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Long duration high-altitude measurements of cosmic-ray ionization using neutral-buoyancy balloons

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Atmospheric ionization rates due to cosmic rays reaches maximum values at altitudes between 15-25 km above the surface (known as the Regener-Pfotzer maximum, or RP max), which are also geomagnetic-latitude dependent and related to the solar cycle. The presence of ions in the lower atmosphere determines the electrical conductivity σ of the vertical column. The fair weather current density (J) flowing in the Global Electrical Circuit (GEC) is related to the vertical component of the fair weather electric field through J=σEz (Rycroft et al., 2004).

During the past year, we have conducted a series of high-altitude measurements in the Levant region using long duration High Altitude Balloon (HAB) platforms, launched from the campus of Ariel University (32°6'N 35°11'E) in Israel. The operational concept was to reach a pre-selected altitude and achieve neutral buoyancy at ∼10-15 km, thus keeping within the lower part of the RP maximum height for extended periods of time (Harrison et al., 2014). This was achieved by counter-balancing the upward motion of the booster balloon with smaller balloons carrying pre-computed air-ballast (Chakrabarti et al., 2014; Voss et al., 2005), along with a miniature mechanical liquid anti-freeze pump. The payload consisted of a Geiger counter, a GPS unit and an Iridium satellite-based telemetry modem that enabled connection to the balloons at ranges > 500 km. Results were transmitted in real-time every 10 seconds and were recorded on the ground (the payloads are not retrievable). We conducted several balloon launches that drifted with the prevailing winds toward east and northeast reaching Turkey, Iraq and Iran, with ranges of 400-1000 km from the launch point and flying times of ∼16-25 hours. Results show the complex and highly variable nature of the ionization rate with location and height. We will discuss the physical mechanisms involved in determining the profile and suggest future improvements.