NASA Science Mission Directorate
Research Opportunities in Space and Earth Sciences
Advancing Collaborative Connections for Earth System Science
Abstracts of selected proposals
(NNH13ZDA001N-ACCESS)

The ACCESS Cooperative Agreement Notice (CAN) solicits projects that provide strategic, near-term improvements in NASA's Earth science data and information systems by leveraging existing technologies. The specific objectives of the 2013 ACCESS announcement are (1) improvements in user's ability to efficiently discover, find, access, and readily utilize useful science content from NASA's increasingly large volumes of multi-mission, multi-instrument Earth science data; (2) tools that improve and expand the accessibility and usability of NASA's Earth science observational data for the modeling and model analysis communities; (3) improving access to NASA's Earth science data systems and data usability for mobile device users (4) enabling discovery, search, and access across both NASA and non-NASA data systems; and (5) other tools and technologies that enhance the accessibility and usability of Earth science data and extend the reach of NASA's Earth Science Division IT investments to new users and communities.

A total of 58 proposals were received for this announcement. All proposals were peer evaluated using an expert panel review. The Earth Science Division of NASA's Science Mission Directorate selected 12 proposals for two-year awards pending satisfactory budget and work plan negotiations. Some of these awards will be partially funded. These projects will help to further improve NASA's Earth Science Division's heterogeneous and distributed data and information systems.

Andrea Donnellan/Jet Propulsion Laboratory
Geodetic Imaging Gateway for Modeling, Analysis, and Response

We will provide access to GPS, InSAR, and UAVSAR geodetic imaging observations through a web- enabled map-based data product search and analysis gateway (GeoGateway). GeoGateway will provide users the ability to customize search and download of geodetic imaging products through an intuitive map interface and interactively perform analysis with capability for further offline analysis. This project utilizes mature QuakeSim and E-DECIDER map-based data and analysis tools to enable users to efficiently find, understand, and interact with multiple heterogeneous NASA Earth science data sets through a mobile- and desktop-compatible Web interface. The objective is to make NASA data readily and intuitively available to science and applications users, including non-experts in GPS and InSAR/UAVSAR observations. End users include disaster responders and hazard scientists.

We will integrate and deploy existing QuakeSim tools that are built on the Open Geospatial Consortium (OGC) compliant GeoServer and the E-DECIDER GIS and mobile device location awareness tools. Specifically users will be able to: 1) select a region of interest, 2) view available heterogeneous data products including UAVSAR, InSAR, GPS, and earthquake faults, 3) turn layers of interest on and off, 4) change color mapping of the InSAR/UAVSAR observations for more intuitive understanding of a

particular product, 5) display in graph form selected segments of the data products, including GPS time series and UAVSAR line of sight ground range change, 6) download customized sets of data products, and 7) view the observations on a mobile device with location awareness for field application and upload relevant images back to the data system.

GeoGateway will be used for scientific discovery as well as field and disaster response applications by providing data overlay and visualization, interactive analysis features, and data product download. The non-interactive backend data processing is carried out through the GeoServer infrastructure to support Web Processing Service (WPS) workflow standards with related provenance support. The system will be robust and reusable, with open source development that allows for maintainability and extension of the application. We will provide for the addition of new data sources and analysis tools into the map interface framework through open standards and APIs. Additionally, other institutions can adopt and deploy the tools either as an iframe in a browser, using REST interfaces, or by using the source code.

Christopher Lynnes/Goddard Space Flight Center
Federated Giovanni for Multi-Sensor Data Exploration

We propose to establish a federation of cooperating data centers, each maintaining its own Giovanni (Geospatial Interactive Online Visualization and Analysis Interface), while sharing datasets among each other to support data inter-comparison. Giovanni has long been a popular tool among remote sensing data users of the Goddard Earth Sciences Data and Information Services Center (GES DISC). It supports about two dozen visualization and analysis services that enable interactive exploration of the data, a key early step in data analysis. Giovanni brings usability, a low learning curve, and the ability to provide visualizations without downloading large volumes of data to the user's location. The trend toward more multi-sensor analysis has further elevated the importance of Giovanni's comparison services (scatterplots, correlation map, difference maps, map overlay, time series overlay). However, one of Giovanni’s limitations is the relative dearth of datasets from NASA data centers other than the GES DISC. Providing Giovanni’s capabilities to other data centers through federation could dramatically increase the number of datasets that are available to interactive data exploration and inter-comparison. This is particularly beneficial to science researchers studying data from multiple sensors and satellites.

Most data variables in Giovanni have come from datasets archived at the GES DISC. However, scientist and user requests for external datasets in Giovanni (one of the more common user requests) have led to the inclusion of several data sets from other data centers (e.g., MODIS Level 1 and Atmospheric Archive Data System, Atmospheric Sciences Data Center). Unfortunately, supporting external datasets by the GES DISC is difficult to sustain over the long run for reasons of efficiency, funding and policy. In order to ensure that multi-instrument, multi-mission data comparisons in Giovanni can be sustained in the long term, it is essential to enable other Distributed Active Archive Centers (DAACs) to employ Giovanni themselves for their own datasets and to share those datasets with each other through the Giovanni infrastructure. This Federated Giovanni would answer the ACCESS call for Tools and Technologies That Improve

Users Ability to Efficiently Discover, Find, Access, and Readily Use Multimission, Multiinstrument Earth Science Data (sec. 1.2.1).

The recent evolution of Giovanni has led to a modular system based on common community standards, giving rise to the possibility of a Federated Giovanni. Federated Giovanni would allow each DAAC to configure and deploy its own Giovanni, while also allowing the various Giovanni deployments to incorporate data sets from each other for data inter-comparisons. In order to meet the different goals and needs of the DAACs, Giovanni federation would be enabled at three different support tiers, with increasing levels of investment and autonomy in offering Giovanni services:

Tier 1 would have the GES DISC hosting a Giovanni portal for DAACs looking to support only a small amount of data; however, the other DAAC would configure, test and maintain the dataset and portal configuration.

Tier 2 would allow the other DAAC to easily deploy a Giovanni Virtual Machine on the hardware of their choice.

Tier 3 would allow DAACs to customize or otherwise enhance the source code, and contribute the enhancement back to the Giovanni source baseline.

In the Federated Giovanni, long-term sustainability is attained by distributing the ability and responsibility for supporting datasets in Giovanni out to the designated DAACs. These DAACs are thus able to decide how much effort to expend on supporting a given dataset in Giovanni (vs. other services, or other datasets). They are also more efficient at supporting the dataset, with better knowledge about the domain, the dataset and the user community for that data.

Chris Currey/Langley Research Center
Multi-Instrument Intercalibration (MIIC) Framework: Extensions and Deployment

Improving the accuracy of the satellite-based Earth Observing System is a crucial objective for climate science. Climate quality measurements require accurate calibration. Intercalibration ties the calibration of one instrument to a more accurate, preferably SI-traceable, reference instrument by matching measurements in time, space, wavelength, and view angles. The challenge is to find and acquire these matched samples from within the large data volumes distributed across international data centers. For intercalibration typically less than 0.1 % of the data volume are required for analysis. Software tools and networking middleware are needed to intelligently select and acquire matched samples from multiple instruments on separate spacecraft. Matched instantaneous observations are also used in cloud, aerosol, and model comparative analysis studies. The Multi-Instrument Intercalibration (MIIC) Framework is a collection of software to support intercalibration and intercomparison studies within NASA and NOAA data systems.

The World Meteorological Organization (WMO) Global Space based Inter-Calibration System (GSICS) working group analyzes methods and recommends algorithms to improve the calibration of both Low Earth Orbit (LEO) and Geostationary Earth Orbit (GEO) instruments. We have implemented a number of the GSICS recommended LEO-LEO and LEO-GEO algorithms as part of the ROSES-2011 Multi-Instrument Intercalibration (MIIC) Framework. We have demonstrated the feasibility and benefit of distributed services built on top of the OPeNDAP networking middleware and server-side functions to support CAL-VAL activities. For this proposal we will extend the features of the MIIC Framework and deploy web services with access to data from both the NASA LaRC Atmospheric Sciences Data Center (ASDC) and the NOAA National Climate Data Center (NCDC) Comprehensive Large Array-data Stewardship System (CLASS). We will leverage the mature capabilities from OPeNDAP, the ASDC, the NCDC, and work performed in the earlier MIIC effort.

The MIIC aggregation services intelligently select and acquire matched data on-the-fly from both data centers. Event Prediction, Data Acquisition, and Analysis web services are used to locate, acquire, and process matched satellite observation data. Users submit instrument sampling and filtering criteria through a web interface or RESTful API. Event Prediction identifies coincident measurements with matched viewing geometries prior to data download using complex orbit propagation and spherical geometry calculations. Data Acquisition communicates with OPeNDAP-MIIC server-side functions to match measurements by resampling data onto common Earth referenced equal angle grids, instrument instantaneous field-of-views (IFOVs), or spectral grids. This combination of intelligent selection and server-side processing significantly reduces network traffic and data to process on local servers. We will demonstrate intercalibration, intercomparison, and model comparison with observations using CERES, CrIS, VIIRS, GOES, SCIAMACHY, and Observing System Simulation Experiments (OSSE) data. The MIIC Framework software will be generalized to support comparative analyses using both Level 1 and Level 2 data parameters. The Event Predictor will be extended to identify satellite instrument data over surface targets such as Libya-4 and Dome C. Histogram data analysis (1D and 2D) and additional atmospheric and surface type filtering will be added. The deployment of the MIIC Framework will enhance access to large distributed collections of multi-mission, multi-instrument data, at both NASA and Non-NASA data centers, in support of intercalibration and other comparative analysis studies.

Edward Armstrong/Jet Propulsion Laboratory
Enhanced Quality Screening for Earth Science Data

Data subsetting and aggregation services such OPeNDAP, LAS and THREDDS are useful tools for earth science users to more easily access large volumes of data, especially satellite data. Most NASA and other government data centers now offer these as part of their standard services suite. However, the data of interest frequently contains commensurate quality information in the form of a flag or other metric that a user must apply to the actual geophysical data to make it meaningful and understandable. In the case of OPeNDAP this is a three-step process. A user must first request the geophysical data, then request the quality data, and finally apply the quality information (e.g., a flag)

to the geophysical data in order to make the result usable for further analysis or even visualization.

To address the Tools and Technologies That Improve Users' Ability to Efficiently Discover, Find, Access, and Readily Use Multimission, Multiinstrument Earth Science Data interest area of the solicitation we propose to design and deploy a quality screening service to make the discovery and application of quality information as transparent to the user as possible. In function, this will be a web-based service that will allow any client to make a RESTful URL based request for data access and subsetting for a granule, while in the same request, accessing and applying the quality information derived from user specification. The system will utilize the NASA developed Webification (AKA w10n) service, that provides efficient RESTful access to all facets of a data store including attributes, metadata, and array data. A query service based in part on a JPL developed OpenSearch protocol will be implemented to bridge different data and quality attribute dialects and generate the proper RESTful requests to one or more w10n instances from a single high-level query. Where possible, our approach will also leverage the quality flagging standardization that is found in rich metadata content satellite granules that adhere to the Climate Forecast (CF) metadata conventions. For example, the CF attributes flag_meanings, flag_values and flag_masks can be identified and used to autonomously recognize arrays that contain quality information, and provide meaning and context to quality flags. This service will first incorporate data streams from the Group for High Resolution Sea Surface Temperature (GHRSST) as well as preliminary products from the SMAP NASA decadal mission. Each of these missions produce data granules that are complex but are well documented with rich metadata. Although we focus on the datasets from these two missions, our goal is to provide a generalized and streamlined service that can be applied to any earth science data that meet a minimum of metadata requirements. Our primary focus will be to improve scientific computing of satellite based earth science data but our service will also support on-demand visualization, real-time data exploration and experimentation, and any other service or methodology that requires the application of quality flagging for data utilization.

Ramakrishna Nemani/Ames Research Center
NASA Earth Exchange: Improving Access to large-Scale Data Analytics Infrastructure

The overall goal of the proposed project is to enhance access and analysis of very large datasets by Earth science researchers and scientists using the NASA Earth Exchange (NEX, Nemani et al., 2011, nex.nasa.gov). NEX is a collaborative platform that brings together state-of-the-art computing facility with large volumes (hundreds of terabytes) of NASA satellite and climate data as well as number of ecosystem and climate models. NEX facilitates end-to-end execution of Earth science research projects complete with data acquisition, process executions and result sharing. The component that will be the core of the NEX analytics services is SciDB - an advanced analytics platform that provides massively scalable complex analytics capabilities with data versioning to support the needs of scientific applications. SciDB is an open source software platform that runs on a grid of commodity hardware or in a cloud. Data on NEX is currently

organized using spatio-temporal schemas in relational and NoSQL datastores that enable NEX users to search for data based on number of different criteria. Currently mostly metadata are stored and users have to use existing tools and utilities to access and process the information within the individual datasets, which is at time limiting especially during the exploratory phase of scientific research. In order to ease adding new datasets to SciDB, we will first develop a set of loaders that will facilitate the import and transformation of the NEX-held datasets into the internal SciDB structures. Because there are number of similarities in the formats of Earth science datasets on NEX, there will be a high degree of reuse of the loaders. We will work with the NEX science team and the NEX User Working Group to prioritize datasets and the loaders that will need to be initially developed. Because we want to integrate not only full datasets, but also information such as features and anomalies that are being currently produced by number of existing NEX projects, we propose to develop a set of tools that will ease the integration of such results with the analytics infrastructure. This will greatly enhance the scientistsâ€™ ability to go beyond their existing datasets and readily corroborate results within multi-mission, multi-instrument global datasets. Finally, we will capture the analytics processes and queries in the existing NEX workflow and provenance system, which further enhances the process reuse, as well as traceability and visualization of results. The proposed integration effort will greatly enhance data analysis capabilities and services to the current and future research on NEX.

Molly Brown/Goddard Space Flight Center
NASA Earth Science Data Products for AGRA Farmer Management and Agro-Input Cell Phone Systems

One of the most immediate and obvious impacts of climate change and weather variability is on the weather-sensitive agriculture sector. These impacts will occur at both local and global scales affecting trends in rainfall and temperature, and ecological resilience, while increasing need for ecosystem services such as fresh water provision and cycling of nutrient waste. In addition there are likely to be changes in economic context with increasing volatility of international commodity prices, which is potentially the most important factor in the ability of humanity to meet its growing food needs. The most vulnerable and food insecure regions of the world such as the Horn of East Africa need locally relevant information products and tools that can reduce the risk posed by food production shortages while enabling productivity increases to meet the needs of a growing population.

This project combines information technology and remote sensing expertise to provide a distributed and platform-independent way for farmers and traders in Africa to access NASA remote sensing satellite data and products that can be used to improve their knowledge of crop and market conditions. Responding to A36 section 1.2.3: Innovative Technologies and Tools we bring together existing communities in applied science programs and information technology to significantly expand the access cell phone users in Africa have to NASA Earth science information. Our primary partner in this effort is the Alliance for a Green Revolution in Africa (AGRA), an Africa based organization working in partnership with governments, agricultural research organizations, farmers,

private sector, civil society and other rural development stakeholders to significantly and sustainably improve the productivity and incomes of resource poor farmers in Africa.

Decades of investment in vegetation, rainfall and crop modeling systems by NASA has created focused satellite-remote sensing derived products useful for monitoring African agriculture. These products are currently only available via the internet and require significant connectivity and knowledge to find and access appropriate NASA and other relevant agricultural datasets. In this project, NASA Goddard Space Flight personnel with information technology programming expertise will interface with experts with remote sensing and modeling experience to develop 1) simple text messaging of weather conditions and probability of crop failure information for user-input locations, 2) create a online website that can provide weather and probability of crop failure information using images and time series, and 3) an application for both iPhone and Android that will provide text, image and time series satellite-derived farmer information. This new system will be named NASA-mFarms.

Michael Wimberly/South Dakota State University
Expanding Earth Science Data Access for Public Health Research and Applications

Increased awareness of the effects of climate and land use change on human health has highlighted the need to incorporate remotely-sensed environmental monitoring data into epidemiological research and public health applications. Satellite remote sensing is a critical source of information about climatic variability that provides consistent, repeatable environmental measurements across nearly the entire surface of the Earth. However, disciplinary and technological barriers still limit its widespread application in the public health arena. To bridge this gap, we have developed the Epidemiological Applications of Spatial Technologies (EASTWeb) software tool to provide health scientists with automated and customizable access to earth science data. EASTWeb is an open-source, client-based application that automatically connects to online archives and acquires reprojects, mosaics, and acquires, processes, and summarizes selected remote sensing datasets. The raw data are then used to calculate and summarize a variety of environmental metrics which are summarized and stored in a relational database. The software first builds a historical database, and then automatically updates it as new data become available. Users can query these data and integrate them into GIS and statistical analysis software for analysis and modeling. EASTWeb is programmed using JAVA for user interface development and overall system control. Spatial analyses are carried out using the GDAL open source geospatial library. PostgreSQL is used to store and manipulate the resulting data summaries. The current version processes and integrates data from multiple online archives including the NASA/USGS LP DAAC, NASA Goddard DISC, and USGS FEWS NET.

To date, the software has been successfully implemented on multiple systems with multiple users to support two public health applications: malaria early warning in the Ethiopian highlands and West Nile virus risk forecasting in the northern Great Plains of the US. These successful prototypes have highlighted the tool’s broader potential for use in public health and other fields. Therefore, the overarching goal of this project is to

improve software extensibility, customizability, documentation, and distribution to the point where it can be used more broadly within the public health community (RRL 8-9). To achieve this goal, we will (1) Extend the capabilities for processing multimission, multiinstrument earth science data by developing a plug-in framework for integrating existing and new data streams; (2) Enhance the user interface to facilitate customized data screening and processing into a format useful to the public health community and other end users; and (3) Expand documentation and develop a distribution strategy that will make the EASTWeb software more accessible to health scientists and other members of the scientific community.

This work will specifically address the needs of the public health research and applications user communities, although we expect that the resulting tool will also be useful in a wider range of fields. We will leverage the existing software that we have developed through our previous NIH-and NASA-funded research by adding enhancements that will better address the varied needs of the user community. This work will be accomplished through collaboration between an earth system scientist with experience in public health application of remote sensing (Wimberly) and a computer scientist with experience developing applications for automated acquisition and processing of remotely-sensed earth science datasets (Liu). The resulting tool will greatly expand end users ability to automatically access data from online archives in near real time and to effectively synthesize heterogeneous data from multiple sources to produce usable information that will support novel research and effective applications in the health sciences and related fields.

Charlie Zender/University of California at Irvine
Easy Access to and Analysis of NASA and Model Swath-Like Data

Swath-like data (hereafter SLD) are defined by non-rectangular and/or time-varying spatial grids in which one or more coordinates are multi-dimensional. It is often challenging and time-consuming to work with SLD, including all NASA Level 2 satellite-retrieved data, non-rectangular subsets of Level 3 data, and model data on non-rectangular grids. Researchers and data centers would benefit from user-friendly, fast, and powerful methods to specify, extract, serve, manipulate, and thus analyze, SLD. This project addresses these needs by extending the functionality, user-base, and integration into NASA data services of the netCDF Operators (NCO), an open-source scientific data analysis software package which our current ACCESS project has augmented with HDF capabilities applicable to most archived and virtually all new NASA-distributed data.

The remote sensing and the weather and climate modeling and analysis communities face similar problems in handling SLD including how to easily: 1. Specify and mask (include/exclude) irregular regions such as ocean basins and political boundaries in SLD (and rectangular) grids. 2. Bin, interpolate, average, or re-map SLD to regular grids.

3. Derive secondary data from given quality levels of SLD. These common tasks require a data extraction and analysis toolkit that is SLD-friendly and, like NCO, is used in both communities. We will improve NCO to support these tasks so that users can 1. Analyze regions specified by familiar names (including Climate-Forecast standardized region names) or user-supplied boundaries. 2. Access sophisticated statistical and regridding functions that are robust to missing data. 3. Create, save, share, and re-use user-defined functions or recipes. These capabilities will ease data specification, software-reuse, and, because they apply to SLD, minimize transmission, storage, and handling of unwanted data. Proof of these claims will be demonstrated by applying the improved NCO to a prototypical, NASA-relevant, Earth System Science research problem: to characterize, evaluate, and intercompare Earth System Model-simulated and NASA-retrieved surface energy budget trends and variability in Greenland, a cryosphereic region experiencing rapid darkening and nearly unprecedented melt.

NCO is a robust element of the scientific software stack used by the community of Earth Science researchers inside and outside of NASA for over fifteen years. We will coordinate infusion of the enhanced NCO into NASA Earth Science data services offered by the Goddard DISC and the LaRC ASDC. Collaboration will include working with data portals such as Giovanni (which already uses NCO) to understand, refine, and address data center needs for SLD capabilities. These centers will expand the community of users interested in their Level 2 data, while researchers will benefit from simplified processing of SLD with higher spatial and temporal resolution and information content than Level 3 data. The proposed work will improve users' ability to access and use EOS data, with methods seamlessly adopted by the modeling and model analysis communities (both are ACCESS 2013 goals). The improved NCO capabilities will apply to all geophysical data archived in HDF and netCDF formats.

The PI is a long-standing climate modeler, software developer, and NASA-funded researcher who understands obstacles to model evaluation by and use of NASA data and who has developed, in the form of NCO, an elegant solution to some. One Co-I is a long-standing information systems architect familiar with NASA data services' operations, community, and vision. The other is primary software engineer responsible for serving data from ASDC. We participate in relevant geoscience communities, including ESDS working groups, IPCC climate assessments, and community model development.

David Blodgett/U.S. Geological Survey
High Performance Multidisciplinary Open Standard Data Services to Serve Terrestrial Environmental Modeling

The primary objective of this proposal is to advance the availability of Land Processes Distributed Active Archive Center (LP-DAAC) Moderate Resolution Imaging Spectroradiometer (MODIS) derived products and the Langley Research Center (LARC) Clouds and the Earth's Radiant Energy System (CERES) data sets to land-surface modelers. Model development and associated scientific assessments that are part of the U.S. Geological Survey National Water Census (NWC) and National Climate Change and Wildlife Science Center's (NCCWSC) network of academic Climate Science Centers (CSC) will be applied to demonstrate the data service outcomes of this work.

The U.S. Geological Survey's (USGS) Center for Integrated Data Analytics (CIDA), a software development team specializing in scalable services for multidisciplinary data sharing and access needs, will lead this effort. CIDA data managers and software developers will work with the LP-DAAC and LARC to implement and vet robust services for their data sets and with USGS science and model development teams to demonstrate the services utility.

These web service interfaces will be implemented in two widely used USGS models. The Soil Water Balance Model that calculates a spatially distributed soil water balance and Software for Assissted Habitat Modeling where the services will be used directly to build and run species distribution models for landscape management decision making. Additional scientific applications around impacts of climate and land use on the hydrologic cycle and ecosystems are being identified and will be presented in the final proposal.

Methods:

CIDA staff have working relationships with the Unidata Program Center team responsible for NetCDF-Java and the THREDDS Data Server, and the Open Source Geospatial team responsible for GeoTools and GeoServer. These two open-source teams are community hubs for implementation of production-grade web servers that can provide numerous source data formats in a variety of output formats through standard web service interfaces.

NASA datasets will be represented using these, and possibly other server implementations. Any software modifications necessary to map NASA data into the applicable common data model will be implemented and committed back to an open-source project. In this way, updates to the open-source projects will be compatible with NASA data going forward.

The CIDA's Geo Data Portal (GDP) allows environmental modelers to access simple server-side processing that extracts meaningful summaries of very large data. The GDP is implemented to allow remote access to any data available via a suite of international data and service standards. As part of this proposal, Geo Data Portal

processing capabilities will be deployed close to the MODIS and CERES data to help provide easy access and value added products to data consumers.

This proposal will include a range of functionality from data discovery to access and processing mature open source projects from both climate and geospatial science domains. The same patterns are being used assist the USGS NCCWSC and NWC (among other initiatives) to access data from, share data with, and disseminate data to partners. We propose to bring the MODIS and CERES data products into this data partnership.
Significance to solicitation:

This proposal is directly applicable to the ACCESS program goals. Multimission, Multiinstrument goals will be achieved through the application of both CERES and MODIS data products. The primary technical goal of the proposal is the application of tools and technologies that improve discovery, access, and ease of use of data products. A major emphasis of this proposal is on access to data and data products for modelling various processes in the hydrology and ecology domains. The outcomes of this proposal will allow environmental data consumers to access data from systems in USGS, NOAA, NASA, and others using the same tools.

William Teng/ADNET Systems, Incorporated
Enhancement of Mutual Discovery, Search, and Access of Data for Users of NASA and GEOSS-Cataloged Data Systems

The ongoing data rods ACCESS project (NNH11ZDA001N-ACCESS; PI: Bill Teng), by removing a longstanding barrier to accessing and using NASA data (i.e., the Digital Divide) for the hydrology user community and, specifically, the CUAHSI Hydrologic Information System (HIS) users, has already demonstrated a dramatic unlocking of the potential of the data (thus far, selected variables of the North American Land Data Assimilation System (NLDAS) and Global Land Data Assimilation System (GLDAS) data sets). These data rods Web services, however, though visible and accessible through the HIS and through the Goddard Earth Sciences Data and Information Services Center (GES DISC), are not easily discoverable by users of other non-NASA data systems. This is also the case for NASA EOSDIS (Earth Observing System Data Information System) data, in general. Conversely, there are vast amounts of non-NASA hydrological data (e.g., those accessible via Web services from CUAHSI HIS) that are not visible and accessible from NASA systems, such as the Simple Subset Wizard (SSW), a common gateway to data archived at NASA data centers.

The Global Earth Observation System of Systems (GEOSS), as a catalog of catalogs, would be a logical mechanism for providing access to the time series coverages of the data rods, as well as on-the-fly time series converted from other EOSDIS data, commonly archived in the time-step array format. There is a just-begun multi-organizational GEOSS Architecture Implementation Pilot Phase-6 (AIP-6) Water Services project (with participants that include members of this ACCESS proposal team) that is aimed at the GEOSS Water Strategic Target â€œto produce [by 2015] comprehensive sets of data and information products to support decision-making for efficient management of the world's water resources, based on coordinated, sustained observations of the water cycle on

multiple scales. The scope of the Water Services project is to develop a global registry of water data, map and modeling services catalogued using the standards and procedures of the Open Geospatial Consortium and the World Meteorological Organization. This AIP-6 project builds on the results of AIP-5, for which a global publication of federated observation services for streamflow was successfully demonstrated. The individual Web Feature Services are registered with the GEOSS Common Infrastructure (GCI) and shown to be discoverable therein. Each feature in a map service describes one observed time series accessible at one location and, if available, contains a link to that time series service. Furthermore, it has subsequently been demonstrated that this infrastructure can also be adapted to provide time series access to model grid information (e.g., NLDAS, GLDAS) or grids of information over a geographic domain for a particular time interval. These prototype efforts have shown the potential for enhancing discovery, search, and access of NASA data by non-NASA users. That these prototypes have been successfully implemented strongly suggests that the proposed work can be similarly carried out and with low risk.

The overall approach of the proposed project comprises the following:

1. Leverage Simple Subset Wizard (SSW) API and ECHO
2. Register data rods and on-the-fly (OTF) converted time series services in GEOSS
3. Develop Web Feature Services (WFS) for data rods and OTF converted time series
4. Enhance metadata in WFS
5. Make non-NASA data visible to NASA users by leveraging SSW
6. Develop hydrological use cases to guide project deployment and serve as metrics

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Paul Stackhouse/Langley Research Center
Enabling Web-Based GIS Tools for Internet and Mobile Devices To Improve and Expand NASA Data Accessibility and Analysis Functionality for Renewable Energy and Agricultural Applications

In the mid-1990s, an effort began that eventually involved collaboration with DOE NREL, Natural Resources Canada RETScreen International, and numerous other partners in industry and universities to make progressively improved NASA science data products available for renewable energy and other energy related applications over the internet. In 2002, NASA Applied Science projects were initiated providing a more focused effort to accomplish the goal of empowering energy related decision support tools using NASA meteorological and climate related data sets. This resulted in a systematically improved web portal called the Surface meteorology and Solar Energy (SSE, http://eosweb.larc.nasa.gov/sse/) that aimed to make long-term solar energy and meteorological data sets available to Energy sector related industries, including sustainable buildings and agroclimatology. The web usage of these tools in terms of numbers of users and data delivered has grown nearly exponentially at times. The success of the web site was found in the provision of data sets via ASCII on a site specific basis for use in decision support tools. However, in the last few years there has been a change in the user requests for more geographically based information. This coupled with recent changes in web site security procedures that reduced capabilities of

the current site necessitates a significant upgrade to continue disseminating data sets for energy and agricultural uses.

The NASA LaRC Atmospheric Science Data Center has initiated a pilot program for the agency to make available off the shelf Geographic Information System (GIS) tools. These GIS tools enable the visualization and data analysis of data sets that provide for a more convenient way to access and use the data for individual needs and decision support systems while retaining the ability to obtain data parameters for a single location. A large number of government and industrial agencies use GIS tools for data analysis. Additionally, there are many new tools for mobile GIS applications where decisions are required in the field, such as in energy industry applications. This proposal, aims to open up to government agencies, industry and individuals a large suite of data parameters produced from NASA science projects and tailored specifically to the renewable energy and agricultural industries to greatly expand the accessibility and usefulness of these parameters for decision support systems utilizing a GIS based SSE by:
(1) Process and reformulate current data to be consistent with ESRI and openGIS tools useful for decision support systems.
(2) Develop functions to improve capability and analysis that mimic the capabilities of the current site to produce on-the-fly data products, extending these past the single location to regional and global scales.
(3) Update the current web sites to enable both web-based and mobile application displays of these parameters, the latter of which will be optimized to the mobile platform independent of its type.
(4) Interact with user communities in government and industry to test formats and usage or optimization and develop a series of metrics to allow for monitoring of performance.

A major expected significance on the inclusion of GIS with SSE will be the development of Open Geospatial Consortium (OGC) compliant web services (WMS, WCS, WFS, WPS) to serve a part of the renewable energy and agricultural application users relying upon GIS services and tools. Each data product and OGC service will be registered within ECHO, the Geospatial Platform, and Data.gov so that the data are easily discoverable within NASA as well as external to NASA. The Geospatial Platform and Data.gov are both efforts to provide wider access to geospatial data, services, and applications for use by government agencies as well as the public. This will support cross agency and cross organization interoperability and access to NASA SSE data products and services.

Charles Meertens/UNAVCO
Plug and Play GPS for Earth Scientists: Providing Immediate Access to Low-Latency Geodetic Products for Rapid Modeling and Analysis of Natural Hazards

The problem addressed by this project can be explained by the following scenario: Suppose a group of scientists in Africa would like to install a GPS receiver to study volcanic activity in the East Africa Rift, adding significant extra value to existing seismometers of the newly developing AfricaArray. These scientists are growing experts on the East Africa Rift and at modeling volcano deformation, but have little expertise in

geodesy, which they perceive as a barrier to proposing their idea, and to carrying the project to its full potential should they get funding. As a consequence, their proposal is either not written or is declined, the GPS receiver is never installed, scientific progress in understanding the East Africa Rift is impeded, the hazards from volcanoes are not mitigated, and there is a missed opportunity for scientific capacity building in a developing region. There are so few instruments in Africa, the whole world (not just scientific community) loses in this scenario.

The vision of this project is that if scientists in this scenario can point to UNAVCO in their proposal, and register their station with UNAVCO, it is guaranteed that within 1-2 hours of installation, they (and the whole world) will have access to 5-minute time series of GPS coordinates at the centimeter level. Their proposal is accepted, and everybody wins. And as a further consequence of this success, NASA has strengthened its ties and opportunities for partnerships in the developing world, reducing the barriers to scientific access in relatively unexplored regions of our planet.

How can this work? Recent NASA technology makes this not only possible, but also relatively easy to implement by those who know how. We leverage two existing technological capacities already developed and funded by NASA with the highest technological readiness level: (1) the UNAVCO data archive system and associated Geodetic Seamless Archive Centers (GSAC) that provides data access and includes the ingestion and formatting of GPS data; (2) the University of Nevada, Reno (UNR) operational system that already produces 5-minute GPS time series for over 2,000 stations with centimeter-level precision with 1-2 hour latency. The UNR system currently picks up hourly data files from the UNAVCO archive, and processes the data using NASA-funded technology and products developed at the Jet Propulsion Laboratory (JPL), including ultra-rapid GPS orbits and clock parameters, and JPL's GIPSY OASIS II software. The UNR system is hands-off, automatically every hour processing 30-hour batches of data from each of hundreds of stations around the globe, with hourly updates to provide the best possible time series at any given point in time. What UNR requires is accurate metadata in the data file headers, something that UNAVCO can insure by a process of registration and approval from newly proposed stations. UNAVCO in turn would be the natural gateway for public access to these products in the most scientifically useful form.

From the point of view of the scientists in Africa, a GPS receiver can be plugged in, and a suite of products are played back to them. These products will include flexible, easy to navigate, graphic, map-based and text based products the allow the users to quickly find the information they want for point positions, time series, velocity, and strain rate fields. This is plug and play GPS for Earth scientists. We have NASA technology ready to do this now.

In addition, to facilitate scientific networks in developing areas of the world, this project will work with specifically targeted users to fine tune the form of the products so that they can be of maximum utility to experts in the rapid modeling and analysis of natural hazards. Groups that have been identified include the NASA's QuakeSim Project,

NASA’s GPS Real-Time Earthquake and Tsunami (GREAT) Alert Project coordinated at JPL, the USGS Volcano Hazards Center, and of course, AfricaArray.