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AN EVALUATION OF WET, DRY, AND TOTAL N AND S DEPOSITION AT 14 NATIONAL PARK MONITORING SITES

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NADP/NTN data are used to characterize the "chemical climate" of the US and observe its changes over time. However, NADP sites collect "wet" only deposition because of the much greater costs and analytical uncertainty involved in sampling "dry" deposition. An outstanding question is the contribution of "dry" deposition to total annual chemical deposition. Here we evaluate the role of dry deposition in total deposition at Park Research and Intensive Monitoring of Ecosystems Network (PRIMENet) sites. We report on the percent contribution of dry deposition to total deposition, year to year variations in the ratio of wet to dry deposition at each site, and evaluate whether the results support converting NADP wet deposition values to total deposition by using a simple wet:dry ratio based on the PRIMENet data.

PRIMENet was established by the National Park Service and the U.S. EPA in 1996 in response to calls for improved environmental monitoring in the United States, with emphasis on UV radiation monitoring in the fourteen PRIMENet parks. The NPS contributed both existing wet and dry deposition monitoring sites, and then added NADP/NTN wet deposition and CASTNet dry deposition sites in those parks that did not have these monitoring stations.

Total N deposition for a majority of the sites was low, below 4 kg N/ha annually. Total S deposition was also low (< 5 kg S/ha) at a majority of sites. Sites with higher annual deposition measurements were closer to pollution sources. For example, Shenandoah NP (7.7 kg N/ha/yr and 9.5 kg S/ha/yr) and Great Smoky Mountains NP (8.7 kg N/ha/yr and 9.0 kg S/ha/yr) are located in close proximity to several coal-fired power plants. High S levels at Hawaii Volcanoes NP (13.7 kg S/ha/yr) are likely due to high S concentrations in sea

salt that enter the atmosphere from the ocean along with sulfuric acid and hydrogen sulfide emissions from ongoing volcanic activity.

Dry N deposition, as a percentage of total N deposition, generally decreases with increasing precipitation amount. For example, the two driest parks in the network, Big Bend NP (20 cm/yr) and Canyonlands NP (27 cm/yr) had the two highest percentages of dry N deposition, both exceeding 50%; the second-wettest park location, Hawaii Volcanoes NP, had the lowest percentage (12%). However, the inverse relationship between precipitation and dry deposition percentage does not hold for all park locations. The wettest site, Olympic NP (326 cm/yr) had an average dry N deposition percentage of 29%, while one of the dry locations, Glacier NP (64 cm/yr) had a very low N deposition percentage of 16%. Dry S deposition as a percentage of total S deposition depended less on precipitation amounts and more on factors such as local emission sources.

Wet to dry deposition ratios vary on a yearly basis at most of the locations. At Acadia NP, the wet to dry S ratio reaches a high of 6.72 in 2000 and falls to a low of 1.99 the very next year. The wet to dry N ratio at Acadia follows the same pattern, falling from 6.12 in 2000 to 1.61 in 2001. At Rocky Mountain NP, wet to dry N ratios range from 2.66 to 8.02. This is also the case for wet to dry deposition ratios within seasons across years. During the winter at Denali NP, wet to dry S ratios range from 0.08 to 0.59 and wet to dry N ratios range from 0.58 to 3.16.

In its simplest form, this ratio does not appear to be stable enough to accurately reflect total deposition if only wet deposition is measured.