# Satellite monitoring of ammonia: from point sources to long-term trends

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## Abstract

IASI satellite $NH_3$ measurements are used to identify, categorise and quantify world's $NH_3$ emission hotspots. In particular, using spatial oversampling and supersampling techniques, we are able to track-down more than 500 localized point sources of agricultural, industrial - fertilizer, coking, soda ash, geothermal and explosives industries-, urban and natural origin. Calculated satellite-based emissions suggest a drastic underestimation of point sources in bottom-up inventories, especially those of industrial emitters. Using IASI dataset for temporal analysis reveals rapid shifts in anthropogenic activities and distinct pattern in long-term trends.

Keywords: Ammonia, IASI satellite, trends

## 1. IASI satellite retrieval

The IASI mission consists of a suite of three infrared sounders providing today over 11 years of consistent global measurements (from end of 2007 up to now). In this work we use the version 3 of the ANNI retrieval algorithm (Van Damme et al., 2017; Franco et al., 2018), recently validated with in-situ columns (Guo et al., in prep.).

## 2. Point sources catalogue

Firstly, using a spatial oversampling approach which allows one to increase the spatial resolution of averaged satellite data beyond what the satellites natively offer, we identify, categorise and quantify over 200 agricultural and industrial $NH_3$ hotspots with associated point sources (and over 170 source regions). More than half of these point sources relate directly to fertilizer industry, but also other industrial sectors emerge as major emitters of $NH_3$. While calculated satellite-based emissions over large source regions are generally in line with what is reported in bottom-up emission inventories, our results suggest a drastic underestimation of point sources, in particular of industrial and agricultural origin (Van Damme et al., 2018).

Secondly, using a superresolution technique common in image processing but applied for the first time to observations of a satellite sounder, we track-down further global point sources. More than 500 of them are now reported in our $NH_3$ catalogue (https://www2.ulb.ac.be/cpm/NH3-IASI.html), classified in 11 categories: five types of industries –fertilizer, coking, soda ash, geothermal and explosives industries–, agriculture, natural, urban and non-determined (Clarisse et al., 2019).

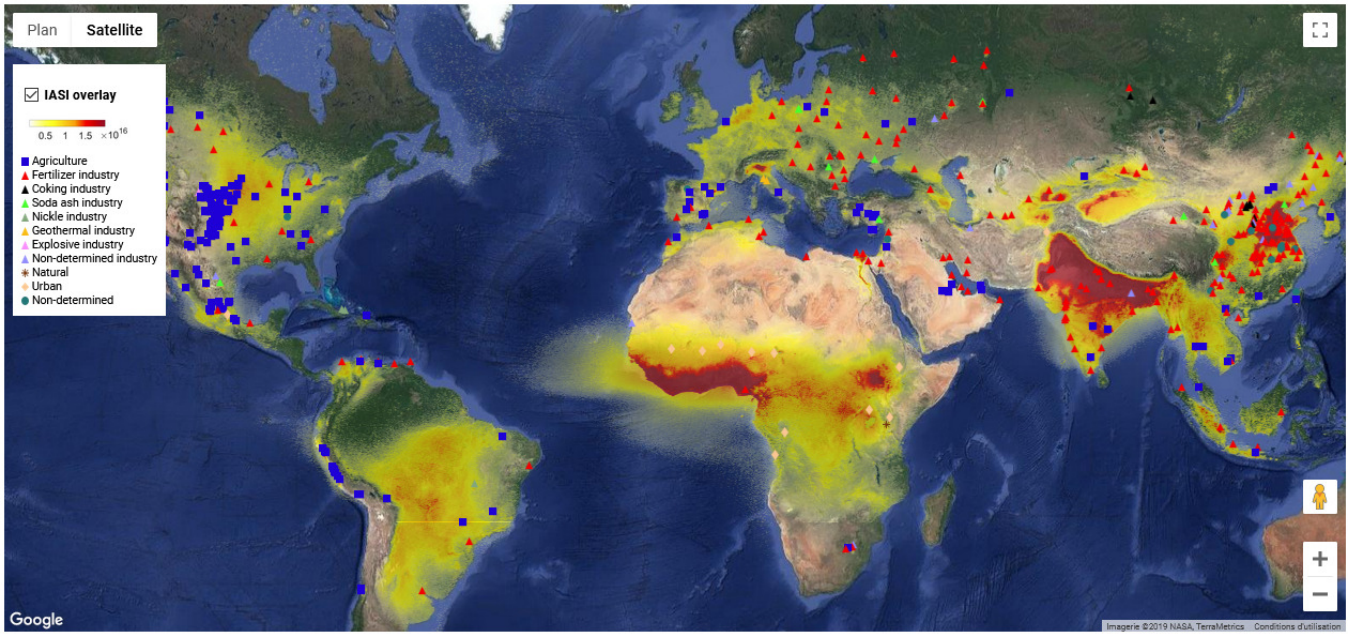


Fig. 1: Global ammonia point sources as seen by IASI satellite instruments. The background average map (molec.cm$^{-2}$) was obtained from ten years (2008-2017) of IASI/Metop-A satellite observations.

## 3. Long-term trends

Using IASI to track $NH_3$ emission changes, temporal analysis revealed rapid shifts in anthropogenic activities, such as the opening or closure of industrial plants. These results demonstrate that using $NH_3$ satellite data will be hugely beneficial for improving conventional bottom-up emission inventories. We also make the most of the extended period covered by the IASI mission to derive trends on the national, region and global scales. Distinct patterns of emissions are extracted over the 11 years of space measurements and these are analysed in light of anthropogenic activities occurring on ground. A special focus will be dedicated to the Netherlands case, where a drastic increase in atmospheric $NH_3$ has been measured in 2018.

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