

11.4 METEOFORUM – INITIAL SUCCESSES IN DATA SHARING LEADING TO THE CREATION OF THE IDD-BRAZIL

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1. INTRODUCTION

MeteoForum is a pilot project that is being developed jointly by the COMET[®] and Unidata programs of the University Corporation for Atmospheric Research (UCAR) using funds provided by the director of the UCAR Office of Programs (UOP) (Spangler, Fulker, 2001). **MeteoForum** is composed of an international network of World Meteorological Organization (WMO) Region III and IV Regional Meteorological Training Centers (RMTCs) working collaboratively with universities to enhance their roles of training and education through information technologies and multilingual collections of resources.

This paper gives an overview of Unidata's efforts to facilitate access to a broad spectrum of data and the establishment of a data relay network to service RMTCs in Brazil, Argentina, and beyond.

2. METEOFORUM VISION

MeteoForum is designed to assist RMTCs to improve service in the areas of hydrometeorology, agriculture, and disaster management. By accessing a comprehensive collection of training materials, software, and real-time and historical data, the RMTCs will be able to enrich the education they offer to hydro-meteorological professionals in their region.

MeteoForum will build a stronger sense of "community" among the RMTCs through Internet-based interactions and through the sharing of educational concepts, educational materials, and real-time hydro-meteorological data with one another and with affiliated universities.

MeteoForum represents collaboration among the participating RMTCs, COMET, and Unidata.

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As enumerated elsewhere (Laing, *et. al.*, 2002), each participant is expected to play an active role.

2.1 COMET's Role

To enhance learning and promote the sharing of educational materials, COMET will:

- Maintain the **MeteoForum** collection of educational materials constructed initially from COMET's freely-available on-line educational modules and courses
- Work with **MeteoForum** member institutions to create new materials or translate existing COMET materials as needed
- Create and maintain a multilingual web site, <http://www.meteoforum.ucar.edu>, that provides free access to the **MeteoForum** collection
- Seek funding in collaboration with **MeteoForum** participants to develop new educational materials aimed at Region III and IV needs for forecast improvement, hazard mitigation, economic enhancement, etc.

2.2 Unidata's Role

Unidata's role in **MeteoForum** is particularly well aligned with its primary mission, the provision of:

Data, tools, and community leadership for enhanced Earth-system education and research

Unidata will conduct the following activities in **MeteoForum**:

- Facilitate data access to a broad spectrum of observations and forecasts
- Coordinate a data-relay network that collects and distributes data in real-time at no cost to educators and researchers

- Build a community where data, tools, and best practices in education and research are shared
- Support faculty at colleges and universities in the use of Unidata systems

2.3 MeteoForum RMTCs Roles

MeteoForum RMTc participants are responsible for:

- Acquiring appropriate computer hardware and Internet access
- Working with Unidata and COMET to train local personnel in the use of **MeteoForum** resources
- Supplementing current curricula with real-time data and interactive multimedia materials
- Developing new curricula or curriculum elements and share them with other **MeteoForum** members

3. INTERNATIONAL DATA RELAY TESTING BEGINS

Since its inauguration in 2001, **MeteoForum** has grown to include all RMTCs in WMO Regions III (South America) and IV (North America). Each of these RMTCs is collocated or closely aligned with prominent national universities:

Argentina	Universidad de Buenos Aires (UBA)
Barbados	University of the West Indies (UWI)
Brazil	Universidade Federal do Pará (UFPA)
Costa Rica	Universidad de Costa Rica (UCR)
Venezuela	Universidad Central de Venezuela (UCV)

During the January, 2002 AMS meeting, RMTc representatives participated in an organizing meeting to become familiar with each other, relate particulars about activities at their site, and learn more about offerings being made available by COMET and Unidata. Following the meeting, surveys of each RMTc's computing and network resources were conducted and tests of network capacities were made. These tests benchmarked each site's ability to receive real-time data feeds from the Unidata Internet Data Distribution (IDD, Domenico, *et. al.*, 1994, Davis and Rew, 1994) system, a network of over 100 North American institutions that cooperate in the sharing of real-time meteorological data. Site visits were then made to the RMTCs in Brazil and Argentina to better understand their operations and to establish real-time data delivery procedures.

In August, 2002, real-time feeds of global observations and GOES-East satellite image sectors to the Brazilian RMTc initiated the field testing of **MeteoForum** data delivery. Results reinforced previous observations (Chiswell, 2001) that the data

delivery engine behind the IDD, the LDM-5, was inefficient when relaying data to machines that are electronically distant. Counter-intuitively, relaying data to a sequence of intermediate hosts actually improved the end-to-end performance of the IDD.

Lessons learned in the UFPA data relay tests were combined with parallel efforts at the Universidade Federal do Rio de Janeiro (UFRJ), the Hong Kong University of Science and Technology, and at the University of Melbourne (Melbourne, Victoria, Australia) in the redesign of the LDM at Unidata. These efforts resulted in a next-generation LDM, the LDM-6 (Emmerson, 2003), that is able to relay substantial volumes of data to both local and remote sites with little to no latency. Recent stress testing at Unidata has demonstrated that the LDM-6 is capable of routinely relaying in excess of 1.5 terabytes of data per day *without* introduction of product latencies.

4. NETWORK INFRASTRUCTURE IS CRUCIAL

An element critical to the success of real-time data delivery is the availability of good-quality, high-speed networking at participating institutions. High speed Internet-2 (I2) interconnects between Brazil and the US have been made possible by connectivity provided by Brazil's Rede Nacional de Ensino e Pesquisa (RNP) and the Academic Network at São Paulo (ANSP) through the NSF-funded America Pathways (AMPATH) project of Florida International University (FIU) and Global Crossing.

Since one of the I2 Brazil landings (connection points) is housed in Rio de Janeiro, and since the UFRJ had independently begun ingesting data as a Unidata IDD leaf node, we proposed the establishment of the UFRJ as a top level IDD relay node initially for Brazil and the UBA in Argentina and then throughout South America (Yoksas, Garrana, 2002). The UFRJ expressed an eagerness to act in this role on behalf of their fellow South America institutions by not only relaying data, but also by improving departmental networking/computing infrastructure if and when needed. This promise was recently fulfilled by the installation of a dedicated IDD relay node in a 24x7 facility on the UFRJ campus.

5. INAUGURATION OF THE IDD-BRAZIL

Two different efforts have made it possible to move substantial volumes of data to remote IDD nodes like those in Brazil:

- Brazil's connection to Internet-2 through the **AMPATH** project

- the modernization of Unidata's LDM to Version 6

The combination of these two advances allows Unidata universities participating in the IDD to relay substantial volumes of data to the UFRJ, including high resolution NCEP model output (the IDD **CONDUIT** and **HRS** streams), high resolution GOES-12 satellite imagery (the IDD **UNIWISC** stream), and global observational data (the IDD **IDS|DDPLUS** stream) with very low latencies (typically one to a small number of seconds). Data transfer tests conducted in late October, 2003 between top-level, US IDD relay nodes and the UFRJ demonstrated the capability of relaying up to 2.7 gigabytes per hour with no introduction of product latency.

The first institution to receive data relayed by the UFRJ was the UFPA and its associated RMTC. At the time this paper was being prepared, a representative of the Centro de Previsão de Tempo e Estudos Climáticos (CPTEC, <http://www.cptec.inpe.br>) expressed interest in actively participating in data relay tests from the UFRJ. Other Brazilian universities canvassed by the UFRJ have also expressed strong interest in participating in these tests. We have named this incipient South American data distribution effort the **IDD-Brazil**.

Efforts aimed at broadening participation in the **IDD-Brazil** are currently underway. One co-author, Mr. David Garrana Coelho has been promoting the benefits of participating in the **IDD-Brazil** and in the usefulness of Unidata display and analysis systems in discussions with various Brazilian universities. He also plans to submit a paper on the **IDD-Brazil** at next year's Brazilian Congress of Meteorology. In the summer of 2003, another co-author, Dr. Elen Cutrim, a professor at Western Michigan University, member of the Unidata Users Committee, and former department chair and WMO RMTC head at the UFPA, visited Brazilian universities to promote the use of various Unidata offerings like real-time data delivered by the IDD and data analysis and display using the Unidata-developed Integrated Data Viewer (IDV).

6. COMMUNITY BUILDING BY SHARING DATA

The existing Unidata community has grown into the vital entity that it is through a variety of efforts spearheaded by the NSF-sponsored UCAR office of Programs Unidata project:

- Establishment of an easy-to-use data distribution network that provides access to a wide variety of real-time, atmospheric science-related datasets
- Provision of data analysis tools and high quality support services for those tools
- Encouraging of active participation through community-based governance and guidance

The same community building approach will be extended to research and education institutions first in Brazil and eventually throughout WMO Regions III and IV. The establishment of the **IDD-Brazil** represents the first step in this community building process.

The need for full and open international exchange of environmental data has been articulated in many documents. In order to understand the myriad complexities of the earth system and the way the different elements interact, it is crucial to collect, share and analyze environmental data from all parts of the world.

The Unidata community recognizes the importance of access to environmental data from other countries, particularly those in the southern hemisphere, to enhance education and research capabilities toward studying global problems like climate change, ozone depletion, and ENSO. A critical requirement for such research studies is the acquisition and assimilation of a complete spectrum of global meteorological, oceanographic and hydrological observations.

The second phase in **MeteoForum** community building activities will be encouraging the sharing of locally held datasets with research and education colleagues throughout the extended Unidata community. Dr. Cutrim is compiling an inventory of Brazilian datasets that university investigators will be willing to share with their Brazilian counterparts and North American universities. Datasets that are being investigated include local radar data from Amazonia, and long term rain gauge records from the UFPA. Discussions are also being held with other Brazilian institutions (e. g., CPTEC) to get access to meteorological and hydro meteorological observations that are not currently available on the Global Telecommunication System (GTS).

7. METEOFORUM COMMUNITY EXTENSION

In parallel with the establishment of the **IDD-Brazil**, Unidata approached the University of Puerto Rico at Mayaguez (UPRM) to enlist their help in relaying data to Caribbean and Central American universities. Like

the UFRJ, UPRM was enthusiastic about playing an expanded role in the Unidata IDD. The UPRM has only been able to assume this role after their networking access was modernized by Puerto Rico's connection to Internet-2 through the **AMPATH** initiative. The Universidad Central de Venezuela (UCV) has also recently become connected to I2 through **AMPATH**, so it should also be able to actively participate in **MeteoForum** data relay activities.

The ability and, therefore, willingness of both the UFRJ and the UPRM to more actively participate in the Unidata IDD were direct results of their connections to Internet-2. Not all Region III and IV RMTTC-affiliated universities affiliated, however, are as fortunate as these institutions.

The Universidad de Buenos Aires in Buenos Aires, Argentina has long suffered from both poor connections to the global Internet and from substandard, in-house network infrastructure. Recently, however, access to Internet-2 has been attained and funding for upgrading in-house networking has been secured.

The University of Costa Rica (UCR) is currently unable to participate in the Unidata IDD, even as a receive-only node. Though networking infrastructure upgrades within Costa Rica have allowed four universities to be able to intercommunicate at substantial speeds, a reliable, high-speed connection to the global Internet still does not exist. Like at the UPRM and the UCV, the situation at UCR would improve dramatically if Costa Rica were to connect to I2 through programs like **AMPATH** (Preston, 2003, Ibarra, 2003). Until this comes to pass, **MeteoForum** is assisting the UCR gain access to real-time global observational data by installing a Unidata-developed NOAAPORT reception system.

The RMTTC in Barbados is in a similar position to its counterpart in Costa Rica. Their ability to participate in the Unidata IDD is limited by their exceedingly poor connection to the global Internet (currently, they use a dedicated 64 kilobit line). Their situation is somewhat different, however, in that there is an existing high-speed internet connection to Barbados through the commercial firm, Cable and Wireless. The problem in connecting to that service is the high cost for speed internet service in Barbados.

8. METEOFORUM DATA DISTRIBUTION PLANS

Unidata will continue to play an active role in establishing a robust IDD relay node for South

America at the UFRJ. We also intend to investigate the establishment of an **IDD-Caribbean** by assisting, through information sharing and advocacy, universities and their associated RMTTCs in establishing reliable networking at their sites. This effort parallels services we undertake for US university sites.

9. REFERENCES

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