Ammonia Distributions and Recent Trends by Thirteen-year AIRS Measurements

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Summary:

- AIRS is a NASA satellite using hyperspectral measurements;
- AIRS covers 13-year period from September 2002 through August 2015;
- AIRS retrieved vertical profiles show good agreement (~5 - 15\%) with in situ profiles from the 2013 DISCOVER-AQ field campaign in central California;
- AIRS daily measurements captures the strong continuous \(\text{NH}_3\) emission sources from the anthropogenic (agricultural) source regions, as well as emissions from biomass burning (BB);
- Strong sources include South Asia (India/Pakistan), China, the US, parts of Europe, SE Asia (Thailand/Myanmar/Laos), the central portion of South America, as well as Western and Northern Africa;
- Recent trends from the last 13 years show increased \(\text{NH}_3\) over agricultural regions and decreased over biomass burning regions.

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AIRS NH$_3$ at 918 hPa for daytime and land only averaged over Sept. 2002 to Aug. 2015;

- Use Q$_0$; DOFS $\geq$ 0.1;
- High concentrations are mainly due to human activities and fires;
- Use occurrences of higher emissions (lower) to distinguish between the two major sources: agricultural (high VMRs & high frequencies); BB emissions (high VMRs & low frequencies);
- Sources are seen in valleys (e.g., San Joaquin Valley, California in the U.S., the Po Valley, Italy, Fergana Valley, Uzbekistan, and the Sichuan Basin in China); Agricultural especially in irrigated lands (e.g., Azerbaijan, Nile Delta and near Nile River in Egypt, the Mid-West U.S., in the Netherlands, in Mozambique and Ethiopia, Africa, and especially the Indo-Gangetic Plain of South Asia).
• Slopes of linear fit of NH$_3$ VMRs for each 1x1 grid.
• Concentrations of anthropogenic emissions increased and BB decreased
• Trends due to BB are not conclusive due to the short record.
NH$_3$ over USA, China, India, and Europe
Using high concentration and high frequencies

Blue boxes are regions used for follow up trend studies.
NH$_3$ vs SO$_2$ over Mid-US, China, India and Europe

- Decreased SO$_2$ from OMI largely explains the reason of NH$_3$ increases in Midwest U.S., China, and Europe.
- In India, SO$_2$ slightly increase except for 2015, NH$_3$ has not varied significantly.
• NH$_3$ in India seasonal variations are broad and no obvious trends in average;
• NH$_3$ for USA and China are similar, with peaks in both spring and summer;
• NH$_3$ low seasonal changes for Europe.