Interview with Professor Penny Sackett, Chief Scientist for Australia

Editor's Note: This interview is based on questions emailed to Professor Sackett, with word limit guidelines.

Please tell us a little of your background and why you became interested in science.

I grew up in Omaha, Nebraska in the United States. I think all children are natural scientists, always asking questions about how things work in the world they live in, I know I certainly did. In high school, when it was possible to take classes in pure science (such as chemistry), it occurred to me for the first time that being a scientist was something you could do for a career. It was then that I began to think about what it would be like to become a scientist. The first connection I made was to medical technicians or medical researchers. I thought there had to be someone who studied your blood after you gave a sample at the doctor's and it seemed pretty amazing you could tell something about the health of somebody just by looking at their blood. It also meant you would get to use a microscope, which seemed like a pretty good deal to me in year 10.

Before being able to take a second year of any science course in my high school, one had to take the first year in all the science courses. This is how I was introduced to physics. Physics was much more than I expected it would be. It involved everything from understanding how the joints work in your body, to understanding why the stars and the planets appear to move across the sky in the way they do, and fun practical things such as how could you package a raw egg so it doesn't break when you drop it from a two storey building…It seemed to me that physics could help you understand any question about the world that you wanted to ask. Even then though, I had no idea what a physicist did for a living only that I wanted to know more about physics.

At what point in your career did you move into administration and why? Did this move clash with your science research and teaching?

I have moved back and forth between research and administration a number of times throughout my career. At times, some have said to me that moving into administration would end my research career, but as my record shows it did not. Sometimes an unusual career path can be an advantage, as it can provide new skills and a new perspective that distinguishes one from the pack and stimulates new approaches to old problems.

How and when did you become interested in the role of Chief Scientist, and why does your experience suit that position?

My previous role as Director of the Research School of Astronomy and Astrophysics and Mt Stromlo and Siding Spring Observatories was enormously challenging; it allowed me to grow and to contribute at the same time. The reconstruction forced upon us by the Canberra bushfires of 2003 that nearly destroyed Mt Stromlo meant that we had an opportunity to recreate ourselves with a new vision. That vision included a reinvigorated graduate training program, remote and robotic observation of the skies, a Fellowship program for the brightest of the new generation of astronomers, and partnership in an international program to build a telescope many times more powerful than now known (the Giant Magellan Telescope). After the end of my first term as Director, I stepped down, feeling that I had given the best of what I had to offer to that post. I wanted another challenge, another beginning, with new opportunities to grow and contribute.

The chance to become Chief Scientist for Australia was just that. Australia has an opportunity, partly borne of necessity, to create and implement a new vision that will take it into the next decades as a leader on the international stage in innovation, scientific research, evidence-based policy, continuous learning, and the emerging low-carbon economy. I'm delighted that my training in physics, mathematics and education, experience in research and science administration on three continents, and international connections can assist in formulating and implementing this vision.

Please explain your role as Chief Scientist and your goals for achievement.

Being Chief Scientist for Australia brings with it a very broad mandate. I provide high-level independent advice to the Prime Minister and other Ministers on matters relating to science, technology and innovation. I provide a link not only between government and science, engineering, innovation and industry groups but across governmental portfolios and scientific disciplines.

I am also an advocate for Australian science internationally and am helping to focus national thinking on science across the states and territories through a national Forum of Australian Chief Scientists. An equally important part of my role is to be a champion of science and research in the community, with a special brief to promote science as a career and help break down the cultural barriers that inhibit collaboration between researchers and industry. Finally, I am also a communicator of science to the general public, with the aim of increasing the understanding of science and how it contributes to our every day lives and can assist in the decisions we must make everyday.

You have now been Chief Scientist for a little over 12 months. Have you been able to meet you goals, and have these changed?

The first 12 months of my term as Chief Scientist have come and gone with remarkable speed. In the last year, among other things, I've worked to institute a new foresight process for the Prime Minister's Science, Engineering and Innovation Council to ensure that Australia is better prepared for the future; made connections with overseas counterparts in North America, Asia, Europe and the Subcontinent; and stressed the importance of immediate, meaningful and sustained action to reduce the emissions of greenhouse gases that are responsible for climate change. We've also instituted a website for the Chief Scientist, and as part of our new communication strategy, have engaged in social media as well.

So what are my goals for this coming year? Well I have a very long to do list, but my priorities include:

- Exploring how local communities, including large cities, can be more proactive in limiting the amount of climate change that will take place, while preparing to adapt to that which cannot be avoided. If we do not alter our present trajectory, then even with the best of intentions, the global average temperature may be 3 to 4 degrees higher than it is today.
- Mathematics: Mathematics is the language of the enabling sciences of biology, chemistry and physics, and in this sense is the "Enabler of the Enabling." It is the basis for the transmission and secure encryption of information, upon which modern commerce depends. Each of us can make wiser decisions at work, at home and in the supermarket if we understand a bit of statistics and are good with numbers. And yet, Australia lags far behind other economically

developed countries in its production of mathematically trained citizens, and the situation is deteriorating. I don't want this to continue.

- I've been proud to be part of the National Youth Science Forum (NYSF), which this year is being held in both Canberra and Perth. These hundreds of Australian year 11 leaders, excelling in science and communication, are an inspiration to me, and I'd like to help them connect with me, with one another, with science, and with their communities. That's why I've decided to take the advice of the 2009 NYSF scholars and become part of the social media revolution with the introduction of my facebook page www.facebook.com/chiefscientist . This year, we'll be using that as a mechanism for my new Young Science Ambassador initiative.

What is your understanding of the air quality problems which can exist in Australia, and their importance?

Australia is a large continent with many wide open and wild places that are less disturbed compared with many parts of the world[1]. Nevertheless, Australia's dependence on fossil fuels and internal combustion engines for vehicle transport and electricity supply[2] with populations centring on the coastal interface mean its urban air quality problems involving outside and indoor air pollution, do affect the health and well being of many people and the surrounding ecosystems. Urban air pollution, often associated with megacities, also affects a large fraction of the global population. The UN Commission on Sustainable Development at its Fourteenth Session on 1-12 May 2006 in New York reported it is responsible for more than 800,000 premature deaths every year[3]. The cocktail of pollutants produced in this way and affecting living things is many and varied and its cumulative and synergistic or combined effects are still not well known.

The science indicates that through the use of fossil fuels in Australia, the most important outside air quality pollutants include carbon monoxide, nitrogen oxides and hydrocarbons from internal combustion motor vehicle exhausts; ozone producing smog that is made when sunlight triggers chemical reactions on nitrogen oxides and hydrocarbons; sulfur dioxide; very fine particulate matter that becomes airborne mostly formed from combustion of fossil fuels[4] as well as waste heat and heavy metals including some very small grained magnetic minerals that are particularly dangerous to humans because of their ability to be inhaled into the lungs[5] as aerosols associated with other heavy metals such as zinc, cadmium, and chromium in combination with mutagenic organic compounds[6].

Natural and human caused bushfires in addition to volcanic activity can also create areas that become polluted on a scale much worse than some city centres.

Indoor air pollution can include many toxic organic and inorganic compounds from buildings and with increased exposure times for occupants living in these structures, the health effects as people seek refuge from heat waves and other extreme weather events sometimes caused by climate change, are yet to be fully analysed. For example, formaldehyde is in carpets and soft furnishings.

As Chief Scientist, do you have an influence on government decision making in relation to air quality control and management? Please explain how.

As Chief Scientist it is my role to provide scientific advice to the Prime Minister and other government Ministers that informs policy making on matters of science, engineering and innovation.

Human emissions contributing to Greenhouse warming, and their link to climate change, have been the subject of all kinds of opinions. How well do you think the science defining this link is established? What should scientists do better to communicate this problem to government and the public?

Despite varying opinions, a large body of scientific evidence is mounting daily that indicates nearly all of the long-term increase of about 35% (107ppm, from 280 to 387ppm) in atmospheric CO_2 concentrations since 1800 is due to human causes. Natural causes over this period contribute to short-term variability on time scales of several months to a few years causing the CO_2 concentrations to fluctuate about 10 ppm or less.

These conclusions rest on data arising from ice core analysis, direct atmospheric CO_2 measurements, careful accounting of the net amount of CO_2 released into the air by humans, and isotopic ``fingerprint" analysis of atmospheric and marine CO_2. In sum, at any given moment in the present, about 90-99% of the industrial era change of 107ppm in the atmospheric CO_2 concentration is due to human activity. The variability of this percentage is due to short-term, oscillatory natural causes. The much larger, steady long-term increasing trend is due to human activities.

The main evidence that human activities are responsible for the increased CO_2 during the industrial era comes from an accounting of the actual amount of carbon dioxide released due to humans. Tallying the increased CO_2 from industrial processes, the amount of fossil fuel extracted and combusted[7],[8],[9], and the reduction of CO_2 sinks caused primarily by land clearing[10], indicates that humans have produced far more CO_2 than now remains in the atmosphere[11],[12],[13]. The remainder has gone into ocean and land "sinks," and is responsible for the increased acidity of the ocean.

Human activities are also shown to be the cause of recent increases in atmospheric CO_2 concentrations by isotopic analysis of oceanic and atmospheric carbon dioxide. Since the last ice age, the pre-industrial age atmosphere has had a relatively constant ratio between two types of carbon, the isotopes 12C and 13C, varying slightly over a few millennia[14]. CO_2 produced from burning fossil fuels or land clearing, however, has a distinct isotopic fingerprint. Plants have a preference for lighter isotopes (12C vs 13C) when building their tissue, resulting in a lower 13C/12C ratio than the atmosphere[15]. Since fossil fuels are ultimately derived from ancient plants, fossil fuels also have low 13C/12C. CO_2 from these materials is released into, and mixes with the atmosphere, and it has been directly measured that the average 13C/12C ratio of the atmosphere decreases[16],[17]. This is consistent with the decreasing 13C/12C ratio measured from CO_2 trapped in ice cores for the period since 1850[18]. Furthermore, 13C/12C analysis indicates that this ratio is also decreasing in the ocean. The atmosphere has an even lower 13C/12C ratio (fingerprint) than the ocean, indicating that 13C-depleted carbon from fossil fuels and deforestation is passing from the atmosphere into the ocean[19],[20] .

In sum, evidence from completely different methodologies indicates that human activity is responsible for the dramatic recent increases in atmospheric CO_2 that are the main contributor to the long-term climate change trends measured over many decades.

As Chief Scientist, do you advise Government on issues related to Greenhouse warming and climate change? How does this process work and what kinds of responses occur?

Yes. The Government has made it clear to me that they consider climate change to be a very important issue for Australia. The political decisions are left to those in politics and the societies that elect them, but it is clear that the science of climate change is important for formulating any government policy. My Office is one of the channels through which the government is kept abreast of the science of climate change, which is derived from many disciplines and from scientists the world over.

What can Australia do internationally in relation to air pollution management and carbon emissions reduction? Are we too small to have an influence, or will international decision makers pay attention to our efforts?

I have heard it said that Australia doesn't matter, which I find distressing. As Australians, we certainly do matter. Our large individual carbon footprints (Australia is one of the largest emitters of greenhouse gas emissions per capita in the world), mean that each of us as individuals can probably do more than almost any other citizens of earth if we reduce our own carbon footprints. Whether collective or individual action, all action begins with individual choices.

FOOTNOTES

1. Beeton RJS, Buckley K I, Jones G J, Morgan D, Reichelt R E, Trewin D, (2006), Australia State of the Environment 2006 Australian Government, http://www.environment.gov.au/soe/2006/publications/report/land-1.html
2. Pandey S K, Tripathi B D, Prajapati S K, Upadhyaya A R, Mishra V K, Rai P K, and Sharma A P, (2005), Magnetic Properties of Vehicle-derived Particulates and Amelioration by *Ficus infectoria:* A Keystone Species, *AMBIO: A Journal of the Human Environment*, pp. 645–647 http://ambio.allenpress.com/perlserv/?request=get-toc&issn=0044-7447&volume=34&issue=8
3. Beder S, Every Breath You Take, *Engineers Australia,* July 2001, p. 52., http://www.uow.edu.au/~sharonb/columns/probe18.html
4. UN CSD, (2006), Atmosphere/Air Pollution: Best Practices, Lessons Learnt and Case Studies By UN Cooperative Programmes and Activities Report of the UN Issues Management Group (IMG) of EMG, http://www.unemg.org/Portals/27/Documents/MeetingsDocs/IMG/AirPoll_IndDev/EMG_AtmosAirPoll_BestPrac_CSD14.pdf
5. Upton R, (1997), Local air pollution begins at home, NOVA Australian Academy of Science, http://www.science.org.au/nova/015/015key.htm
6. Morris W.A, Versteeg J.K, Bryant D.W, Legzdins A.E, McCarry B.E, and Marvin X.H, (1995), Preliminary comparisons between mutagenic and magnetic susceptibility of respirable airborne particle. *Atmospheric Environment,* **29**,3441–3450, http://ambio.allenpress.com/perlserv/?request=link-resolver&cite_doi=1352-2310%281995%29029%5B3441%3APCBMAM%5D2.0.CO%3B2&id=I0044-7447-34-8-645-B03
7. Marland G, Rotty RM (1984) Carbon dioxide emissions from fossil fuels: A procedure for estimation and results for 1950-82. *Tellus Ser.* **B 36**,232-261
8. Marland G, Boden TA, Andres RJ (2006) Global, regional, and national CO_2 emissions. *Trends: A Compendium of Data on Global Change,* Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, USA.
9. Raupach MR, Marland G, Ciais P, Le Quere C, Canadell JG, Klepper G, Field CB (2007) Global and regional drivers of accelerating CO_2 emissions. *PNAS* **104,**10288-10293
10. Houghton RA, (2003), Revised estimates of the annual net flux of carbon to the atmosphere from changes in land use and land management 1850-2000. *Tellus,* **55B(2)**,378-390 http://cdiac.ornl.gov/trends/landuse/houghton/houghton.html
11. Sabine CL, Heimann M, Artaxo P, Bakker DCE, Chen C-TA, Field CB, Gruber N, Le Quere C, Prinn RG, Richey JD, Romero Lankao P, Sathaye JA, Valentini R (2004a) Current status and past trends of the global carbon cycle. In: Field CB, Raupach MR (eds) *The Global Carbon Cycle: Integrating Humans, Climate, and the Natural World.* SCOPE 62, Island Press, Washington, 17-44.
12. Denman, K.L., G. Brasseur, A. Chidthaisong, P. Ciais, P.M. Cox, R.E. Dickinson, D. Hauglustaine, C. Heinze, E. Holland, D. Jacob, U. Lohmann, S Ramachandran, P.L. da Silva Dias, S.C. Wofsy and X. Zhang, (2007): Couplings between changes in the climate system and biogeochemistry, in: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.),. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. (IPCC 2007)
13. Raupach MR, Canadell JG, and Le Qu´er´e C, (2008) Anthropogenic and biophysical contributions to increasing atmospheric CO_2 growth rate and airborne fraction, *Biogeosciences*, **5,** 1601–1613, 2008, www.biogeosciences.net/5/1601/2008
14. Indermühle A, Stocker TF, Joss F, Fischer H, Smith HJ, Wahlen M, Deck B, Mastroianni D, Tschumi J, Blunier T, Meyer R, and Stauffer B (1999), Holocene carbon-cycle dynamics based on CO_2 trapped in ice at Taylor Dome, Antarctica. *Nature,* **398**, 121-126.
15. Park R and Epstein S (1960) Carbon isotope fractionation during photosynthesis, *Geochimica et Cosmochimica Acta*, **21**, 110-126.
16. Prentice IC, Farquhar GD, Fasham MJR, Goulden ML, Heimann M, Jaramillo VJ, Kheshgi HS, Le Quéré C, Scholes RJ, Wallace DWR (2001) Climate Change 2001: IPCC Third Assessment, The Carbon Cycle and Atmospheric Carbon Dioxide in: *The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York (IPCC 2001).
17. Keeling CD, Bollenbacher AF, and Whorf TP (2005) Monthly atmospheric 13C/12C isotopic ratios for 10 SIO stations. In: *Trends: A Compendium of Data on Global Change.* Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, TN
18. Francey RJ, Allison CE, Etheridge DM, Trudinger CM, Enting IG, Leuenberger M, Langenfelds RL, Michel E, and Steele LP (1999) A 1000-year high precision record of d13C in atmospheric CO_2, *Tellus,* **Ser. B**, **51**, 170– 193.
19. Quay PD, Tilbrook B, and Wong CS (1992) Oceanic Uptake of Fossil Fuel CO_2: Carbon-13 Evidence, *Science,* **256**, 5053, 74 – 79.
20. Quay P, Sonnerup R, Westby T, Stutsman J, and McNichol A (2003) Changes in the 13C/12C of dissolved inorganic carbon in the ocean as a tracer of anthropogenic CO_2 uptake, *Global Biogeochemical Cycles*, **17,** 1, 1004-1023

Branch Reports

SA & NT BRANCH

The SA-NT Branch AGM was a success in a new venue on the edge of the CBD near the office building of Branch Secretary Johan Meline. Twenty members and guests attended for the evening combined AGM and Dinner. The guest speaker was Mr David Winterburn, of BHP Billiton, who gave a detailed overview of the Olympic Dam Expansion project. David drew on his experience with the current project and the detailed investigations into potential environmental implications for the site, and the State, given the major use of energy and water involved. If the project proceeds, its projected cost of over $4 billion indicates it will be the largest individual project in the State's history, and will influence many other industrial developments in the State.

The growth in mining and defence industries in SA is encouraging because they are associated with growth in scientific, technical and engineering personnel, who are potential participants in professional development activities run by organisations such as Engineers Australia, I Mech E and CASANZ. Other traditional manufacturing industries have suffered greatly in past years, with associated reductions in opportunities for professional networking and sources of an audience, let alone new members. The Dust Management seminar/workshop held in October 2009 had very strong attendance, and is an indicator of how CASANZ can contribute successfully to professional development and networking in the environment protection field. The mix of current theory and practical experience is an obvious winner in terms of the format for technical programs, and will be followed in future events.

The program for 2010 is still under development, but currently includes a one day course in February on the essential basics of Air Pollution Management and a visit to the Adelaide Office of the Bureau of Meteorology in April. The February 26 course is an abbreviated, special focus version of the normal CASANZ Introduction to Air Pollution. In 2009 we began branch activities with a January barbecue and site inspection of the EPA Air Quality Laboratories, but at an ambient temperature of 43 degrees C as I write, I already feel barbecued, and any casual social/technical event can wait until autumn.

Tom Whitworth PSM
SA & NT Branch President

WA BRANCH

The last quarter of 2009 was full of WA Branch technical events, a full-on Annual General Meeting, Branch Committee meeting and a number of other activities. On 23rd October, 2009 WA Branch organised a very well-attended AGM at Aarons Hotel, Perth. It included presentation of the Clean Air Achievement Award and a technical presentation by the guest speaker, Mr Steve Waller, Director Office of Climate Change, Perth. Steve's presentation was on recent policy developments in the Climate Change area and various aspects of Climate Change science. This presentation was well received and there were lots of questions from those attending the event. Breakfast was served following the presentation.

At AGM Dr Ken Rayner was presented with 2009 Branch Achievement Award in recognition of his long standing contribution to air quality science in Western Australia. The award was presented by Robert Atkins, Deputy Director General, Western Australian Department of Environment and Conservation.

WA Branch Committee held its last quarterly meeting for 2009 in December and discussed ways for enhancement of public participation in CASANZ workshops/seminars and increasing our membership numbers to incorporate more professionals from regional Western Australia as well as tertiary institutions. These would contribute towards our goal of achieving clean air at all platforms. As a part of improving communication, it was agreed that the program for up-coming technical workshops/seminars will be made available publicly well before hand on the CASANZ website. Details until June 2010 should be available shortly on the CASANZ website

WA branch also received a request from