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The O and H stable isotope composition of freshwaters in the British Isles. 1. Rainfall

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Abstract. An understanding of the hydrological cycle in stable isotopic terms requires the characterisation of rainfall. This paper reviews existing and new data for the British Isles. Rainfall at the Wallingford (Oxfordshire) collection station was collected daily from November 1979 to October 1980. Large variations in isotopic content were noted, sometimes from day to day. Winter rainfall was similar to summer in amount, and only slightly depleted isotopically. Amount and temperature correlations with $\delta^{18}\text{O}$ were generally low, only the autumn and winter temperature relationships being significant. A 20-year monthly dataset from 1982 to 2001 for Wallingford gives the following regression: $\delta^2\text{H} = 7.0\delta^{18}\text{O} + 1.2$, a slope somewhat below the world meteoric line but consistent with the those from other long-term stations in NW Europe. The data showed uncorrelated maxima and minima for each year, but rather more consistent amount-weighted averages. Although there is only a small difference in gradient between summer and winter rainfall values, when plotted against the month of the year there are clear changes in the values of both isotopes, and the $\delta^2\text{H}$ - $\delta^{18}\text{O}$ relationship as demonstrated by the d-excess parameter. The isotope-amount correlation is low but significant, with summer months appearing to be well-correlated when considered in terms of month of the year. On this same seasonal basis temperature has a strong correlation throughout the year, giving a positive $\delta^{18}\text{O}$ -temperature relationship of 0.25 ‰ per °C change. The Wallingford monthly record is compared with data from Keyworth (Nottinghamshire) and the Valentia station of the GNIP (IAEA-WMO Global Network for Isotopes in Precipitation) in SW Ireland. While not large, differences between the stations are broadly attributable to the balance between maritime and continental influences. Over the period September 1981 to August 1982 the maximum number of monthly collection stations was operating across the British Isles. While a comparison of the sites serves mostly to illustrate the variability of British weather in space and time, there is clear isotopic evidence for the predominance of frontal rainfall in winter and convective rainfall in summer. The effect of altitude on isotopic content was measured within a high-relief stream catchment in Scotland. The best correlations occurred during winter, when an average relationship of approximately – 0.30 ‰ $\delta^{18}\text{O}$ per 100 m increase in altitude was observed. It is well established that rainfall isotopic composition changes in response to alterations in climate. However these changes are difficult to detect isotopically in the short term, even when the changes are indexed, e.g. in the form of the NAO (North Atlantic Oscillation). The brief duration of rainfall

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isotope records is a further hindrance; for the British Isles proxies such as tree-ring cellulose may have some value in extending the record back.

Keywords: stable isotopes, rainfall, British Isles

▣ [Final Revised Paper](#) (PDF, 706 KB)

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