

Tactical Fire Remote Sensing Advisory Committee (TFRSAC) Meeting

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NASA ROSES A.35 Wildfire Project

Wildland Fire Behavior and Risk Forecasting

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***Affiliated with Colorado State University's Cooperative Institute for Research in the Atmosphere**



Remote Sensing Data used in WRF-SFIRE: Coupled Fire Weather/Fire Behavior Model

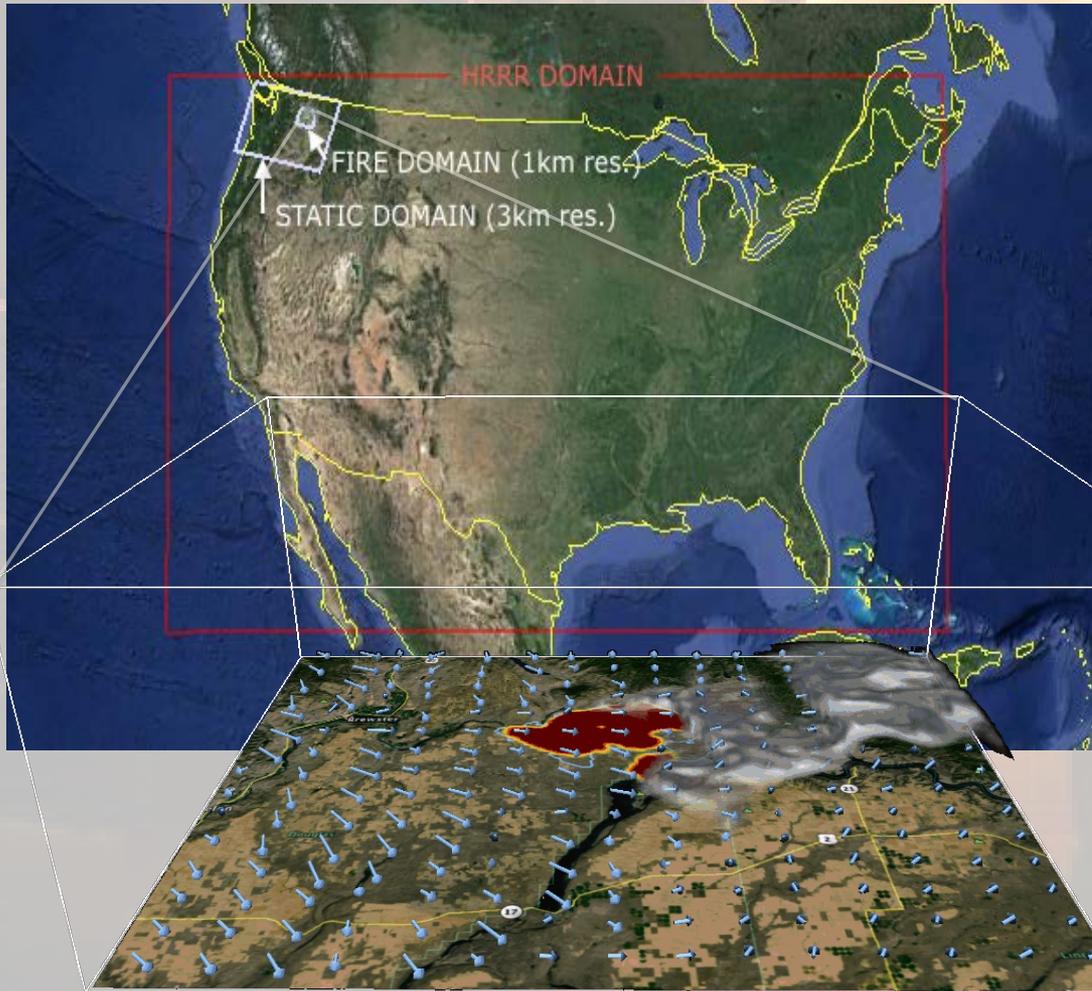
Goal: Real-time wildland fire behavior and risk forecasts, integrated within NOAA and US Forest Service fire weather forecasting systems.

Research Components: Model - The fire forecast system is based on the WRF-SFIRE software, which couples a high-resolution weather forecast with a fire spread model and a dynamic fuel moisture model. **Satellite Obs:** Fire detection and fuel products from MODIS and VIIRS are assimilated into the fire Model.

Operational User: AWIPS Thin Client systems ingest the SFIRE output. NOAA and USFS forecasters utilize the visualization and analysis features of the Thin Client systems in operations.

Research: SFIRE

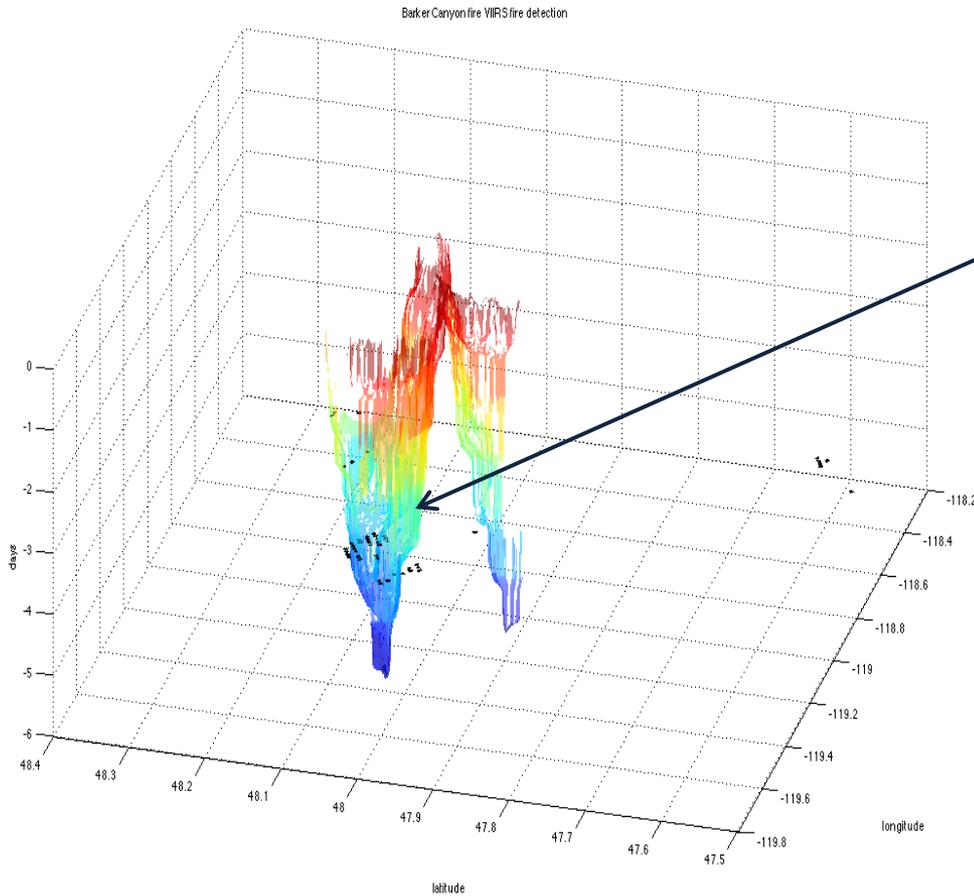
WRF-SFIRE Using NOAA's High Resolution Rapid Refresh (HRRR) Model



Fire simulation domains (white) embedded within the HRRR CONUS domain (red), for the 2012 Barker Canyon Complex fire. The coarser 3km resolution domain is placed statically to cover the whole fire forecast area. One or more smaller and finer 1km resolution domains, placed dynamically depending on the fire location provides:

- *Very high resolution local weather forecast*
- *Fire spread forecast*
- *Smoke forecast*
- *Fuel moisture and Fire risk forecast*

Satellite Obs: Satellite Fire Detection as SFIRE Inputs



Fire arrival time (vertical axis and false color, in days) from WRF-SFIRE simulation, and VIIRS fire detection centroids (black patches), for the 2012 Barker Canyon fire. The clusters at the same height are detections from the same satellite overpass. All fire detection centroids are inside the final fire region, but many are outside at the time of the observation, indicating either a false positive near the fireline, or the need to increase the fire spread rate. The vertical slopes correspond to fire stagnation at night.

Fuel Moisture Model within SFIRE

The fuel moisture model in WRF-SFIRE (Kochanski et al. 2012; Mandel et al. 2012, 2013) simulates the moisture content in idealized, homogeneous fuel species, referred to as 1-hour, 10-hour, and 100-hour time-lag fuel (Pyne et al. 1996), represented on a coarse (WRF atmospheric) mesh. The fuel in the fire propagation is a mixture of these species on a finer grid. The coupling in WRF-SFIRE with atmosphere-driven fuel moisture is also capable of capturing the effect of diurnal variability in relative humidity and temperature on fire propagation.

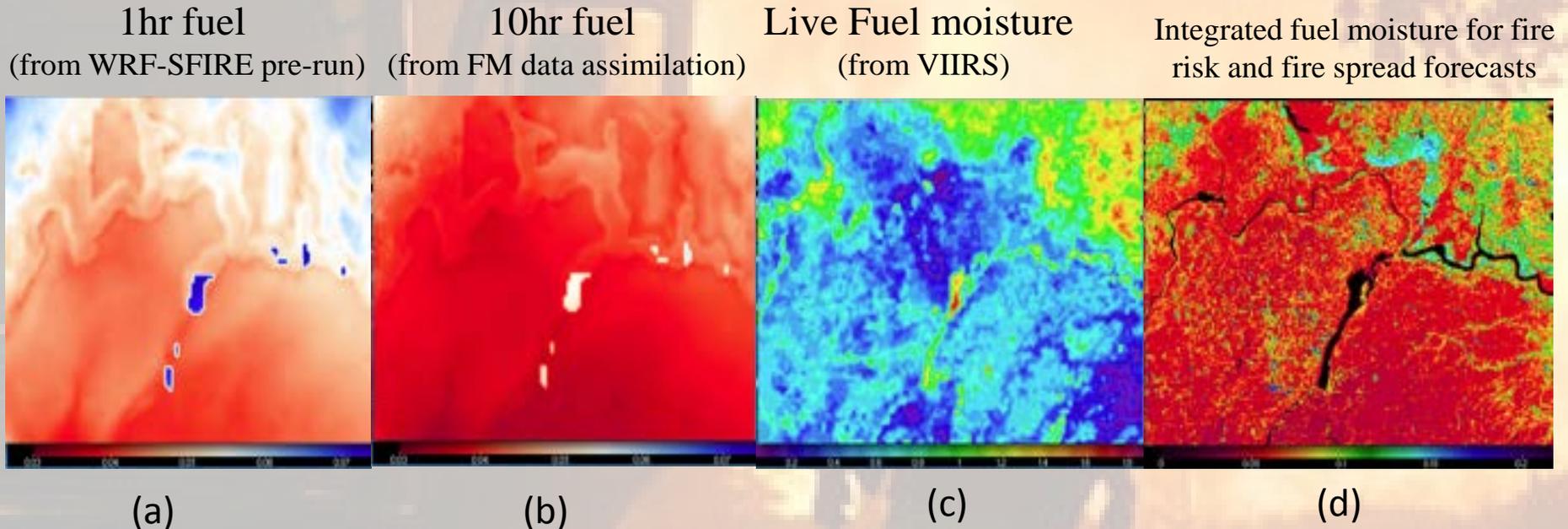
A preliminary version of initialization of fuel moisture fields from satellite NDVI and NDWI has been completed.

Satellite Products

Acquisition and Assessment of Surface Moisture Satellite Products

- VIIRS M7 and M8 used to compute the NDWI and used as a Live Fuel Moisture (LFM) element in the moisture model.
- VIIRS observations are an improvement in spatial and temporal coverage in contrast to on-site LFM measurements.
- Found qualitative evidence that NDWI derived from VIIRS data are positively correlated with live fuel content.

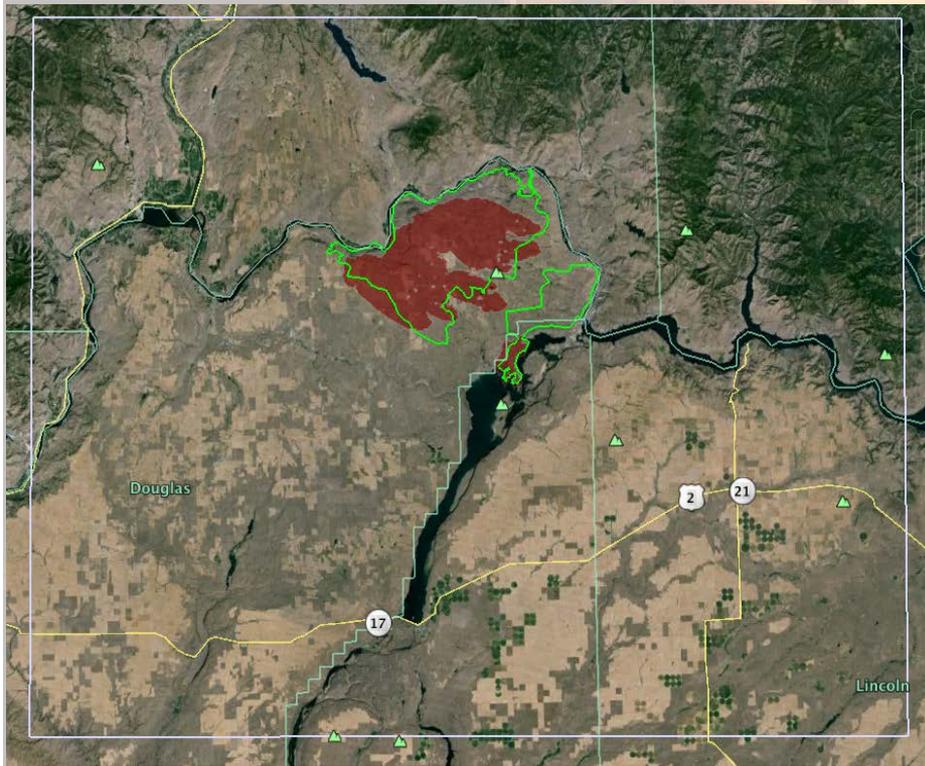
Fuel moisture components from VIIRS and the Fuel Moisture Data Assimilation System



In order to provide the best possible estimate of the fuel moisture for the fire spread forecasts, the system utilizes:

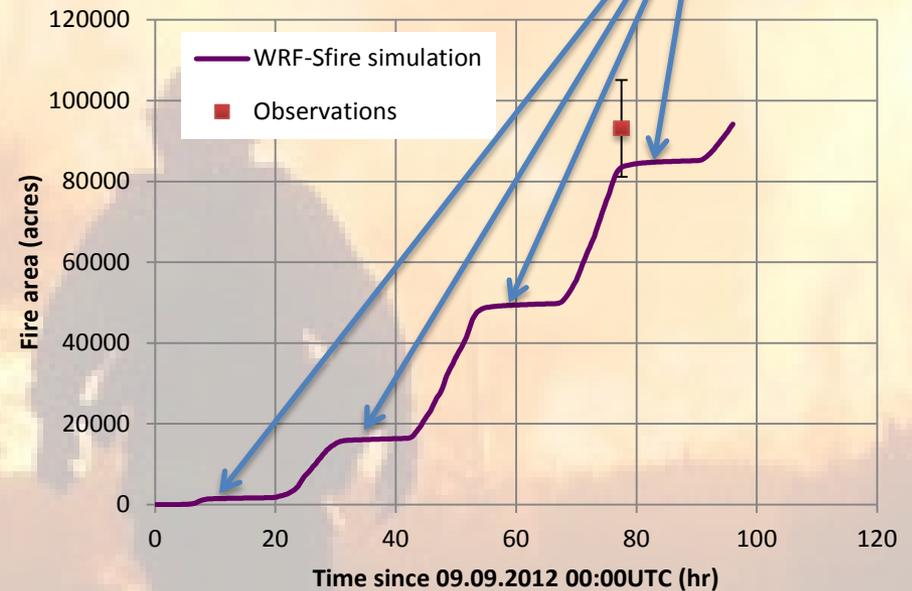
- 1h fuel moisture nowcasts (pre-runs),
- 10h fuel moisture from the data assimilation system utilizing surface fuel moisture observations
- live fuel moisture estimated from VIIRS NDWI

Assessment



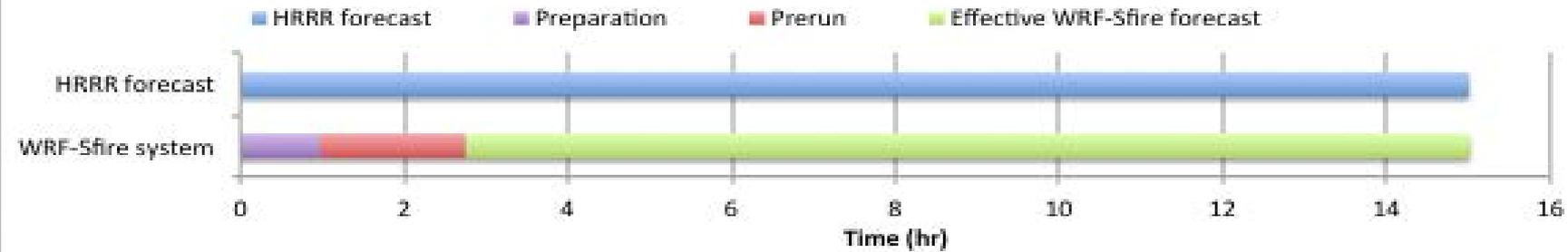
Simulated fire area (red fill) and the observed fire perimeter (green contour).

Fire stagnation due to the nighttime fuel moisture recovery



Diurnal variations in the fire activity being a combined effect of the forecasted changes in the local winds and the variations in the simulated fuel moisture.

Online Initiation and Monitoring of 12-hour fire forecast



NASA project #11-FIRES11-0038 submission



System status

System: gross.ucdenver.edu
 Queued jobs: 0
 Total simulations: 7
 Active simulations: 0
 Free nodes: 12/12
 Status: ONLINE
 Last updated: 2013-09-29_23:01:58

Ignition control

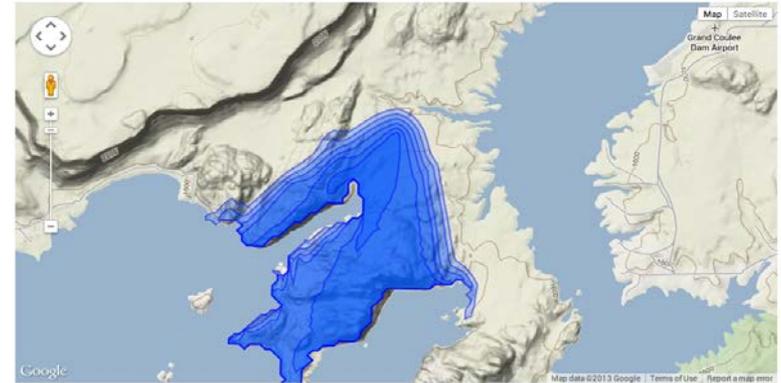
Ignition time:
 Ignition latitude:
 Ignition longitude:
 Forecast length (hr):

System messages

2013-09-29_22:59:48 - Hello from wrfx2 web server.

USAGE
 Click anywhere on map to place ignition point. Coordinates will appear on control panel. Adjust parameters as desired and submit to start a fire simulation. Note the ignition time is fixed in the prototype. After submission, you will be redirected to a page that will render the results of the simulation.

Fire simulation monitor



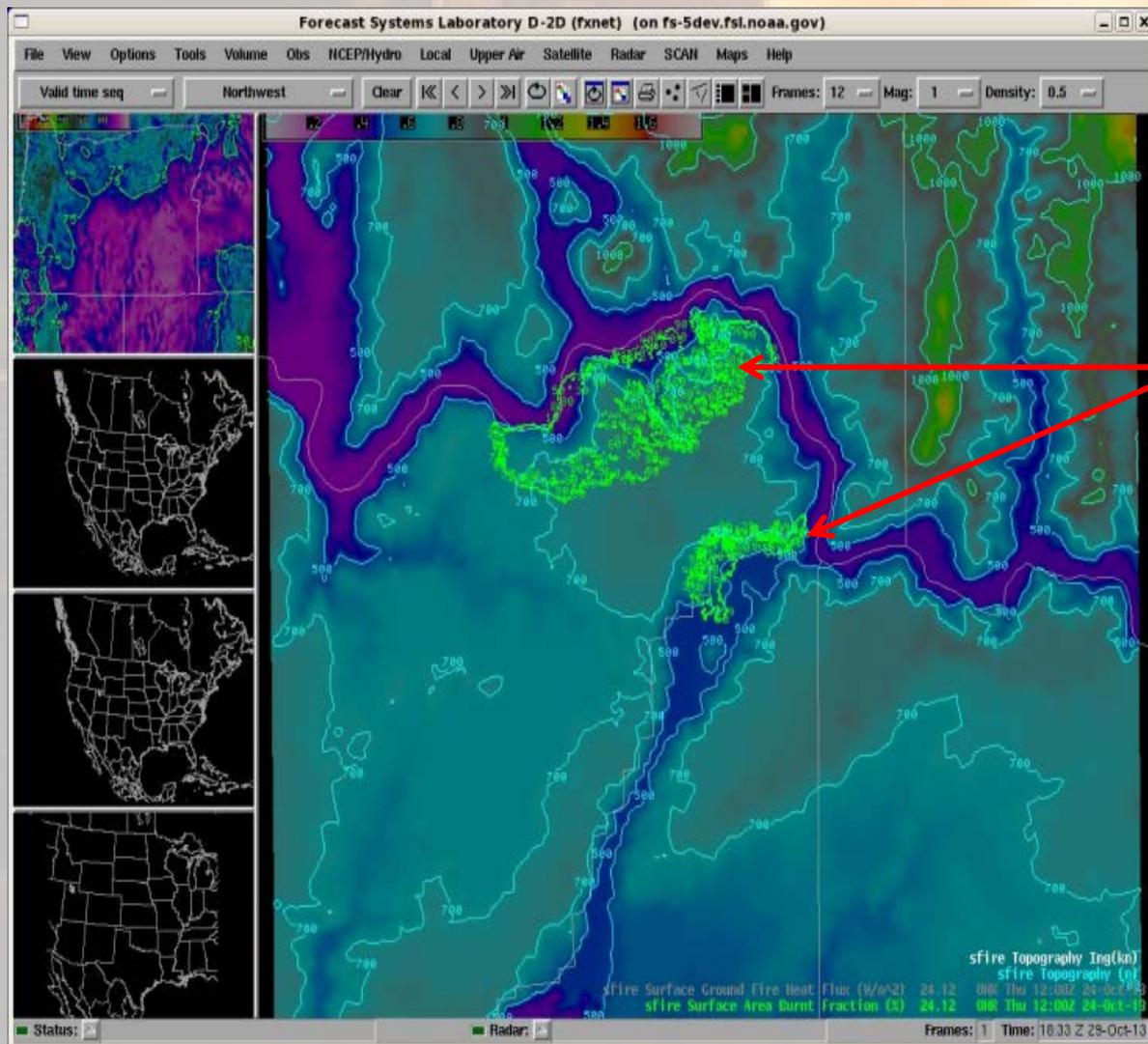
Job status and control

36.7%
 Current KML view:
 Stage:
 Completion time:
 Time in simulation:
 Speedup vs. RT:

System messages

2013-09-24_11:39:48 - CONNECTED
 2013-09-24_11:39:48 - You are monitoring job 35b55327-2c43-4d62-beb9-a314ccf91c9f
 2013-09-24_11:39:50 - Simulation in stage "WRF".

Operational Users: SFIRE and Satellite Data Delivery



*FX-Net used by the NWS IMETS and by NIFC meteorologists, with **WRF-SFIRE simulation output data** and **HRRR output**. The SFIRE light green color contours shows SFIRE forecasted fire area.*

The FX-Net system will also ingest fire perimeter data and satellite-derived fire products.

Concept of Operations incorporating the WRF/SFIRE System

Wildland Fire Concept of Operations Incorporating SFIRE



- NASA and NOAA Satellite
Fire Mapping
Communications
Weather Data Collection
Model Validation

FX-Net System:

Integrated, real-time
Weather and Fire
Behavior information

WRF SFIRE: Fire Scale Winds, Temp, RH

Coupled Weather/Fire Behavior Forecasts

Model Products: SFIRE Portal Interface, NOAA/USFS
Weather, Smoke and Fire Behavior Information:

Smoke Plume and Dispersion
Uncertainty Guidance

Critical Scene UAS Observations

Real-time Fire Behavior Tracking

In-Situ Observations

UAS:
Comms
Fire mapping
In-situ obs



IMET Weather Briefing

Air Drop Operations

Incident Command

Situational Awareness

Fire Fighter Crew Chiefs

VIIRS Fire Product

WRF SFIRE Output informs:

High Fire Danger Areas

Extreme Fire Behavior Alerts

Severe Weather Impacts on Fire Behavior

