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Can't see sky for the trees

HOT summer days are synonymous with the smell of cut grass and air thick with the scent of Eucalyptus trees. But according to CSIRO scientists, these distinctly Australian aromas are a significant source of emissions that contribute to smog formation.

'Trees and grasses release volatile organic compounds that react in the upper atmosphere with sunlight, to produce smog,' Dr Peter Nelson of CSIRO Energy Technology says.

'These volatile compounds add to photochemical smog – a mixture of ozone, other oxidants and particles – in the same way as emissions from human sources, such as cars and industrial process.'

As smog is detrimental to environmental and human health, understanding nature's contribution to its production is essential to smog prediction and control strategies.

'We can only accurately predict where and when smog will form if we understand the ingredients that go into it,' Ian Galbally from CSIRO Atmospheric Research says.

'And we can't fully understand how a control strategy for anthropogenic emissions will work if we don't have the whole picture.'

Nelson and Galbally have taken the first step towards completing that picture. In a project commissioned by the New South Wales Environment Protection Authority, the scientists directly measured and characterised emissions of volatile organic carbons from trees and grasses.

Using giant plastic bags to measure volatile organic carbon emissions.

Transparent plastic bags were placed over the branches of Eucalyptus trees at various locations in the Sydney region, and transparent chambers over patches of grass. Air was blown through these enclosures and over the course of a day (for up to three days), the concentration of compounds in the air coming out of each bag or chamber was measured. The air inside these enclosures was also sampled and analysed.

Using gas chromatography, which separates the different chemical constituents in air, the scientists identified a number of highly reactive hydrocarbons emitted from Eucalyptus leaves, including isoprene and monoterpenes. While isoprene is thought to originate from photosynthetic processes, monoterpenes originate from plant oils, which vaporise during the day.

Numerous hydrocarbons were also identified in grass emissions, many of which are used as common solvents. These included methanol, ethanol, acetone, chloroform and hexenyl acetate – a compound known to perfume aficionados as 'the smell of grass'.

Nelson and Galbally also found that emissions from trees and grasses were dependent on the amount of radiation from the sun. 'Emissions of isoprene increased very rapidly with both temperature and light. They were highest during the day and then decreased to near zero overnight,' Nelson says.

Although the exact contribution of tree and grass emissions to smog is still uncertain, the scientists estimate that 10–50% of volatile organic compounds in urban locations may come from vegetation.

'Because of this significant level of background pollution, other emissions – from cars or industry – will have to be controlled more stringently,' Nelson says.

Nelson and Galbally are preparing to expand the project to look at emissions from other vegetation in the Sydney region.

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Wild game chase

WHY would Australian scientists be interested in microbes that live in the stomachs of African game animals?

The story starts in Queensland, where the exotic shrub leucaena (L. leucocephala) has been used as a nutritional feed for cattle since the 1950s. The shrubs were toxic to cattle until Dr Ray Jones of CSIRO Sustainable Ecosystems introduced a rumen bacterium, Synergistes jonesii, isolated from Hawaiian goats. This enabled cattle to degrade the toxic amino acid in leucaena leaves, and its degradation product in the rumen.

But now leucaena is in trouble, due to a small sap-sucking insect (a psyllid) that is threatening the shrub's productive potential in most tropical countries, including Australia. Alternative plant species have been tried, but none has produced such impressive weight gains in cattle. This is probably due to their high condensed-tannin content, which reduces protein digestibility.

Jones wondered whether African game species, which happily consume tannin-rich browse, may have rumen microbes that handle high levels of condensed tannins, and which could be isolated and introduced to cattle. He and his colleagues decided tested this idea by comparing (in the lab) the digestive ability of rumen fluid from wild game species and from merino sheep.

'It was a lot of work,' Jones says. 'But we concluded that condensed tannins were not being metabolised by the rumen bacteria in the game species we studied.'

It seems that African ruminants may cope with browse due to proteins in their saliva which bind to the tannins, reducing their troublesome effects in the rumen. 'A more rewarding solution could be to exploit the variation in leaf tannin content and in susceptibility to psyllids between different shrub species and cultivars,' Jones says.

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