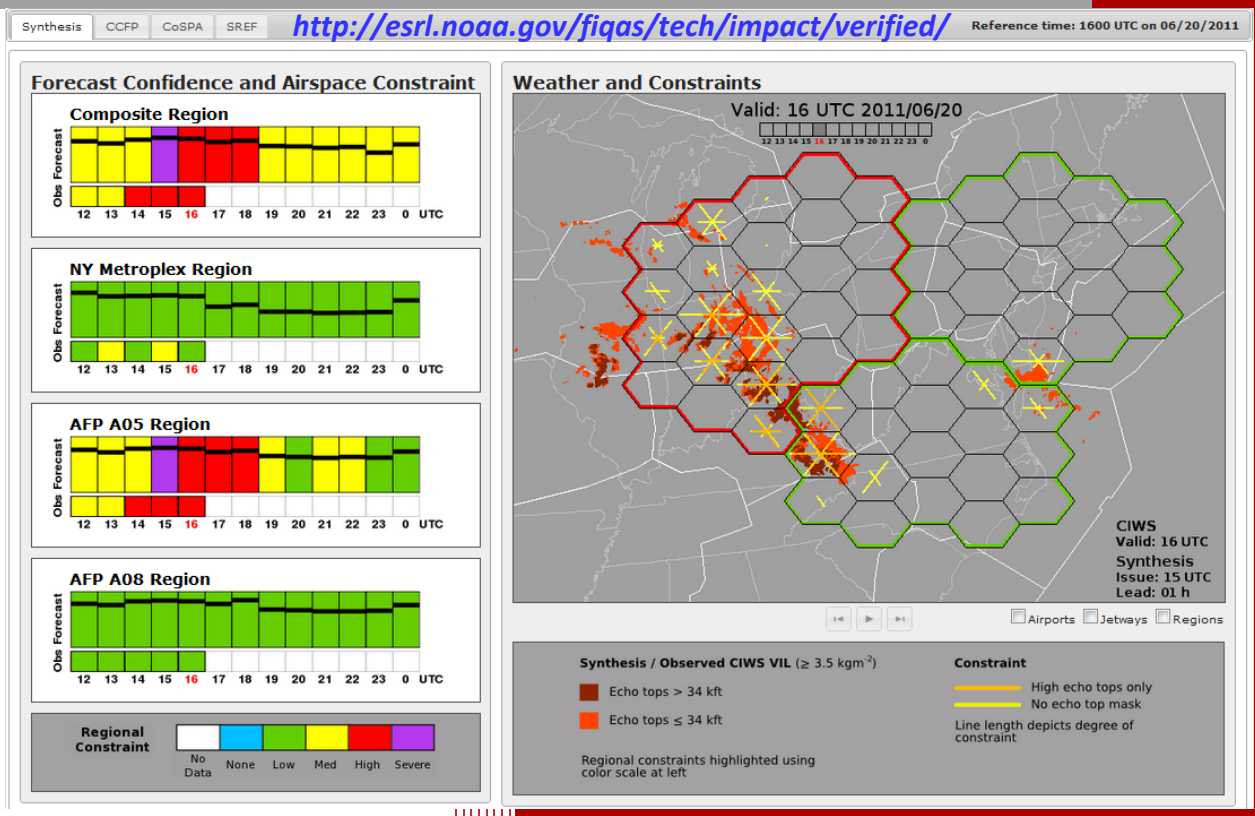
VERIFIED

VERification of Impact-translated Forecasts for IntEgrated Decision-making ▪ Training Manual

Version 1.0



NOAA / ESRL

Forecast Impact and Quality Assessment Section

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VERIFIED: A web-based application that displays unified weather forecast information in support of operational bridging activities established by the FAA Weather Evaluation Team

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http://esrl.noaa.gov/fiqas/tech/impact/verified/

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VERIFIED (VERification of Impact-translated Forecasts for IntEgrated Decision-making) is a web-based application that computes and displays real-time information on potential air traffic flow constraint resulting from convective weather over the northeastern United States. VERIFIED's timely consolidation of convective weather information from numerous forecast sources is specifically designed to support operational bridging activities established by the FAA's Weather Evaluation Team. This application translates convective forecast outcomes into a unified view of **airspace flow constraint** and provides a measure of **confidence** on the likelihood of the specified constraint.

The power of VERIFIED is in the presentation of results derived from statistical computations that are translated into a graphical view of convective weather constraint. The process takes into account the historical performance of forecast products, information on short-term trends, and then merges current predictions into a harmonized (or **synthesized**) view of airspace flow constraint. The process is modeled after the approach of an experienced forecaster who combines knowledge of past forecast performance, current forecast predictions, and awareness of air traffic flow patterns into a consolidated view of potential airspace constraint from predicted hazardous weather. Further considerations relating to the creation of the consolidated airspace constraint field are illustrated in Fig. 1.

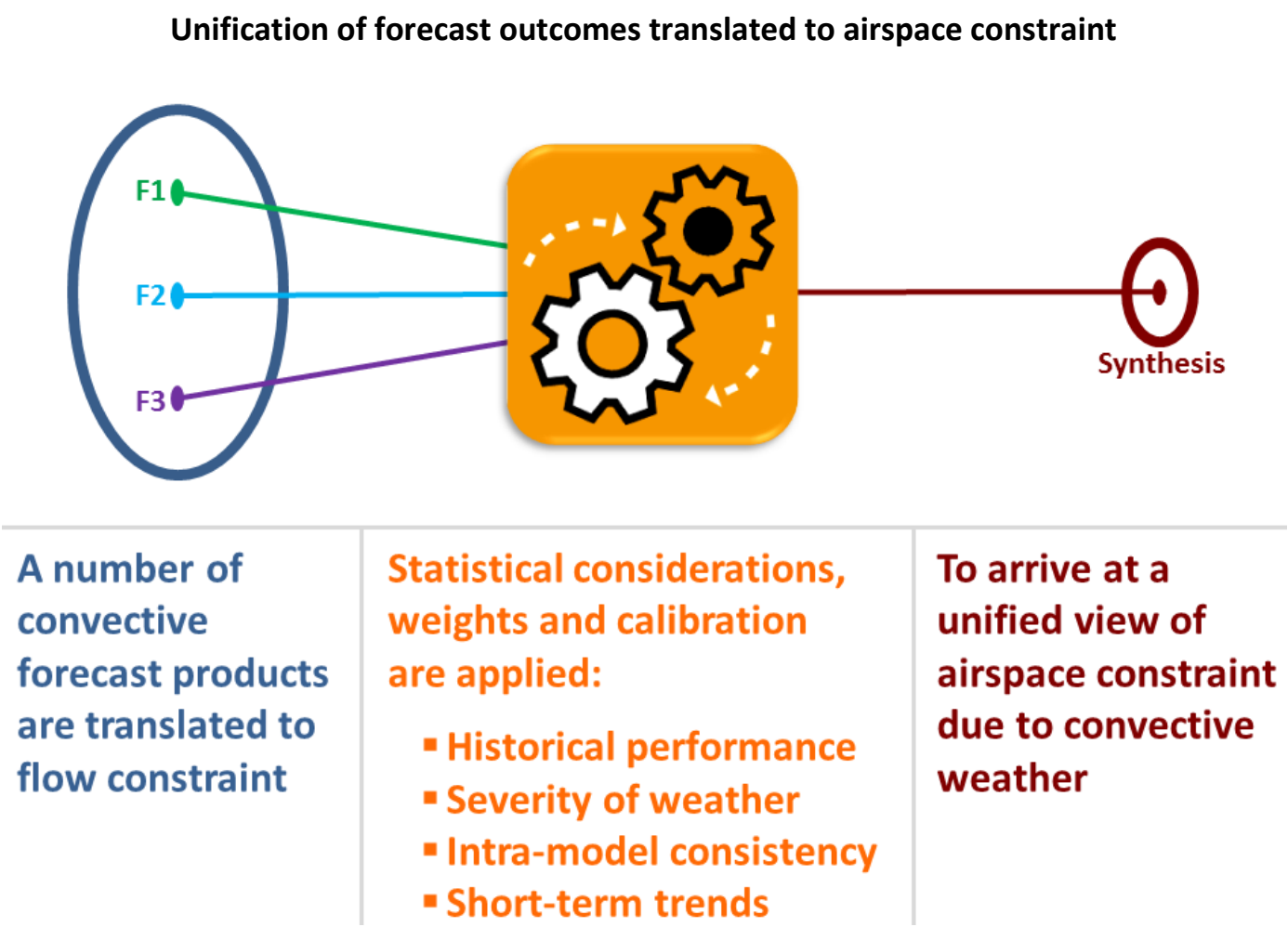

Figure 1: Simplified depiction of the process for translating numerous convective forecast products into a unified measure of airspace constraint.

Airspace Flow Programs (AFPs) are utilized by the FAA to improve en route traffic management in regions where delays are expected due to hazardous weather. These programs rely on the identification of geographic boundaries (**Flow Constrained Areas, FCA**) for traffic entering a particular region. For aircraft scheduled to intersect the boundary of an FCA, an adjustment is made to departure times so that overall flow rates are more manageable. FCAs most notably limit flow into and out of the northeast region of the country, where there are numerous flights and busy airports that can be affected by hazardous weather. AFP **A05** and **A08** are two major boundaries that are activated when the Northeast experiences weather-related reductions to en route capacity (see Fig. 2). Individual hexagons displayed on the accompanying map approximate the size of super-high altitude sectors.

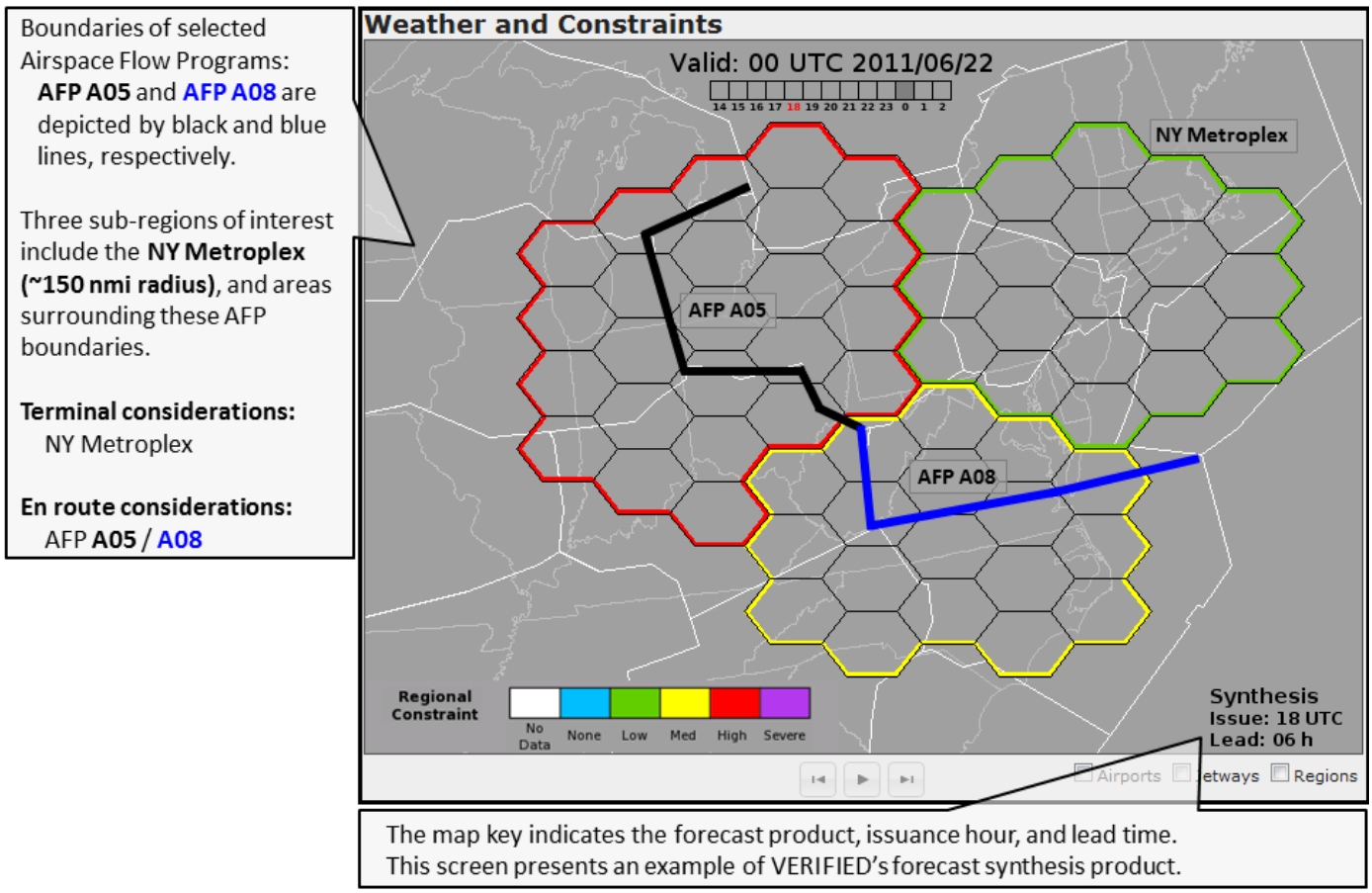

Figure 2: Screen shot from VERIFIED with additional overlays applied to show the position of AFP A05 and A08 (black and blue lines, respectively), and the region identified as the NY Metroplex. Depicted is the 6-h forecast synthesis for 00 UTC on 22 June 2011.

- In this figure, the position of **AFP A05** and **AFP A08** are displayed, along with an important region of the northeast identified as the **NY Metroplex**. The **Composite Region** is all three regions combined.

- Reference time is located near the top of each map in red font. The progress bar shows the forecast hour being displayed.

- The map key provides information on the forecast product, issuance hour, and lead time.

Airspace constraint from convective weather is quantified by computing the potential for flow constraint using the **Flow Constraint Index (FCI)**. This index can be computed from either a field of observed or forecast convection. The measure translates a raw convective weather field into a representation of flow constraint over specified areas. If for one of the areas, little convection is present within the airspace, then the FCI value will be low. If, however, significant convection is present throughout the airspace, then the FCI value will be high.

A hexagonal geometry is used to approximate air traffic corridors when computing the FCI. In the VERIFIED application, hexagons have been chosen to approximate the average size of a super-high altitude sector, with a 75 nmi hexagon height. For individual hexagons, the FCI is computed as outlined in Fig. 3. The hexagonal configuration allows for computation of flow constraint within three distinct corridors, namely: NE↔SW, N↔S, NW↔SE. If for a particular direction of traffic flow, little constraint from convective weather is predicted or observed, then the index will approach a value of zero. If significant constraint from convective weather is predicted or observed, then the index will approach a value of one.

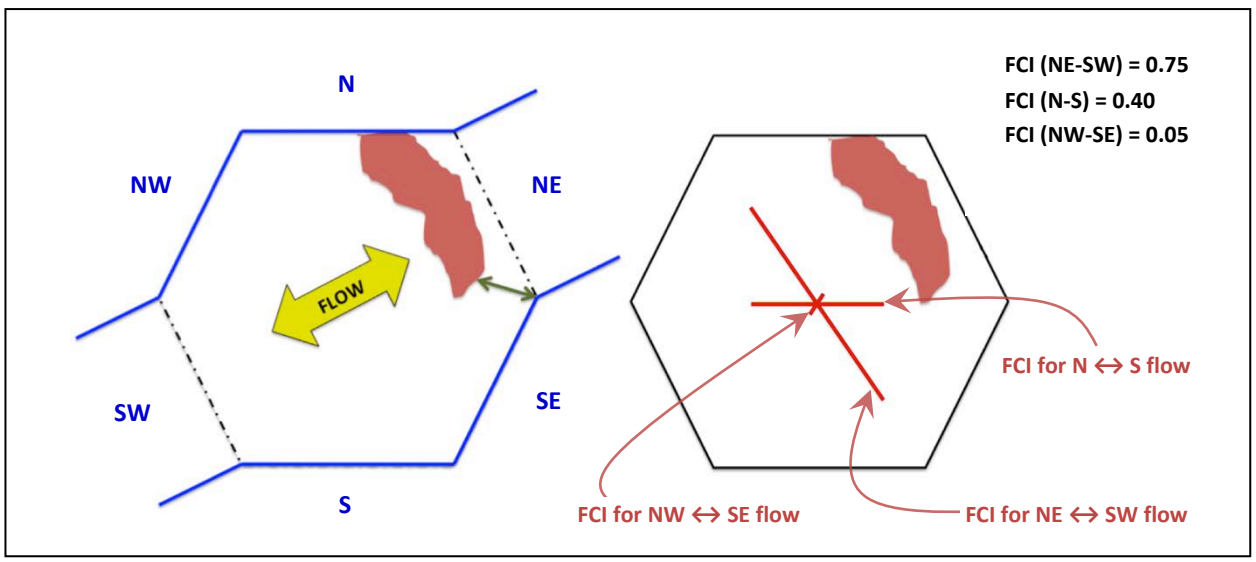

Figure 3: Computation of the Flow Constraint Index (FCI) using a hexagonal configuration.

- Example of flow through a region predicted to be constrained by an area of convective weather (shaded area):
  - Flow constraint is potentially large for flights traveling in the NE↔SW directions: FCI=0.75
  - Flow constraint is smaller in the N↔S directions: FCI=0.40
  - Flow constraint is very small in the NW↔SE directions: FCI = 0.05

- Red lines (referred to as *glyphs*) within the interior of the hexagon are drawn perpendicular to the flow of air traffic, and the length of these interior lines provides a graphical depiction of the magnitude of the measured constraint. The FCI glyphs can be computed and displayed for either a forecast field or an observation field.

*This page presents sample output on regional flow constraint from the forecast synthesis. Screen shots are accompanied by **text boxes** that provide important information about the figure.*

Airspace constraint from convective weather: *regional aggregation of flow constraint*

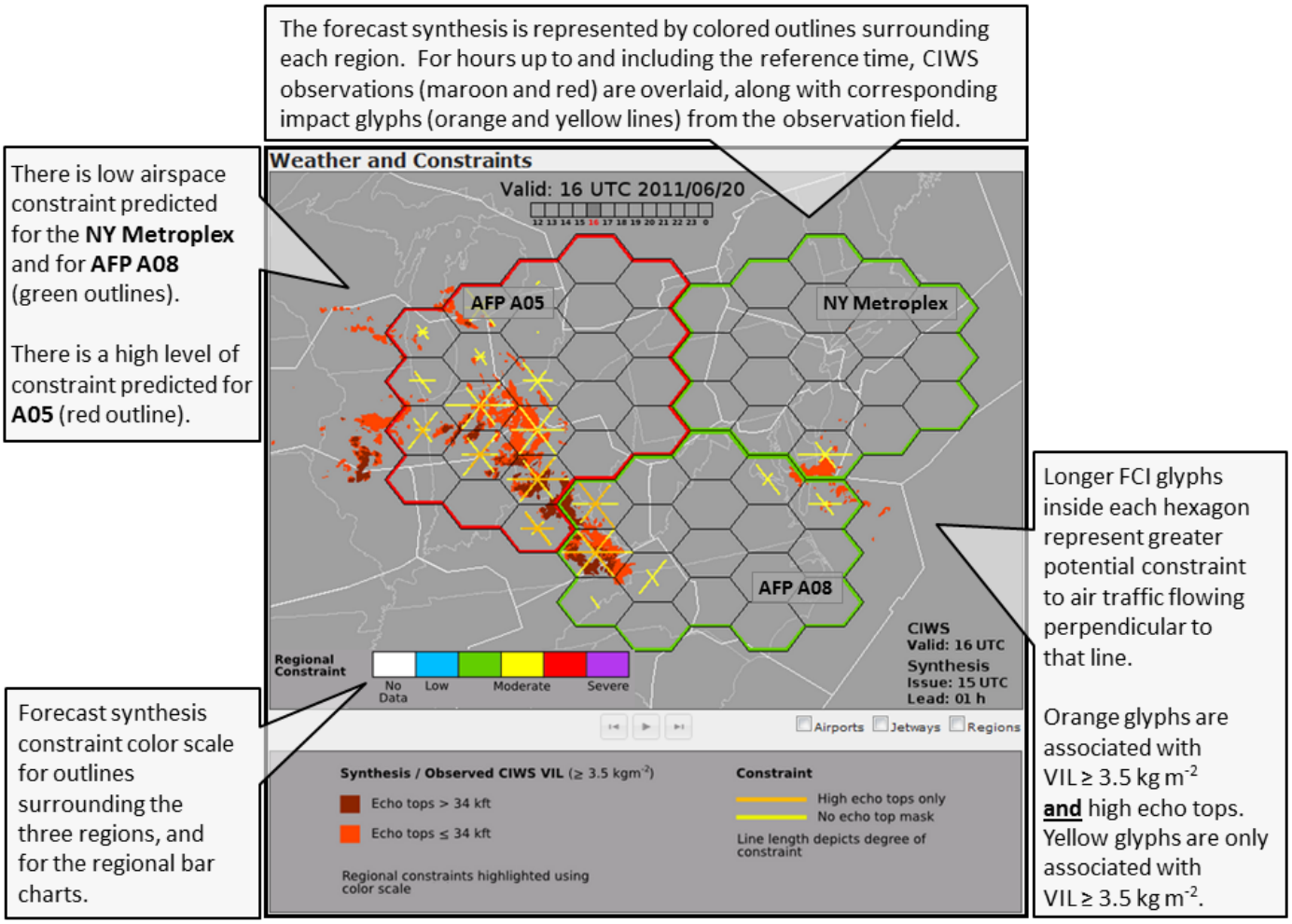

Figure 4: Screen shot from the VERIFIED application depicting the synthesized forecast flow constraint (colored region outlines) as well as the corresponding FCI glyphs from the CIWS observations valid at 16 UTC 20 June 2011. See the reference section for more information regarding the CIWS observation field.

- For each forecast product, the regional airspace constraint is computed by aggregating FCI values from individual hexagons.
- Regional constraint from each forecast product is then statistically combined to create the consolidated synthesis (including for the Composite Region), and is represented here by colored outlines surrounding the three regions: A05, A08, NY Metroplex.
- The constraint color scale applies to regional outlines and to individual bar chart results (not shown here).
- Localized flow constraint computed from CIWS observation is depicted by glyphs within each hexagon.

Forecast synthesis start-up screen

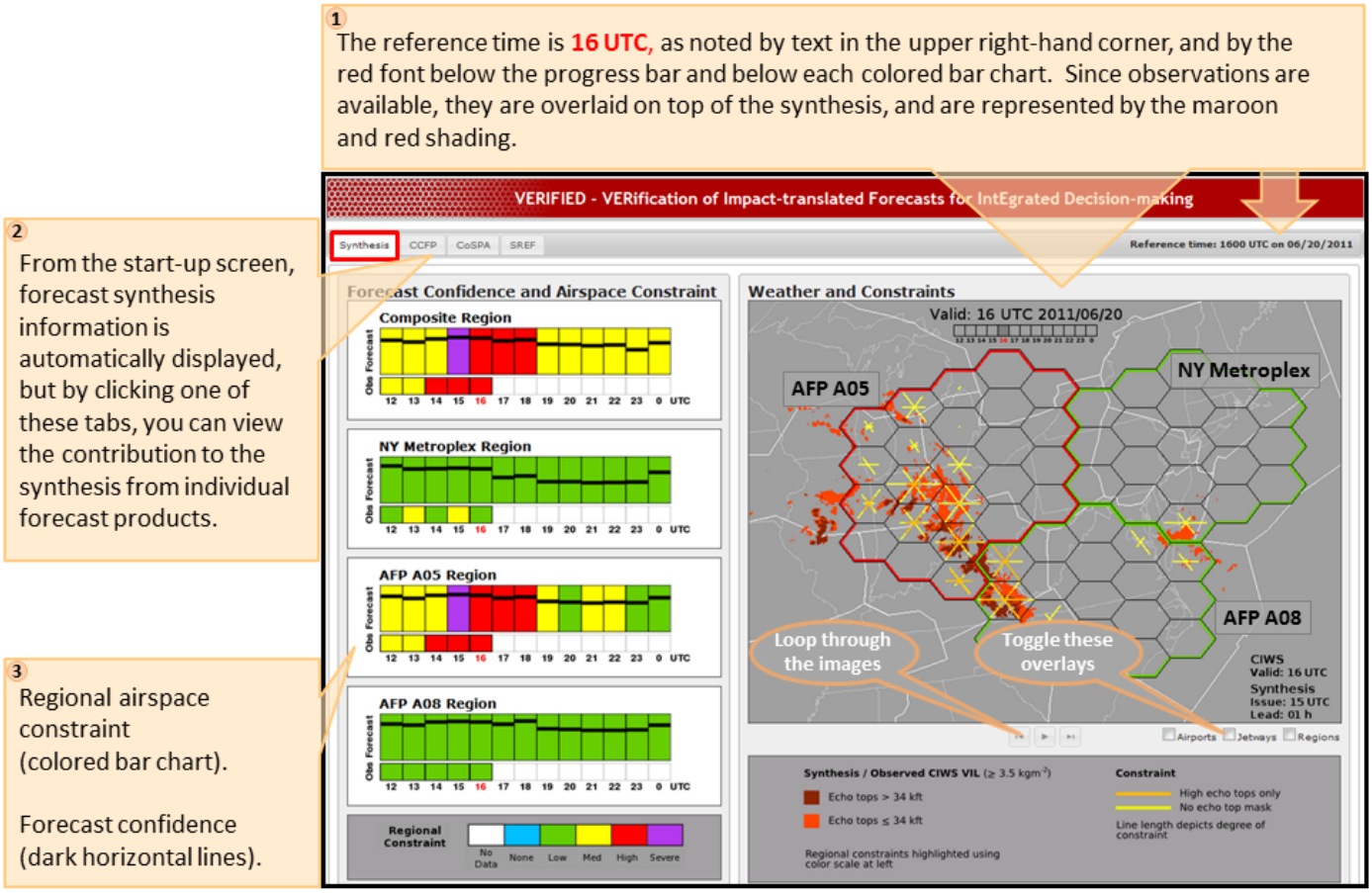

Figure 5: Start-up screen from the VERIFIED application showing the forecast synthesis bar charts and map.

① The reference time is indicated in the upper right-hand corner of the application, also at the top of the map by the red font, and by the red font beneath each bar chart. If the chosen map is from an earlier valid time, then CIWS observations are available and are overlaid, along with FCI glyphs from the observations.

② The default view is this forecast synthesis screen, the consolidation of all forecasts into a unified view of constraint. When new results for the current date are available, this screen automatically displays updated information. **Real-time mode** is the default, and later in this manual we will describe how to access data via **archive mode**, with a toggle switch located at the bottom of the application.

③ Bar charts on the left represent regional airspace constraint and forecast synthesis confidence over time. The constraint color scale is located in the bottom left-hand corner of each screen. Forecast confidence is represented by dark horizontal lines within the charts. The constraint categories are the result of aggregating weighted hexagons using air traffic flow considerations for each region.

Presentation of results for airspace flow constraint and confidence

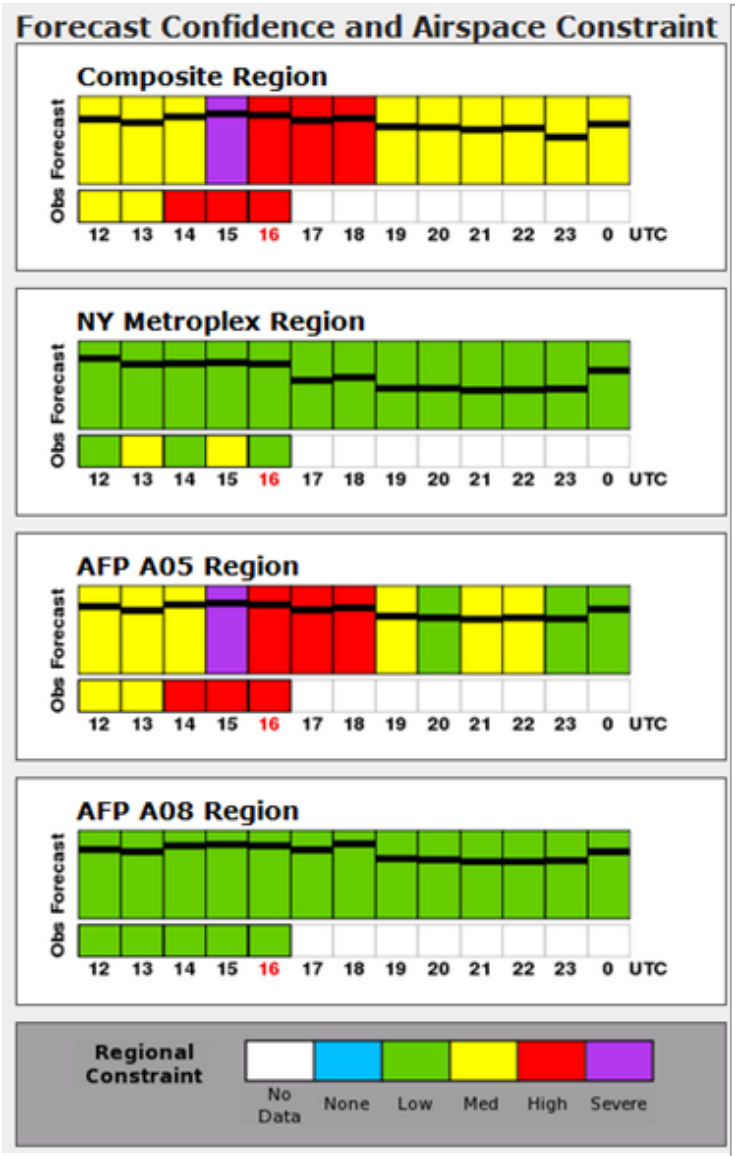

Figure 6: Start-up screen from the VERIFIED application showing the forecast synthesis bar charts located on the left-hand side of each screen.

The left-hand portion of the screen presents a series of regional bar charts that provide the following information:

- Colored boxes along the top row of each figure represent forecast airspace constraint for a given region. Embedded within each of these boxes is a dark horizontal line that provides an indication of the level of confidence in the forecast (range = 0 to 1).
- Colored boxes along the bottom row represent observed airspace constraint from CIWS data up to and including the reference time. For these past cases, the corresponding constraint along the top row is from the shortest lead-time forecast that was valid at the indicated hour.
- Confidence is based on long-term historical performance of the forecast products, and is then modified by:
    - constraint category stratification
    - recent forecast performance data
    - intra-model consistency
    - prolonged forecast latency penalty
- Note the reference hour in red (**16 UTC**). The past 4 hours for this period are 12 – 15 UTC, and the 8 forecast hours are 17 – 00 UTC.
- The constraint color scale is located at the bottom of the figure. It applies to the bar charts and to outlines drawn around the sub-regions on the synthesis map.

Interpretation of results:

- For the Composite Region, the forecast airspace constraint matches well with observed constraint over the past few hours, especially for hours 12, 13, and 16 UTC. The top row of each chart provides results from the forecasts, and the bottom row provides results from the observations.
- It is clear that constraint is the result of convective weather occurring within AFP A05.
- Constraint was both forecast and observed to be less-than-moderate for AFP A08 and the NY Metroplex.

Individual forecast components contributing to the synthesis (hover-over)

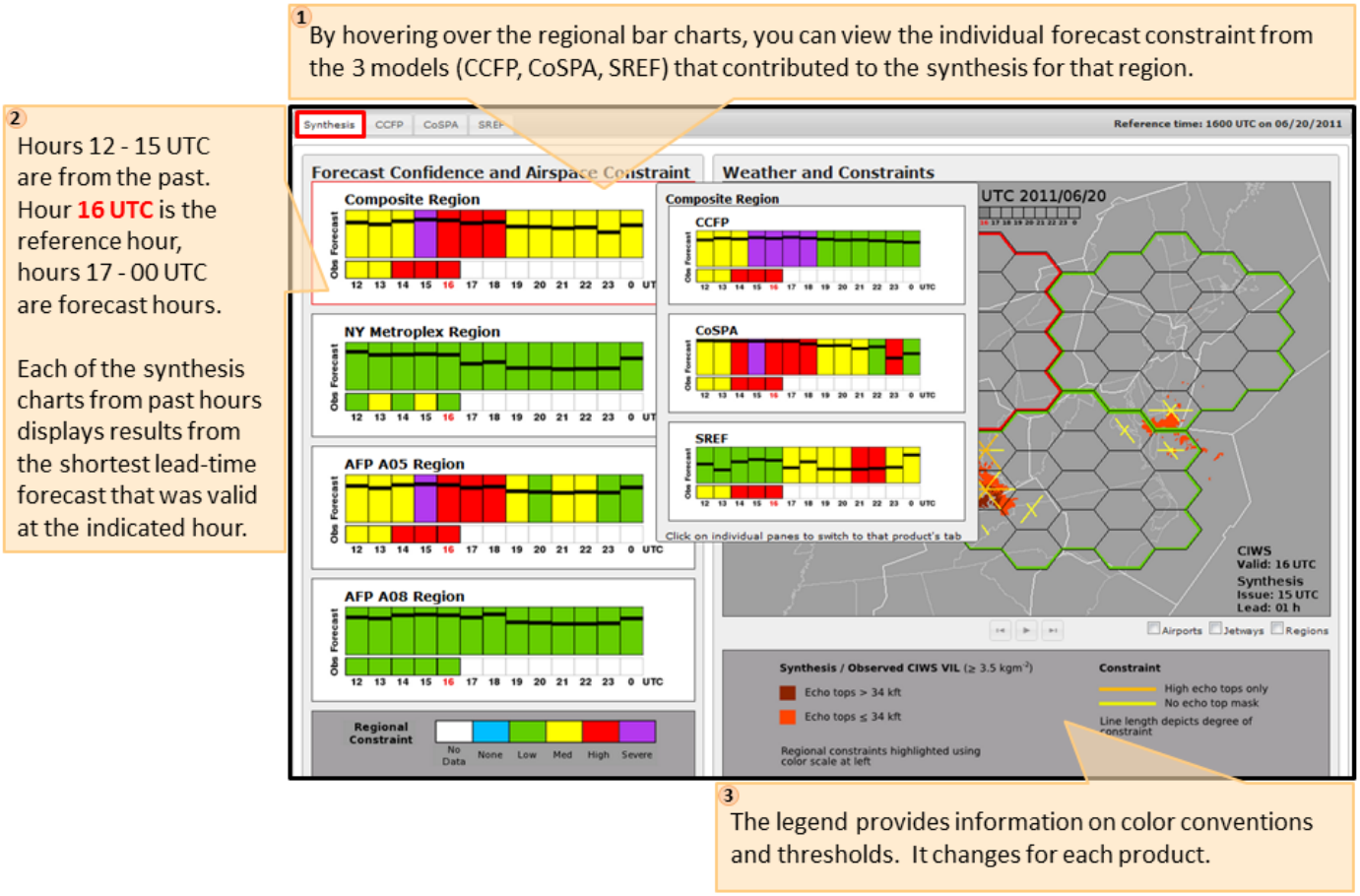

Figure 7: Start-up screen from the VERIFIED application with the mouse hovered over the bar chart for a selected region, thus revealing the individual contribution to the predicted constraint from each of the 3 forecast models (CCFP, CoSPA, and SREF) for that region.

① From the main forecast synthesis screen, you can hover over the regional bar charts on the left to view the contribution to the synthesis from the 3 models (CCFP, CoSPA, SREF) for the selected region.

② The time axis is the same for all bar charts. In this example, the reference time is **16 UTC**, hours 12-15 are from the past, hour **16** is "NOW", and hours 17 – 00 UTC show forecast constraint for the future.

③ Note the legend below each map describing color conventions and thresholds for each product.

CCFP forecast screen

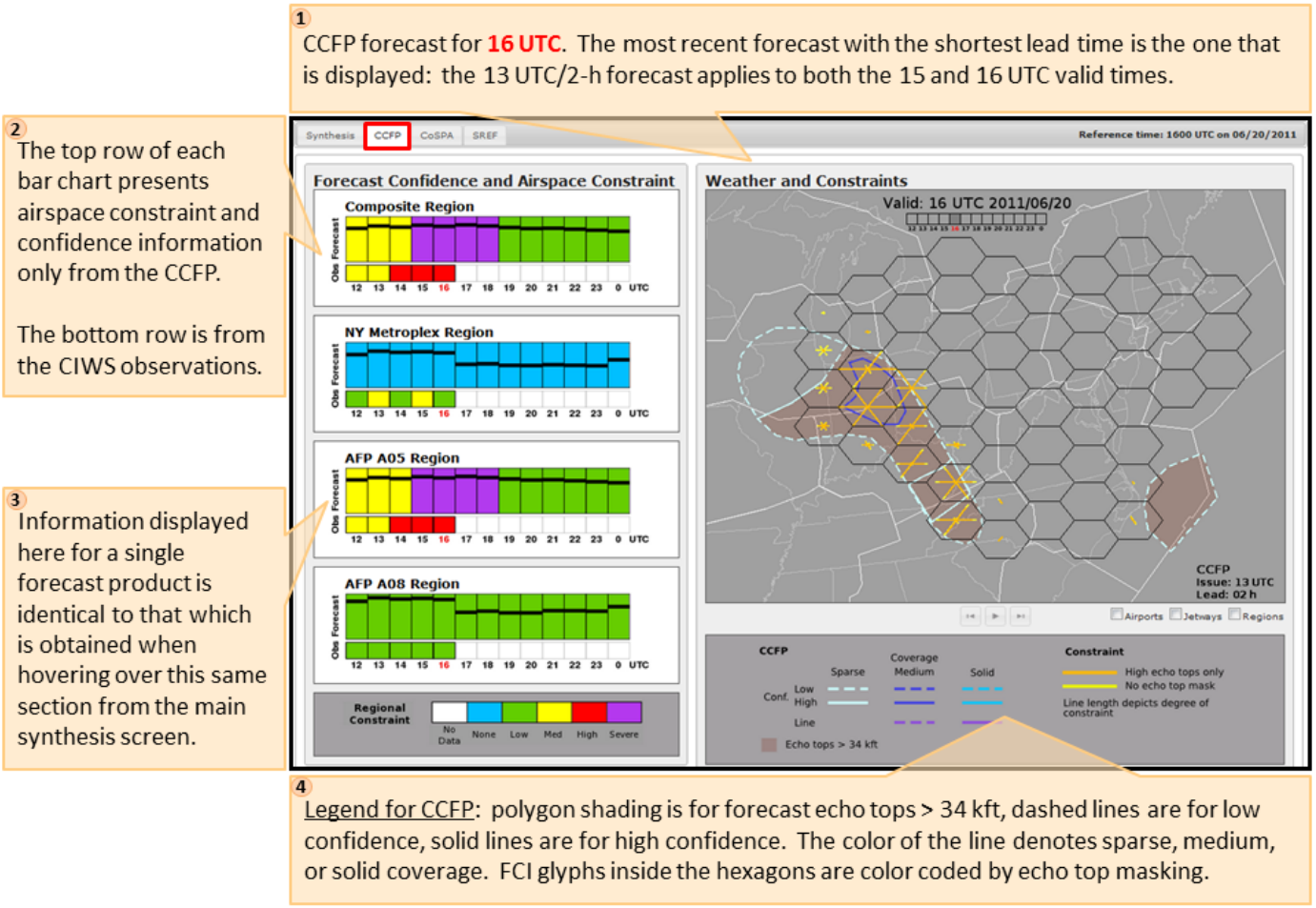

Figure 8: CCFP forecast screen from the VERIFIED application (accessed by clicking the CCFP tab at the top).

① A forecast for CCFP is displayed with the date indicated at the top of the map, and additional information provided in a key in the bottom right-hand corner. For 15 and 16 UTC, the most recent valid forecast is the 2-h forecast issued at 13 UTC. See Table 2 in the reference section for more information on forecast issuance/lead times.

② Bar charts are the same format as those shown on the main synthesis screen, but there is only information provided for this particular forecast product (CCFP), and there is no hover-over capability for this tab. As always, results on constraint from the CIWS observations are displayed along the bottom row of the bar charts.

③ Identical charts for CCFP are accessible from the main synthesis screen by hovering-over the forecast regions.

④ A legend located beneath the map provides useful information on color conventions and thresholds.

A more complete explanation of how the CCFP forecast is incorporated into VERIFIED is provided in the reference section of this manual.

CoSPA forecast screen

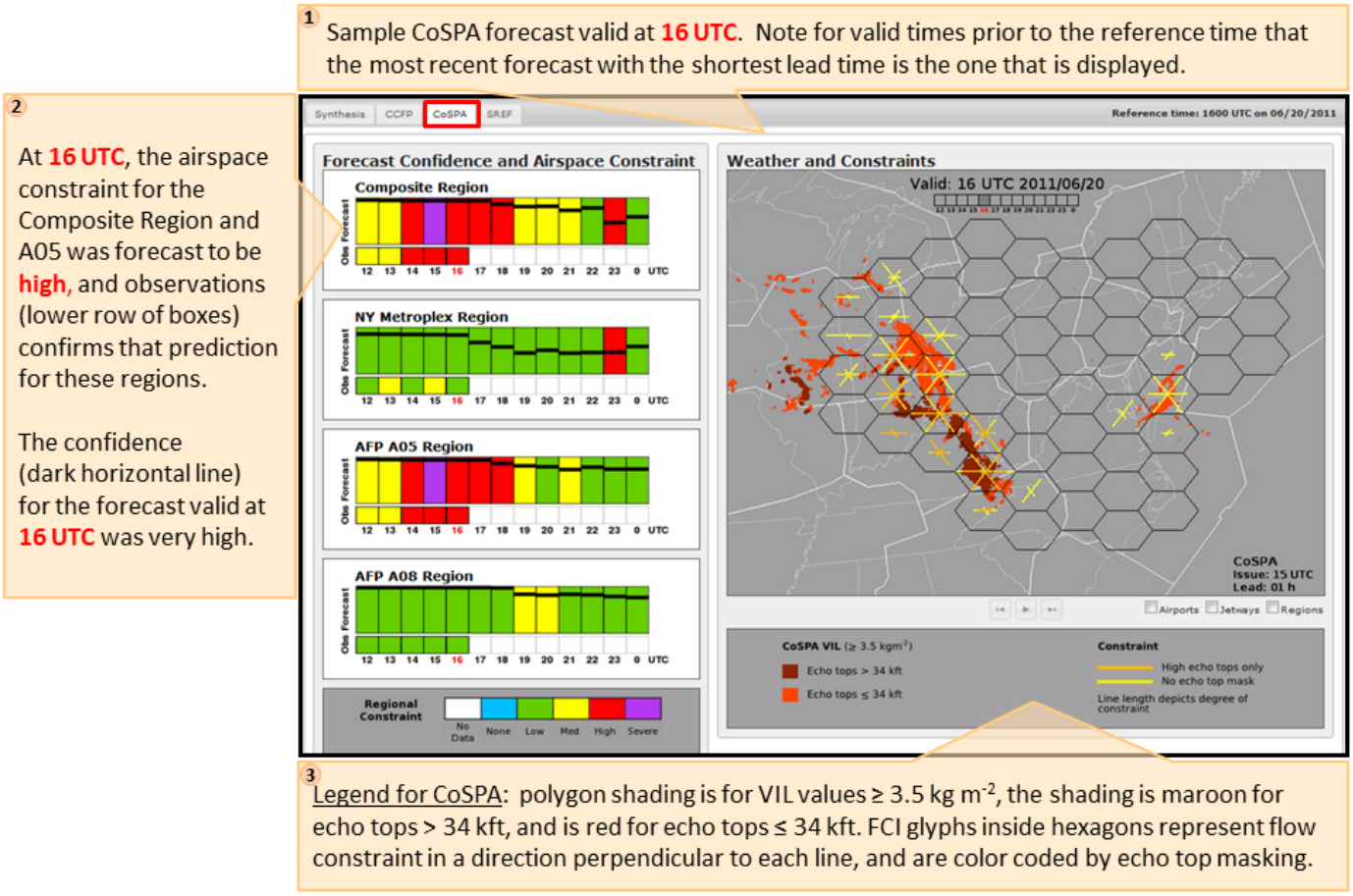

Figure 9: CoSPA forecast screen from the VERIFIED application (accessed by clicking the CoSPA tab at the top).

① A forecast for CoSPA is displayed with the date indicated at the top of the map. Additional information is provided in the key in the bottom right-hand corner.

② Bar charts show a high level of constraint for both the forecast and the observation for the composite region and A05 at 16 UTC, with high forecast confidence in these regions.

③ A legend located beneath the map provides useful information on color conventions and thresholds.

A more complete explanation of how the CoSPA forecast is incorporated into VERIFIED is provided in the reference section of this manual.

SREF forecast screen

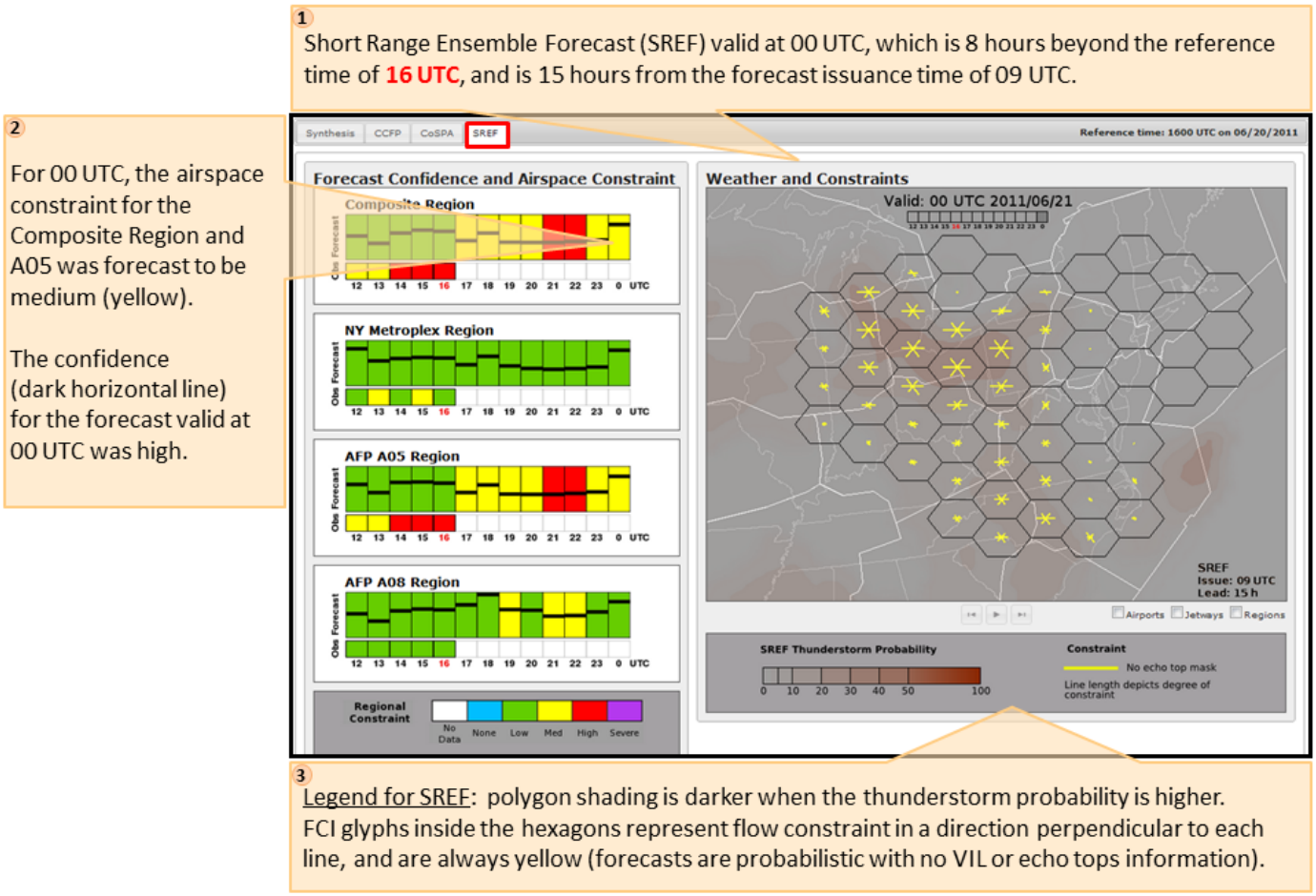

Figure 10: Short Range Ensemble Forecast (SREF) screen from the VERIFIED application (accessed by clicking the SREF tab at the top).

① A forecast for the SREF is displayed with the date indicated at the top of the map. Additional information is provided in the map key in the bottom right-hand corner.

② Bar charts show medium constraint for the Composite Region and A05 at 00 UTC, with high forecast confidence in these regions.

③ A legend located beneath the map provides useful information on color conventions and thresholds. This is a probabilistic forecast, so there are no corresponding VIL or echo top values.

A more complete explanation of how the SREF is incorporated into VERIFIED is provided in the reference section of this manual.

Archived data access and playback

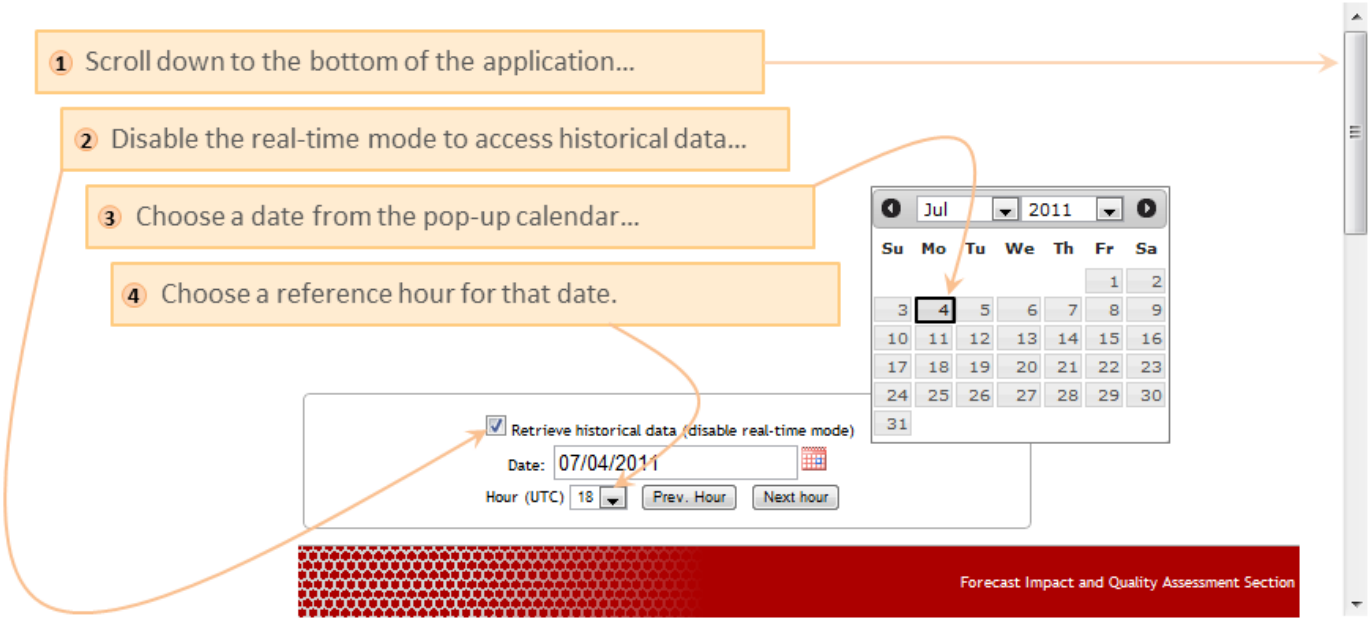

Figure 11: Playback capability to view cases from the past.

① By scrolling down to the very bottom of the application, you can access historical data.

② Disable the real-time mode (real-time updating of available forecast information).

③ Choose a reference date from the pop-up calendar.

④ Choose a reference time from the pull-down menu. Immediately, the forecast synthesis screen will be updated with information from the date and reference time selected.

<u>Interesting dates with significant air traffic flow constraint</u>: (*See case study notes on the next page)*

1) 13 MAY 2011 16 UTC Reference Time
2) 26 MAY 2011 15 UTC Reference Time
3) 25 JULY 2011 14 UTC Reference Time

Case #1 (13 MAY 2011 1600 UTC Reference Time):

Airspace Flow Programs

- FCAA05 valid between 1800 UTC and 0159 UTC on 14 May 2011 issued at 1609 UTC
- FCAA06 valid between 1800 UTC and 0259 UTC on 14 May 2011 issued at 1611 UTC

Constraint Overview

- VERIFIED producing moderate-to-severe constraint in A05 and for the NY Metroplex specifically between 1900 and 0000 UTC.
- CCFP and CoSPA generally agree in moderate to severe constraint over the same time period.
- SREF produces moderate constraint much earlier over the A05 and NY Metroplex region.

Validation (2000 UTC Reference Time)

- The synthesis verifying quite well over the composite region with moderate constraint lasting at least until 0400 UTC the next day.

Case #2 (26 MAY 2011 1500 UTC Reference Time):

Airspace Flow Programs

- FCAA05 valid between 1800 UTC and 0359 UTC on 27 May 2011 issued at 1538 UTC
- FCAA06 valid between 1800 UTC and 0359 UTC on 27 May 2011 issued at 1544 UTC

Constraint Overview

- Moderately impactful convection in NY Metroplex and A05 Region beginning at 1900 UTC is shown in the synthesis.
- Constraint is forecast to be severe in the NY Metroplex at 2100 UTC and beyond.
- Using the hover over capability the forecasts are relatively consistent in the timing and impact, with SREF having moderate constraint beginning earlier.
- CoSPA and CCFP have correspondingly higher confidence than the SREF in this period.

Validation (2000 and 2300 UTC Reference Time)

- CIWS observations show moderate constraint begins at 2000 UTC with more severe constraint at 2300 UTC
  for the NY Metroplex which mirrors the 1500 UTC synthesis forecasts.

Case #3 (25 JULY 2011 1400 UTC Reference Time):

Airspace Flow Programs

- FCAA05 valid between 1700 UTC and 0259 UTC on 26 July 2011 issued at 1439 UTC
- FCAA08 valid between 1800 UTC and 0259 UTC on 26 July 2011 issued at 1439 UTC

Constraint Overview

- At the reference time, it is evident from the overlaid CIWS observations on the prior synthesis forecast that convection was impacting the western gates in the NY Metroplex
- The NY Metroplex is forecast to remain highly impacted over the period with convection intensifying and developing in the A05 region and A08 region with moderate constraint around 1800 - 1900 UTC.
- The products differ significantly on the timing of severe constraint in the NY Metroplex and Composite Regions, with CCFP forecasting severe constraint throughout the later lead-times.

Validation (1900 UTC Reference Time)

- Convection did in fact reach severe levels for an extended period of time. This was captured quite well by the synthesis.
- Convection was moderately impacting the other A05 and A08 regions a couple hours earlier than expected (at 1700 UTC).

The **Corridor Integrated Weather System (CIWS)** provides a high-resolution depiction of the current state of hazardous weather throughout the National Airspace System. The observed, convective state is updated every 2.5 minutes throughout the course of the day. For VERIFIED, the primary observational datasets used from CIWS are the hourly Vertically Integrated Liquid water field (**VIL**) and hourly **Echo Tops** data. The CIWS VIL mosaic is based on reflectivity values from individual NWS and FAA radar sites. A high value of VIL indicates an abundance of *liquid water equivalent* within a column of air, and is often used as an indication of the potential for hail. VIL values are derived from the sum of observed radar reflectivities via the Video Integrator and Processor (VIP). The VIP values are binned into six distinct ranges based upon equivalent radar reflectivity. A VIP level of 3 or greater (radar reflectivity ≥ 40 dBZ, VIL ≥ 3.5 kg m^{-2}) is used to indicate the presence of significant convective weather. The CIWS Echo Tops mosaic provides an estimate of the maximum height of precipitation echoes. This field is defined by the highest altitude at which the NEXRAD reflectivity exceeds a value of 18 dBZ. For VERIFIED, a combination of VIL and Echo Tops are used for identifying observed convective weather activity (see Fig. 12).

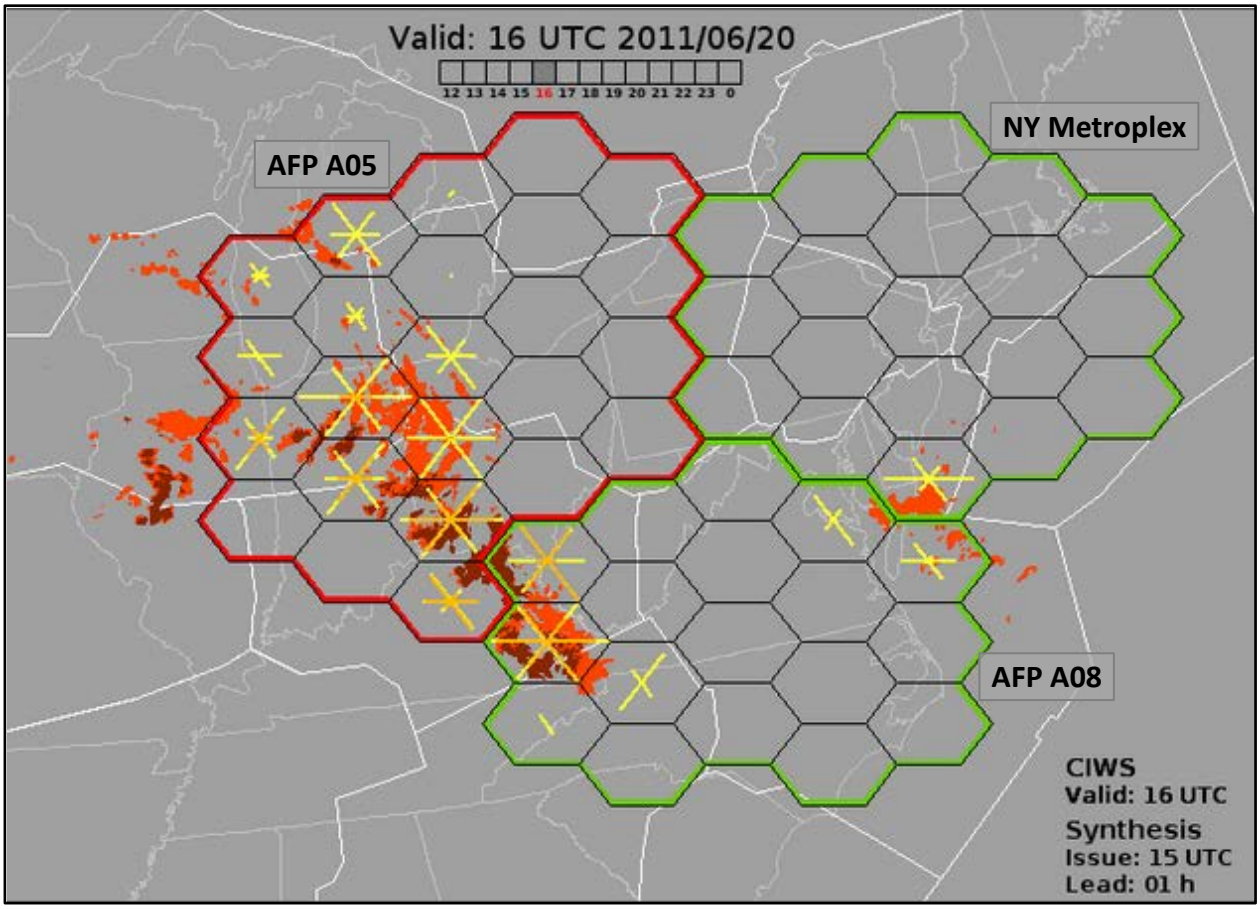

Figure 12: Graphical depiction of **CIWS** observations for 16 UTC on 20 June 2011. The light red areas represent VIL ≥3.5 kg m^{-2} with echo tops ≤ 34 kft. The maroon areas represent VIL ≥ 3.5 kg m^{-2} with echo tops > 34 kft. The glyphs within each hexagon represent the local constraint to air traffic flow in a direction perpendicular to the line itself. Orange lines are for constraint associated with high echo tops (> 34 kft), and yellow lines are for constraint associated with echo tops of any height. Forecast constraint for traffic entering AFP A08 and the NY Metroplex was minimal (noted by the green outline surrounding the boundary of these regions). Forecasted constraint in and around AFP A05 was greater, as noted by the red outline.

The **Collaborative Convective Forecast Product (CCFP)** is a graphical forecast of convective weather provided at lead times of 2-, 4-, and 6 hours. It is a human-generated forecast, produced by the Aviation Weather Center in collaboration with Center Weather Service Units, the Meteorological Service of Canada, and airline offices and other service providers. CCFP is the official convective weather forecast used by Air Traffic Control System Command Center (ATCSCC) traffic flow managers for strategic coordination of flights around areas of expected hazardous weather. Minimum criteria for CCFP polygons are (1) coverage of at least 25% with a composite reflectivity ≥ 40 dBZ, and (2) coverage of at least 25% with echo tops ≥ 25,000 feet, and (3) a forecaster confidence of at least 25%. Each polygon is at least 3,000 square miles in size, and impacted areas are often represented as shaded regions displayed over a map background.

The polygons provide a common forecast perspective for meteorologists who provide guidance on convective weather avoidance for en route air traffic. Attributes of the CCFP are decidedly different from those of other forecast products used in the VERIFIED application (see Fig. 13), notably the coarse minimum resolution of 3,000 square miles with expected coverage amount and level of confidence. Issuance times for the CCFP are listed in Table 1. The CCFP used by the VERIFIED application is calibrated based on climatological comparisons with recent observations taken at the appropriate time for a given forecast length. For example, CCFP "Sparse Coverage" is assigned for forecast values ranging from 25 – 39%, but historically the actual coverage for these polygons is found to be closer to 4 or 5%.

Note in Table 1 for the CCFP that there are a limited number of forecast issuance/lead time combinations, so for example, the 2-h forecast issued at 13 UTC is the most recent forecast valid at both 15 UTC and at 16 UTC. It is important to note that there are no CCFP forecasts with a lead time of 8 hours, so the 6-h forecast is used as a **proxy** for the 8-h forecast in the VERIFIED application.

Table 1: Operational production times for the CCFP collaboration system.

Issuance	Forecast Length and Valid Times		
	2HR	4HR	6HR
0100 UTC	0300 UTC	0500 UTC	0700 UTC
~~0300 UTC~~			
~~0500 UTC~~			
0700 UTC	0900 UTC	1100 UTC	1300 UTC
0900 UTC	1100 UTC	1300 UTC	1500 UTC
1100 UTC	1300 UTC	1500 UTC	1700 UTC
1300 UTC	1500 UTC	1700 UTC	1900 UTC
1500 UTC	1700 UTC	1900 UTC	2100 UTC
1700 UTC	1900 UTC	2100 UTC	2300 UTC
1900 UTC	2100 UTC	2300 UTC	0100 UTC
2100 UTC	2300 UTC	0100 UTC	0300 UTC
2300 UTC	0100 UTC	0300 UTC	0500 UTC

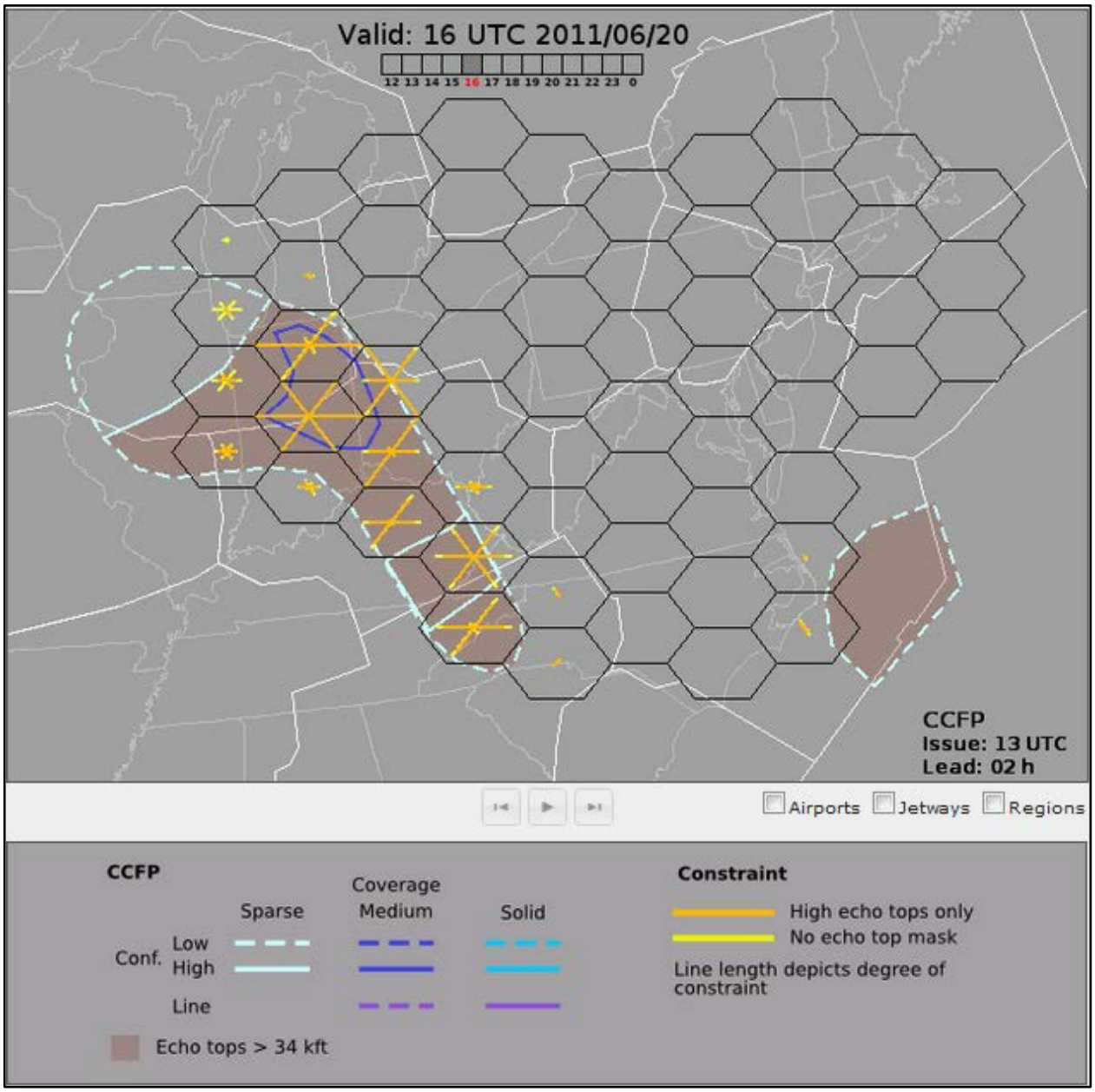

Figure 13: Graphical depiction of output from the **CCFP**, a 2-h forecast issued at 13 UTC on 20 June 2011. This 2-h forecast is the most recent one available for both 15 UTC and 16 UTC. Regions delineated by a dashed line represents a forecast with low confidence, those with a solid outline are forecasts with a high degree of confidence. Light blue outlines are for sparse convective coverage, dark blue outlines are for medium coverage, and bright blue outlines are for solid coverage. Areas shaded in brown depict forecast echo tops > 34 kft. The glyphs within each hexagon represent the local constraint to air traffic flow in a direction perpendicular to that line. Orange lines are for constraint associated with high echo tops (> 34 kft), and yellow lines are for constraint associated with echo tops of any height. The longer the line, the greater the predicted airspace constraint.

CoSPA is an automated convective forecast product produced over the Contiguous United States (CONUS). VIL and Echo Tops forecast fields serve as useful indicators of aviation weather hazards, and are provided by CoSPA every 15 minutes at a resolution of 1 km for forecasts of 0 to 8 hours. CoSPA is composed of (1) an extrapolation forecast provided from CIWS, (2) a high-resolution numerical model provided by the **HRRR**, and (3) blending algorithms used to combine these two products. For the 0-2 hour period, the primary component of CoSPA is the CIWS extrapolated forecast, and then beyond that time period, output is primarily from the HRRR model with blending applied. See Fig. 14 for a sample of CoSPA forecast output.

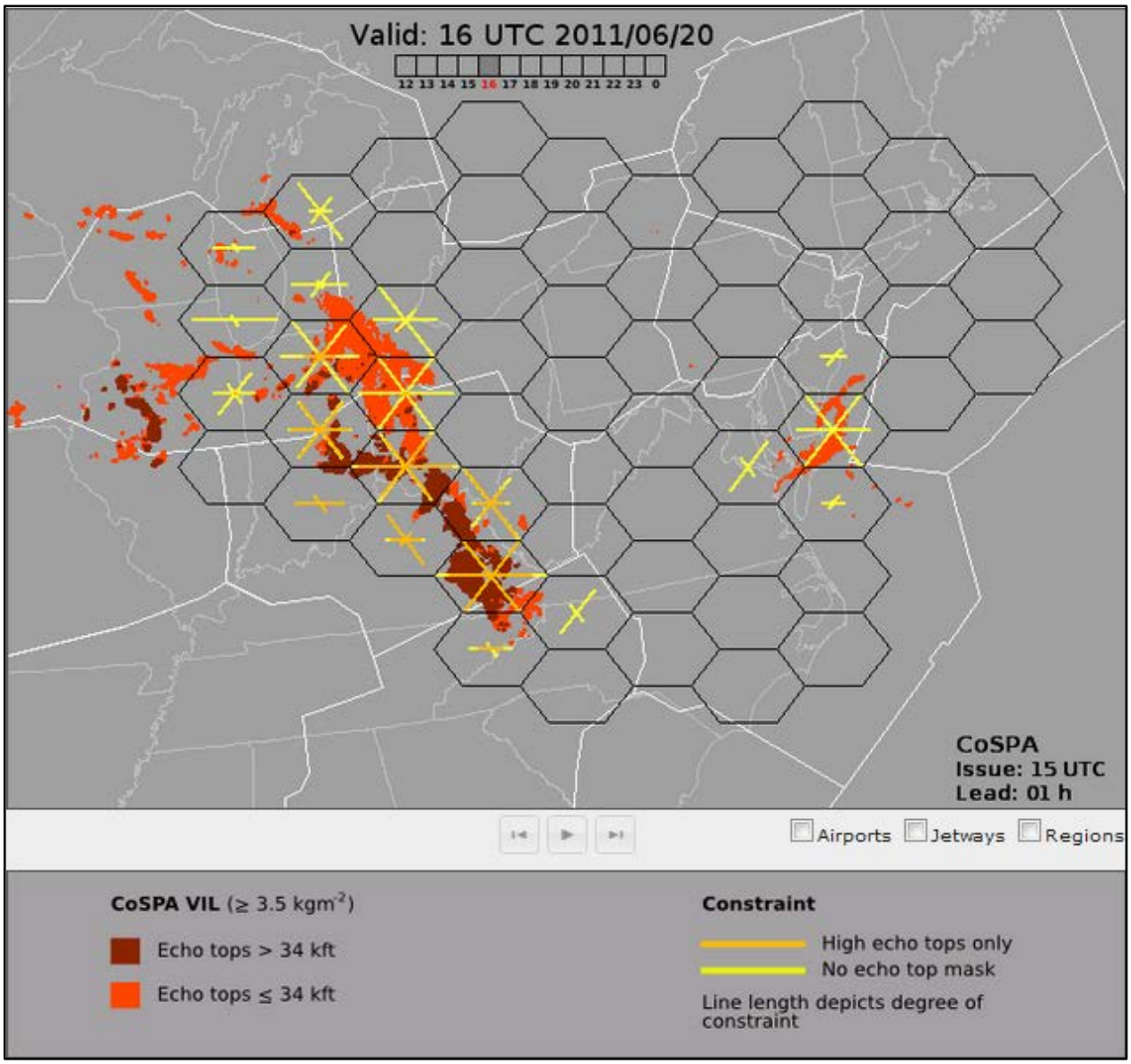

Figure 14: Graphical depiction of output from **CoSPA**, a 1-h forecast issued at 15 UTC on 20 June 2011. The maroon areas represent VIL ≥ 3.5 kg m^{-2} with echo tops > 34 kft, and the light red areas represent VIL ≥ 3.5 kg m^{-2} with echo tops ≤ 34 kft. The glyphs within each hexagon represent the local constraint to air traffic flow in a direction perpendicular to each line. Orange lines are for constraint associated with high echo tops (> 34 kft), and yellow lines are for constraint associated with echo tops of any height. The longer the line, the greater the predicted airspace constraint.

The **Short-Range Ensemble Forecast (SREF)** Calibrated Thunderstorm Probability Field is an additional component utilized in the VERIFIED application. This guidance product, produced by NOAA's Storm Prediction Center (SPC), is created by post-processing 21 mesoscale model forecasts along with the time-lagged, operational North American Mesoscale (NAM) model. The probability field is generated every six hours (03, 09, 15, 21 UTC), with hourly forecast lead times, and data output onto a 40-km grid. This product is focused on the prediction of hazardous weather in support of forecast operations. SREF's multi-model system employs several physics packages and analysis schemes, along with perturbed analyses and lateral boundary conditions, and with bias correction applied to some fields. The output is expressed as probabilities ranging in value from 0 to 100 (see Fig. 15).

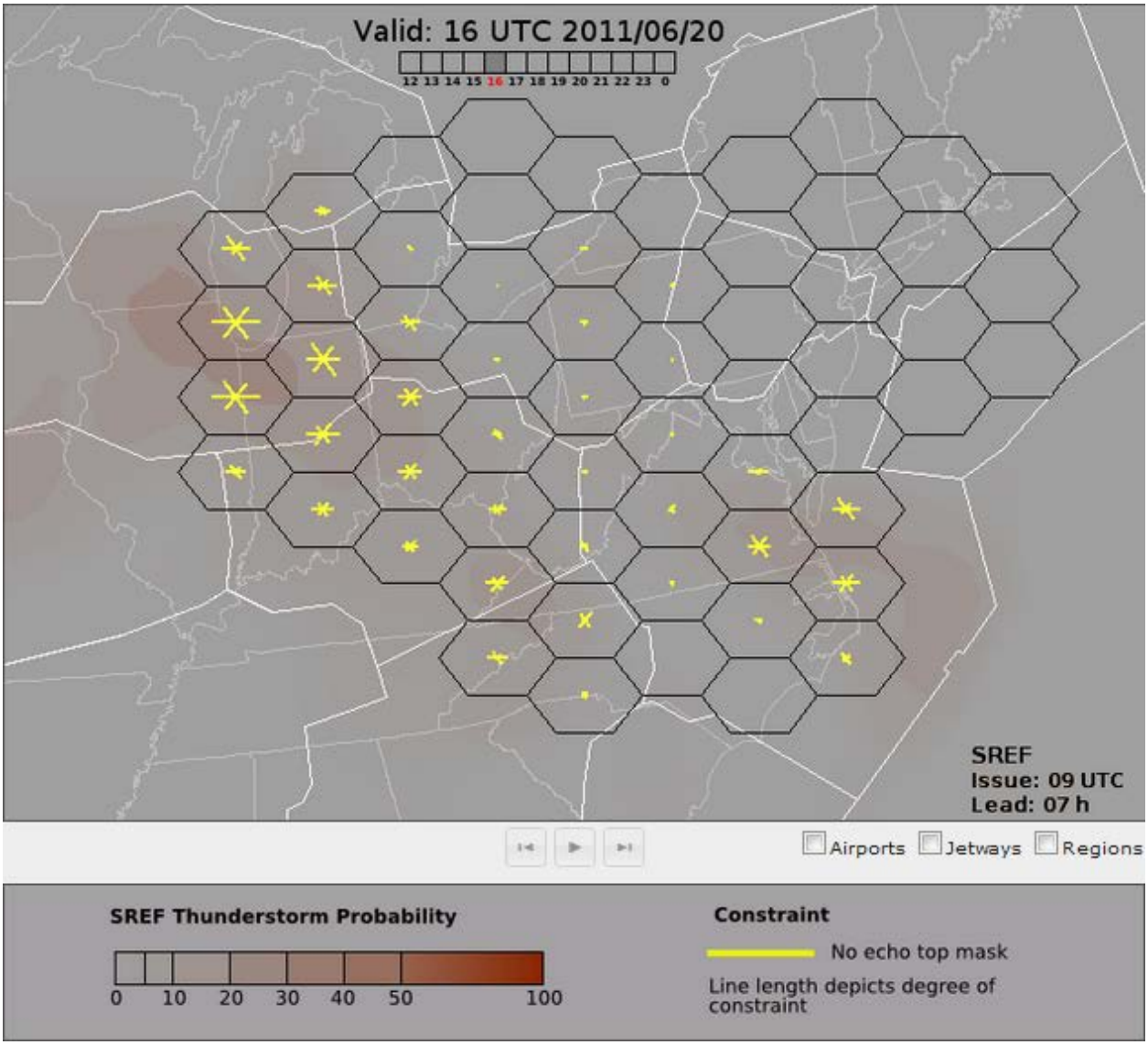

Figure 15: Graphical depiction of output from **SREF**, a 7-h forecast issued at 09 UTC on 20 June 2011. Thunderstorm probability is indicated by the brown shading over the map background. The shading is darker when thunderstorm probability is higher. The glyphs within each hexagon represent the local constraint to air traffic flow in a direction perpendicular to each line. For SREF, which is a probabilistic forecast, all lines are yellow, and are not affected by the value of VIL or echo tops.

CoSPA:

	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
0	19 / 1	20 / 1	21 / 1	22 / 1	23 / 1	0 / 1	0 / 2	0 / 3	0 / 4	0 / 5	0 / 6	0 / 7	0 / 8
1	20 / 1	21 / 1	22 / 1	23 / 1	0 / 1	1 / 1	1 / 2	1 / 3	1 / 4	1 / 5	1 / 6	1 / 7	1 / 8
...													
23	18 / 1	19 / 1	20 / 1	21 / 1	22 / 1	23 / 1	23 / 2	23 / 3	23 / 4	23 / 5	23 / 6	23 / 7	23 / 8

CCFP:

	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
0	17 / 2	19 / 2	19 / 2	21 / 2	21 / 2	23 / 2	23 / 2	23 / 4	23 / 4	23 / 6	23 / 6	23 / 6	23 / 6
1	19 / 2	19 / 2	21 / 2	21 / 2	23 / 2	23 / 2	1 / 2	1 / 2	1 / 4	1 / 4	1 / 6	1 / 6	1 / 6
2	19 / 2	21 / 2	21 / 2	23 / 2	23 / 2	1 / 2	1 / 2	1 / 4	1 / 4	1 / 6	1 / 6	1 / 6	1 / 6
3	21 / 2	21 / 2	23 / 2	23 / 2	1 / 2	1 / 2	1 / 4	1 / 4	1 / 6	1 / 6	1 / 6	1 / 6	1 / 6
4	21 / 2	23 / 2	23 / 2	1 / 2	1 / 2	1 / 4	1 / 4	1 / 6	1 / 6	1 / 6	1 / 6	1 / 6	NA
5	23 / 2	23 / 2	1 / 2	1 / 2	1 / 4	1 / 4	1 / 6	1 / 6	1 / 6	1 / 6	1 / 6	NA	NA
6	23 / 2	1 / 2	1 / 2	1 / 4	1 / 4	1 / 6	1 / 6	1 / 6	1 / 6	1 / 6	NA	NA	NA
7	1 / 2	1 / 2	1 / 4	1 / 4	1 / 6	1 / 6	7 / 2	7 / 2	7 / 4	7 / 4	7 / 6	7 / 6	7 / 6
8	1 / 2	1 / 4	1 / 4	1 / 6	1 / 6	7 / 2	7 / 2	7 / 4	7 / 4	7 / 6	7 / 6	7 / 6	7 / 6
9	1 / 4	1 / 4	1 / 6	1 / 6	7 / 2	7 / 2	9 / 2	9 / 2	9 / 4	9 / 4	9 / 6	9 / 6	9 / 6
10	1 / 4	1 / 6	1 / 6	7 / 2	7 / 2	9 / 2	9 / 2	9 / 4	9 / 4	9 / 6	9 / 6	9 / 6	9 / 6
11	1 / 6	1 / 6	7 / 2	7 / 2	9 / 2	9 / 2	11 / 2	11 / 2	11 / 4	11 / 6	11 / 6	11 / 6	11 / 6
12	1 / 6	7 / 2	7 / 2	9 / 2	9 / 2	11 / 2	11 / 2	11 / 4	11 / 6	11 / 6	11 / 6	11 / 6	11 / 6
13	7 / 2	7 / 2	9 / 2	9 / 2	11 / 2	11 / 2	13 / 2	13 / 2	13 / 4	13 / 4	13 / 6	13 / 6	13 / 6
14	7 / 2	9 / 2	9 / 2	11 / 2	11 / 2	13 / 2	13 / 2	13 / 4	13 / 4	13 / 6	13 / 6	13 / 6	13 / 6
...													
23	17 / 2	17 / 2	19 / 2	19 / 2	21 / 2	21 / 2	23 / 2	23 / 2	23 / 4	23 / 4	23 / 6	23 / 6	23 / 6

SREF:

	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
0	15 / 5	15 / 6	15 / 7	15 / 8	15 / 9	15 / 10	15 / 11	15 / 12	15 / 13	15 / 14	15 / 15	15 / 16	15 / 17
1*	15 / 6	15 / 7	15 / 8	15 / 9	15 / 10	21 / 5	21 / 6	21 / 7	21 / 8	21 / 9	21 / 10	21 / 11	21 / 12
2	15 / 7	15 / 8	15 / 9	15 / 10	21 / 5	21 / 6	21 / 7	21 / 8	21 / 9	21 / 10	21 / 11	21 / 12	21 / 13
3	15 / 8	15 / 9	15 / 10	21 / 5	21 / 6	21 / 7	21 / 8	21 / 9	21 / 10	21 / 11	21 / 12	21 / 13	21 / 14
4	15 / 9	15 / 10	21 / 5	21 / 6	21 / 7	21 / 8	21 / 9	21 / 10	21 / 11	21 / 12	21 / 13	21 / 14	21 / 15
5	15 / 10	21 / 5	21 / 6	21 / 7	21 / 8	21 / 9	21 / 10	21 / 11	21 / 12	21 / 13	21 / 14	21 / 15	21 / 16
6	21 / 5	21 / 6	21 / 7	21 / 8	21 / 9	21 / 10	21 / 11	21 / 12	21 / 13	21 / 14	21 / 15	21 / 16	21 / 17
7*	21 / 6	21 / 7	21 / 8	21 / 9	21 / 10	3 / 5	3 / 6	3 / 7	3 / 8	3 / 9	3 / 10	3 / 11	3 / 12
...													
13*	21 / 6	21 / 7	21 / 8	21 / 9	21 / 10	9 / 5	9 / 6	9 / 7	9 / 8	9 / 9	9 / 10	9 / 11	9 / 12
...													
19*	9 / 6	9 / 7	9 / 8	9 / 9	9 / 10	15 / 5	15 / 6	15 / 7	15 / 8	15 / 9	15 / 10	15 / 11	15 / 12
...													
23	9 / 10	15 / 5	15 / 6	15 / 7	15 / 8	15 / 9	15 / 10	15 / 11	15 / 12	15 / 13	15 / 14	15 / 15	15 / 16

Table 2: A compilation of forecast issuance and lead times for the products used by VERIFIED. The top, shaded row of each table is for time relative to the forecast synthesis reference hour: past times are to the left and forecast times are to the right. These relative times correspond to the block of times encompassed by the regional bar charts. The first, shaded column of each table lists the forecast valid time. Each cell provides information on the forecast issuance hour (UTC), followed by a slash, and then the forecast lead time. Each issuance/lead time is from the most recent forecast that is ideally available for the indicated valid time. Note the orange shaded cells for CCFP forecasts, denoting prolonged lead times caused by CCFP forecasts not being issued at 03 and 05 UTC. SREF forecasts are issued four times a day (03, 09, 15, 21 UTC). However, these forecasts have a long latency and are not available until several hours later (times indicated by the purple shading). The lead times then become progressively longer until the next forecast becomes available.

Post-exercise questionnaire

1) What sources of information for convective weather constraint were most critical to the creation of the Aviation Weather Statement (AWS)? Please rank these in order.

2) When creating the AWS, what information from the VERIFIED application proved to be most useful?

Additionally:

- Were the constraint categories clear?
- Was the confidence information helpful?
- Was the forecast synthesis intuitive? In what weather scenarios did it perform best?
- Should output from additional sources, including other forecast models, be included in this application?

3) Regarding the presentation of information, how could the user interface be improved?

- General layout was clear and overall navigation was straightforward?
- Representations of the model fields and the impact scale were easy to comprehend?
- Time range of the presented information was adequate?
- Additional overlays should be included (some removed)?
- CONUS-scale information needs to be included? If so, for what fields?

4) Is inclusion of a look-back capability (i.e., archive & replay) a desirable feature?

5) What other variables could the VERIFIED framework address (e.g., ceiling and visibility)?

http://esrl.noaa.gov/fiqas/tech/impact/verified/

Comments or questions? Please contact: Melissa A. Petty, melissa.a.petty@noaa.gov