The *Global N_2O Database* – Open & collaborative science for addressing epic N_2O issues

Christopher Dorich[1], Rich Conant[1], Daqi Wang[1], Fabrizio Albanito[2], Klaus Butterbach-Bahl[3], Peter Grace[4], Clemens Scheer[3], Val Snow[5], Tony VanDer Weerden[5], and Iris Vogeler[6]

[1] Natural Resource Ecology Lab, Colorado State University, Fort Collins, U.S.A.
[2] University of Aberdeen, Aberdeen, Scotland, U.K.
[3] Karlsruhe Institute of Technology, Garmisch, Germany
[4] Queensland University of Technology, Brisbane, Australia
[5] AgResearch, Canterbury, New Zealand
[6] Aarhus University, Tjele, Denmark

E-mail: chris.dorich@colostate.edu

Abstract

Nitrous Oxide (N_2O) emissions are notoriously variable – through time, across space, and with management and environmental conditions. Full time, gap-free sampling is a rarity in N_2O emissions due to time, cost, equipment and other constraints. These gaps in data lead to uncertainty that requires gap-filling methods to improve N_2O estimates and better examine the mitigation potentials from various management practices. The creation of a *Global N_2O Database* allows for consolidation and compatibility of data sets, which can serve as a catalyst for methods improvement, improved process understanding and emissions estimates, and model improvement within the N_2O field.

Keywords: Nitrous Oxide, Database, Gap filling

1. Introduction

Nitrous oxide emissions are highly episodic with large proportions of annual emissions often released in a small number of events (Davidson et al., 2000). Due to this episodicity, full year continuous measurements are best. When these continuous measurements are not possible, strong statistically based gap-filling methods are necessary to provide accurate flux estimates. However, these methods are under developed and poorly utilized within the N_2O field. More advanced statistical methods (random forest, neural networks) provide an opportunity to better estimate or gap-fill emissions by using our process knowledge of N_2O to utilize associated meta-data (mineral N, climate, soil temperature/moisture, etc) to better estimate emissions (Taki et al., 2018).

Improved methodology is required in the N_2O field in order to 1) gap-fill missing measurements, 2) improve annual estimates, 3) constrain uncertainty in emission estimates, and 4) to develop sound mitigation practices and policy based on complete estimates. The *Global N_2O Database* allows for evaluation across sites, testing of rigorous statistical methods, and testing of globally convergent algorithms for improved gap-filling methods. The improved understanding and methods developed from these efforts are crucial for solving the global challenges associated with nitrogen.

2. Gap-filling methods

We tested 5 gap-filling methods (multiple regression, GAMs, ARIMA, Random Forest, Neural Networks) for their ability to both provide gap-filling estimates and their ability to estimate continuous site level N_2O emissions. We developed an automated framework for testing the 5 methods that allowed examination of various meta-data parameters, as well as development and examinaiton of the various statistical methods. This framework allowed comparison across sites and prevented overfitting of models to a specific site and scenario. Preventing overfitting to a specific scenario is important as sites have varying amounts of measured N_2O days (initial testing done on sites with 60-365 days) as well as number of meta-data parameters (5-20) and duration of meta-data. Comparing methods across a wide set of sites and input data will help inform future studies of minimal data requirements and useful information for field sampling while also providing improved estimates from previous and future studies. Testing across sites will allow for improved understanding of which method to implement in gap-filling based on available meta-data. The gap-filling framework is publically available through the *Global N_2O Database* (ecoapps.nrel.colostate.edu/global_n2o/) where we are continuing methods testing and data upload of N_2O sites.

Acknowledgements

This work is funded by USDA-NIFA (2018-67019-27812) with supplementary funding from the U.S. Office of the Chief Economist. In-kind support is provided by the *Global N_2O Database* steering committee.

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