Are anthropogenic aerosols affecting rainfall?

Wolfgang Junkermann[1,2] and Jorg Hacker[2]

[1]Karlsruhe Institute of Technology, IMK-IFU, Garmisch-Partenkirchen Germany, [2] Flinders University, School of the Environment, Adelaide Australia


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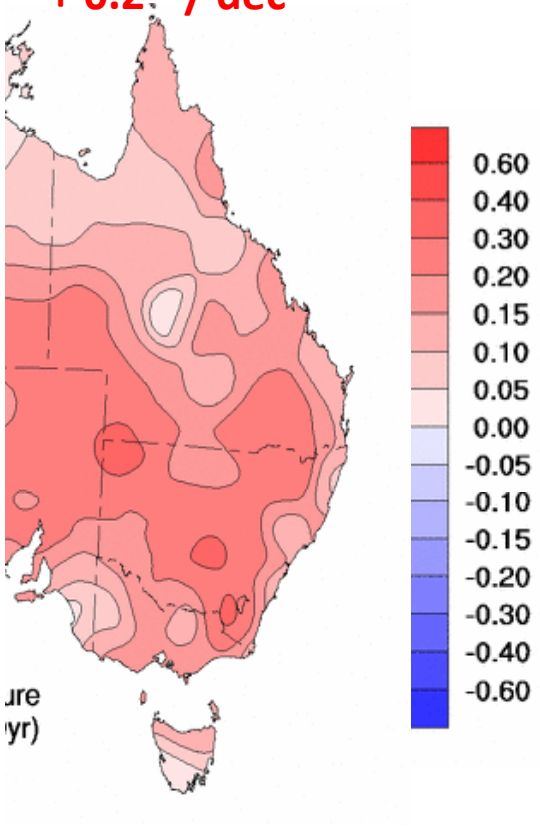
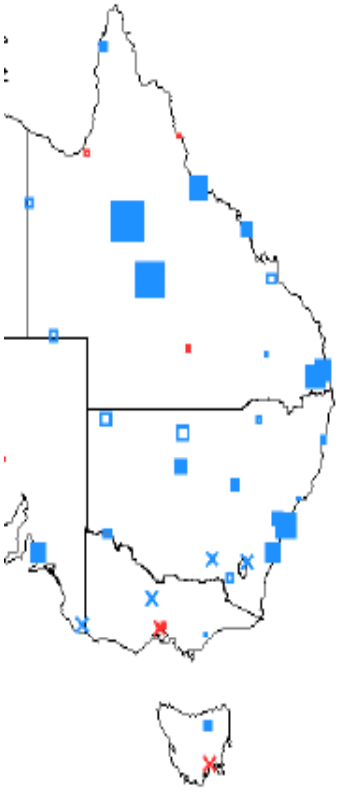
REGIONAL CLIMATE CHANGE IN AUSTRALIA, 1970-2010

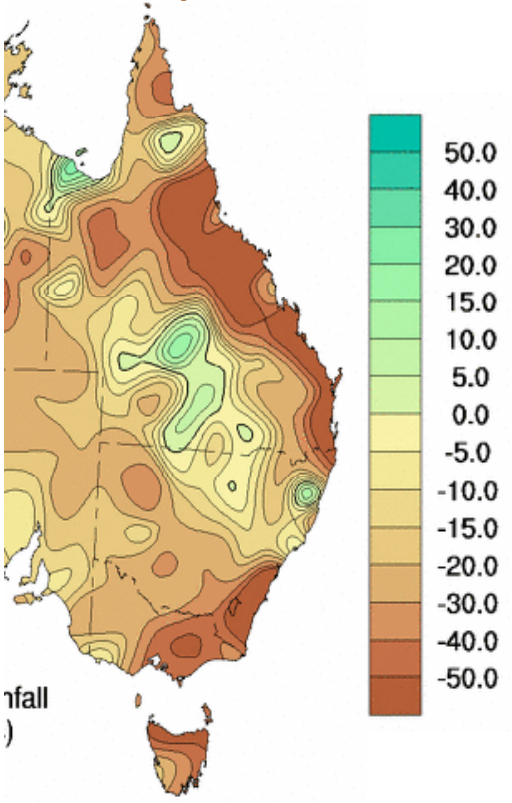
TEMPERATURE
+ 0.2 º / dec



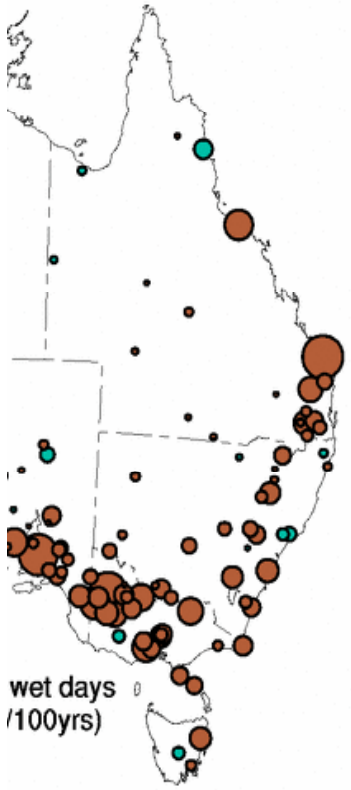
DEWPOINT
+0.25 º / dec

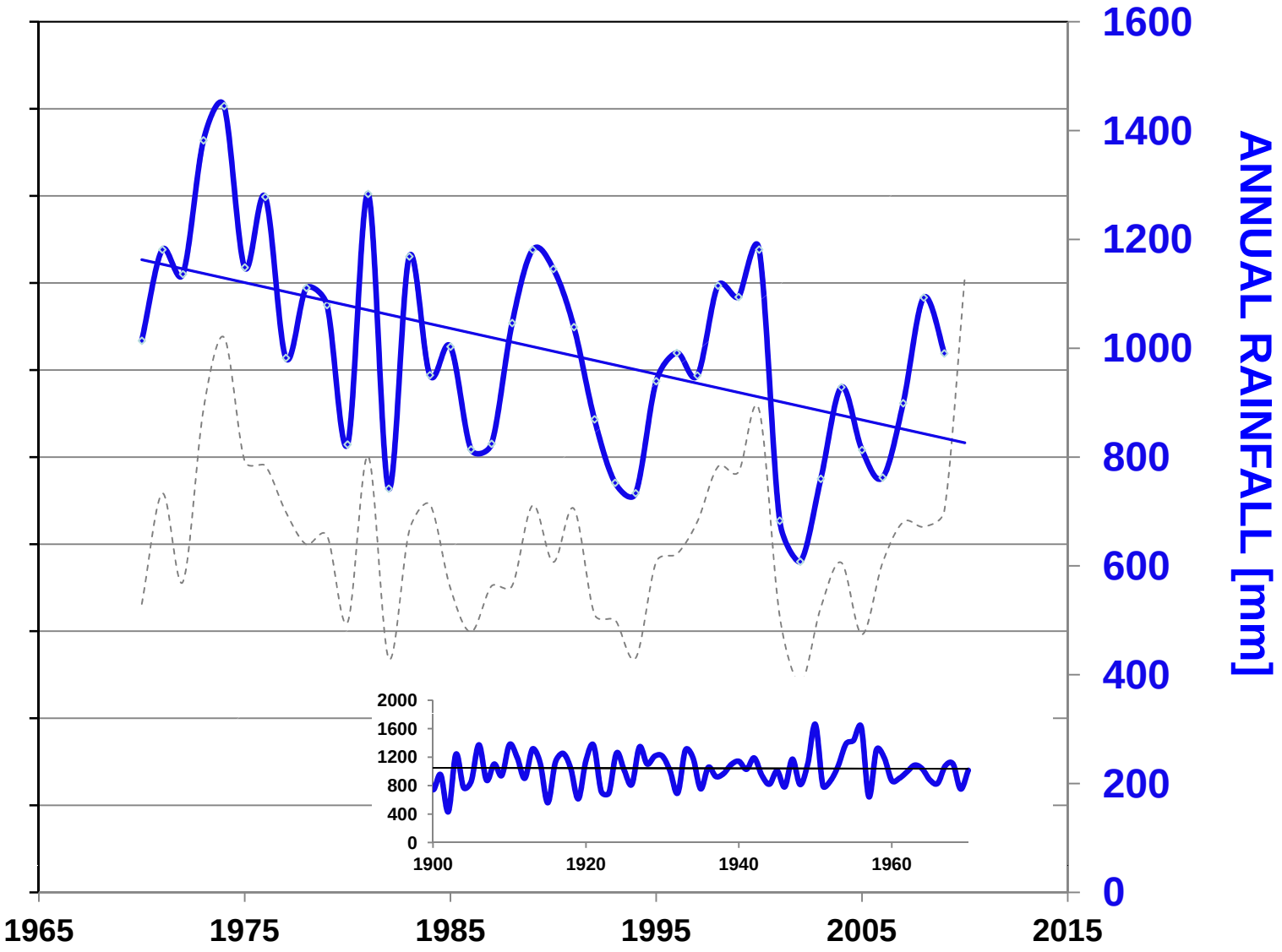


RAINFALL
- 40 mm / dec



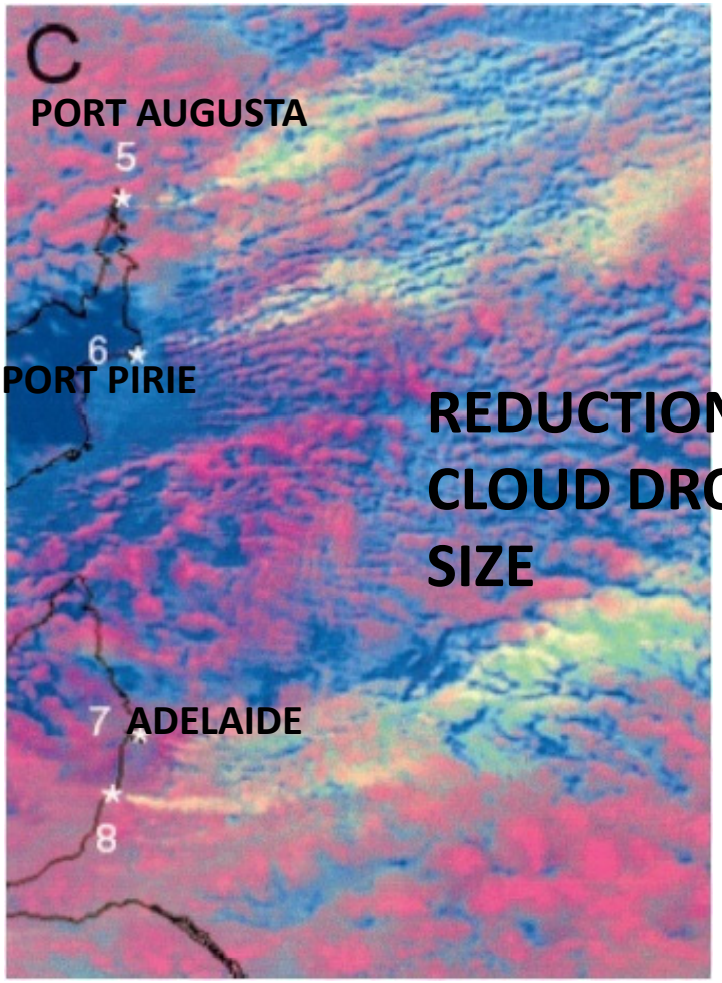
 # OF WET DAYS
- 6-8 d / dec




1600
1400
1200
1000
800
600
400
200
0
ANNUAL RAINFALL [mm]
1965
1975
1985
1995
2005
2015
2000
1600
1200
800
400
0
1900
1920
1940
1960

PORT AUGUSTA , SA, April 2011 / Sept. 2012

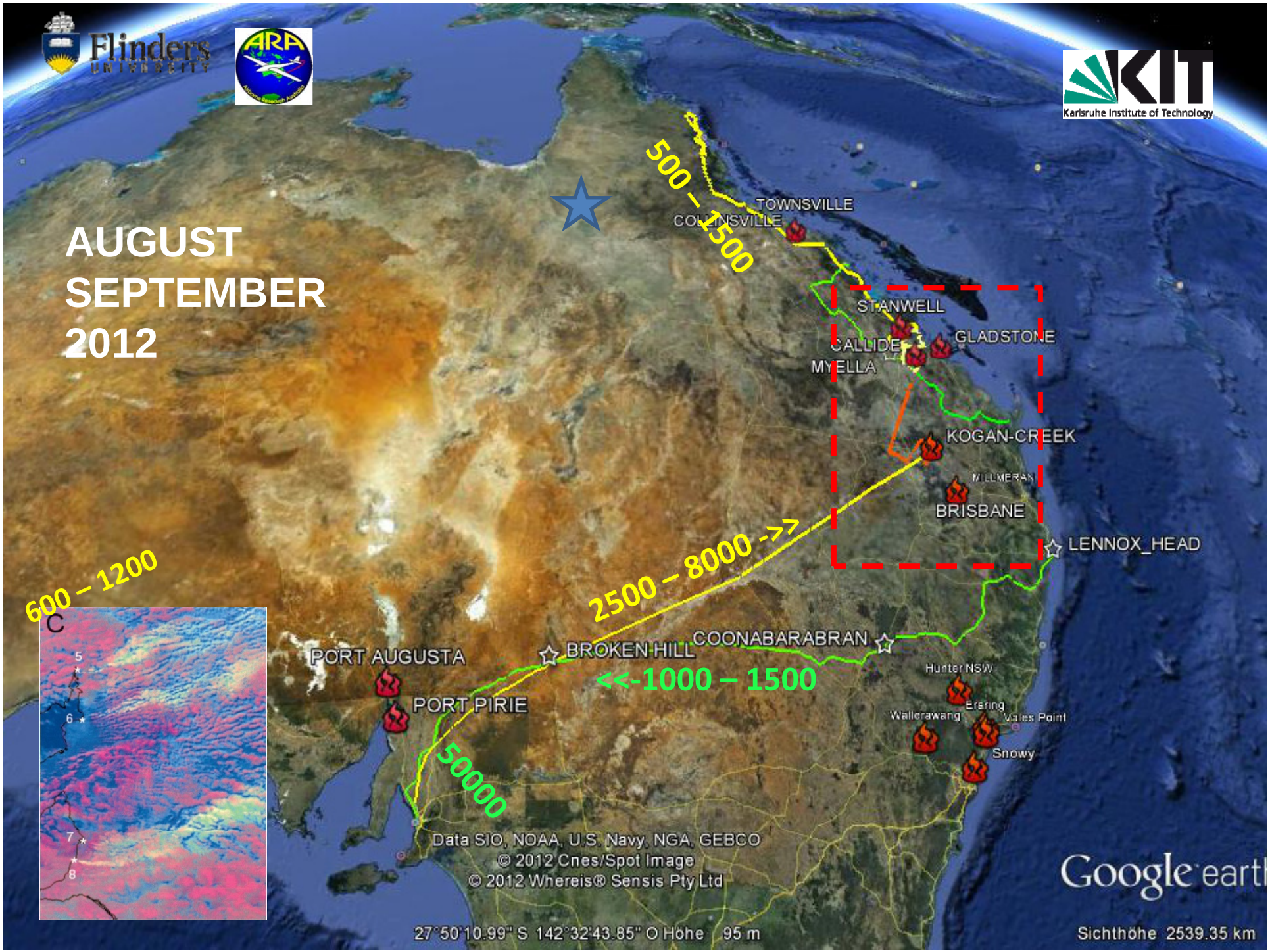
Daniel Rosenfeld
Science **287**, 1793 (2000);

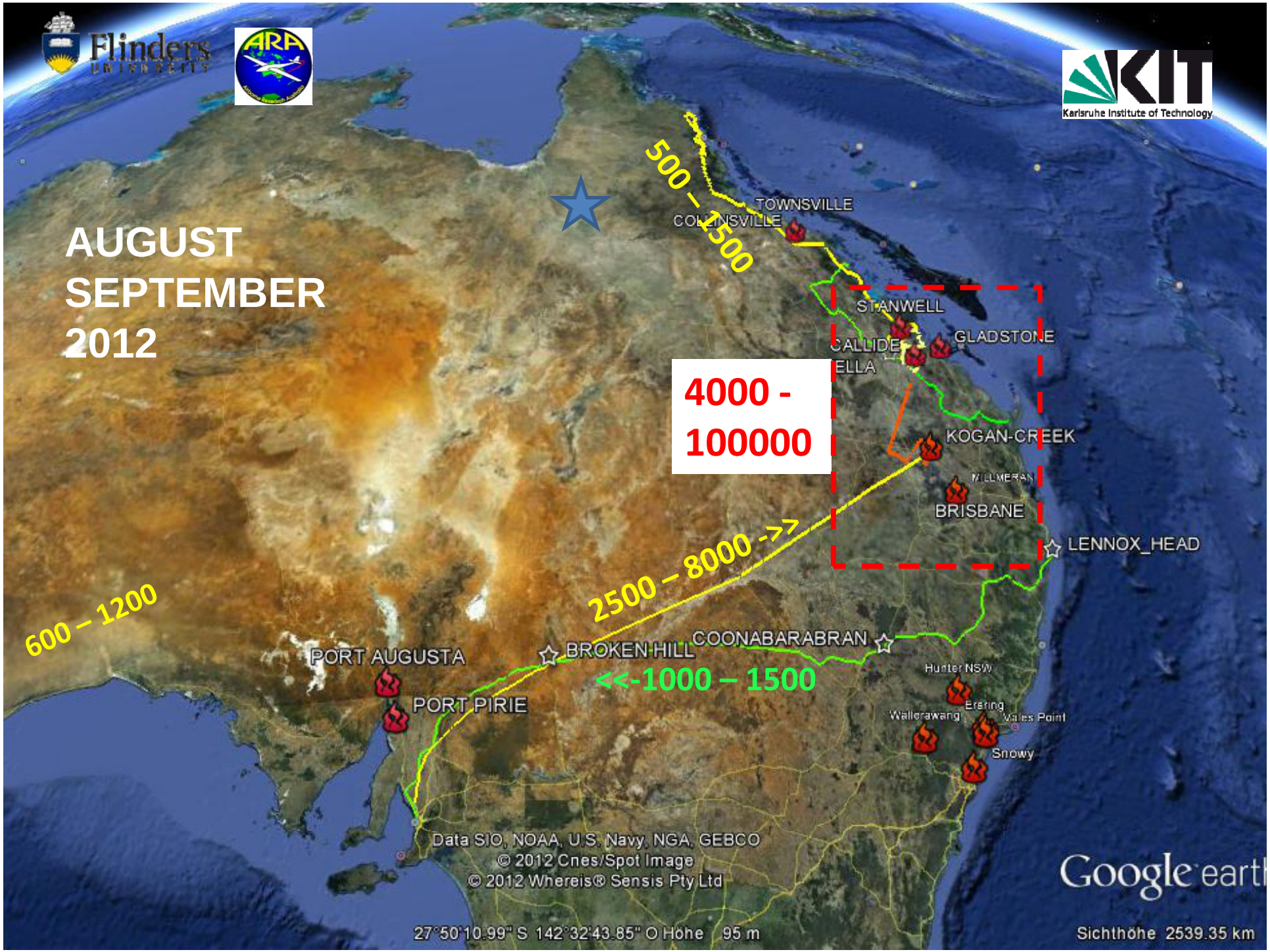


REDUCTION OF CLOUD DROPLET SIZE

Visible cloud effects after about 30 km ~ 2 h (HYSPLIT)

GRIMM SMPS	TSI 3010	GRIMM 1.108 OPC
5-350 nm	> 10 nm	300 nm – 20 um
2 min	1 sec	6 sec


Flinders UNIVERSITY
ARA
KIT
Karlsruhe Institute of Technology
AUGUST
SEPTEMBER
2012
500 – 1500
TOWNSVILLE
COLLINSVILLE
STANWELL
CALLIDE
MYELLA
GLADSTONE
KOGAN-CREEK
MILLMERAN
BRISBANE
LENNOX_HEAD
2500 – 8000 ->>
600 – 1200
C
5
6
7
8
PORT AUGUSTA
BROKEN HILL
COONABARABRAN
<<-1000 – 1500
PORT PIRIE
Hunter NSW
Ebring
Wallerawang
Vales Point
Snowy
50000
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Cnes/Spot Image
© 2012 Whereis® Sensis Pty Ltd
27°50'10.99" S 142°32'43.85" O Höhe 95 m
Google earth
Sichthöhe 2539.35 km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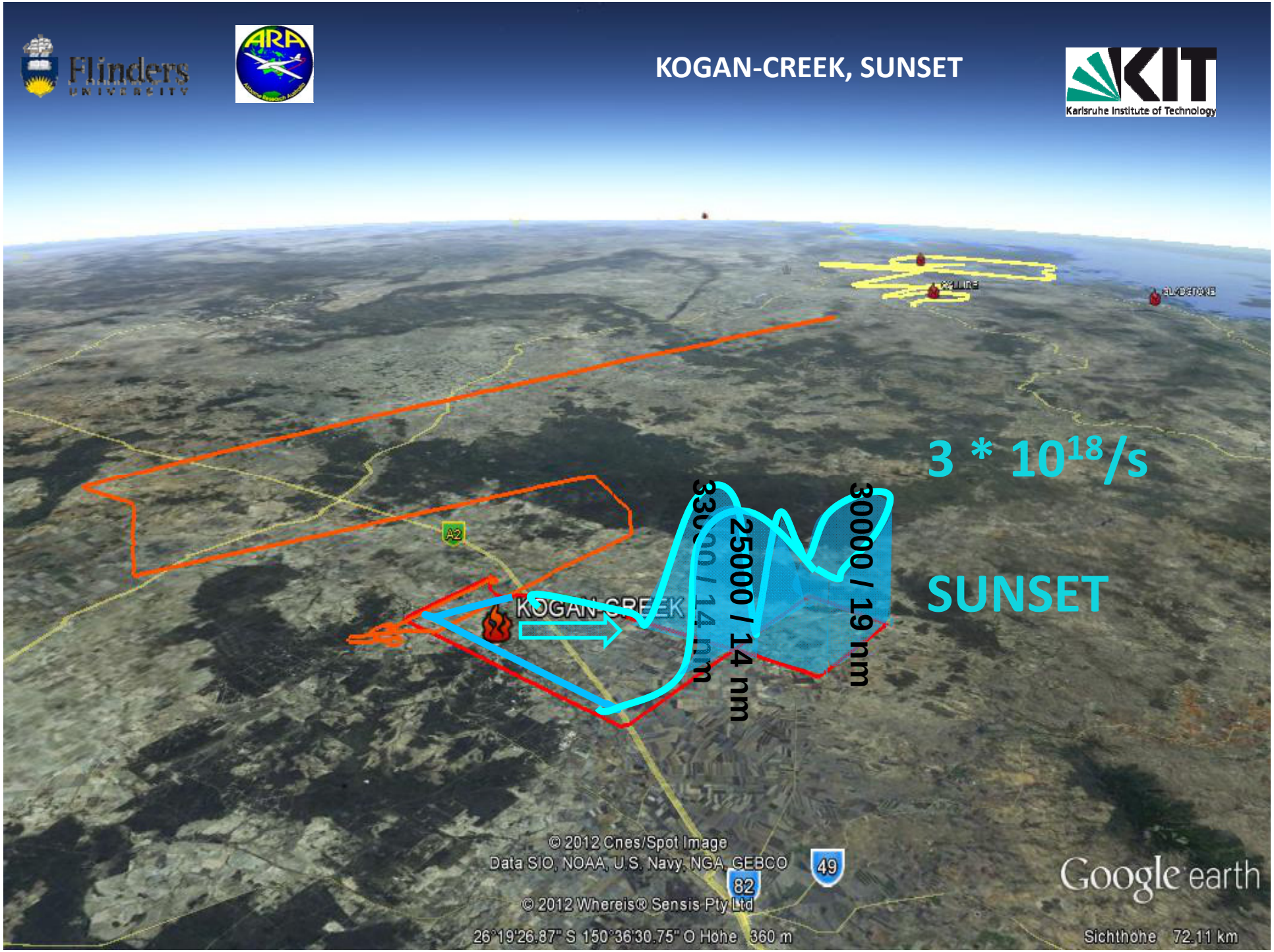
ARA
KIT
Karlsruhe Institute of Technology
AUGUST
SEPTEMBER
2012
500 – 1500
TOWNSVILLE
COLLINSVILLE
STANWELL
CALLIDE
ELLA
GLADSTONE
4000 -
100000
KOGAN-CREEK
MILLMERAN
BRISBANE
LENNOX_HEAD
2500 – 8000 ->>
600 – 1200
COONABARABRAN
BROKEN HILL
<<-1000 – 1500
PORT AUGUSTA
PORT PIRIE
Hunter NSW
Erering
Wallerawang
Vales Point
Snowy
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Cnes/Spot Image
© 2012 Whereis® Sensis Pty Ltd
27°50'10.99" S 142°32'43.85" O Höhe 95 m
Google earth
Sichthöhe 2539.35 km


KOGAN-CREEK, SUNSET
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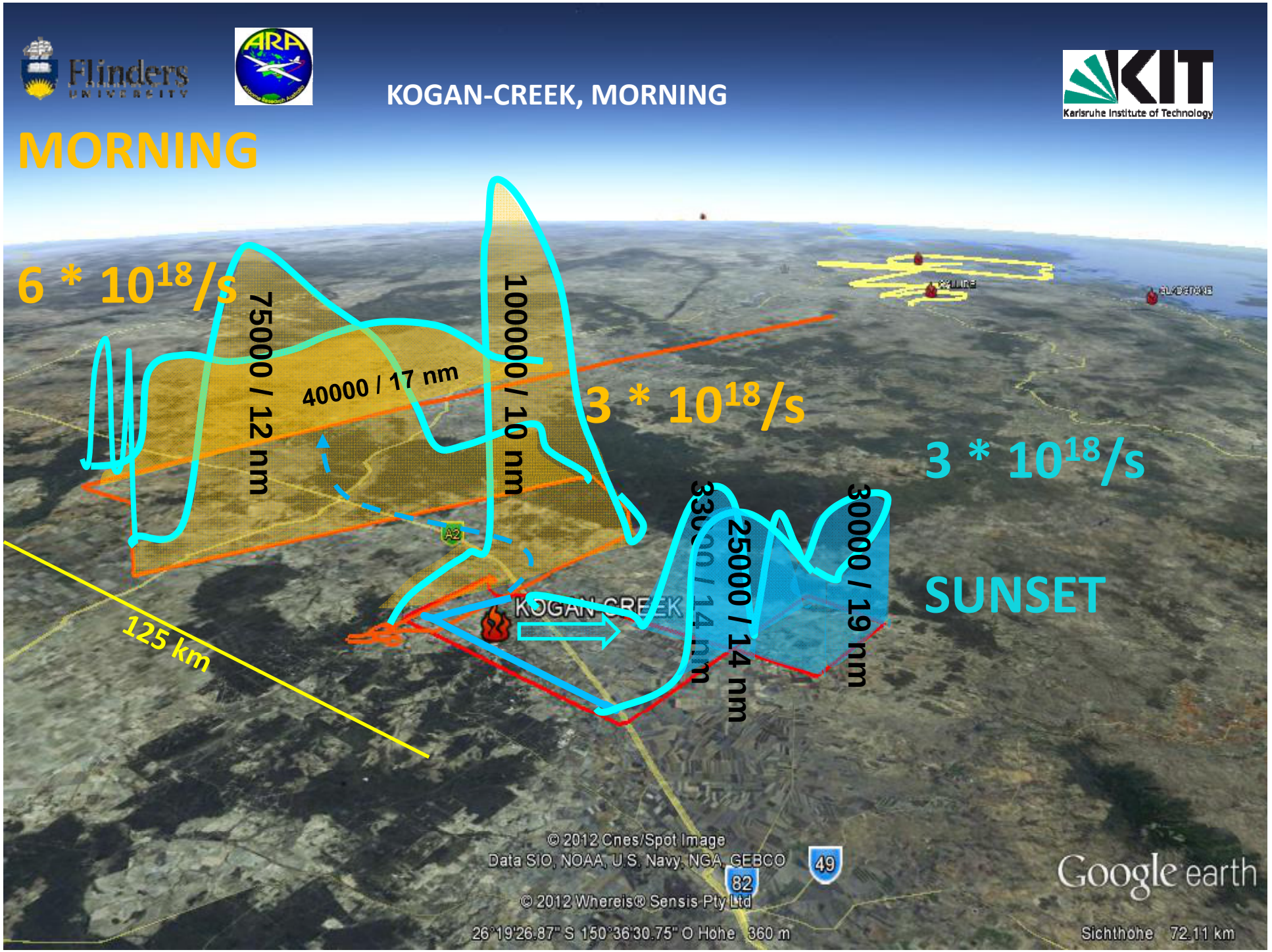
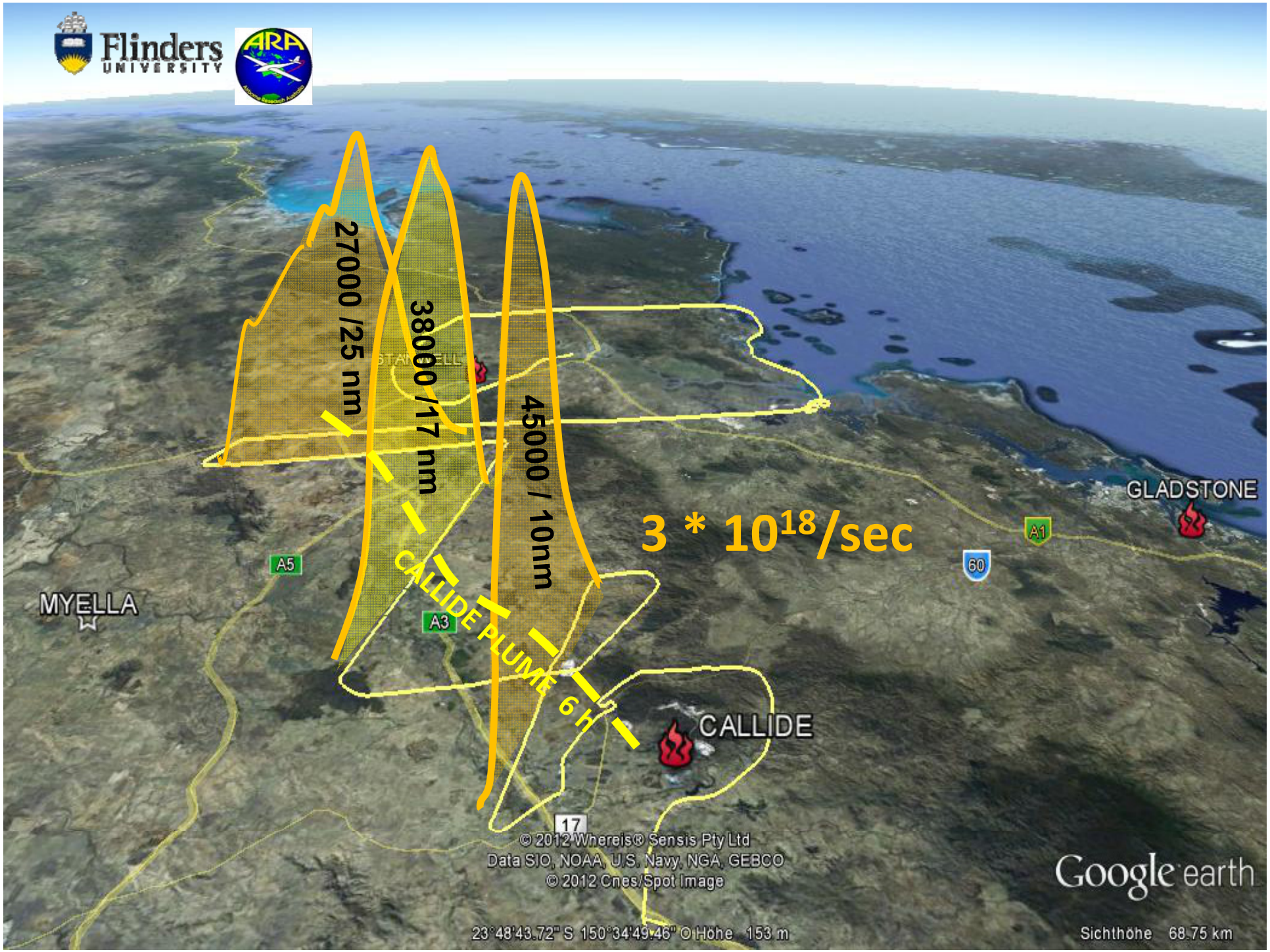
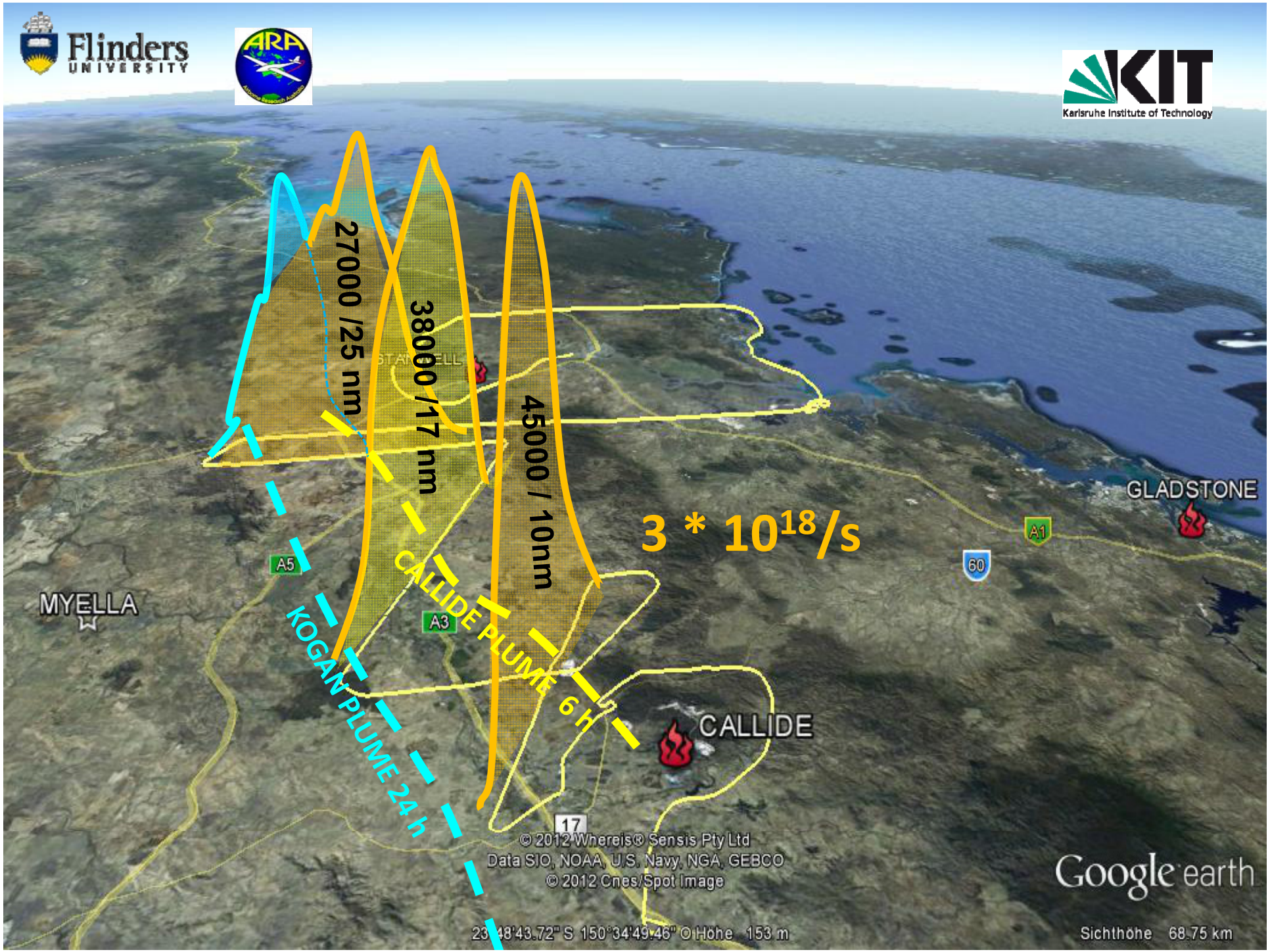
3 * 10^18/s
SUNSET
25000 / 14 nm
30000 / 19 nm
A2
49
82
© 2012 Cnes/Spot Image
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Whereis® Sensis Pty Ltd
26°19'26.87" S 150°36'30.75" O Hohe 360 m
Google earth
Sichthöhe 72.11 km


KOGAN-CREEK, MORNING
MORNING
6 * 10^18/s
75000 / 12 nm
40000 / 17 nm
100000 / 10 nm
3 * 10^18/s
3 * 10^18/s
30000 / 19 nm
25000 / 14 nm
SUNSET
125 km
KOGAN CREEK
A2
49
82
© 2012 Cnes/Spot Image
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Whereis® Sensis Pty Ltd
26°19'26.87" S 150°36'30.75" O Höhe 360 m
Google earth
Sichthöhe 72.11 km


Flinders UNIVERSITY
ARA
27000 /25 nm
38000 /17 nm
45000 / 10nm
3 * 10^18/sec
CALLIDE PLUME 6 H
GLADSTONE
MYELLA
CALLIDE
A5
A3
A1
60
17
© 2012 Whereis® Sensis Pty Ltd
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Cnes/Spot Image
Google earth
23°48'43.72" S 150°34'49.46" O Höhe 153 m
Sichthöhe 68.75 km


Flinders UNIVERSITY
ARA
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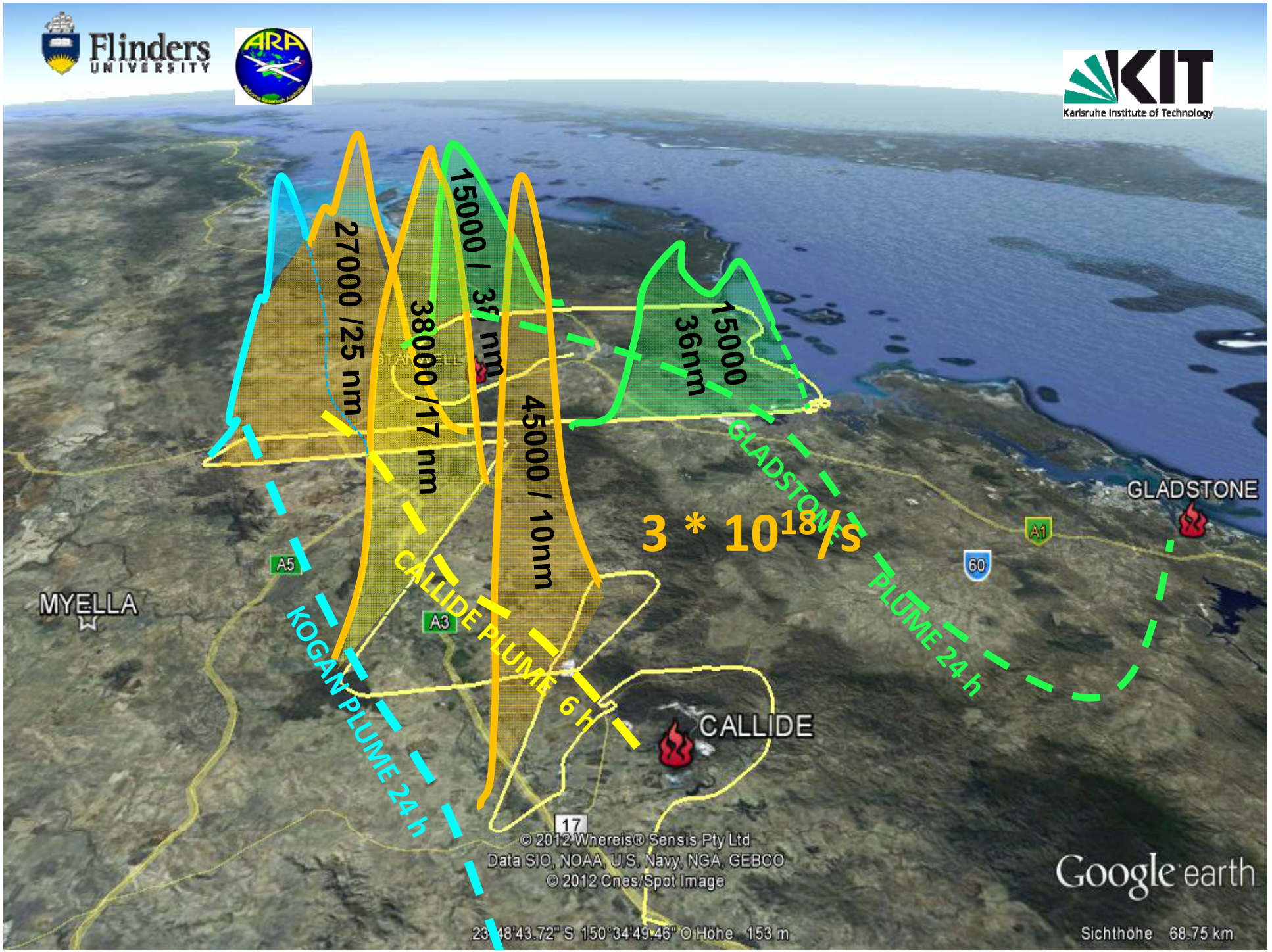
27000 /25 nm
38000 /17 nm
45000 / 10nm
3 * 10^18/s
CALLIDE PLUME 6 H
KOGAN PLUME 24 h
GLADSTONE
MYELLA
CALLIDE
A5
A3
A1
60
17
© 2012 Whereis® Sensis Pty Ltd
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Cnes/Spot Image
Google earth
Sichthöhe 68.75 km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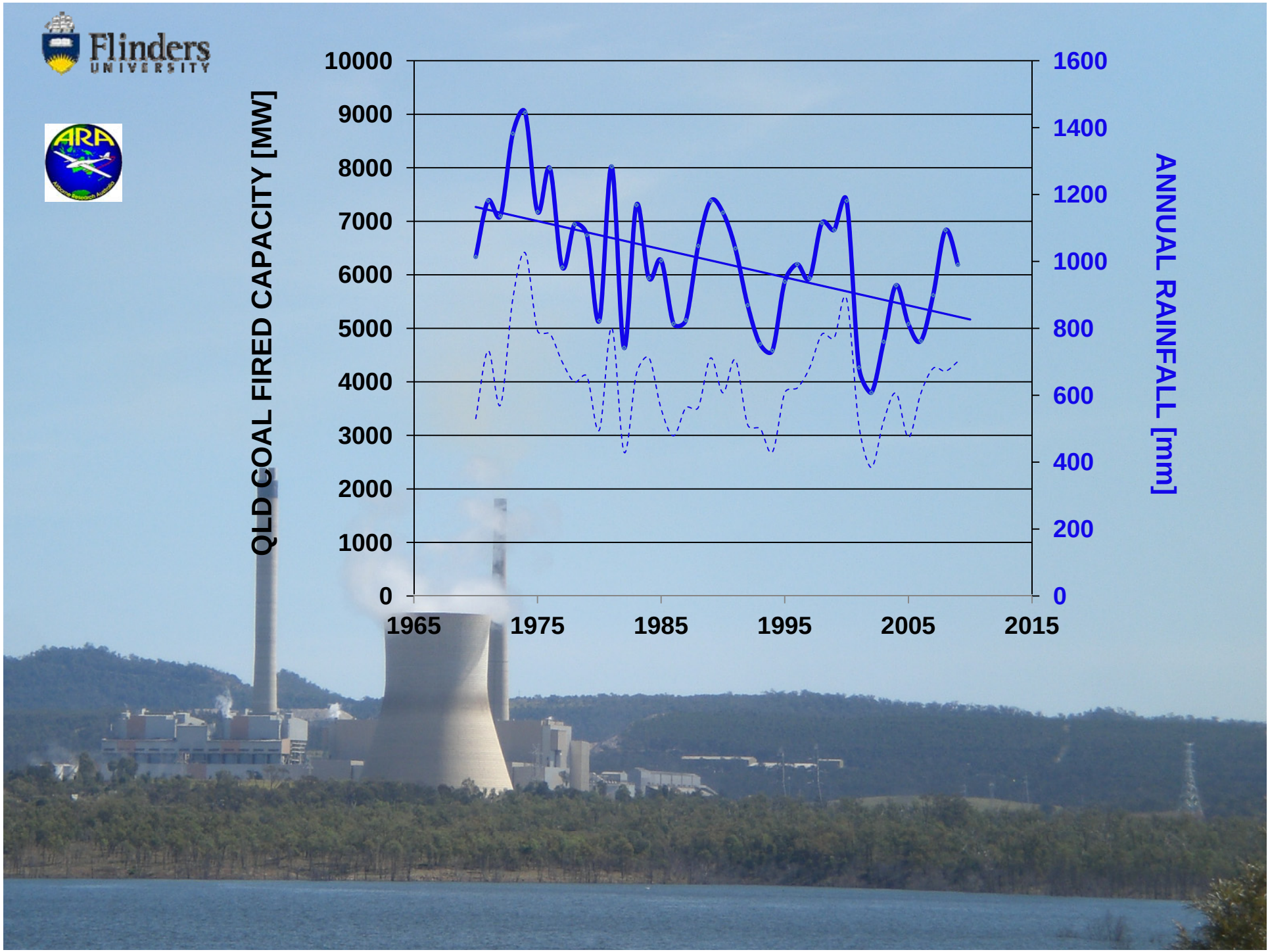
ARA
KIT
Karlsruhe Institute of Technology
27000 /25 nm
38000 /17 nm
15000 / 38 nm
45000 / 10nm
15000
36nm
GLADSTONE PLUME 24 h
3 * 10^18 /s
GLADSTONE
A1
60
A5
MYELLA
A3
CALLIDE PLUME 6 h
CALLIDE
KOGAN PLUME 24 h
17
© 2012 Whereis® Sensis Pty Ltd
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Cnes/Spot Image
Google earth
Sichthöhe 68.75 km


Flinders
UNIVERSITY
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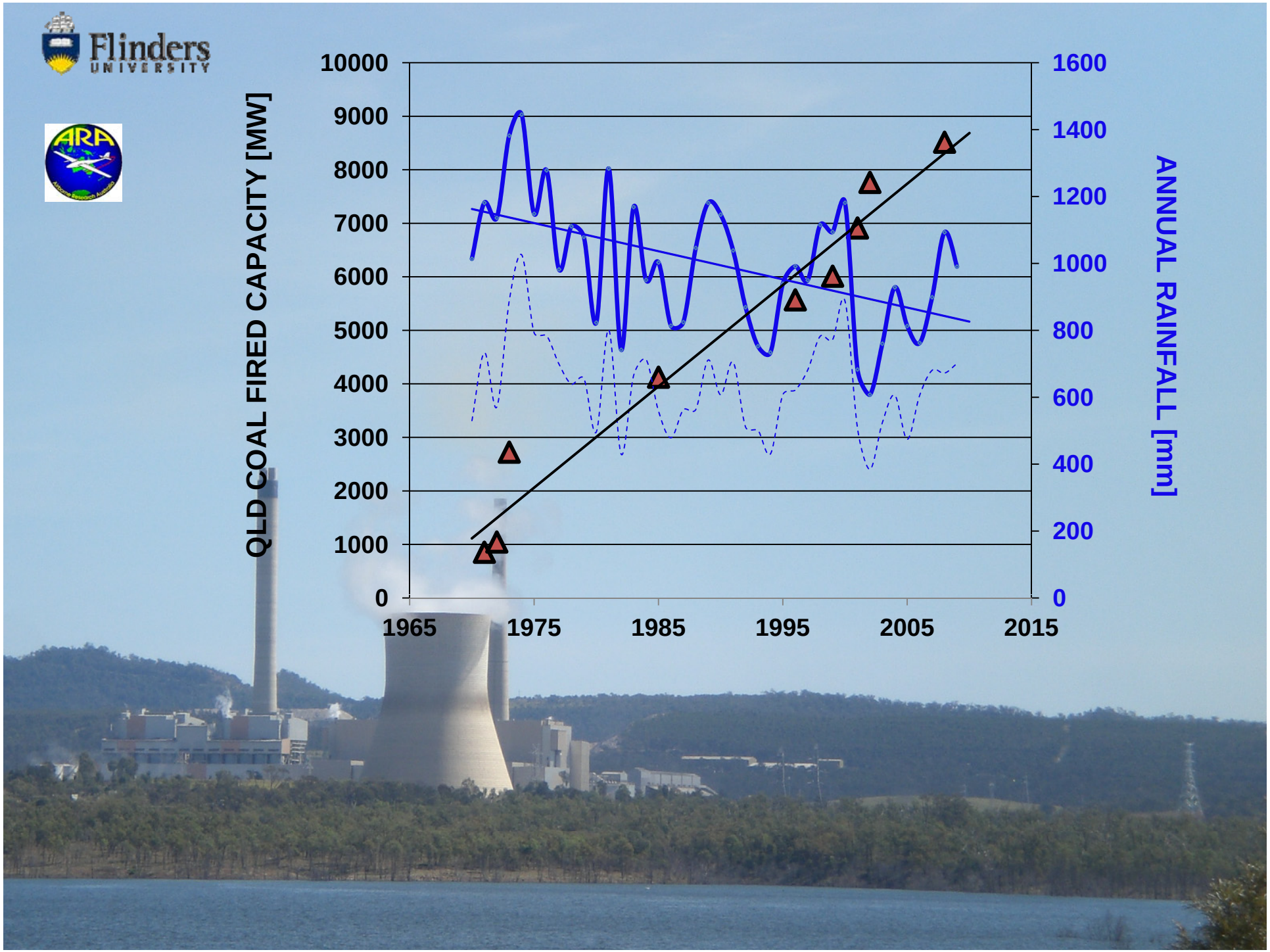
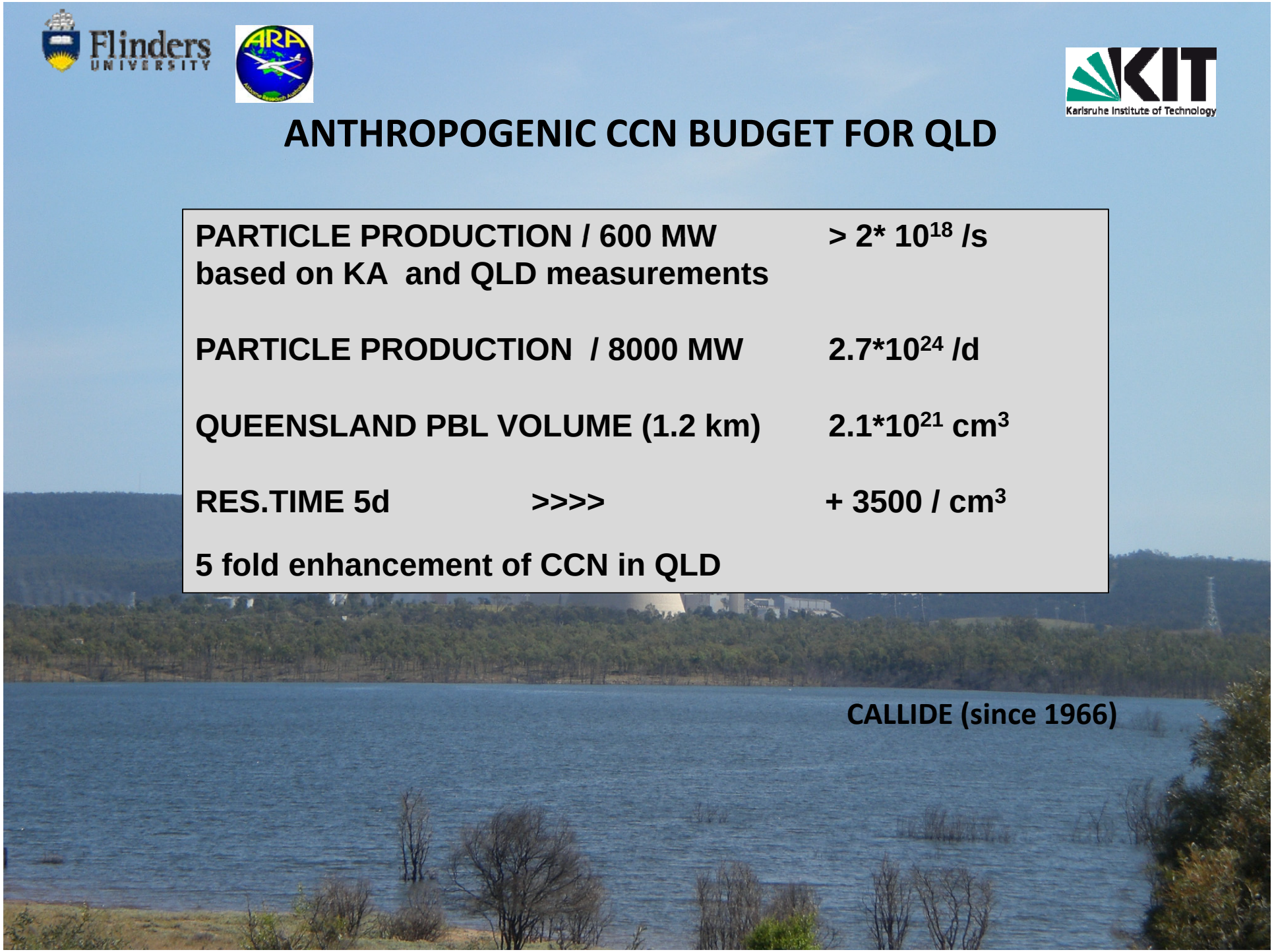
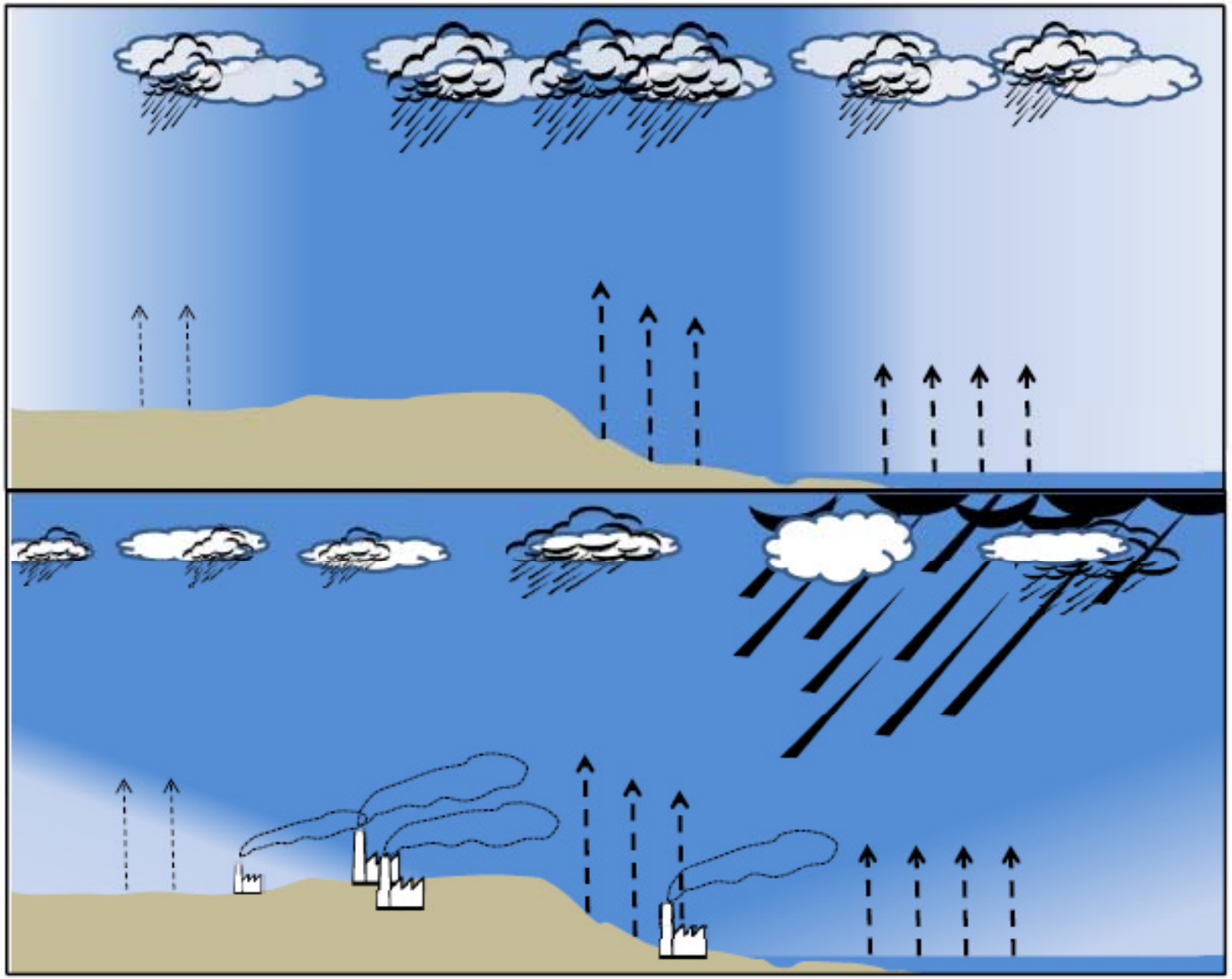
QLD COAL FIRED CAPACITY [MW]
ANNUAL RAINFALL [mm]
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1600
1400
1200
1000
800
600
400
200
0
1965
1975
1985
1995
2005
2015


Flinders
UNIVERSITY
ARA
QLD COAL FIRED CAPACITY [MW]
ANNUAL RAINFALL [mm]
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1600
1400
1200
1000
800
600
400
200
0
1965
1975
1985
1995
2005
2015

ANTHROPOGENIC CCN BUDGET FOR QLD

PARTICLE PRODUCTION / 600 MW based on KA and QLD measurements		> 2* 10^{18} /s
PARTICLE PRODUCTION / 8000 MW		2.7*10^{24} /d
QUEENSLAND PBL VOLUME (1.2 km)		2.1*10^{21} cm^3
RES.TIME 5d	>>>>	+ 3500 / cm^3
5 fold enhancement of CCN in QLD		





SUMMARY

RAINFALL DEFICIENCY

CCN ↑

SOURCES

-> HISTORIC TREND ANALYSIS

THANK YOU FOR YOUR ATTENTION

What‘s the climate effect of increased nucleation mode particles?

Western Australia
regional scale production of ultrafine aerosol following drastic land cover change

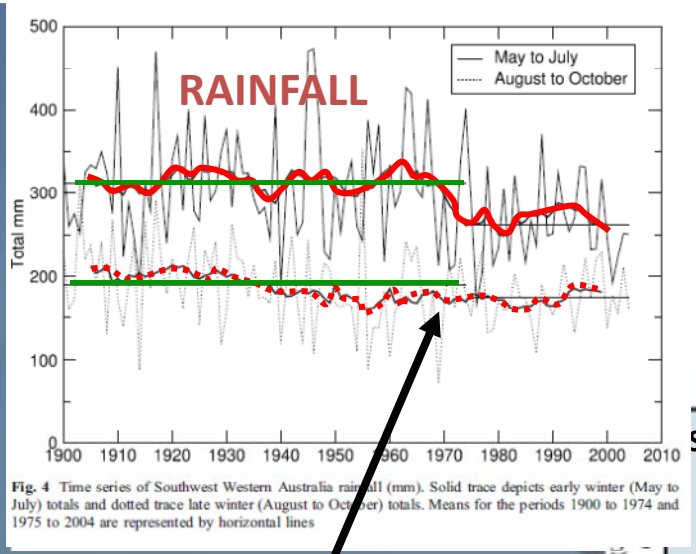


Fig. 4 Time series of Southwest Western Australia rainfall (mm). Solid trace depicts early winter (May to July) totals and dotted trace late winter (August to October) totals. Means for the periods 1900 to 1974 and 1975 to 2004 are represented by horizontal lines

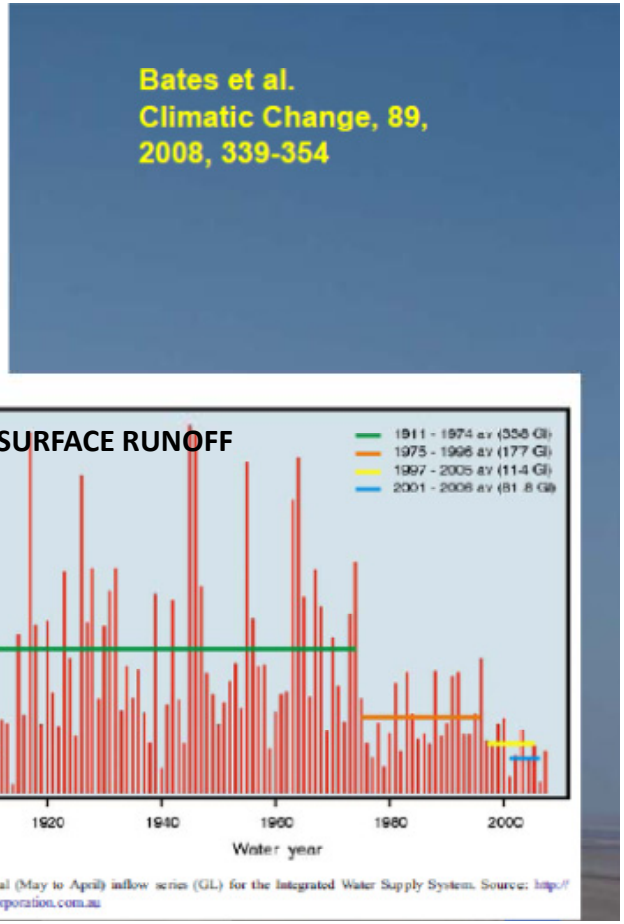
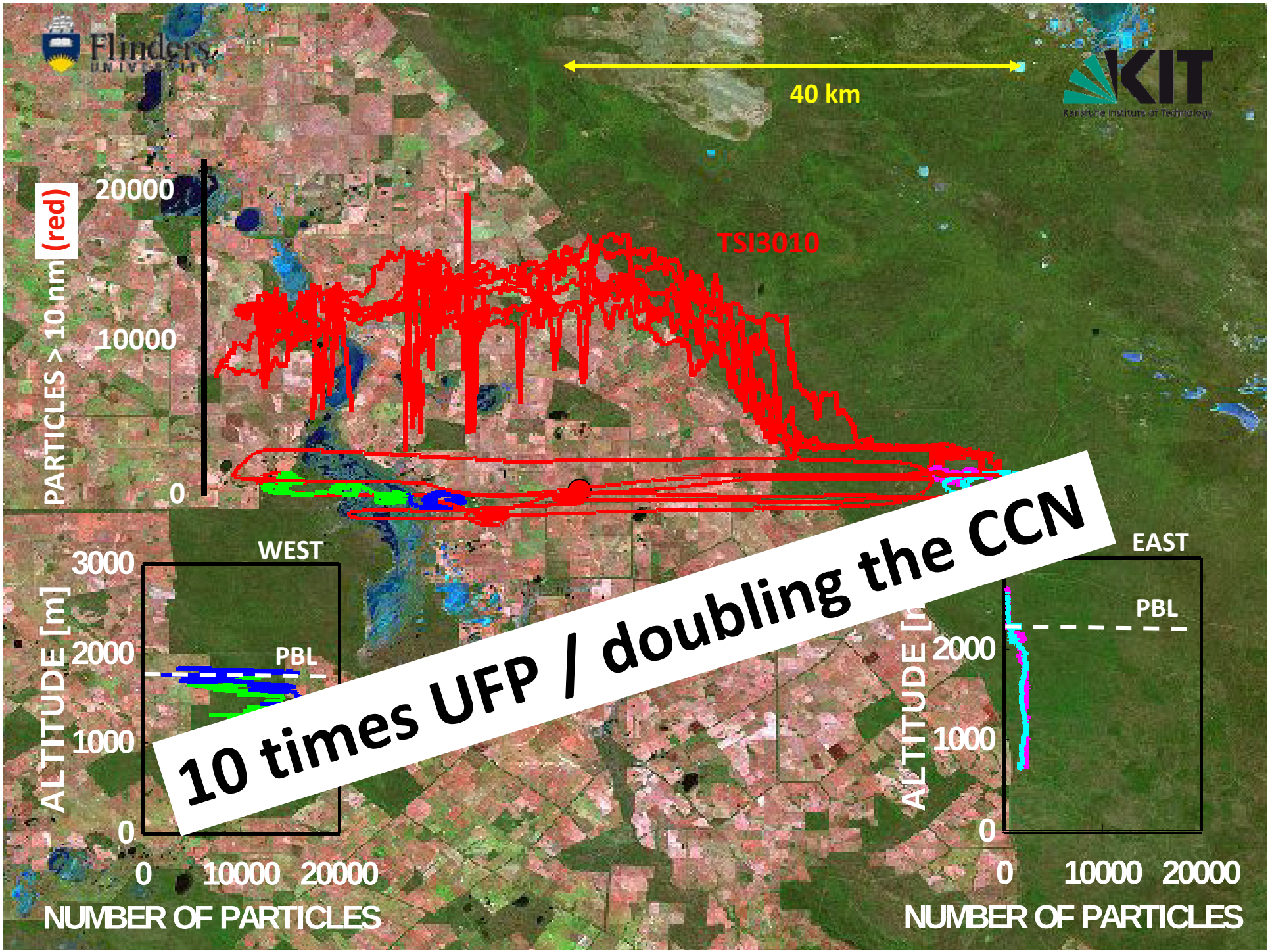
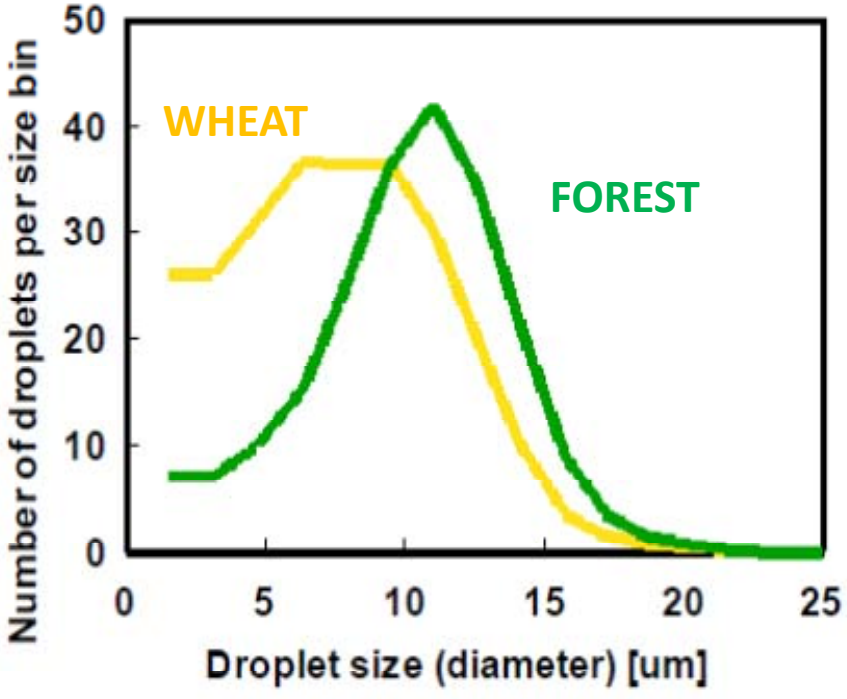


Fig. 5 Annual (May to April) inflow series (GL) for the Integrated Water Supply System. Source: http://www.watercorporation.com.au

BEGIN OF UF-PARTICLE PRODUCTION ?


Flinders UNIVERSITY
40 km
KIT
Karlsruhe Institute of Technology
PARTICLES > 10 nm (red)
20000
10000
0
TSI3010
10 times UFP / doubling the CCN
WEST
EAST
ALTITUDE [m]
3000
2000
1000
0
PBL
0
10000
20000
NUMBER OF PARTICLES

EFFECT OF INCREASED CCN NUMBERS ON CLOUDS



Junkermann et al, ACP, 2009, Australia

	H2O(g)	LWC	%
NAT (198)	**6.1**	**0.15**	**2.4**
AGR (247)	**8.8**	**0.10**	**1.1**
	g/m3		

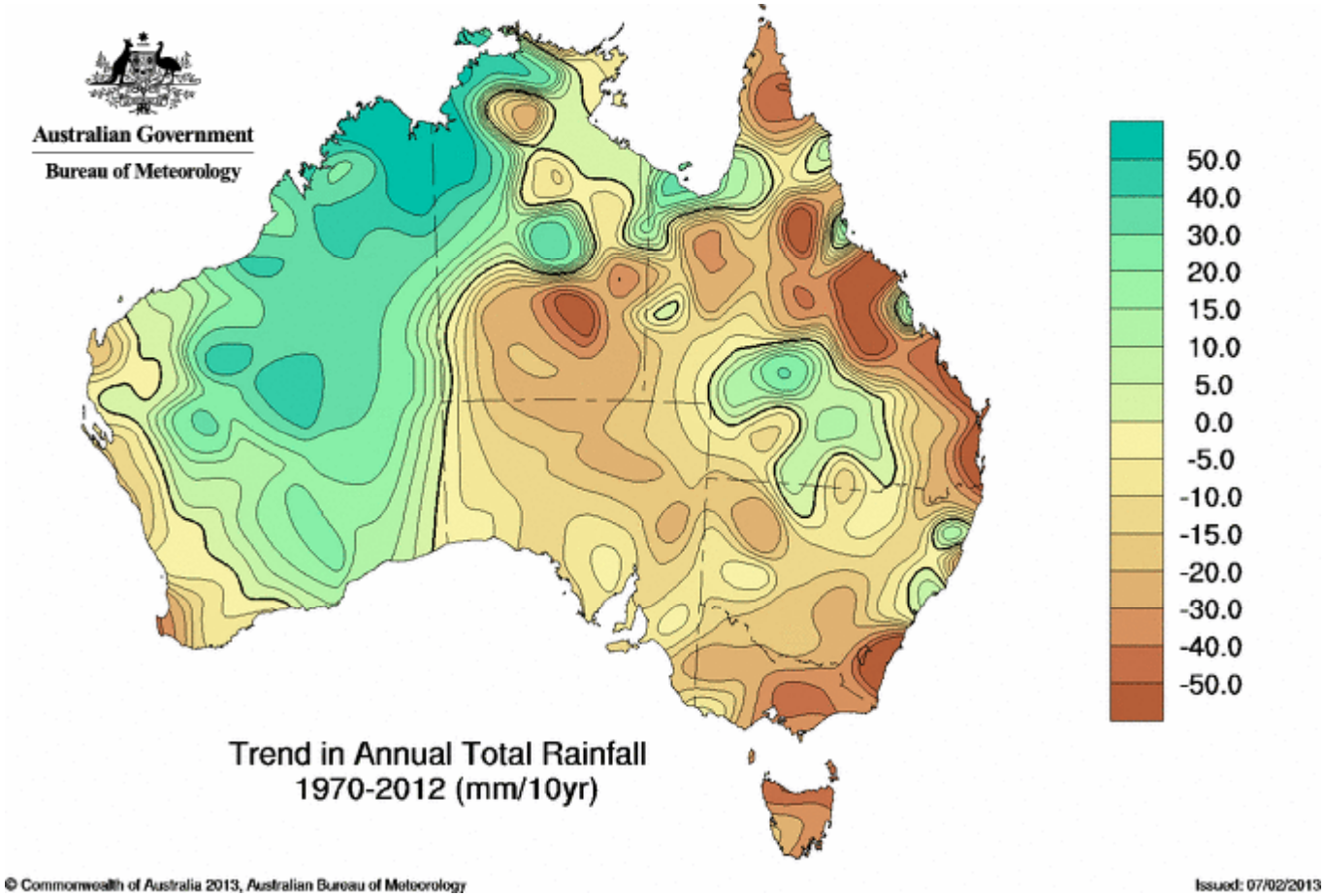
F= 2.0

$$R \sim LWP^{\alpha} N_d^{-\beta}$$

R = rain rate (cloud base)
LWP = liquid water path (macro)
N_d *= drop conc (microphysical)*

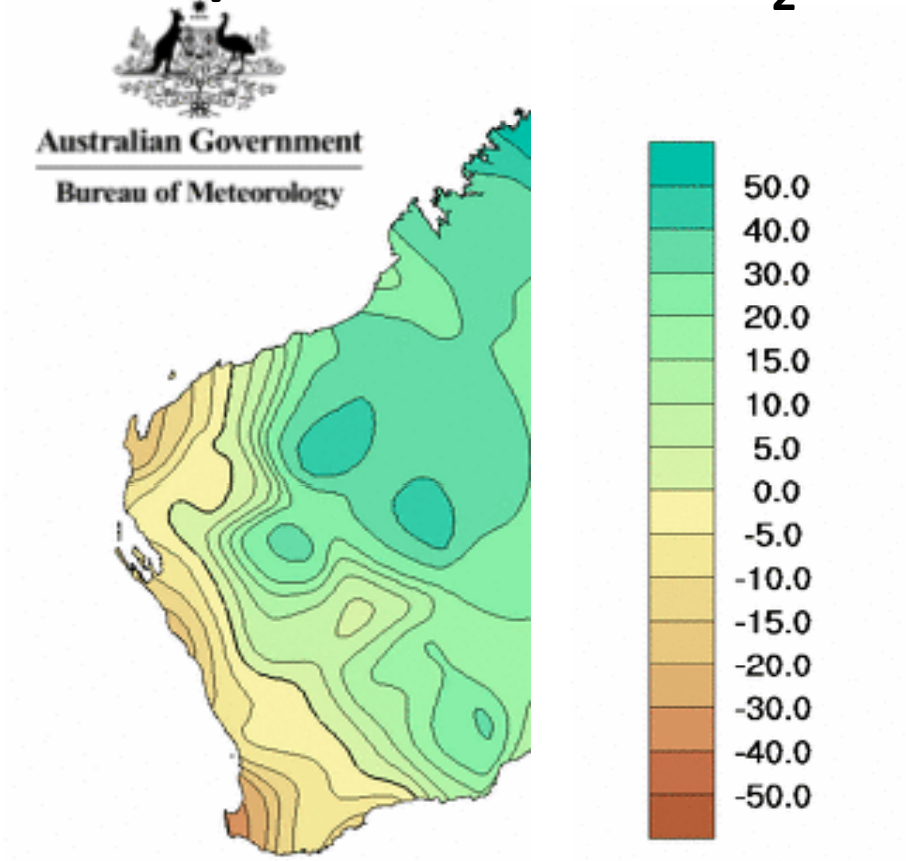
$\alpha \sim 1.50$
$\beta \sim 0.67$

Wang and Feingold, 2009a

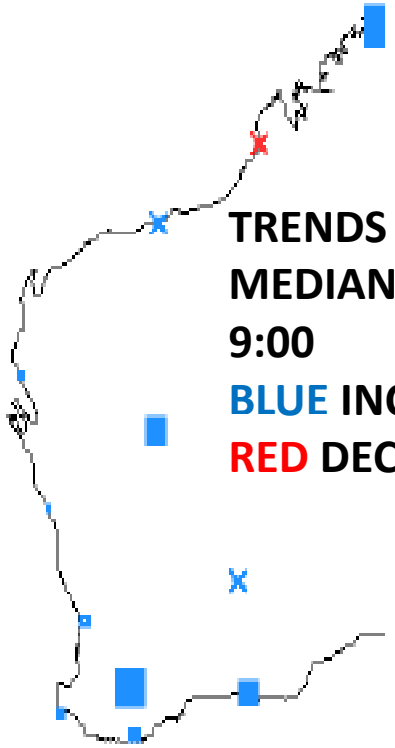


Issued: 07/02/2013

CLIMATE/PRECIPITATION H_2O TRENDS



Trend in Annual Total Rainfall
1970-2010 (mm/10yrs)

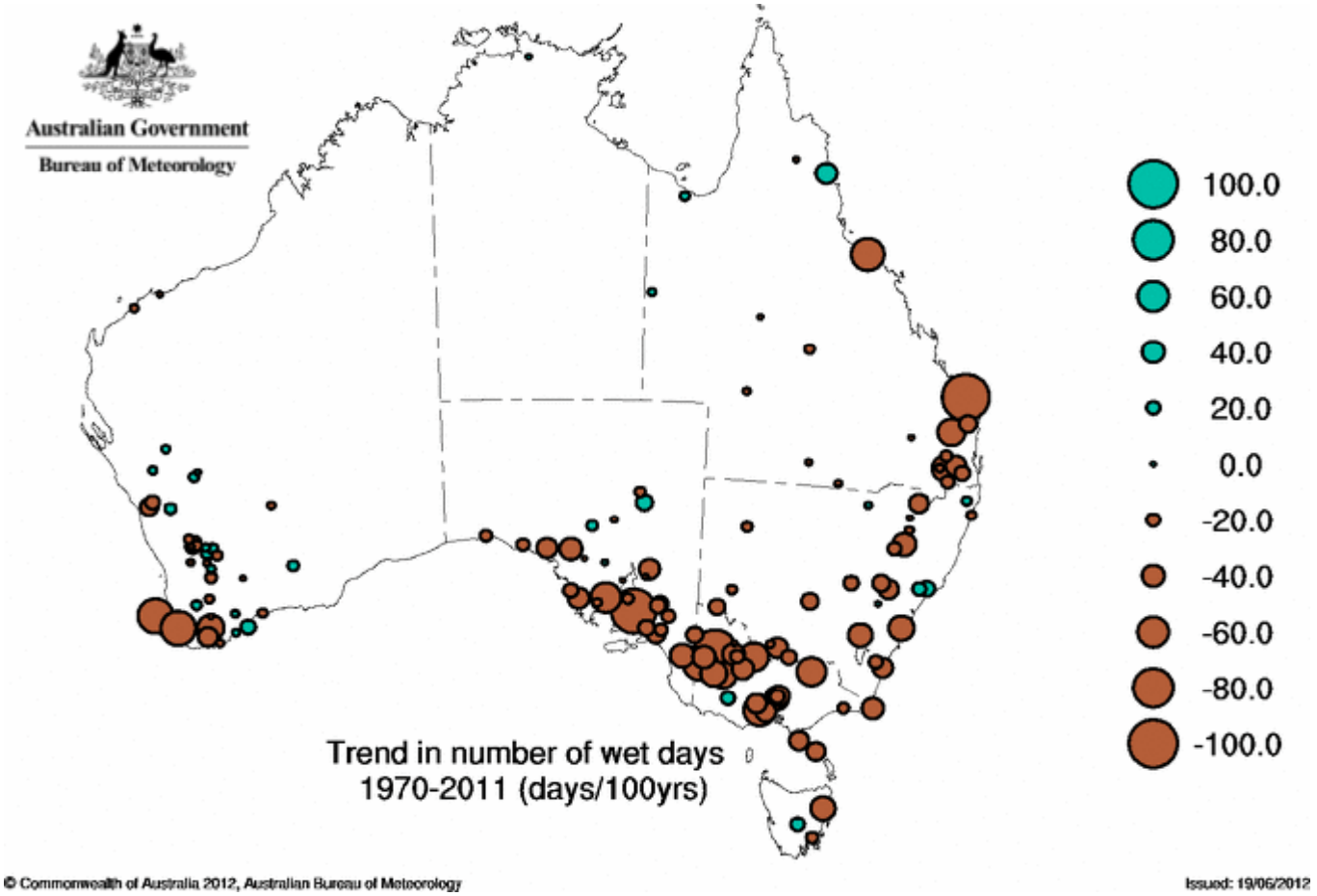


TRENDS IN MONTHLY MEDIAN DEWPOINT AT 9:00

BLUE INCREASING

RED DECREASING

+0.25 C / DECADE


Australian Government
Bureau of Meteorology
Trend in number of wet days
1970-2011 (days/100yrs)
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
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Issued: 19/06/2012