Atmospheric deposition across the CAP LTER ecosystem: some preliminary findings.

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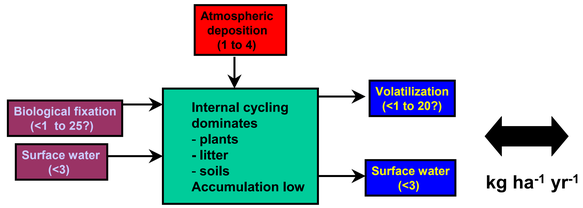
CAP LTER
Central Arizona-Phoenix
Long-Term Ecological Research

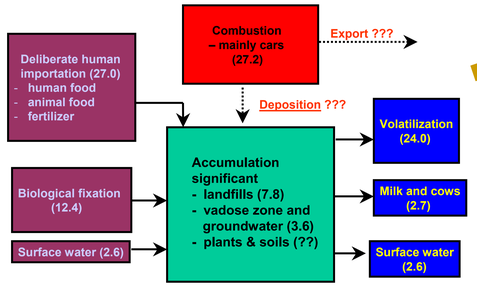
Why measure atmospheric deposition at CAP LTER?

- It can be a significant source of major nutrients (e.g. nitrogen and carbon) to terrestrial ecosystems
- Urban activities can significantly enhance local deposition rates (especially for nitrogen species)
- Existing monitoring has 2 major limitations:
  1) national programs mostly sample only wet deposition – YET dry deposition can be the major component in arid ecosystems
  2) collectors are located in non-urban areas



kg ha^{-1} yr^{-1}

Natural SW arid ecosystem N mass balance
(inputs = purple + red, storage = green, exports = blue)

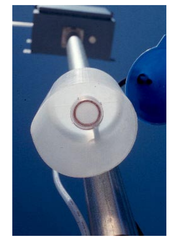


CAP urban ecosystem N mass balance
(inputs = purple + red, storage = green, exports = blue)

Where does urban dust come from?

'Fingerprinting' the main sources of dry deposition to the CAP site

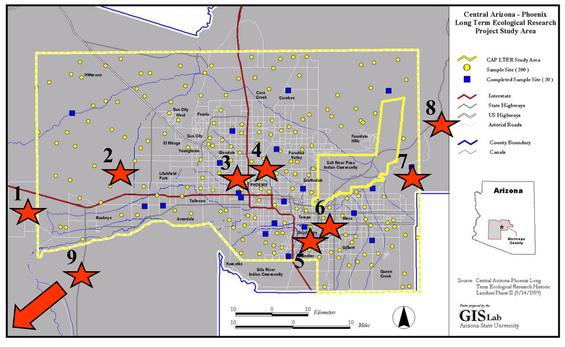
- Study carried out in summer '99 at 3 sites from the urban center to the outlying desert (sites 3, 6 and 7)
- Airborne particles were sampled by air filtration
- Concentrations of elements on filters was determined using Particle Induced X-ray Emission (PIXE) analysis of the filters



Air filters were suspended 10 m above the ground

REU student Shawn Boone conducts PIXE analysis of the air filter samples

Location of CAP wet/dry deposition collectors



CAP deposition sampling sites

1 = Palo Verde – desert
2 = Duncan Family Farms – agriculture
3 = Phoenix Supersite – residential urban core
4 = Sunny Slopes – residential / commercial
5 = Chandler Water Treatment Plant – residential / agricultural
6 = Brooks Road – industrial / commercial
7 = Lost Dutchman State Park – desert
8 = Sycamore Creek – desert
9 = Organ Pipe National Monument – 'control' desert site planned for 2000

One of the AeroChemetrics wet/dry bucket collectors used by CAP LTER to directly measure deposition, at Site 1 near downtown Phoenix

There are 2 approaches to measuring dry deposition:

Direct

- Collect deposition using a 'surrogate surface' e.g. plastic bucket
- Analyze chemically
- Calculate the rate of deposition
- This technique is being used at all CAP sites, via wet/dry bucket samplers

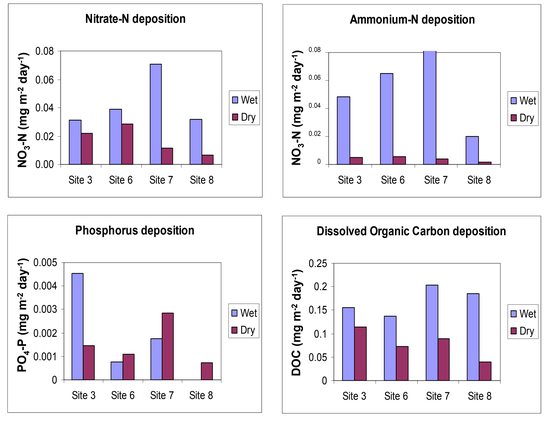
Indirect

- Measure the concentration of airborne particles
- Estimate the rate of deposition to different surface types using modeling
- Data obtained using this technique will be compared with directly measured rates at selected CAP sites (e.g. site 7)

Dry deposition is measured indirectly by NOAA using air filtration from this tower at Lost Dutchman State Park (LTER site 7). Model dry deposition rates from this site will be used to 'calibrate' deposition data obtained using LTER bucket collectors.

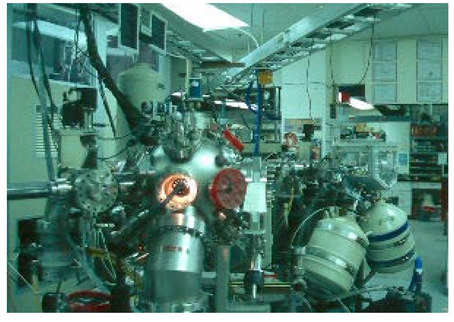
Preliminary results from CAP deposition collectors

Graphs below show average daily deposition rates for NO3-N, NH4-N, PO4-P and DOC between July and October 1999, at 4 LTER monitoring sites.



Preliminary findings are that:

1) N deposition during the late summer/fall occurs mainly in rain.
2) Dry N deposition is significant, especially at urban sites.
3) Deposition of N as ammonium is at least as important as nitrate.
4) Dust is an important component of P deposition at several sites.
5) Dry DOC deposition appears to increase towards the urban center.



PIXE analysis was carried out using the particle accelerator in the Center for Solid State Science at ASU

Multivariate statistical analyses of these data (Principal Components Analysis using the Varimax rotation) identified 5 major sources of dry deposited material

(figures in bold indicate elements of importance for each factor)

Rotated factors & communality						
Varimax						
Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Communality
Mg	**0.765**	0.499	0.205	0.259	-0.136	0.962
Al	**0.920**	0.237	0.004	0.212	-0.173	0.977
Si	**0.934**	0.161	-0.086	0.210	-0.179	0.982
P	0.258	**0.912**	0.062	0.215	0.004	0.948
S	0.064	**0.734**	-0.456	-0.270	0.253	0.888
Cl	0.231	0.054	**-0.912**	0.153	-0.088	0.919
K	**0.898**	0.112	-0.270	0.178	-0.171	0.954
Ca	**0.792**	0.046	-0.352	0.304	-0.222	0.895
Ti	**0.935**	0.063	-0.094	0.180	-0.162	0.946
V	0.277	-0.112	-0.072	0.113	**-0.937**	0.985
Cr	0.446	0.094	-0.187	**0.830**	-0.144	0.953
Mn	**0.822**	0.15	-0.151	-0.050	0.065	0.728
Fe	**0.927**	0.075	-0.174	0.242	-0.176	0.986
Variance	**6.5491**	**1.7722**	**1.3914**	**1.2192**	**1.191**	**12.123**
% Var.	**0.504**	**0.136**	**0.107**	**0.094**	**0.092**	**0.933**

Sources of dry deposition:

Factor 1 = soil dust
Factor 2 = vehicle exhausts
Factor 3 = additives from gasoline
Factor 4 = heavy industry (metal smelting/plating)
Factor 5 = fuel oil burning

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