Climate Change Research Centre

UNSW THE UNIVERSITY OF NEW SOUTH WALES SYDNEY • AUSTRALIA

Dr. Jason Evans
Senior Research Fellow

Climate Change Research Centre

19 March 2009

Submission to the inquiry into the role of government in assisting Australian farmers to adapt to the impacts of climate change

Dr. Jason Evans[1], Dr. Matthew McCabe[2] and Prof. Andy Pitman[1]

[1]Climate Change Research Centre, University of New South Wales, Sydney, 2052
[2]Department of Civil and Environmental Engineering, University of New South Wales, Sydney, 2052

The Australian government plays a major role in promoting research into climate change impacts and assessment of adaptation strategies for Australian farmers. For this research to be effective, it needs to produce accurate projections of climate change at spatial scales of relevance to farmers, and include direct and indirect impacts on vegetation and crop production of increasing concentrations of atmospheric CO2. While changes in temperatures and precipitation are very important when investigating the climate change impacts on vegetation, they are not the only factors that may influence crop production. Many studies have shown that changes in the physical characteristics of the land surface can have an impact on the climate (e.g. N. Zeng & Neelin, 2000; Small & Kurc, 2003; Pitman et al., 2004; R.A. Pielke et al., 1998; Narisma & Pitman, 2003; Hayden, 1998; Dirmeyer & Shukla, 1996; Betts & Ball, 1996; McAlpine et al., 2007). These changes can arise directly from land use activities but may also result from responses of crops to seasonal, inter-annual or longer changes in the atmospheric state. That is, there is a feedback loop between the land and the atmosphere, with each impacting the other. Vegetation (crops, pasture etc) also responds directly to changes in CO_2 (e.g. Farquhar, 1996; Gifford, 1996; Grunzweig & Korner, 2000; Martin, 1993; Narisma et al., 2003) which can change the speed at which crops progress through the various growth stages as well as the total production. Irrigated crops often produce relatively strong coupling between the land and atmosphere and are impacted both by changes in runoff caused by climate change as well as changes in evaporative demand (e.g. Douglas et al., 2009; J.P. Evans & Zaitchik, 2008; Fowler & Helvey, 1974; Ter Maat et al., 2006; Zaitchik et al., 2005). Currently Australia does not have the capacity to produce climate change impact projections that account for these processes. Developing such a capability should be a priority for government backed research in the near future.

In order to achieve this goal an integrated approach to climate and crop modelling needs to be pursued. Such a system would also provide a tool for investigating the likely benefits of adopting different farm strategies such as changing crop types or irrigation techniques as methods for adapting to climate change. This modelling system would consist of

Climate Change Research Centre
Faculty of Science
University of New South Wales
Sydney, NSW, Australia, 2052
Tel: +61 2 9385 7066 Fax: +61 2 9385 7123
Email: jason.evans@unsw.edu.au

- A regional climate model with a fully coupled land – atmosphere system. This allows global climate model projections to be dynamically downscaled to spatial scales of relevance to farmers.
- An explicit carbon cycle that allows vegetation to respond directly to atmospheric CO_2.
- An embedded crop/pasture model that allows crop phenology to respond directly to, and feedback on, the changing climate.
- Incorporation of irrigation systems that represent various irrigation techniques such as flood, sprinkler and drip.

Development of the proposed coupled climate-crop modelling system is a critical scientific activity that would enable characterisation of the impacts of climate changes on Australia's agricultural productivity. The scientific and research challenges of such a project are significant. Achieving this goal would position Australia at the forefront of understanding and capacity to respond to the implications of climate changes on our agricultural sector. Ignoring the challenge on the other hand, will severely limit our capacity to adapt to climate changes, and risk the security and sustainability of future agricultural production.

Adding this capacity needs a research team, including meteorology, crop phenology, soil processes and computer modelling. There is no culture in Australian Universities, or within the groups that have launched the Australian Community Climate and Earth System Simulator, that bring together such capacity at research level, or in undergraduate teaching. Thus we are neither teaching or developing the research capacity to capture the impact of climate change on agriculture. More worryingly, we are not developing an understanding of the opportunities for agriculture to affect climate via reductions in emissions. We are therefore failing to explore all possibilities that agriculture offers to offset greenhouse gas emissions. If a research and undergraduate training capacity is to be developed, strategies to engage the University sector are essential.

Yours sincerely,

Dr. Jason Evans | Dr. Matthew McCabe | Prof. Andy Pitman

References

Betts, A.K., and J.H. Ball (1996), The land surface-atmosphere interaction: a review based on observational and global modeling perspectives, *Journal of Geographical Research*, 101(D3), 7209-7225.

Dirmeyer, P.A., and J. Shukla (1996), The effect on regional and global climate of expansion of the world's deserts, *Q. J. R. Meteorol. Soc.*, 122(530), 451-482.

Douglas, E.M., A. Beltrán-Przekurat, et al. (2009), The impact of agricultural intensification and irrigation on land-atmosphere interactions and Indian monsoon precipitation - A mesoscale modeling perspective, [online] Available from: http://www.scopus.com/scopus/inward/record.url?eid=2-s2.0-59249085954&partnerID=40 (Accessed 18 March 2009)

Climate Change Research Centre

Climate Change Research Centre
Faculty of Science
University of New South Wales
Sydney, NSW, Australia, 2052
Tel: +61 2 9385 7066 Fax: +61 2 9385 7123
Email: jason.evans@unsw.edu.au

Evans, J.P., and B.F. Zaitchik (2008), Modeling the large-scale water balance impact of different irrigation systems, *Water Resources Research*, 44(8). [online] Available from: http://www.scopus.com/scopus/inward/record.url?eid=2-s2.0-53849099999&partnerID=40 (Accessed 22 January 2009)

Farquhar, G. (1996), Effects of vegetation on climate and atmospheric CO_2 and climatic change - part 1, in *Australians and our changing climate. Past experiences and future destiny*, pp. 41-42, Canberra.

Fowler, W.B., and J.D. Helvey (1974), Effect of Large-Scale Irrigation on Climate in Columbia Basin, *Science*, 184(4133), 121-127.

Gifford, R. (1996), Effects of vegetation on climate and atmospheric CO_2 and climatic change - part 2, in *Australians and our changing climate. Past experiences and future destiny*, Canberra.

Grunzweig, J.M., and C. Korner (2000), Growth and reproductive responses to elevated CO_2 in wild cereals of the northern Negev of Israel, *Glob. Change Biol.*, 6(6), 631-638.

Hayden, B.P. (1998), Ecosystem feedbacks on climate at the landscape scale, *Philos. Trans. R. Soc. Lond. Ser. B-Biol. Sci.*, 353(1365), 5-18.

Martin, P. (1993), Vegetation responses and feedbacks to climate: a review of models and processes, *Climate Dynamics*, 8, 201-210.

McAlpine, C.A., J. Syktus, et al. (2007), Modeling the impact of historical land cover change on Australia's regional climate, *Geophysical Research Letters*, 34(22). [online] Available from: http://www.scopus.com/scopus/inward/record.url?eid=2-s2.0-38949086176&partnerID=40&rel=R8.0.0 (Accessed 10 July 2008)

Narisma, G.T., and A.J. Pitman (2003), The impact of 200 years of land cover change on the Australian near-surface climate, *J. Hydrometeorol.*, 4(2), 424-436.

Narisma, G.T., A.J. Pitman, et al. (2003), The role of biospheric feedbacks in the simulation of the impact of historical land cover change on the Australian January climate, *Geophys. Res. Lett.*, 30(22). [online] Available from: ://000186939700003

Pielke, R.A., R. Avissar, et al. (1998), Interactions between the atmosphere and terrestrial ecosystems: influence on weather and climate, *Glob. Change Biol.*, 4(5), 461-475.

Pitman, A.J., G.T. Narisma, et al. (2004), Impact of land cover change on the climate of southwest Western Australia, *J. Geophys. Res.-Atmos.*, 109(D18). [online] Available from: ://000224126500001

Small, E.E., and S.A. Kurc (2003), Tight coupling between soil moisture and the surface radiation budget in semiarid environments: Implications for land-atmosphere interactions, *Water Resour. Res.*, 39(10). [online] Available from: U:\notes\others papers\small&kurc2003.pdf

Ter Maat, H.W., R.W.A. Hutjes, et al. (2006), Meteorological impact assessment of possible large scale irrigation in Southwest Saudi Arabia, *Glob. Planet. Change*, 54(1-2), 183-201.

Zaitchik, B.F., J. Evans, et al. (2005), MODIS-derived boundary conditions for a mesoscale climate model: Application to irrigated agriculture in the euphrates basin, *Mon. Weather Rev.*, 133(6), 1727-1743.

Zeng, N., and J.D. Neelin (2000), The role of vegetation-climate interaction and interannual variability in shaping the African savanna, *J. Clim.*, 13(15), 2665-2670.

Climate Change Research Centre

Climate Change Research Centre
Faculty of Science
University of New South Wales
Sydney, NSW, Australia, 2052
Tel: +61 2 9385 7066 Fax: +61 2 9385 7123
Email: jason.evans@unsw.edu.au