The 6th NWS Ensemble Users Workshop: Aviation Weather Center Update

David R. Bright, Benjamin R. Schwedler, Steve A. Lack, Matt A. Strahan, Jeff S. Smith*, George Liu^, Amy R. Harless, Brian P. Pettegrew, C. Bruce Entwistle

Aviation Weather Center / Aviation Weather Testbed, Kansas City, MO
* Cooperative Institute for Research in the Atmosphere, Boulder, CO
^ NCEP Central Operations, College Park, MD

NWS Ensemble Users Workshop
March 25, 2014

Where Americas Climate and Weather Services Begin

Outline

- **Key Operations at the AWC**
  - Domestic & International Advisories and Warnings
  - Traffic Flow Management (TFM) and Decision Support Services (DSS)
- **Applications of Ensembles**
  - Dashboards & MOTL (CCFP)
  - Collaborative Improvement
- **The Ensemble Processor: A Tool for Building Custom Applications**
- **Proposed World Area Forecast System (WAFS) Ensemble**

Domestic & Caribbean Advisories and Warnings

AIRMETs

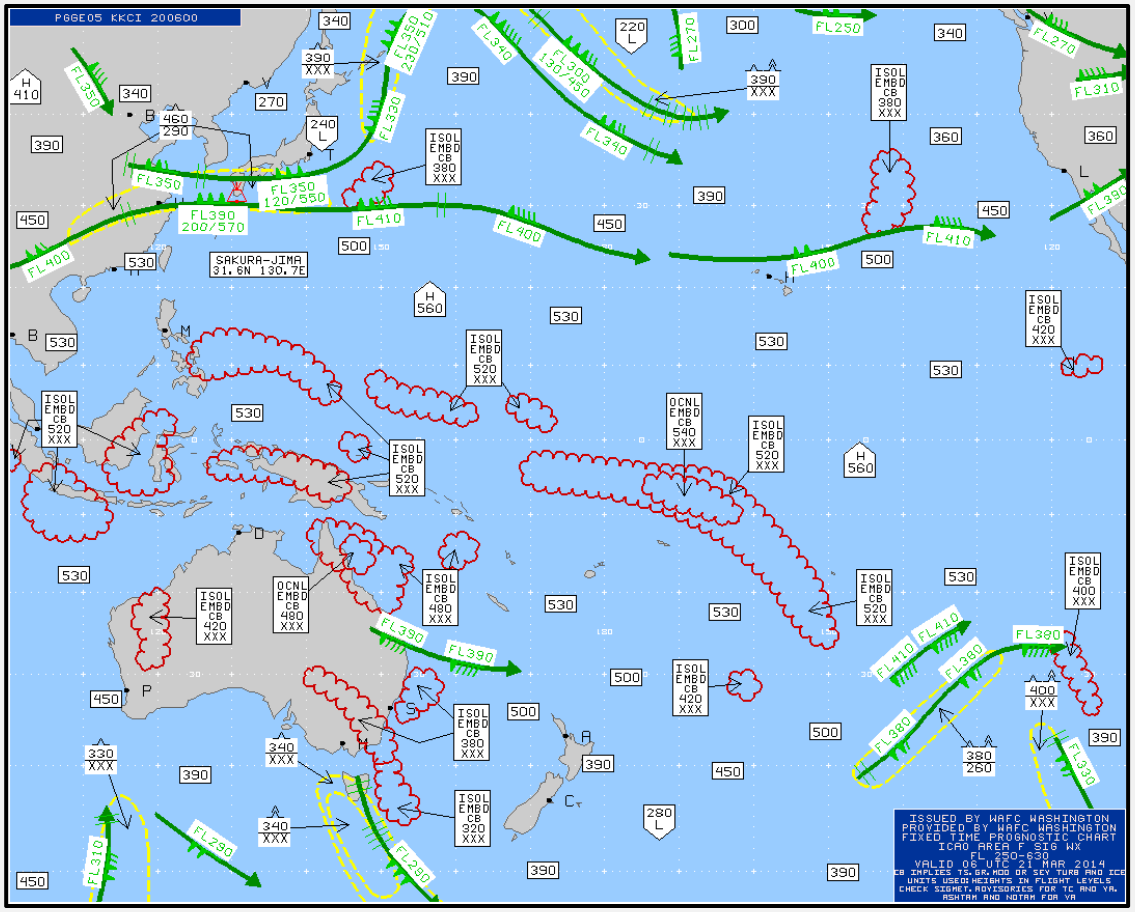
Airmen's Meteorological Information
Advisories to light aircraft & VFR pilots

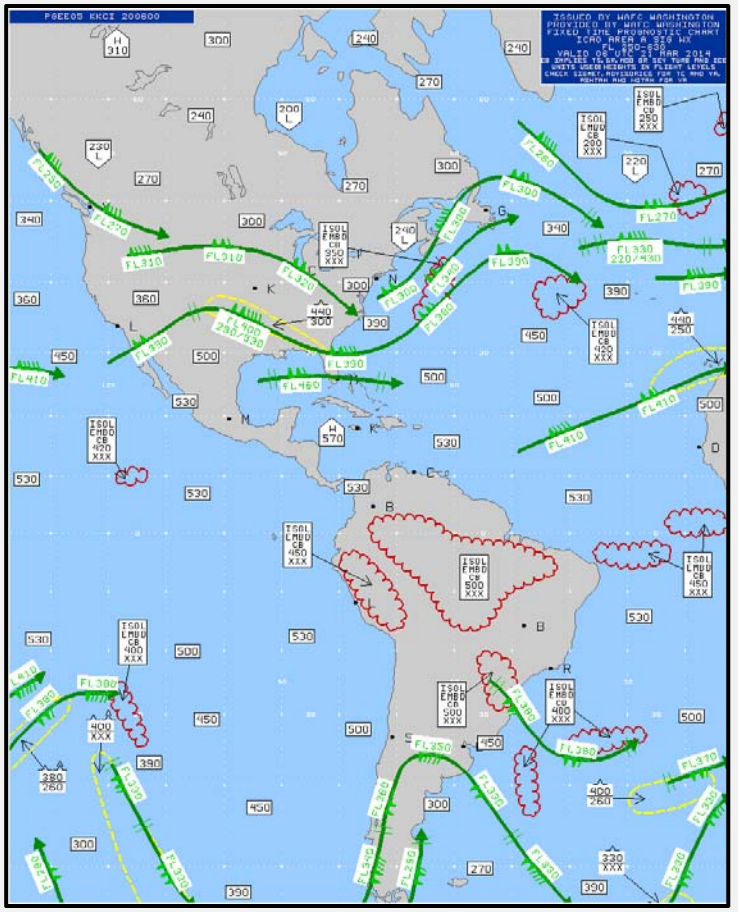
SIGMETs

Significant Meteorological Information
Warnings concerning aircraft safety

International Flight Planning Forecasts

Global Forecasting: Jets, Turb, Icing, Convection, Trop

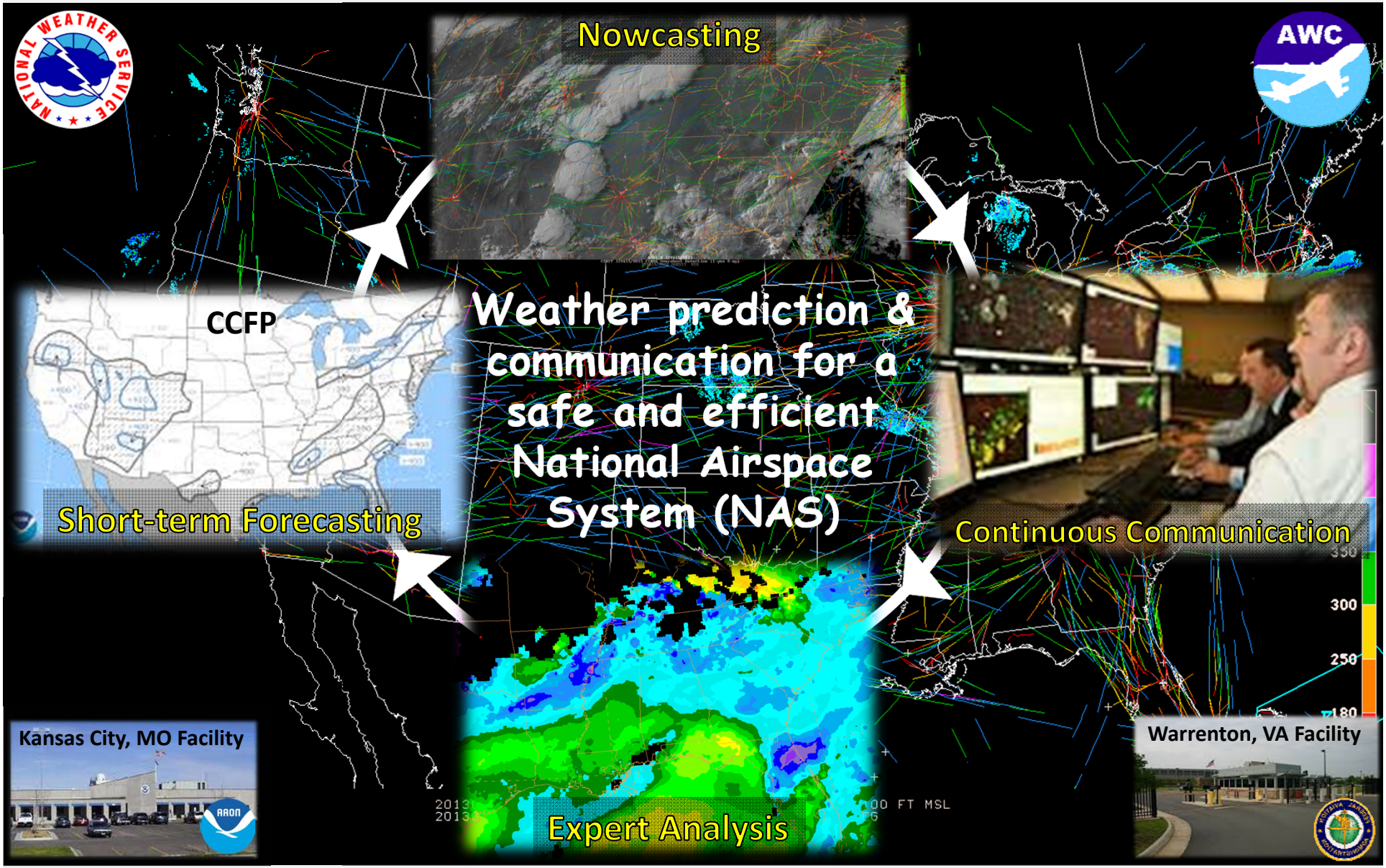




The World Area Forecast System (WAFS):

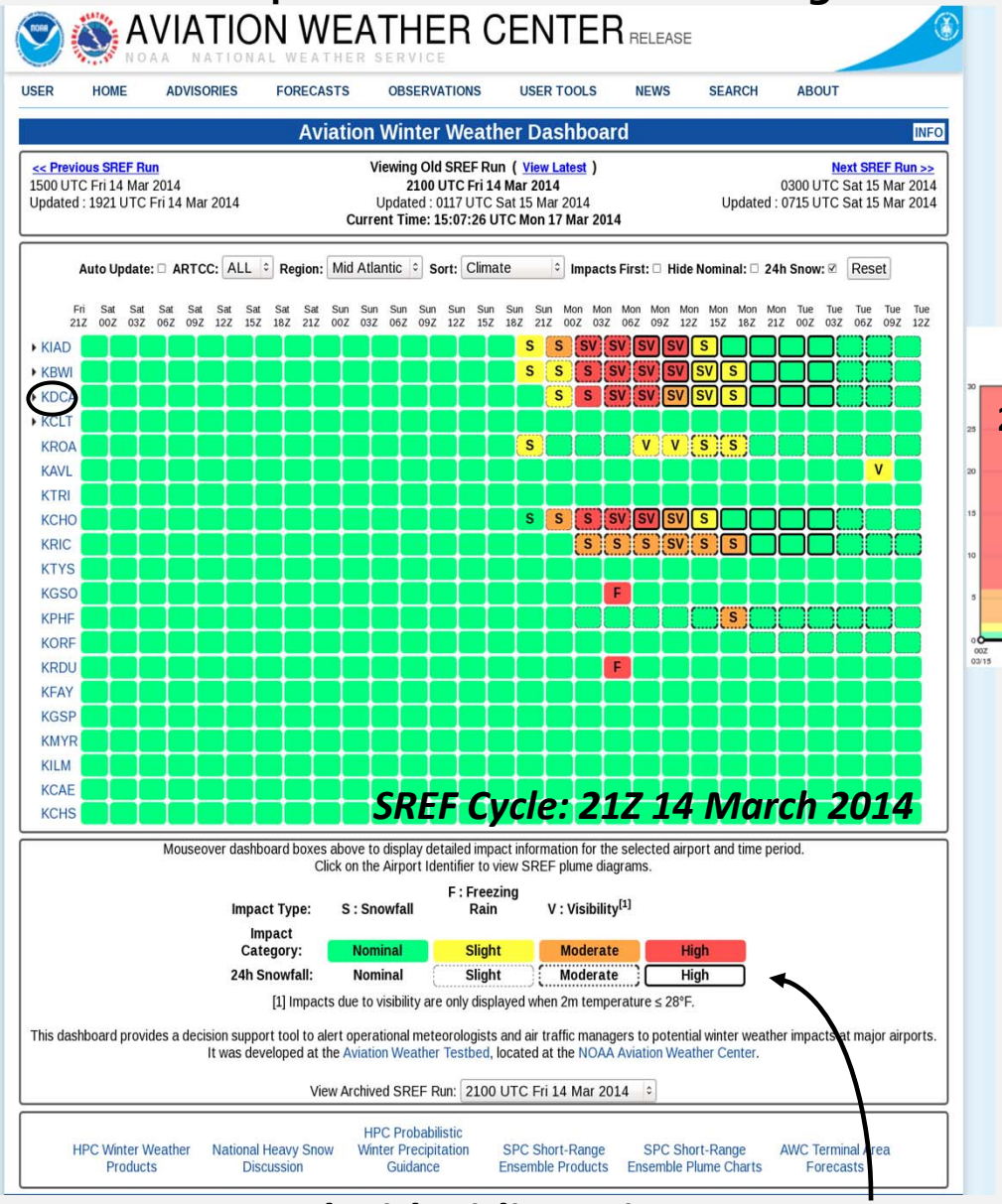
AWC is 1 of 2 World Area Forecast Centers (WAFC)

AWC Traffic Flow Management (TFM) and Impact Decision Support Services (IDSS)



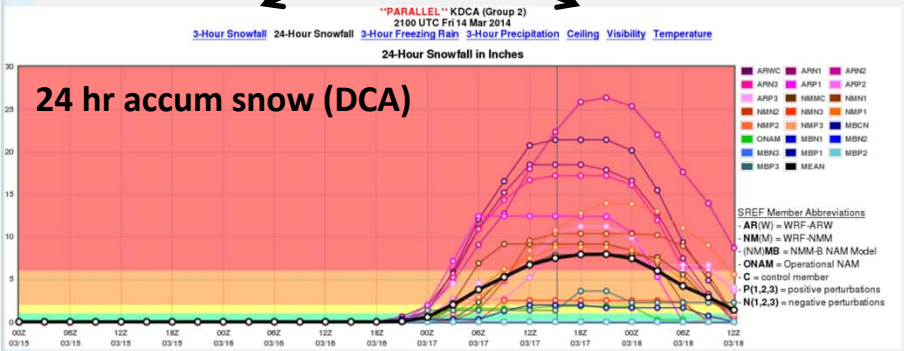
Winter Dashboard: SREF Based Impact

http://www.aviationweather.gov/decisionsupport/winterdashboard



Impact tuned with airlines via CDM-WET

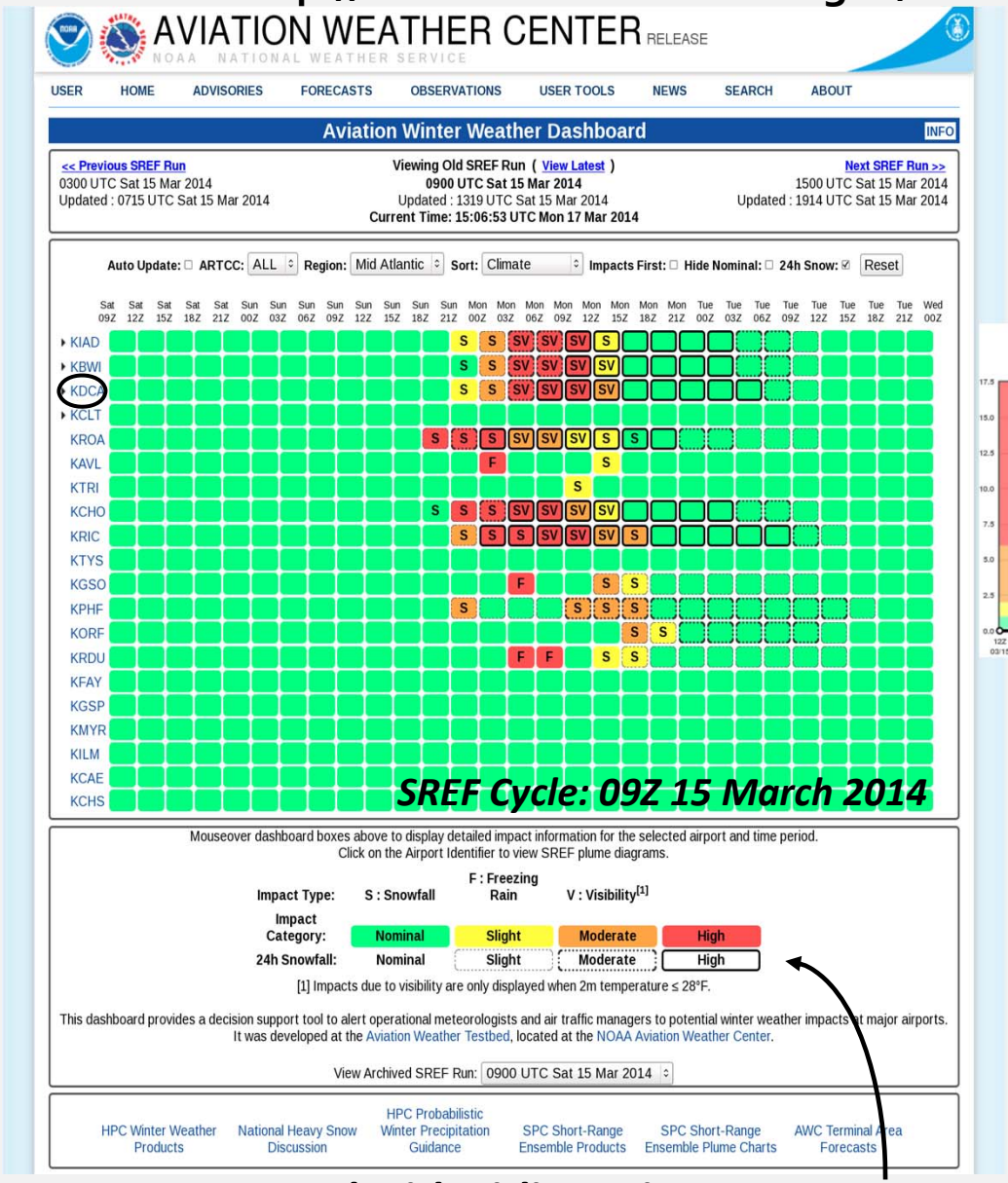
Plume options for ceiling, visibility, precipitation, temperature



- **Collaborative project with FAA and Industry (FAA's CDM-WET)**
- **CORE-30 airports + diversions**
- **Also have a summer convective dashboard (not shown)**

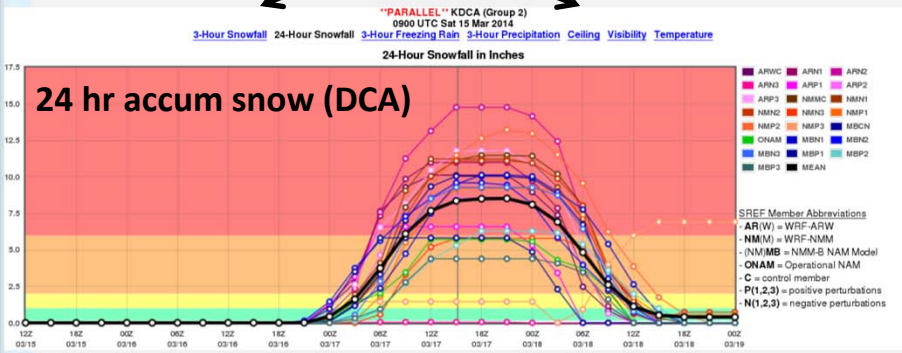
Winter Dashboard: SREF Based Impact

http://www.aviationweather.gov/decisionsupport/winterdashboard



Impact tuned with airlines via CDM-WET

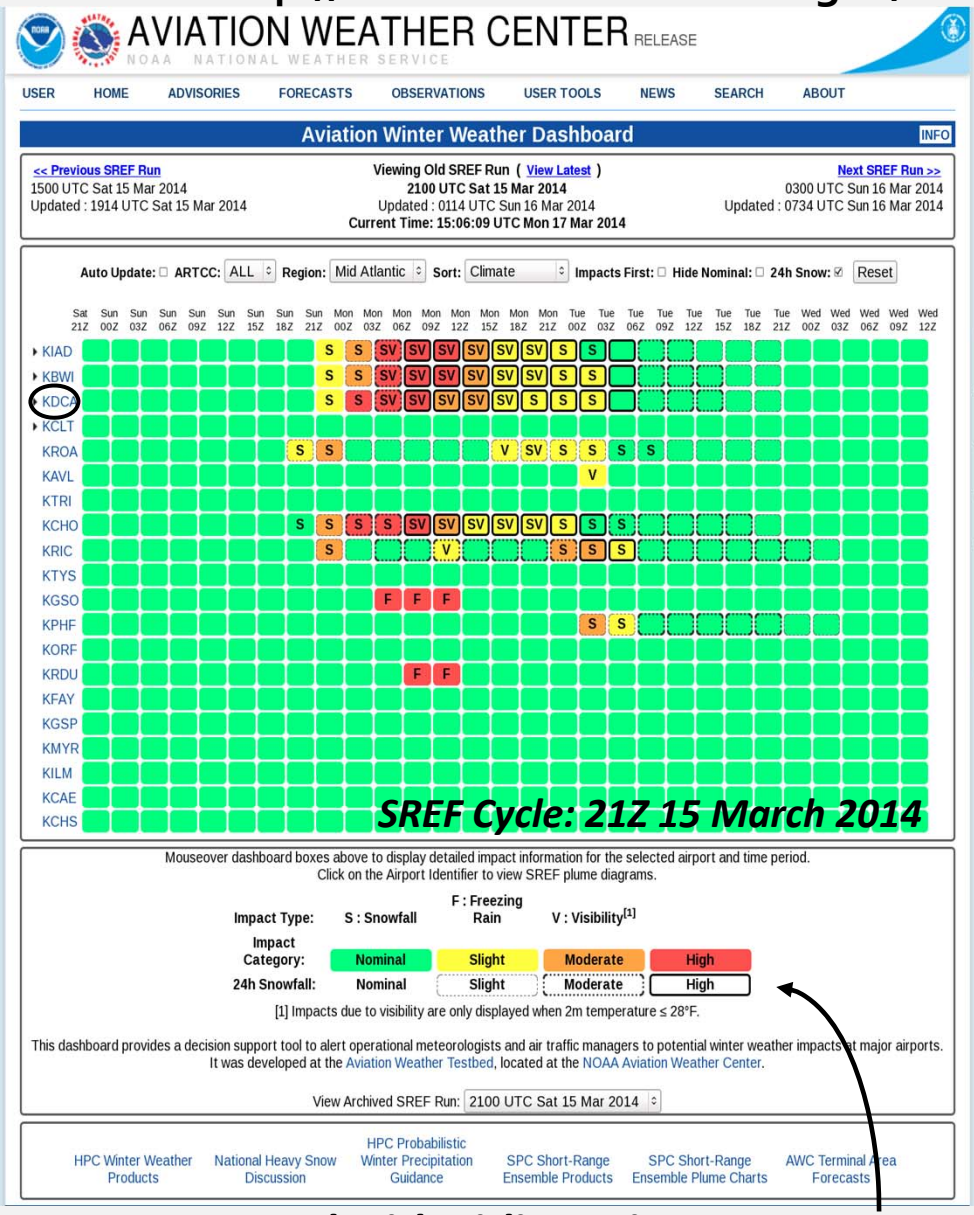
Plume options for ceiling, visibility, precipitation, temperature



- **Collaborative project with FAA and Industry (FAA's CDM-WET)**
- **CORE-30 airports + diversions**
- **Also have a summer convective dashboard (not shown)**

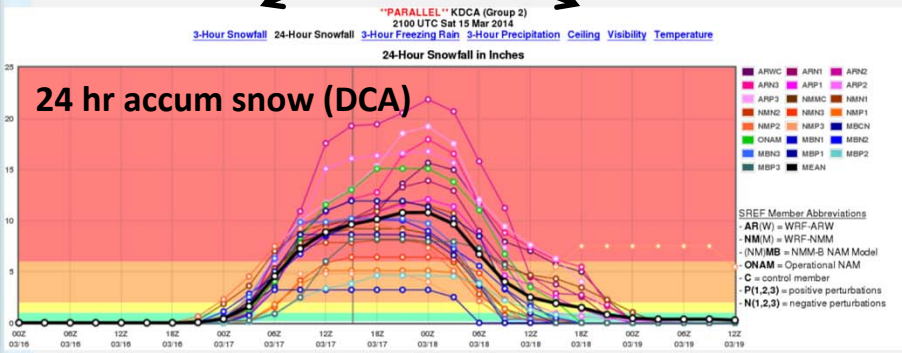
Winter Dashboard: SREF Based Impact

http://www.aviationweather.gov/decisionsupport/winterdashboard



Impact tuned with airlines via CDM-WET

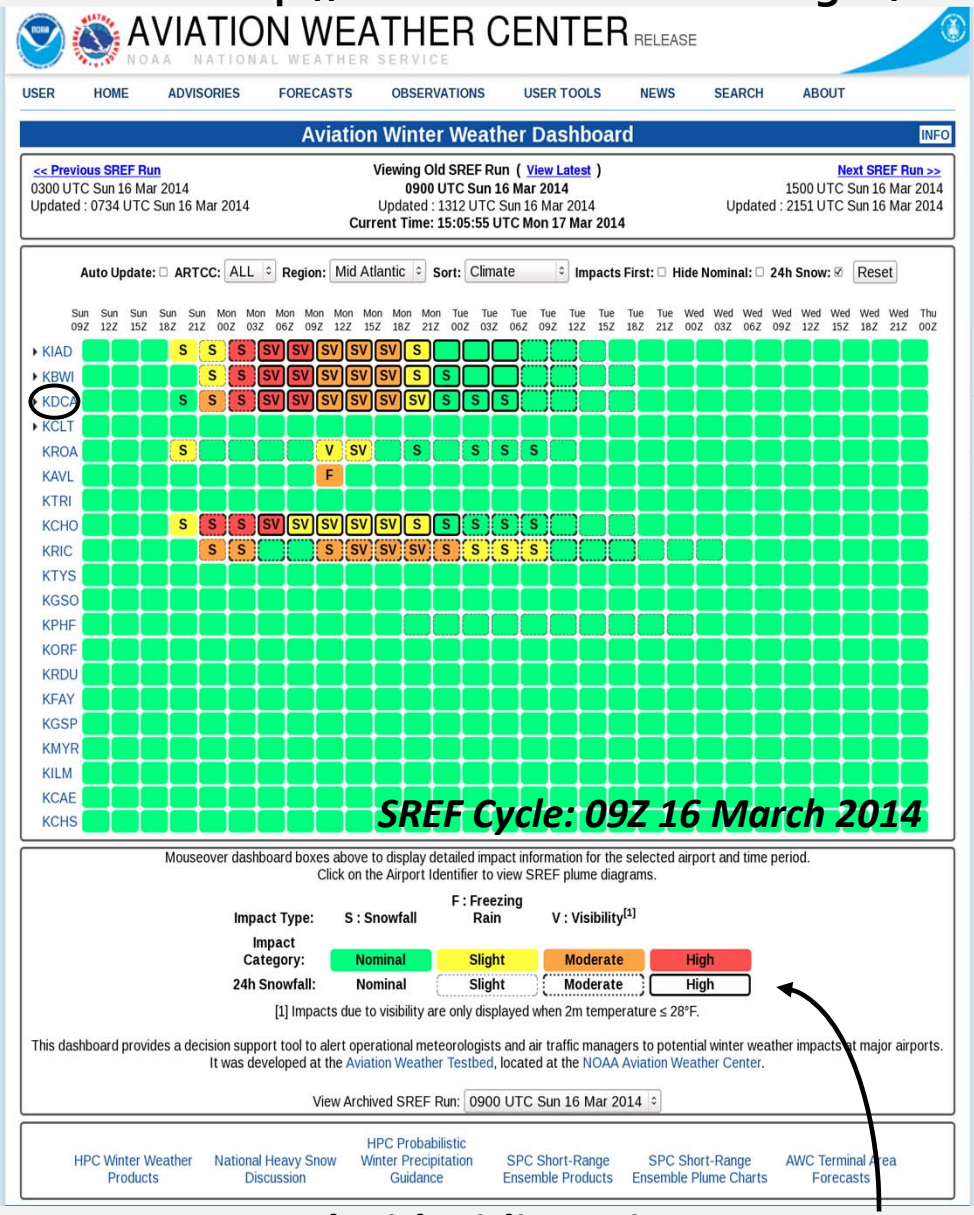
Plume options for ceiling, visibility, precipitation, temperature



- **Collaborative project with FAA and Industry (FAA's CDM-WET)**
- **CORE-30 airports + diversions**
- **Also have a summer convective dashboard (not shown)**

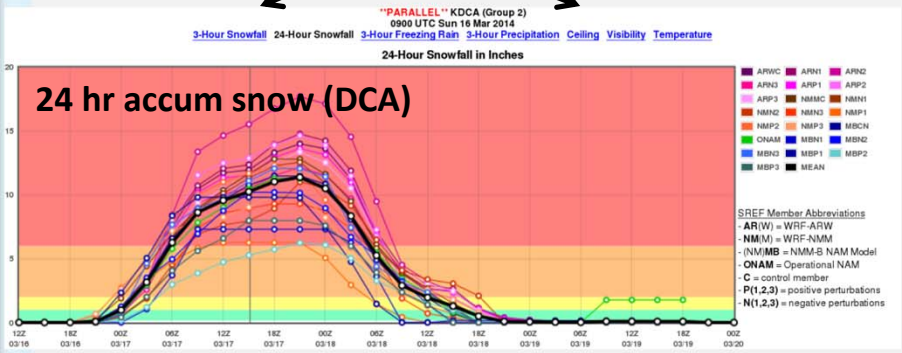
Winter Dashboard: SREF Based Impact

http://www.aviationweather.gov/decisionsupport/winterdashboard



Impact tuned with airlines via CDM-WET

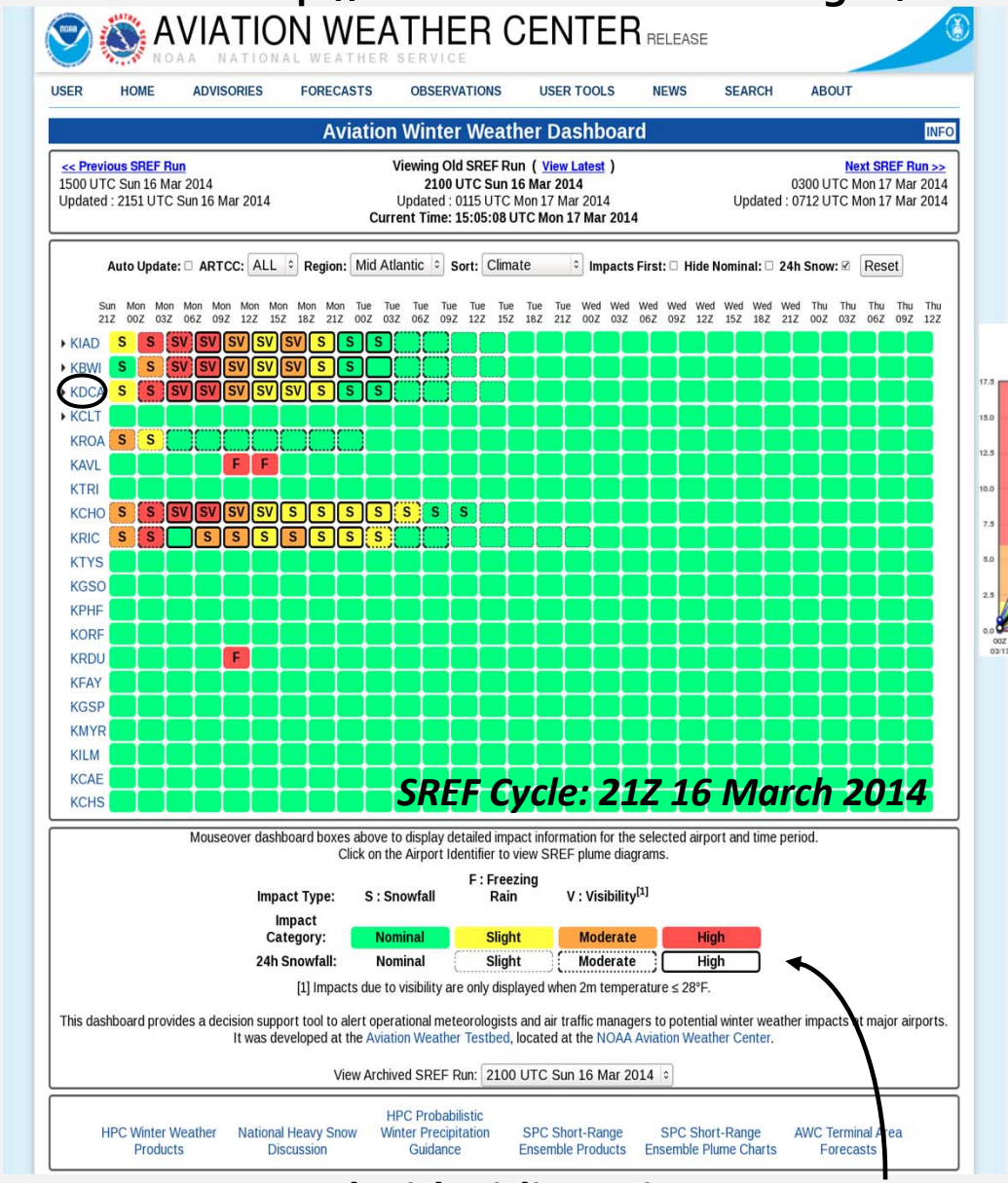
Plume options for ceiling, visibility, precipitation, temperature



- Collaborative project with FAA and Industry (FAA's CDM-WET)
- CORE-30 airports + diversions
- Also have a summer convective dashboard (not shown)

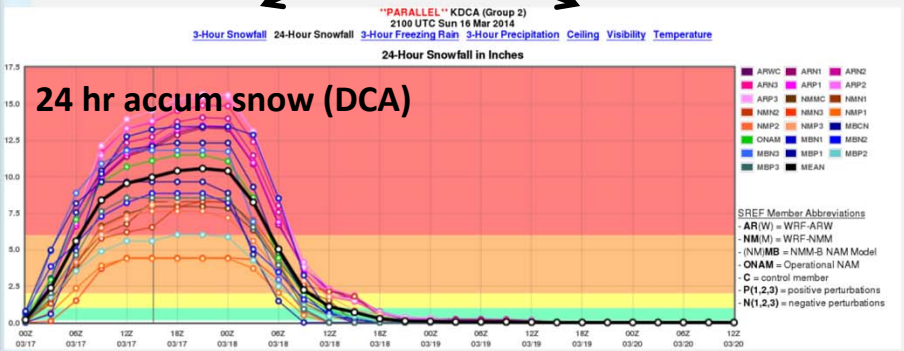
Winter Dashboard: SREF Based Impact

http://www.aviationweather.gov/decisionsupport/winterdashboard



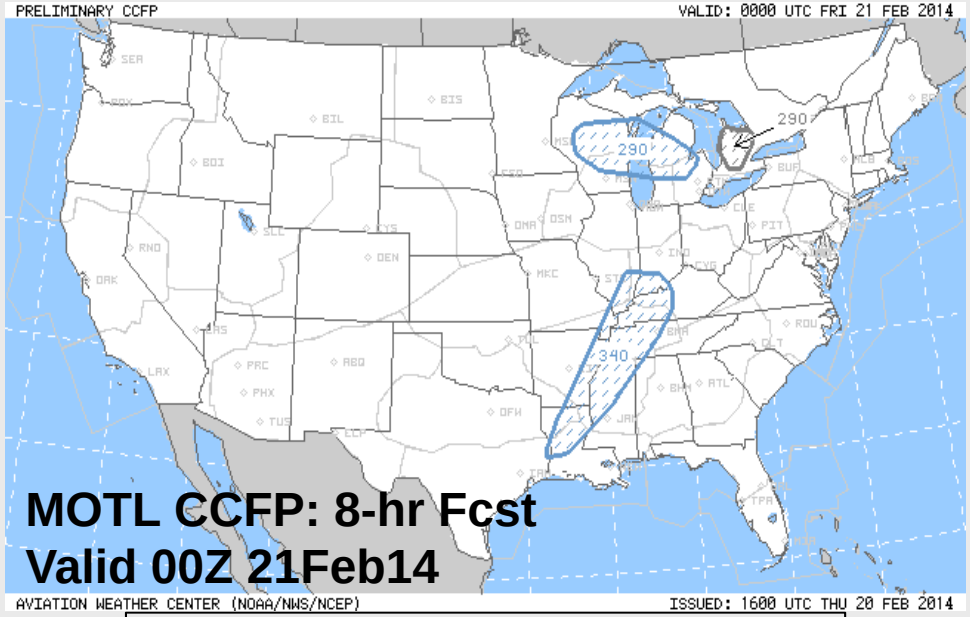
Impact tuned with airlines via CDM-WET

Plume options for ceiling, visibility, precipitation, temperature

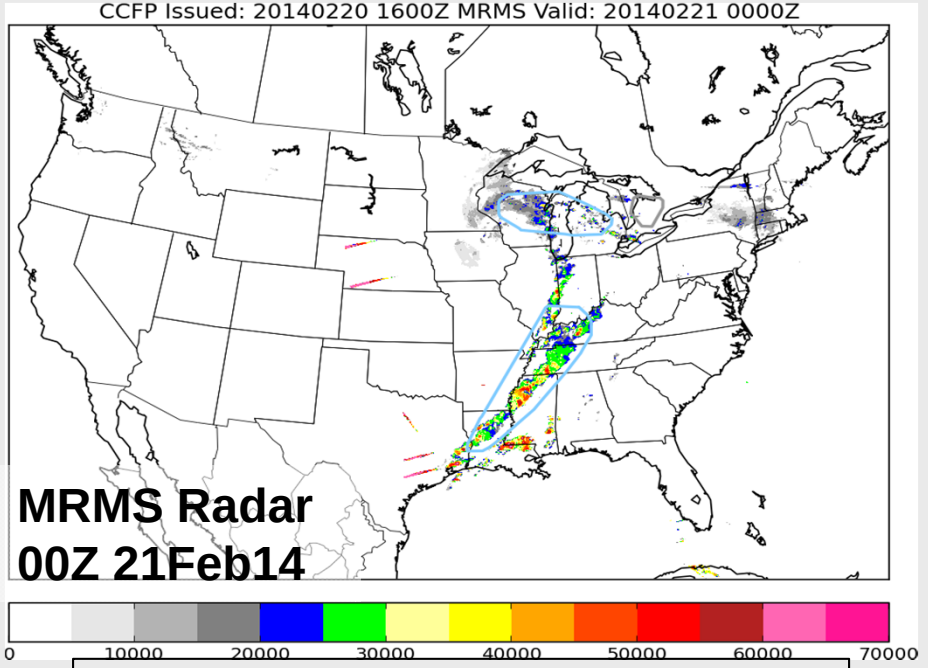


- Collaborative project with FAA and Industry (FAA's CDM-WET)
- CORE-30 airports + diversions
- Also have a summer convective dashboard (not shown)

Ensemble-Based Development of MOTL Guidance



MOTL CCFP: 8-hr Fcst
Valid 00Z 21Feb14



MRMS Radar
00Z 21Feb14

Input: SREF + HRRR-TL
Output: CCFP Polygons

SREF + HRRR-TL and Radar

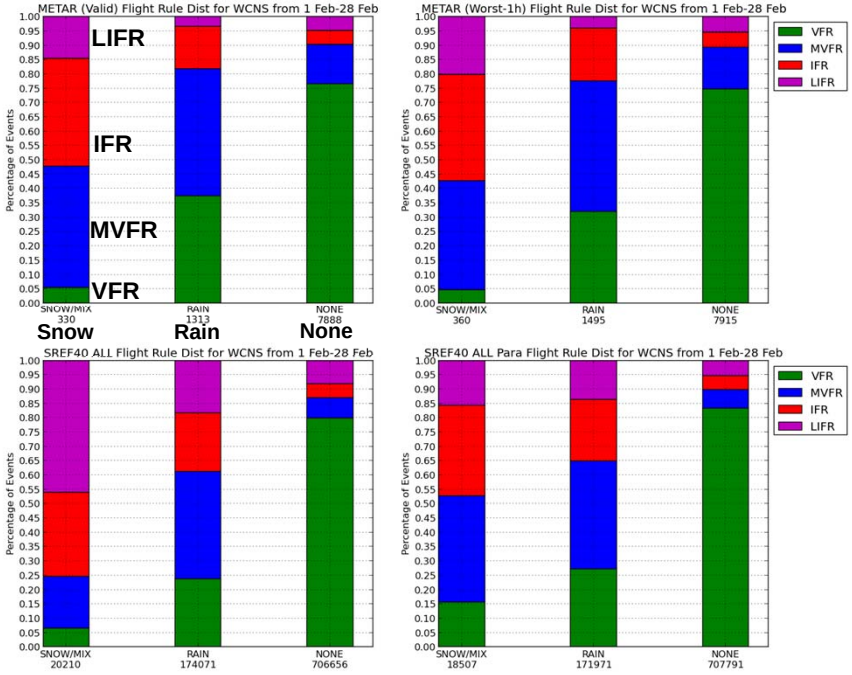
- **Still early in development cycle (since Jan. 2014)**
  - **SREF SPC Calibrated Thunderstorm and HRRR-TL shown here**

- **FAA via CDM-WET & Industry studying MOTL CCFP and introducing AWS**
  - **AWS = Aviation Weather Statement (“TFM Warnings” for DSS)**

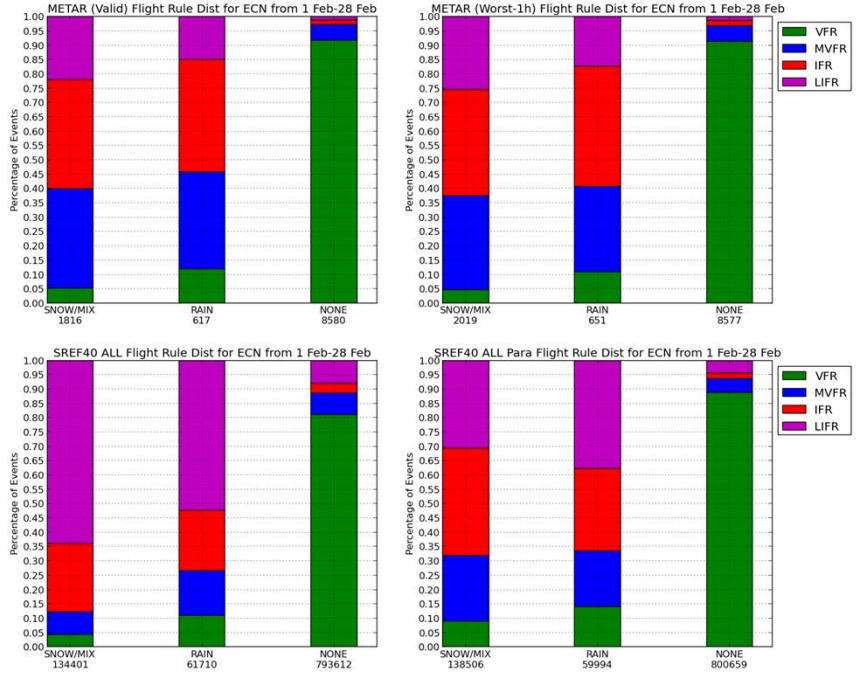
Flight Rules (Ceiling & Visibility) Improvements

SREF Parallel vs. Operational – Flight Rule Distribution
February 1-28, 2014

West Coast (Western OR/WA/CA)



Northeast (NJ/Ern NY to Ern ME)



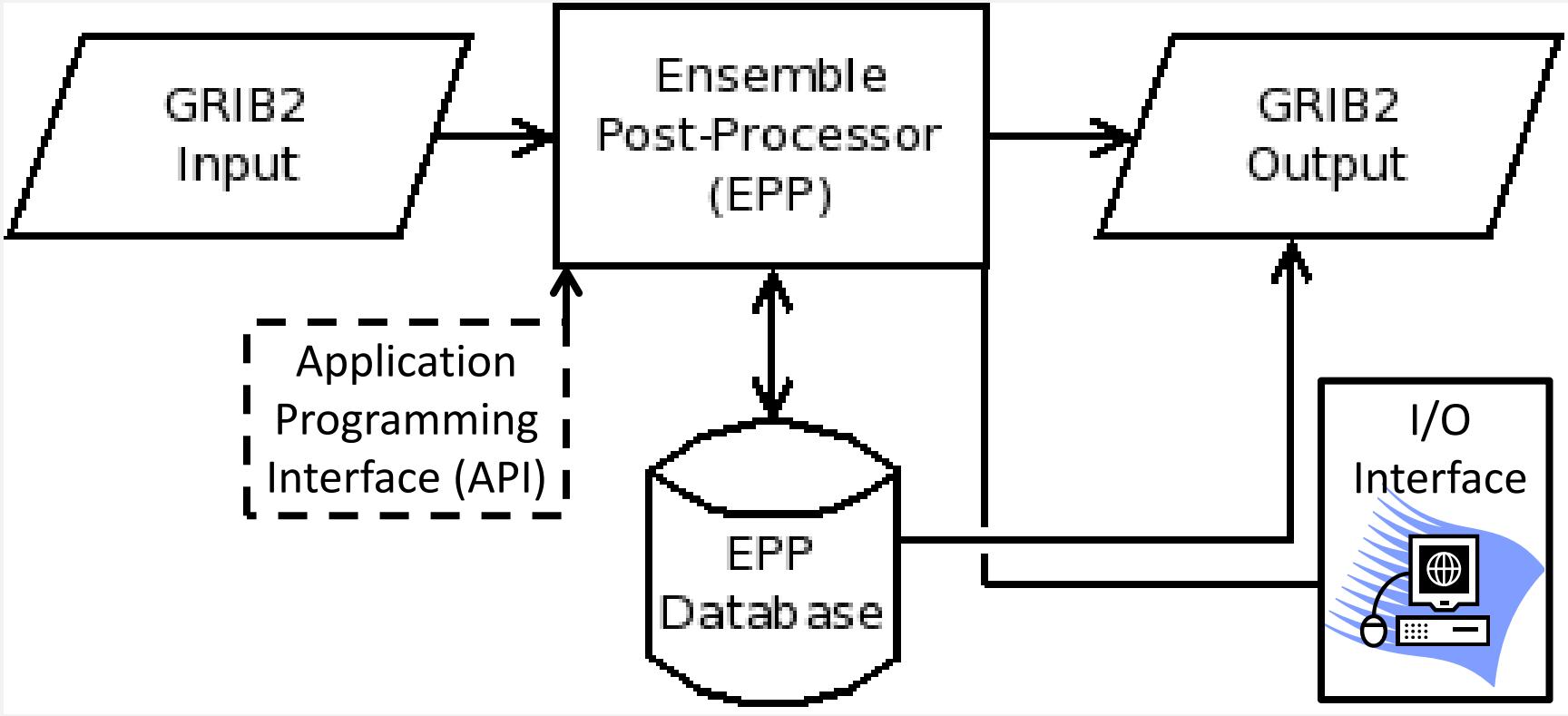
- Overall, much improved distribution of C&V flight categories
  - Ceiling in particular very much improved (not shown)
  - Snow: High LIFR much improved; introduced a small, high VFR bias in snow
  - Rain: Generally improved all categories
  - None: LIFR improved NE and West; High VFR bias WC slightly increased

Ensemble Processor (EP)

Objective: Tool to Build Specialized Applications

- Ensemble framework at center of NWS/NCEP NWP strategy & NextGen (advanced probabilistic forecasting)
- Looking for a tool to rapidly configure and view ensemble systems in the AWT (FY13 to present)
  - Experiment → Research, Explore, Interactive Use
  - Real-time → Automatic processing into NAWIPS (R2O)
- Software capable of adapting to various ensemble systems (e.g., variable membership, resolution)
- Software capable of supporting standard ensemble variables but more importantly, mission specific post-processing
  - Applied ensemble research and R2O for aviation applications through the AWT
  - Early beta stage for NCEP Short-Range Ensemble Forecast (SREF)

Ensemble Processor
Design Schematic

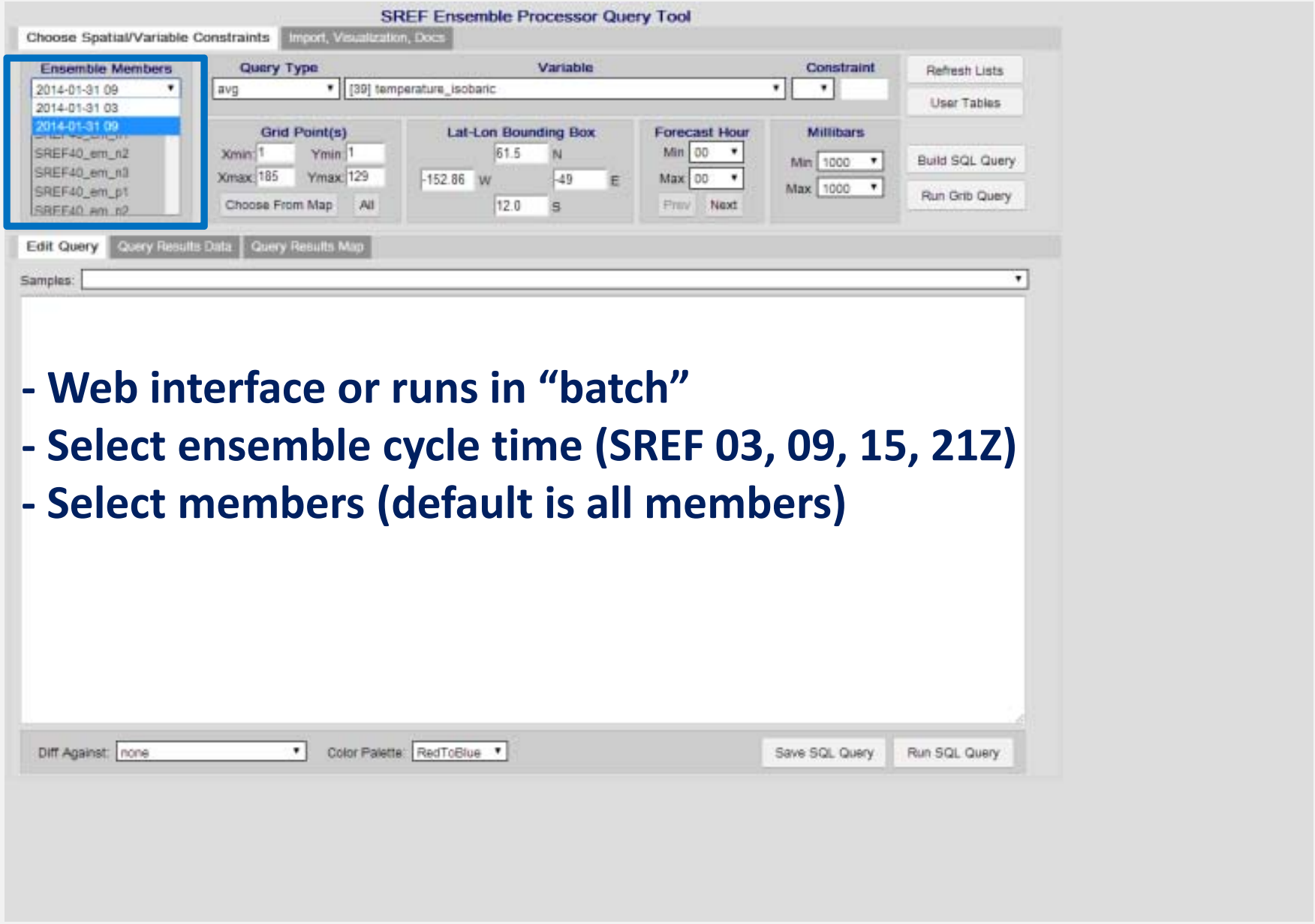


1. Define ensemble
2. Read GRIB2, store members, ensemble calculations
3. Two-way database interaction
4. Automatic or on-demand output to GRIB2 (for NMAP; AWIPS-2)
5. Web real-time interrogation and display

EP Technical Specifications

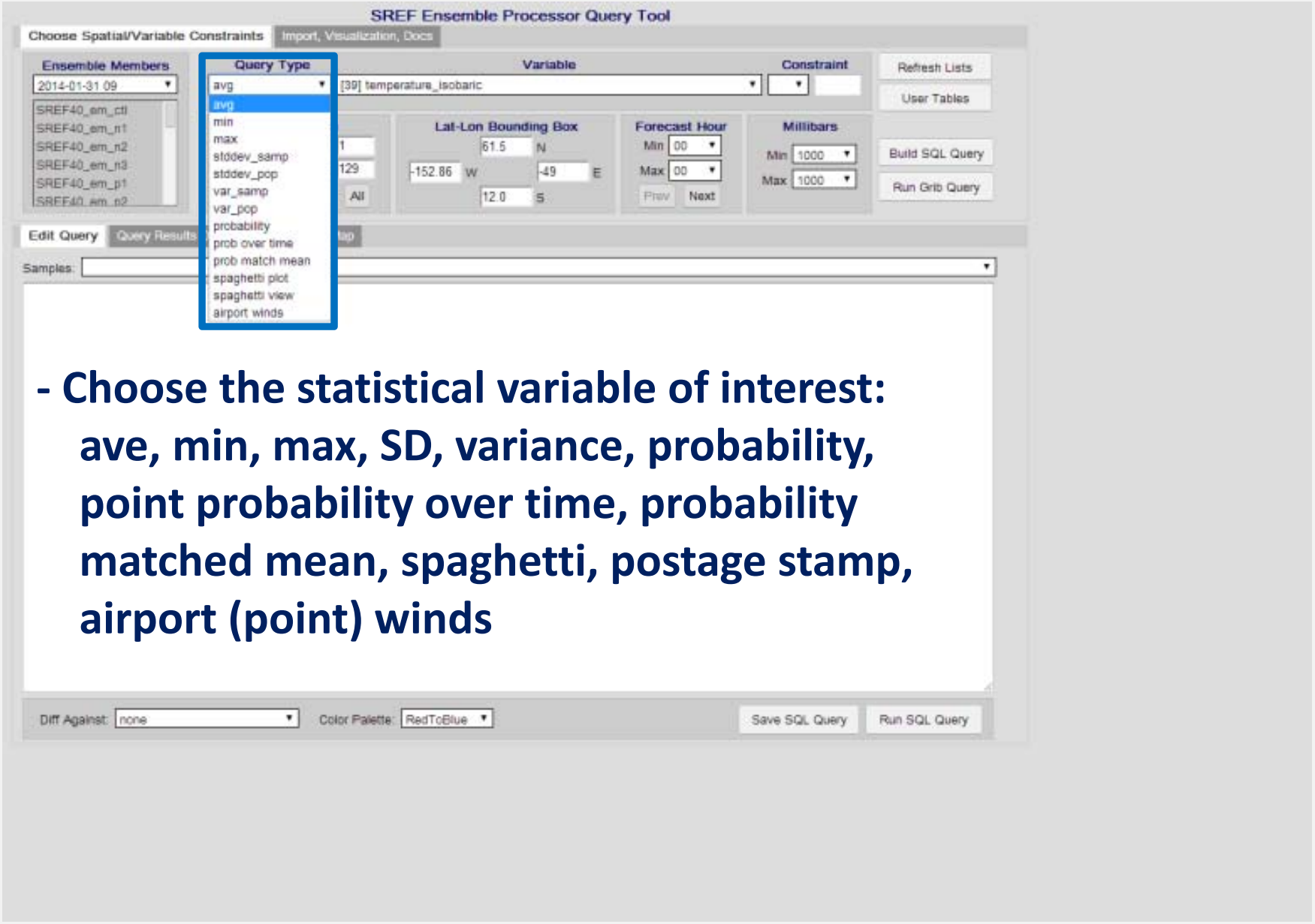
- Server Hardware
  - Twin Xeon X5660 processors (6 core/processor @2.8 GHz)
  - 144 GB of DDR3-1333 RAM
  - Intel SSD 910 800 GB (2000|1000 MB/s read|write; 3X I/O gain HD to SDD)
- Software
  - Developed in Java; APIs are written in Java
  - MySQL Geospatial Database
    - Faster and more efficient than PostGIS
  - NetCDF Java libraries to read|write GRIB2 files
  - XML configuration files read on startup
- Currently functional alpha-beta phase in AWT
  - Real-time data
    - NCEP Short-Range Ensemble Forecast (SREF)
      - 21 members (WRF-NMM; WRF-ARW; NMM-B)
      - 0-87 hours (1-hourly 0-39, 3-hourly thereafter)
      - 40 km Grid 212; 16 km Grid 132

Select Ensemble Data



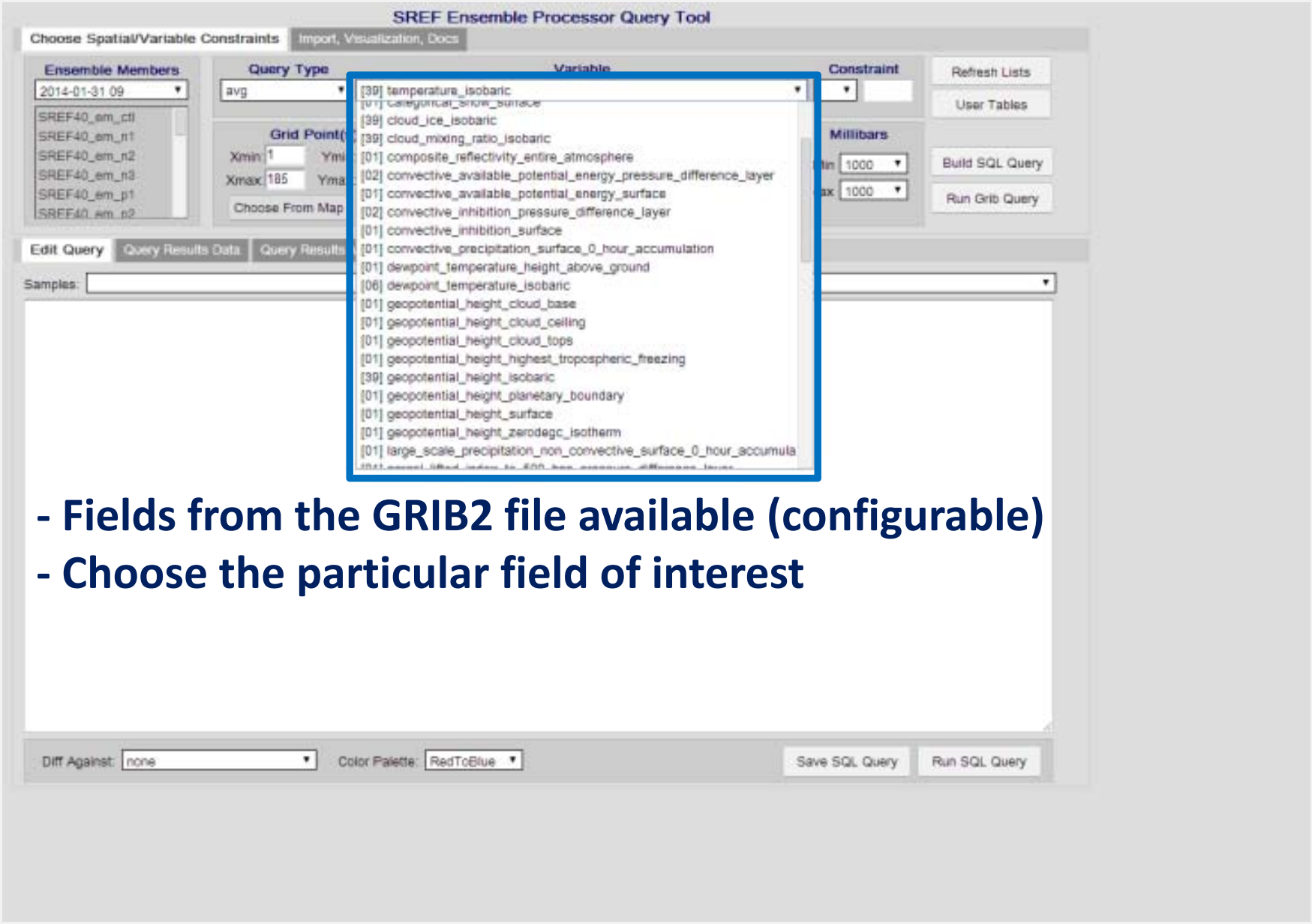
- Web interface or runs in “batch”
- Select ensemble cycle time (SREF 03, 09, 15, 21Z)
- Select members (default is all members)

Select Statistical Calculation



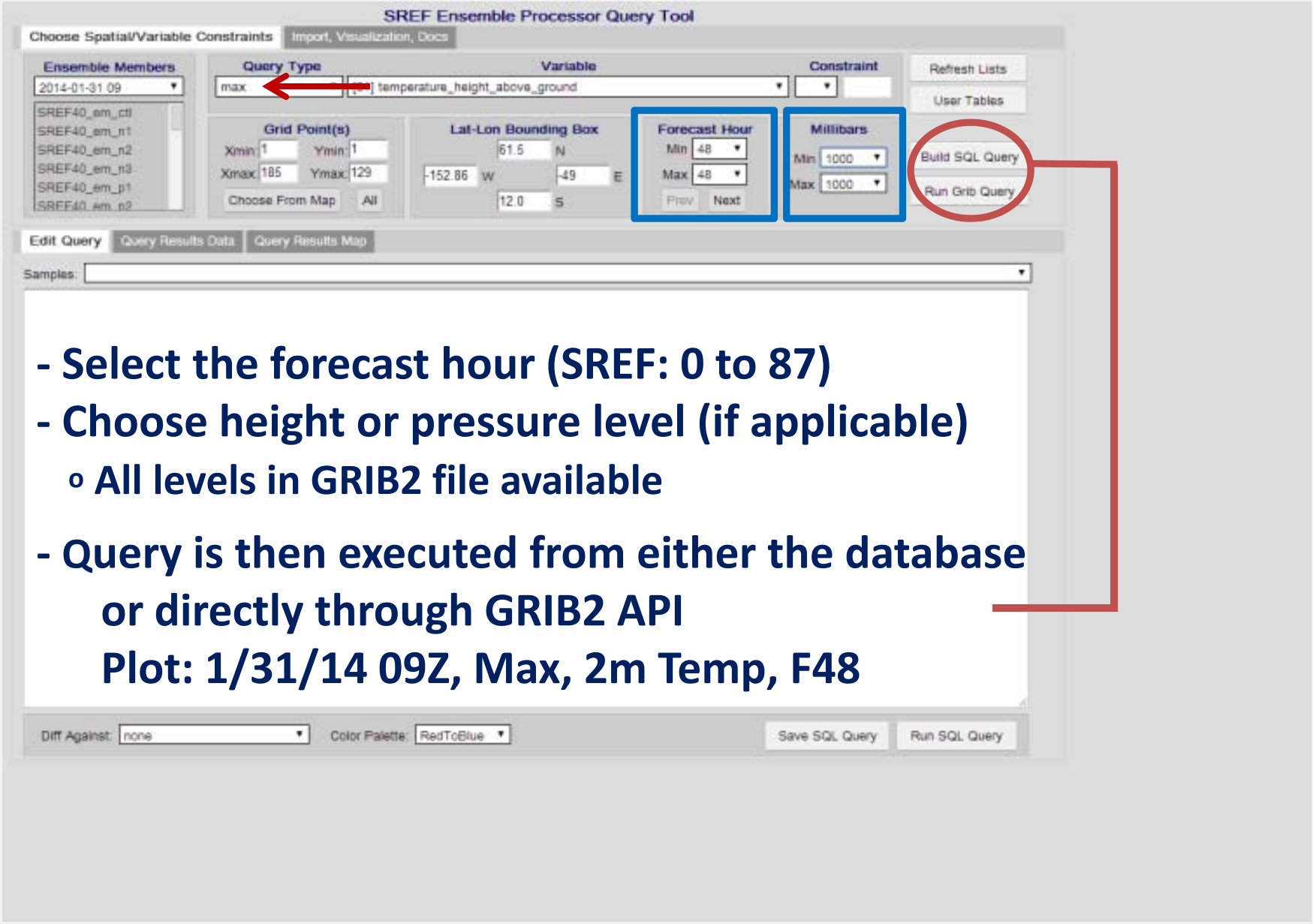
- Choose the statistical variable of interest:
  ave, min, max, SD, variance, probability, point probability over time, probability matched mean, spaghetti, postage stamp, airport (point) winds

Select Model Field to Examine

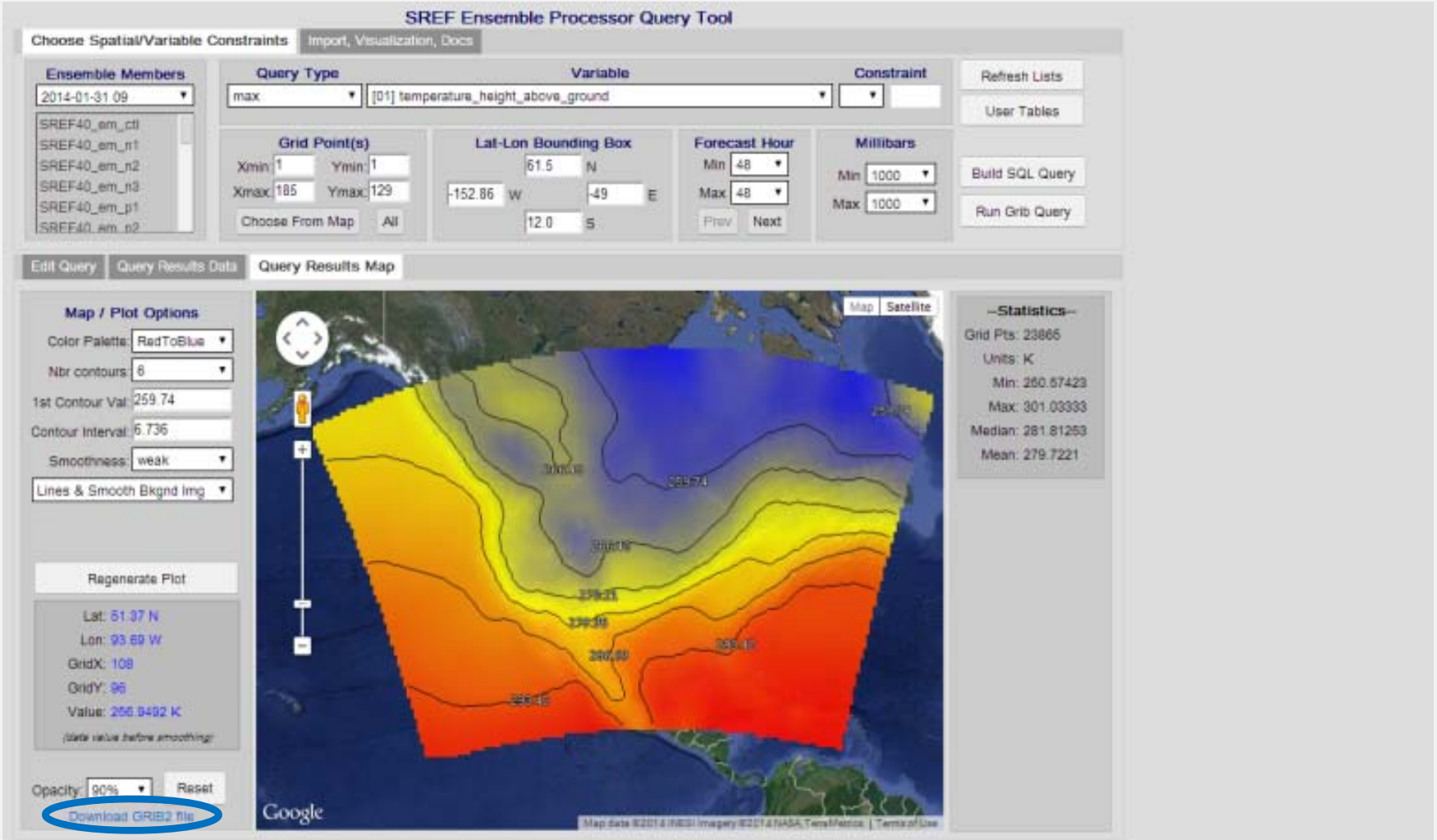


- Fields from the GRIB2 file available (configurable)
- Choose the particular field of interest

Select Forecast Time & Level

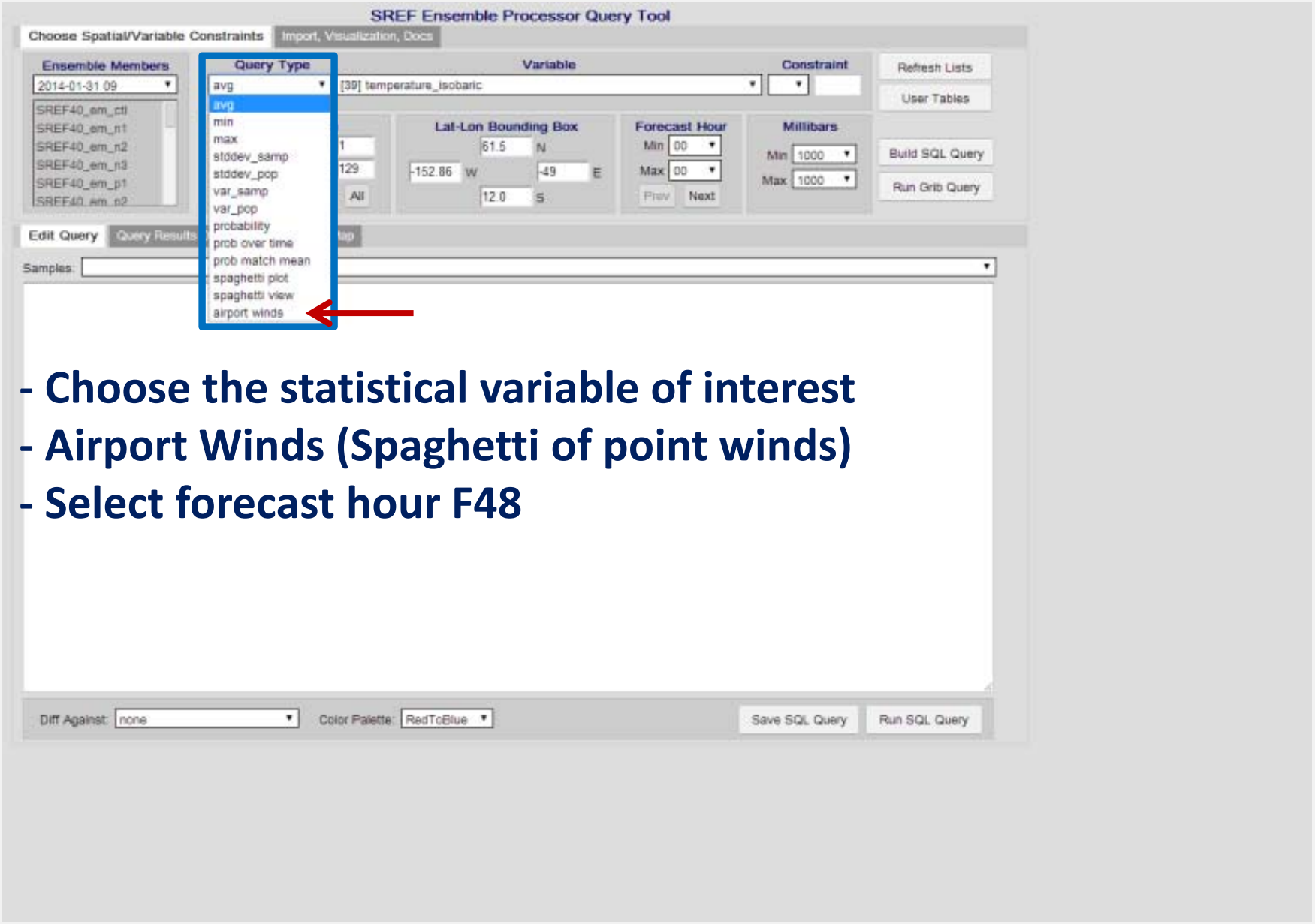


Plot Rendered Over Google Maps



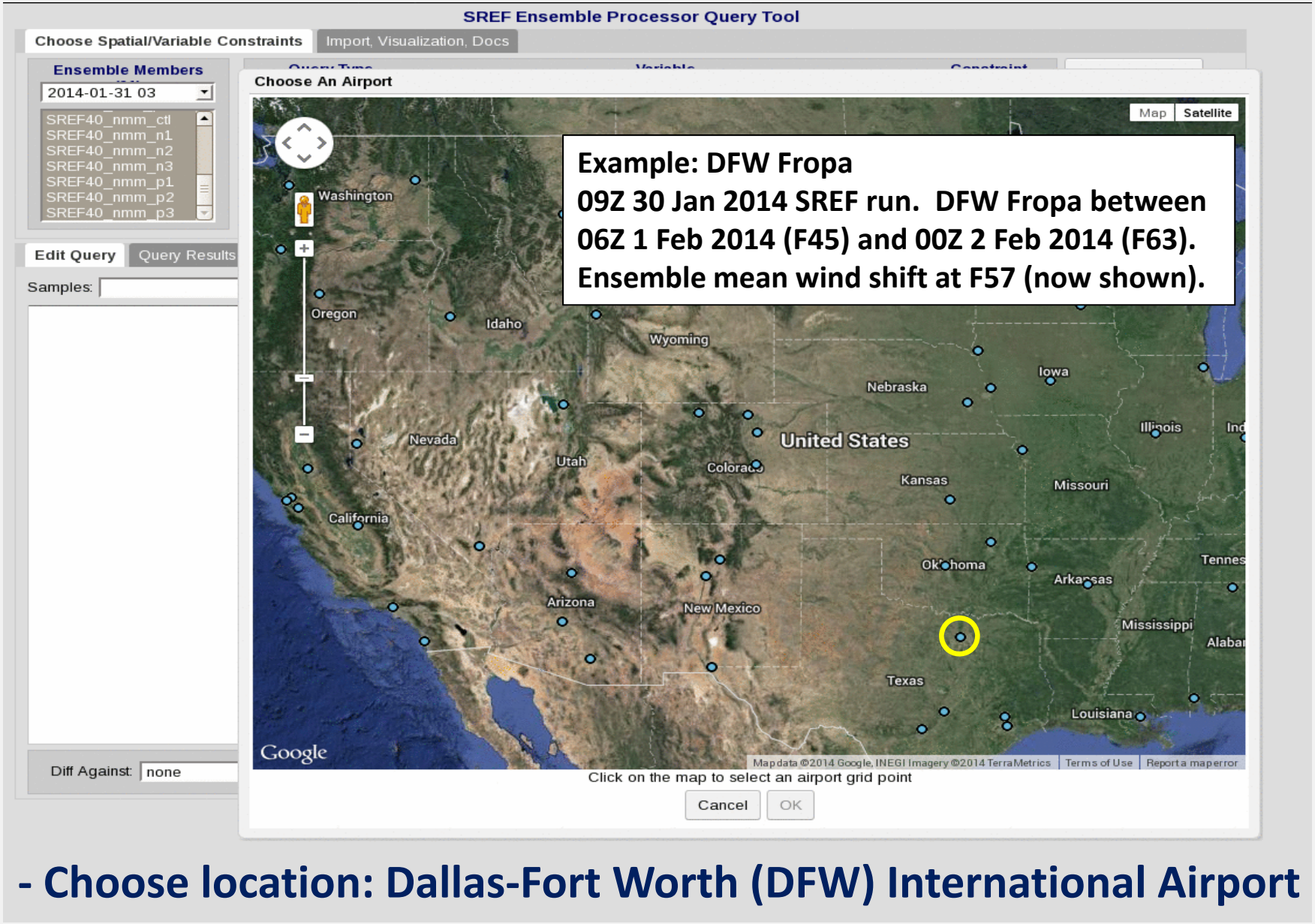
- Option exists to manually download a GRIB2 file…
  can then push to NAWIPS or another platform

Select Statistical Calculation



- Choose the statistical variable of interest
- Airport Winds (Spaghetti of point winds)
- Select forecast hour F48

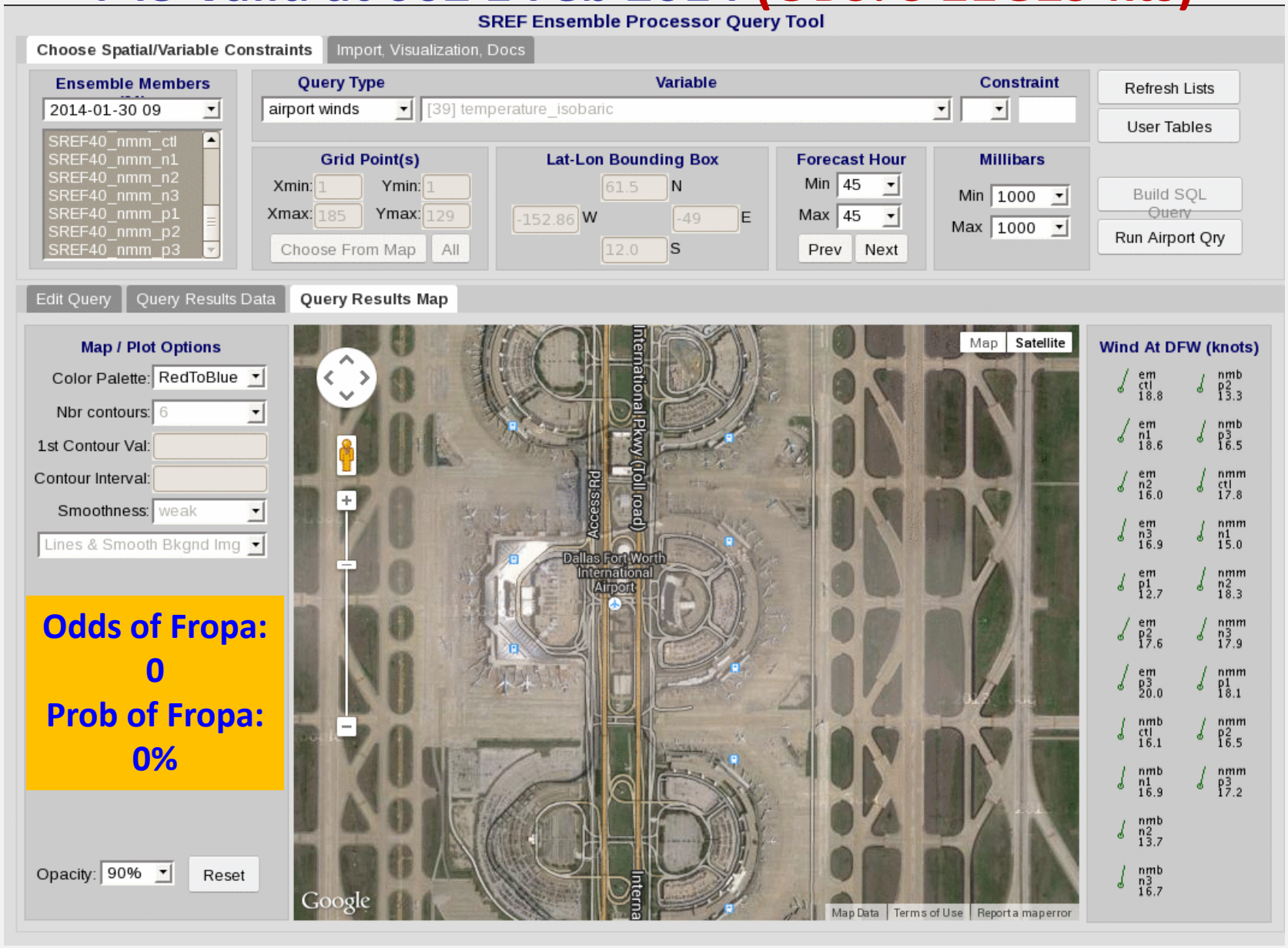
Select Airport Location



- Choose location: Dallas-Fort Worth (DFW) International Airport

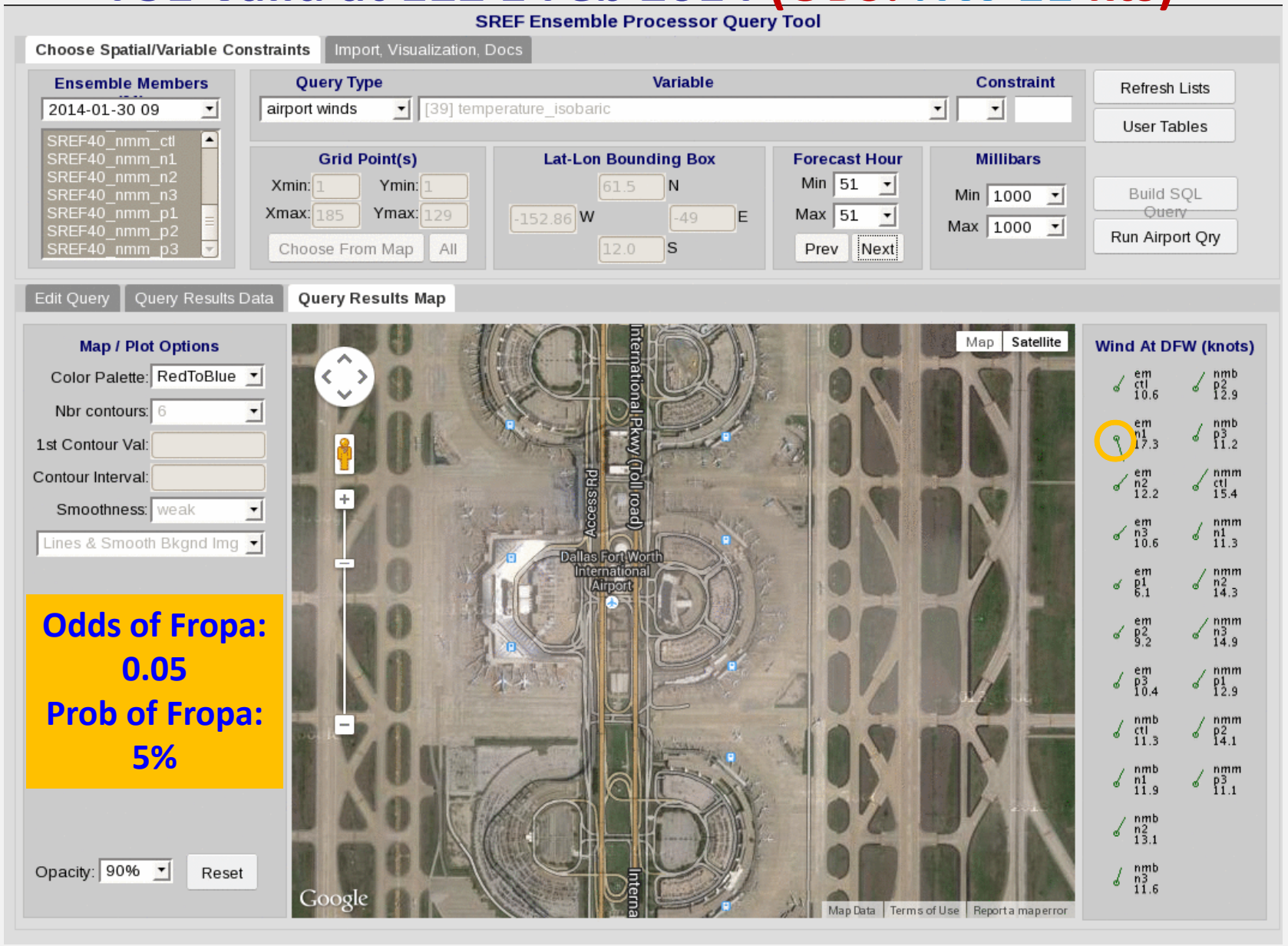
DFW 10 m Wind Forecast

F45 Valid at 06Z 1 Feb 2014 (OBS: S 21G29 kts)



DFW 10 m Wind Forecast

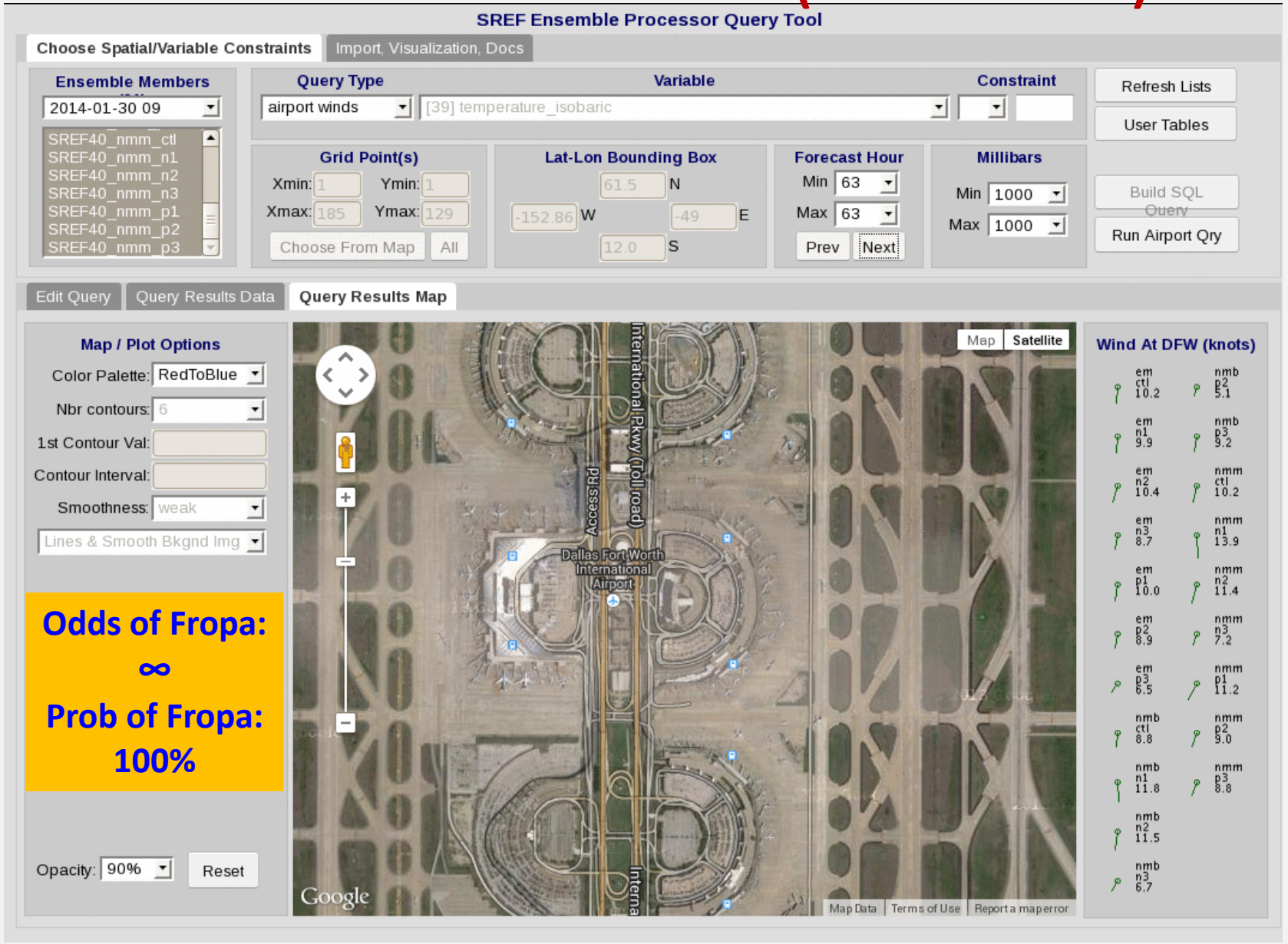
F51 Valid at 12Z 1 Feb 2014 (OBS: NW 11 kts)



11

DFW 10 m Wind Forecast

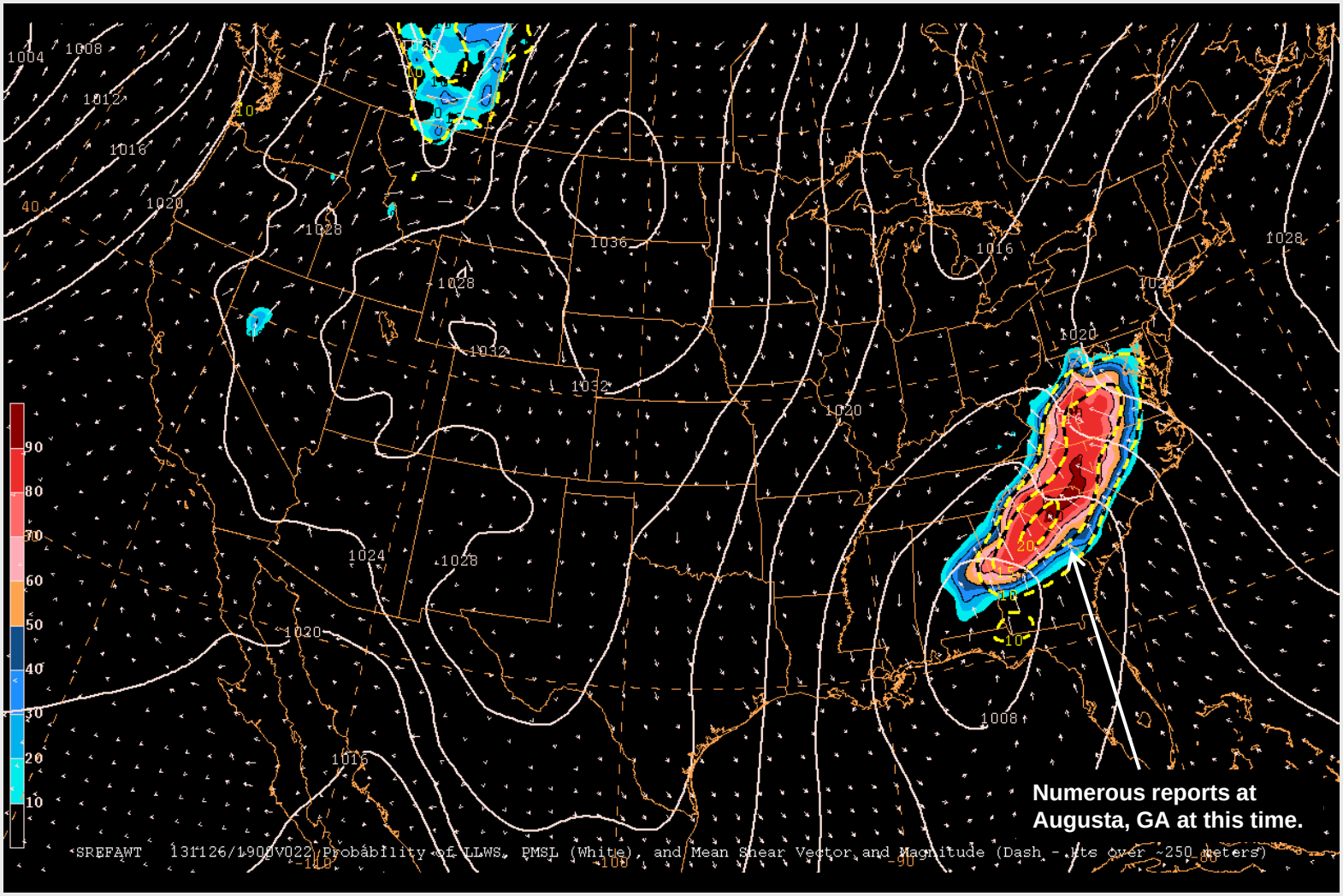
F63 Valid at 00Z 2 Feb 2014 (OBS: N 11 kts)



11

Application Development for DSS

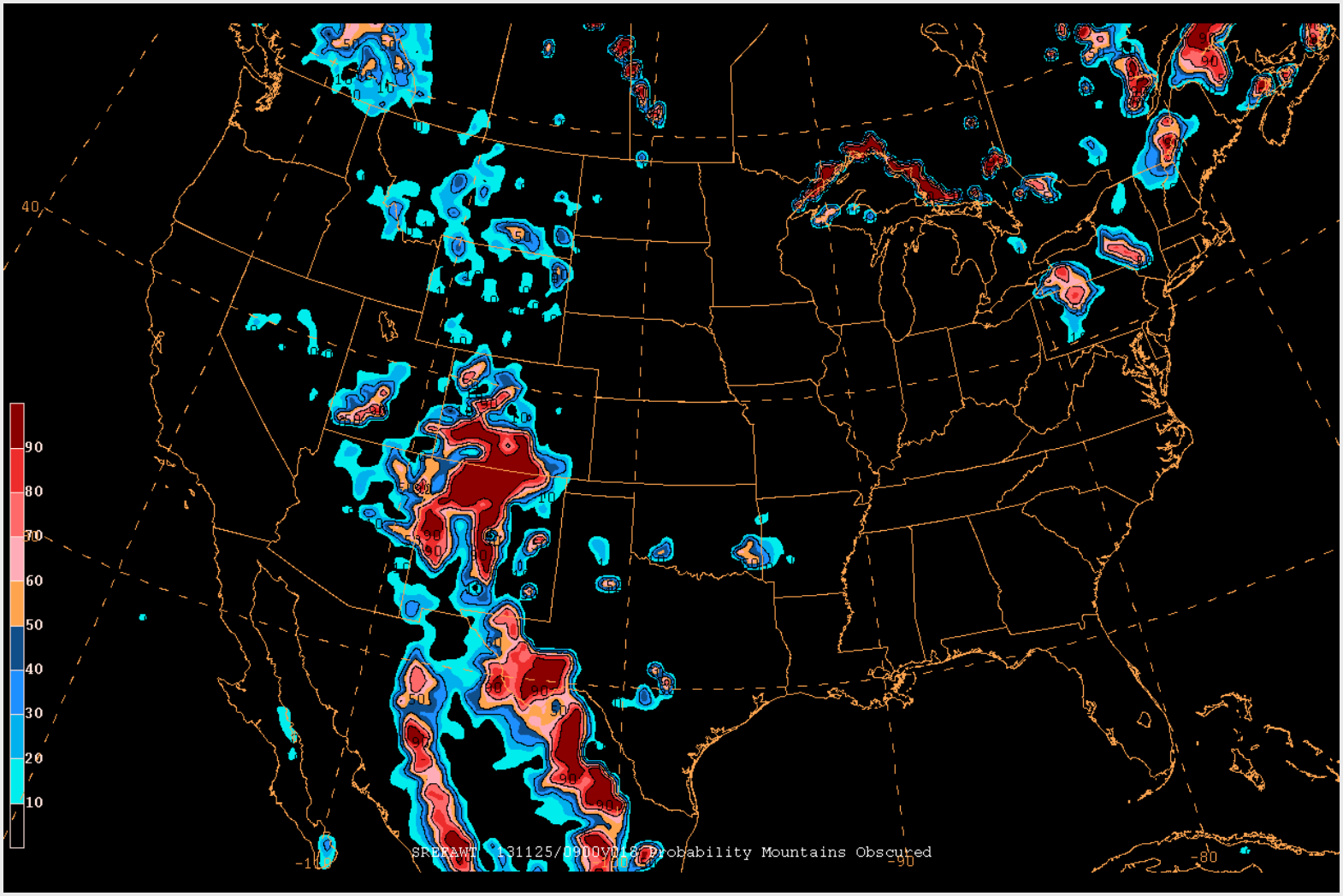
Low-Level Wind Shear



Likelihood of Low-Level Wind Shear, Mean PMSL (white), Mean peak shear (contour) & vector
22-hr Fcst Valid 19Z 26 Nov 2013

Application Development for DSS

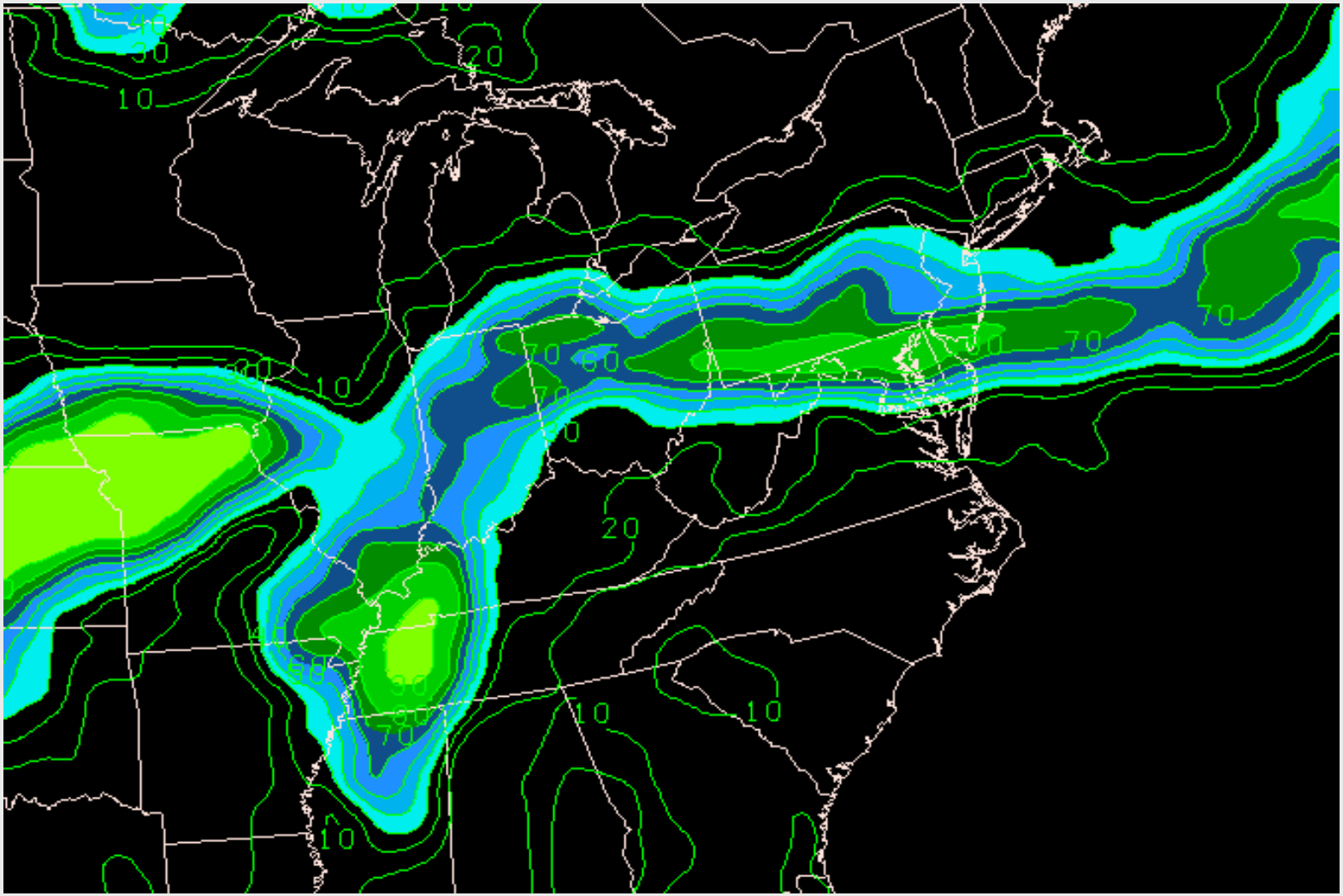
Mountains Obscured by Clouds



Likelihood of Mountains Obscured by Clouds
09-hr Fcst Valid 09Z 25 Nov 2013

Application Development for DSS

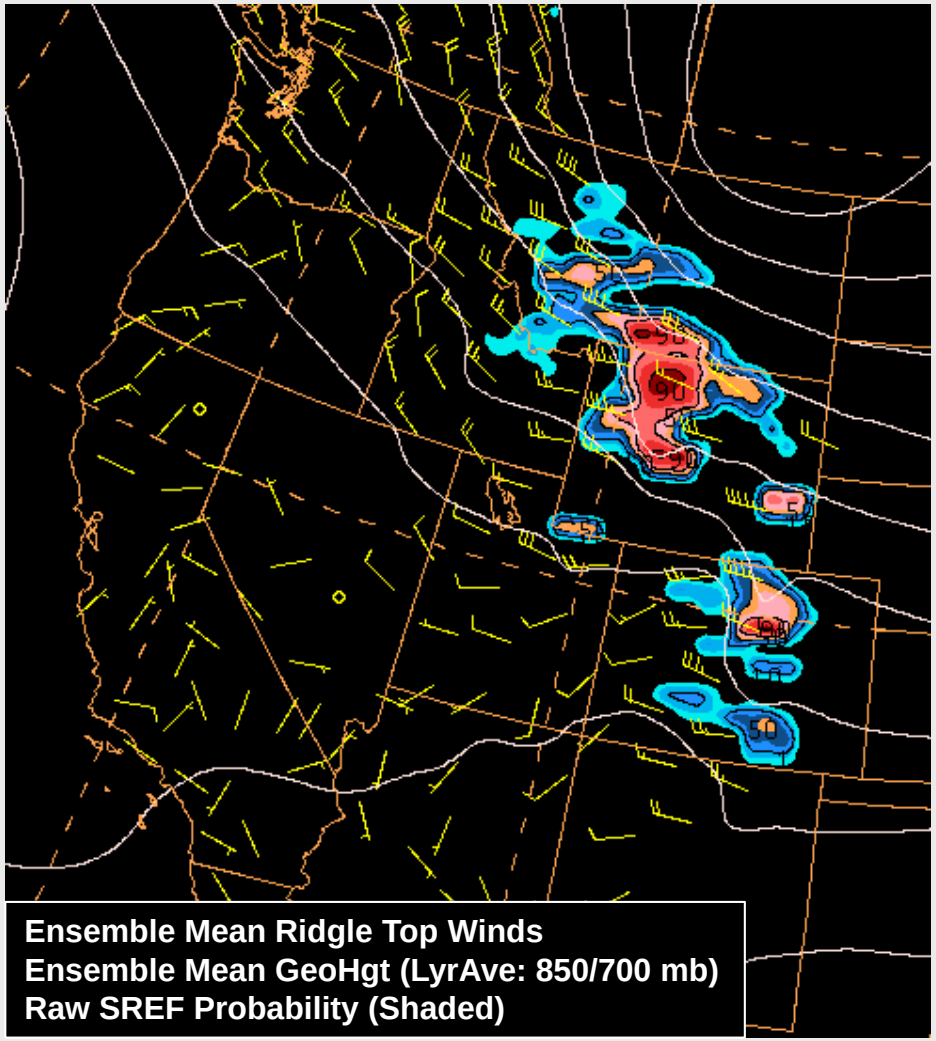
Aircraft Icing



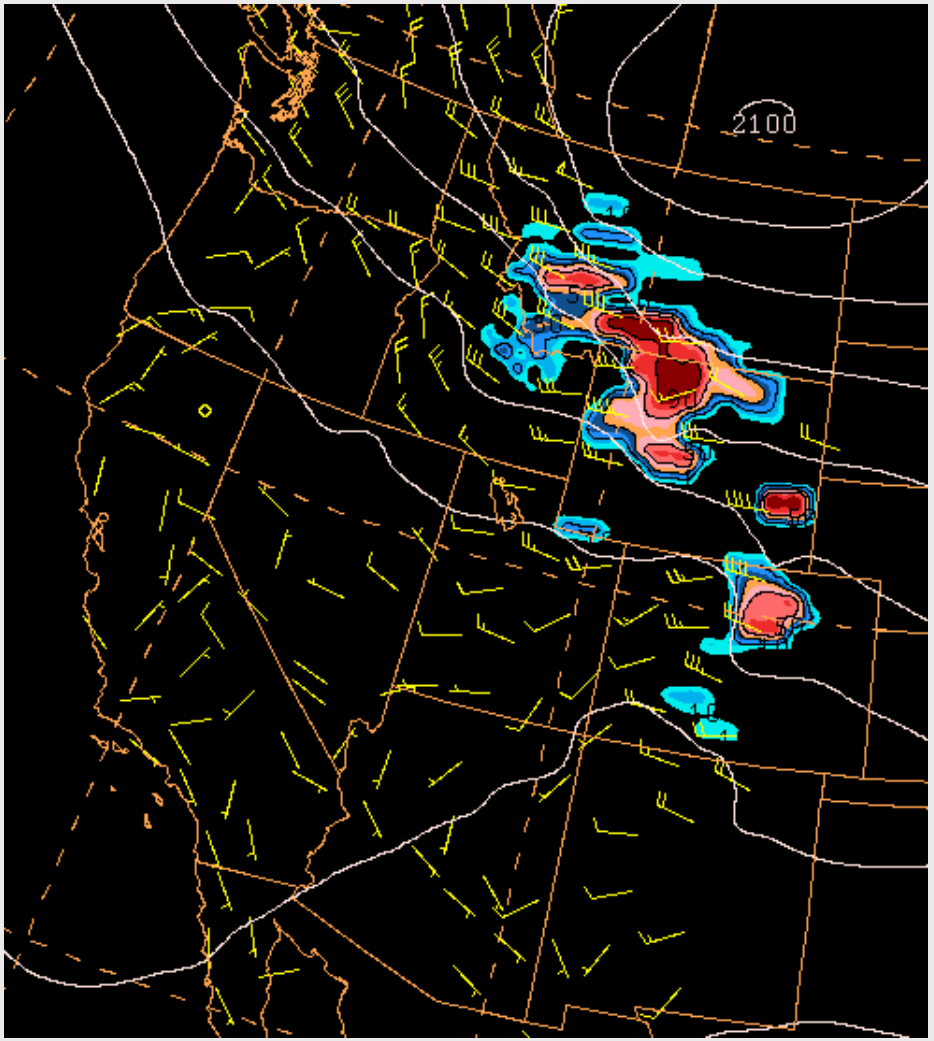
Likelihood of Icing Conditions
12-hr Fcst Valid 15Z 20 Dec 2011

Application Development for DSS

Mountain Waves



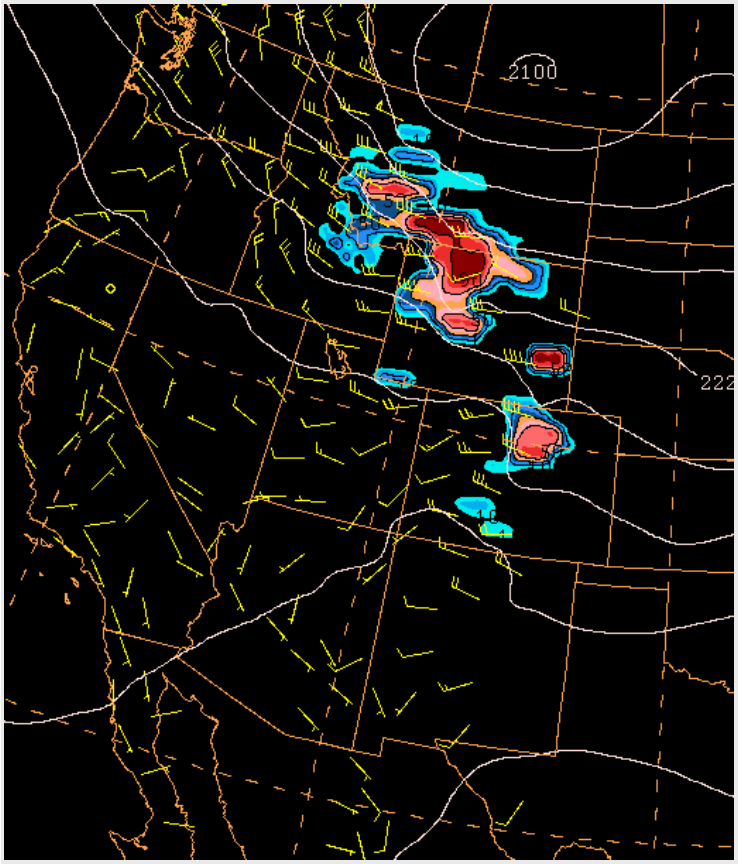
Likelihood of Mountain Wave Conditions
48-hr Fcst Valid 15Z 20 Mar 2014



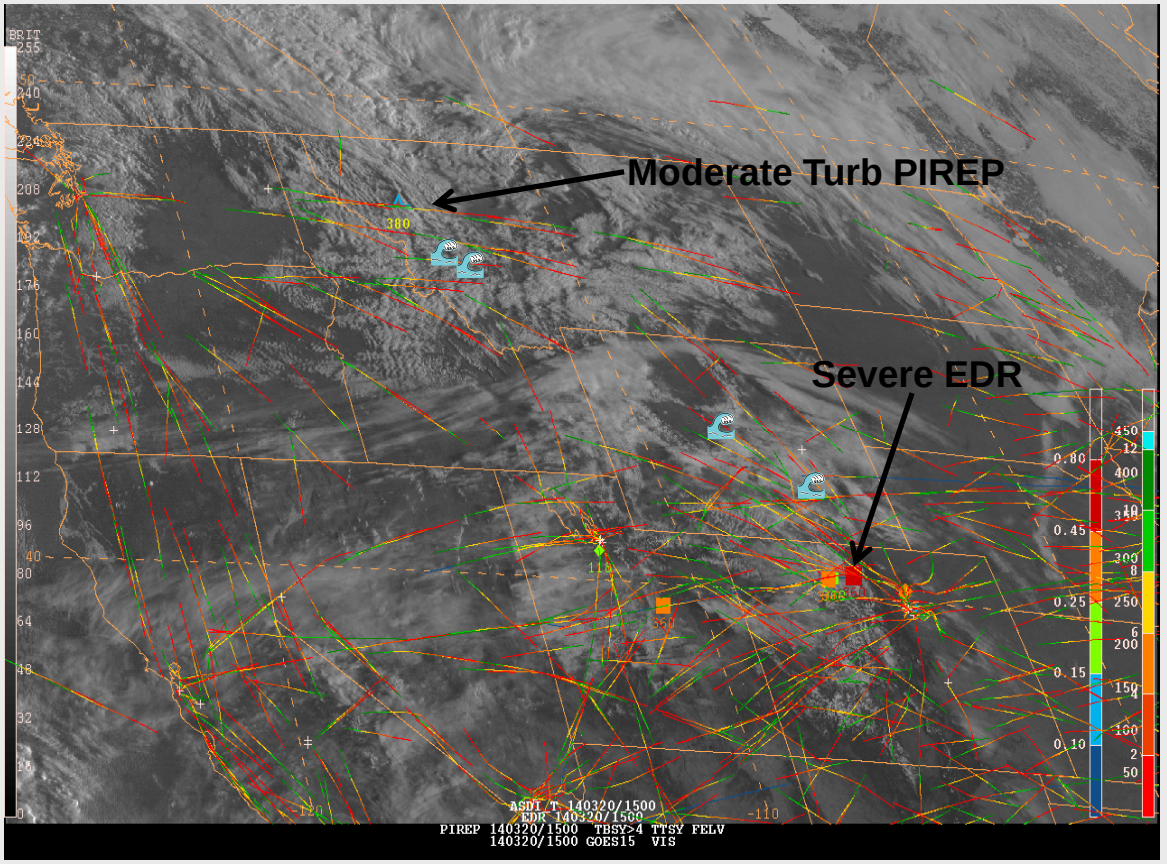
Likelihood of Mountain Wave Conditions
12-hr Fcst Valid 15Z 20 Mar 2014

Application Development for DSS

Mountain Waves



Likelihood of Mountain Wave Conditions
12-hr Fcst Valid 15Z 20 Mar 2014



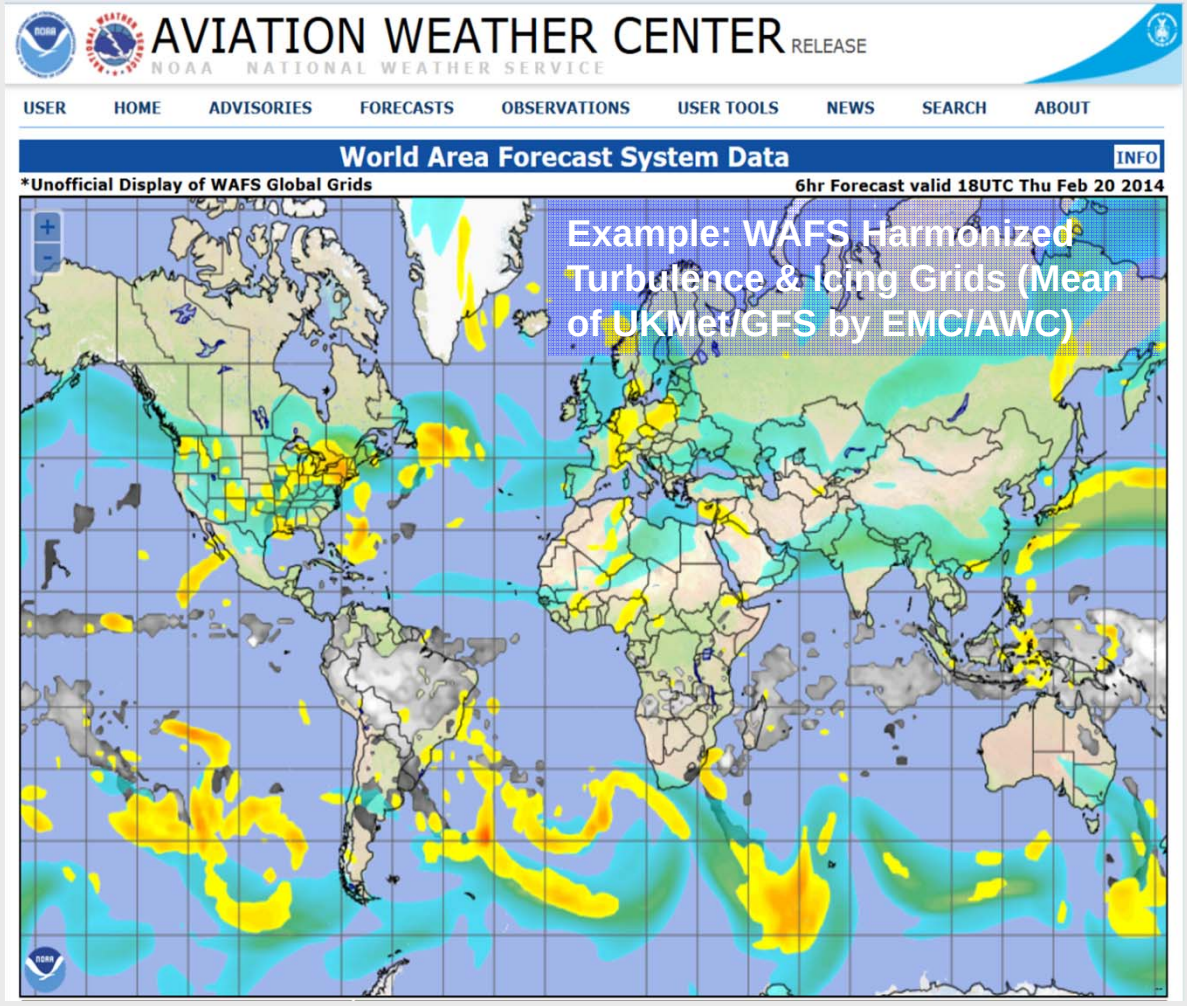
Visible Satellite Image 15Z 20 March 2014
Aircraft Tracks
Eddy Dissipation Rate (EDR; ≥ “moderate” in boxes)
Mountain Wave in PIREP remarks

World Area Forecast Centers

WAFC Washington (Kansas City)

WAFC London (Exeter, UK)

- **World Area Forecast Centers (WAFCs) provided authority to operate under the International Civil Aviation Organization (ICAO) World Area Forecast System (WAFS)**
- **Burgeoning International met offices are seeking a larger role in WAFS forecast process**
- **One option is a proposed, FAA fundable, and ICAO approved plan for an International WAFS Ensemble**



World Area Forecast Centers

WAFC Washington (Kansas City)
WAFC London (Exeter, UK)

- **The WAFS Vision:**
  - WAFS International ensemble of models from qualified Meteorological Service Providers
  - WAFS International ensemble available at multiple resolutions via NOMADS-like interface
  - Goal to become ICAO's global default as the authoritative source of digital aviation NWP guidance
    - Politically seamless (in time, space and policy)
    - Calibrated (by modeling Center and membership therein)
    - Partnerships with NUOPC?
  - Next discussion: The ICAO/WMO Meteorological Division Meeting
    - July 8 – 21, 2014, Montreal, Canada)
    - See Matt Strahan (AWC IOB Chief) for further information & input

AWC Summary

- Ensemble usage increasing at AWC and AWT
- Building ensemble-based tools to support AWC's Domestic and International forecast, advisory, and warning operations
- Ensembles the basis of CDM, TFM and IDSS MOTL tools
- Ensemble approach recommended by the WAFS/ICAO

David.Bright@noaa.gov

Matt.Strahan@noaa.gov