Climate 2.0 – engaging the public through VGI to address issues of climate and weather
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In the past, from the public's perspective, scientific engagement appeared to be a one way street – scientists would collect data to test their hypotheses and, eventually, the data would make their way through the analytic gauntlet. The final outcome would be a peer reviewed paper. If we were very lucky, a map or figure, which could easily explain the results, would be released to the public.

Now, the public is contributing value-added information to science, specifically climate science. Instead of the one way street, there is communication and feedback through user-generated content on maps and photos or directed conversations. The ease of using social media sites to share and contribute information that is of use to the climate and atmospheric community is opening up new opportunities for data collection, conversation, coordination, and civic engagement in the arena of climate monitoring. We can leverage this explosion in the need to describe what is happening in our lives and where it is happening at any minute using these technologies. This position paper describes some projects that are using social media for climate and atmospheric research and visualization, some possible uses for web 2.0 technologies in climate and atmospheric monitoring, and some caveats and practicalities about the incorporation of VGI for research purposes.

The past: Governmental institutions and nonprofit environmental groups have been collecting user-generated content for long term monitoring of climate and biodiversity. The United States National Weather Service's Cooperative Observer Program (COOP), which has been in existence for over 100 years, collects daily records of weather variables at established long term sites[http://www.nws.noaa.gov/om/coop/]. Thousands participate in the Audubon Society's annual bird count to map the distribution of birds during a specific time of year. [http://www.audubon.org/bird/cbc/]. The United States Geological Survey (USGS) collects volunteered earthquake intensity information to develop their shake maps. [http://earthquake.usgs.gov/earthquakes/shakemap/]. These are not mandatory reporting requirements, but rather they depend on citizens willing to contribute information to refine habitat maps and earthquake science. Others feel compelled to contribute data where they find information is lacking, e.g. the OpenStreetMap project [http://www.openstreetmap.org/]. This project empowers users to add content to improve maps through organized field surveys and the digitization of images without using commercial mapping applications. Others might add content to a map because the information is critical and timely, such as dissemination of information using online mapping resources annotated maps during natural disasters. This effort has been elevated during the Haiti and Chilean earthquakes of 2010, where programmers and GIS specialists organized together using social networking tools such as twitter to find the best available data, create databases and build applications for use by first responders on the ground to map the destruction.

Now: User generated content has become a more interactive process. Instead of inputting a sighting in a web page and waiting for some sort of static output such as map or report of your findings, volunteered information is more dynamic and interactive. Results from volunteered information are easy to input and rapidly visualized on a map. This gives the volunteer fast feedback and validation on their contribution. GPS enabled devices and our comfort in qualifying our information with qualitative metadata using descriptive tags allows for more precise locations. The ability to geotag images on photo sharing sites such as Flickr, employ hash tags and geotagged tweets from twitter streams, send text based mapping information through Ushahidi, and development of APIs, empowers the user to add to community developed maps painlessly from the desktop to the mobile device.

Climate/Environment:
The US weather community has built a mesonet of climate and weather observation stations that report data in real time. For severe weather events, the National Weather Service also depends on the trained weather spotters to provide an additional "micronet" of climate observations. Twitter, the microblogging application, has expanded this network to amateur weather spotters. These spotters who are armed with a mobile device and a knowledge of specific hashtags, can provide another layer of information that is useful for

forecast validation. The NWS's southern region is currently testing the feasibility of using directed twitter streams (using hash tags, specific to the project) to storm reporting. Software pulls tweets with specific hashtags *(# WW wxreport (location) WW*) or tagged with ZIP codes which are extracted from the twitter stream, placed into a database and then mapped using a Google Map application [http://wx411.com/codenoobs/examples/NWSTwitter/]. Severe weather can be visualized and text, images, or video attached to the tweet are also displayed. In severe weather events, such hailstorms or windstorms, the visual record makes it easier for damage assessment validation. Since the tweets are stored in a database, the forecast office can go back and do post-storm assessments including checking the storm extent and validation of their models. As with much volunteer collected data, quality control becomes and issue, especially around spurious weather observations. The developers are working on methods to address the data quality issue.

The same model of twitter data collection could be used for a variety of observations including recording tsunami wave run up before first responders can reach the scene, describing surf conditions at local beaches, or snowfall intensity reporting from mobile users. Observers can be trained using simple visual guides. As devices become more sophisticated, these guides - cloud types, wave height estimators, or hail sizing guides could be uploaded to phones to help in determining intensity or type of phenomenon. Data could be transmitted via text message or a purpose built application. Map interfaces and map visualization can be viewed separately or used with other web services for a mashup.

Indicators of climate change include shifts in seasonal patterns of species migration or plant flowering times. In the past, the first skunk cabbage or lilac bloom sighting was marked on the paper calendar, now it is communicated to the world via shared photos, twitter feeds and blogs. The USA National Phenology Network (USANPN) [http://www.usanpn.org/], is an example of a site that collects such data from individuals and groups through web forms and visualizes the data using web mapping. Organizations such as arboretums, garden clubs, and wildlife affinity groups have collected long time series noting such occurrences. Instantaneous sightings are also being captured from twitter feeds. Users can also use a web form to add more detailed data including time of siting, descriptive metadata and location. Climate indicators including ice out and first frost are captured by hundreds of volunteers. Information is then stored in database and maps by category or species can be generated.

Incorporating traditional environmental knowledge into user generated maps helps identify historical places or habitats that might be lost, but are needed for analysis. While it can prove challenging to add data in real time out of phone or wireless range, GPS units with custom software can be used to capture data and information for later analysis. The Igliniit Project [https://gcrc.carleton.ca/confluence/display/ISIUOP/Igliniit+Project], based in Clyde River, Nunavut brought together Inuit hunters with geographers and engineers to devise a ruggedized data collection unit to collect location, weather conditions, and images to capture environmental data during their travels including sea ice extent and time of break up.

Caveats: Whatever words we wish to use to name this phenomenon, community generated content and mapping applications are here to stay. Application developers are making the interfaces are simple and devices have more precise GPS transmitters. More importantly, our need to produce content and share that information immediately with the world expands daily. The ability to capture information and display it has become effortless. As with all data, there are caveats to the use of this information. The observations may be sparse and thus difficult to use for any sort of spatial or statistical analysis. How do we put uncertainty bounds on volunteered data? In terms of data management, how do we integrate this data into our current spatial data infrastructure? Projects such as the Volksdata allow for data sharing using social networking sites and more of these data sharing, data distribution and data management sites are being deployed rapidly [http://www.volksdata.com]. Do we build two parallel tracks? Lastly, how do we begin to integrate this user-generated content into the strictures of data collected in our scientific endeavors? It will take a change in our thinking of how scientific research can benefit from this citizen generated data. Acceptance of citizen generated data into can have the added benefit of engaging the participants about the climate science, climate changes and how it impacts their communities.