Geophysical Research Abstracts,
Vol. 10, EGU2008-A-05315, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-05315
EGU General Assembly 2008

Secular equilibrium of the 222-Rn decaying family in the atmospheric boundary layer

J.-F. Vinuesa (1), S. Galmarini (1) and S. Basu (2)

(1) European Commission - DG Joint Research Centre, Institute for Environment and Sustainability, Italy, (2) Atmospheric Science Group - Department of Geosciences and Wind Science and Engineering Research Center, Texas Tech University, USA. (jeff.vinuesa@jrc.it/+39-0332-0785466)

A decaying chain is in secular equilibrium when the ratio of the activities of its nuclide is equal to 1. This corresponds to a balance between production and destruction of the nuclide. The deviations from the secular equilibrium are often used as an indicator of the residence time in the atmosphere or as an indicator of the atmospheric stability. We used large-eddy simulation to simulate the dispersion of the 222Rn decaying family during a diurnal cycle consisting of three stability regimes; stable, neutral and unstable. By imposing secular equilibrium as initial condition, we focused on the disruption of this equilibrium by the atmospheric stability.

Any air parcel can be considered as containing a mixture of radon and its daughters. At sunset, if this parcel is close to the source of radon, more freshly emitted radon will be present. Because of the slow decay of radon, this air parcel contains more radon than its short-lived daughters. As a result, the equilibrium is disrupted.

Throughout the night, the proportion of aging radon trapped in the stable boundary layer tends to increase (compared to “fresh” radon) and the mixture is evolving toward equilibrium. However, the night is obviously not long enough to enable the secular equilibrium to be fully established.

During the convective daytime period, turbulent eddy motions are mixing the radon being exhaled from the soil into aged radon mixture. Due to the mixing and the short turnover time of the convective boundary layer, any air parcel contains the same

amount of “fresh” and “old” radon. Turbulent transport enables the radioactive system to evolve toward the equilibrium. As a result, after the morning transition, the equilibrium is reached and the homogeneous composition of the radon and short-lived daughter mixture is maintained by the turnover of the convective boundary layer.