CODITA: measuring the cosmic dust swept up by the Earth

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Light scattered by the Zodiacal dust cloud, as seen from Paranal (Chile). This photograph was produced by the European Southern Observatory. Credit: ESO/Y.Beletsky http://www.eso.org/public/images/yb_zodiacal_light_paranal_cc/

Although we think of space as being empty, there is more out there than meets the eye – dust, for example, is everywhere. If all the material between the Sun and Jupiter were compressed together it would form a moon 25 km across. Now a new research programme will try to see how much of this dust enters the Earth's atmosphere. Metals from the cosmic dust play a part in various phenomena that affect our climate. An accurate estimate of dust would also help us understand how particles are transported through different layers of the Earth's atmosphere. Professor John Plane of the University of Leeds will present the Cosmic Dust in the Terrestrial Atmosphere (CODITA) project on Friday 30 March at the National Astronomy Meeting in Manchester.

CODITA has received a €2.5 million grant from the European Research Council to investigate the dust input over the next 5 years. The international team, led by Professor Plane, is made up of 11 scientists in Leeds and a further 10 research groups in the US and Germany.

The main sources of dust in the Solar system are collisions between asteroids, and material evaporating off comets as they approach the Sun. When dust particles approach the Earth they enter the atmosphere at very high speeds, anything from 38 000 to 248 000 kilometres an hour, depending on whether they are orbiting in the same direction or the opposite to the Earth's motion around the Sun.

The particles undergo very rapid heating through collisions with air molecules, reaching temperatures well in excess of 1600 degrees Celsius. At this point they melt and evaporate. Particles with diameters greater than about 2 millimetres give off enough material to produce visible meteors, or "shooting stars". But most of the mass of dust particles entering the atmosphere are much smaller than this, so can be detected only using specialised meteor radars.

"We have a conundrum – estimates of how much dust comes in vary by a factor of a hundred," said Plane. "The aim of CODITA is to resolve this huge discrepancy."

Satellite observations suggest that 100-300 tonnes of cosmic dust enter the atmosphere each day. This figure tallies with the rate of accumulation in polar ice cores and deep-sea sediments of rare elements linked to cosmic dust, such as iridium and osmium. However, measurements in the earth's atmosphere indicate that the input could be as low as 5 tonnes per day. These measurements include meteor radar observations, laser observations of the sodium and iron atoms from evaporating dust in the upper atmosphere, and measurements by high altitude aircraft of meteoritic iron in the lower stratosphere.

"If the dust input is around 200 tons per day, then the particles are being transported down through the middle atmosphere considerably faster than generally believed; if the 5-tonne figure is correct, we will need to revise substantially our understanding of how dust evolves in the Solar System and is transported from the middle atmosphere to the surface," said Plane.

The metals injected into the atmosphere from evaporating dust particles are involved in a diverse range of phenomena linked to climate change.

"Cosmic dust is associated with the formation of 'noctilucent' clouds – the highest clouds in the Earth's atmosphere. The dust particles provide a surface for the cloud's ice crystals to form. These clouds develop during summer in the polar regions and they appear to be an indicator of climate change,' said Plane. "The metals from the dust also affect ozone chemistry in the stratosphere. The amount of dust present will be important for any geo-engineering initiatives to increase sulphate aerosol to offset global warming. Cosmic dust also fertilises the ocean with iron, which has potential climate feedbacks because marine phytoplankton emit climate-related gases."

The CODITA team will also use laboratory facilities to tackle some of the least well-understood aspects of the problem

Plane explained, “In the lab, we’ll be looking at the nature of cosmic dust evaporation, as well as the formation of meteoric smoke particles, which play a role in ice nucleation and the freezing of polar stratospheric clouds. The results will be incorporated into a chemistry-climate model of the whole atmosphere. This will make it possible, for the first time, to model the effects of cosmic dust consistently from the outer Solar System to the Earth’s surface.”

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