Environmental OBT/HTO ratios revisited

P. Jean-Baptiste[a,*], E. Fourré[a], A. Dapoigny[a] and D. Baumier[a]

[a] *LSCE, CEA-Saclay, 91191 Gif-sur-Yvette, France*

Most published results concerning deuterium-hydrogen fractionation in plants are in the range 0.8 - 1, indicating no bioaccumulation of the heavy isotope. In spite of this, an updated compilation of litterature data shows that 77% of OBT/HTO ratios measured in terrestrial plants and food items are greater than one, with a mean value of 1.92 ± 1.42 (n=457). A substantial fraction of the dataset comes from sites close to local tritium sources and could be influenced by sporadic tritium releases. However, many other measurements, representative of "background" environmental conditions, still show the same trend. Our own measurements from various parts of the French territory over the period 2002-2008 give a mean value of 1.94 ± 0.94. On the other hand, OBT/HTO ratios for aquatic samples do not show such a tritium anomaly, with 81% of the published ratios being less than one. This strongly suggests that the cause for the tritium excess in terrestrial organic matter has to be found in the atmosphere. We show, with a simple model of tritium incorporation during plant growth, that the observed distribution of OBT/HTO ratios is well explained by the seasonal cycle of atmospheric tritium which exhibits an annual spring maximum precisely during the growing season. The model is forced by the monthly time-series of tritium in precipitation for mid-northern latitudes (IAEA/ISOHIS database). Plant growth is described by a sigmoid function. At each step of time, the T/H ratio of the incremental OBT is assumed to be equal to the atmospheric one (no isotope fractionation). Once the calculation is complete, sampling dates are selected at random to simulate a OBT/HTO database. The simulated OBT/HTO distribution is similar to the observed one (80% of the samples with OBT/HTO >1, with a mean value between 1.8 and 2), showing that, even in the absence of any isotope fractionation, the annual atmospheric tritium cycle can create the observed OBT/HTO anomalies.