Nowcasting and Urban Interactive Modeling Using Robotic and Remotely Sensed Data

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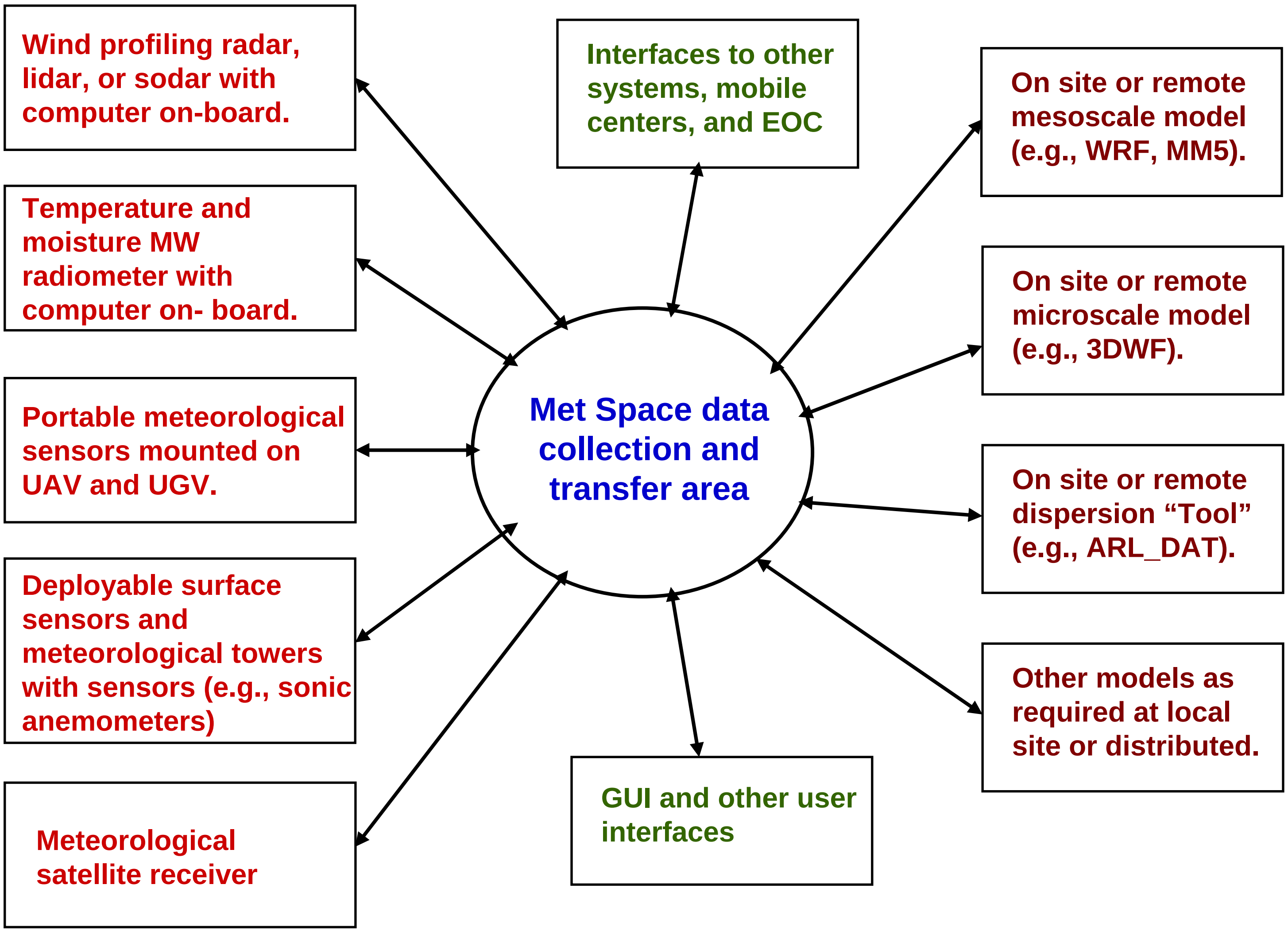
OUTLINE

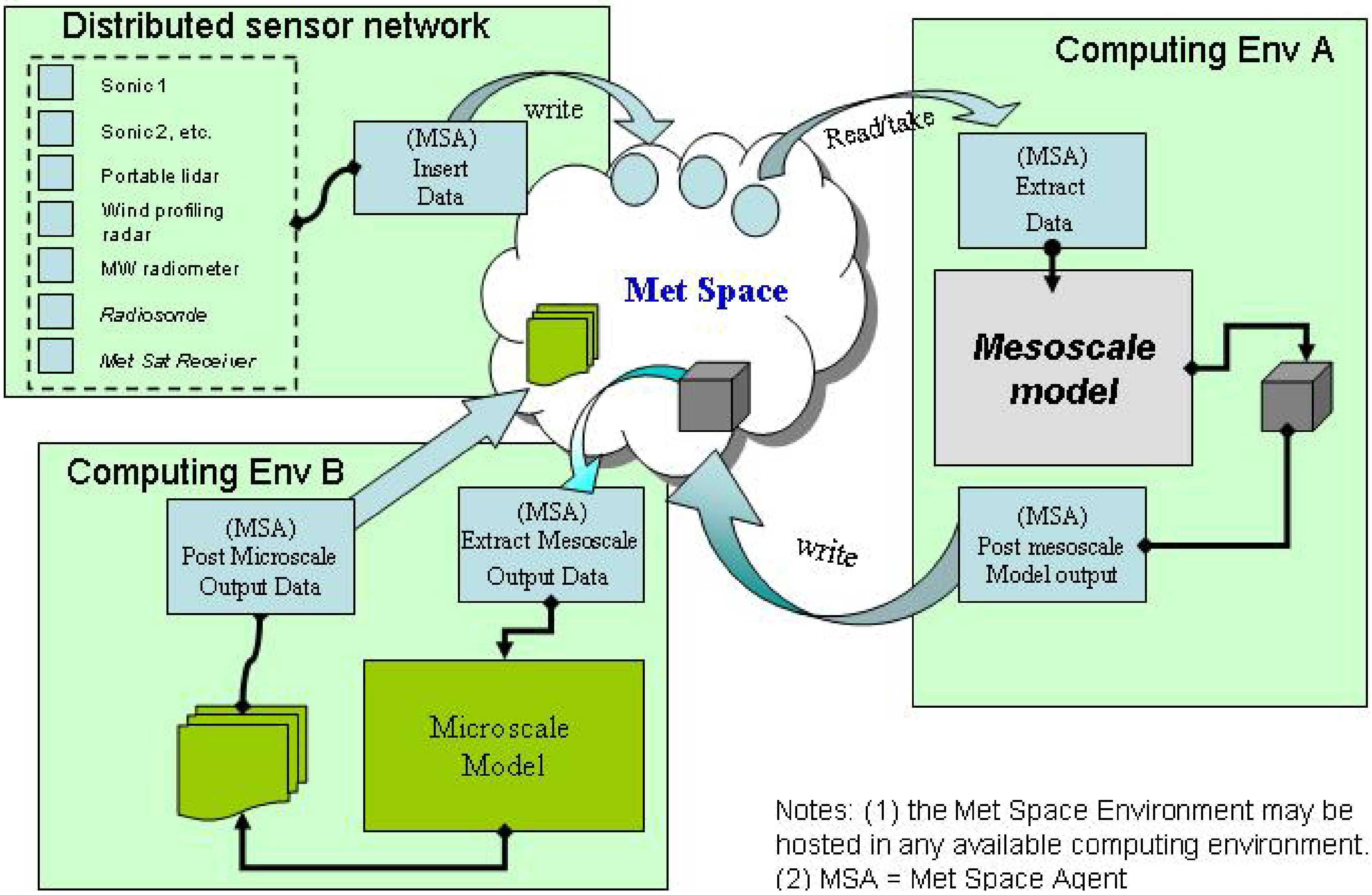
1. Overall System Concept
2. Met Spaces
3. Platforms
4. Sensors
5. Models and Weather Running Estimate – Nowcast (WRE-N)
6. One Concept of Distributed Operation
7. Summary

Block diagram of a possible configuration of a mobile distributed meteorological system



All connections 2-way via the Met Space.

Sample data flow using a networked Met-Space environment



Notes: (1) the Met Space Environment may be hosted in any available computing environment. (2) MSA = Met Space Agent

UAV and UGV

PACBOT

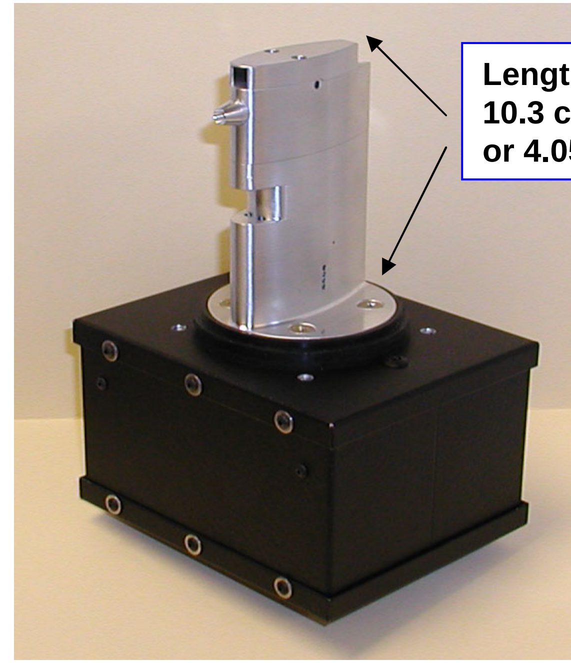
Shadow UAV

Short-range UAV

Acoustic Sensor Test-bed

UAV Met Sensors: Old and New

The TAMDAR On-Board Weather Sensor System: 2005 Technology



The Metprobe: 1990 Technology

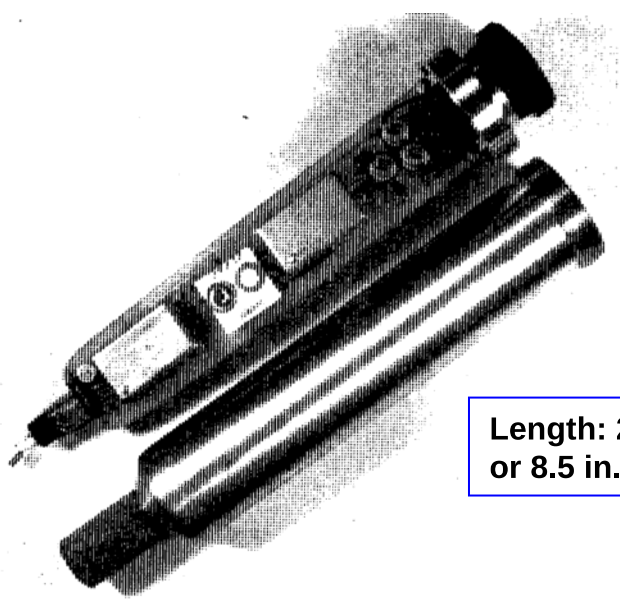


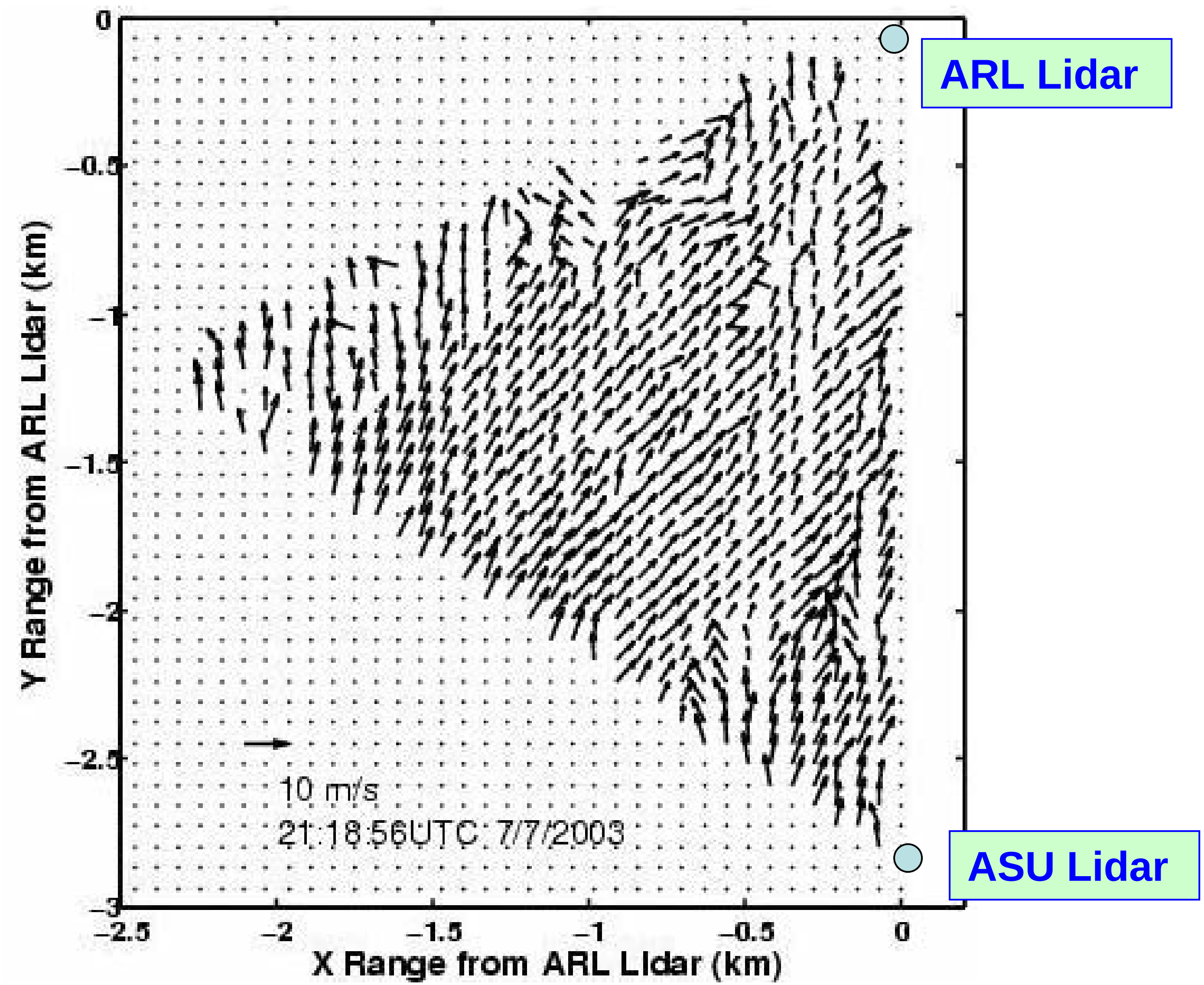
Figure 3. Single probe version of the metprobe. The hybrid chips contain about 90% of the electronics. The temperature and humidity sensors are located at the end of the probe within the filter, and the pressure sensor sits on the board between the hybrid chips.

Detects and determines:

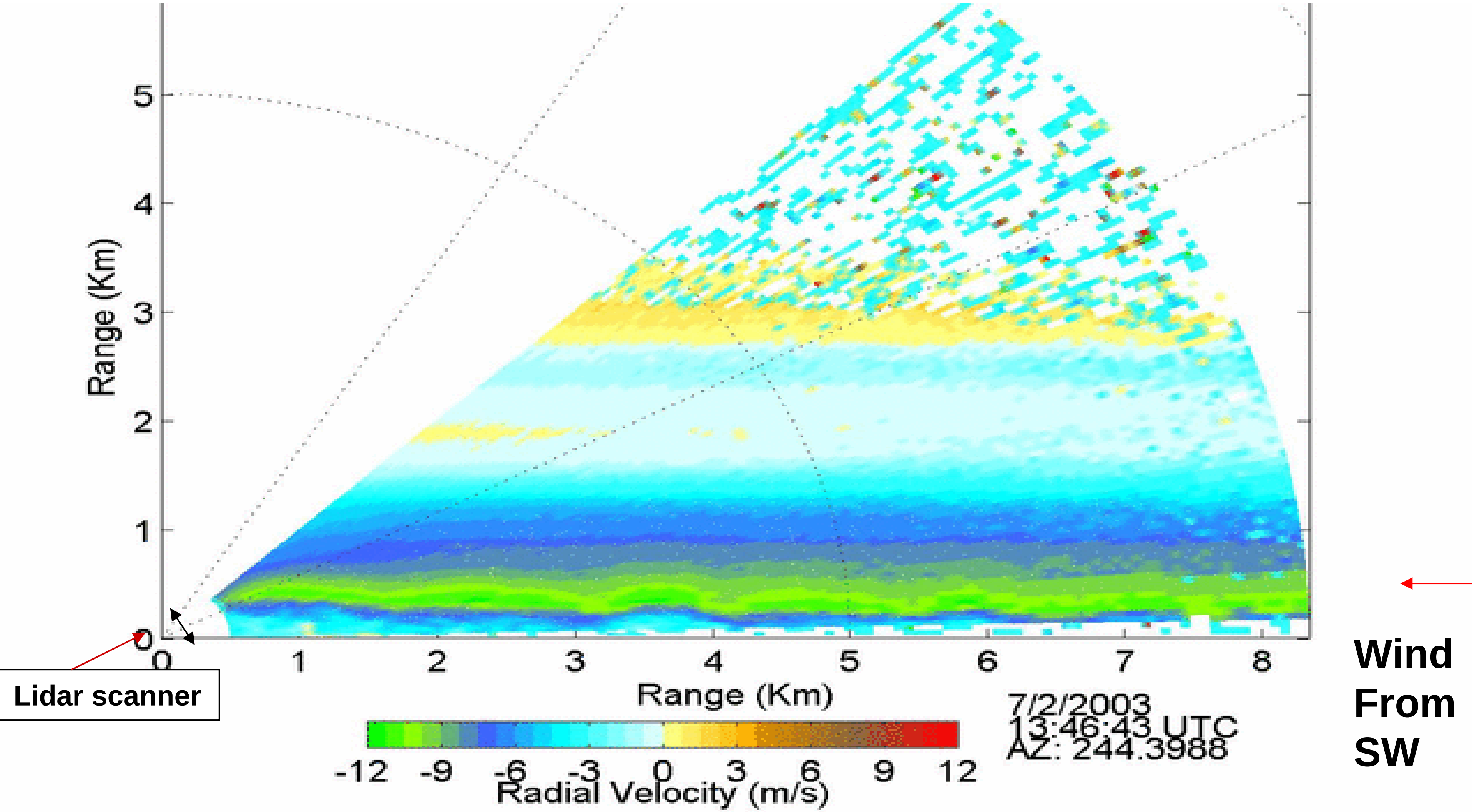
- Ice presence
- Median and peak turbulence
- Static pressure and pressure altitude
- Air temperature (Mach corrected)
- Relative humidity
- Indicated and true airspeed
- Wind speed and direction
- Built-in GPS

Future: Detection of atmospheric chem/bio/radiation presence.

Dual lidar winds south of OKC, July 2003



Boundary Layer Evolution at Oklahoma City under clear skies from the ARL Doppler Lidar



Wind From SW

Weather Running Estimate – Nowcast (WRE-N)

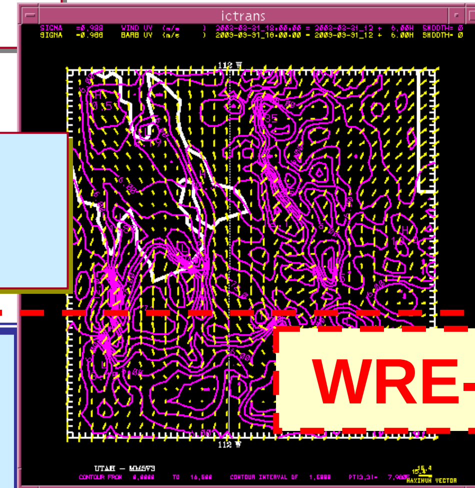
The interactive combination of a rapid data assimilation and analysis tool with a fine resolution mesoscale short range prediction model.

Example: modified LAPS with WRF.

Hierarchy of models for high resolution updates to forecasts

Forecast - Operational Center (AFWA) Mesoscale MM5 Forecast for next 36-72 hours, 2-4 times daily, 45 to15 km resolution on a "global" domain

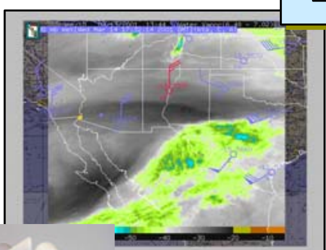
Local short term forecasts at BCT (IMETS/JET)

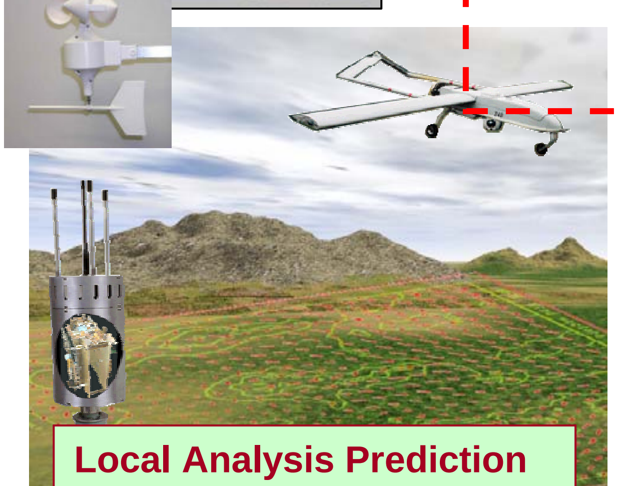


Nowcast (short term forecast) - run hourly, forecasting the next 3 hours on a 2.5 km grid over 150 x 150 km or smaller domains.

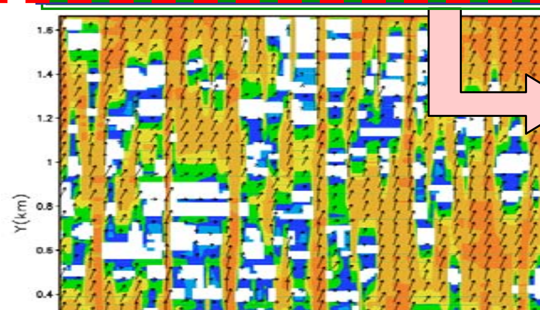
WRE-N

WRE (advanced local analysis) – run every 15-30 minutes on a 1 km grid over a domain within the Nowcast - Integrates local and non-conventional observations (METSAT, UAV sensor data, robotic wind sensors) into current nowcast – example: LAPS objective analysis in development at the University of North Dakota





Local Analysis Prediction System (LAPS) assimilates data at BCT (DCGS-A)



Diagnostic urban wind model running as embedded client on BCT DCGS / FCS

Diagnostic High Resolution Models – fast running (5-10 min) boundary layer wind model at 10-100 m resolution for complex and urban terrain effects on average wind flow – can use local observations

Provides input to advanced applications on DCGS-A.

Tactical Army WRE-N Strategy: Multi-component

WRE-N (BCT MM5 / WRF) Domain

~ 150 x 150 km

Runs every hour

Meso-gamma NWP with data assimilation – uses “hot start” method.

Nested WRE domain:

< 150 x 150 km

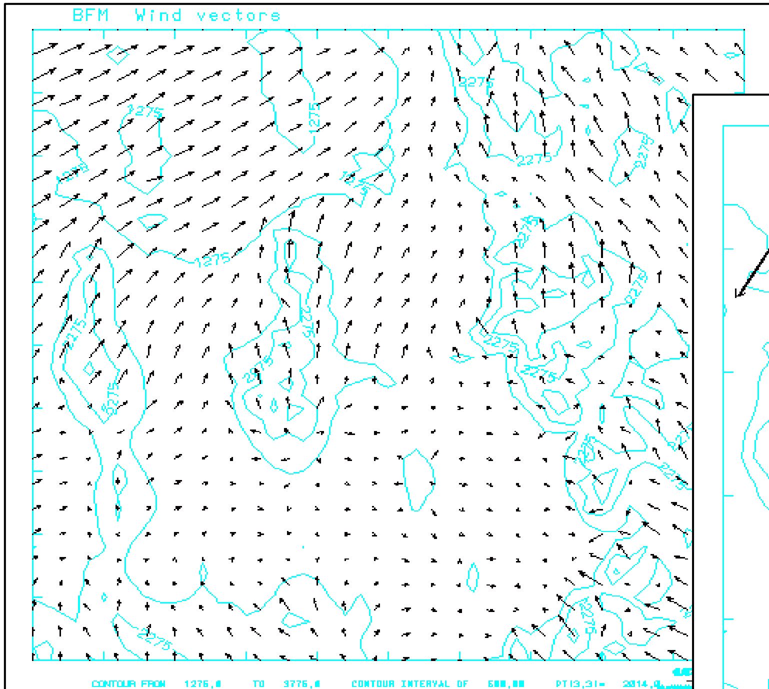
Objective analysis (e.g., modified LAPS, 4DDA)

Microscale model nested in WRE domain

Multiple nested WRE domains may lie within the WRE-N domain

Microscale tools running on mobile platforms (e.g., PDA).

Modification of forecast using observations



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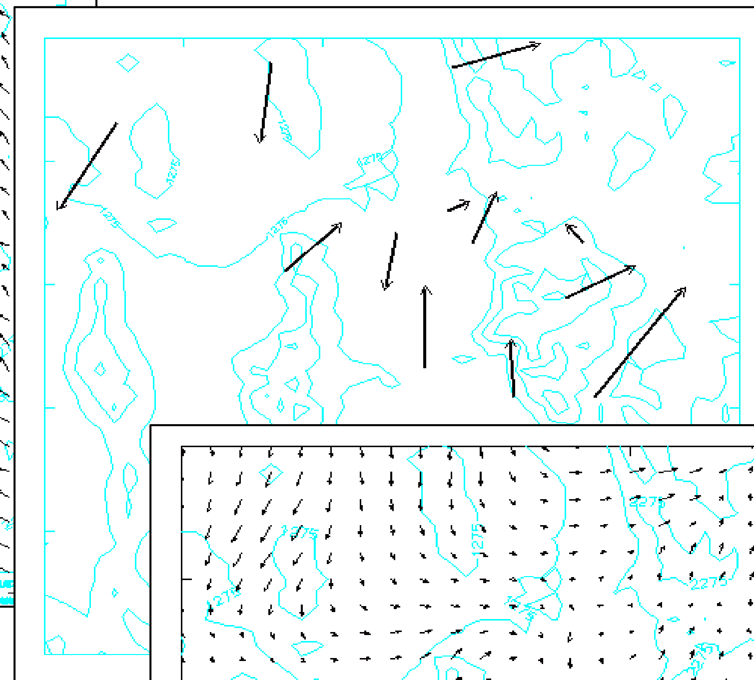

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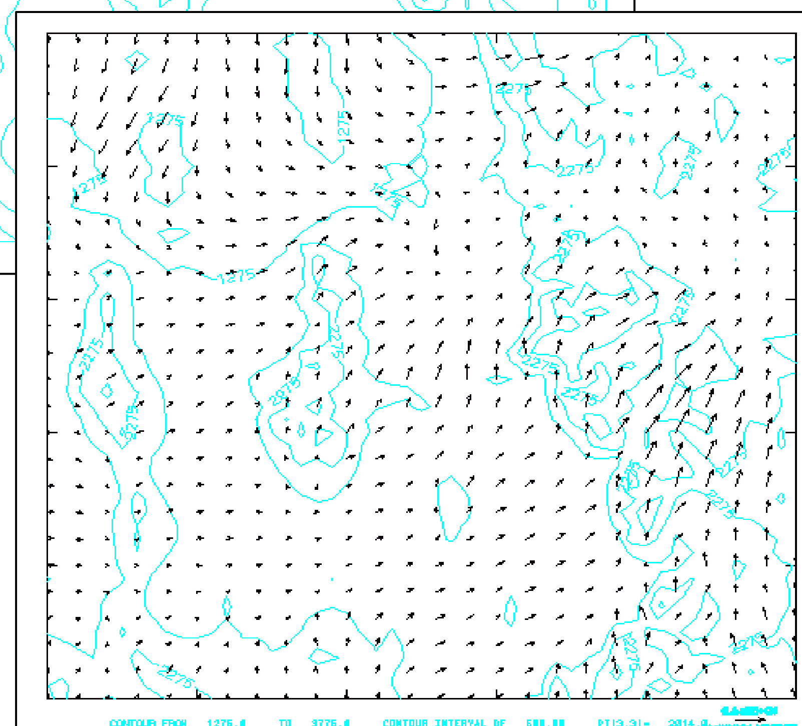
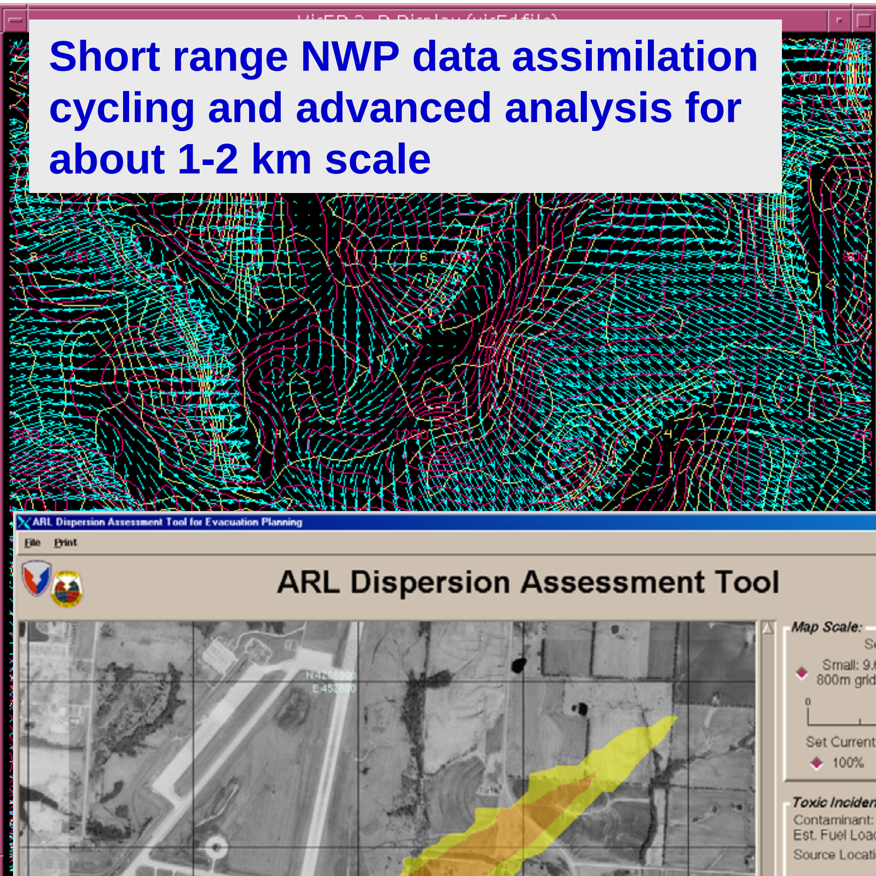


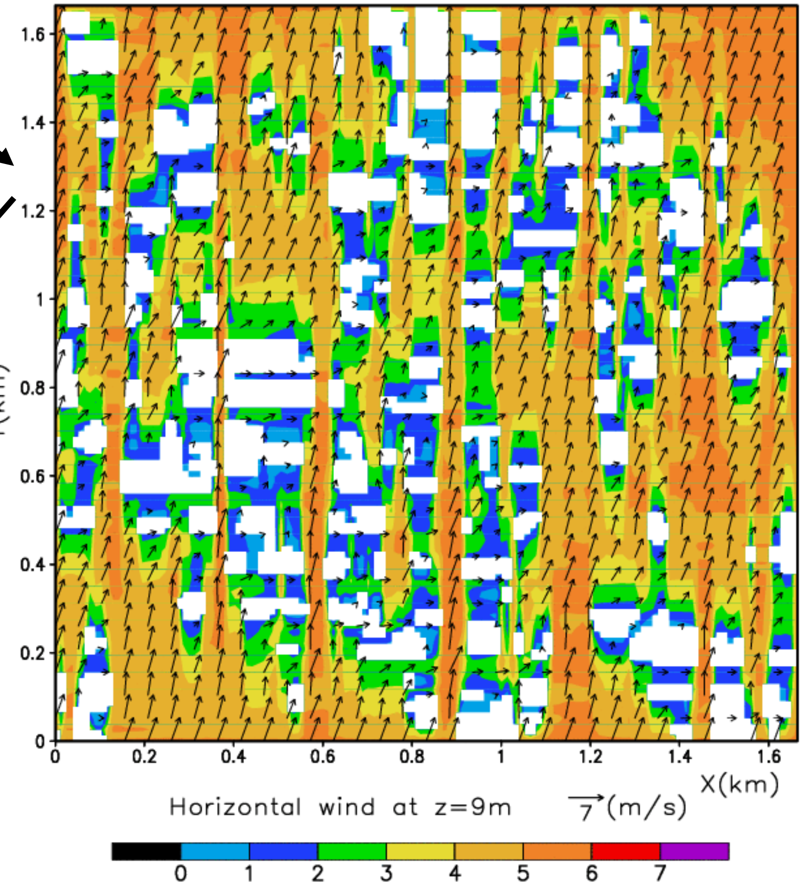
1. **MM5 forecast of the near surface wind field (3.3 km) for area over White Sands Missile Range (WSMR), NM.**
2. **Current wind field observations over the area of interest.**
3. **Wind field modified by fusion of observations into the forecast.**

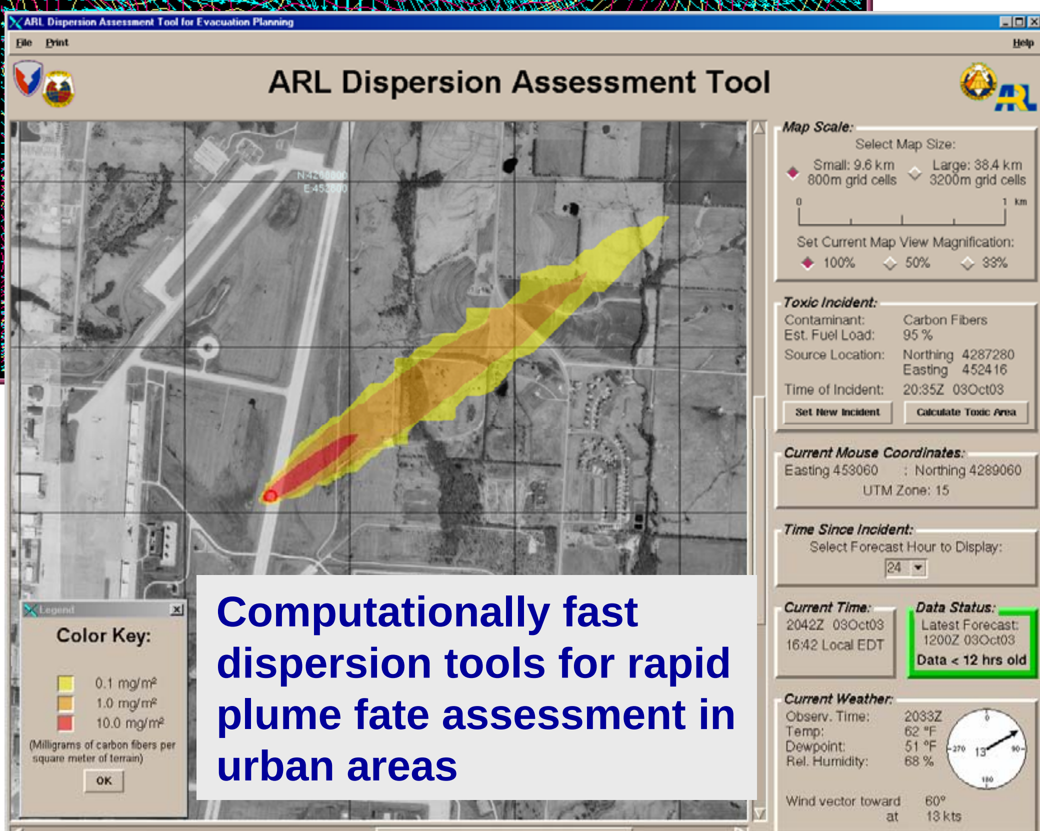
Hierarchal Meteorological Analysis "System" for Microscales

Short range NWP data assimilation cycling and advanced analysis for about 1-2 km scale



Computationally fast diagnostic micro and urban scale models to nest within the 1-2 km resolution analyses

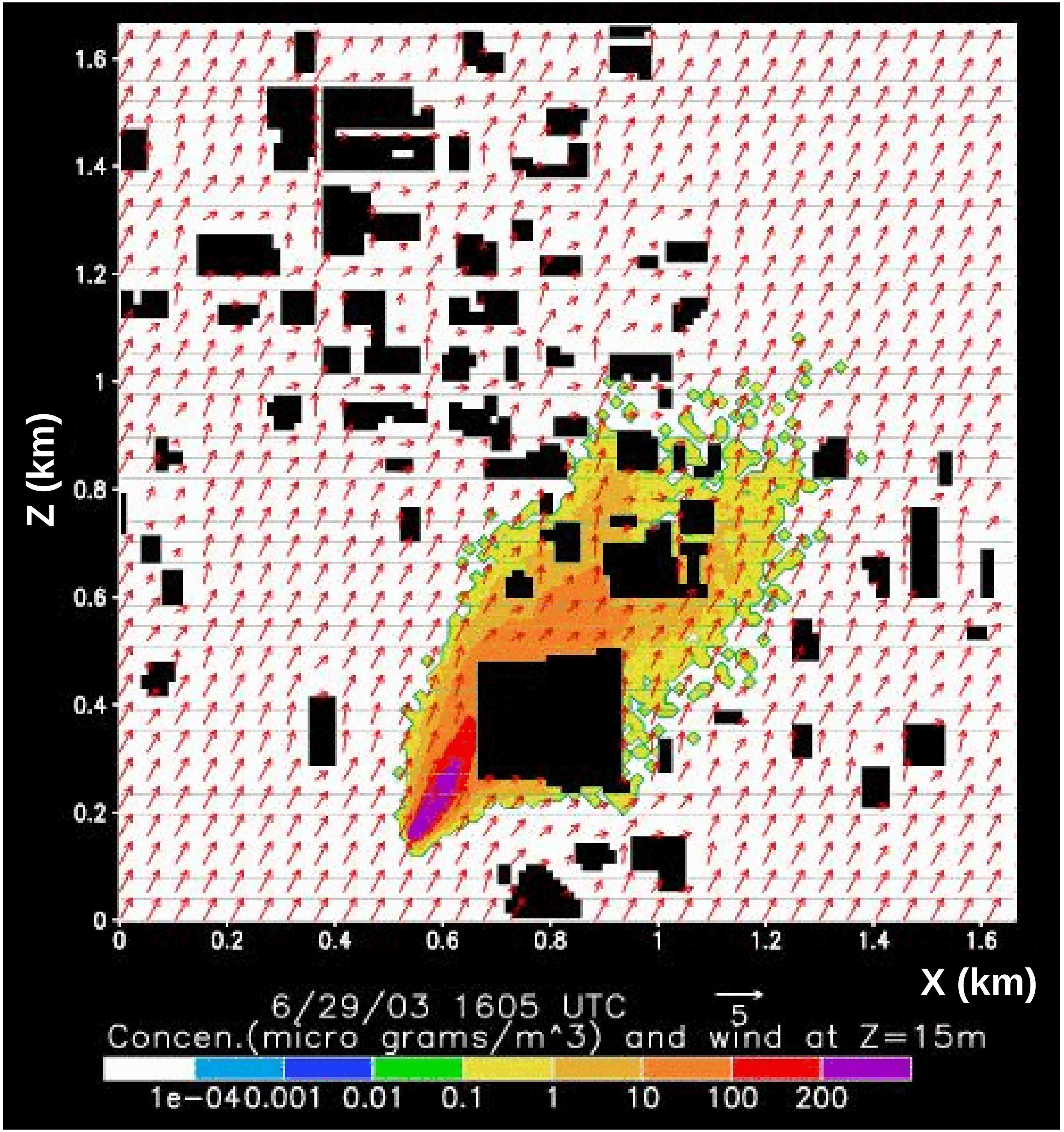




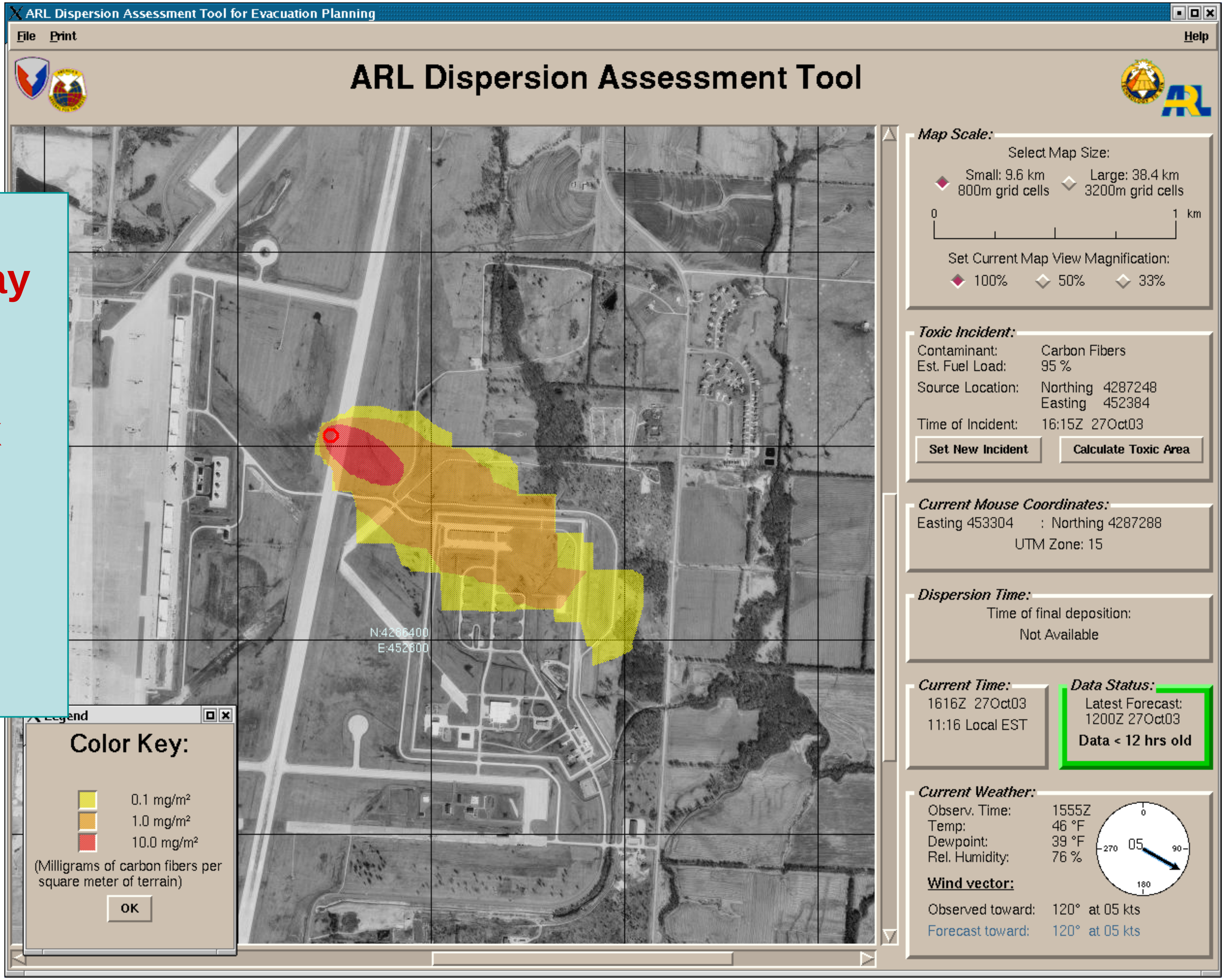
Computationally fast dispersion tools for rapid plume fate assessment in urban areas

Microscale analysis tools running on PDA platforms

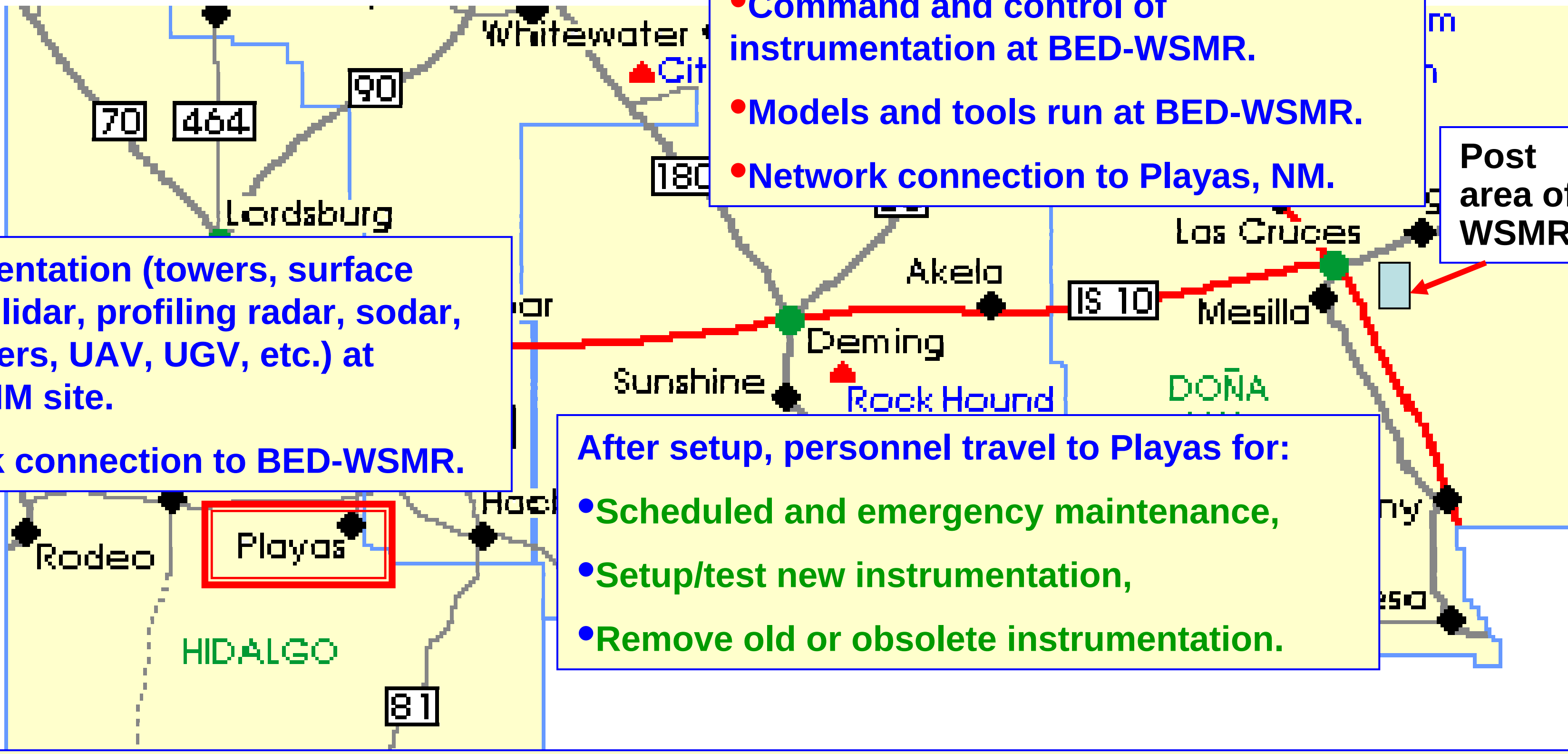
3-D Wind Field (3DWF) with Lagrangian dispersion model showing change of dispersion with time over an urban area.



ARL DAT output display showing the deposition field after six hours following a release of hazardous material.



One concept of distributed operation (WSMR and Playas, NM)



- Command and control of instrumentation at BED-WSMR.
- Models and tools run at BED-WSMR.
- Network connection to Playas, NM.

Post area of WSMR

- Instrumentation (towers, surface stations, lidar, profiling radar, sodar, radiometers, UAV, UGV, etc.) at Playas, NM site.
- Network connection to BED-WSMR.

After setup, personnel travel to Playas for:

- Scheduled and emergency maintenance,
- Setup/test new instrumentation,
- Remove old or obsolete instrumentation.

- Measurements feed analysis and forecast models in near real time.
- Analysis and model output, and user input, help determine instrumentation parameters (frequency of observations, data format, etc.). [Targeted observations.]
- New measurements provide near real time input to models that in turn help determine instrument parameters, ..., and so forth in a feedback loop.

CONTINUATION
(Not the Conclusion)

- Proposal paper on work required to accomplish the goals of this presentation already prepared and available.
- Proposal paper on closely related work that would allow simulation of a distributed meteorological system using certain HPC facilities already prepared and available (not directly discussed in this presentation).

SUMMARY

1. A combined multi-model and sensor system can provide essential information on the state of the atmosphere and short term predictions for operations, CBNRE defense, and natural or man-made emergencies.

2. The system can serve as an R&D test-bed, a means for rapid testing of sensor or model prototypes, or as a local meteorological center.

3. The technology for such a system exists today and will not require a technological breakthrough.

4. The modular design allows the flexibility to handle the addition, subtraction, or replacement/upgrade of sensors, models, or other software with minimal disruption.