The Importance of Earth Observations and Data Collaboration within Environmental Intelligence Supporting Arctic Research

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Within the IARPC Collaboration Team activities of 2016, Arctic in-situ and remote earth observations advanced topics such as :1) exploring the role for new and innovative autonomous observing technologies in the Arctic; 2) advancing catalytic national and international community based observing efforts in support of the National Strategy for the Arctic Region; and 3) enhancing the use of discovery tools for observing system collaboration such as the U.S. National Oceanic and Atmospheric Administration (NOAA) Arctic Environmental Response Management Application (ERMA) and the U.S. National Aeronautics and Space Administration (NASA) Arctic Collaborative Environment (ACE) project geo reference visualization decision support and exploitation internet based tools. Critical to the success of these earth observations for both in-situ and remote systems is the emerging of new and innovative data collection technologies and comprehensive modeling as well as enhanced communications and cyber infrastructure capabilities which effectively assimilate and dissemination many environmental intelligence products in a timely manner. The Arctic Collaborative Environment (ACE) project is well positioned to greatly enhance user capabilities for accessing, organizing, visualizing, sharing and producing collaborative knowledge for the Arctic.

Key Words: Observations, Environmental, Decision-support, Situational awareness

1. Introduction

Created by the U.S. Congress [1] and now a subcommittee of the National Science and Technology Council (NSTC) in the Executive Office of the President, the Interagency Arctic Research Policy Committee (IARPC) contributes directly in a critical role by advancing scientific knowledge and understanding of the changing Arctic through research planning. The IARPC exercises this role through coordination across 16 Federal agencies [2] and collaboration activities focused in seven research areas with outside federal government partners through an implementation structure which has been comprised of 12 IARPC Collaborations Teams [3]. Never has there been a better time and greater need for such strategic and sustained collaboration on a USA National and international basis. Each of these research areas poses unique challenges to scientists, operators, policy makers and public communities. However, together these research areas promise profound insights into the physical, biological, and human dimensions of the region-insights that will inform researcher, operators, decision-makers and the public which will guide the Nation as we work to mitigate and adapt to rapidly changing conditions in Arctic communities and around the world.

Within the IARPC Collaboration Team activities of 2016[4], Arctic in-situ and remote earth observations advanced topics such as :1) exploring the role for new and innovative autonomous observing technologies in the Arctic; 2) advancing catalytic national and international community based observing efforts in support of the National Strategy for the Arctic Region; and 3) enhancing the use of discovery tools for observing system collaboration such as the U.S. National Oceanic and Atmospheric Administration (NOAA) Arctic Environmental Response Management Application (ERMA) and the U.S. National Aeronautics and Space Administration (NASA) Arctic Collaborative Environment (ACE) project geo reference visualization decision support and exploitation internet based tools. Critical to the success of these earth observations for both in-situ and remote systems is the emerging of new and innovative data collection technologies and comprehensive modeling as well as enhanced communications and cyber infrastructure capabilities which effectively assimilate and dissemination many environmental intelligence products in a timely manner.

2. Approach

The NASA Earth Science Division (ESD) is one of many highly regarded international organizations that conducts a wide range of satellite suborbital, aircraft, balloon and ground truth missions to observe Earth's land surface and interior, biosphere, atmosphere, cryosphere, and oceans as part of a program to improve understanding of Earth as an integrated system. Earth observations provide the foundation for critical scientific advances, situational awareness, environmental data collection and modelling products derived from these observations are used in research, operations, education, economics, resource management and many decision making processes as this environmental intelligence enhances significantly an extraordinary range of societal applications including weather forecasts, climate projections, sea level conditions, water management, disease early warning, agricultural production, and the response to natural disasters.

As the complexity of societal infrastructure and its vulnerability to environmental disruption increases, the demands for deeper scientific insights and more actionable information continue to rise. To serve these demands, NASA's ESD is challenged with optimizing the use of its finite resources among measurements intended for exploring new science research areas, care, characterizing long-term changes in the Earth system, and supporting ongoing societal applications with both research and operational environmental intelligence data tools. This challenge is most acute in the decisions NASA makes supporting measurement continuity of earth observation data sets that are critical components of Earth science research programs, the development of new measurement and user application tool capabilities such as the Arctic Collaborative Environment (ACE) project environmental intelligence geo reference visualization and collaboration decision support and exploitation internet based tool.

3. Arctic Collaborative Environment (ACE) Project

The ACE project is a joint project between NASA Marshall Space Flight Center, the USA Department of Defense Office of the Secretary of Defense, Joint Capability Technology Demonstration Program Office, U.S. Army Aviation and Missile Research Development and Engineering Center and the International Arctic Research Center at the University of Alaska Fairbanks. The goal of the ACE project is to enhance awareness and understanding of the Arctic environment, and will support international research, resource management, climate studies, and cooperative operational response to regional events with both content and context awareness, access and a collaborative use capability for both operational and environmental intelligence information.

3.1. Environmental Intelligence (EI)

Traditionally, researchers collect data, develop models, and communicate results through well-established channels that are often slow and inefficient. While the vetting of scientific results ensures that the conclusions are of the highest quality, the process is not well-aligned with the need for rapid information delivery to potential users among research, operations and directly affected public. Environmental Intelligence (EI) is a system through which information about a particular region or process is collected for the benefit of decision makers through the use of more than one inter-related source. EI is timely, reliable and suitable for decision matrix support and integrates observations with modeling, effective data management and data dissemination. The environmental intelligence cycle includes the collection, processing, analysis, assessment and application of both content and context information that then informs the next round of information collection. The faster the environmental intelligence cycle can be performed, the more responsive an entity or agency can be to the needs of stakeholders within the research, operations, education and public user communities. EI is geospatial and other knowledge derived and used in the space and time domain for the purpose of gaining situational awareness and understandings to support research, education, operations, public needs and policy decisions (communities of interest) can be categorized into two basic types of critical knowledge contribution, content and context intelligence.

Environmental data and information derived from earth observations such as weather, ocean conditions and climatology has long been used as context intelligence to support operational awareness, research and planning for all communities of interest. The need to know and the capability to use environmental context information has been increasing rapidly within the research, education, operations, public and policy decisions maker communities in order to better understand and predict a much more comprehensive awareness of the current, future and past influences on specific user Arctic content intelligence. Our ability to observe, collect, display and predict environmental context information is growing, when we provide situational observational data or make predictions, decision makers, the public and operators are taking advantage of this added value context awareness and are demanding rapidly increasing amounts of Environmental Intelligence. Environmental Intelligence is actionable information based upon well founded research and is derived from robust application of science principles, observations, monitoring, assessment, forward and backward modeling, data accessibility and user capable tools .The successful use of geo spatial environmental intelligence derived from earth observations requires a strong, timely and reliable collaborative relationship among the research, operational and public communities. In order to contribute to this success goal, the ACE project is addressing multiple near term, mid-term and long term objectives:

Near-Term, Tactical

- Provide web application, map-based tools for collaborative response to regional activities, studies, and events
- Enable sharing of Arctic geo-referenced maritime and terrestrial data from existing and new remote sensing assets, models, operational status, and in-situ observations
- Provide a real-time collaborative platform for a common Arctic Awareness, study capability, and observation assimilations

Mid-Term, Operational

- Encourage open sharing of operational, research, and educational data and models
- Execute interagency technology development and deployment
- Facilitate international Arctic research
- Identify existing data gaps, new instruments to obtain this data, and formulate enabling missions to enhance Arctic understandings through the use of ACE

Long-Term, Strategic

- Engage the International Arctic Community
- Identify new opportunities for technology
- Identify and define new data sets, instruments, and

infrastructure to support situational awareness, research, observations, and missions that will provide enhanced research, operational, and societal benefits within the Arctic region.

3.2. ACE Web Based Application

The ACE tool provides an open source software application that is Internet based, open-access, and Arctic-focused, for collaborative climate analysis, environmental research, and situational awareness decision-support. The ACE web based tool integrates geo-referenced data from existing earth remote sensing assets, models, and in situ observations and provides for collaborative monitoring, analysis, and visualization based on earth observation data, imagery, and modeling thus enhancing local, regional, and international cooperation and coordination of research and operational activities supporting long-term environmental planning and near-term actions in response to climatic, environmental, and situational changes occurring in the Arctic Region. The ACE tool enables the exchange and real-time sharing of multi-layer visualization workspaces of data, imagery, and models for use in the Arctic Region and provides a collaborative environment for common areas of interest for the Arctic Nations including collaborative chat with automatic language translation. The ACE tool is in the final stages of development for full public release and is a future collaborative and organizing software tool that could be highly important to earth observation data and modeling users working towards understanding and communicating critical environmental intelligence for the Arctic.

4. Conclusions

A sustainable Arctic observing system that supports sharing of data, knowledge and understanding will not only be heavily reliant on robust autonomous earth observation technology but equally on enhanced environmental intelligence gathering, interpretation, application, distribution and collaboration supporting improved research, operational situational awareness, decision support and communities of engagement on a National and international basis. ACE is endorsed by the International Arctic Council as an approved project supporting the Sustaining Arctic Observing Network. In addition, ACE was identified by the White House Office of Science and Technology Policy Arctic Research Plans for FY2012- FY2016 and FY2017-1021 as a strong potential tool for supporting the cyber infrastructure to support the Arctic research and operational communities. The ACE project is well positioned to greatly enhance the capabilities for data organizing, access, visualization, sharing, collaboration and understandings to support users within the research, operations and public communities of interest for the Arctic domain.

References

[1] The Arctic Research and Policy Act of 1984 (ARPA), Public Law 98-373, July 31, 1984, as amended by Public Law 101-609, November 16, 1990.

[2] National Security Presidential Directive/NSPD 66, Homeland Security Presidential Directive/HSPD 25: Arctic Region Policy, The White House, Washington DC, 2009.

[3] National Strategy for the Arctic Region, The White House, Washington DC, 2013

[4] IARPC Collaborations: www.iarpccollaborations.org