise State, NOAA

Designed to study fundamental atmospheric dynamics in complex terrain with applications to wind energy harvesting, alpine warfare, air pollution in urban basins, aviation and firefighting.





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Field Campaign: Perdigão

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Dr. Ragu Krishnamurthy, UND



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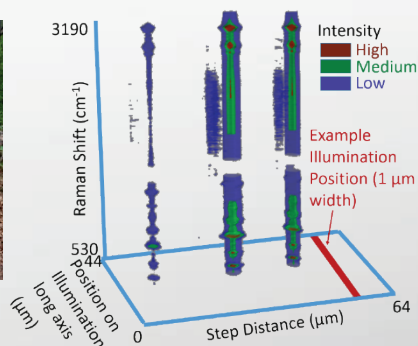
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Aerosol Characterization: Raman Spectroscopy

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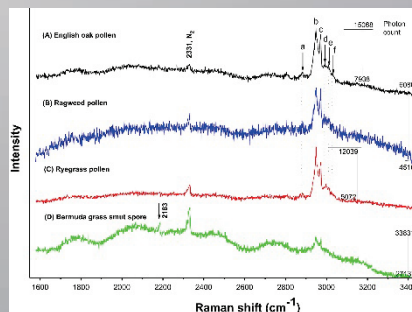
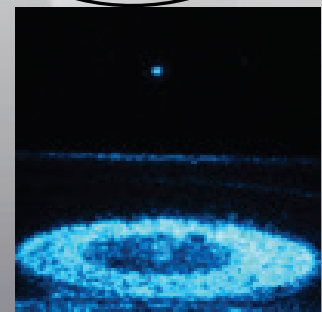
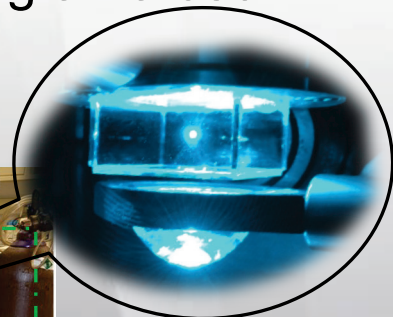
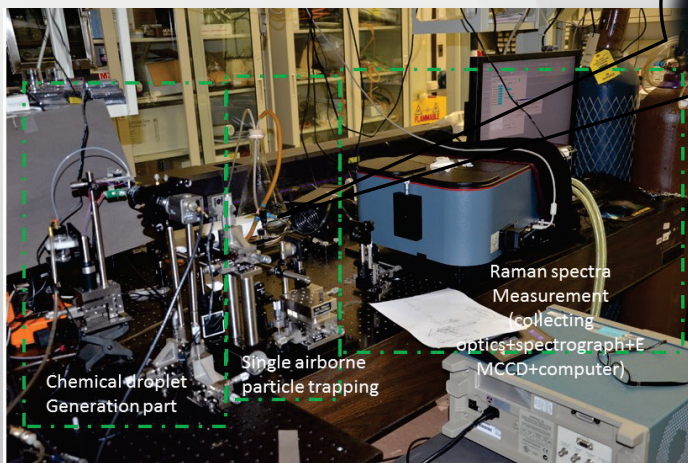
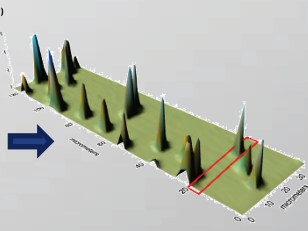
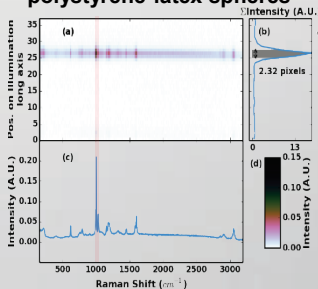


- Automated Aerosol Raman Spectrometer – Optical Characterization of Atmospheric Background Aerosol Particles using Raman Scattering
- Optical Trap Raman Spectrometer – Raman Spectra of Single Aerosol Particles Optically Trapped in Air: Laboratory Studies

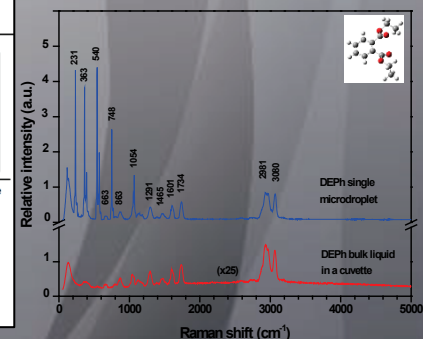


Example of one line-scanned image for 2 micron polystyrene latex spheres

Summed up scans over one 15 minute collection period



Material Type	Particle Shape	
	Spherical	Spatially Irregular
Non-Absorbing	Glass Bead 500 μm	Albumin (bovine) 500 μm
Fluorescent Polymer Sphere		
Absorbing		Johnson Grass Smut Spore 500 μm





Acknowledgements

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- Aerosol Research
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 - Dr. Chris Hocut
 - Dr. Yansen Wang
 - Mr. Robert Brice
 - Mr. Ed Creegan
 - Mr. Sean D'Arcy
 - Mr. Jeff Swanson
- ARL Atmospheric Science Center
 - Dr. Ben MacCall – ASC-Lead
 - Dr. Jeffrey Smith
 - Dr. Robb Randall* (Former Lead, now Senior Climate Scientist at USAF 14th Weather Squadron)



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Questions?

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