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# JP1.6 Lightning Training from the Virtual Institute for Satellite Integration Training: 1999–2001

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## 1. INTRODUCTION

In 1999 the Virtual Institute for Satellite Integration Training (VISIT) began a focused effort to provide lightning training to National Weather Service (NWS) forecasters using distance education techniques. The objective of VISIT lightning training is to teach forecasters how to integrate cloud-to-ground (CG) lightning data into the forecast process. This effort is motivated by the fact that CG lightning data was made available to forecasters only with the deployment of the Advanced Weather Interactive Processing System (AWIPS) completed in June 1999.

This article provides an overview of VISIT lightning training from 1999–2001. The VISIT program and VISITview software are described in Sec. 2. Requirements for VISIT lightning training are listed in Sec. 3. In Sec. 4 lightning teletraining sessions are summarized. In Sec. 5 on-line lightning resources are described.

## 2. THE VISIT PROGRAM AND VISITview SOFTWARE

The VISIT program was formed in 1998 as a joint effort between the NWS, the National Environmental Satellite Data and Information Service (NESDIS) and NESDIS cooperative institutes. The mission of VISIT is to accelerate the transfer of research results based on atmospheric remote sensing data into NWS operations using distance education techniques (Mostek et al. 2002). VISIT personnel comprise producers/instructors of training, software developers and program managers. VISIT training is organized into units on topics such as satellite, radar, lightning, etc. with a producer overseeing each unit (refer to the Integrated Sensor Training [IST] Professional Development Series [PDS] home page). The lead author is the producer of the unit on lightning training.

The term, virtual institute, is appropriate since producers/instructors and software developers are located at NESDIS cooperative institutes in Fort Collins, Colorado and Madison, Wisconsin[1] and at the NWS/Warning Decision Training Branch in Norman, Oklahoma. Program managers are located at the Cooperative Program for Operational Meteorology, Education and Training (COMET) in Boulder, Colorado and at NWS headquarters in Washington, D.C. The development of VISIT training also involves individuals from the greater body of the National Oceanic and Atmospheric Administration (NOAA). NOAA employees, from NWS Science and Operations Officers to NESDIS researchers, have served as producers/instructors, contributors and reviewers.

The VISIT program presented its first teletraining session in 1999 entitled, "Detecting Low-level Thunderstorm Outflow Boundaries at Night Using GOES." At the time of this writing, VISIT teletraining sessions have been presented 373 times on 25 topics. More than 6000 certificates of completion have been issued (Mostek et al. 2002). Most attendees are forecasters working at NWS Weather Forecast Offices (WFOs). Attendees also include NWS personnel from national and regional headquarters, training centers, National Centers for Environmental Prediction, Central Weather Service Units (aviation) and River Forecast Centers. Organizations from outside the NWS have participated in VISIT teletraining and include the Department of Defense, local emergency management and the media.

VISIT teletraining sessions are interactive audio-visual presentations led by producers/instructors and attended by forecasters at multiple, remote locations. Sessions comprise a conference phone call and lesson materials displayed using VISITview, a software package specially designed to link participants and mimic the AWIPS environment (Whittaker et al. 1999). VISITview allows participants to view the same lesson materials simultaneously using a player developed in Java and an Internet connection. VISITview capabilities include animations, zooming, image overlays, and fading between images. But its most important capability is drawing. Any participant can draw on the lesson materials and these annotations can be seen by all (on a computer display). The combination of drawing and conference call allows instructors and forecasters to examine meteorological information in collaboration. The success of the VISIT program is largely due to the high level of interactivity made possible with VISITview.

## 3. REQUIREMENTS FOR LIGHTNING TRAINING

In 1998 the VISIT team identified broad objectives and specific instructional components for lightning training. The objective of VISIT lightning training is to "develop an understanding of the causes of lightning and relate that understanding to the internal conditions of thunderstorm development and decay for various meteorological conditions (IST PDS home page)." This objective is met by addressing the following

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[1] Cooperative Institute for Research in the Atmosphere (CIRA) and Cooperative Institute for Meteorological Satellite Studies (CIMSS), respectively

instructional components:

- lightning detection systems
- lightning climatology
- electrification and lightning production
- lightning applications to forecasting
- application exercises (case studies)
- references and glossary

Teletraining sessions and on-line resources currently available to NWS forecasters have addressed these instructional components—as will be shown in Secs. 4–5. Future efforts are aimed at refining the understanding of thunderstorms and lightning and are described in Secs. 4–5.

## 4. LIGHTNING TELETRAINING SESSIONS

Two teletraining sessions have been offered thus far, "CONUS CG Lightning Activity" and "Lightning Meteorology I: Electrification and Lightning Activity by Storm Scale." A third teletraining session, "Lightning Meteorology II: Anomalous Lightning Activity and Advanced Electrification," is being prepared for release in late 2001. A fourth teletraining session, "Advanced CONUS CG Lightning Activity," may also be developed.

### *4.1 CONUS CG Lightning Activity*

The first teletraining session, "CONUS CG Lightning Activity," was adapted from Zajac (1998). The session was presented 20 times from July 1999–January 2000. Various groups in NOAA attended these 20 sessions including over half of the 115 WFOs in the contiguous United States (or CONUS). 61 WFOs attended the session. Certificates of completion were issued to 283 forecasters. Summarized below are the objectives of the session and post-session evaluations.

The broad objective of CONUS CG Lightning Activity is to show that the distribution of CG lightning over the CONUS is consistent with our understanding of convection. Specific objectives are:

- to review national and regional lightning studies. Emphasis is placed on regional studies since they often document important mesoscale variations in lightning activity.
- to discuss the operations and performance of the National Lightning Detection Network (NLDN). NLDN performance is not homogeneous over the CONUS. Detection efficiencies are lower and location errors are greater along the southern tier states and Atlantic and Pacific coasts.
- to examine the spatial, annual and summertime diurnal distributions of CG lightning over the CONUS and the County Warning Areas of participating WFOs (special plots were created for each office).
  - spatial distributions indicate that factors such as coastlines, topography and proximity to moisture sources control the occurrence of CG lightning. Prominent maxima in CG lightning activity are observed along coastal areas in the southeast and over the southern Rocky Mountains and adjacent High Plains.
  - annual distributions show that the majority of CG lightning occurs during June–August with exceptions of the south-central U.S. (where lightning activity occurs year-round and is often suppressed during mid-summer), intermountain West (where lightning activity peaks during July–September) and Pacific coast (where cold season lightning dominates).
  - summertime diurnal distributions show that CG lightning activity peaks in the afternoon to early evening over most of the western and eastern U.S. The diurnal peak is most pronounced along coastal areas in the southeast and over mountainous areas in the West. Over the central U.S. lightning activity transitions to a weak nighttime maximum over the eastern Great Plains and upper Midwest.

Following the training session, a 15-point evaluation form was sent to all attendees. 90 forms have been returned. In response to the statement, "on the whole, I thought the lesson was a good learning experience," 85% responded agree or strongly agree, 11% responded indifferent and 4% responded disagree or strongly disagree.

### *4.2 Lightning Meteorology I*

The second teletraining session, "Lightning Meteorology I: Electrification and Lightning Activity by Storm Scale," was developed by Bard Zajac and John Weaver and applies to 80–90% of the isolated storms and mesoscale convective systems that occur during the warm season. The session was presented 29 times from January–September 2001 and is still being offered. Various groups in NOAA attended these 29 sessions including 76 WFOs. Certificates of completion have been issued to 526 forecasters. The objectives of the session and post-session evaluations are summarized below.

The broad objective of Lightning Meteorology I is to develop proper methods for interpreting CG lightning data. This objective is accomplished using a mix of theory and AWIPS case studies. Specific objectives are:

- to gain a basic understanding of the ice-ice collisional charging mechanism.
- to identify thresholds in radar reflectivity and cloud top temperature associated with CG lightning.
- to know the charge distributions in thunderstorms and their effect on the timing, location and frequency of –CGs and +CGs.
- to infer precipitation location and intensity (both convective and stratiform) and storm lifecycle using –CGs and +CGs.
- to integrate lightning data with sounding, satellite and radar data

As with the first teletraining session, evaluation forms were sent to all attendees. 232 forms have been returned. In response to the statement, "overall, the session was a good learning experience," 96% responded agree or strongly agree, 3% responded indifferent and 1% responded disagree. No responses of strongly disagree were recorded.

The reader is referred to Zajac and Weaver (2002) for a full description of the Lightning Meteorology I teletraining session.

### *4.3 Lightning Meteorology II*

The third lightning training session, "Lightning Meteorology II: Anomalous Lightning Activity and Advanced Electrification," is being developed by Bard Zajac and John Weaver for release in late 2001.

The broad objective of Lightning Meteorology II is to highlight storms that do not conform to the conceptual models and observations examined in Lightning Meteorology I. Several AWIPS case studies will be presented to show anomalous lightning activity and advanced theories will be offered for explanation. Specific objectives are:

- to know the spatial distribution of severe storms classified as negative strike dominated (NSD) or positive strike dominated (PSD)
- to understand why more intense storms do not necessarily produce more CG lightning
- to observe CG lightning pulsing in severe NSD storms
- to observe severe PSD storms and severe storms that transition between NSD and PSD modes during the mature phase
- to mention other anomalies including winter storms and small cumulonimbus

Ongoing session development is focusing on the relationship between severe PSD storms and the dryline since previous studies suggest a relationship between CG lightning polarity and surface moisture (e.g., Zajac and Rutledge 2001). The mesoscale, synoptic and vertical distributions of moisture in dryline environments are being examined. Moisture at mid-levels is of particular interest since it can affect cloud liquid water, a factor known to control the polarity of charge transfer during ice-ice collisions (Zajac and Weaver 2002). The role of aerosols cannot be ruled out due to effects on microphysics (e.g., Danielsen 1975) and CG lightning polarity (e.g., Lyons 1998).

### *4.4 Advanced CONUS CG Lightning Activity*

The first teletraining session, "CONUS CG Lightning Activity," is based on Zajac (1998), which analyzed three years of data at 100-km spatial resolution. In the session, no distinctions were made between +CGs and –CGs.

It may be worthwhile to update this session to include results from Zajac and Rutledge (2001) and results on +CGs and –CGs. Zajac and Rutledge (2001) contains a five-year analysis performed at 20-km spatial resolution. Results from this research depict finer scale variations in CG lightning activity that could be useful to forecasters. Information on +CGs and –CGs could also be valuable to forecasters now that they have a solid understand of CG lightning polarity.

## 5. ON-LINE LIGHTNING RESOURCES

The VISIT home page contains links to student guides for each VISIT teletraining session. Student guides contain summary information and provide access to VISITview and web-based versions of the sessions.

The VISIT home page also contains links to two lightning resources, "VISIT Lightning Links" and "VISIT Lightning Dialog." VISIT Lightning Links contains many web sites with information on forecast utility, real-time observations, short-term forecasts, research, field programs, detection systems, safety, etc. VISIT Lightning Dialog is a forum for interaction between operational and research meteorologists. Most dialog follows from lightning teletraining sessions.

The VISIT home page is located at www.cira.colostate.edu/visit

## 6. CONCLUSIONS

VISIT teletraining sessions and on-line resources provide NWS forecasters with a wealth of information on lightning meteorology and forecast applications. Efforts to date have exposed forecasters to well-accepted information about thunderstorms and lightning. Continuing efforts will bring forecasters closer to the boundaries of research and knowledge. The interested reader is encouraged to check the VISIT home page occasionally for developments.

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