SPACE-EARTH INTERACTIONS

UTAustin Portugal

Gamma radiation monitoring at the Eastern North Atlantic (ENA) station (Azores)

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Background

Gamma radiation at ground level reflects atmospheric and solid-earth processes, as well as space and solar conditions. Thus the continuous monitoring of gamma radiation allows to acquire relevant information on a wide range of physical processes associated with space-earth interactions (Fig. 1).

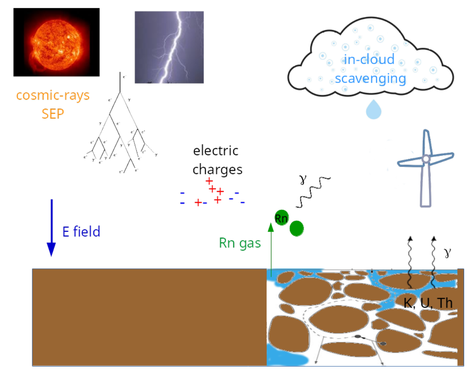
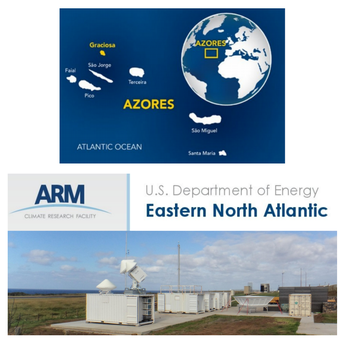


Fig. 1: Gamma radiation reflects processes acting in several domains. In addition to the terrestrial gamma radiation originating from the radioactive decay of radionuclides in the Earth's crust, gamma rays are also continuously produced in the atmosphere from the interaction of both SEPs (solar energetic particles) and cosmic rays with molecules in the upper atmosphere and trace gases. Gamma radiation near the ground is affected by atmospheric conditions (aerosols precipitation scavenging, wind, lightning) and drives ion formation near the earth surface, influencing the atmospheric electric field and air conductivity.

Methodology

The Gamma Radiation Monitoring (GRM) campaign was set-up at the Eastern North Atlantic (ENA) ARM facility at the Graciosa island (Azores). High-resolution gamma radiation data is being acquired since 2015 (Fig. 2), complementing the comprehensive dataset of surface and atmospheric measurements performed at the ENA facility.



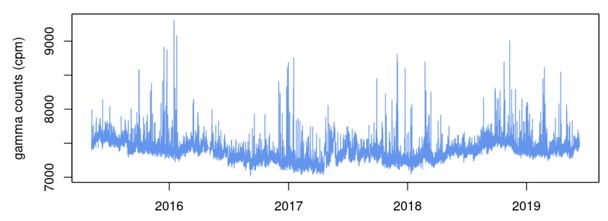


Fig. 2: Geographic setting (left) and time series of gamma radiation counts (in counts/minute) from the GRM campaign (right).

Results

- gamma radiation & precipitation (Fig. 3)
  * gamma peaks due to in-cloud scavenging of Rn progeny
  * no washout of progeny in case of convective rain

- gamma radiation as a proxy of soil water content (Fig. 4)

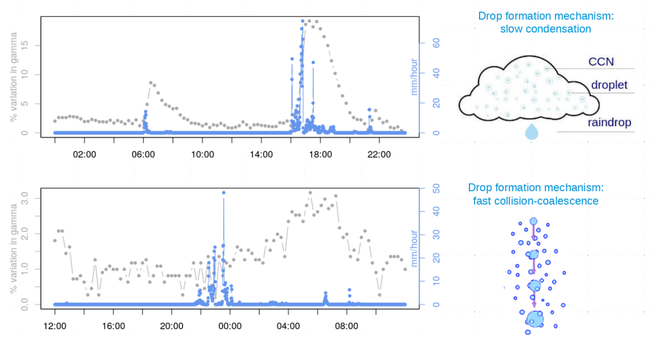


Fig. 3: Gamma radiation and precipitation measurements.

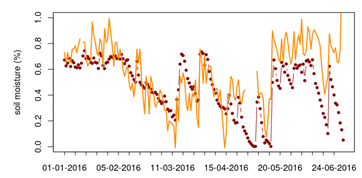


Fig. 4: Soil moisture prediction from gamma radiation: in-situ soil moisture observations (points, red) for the 1st semester of 2016 and 6 months horizon soil moisture predictions (line, orange) from a linear model using exclusively gamma radiation measurements from 2015. The mean average prediction error (MAPE) is 25%.

Impact

The GRM campaign demonstrates the impact of combining targeted multidisciplinary measurements at a reference site and state of the art data science for advancing the study of earth-atmosphere interactions. All the data from the campaign are curated following the FAIR principles, and are publicly available for further use by the scientific community.

Barbosa S, Huisman JA, Azevedo EB, 2018. *Meteorological and soil surface effects in gamma radiation time series - Implications for assessment of earthquake precursors*. J Env Rad 195, 72-78.

Barbosa SM, Miranda P, Azevedo EB, 2017. *Short-term variability of gamma radiation at the ARM Eastern North Atlantic facility (Azores)*. J Env Rad 172, 218-231.

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