National Atmospheric Deposition Program

# Measurement Model Fusion Approach for Estimating Total Deposition

## Total Deposition Science Committee

The mission of the Total Deposition Science Committee (TDep) is to improve estimates of atmospheric deposition by advancing the science of measuring and modeling atmospheric wet, dry, and total deposition of nitrogen and sulfur species. TDep provides a forum for the exchange of information on current and emerging issues within a broad multi-organization context including atmospheric scientists, ecosystem scientists, resource managers, and policy makers. Specific charges of the committee and more information and resources can be found on the NADP website at http://nadp.slh.wisc.edu/committees/tdep.

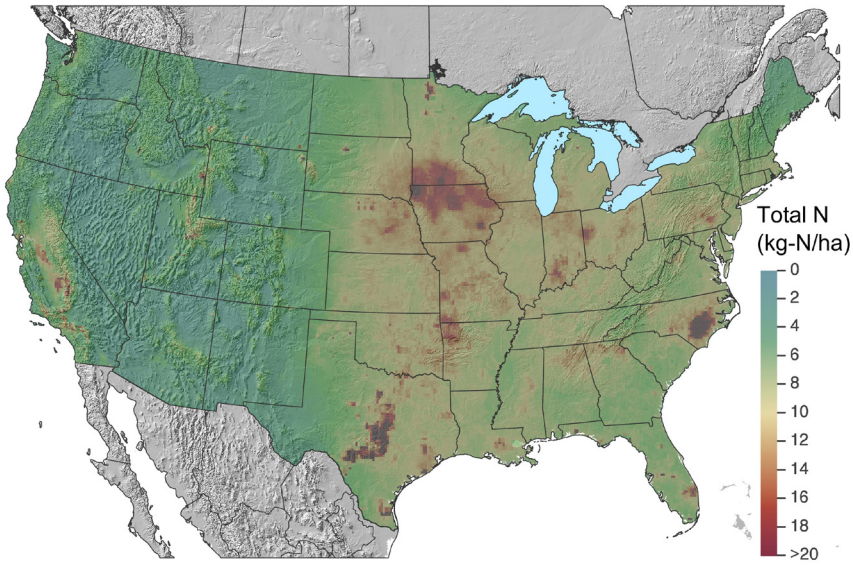


*Figure 1. Map of Total Nitrogen Deposition for a 3-year average of 2019 to 2021*

A goal of TDep is to provide estimates of total nitrogen and sulfur deposition fluxes (Figure 1) across the U.S. for use in critical loads and other ecological assessments, particularly where loading results in the acidification and eutrophication of ecosystems. Total deposition flux estimates are derived from summing contributions from wet and dry deposition. Members of the TDep committee developed and now maintain a measurement-model fusion approach (herein TDep MMF) to map total deposition that combines measured and modeled values. This provides a product that utilizes both the accuracy of the measurements and the spatial continuity of modeled estimates.

In the TDep MMF, measured values are given more weight at the monitor locations, while modeled data are used to fill in spatial gaps and provide information on chemical species that are not measured by routine monitoring networks. One of the main advantages to this approach is that it provides continuous spatial and temporal coverage of total deposition estimates in the U.S. (beginning in 2000). This allows the analysis of trends over time for any location. Figure 2 illustrates changes in the mean deposition fluxes for total N, oxidized N, and reduced N over the contiguous U.S. since 2000. While fluxes of oxidized N—generally stemming from combustion emissions—have decreased due to regulations on air pollution, fluxes of reduced N—mostly contributed by agricultural emissions—have grown. This has led to an overall slight decrease in total N, with a flatter trajectory in recent years.

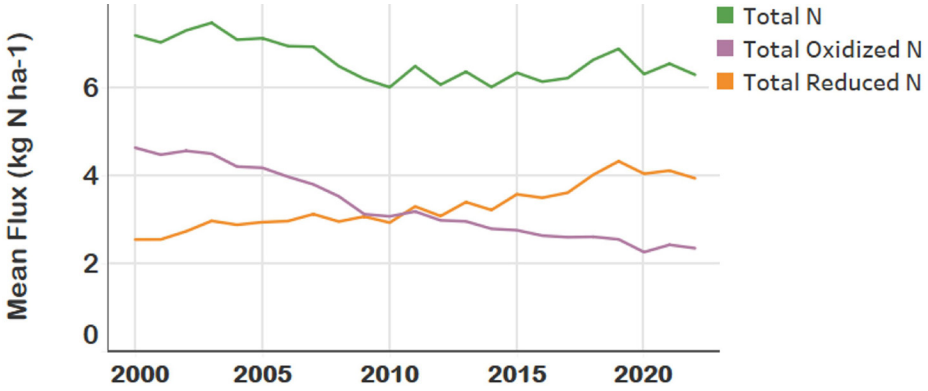


*Figure 2. Trends in mean deposition fluxes of total N, oxidized N, and reduced N over the contiguous U.S. from 2000 to 2022.*

## Methodology

(Details are provided in NADP, 2023 and Schwede and Lear, 2014)

- Wet deposition values are obtained from combining NADP/National Trends Network (NADP/NTN) measured values of precipitation chemistry with precipitation estimates from the Parameter-elevation Regression on Independent Slopes Model (PRISM; https://prism.oregonstate.edu/). The PRISM model estimates precipitation across the U.S. based on elevation and slope as well as weather data.
- Dry deposition flux values are obtained by combining measured air concentration data from the Clean Air Status and Trends Network (CASTNET) with modeled deposition velocities estimated from EPA's Air QUAlity TimE Series Project (EQUATES; https://www.epa.gov/cmaq/equates) decadal simulation using Community Multiscale Air Quality (CMAQ) model 5.3.2 (12km resolution) spanning the years 2002 to 2019. These flux estimates are spatially extrapolated and are fused with the modeled dry deposition fluxes from the EQUATES dataset.
- Dry deposition values for unmeasured species (PAN, $N_2O_5$, NO, $NO_2$, HONO and organic nitrate) are estimated with the EQUATES dataset.
- Dry deposition values are combined with the wet deposition values to produce the final estimates of total deposition.

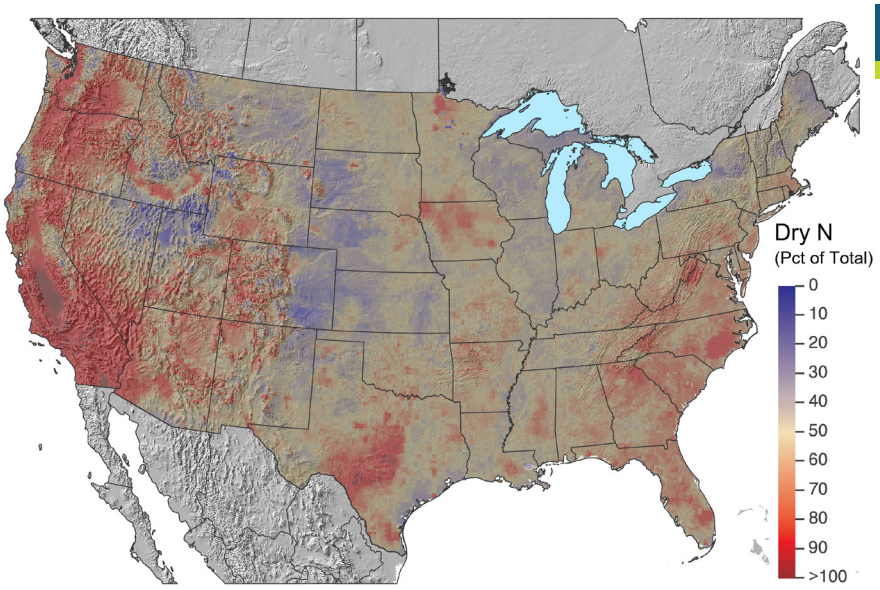


*Figure 3. Map of Dry Nitrogen as a percentage of Total Nitrogen Deposition (bottom) for a 3-year average of 2019 to 2021*

## Availability of Maps and Data

TDep MMF map images and gridded data are available as GeoTIFF files on an annual average basis for years 2000-2022 and as 3-year averages for all components of total sulfur and nitrogen deposition. These components include wet and dry deposition (e.g. shown as a percentage of total N in Figure 3), oxidized and reduced nitrogen, and many of the principal species that make up total sulfur, nitrogen, and base cation deposition. The TDep MMF products are evaluated and updated annually as both model simulations and measurements become available and as the methodology evolves. The products are publicly available for download from the NADP website at https://nadp.slh.wisc.edu/committees/tdep/.

## References and Contact Information

**Contact:**
Greg Beachley (beachley.gregory@epa.gov)

**References:**

- National Atmospheric Deposition Program, 2024. Total Deposition Maps README. Total Deposition Estimates Using the Measurement Model Fusion (TDep MMF version 2023.01) Approach with Modeled and Monitoring. https://nadp.slh.wisc.edu/committees/tdep/ . [4/17/24].
- Schwede, D.B. and G.G. Lear, 2014. A novel hybrid approach for estimating total deposition in the United States, Atmospheric Environment, 92, 207-220. 10-15. 10.1016/j.atmosenv.2014.04.008.

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