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Introduction

Pabai & Anor v Commonwealth of Australia (VID622/2021) (Proceedings)

Federal Court of Australia Expert Report prepared for the Australian Government Solicitor.

I have read, understood and complied with the Expert Evidence Practice Note (**GPN-EXPT**) of the Federal Court of Australia, including the Harmonised Expert Witness Code of Conduct at Annexure A to that Practice Note, and agree to be bound by those documents.

Those documents were provided to me on 21 August 2023.

Professor Andrew Pitman, AO, FAA (climate scientist), 8 October 2023

Expert Report by Professor Andrew Pitman
The University of New South Wales

Instructions and Purpose of Report

On 21st August 2023, I received a Provisional Engagement Letter from the Australian Government Solicitor on behalf of the Commonwealth in the Proceedings between Pabai & Anor v Commonwealth of Australia (VID622/2021). As part of this provisional engagement, I was asked to review the following documents:

- Applicants' Second Further Amended Statement of Claim dated 11 April 2023 (**SFASOC**).
- Respondent's Defence to the SFASOC dated 9 May 2023.
- Applicants' Amended Concise Statement dated 15 May 2023.
- Respondent's Amended Concise Statement in Response dated 29 May 2023.

Subsequently, I received an Engagement Letter dated 1st September 2023 requesting that I review the above documents and also:

- Expert report by Professor David Karoly
- Expert report by Professor Malte Meinshausen

On 25th September 2023, I received an Instruction Letter which asked me to prepare an expert report for the purpose of the above Proceedings that answers the following questions:

1. Please explain the process of modelling the effects of increasing GHG emissions on the impacts of climate change at a regional level and in particular in the Torres Strait, including explaining any difficulties in that process.

2. If Australia had in 2014 implemented a GHG emissions reductions target of 47% reduction over 2005 levels by 2025, and assuming Australia had a straight line path to 47% reduction by 2025, what effect, if any, would the reduction in Australia's total GHG emissions from 2014 to date have had on the impacts of climate change in the Torres Strait?

3. If Australia had in 2014 implemented a GHG emissions reductions target of net zero by 2024, and assuming Australia complied with that target on a straight line path to net zero by 2024, what effect, if any, would the reduction in Australia's total GHG emissions from 2014 to date have had on the impacts of climate change in the Torres Strait?

On 6 October 2023, I received a Supplementary Letter enclosing a report from Josep Canadell of the same date (**Canadell Report**), asking that I review the report and, to the extent necessary, rely on any data or conclusions reached therein to prepare my report.

The above letters are at **Annexure A** to this report.

The opinions set out in this report are based wholly or substantially on my specialised knowledge arising from 35 years of relevant research experience including relevant roles in the Intergovernmental Panel on Climate Change (**IPCC**).

I have made all the inquiries that are desirable and appropriate (save for any matters identified explicitly in the report), and no matters of significance I regard as relevant have, to my knowledge, been withheld from the Court.

Basis of expertise

Question 1. Please describe your academic qualifications, professional background and experience that is relevant to your answering the questions in the letter of instruction. You may wish to do so by reference to a current curriculum vitae.

1. I am a climate scientist with 35 years of experience in areas of global and regional climate modelling, climate projections, understanding of extremes, model evaluation and terrestrial processes. I have over 200 peer-reviewed publications in the scientific literature. I was a lead author on chapters in two reports by the IPCC and a Review Editor of a chapter in the 6th Assessment Report. I shared the Nobel Peace Prize in 2007 for work by the IPCC. I am a Fellow of the Australian Academy of Science, a Fellow of the American Meteorological Society and a Fellow of the Australian Meteorological and Oceanographic Society. I was the Director of the ARC Centre of Excellence for Climate System Science, and I am currently Director of the ARC Centre of Excellence for Climate Extremes. My CV is at **Annexure B** to this report.

Modelling the regional impacts of climate change

Question 2. Please explain the process of modelling the effects of increasing GHG emissions on the impacts of climate change at a regional level and in particular in the Torres Strait, including explaining any difficulties in that process.

2. Simulations of climate change over the past, present and future rely on mathematical models that bring together our understanding of the physics of the Earth's climate. These models use a latitude-longitude grid across the globe, and multiple layers through the ocean, land and atmosphere to create a three-dimensional grid[1]. These models are known as Global Climate Models. The IPCC provides a list of current Global Climate Models[2] and in the most recent report by the IPCC, 64 different Global Climate Models are listed. These include multiple models from multiple institutions. There is no agreed means to determine which is the best climate model; even properly evaluating these models for specific needs is very complex[3]. The IPCC typically use all the available models in their assessment process.

3. A large number of equations are used to describe the physics of the Earth's climate in global climate models; these calculate many variables for a point in time, and then update those variables for the next point in time, and this continues through time to achieve a simulation that might start in 1850 and end in 2100. A typical model of the Earth's climate might include 1 million lines of computer code, and utilize nationally significant supercomputer systems such as the National Computational Infrastructure Facility[4].

4. The process of solving these equations is computationally very expensive and to limit the computational cost to a reasonable level the size of each latitude-longitude grid point is necessarily coarse – currently around 80km x 80km to around 250km x 250km[5]. That is, equations are solved to provide a single surface temperature, a single amount of convective rainfall and so on for each unit of time (commonly 30 minutes) for each pixel of 80km x 80km to 250km x 250km, and then the equations are updated for the next 30 minutes and so on until simulations are complete. For climate projections, simulations usually start from around 1850 and run through to 2100 although some simulations further into the future can be undertaken.

5. Global Climate Models are designed to simulate the global climate. The IPCC's recent assessment of these models[6] states:

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[1] Many basic texts on climate modelling exist that summarise the basic formulation of these models. For example, Neelin, J.D., 2012, Climate Change and Climate Modelling, Cambridge University Press.
[2] https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_AnnexII.pdf, Table AII.5.
[3] https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf
[4] https://nci.org.au
[5] see https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_AnnexII.pdf Table AII.5.
[6] https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf

a. there is very high confidence that they "reproduce the general features of the global-scale annual mean surface temperature[7] increase over the historical period",

b. "large-scale patterns of precipitation has improved … although models continue to perform less well for precipitation than for surface temperature".

There is a vast scientific literature on Global Climate Models including an evaluation of simulations of averages, variability, extremes and so on including formal assessments in the 4th, 5th and 6th reports by the IPCC (see footnotes [8,9,10]). Global Climate Models have demonstrably improved over time[11] and now provide robust and reliable tools for the simulation of the large-scale climate. However, the use of spatial resolutions of 80 x 80 km to 250 x 250km necessarily leads to limitations in how they can capture climate change on spatial scales below large regions. These limitations are well-recognised by climate science and have led to the development of methods to create higher resolution information (see below).

6. A single value for each meteorological and hydrological variable at a spatial scale of 80km x 80km to 250km x 250km is not typically very useful in assessing the impacts of climate change, or for identifying strategies to adapt to climate change at regional scales. Far higher spatial detail is typically required to determine where investment in adaptation might reduce risk. For example, the city of Sydney has a spatial extent of approximately 100 x 100 km so a Global Climate Model with pixels of around that size would produce a single value of temperature change over the whole city. In reality, suburbs close to the ocean are likely to be much less impacted by high temperatures than western suburbs due to the moderating effect of the ocean. Further, within the city, risk associated with fire varies considerably with the nature of the vegetation. In short, a single value of temperature, fire risk, flood risk etc reflecting conditions across the whole of Sydney does not provide useful guidance for adapting to climate change.

7. In addition, most extreme events that might threaten a community are not captured at a spatial resolution of 80km x 80km or over as skilfully as average events. One cannot capture how a tropical cyclone, for example, intensifies using such a resolution because the structure of a tropical cyclone (the eye, the eye wall, the speed of rotation and so on) all occur on spatial scales far below that resolution. That said, conditions conducive to tropical cyclone formation such as large-scale patterns of warm ocean temperatures, or other phenomenon of note can be simulated, and the frequency of tropical cyclones does appear to be reasonably well captured in some Global Climate Models[12].

8. The challenges associated with coarse spatial detail from Global Climate Models are well known and to resolve the spatial resolution challenge two basic modelling approaches have been developed to overcome this spatial resolution problem: Regional Climate Models and "Stretched grid" or "variable resolution" global climate models[13]. Results from both types of approach are integrated into the two most recent IPCC reports[14,15].

9. The IPCC notes[16], in the context of dynamical downscaling, that:

> Regional downscaling methods are used to provide climate information at the smaller scales needed for many climate impact studies, and there is high confidence that downscaling adds value both in regions with highly variable topography and for various

[7] Note "surface temperature" refers here to the "surface air temperature" – that is the temperature of the air 2 metres above the surface.
[8] https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg1-chapter8-1.pdf
[9] https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf
[10] https://report.ipcc.ch/ar6/wg1/IPCC_AR6_WGI_FullReport.pdf, specifically Chapters 1,3,9,10,11.
[11] For example, https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf
[12] https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf
[13] https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf
[14] https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf
[15] https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_AnnexII.pdf
[16] https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf

small-scale phenomena. Regional models necessarily inherit biases from the global models used to provide boundary conditions. Furthermore, the ability to systematically evaluate regional climate models, and statistical downscaling schemes, is hampered because coordinated intercomparison studies are still emerging. However, several studies have demonstrated that added value arises from higher resolution of stationary features like topography and coastlines, and from improved representation of small-scale processes like convective precipitation.

10. Dynamical downscaling uses mathematical models that are similar to the Global Climate Models, except they only attempt to simulate one region. There are many examples of these Regional Climate Models. An international program called the Coordinated Regional Climate Downscaling Experiment (**CORDEX**) which is part of the World Climate Research Program, provides a list of Regional Climate Models used in various simulations[17] and a further list is provided by the IPCC[18].

11. Since they only simulate one region, Regional Climate Models can use far higher spatial detail in comparison to Global Climate Models. It is common to use spatial resolutions of 10 x 10 km to 50 x 50 km. A list of spatial resolutions used in CORDEX, as part of the latest IPCC report is available[19]. At 10 x 10 km resolution, a regional climate model can generally be expected to simulate the behaviour of extreme storms, tropical cyclones, processes that lead to extreme heat waves and so on. However, to determine if a Regional Climate Model captures the conditions in a specific region requires an analysis for a specific model for the specific region as downscaling skill varies with location, season, and boundary conditions[20]. The fact that a Regional Climate Model can be shown to perform well over a region of the United States, or Europe, or Victoria does not mean it will necessarily perform well over a different region of the Earth.

12. A Regional Climate Model cannot be used to simulate a region (e.g. the Torres Strait) without providing the Regional Climate Model with the conditions outside that region because the climate within any region is substantially affected by how the large-scale (hemispheric) state of the atmosphere and ocean responds to changes in greenhouse gas concentrations. At the edge of a region of interest, defined by a rectangular box, information must be provided and these are known as boundary conditions. A regional climate model is provided with boundary conditions including wind, temperature, pressure and humidity at the boundaries of any region. One such region, used by the CORDEX project, representing Australasia, contains the Torres Strait[21]. For all regions modelled using Regional Climate Models, boundary condition data is typically provided every 6 hours, for the length of the simulation.

13. For projecting the future climate of a region including the Torres Strait using a Regional Climate Model, the only source for the boundary condition data for the climate of the future are Global Climate Models that have been previously run to create these boundary conditions.

14. An alternative method to dynamical downscaling using Regional Climate Models exists, and has been used by the Queensland government, using a “stretched grid” or “variable resolution” approach developed by several groups around the world including CSIRO[22]. This simulates the whole globe, like a Global Climate Model, but with a spatial grid that is very high resolution (e.g. 10 x 10 km) centred on a region of choice, with gradually coarser spatial resolution as you move away from this region of choice such that the opposite side of the Earth is resolved at very coarse resolutions (e.g. several hundred kilometres). This method does not require the boundary conditions used by Regional Climate Models (temperature, humidity, winds from near the surface to the top of the atmosphere), but remains dependent on the Global Climate Models for projections of sea surface temperatures and for information on the atmosphere via an approach called

[17] http://is-enes-data.github.io/CORDEX_RCMs_ToU.txt
[18] https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_AnnexII.pdf
[19] https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_AnnexII.pdf, see Table AII.1.
[20] https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf
[21] https://cordex.org/domains/region-9-australasia/
[22] This is the Conformal Cubic Atmosphere Model developed by CSIRO – see https://www.csiro.au/en/research/environmental-impacts/climate-change/ccam

nudging[23]. This means that the benefits from the high spatial resolution are partly offset by the use of coarse sea surface temperature patterns. The implications of this for projections of future climate in the Torres Strait, where geographically small individual islands are surrounded by oceans would need to be explicitly examined and I am not aware of any studies of this kind. However, any errors in the sea surface temperatures simulated by the Global Climate Models are likely to very strongly influence the projections of future conditions on the Torres Strait islands because the conditions on small islands tends to be dominated by the nature of the surrounding ocean.

15. The scientific community has a diversity of views on the value of dynamical downscaling. Some strongly support the use of Regional Climate Models using boundary conditions from Global Climate Models arguing the higher spatial resolution adds considerable value[24] and the IPCC note that[25] "several studies have demonstrated that added value arises from higher resolution of stationary features like topography and coastlines, and from improved representation of small-scale processes like convective precipitation". Some in the scientific community strongly disagree with the approach arguing that the global climate models have systematic biases that affect the Regional Climate Model – and the IPCC note that "regional models necessarily inherit biases from the global models used to provide boundary conditions" for example[26]. To determine which of these views holds for the Torres Strait region cannot be assessed without a systematic model evaluation study which has not been undertaken using up-to-date models so far as I can ascertain (see Paragraph 20).

16. Dynamical downscaling using regional models is computationally and logistically challenging. The models used are complex computer codes that typically require extensive programs of model evaluation, choices over specific components to be used, long periods of computer simulation and management of petascale[27] data. Exemplar projects exist in Australia including the NARCLiM[28] project by the NSW government. A second exemplar project was undertaken by the Queensland government using the stretched grid (variable resolution) approach[29]. The region modelled at high spatial resolution by the NSW government initiatives do not extend to the Torres Strait. The Queensland government's initiative does extend across the Torres Strait by using one modelling method (the Conformal Cubic Atmospheric Model, a stretched grid modelling approach) using sea surface temperatures and some atmospheric information sourced from 11 Global Climate Models[30]. The Australasia region of the CORDEX project, which includes multiple Regional Climate Models, includes the Torres Strait area. I am not aware of any published analysis of these data for the Torres Strait Islands.

17. Rather than detailed examination of the Torres Strait islands using information from either Regional Climate Models using boundary conditions sourced from Global Climate Models, or the use of the stretched grid approach, the Torres Strait sub-regions are combined into larger regions and broad statements of how climate will change are made. For example, the Climate Change in Australia product combines the wet tropics, including the Torres Strait, into one region[31]. Similarly, the Queensland government's product is aggregated into bio-regions, or local government areas, or several other aggregation choices[32]. This aggregation of information from individual Regional

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[23] See https://confluence.csiro.au/display/CCAM/Scientific+description

[24] See for example Di Luca, A., de Elía, R. & Laprise, R. Challenges in the Quest for Added Value of Regional Climate Dynamical Downscaling. Curr Clim Change Rep 1, 10–21 (2015). https://doi.org/10.1007/s40641-015-0003-9

[25] https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf

[26] https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf

[27] Petascale (which can be petaflops for the speed of a computer, or petabytes for the storage of data) is one thousand million million (10^{15}) flops or bytes.

[28] https://www.climatechange.environment.nsw.gov.au/climate-projections-used-adaptnsw

[29] Details are available at: https://www.longpaddock.qld.gov.au/qld-future-climate/understand-data/ based on peer reviewed papers including Hoffmann et al., Bias and variance correction of sea surface temperatures used for dynamical downscaling, https://doi.org/10.1002/2016JD025383.

[30] The 11 models are listed here: https://www.longpaddock.qld.gov.au/qld-future-climate/understand-data/

[31] https://www.climatechangeinaustralia.gov.au/en/projections-tools/regional-climate-change-explorer/super-clusters/?current=NSC&tooltip=true&popup=true

[32] https://www.longpaddock.qld.gov.au/qld-future-climate/dashboard/

Climate Model grid points up to the scale of a region followed by general statements made about the impacts of climate change[33] is common practice. These general statements, for the wet tropics, include coastal Queensland, regions of high topography, islands and so forth, as distinct from information focussed on just one of these areas. Consequently, the information provided provides a high-level and general picture of future climate across the wet tropics, as distinct from information that can be interpreted for any specific location within the wet tropics.

18. The nature of regional downscaling and the costs involved limit the reliability of these methods in calculating extreme events that might occur once every 50 or 100 years. This is because to calculate how these events might change under higher atmospheric carbon dioxide concentrations requires a reasonably large number of simulations to be undertaken – this is normally too computationally expensive to conduct. The number of simulations required depends on the region, and the problem being examined. For example, Risbey showed thousands of years of simulation were required to capture the conditions favourable for an extreme heat event in the Pacific northwest[34]. More commonly, tens to hundreds of simulations are ideal, but are not normally able to be undertaken due to computational constraints.

19. It is noteworthy that even with the use of broad regions, such as the wet tropics, care needs to be taken in interpreting dynamical downscaling with regional climate models or variable resolution models. While dynamical downscaling is a commonly employed tool used by the IPCC for obtaining more spatially detailed climate projections, its utility is particularly recognised in areas of highly variable topography or special cases such as downscaling over urban areas[35]. I have not been able to find any information on the additional capability downscaling might offer at the scale of the islands in the Torres Strait, but note that downscaling is recognised as necessary to provide this information[36]. However, all models attempt to simplify the distribution of land and sea geography. Specifically, Global Climate Models would not represent small islands. Where a Global Climate Model's grid is 80 x 80 km, for a pixel to be defined as "land" requires a sizeable fraction of the total area to be land. Most of the Torres Strait islands are of order 10 x 10 km and as such would occupy too small a fraction of a pixel for that pixel to be designated "land". In the Regional Climate Models, it is possible that some of the Torres Strait islands are represented by land, and I have attempted to determine whether the islands in the Torres Strait are ocean points or land points in the models but I have not been able to find the "land mask" files that form part of the ancillary input data for the models. Whether Regional Climate Models assign the location of an island in the Torres Strait as land or ocean has a material impact on the reliability of model projections over those locations.

20. The IPCC assesses the impacts of climate change on small islands[37], but none of these islands are in the Torres Strait. The only systematic study of the impact of climate change over the Torres Strait I am aware of was undertaken in 2010 by Suppiah et al.[38] Suppiah used data from the 3rd phase of the Coupled Model Intercomparison Project (CMIP-3) which was undertaken in 2007. CMIP is an internationally coordinated suite of climate simulations under the guidance of the World Climate Research Program and provides the model simulations that are subsequently used by the IPCC[39]. CMIP-3 has been superseded by the 5th phase (CMIP-5) in around 2012 and the 6th phase (CMIP-6) in around 2016 (there was no 4th phase). The CMIP-3 data analysed were at monthly temporal resolution from global climate models which then used spatial resolutions coarser than present models (e.g. mostly 200 x 200 km, to 400 x 400 km, although some CMIP-3 models used spatial

[33] E.g. https://www.climatechangeinaustralia.gov.au/en/projections-tools/regional-climate-change-explorer/super-clusters/?current=NSC&tooltip=true&popup=true

[34] Risbey et al., 2023, A large ensemble illustration of how record-shattering heat records can endure, Environ. Res.: Climate 2, 035003, DOI 10.1088/2752-5295/acd714

[35] Di Luca, A., de Elía, R. & Laprise, R. Challenges in the Quest for Added Value of Regional Climate Dynamical Downscaling. Curr Clim Change Rep 1, 10–21 (2015). https://doi.org/10.1007/s40641-015-0003-9

[36] https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-15/

[37] https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-15/

[38] Suppiah, R., et al, 2010, *Observed and Future Climates of the Torres Strait Region,* Report prepared for the Torres Strait Regional Authority, CSIRO Marine and Atmospheric Research, p. 60.

[39] https://www.wcrp-climate.org/wgcm-cmip

resolutions of around 100 x 100 km – a table providing details is available[40]). In my view, this study by Suppiah is now too out of date to provide useful information for any variables, and models now 15 years old would not represent processes, and in particular extremes, with useful skill.

Counterfactuals

Question 3. Meinshausen Report [69(a)]

If Australia had in 2014 implemented a GHG emissions reductions target of 47% reduction over 2005 levels by 2025, and assuming Australia had a straight line path to 47% reduction by 2025, what effect, if any, would the reduction in Australia's total GHG emissions from 2014 to date have had on the impacts of climate change in the Torres Strait?

21. CO_2, the most important human-emitted greenhouse gas[41], is a well-mixed greenhouse gas whereby emissions from any source becomes distributed globally. It is the most important greenhouse gas emitted by human activity due to its high warming potential and because it is long-lived in the atmosphere. Emissions of CO_2 from Australia do not remain over Australia, rather they become spread out over the entire globe. Increases in CO_2 over Australia therefore reflect, in part, Australian emissions, but also emissions from all over the Earth.

22. An increase in greenhouse gases in the atmosphere adds to the amount of energy available to our climate. Technically, increases in greenhouse gases add to the "radiative forcing" of climate measured in Watts per square metre. Radiative forcing is a common term in climate science and is defined[42] by the IPCC, but is most simply the net change in the energy balance of the Earth system due to some imposed perturbation (e.g. an increase in greenhouse gas concentrations). There is no doubt that the addition of greenhouse gases has added an important amount of energy to the Earth's climate.

23. Human activities, including the burning of fossil fuels and land cover change have added approximately 2.72 Watts per square metre of energy to the climate for the period 1750 to 2019[43]. This is, in total, a very large increase that has led to global average warming of about 1.1°C (the amount of warming measured over 2010-2019 relative to 1850—1900)[44].

24. However, while the accumulated impact of emissions of greenhouse gases since the Industrial Revolution are very large, the increase in radiative forcing averaged over the period 1750-2019 is only about 0.01 Watts per square metre per year – this is from all emissions aggregated globally (this is calculated simply as 2.72 divided by the number of years between 1750 and 2019 = 0.01).

25. The gradual increase in radiative forcing between 1750 and 2019 has been caused by increases in greenhouse gases[45]. This has led to long-term trends (trends averaged over 30 years and longer) in the frequency, magnitude and intensity of heatwaves and the intensity of rainfall[46].

26. At the same time as increases in greenhouse gases in the atmosphere are causing climate change, our climate varies naturally. Well known drivers of variability[47] include the El Nino-Southern

[40] https://archive.ipcc.ch/publications_and_data/ar4/wg1/en/ch8s8-2.html
[41] https://www.epa.gov/report-environment/greenhouse-gases#:~:text=Carbon%20dioxide%20is%20widely%20reported,warming%20associated%20with%20human%20activities.
[42] https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf
[43] Figure 7.6 of the 6th Assessment report by the IPCC
[44] Figure SMP2, at https://www.ipcc.ch/report/ar6/wg1/chapter/summary-for-policymakers/
[45] https://www.ipcc.ch/report/ar6/wg1/downloads/faqs/IPCC_AR6_WGI_FAQ_Chapter_03.pdf
[46] https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf
[47] https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_AnnexIV.pdf

Oscillation, the Southern Annual Mode, and the Indian Ocean Dipole[48]. These causes of natural variability lead to large variations in regional temperature and rainfall[49], and can influence the occurrence of major extreme events including heatwaves and the number of tropical cyclones that occur each year. For example, with a natural switch from an El Nino to a La Nina, summer temperatures can vary across the Torres Strait by several tenths of a degree, and rainfall can vary by 0.5 mm per day[50].

27. Year to year variability in temperature and rainfall, and even variability on timescales of 10-20 years are dominated by natural variability as explained in FAQ 3.2 by the IPCC[51]. Crucially, large variations in regional climate including variations in temperature, rainfall and the occurrence of other phenomenon (e.g. tropical cyclones[52]) occur naturally on a year-to-year or decade-to-decade timescale.

28. To separate changes associated with year-to-year or decade-to-decade variability from changes associated with GHG emissions requires long periods of observations, and/or long simulations with Global Climate Models or Regional Climate Models. The observational record at Horn Island, which is an Australian Bureau of Meteorology measurement site[53], is insufficient to fully characterise the impact of natural variability (for example, a 30-year climatology is not available at this site due to missing data). The Australian Bureau of Meteorology notes in relation to its climate statistics generally[54]:

    For all elements, climate statistics have been derived only when there is at least 10 years of data available. Because of the annual variability in rainfall, a period of less than 30 years of rainfall data may not produce reliable statistics and such information should be used with caution. As a comparison, some 5-10 years of temperature data will provide a reasonable estimate of the mean, although probably not of the extremes.

    It is therefore challenging to characterise the climate of Horn Island, the only observational site in the Torres Strait that forms part of the Australian Bureau of Meteorology's climate change site network[55].

29. Canadell, in the Canadell Report, calculates that had Australia in 2014 implemented a GHG emissions reduction target of 47% reduction over 2005 levels by 2025, and assuming Australia had a straight line path to 47% reduction by 2025, the total reduction in emissions would have been 307.63 $MtCO_2e$ which he estimates would have led to avoided warming in the global mean surface air temperature of 0.00009°C (range: 0.00005°C to 0.00013°C).

30. I note that avoided warming of 0.00009°C, had this been avoided in the Torres Strait, could not be demonstrated, or measured – the accuracy of temperature measurements are typically a few tenths of a degree[56]. In short, it is not possible to demonstrate that the avoided emissions would have had a measurable impact on the Torres Strait, and any impact is dwarfed by natural variability such that any link between avoided temperature rises and the avoided emissions could not be made with

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[48] See for example details at http://www.bom.gov.au/climate/about/australian-climate-influences.shtml?bookmark=sam. A very substantial science literature exists on the influence of these modes of variability on Australian rainfall, temperature, other extremes etc.

[49] https://www.sciencedirect.com/science/article/pii/S2589004222001250

[50] https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_AnnexIV.pdf

[51] https://www.ipcc.ch/report/ar6/wg1/downloads/faqs/IPCC_AR6_WGI_FAQ_Chapter_03.pdf

[52] https://link.springer.com/chapter/10.1007/978-3-030-32878-8_6

[53] https://reg.bom.gov.au/climate/change/hqsites/, site 027058 located at Latitude: 10.58 °S, Longitude: 142.29 °E commenced in 1995, see http://www.bom.gov.au/climate/averages/tables/cw_027058.shtml

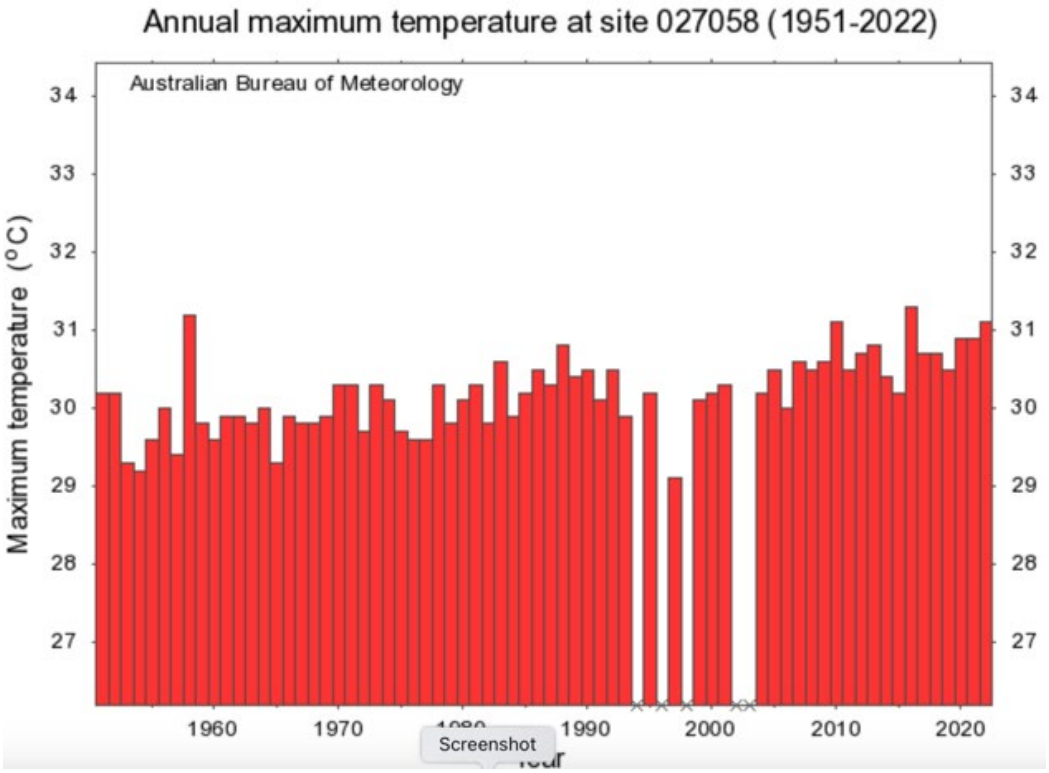
[54] http://www.bom.gov.au/climate/cdo/about/about-stats.shtml

[55] https://reg.bom.gov.au/climate/change/hqsites/

[56] I have found it hard to identify robust sources for how accurate temperature measurements of the type taken on Horn Island are likely to be. However, https://web.stanford.edu/group/csp/cs21/calibration.html suggests calibration of instruments to an accuracy of 0.01°C is possible. The degree to which this accuracy is realised on Horn Island, or by the Australian Bureau of Meteorology in general would require further investigation. However, for the purposes of this report, there is no suggestion that measurement accuracy approaches 0.00009°C.

scientific rigor. It is certainly impossible to characterise this site, or indeed any site, with sufficient precision to identify a difference in temperature of 0.00009°C (or 0.00005°C to 0.00013°C).

31. There is no direct way to associate avoided warming in the global mean surface air temperature of 0.00009°C (or 0.00005°C to 0.00013°C) with the amount of warming avoided over the Torres Strait. However, the chart below shows data from the Australian Bureau of Meteorology[57] for Horn Island. It is apparent that the annual maximum temperature can vary in sequential years by up to around 1°C, and an apparent cooling trend, caused by natural variability, can occur over 5 years of about 1°C (e.g. 1988-1993). Clearly, the natural variability on timescales of 1 to 5 years at Horn Island dwarfs the calculated warming avoided of 0.00009°C (range: 0.00005°C to 0.00013°C).



32. In the absence of very long (century scale) observations, an alternative approach to separating natural variability from changes associated with increases in greenhouse gases is to use global or regional climate models.

33. The figure below[58] highlights the impact of increases in radiative forcing, due to increases in GHG concentrations in the atmosphere, relative to uncertainty (sourced both from model internal variability and uncertainty in the models). Multiple Global Climate Models are included in this figure to create an "ensemble range" which is an estimate of the uncertainty in how the Earth's climate will respond to increases in GHGs.

34. In panel (a) the large area of red represents the future under a relatively high emissions future (SSP3-7.0), and specifically a 7 Watts per square metre increase in radiative forcing by the end of the century. This increase in radiative forcing is associated with a global temperature rise shown on the right hand side of the panel of approximately 3°C by the end of this century.

35. In panel (a) the grey represents the future under a relatively low emissions future (SSP1-2.6), and specifically a 2.6 Watts per square metre increase in radiative forcing by the end of the century. This

[57] http://www.bom.gov.au/cgi-bin/climate/hqsites/site_data.cgi?variable=maxT&area=aus&station=027058&dtype=raw&period=annual&ave_yr=5
[58] Edited from Figure TS8, https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_TS.pdf

increase in radiative forcing is associated with a global temperature rise shown on the right had side of the panel of approximately 1°C by the end of this century.

36. Panel (a) shows that as the concentration of GHGs increases from 2000 to 2100, the global mean temperature increases under both SSP3-7.0 and SSP1-2.6. However, the uncertainty shown by the width of the pink shading for SSP3-7.0 and the width of the grey shading for SSP1-2.6 overlap from 2000 through to around 2060.

37. This overlap exists through to around 2060, and is very significant through to around 2040. This means that climate models struggle to separate the impact of approximately a 6 Watts per square metre increase by 2060 (SSP3-7.0) from a 4 Watts per square metre increase by 2060 (SSP1-2.6).[59] This overlap means uncertainty associated with modelling, combined with natural variability represented in the Global Climate Models, cannot be separated from the impact of the increase in GHGs.

38. Clearly, if climate models cannot clearly separate the impact of 2 Watts per square metre differences in radiative forcing, from natural variability, they cannot separate a difference in the consequences of increases of greenhouse gases, associated with global emissions, on radiative forcing on a 10 or 20 year timescale (approximately a 0.1 – 0.2 increase in Watts per square metre).

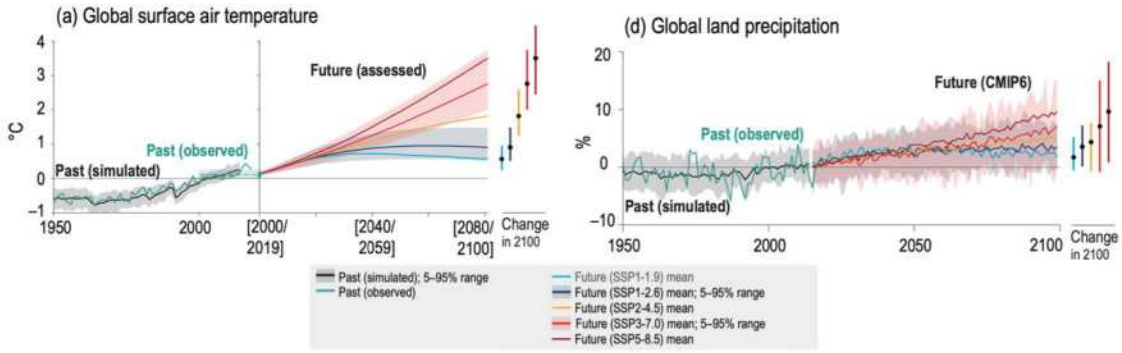
39. Note that this 0.1 – 0.2 increase in Watts per square metre is the increase in radiative forcing associated with global emissions of GHGs, as distinct from emissions by Australia.

40. Panel (d) shows results for global mean rainfall change. Here, the variability in rainfall is much greater than the variability in temperature and the pink shading and the grey shading overlap to the end of the century. This means that identifying a trend in rainfall, or a change in rainfall, or the role of increasing CO_2 on rainfall is much harder than for temperature.

41. Given global and regional climate models cannot separate the impact of a difference of 2 Watts per square metre, and given the increase in radiative forcing over 10-20 years is 0.1 – 0.2 Watts per square meter, and given Australia's emissions contribute approximately 1% to 1.4% to the global total[60,61], and therefore approximately 1% to 1.4% to the change in radiative forcing, it is therefore not possible, using global or regional climate models, to demonstrate any impact on the Torres Strait that might have been achieved via a reduction in globally-averaged radiative forcing had Australia in 2014 implemented a GHG emissions reductions target of 47% reduction over 2005 levels by 2025, and assuming Australia had a straight line path to 47% reduction by 2025.

42. The annual increase in radiative forcing has to be aggregated over many decades (typically 20-30 years) in order to identify the impact of increases in GHG concentrations on temperature-related variables, and likely longer for rainfall related variables. Systems that occur less frequently (e.g. droughts, cyclones, rare and extreme events) require longer timeseries of observations before clear statements linking these events to increases in atmospheric greenhouse gases can be made.

[59] See https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_TS.pdf Figure TS.4.
[60] https://www.csiro.au/en/research/environmental-impacts/climate-change/climate-change-qa/sources-of-co2
[61] https://climateanalytics.org/media/australia_carbon_footprint_report_july2019.pdf



Meinshausen Report [69(b)]

Question 4. If Australia had in 2014 implemented a GHG emissions reductions target of net zero by 2024, and assuming Australia complied with that target on a straight line path to net zero by 2024, what effect, if any, would the reduction in Australia's total GHG emissions from 2014 to date have had on the impacts of climate change in the Torres Strait?

43. Canadell, in the Canadell Report, calculates if Australia had in 2014 implemented a GHG emissions reductions target of net zero by 2024, and assuming Australia had a straight line path to net zero by 2024, the impact on GHG emissions would have been 1440.91 $MtCO_2e$. Canadell further notes that this would have led to an avoided global mean surface air temperature of 0.00045°C (range 0.00027°C to 0.00063°C).

44. The logic explained in paragraphs 21-42 applies here. It is not possible to link or demonstrate this change in GHG emissions and any avoided increase in global mean temperature to any change in temperature, rainfall or other phenomenon over the Torres Strait. The amounts of avoided emissions are simply too small to demonstrate any link between these emissions and any climate impact.

45. I am not aware of any published literature that identifies what the smallest change in the global mean surface air temperature, resulting from avoided GHG emissions, that could be demonstrated to be caused by the avoided emissions would be. Canadell's calculation of avoided increases in global mean surface air temperature of 0.00045°C (range 0.00027°C to 0.00063°C) is well below a value that could be linked to a change in any climate variable over the Torres Strait. A value of 0.01°C and very probably 0.1°C would be equally impossible to link to a change in any climate variable over the Torres Strait. This indicates that if Canadell's calculations were incorrect by a factor of 100 and very probably a factor of 1000, my assessment in Paragraph 44 would remain the same.

[redacted]
Redactions for public file

Professor A.J Pitman

Director of the ARC Centre of Excellence for Climate Extremes,

The University of New South Wales, Sydney, NSW, 2052.

8 October 2023

ANNEXURE A

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Our ref. 21008585

21 August 2023

Professor Andy Pitman
Director, ARC Centre of Excellence for Climate Extremes

By email: Redactions for public file

PRIVILEGED & CONFIDENTIAL

Dear Professor Pitman

Pabai & Anor v Commonwealth of Australia (VID622/2021) | Provisional engagement letter

PROVISIONAL ENGAGEMENT

1. We confirm we act for the Commonwealth of Australia (the **Commonwealth**) in the above class action before the Federal Court of Australia.

2. The applicants (Pabai Pabai and others) commenced this class action on 26 October 2021 on their own behalf and on behalf of all persons who at any time during the period from about 1985 and continuing, are of Torres Strait Islander descent and suffered loss and damage as a result of the alleged acts and omissions of the Commonwealth (**Group Members**).

3. The proceeding relates to the impacts of climate change in the Torres Strait. In summary, the applicants allege that the Commonwealth:

    a) owes a legal duty to Torres Strait Islanders to take reasonable steps to protect Torres Strait Islanders, their traditional way of life and the marine environment in and around the Torres Strait from the current and projected impacts of climate change, and breached that duty by (amongst other things) failing to identify a GHG emissions reduction target consistent with the 'best available science'; or

    b) further or alternatively, owes a legal duty to Torres Strait Islanders to take reasonable steps to avoid causing property damage, loss of fulfilment of *Ailan Kastom* and other damage arising from a failure to implement or adequately implement adaptation measures to prevent or minimise the impacts of climate change in the Torres Strait, and breached that duty.

4. The Commonwealth (amongst other things) denies that it owes the pleaded duties of care, and denies that it breached any such duties of care.

5. We are instructed to engage you, on a provisional basis, as an expert in this matter.

6. The provisional engagement will consist of an initial conference between you and the Commonwealth's legal team. The purpose of this conference will be to determine the capacity, if any, in which you may be able to act as an independent expert retained by the Commonwealth in this proceeding.

7. Following that conference, the Commonwealth may offer you an ongoing engagement as an independent expert in this proceeding.

8. We confirm that any engagement would be with you as an individual independent expert. Any opinions expressed by you should be your own.

9. We enclose the following documents by way of general reading for you before the conference with us:

   a. The Federal Court's Expert Evidence Practice Note (GPN-EXPT). This Practice Note sets out guidelines for expert witnesses to follow in proceedings before the Court. Please read these guidelines carefully. You are requested to follow this Practice Note in your dealings with us.

   b. The pleadings in the proceeding, namely the:

      – Applicants' second further amended statement of claim dated 11 April 2023 (**SFASOC**).

      – Respondents' defence to the SFASOC dated 9 May 2023.

      – Applicants' amended concise statement dated 15 May 2023.

      – Respondents' amended concise statement in response dated 29 May 2023.

OTHER MATTERS

10. Your communications with us are confidential and subject to the Commonwealth's legal professional privilege.

11. To ensure that the Commonwealth retains legal professional privilege in relation to your work, we request that you comply with the following communication and information management protocol during the course of this engagement:

    a. Unless instructed otherwise, communications (written or oral) should be with Dejan Lukic, Grace Ng, Zoe Maxwell and Sam Nitschke of the Australian Government Solicitor.

    b. This letter, any other materials provided to you, and any working notes prepared by you, should also be maintained in a file clearly marked 'Confidential and subject to legal professional privilege – for the Commonwealth of Australia'.

12. Subject to any orders of any court, our instructions, and any information obtained and working notes prepared by you in relation to this matter (including this engagement) must not be disclosed to any other person.

13. If you have any questions please contact us.

Yours sincerely

Zoe Maxwell
Senior Lawyer
T 03 9242 1219
zoe.maxwell@ags.gov.au

FEDERAL COURT OF AUSTRALIA

EXPERT EVIDENCE PRACTICE NOTE (GPN-EXPT)

General Practice Note

1. INTRODUCTION

1.1 This practice note, including the *Harmonised Expert Witness Code of Conduct* ("**Code**") (see **Annexure A**) and the *Concurrent Expert Evidence Guidelines* ("**Concurrent Evidence Guidelines**") (see **Annexure B**), applies to any proceeding involving the use of expert evidence and must be read together with:

(a) the Central Practice Note (CPN-1), which sets out the fundamental principles concerning the National Court Framework ("**NCF**") of the Federal Court and key principles of case management procedure;

(b) the Federal Court of Australia Act 1976 (Cth) ("**Federal Court Act**");

(c) the *Evidence Act 1995* (Cth) ("**Evidence Act**"), including Part 3.3 of the Evidence Act;

(d) Part 23 of the *Federal Court Rules 2011* (Cth) ("**Federal Court Rules**"); and

(e) where applicable, the Survey Evidence Practice Note (GPN-SURV).

1.2 This practice note takes effect from the date it is issued and, to the extent practicable, applies to proceedings whether filed before, or after, the date of issuing.

2. APPROACH TO EXPERT EVIDENCE

2.1 An expert witness may be retained to give opinion evidence in the proceeding, or, in certain circumstances, to express an opinion that may be relied upon in alternative dispute resolution procedures such as mediation or a conference of experts. In some circumstances an expert may be appointed as an independent adviser to the Court.

2.2 The purpose of the use of expert evidence in proceedings, often in relation to complex subject matter, is for the Court to receive the benefit of the objective and impartial assessment of an issue from a witness with specialised knowledge (based on training, study or experience - see generally s 79 of the Evidence Act).

2.3 However, the use or admissibility of expert evidence remains subject to the overriding requirements that:

(a) to be admissible in a proceeding, any such evidence must be relevant (s 56 of the Evidence Act); and

(b) even if relevant, any such evidence, may be refused to be admitted by the Court if its probative value is outweighed by other considerations such as the evidence

being unfairly prejudicial, misleading or will result in an undue waste of time (s 135 of the Evidence Act).

2.4 An expert witness' opinion evidence may have little or no value unless the assumptions adopted by the expert (ie. the facts or grounds relied upon) and his or her reasoning are expressly stated in any written report or oral evidence given.

2.5 The Court will ensure that, in the interests of justice, parties are given a reasonable opportunity to adduce and test relevant expert opinion evidence. However, the Court expects parties and any legal representatives acting on their behalf, when dealing with expert witnesses and expert evidence, to at all times comply with their duties associated with the overarching purpose in the Federal Court Act (see ss 37M and 37N).

3. INTERACTION WITH EXPERT WITNESSES

3.1 Parties and their legal representatives should never view an expert witness retained (or partly retained) by them as that party's advocate or "hired gun". Equally, they should never attempt to pressure or influence an expert into conforming his or her views with the party's interests.

3.2 A party or legal representative should be cautious not to have inappropriate communications when retaining or instructing an independent expert, or assisting an independent expert in the preparation of his or her evidence. However, it is important to note that there is no principle of law or practice and there is nothing in this practice note that obliges a party to embark on the costly task of engaging a "consulting expert" in order to avoid "contamination" of the expert who will give evidence. Indeed the Court would generally discourage such costly duplication.

3.3 Any witness retained by a party for the purpose of preparing a report or giving evidence in a proceeding as to an opinion held by the witness that is wholly or substantially based in the specialised knowledge of the witness[1] should, at the earliest opportunity, be provided with:

(a) a copy of this practice note, including the Code (see Annexure A); and

(b) all relevant information (whether helpful or harmful to that party's case) so as to enable the expert to prepare a report of a truly independent nature.

3.4 Any questions or assumptions provided to an expert should be provided in an unbiased manner and in such a way that the expert is not confined to addressing selective, irrelevant or immaterial issues.

[1] Such a witness includes a "Court expert" as defined in r 23.01 of the Federal Court Rules. For the definition of "expert", "expert evidence" and "expert report" see the Dictionary, in Schedule 1 of the Federal Court Rules.

4. ROLE AND DUTIES OF THE EXPERT WITNESS

4.1 The role of the expert witness is to provide relevant and impartial evidence in his or her area of expertise. An expert should never mislead the Court or become an advocate for the cause of the party that has retained the expert.

4.2 It should be emphasised that there is nothing inherently wrong with experts disagreeing or failing to reach the same conclusion. The Court will, with the assistance of the evidence of the experts, reach its own conclusion.

4.3 However, experts should willingly be prepared to change their opinion or make concessions when it is necessary or appropriate to do so, even if doing so would be contrary to any previously held or expressed view of that expert.

Harmonised Expert Witness Code of Conduct

4.4 Every expert witness giving evidence in this Court must read the *Harmonised Expert Witness Code of Conduct* (attached in Annexure A) and agree to be bound by it.

4.5 The Code is not intended to address all aspects of an expert witness' duties, but is intended to facilitate the admission of opinion evidence, and to assist experts to understand in general terms what the Court expects of them. Additionally, it is expected that compliance with the Code will assist individual expert witnesses to avoid criticism (rightly or wrongly) that they lack objectivity or are partisan.

5. CONTENTS OF AN EXPERT'S REPORT AND RELATED MATERIAL

5.1 The contents of an expert's report must conform with the requirements set out in the Code (including clauses 3 to 5 of the Code).

5.2 In addition, the contents of such a report must also comply with r 23.13 of the Federal Court Rules. Given that the requirements of that rule significantly overlap with the requirements in the Code, an expert, unless otherwise directed by the Court, will be taken to have complied with the requirements of r 23.13 if that expert has complied with the requirements in the Code and has complied with the additional following requirements. The expert shall:

(a) acknowledge in the report that:

(i) the expert has read and complied with this practice note and agrees to be bound by it; and

(ii) the expert's opinions are based wholly or substantially on specialised knowledge arising from the expert's training, study or experience;

(b) identify in the report the questions that the expert was asked to address;

(c) sign the report and attach or exhibit to it copies of:

(i) documents that record any instructions given to the expert; and

(ii) documents and other materials that the expert has been instructed to consider.

5.3 Where an expert's report refers to photographs, plans, calculations, analyses, measurements, survey reports or other extrinsic matter, these must be provided to the other parties at the same time as the expert's report.

6. CASE MANAGEMENT CONSIDERATIONS

6.1 Parties intending to rely on expert evidence at trial are expected to consider between them and inform the Court at the earliest opportunity of their views on the following:

(a) whether a party should adduce evidence from more than one expert in any single discipline;

(b) whether a common expert is appropriate for all or any part of the evidence;

(c) the nature and extent of expert reports, including any in reply;

(d) the identity of each expert witness that a party intends to call, their area(s) of expertise and availability during the proposed hearing;

(e) the issues that it is proposed each expert will address;

(f) the arrangements for a conference of experts to prepare a joint-report (see Part 7 of this practice note);

(g) whether the evidence is to be given concurrently and, if so, how (see Part 8 of this practice note); and

(h) whether any of the evidence in chief can be given orally.

6.2 It will often be desirable, before any expert is retained, for the parties to attempt to agree on the question or questions proposed to be the subject of expert evidence as well as the relevant facts and assumptions. The Court may make orders to that effect where it considers it appropriate to do so.

7. CONFERENCE OF EXPERTS AND JOINT-REPORT

7.1 Parties, their legal representatives and experts should be familiar with aspects of the Code relating to conferences of experts and joint-reports (see clauses 6 and 7 of the Code attached in Annexure A).

7.2 In order to facilitate the proper understanding of issues arising in expert evidence and to manage expert evidence in accordance with the overarching purpose, the Court may require experts who are to give evidence or who have produced reports to meet for the purpose of identifying and addressing the issues not agreed between them with a view to reaching agreement where this is possible ("**conference of experts**"). In an appropriate case, the Court may appoint a registrar of the Court or some other suitably qualified person ("**Conference Facilitator**") to act as a facilitator at the conference of experts.

7.3 It is expected that where expert evidence may be relied on in any proceeding, at the earliest opportunity, parties will discuss and then inform the Court whether a conference of experts and/or a joint-report by the experts may be desirable to assist with or simplify the giving of expert evidence in the proceeding. The parties should discuss the necessary arrangements for any conference and/or joint-report. The arrangements discussed between the parties should address:

(a) who should prepare any joint-report;

(b) whether a list of issues is needed to assist the experts in the conference and, if so, whether the Court, the parties o r the experts should assist in preparing such a list;

(c) **t**he agenda for the conference of experts; and

(d) arrangements for the provision, to the parties and the Court, of any joint-report or any other report as to the outcomes of the conference ("**conference report**").

Conference of Experts

7.4 The purpose of the conference of experts is for the experts to have a comprehensive discussion of issues relating to their field of expertise, with a view to identifying matters and issues in a proceeding about which the experts agree, partly agree or disagree and why. For this reason the conference is attended only by the experts and any Conference Facilitator. Unless the Court orders otherwise, the parties' lawyers will not attend the conference but will be provided with a copy of any conference report.

7.5 The Court may order that a conference of experts occur in a variety of circumstances, depending on the views of the judge and the parties and the needs of the case, including:

(a) while a case is in mediation. When this occurs the Court may also order that the outcome of the conference or any document disclosing or summarising the experts' opinions be confidential to the parties while the mediation is occurring;

(b) before the experts have reached a final opinion on a relevant question or the facts involved in a case. When this occurs the Court may order that the parties exchange draft expert reports and that a conference report be prepared for the use of the experts in finalising their reports;

(c) after the experts' reports have been provided to the Court but before the hearing of the experts' evidence. When this occurs the Court may also order that a conference report be prepared (jointly or otherwise) to ensure the efficient hearing of the experts' evidence.

7.6 Subject to any other order or direction of the Court, the parties and their lawyers must not involve themselves in the conference of experts process. In particular, they must not seek to encourage an expert not to agree with another expert or otherwise seek to influence the outcome of the conference of experts. The experts should raise any queries they may have in relation to the process with the Conference Facilitator (if one has been appointed) or in

accordance with a protocol agreed between the lawyers prior to the conference of experts taking place (if no Conference Facilitator has been appointed).

7.7 Any list of issues prepared for the consideration of the experts as part of the conference of experts process should be prepared using non-tendentious language.

7.8 The timing and location of the conference of experts will be decided by the judge or a registrar who will take into account the location and availability of the experts and the Court's case management timetable. The conference may take place at the Court and will usually be conducted in-person. However, if not considered a hindrance to the process, the conference may also be conducted with the assistance of visual or audio technology (such as via the internet, video link and/or by telephone).

7.9 Experts should prepare for a conference of experts by ensuring that they are familiar with all of the material upon which they base their opinions. Where expert reports in draft or final form have been exchanged prior to the conference, experts should attend the conference familiar with the reports of the other experts. Prior to the conference, experts should also consider where they believe the differences of opinion lie between them and what processes and discussions may assist to identify and refine those areas of difference.

Joint-report

7.10 At the conclusion of the conference of experts, unless the Court considers it unnecessary to do so, it is expected that the experts will have narrowed the issues in respect of which they agree, partly agree or disagree in a joint-report. The joint-report should be clear, plain and concise and should summarise the views of the experts on the identified issues, including a succinct explanation for any differences of opinion, and otherwise be structured in the manner requested by the judge or registrar.

7.11 In some cases (and most particularly in some native title cases), depending on the nature, volume and complexity of the expert evidence a judge may direct a registrar to draft part, or all, of a conference report. If so, the registrar will usually provide the draft conference report to the relevant experts and seek their confirmation that the conference report accurately reflects the opinions of the experts expressed at the conference. Once that confirmation has been received the registrar will finalise the conference report and provide it to the intended recipient(s).

8. CONCURRENT EXPERT EVIDENCE

8.1 The Court may determine that it is appropriate, depending on the nature of the expert evidence and the proceeding generally, for experts to give some or all of their evidence concurrently at the final (or other) hearing.

8.2 Parties should familiarise themselves with the *Concurrent Expert Evidence Guidelines* (attached in Annexure B). The Concurrent Evidence Guidelines are not intended to be exhaustive but indicate the circumstances when the Court might consider it appropriate for

concurrent expert evidence to take place, outline how that process may be undertaken, and assist experts to understand in general terms what the Court expects of them.

8.3 If an order is made for concurrent expert evidence to be given at a hearing, any expert to give such evidence should be provided with the Concurrent Evidence Guidelines well in advance of the hearing and should be familiar with those guidelines before giving evidence.

9. FURTHER PRACTICE INFORMATION AND RESOURCES

9.1 Further information regarding Expert Evidence and Expert Witnesses is available on the Court's website.

9.2 Further information to assist litigants, including a range of helpful guides, is also available on the Court's website. This information may be particularly helpful for litigants who are representing themselves.

J L B ALLSOP
Chief Justice
25 October 2016

Annexure A

HARMONISED EXPERT WITNESS CODE OF CONDUCT[2]

APPLICATION OF CODE

1. This Code of Conduct applies to any expert witness engaged or appointed:

   (a) to provide an expert's report for use as evidence in proceedings or proposed proceedings; or

   (b) to give opinion evidence in proceedings or proposed proceedings.

GENERAL DUTIES TO THE COURT

2. An expert witness is not an advocate for a party and has a paramount duty, overriding any duty to the party to the proceedings or other person retaining the expert witness, to assist the Court impartially on matters relevant to the area of expertise of the witness.

CONTENT OF REPORT

3. Every report prepared by an expert witness for use in Court shall clearly state the opinion or opinions of the expert and shall state, specify or provide:

   (a) the name and address of the expert;

   (b) an acknowledgment that the expert has read this code and agrees to be bound by it;

   (c) the qualifications of the expert to prepare the report;

   (d) the assumptions and material facts on which each opinion expressed in the report is based [a letter of instructions may be annexed];

   (e) the reasons for and any literature or other materials utilised in support of such opinion;

   (f) (if applicable) that a particular question, issue or matter falls outside the expert's field of expertise;

   (g) any examinations, tests or other investigations on which the expert has relied, identifying the person who carried them out and that person's qualifications;

   (h) the extent to which any opinion which the expert has expressed involves the acceptance of another person's opinion, the identification of that other person and the opinion expressed by that other person;

   (i) a declaration that the expert has made all the inquiries which the expert believes are desirable and appropriate (save for any matters identified explicitly in the report), and that no matters of significance which the expert regards as relevant have, to the

[2] Approved by the Council of Chief Justices' Rules Harmonisation Committee

knowledge of the expert, been withheld from the Court;

(j) any qualifications on an opinion expressed in the report without which the report is or may be incomplete or inaccurate;

(k) whether any opinion expressed in the report is not a concluded opinion because of insufficient research or insufficient data or for any other reason; and

(l) where the report is lengthy or complex, a brief summary of the report at the beginning of the report.

SUPPLEMENTARY REPORT FOLLOWING CHANGE OF OPINION

4. Where an expert witness has provided to a party (or that party's legal representative) a report for use in Court, and the expert thereafter changes his or her opinion on a material matter, the expert shall forthwith provide to the party (or that party's legal representative) a supplementary report which shall state, specify or provide the information referred to in paragraphs (a), (d), (e), (g), (h), (i), (j), (k) and (l) of clause 3 of this code and, if applicable, paragraph (f) of that clause.

5. In any subsequent report (whether prepared in accordance with clause 4 or not) the expert may refer to material contained in the earlier report without repeating it.

DUTY TO COMPLY WITH THE COURT'S DIRECTIONS

6. If directed to do so by the Court, an expert witness shall:

(a) confer with any other expert witness;

(b) provide the Court with a joint-report specifying (as the case requires) matters agreed and matters not agreed and the reasons for the experts not agreeing; and

(c) abide in a timely way by any direction of the Court.

CONFERENCE OF EXPERTS

7. Each expert witness shall:

(a) exercise his or her independent judgment in relation to every conference in which the expert participates pursuant to a direction of the Court and in relation to each report thereafter provided, and shall not act on any instruction or request to withhold or avoid agreement; and

(b) endeavour to reach agreement with the other expert witness (or witnesses) on any issue in dispute between them, or failing agreement, endeavour to identify and clarify the basis of disagreement on the issues which are in dispute.

ANNEXURE B

CONCURRENT EXPERT EVIDENCE GUIDELINES

APPLICATION OF THE COURT'S GUIDELINES

1. The Court's Concurrent Expert Evidence Guidelines ("**Concurrent Evidence Guidelines**") are intended to inform parties, practitioners and experts of the Court's general approach to concurrent expert evidence, the circumstances in which the Court might consider expert witnesses giving evidence concurrently and, if so, the procedures by which their evidence may be taken.

OBJECTIVES OF CONCURRENT EXPERT EVIDENCE TECHNIQUE

2. The use of concurrent evidence for the giving of expert evidence at hearings as a case management technique[3] will be utilised by the Court in appropriate circumstances (see r 23.15 of the *Federal Court Rules 2011* (Cth)). Not all cases will suit the process. For instance, in some patent cases, where the entire case revolves around conflicts within fields of expertise, concurrent evidence may not assist a judge. However, patent cases should not be excluded from concurrent expert evidence processes.

3. In many cases the use of concurrent expert evidence is a technique that can reduce the partisan or confrontational nature of conventional hearing processes and minimises the risk that experts become "opposing experts" rather than independent experts assisting the Court. It can elicit more precise and accurate expert evidence with greater input and assistance from the experts themselves.

4. When properly and flexibly applied, with efficiency and discipline during the hearing process, the technique may also allow the experts to more effectively focus on the critical points of disagreement between them, identify or resolve those issues more quickly, and narrow the issues in dispute. This can also allow for the key evidence to be given at the same time (rather than being spread across many days of hearing); permit the judge to assess an expert more readily, whilst allowing each party a genuine opportunity to put and test expert evidence. This can reduce the chance of the experts, lawyers and the judge misunderstanding the opinions being expressed by the experts.

5. It is essential that such a process has the full cooperation and support of all of the individuals involved, including the experts and counsel involved in the questioning process. Without that cooperation and support the process may fail in its objectives and even hinder the case management process.

[3] Also known as the "hot tub" or as "expert panels".

CASE MANAGEMENT

6. Parties should expect that, the Court will give careful consideration to whether concurrent evidence is appropriate in circumstances where there is more than one expert witness having the same expertise who is to give evidence on the same or related topics. Whether experts should give evidence concurrently is a matter for the Court, and will depend on the circumstances of each individual case, including the character of the proceeding, the nature of the expert evidence, and the views of the parties.

7. Although this consideration may take place at any time, including the commencement of the hearing, if not raised earlier, parties should raise the issue of concurrent evidence at the first appropriate case management hearing, and no later than any pre-trial case management hearing, so that orders can be made in advance, if necessary. To that end, prior to the hearing at which expert evidence may be given concurrently, parties and their lawyers should confer and give general consideration as to:

   (a) the agenda;

   (b) the order and manner in which questions will be asked; and

   (c) whether cross-examination will take place within the context of the concurrent evidence or after its conclusion.

8. At the same time, and before any hearing date is fixed, the identity of all experts proposed to be called and their areas of expertise is to be notified to the Court by all parties.

9. The lack of any concurrent evidence orders does not mean that the Court will not consider using concurrent evidence without prior notice to the parties, if appropriate.

CONFERENCE OF EXPERTS & JOINT-REPORT OR LIST OF ISSUES

10. The process of giving concurrent evidence at hearings may be assisted by the preparation of a joint-report or list of issues prepared as part of a conference of experts.

11. Parties should expect that, where concurrent evidence is appropriate, the Court may make orders requiring a conference of experts to take place or for documents such as a joint-report to be prepared to facilitate the concurrent expert evidence process at a hearing (see Part 7 of the Expert Evidence Practice Note).

PROCEDURE AT HEARING

12. Concurrent expert evidence may be taken at any convenient time during the hearing, although it will often occur at the conclusion of both parties' lay evidence.

13. At the hearing itself, the way in which concurrent expert evidence is taken must be applied flexibly and having regard to the characteristics of the case and the nature of the evidence to be given.

14. Without intending to be prescriptive of the procedure, parties should expect that, when evidence is given by experts in concurrent session:

(a) the judge will explain to the experts the procedure that will be followed and that the nature of the process may be different to their previous experiences of giving expert evidence;

(b) the experts will be grouped and called to give evidence together in their respective fields of expertise;

(c) the experts will take the oath or affirmation together, as appropriate;

(d) the experts will sit together with convenient access to their materials for their ease of reference, either in the witness box or in some other location in the courtroom, including (if necessary) at the bar table;

(e) each expert may be given the opportunity to provide a summary overview of their current opinions and explain what they consider to be the principal issues of disagreement between the experts, as they see them, in their own words;

(f) the judge will guide the process by which evidence is given, including, where appropriate:

(i) using any joint-report or list of issues as a guide for all the experts to be asked questions by the judge and counsel, about each issue on an issue-by-issue basis;

(ii) ensuring that each expert is given an adequate opportunity to deal with each issue and the exposition given by other experts including, where considered appropriate, each expert asking questions of other experts or supplementing the evidence given by other experts;

(iii) inviting legal representatives to identify the topics upon which they will cross-examine;

(iv) ensuring that legal representatives have an adequate opportunity to ask all experts questions about each issue. Legal representatives may also seek responses or contributions from one or more experts in response to the evidence given by a different expert; and

(v) allowing the experts an opportunity to summarise their views at the end of the process where opinions may have been changed or clarifications are needed.

15. The fact that the experts may have been provided with a list of issues for consideration does not confine the scope of any cross-examination of any expert. The process of cross-examination remains subject to the overall control of the judge.

16. The concurrent session should allow for a sensible and orderly series of exchanges between expert and expert, and between expert and lawyer. Where appropriate, the judge may allow for more traditional cross-examination to be pursued by a legal representative on a particular issue exclusively with one expert. Where that occurs, other experts may be asked to comment on the evidence given.

17. Where any issue involves only one expert, the party wishing to ask questions about that issue should let the judge know in advance so that consideration can be given to whether

arrangements should be made for that issue to be dealt with after the completion of the concurrent session. Otherwise, as far as practicable, questions (including in the form of cross-examination) will usually be dealt with in the concurrent session.

18. Throughout the concurrent evidence process the judge will ensure that the process is fair and effective (for the parties and the experts), balanced (including not permitting one expert to overwhelm or overshadow any other expert), and does not become a protracted or inefficient process.

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Darwin

Our ref. 21008585

1 September 2023

Professor Andy Pitman
ARC Centre of Excellence for Climate Extremes
Level 4, Mathews Building
University of New South Wales
Sydney NSW 2052

By email: Redactions for public file

PRIVILEGED & CONFIDENTIAL

Dear Professor Pitman

Pabai & Anor v Commonwealth of Australia (VID622/2021) | Engagement as independent expert

ENGAGEMENT AS INDEPENDENT EXPERT

1. We act for the Commonwealth of Australia (the **Commonwealth**) in the above class action before the Federal Court of Australia.

2. We are instructed to engage you as an independent expert in the above class action.

BRIEFING MATERIALS AND INSTRUCTIONS

3. **Annexure A** contains a list of documents briefed to you.

4. At this stage, you are required to undertake a review of the documents briefed at Annexure A.

5. We will in due course send you a letter with specific questions for you to address in a written expert report. We anticipate those questions will relate to the modelling of impacts of climate change at a regional level, and in particular in the Torres Strait, including any uncertainties or difficulties in modelling those impacts.

6. Any expert evidence to be relied on by the Commonwealth is due to be filed by **6 October 2023**. Please let us know if you consider it will not be possible to meet that date and we will consider what arrangements can be made.

7. You may also be required to give oral evidence before the Court. The hearing is listed from 6 to 27 November 2023, in Melbourne. We will advise you closer to the date if you will be required to give oral evidence and, if so, on which dates.

YOUR ROLE AS AN EXPERT

8. We enclose in Annexure B the Federal Court of Australia Expert Evidence Practice Note (GPN-EXPT) (**Practice Note**) and Part 23 of the *Federal Court Rules 2011* (Cth). These documents set out guideline for expert witnesses to follow in proceedings before the Court. Please read these guidelines carefully. You are requested to follow these guidelines in your dealings with us, and in preparing your report.

9. We draw your attention to the following sections of the Practice Note:

    a) Section 4 'Role and Duties of the Expert Witness': Paragraph 4.1 provides that your role is to provide relevant and impartial evidence in your area of expertise. You should never mislead the Court or become an advocate for the Commonwealth (as the retaining party).

    a) Section 4 'Role and Duties of the Expert Witness': Paragraph 4.4 provides that every expert witness giving evidence must read and agree to be bound by the Expert Witness Code of Conduct. You are required to strictly comply with the terms of the Expert Witness Code of Conduct. Please ensure your report/s contains an acknowledgment that you have read and agree to be bound by the Expert Witness Code of Conduct.

    b) Section 5 'Contents of an Expert's Report and Related Material': Paragraph 5.2 sets out the requirements for the contents of any report, in addition to those requirements set out in the Expert Witness Code of Conduct.

CONFIDENTIALITY AND LEGAL PROFESSIONAL PRIVILEGE

10. Your communications with us are confidential and subject to the Commonwealth's legal professional privilege.

11. To ensure that the Commonwealth retains legal professional privilege in relation to your work, we request that you comply with the following communication and information management protocol during the course of this engagement:

    a. Unless instructed otherwise, communications (written or oral) should be with Dejan Lukic, Grace Ng, Emily Nance, Zoe Maxwell and Sam Nitschke of the Australian Government Solicitor.

    b. This letter, any other materials provided to you, and any working notes prepared by you, should also be maintained in a file clearly marked 'Confidential and subject to legal professional privilege – for the Commonwealth of Australia'.

12. Subject to any orders of any court, our instructions, and any information obtained and working notes prepared by you in relation to this matter (including this engagement) must not be disclosed to any other person.

ANY ASSISTANCE IN PREPARING YOUR REPORT

13. It is not expected that you will require assistance from any other person to prepare the evidence requested. If you wish to involve another person, please let us know.

NEXT STEPS

14. Please begin considering the materials in your brief. As noted above, we will in due course provide you with some specific questions to answer.

15. If you have any questions please contact us.

Yours sincerely

Zoe Maxwell
Senior Lawyer
T 03 9242 1219
zoe.maxwell@ags.gov.au

ANNEXURE A – BRIEFED DOCUMENTS

TAB	DOCUMENT	DATE
1.	Federal Court's Expert Evidence Practice Note (GPN-EXPT)	25 October 2016
2.	Applicants' second further amended statement of claim (**SFASOC**)	11 April 2023
3.	Respondent's defence to the SFASOC	9 May 2023
4.	Applicants' amended concise statement	15 May 2023
5.	Respondent's amended concise statement in response	29 May 2023
6.	Part 23 of the *Federal Court Rules 2011*	13 January 2023
7.	Expert report of David Karoly (sealed)	26 May 2023
8.	Expert report of Malte Meinshausen (sealed)	14 July 2023

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Our ref. 21008585

25 September 2023

Professor Andy Pitman
ARC Centre of Excellence for Climate Extremes
Level 4, Mathews Building
University of New South Wales
Sydney NSW 2052

By email: [redacted] Redactions for public file

PRIVILEGED & CONFIDENTIAL

Dear Professor Pitman

Pabai & Anor v Commonwealth of Australia (VID622/2021) | Instruction letter

1. We refer to our engagement letter dated 1 September 2023 (**Engagement Letter**).
2. We confirm we would like you to prepare an expert report for the purpose of the above class action that answers the questions set out in **Annexure B** to this letter.
3. In answering those questions, please consider, as you consider relevant, the materials provided in in Tabs 2-5, 7 and 8 of **Annexure A** to the Engagement Letter.
4. Again, we refer you to the Federal Court of Australia Expert Evidence Practice Note (GPN-EXPT) and Part 23 of the *Federal Court Rules 2011* (Cth), provided in **Annexure A** to the Engagement Letter. We reiterate that you are required to follow these guidelines in your dealings with us, and in preparing your expert report.

NEXT STEPS

5. Please proceed to prepare your written report.
6. As noted previously, any expert evidence to be relied on by the Commonwealth is due to be filed by **6 October 2023**. Please let us know if you consider it will not be possible to meet that date and we will consider what arrangements can be made.
7. If you consider there are further materials or information you require in order to answer those questions, please let us know.

8. If you have any other questions please contact us.

Yours sincerely

Zoe Maxwell
Senior Lawyer
T 03 9242 1219
zoe.maxwell@ags.gov.au

ANNEXURE B – QUESTIONS FOR REPORT

Basis of expertise

1. Please describe your academic qualifications, professional background and experience that is relevant to your answering the questions in the letter of instruction. You may wish to do so by reference to a current curriculum vitae.

Modelling the regional impacts of climate change

2. Please explain the process of modelling the effects of increasing GHG emissions on the impacts of climate change at a regional level and in particular in the Torres Strait, including explaining any difficulties in that process.

Counterfactuals

Meinshausen Report [69(a)]

3. If Australia had in 2014 implemented a GHG emissions reductions target of 47% reduction over 2005 levels by 2025, and assuming Australia had a straight line path to 47% reduction by 2025, what effect, if any, would the reduction in Australia's total GHG emissions from 2014 to date have had on the impacts of climate change in the Torres Strait?

Meinshausen Report [69(b)]

4. If Australia had in 2014 implemented a GHG emissions reductions target of net zero by 2024, and assuming Australia complied with that target on a straight line path to net zero by 2024, what effect, if any, would the reduction in Australia's total GHG emissions from 2014 to date have had on the impacts of climate change in the Torres Strait?

Definitions

For the purpose of answering the above questions:

A. **GHG emissions** means greenhouse gas emissions.

B. **Impacts of climate change** refers to the following:

    a. increase in surface temperature;

    b. ocean acidification;

    c. increase in ocean temperature;

    d. sea level rise;

    e. increase in the frequency, size and/or intensity of extreme weather events such as tropical cyclones, terrestrial and marine heatwaves, severe storms and flooding.

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Our ref. 21008585

6 October 2023

Professor Andy Pitman
Director, ARC Centre of Excellence for Climate Extremes

By email: Redactions for public file

Dear Professor Pitman

Pabai & Anor v Commonwealth of Australia (VID622/2021) | Supplementary letter

1. We refer to:

   a. our engagement letter dated 1 September 2023, engaging you to act as an expert in the proceedings and enclosing materials for your review; and

   b. our supplementary letter dated 25 September 2023 setting out the questions we wished you to address in your expert report.

2. Further to those letters, we enclose a copy of a report from Josep Canadell dated 6 October 2023 (**Canadell Report**) which has been prepared for the Commonwealth in the proceeding.

3. We request that you review the Canadell Report and, to the extent you consider necessary, rely on any data or conclusions reached therein to prepare your report. To the extent that you do rely on any such data or conclusions, please make clear in your report the precise matters on which you rely.

4. If you have any other questions, please contact us.

Yours sincerely

Grace Ng
Senior Lawyer
T 02 9581 7320
grace.ng@ags.gov.au

ANNEXURE B

Full Curriculum Vitae: Andrew John Pitman, AO, FAA

Address ARC Centre of Excellence for Climate Extremes
The University of New South Wales, Sydney, NSW, 2052.

Redactions for public file

Redactions for public file

Born 18th June, 1964
Citizenship Australian and British
andy.pitman

Qualifications

Undergraduate	1982-85	Liverpool University	B.Sc. (Hons) Physical Geography
Postgraduate	1985-88	Liverpool University	Ph.D *The Development and implementation of a new land surface scheme for use in general circulation models.*
Postgraduate	2000-01	Macquarie University	Postgraduate Certificate in Educational Leadership (Higher Education)

Honours, Awards, Prizes

2004	AMOS Priestly Medal for excellence in Atmospheric Science Research
2005	Dean's Award for Science Leadership
2007	Nobel Peace Prize (IPCC, shared with all other IPCC Lead Authors)
2009	Australian Meteorological and Oceanographic Society Medal
2010	Eureka Prize for Copenhagen Diagnosis (national finalist)
2010	Winner, Future Justice Prize, Copenhagen Diagnosis
2010	Winner, NSW Scientist of the Year Awards – Environment, Water and Climate Change Sciences Category
2010	Sydney Magazine's list of the 100 most influential people
2012	The Atmospheric Science Librarians International "best book" in meteorology / climatology / atmospheric sciences for *The Future of the World's Climate*
2012	Outstanding Academic Title awarded by the American Library Association's Choice publication for Copenhagen Diagnosis
2014	Elected Fellow of the Royal Society of NSW (FRSN)
2015	Elected Fellow of the Australian Meteorological and Oceanographic Society (FAMOS)
2015	Actuaries Institute of Australia Taylor Fry Prize (with S Paddam, J Egan, J Harwood)
2016	Elected Fellow of the American Meteorological Society
2017	Eureka Prize, CSIRO Eureka Prize for Scientific leadership (national finalist)
2018	Eureka Prize, CSIRO Eureka Prize for Scientific leadership (national finalist)
2019	Officer of the Order of Australia (AO) "for distinguished service to science as a leading researcher, particularly of climate systems and the environment"
2020	Royal Society of Victoria Medal for Excellence in Scientific Research
2021	Elected Fellow of the Australian Academy of Science, FAA.

Key current and former positions

Jul 2017 – June 2024	Director, ARC Centre of Excellence for Climate Extremes
Jul 2011 – June 2017	Director, ARC Centre of Excellence for Climate System Science
Apr 2007 - date	Professor, University of New South Wales

Jan 2002 – Apr 2007	Personal Chair, Macquarie University
Aug 2000 - Dec 2003	Deputy Dean of Division, Macquarie University
Jan 1999 - Dec 2003	Head of Physical Geography, Macquarie University
Jan 1999 – Dec 2002	Professorial Fellow, Macquarie University
Jan 1997 – Dec 1999	Associate Professor Macquarie University
Mar 1989 - Dec 1996	Research Fellow, Lecturer, Senior Lecturer, Macquarie University

Teaching and mentoring

- I taught extensively at undergraduate levels prior to my appointment at UNSW. I initiated and developed one of the world's first fully on-line courses and published both the pedagogic outcomes and an innovative analysis of how students engaged with an internet-based course. See list of publications, Rich et al. (2000) and Pitman et al. (1999).

- I contributed to some innovative teaching initiatives including a new 1st year undergraduate course at UNSW utilizing web-based technologies.

- I have led the supervision of over 20 PhD students and about 10 Honours and Masters students. I have been a member of the supervisory panels for many more.

- I mentor, to varying degrees, a large number of students and early career researchers through the ARC Centre of Excellence's Graduate Programme.

Academic and research leadership and impact

- I am the Director of the ARC Centre of Excellence for Climate Extremes (2017-2024). This is the most significant leadership role in my research field within the University sector. I previously led the ARC Centre of Excellence for Climate System Science (2011-2017).

- My leadership of both Centres of Excellence was founded on my development of a coordinated and strategically aligned community via my Convening of the ARC Research Network for Earth System Science.

- My leadership in University and national climate science is outstanding. In recognition I was shortlisted for the CSIRO Eureka Prize for science leadership in 2017 and 2018.

- My personal research focusses on land processes including land-atmosphere relationships. I have an extensive history of leadership, innovation and discovery in land surface and atmospheric processes, including the use of the land to mitigate climate change.

- My leadership credentials include academic leadership (two ARC Centres of Excellence) through to roles in national e-research strategy. I have been instrumental in national strategies around high performance computing, big-data, NCRIS and policy development.

- More than AU$70 million in external research grants, via Centre, Discovery, Linkage and ARC Network schemes. A further $1.75 million in infrastructure funding (LIEF etc).

- I have published over 250 peer reviewed journal papers, 20 book chapters, plus a book and a teaching text.

- I have a Web of Science h-index of 62, with over 18,000 citations (Google, h-index 80, citations 30,000).

- I co-established and co-led the Climate Change Research Centre at UNSW with Professor Matthew England.

- I am a regular Keynote and Plenary Speaker at national and international conferences, and a regular conference organizer and member of program committees. I speak regularly to schools, voluntary organisations and other public groups.

Academic service roles

Current roles

- WMO Research Board - task team on data exchange (from 2022)

- Science Ambassador, Global Energy and Water Exchanges a core project of the World Climate Research Programme

- Ministerial appointment to the Antarctic Science Council

Former roles

- International panelist and reviewer for the Croucher Foundation (Hong Kong).

- Lead author for the Intergovernmental Panel on Climate Change, 2001 (WG 1, Chapter 8).

- Lead author for the Intergovernmental Panel on Climate Change, 2007 (WG 1, Chapter 8).

- Review Editor for the Intergovernmental Panel on Climate Change, 2013 (Chapter 9).

- Chair of the New South Wales panel for the Monash Foundation.

- Editor, *Journal of Climate* (2007-2011), former associate editor *Journal of Geophysical Research and Annals of the Association of American Geographers, International Journal of Climatology.*

- Reviewer *for Nature, multiple American Geophysical Union, American Meteorological Society* and *European Geophysical Union journals.*

- Proposal reviewer for Australian Research Council, the U.S. National Science Foundation, the NOAA Global Environmental Change programme, and the Presidential Faculty Fellows Program. I am a regular examiner of Honours, Masters and PhD theses.

- Co-chair of the International of Land-Use and Climate, Identification of robust impacts (LUCID), a GEWEX-iLEAPS project.

- Science Steering Committee Member for the International Geosphere Biosphere Program's terrestrial committees (BAHC and iLEAPS).

- Member (2014), national strategic planning team for Ecosystem Science and co-author of the report: *Foundations for the future: A long-term plan for Australian ecosystem science.*

- Member (2010) of the Australian Academy of Science's strategic planning team for Earth System Science and co-author of the report: *To live within Earth's limits: an Australian plan to develop a science of the whole Earth system.*

Advisory boards and panels

Current roles

2022-present: National Environmental Science Program (NESP) Climate Systems steering committee.

2021-present: UNSW nominee for the Australian Community Climate and Earth System Simulator National Research Infrastructure board.

2021-present: Science Advisory Board for the Terrestrial Ecosystem Research Infrastructure.

2010-present: Advisory Board Member of *Risk Frontiers*, an Insurance Industry funded research centre.

2000-present: Chair of the Academy of Science's National Committee for Earth System Science.

2018-present: Member, Academy of Science's National Committee for data in science.

Former roles

1990-2000: Co-chair, World Climate Research Program's Project for the Intercomparison of Land surface Parameterization Schemes.

1999-2005: Member, World Climate Research Program's committee on Global Land Atmosphere System Study (GLASS).

2014: Member of the national review panel for the Federal Department of Education and co-author of *The Australian Research Data Infrastructure Strategy, The data revolution: Seizing the opportunity.*

2016-2022: International review board member of the Max Planck Institute for Meteorology, Germany.

2016-2017: Ministerial appointee to the National Collaborative Research Infrastructure Strategy (NCRIS) Roadmap for research infrastructure, led by Professor Alan Finkel and co-author of the subsequent roadmap.

Appointee to the Ministerial Council of the Office of Environment and Heritage, NSW.

2019-2020: Former national board member of the Australian Meteorological & Oceanographic Society.

2007: Appointee to the Prime Minister's Science, Engineering and Innovation Council, Regional Climate Change (March, 2007) and co-author of the resulting report: *Climate change in Australia: regional impacts and adaptation, managing the risk for Australia.*

2011: Member of the review panel for NCRIS e-research for the Federal Department of Education and co-author of the Strategic roadmap for Australian research infrastructure, Department of Innovation, Industry, Science and Research (2011).

2018-2019: Ministerial appointee to the NCRIS scoping study and submission for the ACCESS National Research Infrastructure initiative.

Former member of the Australian e-research research council which was an appointment by the Federal Minister.

2018-2021: Advisory Board Member of the National Environmental Science Program (NESP) for Earth Systems and Climate Change (ESCC) of the Federal Department of the Environment.

2023: Taxonomy and Natural Capital Australian Sustainable Finance Institute Technical Advisory Panel.

Conference presentations, plenary/keynote lectures, invited symposium lectures

I have delivered more than 20 keynote, plenary and invited addresses at national/international meetings. Recent examples include:

- Internationally: ETH Zurich, Switzerland, Reading University, UK, Centre for Environmental Hydrology, Wallingford.

- Within Australia, in the last year, I have been invited to address the Australian Prudential Regulation Authority, the Research Bank of Australia, the Department of Primary Industry, AON Benfield and the Goyder Institute for Water Research Annual Water Forum.

- I have given invited talks at Greenhouse 2015, sessions of the national annual meeting of the Australian Meteorological and Oceanographic Society (2014, 2015, 2016).

I have served as Convenor, Organisation Committee Member or Session Chair for over 30 national/international meetings. Recent examples include:

- Internationally: Co-convenor of the Addressing the Challenge on Compound Events, ETH Zurich, I was an Organisation Committee Member for the 4th iLEAPS Science Conference: Terrestrial ecosystems, atmosphere, and people in the Earth system hosted in Nanjing.

- Nationally: session organiser of the AMOS/MSNZ Conference and ANZ Climate Forum 2017. I routinely host focussed workshops for groups of experts to identify and solve specific research problems.

Selected Research grants

Source	Lead investigators	Title	Amount
ARC Networks	Pitman and many others	The ARC Earth System Science Network Investigators	$1.9 million
ARC LIEF	Botten and many others	A large memory, high performance computing system for the ac3 Research Consortium	$718,000
ARC Discovery	Beaumont, Pitman, Thueller, Williams	Where will species go? Revolutionising projections of species distributions with climate change	$400,000
ARC Discovery	Pitman, Beringer, Steffen, Richards, Wang	Reengineering a dynamic vegetation model to explore the stability of Australian terrestrial carbon	$280,000
ARC Discovery	Pitman, Wang, McGregor	Do terrestrial processes intensify Australian droughts?,	$240,000
ARC Linkage	Loosemore and many others	Assessing the adaptive capacity of hospital facilities to cope with climate-related extreme weather events: A risk management approach	$400,000
ARC Linkage	Sharma, Pitman, Tuteja	Integrated assessment of climate change, climate input errors and land-use change on soil-moisture and carbon-balance in a catchment simulation framework	$260,000
ARC Centre	Pitman and many others.	The ARC Centre of Excellence for Climate System Science	$21.4 million
ARC Discovery	Abramowitz, Leuning and Pitman	Are proposed land-based sinks for greenhouse gases resilient to climate change and natural variability?	$300,000
ARC Discovery	De Kauwe, and many others	Resilience of eucalypts to future droughts	$430,000
NHMRC	Green, Alexander, Bambric and Pitman	Health impacts of climate change on Indigenous Australians: identifying climate thresholds to enable the development of informed adaptation strategies	$350,000
NSW Environmental Trust	Pitman and many others	Dynamically downscaled climate projections for the Eastern Seaboard	$200,000
ARC LIEF	Botten and many others	Strengthening merit-based access and support at the new NCI petascale supercomputing facility	$3.65 million
ARC Linkage	Newell and many others	Creating a Climate for Change: From Cognition to Consensus	$200,000
ARC Super Science Fellowships	England and many others	Precipitation-groundwater interactions over eastern Australia: climate change impacts at multiple scales	$835,000
ARC LIEF	Pitman and many others	Connecting big data with high performance computing for climate science	$490,000
ARC Centres	Pitman and many others	The ARC Centre of Excellence for Climate Extremes	$30 million

Full publication list

Students I have supervised are underlined, Research Fellows I have supervised are italicised

Books

1. Aplin, G., Mitchell, P., Cleugh, H.A., Pitman, A.J. and Rich, D.C., 1995, *Global Environmental Crises*, *An Australian Perspective*, Oxford University Press, 317pp. ISBN 0 19 553600 2.

2. Aplin, G., Beggs, P., Brierley, G., Cleugh, H.A., Curson, P., Mitchell, P., Pitman, A.J. and Rich, D.C., 1999, *Global Environmental Crises*, *An Australian Perspective*, Oxford University Press, 392pp. ISBN 0 19 550827 0. (Second edition).

3. *Vegetation and Climate Interactions in Semi Arid Regions*, 1991, edited by A. Henderson-Sellers and A.J. Pitman, Kluwer Academic Publishers, 238pp. ISBN 0-7923-1061-6.

Major Reports

1. Sutton, G., Rathjen, D., Gunasekera, D., Howden, M., Mitchell, C., Nicholls, A.J. Pitman, N., Smith, N., Whelan, R., 2007, *Climate change in Australia: regional impacts and adaptation, managing the risk for Australia*, report to the Prime Minister's Science, Engineering and Innovation Committee, 64pp.

2. *2011 Strategic roadmap for Australian research infrastructure, Department of Innovation, Industry, Science and Research*, 97pp. Contributing author to the e-research infrastructure chapter.

3. *To live within Earth's limits: an Australian plan to develop a science of the whole Earth system*, Australian Academy of Science (2010).

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