Use of the Granite Mountain Atmospheric Sciences Testbed for Meteorological Project Support

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Meteorology Division
Dugway Proving Ground

An ATEC operated proving ground with installation operations managed by IMCOM.

Dugway's Meteorology Division

Core Mission Areas

- Operational Support (Weather, Dispersion Modeling) for testing at Dugway Proving Ground
- Meteorological and Dispersion R&D
- Manager for ATEC's Operational Meteorology Program
- Support to Night Vision testing at Ft A.P. Hill, Virginia (transmission, scattering, scintillation)

Dugway's Meteorology Division

Core Mission Areas

—Operational Support for testing at Dugway

- Weather and dispersion modeling support for chem/bio tests
- Weather support for unmanned aircraft missions
- Management of tests related to meteorology (MATERHORN) or transport & dispersion (Jack Rabbit 1 & 2)

Granite Mountain Atmospheric Sciences Testbed (GMAST)

- Established by Met Division in 2009 to meet DPG needs for improved capability for forecasting over mountains on DPG
  - Also study boundary-layer meteorology across entire range
- *GMAST Concept: Improve operations through customer-funded R&D projects*
- Combine long-term data collection with intensive observation periods (IOPs)
- Visiting scientists augment the Dugway data baseline
  - Bring additional equipment, personnel
  - Use Dugway data collection system when possible
- Opportunity to conduct repeated studies, comparing results with other scientists working in the same domain
  - In time, become a standard model evaluation reference

Dugway's Meteorology Division

Core Mission Areas

- Meteorological and Dispersion R&D
  - Lead DPG division for many dispersion tests (DHS, DTRA)
  - R&D in air flow over urban areas, mountains
  - R&D in numerical weather prediction
  - R&D in sensor data fusion
  - R&D in boundary layer meteorology

  - Developed, maintain servers and web sites for DTRA & DHS programs

  - Collaboration with Utah Division of Air Quality, Army Research Lab

  - Former lead and participant on Technical Panel 9 of TTCP

Recent Field Studies

DOE Vertical Transport and Mixing eXperiment (VTMX) (2000) – Salt Lake City

DTRA Mock Urban Setting Test (MUST) (2001) – DPG

DTRA Urban Modeling Program – Joint Urban 2003 in Oklahoma City

DARPA Pentagon Shield (2004) – Pentagon

DHS Urban Dispersion Studies (2005) – Manhattan

Forest Service Long Range Drift Program (2006) – DPG

JSTO Sensor Data Fusion Program – Fusion Field Trial (2007) – DPG

Complex Terrain testbed (GMAST) (2009 →) – DPG

DHS Jack Rabbit chlorine/ammonia tests (2010) – DPG

DoD SERDP Dust Devil (2012) – DPG

Precision Airdrop Wind Sensing (PAWS Demo) I and II (2012-13) – DPG

Complex Terrain Field Studies (MATERHORN) (2012-13) – DPG

Gunship Wind Sensing (PAWS Demo III) (2014) – DPG

Precision Airdrop Tracer (2015) – DPG

DHS Jack Rabbit 2 chlorine tests (2015-16) – DPG

MATERHORN project

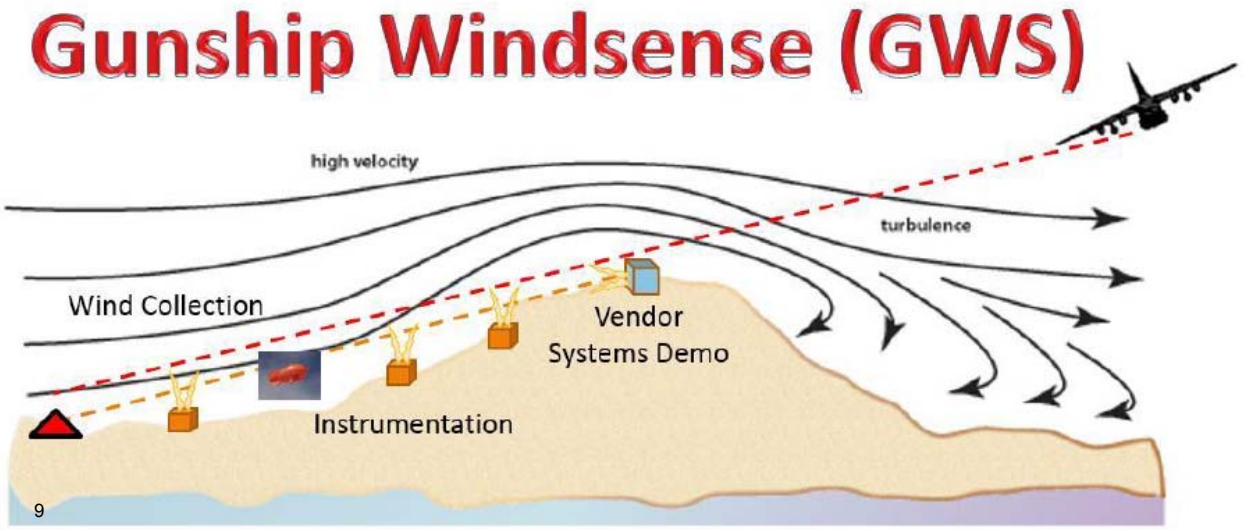
- MOUNTAIN TERRAIN ATMOSPHERIC MODELING AND OBSERVATIONS (MATERHORN) (discussed separately at this workshop)
- Collaboration of universities and government
- Two large field tests utilizing the Granite Mountain Atmospheric Sciences Testbed
- Designed to identify and study the limitations of current mesoscale models for mountain terrain weather prediction and develop tools to improve predictability
- Project components:
  - Modeling Component (MATERHORN-M)
  - Technology Component (MATERHORN-T)
  - Parameterization Component (MATERHORN-P)
  - Field Experiment Component (MATERHORN-X)

Precision Airdrop Wind Sensing & PAD Tracer tests

- Test LIDAR and RADAR capabilities and provide data for AFRL PAD modeling & simulation efforts
- Tests include ground based measurements and airdrops (drop sondes and simulated cargo/pellets)
- DPG support: forecast, measurements and test management

Gunship Wind Sensing

- Test current vendor system capabilities of unmodified ground based LIDAR and RADAR wind sensing systems
- Improve the accuracy of unguided munitions
- Ground based measurements (from Sapphire Mtn. pointing down to the valley) and airborne (Twin Otter)



Dugway Meteorological Instrumentation Supporting GMAST

SAMS (Surface Atmospheric Measurement System) - 10 m fixed-site meteorological towers for standard weather measurements (2m and 10m) (35 stations)

mini-SAMS - 10 m fixed-site meteorological towers for high-frequency wind and temperature measurements (51 stations) on 1 mile spaced array over primary test range

PWIDS – 2 m portable meteorological stations for specific test support (113 stations)

32 m portable towers for multiple levels of sensing heights up to 32m above the surface (7 stations)

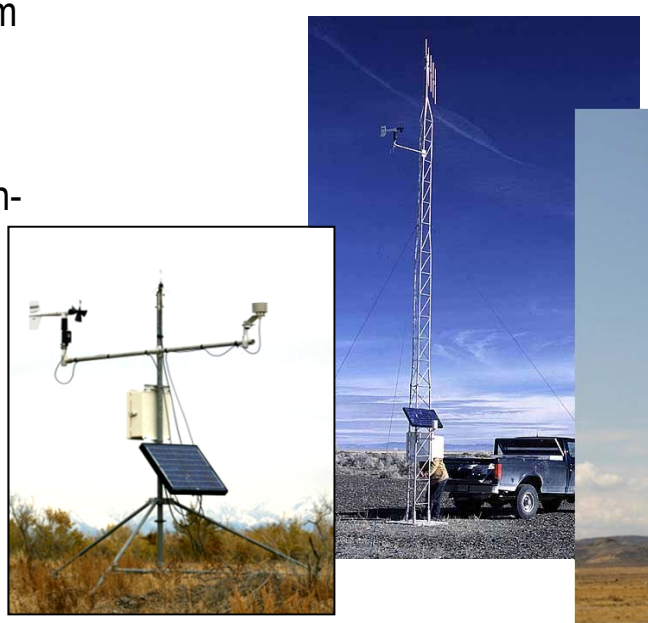
32 m fixed towers for multiple levels of sensing heights up to 32m above the surface (3 stations)

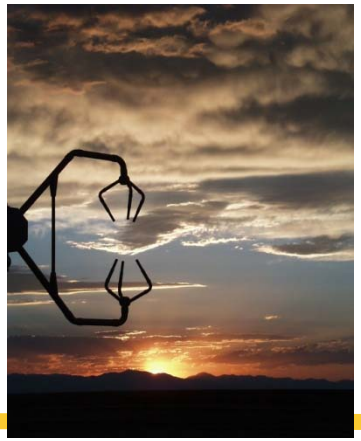
Upper air instruments (5 stations)

-- 3 Vaisala rawinsonde base stations

-- 2 tethersondes

Sonic Anemometers (over 60)





GMAST Instrumentation (Cont)

Lidar

Sodars (3)

Doppler radars (C-band, mobile X-band)

FM/CW boundary layer radar

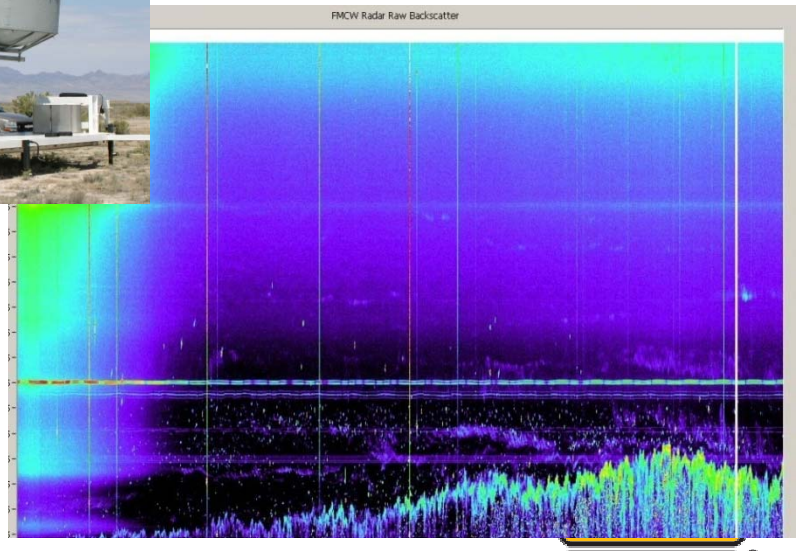
Radar wind profilers (5)

Ceilometers (3)

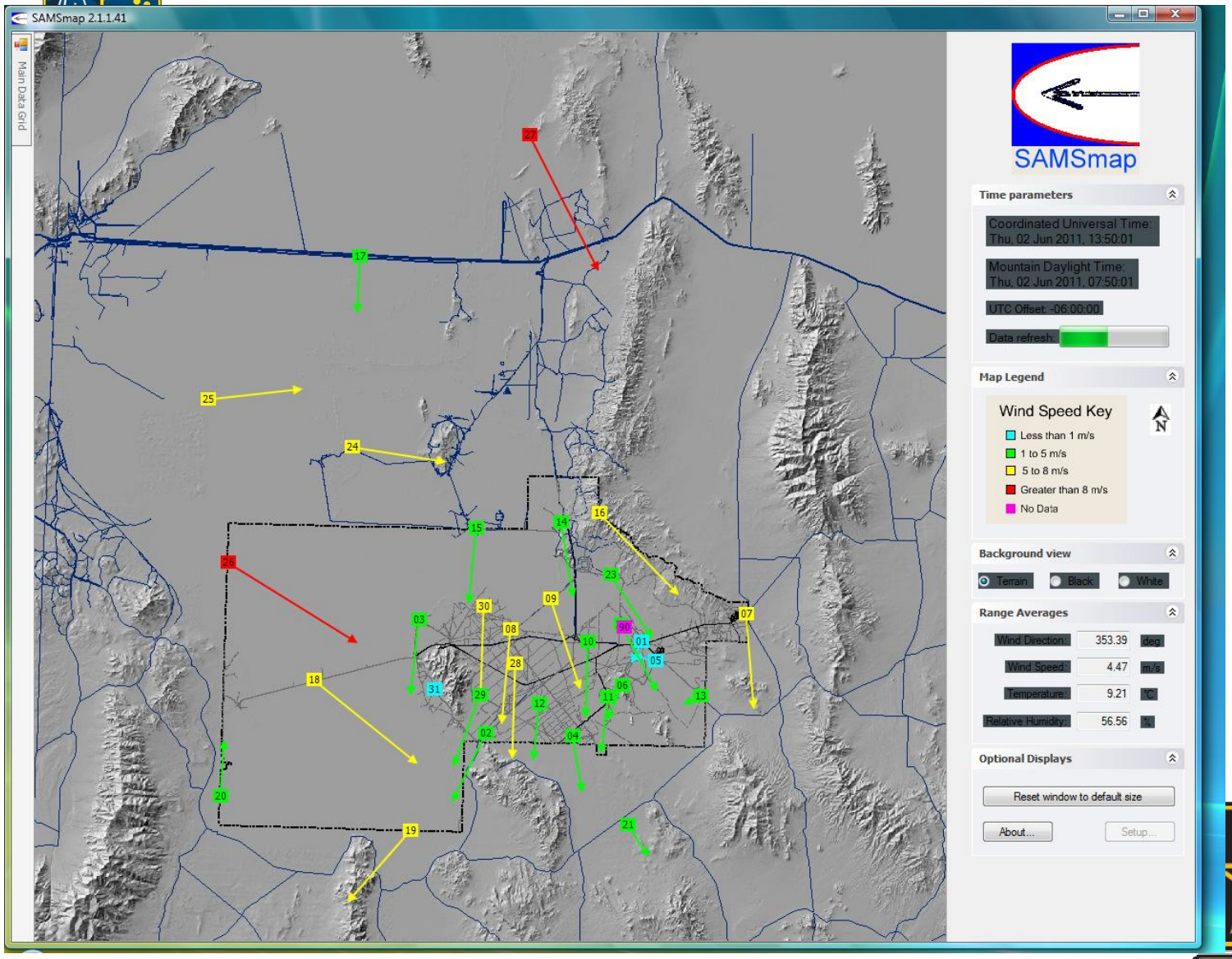
Field Meters (53)

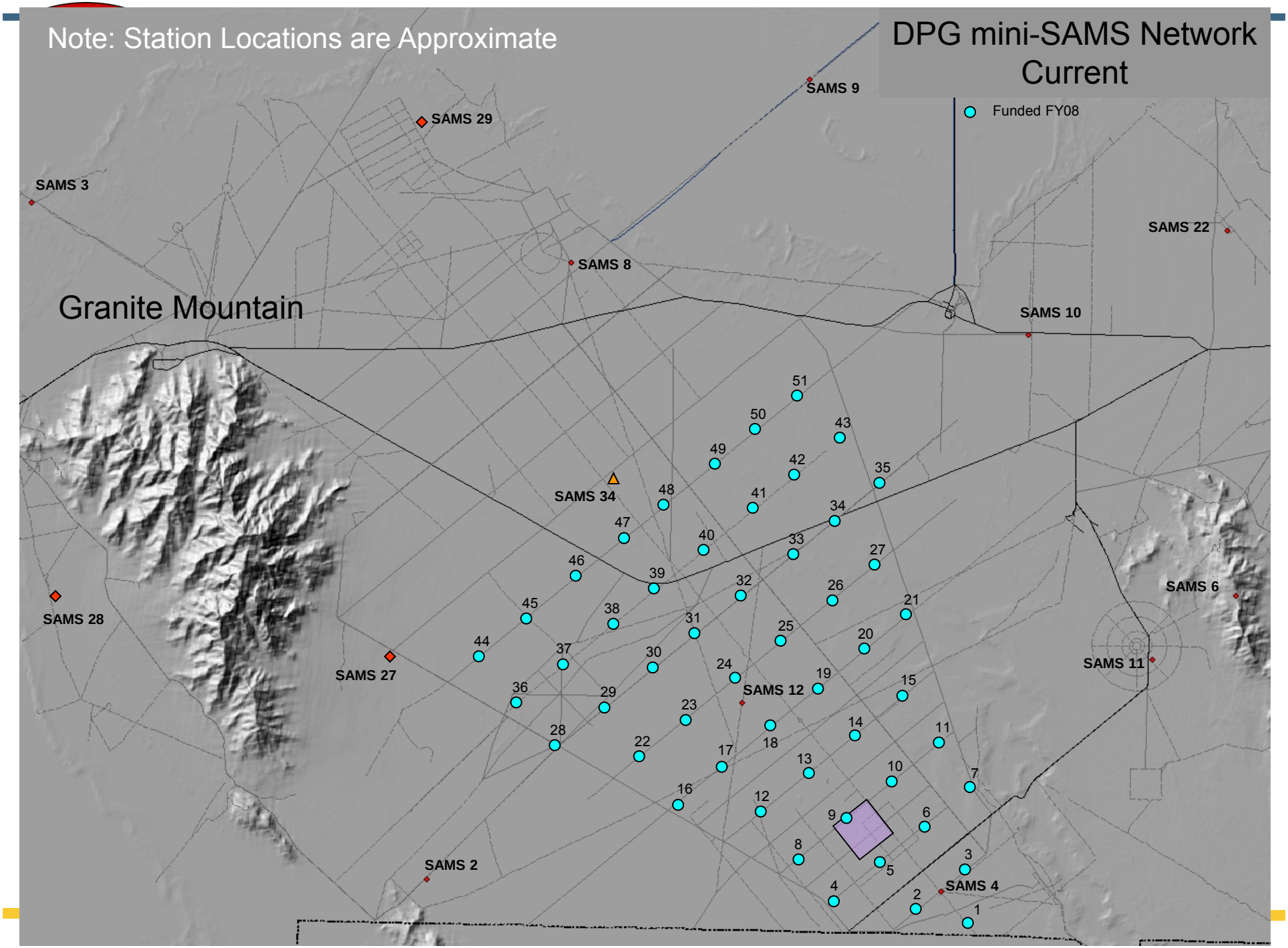
Radiometers (2)

Lightning Mapping Array sensors (12)



SAMS Station Locations




Note: Station Locations are Approximate
DPG mini-SAMS Network
Current
Funded FY08
Granite Mountain
SAMS 9
SAMS 29
SAMS 3
SAMS 22
SAMS 8
SAMS 10
SAMS 34
SAMS 28
SAMS 27
SAMS 6
SAMS 11
SAMS 12
SAMS 2
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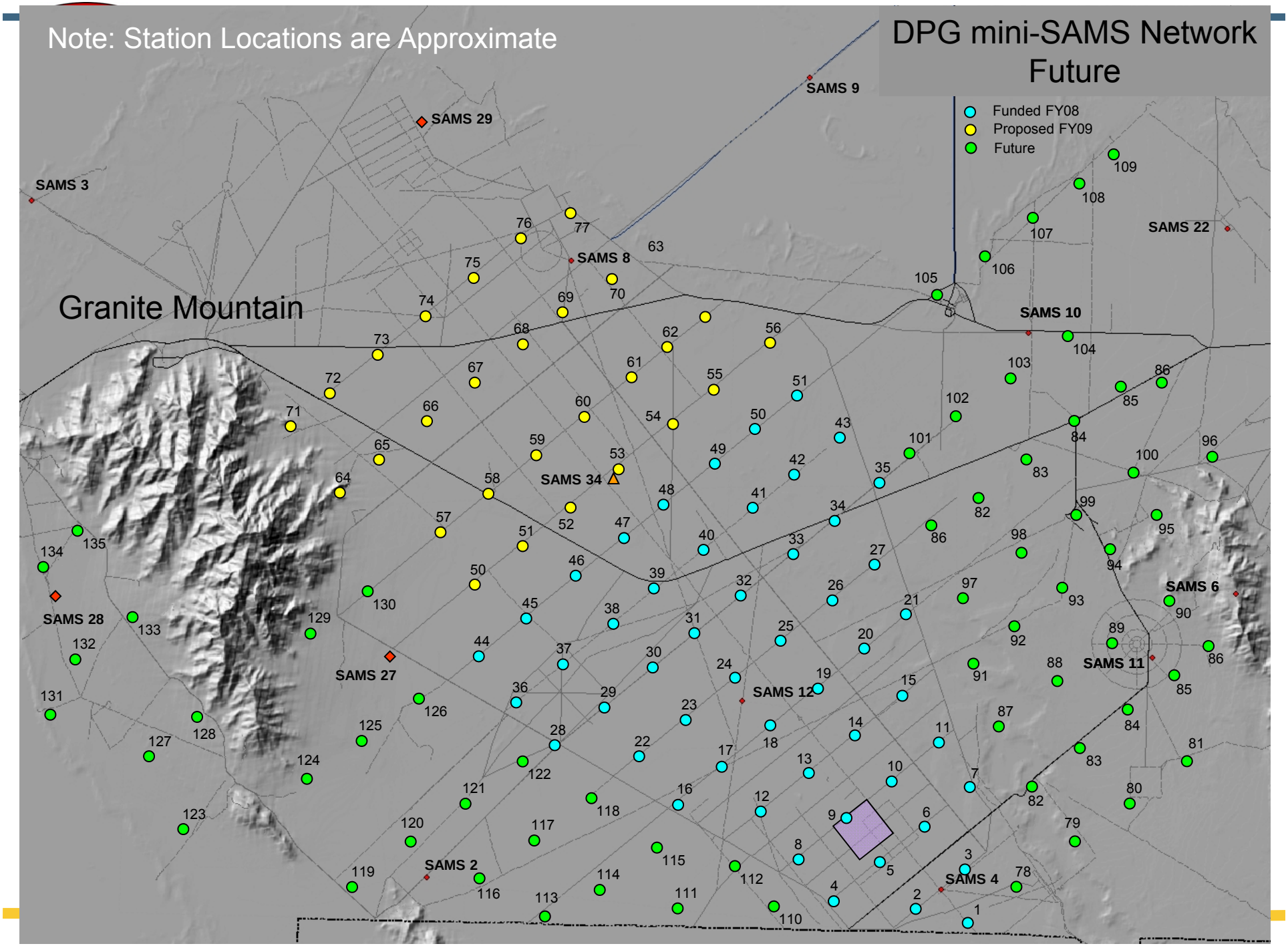

Note: Station Locations are Approximate
DPG mini-SAMS Network
Future
Funded FY08
Proposed FY09
Future
Granite Mountain
SAMS 3
SAMS 29
SAMS 9
SAMS 8
SAMS 10
SAMS 22
SAMS 34
SAMS 28
SAMS 27
SAMS 12
SAMS 11
SAMS 6
SAMS 2
SAMS 4

Data Retrieval and Processing

- Most observational data are relayed via radio to DPG Weather Building
- Data are archived in the ARMADA system
- Data also sent to weather community (MesoWest, 4DWX)
- Provides access for forecasters, consistent units, convenient displays

Dugway's Meteorology Division

Core Mission Areas

—Manager for ATEC's Operational Meteorology Program

- Provide technical management for operational meteorology program at 8 RDT&E ranges in US
- Provide technical leadership of ATEC program
- *Supervise development of Four-Dimensional Weather (4DWX) program*

Four-Dimensional Weather (4DWX)

- Four-Dimensional Weather (4DWX) Program
  - Highly advanced meteorological modeling system developed by National Center for Atmospheric Research (NCAR)
  - Designed specifically to maximize use of dense instrumentation networks at ranges
  - Output tailored to test support requirements
  - Constantly updated using progress from many NCAR customers
- Core capability for forecasters at all ATEC test centers
  - Enabled by consolidating efforts and funds across all ATEC test centers
- Ensemble version of 4DWX runs on HPC system at DPG

Ensemble 4DWX

- Ensemble version of 4DWX running at DPG since 2007
  - 30 members over same domain at same time, with different inputs
  - Provides estimate of uncertainty in forecast results – very useful

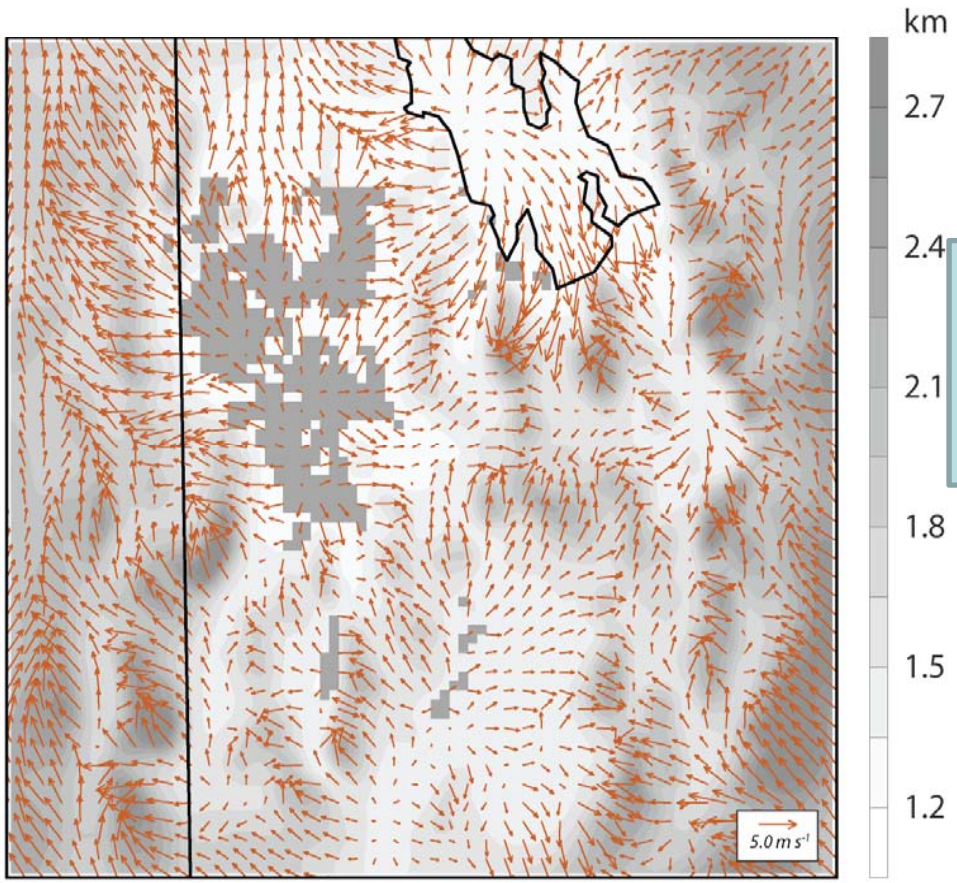
- Current system supports only DPG
- Developing ensemble capability for all test centers
  - Using designated partition of a High Performance Computing Modernization Program system at Stennis Space Center, MS

GMAST Connection to 4DWX

- NCAR makes use of data from GMAST programs to improve 4DWX
- MATERHORN is a gold mine for NCAR model development
  - High resolution wind data over Granite Mountain and nearby areas
  - Surface measurements support physics parameterization development

4DWX High-Resolution Modeling

Δx = 3.3 km



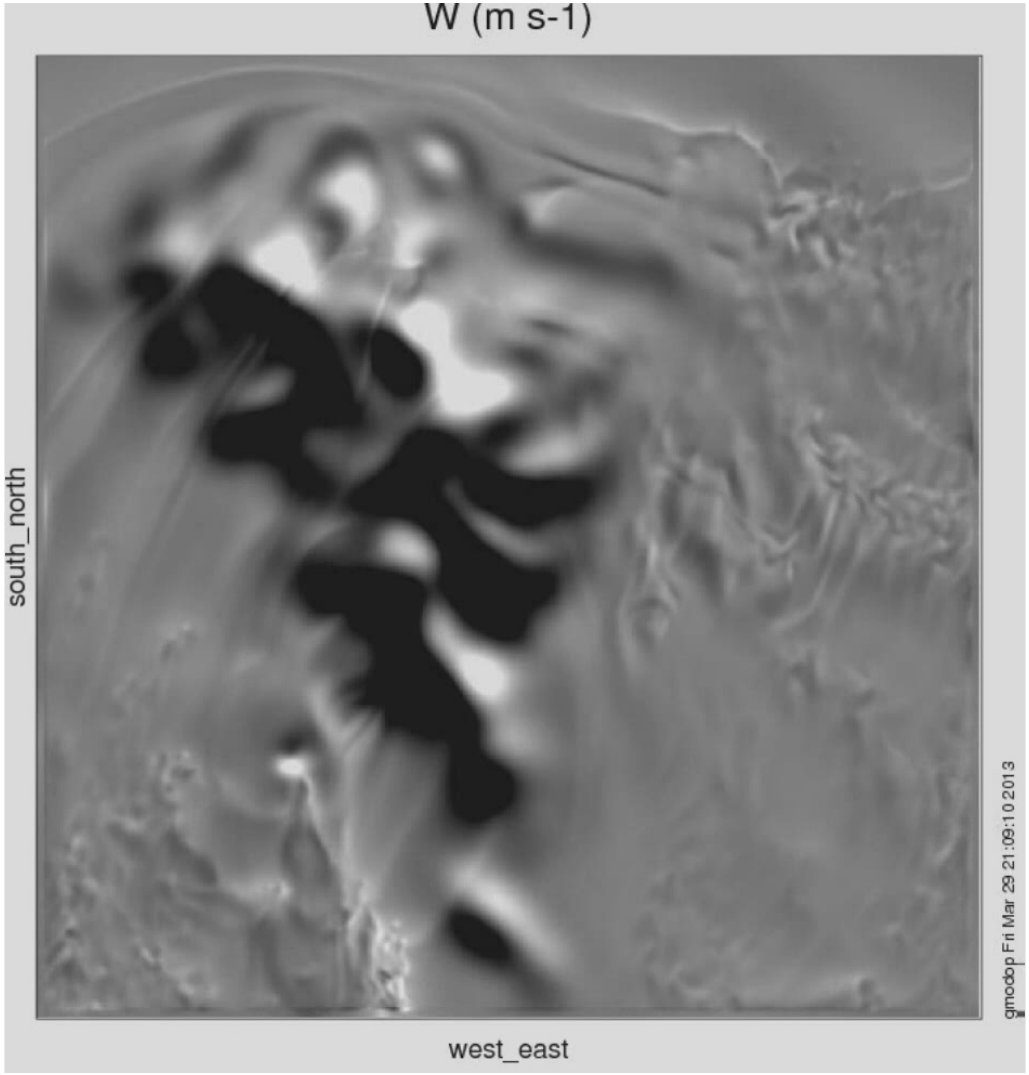
Winds reflect presence of terrain and land surface features

4DWX provides accurate weather information at resolutions approaching scales of tests

4DWX combines all weather data sources for effective use

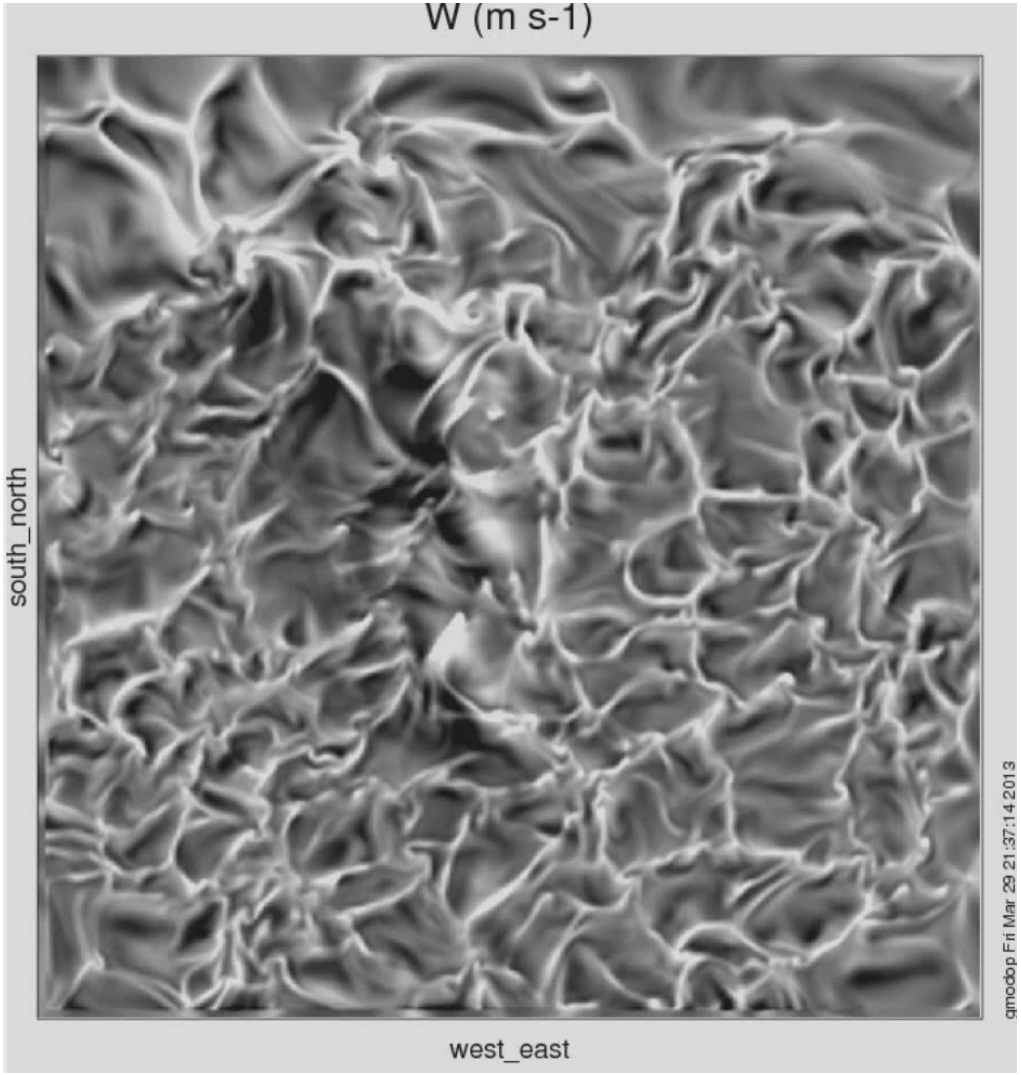
U.S.ARMY

Very Large Eddy Simulation Model



Nighttime
Stable

Very Large Eddy Simulation Model



Morning
Transition

Close the Circle

- Use operational experience, extensive instrumentation, and advanced modeling systems to plan and design field studies
  - Site CB referee sensors, weather sensors, and systems being tested
  - Use 4DWX and Transport & Dispersion modeling guidance (HPAC, JEM) along with climatological data and operational experience
  - Use model guidance for safety checks during test activities

- Use results from R&D studies to improve operational capabilities
  - Detailed results from MATERHORN inform forecasters about scale interactions
  - Awareness of flow patterns revealed during MATERHORN, combined with observations, enables more accurate forecasts

Questions and Discussion