National Weather Service Eastern Region

Aviation Best Practices

August 2003

Overview

The National Weather Service (NWS) Eastern Region Aviation Best Practices team was formed to consolidate the knowledge and lessons learned from each NWS Eastern Region Weather Forecast Office (WFO) and Center Weather Service Unit (CWSU).

The Aviation Best Practices document was put together for two reasons. It summarizes aviation best practice information gathered from a variety of offices, and serves as a reference to WFOs and CWSUs for bringing their aviation programs closer to a uniform level. The team anticipates this document will spawn new ideas and best practices, and encourages WFOs and CWSUs to forward them to the ER RAM.

Forecast Philosophy

- Do not forecast to cover all possibilities or to make the forecast non-amendable
- Be pro-active with amendments, especially for thunderstorm beginning and ending times
- Be judicious in the use of TEMPO and PROB groups. They are not intended to be used to cover a myriad of "what ifs"
- TWEBs - flexible and narrative format allows for greater detail than TAFs
- Use "VC" or "CB" for scattered thunderstorms rather than having a large TEMPO window
- Be aware of ceiling and visibility thresholds not associated with flight categories that impact all users (i.e. the 2000/3 rule, airport specific wind directions, etc - see "Know Your Customers/Outreach" Section)

Operations

- Compile a "Terminal Forecast Reference Book" (TFRN) containing information for each TAF site in your forecast area . Obtain a copy of the TFRN for each TAF site in your service backup area. Information in the reference book should consist of, at a minimum,
  - airport layout
  - ceiling/wind/visibility climatology
  - locally developed "rules of thumb"

- contact numbers for:
  tower, non-FAA observer, servicing AFSS, airport managers
  airlines/major commercial airport users
  any flying clubs based at airport

- The U.S. Air Force Combat Climatology Center (USAFCCC) has "Forecaster Reference Binders" available for many airports. The information in the binders may be very useful in developing your reference book. The USAFCCC also maintains climate data and the ModCV program. The website is http://www.afccc.af.mil/

- The internet is an excellent resource. Many of the airports have their own homepages and reference material.

Science and Aviation

- Perform post-mortem or case studies on events that had an impact on aviation. It will help to define or refine "rules of thumb." Utilize the Weather Event Simulator (WES) for aviation cases.

- Integrate "new"and "non-standard" data sources into your aviation program:
  - Model Soundings/BUFKIT
  - Aircraft Soundings (MDCARS/ACARS)
  - Satellite Soundings
  - Mesonets (data available from FSL)

- Investigate how you may use various technologies already in place, such as ASOS and the WSR-88D, to improve deficiencies in forecasts

- Use ModCV available at http://www.afccc.af.mil/

- Consider using the MAKETAF program available on the Local Applications Database. It combines model guidance, persistence, and enhanced conditional climatology to assist in TAF preparation. (Climatological information not yet available for all airports.)

- Local testing of UPS fog algorithm

- Include an AVIATION section in your Area Forecast Discussion (AFD) to convey aviation-specific information and forecast uncertainty.

Know our Customers/Outreach

Aviation forecasts, specifically TAFs, are used by different groups in different ways. The following provides some information as to how Amajor@ groups use our forecasts. This list is not meant to be complete, and all offices should work to contact users that operate in their local area as well.

- *Major Commercial Airlines*
  - American Airlines
    - Operates 265 MD-80 aircraft, 77 Boeing 737s, 124 Boeing 757s, 73 Boeing 767s, 43 Boeing 777s, 34 Airbus A300s, 2 DC-10s, and 74 Fokker F28s.
    - Contracted meteorology department out to Weathernews Inc. whose aviation center is located in Norman, Oklahoma. Contract includes American Eagle.
    - Hubs located at DFW, ORD, STL, MIA, JFK, and BOS.

  - United Airlines
    - Operates 158 Boeing 737s, 55 Airbus A319s, 94 Airbus A320s, 42 Boeing 727s, 34 Boeing 747s, 97 Boeing 757s, 55 Boeing 767s, and 60 Boeing 777s.
    - Meteorology department has 18 forecasters plus one non-meteorologist on staff.
    - Hubs located at ORD, IAD, DEN, JFK, and SFO

  - Delta Airlines
    - Operates 148 Boeing 737s, 2 Boeing 727s, 121 Boeing 757s, 123 Boeing 767s, 8 Boeing 777s, 14 MD-11s, 120 MD-88s, and 16 MD-90s.
    - Meteorology department has 15 meteorologists plus two non-meteorologist support staff.
    - Hubs located at ATL, CVG, SLC, and DFW.

  - Northwest Airlines
    - Operates 168 DC-9s, 24 DC-10s, 60 Airbus A319s, 76 Airbus A320s, 10 Boeing 727s, 47 Boeing 747s, and 67 Boeing 757s.
    - Meteorology department has two offices. The main office in Minneapolis has 17 forecasters with two other support staff. They produce TAFs for their three domestic hubs. The second office in Tokyo, Japan has 9 meteorologists, and they produce 14 TAFs for their Asian bases.
    - Hubs located at DTW, MSP, and MEM.

  - Southwest Airlines
    - Operates 378 Boeing 737s.
    - Heaviest served cities are PHX, LAS, BWI, HOU, MDW, DAL, OAK, and LAX.
    - Uses NWS aviation products.

  - Continental Airlines
    - Operates 234 Boeing 737s, 45 Boeing 757s, 26 Boeing 767s, 18 Boeing 777s, 29 DC-9s, and one DC-10.

- Weather support comes from contract with Northwest Airlines Meteorology Department.
- Hubs located at IAH, EWR, and CLE.

- US Airways
  - Operates 118 Boeing 737s, 32 Boeing 757s, 10 Boeing 767s, 62 Airbus A319s, 23 Airbus A320s, 28 Airbus A321s, 9 Airbus A330s, and 2 Fokker F-28s.
  - Uses private weather services and TAFs.
  - Hubs located at PHL, PIT, and CLT.

- America West
  - Operates 48 Airbus A320s, 32 Airbus A319s, 47 Boeing 737s, 13 Boeing 757s, 35 CRJ regional jets, and 8 DeHavilland Dash 8s.
  - Mainly operates in western part of country with hubs located at PHX and LAS.

- American Trans Air
  - Operates 30 Boeing 737s, 24 Boeing 757s, and 8 Lockheed L-1011s.
  - Hubs located at MDW and IND.

- Jet Blue
  - Operates 42 Airbus A320s with 11 more to be delivered in 2003, ordered 100 Embraer 190 regional jets with options for 100 more.
  - Based out of JFK.

- *Major Cargo Operators:*
  - Federal Express
    - Operates 135 Boeing 727 Freighter aircraft, 65 Douglas DC-10s, 42 MD-11s, 41 Airbus A300s, 51 Airbus A310s, and 300 Cessna Caravan (single engine turboprop) aircraft.
    - Meteorology department has 12 meteorologists plus one non-forecaster.
    - Hub located at MEM.

  - United Parcel Service
    - Operates 75 Boeing 757s, 60 Boeing 727s, 15 Boeing 747s, 32 Boeing 767s, 24 Airbus A300s, 49 Douglas DC-8s, and 5 MD-11s.
    - Meteorology department has 5 meteorologists.
      - Proprietary forecasts are produced for worldwide major hub locations.
      - Does use and rely on NWS TAFs for Asmaller@ destination airports
    - Hub located at SDF.

- Airborne
  - Operates 74 Douglas DC-9s, 21 DC-8s, and 21 Boeing 767s.
  - Hub is at ILN.

- DHL (renamed Astar Air Cargo on 6/30/03)
  - Operates 24 Boeing 727s, 8 Douglas DC-8s, and 6 Airbus A300s.
  - Bases of operations at CVG and SFO, expected to transfer to MIA.

- Emery Worldwide
  - Main hub at DAY with nine other regional hubs.

- Ryan International
  - Contracted with U. S. Postal Service air operations and Emery.
  - Operates 17 Boeing 727s.
  - Hub at IND

- TAF is used as an important planning tool.

  - Especially important are 06Z and 12Z TAFs for timing of afternoon convection as bulk of daily airline flight plans are being done in the early morning.
  - Waiting until TAF issuance to make major changes hurts carriers.
  - Dispatchers of commuter and regional airlines, and some major airlines without their own forecast staff, rely heavily on NWS TAFs.
  - Convection forecasts are a big issue nationally.

- Each airport is impacted differently by the weather:

  - San Francisco has marine stratus/fog issues.
    - Best capacity is achieved using closely spaced parallel visual approaches to runways 28 Left and 28 Right with departures from runways 1 Left and 1 Right with 3500 foot ceilings or better. Published visual approaches (with lower acceptance rates) require 2100' ceilings and 5 SM visibility at SFO or 1000'/3 SM with 5 SM sector visibility from 030 degrees clockwise to 120 degrees at SFO and 2400 to 2500 foot ceilings and 5 SM visibilities at San Mateo or San Carlos in the South Bay area.
    - With light east winds, arrivals may still be using west-facing runways. At the same time, those winds may require heavy jets departing to the Far East to depart in the opposite direction on runways 10 Left or 10 Right forcing arrival delays of half an hour or more. If runways become wet, even with east to southeast winds at speeds as little as 3 knots, all operations may be forced into an east-facing configuration.

  - New York City airports - wind direction and speed can have major impacts.
    - JFK: best arrival rate using visual approaches commonly when runways 13 Left and 22 Left are in use for landing with departures using runway 13

Right with 68/hour acceptance rate. Under IFR conditions, 48/hour rate can be achieved with landings to runways 31 Left and 31 Right. Bulk of departures are launched between 1600 and 1900 local time.

- LGA: If JFK changes to ILS runway 13 Left arrivals, LaGuardia ends up changing to runway 13 and the acceptance rate can plunge to around 17 to 20/hour. Runway 22 is seldom used for departures due to noise abatement restrictions, except under extremely high wind conditions. Best acceptance rate of 39/hour is achieved with visual approaches to runway 22 with departures off runway 13, but this requires a 3200 foot ceiling and visibility of 4 miles.
- EWR: Teterboro operations can greatly impact traffic attempting to depart runway 29 or land runway 11 at Newark. Departures off of runway 22 Right can be difficult for controllers if LGA is conducting arrivals to runways 4 or 31. Best visual approach acceptance rate is 50/hour with landings to runways 22 Left and 11 with departures from runway 22 Right, but this requires a 3000 foot ceiling and 4 mile visibility.

- Washington DC airports - IAD/DCA are subject to fog, and very sensitive to wind direction.
  - IAD: Best acceptance rate is with visual approaches to a set of the parallel runways (1L/R or 19L/R) and runway 12 is 90 aircraft/hour. Best acceptance rate under IFR conditions occurs when either the parallel runways are in use for landing or runway 12 and one of the south-facing runways. Under IFR conditions acceptance rate goes to a 45 rate.
  - DCA: only full Atrue@ ILS is to the north facing runway. Diversions are frequent with strong south winds, and a ceiling seven hundred feet or less or visibility under a mile and a quarter.

- Boston: with strong northwest winds, BOS is restricted to a single runway (33 Left) configuration due to inability to use runway 27 for departures in most cases, and the parallel runway 33 Right is not long enough for most aircraft. This results in an acceptance rate of only 34/hour even with unlimited visibilities and clear sky conditions. Runway 15 Right operations on a southeast flow are only marginally better with a 36 rate. If the runways get wet when VFR landings are in use to runways 22 Left and 27, acceptance rate drops from 60/hour to 50.

- Pittsburgh: when conditions permit, likes to make use of simultaneous converging approaches. However, under some conditions (wind speed greater than 10 knots or restricted visibility and ceilings), they are forced to go to parallel runway operations which reduce their acceptance rates. Crosswind runway 32 has relatively high (1 mile) visibility requirement. Arrival and departure rushes may occur simultaneously.

- Cleveland: can have lake effect snow or fog problems. When ceilings and visibility are low, acceptance rates diminish because runways are close together.

Strong northwest winds can force use of crosswind runway (28) which is marginal in length especially when contaminated by snow or ice.

FAA rules are strict on any prevailing or TEMPO forecast of less than 2000ft and/or 3SM requiring the need for an "alternate" and additional fuel to reach alternate. While keeping safety in mind for aviation operations, forecasters should be mindful that this is an important threshold for airline operations, and it should be assessed with great care.

Contact your CWSU or local airport manager for determining weather impacts.

- *Private and General Aviation (GA)*
  - Most GA pilots may never see TAF forecasts since they are briefed by FAA Flight Service Stations (FSS).
  - May use AWC website for Aunofficial@ self-briefing.
    - DUATS system is a self brief.
  - Since biggest portion of GA are VFR pilots, forecasts for IFR have major impact.
  - Even though GA comprises nearly half of all aircraft in the air at one time, they account for a high majority of all aircraft accidents and deaths.
- *FSS*
  - The FAA operates a total of 66 FSS across the county. The primary duty of the FSS is to file flight plans, conduct pre-flight briefings, issue NOTAMS (Notices to Airmen), and conduct in-flight weather briefings.
  - The non-meteorologists at FSS use a variety of systems including Model 1 for text and WSI for radar and satellite imagery. TAFs, AIRMETs, SIGMETs, and Area Forecasts are used in conjunction with Radar, Satellite, METAR, and PIREP observations to conduct pre-flight and in-flight briefings.
  - FSS briefers explain to pilots (other non-meteorologists) differences between the data. It is essential to keep NWS aviation products consistent through consensus and collaboration.
  - FSS briefers convey to pilots expected conditions within one hour of arrival. TAFs that are long and complex make this task extremely difficult.
  - All NWS forecasters should visit a FSS at least twice per year. The WFO Aviation Focal Point should visit more often.
  - WFOs should develop a close relationship with their local FSS.
- *Air Traffic Control Centers*
  - CCFP
    - Traffic managers don=t like large inconsistencies between forecast products.

- TAFs
  - Major hub airports play big role, but even forecasts for smaller sites have impact on determining en route conditions and resulting aircraft routings.
  - Many air traffic control planning decisions are made prior to the release of the 12Z TAFs because weather affecting transcontinental flights must be taken into account four to six hours in advance of the scheduled arrival time.
  - All TAFs are critical to aviation operations. However, the 06Z TAFs are most important for planning and dispatching of aircraft.
  - Waiting for the 12Z TAF issuance to include significant anticipated changes to the forecast may cause problems. Always amend a TAF if forecast thinking changes.

- *Things NWS and CWSU offices may do*
  - Visit or contact airline meteorology and dispatch offices.
  - Meet with flying clubs.
  - Discuss NWS products, including RDF (because some planning does happen beyond 24 hours).
  - Use NWS and FAA aviation brochures.
  - Visit FSS, towers, and airport operations and invite them to visit your office. .
  - On FSS visits, ask specific questions, discuss effects of NWS directives (e.g. NWSI 10-813) and forecast philosophy.
  - Ensure CWSU and WFO representatives go on visits together, especially to towers.

Forecast Coordination

The Aviation forecast coordination process is multi-tiered and occurs both directly and indirectly.

- *Use of TAFs as guidance product*
  - AWC
    - Displays TAFs in a graphical form
    - Prevailing and temporary groups ceiling, weather/obstruction to visibilities, surface winds
    - viewable on AWC website: www.aviationweather.gov/awc/awc-taf.html
    - Used to assist the AWC forecasters in composing Area Forecasts.
    - Collaborative Convective Forecast Product (CCFP)
      - Snapshot of thunderstorm areas of 3000 sq miles or more at 2, 4, and 6 hours in the future (max tops at least 25000ft and minimum expected reflectivites of 40 dBz).
      - Thunderstorm portion of TAF weather graphics used in sketching out initial forecasts before collaboration process with CWSUs.
    - Convective SIGMETs
      - Consult TAFs to obtain a preliminary region of consideration for Convective SIGMET issuances, especially in the outlook portion of that product.

- CWSU
  - TAFs used as input into CWSU Aproducts@.
  - Center Weather Advisory (CWA)
    - The CWA is an aviation-style NOWcast that is valid for a period of two hours or less. It is often broadcast to pilots at its initial issuance and placed on selected HIWAS outlet recordings (normally on Very High Frequency Omnidirectional Range stations or non-directional beacons such that pilots can obtain information while en route).
  - Meteorological Impact Statement (MIS)
    - Contains similar information to the CWA, but for a 2 to12 hour time frame.
    - Used by the Traffic Management Unit to plan flight routes and for Severe Weather Avoidance Plans.
    - Heavily used by the Air Traffic Control Command Center to direct inter-airspace coordination efforts including ground delay programs.
  - Graphical Forecast Briefings
    - Audience of these briefings is the traffic management and supervisory personnel at the Center.
    - Presentations to FAA personnel may include satellite and radar imagery, and graphics depicting flight hazards including areas of thunderstorms, IFR flight conditions, icing, turbulence, strong winds, and low level wind shear.
  - Verbal Forecast Briefings
    - Telephone briefings to radar approach control facilities occur multiple times per day.
    - Discuss forecasts for Arrival Fixes.
      - Arrival fixes are typically 20 to 40 miles from the airport, but can be in excess of 200 miles.
  - Consultation Briefings
    - Frequent and spur-of-the-moment forecast questions asked of CWSU forecasters during active weather (generally asking for 1 to 2 hour forecast).
    - Equivalent to working severe weather at WFOs.
    - The briefed forecast may result in the holding or diversion of aircraft or aircraft may be held on the ground to avoid saturating the available airspace, should the weather preclude the use of certain navigational fixes or routes used to direct aircraft.
    - CWSU forecasters rely heavily on TAFs, especially if request relates directly to a major airport.
    - Desired response time to provide forecast information is well less than 1 minute.
    - Frequently amended TAFs are huge benefit to CWSU forecaster in these cases.

- TAFs at smaller airports also very important for Air Traffic Control planning of weather impact on overflight traffic or air traffic going by a nearby navigational fix point.
- Forecast feedback to CWSU forecaster will be made directly from the customer or user within the hour

- *Use of AWC forecasts as guidance*
  - CWSU
    - Area Forecasts used as input into:
      - Graphical Forecast Briefings
      - Verbal Forecast Briefings
      - Convective SIGMETS
      - Consultation Briefings
    - National Convective Weather Forecast (NCWF)
      Automated system that extrapolates existing convection in the short range
      - Does not currently forecast convective development.
      - Primary tool for Traffic Management Unit personnel to make short-fused decisions.
      - CWSU forecasters should monitor NCWF to ensure TMU personnel not getting mislead by false indications

  - WFO
    - NCWF and CCFP
      - May provide useful short term (0 to 6 hour) guidance for thunderstorm location and timing in areas adjacent to your county warning area.

- *Direct Coordination*
  - CWSUs and WFOs
    - Attempts should be made on both parts to coordinate during significant (to aviation interests) weather scenarios prior to TAF release.
    - CWSUs, as the situation dictates, should make calls to WFOs for information upon opening up office to assist in the self-briefing and creation of morning verbal briefings to Center personnel.
    - Collaborate on TAFs prior to issuance through use of a WRKTAF product. CWSUs may view it on the AWIPS Remote Display (ARD) from the host WFO.. Non-host WFO's may use the AWIPS Wide Area Network to send WRKTAF products to one another for collaboration.
  - CWSUs and AWC
    - CWSU forecaster should attempt to contact the AWC to coordinate CWA issuances with the Convective SIGMET forecaster in case of thunderstorms.
    - CWSU should contact AWC-s Area Forecaster for IFR conditions, icing, turbulence, or low level wind shear.

- WFOs and AWC
  - WFO forecasters should monitor Area Forecasts, SIGMETs, and AIRMETs to ensure consistency with TAFs.
  - WFOs should have AWC phone numbers at workstations. Contact AWC when TAFs are admended significantly (i.e. P6SM SCT100 to 2SM -RA BR OVC012).

Verification

- Locally track numbers that are involved with national verification goals.
  - Look at "fuel" verification scores. (2000ft CIGS and 3SM VSBY)
  - One of the few performance stats available for any program area in which numbers are directly correlated to forecast "service".

- Compute scores on a seasonal time frame.

- Real time verification - use TAFTrack - AWIPS program developed in Tulsa

- Presentation of statistics
  - Don't provide raw output without an explanation
  - Use combination of graphs and tables
  - Provide forecaster with both negative and positive comments on their performance.

- Monitor and reward ("gold star") forecasters for good individual forecasts or quarterly performance.

- Use verification as encouragement, not punishment.

Training

- Work with FSS Training officers
  - Invite them to your office for presentations on FSS activities and offer to give appropriate seasonal presentations at their facility.

- WFOs and CWSUs should develop an aviation training program checklist
  - Checklist below based upon Southern Region Aviation Training Plan

A. Technical Directives and Instructions and General Knowledge

Item/Module
NWSD 10-8 ... Aviation Policy Directive, Aviation Weather Services NWSI 10-801 ... Airport Weather Warnings NWSI 10-802 ... Aviation Weather Outreach NWSI 10-804 ... In-Flight Reports from Pilots (PIREPs) NWSI 10-805 ... Transcribed Weather Broadcasts NWSI 10-813 ... Terminal Aerodrome Forecasts NWSI 10-803 ... Support to Air Traffic Control Facilities NWSI 10-807 ... International Service Agreements NWSI 10-808 ... International Aviation In-Flight Advisories NWSI 10-809 ... Support to Federal Aviation Administration Pilot Weather Briefing Facilities NWSI 10-810 ... Domestic Products NWSI 10-811 ... International Products NWSI 10-812 ... CONUS Wind/Temperature Aloft Forecasts
NWSPD 10-20 ... Operations and Services Forensic Services NWSI 10-2001 ... Definitions NWSI 10-2002 ... Roles of Other Government Departments and Offices NWSI 10-2003 ... Records Retention NWSI 10-2004 ... Accident Notification NWSI 10-2005 ... Handling and Releasing Accident-Related Weather Information NWSI 10-2006 ... The Accident Investigation/Litigation Process
Visit a FAA Flight Service Station Visit a CWSU/ARTCC Vist AWC
Browse and become familiar with the Aviation Weather Center web site (http://aviationweather.noaa.gov/)
Browse and become familiar with the Aviation Weather Center web site (http://aviationweather.noaa.gov/)
Local WFO Station Duty Manual, appropriate sections

B. Knobology for forecasts and operations

Item/Module
WFOs - Knowledge of aviation forecast editor/monitor software (AVNFPS, Aviation Workstation)
CWSUs - Knowledge of ARD, WARP, AIS operations
WFOs Aviation Verify Program (SOOs and Aviation Focal Points) ability to start program and view output) (http://www.srh.noaa.gov/ftproot/sram/support/avnverify.html)

C. Technical Forecasting/Observations Modules

Item/Module
TAF Module, produced by NWSTC (RTM-253) (http://www.nwstc.noaa.gov/nwstrn/aviation_met.htm)
Introduction to TWEB Forecasting, produced by NWSTC (RTM-251) * (http://www.nwstc.noaa.gov/nwstrn/aviation_met.htm)
Federal Meteorological Handbook No. 1, U.S. Dept. of Commerce, NOAA, National Weather Service, (http://205.156.54.206/oso/oso1/oso12/fmh1.htm)
Pilot Reports (PIREPs) interpretation Power Point slide show, (http://www.atctraining.faa.gov/afss/FieldTraining/index.htm)
ASOS Algorithm Tutorials (http://meted.ucar.edu/export/asos/index.htm)
DLOC or Resident WSR-88D Radar Training Course (Warning Decision Making Training Branch Distance Learning Operations Course (http://www.wdtb.noaa.gov/)

D. Meteorological Training Specific to Aviation

General Weather

Item/Module
Distance Learning Aviation Course, DLAC (The time frame for completing this training will be determined after the course is developed.)
"Radiation Fog" CBL, COMET (http://meted.ucar.edu/fogstrat/ic31/ic311/index.htm)
Skew-T, Log P, NWS Training Center, Kansas City, MO, RTM-230 (http://www.nwstc.noaa.gov/nwstrn/intern.htm)
Weather Event Simulator (WES) training cases (if available and applicable)
"Model Fundamentals", COMET CBL Series on NWP (http://www.comet.ucar.edu/modules/NWP1-1.htm)
"How Models Produce Precipitation and Clouds", COMET CBL Series on NWP (http://www.comet.ucar.edu/modules/NWP1-3.htm)
"Intelligent Use of Model-Derived Products", COMET CBL Series on NWP, (http://meted.ucar.edu/nwp/pcu1/ic5/index.htm)
"Low Level Wind Shear", Robert Jackson, MIC, ZSE CWSU (http://www.wrh.noaa.gov/wrhq/training.html)

Satellite Modules

Module/Item
Satellite Meteorology: Remote Sensing Using the New GOES Imager (http://www.comet.ucar.edu/modules/SatMet1.htm)
Satellite Meteorology: Case Studies Using GOES Imager Data (http://www.comet.ucar.edu/modules/SatMet2.htm)
Satellite Meteorology: Using the GOES Sounder (http://www.comet.ucar.edu/modules/SatMet3.htm)
Polar Satellite Products for the Operational Forecaster, Module 1: POES Introduction and Background (http://meted.ucar.edu/ist/poes/)
Polar Satellite Products for the Operational Forecaster, Module 2: Microwave Products and Applications (http://meted.ucar.edu/ist/poes2/index.htm)
Polar Satellite Products for the Operational Forecaster, Module 3: Case Studies (http://www.meted.ucar.edu/ist/poes3/index.htm)
Polar Satellite Products for the Operational Forecaster, Module 4: Soundings (http://www.meted.ucar.edu/ist/poes4/index.htm)

Aircraft Icing Modules

Module/Item
Aircraft Icing (NWS Training Center, Kansas City, MO, MMFDC252)
“Forecasting Aviation Icing: The Icing Event of 6 March, 1996”, COMET CD-ROM Module, 1998.
Forecasting Aviation Icing: Icing Type and Severity (http://www.comet.ucar.edu/modules/Ice1.htm)
Forecasting Aviation Icing: Icing Assessment Using Sounding and Wind Profiles (http://www.comet.ucar.edu/modules/Ice2.htm)
Forecasting Aviation Icing: Icing Assessment Using Observations and Pilot Reports (http://www.comet.ucar.edu/modules/Ice3.htm)
Forecasting Aviation Icing: The Icing Event of 6 March 1996 (http://www.comet.ucar.edu/modules/Icecase.htm)

Resources

- NWS ER Aviation webpage - http://www.werh.noaa.gov/msd/ram/ram.htm

- NCDC world wide station climatology CD-ROM.

- Members of the ER Aviation Best Practices team are excellent contact points on their respective areas of expertise:

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