Urban Climate Impact and Prioritization of ECVs

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URBAN CLIMATE IMPACT AND PRIORITIZATION OF ESSENTIAL CLIMATE VARIABLES

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1. INTRODUCTION

Advancement in understanding, predicting and mitigating against adverse urban climate change implies collaboration, close monitoring of Essential Climate Variables (ECV)'s related to urban climate change, consensus among Subject Matter Experts (SME's)/leaders, and implementation of an effective action plan with specific thematic focus on human and environmental impacts. Towards this end, NCDC's Scientific Data Stewardship (SDS) Team created CLIO [1] (Climate Long-term and global Information Observations system), an international online tool and functional "*proof-of-concept*" interactive prototype (http://www.ncdc.noaa.gov/sds/dualimpactmatrix.html). CLIO is capable of accepting and displaying Web-based input from SME's providing a global to urban scale perspective of all ECVs, potential Climate Data Records (CDR)'s and their impacts upon climate. Effective implementation of an effective Climate Change Action Plan will necessarily focus upon using appropriate technologies to mitigate adverse global climate change and in-situ disasters. CLIO is a rapid prototype product that is capable of displaying the readiness levels of these technologies and their relationships to climate change ECV's and CDR's. CLIO is capable of rapidly identifying feasibilities, weaknesses/ strengths in monitoring urban climate change ECV/ CDR's; and their associated Technology Readiness Level (TRL)'s. Using CLIO, SME's will be able to access and interact with geospatial and temporal data from the past, present, and for future planning of products, datasets, dataset versions, instruments, platforms and networks. The forthcoming 3.0 version of CLIO is scheduled to provide ISO-compliant detailed geospatial and temporal provenance of archive, producer, processes (algorithm families, their job sets, versions, variants, anomalies; strophies, and jobs); and files (products, their datasets, versions, variants, anomalies, strophies and data files); and their associated metadata.

CLIO offers *quantifiable prioritization of ECV/CDR impacts* that effectively deal with climate change issues; associated impacts upon urban climate, and offers an objective collaboration and consensus building tool.

Civilization's anthropogenic activity has contributed to adverse changes for in-situ environmental conditions around the Earth, i.e., declining vegetation, evapotranspiration rates, and rainfall; increasing Greenhouse Gases (GHGs), land desertification and temperature. While the solar constant is an example of something civilization may not likely change; the reduction of GHGs, desertification of land and urban infrastructure (over-pavement of land, etc.) are examples of things that may be altered, or reversed. In order to implement beneficial changes of in-situ environmental conditions for urban climate, it is necessary to: (1) closely monitor and document urban climate change and impacts; (2) achieve positive useful environmental collaboration and consensus among international leadership and SME's; and to (3) implement a Climate Change Action Plan based upon the previous two requirements that are detailed enough to be practical or useful. Such a Climate Change Action Plan (CCAP) will necessarily be composed of international recommendations; and require endorsement, enforcement and support from world leaders and the scientific community. CCAP recommendations may span from traditional to emerging technologies that include both operational and research disciplines of science and society.

NCDC's SDS Project Office developed CLIO in response to request for assistance in management of the selection, generation and stewardship of Climate Data Records (CDR)'s. NCDC may now assist the Climate Change Science Program (CCSP) and the Intergovernmental Panel on Climate Change (IPCC) in prioritizing measurement capabilities for climate observations. NCDC is capable to provide assistance in developing an effective CCAP using CLIO to derive global consensus achieved through national and international collaboration based upon world, national, and Community Weighted Values (CWV)'s of relevant climate change ECV's and CDR's. Toward this end, CLIO is a component of NCDC's SDS Corporate Website [2] that affords an operational, world-class online collaboration mechanism for building

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[1] CLIO (Climate Long-term and global Information Observations system) version 2.4, named after the Greek Muse of history.

[2] SDS (Scientific Data Stewardship)'s corporate Website, http://www.ncdc.noaa.gov/sds

consensus among world leaders and subject matter experts.

2. COLLABORATION & CONSENSUS BUILDING

International leadership, in conjunction with the United nations, Intergovernmental Panel on Climate Change (IPCC) and the Group of Eight (G8) Summit in Japan, indicate value in collaboration; building consensus, and monitoring climate change ECV's and CDR's. Developing an effective CCAP from global consensus may be achieved through national and international collaboration based upon the integration of Community Weighted Value (CWV)'s of relevant climate change ECVs and CDRs.

NCDC's SDS Project Office may assist in the implementation of an effective CCAP through CLIO as a useful online mechanism. CLIO can assist in collaboration and is able to integrate aggregate consensus of national CWV's of relevant climate change ECVs and CDRs from Subject Matter Expert (SME)s' and leaders. Specific ECVs and CDRs having impacts for Urban Climate are depicted in Fig. 1. All columns of data are sort able by users.

Effective collaboration necessarily requires the ability to collectively visualize a global perspective of urban climate impact areas directly related to relevant ECV's and CDR's. CLIO provides this perspective via online ECV/CDR Matrices to include the feasibility of implementing climate monitoring of specific urban climate ECV's and CDR's discussed later in this text. CLIO provides three (3) ECV/CDR matrices that provide different perspectives: (1) the "*ECV versus IPCC Impacts*" Matrix, (2) the "*ECV versus Societal Impacts*" Matrix, and (3) the "*ECV versus Impact Areas*" (or Dual) Matrix. The first (or IPCC) matrix provides the IPCC perspective of climate change ECV and CDR impacts in areas such as; Attribution, Carbon Dioxide sources and sinks; ecosystems, El Niño, human interactions; Ozone recovery; uncertainty reduction and warming potential. The second (Societal) matrix provides the social perspective of climate change ECV and CDR impacts in the following impact areas: urban climate, disaster, health, energy, climate, water, weather, ecosystems, agriculture and biodiversity. The latter (Dual or IPCC and Societal) matrix combines both first and second matrices together and thereby presents a more comprehensive viewpoint. SME's and leaders are provided the capability to enter their expertise associated with respective impact values and associated benefits related to climate change ECV's and CDR's via the SME Interface[3]. These values can be vetted by committee and then displayed online during scientific conferences, workshops and meetings for collaboration and consensus building around the world. Vetted input from world leaders and SME's can be visualized with immediate and objective global perspective. Individual nations, societies, agencies, organizations, and communities may potentially gain greater awareness and perspective outside of their disciplines and cultures, thereby potentially providing increased clarity and objectivity.

Fig. 1: Urban Climate Change related variables & community impact values can be easily input, vetted and displayed.

In addition to SME and Leadership input, useful perspective for effective collaboration and consensus will necessarily focus on the need to visualize support information for ECV/CDR data and metadata within the same environment. CLIO can link ECV/CDR support information with technologies, satellite platforms, in-situ networks and their pertinent instruments to include: products, datasets, dataset versions, strophes, jobs and files. A basic detailed description is provided by Barkstrom (2008).

Ideally, it would be most productive and intuitively efficient for the same audience to access and visualize this support information at one location within the same setting and environment. Toward this end, CLIO has been designed to provide ECV/CDR support information. CLIO currently provides the interactive capability to temporally display gaps and overlaps of satellite and in-situ data/metadata to include: instruments, products, datasets, dataset

[3] CLIO's Subject Matter Expert (SME) Interface is an online interactive tool for collecting and archiving input and feedback from leadership and scientific communities throughout the world.

versions, variants, anomalies, strophes, jobs and files. These variants and strophes are discussed in greater detail by Barkstrom (2008).

Adaptability and versatility are critical components for survival of any species. In order to be effective, it seems prudent for civilization's societies to work together as one, integrating aggregate consensus of relevant international urban Community Weighted Value (CWV)'s of impacted areas into a CCAP, or global plan of action. Fig. 2 illustrates the Urban Climate Community's impact values. This CCAP may then be directed toward mitigation against harmful environments conducive to in-situ disasters. The world's nations may respectively collect CWV impacts from their respective communities (*urban, agricultural, scientific, etc.*); build internal consensus, monitor climatic change ECV's; and further develop a CCAP. This CCAP may then derive its support from global consensus through national and international collaboration that could focus upon the realistic prevention of adverse weather change.

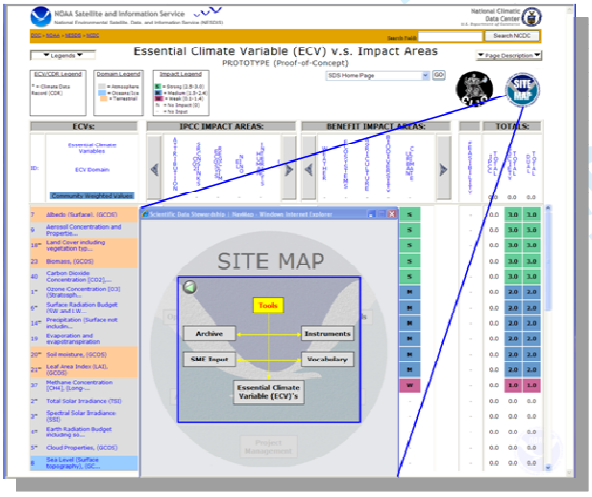

Fig. 2: Subject Matter Expert (SME) Interface for CDR's and ECV's include specific impacts and values within urban climatology. Atmospheric, terrestrial and oceanic domains ECVs/CDRs have gray, light brown, and blue backgrounds, respectively.

3. URBAN CLIMATOLOGY DATA SUPPORT

A critical concept associated with CLIO is to provide intelligent, comprehensive, rapid and accurate query functionality to data and metadata for this interactive capability. The query functionality designed is to be transparent to the user(s) in order to reduce potential confusion and discovery time, yet yield more accurate and adaptive query results. Ideally, queries can be made for this interactive capability to data and metadata for all aspects of both file and processing paradigms. Queries may then yield all metadata and data for not only products, datasets, dataset versions and files but also the processes that were used to produce these data files. Queries may then dynamically display these processes that include algorithm family, job set, Job Set Version (JSV), JSV strophes and jobs that produced the products, datasets, dataset versions, strophes and files, respectively. CLIO is being designed to provide a means to potentially coordinate, display and manage preprocessing and re-analyses of CDR's and ECVs. Query functionality for data and metadata is being designed to automatically span space-time (Fig. 3) and discontinuity between different data formats and associated data points of origin.

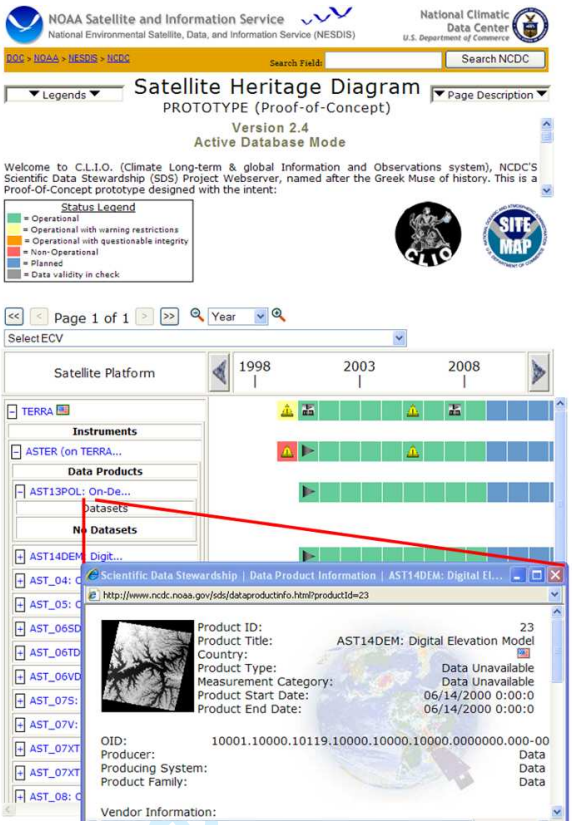

Fig. 3: Support Information for CDR's and ECV's including satellites, In-situ networks and instruments.

Intelligent query capability for Urban Climate ECVs is currently under development at NCDC's Archive Branch (AB) using mathematical linguistic algorithms to interpret between controlled vocabularies associated with these ECVs and their major different data formats and respective data centers. Use of Object Identifiers, or OIDs, provide an expeditious mechanism for organized rapid query and provenance. Combining OIDs with the International Standards Organization (ISO)'s industry practices also assures long-term compatibility for rapid query and archive functionality across multiple different data formats and data points of origin. The author coins this combination of ISO-compliant Object Identifiers as "*ISOIDs*". The integration of "*ISOIDs*" (or International Standards organization Object Identifier

tags) into CLIO enhances intelligent query functionality and moves towards International Standards Organization (ISO) 19115-2 compliancy. *ISOID*s, a merger of the ISO (International Standards Organization) and OIDs (Object Identifiers), help to significantly augment lineage description and intelligent query functionality across multiple stove-piped data points of origin and data centers. This OID-ISO merger affords an organized archive paradigm for metadata of data files and the processes that produced the data files. Further, conceptually speaking the OID-ISO merger offers organized structure, or schema, for archive directories. Provided an ISO-compliant interpretation mechanism is employed between controlled vocabularies of different data centers (and their respective formats); *ISOID* synchronized directories would potentially be readily compatible with one another. Rapid query for accurate and timely access display of data and metadata for process provenance consists of two (2) basic components: (1) Algorithm templates/code and (2) a Relational Data Base Management System (RDBMS).

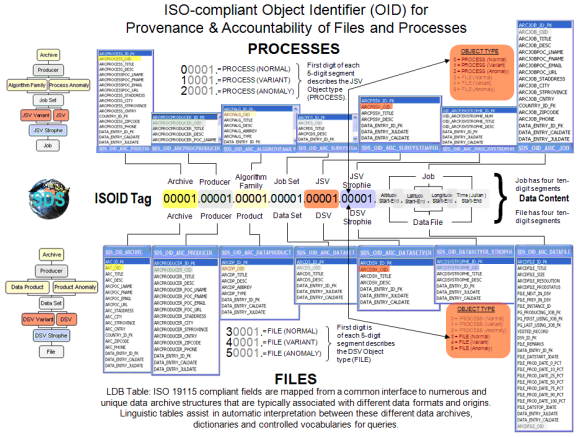

Fig. 4: Illustration of an "*ISOID" (*ISO-compliant OID (Object Identifier) tag linked to a LDB (Lineage Data Base) that maps out archive File & Process provenance for rapid query.

Fig. 4 illustrates how *ISOIDs* are able to empower any database of any community with complete provenance and accountability for data files; data processes independent of data format(s) and file naming convention(s). *ISOIDs* are made ISO-compliant by creating fields within a Lineage Data Base (LDB) that correspond to ISO 19115-2 schema and use a common online interface that is mapped from the LDB to numerous and even unique (even potentially disparate) data archive structures.

21st Century provenance and dependency algorithm templates have been designed by NCDC's SDS Project Team. Program code for archive and access to processes and files are mapped to *ISOIDs* within the Lineage Data Base (LDB) of the RDBMS. These components provide a common, organized and comprehensive approach for the futuristic archiving processing and file production associated with analyses and re-analyses of CDR and ECV data. *ISOIDs* by-pass continual metadata naming convention conflicts between major data formats and associated data points of origin. *ISOIDs* may be contained within any database and thereby renders naming convention conflicts irrelevant. *ISOIDs* provide an additional query component that is comprehensive, affords organization, and uses a more traditional RDMS archive/access mapping approach to display provenance of jobs and files. Fig. 4 illustrates how LDB tables may be mapped to numerous and unique data archive structures that are typically associated with different data formats. *ISOIDs* help to map out different data structures to a common interface that is linked to a LDB. This LDB is designed to retain ISO-19115 compliant fields that are linked to a programmed online interface. Linguistic algorithms assist in automatic interpretation for terms that are similar between different data formats and data origins for data query functionality.

4. URBAN CLIMATE & ECV IMPACT PRIORITIES

Specific potential Essential Climate Variable (ECV)'s that impact urban climatology have been initially identified for atmospheric and terrestrial domains. Atmospheric and terrestrial domain ECVs have gray and orange backgrounds, respectively; and are listed in the extreme left hand side of Fig. 5.

Urban Climate Change ECV/CDRs within the terrestrial domain have been initially identified as: Surface Albedo, Soil Moisture, Leaf Area Index (LAI), Chemicals, Biomass, Land Temperature, and Land Cover including vegetation type.

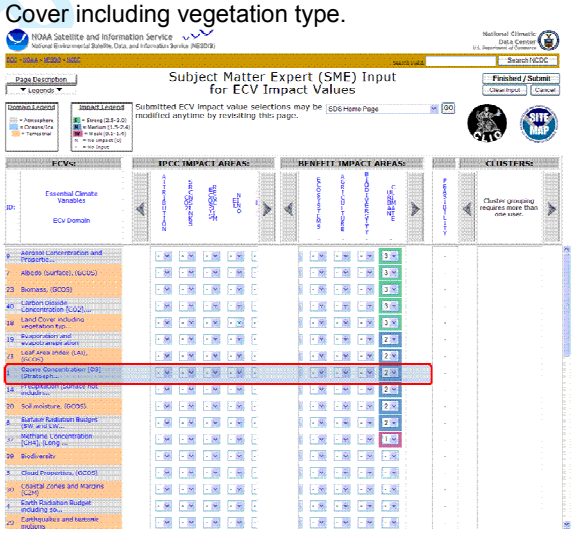

Fig. 5: The Subject Matter Expert (SME) Input Interface for CDRs/ECVs includes specific impacts and values within urban climatology. These values are quantifiable values ranging from 0 to 3 reflecting impacts ranging from none through strong (0= Not Applicable, 1= Weak, 2= Medium, and 3= Strong) values. Atmospheric, terrestrial and oceanic domains ECVs/CDRs have gray, brown and blue- colored backgrounds, respectively.

Fundamental atmospheric ECVs related to urban climate change are: Green House Gases (GHG)'s that include Carbon Dioxide [CO_2], Perflourocarbon [PFC]'s, Methane [CH_4], Nitrous Oxide [N_2O], Sulfur Hexafluoride [SF_6], and Ozone [O_3]. These ECVs constitute the bulk of Earth's GHGs' that influence urban climate change. Aerosol concentrations also constitute an important urban climate change ECV affiliated within the atmospheric domain.

Other atmospheric domain climate change EVC's were identified to be Evaporation & Evapotranspiration; Precipitation (not including Virga), Surface Albedo, Surface Winds, and Surface Radiation Budget. Land desertification variables span across environmental domains and include land temperature, precipitation, land cover (including vegetation), surface albedo, soil moisture, Leaf Area Index (LAI), evaporation/evapotranspiration, and biomass.

5. URBAN COMMUNITY WEIGHTED VALUES

Urban Climate community climate change variables can be given quantifiable impact values by SMEs and can be made immediately viewable within conferences and workshops. Impact values may be visualized for the Urban Climate Community concurrent with broader global perspective for different communities within both societal and scientific paradigms.

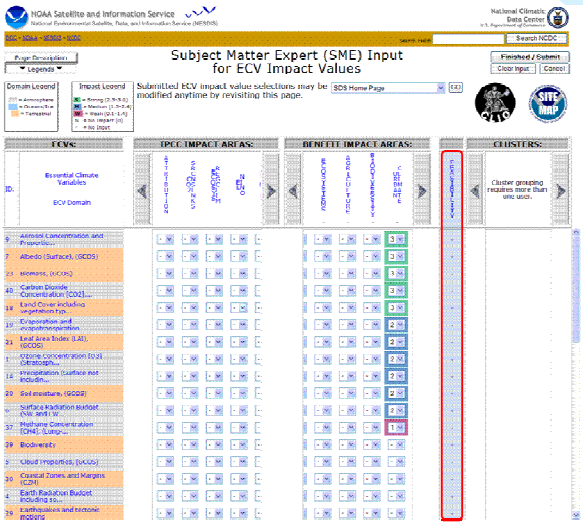

Fig. 6: Subject Matter Expert (SME) Input Interface for CDRs/ECVs that include specific feasibility values for monitoring Urban Climate related CDRs and ECVs.

In Fig. 6, the feasibility (red through strong, where 0 = Not Applicable, 1 = Weak, 2 = Medium, and 3 = Strong).bounded area) of monitoring urban climate change and its respective TRLs can be input, vetted and displayed. Quantifiable feasibility values may range from 0 to 3, reflecting analogous values from none

6. SUMMARY

CLIO provides a real-time opportunity for scientific community experts and world leaders to objectively analyze impacts of climate change to urban climatology. This tool offers societal experts, leaders and scientists an environment in which to closely collaborate and build consensus with the ability to collectively and comprehensively view impacts of climate change across the board. CLIO affords the capability to zoom in with great detail on specific climate change ECV and CDR information, their benefits and issues; specific area impacted; and the feasibility of mitigation against adverse climate change. Support information is also potentially made available within the same environment to include remote sensing platforms, in-situ networks, instruments, products, datasets, dataset versions, strophes, jobs and files.

CLIO is a scientific tool for advancement in understanding and collaboration that offers *quantifiable prioritization of ECV/CDR impacts* which effectively deal with climate change issues; and associated impacts upon urban climate. This tool may assist in implementing an effective climate change action plan for mitigation against adverse urban climate change and is available at http://www.ncdc.noaa.gov/sds/dualimpactmatrix.html

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