Investigating hemispheric circulation and synoptic transport events at two Antarctic monitoring stations using Radon-222

Korea Polar Research Institute, KORDI
한국해양연구원 부설 극지연구소

S.D. Chambers, S.-B. Hong, A.G. Williams, T. Choi, S.-J. Park and J. Crawford

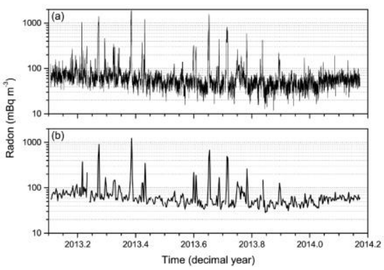
Background

Pollutants, nutrients and other reactive precursors come to various locations in Antarctica by one of three mechanisms: (i) synoptically-driven transport in the marine boundary layer, (ii) subsiding tropospheric air masses, or (iii) local advection from elsewhere in Antarctica. Characterising the seasonal variability in concentrations of trace constituents resulting from each of these processes is of multidisciplinary interest, and is contingent upon developing techniques to reliably identify the various transport events.

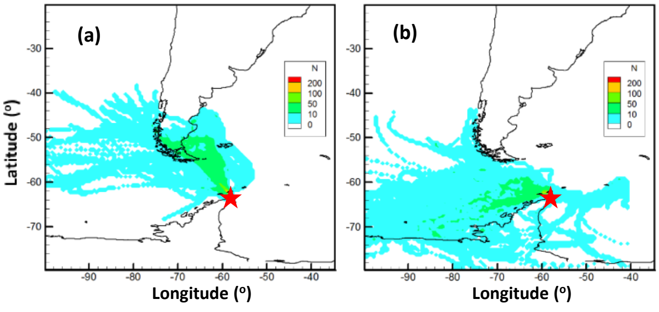
Radon in Antarctica

Radon-222 is a naturally-occurring radioactive gas of primarily terrestrial origin that is frequently employed in atmospheric transport and mixing studies. At remote sites, radon's 3.8 day half-life makes it a useful indicator of terrestrial influences on an air mass that have occurred in the past 2-3 weeks. Dual-flow-loop two-filter radon detectors have been installed at King George Island and Terra Nova Bay, Antarctica. These detectors provide direct (not "by-progeny") continuous half-hourly observations with a lower limit of detection of 0.02-0.03 Bq m^{-3}.

Antarctic Peninsula: King Sejong Station



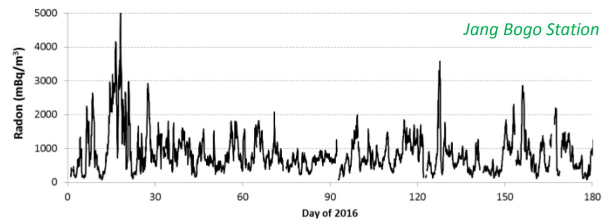
Hourly and daily mean radon at King Sejong station show background values ranging from 20-100 mBq m^{-3}. Peaks above 200 mBq m^{-3} in late summer and winter are a result of rapid transport from South America. The seasonal cycle in background values results from changing terrestrial influence on tropospheric air (Chambers et al. 2014).

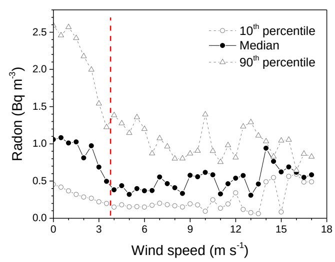


(a) Back trajectories corresponding to radon > 200 mBq m^{-3} indicate transport from over or near South America; dilution factors of 3-4 were estimated based on an estimated terrestrial radon flux. (b) Back trajectories corresponding to "background" values (< monthly 25th percentile radon) indicate no significant recent contact with South America or other southern hemisphere continents.

Terra Nova Bay: Jang Bogo Station

Exposed rock along the foothills of the Transantarctic Mountains, low wind speeds and influences from Mt Melbourne and Mt Erebus result in higher, and much more variable, radon concentrations at Jang Bogo than at King Sejong.

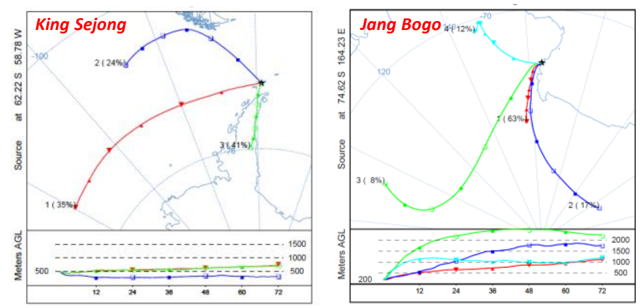


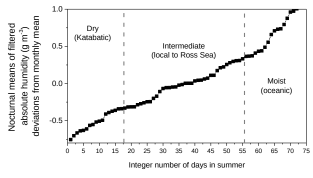


When Jang Bogo wind speeds drop to 3.5 m s^{-1} or less (68% of the time in summer), a rapid increase in radon concentration is observed as a result of local influences.

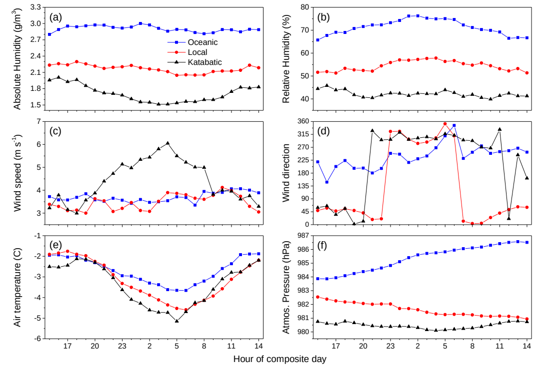
Based on a mixing depth of 50 m for stable flow over mixed rock/ice we estimate a mean radon flux of 0.07-0.13 atoms cm^{-2} s^{-1} for coastal regions with partially exposed rock surfaces.

Back trajectory cluster analysis indicated relatively even split between Antarctic, Southern Ocean and South American fetch at King Sejong Station. At Jang Bogo, 80% of air masses approached from east of the Transantarctic mountains, from lower elevations. The remaining air masses were associated with subsidence events.





Nocturnal mean values of hourly absolute humidity (high pass filtered with a monthly cut-off) can be used to identify nights on which katabatic, oceanic or local Antarctic air masses have the dominant influence on observations. Specifically, this enables characterisation of tropospheric air subsiding over the pole arriving at the station as katabatic flow.



Jang Bogo katabatic (tropospheric subsidence) events are dry, cold and windy with wind directions of around 300° and steady atmospheric pressure.

Please direct comments or questions to: szc@ansto.gov.au

Chambers, SD, Hong, S-B, Williams, AG, Crawford, J, Griffiths, AD, and Park, S-J, 2014: 'Characterising terrestrial influences on Antarctic air masses using Radon-222 measurements at King George Island', Atmos. Chem. Phys., 14, 9903-9916.