Douglas Mans (EMSL Director): 00:00:00 - 00:00:57

Steven Ashby (PNNL Laboratory Director): 00:00:57 - 00:5:37:00

Asmeret Asefaw Berhe (DOE Office of Science Director): 00:05:38:00 - 00:23:08:00

John Bargar (EMSL/ MONet Team Lead): 00:23:36:00 - 00:31:59:00

Maggie Bowman (EMSL): 00:40:15:00 – 00:39:57:00

Tamas Varga (EMSL): 00:35:30:00 - 00:40:07

Emily Eloe-Fadrosh (JGI, NMDC): 00:40:08:00-44:04:00, 00:00:58:15 - 01:10:10:28

Emily Graham (EMSL): 00:43:57:00 - 00:49:03:00

Yuri Corilo (EMSL): 00:49:00:00 – 00:53:00:00

Kate Thibault (NEON): 00:53:41:00 – 00:59:13:00

Transcript

[start]

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00:00:48:18 - 00:10:00:06

Douglas Mans

So can everybody start to gather up and sit if you like. We're going to get started.

00:10:05:21 - 00:10:16:01

Douglas Mans

There's a thing I was noting. There's another.

00:10:16:01 - 00:10:43:23

Douglas Mans

I like to wing it. Oh, my goodness.

00:10:49:05 - 00:11:07:20

Douglas Mans

Okay. All right. Thank you for joining us today. We have an exciting lineup of speakers to introduce EMSL’s latest project, the Molecular Observations Network, also known as MONet. Before we get started, I wanted to ask our in-person attendees to please silence your cell phones, avoid if

00:11:07:20 - 00:11:17:16

Douglas Mans

possible moving chairs, and resist the urge for side conversations. We're broadcasting this live and we want to make sure that our virtual audience can hear our speakers clearly.

00:11:18:12 - 00:11:38:07

Douglas Mans

Also, a thank you to our virtual audience for tuning in. If you have questions as this event proceeds, please add them to the livestream chat. We'll be gathering your questions and answering as many of them as we can at the end of this program. And with that, I want to introduce Dr. Steve Ashby, the lab director of the Pacific Northwest National Laboratory.

00:11:43:23 - 00:12:18:25

Steven Ashby

Well, good afternoon and welcome, everyone. Today is an exciting day. We come together at PNNL’s Energy Sciences Center to launch MONet, short for Molecular Observation Network. We're honored to be joined by DOE, Office of Science leadership for the special event. On behalf of all of us at PNNL, I extend our deep appreciation to you, Dr. Berhe, and your team for your engagement this afternoon, as well as the time you spent with us over the past day and a half to meet our talented staff and to witness firsthand the breadth and impact of their contributions.

00:12:19:19 - 00:12:51:12

Steven Ashby

MONet is one of the ambitious science objectives, foundational to the 10-year year strategy for the Environmental Molecular Sciences Laboratory, or EMSL, which we proudly steward on behalf of the DOE, Office of Science. I commend EMSL Director Douglas Mans and his team for developing this exciting strategy. The MONet platform is more than two years in the making and the personal passion of many of you in this room through your individual contributions and close collaboration.

00:12:52:00 - 00:13:33:11

Steve Ashby

You're bringing an unparalleled research capability to our national and international scientific community. MONet will help to address a critical gap in our understanding of the molecular, chemical and biological level composition, structure and interactions in soil systems and the plant and microbial communities living within. It also will aid researchers seeking entirely new insights into how these soil systems perform important functions, including the uptake or release of greenhouse gases and the cycling of carbon, which in turn will improve multi-scale models of Earth systems across entire regions.

00:13:34:01 - 00:14:02:03

Steven Ashby

Today, we'll hear from our MONet core team who explain how it works, the data we will obtain and the value it will bring to understanding, ecosystem function and response. I wish to take a moment to acknowledge this core team comprised of John Bargar, Emily Graham, Sarah Leichty, Yuri Corilo, Maggie Bowman, and Odeta Qafoku. I hope we got all those names right.

00:14:02:21 - 00:14:33:20

Steven Ashby

And of course, something of this magnitude requires a talent of many more people, and in this case, the contributions of more than 30 of our colleagues at EMSL. Their collective expertise embodies a multi-discipline area approach to addressing national and global challenges that are the hallmark of a national laboratory. And we could not be prouder of the efforts that you've brought that you've expended to bring us to this moment in time, and we eagerly await your future discoveries.

00:14:34:07 - 00:15:06:22

Steven Ashby

Now, I know we're all eager to hear from Dr. Berhe. It was my honor to introduce her today. Dr. Asmeret Asefaw Berhe is the director of the DOE Office of Science, which is the largest funder of physical sciences research in the United States. Key to its success is stewardship of the world's largest array of scientific user facilities, including EMSL and the Atmospheric Radiation Measurement Climate Research Facility, both of which PNNL proudly operate on behalf of DOE.

00:15:07:15 - 00:15:33:05

Steven Ashby

In her role, Dr. Berhe also provides oversight for the ten national laboratories stewarded by the Office of Science, and this includes PNNL. Dr Berhe is currently on leave from the University of California Merced, where she holds the Ted and Jan Falasco Chair in Earth Sciences and Geology; is a professor of Soil Biogeochemistry; and previously served as Associate Dean for Graduate Education.

00:15:33:24 - 00:16:06:09

Steve Ashby

Dr Berhe’s internationally recognized research lies at the intersection of soil science, global change science, and political ecology, with an emphasis on how the soil system regulates the Earth’s climate, and the dynamic two-way relationship between the natural environment and human societies. She previously served as the Chair of the U.S. National Committee on Soil Science and member of the Board of International Scientific Organizations at the National Academies, among other prestigious positions.

00:16:06:21 - 00:16:37:05

Steve Ashby

Her scholarship and efforts to ensure equity and inclusion of people from all walks of life in the scientific enterprise have received numerous awards and honors. And as many of you know, Dr. Berhe has been active in the EMSL user community dating back more than a decade, and most recently co-authored a paper in 2022 with colleagues in EMSL regarding impacts and mitigation strategies for forest fires on soil ecosystems.

00:16:37:06 - 00:16:52:28

Steve Ashby

She is clearly a hands-on leader! Dr. Berhe, it is our pleasure to hear from you. Please join me in a warm welcome.

00:16:58:03 - 00:17:24:24

Asmeret Asefaw Berhe

Nice to be in the room with a lot of familiar faces. Thank you, everyone. Let me start by saying thank you to Steve for that kind introduction. It's truly a pleasure for me to be back here at PNNL. Thank you so much for inviting me to be part of this incredible event. I could not be more excited about what you're doing here and the inspiring and important scientific endeavors that you're launching today.

00:17:26:00 - 00:17:51:01

Asmeret Asefaw Berhe

The research, obviously being done as part of MONet is literally in my backyard, right, with all the puns intended there. For those who don't know me, but you heard a little brief introduction from Steve. I'm a soil scientist. a biogeochemist by training. Of course, it's not lost on me that I'm also the very first Earth scientist to be serving in the position of Director of the Office of Science.

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Asmeret Asefaw Berhe

I've been in this position now for a bit less than a year. And as you heard, I was previously a professor. Well, I'm on leave from my position as a professor of soil biogeochemistry at UC Merced. And so I could not be more at home with the research that you are all doing, the mission and the goals of this project.

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Asmeret Asefaw Berhe

Of course, I think I should note that when I was a grad student, when I first came to EMSL and PNNL and how to conduct research that it would not have occurred to me that I would be returning in this capacity to help get the word out about a tremendous new opportunity that we're here to celebrate. So when I was a student, a grad student at Berkeley, I was very fortunate to be able to be advised and mentored by some folks names whose very familiar to people doing this kind of work and folks in the room.

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Asmeret Asefaw Berhe

So I had my advisor at UC Berkeley, John Harte, who, you know, was a pioneering ecologist. He was actually a converted a reformed physicist, if you will, who decided to do global change work. But at the same time, I had two mentors. One of them was at the Lawrence Berkeley National Lab, Margaret Torn, and then another one, Jennifer Harden, who was at USGS, Menlo Park.

00:19:16:14 - 00:19:42:15

Asmeret Asefaw Berhe

And it's really the mentorship that I received in particular at LBNL by Margaret that was the reason why I was able to even know about EMSL and was able to write user proposals to come and visit and spend time at PNNL. And I should note that I, along with those visits, I spent a lot of, you know, quote unquote, fun times at the guest house while I was working around the clock on them.

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Asmeret Asefaw Berhe

So. But in all seriousness, though, EMSL and PNNL were instrumental in the success of my research and helping us really advance the work that we were doing at the time, which was to help understand, improve our understanding of how geometric processes control the soil's ability to sequester atmospheric carbon dioxide. We were able to use NMR to determine the composition of soil organic matter across the watershed and the first project that we did.

00:20:12:25 - 00:20:42:12

Asmeret Asefaw Berhe

And so specifically we tried at that time and successfully applied both direct fertilization and cross polarization, in particular RCP magic angles spinning 13 C in a MA techniques in soil along both topographic and depth gradients so that we can demonstrate how and why soils in dynamic landscapes, in particular in the depositional landform positions were able to not just store but also stabilize carbon in organic matter.

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Asmeret Asefaw Berhe

And so, you know, to be able to do this work though, as a student with my kind of background, I came into the project with limited coursework in spectroscopy, right. Because it wasn't it simply wasn't available to students pursuing topics like I was studying at the time especially. So I pretty much learned everything that I needed to know about the spectroscopy and got hands on experience that I was able to apply through my entire career, really including application of that work through some of my students.

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Asmeret Asefaw Berhe

That is happening right now by working very closely with scientists that are here at PNNL and EMSL. And, you know, I think, for example, I'll give a lot of credit, for example, to a person that you all might know, Sarah Burton, who works at EMSL and others who were associated with EMSL at the time in the NMR groups, in particular for the many lessons and collaborations that they were able, you know, kind of to generously share with me over the years that have made better not just my own research, but also the research of my mentees and collaborators across the many years we've been working with them.

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Asmeret Asefaw Berhe

So. And kind of switching gears on the topic of today. I love this idea behind the MONet project, not only because I care deeply about soil, but because this research also has so many components that make it exemplary. It includes, of course, fundamental discovery science that we would learn a lot from this, but it also includes a component that inclusive citizen science kind of project, and it also allows us to make the hidden world visible, right in many ways, connecting the local processes to national ones.

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Asmeret Asefaw Berhe

And it also then in the process keeps the, you know, kind of making contributions to how we can solve perhaps part of the climate crisis. And one of the aspects that I like most about MONet, it also has to be that it is clear it has this really neat, well-thought out plan. And as many of you here would know, when was established as one of EMSL’s 10-year objectives.

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Asmeret Asefaw Berhe

But before the project could be launched as a full scale program, researchers started with a much smaller pilot project that we got to hear a little bit about today. And this pilot that was called the 1,000 Soils aim to collect creating analyze these samples course across the United States and will do so in the project to help understand, you know, many of these processes in soil And it's incredible.

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Asmeret Asefaw Berhe

You know what, Emily, a scientist leading this work, Emily Graham, and the other researchers in this project have developed and have, you know, enabled to be standardized for the collection so that workflows can be standardized for soil samples. And I also have to admire how they've worked and continue to work with indigenous communities gathering and gathering this data.

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Asmeret Asefaw Berhe

And that from the get go, the project was able to engage communities and in particular community, the communities that we must, all of us in science, do better to serve and engage in the work that I do. I think this is an extremely important has huge value in understanding soil systems and improving our understanding to predict climate impacts and many other issues.

00:24:21:19 - 00:24:46:00

Asmeret Asefaw Berhe

So in our Office of Science, these outstanding users facilities that we have, like EMSL, are incredible because they allow us to have this really important finding and play important roles, if you will, in efforts like this And the ambitious EMSL MONet our heads together. Right.

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Asmeret Asefaw Berhe

And so I like to, you know, kind of take a moment to chime in about our amazing use of facilities overall. Of course, as you heard, there's 28 of them from the of that we have at the Office of Science, including EMSL. And these use of facilities are, of course, homes to the most advanced tools across many areas of modern science and ranging from, you know, supercomputers to particle accelerators to specialized facilities for things like nanoscience and genomics and more.

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Asmeret Asefaw Berhe

And of course they include EMSL and together, these tools that we have in their use of facilities provide the scientific community with critical and unique. I think it should all be said premier capabilities for addressing so many of the modern challenges we're trying to work on these days, including in areas of energy and environment and areas that have to do with some security challenges and more.

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Asmeret Asefaw Berhe

And as a user facility then in EMSL, MONet would provide leadership in fundamental biological and environmental sciences in the scientific community that can then leverage those world class, you know, scientists, biologists, earth scientists, chemists and computational engineers and software developers. And many of these state of the art tools and instruments and workflows, including high performance computing, that includes powerful software tools that can improve efficiencies in not just collection of data, but that we capture it, stored, analyze it and more.

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Asmeret Asefaw Berhe

And then researchers from around the world can hopefully get a chance to access these premier tools, not just here at EMSL, but also at all use of facilities at no charge, as we always do. And of course, once their research proposals are accepted through a competitive selection process and now with this and so many of the other things that we have seen today, for example, EMSL has made a giant leap forward in a breathtaking and engaging way in developing money and such an exciting, of course, new national collaborative for addressing challenges in soil science research.

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Asmeret Asefaw Berhe

The Molecular Observation Network will provide, of course, molecular level information and micro structural information on soils or water or soil microbial communities from soils around the U.S. through a robust, free and completely accessible data basis. I can't tell you how happy that makes me. This is incredible. Soils are amazing, but they're also complex and not necessarily the easiest things to study.

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Asmeret Asefaw Berhe

So these kinds of things make a world of difference. And through a growing range of partners like the Joint Genome Institute and the National Ecological Observatory Network or NEON, or also national use of facilities in their own right, Right. MONet seeks to work with federally funded labs, academics, students and citizen scientists in this incredibly ambitious and critical, important project.

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Asmeret Asefaw Berhe

And the collective work I think that's being done here will further our understanding, of course, of some really key basic soils system process is throughout the country in diverse environments, enrolling in enabling scientific discovery that I think that will be conducted by all but also has a benefit for all. The idea of engaging citizen scientists in these kinds of collective efforts in particular I think are just incredibly important and it really helpful also to bring the public along, if you will, as we unlock the mysteries of the molecular world.

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Asmeret Asefaw Berhe

Literally, that's under our feet. So, you know, it's really super cool about MONet, is that I love the fact that anyone can submit their samples, anyone can volunteer to be part of this. And the goal to make this completely accessible to wider research, you know, kind of world that's out there is just amazing. Everyone, I think when we engage people in research in one way or another, especially students, I think we see the benefits of that in many different ways.

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Asmeret Asefaw Berhe

So many people can benefit and we want publicly funded science, of course, to benefit everyone. And so this is extremely important. And of course this is different, right, from how many of the other use of facilities which require a competitive proposal process for use function. And that this new direction I think with Monet is is amazing and it would engage hopefully more people.

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Asmeret Asefaw Berhe

It will be inclusive and let really anyone to be able to dive in today and to ask communities and researchers from across the country literally to be part of this and contribute and share a piece of their backyards for the science and and many other benefits that will come from it. So I don't think I you know, you would not be a surprise for you at all to hear that.

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Asmeret Asefaw Berhe

I think this is extremely exciting and important work and I think we simply just don't have enough understanding and detail and data on how soil processes operate, things like respiration, for example, how do they occur, why do they vary from one place to another and different types of soil? And how do we represent things like this and our efforts in earth system size and the modeling capabilities that we heard about earlier, for example, with E3M and others.

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Asmeret Asefaw Berhe

And so being able to collect these kinds of molecular data that MONet will capture will be incredibly important in helping us improve our understanding capabilities to model it and even just better insights into the models that would help us understand soil processes better. And so, you know, the citizen scientist, the students, members of the academic community and industry folks working in our national labs, other researchers, I think everybody would be able to benefit from what will be derived from this project.

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Asmeret Asefaw Berhe

And since it's also open, it could be the perfect project, right for you can imagine junior high, high school students, like my kids are at this point, university students, graduate students, of course, and others that could get involved. I can imagine youth groups in every corner of the country and families and even me potentially even getting their hands on some kids and contributing to this incredible effort.

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Asmeret Asefaw Berhe

And from what I understand, you'll also be sending folks, these giant soil kids in a suitcase that has all the standard sampling kits that typically, you know, only soil scientists get to play along with that and play with toys like that. And I think everybody should have a chance to do that. I think soil is cool, in case that's not clear so far.

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Asmeret Asefaw Berhe

So I feel like it's really a good idea of everybody gets a chance to get their hands dirty and learn more. And of course, researchers could use the equipment in that soil kit that they're sending them to dig this course, give them the info they want and and contribute to the metadata and social needs. And once the samples are then sent back here to EMSL, they will run through the their, you know, kind of list of analysis that they laid out.

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Asmeret Asefaw Berhe

And once the information then is collected, be able to join the database and be freely accessible to the public. I think this is exactly how publicly funded science should work right? Publicly funded science that we enabled through the Office of Science, for example, through our many of our programs, including the biological and environmental research program, is exemplary of what we know, kind of what we can do together.

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Asmeret Asefaw Berhe

And we're doing this for not just for now, but also for the future and the future health of our environment. And it's everybody's future that we are looking to protect, of course, and inform. We must return to fundamental science of course, to figure out what is driving climate and climate related processes. So this is a call to get everyone involved to contribute to the soil story of their community doing this for now, for their future, doing our part to mitigate the climate crisis.

00:33:23:17 - 00:33:46:27

Asmeret Asefaw Berhe

And as always as we do, we're looking to the fundamental science for solutions. And I applaud you and everyone involved here on this milestone that you've reached at this point, knowing we have obviously, of course, a lot of work left to do, a long way to go on this fundamental science journey that you're all embarking together. So thank you, everyone.

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Asmeret Asefaw Berhe

I really appreciate you all inviting me and being part of this.

00:33:57:00 - 00:34:23:12

Douglas Mans

Thank you, Dr. Berhe, for this next portion of the event you hear from our MONet researcher team on the various analyzes that will perform on these soil samples and how that data will be analyzed, captured and made available for everyone to use. I'm honored to introduce MONet lead scientist and honestly, the heart of this project, Dr. John Bargar.

00:34:23:12 - 00:34:52:09

John Bargar

Thank you very much, Douglas. And what she just said. So soils contain enormous amounts of carbon, more than all the above ground biomass around the planet and all the CO2 in the atmosphere combined. Moreover, soils are intimately in contact with the atmosphere and they enter convert carbon between CO2, organic and mineral forms. This means that CO2 can escape from soils and it also means it can be stabilized in soils.

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John Bargar

This means that soils are profoundly important to controlling atmospheric CO2. I just want to point out the soils contain both inorganic and organic forms of carbon. Today we're focusing mostly on soil organic matter, which forms the largest pool globally. So whether or not carbon will be stabilized in soil or will be released back to the atmosphere as CO2 or methane is determined by molecular processes that govern the movement of carbon between plants, microbes and minerals.

00:35:29:27 - 00:35:51:21

John Bargar

And these processes are highly complex. Imagine, if you will, a large organic carbon molecule that breaks into lots of small, smaller molecules, each of which can continue to break down into lots more smaller molecules or can stick on a mineral surfaces or can dissolve in the water or can be eaten by microbes, in which case it all goes around the circle.

00:35:51:21 - 00:36:26:14

John Bargar

Again, there's a lot going on here to make matters more complicated, and the rates of all these processes are highly variable. Very few models incorporate the needed molecularly specific information, but they should, because this process complexity leads to uncertainty in our systems and climate models. Indeed, our failure to represent this process complexity is molecular process. Complexity is one important reason why atmospheric CO2 predictions contain so much uncertainty.

00:36:26:14 - 00:36:56:29

John Bargar

We urgently need to do a better job of understanding these molecular and micro-scale processes. But we also need to understand these tiny processes over very large scales like you see here. This is what Monet is about. And here's why. As you look out across this landscape, you can see lots of individual soil plots and you can appreciate that each plot receives different amounts of sunshine or rainfall, has different vegetation, different land use types, blah, blah, blah.

00:36:56:29 - 00:37:20:21

John Bargar

It can go on. The main point here is that each of these soil plots will respond to climate change or to drought or to flooding or other types of forcing events in very different ways. Our job is to integrate all these different types of behaviors and how they interact with the atmosphere together to understand how climate changes is acting.

00:37:21:09 - 00:37:49:10

John Bargar

That is to say we need to collect soil samples across entire regions. Which brings me back to the statement I made just a minute ago, which is that we need to understand these tiny processes over very large length scales. So how do we do this? We use models to connect across distance and time, but models are no good without data.

00:37:49:10 - 00:38:12:17

John Bargar

The problem is that we don't actually have standardized molecular and microscale data across the entire region. So this is so important that I'm going to repeat it. We don't have standardized molecular and microscale data across soil regions, but thankfully we do have soil ecological networks like neon and mirror flux that are collecting and compiling soil data across the United States.

00:38:13:07 - 00:38:49:20

John Bargar

These networks aren't focusing on molecular carbon or microscale soil properties, so the Monet program is creating a new database to provide this critical molecular and microscale soil data and also to build on these other ecological networks. So here's how we're doing this. The most important product is a high quality, high volume database of these important information resources that are needed by environmental and climate scientists, modelers and data and climate modelers, experimenters alike.

00:38:50:01 - 00:39:21:03

John Bargar

The data need to be findable, accessible and findable, accessible and then searchable by everyone. That is to say, we need to ensure that access to these data is democratized for all communities and scientists to use it. Dr. Yuri Corilo, we'll talk more about this in just a few minutes. To generate big data, we're finding ways to convert traditional labor intensive molecular methods into high throughput standardized workflows.

00:39:21:14 - 00:39:49:06

John Bargar

So standardization is a term you'll hear a lot about today. There will be a quiz at the end so everyone take notes. Standardization is important because it's critically important. It ensures that all of the data will be usable. It also reduces uncertainty within the data and it also helps remove the effects of inherent human bias. So within this molecular space, the Joint Genome Institute or JGI is a very important partner.

00:39:49:18 - 00:40:18:27

John Bargar

JGI is supplying critical molecular data on soil microbiomes that are going into them on a database. So Dr. Emiley Eloe-Fadrosh from GI will be, along with Dr. Tamas Varga, from EMSL. We'll be speaking just in just a few minutes more about molecular methods before we can create big data. However, we need to collect thousands of soil samples from across the United States.

00:40:19:26 - 00:40:51:18

John Bargar

To do this, we developed a sample collection kit and standardized procedures for scientists participating in this open science network. We send these kids to scientists across the country. They send them back. We analyze the data and provide with results. In this endeavor, NEON has been a very important partner. Last year, during a pilot project, Neon collected and sent us more than 70 cores, which were extremely important in helping us learn how to do this important step.

00:40:52:02 - 00:41:21:23

John Bargar

So Dr. Maggie Bowman from EMSL will tell us more about our standardized soil collection procedures in just a minute. So this this is a very big project. We simply can't do it ourselves because it's just simply too big. However, by collaborating with thousands of partners across the United States, we can solve truly large problems together. In case you haven't noticed, this is not a traditional way of doing science.

00:41:22:06 - 00:41:49:09

John Bargar

MONet is an open science network. Open networks provide a way to solve truly challenging problems at scale, and we're providing you with an opportunity to participate in this open Science network. There's no cost to participate other than collecting and submitting the sample cores. As I mentioned just a minute ago, we analyze the samples and provide you with more than 20 advanced data types for your research.

00:41:49:19 - 00:42:27:01

John Bargar

Moreover, these data are accumulating in a cutting edge database that allow anybody to access it. So it's win, win, win on all sides. Crucially, also, open networks provide opportunities to expand participant participation by traditionally underrepresented communities along these lines. We're inviting undergrad as well as graduate students, postdocs, faculty from schools across the country to participate. We're also inviting high school teachers, national lab researchers, industrial scientists, citizen scientists to send US soil cores.

00:42:28:02 - 00:42:52:28

John Bargar

So by growing new collaborators, new data types and a new user community will transform our understanding of soils and provide new tools to society for adapting to and counteracting climate change. And with that, I'll start. So thank you very much and turn the baton over to Dr. Maggie Bowman, who will tell us more about our standardized soil collection.

00:42:57:25 - 00:43:33:00

Maggie Bowman

Hi. Thank you. As John mentioned, I'm Maggie Bowman, and we have designed you standardize a protocol and a sampling kit, which includes field measurements and a soil kit. And Dr. Berhe had mentioned it's a large suitcase that is shipped to participants to collect samples. These standardized field measurements and protocols are used to reduce variability. This will help us overcome, overcome and compare measurements across diverse soil types, disturbance and eco climates.

00:43:33:00 - 00:43:56:12

Maggie Bowman

When a MONet proposal is accepted, our team starts in scale by scheduling a meeting with you to coordinate a sampling plan. Then will ship the soil sampling kits, coolers and everything you need for sample collection directly to you. The sampling kit contains all the equipment you would need to collect soil cores, as well as alternative methods for stubborn soils.

00:43:57:20 - 00:44:24:28

Maggie Bowman

You will collect two large cores which typically contain the organic and mineral soil horizons, as well as four smaller cores, to make sure that we capture the representative diversity of your surface soils, you will also collect field measurements like temperature and soil moisture. Once your colleagues are collected, you will send your kids back to us for immediate processing using our standardized protocols.

00:44:25:24 - 00:44:52:28

Maggie Bowman

When soils arrive at the lab, your quarters are unpacked and we verify that all information is complete. The two large cores are used for two main workflows. One fruit is used for time sensitive measurements, where the other is used for structural measurements. The core used for time sensitive measurements is processed immediately while the soils are still fresh. That helps us characterize the

00:44:52:28 - 00:44:53:28

Maggie Bowman

biological

00:44:53:28 - 00:45:25:13

Maggie Bowman

and chemical composition of the soil. For this core, we collect measurements ranging from the molecular to bulk scale, and our molecular measurements include data like metagenomics and high resolution organic matter composition. And while the bulk characterization includes data like respiration and total carbon, the core used for structural measurements allows us to capture data on the physical structures of the soil.

00:45:25:13 - 00:46:03:27

Maggie Bowman

This includes high resolution X-ray, computed tomography on the intact core and coarser scale measurements like texture at different depths. Now, I really want to highlight again the reason why this standardization is so important. It's because we're measuring very, very tiny things, measured thousands of times across hundreds of soils. If this collection process sample handling analysis are not standardized, then the pieces won't fit together in our great puzzle with this Tamas Vargas.

00:46:05:03 - 00:46:13:01

Maggie Bowman

Tamas Varga will provide an example of some of the very tiny things we're measuring and how we can use that data.

00:46:16:25 - 00:46:47:26

Tamas Varga

Hi, I'm Tamas Varga. Let's talk about the very tiny things we are measuring. EMSL uses a highly sensitive and extremely powerful technique called Fourier transform ion cyclotron, resonance mass spectrometry or FTICR mass spectrometry. It is a unique and powerful tool in helping us characterize soil organic matter. There are only a few of these instruments in the United States, and our 21 Tesla magnet makes it one of only two in the world.

00:46:47:26 - 00:47:17:19

Tamas Varga

And so EMSL’s fleet of mass spectrometers is a national resource for soil organic matter characterization and modeling. From our ultra-high resolution FTICR mass spectrometry, we got an unparalleled molecular scale view of the chemical complexity of soil organic matter. With FTICR mass spectrometry, we are able to detect and determine the chemical formula for thousands of molecules in soil samples.

00:47:18:09 - 00:47:52:19

Tamas Varga

This helps us understand the organic two types of organic and inorganic chemical transformations that occur in different soils across spatial and temporal scales. The connected open spaces that exist in soils, what we call soil. Poor networks direct the flow and transport of minerals and microbes in the soil. This influences carbon, respiration, soil, organic matter, decomposition, and eventually carbon dioxide and methane release.

00:47:53:16 - 00:48:31:26

Tamas Varga

Therefore, in addition to the molecular information, we also gather structural information about soils. Using X-ray computed tomography. We gather high resolution data showing how the different sources are packed together. In other words, we look at where open spaces exist in the soil, again called soil pause, and we look at how those forces are connected or isolated. The data from X-ray computed tomography helps us create a three dimensional image of each soil, cause internal port structure.

00:48:32:18 - 00:49:08:04

Tamas Varga

Through these 3D images, we can determine pore sizes, the distribution important for connectivity. This three dimensional rendering of soil sample is from a micro computed tomography scan. Here we are looking at the inner pore structure of our soil sample. The connected, solidly unconnected pores are shown in red and the connected pores are shown in blue. We can also see how the pores are connected to pore network through the white lines and yellow dots.

00:49:08:28 - 00:49:38:10

Tamas Varga

Through this level of detail, we can see the many factors that control organic matter, stability in soils. That is how easily it can be converted into carbon dioxide or methane. Organic matter can be protected in the smallest pores, pores so small that you can see them in this image. Organic matter can also be protected by physically or chemically binding to mineral surfaces.

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Tamas Varga

Soils with very small pores tend to have lower permeability, meaning that water doesn't move through as easily the soil through the soil as easily as in soils with larger pores. Low permeability tends to create chemical conditions where organic matter decomposition is slow. I mentioned these factors to demonstrate that understanding the chemistry of organic matter is crucial to understanding its decomposition.

00:50:11:09 - 00:50:42:02

Tamas Varga

As John noted earlier, we can reduce uncertainty in earth system and climate models by including more chemical specificity. And this is what FTICR mass spectrometry is important. It can provide us with that level of chemical specificity. Now we do additional experiments and FTICR our measurements. We can actually learn what molecules are contained in various sized pores. And while we are on the topic of soil pores.

00:50:42:02 - 00:50:58:07

Tamas Varga

Emily Eloe-Fadrosh is here to discuss how we conduct metagenomic analysis of the microbes contained in these spores.

00:50:58:07 - 00:51:20:09

Emily Eloe-Fadrosh

So there are more microbes in a teaspoon of soil than. There are people on the earth. But studying the diversity and function of these microbes is really challenging. Using traditional microbiological approaches, we cannot grow them in the laboratory. We cannot do experiments using controlled conditions to understand how they decompose this organic matter, how they interact with one another.

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Emily Eloe-Fadrosh

Instead, we call it we use a method called metagenomics to access their genomes in bulk and compare these sequences to what we know about the Tree of Life. Metagenomics is a lens through which we can access wild microbial genomes and viral genomes to infer function and to get a clearer picture of who is out there. What are they doing and how they're impacting climate.

00:51:44:03 - 00:52:23:12

Emily Eloe-Fadrosh

Through an innovative partnership with EMSL, the Joint Genome Institute will support large scale metagenome sequencing, and for the MONet program, the JGI is a flagship DOE user facility that provides genomic resources to this global scientific community. Over the last 25 years, the JGI has pioneered metagenome sequencing and analysis approaches from diverse environmental samples. Our team at the JGI has enabled remarkable science by harnessing our metagenomics expertise to uncover novel microbial groups and viruses from soils, from oceans, from plants and animals, and deep within the Earth's crust.

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Emily Eloe-Fadrosh

We have scaled sequencing 30-million fold through the application of new sequencing technologies like the Illumina NovaSeq and developing new computational tools to assemble and annotate this immense data. By partnering with EMSL and the research community, the JGI will generate several hundred metagenomes on an annual basis, which amounts to nearly 20 Terabases of data per year from diverse soil microbial communities.

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Emily Eloe-Fadrosh

This is an incredible scale of data from soil microbiomes. The JGI will also use our state-of-the-art analysis pipelines to process this data, taking a genomic-centric approach to assembly and annotation to provide a large collection of wild microbial and viral genomes from soils to date. The JGI will host this treasure trove of metagenome data in the Integrated Microbial Genomes & Microbiomes computational platform, along with seamlessly sharing this data back with EMSL. The standardized pipelines allow all data to be compared across diverse soils and will allow the research community to study how soils samples compare to one another, across field sites, and across the United States at scale.

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Emiley Eloe-Fadrosh

And of course, this metagenome data can be analyzed within the context of all the additional molecular measurements that you just heard about to gain a comprehensive picture of soil microbial communities. Beyond the tools the JGI and EMSL will provide for metagenome data processing and annotation, I am really excited to think about how new tools like machine learning can be applied to gain even further insight into microbial function.

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Emiley Eloe-Fadrosh

The MONet metagenome data and all the rich molecular measurements will be such a foundational reference catalog that will enable new science to be done, from modeling microbial communities to understanding their function to being able to predict how those communities will change or be resilient over time. I also can envision how this remarkable data could feed into new climate models that incorporate microbial contributions that is just not possible right now.

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Emily Eloe-Fadrosh

Now, I'd like to hand it over to Emily Graham to share some initial insights on the 1000 Soils Project.

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Emily Eloe-Fadrosh

Thank you.

00:54:49:12 - 00:55:23:10

Emily Graham

So I'm Emily Graham. I helped lead the 1000 Soils pilot that helped us develop standardized methods and approaches for MONet. I'm always super impressed by all my colleagues, and I think what you've seen so far really highlights that EMSL’s Molecular Observation Network can give us unprecedented insight into the mechanisms that regulate key environmental processes. So one thing that people always ask me is, okay, so now you have all this ultra high resolution data.

00:55:23:10 - 00:55:52:29

Emily Graham

What do you do with that? And so that's something we're really focused on right now, using our data from the 1000 Soils pilot, helping develop example use cases and tools for our user community. So during that pilot effort, we were able to collect nearly a hundred sets of queries distributed across the continental US. These covered a wide range of variation and environmental parameters that we know are associated with soil carbon cycling.

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Emily Graham

So things like moisture, content, carbon and nitrogen ratios and other factors. And so for first, look at the data, we combined data from our mass spectrometer that Thomas talked about. Well, has been really involved in that as well and microbial metagenomics that Emiley just talked about. We looked at differences and carbon cycling across different biomes with these data.

00:56:23:07 - 00:56:59:21

Emily Graham

So from the mass spec data we can pull out and varied biochemical transformations that really tell us a lot about the specific carbon cycling reactions that are associated with respiration. And from metagenomics, that gives us an idea of the full range of metabolic pathways that can possibly occur in our biome. So we can take these two data types and then correlate them with the soil respiration measurements that we take and get an idea of very specific pathways that may correspond to land atmosphere, fluxes of carbon dioxide.

00:57:01:05 - 00:57:28:04

Emily Graham

So when we do this, this may not be surprising to you guys. We see a tremendous amount of variation across different biomes. And while this isn't surprising, it's also not typically how we represent carbon cycling and models. So even the most state of science carbon cycling models are really just different pools of carbon that are linked by different processes that connect them.

00:57:28:23 - 00:57:57:20

Emily Graham

So these models in general are structured to be widely applicable so we don't have to have detailed models for different ecosystems. But that's in fact what the data are starting to show. So just to give one example here, when we look at datasets distributed across all deserts within the continental U.S., we're seeing that amino acid and manganese cycling may be important in under considered aspects of carbon cycling.

00:57:58:09 - 00:58:26:07

Emily Graham

When we put this in the broader context of climate change and changing precipitation regimes, we know that certain areas of the country are going to get drier. And so these may be really important mechanisms to think about in our next generation of models. Some other things that we're doing here where we're using machine learning and process based models to look at specific processes that may be important as well.

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Emily Graham

So to give one example from our FTICR, as we get 10,000 or more different molecules per samples, a lot of those are inactive molecules and only a fraction of them are cycled and so we were able to pull out two mega features from machine learning that correlate strongly with respiration. And so this is a really tractable set of data that we can then put in process based models like PFLOTRAN, which is reactive transport model used by the user community.

00:59:01:11 - 00:59:35:03

Emily Graham

So interpreting these data I think is one of the most pressing soil science and climate change related challenges of our modern day. We're getting a lot of cool things with just a few of us looking at the data, and I'm confident we're really just scratching the surface. I can't wait for the broader community to get their hands on this data so we can all put our brains together and start pulling out different trends and processes that we really need to represent in models.

00:59:35:23 - 00:59:48:22

Emily Graham

And so next up Yuri is going to talk about how we're managing that data, how we're making it fair and accessible, and how we're encouraging people to be creative with our data.

00:59:53:12 - 01:00:24:03

Yuri Corilo

Thank you, Emily. So, hi, I'm Yuri Corilo and I'm here to talk about the practice of democratizing the data. So how we're going to do our part, the record of democratizing data through money. So as we know, access to the data is critical for decision making in both the professional and academic spheres, but limited access to the scientific data can only create barriers to its democratization, and it slows down the pace of scientific innovation.

01:00:24:19 - 01:00:51:00

Yuri Corilo

And this is where importance of having a defined data model comes into play. So you're probably wondering what is a data model? What is it you find out about them? Well, essentially it is a model that allows us to organize documents and define them data in a standardized way. So what it tangible benefits or it makes it easier to access understand it, reuse the data.

01:00:51:17 - 01:01:17:20

Yuri Corilo

We can use the data more efficiently and more effectively. You can reduce of the risk of errors and inconsistencies. So along with the fine data model, having metadata standards also play a crucial role in decreasing the rate, the barriers to the data democratization. Mandatory standards provide us an extension information about the data like historians purpose and quality.

01:01:18:07 - 01:01:46:01

Yuri Corilo

It helps improve the understanding and the trustworthiness of the data, making it a more accessible and usable by a bigger audience. The efficacy of the data overuse is another reason we need to democratize the data we're using. Data can significantly increase its value, especially when you can be using which for context and for various purposes we use. Data can save time, reduce costs as researchers will not have to.

01:01:46:01 - 01:02:16:15

Yuri Corilo

Collecting the data and re-use data also enable scientists with different perspectives the ability to examine the data, draw new ideas as hypothesis and conclusions. For example, data from analytical and molecular experiments can significantly support the research community and usher new scientific discovery. By leveraging existing data, researchers can save valuable time resources and avoid the need conduct redundant specimens.

01:02:16:25 - 01:02:53:03

Yuri Corilo

This, in turns, allows for faster progress in their fields and the ability to focus on new innovative research. Additionally, data reuse increases data collaboration, sharing knowledge across the scientific community. With the ability to build on previous results and findings, researchers can make more informed decisions, identify new patterns in relationships, and discover new insights. So the democratization of the data reused in the scientific community can lead to a more efficient and effective scientific ecosystem driving discoveries in advancement

01:02:53:03 - 01:03:29:13

Yuri Corilo

of the fields, in all the fields of research. This is why MONet is built with the user in mind. MONet provides a user-centered approach to data management and access. This system will become an essential part of our national scientific data services ecosystem, providing a comprehensive and intuitive platform for data access and reuse.

01:03:29:13 - 01:04:03:22

Yuri Corilo

MONet will empower users to work with data in a way that meets their specific needs and requirements. Our commitment to MONet users makes it a game-changer in our national data services ecosystem—allowing for the democratization of data and enabling the next generation of scientific discovery and innovation. Thank you. Douglas Mans

Thank you MONet team. That was excellent insight into MONet’s ambitions and how it works.

01:04:04:09 - 01:04:25:19

Douglas Mans

We're now going to take talk a bit more about the partnerships we're building through MONet. You've heard of a few of our speakers reference the National Science Foundation's facility user facility called NEON, or the National Ecological Observation Network. Here to talk a bit more about NEON is Kate Thibault, Neon science lead.

01:04:31:15 - 01:05:02:07

Kate Thibault

Hi. The National Science Foundation's National Ecological Observatory Network, or NEON, is a continental scale observatory that shares in a broader mission, with MONet providing open data to advance regional and continental scale understanding of ecosystem processes and environmental change across the United States. As a user facility, NEON's more than 180 publicly available data products are collected using standardized methods.

01:05:02:18 - 01:05:30:27

Kate Thibault

Year after year, at 81 terrestrial and aquatic field sites, these sites are distributed throughout the 20 distinct eco climatic domains of the U.S.. As you see in this map here in Richland, Washington, we are about 175 miles east of the tallest instrumented flux tower in the NEON Network at Wind River Experimental forest. So we invite you all to please come visit us.

01:05:32:02 - 01:05:59:02

Kate Thibault

Next, we'll take a virtual walk around the observatory and give you a few more details. So we'll start with our instrumented systems. NEON has flux towers at each terrestrial field site, similar to a map of flux towers equipped with different sensors at different levels above the ground that measure many different aspects of the atmosphere, including barometric pressure and carbon dioxide flux.

01:05:59:21 - 01:06:39:18

Kate Thibault

We also have plots for ground and below ground measurements laid out near the tower. And as an example, our soil arrays and through fall instruments collect data that can be used to study heat flux, biogeochemical cycling and much more. Our aquatic sites are also fully instrumented to collect data on freshwater ecosystems from small streams to larger lakes. And there are plenty of other aspects to our instrumented systems, including automated cameras, to track plant phenology, groundwater, well stations, and really too many to show here.

01:06:39:29 - 01:07:11:16

Kate Thibault

And they're all maintained by our distributed teams of trained field staff, which number over 350 across the country during our peak sampling season. We also have mobile versions of our instrumentation that researchers with funding can request to be deployed at any location, like you see with this controlled burn in Kansas. And now to our observational sampling. And these are data that are collected by our field staff rather than sensors.

01:07:12:05 - 01:07:46:00

Kate Thibault

These staff samples and water and a diversity of taxa, including plants, animals and microbes. And MONet has successfully leveraged neon's distributed field teams to collect soil samples, as you've heard about at most of our field sites already using the excellent Monet sampling kits. Each domain also has a central processing facility for sample processing and shipping to external facilities such as the neon bio repository at Arizona State University that you're see here.

01:07:47:12 - 01:08:19:19

Kate Thibault

And finally, our airborne observation platform. These are planes equipped with instrument payloads to collect ecological data from the sky. Our Twin Otter aircraft fly low and slow over a hundred square kilometer footprint above our sites, collecting high quality hyperspectral lidar and camera imagery. And with these remote sensing data, we can generate incredibly high resolution images of the vegetation and topography of our sites.

01:08:20:21 - 01:08:50:02

Kate Thibault

And we do this all during periods of peak greenness. So all of these systems are designed to be connected and work together to provide open data for use and integration with complement theory efforts like MONet for tackling the most pressing ecological questions of today, including are there really a trillion species of microbes? So now I'll hand it over to Emiley Eloe-Fadrosh to give you a bit more information about the Joint Genome Institute.

01:08:50:03 - 01:08:52:10

Kate Thibault

Thank you.

01:08:55:24 - 01:09:31:00

Emiley Eloe-Fadrosh

As I mentioned earlier, over the 25 years that JGI has been in operation, we have provided foundation and genomic resources to the global scientific community. This includes sequencing, annotation and analyzing genomes from plants, fungi, microbes and microbial communities that are relevant to carbon and nutrient cycling and bioenergy and developing associated tools and services. The JGI has the experience and high throughput capabilities for environmental metagenomics, and we'll be bringing that as part of our partnership with the MONet program.

01:09:31:14 - 01:09:51:22

Emiley Eloe-Fadrosh

JGI and EMSL have a longstanding partnership through the focus program, and we are very much looking forward to evolving that partnership through the many and continuing to benefit the global research community.

01:09:56:18 - 01:10:10:28

Emiley Eloe-Fadrosh

Thank you.

01:10:14:26 - 01:10:36:04

Linda Isakson

Thank you, Emiley. And also thank you to Kate and Douglas. So let's take some time to chat more about The Importance of collaboration. So first question now, why do you think that we need a national scale collaboration for understanding soils? I mean, how and how will your facility fit into this effort?

01:10:36:18 - 01:11:05:29

Douglas Mans

So I guess one of the things that I hope has become readily apparent from the prior speakers is that we can accomplish this on our own. There's the science is simply too big. The expertise and the diversity of capabilities that is required is much bigger than what EMSL has. And so a tenet when we were creating this Monet platform, the objective was that we recognize the need for strategic and resource partners as part of this to be successful.

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Douglas Mans

So although EMSL has a very formidable array of analytical capabilities for soils analysis across multi-omics chemical imaging and molecular composition, one of the greatest strengths of the DOE Office of Science and the broader U.S. government scientific enterprise are the incredible breadth of scientific capabilities and resources that are synergistic with those of EMSL. Bringing these resources together through partnerships exponentially amplifies the impact on scientific knowledge.

01:11:38:27 - 01:11:57:07

Douglas Mans

It’ll help us understand our efforts, and it can generate a tremendous wealth of data and content that's content rich, multimodal, fair and high quality that would be unimaginable to assemble without these partners coming together and helping us join this.

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Emiley Eloe-Fadrosh

And I'll also add to that, and I completely agree with Douglas that the JGI and EMSL as user facilities just have this perfect synergy for providing high quality molecular measurements. multi-omics data sequencing data, and at a throughput that isn't possible for just individual labs. And so I think this is a really exciting partnership that we've had through the FICUS program and that we will continue to have and evolve through the MONet program.

01:12:31:15 - 01:12:51:00

Emiley Eloe-Fadrosh

I also think that it's really exciting to have partners such as NSF's NEON because the science really doesn't have agency boundaries. And so by being able to support and collaborate through DOE and NSF resources, we can be greater than the sum of just our individual parts.

01:12:52:19 - 01:13:47:11

Katie Thibault

Well said, Emiley. I'll just add that, you know, NEON collects an unprecedented diversity of data about the environment and ecology. But at our 81 sites and of course, and we don't collect the molecular composition data and all of the microbial data, although we do collect quite a bit of that as well that humans will be delivering. And so NEON is going to contribute a lot of important contextual about plants and their diversity and productivity, about the land atmosphere, surface atmosphere, exchange of greenhouse gases in a diversity of other variables that will be helpful for interpreting and understanding dynamics in the soils that MONet discovers.

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Kate Thibault

But MONet is also going to be able to get data from many, many more sites than Neon is able to. So we've concentrated in a set of sites and MONet is going to be able to collect a more limited set of data, but highly complementary in many, many places with the help of professional and community scientists alike. And, you know, the National Science Foundation and the Department of Energy did just recently formalize a memorandum of understanding.

01:14:18:09 - 01:14:32:13

Kate Thibault

And I think this partnership really exemplifies the power of working together to solve our big problems that the planet is facing. And so I'm excited to be here. Thank you.

01:14:32:29 - 01:14:47:07

Linda Isakson

Wonderful. So can you think of similar past or current efforts like MONet? Essentially, what will MONet bring to the scientific community that's different from past efforts?

01:14:47:23 - 01:15:18:12

Kate Thibault

I'll start with that one. So large scale research like MONet is implementing is not extremely common because it is extremely difficult to do. It requires a lot of coordination and a lot of resources. In terms of continental scale environmental data. NASA has really led the way with satellite derived datasets that provide some really helpful parameters like forest structure, canopy, greenness, soil moisture.

01:15:19:16 - 01:15:51:22

Speaker 5

But of course, a lot of ecological processes operate at different scales. And so we really need to understand all of the scales, too, to enable a holistic understanding. So NEON and MONet bring the local scale and regional scale perspectives in their approaches. So our airborne observationt platform brings some regional level data that our ground measurements can be linked to for our understanding of local processes.

01:15:52:14 - 01:15:57:29

Kate Thibault

And I think that I've lost my train of thought.

01:15:58:25 - 01:16:00:17

Linda Isakson

Okay, it's all good.

01:16:01:03 - 01:16:36:00

Emiley Eloe-Fadrosh

I can also jump in there and say, in addition to the great example of now, if we look to the oceanographic community. So being able to monitor different processes within the ocean has been a long time impact and being able to do so in really collaborative way with large research teams. And so being to monitor viruses, microbes, plankton, communities across ocean scales, across ocean currents could be another example.

01:16:36:00 - 01:17:12:29

Emiley Eloe-Fadrosh

When we think about soil communities, back in 2010, the Earth Microbiome Project was launched and that was a large crowd sourced community effort to try to globally characterize microbes from various different environments. And so from my perspective, MONet is really kind of an extension of that concept and idea, but at a much larger scale. And having institutional partners which really make the whole process really impactful by being able to have the data available and accessible in a way that individual researchers can't do.

01:17:14:11 - 01:17:38:24

Kate Thibault

I was also going add that, you know, the key features of MONet that I think are extremely valuable are the standardization, which is of course something that NEON also highly values and you've heard a lot about today. But this involvement of the community scientists so that so many more samples can be collected than professional scientists could possibly accomplish.

01:17:39:08 - 01:18:13:05

Kate Thibault

And what it reminds me of, given my research background, is the United States Geological Service Breeding Bird Survey and is a standardized survey that's been going on for decades and relies on thousands of community scientists who are willing to learn to birds by sight and sound in their communities. And all of those data are collated and made publicly available, and I use those in my professional research to look at the continental scale patterns in bird biodiversity.

01:18:13:15 - 01:18:21:13

Kate Thibault

And so these are the sorts of uses that I I'm imagining for MONet as datasets.

01:18:21:20 - 01:18:46:26

Douglas Mans

So I'll keep my answers short, since I agree with everything that was said. I think MONet is meant to compliment a lot of these efforts. So, you know, NSF NEON, AmeriFlux, which is another program that DOE stewards in BER, the CZ Net and the Critical Zone Network. All of these are large scale ecosystem studies that I think MONet is looking to complement with our molecular to poor scale resolution data.

01:18:47:19 - 01:19:07:10

Douglas Mans

And so the intent is to help accelerate and more efficiently connect into these multi-scale models, allowing us to go from the first principles, models all the way up to ecosystem in or scale models much more efficiently than we currently can because we didn't have access to that type of data.

01:19:07:10 - 01:19:18:27

Linda Isakson

Right. Let's talk about data now. So how do we store it? How are we going to get it? Who's going to have access to? Can you speak more about that?

01:19:20:19 - 01:19:46:15

Emiley Eloe-Fadrosh

I can start. So there's just going to be a tremendous amount of data. And that's where I think the partnerships really come into play because both EMSL, NEON, and JGI. I have experience with handling just the sheer volume of data and how that data can be processed in a standardized way. And so that's where I think this again, this partnership is really important to be able to have that data.

01:19:46:20 - 01:20:13:19

Emiley Eloe-Fadrosh

In terms of the metagenomic data, we will be having that produced, processed, and made available through the JGI platforms will. Also be sharing that with EMSL, with NEON, and then also with NCDI, which is the primary repository for sequence data. And so by distributing these resources, we enable broader access to all of the outputs of the MONet data.

01:20:13:19 - 01:20:39:17

Kate Thibault

Great. And that, of course, is the goal of fair data, and we're all strong partners in that. NEON has long been a champion of fair data providing, as I said, all of our data products are available either through an online user interface or through an application programing interface, which is extremely powerful for scientists having to use such large and varied data sets.

01:20:40:20 - 01:21:07:05

Kate Thibault

We also have extensive documentation on our website as MONet ,I'm sure, is dutifully preparing for their data because it is a lot of work to use these data, but not as much as collecting it. So there's, I think, a lot of great opportunities. I think another benefit of partnership is increasing awareness of each other's data sets as well.

01:21:08:00 - 01:21:33:04

Kate Thibault

So not only are we working with MONet, but NEON does have a relationship as well with Emiley's team at the National Microbiome Data Collaborative. And so we're actively working to get NEON's Metagenomic data discoverable through their platform as well, so that even more people become aware of all the various resources out there.

01:21:33:07 - 01:22:01:15

Douglas Mans

Yeah. So, you know, ultimately the MONet data will all reside in the MONet database and as Kate was intimating, it will be pointers to other databases for complementary datasets. So the National Microbiome Data Collaborative, the neon bio repository will have pointers so that additional data can be findable and accessible and reusable. I guess I'll speak to a little bit about so you know, how who's going to use it and how are we going to keep it, etc.

01:22:02:12 - 01:22:21:28

Douglas Mans

My hope is ideally that the experimentalists and the modelers will use this jointly so that as we start to build our models, they will start to find holes or where the where the model needs to be refined. And that will then inform the experimentalist of what should be the next round of experiments to do to fill those gaps.

01:22:22:28 - 01:22:52:16

Douglas Mans

But equally you could use it. You can use the data separately. The experimentalists could use that data to drive their next hypothesis to study or the modelers could use this data in explicitly parameters using biological functions that they didn't do before. So I see them as complementary and hopefully driving model improvements. I will say one of the things that we as a core principle for MONet, when we were we were creating this program and this objective was to accelerate science.

01:22:53:10 - 01:23:26:02

Douglas Mans

And one of the ways you can accelerate science is by getting that data out there as soon as possible. And so one of the principles with this is that all of the MONet data is immediately accessible. There is no data embargo. So once the data has been quality controlled with the JGI processes and those processes or NSF NEON's processes, that data is immediately searchable and available and anyone can come into the MONet database and download the data, will have a log in ID or an orchid ID, but that's largely for data attribution and proper siting.

01:23:26:19 - 01:24:00:15

Douglas Mans

But there's no cost in the data is immediately available. And so I think that's the other core tenant of how we're trying to drive open science and engage this, which my last point will be. I think there is a tremendous opportunity given NSF mission and DOE's mission around STEM education and DOE’s workforce development. These datasets are going to be a massive training ground opportunity, if you ask me, in terms of teachers and researchers in developing hypotheses, doing data analysis skills, model generation, etc.

01:24:00:16 - 01:24:09:01

Douglas Mans

And so one of the areas that we're looking to in the future is how our partners can work together to form training curricula using these datasets as well.

01:24:11:02 - 01:24:33:04

Linda Isakson

All right. Well, this is a perfect segue way then to the very last question. So we've mentioned this a couple times, but I want to make sure that we really hit home on this topic and for our virtual audience is to really understand the magnitude of this project. So who can get involved? You know, let's talk a little bit more about that.

01:24:33:08 - 01:24:40:06

Linda Isakson

We've mentioned it, but talk more. Who can get involved to, you know, can participate in this in this project?

01:24:40:15 - 01:25:12:23

Douglas Mans

So short answer. The short answer is everyone. So when we were creating MONet. One of the interesting concepts that I was envisioning with this was, is this ability for anyone and everyone to be involved from high schools to community college to college students all the way up to the high powered research institutes at the national labs and the academic institutions. And so, you know, we'll have specific areas of call focus for where we might want samples from.

01:25:12:23 - 01:25:41:15

Douglas Mans

but fundamentally, everyone can be involved in this. And we've tried to make it as seamless as possible, as you saw with Maggie and Yuri's talks around the data and the sampling kits. We have a sampling kit. Everything is included in it. We send it to you for free, All the instructions on how to use it are there. We've worked with the NMDC, the National Microbiome Data Collaborative, to leverage their portal, their meta data submission portal for now to make it as easy as possible.

01:25:41:15 - 01:25:56:25

Douglas Mans

It's a web based application so that the barrier to entry is extremely low. And I think because of that, it truly is meant to be an open science capability for the nation to take part in it.

01:25:57:09 - 01:26:31:25

Kate Thibault

Yeah, of course I agree in in the sense that everyone is invited to join in and engage with all of these data that we're talking about. You know, they have been designed with initial questions for use by professional scientists to start with. But of course, you know, the I think one of the great things about these kinds of projects and open science is that there are many questions that we hope these data will answer that we never even envisioned in the initial phases of the project.

01:26:31:25 - 01:27:09:18

Kate Thibault

So for NEON, a great example of that is you know, environmental scientists and ecologists. Very few were thinking about artificial intelligence methods when neon was initially envisioned. And of course now a whole new world of options to leverage our data as well as as our samples. And I think the more that people engage with all of these data and we work together and we develop new tools, we can also make the data more accessible and meaningful to policymakers and to educators and parents and community scientists.

01:27:10:23 - 01:27:31:09

Kate Thibault

And so we the more folks get in there, I think the more benefit we can derive from all of these open datasets. And the more people that are thinking about these data as well, we'll come up with even new and novel questions and methods that we're not envisioning today.

01:27:33:02 - 01:27:47:17

Emiley Eloe-Fadrosh

Yeah, I'll just keep this short and say ditto. I agree with all of that. This is for everyone. MONet was designed to be inclusive and in very a very purposeful way. So I think it's a really exciting opportunity.

01:27:49:06 - 01:28:11:12

Linda Isakson

All right. Well, at this point, we are going to transition into the question and answers. So for those folks who have been joining us, virtually, we've been carefully making note of the questions that you've been asking. And so we will jump into answering those as well here in the audience. If you have questions, feel free to raise your hand.

01:28:12:04 - 01:28:40:00

Speaker 6

And then I invite all the rest of the speakers to come up on stage so that we have a good representation of folks who can answer your questions. So we are going to start with I'm not on the YouTube livestream. One of the questions that we received is essentially what is your definition of quote unquote fresh soil and how is that going to be standardized?

01:28:40:08 - 01:28:42:24

Speaker 6

So I believe this question is for Maggie.

01:28:42:24 - 01:29:25:01

Speaker 5

Then she should be on. Yeah, So fresh is a relative term. Ideally, we would love to grab these, you know, as we pull it out of the ground. But all the sales are shipped back to us within 48 hours. So all of the sampling happens early in the week. It's shipped out by Wednesday, we get it back. So within 72 hours of collection, we have preserved the metagenomes and so we standardize it by collecting that data within the 72 hours of the soil being collected and immediately upon arrival at the labs.

01:29:25:01 - 01:29:37:21

Speaker 6

Great thing I'm going to do. Right on. All right. We're going to take a question from the audience. Does anybody have any questions out there? Yeah. Wonderful.

01:29:38:05 - 01:29:41:01

Douglas Mans

Oh, yeah.

01:29:41:01 - 01:30:04:17

Speaker 3

This is terrific. So I have two questions. One is you're sending excuse me? You're sending these kids out all over from high school students up to experience researchers and you're providing instructions. But how do you get to managing the quality control to make sure that they're actually following the instructions? I remember as an adult, I had instructions are assemble things at Christmas, and they didn't always turn out right.

01:30:05:10 - 01:30:05:27

Speaker 3

And so.

01:30:06:09 - 01:30:07:24

Douglas Mans

And the question is, how sensitive.

01:30:07:24 - 01:30:24:24

Steve Ashby

Is your analysis to the proper collection of soil sample? And the second question for the data, folks is you provide the way to sharing the data. But I know, for example, an ARM, they also provide a number of data products, allow for analysis of data. Will you also be doing that to help researchers take advantage of that?

01:30:25:03 - 01:30:25:16

Steve Ashby

Thank you.

01:30:26:12 - 01:30:32:06

[Misc background noise]

01:30:34:04 - 01:31:00:02

Emily Graham

So yeah, that's a good question and a challenge with any citizen science effort. I will say that we have a node section and things do go wrong. Even with our professional researchers, things go wrong like you hit a rock and you kick the full cord. And so we have about three 3 to 4 backup plans in the kit when we run into it before people provide notes.

01:31:00:02 - 01:31:30:02

Emily Graham

And it's fairly obvious when something doesn't pass a QC. You see, we have alternative laboratory processing structures as well. If they mess up the structure, you can still get chemical and biological measurements from it. And then beyond that, we have pretty robust internal queuing QC standards and so things go through flags if through the analytic, and it messes up somewhere along the lines.

01:31:30:13 - 01:31:48:06

Speaker 8

And I will say I've looked at the data a little bit. It's the cleanest data I've ever worked with. I was putting together my AG. You talk and I was like, This can't be right like this to clean. So I think for now we have done a really good job and we definitely have a very strong emphasis on QC.

01:31:48:07 - 01:32:25:29

Maggie Bowman

In addition to a written protocol. We also, thanks to our great communications team, have a video protocol which shows people how to assemble the kids, how to put it together and how to do the sampling, which is a great tool for the people who have never sampled soil before, never used a slide hammer, which I mean, admittedly my first time using a slide hammer was on this project because I was a soil scientist, that leveraged early on about five years ago and got me on samples from NEON.

01:32:27:13 - 01:32:52:26

Yuri Corilo

So for the data question, you know, like along with just the data they were providing, like the raw data, the instruments where we are providing the data products by the, the, the standardization goes also on how they're processing, how we generated that dataset. In addition to that, we also providing how all the software does be generated, right on how we're processing the data and make it available for the community to reuse that in different levels of access.

01:32:52:26 - 01:33:09:12

Yuri Corilo

Right. On the code level, we common lightning interfaces and we also have an API will allow people to reprocess in the way that they would like, right? In connecting those services together to make that the ecosystem of their services that we're talking about.

01:33:09:12 - 01:33:34:24

Speaker 6

All right. So this question comes from again, one of our members in the virtual audience. So exciting opportunity. Yes, it very much is. Do you accept soil samples, soil pit rather than cause for available analysis already are collected and archived? So do you accept soil samples already collected and archived.

01:33:39:29 - 01:34:01:15

Emily Graham

So as part of MONet? No, not right now. But we encourage you to reach out and talk to us. We have other avenues, so we have our standard user program. The reason for not accepting them is not because we don't want them. It's just part of our standardization pipeline. So we start accepting our soils from all over the place,

01:34:01:15 - 01:34:10:02

Emily Graham

different depths, data becomes less comparable. And so we do have a full user program. We're happy to facilitate that sort of access.

01:34:11:03 - 01:34:38:08

Linda Isakson

And if you are wanting to reach out to the MONet team, it's just as easy as sending us an email at monet@pnnl.gov. All right, so we can take another audience question. If anybody has one for us. Yes. Wonderful. Or Oh, I'm sorry. Okay.

01:34:38:08 - 01:35:10:16

Audience question

Hello. My question is about training to use these data. So you have this all these new components, a molecular components of data. And so we're democratizing data collection from everybody. How do we ensure that everybody has training to use these?

Douglas Mans

So I'll take it a bit and then John and Emily can chime in as well. This is one of the beauties of having this as part of EMSL and partners with JGI and NEON is we have inherent in our user facility capabilities training.

01:35:10:16 - 01:35:35:03

Douglas Mans

So this summer, this example for the summer, our summer school is focused on quote unquote demystifying multi-omics through data science. And so the whole intent will be how to use these multi-omics data sets and process and visualize them and analyze them, which can be directly applicable to then taking the data from Monet and working with them. And I know JGR has a similar type of activity as well.

01:35:35:09 - 01:35:48:26

Emiley Eloe-Fadrosh

And so as you said, you also have access to all of the software that we've developed both at JGI with the metagenome analysis and annotation as well as AMS or software suites as well.

01:35:48:26 - 01:35:54:21

Linda Isakson

All right. Was there a question? Yeah. Okay.

01:35:54:21 - 01:36:25:06

Speaker 4

Thank you. So not that you all need any more work, but you know, in this, in the way that the neon samples have been an incredible asset. Right. For a lot of folks, I'm curious whether once you get all these cores back, is there an effort to archive the samples in a way, hopefully get to share them later with folks that might have interesting questions, additional questions that they would like to ask.

01:36:25:06 - 01:36:50:07

Speaker 3

So right now, we're not we're not archiving course just partly because of the dramatically expands the cost scope of the project. In terms for the archiving, however, a lot of the cores are actually collected from NEON sites. So in fact, we actually do have either direct replicates that are being stored by neon or we have very close approximations of them.

01:36:51:07 - 01:36:52:26

Speaker 6

All right. Another question from.

01:36:53:14 - 01:37:20:26

Speaker 5

Linda. I had to I have to add, too, Neon does have I mentioned the bio repository? I showed it. We do collect soil's dried soils and, archived those in the bio repository from all of our sites three times a year. Actually. We collect frozen soils that are then stored in liquid nitrogen for metagenomics and other sorts of resources.

01:37:20:26 - 01:37:31:06

Speaker 5

So there is a lot of soil there. We also partner with the the nurses as well. So have a lot of soil. So yeah, thank you.

01:37:33:13 - 01:38:06:22

Linda Isakson

Yeah. Yeah. We've got two questions from the virtual audience and then that will be the end of this Q&A session. So from one of our virtual attendees. Amazing project. Yes, it is. Thank you. All the credit here. Congrats to the developers. Are there any perspectives of an international partnership in the future? How is it planned long term I'm sure we expected this.

01:38:06:22 - 01:38:07:07

question

01:38:08:10 - 01:38:36:12

Douglas Mans

Yes, I guess I will just say baby steps in the continental U.S. is quite large as it is right now, and so I'm not ruling it out and we would definitely be interested in it. But I think our focus now is making sure we we can tackle the continental U.S., but we're happy to have conversations with our potential, you know, international partners on how we might expand this more broadly, especially if we could standardize open up those databases globally.

01:38:37:21 - 01:38:52:29

Linda Isakson

Yeah. And this one's another one about expand extending the network, but a little more locally. So this person would like to know, are there plans to extend the network to freshwater and seawater samples?

01:38:52:29 - 01:39:20:19

Douglas Mans

Well, I'll answer a bit for the one, because we also have BER funding a suite of projects that are involved in freshwater work. So we have our Compass project, which is looking at coastal water systems as well as another open science effort that is a multi effort called WHONDRS that are looking at watersheds. And so we were trying to make more to be complementary as opposed to duplicative.

01:39:20:19 - 01:39:40:14

Douglas Mans

And so a lot of that work is actually already ongoing and we're hoping to sort of just link into those databases as well. I won't maybe I'll let John or Emily speak to the salt water, if we will. The coastal effort does do some of that, but it is not meant to be true blue ocean.

01:39:40:14 - 01:40:00:11

John Bargar

So I guess I don't really have a lot to add to that. I think we are very fortunate in the sense that we have very strong collaborators right now through wonders and the other projects that Douglas mentioned who are focusing on surface water collection there. We didn't we're not absolutely ruling out that we'll be doing sea water sampling right now.

01:40:00:11 - 01:40:15:00

John Bargar

it is beyond we're just focusing on trying to be successful in our first year with soils. Soils are really super complicated and so that's really where we're putting our effort right now. So ask us again in another few years and thank you for the question whoever asked.

01:40:16:27 - 01:40:19:14

Douglas Mans

Speaker 6

All right.

01:40:19:14 - 01:40:57:27

Douglas Mans

All right. Well, I want to thank all of our presenters here today. This concludes the MONet launch event. And I want to thank all of our attendees online. And for those of you here in the ESC lobby, we have a reception here afterwards that we encourage you to join. And I wanted to thank you all again and hope to see all of you working with us to make this MONet effort successful.

<<music>>

[end]