Caltrans WeatherShare System:

A look at design, development, and usability

www.weathershare.org

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Disclaimer

This is a research project and the information presented herein is for discussion purposes only. It does not necessarily represent the views of the sponsor agency, the California Department of Transportation.

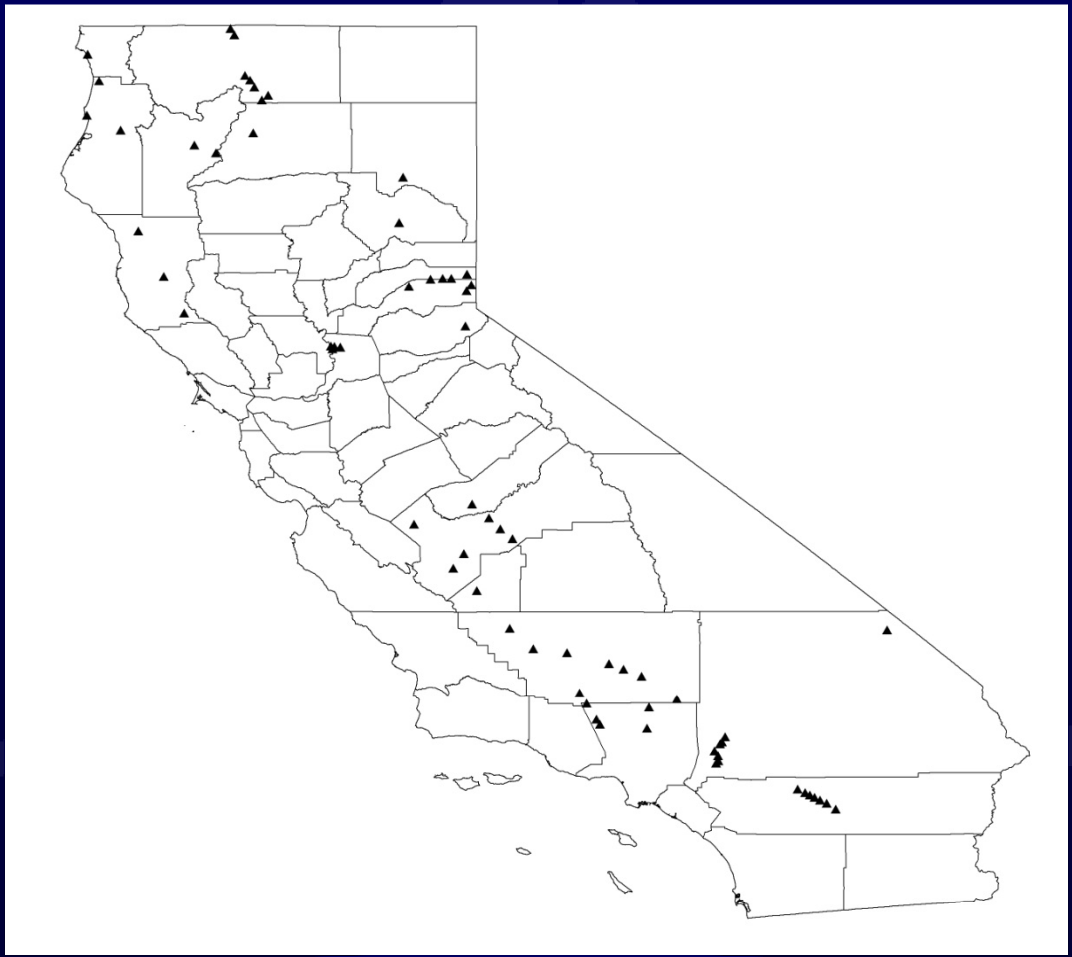
Agenda

- Introduction to WeatherShare
- Acquiring/parsing data
- Data quality control
- Presenting data
- General lessons learned
- Related projects

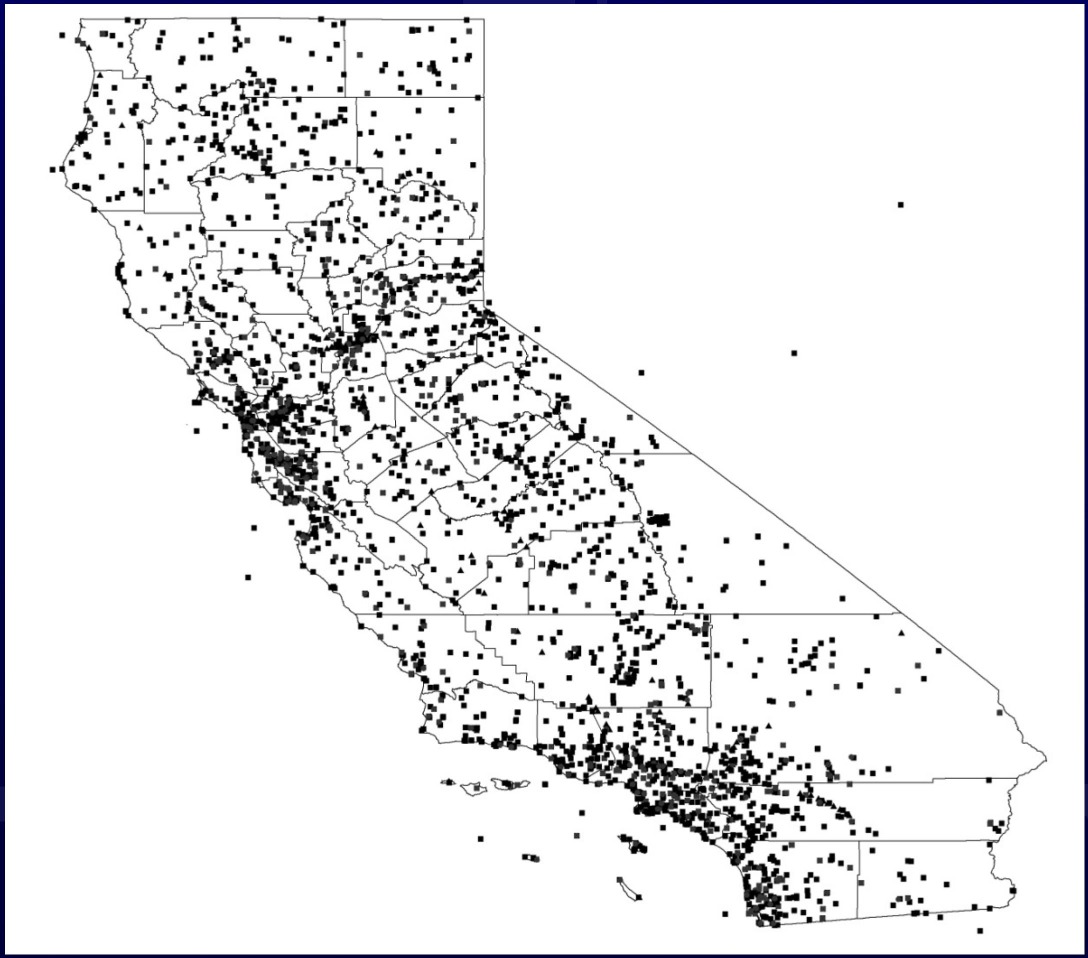
WeatherShare Phase II Background

- Aims at improving weather incident recognition and response by providing streamlined access to surface weather data from multiple sources
- Statewide coverage
- Total 3271 surface real time weather stations
  - 107 Caltrans RWIS stations
  - 690 Madis stations
  - 2474 Mesowest stations
- Mapping National Digital Forecast Database (NDFD) data to California mileposts
- Enhanced alert capability
- Layered Google Maps display

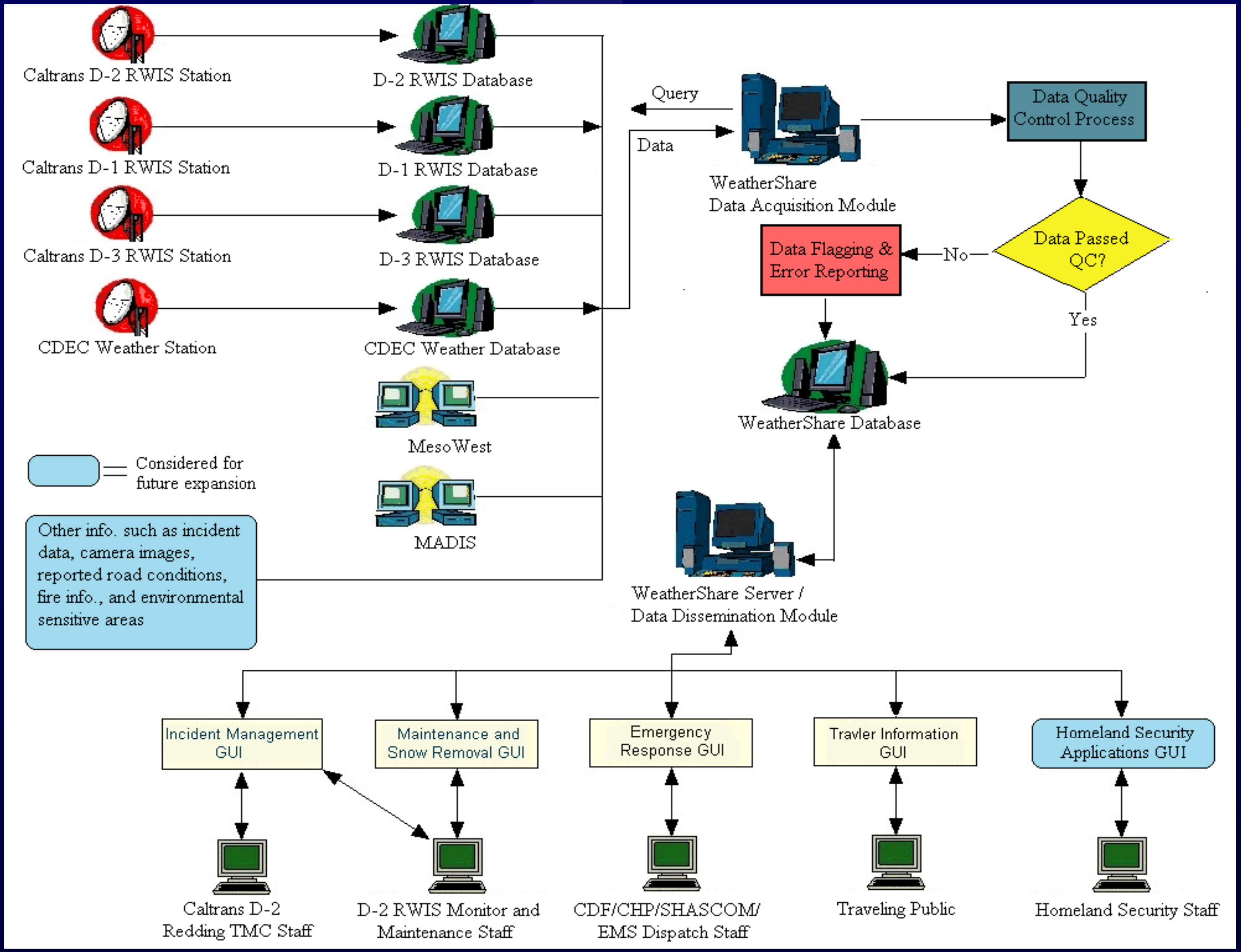
Caltrans RWIS stations



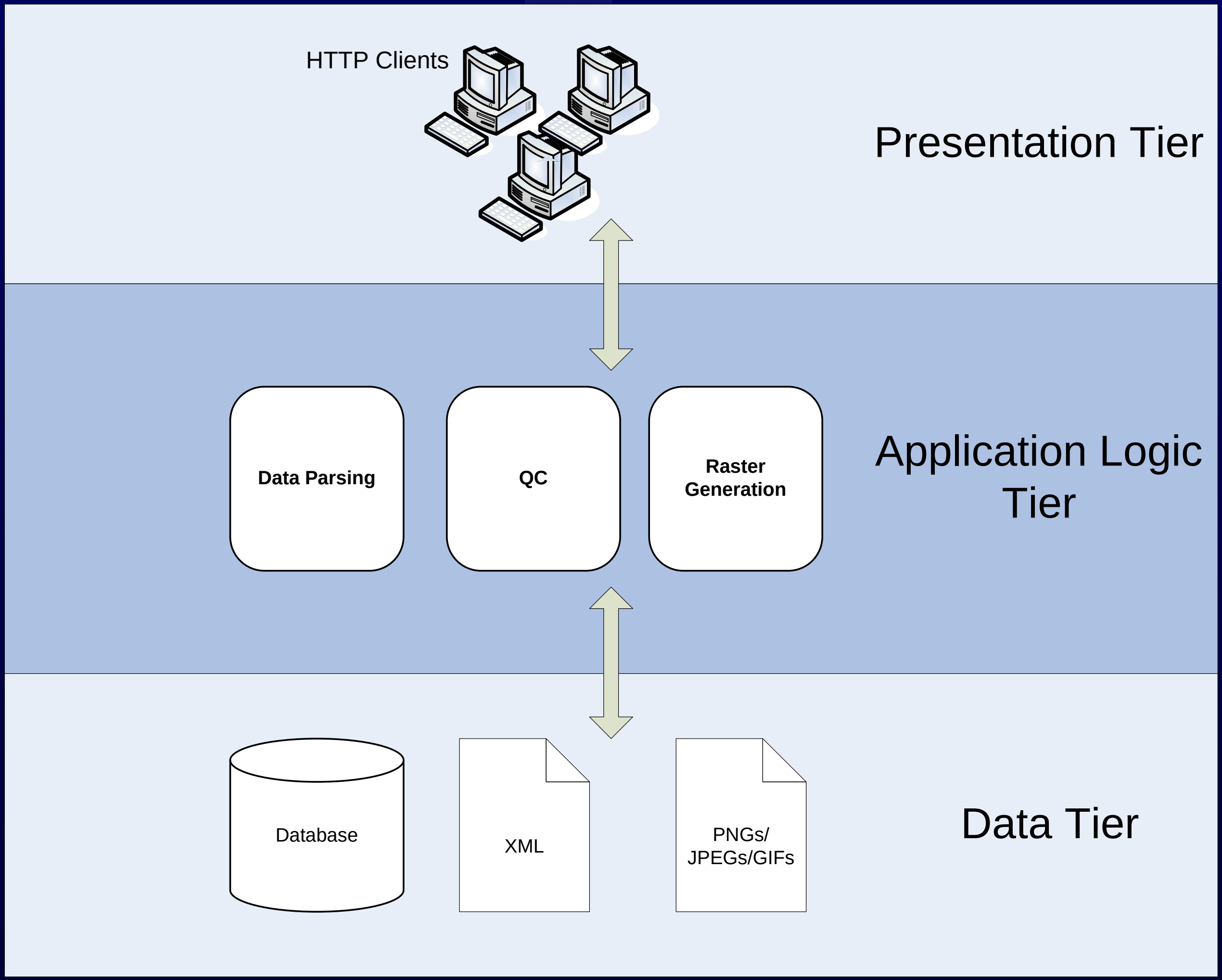
Surface weather stations



WeatherShare Concept & Information Flow



Three-tier System Architecture



System Hardware Configuration

old

- Dual Intel(R) Xeon(TM) CPU 2.40GHz
- Hard drives: 80 GB x 2
- 1 GB memory

↓

new

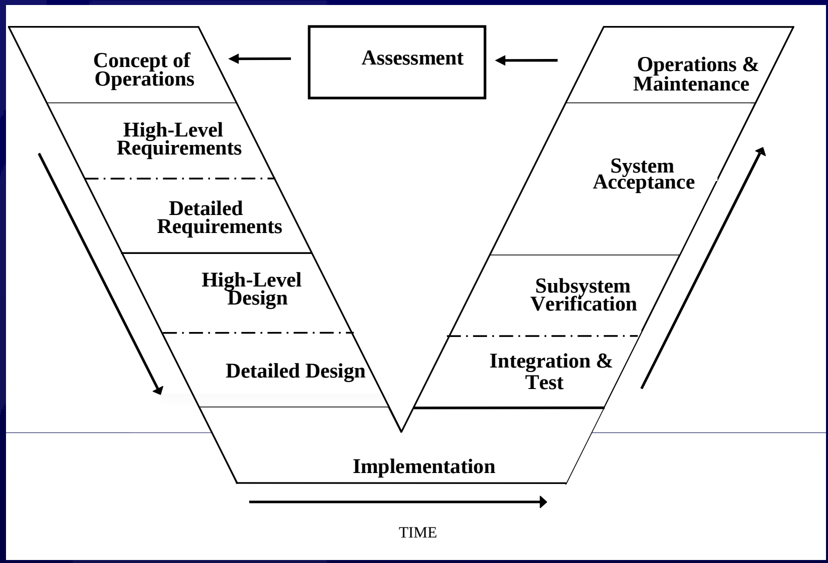
- Dual Quad Core Intel® Xeon®X5450 3.0GHz
- Hard drives: 300 GB x 2 RAID 1
- 16 GB memory

Open Source Platform

old	new
Debian Linux (kernel 2.4.25)	Debian Linux (2.6.26-1-amd64)
Apache v 1.3	Apache v 2.0
MySQL v 5.0.32	MySQL v 5.0.51
Perl v 5.8.8	Perl v 5.10.0
PHP v 4.4.4-8	PHP v 5.2.6-1
GCC v 4.1.2	GCC v 4.3.2
GD 2.0	GD 2.0

Systems Engineering Process

- Phased approach
  - Phase I: Prototype system (2003 – 2006)
  - Phase II: Full system (2006 – 2009)
- Follow the V model on a small scale



Current Condition Data Sources, Update Frequency & Sensor Readings

- MADIS(690 stations): every 30 minutes Air Temperature, Relative Humidity, Avg Wind Speed, Avg Wind Direction, Max Wind Gust Speed, Max Wind Gust Dir, Dewpoint Temp, Atmospheric Pressure, Fuel Moisture, Fuel Temperature, Precipitation Rate, Precipitation in 24Hours
- MesoWest(2474 stations): every 15 minutes

  Air Temperature, Relative Humidity, Avg Wind Speed,Avg Wind Direction,Max Wind Gust Speed, Atmospheric Pressure, Solar Radiation
- Caltrans RWIS(107 stations): every 30 minutes

  Air Temperature, Dewpoint Temp, Max Temp, Min Temp, Avg Wind Speed, Max Wind Gust Speed, Avg Wind Direction, Max Wind Gust Dir, Relative Humidity, Precipitation Intensity, Precipitation Rate, Accumulate Precipitation, Visibility
- NWS Observed 24 Hours precipitation: Twice in 24 hrs

Forecast Condition Data Sources, Update Frequency

- NDFD data: every 60 minutes Air Temperature, Humidity, Avg Wind Speed, Avg Wind Direction, Max Wind Gust Speed, Max Wind Gust Dir, Sky cover, 12 hours probability of precipitation, 6 hours amount of precipitation, Snow, weather
- NWS Warnings, Watches and Advisories: every 15 minutes

Warnings: Tornado, Flash flood, Blizzard, Winter Storm, High Wind, Storm, Avalanche, Severe weather statement, Flood, Red flag, Heavy Freezing Spray

Watches: Flash Flood, Winter Storm, Flood, High Wind, Fire Weather, Coastal Flood Statement, Special Weather Statement, Short Term Forecast

Advisories: Winter Weather, Flood, High Surf, Small Craft, Brisk Wind, Lake Wind, Wind

Methods for accessing, converting, and storing data

- Accessing data through ftp, http, no push
- Raw data format: csv, xml, netCDF
- Parsed and saved into MySQL database
- With large amount of saved data, database design and access must be optimized
- CALTRANS - http
- MADIS – accessed via ftp
- MESOWEST – accessed via ftp
- NDFD – via http

Problems encountered while dealing with data and solutions

- Data outage : register email list for earlier notification
- Data format change : error control in code
- Daylight saving time: all times converted to UTC time
- Station META data (Name, locations, etc) changed without notification: manually update based on station error report or batch program update
- There is overlap: we are using it for “backup” purposes
- Not all stations report new readings with the indicated frequency: only display data updated within 90 minutes
- Server running slow for bin/raster process: upgrade server, optimize codes

Quality Control

- **Level I:**
  - Range checks
- **Level II:**
  - Temporal consistency checks: rate of change
  - Single sensor time series test: acceptable Delta
- **Level III:**
  - Statistical spatial consistency checks: “buddy” check
    - Multivariate linear regression is being implemented for Level 3 quality control for air temperature only
    - Results are experimental
    - No uniform standard for this
    - It has already proven useful
    - Requires further investigation

Range checks

Location	Latitude 0° – 90°N; Longitude 20°W – 120°E
Station Pressure	6.8 inches (568mb) – 32.5 inches (1100mb)
Air temperature	-60°F – 130°F
Soil temperature	-40°F – 150°F
Dewpoint	-80°F – 90°F
Relative Humidity	0 – 100%
Wind Direction	0° – 360°
Wind Speed	0 – 250 knots
Maximum Gust	11 – 250 knots
Visibility	0 – 100 miles
Accumulated Precipitation (24-hour)	0 – 44 inches

Temporal consistency checks

• Pressure (station)	0.150 inches/hour
• Air Temperature	20°F/hour or no change in 24 hours
• Dewpoint	20°F/hour
• Relative Humidity	50%/hour

Spatial Consistency Checks

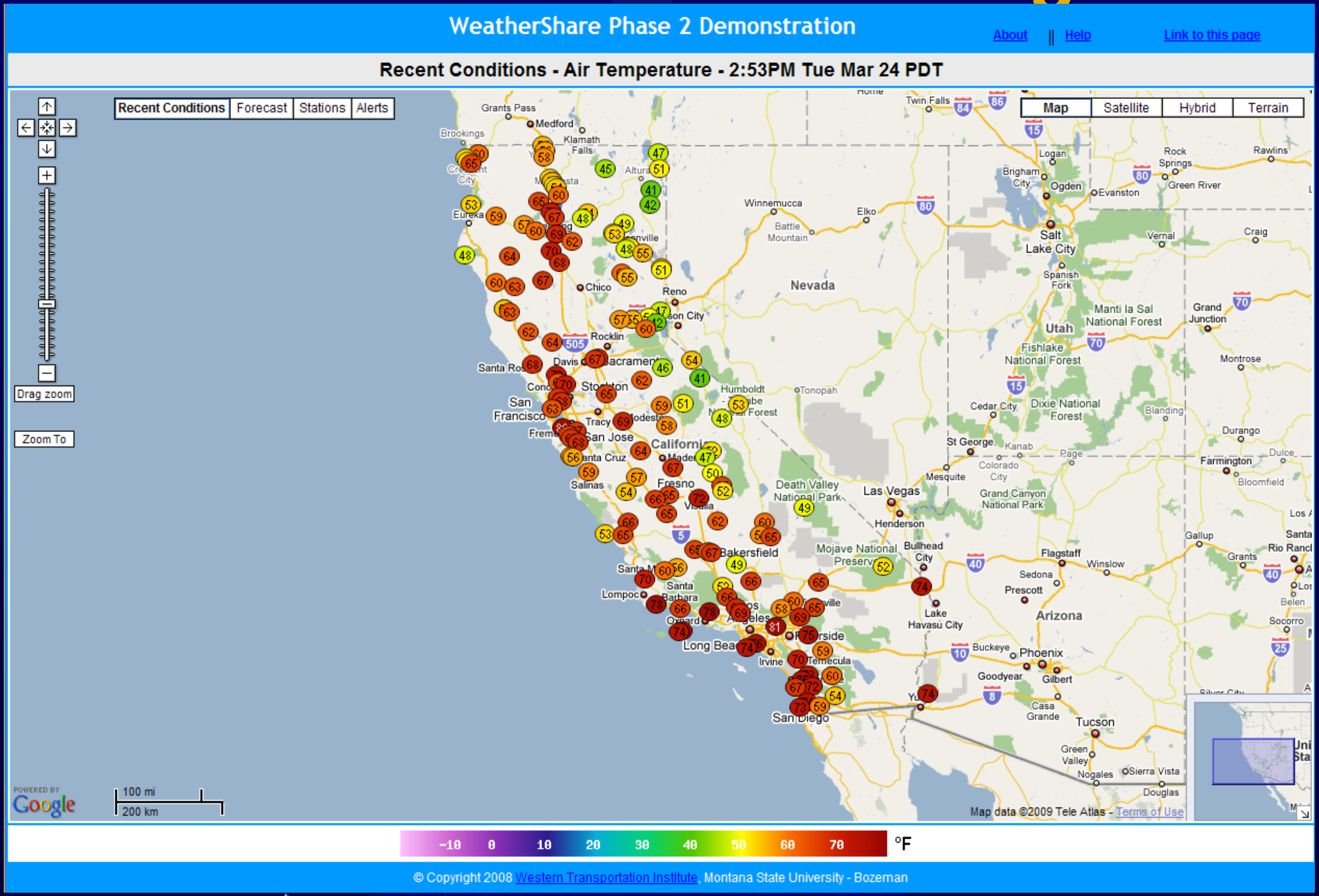
- First, using observation data within the past hour from multiple weather stations, multivariate linear regression is used to establish the observational parameter (e.g. air temperature) as a function of the station's positional coordinates including elevation
- Then, predicted values are compared to reported values. If the reported temperature data is different from the predicted regression value over the last 90 minutes by over 10°F, the observation is flagged as "failed"

Refe:Splitt, M.E., and J., Horel (2005). 3, 2005.

Presenting data: Decisions about screen layout

- A System for Statewide Coverage and Deployment
- Enhance Alert Capability
- Improve Reporting Capability
- Weather Forecasts and Alerts

WeatherShare URL: www.weathershare.org



The WeatherShare Phase II Interface

- Using Google maps api
- HTML
- DHTML
- JavaScript
- AJAX
- Web 2.0
- Broadband connectivity preferred
- Future alert distribution may include: Email, RSS, CAP

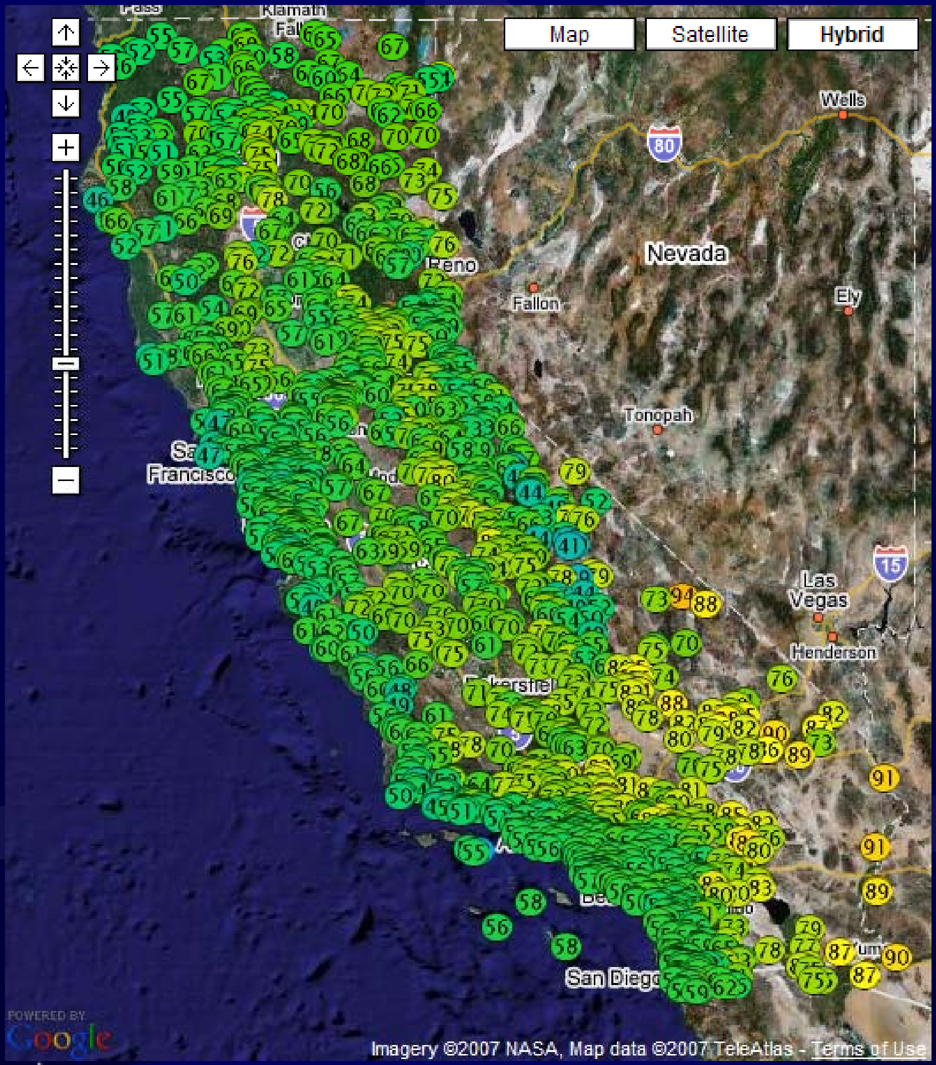
GIS related issues/problems

- Highway milepost
- Raster graph generation using Mercator Projection
- NWS public and fire zone for Warning/Alert

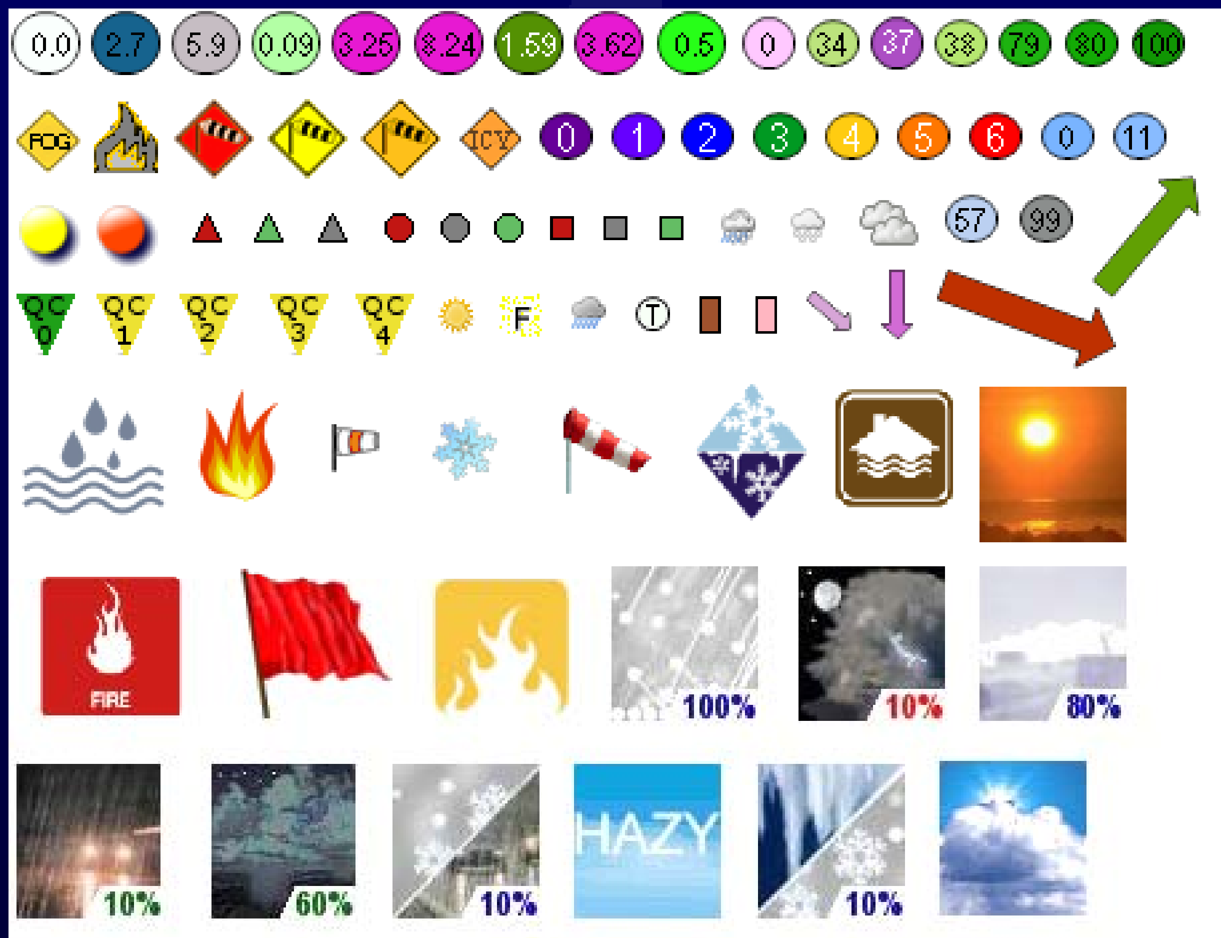
Browser related issues/problems

- Programming for different Browsers, Firefox vs. IE
  - Different style sheets necessary to keep consistent spacing/appearance
  - Different methods to attach/detach and event to an object
- Server side vs. client side code

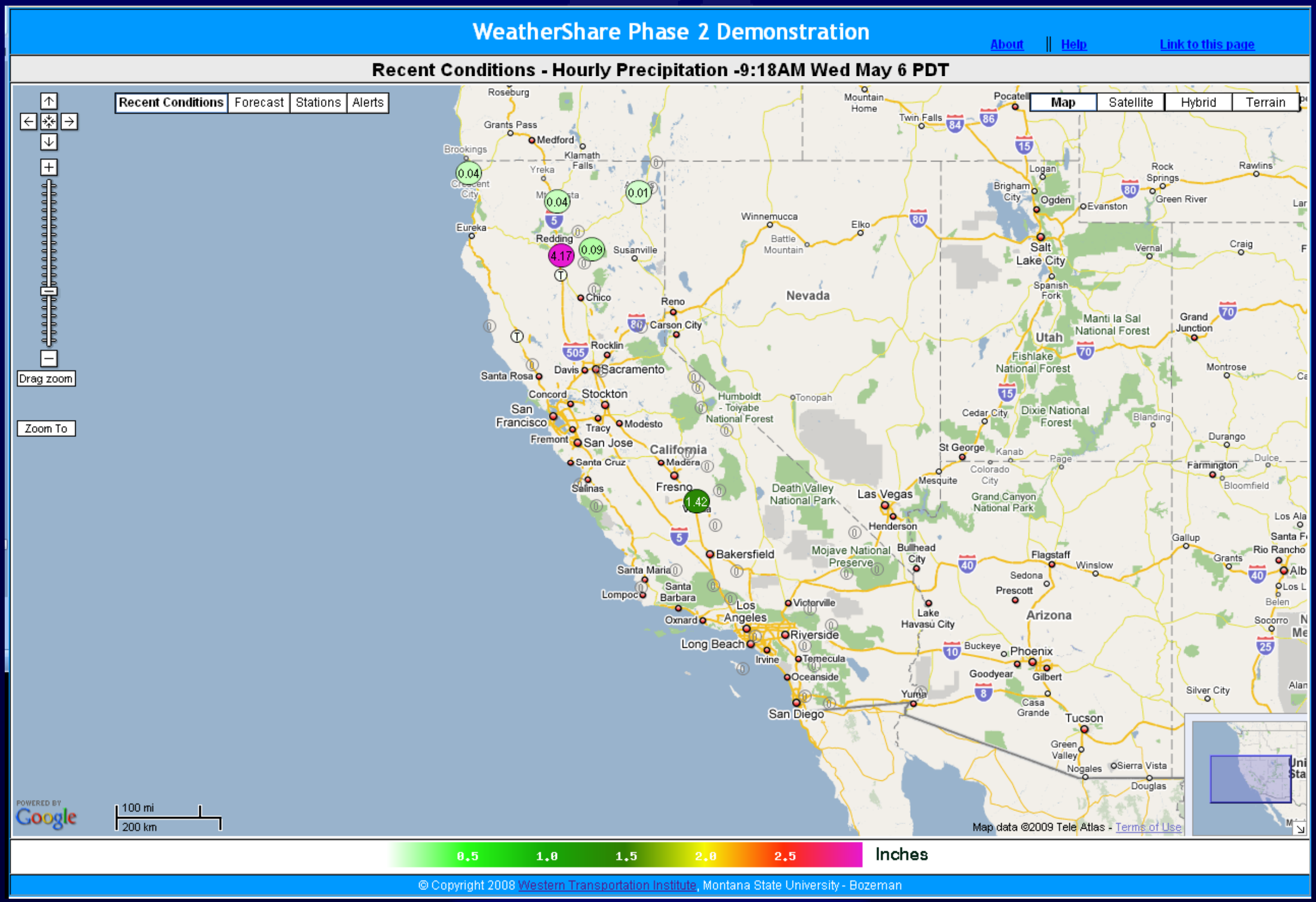
Data display techniques/problems



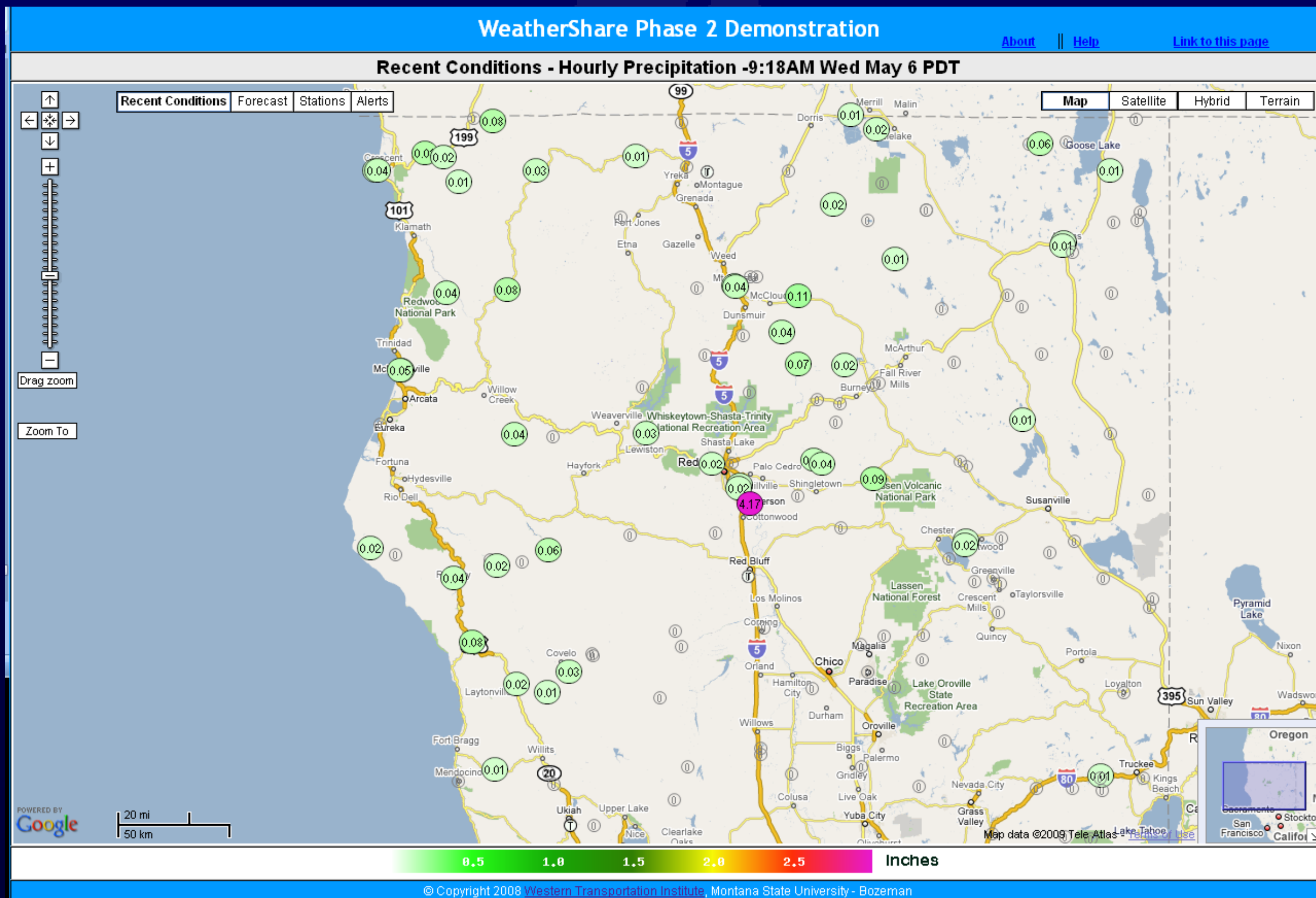
Picking Meaningful Icons



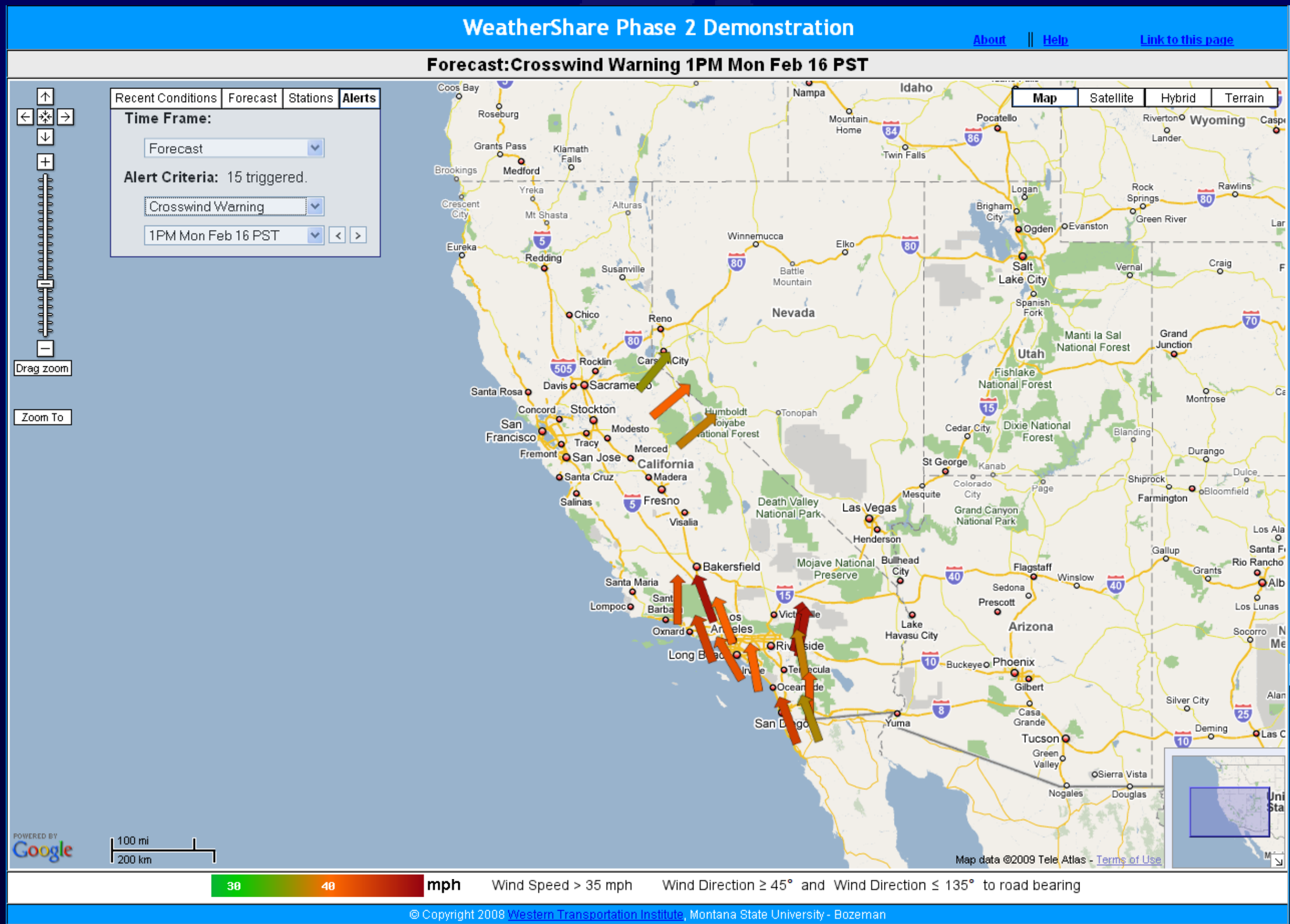
Picking values to display



Display more data at higher zoom levels



Areas with Crosswinds



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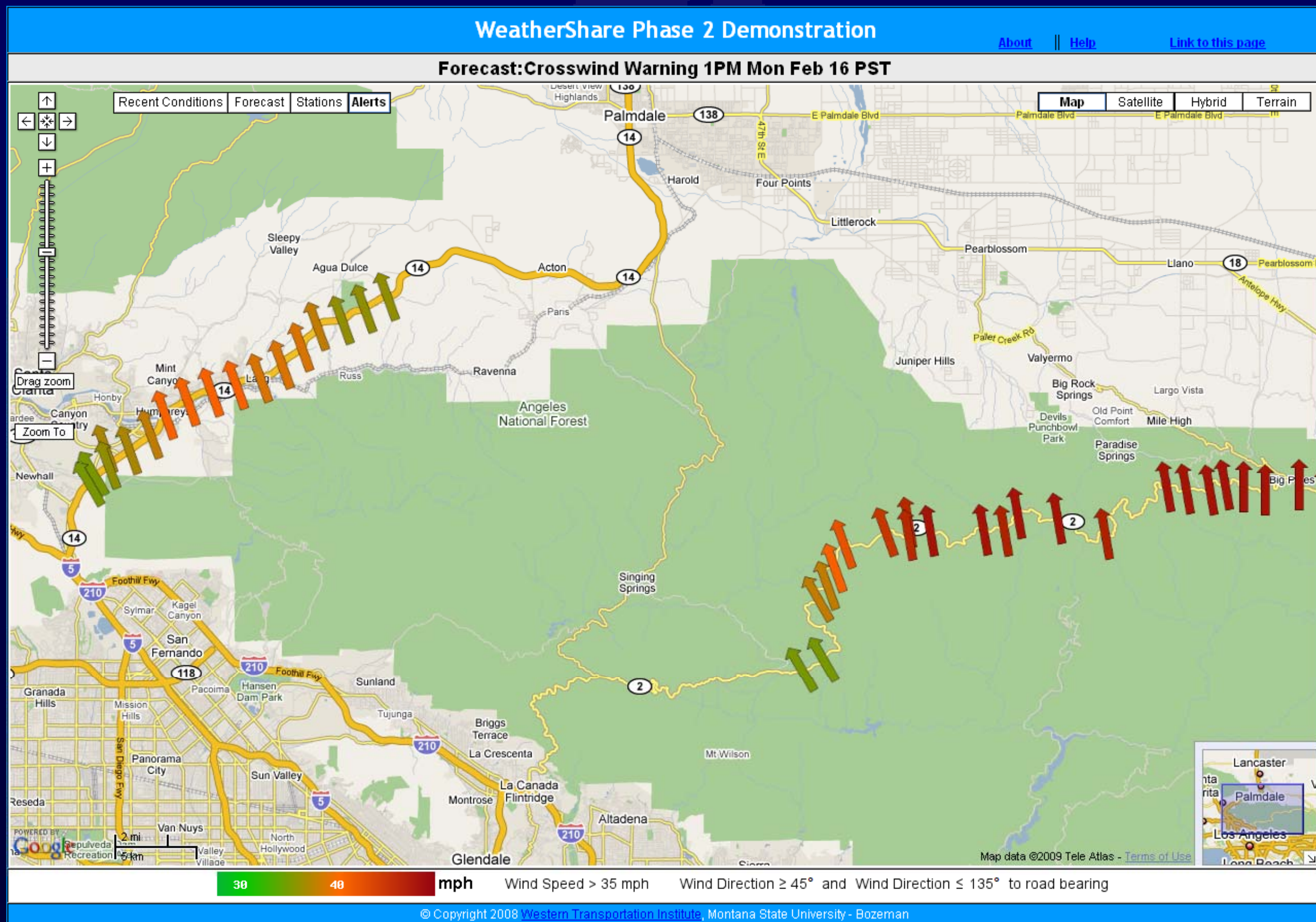
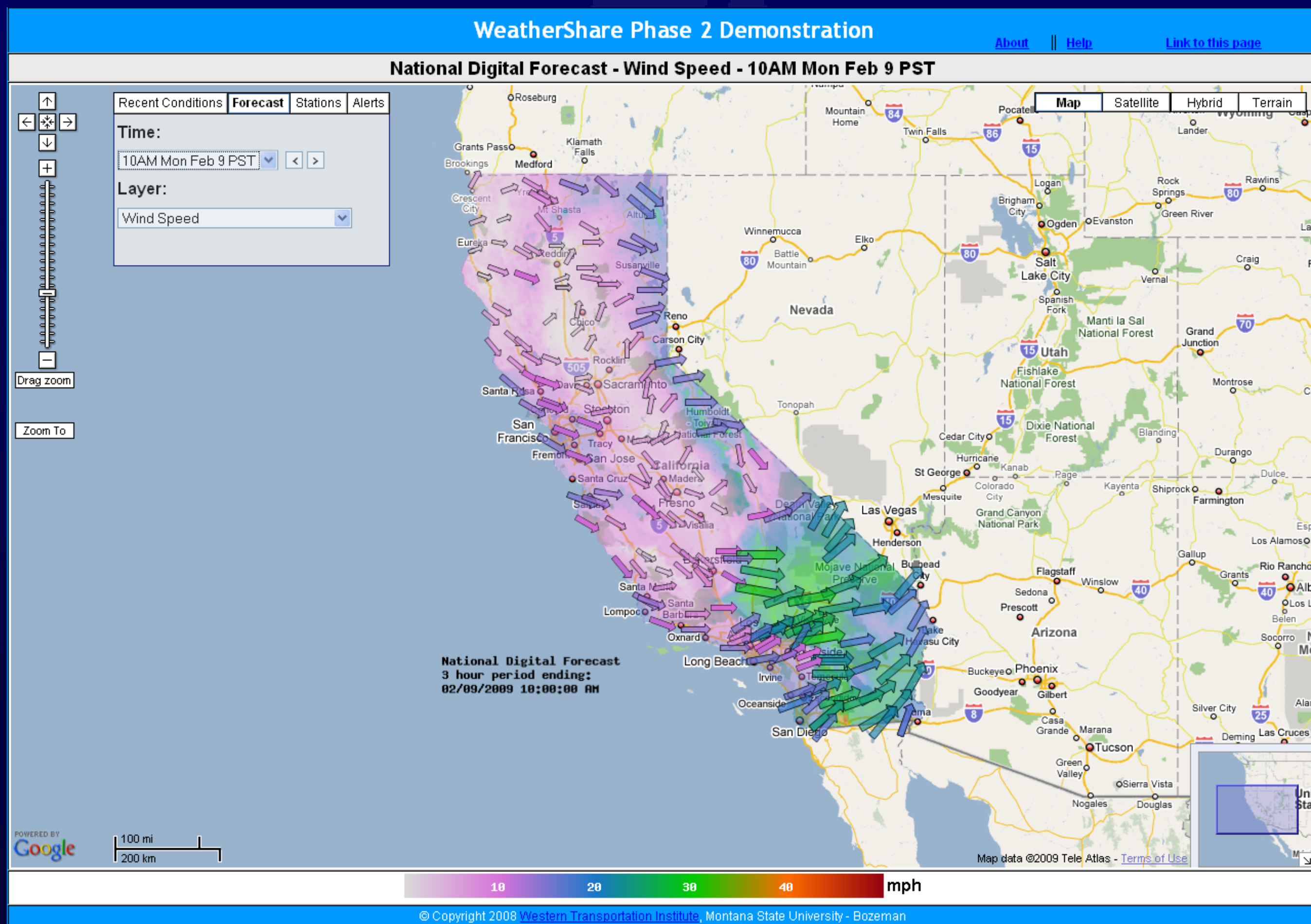
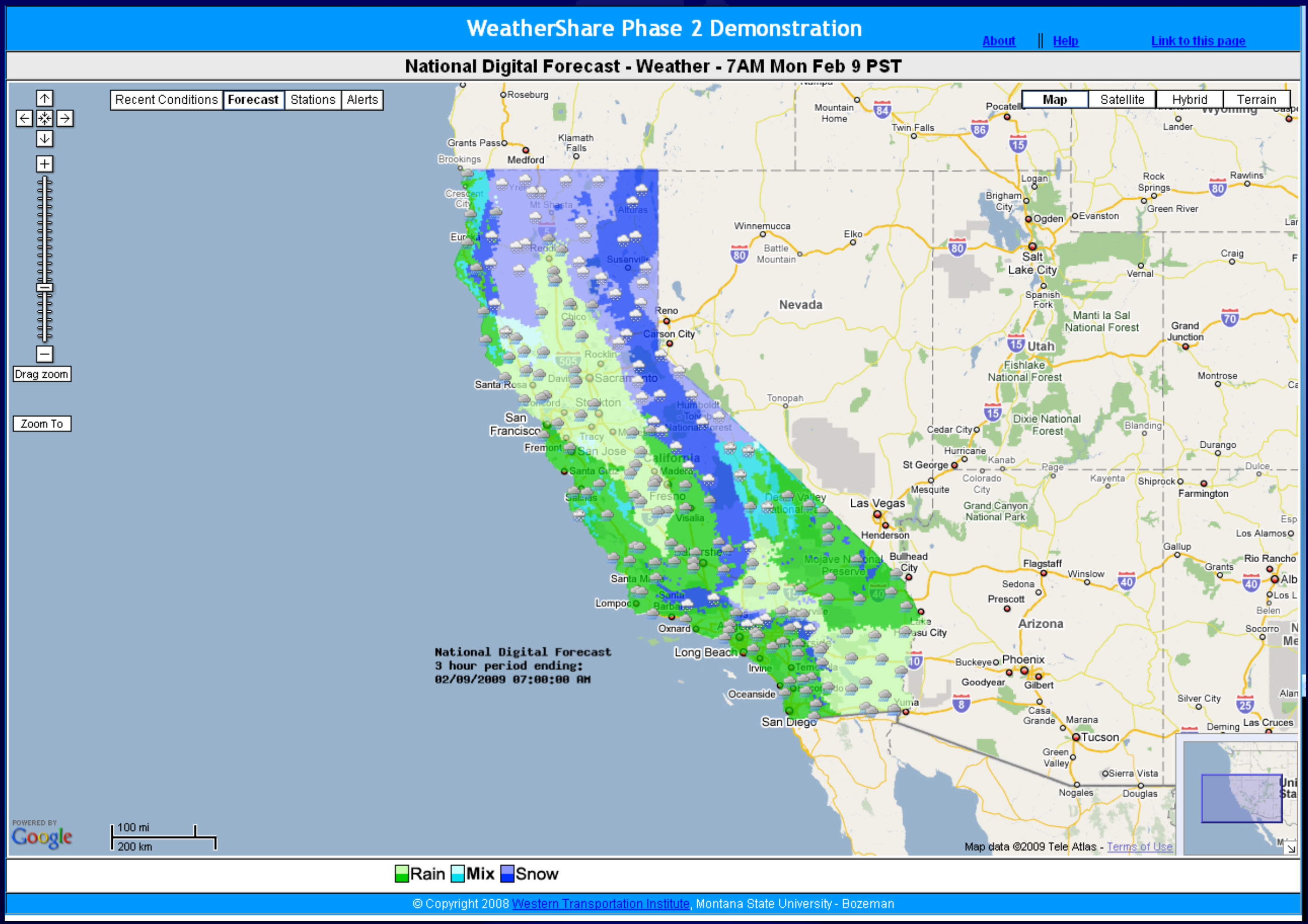
Crosswind Detail



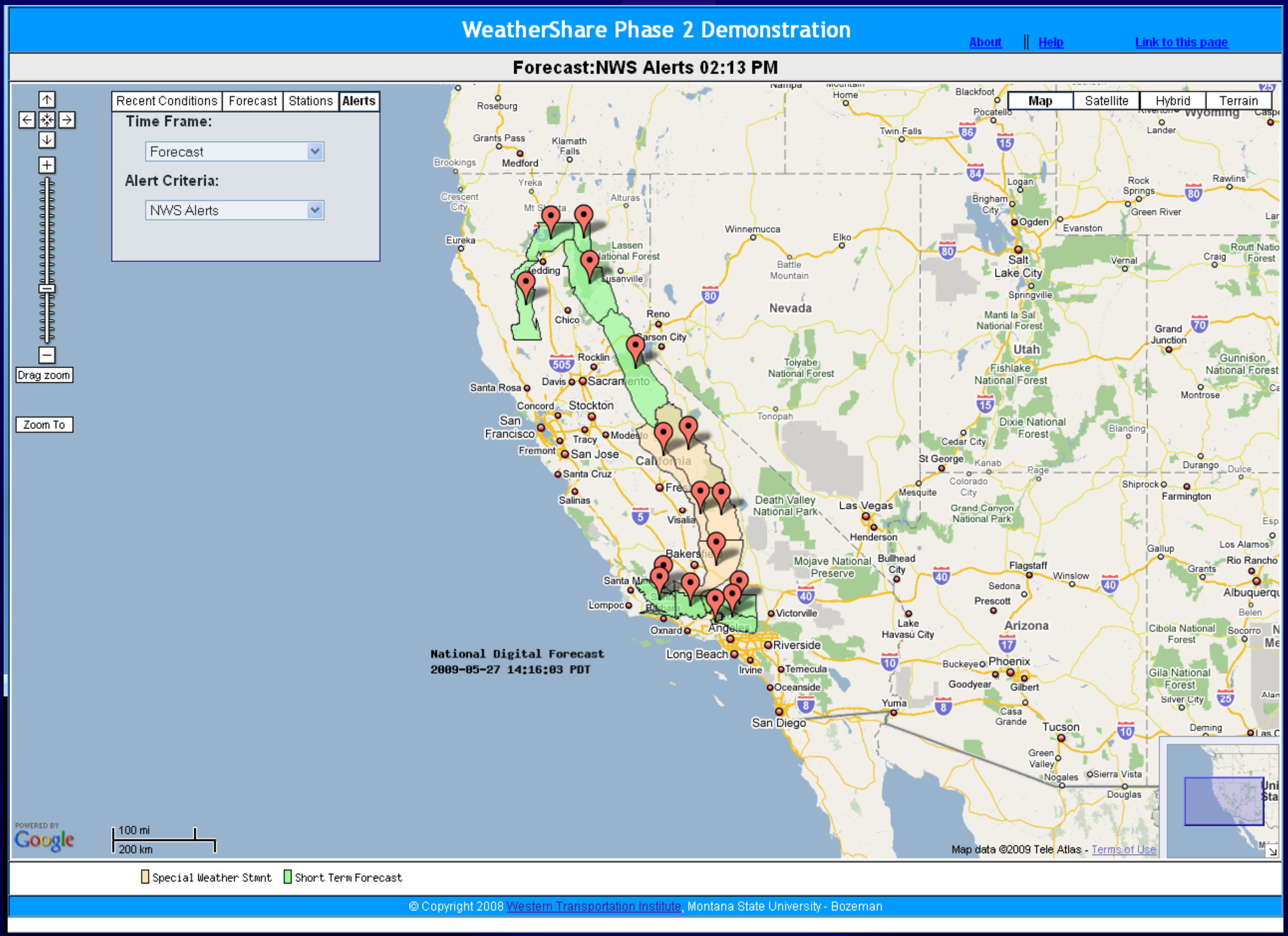
Example of intensity and direction of forecast winds



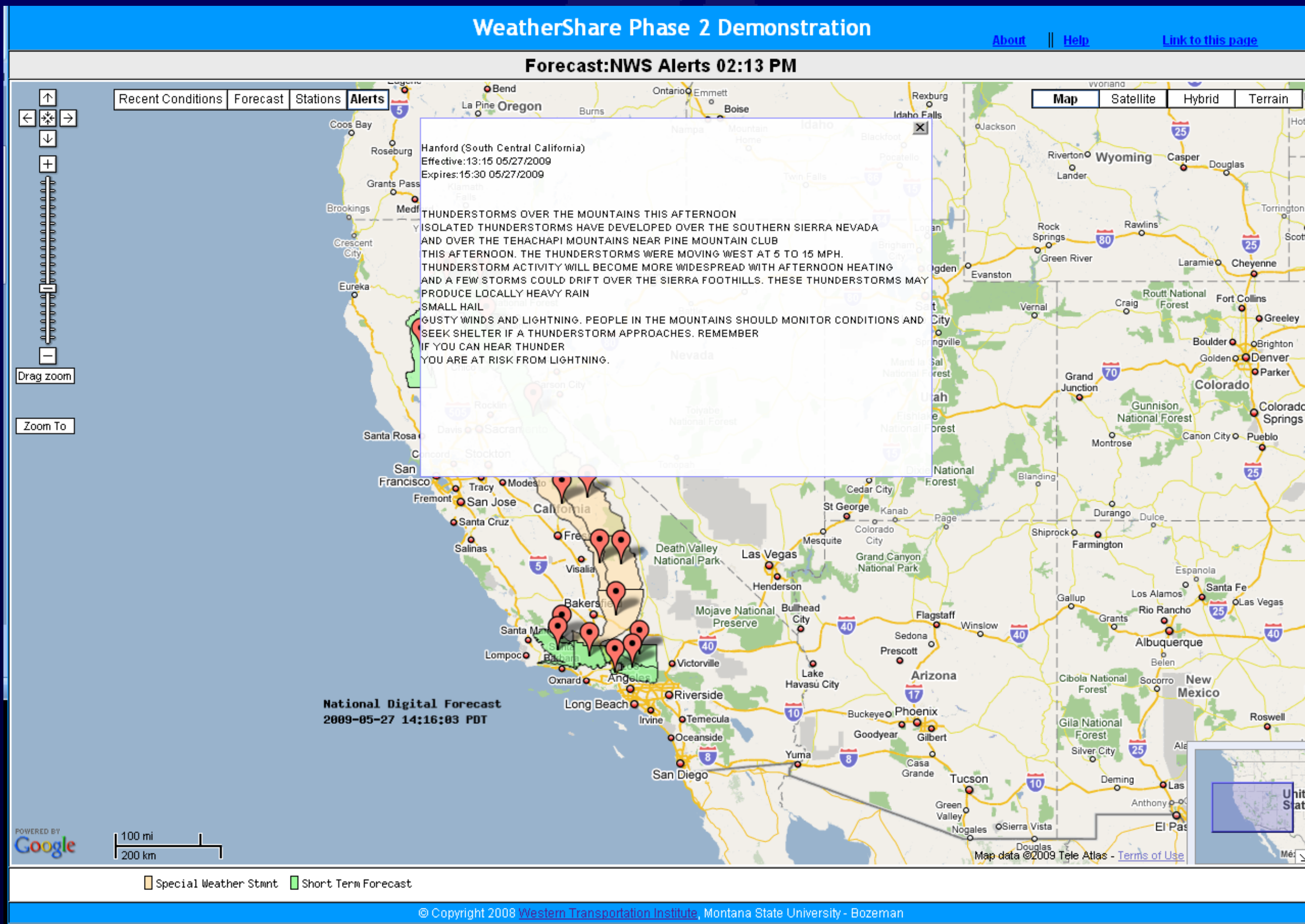
Beautiful February Forecast for California



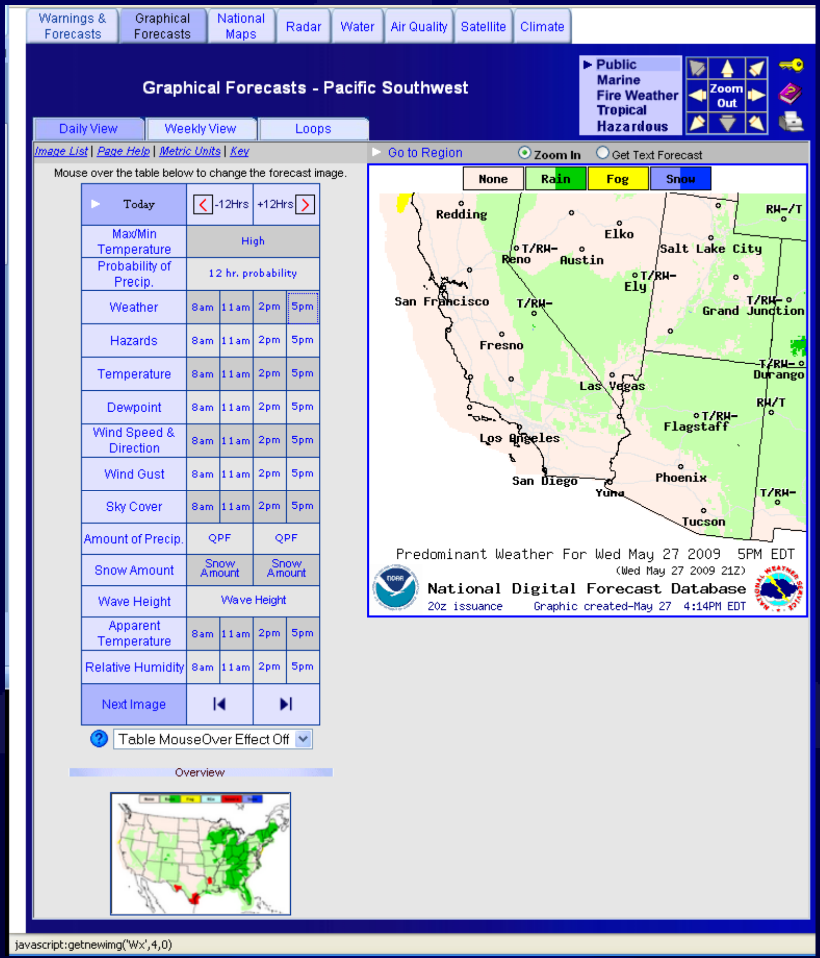
Forecast Alerts



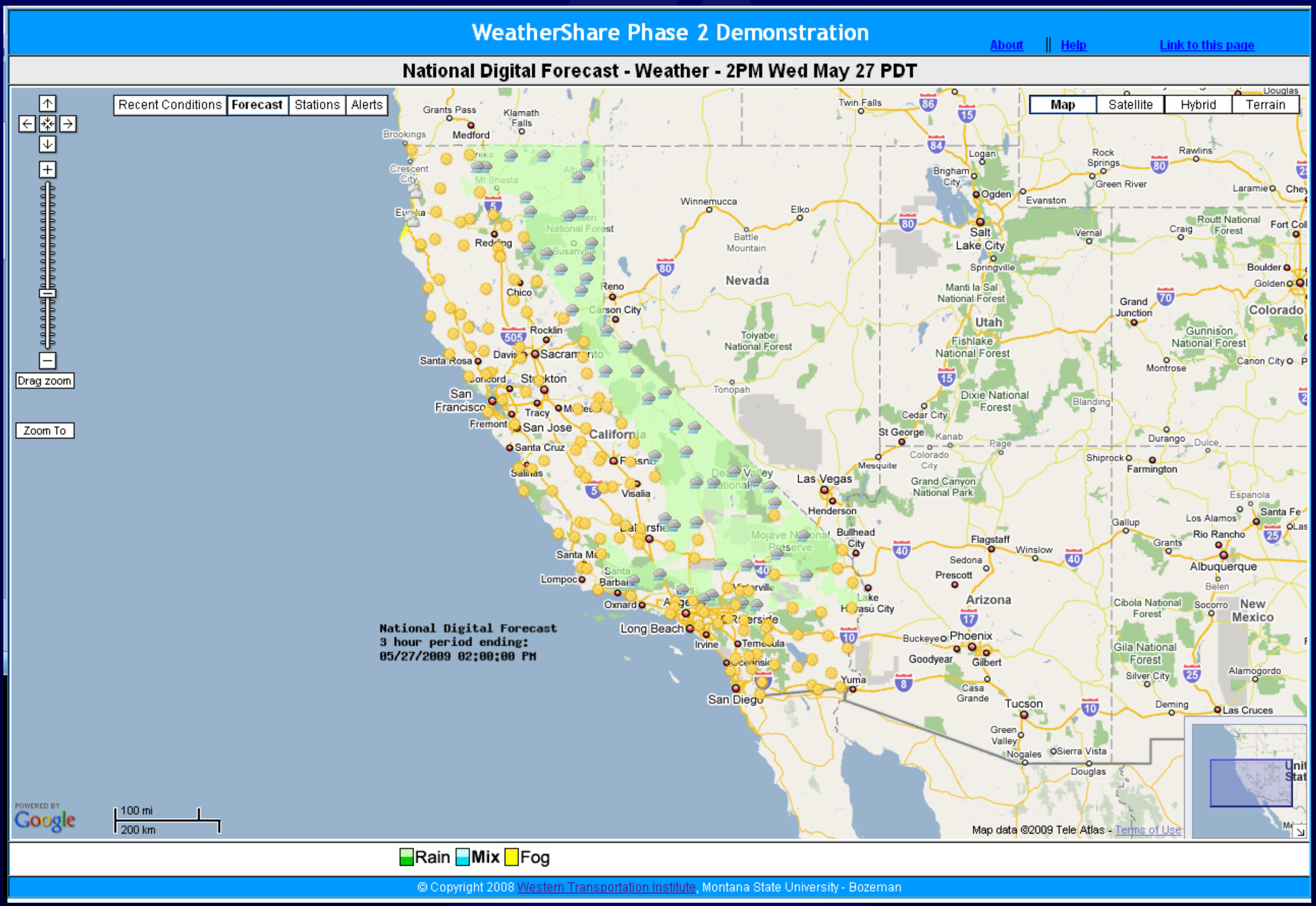
Forecast Alert Detail



NOAA Graphical Display



WeatherShare Graphical Display



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General lessons learned

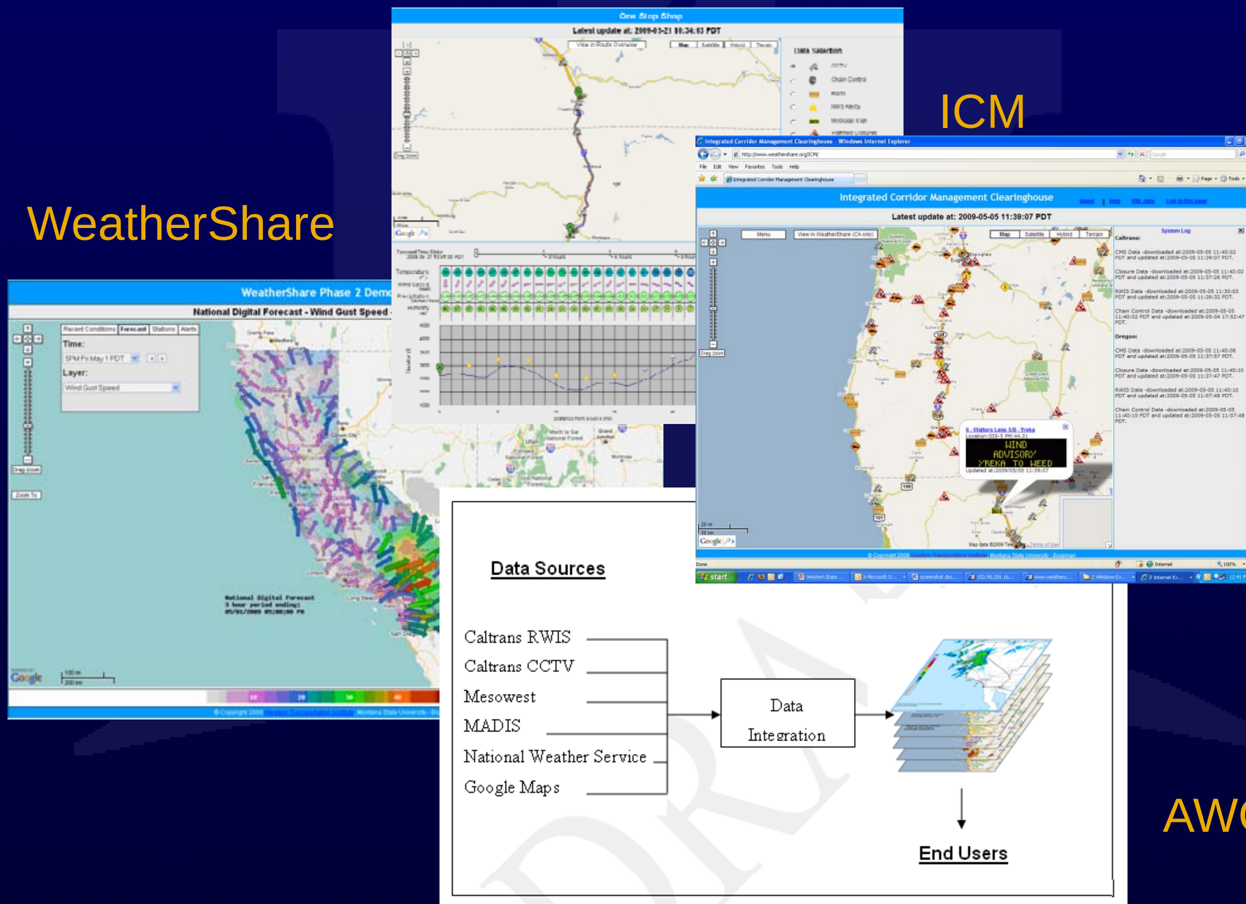
- Understand how users will work with system and give careful consideration to screen layout
- Check and double check incoming data vs. displayed data
- Google Maps platform has some limitations when trying to display many markers on map
- Watch for memory leaks
- Overall a good platform for displaying location based data that can be leveraged to other projects

Building on WeatherShare

One Stop Shop

ICM

WeatherShare



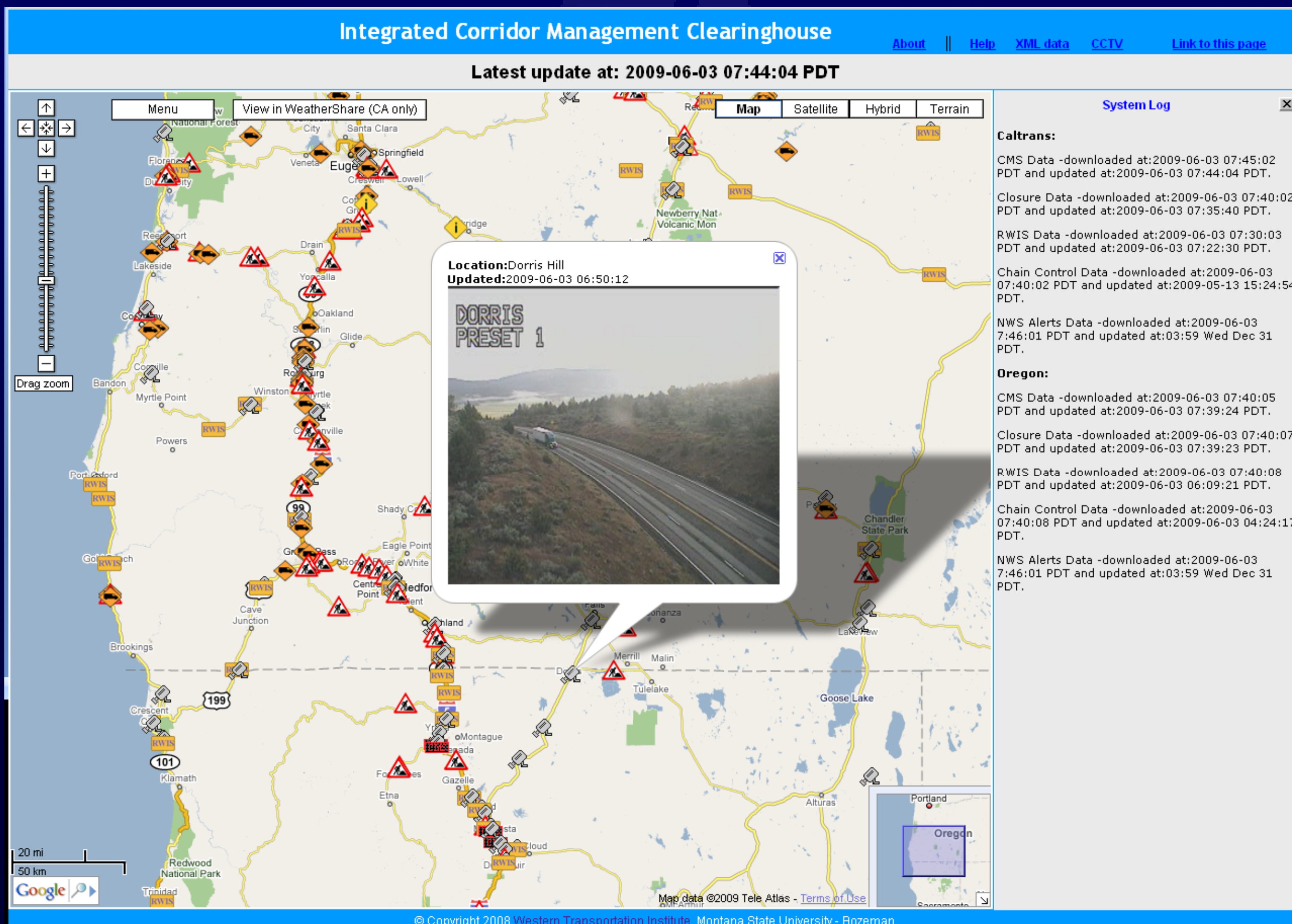
AWOS/ASOS

Related projects

- Integrated Corridor Management Clearinghouse (ICM)
- Integration of Aviation Automated Weather Observation Systems (AWOS) with Roadside Weather Information Systems (RWIS)

Integrated Corridor Management Clearinghouse

http://www.weathershare.org/ICM/



Objectives

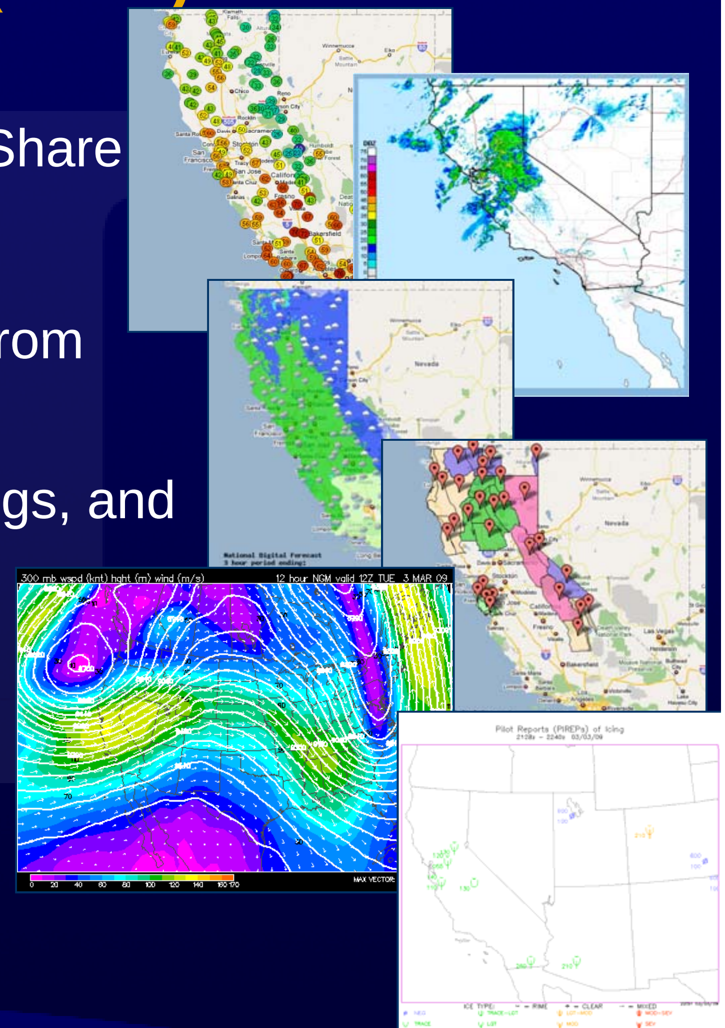
- Investigate the application of ICM to rural areas, as a proof of concept
- Coordinate individual network operations between parallel facilities/routes to create an interconnected system allowing cross network travel management
- To provide agencies with timely information related to the roadway network (including images, chain requirements, closures, etc.) for a broad geographic region
  - Implement plans for diverting traffic around impacting events
  - Better use of existing roadway assets

Study Area/Routes

- I-5 and US97/OR58
- Roughly parallel routes
- Host to ITS deployments
- Twelve mtn. passes
- Potential for numerous scenarios
  - Weather conditions
  - Construction
  - Wildfires
  - Seasonal peaks
  - Accidents

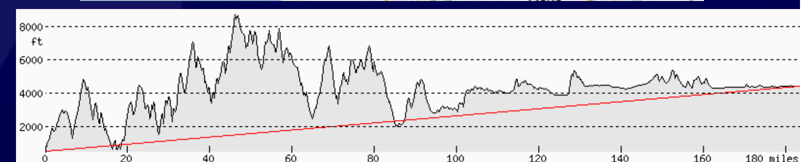
Integration of Aviation Automated Weather Observation Systems (AWOS) with Roadside Weather Information Systems (RWIS)

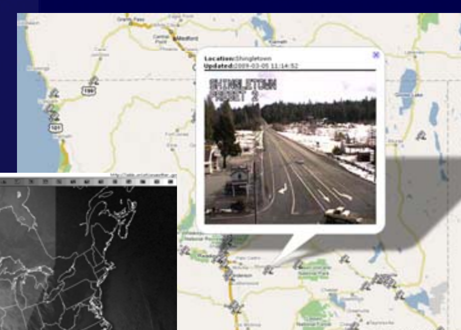
- Surface weather data layers from WeatherShare
- NWS Radar Mosaic
- National Digital Forecast Database layers from WeatherShare
- National Weather Service Watches, Warnings, and Advisories layer from WeatherShare
- NWS wind/temperature aloft
- Pilot reports (PIREP)
- METAR Reports
- Terminal Aerodrome Forecasts



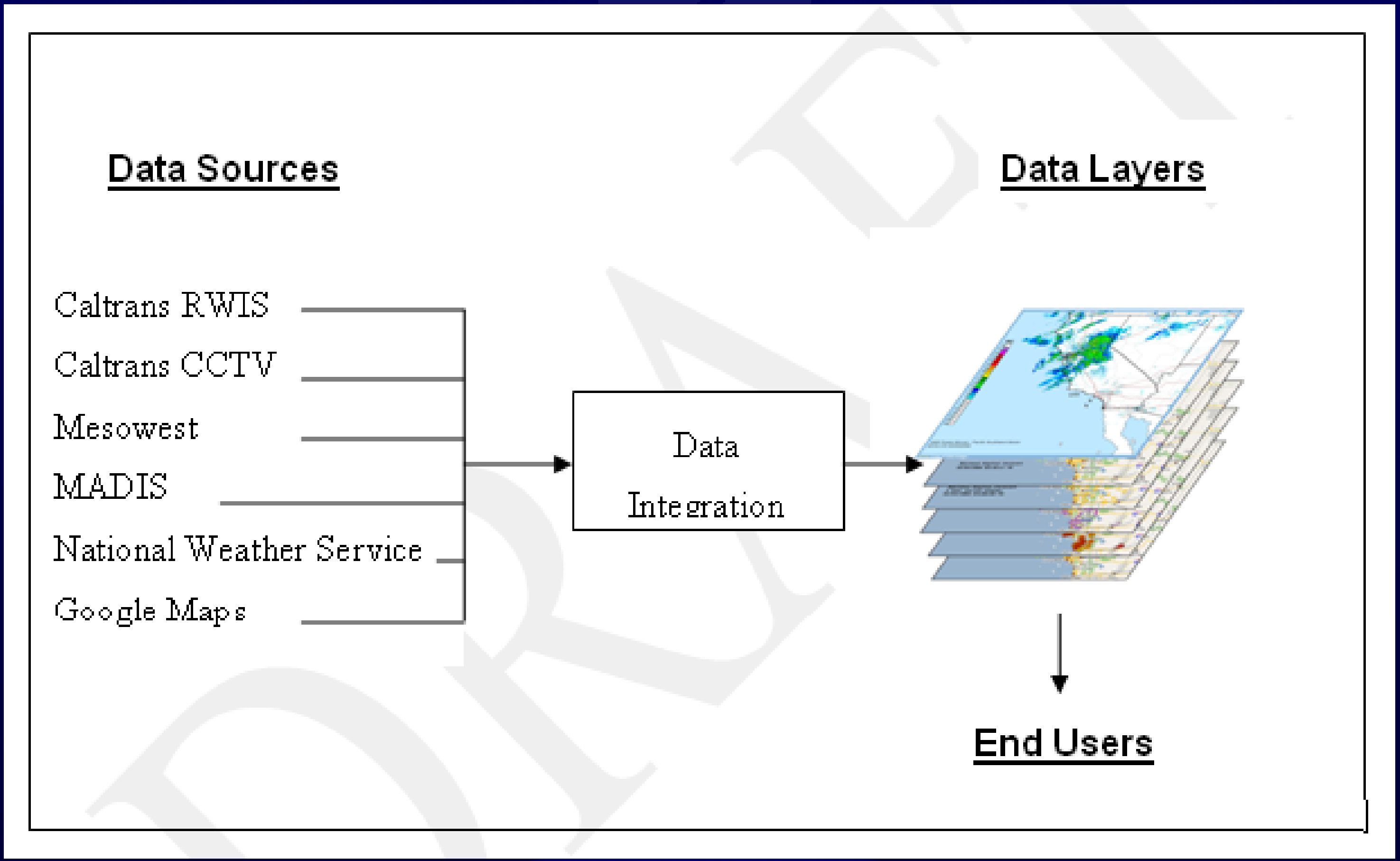
Integration of Aviation Automated Weather Observation Systems (AWOS) with Roadside Weather Information Systems (RWIS) cont.

- Flight Path Profile
- Caltrans CCTV
- NWS Satellite Image
- …..

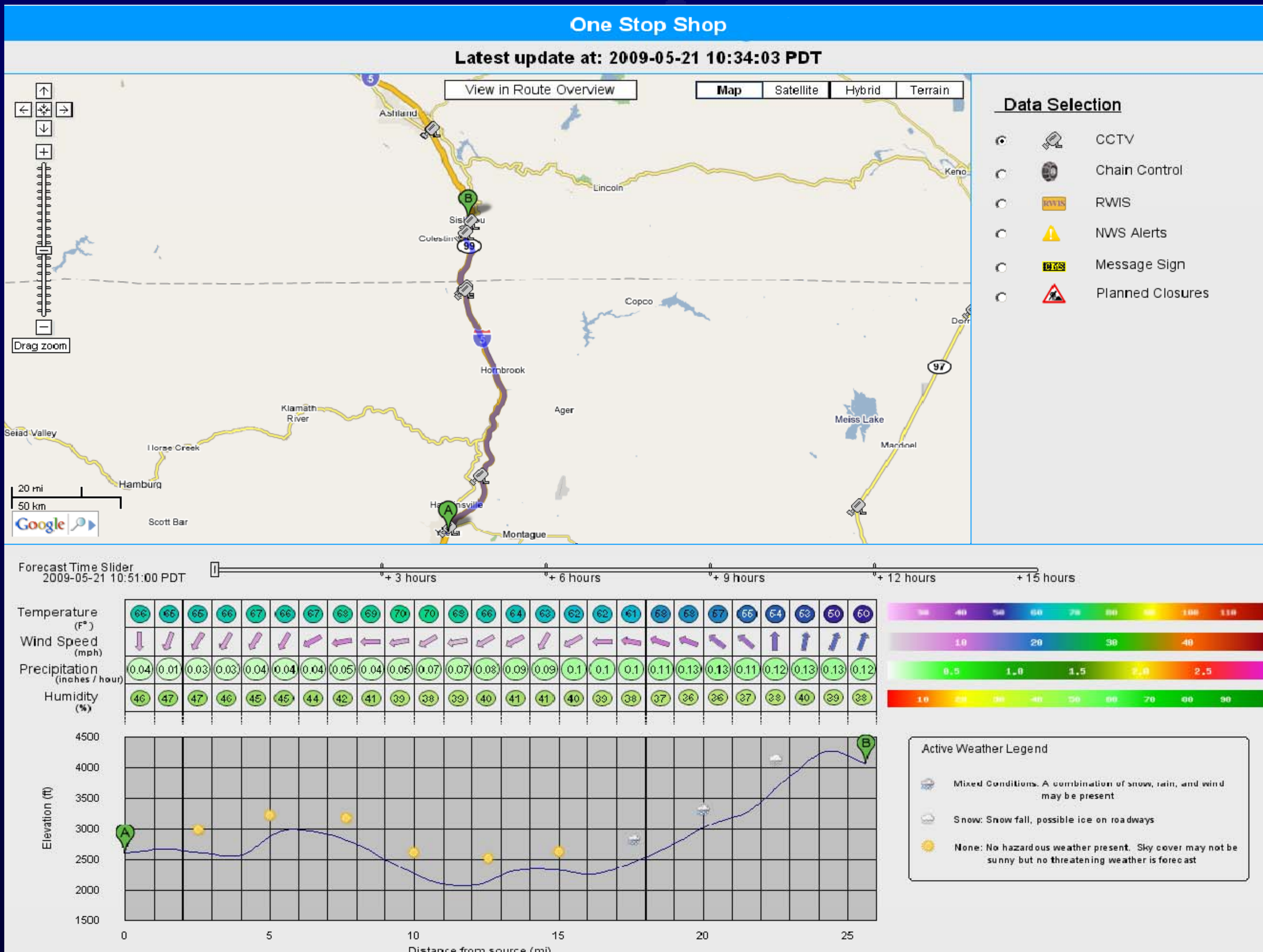




Integration of Aviation Automated Weather Observation Systems (AWOS) with Roadside Weather Information Systems (RWIS) cont.



One Stop Shop



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- Caltrans DRI
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- WTI
  - Students
- Other Stakeholders
  - Norcal EMS
  - CDF
  - Shascom
  - Others

www.weathershare.org