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DUSTER (Dust from Upper Stratosphere tracking experiment and Retrieval) dust collection 2011

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Abstract

DUSTER (Dust in the Upper Stratosphere Tracking Experiment and Retrieval) is a balloon-borne instrument for the non-destructive collection of solid particles between 200 nm to 40 microns in the upper stratosphere between 30 and 40 km altitude. In 2011 DUSTER performed its third successful flight confirming its capability to collect solid aerosol particles of meteoric dust smaller than 3 microns. These collections fill in the information gap on the amounts, and physical and chemical properties of the stratospheric dust at high altitude.

1. Introduction

The first DUSTER scientific flight was performed in June 2008 with a 30,000 m^3 balloon from Longyearbyen (Svalbard, Norway) and was recovered in Greenland after having sampled 6.6 m^3 of air for 55 hours. After recovery the collecting chamber was opened in a clean room and the collector with the collected dust was analyzed using the FESEM. Twenty-five stratospheric particles were collected at ~38 km altitude with, more than half in the size range from 0.4 micron to 2 micron [1]. During a second flight DUSTER flew from the same base to Baffin Island, Canada, in July 2009 with a 8.5 $\times 10^5$ m^3 balloon that sampled more then 35 m^3 of air in 86 hours. Unfortunately, it experienced a crash after landing that caused a small leak in the valve of the collecting chamber. The contamination caused by the leak delayed the post flight analyses to identify by FESEM the collected particles. Still because of the strict contamination control instrument design it proved possible to identify collected stratospheric particles even after the accident occurred. The third scientific flight was performed in 2011. In the following we concentrate on the results of this flight campaign.

2. 2011 DUSTER Campaign

On the 11 of April 2011 DUSTER was launched from Esrange in Kiruna, Sweden, by the CNES team. The instrument was mounted on a shared gondola with other two instruments and connected to the ETNA CNES telemetry allowing a remote control of the operations (start and stop of the sampling at altitude).

At an altitude between 31.6 and 33.7 km DUSTER sampled a volume of 3.9 m^3 in 2.8 hours. DUSTER 2011 validated the increased amount of flow rate expected after some design modification made with respect to the 2008 and 2009 version of the instrument on the whole range of altitudes and temperatures provided in the instrument requirements.

Figure 1: DUSTER 2011 campaign flight path (black arrows) over the North of Sweden

3. 2011 DUSTER Collection

After the 2011 DUSTER flight we proceeded with the comparison between the pre-flight and post-flight FESEM imaging characterization of the collection substrate. We identified 42 particles. They can be divided in 4 different compositional groups: 1) eight C-O-Si particles (Figure 2); 2) 4 C-O-Al particles (Figure 3); 3) eleven mixed Al-Si particles (Figure 4).; 4) five pure Carbon particles (Figure 5).. In addition to these four groups we found: one biological particle (spore or pollen); one particle containing F; one containing high Ca particle similar to the DUSTER 2008 collection and eleven classified as contaminants.

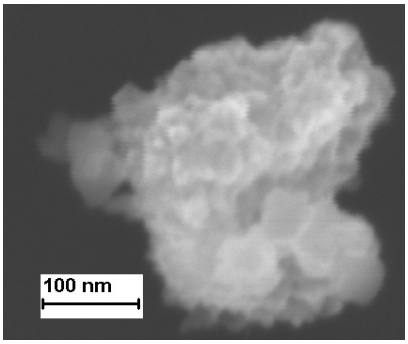

Figure 2: C-O-Si collected particle

The first group, showing a high silicate content, consists of particles with a spherical morphology often organized in aggregates of spheres. This preliminary characterization does not allow yet inferring the extraterrestrial versus terrestrial origin of the collected particles.

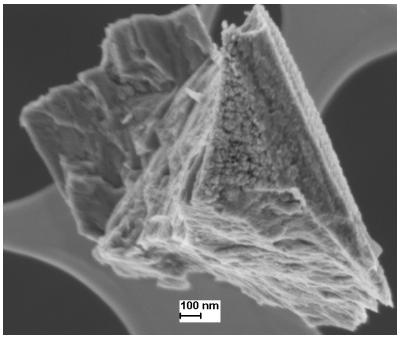

Figure 3: C-O-Al particle

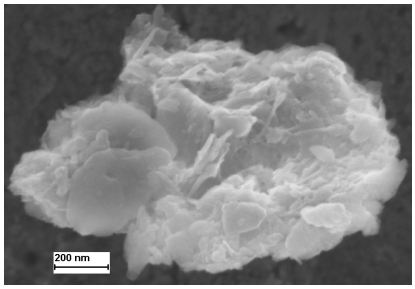

Figure 4: Al-Si particle

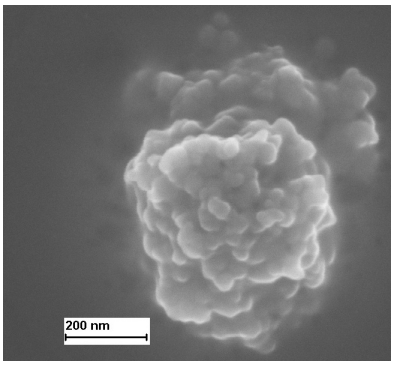

Figure 5: Pure Carbon particle

4. Summary and Conclusions

DUSTER collected 31 particles at 33 km of altitude, upper Earth stratosphere on 11 April 2011. FESEM-EDX analyses revealed 5 different groups of particles. The DUSTER 2011 collection contributed to explore the aerosol population in the sub micron range in size morphology and composition. Further work is in progress to define the extraterrestrial. or terrestrial origins of the collected particles.

Acknowledgements

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References

[1] Della Corte V. et al. (2012) SSR, 169, 159–180; DOI