Global mapping of aerosol properties using neural network inversions of ground and satellite based data

FP7-MC-IEF 300515 AEROMAP

1 Publishable summary

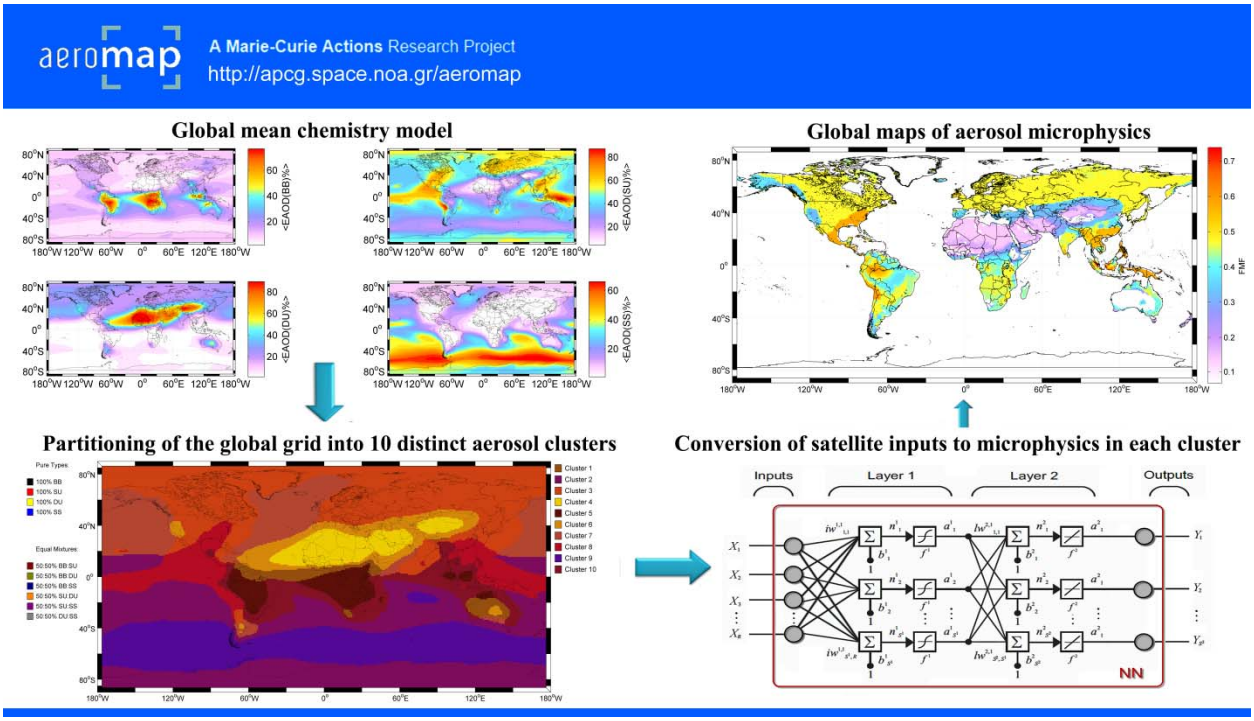
The largest uncertainty in current estimates of the planetary radiation budget is due to atmospheric aerosols and has caused the International Panel on Climate Change (IPCC) to call for an expansion of global studies to help monitor and characterise aerosols. Aerosol properties are most routinely monitored by the ground-based networks such as the aerosol robotic network (AERONET). However, while there is a high density of AERONET instruments in populated areas and megacities, the most dominant sources of aerosol originate from often uninhabited regions like the planet's deserts, oceans and ice-caps where few instruments exist. There is therefore a lack of knowledge of the overall global spatial and temporal variation of aerosols and their composition. The AEROMAP project was designed to provide a solution to overcome this lack of information without the need to invest in hundreds of new AERONET sites. To achieve this, AEROMAP capitalizes on full-Earth measurements provided daily by satellite remote sensing instruments to produce global maps of aerosol microphysics including the distribution of particle sizes in the atmosphere. In this regard, AEROMAP has developed and validated new data mining tools based on cluster analysis and neural networks to convert satellite measurements into aerosol microphysical properties for different globally-distributed aerosol types – something which has, until now, not been possible from space. The near-daily global maps produced allow for monitoring and classification of aerosols as they move across the Earth's surface.

The main goals of AEROMAP have been to find a way to partition the globe into distinct aerosol type/mixture and then to code neural network models to convert satellite measurements in each pixel of the global grid to estimates of aerosol microphsics. In addition, AEROMAP aimed to test the feasibility of performing global near real-time monitoring of aerosols and to construct an air quality index from microphysics data to assess climatological risks for issuing early-warning alerts of aerosol impact. It was found that the average global distribution of aerosols can be separated into 10 distinct regions, each having a distinguishable aerosol composition. Neural model, models were then successfully trained on over 8 years of daily data in each region and validated for their ability to accurately retrieve aerosol microphysics. As a result, global maps of the size distribution of atmospheric aerosol in each 1x1 degree pixel were produced and used to monitor the evolution of events including volcanic eruptions, urban smog clouds and desert dust storms. AEROMAP's "virtual observatories" provided access to the detailed microphysics of aerosol originating from vast and natural sources over the oceans, deserts and ice caps. AEROMAP has also produced the first near-daily global air quality index maps deduced from aerosol microphysics rather than chemistry. Two indices have been produced to measure the potential impact on health and also visibility.

The project has brought together the skills of the fellow Dr Michael Taylor as an experienced researcher in the fields of applied mathematics and computational physics with the expertise of the scientist in charge Dr Stelios Kazadzis in the fields of atmospheric physics, remote sensing and aerosol science at the National Observatory of Athens - a centre for aerosol monitoring. The highly multidisciplinary nature of AEROMAP has meant that it has been able to successfully capitalize on the synthesis and exchange of knowledge, 4 peer-reviewed publications in top journals in the fields of

atmospheric physics, chemistry and measurement techniques, as well as 2 conference papers. The articles published have already accrued a total of 658 PDF downloads and 937 HTML views.

AEROMAP is actively contributing to the provision of new information on one of the most important climate change parameters - the global distribution of aerosol. Considering the cost of satellite data acquisition, and especially the large data quantities involved with global modelling, AEROMAP has placed great emphasis on efficient data exploitation so that these new modelling techniques can be readily incorporated into existing operational algorithms. The interest that the published results of the project are generating as indicated by a large number of downloads and online views is helping to raise the profile of the host institute a in the field and the European Research Area as a pole of attraction for researchers. AEROMAP's global classification of aerosol types and composition, together with near-daily maps of aerosol microphysics can help funding agencies at the national or regional level better determine where to locate new aerosol monitoring stations. In addition, AEROMAP's near-realtime global maps of air quality indices that measure the impact of aerosols on health and visibility from space, can help to ensure that environmental policy-making decisions will have positive rather than negative repercussions.



Contact Details

Dr Stelios Kazadzis (***SIC***)
Dr Michael Taylor (***Research Fellow***): patternizer@gmail.com

Institute for Environmental Research and Sustainable Development,
National Observatory of Athens,, Lofos Koufou, GR 152 36, P. Penteli, Athens, Greece.
Tel: +30 (0)210 8109151 / Fax: +30 (0)210 8103236

Project Website

http://apcg.space.noa.gr/aeromap