Research summary:

The **lightning** discharge is an electrical breakdown current which flow from cloud to ground or within thunderclouds. It radiates powerful radio waves over a wide frequency range from a few Hz to several hundreds of MHz. My research is focused on the lower frequency band of the electromagnetic radiation emitted by the lightning discharge: ELF band (Extremely Low Frequency, 3-3000 Hz) and VLF band (Very Low Frequency, 3-30 KHz). In this frequency band the waves exhibit low attenuation rate while propagating in the Earth-Ionosphere waveguide, therefore can be sensed from far distances from its origin. These waves can even propagate a few times around the globe before dissipating, so due to constructive interference standing resonant waves are produced at 8, 14 and 20Hz (Schumann Resonances).

About 2000 thunderstorms occur somewhere around the globe at any given time, producing in an average approximately 100 lightning discharges per second. There are three main centers of lightning activity around the globe in South-East Asia, Central and Africa and Central America, see Figure 1. Studying **global lightning activity** using ELF and VLF radiation emitted from lightning discharges around the planet has been limited to brief periods, or small geographic regions up until now. Due to the increased computing power and data storage in recent years, we are now able to continuously monitor and analyze huge geophysical data sets, close to real-time.

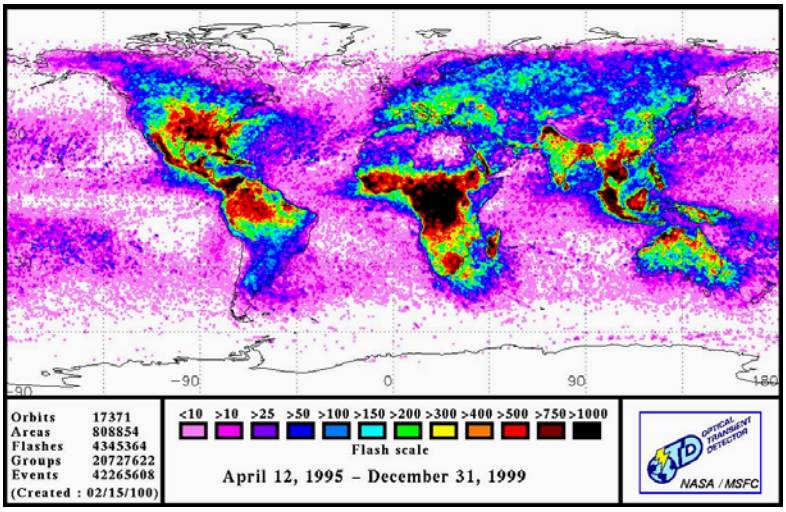

Figure 1: World wide lightning distribution

The ELF instruments I use in this research are located at Tel Aviv University's Wise astronomical observatory near the town of Mitzpe-Ramon in the Negev Desert. This remote area which has a much reduced anthropogenic electromagnetic noise levels is located far away from industrial activity which produces different kinds of ELF interferences (50 Hz power supply lines) contaminating the signal. The station has two horizontal magnetic induction coils for receiving the magnetic field in the north-south direction and the east-west direction and one vertical electrical ball antenna- see Figure 2.

(a) (b)

Figure 2: ELF sensors- (a) Magnetic field coils and (b) Electric field ball antenna.

My research intends to expand our knowledge about the global lightning activity which can be an indicator for **climate change** and the **global warming**, since lightning flash rate increases nonlinearly with temperature. The nonlinearity of the lightning-to-temperature relation provides a natural amplifier and a sensitive "thermometer". The warming of the Earth has been the subject of intense debate and concern for many scientists for at least the past decade. One of the important aspects in understanding the global climate change is development of tools and techniques that would allow continuous and long-term monitoring of processes affecting the global climate. This kind of research is one of the very few tools that can provide such information.

Another geophysical phenomenon which I investigate is transient luminous event known as **'sprite'**, see Figure 3. This newly discovered optical neon-like flash is reddish-orange due to collision of accelerated electrons with nitrogen molecules. Sprites usually occur in clusters and look like a jelly fish. They stretch at the altitude range of 40–90km with horizontal extent of tens of km and a typical lifetime of tens of ms. Sprites initiated by powerful positive lightning discharges which emit strong electromagnetic energy in the ELF range. By detecting these signals we can expand the knowledge about the physical mechanism for the initiation of sprites and the global occurrence of this phenomenon. This research began during the **MEIDEX** (Mediterranean Israeli Dust Experiment) on board of the Columbia space shuttle by Ilan Ramon, the first Israeli astronaut, and will be carried on in the framework of the ILAN campaign (Imaging of Lightning And Nocturnal flashes – http://geophysics.tau.ac.il/personal/ilan).

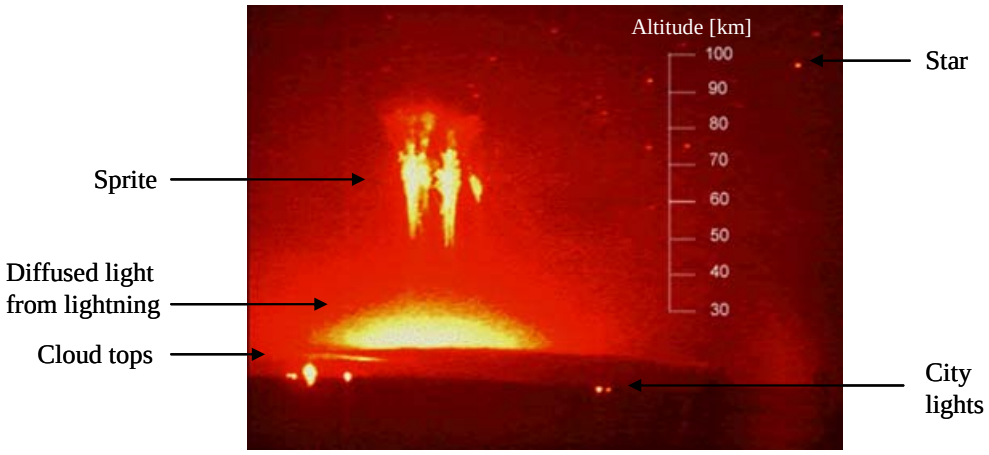

Figure 3: An image of a Sprite