IN21C-1700

Provenance of Earth Science Datasets – How Deep Should One Go?

Gerald Manipon[1] geraldjohn.m.manipon@jpl.nasa.gov, Hampapuram Ramapriyan[2] Hampapuram.Ramapriyan@ssaihq.com, Steve Aulenbach[3] saulenbach@usgs.gov, Brian Duggan[4] brian@promptworks.com, Justin Goldstein[5] jgoldstein@usgcrp.gov, Hook Hua[1] hook.hua@jpl.nasa.gov, Dexter Tan[6] Dexter.C.Tan@jpl.nasa.gov, Curt Tilmes[7] curt.tilmes@nasa.gov, Brian Wilson[1] bdwilson@jpl.nasa.gov, Robert Wolfe[5] rewolfe@usgcrp.gov, Stephan Zednik[8] zednis2@rpi.edu
[1]Jet Propulsion Laboratory, California Institute of Technology, [2] Science Systems and Applications, Inc., [3]US Geological Survey, [4]PromptWorks, [5]US Global Change Research Program, [6]Raytheon Company, Pasadena, [7]NASA Goddard Space Flight Center, [8]Rensselaer Polytechnic Institute

Why Provenance?

- Transparency and reproducibility essential for scientific credibility
- Answers to scientific questions can have global socio-economic impact and are viewed critically with "healthy skepticism"
- Office of Management and Budget, "Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility and Integrity of Information Disseminated by Federal Agencies; Notice; Republication", February 22, 2002, http://www.whitehouse.gov/sites/default/files/omb/assets/omb/fedreg/reproducible2.pdf
  - Emphasizes the need for reproducibility of influential scientific results. In this context, influential implies that the information has a "clear and substantial impact on important public policies or important private sector decisions".
  - "If an agency is responsible for disseminating influential scientific, financial, or statistical information, agency guidelines shall include a high degree of transparency about data and methods to facilitate the reproducibility of such information by qualified third parties."

Traceability – Prerequisite for Reproducibility

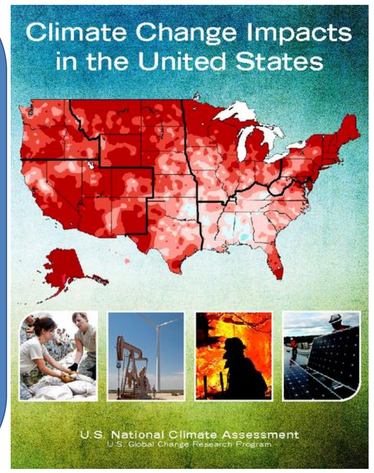
- From conclusion in a paper to objects, their provenance and context leading to the conclusion
- Provenance (lineage) tracing tools help – generally can express trace-back as {Entities (inputs & outputs), Activities, Agents}

Global Change Information System

- Established by US Global Change Research Program (USGCRP) "to better coordinate and integrate the use of federal information products on changes in the global environment and the implications of those changes for society".
- Open-source, web-based resource for "traceable, sound global change data, information, and products."

The Third National Climate Assessment (NCA3)

- Summarizes impacts of climate change on the United States, now and in the future.
- Produced by >300 experts guided by a 60-member Federal Advisory Committee
- Extensively reviewed by the public and experts, including federal agencies and a panel of the National Academy of Sciences.



GCIS and NCA3

- GCIS provides capabilities for interactive exploration of NCA3
- NCA3 - "featured report" in GCIS
- Report has *chapters*, *figures*, *tables*, *findings (key messages)*, and *references*
- Generally figures, tables and references support findings
- Datasets and/or images are used in figures
- Important to trace back to sources of all items supporting a key message
  - e.g. finding → figure → image → dataset → algorithm → input data → instrument → satellite; algorithm → ATBD → Reference; dataset → archive; dataset → metadata/ documentation)

Figures in NCA3 using NASA Datasets

- Figure 2.26: Past and Projected Changes in Global Sea Level Rise
- Figure 9.3: Wildfire Smoke has Widespread Health Effects
- Figure 16.3: Flooding and Hurricane Irene
- Figure 16.5: Urban Heat Island
- Figure 33.14: Warming-trend-and-effects-of-el-**Niño**-la-Niña
- Figure 34.16: Observed Change in Global Average Temperature

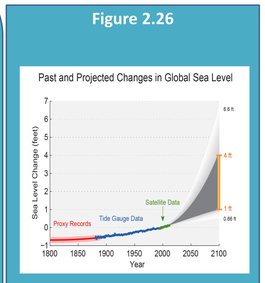
Tracing Back – Typical Issues

- Missing source images – Available when the report was written; author downloaded and used it, but image not in long-term archive
- Author unavailable for answering questions
- Description of how a figure was created is not available (even when source of data has been acknowledged)
- Completeness of available metadata - Original spatial or temporal extent not available
- Handling discovered errors – cannot fix report but can note errata

Key message: "Global sea level has risen by about 8 inches since reliable record keeping began in 1880. It is projected to rise another 1 to 4 feet by 2100"

- Inputs: four inputs for four sections of graph - Proxy Records, Tide Gauge Data, Satellite-Derived, Scenarios
- Method
  - Part 1: Plotted using Matlab code by first converting SI units into feet (Trace back includes code).
  - Part 2: For satellite data (TOPEX, Jason-1, Jason-2), Time periods covered by each is given in table at http://sealevel.colorado.edu/content/data-processing-methods. Processing method is described in detail in: DOI 10.1080/01490419.2010.491031)
- Comment: Detailed trace back needed since data are used to draw quantitative conclusions

Figure 2.26



Key message: "Infrastructure will be increasingly compromised by climate-related hazards, including sea level rise, coastal flooding, and ***intense precipitation events***"

- Inputs: Two granules of MODIS Aqua dataset MYD021KM
- Method: Input granules were mosaicked and subset to extract desired area to display region covered by Hurricane Irene.
- Comment: Simple trace to identify granules used is enough - figure only illustrates extent of precipitation event; other sources are used to show quantitative consequences

Figure 16.3

Flooding and Hurricane Irene

Lessons Learned

- Trace back difficult after report delivery
  - Difficult to contact authors and follow-up to get complete provenance information
  - Follow-up attempts could be misinterpreted as questioning their research
- Instructions and templates to record provenance should be provided to authors before report generation
- Data and images used for the report should be held in a long-lived , user-accessible repositories
- Generally information in the form of inputs, outputs, agents and activities (descriptive and/or mathematical) is useful for each dataset used, images or figures generated and key messages
- Capturing the extra contextual knowledge around the findings could shed light into why certain decisions were made during the findings.
- Depth of trace back should be commensurate with information needed to reproduce results

Paper #IN21C-1700 - Presented at the 2015 Fall Meeting of the American Geophysical Union, Dec. 14-18, 2015, San Francisco, CA.