

Historical perspective on Ian Enting's career by Roger Francey

I first met Ian in 1981 when we shared an office for the best part of a year at CSIRO, Aspendale. I then left for a 2-year secondment to Cape Grim, Tasmania, to act as the first scientific Director of the Cape Grim Baseline Atmospheric Station. He was newly hired by Graeme Pearman at CSIRO to develop mathematical models of the global carbon cycle, and he began pioneering the use of inversion techniques for interpreting spatial and temporal differences in atmospheric CO₂ measurements in terms of changes in surface sources and sinks. These techniques underpin the main tools today being applied world-wide to reconcile atmospheric trace gas changes with anthropogenic emissions from industry and land use activities.

I had previously made measurements of stable carbon isotopes in tree rings to assess their potential for reconstructing past atmospheric CO₂ levels (demonstrating that tree-rings were unsuitable for this task). The Cape Grim appointment coincided with my first foray into direct measurement of CO₂ isotopes in the atmosphere. Ian included isotopic composition of CO₂ into his global models (one of few to have done so), providing a vital interpretative framework for the measurements. One of the most valuable insights gained from working closely with Ian concerned the limitations of the models. It prompted me to joke that his work had given my life a purpose – to prove his models 'wrong'. This was meant, and accepted I hope, as a compliment. It reflected a view that his models were important enough to spend a lifetime dreaming up measurements that would help to refine them.

In the early 1990s, building on a firm foundation of past CO₂ measurement, CSIRO opened the Global Atmospheric Sampling Laboratory (GASLAB). GASLAB ushered in unprecedented cooperation between scientists in sharing resources to maintain high quality monitoring of a suite of 'greenhouse gases', and this included interpretative modelling. It had a focus on the sparsely-sampled huge well-mixed volume of the global atmosphere over the Southern Oceans. From the start, GASLAB set out to measure both the contemporary atmosphere, and archived air in Antarctic ice cores and in the Cape Grim Air Archive, using consistent techniques and reference standards. The high precision requirements for detecting the small but extensive and globally significant trace gas changes over the Southern Oceans, and the sample size restrictions imposed in archived air samples (also by reference standard longevity), prompted the development at CSIRO of new measurement techniques. These were mostly conceived by Paul Steele and realised with highly-skilled and innovative CSIRO technical and engineering staff. For example, the LoFlo CO₂ analyser at Cape Grim has provided by far the most precise and globally-representative CO₂ record since the early 1990s.

Ian's contribution, while crucial for the interpretation of the contemporary measurements, was equally vital for our archived air measurements. He pioneered the development of the CSIRO firn diffusion model to interpret the influence of trapping processes in air recovered from bubbles in ice cores. GASLAB provided trace gas data with an unprecedented range of diffusion constants to confirm the model. This work has led to the definitive histories of global sources and sinks of atmospheric CO₂, CH₄ and other trace gases over the past two millennia.

While both Ian and I resigned from full-time employment in CSIRO in 2004, I have continued to work in an honorary capacity at CSIRO, using the high quality GASLAB data to challenge model descriptions of the global carbon budget. My two most recent papers, included at the end of the reference list below, are evidence that this remains a productive research approach (the last acknowledges valuable assistance from Ian).

Ian's contribution to this overall effort has been invaluable, featuring enthusiastic interest and willing guidance on the measurement strategies. During the 1990s I co-authored with Ian six frequently-

cited journal papers that are referenced below (including citation numbers). In subsequent years I co-authored many other frequently cited papers, with e.g. Peter Rayner, Cathy Trudinger and Rachel Law, each using models firmly based on Ian's earlier work.

Ian remains a firm friend with an astonishing repository of knowledge on a wide range of topics (including the full formal wording of a toast to the Queen - a party hit with 'Commonwealth Club' members at international CO₂ conferences, where the entry criteria included a duty-free bottle of single malt whisky). There are many other examples of his contribution to the scientific community morale and cooperation, at home and overseas.

References. (*GoogleScholar citations*)

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