Review of 222Rn Emissions

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Radon-222 is emitted from all ice-free land surfaces. Ice cover inhibits its emission. Oceans, where its parent material, 226Ra, is in solution emit about two orders of magnitude less 222Rn than continents (Lambert et al., 1982). Negligible amounts are emitted in gas emanating from volcanoes (Lambert et al., 1979). There are no other sources of atmospheric 222Rn.

Turekian et al. (1977) estimated 222Rn flux from continents to be 1.2 atoms cm$^{-2}$s$^{-1}$. Lambert et al. (1982) derived an average 222Rn flux of 0.71 atoms cm$^{-2}$s$^{-1}$ for the northern, and 0.72 atoms cm$^{-2}$s$^{-1}$ for the southern hemisphere. Conen and Robertson (2002) proposed an emissions distribution of 1 atom cm$^{-2}$s$^{-1}$ for 60oS to 30oN, declining linearly northwards to 0.2 atoms cm$^{-2}$s$^{-1}$ at 70oN. All these values are based on atmospheric 222Rn concentration and 210Pb deposition flux measurements. Based on directly measured 222Rn soil flux and related parameters, Schery and Wasiolek (1998) modelled global 222Rn flux on a 1o x 1o grid and estimated a global average of 1.6 (±0.4) atoms cm$^{-2}$s$^{-1}$ with significant regional variations (map can be accessed on Stephen D. Schery's home page: http://www.nmt.edu/~schery/.)

In validating global circulation models (GCM), 222Rn flux is generally assumed to be spatially uniform and 1 atom cm$^{-2}$s$^{-1}$ from ice-free land surfaces and zero from oceans. However, including emissions of 0.01 atoms cm$^{-2}$s$^{-1}$ from oceans between 60oS and 60oN improved predictions of measured 222Rn concentrations by the GCM NIRE-CTM-96 at remote sites in the South Indian Ocean and Antarctic (Taguchi et al, 2002). For continental emissions Lee and Feichter (1995) concluded that a non-uniform distribution (1 atom cm$^{-2}$s$^{-1}$ from 60oS to 60oN; 0.005 atoms cm$^{-2}$s$^{-1}$ from 60oN to 70oN) would improve predictions of global transport and deposition of 210Pb, a daughter product of 222Rn. A similar assumption (1 atom cm$^{-2}$s$^{-1}$ from 60oS to 60oN; 0.5 atoms cm$^{-2}$s$^{-1}$ from 60oN to 70oN) was made in a comparison of scavenging and deposition processes in global models at the WCRP Cambridge Workshop 1995 (Rasch et al., 2000).

Predictions by the GCM STOCHEM3 for 222Rn concentrations in the surface layer based on a uniform (1 atom cm$^{-2}$s$^{-1}$) and a northwards declining emissions distribution are currently compared to long-term 222Rn concentrations measured at 17 ground based stations around the globe (L.B. Robertson, D.S. Stevenson & F. Conen; University of Edinburgh, in preparation). (Radon concentration data for 1991-1996 at Mauna Loa and Bermudas can be found at http://www.eml.doe.gov/databases/radon/).

In the long term, a reduction of the ice-covered land surface might result in very small increases in global 222Rn emission. However, some of this increase would be offset by increasing sea levels and subsequent submersion of coastal areas.

Regionally, seasonal variations of ± 25% (Schüler, 1996, cited in: Levin et al, 1999; Whittlestone et al., 1998) or of a factor of two (Schery & Wasiolek, 1998) have been reported, with largest emissions during summer and smallest emissions in winter.
Important factors affecting 222Rn emission are 226Ra content of the soil (Schery & Wasiolek), precipitation (Ferry et al., 2001), soil moisture (Nazaroff, 1992), water table depth (Conen & Robertson) and soil texture (Dörr & Münnich, 1990).

References


Turekian, K.K., Nozaki, Y. & Benninger, L.K. 1977. Geochemistry of atmospheric radon


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