Satellite observations of ammonia over India for improved emission source estimates

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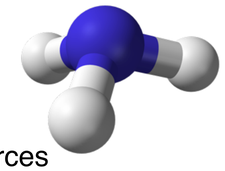
INTRODUCTION

Ammonia is a key precursor of haze particles (ammonium nitrate - NH_4NO_3) and the global nitrogen cycle.

- Forms NH_4NO_3 through reaction with nitric acid

India is important due to:

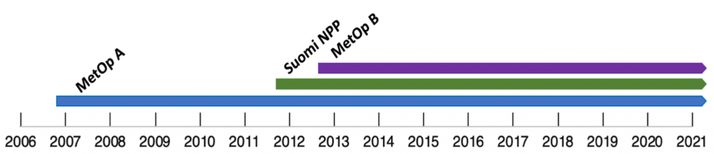
- Rising population
- Rapid urban development
- Poor air quality
- Numerous and varied emission sources



SATELLITE REMOTE SENSING

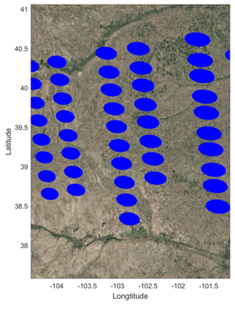
Objective: Use new advances in satellite observations to understand air quality and climate.

- Produce high-resolution maps of ammonia sources in India (agriculture, fires, urban).
- Use improved emissions inventories to improve models and make more accurate predictions for air quality and climate.

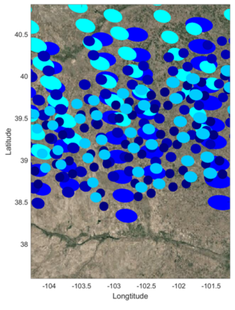


OVERSAMPLING

Measurements from multiple overpasses may be combined and averaged spatially.
A 2-D Gaussian is used to estimate the spatial response function of each pixel, determining the weighting of overlapping pixels. These data can then be applied to a regular grid.



Satellite footprint from single track

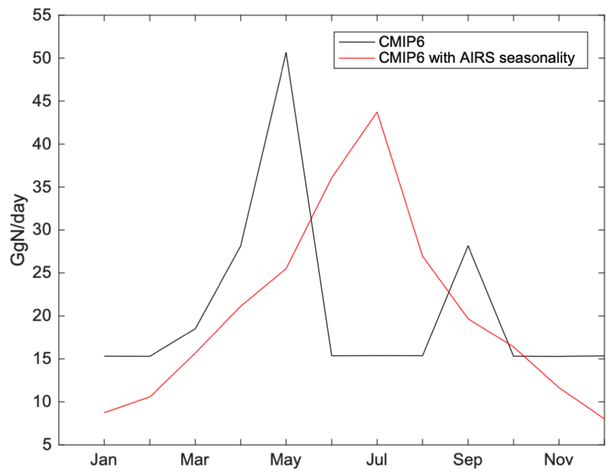


Satellite footprint from multiple days

EMISSION INVENTORIES

Most current models for India use CMIP6 emissions outputs. CMIP6 Indian emissions estimates are based on those from Europe.

- These have a bimodal annual cycle
- Peak in spring and autumn

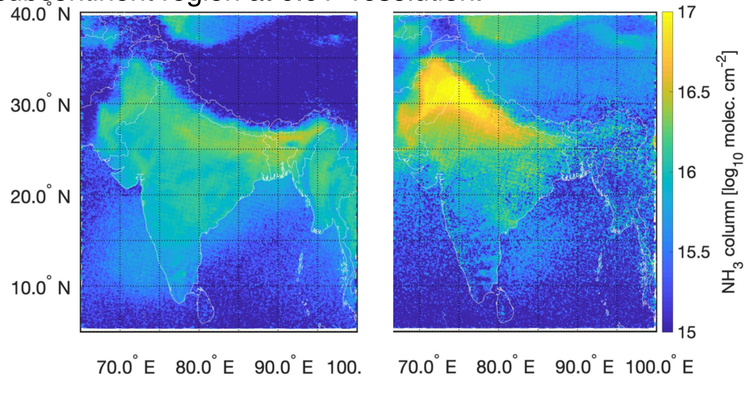


CMIP6 ammonia emissions for India with seasonality from CMIP6 (black) and AIRS (red)[2]

Modeled (AM3) ammonia emissions using observed Seasonality results in a reduction of winter aerosol effect from -2.7 to -19 W m^{-2} dec^{-1}.

RESULTS

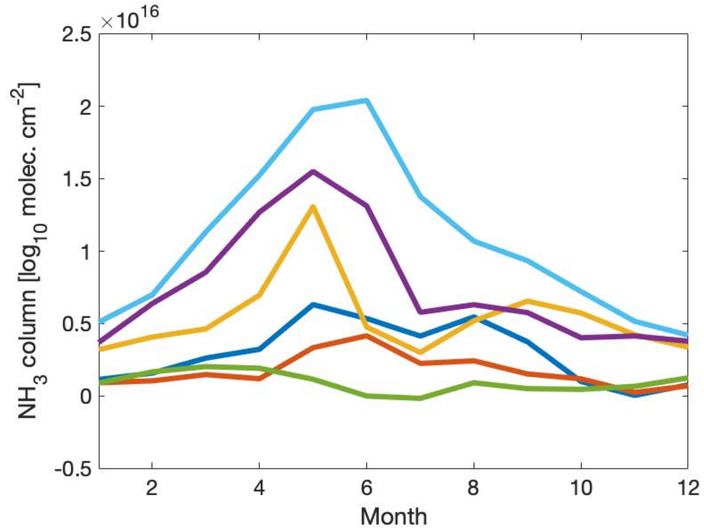
Oversampled IASI (Infrared Atmospheric Sounding Interferometer[3]) data have been studied over the Indian subcontinent region at 0.01° resolution.



Spatiotemporal variation in NH_3 column, March (left) and July (right) of 2015.

NH_3 SEASONALITY

Seasonal trends for ammonia have been measured across various regions of India.



CMIP6 predicts the May maximum contributing to 21% of total nitrogen across the region, we observe this varies between 5% in northwest India to 25% in Nepal and southeast India.

SUMMARY

India shows high spatiotemporal variation in observed NH_3 column due to varied emissions sources.
Oversampling to a regular grid allows spatial dependence of NH_3 seasonality to be measured.
Ongoing work focuses on utilizing the maps obtained from satellite observations and improved model input parameters to provide better estimation of the NH_3 emission sources for accurate predictions of air quality and climate in this region.
Satellite measurements of CO and fire count can help Determine contribution of biomass burning to NH_3 emissions.

REFERENCES

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