Forum on Citizen Science and Earth Observations

On July 10, 2015, the US Group on Earth Observations (USGEO) and the Federal Community of Practice on Crowdsourcing and Citizen Science (FCPCCS) held a forum at NASA Headquarters to explore current programs at Federal agencies that use citizen science for Earth observation-related work and the place of citizen science as a tool in the Federal government's Earth observation portfolio. Experts from a variety of USGEO member agencies presented examples of current work, after which there were breakout discussions among the attendees and presenters on citizen science topics of interest to the USGEO community.

NASA Chief Scientist Dr. Ellen Stofan welcomed the attendees to NASA HQ, noting NASA's longstanding support for citizen science, and highlighting Zooniverse.org as an example of amateur scientists contributing great things to science using NASA data. USGEO Program Director Timothy Stryker introduced USGEO, noting the call in the *National Plan for Civil Earth Observations* for USGEO to explore the use of citizen science. Dr. Lea Shanley, Presidential Innovation Fellow at NASA, introduced the FCPCCS, highlighting the US Global Climate Change's 2014 workshop and inclusion of citizen science in the *National Climate Assessment.* Following those introductions, a series of agency experts discussed citizen science and crowdsourcing projects currently ongoing.

Dr. Ellen McCallie discussed NSF's exploration of citizen science as an education and outreach tool, and how those projects can contribute valuable science. Dr. David Applegate talked about how the USGS is using crowdsourced data and social media data to improve understanding of natural disasters, such as earthquakes and volcanoes. Jay Benforado traced back the history of citizen science more than 100 years, and explained how technology is changing the EPA's capabilities in using crowdsourcing for air quality monitoring with low-cost sensors. Dr. Cindy Schmidt presented on NASA's Applied Sciences Ecological Forecasting Program, projects supported by NASA's Earth Science Division that combine Earth observation data with some citizen science component to improve understanding of changing ecosystems. Jim Zdrojewski explained how NOAA has been able to maintain its National Cooperative Observer Program (COOP) with stations monitored by citizens for over 100 years. And finally, Dave Johnson spoke about USDA's collaboration with farmers in running the National Agricultural Statistics Service, both collecting survey data from farmers and developing tools that citizens can use to analyze and understand land use data.

The breakout discussions were focused on four topics: (1) ocean, water, and arctic applications of citizen science; (2) terrestrial applications of citizen science; (3) citizen science for sustained observations; and (4) data quality and data management considerations for citizen science. The main points that came out of the breakout discussions are summarized below:

- General considerations:
    - Citizen Science and crowdsourcing can augment science research and Earth observation activities at agencies, but is not a replacement. It opens up new capabilities, but does not negate the need for current satellite and in situ systems.
    - Citizen science is often thought of as a low-cost option, but it is not free, and requires time and resources to properly manage projects for optimal scientific output.
    - The White House OSTP Federal Crowdsourcing and Citizen Science Toolkit, built in collaboration with FCPCCS, is planned for release in late September of 2015 (specific

date to be determined) and will provide useful guidance on developing and managing projects.
    - The Woodrow Wilson International Center for Scholars is developing a database of Federal citizen science projects. The projects can be sorted by science topic, agency, geography, and other criteria. The database is currently incomplete and still being populated, but can be found here: http://ccsinventory.wilsoncenter.org/
- Ocean, Water, and Arctic Applications:
    - Crowdsourcing projects are less viable in areas with very low population density. Two possible approaches are (1) to tailor projects more specifically to local community; or (2) to use projects where citizen scientists are involved at the data analysis stage rather than data collection.
    - There is opportunity to use commercial and fishing vessels for ocean observations in areas where regularly spaced coverage of observations is not a high priority.
    - For projects that cross geopolitical boundaries (e.g. ocean projects), data standards are very important and must be well-considered to avoid systematic errors based on location.
- Terrestrial Applications:
    - Projects must consider both volunteer training and user interface ease of use. Less of the former requires an increase in the latter, and some combination of both will be required depending on the goals of the project.
    - Recognize that for most projects, a small fraction of the volunteers will contribute a large fraction of the input.
    - Game-ifying projects can help recruit and sustain volunteers.
- Sustained Observations
    - Sustainability is considered three ways: (1) sustained supply of volunteer effort; (2) sustained funding to manage projects; and (3) sustained level of observations, through passive data collection.
    - Volunteers maintain interest much longer if they see how their contributions are incorporated and used. Active engagement with volunteers is necessary to sustain over time.
    - The boundary between what humans do well vs. what computers do well will constantly shift due to technology, and citizen science projects need to be aware of that boundary to use volunteer effort optimally.
- Data Quality/Management:
    - It is important for citizen science projects to consider data management and data quality before beginning and to use their scientific priorities and requirements to guide the development of the data infrastructure.
    - Understanding and quantifying systematic and statistical uncertainties is often more important (and easier) than maximizing data quality at all costs.
    - Grooming experts within the citizen scientists is crucial for projects, especially over extended time periods. A hierarchy of volunteers can improve quality control, and badges/certifications/expert recognition are effective in maintaining interest.
    - All observing systems require extensive calibration. Because humans are complicated machines, calibration and integration of crowdsourced data takes more time than for many other systems. Patience is required but many citizen science projects have proven the value in putting in that work.