Global Lightning Observation by Schumann Resonances at a North Polar Station and in two European Field Sites

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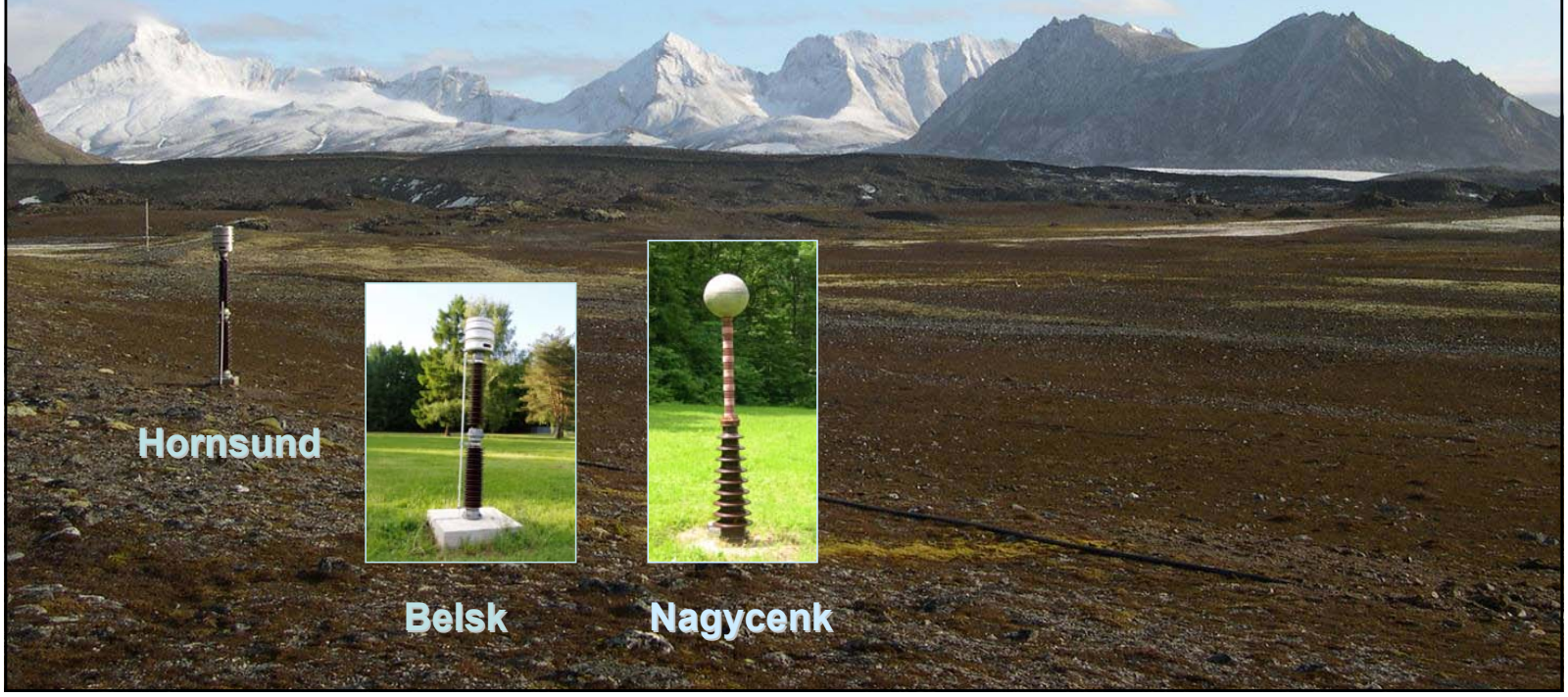


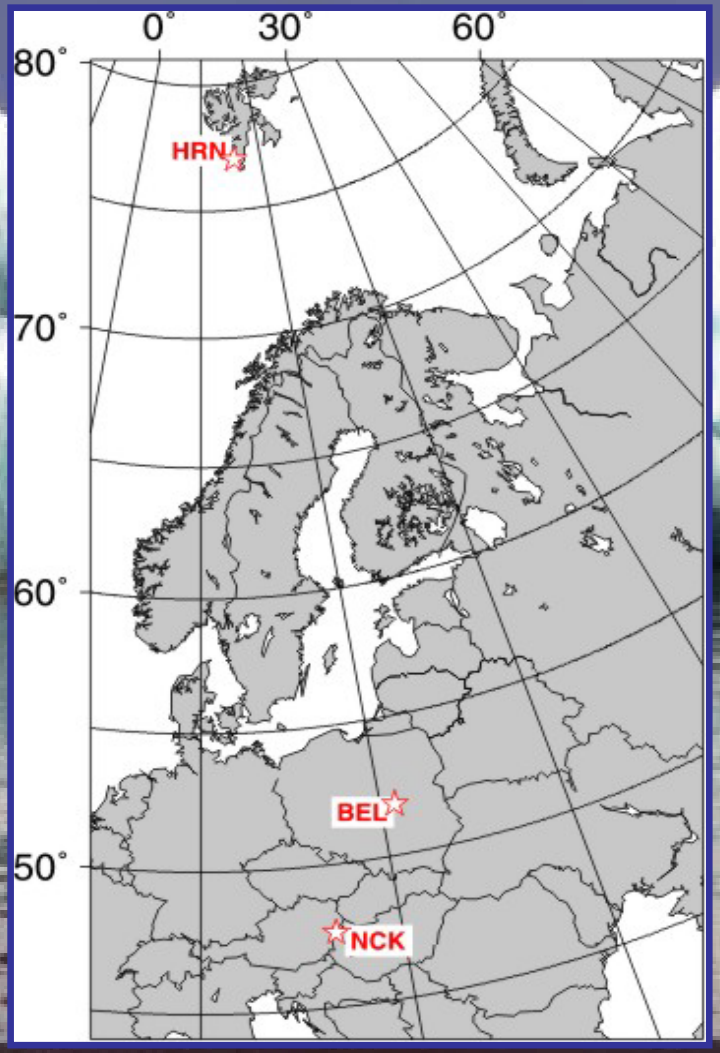
Importance of Monitoring Schumann resonances has increased for two main reasons:

1) **Studying global lightning from the point of view of global warming as lightning activity is very responsive for small variations of surface air temperature.**

2) **Studying global lightning as global parent source of lightning related phenomena like as transient luminous events (TLE) and terrestrial gamma ray flashes (TGF) as well as other newly discovered relations from the troposphere up to the magneto-sphere.**

A new Schumann resonance (SR) recording system was installed at the Polish Polar Station (77º N, 15.5º E), Hornsund (HRN) in Spitsbergen in 2004 and in the Belsk Observatory (BEL: 51.8 º N , 20.8 º E), Poland in 2005. Continuous SR measurements have been running in the Nagycenk Observatory (NCK: 47.6 N, 16.7 E) since 1993. The Spitsbergen SR station is located almost at the same longitude as the Nagycenk Observatory (NCK:), Hungary, and in addition, the three SR stations (HRN, BEL, NCK) are situated in the longitudinal range of Africa which has the most intense lightning activity in the world.

Configuration of the three stations



Since the purpose of monitoring Schumann resonances is to determine the intrinsic spatial-temporal parameters of global lightning activity, the parameters cannot be estimated directly from observations, and an accurate ELF propagation theory is required to ”correct” the ”distorting” effect of the propagation process occurring between the lightning sources and observer.

There are two main distorting effects:

1) Source-observer distance variation
2) Non-uniformity (day/night asymmetry) of the cavity

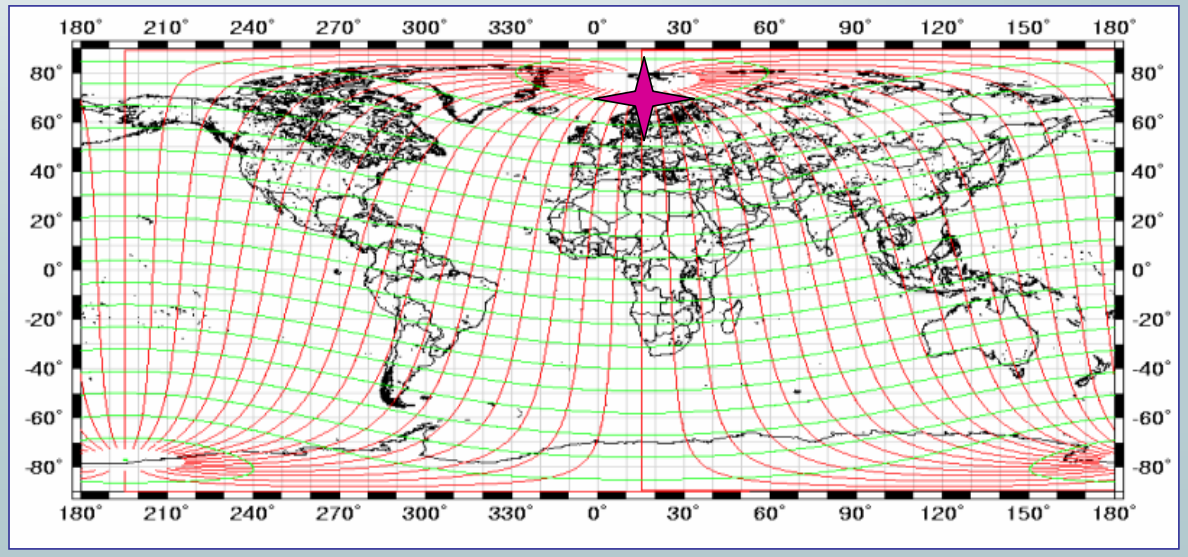
In the recent study, all three SR stations are almost in equal angular distances from Asia/MC and Americas and the local ionospheric day/night transition is almost missing at the north-polar station, Hornsund in the most part of the year (full-day or full night conditions).

Same type of induction coils has been used for recording the magnetic field component at the two Polish SR stations and similar ball antennas were installed for measuring the vertical electric field component in the three SR field sites as well as the same spectral technique (complex demodulation) was applied for processing SR data sets at the three SR stations. In this way a <u>software-hardware independent compatible SR data sets</u> can be used for comparisons from the point of view of global lightning activity.

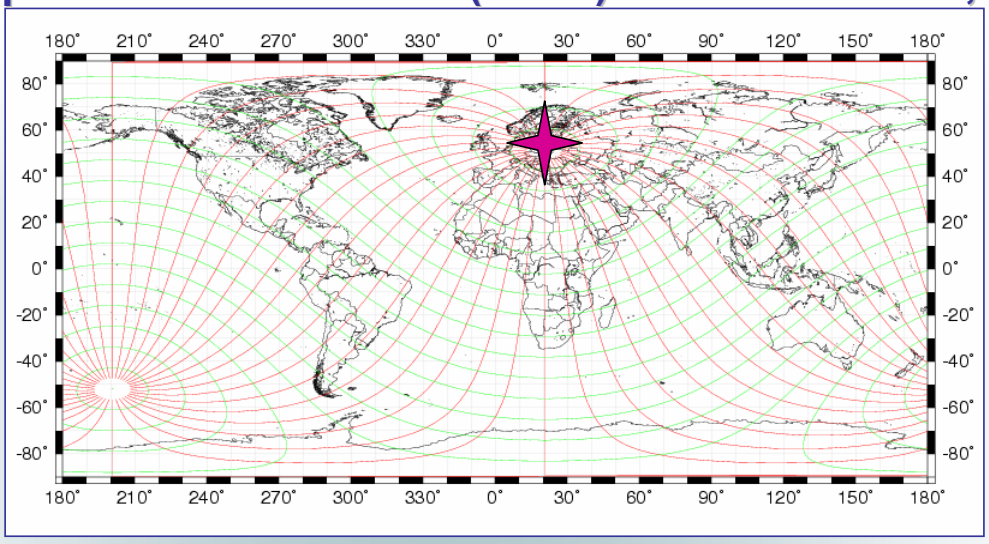
The SR recording system at Hornsund has a rather good view to the two other tropical regions (South America; SA and the Maritime Continent; MC) and it is far enough from the Northern American and Eurasian lightning regions during the Northern hemisphere summer yielding reliable Schumann resonance parameters from those source regions, too.

All three SR stations are almost in equal angular distances from Asia/MC and Americas.

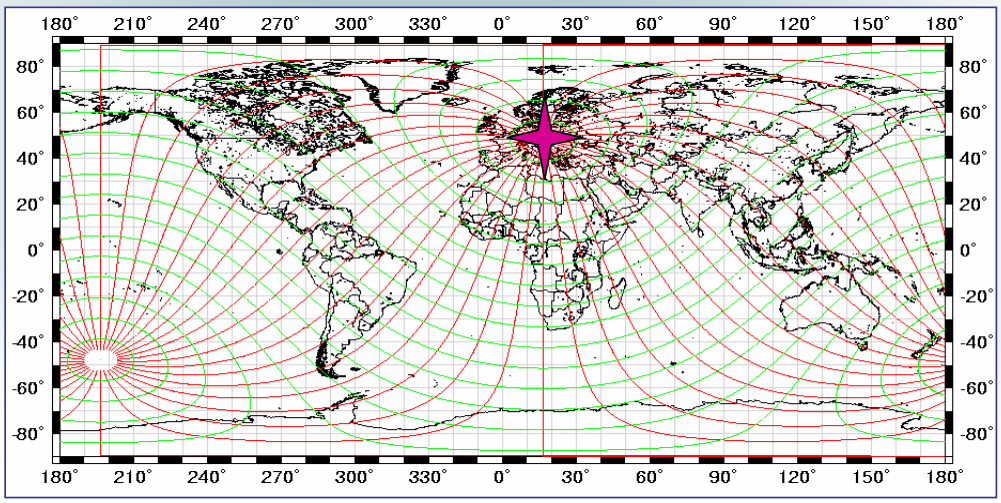
Great circle path and iso-distance (1 Mm) curves for Hornsund



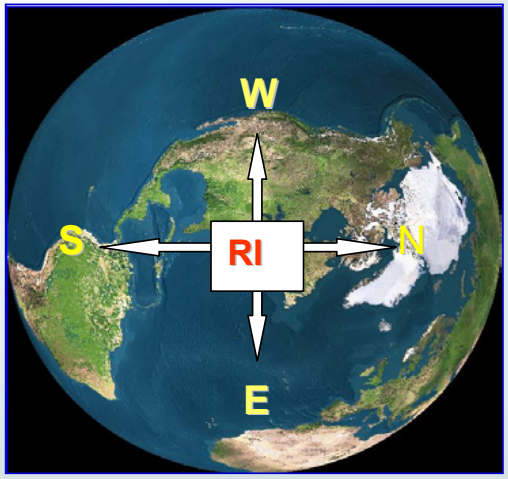
Great circle path and iso-distance (1 Mm) curves for Belsk, Poland

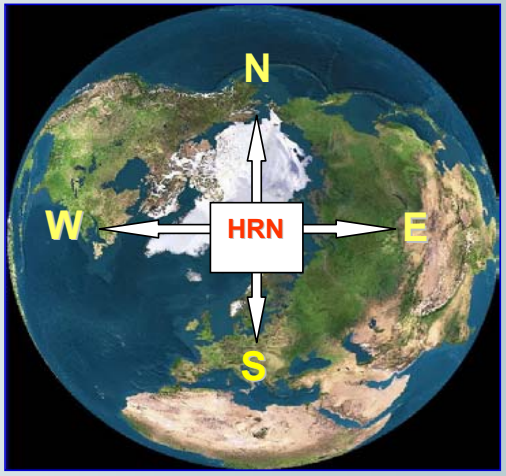


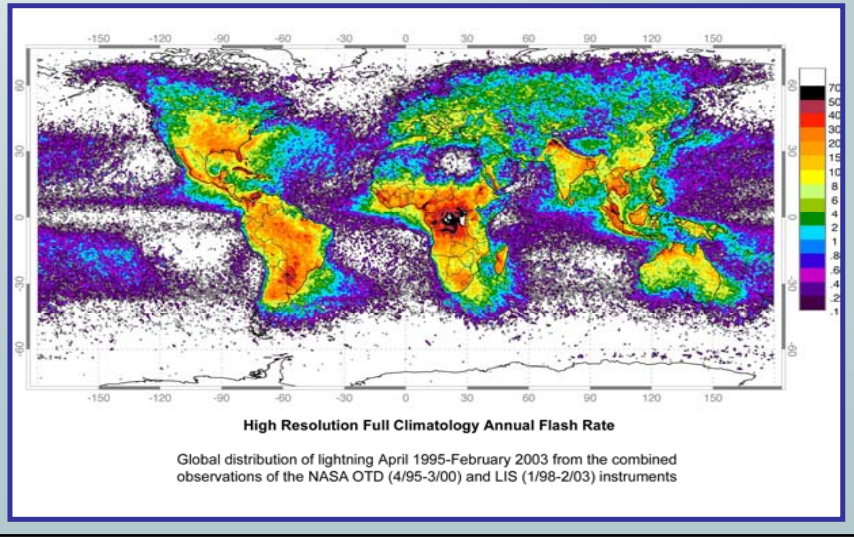
Great circle path and iso-distance (1 Mm) curves for Nagycenk, Hungary



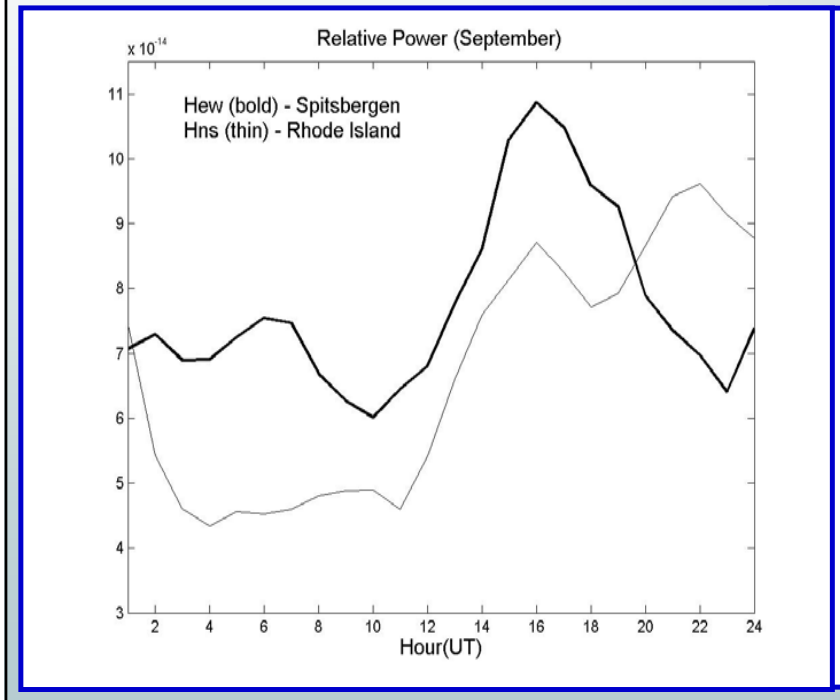
Orientation of induction coils at Rhode Island and Hornsund with respect to the main thunderstorm regions

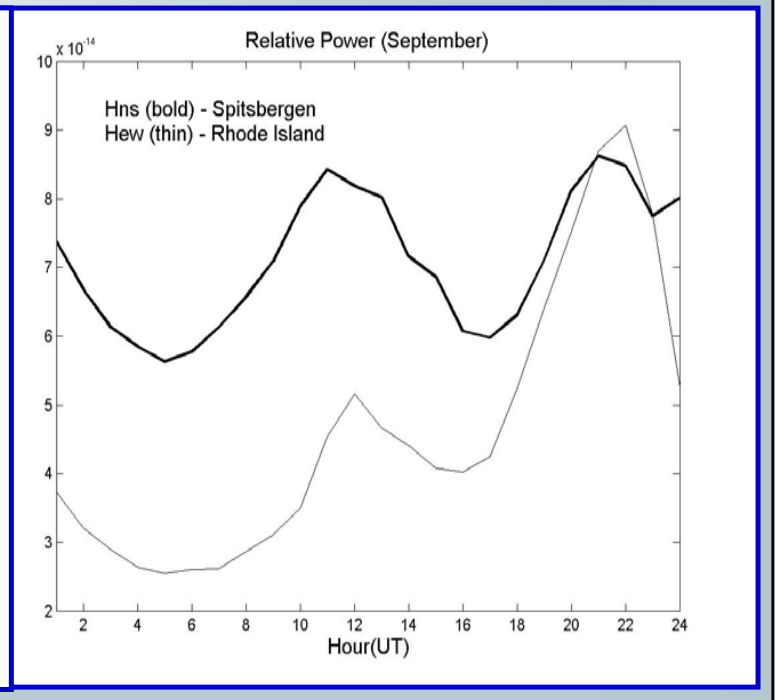




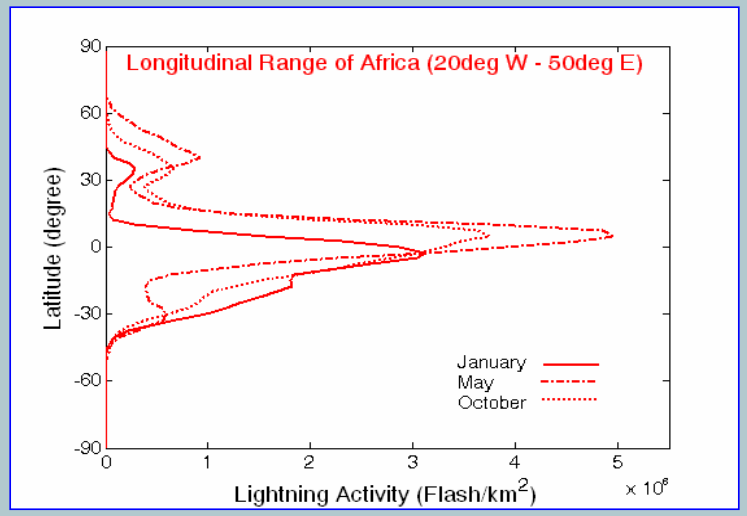


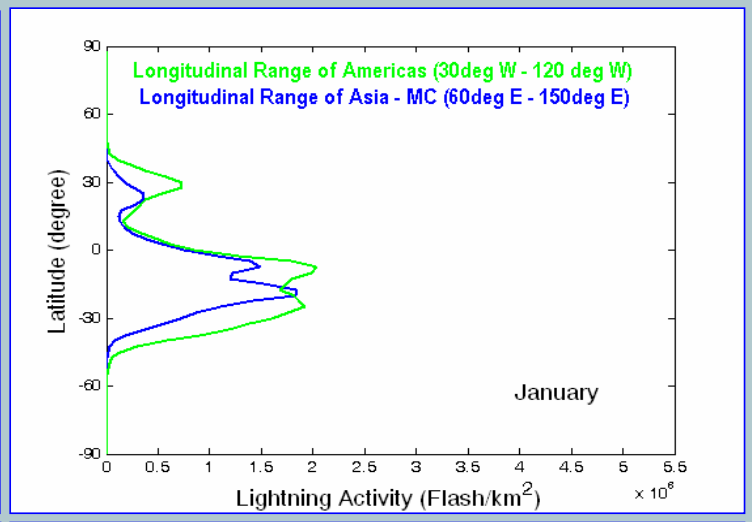
As it is expected in case of Spitsbergen and Rhode Island SR stations the magnetic cross- field components (Hns and Hew) show similarity

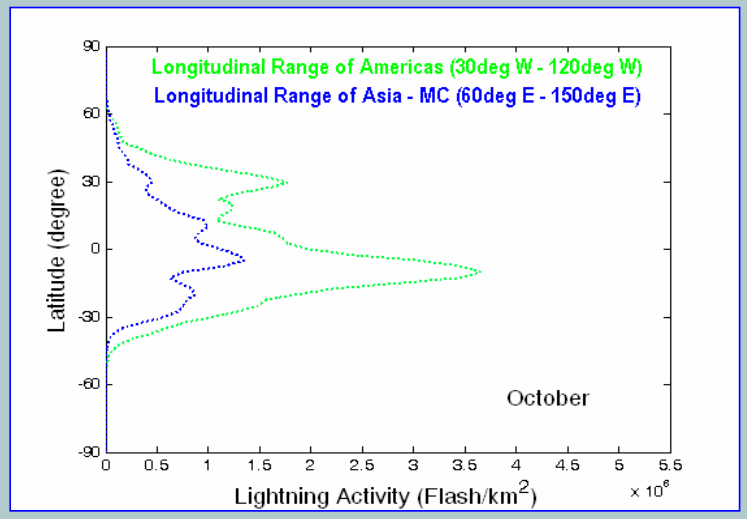


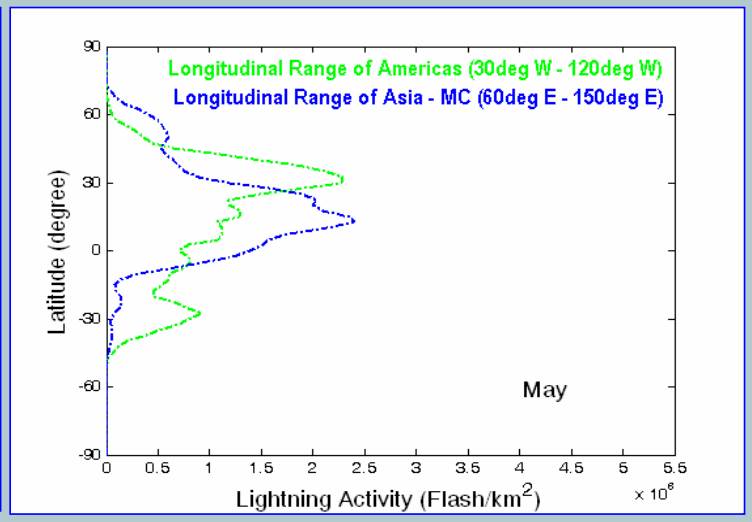


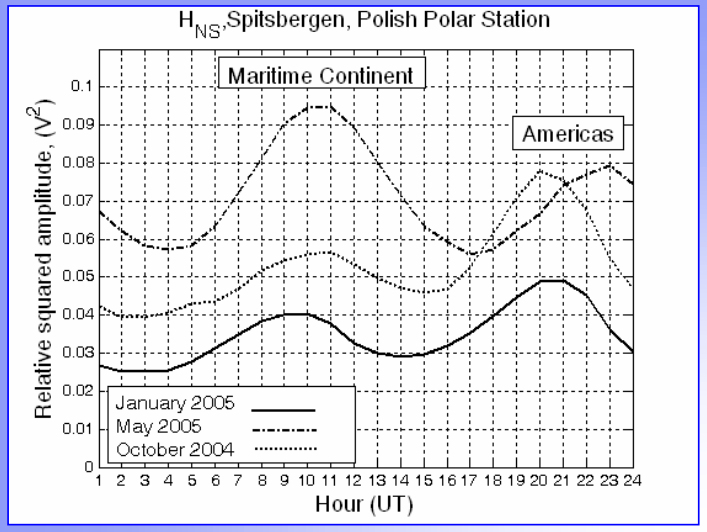
OTD/LIS satellite lightning observations

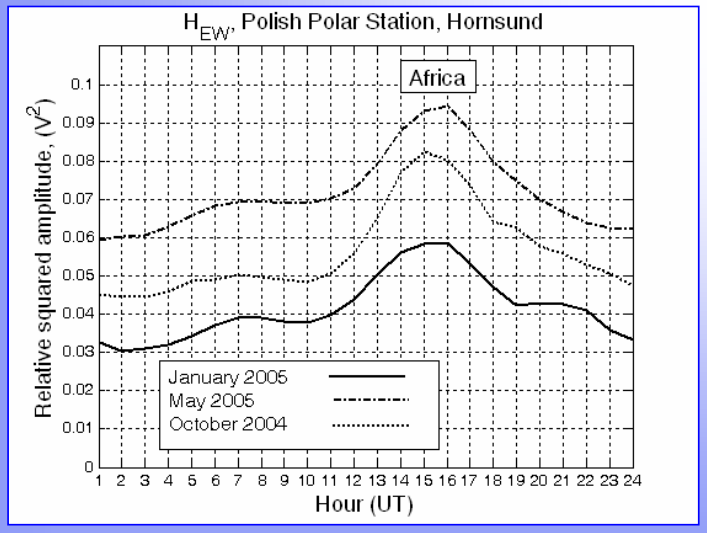


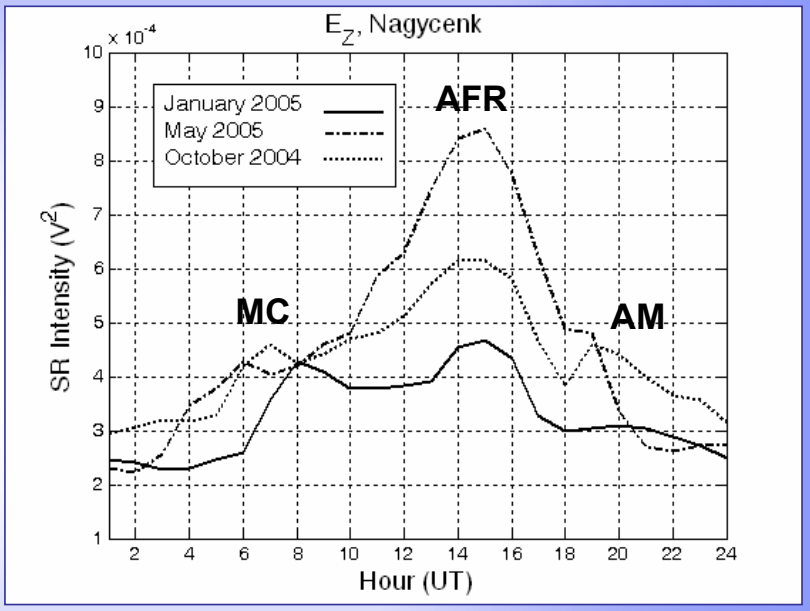


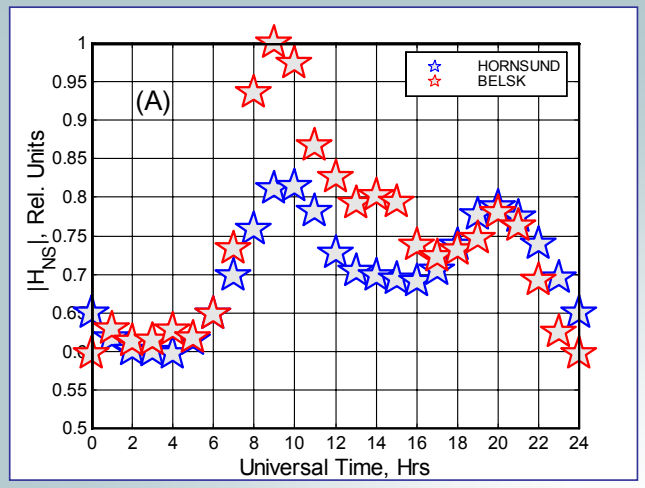




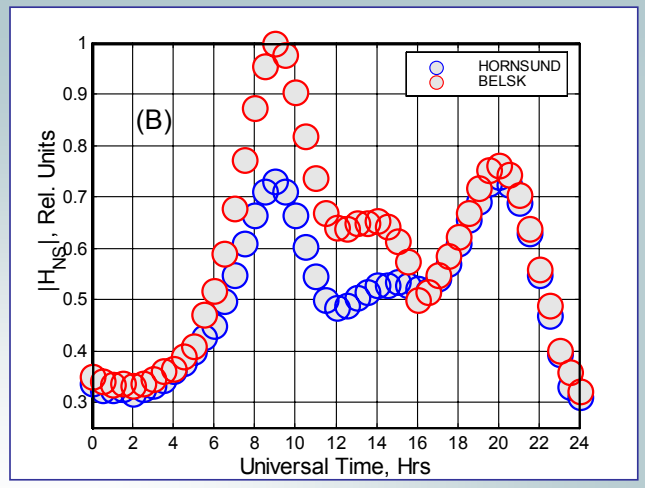

H_NS,Spitsbergen, Polish Polar Station
Maritime Continent
Americas
Relative squared amplitude, (V^2)
Hour (UT)
January 2005
May 2005
October 2004


H_EW, Polish Polar Station, Hornsund
Africa
Relative squared amplitude, (V^2)
Hour (UT)
January 2005
May 2005
October 2004


E_Z, Nagycenk
x 10^-4
January 2005
May 2005
October 2004
AFR
MC
AM
SR Intensity (V^2)
Hour (UT)

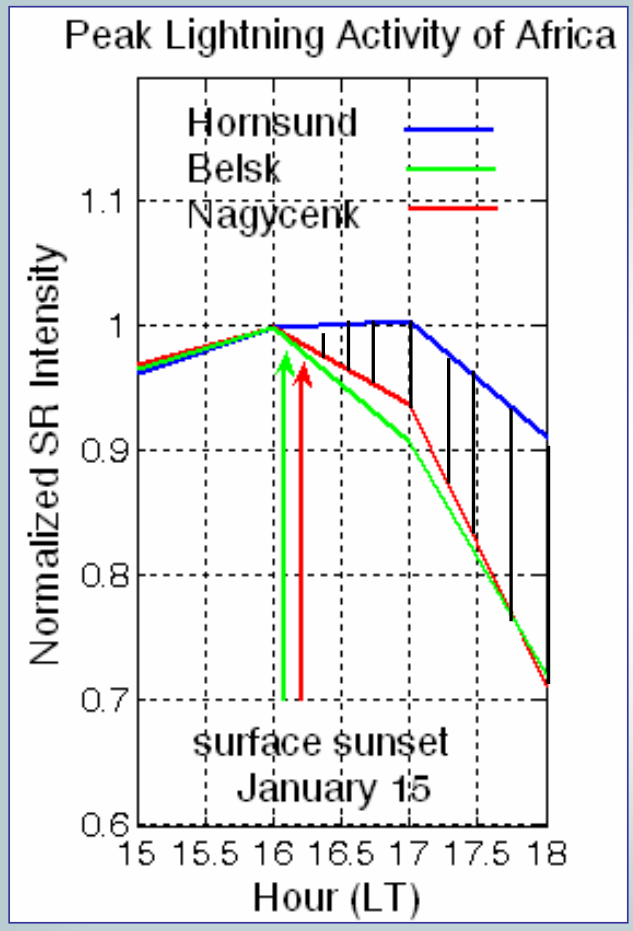


The normalized diurnal variations of the north-south magnetic background field observed at the Belsk (Poland) and Hornsund (Spitzbergen) ELF stations in February, 2005.



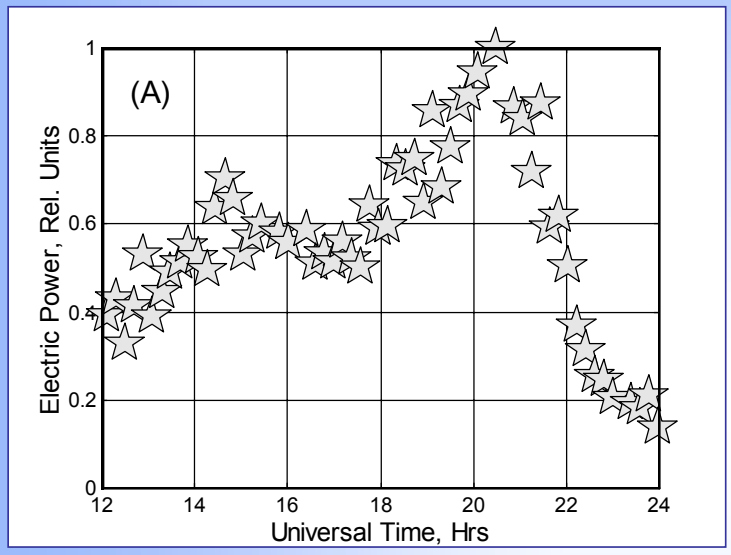
The TDTE-simulated diurnal variations of the north-south magnetic background field for the Belsk and Hornsund ELF stations in February, 2005

The positions of the Belsk and Hornsund ELF stations relative to the day/night boundary during the respective periods of the maximum activities in the Asian (left) and American (right) "chimneys". *(Sátori et al., 2008.,* under submission*)*

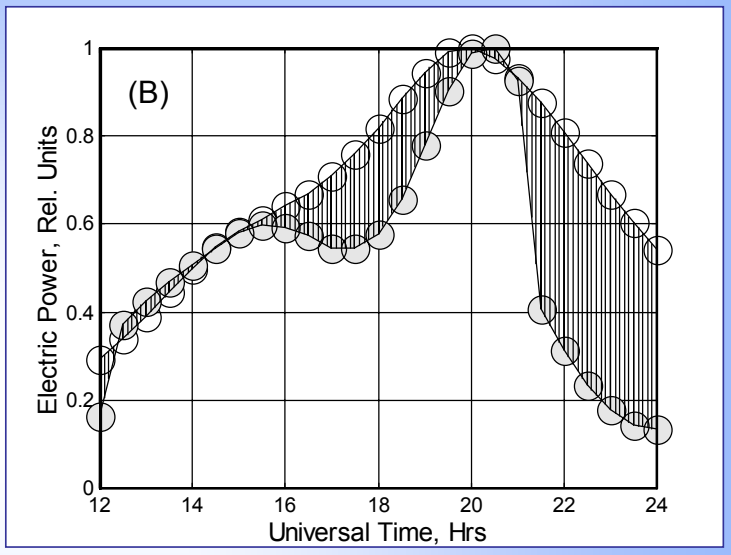


Distortion of peak lightning activity of Africa can be observed in those two observatories, Belsk and Nagycenk, where local iono-spheric day/night transition occurs.

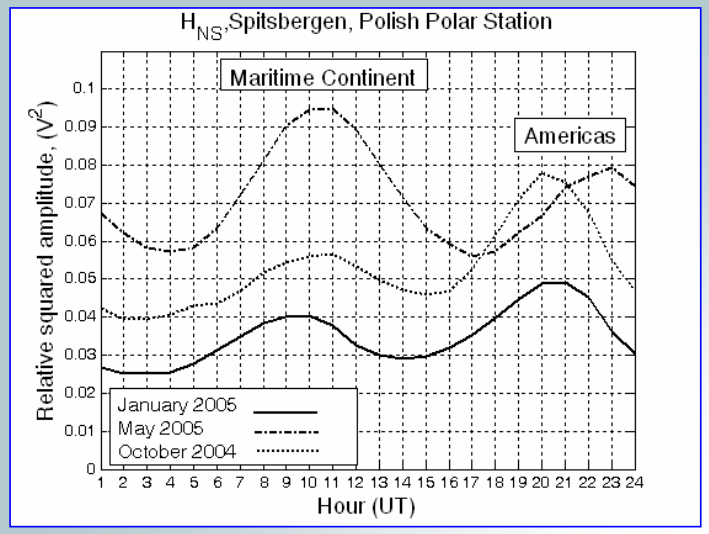
Similar distortion effect of the day/night asymmetry could be observed in SR power at Rhode Island, USA at the time of peak lightning activity in South America

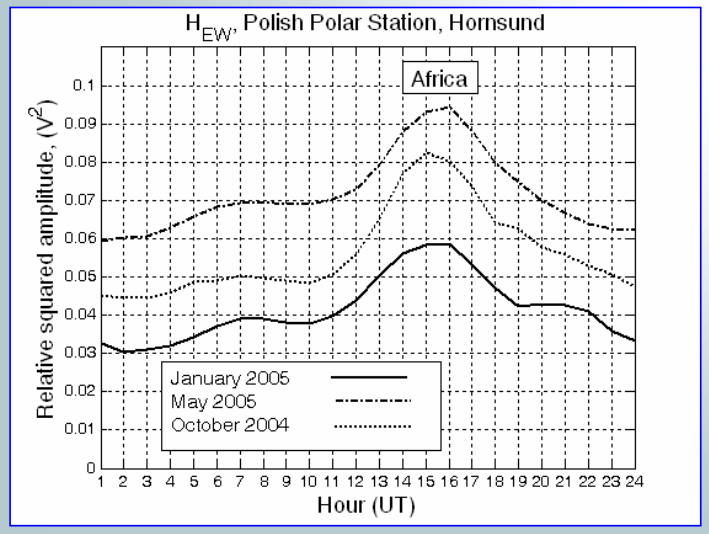


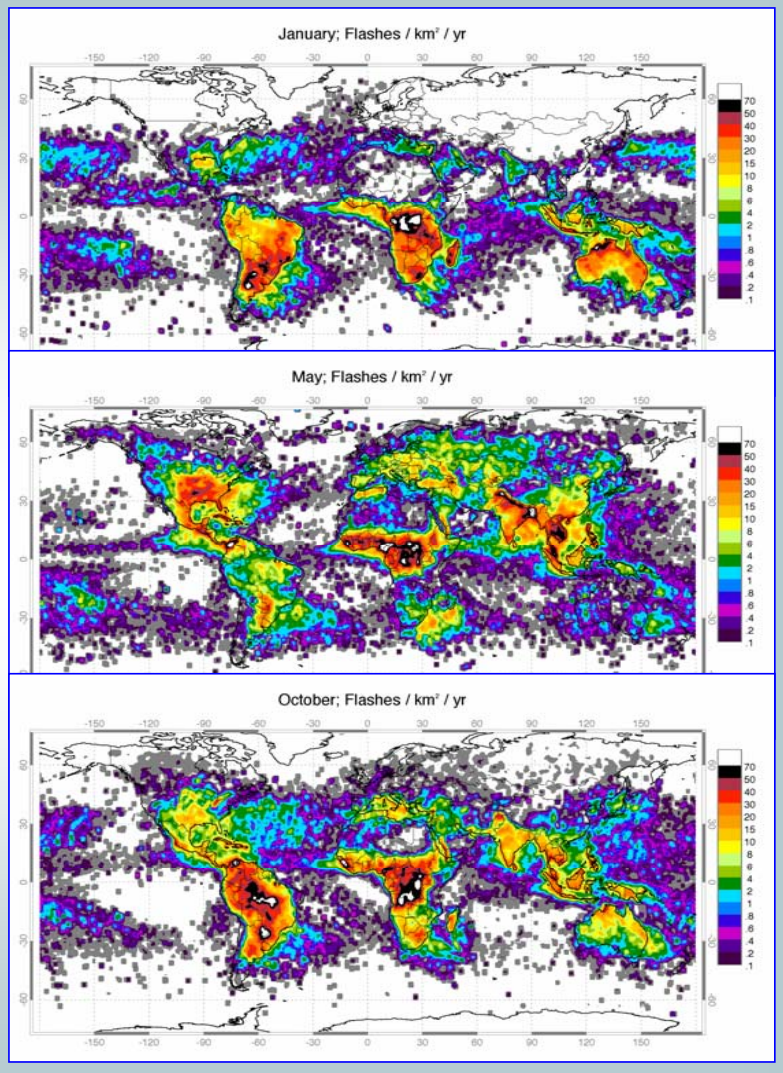
The normalized observed half-day temporal variation of the background electric power at the Rhode Island ELF station on December 18, 1996.



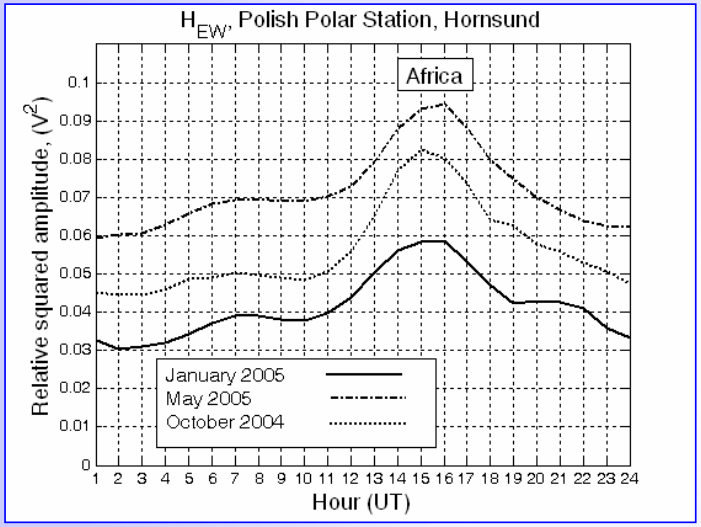
The uniform- (open circles) and TDTE- (filled circles) simulated half-day temporal variations of the background electric power for the Rhode Island ELF station in December. The shaded area demonstrates the amplitude effect of the day/night asymmetry (in print *Musthak and Williams*, 2008).

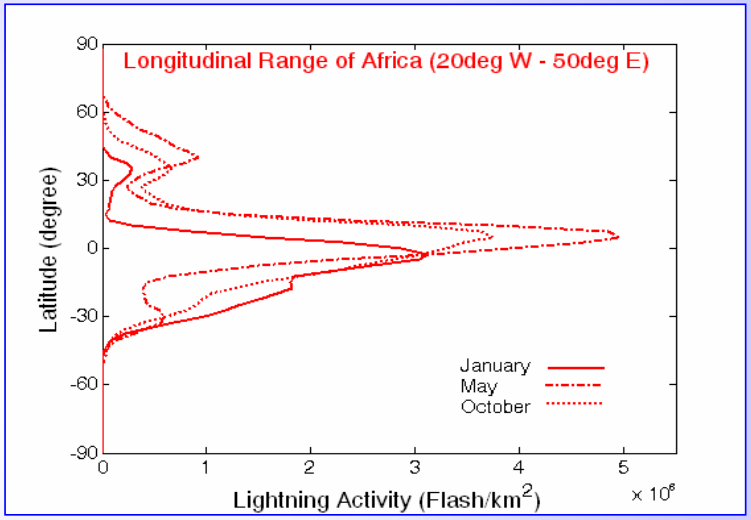

H_{NS},Spitsbergen, Polish Polar Station
Maritime Continent
Americas
Relative squared amplitude, (V^2)
Hour (UT)
January 2005
May 2005
October 2004


H_{EW}, Polish Polar Station, Hornsund
Africa
Relative squared amplitude, (V^2)
Hour (UT)
January 2005
May 2005
October 2004


January; Flashes / km² / yr
May; Flashes / km² / yr
October; Flashes / km² / yr

Peak African lightning activity in three different months observed by Schumann resonances at Hornsund (left) and combined OTD/LIS satellite observations





Conclusion: Polar SR station has the most favourable location to observe undistorted SR intensity characteristic for the intrinsic lightning source activity.

Thank you for your attention!
Hornsund