Relative contributions of NH_3, NO_2, NH_4^+ and NO_3^- to dry deposition of Nitrogen at an agricultural site in the Indo-Gangetic Plain of India

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Reactive N

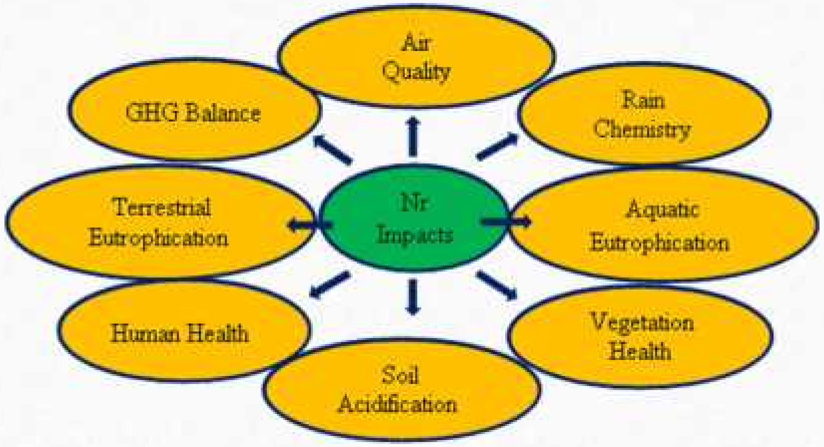
- ✓ Nitrogen gas (N_2) accounts for more than 99.99% of all the nitrogen present in the atmosphere, while of the rest, again 99% is accounted for by nitrous oxide (N_2O) (Wallace and Hobbes, 2006). Other N species are thus only present in trace concentrations, but nonetheless play a vital role in atmospheric chemistry.

- ✓ It includes all biologically, chemically, and or photochemically active N compounds in the environment .

- ✓ Different forms of reactive N occurring under natural conditions are (NH_3), (NH_4^+), (NO), (NO_2), (HNO_3), (N_2O), and (NO_3^-) and organic compounds (urea, amines, nucleic acids and proteins).

Alarming threat..

Estimated total reactive nitrogen deposition from the atmosphere (wet and dry) in early 1990s, and projected for 2050.



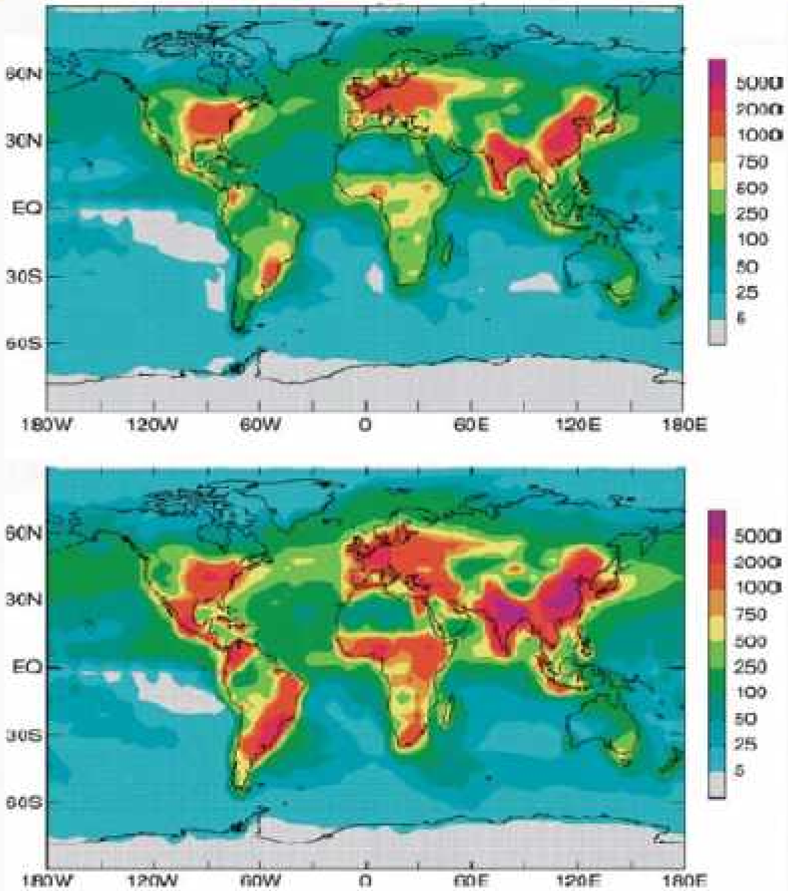


Fig: Spatial patterns of total inorganic nitrogen deposition in (a) early 1990s, and (b) 2050 (unit in mg N /m^2 /yr)

(Galloway et al., 2004).

Motivation

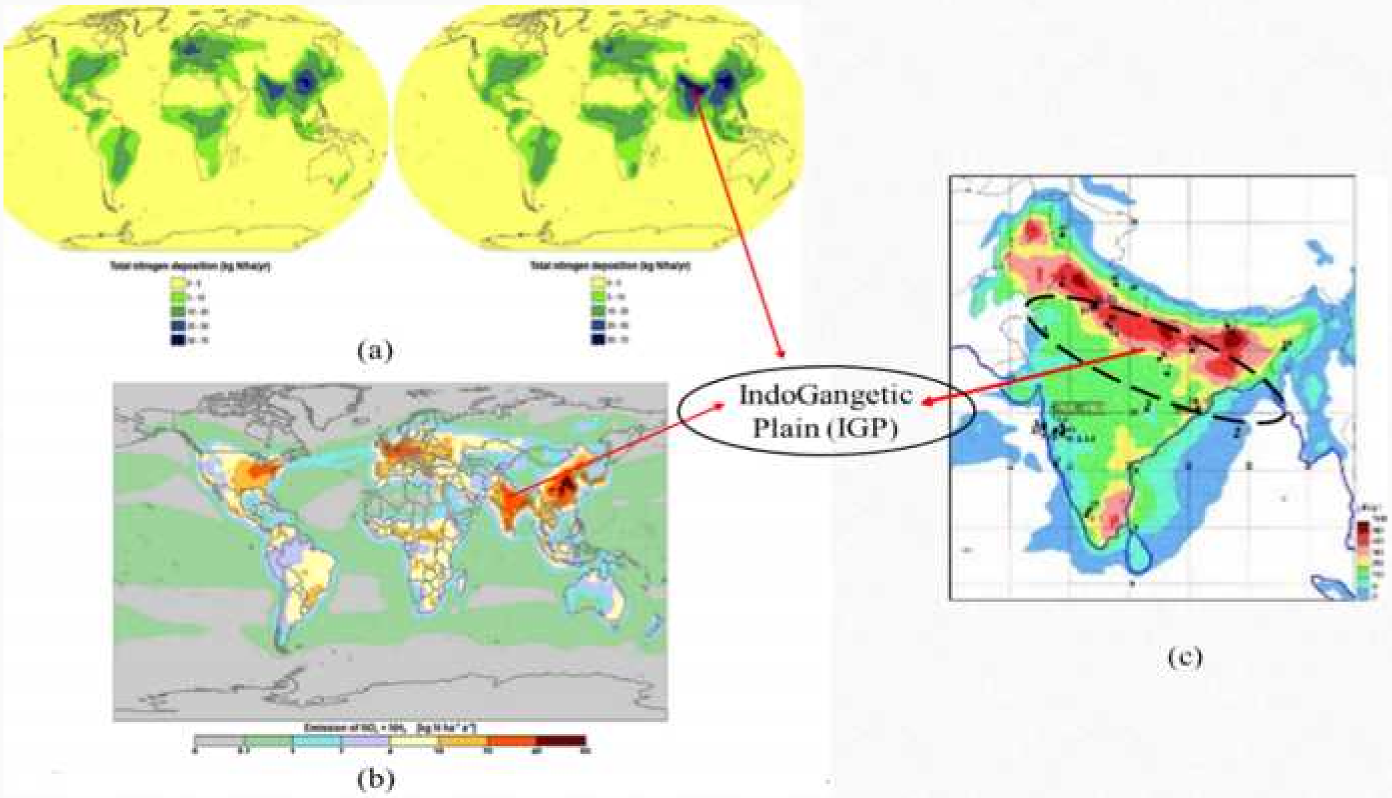
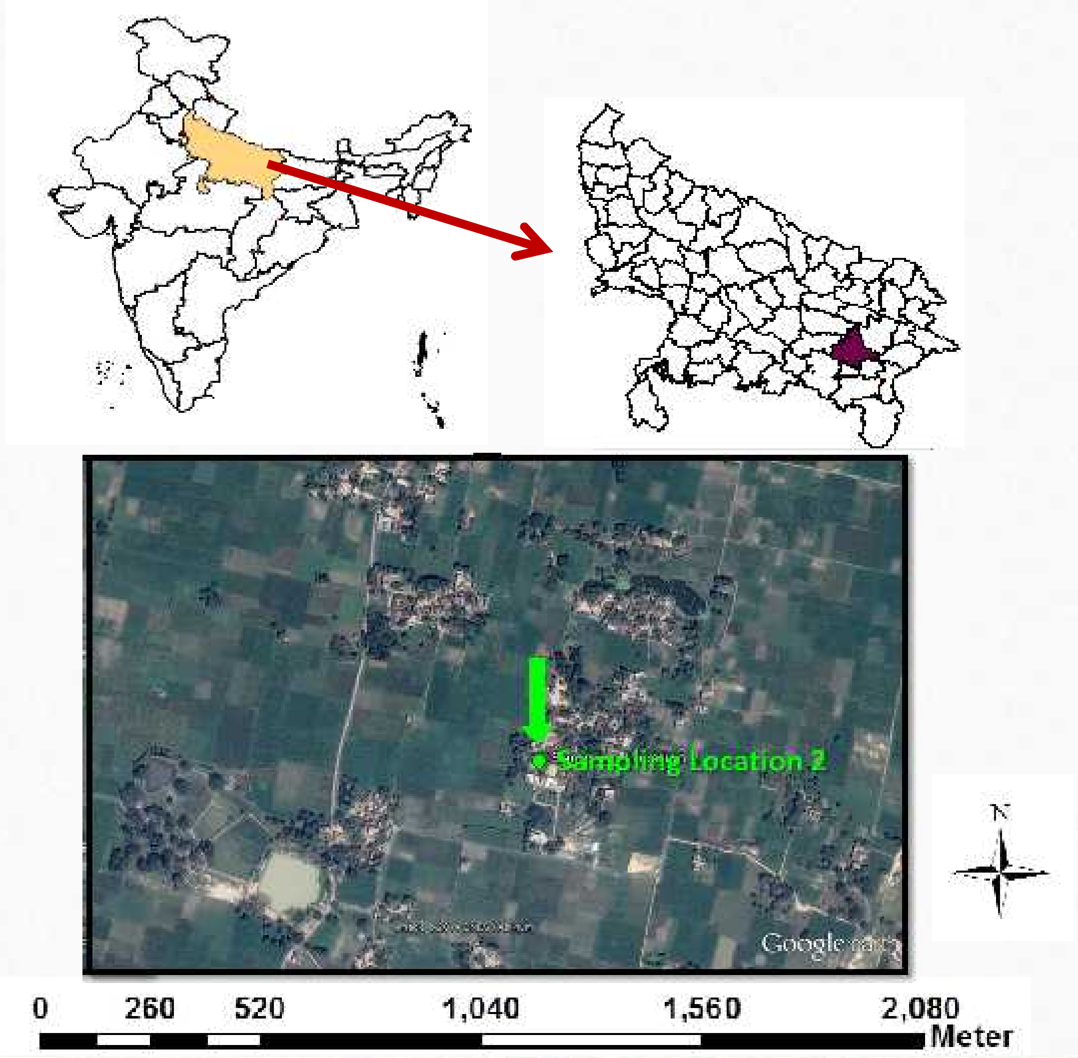


Fig: Nr deposition in India indicating IGP as a hotspot (a) Spatial distribution of total N (Kg N/ha/yr) for 2000 (left) and 2030 (right) (Bleaker et al., 2011) (b) NO_x –N + NH_3-N (Kg N/ha/yr) obtained from the 16 HTAP NO_x models 7HTAP NH_3 models (Vet et al., 2014) (c) Concentration of NH_4^+ in rain (μeq/l) (Kulshrestha et al., 2005).

Study site



Mai Village, Jaunpur, Uttar Pradesh (rural site)
25^{0}62'N and 82^{0}51'E

- ✓ Approximately 62 % area is used for agricultural purpose.
- ✓ Urea and DAP fertilizer

Sample collection

Dry deposition

- Gases (NH_3, NO_2) & Particulates
- Impinger method
- Handy Sampler
- Monthly basis
- Monsoon 2013

Sample collection procedure and analysis

1. Gaseous Samples: (NH_3 & NO_2)

- ✓ Gaseous samples (NH_3 and NO_2) were collected on **8 hour basis** together with aerosol samples at a **flow rate of 1 LPM** on monthly basis. On an average 7 days sampling was done in a month on day-night basis.

- ✓ Absorbing solution

  NH_3 - 25 mM H_2SO_4 solution

  NO_2 - 0.1 M NaOH solution

- ✓ All gaseous samples were stored at $4^{O}C$ before chemical analysis.

Gaseous NH_3 was analysed by Blue Indophenol method and NO_2 was estimated colorimetrically by using spectrophotometer.

2.Particulate Phase Sampling:

Fine aerosol samples were collected using handy sampler (Envirotech make) covering all the seasons, with flow of 1 LPM using Teflon filters (25mm dia).

3.Analysis of major ions:

Major anions (Cl^-, F^-, NO_3^- and SO_4^{2-}) and cations (Na^+, K^+, NH_4^+, Ca^{2+} and Mg^{2+}) were determined in the water soluble extracts of aerosols and rain water by using ion chromatograph (IC).

Ion balance method was adopted for the quality check of samples.

Instruments used for analysis

(a) Ion chromatograph

(b) UV-Vis Spectrophotometer

(c) pH meter

Deposition Flux calculation

- Dry deposition flux was calculated as the product of the atmospheric concentration and deposition velocity of a given a given compound. (Roberage et al., 2002; Horii et al., 2005; Shen et al., 2013).

$$F= V_d * C$$

Where V_d is deposition velocity of gas or aerosol and C is concentration (µg/m^3) in ambient atmosphere.

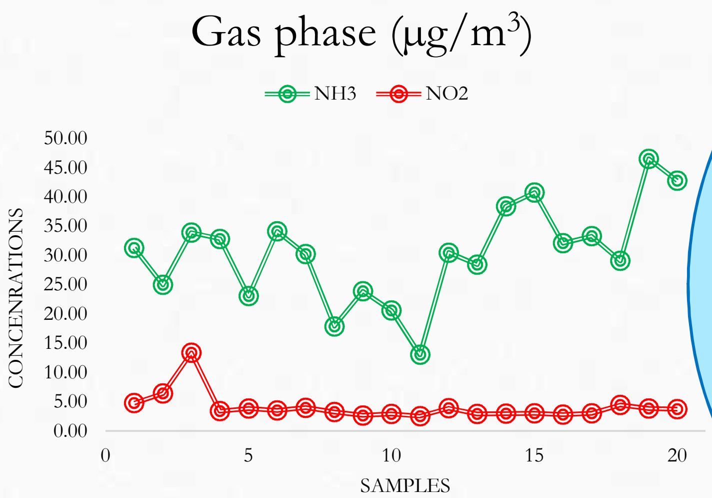
For gaseous NH_3, V_d is taken as 0.2 cm/sec while for NH_4^+ the value was 0.15 cm/sec. (Kulshrestha et al., 2005; Zhang et al., 2012).

- Wet deposition fluxes (kg/ha/yr) of NH_4^+ and NO_3^- were calculated on the basis of following formula

$$\text{Flux} = \text{Concentration of species (C)} \times \text{precipitation amount (P)}$$

Results

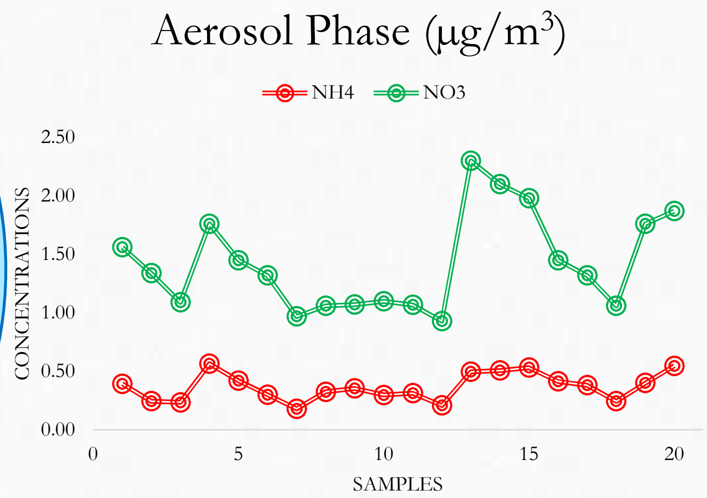
Dry Deposition



Total concentration of N in DD= 26.90 ($\mu g/m^3$)

Fractions %

Oxidized = 5.83
Reduced = 94.17
Gas = 97.73
Aerosol = 2.27



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Where V_d is deposition velocity of gas or aerosol and C is concentration (µg/m^3) in ambient atmosphere.

- ✓ For gaseous Nr, V_d is taken as 0.2 cm/sec while for aersol Nr the value was 0.15 cm/sec. (Kulshrestha et al., 2005; Zhang et al., 2012).

DD flux (KgN/ha/yr)

N-NH_3 = 15.78
N-NO_2 = 0.77
N-NH_4^+ = 0.14
N-NO_3^- = 0.15

Total Dry Deposition Flux = 16.84 KgN/ha/yr

* 98 % of dry deposition occurred in gas phase at this site.

Total Dry inorganic N deposition Flux

Relative Contribution

N- DD Flux = 16.84 KgN/ha/yr

Reduced N = 94.54 %
Oxidized N = 5.46 %

N-NH_3 (g) = 93.70 %
N-NO_2 (g) = 4.57%
N-NH_4^+(p) = 0.8%
N-NO_3^- (p) = 0.9 %

Conclusions

- Total dry deposition flux of inorganic nitrogen at the site was 16.84 KgN/ha for the monsoon period.
- Relative contribution of reduced N deposition was much higher (94.5 %) that oxidized N deposition.
- Contribution of Gaseous NH_3 was highest in total Nr dry deposition at the site with 93.7 %.
- The results of this study are highly important not only to strengthen our understanding about Nr deposition in India but also for necessary abatement measures and **with these future outlook…..**

✓ Due to higher deposition of Nr in Indo-Gangetic plain and its related adverse effect, the research of Nr in atmosphere become very significant.

✓ There is a gap between atmospheric Nr understanding in Indian research community, because of less data available from past, research in field of Nr needs urgent attention of scientific community in India.

Thank you !!

☺☺

Suggestions/Questions/Comments

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Reduce your N Print