Realistic and Practical Modeling of Tritium Deposition to Bare Soil

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The process of transporting atmospheric HT to the ground surface and converting it to HTO in soil has been conventionally termed as deposition and its efficiency as deposition velocity. Many laboratory and field studies have been done on the tritium deposition and the conversion from HT to HTO. Deposition velocity reported in these studies scatter in a wide range from 10^{-7} to 10^{-3} m s^{-1}. It has also been found by these studies that the deposition velocity has strong dependences on the soil temperature and on the water content or the volumetric fraction of air in soil. However, these dependences were not well modelled.

Our recent experimental study showed the temperature and moisture dependence of the HT oxidation rate that is not affected by conditions of atmospheric transport and in-soil diffusion. This paper firstly develops a theoretical model of tritium deposition, which is then combined with the experimental results. The model describes the atmosphere-to-soil HT deposition process in terms of the atmospheric transport in the surface boundary layer, the transport in soil and the oxidation process by microbial activity. This model was favourably validated with the field data from the Canadian tritium release experiment. Based on this fundamental but sophisticated model, a practical model of HT deposition velocity was developed as a simple function of the soil temperature and the soil moisture. This model drastically reduces the uncertainty in the deposition velocity from a few orders of magnitude to a factor of 2.