





































## Nitric Acid/Water Equilibrium

- Vapor/liquid equilibrium
- Aqueous reactions
- · Effective Henry's Law constant
- Dominant aqueous form (NO<sub>3</sub><sup>-</sup>) in all clouds

## Ammonium in Rain

- Ammonium (NH<sub>4</sub><sup>-1</sup>) is the other important N-species in rain. It forms predominantly via the reaction between water and ammonia:  $H_2O + NH_3 = NH_4^{++}OH^{-1}$
- The hydroxyl ion , OH ; formed in this reaction raises the pH of rain. The residence time for NH<sub>3</sub> gas is about 6 days. Once it is dissolved in rain and converted to ammonium, it takes about 5 days to remove the ammonium
- A second reaction is one between NH<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub> which leads to the formation of a (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> aerosol. This aerosol can be transported over long distances (5000 km) before it is removed by rainout or settling. Ammonia analyses are difficult. Contamination is a problem.

Location	Ratio	Observer
Frankfurt/M, winter	4	Georgii
Frankfurt/M, summer	6	Georgii
St. Moritz	10	Weber
Florida	42	Junge
Hawaii	52	Junge
Zugspitze (3000 meters)	57	Georgii
Mauna Kea (3200 meters)	360	Junge
Georgii (1960).		



	Source of Ammonia	Emission (Tg(N) yr <sup>-1</sup>
	ANTHROPOGENIC	
	Dairy cattle	5.5
	Beef cattle/buffalo	8.7
ricultural practices	Pigs	2.8
result in 2/3 of total global ammonia emissions	Horses	1.2
	Sheep/goats	2.5
	Poultry	1.3
	Fertilizer	6.4
	Biomass burning	2.0
	Subtotal	30.4
	NATURAL	
	Wild animals	2.5
	Vegetation	5.1
	Ocean	7.0
	Subtotal	<u>14.6</u>
	Total	45.0







