Pre-meeting discussion:

Opened with discussion of total deposition map, specifically ways we can get at measurement-modeling comparison with respect to American cities:

Urban areas do not have wet deposition data, and therefore gradients are not captured in the TDep total deposition maps. Greg Wetherbee questions, Donna Schwede refers Greg to Sarah Benish's talk later during the MMF section of the Science Symposium. Jesse Bash and Kristen Foley will also be listening in.

Could use AMet software to compare modeled urban deposition to measured. According to Wetherbee, this is a paper that needs to be (3-4x difference in Denver between measured total and interpolated deposition).

Introduction (*Greg Beachley*)*:* Welcome to TDep!

- **Recap of TDep Spring meeting -** Minutes were approved via email. In the Spring TDep presented a Leadership roles and responsibilities document along with Workgroup updates:

  CityDep: Motion passed to add CityDep as workgroup, SPARROW model presented (now published), RCN proposal update

  EOS: TDep fact sheet, discussed increasing outreach

  Stakeholder: Rich Grant update for MSRP, Greg Zwicke overview of Ag Air Task Force, reviewed where Ag Stakeholder engagement plan is

  Deposition uncertainty: elevation impacts, throughfall vs TDep, discussion on IER measurement vs modeled

  Measurement and Monitoring: intent to form workgroup, Amy Sullivan presented total N stability (with organic N), Zhiyong Wu presented canopy vertical flux and sink profiles for reactive N and S

  Measurement Model Fusion: preliminary results, WMO_GTAD MMF update (Amanda Cole), Sarah Benish presented differences between EQUATES and ECODEP, Paul Makar gave update on AQMEII-Phase 4 comparison of regional deposition models

NADP Website status has a new format under development and beta test looks great. An open question of whether TDep should host shared folders for the committees and workgroups was asked. Leadership is currently using Greg Beachley's EPA Sharepoint folder, which really helps with collaboration. However, shared folders would be more properly hosted in the NADP TDep domain, particularly with the leadership rotation. No comments were made, Greg would like to put this on TDep's radar in the future (maybe involving the program office).

Leadership will start on 2021 TDep Annual Report and will link projects to research needs identified in the white paper. Leadership will review and report on the TDep Project Tracker in Spring 2022. TDep attendees are encouraged to email Greg with any projects you'd like to include or to participate in!

Next TDep meeting will take place in Spring 2022, hopefully in-person in Madison, WI, or somewhere else (TBD). Leadership would like to preserve some aspect of the virtual format, which has increased participation in TDep meetings. Prior to the virtual option, only 30-40 people attended TDep. With the virtual option, TDep now sees 60-70 participants. Attendees encouraged to brainstorm on topics for the Spring 2022 meeting. The Spring 2022 will feature workgroup updates, project updates, and have a recap of the TDep and Ag Stakeholder Forum.

Motion to accept Leadership document: Amanda Cole motions to accept final Leadership document and Chris Rogers seconded.

Motion is accepted with 100% positive voting.

Workgroup updates:

Ag Stakeholders:

Nitrogen Deposition in the Snake River Valley *April Leytem*

The Snake River valley in southern Idaho is either irrigated agricultural (ag) or sagebrush steppe, which is sensitive to nitrogen (N) inputs.

Idaho is the 3rd largest milk producing state in the U.S. with half a million milking cows - 75% of which are in south central Idaho. Idaho also hosts lots of beef cattle production.

Talk focuses on the Magic Valley area. Fifteen years ago, April and colleagues began evaluating emissions of NH_3. Approximately 31,000 metric tons (MT) of N lost per year from dairy industry and 13,000 MT N per year from fertilizer. 47% of N removed by crops in the region comes from agricultural sources.

Where is the N going? Are problems likely to occur? Federally protected lands are nearby including some national parks and national monuments.

April created a "mini-AMoN network" in 2018 (one official and 6 unofficial sites across 2 transects). A site was added in 2019. The mini-network collected data through Dec 2020 following AMoN protocols, but always with 2 replicates per site.

Peak NH_3 emissions much lower in most concentrated site during 3rd year, peaking around 80 $\mu g\ m^{-3}$. Seasonal trends are very consistent. Areas with minimal agriculture had the lowest ambient NH_3 concentrations with ag higher and ag + dairy the highest.

Anticorrelations with wind speed and relative humidity. Correlations with solar radiation and surface, air, and soil temperatures

Satellite data captures spatial trends better than GIS techniques

John Walker tagged in:

Zhiyong Wu modeled dry deposition using the STAGE (Surface Tiled Aerosol and Gaseous Exchange) Model, which simulates bi-directional exchange using compensation points (estimated from soil and vegetation measurements). Wu used CMAQ outputs to derive diurnal profile combined with biweekly Radiello measurements, leaf area from MODIS, and met data from climate station and forecast model, to run hourly simulations.

Monthly component fluxes (2018-2020) – stomatal, cuticular, and soil fluxes (components) show that during peak leaf area cuticular flux dominates. During lower leaf area seasons, soil flux is most important. Air concentration peaks during the summer but does not necessarily coincide with maximum deposition - that depends upon the compensation points. Small emissions from stomatal pathway occur during spring/summer. Soil flux makes a much larger contribution to net canopy exchange than what is typically seen in the east and therefore important to get the soil flux correct.

April tagged in:

Average flux estimates, comparing TDep and STAGE modeling, show significant differences between concentrations and deposition numbers. The TDep results are using the v5.0.2 CMAQ deposition runs (i.e. ECODEP) for 2012 data. New TDep results will use the v5.3 CMAQ deposition runs (i.e. EQUATES) and a more recent CMAQ year can be used in the comparison. We expect the updated model version to have more of a difference than the more recent year.

Q&A:

Chris Clark: What's the source of the 2 kg N ha^{-1} threshold for rangeland? Amy Austin's work?

May have come from Mike Bell, certainly the US Forest Service. There has been some work at Craters of the Moon to estimate this threshold.

Chris Clark: Given big differences seen between TDep and STAGE, what are future research plans?

Walker: I think we're seeing differences based on emissions. We're going to look at the new EQUATES run with different emissions and see how those compare to April's measurements. Estimates for CMAQ are from 2012.

Greg Beachley: We're looking at EQUATES data, and there appears to be reduced nitrogen deposition over the previous estimates.

Walker: Additional data sets will be acquired to further evaluate model intercomparison.

Bret Schichtel: The really steep concentration gradients are interesting. Probably are a bunch of things going on including dilution. You could consider some dispersion modeling / inverse modeling to look into this. Do you have any sense how dilution vs deposition could be contributing to that?

Walker: We haven't done any modeling to look at that yet.

April: Some components of the deposition are missing including probably some dilution components that could involve transport to upper atmosphere, which is part of what motivated coordinating flight

measurements. We are still in the infancy of looking at this. We don't have wet deposition measurements due to very little rain and snow in the Magic Valley.

Donna Schwede: Modeling scale could be a part of the disagreement. Schwede does have 4 km grid cell runs that could be used for gradients in the area. Also want to look at location of samplers within the grid cell - could also include more site-specific values for things like ground cover.

Kristi Morris: How are you coordinating with owners of the dairies?

April: None of the locations are actually on a dairy. We picked places like air strips. Wendell location is owned by another Aris (sp) member (rangeland surrounded by dairies). We had to find land owners willing to have a sampler on their land.

Kristi Morris: Is there a forum for sharing the data with the dairy owners?

April: Idaho Dairy Owners Association (sp) have seen a presentation. Although they are probably not thrilled with the results, they know that they need to be on top of deposition issues. They have even funded emission studies, which we plan to publish within the next year.

TDep Stakeholder Workgroup Update: *John Walker*

The Stakeholder Workgroup is in the process of developing a communication and engagement plan to better connect with ag community. The plan will assist researchers and create and outline annual timeline for communication products, engagement, and collaboration (one year in advance). The workgroup is trying to identify products and activities that will be useful for ag stakeholders. The draft plan is complete and in review with workgroup members.

Workgroup is identifying activities that could be useful for interacting with ag stakeholders and working to identify what needs to be added, incorporating social media components, and annual summaries.

Engagement activities include inviting participation in TDep meetings (current examples include April Leytem's talk, Greg Wetherbee's collaboration for network sustainability meeting, Greg Zwicke's talks on the USDA Air Quality Task Force), science forum planned for spring 2022, organized meetings, participation in stakeholder research planning (USDA NIFA listening sessions for RFA development), participating with stakeholders in collaborative research projects (USDA NCRA SAES multi-state research project NC1213 (led by Rich Grant), and USDA/EPA project in Idaho's Magic Valley.

TDep will host an Ag Stakeholder Science Forum in April 2022. This is a half day workshop hosted by TDep in April 2022 before the Spring meeting. The forum builds on a 2019 TDep Ag workshop, Ag/air linkages important to stakeholders (further discussion this afternoon), enhanced value of data to stakeholders, linking air monitoring to existing ag monitoring, ways to continue productive communication.

Update on NC1213: Sources and fate of ammonia across the landscape (*Rich Grant*) *(Purdue University)*

Project objectives include:

- better understanding NH3 emissions from crop and livestock across different spatial scales within the Midwestern U.S.,
- characterizing NH3 deposition in natural and cultivated landscapes, and
- Better understanding NH3 transport and fate of NH3 and particularly their impact on particulate matter formation and nitrogen deposition

Outline and key details available at – https://www.nimss.org/project/view/mrp/outline/18780

More to come at the Spring 2022 meeting!

Q&A:

Linda Geiser: What collaboration does the team plan in the future with NASA/NOAA/ESA/ to merge data and interpretative tools?

April Leytem: Some researchers (Mark Shephard at ECCC and Karen at JPL) are using some of our data to ground truth some satellite data products, looking for more collaborations aimed at improving concentration/deposition estimates from satellite data.

EOS Workgroup — *Chris Rogers, Kristi Morris*

May is the month for TDep to provide social media posts to EOS. In the past TDep has provided some posts including one on the fact sheet. We have talked about doing one for the Ag Stakeholder workgroup. As folks complete research projects related to TDep, let the EOS Workgroup know so that we can share your work with EOS and everyone else!

Q&A:

Donna Schwede: I know CLAD has been working on some videos, is TDep thinking of working on something like that?

Greg Beachley: If we have an educational tweet for May, we could just do announcements as they come. The manuscript for the new maps should be out by then too.

Chris Rogers: Some of the items that we want to post take a fair amount of approvals, providing announcements as early as possible is helpful for successfully getting items posted.

Deposition Uncertainty Workgroup: — *Mike Bell*

Our goal is to continue assessing the TDep model to better understand confidence (and consistency of confidence) deposition across the continental US. Within the past couple of years, we published the WDUM metric for assessing model uncertainty.

Leora Nanus will give presentation on ion exchange resin (IER) collectors and Mike Bell will give a presentation building on Jesse Bash's work downscaling to a finer grid scale. Relevant to the workgroup are a couple of talks during the science symposium. Eiko Nemitz talk is important to this work as well since most of preserved federal lands in the US exist in complex terrains.

Comparison of measured and modeled atmospheric nitrogen deposition to inform critical loads across the western US *Leora Nanus*

The goal of this work was to evaluate the relationship between N deposition field measurements and TDep estimates. Sites were located along the western coastal states. Ion exchange resin (IER) collectors were used for bulk and throughfall deposition – collect ammonium, nitrate, and sulfate (focused on nitrogen for these studies).

Data were compiled from CA, OR, and WA (n=552). Values from each measurement site from 12 km grid scale TDep data were extracted.

Data were significantly and positively corrected ($p < 0.0001$, $n = 25$). Modeled NO_3^- and NH_4^+ were not statistically related.

Significant correlation for measured vs modeled in southern California (showed NO_3^- from twig surface analysis).

Significantly higher in San Bernadino mountains than in the Sierra Nevada mountains (from measured throughfall deposition).

Modeled vs measured lichen data are significantly correlated albeit slightly higher for lichen measured data, which is usually the case.

Last figure shows measured throughfall was higher than and significantly related to modeled deposition values (mean measured = 9.5, TDep modeled = 7.7 kgN ha^{-1} yr^{-1}) in the western U.S. from 2000-2011.

Elevation and precipitation levels did not significantly affect correlation; however, TDep tends to underestimate throughfall. Relationships can vary across multiple indicators and scales (requires further investigation).

Future work: gather additional data, incorporate CMAQ for further evaluation, additional variables (tree species, urban vs rural), climate differences (wet vs dry), and expand into the Rocky Mountains.

As Donna Schwede mentioned, looking at where IER sites are within grid cells and downscaling to 4 km grid would be helpful.

Q&A:

Greg Wetherbee: Urban deposition is not included in the measurements. There appears to be a radius of influence that models can't capture in areas close to source terms. Could the satellite data be used to explore these strong source areas?

Donna Schwede: Another thing to consider is that the throughfall measurement is not necessarily an apples-to-apples comparison with what the model is putting out.

Downscaling presentation: *Mike Bell*

How disaggregated land use specific N flux data impacts critical load (CL) exceedances:

Jesse Bash developed an R script to disaggregate land use specific flux data. Results confirmed that the mass of the 30 m disaggregated flux is equivalent to the 12 km grid cell flux. Data at 500 m compared similar enough to 30 m data, and running at that resolution improved model performance.

Steps: 12 km CMAQ dry dep → disaggregate total deposition based on landcover types within cell → link each type to appropriate 30 m MODIS landcover data → compile to 500 m → 30 m MODIS landcover compiled to 500 m with weighted average

Two case study areas: Otter Creek Wilderness and Shenandoah National Park

Deposition at Shenandoah NP increased along the edges of the park near agriculture in the Shenandoah Valley. Deposition decreases in some 500m cells within Otter Creek where there are gaps in the forest.

Exceedance areas change when gridded to the finer scale. In Shenandoah some areas in exceedance appear at the finer scale, and Otter Creek shows appearance of some areas in compliance.

Method provides new estimates at a finer scale (500 m grid), changes the exceedance categories of critical loads near the level of deposition and the area in exceedance, and may provide a clearer picture of deposition in mixed forests.

Q&A:

Greg Beachley: Taking the coarse emissions and concentration gradients (12 km grid scale) and reduce the scale using the land use type. Analysis just looks at the dry deposition. This is really useful for Class 1 areas but maybe not as useful for high concentration areas, like CAFOs.

Greg Wetherbee: How does the TDep model work here? Leora has shown that throughfall is higher than what we might interpolate from NADP wet deposition measurements. Mike is showing that refinement could be achieved with finer land grids. Does the model adjust for wet deposition based upon land cover?

Greg Beachley: No, the model just performs spatial linear interpolation.

Mike Bell: Also biases due to topography (PRISM mentioned). Could add additional layer of complexity to refine model by incorporating land type. This is still in the works. The TDep to-do list is large, so this may take some time

<u>Measurement and Monitoring PROPOSED Workgroup</u> *Greg Beachley*

Although members have expressed lots of interest, we haven't had a lead volunteer for this workgroup. Please contact Greg Beachley or Ryan Fulgham if you have interest in leading this workgroup.

Preliminary Results from Eagle Heights *Chris Worley*

There is an ongoing discussion about how to collect total nitrogen and total phosphorus. Total N and P require sample preservatives.

We add a small (250 mL) polyethylene bottle to the NTN bucket precipitation sampler. Samplers could be modified to adapt to other different containers.

What's needed: NCON sampler (90% of needs), modified sampler lid (Richard Tanabe can talk a bit about that), strap, SNiPiT, preservative (H_2SO_4 ampule [1 mL of 1:3]), and 250 mL bottle

SNiPiT (Sampler for Nitrogen & Phosphorus in Total)

Utilize "QuikChem methods 10-107-04-4-C and 10-115-01-4-C. Can digest total N and P using same digestion process, ranges 0.005 – 0.5 mgN L^{-1} as NO_2+NO_3 and 0.01 – 1.0 mgP L^{-1}

Means from preliminary work (0.0024 mgN L^{-1} and 0.0027 mgP L^{-1} (signal to noise is a bit high, 26.1 for total N and 12.3 for total P)

Validations performed with glyphosate, phytic acid, AMP, ATP, and some other amino acids (from USGS SRS samples)

Looked for crossover contamination with preservative (H_2SO_4), compared two NTN buckets on a single sampler with a SNiPiT attached to only one of the buckets. Non-SNiPiT bucket had higher concentrations than the SNiPiT bucket!

Measured total N, total P, NTN NH4+, NTN NO3-, and organic N (difference of total N and NTN) from unfiltered NTN samples. Most of the total N and NTN ions measured above minimum detection limits. However, less than half of the total P measured above MDLs.

Several differential organic nitrogen values calculated were negative, I.e. the sum of NTN NH4+ and NO3- was larger than total N.

A substantial amount of total P was found to be unidentified or perhaps organic P.

Next steps: further troubleshoot negative organic N, comparison studies in Duke Forest, expand pilot study, and further sampling. *Q&A:*

Tom Butler: Will SNiPiT work with Aerochem collectors?

Richard Tanabe: We have thought of some ideas. SNiPiT may require lid replacement, but I think it is possible. With current Aerochem set up, SNiPiT will not work. Accommodations can be made though!

MMF Workgroup: *Greg Beachley*

Script transcription recap and results. More results presented in NADP science symposium.

Status of 2020 runs and others, preliminary results for 2016 v2021.1/EQUATES run, and outlook of activities until TDep Spring 2022.

Tune into science symposium presentations! Geddes, Beachley, Benish, Robichaud, and Akter

Progress from last spring: TDep MMF script transcription is essentially complete (called v2021.1)

New bias correction method: v2018.2 averaged over week offset (i.e. week ± 1) and all years in time-series for N=33 (for ECODEP), v2021.1 includes a seasonal median bias within the target year (N=13) (ORD recommendation).

Manuscript in preparation detailing the new version and comparison to v2018.2 using 2010 simulations.

Showed some data v2021.1 vs 2018.2 both using ECODEP, differences are pretty small and spaced out across ConUS.

Review of intermediate products have been helpful for diagnostics and will be implemented in QA protocol.

EQUATES data successfully incorporated in v2021.1, runs for 2010, 2017, and 2018 finalized and initial QA (error found and now corrected).

Initial 2010 results with EQUATES shows greater differences than v2021.1 and v2018.2 with both using ECODEP (less oxidized nitrogen deposition in urban areas, less reduced nitrogen deposition in intensive ag areas like the Magic Valley).

CityDep: *Greg Wetherbee*

CityDep met on October 19 and developed a mission statement: to enhance NADP through collaborative research on air quality and atmospheric deposition and their effects on ecological and human health in urban environments.

Near suburban lichen measurements have been a major topic of discussion in CLAD. CityDep could consider taking on some of these science objectives.

CityDep needs a product to focus on and rally together to complete. One component could be the outcome of an RCN grant proposal made by Leora Nanus to NSF.

US Department of Energy (DOE) putting out a call for urban environmental research for underrepresented universities.

Pollen study is an important thrust of CityDep work.

A lot of interest in microplastics in urban environments.

PFAS site in the Bronx sampling urban PFAS.

Purple air (Doug Burns) will try to deploy at some NADP sites. Perhaps another instrument, the clarity node, might be more appropriate, though.

Next TDep Leadership Committee Secretary: *Greg Beachley*

Katie Benedict's work has departed from TDep related areas, has asked to step down from TDep leadership. Katie brought a lot of much needed measurement perspective (Greg is more of the model person). TDep should continue to focus on this trend.

Ryan Fulgham will become the new co-chair in Katie's stead.

Greg opens nominations with Amanda Cole (of Environment and Climate Change Canada (ECCC)). Amanda is a member of the TDep Steering Committee and has worked heavily with ADAGIO Measurement Model Fusion.

Kristi Morris seconded Amanda Cole for TDep secretary.

Amanda elected with 100% positive vote.

Any additional business / wrap-up:

Bret Schichtel has question for Chris Worley. Amy Sullivan showed that frozen samples show no loss while John Walker's work has shown losses in the past. Would it be possible to look at filtered samples of standard NADP collection and look for differences in the two methods?

Chris Worley can definitely do this.

North Carolina seems like a perfect place to look at these types of storage losses. (Walker confirms). Can you filter a subset of the samples? Walker says we can do that with the same filters that are used in Wisconsin. The idea is to filter upon collection (ASAP) in order to prevent microbiological activity. How to do that with a weekly sampling frequency? Still have some loss during the week, but filtering upon sampling would curtail transport digestion. Maybe we should talk with Amy Sullivan and Jeff Collett to coordinate that. Martin Shafer offers that an unfiltered SNiPiT and the NTN. Walker suggests circulating a list of tests that have been done to figure out what we can do in NC to add value. Chris and Martin can work together to put together a summary of what's being done on the Wisconsin end.

Ryan Fulgham motions to adjourn. Selma Isil seconds.

TDep 2021 Fall Meeting Agenda

11:00 am – 3:00 pm EDT on Tuesday, Oct 26th, 2021

https://us06web.zoom.us/meeting/register/tZwtfuytrjssH9OIU2jx6WgfTnJyc5Zkrk77

11:00 Introduction/Overview (*Greg Beachley, EPA; Katie Benedict, LANL*)

- Recap of Spring 2021, TDep Project Tracker, 2021 TDep Annual Report

11:15 Motion to accept TDep Committee Structure, Leadership Roles and Responsibilities Document (*Greg Beachley*)

11:20 Workgroup Updates & Presentations

Stakeholder Workgroup (*John Walker, EPA*)

- ***Presentation:*** *N Deposition in Snake River Valley (April Leytem, USDA)*
- Update of Stakeholder Engagement Plan
- Update on NCDC233 Sources and Fate of NH_3 Across the Region
- Plan for 'Strengthening connection between TDep and Agricultural Stakeholders Forum' targeted for late March 2022
    - Identifying potential connections and stakeholders

12:15 EOS (*Chris Rogers, Wood; Kristi Morris, NPS*)

- TDep Twitter material for EOS (products, Educational awareness, other ideas?)

---------- BREAK: 30 min ----------

1:00 Deposition Uncertainty Workgroup (*Mike Bell, NPS*)

- Uptake on uncertainty in deposition in complex terrain
- ***Presentation:*** *IER vs. The TDep analysis (Leora Nanus, SFU)*
- ***Presentation:*** *Impacts of downscaling CMAQ deposition impacts Critical Load Exceedances (Mike Bell)*

1:45 Measurement & Monitoring ***Presentation:*** *Preliminary results from NADP Eagle Heights on Organic N sample stability (Chris Worley)*

2:10 Measurement Model Fusion (MMF) Workgroup (*Greg Beachley*)

- Update on results from MMF Script Transcription, status of 2020 TDep runs with EQUATES

2:30 CityDep Workgroup Update (*Greg Wetherbee, USGS*)

2:40 Nomination and Vote of Next TDep Committee Secretary

2:45 Additional Business; Wrap up, and Adjourn