Ammonia Emissions

Facts and Sources

- Ammonia is a colorless gas with a strong odor
- It is in found in many industrial cleaners including window cleaners
- Anhydrous ammonia is compressed into a clear, colorless liquid and combined with nitrogen when used for agriculture fertilizer which is important for crop growth
- Once the liquid is exposed to air, it quickly turns into a gas
- Approximately 85% of the U.S.'s ammonia emissions are sourced from agriculture
- Regions with large population growth, and industrial booms are found to have higher concentrations of ammonia in their air and water
- Hence the largest increase in ammonia sources are predicted to occur in India and Asia

Risks

- Typical environmental concentrations of ammonia are harmless.
- Exposure to high levels of ammonia in air may be irritating to the skin, eyes, throat, and lungs, often cause coughing and burns, and can even lead to death.
- Recent studies shows that cancer cells recycle ammonia waste to grow, increasing the growth of cancerous tumors (sciencemag)

The chemistry

- Ammonia in the atmosphere increases the the production of fine particles and the deposition of nitrogen; considered a nitrate precursor emission
- Ammonia reacts rapidly with sulfuric and nitric acids, promoting nucleation in the atmosphere
- Nitrate and ammonium aerosols increase the number of particle surfaces for scattering incoming ultraviolet solar radiation, consequently this disturbs photochemical oxidant production by alters photolysis frequencies (S.E. Bauer)
  - Causes poor visibility and effect radiative balance
- The gas of ammonia is involved in cloud formation, so it may act as a cooling agent and help compensate for the human-caused greenhouse gas effect (Livescience)
- Ammonia emissions directly have hardly any impact on the sulphate and the ozone cycle, but impact significantly nitrate production
- Ammonia v. ammonium ion; the major factor that determines the proportion of ammonia to ammonium in water is pH.
- Relates to ocean acidification; un- ionized NH_3 can be harmful to aquatic organisms, while ionized ammonium is basically harmless.
- The chemical equation that drives the relationship between ammonia and ammonium is:
  - $NH_3 + H_2O <-> NH_4^+ + OH$
  - When the pH is low, the reaction is driven to the right, and when the pH is high, the reaction is driven to the left.
- Gaseous ammonia and nitric acid react in the atmosphere to form aerosol ammonium nitrate,
  - NH_4NO_3. $NH_3(g) + HNO_3(g)$ $NH_4NO_3(s)$
- Ammonia-poor: when there is not enough NH3 to neutralize the available sulphate and the aerosol phase will be acidic.

  $NH_3 + H_2SO_4(g) <-> (NH_4)HSO_4$

- Ammonia-rich: excess ammonia, so that the aerosol phase will be largely neutralized. The ammonia that does not react with sulphate is able to react with nitrate to produce NH4NO3.

  $NH_3 + (NH_4)H_2SO_4(g) <-> (NH_4)2SO_4$

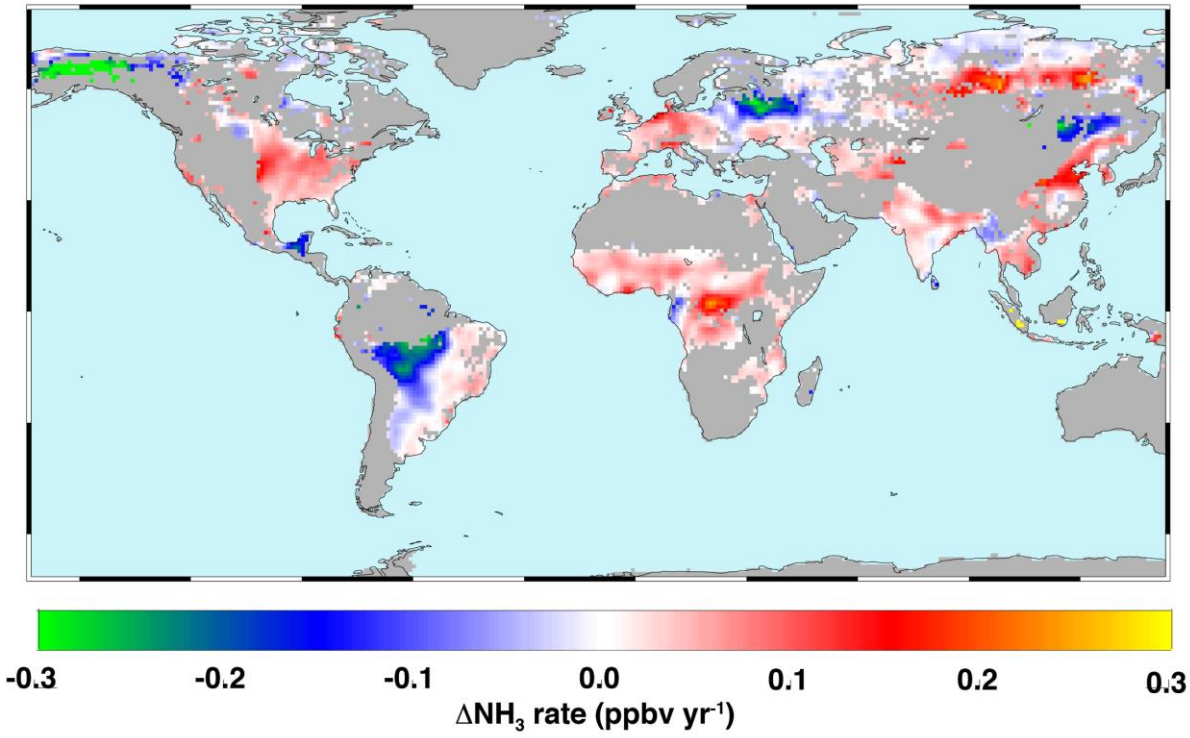

Photo: NASA's AIRS (Atmospheric Infrared Sounder) helps locate global ammonia hotspots.

Resources:

https://www.ewg.org/release/farm-runoff-causing-widespread-drinking-water-pollution-midwest#.WtqXl4pMGf1
https://www.sciencedaily.com/releases/2017/10/171019101016.htm
https://www.esrl.noaa.gov/csd/AQRS/reports/ammonia.pdf
https://support.hach.com/app/answers/answer_view/a_id/1011356/~/ammonia-vs.-ammonium-%E2%80%93-what-is-the-difference-between-these-forms-of-nitrogen%3F-
https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=10&tid=2
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https://www.atmos-chem-phys.net/7/5043/2007/acp-7-5043-2007.pdf
https://www.nasa.gov/feature/jpl/nasa-satellite-identifies-global-ammonia-hotspots