Managing and Servicing Physical Oceanographic Data at a NASA Distributed Active Archive Center

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***Abstract*— The NASA Earth Science Data Information Systems Project funds and operates 12 Distributed Active Archive Center(s) (DAAC) throughout the United States. Of these 12 centers, the Physical Oceanography DAAC (PO.DAAC) is committed to providing long term archival, distribution and stewardship for NASA physical oceanographic data, primarily derived from space-born satellite systems, but also including a growing set of recent and future in situ observations from the SPURS-1 and SPURS-2 campaigns. Notable NASA missions supported include: Seasat, TOPEX/Poseidon, NSCAT, QuikSCAT, ISS-RapidScat, Jason-1, Jason-2/OSTM, GRACE, Aquarius, GHRSST, and MODIS. The following interagency and international missions are also supported by PO.DAAC: AVHRR, Coriolis, DMSP, MetOp-A, MetOp-B, Oceansat-2. The PO.DAAC currently holds 525 datasets in public distribution, spanning the following observational parameters: sea surface temperature, sea surface salinity, ocean color, ocean surface currents, ocean surface wind speed, ocean surface wind direction, sea surface height, significant wave height, ocean water mass/thickness, and sea ice age. A hundred of these datasets are available in near-real-time. Datasets are distributed through a variety of open-source access protocols including FTP, OPeNDAP, and THREDDS. FTP will soon be phased out in favor of a recently introduced HTTPS PO.DAAC Drive interface that supports WebDAV and interoperable machine-to-machine communication. OPeNDAP supports remote data/metadata query, subset, and download. THREDDS provides the features of OPeNDAP with the additional feature of temporal aggregation. PO.DAAC also offers proprietary tools and services to further enhance the data discovery, visualization and analysis experience, including but not limited to: State of the Ocean, Web Services (data/metadata discovery and extraction), HiTIDE Level-2 subsetter, Live Access Server (LAS), Webification (w10n-sci), and Rich Site Summary (RSS) Datacasting. To assist with provenance of datasets, PO.DAAC has implemented DOIs for the data it distributes so that they can be properly cited. There is a user forum and helpdesk that contains data recipes and via which users can get guidance. In summary, this presentation aims to provide a general overview of PO.DAAC's web portal and data holdings along with a set of illustrative examples leading prospective data users into the practical utility of its tools and services.**

Keywords—po.daac, podaac, daac, jpl, jet propulsion laboratory, nasa, eosdis, esdis, earth science, oceanography, ocean science, data, satellite, archive, stewardship, management, distribution, access, subsetting, visualization, preservation, quality, web, services, forum, online, ftp, opendap, thredds.

I. Introduction

At this moment in time, the Phsical Oceanography Distributed Active Archive Center (PO.DAAC) retains and actively distributes 525 openly accessible and searchable datasets, of which 100 datasets are distributed in near-real-time (i.e., constrained by a latency of under 24 hours). The actual number of datasets as indicated above varies from week to week, either due to an influx of new datasets or a deprecation of older versions of datasets which may have been superceded by newer versions. Therefore, it may be worth a visit to the PO.DAAC web portal [1] for the most up-to-date listings of datasets in public distribution. The PO.DAAC is chartered, with direct funding and oversight from the National Aeronautics and Space Administration (NASA) Earth Science Data Information Systems (ESDIS) project, to provide access and user support services for data from key NASA Earth Observation System (EOS) remote sensing missions pertaining to the primary domain of phsyical oceanography. Given the diversity of the data from these missions, it has become increasingly important to retain a knowledgebase via the leveraging of subject matter expertise to bridge the gaps between data that exists, data that is to be used for the correct intended purpose, the understanding of such data and corresponding metadata both prior and after utilization, and the more efficient and targeted use of such data. Technology has provided a way to further bridge these gaps in a manner that syngergizes the human knowledge base with the machine-to-machine domain. Such technological developments translate to key services and Application Programming Interfaces (APIs) we currently employ, such as: on-demand data subsetting/visualization, time-series aggregation, webification, Rich Site Summary (RSS) data/metadata streaming, regular-expression keyword searching, faceted web portal searching, web services API for data and metadata query and extraction in a variety of interoperable formats, Web Distributed Authoring and Versioning (WebDAV) API for more flexible data mining and extraction via a plethura of command-line utilities, User Registration System (URS) for improved user characterization, and a user forum that is synchronized with a semi-automated ticketing system for more expedited response to user inquiries. Other considerations being dealt with are with respect to data quality, data preservation, provenance, citations, and continued optimizations of data management throughout the complete data lifecycle.

II. Dataset Landscape

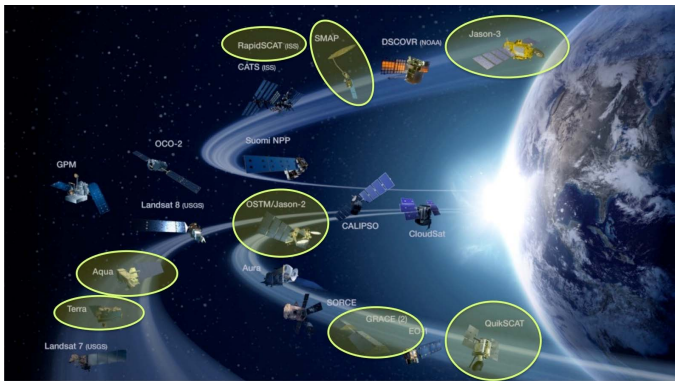

Fig. 1. NASA EOS missions supported by PO.DAAC (encircled and highlighted in green).

Aside from the primary focal point of physical oceanography, PO.DAAC manages data over a rather diverse interdiscplinary landscape that also includes biological oceanography, air-sea interaction, ice-ocean interactions, cryosphere, climate, maritime weather, geodysy, and hydrology. Primary measurement parameters include, sea surface temperature, sea surface salinity, sea surface height, ocean surface wind vectors, ocean mass, land mass, equivalent water height, ocean surface currents, and significant wave height. Synergisic parameters include sea ice and ocean color. While the majority of these data originate from flagship NASA EOS missions (see Figure 1), other sources include missions either partnered with or solely provided by Argentinian, European, Japanese, and Indian government institutions/agencies.

As indicated by Figure 1, the PO.DAAC supports key missions that are vital to it's fundamental role of providing data stewardship for NASA physical oceanography data. The most recently launched of these missions is Jason-3, the third in the Jason series (including OSTM/Jason-2) of satellite altimeters, for which we are still awaiting science-quality ocean surface topography data to be made publicly available. The Soil Moisture Active Passive (SMAP) satellite mission, while it's primary objective is not physical oceanography and the active portion of the instrument is no longer operational, simultaneously will provide us with sea surface salinity and ocean surface wind speed data at a level of quality that is suitable for science and continues the legacy left by the first of it's kind salinity mission known as Aquarius/SAC-D. The Rapid Scatterometer (RapidSCAT) is the first EOS mission to fly on the International Space Station (ISS; see Figure 2), and after nearly two years of succesful flight operations, has shown to be a valuable continuation to the QuikSCAT ocean surface wind vector retrieval mission. RapidSCAT's unique asynchronous low-earth orbit allows for bi-monthly resolution of the diurnal and semi-diurnal winds of the global oceans between 54° N and 54° S latitude. The Gravity Recovery and Climate Experiment (GRACE) has been going strong for over 14 years in providing us with monthly maps of gravity-based equivalent water height (over ocean), land mass, ice mass, and terrestrial water storage. The sister satelites known as Aqua and Terra provide us with data from a key instrument known as Moderate Resolution Imaging Spectroradiometer (MODIS); MODIS provides users with data to resolve the sea surface temperature and ocean color. Aqua has an additional instrument known as the Advanced Microwave Scanning Radiometer for EOS (AMSR-E), which unfortunately stopped functioning in October 2011, but which provided complementary sea surface temperature, atmospheric moisture, and wind speed data.

Moving beyond the NASA EOS data landscape, the PO.DAAC also publicly distributes data from a variety of international missions through a network of data sharing partners. The largest and perhaps most well organized of these is known as the Group for High Resolution Sea Surface Temperature, which is responsible for funding and organizng the creation, distrubution and archival of hundreds of global sea surface temperature products from international missions including but not limited to: MetOp(A/B), ENVISAT, Himawari, Meteosat Second Generation (MSG), Meteosat-10, Global Change Observation Mission (GCOM) W1, and the Multi-Functional Transport Satellite (MTSAT) 1R and 2. GRHSST also supports data creation and stewardship for a number of domestic missions previously mentioned, in addition to the following inter-agency missions: Coriolis, Geostationary Operational Environmental Satellite (GOES), NOAA series of polor orbiting satellites, and Suomi NPP.

Fig. 2. RapidSCAT as mounted to the International Space Station (ISS).

While the vast majority of these datasets come from satellite remote sensing instruments, we have recently begun accepting data from NASA-funded field campaigns, starting with the Salinity Processes in the Upper Ocean Regional Study (SPURS) project (see Figure 3). The SPURS project consists of a series of science process studies and associated oceanographic field campaigns that aim to provide a more clear picture on key mechanisms responsible for near-surface salinity variations in the oceans. In particular, SPURS intends to quantify the relative significance of circulation, evaporation, precipitation over a range of scales for representative areas of the open ocean. SPURS also will also help scientists look

deeper into the fundamental role the ocean plays in global water cycle budgets and its relationship to climate. Co-located sea surface salinity data from Aquarius/SAC-D and the Soil Moisture Active Passive (SMAP) satellite instruments will play a major role in improving the characterization of salinity over large regional and time-varying domains. The SPURS-2 campaign has just recently launched this summer and will be a continuation of SPURS over a new region focusing on the fluctuations of fresh water tongue of the rainy eastern Tropical Pacific.

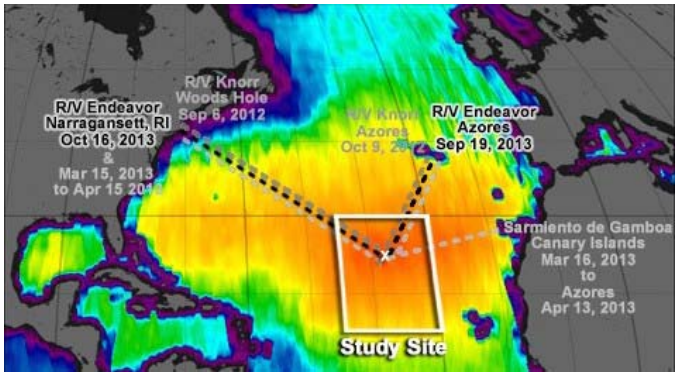

Fig. 3. The location of the SPURS-1 campaign covering the subtropical North Atlantic ocean. Sea surface salinity data is mapped from data provided by the AQUARIUS/SAC-D satellite to provide improved characterization of the salinity structure.

III. Data Access Protocols

Over the past decade, the PO.DAAC has significantly increased its points of access and created new, optimized modes of search, discovery and extraction of its data holdings. As we were moving away from CD/DVD and tape media for data distribution just a little over a decade ago, a basic File Transfer Protocol (FTP) became the PO.DAAC's first significant step toward increasing user accessibility to its digitized data. Then began the daunting process of migrating all of the PO.DAAC's data and metadata holdings from offline media to an online, web-accessible environment. The first major step toward an interoperable data server to promote index-based subsetting was the launching of an Open Source Project for a Network Data Access Protocol (OPeNDAP) server that was initially supported by the Distributed Oceanographic Data Systems (DODS) framework maintained by NOAA, which has since been upgraded to the most recent Hyrax data server. Hyrax enables OPeNDAP [2] to function much faster with less downtime through a more robust, efficient servlet architecture. The newest version of OPeNDAP (recently upgraded earlier this year) allows for dynamic aggregation. Shortly following the DODS/Hyrax upgrade was the introduction of the PO.DAAC's Thematic Real-time Environmental Distributed Data Services (THREDDS) Data Server (TDS) supported by Unidata. Our THREDDS server [3] takes OPeNDAP one step further by providing a metadata catalogue powered by the NetCDF Markup Language (NcML) to efficiently aggregate gridded datasets as a function of time, keeping the geospatial grid and underlying dataset metadata elements fully intact. This brings us to circa 2010.

The next step was to move away from a static, 1990s-era web page, with the primary goal in mind to make it difficult for novice, incoming data users to search and discover PO.DAAC's data holdings. Leveraging a Drupal-based web content management system for improved UI/UX and more fluid content management, the PO.DAAC made it's first radical web re-design in 2011, what we hereafter refer to as the PO.DAAC web portal. The web portal, for the first time ever, featured both a faceted and keyword search interface. The keyword search interface was later improved to provide a "Google-like" query syntex [4]. There have been some additional iterations to the web portal, but the faceted and keyword search remains in place.

The next set of enhancements were with regard to improving how both data and metadata can be searched, subsetted and extracted. By this time, existing Graphic User Interface (GUI) tools were in place to perform data subsetting on a visual map (see Section IV: Data Visualization and Subsetting Services), but there were some limitations, such as: 1) no machine-to-machine interface, 2) services were limited to specific dataset processing levels (i.e., L2, L3, L4), and 3) services were limited to a small selection of the complete data holdings due to the difficulty of integrating new datasets. Then enters PO.DAAC Web Services [5], which provides both a web form and an Hypertext Transfer Protocol (HTTP) Application Programmer Interface (API) utilizing a Representational State Transfer (REST) URL syntax. This new service solved the previous GUI-centric plague of limitations and provided users with a more efficient way to query and extract temporally and spatially subsetted data from our database. With Web Services, metadata records can also be extracted using a variety of interoperable formats including XML and JSON. A RSS feed can also be created and customized by Web Services using space/time query that is provided by Atom Syndication Format, which is an XML-based language designed for RSS feeds. These RSS feeds can then be inserted into an RSS feed reader or a "live bookmark" for RSS-enabled web browsers for automated updating of information. RSS feeds are also referred to as "Datacasting Feeds", which are also made available (only for select datasets) on a global basis using a stand-alone Datacasting service [6].

The most recent data access improvement is with a service called PO.DAAC Drive [7], which is the beginning of a phase-out of FTP and provides users with the ability to mount a virtual drive to their machine, using what is referred to as a WebDAV API for more efficient navigation and extraction of data. PO.DAAC Drive also provides a more robust and secure way via authenticated HTTPS to mine and extract data using machine-to-machine scripting through command-line services such as CURL and WGET. As an added feature, the PO.DAAC Drive is authenticaed using URS, which opens the door for improved user characterization for an optimized user experience with more custom-tailored user support. The PO.DAAC Drive service is currently offered in a User Acceptance Testing (UAT) beta release and will soon be upgraded with full operational support as an intended replacement for FTP.

IV. Data Visualizaton and Subsetting Services

For data users who are either less tech-saavy, want to save some time making a plot or subset datasets quickly and easily, there are a number of services offered. For someone who just wants a quick glance of the most recent 30 days of oceanographic data, there is a tool called State of the Oceans (SOTO) [8] that provides static and animated raster images of data that can be overlayed on a map or other raster images of datafor a range of parameters: sea surface temperature, sea surface height, ocean surface wind vectors, ocean surface current vectors, chlorophyll concentration (as a proxy for ocean color), and true color imagery from MODIS on Aqua and Terra (see Figure 4 for an example). In addition to providing satellite data, SOTO also provides overlays from in situ sources (i.e., buoys, platforms and ships), fixed coastal High Frequency (HF) Radar (for surface currents), and storm tracks over the ocean (i.e., from tropical cyclones and transitioning extratropical cyclones); these are available from the "Other Layers" option in the top left panel.

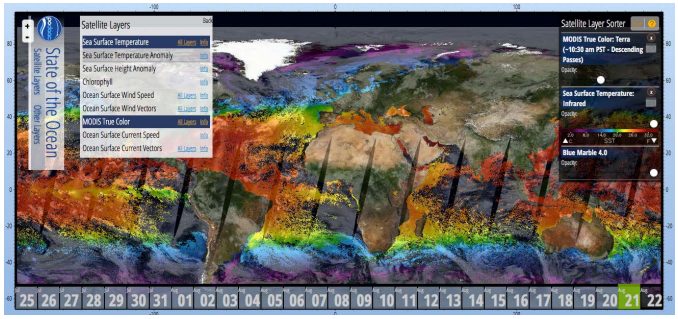

Fig. 4. State of the Oceans (SOTO) displaying infrared sea surface temperature in background from MODIS (using both Aqua and Terra satellites), MODIS Blue Marble depecting continents and islands, and MODIS True Color (i.e, depicting clouds as white) as the overlay using a 40% opacity filter on 21 August 2016. The upper left panel shows the various satellite layers to choose from. The upper right panel shows the "Satellite Layer Sorter" to select opacity and sort the ordering of layers. The bottom panel shows the calendar day of the most recent month.

Moving on to more of a subbsetting and analyis service is PO.DAACs's Live Access Server (LAS) [9], developed and maintained by the NOAA Pacific Marine Environmental Laboratory (PMEL). LAS has been online since 2013 and was a direct replacement for a depricated subsetting and visualization service known as the PO.DAAC Ocean ESIP Tool (POET). Like POET, LAS only functions with satellite-derived datasets processed at Level 3 or 4 (i.e., regularly gridded datasets). One of the main advantages to LAS is its relative ease (compared to other subsetting services) of integrating new datasets, which is simply a matter of ensuring that those datasets are properly integrated into THREDDS. Thus, LAS is powered by THREDDS, which makes LAS a rather lightweight service that requires minimal resources to operate and maintain. From a user perspective, LAS offers the ability to: 1) select the precise date/time (or a date/time range) of data to analyze, 2) compare up to four plots of the same dataset at different time steps, 3) adjust color pallette (from preset color tables) and max/min colorbar range, 4) adjust plot type: lat/lon, time series, longitude linear, latitude linear, and Hovmoller (see Figure 5 for an example). Data from LAS can also be exported as netCDF, ASCII, CSV, or arcGrid.

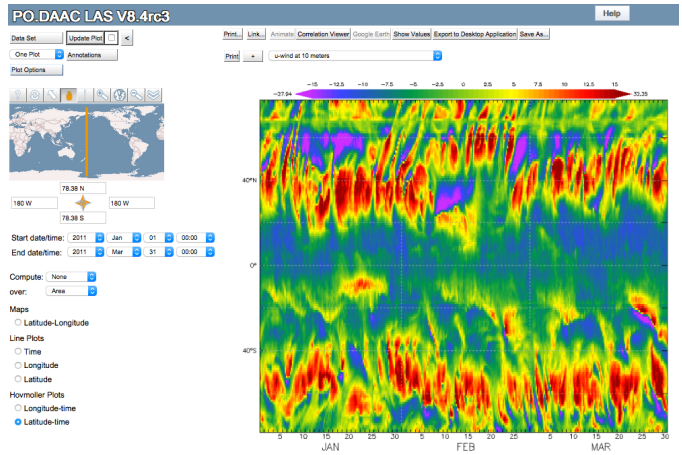

Fig. 5. Latitude-time Hovmoller plot provided by the PO.DAAC LAS depicting the U component (i.e., eastward) of the wind vector (m/s) from 1 January 2011 through 31 March 2011.

Proprietary to the PO.DAAC is the High-level Tool for Interactive Data Extraction (HiTIDE) [10], which is our exclusive GUI service for subsetting and extracting Level 2 satellite datasets. Since Level 2 satellite data is on an irregular grid with respect to the orthogonal latitude and longitude grid orientation, there is an inherent higher level of difficulty in working with Level 2 data (compared to Level 3 or 4) both in terms of computational processing and increased level of detailed information that can either be filtered out or extracted via numerous types of quality flags/indicators within the data files. Aside from the difficulty in working with Level 2 data, the learning curve alone in understanding the structure of some Level 2 data files has been enough to deter even seasoned scientists away and into the direction of Level 3 and 4 data. Due to the fact that Level 2 data offers an inherent richness, both in terms of quality and detail, that cannot be mached by higher level datasets, having a tool such as HiTIDE is important in removing most of these barriers and making Level 2 data much more accessible and usable to the less saavy data user.

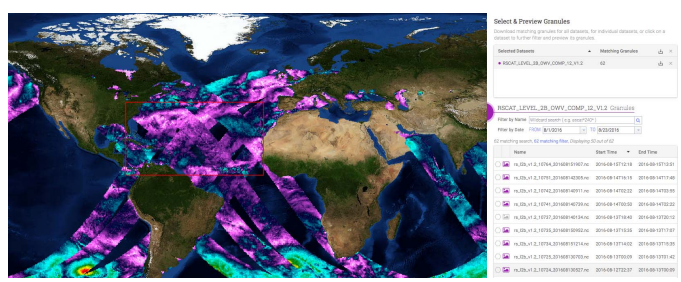

Fig. 6. A bounding box (red bordered square in the middle of the map) shows where matching Level 2 orbital tracks from the RapidSCAT instrument onboard ISS. The data overlaid is wind speed callibrated to a reference height of 10 m above the ocean surface. The search box to the right shows the selection of files used to generate this preview image.

Aside from the fact that HiTIDE provides an option to visualize data on-the-fly (see Figure 6), HiTIDE's primary purpose and real strength is in it's ability to quickly subset data of long time series and a user-specified bounding box in a manner that is much more efficient compared to remote service calls to OPeNDAP and with a significant reduction to the

overall amount of data volume a user would need to download and store on his/her hard drive. HiTIDE's viusalization option is meant as more of a preview function to briefly get a sense of the data within a bounding box. Scientists often use HiTIDE to create long time series subsets in very specific regions that are unique to their area of study, and may typically use the HiTIDE visualization option to narrow their results as opposed to making critical analyis.

The final service of note is refered to as Webification, or W10n [11].This utilizes the JPL W10n extension known as W10n-sci, meaning that it has a focus on applications to Earth science data formats which include include NetCDf, HDF4/5 and EOS extensions, and GRIB. W10n functions as a ReST-ful webservice API that can query and extract data by value rather than the typical method which is by index. Data serviced by W10n are often referred to as "webified". Direct calls to the webified data can be made by web browser, script, or any client that can send communicate to an HTTP/HTTPS API using a ReST URL. The URL request can support a variety of output formats including JSON, HTML (metadata only), flat binary, and netCDF.

V. User Services

An expose on data management would not be complete without discussing user interactions and the services that have since been developed to address user inquiries both post-hoc and in a pre-emptive sense. Not a day goes by without at least one question or request by anyone from the casually interested citizen concerned about the state of an impending weather event, to the deadline-driven industry data analyst, and of course the fundamental science researcher. What all of these requests generally have in common is a desire for instant gratification (i.e., "I want my answer ASAP or I will pull my hair out!"), or at minimum some might just want to see if there's a real person on the other side of the computer screen. Whatever the motivation, there really is an inherent sense of urgency behind these requests that cannot always be dealt with in a timely manner by a data center that only operates on a 40-hour per week schedule with occasional holidays, vacations, and without regard to time zones that are 12 time zones away. Of course there are the few of us weekend warriors who ignore the calendar and occasionally respond to a stray weekend user question. Nevertheless, there is a consistency of service that we strive for which cannot always be adhered to, particularly when a user community is extremely diverse both in a disciplinary sense and professionally. So how do we tackle these challenges?

Step 1: Develop a knowledge base. One major positive development at many NASA DAACs, including the PO.DAAC, is the recognition of the importance of retaining a Subject Matter Expert (SME) acting as a resident authority on datasets spanning a common discipline. At present, the PO.DAAC retains six full-time SMEs who simultaneously carry out a data stewardship role. Gone are the days of simply having a computer scientist being the first line of defense in response to a user with a technical data question, which in such cases would often result in that question being sidelined or forwarded to someone else who may be a data expert but with a primary job responsibility that has little to do with answering these types of questions. When you have SMEs fully dedicated to answering technical data questions, you increase the inherent value and credibility of your data center with many happy, repeat customers.

Step 2: Conslidate the method of response and tracking of user inquiries. Over the last 10 or more years we have gradually weened ourselves away from that itching desire to send a personal email or phone call to a user who asks repeated questions. One might seem to think that by giving away their personal email or phone number to the continually frustrated or curious data user they are doing a greater service by allowing that data user to ask their question to the direct person who is the SME on a particular dataset; thus, time is theoretically saved and the data user goes from a frustrated user to a happy user. Truth be told, that story doesn't play out as often as one might think it would. More often than not, that exceedingly curious or frustrated data user who now has your personal email address and/or personal phone number will contact you more in the long run, thus taking your attention away from other data users who may have just as important data issues to resolve. Years after the implementation of a consolidated email system that masks the personal email of an SME, the surprising result is overall less daily inquiries per SME per dataset. Please note: this is anecdotal and mileage may vary.

Step 3: Pre-empt the frequently asked questions by creating Frequently Asked Questions (FAQs). Since every user question over at least the last several years has been tracked in a database, it is that much easier to assess which questions seem to overlap and perhaps even repeat to some degree. Years of experience in the trenches of frustrated data users can also lead to a sort of pre-cognitive awareness of what types of questions might be asked given the prospect of a new dataset about to be released. In either case, it has proven worthwhile to document these questions in a long term repository that can be searched and readily accessed when needed. This is accomplished within our Forum [12], which is mentioned in further detail in Step 4 below.

Step 4: Provide a more public and user-friendly space for user interaction with SMEs. Hence, we have our Forum (see Figure 7). This has resulted in a substantial reduction (again, I speak anecdotally here) in the number of user inquiries that arrive via our conslidated email system. Not only do we use this to provide FAQs, but we also provide information on Data Recipes [13] that have on many occasions resulted in a solution to a data access, extraction or usage dilemma. Part of the success in this is of course seeding the Forum with interesting topics such as Ocean Stories [14] and Dataset Highlights [15]. It also requires public engagement in social media and community engagement events. Perhaps even when the most casual of data users realizes that there is a free and open space to ask questions and get real answers from known and respected data experts, it can have a socially magnetic affect. Our Forum may not be where we want it to be in terms of user participation, but it is slowly and steadily gaining traction and attention.

PODAAC FORUMS	TOPICS	POSTS	LAST POST
General Questions	12	22	by mark112 Sun Aug 14, 2016 4:13 am
Data Recipes Programming scripts on how to read, analyze and access PO.DAAC data	17	41	by yiboj Mon Aug 22, 2016 12:52 pm
Data Access Tools and services	26	65	by podaac Tue Aug 02, 2016 8:36 am
Ocean Stories Discussions A forum where our User community can discuss about Ocean Stories we've published in our Web Portal.	15	18	by jenifferhomes Wed Aug 10, 2016 1:04 am
FREQUENTLY ASKED QUESTIONS	**TOPICS**	**POSTS**	**LAST POST**
General Information FAQ	23	23	by podaac Fri Feb 05, 2016 12:03 pm
User Registration System (URS) FAQ	4	4	by podaac Tue Jul 29, 2014 1:33 pm
ANNOUNCEMENTS	**TOPICS**	**POSTS**	**LAST POST**
PODAAC General Announcements	96	99	by jenifferhomes Mon Aug 08, 2016 11:05 pm
System Monitor Announcements	12	12	by podaac Tue Apr 05, 2016 9:36 am
SCIENCE COMMUNITY COLLABORATIVE FORUMS	**TOPICS**	**POSTS**	**LAST POST**
Gravity	3	3	by dmoroni Tue Mar 08, 2016 2:35 pm
Ocean Circulation	1	2	by podaac Mon Apr 04, 2016 9:04 am
Ocean Temperature	12	37	by podaac Fri Apr 29, 2016 10:24 am
Ocean Topography	7	9	by podaac Thu Apr 28, 2016 10:14 am
Ocean Wind	17	22	by dmoroni Thu Jun 09, 2016 3:44 pm
Salinity	22	36	by vtsontos Wed Jun 29, 2016 4:07 pm
Sea Ice	0	0	No posts

Fig. 7. A high-level snapshot of the topics and most recent activity within the PO.DAAC Forum.

ACKNOWLEDGEMENT

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REFERENCES

[1] PO.DAAC Web Portal, http://podaac.jpl.nasa.gov, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[2] PO.DAAC OPeNDAP Server, http://opendap.jpl.nasa.gov/opendap/, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[3] PO.DAAC THREDDS Server, http://thredds.jpl.nasa.gov, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[4] PO.DAAC Web Portal Search Help Page, http://podaac.jpl.nasa.gov/DatasetSearchHelp, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[5] PO.DAAC Web Services, http://podaac.jpl.nasa.gov/ws, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[6] PO.DAAC Datacasting Feeds, http://podaac.jpl.nasa.gov/dataaccess/datacasting, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[7] PO.DAAC Drive, https://podaac-uat.jpl.nasa.gov/drive, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[8] PO.DAAC State of the Oceans 2D, http://podaac-tools.jpl.nasa.gov/soto-2d/, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[9] PO.DAAC Live Access Server, https://podaac-uat.jpl.nasa.gov/las, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[10] PO.DAAC High Level Tool for Data Extraction, http://podaac-tools.jpl.nasa.gov/hitide/, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[11] PO.DAAC Webification (W10n), http://podaac-w10n.jpl.nasa.gov/, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[12] PO.DAAC Forum, https://podaac.jpl.nasa.gov/forum/, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[13] PO.DAAC Data Recipes, https://podaac.jpl.nasa.gov/forum/viewforum.php?f=5, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[14] PO.DAAC Ocean Stories, https://podaac.jpl.nasa.gov/forum/viewforum.php?f=23&sid=ffb0acaa3f75d3af3376401ba1723571, Jet Propulsion Laboratory, California Institute of Technology, 2016.

[15] PO.DAAC Dataset Highlights, https://podaac.jpl.nasa.gov/highlights, Jet Propulsion Laboratory, California Institute of Technology, 2016.