1. **Welcome and Introductions** (Greg Beachley)

2. **Approval of Spring 2018 Minutes**(Greg Beachley)
   - Minutes were approved

3. **TDep Research Needs White Paper (WP) Update** (Greg Beachley)
   - Full draft has been submitted to NADP review team of Butler and Padgett, internal EPA review, and to the Topic Captains (TCs) on September 25, 2018
   - Others welcome to review but comments must be in by November 17, 2018.
   - Detailed Time Frame of Review Process:
     - October through November: NADP technical review in parallel with EPA internal review. Comments returned by end of November
     - October through November 17, 2018: Authors and open revisions
     - December through January: Final revisions and formatting by Greg and John coordinating with TCs. Coordinate with the Program Office (PO), WSLH/UW for online publication criteria
     - January 31: Ready for posting to NADP website. Will obtain DOI number for easier referencing
     - Initial feedback has been good with only minor revisions recommended thus far.
   - EM Submission:
     - There will be three papers:
       1. Summary of the WP
       2. Summary of effort from ecological perspective
       3. Long-term trends in Nr deposition
     - Publication will be in July 2019, after White Paper has been published on NADP web site
     - Must be submitted by March 2019
     - 1500 words not including text for figures, tables and references
   - STOTEN Submission:
     Currently open for submission until January 31, 2019:
     https://www.journals.elsevier.com/science-of-the-total-environment/calls-for-papers-virtual-special-issues/toward-the-development-of-total-reactive-nitrogen-deposition
     - Current list of expected papers:
       - Overview Synthesis paper (Walker, Beachley, all co-authors)
       - Bidirectional NH3 and direct flux measurements (Bash et al.)
       - Estimating Uncertainties in Deposition Fluxes (Walker et al.)

    - In-Canopy Models (Saylor et al.)
    - Isotopic Methods (Elliott et al.)
    - Occult Deposition (Isil and Rogers)
    - Urban Deposition (Wetherbee et al.)
- Next Steps: Utilizing the White Paper
    - Motivating research, collaboration, and funding
        - Satisfies EPA ORD deliverable for internal planning purposes
- Guide for future scientific direction of NADP program
    - NCDC233 project 'Sources and Fate of NH3 across the Region' plans on drawing from the needs from WP to build the proposal
    - USDA "Listens" program: opportunity for stakeholder input for topics represented in NIFA RFAs
        - Similar programs for other agencies?
    - 2019 International Workshop on Uncertainty in Measurement and Modeling of total Deposition Budgets
    - Monthly Webinars (K. Morris, M. Bell)
        - Host two 20 minute sessions per month in 2019
        - On standing TDep/CLAD WorkgroupG-4 Deposition Uncertainty calls
        - 3rd Tuesday of month at 1400
    - Plan to advertise to NADP audience and reach out to audiences external to NADP
- Important Dates:
    - November 17, 2018: Reviewer comments due
    - December 2018-January 2019: TC revisions
    - January 31, 2019: Publication deadline; STOTEN manuscript deadline
    - March 2019: EM summaries due

4. TDep Map Update (Greg Beachley)

- 2016 Maps Status
    - Recap of changes for TDEPv2018.1: revised PRISM model; SO2 correction to 2015 CASTNET data; SEARCH network values removed
        - Resulting changes: increased wet deposition by approximately 10% for all variables west of MS for 2000-2013
    - An aggregation artifact for CMAQ hourly data in the 53rd week for the 2002 runs was identified and corrected during summer 2018
        - Updated version is TDEPv2018.2
        - Grids, images, and updated documentation are available on out-going EPA ftp (ftp://ftp.epa.gov/castnet/tdep)
- 2016 Map Summary

    - Completed and in review. Expected online as e-copy in mid-November. TDEP website is under 'TDEP Reports'
    - Changes from 2015 to 2016 were minor and mostly dealt with precipitation-driven wet deposition changes (increases in the Pacific; decrease in mid-west and southeast; loss of sampler in Puget Sound)
    - The 53rd week aggregation error resulted in changes in non-measured species for 2000-2002
    - Nitrogen speciation charts are now using the entire TDEP grid instead of CASTNET sites
    - PO information has been updated.
    - No difference for measured compounds, only the modeled NH3 dry deposition and unmeasured species as noted above
    - The 2002 CMAQ run was used for 2000-2002 Tdep runs
- Remaining Issues
    - 2017 maps will use v2018.2 and are in progress. v2018.2 still uses CMAQ 5.0.2 2002-2012
    - Planning to use CMAQ v5.3 for 2018 map product. Will use bias correction product for CMAQ 5.0.2 transition to v5.3. Will need the converted map script for this.
- Desired Improvements compiled from previous discussions:
    - Precipitation differences with PO. Involves new PRISM algorithm, precipitation grids (2 versus 4 km), computational precision difference, AIRMoN precipitation, MDN sites, and completeness criteria
    - NH3:issues with emissions inventory and fusing the bi-di surface with measured values
    - Adjustments to radius of influence and interpolation methods
    - Sea salt surface estimates
    - 1in3 networks
    - Urban continuous SO2 network
    - O3 dry deposition
- Other Ideas:
    - Extending CMAQ coverage beyond the CONUS
    - Land-surface dependent deposition parameterization
    - Time format and flexibility to resolution (e.g. water year estimates, monthly estimates)
    - Incorporating remote sensing data
- New Ideas:
    - Metric of deposition uncertainty: simple weighting of TDep map using discrete levels of uncertainty assigned to confidence level in measurement
    - Production of deposition distributions

- Script Conversion:
  - CAMD is functional in AML to run 2017 maps
  - Will need converted script for CMAQ 5.0.2 to CMAQ v5.3 transition by Spring 2019, Slow going thus far on this
  - Working on detailed SOW with flow charts which will help contribute to goal of improved documentation
  - There are approximately 20 plus ESRI commands that need workaround in new language. Gary Lear had created a task list which was presented in San Diego. Will start with this list to create a flow chart and fill-in the ESRI commands. The AML routine is the template, but not trying to reproduce this.
  - Gary Lear's Task List:
    1. Download and interpolate weekly ambient data into rasters
    2. Download and interpolate annual wet deposition measurement data into rasters
    3. Extract layers and variables from hourly NetCDF model output files into subsetted NetCDFfiles. This task will migrate to a Python platform.
    4. Download, inventory, manage, and archive extracts in NetCDF format
    5. Extract hourly values from NetCDF and aggregate into weekly raster files
    6. Manipulate weekly raster files:
       a. Calculate average model bias
       b. Calculate aerosol particle ratios
       c. Combine weekly model and measurement raster files
       d. Aggregate combined weekly raster files into annual raster files
    7. Plot/format maps from annual raster files
    8. Export and distribute annual raster files
    9. Documentation of SOPs

5. **TDep Flux Metadatabase Update** (John Walker, Chris Rogers)
   - Purpose:
     - Collect metadata on completed and ongoing Nr flux measurement studies such as direct flux measurements, micrometeorological methods
     - Construct publicly available (NADP) searchable metadatabase of study details of global coverage
     - Metadatabase will
       - Increase availability of Nr flux datasets
       - Facilitate evaluation and improvement of dry deposition models
       - Promote collaboration among flux measurement and modeling communities
       - Complement similar effort for throughfall measurements in the U.S.

- Status:
  - Questionnaire sent out on 7/24/2018
  - 11 responses thus far dealing with crops, wetlands, forests, and grasslands
  - 9 additional positive responses where intending to submit questionnaire. Many intend to submit multiple datasets
  - Follow up needed with others
  - Routine developed to process pdf questionnaires without manual entry
- Details on Received Questionnaires:
  - Crops:
    - Corn, NH3, SE US
    - Soybean, NH3, SE US
    - Corn, NH3, total Nr, Germany
    - Wheat, NH3, Total Nr, Germany
  - Wetland:
    - NH3, Germany
  - Forest:
    - Mixed, NH3, HNO3, HONO, aerosol NH4, aerosol NO3, Germany
    - Mixed, Organic N, SE US
    - Mixed, NOy, NE US
  - Grassland:
    - NH3, NO, NO2, O3, Switzerland
    - NH3, HNO3, aerosol NO3, Aerosol NH4 SE US
- Next Steps:
  - Continue to follow up with individuals that have not responded or indicated they would be participating but have not
  - Continue processing questionnaires
  - Make database publicly available in January 2019
  - Annual literature review to identify new datasets

6. **Throughfall Database: Deposition Measurements versus TDep Modeled Nitrogen Deposition** (Mike Bell)
   - Datasets:
     - Hubbard Brook: 9 conventional collectors 3 of which are in TDep grid cells. Collectors are in cleared openings in the forest. Yearly data collected from 1963-2014.This analysis focuses on 2000-2013
       - Southern California: Ion exchange resin (IER) columns at 14 sites under oak and pine
   - Results from Hubbard Brook:
     - Oxidized N deposition: Model over predicted about 30%.

- NO3: slopes are relatively parallel; consistently collecting approximately 70% of what was modeled.
- Nr deposition: parallel slopes for collected versus modeled results
- NH4: slopes are not parallel. Measured NH4 decreases over time but modeled NH4 is slightly increasing
- Sulfur deposition: good agreement with both total and wet deposition
- NH4:NO3 Ratio: Higher percent of reduced N in both of the models (wet and total) compared to measured values

- Results from Southern California: there is a gradient of deposition based on location
  - Oak and Pine deposition:
    - TDep model not good near cities
    - More NO3 deposition under pine
    - Measured versus modeled ratios are not good.
    - Overestimation under pine and under estimation under oak for NH4
- Conclusions:
  - Hubbard brook:
    - Bulk deposition measurements align with modeled deposition, however, issue is where forest is cleared but TDep cell is mostly under forest canopy
    - Does not align with modeled trend of increasing NH4:NO3 ratio.
  - Southern California:
    - Tree species specific issues:
      - Oaks: model > measurement
      - Pine: measurement > model
    - High deposition (> 20 kg/ha/yr) sites are less aligned
    - Need to analyze more sites and species
- Comments:
  - Canopy uptake needs to be understood better
  - Expand database to include leaf wash studies

7. **Proposal for Formation of TDep Workgroups (WGs)** (Greg Beachley)
   - Rationale and objectives:
     - Increased structure will make projects as community-involved as possible
     - Make work more accessible and with greater distribution of workload
     - Stimulate more contribution and involvement from peripheral members
     - Help attract new interest by facilitating easier access and participation
     - Accomplish more between meetings
   - Logistics
     - Start small: only three groups to start with
     - Keep things fluid
     - Use CLAD model and experience

- Perspectives from the CLAD Model
  - First 3 CLAD WGs established three years ago; two have been added since
  - Each WG has its own leader with second in command
  - CLAD also has a project manager to coordinate the WGs
  - Leaders help get projects off the ground quickly and keep momentum moving forward
- TDep Logistics
  - Start small with three groups
  - Follow CLAD model
  - Assign two WG leads
  - Status reports at meetings which will be quick updates
  - Discussion items will be earmarked ahead of time for time allotment
- Initial Groups and Descriptions
  - Two WGs are already in progress: Maps and Stakeholder WGs
  - The TDep maps have already had two updates since 2012 and most of the work has been accomplished by Gary and Donna. At this point, group contribution is desired
  - Stakeholder WG was established Spring 2018. Idea stemmed from TDep white paper. This group will be involved with:
    - 2019 Uncertainty Workshop
    - Increased presence in NH3 work with the USDA
- Example problem for Maps WG
  - Recently found out that USGS scientist using rudimentary deposition map
    - Points to lack of outreach for TDep map products. Also, TDep maps are limited to CONUS. Should we expand coverage?
    - EPA NCEA scientist looking for monthly aggregate maps to use for water years. Should we make time resolutions more flexible?
    - The 53rd week error of the 2002 CMAQ run was a question that led to a correction and re-run of maps
- Behind the scenes Maps work that larger TDep group may not be aware of:
  - Developing a routine for error checking the grids
  - Writing a results summary or narrative describing the changes in the maps and why they may have occurred
  - Improved documentation (code, version differences, corrections logs, etc.)
  - Comparisons and development of measurements:model fusion techniques like ECCC, OAQPS data fusion group
  - Laundry list of desired improvements
- Possibilities for the Third WG:
  - Application WG:
    - Focus would be on different ways TDep products could be used besides

CLAD
    - Keep tabs on related publications
  - Communications WG:
    - Focus on updating other WG's and keeping website updated
    - Interact with EROS
    - Outreach via monthly webinars of white paper topics
    - Work on upcoming meetings, TDep attendance, presentations, etc.
- Attendees were asked to sign up for WGs of interest
- Discussion points:
  - Pam Padgett thinks that if we combine our efforts with EROS we can accomplish more as far as communications and outreach WG. A good example would be the Flux Database Project. The merged group could serve CLAD, TDep , Aeroallergan , etc. instead of each group having their own outreach panel
  - Each committee would have their own EROS representative
  - Scheduling conflicts as far as overlapping committee meeting times could be an issue
  - CLAD ran into limitations of how far to go with communications as everybody on CLAD committee was already involved with other work. So a joint group to do just communications would be helpful
  - What would be the role of the PO in this effort? Jamie or Jan from UW could help? We have access to a wide range of people at UW
  - Original TDEP maps were based on EPA-CDC PHASE runs which were a mix of model versions and modeling platforms across the years
  - Newer TDEP version uses the CMAQ 5.0.2 runs that were done more consistently
  - CMAQv5.0.2 runs were for 2002-2012. For 2013-2017, TDEP uses the CMAQ 2012 runs combined with year-specific observational data
  - There are some CMAQ model runs available post-2012 but for different model versions
  - TDEP committee needs to decide how to move forward given available model runs and resources
  - Donna pointed out that we really already have an Uncertainty WG and proposed a Measurement-Model Fusion WG
- Final WGs that were proposed are:
  1. Stakeholder WG (already functional)
  2. Measurement-model-maps WG
  3. Applications WG

8. **TDep Stakeholder Workgroup Report (**John Walker)
   - Motivation to form stakeholder WG
     - While developing the white paper, enhanced coordination and collaboration across Federal and State agencies, academia, and non-profit groups was identified as a common need to address the most critical knowledge and data gaps in a timely manner.
     - To meet this need a stakeholder WG was formed and focused on building collaboration among groups interested in Nr deposition science.
   - Objectives of Stakeholder WG:
     - Increase communication across scientific communities (atmospheric chemistry, ecology)
     - Create new opportunities for collaborative research by promoting the inclusion of deposition science in grant programs
     - Advance the integration of TDep science needs into existing research programs across stakeholder groups
     - Facilitate communication among program managers within stakeholder agencies and user groups
   - Current Activities
     - Group has held three conference call since Spring 2018 TDep meeting
     - Exploring TDep/NADP participation in new USDA North Central Regional Development Committee Project: NCDC233 Sources and Fate of NH3 Across the Region. This project has been developed by Rich Grant and colleagues.
     - Organization of 2019 workshop on Uncertainty in Measurements and Modeling of Total Deposition Budgets.
   - NCDC233: Sources and Fate of Ammonia Across the Landscape
     - USDA NCDC Committee has been established to write a proposal to USDA NIFA for formation of a Multistate Research Committee (MSRP) within two years titled “Sources and Fate of Ammonia Across the Landscape”
     - USDA and non-USDA folks can sign up to participate in proposal development
     - Participants will include their research objectives where they overlap
     - If proposal accepted interested individuals sign up to participate in project
     - Complete project description can be found at: https://www.nimss.org/projects/view/mrp/outline.18558
     - There will be Thursday lunch meeting (12:10-1:30 in “Anteroom” to discuss project and participation in more detail with Rich Grant, Jamie Schauer and others.
   - TDep Interests in NCDC233 Project:
     - To increase understanding of the linkage between agricultural emissions and Nr deposition. This objective was identified in the TDep WP as a key area where additional research and coordination across stakeholders is needed

- Project is relevant to a number of knowledge gaps and research needs identified in the TDep WP
- Opportunity to advance some of these research needs and engage with agricultural stakeholders (USDA, academia)
- Specific TDep needs identified in WP that relate to this project:
  - Expanded monitoring in agricultural areas to characterize spatial and temporal variability of NH3 near and downwind of sources
  - Improvement of NH3 emission inventories for animal production facilities and fertilized soils
  - Process-level measurements of bidirectional NH3 fluxes and biogeochemistry in natural and agricultural ecosystems

- NPS-ARD Project: Contributions of Agricultural Activities to Air Quality Issues in National Parks and Rural Lands
  - Chemical transport modeling (CAMx)
    - 2014 modeling inputs used for WRAP visibility modeling
    - Enhanced NEI emission inventory
    - WRF meteorology
  - Agricultural Activities
    - Confined animal feeding operations (CAFOs)
    - Crops
    - Agricultural fires
  - Air quality issues
    - Nr deposition (ecosystem health)
    - Visibility (Visitor experience/recreation)
    - Fine particulate matter (human health)
    - Ozone (ecosystem and human health)
  - Approach
    - Base case simulation and evaluation
    - Estimate contributions from CAFOs, crop activities, agricultural fires, wind blown dust
  - Modeling refinements
    - Emissions (NH3 and NOx)
    - Precipitation
    - Physical/chemical processes (e..g. dew processes)
    - Modeling domain boundary conditions
  - Comments:
    - Donna was wondering about mitigation strategies component in this project. She thinks that you can make a financial case as far as the fertilization aspects, but harder case for animal production aspect. Have to find mitigation strategies that provide some benefit to production people.

Current strategy of having animals out during 'safe' times is hard to implement. Bret noted that it is easier to limit N input to the animals but people are worried that animals will not gain as much weight

- Need buy-in from ag community. UW is a huge ag community and would like to do something about emissions but do not have the science. Jamie S. thinks working with the community will have more impact than regulatory approach. UW has person that works with manure such as how to mix manure so there are less emissions.

- Planning for Fall 2019 Workshop: ***International Workshop on Uncertainty in Measurement and Modeling of Total Deposition Budgets***
  - Kick-off interest session during this symposium (4 invited talks): Thursday @2:10 pm – Atmospheric Deposition – Total and Reduced Nitrogen
  - For 2019:Workshop (WS) to be tacked onto Fall 2019 NADP Science Symposium
  - Invited Speakers:
    - Include stakeholders (NSF atmospheric chemistry, USDA NIFA program, EPA Office of Water, States, etc.)
    - International Community: GAW total deposition measurement-model fusion; Air Quality Model Evaluation International Initiative (AQMEII); Regional measurement networks
    - Build on interactions with groups participating in the TDep flux metadatabase project
  - What do we want outcome of workshop to be?
    - Focus on exchange of information (no formal product)
    - Formal product: white paper, manuscript that extends relevant aspects of the TDep WP (not a rehash of WP, but an international perspective)
    - Development of a strawman collaborative research project addressing relevant knowledge gaps in the TDep WP:
      - Global Atmospheric Watch (GAW) – measurement-model fusion example
      - Dry deposition model evaluation building on TDep metadatabase?
      - Pilot study to integrate AMoN with Ameriflux for ecosystem Nr flux modeling
    - Rough Timeline:
      - December 2018: develop 1-page paper for distribution and comment in TDep. Will state purpose and objectives of workshop; potential session topics; initial list of invitees
      - Begin coordinating with NADP executive committee and PO on logistics
      - Early 2019: begin contacting key speakers
  - Comments:

- Send thoughts and ideas on WS via email
- Jeff Collett mentioned that there is an international WS scheduled around the same time in Germany.
- Donna thinks we should go for a product like set of papers as a results of WS in order to get big name speakers
- Pam suggested coming up with a project as a results of WS. Do not develop anything outside of current endeavors but coordinate ongoing projects. Flux database could be useful in this aspect.

9. Overview of Phase IV of the Air Quality Model Evaluation International Initiative (Donna Schwede)

- Background
  - AQMEIIIs North American-European coordination effort of conducting research projects and model inter-comparison exercises aimed at advancing model evaluation practices and informing air quality model development
  - Since 2009, this effort has brought together 37 modeling groups from 17 countries in NA and Europe
  - Previous analyses have included deposition , but focused mainly on atmospheric concentration and meteorological variables
    - Phase 1: Initial comparisons and proof of concept
    - Phase 2: Coupled models; chemistry-met feedbacks
    - Phase 3: Global to regional modeling; effect of boundary conditions
  - http://aqmeii.jrc..ec.europa.eu/contacts.html
- Phase 4 Objectives:
  - Quantify the performance and variability of dry and wet deposition fields simulated by multiple state-of-science regional air quality models
  - Document deposition schemes and key parameters used in these models
  - Perform box model simulations to quantify the impacts of different deposition schemes and parameters on simulated dry deposition
  - Investigate the variability in critical load exceedances resulting from the use of deposition estimates from an ensemble of air-quality models to inform policies such as emissions controls
- Air Quality Model Simulations
  - NA: 2010 and 2016 (emission focus)
  - Europe: 2009 and 2010 (met focus)
  - Target horizontal resolution: 0.125x0.125 degrees
  - Groups will perform their own met modeling
  - Chemical boundary conditions will be extracted from a common set of 3-D fields simulated by the global Copernicus Atmosphere Monitoring system
  - Groups will use common anthropogenic emissions

- Biogenic emissions will be calculated by each group
- Models will be modified to provide additional outputs (e.g. resistances, land use specific deposition velocity and flux)

- Model Outputs
  - Fields of met variables. Gas and aerosol concentrations, and wet and dry deposition (LU-specific DD velocities mean that LU-specific DD fluxes would not be needed unless using bidi)
  - Dry deposition velocity and all of its component reisistances (needed to calculate partial conductances) for the total grid cell, and by the model land-use types used in the deposition calculation, for a suite of gases and particles
  - Fractional area for each model land use/land cover type used in the deposition calculations spatially transformed to a common grid
  - Time-varying leaf area index information used in the deposition calculations on the common grid
  - Note: groups do not lump LU categories but report values for each LU category used in their model
- Specialized Air Quality Model Run
  - Run CTMs for 1 hour with the same met inputs at all grid points:
    - Day versus night
    - Summer versus winter
    - Dry versus wet conditions
  - Focus is on output deposition velocities and resistances, not fluxes
  - Allows comparison of component resistances and model response given the same met
- Box Modeling
  - Deposition modules from each CTM will be exported to a box model to run with field scale data
  - Data (met, site characteristics, etc.) for several sites will be provided to models
  - Potential sites: Harvard Forest, US; Blodgett Forest, US; Hyytiala Forest, Finland; Borden Forest, Canada; Duke Forest, US
- Data and Analysis
  - Model data and observations will be hosted in the web based ENSEMBLE platform (Galmarini et al., Atmos Env, 2012) (http://ensemble.jrc.ec.europa.eu)
    - Pairing of model and observed data
    - On-line visualization and analysis
  - Anyone can request access for research purposes
- Example Science Questions
  - How do simulated deposition fields for specific land use types differ between modeling systems? What are the key drivers of these differences?

- How well do these models' simulated deposition fields agree with observations?
- How does simulated dry deposition velocity vary across land cover types and between models under standardized met conditions?
- What are the effects of three key factors (days night, summer vs winter, and dry vs wet) on simulated dry deposition velocity?
- How do individual deposition processes contribute to intermodel differences and model biases against observations?
- How large are inter-model dry deposition differences under standardized conditions compared to intermodal differences with model-specific met?
- Does the ensemble estimate of deposition compare more favorably to observations than individual model estimates?
- Can model-measurement fusion be applied to the ensemble to provide improved deposition maps?
- How much variation in calculated exceedances can be expected through the use of different models and different critical load estimates?

- Phase 4 Tentative Timeline
  - August/September 2018: Initial call for participation
  - December 2018/January 2019: Distribute boundary conditions and emissions
  - January to March 2019: Distribute final specs and begin simulations
  - Summer 2019: Data submission
  - September 2019: AQMEII workshop in conjunction with ITM Hamburg, Germany
  - 2020: Submission of journal articles to special issue
- Participation
  - Already committed are 12 participants in the European domain and 8 participants in the North American domain
    - CMAQ (multiple dry dep options)
    - WRF-CHEM (multiple configurations)
    - GEM-MACH
  - Contact Christian Hogrefe if you want to participate in the modeling: Hogrefe.Christian@epa.gov
  - For the NADP community:
    - How would you use the data?
    - Do we have the right outputs?
    - Are there other observational data sets we should consider?
  - Help other groups such as ecosystem research to better understand deposition estimates and uncertainty
  - Complement similar effort to develop database of throughfall measurements for the United States (Bell)

- Current status
  - Draft questionnaire reviewed by TDEP steering committee
  - Final questionnaire developed as editable PDF
  - Overview letter recently drafted
  - Need to finalize plan for a home for the database:
    - Publicly available
    - Will be ongoing effort
    - Updated with annual literature review
    - Can submit new studies
  - Questionnaire will be sent out in weeks following this meeting
- For a copy of the questionnaire and the recipient list, please see presentation posted on the TDEP webpage.

10. Uncertainties in Modeling Nitrogen Deposition in the Western US (Mike Barna)

- NPS efforts to simulate nitrogen deposition
  - Recent N deposition modeling:
    - RoMANS 2009 in the Rocky Mountain National Park (RMNP)
    - GrandTReNDS 2011 in the Greater Yellowstone area (GYA)
    - Oil and gas impacts in the Intermountain West (IMW) 2011
  - Goals of Modeling:
    - Source apportionment (SA)
    - Estimation of critical loads (CL)
  - How can we reduce uncertainties in future model?
- Recent N deposition studies: identify future needs
  - Oil and gas impacts on national parks in the IMW. Active wells as of 2015"
    - WY:66,300
    - UT:27,400
    - CO: 72,300
    - NM: 60,000
  - GransTRENDS: Impact of multiple regions/sectors on the GYA. There are 26 source regions for emission sectors such as agriculture, oil and gas, fire, 'other', and boundary conditions
- Model performance for N could be better
  - Ammonia is most difficult species to predict, compared to HNO3 and NO3
  - Typically underpredict nitrate and ammonium deposition in the western US
  - Need to get concentrations and removal (precipitation or dry deposition velocity) correct
  - Not many measurements for model evaluation, especially with respect to ammonia
- Things to consider for next round of model:
  - Precipitation; bidirectional flux; agricultural emissions, especially from CAFOs; role of boundary conditions; NOx emissions from agriculture
  - Less likely to be in next round of model but still important: wind in complex terrain, Canadian and Mexican emissions, Re-emission from dew, heterogeneous HONO formation
- Precipitation
  - WRF precipitation is more frequent, intense

    - Replace with PRISM? But no longer internally consistent (rain when clear)
    - Assimilate precipitation? Finer grid?
- Bi-directional ammonia flux
    - NH3 re-emission long recognized as important
    - CAMx 6.6 will include Leiming Zhang's bidi. It is a simpler mechanism than EPIC-CMAQ. Depends on land use 'emission potential'
    - New bidi CMAx being tested on Zhang et al.'s 2011 Yellowstone study
    - Refine land use potentials?
    - Re-emitted NH3 treated as 'natural' in source apportionment
    - There is still a challenge with generally estimating dry deposition velocities
- Agricultural emissions
    - Agricultural emissions, especially CAFOs, are important for ammonia (e.g. in Colorado)
    - Mark Zondlo from Princeton is using oversampling of IASI retrievals for ammonia evaluation
    - Lots of time spent trying to figure out where the CAFOs are
    - Compare IASI top-down estimate to NEI
- Role of boundary conditions
    - Boundary conditions typically play a large role in western US air quality
    - Should they be this large?
        - N deposition around 20 percent
        - Ozone between 40 and 80 percent
    - Which global model to use?
    - Any way to adjust?
    - EPRI conducting study on boundary conditions for 2016
- NOx emissions from agriculture
    - Soil NOx emissions from ag sources can be significant (e.g. 20-32 percent in recent California study)
    - How to update in emission inventory?
- Summary
    - Lots of challenges with regard to nitrogen deposition modeling:
        - Precipitation
        - Bidirectional flux
        - Agricultural emissions, especially CAFOs
        - Role of boundary conditions
        - NOx emissions from agriculture soil
    - Next modeling effort: 2014 agricultural impacts on national parks
        - Inputs: meteorology and boundary conditions from EPAs 12 km NATA
        - Start with 2014 NEI, but refine sectors as needed (CAFOS, soil NOx)
        - IS CAMx with bidi comparable with CMAQ-EPIC?
        - How to treat re-emitted ammonia? Is it really 'natural'?
        - How to incorporate satellite products for model evaluation/emission inventory development:
            - Mark Zondlo (Princeton) – NH3 and IASI
            - Jessica Neu (JPL) – background ozone
            - Arlene Fiore (Columbia) – PM and haze

11. **Total Reduced Nitrogen (NHx) Measurement Methods for Implementation in Long-term Monitoring Networks** (John Walker)
    - This is an update on study that a lot of people have worked on. This study builds on Collett et al. work.
    - Driver: routine monitoring of NHx (NH3 + NH4) is needed to support NAAQS and regional haze programs.
        - Clean Air Status and Trends Network (CASTNET)
            - 97 sites, weekly integrated NH4 by filter pack
        - NADP Ammonia Monitoring Network (AMoN)
            - 99 sites, two-week integrated NH3 by passive sampler
        - CASTNET/AMoN combined: 70 collocated sites that produce two-week integrated NHx results
        - Interagency Monitoring of Protected Visual Environments (IMPROVE)
            - 160 sites, 1 in 3 day sampling, 24-hour integrated sample
        - Chemical Speciation Network (CSN)
            - 150 sites, 1 in 3 or 1 in 6 day sampling, 24-hour integrated sample
        - Can a filter based method for total NHx be implemented in IMPROVE and CSN?
    - Southeastern US CSN/IMPROVE NHX Pilot Study
        - Purpose: Co-located study to compare acid-coated CSN/IMPROVE filters/modules to ADS and CASTNET/AMoN
        - Follow-on to IMPROVE NHx study in West/Midwest (Chen et al., 2014)
        - Southeastern study:
            - Duke Forest, NC (ORD) and Gainesville, FL (Wood)
            - Operated for 6 months from May through October of 2017
    - Results of IMPROVE NHx Pilot Study in the West/Midwest
        - Comparison with URG reference method at CSU
        - Good agreement between IMPROVE NHx and URG filter+denuder
        - Good agreement between IMPROVE nylon filter NH4 and URG-NH4
            - IMPROVE NH4 low due to NO3NH4 loss
    - Southeastern US Study Design
        - URG denuder/filter pack (ADS)
            - Separates NH3 and NH4
                - Acid coated denuder (NH3)
                - Nylon filter (NH4)
                - Backup denuder (volatile NH3)
            - PM2.5 inlet at 10 lpm
        - CSN
            - One module collecting NH4 on nylon filter

        - Second module collecting total NHx on acid impregnated cellulose filter
        - PM2.5 inlet at 6.7 lpm
    - IMPROVE
        - Acid impregnated cellulose filter to capture total NHx
        - PM2.5 inlet at 22.8 lpm
- Results:
    - Median concentrations are similar across methods
    - CSN and IMPROVE measure less NHx than ADS
    - High correlation between ADS and IMPROVE. Show similar performance to Chen et al. 2014
    - Moderate correlation between ADS and CSN
    - CSN measures less NHx than ADS at higher concentrations
    - Moderate correlation between methods
    - Low variability
    - Larger bias at higher concentrations for CSN
- What is causing disagreement between methods?
    - ADS performance?
        - ADS results showed a large fraction of NH4 on the backup acid denuder which is downstream of nylon filter
        - This could be caused by NH3 breakthrough on the primary acid denuder and/or NH4 volatilization from the nylon filter
        - Three 24-hour samples were collected at the end of the study with additional denuders to test breakthrough on both the primary and backup acid denuders
        - These tests indicated breakthrough on the primary denuder and motivated a follow up study at RTP to test the collection efficiency of the acid denuder.
        - RTP study showed good NH3 denuder collection efficiency
        - Issue with nylon filter retaining NH4 but total NHx captured with backup acid denuder
        - Anion analysis suggests filter issue related to chemistry not particle collection efficiency
- Nylon filters for NH4
    - Wood analyzed extracts for NO3 and SO4 from CSN and ADS nylon filters
    - CASTNET uses Teflon for NH4, SO4 and NO3 whereas CSN uses nylon filters for these three analytes
    - ADS uses nylon+backup denuder for NH4
    - NH4/SO4 ratio showed loss of NH4 but not SO4 on nylon filters
    - Perkinstown, WI and Arendtsville, PA collocated CASTNET/CSN sites show similar patterns

- CSN Cellulose filter for NHx: Why is CSN biased low?
  - NHX bias increases with concentration at both sites
  - Negative bias may become larger as NHX becomes dominated by aerosol NH4 fraction
  - Bias may be more related to NH4 than NH3?
  - IMPROVE: type 40 cellulose filter with 98 percent retention of 8 mm particles
  - CSN: type 41 cellulose filter with 98 percent retention of 20 um particles
  - CSN cellulose filter collecting fewer NH4 particles?
- Recommendations and next steps
  - Is NHx sampling suitable for deployment in IMPROVE and/or CSN networks?
    - Not in humid areas
    - Need to resolve CSN low bias
    - Need to develop filter handling protocols for deployment in routine networks
  - Interpret Gainesville/Duke Forest data in the context of meteorology (RH, dew, Temperature)
  - Final summary report of southeastern study (November 2018)
  - Revisit other CASTNET studies to evaluate ADS versus CASTNET NH4 Aerosol
  - Comparisons of other NHX methods at Duke Forest:
    - CASTNET/AMoN total NHx
    - MARGA (online IC)
    - Nitrotrain (chemiluminescence)
  - Comparison of the cellulose filters at Duke Forest or RTP to test particle Collection efficiency
  - Measure NHx at co-located CSN/IMPROVE sites to further test the method and develop protocols
  - Investigate mechanism of NH4 loss from nylon filters

12. Additional Business

No additional business

13. Meeting Adjourned