MeteoForum
An International Network of Meteorological Training Centers for the 21st Century

presented by

Tom Yoksas
Unidata

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COMET®

UCAR, Unidata, and COMET Missions

- *University Corporation for Atmospheric Research* is a nonprofit consortium of 66 universities, committed to advance understanding of the atmosphere & other Earth systems

- *COMET* is funded primarily by the U.S. National Weather Service to enhance the knowledge & skills of forecasters & forecast users

- *Unidata* is funded primarily by the U.S. National Science Foundation to help universities acquire, display, and analyze Earth-system data

MeteoForum
A Pilot Project
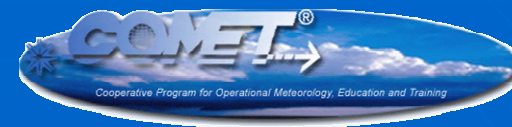
- Developed jointly by two UCAR Programs
  - *COMET*
  - *Unidata*

- Collaboration with WMO Region III & IV Regional Meteorological Training Centers (RMTCs)

- Funded by UCAR Office of Program (UOP) Director's opportunity funds

MeteoForum RMTC Participants

Universidade Federal do Pará

Universidad de Buenos Aires

Universidad de Costa Rica

Caribbean Institute for Meteorology and Hydrology

Universidad Central de Venezuela

MeteoForum Concept

Use the Internet to strengthen RMTCs by:

- Enabling free access to:
  - *Rich data resources*
    - Real-time flows of observations & model outputs
    - Case-studies with comprehensive data sets
    - Remotely-sensed data including satellite imagery
    - Climate records...
  - *Software for data display & analysis*
  - *Training & reference materials, on Web or CD*
- Promoting coordination among RMTCs, universities, and national meteorological services

MeteoForum Benefits

- **RMTCs will**
  - *Gain capabilities that enhance student learning about present/future observing systems & models*
  - *Gain strength to undertake new missions*
    - Seasonal and inter-annual forecasting
    - The economic impacts of weather
    - Environmental decision support
  - *"Own" MeteoForum by exchanging educational materials, ideas, & data--freely & openly*
- **NMS workforces will be prepared for impending change & greater prominence**

MeteoForum - COMET's Role

- Maintain the MeteoForum collection of educational materials

- Work with member institutions to create new materials or translate existing COMET materials as needed

- Seek funding in collaboration with RMTC participants to develop new educational materials

- Create and maintain a multilingual web site

MeteoForum – Unidata's Role

- Facilitate data access to a broad spectrum of observations and forecasts
- Coordinate a data-relay network that collects and disseminates data in real-time
- Support faculty at RMTC-associated colleges and universities in the use of Unidata systems
- Build a community where data, tools, and best practices in education and research are shared

MeteoForum – RMTCs Role
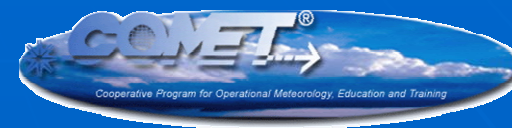
- Acquire appropriate computer hardware and Internet access

- Work with Unidata and COMET to train local personnel in use of MeteoForum resources

- Supplement current curricula with real-time data and interactive media materials

- Develop new curricula or curriculum elements and share them with other MeteoForum members

- Share locally held datasets of interest with other MeteoForum members

Unidata Program Center:
Principle activities being made available in MeteoForum

- Facilitate Data Access to a broad spectrum of observations & forecasts (most in real time)

- Provide Tools to visualize, analyze, organize, receive, & share data

- Support Faculty who use Unidata systems at RMTCs and associated universities

- Help Build a Community where data, tools, & best practices in education/research are shared

At Unidata Tools Are Central

- Unidata offers software developed by others
  - *Meteorological display and analysis tools from U of WI (McIDAS), National Weather Service (GEMPAK), & others*
  - *OPeNDAP/DODS (U of RI) (THREDDS server component)*

- Unidata develops software internally
  - *Widely used tools for managing scientific data (e.g., LDM, netCDF, THREDDS)*
  - *Java-based tools (IDV Framework built on top of VisAD) for 3-D visualization and next-generation, collaborative data analysis*

- Unidata <u>supports</u> software by offering training, consultation, bug fixes, enhancements, and upgrades

Internet Data Distribution
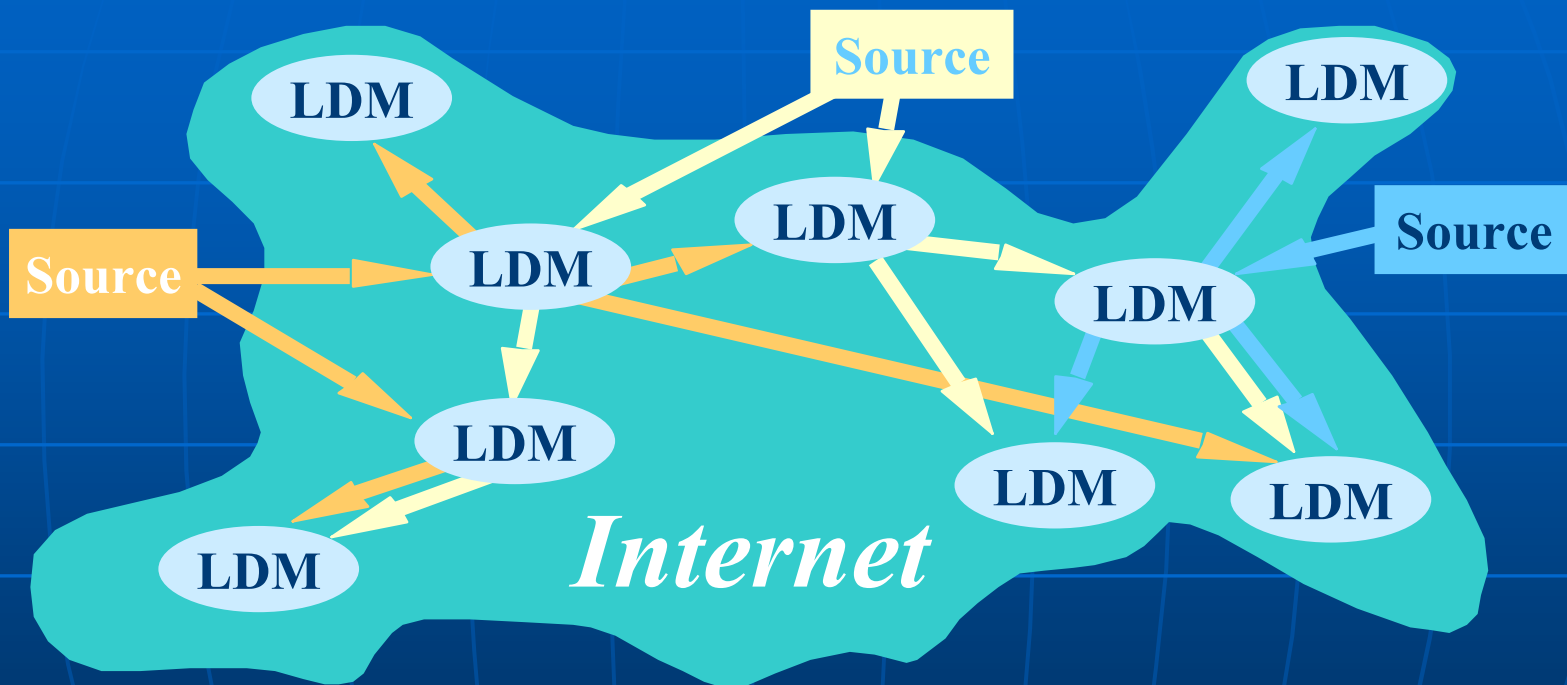
Using LDM software for <u>relaying data</u>, some 160 Unidata universities cooperate to acquire real-time, global, atmospheric & oceanic observations, model outputs, remotely sensed images, etc. This is possible through coordinated <u>community effort.</u>

South America Data Relay Inauguration
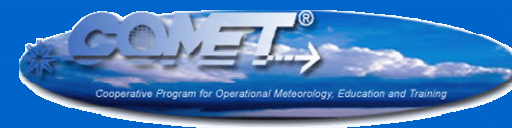
- Spangler & Yoksas visit S.A. RMTCs in July 2002
  - *Universidade Federal do Pará (UFPA), Belem Brazil*
  - *Universidad de Buenos Aires (UBA)*
  - *National Meteorological Service, Buenos Aires Argentina*
- UFPA Vice-Chancellor meets with Spangler
  - *Discussed MeteoForum objectives*
  - *Met with university's networking director to discuss needed infrastructure improvements*
    - UFPA's 6 Mbps Internet pipe set by use; if demand increases, bandwidth will be increased by the Brazil's National Education and Research Network authority (RNP) for *no charge*
    - "We can create the demand this afternoon"
- LDM-5 and McIDAS-X installed at UFPA
- Test ingest of global GTS observations, NCEP model output, and GOES-East imagery

UFPA Data Relay Results
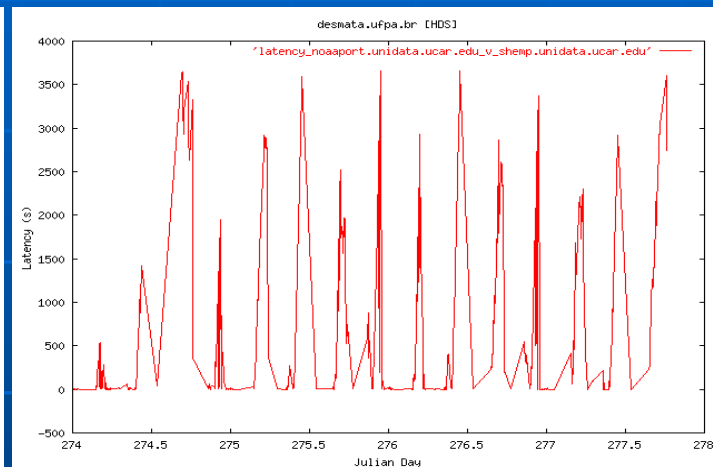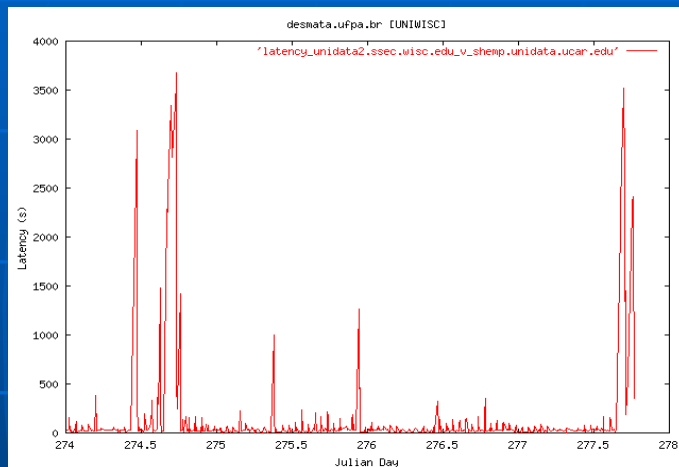
- Internet connectivity at UFPA found to be reliable but not spectacular
- Data delivery functional, but disappointing
- Data latency a function of data stream volume

LDM-5 Deficiencies

- Originally developed in era of low data volumes
- Data delivery guaranteed by use of blocking RPCs
- Large products segmented into 16 KB chunks
- Did not take advantage of TCP's guaranteed delivery

- Performance over unreliable connection limited by inherent receive-timeouts of RPCs
- Relay faster with intermediate nodes

LDM-6 Modernization
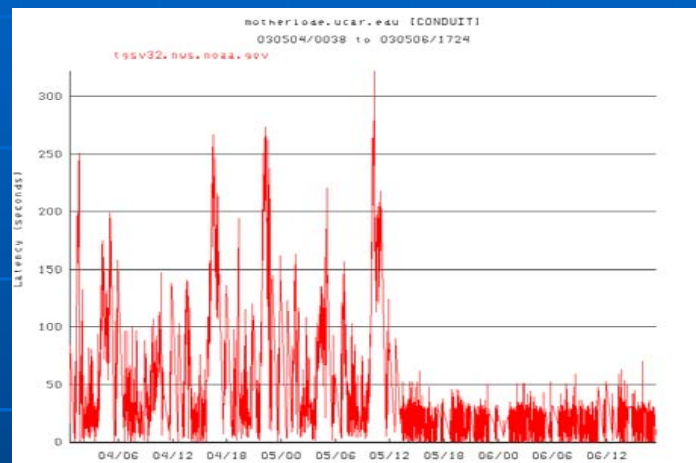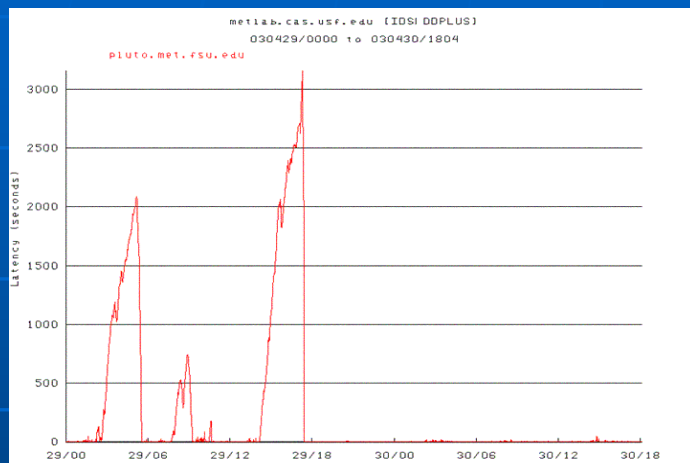
- Use TCP guaranteed delivery instead of RPCs
- User-selectable product "chunking"
- Code cleanup for greater efficiency
- Evolution of real-time statistics gathering and display

MeteoForum – A Good Match for AMPATH and CLARA

MeteoForum Network

AMPATH

CLARA
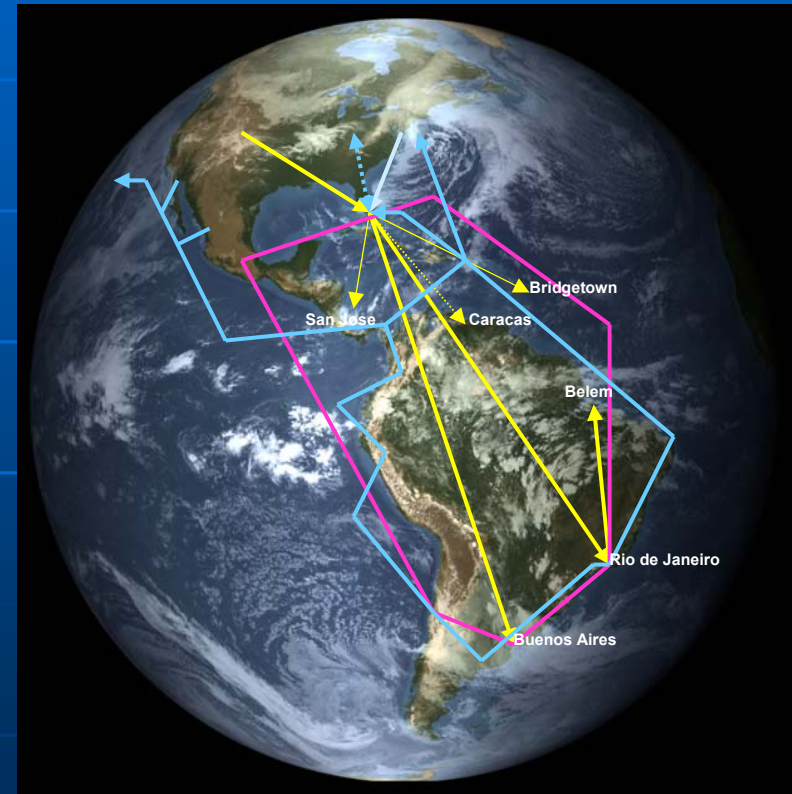
Building a South American Data Relay Network - 1
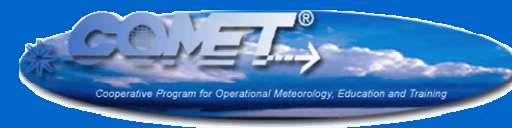
- Internet2 and RNP connections on UFRJ campus in Rio de Janeiro
- Contacted UFRJ to propose establishment of top-level relay node for Brazil
  - *Enthusiastic acceptance*
  - *Procured new computing resources to further project*
  - *Dedicated personnel time to make things work*
  - *Located relay node in 24x7 Network Operations Center*
  - *Performing outreach to Brazilian education and research institutions*
- Jointly established principles of *IDD-Brazil* based on Unidata IDD

IDD-Brazil Relay Sites - UFRJ

IDD-Brazil - Stress Testing
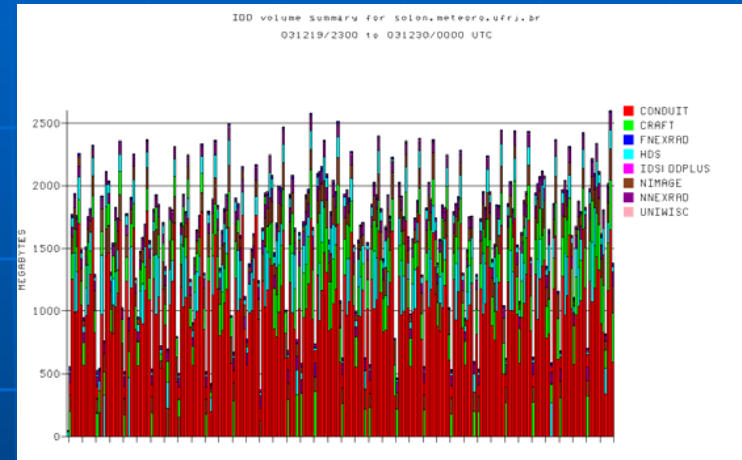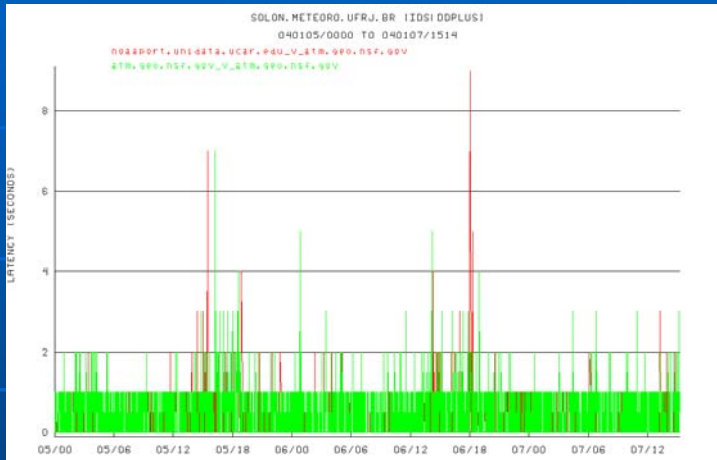
IDD relay of all open feeds to UFRJ

- *Sustained 1.6 GB/hr over 10 day period at end of December*
- *Peak rates routinely over 2.3 GB/hr over same period*
- *Typical latencies range from 1 to several seconds*
- *Impact on relay machine negligible*

IDD-Brazil - Participation Expands

- Waldenio Gambi de Almeida
  - *CPTEC/INPE data section*
  - *Attended Unidata Fall 2003 training workshop series*
  - *Leading CPTEC data outreach to educational and research sites*

- Elen Cutrim
  - *Joined Unidata Users Committee member*
  - *Long time Unidata participant at Western Michigan*
  - *Former head of UFPA atmospheric science department*
  - *Former head of UFPA RMTC*

Building a South American Data Relay Network - 2

- Training on Unidata LDM
  - *Gambi (CPTEC/INPE) attends Unidata Fall 2003 workshop*
  - *Garrana (UFRJ) collaborates via email*
- Cooperation established between UFRJ and CPTEC; data flows begin
- CPTEC outreach to Brazilian institutions recruits USP as IDD leaf node
- Sharing of model forecast and mesonet station observations with USP as proof of concept
- Data begins flowing from UFRJ to UFPA

IDD-Brazil Relay Sites - CPTEC

IDD-Brazil Connects to Unidata IDD

- Current Participants
  - *NSF/ATM*
  - *University of Miami*
  - *Unidata Program Center*
  - *UFRJ*
  - *UFPA*
  - *CPTEC/INPE*
  - *USP*

- Infrastructure
  - *Internet2*
  - *AMPATH (NSF)*
    - FIU
    - Global Crossing
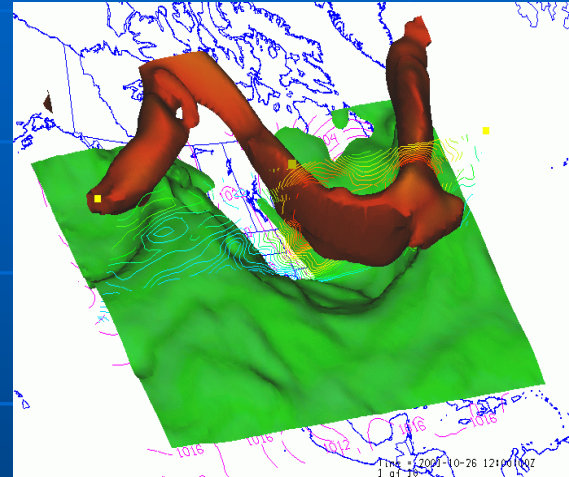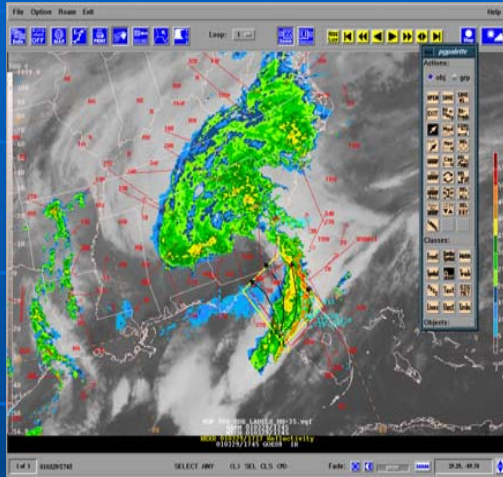 - *RNP*
  - *ANSP*
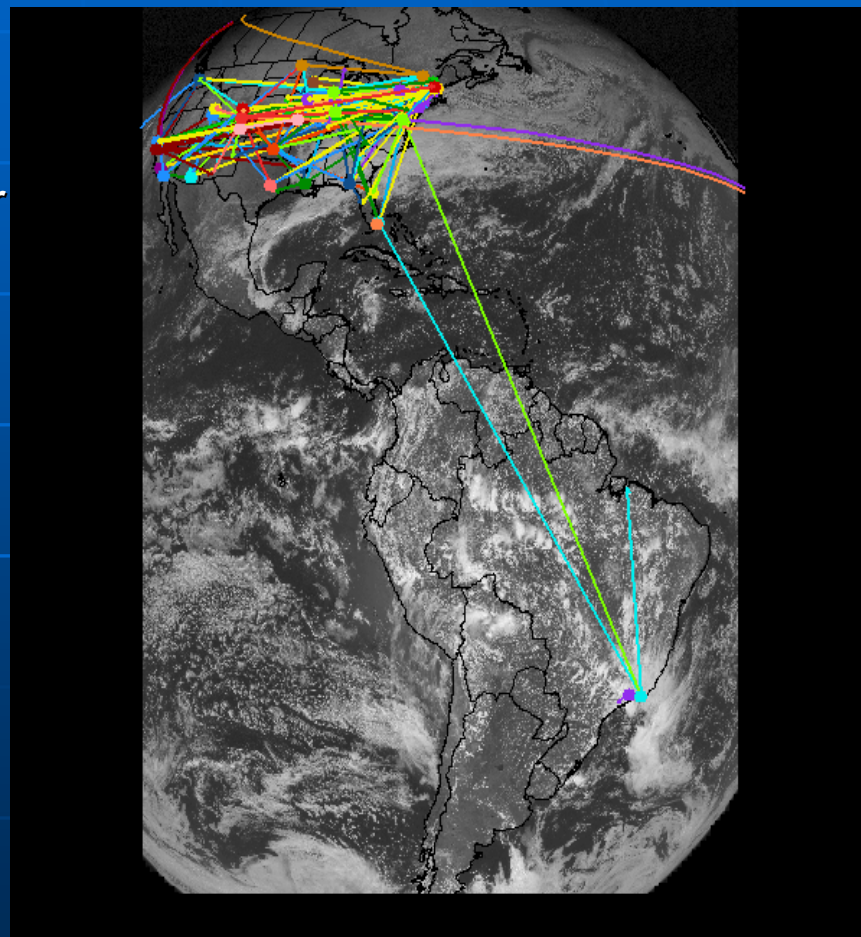
IDD-Brazil - Future Growth

- Possible New Educational Participants
  - *UEMA*
  - *UFAL*
  - *UFPB*
  - *UFPel*
  - *UNIVAP*
  - *INPA*
- Operational Sites are Interested
  - *FURNAS*

Visualization Software
GEMPAK, IDV, McIDAS
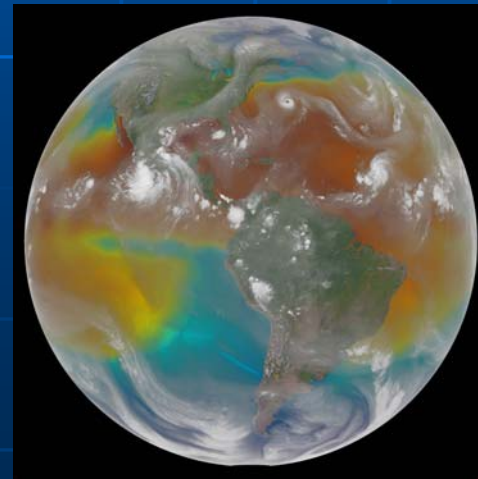
COMET Program:
Principle Facilities being made available in MeteoForum

- **Distance Learning** – lectures, student interaction, & a large collection of educational graphics (accessible via the Web or on CDs)

- **Outreach Program** – partnerships between the academic research community and forecasters

- **Residence Courses** – advanced meteorology & hydrology courses that include lectures & hands-on laboratory activities

- **Case Studies** – a collection of meteorological data sets for specific events (available online)

COMET Resources
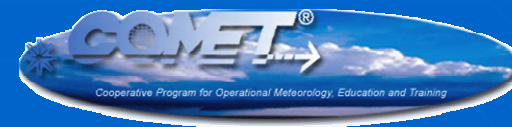
- Complete educational modules for
  - *Aviation forecasts: icing, fog, ceilings, & visibility*
  - *Numerical Weather Prediction*
  - *Severe Convective Weather*
  - *Hurricane Preparedness*
  - *Satellite meteorology*
  - *Marine meteorology*
- Over 30,000 pages of online material
- Case-study data sets of North American weather, ideal for teaching or research

Reusable, Adaptable Materials
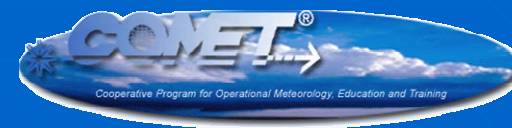
- COMET operates a training Web site that is freely accessible by any educational user, worldwide

- COMET materials are
  - *Based on sound science*
  - *Adaptable to new purposes & contexts*

- COMET helps other organizations define training standards & procedures

- COMET helps organizations develop specialized distance-learning modules
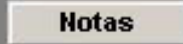
COMET Training Modules

- Remote Sensing of Land, Oceans, and Atmosphere with MODIS
  http://meted.ucar.edu/npoess/modis

- Coastally Trapped Wind Reversals
  http://meted.ucar.edu/mesoprim/ctwr

- Huracanes: Preparación de la Comunidad
  http://meted.ucar.edu/hurrican/chp_spa

Forecast Process (Spanish/English)

Hurricane: Community Preparedness (Spanish/English)
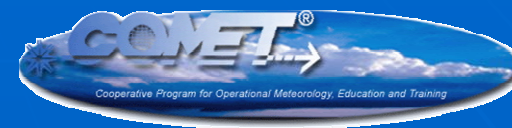
MeteoForum - Initial Successes

- Establish data distribution network linking Unidata IDD with research and educational institutions in Brazil - *IDD-Brazil*

- Fund translation of select COMET training modules into Spanish (Costa Rica and Argentina)

- Install Unidata-developed NOAAPORT reception system and high-end application workstation at Universidad de Costa Rica

MeteoForum - Next Steps

- Expand *IDD-Brazil* services throughout Brazil and extend service to UBA in Buenos Aires, Argentina
- Install THREDDS servers on UFRJ *IDD-Brazil* relay
- Create multilingual *IDD-Brazil* web site at UFRJ

- Install high end server with all Unidata applications and LDM at CIMH in Barbados (May)
- Work with Universidad Central de Venezuela to extend real-time data feeds to Venezuelan RMTC

- Assist MeteoForum members in the installation and use of Unidata-supported display and analysis packages
- Seek funding to continue MeteoForum activities
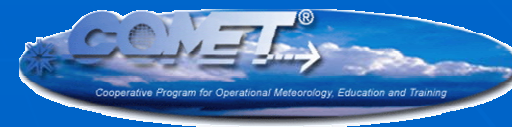
MeteoForum – A work in progress

- Are RMTCs better off now
  - *Technical capabilities have been improved, but the work is just beginning.*

- Has instruction improved at RMTCs
  - *Not yet. The next steps include training workshops that address use of real-time data in the classroom.*

MeteoForum – A work in progress (cont.)

- Have international organizations have been engaged
  - *US National Weather Service*
    - For 1st time, the Weather Service has developed an international training plan, and it includes roles for COMET and Unidata
    - Co-funded NOAAPORT ingest system and high-end application server at the Universidad de Costa Rica
    - Funded high-end application server for CIMH (Barbados)
  - *Canadian Weather Service*
    - Co-funded NOAAPORT ingest system at the Universidad de Costa Rica
  - *World Meteorological Organization*
    - Provided travel monies to RMTC representatives for MeteoForum planning meetings
    - Approached Spangler about creation of a *MeteoForum Africa*
    - Thanked UCAR for MeteoForum activities at 2003 WMO Congress
  - *EUMETSAT*
    - Interested in MeteoForum's use of EUMETSAT's Data Distribution System, EUMETCast, for real-time satellite and conventional data, and training material delivery in Africa

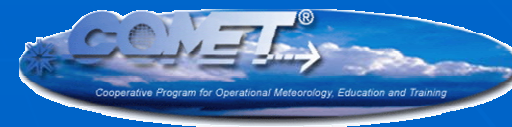# MeteoForum – A work in progress (cont.)

- Have UOP opportunity fund monies been well spent
  - *$38K spent so far*
  - *approximately $200K in additional funding generated (primarily from the US NWS)*
  - *$55K indirect costs generated for UCAR*

Contact Information

MeteoForum   http://meteoforum.ucar.edu

COMET   http://www.comet.ucar.edu

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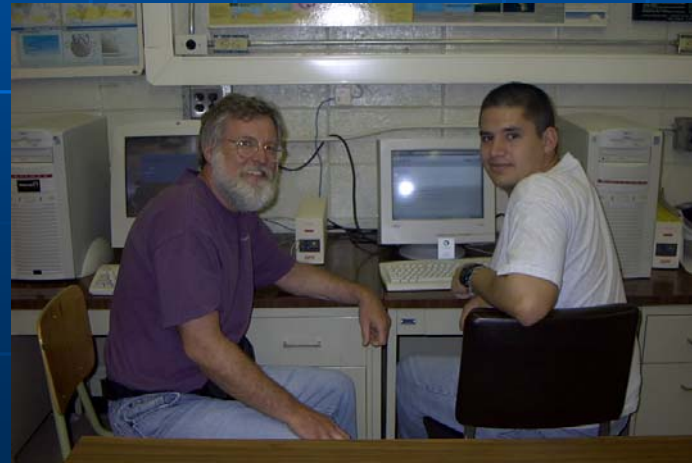
NOAAPORT Installation at UCR

NOAAPORT Installation at UCR

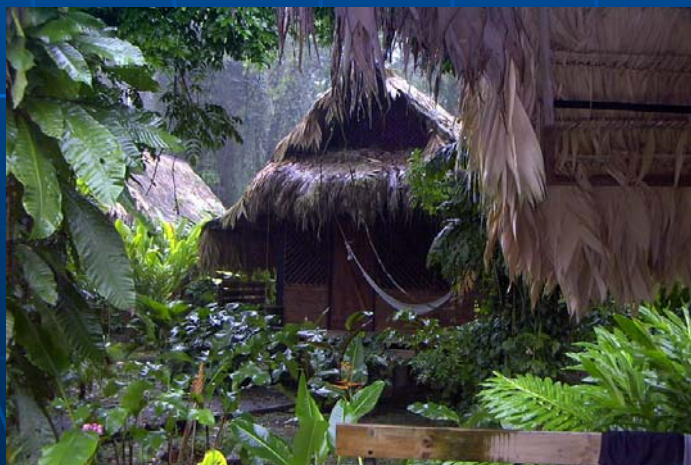# NOAAPORT Installation at UCR
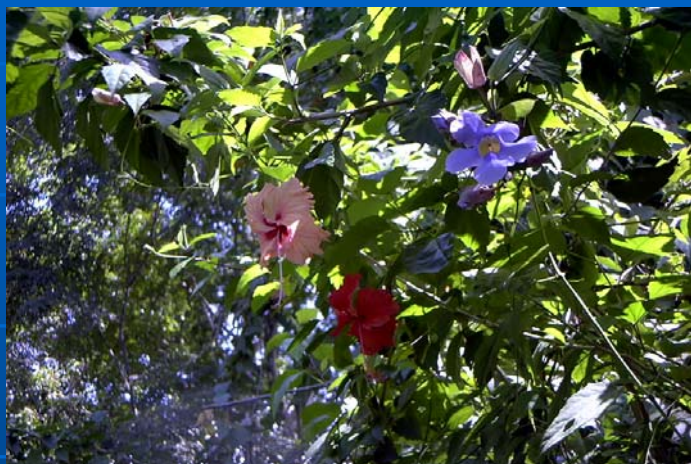
Playa del Flamingo

Biological Research Station - Panama

Caribe

Caribe

Cartago and San Jose

UCR

Heading Home