

**1. Introduction/Overview** (Greg Beachley, EPA; Katie Benedict, LANL)

- Second TDep meeting conducted virtually;
- Self-introductions were skipped again as in the Spring meeting due to Zoom format. Instead, participants were asked to fill out registration form and to use first and last name for the Zoom Broadcast ID. Attendance list to be included on the meeting minutes
- Will have nomination and vote on the next TDep secretary to replace outgoing secretary
- Recap of Spring 2020 meeting and conclusions:
  - Meeting minutes approved via email in June 2020
  - Katie Benedict approved as TDep Co-chair
  - City Dep given spot on TDep agenda
  - Workgroup updates
  - Presentations:
    1. Kristin Foley, EPA: CMAQ v5.3 time-series;
    2. Todd McDonnell, E&S Env: Impacts of differences in modeled deposition to CL;
    3. Amanda Cole, ECCC: Progress on ADAGIO and comparison to TDep on N deposition and update on the Global Atmosphere WATCH MMF for Global Total Atmospheric Deposition;
    4. Changsy Chang and Nathan Pavlovic, Sonoma Tech: Specifics on the TDep MMF Script Conversion.
- TDep History:
  - TDep was established in 2011 to improve estimates of atmospheric deposition by advancing the science of measuring and modeling atmospheric wet, dry and total deposition.
  - Early years focused on developing hybrid methods for estimating total deposition; first TDep maps produced; focused on development of new sampling techniques and studies.
  - Specific Goals:
    1. Support national deposition monitoring networks by providing information on emerging measurement techniques, model development and associated uncertainties;
    2. Identify and prioritize knowledge gaps in measuring and modeling of atmospheric deposition; advocate for research to address gaps;
    3. Coordinate with CLAD and other groups;

4. Provide expertise and advice on present and potential decisions and regulatory actions;
  5. Encourage greater communication and collaboration between groups from different disciplines and countries.
- Mission Statement revised in 2016: The mission of TDep is to improve estimates of atmospheric deposition by advancing the science of measuring and modeling atmospheric wet, dry, and total deposition of species such as sulfur, nitrogen and mercury by providing a forum for the exchange of information on current and emerging issues within a broad multiorganization context including atmospheric scientists, ecosystem scientists, resource managers, and policy makers.
  - Recent Activities:
    1. Mercury deposition activities shifted to MELD;
    2. Increased emphasis on flux measurements and datasets;
    3. Continued research on developing new measurements methods and improved measurements of N species at IMPROVE and CSN sites;
    4. Comparisons of models, measurements and development of methods to inform and quantify uncertainties;
    5. TDep White Paper, associated publications, and seminar series;
    6. Fall 2019 TDep Workshop;
    7. New Workgroup (WG) format established in 2019:
      - Stakeholder, Measurement Model Fusion (MMF), and Deposition Uncertainty WG's
      - Two TDep representatives to Education and Outreach Subcommittee (EOS)
  - Website Update:
    - Added 2019 TDep Agricultural Workshop Summary Report;
    - Upcoming: 2020 Annual Report; Map Summaries for 2018 and 2019;
    - Current Links:
      1. White Paper on Nr Deposition
      2. White Paper related articles:
        - July 2019 Special Issue of EM magazine :”Improving Nitrogen Deposition Budgets in the United States”
        - Bibliography and links to STOTEN virtual issue articles
  - 2020 Annual Report: Goal is to have finished, committee-approved report prior to Spring Meeting. Report will:
    - Document activities and accomplishments;
    - Reference for TDep information (officers, mission statement, specific charges);
    - Highlights of progress and WG activities;
    - Highlights of ongoing work by TDep members with the goal of increasing project awareness within committee and to foster collaboration.

- 2020 TDep Accomplishments:
  - Completed monthly TDep White Paper Webinars;
  - Draft TDep Nr Deposition White Paper Fact Sheet;
  - Summary of 2019 TDep Workshop;
  - Conversion of TDep Measurement Model Fusion scripts from AML to ArcPy;
  - Report on “Improving characterization of reduced nitrogen at IMPROVE and CSN monitoring sites”;
  - Final report on measurement portion of “AMoN Flux Characterization Pilot Study” summarizing collection and basic data analysis. Modeling aspect will be next.
- TDep Project Queue and On-going Work
  - Current Projects:
    1. Conversion of TDep measurement model fusion scripts from AML to ArcPy;
    2. AMoN Flux Characterization Pilot Study – modeling aspect;
    3. Reactive N flux measurements by eddy covariance;
    4. Low-cost dry deposition system;
    5. Water soluble organic nitrogen pilot study status;
    6. Flux metadatabase;
    7. WMO Measurement-Model Fusion for Global Total Atmospheric Deposition Initiative;
    8. Deposition to South Platte River sub-basins: TDep Nr total combined with SPARROW to estimate urban component of N deposition in total N loads;
    9. Open-access dataset of atmospheric N deposition to Chesapeake Bay watershed;
    10. Other submissions to Atmos. Environ. Special Issue to commemorate 30 years since passage of the Title IV CAA amendments.
- Long-range Outlook for TDep Meetings
  - Spring 2021: Madison, WI – Virtual or In-Person?: Anticipated Topics:
    1. Final project summary of ArcPy conversion and new TDep MMF products;
    2. Initial incorporation of CMAQ time-series into TDep MMF;
    3. Progress on the Agricultural Stakeholder Engagement Plan;
    4. Review of TDep leadership positions.
  - Fall 2021: Anticipated Topics
    1. Comparison of CMAQ v5.0.2 and v5.3 time-series into TDep MMF;
    2. Others? Please let us know if you have a future topic.
- TDep Relevant Presentations at NADP Science Symposium
  - There was a total of 15 presentations spread out over the 8 sessions;
  - There were 9 TDep relevant posters presented during the poster session.

- Third EmPOWER Air Data Challenge
  - Submit ideas for creative analyses using EPA's emissions and/or environmental monitoring data (CAMD's Power Sector Emissions Data, CASTNET, TDep grids, and CAMD's LTM);
  - Work with EPA experts to use and understand the data during the 2021-2022 academic year;
  - Open to researchers at universities or think tanks;
  - Application period opens December 1 and closes February 22.

## 2. Workgroup Updates and Science Presentations

- **EOS Update** (Chris Rogers, Wood; Kristi Morris, NPS)
  - EOS will meet on Thursday, November 5<sup>th</sup>
  - TDep Fact Sheet is pending
  - A recap was given of the TDep White Paper Webinar;
  - Posts for social media platforms will be developed and specific requirements for TDep will come into focus after EOS meeting.
- **CityDep Update** (Greg Wetherbee)
  - Identified several related projects one of them being an NSF proposal lead by L. Nanus, A. Ponette, and P. Templer;
  - Description of CityDep which included review of old brochure;
  - CityDep was formed because the extrapolation of regionally representative rural measurements are not applicable to urban areas and thus Total N deposition, particularly from urban sources, is underpredicted;
  - Greg is wrapping up the Denver CityDep Study;
  - There is some uncertainty as to what CityDep is as a science subcommittee. It is more closely aligned with the goals of TDep;

Question from Doug Burns asked what determines whether a site is urban, what are the siting criteria? Example given that some older sites that were rural may have become urban in 40 years?

  - Bob Larson has a list of urban NADP sites;
  - Bret Schichtel mentioned that urban sites should have a rural or suburban Counterpart (i.e. paired sites) to compare background levels as well as test assumption that urban sites will have more deposition. Greg agreed, but thought the issue will be regionally specific due to terrain, weather patterns and effect.
- **Stakeholder Work Group Update** (John Walker)
  - John reviewed the Agricultural Workshop summary and that the summary was finished and posted on the NADP website.
- **Presentation: Elements of a Stakeholder Engagement Plan** (Anne Rea, Alexie Rudman, Katherine Canfield), presented by Anne Rea
  - This engagement plan arose from the TDep Science Needs White Paper and the

TDep Agricultural Workshop;

➤ Application to TDep:

1. Stakeholder Engagement/Communication (near term)
  - Identify relevant agricultural (ag) stakeholders;
  - Communicate purpose and objectives of NADP and TDep to ag Stakeholders;
  - Identify specific stakeholder interests in NADP and TDep data/products/research;
  - Recruit new stakeholder participation in TDep;
  - Communicate relevant research results and ongoing TDep research.
2. Problem Formulation (long term)
  - Identify opportunities to make existing data/products/ongoing research more useful to ag stakeholders
  - Develop new TDep research with shared TDep/stakeholder objectives such as evaluation of BMPs for NH3 emissions and impacts on deposition
3. Determine who and how to engage with stakeholders and in what capacity
  - Identify goals for communicating with stakeholders;
  - Identify stakeholders: subject matter experts, historically excluded, the 4I's (interested, influential, invested, impacted); what is the role of each stakeholder?
  - When are critical times to engage with stakeholders during research process?
4. Elements of a Communications, Outreach and Engagement plan
  - Introduction and background: overview of research effort and data products the plan will assist; what science problem is research going to inform?; What research has been planned, etc. to address problem; what is potential impact of research?
  - Plan Purpose: request stakeholder feedback in research needs or research in progress; Assist TDep researchers in streamlining engagement and communication; create communication products targeted to specific stakeholders;
  - Goals for communications, outreach and engagement: Build and maintain relationships with stakeholders; Ensure usability and transferability of research products;
  - Objectives: describe how activities will be tracked; establish baselines.
5. Activities:
  - Meetings/calls/webinars; fact sheets; news/press release; webpage; use of trade associations'/professional societies' existing communications; NADP meetings/workshops.

- 6. Timeline:
  - Activity, timeframe for completion, and leads
- 7. Problem Formulation
  - Include multiple stakeholders and disciplines to understand different perspectives on the problem;
  - Problem formulation: Stakeholder recruitment; problem elucidation; brainstorming of research questions and outputs; engage with stakeholders throughout entire research process;
  - Outputs: translate science into usable information
- 8. Other Elements of Note:
  - Achieve effective stakeholder engagement by building trust;
  - Provide an inclusive environment for exchange of ideas and Information;
  - Build capacity for stakeholders to be involved in research.
- Peter Vadas offered to help TDep connect to ag stakeholders through the USDA-ARS experience, resources, current connections, etc.
- John Walker noted that we need to identify stakeholders who use TDep data now but are marginally involved
- Greg Wetherbee mentioned Ag Experiment stations and David Gay said that we should talk with directors of these groups, but discussion would be more effective one on one with scientist. Greg W said to put this on list of things to do in 2021, identify Ag Experiment stations that use NADP data pr projects that fit.
- **Deposition Uncertainty Workgroup Update** (Mike Bell)
  - Assisted with White Paper Uncertainty Seminar series;
  - Met in May 2020 to discuss status of projects related to deposition uncertainty. Handful of projects have started to fill in some identified knowledge gaps.
  - Also trying to get a stated accuracy of deposition estimates per group, like lichens
  - Projects:
    1. Intermode comparison of CMAQ and TDep. McDonnell et.al. 2020.
    2. Atmospheric nitrogen deposition estimates for CONUS and CL exceedances for selected national parks (need to get authors for this).
    3. Measured versus Modeled Deposition:
      - Mark Fenn – Pacific SW research station
      - Leora Nanus – San Francisco University
        - Working with NPS and USFS
        - Phase I – western IER columns
        - Phase II – throughfall and snowpack
    4. Lichen tissue versus modeled deposition, Meaghan Petix, Washington State University.
      - Limited to OR and WA

- Lichen data versus CMAQ/TDep
- 5. Postponed project (COVID): Nitrogen flux versus throughfall, John Walker
  - Comment on uncertainty of deposition modeling and the TDep MMF process: Is it possible to break down uncertainty to different components of the model?
- **Measurement Model Fusion (MMF) Workgroup Update** (Greg Beachley)
  - Script conversion status and outlook
    1. Completed tasks includes: 3 versions updates (v0.0.1; v0.2.0; v0.3.0) which include data dictionaries for overall configuration, measurement and model inputs; Draft README file to install required programs (ArcGISpro 2.4 or above) and Python IDE (Spyder).
    2. Remaining tasks consist of finalized version (v0.4.0) pending v0.3.0 performance assessment; revised README document; and user modification chapter (protocol and checklist of modifications to MMF applications).
  - Schedule Overview:
    1. Task slightly behind schedule, extended through end of 2020;
    2. ArcPy/AML 2010 output (using CMAQv5.0.2) and comparison (start of 2020)
    3. 2019 TDep MMF maps (AML version) (After Fall 2020 meeting);
    4. ArcPy/AM: 2010 output (using CMAQv5.3) and comparison (Spring 2021 meeting update).
  - ArcPy Evaluation: Visual Inspection: Goal is to compare ArcPy grid with AML product as first step (Version 0.3.0).
    1. Total N: very similar, slightly darker on CONUS.shp (MN lake), font switch;
    2. DryN: Very similar;
    3. Wet N: Very similar, tip of New Orleans, LA;
    4. Dry S: very subtle change in deposition around southern UT and northern AZ; changes in %dry (overall more dry S in western CONUS). Visually slight difference that is more apparent in %Dry grid. No difference in Wet S grid.
      - No visual difference in precip supports conclusion of slightly higher dry S deposition in ArcPy.
    5. Dry SO<sub>2</sub> and pSO<sub>4</sub>: SO<sub>2</sub> is very similar but differences in pSO<sub>4</sub> in that there are increases on the west coast, SE Texas, southern Utah, northern AZ, NM and FL;
    6. Total Base Cation: decrease in West VA, less spots in the 4corners region, and decreases in the northeast and Midwest;
    7. Dry and Wet Base Cation: Changes in Total appear to be driven by changes in dry map. Dry map shows decreases in West VA and the 4corners as well as the northeast and Midwest.
  - Conclusions:
    - Overall, script transcription performs well (no evident changes);
    - Particle dry deposition has changes (increase in pSO<sub>4</sub>, decrease in

base cations). Particle differences masked in total grids. Likely stems from difference in the CMAQ aggregate ions which could not be reproduced;

- Next Steps: comparing some intermediate grids to pinpoint difference.
- Grid Difference (AML – ArcPy) Evaluation:
  1. Resolved issues from evaluation
    - Bullet holes from precip stations
    - Extent issue
    - Stability of calculated dry deposition
  2. Remaining issues (October 2020)
    - Grid difference creates a “thatch” from cell misalignment (thatch slivers manifest as high differences in high deposition areas)
    - Believe that these stem from change in projection (GRS1980 to NAD1983), and grid size difference (4.134 km<sup>2</sup> to 4 km<sup>2</sup>)
- Steps in October 2020:
  1. Rerun ArcPy script to match AML projection and settings (GRS1980 and 4.134 km<sup>2</sup>). This will also help quantify differences due to these changes.
- Next steps for script transcription:
  1. Continued evaluation of v0.3.0
    - Version 0.4 will address the CMAQ projection issues and the 5 remaining artifacts of thatching, ghost bullet holes, spots, bands, and rainbows.
  2. Delivery of v0.4.0 and evaluation:
    - Explanation of differences in CMAQ projection, differences in CMAQ ion dataset, and the 5 artifacts (thatch, banding, bullet holes, spots, rainbows).
  3. Final Delivery:
    - Coding of last tweaks
    - User modification chapter (protocol and checklist for future additions to TDep MMF application)
    - Full documentation
- Next Steps for TDep MMF:
  1. 2019 TDep maps
  2. Reproduction of 2000 through 2019 maps with ArcPy script
  3. Maps summaries (2018 and 2019)
  4. ArcPy/AML 2010 output using CMAQv5.3
  5. Future Modifications:
    - Fused CMAQ wet deposition product (Zhang et.al., 2019)
    - Shorter aggregation periods
    - Expand the measurement dataset to include data from IMPROVE, Urban, Ozone, SLAMS NO<sub>2</sub>
    - Utilize NADP/AMoN data for NH<sub>3</sub> bias adjustments



- Incorporate remote sensing data
- Improve web visualization tools and queries for output grids
- Discussion:
  1. Greg Wetherbee: AML maps should be archived and made available at least per request as users may need to access these for some time afterwards. Greg Beachley agreed.
  2. A data tool to select grid values at specific locations was requested. Donna Schwede noted that the CL mapper already does this and so does Enviroatlas. Donna recommended that we submit TDep grids to these tools.
  3. Donna also noted that new CMAQv5.3 should be improved dataset to use for trends as steps have been taken to reduce year-to-year fluctuations.
  4. Greg W pointed out that a lot of the differences in dry particle maps seem to be associated with sea salt.
  5. Amanda Cole remarked that she has seen similar artifacts to the 'rainbows' and that they were due to a difference in precision of the coordinates. Justin Coughlin commented to check the XY tolerance in ArcGIS.

### **3. Nomination and Vote for Next TDep Secretary**

- Motion unanimously approved. Ryan Fulgham replaces Selma Isil as TDep secretary.

### **4. Round-robin discussion on: 1) Current or planned TDep relevant projects, 2) How are you using TDep and any other deposition-related products, applications, etc., 3) Additional areas that TDep should consider.**

- Greg Beachley: using TDep trends to analyze pollution in certain regions.
- Bret Schichtel: Hired new modeler Gustavo Cuchiara, to look at impacts of agriculture, specifically N and NH<sub>3</sub> deposition on national parks.
- Justin Coughlin: TDep products have been integral in NO<sub>x</sub>/SO<sub>x</sub> secondary review.
- John Walker: Bidi model for AMoN sites; project in Idaho to develop bidi flux model; Ryan Daly is working on COTAG systems. One is being used in Idaho and another system will be ready by spring for use at Duke Forest. Also working on size-resolved particle fluxes, eddy covariance system for nitrogen at Duke Forest.
- Throughfall study by Djurkovich to get going in the spring and will add PFAS later.
- Region 8 has been funded to conduct flux measurements with CSU for NH<sub>3</sub> measurements.
- Peter Vadas: USDA ARS developing project (called ADAPT) to evaluate dry deposition near animal production facilities. Dan Miller from ARS in Lincoln Nebraska is leading the project, which includes deposition measurement for two

years near animal facilities at several ARS locations in Idaho, Texas, Iowa, Nebraska, South Carolina, and Kentucky.

- Greg Wetherbee: NADP should be paying attention to bias or uncertainty in their data. Uncertainty analysis should fold in differences in collectors (NCON versus other collectors). Greg thinks we are underestimating deposition. Get higher deposition from NCON collectors versus Aerochem Metrics. Have never adjusted for this.

Greg Beachley thought that this factors into the WDUM deposition uncertainty effort.

- Greg Wetherbee: Urban site radius of influence needs research.
- Emily Elliott: Asked about the significance of NO<sub>2</sub> deposition as nitrite. John Walker commented that concentrations in wet deposition are usually below MDL. Emily said they see it in some of their resin work. John thinks this issue should be investigated on an event basis.
- There is interest in creating a Measurement Work Group, but sufficient leadership is needed.
- Greg Wetherbee: Need to look at more cost-effective ways to collect NADP data. If cheaper, may get more participants. Some ideas he has are to process samples on site and ship one sample/month. Need to figure out how to analyze sample monthly, collect weekly, preserve nitrogen, process on site. This would mean less analysis, less shipping. Maybe we only have monthly data? Need something to pivot to in case federal funding goes away.
  - Bret Schichtel: Noted that they are facing identical situation in IMPROVE
  - Ryan McCammon: Wanted to know what processing on-site might involve?  
Greg W: Weekly collection, pour through IER column, cap and refrigerate, and ship IER columns. Could also composite on-site but this would involve more bookkeeping.
  - Uncertainty in changing sampling protocol would complicate things in that sampling artifacts may be an issue if switch to monthly sampling.
  - John Walker mentioned incorporating other preservation methods, i.e. chemical preservative. Lower cost sites might have different approach with different data quality objectives.
  - Another option could be to just have a collector and no rain gauge.

## **5. Meeting Adjourned**