

The yearly and seasonal variations from 7-year data set of daily cosmogenic nuclide Be-7 concentrations in the atmosphere

¹Dept. of Physics, Yamagata University

²National Institute of Polar Research

S. Kikuchi¹, H. Sakurai¹, S. Gunji¹, F. Tokanai¹,
N. Sato², A. Kadokura²

Motivation

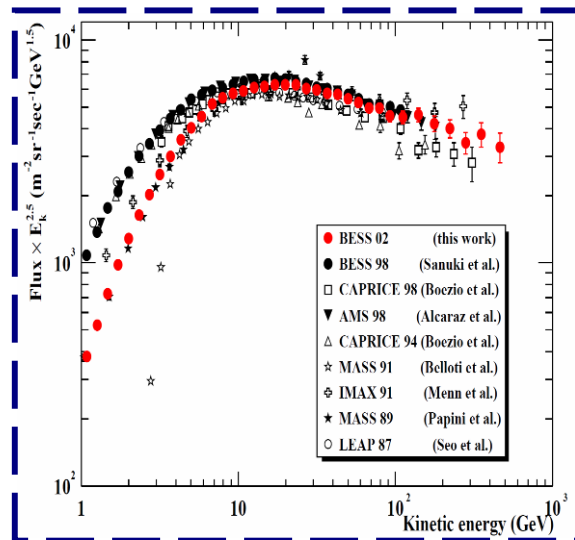
- We have been studying the relationship between the cosmogenic nuclides and solar activities.
- **Topics**
 - **Daily profile of Be-7 concentrations** in the atmosphere for 7 years from 2000 at Yamagata(38.3° N), Japan.
 - **Comparison among the yearly profiles** of which are the Be-7 concentrations, the Sunspot Number (SSN) and the neutrons
 - A relationship between **the seasonal variation of Be-7** and the yearly profile of SSN
 - **A response of the daily Be-7 concentrations to the 27-days periodic variation of SSN**

Solar modulation of cosmic rays

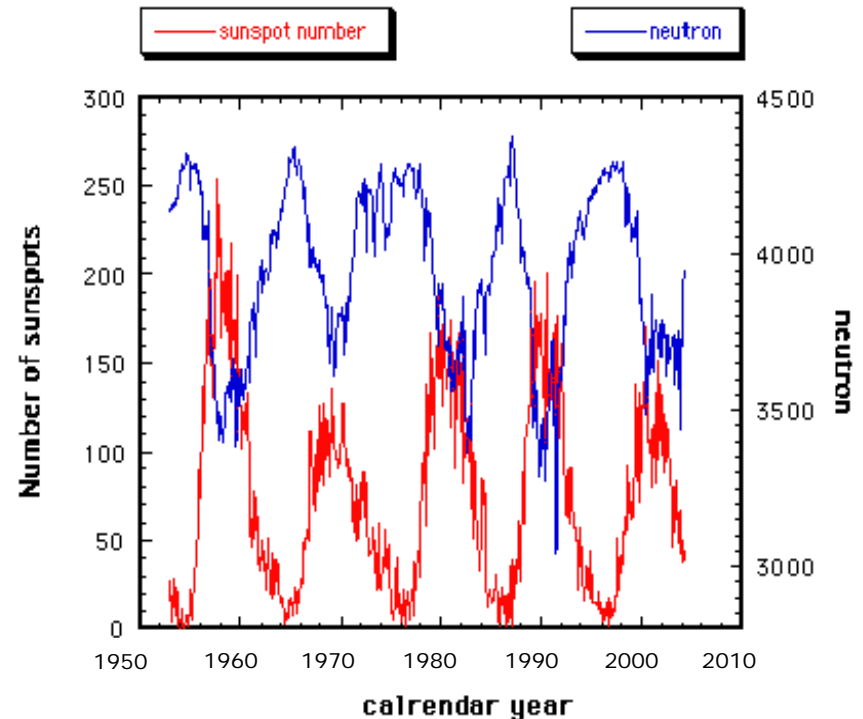
Solar activities affect the magnetic field in the heliosphere by the solar wind.



Galactic cosmic rays are modulated.



The energy spectrum of primary protons

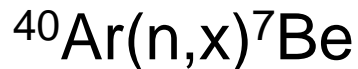
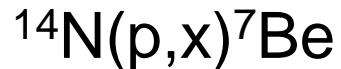
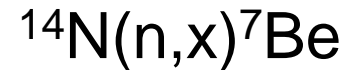


11 year periodic variation of solar activities
(neutrons @ Climax (Alt.:3400 m,
Cut-off rigidity:2.97GV))

Do cosmogenic nuclides are modulated by solar activities, really?

Cosmogenic nuclide Be-7

■ Production



Cosmic rays collide
with the atmospheric elements



Be-7 is produced



Be -7 is oxidized and attaches to aerosols.

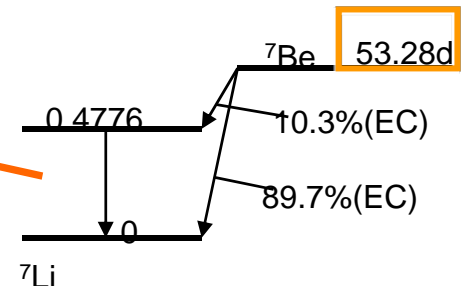


Aerosols with Be-7 fall down to the ground.

■ We collect the aerosols and measure the radioactivity of Be-7.

detection

Gamma ray: 477 keV



Collection and Measurement of Be-7 in the air



Collected filter
• Glass fiber filter
collection efficiency :
99.99%
(ϕ 0.3 μm particle)

Measurement time : 6 hours

detection efficiency	2.68%
resolution @1.33MeV	1.69keV

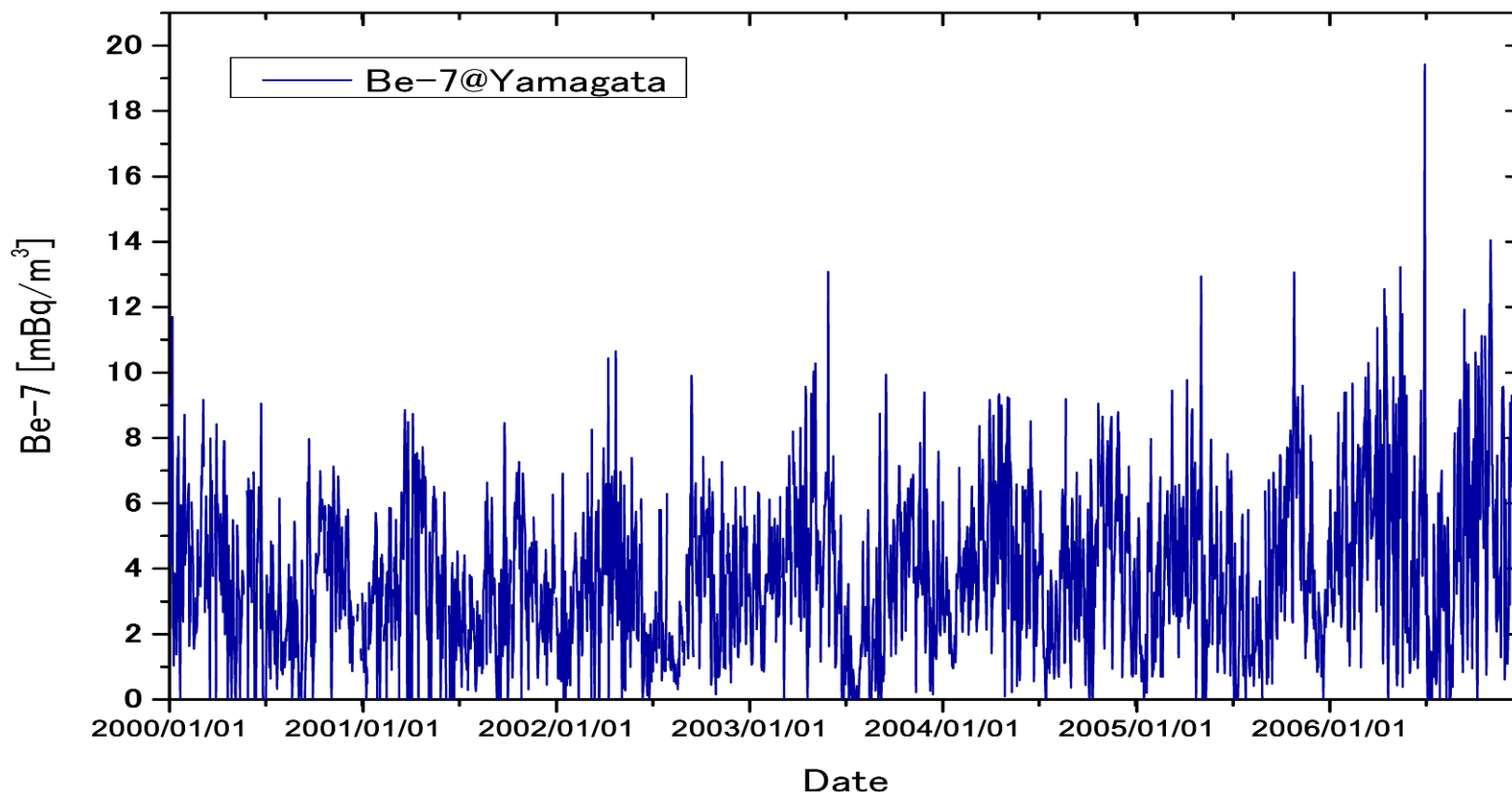


HPGe detector

High Volume Air Sampler (HV-100F)

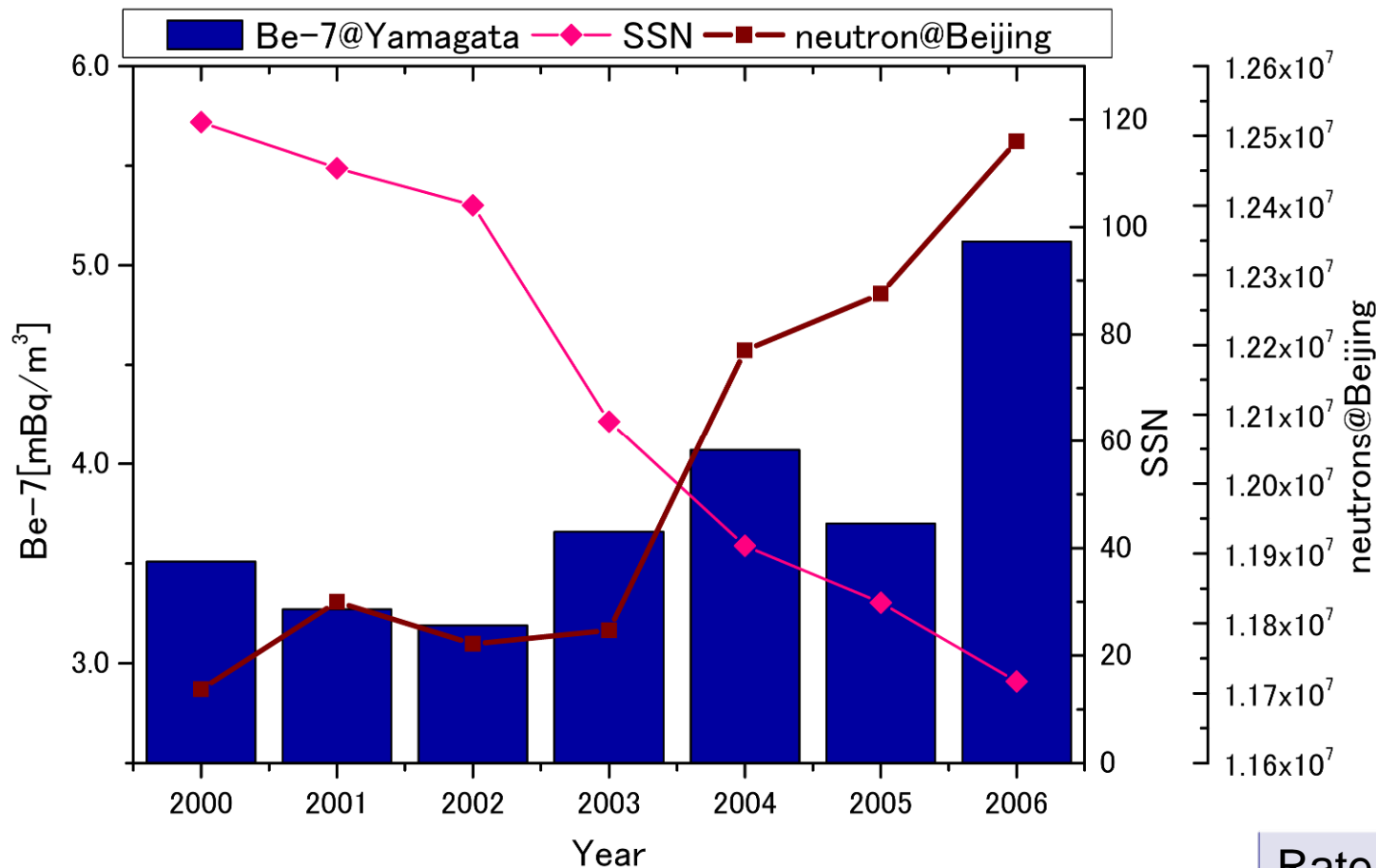
- Collection: Daily from 2000
- Location: Yamagata(38.3° N), Japan
- Intake rate: 1000 L/min
- Collection time: 23 hours/day

Daily profile of Be-7 concentration for 7 years



1. The daily Be-7 is very variable and complex.
2. The seasonal variation
3. gradually increasing

Yearly variation



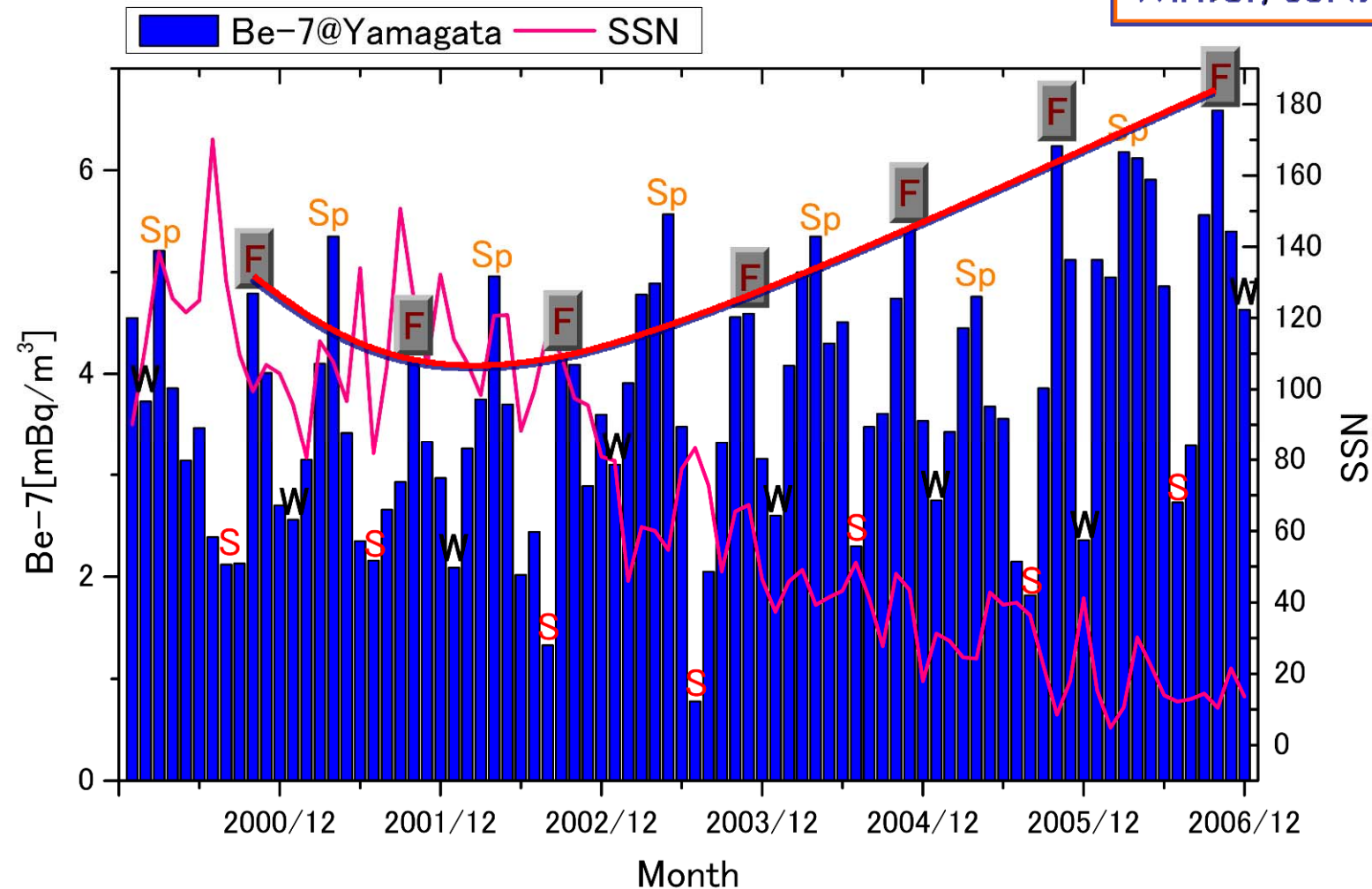
	Cut-off rigidity
Yamagata	About 10 GV
Beijing	9.56 GV

correlation coefficient
 Be-7, SSN: -0.79
 Be-7, neutron: 0.84
 SSN, neutron: -0.92

Rate of variability
 between Max and Min
 Be-7: 60 %
 SSN: -87%
 neutron: 6.7%

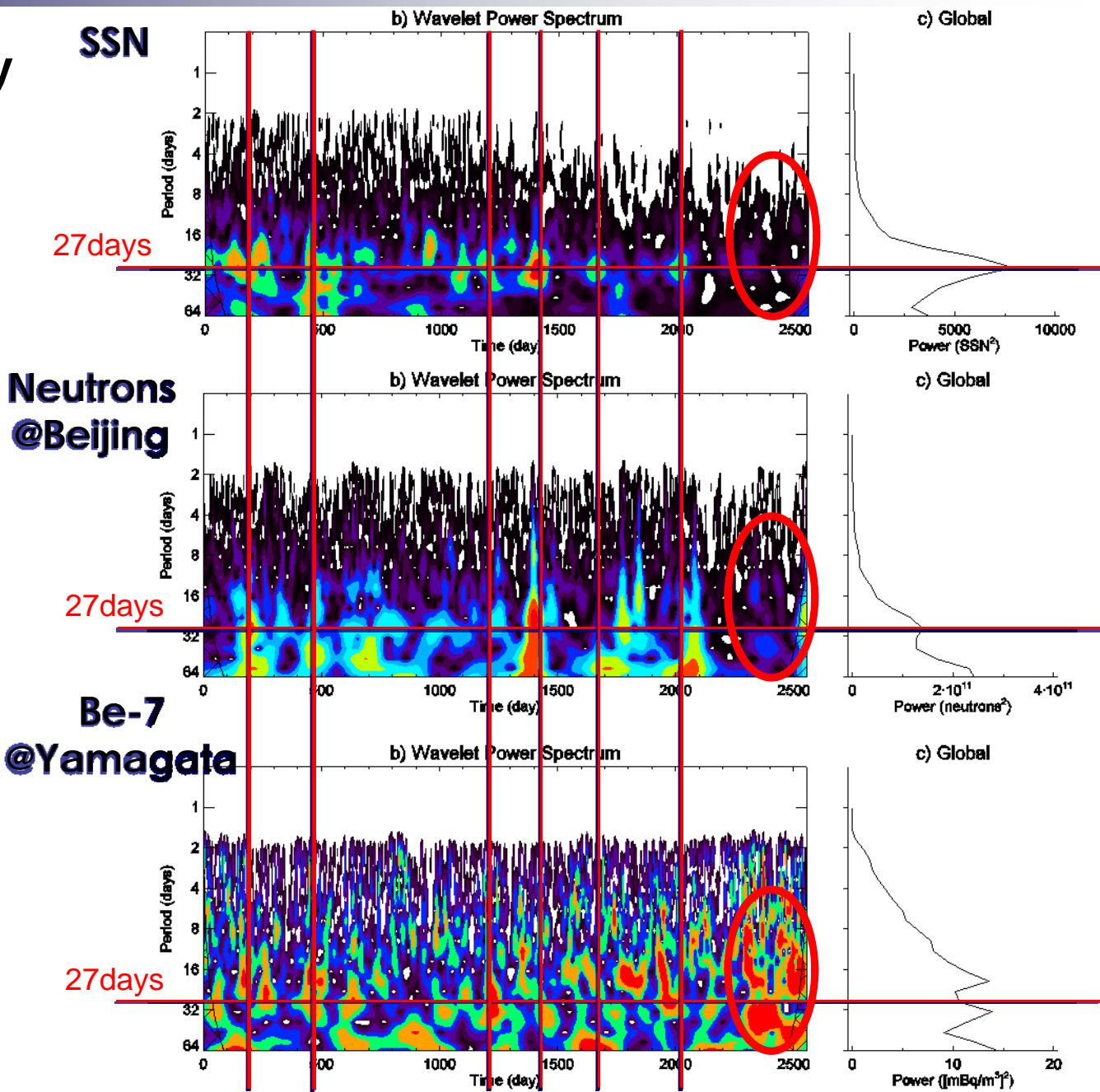
Seasonal variation

correlation coefficient
Spring, SSN: -0.39
Summer, SSN: -0.47
Fall, SSN: -0.95
Winter, SSN: -0.31



Periodic analysis by Wavelet for 7-year daily data sets

- 1) The SSN indicates a periodic variation of 27 days corresponding to the rotation period of the sun.
- 2) The spectrum Be-7 at 2006 is different from the others.
- 3) The spectrum of Be-7 at the several portions correspond to that of the 27days periodic variation of the SSN except at 2006.



Summary

- We have been continuously observing the daily Be-7 concentration at Yamagata, Japan for 7 years since 2000.
- The rate of variability of Be-7 concentrations and sunspot number in yearly data are 60% and -87%, respectively.
- The seasonal variation of Be-7 concentration in the fall is strongly anti-correlated to the variation of the sunspot number.