# Gleim Aviation Weather and Weather Services

Seventh Edition, First Printing
Updates
August 2022

NOTE: Sections with changes are indicated by a vertical bar in the left margin. Text that should be deleted is displayed with a line through it. New text is shown with blue underlined font.

If you are tested on any content not represented in our materials or this update, please share this information with Gleim so we can continue to provide the most complete test preparation experience possible. You can submit feedback at www.GleimAviation.com/questions. Thank you in advance for your help!

These updates are due to industry changes and for clarity. Edits performed throughout the book, but not represented in this document, include changing “cockpit” to “flight deck” and updating “Notice to Airmen” to “Notice to Air Missions.”

## Part I/Study Unit 2: Temperature

Page 8, Subunit 2.3, Items 3.b.1)-2).

1) Under certain conditions, supercooled (not yet frozen) droplets of water can be found in clouds at temperatures down to ~~–15~~40°C (~~5~~–40°F). This will be further explained in Part I, Study Unit 3, “Water Vapor,” beginning on page 17.
2) Supercooled water will readily freeze if sufficiently agitated, which is why it freezes on impact with an airplane.

## Part I/Study Unit 3: Water Vapor

Page 21, Subunit 3.2, Item 4.b.

b. Supercooled water drops very often are in abundance in clouds at temperatures between 0°C and ~~–15~~20°C, with decreasing amounts at colder temperatures.
    1) Usually, at temperatures colder than ~~–15~~20°C, sublimation is prevalent, and clouds and fog may be mostly ice crystals with a lesser amount of supercooled water.
    2) Strong vertical currents may carry supercooled water to great heights where temperatures are much colder than ~~–15~~20°C.
        a) Supercooled water has been observed at temperatures colder than –40°C.

Page 23, Subunit 3.4, Items 2.a.-c.

a. Fog when temperature-dew point spread is ~~3~~2°C (~~5~~4°F) or less and decreasing.
b. Lifting or clearing of low clouds and fog when temperature-dew point spread is increasing.
c. Frost on a clear night when temperature-dew point spread is ~~3~~2°C (~~5~~4°F) or less and is decreasing, and the dew point is lower than 0°C (32°F).

## Part I/Study Unit 11: Weather, Obstructions to Visibility, Low Ceiling, and Mountain Obscuration

Page 115, Subunit 11.8, Item 3.c.

c. Fog when temperature-dew point spread is ~~3~~2°C (~~5~~4°F) or less and decreasing

## Part II/Study Unit 1: The Aviation Weather Service Program

Page 198, Subunit 1.4, Items 3.d.2)a)iv)-x).

iv) ~~Area~~Graphical Forecasts for Aviation (GFA)
v) Significant Weather Prognostic Charts (low, middle, and high)
~~vi) National Convective Weather Forecast (NCWF)~~
~~vii)~~vi) Current Icing Product (CIP)
~~viii)~~vii) Forecast Icing Product (FIP)
~~ix)~~viii) Graphical Turbulence Guidance (GTG)
~~x) Ceiling and Visibility Analysis (CVA) product~~

Pages 204-206, Subunit 1.6, Items 6.-7: The outdated Telephone Information Briefing Service (TIBS) and Hazardous Inflight Weather Advisory Service (HIWAS) coverage was removed. Subsequent items have been renumbered accordingly.

Pages 207-208, Subunit 1.6, Item 8.j. and Tables 1-1 and 1-2.

~~j. Users should report FIS-B malfunctions not attributed to aircraft system failures or covered by active NOTAM by emailing adsb@faa.gov.~~

~~1) Users may also report malfunctions by submitting FAA Form 8740-5, *Safety Improvement Report*, via mail, fax, or email to their local Flight Standards District Office (FSDO) Safety Program Manager (SPM).~~

| Product | FIS-B Over UAT Service Update Interval[1] | FIS-B Service Transmission Interval[2] |
|---|---|---|
| AIRMET | As available | 5 minutes |
| **[. . .]** | | |
| Special Use Airspace Status | As available | 10 minutes |
| TAF/AMEND | ~~8~~6 hours/as available | 10 minutes |
| Temperature Aloft | 12 hours | 10 minutes |
| Winds Aloft | 12 hours | 10 minutes |
| Lightning Strikes | 5 minutes | 5 minutes |
| Turbulence | 15 minutes | 15 minutes |
| Icing Forecasts | 15 minutes | 15 minutes |
| Cloud Tops | 15 minutes | 15 minutes |
| Graphical AIRMETS | 00Z,03Z, 06Z, 09Z/12 hr forecasts | 3 hour |
| Center Weather Advisories | As available | As available |

1. *The Update Interval is the rate at which the product data is available from the source.*
2. *The Transmission Interval is the amount of time within which a new or updated product transmission must be completed and the rate or repetition interval at which the product is rebroadcast.*
3. *Notice to Air Missions-Distant (NOTAM-D) and Notice to Air Missions-Flight Data Center (NOTAM-FDC) products broadcast via FIS-B are limited to those issued or effective within the past 30 days.*

Table 1-1. FIS-B Over UAT Product Update and Transmission Intervals

| Product | Surface Radios | Low Altitude Tier | Medium Altitude Tier | High Altitude Tier |
|---|---|---|---|---|
| CONUS NEXRAD | N/A | CONUS NEXRAD not provided | CONUS NEXRAD imagery | CONUS NEXRAD imagery |
| [. . .] | | | | |
| NOTAMs–D/FDC/TFR | 100 NM look-ahead range | 100 NM look-ahead range | 100 NM look-ahead range | 100 NM look-ahead range |
| Lightning Strikes | N/A | 150 NM look-ahead range | 200 NM look-ahead range | 250 NM look-ahead range |
| Turbulence | N/A | 150 NM look-ahead range | 200 NM look-ahead range | 250 NM look-ahead range |
| Icing Forecasts | N/A | 150 NM look-ahead range | 200 NM look-ahead range | 250 NM look-ahead range |
| Cloud Tops | N/A | 150 NM look-ahead range | 200 NM look-ahead range | 250 NM look-ahead range |
| Graphical AIRMETS | N/A | 250 NM look-ahead range | 375 NM look-ahead range | 500 NM look-ahead range |
| Center Weather Advisories | N/A | 250 NM look-ahead range | 375 NM look-ahead range | 500 NM look-ahead range |

Table 1-2. Product Parameters for Low/Medium/High Altitude Tier Radios

j. Users should report FIS-B malfunctions not attributed to aircraft system failures or covered by active NOTAM by emailing adsb@faa.gov.

## Part II/Study Unit 3: Observations – Aviation Routine Weather Reports (METAR) and Special Weather Reports (SPECI)

Page 221, Subunit 3.6, Table 3-2.

| QUALIFIER | | WEATHER PHENOMENA | | |
|---|---|---|---|---|
| INTENSITY OR PROXIMITY ~~1~~ | DESCRIPTOR ~~2~~ | PRECIPITATION ~~3~~ | OBSCURATION ~~4~~ | OTHER ~~5~~ |
| - Light | **MI** Shallow | **DZ** Drizzle | **BR** Mist | **PO** Dust/Sand Whirls |
| Moderate | **PR** Partial | **RA** Rain | **FG** Fog | **SQ** Squalls |
| + Heavy | **BC** Patches | **SN** Snow | **FU** Smoke | **FC** Funnel Cloud, Tornado or Waterspout |
| **VC** In the Vicinity | **DR** Low Drifting | **SG** Snow Grains | **VA** Volcanic Ash | **SS** Sandstorm |
| | **BL** Blowing | **IC** Ice Crystals (Diamond Dust) | **DU** Widespread Dust | **DS** Duststorm |
| | **SH** Shower(s) | **PL** Ice Pellets | **SA** Sand | |
| | **TS** Thunderstorms | **GR** Hail | **HZ** Haze | |
| | **FZ** Freezing | **GS** ~~Small Hail and/or~~ Snow Pellets | **PY** Spray | |
| | | **UP** Unknown Precipitation | | |

[ . . . ]

Table 3-2. METAR/SPECI Notations for Reporting Present Weather[1]

Page 222, Subunit 3.6, Item 8.b.1)a).

a) They are coded with precipitation types, except ice crystals (**IC**) and hail (**GR** ~~or **GS**~~), including those associated with a thunderstorm (**TS**) and those of a showery nature (**SH**).

Page 223, Subunit 3.6, Items 8.d.6)-7) and 8.e.1)a).

6) The descriptor for showery-type precipitation (**SH**) is coded only with one or more of the precipitation qualifiers for rain (**RA**), snow (**SN**), ice pellets (**PL**), ~~small hail (**GS**),~~ or ~~large~~ hail (**GR**). When any type of precipitation is coded with **VC**, the intensity and type of precipitation is not coded.

7) The descriptor for thunderstorm (**TS**) may be coded by itself when the thunderstorm is without associated precipitation. A thunderstorm may also be coded with the precipitation types of rain (**RA**), snow (**SN**), ice pellets (**PL**), ~~small hail and/or~~ snow pellets (**GS**), or hail (**GR**). For example, a thunderstorm with snow and small hail and/or snow pellets would be coded as **TSSNGS**. **TS** is not coded with **SH**.

**[ . . . ]**

e. **Precipitation**

**[ . . . ]**

a) The precipitation types are drizzle (**DZ**), rain (**RA**), snow (**SN**), snow grains (**SG**), ice crystals (**IC**), ice pellets (**PL**), hail (**GR**), ~~small hail and/or~~ snow pellets (**GS**), and unknown precipitation (**UP**).

## Part II/Study Unit 5: Observations – Radar Observations

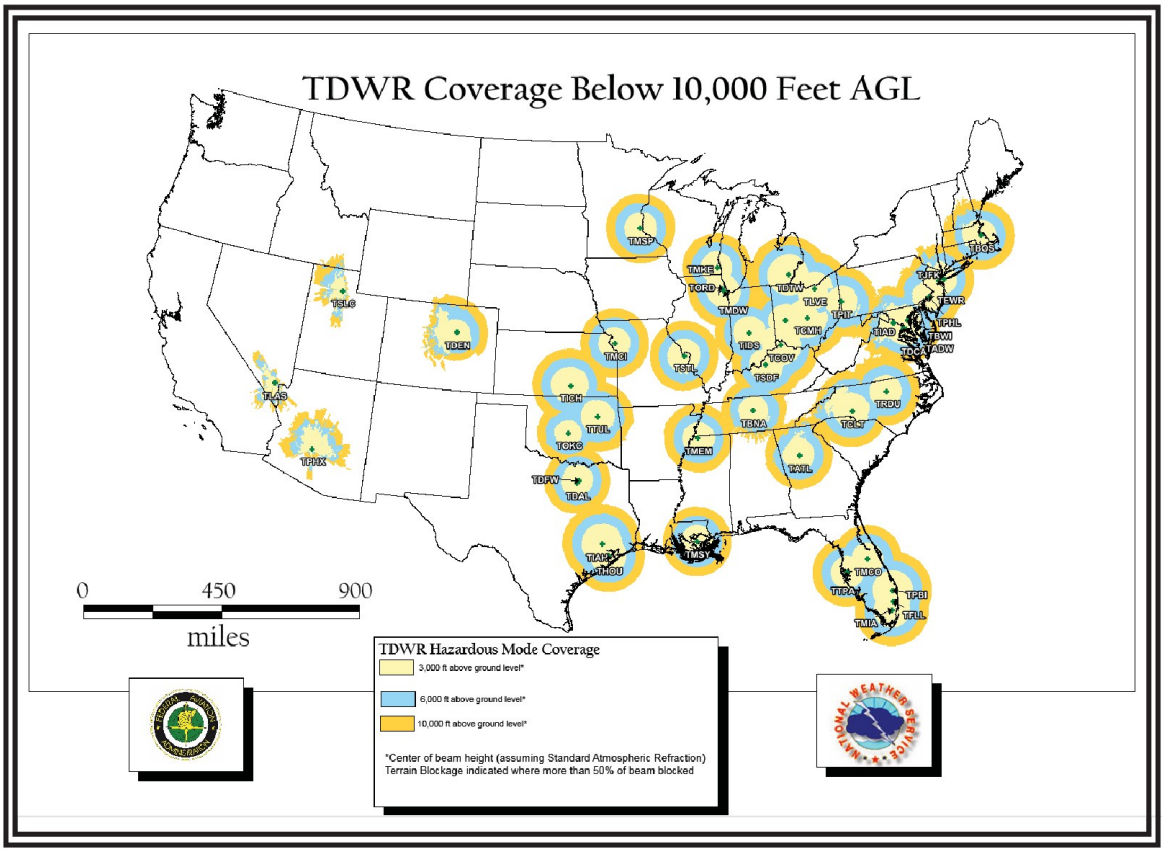
Pages 259-260, Subunit 5.5, Item 5.: The outdated radar coded message (RCM) coverage was removed.

Page 267, Subunit 5.9: This subunit was replaced with new material on the Terminal Doppler Weather Radar (TDWR) network, reproduced below without blue underlined font.

## 5.9 TERMINAL DOPPLER WEATHER RADAR (TDWR)

### 1. Introduction

a. The TDWR network is operated by the FAA and used primarily for the detection of hazardous windshear conditions, precipitation, and winds aloft on and near major U.S. airports in climates with great exposure to thunderstorms.




TDWR Site Locations

b. The National Centers for Environmental Information (NCEI) archives the products produced by the NWS Supplemental Product Generator (SPG) (called Level III), which are in the same data format as NEXRAD Level III.

1) NCEI does not archive the base data (called Level II).

c. TDWR was developed in the early 1990s at Lincoln Laboratory, which is part of the Massachusetts Institute of Technology (MIT).

d. The TDWR system was funded by the FAA to assist air traffic controllers by providing real-time windshear detection and high-resolution precipitation data.

e. In 2004, the NWS established the policy with the FAA to allow the operational use of TDWR data and began to develop the SPG.

1) Initial deployment of the SPG began in 2005 and finished in 2008.

f. As of 2016, there were 47 operational TDWR-SPG radar systems in major metropolitan locations across the United States and Puerto Rico.

2. **Radar Data Access**

   a. Weather radar data at NCEI are stored on a tape archive system and are accessed by placing orders through the NCEI website. There are several ordering systems available, optimized for different situations, including small orders, multisite and multiday orders, and large bulk orders.

      1) Currently, TDWR-SPG data are only available from the “Select by Site” and “Select by File” ordering systems.

      2) Small orders are typically completed in less than 15 minutes.

   b. There are occasional gaps and missing data for each site in the archive. These gaps are caused by a number of reasons, including scheduled maintenance at the radar sites, unplanned downtime due to severe weather, communications problems, or archival problems.

      1) The data access web pages include lists or visualizations of file availability.

3. **Products**

   a. TDWR-SPG Products

      1) This complete list of all available data products (called Level-III products) includes descriptions and possible uses.

      2) There are 26 TDWR-SPG Level-III products routinely available from NCEI, including precipitation estimates, storm relative velocity, and echo tops.

   b. Comparison of the TDWR to the WSR-88D

      1) The range resolution of the TDWR is finer than that of the WSR-88D or any other FAA radar with weather channel capability.

         a) The TDWR utilizes a range gate resolution of 150 m for Doppler data.

         b) It has a resolution of 150 m for reflectivity data within 135 kilometers (km) and 300 m from beyond 135 km to 460 km.

         c) By contrast, the WSR-88D employed by the NWS, FAA, and DOD has a maximum range gate resolution of 250 m for Doppler and 1 km for surveillance data.

      2) The angular (azimuth) resolution of the TDWR is nearly twice that of the WSR-88D.

         a) Each radial in the TDWR has a beam width of 0.55 degrees.

         b) The average beam width for the WSR-88D is 0.95 degrees.

         c) Table 3-8 compares the technical specifications of the WSR-88D and the TDWR.

| | WSR-88D | TDWR |
|---|---|---|
| Wavelength | 10 cm | 5 cm |
| Volume Scan Time | 4 minutes in Volume Coverage Pattern (VCP) 12 | 1 min 0.2 degree, Hazard (HAZ) |
| Bean Width | 1.25 degrees | 0.5 degrees |
| Range Gate | 0.13 NM in velocity<br>0.54 NM in reflectivity | 0.067 NM |
| Max Unambiguous Velocity | Up to 62 kts | 20–30 kts |
| Max Doppler Range | 230 km | 90 km |

Table 3-8. Technical Specifications: WSR-88D vs. TDWR

*The National Oceanic and Atmospheric Administration's (NOAA) Radar Operations Center (ROC) has detailed information (www.roc.noaa.gov/).*

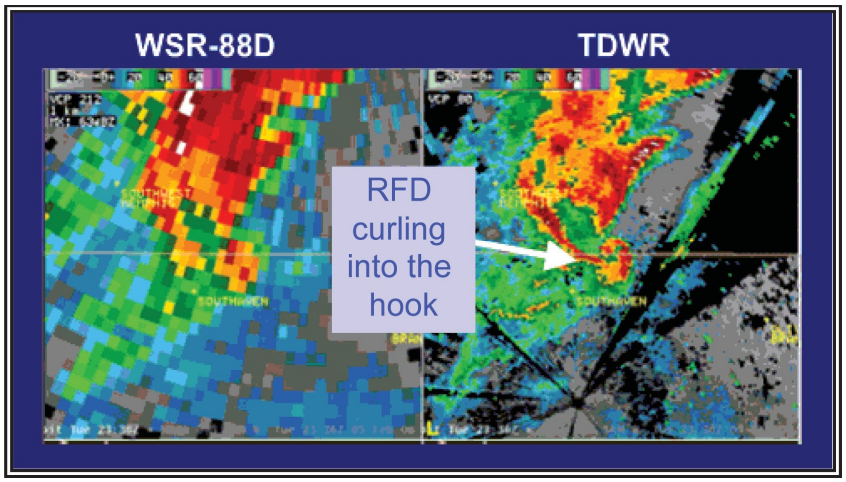



Figure 3-27. WSR-88D vs. TDWR (Image Credit: NWS)

4. **How the Radar Collects Data**

   a. The FAA designed the TDWR to look for low-altitude phenomena, such as wind shifts over the runways, windshear along the immediate approach and departure corridors, and downbursts.

   b. These radars are located close to major airports and use a scanning strategy optimized to sample the atmosphere over their associated airports.

      1) This scanning strategy is called monitor mode and is similar to the WSR-88D clear-air mode. The TDWR remains in monitor mode until one of the two following conditions is recognized:

         a) The radar detects a region of 20 dBZ echoes located within 24.3 NM from the associated airport with a nominal areal extent of 1.3 NM and an altitude of at least 1.3 NM AGL.

         b) The radar detects windshear or a microburst.

      2) This is a departure from WSR-88D operations, which can switch from clear-air mode to precipitation mode if the areal coverage of precipitation exceeds an adaptable parameter anywhere on the scope.

         a) The TDWR ties its decision on the area of influence directly to its associated airport.

5. **Volume Coverage Pattern (VCP) 90**

   a. VCP 90 is the TDWR monitor mode (clear air) and consists of 17 scans in about 6 minutes.

      1) The first cut is always a low Pulse Repetition Frequency (PRF), long-range scan (276 km). All remaining scans are short range (90 km).

         a) There is a small variation in the elevation angles of the lower scans, but all scans above 5 degrees are the same in all systems.

      2) Cuts two and three employ a split cut strategy.

         a) Cut two contains no dealiased Doppler data.

         b) Cut three (at the same elevation as cut two) is the first cut to contain dealiased Doppler velocity data.

      3) The first three cuts are used to initialize wind field models and velocity unfolding algorithms.

6. **Volume Coverage Pattern (VCP) 80**

   a. VCP 80 is the TDWR hazardous mode (precipitation mode).

      1) The first cut is always a low PRF, long-range scan (276 km).

      2) Cuts two and three are short-range, split cut scans used to collect information for unfolding and clutter migration algorithms.

         a) The first cut with dealiased Doppler data is cut three.

      3) There are two sub-volumes or aloft scans contained in each full volume, as denoted by the use of red and orange.

      4) Every fourth scan, the TDWR provides a short-range elevation scan at the same elevation as cuts two and three.

Figure 3-29. Thunderstorm Producing a Microburst (Image Credit: MIT Lincoln Labs)

7. **Where to Get Details on TDWR-SPG**

   a. NOAA's ROC maintains papers, presentations, and detailed information on the TDWR-SPG system (www.roc.noaa.gov/spg/default.aspx).

   b. NCEI provides descriptions and possible uses of radar products generated from the TDWR network operated by the FAA. All data are available digitally at NCEI for free (visit www.ncdc.noaa.gov/nexradinv/).

8. **TDWR Level-II (Base) Data**
    a. The TDWR Level-II Base Data is not available from NCEI.
9. **TDWR Level-III Products**
    a. There are 26 TDWR Level-III products routinely available from NCEI.
        1) Most Level-III products are available as digital images, color hard copy, grayscale hard copy, or acetate overlay copies.
        2) Each copy includes state, county, and city background maps.
            a) The Certification of Data page (www.ncei.noaa.gov/certification) has further information on hard copy radar products, pricing, and certification information.
            b) A detailed list of Level-III product codes is also available at www1.ncdc.noaa.gov/pub/data/radar/RadarProductsDetailedTable.pdf.
    b. General Products
        1) General products include Base Reflectivity and Base Velocity as well as graphical products derived from algorithms, including Spectrum Width, Vertically Integrated Liquid, and the Velocity Azimuth Display (VAD) Wind Profile.
    c. Precipitation Products
        1) Precipitation products provide estimated ground accumulated rainfall. Estimates are based on a reflectivity and rainfall rate relationship called Z-R (www.weather.gov/tae/research-zrpaper).
    d. Overlay Products
        1) Overlay products provide detailed information for identified storm cells.
    e. Radar Messages
        1) Radar messages provide information about the radar status and special product data.

## Part II/Study Unit 6: Observations – Satellite Imagery

Page 274, New Subunit 6.3: New material on Polar Orbiting Environment Satellites was added to increase students' knowledge base. The new subunit is reproduced below without blue underlined font.

### 6.3 POLAR ORBITING ENVIRONMENT SATELLITES

1. Polar Orbiting Environment Satellites (POES) constantly circle the Earth and track along various orbits around the poles. [The U.S. polar satellite program was recently renamed the Joint Polar Satellite System (JPSS).]
    a. Typically, POES are somewhere between 124 and 1,240 mi. above the Earth's surface.
    b. The satellites scan the Earth in swaths as they pass by on their tracks.
2. Because they are so much closer to Earth, the satellites can take very high resolution images, i.e., better than 0.5 km. (or ~5/8 mi.), allowing for weather and surface features to be seen in much greater detail.
    a. This is particularly useful over the poles and arctic areas because the quality of geostationary satellite data degrades the further you get from the poles.

3. The most significant shortfall of POES is the latency, or the time between when the satellite scans the area and when the data become available to a user.
    a. Because polar satellites are moving, they cannot continuously transmit to a single station.
        1) Instead, there are a series of stations around the globe through which the data are collected.
        2) The stations then transmit the data to other locations.
            a) At times, it can take several hours or more to reach operational users in the United States (it is much quicker in polar areas).
        3) There are some direct ground stations closer to the United States that can cut the latency to ~45 minutes when utilizing the newer polar satellites.
            a) For the purpose of the AWC, that is at the limit of usefulness for real-time operations.

## Part II/Study Unit 11: Analysis – Ceiling and Visibility

Page 304, Subunit 11.2: This subunit was removed due to industry changes.

## Part II/Study Unit 13: Forecasts – Significant Meteorological Information (SIGMET)

Page 314, Subunit 13.6, Item 3.

3. Although the areas where the Convective SIGMETs apply may be shown graphically, such a graphical depiction of a Convective SIGMET ~~area is not the entire Convective SIGMET~~ polygon is a “snapshot” that outlines the area (or line) of thunderstorms at the issuance time of 55 past each hour.
    a. ~~Information regarding the Convective SIGMET identified by graphical depiction should be referred to for further information.~~During the valid time of the SIGMET, the area/line will move according to the movement vector given in the SIGMET.
    b. Fast moving areas or lines will very likely end up outside the SIGMET polygon by the end of the hour.
    c. Slow moving or stationary areas or lines will likely remain in or very close to the original polygon.
    d. For additional clarification, the movement “MOV FROM…” within the Convective SIGMET describes the current movement of the SIGMET area or line.
    e. In cases when cell movements are different within the area, the SIGMET will include an additional line that states “CELL MOV FROM.”
4. Detailed information regarding the Convective SIGMET depiction should be compared to the textual version for storm movement, velocity, cloud tops, and several other important elements.
5. Users should exercise caution as areas of convection and their associated polygons can change and should only be used for strategic planning.

## Part II/Study Unit 18: Forecasts – Additional Products for Convection

Pages 364-367, Subunits 18.6-18.9: These subunits were replaced. The new subunits are reproduced below without blue underlined font.

### 18.6 TRAFFIC FLOW MANAGEMENT (TFM) CONVECTIVE FORECAST (TCF)

1. The TCF is a high-confidence graphical representation of forecasted convection meeting specific criteria of coverage, intensity, and echo top height.
2. The TCF graphics are produced every 2 hours and are valid at 4, 6, and 8 hours after issuance time. Areas of convection in the TCF include any area of convective cells containing the following (at a minimum):
    a. Composite radar reflectivity of at least 40 decibels (dBZ);
    b. Echo tops at or above FL250;
    c. Coverage (1 and 2) of at least 25% of the polygon area; and
    d. Forecaster confidence of at least 50% (high) that criteria (1, 2, and 3) will be met.
3. Lines of convection in the TCF include any lines of convective cells having the following (at a minimum):
    a. Composite radar reflectivity of at least 40 dBZ having a length of at least 100 NM;
    b. Linear coverage of 40% or greater;
    c. Echo tops at or above FL250; and
    d. Forecaster confidence of at least 50% (high) that criteria (1, 2, and 3) will be met.
4. All four of the threshold criteria listed above for both areas and lines of convection are required for inclusion in the TCF. This is defined as the minimum TCF criteria.
5. The TCF domain is the FIR covering the CONUS and adjacent coastal waters. It also includes the Canadian airspace south of a line from Thunder Bay, Ontario to Quebec City, Quebec.
6. The TCF is issued 24 hours a day, 7 days a week, at 30 minutes prior to the indicated issuance time.
    a. The issuance time supports the FAA's Strategic Planning (SP) Webinar, which occurs 15 minutes following odd hours Eastern Time (ET).
    b. The Canadian portion of the forecast is available from April 1 through September 30. However, Nav Canada may request the issuance of each forecast as early as March 1 and as late as October 31.
        1) All available Canadian forecasts are incorporated into the TCF. During times the forecasts are not available for Canadian airspace, the TCF graphics will be annotated with "No Canadian TCF."
7. The TCF is intended to be used as a Strategic Planning (SP) tool for air traffic flow management.
    a. It aids in the reduction of air traffic delays, reroutes, and cancellations due to significant convection. It is not intended to be used for tactical air traffic flow decisions, in the airport terminal environment, or for pilot weather briefing purposes. The graphical representation is subject to annual revision.

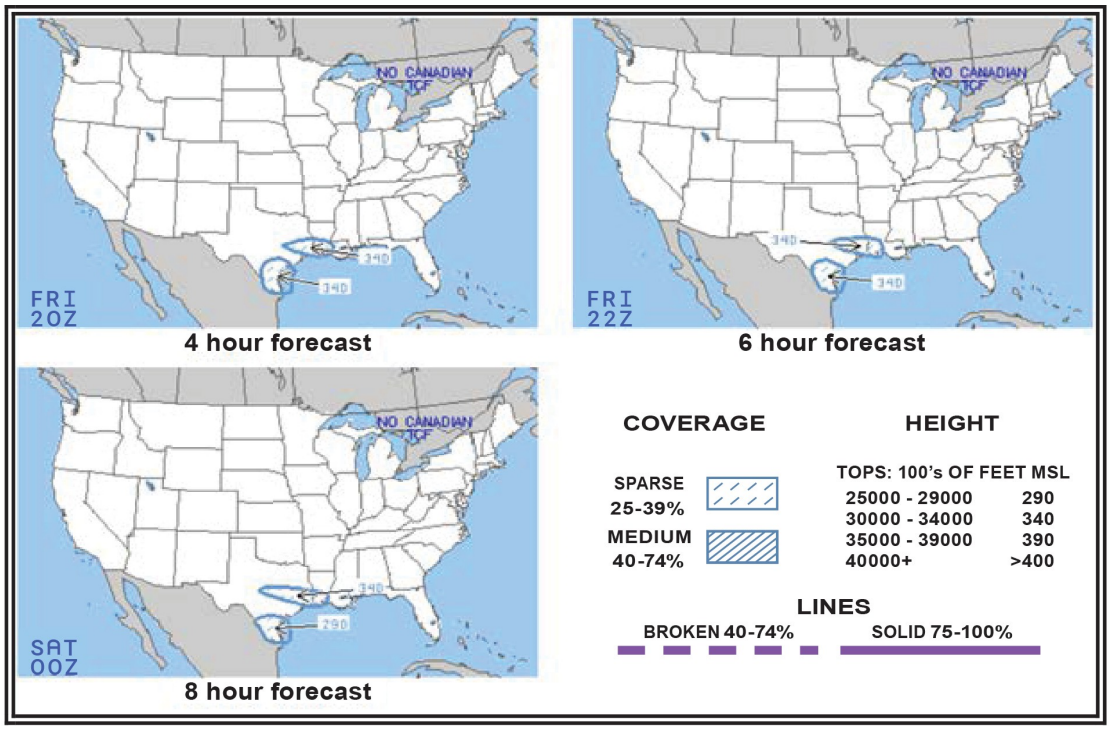



Figure 5-25. TFM Convective Forecast (TCF)—Example

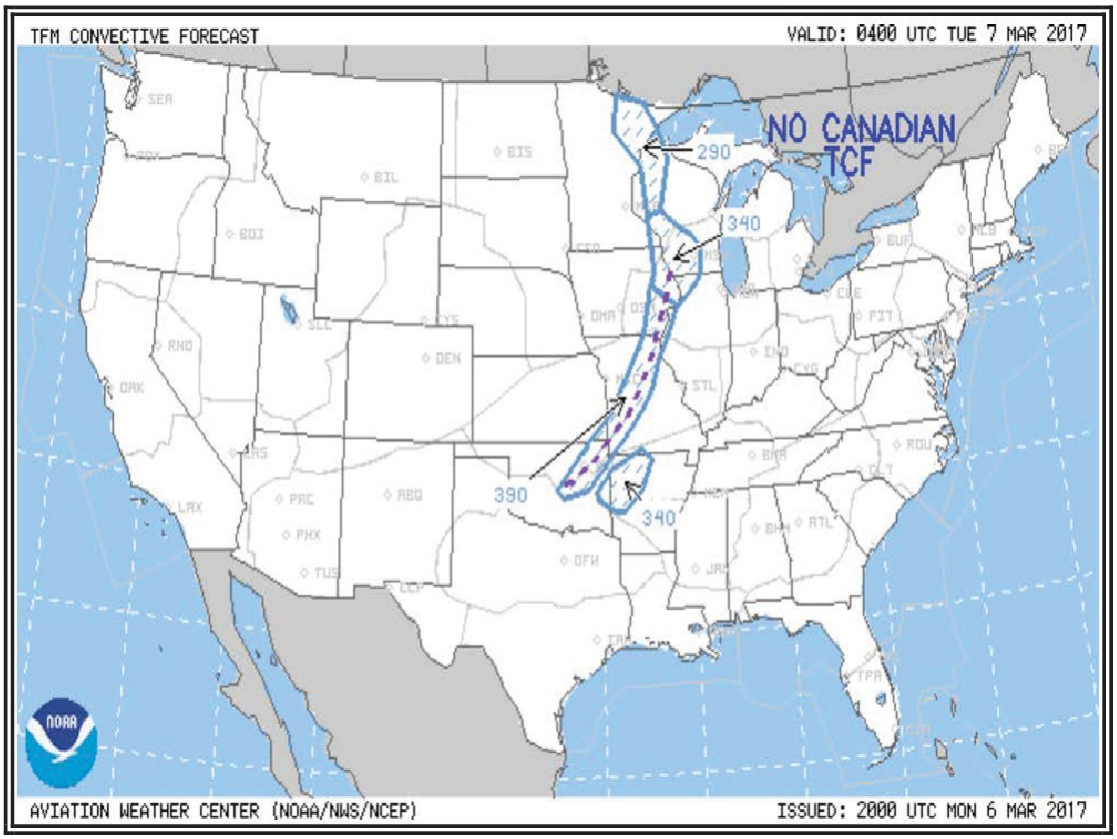
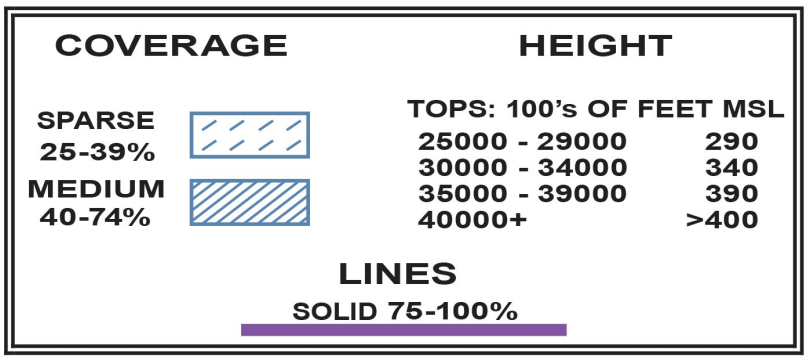



Figure 5-26. TFM Convective Forecast (TCF)—Example

## 18.7 TCF -- CONTENT AND COVERAGE

1. Content
   a. Data graphically displayed on the TCF consist of coverage of convection within a defined polygon, maximum tops, and confidence of convective occurrence meeting the TCF minimum criteria.
   b. Additional information on the TCF product is available on the TCF website form under the INFO tab at www.aviationweather.gov.
2. Coverage
   a. The convective coverage within the forecast polygon is represented by the amount of fill within the polygon (as shown in the figure below, TCF Product Legend). The polygon is then assigned as a sparse or medium coverage.
      1) Medium coverage, defined by medium fill, indicates 40 to 74% of the polygon is forecast to contain convection.
      2) Sparse coverage, represented by sparse fill, means 25 to 39% of the polygon is forecast to contain convection.




TCF Product Legend

   b. Confidence
      1) The TCF is a high confidence (50 to 100%) graphical representation of forecasted convection that denotes the forecasters' confidence that the represented convection will meet the minimum criteria. Confidence is not to be associated with probability of occurrence.
   c. TOPS
      1) The word "TOPS" is used to depict the forecast maximum echo tops, in thousands of feet MSL, specified by four selected layers listed in the figure above. The heights of the forecast echo tops must cover at least 25% of the polygon. The exact location of the highest echo top within the polygon cannot be determined.

## 18.8 TCF -- ISSUANCE

1. The TCF is issued by the AWC every 2 hours.
   a. The TCF product issuance time is approximately the bottom of the hour preceding the FAA ATCSCC's SP telecom (i.e., the 1600 UTC issuance would be available at ~1530 UTC for the 1615 UTC SP telecom).
   b. The product can be found at www.aviationweather.gov.

**18.9 TCF -- USE**

1. The TCF is an SP tool for air traffic flow management in the 2- to 8-hour forecast period.
2. The TCF does not include a forecast for all convection. If the convection does not meet the threshold criteria, it is not included in the TCF. The TCF is not intended to be used as a tactical short-term decision product.
3. The product is not intended to be used as a pilot weather briefing product; however, TCF is available to pilots and aircraft dispatchers as an additional product for SP.

Page 367, Subunit 18.10: The edits for this subunit consist of replacing the acronym “CCFP” with “TCF” due to industry changes.

## Part II/Study Unit 21: Forecasts – Area Forecasts (FA)

Pages 379-386, Study Unit 21: This study unit was replaced with new material on graphical forecasts for aviation. The new study unit is reproduced below without blue underlined font.

# STUDY UNIT TWENTY-ONE
# FORECASTS -- GRAPHICAL FORECASTS FOR AVIATION

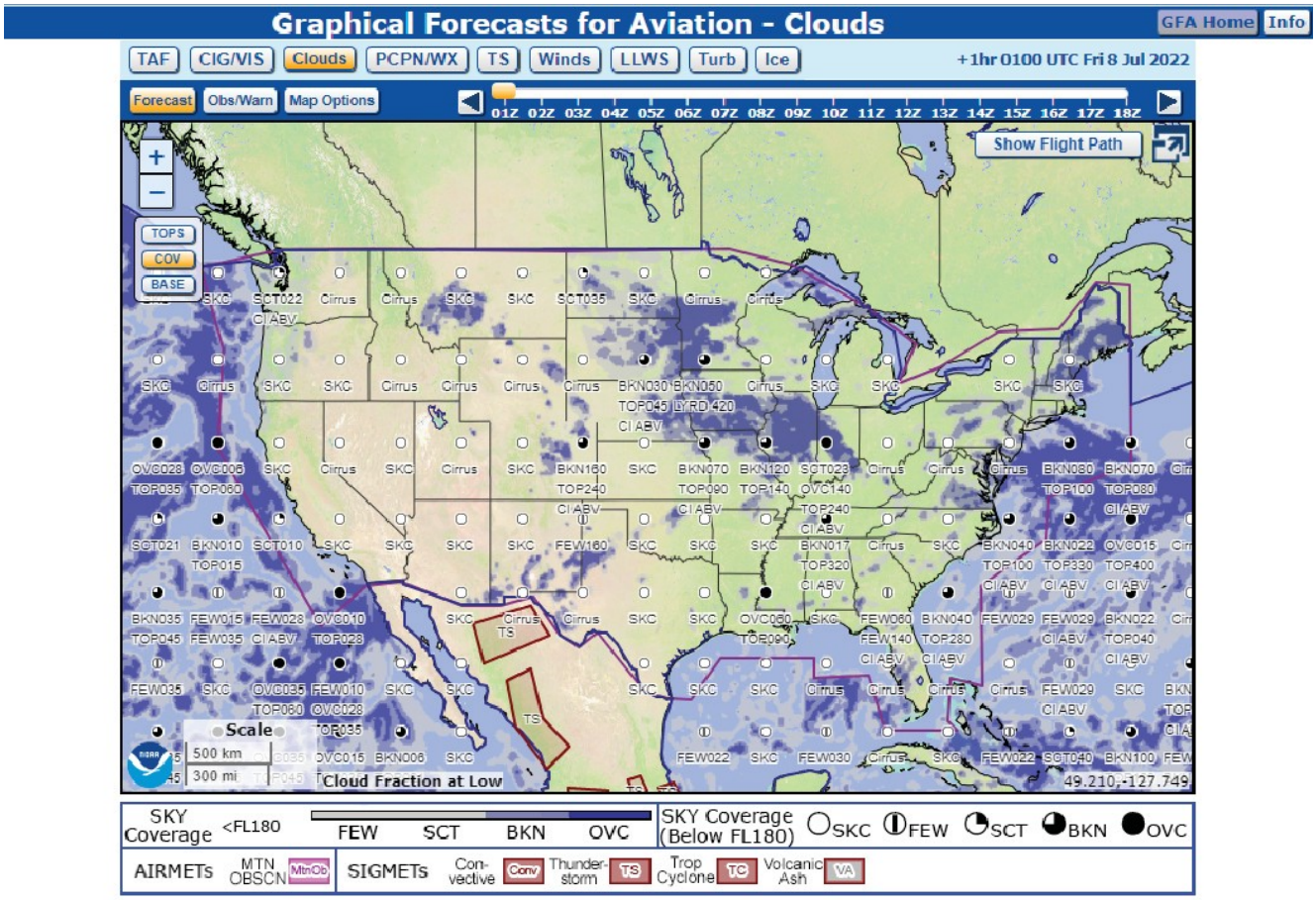
(6 pages of outline)



**21.1 PRODUCT DESCRIPTION**

1. The Graphical Forecasts for Aviation (GFAs) are a set of Web-based displays that provide aviation weather information that may affect flights in the continental United States (CONUS).
    a. The displays are updated continuously and provide forecasts, observational data, and warnings of weather phenomena from 18 hours in the past to 18 hours in the future.
    b. This product covers the surface up to flight level (FL) 420 (or 42,000 ft. MSL). Wind, icing, and turbulence forecasts are available in 3,000-ft. increments from the surface up to 18,000 ft. MSL and in 6,000-ft. increments from 18,000 ft. MSL to FL420.
        1) Turbulence forecasts are also divided into low (below 18,000 ft. MSL) and high (above 18,000 ft. MSL) graphics.
        2) A maximum icing graphic and maximum wind velocity graphic (regardless of altitude) are also available.

c. The graphic below is an example of an aviation forecast for clouds.




## 21.2 TIME SELECTION AND SLIDER

1. Available weather product tabs are configured based on time selection. Users may choose between Forecast and Observations/Warnings (Obs/Warn). A specific hour may then be chosen by using the time slider.


2. **Forecast Weather Products Tabs**

   a. Weather products with forecast information are available by selecting one of the tabs at the top of the display above the time selector.

      1) The selected product will be highlighted.
      2) The default is TAF.


3. **Forecast Weather Product Elements Tabs**

   a. Table 5-11 shows which weather elements are displayed on each forecast product tab.

   b. Explanations of the acronyms used in this table are displayed at the bottom of the GFA and reflect the currently selected product. A complete list of acronyms can be reviewed using the NWS Hazard Codes and AWC SIGMET Codes tables found at www.aviationweather.gov/gfa/help?page=products.

| Product | Gridded Product | Weather Data Overlay | SIGMET | NWS Warnings | AIRMET | Vertical Levels |
|---|---|---|---|---|---|---|
| TAF | - | - | All | All | - | - |
| CIG/VIS | LAMP Flight Category, Ceiling, or Visibility | NDFD Precipitation/ Weather Type and Intensity Symbol | C-SIG TC TS BD BS VA | WS BZ | Sierra (IFR) | - |
| Clouds | RAP Model Cloud Coverage, Tops, or Bases | RAP Model Cloud Base, Layers, and Tops | C-SIG TC TS VA | - | Mountain Obscuration | - |
| PCPN/WX | NDFD Precipitation/ Weather Type and Likelihood | NDFD Precipitation/ Weather Type and Intensity | C-SIG TC TS BD BS VA | TO TS WS BZ IS LS ST | - | - |
| TS | NDFD Thunderstorm Coverage | NDFD Thunderstorm Type and Intensity | C-SIG TC TS | TO TS | - | - |
| Winds | RAP/NDFD Wind Speed | RAP/NDFD Wind and Gust Barb | C-SIG TC TS | WS BZ IS ST GA HW | LLWS, Strong Surface Winds | SFC, MAX, every 3,000 ft from FL030 to FL300; every 6,000 ft from FL300 to FL480 |
| Turb | Graphical Turbulence Guidance (GTG) | - | C-SIG TC TS TB | - | Turbulence | LO, HI, every 3,000 ft from FL030 to FL300; every 6,000 ft from FL300 to FL480 |
| Ice | FIP @ "SFC" NDFD Winter Precipitation/ Weather Type and Likelihood | @ "SFC" NDFD Winter Precipitation/ Weather Type and Intensity | C-SIG TC TS IC | @ "SFC" WS BZ IS LS | Icing | SFC, MAX, every 3,000 ft from FL030 to FL300; every 6,000 ft from FL300 to FL480 |

Table 5-11. Weather Elements on Forecast Product Tabs

4. **Observations/Warnings (Obs/Warn)**

   a. The Observation/Warning option displays weather data for the current time and the previous 18 hours (rounded to the nearest hour).

      1) Users may advance through time using the arrow buttons or by clicking on the desired hour.


Figure 5-38. Observations/Warnings Tab

5. **Observations/Warnings Weather Product Tabs**

   a. The following table shows what is displayed on each Observations/Warnings weather product tab.

   b. Each product in this menu is overlaid on an infrared (IR) satellite image with a radar loop of the five most recent images up to the selected hour.

| Product | Weather Data Overlay | SIGMET | NWS Warnings | Vertical Levels |
|---|---|---|---|---|
| METAR | METAR Station Plot | All | All | - |
| PCPN/WX | METAR Precipitation Weather Symbol | C-SIG TC TS BD BS VA | TO TS WS BZ IS LS ST | - |
| CIG/VIS | FLT CAT: Non-VFR Color-Coded METAR Flight Category Symbol<br>CIG: Number (ft/100)<br>VIS: Number (SM) | C-SIG TC TS BD BS VA | WS BZ | - |
| PIREP | PIREP symbols | All | - | ALL, every 3,000 ft from FL030 to FL300; every 6,000 ft from FL300 to FL480 |
| RAD/SAT | - | All | All | - |

Table 5-12. Products Displayed on Observations/Warnings Weather Products Tab

## 21.3 STATIC IMAGES

1. Users with limited Internet connectivity may access static GFA images via the AWC at www.aviationweather.gov/gfa/plot.
2. There are two static graphical images available: “Aviation Cloud Forecast” and “Aviation Surface Forecast.”
   a. The Aviation Cloud Forecast provides cloud coverage, bases, layers, and tops with AIRMET Sierra for mountain obscuration and AIRMET Zulu for icing overlaid.
   b. The Aviation Surface Forecast provides visibility, weather phenomena, and winds (including wind gusts) with AIRMET Sierra for IFR conditions and AIRMET Tango for sustained surface winds of 30 kts. or more overlaid.
   c. These images are presented on 10 separate maps–one of the entire CONUS and nine regional views with additional details.
   d. They are updated every 3 hours and provide forecast snapshots for 3, 6, 9, 12, 15, and 18 hours in the future.

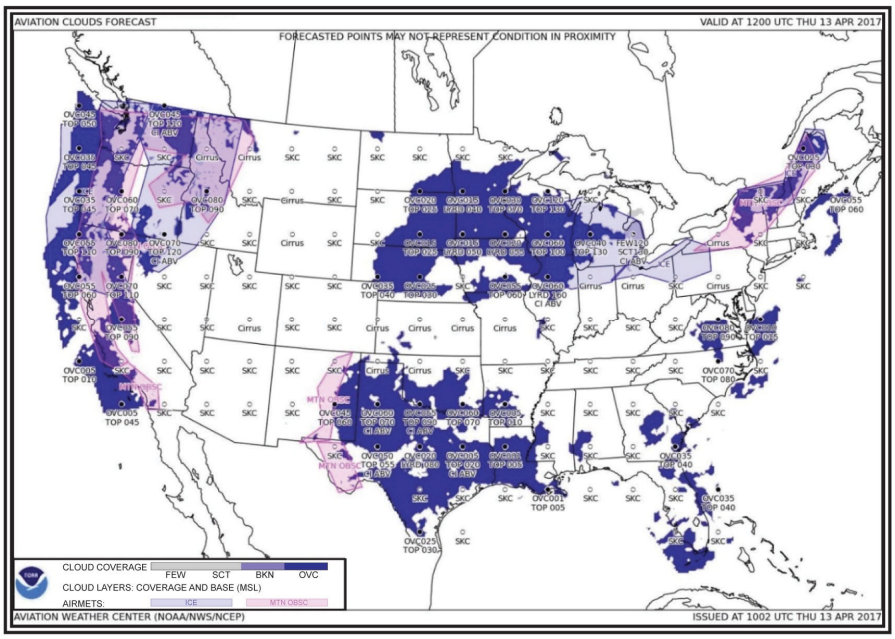
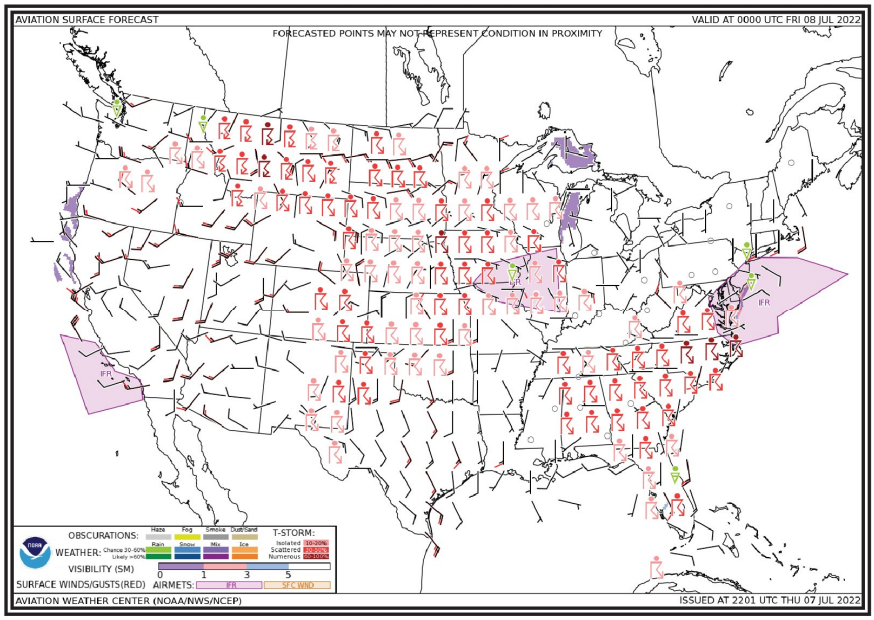



Figure 5-39. GFA Static Cloud Forecast




## 21.4 STRENGTHS AND LIMITATIONS

1. **Strengths**
   a. One-stop shop for multiple data fields
   b. Focused on low-altitude flights common to the GA community
   c. Simplified display for non-meteorologist users
   d. Available 24 hours a day, 7 days a week
   e. Updated continuously
   f. Resolution of 2.2 km
   g. Available from 18 hours in the past to 18 hours in the future
2. **Limitations**
   a. Caution should be applied as users configure the GFA for use.
   b. Users can turn certain functions on and off, such as AIRMET's and SIGMET's overlays for a given geographical area.
      1) This can lead to hidden areas of hazardous weather for a given flight path.

## 21.5 RECOMMENDED ACTION FOR USERS

1. For more information on how to use this product, all users are encouraged to visit the GFA interactive web tool at www.aviationweather.gov/gfa.
2. A short video explaining how to navigate the GFA can be found at www.youtube.com/watch? v=kLe6Eu3fwS0.
3. Users may provide feedback for the Aviation Surface Forecast and the Aviation Cloud Forecast graphics at www.aviationweather.gov/areafcst.

## Part II/Study Unit 22: Forecasts -- Localized Aviation Model Output Statistics Program (LAMP)

Page 387, New Study Unit 22: New material on the Localized Aviation Model Output Statistics Program (LAMP) was added. Subsequent study units have been renumbered accordingly. The new study unit is reproduced below without blue underlined font.

# STUDY UNIT TWENTY-TWO
# FORECASTS -- LOCALIZED AVIATION MODEL OUTPUT STATISTICS PROGRAM (LAMP)

(1 page of outline)



### 22.1 PRODUCT DESCRIPTION

1. The LAMP weather product is a statistical model program that provides specific point forecast guidance on sensible weather elements (perceivable elements such as temperature, wind, sky cover, etc.).
2. LAMP weather product forecasts are provided in both graphical and coded text formats and are currently generated for more than 1,500 locations.
3. The LAMP weather product is entirely automated and may not be as accurate as a forecast generated with human involvement.
    a. However, information from the LAMP weather product can be used in combination with Terminal Aerodrome Forecasts (TAFs), and other weather reporting and forecasting products and tools, to provide additional information and enhance situational awareness regarding a particular location.

### 22.2 STRENGTHS AND LIMITATIONS (LAMP)

1. Strengths
    a. Updated hourly, incorporating the latest surface conditions to produce hourly forecasts of weather elements reaching up to 25 hours in the future.
    b. Users can access fresh forecast information for the next 24 hours.
    c. Provides both categorical and probabilistic forecast guidance on various elements, allowing users to extract the type of information they want.
    d. Categorical ceiling/visibility forecast information is presented, along with forecasts dependent on the occurrence of precipitation. This data attempts to account for some of the temporary fluctuations that occur in flight.
2. Limitation
    a. May not be as accurate as a forecast generated with human involvement.

### 22.3 RECOMMENDED ACTION FOR USERS

1. A list of LAMP airports can be found at www.nws.noaa.gov/mdl/gfslamp/gfslamp.shtml.
2. A detailed description of the LAMP can be accessed at www.nws.noaa.gov/mdl/gfslamp/docs/LAMP_description.shtml.
3. The NOAA/NWS LAMP home page can be accessed at www.nws.noaa.gov/mdl/lamp/index.shtml.

## Part II/Study Unit 23: Forecasts – Terminal Aerodrome Forecasts (TAF)

Page 394, Subunit 23.2, Item 2.

| | |
|---|---|
| BECMG 0522/0524 20013G20KT 4SM SHRA OVC020 | PROB30 0600/0606 2SM TSRA OVC008CB= |
| 12. | 13. |

**[. . .]**

12. The BECMG group is used when a gradual change in conditions is expected over a longer time period, usually 2 hours. Note that the NWS does not use BECMG in the TAF. You will only see BECMG in military or international TAFs

~~12.~~13. Probability (30% chance) between 0000 UTC and 0600 UTC on the 6th day of visibility 2 SM, thunderstorm, moderate rain, ceiling 800 ft. overcast, cumulonimbus clouds (the = sign indicates end of forecast)

Page 402, Subunit 23.2, New item 13.

13. Low-Level Wind Shear Alert System (LLWAS)

a. The LLWAS (Phase-1) system was originally developed by the FAA in the 1970s to detect large-scale wind shifts (sea breeze fronts, gust fronts, and cold and warm fronts) in response to an accident at JFK Airport in New York where the aircraft (Eastern 66) landed during a wind shift caused by interacting sea breeze and thunderstorm outflows.

1) This Phase-1 LLWAS was very simple. It compared a center field wind to five other sensors around the airport.

2) When there was a 15-kt. vector difference, it would flash the wind data to the air traffic controller. The controller would then read the raw winds in degrees/knots, for example, 120/35 (120° at 35 kt.), from each sensor to the pilot landing or about to take off. The pilot had to mentally perform the vector addition to determine the headwind/tailwind components.

3) This simple system worked for large-scale weather features, but its sensors were too far apart to capture small, intense windshear events important to aircraft. It also had a serious false alarm problem.

a) Because all other sensors were compared to center field, windshear alarms would be triggered if the wind at center field was variable.

b. LLWAS History

1) Research conducted at the NCAR in the 1980s indicated that microburst windshear was very dangerous to aircraft below 1,000 ft.

a) Several major accidents during the 1980s also implicated windshear as a factor.

2) In 1983, the FAA asked NCAR to develop a version of LLWAS that could detect microbursts.

3) Between 1983 and 1988, NCAR developed and tested a new LLWAS (Phase-2) system, called enhanced LLWAS (or LLWAS–Network Expansion) that detected microbursts, determined their strength in terms of headwind/tailwind gains or losses (in knots), and located the event (on the runway or at 1, 2, or 3 NM on departure or arrival).

4) The Phase-2 system was designed to provide alerts specific to each runway operation and to have a probability of detection of 90% or greater and a false alarm rate of 10% or less.

5) This system was later refined into the Phase-3 LLWAS.
    a) A typical Phase-3 LLWAS has sensors spaced 2 km. apart (~1 NM apart) and has enough sensors to cover 2 NM from the end of each major runway.
    b) The largest LLWAS is at Denver International Airport and has 32 wind sensors. Most Phase-3 systems have between 12 and 16 wind sensors.
    c) A siting evaluation is done for each airport to determine its network geometry, which depends on terrain, number of runways, obstructions, etc.
    d) If a pilot is landing on runway 08 and there is a microburst on their path, the controller's display would show: 08A MBA 30K–3MF 350/25.
        i) This would be read to the pilot by a final controller as "microburst alert (MBA), expect a thirty knot loss (30K–) at three miles final (3MF), threshold wind three–five–zero at 25 (knots)."
    e) If a pilot is departing runway 25 left and there is a windshear with a wind speed gain at 1 mile departure (headwind gain), the final controller's LLWAS display would show: 25LD WSA 15k+ 1MD.
        i) This would be read as "windshear alert, expect a fifteen knot gain at one mile departure."
6) There are Phase-3 LLWAS systems at 9 U.S. airports and Phase-2 systems at more than 100 airports.
    a) The FAA originally had 110 Phase-1 LLWAS systems, which were upgraded to Phase-2 systems.
        i) A Phase-2 LLWAS has the same number of sensors (5 to 6) as a Phase-1 system (described on the previous page), but its upgraded windshear algorithm significantly decreases the number of false alarms.
    b) The FAA also has Terminal Doppler Weather Radars (TDWR) for windshear detection at 45 airports and Airport Surveillance Radar-9 (ASR-9)-based windshear detection systems at another 37 airports.
7) Taiwan, Korea, Singapore, Saudi Arabia, and Kuwait are now implementing Phase-3 LLWAS systems.
8) When NCAR developed the Phase-3 LLWAS, it gave the specifications to the FAA.
9) The University Corporation for Atmospheric Research (UCAR) Foundation owned the intellectual property for the windshear algorithm during the lifetime of the patent.
    a) A license agreement was required for companies to implement LLWAS technology until early 2013 when the patent exclusion expired.
    b) A license from UCAR Foundation is no longer required to utilize the LLWAS algorithm.
    c) The UCAR Foundation does, however, provide technical materials, such as test datasets, test airport configuration files, test alert outputs, etc., to aid companies in the implementation and testing of the Phase-3 LLWAS algorithm.

## Part II/Study Unit 34: Forecasts – Space Weather

Page 477, Subunit 34.3, Item 2.

2. Information on these products is provided on the SWPC web page (www.swpc.noaa.gov/~~content/aviation-community-~~dashboards), including intended usage, impacts on various systems (e.g., GPS), and details on issuance times and frequency.

## Appendix D: Internet Links (AC 00-45H APP D)

Page 489, Appendix D, Items 5.-8.

5. Alaska Aviation Weather Unit (AAWU): ~~aawu.arh.noaa.gov~~www.weather.gov/aawu/
   a. This is the National Weather Service site for aviation weather specific to Alaska.
6. Center Weather Service Unit~~s~~ (CWSU): ~~www.nws.noaa.gov/aviation/pages/cwsu/cwsu.php~~www.weather.gov/aviation/cwsu
   a. The CWSU site provides the most accurate and dependable weather information possible to Federal Aviation Administration (FAA) customers, both in-house and off site. The CWSUs are co-located within air route traffic control centers. CWSU meteorologists provide face-to-face, on-the-spot briefings to air traffic controllers. This is vital in helping FAA personnel safely and efficiently route traffic.
7. Weather Forecast Offices (WFOs): ~~www.srh.noaa.gov/jetstream/nws/wfos.htm~~www.weather.gov/srh/nwsoffices
   a. National Weather Service Forecast Offices monitor weather around-the-clock. In addition to the forecast issued two to four times daily, WFOs are always monitoring hazardous weather conditions. Should threatening weather occur or appear imminent, WFOs issue weather watches and/or warnings to alert you to the threat. This site gives you a map of the WFOs located around the country.
8. Weather Forecast Office (WFO) Honolulu, HI~~—Aviation Products~~: ~~www.prh.noaa.gov/hnl~~www.weather.gov/hfo/
   a. This site provides WFO weather, including aviation weather, specific to Hawaii.

## Appendix F: Area Forecasts (FA) – Continental United States (CONUS) and Hawaii (AC 00-45H APP F)

Page 493, Appendix F: This appendix was removed, and subsequent appendixes have been relettered accordingly.

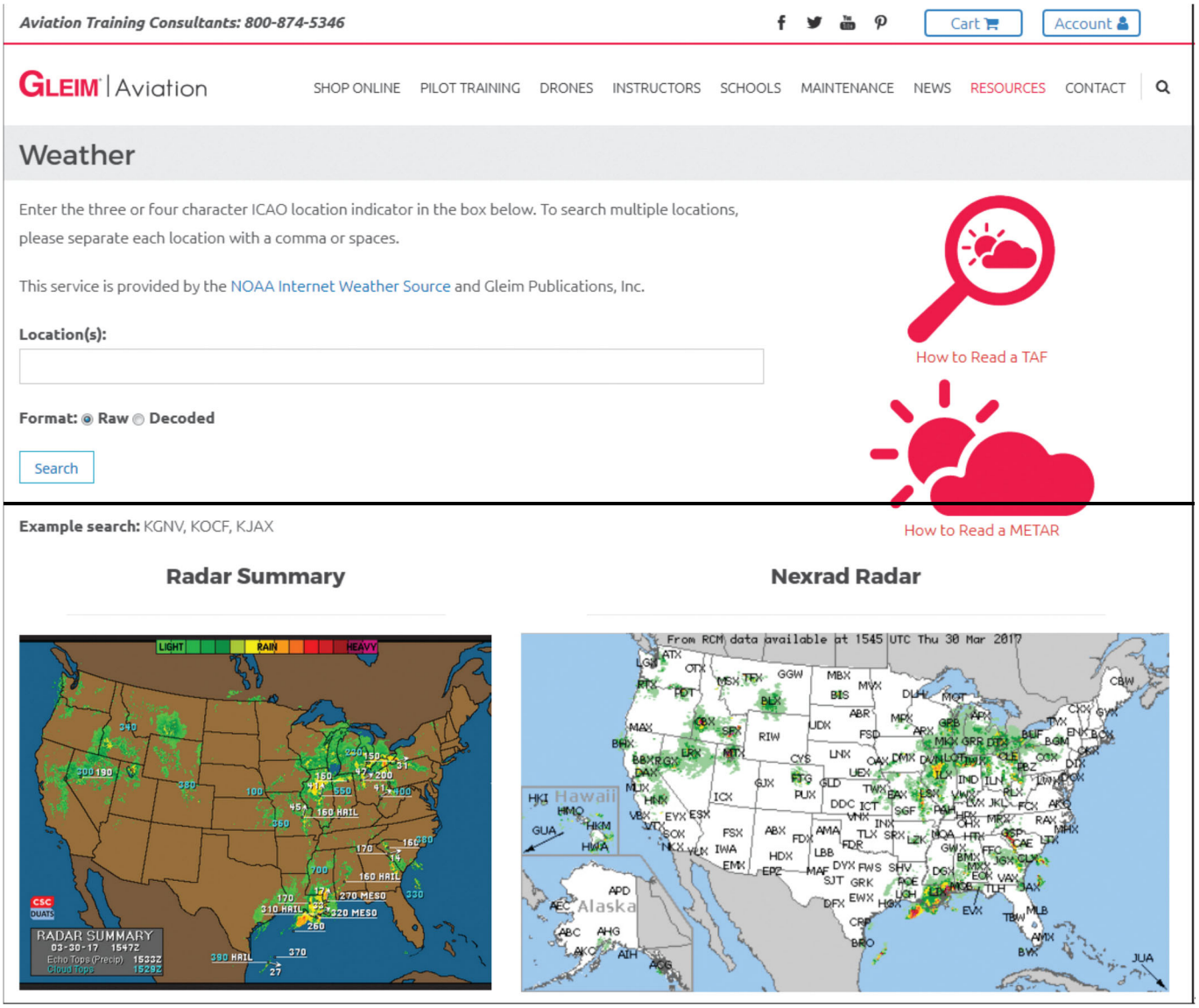
## Appendix H: Aviation Weather Services on the Internet

Pages 508-510, Appendix H, Item 2.c.

c. The following sites are popular weather resources for pilots.

~~1) Gleim Aviation Weather: www.gleimaviation.com/resources/weather~~

~~a) Links to National Weather Service radar images as well as METAR/TAF reports by airport, winds aloft, and area forecast reports. An easy one-stop aviation weather information resource.~~




~~2)~~1) Aviation Weather Center: www.aviationweather.gov

a) Official products, such as SIGMETs, AIRMETs, ~~weather depiction,~~ surface analysis, PROG Charts, METARs, TAFs, winds aloft forecasts, ~~area forecasts~~graphical forecasts for aviation, PIREPs, and excellent National Radar with tops and satellite imagery, etc., are available on this official government website.

**[ . . . ]**

~~3)~~2) National Weather Service: www.weather.gov

a) The official site of the National Weather Service contains local and national forecast products and full color maps.

i) Many products are interactive, allowing the user to quickly zoom to specific regions and display a wide range of user-selected weather products including hazards, temperature, winds, sky cover, precipitation, etc.