SHORT TERM SCIENTIFIC MISSION (STSM) SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA16202 - International Network to Encourage the Use of Monitoring and Forecasting Dust Products
STSM title: Experimental Campaign for Dust Orientation, Cyprus
STSM start and end date: 07/11/2019 – 20/11/2019
Grantee name: Alexandra Tsekeri

PURPOSE OF THE STSM:

(max.200 words)

Observations of dust transportation indicate the presence of a counteracting mechanism to the settling of the large particles. One of the major mechanisms considered for the large particle retention is the Triboelectric charging of the dust particles. The exact charging mechanisms are not clear but measurements indicate that, on average, larger particles become positively charged while the smaller ones become negatively charged. The electric field within the dust cloud may cause subsequent preferential orientation of the asymmetric dust particles.
The purpose of the STSM in the Energy, Environment and Water Research Center (EEWRC) of the Cyprus Institute (CyI) is to investigate the dust electrification and dust particle orientation, using prototype remote sensing instruments (WALL-E polarization lidar), as well as surface and airborne in situ measurements (Atmospheric Electricity sensor launches). Overall, the advancement of dust monitoring remains a priority of the proposed Short Term Mission, along with the training of early stage career scientists that collaborate with NOA in the operation of the used instrumentation.
Lastly, we note that since the necessity for a unified dust deposition model that will include both particle electrification and orientation is imperative, all STSM related available data will be provided to the NOA-ReACT modelling group that intends to ameliorate dust forecasting products.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSM

(max.500 words)

During the STSM we have conducted remote sensing and in situ measurements (both at surface and on-board the Unmanned Aerial Vehicle (UAV) fleet of CyI), at the premises of the EEWRC of the CyI, from 8/11/2019 to 19/11/2019. CyI's selection as a Host Institute is ideal, since it provided a much-needed expertise on the in situ characterization of atmospheric aerosols through the collaboration with highly skilled researchers.

Remote sensing ground-based instruments:

1. In order to monitor dust orientation, we have designed a novel dual-polarization lidar system, detecting the different states of polarization of the backscattered light from airborne dust particles. The system was constructed by Raymetrics S. A. and it was deployed during the Cyprus campaign.

2. Another remote sensing instrument that provides measurements of particle orientation is the direct-sun polarimeter SolPol, kindly provided by the University of Hertfordshire, which measures the sunlight dichroic extinction, a direct flag for dust particle orientation.

In situ the surface and on airborne platforms:

1. In order to measure the electric field in the dust plume, we used innovative ground-based and airborne atmospheric electricity sensors, on board the UAV fleet of CyI.
2. For size distribution measurements we used the POPS OPC on board the UAV fleet of CyI.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

Below we present some of the highlights of the STSM.

Remote sensing ground-based instruments:

1. Novel polarization lidar

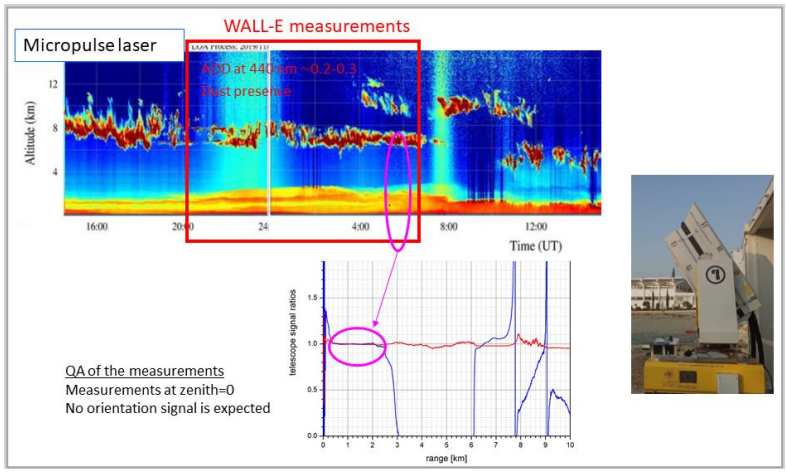


Figure 1: Polarization lidar ("WALL-E") measurements on 13-14/11/2019, and quicklook of the micropulse laser of CyI. The measurements where acquired during dust presence. These are Quality assurance measurements at zenith viewing angle=0, where no orientation signal is expected, as shown in the plot up to ~2 km, with the value "1".

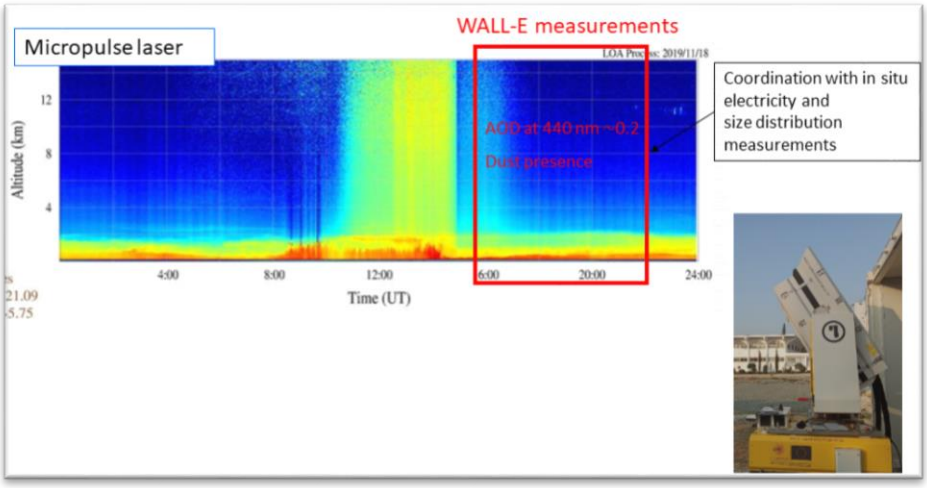


Figure 2: Polarization lidar ("WALL-E") measurements on 17/11/2019, and quicklook of the micropulse laser of CyI. The measurements where acquired during dust presence. The measurements are coordinated with in situ size distribution and electricity measurements. The data are still under analysis.

Two weeks training from 8-17/11, over WALL-E's operation, of a NOA post-graduate researcher and a PhD student under realistic experimental conditions, so as to prepare for the ESA EVE polarization lidar build-up (similar system design to WALL-E). EVE will be operated in Cape Verde in June/July 2020 as the primary

component for the evaluation of the AEOLUS satellite aerosol product in the ASKOS campaign co-ordinated primarily by NOA.

2. SolPol, direct-sun polarimeter

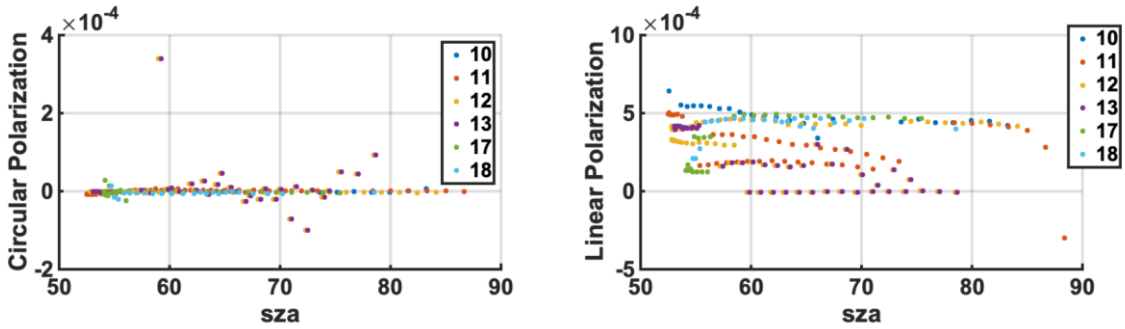
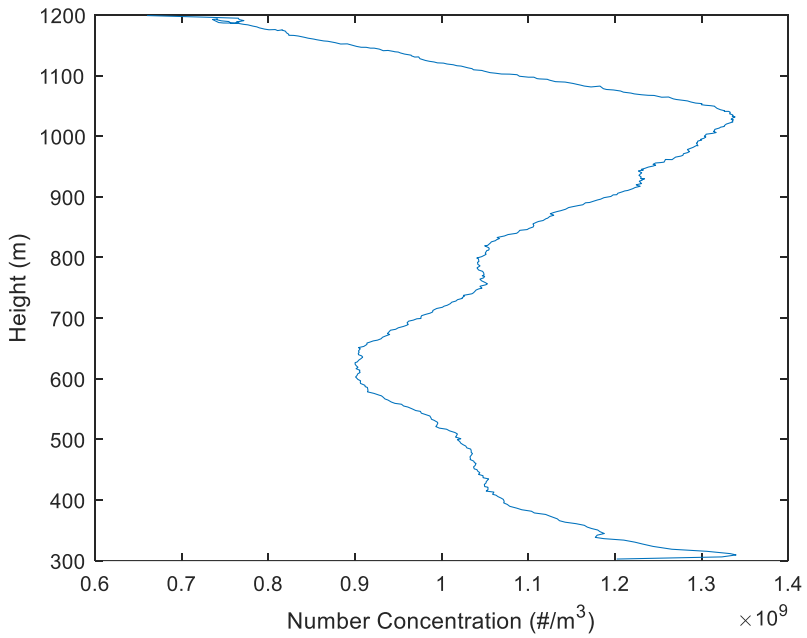


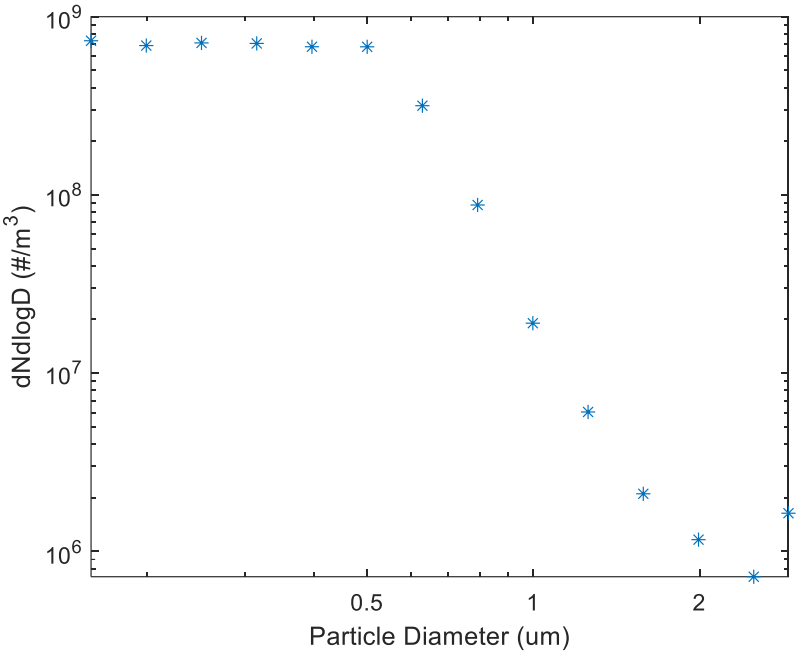
Figure 3: Preliminary analysis of the measurements of SolPol direct sun polarimeter. The plot at the left shows the circular polarization vs the sun zenith angle (sza) and the plot at the right shows the linear polarization vs sza, during the campaign days 10, 11, 12, 13, 17 and 18/11/2019.

In situ the surface and on airborne platforms:

1. Surface and airborne in situ measurements of atmospheric electricity
   The measurements are still under analysis.
2. Airborne measurements of particle size distribution

POPS preliminary results





FUTURE COLLABORATIONS (if applicable)

The CyI is interested in participating in the ASKOS campaign in Cape Verde, on June-July 2020. The Cape Verde environment is ideal for aerosol studies and desert dust specifically. Situated downwind of the Sahara desert, Cape Verde receives a large influx of dust, particularly in summer during the peak of the dust season. The CyI plans to operate its fleet of UAVs equipped with 1) Optical Particle Counters (e.g. PoPs), 2) sunphotomer (e.g. mini-SASP), and 3) filter sampling for Elemental Analysis. The Cyprus campaign during the STSM period showed the great potential in the collaboration with the remote sensing and in situ techniques of NOA, towards an effective characterization of dust triboelectrification and orientation. In terms of further enhancing the instrumental suite of CyI and extend the collaboration with the Institute, we thoroughly demonstrated the operational capabilities and the new features of WALL-E lidar to the stakeholders. In this framework, we co-ordinated a visit of the Raymetrics S.A. (the same Greek company that collaborated with NOA for the build up of WALL-E) to CyI in order to discuss the manufacturing of a new dust polarization lidar and, therefore, promote NOA capacity building within the InDust consortium.

THE WORK CARRIED DURING THE STSM IN RELATION TO THE INDUST OBJECTIVES

INDUST OBJECTIVES	THE WORK DURING THE STSM
Establish a network involving research institutions, service providers, and end users of information on airborne dust.	Collaboration of NOA with the in-situ dust monitoring group of the CyI.
Identify and exploit dust monitoring observations (from both ground-based and satellite platforms) best suited to be transferred/tailored to the needs of end-users.	Performed dust monitoring with remote sensing and in situ measurements (both at surface and on-board the Unmanned Aerial Vehicle (UAV) fleet of CyI)
Identify and exploit dust forecast products best suited to be transferred/tailored to the needs of end-users.	During the STSM period the NOA-ReACT modelling group provided dust forecasts for the area of measurements. These forecasts will be assessed in the future using the acquired remote sensing and in-situ measurements of dust.

Coordinate the current R&D activities and enhance the availability of appropriate products to assist the diverse socio-economic sectors affected by the presence of airborne mineral dust.	Co-ordinated visit of the Raymetrics S.A. (the same Greek company that collaborated with NOA for the build up of WALL-E) to Cyl in order to discuss the manufacturing of a new dust polarization lidar.
Build capacity through the high-level teaching of end-users (stakeholders from different socio-economic sectors) to promote the use of the delivered dust products.	No action taken.
Train technical staff to properly use the available observational and forecast products to design and implement preparedness and mitigation measures.	Two weeks training from 8-17/11, over WALL-E's operation, of a NOA post-graduate researcher and a PhD student under realistic experimental conditions, so as to prepare for the ESA EVE polarization lidar build-up (similar system design to WALL-E). EVE will be operated in Cape Verde in June/July 2020 as the primary component for the evaluation of the AEOLUS satellite aerosol product in the ASKOS campaign co-ordinated primarily by NOA
Enhance the cooperation with institutions from near-neighbouring and international partner countries in Northern Africa and the Middle East to involve them in the European-driven climate change science and mitigation/adaptation strategies.	No action taken.