



# ***Recent Australian Developments in MODIS and Other Activities for Integrated Environmental Monitoring***

**Reported by**  
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Presented at the Asia Pacific Environmental Innovation Strategy (APEIS) Capacity Building Workshop, Singapore December 9-10 2004

# Areas of current MODIS Application

## ❖ Natural Resource Management

- ◆ Sustainable resource management
  - » Land-Cover dynamics
  - » Land-use dynamics (Mod13q time-series)
  - » Carbon budget modelling
  - » Coastal & ocean water-quality dynamics modelling
  - » Aerosol Dynamics

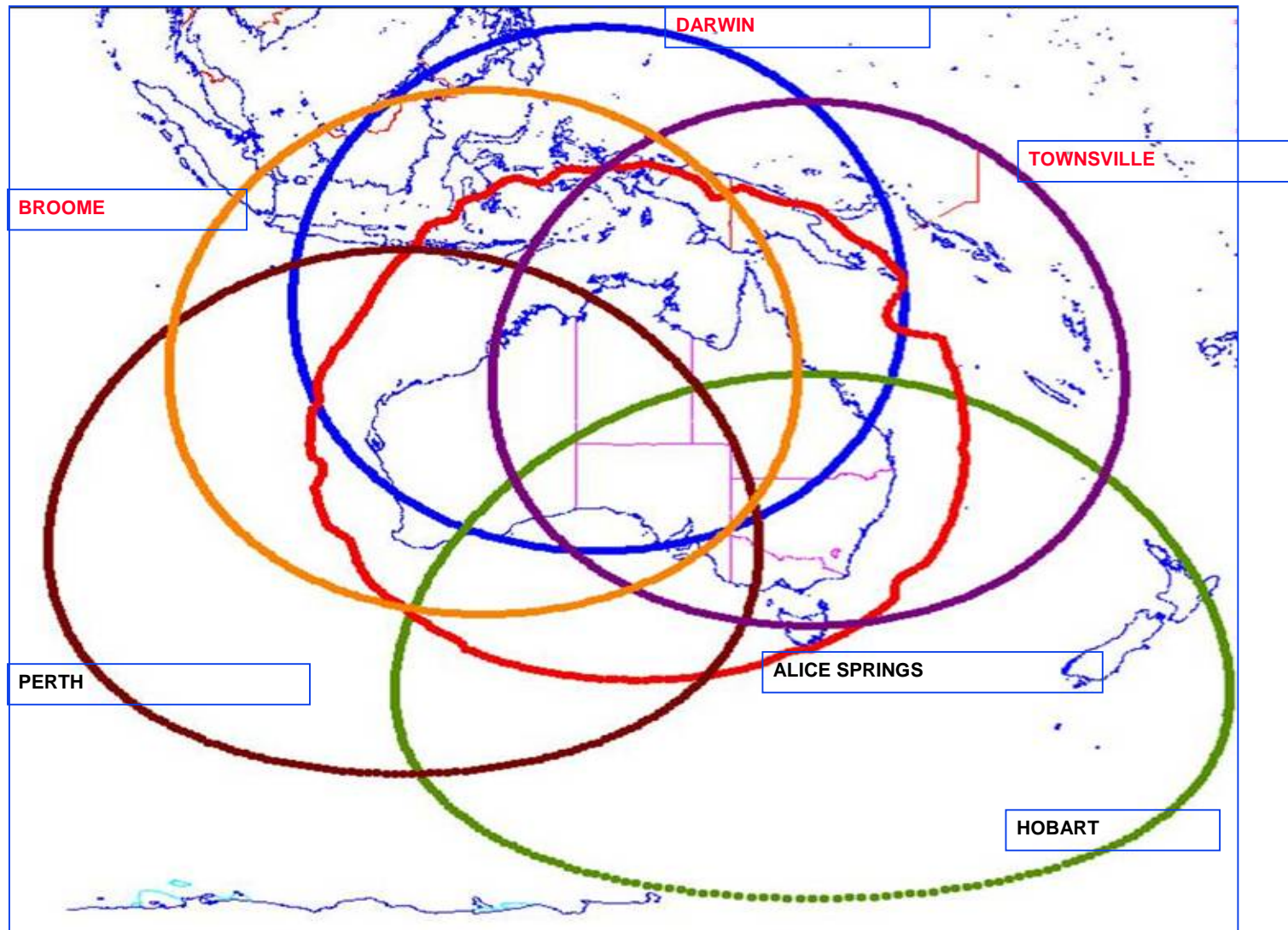
## ❖ Production System Management

- ◆ Production systems (agriculture, forestry and fisheries)
  - » “Pastures from Space”
  - » “CropCast” Projects

## ❖ Emergency Response

- ◆ Management of emergencies such as fires and floods
  - » Sentinel Hotspots, FireWatch
  - » Volcanic Ash Detection

# Australian Regional Coverage



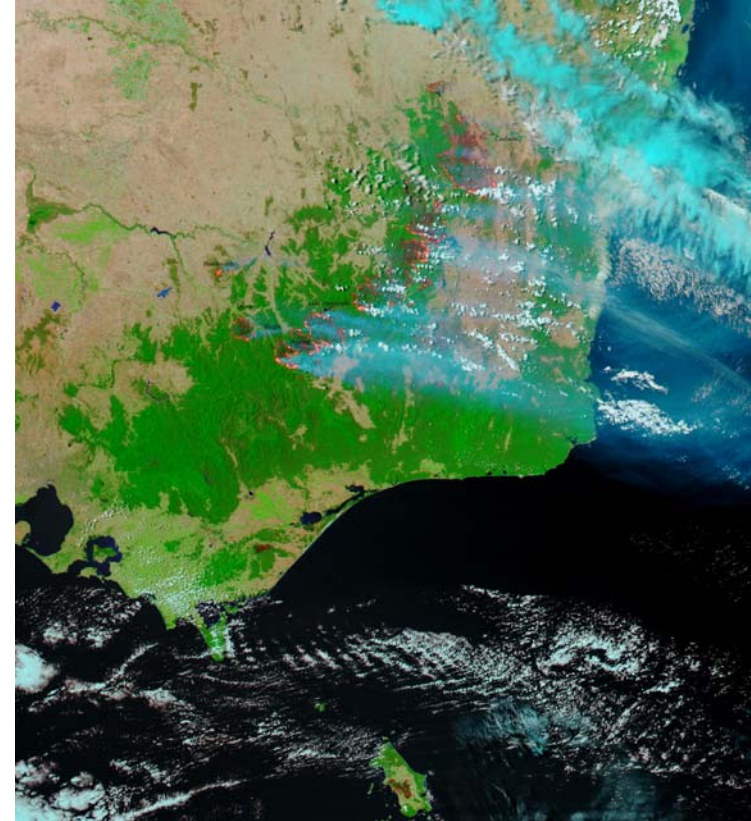


# Geoscience Australia - ACRES



Australian Government  
Geoscience Australia

## MODIS ACTIVITIES AT GEOSCIENCE AUSTRALIA



## ACRES MODIS online product

on-line for 7 days, free of charge

- ❖ Available in Map oriented and Level 1b formats
- ❖ Individual bands
- ❖ Browse JPEG - bands 1,4,3 as RGB
- ❖ Metadata file, 1 for each resolution
- ❖ Header file for ENVI & ER Mapper
- ❖ Registration required

See [http://acres.ga.gov.au/modis\\_data](http://acres.ga.gov.au/modis_data)

# ACRES MODIS web interface (1)

**TERRA-1**

**NEXT →**

**Orbit 16510**

**Date: 2003-01-25**

**Time: 02:35:10 (utc)**



Granule 1	Latitude	Longitude
Window UL :	02:50:40 S	107:37:06 E
Window UR :	05:13:26 S	130:21:38 E
Window LR :	11:42:03 S	130:16:25 E
Window LL :	09:06:16 S	106:21:25 E



Granule 2	Latitude	Longitude
Window UL :	07:36:11 S	105:05:50 E
Window UR :	10:28:28 S	130:12:06 E
Window LR :	21:44:31 S	130:01:36 E
Window LL :	18:28:17 S	102:34:03 E



Granule 3	Latitude	Longitude
Window UL :	17:22:49 S	102:01:36 E
Window UR :	20:47:32 S	129:47:28 E
Window LR :	31:47:32 S	129:33:55 E
Window LL :	28:01:01 S	99:05:38 E



Granule 4	Latitude	Longitude
Window UL :	27:11:04 S	98:44:25 E
Window UR :	31:04:38 S	129:50:45 E
Window LR :	40:35:05 S	129:38:09 E

## ACRES MODIS web interface (2)

Bands 1-2 at 250m	Download	
Band 1 (620-670 nm) (37.86 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>
Band 2 (841-876 nm) (36.07 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>
Metadata <a href="#">View</a>	<a href="#">ftp</a>	<a href="#">http</a>
All 250m bands (tar of gzip data + meta) ( ~ 73.93 MB )	<a href="#">ftp</a>	not via http

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Bands 1-7 at 500m	Download	
Band 1 (620-670 nm) (9.71 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>
Band 2 (841-876 nm) (9.16 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>
Band 3 (459-479 nm) (9.03 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>
Band 4 (545-565 nm) (9.09 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>
Band 5 (1230-1250 nm) (9.15 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>
Band 6 (1628-1652 nm) (9.76 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>
Band 7 (2105-2155 nm) (8.81 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>
Metadata <a href="#">View</a>	<a href="#">ftp</a>	<a href="#">http</a>
All 500m bands (tar of gzip data + meta) ( ~ 64.71 MB )	<a href="#">ftp</a>	not via http

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Bands 1-36 at 1000m	Download	
Band 1 (620-670 nm) (2.49 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>
Band 2 (841-876 nm) (2.38 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>
Band 3 (459-479 nm) (2.38 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>
Band 4 (545-565 nm) (2.36 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>
Band 5 (1230-1250 nm) (2.53 MB compressed)	<a href="#">ftp</a>	<a href="#">http</a>



# MODIS LOCATIONAL ACCURACY 1

- ❖ Multi-temporal sub-pixel registration of MODIS AQUA & TERRA data are important for most applications
- ❖ The locational accuracy specifications for TERRA MODIS data are about 50 m ( $1 \sigma$ ) at nadir
- ❖ The accuracy specifications for NRT AQUA MODIS data are larger as AQUA has no on-board GPS capability
- ❖ The major determinant of the locational accuracy of MODIS products in a NRT environment is the accuracy of the ephemeris used in product generation
- ❖ Errors in the swath to grid software (MS2GT), used to generate map oriented products, were corrected in May 2004. The locational accuracy of ACRES NRT products are approaching the theoretical limit



## MODIS LOCATIONAL ACCURACY 2

- ❖ ACRES has implemented geometric quality assurance procedures for our MODIS products
- ❖ A sample of MODIS products are automatically assessed against resampled AGO 2000 Landsat ETM mosaic of Australia
- ❖ The mean error of ACRES NRT MODIS Terra and AQUA products is 50 and 200 metres respectively with a standard deviation of 135 and 160 metres respectively
- ❖ These figures are derived from a sample of all pixels (nadir & off nadir)



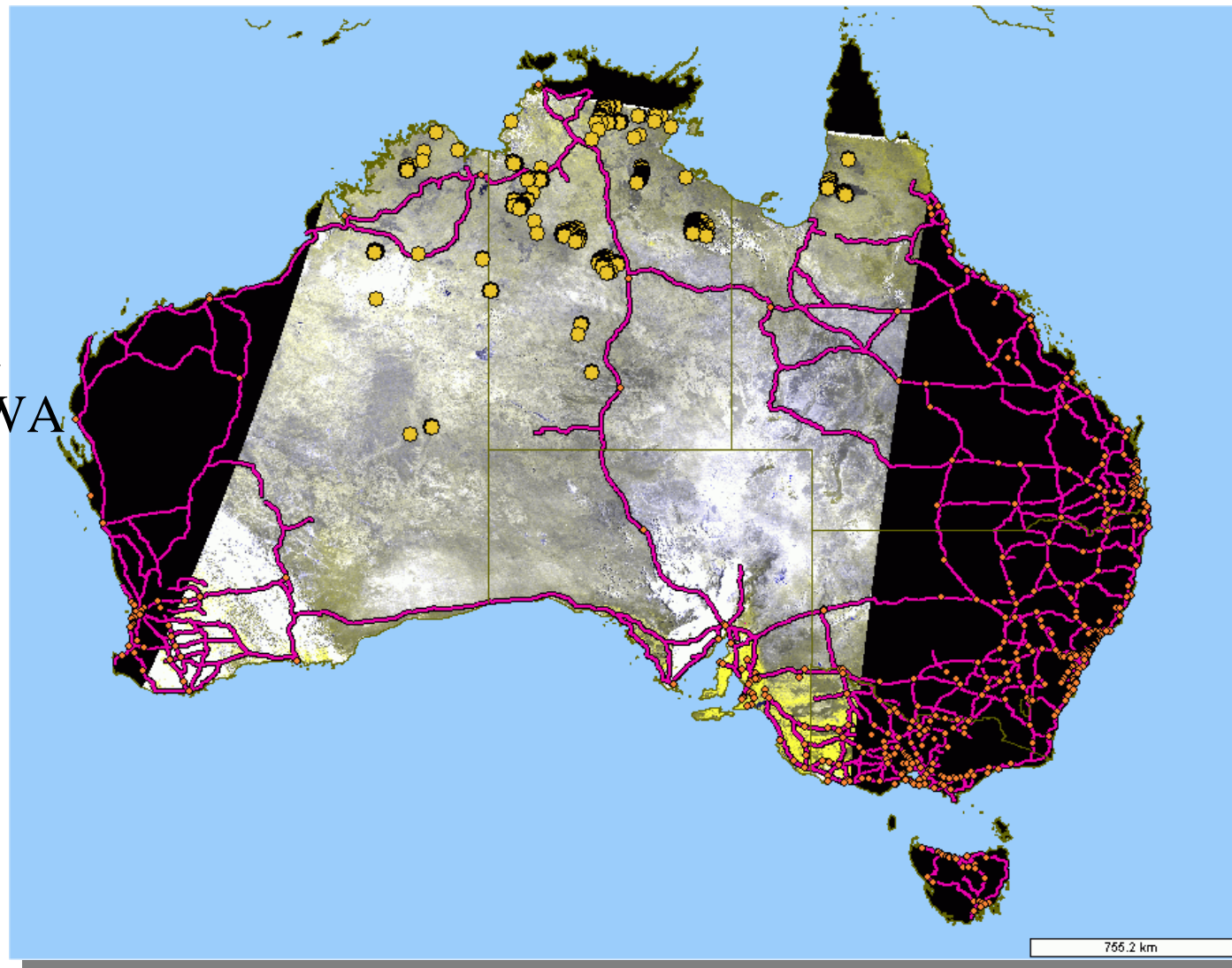
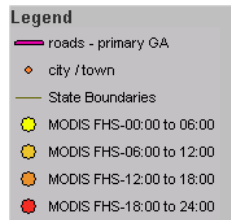
# GA MODIS ONLINE ACCESS Statistics


# Near Real Time Hotspots and Images for Burnt Area, Smoke and Cloud Identification

available on-line  
within 1h of  
acquisition

Department of Land  
Information, Perth WA

06/10/04  
09:20WST



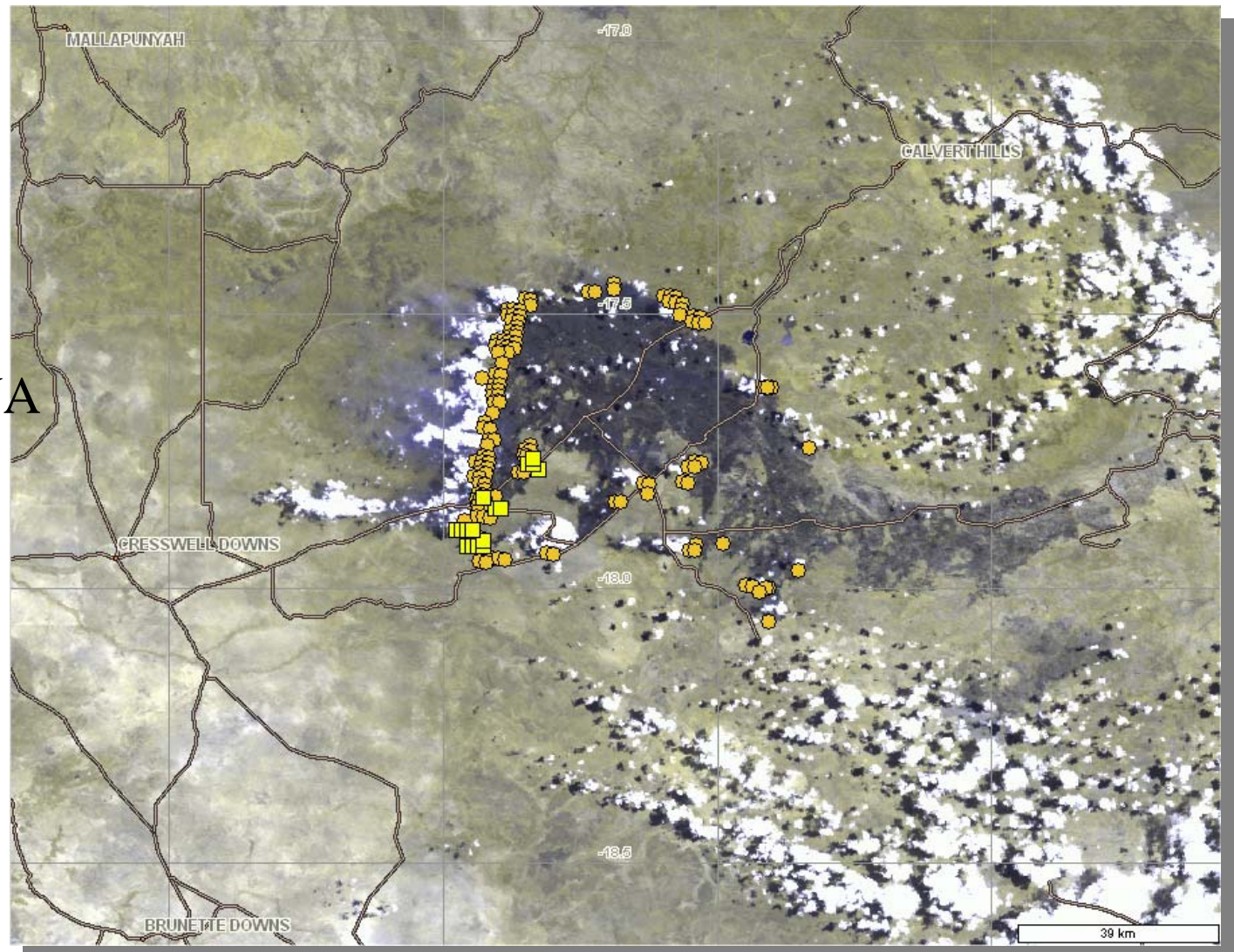
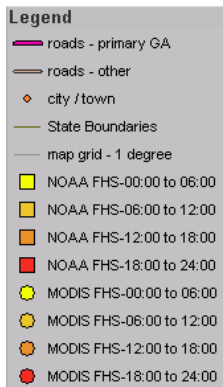


# Near Real Time Hotspots and Images for Burnt Area, Smoke and Cloud Identification

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Department of Land  
Information, Perth WA

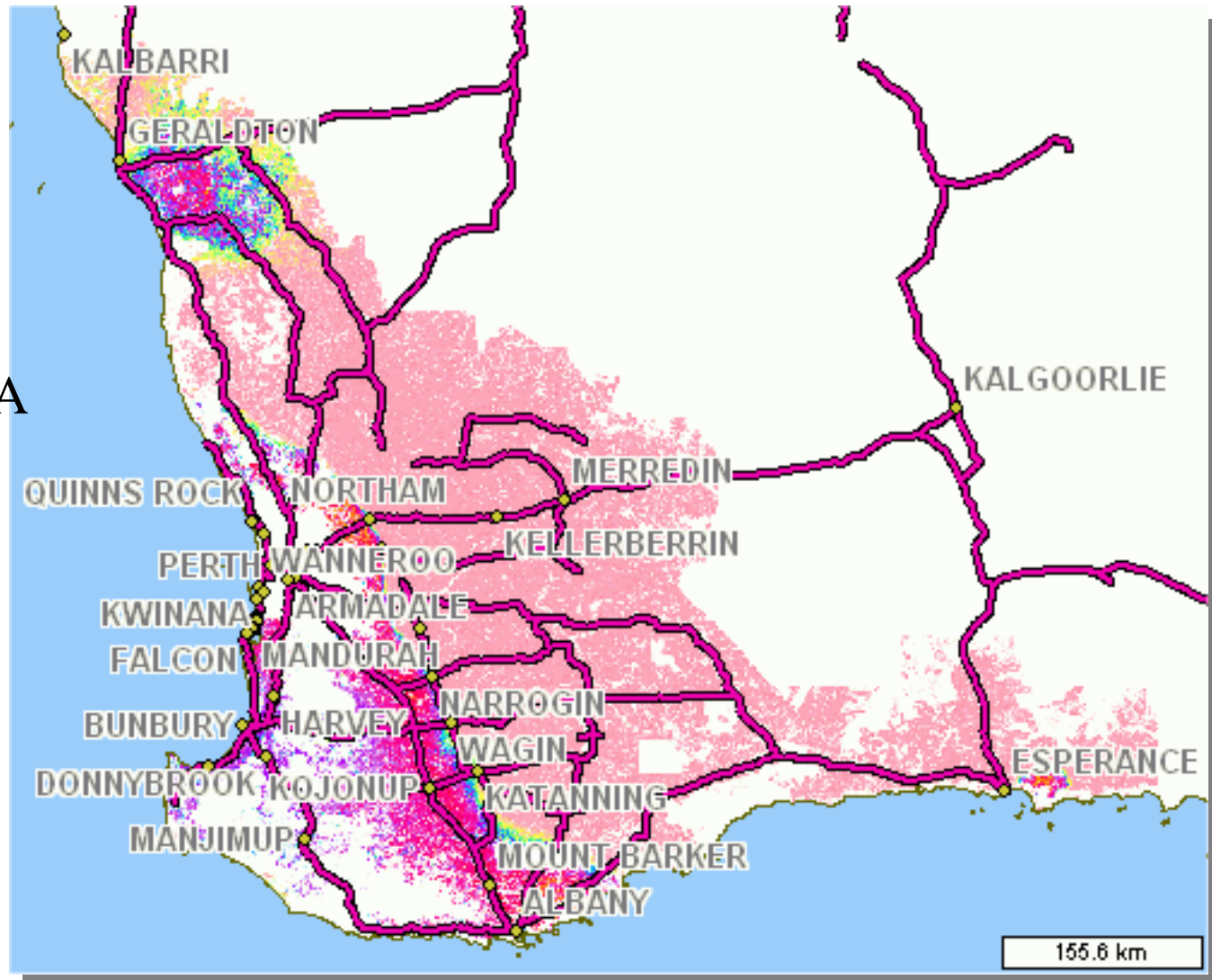
06/10/04  
09:20WST



# Pasture Growth Rate Western Australia

Department of Land  
Information, Perth WA

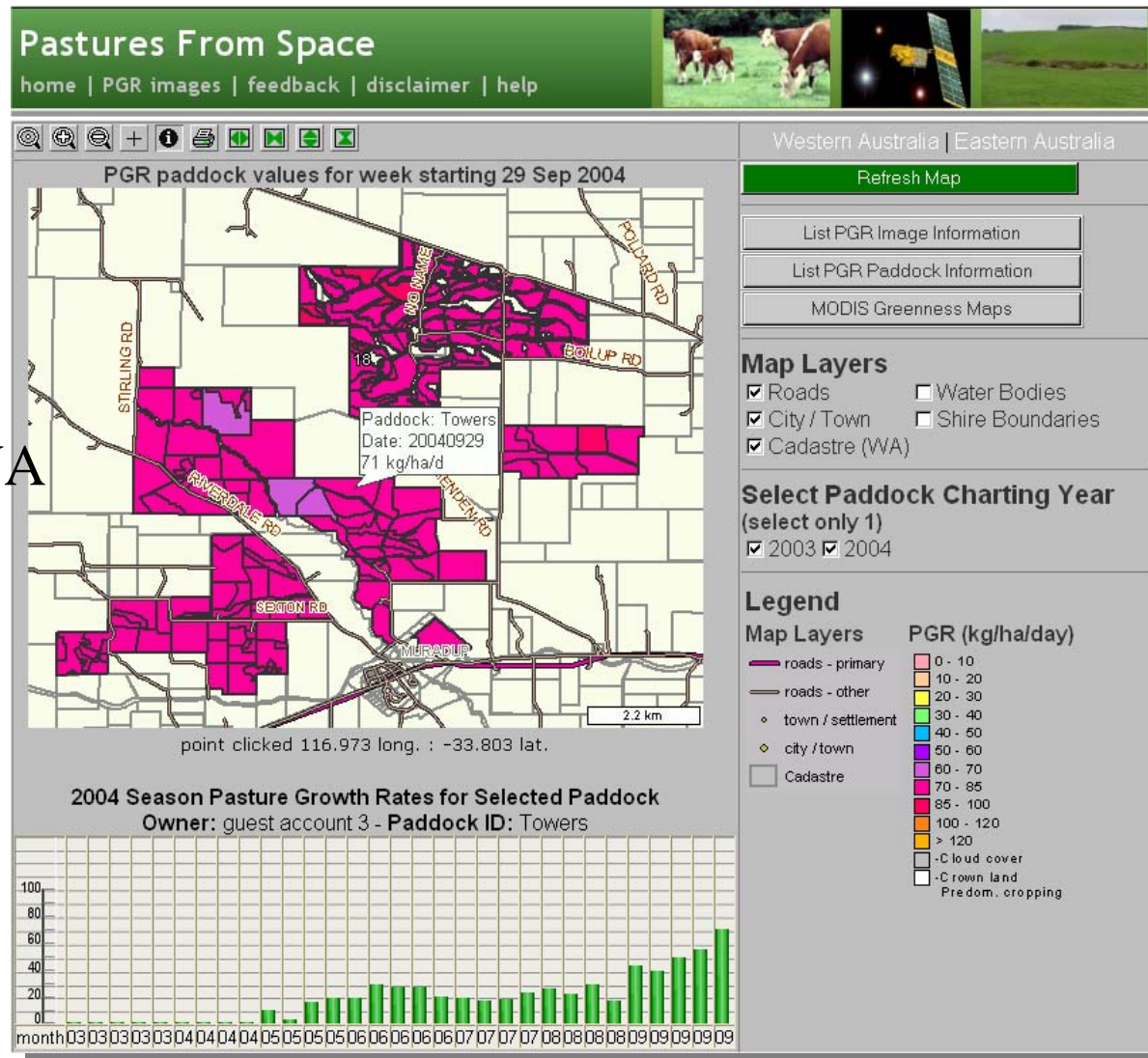
29/09/04  
to  
05/10/04





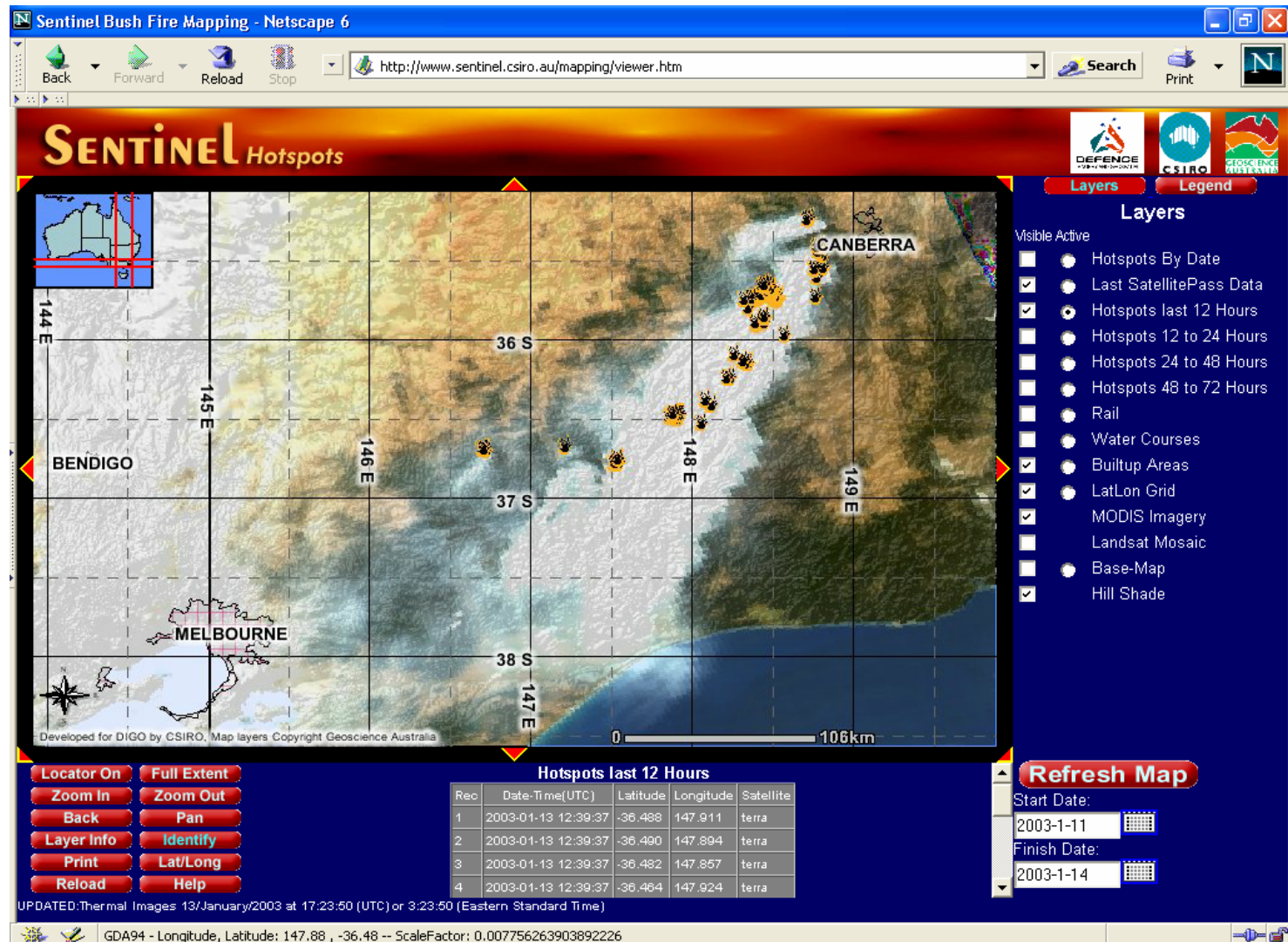
# Pasture Growth Rate Paddock

Department of Land  
Information, Perth WA





Sample from <http://www.sentinel.csiro.au>





# Coordinating Bushfire Detection & Tracking Systems



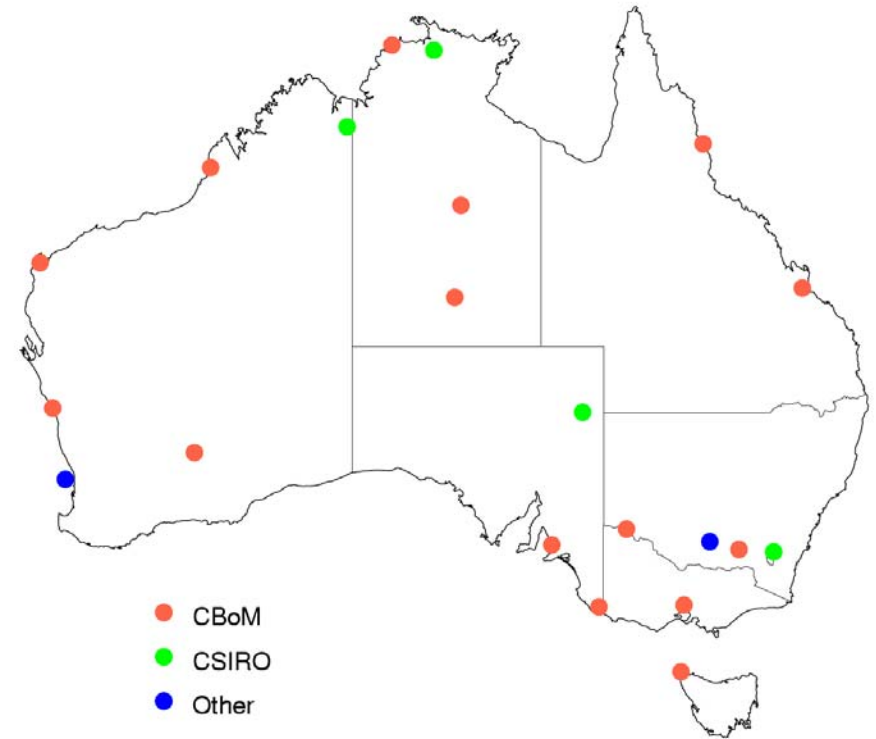
- ❖ NRT Data interchange between *Sentinel Hotspots* & FireWatch
- ❖ Provision of additional interpretive spatial products to fire agencies
  - ◆ Vegetation 'dryness' (curing) – CRC Bushfire & BoM
  - ◆ 'Fire Weather' layers - BoM
  - ◆ Lightning detection and history (various sources)
  - ◆ Fire-scar history (DLI)
  - ◆ Other spatial layers (cadastral info, DEM, roads, water sources, etc.) (GA)
- ❖ Development of single Fire Detection Portal at GA
- ❖ Continuing R&D to improve products or development of new products

## Commercial Developments at ES&S

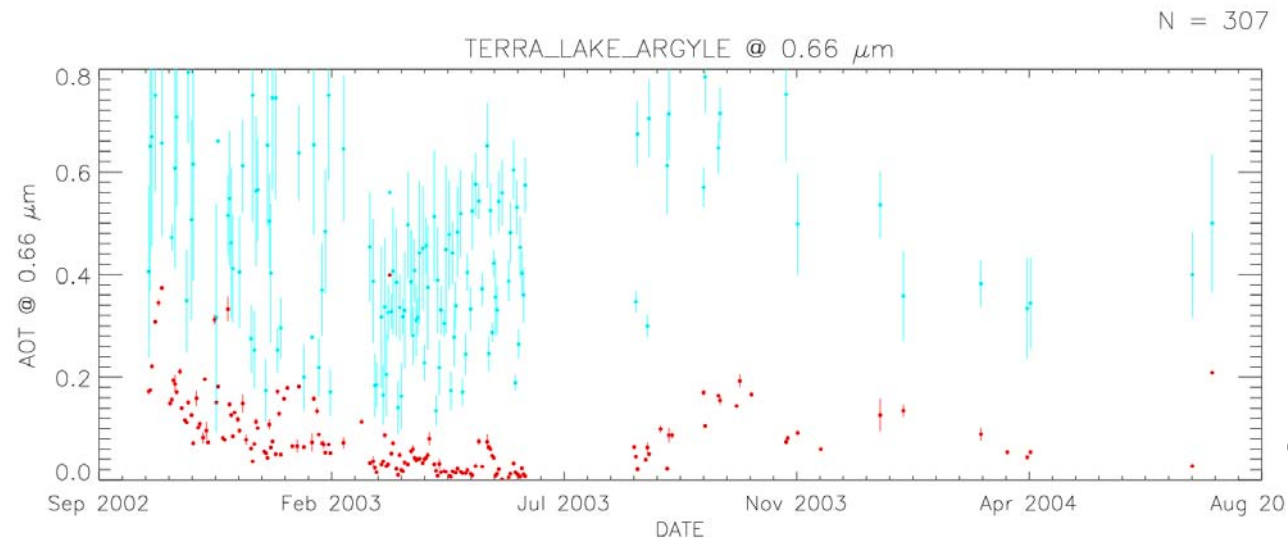
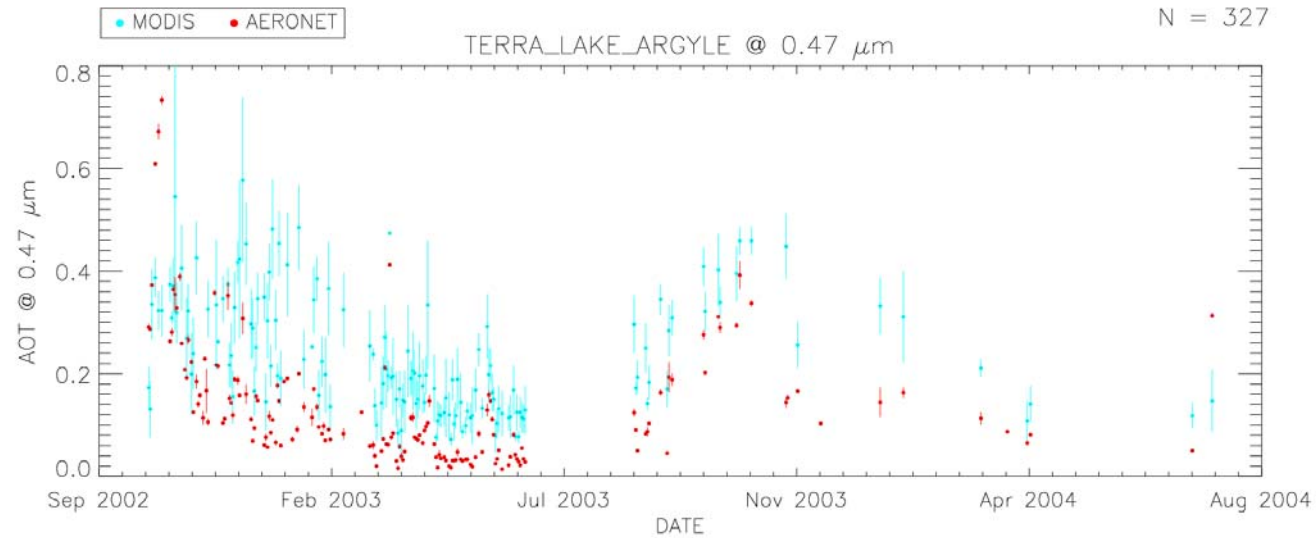
- ❖ ES&S (Australia) have commercial AVHRR, GMS, MTSAT and MODIS stations and software on offer
- ❖ Three SATRAX systems delivered to SE Asian countries
- ❖ The full system comprises:
  - ◆ SATRAX700 X/Y mount
  - ◆ satraxMODAPPS software suite for processing MODIS
  - ◆ METEOR image processing system
  - ◆ ESS300 receiver
- ❖ ESS300 can be sold separately and the antenna, satraxMODAPPS and METEOR output standard HDF and can be used separately and independently

# BoM & CSIRO: Validation of MOD04 aerosol

- ❖ Database established by MODIS aerosol team (MAPSS) of statistics over sunphotometer sites:
- ❖ - MOD04 50 km x 50 km
- ❖ - Sunphotometer 30 minutes
- ❖ - 470 nm, 660 nm
- ❖ 4 CSIRO sites (Mitchell)
- ❖ 15 Bureau sites (Forgan)



# In smoke and dust areas there are some issues



# Validation of MOD04 aerosol

	Mean 0.47	StdDev 0.47	Mean 0.66	StdDev 0.66	Number Samples
<b>Canberra</b>	-0.02	0.07	0.04	0.08	36
<b>Coleambally</b>	0.06	0.16	0.10	0.16	78
<b>Darwin</b>	0.06	0.09	0.13	0.09	113
<b>Jabiru</b>	-0.01	0.09	0.03	0.06	186
<b>Lake Argyle</b>	0.38	0.20	0.31	0.12	151
<b>Rottnest Island</b>	0.12	0.13	0.13	0.12	141

Statistics of the aerosol errors from sun photometers and MODIs

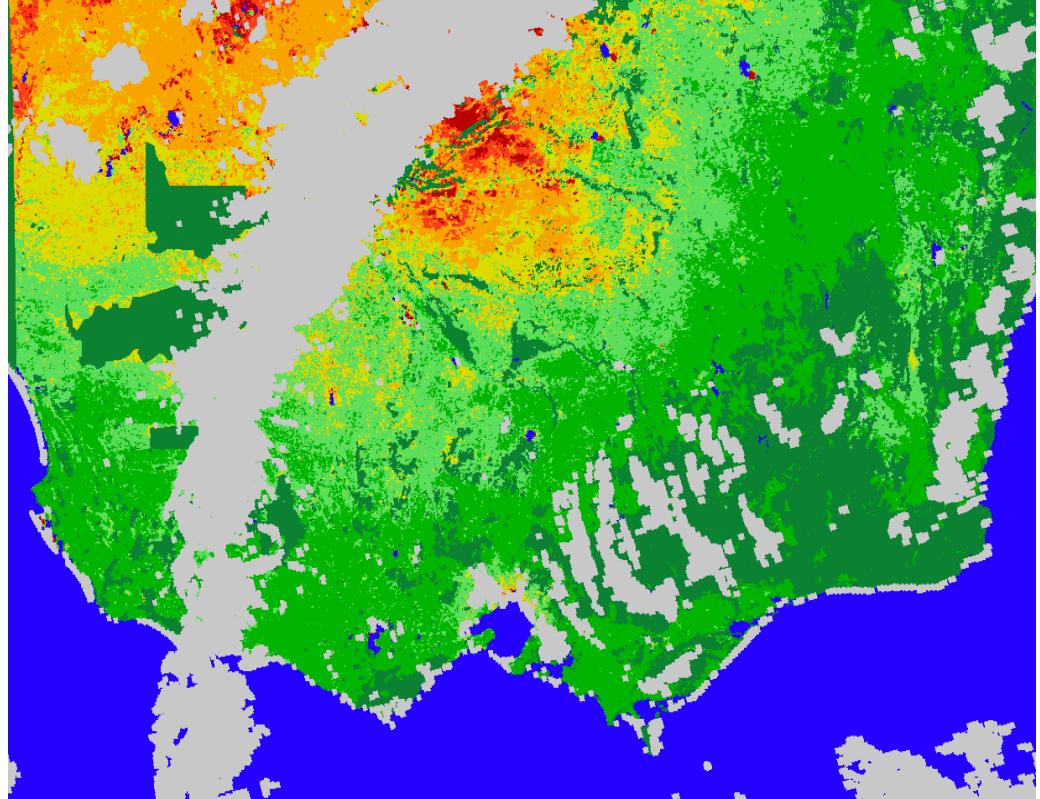


Australian  
Government  
  
Bureau of  
Meteorology

# Bushfire CRC - Grassland Curing Project

A successful daily AVHRR-based map of Grassland Curing Index for south-eastern Australia has been distributed by the Bureau for three years.

The BoM and others are implementing a MODIS version and studying alternatives based on current MODIS indices



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Meteorology



# Good BRDF methods are needed

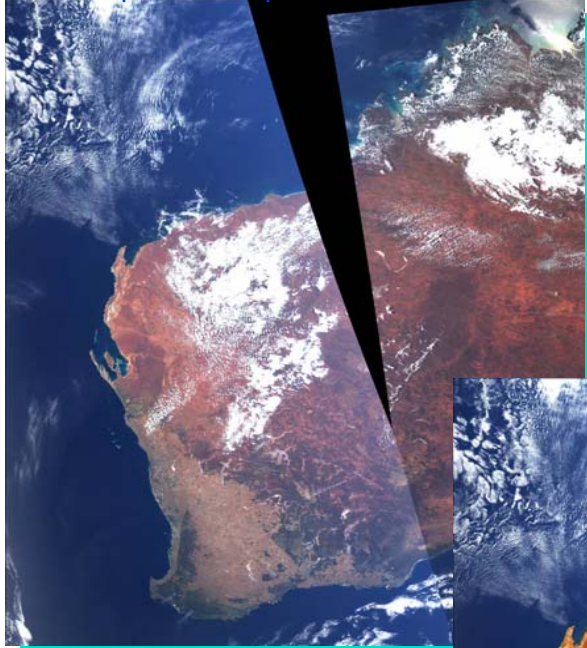




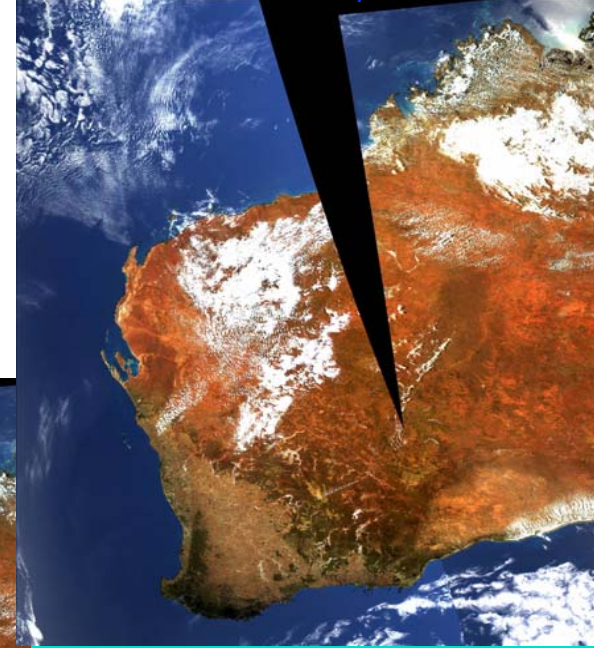


# Product Implemented by DLI and multi-group Collaboration with Boston University has commenced for DB MOD43

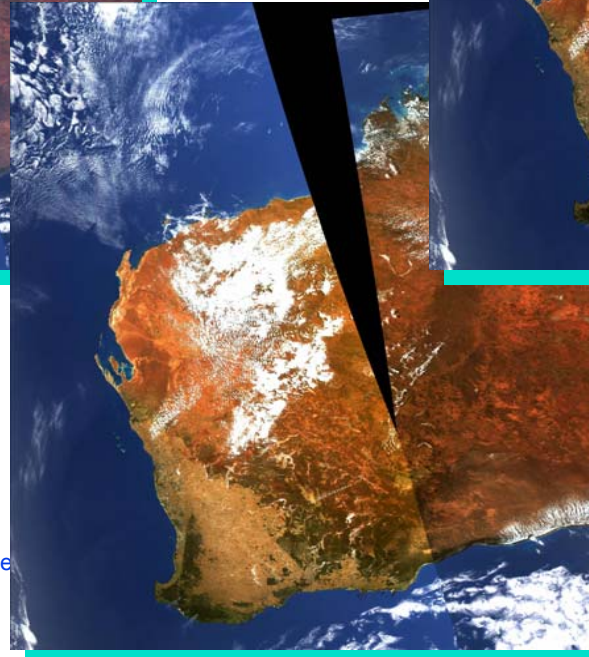
top-of-atmosphere reflectance



NADIR bottom-of-atmosphere reflectance



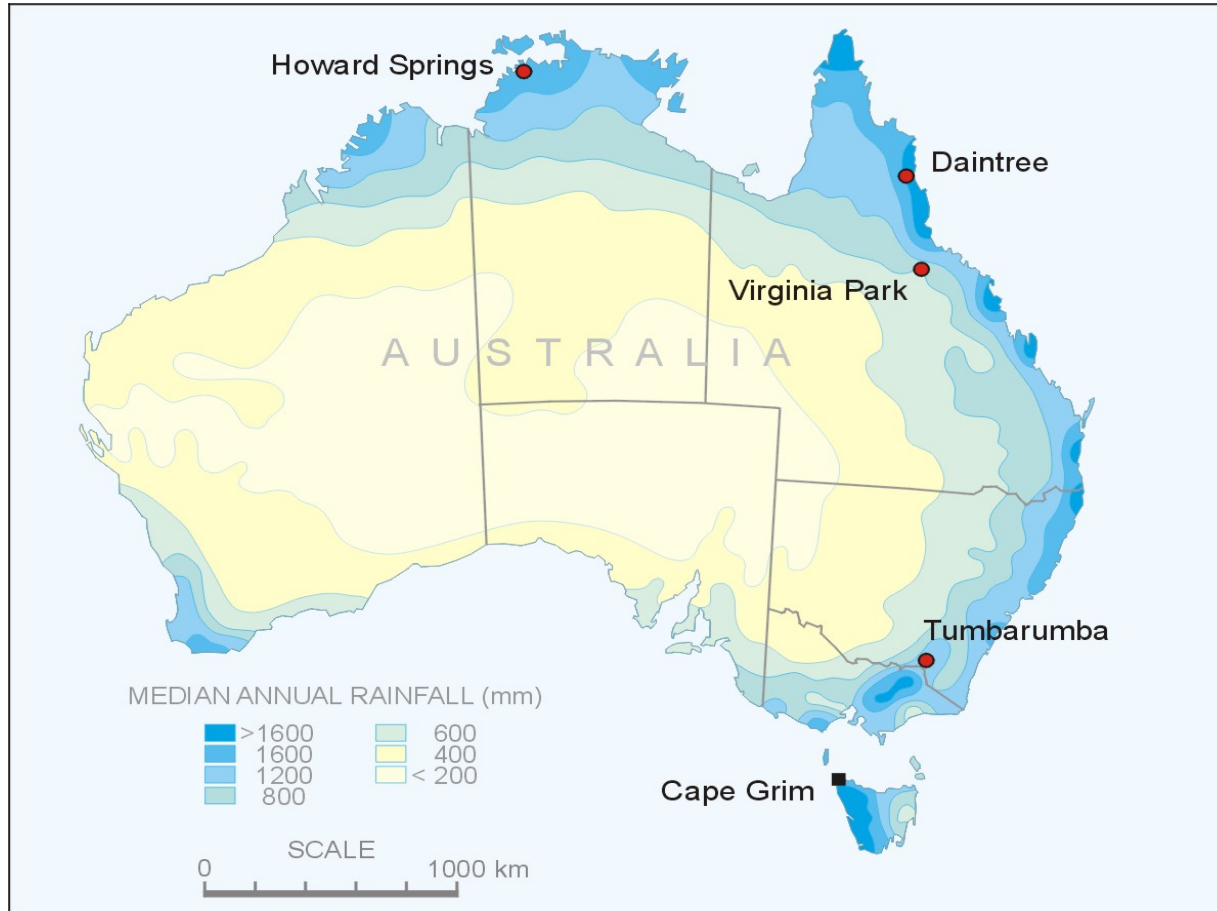
Sensor: MODIS/Aqua  
Date: 22/11/2003 consecutive orbits at 04:43UTC + 06:20UTC  
Bands: 1/4/3  
Receiving Station: WASTAC - Perth, Australia  
Processing: Satellite Remote Sensing Services, DLI, WA  
atmosphere correction using the Simplified Method for  
Atmospheric Corrections (SMAC)  
BRDF correction using Ross-Thick/Li-Sparse kernel driven model  
corrections applied to land pixels only



bottom-of-atmosphere reflectance

Department of Land  
Information, Perth WA

## Ozflux Measurements – local to global fluxes



CSIRO flux stations:

Near surface  
meteorology

Continuous energy,  
water and CO<sub>2</sub> fluxes

Contrasting ecosystems  
with very different  
meteorology and climate

# Major OzFlux Sites

## ❖ Virginia Park:

- ◆ Tropical, seasonally-wet savanna
- ◆ Sparse *Eucalypt* canopy, ~ 8 m tall with C4 grasses
- ◆ LAI ~ 0.5



## ❖ Tumbarumba:

- ◆ Cool temperate, upland (1200 m) *Eucalypt* forest
- ◆ Evergreen, broad-leaved and 40 m tall
- ◆ LAI ~ 2.5







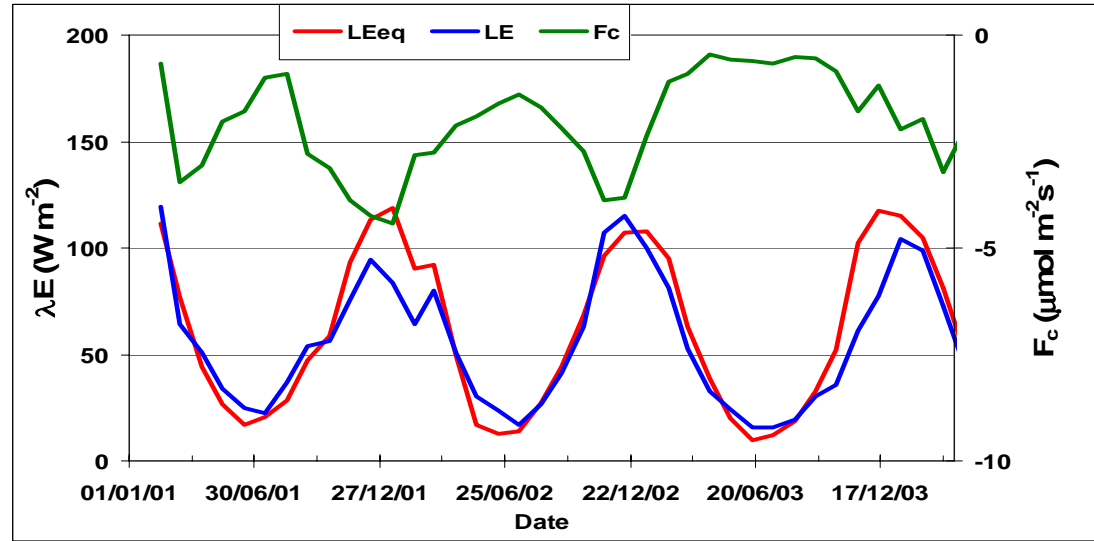
CSIRO

EARTH OBSERVATION

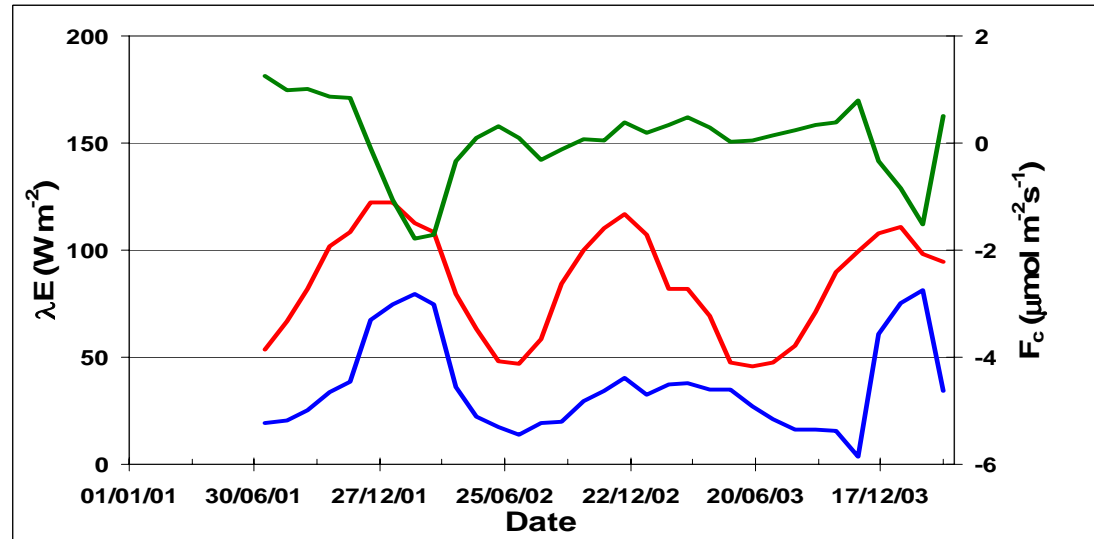


## Tumbarumba

Monthly  $\text{H}_2\text{O}$ ,  $\text{CO}_2$  fluxes



## Virginia Park

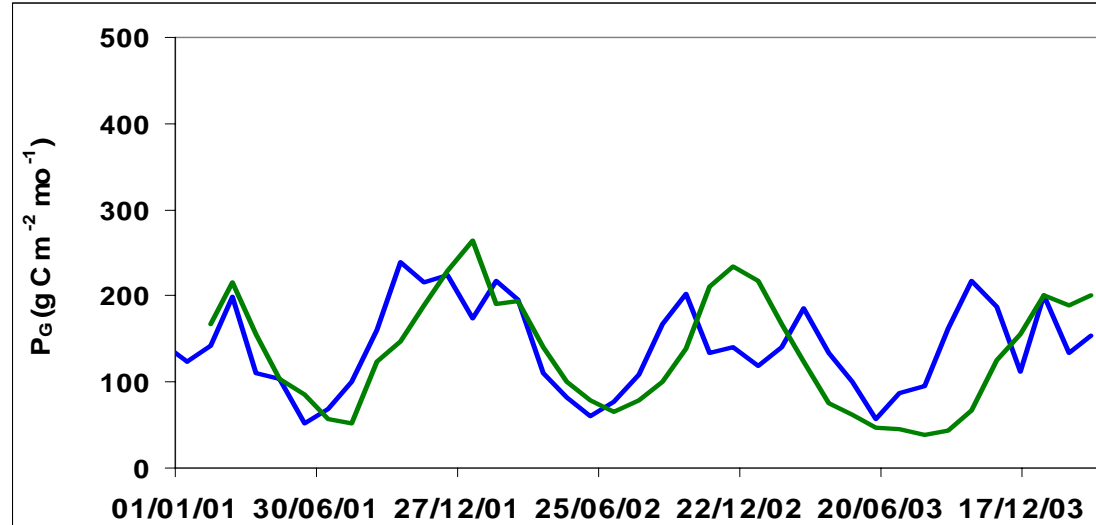


## MODIS Remote Sensing Data

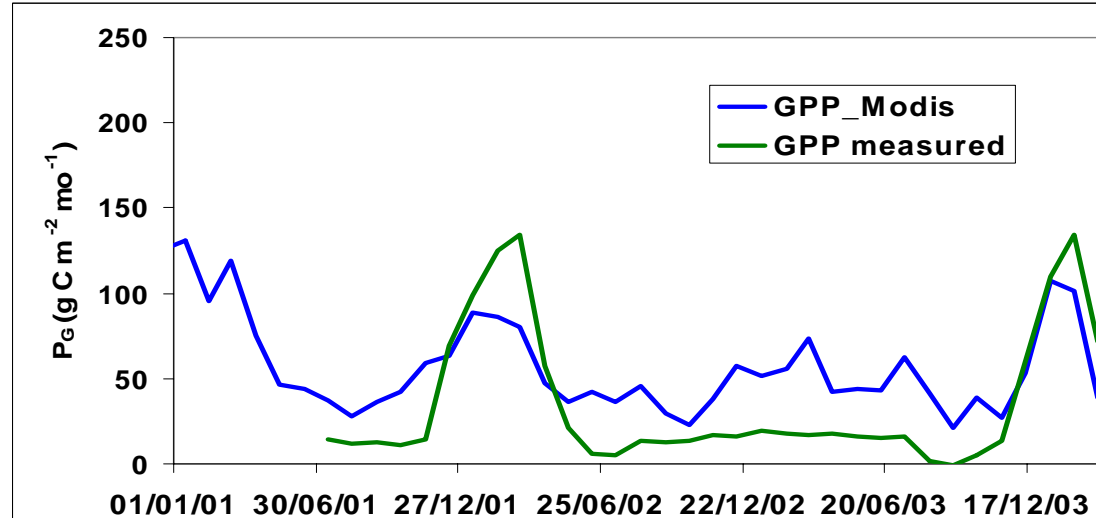
- ❖ MODIS (Collection 4, *Terra* satellite)
- ❖ 7 x 7 km region surrounding flux towers:
  - ◆ Land surface temperature
  - ◆ Leaf area and vegetation indices (LAI, NDVI)
  - ◆ Gross primary productivity (GPP)
- ❖ Fluxes, forcing meteorology and remote sensing data all averaged to 16 days

## Tumbarumba

MODIS GPP vs measurements

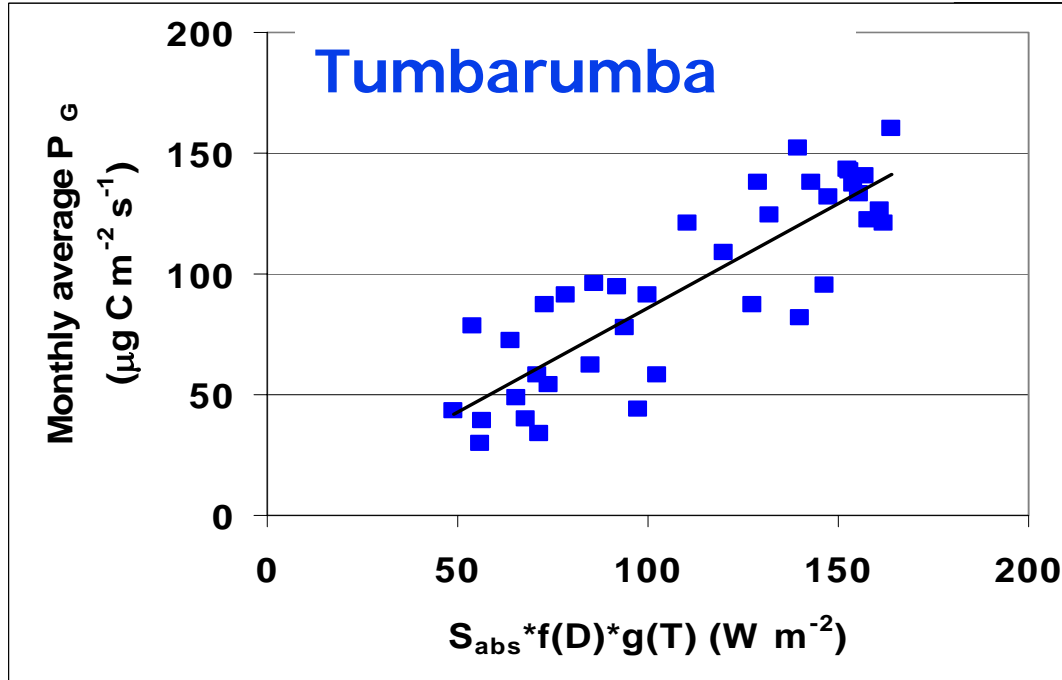


## Virginia Park



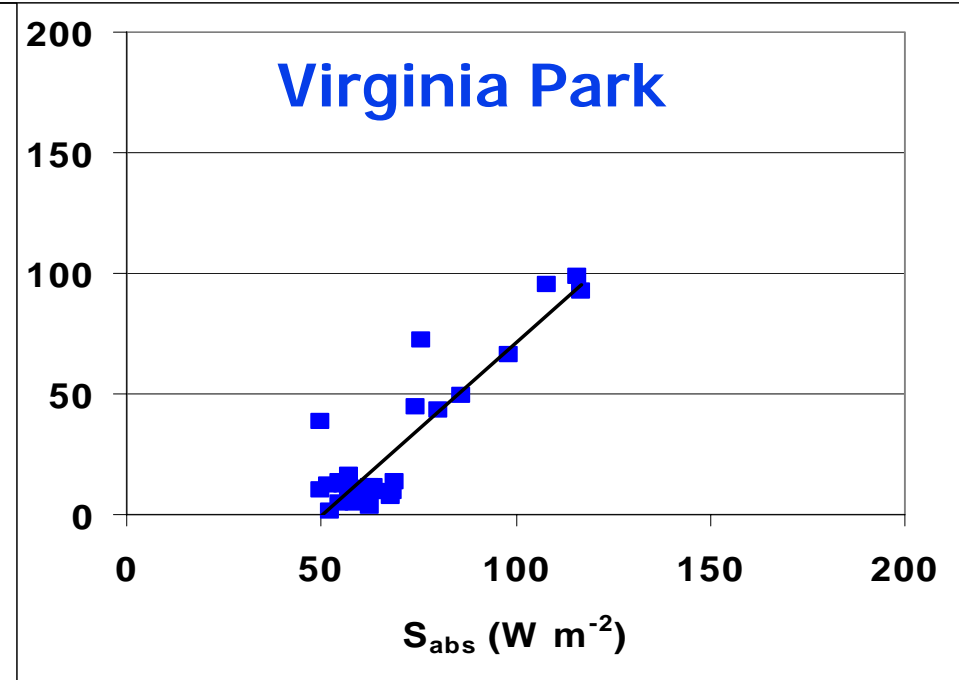


# MODIS GPP parameterization



Slope = 0.85

$R^2 = 0.73$

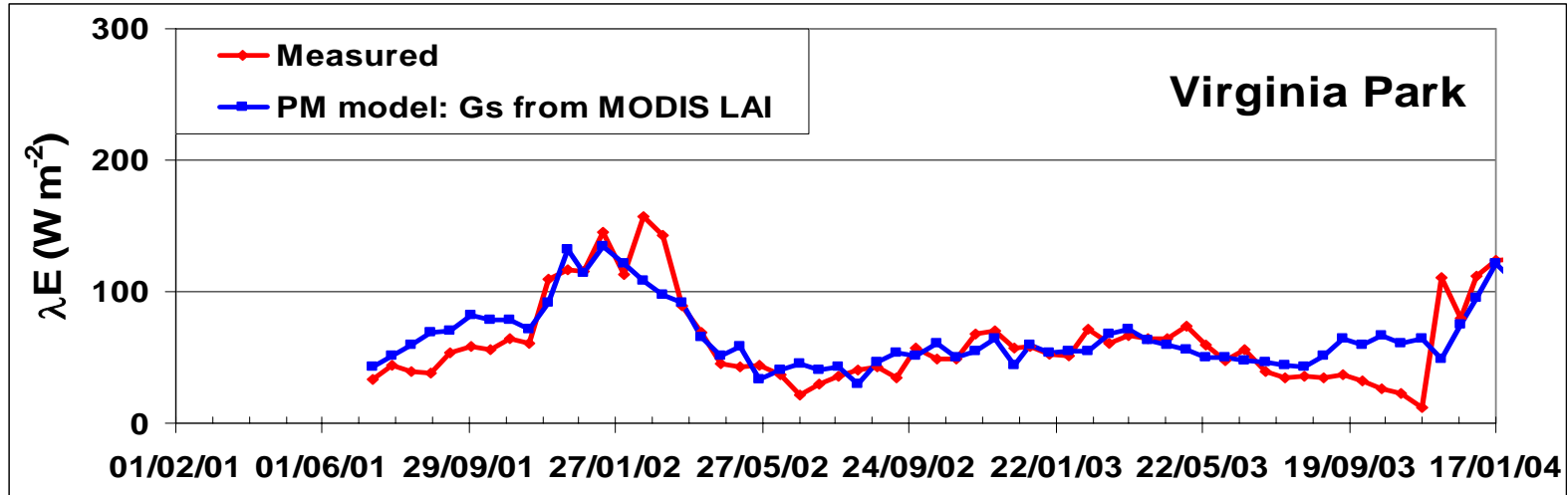
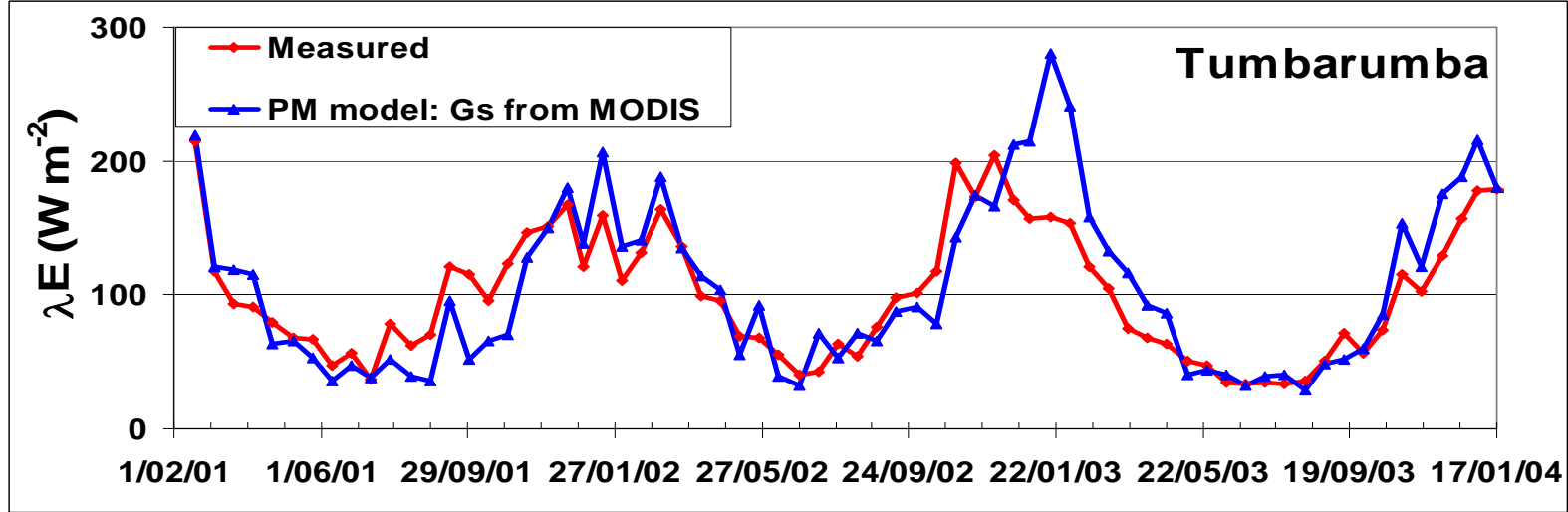


Slope = 1.43

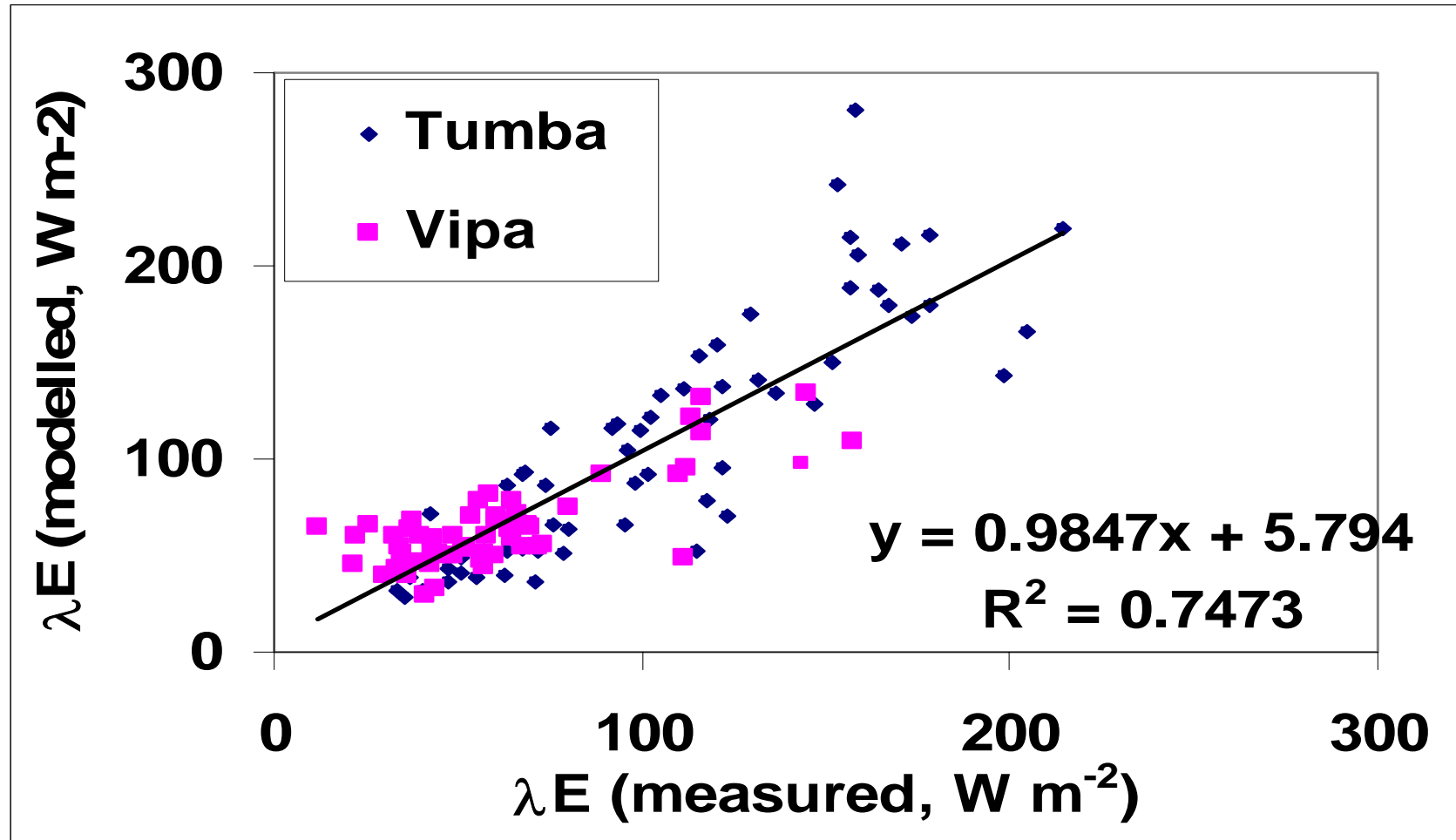
Int. = -71

$R^2 = 0.81$

# Measurements of Evapotranspiration



## MODIS evaporation using P-M model vs flux tower measurements



# Summary

- ❖ Australian X-Band Network expanding
- ❖ Commercial systems becoming available
- ❖ High use of ACRES on-line MODIS facility
- ❖ Many scientific and public good uses operating
- ❖ Science issues are validation and BRDF corrections
- ❖ Flux network linking with MODIS data
- ❖ Thermal and Vegetation Index data being used for advanced modelling
- ❖ Scaling up from Flux station to continent is a prime objective



# Contacts

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