The view of clouds from below and above with citizen science: The 2018 GLOBE Clouds Spring Data Challenge

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The Global Learning and Observations to Benefit the Environment (GLOBE) Program is a NASA-funded international science and education program.

Provides student and the general public with opportunities to participate in data collection and the scientific process, and contribute meaningfully to our understanding of the Earth system and global environment.

**GLOBE Clouds is LaRC specialty – collocated ground cloud obs. with satellite data**

In addition to outreach, GLOBE Clouds supports the CERES mission and broader atmospheric science community by providing ground observations to complement and validate spaceborne measurements.

To bolster normal data collection and public enthusiasm, GLOBE Clouds has performed two intensive observing periods, the Spring and Fall Cloud Challenges.

I will discuss some of the early results based on data collected during the Challenges.
The GLOBE Observer app allowed participants to easily report weather with just their own phones.
Satellite Matching – giving a view of clouds from above and below

Aqua/Terra Cloud data are taken from the CERES FLASH_SSF dataset
Spring Cloud Challenge (15 Mar - 15 Apr 2018)

Fall Cloud Challenge (15 Oct - 15 Nov 2019)
Clouds Around the World: How a Simple Citizen Science Data Challenge Became a Worldwide Success

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GLOBE Observer (GO) and Satellites Agree on Global Cloud Cover.

Mean cloud cover in most regions is similar, when we may expect disagreement of 5% or more.

Terra and Aqua data show similar agreement on mean global cloud cover.

There does not have to be such close agreement, as other varbs (e.g. cloud occurrence freq.) disagree by > 10%.

This result allows easier investigation of differences in cloud cover by height.
The vertical profile of mean cloud cover differs between GO and satellites globally and regionally.

Some difference is expected because of different viewpoint of ground vs. space.

Global difference makes sense – ground observers will see more low clouds than high clouds; vice versa from space.

Disagreements between Terra and Aqua may arise from diurnal cycle. (WIP)
Question: What is the uncertainty of GO mean cloud cover caused by limited GO observations?

In other words, what is the value of large numbers of obs.?

NAM has ~12,000 obs, and provides an opportunity to subsample set of obs to determine sensitivity of mean cloud cover to sample size.

Method:
1. Take small number of NAM obs. (such as 10), and calculate mean cover from that subsample
2. Repeat subsampling and calculation many times (50 in this example)
3. Increment number of samples (ex. 20), and repeat (1) and (2)

Result shows how uncertainty of mean cover is reduced as sample size increases.
GO and sats agree closely on mean cloud cover. However, previous studies found that ground observers tend to overestimate cloud cover. What leads to the close agreement of our results?

At all altitudes, sats report less cloud cover than GO in cloudy conditions (as previously found). However, sats report greater cloud cover than GO in clear conditions. So GO/sat agreement on mean cloud cover occurs because of compensating errors in cloudy and clear conditions.

For low clouds, “OVC” disagreement is greater because sats often cannot see low cloud cover.
Passive sat instruments struggle to detect/retrieve optically thin high clouds.
Previous studies use active sat measurements (i.e. CALIPSO).
Can GO data inform us about high clouds missed by sat?

Is GO/sat comparison sensitive to cloud optical depth?

GO participants commonly report cloud opacity by altitude.
In cloudy conditions, sat have change in agreement of 15-35%.
Terra/Aqua are more strongly affected than GEO.

Opacity is the largest tested factor influencing GO/sat agreement, and results from SCC and FCC agree.
Future Cloud Challenges

Data sets of clouds and sky conditions for each season:
- Summer Cloud Challenge 2020
- Winter Cloud Challenge 2021
Contrails Investigation Pilot

Development of an automatic input system to increase the number of participants and their entry.
https://observer.globe.gov/get-data/cloud-data

If you are interested in obtaining the data, please access it at this location.

These datasets include the collocated satellite observations.
ROSES – Citizen Science A.41

A.41 CITIZEN SCIENCE FOR EARTH SYSTEMS PROGRAM

NOTICE: NASA anticipates soliciting this program element in the spring of 2020. The final text will be released as an amendment to ROSES-2020 with a submission deadline no fewer than 90 days after the release of the amendment.

The program aims to advance the use of citizen science in scientific research about the Earth by directly supporting citizen science activities, as well as by deploying technology to further citizen science research. ESD encourages proposals in particular that connect to the utilization of unique NASA capabilities in studies of the Earth.

This solicitation is expected to be released in the Spring of 2020. Funding for this opportunity is anticipated to be $2M/year. Proposers can visit https://science.nasa.gov/citizenscience for additional information on SMD citizen science activities.

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(i) Citizen science

Citizen science is a form of open collaboration in which individuals or organizations participate voluntarily in the scientific process. Proposers to any ROSES program element are invited to incorporate citizen science and crowdsourcing methodologies into their submissions, where such methodologies will advance the objectives of the proposed investigation. The current SMD Policy on citizen science, that describes standards for evaluating proposed and funded SMD citizen science projects. For more information see Section 3 H.R.6414 - Crowdsourcing and Citizen Science Act of 2016, which authorizes federal agencies to utilize crowdsourcing and citizen science and the [https://science.nasa.gov/citizenscientists](https://science.nasa.gov/citizenscientists) webpage, that provides information about existing SMD-funded projects, including how to sign up for the NASA-SOLVE email listserve.

Full ROSES 2019 Summary of Solicitation (PDF), [https://tinyurl.com/y2fkrfnb](https://tinyurl.com/y2fkrfnb)

Additional funding may be available for proposals incorporating citizen science.
GLOBE Clouds Team

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Passive sat instruments struggle to detect/retrieve optically thin high clouds

Previous studies use active sat measurements (i.e. CALIPSO)
Can GO data inform us about high clouds missed by sats?

There may be many reasons for GO/sat disagreements
GO reporting errors
Sat retrieval errors
GO vs. sat field of view
Sat viewing angle
Etc.

But what if GO/sat comparison is contaminated by low/mid cloud cover that blocks view of GO participant from high clouds?

Restricting high cloud reports to only those with no or few low/mid clouds has little effect on GO/sat (dis)agreement