

WILDFIRE MANAGEMENT TOOL WEB EDITION



Using NASA Web World Wind to Predict Wildfire Behavior

Southern California Government GIS User Group

Torrance, CA

September 16, 2015



The Wildfire Management Tool (WMT)

<http://wmt.emxsys.com/>

Mobile and desktop compatible web app



The Wildfire Management Tool (WMT)

<http://eurochallenge.como.polimi.it/>

1st place in the
***NASA World Wind
Europa Challenge 2015***

FOSS4G Europe,
Como, Italy

Bruce Schubert

T.J. Walton

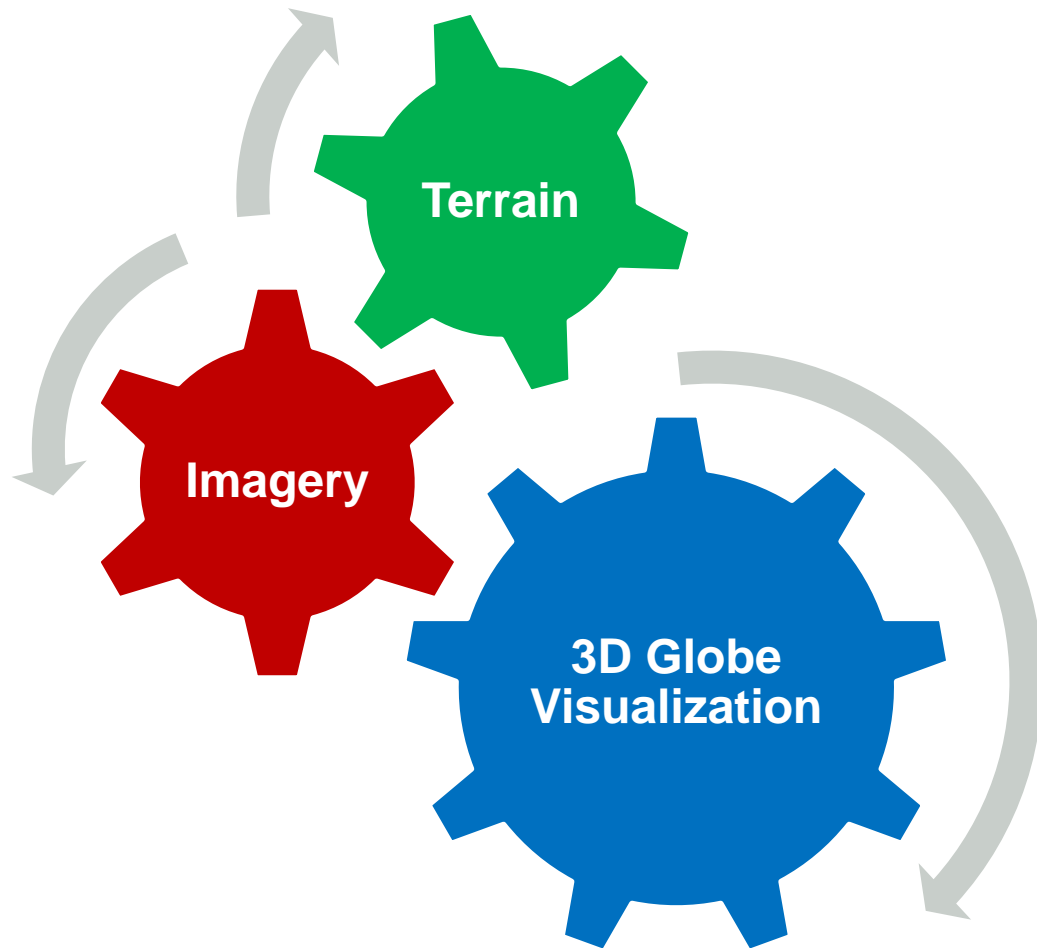
Shawn Patterson



Built on NASA's Web World Wind SDK



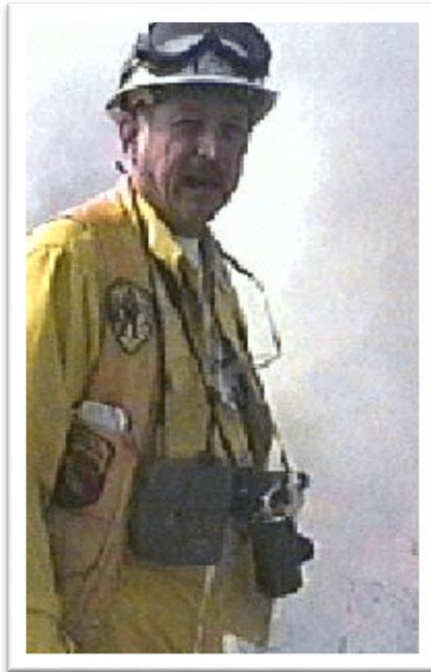
<http://webworldwind.org/>



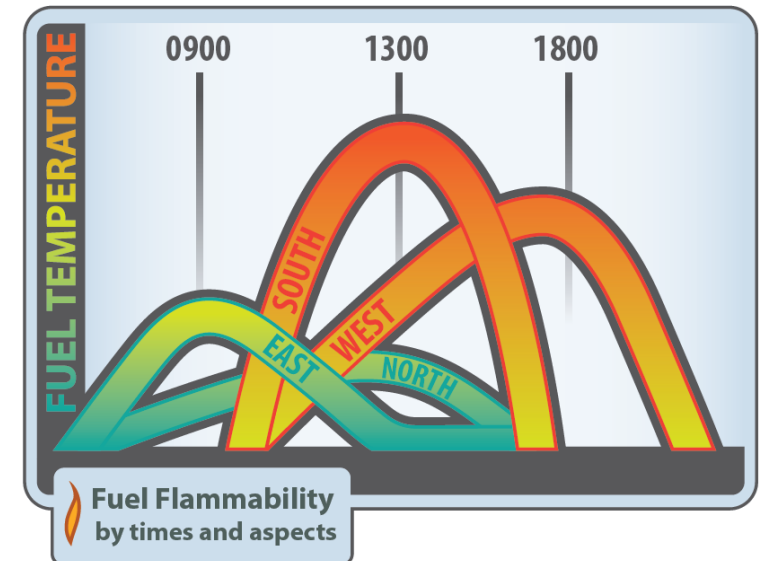
- JavaScript API
 - Well crafted; extensible, easy to use
- Custom shapes
 - Analytic surfaces, rigid shapes, terrain conforming surface shapes, volumes, place marks, geographic text,
- 3D globe and continuous 2D map mode with extensible projections
- KML and Collada support
- Flexible and extensible viewing and navigation system
- Shapefile support
- WCS and WMS support

Embodies the Campbell Prediction System (CPS)

Learn from the Past—Predict the Future
What does the fire tell you?



- Alignment of Forces Concept
 - In-alignment tracks
- Trigger Points
 - Geographic/Temporal
- Fuel Flammability Curves
- Replications



Includes Rothermel's Fire Spread Model

$$R_{surface} = \frac{I_R \xi (1 + \phi_w + \phi_s)}{\rho_b \epsilon Q_{ig}}$$



Richard C. Rothermel

Figure 2.--Schematic of no-wind fire.

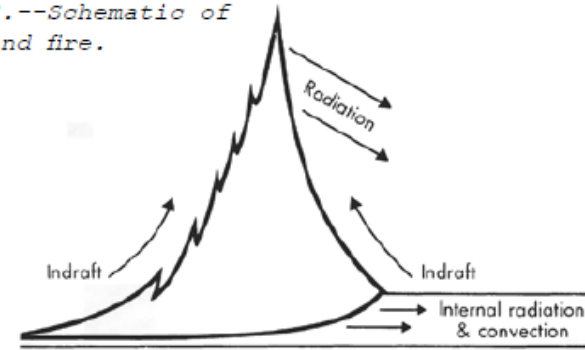


Figure 3.--Schematic of wind-driven fire.

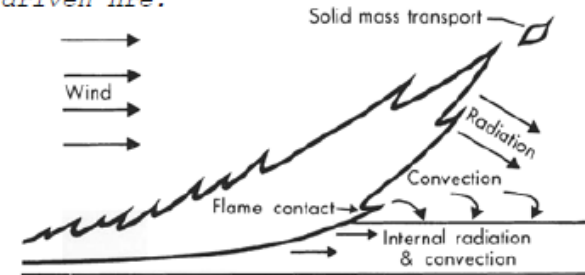
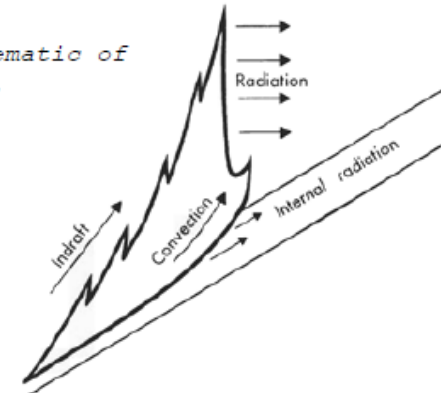


Figure 4.--Schematic of upslope fire.

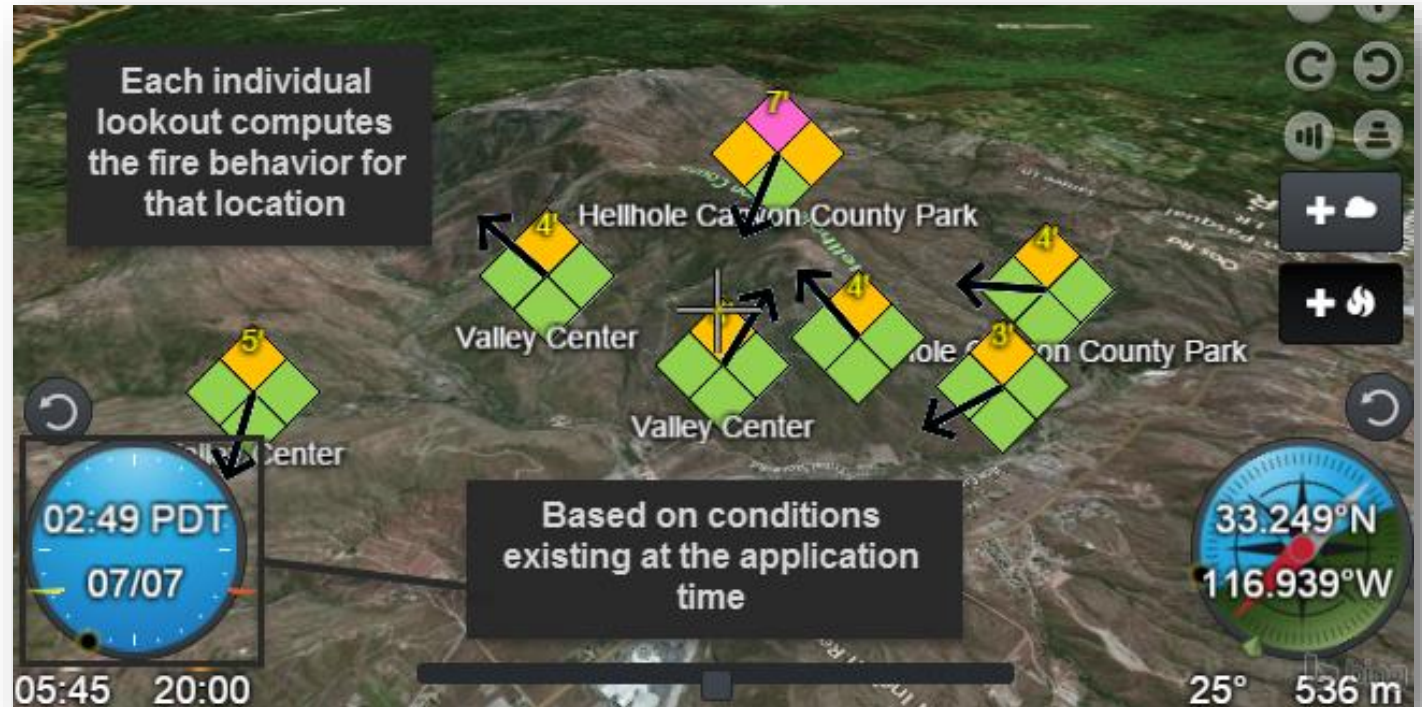


Fire Lookouts – *Dynamic Spatiotemporal Markers*



Fire behavior is the manner in which a fire reacts to the influences of: fuel, weather, topography.

- Simply drag-n-drop *Fire Lookouts* where you want to know the potential fire behavior.
- *Fire Lookouts* show fuel model, flame lengths for head, flanks & heal, and direction of max spread.

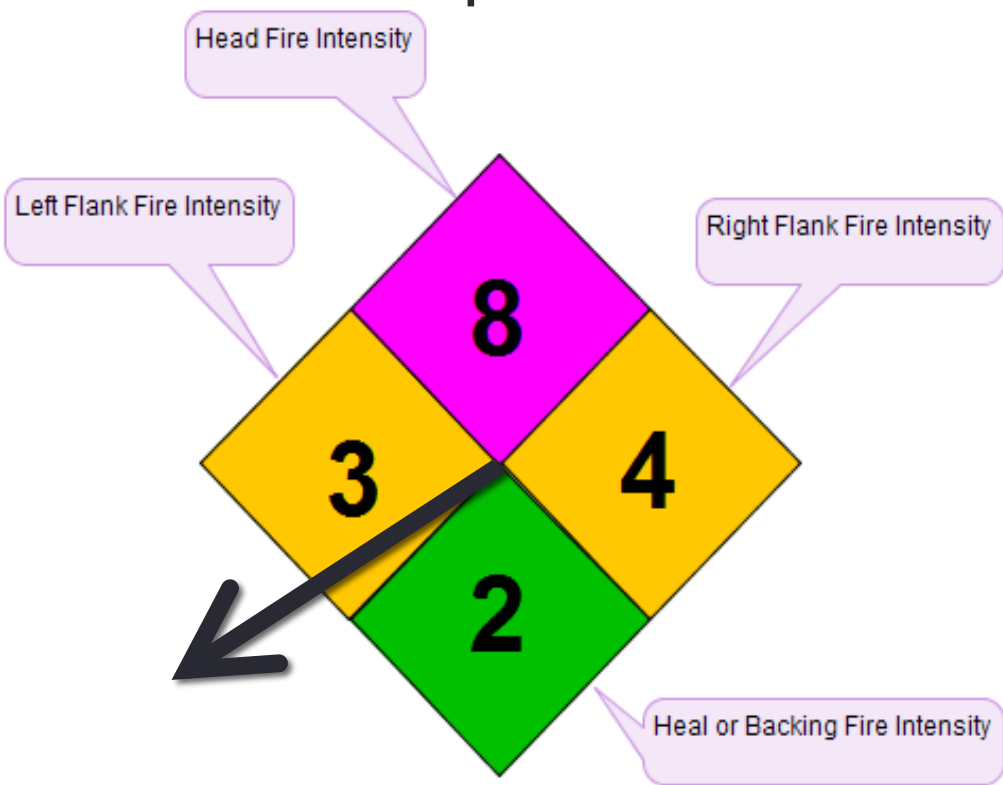


- Fire Lookouts react to changes in weather and temporal solar conditions.

Developer Note: Fire Lookouts are custom composite renderables made from Placemark and GeographicText objects

New Symbol – The Wildfire Diamond

Fire behavior depicted for all quadrants





Intensity	Flame	Description
Low	0-1'	Very little resistance to control and direct attack with firefighters is possible.
Moderate	1'-3'	Moderate resistance to control but can be countered with direct attack by firefighters.
Active	3'-7'	Substantial resistance to control. Direct attack with firefighters must be supplemented with equipment and/or air support.
Very Active	7'-15'	Extreme resistance to control. Indirect attack may be effective. Safety of firefighters in the area is a concern.
Extreme	> 15'	Extreme resistance to control. Any form of attack will probably not be effective. Safety of firefighters in the area is of critical concern.

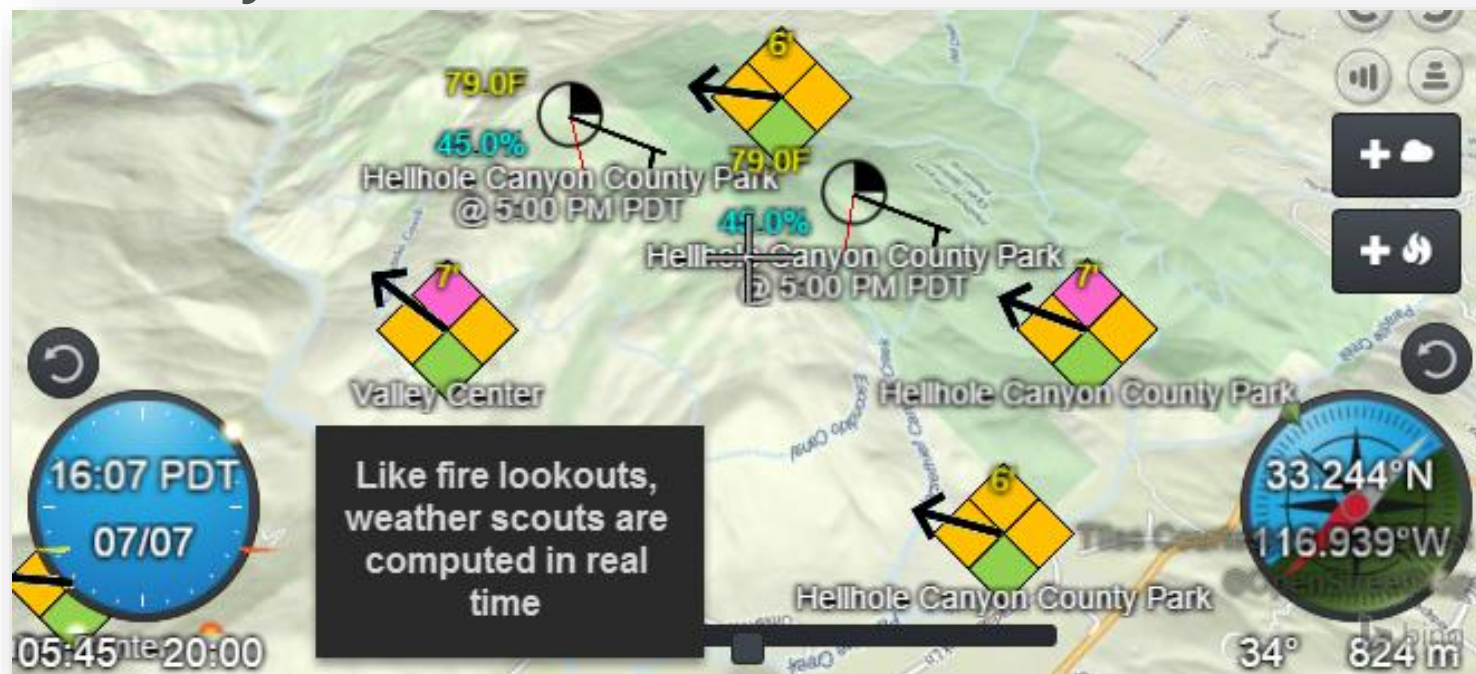
Weather Scouts

National Weather Service point weather forecasts are rendered using standard weather station symbols.

- Simply drag-n-drop *Weather Scouts* to where you want to know the wx.
- *Weather Scouts* show:

- Sky cover 
- Wind speed and direction 
- Air temperature (F)
- Relative humidity (%)




- *Weather Scouts* are spatiotemporal markers.







Developer Note: Weather Scouts are custom composite renderables made from Placemark and GeographicText objects.

Spatiotemporal Data at Reticule

Temporal Widget

- Application date and time
- Sunrise and sunset times 
- Local solar hour angle (sun icon) 
- Sunrise and sunset hour angles (tick marks) 

Location Widget

- View orientation (compass) 
- Solar azimuth (sun icon) 
- Slope (% and inclinometer) 
- Aspect (tick mark) 
- Ground elevation (m)



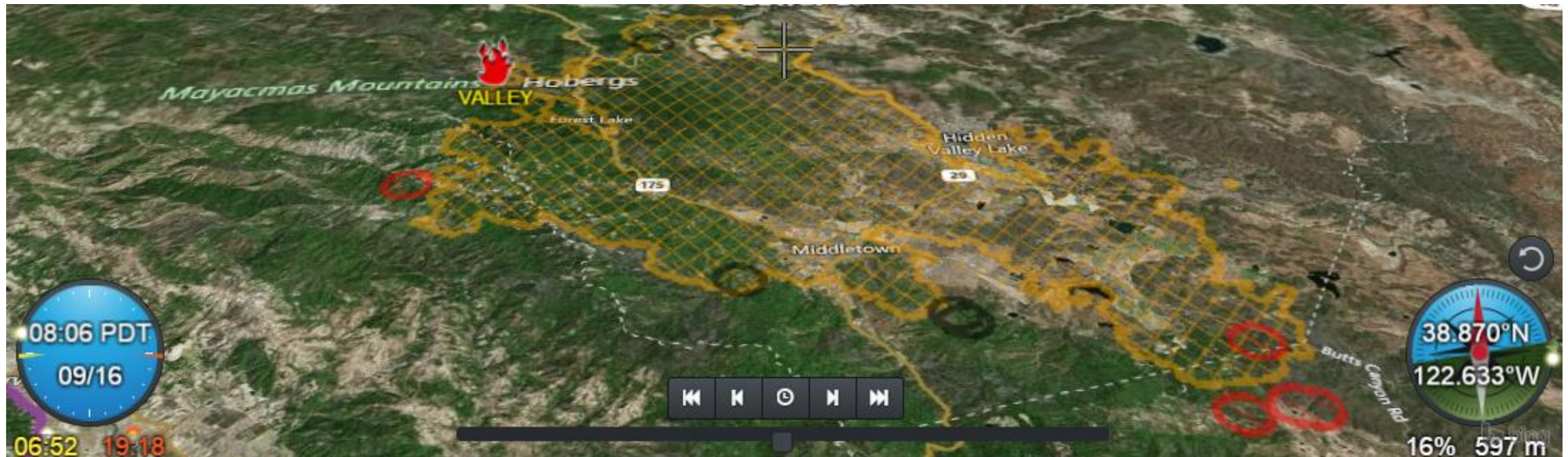
Developer Note: Widgets are custom composite renderables made from ScreenImage and ScreenText objects; slope and aspect are computed from Globe and ElevationModel objects.

GeoMAC Wildfire Incidents



<http://www.geomac.gov/>

- REST: http://wildfire.cr.usgs.gov/arcgis/rest/services/geomac_fires/MapServer
 - Active fires
- WMS: http://wildfire.cr.usgs.gov/ArcGIS/services/geomac_dyn/MapServer/WMSServer
 - Perimeters: current, previous and historic
 - Recent fire activity: MODIS and HMS satellite imagery analysis

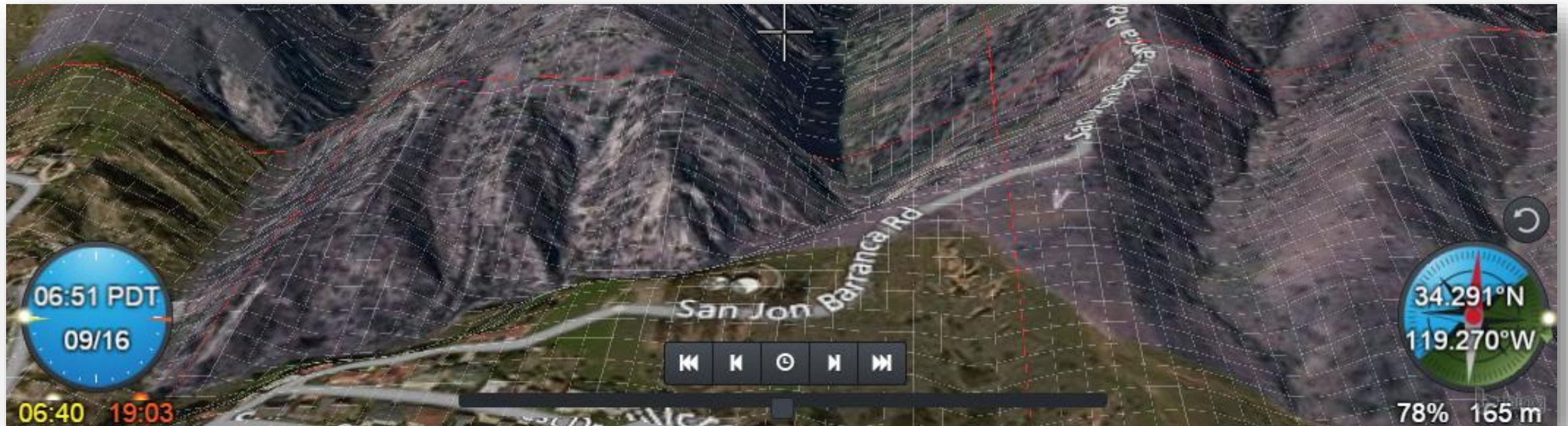


Developer Note: Active Fire icon is a standard Placemark object.

NASA World Wind's Earth Elevation Model



- WMS: <http://worldwind26.arc.nasa.gov/elev/>
- Layers:
 - USGS NED 10m (USGS-NED)
 - ASTER GDEM Version 2 30m (aster_v2)
 - General Bathymetric Chart of the Oceans (GEBCO)



LANDFIRE Fuel Models



<http://www.landfire.gov/>

- REST: <http://landfire.cr.usgs.gov/arcgis/rest/services/Landfire>
- WMS: http://landfire.cr.usgs.gov/arcgis/services/Landfire/US_130/MapServer/WMSServer

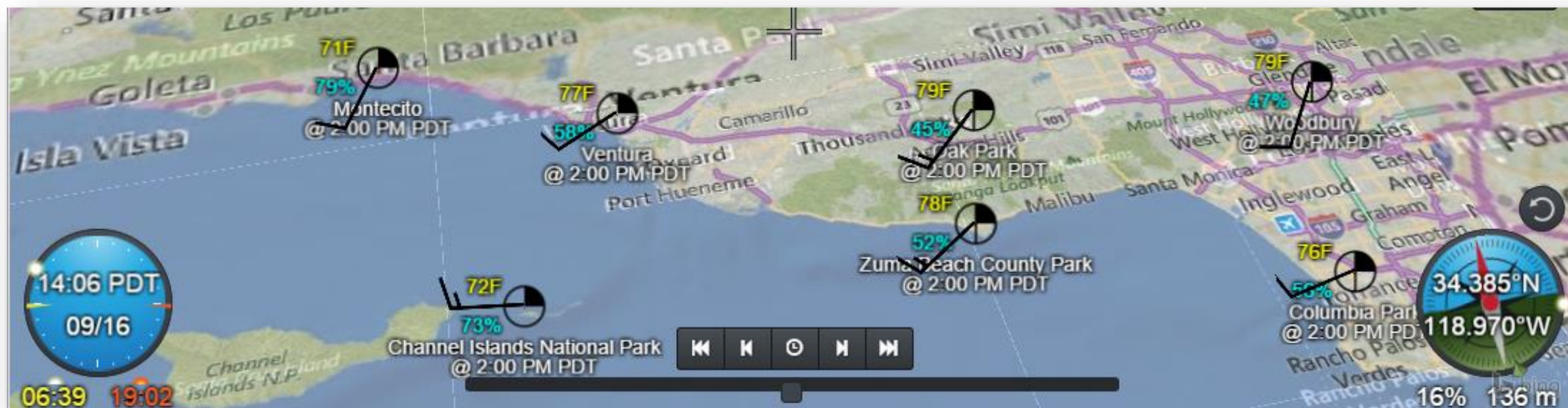


NWS Point Forecasts



National Digital Forecast Database (NDFD) REST Web Service

- Documentation: <http://graphical.weather.gov/xml/rest.php>
- REST: http://graphical.weather.gov/xml/sample_products/browser_interface/ndfdXML.htm
- Results in Dynamic Weather Markup Language (DWML), i.e., XML
 - Processed by WMT-REST server and sent to WMT client via JSON



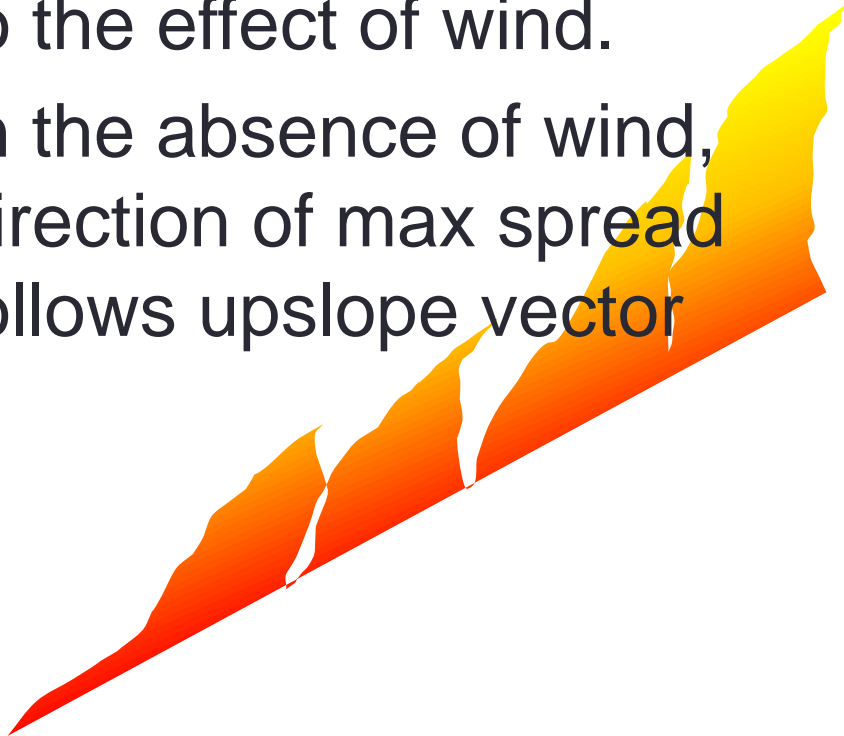
Wind Affects Fire

- Flames are inclined towards the fuel
- Fuels are heated by radiation and convection
- Direction of max spread is inline with wind direction



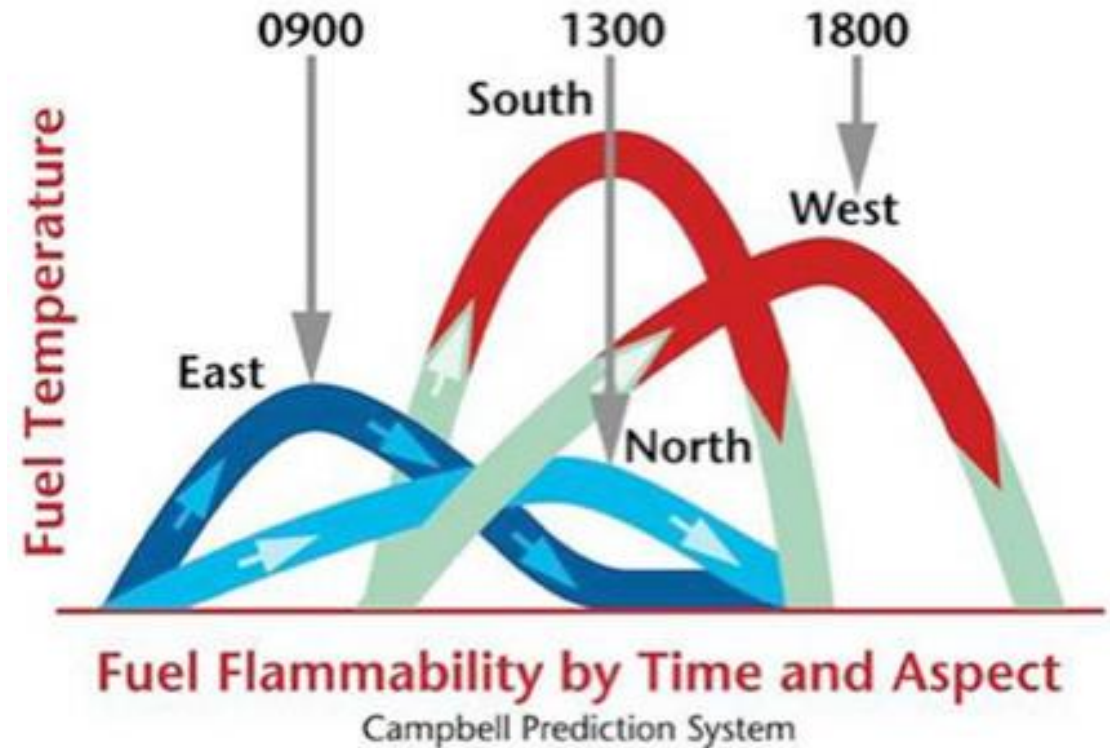
Slope Affects Fire

- Upslope fuels are closer to the flames.
- The results are very similar to the effect of wind.
- In the absence of wind, direction of max spread follows upslope vector



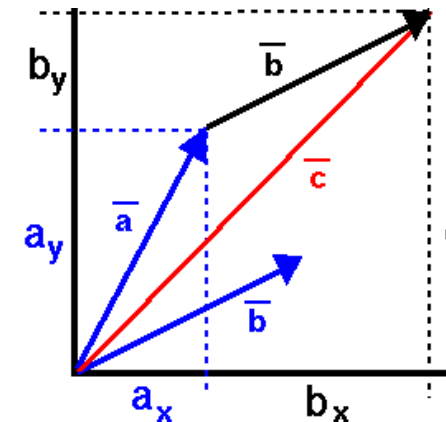
Solar Radiation Affects Fire

- Changes the fuel flammability
 - Solar Radiation *preheats* the fuel
 - *Drives off moisture, making the fuel more flammable*
- Changes with time and aspect
 - Creates an unstable fuel bed

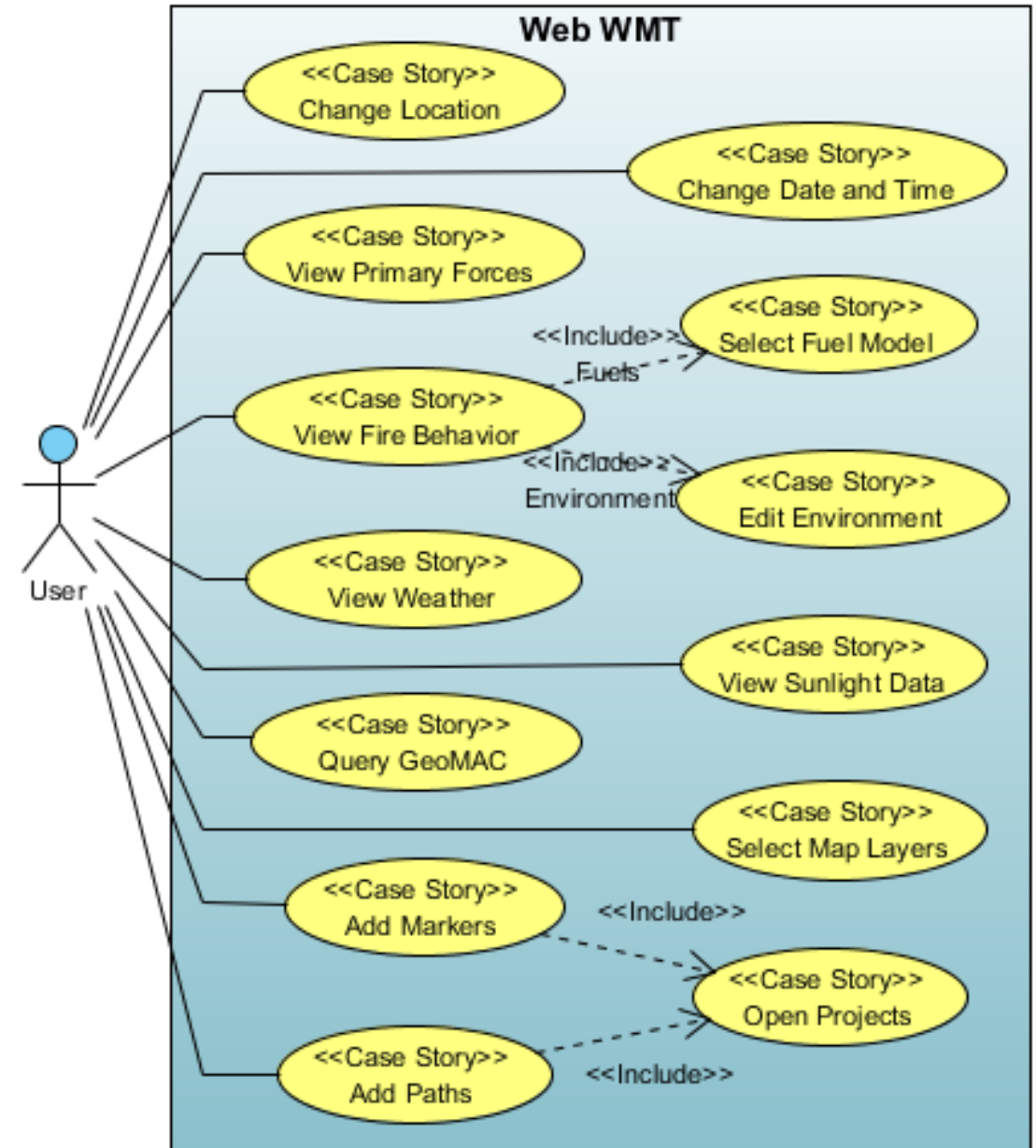
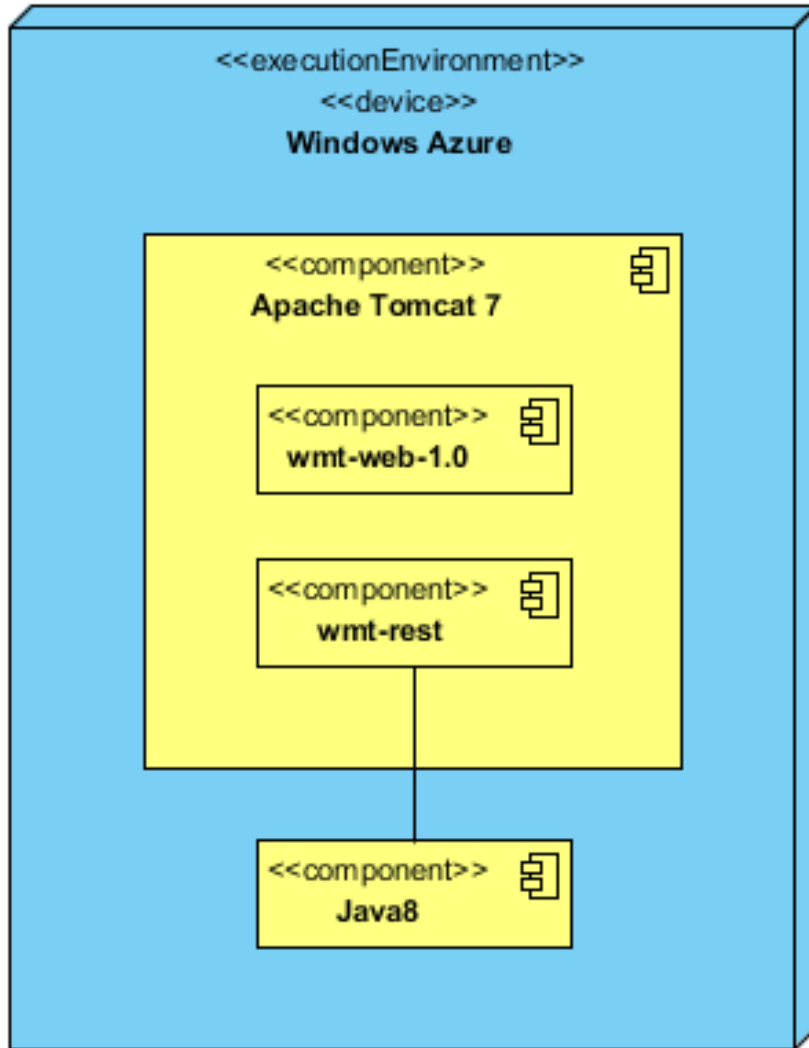


CPS Alignment of Forces Concept

- **Variations in Wind, Slope and Preheating explain changes in fire behavior**
- **Wind, Slope and Preheat are the primary forces**
 - Fire Behavior is affected by variations in:
 - Strength
 - Dominance
 - Alignment
- **In-Alignment Forces Exacerbate** Fire Behavior
- **Out-of-Alignment Forces Reduce** Fire Behavior



Software Architecture



In Closing

- Email:
 - “Bruce Schubert” bruce@emxsys.com
- Website:
 - <http://emxsys.com>
- WMT Web App:
 - <http://wmt.emxsys.com>
- Wildfire Management Tool – Web open source project (wiki, issue tracker, and source code):
 - <https://bitbucket.org/emxsys/wildfire-management-tool-web/>