

TDep Spring 2026 Meeting Notes

June 3, 2026

- Notes for the three breakout sessions:
 - Addressing Data Gaps with Non-Routine Measurements of Total N
 - Making the Most of New Data Visualization Tools
 - Developing and Evaluating TDEP Fusion Methods

Addressing Data Gaps with Non-Routine Measurements of Total N

Facilitators: Ryan Fulgham, Melissa Puchalski, Environmental Protection Agency

Notetaker: Da Pan, Georgia Tech University

Charge Questions

1. What reactive nitrogen measurements are the most important to improve estimates of total N deposition?
2. What combination of direct flux measurements versus indirect measurements is needed to improve total N deposition surfaces?
3. Where are the most important places to measure?
4. Are there pollutants we no longer need to measure in certain locations?
5. How do we overcome funding challenges to address measurement needs?

Notes

We need more urban NH₃ measurements! - Stuart Weiss

Need evaluation of size-dependent aerosol deposition (over different land types?) - MMF update showed step changes

Ryan: May conduct direct flux measurements at Duke Forest collocated with other passive/low-cost measurement techniques.

Da: What's the uncertainty level acceptable for low-cost techniques?

Jeff: Total nitrogen through preservative is possible and could be reasonable. Different types of uncertainties. For new measurements, some uncertainty is acceptable, but may need a more wholistic view of uncertainty.

Melissa: Maybe related to Jason's perspective about meta data collection of existing measurements.

Ryan: Part of the 2019 white paper was an attempt to put together a database of existing direct flux measurements. It didn't get attention from the measurement community. May be worth trying again.

Jason: Such a database would definitely be valuable.

Da: WMO might be a potential pathway to reach the measurement community.

Jeff and Melissa: Should we focus on global or the US? It might be tractable for North America.

Da, Ryan, Jeff: 10 - 30 studies in the U.S.

Da: Where are the most important places to measure?

Ryan: Easiest would be where infrastructure already exists.

Jeff: Some trade-off between intensive campaign and larger spatial coverage.

Ryan: FarmFlux will be measuring over certain regions.

Jeff: Satellite observations have a lot of potential, but it's challenging to translate to surface fluxes.

Da: Third TDEP webinar series speaker Kang Sun has been working on linking satellite measurements to surface fluxes.

Jeff: Ag community is also using satellite observations to estimate CAFO data.

Jason: ON importance may depend on its interaction with anthropogenic activities. Things that are enhancing total N may be important to know. Fire impacts can be considered both natural and anthropogenic.

Round Robin Question

What's your favorite reactive nitrogen measurement important to improving estimates of total N deposition?

Ryan - Size Resolved Particle Flux Measurements

Nate - Water Soluble Organic Nitrogen

Jeff - wet deposition or gas phase deposition. Organic N is important but we don't understand as much about gas phase.

Melissa - NH₃ measurements. AMoN spatial gradient. Urban measurements.

Jason - Relating N pollutants to ecosystems. Key metric is total N deposition.

Da - Eddy flux measurements. Linking it to low-cost methods for better flux estimation.

Hazel - NH₃ passive measurements. Cost effective low concentration measurements.

Parking Lot

Jeff - Measuring phosphorus is still challenging.

Revisit Charge Questions/Action Items

- Collocate direct flux measurements with routine measurements.
- Meta database of existing direct flux measurements. Probably starting from a subset in the U.S.
- Compile a database for ON. Have a discussion about the critical load importance of ON.
- Review where total N in precipitation (SNIPIT) work left off - current work has focused on P.
- Translate ambient concentration to deposition estimates for regulatory purposes.
- Need to discuss acceptable levels of uncertainty in different non-routine measurement

Making the Most of New Data Visualization Tools

Facilitator: Mike Bell, National Park Service

Notetaker: Kristen Foley, Environmental Protection Agency

Attendees: Mark Kuether, Naomi Tam, Noel Deyette, Richard Tanabe, Stuart Weiss

Charge Questions and Discussion

1. What information about the weekly site data will be most useful for your site/operation/agency?

It would be helpful to see what fraction of total deposition does a week/month represent. Are there ways to flag certain date ranges that may need closer inspection? Can we link specific sites to an internal dashboard so that it always loads with our sites of interest?

2. What type of TDep data would be useful to add to the tool?

PFAS data sooner rather than later. For years with a lot of data that does not meet completeness criteria, can we post TDep estimate as a reference? Perhaps we can include Greg's leave-one-out cross validation analysis to show how impactful missing data from a specific site is.

3. Should we reconsider some of the completeness criteria based on what we're seeing?

Perhaps, but we don't want to just cherry pick sites. We could look at sites where a different completeness criteria makes sense to figure out alternative standards that would be applied for the whole network, e.g., related to sampling during very cold months where weather/snow may impact the sampling schedule. Need to set up some FAQs for folks who see issues at their sites. Need to make sure PO has time to respond if we make this type QA data available to everyone (public) who then bombard the PO with questions.

Round Robin Question

What is your relationship to NADP NTN data and who do you need to communicate the data to?

- Mike Bell - compare to ecosystem responses to see if ecological harm will occur. Also need to figure out how accurate the numbers are.
- Mark Kuether, NADP data manager - review data, make the charts, put data on the web. Most helpful is feedback if there is a specific data product that is useful.
- Noel Deyette, NADP site coordinator - over 70 sites in the network, making sure sites are meeting completeness criteria, where there are issues understanding how to address these including reaching out to site operators.
- Stu Weiss - conservationist ecologist, impacts on biodiversity in CA. Availability of deposition data is critical to communicate the crisis we are in. People just don't know about atmospheric deposition. Knowing cumulative loadings and spatial

patterns is valuable to communicate with people and developing mitigation programs.

- Naomi Tam - manage network in Alberta Canada and recently station joined NADP. Small team with a lot to do to QA and manage network. Learning NADP data products and reporting has helped with work that her team does.
- Richard Tanabe, NADP program manager - Next Tuesday NADP meeting will give presentation on updating site support data with tools from Google Workspace. Because of government shutdown in 2025 will cause many sites to not meet completeness criteria. Need to discuss ways to deal with this. This one is trickier than 2019 shut down.
- Kristen Foley, EPA - communicating to management how the value of the TDEP data products and the many ways the data are being used.

Mike Bell showed examples of using the Power BI tools to QA unusual patterns in the data (e.g., an extremely large precip measurement or unusual spikes in weekly deposition measurements). Validity Figures can be used to look at invalid codes at a specific site (CA75 - Giant Forest)

Mike: do we want to establish a category of winter mountain sites that may previously have been considered invalid but can be switched to valid, e.g., site is inaccessible but sampled within 3 days and temps have not been above 30 degrees, then can still consider it a valuable sample? Use the tool to learn what types of samples are being called invalid and should they actually be considered valid.

Noel: options of things that we would or would not want to share with operators and internal agency partners to let them know what is available?

Mike: folder on share drive where Mike downloads the full dataset as NADP and then it automatically updates all the data. One of those files is a list of sites. If anyone wanted their site removed and not used from this tool then Mike can remove from that file and it will not show up on the tool. Could have an internal tool with all sites and then can have a customized site list for public version.

Noel: How often is the tool updated with new data?

Mike: whenever I download and upload the files from NADP website. Long term this will eventually be automated process, probably with monthly updates. For now Mike will do this manually on a quarterly basis unless there is a strong need for this to be more frequent.

Noel: Concern with cherry picking sites to change from invalid to valid.

Mike: We want a scientific defensible method to use as much data as we can. This will require exploring types of cases where data was very close to being valid and the coming up with clear rules/guidelines on specific cases where the data could be included as valid.

Noel: Good to have this tool to start these types of conversations about the data at specific locations.

Mark: Contaminated status is reviewed by the program after the operator has flagged it.

Mark: Operator notes are critical for issues with sample collection, etc

Richard: Would be good to set up a Q&A section on the NADP website to give suggestions for problems with contamination or other operating issues.

Stu: What does a public release mean for this?

Mike: Will share public link with a targeted list rather than a broad announcement. The primary audience is for the agencies that are funding and maintaining these sites.

Naomi - For our network, we typically give an annual report card for each site and then have a conversation with the site operators about what the data is showing. Information on why the sample was held on site for an extended amount of time. Particularly want to learn about issues during winter. Want the operators to see how the data is being used so they see the value of their work in collecting the samples.

Mike: Previously site operators would need to download the data and investigate it on their own or wait 2 years for the trend report. This new tool would allow issues to be identified much faster. Will be able to help guide future work to improve sites and increase valid samples.

Richard: QAAG Special Study: Criterion 4 : https://nadp.slh.wisc.edu/wp-content/uploads/2021/05/Criterion4report_wslh.pdf

Developing and Evaluating TDEP Fusion Methods

Facilitator: Greg Beachley, Environmental Protection Agency

Notetaker: Mike Barna, National Park Service

Background

Following up from the brief TDep MMF breakout discussion last December, we touched on a few thoughts on *‘How TDep could expand on including new data sources and how these new data sources might balance with Network Sustainability efforts’?*

Briefly, changes to site density and locations driven by necessity from operating costs will complicate stability and consistency of data trends. This has been partially addressed in the past with network measurement completeness criteria and annual assessment, but significant recent changes are influencing the maps and trends.

The future landscape of monitoring will likely evolve given new data fusion advances and the availability of big data (e.g. satellite products and low cost sensor networks). These have the capability to greatly improve spatial and temporal density of measurements albeit with challenges in measurement uncertainty and other limitations. Additionally, the recent issue of the model version update resulting in a deposition flux step change has exemplified the problem of technical advances creating logistical issues for the maps.

Past TDep discussions have introduced the possibility of a separate trends product and research-oriented products. With the addition of TDep into accessible tools like ClimateEngine, we need to consider the advantages of the TDep product and how it meets stakeholder needs. Many of these Measurement Model Fusion discussions navigate towards what is scientifically possible without consideration of what is logistically maintainable (e.g. custodial effort of handling many versions).

Charge Questions

1. Outside of current projects (fusion of modeled annual wet deposition and an evaluation of the step change in deposition flux due to the CMAQ update), please provide some prioritization on the following potential TDep MMF projects. Please share the rationale for your rankings along with any additional ideas and experiences you may have!
 - A. Establish a protocol for using TDep products with different external data products
 - B. Increase TDep products from temporal resolution from annual to seasonal
 - C. Incorporate new data sources into TDep surfaces (e.g. satellite, low cost sensor data)
 - D. Understanding deposition uncertainty and analysis of modeled deposition data
 - E. Improved accessibility and documentation of TDep MMF products
 - F. Improving on existing measurement interpolation methods

G. Including NADP AMoN data into the TDep MMF fusion product

H. Others

2. Past discussions have introduced the possibility of a separate trends product and research-oriented products. What do the logistics of maintaining multiple products look like? Should we reduce the number of measurement sites to a set of core long-term sites included in a trends product?

Notes

- Better ways to facilitate data sharing, expand outreach
- Mike - Ways to evaluate which model might be better for deposition estimates, default to CMAQ?
- Introduce different models to the MMF product?
- Krish - better ways to characterize model uncertainty, how to isolate, test with respect to precipitation or other meteorological parameters, 'define top three sources of uncertainty', ammonia is difficult to characterize
- Colleen - hard to constrain deposition estimates, e.g., meteorological variances and influence on deposition
- Liam - study on deposition uncertainty, uncertainty is going down nationally
- Krish - easier way to distribute MMF products? Greg - ClimateEngine might be a template, user interface
- Patrick - N deposition from fires, votes for 'D', dry deposition, AQMEII a good approach for model comparison, land surface very important, dry deposition velocity
- Amanda - the value of TDep is bringing in the measurements, helps constrain the models, what is the role of TDep?, bringing in more data sources
- Ian - how to utilize ammonia, AMoN for TDep
- Colleen - adding AMoN would be useful, bi-di flux might be an issue
- Christian's top 3 priorities: D1, A2, C3

Rationale: As the point of contact for the TDep MMF products, I frequently receive requests for TDep associated products. These can range from simple extractions to modifying processes (e.g. running the bias adjustment for NH₃ concentrations to experiment what the end product looks like). Questions have led to scientific publications and collaborative research that is informative to the TDep MMF product. This helps TDep in terms of development of the MMF products and outreach. Establishing a protocol may help communicate potential applications of TDep products and collaborative research may help to advance some of these TDep MMF priorities.

Round Robin Question

Please share your ranking and rationale if you have not yet. Have you used TDep MMF or another Data Fusion product before? Please describe the project and how deposition estimates were used. What worked well? What was most frustrating?