3B.7 Transitioning the Meteorological Assimilation Data Ingest System (MADIS) into NWS Operations

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1. INTRODUCTION

The Meteorological Assimilation Data Ingest System (MADIS) is a complex data acquisition and distribution system developed by NOAA's Office of Atmospheric Research with many innovative functions including: ingesting, integrating, processing and transmitting NOAA and non-NOAA surface meteorological observations across the country and ocean-based, many types of upper air soundings including balloon-borne and aircraft, and remote sensing from both ground-based and satellite systems. It has reached a point where it can now be transferred from research into an operational environment under NOAA *Policy on Transition of Research to Operations* (NAO 216-105, dated May 31, 2005). The plan is to transition MADIS to the National Weather Service's Telecommunications Operations Center (TOC) in Silver Spring, Maryland in the late 2008 timeframe. This extended abstract will discuss some of the design considerations for the transitioned system and how it will benefit NOAA customers through integrated, quality-controlled datasets which can be assimilated into their applications in a seamless manner.

Although MADIS is a mature developmental system, it still requires a substantial effort to transition this capability from a research environment to an operations one. However, traditional methods for designing, building, and implementing this type of system could far exceed the time frame expected for delivering this capability into operations. Therefore, a new approach is needed for rapidly building and delivering this capability without disregarding some of the traditional attributes of a well-managed systems engineering approach.

2. BACKGROUND

What Is MADIS? Since fiscal year (FY) 2000, NOAA has invested in the MADIS as a research system to help improve weather forecasting, by providing support for data assimilation, numerical weather prediction, and other hydrometeorological applications. NOAA's Earth System Research Laboratory (ESRL) Global Systems Division (GSD) (formerly the Forecast Systems Laboratory (FSL)) developed MADIS. In FY 2006, MADIS was ingesting approximately 20,000 observational sites from disparate government, and non-government systems and networks. Sources of meteorological observational data include: automated surface observing systems, upper air observing systems (radiosondes and profiler), hydrological observing systems, automated aircraft sensors and reporting systems, GPSMET (water vapor), satellite radiometers and sounders, and snow-accumulation observing systems.

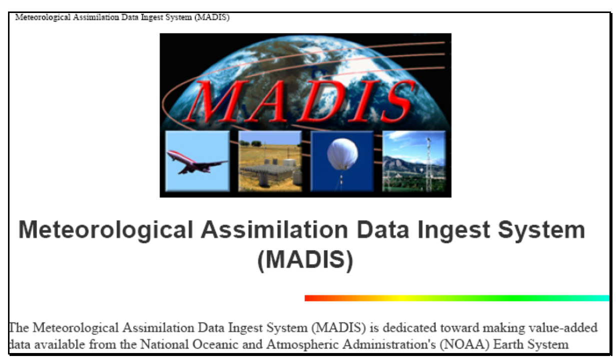


Figure 1. MADIS website.

2.1 General MADIS Functions

The following are general functions and characteristics of the current MADIS:

- Functions

- Provides real-time observation collection, integration, quality control, and distribution for over 19,000 surface stations + upper-air datasets
    - Provides for selective distribution of public and proprietary data
    - Network monitoring capabilities for surface observations include frequency of failure, RMS, and mean errors, outages
    - Observation latency to NWS WFOs ~15 seconds, mean latency for customer parameter files ~3 minutes
    - Data storage at ESRL

- Computing
    - Networked Linux servers

- Communication
    - Internet (data polling and automated data routing, using ftp, ldm, OPeNDAP)
    - Selective access to the data based on distribution categories

- Automated Quality Control Checks
    - Validity, temporal consistency, internal consistency, spatial consistency, based on established, well-tested procedures

- Station Monitoring
    - Hourly, daily, weekly, and monthly reports to network managers, e.g., mesonets

- Upper Air Observations
    - Radiosonde
    - Automated Aircraft
    - NOAA Profiler Network (NPN) Wind Profiler
    - Multi-Agency Profiler
    - Radiometer
    - Satellite Winds
    - Satellite Soundings
    - Satellite Radiances

- Surface Observations
    - Meteorological Aviation Reports (METARs)
    - Maritime
    - Surface Aviation Observations (SAOs-Canada)
    - NERON [NOAA's Environmental Real-Time Observation Network]
    - Other mesonets
    - Snow Reports
- Current mesonet sites = 18,894
- Current mesonets = 116
- Largest mesonets: AWS Convergence Tech. Inc., Citizen Weather Observing Program
- (CWOP), Interagency Fire Center's Remote Automated Weather System (RAWS)
- Uniform Data Formats
- Observations and Quality Control Flags
- Real-Time Distribution: ftp, LDM, OPeNDAP
- On-Line Archive (saved real-time data files) from July 1, 2001
- On-Demand Web Services
    - Text, XML (surface data only)
    - Real-time observation displays
- QC Statistics for Data Providers
- Provides distribution of observation and QC information to:
    - NOAA's customers, e.g, Weather Channel
    - NWS forecast offices and modeling centers
    - Federal, state, and local government agencies
    - Universities and research organizations
        - Full distribution to all
        - Distribution specifically to NOAA, e.g., MDCRS & proprietary surface networks
        - Distribution specific to government, research, and education organizations

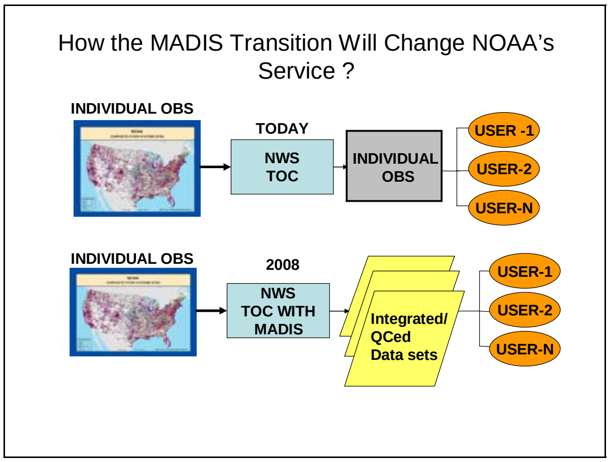
3. Benefits of Transition

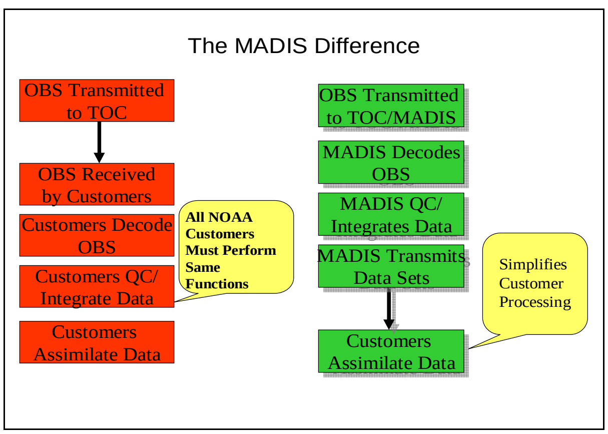
The following benefits will result from transitioning MADIS into full operations:

- Accelerate scheduled ingest of new datasets and additions to existing datasets in order to increase the effectiveness and use of observations for NOAA forecasts/warnings and essential services.
- Accelerate hardware upgrades.

- Better meet NOAA requirements for inter-modal (land, sea, air) NOAA operational data management needs.
- Further leverage non-NOAA observation networks including acceleration of data available from mobile sensors.
- Improve customer service.
- Improve archive capabilities.

Figures 2 and 3 below describe the impacts of the transition on NWS operations and the benefits to NOAA customers.





Figures 2 and 3. MADIS impact on NWS operations.

3.1 Transition Phases

The NWS is planning the following transition phases:

- ***Phase*** *1* -- Plan the transition around the concept of an "Initial Operating Capability (IOC)":
  - – Replicating most of today's MADIS architecture for operations with new interfaces
  - – Identifying equipment options for the transition
  - – Developing "data throughput" goals for determining speed of products into the hands of NOAA's customers
  - – Developing new maintenance monitoring concept

- – ***Phase 2*** -- Execute Phase 1 plan. Expand IOC capabilities to meet larger integration goals -- "Full Operating Capability (FOC)."

3.2 Initial Operating Capability

At IOC, the following capabilities are expected from the transitioned MADIS:

- Deliverables:
  - o TOC Hardware, operating systems, and support systems (hardware and software)
  - o Hardware/communications documentation
  - o Applications software and documentation under configuration management
  - o Operations instructions
  - o Configuration management system
  - o OT&E test results

- Training of operations staff

- Primary Operations
  - o Operation 24h by 7 days a week out of the NWS TOC
  - o NWS to provide help desk, with support from ESRL
  - o Data archive at NCDC

- Communication
  - o NOAAport, NOAANET, Internet, LDM, FTP

- Selective access to the data based on distribution categories

- Backup Operations
  - o ESRL Boulder provide backup as needed

- Maintenance
    - Hardware maintenance to be provided by hardware vendor
    - Three-year hardware replacement cycle planned
    - COTS software in support of operating system, security, middleware to be upgraded as license and requirements dictate

- Applications software maintenance shared by NWS and ESRL development teams
    - Metadata Files based on HADS or MI^3 (NOAA/NESDIS)
    - Station data files including information of sensor types, heights, etc.
    - GIS-depicted metadata produced on topographic GIS software
    - Digital pictures of sites
    - Metadata forwarded to NCDC

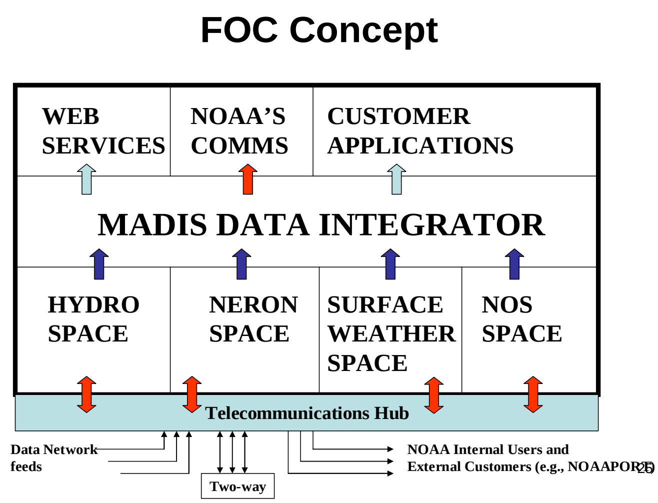
3.3 Full Operating Capability (FOC)

The goal of the FOC is to expand the initial system to subsume new capabilities and data systems. All the IOC functions will remain with some exceptions as stated below. The following capabilities are anticipated for the FOC phase of the transition:

- HADS (NWS hydrologic system operational within the TOC)
- CADAS (NWS hydrologic system operational within the TOC)
- NERON is currently a risk reduction system
- National Surface Weather Observing System in support of the surface weather program
- Multi-cast capability for large-scale data streams; Radar server, National Profiler Network, lightning, and hi-resolution ASOS data.
- Implementation of an advanced quality control and maintenance monitoring capability

- Primary Operations
    - Operation 24h by 7 days a week out of the NWS TOC
    - NWS to provide help desk
    - Data archive expands at NCDC as new data sets are ingested

- Backup Operations
    - ESRL Boulder no longer provides backup as was needed at IOC
    - Off-site 24-hour by 7day a week backup provided by NWS at backup TOC site



Figures 4. General MADIS architecture after transition.

4. CONCEPTUAL ARCHITECTURE

The basic architecture for the transferred system is centered on TOC operations, meaning the system must reside and interface within the TOC floor space and be interfaced to the NWS Gateway and its web services. Basically, MADIS becomes the *middleware* (see Figure 4) data integrator for a variety of diverse data feeds including the NSWOS, NERON, Hydrology, non-NOAA mesonets, etc. The middleware would QC and integrate the various data sets and pass them on in certain prescribed formats to NOAA customers via NWS telecommunications and web services. Meanwhile the individual components would function independently for its specialized functions. For example, NERON may have its own set of applications it needs in order to meet its climate customer requirements and yet the data would be integrated and disseminated to the wider NOAA customer base through the transitioned MADIS functionality. In this way, data are leveraged on different levels for different applications.

4.1 FOC - Information Bases

As stated above, one of MADIS' strengths is its ability to compile observational data, which have been quality-controlled and integrated into datasets. Initially, the transitioned MADIS functionality will continue the types of datasets and formats being provided to customers. However, after MADIS is transitioned to NWS, it offers the opportunity for NOAA to begin transmitting entire information bases (IB), which serve more as databases for NOAA's customers and are more in line with current trends. An example of IB structures is illustrated in Figure 5. IBs would be segmented into recognizable surface (-10m to +10m), planetary boundary layer (+10m to 3 km), tropospheric data (3km to 15km), and stratospheric data (15+ km). Customers would be able to tap into the IBs and "mine" the real-time data using relational data base techniques. The Office of Hydrology within the NWS has demonstrated this capability and may be assisting with developing this capability as part of this effort. Specialized IBs could be derived for such parameters as wind or snowfields. The ultimate goal will be to expand the databases for global data, which is easily attainable through the NWS' TOC.

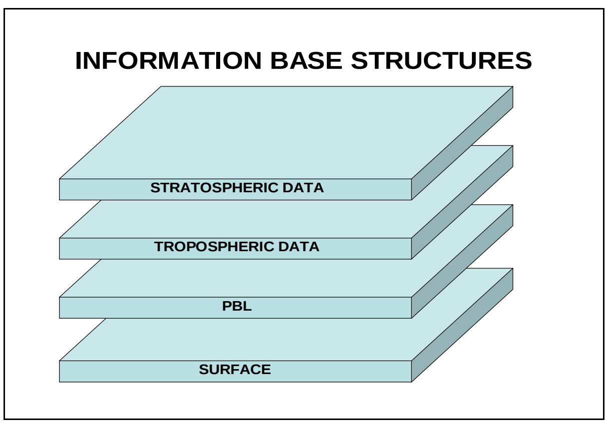


Figure 5. **Future IB Structures**

5. CONCLUSION

The purpose of this paper was to inform the community about the efforts underway within NOAA to transition MADIS from its prototype version to a fully operational state within the NWS' TOC. With this capability in the TOC, the NWS will be in a position to provide its customers integrated data sets of observations, which have been quality-controlled and repackaged to meet customer needs. Although the current method of data transmission will not be impacted by this transition and thus customers will still be able to acquire data as today, the greatest benefit will be the integration of both NOAA and non-NOAA data into seamless data sets which can be assimilated easily into customer applications.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

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