

Impression of the view of the bolide (meteoroid fireball) near the explosion site.

D. RATCLIFFE AND A. KLEKOCIUK, AAO



Dodging Armageddon

Every day some 50–100 tonnes of solar system debris enters Earth's atmosphere. Most of this material, which comes from meteoroids and comets, enters at high velocities (several to a few tens of km/s), and friction reduces the material to smaller fragments and gases. We can see this process in action each night – the 'shooting stars' or meteors we see as brief streaks of light in the sky represent the demise of particles that are usually smaller than a grain of sand. If the parent body is sufficiently large, solid fragments can survive to reach the Earth's surface. These fragments are called meteorites and their study has revealed much about the formation of the solar system.

The largest meteoroids often produce spectacular fireballs and sonic booms due to the release of significant energy during disintegration. These so-called 'bolides' are relatively rare events and are caused by meteoroids typically less than one metre in diameter. Two large and well-documented events that have led to the recovery of meteorite material were at Tagish Lake (Canada) in 2000 and the Sikhote-Alin Mountains (Russia) in 1947. These events were due to bodies of about 10 m diameter.

Meteorites larger than 500 m are believed capable of long-lasting disruption to global climate. During human evolution there have been a handful of such events. The most recent occurred 800 000 years ago when a four kilometre-wide meteorite hit the Indochina region. The movies 'Armageddon' and 'Deep Impact' portray the potential consequences of such an event today.

Several groups of astronomers are scanning the skies in an effort to catalogue and track bodies that pose a risk of collision with Earth. Their main goal is to find greater than 90% of all bodies larger than one kilometre in diameter by the end of this decade. However, objects of a few tens of meters across are also of interest. A meteorite this size produced the largest recorded natural atmospheric explosion near the Tunguska River, Siberia, in 1908. This event devastated a sparsely populated region over 2000 km² in area.

To date, the smallest object detected beyond the Earth is the five metre-wide 2003SW₁₃₀. However, at the time of discovery it had passed the point of closest approach. It is extremely difficult to provide any advanced warning of bodies this small, because the objects need to be close by to be detectable and not in the line of sight to the Sun or full moon. As for those rocks that enter the atmosphere unannounced; at this stage we'll just have to hope that the bits land somewhere else.

Further information:

Klekociuk AR, Brown PG, Pack DW, ReVelle DO, Edwards WN, Spaulding RR, Tagliaferri E, Yoo BB. and Zagari J. Detection of Meteoric Dust from an Asteroidal Airburst. *Nature* (in press).

The Tunguska explosion <<http://www-th.bo.infn.it/tunguska/>>

The Sikhote-Alin meteorite <<http://www.meteoritearticles.com/saarticle.html>>

The Tagish Lake meteorite <<http://aquarid.physics.uwo.ca/~pbrown/tagish/>>

NASA's Near Earth Object Program <<http://neo.jpl.nasa.gov/neo/>>

Impact craters on Earth; <http://www.solarviews.com/eng/tercrate.htm>.

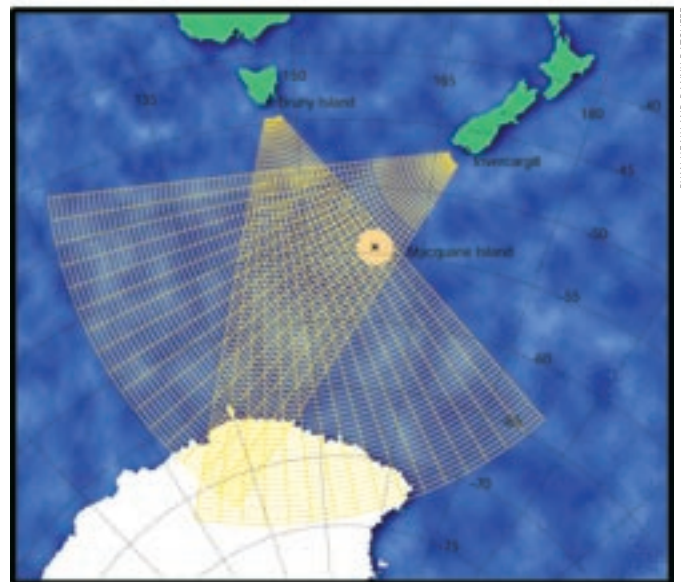
Gallery of images from the Moderate Resolution Imaging Spectroradiometer instrument on NASA's Aqua and Terra satellite <<http://modis.gsfc.nasa.gov/gallery/>>

New space weather



The new space weather telescope at Greifswald will warn of sun activity, such as coronal mass ejections (CME). Here a CME blasts off the sun's surface. If travelling in the direction of Earth, after two to four days the CME cloud strikes and is mostly deflected around the Earth's magnetosphere. The magnetic cloud of plasma can extend to 30 million miles wide by the time it reaches Earth. The geomagnetic storms that result from such events can disrupt communications and navigational equipment, damage satellites, and cause black outs.

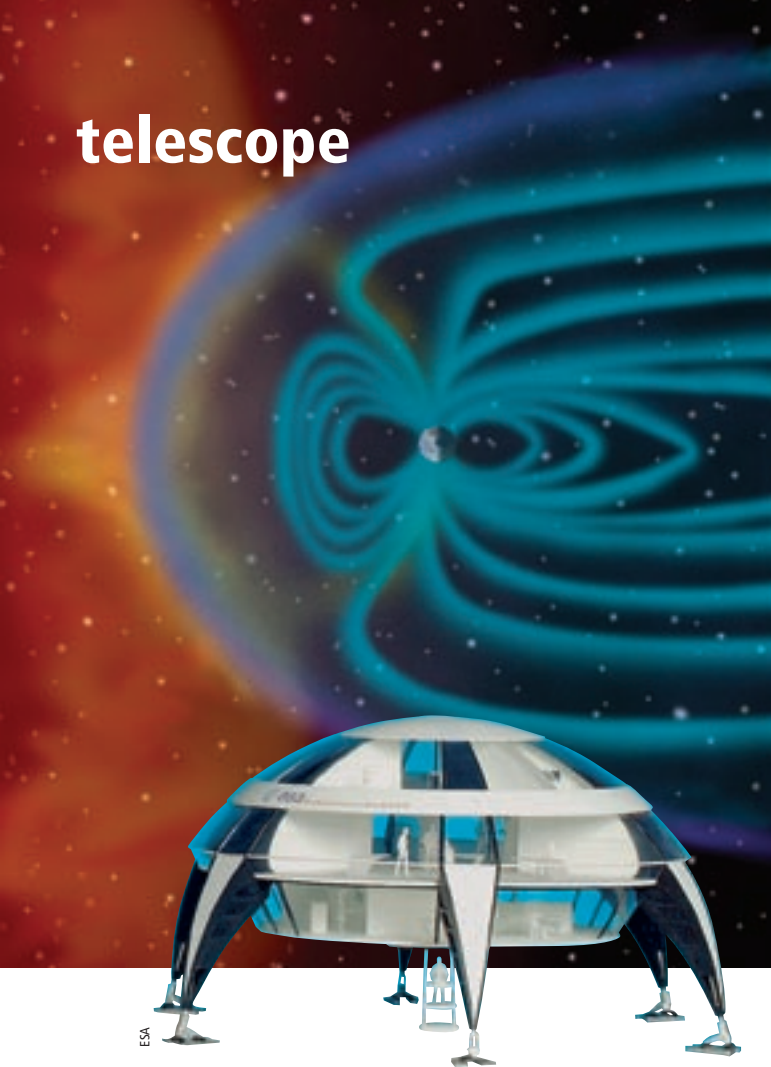
ESA & NASA



RYAN HEALY AND DANNY RATCLIFFE



MARK GENTILE



A new space weather telescope will be built in Greifswald, Germany, this year, as part of the European Space Agency's space weather programme. It will join an international network of telescopes – in Australia, Japan and Brazil – monitoring the activities of the sun, in particular coronal mass ejections. These ejections of charged particles (plasma) can cause geomagnetic storms on Earth, damaging communication satellites, power supplies and electronic equipment, and exposing astronauts or passengers in high-flying aircraft to radiation.

The telescope network will allow scientists to forecast the arrival of plasma clouds on Earth up to 24 hours in advance. This will enable potential risks to Earth's infrastructure and human health to be minimised.

The 'muon space weather telescope for anisotropies at Greifswald' (MuSTAnG) will be built by the University of Greifswald and a number of international collaborators including the AAD and Shinshu University in Japan. MuSTAnG will deliver real time information about sun activity to the German Aerospace Centre. It may also support tourism in northern regions by improving the predictability of the polar lights.

—MARC DULDIG

Ice, Oceans, Atmosphere and Climate Programme, AAD

Model of the building in which the MuSTAnG will be housed in Greifswald.

Radars map atmospheric phenomena

A second high frequency Tasman International Geospace Environment Radar (TIGER) was commissioned this February at Awarua near Invercargill, New Zealand. The radar, named 'Unwin' after New Zealand scientist Dr Bob Unwin – a pioneer in auroral radar development – will operate in tandem with the original radar established on Bruny Island, Tasmania, in 1999 (*Australian Antarctic Magazine* 1:27–28). Together, they will map the motions of aurora, meteors and ocean waves in the southern hemisphere.

TIGER operates as a stand-alone dual radar system, but is also part of the international Super Dual Auroral Radar Network, operated by ten nations, which covers southern and northern polar atmosphere regions. The radars survey the ionosphere, 100–300 km above the Earth, to provide

measurements of the aurora australis and other phenomena. The information they provide will improve our knowledge of space weather processes, allowing us to better manage radio communications, navigation systems, satellite operations and magnetic mineral surveys. The radars can also derive ocean wave motion from backscattered sea echoes and detect echoes from meteors, which are used to calculate wind speeds at heights around 100 km.

TIGER is operated by a consortium of Australian research institutes headed by La Trobe University and including Monash University, University of Newcastle, AAD, IPS Radio & Space Services, British Antarctic Survey and the Defence Science and Technology Organisation.

—RAY MORRIS

Ice, Oceans, Atmosphere and Climate Programme, AAD

—PETER DYSON

Department of Physics, La Trobe University

The Bruny Island and Unwin radar beams intersect above Macquarie Island, enhancing the value of ground-based experiments on the island. The overlapping radar beams provide accurate velocity measurements of aurora motion within the ionosphere.

The transmitting and receiving antennas of the Unwin radar facility opened on 11 February 2005 in New Zealand. The radar operates at high frequency, between eight and 20 MHz and uses 300 m-long antenna arrays to probe a 52° azimuth sector, with a range from 200–3000 km south.