The global observation for lightning whistlers by ZH-1 satellite

Qiao WANG[1,2], Jing YUAN[3], Zeren ZHIMA[4]

1 Institute of Geophysics, China Earthquake Administration, Beijing, China; 2 Beijing Baijiatuan Earth Sciences, National Observation and Research Station, Beijing, China; 3 Institute of Disaster Prevention, Hebei Province, China; 4. National Institute of Natural Hazards, MEM, China

Abstract

The lightning whistler has a high occurrence rate and connects the atmosphere, ionosphere, and magnetosphere. We give the global lightning whistlers using an automatic recognition algorithm based on the ZH-1 Satellite Search Coil Magnetometer data within the 1kHz – 5kHz range. Further, the dispersion parameters representing the ionospheric condition of their propagation were estimated for the world wide.

Data and Method

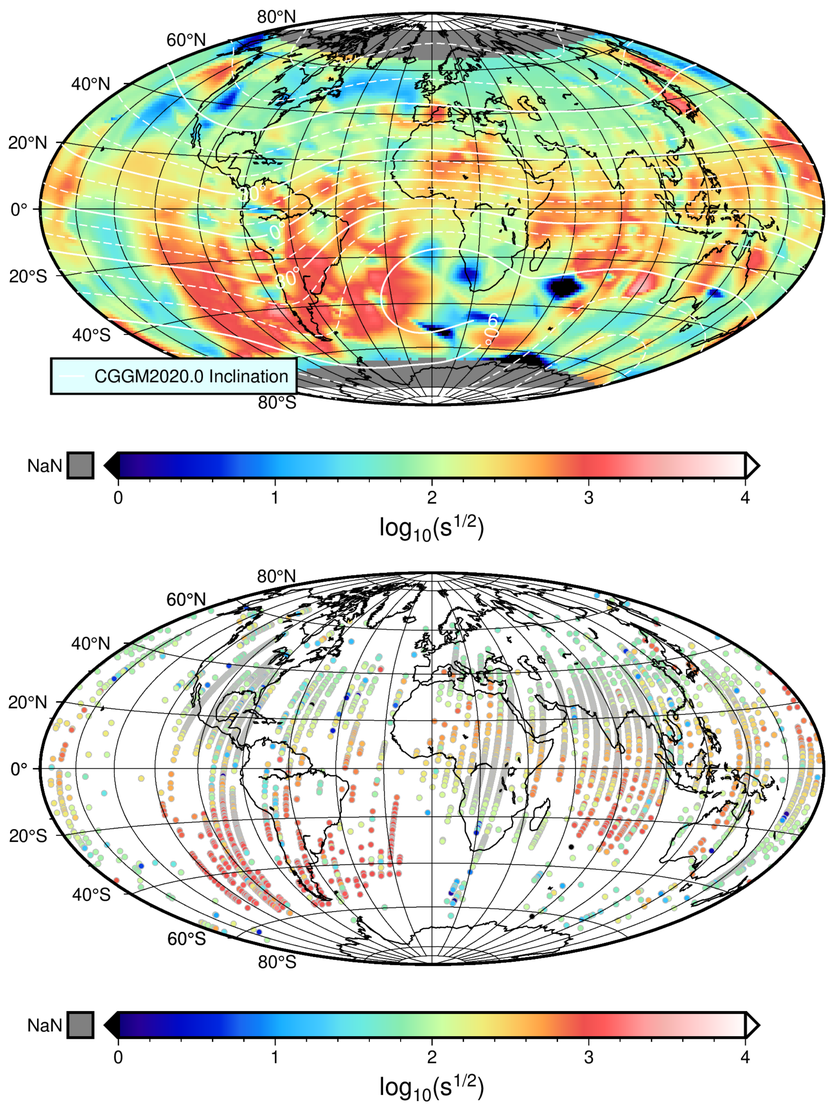
The results are based on the tri-axial search coil magnetometer (SCM). The SCM data product has three frequency bands: ULF (1 Hz to 200 Hz), ELF (200 Hz to 2.2 kHz), and VLF (12.5 Hz to 20 kHz), with sampling rates of 1024 Hz, 10.24 kHz, and 51.2 kHz, respectively. To obtain the global results, we chose the ELF band.

For each recognized whistler, the spectrogram is calculated and the $t \propto \sqrt{f(t)}$ relationship is plotted to obtain the D by a robust regression based on the following equations under some appropriate propagation assumptions.

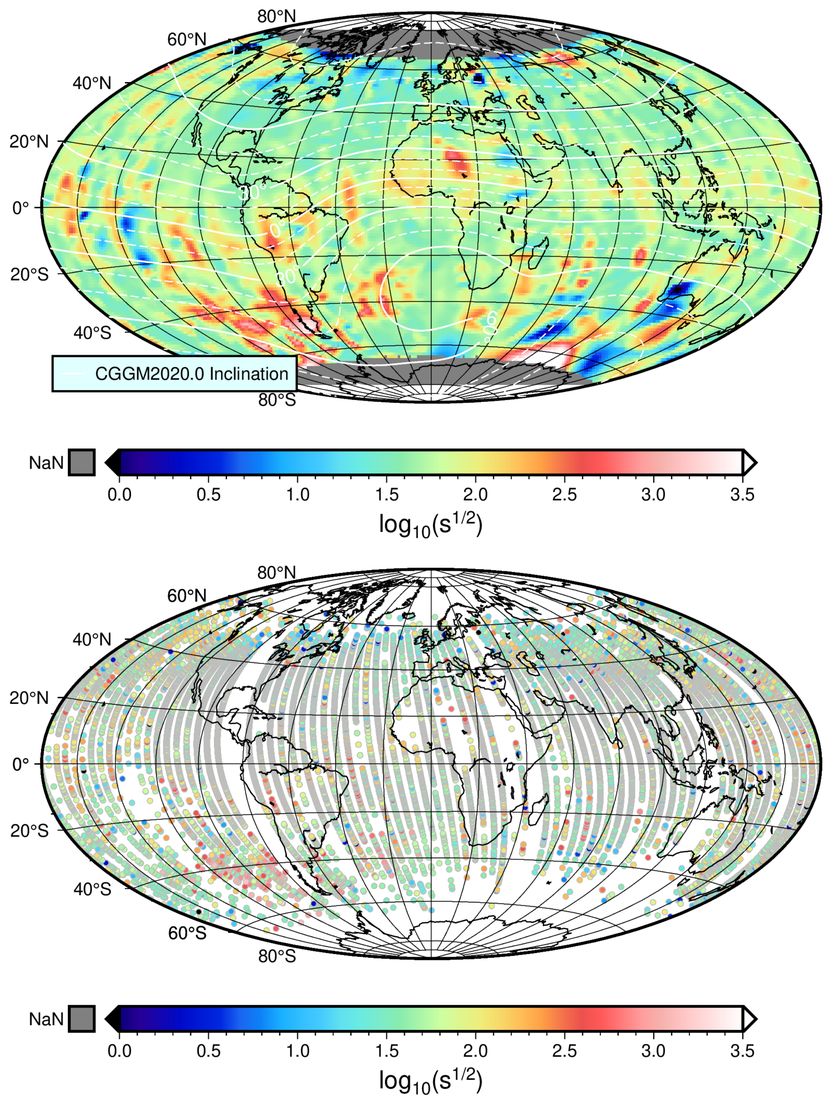
$$t = \frac{D}{\sqrt{f(t)}} + t_0$$

$$D \equiv \kappa(f, B, S, \psi) \int_S \sqrt{N_e(s)} ds$$

20190923-20190927 SCM Whistler Dispersion Day



20190923-20190927 SCM Whistler Dispersion Night



21,383 whistlers, dayside

84,555 whistlers, nightside

Discussions and Conclusions

(1) SCM has a high sensitivity within 10Hz – 20kHz and a low noise level in ELF band. Global lightning whistlers are recognized automatically and used to calculate the ionospheric parameters, i.e. the integral Total Root Electron Content (TREC) proposed by Jenner et al. at the 12th Swarm Data Quality Workshop).

(2) The number of recognized whistlers in dayside is significantly larger than that in nightside. This may due to the propagation conditions and weak recognition for 0+ whistlers.