

Investigation of sources and sinks of isocyanic acid, formamide and acetamide in the north-western Indo-Gangetic Plain (NW-IGP) during winter season

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*A dissertation submitted for the partial fulfilment of
BS-MS dual degree in Science*



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Certificate of Examination

This is to certify that the dissertation entitled “**Investigation of sources and sinks of isocyanic acid, formamide and acetamide in the north-western Indo-Gangetic Plain (NW-IGP) during winter season**” submitted by **Mr. Abhishek Verma** (MS13091) for the partial fulfilment of BS-MS dual degree program of the Institute, has been examined by the thesis committee duly appointed by the Institute. The committee finds the work done by the candidate satisfactory and recommends that the report be accepted.

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Dated: April 20, 2018

Declaration

The work presented in this dissertation has been carried out by me under the guidance of Dr. V. Sinha at the Indian Institute of Science Education and Research Mohali.

This work has not been submitted in part or in full for a degree, a diploma, or a fellowship to any other university or institute. Whenever contributions of others are involved, every effort is made to indicate this clearly, with due acknowledgement of collaborative research and discussions. This thesis is a bonafide record of original work done by me and all sources listed within have been detailed in the bibliography.

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In my capacity as the supervisor of the candidate's project work, I certify that the above statements by the candidate are true to the best of my knowledge.

Dr. V. Sinha
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Notation (Abbreviations)

1. **NW-IGP:** north western Indo Gangetic Plain
2. **VOC:** Volatile organic compounds
3. **PTR-MS:** Proton transfer reaction mass spectrometer
4. **DPM:** Dew point mirror
5. **ALW:** Aerosol liquid water

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Abstract

Biomass burning/fossil fuel combustion are considered to be the major sources of atmospheric isocyanic acid and its precursors (formamide and acetamide). This study provides new insights into the sources and sinks of these Volatile Organic Compounds (VOCs) during winter time.

All VOCs measurements were carried out using a Proton Transfer Reaction-Mass Spectrometer (PTR-MS) from 14.12.2014 to 03.02.2015 at a 4 minute temporal resolution at a representative suburban site in the NW-IGP (north-western Indo-Gangetic Plain). Average VOC concentrations during winter time were formamide (5.1 ppbV) > acetamide (1.1 ppbV) > isocyanic acid (0.4 ppbV).

Good correlation of ICA with solar radiation ($r = 0.7$) suggests photochemical production to be its predominant source. Diel profile analysis of acetamide and formamide suggests that these compounds are the dominant precursors of isocyanic acid. Inter gas phase specie correlation reveals that biomass burning/fossil fuel combustion does not appear to be major source of isocyanic acid and its precursors ($r \leq 0.5$ for correlation with CH_3CN , CO, NO_x and C_6H_6).

A strong correlation ($r \geq 0.9$) of isocyanic acid, formamide and acetamide with SO_2 and NH_3 suggests aerosol-gas phase bidirectional transfer. Strong positive correlation of formamide and acetamide was observed ($r = 0.8$) with relative droplet volume ($\text{H}_2\text{O}(\text{g})/24\text{hr Average}$), indicating aqueous phase uptake plays a significant role in regulating their levels whereas weak correlation ($r = 0.4$) in the case of isocyanic acid indicates partial role of aqueous phase. Comparison of $d[\text{isocyanic acid}]/dt$ (from sunrise to daytime maxima) in three distinct periods during winter followed the order sunny > overcast > fog which was opposite to levels of RH (a proxy for aerosol liquid water) consistent with the above hypothesis.

The ambient concentration of isocyanic acid exceeded 1ppbV (exposure level of documented concern) on 28 out of 46 days highlighting the need for controlling the sources of its precursor compounds regionally.