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A Methodology for Determining the Impact of Climate Change on Ozone Levels in an Urban Area
Final Report

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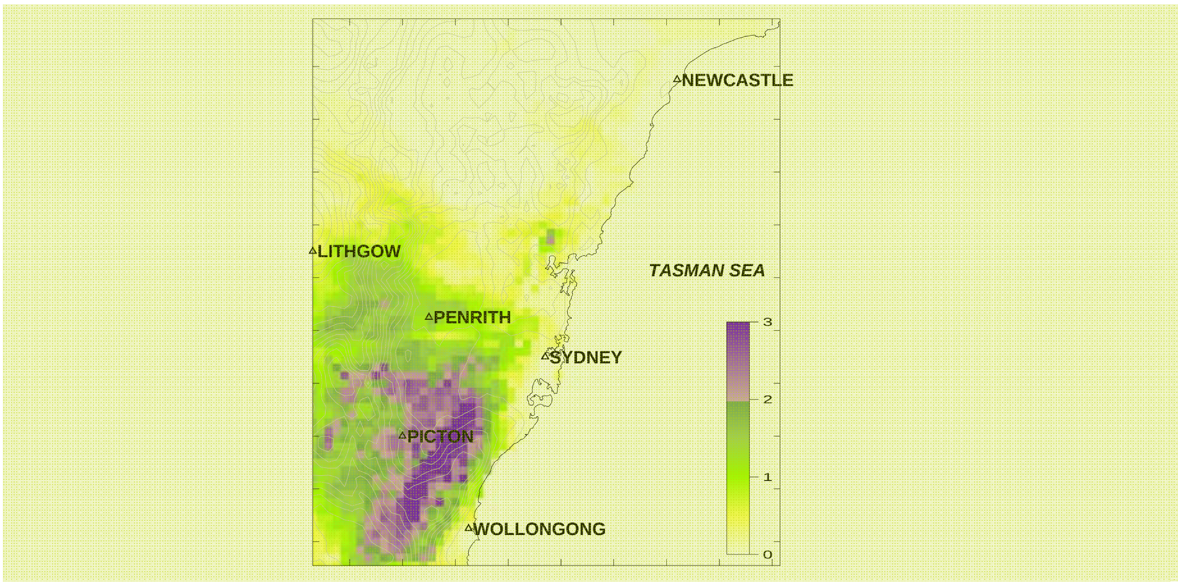

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1. EXECUTIVE SUMMARY

The primary objective of this project was to demonstrate a methodology that can robustly predict ozone concentrations under climate change conditions for any period or location in Australia, and specifically to give an insight into the impact of climate change on ozone levels in Sydney in 20 and 50 years time. The methodology comprises a dynamical downscaling system that uses 200 km resolution global climate simulations and, through a two stage process, generates 3 km resolution mesoscale meteorological and trace gas concentration fields over populated areas.

The system was assessed for Sydney and was found to perform well in the prediction of the historical ozone climatology, mesoscale meteorology and peak ozone concentrations. Projected changes in Sydney weather and peak ozone concentrations were calculated for a global climatology based on an A2 SRES greenhouse gas emission scenario (a high end CO_2 emissions growth scenario) and for a range of Sydney air pollution emission scenarios. When air pollution emissions were held fixed at current decade levels, it was found that the climate change scenario resulted in a 40% (2020–2030) and 200% (2050–2060) increase in the projected number of hospital admissions due to ozone pollution relative to 1996–2005. Analysis of the model results suggests that the increase in ozone-related morbidity resulted from an increase in daily maximum temperatures and the subsequent flow-on effects to factors which control ozone generation, such as the emissions of volatile organic compounds (which react to form ozone and are emitted at higher rates as temperatures increase), and increases in ozone precursor production rates (which also increase with ambient temperature).

The project also modelled the emissions reduction required to achieve compliance with AAQ–NEPM ozone standards in Sydney, for ozone generated under the 2051–2060 climatology. Ozone concentrations were predicted on the basis that emissions of carbon monoxide, volatile organic compounds and oxides of nitrogen (i.e. the precursors required for ozone generation) were progressively decreased by 40% and 60% compared to current decade emission rates. It was found that although the most stringent emission reductions lead to a 25 and 36% reduction in peak 1–hour and 4–hour ozone concentrations respectively, this was not sufficient to achieve compliance with the NEPM long term objectives for ozone.

The tools that were developed and assessed in this project are intended to provide a capability which can aid policy makers in formulating long term air pollution policies where the impact of climate change has to be considered. However, when applied for this purpose, it is recommended that the system be operated in an ensemble mode whereby a range of model projections are generated (based on different climate simulations and models) and an estimate of likelihood can be calculated.

It is further recommended that the system be enhanced to consider the formation and fate of fine particles (primary and secondary) as this air pollutant is considered to cause the largest air quality related health impacts in Australia.

2. GLOSSARY

AAQ–NEPM: Ambient air quality National Environment Protection Measure
AMG: Australian Map Grid
ANU: Australian National University
A2-ASF: A2- the Atmospheric Stabilization Framework
CCAM: Cubic Conformal Atmospheric Model
CMAR: CSIRO Marine and Atmospheric Research
CMAQ: the Community Multi-scale Air Quality
CO: Carbon monoxide
CTM: Chemical Transport Model
DEWHA: Department of Environment, Water Resources, Heritage and the Arts
DECC: NSW Department of Environment and Climate Change
DJF: December-January-February
GASP: Global Analysis and Prediction
GCTM: Global Chemical Transport Model
GCM: Global Climate System Model
GMR: Sydney Greater Metropolitan Region
IPCC: Intergovernmental Panel on Climate Change
MAM: March-April-May
MSLP: Mean sea level pressures
NCEP: The US National Centre for Environmental Prediction at Boulder
NCEPH: the National Centre for Epidemiology and Population Health at ANU
NEPM: National Environment Protection Measure
NO_x : Oxides of nitrogen
PM: Particulate matter
SLA: Statistical Local Area
SRES: IPCC Special Report on Emissions Scenarios
SOA: Secondary Organic Aerosol
SON: September-October-November
SST: Sea Surface Temperature
TAPM: The Atmospheric Pollution Model
TAPM-CTM: The Atmospheric Pollution Model - Chemical Transport Model
VOCs: Volatile organic compounds
VPX: the Tailpipe emission of Petrol fuelled vehicle
VLX: the Tailpipe emission of LPG fuelled vehicle
VPV: the Evaporative emission of Petrol fuelled vehicle