Users Committee Meeting Agenda

Thursday, June 2nd

(Times are Mountain Daylight Time)

09:00 - 09:15 Open Meeting. Introduce new staff, discuss dates for fall meeting, review action items

09:15 - 10:15 Director's Report (Mohan Ramamurthy)

10:15 - 10:30 Break

10:30 - 12:00 Discussion of Users Workshop. Describe historical evolution of Users workshops over the years. Consider possible new goals for future workshops, focusing on hoped-for outcomes. Please spend some time thinking about the workshop-related questions posed before the meeting.

12:00 - 13:15 Lunch at the Foothills Lab cafeteria.

13:15 - 13:45 New Technologies to be aware of. Presentations and demonstrations by Unidata Program Center staff of new things that are on our radar.

13:45 - 14:15 NCEP report and questions (Anne Myckow)

14:15 - 15:00 Staff Status Reports. Please review the written reports prior to the meeting and bring questions.

15:00 - 15:45 DeSouza Award. Discuss the status of the program, potential adjustments, and the nominating process. What is the role of the Users committee in finding honorees? What is the role of the Program Center? Discuss candidates for the 2022 honor.

15:45 - 16:00 Break

16:00 - 16:15 Community Equipment Awards. What types of "equipment" can be funded by the award?

16:15 - 17:00 Quick Topics. (These are intended as short presentations or discussions. There will be time on Friday to extend discussion if necessary.) UCP review (Mohan), Himawari data from AWS, DEI/Culture Survey implementation plan, Role of Data Expert (including any community needs), Introduce strategic planning process, closure on the User Survey.

17:00 Adjourn

18:30 Collaborative discussion on the day's proceedings over dinner at Aperitivo, 5530 Spine Rd, Boulder, CO 80301 (map)

Friday, June 3rd

(Times are Mountain Daylight Time)

09:00 - 09:15 Convene and outstanding items

09:15 - 10:30 Blue Sky: Barriers discussion. What two things do committee members need to better pursue research and teaching? Use case, tools currently used/misused, current barriers. Please spend some time thinking about the "barriers" questions posed before the meeting.

10:30 - 10:45 Break

10:45 - 11:45 Role of the Users Committee. What does Unidata need from the committee? What does the community need from its representatives? Discuss the need for a formal charter outlining the purpose of the committee. Please spend some time thinking about the "role of the committee" questions posed before the meeting.

11:45 - 12:30 All Other Business. Continued discussion of topics started previously, if necessary.

12:30 Close meeting.

Status Report: Users Committee Actions

October 2021- June 2022

Unidata Program Center Staff

Actions from the Previous Meeting

Action 1

Share code for IDV kiosk with committee (Jeff Weber)

Result

Action 2

Agenda item in spring to discuss how to access Himawari data from AWS and decide on any changes to LDM feeds. (Doug Dirks)

Result

Scheduled for “Quick Topics” section of the June meeting.

Action 3

Add instructions on creating scripts within LDM documentation (Steve Emmerson., Mustapha Illes)

Result

The next release will have updated documentation on scripts.

Action 4

Have exec and pipe print out command line of abnormally terminated processes (Steve Emmerson., Mustapha Illes)

Result

This feature already exists in the LDM, and has for quite some time.

Action 5

Day Snow requires gamma correction that McIDAS can’t do. (Tom Yoksas)

Result

This request has been and continues to be addressed by SSEC McIDAS developers.

Action 6

Example of satellite reprojection in Metpy (Ryan May)

Result

Prepared *May 2022*

Status Report: AI/ML

October 2021- June 2022

Unidata Program Center Staff

Activities Since the Last Status Report

- Rio McMahon left Unidata in January 2022.
- The search for an engineer to focus on AI/ML work is in progress.

Prepared *May 2022*

Status Report: AWIPS

October 2021- May 2022

Tiffany Meyer, Shay Carter

Areas for Committee Feedback

Are you aware of AWIPS Tips? Have you ever read any, and have you found any editions particularly helpful?

Would a beta version of AWIPS v20 be useful? Ie. A NWS version of AWIPS with operational functionality removed, but not necessarily having all Unidata-specific functionality incorporated back into it?

Activities Since the Last Status Report

AWIPS

Unidata's Jetstream production EDEX server continues to serve real-time weather and geographic data to CAVE clients and the python-awips data access framework API. Through the use of ancillary EDEX machines we have been able to decouple certain datasets from the main EDEX instance. Since the last status report, we've added an additional satellite ancillary EDEX machine, which has resulted in lower processing latencies while providing new products. This allows us to process and serve more data, faster than ever before. The distributed architectural concepts of AWIPS allow us to scale EDEX in the cloud to account for the size of incoming data feeds. Texas A&M has been using this distributed architecture since Summer of 2021. We have worked closely with them throughout the past year as we've released new versions of AWIPS, to help them transition between versions and identify weaknesses in their EDEX server.

Since the last status report, we've put out 2 major releases (18.2.1-3 and 18.2.1-5) and a minor release (18.2.1-4) of AWIPS – which includes updates to both CAVE and EDEX. Additionally, the current AWIPS team has been able to make our first updates and releases to the python-awips package, with version 18.1.10, released in April 2022, being the most recent release.

A link to all of our AWIPS release notes can be found here. With this being a direct link to the major 18.2.5 release.

The releases include several upgrades to both EDEX and CAVE; some feedback and suggestions came from our users. On the EDEX side of things we have:

- implemented the addition of new GOES products
- updated the packaged version of LDM
- included GLM updates
- added functionality for installed Undiata EDEX servers to check for station ID updates
- restructured the Models menu
- added National Blended Models (NBM) products
- re-enabled the GFE
- added support for snow squall warnings.

For CAVE we have:

- made improvements to the Warngen and Import GIS dialogs to accommodate for different user screen sizes/resolutions
- improved the connection dialog and added additional functionality for resolving the backend EDEX IP address or not
- updated our UI and menu items for clarity and consistency with our documentation.
- added, additional display capabilities and functionality for our Warnings, Watches, and Advisories (WWA) layers

More specifically, our WWA layers now have the capability to turn on/off the outline or fill for each of the Warnings, Watches, and Advisories, respectively. This was a feature suggested by one of our users.

It was also from user feedback that we realized our AWIPS did not have some of the latest WWA phensigs. We updated both EDEX and python-awips to handle the new phensigs of SQ.W (snow squall warnings) and DS.Y (dust advisories). This prompted the first release of python-awips for the current AWIPS team. We were able to set up GitHub Actions to help make the build and release process a seamless one for PyPI (pip install), and created thorough, private documentation for how to push the release to Conda as well. Thus, re-establishing our ability to make changes and publish new releases to the python-awips package.

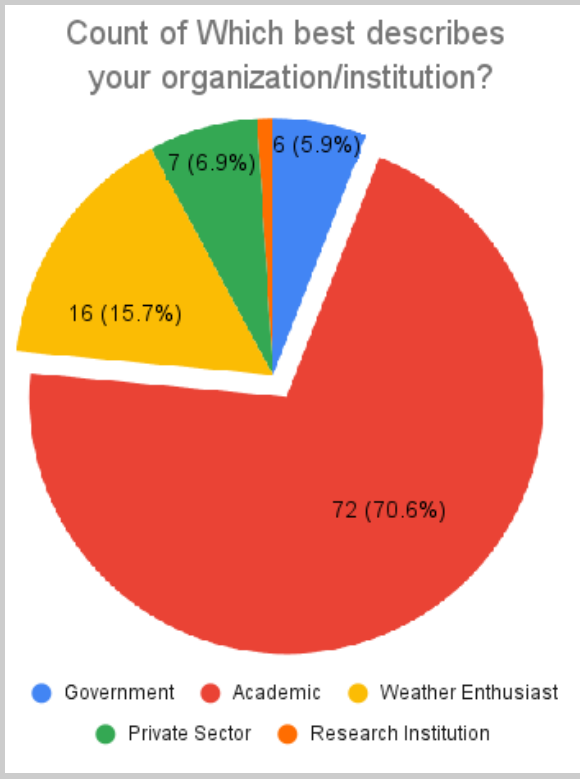
Additionally, we have implemented a new GitHub Action for our main awips2 GitHub repo, which makes use of GitHub secrets to make daily checks with an NWS SVN repo to look for updates to station ID information. It then automatically updates our own repo, which our users are pulling from nightly as well, so they receive the station updates as soon as we do.

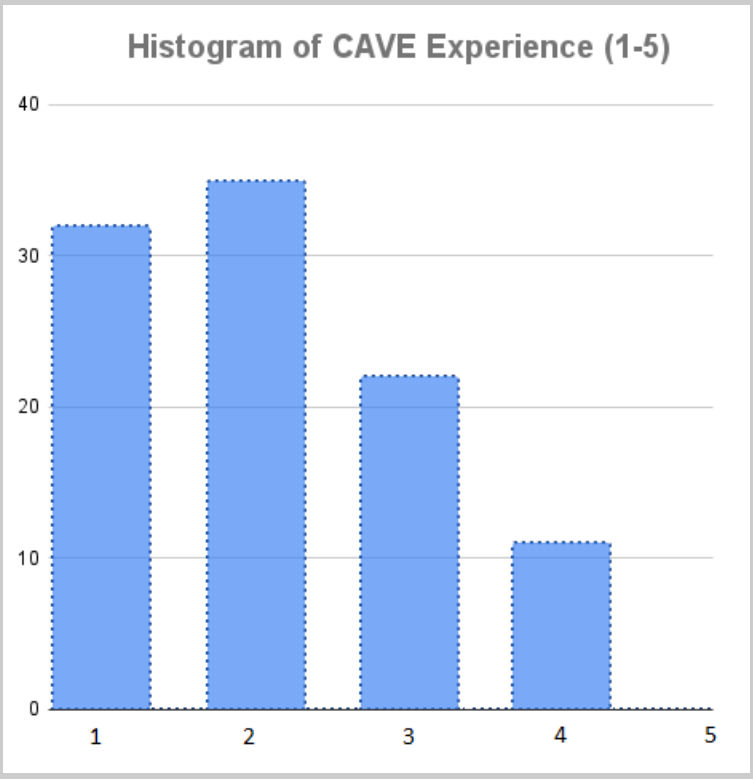
We also have transitioned our public EDEX server away from sharing Eric Bruning's gridded GLM products to now serving the NOAA hosted and created products. We are in the process of adding these new data products to our public IDD and plan to have them available early this summer.

A significant portion of our documentation both for CAVE, EDEX, and python-awips has been modified for easier understanding and comprehension. We are continuing to update our

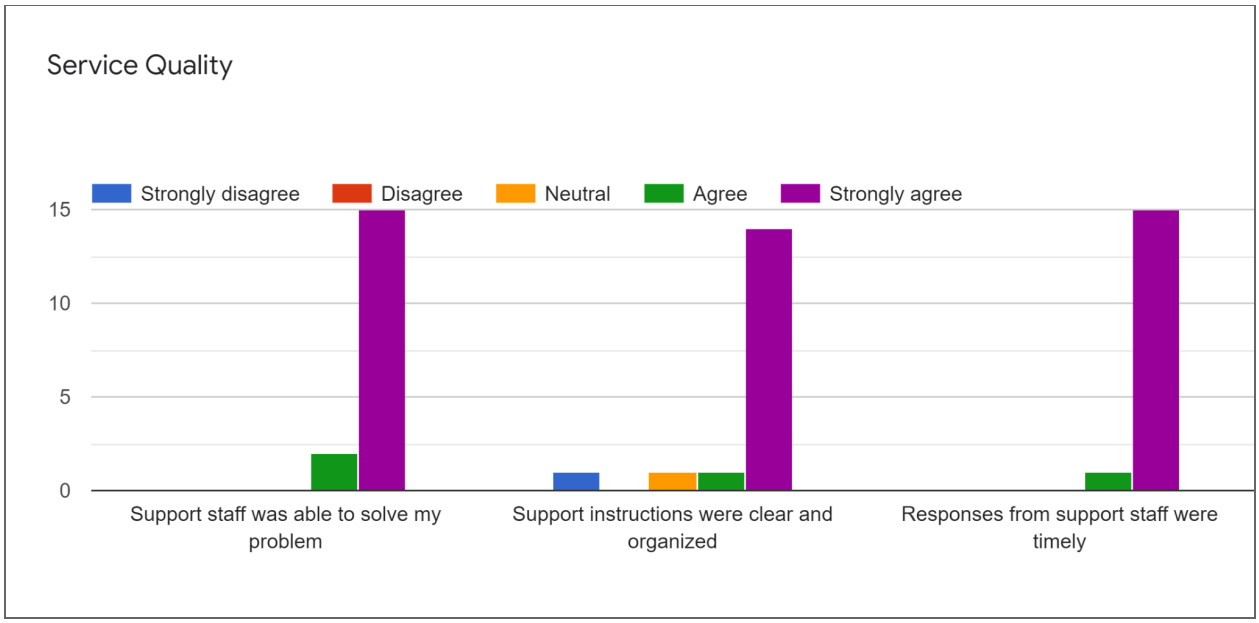
python-awips example notebooks to follow our new template that contains a helpful table of contents, with consistent subsections across the various example topics.
Our blog series, AWIPS Tips, has successfully been running every other week for over a year now. As of June 1, 2022, we will have released 31 blog entries . A current list and breakdown of all the entries is provided on our documentation website in the Educational Resources page. We plan to continue the blog series for the foreseeable future and have several more ideas already planned out for upcoming entries. Announcements for new blog posts are shared through our mailing list (awips2-users@unidata.ucar.edu), and our social media accounts (Facebook, Twitter, LinkedIn, and YouTube when applicable). This work has also been made possible with contributions from Nicole Corbin.

Our asynchronous CAVE training course has been live since October 2021. We have had over 100 users sign up and take our course. We encourage those who have never used CAVE and those who have but still might be fairly new to the software to sign up and try out the course for themselves. The demographic is shown in the charts below summarizing the institution and CAVE experience level the learner had identified with.





The AWIPS team still has an active support evaluation survey that is advertised in our support email signatures. Since the last status report we have had five new evaluation entries, which is slightly under our average of one per month. The majority of our feedback has been overwhelmingly positive, and the graphic below is a summary from all responses we've received regarding the quality of service we provide:



Some of the latest open-ended feedback from the support evaluations includes the following:
"Fast great assistance during a historic storm"
"Your team responded to my inquiry exceptionally fast. Frankly I was surprised and pleased!"
"Your AWIPS Team is awesome. I'm getting responses back usually in less than two to three hours. More responsive than the NWS AWIPS Program Office!!"

At AMS 2022, the AWIPS team presented on work done to integrate a machine learning pipeline into an EDEX server for display in CAVE. The poster presented on this topic can be seen here. This pipeline also took advantage of another modern technology in Docker. All of the files and configurations associated with this project are available on GitHub. We hope the outcome of these efforts will be a docker container that is easy to install and will allow our community to test out different ML algorithms and easily see them in CAVE. This is still currently work in progress.

We also presented a current update of Unidata AWIPS at AMS 2022. The update included highlights about some of our releases from the past year, as well as our plans for moving forward throughout the rest of this year.

Aside from direct AWIPS development and presentation, we have also been working closely with the Jetstream team here at Unidata to transition our backend EDEX servers from Jetstream1 to Jetstream2. This process began in early May of 2022, and we hope to have fully functional EDEX servers by the end of the month to test on. We will need to completely migrate off of Jetstream1 by July 1st, 2022, because the project will be at its end of life, and will no longer be active. We hope to have at least several weeks of "overlap" time with EDEX servers available from both Jetstream1 and Jetstream2 to handle any unforeseen bugs or issues.

Finally, we are proud to announce this summer we will have a Unidata student intern focused on the AWIPS package. This will be the first "AWIPS" intern in recent history. We are going to present her with a variety of topics and options to work on this summer, but overall it will have a learning and training focus. We are hoping she will gain valuable knowledge over the summer, and we are optimistic to see the materials she contributes that will benefit the AWIPS learning experience.

Software Releases

Since our last status report we have put out several new AWIPS (CAVE and EDEX) releases. We have released two major updates that are available for all three platforms (Linux, Windows, and MacOS): 18.2.1-3 and 18.2.1-5. We also put out a minor release to address some EDEX bugs that were introduced, the minor release was 18.2.1-4. All of these releases were fully signed (and notarized, in the case of the Mac) packages to allow for easy download and installation.

In addition to pushing out new releases of CAVE and EDEX, we also have made two small releases (18.1.8 and 18.1.10) for our Python package, python-awips. The release notes for both of those versions can be found on the GitHub page. We now have a partially automated and fully documented process for making python-awips changes and packaging and publishing the releases to both PyPI and Conda.

We currently have a few more changes/updates in development for Unidata's AWIPS version 18, so we are planning on making at least one more release sometime later this year. Our next main focus which we've started shifting to is creating and releasing a version 20 of AWIPS. This release will be a major upgrade (and incompatible with version 18.*), but will include updates like moving to Python3 andava11.

Activities Ongoing/In-Progress

AWIPS development activities are constantly ongoing. Currently the following activities are in progress:

- The AWIPS team has been testing and implementing changes to improve and optimize our cloud EDEX server.
- The AWIPS team is exploring the possibility of adding additional data and increasing the archive time of some existing data.
- The AWIPS team is responding to all AWIPS support questions from the community and striving to provide realistic solutions in a timely manner.
- The AWIPS team has worked through the build process for the Linux, Windows, and MacOS distributions of CAVE and is actively developing improvements and features for new releases.
- The AWIPS team has maintained a bi-weekly blog series called AWIPS Tips that began on April 7th, 2021 and has been used to highlight useful functionality and fundamentals for CAVE, EDEX, python-awips, and general AWIPS announcements.

- The AWIPS team is getting close to putting out an additional release that includes both EDEX and CAVE improvements for version 18.2.1.
- The AWIPS team is working on recreating our existing EDEX infrastructure (3 machine systems, with a fully functional duplicate for backup/testing) on the new Jetstream2 platform.
- The AWIPS team is actively developing a new release of AWIPS that upgrades to Python3 and Java11.

Future Activities

Future plans are constantly evolving to meet the needs of our users. In the short term, the AWIPS team is focused on migrating our public EDEX servers from Jetstream1 to Jetstream2. We are also preparing to host our first Unidata student intern since both Tiffany and Shay joined Unidata. The AWIPS team is looking to make at least one more AWIPS release for version 18, and we are actively starting to develop on version 20. We are hoping to release some iteration of version 20 by the end of the year (2022).

Metrics

Downloads October 1, 2021 - April 30, 2022

AWIPS downloads: 7,256

Strategic Focus Areas

We support the following goals described in Unidata Strategic Plan:

1. **Managing Geoscience Data**
   The cloud-based EDEX data server continues to see widespread use and growing adoption. More and more datasets continue to be added to the server as Unidata deploys more decode/ingest nodes.

2. **Providing Useful Tools**
   All AWIPS tools (EDEX, CAVE, and python-awips) are freely available, and also incorporate LDM/IDD technology for accessing geoscience data.

3. **Supporting People**
   At this juncture, we are providing full technical support with regards to AWIPS for the community.

Status Report: Science Gateway and Cloud Computing Activities

October 2021- May 2022

Shay Carter, Julien Chastang, Bobby Espinoza, Ward Fisher, Ryan May, Tiffany Meyer, Jen Oxelson, Mohan Ramamurthy, Jeff Weber, Tom Yoksas

Areas for Committee Feedback

We are requesting your feedback on the following topics:

1. In the post-pandemic era what changes have you noticed in the instructional landscape? Have students adapted to online instruction and prefer it? What about in class instruction and “flipped classrooms”?

Activities Since the Last Status Report

NSF Jetstream2 Grant Application Successfully Awarded for 2022-2023

Jetstream 1 will be end-of-lifed shortly. We submitted an NSF XSEDE grant application to obtain Jetstream2 resources so that Unidata may transition operations from Jetstream1 to Jetstream2. We requested sufficient resources to migrate the Unidata Science Gateway and AWIPS to Jetstream2. We also asked for Jetstream2 GPU and "large memory" resources to explore those Jetstream2 capabilities. In collaboration with Doug Dirks, Tiffany Meyer and Shay Carter, we submitted this multipart grant application to XSEDE on January 15. Our request for these resources was accepted and on March 15, we were awarded 5,000,000 SUs on Jetstream2. This allocation includes access to specialized hardware such as large memory instances and GPU computing capability.

Migrate Unidata Operations from NSF Jetstream 1 to Jetstream 2

We are currently migrating Unidata operations running on Jetstream 1 to Jetstream 2 including Unidata Science Gateway and ancillary services (TDS, Radar Server, ADDE, RAMADDA, LDM). We are also determining how to launch JupyterHub servers on Jetstream2 given that these servers are in high demand. In addition,we are assisting the AWIPS team with the same objective, ensuring that all EDEX related VMs are available and properly configured on Jetstream 2. We must complete this work by July 1, 2022 before Jetstream1 is end of lifed.

Dask Cluster

Steve Decker (Rutgers) contacted us in December 2021, about launching a JupyterHub Dask cluster for his Spring 2022 semester class. After many false starts, in collaboration with Andrea Zonca, we created a functioning Dask Cluster working on Jetstream2 in Spring of

2022. Employing Daks, we were able to run a Jupyter notebook analyzing WRF data from a UCAR RDA case study. We presented our work at a MiniGateways 2022 conference. Unfortunately, we did not meet this milestone in time for Steve's class. We are hopeful, however, that this will interest committee members and the community in the future especially in the era of Jetstream2 because of the powerful scientific computing resources that are available on that platform (e.g., GPUs, "large instance" hardware consisting of many CPUs and large amounts of RAM). These specialized resources in conjunction with Dask may become more important as we go deeper into the AI/ML arena.

Custos OAuth with Indiana University

For the numerous JupyterHub servers Unidata has deployed, we have employed GitHub OAuth. This technology has worked well for us and is reliable, but lacks certain features such as user scopes and being able to obtain user information (e.g., email addresses). We collaborated with Suresh Marru's team at Indiana University to explore CustOS OAuth technology which can hopefully address some of our concerns. We successfully launched a proof-of-concept in time for an NSF Review deadline at Indiana University. We are now planning on experimenting with this technology at jupyterhub.unidata.ucar.edu.

Science Gateway New Hire

With NSF supplemental funds now available, we hired a software engineer 2 for the Unidata Science Gateway Project. We spearheaded this effort by forming a hiring committee team and conducting a candidate search. This task was completed in January of 2022 when we hired Bobby Espinoza. Welcome aboard Bobby!

JupyterHub Servers for Online Instruction During COVID-19 Crisis Fall 2021 / Spring 2022

Unidata JupyterHub activities continue to advance since the last status report. These JupyterHubs are deployed In collaboration with XSEDE, ECSS (Extended Collaborative Support Services) and the Jetstream group at Indiana University (IU).

We have supported a number of semester-long classes, and workshops with JupyterHub servers hosted on the Unidata Science Gateway. The JupyterHub servers are tailored to the instructor's objectives with pre-configured PyAOS (Python for the Atmospheric and Oceanic Sciences) environments, classroom material and data. Demand for Unidata JupyterHub servers has increased since the arrival of the COVID-19 pandemic and the transition to online learning. We are more than happy to assist instructors in this area, and would like to help in whatever way we can with these resources. See the metrics section below for more detailed numbers on this topic.

University of Oklahoma with Ben Schenkel

Unidata collaborated with Ben to provide data sets via the science gateway RAMADDA server. We also deployed a JupyterHub server so that NSF REU students at OU could access those

data for their projects.

Unidata Docker Container Improvements

- We implemented a Github Actions workflow to ensure images (e.g., thredds-docker) remain up-to-date and secure with respect to upstream changes and improvements
- We automated push of updated images to DockerHub
    - Collaborated with the TDS group to allow them to build and push the TDS Docker images as part of their workflow.
- For the thredds-docker container, we made major/minor version updates, as well as security patches and bug fixes, to base images (Tomcat, Rocky Linux, etc.) that automatically propagate to child containers
- Made some `Dockerfile` improvements leading to smaller image sizes
- As CentOS 7 is nearing end-of-life, we are transitioning to Rocky Linux based containers wherever possible. Rocky Linux is another RHEL-flavored OS that is meant to be the successor to CentOS.

Ongoing Activities

NOAA Big Data Program

- Unidata continues to manage the NEXRAD archive in Amazon S3, ensuring that realtime data are successfully delivered to the noaa-nexrad-level2 bucket. LDM is employed to deliver these data.
- Unidata also continues to deliver NEXRAD level 3 products to the unidata-nexrad-level3 bucket, part of the AWS public datasets program.
- TDS on Jetstream for level II NEXRAD: http://thredds-aws.unidata.ucar.edu/thredds/catalog.html
- AWS Explorer (Public access): https://s3.amazonaws.com/noaa-nexrad-level2/index.html
- Public Bucket for level II NEXRAD: https://noaa-nexrad-level2.s3.amazonaws.com
- Continue to populate the NEXRAD level II archive with real time data.
- Continue to populate new GFS 0.25 degree output and NCEP HRRR output to an S3 bucket for access. We did not place a TDS on this collection as this output is available from our standard sources.

JupyterHub Demonstration Server

Unidata continues to enhance the Unidata JupyterHub demonstration server. This server needs to be regularly updated as the Jupyter, JupyterHub, and JupyterLab ecosystems rapidly evolve.

Docker Containerization of Unidata Technology

Beyond what we mentioned earlier about improvements in this area, we continue to employ Docker container technology to streamline building, deploying, and running Unidata

technology offerings in cloud-based environments. Specifically, we are refining and improving Docker images for the LDM, ADDE, RAMADDA, THREDDS, and AWIPS. In addition, we also maintain a security-hardened Unidata Tomcat container inherited by the RAMADDA and THREDDS containers. Independently, this Tomcat container has gained use in the geoscience community.

Progress has been made on the following

- See earlier section on “Unidata Docker Container Improvements”

Product Generation for IDD

For the past five years, Unidata generated products for the IDD, FNEXRAD and UNIWISC data streams have been created by a VM hosted in the Amazon cloud. This product generation has been proceeding smoothly with almost no intervention from Unidata staff.

AWIPS EDEX in Jetstream Cloud

Unidata continues to provide an EDEX data server on the Jetstream cloud, serving real-time AWIPS data to CAVE clients and through the python-awips data access framework (DAF) API. The distributed architectural concepts of AWIPS allow us to scale EDEX in the cloud to account for the desired data feed (and size). We continue using Jetstream to develop cloud-deployable AWIPS instances, both as imaged virtual machines (VMI) available to users of Atmosphere and OpenStack, and as Docker containers available on DockerHub and deployable with the science gateway toolset.

EDEX is designed with a distributed architecture, so different components can be run across separate virtual machines (VMs) if needed, to improve efficiency. Our current design makes use of three VMs: one large instance to process most of the data and run all of the EDEX services including all requests, and two other ancillary machines which are smaller instances used to ingest and decode radar and satellite data individually.

For the past year, we have successfully maintained a duplicate set of VMs to mirror our production EDEX environment. These backup VMs have served as a testing ground for implementing new changes, as well as a backup for when our production server is unavailable. This has also allowed us to perform regular patches and software updates on the machines, since we can quickly “fall back” on the other set whenever we need the downtime. Our systems are more secure and protected because of this ability.

During May of 2022 the AWIPS team has been working closely with other Unidata members to begin transitioning our servers from Jetstream1 to the new Jetstream2 platform. We currently have 6 new machines for our EDEX systems, created and running in Jetstream2. By July 1st, 2022 we plan on having all of our users pointing to our new servers in the Jetstream2 cloud.

Along with our new grant for Jetstream2, we have secured access to an even more powerful instance that we plan on testing and seeing how much the single machine can ingest, process and serve. This will be a valuable learning opportunity about performance and efficiency on

the most powerful server we've ever had access to.

Nexrad AWS THREDDS Server on Jetstream Cloud

As part of the NOAA Big Data Project, Unidata maintains a THREDDS data server on the Jetstream cloud serving Nexrad data from Amazon S3. This TDS server leverages Internet 2 high bandwidth capability for serving the radar data from Amazon S3 data holdings.

Jetstream Security

We work with the Unidata system administrator staff to ensure that our web-facing technologies and virtual machines on Jetstream adhere to the latest security standards. This effort involves such tasks as ensuring we are employing HTTPS , keeping cipher lists current, ensuring docker containers are up-to-date, limiting ssh access to systems, etc.

Unidata Science Gateway Website and GitHub Repository

Website

The Unidata Science Gateway web site is regularly updated to reflect the progress of what is available on the gateway. The news section is refreshed from time-to-time for announcements concerning the gateway. The conference section and bibliography is also maintained with new information.

Repository

All technical information on deploying and running Unidata Science Gateway technologies is documented in the repository README. This document is constantly updated to reflect the current state of the gateway.

Presentations/Publications

- J. Chastang and K. Maull. Unidata partners with ucar soars program to help protégés and their mentors with atmospheric science internships. In Proceedings, Third Symposium on Diversity, Equity, and Inclusion, 102nd AMS Annual Meeting, Houston, Texas, USA, Jan. 23-27 2022. American Meteorological Society.
- A. Zonca and J. Chastang. Distributed computing on the cloud for science gateways with dask. In Mini Gateways 2022, Online, Apr. 5-7 2022.
- M. K. Ramamurthy and J. Chastang. The use of the unidata science gateway as a resource for facilitating education and research during covid. In 2021 AGU Fall Meeting, New Orleans, Louisiana, USA, Dec. 13-17 2021.

New Activities

Over the next three months, we plan to organize or take part in the

following:

Forthcoming Conference Attendance

- EGU General Assembly, May 2022
- Science Gateways Community Institute (SGCI) October 2022 Conference

Over the next twelve months, we plan to organize or take part in the following:

XSEDE ECSS JupyterHub Collaboration

We plan to continue our collaboration with Andrea Zonca (XSEDE ECSS, San Diego Supercomputing Center) for deploying JupyterHub clusters on Jetstream2 and exploring new technologies in this area such as Dask. We continue to provide Andrea with feedback as he releases new versions of the software. As the ECSS project appears to be winding down, Andrea is looking for a new source of funding to continue this vital collaboration.

Relevant Metrics

Fall 2021 / Spring 2022 JupyterHub Servers

Since spring of 2020, Unidata has provided access to JupyterHub scientific computing resources to approximately 850 students (including a few NSF REU students) at 14 universities, workshops (regional, AMS, online), and the UCAR SOARS program. Below are the latest metrics since the last status report.

Fall 2021			
User Affiliation	**# of Users**	**Point of Contact**	**Notes**
OU	20	Shawn Riley, Ben Shenkel OU School Meteorology	JupyterHub started summer 2021
U of Louisville	6	Professor Jason Naylor	
U of North Dakota	3	Dr. Aaron Kennedy Assoc Prof Dept of Atmos Sciences U of North Dakota	
U of North Dakota 2	15	Dr. David Delene Prof Dept of Atmos Sciences U of North Dakota	
Southern Arkansas U	34	Keith Maull (UCAR/NCAR Library)	
Fall 2021 Python Workshop	6	Drew and Nicole	
OU REU	2	Ben Shenkel OU School Meteorology	

Spring 2022			
U of Northern Colorado	8	Prof. Wendilyn Flynn, Department of Earth and Atmospheric Sciences	
~~Rutgers U~~		~~Steve Decker~~	JH received no use (could not get Dask cluster to work until too late in semester)
AMS 2022 Python Workshop	32	Drew Camron, Unidata	
Valparaiso U	19	Prof. Kevin Goebbert, Department of Geography and Meteorology	
U of Louisville	12	Professor Jason Naylor	
Spring 2022 Python Workshop	45	Drew Camron, Unidata	`
OU	3	Ben Shenkel OU School Meteorology	
UND	1	Dr. David Delene Prof Dept of Atmos Sciences U of North Dakota	
U of North Dakota	2	Dr. Aaron Kennedy Assoc Prof Dept of Atmos Sciences U of North Dakota	
OU	7	Ben Shenkel OU School Meteorology	

Github Statistics

Repository	Watches	Stars	Forks	Open Issues	Closed Issues	Open PRs	Closed PRs
science-gateway	4	14	10	11	153	0	495
tomcat-docker	9	52	57	2	36	0	67
thredds-docker	13	24	24	5	108	0	156
ramadda-docker	2	0	2	1	10	0	24
ldm-docker	6	13	13	3	33	0	58
tdm-docker	3	3	6	1	9	0	16

Strategic Focus Areas

We support the following goals described in Unidata Strategic Plan:

1. **Managing Geoscience Data**
   Unidata supplies a good portion of the data available on the IDD network to the Jetstream cloud via the LDM and the high bandwidth Internet 2 network. Those data are distributed to the TDS, ADDE, RAMADDA and AWIPS EDEX installations running on Jetstream for the benefit of the Unidata community. Unidata also makes the AWS Nexrad archive data accessible through the TDS Nexrad server running on Jetstream at no cost to the community. These data can be accessed in a data-proximate manner with a JupyterHub running on Jetstream for analysis and visualization. Containerization technology complements and enhances Unidata data server offerings such as the TDS and ADDE. Unidata experts install, configure and in some cases, security harden Unidata software in containers defined by Dockerfiles. In turn, these containers can be easily deployed on cloud computing VMs by Unidata staff or community members that may have access to cloud-computing resources.

2. **Providing Useful Tools**
   Jupyter notebooks excel at interactive, exploratory scientific programming for researchers and their students. With their mixture of prose, equations, diagrams and interactive code examples, Jupyter notebooks are particularly effective in educational settings and for expository objectives. Their use is prevalent in many scientific disciplines including atmospheric science. JupyterHub enables specialists to deploy pre-configured Jupyter notebook servers typically in cloud computing environments. With JupyterHub, users login to arrive at their own notebook workspace where they can experiment and explore preloaded scientific notebooks or create new notebooks. The advantages of deploying a JupyterHub for the Unidata community are numerous. Users can develop and run their analysis and visualization codes proximate to large data holdings which may be difficult and expensive to download. Moreover, JupyterHub prevents users from having to download and install complex software environments that can be onerous to configure properly. They can be pre-populated with notebook projects and the environments required to run them. These notebooks can be used for teaching or as templates for research and experimentation. In addition, a JupyterHub can be provisioned with computational resources not found in a desktop computing setting and leverage high speed networks for processing large datasets. JupyterHub servers can be accessed from any web browser-enabled device like laptops and tablets. In sum, they improve "time to science" by removing the complexity and tedium required to access and run a scientific programming environment.

3. **Supporting People**
   A Unidata science gateway running in a cloud computing setting aims to assist the Unidata community arrive at scientific and teaching objectives quickly by supplying users with pre-configured computing environments and helping users avoid the complexities

and tedium of managing scientific software. Science gateway offerings such as web -based Jupyter notebooks connected with co-located large data collections are particularly effective in workshop and classroom settings where students have sophisticated scientific computing environments available for immediate use. In the containerization arena, Unidata staff can quickly deploy Unidata technologies such as the THREDDS data server to support specific research projects for community members.

Prepared *May 2022*

Status Report: Community Services

October 2021- May 2022

Nicole Corbin, Doug Dirks, Jeff Weber

Areas for Committee Feedback

We are requesting your feedback on the following topics:

Do your needs from the Unidata Program Center change during this unique time?

Activities Since the Last Status Report

News@Unidata blog

Posts to the News@Unidata blog appear regularly, but not on a specific schedule. Some highlights:

- Unidata Staff at AGU Fall 2021 Meeting
- Unidata Staff at AMS 2022 Meeting
- Call for Proposals: Unidata 2022 Community Equipment Awards
- Unidata Summer Student Internships Available!
- Community Supported GEMPAK: an Update
- Unidata is looking for a Community Services Manager
- Unidata Program Center Welcomes Tara Drwenski
- Unidata Program Center Welcomes Bobby Espinoza
- Unidata Committee Nominations Open
- Unidata is Looking for an AI/ML Software Engineer
- 2022 DeSouza Award Nominations
- RAMADDA Manages Diverse Digital Content
- 2022 MetPy Users Survey
- Software release information
- Many AWIPSTips and MetPy Mondays episodes
- Community job postings
- Community meetings and other announcements

Dependencies, challenges, problems, and risks include:

- Finding community members willing to contribute stories (or story ideas) for the blog is an ongoing challenge. We're starting to make progress working with committee members, but there is more to do.

Community Outreach and Services

The community services group continues to actively reach out to and engage with Unidata community members.

Progress has been made on the following:

- Continue to engage with underserved populations and institutions as part of Unidata's outreach efforts to groups such as Rising Voices, SACNAS and AISES
- Continue to serve on the CUAHSI HIS standing committee.
- Continue to serve on the CUAHSI DEI standing Committee.
- Engage with the Arctic Research Consortium of the US on multidisciplinary projects
- We continue to update Unidata's social media channels (Facebook, Twitter, Google+).
- We continue to publish short videos/screencasts on the Unidata YouTube channel.
- Represent Unidata at the National Weather Service Partners events
- We continue to actively support the NCAR/SOARS program.
- Actively participate in Super Science Saturday.
- Engage and support the Undergraduate Leadership Workshop (ULW) at UCAR.
- Support the development and operation of the UCAR:NCAR Equity and InclusiON (UNEION) community of practice.

Dependencies, challenges, problems, and risks include:

- Facilitating community adoption of new technological services (cloud, etc)
- Engagement with Unidata social media streams among community members is not particularly high.

Learning and Outreach

The community services group has expanded efforts to promote learning Unidata products and workflows.

Progress has been made on the following:

- Delivered a modified Introduction to MetPy workshop at the 2022 AMS Student Conference in January, and a brand new MetPy for Computational Analysis of Meteorological Data short course for postponed 2022 AMS in March.
- Launched Unidata's eLearning hub (Moodle) which currently hosts Learn AWIPS CAVE. Learners can now save their progress and achieve a badge for completion. Unidata gets more data on learner participation and completion as well.
- Continuing to share tips and best practices for using AWIPS through the AWIPS Tips blog series

Dependencies, challenges, problems, and risks include:

- What learning materials are most helpful now, given the reduced travel restrictions? Should more emphasis be placed on large-scale synchronous learning (either facilitated by Unidata, or tools for self-facilitated synchronous learning), or embedded micro-learning (simulations, job aids, etc)?

- To evaluate the success of our learning opportunities, we need access to learners after the learning event. This can be difficult without someone keeping learners accountable.
- With the increase in scalable/reusable training materials offered for MetPy and AWIPS, we are interested in increasing participation and learning more about potential barriers to use. Of particular interest is participation in virtual workshops and using ready-to-use materials in the classroom/lab.

Ongoing Activities

We plan to continue the following activities:

- Engagement with science or cyber communities at large
- NAWIPS migration to AWIPS, including the overall AWIPS project
- Ongoing development of news articles for publication through News@Unidata
- Continue to support and contribute to governing committees
- Seminars
- Outreach
- Inclusion and equity
- Engagement with professional societies
- Support for cloud-related projects
- Further development of the Data Management Resource Center
- Support the pursuit of funding
- Site visits as the budget and pandemic allow
- Engage other UCAR/NCAR divisions regarding Unidata software use i.e. CESM/IDV
- Active participation in CUAHSI HIS (Hydrologic Information System) and DEI
- Active participation in the Hydroshare Advisory Committee

New Activities

Over the next three months, we plan to organize or take part in the following:

- Expanded emphasis on engagement with MSIs
- Expanded effort organizing and supporting community seminars/working sessions
- Provide additional support for instructors/supervisors using or planning to use Learn AWIPS CAVE, especially in the form of content that can be embedded into university LMSs.

Over the next twelve months, we plan to organize or take part in the following:

- Make structural changes to broaden participation in Unidata community engagement
- Continue to engage the hydrologic community regarding WRF-Hydro/IDV interactions

and the National Water Center's efforts
- Continue to engage the arctic community to find opportunities for collaboration
- Seek additional opportunities to engage and listen to the community
- Build out our staff mentorship program to include technical mentorship, potentially leveraging external (community) mentors.
- Create a plan to address the internal Culture Survey, including plans to create additional, meaningful engagement opportunities with the community.

Beyond a one-year timeframe, we plan to organize or take part in the following:

- Support the providing additional cloud-related training

Relevant Metrics

Statistics from the Community pages on the Unidata web site. Comparisons are made with statistics from the previous six-month period.

All community pages

Most recent six months:

- 43,711 unique pageviews (42,201 in previous period)
- 9.5% of total unique pageviews (7.8% in previous period)

Top community pages

1. All blog pages
   28664 unique pageviews (33815 in previous period)
   68% of total community pageviews (80% in previous period)
2. www.unidata.ucar.edu/community
   10415 unique pageviews (3728 in previous period)
   25% of total community pageviews (9% in previous period)
3. www.unidata.ucar.edu/about
   2917 unique pageviews (2546 in previous period)
   7% of total community pageviews (6% in previous period)
4. www.unidata.ucar.edu/events
   1188 unique pageviews (1600 in previous period)
   3% of total community pageviews (4% in previous period)

Social media statistics, May 23, 2022

1. # of Twitter followers: 1842 (up from 1841)

2. # of Facebook followers: 891 (up from 841)
3. # of YouTube subscribers: 2578 (up from 2575)
4. # of LinkedIn followers: 50 (unchanged from last report)

Strategic Focus Areas

We support the following goals described in Unidata Strategic Plan:

1. **Managing Geoscience Data**
   We monitor and collaborate with data sources to stay apprised of impending changes and to advocate for the needs of our user community.

2. **Supporting People**
   We provide user workshops, tutorials, and community workshops to help build supportive relationships between community members.

   We coordinate with our governing committees to find ways to expand Unidata's community participation. We use our web site, electronic newsletters, and social media to keep community members informed about enhanced data services, software tools, and cyberinfrastructure.

   We participate in UCAR/NCAR and NSF projects for underrepresented populations and minority communities (SOARS, AIHEC, outreach to HBCUs). We provide services and tools to facilitate education and research in diverse communities. We work to broaden the Unidata community by participating in student and professional conferences.

Prepared *May 2022*

Status Report: Data Standards and Technical Outreach

October 2021 - May 2022

Ethan Davis, Ward Fisher, Hailey Johnson, Dennis Heimbigner, and Ryan May

Areas for Committee Feedback

We are requesting your feedback on the following topics:

No requests currently.

Activities Since the Last Status Report

WMO Task Team for CF-netCDF

The WMO Expert Team on Data Standards (ET-Data) was formed in late 2020 and tasked with maintaining and developing the various WMO data standards. The newly formed Task Team for CF-netCDF (TT-CFNetCDF) is one of several ET-Data Task Teams and tasked with developing WMO profiles detailing how WMO will store data in CF-netCDF. So far the TT-CFNetCDF has developed WMO Profiles for radar data (based on CF-Radial) and oceanographic glider data. The profiles have been approved for experimental distribution on the WMO Information System (WIS) 2.0. The WIS 2.0 provides similar functionality to the GTS as well as more interactive access to data and is intended to eventually replace the GTS.

Progress has been made on the following:

- Ethan Davis joined the TT-CFNetCDF (and ET-Data) when it formed in late 2020.
- Taking part in discussions of how WMO CF-netCDF profiles and the WIS 2.0 transition will impact and benefit the University community.

Dependencies, challenges, problems, and risks include:

- Possible direct connection between LDM/IDD and WIS 2.0 would likely require development work.
- WMO moves very slowly, WIS 2.0 transition likely years away.

NCZarr/Zarr Specification Efforts

As part of implementing Zarr support in both the netCDF-C and -Java libraries, the NCZarr convention/extension has been developed to provide a clean and complete mapping between the netCDF and Zarr data models. During this work, the netCDF developers have been participating in discussions around clarification and evolution of the Zarr (version 2 and 3) specifications.

Progress has been made on the following:

- The Zarr community has added an Implementation Council to the Zarr governance structure. Dennis will represent the netCDF-C library and Hailey will represent the netCDF-Java library on the Zarr Implementation Council.

Updating and Reorganizing NetCDF User's Guide (NUG)

The NetCDF User's Guide (NUG) was initially developed when the netCDF-C library was the only netCDF implementation. While many sections of the NUG apply to all netCDF implementations (e.g., the data models and the file format descriptions), these more abstract parts of the current NUG are often still intertwined with netCDF-C implementation details. Similarly, support, development, and advancement of the NUG have also been intertwined with the netCDF-C library.

The goals of this work are to

1. Separate the aspect of netCDF that are useful to any user/developer, independent of which library or tool they use (i.e., data model, file formats, CDL definition, conventions, and best practices) from those that are library or language specific and
2. Clarify where and how the netCDF community can ask questions about the NUG as well as discuss and contribute to the development and advancement of the NUG.

Progress has been made on the following:

- A GitHub repository has been created for library independent netCDF documentation.
- An initial draft of a library independent NUG has been created.

Registering netCDF Media Type (application/netcdf) with IANA

The idea of registering a netCDF media type has been discussed a number of times over the years but never gained the momentum needed to undertake the effort. A request from the group developing the OGC Linked Data in NetCDF standard (and their offer of assistance) initiated the current effort to officially register the netCDF media type with IANA.

Progress has been made on the following:

- The netCDF media type ("application/netcdf") has been added to IANA's provisional registry list with Unidata listed as the standards-related body supporting the effort.
- Documents in support of this effort are being developed in the new Unidata/netcdf GitHub repo.

CF Conventions for netCDF activities

Unidata has a long history of involvement in the development of the CF Conventions for netCDF. These efforts continue with ongoing participation in development conversations on the CF GitHub repositories, participation in and help in organizing the annual CF Workshops, and participation in the governance of CF.

Progress has been made on the following:

- The 2022 CF Workshop will be held 13-15 Sept 2020 in Santander, Spain.
- A CF-netCDF focused session was held at the 2021 AGU Fall Meeting.
- Ethan Davis continues serving as chair of the CF Governance Panel.

Open Geospatial Consortium (OGC) activities

The Open Geospatial Consortium (OGC) is an international organization of more than 500 businesses, government agencies, research organizations, and universities working to improve access to geospatial (location-based) information. The OGC community creates free, publicly-available geospatial standards and participates in an OGC-managed agile and collaborative research & development process. A number of people and projects at Unidata, RAL, CISL, and other groups at UCAR/NCAR have been involved in various OGC efforts including the development of and the use of OGC standards.

UCAR and the OGC have had a Memorandum of Understanding (MOU) since June 2014. The MOU provides UCAR with an OGC Technical Committee membership which includes voting rights on approval of standards documents and related matters.

Progress has been made on the following:

- A new MOU is approaching approval by both OGC and UCAR.
- The "OGC Encoding Linked Data Graphs in NetCDF Files" [OGC 19-002] proposed standards will be going out for public comment before going up for a vote to approve it as a new OGC standard.

Ongoing Activities

We plan to continue the following activities:

- Represent Unidata in Earth System Information Partners
    - Unidata has been a Type II ESIP Partner Organization since 1999
    - Ethan Davis is currently the Unidata voting representative to ESIP.
- Represent UCAR and Unidata in OGC and various OGC working groups
    - Ethan Davis is the UCAR voting representative to the OGC Technical Committee, Jeff de la Beaujardiere (NCAR/CISL) is alternate voting representative.
    - Participate in OGC MetOcean Domain Working Group (DWG) meetings.
    - Ethan Davis is co-chair of the OGC netCDF Standards Working Group (SWG)
    - Track and participate in the OGC Environmental Data Retrieval (EDR) SWG meetings.
    - Track and participate in OGC Community Standard process for CoverageJSON.

New Activities

Over the next three months, we plan to organize or take part in the following:

- Deploy a draft version of the new, library independent, NetCDF User's Guide (NUG).

Over the next twelve months, we plan to organize or take part in the following:

- Submit request for full registration of the netCDF media type with IANA

Strategic Focus Areas

We support the following goals described in Unidata Strategic Plan:

1. **Managing Geoscience Data**
   Unidata's various data standards efforts contribute to important tools for data producers, especially those that design and develop new data products, and for those that develop software tools for data management, analysis, and visualization.

Prepared *May 2022*

Status Report: Unidata Community Equipment Awards

Sponsored by the National Science Foundation

October 2021- June 2022

Areas for Committee Feedback

We are requesting your feedback on the following topics:

1. Suggestions from previous panel members on how to improve the program

Community Equipment Awards

The NSF provides the Unidata Program Center up to $100k in equipment grant funds each year. In alignment with the Unidata 2024 proposal, the Equipment Awards Program is designed to broaden participation and promote the use of Unidata tools and systems (e.g., THREDDS, NetCDF, IDV, GIS connections) to support education and research on various aspects of climate studies (e.g., diagnostics, change and impacts), by providing grants to be used in the procurement of new computers and equipment including upgrades to existing classroom and laboratory equipment.

The Review Panel met virtually on April 29, 2022. One proposal was funded.

Relevant Metrics

Since taking over the management and administration of the Equipment Awards program in 2003 on behalf of the NSF, Unidata has made 104 awards totaling over $1,300,000.

Prepared *May 2022*

Status Report: GOES-East/West, NOAAPort and Other Satellite Imagery

October 2021- May 2022

Mike Schmidt, Tom Yoksas

Questions for Committee Members

- What image coverages, spatial and temporal resolutions and possibly projections should be considered for addition to the **UNIWISC** IDD feed?

- What kind(s) of data access methods are most desired/usable for the community?

  We currently provide access via the IDD (push), THREDDS Data Server (pull), McIDAS ADDE (pull) and AWIPS EDEX (pull).

- Other questions?

Activities Since the Last Status Report

- We are still working towards establishing additional GOES-R downlinks in locations that have good views of the southern skies

  Comment(s):

  An effort to establish a new GOES-R downlink facility at the NCAR Marshall field site (just south of Boulder) was slowed by an NSF moratorium on any ground penetrations until an environmental impact assessment has been done for the entire site. Exactly when an environmental impact assessment will be done is currently unknown.

  By any measure, GOES-16/17 imagery continues to be **very** popular in the community!

Ongoing Activities

We plan to continue the following activities:

- Participate in UW/SSEC's "fanout server" sharing of GOES-R/S data (redistribution of the GRB-200 UDP unicast stream over TCP) for GOES-16/17/18 GRB products.

  We are feeding from SSEC's GOES-16/17 fanout servers, and they are feeding from the ingest machine that we operate. Sharing of the feed streams has allowed SSEC and Unidata to minimize effects of solar and terrestrial interference.

- Ingest GOES ReBroadcast (GRB) streams from GOES-16 and GOES-17/18 in real-time

  Repointing the 4.5m satellite dish at the NCAR Mesa Lab from GOES-16 (75 W to GOES-17 (137.2 W), the Terrestrial Interference (TI) that had been hampering GOES-16 data ingest activities has decreased to the point that our ingest quality rivals what UW/SSEC experiences on their 6.3m dishes. Replacement of the power lines at the base of the hill on the south side of the Mesa lab facility may allow the dish to be repointed at GOES-16 as it was originally intended. If this is the case, a new dish will be installed on the western pad at the Mesa Lab, and it will be pointed at GOES-West which will likely be GOES-18 when the work is done.

  Background:

  In the fall of 2017 we began experiencing significant TI in the GOES-16 signal being received by our 4.5m satellite dish at the NCAR Mesa Lab. An outcome of the collaborations we had with Quorum Communications (the manufacturer of the electronics we use in our GOES-R/S ingest installations) was our moving of the GOES-16 ingest to a 3.8 m satellite dish located at the UCAR FL-2 location. The relocation of GOES-16 ingest required that an additional signal cable be pulled from the satellite dish that was repurposed from GOES GVAR ingest into the 2nd floor FL-2 NCAR/RAL computer room where our ingest electronics are located. The cost of this work was contributed by the UCAR/NCAR networking group.

  While the actual source of the TI being experienced at the Mesa Lab could not be pinpointed, the best guess at the time was that the noise being experienced was coming from power lines that lie south and downhill from the Mesa Lab. All of those power lines have since been replaced (by Xcel Energy), so there is a possibility that the TI is now gone. We will be conducting an experiment of re-pointing the dish from GOES-West back to GOES-East to see if the power lines were, in fact, the source of the TI. If the results of the test are positive, meaning the TI is gone, we will leave the dish pointing at GOES-East and resurrect the original plan of installing a GOES-West downlink on the western satellite pad at the Mesa Lab. This experiment will be conducted in conjunction with UWisc/SSEC to minimize potential data loss to the Unidata community.

  In the spring, we were given a 3.7m satellite dish that was being excessed by a private company that was relocating their operations. We will use this dish to establish a GOES-R downlink at the NCAR Marshall field site. Even more recently, we were given an additional 3.8m satellite dish that was being replaced by another company in Centennial, CO (on the southern side of Denver). Pending the testing described above, this dish may be installed on the western satellite pad at the Mesa Lab and used for GOES-West data ingestion.

- Continue to distribute GOES-16 and GOES-17 data via the LDM/IDD and serve the data via the TDS, ADDE and EDEX

  The volume of data available in the SATELLITE datastream can be seen in:

http://rtstats.unidata.ucar.edu/cgi-bin/rtstats/iddstats_vol_nc?SATELLITE+oliver.unidata.ucar.edu

Future Activities

CSPP GEO Gridded Geostationary Lightning Mapper (Gridded GLM)

On March 21, 2021 Graeme Martin (UWisconsin/CIMSS) announced the initial release of **Gridded Geostationary Lightning Mapper (Gridded GLM)** software package:

The software is capable of processing GOES-16 and GOES-17 GLM Level 2+ products in mission standard format, generating a new set of products which have been gridded to the Advanced Baseline Imager (ABI) 2-km resolution, and are aggregated at one-minute intervals. Spatial extent information that is not readily available in the GLM L2+ data is recovered and used to create the gridded products.

The following products can be produced:
- Minimum Flash Area
- Flash Extent Density
- Total Optical Energy

AWIPS-compatible tiles can optionally be generated, using functionality that was developed within the open source Python SatPy library.

Input GLM L2+ files can be obtained from the CSPP Geo GRB software running at a direct broadcast site, or from NOAA CLASS. Output is in NetCDF4 format.

We intend to implement this software, evaluate the products, and distribute them in the IDD when appropriate.

Gridded Geostationary Lightning Mapper (Gridded GLM) products from Amazon AWS S3

We have obtained access (effort spearheaded by Tiffany Meyer) to Gridded GLM products being created by the NWS for use in forecast offices. Redistribution of these products in the IDD as replacements for the Gridded GLM products currently being created by Eric Bruning of Texas Tech University will be implemented by the beginning of June.

Himawari Imagery and Level 2 Products

We have also obtained access to Himiwari imagery and Level 2 products from Amazon AWS S3. We are asking the User Committee to weigh in on the importance/need of adding some of these products to the IDD. One thing that must be kept in mind is the volume of Himiwari data is ***large***, so the ability of end user sites to handle real-time feeds of the full set of data is in question.

NOAAPort SBN

The tuned cavity filter that was installed on the UCAR NOAAPort dish in the front of FL-2 resulted in a great reduction of ingest errors that were being caused by Terrestrial Interference (TI) being caused by 5G phone service. After seeing how good ingest could be after the installation of a 5G filter, we lobbied the sites that are running NOAAPort ingest installations to have filters installed on their dishes. This lobbying effort was only partially successful as some sites are waiting to do their own filter installation until the NOAAPort broadcast is moved from Galaxy 28 to a satellite that is further west. Exactly when this transition will occur is not known.

We are trying to keep abreast of a possible expansion of the NOAAPort SBN that would, if implemented, increase available bandwidth twofold. As one might imagine, progress on this and other fronts has been slowed by reorganization of priorities during the COVID-19 epidemic.

IDD NIMAGE and UNIWISC Datastreams

As noted earlier, both the **NIMAGE** and **UNIWISC** datastreams were revamped to include GOES-East/West imagery and products, and we will add more products if asked to do so by the governing committees. The **FNEXRAD** datastream was enhance by the addition of MRMS products we receive in an LDM feed from NOAA/NCEP, and very recently, the N0Q U.S. national radar composite was replaced by a composite of the so-called "super res" N0B product that was, along with several others, added to NOAAPort by the NWS.

The volume of data available in the **NIMAGE**, **UNIWISC,** and **FNEXRAD** datastreams can be seen in:

http://rtstats.unidata.ucar.edu/cgi-bin/rtstats/iddstats_vol_nc?NIMAGE+oliver.unidata.ucar.edu

http://rtstats.unidata.ucar.edu/cgi-bin/rtstats/iddstats_vol_nc?UNIWISC+oliver.unidata.ucar.edu

http://rtstats.unidata.ucar.edu/cgi-bin/rtstats/iddstats_vol_nc?FNEXRAD+oliver.unidata.ucar.edu

VALUE-ADDED Products

Texas Tech University (Eric Bruning) has been creating value-added Level 2 products created from Geostationary Lightning Mapper (GLM) images as a precursor for similar products potentially being added to NOAAPort. We have been distributing these Level 2 products in the **NIMAGE** IDD datastream. Creation of these GLM Level 2 products is scheduled stop when the Unidata equipment grant that funded the effort expires in June. As mentioned above, these GLM products will be replaced by others that are being created by tiles that are being generated in AWS by NOAA.

We welcome contributions of additional value-added Level 2 satellite products community members.

SSEC Collaboration

Continue working with SSEC on their *fanout* approach that insulates GRB ingestion from expected (e.g., NCAR twice per year power downs; twice per year solar interference periods; etc.) and unexpected (e.g., TI caused) service interruptions

L2 Product Creation Testbed

We still intend to establish a test bed for the creation of Level 2 (L2) products from GOES-16/17 imagery, model output and observational data.

The objective would be to provide the capability of running user site submitted algorithms to create L2 products and make them available for testing for a short period of time via the IDD, the TDS, McIDAS ADDE and AWIPS EDEX. This initiative has been slowed by the inability by most staff to work on-site.

Relevant Metrics

- Lots O Data!

  The volume of GOES-16 and GOES-17 GRB products (13 GB/hour average and 20 GB/hour maximum; that this is the second most voluminous IDD feed!) can be seen in the real-time statistics plot from our GOES-R/S ingest machines:

  http://rtstats.unidata.ucar.edu/cgi-bin/rtstats/iddstats_vol_nc?SATELLITE+oliver.unidata.ucar.edu

- Feeding data to a slowly growing list of sites via the IDD:

  We are distributing all or part of the GOES-East/West GRB products to:

  - Groups within UCAR/NCAR (3: all products Unidata, EOL, RAL))
  - U.S. Universities (25: variety of feeds; GLM very popular)
  - U.S. Government (3: all products to 2 NOAA sites and one Military site)
  - International (3: Full Disk imagery and GLM L2 products)

Strategic Focus Areas

We support the following goals described in Unidata Strategic Plan:

1. **Managing Geoscience Data**
   Providing TDS, ADDE and EDEX servers for GOES-16/17 imagery and products benefits

the greater community by providing access to real-time observations from the U.S. operational satellite constellation.

2. **Supporting People**
   Providing access to data in real-time has been a fundamental Unidata activity since its inception. Continuing to provide data enables Unidata sites to focus on their educational and research activities.

Prepared *May, 2022*

Status Report: Internet Data Distribution

October 2021 - May 2022

Steve Emmerson, Mustapha Iles, Mike Schmidt, Jeff Weber, Tom Yoksas

Questions for Committee Members

- Do you have suggestions regarding content of data streams like CONDUIT, FNEXRAD, NIMAGE, UNIWISC, NLDN Lightning, SATELLITE, etc.?

  We (UPC, the Unidata community and UAlbany for the NLDN component of LIGHTNING) have control of the content of these data streams, so their contents are open for suggestions.

  NB: We now have access to Himiwari imagery and Level 2 products on AWS S3, so we could add some of these products to the IDD (probably in the SATELLITE feed), IF the committee thinks that this would be useful AND manageable by sites. Also, we are working with the UCP JCSDA group to get access to METEOSAT imagery from Eumetsat. If this access can be established, select METEOSAT imagery could be added to the IDD feed (probably in the SATELLITE feed).

Activities Since the Last Status Report

Internet Data Distribution (IDD)

IDD data volumes have not increased since the last meeting.

The following output is from a Linux-based data server that the UPC operates on behalf of the community, lead.unidata.ucar.edu:

```
20220523

Data Volume Summary for lead.unidata.ucar.edu

Maximum hourly volume 123306.025 M bytes/hour
Average hourly volume  77538.177 M bytes/hour

Average products per hour     507236 prods/hour

Feed                            Average             Maximum     Products
                       (M byte/hour)            (M byte/hour)   number/hour
CONDUIT                 16120.791    [ 20.791%]    51477.359    93879.316
SATELLITE               15073.617    [ 19.440%]    19881.729     6688.842
NIMAGE                   9851.451    [ 12.705%]    13670.083     7662.316
NEXRAD2                  9641.304    [ 12.434%]    13249.611   110831.553
```

NGRID	7414.763	[9.563%]	11523.417	67577.316
HDS	5179.291	[6.680%]	12504.108	30438.895
FNEXRAD	4750.455	[6.127%]	5226.165	9820.053
EXP	4259.352	[5.493%]	6533.706	27448.526
NEXRAD3	3542.625	[4.569%]	4919.910	94583.658
UNIWISC	958.698	[1.236%]	1138.804	919.947
FSL2	322.458	[0.416%]	824.791	1560.816
NOTHER	280.998	[0.362%]	884.447	46.421
IDS|DDPLUS	86.472	[0.112%]	99.782	55131.605
SPARE	50.786	[0.065%]	60.202	237.000
LIGHTNING	5.116	[0.007%]	13.433	409.947

Data Distribution:

IDD CONDUIT feed:

After the GFS model was upgraded from v15.3 to 16.0 in the spring of 2021, we upgraded our ingest machine to be able to handle the increased volume. The same action was not taken by NCEP on the virtual machines that they use to create the CONDUIT datastream until the early spring this year. Since the NCEP relay machines were updated, IDD latencies have dropped from unacceptable levels back to levels typical of the period before the GFS upgrade.

IDD FNEXRAD, NIMAGE and UNIWISC feeds:

We continue to create the content for the FNEXRAD (NEXRAD Level III national composites), NIMAGE (GOES-East and -West Level 2 images and products, fully reconstituted images from NOAAPort tiles and with broadcast headers and footers stripped off to leave “bare” netCDF4 files), and UNIWISC (select GOES-East and -West images converted to McIDAS AREA format for use in legacy systems like GEMPAK).

Recently, the N0Q (so called “high res” base reflectivity) U.S. national composite was replaced with a N0B (so called “super res” base reflectivity) U.S. national composite. This change was a result of the replacement of lower resolution NEXRAD Level III products, including N0Q, with higher resolution products in NOAAPort. We submitted a request for an LDM feed of all NEXRAD Level III products from the RPCCDS to NCEP, and the request has been approved. We were informed that it would take 2 to 3 months for the LDM feed to be setup on the NCEP side. After the feed has been established, it is our intention to re-add products that have been removed from NOAAPort to the IDD. Exactly which products will be re-added is to be determined.

IDD NIMAGE feed:

The NIMAGE feed, which was originally populated solely with GINI imagery distributed in NOAAPort, was enhanced by the addition of three products being created by CSU/CIRA: GeoColor, DebraDust and CloudSnow. GOES-East CONUS and -West PACUS coverages are available for the GeoColor and CloudSnow products while the DebraDust product is available in a GOES-East CONUS coverage. All three of these are RGB products - displays are created using different wavelength channels to drive the Red, Green and Blue portions of a composite display. The GeoColor product is quite useful (they are especially useful in identifying sources of smoke from wildfires), so users are strongly encouraged to take a look!

Support for displaying these RGB images has been added to Unidata AWIPS, Unidata and SSEC McIDAS-X, the IDV and McIDAS-V.

Experimental HRRR feed to eventually be replaced by RRRS:

Unidata used to receive experimental High Resolution Rapid Refresh (**HRRR**) grids (both 2D and 3D fields) in an LDM/IDD feed from NOAA/GSL and feed these products to a small number of university sites on **hrrr.unidata.ucar.edu** (which is also known as **lead.unidata.ucar.edu**). Once the HRRR data went operational, NOAA/GSL stopped creating experimental **HRRR** output. The experimental **HRRR** is, however, being replaced by the **RRFS** (Rapid Refresh Forecast System) in NOAA/GSL. We have requested a feed of these data, but we have been told that the **RRFS** is still a few months away from being available.

Existing Data Distribution:

The primary top level IDD relay cluster, idd.unidata.ucar.edu, has been operating well since its move to the NCAR Wyoming SuperComputer (NWSC) facility in Cheyenne, WY.

The data volume seen in the **SATELLITE** (which is known as **DIFAX** in LDM distributions prior to v6.13.6) listing above represents all products received in the GOES ReBroadcast (GRB) downlinks that we installed in UCAR (currently GOES-17 at the NCAR Mesa Lab and GOES-16 at UCAR Foothills Lab 2). The data volume seen in the **NIMAGE** entry represents GOES-East/West ABI Level 2 imagery that has been reconstituted by stitching together tiles that are distributed in NOAAPort and all other Level 2 products. In both cases, binary headers and footers that are added to products before distribution in NOAAPort have been stripped off leaving “raw” netCDF4 files. The **UNIWISC** feed represents the volume of 3 select channels (0.64um VIS, 6.2um WV and 10.3um IR) for all coverages (CONUS, FullDisk, Mesoscale-1 and Mesoscale-2) of GOES-East/West image products that are in PNG compressed McIDAS AREA format that is suitable for use in GEMPAK, the IDV and McIDAS-V, McIDAS-X, and AWIPS.

Challenges, problems, and risks:

More sites, including UCAR, are installing intrusion detection/prevention systems (e.g., Palo Alto), which can adversely affect LDM throughput if not configured correctly.

Ongoing Activities

We plan to continue the following activities:

- Unidata has long distributed GPS radio occultation solutions from COSMIC. The LDM feed from COSMIC to Unidata was interrupted by UCAR security perimeter changes (as was/is the SUOMINET products).

- Many, but not all, of the products in NCEP operational HRRR are being distributed in the NOAAPort SBN and relayed in the IDD NGRID feed. Fire weather products (HRRR Smoke) that are being made available by NOAA/GSL in an EXP feed were added to the set of HRRR products that are available from hrrr.unidata.ucar.edu. All of these products along with with other model output are available via the TDS and Unidata AWIPS EDEX:

- Other data sets we continue to explore with NOAA/GSD/ESRL are:
    - FIM
    - HIWPP
    - RRFS

- NCEP (operational) HRRR fields and forecasts times were added to the IDD CONDUIT datastream.

NOAAPort Data Ingest

- Ingest of the DVBS-2 NOAAPort Satellite Broadcast Network (SBN) products and their relay to end-users via the IDD has been “operational” at the UPC since August 2014.

  Unidata continues to assist LSU/Climate (formerly LSU/SRCC) with the maintenance of their NOAAPort ingest capability. Activities have included providing a spare LNB to bring their NOVRA S300N receiver to Boulder for testing, configuration, power supply replacement, routine monitoring of their data and distribution, and consultation on satellite dish maintenance and pointing.

  Considerable effort has been expended in streamlining our NOAAPort ingest systems and assisting sites (UW/SSEC, NOAA/GSL, NOAA/SPC, Fox13 TV) in troubleshooting problems being experienced in their systems. More on the most recent of these activities can be found in the LDM status report.

- The NOAAPort-derived data streams (**HDS**, **IDS|DDPLUS**, **NGRID**, **NIMAGE**, **NEXRAD3** and **NOTHER**) are redundantly injected into the IDD at five geographically separate locations: UCAR/Unidata, UW/SSEC, LSU/Climate, Allisonhouse.com and Fox13 TV in Tampa, FL. Even though GOES-15 will periodically be taken out of storage for use in western Pacific hurricane monitoring, the GINI image products that are created from its scans are only available during the short periods when the satellite is taken out of

storage.

- Unidata's NOAAPort ingest package is bundled with current versions of the LDM. The current LDM release is v6.13.16. A new LDM distribution is being tested on Unidata ingest machines, and should be ready for release in early summer.

Relevant Metrics

- Approximately **556** machines at **192** sites are running LDM-6 **and** reporting real-time statistics to the UPC.

  We routinely observe that the number of sites reporting real-time statistics fluctuates. We are not certain why this may be the case, but our best guess is that some sites do not keep their LDMs running all of the time; campus firewall adjustments block the sending of the statistics; and/or sites decide to stop sending statistics. The latter possibility seems to be happening more frequently.

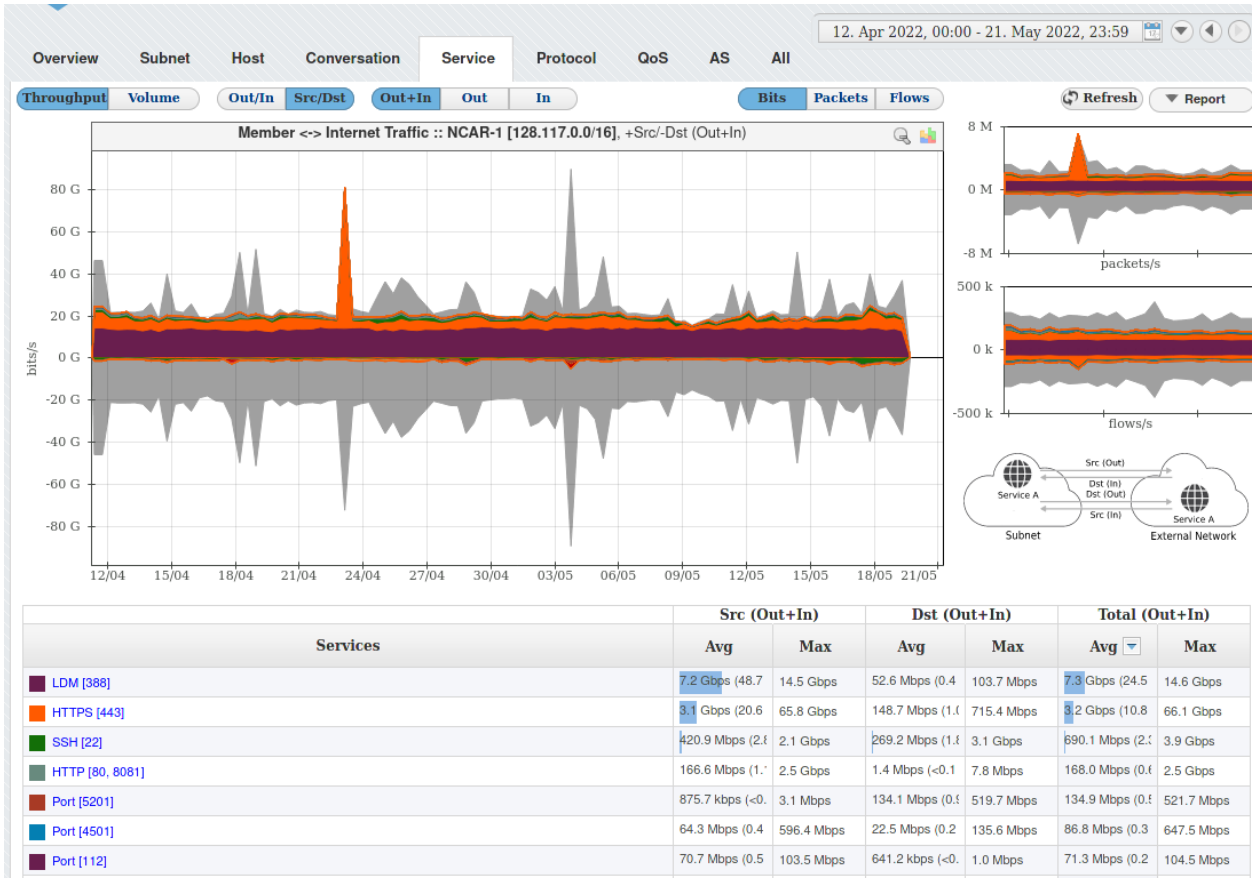
  We know that there are a number of sites that are participating in the IDD, but are not reporting real-time statistics back to us. Reporting of real-time statistics is not and never has been mandatory.

  Unidata staff routinely assist in the installation and tuning of LDM-6 at user sites as a community service. We have learned about sites not sending real-time statistics during these kinds of support activities, and a number of times the impediment to sending in stats is firewall configurations at the user sites.

- A number of organizations/projects continue to use the LDM to move substantial amounts of data that do not report statistics to Unidata: NOAA, NASA, USGS, USACE, Governments of Spain, South Korea, private companies, etc.).

- UCAR IDD toplevel relays, **idd.unidata.ucar.edu and iddb.unidata.ucar.edu**

  The IDD relay clusters, described in the June 2005 CommunitE-letter article Unidata's IDD Cluster, routinely relays data to more than 1205 downstream connections. The primary IDD relay cluster, **idd.unidata.ucar.edu**, was moved to the NCAR/Wyoming Super Computing facility in Cheyenne, WY in late August 2019.



Services	Src (Out+In)		Dst (Out+In)		Total (Out+In)	
	Avg	Max	Avg	Max	Avg	Max
LDM [388]	7.2 Gbps (48.7	14.5 Gbps	52.6 Mbps (0.4	103.7 Mbps	7.3 Gbps (24.5	14.6 Gbps
HTTPS [443]	3.1 Gbps (20.6	65.8 Gbps	148.7 Mbps (1.(	715.4 Mbps	3.2 Gbps (10.8	66.1 Gbps
SSH [22]	420.9 Mbps (2.8	2.1 Gbps	269.2 Mbps (1.8	3.1 Gbps	690.1 Mbps (2.(	3.9 Gbps
HTTP [80, 8081]	166.6 Mbps (1.·	2.5 Gbps	1.4 Mbps (<0.1	7.8 Mbps	168.0 Mbps (0.(	2.5 Gbps
Port [5201]	875.7 kbps (<0.	3.1 Mbps	134.1 Mbps (0.8	519.7 Mbps	134.9 Mbps (0.8	521.7 Mbps
Port [4501]	64.3 Mbps (0.4	596.4 Mbps	22.5 Mbps (0.2	135.6 Mbps	86.8 Mbps (0.3	647.5 Mbps
Port [112]	70.7 Mbps (0.5	103.5 Mbps	641.2 kbps (<0.	1.0 Mbps	71.3 Mbps (0.2	104.5 Mbps

Over the period from April 12 through May 21, 2022 (IDD volume snapshots are taken during periods that do not have monitoring dropouts in NetVizura plots) the average volume of LDM/IDD data flowing from the UCAR/NCAR network averaged around 7.2 Gbps (~78.8 TB/day), and peak rates reached 14.6 Gbps (which would be ~158 TB/day if the rate was sustained (which it is definitely **not**)).

The following table of volume snapshots shows that the volume of data flowing to downstreams out of UCAR has been reasonably consistent:

Date range	Src Ave Max	Dst Ave Max	Total Ave Max
20200508 - 20200630	5.4 7.5	42.1 52.9	5.5 7.5
20200701 - 20200930	5.4 7.9	41.9 60.3	5.4 7.9
20201001 - 20201231	5.2 6.9	39.9 55.9	5.3 7.0
20210101 - 20210331	5.5 8.0	42.3 59.9	5.5 8.1
20210401 - 20210415	6.1 15.5	46.4 112.7	6.1 15.7

20210601 - 20210719	6.6 9.2	50.5 73.0	6.6 9.2
20210908 - 20211005	7.6 14.9	59.3 121.7	7.7 15.0
20211101 - 20211231	6.7 9.1	52.4 71.4	6.8 9.2
20220208 - 20220311	6.6 15.2	53.5 114.8	6.6 15.3
20220412 - 20220521	7.2 14.5	52.6 103.7	7.3 14.6

NB: The units for Src and Total Ave and Max are Gbps (gigabits per second), and the units for Dst are Mbps (megabits per second).

Strategic Focus Areas

We support the following goals described in Unidata Strategic Plan:

1. **Managing Geoscience Data**
   The IDD project demonstrates how sites can employ the LDM to move and process data in their own environments.

2. **Providing Useful Tools**
   The freely available LDM software and the IDD project that is built on top of the LDM have served as a demonstration for distribution of real-time data for a variety of organizations including the U.S. National Weather service.

   The cluster approach for LDM/IDD data relay that Unidata pioneered has been been adopted by several Unidata university sites, and is currently being implemented at U.S. government sites.

   Unidata's NOAAPort ingest package, which is bundled with LDM-6, is being used by a variety of university, U.S. government, and private sector entities.

   Both the LDM and NOAAPort ingest packages are bundled with AWIPS.

3. **Supporting People**
   The IDD is the primary method that core Unidata sites use to get the meteorological data that they need. Providing access to data in near real-time is a fundamental Unidata activity. The IDD-Brasil, the South American peer of the North American IDD, and IDD-Caribe, the Central American peer of the North American IDD, are helping to extend real-time data delivery throughout the Americas

Status Report: IDV with RAMADDA

October 2021– May 2022

Yuan Ho, Julien Chastang

Activities Since the Last Status Report

IDV Release

The IDV 6.1 will be released in July of 2022.

IDV System Changes

__Latest netCDF-Java Version__

The version of the netCDF-Java library currently distributed with the stable release version (6.0u1) is the 5.5.3-SNAPSHOT . There have been many new features and bug fixes in that range. The complete release notes for these versions can be found here.

__IDV Certificates__

Java Webstart, Windows app and MacOS certificates have been renewed and will be valid until at least May 30, 2021 (MacOS certificate is valid until 2024). Moreover, as properly signing the IDV under these different environments can be an involved process, this information has been thoroughly documented here.

__IDV Webmod2 Migration__

Webmod2 project: Working with other developers to migrate all the IDV related resources, release engineering process, and documents to the new UCAR web infrastructure.

__Changes to nightly release that will eventually be incorporated into into stable version__

- IDV uses the latest Java 8 AdoptOpenJDK
- IDV employes latest Java3D (1.6.2)
- Updated the IDV code signing certificates on all platforms (i.e., MacOS, Windows, Webstart)
- IDV now “notartized” on MacOS
- Updated Unidata's Install4J license from version 5 to 8.
- Updated the IDV Install4J configuration.

IDV Display Changes

__Dark Mode Appearance__

In macOS and Linux users can choose to adopt a light, dark, or IDV regular appearance. The dark appearance, known as Dark Mode, implements an interface style that many apps already adopt. Users can edit the preference and can choose their interface appearance based on ambient lighting conditions.

__New PROBSEVERE Data Display__

The IDV has developed a new data source type to create a time series display of the PROBSEVERE Statistical models output that provide probabilistic guidance to forecasters on the likelihood of severe weather occurrence for convection in the near term. Algorithms of PROBSEVERE incorporate multiple datasets from satellite, radar, total lightning, and NWP into easy-to interpret products. With a direct connection to the NCEP PROBSEVERE web page to retrieve data of the last 24 hours and the time matching feature of the IDV, it is very easy to integrate PROBSEVERE model data with other data source types and to assist forecasters in severe weather situations.

__New ADT Integration__

The ADT integration and development: The Advanced Dvorak Technique (ADT) utilizes longwave-infrared, temperature measurements from geostationary satellites to estimate tropical cyclone (TC) intensity. The Dvorak Technique continues to be the standard method for estimating TC intensity.The IDV ADT integration is still experimental and has not been found through testing. More information about the ADT and various run-time options, algorithms, and program outputs can be found in the McIDAS-X ADT-Version 8.2.1 Users' Guide at http://tropic.ssec.wisc.edu/misc/adt/info.html. We are going to further integrate the ADT feature with the IDV ACTF hurricane track analysis interface to provide a more powerful tool for the community.

__MP4 Movie Capture__

Other than Quicktime and animated GIF and other movie formats, the support of MP4 format has been added to the output format list in this release.

__WRF Grid Diagnostics Formulas__

The original WRF netCDF output is in sigma coordinate. The current grid diagnostic formula is mostly designed for the isobaric surface parameters. The newly added WRF derived formulas

provide the capability to directly create the derived parameters such as: Equivalent potential temperature, relative humidity, Saturated Equivalent potential temperature, dewpoint, and others.

__Latest Version of VisAD__

The SSEC team at UW, Madison has made a number of improvements to support 3D trajectories.

IDV Community Support

In the hybrid environment of in person and remote-learning system as a result of the COVID-19 pandemic, we keep helping universities and research institutes to run Unidata's Integrated Data Viewer (IDV) at home. I provided a remote IDV training class to a group of radar class students from the University of Millersville. Yuan also prepares several remote IDV training classes for the coming school year.

As international collaborations, I provided several online training classes for university students of Turkey, Spain, and Italy. Students from Turkey ran the regional WRF models and do the analysis and visualizations of outputs with the IDV, students from Spain using the GFS datasets from our TDS server and the IDV new grid coverage feature to do analysis across the data boundary, and students from Italy run the IDV to visualize 3D oceanographic observations in the Mediterranean sea for climate research.

KIOSK IDV Project

In collaboration with UCAR Center for Science Education and Computational Information Systems Laboratory, the project developed an extended IDV package for a Real-Time Weather Museum Touchscreen. This new real-time weather museum touchscreen display will undergo further usability testing to eventually join other weather and climate exhibits at NCAR's Mesa Lab in Boulder, CO, and at the NCAR-Wyoming Supercomputing Center Visitor Center in Cheyenne, WY.

IDV Publication Highlights

Synoptic–Dynamic Meteorology in 3D: Introducing an IDV-Based Lab Manual by Gary Lackmann, B. Mapes and K. Tyle

A Google Scholar Search reveals a number of publications that cite use of the IDV (doi:10.5065/D6RN35XM).

IDV and RAMADDA Training, Conference Attendance and Presence

__2021 AGU Fall Meeting__

- Impact of GNSS radio occultation data on the prediction of convective systems associated with a Mei-Yu front
- Machine Learning Predictive Model of Ice Supersaturated Regions (ISSRs) with Advanced 3D Visualization and Analysis

__2022 AMS Annual Meeting__

- Cross boundary subset of 2D/3D Grid coverage dataset and visualization

Ongoing Activities

We plan to continue the following activities:

__Investigation of Java 3D Alternative__

Because of concerns about the long-term viability of the open-source Java 3D project, the IDV team has begun discussions with our University of Wisconsin, SSEC collaborators to replace Java 3D with a more viable alternative within the VisAD API. We have started investigating whether the Ardor 3D can meet that objective. Looking into alternatives to Java 3D was also a goal described in the Unidata 2018 Five-year plan.

New Activities

Over the past few months, we plan to organize or take part in the following:

We plan to upgrade the version of OPenJDK Java. This change will necessitate in depth testings and the IDV building and distribution workflow.

Relevant Metrics

__E-Support__

The IDV team continues to provide the geoscience community with high-quality support through e-support software and idv-users mail list. In the last half year the IDV team has closed ~40 e-support tickets. Each individual ticket may and often does involve many back-and-forth messages. There is an especially large number of support requests coming from international users.

Top ten universities running IDV are: Millersville, Oklahoma, University of Utah, St Cloud state, Plymouth, NC State, West Kentucky, Lyndon State, University of Illinois, and San Francisco State.

__GitHub Pull Requests__

In the area of greater collaborative development, since the migration of the IDV project to github, we have closed a total of 125 “pull requests” or code contributions from internal and external collaborators.

__Youtube IDV Instructional Videos__

In the area of online IDV training, the Youtube IDV instructional videos have been viewed thousands of times.

Strategic Focus Areas

We support the following goals described in Unidata Strategic Plan:

1. **Managing Geoscience Data**
   The IDV is a state of the art geoscience visualization application. It gives users the ability to view and analyze a rich set of geoscience data, including real time data, in a seamless and integrated fashion. This analysis is captured in IDV bundles. RAMADDA is a content management system and service specifically tailored towards the sharing and distribution of IDV bundles facilitating distribution of scientific data and analysis.

2. **Providing Useful Tools**
   The IDV has been an open-source project for several years. The IDV is available on the github version control platform for greater open-source collaboration. The IDV provides users the unparalleled ability to analyze, integrate, and visualize heterogeneous geoscience data in two, three, and four dimensions. The IDV coupled with RAMADDA enables geoscience specialists the capability to share and collaborate their IDV analysis via social scientific networks.

3. **Supporting People**
   Unidata offers yearly multi-day training and occasionally regional workshops for IDV and RAMADDA. The IDV coupled with RAMADDA enables our earth science community partners to distribute geoscience data and metadata through web-based technologies thereby fostering scientific collaborations. Moreover, the IDV's ability to share bundles through RAMADDA creates a scientific social and collaborative network for the geoscience community.

Prepared May, 2022

Status Report: Information Technology

October 2021- May 2022

Mike Schmidt, Matt Perna, & Jennifer Oxelson

Major Activities

****Remote working**** -- with most of the Unidata staff continuing with remote working over the long term, we have and will continue to experience some level of ongoing challenges managing remote systems, especially for users out-of-state who are never expected to come to the office. Overall, it's been a successful test of the infrastructure and software supporting remote working staff

****Data center upgrades**** -- UCAR is nearing completion of their Mesa Lab Data Center (MLDC) co-location facility upgrade. We have been putting pieces in place to facilitate the relocation of our MLDC based servers when the time comes. There may be the need to roll some of our Internet based services to the NWSC in Cheyenne for extended outages.

****Security**** -- we continue efforts to keep services and systems secure which takes consistent attention and occasional herculean efforts (to patch everything all at once). UCAR has embarked on a number of new initiatives to segment the network into smaller and smaller zones, centralize DNS, and gain a more dynamic inventory of assets on the network. Unidata continues to play a role in these efforts.

****LDM 7 node**** -- we maintain a LDM7 test node at the Front Range GigaPOP (FRGP) just off downtown Denver in co-location with the major backbone networks supporting FRPG participants (UCAR, ..). We expect to support intensive data movement and LDM testing for the next few years on this effort.

Ongoing Activities

We plan to continue the following activities:

- Day-to-day system and network support to the community as needed
- Resolve daily staff help desk issues
- Maintain security profile and exceed UCAR security standards

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Prepared May, *2022*

Status Report: LDM

October 2021 - May 2022

Steve Emmerson, Tom Yoksas, Mike Schmidt, Mustapha Iles

Activities Since the Last Status Report

LDM

The LDM is the primary software package by which research and education institutions obtain near real-time meteorological and related data.

Progress has been made on the following:

- Installation:
  - Changed default time-servers in LDM registry to just “us.pool.ntp.org”
- ldmd(1):
  - Made the process by which the LDM daemonizes itself more robust
  - Set the ownership of the top-level ldmd(1) process to root before sending a SIGTERM to its process-group to ensure that all child processes receive the termination signal (including those owned by root)
- NOAAPort:
  - Created the multi-threaded program blender(1) to merge together TCP streams of the same NOAAPort channel from "fanout" servers at multiple NOAAPort receiving sites to enable the creation of a near-perfect NOAAPort feed (i.e., one with no gaps)
  - Created the program noaaportBlender.py(1) to execute (and keep running) a blender(1) and noaaportIngester(1) pair
  - Added new parameters to GEMPAK tables:
    - Joint Fire Weather Probability
    - Dry Thunderstorm Probability
- Logging:
  - Improved the determination of whether or not the current process is a daemon by testing for a controlling terminal. This correctly handles the standard error stream being open on /dev/null.
- Miscellaneous: Removed lint identified by clang(1) and Coverity Scan
- Documentation:
  - Enhanced section on pqact(1) decoders in the "Programs" page:
    - Corrected the HTML to make visible the paragraph on shell scripts
    - Added an example shell script that duplicates the FILE action and uses the ulogger(1) utility to log error messages
- Support:

- Answered many questions from Universities, NOAA, US Military, and corporations

Dependencies, challenges, problems, and risks include:

The LDM is sometimes held responsible for decisions made by the NWS when they don't follow their own policy on how to categorize and name data products (not a new challenge).

More sites are installing intrusion detection/prevention systems (e.g., Palo Alto), which can adversely affect LDM throughput if not configured correctly (again, not new).

The documentation from NOAA on the semantics and syntax of NOAAPort frames is sub-optimal; consequently, creation of the blender(1) program required more effort than initially thought.

Ongoing Activities

We plan to continue the following activities:

- Support and maintain the LDM

Relevant Metrics

- Data on LDM downloads
- The LDM system at the Unidata Program Center powers the Unidata IDD (Internet Data Distribution) system. Metrics on that program can be found in the IDD status report.

Strategic Focus Areas

We support the following goals described in Unidata Strategic Plan:

1. **Managing Geoscience Data**
   By enabling researchers, teachers, and students to process a wide variety of meteorological and related data in near real time.

2. **Providing Useful Tools**
   By enabling researchers, teachers, and students to obtain a wide variety of meteorological and related data in near real time and at no cost via the Internet.

   By using the LDM to move data into the cloud and developing multicast technologies.

3. **Supporting People**
   By answering support questions, writing documentation, and conducting workshops.

Status Report: McIDAS

October 2021- May2022

Tom Yoksas

Areas for Committee Feedback

We are requesting your feedback on the following topics:

1. Are there any features that users would like to be added to Unidata McIDAS-X and/or ldm-mcidas?

Activities Since the Last Status Report

Aside from routine updates/bugfixes to existing code and tables, the main area of activity recently has been the incorporation of Unidata-developed code into the next UW/SSEC McIDAS-X/XCD release, v2021.1. The main development area that we have been involved in is enhancing ADDE serving to better handle the various forms of ABI satellite imagery, satellite Level 2 products, and NEXRAD Level 3 products.

Current Activities

- Support use of McIDAS-X/XCD in-house and in the community

- Ensure that the Unidata instances of McIDAS ADDE continue to function efficiently (ADDE serves on the order of 1.7 TB/day from three servers that Unidata operates on behalf of the community)

- McIDAS-X is used to convert GOES-East/West ABI imagery that is in netCDF4 format to McIDAS AREA format that is usable by all supported display and analysis packages (except Python/MetPy) for the Unidata-Wisconsin (**UNIWISC** aka **MCIDAS**) IDD feed.

The SSEC v2021.1 release features the following:

- Added support for McIDAS-X on **macOS 11** systems.
- Updated **GOES-R Series ABI and GLM** servers with additional bug fixes and enhancements, including preparations for future GOES-18 and GOES-19 satellites, adding support of database search capabilities for improved performance in the SDS ABI archive, and access to ABI L2 Cloud and Moisture Imagery (CMIP) data.
- Updated the **VIIRS and MSG** servers and calibration modules to allow **IMGPROBE** to return VIIR REF and NREF values and MSGS/MSGT RAD values with more precision.
- Updated the ADDE servers to honor both the client's and the server's **ADDETIMEOUT** environment variable. ADDETIMEOUT now overrides the 600 second timeout of the default ADDE server.

- The **GVAR** servers were updated for **EWS-G1** satellite data. GOES-13 became EWS-G1 on 8 September 2020. McIDAS-X checks for that date to appropriately set the SS number correctly for each satellite.
- The **GRIB servers and GRD* commands** were updated to list and display GRIB data with decimal pressure levels between 0 and 1 hPa, levels in potential vorticity units (PVU), and soil temperature levels in units of meters below ground (MBG).
- The **mcinet.sh** script was updated to allow the McIDAS-X system service to be controlled by **systemd** or **xinetd**.
- Improvements were made to the **IMGPROBE** command. The new NORM option enhances the displayed image with a histogram normalization by taking the min/max of the specified unit in the defined region and having the displayed BRIT values stretched from 0 to 255. IMGPROBE was updated so the BOX region has a limit of 30,000,000 points, and the BOX CONT (contouring) option has a limit of 10,000,000.
- The **GAMMA=** keyword was added to the **IMGOPER** command to apply gamma values to output AREA files, and **RGB.MCB** was added to -XRD, along with many **RGB recipes for current real-time satellites**. The **RGB** recipes use **IMGOPER** with GAMMA= to calculate the red, green, and blue channels, and then **RGBDISP** to display the products.
- Changes were made to the McIDAS-XRD Python Package to better handle single quotes in McIDAS-X commands. Each user must redo the **mcxpyinstall** installation step to utilize this new feature.
-

Ongoing Activities

We plan to continue the following activities:

- SSEC McIDAS Advisory Committee (MAC)

  The UPC (Yoksas, Ho) continues to participate as the Unidata representative to the McIDAS Advisory Committee (MAC) that is operated by SSEC.

  The MAC was assembled by UW/SSEC to advise SSEC on McIDAS-X users' needs/concerns/desires for development in the next generation McIDAS, McIDAS-V. The MAC was modeled after the Unidata IDV Steering Committee.

- Interest in McIDAS by non-core users

  The UPC occasionally receives requests for McIDAS-X and help using McIDAS-X from international university users, U.S. government agencies and other non-traditional Unidata users (e.g., private businesses, etc.). Government agencies and non-traditional Unidata users are referred to UW/SSEC for access to McIDAS; international educational community user requests are granted on a case-by-case basis after they provide a clear statement of their acceptance of the terms of use provided by SSEC.

- Continued support of existing and new community members

New Activities

- Add support for new types of data when they become available, otherwise McIDAS-X support is in maintenance mode.

Relevant Metrics

- Data delivered by the Unidata McIDAS ADDE servers exceeds 1 TB/day. The great majority of the data being served is imagery from GOES-16 followed by imagery from GOES-17.

- McIDAS-X/-XCD Inquiry Metrics

ldm-mcidas Decoders Activities

Development

ldm-mcidas releases are made when needed to support changes in software development and operating system environments. **ldm-mcidas** v2012 was released at the end of September, 2012. Recently, the ldm-mcidas code was moved to GitHub.

Geostationary Satellite Data Ingest and Data Serving

Unidata continues to ingest GOES-East and GOES-West imager data at the UCAR Foothills Lab and NCAR Mesa lab campuses in Boulder.

- Direct, programmatic access to real-time GOES-East (GOES-16) and GOES-West (currently GOES-17 but soon to be GOES-18) data via McIDAS ADDE services on three publicly accessible servers (lead.unidata.ucar.edu, atm.ucar.edu and adde.ssec.wisc.edu) has been averaging on the order of 1.7TB/day for the past two years.

Planned Activities

Ongoing Activities

Continued ingest, distribution via the IDD and ADDE serving of GOES-East and GOES-West

imagery from the GRB downlinks we installed in UCAR

Continued ingest and ADDE serving of GOES-15 and GOES-14 imagery when available. GOES-15 and GOES-14 were put into standby mode on March 2, 2020. GOES-14 remains in its standby location (104W) and will be turned on for periodic testing as needed. GOES-15 supplemental operations began on Sunday, August 9, 2020 at 0000 UTC and continues to provide surveillance during Pacific hurricane seasons.

These efforts require maintenance of the satellite ingest and data serving equipment.

New Activities

Establish a testbed for generating Level 2 products from GOES-East/West imagery and select model output. The intention is to be able to test vetted algorithms submitted by community members for a long enough period for the algorithms to be fully tested.

Strategic Focus Areas

We support the following goals described in Unidata Strategic Plan:

1. **Managing Geoscience Data**
   Remote, programmatic access to data provided by the Abstract Data Distribution Environment (ADDE) environment of McIDAS has been a model for the development of remote access methodologies since 1994. Concepts articulated in ADDE inspired the development of THREDDS (to address the lack of rich metadata available in ADDE) and RAMADDA. ADDE remains one of the most used data services in the Unidata suite. ADDE servers operated by Unidata are currently serving in excess of 1.6 TB/day.

2. **Providing Useful Tools**
   McIDAS remains the application of choice for the satellite meteorology community. The Abstract Data Distribution Environment (ADDE) component of McIDAS was the first application offered by Unidata to provide remote, programmatic access to a wide variety of data that is important to the atmospheric science community.

   The fifth generation of McIDAS, McIDAS--V, unlike its predecessors, is a fully open source application that is in wide scale and growing use in the worldwide satellite meteorological community

   McIDAS ADDE continues to evolve and provide access to a rapidly increasing volume of imagery and non-image data.

3. **Supporting People**
   McIDAS is still in active use by those interested in satellite meteorology worldwide.

Status Report: netCDF

October 2021- May 2022

Ward Fisher, Dennis Heimbigner

Areas for Committee Feedback

We are requesting your feedback on the following topics:

1. In what specific ways can netCDF be modified to help with the modern cloud-based scientific workflow?
2. Are there other cloud-based block storage formats/locations (TileDB, Azure, etc) that are actively in use? What is the next venue for investigation once we have our Zarr support in place?
3. What aspects of the modern AI/ML workflow might be improved by changes to the netCDF technical infrastructures.

Activities Since the Last Status Report

We are using GitHub tools for C, Fortran and C++ interfaces to provide transparent feature development, handle performance issues, fix bugs, deploy new releases and to collaborate with other developers. Additionally, we are using docker technology to run netCDF-C, Fortran and C++ regression and continuous integration tests. We have migrated away from Travis-CI to Github Actions for Continuous Integration software testing. We currently have **175** open issues for netCDF-C, **92** open issues for netCDF-Fortran, and **46** open issues for netCDF-C++. The netCDF Java interface is maintained by the Unidata CDM/TDS group and we collaborate with external developers to maintain the netCDF Python interface.

In the netCDF group, progress has been made in the following areas since the last status report:

- The netCDF and netCDF-Java teams have joined with the Zarr Implementation Committee, in order to help guide the development of the Zarr v3 and future specifications in a way that promotes broad compatibility across Zarr implementations.
- The release of ncZarr (netCDF with native Zarr support) has been improved as of netCDF-C version 4.8.1.
- Continuing improvement for the NUG: We previously migrated the NetCDF User's Guide to a new, separate repository. This repository will contain the concise, language-agnostic summary of the netCDF data model. Language-specific documentation (primarily used by developers) will remain associated with the individual code repositories.
- Further enhancements to the netCDF-C documentation, modernization of the netCDF-Fortran and netCDF-C++ documentation.
- We continue to see a high volume of contributions to the netCDF code base(s) from

our community. While these contributions require careful review and consideration, it is encouraging to see this model of development (enabled by our move to GitHub) being more fully embraced by our community.

Dependencies, challenges, problems and risks include:

- The small group of netcdf developers is under a lot of pressure to provide project management as well as implement new features, fix bugs, provide esupport, etc. With 1.5 FTE assigned to the project, the workload is significant.
- Rapid evolution of Zarr standard is very useful, but also provides a bit of a moving target.
- Increase in external contributions has greatly increased the project management overhead for netCDF-C/C++/Fortran.
- Advances in compilers (GCC 10.x) and newer architectures (such as Apple's ARM M1 architecture) are requiring additional overhead to ensure compatibility.

Ongoing Activities

We plan to continue the following activities:

- Continue work towards adoption of additional storage options, separating out the data model from the data storage format (as much as possible).
- Provide support to a large worldwide community of netCDF developers and users.
- Continue development, maintenance, and testing of source code for multiple language libraries and generic netCDF utility programs.
- Continue modernizing the documentation for netCDF-C, Fortran and C++ libraries.
- Extend collaboration as opportunities arise, for increasing the efficiency of parallel netcdf-3 and netcdf-4.

New Activities

NetCDF/Zarr Integration

The netCDF team has released the first public version of netCDF-C which provides Zarr I/O compatibility, dubbed 'ncZarr'. This work has been highly anticipated, and well received, by the broader netCDF and Zarr communities.

Over the next three months, we plan to organize or take part in the following:

- Release the next version of netCDF with Zarr+Xarray support (ncZarr).
- Release iterative versions of netCDF-C, netCDF-Fortran, netCDF-C++.
- Continue modernizing/editing the netCDF documentation to provide easy access to documentation for older versions of netCDF.

Over the next twelve months, we plan to organize or take part in the following:

- Release an official Windows port of the netCDF-Fortran and netCDF-C++ interfaces.
- Continue to encourage and support the use of netCDF-4's enhanced data model by third-party developers.
- Expand support for native object storage in the netCDF C library.
- Continue to represent the Unidata community in the HDF Technical Advisory Board process.
- Continue to represent the Unidata community in the Zarr/n5 collaboration conference calls.

Beyond a one-year timeframe, we plan to organize or take part in the following:

- Improve scalability to handle huge datasets and collections.
- Improve the efficiency of parallel netcdf3 and parallel netcdf4.
- Continue to add support for both file-storage and object-storage options.

Relevant Metrics

Google Metrics

Google hits reported when searching for a term such as netCDF-4 don't seem very useful over the long term, as the algorithms for quickly estimating the number of web pages containing a specified term or phrase are proprietary and seem to change frequently. However, this metric may be useful at any particular time for comparing popularity among a set of related terms.

Currently, Google hits, for comparison, are:

- **1,130,000** for netCDF-3
- **1,250,000** for netCDF-4
- **1,990,000** for HDF5
- **113,000** for GRIB2

Google Scholar hits, which supposedly count appearances in peer-reviewed scholarly publications, are:

- **414** for netCDF-3
- **1,160** for netCDF-4
- **20,900** for HDF5
- **1,540** for GRIB2

Strategic Focus Areas

We support the following goals described in Unidata Strategic Plan:

1. **Managing Geoscience Data**
   by supporting the use of netCDF and related technologies for analyzing, integrating, and visualizing multidimensional geoscience data; enabling effective use of very large

data sets; and accessing, managing, and sharing collections of heterogeneous data from diverse sources.

2. **Providing Useful Tools**
   by developing netCDF and related software, and creating regular software releases of the C, C++ and Fortran interfaces; providing long-term support for these tools through the various avenues available to the Unidata staff (Github, eSupport, Stackoverflow, etc).

3. **Supporting People**
   by providing expertise in implementing effective data management, conducting training workshops, responding to support questions, maintaining comprehensive documentation, maintaining example programs and files, and keeping online FAQs, best practices, and web site up to date; fostering interactions between community members; and advocating community perspectives at scientific meetings, conferences, and other venues.

Prepared *April, 2021*

Status Report: Outreach to Underserved Communities

October 2021- May 2022

Doug Dirks, Jeff Weber

Areas for Committee Feedback

We continue to request your feedback on the following topics:

Are you currently collaborating with an MSI?

Are there MSI's geographically close to you that you have not engaged with?

Are there other underrepresented communities you would like to engage with?

Activities Since the Last Status Report

- Proposal to NSF solicitation **CISE 21-533**, Titled:
  A Sovereign Network System for Environmental Monitoring, Data and Information Exchange, and Collaboration among Tribal Colleges and Universities
  Was fully funded
  - Instrumentation (towers, soil moisture sensors, air quality sensors) will be mostly deployed this summer (SIPI) with some in the fall (NTU)
  - Jeff Weber presented a workshop involving LDM configuration, IDV visualizations, RAMADDA install and set-up at SIPI. SIPI and NTU faculty and students participated.
  - Jeff Weber will hold additional training workshops this summer at SIPI for data transfer and processing via the LDM and RAMADDA servers, hopefully going to be in person Summer 2022.
  - Jeff Weber, **Co-PI of CISE 21-533**, may do site visits to SIPI and NTU this fall if pandemic allows.
- Institutions involved with Unidata are: Southwestern Indian Polytechnic Institute, Navajo Technical University, and Tohono O'odham Community College
- We are also engaging with 2 field campaigns (SAIL (DOE) and SPLASH (NOAA)) to examine the potential for collaboration. SAIL and SPLASH are monitoring the snow/precip process as it relates to discharge into the Colorado River. TOCC and NTU are in the Colorado River basin and will be collecting met tower data including a full radiation suite, and precip, soil moisture, and air quality sensors. This will help us demonstrate the abilty to share some data, while holding other data sovereign to the

tribe, college, or institute.
    - This effort was diminished by the rejection of their equipment grant proposals, but we will continue the effort with existing resources

Engaged with Rising Voices

- Jeff Weber is actively involved with Indigenous Peoples Climate Change Working Group **(IPCC-WG)**
- Jeff Weber is actively involved with **Indigenous-FEWSS**. Indigenous Food, Energy & Water Security and Sovereignty

Internships

- Active engagement in the SOARS program
    - Jeff Weber participated on Selection Committee for 2022
    - Jeff Weber served on the SOARS Advisory Committee for 2022

Jeff Weber is working with DOE/SAIL and NOAA/SPLASH this summer with students and faculty from NTU and SIPI

Progress has been made on the following:

- Designing structural changes (e.g. modifications to how equipment awards, internships, workshops, and committee placements are announced and selected)
    - This work is on hold currently awaiting new Community Services Manager

Dependencies, challenges, problems, and risks include:

- The only known dependency is regarding funding and time both of which have been dedicated to this effort. Since this is a new project, other dependencies or risks have not been identified at this time. This activity continues to need the **full support** of the program and the Unidata Community

Ongoing Activities

We plan to continue the following activities:

- SACNAS and Rising Voices engagement

New Activities

Over the next three months, we plan to organize or take part in the following:

- Continue to develop outreach stakeholder list for broadening distribution of opportunities (equipment awards, internships, etc) and engage remotely
- SIPI and NTU site visits
- Jeff Weber is actively involved in the “Sensing the Earth” conference with planning, hosting, and presenting. This conference involves TCU’s and partners. Planning committee members are from UCAR, NEON, and AIHEC. This conference is in person at UCAR June 15-17.
- Jeff Weber is working with AIHEC, NEON, UCAR/NCAR staff on an NSF proposal for an MSI engagement and data sovereignty project.

Over the next twelve months, we plan to organize or take part in the following:

- Implement changes to the process of how Unidata opportunities are announced and awarded
- Plan exhibition or other activities at subsequent appropriate conferences
- Identify relevant metrics (contacts, partners identified, meetings attended)
- Identify sustaining partnerships for the next five years
- Engage other underrepresented communities

Beyond a one-year timeframe, we plan to organize or take part in the following:

- This effort is an ongoing commitment for the next award period (5 years); however, during this first year we are piloting efforts and then will apply lessons learned for the next 4 years.

Relevant Metrics

Relevant metrics should be discussed and decided for reports going forwarded

Strategic Focus Areas

We support the following goals described in Unidata Strategic Plan:

1. **Providing Useful Tools**
   Better understanding these communities and characterizing their needs will allow us to develop more fit for purpose tools that can and will be adopted

2. **Supporting People**
   Unidata has always served the broad geoscience community; however we are making a concerted effort to expand our reach to underrepresented individuals and organizations as an emphasis of our new award

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Prepared *May, 2022*

Status Report: Python

October 2021 - May 2021

Ryan May, Drew Camron, Julien Chastang, Nicole Corbin

Areas for Committee Feedback

We are requesting your feedback on the following topics:

1. Does the requirement of using units through Pint impede your teaching or use of MetPy?
2. To you and your own community, what enhancements to documentation, tutorials, or examples would most benefit you, especially in the short-term?

Activities Since the Last Status Report

Python Training Efforts

Supported by engineers and Unidata's instructional designer, Python education remains a focus for workforce development, community engagement, and user feedback. Synchronous and asynchronous virtual efforts continued throughout 2021-2022, and synchronous in-person activities are hoped to resume this year. Synchronous virtual workshops and tutorials have remained mostly bespoke, though we've learned more about the reusability and packaging of our materials, and plan to modularize these to better suit the needs of our community. We continue to refine our resources to be more accessible, with an eye towards supporting new institutions and communities.

To support this, we have refined the goals of our expanded Python Training resources and are close to having a new draft website built on sustainable technologies in-line with our other Python projects. Lessons learned from our educational collaborations and the fast-moving Jupyter ecosystem are being leveraged to best fit the Python learning needs of our community.

Progress has been made on the following:

- After COVID delays, Unidata hosted a two-day AMS 2022 Virtual Short Course on intermediate calculations and workflows with MetPy and Siphon with Dr. Kevin Goebbert
- After the AMS Annual meeting went fully remote, Unidata hosted an AMS 2022 Student Conference virtual beginner Python workshop
- Unidata has led short-form tutorial webinars for the NCAR Xdev and DOE ARM Open Science communities
- Unidata continues to be a primary collaborator on *Project Pythia*, which is establishing itself as an authoritative presence on Python learning in geoscience via Jupyter
- John Leeman continues to lead the "MetPy Mondays" effort.

MetPy

Development continues to be driven by requirements for our dedicated awards (in addition to bug reports and pull requests from community members). MetPy 1.2 was released in January 2022 with a variety of fixes and enhancements including:

- Added K-Index and Totals Totals sounding calculations (community contribution)
- Performance increases for moist lapse calculation and GEMPAK sounding reader
- Fixes for compatibility with Matplotlib 3.5
- Support Python 3.10

MetPy 1.3 (April 2022) and 1.3.1 (end of May 2022) were also released, dropping support for Python 3.7 and providing a variety of bug fixes.

The MetPy team has embarked on a plan to increase the release cadence for the project to every other month. This is aimed to avoid having releases slide to get “one more thing” in the release, and instead more readily get developments in the hands of the user–whenever they choose to upgrade.

Moving forward, 1.4 is planned for release at the end of July. This will include the long-promised support for plotting fronts and analysis from the WPC. It will also finally include the full corrections of spherical terms for calculations involving spatial derivatives. More broadly, we will also be continuing the performance improvement work that is the focus of the CSSI award, as well as incorporate the “automated solver” from the previous award.

The 2022 MetPy User Survey was conducted from April to mid-May 2022. On this survey, 72.8% of users scored MetPy as a 4 or higher (on a 5-point scale) when asked “In your experience how easy is it to use MetPy for your various activities?”. 88.2% also rated the quality of MetPy’s documentation as either “Good” or “Excellent”. On the contribution side, while only 8.5% of respondents had submitted a Pull Request (PR) to MetPy, 13.6% had contributed PRs to other projects, while 37.3% had considered contributing to MetPy. The respondents to the survey were overwhelmingly from the University/Education sector (65.5%), with 84.7% indicating “Research” as one of their primary uses of MetPy.

Progress has been made on the following:

- MetPy 1.2 was released January 2022
- MetPy 1.3 released April 2022
- MetPy 1.3.1 released end of May 2022
- Work towards requirements of MetPy-related NSF awards
- Community awareness continues to grow, with the volume of engagement (especially support requests) and mentions on social media growing; the MetPy twitter account has reached 2279 followers.
- A manuscript for an article on MetPy for the Bulletin of the AMS was accepted (with minor revisions) in May 2022

Siphon and Data Processing

Siphon continues to exist in a steady state–continued maintenance and use, but minimal feature advancement. Some of this is due to limited development resources being focused on MetPy's needs; it is also due to limited pressing needs on the data access side. Largely, Siphon meets the needs we have identified for Python data access (that aren't also already met by zarr, xarray, etc.). With that said, Siphon does remain an important part of the stack used by our training work, and by Unidata's community of Python users in general. The most pressing developments we anticipate for Siphon are improvements to working with Siphon in interactive sessions, like the Jupyter notebook environment: improved catalog crawling interface, better string representations, and tab completion.The decision has been made to separate **non-TDS functionality** (e.g. Wyoming Upper Air archive access) out into a new remote-access toolset contained within MetPy, and we hope to begin this transition work soon.

We also continue to maintain the LDM Alchemy repository as a collection of LDM processing scripts in Python. Currently this includes the code powering the AWS NEXRAD archive as well as the program that reconstitutes NOAAPORT GOES-16/17 imagery. As we transition more of our internal data processing to Python, this repository will hold those scripts. We have seen several community questions regarding both the GOES and NEXRAD processing software.

External Participation

The Python team attends conferences as well as participates in other projects within the scientific Python ecosystem. This allows us to stay informed and to be able to advocate for our community, as well as keep our community updated on developments. As participants in a broader Open Source software ecosystem, the Python team regularly encounters issues in other projects relevant to our community's needs. As such, we routinely engage these projects to address challenges and submit fixes. We also continue to host Jeff Whittaker's netCDF4-python project repository; Jeff continues to be the active maintainer of the project. The overall involvement helps ensure that important portions of our community's Python stack remain well-supported. Ryan May continues to serve as a core developer for CartoPy as well as a member of Matplotlib's Steering Council and conda-forge's core team.

Progress has been made on the following:

- We continue to engage with the Pangeo project, a grass-roots effort to develop a community stack of tools serving the atmospheric, oceanic, land, and climate science. This engagement is enhanced by work on the Pangeo EarthCube award, which will likely drive some contributions to the XArray project.
- Ryan May continues to work as a developer on the matplotlib and CartoPy projects, and as a member of conda-forge core team.
- We also continue to actively engage with the xarray and pint projects.

Ongoing Activities

We plan to continue the following activities:

- Supporting Unidata's collection of online Python learning materials
- Engaging in synchronous Python teaching opportunities, virtual or otherwise
- Growing Siphon as a tool for remote data access across a variety of services
- Growing and developing MetPy as a community resource for Python in meteorology
- Continued participation in the scientific Python community as advocates for the atmospheric science community
- Working with JupyterHub as a way to facilitate data-proximate analysis
- MetPy Mondays for engaging the community

New Activities

Over the next three months, we plan to organize or take part in the following:

- Deploy a new version of the Python Training website using sustainable technologies
- Release MetPy 1.4 mid-summer 2022 with a variety of features, including frontal analysis plotting and support for calculations that account for spherical geometry
- Engage in AMS 2023 student conference
- Engage in continued support of Project Pythia and adjacent UCAR Python education efforts

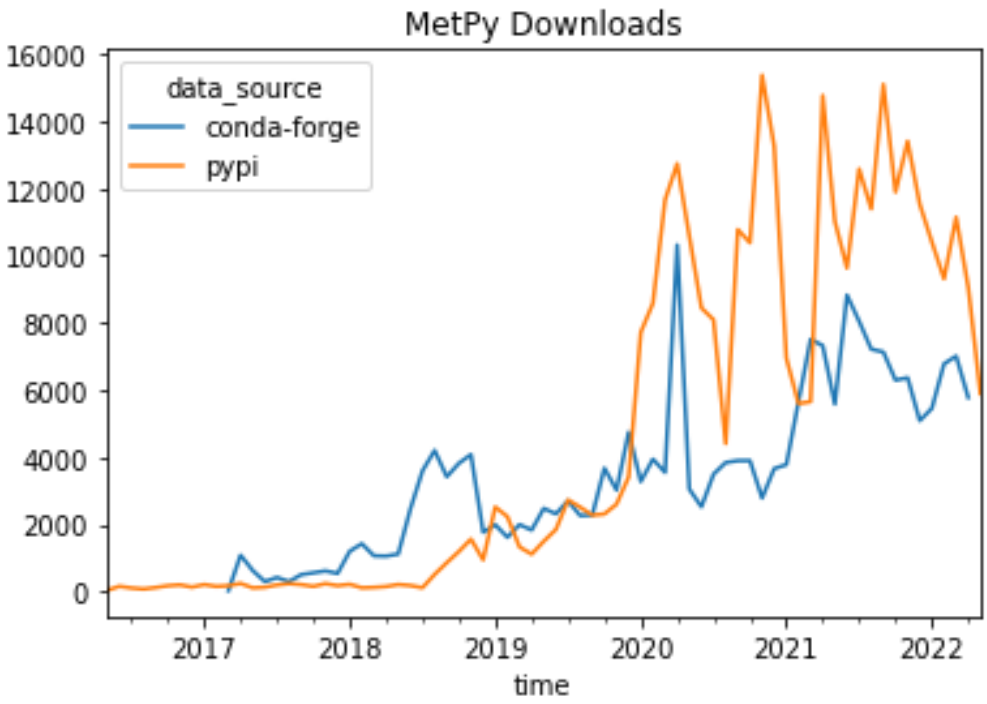
Over the next twelve months, we plan to organize or take part in the following:

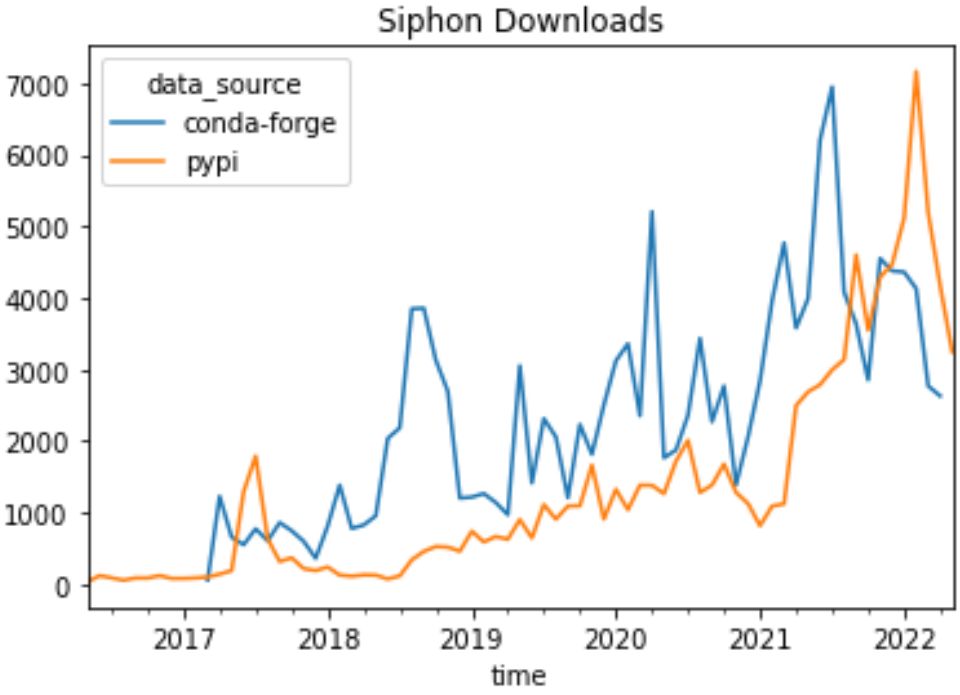
- Offer additional virtual or in-person MetPy workshops
- Separate non-TDS siphon capability into new MetPy remote functionality
- Develop more training ideas for a proposal in response to NSF's CyberTraining RFP
- Explore ways to leverage Web Assembly to provide MetPy as an in-the-web-browser experience for users

Beyond a one-year timeframe, we plan to organize or take part in the following:

- Evaluate the possibility of extending siphon functionality to interface with the AWIPS-II EDEX server

Relevant Metrics





MetPy

- 95% test coverage
- Watchers: 60
- According to GitHub, 249 repositories and 26 packages depend on MetPy
- Downloads for the releases made in the last year (Conda + PyPI):

    - 1.0.1: 53817
    - 1.1: 63918
    - 1.2: 25825
    - 1.3: 6070
- Since 1 October 2021
    - Active Issues: 90 (64 created, 43 closed)
    - Active PRs: 188 (174 created, 178 closed)
    - External Issue Activity: 46 opened, 79 comments
    - External PR Activity: 26 opened, 32 comments
    - Unique external contributors: 38
    - Stars: 77 (875 total)
    - Forks: 2 (317 total)
    - Commits: 436
- Since 1 April 2021
    - Active Issues: 217 (154 created, 122 closed)
    - Active PRs: 418 (396 created, 401 closed)
    - External Issue Activity: 108 opened, 225 comments
    - External PR Activity: 83 opened, 129 comments
    - Unique external contributors: 90
    - Stars: 146 (789 total)
    - Forks: 5 (292 total)
    - Commits: 980

Siphon

- 98% test coverage
- Watchers: 14
- According to GitHub, 119 repositories and 12 packages depend on Siphon
- Downloads for releases made in the last year (Conda + PyPI):
    - 0.9.0: 75687
- Since 1 October 2021
    - Active Issues: 8 (3 created, 3 closed)
    - Active PRs: 115 (97 created, 106 closed)
    - External Issue Activity: 1 opened, 7 comments
    - External PR Activity: 6 opened, 5 comments
    - Unique external contributors: 7
    - Stars: 9 (164 total)
    - Forks: 0 (56 total)
    - Commits: 159
- Since 1 April 2021
    - Active Issues: 12 (7 created, 3 closed)
    - Active PRs: 178 (172 created, 168 closed)
    - External Issue Activity: 2 opened, 10 comments
    - External PR Activity: 7 opened, 5 comments
    - Unique external contributors: 7
    - Stars: 23 (164 total)
    - Forks: 1 (56 total)
    - Commits: 197

Strategic Focus Areas

We support the following goals described in Unidata Strategic Plan:

1. **Providing Useful Tools**
   Python has become a key tool in the atmospheric sciences, and the geosciences in general. MetPy leverages the rest of the scientific Python ecosystem to provide a suite of documented and tested domain-specific functionality, supporting greater use of Python by the community. Siphon serves to provide access to the growing collection of remote data sets. Together, MetPy and Siphon give the community a platform for scripted analysis of real-time and archived weather data. These tools are also readily used in the Jupyter Lab/Notebook environment, for ease of use in cloud and HPC computing environments, facilitating data-proximate analysis. We also participate in a variety of projects in the broader scientific Python ecosystem, to help ensure the ecosystem's viability and that it continues to meet our community's needs.

2. **Supporting People**
   We provide a variety of online training resources to facilitate our community's education and use of Python. We also regularly conduct training workshops to teach attendees how to use tools and apply them to their problems and challenges in research and education.

Prepared *May 2022*

Status Report: Support

October 2021 - May 2022

Jennifer Oxelson, Tom Yoksas, UPC Staff

Areas for Committee Feedback

We are requesting your feedback on the following topics:

1. Is the support that we provide sufficient for the community's needs?

   If not, what else should we be doing?

Activities Since the Last Status Report

Training

Ryan May and Drew Cameron gave the following training workshops in the past year:

- 14 Sept 2021: "Introduction to MetPy" (virtual)
- 22-23 March 2022: "MetPy for Quantitative Analysis of Meteorological Data" (AMS virtual short course)
- 12 May 2022: "MetPy: A Community-Driven Python Toolkit for Meteorology and Atmospheric Science" (Tutorial at ARM Open Science Workshop)

Steve Emmerson and Tom Yoksas gave the following training workshop in the past year:

- 15-17 Sept 2021: "NOAA LDM Training Workshop" (virtual)

New Activities

In order to fulfill our objectives articulated in the Unidata 2018 Proposal, focused efforts are needed in two major areas:

- Enhance electronic support offerings
- Create instructional materials for online virtual training

Relevant Metrics

Since January 26, 2006 approximately 67230 user support "transactions" (new inquiries and follow-ups) have been processed through the Unidata inquiry tracking system. Other methods of providing answers to questions posed (e.g., Github, Stack Overflow, Jira, mailing list replies, etc.) add substantially to the support load.

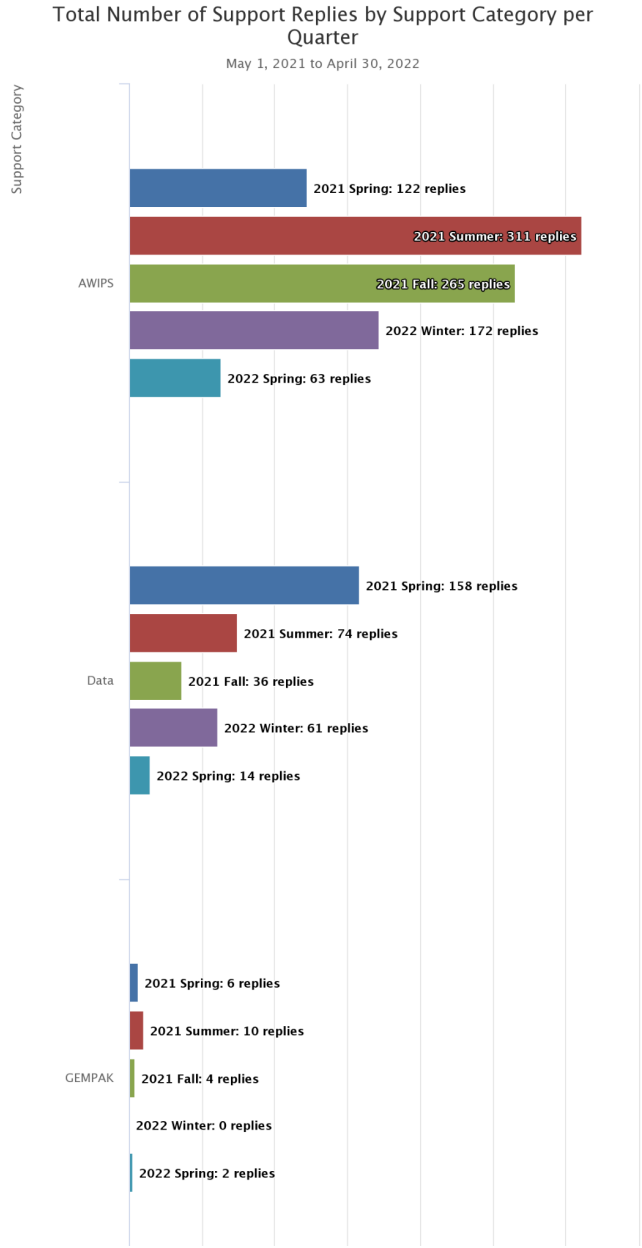
Additional metrics may be found in the Comprehensive Metrics Data portion of this meeting's agenda.

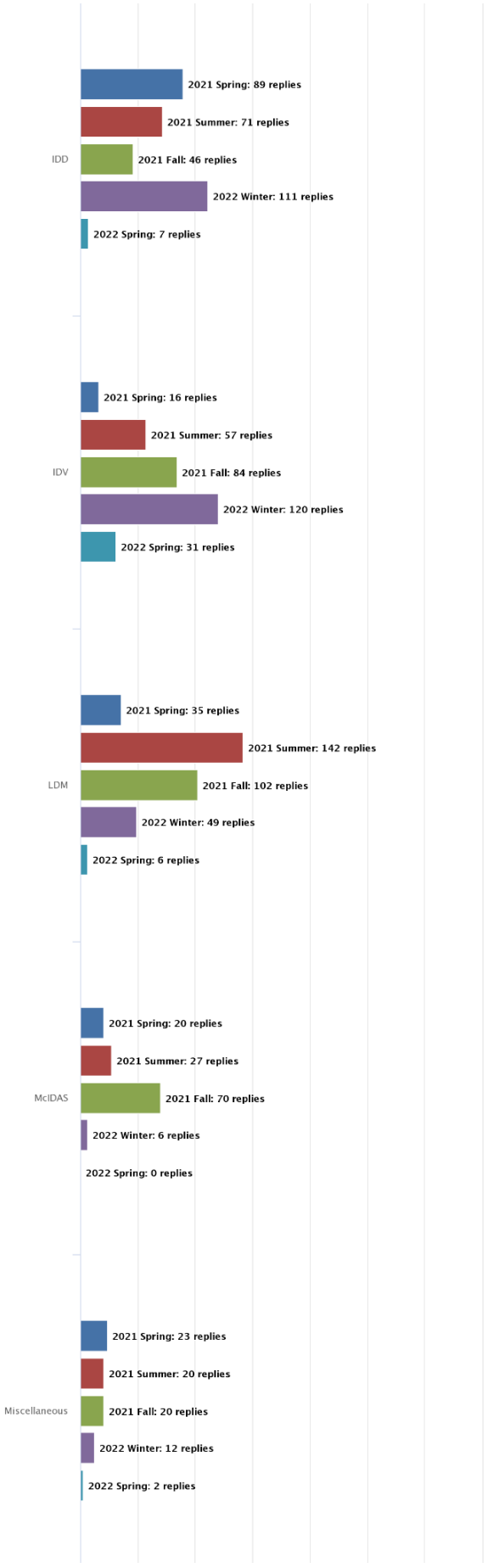
Fig. 1: Below are histograms that portray the number of Unidata email responses for

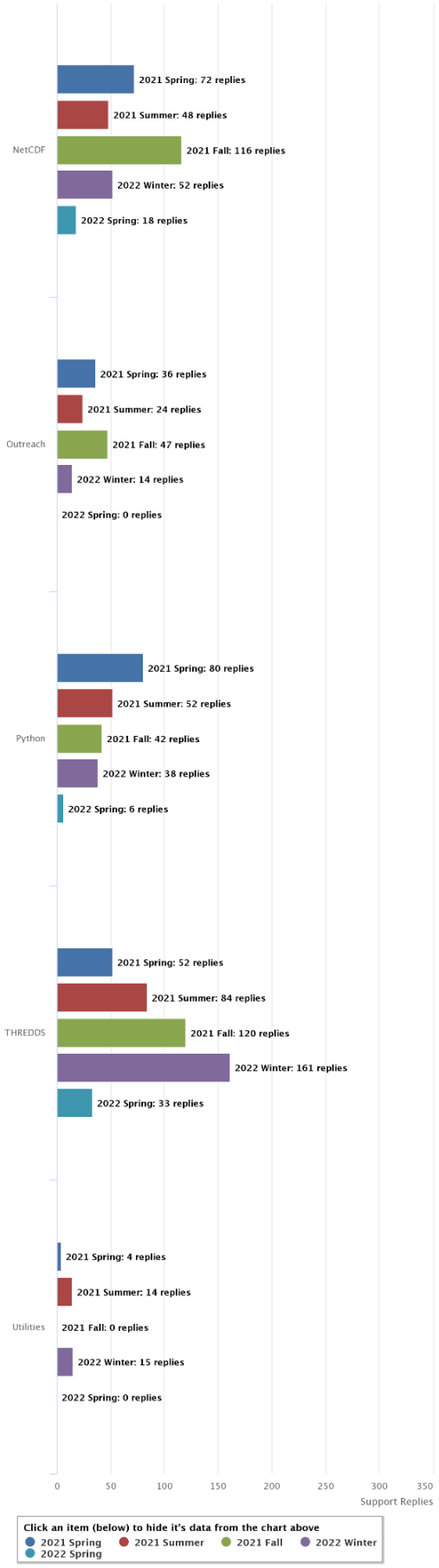
categories of support logged in the Unidata Inquiry Tracking System for the 12 month period from May 1, 2021 until April 30, 2022.

The quarters shown are defined as:

Winter:	**Spring:**	**Summer:**	**Fall:**
January, February, March	April, May, June	July, August, September	October, November, December




IDD
2021 Spring: 89 replies
2021 Summer: 71 replies
2021 Fall: 46 replies
2022 Winter: 111 replies
2022 Spring: 7 replies
IDV
2021 Spring: 16 replies
2021 Summer: 57 replies
2021 Fall: 84 replies
2022 Winter: 120 replies
2022 Spring: 31 replies
LDM
2021 Spring: 35 replies
2021 Summer: 142 replies
2021 Fall: 102 replies
2022 Winter: 49 replies
2022 Spring: 6 replies
McIDAS
2021 Spring: 20 replies
2021 Summer: 27 replies
2021 Fall: 70 replies
2022 Winter: 6 replies
2022 Spring: 0 replies
Miscellaneous
2021 Spring: 23 replies
2021 Summer: 20 replies
2021 Fall: 20 replies
2022 Winter: 12 replies
2022 Spring: 2 replies


NetCDF
2021 Spring: 72 replies
2021 Summer: 48 replies
2021 Fall: 116 replies
2022 Winter: 52 replies
2022 Spring: 18 replies
Outreach
2021 Spring: 36 replies
2021 Summer: 24 replies
2021 Fall: 47 replies
2022 Winter: 14 replies
2022 Spring: 0 replies
Python
2021 Spring: 80 replies
2021 Summer: 52 replies
2021 Fall: 42 replies
2022 Winter: 38 replies
2022 Spring: 6 replies
THREDDS
2021 Spring: 52 replies
2021 Summer: 84 replies
2021 Fall: 120 replies
2022 Winter: 161 replies
2022 Spring: 33 replies
Utilities
2021 Spring: 4 replies
2021 Summer: 14 replies
2021 Fall: 0 replies
2022 Winter: 15 replies
2022 Spring: 0 replies
0
50
100
150
200
250
300
350
Support Replies
Click an item (below) to hide it's data from the chart above
2021 Spring
2021 Summer
2021 Fall
2022 Winter
2022 Spring

Individual support activities included in the categories shown above are listed in the following table.

Category	eSupport Departments
AWIPS	Support AWIPS
Data	Support CaseStudy, Support CONDUIT, Support Datastream, Support LEAD, Support Level II, Support NOAAPORT, Support SUOMINET
GEMPAK	Support GEMPAK
IDD	Support IDD, Support IDD Antarctica, Support IDD Brasil, Support IDD Cluster, Support IDD SCOOP, Support IDD TIGGE
IDV	Support IDV, Support IDV Storm, Support McV, Support VisAD
LDM	Support LDM
McIDAS	Support McDevelop, Support McIDAS
Miscellaneous	Administration, Development, Plaza, Staging Folder, Support, Support eSupport, Support Miscellaneous, Support Platforms, Support Plaza, Student Interns, Systems
NetCDF	Support LibCF, Support netCDF
Outreach	Outreach, Polcomm, Science Gateway, Support Egrants, Support eLearning, Support News, Support Outreach, Support Workshop, Usercomm, Student Interns
Python	Support Python
RAMADDA	Support RAMADDA
THREDDS	Support netCDF Java, Support THREDDS
Utilities	Support LDM-McIDAS, Support netCDF Decoders, Support netCDF Perl, Support OPeNDAP, Support Rosetta, Support UDUNITS

Comments

- The total support provided by the UPC continues to be substantial: yearly totals have shown a slight decline over the past several years, but this is most likely attributable by the increased ways support is being provided. Overall support activities vary by somewhat by quarter. Spikes in support for individual packages is largely correlated with the releases of new distributions of the packages.
- Support for netCDF continues to be substantial, and is understandable given the very large number of users of the package worldwide.
- Support for the legacy visualization packages GEMPAK and McIDAS has decreased over the past several years, most likely due to GEMPAK users investigations of use of AWIPS and Python/MetPy.
- Support for AWIPS has steadily increased and has exceeded that for GEMPAK over the past couple of years.
- Support for Python scripting using MetPy is growing markedly.
- Support for LDM, IDD, and Data continue at a high levels and show some variability throughout the year.

Notes

These numbers and conclusions should not be taken too literally, for several reasons:

- For some packages, multiple responses in the same thread may be bundled into a single archived email. Other packages have each response in a thread counted separately.
- After a new release of software, there may be a flurry of the same or similar questions, which can be answered in separate emails or in a single mailing list posting.
- The graph primarily represents support of end users and site administrators, not developers. Support for non-Unidata developers in projects such as THREDDS, IDV, GEMPAK, and McIDAS requires significant resources, but is difficult to assess.
- Not all support records were indexable for this report. Given this, the above numbers are an **underestimate** of the actual support being provided by the UPC.

Additional User Support Metrics

Strategic Focus Areas

We support the following goals described in Unidata Strategic Plan:

1. **Managing Geoscience Data**
   Unidata User Support enables access to geoscience data by supporting the use of tools created and/or supported by the UPC.

2. **Providing Useful Tools**
   A significant part of providing useful tools is providing support for those tools. Unidata has always provided world class support for all of the tools that it makes freely available to the greater geoscience community.

3. **Supporting People**
   The user support provided by the UUPC is recognized throughout the atmospheric science community. Unidata's outreach efforts are routinely noted as being exceptional in surveys of the NCAR/UCAR community.

Prepared *May 2022*

Status Report: THREDDS

October 2021- June 2022

Hailey Johnson, Tara Drwenski, Jennifer Oxelson, Ryan May, Ethan Davis, Dennis Heimbigner

Areas for Committee Feedback

We are requesting your feedback on the following topics:

1. What has been your experience so far with the TDS v5 migration process? Do you have any concerns or suggestions for how to best support our community through the transition?
2. Do you have thoughts on the migration of the TDS to microservices? What do you foresee as the greatest challenges and benefits associated with the change?
3. How can we help you and your students? We can do much more than Java programming - we love Python too! Our team comes from a variety of academic backgrounds as well, including Meteorology (boundary-, surface-, and canopy-layer, in-situ observations, radar), Computer Science, Oceanography, Chemistry, and Physics!

Activities Since the Last Status Report

Staffing Changes

Tara Drwenski joined the THREDDS team on February 28, 2022. Welcome, Tara! We are in the process of searching for an additional third team member as well, who will hopefully be joining us in the next few months.

The THREDDS Project

The THREDDS Project encompases four projects: **netCDF-Java, the THREDDS Data Server (TDS), Rosetta, and Siphon** (the Unidata Python client to interact with remote data services, such as those provided by the TDS). For specific information on Siphon, please see the Python Status Report. This status report contains updates on cloud compatibility within netCDF-Java and the TDS; for updates on further cloud efforts, including the popular Docker container effort, please see the Cloud Computing Activities Status Report.

Log4Shell and Spring4Shell

- The Java world over the last few months has seen an unusual number of critical security exploits, including Log4Shell in December and Spring4Shell in April.
- The THREDDS team has responded with a number of quick releases containing solely upgrades to third party libraries.
- Throughout this period, we relied more heavily on snapshot releases to respond quickly to security concerns. The current security-compliant release of netCDF-Java

and the TDS are both snapshot releases. Most users have responded positively to our handling of the situation and have been willing to put snapshots into production.

NetCDF-Java

- NetCDF-Java is now on version 5.5.3-SNAPSHOT
- Since the last report, netCDF-Java has completed read support for the Zarr data format. This includes a new, extensible module for data filters, allowing users to provide their own compressors to the library.
- Version 5.5.3 (official release) will be released soon, containing a number of bug fixes and enhancement for the TDS, including:
    - HttpServer access for S3 objects
    - Expanded `Coverage` feature to support accessing profile features

TDS version 4.6.x (Maintenance)

- The maintenance release of the TDS is now on version 4.6.21-SNAPSHOT.
- An official release of 4.6.21 will be available soon.
- The end of life for TDS 4.6.x was pushed to August 2022 as we work out issues in TDS 5.x. We will continue to provide security upgrades only in the meantime.

TDS version 5.x (Current)

- The current release of the TDS is version 5.4-SNAPSHOT.
- Since the release of 5.0.0, a number of bugs have been identified and fixed, including:
    - The ncss map widget
    - Grid as point requests
    - The Godiva3 viewer
    - …and more
- Version 5.4 (official release) will be released soon and will address a number of user concerns and support tickets.

Rosetta

Rosetta remains in a temporary maintenance mode due to limited development resources; no new development is planned for the short-term future.

Ongoing Activities

We plan to continue the following activities:

Maintenance

- Maintain thredds.ucar.edu and keep up with the addition of new datasets to the IDD.
- Closely monitor the security status of our project dependencies, and provide updated versions of our libraries and server technologies to address as needed.
- Maintain threddsrc.ucar.edu as a production server running TDS version 5, until we are

ready to transition thredds.ucar.edu to the latest version.
- Solicit and respond to user feedback regarding threddsrc.ucar.edu and TDS 5.x.

Development

- netCDF-Java
    - Continued work to implement write support for Zarr and NCZarr.
    - Continue development of the new filters module and add support for requested common filters, starting with ZStandard.
    - Continued work to curate existing and create new documentation.
- gCDM (gRPC for the Common Data Model)
    - gCDM is an ongoing effort which currently exists for netCDF-Java versions 6 and 7 (branches __6.x__ and __develop__) and is a new way to allow netCDF-Java to communicate remotely. See April 2021 THREDDS status report for an in depth description of the gCDM project.
    - gCDM stands for "gRPC Cdm", where gRPC is a recursive acronym that stands for "gRPC Remote Procedure Calls". For more information on gRPC, checkout the gRPC FAQ.
    - Work is beginning soon to port gCDM back to netCDF-Java version 5.
    - Porting gCDM to netCDF-Java 5.x will allow the TDS to include a gCDM endpoint.
- Cloud Storage
    - Expand S3 support in netCDF-Java and TDS to effectively mirror that of local storage.
    - Expand testing for S3 support.
    - Improve performance for TDS S3 access, particularly for large aggregations, to prevent potential server timeouts.

The following active proposals directly involve THREDDS work:

- We are in our final four months of the NOAA IOOS award titled "A Unified Framework for IOOS Model Data Access", in which we are partnered with Rich Signell and Axiom Data Science. The goal is to enable support of the UGRID specification within the THREDDS stack, as well as create a GRID featureType to allow for serving large collections of gridded datasets (including UGRID). This work **strategically aligns with the Unidata 2024 focus area “Managing Geoscience Data, Making Geoscience Data Accessible** by improving the reliability and scalability of the TDS to handle very large collections of gridded datasets, as well as **“Managing Geoscience Data, Enhancing Community Access to Data”** through the addition of UGRID support (example: MPAS output is on a mesh, a.k.a. “unstructured”, grid).

New Activities

Over the next three months, we plan to organize or take part in the following:

- netCDF-Java
    - Release version 5.5.3 in support of TDS 5.4.
    - Migrate the HDF5 filter support to use the same filters module used by Zarr.

- TDS
    - Release version 5.4 as a stable, feature-complete TDS release.
    - Migrate the main Unidata THREDDS instance to version 5.4.
    - Help the user community upgrade their servers to TDS version 5.4.
    - Complete unstructured grid support.

Over the next twelve months, we plan to organize or take part in the following:

- netCDF-Java
    - Initial support for any codecs the community deems necessary for reading Zarr and NCZarr.
    - Re-evaluate the future of netCDF-Java versions 6-8 and consider forking a new API that more heavily relies on user contributions.
- TDS
    - Add gCDM support to the TDS.
    - Re-evaluate the TDS dependency on Java and consider development options to optimize maintainability.
    - Begin development of a new product based on microservices.
    - Better curate existing documentation into four documentation sets: server administrator (with quick start guide), end user (browser), developer (web access via api), reference (nitty-gritty details, for those interested in learning more or hacking on the TDS codebase).

Beyond a one-year timeframe, we plan to organize or take part in the following:

- netCDF-Java
    - Fully support Java 11 and the Java Platform Module System (end of Java 8 support)
- TDS
    - Continue development of a new product based on microservices.
    - Continue to explore object storage as it relates to the TDS.

Relevant Metrics

THREDDS Startup Metrics

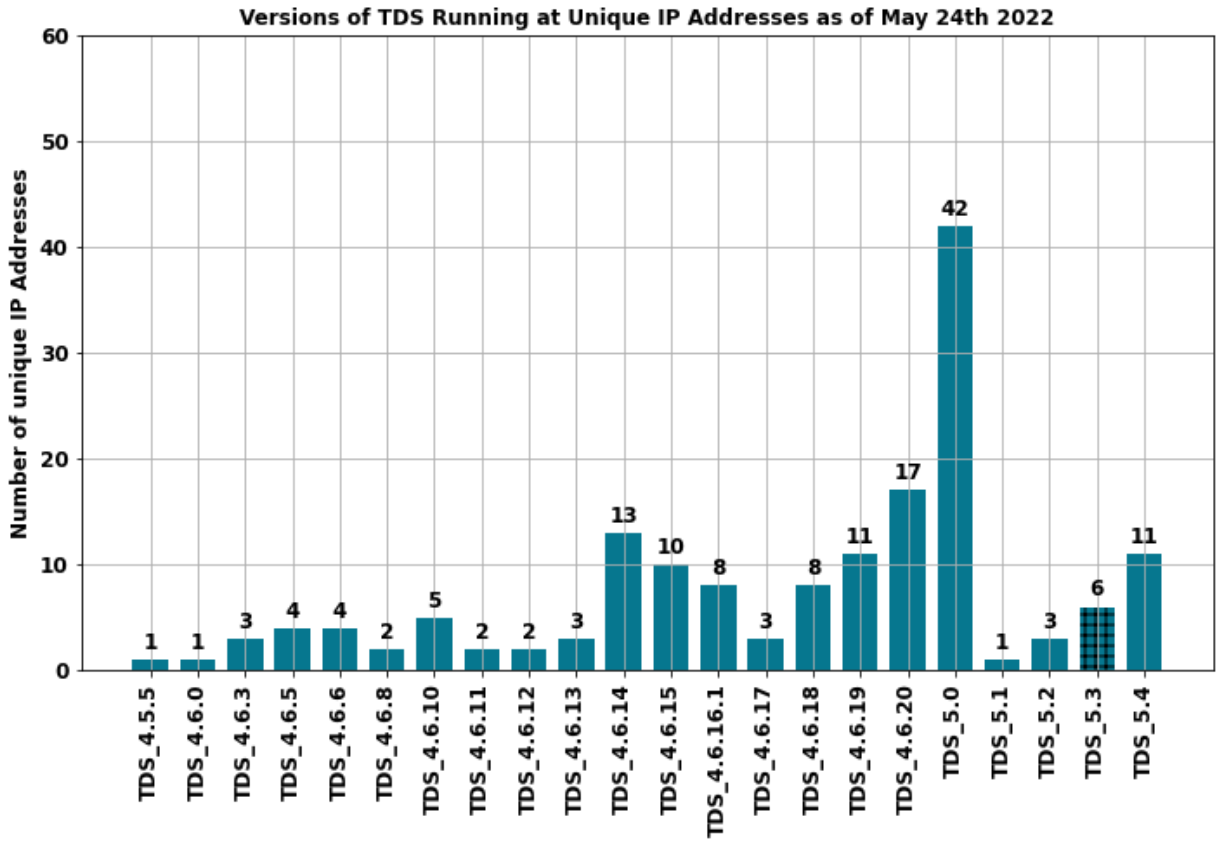
	2021-10 — 2022-05	2014-08 — 2021-04
TDS Startup (unique IP address count)	1,626	38,234

	Total Servers	Information page updated

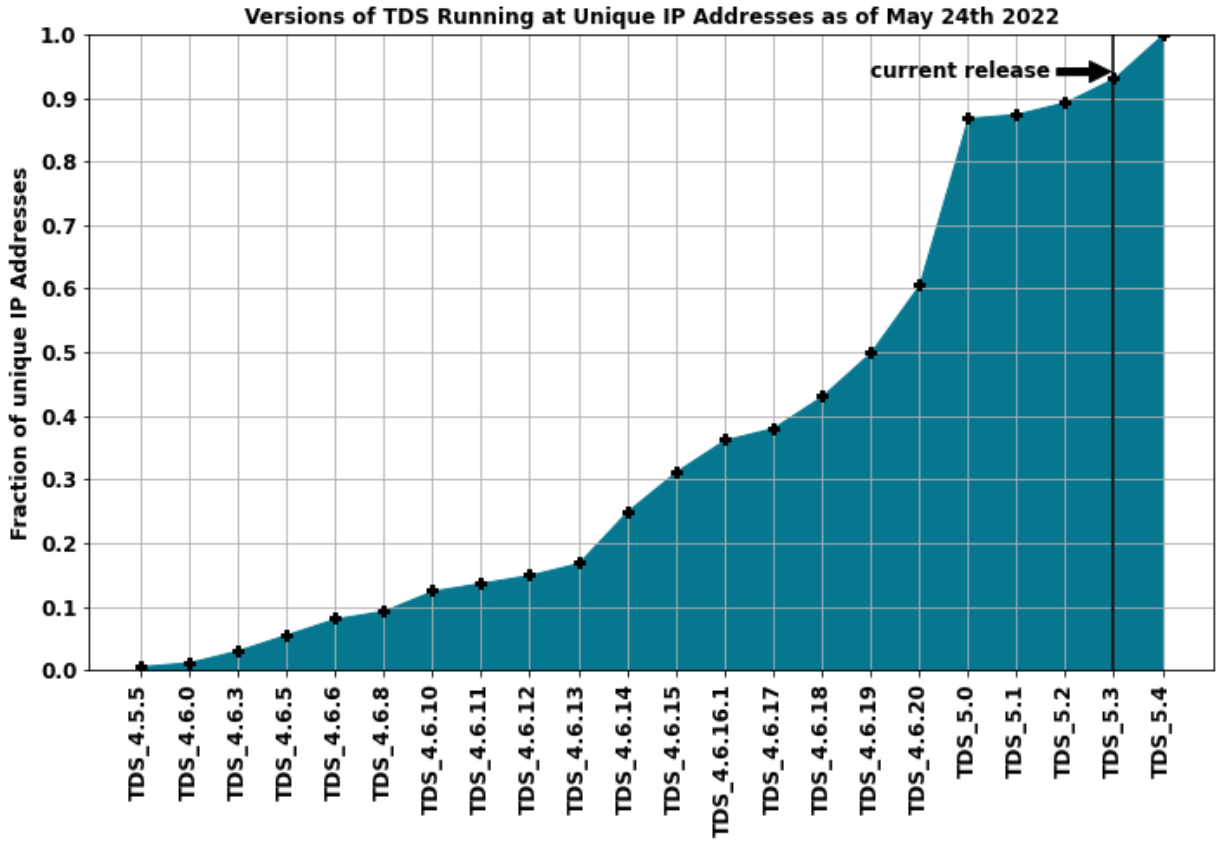
Publicly Accessible[1] TDS count	160	85

Over the past six months, **1,626** unique IPs started up the TDS (October 2021 through May 2022). Since we've started tracking these metrics (v4.5.3, August 26th, 2014), we've seen the TDS startup from **38,234** unique IP addresses. There are currently **160** publically accessible TDSs running "in the wild" (31 fewer than our last report) . Of the **160** publically accessible servers, **85** have updated the name of their server in their server configuration file (taken as a sign that they are maybe, possibly, intended to be used by others...maybe…).

The figures below show the distribution of TDS versions (top), and the fractional share of servers running version X or older (bottom). Each labeled version includes betas and snapshots, not just the official release of that version, for presentation simplicity. The majority of the publicly accessible servers are running v4.6.13 or above . TDS v5.0 is the dominant specific version running in the wild.



[1] "Publicly accessible" means we could find a top-level THREDDS Client Catalog. We checked <server>/thredds/catalog.xml (version 4), <server>/thredds/catalog/catalog.xml (version 5), including the most common ports of 80, 8080, 443, and 8443.



Strategic Focus Areas

The THREDDS projects covered in this report support the following goals described in Unidata Strategic Plan:

1. **Managing Geoscience Data**
   The component software projects of the THREDDS project work to facilitate the management of geoscience data from four points of view: __Making Geoscience Data Accessible, Making Geoscience Data Discoverable, Making Geoscience Data Usable, and Enhancing Community Access to Data__ . As a client-side library, **netCDF-Java** enables end users to read a variety of data formats both locally and across numerous remote technologies. Less user-friendly formats, such as GRIB, are augmented with metadata from community driven metadata standards (e.g. Climate and Forecast metadata standards), and viewed through the more user friendly Common Data Model (very similar to the netCDF Data Model), providing a single set of Java APIs for interacting with a multitude of formats and standards. The **THREDDS Data Server** exposes the power of the netCDF-java library outside of the Java ecosystem with the addition of remote data services, such as __OPeNDAP__ , __cdmremote__ , __OGC WCS__ and __WMS__ , __HTTP direct download__ , and other remote data access and subsetting protocols. The TDS also exposes metadata in standard ways (e.g. ISO 19115 metadata records, json-ld metadata following schema.org), which are used to drive search technologies. **Rosetta** facilitates the process of translating ascii based

observational data into standards compliant, archive ready files. These files are easily read into netCDF-Java and can be served to a broader community using the TDS.

2. **Providing Useful Tools**
   Through Rosetta, the THREDDS project seeks to intercede in the in-situ based observational data management lifecycle as soon as possible. This is done by enabling those who produce the data to create archive ready datasets as soon as data are collected from a sensor or platform without the need to write code or intimately understand metadata standards. NetCDF-java and the TDS continue to support legacy workflows by maintaining support for legacy data formats and decades old data access services, while promoting 21st century scientific workflows through the creation of new capabilities and modernization of existing services (e.g. Immutability, upgraded technical stack, microservice development).
3. **Supporting People**
   Outside of writing code, the THREDDS project seeks to support the community by __providing technical support, working to build capacity through Open Source Software development, and by building community cyber-literacy__ . The team provides expert assistance on software, data, and technical issues through numerous avenues, including participation in community mailing lists, providing developer guidance on our GitHub repositories, and leading and participating in workshops across the community. The team also actively participates in “upstream” open source projects in an effort to help sustain the efforts of which we rely and build upon. We have mentored students as part of the Unidata Summer Internship Program, and worked across organizations and disciplines in support of their internship efforts.

Prepared *May, 2022*