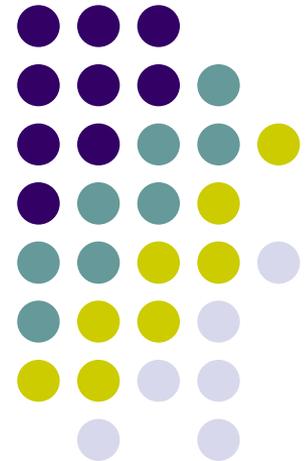


Objectives, strategies and estimated costs for reactive N monitoring in RMNP and NE Colorado

Jeff Collett

Atmospheric Science Department
Colorado State University
Fort Collins, CO 80523



Monitoring Objectives



I Agriculture

- I Monitor and track changes in ammonia concentration in the Front Range/NE CO
- I Separate contributions from agriculture and other activities to Front Range/NE CO ammonia

I Rocky Mountain NP

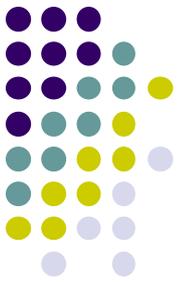
- I Monitor and track changes in total reactive N deposition at RMNP
- I Apportion total deposited N to oxidized (HNO_3 , NO_3^-) and reduced (NH_3 , NH_4^+) N compounds
- I Apportion contributions of source regions and source sectors to N deposition with a focus on eastern CO

Reactive N monitoring

- | Should include concentrations in source and receptor regions
- | Should capture N species concentrations at timescale relevant to transport and deposition
 - | Hourly to daily
- | Should quantify major reactive N species
 - | NH_3 gas
 - | NH_4^+ particles
 - | HNO_3 gas
 - | NO_3^- particles
- | Should be cost effective and practical for multi-year deployment

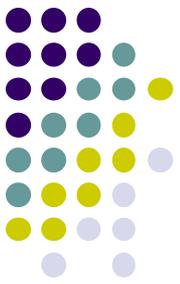


Planning strategy



- | 2 locations with high time resolution measurements
 - | RMNP and NE Colorado
- | Focus on NH_3 in NE Colorado where it dominates the reactive N atmospheric budget
 - | Use high time resolution (~minutes) NH_3 monitor to examine concentration vs. wind direction
 - | Embed within larger NE CO passive NH_3 weekly monitoring network
- | Include gaseous NH_3 and HNO_3 and $\text{PM}_{2.5}$ NH_4^+ NO_3^- in RMNP
 - | 24 hr URG samples every 2nd day
 - | Hourly measurement MARGA option
- | Continue seasonal (spring-fall) Radiello passive sampler network characterizing NE CO NH_3 source region

Proposed plan



I Measurements mid-March to mid-Oct

Measurement	Capital cost (1x)	Annual operating cost*	Notes
Continuous NH ₃ and meteorology in NE Colorado	\$35K	\$37K	Does not include instrument shelter/utility costs
Daily NH ₃ , HNO ₃ , NH ₄ ⁺ , and NO ₃ ⁻ in RMNP (URG)	\$0K	\$31K	24 hr samples collected every 2 nd day
Daily wet deposition NH ₄ ⁺ and NO ₃ ⁻ in RMNP	\$38K	\$18K	Assumes travel funded by URG project
Hourly NH ₃ , HNO ₃ , NH ₄ ⁺ , and NO ₃ ⁻ in RMNP (MARGA)	\$150K	\$34K	+1 weekly visit budgeted Assumes MARGA consumables funded by EPA
Weekly NE CO NH ₃ network (Radiello)	\$0K	\$35K	Expect continued CSU Ag Expt Stn funding

* Operating costs increase ~3% annually

Capital equipment notes



- | Continuous NH_3 measured by PMS Air Sentry II
 - | Requires installation in climate-controlled shelter
 - | Basic met station co-located with Air Sentry
- | Existing NPS samplers used for URG measurements
- | Daily wet deposition sampled using automated BIRAL precip collector w/ 8 samples
- | EPA might provide MARGA unit and cover MARGA consumable costs