THE 2012 DRACONID STORM AS OBSERVED BY THE CANADIAN METEOR ORBIT RADAR AND POTENTIALLY SAMPLED BY ER-2 AIRCRAFT.

R. Bastien[1], S. Broce[2], P. Brown[3,4], P.J. Burkett[1], M. Campbell-Brown[3,4], D. Frank[1], D. Gearheart[5], M. Kapitzke[6], T. Moes[6], M. Rodriguez[1], D. Steel[6], T. Williams[6], M. Zolensky[7]. [1]Jacobs Engineering Corp., Houston, TX 77058 (ronbastien@nasa.gov), [2]Computer Sciences Corporation, Dryden, CA, [3]Dept of Physics and Astronomy, University of Western Ontario, London, Ont., Canada N6A 3K7, [4]Centre for Planetary Science and Exploration, University of Western Ontario, London, Ont., Canada, N6A 5B7, [5]UC Santa Cruz, CA, [6]NASA Dryden Flight Research Center, Dryden CA, [7]ARES, NASA Johnson Space Center, Houston, TX.

Introduction: At the urging of Herb Zook and Al Jackson in 1990 [1], as seconded by Scott Messenger a decade later [2], NASA JSC's Cosmic Dust Collection Program has made special attempts to collect dust from particular meteor showers [3] and asteroid families when flights can be planned well in advance. However, it has rarely been possible to make collections on very short notice. In 2012 we were very fortunate.

2012 Draconid shower: The Draconid meteor shower, originating from Comet 21P/Giacobini-Zinner, has produced both outbursts and storms several times during the last century [4,5] most recently on Oct 8 2011 when visual rates approached 300/hr [6]. The 2012 return was not expected to show significant enhancement [7] and few visual observations were conducted due to this prediction and also poor lunar conditions. Thus we had not considered a targeted stratospheric collection effort for the Draconids, despite the fact that they have one of the slowest atmospheric entry velocities (23 km/s), and thus offer significant possibilities of successful dust capture. However, radar measurements obtained by the Canadian Meteor Orbit Radar during the 2012 Draconid shower indicated a meteor storm occured with a peak at λ_O = 195.622° or 16:38 (±5 min) UT on Oct 8, 2012, of total duration ~2 hrs.

Meteor Observations: The Canadian Meteor Orbit Radar (CMOR) is an automated radar meteor echo detection and orbital measurement system operating at 29.85 MHz consisting of a main transmit site and five outlying stations [8&9]. CMOR records ~5000 orbits per day for meteoroids with mass >10^{-7} kg on average. At Draconid entry speeds (23 km/s), the radar typically detects particles with diameters >500 μm. Following the procedures described in [10&11] the echoes most likely associated with the Draconids during Oct 8, 2012 were identified and the equivalent shower and sporadic flux at the top of the atmosphere computed (Fig 1). The Draconid shower flux measured by CMOR in 2012 was the highest shower flux measured during the entire operational lifetime of CMOR (1999-present). The peak flux was more than an order of magnitude higher than measured by CMOR for the 2005 [12] or 2011 Draconid outbursts. The equivalent Zenithal Hourly Rate (ZHR) (for 5 minute bins) was in excess of 5000 at the peak. The shower flux also exceeded the contribution from the entire sporadic background to the same limiting mass from 16-18 UT. The fluence of Draconid meteoroids during the storm to this limiting size was ~10% of the daily fluence of all sporadic meteoroids on Oct 8, 2012, a substantial daily mass input from one shower.

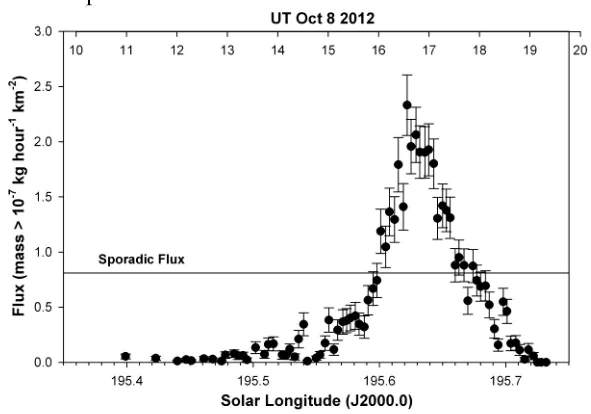

Figure 1. The observed Draconid shower flux in 2012 based on 5 minute bin intervals as measured by CMOR at 29.85 MHz. The average sporadic flux to the same limiting meteoroid mass (10^{-7}kg) as measured by CMOR on this date is also shown (horizontal line).

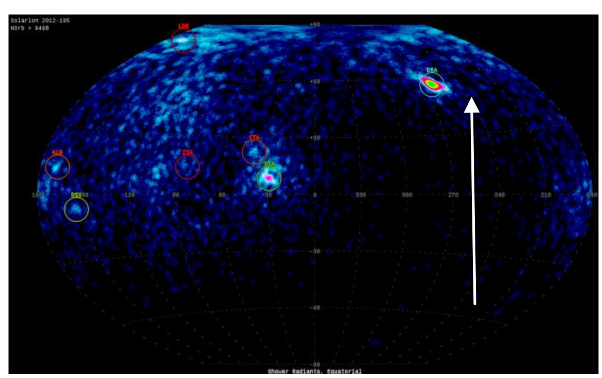

Figure 2. The distribution of all meteor radiants observed by CMOR on Oct 8, 2012. The strong peak related to the Draconids is shown by the arrow. The plot is given in astronomical equatorial coordinates (right ascension- horizontal and declination - vertical) with each radiant position shown by a single circle.

Using the cumulative distribution of peak Draconid echo amplituides and the procedure described in [13] we find the mass index to be s=1.87 ± 0.02, higher than in 2011 (the mass index is the the power law exponent in $dN=m^{-s}$ dm, where s is the mass index and dN is the number of meteoroids between mass m and m+dm). The storm appears to have been particularly rich in smaller meteoroids as the fraction of overdense echoes recorded by CMOR in 2012 from the Draconids is much lower than during the 2011 return.

Collection efforts: Large and small area cosmic dust collectors (LACs and SACs) L2094, L2095, L2096, L2097, U2153 and U2154, were flown from October 15th to 17th, 2012 on ER2 aircraft. Flight time accumulated by date was: Oct.15th - 7.8hrs, Oct. 16th - 7.3hrs, Oct. 17th - 8.1hrs. The small collectors (U2153 and U2154) received an additional 5.7hrs on Oct. 11th. All collectors were received at JSC in late October 2012. We noted that one pair of large collectors (L2096 and L2097) had suffered an o-ring failure and possible ground contamination collection time was stopped after 15.1 hours. Preliminary examination of L2094 and L2095 revealed a low concentration of particles, due to the short collection period (23 hrs). Small collectors U2153 and U2154 have received a visual inspection only and show a larger amount of particulate matter not normally seen for such a short (30 hours) exposure time, possibly a result of ground contamination.

Particle Prelinary Examination: We have begun to harvest comely particles from the various collection surfaces. As we routinely do, an example of each cluster particle is examined, as is a subset of all individual grains. The instrument used for cataloguing IDP particles is the JEOL 5910LV SEM using Iridium Ultra, operated at 15kV in scanning SEI and backscatter BEI modes. EXD spectra are collected for each grain, which we do not attempt to quantify. Several examples of potential Giacobini-Zinner grains are shown in Figure 3, although it may never be known which particular grains are from this comet. All collected grains are available for allocation to qualified investigators; see http://curator.jsc.nasa.gov/dust/index.cfm

References: [1] Jackson & Zook (1990) Workshop on the Analysis of Interplanetary Dust Particles. LPl Technical Report 94-02, [2] Messenger (2002) Meteorit. Planet. Sci. 37, 1491–1505, [3] Busemann et al. (2009) Earth Planet. Sci. Lett. 288, 44-57, [4] Davies, J.C. and Turski, W. (1962) Mon. Not. Roy. Astron. Soc., 123, 459-470, [5] Jenniskens, P. (1995), *A&A*, 295, 206-235, [6] Kero, J. et al. (2012) Mon. Not. Roy. Astron. Soc., 424, 1799-1806, [7] Maslov, M., (2011) JIMO, 39, 64-67, [8] Brown, P. et al (2010) Icarus, 207, 66-81, [9] Jones, J. et al (2005) Pl. Sp. Sci., 53, 413-421, [10] Brown, P. and Jones, J. (1995) EMP, 68, 223-245, [11] Campbell-Brown, M.D and Jones, J. (2006) Mon. Not. Roy. Astron. Soc., 367, 709-716, [12] Campbell-Brown, M.D et al. (2006) *A&A*, 451, 339-344, [13] Blaauw, R., et al. (2011) Mon. Not. Roy. Astron. Soc., 414, 3322-3329.

Figure 3. This is a photo from the Draconids LAC ER-2 flight on October 16th, 2012: It was taken over Los Angeles looking west at Ventura, Santa Barbara and the Channel Islands. Altitude over 70k feet. One of the LACs are shown hanging underneath the aircraft wing.

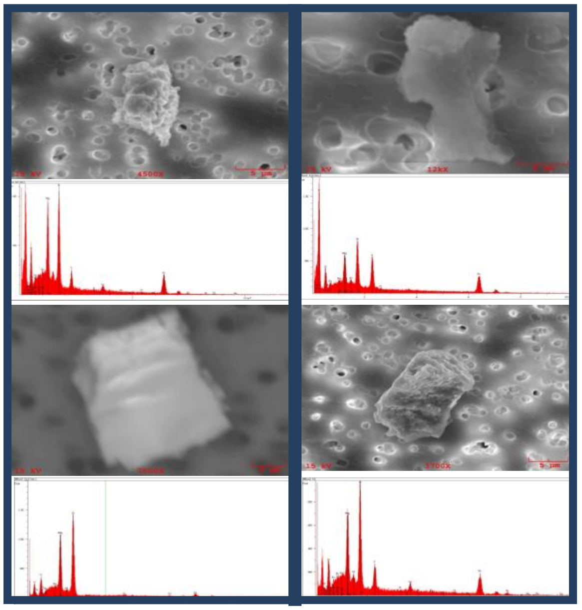

Figure 3. Four particles harvested from collector L2094, whose EDX spectra are consistent with an extraterrestrial origin. Shown are SEI images and EDX spectra. These particles have not yet received final names.