5.2 IDV PERSPECTIVE: CLIMATOLOGY OF THE 2005 HURRICANE SEASON

Shelley O. Holmberg*
University of North Carolina at Charlotte, Charlotte, NC

Brian J. Etherton
University of North Carolina at Charlotte, Charlotte, NC

Jeff Weber
Unidata Program Center, Boulder, CO

1. INTRODUCTION

Instead of just looking at data sets, what if students could interact with them? The Integrated Data Viewer (IDV) is a program under development that allows students to gain a multi-dimensional perspective of the atmosphere, and thus atmospheric processes, with the ability to probe the data and manipulate the data display. IDV is able to display an interchangeable variety of data overlays to illustrate atmospheric processes of interest. Such data includes: satellite imagery; surface observations; radiosonde balloon soundings; NWS WSR-88D Level II and III RADAR data; NOAA National Profiler Network data; and gridded data. Gridded data includes numerical weather prediction model output from the National Centers for Environmental Prediction's (NCEP) North American Mesoscale (NAM), Global Forecast System (GFS), and Rapid Update Cycle (RUC) models. Data from these sources is viewable in two and three dimensions. IDV contains several useful formulas to enable the user to derive unavailable variables, such as wind shear vectors, speed from 2 components, flow vectors from u and v, simple time differences, etc. The user is also allowed to create new formulas not included within the program. Through the multiple capabilities of IDV, the student user is able to interact with two and three-dimensional data sets by probing the data and creating cross-sections, profiles, animations and value read-outs. (IDV User's Guide)

An interactive, educational "2005 Atlantic Tropical Cyclone Season" module is being built using IDV to illustrate which climatological processes were present to force the unusually active season. This module offers a climatic perspective on the extremely active season by using IDV overlays of certain climatological parameters and synoptic features. It is possible to infer climatic forcing on decadal and interannual timescales, by comparing the 2005 data overlays of the prevalent conditions, to those of the climatic average, since 1971.

* *Corresponding Author Address:* Shelley O. Holmberg, University of North Carolina at Charlotte, Department of Earth Sciences, Charlotte, NC 28223-0001; email: soholmbe@uncc.edu

2. DATA

2.1. *IDV Supported Data Format*

ADDE (Abstract Data Distribution Enterprise) servers and THREDDS (Thematic Real-time Environmental Distributed Data Services) catalogs, through OPeNDAP (Open-source Project for the Network Data Access Protocol), provide data in IDV supported formats. This allows for a variety of disparate data sets to be incorporated into one view using the IDV client. Connection with ADDE servers, maintained by Unidata, supplies real-time and archived atmospheric data, such as satellite, Level III radar, and sounding data. Stored gridded and NEXRAD radar data can be accessed from THREDDS catalogs, using the OPeNDAP protocol. Data sets can also be accessed by IDV through local files and http sources.

2.2. *Data Sources*

Real time data is readily accessible through IDV, in a rotating one-week archive, in the form of satellite imagery, gridded data, NWS radar (level II and III) data, point surface observations, RAOB soundings, and NOAA profiler data. GIS data, accessible through local files, and Quicktime movies are also IDV supported data sources.

Reanalysis data, available through NCEP, NCDC, NOAA, etc., are also available in IDV supported formats. These sources provide access to climatological data, as is used in the "2005 Atlantic Tropical Cyclone Season" module. However, limited availability of some types of data, such as raw satellite and radar data, restricts the possible data displays.

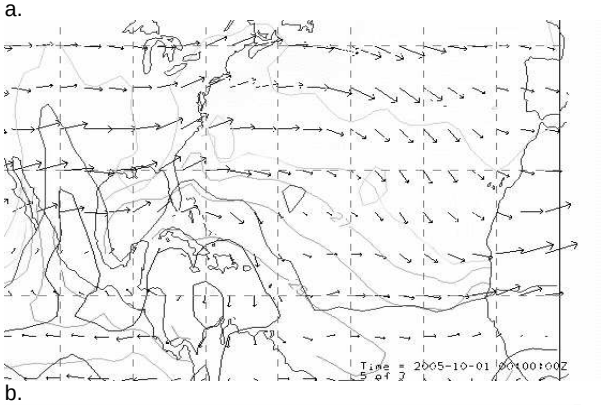
3. METHODS

In IDV, a user is able to save all current data displays, including data sources, data fields, views, times, etc. into a data "bundle." By saving this bundle the user is able to return to that exact view at any future time, as well as export that bundle so that it may be accessed by others. The "2005 Atlantic Tropical Cyclone Season" module was constructed by saving bundles of pertinent reanalysis data, such as sea surface temperatures, humidity data, wind, pressure, and vorticity fields. This 2005 reanalysis data was compared to the climatic average (since 1971), and the resulting anomalies, or departures from that climatic average.

Of the various display options possible through IDV, the 2 Pane Map Display Window was the most illustrative for the side-by-side comparison of the 2005

conditions and climatic average (since 1971) conditions, see Figure 1.

a.



b.

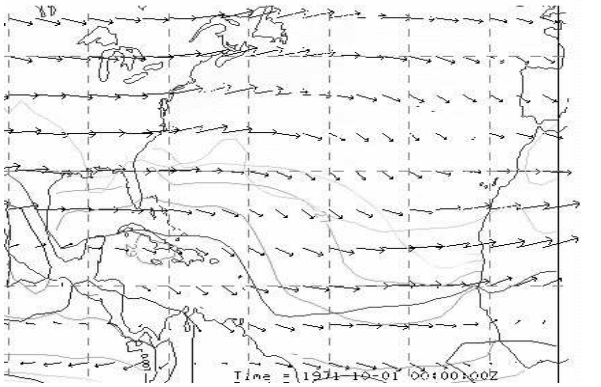


Figure 1. Illustrated above are the more favorable specific humidity (thick contours), sea surface temperatures (thin contours), and vertical wind shear (vectors) conditions present in (a) October 2005, than the (b) climatic average since 1971 for October.

4. BUNDLE ANALYSIS

By using IDV, the major conditions necessary for tropical cyclone genesis and maintenance (increased sea surface temperatures, lowered wind shear, increased thermodynamic instability, and a more moist mid-troposphere) prove to be more favorable in 2005 than the aforementioned climatic average. It can also be inferred and illustrated within IDV, that the Atlantic Multi-Decadal Oscillation (AMO) and Inter-Annual Variability played a role in the increased activity of the 2005 Atlantic Ocean tropical cyclone season. The AMO is caused by an increased flow of warm equatorial waters pole ward, which will result in a greater extent of warmer sea surface temperatures. An active AMO will also result in: lower surface pressure; higher pressure aloft; more favorable African Easterly Jet; westward expansion of upper level easterlies; weaker Easterly trade winds (which carries the Saharan Air Layer); and resultant weaker vertical wind shear (Goldenberg). The presence of Inter-Annual Variability is apparent in the approximately ten day periods with formation of multiple tropical cyclones (most notably 22 August through 6 September, Tropical Storm Jose through Hurricane Ophelia), followed by weeks with little or no tropical cyclogenesis (Marks 649-650).

5. EDUCATIONAL VALUE

With the “2005 Atlantic Tropical Cyclone Season” module, the student has an opportunity to explore, and determine, the amount of forcing exerted by the anomalous environment on the frequency and severity of Atlantic tropical cyclones in 2005. When used as an educational tool, the “2005 Atlantic Tropical Cyclone Season” module will lead to a better understanding of the climate forcing mechanisms present in that unprecedented season. The student can then apply the knowledge gained while navigating this module to current, individual tropical cyclones, or entire seasons. The “2005 Atlantic Tropical Cyclone Season” module enables the student to better understand and recognize climate patterns (similar to those present in 2005), and their implications in tropical cyclogenesis and maintenance. The additional use of multi-media COMET (Co-operative Program for Operational Meteorology, Education, and Training) modules enhances the educational aspect of this case study and makes for a richer learning experience. This module’s capabilities enable educators to reach a wide range of students, though it targets upper level meteorology undergraduates.

Through IDV, student users are able to manipulate data combinations by creating/using bundles of pertinent data and then making cross sections, soundings, and probing that data. The use of real data, as opposed to cartoon-like over simplifications, to analyze these connections will more accurately illustrate natural atmospheric processes. When used in as educational tool, IDV can better prepare students entering the atmospheric science career field.

6. FUTURE WORK

The “2005 Atlantic Tropical Cyclone Season” module is only the first of several educational modules to be produced using IDV. A “Hurricane Katrina” module will cover the factors that contributed to the vast magnitude of societal impacts and resultant catastrophe on the Gulf Coast. A “Hurricane Wilma” module, will utilize the predominant and relevant meteorological and oceanographic features to illustrate the formation of the most intense hurricane on record in the Atlantic basin. These two additional modules, along with the “2005 Atlantic Tropical Cyclone Season” module, will be able to reach, and educate, across a broad spectrum of IDV.

7. References

Goldenberg, S.B., C.W. Landsea, A.M. Mestas-Nuñez and W.M. Gray, 2001: The recent increase in Atlantic hurricane activity : Causes and implications. Science, 293(5529): 474-479.

Marks, Frank, D., Jr., 2003: Hurricanes. *Handbook of Weather, Climate, and Water: Dynamics, Climate, Physical Meteorology, Weather Systems, and Measurements,* Editors: Thomas D. Potter and Bradley R. Colman. John Wiley & Sons, 641-675.

Unidata Program Center, IDV Users Guide, Version 2.0, July 7, 2006.