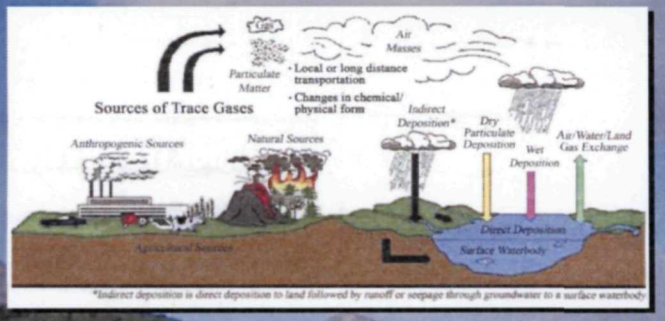
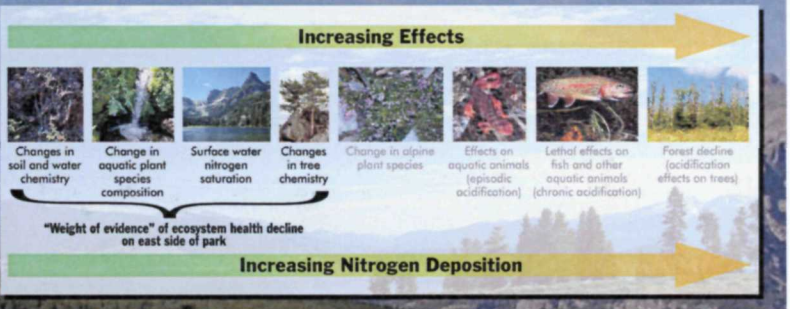
Rocky Mountain Atmospheric Nitrogen and Sulfur study (RoMANS)



Nitrogen enters the atmosphere through many mechanisms and in various molecular forms. Once in the atmosphere, it is transported and transforms into a variety of molecular gaseous and particulate species. While in the atmosphere nitrogen species contribute to visibility impairment, alter the radiation balance (global climate), and contribute to the depletion of the ozone layer. Ultimately all nitrogen species deposit to the earth's aquatic and terrestrial ecosystems where they tend to cause deleterious effects, as discussed below, in high alpine areas such as Rocky Mountain National Park.



Concerns About Increasing Reactive Nitrogen in Rocky Mountain National Park

- Low capacity to sequester atmospheric N deposition
- N enrichment and shifts in diatom communities in alpine lakes
- N enrichment in organic soil layer and Engelmann spruce needles on the eastern slope
- Increased haze-reducing visibility

RoMANS Objectives

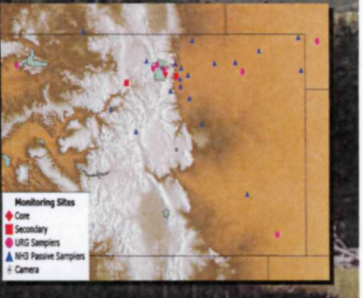
- Characterize the atmospheric concentrations of sulfur and nitrogen species in gaseous, particulate and aqueous phases (precipitation and clouds) along the east and west sides of the Continental Divide (organic nitrogen?)
  - Gas: NH_3, NO_x ($NO+NO_2$), NO_Y (HNO_3, PAN, etc)
  - Particle: NH_4, NO_3, organics?
  - Wet: NH_4, NO_3, organics (cloud + wet dep)
- Identify the relative contributions to atmospheric sulfur and nitrogen species in RMNP from within and outside the state of Colorado.
- Identify the relative contributions to atmospheric sulfur and nitrogen species in RMNP from more emission sources along the Colorado Front Range versus other areas within Colorado.
- Identify the relative contributions to atmospheric sulfur and nitrogen species from mobile sources, agricultural activities, and large and small point sources within Colorado.

RoMANS Measurement Network

Core site in RMNP
- Particle, gas, wet deposition
- Meteorology measurements
- High time resolution

Secondary sites
- Lyons and Gore Pass
- Daily time resolution
- Characterize air masses on east and west slopes

Additional monitoring sites
- Within RMNP
- Near state boundaries
- Weekly NH_3 monitoring sites

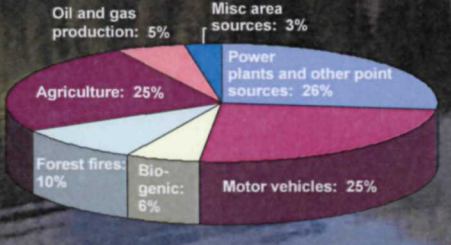


COLORADO EMISSIONS

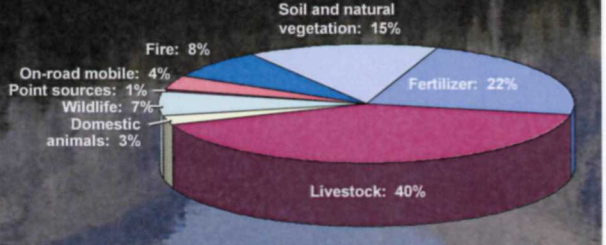
Combustion sources
- N_2 and O_2 combine at high temperature to produce nitrogen oxides (NO_x)
- Power plants, vehicles, fires

Agricultural sources
- NH_3 is major nitrogen pollutant
- Animal waste, fertilizer

Colorado Nitrogen Emissions

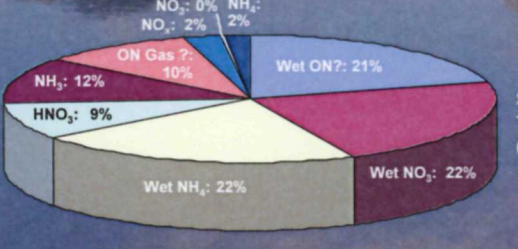


Colorado NH_3 Emissions



PRELIMINARY RESULTS

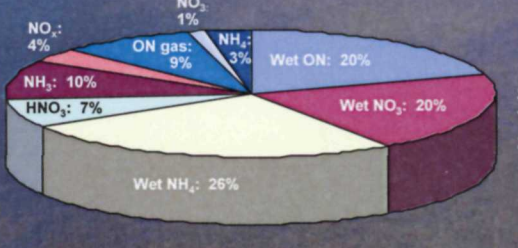
- Total N deposition was about twice (2) as high during the summer vs. spring.
- About 45% of N deposition is not being measured in the current monitoring programs (NAPD & CASTNET).
- Deposition of N is about 2/3 wet (rain and snow) and 1/3 dry (particles and gases).
- Organic N may be about 30% of total deposition and is not currently being measured.



SUMMER
Total Dep = 6228 µg/m²

REMAINING TASKS

- Apportion N deposition between agricultural, urban, and natural emissions
- Assess the contribution from sources inside Colorado to total deposition
- Contributions from agricultural activity
- Mobile sources
- Other
- Simulate deposition rates on a high temporal and spatial scale throughout RMNP for a period of one year.
- Apply model to other parks in the western United States



SPRING
Total Dep = 3326 µg/m²