

Yearly variations in Be-7 concentrations in surface air at Iceland and Japan for 15 years from 2003: Solar modulation of cosmogenic nuclide

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Be-7 concentrations (BEC) in surface air should be correlated to cosmic rays, because Be-7 is produced by interactions between cosmic rays and nitrogen and/or oxygen in the atmosphere, and then it falls down with aerosols. Since cosmic rays which reach the earth are modulated by the solar activities when travelling the heliosphere, the variation in BEC involve some modulation profiles such as 27-day variation and 11-year solar cycle. Daily Be-7 concentrations in surface air have been continuously observed at Yamagata (38° N), Japan since 2000. To investigate the latitude effect of 11-year solar cycle, we set up a daily observation system of Be-7 concentration at Husafell in Iceland located (64° N) and have been continuously observed BEC since September 2003 as well as in Japan. Figure 1 shows the yearly variations in the BEC in Iceland and at Yamagata, with the neutrons and the sunspot number (SSN), respectively. Both the BECs and the cosmic ray neutrons produced in the atmosphere inversely vary corresponding to the variation in sunspot number, because the energy spectrum of incoming cosmic rays change with the variation of the solar magnetic fields. As shown in the SSN, the solar cycle 24 began in 2009 and then reached its maximum in 2014. After that the activity is descending to the minimum. The present solar activity is almost a minimum state.

The peak of BEC in Iceland is in 2007 and 2008 at the solar cycle 23. However, its peak at the solar cycle 24 is unclear even in 2018. If the period is 11-year, the peak might appear in 2019. The decreasing rates of BECs in Iceland from 2008 to 2015 and that at Yamagata from 2009 to 2012 are approximately 38% and 26%, respectively, although that of the neutron from 2009 to 2015 is approximately 10%. The larger variability of BECs compared to the neutron indicates the production due to low energy cosmic rays below the threshold energy for the neutron production. The BEC in Iceland is approximately 40% of that at Yamagata on average from 2004 to 2018 with an indication that the air-mass with thick BEC flow upward from the troposphere to the stratosphere in polar region. The ratio might imply an indicator of the global air circulation.

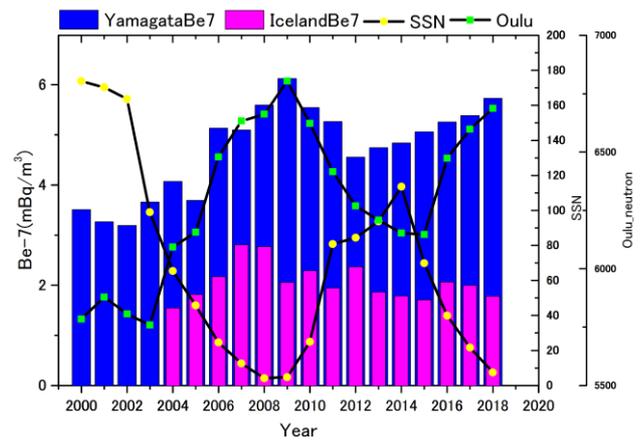


Figure 1. Yearly profiles of the Be-7 concentrations, the sunspot numbers, and the cosmic ray neutrons

We describe comparison of the Be-7 concentrations between at Yamagata and in Iceland relating to the SSN and neutron monitor data for the solar modulation, involving the response of the BECs and air-mass motion at Iceland to the unusual 24th solar activity after 2012.