Developing next-generation capability to measure soil moisture from space

9 November 2017

Professor Jeff Walker, Civil Engineer/Hydrologist at Monash University, is leading the way in soil moisture research that uses remote sensing technology on satellites orbiting the earth. Data collected on these missions is used to create soil moisture maps which can improve the prediction of such things as heatwaves and rainfall.

Professor Jeff Walker using remote sensing technology

To date, soil moisture levels have been measured using “L-band (1.4GHz) technology", but the current L-band satellites can only detect soil moisture in the top 5cm of soil. Professor Walker and his team, which includes representatives from NASA and ESA, is now pushing the envelope in a world-first that will use P-band technology (0.75GHz) to detect moisture content in layers of soil up to three times deeper, resulting in more useful soil moisture maps.

The team recently launched the first phase of this important research with the installation of an automated tower that will be used to test the P-band technology in preparation for the next generation of soil moisture satellite missions.

Until now, there has been no way to undertake such a comprehensive and integrated study anywhere in the world.

This research is timely as there is mounting interest in this technique, with an L- and P-band satellite concept recently proposed for inclusion in the NASA Decadal Survey, a document that recommends priority satellite missions for the next decade.

Professor Walker says of the technology “P-band has the potential to not just provide soil moisture for a deeper layer of soil, but to also provide a more accurate estimate for a larger portion of the continent, as it can see through the vegetation more easily than L-band”.

This research is being supported by an ARC grant awarded at the end of 2016 to establish a P-band testing program to demonstrate what this technology can achieve.

This project represents Australia's commitment to Earth observation and a realisation that we cannot rely on others to determine the future of such an important observing capability for us.

Why is it important to measure soil moisture?

It's estimated that by 2050 we will need to produce 60% more food from the same amount of land and water we have today, in order to meet the world's growing population.

Since agriculture is one of the largest water users in Australia, measuring soil moisture content could save significant amounts through smart irrigation. Crop production can also be increased because farmers could anticipate the best times to plant crops. They can also anticipate pasture growth for their herds.

There are further applications for this technology; soil moisture evolution can infer drought severity and provide an important boundary condition for climate predictions on heatwaves, and both short and long-term rainfall.

How does it work?

Earth naturally emits microwave radiation at all wavelengths proportional to its physical temperature and emissivity, and in turn the emissivity is affected by the soil moisture content through the dielectric constant contrast between water and dry soil. Complicating factors include the roughness of the soil which enhances this emission, and any overlying vegetation which both attenuates the ground emission and contributes its own emission proportional to the water in the foliage. Importantly, the longer the wavelength the deeper the layer of soil from which emissions can be observed, the lower the impact of surface roughness, and the more transparent the vegetation layer. Satellites orbiting the Earth can measure these naturally emitted microwave signals and in turn infer global soil moisture maps every few days. But at present there is no passive microwave satellite operating at P-band.