5.9 Atmospheric Angular Momentum Functions

The Atmospheric Angular Momentum (AAM) functions were proposed to evaluate the earth rotational variation by precisely estimating the variation of the atmospheric angular momentum. The AAM is being sent to NCEP through GTS in order to monitor the atmospheric effect on the earth's rotation. The AAM functions are expressed as follows.

$$\chi_1 = -1.00\left[\frac{r^2}{(C-A)g}\right]\int P_S \sin\phi\cos\phi\cos\lambda\, dS - 1.43\left[\frac{r}{\Omega(C-A)g}\right]\iint (u\sin\phi\cos\lambda - v\sin\lambda)\, dPdS \qquad (5.9.1)$$

$$\chi_2 = -1.00\left[\frac{r^2}{(C-A)g}\right]\int P_S \sin\phi\cos\phi\sin\lambda\, dS - 1.43\left[\frac{r}{\Omega(C-A)g}\right]\iint (u\sin\phi\sin\lambda + v\cos\lambda)\, dPdS \qquad (5.9.2)$$

$$\chi_3 = -0.70\left[\frac{r^2}{Cg}\right]\int P_S \cos^2\phi\, dS - 1.00\left[\frac{r}{\Omega Cg}\right]\iint u\cos\phi\, dPdS \qquad (5.9.3)$$

In the expressions (5.9.1) - (5.9.3), P is the pressure, $\int dS$ is the surface integral over the globe, (ϕ, λ) are latitude and longitude, u, v are the eastward and northward components of the wind velocity, P_S is the surface pressure, g is the mean acceleration of gravity, r is the mean radius of the earth, C is the polar moment of inertia of the solid earth, A is the equatorial moment of inertia, and Ω is the mean angular velocity of the earth.

Functions χ_1 and χ_2 are the equatorial, and function χ_3 is the axial component. Every component is non-dimensional. The first term of each component is a pressure-term, which is related to the redistribution of the air masses. The second term is a wind-term, which is related to the relative angular momentum of the atmosphere.

The variation of the AAM functions computed from the JMA's global analysis data has been reported to well correspond to the variation of the earth rotation. Fig. 5.9.1 shows the seasonal variation of the observed earth rotation and the computed atmospheric relative angular momentum (the wind term of χ_3). The computation was carried out

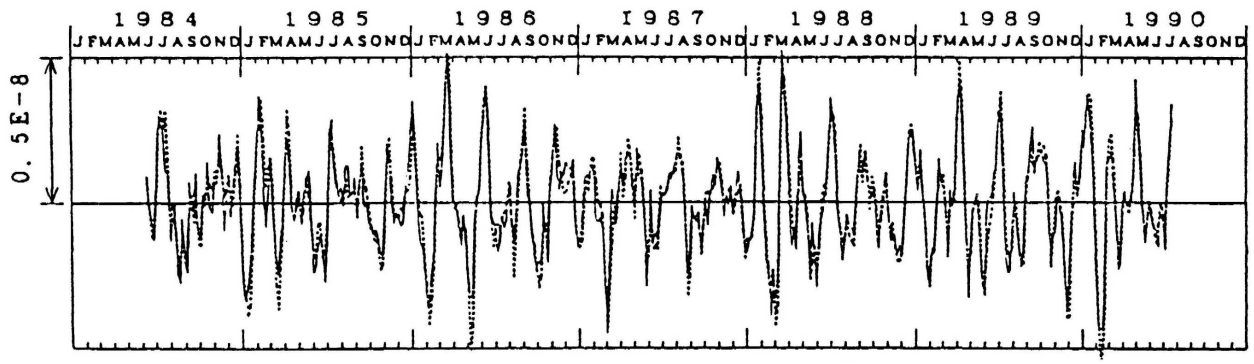

Fig. 5.9.1. Seasonal variations of the observed earth rotation (solid line) and the computed atmospheric angular momentum (broken line). Both data are 150 days' high-pass filtered.

by National Astronomical Observatory of Japan.

Since early 1993, the AAM functions computed from the JMA global analysis data at 00UTC, 06UTC, 12UTC and 18UTC have been provided operationally. Now, the AAM functions computed from the JMA global 8-day forecast data at 12UTC also have been provided operationally.

The AAM functions which are computed in a test period between 21 June and 30 September 1992 are shown in Fig. 5.9.2. In this figure, day 1 - 102 corresponds to 21 June - 30 September 1992. Each term of the AAM functions is multiplied by 10^7. The broken line shows the 6-hourly values of the AAM functions (difference from the period mean values), and the solid line shows the 5-10 days' band-pass filtered values. It can be noticed that an oscillation that has a 5-10 day period is remarkable in each term of the each component, which implicitly means that there is a 5-10 day period oscillation in the global scale atmosphere.

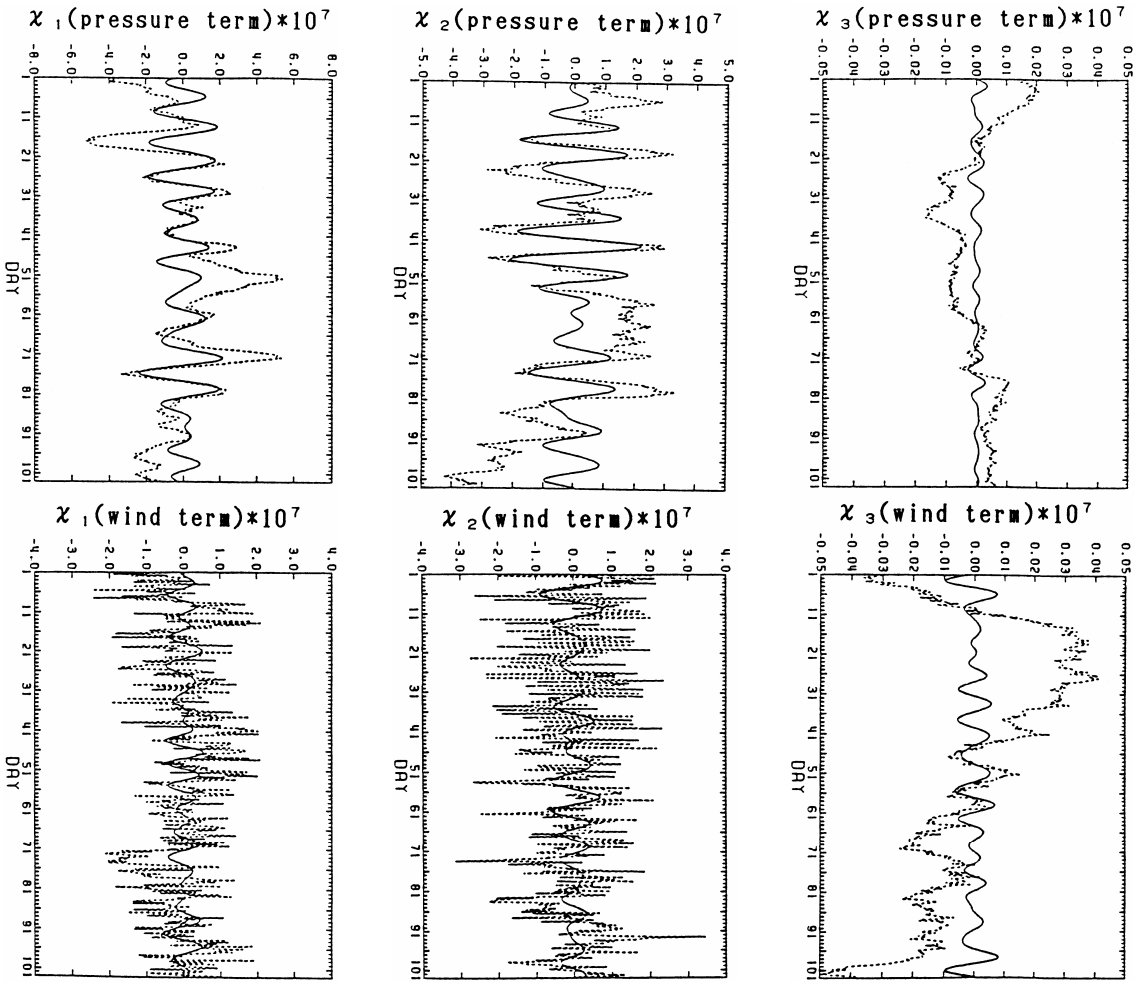

Fig. 5.9.2. Pressure terms (top) and wind terms (bottom) of the AAM function. The left panels are the χ_1 component, the center ones are the χ_2 and the right ones are the χ_3. Day 1 - 102 corresponds to 21 June - 30 September 1992. The broken line shows the 6-hourly values of the AAM functions, and the solid line shows the 5-10 days' band-pass filtered values. Each value is multiplied by 10^7.