The MY NASA DATA Project

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ABSTRACT

On the one hand, locating the right dataset, then figuring out how to use it, is a daunting task that is familiar to almost any scientist or graduate student in the fields of Earth system science. On the other hand, the ability to explore authentic Earth system science data, through inquiry-based education, is an important goal in US national education standards. Fortunately, in the digital age, tools are emerging that can make such data exploration commonplace at all educational levels.

This paper describes the conception and development of one project that aims to bridge this gap: Mentoring and inquirY using NASA Data on Atmospheric and Earth science for Teachers and Amateurs (MY NASA DATA; mynasadata.larc.nasa.gov). With funding from NASA's Science Mission Directorate, this project was launched in early 2004 with the aim of developing 'microsets' and identifying other enablers for making data accessible. A key feature of the project is a Live Access Server, the first educational implementation of this open source software, developed by NOAA, that makes it possible to explore multiple data formats through a single interface. This powerful tool is made more useful to the primary target audiences (K-12 and amateur scientists) through careful selection of the data offered, user-friendly explanations of the tool itself, and age-appropriate explanations of the parameters. However experience already shows that graduate students and even practicing scientists can also make use of this resource. The website also hosts teacher-contributed lesson plans, and seeks to feature reports of research projects that use the data.

The Challenge

As any scientist or graduate student knows, finding and then using the right dataset to address a question of interest can be an extremely difficult and time-consuming effort. Educational standards in the US currently encourage scientific inquiry for students at the K-12 level. While some students working with special teachers have done such projects, expecting all high school or middle school students to persevere through the current challenges of locating and deciphering data in order to pursue a question is not realistic. Fortunately, emerging information technologies and open source standards can make this problem more tractable. This paper describes one NASA project whose goal is to make the vast NASA collection of Earth system science data, acquired thanks to investment of taxpayer funds, accessible to the K-12 and citizen scientist communities.

Solution 1: Microsets, Static and Custom

The initial technical approach to solving this challenge was the creation of what we term 'microsets'. These are especially small subsets of the typical large scientific dataset. They consist of a single parameter over the globe, or perhaps a time series for a single location (or two). The goal is to get to a file size that is easy to transfer, even for a school with very basic computer access. This small size also enables the use of very simple file formats, such as ASCII (text) so that educators and students don't have to buy custom software or learn to use custom tools. Very simple static microsets (Figure 1) can provide powerful opportunities for learning about the Earth.

Of course, offering a limited number of static microsets is not an effective way to enable scientific inquiry. Thus, a second piece of the solution was to make available a larger amount of data that students could explore to create custom microsets that relate to a particular question of interest to them. The team explored a number of emerging options before settling on the Live Access Server (LAS), an open source software tool originally developed by NOAA (http://ferret.wrc.noaa.gov/Ferret/LAS/). LAS integrates a visualization tool, Ferret, with tools that provide access to geo-referenced data. Incorporating OPeNDAP allows the LAS to make available datasets that may not reside locally, and that may be in a variety of different scientific formats (such as NetCDF, HDF, and others). It provides a single web interface for the exploration of all these data. It also has the capability to output the selected data in a variety of formats, including imagery for visualization and ASCII and other output formats for further analysis. See Figure 2 for a composite of screenshots from the LAS.

The MY NASA DATA LAS currently makes available over 100 parameters, most related to atmospheric science (because we are housed at the Atmospheric Science Data Center (ASDC)). Datasets on precipitation and Sea Surface Temperature (SST) from NOAA, and ocean data from JPL, are some of the other datasets that the team currently offers or is exploring. This collection of data offers a good starting point for student inquiry in Earth system science. We continue to seek other datasets that may be appropriate for this interface.

Solution 2: User-friendly documentation

Once the LAS was in place, it quickly became apparent to the MY NASA DATA team that this technical solution alone was not sufficient to meet the needs of our target audiences, especially the K-12 portion. Although the LAS offers a relatively simple means of data exploration, particularly compared to other options, it still is not simple enough. Thus, the team has developed some customized documentation targeted to the needs of educators and students. In approximate order of development these include:

1. Science glossary: To provide age-appropriate definitions of parameters and related terminology that is specifically aligned to the content and methods of the MY NASA DATA site. Many of the definitions include illustrations and links to additional information. Development of this glossary is ongoing as new terms and parameters are identified or added to the LAS.

2. LAS custom help: Because LAS is open source software, the team was able to customize some of its help features. In particular, we are able to provide information specific to MY NASA DATA within the information that is accessed through the icon of the LAS interface. In this way we can steer the audience to information that is particularly relevant to the parameters they are exploring.

3. LAS Introduction: This brief explanation uses the analogy of a menu and waiter in a restaurant to provide a helpful introduction to the LAS. It serves as an example to give teachers and students the "big picture" of this tool so they will be more comfortable exploring it. As part of the development of this document, the parameters in the LAS were renamed so that they all follow a common naming scheme. This scheme consistently provides information about Time Interval (Daily, Weekly, Monthly...), Place (Surface, Top of Atmosphere, Cloud, Tropopause, ...), Parameter, and the source of the data. Thus, users browsing the LAS can become familiar with the way that parameters are labeled and know what they are getting.

4. Time Coverage at a Glance: Because we obtain our parameters from different satellites and instruments, the available time coverage can vary from one to the next. If a teacher or student is interested in a question that involves multiple parameters, this chart provides the time period that can be usefully explored. This helps to prevent user frustration in spending time developing information about one parameter only to discover another needed parameter is not available for the same timeframe. It also provides the audience some insight into the effort required to acquire thedata.

5. Discipline specific documentation: A number of LAS parameters cover the Earth's Radiation Budget, a focus area for the ASDC (and the first author). While this topic is included in the K-12 curriculum, the details of its many parameters are not. Thus a brief explanation was put together in an attempt to contextualize and explain the many parameters that can be explored in the LAS. For the topic of Aerosols, a link has been provided to a well-written NASA Fact Sheet. Similar documentation is being developed for other topic areas relating to parameters in the LAS.

6. LAS Tutorial: A Powerpoint tutorial that takes users step by step through the screens of the LAS has also been developed for those who are least comfortable with technology. This tutorial provides an explanatory look at the various steps in the process of generating a custom graph or microset.

7. Information about Data Sources: Teachers often want to know the source of the data, and to share that information with their students. Thus, we have added a web page that gives a complete summary of the sources of data in the LAS, including satellites, instruments, and analysis products. In a short paragraph, the basics of each source are given, along with links to further information and definitions of terms. A picture or illustration also provides further insight into the data source.

The documentation process is not complete. Our next step is to develop sample images illustrating the parameters available from each data source, so that a quick data exploration can occur even outside the framework of the LAS.

Solution 3: Targeted Resources

In addition to microsets and documentation, MY NASA DATA provides resources that we hope are directly useable by our target audiences. For teachers, this means providing example lesson plans that illustrate how some specific microsets can be used to teach standards-aligned topics. The MY NASA DATA site features a growing collection of lesson plans, both those developed by the team, and lessons contributed by teachers who use the site. These lessons are also submitted to the semi-annual NASA education review to further improve their quality.

For the citizen science community, which we define broadly to include K-12 students who are doing a science project as well as amateur scientists of all ages, we provide a growing list of project ideas that may give them some ideas for possible exploration using MY NASA DATA parameters.

Neither of these are intended to provide a complete picture of what is possible using MY NASA DATA. They are merely introductory examples to inspire educators and citizen scientists to develop their own inquiry questions using the resources that are being made available.

Solution 4: Community interaction

To ensure success, based on lessons learned by some MY NASA DATA team members through the S'COOL Project (Chambers et al., 2003), community interaction occurs in the MY NASA DATA Project at a variety of levels.

1. Intraproject: The MY NASA DATA team includes a diverse set of individuals: scientists, mathematicians, computer scientists, administrative personnel, an educator, and a consulting citizen scientist (all but one of which devote only part-time effort to the project). The team also includes diversity in terms of age and experience, so that we can represent a variety of points of view within the team. (Figure 3)

2. Teacher workshops: Workshops, which provide direct contact with educators from a variety of backgrounds, skill levels and comfort with technology, have been a very important source of feedback for the continued development of the project. The team has experimented with several workshop models, including intensive on-site workshops drawing a national crosssection of educators, targeted local professional development workshops, and short courses at regional and national educator conferences. Many of the documentation pieces described in Solution 2 are an outgrowth of intensive contact with a group of educators at our on-site teacher workshops. As part of this interaction, we asked educators to prepare and share lesson plans that use data pertinent to their specific classroom situation and curriculum. This was an optional part of the first annual workshop, and a required element in the second workshop. In both cases, some teachers went above and beyond the basic requirements to provide a number of really excellent lesson plans that can provide inspiration to other educators.

3. E-Mentor Network: The original MY NASA DATA proposal to NASA envisioned a network of local mentors, including individuals such as retired scientists and engineers, who would be able to interact directly with teachers and students. However, discussions with other groups and consideration of the requirements for background checks and other security measures quickly lead us to modify this idea. Currently the mentor network consists of a variety of individuals, scientists and educators, who are available via email for consultation on MY NASA DATA-related concerns. These concerns might be scientific questions that arise as a teacher or student is exploring a custom microset; or they might be pedagogical questions from a teacher who is developing a lesson plan incorporating data. Questions are submitted via the website using a simple web form, and forwarded to the mentor network after a review by the team. This allows the team to directly respond to simple questions, and to filter out questions that are outside the scope of the project. For questions of interest, multiple responses may be received from the mentors. As needed, these are integrated by the team into a single response, or sometimes multiple responses are provided with information about the expert. An email is then sent back to the questioner, and the question and response are also posted on the website under the Frequently Asked Questions. The mentor network has not been used much to date, but a few excellent questions have been submitted (example: If water vapor is invisible, why can you see steam?).

4. Monthly e-notes: This feature was initiated in August 2006, to further foster a MY NASA DATA community. A brief (about one page) email update is sent to workshop alumni, e-mentors, and subscribers to a MY NASA DATA newslist maintained by the ASDC. This E-note provides an update on new things (lesson plans, project ideas, datasets, …) that have been posted on the website, and provides information on any timely events (Earth Science Week, National Metric Week, etc.). Each E-note also features a feedback question of the month, through which we invite dialog from the MY NASA DATA community about various features of the project.

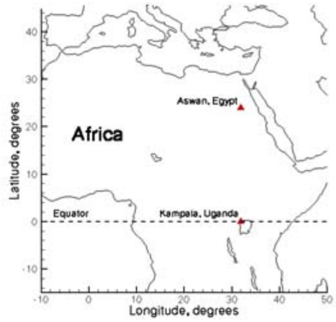
5. Future interaction: An additional type of interaction that we plan for but have not yet achieved is to get and post student and citizen science reports on projects that have been carried out using MY NASA DATA resources. These projects should provide examples and inspiration for other students who may be interested in starting a project using authentic NASA data.

Summary

The MY NASA DATA project provides one approach to making exploration of authentic Earth system science data accessible to larger communities. We invite the Bulletin's readership to join the MY NASA DATA community by: suggesting additional datasets for the LAS, joining the e-mentor network, sharing this resource with citizen scientists, and providing other suggestions.

References

Chambers, L. H., D. F. Young, P. K. Costulis, P. T. Detweiler, D. B. Stoddard, R. Sepulveda, Joyce D. Watkins, and A. Falcone, 2003: The CERES S'COOL Project, *Bull. Amer. Meteor. Soc.*, June, 2003, pp. 759-765.



Cloud Coverage, %		
Date	Aswan	Kampala
Jan-00	39.5	57
Feb-00	32	58.5
Mar-00	24.5	70
Apr-00	23.5	66
May-00	21	64
Jun-00	11.5	48.5
Jul-00	16	49.5
Aug-00	6.5	61
Sep-00	15	60.5
Oct-00	8.5	74.5
Nov-00	15.5	77
Dec-00	18.5	68.5

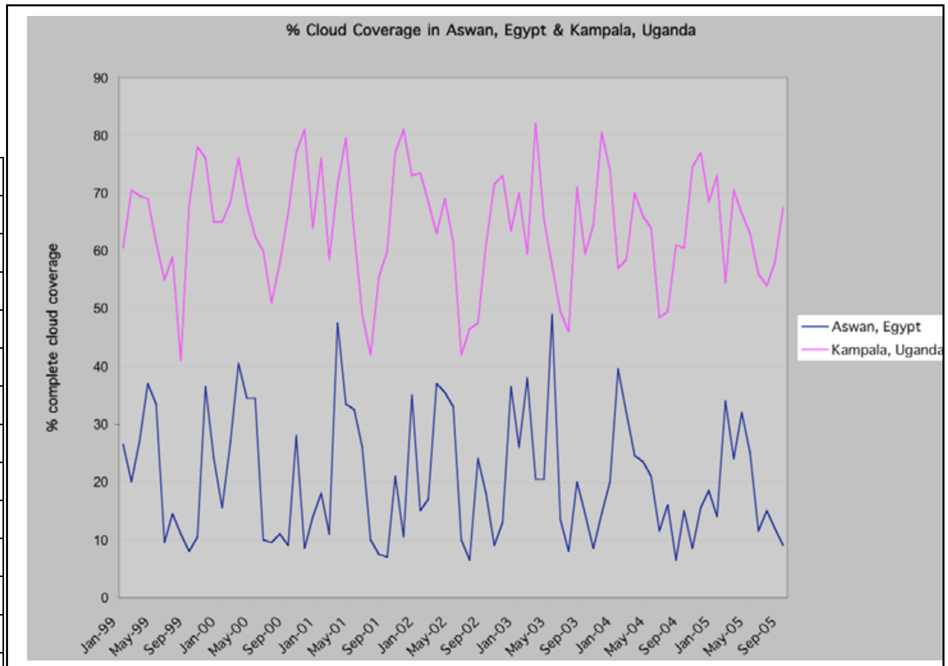


Figure 1 – A simple static microset comparing monthly average cloud fraction for two locations in Africa: Aswan, Egypt at (24 N, 32 E) and Kampala, Uganda at (0 N, 32 E). This microset is a powerful illustration of the impact of the Intertropical Convergence Zone on the weather and climate of this region.

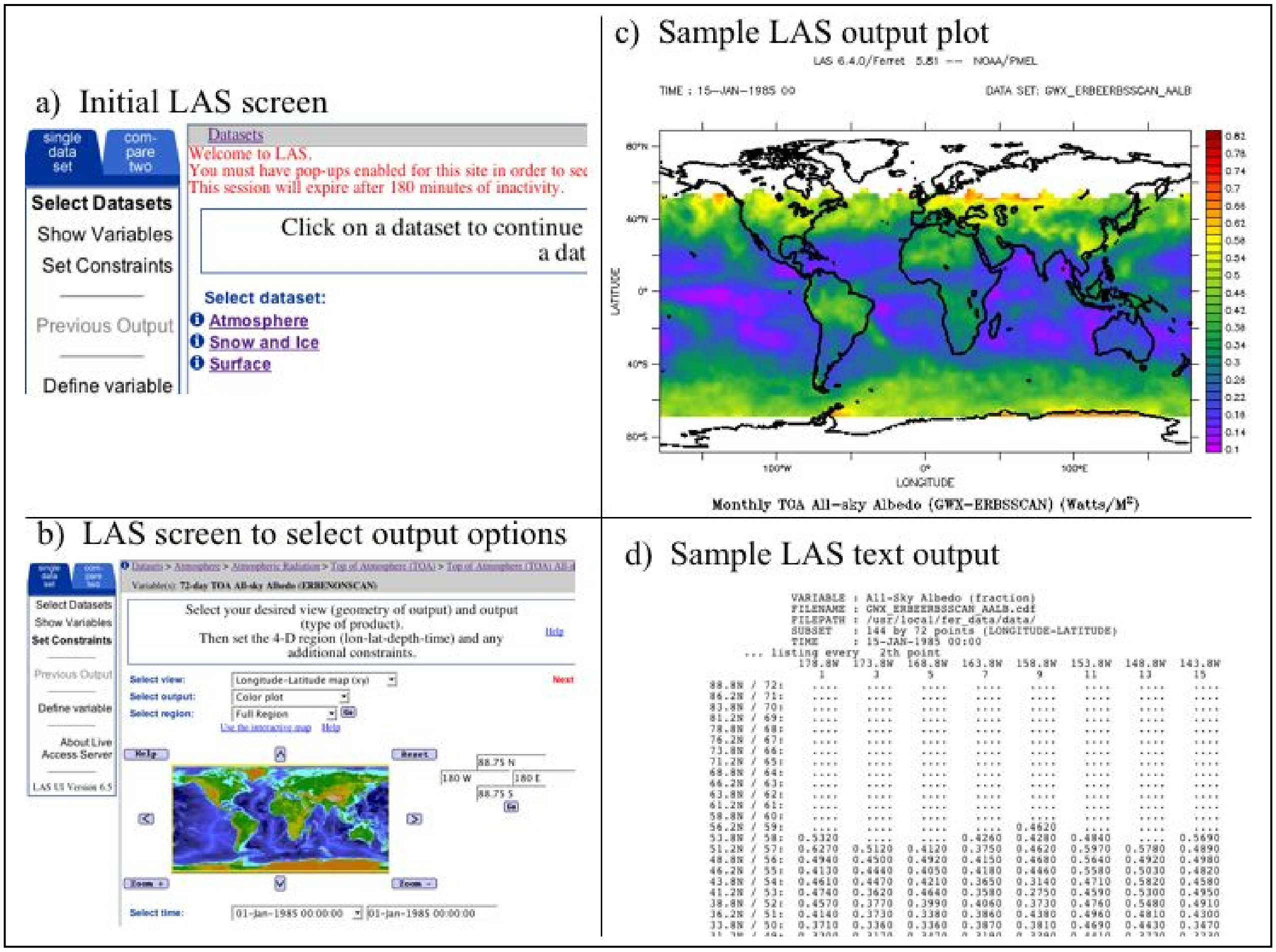


Figure 2. Sample screen shots from the Live Access Server (LAS) which allows the creation and exploration of custom microsets from over 100 Earth sytem science parameters. a) Initial screen showing highest level topical selection. b) Common interface for selection of output options, which allows selection of either image or text output. c) Sample of image output. d) Sample of text output, including the notation "….." for unavailable or default values.

Figure 3. The MY NASA DATA team, a diverse group of programmers, scientists, educators, and administrative support. The citizen scientist consultant, who is located remotely, does not appear in this photo.