COMPARISON OF LONG-TERM PRECIPITATION CHEMISTRY MEASUREMENTS AT THE HUBBARD BROOK EXPERIMENTAL FOREST, NEW HAMPSHIRE

C. WAYNE MARTIN1*, GENE E. LIKENS2 and DONALD C. BUSO2

1 Northeastern Research Station, Durham, NH, 03824 U.S.A.; 2 Institute of Ecosystem Studies, Millbrook, NY, 12545 U.S.A.

(* author for correspondence, at Hubbard Brook Experimental Forest, RR 1 Box 779, Campton, NH 03223, U.S.A.)

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Abstract. From 1978 through 1989, a wet-only precipitation collector operated for the National Atmospheric Deposition Program, an independent wet-only collector, and a bulk precipitation collector were co-located at the Hubbard Brook Experimental Forest (HBEF) in central New Hampshire. A second bulk precipitation collector was maintained at another location within the HBEF. There were statistically significant differences between the chemistry from co-located wet-only collections for Ca²⁺, K⁺, NH₄⁺, pH, and NO₃⁻. The differences for K⁺ and pH though statistically significant were very small but consistent. The differences for Ca²⁺ were related to early contamination problems, and differences in NH₄⁺ and NO₃⁻ were related to episodic events. Bulk precipitation was significantly richer in K⁺ than wet-only precipitation. There were no differences for any ions between the bulk collections at the two locations. While there were minor differences, after 1981 when the contamination problems had been resolved, data from all collectors at all locations adequately characterized the precipitation chemistry of the site.

Keywords: acidic deposition, acid rain, NADP, precipitation chemistry

1. Introduction

The chemistry of precipitation has been measured routinely at the Hubbard Brook Experimental Forest (HBEF) in central New Hampshire since 1963. These 35 yr represent the longest continuous record for a single site in North America. Because of the length and integrity of these records, data from the Hubbard Brook Ecosystem Study (HBES) have been used widely in scientific research and national policy decisions (Likens, 1989, 1992).

In 1978, the National Atmospheric Deposition Program (NADP) was established to monitor long-term changes in the chemistry of precipitation nationwide using uniform protocols, equipment, and analytical methods (Knapp et al., 1988). An NADP wet-only precipitation collector was established at HBEF in 1978 and has operated to the present. There were three major differences in the protocols used by NADP and long-term HBES collectors: 1) the NADP network collected wet-only precipitation while the long-term records of precipitation chemistry for
HBEF were collections of bulk precipitation (Driscoll et al., 1989; Likens et al., 1967; Likens et al., 1977), 2) the NADP and HBES collections were made at different topographic locations within the HBEF, and 3) the analytical laboratories and QA/QC procedures differed for the two collections.

Often it is assumed that precipitation chemistry from a single site will be representative of regional patterns. It is important to determine the validity of this assumption. At HBEF, precipitation has been collected as both bulk and wet-only forms at more than one location for many years. From 1978 through 1989, the NADP wet-only collector (NADP-wet), a HBES wet-only collector (HBES-wet), and a HBES bulk collector (HBES-bulk) were co-located in the same clearing within the HBEF. Samples of precipitation from these collectors were analyzed for chemical constituents by separate laboratories, each with its own established QA/QC protocols. In addition, HBES bulk precipitation collectors have operated within the HBEF since 1963. The bulk collections of precipitation chemistry near Watershed 6 (W6-bulk) have been used for the long-term record for the HBEF (Likens and Bormann, 1995). However, published data from both W6-bulk and NADP-wet have been used to show long-term trends in precipitation chemistry for the northeastern United States, and have been instrumental in influencing legislation to mitigate the effects of air pollution in eastern North America. It is important to understand the differences and similarities in the results generated from these two data sets.

2. Hubbard Brook Experimental Forest

Located in the White Mountains of central New Hampshire, at 43°57′ latitude and 71°42′ longitude, the HBEF is a 3160-ha reserve ranging in elevation from 222 to 1015 m. It is covered by northern hardwoods composed primarily of yellow birch (Betula alleghaniensis Britt.), sugar maple (Acer saccharum Marsh.), and American beech (Fagus grandifolia Ehrh.). There is a minor component of red spruce (Picea rubens Sarg.) and balsam fir (Abies balsamea L. Mill.), mostly at higher elevations. Meteorological and hydrological data on the HBEF were recorded beginning in 1955 (Federer et al., 1990); precipitation chemistry had been recorded since 1963 (Likens and Bormann, 1995). A clearing containing the co-located NADP-wet, HBES-wet, and the HBES-bulk collectors was established in 1978 at the eastern edge of the Hubbard Brook Valley (Figure 1) near the USDA Forest Service’s Robert S. Pierce Ecosystem Laboratory near Woodstock, New Hampshire (elevation of 252 m). The second clearing, the site of W6-bulk collector since 1963, was located about 4 km west (elevation of 550 m) at the base of Watershed 6 (WS 6), the biogeochemical reference watershed.