Short Term Climate Forecasting Does it Work?

Beth Ebert
Bureau of Meteorology Research Centre, Melbourne

Can Short Term Climate Forecasting Improve Irrigation Efficiency? Workshop, Indooroopilly, 6-7 June 2001

What is meant by *short term climate forecasting*?

→ Nowcasts	0-3 hours
→ Short range weather forecasts	3 hrs - 2 days
→ Medium range weather forecasts	3-10 days

Forecast quantities:

- Temperature
- Humidity
- Wind
- Precipitation
- others...

What is meant by *"Does it work?"*

(in the context of this workshop...)

→ Does it provide useful information for making irrigation decisions?

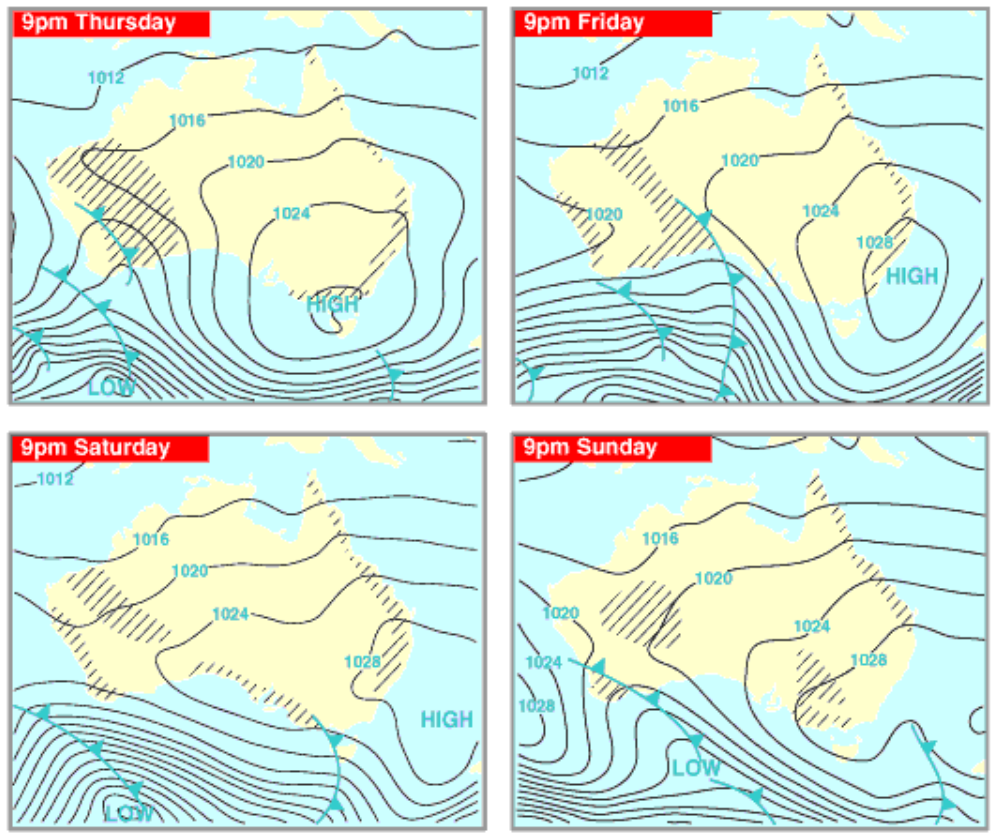
- What will the temperature be?
- Will it be windy?
- Will it rain?
- How much will it rain?

This talk will address:

1. What weather forecasts are easily available
2. Numerical weather forecasts from models
3. Accuracy of forecasts
4. Future developments and products

Mean Sea Level Pressure Prognosis

Issued: May 30, 2001



Forecast Rain to 9pm

— 1024 —
HectoPascal (hPa)

trough

cold front

warm front

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SERVICES

Special Services Unit

Select from drop menu below to see other services:

Quick index

FARMWEATHER

FARMWEATHER is a detailed rural forecast available on demand. It combines a weather graphics page, a recent satellite picture together with an expert opinion composed by meteorologists in plain English. The information describes the weather out to 4 days ahead for particular regions, allowing effective short term management decisions to be made by Agri-businesses and farmers.

You don't have to subscribe to Farmweather. All you need is a fax machine. Simply set your fax to 'poll mode' and dial in the number of the appropriate service. It's that easy!

Other customized services for rural clients are available that include a combination of manual forecasts and computer model output. These are mainly targeted at farming cooperatives where for a modest fee, each member of the cooperative can access a detailed Web page tailored for their region.

FARMWEATHER is available via fax for more than 20 regions throughout mainland Australia :

- Queensland
- New South Wales
- Victoria

…to be upgraded
4th quarter this year

Document: Done

SPECIAL SERVICES UNIT
BUREAU OF METEOROLOGY

FARMWEATHER

Cattle and Cane
Issued Sunday 03 June 2001

COMMENTS ON THE CURRENT METEOROLOGICAL SITUATION

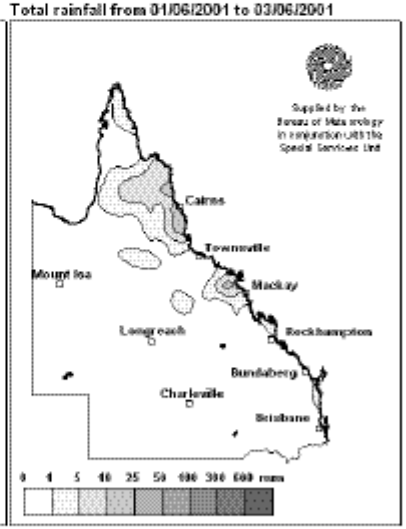
A belt of high pressure extending from the western Tasman Sea to near New Zealand will remain the dominant feature on the weather for the next few days. This system will maintain a firm ridge along much of the Queensland coast with showery and windy conditions especially about the central and north Queensland coasts. Computer models move the next upstream surface trough and associated weather into western and southern inland parts of the state around midweek, possibly affecting the southeast of the state later in the week. Forecasting confidence around this time is reduced. It should be fine for much of the time; the onshore (SE to NE) airflow however will deliver some cloud at times with the odd shower. More significant cloud (and precipitation) may affect the region later in the week as the next trough draws nearer. Temperatures both day and night should be mostly average to slightly above.

The probability that rainfall is expected to exceed 5 mm in 12 hours, for selected areas, appears on page 2.

FORECASTER: Queensland Special Services Unit

Total rainfall for 24 hour period to 9 AM 3/6/2001

Total rainfall from 01/06/2001 to 03/06/2001



FARMWEATHER products for Queensland

Cattle & Cane	1902 935 384	Crops & Grain	1902 935 386
Beef & Cotton	1902 935 385	Tropical Canefields	1902 935 387

FARMWEATHER is a product of the Bureau of Meteorology Special Services Unit.

SPECIAL SERVICES UNIT
BUREAU OF METEOROLOGY

FARMWEATHER 4 Day Forecast

Cattle and Cane
Issued Sunday 03 June 2001

	Wind (km/hr) AM	Wind (km/hr) 3PM	Rain Probability AM	Rain Probability PM
Monto				
Monday	ESE 20	E 20	0%	0%
Tuesday	ESE 20	E 25	0%	0%
Wednesday	E 20	E 20	0%	0%
Thursday	ESE 15	E 20	0%	0%
Gayndah				
Monday	E 15	E 20	0%	0%
Tuesday	ESE 20	E 25	0%	0%
Wednesday	E 20	E 20	0%	0%
Thursday	ESE 15	ENE 20	0%	0%
Kingaroy				
Monday	E 15	E 15	0%	0%
Tuesday	ESE 20	E 25	0%	0%
Wednesday	E 20	E 20	0%	0%
Thursday	E 15	ENE 15	0%	0%
Bundaberg				
Monday	E 25	E 25	10%	10%
Tuesday	ESE 30	ESE 35	10%	10%
Wednesday	E 25	E 25	10%	10%
Thursday	ESE 20	E 25	10%	5%
Gympie				
Monday	E 20	E 20	10%	10%
Tuesday	ESE 25	ESE 30	10%	10%
Wednesday	E 25	E 25	10%	5%
Thursday	E 15	E 20	10%	0%
Sunshine Coast				
Monday	E 20	E 20	20%	10%
Tuesday	ESE 25	ESE 30	20%	10%
Wednesday	E 25	E 25	20%	10%
Thursday	E 20	E 20	10%	0%
Brisbane Valley				
Monday	ESE 10	ESE 15	0%	0%
Tuesday	ESE 20	ESE 25	5%	5%
Wednesday	E 15	E 20	5%	5%
Thursday	E 10	ENE 15	5%	0%
Gold Coast				
Monday	E 15	ESE 20	20%	10%
Tuesday	ESE 20	ESE 25	20%	10%
Wednesday	E 20	E 20	20%	10%
Thursday	E 10	ENE 15	10%	0%
Lismore				
Monday	ESE 5	ESE 15	10%	5%
Tuesday	ESE 10	E 15	10%	5%
Wednesday	E 10	ENE 15	10%	5%
Thursday	ENE 5	ENE 10	0%	0%
Grafton				
Monday	Calm	SE 10	5%	0%
Tuesday	E 10	E 15	5%	0%
Wednesday	NE 10	NE 15	5%	10%
Thursday	NNW 5	NNE 10	0%	0%

Also 4-panel charts and up-to-date satellite IR image

Australian Weather Charts - Netscape

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Australian Region 10S to 50S | 90E to 180E

MSL Manual Anal: Latest or 00z | 06z | 12z | 18z - Fax: 1902 93 5 210
MSL Manual Prog: 00z - Fax: 1902 93 5 211
MSL MESO-LAPS: +00hr | +12hr | +24hr | +36hr
MSL/Thickness LAPS: +00hr | +12hr | +24hr | +36hr | +48hr - Fax: 1902 93 5 438
MSL LAPS: +24hr (Isobars only)
MSL/Thickness Smoothed LAPS: +00hr | +12hr | +24hr | +36hr | +48hr
MSL Full Domain LAPS: +00hr | +24hr | +48hr
Isallobars GASP: +00hr
MSL GASP: +00hr,+24hr | +36hr | +48hr,+72hr | +96hr,+120hr | +144hr,+168hr | +192hr
Multi-day runs of charts: (approx 100Kbytes each)
00z MSLs (manual): last 5 days
LAPS MSLs (0-2 days): current run | 1 run before | 2 runs before (2 runs per day)

Calls to Weather by Fax 190 numbers are charged at 66c per minute, inc. GST.
(More from International, Inmarsat or mobile phones.)

GASP MSLs (0-7 days): current run | 1 run before | 2 runs before (2 runs per day)

850 HPA LAPS: +00hr | +24hr
700 HPA LAPS: +00hr | +12hr | +24hr | +36hr
500 HPA LAPS: +00hr | +12hr | +24hr | +36hr
400 HPA LAPS: +00hr | +12hr | +24hr
300 HPA LAPS: +00hr | +12hr | +24hr | +36hr
250 HPA LAPS: +00hr | +12hr | +24hr | +36hr
200 HPA LAPS: +00hr
LAPS upper level analyses (+00hr) - Fax: 1902 93 5 353

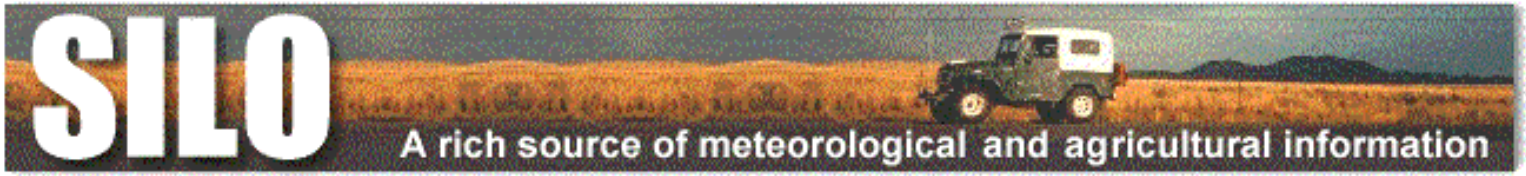
Grid Point Winds Bulletin: 00z | 06z | 12z | 18z

Calls to Weather by Fax 190 numbers are charged at 66c per minute, inc. GST.
(More from International, Inmarsat or mobile phones.)

UV chart: UV index for local noon tomorrow - Fax: 1902 93 5 018

Daily Rainfall Analysis: Australia | Murray/Darling | South East Australia

Document: Done



Products Index

SILO provides a rich source of meteorological and agricultural data of particular interest to anyone involved in the agricultural arena. All meteorological products are brought to you by the Bureau of Meteorology.

- **Bureau of Meteorology Weather Reports**

  The Bureau of Meteorology Weather Reports provide you with the most current weather forecasts, warnings, satellite images and mean sea level charts available from the Bureau.

- **Meteograms**

  Meteograms allow you to generate weather guidance for any location around Australia. They graph certain weather variable outlooks for up to 7 days ahead, using one of four selectable computer models, depending on the period & level of detail required. Meteograms are guidance material only and do not represent the Bureau's 'official' weather forecasts to the public.

- **Weather prediction maps and grids**

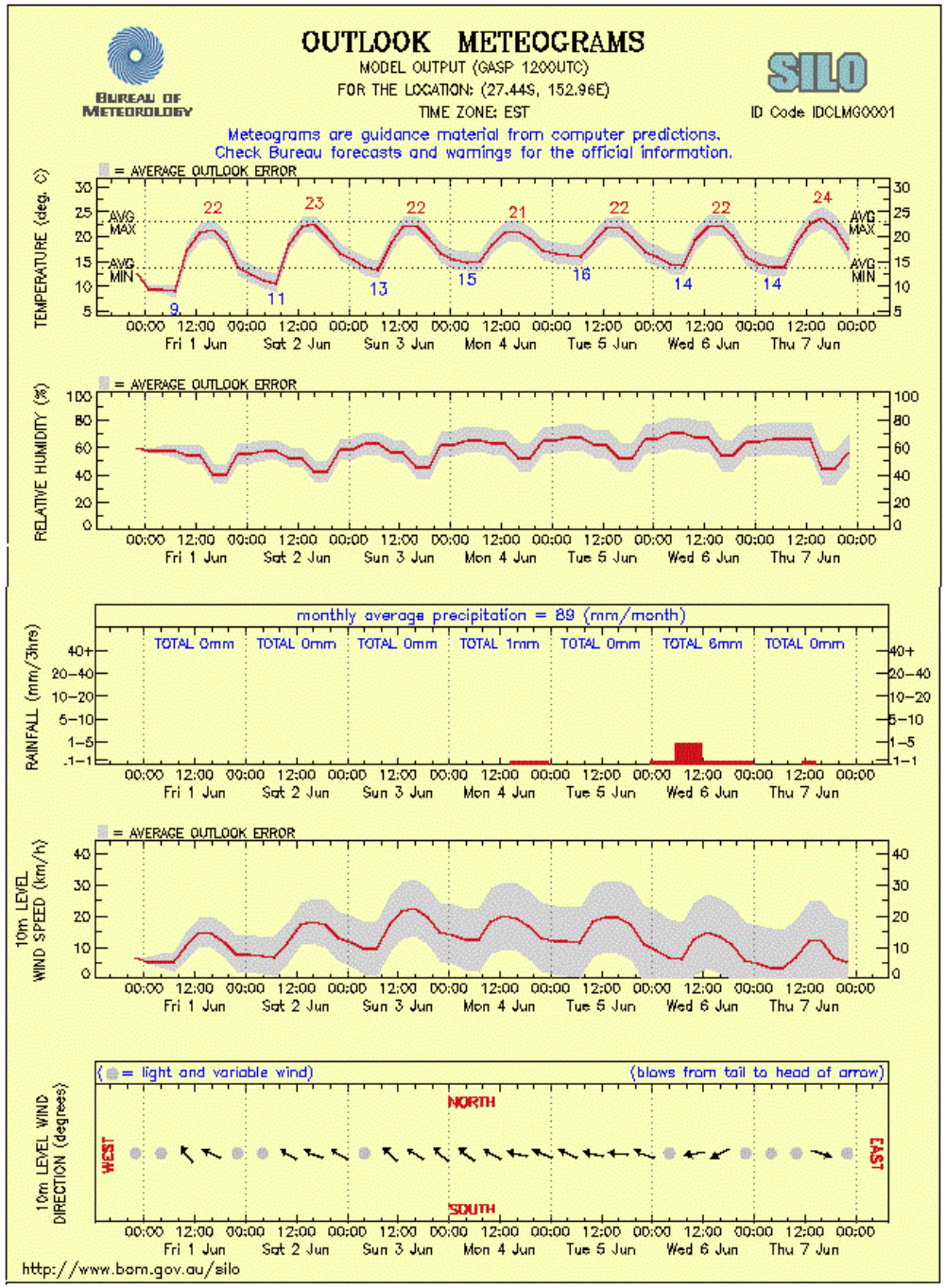
  Weather prediction maps and grids (from numerical weather prediction models) are available via subscription from the Bureau of Meteorology.

- **Rainfall Information**

  Rainfall information for your particular area of interest is available for short time frames. Create

more...

Sample meteogram for Brisbane, prepared Friday 1 June 2001.



Numerical Weather Prediction (NWP) models

Input: observations of the atmosphere from surface stations, balloon-borne radiosondes, satellites, aircraft, radar, etc.

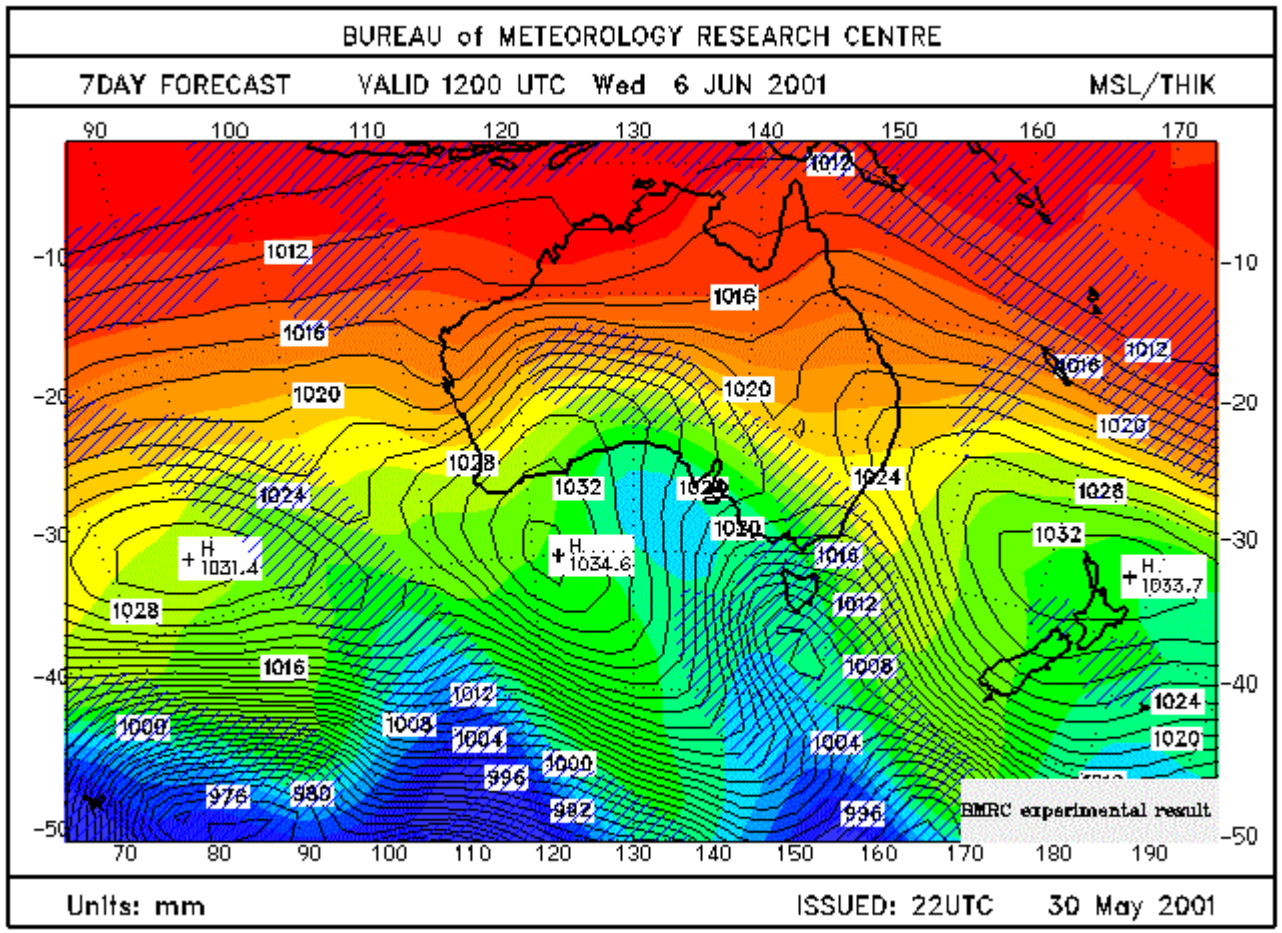
Initialization: insertion of observations into an existing "first guess" field, followed by adjustment to ensure balance

Forward integration: equations for atmospheric motion (wind) and physical processes (radiation, cloud development, precipitation, surface-atmosphere energy exchanges, etc.)

Output: 3-dimensional fields of temperature, humidity, mass (wind); surface-level fields of precipitation, fluxes, etc.

Global Assimilation and Prediction System (GASP)

Runs twice daily at 11 and 23 UTC, forecasts to 7 days
~0.75° spatial resolution

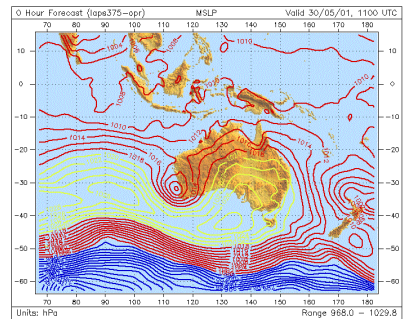


http://www.BoM.GOV.AU/bmrc/medr/mslpTH8.html

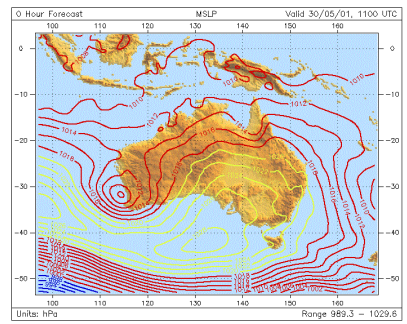
Limited Area Prediction System (LAPS) suite

Nested inside GASP model
Runs twice daily at 11 and 23 UTC

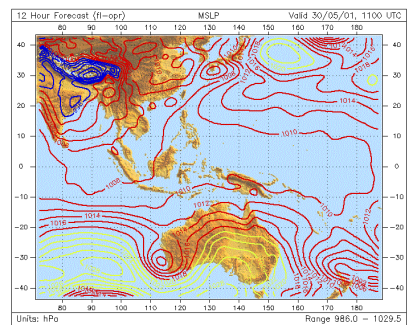
LAPS - forecasts to 48 hours (2 days)
0.375° spatial resolution



mesoLAPS - forecasts to 36 hours (1 1/2 days)
0.125° spatial resolution



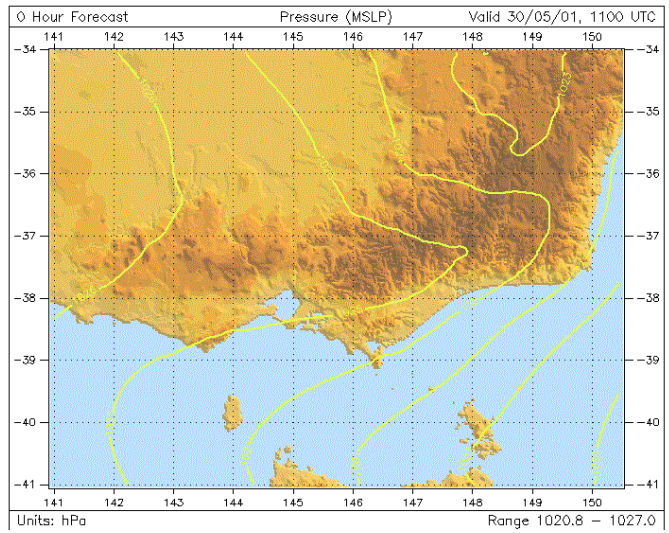
Tropical LAPS (TLAPS) - forecasts to 48 hours
0.375° spatial resolution (2 days)



LAPS suite (continued)

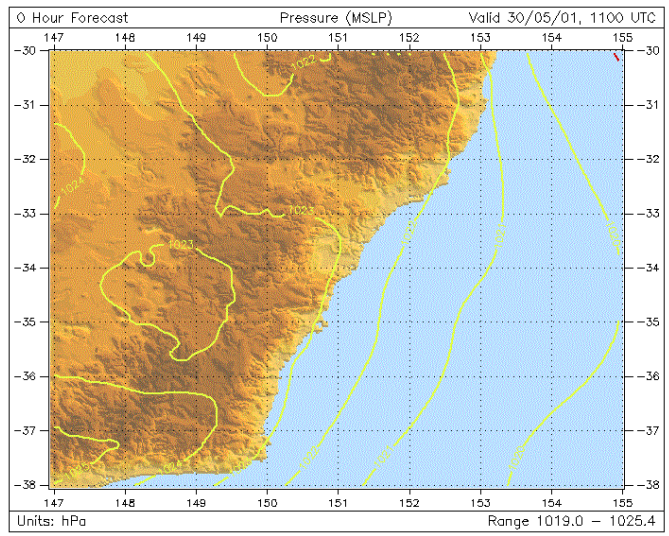
LAPS Melbourne domain
- forecasts to 36 hours (1 1/2 days)

0.05° spatial resolution



LAPS Sydney domain
- forecasts to 36 hours (1 1/2 days)

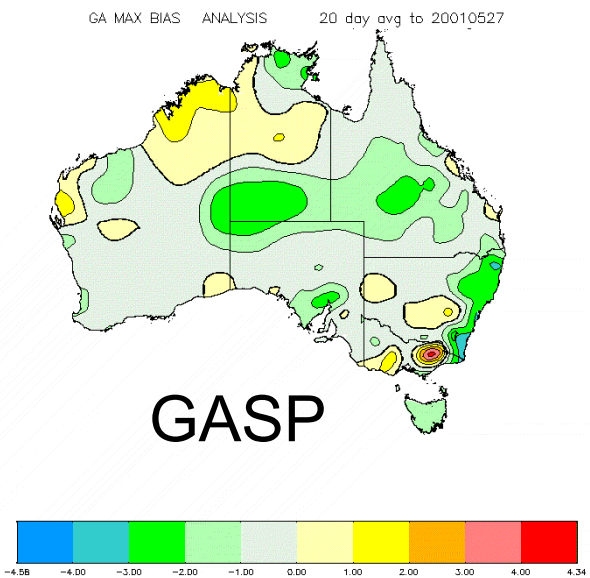
0.05° spatial resolution

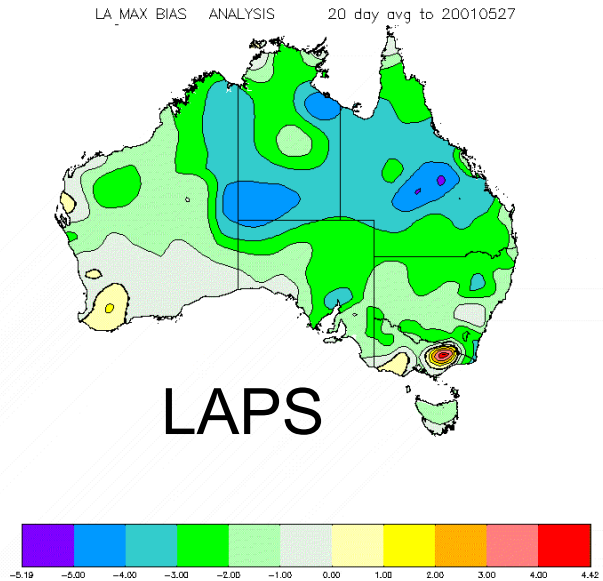


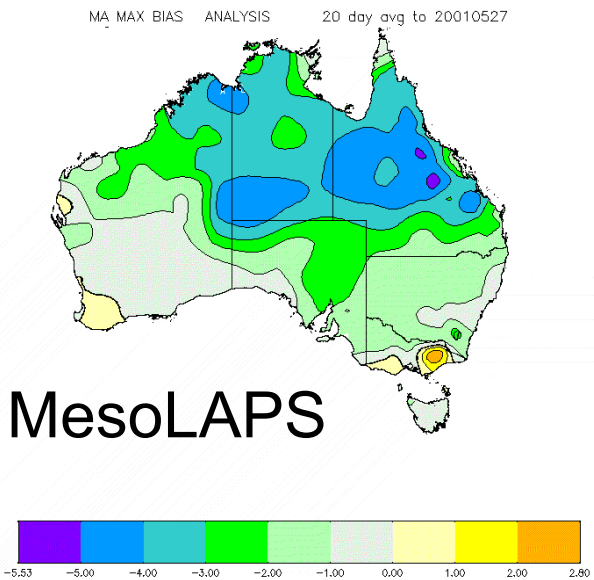
Meteogram Day+1
RMS errors in temperature forecasts
30 April - 29 May 2001, 165 stations

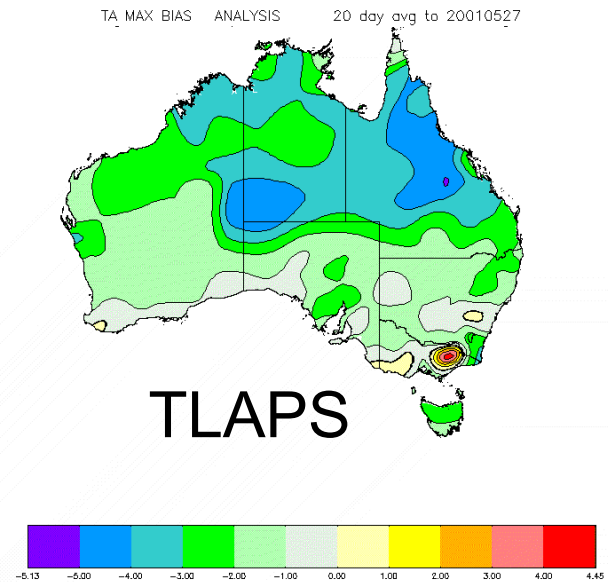
System	Max T (°C)	Min T (°C)
GASP	**2.28**	**3.34**
LAPS	**2.78**	**3.98**
MesoLAPS	**2.45**	**2.75**
Tropical LAPS	**2.76**	**4.46**
Regional Forecast Centre	**1.56**	**2.04**

Meteogram Day+1 T_{max} bias (20 day average to May 27)

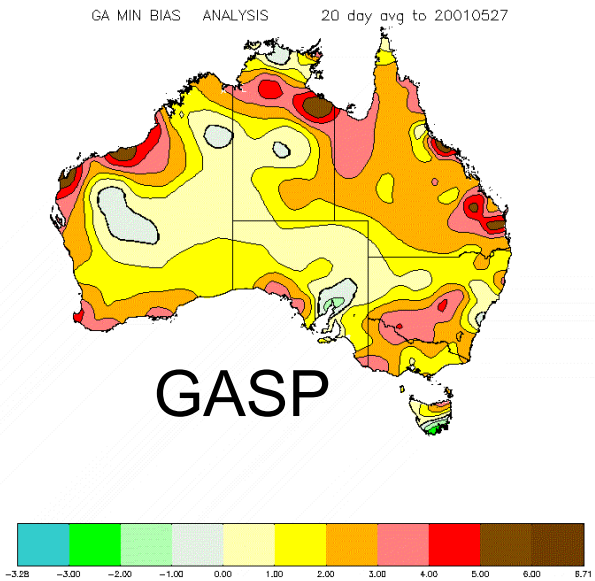


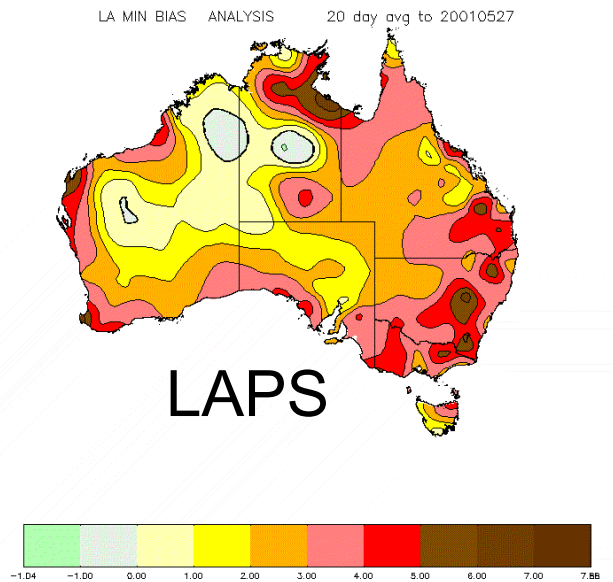


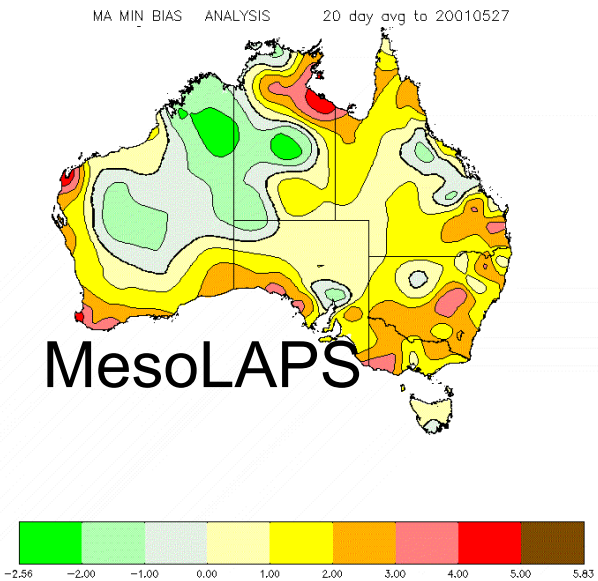


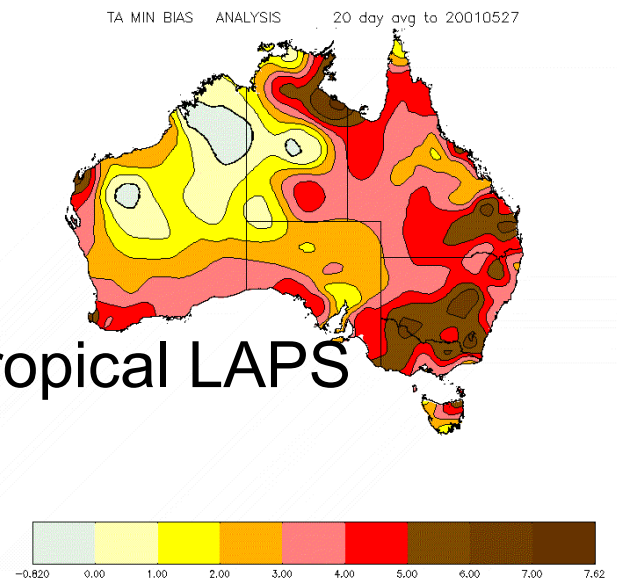


Meteogram Day+1 T_{min} bias (20 day average to May 27)

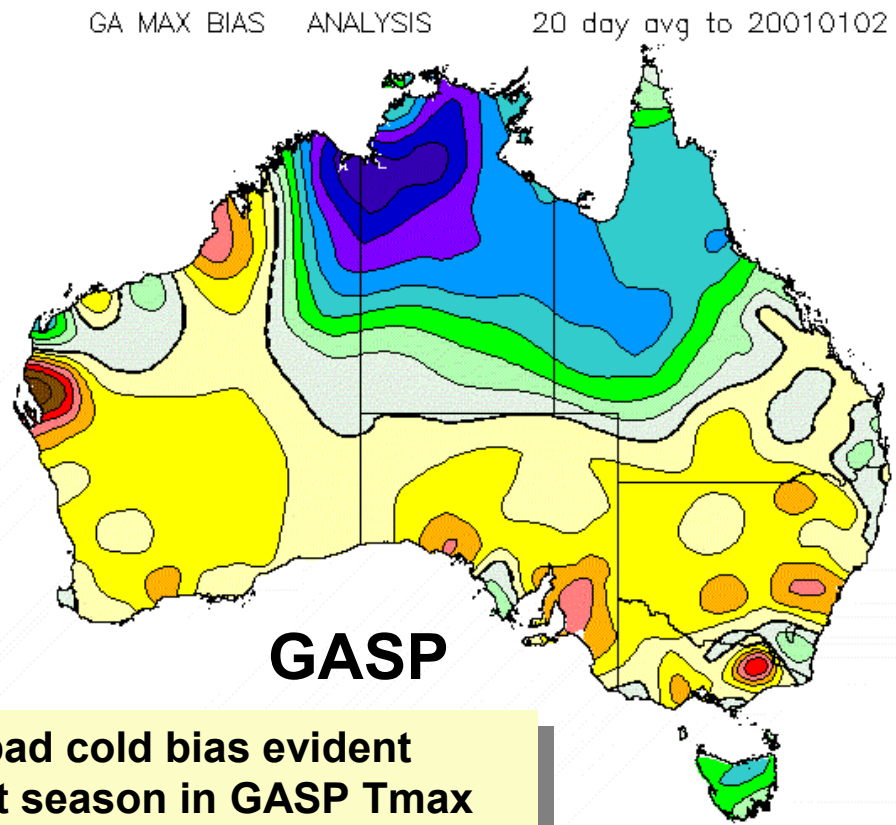






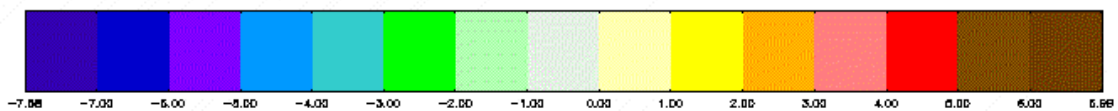


Meteogram Day+1 T_{max} bias (20 day average to Jan 2)

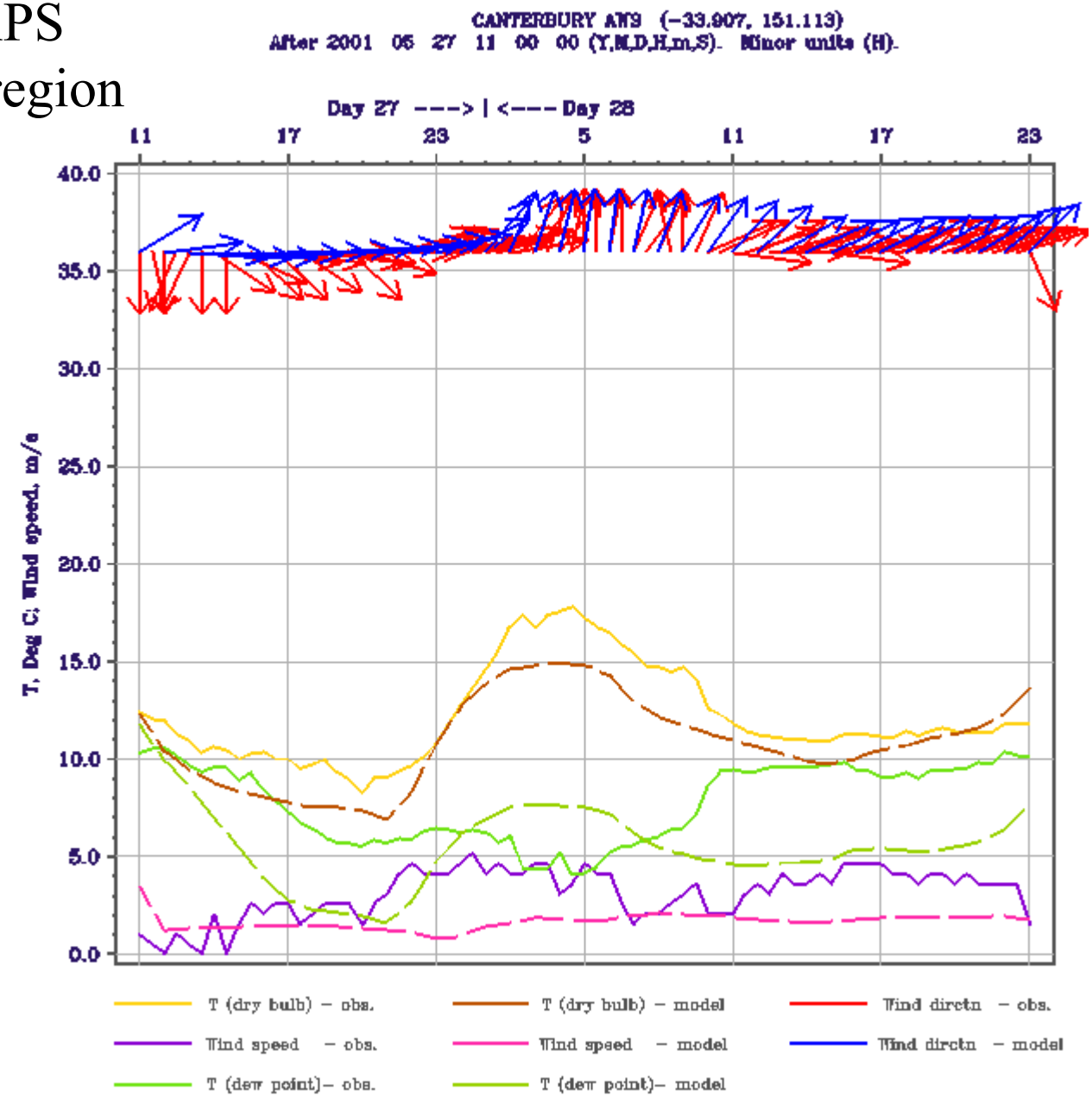


GASP

Comment: Shows bad cold bias evident during northern wet season in GASP Tmax forecasts - attributable to simplistic land surface/soil moisture scheme in use

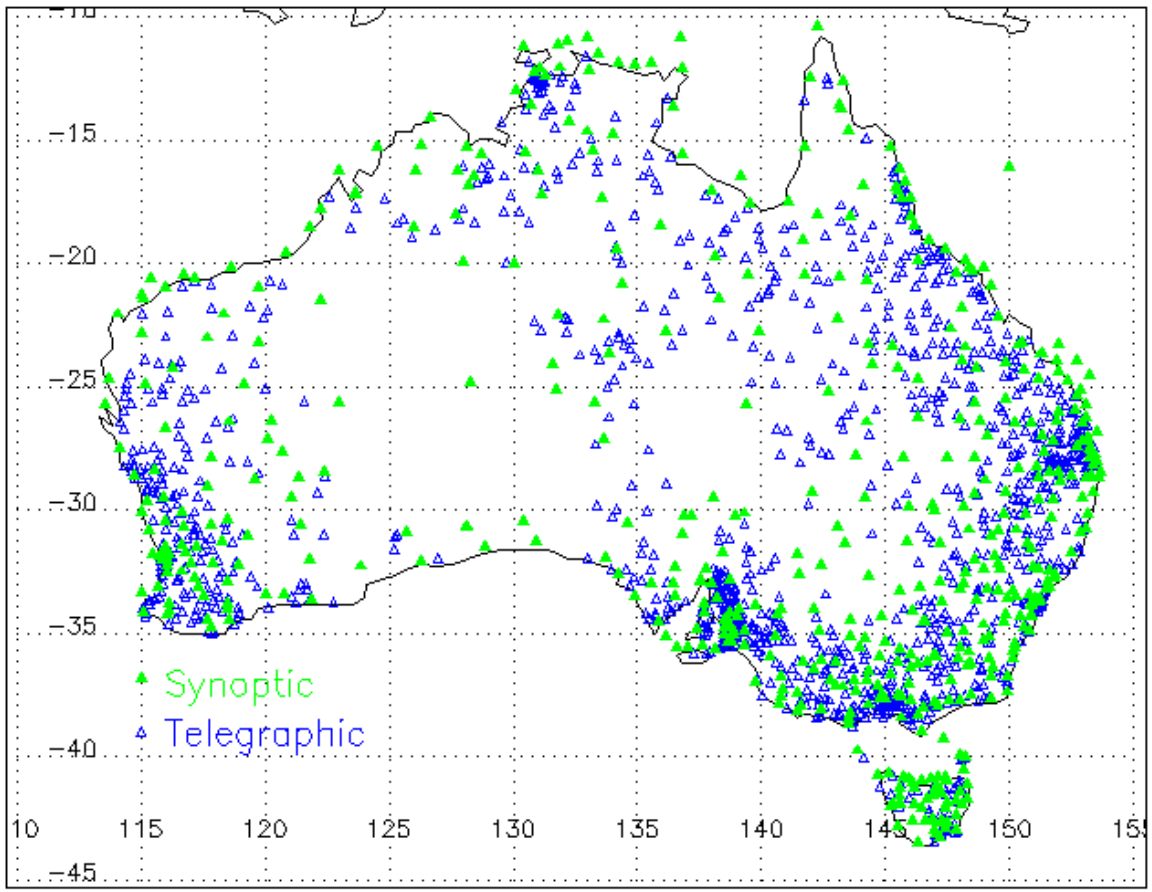


5 km LAPS
Sydney region



Australian verification data for 24 h QPFs

"Real-time" objective rainfall analyses are produced daily within a few hours of 9 a.m. reporting time.



~ 400 synoptic stations report every day

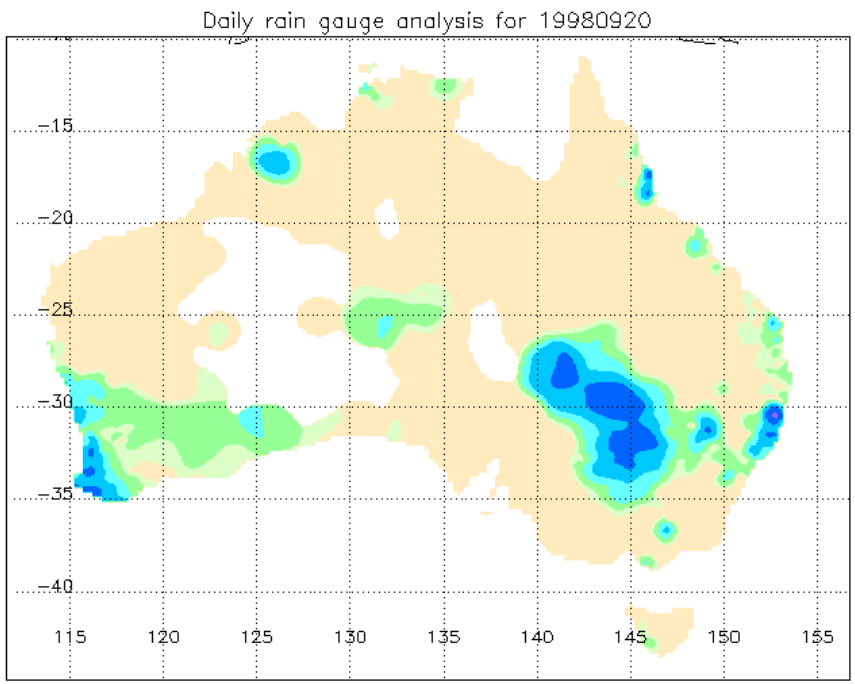
~ 1500 telegraphic stations report only when raining

~ 4000 cooperative network stations report at end of month

Operational Objective Rainfall Analysis

3-pass Barnes successive corrections scheme:

Starts with field of zero rainfall
Pass 1 - 80 km length scale → smooth rainfall field
Passes 2, 3 - 44 km length scale → adds detail



Final analysis is on a 0.25° grid over Australia.

Verification of quantitative precipitation forecasts from NWP models

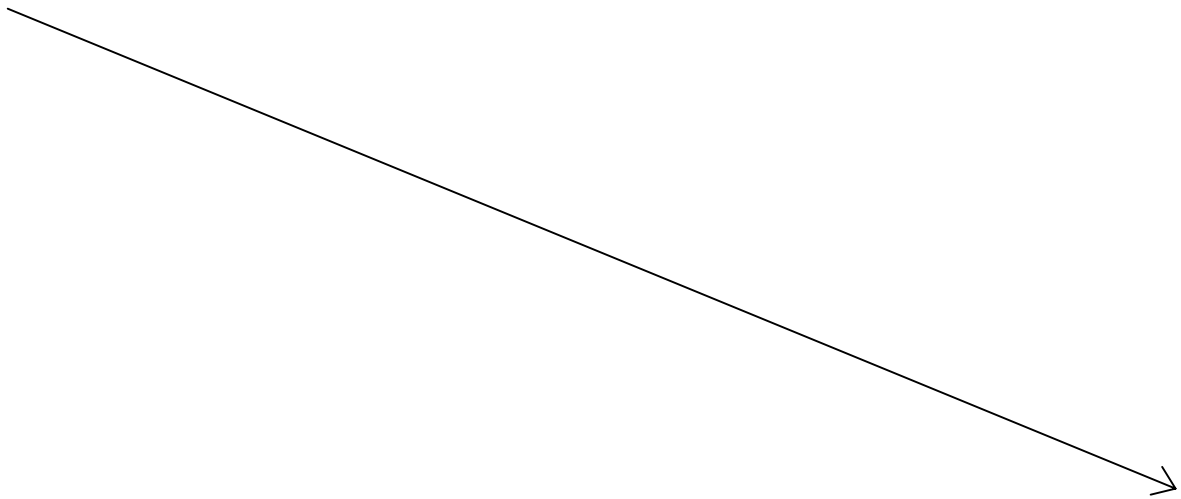
Maps Error statistics Time series

Global

Regional

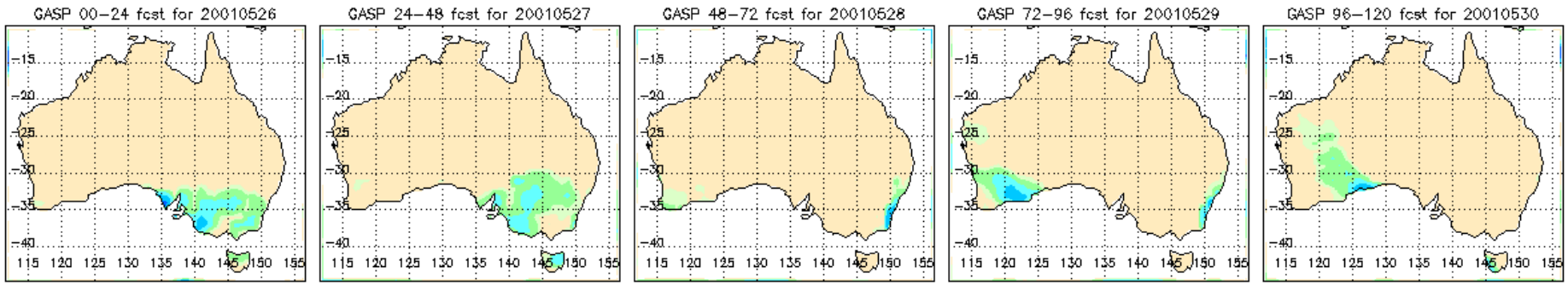
Basin

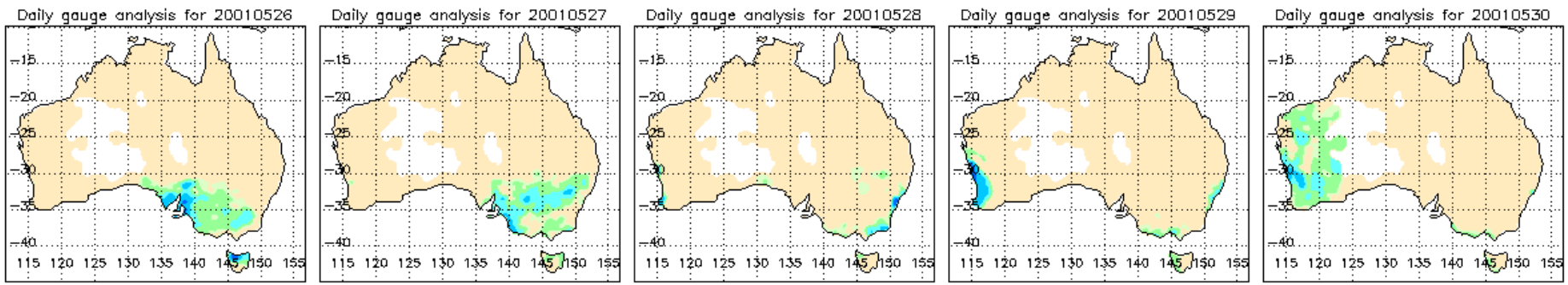
Point



GASP 5-day rainfall forecast issued 26 May for 26-30 May 2001

forecast

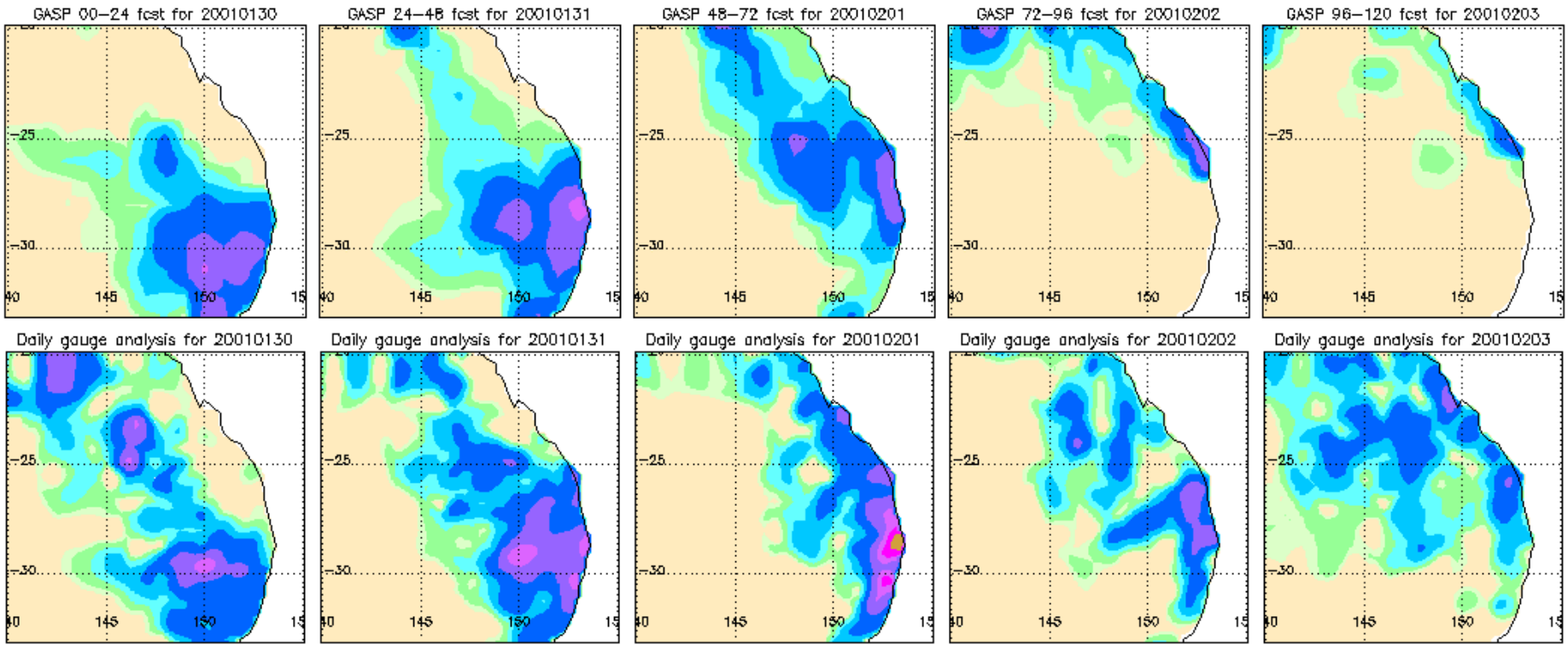




observed

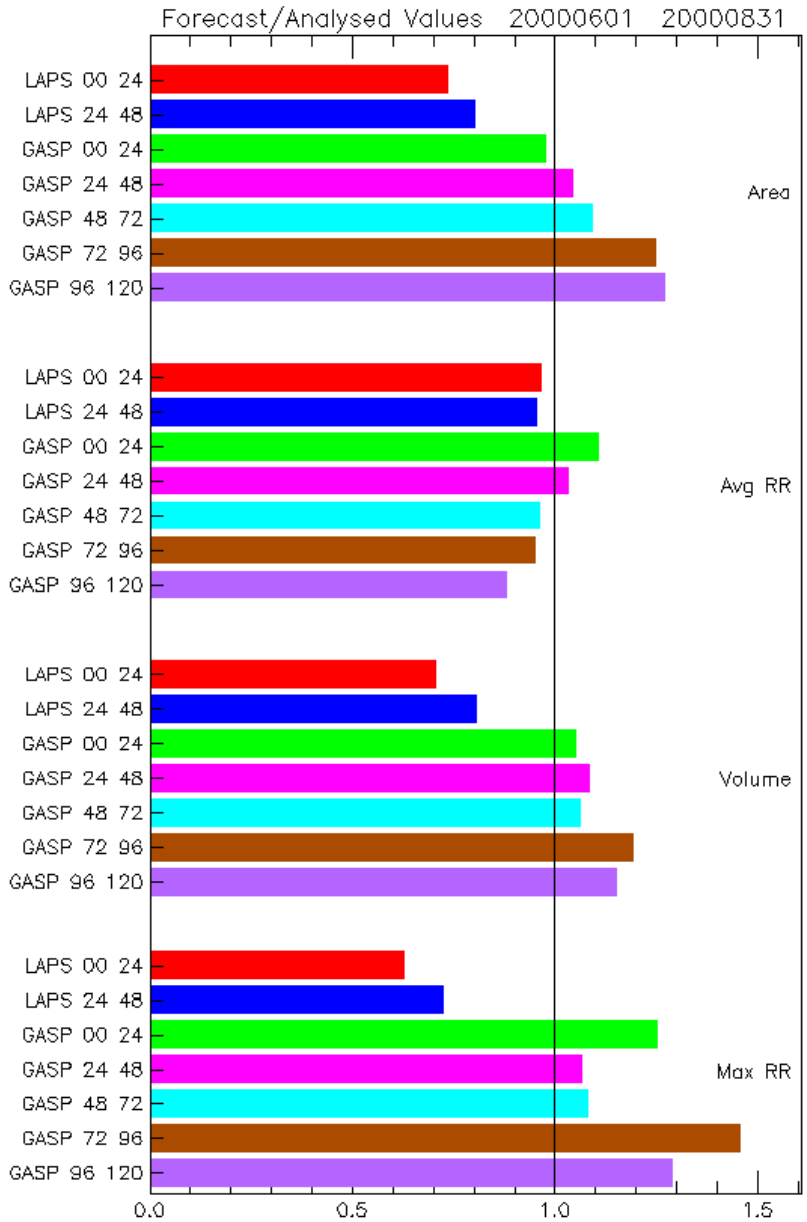
GASP 5-day rainfall forecast issued 30 January for 30 January -3 February 2001

forecast

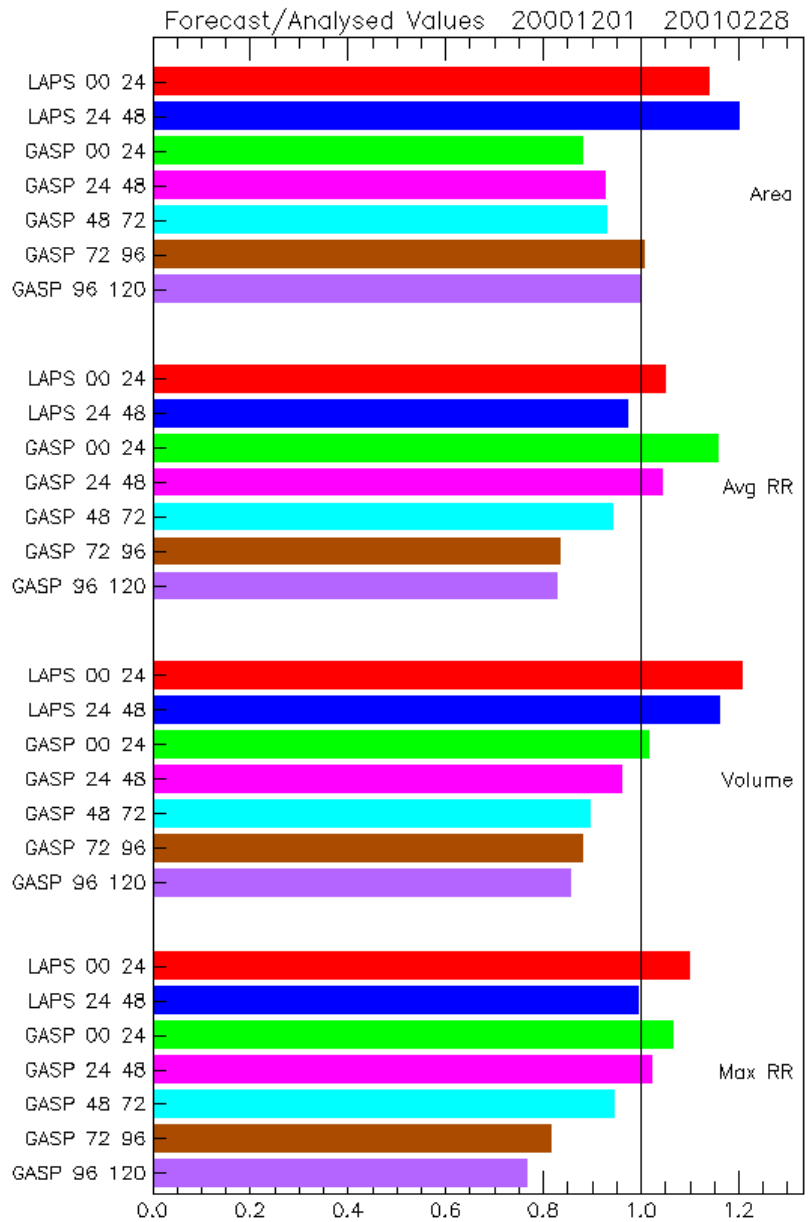


observed

Winter 2000



Summer 2000-01



Verification measures for quantitative precipitation forecasts

Statistics for rain amount
Mean difference
Mean absolute error
Root mean square (RMS) error

Statistics for rain pattern
Correlation coefficient

Statistics for rain occurrence (categorical statistics)

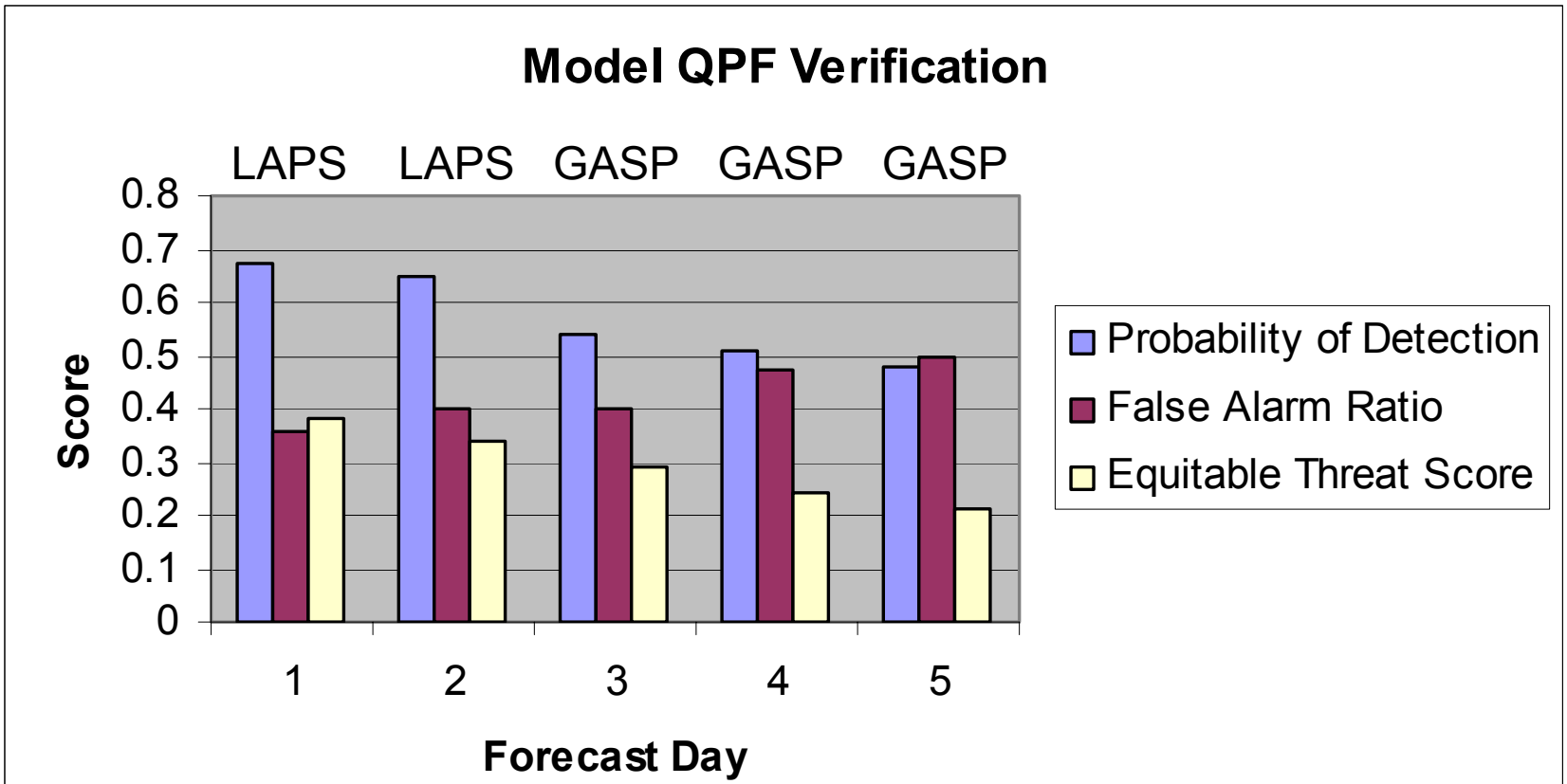
Bias Score $$BIAS = \frac{\text{rain forecasts}}{\text{rain observations}}$$

Probability of Detection $$POD = \frac{\text{correct rain forecasts}}{\text{rain observations}}$$

False Alarm Ratio $$FAR = \frac{\text{false alarms}}{\text{rain forecasts}}$$

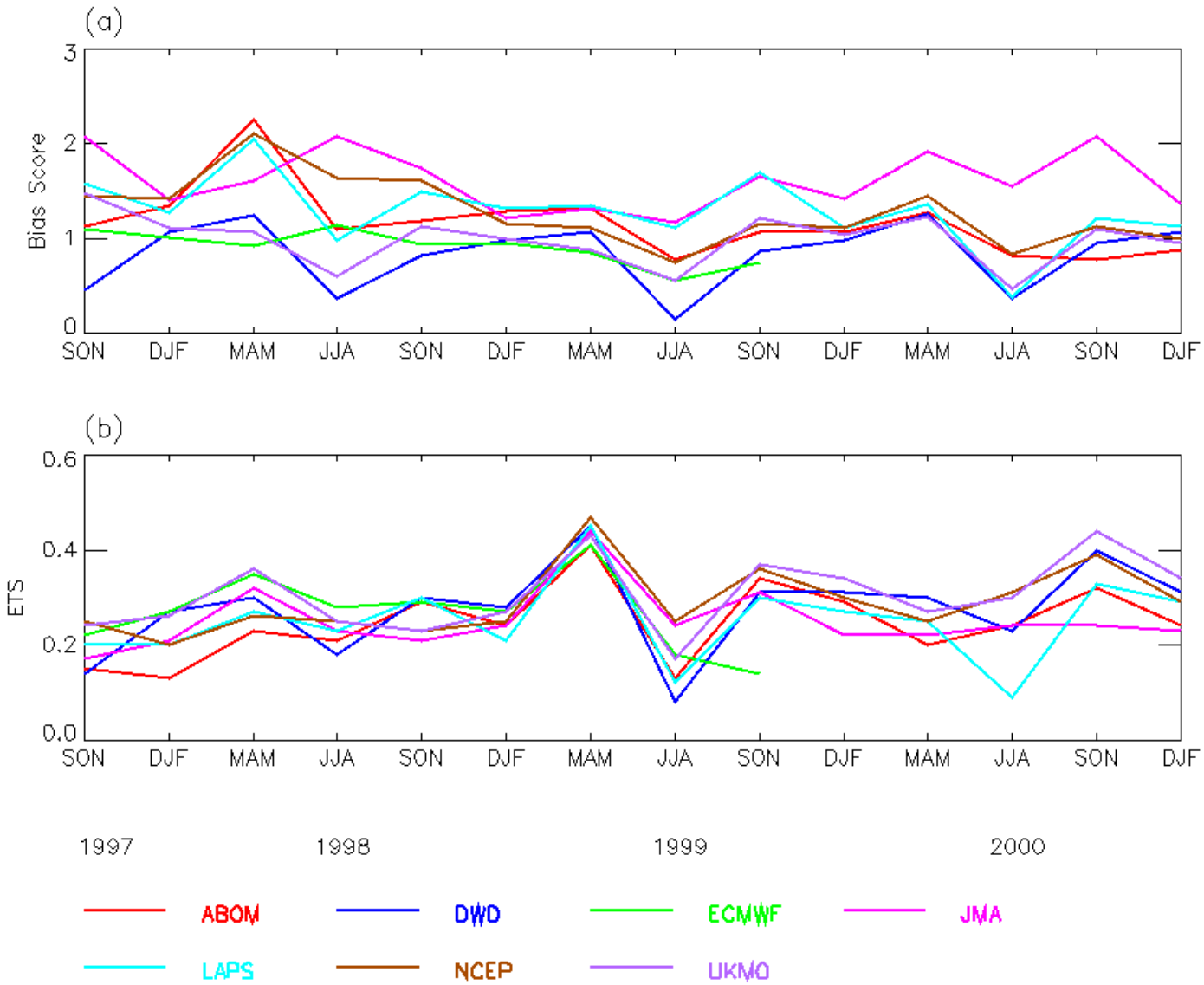
Equitable Threat Score $$ETS = \frac{\text{correct rain forecasts} - \text{random hits}}{\text{rain forecasts} + \text{observations} - \text{random hits}}$$

Australia-wide verification scores (model resolution) for 1- to 5-day forecasts, January-May 2001

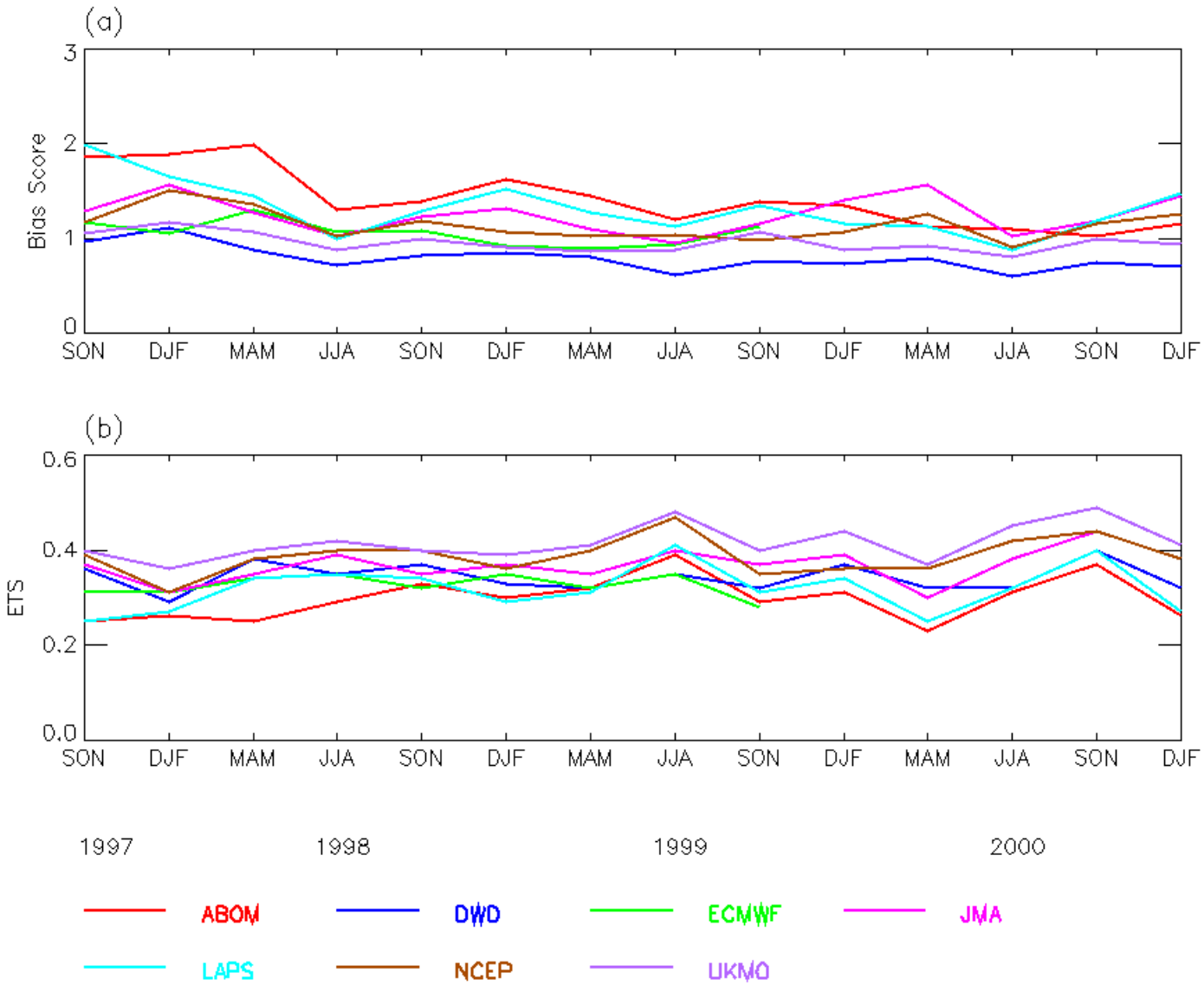


Note: Equitable threat score for "Persistence" forecast is 0.29, i.e., equal to Day 3 score for model forecast

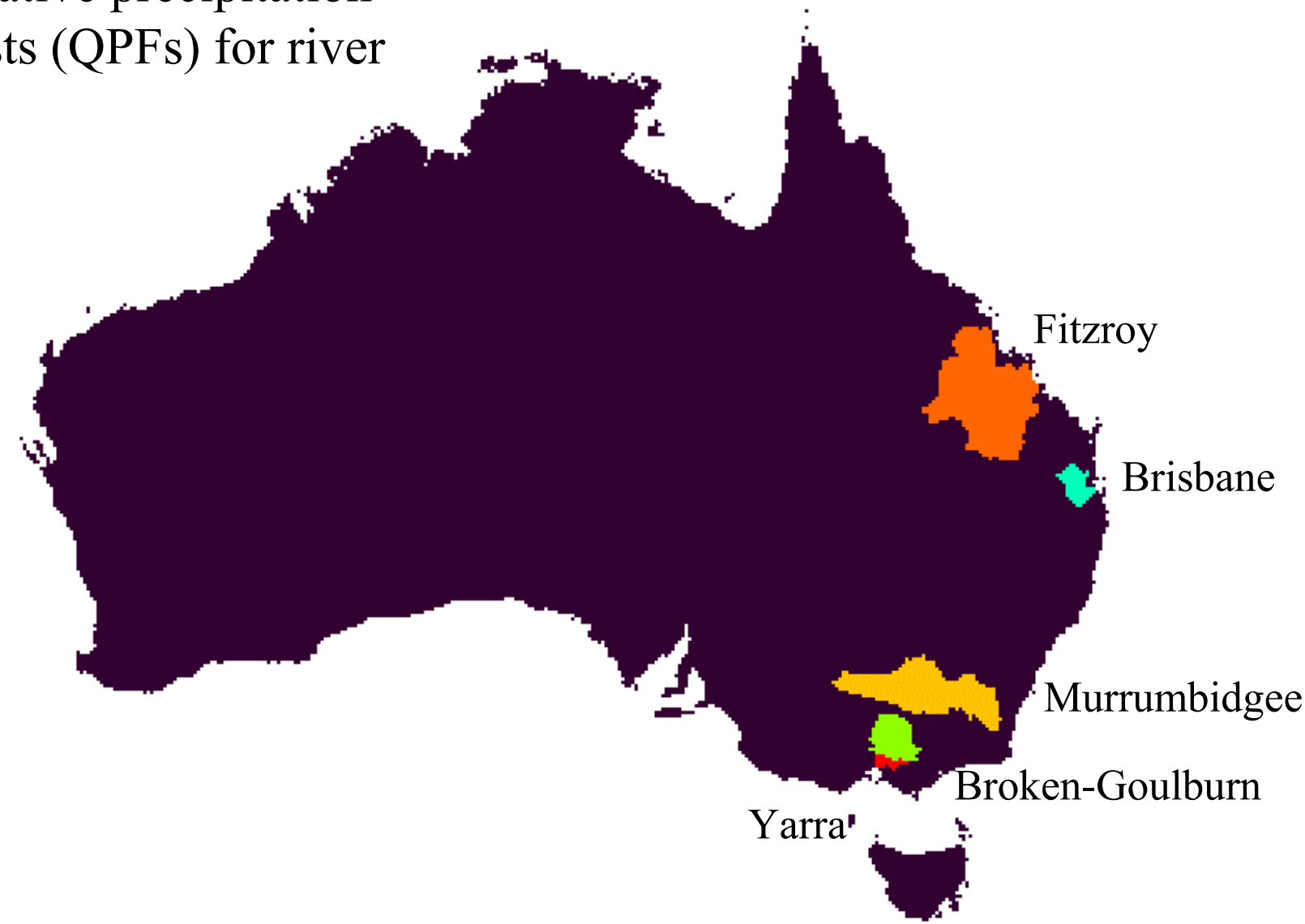
Verification scores for northern (tropical) Australia 48 h QPFs from 6 global and 1 regional NWP model

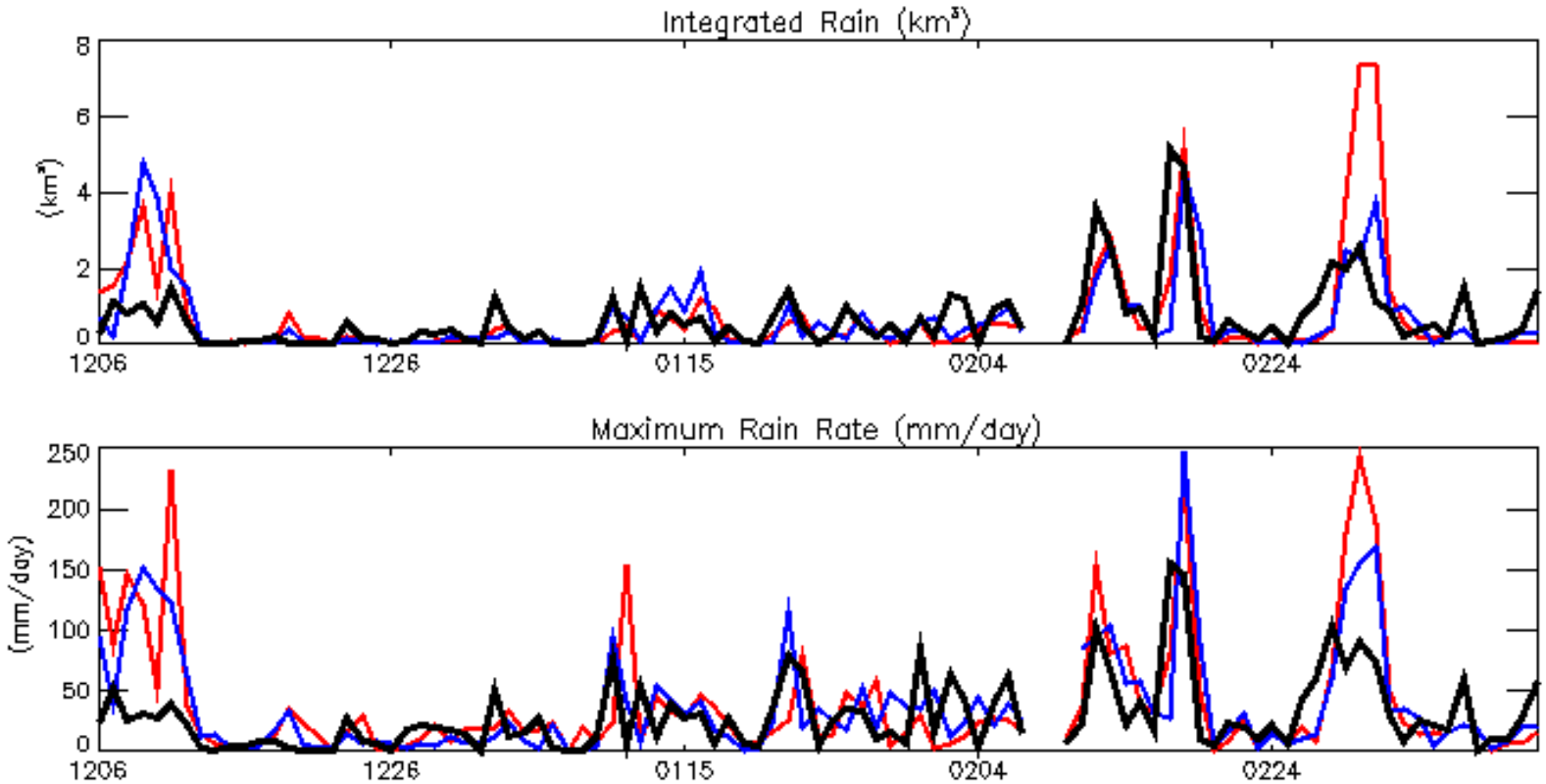


Verification scores for southeastern Australia
48 h QPFs from 6 global and 1 regional NWP model



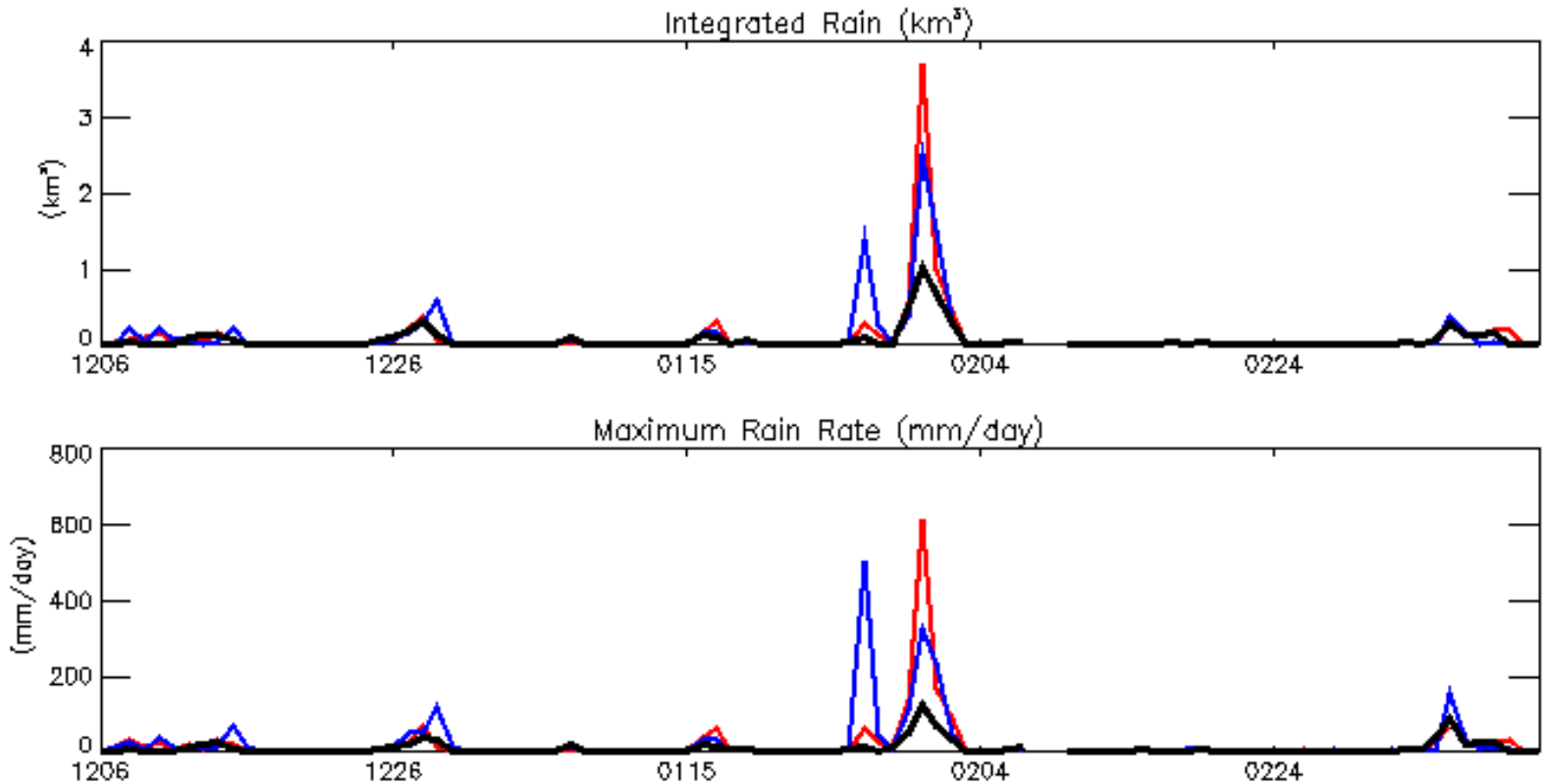
Verification of NWP model quantitative precipitation forecasts (QPFs) for river basins





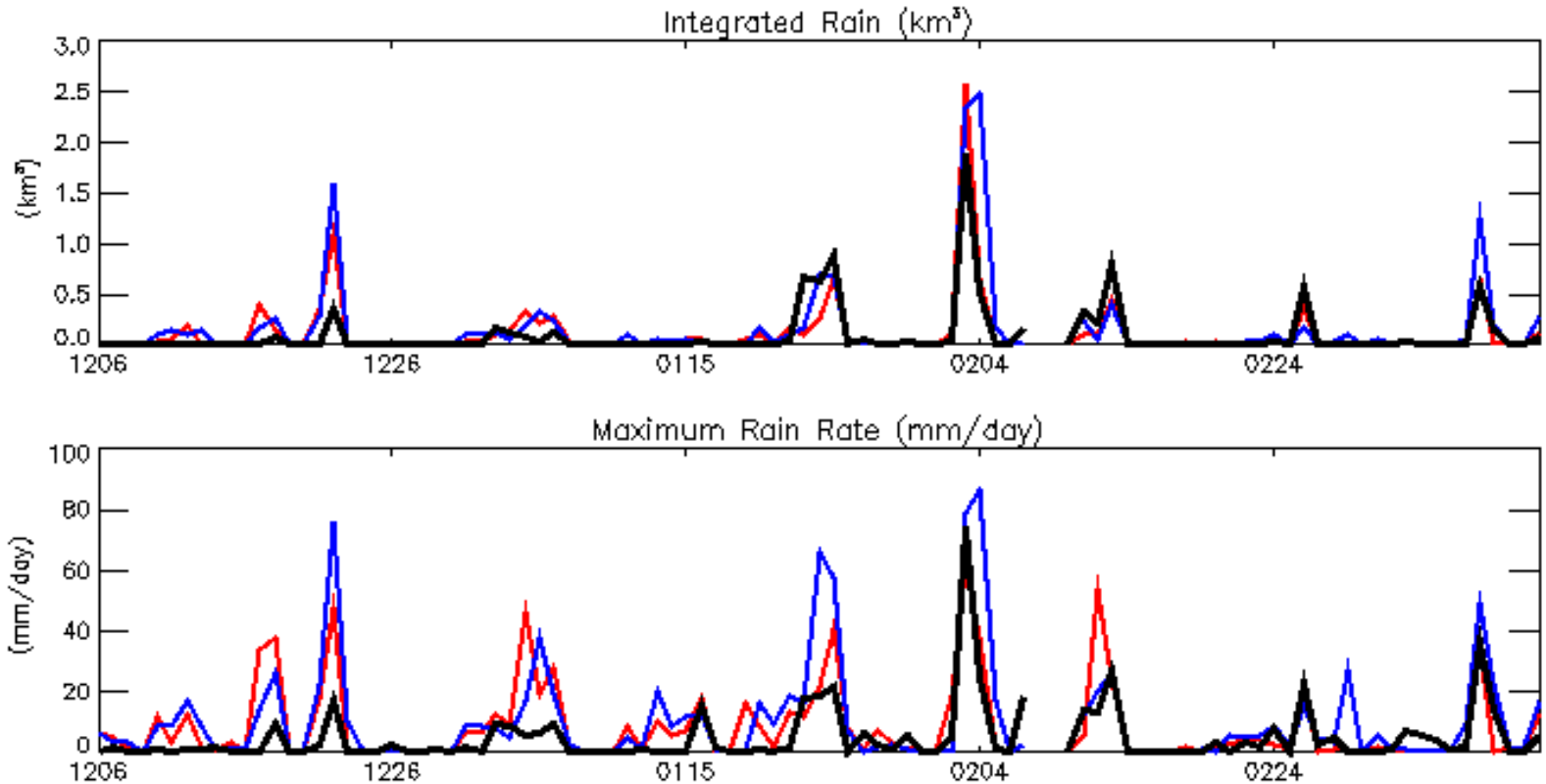
Fitzroy Basin

Observed mesoLAPS 24 h mesoLAPS 36 h



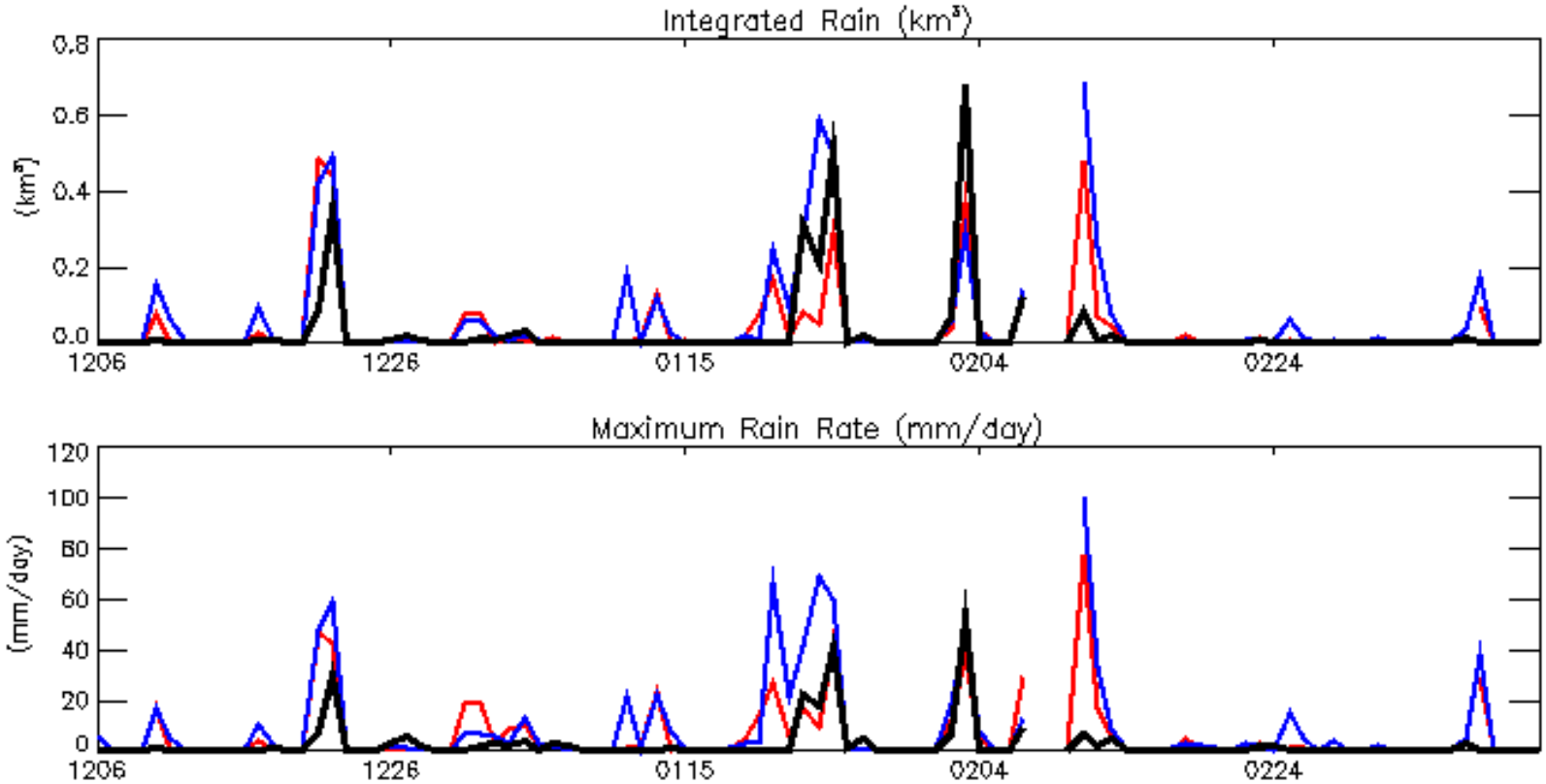
Brisbane Basin

Observed mesoLAPS 24 h mesoLAPS 36 h



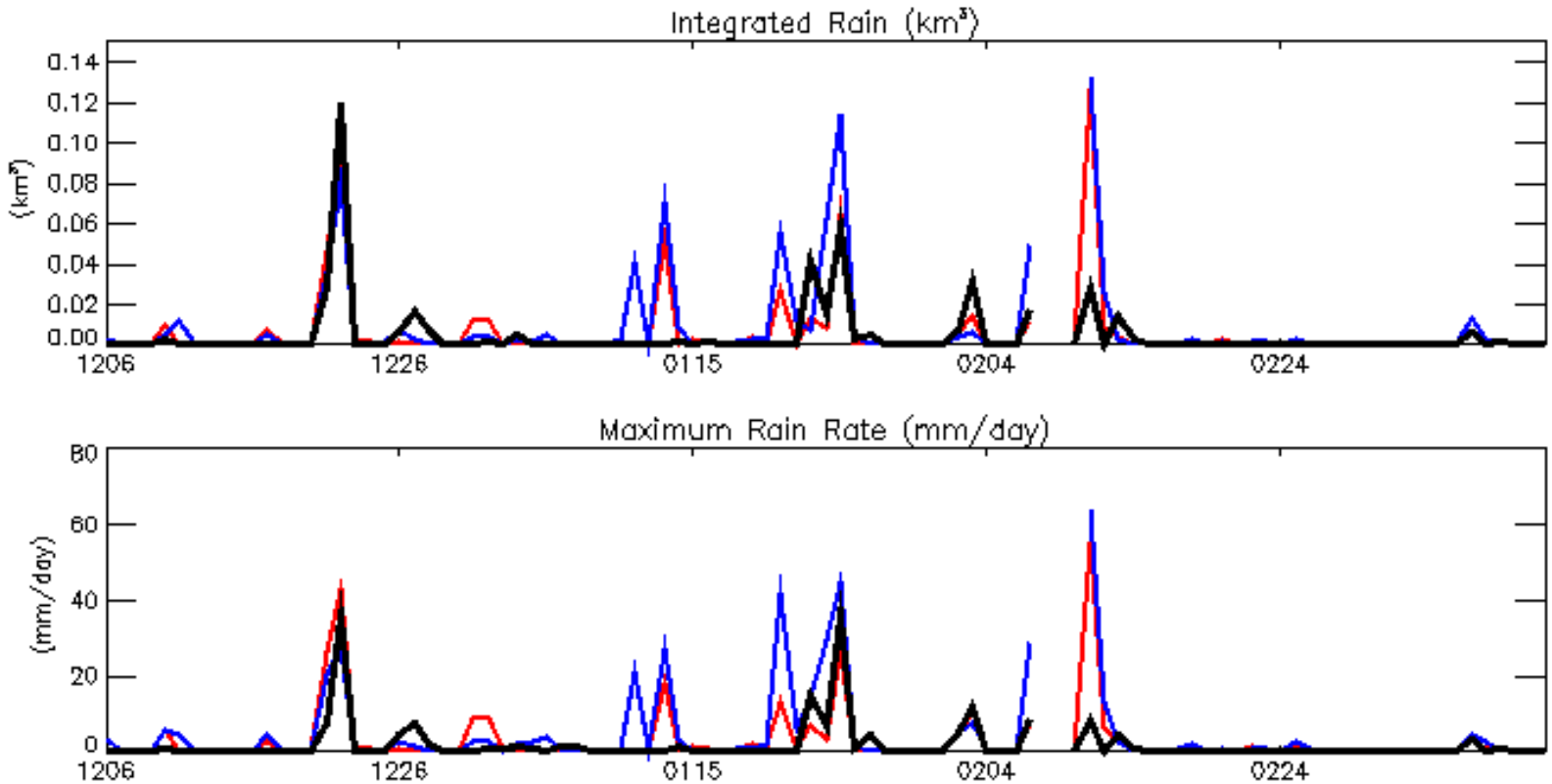
Murrumbidgee Basin

Observed mesoLAPS 24 h mesoLAPS 36 h



Broken-Goulburn Basin

Observed mesoLAPS 24 h mesoLAPS 36 h



Yarra Basin

Observed mesoLAPS 24 h mesoLAPS 36 h

Basin	Yarra	Broken-Goulburn	Murrum-bidgee	Brisbane	Fitzroy
24 h mesoLAPS forecasts					
% error in rain area	-6	12	28	-19	-1
% error in average daily rainfall	6	24	50	49	18
% error in maximum daily rainfall	35	61	66	62	45
Correlation coeff. for daily rainfall	0.83	0.70	0.81	0.85	0.82
36 h mesoLAPS forecasts					
% error in rain area	16	48	40	-19	-4
% error in average daily rainfall	32	42	47	63	11
% error in maximum daily rainfall	49	85	66	84	19
Correlation coeff. for daily rainfall	0.69	0.73	0.76	0.82	0.79

Verification of mesoLAPS forecast daily rainfall for 1 October 2000-14 April 2001

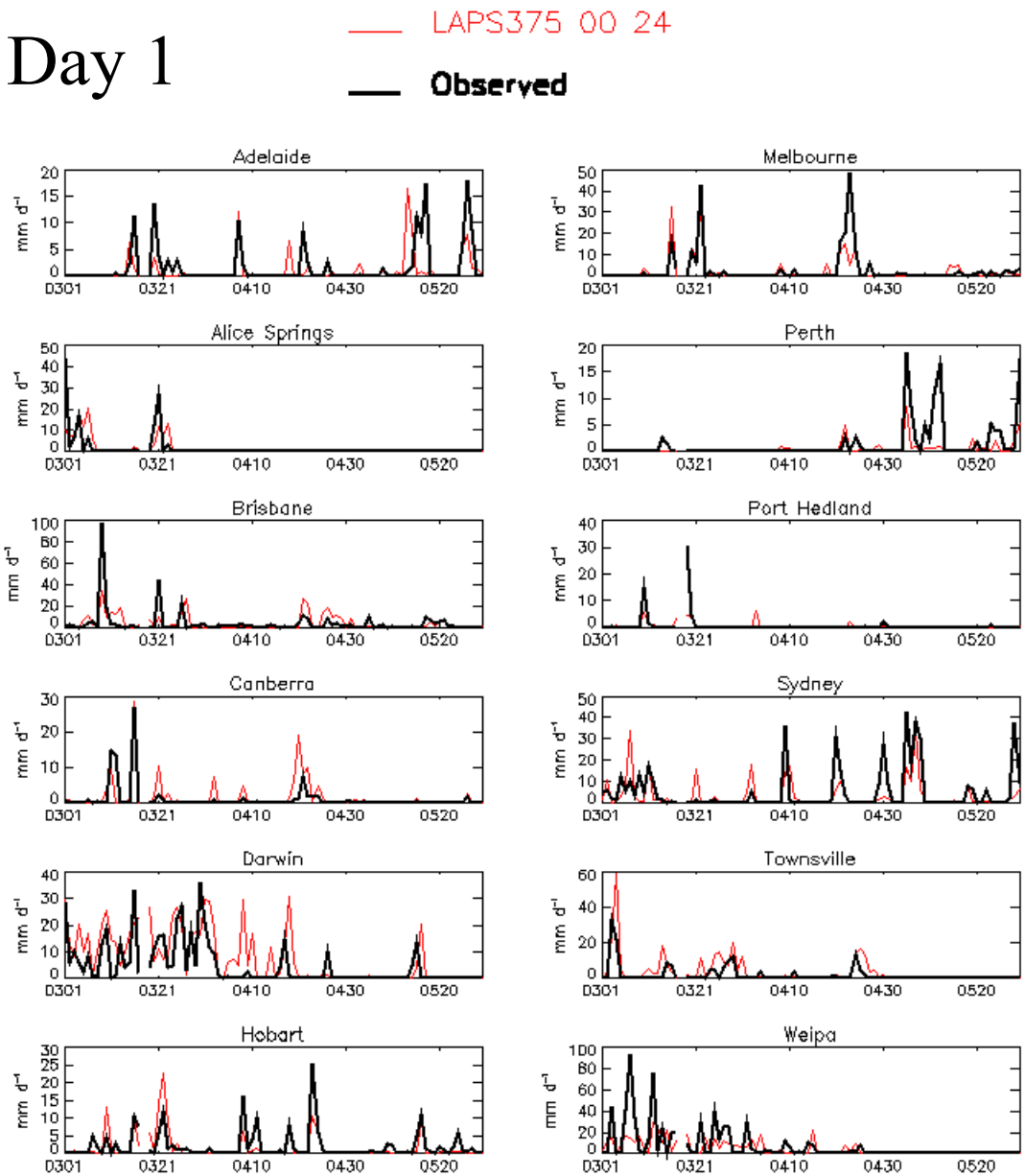
Bureau of Meteorology's model QPFs interpolated to point locations

Verified against daily rainfall analysis interpolated to point locations (fairer comparison than raw gauge data)

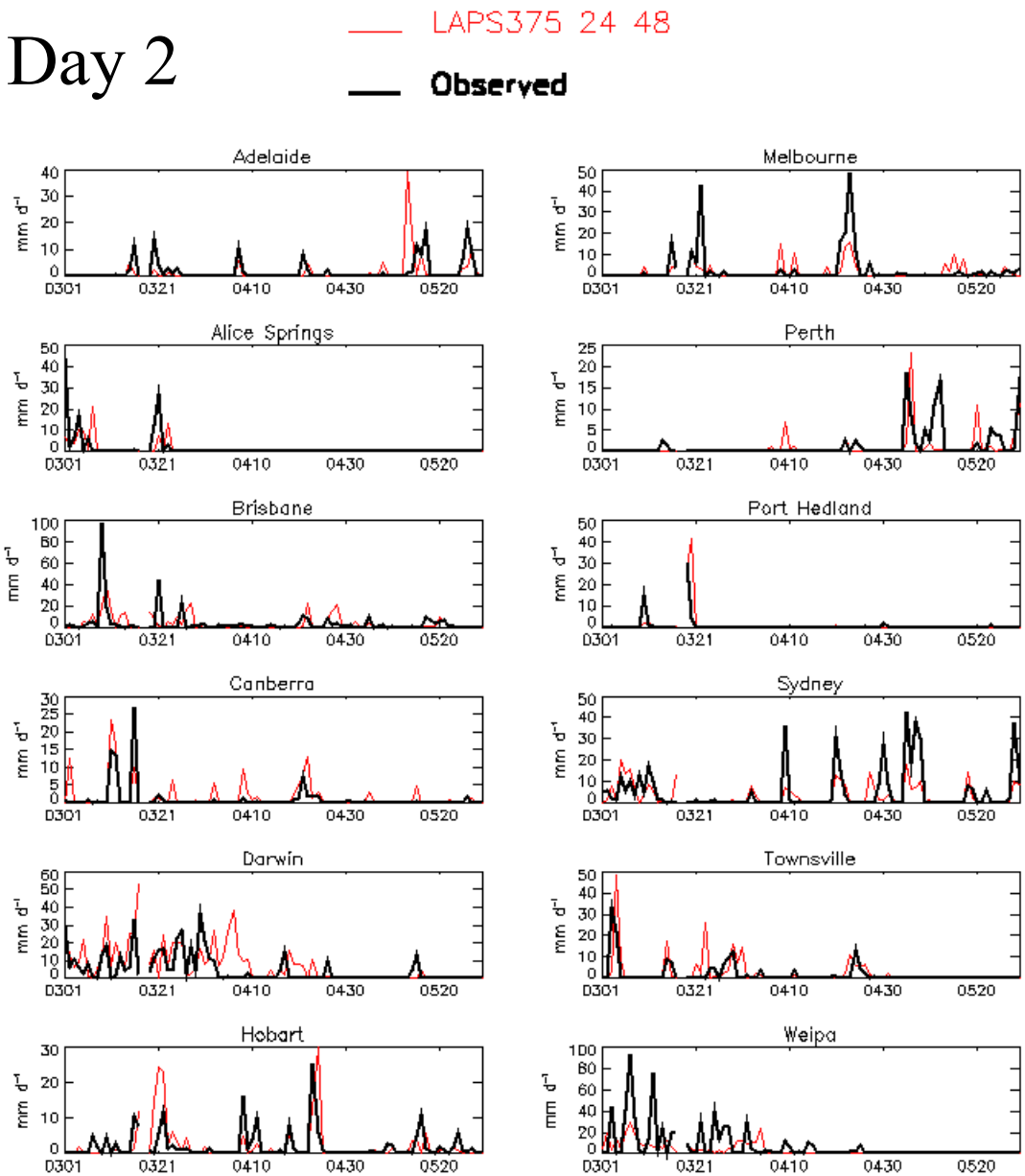
12 cities around Australia:

Adelaide	Darwin	Port Hedland
Alice Springs	Hobart	Sydney
Brisbane	Melbourne	Townsville
Canberra	Perth	Weipa

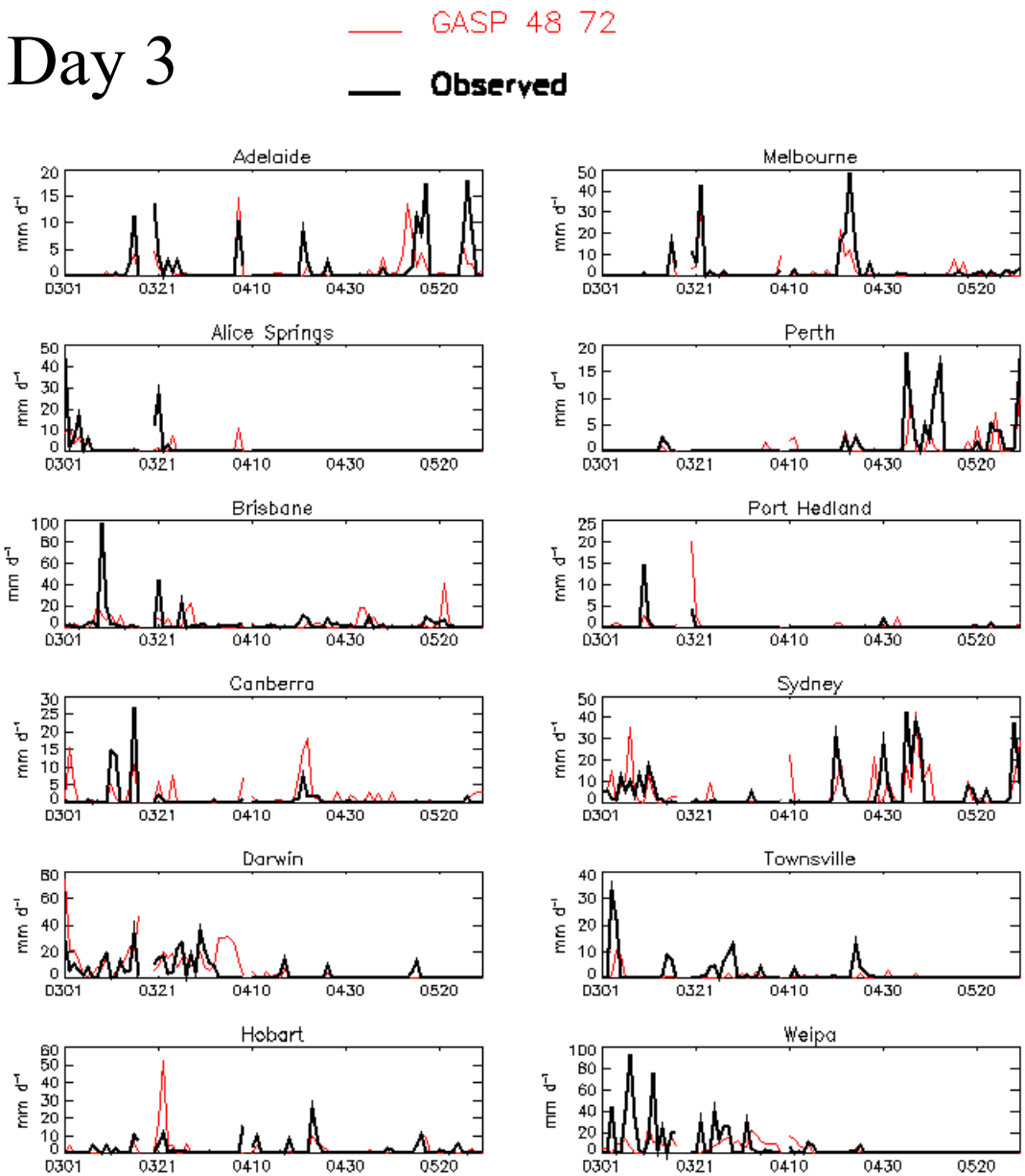
Day 1


LAPS375 00 24
Observed
Adelaide
Melbourne
Alice Springs
Perth
Brisbane
Port Hedland
Canberra
Sydney
Darwin
Townsville
Hobart
Weipa
mm d⁻¹
0301
0321
0410
0430
0520

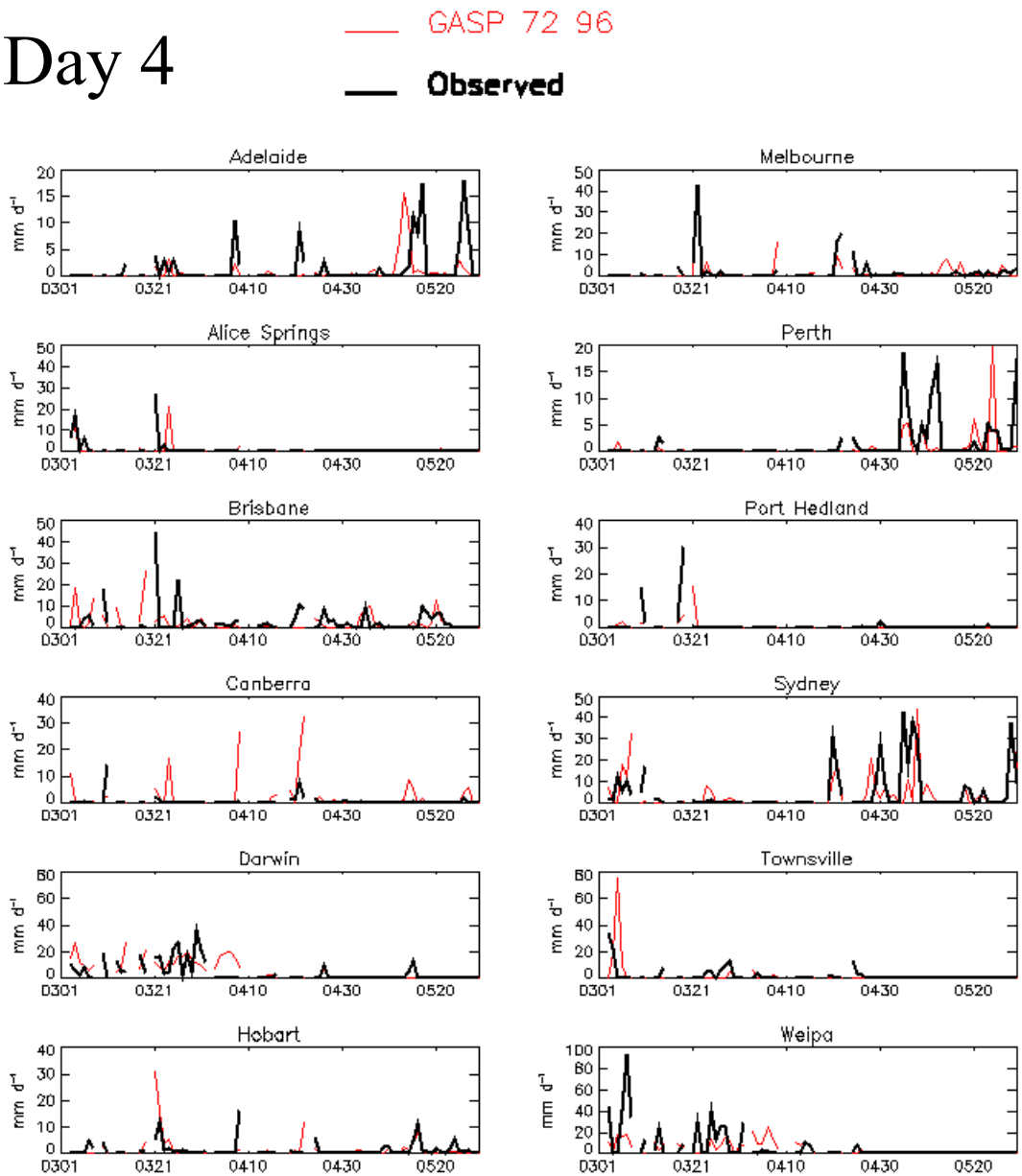
Day 2


LAPS375 24 48
Observed
Adelaide
Melbourne
Alice Springs
Perth
Brisbane
Port Hedland
Canberra
Sydney
Darwin
Townsville
Hobart
Weipa
mm d-1
0301
0321
0410
0430
0520

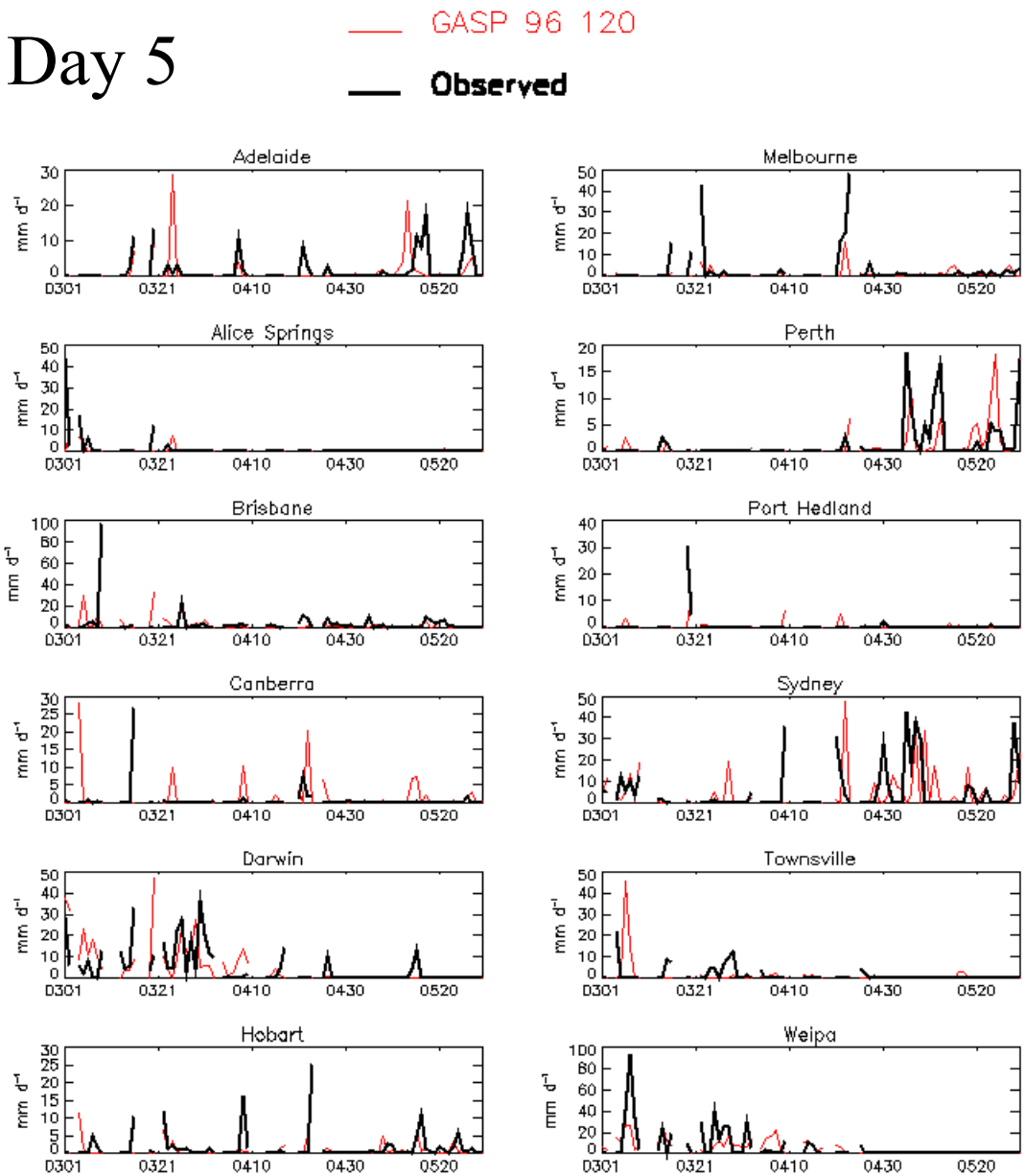
Day 3


GASP 48 72
Observed
Adelaide
Melbourne
Alice Springs
Perth
Brisbane
Port Hedland
Canberra
Sydney
Darwin
Townsville
Hobart
Weipa
mm d⁻¹
0301
0321
0410
0430
0520

Day 4


GASP 72 96
Observed
Adelaide
Melbourne
Alice Springs
Perth
Brisbane
Port Hedland
Canberra
Sydney
Darwin
Townsville
Hobart
Weipa
mm d⁻¹
0301
0321
0410
0430
0520

Day 5


GASP 96 120
Observed
Adelaide
Melbourne
Alice Springs
Perth
Brisbane
Port Hedland
Canberra
Sydney
Darwin
Townsville
Hobart
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mm d⁻¹
0301
0321
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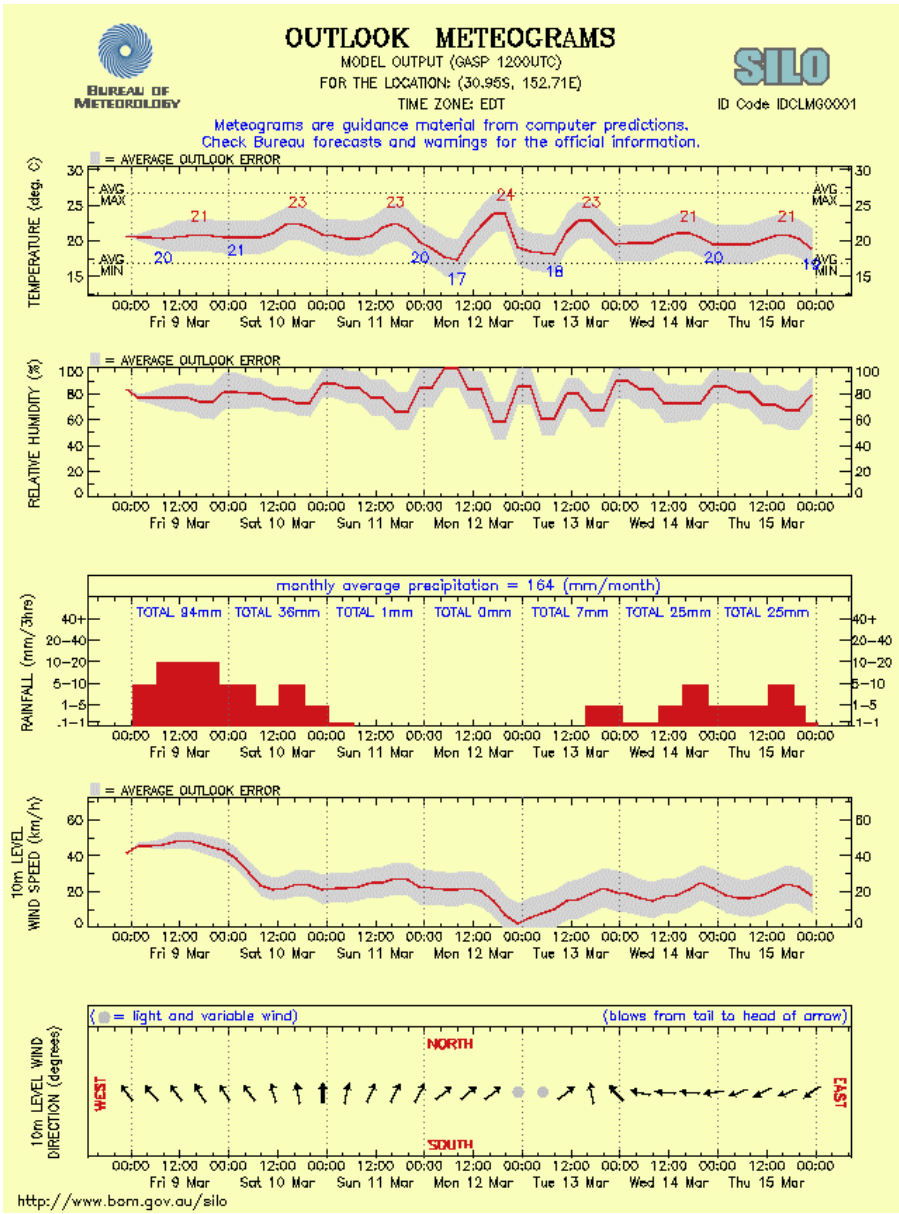
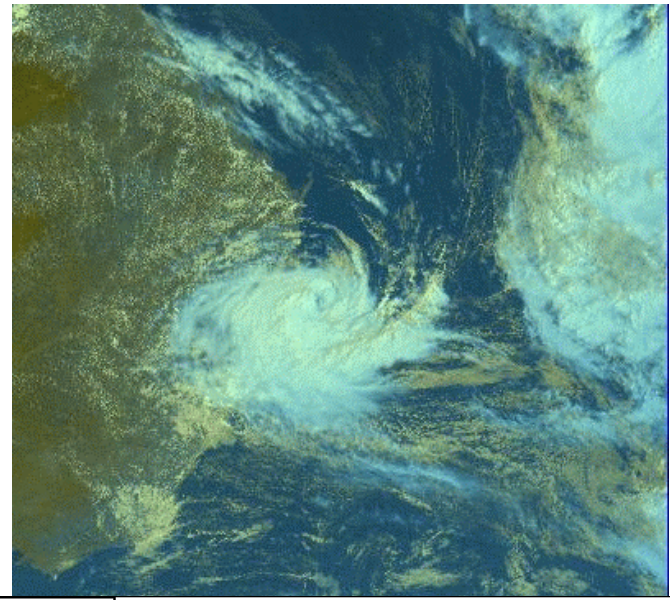
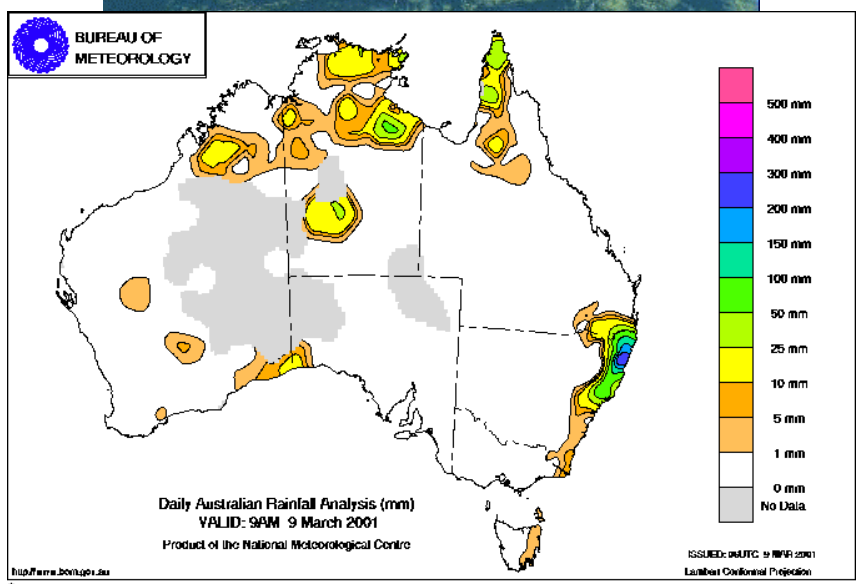
Tropical Cyclone Donald, 9 March 2001







Conclusions regarding quality of model QPFs

1. Forecast skill is highest early in the forecast period and decreases with time

2. The models show seasonal biases in rainfall frequency and intensity
   LAPS underestimated winter rain, overestimated summer rain
   GASP overestimated winter rain, underestimated summer rain
   Both models showed rain area increasing and rain intensity decreasing as forecast period progressed

3. The greater the large-scale organization of the rain-bearing system, the better the forecast will be

4. Lowest skill shown in tropics in winter, highest skill shown in mid-latitudes in winter

Future developments and work in progress

1. Better observations and use of observations

- instrument upgrades
- new satellite sensors
- better techniques for data assimilation into models

2. Better model physics and numerics

3. Statistical forecast modification

- bias correction
- compositing of various products

4. Ensemble forecasts

- ensemble prediction systems
- “poor man’s” ensemble

Experimental Statistical Temperature Forecasts

Starting with the following primary objective forecasts:

GSM = Generalized Analogue Statistics Model (GASM)
MOF = NMOC's current Model Output Statistics forecasts from LAPS375
L375 = Forecast derived from LAPS model (0.375° resolution)
L125 = Forecast derived from mesoLAPS model (0.125° resolution)

Bias-correction is done with respect to the measured bias over the previous 20 days. This is either a straight bias-correction or a weighted composite of regression- and bias-correction.

Compositing is accomplished using weights inversely proportional to mean square errors.

Various combinations of bias-correction and compositing of the primary objective forecasts were used to generate secondary forecasts:

BCGSM = **Bias-corrected** GSM
BCMOF = **Bias-corrected** MOF
BCL375 = **Bias-corrected** L375
BCL125 = **Bias-corrected** L125

BCMOG = **Composite** of BCGSM, BCMOF
CMP = **Composite** of BCGSM, BCMOF, BCL125 and BCL375

Accuracy is used to refer to the percentage of forecast errors less than or equal to 4.5°C, a measure agreed from consensus of surveyed readers. Better forecasts (higher accuracies) have lower values.

Day $_{+1}$ minima (best forecasts are in yellow highlight)

Percent of absolute errors >= 4.5^{0}C									
	QLD	NSW	VIC	TAS	SA	WA	NT	ALL	ALL EVENTS
GSM	3.1	6.6	5.8	2.1	4.8	10.2	-	6.3	1950
BCGSM*	4.0	6.0	6.8	0.0	6.1	9.3	-	6.4	1950
MOF	13.8	10.2	6.2	6.4	4.9	5.9	9.0	8.7	2535
BCMOF*	5.8	6.2	5.3	5.1	3.7	5.7	0.8	5.2	2535
BCMOG	2.7	3.4	2.1	2.6	1.6	4.9	0.8	3.0	2535
L375	14.5	19.1	31.3	15.4	29.0	29.2	21.8	22.9	2535
BCL375*	3.9	3.8	8.6	7.7	5.6	8.5	1.5	5.5	2535
L125	3.9	7.2	13.7	5.3	11.6	9.7	3.9	8.1	2535
BCL125*	1.8	3.2	6.8	2.7	4.8	5.7	0.0	3.9	2438
CMP	1.2	1.9	2.5	2.6	1.9	4.5	1.5	2.3	2535

* Used in CMP.

Day $_{+1}$ maxima

Percent of absolute errors >= 4.5^{0}C									
	QLD	NSW	VIC	TAS	SA	WA	NT	ALL	ALL EVENTS
GSM	1.8	4.7	7.6	3.8	5.8	8.6	-	5.6	1905
BCGSM*	1.5	4.1	7.6	0.0	5.0	7.9	-	4.9	1905
MOF	16.0	15.4	3.8	7.0	3.9	8.4	11.7	10.6	2481
BCMOF*	4.6	8.4	5.6	6.1	6.5	11.3	4.7	7.3	2481
BCMOG	2.6	3.0	4.7	0.9	3.4	6.9	4.7	3.9	2481
L375	13.6	16.5	13.7	8.7	22.5	17.9	14.8	16.4	2481
BCL375*	5.1	11.1	7.3	7.0	12.8	11.1	7.0	9.3	2461
L125	13.4	4.3	4.0	1.8	7.5	11.1	4.1	8.0	2383
BCL125*	1.1	3.6	4.0	1.8	2.0	6.6	1.6	3.2	2383
CMP	2.4	6.1	2.1	0.9	2.7	6.6	5.5	4.2	2481

* Used in CMP.

Day $_{+2}$ minima

	QLD	NSW	VIC	TAS	SA	WA	ALL	ALL EVENTS
GSM	5.1	8.3	4.5	2.2	6.8	9.0	6.1	1065
BCGSM*	6.2	14.6	5.1	2.2	7.6	7.5	6.8	1065
MOF	11.5	12.7	9.0	2.6	8.6	7.7	9.5	1401
BCMOF*	7.0	10.9	12.0	2.6	10.1	5.2	8.0	1401
BCMOG	5.5	7.3	3.4	2.6	7.8	3.0	5.1	1409
L375	13.2	29.1	31.2	13.2	30.4	32.2	23.1	1401
BCL375*	3.8	9.1	8.1	6.6	6.6	6.0	5.8	1401
CMP	3.7	5.5	3.0	2.6	4.7	3.0	3.6	1401

* Used in CMP.

Day $_{+2}$ maxima

	QLD	NSW	VIC	TAS	SA	WA	ALL	EVENTS
GSM	4.4	4.3	5.1	0.0	6.6	9.4	5.5	1084
BCGSM*	2.8	4.3	7.6	0.0	6.1	8.3	5.3	1084
MOF	7.9	12.8	15.6	6.4	13.7	17.8	11.9	1409
BCMOF*	5.9	1.3	15.6	8.2	16.1	15.1	10.6	1409
BCMOG	4.8	0.0	6.2	0.9	6.0	10.7	5.6	1409
BCL375*	3.3	15.4	26.2	12.7	33.3	24.0	17.0	1409
CMP	2.7	1.3	7.1	2.7	7.2	10.7	5.4	1409

* Used in CMP.

Ensemble prediction systems

Multiple integrations of a NWP model:

One control run

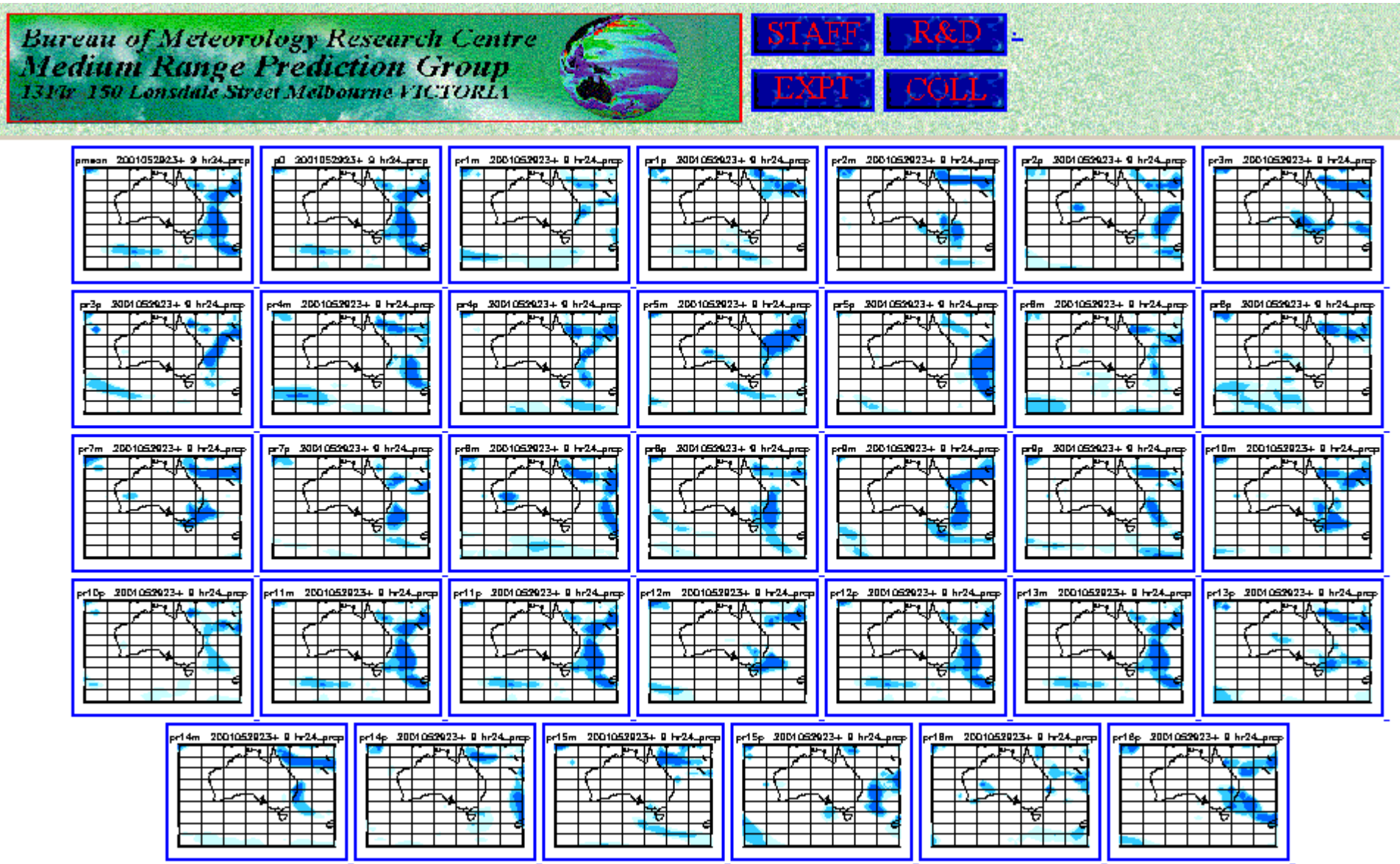
Many runs with perturbed initial conditions

Advantages:

- Ensemble mean more accurate than single run
- Can predict probability of occurrence (of rain exceeding 1 mm d^{-1}, for example)
- May be able to estimate forecast uncertainty

Disadvantages:

- Computationally expensive
- Lower spatial resolution
- Spread of forecasts often not broad enough



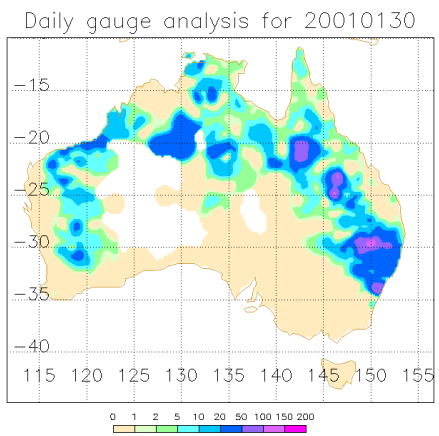
GASP Ensemble Prediction System (33 members)

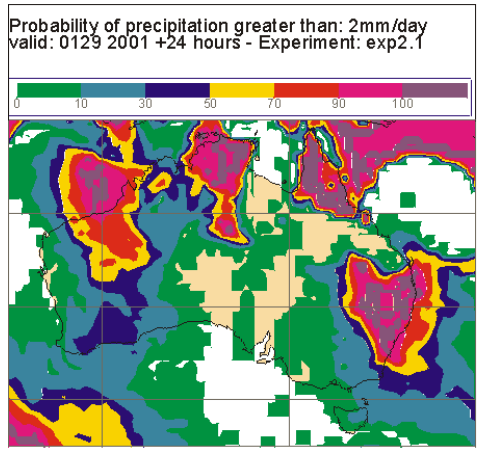
9-day forecast of 24 h precipitation valid 23 UTC Wed June 7

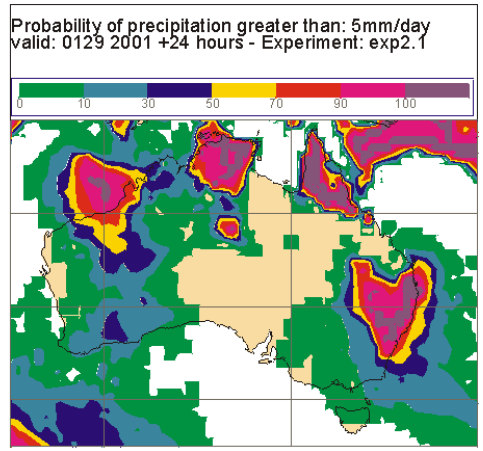
Probability of precipitation (POP) from LAPS Ensemble Prediction System (33 members)

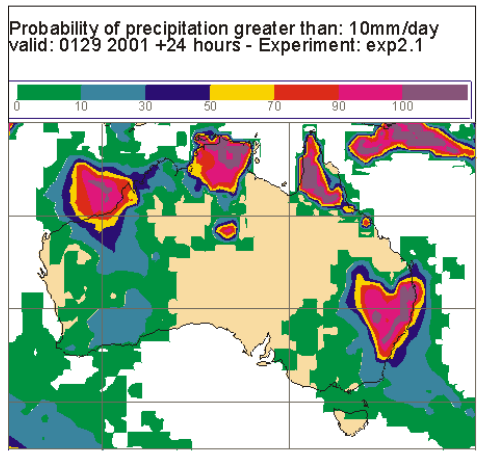
24 h precipitation valid 23 UTC Jan 30 2001

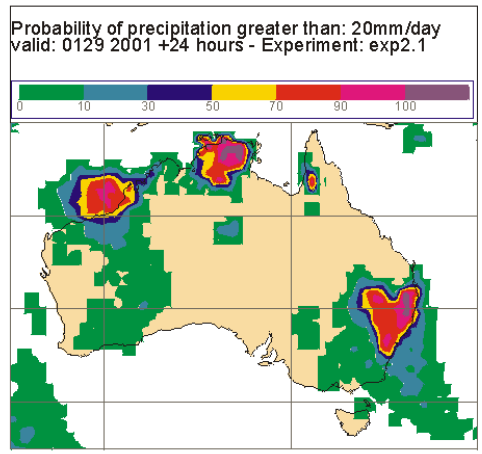
observed

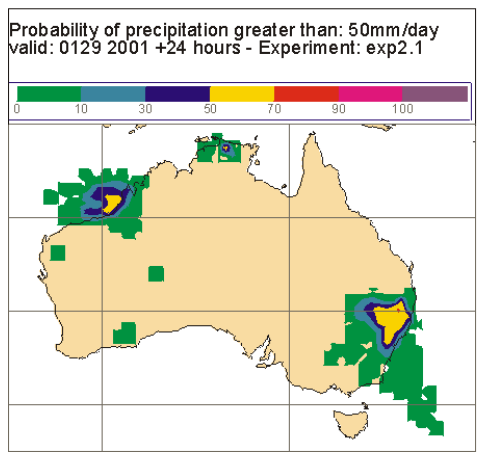


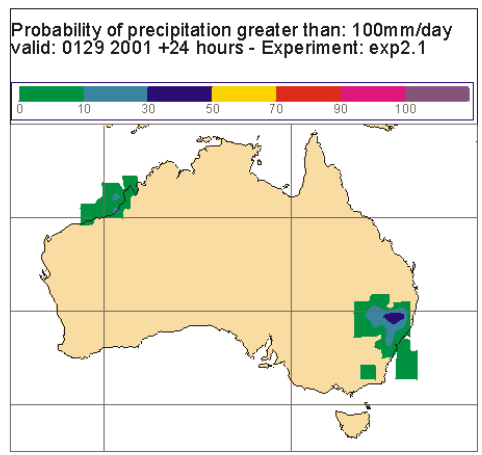








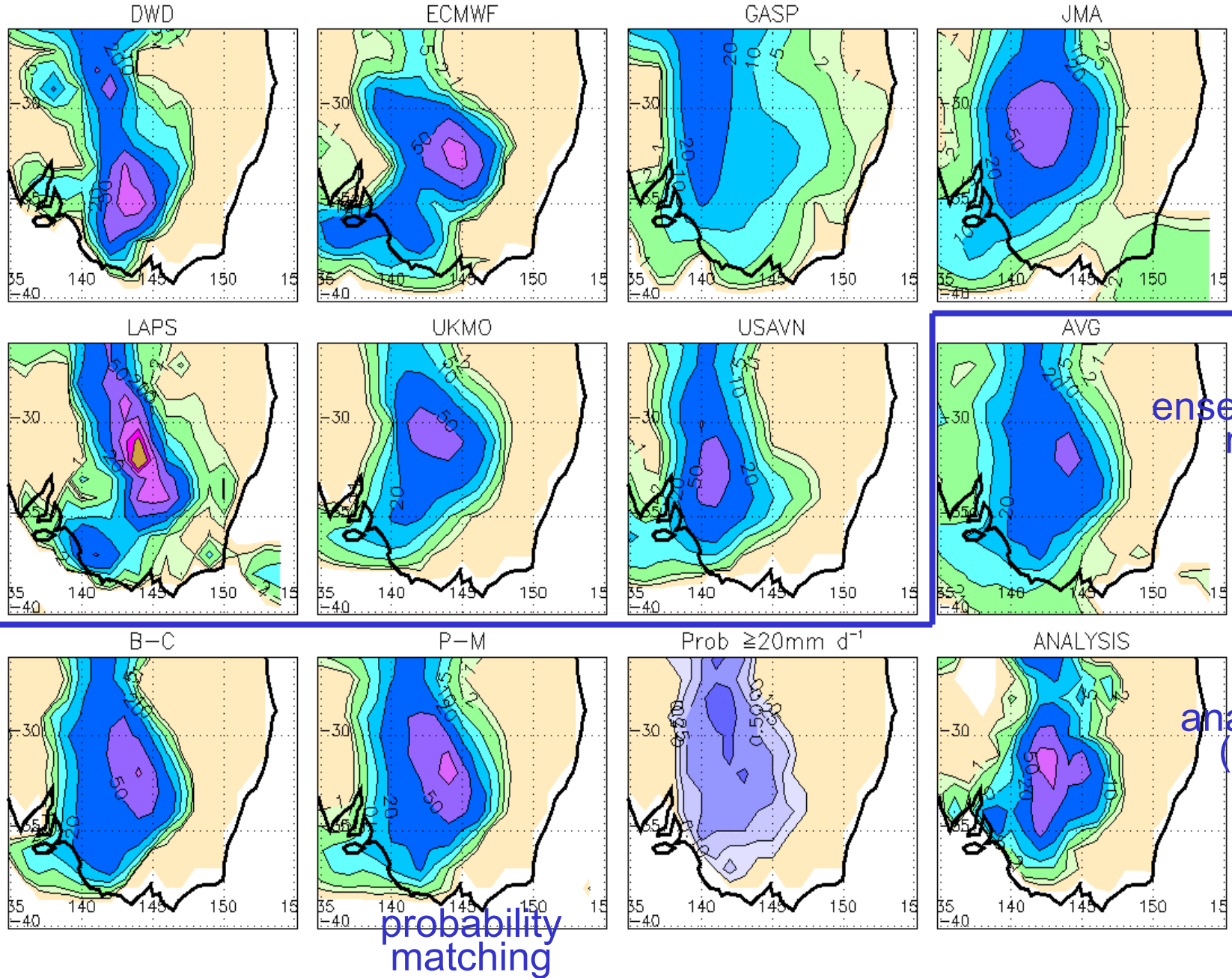




Poor man's (multi-model) ensemble

- Combines output from several operational NWP models
- Easy to produce, essentially no cost
- Compared to individual NWP models, the poor man's ensemble *deterministic* forecasts have
  - Smaller location errors
  - Lower RMS errors
  - Higher spatial correlation coefficients with observations
  - Higher maximum rain rates when probability-matching is used
- *Probabilistic* QPFs from the poor man's ensemble show high skill at 24 h but are less skilled at 48 h.

Poor man's ensemble for flash flooding event, 20 Feb 2000



When will these products be available?

MOF upgrade	July 2001, ongoing
Bias-corrected and composited temperature meteograms	February 2002
Poor man's ensemble	February 2002
Ensemble prediction systems	April 2002