New radar tracks drama of the ionosphere

ONE HUNDRED KILOMETRES above the earth is a region so full of drama that eighteen radar transmitters are trained on it twenty-fours hours a day.

The transmitters send out high frequency radio waves from around the world to pick up evidence of storms in space, plasma irregularities, stray electrical currents, solar winds and fierce magnetic forces.

All of these atmospheric effects can wreak havoc with the systems that govern our global infrastructure. They can knock out GPS and HF radio, blow up power stations, corrode pipelines – and even interfere with individual banking transactions transmitted via satellite.

Physicists and engineers at La Trobe University are part of the international consortium of universities dedicated to the task of tracking this drama of the ionosphere. They recently received a $450,000 ARC Linkage Infrastructure grant with the University of Newcastle and the University of Adelaide for a nineteenth radar installation.

'This will be the first fully digital system,' says Principal Investigator, La Trobe's Dr Roman Makarevich, who is Australia's representative at the regular scientific meetings called to discuss the project.

Delegates from Australia, United States, United Kingdom, France, Japan, Canada, France and South Africa recently met at Newcastle where issues relating to the new installation were high on the agenda.

The new radar will be installed at Buckland Park, Adelaide where it will join two other bases – one on Bruny Island south of Tasmania and the other in Invercargill, New Zealand – collectively known as TIGER (Tasman International Geospace Environment Radar).

La Trobe physicists and electronic engineers led by Emeritus Professor Peter Dyson and Professor John Devlin have played a major role for more than a decade in building and operating these southern hemisphere bases. TIGER3 will increase the coverage in the region from the Southern Ocean and Antarctica to include Victoria, Tasmania and the south island of New Zealand.

Most of the ionosphere is now covered, Dr Makarevich says, with each installation operating in a cone measuring over four million square kilometres on the earth's surface, an area greater than those of countries like India or Argentina.

'They are the largest instruments in the world in terms of coverage,' says the enthusiastic researcher. 'They operate synchronously and in unison.'

The transmitted radio waves travel thousands of kilometres from their source until they encounter an irregularity in the atmosphere when they return to the receiver.

Dr Makarevich is hoping that the increased coverage will allow him to track 'very-fast plasma flows' – the ionised gas that streams towards earth from the Sun – that travels at speeds up to three kilometres per second and only occurs at latitudes to be covered by the new radar.

The aim is to improve ionospheric forecasting and, ultimately, provide real-time corrections for equipment dependent on signals passing through the region.

'Satellites can only provide information about a particular location every 100 minutes or so. Their time resolution is very limited. We are trying to improve that by several factors of magnitude, to below one minute resolution, to study origins of plasma flows and irregularities.'

Dr Makarevich say the work will impact on Australia's position as a world leader in developing high frequency radar surveillance systems, such as JORN, the Jindalee over-the-horizon radar network.

'Australia's ability to support these operations and remain a leader in these fields depends on its capacity to nurture expertise and train new personnel,' he says. 'The new radar system will play a crucial role in this respect, providing high-level training in radar technology and a test bed for the development of new instrumental and data analysis techniques.'

Stealth aircraft, for example, have a coating on their underbellies to protect them from radar. JORN uses the same principle as TIGER and works by bouncing its signals off the ionosphere to pick up the craft from above.

Professor Dyson, a foundation member of the La Trobe Space Physics Group, says the Federal Government has recognised the importance of this and other areas of space science in its recent budget.

'New competitive funding of $40m for programs in space science will provide an excellent opportunity for La Trobe to expand its research for the radar and other space physics projects, thereby helping build vital capacity in areas of increasing national and regional interest.'



Dr Makarevich, left, with Professors Dyson and Devlin.

Image: Jorgen Hedin