Dry deposition of reactive Nitrogen over the São Paulo state, Brazil

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Abstract

Human activities have been changing deposition rate of the atmospheric reactive N over the last decades. The understanding of the process that rules the accumulation and deposition of reactive nitrogen in the environment still faces major gaps mainly in regions with lack of data as South America. In this work, we evaluated the atmospheric dry deposition of reactive nitrogen (Nr) using concentration measurements of different chemical species, in six sampling sites with different environmental characteristics in the state of São Paulo, Brazil, for a sampling period of approximately 24 months (2015-2017). We used the sampling system DELTA (Sampler for Atmospheric Sampling of Long Term), and ion chromatography method to determine the concentration of gaseous (NH3 and HNO3), and particulate (NH4+ and NO3-) chemical species in the atmosphere. The N-NH3 (gaseous) was the dominant form of Nr in the atmosphere at all sampling sites. The highest N-NH3 mean value was found near the urban area of the municipality of São Paulo (SP, 1.58 ± 0.73 μgN m-3) and the lowest mean value in the most eastern sampling site (0.26 ± 0.26 μgN m-3). The high values in the SP sampling site is related to the intense traffic in the metropolitan area and, also to waste management, industrial NH3, and human emissions as observed in other urban areas around the world. The particulate N-NH4+ is the second most common form of Nr in the São Paulo state atmosphere. The other forms of Nr in the atmosphere, the gaseous HNO3 and particulate NO3, represent only about 10% of the total Nr in the atmosphere each. The total gaseous Nr concentration was a factor of 1.7 larger than particulate Nr. The Nr deposition varied throughout the years. We did not observe a pattern of variation linked to meteorological characteristics of dry and wet season, as observed in other regions of the globe. However, we found good correlation with wind speed higher than 3.5 m s-1 and humidity. Our results provide the first spatial analysis of Nr deposition using in situ data in a Latin American region and will contribute to the understanding of nitrogen balance and to improve Nr deposition modelling approaches. This study was supported by the project Nitrogen cycling in Latin America: drivers, impacts and vulnerabilities (Nnet, IAI/CRN3005 and FAPESP 2012/06416-1), PCI Program of the MCTIC, and collaborators.

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Problem Definition

Human activities have been changing deposition rate of the atmospheric reactive N over the last decades. However, the understanding of the process that rules the accumulation and deposition of reactive nitrogen in the environment still faces major gaps mainly in regions with lack of data as South America.

Objective

Evaluate the atmospheric dry deposition of reactive nitrogen (Nr)

Using concentration of:

- Gaseous: NH_3 and HNO_3
- Aerosol: NH_4^+ and NO_3^-

Deposition velocity (Flechard et al. 2011)

Methods

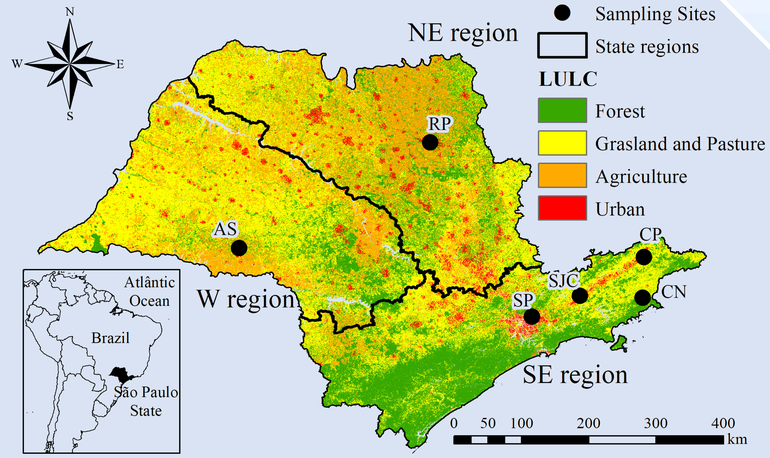
Sampling period: 24 months (2015-2017);

6 sampling sites, with different environmental characteristics;

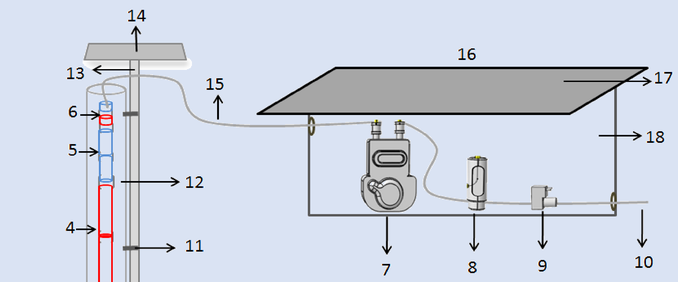
State of São Paulo, Brazil;

Sampling system DELTA;

Determine the concentration: Ion chromatography method.



Study site (State of São Paulo, Brazil).



1: Input Air
2: Funnel
3: Teflon Inlet
4: Basic Denuder (HNO_3)
5: Acid Denuder (NH_3)
6: Basic Filter (NO_3^-)
Acid Filter (NH_4^+)
7: Gas Meter
8: Rotameter
9: Air Pump
10: Output Air
11: Brackets
12: DELTA Enclosure
13: Galvanized Tube
14: Enclosure
15: Silicone tube connection
16: Air Pump System
17: Solar Panel
18: Equipments enclosure

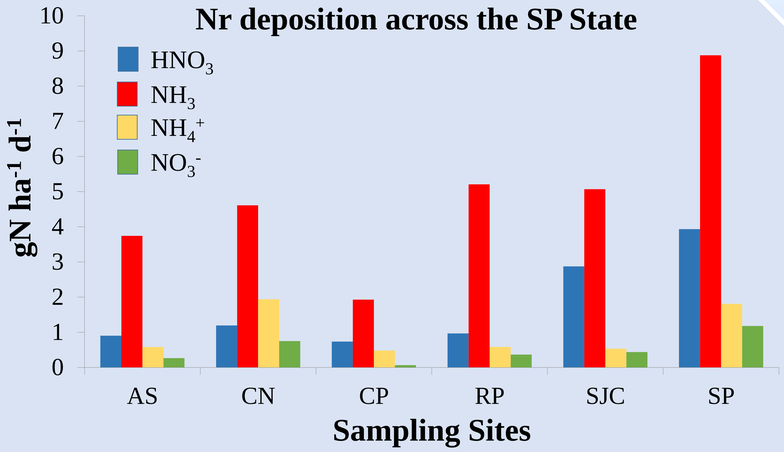
Schematic diagram of the DELTA system.

Results and Conclusion

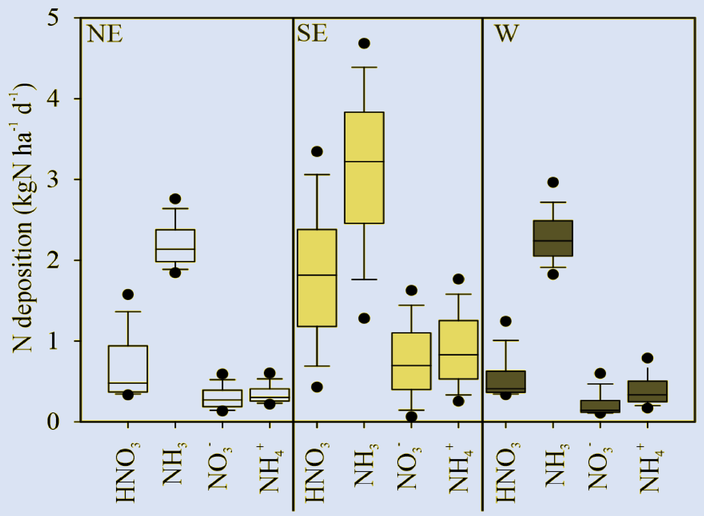
Atmospheric Nr concentration

- N-NH_3: dominant form of Nr in the atmosphere at all sampling sites (57%)
- NH_4^+: The second most common form of Nr
- HNO_3 and NO_3: represent 10% of the total Nr in the atmosphere each

Atmospheric Nr deposition



- Not observe a pattern of variation linked to meteorological of dry/wet season
- Found good correlation with:
  - Humidity
  - Wind speed higher than 3.5 m s^{-1}



- High deposition in fragments of Atlantic Forest: higher than the critical N and may represent a high risk for the local biodiversity.

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