ARC CENTRE OF EXCELLENCE FOR CLIMATE SYSTEM SCIENCE

MONASH University

The representation of north Australian rainfall in CMIP5

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Outline

- Focus on the diurnal cycle of precipitation and circulation over Australia.
- Case study using ACCESS1.3 (30-year AMIP run).
  - Early deep convection.
  - Nocturnal convection from the heat low.
- Expand analysis to 10 other GCM (AMIP) simulations from CMIP5.
  - Do we see the same processes as in ACCESS1.3?
- Could the processes also be occurring elsewhere?
  - How much does it matter?

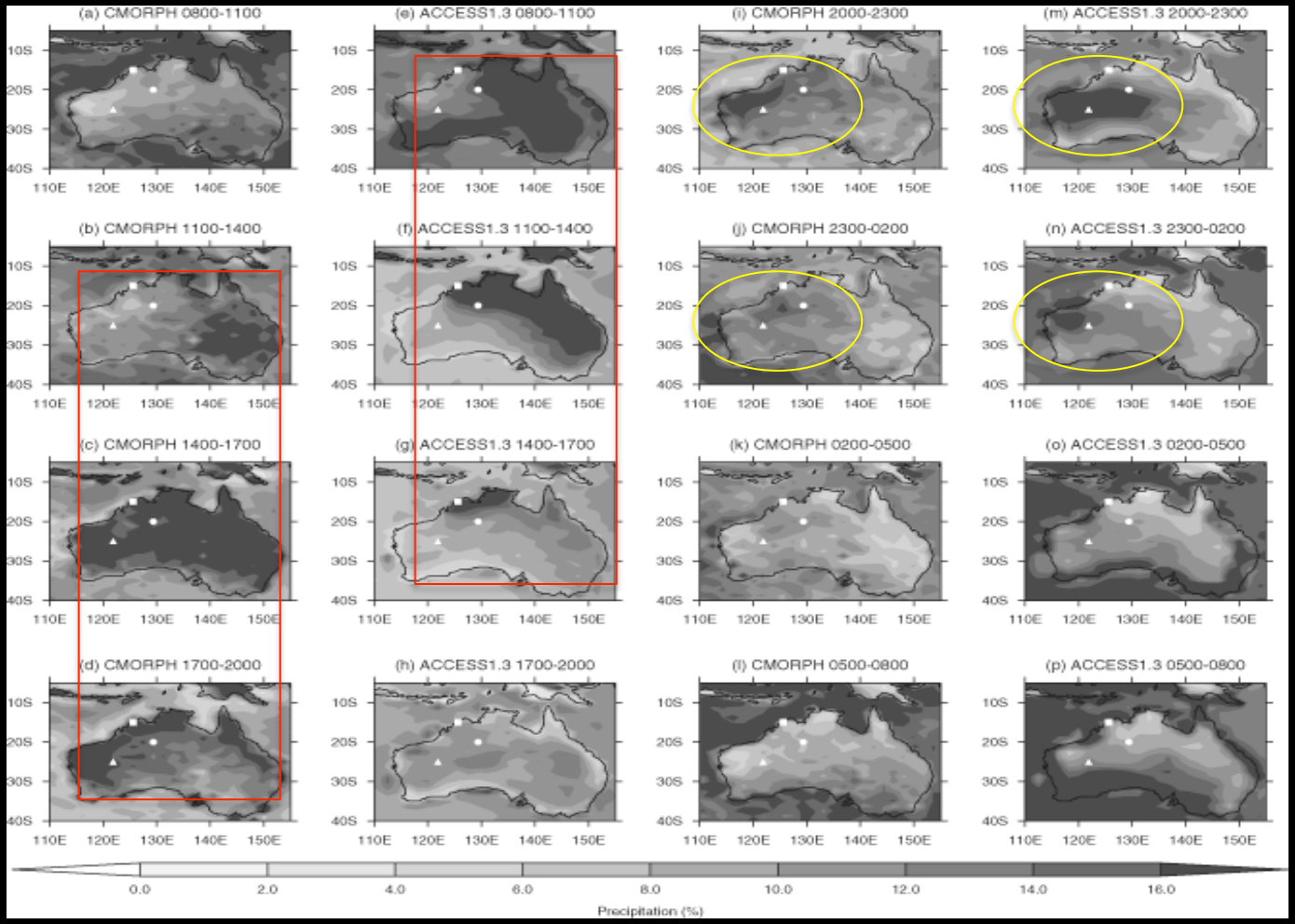
CMORPH ACCESS1.3 CMORPH ACCESS1.3

08-11 AWST

11-14 AWST

14-17 AWST

17-20 AWST



20-23 AWST

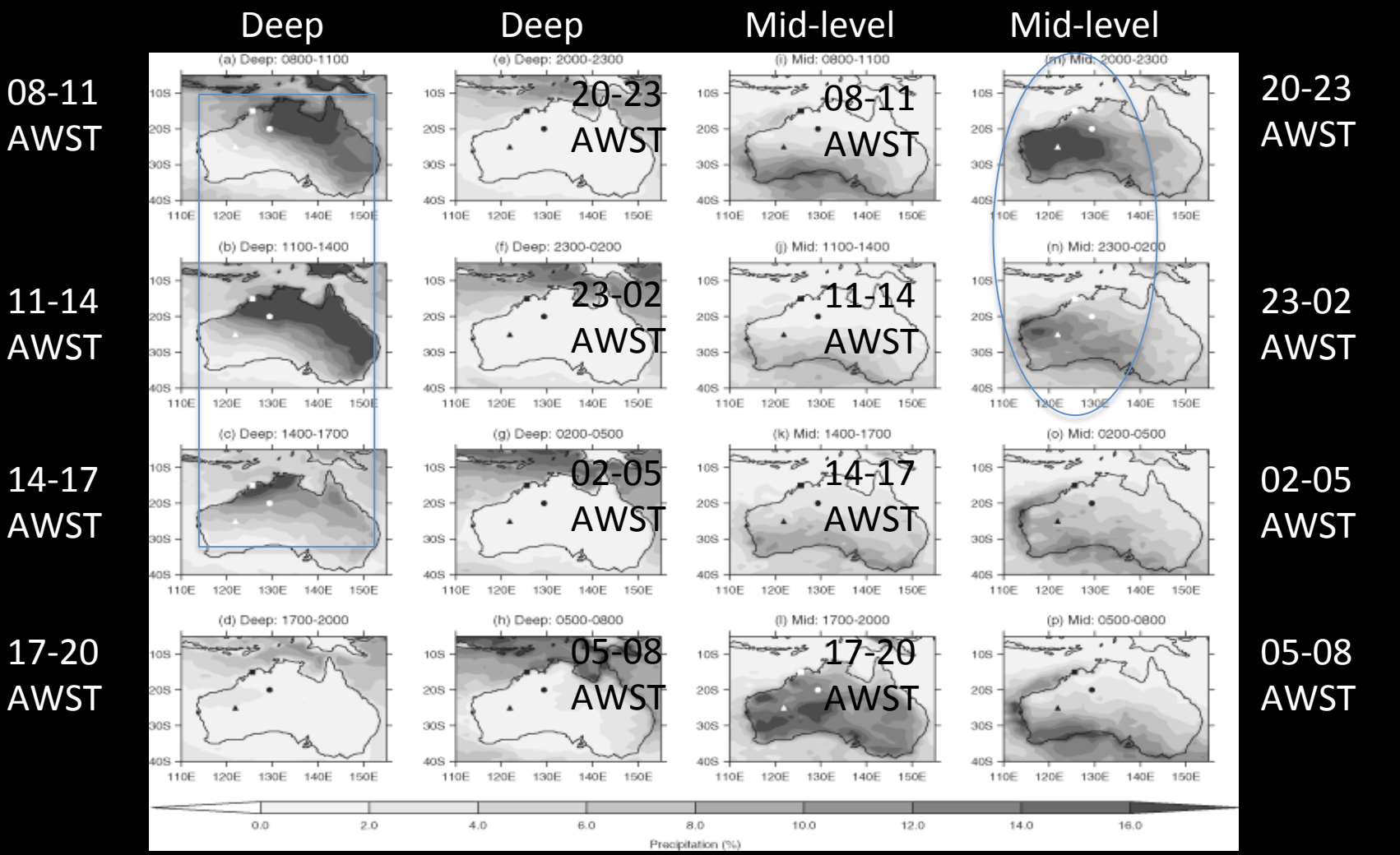
23-02 AWST

02-05 AWST

05-08 AWST

3-hourly precipitation as % of daily accumulation

- Columns 1 and 3 are taken from CMORPH estimates, columns 2 and 4 from ACCESS1.3.
- AWST – Australian Western Standard Time (UTC+8)
- Early precipitation in the east in CMORPH and late precipitation in the evening in the west.
- ACCESS tends to have too much rain too early in the north.
- Rainfall has a distinct “on – off – on – off” pattern in the model.



3-hourly convective precipitation as % of daily accumulation of convective rainfall in ACCESS1.3

- Columns 1 and 3 are taken from the deep convection scheme
- Columns 2 and 4 are from the mid-level convection scheme.
- 'Mid-level' convection is initiated above the boundary layer.
- Nocturnal rainfall occurs above the nocturnal boundary layer.

6-hourly ageostrophic flow and convergence

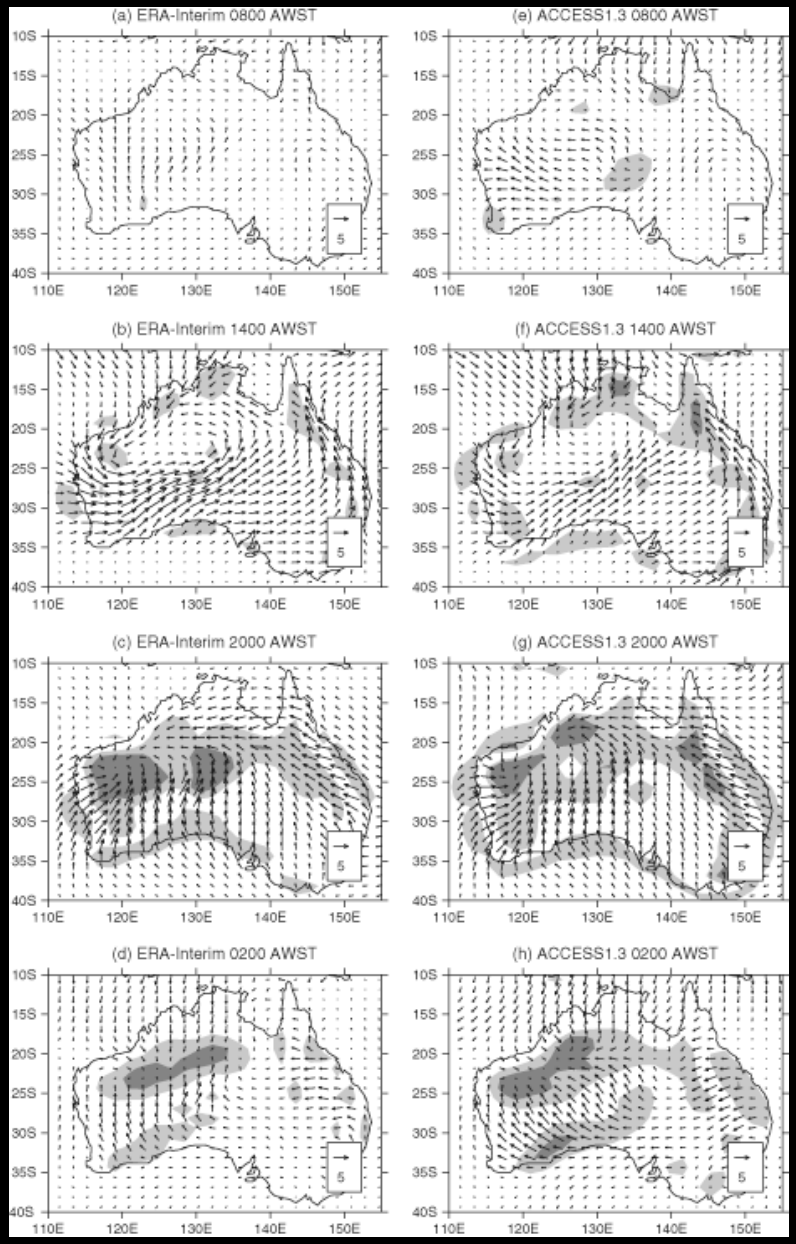
- Mean (DJF 1979-2008).
- Ageostrophic flow vectors at 925 hPa at 0800, 1400, 2000 and 0200 AWST (UTC+8).
- Strong convergence shaded.

- ERA-Interim:
  - Convergence near coast during the day.
  - Nocturnal convergence inland overnight.

- ACCESS1.3
  - Similar patterns in the model.
  - Costal convergence
  - Inland convergence overnight.

- Convergence weaker inland in the model.

ERA Interim ACCESS1.3

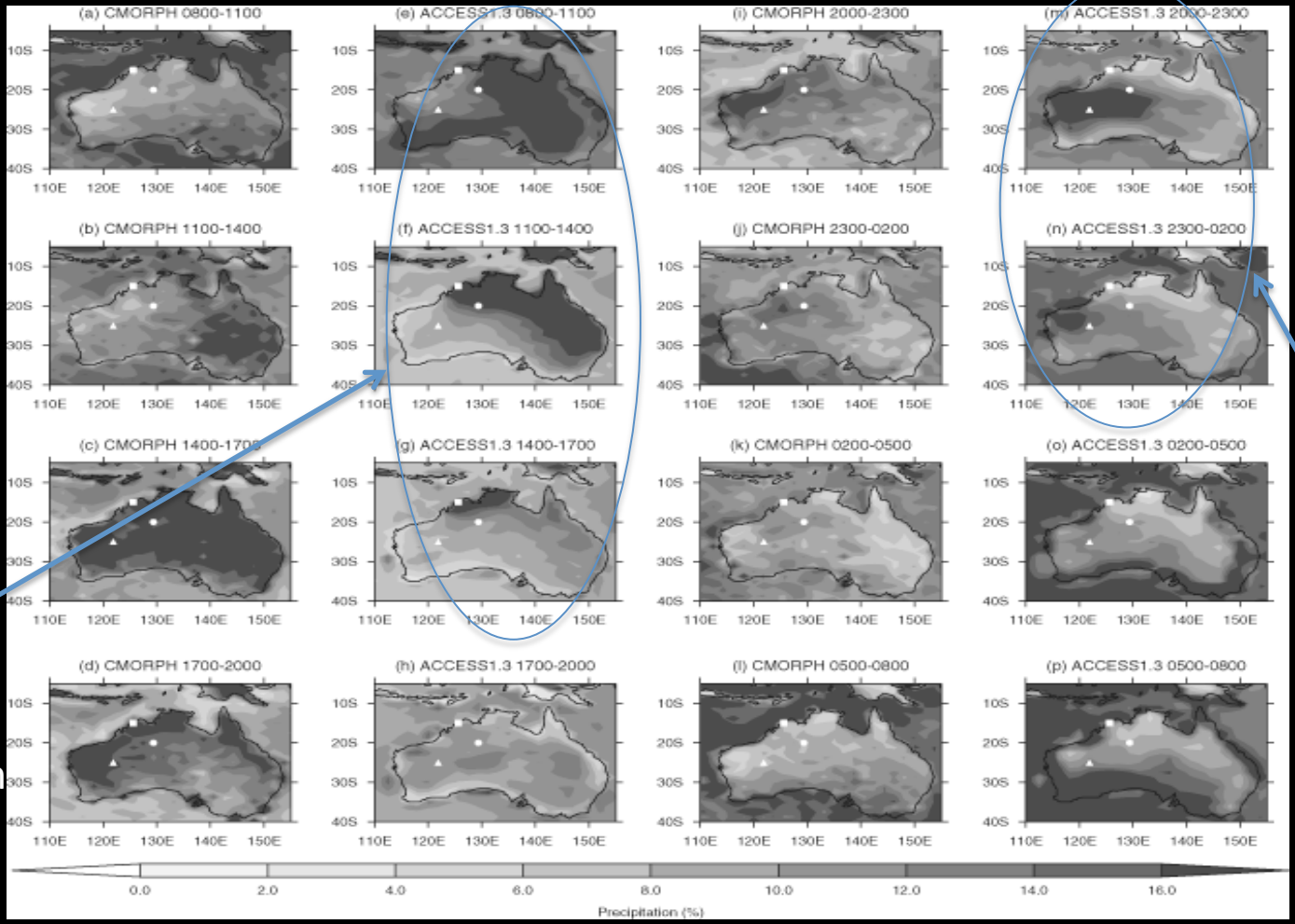


0800 AWST

1400 AWST

2000 AWST

0200 AWST



Solar heating Deep Convection

Nocturnal heat low forced, mid-level convection.

3-hourly precipitation as % of daily accumulation in CMORPH and ACCESS1.3

- No large-scale forcing of early precipitation
- Model nocturnal rain - heat low re-arrangement.
- Real world – not as obvious and unlikely to be same.

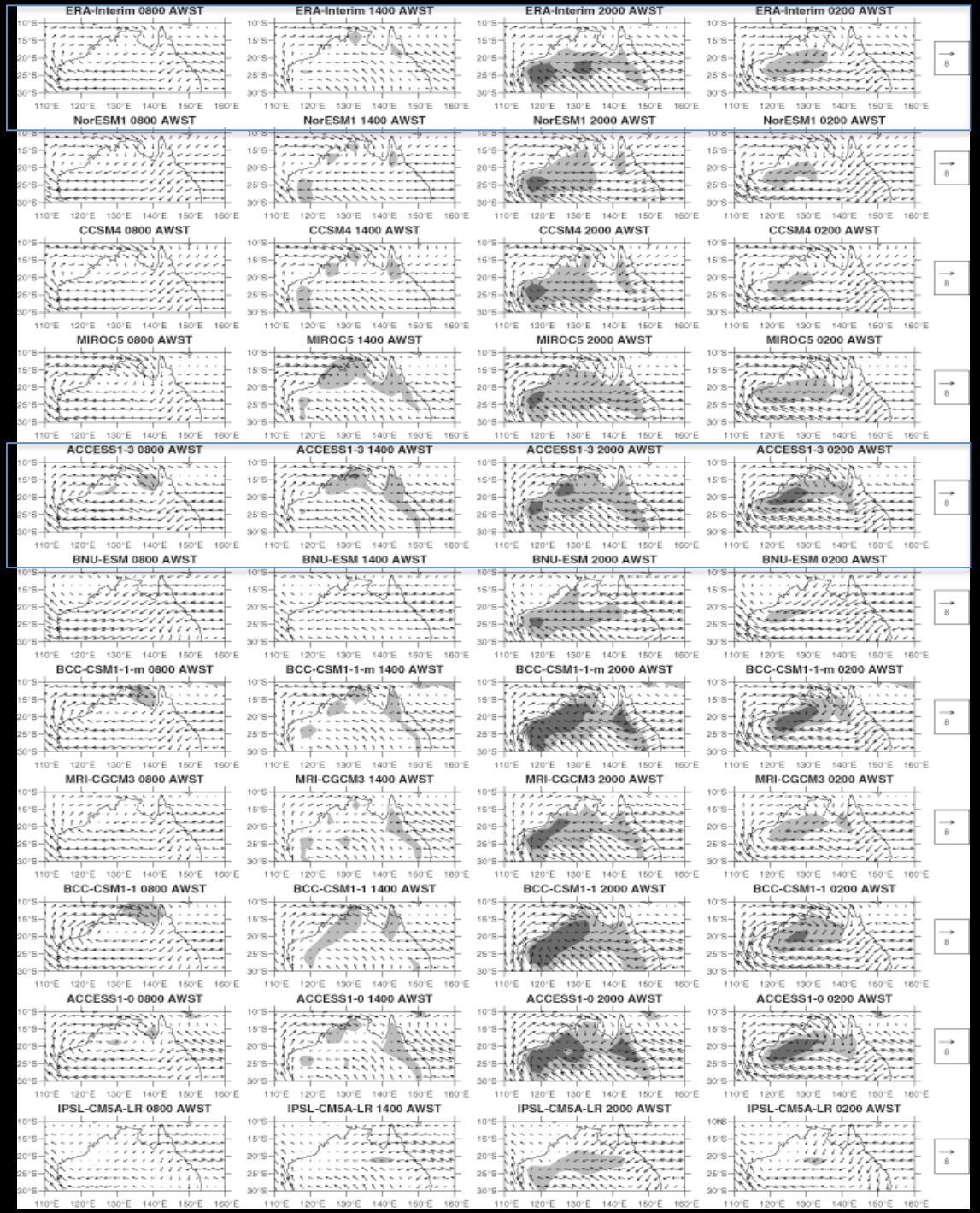
CMIP5: Diurnal cycle of circulation. (DJF composites)

- Flow vectors at 925 hPa at 0800, 1400, 2000 and 0200 AWST (UTC+8).
- Strong convergence shaded.

- ERA-Interim (top row):
  - Nocturnal convergence inland overnight.

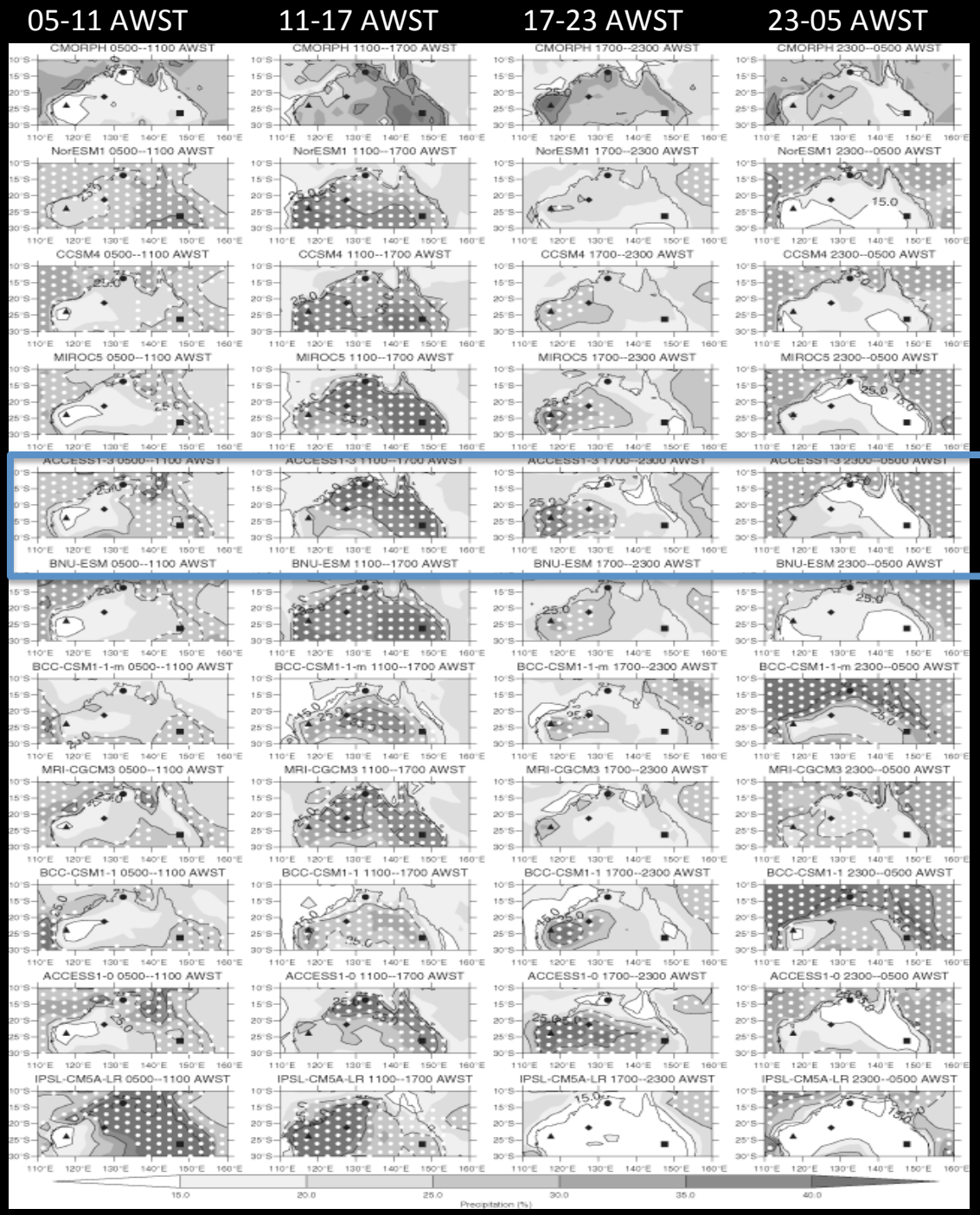
- CMIP5 AMIP simulations:
  - Similar patterns in the model.
  - Inland convergence overnight in all cases.

- How does this impact on rainfall in the models and?



CMIP5: Diurnal cycle of precipitation

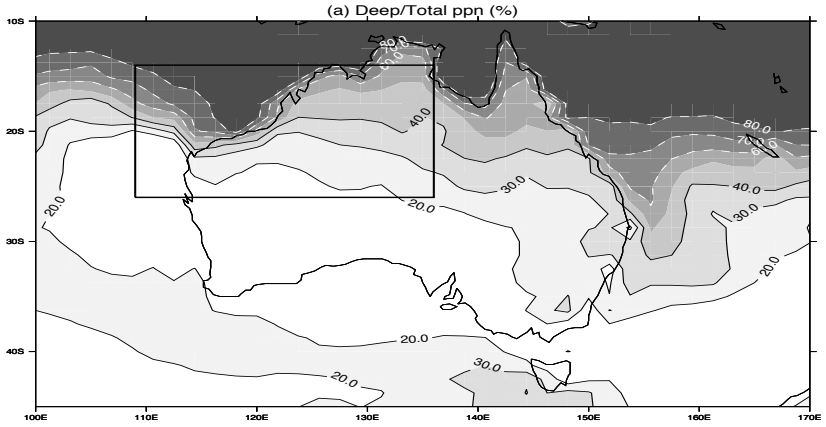
- Very similar to ACCESS1.3…
- % contribution of ***6-HOUR*** precipitation to the daily total.
- CMORPH data top row.
- 10 models beneath.
- Stippling indicates strong convective rainfall contribution.
- Early convection widespread around 1400 AWST (primarily between 1100-1400)
- Remaining area of convective precipitation in the heat low.

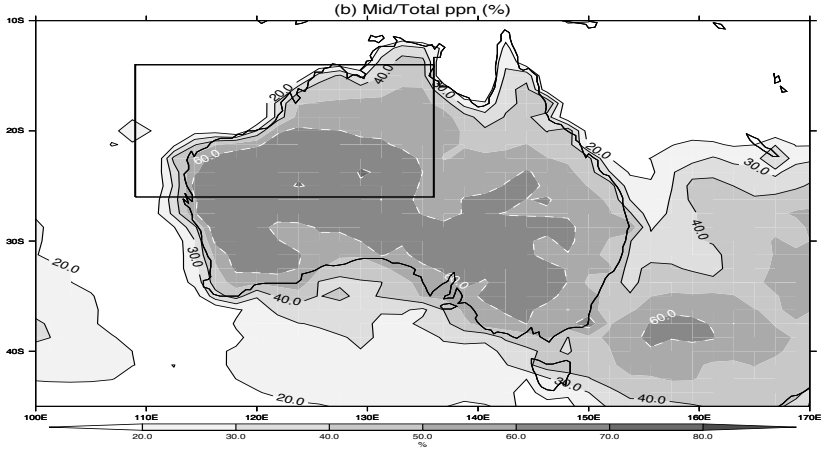


- Two questions:
  - How much does this ‘mid-level’ convection contribute to the total rainfall over Australia?
  - Does it happen elsewhere and does it matter there (e.g. West Africa)?

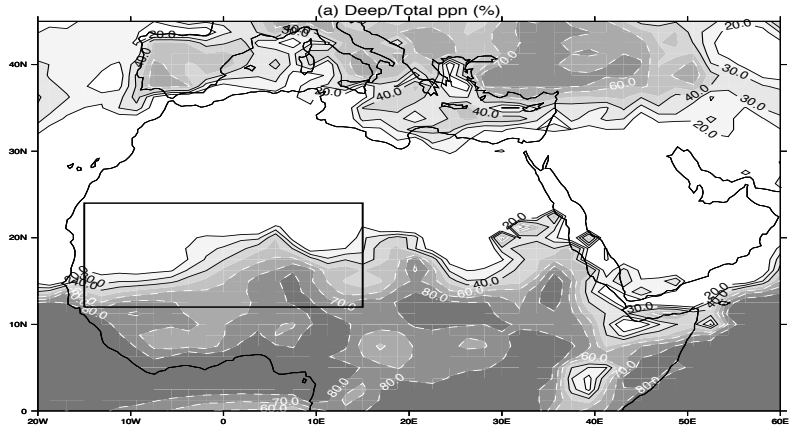
% contribution of deep and mid-level convection to TOTAL rainfall in ACCESS1.0 (similar to ACCES1.3) Between 30-70% of TOTAL rainfall!!!

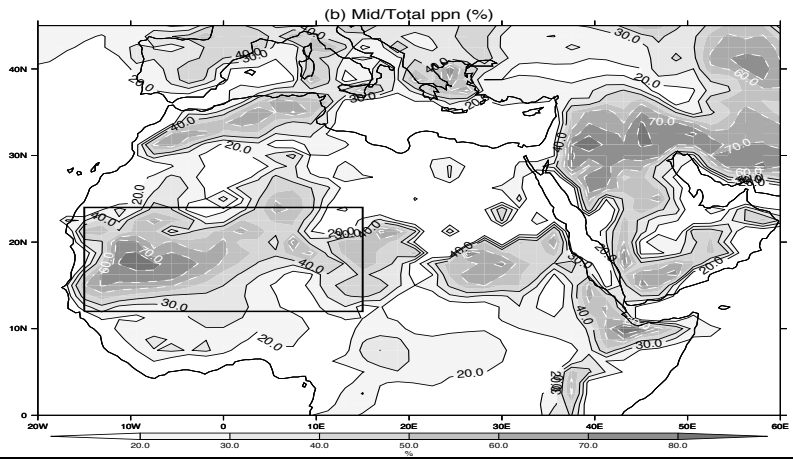
AUSTRALIA (DJF)





WEST AFRICA (JJA)





Next steps

- Look in more detail at the ACCESS simulations.
- Extend the analysis to West Africa.
  - Identify the physical process at work in the models.
- Is it an artifact of using parameterized convection?
  - Assessment using high-resolution simulations with and without convective parameterization.
  - Extend the analysis to the CMIP5 models based on the results from the high-resolution model.