AIR QUALITY COMMUNITY EXPERIENCES AND PERSPECTIVES ON INTERNATIONAL INTEROPERABILITY STANDARDS
ABSTRACT

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ABSTRACT

The air quality community includes a broad range of organizations across government, academia and industry addressing various components of the air quality system, including near real time monitoring of air pollution concentrations from surface, aerial and satellite sensors, forecasting of air quality conditions, and retrospective analysis of air quality. These activities have generated multiple projects and information systems that address different aspects of air quality science and management. The community has recognized the value of interoperability among these projects and systems and is collaborating in the use of international standards for data and information exchange in developing information networks across these systems. This abstract describes recent efforts and experiences in the use of web standards and anticipated next steps in the evolving air quality community information infrastructure.

Index Terms— air quality, interoperability, standards, GEOSS, HTAP, atmospheric composition

1. INTRODUCTION

Organizations across the air quality information community are working to achieve interoperability among their systems in order to create a network that meets the air quality science, management and policy information and analysis needs more comprehensively than any individual system can on its own. Progress has been made in achieving initial levels of interoperability and in demonstrating more advanced forms of interoperability by leveraging project resources and capabilities through testbeds and pilots with the goal of incrementally building persistent connections among the community to form a robust air quality information infrastructure.

2. AIR QUALITY INFORMATION COMMUNITY

The air quality community spans efforts to monitor the atmosphere (surface, satellite and aerial systems), model

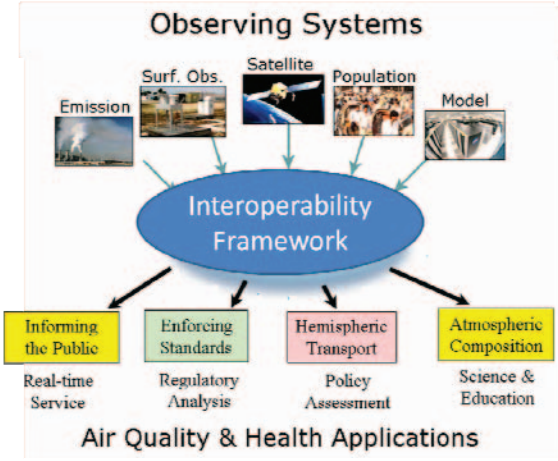

Figure 1.

f future atmospheric behavior and air quality conditions, measure and estimate emissions of pollution and pollution forming gases and particles, and combine those information with socio-economic data for decision making analyses. The vision is to have these data available through an interoperability framework that allows them to be used via various subsets and combinations to support specific research and decision applications (Figure 1).

3. INTEROPERABILITY EFFORTS

Various subsets of the air quality community have been collaborating over the past few years to implement, demonstrate and evaluate interoperability standards in order to make progress toward shared and common framework for networking air quality systems and projects. Some of these efforts are described below.

3.1. GEOSS Architecture Implementation Pilot

The GEOSS Architecture Implementation Pilot-II (AIP-II) was organized with workgroups for societal benefit areas (SBAs) and transverse technologies (TTs). The overall objective of the AQ Workgroup during AIP-2 was to test

and evaluate the GEOSS Common Infrastructure (GCI) from

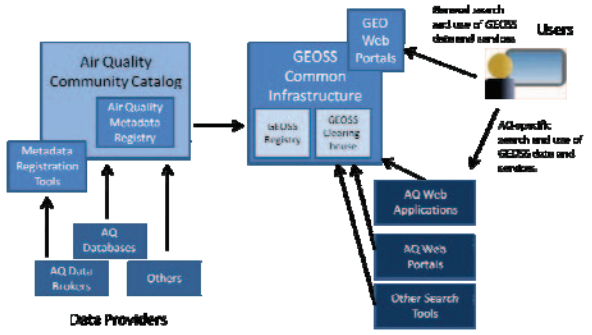

Figure 2.

the perspective of the air quality community and, in the process, define an initial AQ Community Infrastructure that connects with the GCI to share, find, and use distributed data, visualization and analysis services. There are numerous Earth Observations that are available and, in principle, useful for air quality applications such as informing the public and enforcing AQ standards. However, connecting a user to the right observations or models is accompanied by an array of hurdles. The GEOSS Common Infrastructure aims to allow the reuse of observations and models for multiple purposes.

GEOSS mandates that metadata and data are registered using standard protocols such as WMS, WCS and W3C WSDL for data access and ISO 19115 and 19119 for metadata. During AIP-2, these standards allowed the data being registered in community catalogs to be findable in the GEOSS Clearinghouse and automatically accessible through web applications and portals (Figure 2). In particular, the group used OGC WMS, OGC WCS, ISO 19115, and CF-NetCDF.

Based on the experience in AIP-2 key next steps were identified as:

- Coordinate the operation of Clearinghouses to define a core set of metadata elements needed for interoperability.
- Define a process for defining standards implementation conventions for a community and test engines to validate standards implementation compliance/conformance.
- Engage more providers to register data services
- Continue working with user groups in formulating and evaluating user requirements

3.2 HTAP Network

An international Task Force on Hemispheric Transport of Air Pollution (HTAP) was established to develop a fuller understanding of intercontinental transport of air pollution in the Northern Hemisphere. Part of the HTAP initiative involves developing a network across its data and modeling organizations. An initial effort is focused on developing an HTAP data information system that adapts the Web Coverage Service (WCS) as the standard data query language. The adoption of a set of interoperability standards is a necessary condition for building an agile data system from loosely coupled components for HTAP. HTAP members have progressed in evaluating and selecting suitable standards. They also participated in the extension of several international standards, most notably standard names (CF Conversion), data formats (CF-netCDF) and a standard data query language (OGC Web Coverage Service, WCS).

The combination of netCDF-CF and WCS protocols offers the means to create agile, loosely coupled data flow networks based on Service Oriented Architecture (SOA). The netCDF-CF data format provides a compact, standards-based self-describing data format for transmitting Earth Science data pockets. The OGC WCS protocol supports the Publish, Find, Bind, operations required for service oriented architecture.

The HTAP Network effort is working through OGC WCS implementation issues such as:

- Consistency in specifying latitude, longitude bounding boxes
- Specifying time instances and time ranges
- Specifying the coverage name and parameter name as a OGC WCS Coverage
- Reconciliation between OGC WCS specification versions 1.1.0 and 1.1.2

Detailed descriptions of these issues are described here:
http://wiki.esipfed.org/index.php/WCS_Access_to_netCDF_Files

3.3 CEOS Atmospheric Composition Portal

The Atmospheric Composition Constellation (ACC) and the Workgroup for Information Systems and Services (WGISS) within the Committee on Earth Observation Satellites (CEOS) is developing a portal to support interoperability among the atmospheric composition research and applications communities. The portal will provide data access, tools and contextual guidance for an international suite of remote sensing datasets. The initial prototype will provide access to services and data hosted by DataFed, NASA's Goddard Earth Sciences Data and Information Services Center (GES DISC) and the World Data Center for Remote Sensing of the Atmosphere (WDC-RSAT), in St. Louis, Greenbelt and Munich, respectively. Distributed access to data is implemented via interoperability standards, including the Open Geospatial

Consortium's (OGC) Web Map Service (WMS) and Web Coverage Service (WCS). An initial prototype implementation has been developed to compare data from WDC-RSAT, DataFed and GES DISC, using the GES DISC Giovanni tool for online analysis and visualization. Data are transmitted from WDC-RSAT and DataFed via WCS to Giovanni for analysis and the resulting visualization is transmitted via WMS to WDC-RSAT (which is hosting the portal). Users make the data comparison request through a graphical interface that resides on the ACP but that accesses data and analysis services distributed across the ACP network.

International standards are used to the maximum extent possible to enable interoperability for data (CF netCDF), metadata (e.g., ISO 19115/19119) and access methods (WCS) prove quite useful for an overall interoperability framework. However, developing a robust portal to serve a particular research community with applications use cases requires the accommodation of a community's unique needs and can push such standards to their limits.

Some example challenges encountered include:

- Implementing a legend graphic for OGC WMS that allows user specified scale ranges (min, max values)
- Best approach to handling OGC WMS with many data layers resulting in large GetCapabilities documents
- While OGC WCS works reasonably well for data on a regular horizontal grid, it is more difficult to apply to other data structures, such as vertical profile data from a limb sounder.
- The data access relationships arising from distributed data source displayed within the portal raise serious provenance questions, which are not yet accounted for in a standardized way.

The air quality community may need to extend these standards, ideally folding them back into the overall standards through the established processes.

4. SUMMARY AND NEXT STEPS

In general, the air quality interoperability efforts have found success in using existing web standards to achieve a base level of interoperability but have extended their ability to share and use information across systems by extended the standards to meet community-specific requirements. As the community gains experience in how to implement and tailor the standards they will develop best practices that can be shared across the air quality community and more broadly to other interoperability communities for evaluation and potential integration with the formal standards development processes.

The interoperability efforts described in this abstract have focused on OGC standards. However, there is a desire to evaluate the applicability of other web standards for air quality systems, in particular OPeNDAP. The experiences gained with OGC standards are useful because they provide not only specific insights related to OGC standards but also reveal general best practices in achieving interoperability.
An upcoming interoperability activity that is expected to not only advance interoperability among air quality information systems but also provide a common environment in which to connect the multiple interoperability efforts (not only those described above but others in other countries) is Phase 3 of the GEOSS Architecture Implementation Pilot, slated to begin in Spring 2010.