ON THE DYNAMICS OF SEASONAL REDISTRIBUTION OF GLOBAL LIGHTNING AS SHOWN BY SCHUMANN RESONANCE OBSERVATIONS IN THE SZÉCHENYI ISTVÁN GEOPHYSICAL OBSERVATORY AT NAGYCENK

G. SÁTORI

"Single station – global sense" idea is demonstrated in this study. The results presented here are valid in global sense and they are based on Schumann resonance observations in the Széchenyi István Geophysical Observatory at Nagycenk, Hungary. The daily Schumann resonance frequency (SRF) patterns are mainly determined by the lightning source-observer configuration. This configuration changes during the north-south seasonal lightning migration, consequently the daily SRF patterns vary, too. Four basic types of daily SRF patterns have been distinguished corresponding to the four seasons observed for each SR mode at Nagycenk, Hungary. Cross-correlation analysis has been used between the monthly means of daily SRF patterns in two adjacent months to identify the seasons. The number of months with daily SRF patterns characteristic for a season was different. Similar daily SRF patterns have been observed during five months (Nov–Dec–Jan–Feb–March) in the Southern hemisphere summer, in two months in both transition (spring and fall) seasons and during three months (June–July–August) in the Northern hemisphere summer. The same time sequences (four seasons with different lengths) can be recognized in the meridional lightning distributions observed by OTD (Optical Transient Detector) and LIS (Lightning Imagine Sensor) as disclosed by the seasonal distributions of the daily SRF patterns.

The ratio of land area to ocean area is smaller in the Southern hemisphere than in the Northern hemisphere. The oceanic surface thermodynamics can influence the tropospheric thermal properties of the Southern hemisphere lands embedded in the oceans. The large oceanic thermal inertia seems to be manifested in the dynamics (speed) of the north-south lightning migration identified by the long lasting southern position of global lightning in the Southern hemisphere summer and by the time lag of the northward lightning migration as compared to the "solar marsh" in spring in spite of the fact that lightning is first of all a land related phenomenon. The spring-fall asymmetry of the migration speed is attributed to the different thermodynamical properties of land and ocean.

Schumann Resonance Frequency (SRF)

The diurnal pattern of SRF is highly determined by the angular distance between the lightning source and the observer and characteristic for each SR mode and field component (Sentman 1995, Sátori 1996, Nickolaenko et al. 1998, Musthak 1999). The diurnal pattern of SRF is preserved if the source-observer distance is stable and it changes if the source moves with respect to the observer. In this way the time history of the north-south migration can be followed by the variations of SRF.

SRF data have been available in hourly time resolution from May 1993 up to the present at Nagycenk, Hungary. At first, the monthly means of the diurnal patterns of SRF have been computed. Collection of the SRF patterns into groups has been done by cross-correlation analysis. SRF patterns have got to a group depending on the values of the correlation coefficients in two adjacent months. Very high correlation coefficients (> 0.95) presented themselves in summer months of both hemispheres but with different number of months. The rest of the SRF patterns with lower correlation coefficients has got to the group of the transition (spring or fall) seasons. Just the sudden decrease of the correlation coefficients due to changing SRF patterns indicates the quick variations in the source-observer geometry in these transition seasons. Four characteristic shapes of mean daily SRF were identified corresponding to the four seasons separately for the 1st and 2nd SR modes as shown in Fig. 1a,b.

OTD/LIS Lightning Observations

OTD/LIS lightning data have been used (Christian et al. 2003) to reveal the results exhibited by SRF on the dynamics of the north-south migration of lightning. Meridional lightning distributions have been determined in world-wide sense (Fig. 2a) and then for the longitudinal range of Americas (Fig. 2b), Africa/Europe (Fig. 2c), as well as, the Maritime Continent /Asia (Fig. 2d) in every month. The same correlation analysis has been done for the OTD/LIS data as in case of SRF. The four seasons were identified by the similar meridional lightning distributions. The different duration of the Northern and Southern hemisphere summers is again striking. The meridional lightning distribution exhibits rather stable position int he Southern hemisphere during five months (Nov–Dec–Jan–Feb–March) both in global sense and the different longitudinal ranges with exception of the Maritime Continent/Asia where it is only four months while the lightning distribution is only

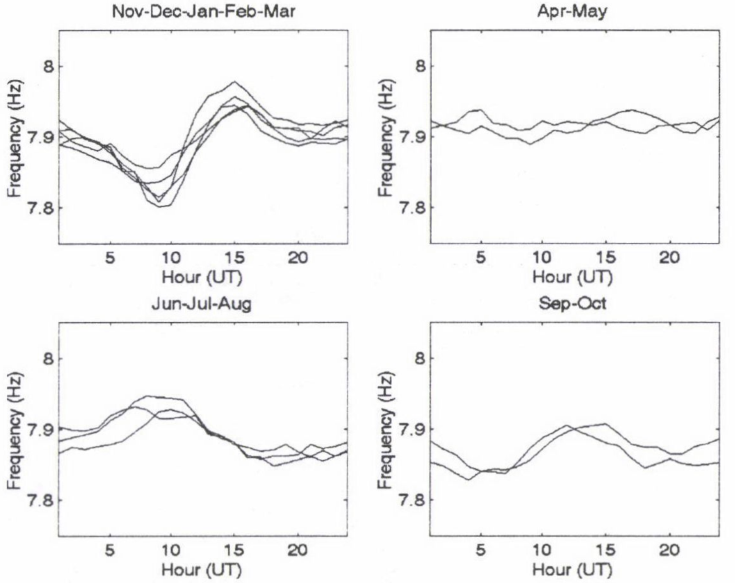

Fig. 1a. Monthly means of the diurnal frequency patterns in four seasons in case of the 1st SR mode as observed int he Széchenyi István Geophyiscal Observatory at Nagycenk

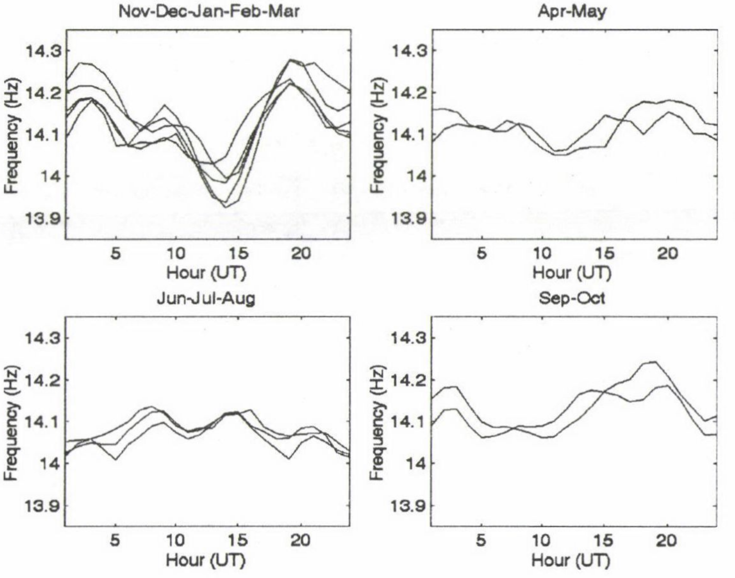

Fig. 1b. Monthly means of the diurnal frequency patterns in four seasons in case of the 2nd SR mode as observed int he Széchenyi István Geophyiscal Observatory at Nagycenk

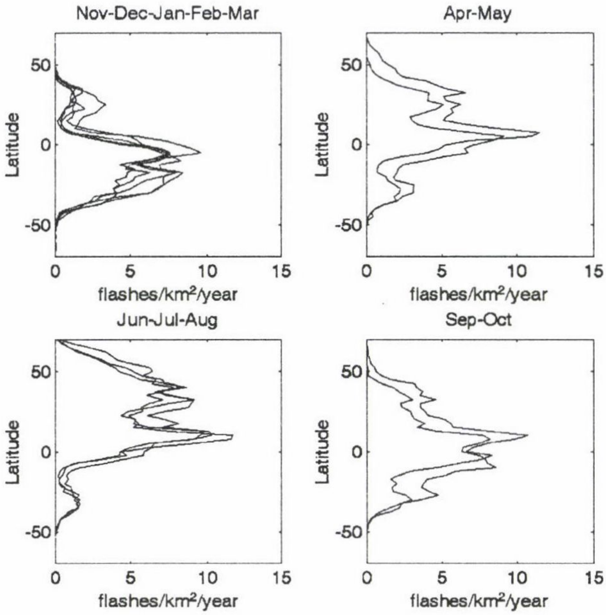

Fig. 2a. Global meridional lightning distributions observed by OTD/LIS satellites in the four seasons grouped on the base of the result of the cross-correlation analysis

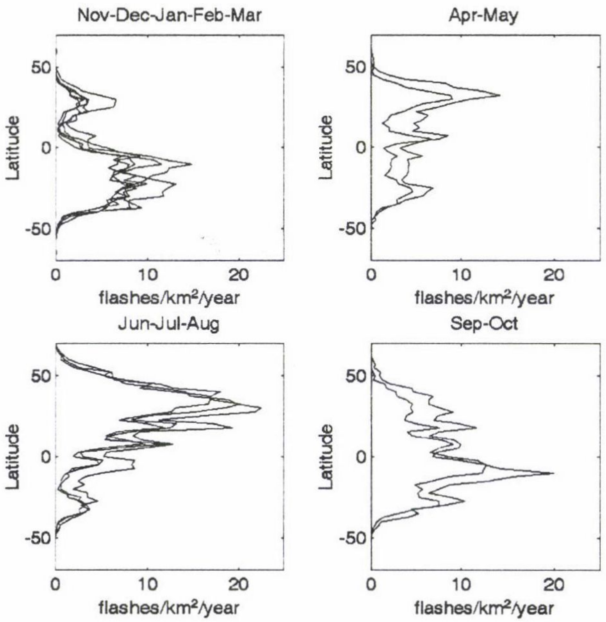

Fig. 2b. Meridional lightning distributions in Americas observed by OTD/LIS satellites in the four seasons grouped on the base of the result of the cross-correlation analysis

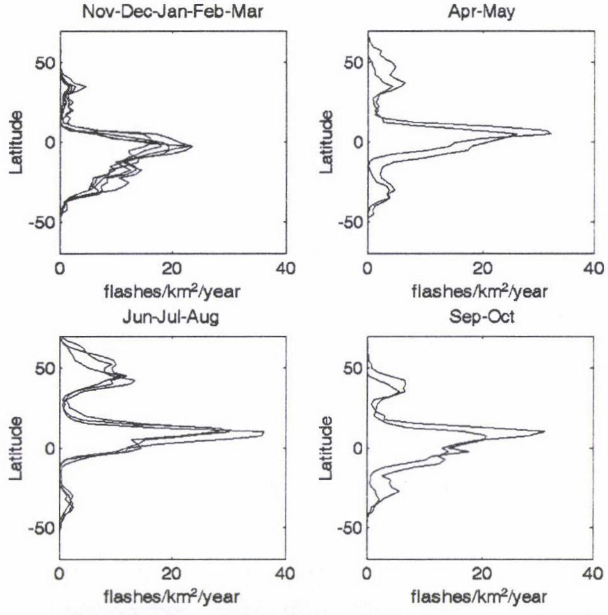

Fig. 2c. Meridional lightning distributions in Africa/Europe observed by OTD/LIS satellites in the four seasons grouped on the base of the result of the cross-correlation analysis

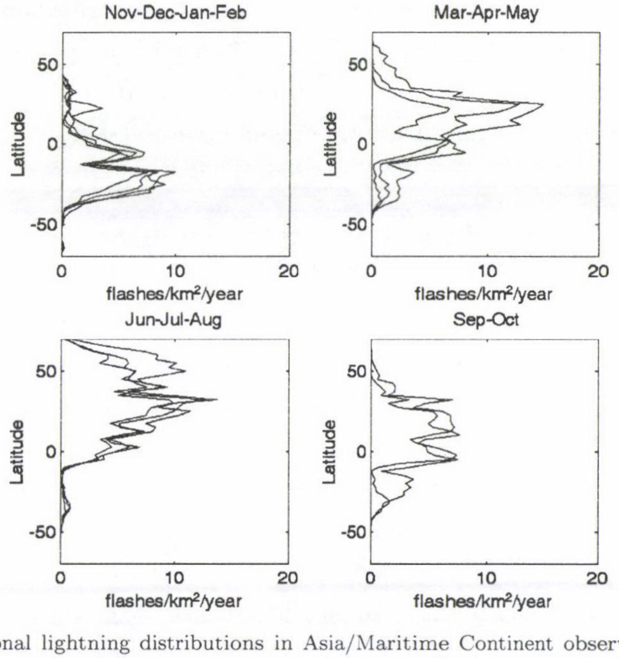

Fig. 2d. Meridional lightning distributions in Asia/Maritime Continent observed by OTD/LIS satellites in the four seasons grouped on the base of the result of the cross-correlation analysis

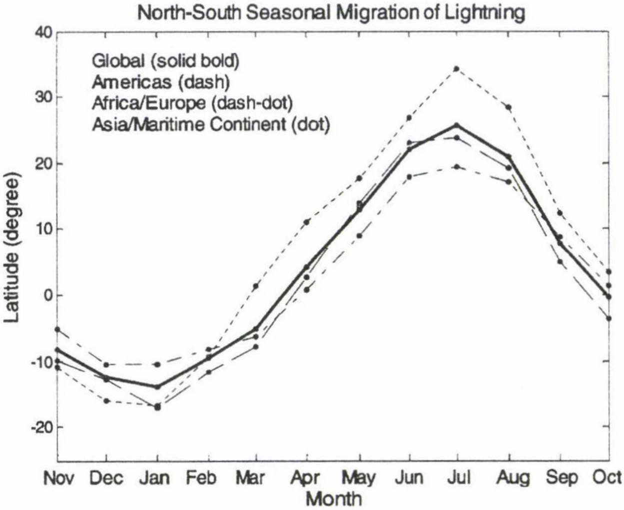

Fig. 3. The latitudinal positions indicate a longish dwell time of lightning in the Southern hemisphere summer, especially in America and Africa

stable for three months in the Northern hemisphere summer bot hon global sense and in the three main land regions.

The latitude of the center of the meridional lightning distribution was computed in every month in case of global lightning and that of the three main lightning regions as shown in Fig. 3. The latitudinal range covered by the annual lightning migration is the narrowest for Africa/Europe and the widest for the Asia/Maritime Continent.

Discussion

The global lightning doesn't follow the Sun in the Northern hemisphere winter months of the year during its northward migration from the southern latitudes to the northern ones (Fig. 4.). There is about one month time lag with respect to the "solar march" in spite of the fact that lightning is dominantly a land related temperature dependent phenomenon. The time lag rapidly disappears between August and September when the migration speed is the highest backward in south direction. This behavior of the global lightning has been recognized by Schumann resonance frequencies and revealed by satellite (OTD/LIS) lightning observations.

Figure 5 shows annual surface air temperature variations for some land stations in both hemispheres and in the South Pacific. The temperature profiles of tropical

South Pacific and Southern hemisphere lands exhibit common characters with high and rather stable temperatures from November to March while the temperature maximum is confined only for three months (June–July–August) in the Northern hemisphere lands.

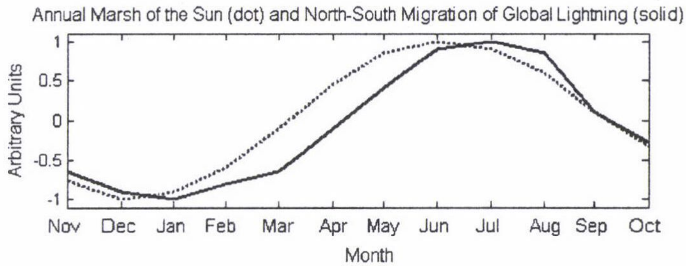

Fig. 4. Annual marsh of the Sun and the world lightning centers

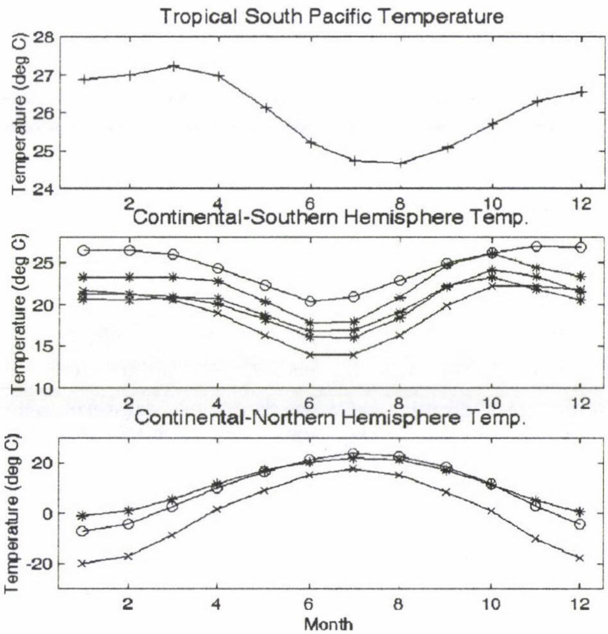

Fig. 5. Annual surface air temperature variations in the South Pacific and for some land stations in both hemispheres

Conclusion

The oceanic surface thermodynamics can influence the tropospheric thermal properties of the Southern hemisphere lands embedded in the oceans. The large oceanic thermal inertia seems to be manifested in the dynamics (speed) of the north-south lightning migration identified by the long lasting southern position of global lightning in the Southern hemisphere summer and by the time lag of the northward lightning migration in spring in spite of the fact that lightning is first of all a land related phenomenon. The spring-fall asymmetry of the migration speed is attributed to the different thermodynamical properties of land and ocean.

Acknowledgement

This work was supported by the Hungarian Scientific Research Fund NI 61013.

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