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Hellenic Foundation for Research & Innovation

Description of the funded research project

1st Call for H.F.R.I. Research Projects to Support Faculty Members & Researchers and Procure High-Value Research Equipment

Title of the research project: Atmospheric parameters affecting spectral solar irradiance and solar energy (ASPIRE)

Principal Investigator: Dr. Konstantinos Eleftheratos, Assistant Professor

Reader-friendly title: Atmospheric effects on solar irradiance and energy

Scientific Area: Environment and Energy

Institution and Country: NKUA, Greece

Host Institution: National and Kapodistrian University of Athens (NKUA)

Collaborating Institutions: National Observatory of Athens, World Radiation Center of WMO (PMOD/WRC), Institute of Atmospheric Physics (DLR-IPA), University of Bremen

Budget: 163.983,60 €

Duration: 36 months

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Research Project Synopsis

The ASPIRE project aims to contribute on the scientific knowledge of interdisciplinary aspects that are related with solar radiation. Such aspects deal with solar energy research and technology (e.g. photovoltaic systems), impact on health (melanoma, skin cancer and Vitamin D efficiency) and agriculture (photosynthetically active radiation and crop production). The means to fulfil this goal is a sophisticated atmospheric field experiment to be held in the city of Athens, with a unique set of instrumentation and a synergistic approach on the retrieved datasets. Atmospheric composition and solar radiation related measurements and models will be coordinated in ASPIRE in order to address the above mentioned solar radiation applications and impacts.

Project originality

The breakthrough of this project is directly linked with the unique dataset that will be recorded during the one year campaign in Athens area. The quality of the proposed instrumentation (which is rarely found coordinated at a European level) and the synergistic approach of all the measurements planned, will provide the opportunity to assess uncertainties and inaccuracies, due to simplifications/assumptions used in solar radiation related products. More specifically, the novel dataset of ASPIRE contributes to the following scientific advancements:

- **To the improvement of PV efficiency, as detailed spectral information will be available and as the atmospheric variables that attenuate spectral solar irradiance will be linked with possible deviations of the PV output, by comparing real (measured) with simplified (actually used) atmospheric conditions.**
- **To the improvement of now-casting solar energy estimations, which is a crucial aspect for national and private power transmission and distribution system operators worldwide. Detailed evaluation and improvement of such a developed system for Greece is an important aspect of the project, given the fact that the proposed solar energy calculation system SENSE has been used by the national energy transmission operator.**
- **To the accuracy of public awareness related factors, such as UV Index, eye cataract, DNA damage, Vitamin D production and agricultural and marine related indexes such as plant photosynthesis and phytoplankton, which could be essentially improved using the proposed measurements' dataset.**

Expected results & Research Project Impact

- **Major objectives of ASPIRE are linked with the improvement of specific solar energy related applications (PV efficiency and real time solar energy retrievals). The energy sector is both directly and indirectly, greatly favored from such a study, since solar energy related installations have been increasing their share on the total energy demand. The analysis of the atmospheric parameters' impact on spectral solar irradiance and solar energy, thus its electric power outcome, will be valuable for the energy market, for our understanding of the Earth's radiation budget, and for the related socio-economic implementation areas. Such goals are in line with scientific innovation on solar energy related technological field, towards fostering the environment and sustainable employment in Greece. A clear example of such impact is the validation and improvement of the now-casting solar energy system SENSE that is used (through the GEO-CRADLE project) by the Greek ADMIE.**
- **Spectrally-weighted indices of the surface solar radiation have an impact on various interdisciplinary fields related with the ecosystem. Indicatively, the health sector is actively related with the DNA damage, the Vitamin D Effective Dose and the UV index (erythema) for the human exposure to the sun and for numerous vulnerable population groups (e.g. pregnant women, light-colored skins etc.) as described by the World Health Organization. The agricultural sector exploits the Photosynthetically Active Radiation (PAR) for the plant growth, while the oceanographic sector needs the effective radiation for the phytoplankton growth rate. Thus, the study of spectral solar irradiance and of the atmospheric parameters affecting it, is crucial for the quality of inputs given to various scientific communities with different multidisciplinary aspects.**

The importance of this funding

The funding of the ASPIRE project:

- **Adds new knowledge to the international scientific community on applications related to the environment and energy.**
- **Offers work and new knowledge to postdoctoral fellows, PhD candidates and postgraduate students, giving them powerful scientific benefits for their future development in the field of energy.**
- **Provides cooperation of NKUA with other high level Institutions, such as the National Observatory of Athens, the World Radiation Center of WMO, the Institute of Atmospheric Physics of the German Aerospace Service and the Institute of Environmental Physics of the University of Bremen.**
- **Creates a new set of data from detailed measurements of spectral solar irradiance in Athens for one year, which will be available to a number of scientists and end users from interdisciplinary scientific communities (energy, health, agriculture, biology, marine sciences, atmospheric chemistry) for any future studies on high-precision solar radiation measurements or atmospheric parameters (clouds, aerosol properties, ozone, NO_2, SO_2, water vapor).**

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