Smoke composition and flammability of tropical and temperate grasses

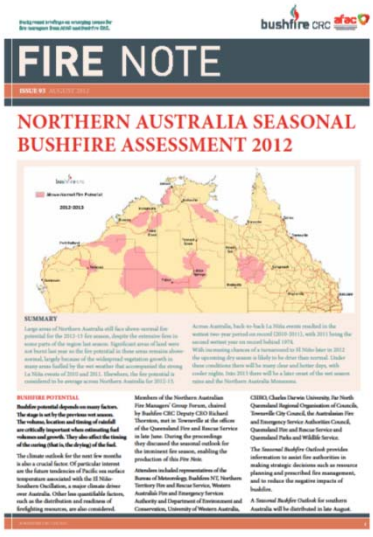
FACULTY OF AGRICULTURE & ENVIRONMENT

Dr. Malcolm Possell

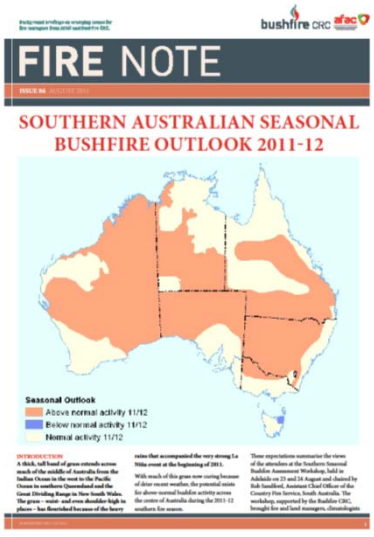
THE UNIVERSITY OF SYDNEY

bushfire CRC

Risk of grass fires


FIRE NOTE

NORTHERN AUSTRALIA SEASONAL BUSHFIRE ASSESSMENT 2012


FIRE NOTE

SOUTHERN AUSTRALIAN SEASONAL BUSHFIRE OUTLOOK 2011-12

Seasonal Outlook
Above normal activity 11/12
Below normal activity 11/12
Normal activity 11/12

2

Previous studies

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 115, D16314, doi:10.1029/2009JD013309, 2010

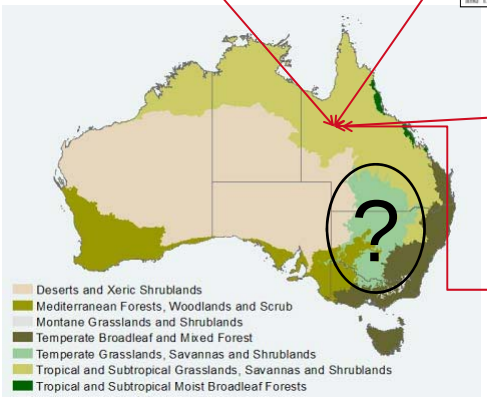
Trace gas emissions from savanna fires in northern Australia

C. Paton-Walsh,[1] N. M. Deutscher,[1] D. W. T. Griffith,[1] B. W. Forgan,[2] S. R. Wilson,[1] N. B. Jones,[1] and D. P. Edwards[3]

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 108, NO. D3, 8406, doi:10.1029/2001JD000841, 2003

Emission estimates of selected volatile organic compounds from tropical savanna burning in northern Australia

T. Shirai,[1] D. R. Blake,[2] S. Meinardi,[2] F. S. Rowland,[2] J. Russell-Smith,[3] A. Edwards,[3] Y. Kondo,[4] M. Koike,[5] K. Kita,[6] T. Machida,[7] N. Takegawa,[8] N. Nishi,[9] S. Kawakami,[1] and T. Ogawa[1]



Journal of Atmospheric Chemistry **18**: 33–56, 1994.
© 1994 *Kluwer Academic Publishers. Printed in the Netherlands.*

Measurements of Trace Gases Emitted by Australian Savanna Fires During the 1990 Dry Season

DALE F. HURST and DAVID W. T. GRIFFITH
Department of Chemistry, University of Wollongong, Wollongong, NSW, 2522, Australia
JOHN N. CARRAS and DAVID J. WILLIAMS
CSIRO Division of Coal and Energy Technology, North Ryde, NSW, 2113, Australia
PAUL J. FRASER
CSIRO Division of Atmospheric Research, Aspendale, VIC, 3195, Australia

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 99, NO. D8, PAGES 16,441–16,456, AUGUST 20, 1994

Trace gas emissions from biomass burning in tropical Australian savannas

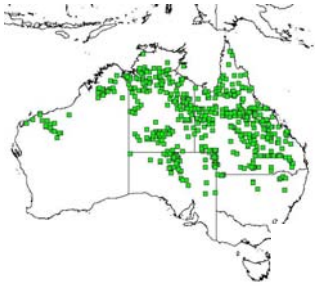
Dale F. Hurst[1] and David W. T. Griffith
Department of Chemistry, University of Wollongong, Wollongong, New South Wales, Australia
Garry D. Cook
CSIRO Tropical Ecosystems Research Centre, Darwin, Northern Territory, Australia

http://www.environment.gov.au/parks/nrs/science/bioregion-framework/terrestrial-habitats.html

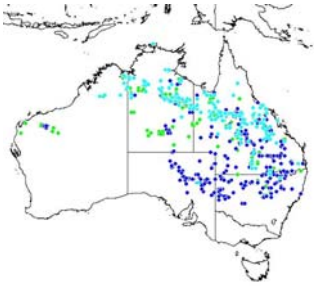
Study locations

Distribution of NT material

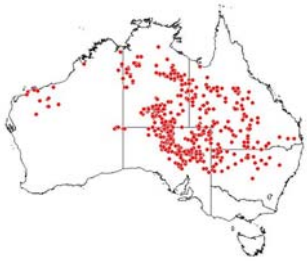
Aristida latifolia



Astrebla spp



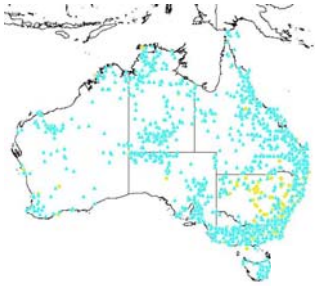
Astrebla pectinata



Figures: http://www.anbg.gov.au/avh/index.jsp 5

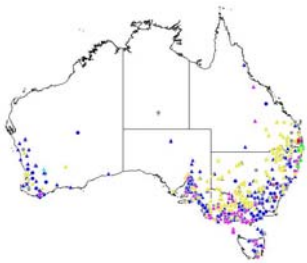
Distribution of ACT material

Themeda triandra



Eragrostis curvula

Phalaris spp.



Figures: http://www.anbg.gov.au/avh/index.jsp 6

Smoke composition and flammability measurements

IRGAs:
CO_2 and CO concentrations

PTR-MS:
VOC measurements

Mass-loss calorimeter:
Energy release and mass loss under a fixed irradiance

Definitions

Flammability (Anderson, 1970; Martin *et al*. 1994)

1. Ignitability: time taken until ignition on exposure to a heat source
2. Sustainability: the ability to maintain fire once it is ignited
3. Combustibility: rate of burning after ignition
4. Consumability: proportion of mass or volume consumed by fire

Emission factor

- The amount of a given compound released per amount of dry fuel consumed

8

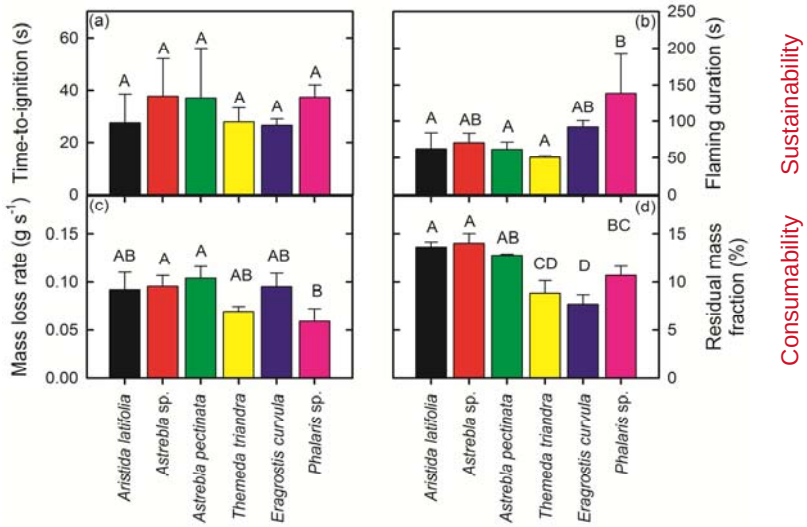
Flammability components

Ignitability

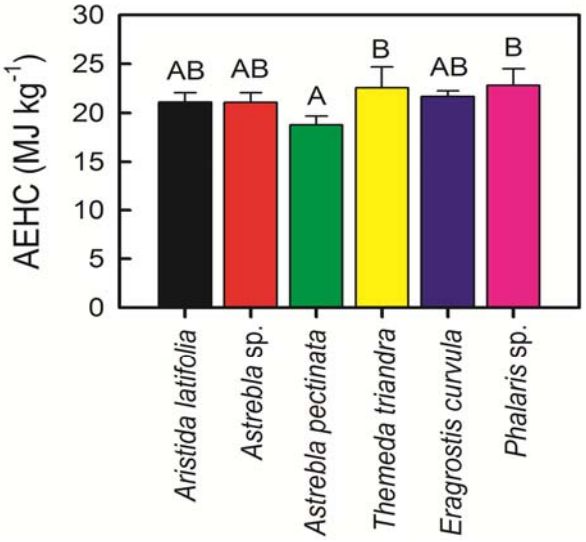
Sustainability

Combustibility

Consumability



Energy of combustion

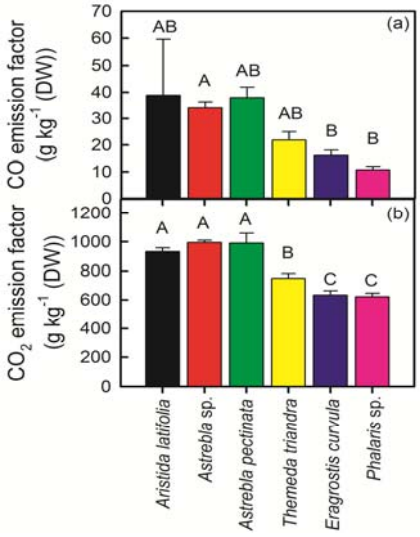


Multi-criteria analysis of flammability

Species	Normalised scores[a]					
	Time-to-ignition	Flame duration	Mass-loss rate	Residual mass fraction	Total	Rank
Aristida latifolia	91.18	13.96	73.17	6.22	46.13	3
***Astrebla* sp.**	0	23.40	81.28	0	26.17	6
Astrebla pectinata	5.88	13.21	100.00	20.12	34.80	5
Themeda triandra	88.24	0	23.04	81.98	48.32	2
Eragrostis curvula	100.00	47.17	80.02	100.00	81.80	1
***Phalaris* sp.**	2.94	100.00	0	53.31	39.06	4

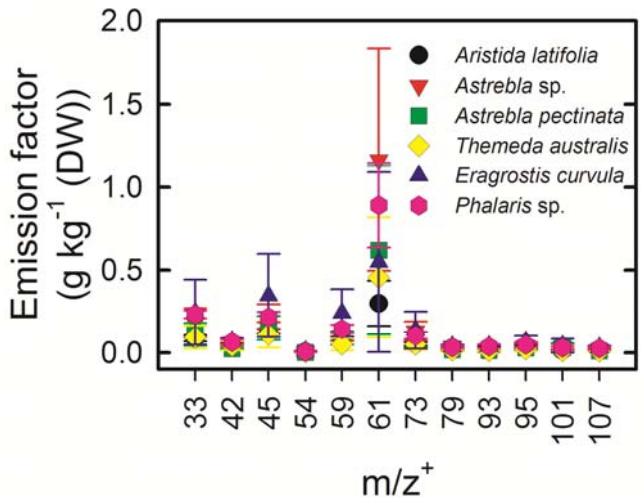
11

CO_2 and CO emission factors



12

VOC emission factors



13

VOC emission factors

	Australian savanna and grassland		Global savanna and grassland	
Compound(s)[a]	This study	Shirai et al. (2003)	Akagi et al. (2011)	Andreae and Merlet (2000)
Methanol[b]	0.162 ± 0.107	-	1.18 ± 0.41	1.30
Acetonitrile[b]	0.049 ± 0.023	-	0.11 ± 0.07	0.11
Acetaldehyde[b]	0.198 ± 0.130	-	0.57 ± 0.30	0.50 ± 0.39
Acrylonitrile[b]	0.004 ± 0.002	-	0.05 ± 0.02	
Acetone[b]	0.120 ± 0.086	-	0.16 ± 0.13	0.25 - 0.62
Acetic acid [d]	0.684 ± 0.485	-	3.55 ± 1.47	1.30
Methyl ethyl ketone[b]	0.094 ± 0.061	-	-	0.26
Benzene[b,c]	0.028 ± 0.001	0.035 ± 0.004	0.20 ± 0.08	0.23 ± 0.11
Toluene[b,c]	0.024 ± 0.014	0.012 ± 0.001	0.08 ± 0.07	0.13 ± 0.06
Phenol[b]	0.040 ± 0.022	-	0.52 ± 0.36	0.003
Methyl isobutyl ketone[b]	0.028 ± 0.023	-	-	-
Xylenes[b,c] Ethylbenzene[b] Benzaldehyde	0.018 ± 0.001	-	-	-

14

Summary

- There are a number of differences in the components of flammability and emission factors between grass species.
- Except for the emission factors for CO_2, no obvious patterns between the grasses were measured.
- The invasive grass has the potential to be more flammable than the native grasses.
- More data is needed from other grass species.
- Do grasses from other grasslands behave the same?

15

Acknowledgments

- Bill Harney for access to his property in the Northern Territory
- **University of Sydney**

Dr. Tina Bell
Dr. Tony Winters
Dr. Sebastian Pfautsch
Felipe Aires
Vicky Aerts
Valerie Densmore

- **ACT Parks and Conservation Service**

Neil Cooper (Lead end user)
Adam Leavesley

16