**Ammonia Emission Potentials for Arctic Soils**

Nahidha Jauhar, Jennifer G. Murphy  
*Department of Chemistry, University of Toronto*

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### Introduction

- NH$_3$ is the most prevalent basic gas in the atmosphere.$^1$
- Can neutralize H$_2$SO$_4$ particles and stabilize them, which can affect air quality.$^1$
- Tropospheric particles can impact radiative forcing by inducing a cooling effect, which can impact climate change by counteracting the radiative forcing of greenhouse gases.$^2$
- Seabird colonies are likely to be an important source of ammonia in the summertime Arctic.$^3$

**Figure 1:** Schematic of soil-atmosphere bi-directional exchange  
- Compensation point is the equilibrium concentration of NH$_3$($g$) based on the pH and ammonium content of the soil.  
- Equation for $\chi$ is derived from the van’t Hoff equation.
- If ambient NH$_3$ $>$ $\chi$, deposition occurs, and if NH$_3$ $<$ $\chi$, emission occurs.

### Methods

- Soil data were obtained from existing literature and the Arctic Data Centre repository.$^4$  
- Temperature data were obtained from the Government of Canada website.  
- Ambient ammonia data was collected in 2015 by Murphy and group members.  
- Variables of interest were soil ammonium content, pH, and moisture content, which were then used to calculate emission potential of ammonia.  
- In the calculation, the ratio of NH$_3$($g$) to H$^+$ was determined per dry weight of soil (mol/kg dry soil).  
- Molarity ratios could not be used since the pH of added liquid for soil slurries was not known.

### Results

- Even at one site, emission potential ranges over more than one magnitude.  
- The lowest value was less than 1 while the highest was over 1000 units among all sites studied.

**Figure 2:** Histogram of all emission potentials  

- pH varies more than NH$_4^+$ in Arctic soils, thus leading to more variation in emission potential.  
- At a given site, emission potentials can vary over large magnitudes, which is likely due to varying soil characteristics.  
- It is difficult to determine a single emission potential value to describe the Arctic.  
- At ALERT/ Patterson River, the soil appears to be a source of ammonia since ambient ammonia is less than the compensation point.  
- Sources of error may include the assumption that emission potential is constant throughout the year as well as for different years (Figure 7); this is a limitation of the data.  
- Another source of error is the fact that air temperatures were used for compensation point calculation, as opposed to ground surface temperature.  
- Future studies could look at the impact of different microbial communities on ammonia in Arctic soils. This study could also be part of a larger one on ammonium cycling in the Arctic in general.

### Discussion

**Figure 3:** Map of sites with histograms of emission potential  

**Figure 4:** Gradient plot of NH$_3$($g$) with H$^+$ with data points  

**Figure 5:** NH$_4^+$ and pH with emission potential scatterplots  

**Figure 6:** Compensation point at Patterson River in 2009  

**Figure 7:** Compensation points and ambient ammonia at ALERT, Nunavut in 2016  

- For a given site, emission potential can be estimated if NH$_3$($g$) and H$^+$ are known. To use pH, one requires the moisture content range to obtain an estimate of possible emission potential values.

**Figure 8:** Histogram of all emission potentials based on the pH and ammonium content.  

**Figure 9:** Compensation point at Patterson River in 2009 which is close to Patterson River.

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Arctic Data Centre: [https://arcticdata.io/catalog](https://arcticdata.io/catalog)

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