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ATMOSPHERIC NITROGEN SPECIES DISTRIBUTION UNDER INFLUENCE OF AGRICULTURAL SOURCES IN A BRAZILIAN REGION

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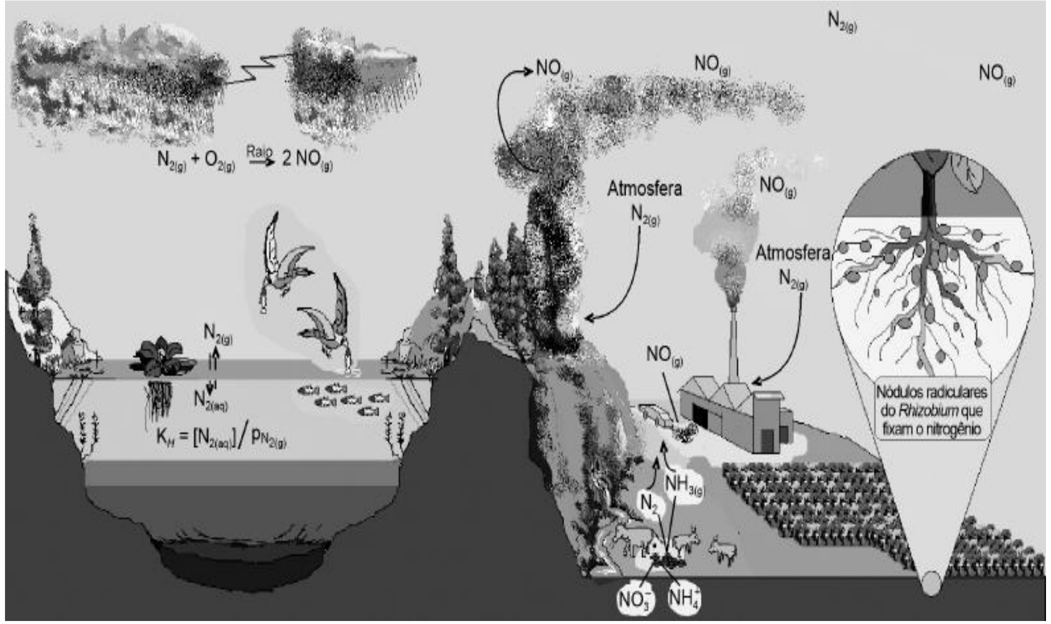
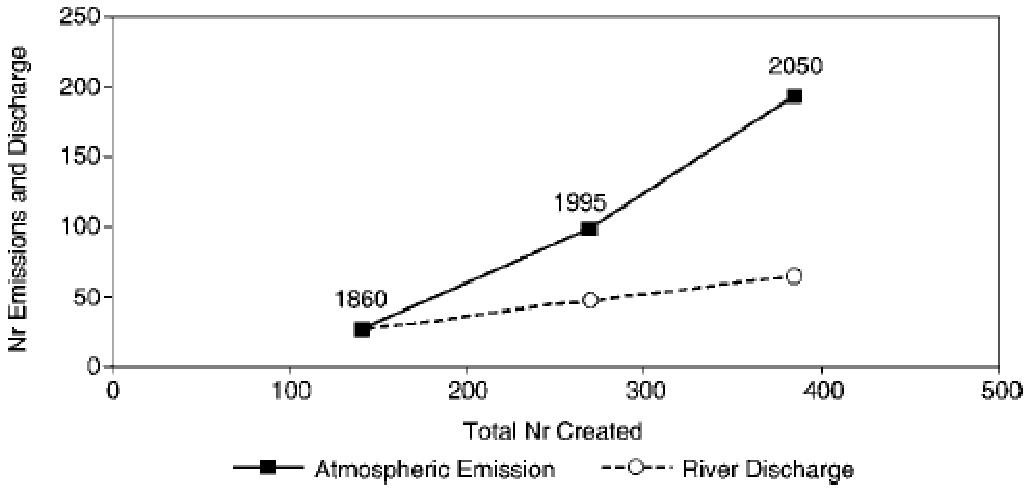
ATMOSPHERIC NITROGEN EMISSIONS

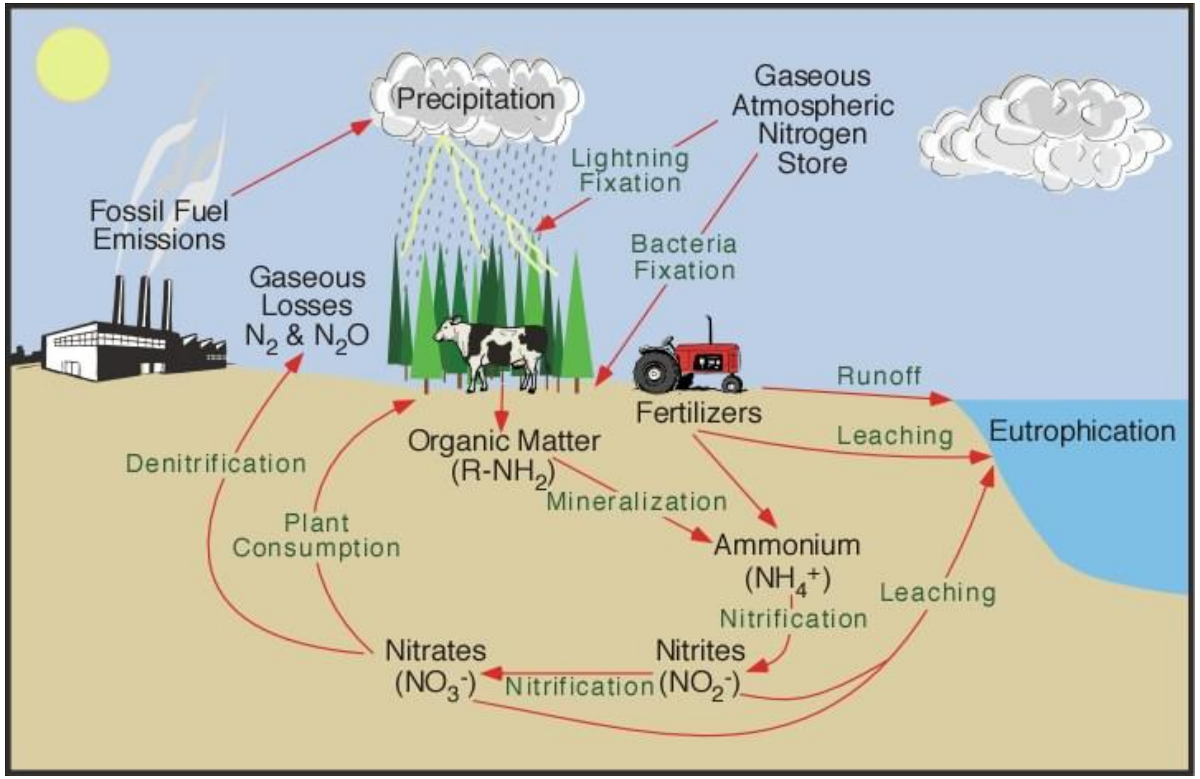
In the last centuries, several activities, such as fossil fuel combustion, mobile exhaust engines and agricultural activities account to increase reactive nitrogen (Nr) emissions into atmosphere.





Lenzi and Favero (2019); Xing et al. (2018); Galloway et al. (2004).

ATMOSPHERIC NITROGEN DEPOSITION

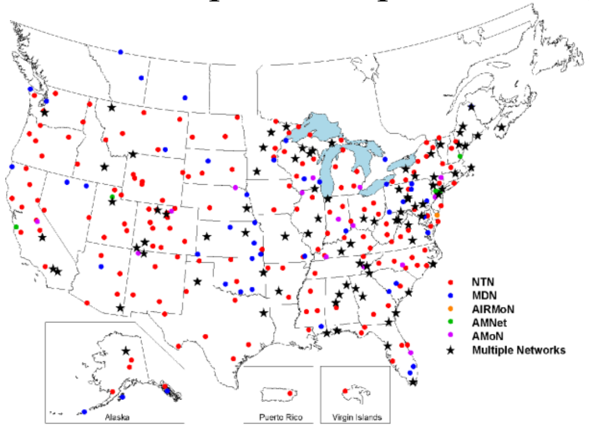


- These species may be modified by (photo)chemical reactions and enter into biogeochemical cycles of terrestrial and aquatic ecosystems through bulk deposition (dry deposition + wet-only deposition).
- In the environmental ecosystems, N deposition may be a source of nutrients and could improve productivity. On the other hand, the excessive nitrogen input may cause acidification of forest soils, eutrophication, unbalance and decreases in biodiversity, and enhanced greenhouse gas emissions.

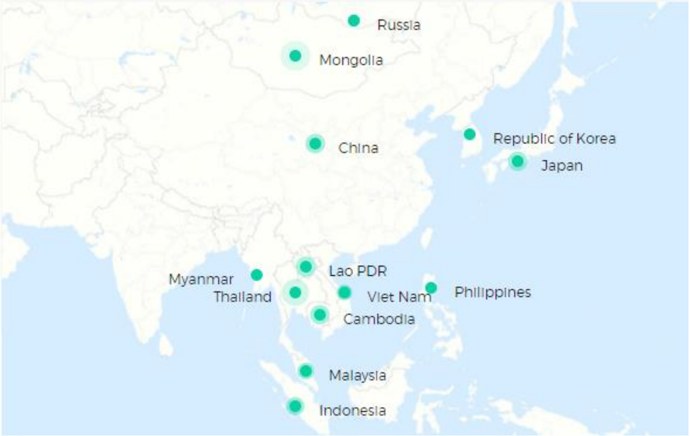
Qiao et al. (2018); Stevens et al. (2018); Violaki et al. (2010).

MOTIVATION AND GOALS

National Atmospheric Deposition Program



Acid Deposition Monitoring Network in East Asia



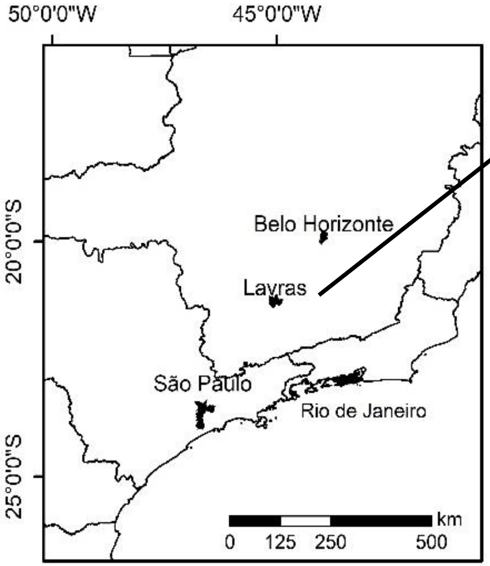
No established network for monitoring nitrogen deposition

We evaluated and quantified the atmospheric deposition fluxes of TDN, DIN and DON in a region with agricultural influences in the Southern Minas Gerais region, Brazil.

Wang et al. (2018); Vet et al. (2014).

SAMPLING SITE

Sampling site: Brazilian city with rural background



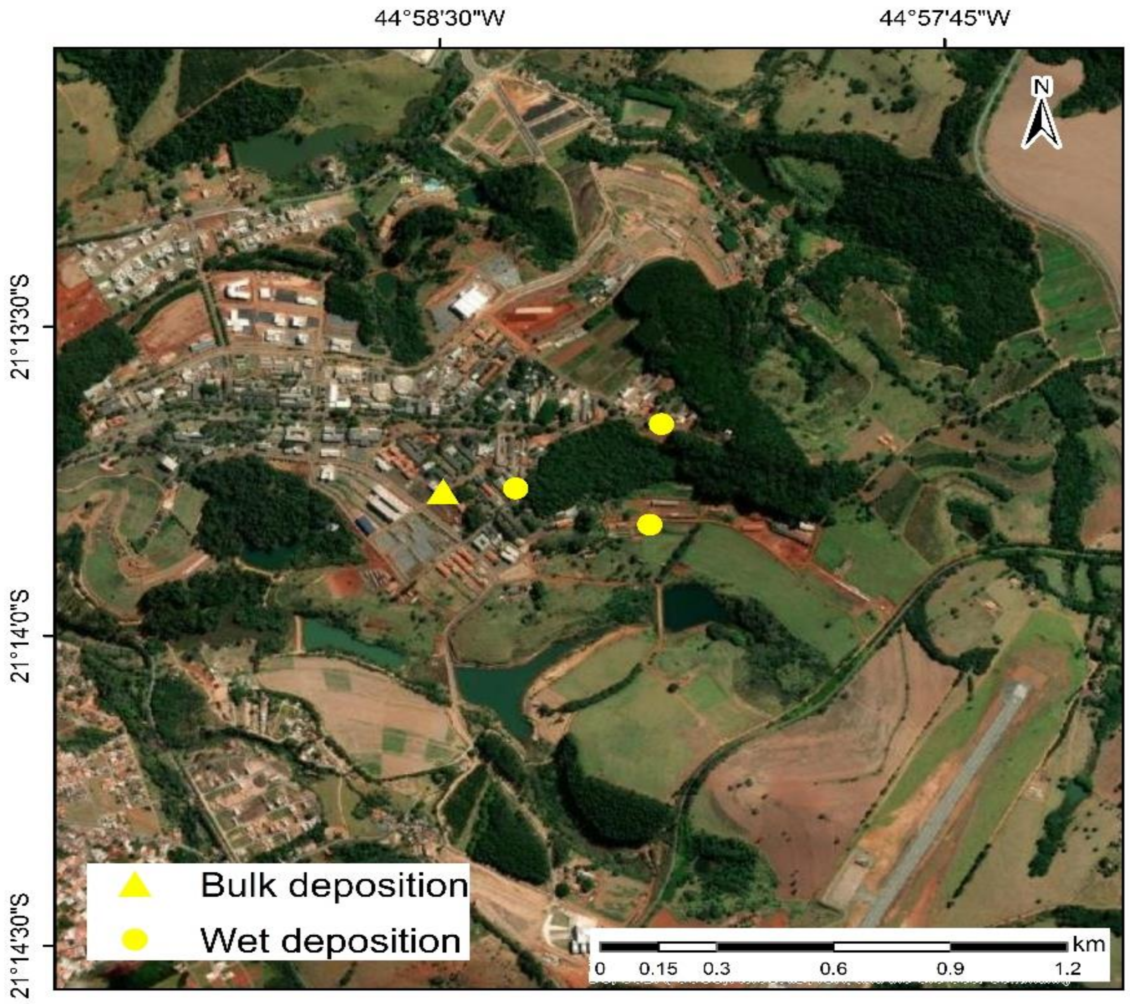
LAVRAS – MG

- Area of 564.744 km², 919m of altitude and a population of 102,728 inhabitants;
- 19% (107 km^2) of its total area is associated with agricultural activities, mainly coffee production and an average synthetic nitrogen fertilizers application rate in Minas Gerais region is around 110.4 $kgha^{-1}yr^{-1}$;
- Its vehicular fleet has about 50 thousand light-duty vehicles, comprising 54% automobiles and 26% motorcycles;
- Long-term average annual precipitation (1981-2010) is 1462 mm, with 85% of the rainfall occurs in the wet period (October to March). The mean annual temperature is 20.3ºC.

IBGE (2014); IBGE (2018); DENATRAN (2018); INMET (2019).

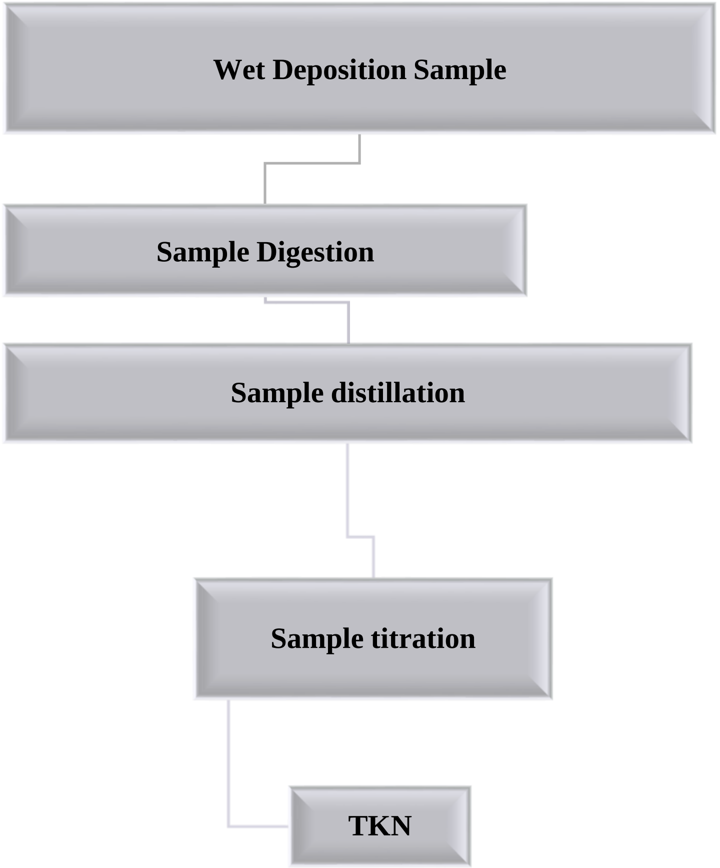
SAMPLING SITE

From May 2018 until April 2019 we monitored nitrogen atmospheric deposition, trough both wet and bulk deposition samplers, which were installed in the campus of Universidade Federal de Lavras.



WET DEPOSITION SAMPLING

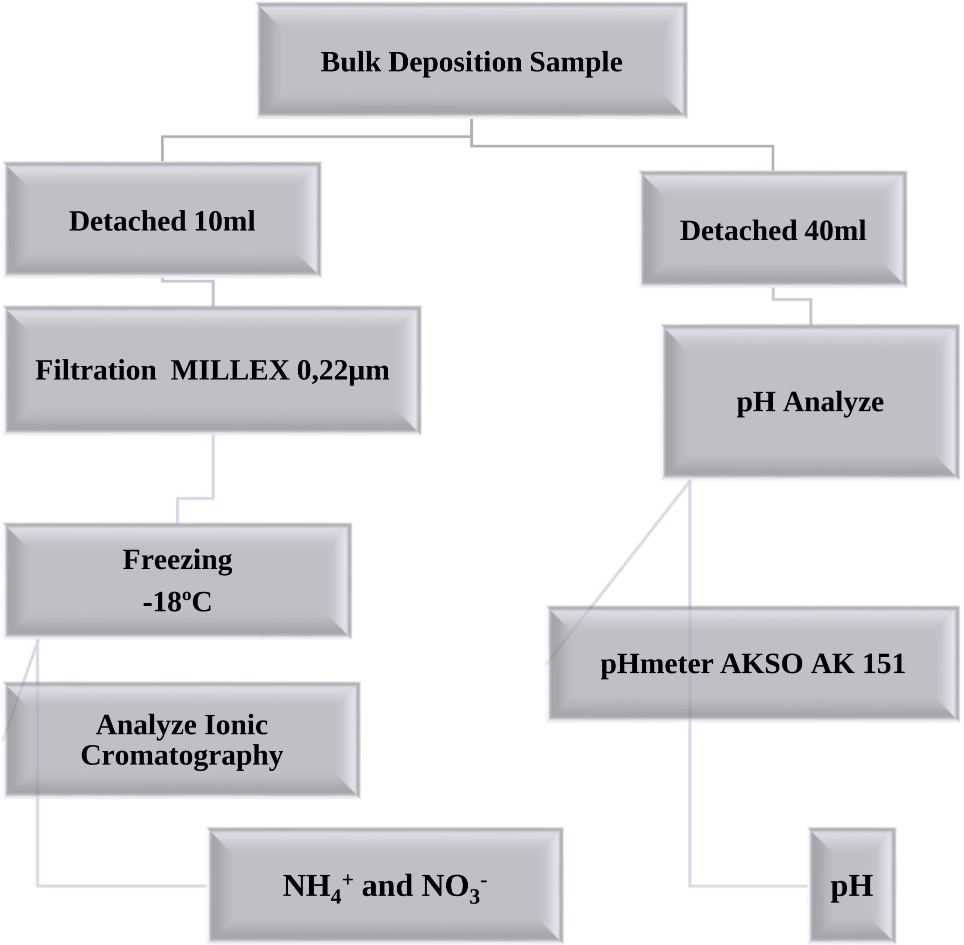
- 61 different precipitation events were collected with at least 5 mm;
- Sampling after each precipitation event;
- Sampler: 3 Ville de Paris-type rain gauges;
- Samples were analyzed monthly, adding an aliquot of each rain-gauge in the same flask.



APHA (2014)

BULK DEPOSITION SAMPLING

- 36 bulk deposition samples;
- Sampling period: around 7 days;
- Sampler: high-density polyethylene bucket (NALGON) of 10L with a collecting area of 439 cm^2, inside a PVC structure attached in a wood stand with 1,50 meters above ground level, covered with a nylon screen;
- We added 50 mL of deionized water in the absence of precipitation, in order to analyze soluble species.



WMO (2004)

DATA ANALYSIS

Monthly and Annual Nitrogen Deposition Fluxes of TKN, NH_4^+ and NO_3^-

$$I = 0.01 \sum_{i=1}^{n} C_i \left(\frac{V_i}{A}\right) \quad (1)$$

I = input (kg.ha-1.month-1 or kg.ha-1.yr-1);
C = nitrogen specie concentration ($mg.L^{-1}$);
V = volume of sample (L);
A = collector area (m^2);
i = number of sample;
n = amount of samples at the corresponding monthly or annual scale.

Filoso et al. (2003) and Allen et al. (2011):
Wet = 0.50 * Bulk

Monthly and Annual Nitrogen Deposition Fluxes of DON, DIN and TDN

$$DON = TKN - NH_4^+ \quad (2)$$

$$DIN = NH4+ + NO3- \quad (3)$$

$$TDN = DIN + DON \quad (4)$$

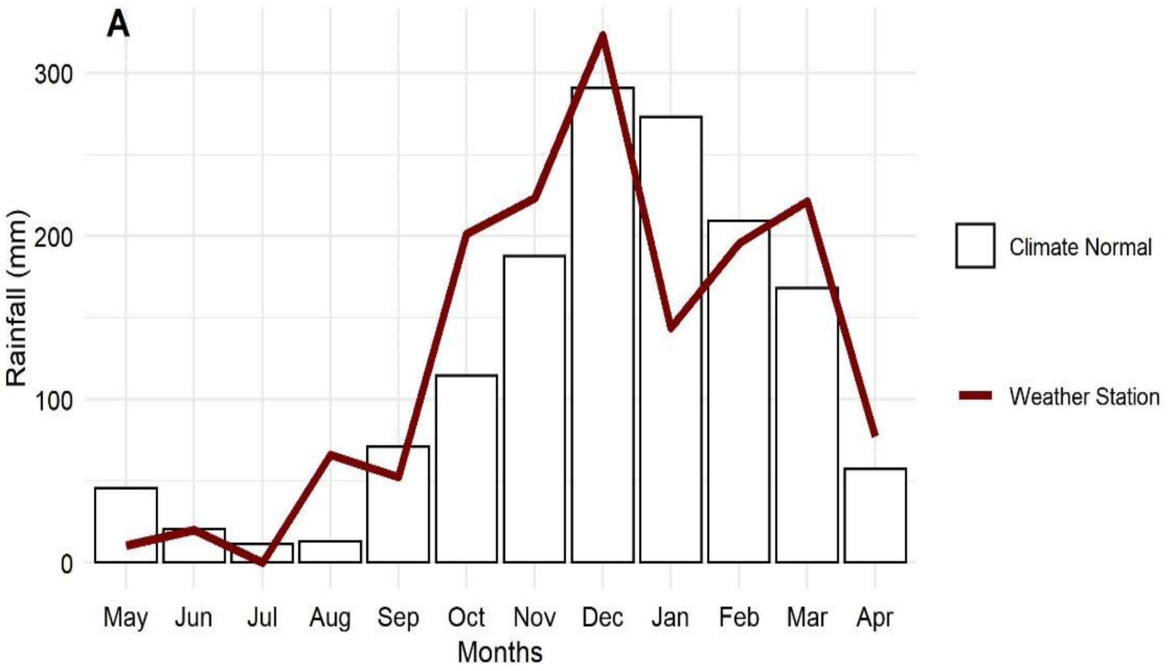
Statistical Analysis

All statistical analysis (correlation and variance analysis - ANOVA) and data processing was performed in R environment.

Song et al. (2017); Zhang et al. (2020); Filoso et al. (2003), R Core Team (2019).

FINDINGS - RAINFALL SEASONAL PATTERNS

Period: May 2018 – April 2019



Climatological Normal (1981 to 2010): 1462 mm
Lavras' weather station: 1535.3 mm (positive anomaly +5%)

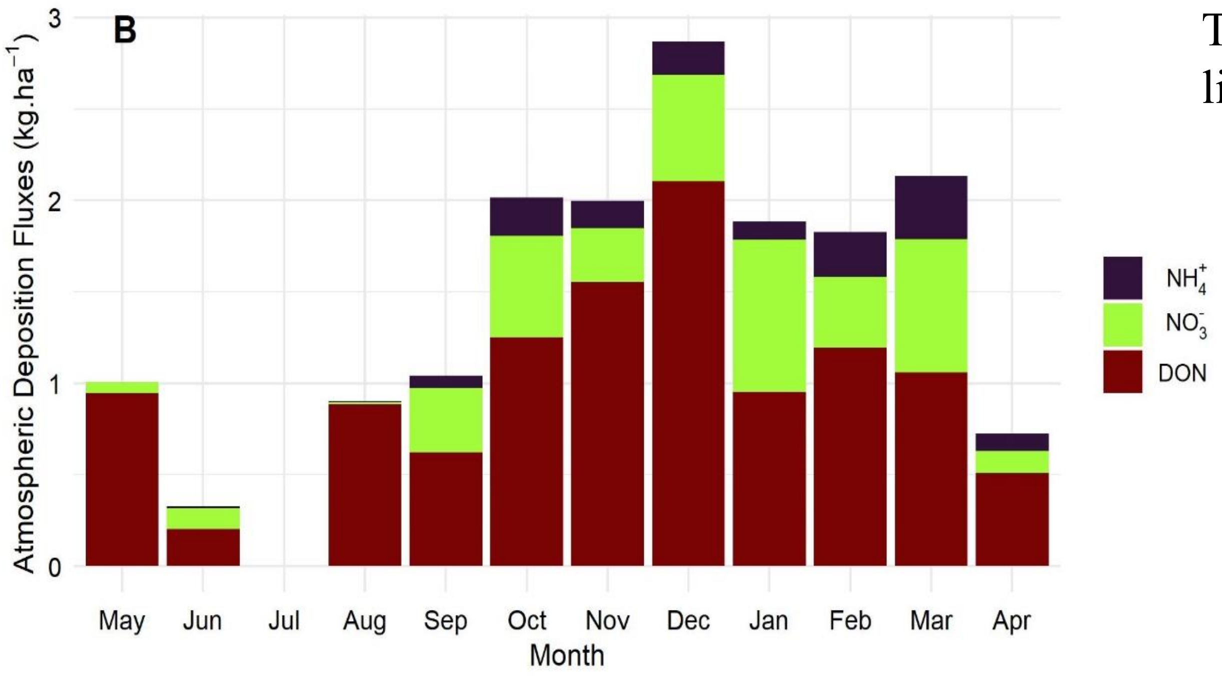
Wet deposition:
1524.6 mm
99% from rainfall values

Bulk deposition:
1050.4 mm
68% from rainfall values

Wet season (October to March):
86% of the rainfall
(ANOVA test; p-value < 0.05)

INMET (2018)

FINDINGS – NITROGEN DEPOSITION FLUXES



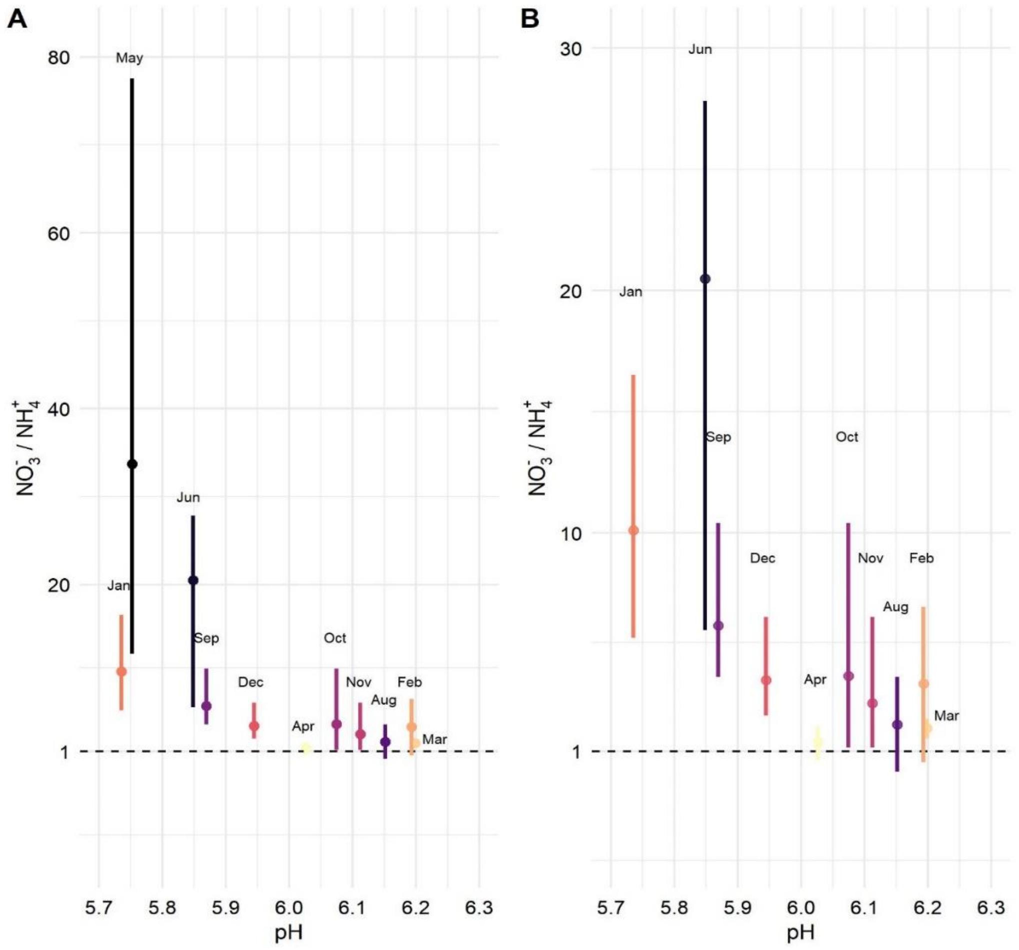
TDN fluxes were comparable with the global estimates at sites like eastern North America, Southern Brazil, Europe and Asia.

Monthtly Variability ($kg.ha^{-1}.month^{-1}$)	Annual Fluxes ($kg.ha^{-1}.year^{-1}$)
NH_4^+: 0.003 – 0.343	NH_4^+: 1.41 (8%)
NO_3^-: 0.011 – 0.831	NO_3^-: 4.04 (24%)
DON: 0.203 – 2.103	DON: 11.28 (68%)
TDN : 0.328 – 2.869	TDN : 16.73

NH_4^+, NO_3^- and DON fluxes increased by 6.74, 5.15 and 2.56 times, respectively, during the October to March period (wet season), shown a distinct seasonal pattern significant in comparison with the dry season (ANOVA test; p-value < 0.05).
October to March: nitrogen fertilizers application period.

Vet et al. (2014)

FINDINGS – NO_3^-/NH_4^+ RATIO



pH values

Min: 5.7 in May
Max: 6.2 in April
Annual average: 5.98

pH values were above 5.6 for all study period, suggesting alkaline behavior.

NO_3^-/NH_4^+

Min: 1.36 in April
Max: 33.7 in May
Annual average: 8.25

NO_3^-/NH_4^+ ratios were above 1 for all study period, suggesting predominance of oxidized nitrogen species as NOx from agricultural soil emissions

Low NO_3^-/NH_4^+ ratios were associated to high pH values and rainy months.

Zheng et al. (2020)

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SUMMARY

- TDN, DIN and DON deposition fluxes were influenced by the rainfall distribution pattern and agricultural sources inside the county air basin;

- DON was the predominant specie throughout the sampling campaign, with a monthly relative TDN contribution ranging from 50% to 98%;

- High NO_3^-/NH_4^+ ratios were linked to NOx emissions from agricultural soils and lower NO_3^-/NH_4^+ ratios were associated to higher pH values, suggesting neutralizing processes in the atmosphere;

- The distribution pattern of inorganic species may be associated with DON deposition fluxes.

Thank you for your time!