NOAA Fire Weather Research Program LAPS Downscaling

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NOAA Fire Weather Research Directives

- Western Governor's Association 2008 Report Recommendations
- NOAA Science Advisory Board, Fire Weather Research Working Group, 2009
- 2010 NWS Science and Technology Fire Weather Road Map, and 2012 NWS Weather Ready Nation Road Map
- NWS "Social Sciences Strategic Plan for Weather and Water", 2010
- Office of the Federal Coordinator for Weather, 2011 updated Fire Weather Research Report

NWS S&T Roadmap Fire Weather Vision/Outputs/Impacts

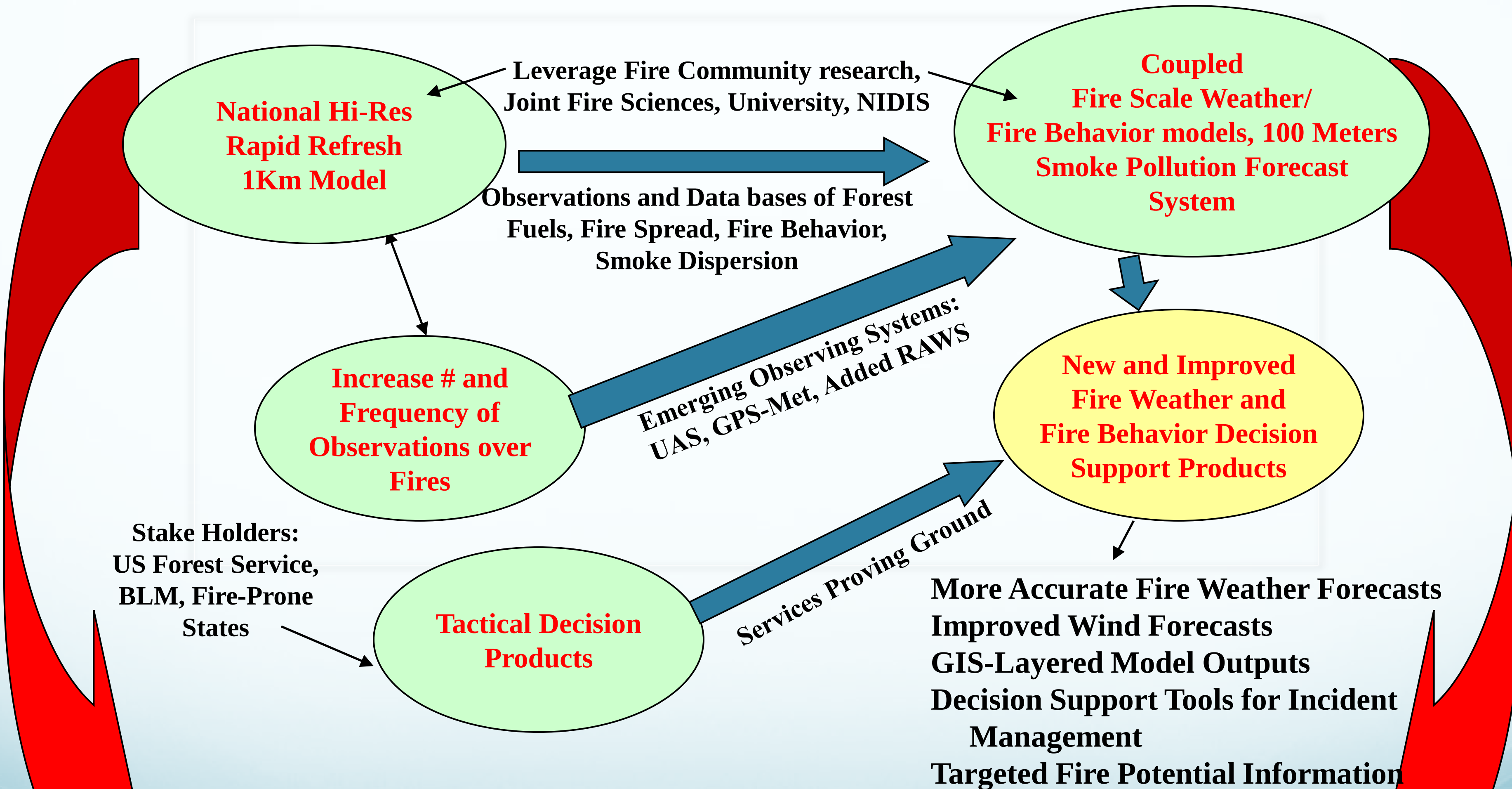
Vision

High-resolution fire weather information and services, in close collaboration with agency partners, focused on providing impact-oriented, integrated improvements of fire danger and behavior predictions that save lives and reduce impact to property

Impacts

– Improved decision support systems and tools
– Extended lead time of high threat areas
– Efficient evacuation of threatened communities
– Reduced risk of escaped prescribed burns
– Reduced out-of-control acreage burned
– Improved public safety (evacuations)

NOAA's Fire Weather Response: Improving Essential Services



Public Safety, Economic Benefit,
Supports Federal Fire Use and Suppression Policies

Executing Directives at OAR

Modeling

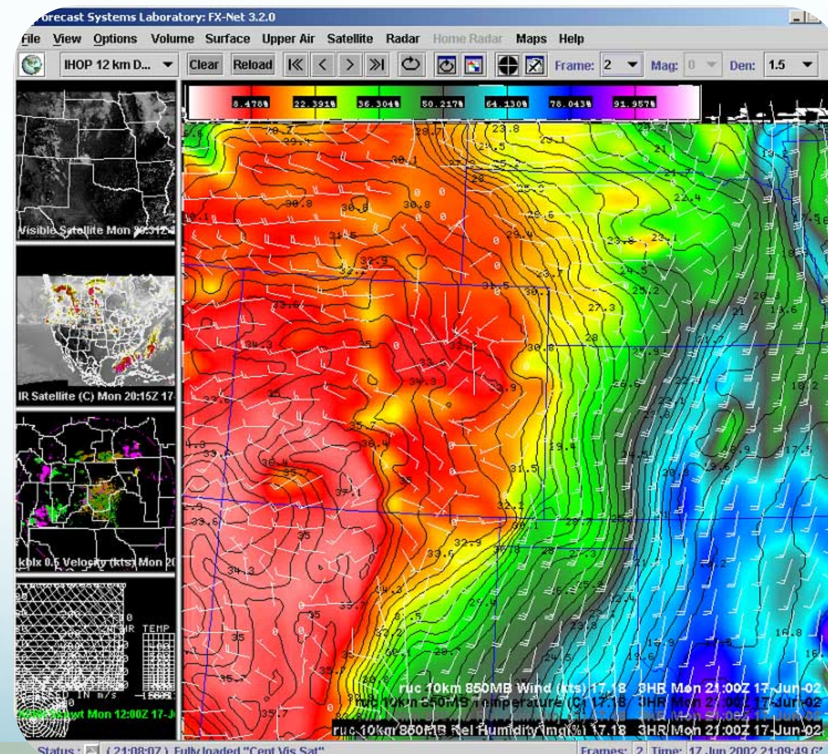
- Downscaling Winds (LAPS/STMAS) (GSD)
- Integrated Smoke forecasts (HR/Chem/Fire) (GSD)
- Improved lightning prediction algorithms (NSSL)
- Use of HySplit model by NWS Incident Meteorologists (IMETs) (ARL)

Observing Systems

- Proposed use of small Unmanned Aircraft Systems over prescribed burns and active fires. (NOAA Partnership with Center for Unmanned Aircraft Systems, C-UAS)
- Distribution of EPA AirNow data to operations (GSD,FX-Net)
- Use of NESDIS satellite products in models and distributed to operations (GSD, FX-Net)
- USFS/NWS experimental model data distributed to operations (GSD,FX-Net)

IMETs Forecast Tools and Needs

- Laptop w/“FX-Net” software, access to models, satellite, radar, observations
- Need Hi-Res Forecasts



Fire Modeling Challenges: Large range of scales

Need to close the Gap

ESRL HRRR with Fire Emissions

~1000 km (domain) **~1 km (grid cell)**

NIST Neighborhood Scale WFDS

~1 km (domain) **~1 m (grid cell)**

Gap (LAPS/STMAS)

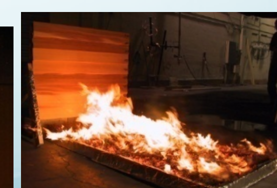
regional

community

Photo by JOHN GIBBINS / Union-Tribune
Cedar Fire about to engulf the Scripps Ranch residential community

neighborhood

NIST Laboratory Scale WFDS

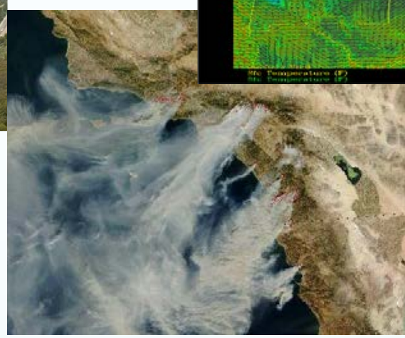


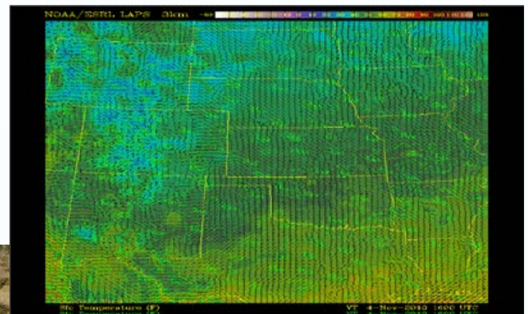
lab

Automated Downscaling in Fire Weather

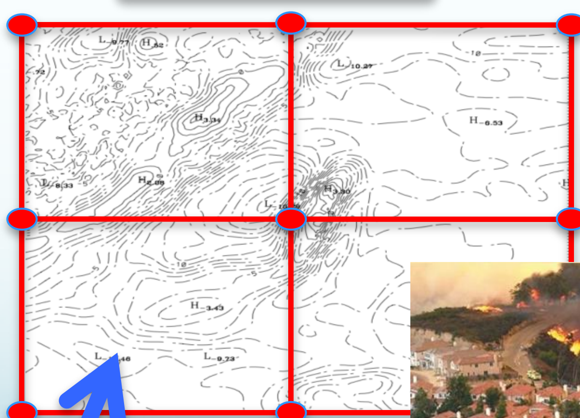
LAPS/STMAS

Incident report





Downscaling



Fine scale forecast

Regional scale data

Photo by JOHN GIBBINS / Union-Tribune

Cedar Fire about to engulf the Scripps Ranch residential community

Photo courtesy W. (Ruddy) Mell

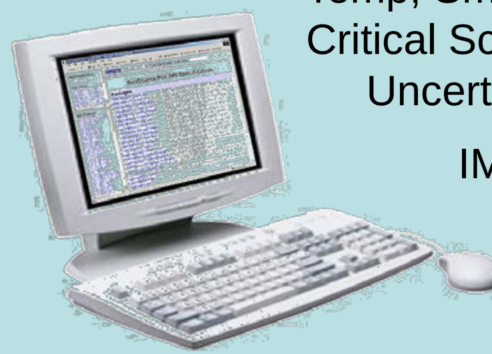
Fills in the small scales

Fire Weather Ops of the Future

- Fire Mapping
- Communications
- Fire Scene Weather

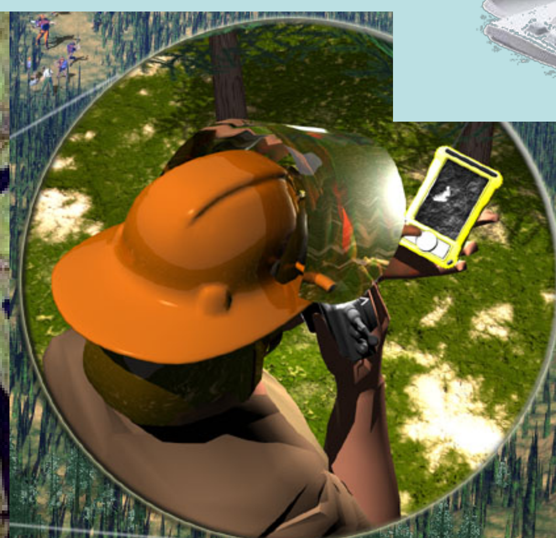
Model Output: Fire Scale Wind Analysis (500 meter),
Coupled Fire Weather/Fire Behavior/Smoke Forecasts

Model Products: Hourly Fire Scale Wind, RH,
Temp, Smoke Plume & Dispersion
Critical Scene Wind Profiles
Uncertainty Guidance



IMET Briefing
Incident Command
Fire Analyst (FBAN)
Fire Fighter Crew Chiefs

Intelligent Assistant
AWIPS II Thin Client
Decision Support Tools



Fire Perimeter Forecast Map
GIS Smoke Dispersion map
Severe Weather Impacts map

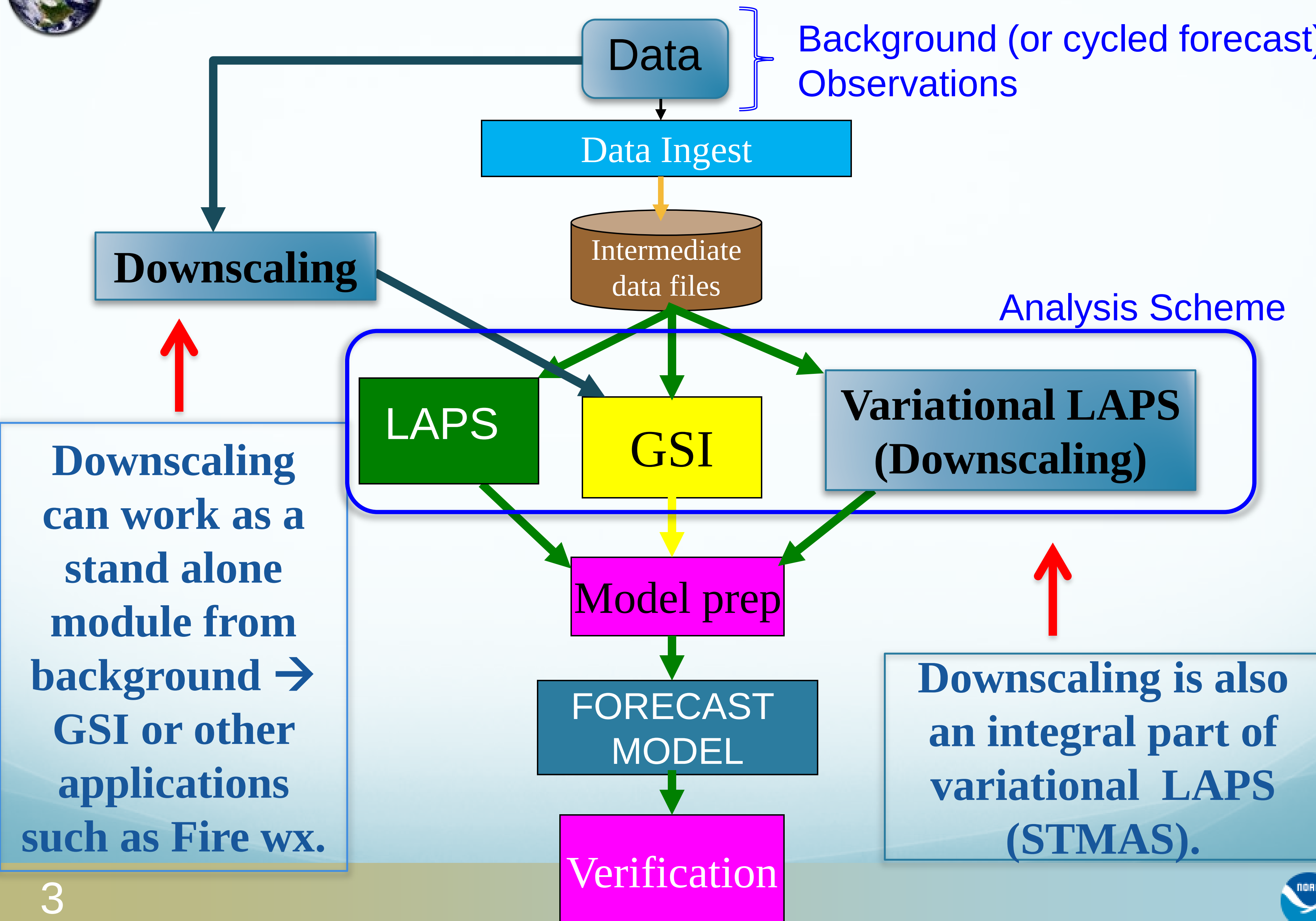
Multiscale Downscaling in Fire Weather Research

Hongli Jiang’s slides

Downscaling in Fire Weather Research

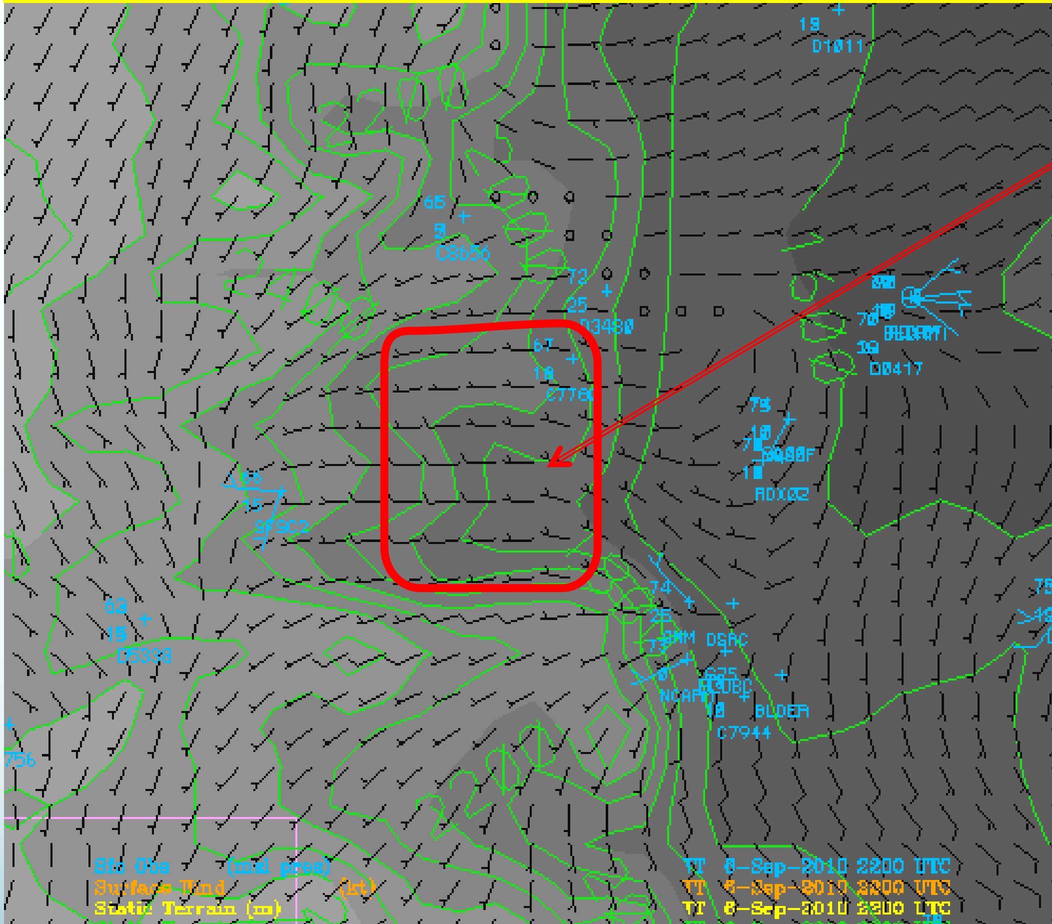
- In regions over complex terrain, observations are sparse, or lack of high-quality measurements, downscaled data will provide dynamically balanced fine scale proxy for analysis;
- Downscaling is an integral part of the variational LAPS (STMAS); is part of the dynamic constraint, and is in the terrain-following coordinate;
- Downscaling can work as a stand alone module to use in many applications, Aviation, Fire Weather, Renewable energy; For fire weather -- to generate high resolution winds, Temperature, Humidity over complex terrain;
- NCEP expresses strong interest in the downscaling for use in conjunction with other data sources

SCHEMATIC ANALYSIS & FORECAST DATA FLOW



Four Mile Canyon Fire, Boulder, CO (6 Sept. 2010)

LAPS 1km wind Analysis, 6 Sept. 2010, 22UTC



- No surface OBS in Four Mile Canyon;
- Few OBS over the higher terrain;
- Observed wind over complex terrain is known to be unreliable
- How to evaluate?

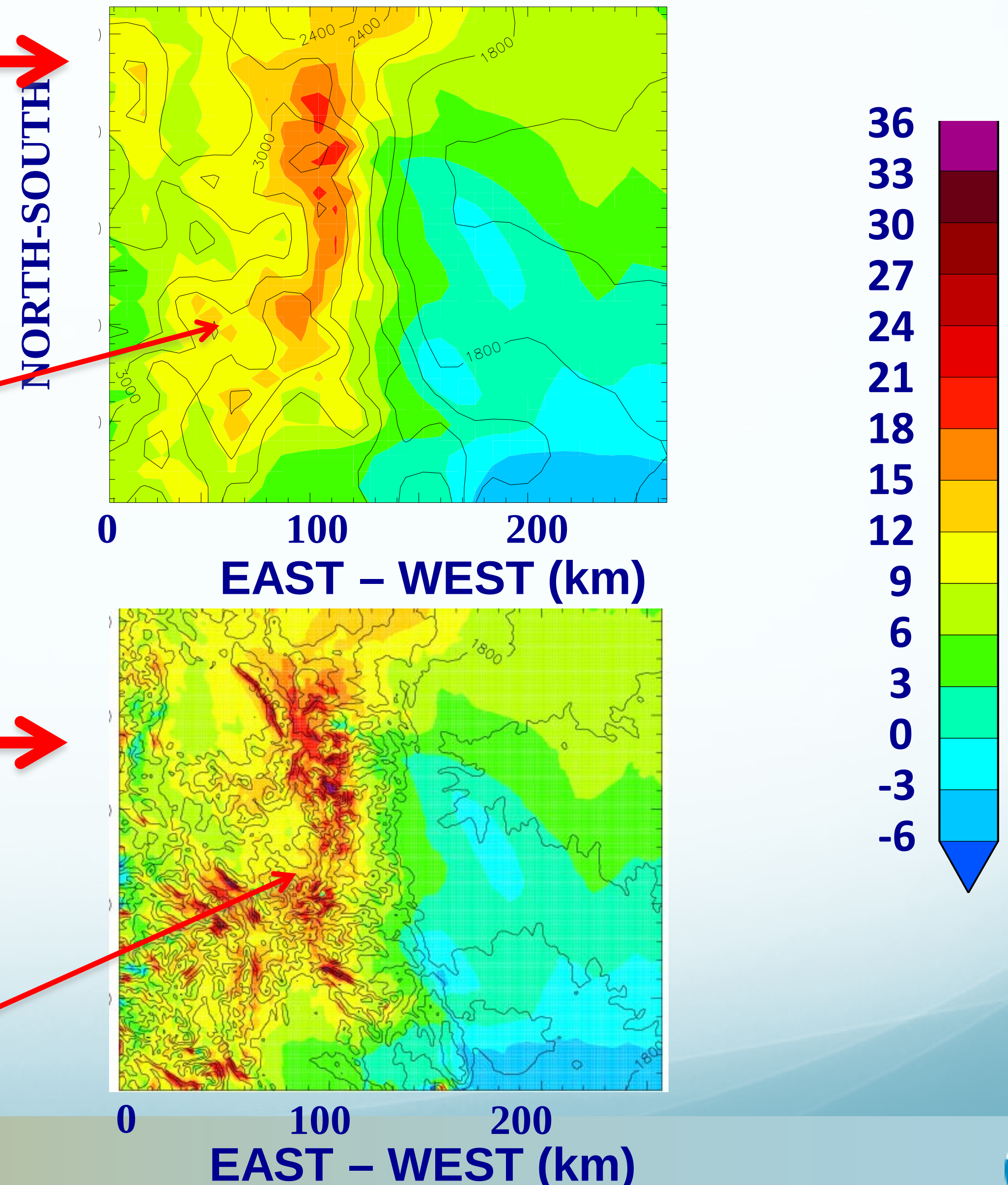
Example of Downscaling: Four Mile Canyon Fire Surface U wind (colors)

Initial input at 8km res

Contour lines: topography

Downscaled output at 1km resolution

Finer details in wind in response to high resolution terrain



Status of STMAS downscaling

Progress:

- Wind analysis shows very promising fine scale structure in steep terrain areas; these areas are crucial for Fire Weather;
- Developed codes to ingest observational data on terrain following coordinate, and tested on various domains and cases;

Issues

- Temperature and Pressure analysis are not satisfactory; the issue is a highly non-linear, and has multiple solutions;
- Several schemes have been proposed and tested; one scheme is to use WRF to integrate the background data for a few iterations to obtain more balanced initial guess;
- Addresses difficulty with running WRF at 1 km resolution over complex terrain.