A new mesoscale NWP system for Australia

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Earth System Modelling (ESM) and
Weather&Environmental Prediction (WEP)

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Australian Government
Bureau of Meteorology

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

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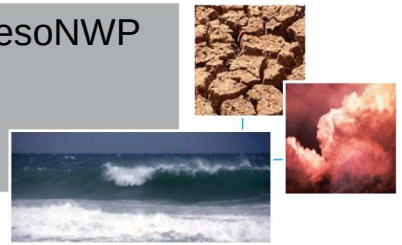
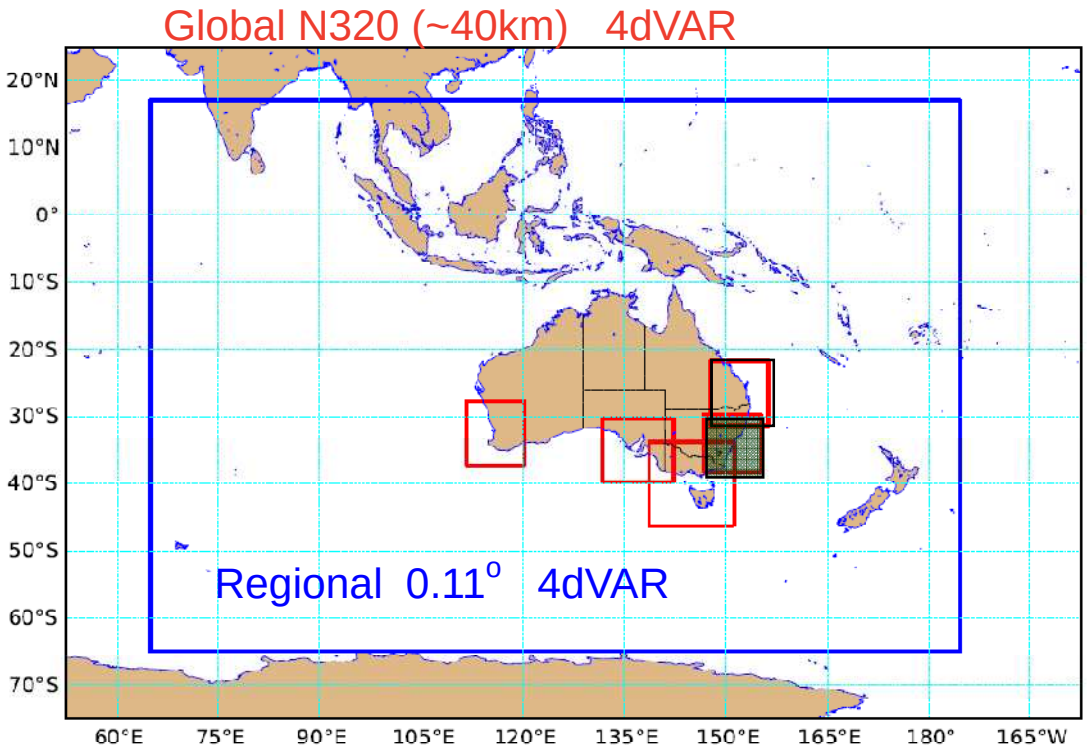
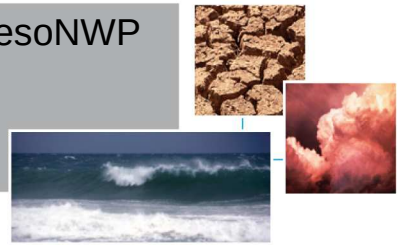
NWP environment



- Met Office Unified Model
  - **UM 7.5 / L70**
- 6 hourly 4dVAR
  - Global, Region
- 4km City Systems **(UM7.6)**
  - **No Assimilation**
  - Grey zone
- 1.5km **(UM7.6)**
  - 3dVAR + radar winds & precip (LHN)
  - Relocatable
  - Transition to operations 2014-15
- Ensembles?
  - Global & Regional EPS
    - Research only
  - Need deterministic high res.



Issues



- Radar data & NWP
  - Historically distinct

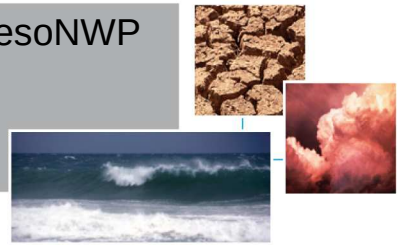
  → Compare NWP fields & radar data (precip & winds)

- Convection permitting resolutions
  - Configure and test model away from the UK
  - Feasible within Bureau resources

- Objective use of radar data
  - Data quality & error characteristics
  - Value & quality of clear air echoes?

- Development of a suitable NWP system
  - Assimilation of precipitation data & Doppler radial winds
  - Limitations of Aust observing network etc.
  - Evaluation of NWP system

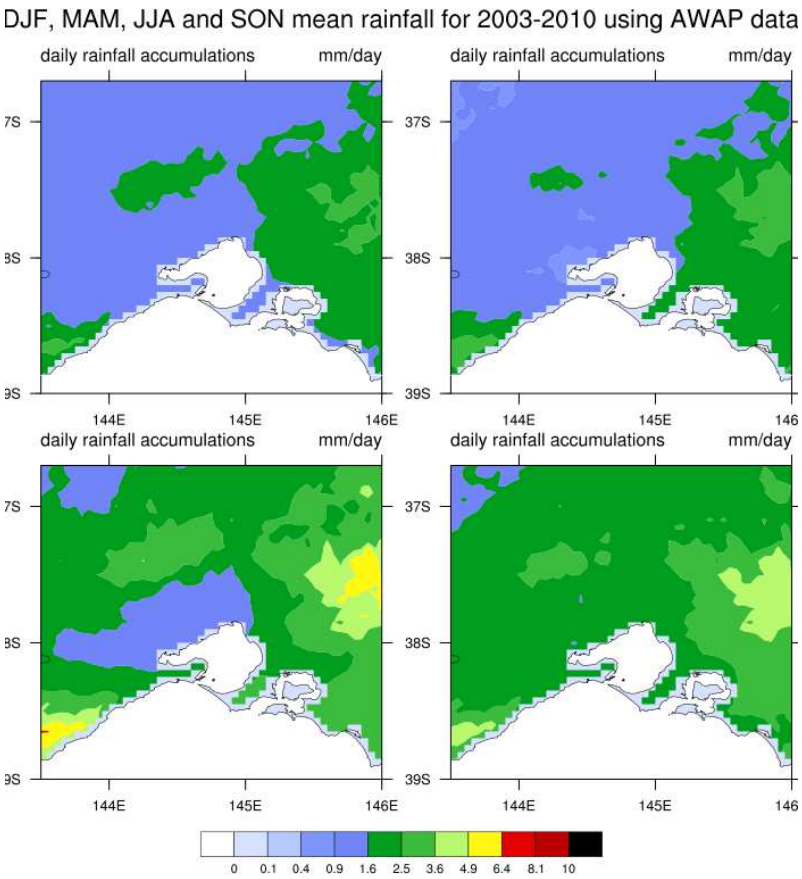
Experimental 1.5km system



- Aim for system capable of using radar data
  - 3dVAR (3 hourly initially)
    - Move to Hourly
  - Latent Heat nudging
  - Doppler radial winds
    - Best coverage is over Eastern NSW (Sydney Domain)
  - Covariances from 12km system

- Main focus so far
  - Radar & QPE quality control
    - Errors in radar QC introduce spurious rainfall patterns
  - Doppler radial wind QC
    - precip & clear air echoes
  - Assessing model performance
  - Configuring 3dVAR and Latent Heat Nudging (ongoing)

Systematic errors in radar rain estimates

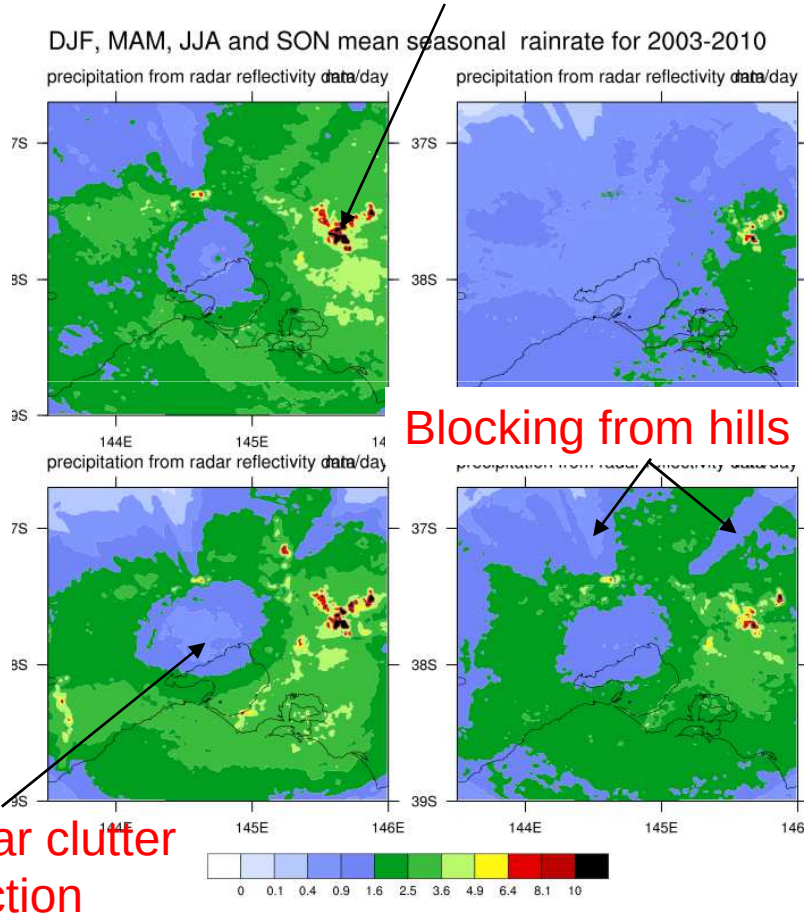


Gauge climatology

Clutter

Blocking from hills

Radar clutter rejection



Radar climatology

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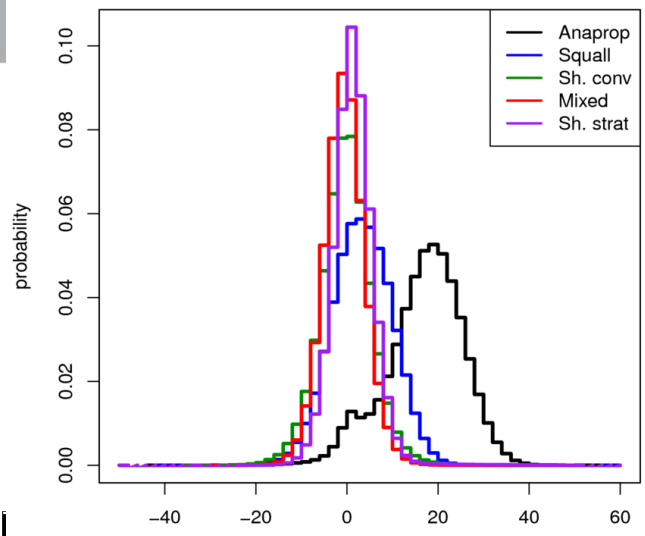
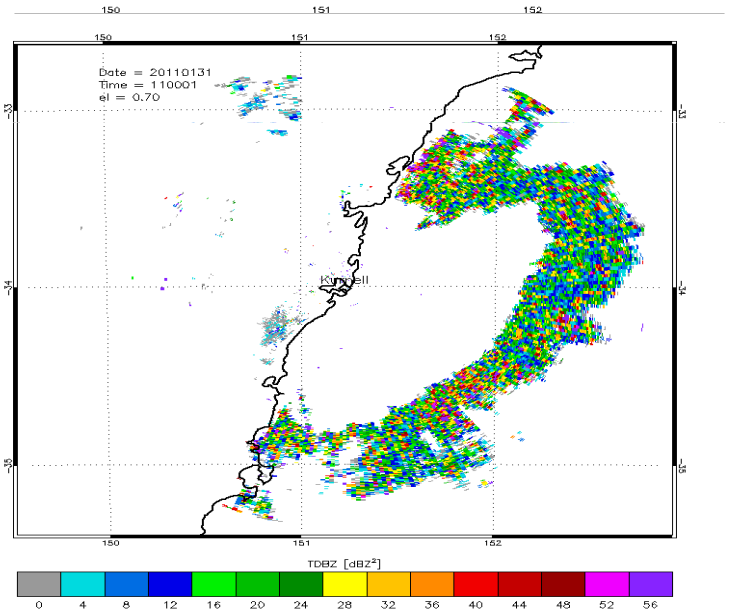
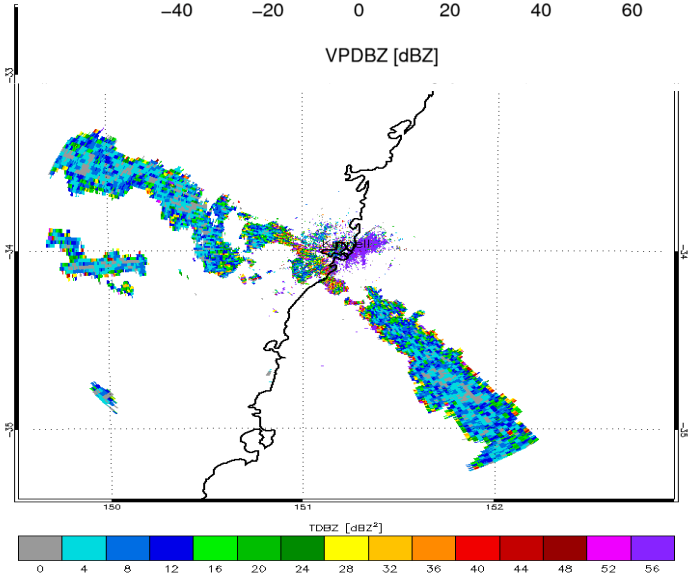
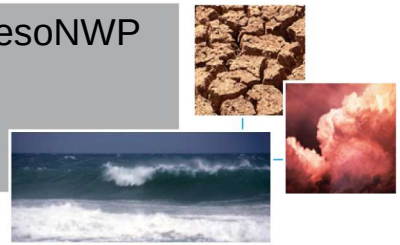
Cleaning up the radar data

- Detect anomalous propagation & clutter
  - 3d structure of texture



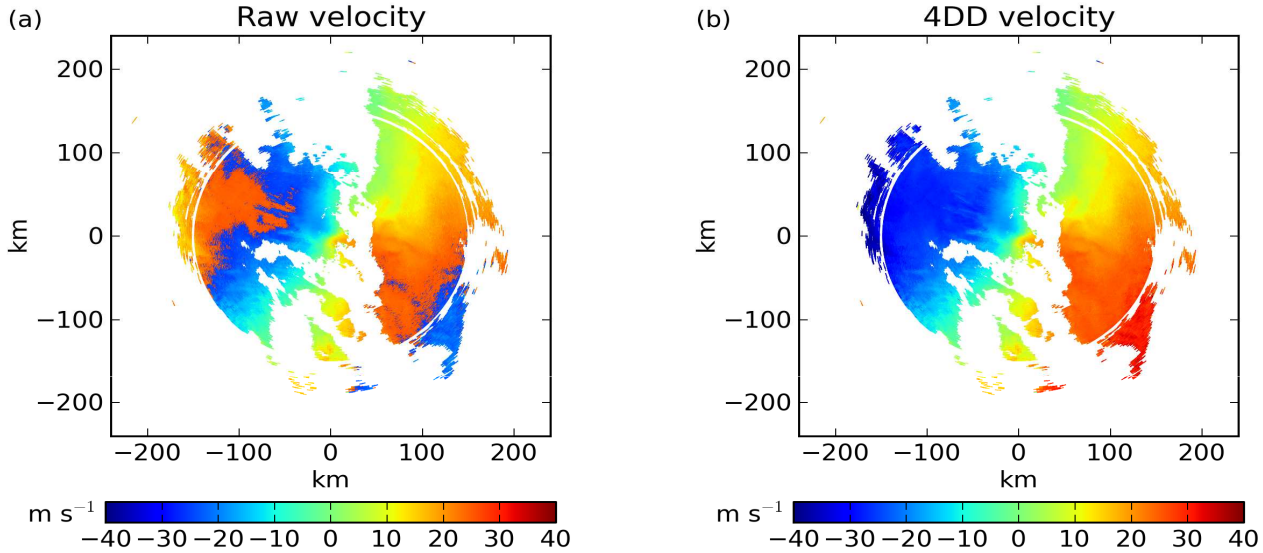






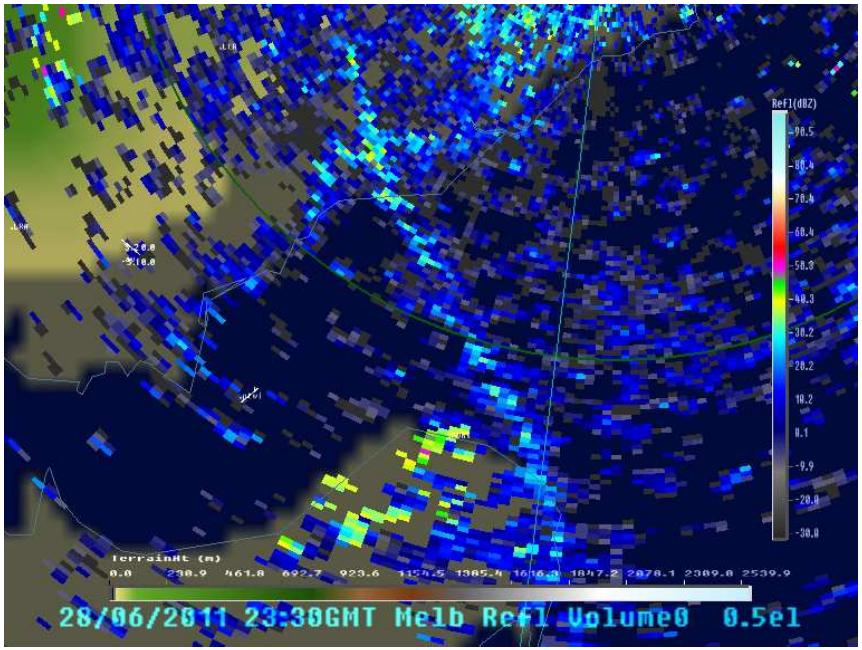
Doppler wind processing

De-aliasing algorithms are being implemented in the quality control

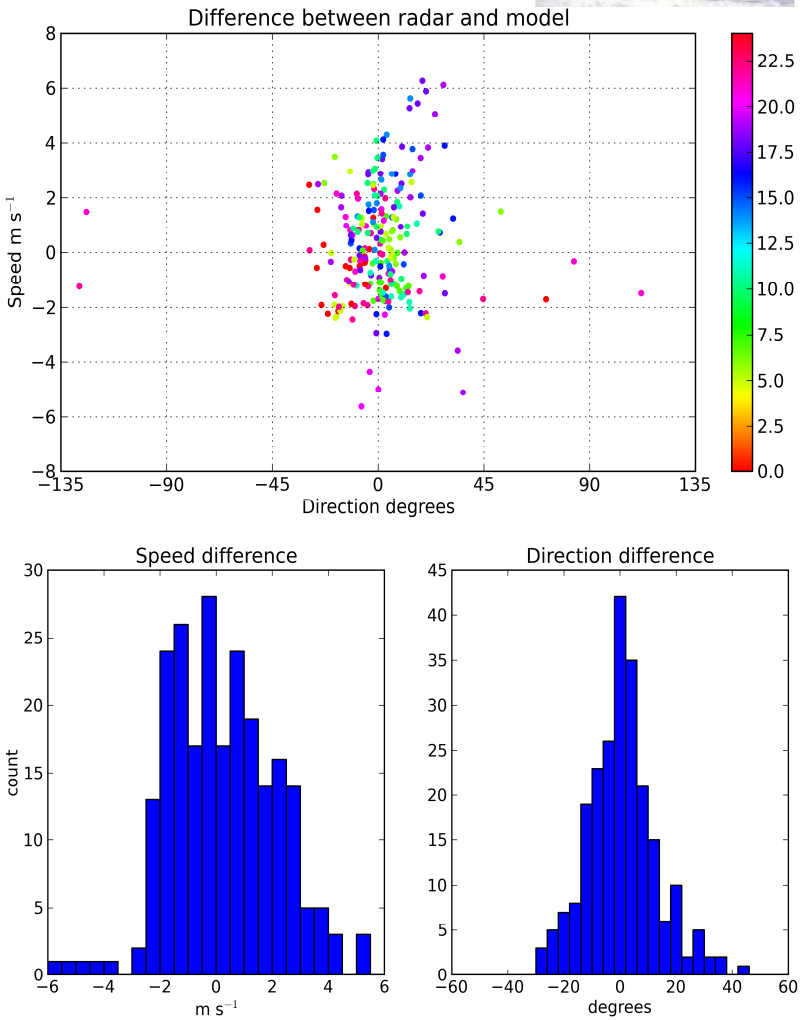


- ACCESS-A / radial wind usually within ±2 m s^{-1} and ±20º.
- Bias is small.
- Continue investigation of insect winds in NWP.

Quality of Clear Air Winds - birds and bees?

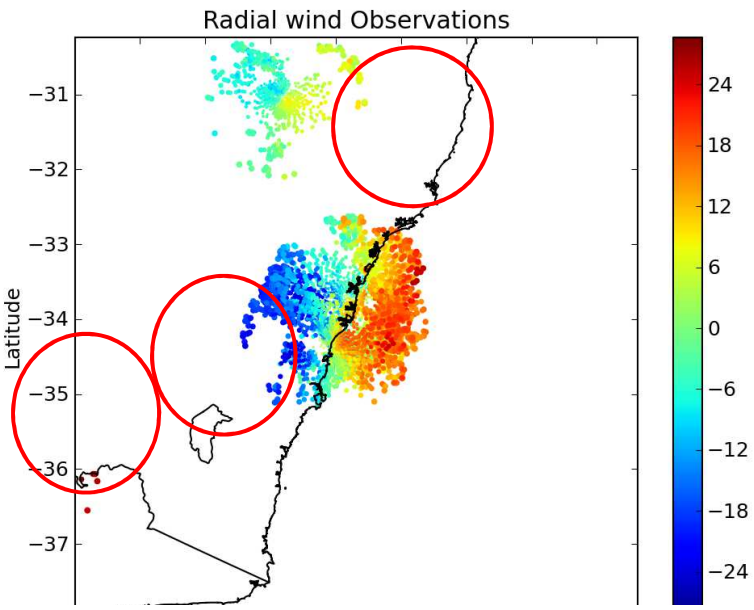


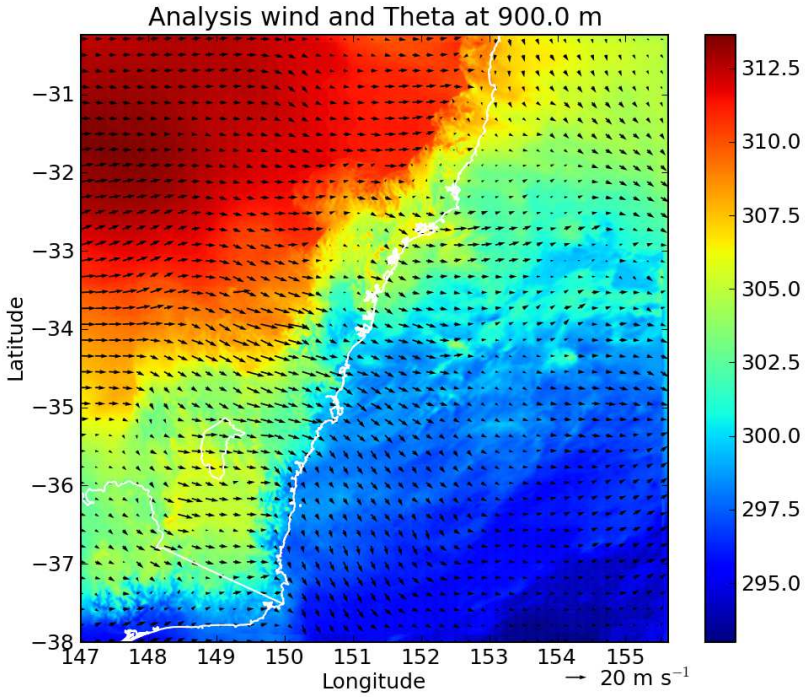
Birds are not OK

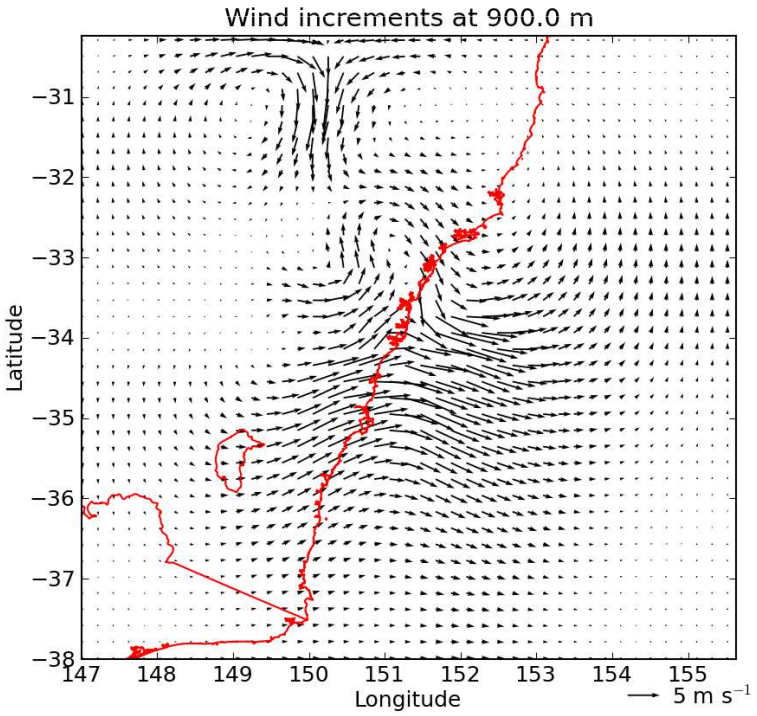


Insects are OK

Assimilation of clear air wind



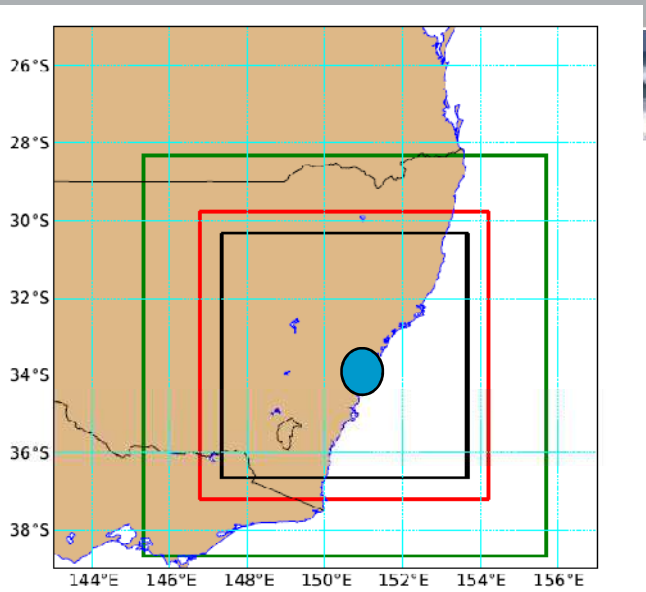


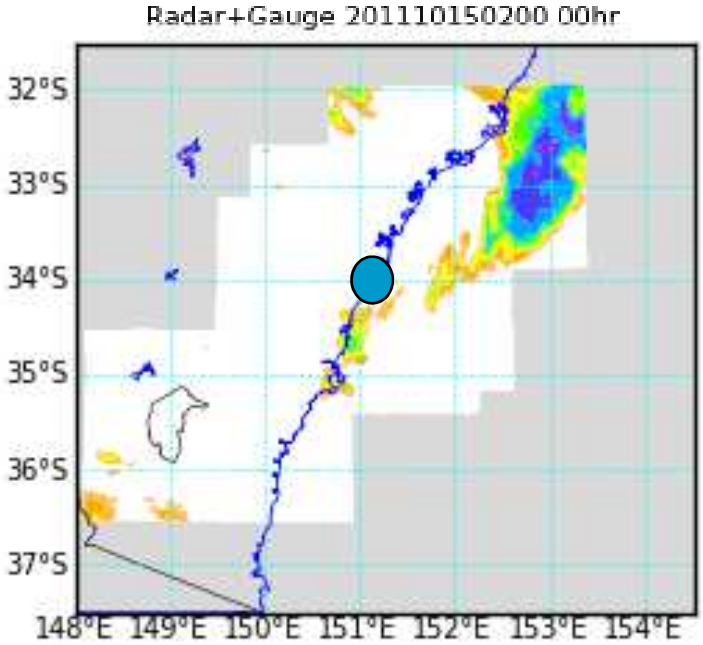


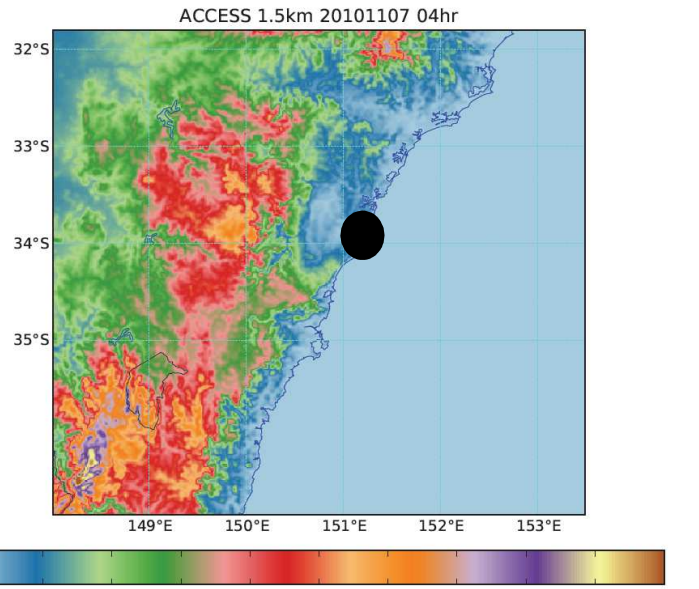
Target area?

- High population
- Best observing system
  - Radar & surface
- Susceptible to severe weather
  - Heavy rains, storms etc.

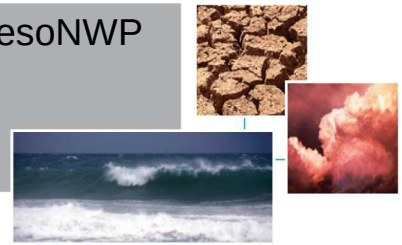
→ Sydney & Eastern NSW





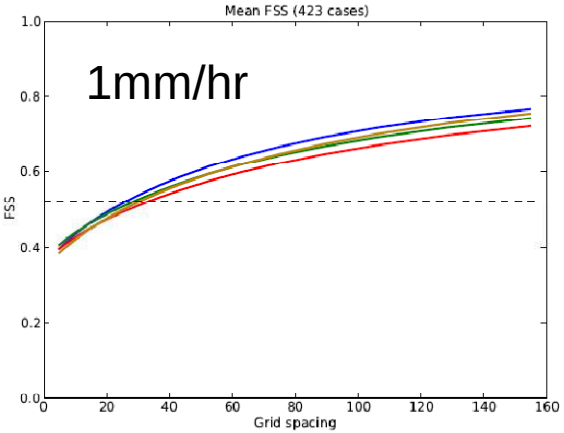


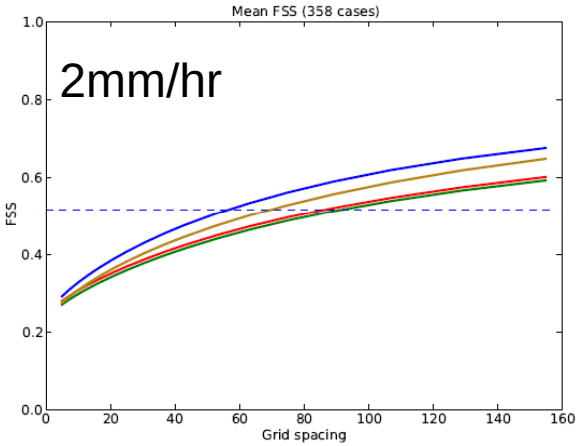
Fractions Skill Score (Sep2011-Feb2012)

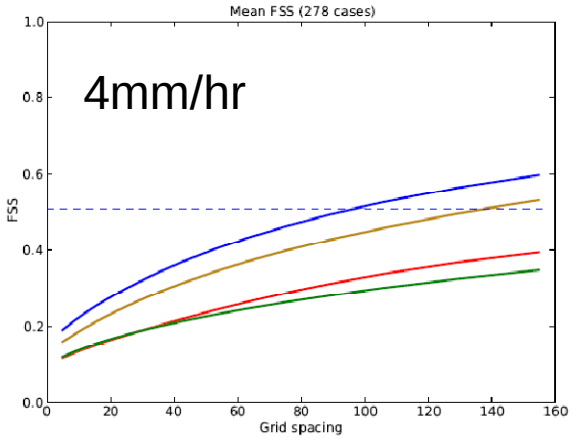


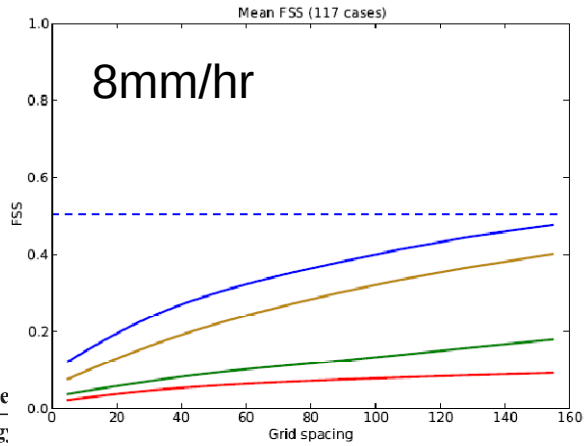
- 70+ days : 02Z, 05Z, 08Z… 23Z
- 5 hour forecasts

1.5km+3dVAR+LHN **ACCESS-SY 0.05º (APS0)**
ACCESS-A 12km **ACCESS-SY 4km (APS1)**









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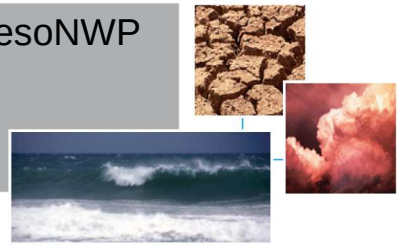
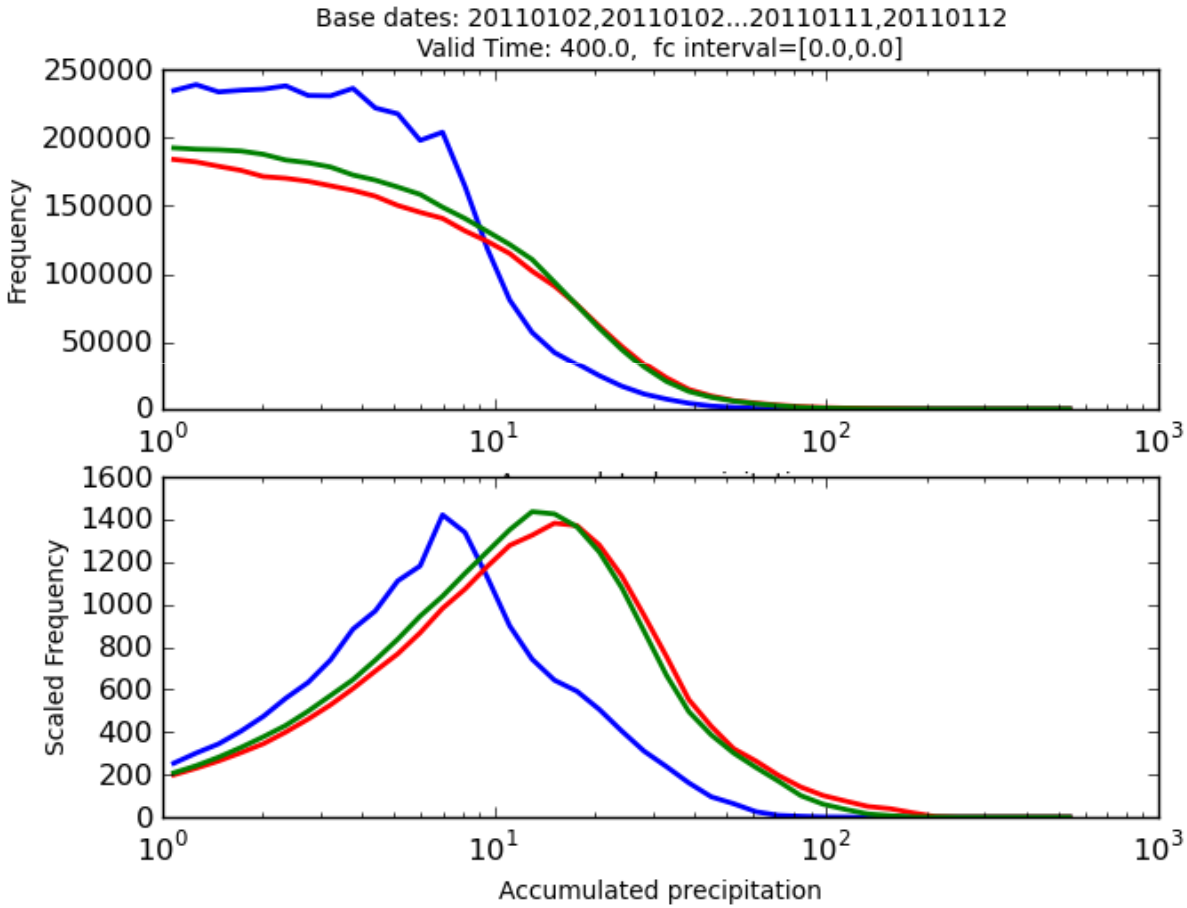
Model Issues: Distribution of rainfall intensity

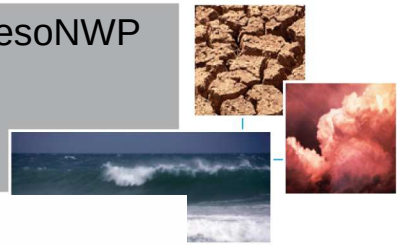


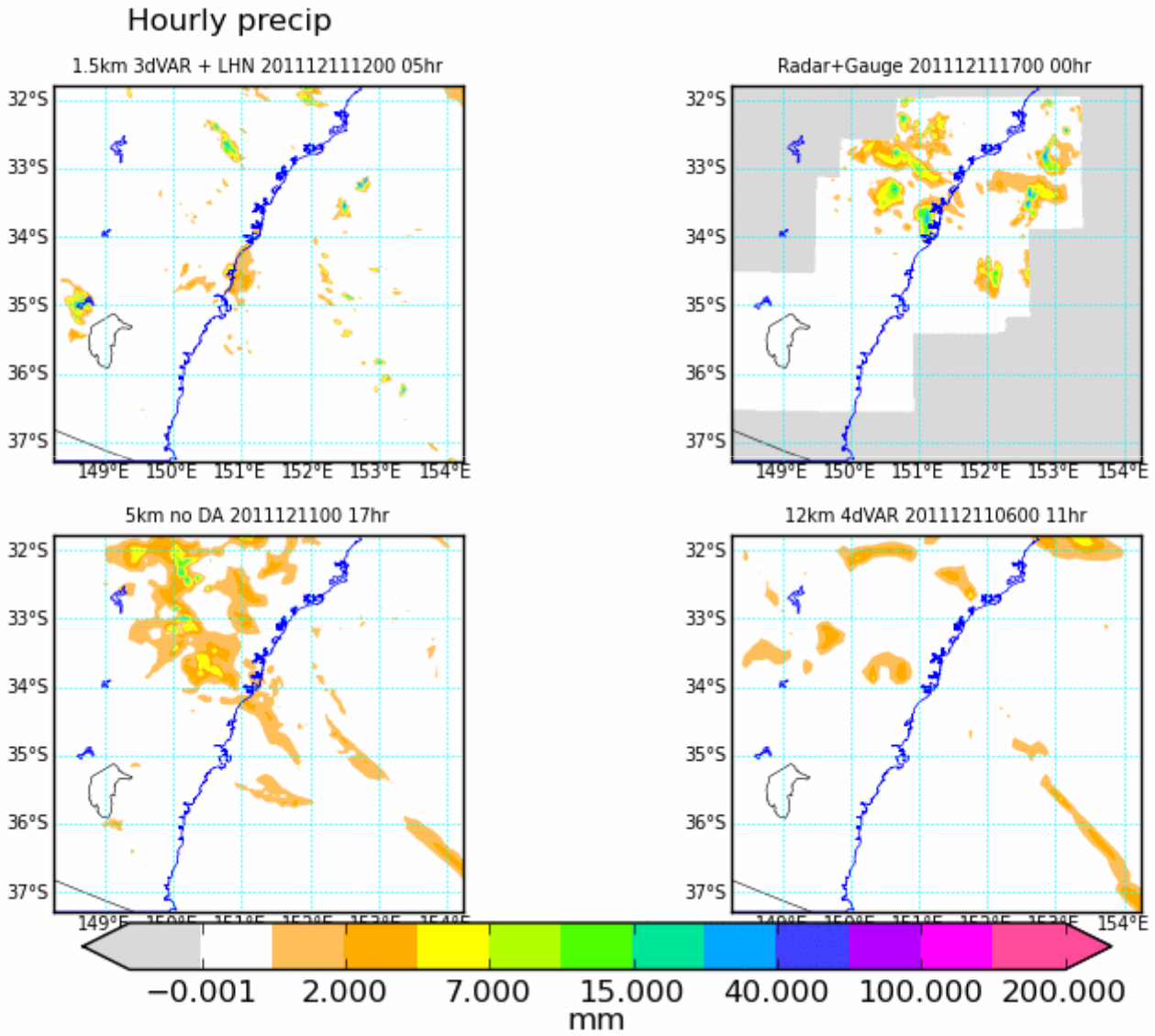
Too much convection & too strong



Obs
3dVAR+LHN
3dVAR only

Example





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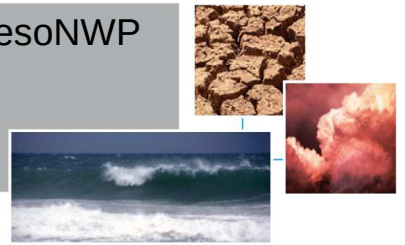


Value-added by Latent Heat Nudging over 3dVAR

- Adds value for a few hours only
- Increases Prob. of Detection

  & decreases False Alarm Ratio

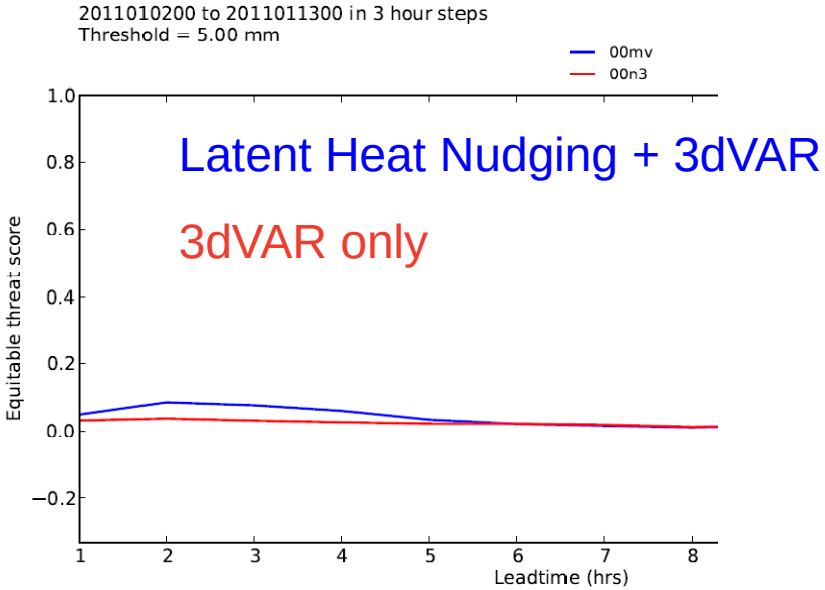
- Modifications required
  - reduce nudging strength rel. to UK
  - Limit size of increments
- Possible reasons:

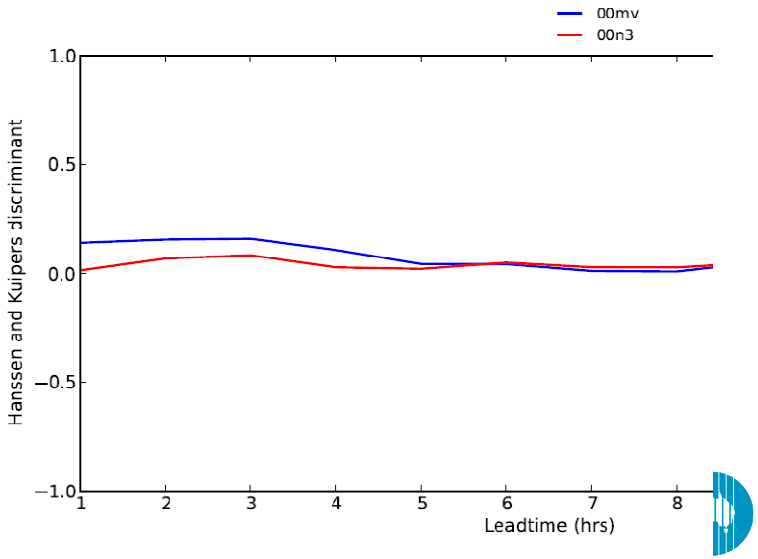
  Different atmospheric environment (shear)

  Lag in cloud formation & preciptation

  vs effect of nudging

  No cloud analysis in Aus





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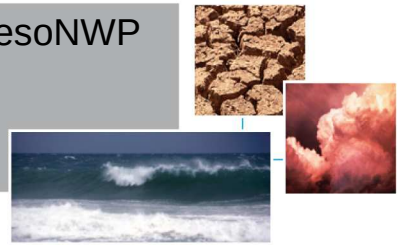
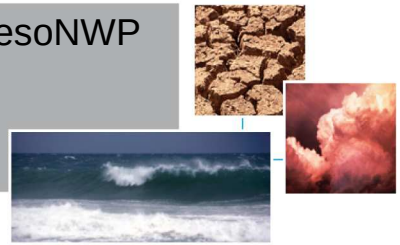
Where are we?



- 1.5km + 3dVAR +LHN improves short range hourly precip forecasts
  - Resolution matters (both for UM & VAR: 1.5km vs 12km)
- Latent heat nudging adds value for ~6 hours
  - Better at spinning up some weak precipitation than heavy precip
  - Cloud nudging for deep convection?
- Have improved QC of radar reflectivity
- Doppler winds seem OK so far
  - Clear air winds comparisons encouraging

So where to?



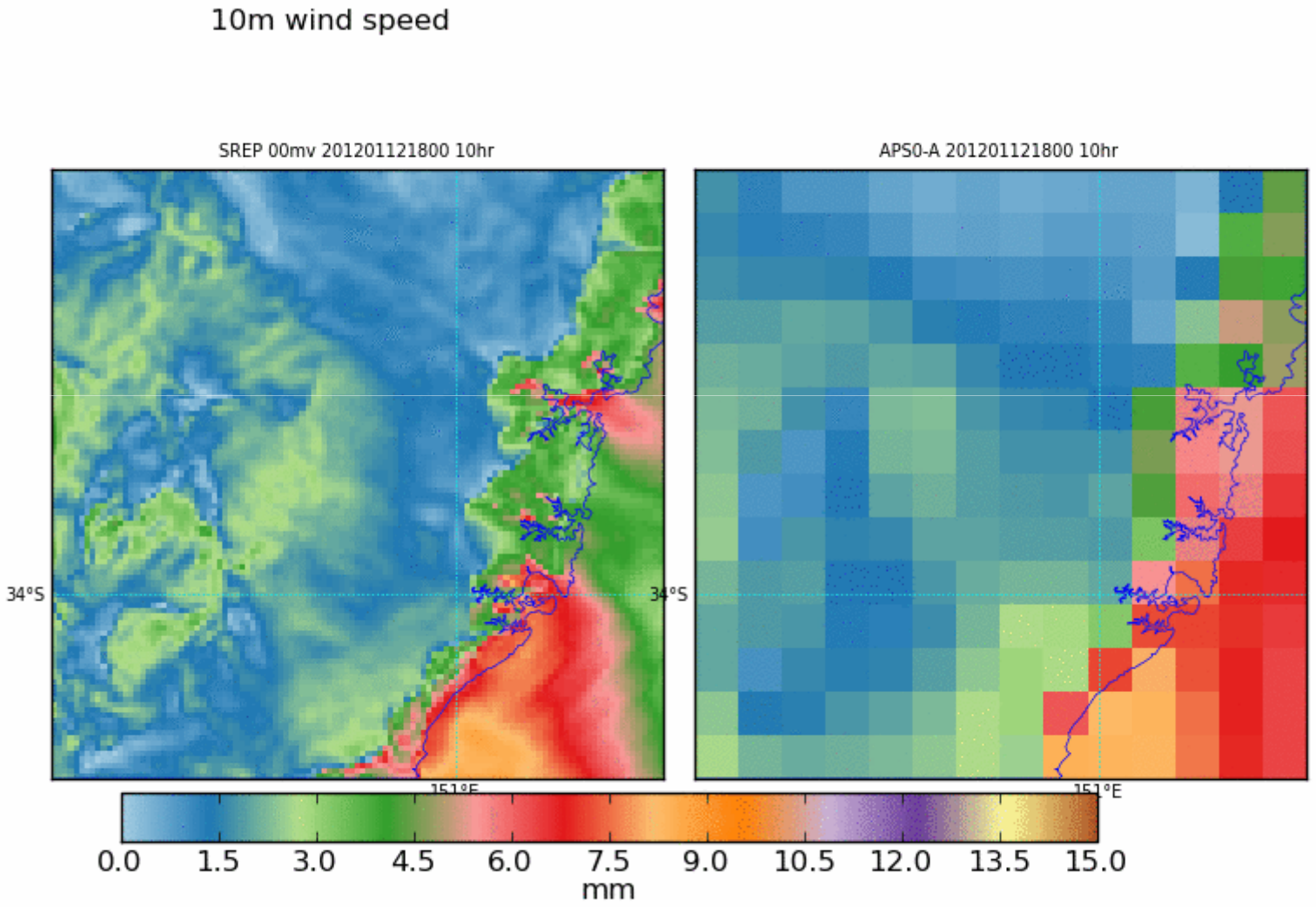
- Address model issues
  - Cloud & Rainfall processes
    - Too many intense cells, too little light rain
    - Too much frozen water in 1.5km clouds
  - Improved lateral boundary conditions
    - Stretched grid & Improved large scale systems

- Assimilation
  - Doppler winds
  - Hourly DA
    - Gravity wave noise due to DA seems insignificant

  >> Forecasters VERY interested in hourly high-res analyses that use all data <<

How will forecasters use this ???

1.5km vs ACCESS-A: 10m wind speed 00Z to 09Z



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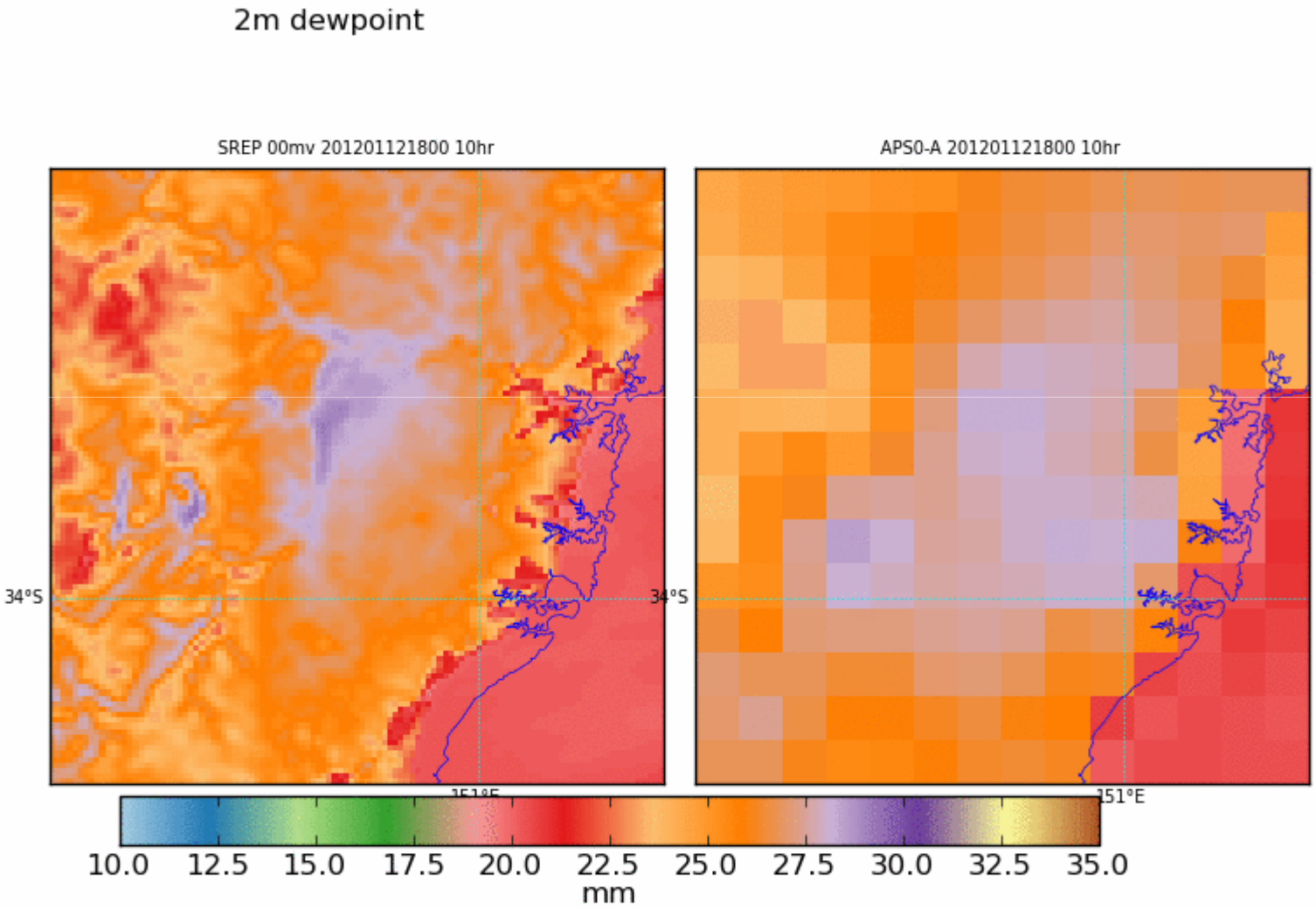
1.5km vs ACCESS-A: screen dewpoint 00Z to 09Z



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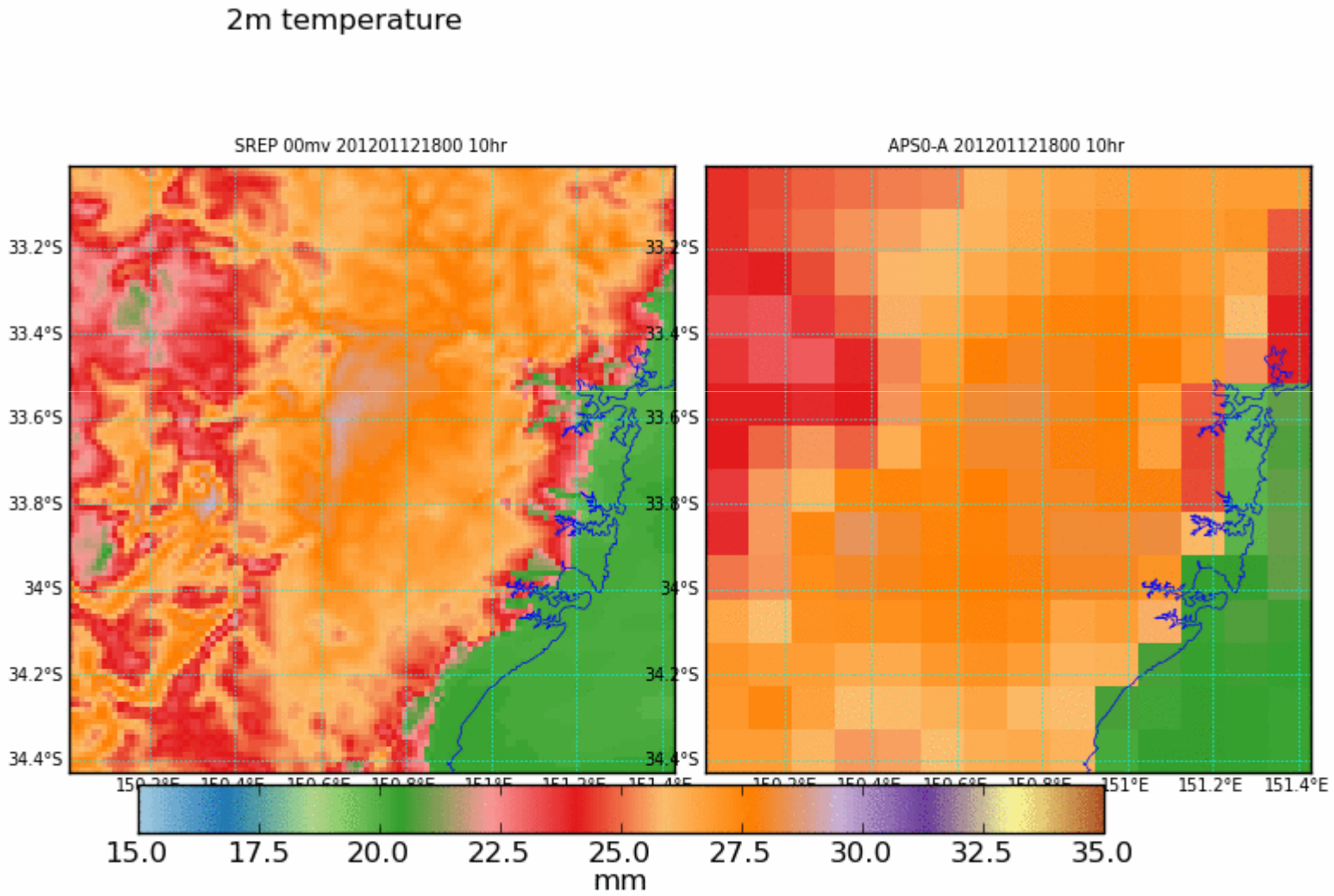
1.5km vs ACCESS-A: screen temperature 00Z to 09Z



Summary

- 1.5km system is very encouraging
- Latent Heat nudging seems to only provide value for a few hours
- Hourly 3dVAR is our preferred strategy at the moment
- Need to improve microphysical processes
  - And various other aspects of NWP
- Forecasters have been very quick to see the potential value

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CSIRO

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Thank you

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