NADP Measurement Confidence Intervals for Critical Load Contingency Planning

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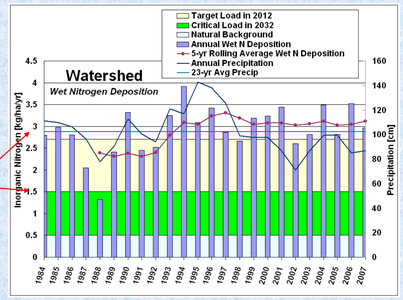
Q1: How can we be certain that NADP measurements are adequate to detect when annual deposition approaches or departs from the critical load?

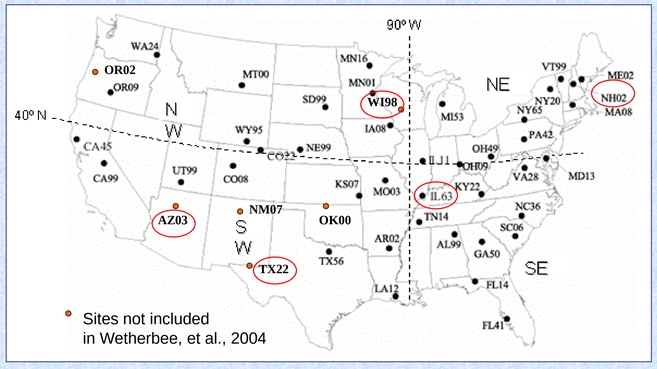
In other words, can NADP data be used to distinguish between these values, and with what degree of confidence?

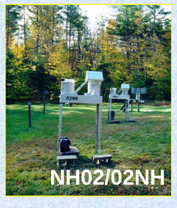


A1: Use the USGS Co-located Sampler Program data, …

During 1986-2006, USGS collected replicate data from 47 pairs of identical NTN wet/dry precipitation collectors and precipitation gages. Instruments at each co-located site are positioned within 5 to 30 meters of each other.

USGS CO-LOCATED SAMPLER PROGRAM SITES 1989-2009





A1: … and do some math...

$$Annual\ \ Dissolved\ \ Inorganic\ \ N(kg/ha) = \sum_{1}^{n}\left(\left[NO_3^-\right]*(14.01/62.01)+\left[NH_4^+\right]*(14.01/18.01)\right)*ppt*.01$$

Weekly measurements were summed to estimate annual dissolved wet-deposition of selected constituents for each of the paired sites.

Assumption: Analytical variability within each weekly concentration and precipitation-depth measurement is small in comparison to variability between replicate measurements, and is consistent over time.

Relative standard deviations (RSDs) of replicate annual measurements were calculated for each site (N=2). Next, the average of the RSDs was calculated (N=47). The $RSD_{average}$ could also be calculated on a regional, precipitation type, or altitude basis by selecting specific groups of sites.

Next, the minimum resolvable difference estimator is calculated.

"Wetherbee's"

Minimum Resolvable Difference Estimator (m_d)

$$m_d = \left(\frac{(1+Z\bullet RSD_{average})}{(1-Z\bullet RSD_{average})}\right)$$

Confidence Level	z
95%	1.96
90%	1.645
80%	1.28

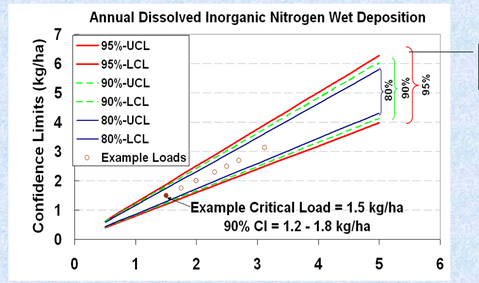
Use the minimum resolvable difference estimator (m_d) to compute the confidence interval for any individual measurement.

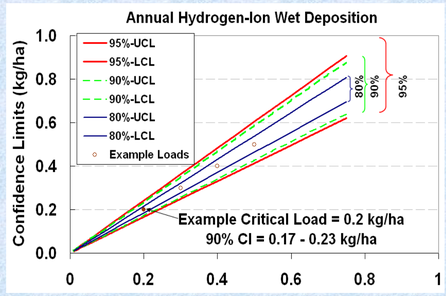
$CL_{Upper} = m_d \odot$ *Annual Dissolved Inorganic N (kg/ha)*

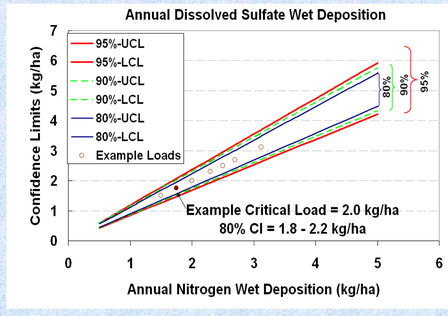
$CL_{Lower} =$ *Annual Dissolved Inorganic N (kg/ha)* $\div m_d$

Confidence Interval = CL_{Upper} - CL_{Lower}

A1: … to obtain results.







Q2: How much uncertainty can we accept in determining annual deposition and whether it is increasing or decreasing?

A2: That depends on Data-Quality Objectives (DQOs) and ecosystem status.

Acceptable Uncertainty in Annual Deposition	Example Consequence of being wrong *(DQO)*
5%	Ecosystem collapse
10%	Selected resources harmed
20%	Install emissions controls