GOES-16 Data Dissemination in Unidata

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UCAR COMMUNITY PROGRAMS

NSF

Typical University Facilities in Late 1970s

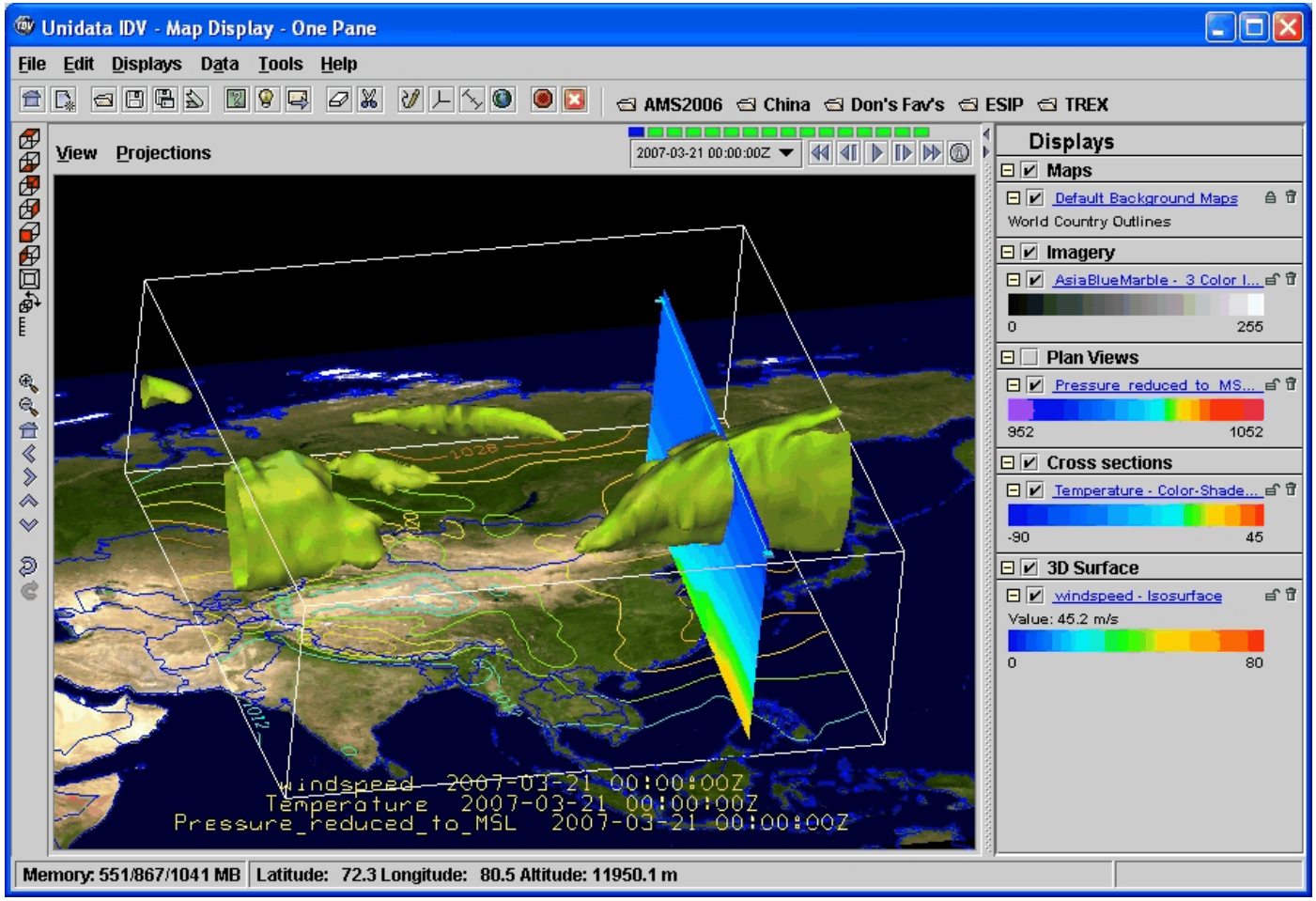
Teletype for observations

- Free 300 baud circuit from local WFO
- Service A, C
- hand-decoded data
- hand-plotted maps, soundings

Wet paper facsimile

- Free facsimile service from local WFO
- 2-D maps
- Satellite imagery
- Populated the Weather Wall

Typical University Capabilities Today



GFS Windspeed Isosurface and Temperature Cross Section

Unidata's Birth
Madison Workshop - 1983

- 80+ university participants
- Demonstration of mainframe McIDAS
- Proposal to NSF to fund a UNIversity DATA system initiative within UCAR (Dutton, *et. al.*)
- UNIDATA launched in 1984 - 2 employees
- Initial foci:
  - Broad menu of weather data including satellite imagery
  - Local interactive analysis
  - Communications to central mainframe
  - Interactive operation of field programs
- Mantra: "Don't do anything centrally that the universities themselves can do well"

UNIversity DATA systems - UNIDATA

- Funded primarily by the U.S. National Science Foundation
- Mission:

  To provide data services, tools & cyberinfrastructure leadership that advance Earth system science, enhance educational opportunities & broaden participation
- At the Unidata Program Center, we
  - Provide access to data (via push and pull systems)
  - Develop open source tools and infrastructure for data access, analysis, visualization, and data management
  - Support users of our technologies: faculty, students, and researchers
  - Help to build, represent, and advocate for a community

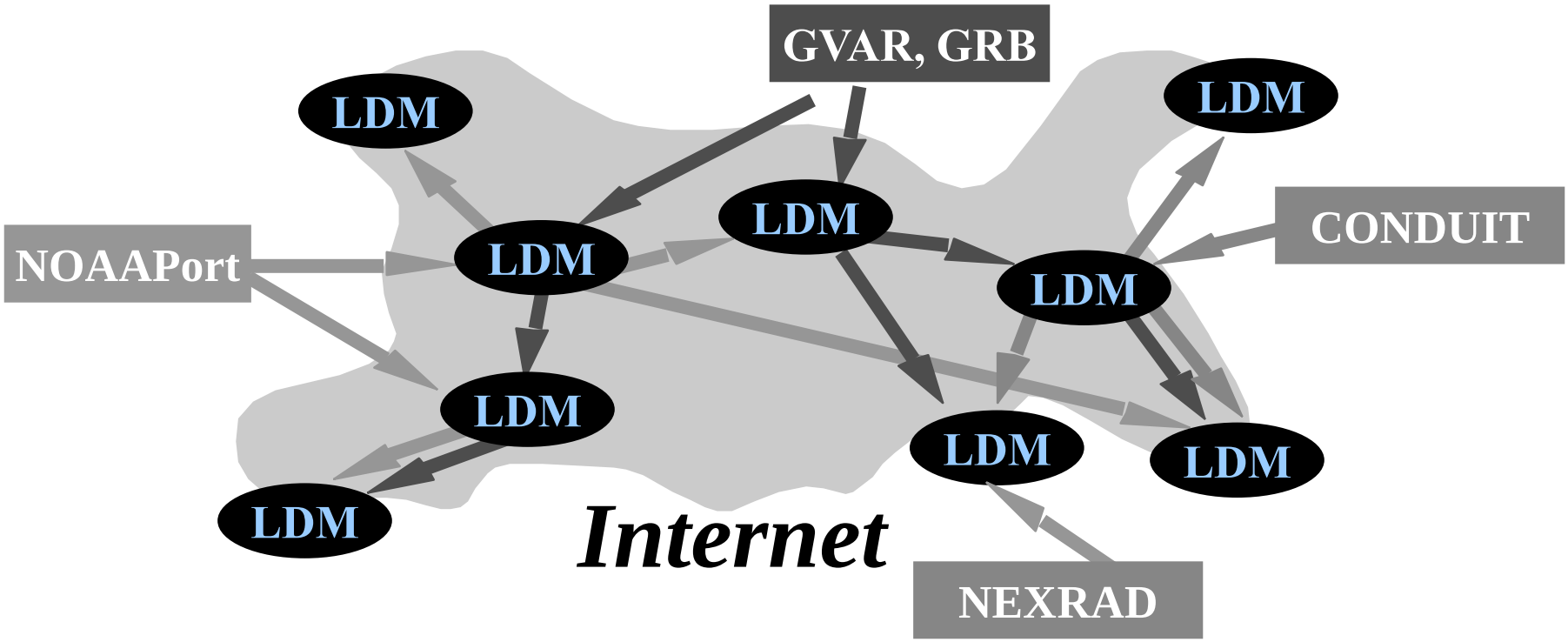
Tools and Support Are Central

- Enhance and distribute software developed by others
  - Meteorological display and analysis tools from UW/SSEC (McIDAS-X), National Weather Service (GEMPAK, AWIPS), Purdue (WXP), etc.
  - Remote access technologies: OPeNDAP (U of RI, NASA, and others), ADDE (UW/SSEC)
- Develop software in-house
  - Widely used tools for manipulating scientific data (e.g., LDM, netCDF, UDUNITS, MetPY, data decoders, etc.)
  - Java-based tools (IDV Framework built on top of VisAD) for 2D and 3D visualization and next-generation, collaborative data analyses
- Build systems from the software we support
  - Internet Data Distribution (IDD) system
  - THematic Realtime Environmental Data Distributed Services (THREDDS) Data Server (TDS)
- Support the use of software by offering training, consultation, bug fixes, and upgrades

LDM and Internet Data Distribution System

- Local Data Manager (LDM) – one of largest distributed applications – put met departments on leading edge of Internet use
- Initiated in the mid-1990s in response to weather-data ingest challenges:
  - Solar occultation data loss
  - Terrestrial interference
  - Campus *beautification* committees
- Event-driven network of cooperating Unidata Local Data Manager (LDM) servers interconnected by TCP/IP Ethernet
- Built to realize a communications goal laid out in the earliest Unidata planning documents (Cooper, 1985)
  - Active use of local-area and national network infrastructure
  - Allow for multi-way sharing of data including locally-held datasets
- Evolved in lock-step with national and international networking capabilities
- Profoundly changed how universities acquire and use (real-time) data
- Lowered costs ***and*** increased reliability of data delivery

Internet Data Distribution System



Sharing data from multiple sources using cooperating LDMs

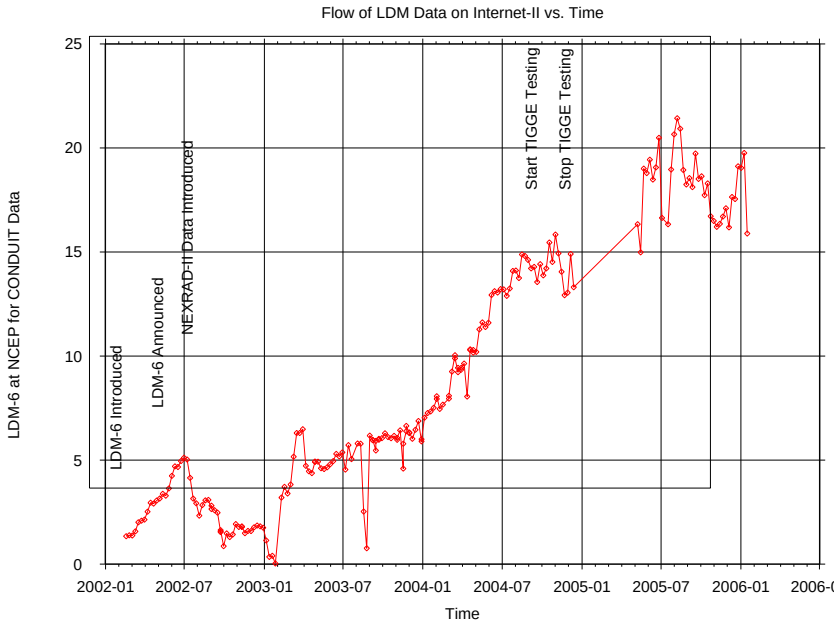
Real-time Data Flows

In the Beginning...

Service	Data Rate (Bits Per Second)
NAFAX	Analog
DIFAX	2400
Watches & Warnings	1200
U.S. Surface/Upper-Air	4800
NMC & ECMWF Grids	4800
Wisconsin Channel	9600
International (GTS) Data	1800
FAA 604	1200
Lightning Data & Others at Non-Discounted Prices	

"a dizzying volume of information – on the order of 100 MB/day, aggregate" (Davis and Rew, 1990)

Early 2000s

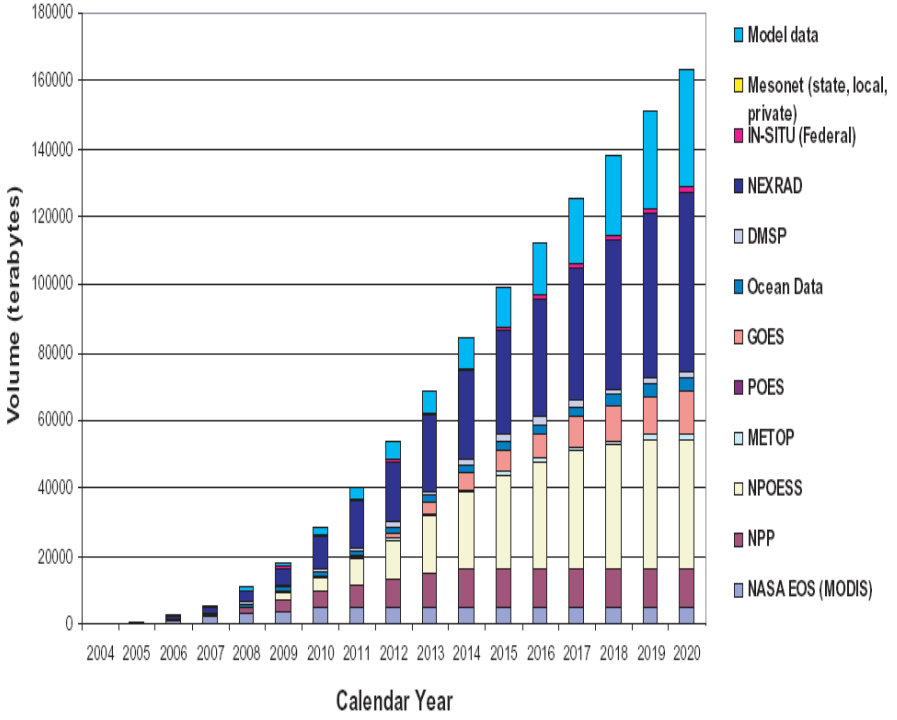


LDM-6 Internet2 bandwidth use > 35 TB/week

The Ongoing Data Deluge

More Data and New Data Sources

- NEXRAD Dual Polarization data
- GOES-R/S / JPSS
- MSG, MTG, METOP
- Global, coupled models at a grid spacing of 0.25-1 km, integrated for multi-decades
- NCAR Global WRF in Weather and Climate research
- NEXRAD Level II
- AMPS – Antarctic WRF
- New initiative
- More, More, More



Unidata

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

Satellite Data Ingest

NOAAPort

GVAR

GOES-R

GOES-S

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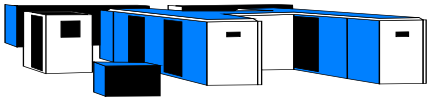
Historic Data Flow Paradigm

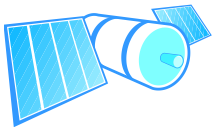


Forecast Model Output

Weather station observations

Unidata user running GEMPAK, McIDAS, WXP

Application specific protocols



Satellite imagery

Decoders

Decoders

Decoders

IDD

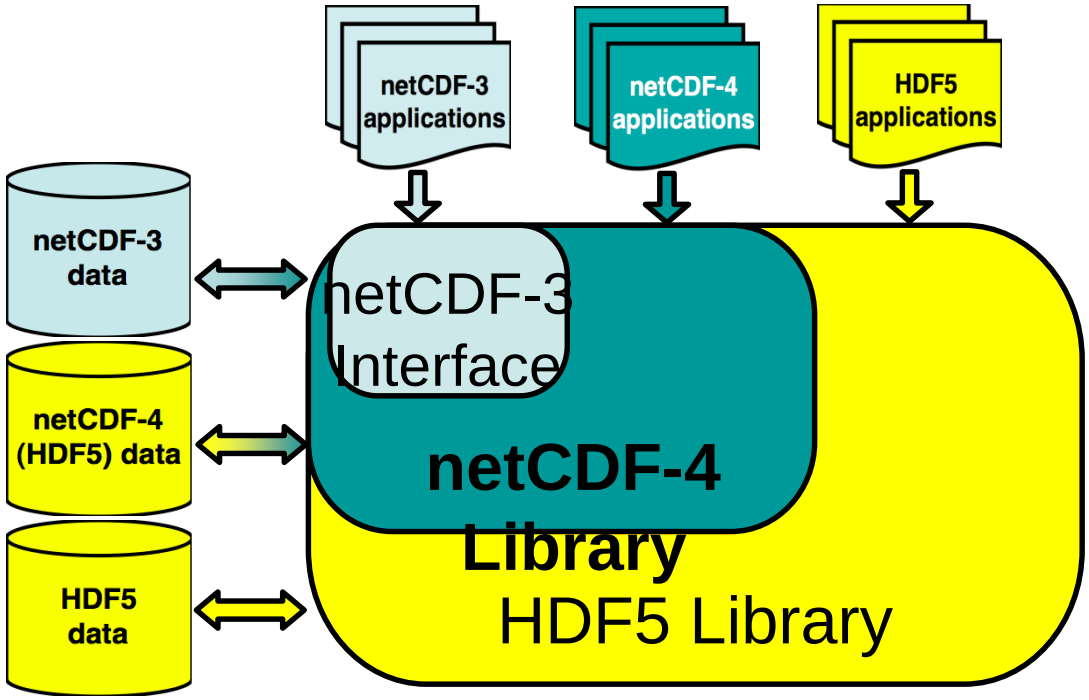
Radar data

Local data decoded into application-specific formats

Lightning, aircraft, GPSmet, etc.

Data Storage: Network Common Data Form netCDF-3, netCDF-4

- Stable, multi-platform, multi-language data access since 1988
- Data model for multidimensional and structured scientific data
- Set of APIs (C, Java, Fortran, C++, Perl, Ruby, MATLAB, Objective C, Tcl/Tk, …) for data access
- Reference implementation for the APIs
- Over 100 software packages provide netCDF access
- In use in over 100 countries



NetCDF/HDF5 Merger

McIDAS Abstract Data Distribution Environment ADDE

ADDE Assets

- Access to real-time and archived datasets
  - GRID (model output, objective analysis, etc.)
  - IMAGE (satellite imagery, radar, etc.)
  - POINT data (surface observations, lightning, wind profiler, etc.)
  - TEXT (free form text)
- Access implemented by a variety of applications: McIDAS-X/V, IDV, Matlab, IDL
- One of the largest *advanced application* users of Internet2 bandwidth
- Longest lived demonstration of scientific programmatic remote data access

ADDE Deficits

- Limited data discovery
- Limited metadata
- Proprietary implementation: Unidata can provide McIDAS-X to universities only

Thematic Real-time Environmental Distributed Data Services Data Server - TDS

- THREDDS Data Server (TDS):
  - a web-based server which provides metadata and data access
  - provides several data access protocols including OPeNDAP and HTTP
  - developed, distributed and supported by Unidata
  - written in Java and easily implemented by the Tomcat server

- Free and open access to the data is now available to users around the world using standard web browsers and TDS-enabled applications:
  - Integrated Data Viewer (IDV, Unidata)
  - McIDAS-V (McV, UW/SSEC)
  - MetPY

AWIPS Environmental Data Exchange - EDEX

- Main server for AWIPS
- Qpid sends alerts to EDEX when data stored by the LDM is ready for processing
- Qpid messages include file header information which allows EDEX to determine the appropriate data decoder to use
- Default ingest server (simply named ingest) handles all data ingest other than grib messages, which are processed by a separate ingestGrib server
- After decoding, EDEX writes metadata to a Postgres database and saves processed data in HDF5 via PyPIES
- A third EDEX server, request, feeds requested data to CAVE clients

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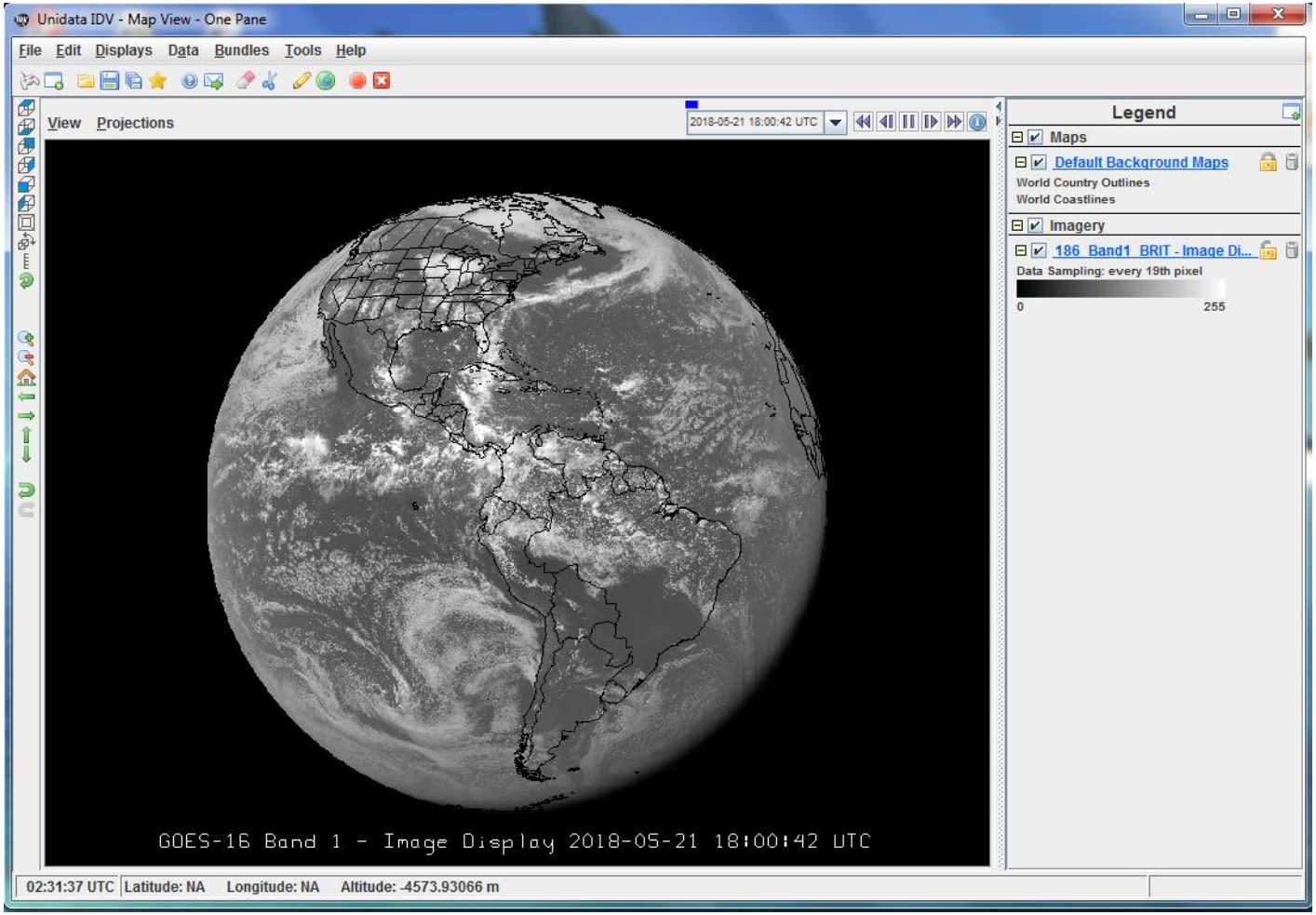
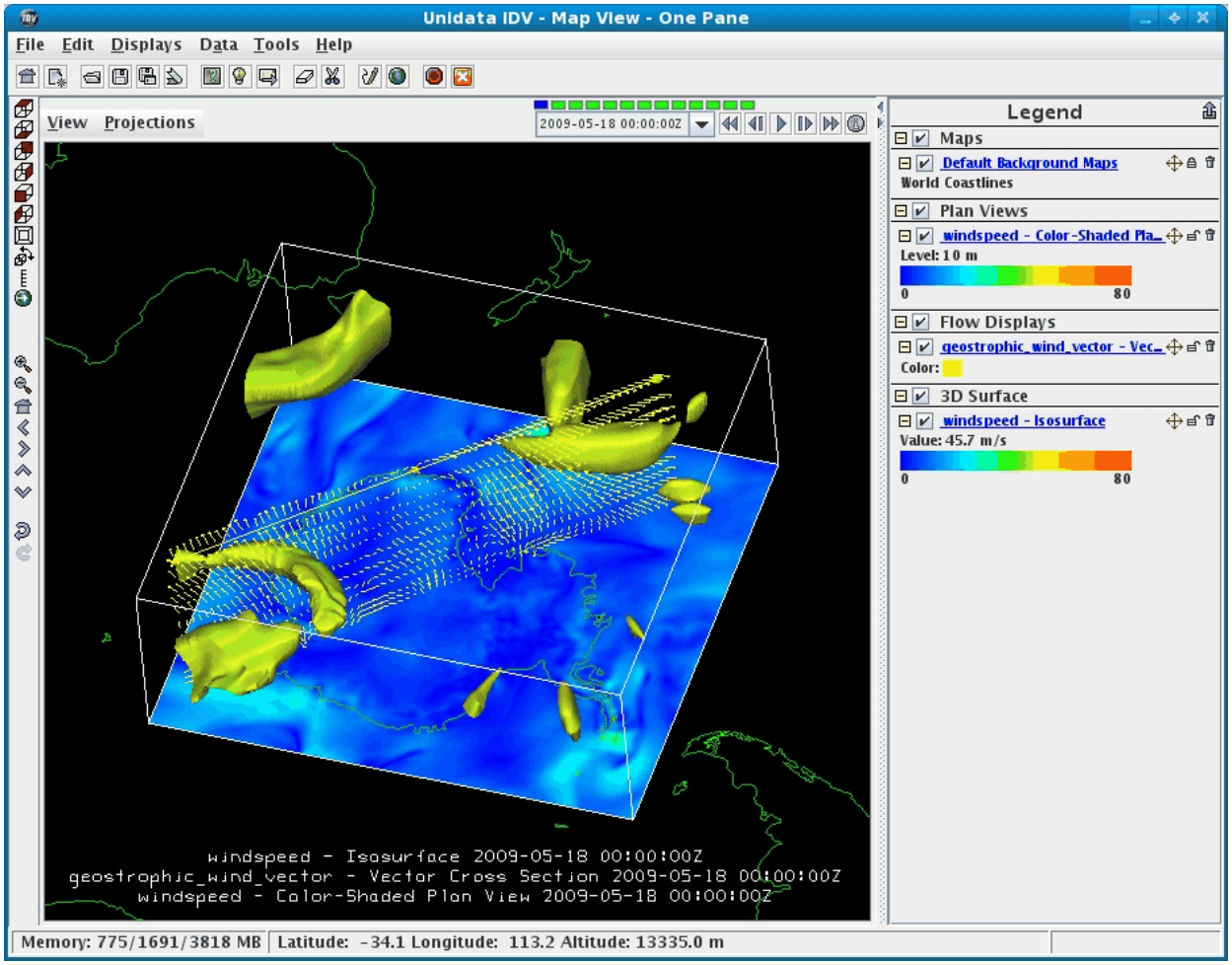
IDV: GOES-16 Full Disk 0.47 um VIS served by ADDE



http://www.unidata.ucar.edu/software/idv

IDV: AMPS model output served by TDS



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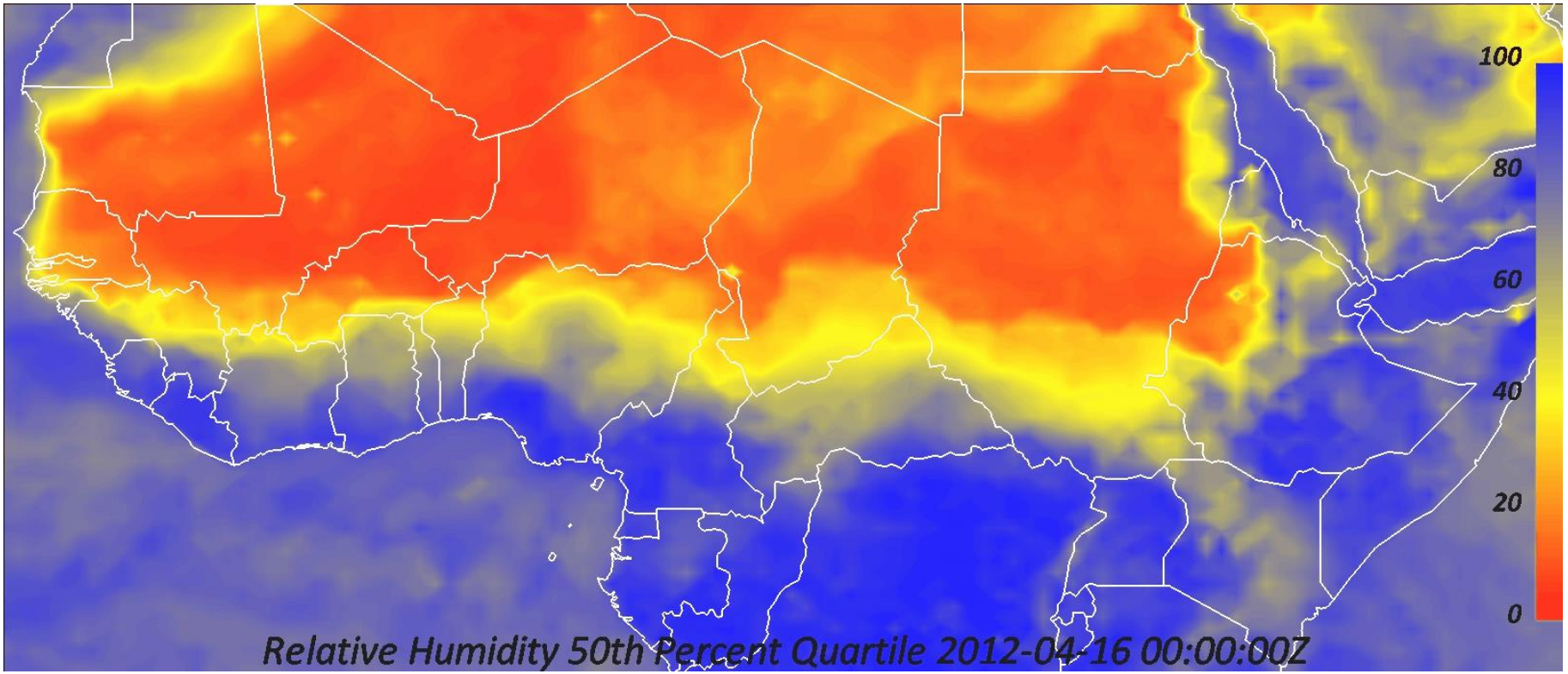
IDV: ECMWF Ensemble model output from local data



ECMWF Ensemble RH 50th Percent Quantile for 20120416

Unidata GOES-16/17 Data Access

Service	Current	Future
IDD	idd.unidata.ucar.edu iddb.unidata.ucar.edu Idd.meteo.psu.edu iddcc.ucr.ac.cr	idd.aos.wisc.edu
ADDE	lead.unidata.ucar.edu atm.ucar.edu	adde.ucar.edu adde.ssec.wisc.edu AWS, Azure, Jetstream
TDS	thredds-test.unidata.ucar.edu	thredds.ucar.edu AWS, Azure, Jetstream
EDEX	edex-cloud.unidata.ucar.edu	AWS, Azure, Jetstream
WEB	atm.ucar.edu	motherlode.unidata.ucar.edu adde.ssec.wisc.edu

Unidata Information

HomePage	www.unidata.ucar.edu
Support	support@unidata.ucar.edu
Software	www.unidata.ucar.edu/software
LDM	www.unidata.ucar.edu/software/ldm
netCDF	www.unidata.ucar.edu/software/netcdf
IDV	www.unidata.ucar.edu/software/idv
AWIPS	www.unidata.ucar.edu/software/awips2
McIDAS	www.unidata.ucar.edu/software/mcidas
TDS	www.unidata.ucar.edu/software/current/tds