TDEP Committee Meeting, April 30, 2018, Milwaukee, Wisconsin

1. **Welcome and Introductions** (Chris Rogers)

2. **Approval of Fall 2017 Minutes**(Chris Rogers)
   - Minutes were approved

3. **TDEP Map Update** (Greg Beachley)
   - Map Status:
     - In transition from Gary Lear to Greg Beachley, Donna Schwede, etc.
     - Updated scripts for 2016 TDEP maps on GitHub by June 1, 2018
     - 2016 maps are completed (TDEPv2018.1) and will be on the website by April 15, 2018. *Update: 2016 maps will be posted to the website during the latter half of the year.*
     - Changes in the 2016 maps:
       - Revised PRISM model (~2014 version) used. This increased wet deposition for all variables by 10%
       - SO2 update: corrects error from 2015 sulfur values
       - SEARCH network values removed for all years
   - The 2016 Map Summary is under development. Draft is expected soon for review
   - Remaining Issues for Future Versions:
     - Modeling Consistency:V2018.1 still uses CMAQ 5.0.2 2002-2012
     - Bias correction is now a deliverable from EPA's Office of Research and Development (ORD)
       - Bias correction surfaces will be delivered in FY 2019
     - Follow up external documentation on model bias is planned. The FY 2018 deliverable for ORD is an EPA internal report.
     - List of issues that will be dealt with in future versions:
       - Precipitation differences with the Program Office
       - Ammonia: issues with emissions inventory and fusing the bi-di surface with measured values
       - Radius of influence/interpolations
       - Sea salt surface estimates
       - 1 in 3 networks
       - Urban continuous SO2 network
       - Ozone dry deposition
   - Script Conversion Progress
     - Greg B has gone through AML scripts with Gary, quasifunctional in Python

- EPA NCEA ORISE fellow Jennifer James has been assisting in the process but her term ends 5/31/2018
- Contractual assistance from Adasphere with Python programming experience. Tasked with converting CASTNET and NADP maps
- Plan is to run maps with Python this summer to work out kinks

- Script Conversion Steps
  - List of Tasks that go into creating TDEP maps
    - Download and interpolate weekly ambient measurement data into rasters (CAMD)
    - Download and interpolate annual wet deposition measurement data into raster files (CAMD)
    - Extract layers and variables from hourly NetCDF model output files into subsetted NetCDF files. This task will migrate to a Python platform (D Schwede)
    - Download, inventory, manage, and archive extracts in NetCDF format (CAMD). Currently, these are not publicly accessible as behind EPA firewall. If public accessibility desired, then this task will have to move
    - Extract hourly values from NetCDF and aggregate into weekly raster files (CAMD)
    - Manipulate weekly raster files (CAMD)
      1. Calculate average model bias
      2. Calculate aerosol particle ratios
      3. Combine weekly model and measurement raster files
      4. Aggregate combined weekly raster files into annual raster file
  - Plot/format maps from annual raster files (CAMD)
  - Export and distribute raster files (CAMD)
  - Document as SOPs (CAMD)
  - It was pointed out that most tasks are being performed by CAMD and help would be appreciated
- The 2016 Map Summary cover will be maps of reduced N as a percent of total; 2000-2002 versus 2014-2016
- Maps of NOx and NHx from 2000-2002 and 2104-2016 show big differences. There is a lot less NOx in 2014-2016 and there is more NHx in 2014-2016
- There are changes in the 2016 maps from the 2015 maps but Greg and Gary feel that the 2014-2016 maps are a more accurate depiction than the 2013-2015 maps
  - The 2016 map shows increased total annual precipitation in the NW and decreased SE precipitation
  - Total N deposition is decreased in OK and N Texas due to decreased precipitation amounts

- ➢ There is more wet N deposition in the Puget sound area and less in OK, N Texas and SE NC
- ➢ There is an increase in reduced N in the Puget Sound, west coast and N California with the increased precipitation and a decrease in reduced N in OK/N Texas. However the percent reduced N stays the same as a result of the decreased precipitation.
- ➢ Question from Doug Burns about if the maps shown included organic N? Right now it is not separated out in the maps. Some changes do not show since the model has not changed yet.
- ➢ Greg Wetherbee wanted to know if data completeness can affect the maps and is data completeness the same between 2015 and 2016? This issue needs to be looked into. Donna said that you can see where sites pop in and out. ADAGIO has similar issues.
- ➢ Chris Rogers wanted to know how we bring the AMoN data into this. Donna replied that AMoN data are used for CMAQ model evaluation. There are two plans including Walker's site characterization study. John said that this is research correction. Some questions are: How do we bias correct the air concentration field? How important is the bias correction? Donna thinks we can get a grid estimate and then compare this estimate to actual measurements, but this is difficult to do and the selected site is very important.

4. TDEP Research Needs White Paper Update (Greg Beachley)

- Science Needs Status
  - ➢ There are 19 Science Need Topics with knowledge gaps
  - ➢ Topics that were merged:
    - Modeling Evaluation and TDEP Uncertainties (group assembled)
    - Importance of Deposition Episodes was added to ON Speciation
    - NOx Measurements was added as a section to Satellite Methods
  - ➢ 'Science Need Summaries' and a 'Knowledge Gap' list were added as call-outs for easier reader reference
  - ➢ Revisions were begun with returned comments which are due May 18th
  - ➢ Second round of revisions and topic finalizations are due August 1st.
- White paper Publication: EM Submission
  - ➢ There will be one paper which will be a summary of the White Paper
    - Publication will be November 2018, after White Paper published on NADP website. *Update: Now targeting spring 2019 issue of EM*
    - Needs to be submitted August 2018
    - 1500 words not including text for figures, tables and references
- White paper Publication: STOTEN Special Issue

- Plan is to open submissions from May 1 through November 30th. *Update: Now August 1, 2018 – January 31, 2019.*
- Ten submissions are confirmed at this point:
  - Overview Synthesis paper (Walker, Beachley and all co-authors)
  - In-canopy Models (Saylor et al)
  - Isotopic Methods (Elliott et al)
  - Trends (Rogers et al)
  - Occult Deposition (Isil et al)
  - Bidirectional NH3 and Direct Flux Measurements (Walker et al)
  - Modeling Uncertainties (Bell et al)
  - Organic Nitrogen Speciation (Benedict et al)
  - Urban Wet Deposition (Wetherbee et al)
  - Source Apportionment (Thompson et al)

- Chapter 4:Enhanced Coordination to Meet Research Needs
  - Has been reviewed by Rea, Wetherbee, Amos, Cruz and Schichtel. Others are welcome to review
  - Current sections:
    - Examples of cooperative stakeholder research needs
    - Identifying opportunities for stakeholder collaboration
    - Strategies for increasing stakeholder coordination
  - General comments
    - Establish more inclusivity (not just agency-specific)
    - Develop a "kick off activity" to have a shared activity and goals
  - Recommendation to form a Stakeholder Workgroup
- Chapter 5:From Deposition to Ecosystem Response
  - Short section, 5 to 6 paragraphs
  - Revisits overarching policy-oriented questions and how they are addressed in the document
  - Reviews scope of document with emphasis on deposition
  - Concluding Points:
    - TDEP should engage more closely with the ecological communities (e.g. CLAD) to prioritize science questions at the interface between deposition and ecosystem response
    - Policy relevant questions linking deposition to ecosystem response and ecosystem services represent an opportunity for extension of this work
- Revised Schedule
  - April – May 2018
    - Revisions to chapters 4 and 5 based on comments from this meeting
    - Topic Captains – first revisions by May 18th
  - April - July 2018

  - Finalization of topics via back and forth dialogue
  - Development of previously unclaimed and expanded topics:
    1. Organic N speciation (importance of Nr deposition episodes)
    2. Spatial NH3 variability
    3. Modeling Uncertainty
    4. Remote Sensing Methods (section to be added to NOx Measurement topic)
- ➢ August 2018
  - Finished draft for NADP internal review by Padgett and Butler
- ➢ September 2018
  - Final draft ready for agency-specific internal reviews
- ➢ September – November 2018
  - Preparation of the Summary and Synthesis submissions for EM and STOTEN
  - Preparation of Topics for submission to STOTEN

5. **AMoN Site Characterization Study** (John Walker)
- Background:
  - ➢ Reduced inorganic N (NH3, NH4+) is an important component of the atmospheric N budget
  - ➢ Air-surface exchange of NH3 is bi-directional and difficult to accurately simulate in dry deposition models
  - ➢ Site specific models may allow for improved estimations of NH3 deposition
- Objectives:
  - ➢ Develop methodology for using 2-week average AMoN concentrations in a bi-di NH3 flux model
  - ➢ Provide NADP with model for calculating and reporting net and component NH3 fluxes at AMoN sites.
  - ➢ Inform use of AMoN measurements in TDEP maps
- Study Design:
  - ➢ Phase I: Develop databases of soil and vegetation chemistry, micrometeorology, and surface physical characteristics at three AMoN sites
  - ➢ Phase II: Use datasets to parameterize and test a bi-di NH3 flux model for use at AMoN sites
    - Assess model sensitivities to biogeochemical and meteorological inputs
    - Develop method to use two-week NH3 concentrations
    - Standardize model for implementation across AMoN
- Input for Bi-directional Flux model
  - ➢ Field-scale inputs include measured soil and vegetation chemistry, ambient NH3 concentrations, and met. This study focuses on compensation points of the

    - foliage and ground layers.
    - Emission potential calculated from model inputs. Currently, data sets of emission
    - potential derived from European experiments. Need relevant biogeochemical
    - data for North America
- Site Selection
    - Three pilot sites were selected based on land use, vegetation and soil type, and atmospheric NH_3 concentrations. The sites are co-located with CASTNET, NADP/NTN, and NADP/AMoN
    - The three sites are: CHA467/AZ98, BVL130/IL11, and DUK008/NC30
- Field measurements collected are:
    - Hourly meteorological measurements of 3D wind components, solar radiation, temperature (2 and 9m), wetness, wind speed and direction
    - Soil moisture and temperature
    - Soil chemistry (NH_4^+, NO_3 and pH)
    - Vegetation structure determined via LAI measurements
    - Vegetation chemistry: moisture and total N, NH_4^+ and pH determined from analysis of bulk leaf and litter
- Status of Phase I Activities:
    - QAPP developed
    - Method developed for vegetation extractions
    - Three rounds of seasonal sampling have been completed with two sets of data received from the analytical laboratory
    - Development of chemistry database underway
    - Template developed for processing of sonic data via LICOR Eddy Pro Software
- Methodology for vegetation NH_4^+ Extractions
    - Litter and leaves/grass samples are ground in liquid N and extracted in water
    - Concentrations of bulk soluble NH_4^+ and H used to calculate stomatal and litter emission potentials
    - Mass of NH_4^+ collected from extracts using sealed headspace diffusion technique
    - Average recovery of greater than 98% across range of standard concentrations from 25-300 micrograms NH_4^+-N
    - Sample concentrations generally range from 10-150 micrograms NH_4-N
- Preliminary chemistry results
    - Soil chemistry is impacted by the vegetation growing on it
    - DUK008 has a lot more NH_4^+ whereas CHA467 has more NO_3. BVL130 has lot of NO_3^- but should change in the spring after fertilizer application
    - Soil pH determined two ways: via extraction in water or $CaCl_2$
    - Acidity of pine needles (DUK008) drives pH values lower. Arid soils at CHA467 have higher pH’s.

- CaCl2 extraction yields lower pH values
- Soil emission potentials ([NH4+]/[H+]) were highest at CHA467; lower emission potential from soils from the pine stands at DUK008
- Compensation point is a function of soil temperature and emission potential
  - Looking at compensation points at 15 degrees C shows that the soil from the hardwood forest at DUK008 is more likely to be source of NH3 to the atmosphere versus the soil from the pine stands at DUK008

- Next steps
  - Finish the last rounds of field sampling
  - Complete database of soil and vegetation chemistry
  - Process 10 hz sonic anemometer data
  - Develop database of micrometeorology and continuous soil measurements
  - Summarize seasonal leaf area measurements
  - Continue to Phase II: bi-directional model evaluation

6. **Proposal for Stakeholder (SH) Workgroup to Address Needs Identified in White Paper** (John Walker)

- Background and purpose of workgroup (WG)
  - The objective of the TDEP White paper is to identify and prioritize needs in Nr deposition
  - Motivation to form SH WG arose from developing the white paper. Collaboration across federal and state agencies, academia, and non-profit groups was identified as a common need to address the most critical knowledge gaps in a timely manner
  - To meet this need, a SH WG focused on building collaboration among groups interested in Nr deposition science is being proposed.
  - This was initially proposed as “inter-agency WG” and evolved from the discussion at the Spring 2017 meeting where it was agreed that a need for this existed and that a smaller subgroup would be the most effective structure
  - Focus is on research needs and policy aspects
  - Interagency was broadened to stakeholder WG to include non-federal partners with a focus on shared goal activities
- Specific objectives
  - Increase communication across scientific communities through organization of scientific workshops, special sessions, and webinar series
  - Create new opportunities for collaborative research by promoting inclusion of deposition science in grant programs
  - Advance integration of TDEP science needs into existing research programs across SH groups
  - Facilitate communication among program managers of the various groups

- Coordinate and engage with user communities, managers and decision makers that need information on deposition
    - Group would not duplicate efforts of the TDEP Science committee
- Structure
    - Group accessible to TDEP and NADP communities
    - Membership likely to expand beyond current TDEP committee to include representation from other groups such as NSF, NASA, EPA Office of Water, EPA regional offices, States, non-profit groups and partnerships like Association of National Estuary Programs, Chesapeake Bay Program, Western regions Air Partnerships, etc.
- Potential Activities for Year One
    - Advance TDEP research activities by picking one of the overarching research topics in the white paper, identify specific opportunities for collaboration, and identify and engage stakeholders and program managers.
    - Create new opportunities for research by engaging with PMs at USDA (NIFA, ARS) to develop a better understanding of RFA development and research planning process
    - Increase communication across scientific communities by planning a workshop with a cross-disciplinary topic that will bring together scientists, PMs, and SHs
- Potential Kickoff Activity
    - An international workshop on uncertainty in measurement and modeling of total deposition budgets.
        - This would be a part of the Fall 2019 NADP Science symposium
        - There will be 3 to 4 invited presentations at Fall 2018 science symposium to present idea and build interest. Presenters would include SHs from NSF Atmo chem, USDA NIFA program, EPA Office of Water, States. Presenters would discuss how deposition science is important to their program.
        - Effort to engage the international community by including GAW total dep measurement-model fusion, Air Quality Model Evaluation International Intitiative (AQMEII), and regional measurement networks in Europe, Asia and Africa.
- So far groups consists of John Walker, Greg Beachley, Anne Rea, and Karelyn Cruz. *Update: Kristi Morris and Bret Schichtel have joined group since this meeting.*
    - Looking for more volunteers
    - Groups to communicate via monthly teleconferences

7. **Dry Deposition Comparison: CMAQv5.0.2 versus CMAQv5.2** (Donna Schwede)

- Introduction:
    - 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

- What is new since CMAQv5.0.2
  - WRF Updates:
    - Land surface model (PX) have a change in stomatal conductance and in soil temperature nudging
    - ACM2 vertical mixing
  - Chemistry:
    - New chemical mechanism (CB6r3)
    - NOy updates and additions: new organic N species with range of solubilities. MPAN and NOx cycling updates
  - Aerosols
    - SOA updates
  - Air-surface exchange
    - Sea salt emissions update to size distribution and added temperature dependency
    - O3 over water – interactions with halogens
    - Gravitational settling of aerosols from upper to lower layers
    - New windblown dust algorithm
- Comparison of CMAQv5.0.2 and v5.2+
  - 2011 used in this presentation; plan to do other years
  - Simulations are CMAQv5.2+ (this is an unreleased version with some updates and is close to v5.3)
    - Different bi-di framework:
      1. Difference in parameterization of compensation point
      2. Reduces to unidirectional with compensation point=0. CMAQv5.0.2 had separate algorithms for uni and bi-directional
      3. Venterea approach for partitioning NH4+ between soil and water solution and soil particles
  - V5.2 boundary conditions are different than v5.0.2
  - Different WRF version
  - NEI updated, but this happens all the time as states submit more data, etc.
- Maps comparing changes between v5.0.2 and v5.2
  - Total S and N maps show changes in N

- ON map shows big changes in the Appalachians. There are also real differences over water; still under predicting ON
- Base cation map shows differences in SW US

- TDEP Wet Deposition – ready for fusion?
  - CMAQ modeling improvements:
    - Lightning data assimilation has improved precip for convective events
    - Model improvements have improved species concentrations
    - ON improved in model; missing in measurements
    - Many updates still planned for aqueous processes, clouds, etc
- TDEP/NADP versus CMAQv5.0.2 Fusion
  - The TDEP approach uses:
    - NADP concentrations and,
    - NADP/PRISM precipitation
  - CAMQv5..0.2 Fusion uses:
    - precipitation adjusted using PRISM
    - bias corrected using NADP
    - more relaxed completion criteria than NADP
  - Donna thinks this approach should be considered
- Future CMAQ Development Plans
  - CMAQ v5.2.1 is available now
  - CMAQ5.3: beta in the Fall; release in Spring 2019
    - Dry deposition options are:
      1. M3DRY: revised from current m3dry; grid based compensation points
      2. STAGE: tile/mosaic approach; 5.2+ additions that were described earlier; Wet cuticle resistance
      3. AERO7: Monoterpene SOA updates; more organic nitrate updates; biomass burning updates
      4. Aqueous chemistry updates
- TDEP Decisions
  - Extend the time series with v5.2/5.3 runs that are available?
    - Effect on trends of using different model versions: which adds more error, using the wrong model year or using different model version?
    - Model run availability: 2015 and 2016 are planned
    - Generating new time series: resource intensive and which version to use?
    - Add wet deposition fusion
      1. Dennis/Foley method is different than what is used for dry dep. What method should be used?
      2. Scripts would need to be developed
  - Discussion: The big question was "Should we go ahead and integrate different model versions into TDEP?

    - Trends analyses will be impacted, but single year estimates will improve
    - We have already used a different version of CMAQ for 2013-2014 than for previous years
    - Since we will need to use different model version at some point, group was in favor of using new versions
    - If we overlap one year, like 2011, we can quantify the differences
    - We can also run one year with two different model versions to help quantify the differences
- CMAQ – CAMx Comparisons
  - ➢ There are a number of differences between the models. The following differences will be with respect to deposition velocity (Vd)
  - ➢ CMAQ uses the Pleim and Ran (2011) model
  - ➢ CAMx is based on the Zhang model but is not exactly the same as Zhang model
  - ➢ Work underway to implement CAMx Vd into CMAQ for diagnostic purposes
  - ➢ Model runs were done for CMAQ Southeastern US Benchmark Case
    - CMAQv5.2 and CAMx v6.4 were used
    - CAMx met inputs were processed through WRF-CAMx. Same WRF runs were for both (but not 100% SURE)
    - Comparisons are for outputs from each model and not as CAMx algorithms in CMAQ
    - There is a difference of 4 cm/sec in Vd for HNO3 which is pretty big. The HNO3 Vd should be more similar since both use similarity theory. So why the differences?
      1. Tile approach (CAMx) versus grid-averaged parameters (CMAQ)
      2. Different land use parameters (e.g. roughness)
      3. CAMX Vd much higher along the coast. Layer collapsing could have something to do with this
      4. CAMx is depositing a lot more during transition from day to night.
    - SO2 comparison is not as dramatic. CMAQ SO2 Vd to wetted surfaces is probably too fast
  - ➢ This comparison process is helping Donna improve CMAQ

7. **Are Recent Annual Nitrogen Wet Deposition Concentrations at Loch Vale , CO biased?** (Bret Schichtel)

- The goal is to reduce N levels in Rocky Mountain national Park (RMNP) to 1.5 kg/ha/year but from 2013 on depositions have been increasing
- However, there were a lot of missing data in 2013, so the results may not have been realistic. So an analysis of how missing data are handled in annual flux estimates was performed.

- Missing ion concentrations are replaced with precipitation weighted annual average of available data.
    - Assumes ion concentrations and precipitation rate are independent and no seasonality in concentrations or missing data
    - These assumptions are not reasonable because there is a strong non-linear dependence of ion concentrations and precipitation as a log regression produced the best fit for concentrations versus precipitation
    - Some sites are highly seasonal like Loch Vale
- How robust are the Loch vale trends? Three issues were investigated:
    - Impacts of incorporating some flagged data
    - Impacts of using alternative data filling methods, and
    - Impacts of excluding some valid data with low bucket sample collection (bucket precipitation rate < rain gauge rate), i.e. only collecting a percent of actual precipitation
- Use of flagged data
    - Valid and invalid concentrations were compared to annual averages for all sites from 2000-2016
        - Contaminated samples and many bulk samples were clearly biased
        - Extended and undefined samples had similar statistics as valid samples
        - Addition of extended and undefined samples to the annual averages did not change the annuals means, on average, but could significantly change a given site-year nitrogen wet deposition rate
- Evaluation of different data filling methods
    - Current method fills in missing ion concentrations using the annual precipitation weighted mean
        - Does not account for ion concentration dependence on precipitation rates and seasonality
    - Use of log regression fit to ion concentrations and precipitation rate for each site and each species
        - Accounts for spatial variation but not seasonal
        - Lack of an extended database at newer sites creates regression stability issues
    - Use of log regression fit to scaled ion concentration across all sites for each species and each season
        - Ion concentrations are scaled by the average at each site and year
        - Assumes concentration-precipitation rate relationship is not spatially dependent
        - Derived seasonal relationships account for the average ion concentration seasonality across the U.S. as well as changes in concentration-precipitation relationship.

- The log ion-precipitation fits produced less bias averages over a year than using the annual average for NH4+ and NO3

- Trends in Loch Vale Nitrogen Wet deposition
  - First used only NADP data flagged as valid
  - Then added non contaminated flagged data
    - Undefined, extended, and bulk samples
    - Buckets collected >20% of precipitation sample
  - Filled in missing ion concentrations values
    - Annual precipitation weighted average
    - Global seasonal logarithmic curve fit equations to fill in missing values
    - Annual site specific annual logarithmic curve fit equations. Each annual equation developed using 5 years of data
  - Conclusions:
    - It appears that using the NADP aggregation methods with <75% valid ion concentrations produced biased values that influenced Loch Vale trends
    - Filling in missing values using a log-precipitation relationship appears to reduce the biased annual averages resulting from large fractions of missing precipitation ion concentrations
    - Incorporation of flagged samples as undefined, extended, and bulk increased sample collection from often <70% to over 75% in most years
- Should some valid data be invalid?
  - NADP uses the rain gauge precipitation rate, when available, to calculate annual averages
  - Valid NADP sampler generally collects a fraction of the total precipitation. Sometimes it can be a very small fraction (<5%)
  - Are ion concentrations dependent on the fraction of precipitation collected?
- Dependence of Concentrations on Fraction of Precipitation Collected
  - There is an apparent increase in ion concentrations as the fraction of precipitation loss from the sampler increases
  - The ion concentration dependence is explained by changes in precipitation rate, except when <25-50% of precipitation sample is collected
  - Low sample volumes in the rain gauge primarily occur in the winter, likely snow events, when ion concentration tend to be lower
  - So concentrations at low rain gauge sample volumes are biased high
- Ion Concentration versus Precipitation Rate
  - There is a strong non-linear dependence of ion concentrations and precipitation
  - Log regression produced the best fit
  - Across the network and the over the decades there is some seasonality
  - Spring concentrations are approximately 50% higher than winter, and spring
  - precipitation is approximately 25% higher than winter

- Sources of Uncertainty
    - Measurement errors
    - Contamination
    - Incomplete Samples
    - Missing Data
- Questions to ponder
    - Can some currently invalid data be used in the annual averages?
    - Can we do a better job filling in missing ion concentrations than using the annual average values?
    - Are there valid data that are systematically biased and should be removed?
- NPS would like to use some of the invalid data and are moving towards some of these alternative methods.
    - Spring workshop in May to discuss this issue: how to use alternative methods in Loch Vale data and other situations as well

9. Update on Flux Studies Database (Chris Rogers)

- Objective is to collect information on completed and ongoing Nr flux measurement studies worldwide
- Database will:
    - Address TDEP methodology for the United States
    - Support model development and evaluation
    - 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. Update on CLAD-TDEP Work Group on Deposition Uncertainty Mike Bell)

- Official launch for work group was in October 2017. Group communicates via monthly conference calls to discuss various topics around deposition monitoring, models, and model use with critical loads

- Model Uncertainty and Critical Loads
  - CLs have been established with a variety of measurements and models
  - Many measurements are on a short timeframe. Can these values be extrapolated?
  - Grid size of deposition models makes it difficult to use at local scales.
- Current objectives
  - Develop database of deposition measurements
  - Downscale deposition models
  - Deposition model comparisons
- Measurement Database
  - 196 snowpack sites distributed throughout the Rockies
  - 136 bulk/throughfall deposition collectors; locally dense, wide distribution
- Comparison Issues
  - Most measurements are not from January to December
  - How easy is it to rearrange model data to fit collectors? (Donna noted that you can aggregate to different time frames)
- Downscaling Deposition
  - Models average land cover types based on percent coverage within grid cell
  - Breaking these down by open and closed canopy systems can assist accuracy and will help with dry deposition and bi-di NH_3
- Model comparisons
  - In order to develop more precise exceedance values, understanding how the modeled values relate to one another is essential
  - Models are TDEP, CAMx, CMAQ, and ADAGIO
- Highlighting Differences
  - Where do they geographically align or conflict?
  - Do these differences lead to change in exceedance?
  - Is there consistency in the areas of difference among sensitive areas?
  - Goal is to determine which factors are most important to define uncertainty moving forward
- CLs for ten different sites using TDEP versus CAMx show significant differences more often than not
- Critical Load Variability
  - Models are being used to develop refined CL maps
  - This work will assist researchers to clarify where the uncertainties are
- Comments:
  - How to best display where these differences do and do not matter? Another WG in CLAD is looking at similar things like this, but in a lot more site specific fashion.

Getting down to the site level makes it a lot easier to quantify what we do and don't know

- Running Monte Carlo for years and years but with deposition there has been guesswork. In certain areas there is a lot of agreement, but not in high elevation areas. The 2010 comparison between TDEP and ADAGIO is a help in this effort.

11. **Update on Total Deposition by Measurement-model Fusion using ADAGIO** (Amanda Cole)

- Measurement-model fusion concept
  - Models:
    - spatially and temporally continuous
    - biases compared to measurements
    - Gaps: compounds, sources, sinks
  - Observations:
    - Superior precision and accuracy at measurement sites
    - Misses hotspots between stations
    - Gaps: compounds, time periods
- Optimal interpolation (OI)
  - $X^a = X^b + K(z-H(X^b))$
    - X^a is the final analysis of fusion values
    - X^b is the model values
    - K is the weight matrix
    - Z is observations
    - H is observation operator
  - Optimal K minimized analysis error variance which depends on observation error variance and model error variance
  - Wet and dry concentrations of each species and season
  - Daily precipitation
- Version 2 of OI
  - More consistent procedure to estimate error statistics
  - Reduces empiricism in the methodology of calculating error stats
  - Recently completed for N and S
  - Results similar to version 1
  - Version 2 subsets 80% of data to calculate error statistics; built in independent validation
  - Final analysis uses all station data
  - Plots of version 2 versus version look almost identical for S and N
- Plots:
  - Reduced versus oxidized N plots show lots of Nr in the Midwest
  - Wet versus dry N deposition plots for S and N show that some station values

inordinately influence model

- Ongoing Work:
    - Quantitative comparison with TDEP (in US)
    - Ozone dry deposition
    - Next model evaluation run:2016
    - Routine annual deposition maps using QC'ed measurements and archived values from operational GEM-MACH runs (2108-)
    - Investigating methods to incorporate satellite measurements of SO_2, NO_2, NH_3
- Ozone dry deposition next as it has been identified as a priority for the global MMF project in terms of ecosystem impacts and atmospheric chemistry

12. CSN/IMPROVE NHx Study in the Southeastern US (Chris Rogers)

- Interest expressed in using existing monitoring platforms to measure NH_3 or NHx for more than 15 years
    - 2003 NADP Scientific Symposium NH_3 Workshop
    - Launch of NADP/AMoN in 2007
    - Testing of fourth, acid-impregnated filter in CASTNET filter pack in the late 2000's in Colorado and Florida
    - Testing of acid-impregnated filter in an additional IMPROVE sampler module in 2010 in the western US
- CASTNET 4th Filter
    - Derek Day at CIRA/CSU successfully ran a CASTNET filter pack with a 4th acid-impregnated filter
    - Attempted in Gainesville using phosphorus acid as part of testing for the ammonia CASTNET CSN Study (ACCS)
- Mini-parallel Plate Denuder (CSN)
    - Mischa Shurman at CSU did initial testing and method development
    - Deployed as part of ACCS at 3 CASTNET sites
    - MRPD versus ADS was about 38%
- Some results from ACCS
    - MRPD for AMoN versus ADS was -9%
    - Precision of the ADS and AMoN samples was 5% for both
    - IMPROVE Pilot Study in the West (Chen et.al. 2014)
    - Comparison with URG reference method at CSU yielded great correlations
    - Very good precision at Rocky and Bondville
- Southeastern US Study design
    - Conducted at two locations: Duke Forest, NC and Gainesville, FL
    - URG denuder/filterpack with a PM2.5 inlet with flow at 10 lpm
    - \- Acid coated denuder collects NH_3

- Nylon filter collects NH4+
- Backup denuder captures volatile NH4+
- Duplicates were run

➢ CSN
- One module collecting NH4+ on nylon filter
- 2nd 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

➢ Preliminary results from Duke Forest showed pretty good agreement from all 3 measurement methods. Results from Gainesville did not show good Agreement

- Next Steps
    - ➢ Complete data analysis and data review
    - ➢ Analyze ADS and CSN nylon filter extracts for anion concentrations (mass balance for NH4+)
    - ➢ Look into "interesting" findings for ADS
    - ➢ Study report
    - ➢ Compare AMoN+CASTNET NHx values
    - ➢ Possibility of some additional IMPROVE and CSN (no ADS) sampling this summer

13. Additional Business

- Election of new TDEP co-chair
    - ➢ Chris Rogers nominated Greg Beachley
    - ➢ Greg Beachley approved by the committee as new co-chair

14. Meeting Adjourned