The Cape Town Carbon Observatory

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our future through science

WORKING BACKWARDS TO GO FORWARD

Calculating the greenhouse gas emissions from an area is usually done by adding up all the known sources. Some can be missed, and others under-reported. But there is now a way to conduct an independent check. By measuring the concentration of gases in the air very precisely and continuously, and by knowing how the air moves over the Earth's surface, it is possible to estimate where the gases came from, and in what quantity. This is called **inverse modelling**. The method has been developed and tested at the scale of the whole planet, but this does not give any national or local detail – the scales at which greenhouse gas management occurs. The Carbon Observatory project is testing whether the inverse modelling method can be applied at the scale of a large metropolitan area.

THE CAPE TOWN TEST CASE

As a test case, Cape Town has been surrounded by a ring of monitoring instruments (**Figure 1**), located at Cape Hangklip, Robben Island and Cape Point (**Figure 2**). The instruments measure the important greenhouse gases carbon dioxide (CO_2) and methane (CH_4) every minute, 24 hours a day, with a precision of less than 0.1 parts per million. The Cape Point monitoring station, which is run by the South African Weather Service, is a Global Atmospheric Watch Station – an international network of high precision atmospheric monitoring stations. It has been collecting CO_2 concentration data since 1992. The atmospheric modelling capacity at CSIR is able to simulate air movements in 18 vertical layers, and at a resolution of 1 km, for the entire region from Langebaan to Cape Agulhas. Sophisticated statistical methods are then applied to estimate the sources and sinks of the measured gases. These estimates can be verified against emission data collected by the Cape Town metropolitan authorities.

This technology has never before been applied in South Africa, and is very new worldwide. If it is found to be practical, accurate and cost effective at sub-global scales, the next step is to install a ring of monitors around the whole country, and perhaps around other major metropolitan areas within South Africa.

Figure 1: The Picarro Cavity Ring-Down spectrometer provides very precise and stable measurements of several greenhouse gases. To ensure that all the instruments in the system are exactly calibrated, they are checked on a frequent basis against test gases provided by the National Oceans and Atmosphere Administration in the USA

IMPROVED ESTIMATES OF CARBON UPTAKE AND EMISSIONS OVER SOUTHERN AFRICA

Improving the spatial scale of CO_2 measurements over South Africa not only improves our ability to monitor sources and sinks of greenhouse gases nationally, but improves continental and global estimates as well. Under-sampling in the tropical and sub-tropical regions of the world is a major source of uncertainty in global models, particularly in Africa and South America. By expanding the measurement network in Southern Africa, the uncertainty in global estimates of sources and sinks will be reduced.

This project is part of SA-ICON, the South African Integrated Carbon Observatory Network. SA-ICON combines advanced capabilities in the CSIR and the South African Weather Service to measure carbon dioxide in the atmosphere, on land and in the oceans, in order to better understand the causes and possible future development of global change in the southern African region. The control of carbon dioxide levels in the atmosphere has becomes an urgent and economically important issue worldwide. Through SA-ICON, South Africa will have an independent capability to verify the sources and sinks in its territory.

Figure 2: The main wind directions across the Cape Town metropolitan area are from the northwest and southeast. By placing monitors at the lighthouses at Cape Hangklip and Robben Island, it is possible to measure clean maritime air on the upwind side of the city, and polluted air downwind, for both of these wind directions. The monitor at Cape Point allows north easterly winds to be monitored as well. It also provides globally-important information about sources and sinks in the vast South Atlantic Ocean

The need to reduce greenhouse gas emissions is filtering down from global, to national, local and even individual levels. In an era of accountability for emissions, carbon taxes and the trading of emission permits or uptake amounts, how can we be sure that the data provided by individual sources is accurate? How can we determine the role of natural ecosystems in mitigating climate change?

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