THE STRONG RELATIONSHIP BETWEEN DUST LIFTING AND ATMOSPHERIC ELECTRIC PROPERTIES DURING AEOLIAN PROCESSES. F. Esposito[1], R. Molinaro[1], C.I. Popa[1], C. Molfese[1], F. Cozzolino[1,2], L. Marty[1], K. Taj Eddine[3], G. Di Achille[4], S. Silvestro[1], G. G. Ori[5,3], [1]INAF-Osservatorio Astronomico di Capodimonte, Napoli, Italy (francesca.esposito@na.astro.it), [2]Università di Napoli "Federico II", Napoli, Italy, [3]Ibn Battuta Centre - University Cadi Ayyad, Marrakech, Morocco, [4]INAF-Osservatorio Astronomico di Teramo, Teramo, Italy, [5]IRSPS Università G. D'Annunzio.

Introduction: Airborne dust and aerosol particles affect climate by absorbing and scattering thermal and solar radiation and acting as condensation nuclei for the formation of clouds. So, they strongly influence the atmospheric thermal structure, balance and circulation ([1], [2], [3], [4], [5], [6], [7], [8]). On Earth and Mars, this 'climate forcing' is one of the most uncertain processes in climate change predictions ([9[, [10]). On Titan, aerosols are involved in the methane hydrological cycle. They also may behave like sediment on Titan's surface and participate in both fluvial and aeolian processes. Wind-driven blowing of sand and dust is also responsible for shaping planetary surfaces through the formation of sand dunes and ripples, the erosion of rocks, and the creation and transport of soil particles. These processes are not confined to Earth, but occur also on Mars, Venus and Titan.

It is clear that the knowledge of the atmospheric dust properties and the mechanisms of dust settling and raising into the atmosphere are important to understand planetary climate and surface evolution.

On Mars the physical processes responsible for dust injection into the atmosphere are still poorly understood, but they likely involve *saltation* as on Earth. Saltation is a process where large sand grains are forced by the wind to move in ballistic trajectories on the soil surface. During these hops they hit dust particles, that are well bound to the soil due to interparticle cohesive forces, thus transferring to them the momentum necessary to be entrained into the atmosphere.

Recently, it has been shown that this process is also responsible to generate strong electric fields in the atmosphere up to 100-150 kV/m ([11], [12], [13]). This enhanced electric force acts as a feedback in the dust lifting process, lowering the threshold of the wind friction velocity u_* necessary to initiate sand saltation ([14]). It is an important aspect of dust lifting process that need to be well characterized and modeled. Even if literature reports several measurements of E-fields in dust devils events, very few reports deal with atmospheric electric properties during dust storms or isolated gusts.

We present here preliminary results of an intense field test campaign we performed in the West Sahara during the 2013 and 2014 dust storm seasons. We collected a statistical meaningful set of data characterizing relationship between dust lifting and atmospheric E-field that had never been achieved so far.

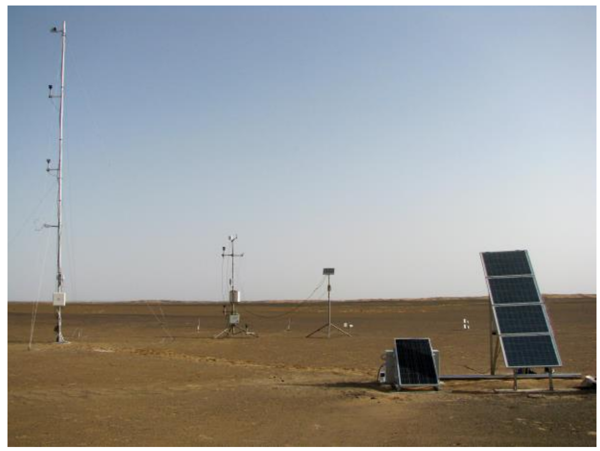

Figure 1: Measurement station mounted in the Merzouga desert in the 2014 field test campaign.

Experimental set-up: Field campaigns were performed in the desert Merzouga region (Morocco) in the period July-September 2013 and June – August 2014. Summer period in Merzouga is characterized by intense dust activity peaking in July.

The chosen sites of these campaigns were flat surfaces constituted by Quaternary lake sediment beds. Both sites have the same mineralogical depth profile. The main difference between them comes from the fact that the lake sediments of 2014 site are covered with pebble gravel size (desert varnished shale eroded material), that forms a centimeter sized mesh whose openings serve for the fine sand (merely quartz and carbonate in composition) entrapment. The sand is shadowed by the pebble height making it reside long periods on the surface, influencing the topsoil overall electric behavior. The soil of the site chosen for year 2014 campaign is also drier than the one chosen for year 2013.

In 2013 we deployed the following instrumentation: three 2D sonic anemometers, from which wind vertical profile was derived, two thermometers installed at different heights from the ground, sensors for the measurement of pressure, relative humidity, solar irradiance, atmospheric electric field, soil temperature and moisture, the size resolved airborne dust concentration in the range 0.265- 34 µm vs time, two impact sensors for the detection of saltating sand grains, three sand catchers for daily collection of sand saltating at different heights. The collected grains are then analysed in laboratory. Measurements were performed 24 hours/day at a sampling rate of 1 Hz for about three months. A solar panels system powered the station. The 2013 measurement station was upgraded in 2014 with the addition of a 3D sonic anemometer, 2 additional 2D sonic anemometers and a camera collecting images every 15 minutes (Fig. 1).

Observations: During the campaigns we were able to observe dozens of dust storms and dust entrainment into the atmosphere due to isolated gusts.

Main findings in the preliminary data analysis are: 1) there is a strict and clear relationship between the concentration of fresh lifted dust and the enhancement of E-field intensity; 2) this relationship is linear for values of air relative humidity RH < 20% but change for higher RH; 3) E-field intensity is influenced by the size distribution of lifted dust (Fig. 2); 3) during dust events, we found E-field is generally directed downward (same sign of fair weather E-field) with some sporadic sign inversion; 4) positive E-fields are never observed in dry condition (air relative humidity RH < 10%) and generally increase in intensity for increasing RH.

These observations will allow a step forward in the study of dust lifting processes with implication on climate modeling.

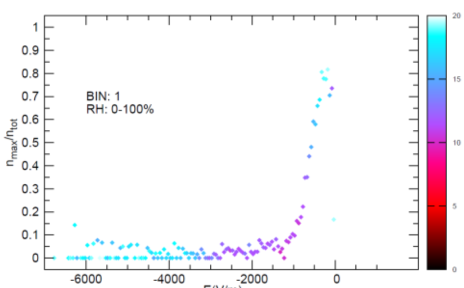

Figure 2: Fraction of events with measured dust size distribution peaked on finest grains (<265 nm) versus atmospheric E-field. Color scale refers to RH values.

References: [1] James et al. (1992) in Mars (Kieffer et al. eds), 934. [2] Jakosky and Haberle (1992) in Mars (Kieffer et al. eds), 969. [3] Kahn et al. (1992) in Mars (Kieffer et al. eds), 1017. [4] Ryan and Henry (1979) JGR 84, 2821. [5] Forget et al. (2006) in Planet Mars – Story of another world; Springer, 137. [6] Martin and Kieffer (1979) JGR, 84, 2843. [7] Martin (1981) Icarus, 45, 427. [8] Jakosky and Martin (1987) Icarus, 72, 528. [9] IPCC (2007) IPCC, Climate Change 2007 (S. Solomon et al. eds); Cambridge Univ. Press. [10] Spiga and Lewis (2010) Mars, 5, 146. [11] Schmidt et al. (1998) JGR, 103, 8997. [12] Stow (1969) Weather, 24, 134. [13] Renno et al. (2004) JGR, 109, E07001 [14] Kok and Renno, (2006) GRL, 33, L19S10.