Experiences in Bridging the Gap Between Science and Decision Making at NASA's GSEC Earth Science Data and Information Services Center (GES DISC)

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Abstract

- Recognizing the significance of NASA remote sensing Earth science data in monitoring and better understanding our planet's natural environment, NASA has implemented the 'Decision Support Through Earth Science Research Results' program (NASA ROSIS solicitations).
- This successful program has yielded several monitoring, surveillance, and decision support systems through collaborations with benefiting organizations.
- The Goddard Space Flight Center (GSFC) Earth Sciences Data and Information Services Center (GES DISC) has participated in this program on two projects (one complete, ongoing), and has had opportunities to help organizations gain experience in the formulation, management, development, and implementation of decision support systems utilizing NASA Earth science data.
- In addition, GES DISC's understanding of Earth science missions and resulting data and information, including data structures, data usability and interpretation, data interoperability, and information management systems, enables the GES DISC to identify challenges that come with bringing science data to decision makers.
- The purpose of this presentation is to share GES DISC decision support system project experiences in regards to system sustainability, required data quality (versus timeliness), data provider understanding of how decisions are made, and the data receivers' willingness to use new types of information to make decisions, as well as other topics. In addition, defining metrics that 'really' evaluate success will be exemplified.

NASAs ‘Decision Support Through Earth Science Research Results’ Program

NASA’s Applied Research Program focuses on extending Earth science research results to decision making activities. Through the ‘Decision Support Through Earth Science Research Results’ proposal solicitation, NASA has striven to develop and demonstrate innovative and practicable applications of NASA Earth science observations and research in eight applications areas for the purpose of improving decision making activities.

- Agricultural
- Air Quality
- Climate
- Disaster Management
- Ecological Forecasting
- Public Health
- Water Resources
- Weather (Aviation)

Using NASA TRMM Precipitation Data for Monitoring Crop Conditions

The GES DISC Agricultural Information System (AIS) provides NASA environmental data and information to support global crop monitoring at the U.S. Department of Agriculture (USDA) Foreign Agricultural Service (FAS) and the U.N. World Food Program (WFP). The primary goal of FAS is to improve foreign market access for U.S. agricultural products. The WFP uses food monitoring to meet emergency needs and to support economic and social development.

Using NASA Soil Moisture Data in NASA/NOAA Land Surface Models to Enhance the National Weather Service River Forecast System (NWSRFS)

This project focuses on improving evapotranspiration (ET) inputs to the NWSRFS, a sub-Decision Support System of the NWS’s Advanced Weather Interactive Processing System (AWIPS). By integrating NASA’s Aqua/AMSR-E and TRMM/MTM soil moisture products into land surface models that provide improved ET data seamlessly to the NWSRFS, the capability for flood and drought forecasting and disaster management are expected to be greatly enhanced. The project focuses on the Ohio River Forecast Center (ORFC), for which floods and droughts are two major natural hazards that have significant impacts on the region’s agriculture, industries, commercial navigation, and residential communities.

Using NASA Atmospheric Data for Air Quality Monitoring

The GES DISC has created the Cleveland Air Quality Index (CAQI) for visualisation and exploration of remotely-sensed and in-situ data products related to air quality. For the contiguous United States, the Air Quality (PM2.5, Ozone, Particulate Matter) and Aerosol Environmental Protection Agency AirNow PM2.5, data, aerosol and cloud data products from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the Terra and Aqua satellites, and aerosol products from the Clouds and the Aerosol Measuring Instrument (CAMI) on the A-Train are available. Long-term and correlation maps, animation, time series, scatter plots, and statistics are available through the use of Giovanni.

The Use of Science Data for Decision Making

<table>
<thead>
<tr>
<th>For Science</th>
<th>For Decision Making</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timeliness availability</td>
<td>Not urgent for research</td>
</tr>
<tr>
<td>System Sustainability</td>
<td>Part of Science</td>
</tr>
<tr>
<td>Data Documented</td>
<td>Algorithms; product description</td>
</tr>
<tr>
<td>Data Requirements</td>
<td>Clear science concept</td>
</tr>
<tr>
<td>Desired Data Representation</td>
<td>Images for data analysis; Image browse</td>
</tr>
<tr>
<td>Spatial and Temporal Resolution</td>
<td>Information for decision making; Images for data analysis; Equations for data relationship; Statistical analysis</td>
</tr>
<tr>
<td>Data Validation</td>
<td>More complex; may need special training</td>
</tr>
</tbody>
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Bridging the Gap - Challenges

- Translating science data for decision support systems
  - Understanding the decision space to determine relevant science data inputs to decision making
  - Determining the best way to communicate science content to decision makers
  - Determining the appropriate level of detail
  - Providing data formats that can be easily understood and transparently used by the decision makers
  - Co-registering science data with application data (often collected by boundary region, e.g., states)
  - Determining the right balance: Highly validated data vs. low cost, rapidly collected data
  - - How highly validated do NASA data need to be?
  - - How well data (or images) can be used?
  - - Maintaining resources needed to sustain the operational decision making system: New data sets, new tools, new technologies
  - - Meeting required spatial and temporal resolution to facilitate decision making

- Changing the decision making tools paradigm by demonstrating the benefits to decision making organizations of employing new tools and technologies
- - Maintaining continuous near real time science data inputs to decision makers. (i.e., Maintaining the timeliness of data for making decisions)
- - Overcoming inertia in the decision making environment.
- - Integrating new data and technologies seamlessly into an operational applications environment
- - Continuity of NASA data

Bridging the Gap - Mitigations

- Keep method of data transfer flexible, to unveil the project of the latest technology advances.
- - Acquire deep understanding of the decision making environment (DME) and needs (i.e., follow the consumption chains from usage scenarios back to relevant data).
- - Strive for seamless as possible an integration of project data and services into existing DME.
- - As much as possible, get stakeholders to really feel they have a stake in the project. The raison d’être for the project should come from the DME as well as the providers of project data and services.
- - Plan for possible changes to the proposed collaboration; DMEs are operational and their needs could change.
- - Involve the expertise of science data providers (e.g., algorithm developer), preferably as members of the collaboration.
- - Plan for training in use of science data and services by DME personnel.
- - Transition DME into a sustainable environment
  - - Build for low maintenance costs
  - - Understand upfront, with the decision making organization, how the DME will be sustained
  - - Should be designed from the beginning to be integrated with the decision making organization systems
- - Document the DME, development and operations

Bridging the Gap - Metrics for Success

- Science data arrives on time to be utilized for decision support at a percent of the time to be specified by the decision making organization
- Science data utilization in the decision support system results in a marked improvement in prediction correctness. Before and after prediction analysis should be planned
- Science data are routinely used by a specified percent of the decision making organization's staff
- Number of references, reports, or publications that cite science data as input to decision making process
- New success: Number of new potential decision support users of NASA science data
- Number of external, non-NASA stakeholders to further collaborate (e.g., requesting additional useful science data products)
- - Forming data interfaces and science data transfers due to growing dependency on the data
- - Suggestions?
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