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Temperature response measurements from eucalypts give insight into the impact of Australian isoprene emissions on air quality in 2050

Kathryn M. Emmerson et al.

Correspondence to: Kathryn Emmerson (kathryn.emmerson@csiro.au)

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1. Australian distribution of eucalypt species used in this experiment

From Atlas of Living Australia, accessed 19.3.2020. https://www.ala.org.au/

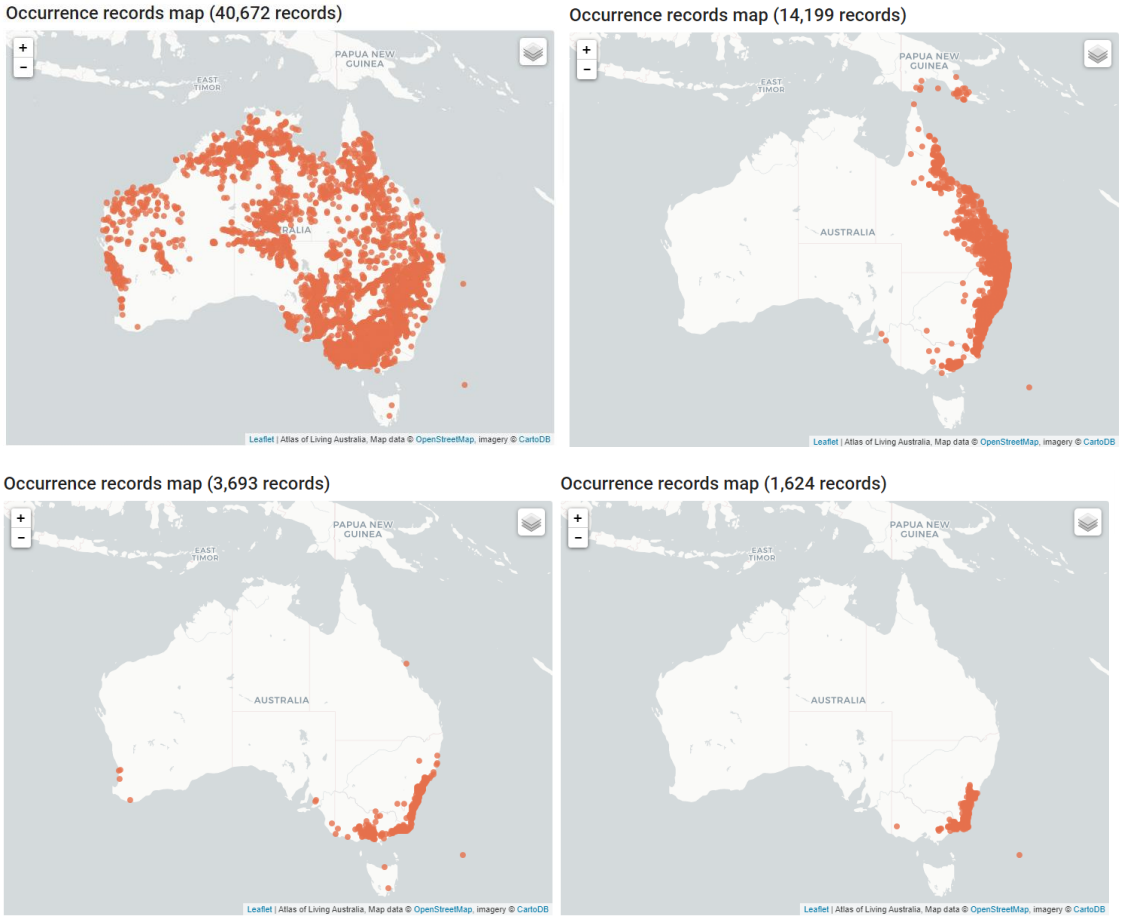

Figure S1 clockwise from top left. *E camaldulensis, E tereticornis, E smithii, E. botryoides*.

The occurrences are unfiltered records and include points in arboreta or points over water bodies.

2 Condition of sapling eucalypt specimens.

The trees are ~1.5 m tall and have produced plenty of leaves prior to the experiment.

Figure S2 photograph of experimental set-up. Left *E. camaldulensis*, right *E tereticornis*

There are 5 or 6 replicates in each of the growing treatments. Figure S3 shows the variation in isoprene emission for each species, alongside the default MEGAN response.

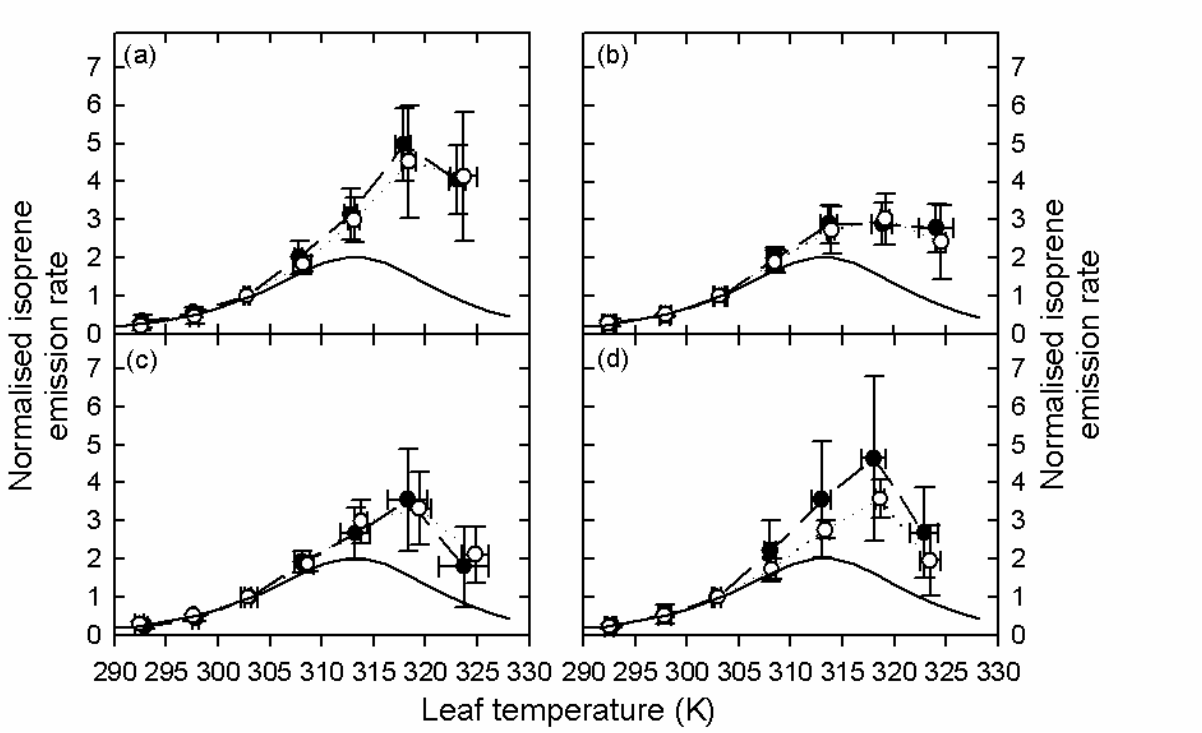

Figure S3 Temperature response of normalised isoprene emission rate from four *Eucalyptus* species (a) *E. camaldulensis*, (b) *E. botryoides*, (c) *E. smithii* and (d) *E. tereticornis* grown under two different temperature regimes. Open circles (dotted lines) are current climate and filled circles (dashed line) are future climate. The solid line in each panel is the normalised isoprene emission calculated using default MEGAN values. Data are normalised to the isoprene emission rate measured at a leaf temperature of 303 K. Error bars (horizontal and vertical) are means ± one standard deviation of 4-6 replicate plants.

3 ESA to NCAR plant functional type classifications

Constructed for 2010, the ESA uses 36 land cover classes to describe global vegetation. These land cover classes have been processed to the NCAR plant functional types as required by MEGANv2.1 using similar methods as Emmerson et al. (2016). The ESA dataset also describes the percentage tree and shrub cover, so only minor estimation of tree/shrub/grass coverage is required (for example where the percentage of total trees is split between broadleaf evergreen and deciduous species). Any remaining ground is classed as bare soil and contains no vegetation. Table S1 gives the details of how each ESA land cover type has been split into the NCAR plant functional types (PFTs) as required by MEGAN.

Table S1. Relationship of ESA land cover types to NCAR PFTs, sorted according to boreal, temperate and tropical biomes. Not all land cover types are present in Australia.

ESA land cover type		**NCAR Plant Functional Types**		
		Boreal **≤-19 °C**	**Temperate** **-19 °C ≤ X ≤ 15.5 °C**	**Tropical** **≥15.5 °C**
0	No Data			
10	Cropland, rainfed	90% Crop 10% Corn	90% Crop 10% Corn Bt Eg T	90% Crop 10% Corn Bt Eg Tr
11	Herbaceous cover			
12	Tree or shrub cover			
20	Cropland, irrigated or post flooding			
30	Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous	85% Crop	85% Crop 15% Sb Eg T Bt Eg T	85% Crop 15% Gs C3 W Bt Eg T
40	Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%)		Sb Eg T 75% Bt Eg T 25% Bt Dc T	Gs C3 W 75% Bt Eg Tr 25% Bt Dc Tr
50	Tree cover, broadleaved, evergreen, closed to open (>15%)		Bt Eg T	Bt Eg Tr
60	Tree cover, broadleaved, deciduous, closed to open (>15%)	Bt Dc B	Bt Dc T	Bt Dc Tr
61	Tree cover, broadleaved, deciduous, closed (>40%)			
62	Tree cover, broadleaved, deciduous, open (15-40%)			
70	Tree cover, needleleaved, evergreen, closed to open (>15%)	Nt Eg B	Nt Eg T	

71	Tree cover, needleleaved, evergreen, closed (>40%)			
72	Tree cover, needleleaved, evergreen, open (15-40%)			
80	Tree cover, needleleaved, deciduous, closed to open (>15%)	Nt Dc B		
81	Tree cover, needleleaved, deciduous, closed (>40%)			
82	Tree cover, needleleaved, deciduous, open (15-40%)			
90	Tree cover, mixed leaf type (broadleaved and needleleaved)	50% Nt Dc B 50% Nt Eg B	33% Nt Eg B 33% Bt Eg T 33% Bt Dc T	50% Bt Eg Tr 50% Bt Dc Tr
100	Mosaic tree and shrub (>50%) / herbaceous cover (<50%)		Sb Eg T Bt Eg T	Gs C3 W Bt Eg Tr
110	Mosaic herbaceous cover (>50%) / tree and shrub (<50%)	Sb Dc B	Sb Dc T Sb Eg T	
120	Shrubland		34.5% Sb Eg T 34.5% Sb Dc T 25% Gs C3 Cl 50% Bt Eg T 50% Bt Dc T	25% Gs C3 W 50% Bt Eg Tr 50% Bt Dc Tr
121	Evergreen shrubland		Sb Eg T	
122	Deciduous shrubland		Sb Dc T	
130	Grassland	Gs C3 Cd	Gs C3 Cl 75% Bt Eg T 25% Bt Dc T	Gs C3 W 75% Bt Eg Tr 25% Bt Dc Tr
140	Lichens and mosses	-	-	-
150	Sparse vegetation (tree, shrub, herbaceous cover) (<15%)		10% Sb Eg T 10% Sb Dc T	
152	Sparse shrub (<15%)			

153	Sparse herbaceous cover (<15%)		80% Gs C3 Cl Bt Eg T	Gs C3 W Bt Eg Tr
160	Tree cover, flooded, fresh or brackish water		Bt Eg T	Bt Eg Tr
170	Tree cover, flooded, saline water		Bt Eg T	Bt Eg Tr
180	Shrub or herbaceous cover, flooded, fresh/saline/brackish water		Sb Eg T	
190	Urban areas		Sb Eg T Gs C3 Cl 50% Bt Eg T 50% Bt Dc T	 Gs C3 W 50% Bt Eg Tr 50% Bt Dc Tr
200	Bare areas	-	-	-
201	Consolidated bare areas	-	-	-
202	Unconsolidated bare areas	-	-	-
210	Water bodies	-	-	-
220	Permanent snow and ice	-	-	-

Notes: B = Boreal, T = Temperate, Tr = Tropical.

Nt Eg = needleleaf evergreen tree, Nt Dc = needleleaf deciduous tree, Bt Eg = broadleaf evergreen tree, Bt Dc = broadleaf deciduous tree, Sb Eg = evergreen shrub, Sb Dc = deciduous shrub, Gs C3 = grass (can be Cd = cold, Cl = cool or W = warm depending on climatic zone).

4 Climate models used for 2050 temperature projections.

Surface temperature data for eight models considered in the Climate Model Intercomparison Project CMIP5 were downloaded for Australia. https://www.climatechangeinaustralia.gov.au/en/climate-projections/explore-data/map-explorer/

The eight models are: CanESM2, CNRM-CM5, ACCESS1.0, MIROC5, HadGEM2-CC, NorESM1-M, GFDL-ESM2M and CESM1-CAM5. The models were chosen to represent a wide range in climate projections and were judged to have performed well against 20th century observations.

The period December to February was chosen to correspond with the summer field campaigns used in this work. The change in seasonal temperature is calculated compared to the seasonal average between 1986 and 2005.

A range in warming is predicted by the eight models, with maximums ranging between 1.74°C and 3.83°C. For the purposes of this study, an average change in temperature was calculated from the ensemble. These delta temperatures were re-gridded to suit the four domains used by the C-CTM.

5 Variation in observed standard deviation.

Figure S4 shows how often the best performing model in terms of statistical r^2 fit, CC_γT+LEF is within =/1 1 standard deviation of the isoprene observations Note the colour of the CC_γT+LEF run has changed to red here for visibility.

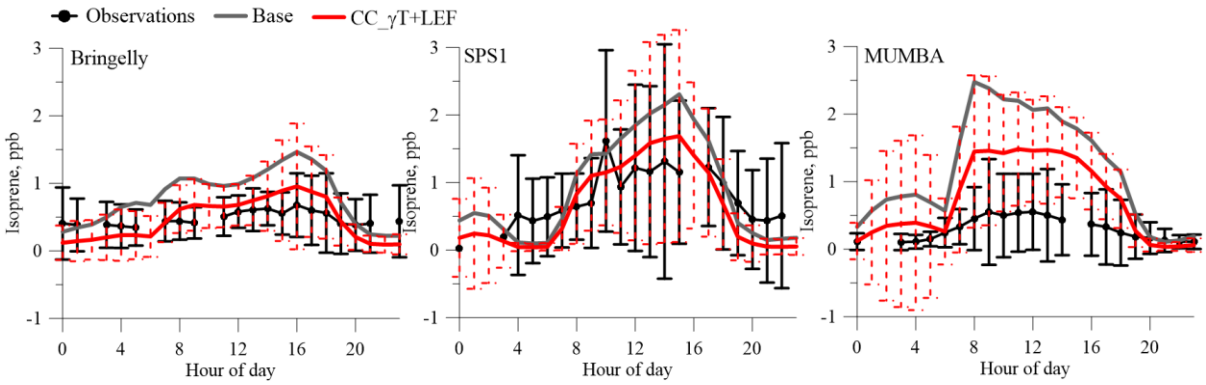

Figure S4 Average diurnal timeseries in modelled and observed isoprene, showing ±1 standard deviation for the observations and CC_γT+LEF run.

We calculate the percentage of modelled hours which are within +1 standard deviation of the observed isoprene as follows:
Base run (CC_γT+LEF run). Bringelly = 40% (90%); SPS1 = 89% (100%); MUMBA = 19% (33%).