ON DETERMINING THE IMPACT OF INCREASING ATMOSPHERIC CO_2 ON THE RECORD FIRE WEATHER IN EASTERN AUSTRALIA IN FEBRUARY 2017

Pandora Hope, Mitchell T. Black, Eun-Pa Lim, Andrew Dowdy, Guomin Wang, Acacia S. Pepler, and Robert J. B. Fawcett

This document is a supplement to "On Determining the Impact of Increasing Atmospheric CO_2 on the Record Fire Weather in Eastern Australia in February 2017," by Pandora Hope, Mitchell T. Black, Eun-Pa Lim, Andrew Dowdy, Guomin Wang, Acacia S. Pepler, and Robert J. B. Fawcett (*Bull. Amer. Meteor. Soc.*, **100**, S111–S117) • ©2019 American Meteorological Society • *Corresponding author:* Pandora Hope, pandora.hope@bom.gov.au • DOI:10.1175/BAMS-D-18-0135.2

OBSERVED TRENDS. The drought factor (DF) represents a temporally accumulated antecedent soil moisture deficit derived from temperature and rainfall data from 20 days prior to the targeted fire danger period. To estimate the change in (DF) due to increasing atmospheric CO_2 since 1960, we remove 1°C from daily maximum temperatures (Tmax), and leave the precipitation as is. The observed trend from 1960 to 2017 in January Tmax shows some variation across the country (Fig. ES1a). Eastern Australia has generally been warming, in some places by more than 2°C. Thus applying an increase of 1°C is a reasonable, conservative estimate of the increase due to atmospheric CO_2 increase over the period. Rainfall trends range from little change to a slight drying (Fig. ES1b), thus an estimate of zero change for the calculation of the DF is also reasonable.

BACKGROUND ANOMALIES TO CAPTURE THE CHANGE SINCE 1960. The sea surface temperature anomalies imposed are shown in Fig. ES2. Note that the low-CO_2 February 2017 forecasts in this study were initialized using anomalies of temperature and salinity through the full depth of the ocean. Anomalies of change in the atmospheric temperature and humidity and also land surface temperature and soil moisture were also imposed prior to initialization, following (Wang et al. 2016). Initialization shock was tested in the first three days' precipitation differences between the current and low-CO_2 environment, and the differences were smaller than the variability of the current climate rainfall forecast except in three small regions northwest of Australia and in the South Pacific.

ESTIMATED FFDI. The estimated FFDI in 2017 is the highest compared to the climatology. It follows the observed FFDI closely ($r = 0.88$); however, this close match will be partly due to the inclusion of the observed precipitation in the DF. A sensitivity analysis on each component could be done in a future study.

REFERENCES

Dowdy, A. J., 2018: Climatological variability of fire weather in Australia. *J. Appl. Meteor. Climatol.*, **57**, 221–234, https://doi.org/10.1175/JAMC-D-17-0167.1.

Wang, G., P. Hope, E.-P. Lim, H. H. Hendon, and J. M. Arblaster, 2016: Three methods for the attribution of extreme weather and climate events. Bureau of Meteorology Research Rep. 18, 31 pp., www.bom.gov.au/research/publications/researchreports/BRR-018.pdf.

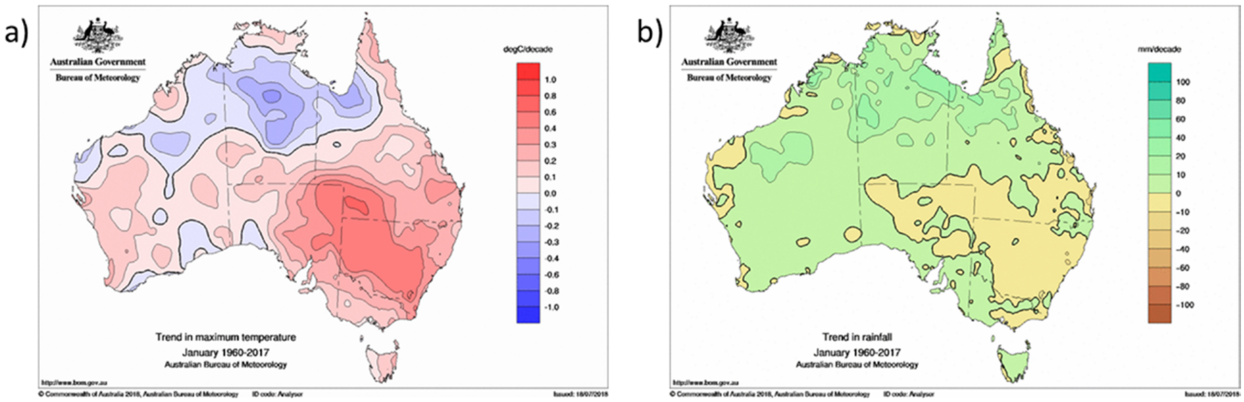

Fig. ES1. Trend 1960–2017 in (a) average January daily maximum temperature and (b) January precipitation.

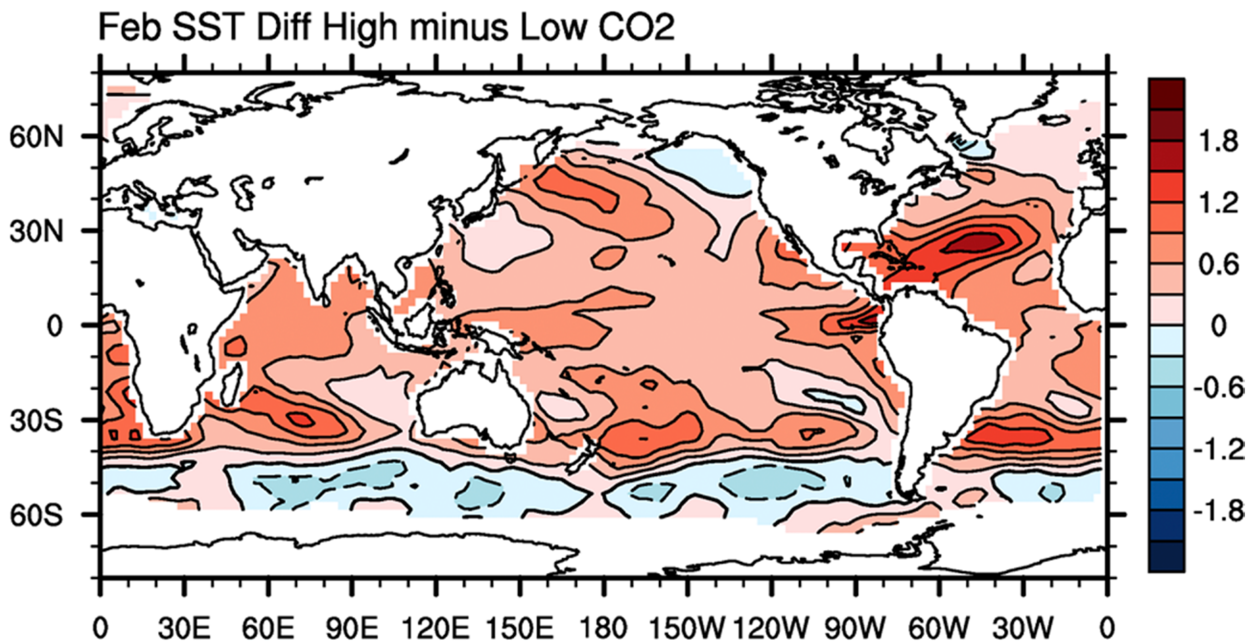

Fig. ES2. The sea surface temperature anomaly resulting from two long simulations of the POAMA model with high (~400 ppm) and low (~315 ppm) atmospheric CO_2 levels, with ensemble members initialized from the 2000s or 1960s respectively. Note that anomalies of ocean temperature and salinity through the full depth of the ocean are taken from the initial conditions, not just the sea surface temperature.

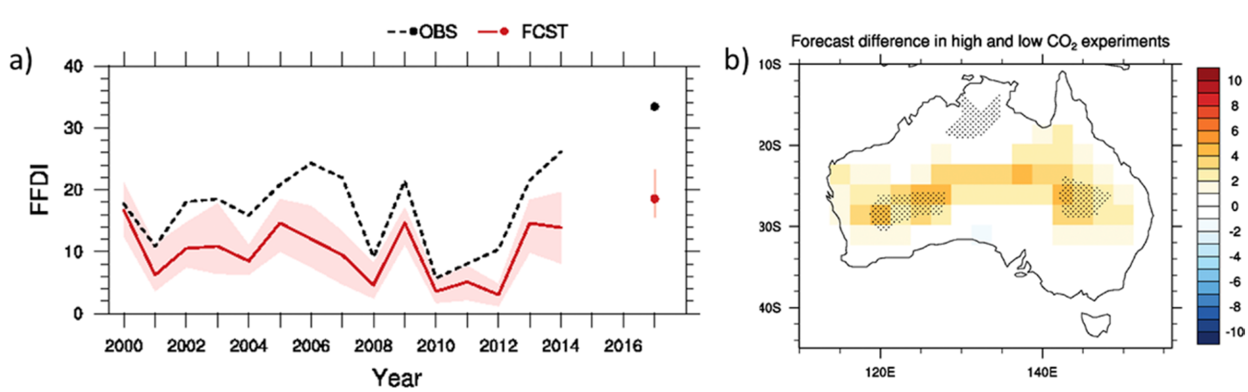

Fig. ES3. (a) Time series of FFDI based on observations and reanalyses (Dowdy 2018) and the hybrid estimate FFDI, including the spread of ensemble members, in the current climate. (b) Current minus low-CO_2 hybrid estimate of FFDI (FFDI units). Note there are many caveats to this method.