The Australian Community Climate and Earth System Simulator, ACCESS – towards seamless prediction

www.cawcr.gov.au

Kamal Puri

Earth System Modelling Programme

18 February 2014

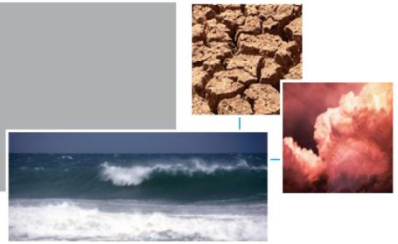
Thanks to ESM colleagues

Australian Government
Bureau of Meteorology

The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

CSIRO

What is ACCESS?

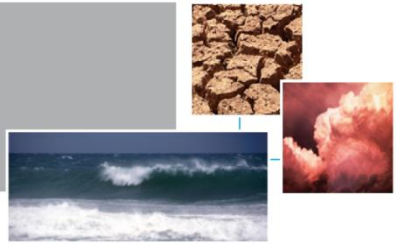


Australian Community Climate and Earth system Simulator

- Fully coupled system
  - Provide a *national* approach to climate and weather prediction model development
- Joint initiative
  - Bureau of Meteorology
  - CSIRO
  - Australian universities > access to common system
  - DCCEE
- Focus on the needs of a wide range of stakeholders:
  - Providing the best possible services
  - Analysing climate impacts and adaptation
  - Linkages with relevant University research
  - Meeting policy needs in natural resource management

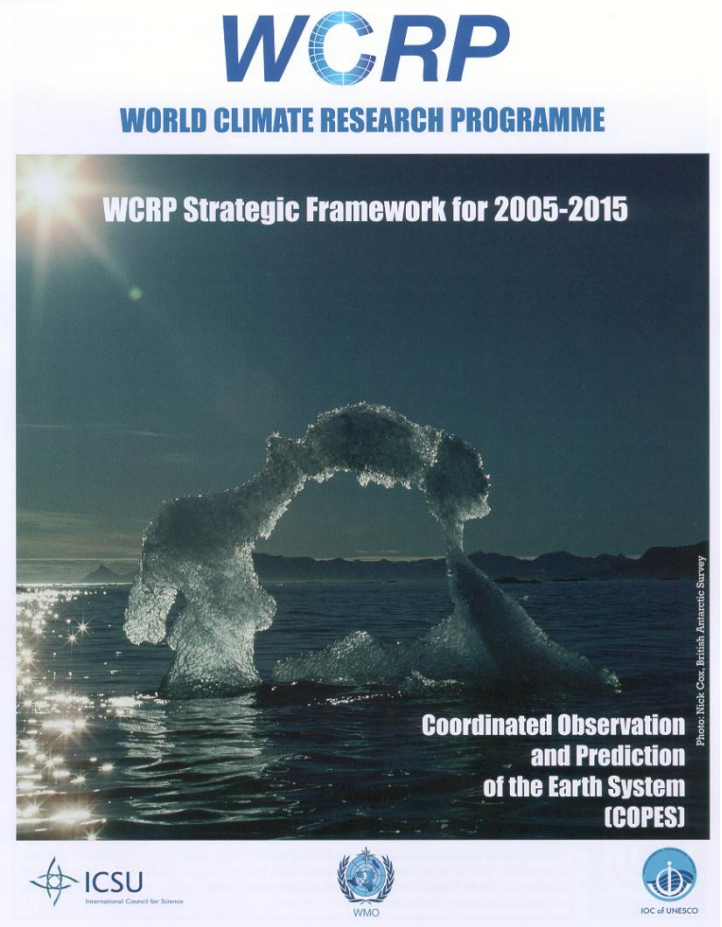
NWP
Seasonal
Climate

Seamless Prediction



'There is now a new perspective of a continuum of prediction problems, *with a blurring of the distinction between shorter-term predictions* and *longer-term climate predictions*'

'Increasingly, decade- and century-long climate projection will become an *initial-value problem requiring knowledge of the current observed state of the atmosphere, the oceans, cryosphere, and land surface* to produce the best climate projections as well as state-of-the-art decadal and interannual predictions



Design of ACCESS
Towards Seamless Prediction

0d 10d 20d 30d

H Res

Atmosphere

Atmosphere

Red. Res

Ocean

H Res

Red. Res

Atmosphere

Atmosphere

Ocean

H Res

Red. Res

Atmosphere

Ocean

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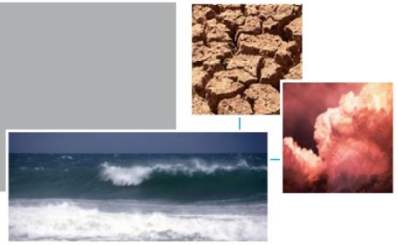
What is ACCESS?
Schematic



OBS

Assimilation (4DVAR)

Atmosphere (UM)

Weather Prediction

Seasonal Prediction

Climate
Earth system

Dynamic Veg. (LPJ)

Assimilation

Land surface (CABLE)

Coupler (OASIS)

Chemistry (UKCA)

Ocean Carbon (CSIRO)

Ocean (MOM4)

Sea-ice (CICE4)

Assimilation (BODAS)

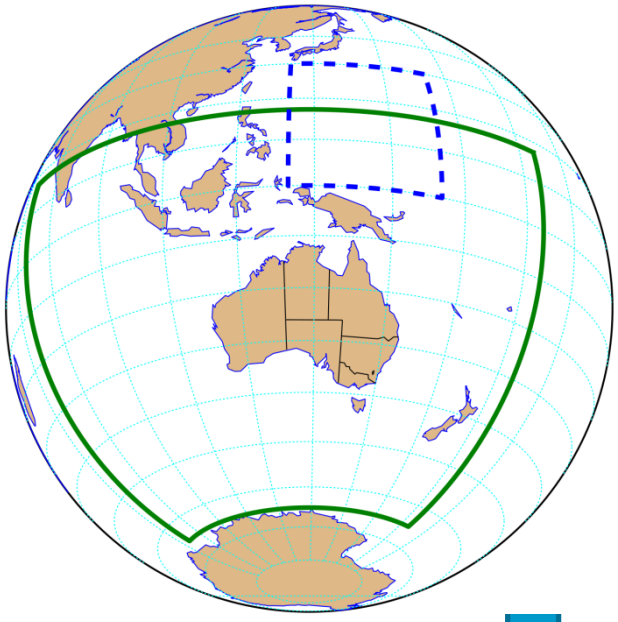
OBS

Australian Government
Bureau of Meteorology

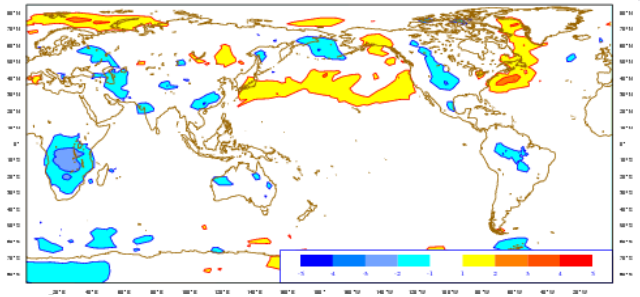
The Centre for A… e Research
A partnership be… Meteorology

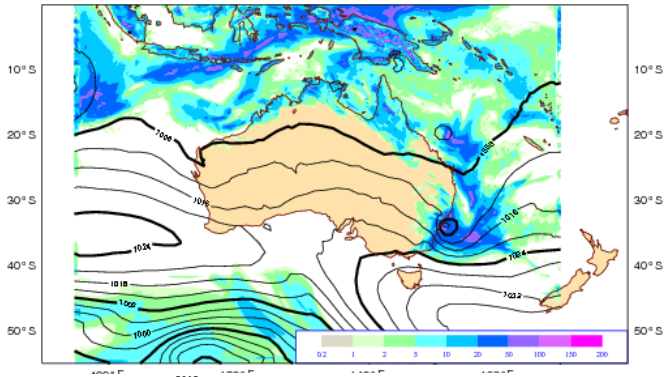
CSIRO

ACCESS
Seamless prediction



Unified Model



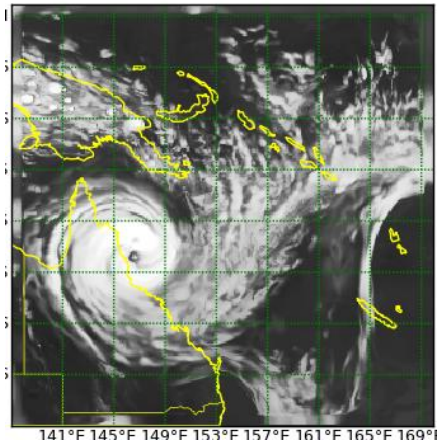


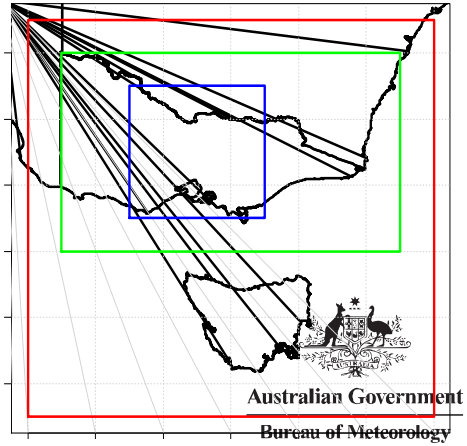
ACCESS-G
40km; L70

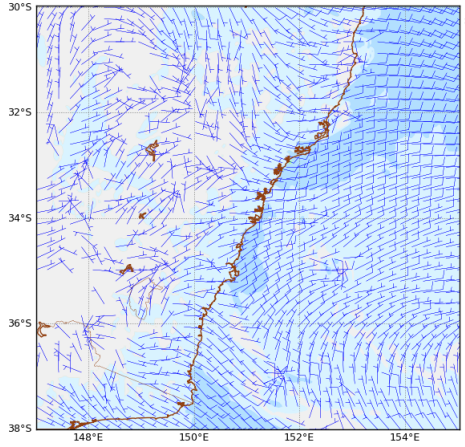
ACCESS-R
12km; L70

ACCESS-TC

ACCESS-SREP, Fire Wx







ACCESS-C
4km; L70

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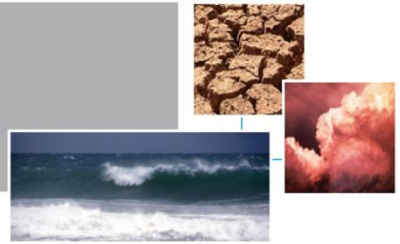
AGREPS – ACCESS ensemble prediction system

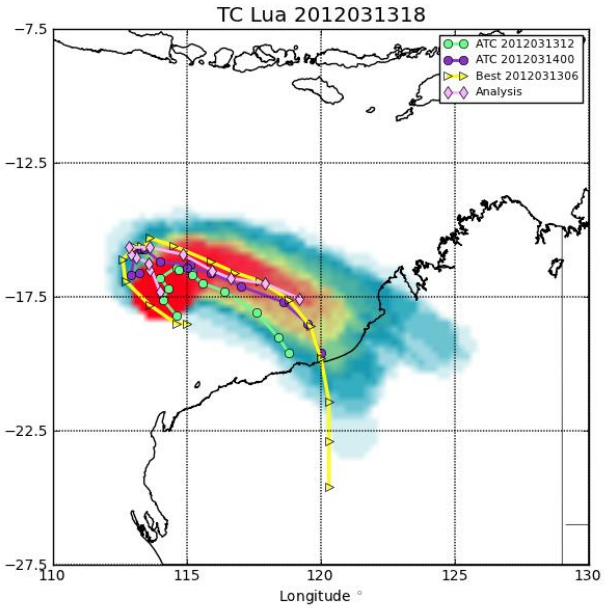


24-member numerical weather prediction ensemble

ACCESS
The Australian Community Climate and Earth-System Simulator

MOGREPS

- Based on UKMO MOGREPS
- Global ensemble to 10 days
  - ➢ 60 km (N216) (APS1)
- Regional ensemble over Australian Region to 3 days (suspended running)
  - ➢ 37.5 km (APS0)
- High resolution ensemble over domains around major cities, with relocatable capability for high impact weather events **(planned)**
- 2.2 km (12 members)



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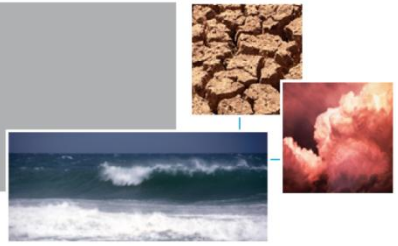
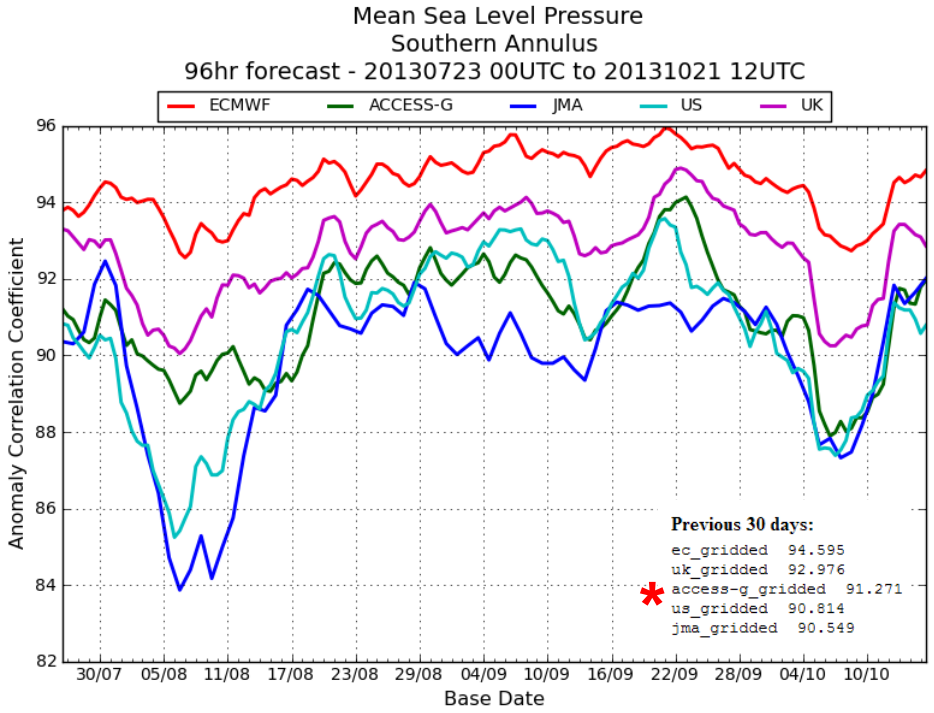
ACCESS-G verification
July to October 2013

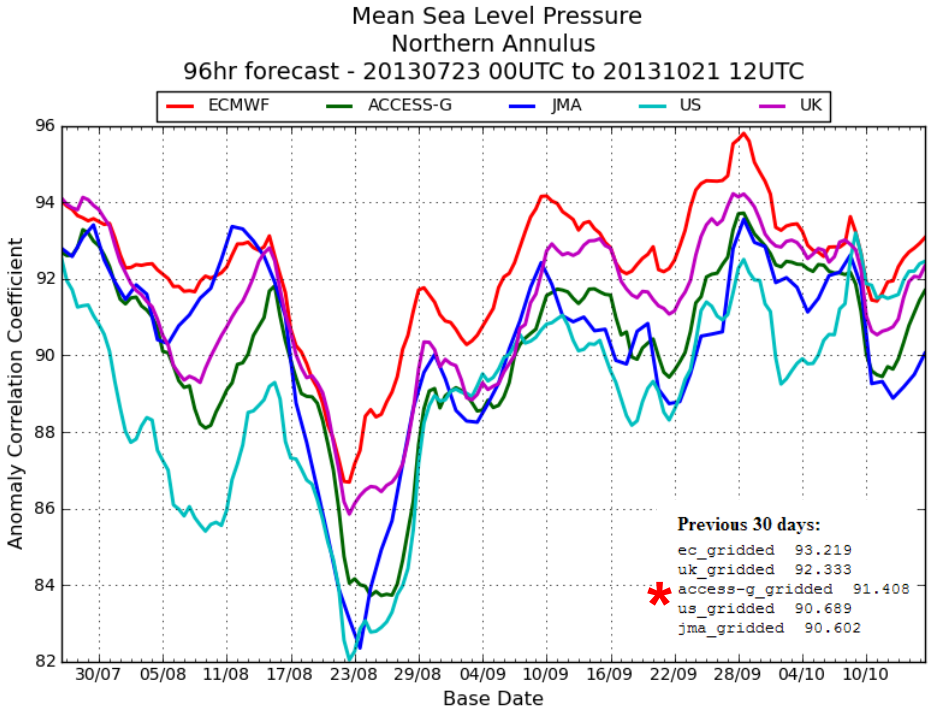


96 hour forecasts

SH

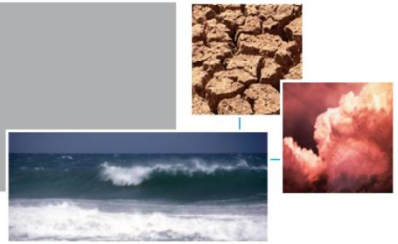


NH



ACCESS among top performing NWP models

ACCESS
Application to severe weather prediction



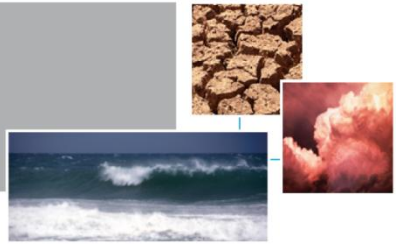
A prime requirement for operational NWP

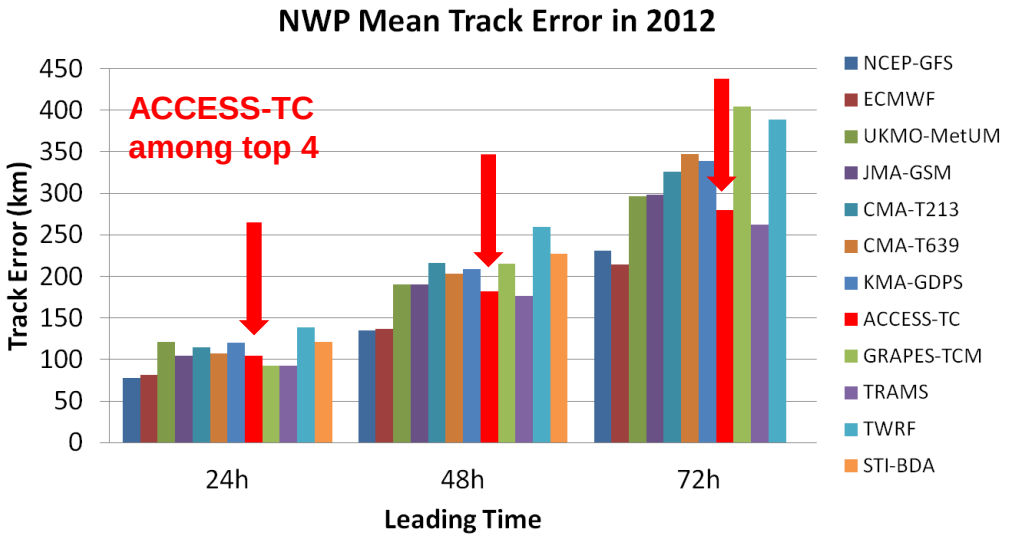
is to provide outputs that meet societal needs

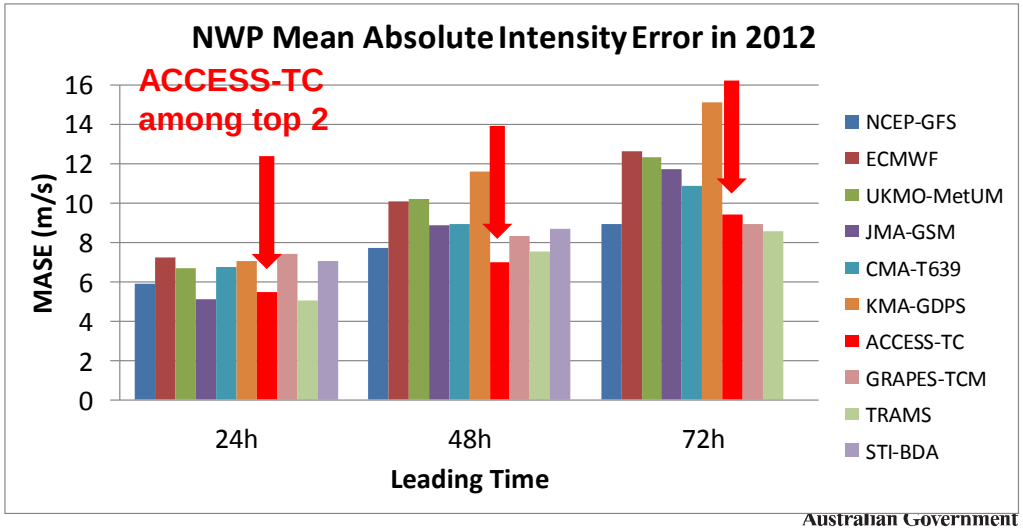
– Severe weather prediction is a key deliverable

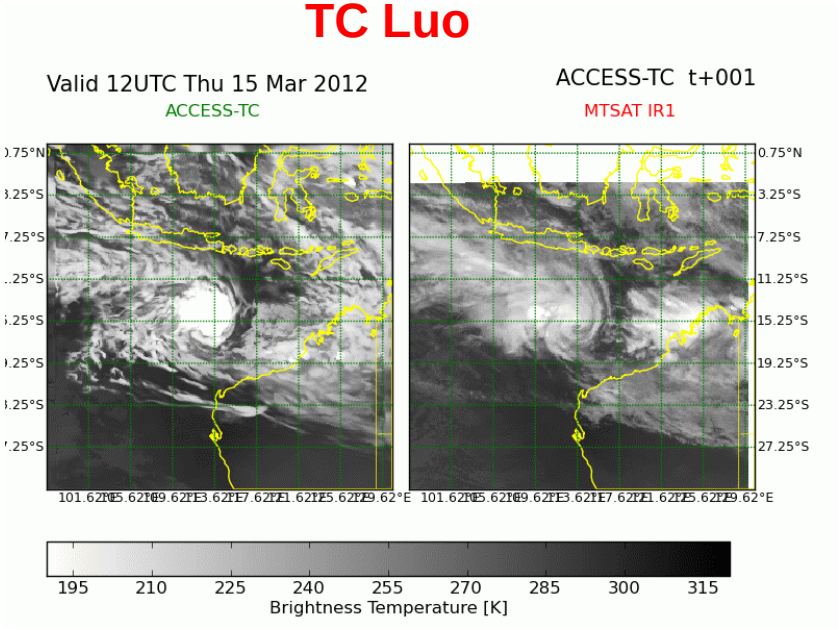
– Some examples of performance of ACCESS

TC verification for NW Pacific
Shanghai Typhoon Institute









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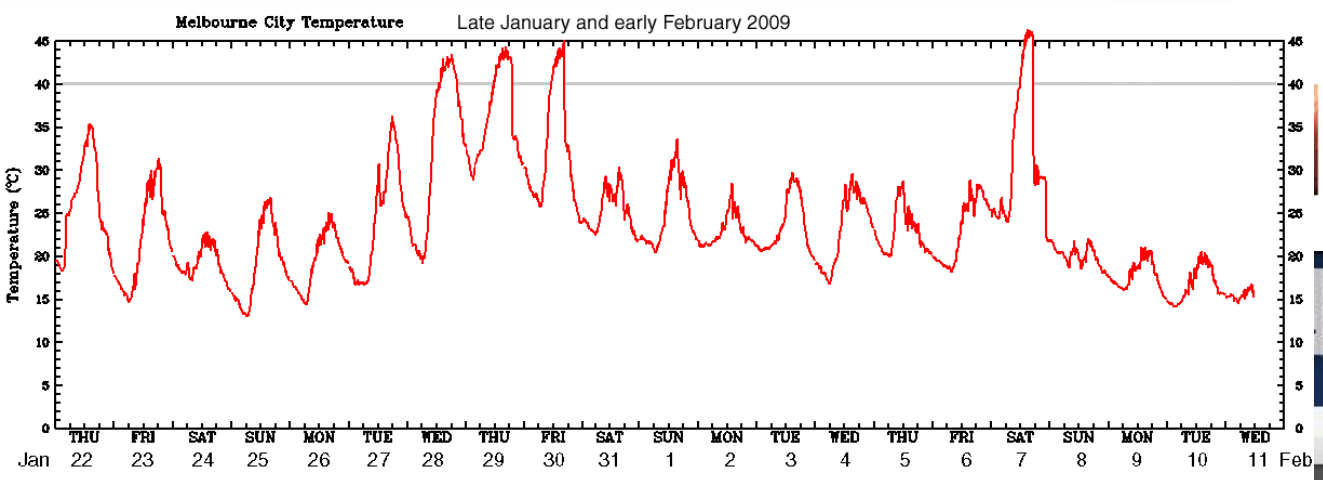
CSIRO

Heatwave Black Saturday



Temperature charts for Melbourne, Australia, 22 January to 10 February 2006. From 1885 to 2006, the mean maximum and minimum temperatures for this time of year were 26C and 14C respectively (79F & 57F) (www.earthsci.unimelb.edu.au/~awatkins/melbmeantemp.html). The 7 Feb peak of 46.4C (115.5F) with 5% relative humidity was the hottest in 150 years of records for any Australian capital city. Graphs by Andrew Watkins: www.earthsci.unimelb.edu.au/~awatkins/melbtemp.html With Andrew's permission, © public domain by Robin Whittle 2009-02-11.

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Melbourne braces for heatwave

Updated January 27, 2009 08:13:00

The forecast of four consecutive days of 40 degrees Celsius or more from tomorrow has Melbourne poised to break some hot weather records.

Melbourne has not had three days in a row above 40 since 1959.

The mercury is expected to reach 38 today before climbing to 41 tomorrow then dropping back slightly to 40 until Sunday when it should be a relatively cool 31.

Senior forecaster at the Bureau of Meteorology, Terry Ryan, says it also looks like it will be one of the driest Januaries on record.

"It's very dry, we've only had 0.8 of a millimetre, the driest ever was 1932 at 0.3 of a millimetre, so at this stage it's the second driest January in 150 years," he said.

Transport test

PHOTO: Melbourne's forecast hot weather likely to break records.

MAP Melbourne 3000

N. Nicholls

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Jakarta has added another car free day to its calendar to reduce congestion and to give its millions of bike riders, joggers and walkers more recreational space.

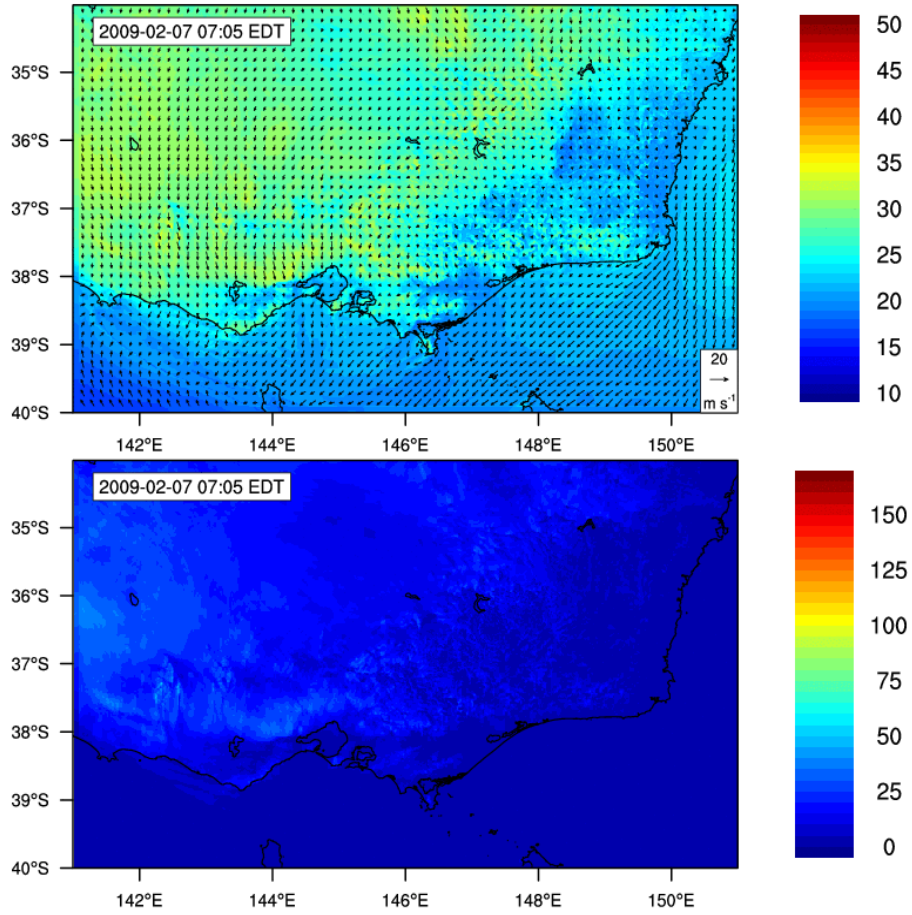
NASA has unveiled its design for a new rocket to take its astronauts to Mars.

The father of the late singer Amy Winehouse has launched a foundation aimed at helping disadvantaged youngsters.

The man charged with Sydney's collar bomb hoax,

Fire-weather/heat wave

Black Saturday 7 Feb 2009



400m ACCESS run

Australian Government
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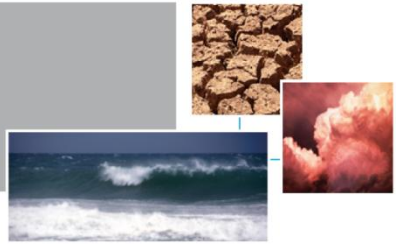
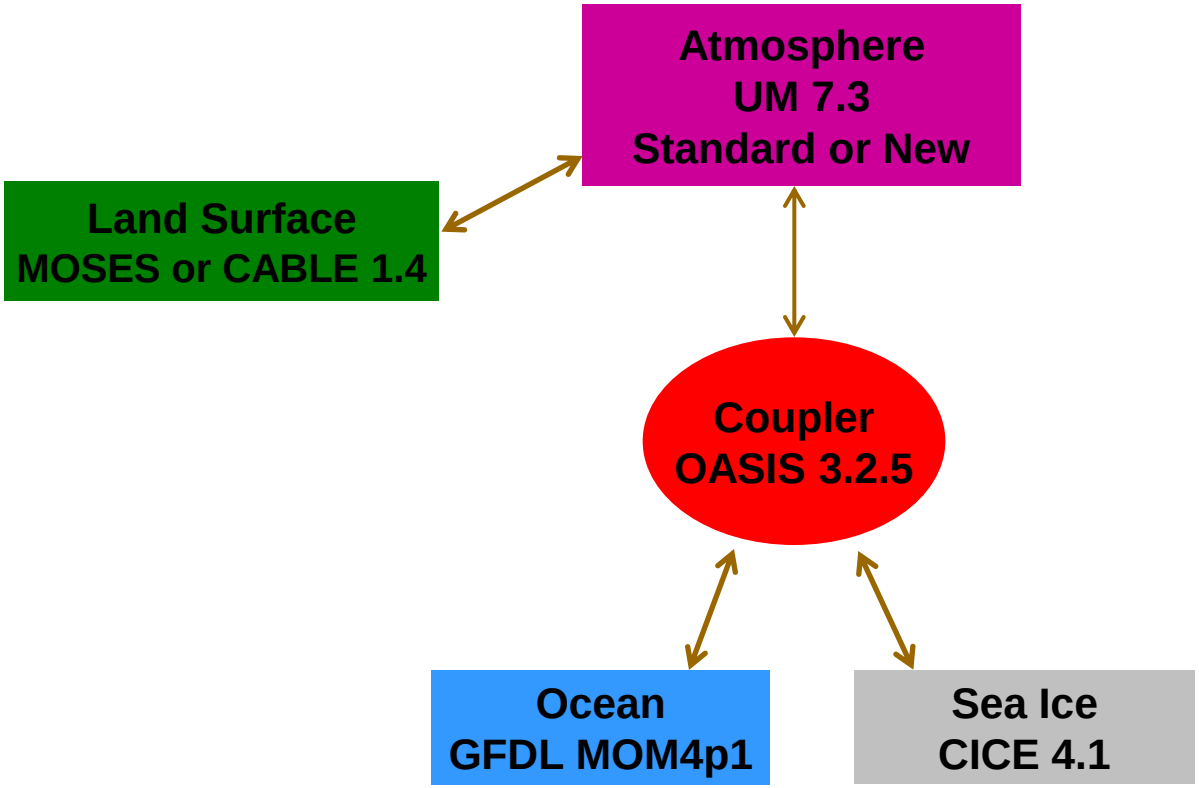
ACCESS coupled model
IPCC AR5 runs

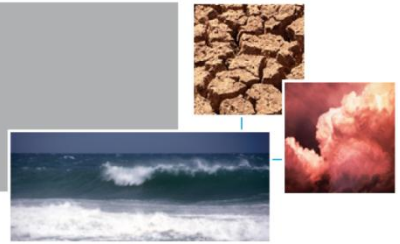




Atmosphere: N96 – 1.875° lon x 1.25 ° lat; 38 levels

Ocean and sea ice: 1° x 1° grid, enhanced tropical, high latitudes; 50 levels

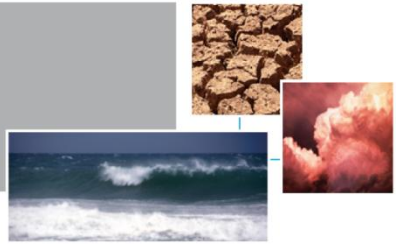
2 versions of ACCESS coupled model completed



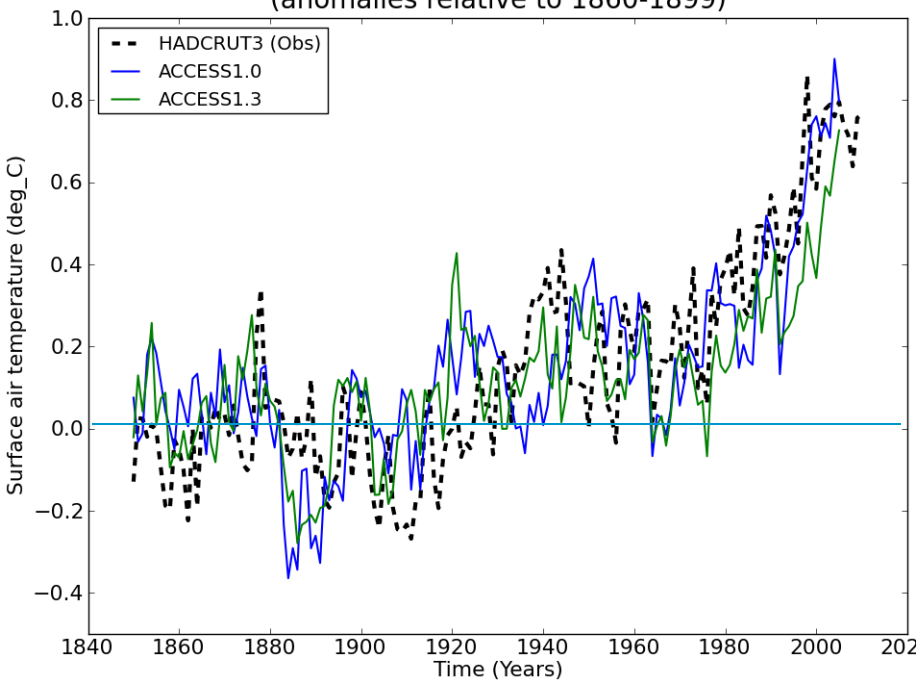
- ACCESS1.0
  - Our basic version
  - Standard atmospheric physics options
  - MOSES land surface model (MetOffice)

- ACCESS1.3
  - Our 'aspirational' version
  - New atmospheric physics options including CAWCR modifications
  - CABLE Australian community land surface model

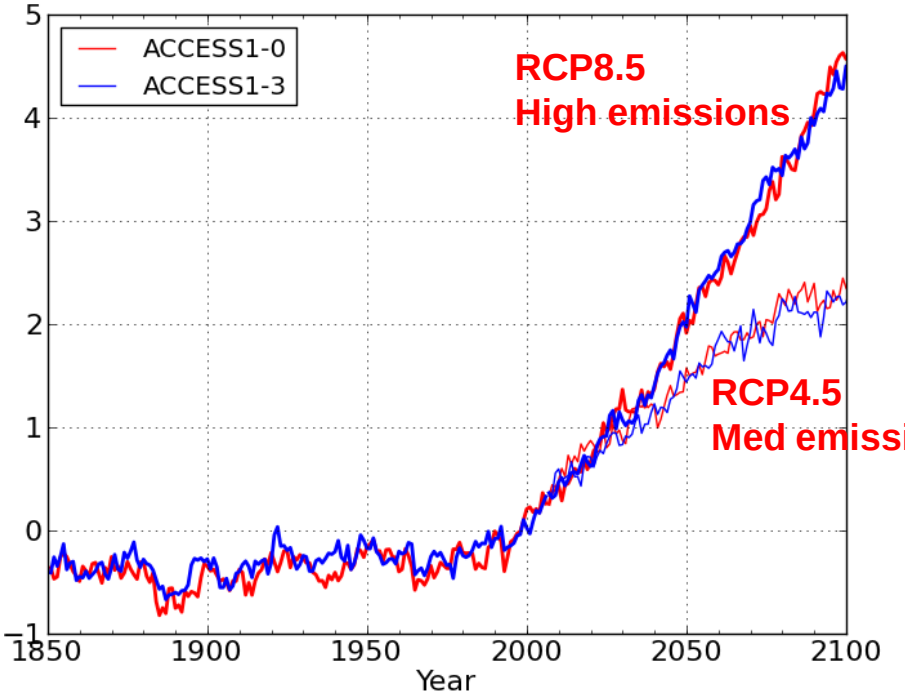
Annual Mean surface air temperature
ACCESS Historical runs



Global, Average Temperature at 1.5m
(anomalies relative to 1860-1899)



ACCESS - RCP4.5 and RCP8.5
Global annual mean surface air temperature
(relative to 1985 – 2005)



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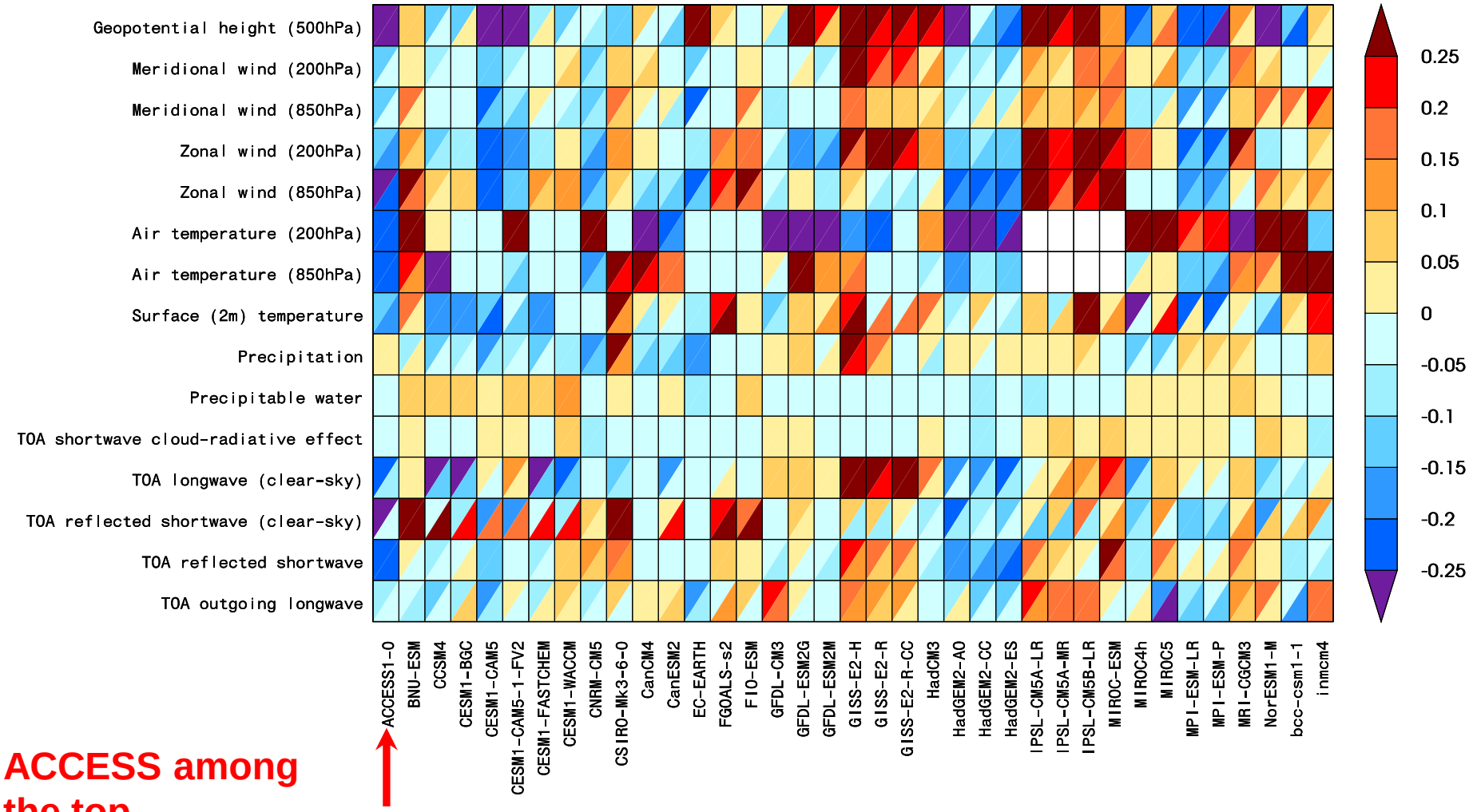
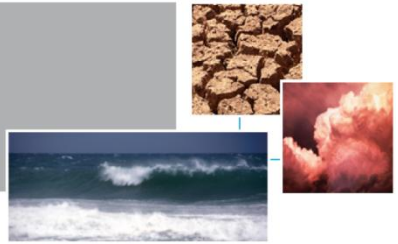
ACCESS coupled model evaluation – ranking versus other CMIP5 models

Relative space-time global RMSE in climatological annual cycle



ACCESS among the top performing models

Australian Government
Bureau of Meteorology



ACCESS-based POAMA-3 system:

Initial Conditions

PECDAS
POAMA
Ensemble
Coupled
Data
Assimilation
System

Coupled global model

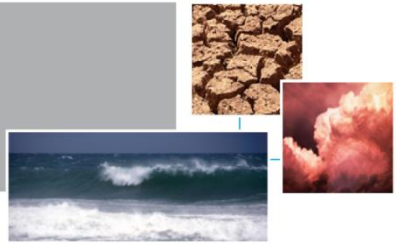
ATMOSPHERE
UM (UKMO)

SEA ICE
CICE
(LANL)

LAND
CABLE
(CSIRO)

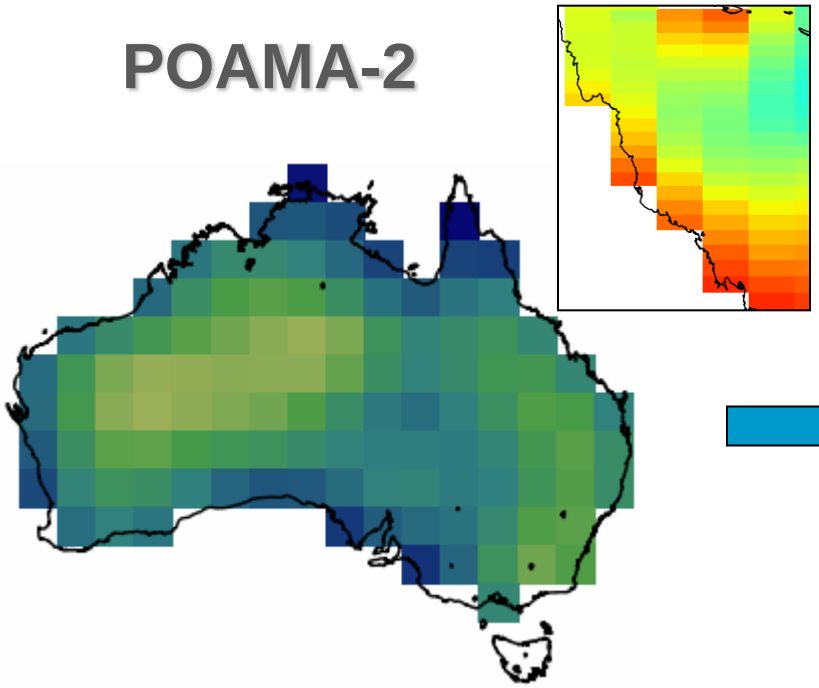
OCEAN
MOM (GFDL)

Ensemble of forecasts



Vertical and horizontal resolution increase in POAMA-3

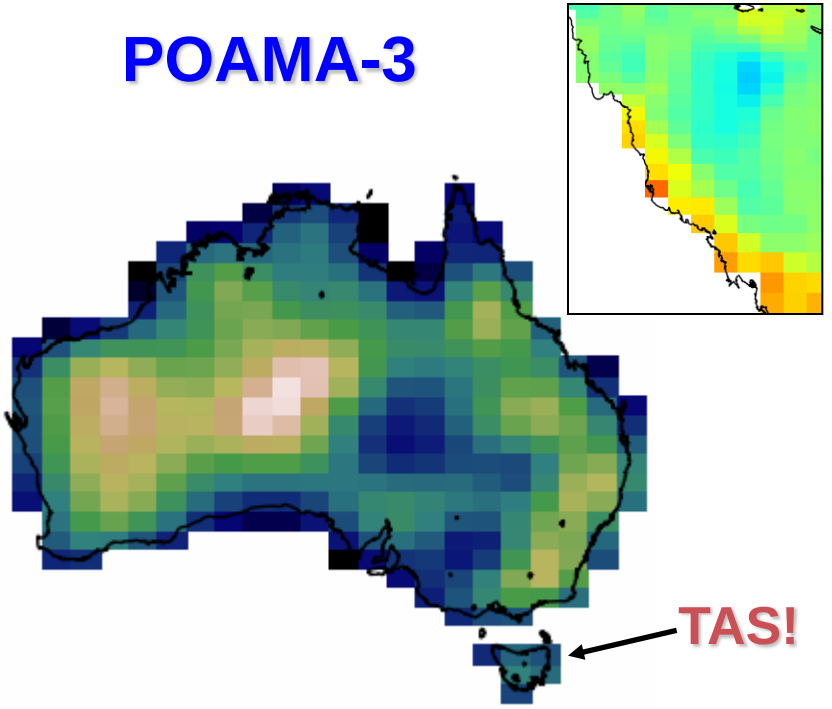
POAMA-2



Atmosphere/Land: ~250km

Ocean: ~200km

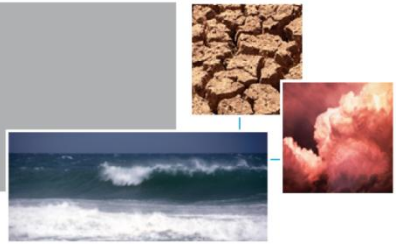
POAMA-3



Atmosphere/Land: ~150km

Ocean: ~100km

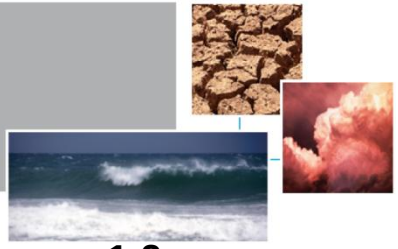
Multi-week/Seasonal System



- ACCESS-MSP
  - Prototype system has been assembled
  - Based on ACCESS1.0
  - Detailed testing has commenced

- Assembly and commencement of testing of ACCESS-MSP completes the first stage towards making ACCESS a seamless system
  - Use of a single system for prediction and projects across all space and time scales

Schematic for severe weather prediction
Capitalisation on a seamless modelling system



Multi-week Outlook

ACCESS-MSP

Medium-term

ACCESS-G

Short-term

ACCESS-G, R

1-2 days

ACCESS-R, C

Heavy rain?

YES

Forc, ACCESS-G: Consistency? Uncertainty (AGREPS-G)? Tracking with anal?

YES

Forc ACCESS-G, R: Consistency? Uncertainty? (AGREPS-G) Tracking with anal?

YES

ACCESS-C, SREP 'Model on Demand' High res AGREPS-C Specialised products

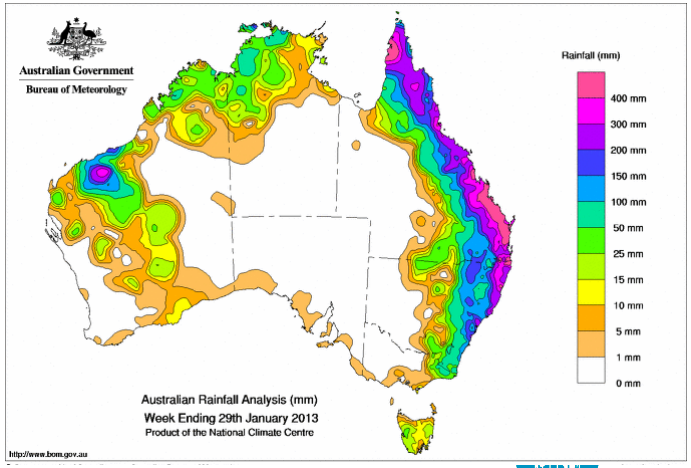
NO

NO

Continue to monitor

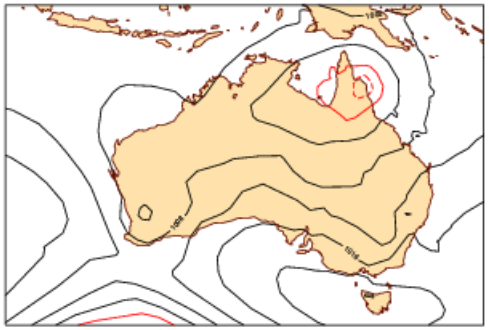
NO

Monitor closely

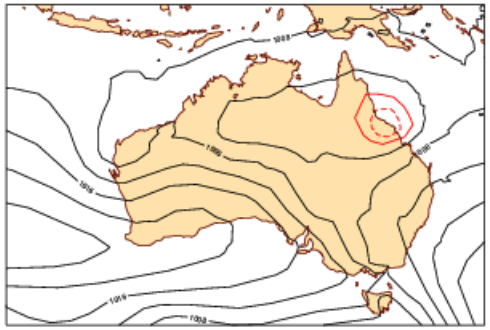


Medium-term forecasts
Consistency?
Tracking with analysis?

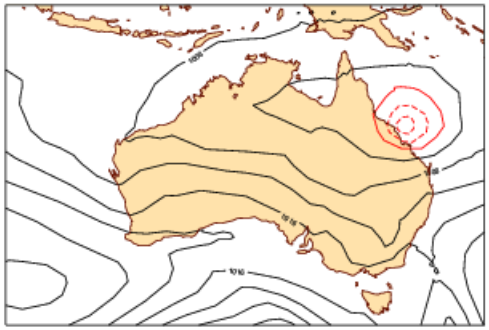
20130121 0Z + 48h, oper access-g



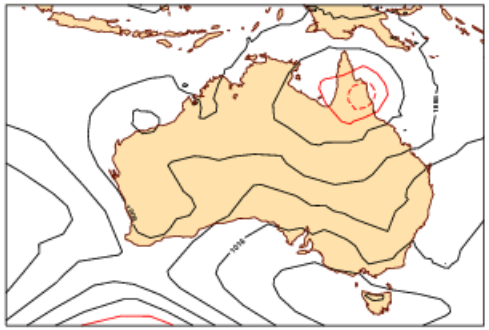
20130121 0Z + 96h, oper access-g



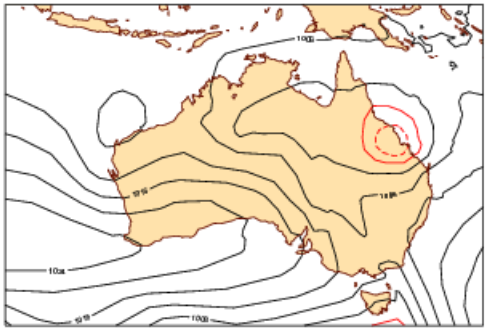
20130121 0Z + 144h, oper access-g



20130123 0Z an, oper access-g



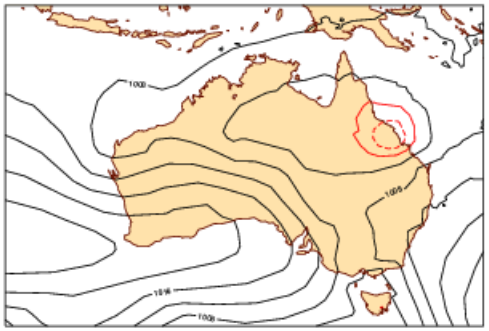
20130125 0Z an, oper access-g



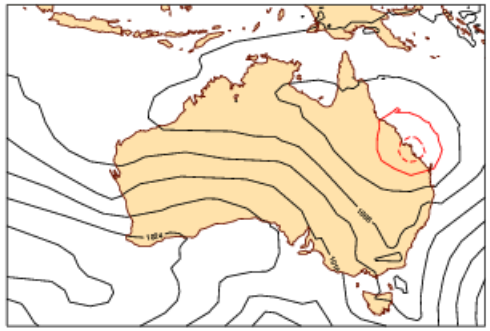
Tracking with anal?
Yes

Forecast Consistency?
Yes

20130123 0Z + 48h, oper access-g

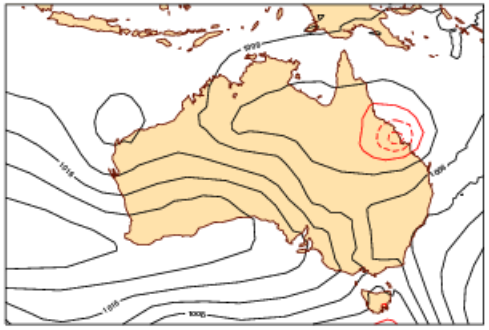


20130123 0Z + 96h, oper access-g

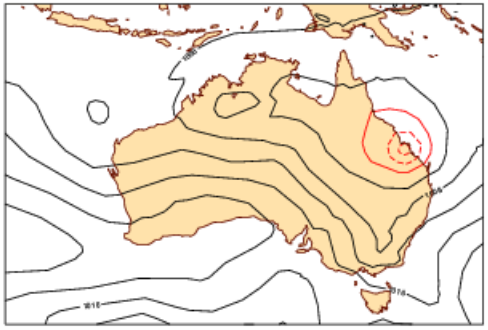


Short-term forecasts
Consistency? **YES**
Tracking with analysis? **YES**

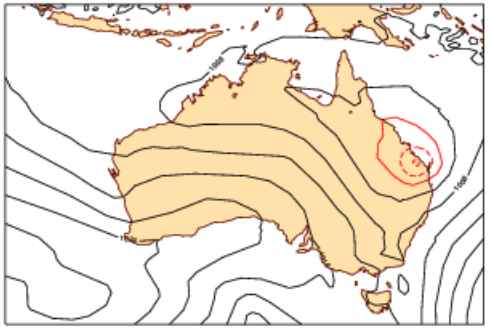
20130124 0Z + 24h, oper access-g



20130124 0Z + 48h, oper access-g

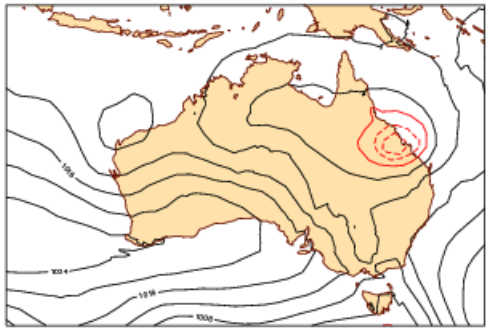


20130124 0Z + 72h, oper access-g

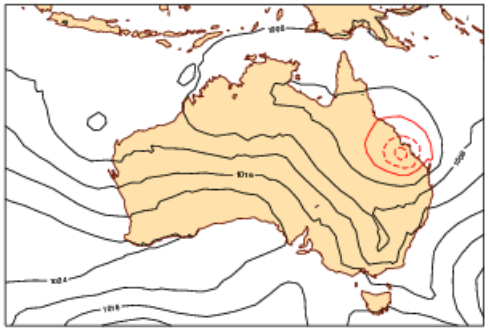


ACCESS-G

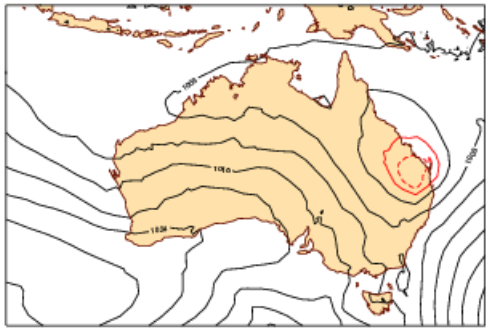
20130124 0Z + 24h, aps1 access-r12



20130124 0Z + 48h, aps1 access-r12

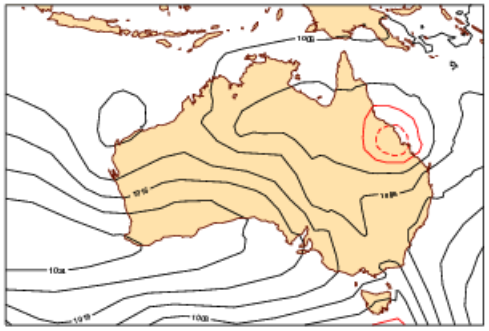


20130124 0Z + 72h, aps1 access-r12

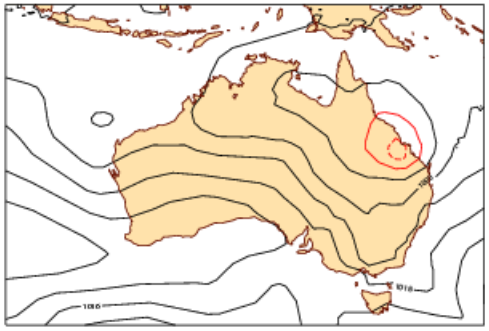


ACCESS-R12

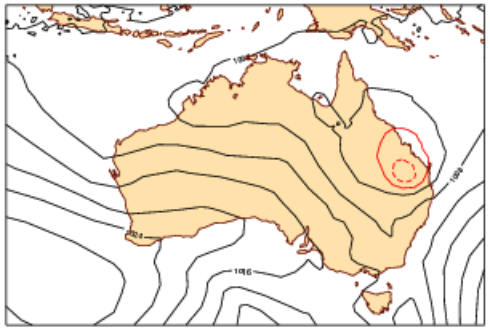
20130125 0Z an, oper access-g



20130126 0Z an, oper access-g

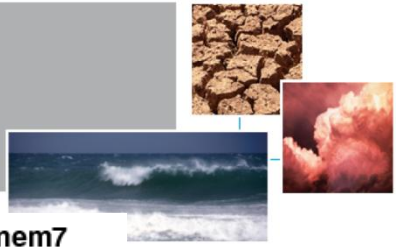


20130127 0Z an, oper access-g



Analyses

Short-term forecasts
Uncertainty? LOW



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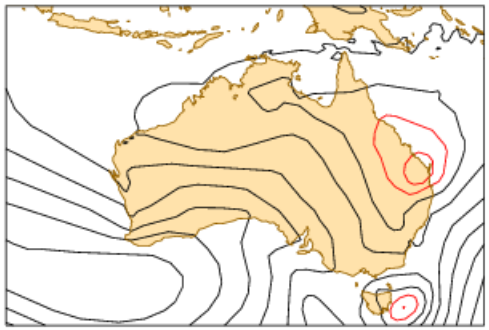

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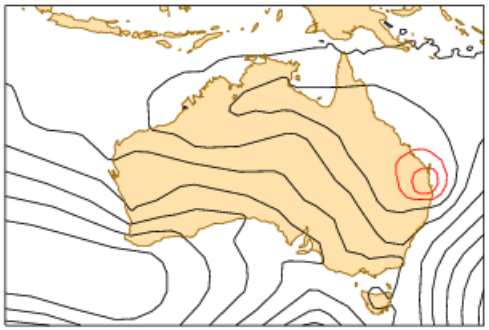
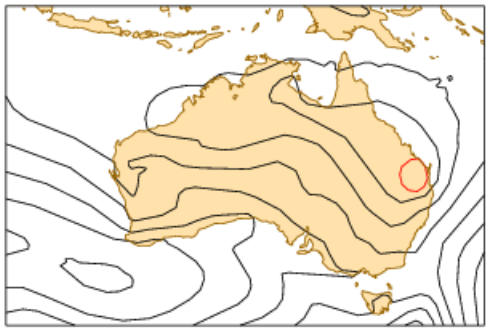


msl 20130124 1200Z + 72, mem7



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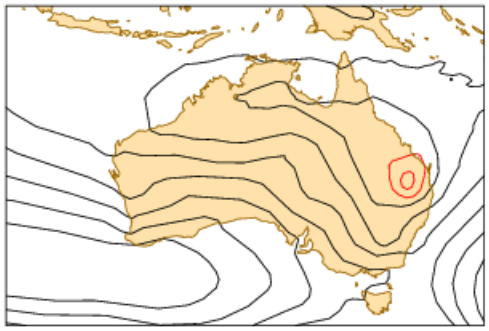

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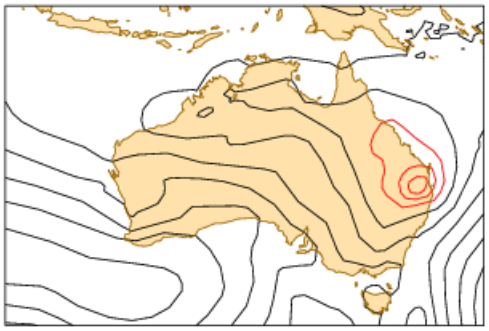

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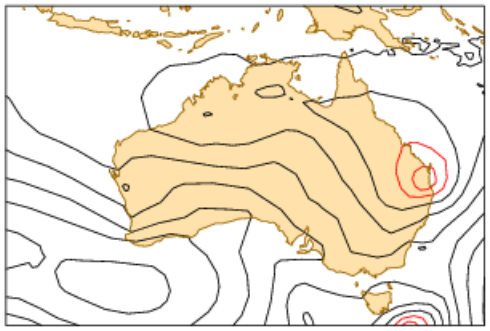
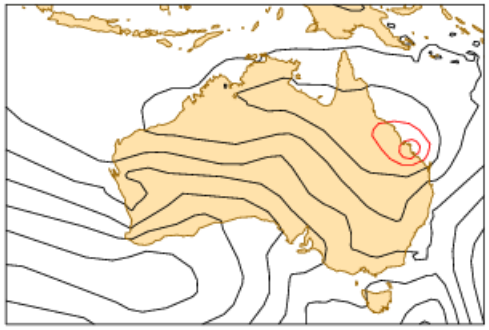


AGREPS members

msl 20130124 1200Z + 72, mem17



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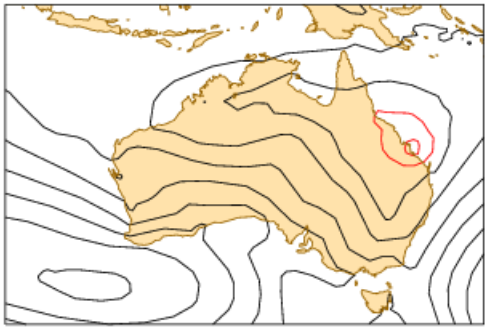

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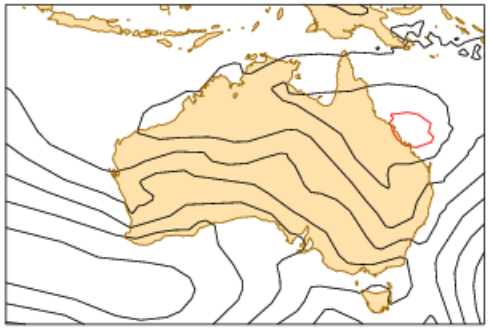
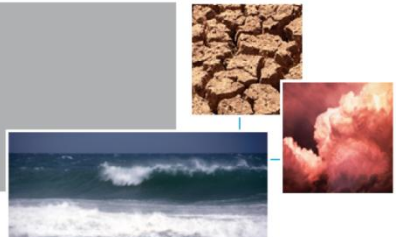
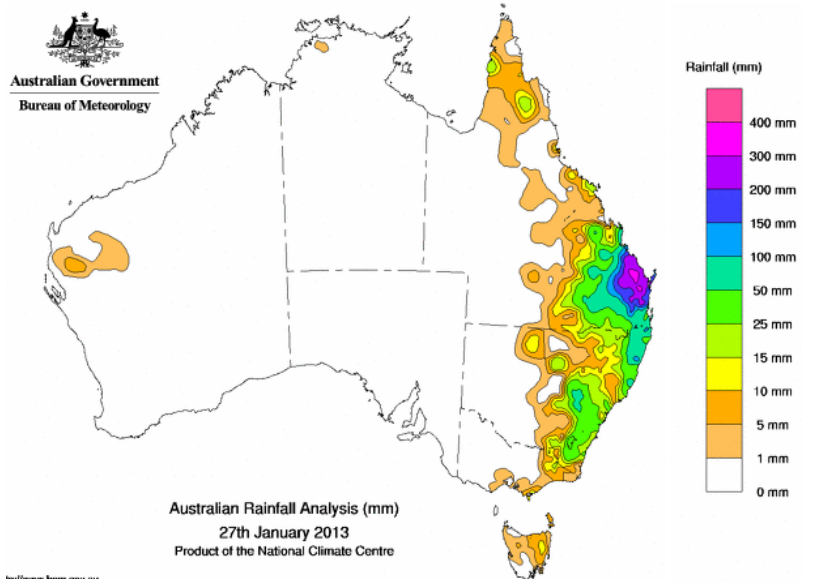
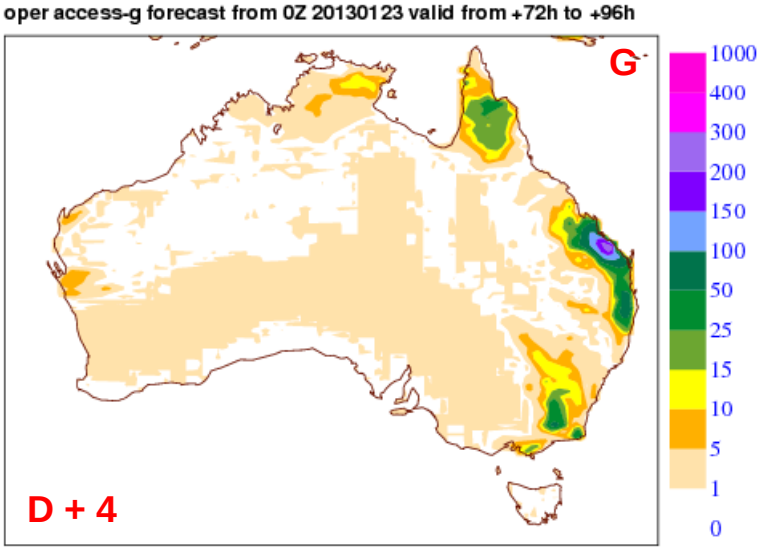
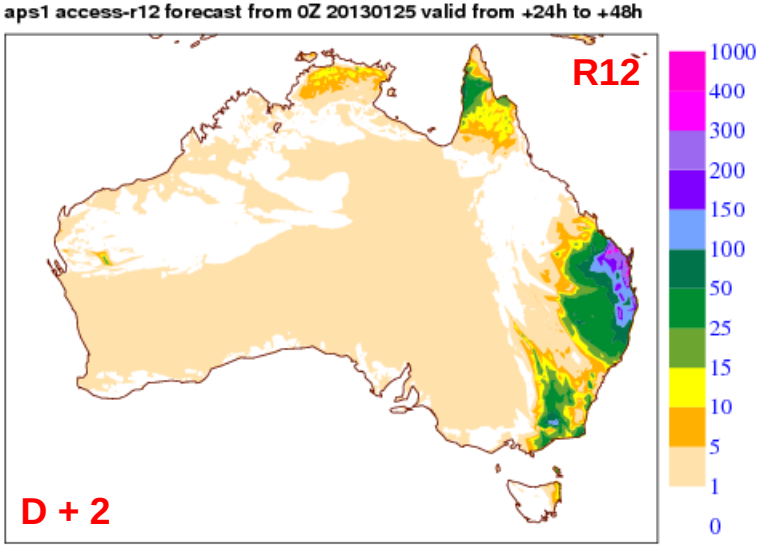


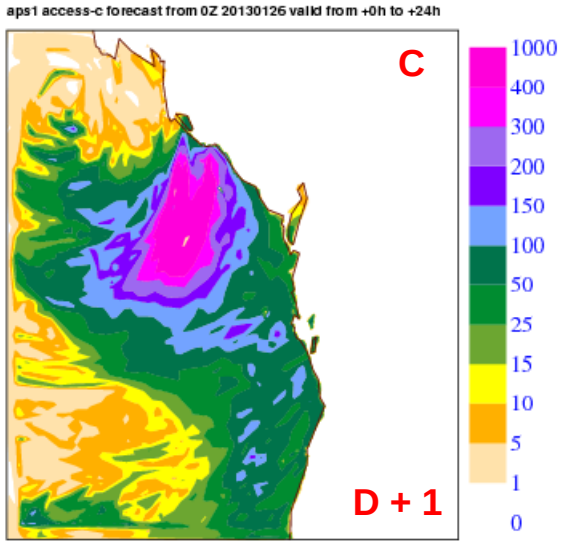
How did the system perform?
Rainfall: ACCESS-G, -R12, -C









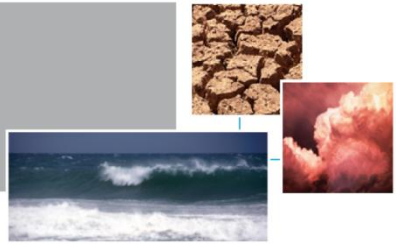


Government
Bureau of Meteorology

The C
A partnership between CSIRO and the Bureau of Meteorology

CSIRO

‘Model on Demand’



Severe weather criteria satisfied?

NO

YES

1. ….
2. ….
3. ….

Select event
Provide lat/lon

Customised high resolution ACCESS run

Customised high resolution ACCESS EPS run

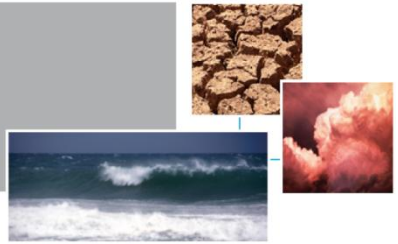
Run downstream models

Operational ACCESS-G, R12, C

Generate customised products

‘On Demand’
modelling capability

Concluding comments



ACCESS development has made significant progress

- Operational implementation of NWP component of ACCESS
  - Significantly improved performance
- Fully coupled ACCESS assembled and tested
  - AR5 runs completed and submitted
- Development of high resolution version for severe weather prediction
  - Radar data assimilation
  - Fire weather studies
- Implementation in research mode of the ACCESS ensemble prediction system
- Development of ACCESS-based seasonal prediction system commenced
  - Prototype developed and being tested
- First stage towards a seamless system completed
  - However a lot more needs to be done

Australian Government
Bureau of Meteorology

The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

CSIRO

Kamal Puri
Research Programme Leader
Earth System Modelling Programme

Thank you

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