

# Applications of very high resolution atmospheric modelling for bushfires

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High Impact Weather Research

AFAC, Sept 2, 2013

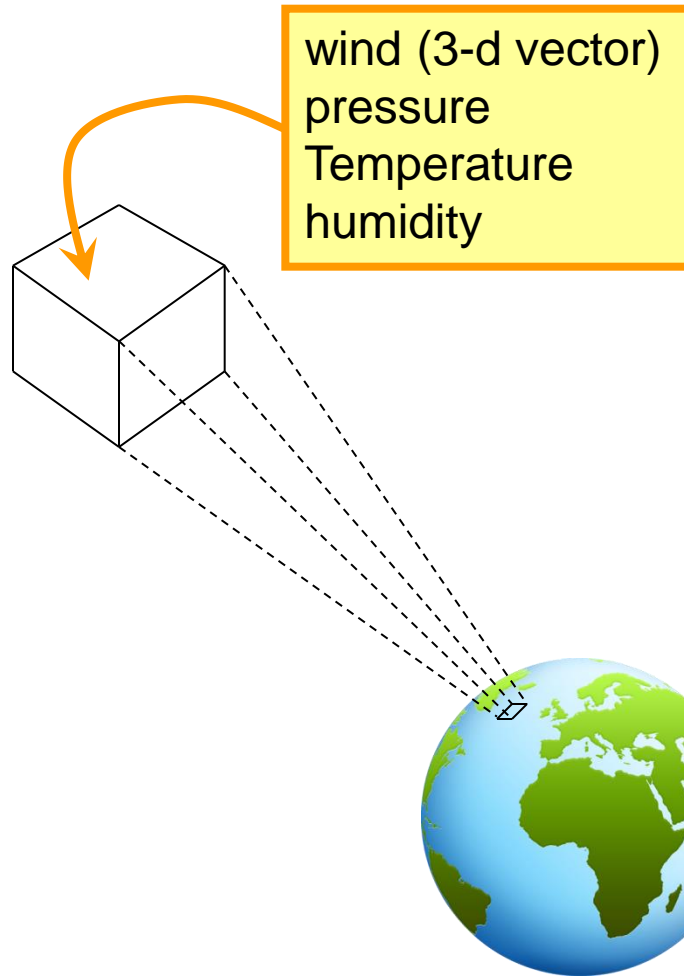


**Australian Government**  
Bureau of Meteorology

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

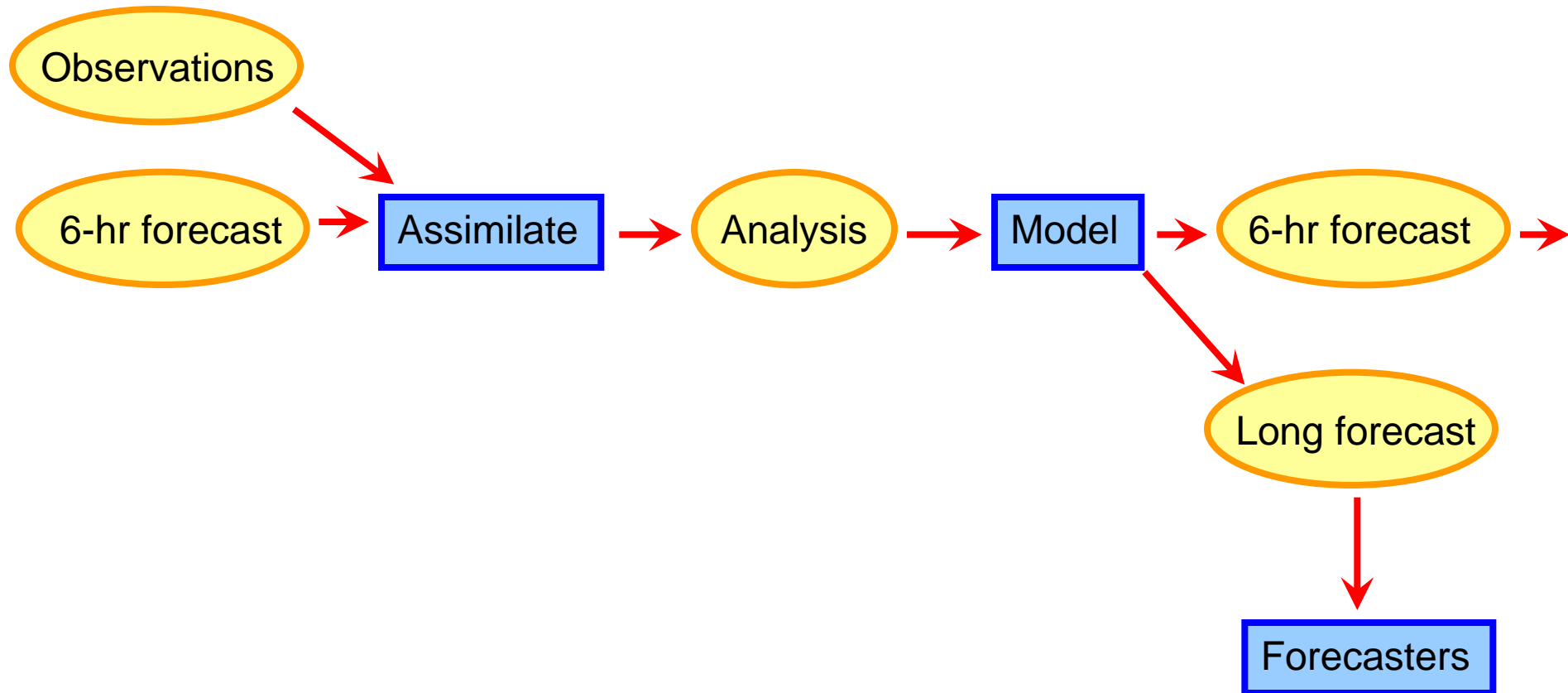


# Newton's laws in the atmosphere

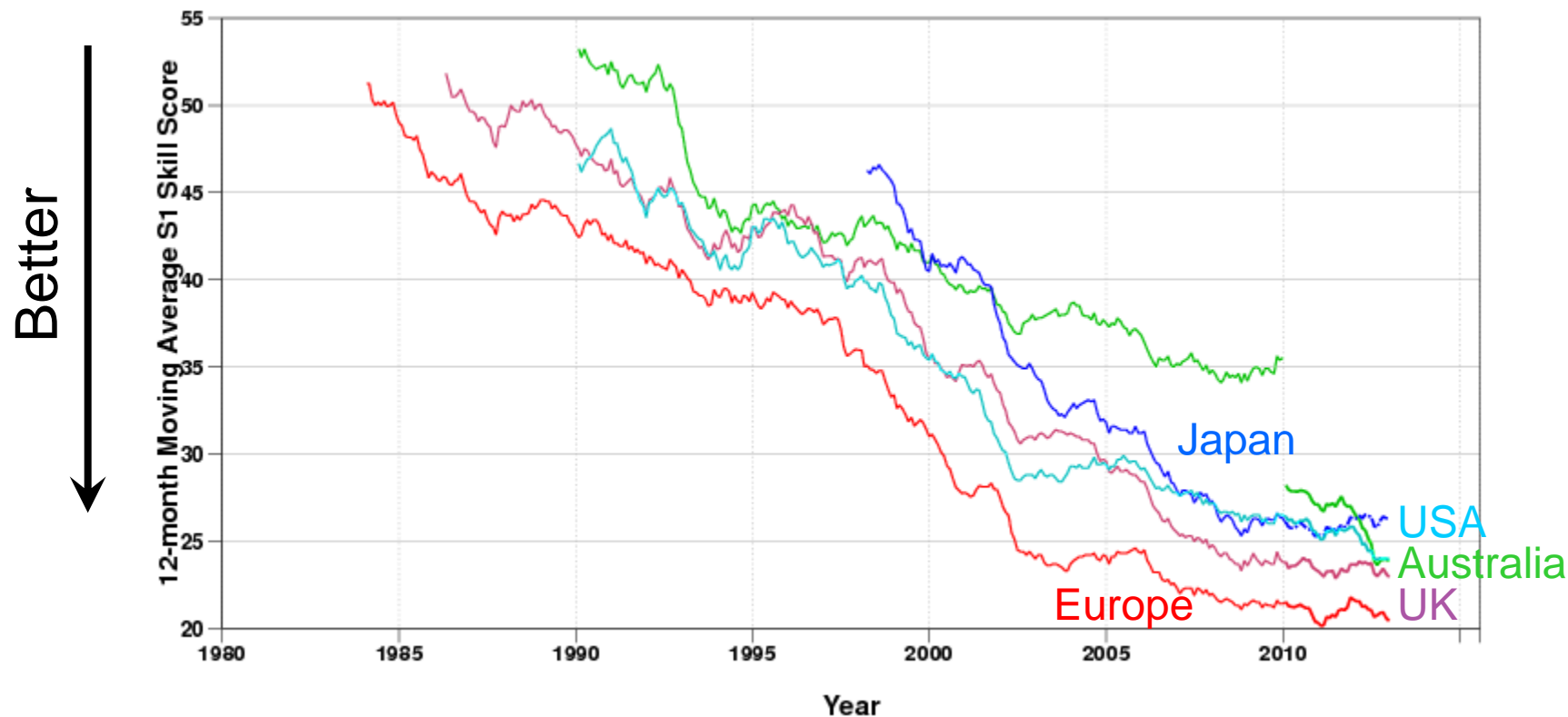


- Divide the atmosphere into millions of cells.
- In each cell, solve
  - $F = ma$  (in all three directions)
  - $pV = nRT$
  - Conservation of mass
  - Conservation of water vapour
- at each time step.
- Repeat until you get to the desired forecast length.

# Cycling Numerical Weather Prediction



# International Skill Levels

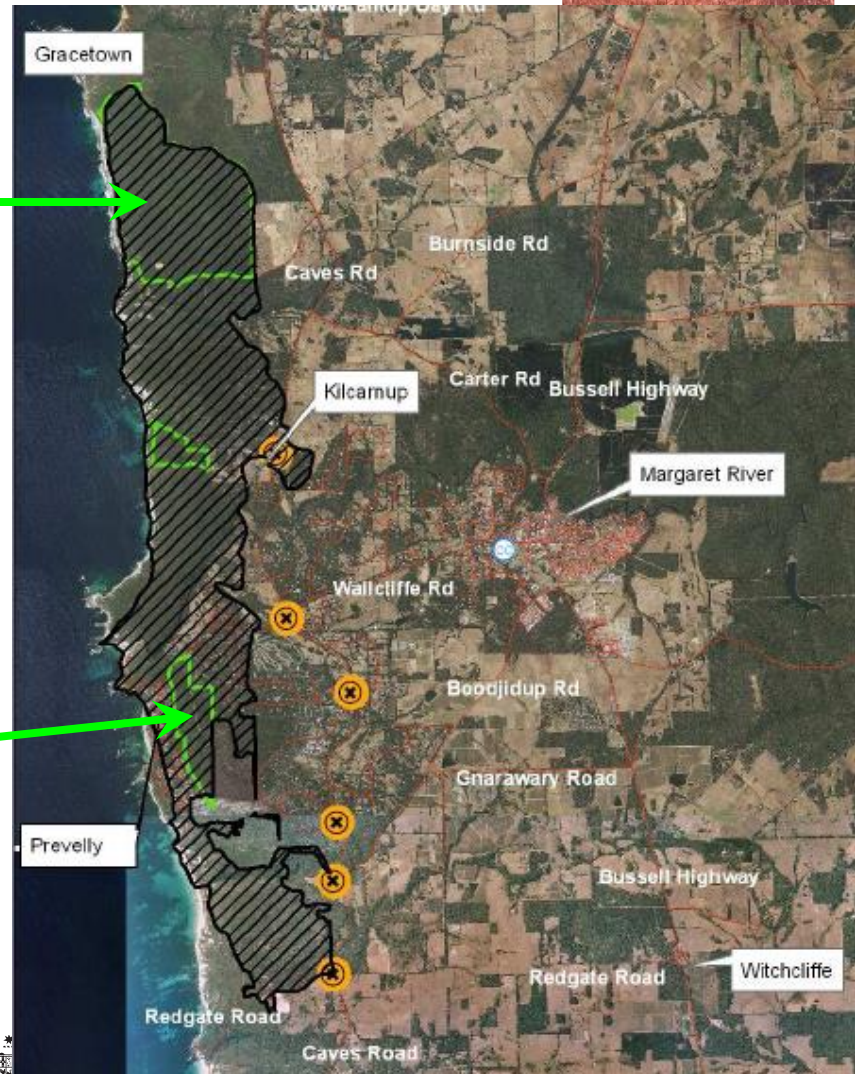


# The Margaret River Fire

Ellensbrook  
prescribed burn area (green)

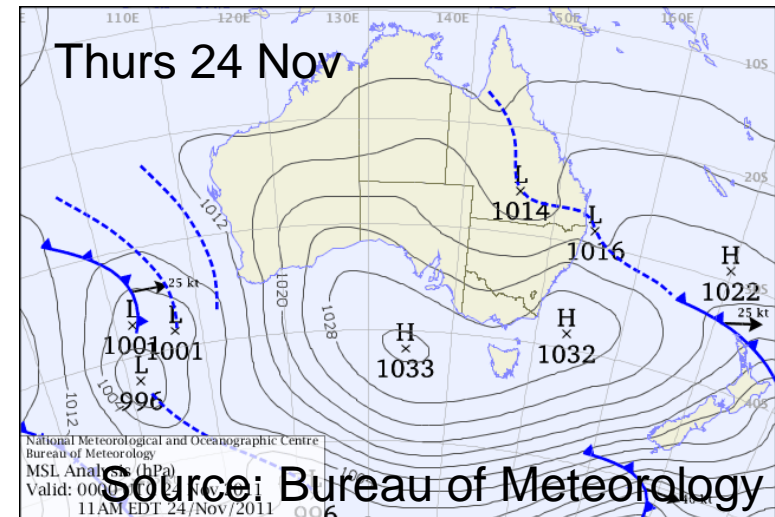
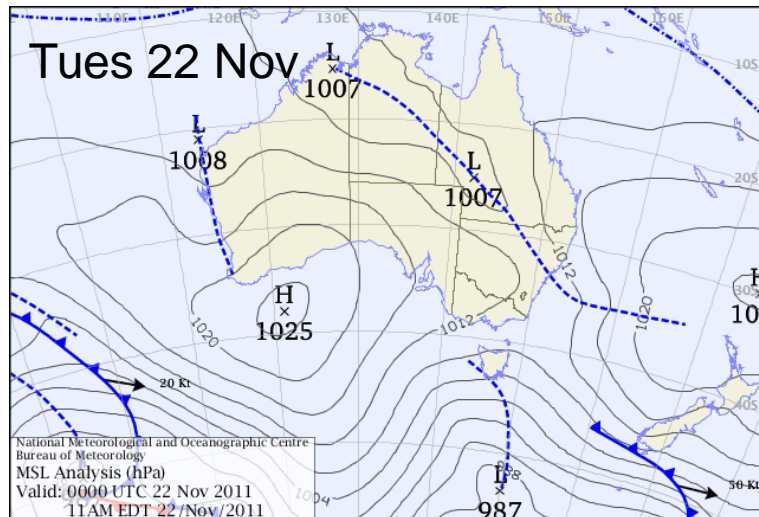
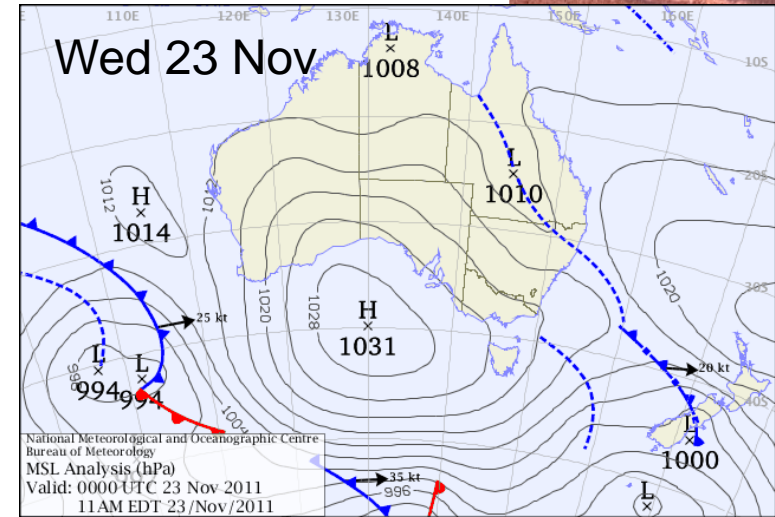
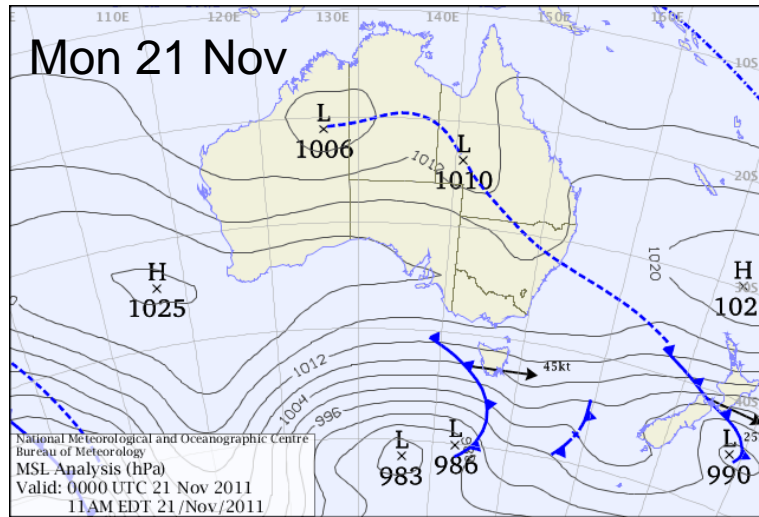
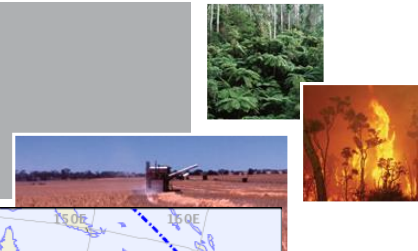
Actual burnt area shown hatched

Prevelly  
prescribed burn area (green)





# MSLP, 8 am local (00 UTC)



Source: Bureau of Meteorology

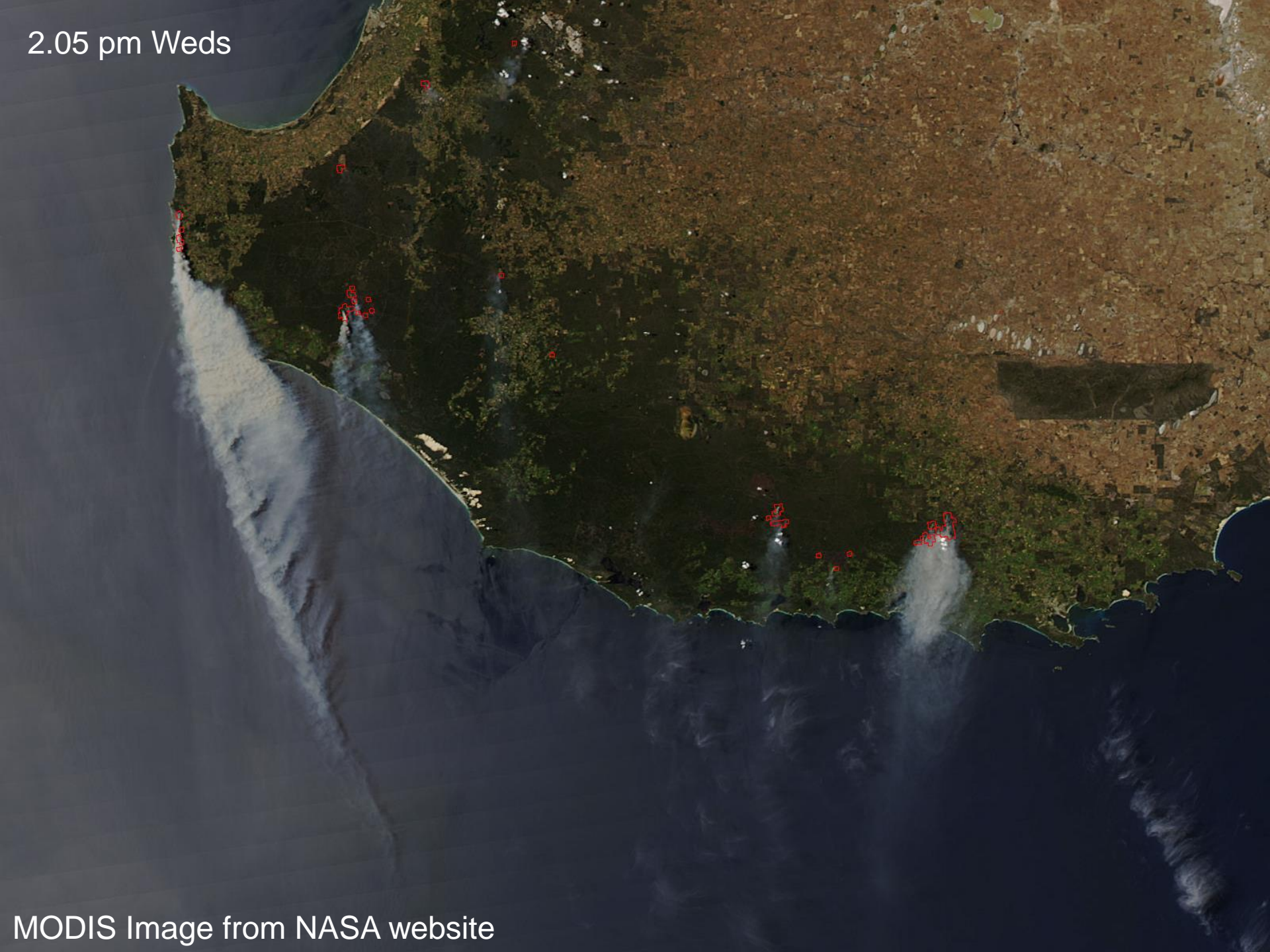
1 pm Weds, Kilcarnup Rd



Photo: John Harrison



2.05 pm Weds



MODIS Image from NASA website

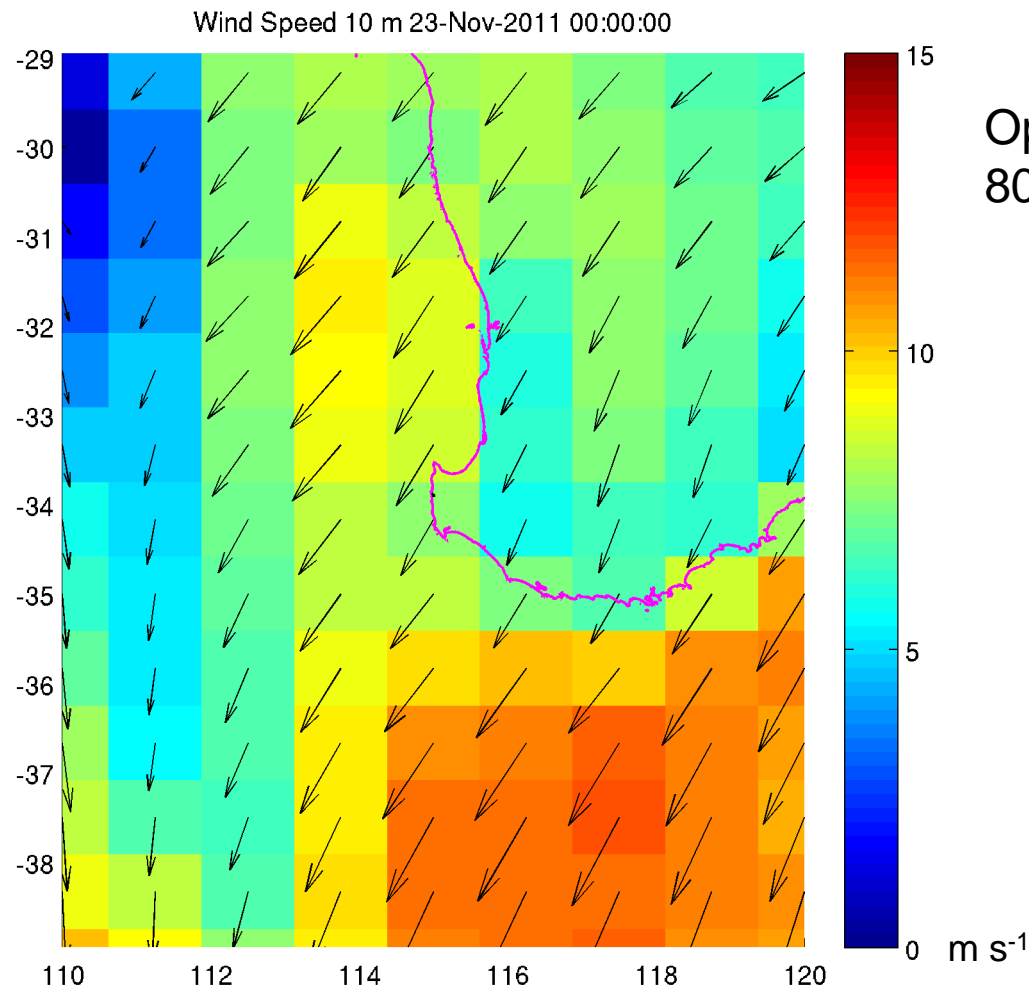


# Model and Configuration



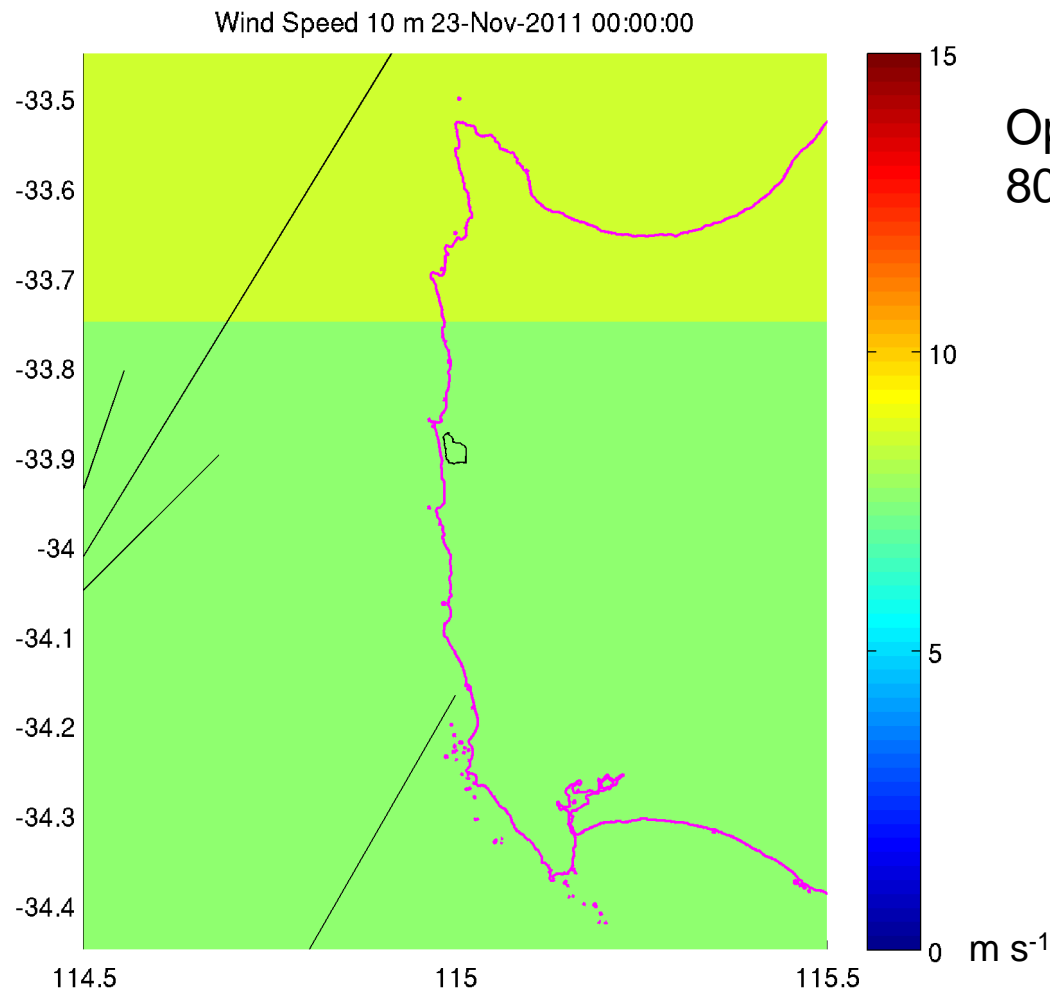
- **ACCESS Model and Assimilation**
  - Operational NWP system for Bureau of Meteorology since Sept 2009
  - Developed by UK MetOffice
  - Currently in the top 4 or 5 internationally for forecast performance
- **Simulation started from Bureau operational global analysis, 00UTC Nov 22.**
- **Five nested simulations**
  - Global, ~40 km grid
  - Australian region + surrounding oceans, ~11 km grid
  - SW WA, ~3.6 km grid, ~800 km square
  - SW WA, ~1.2 km grid, ~500 km square
  - SW WA, ~400 m grid, ~300 km square
- **50 levels, 10 in lowest 2 km of atmosphere**

# Drilling down to higher resolution ...

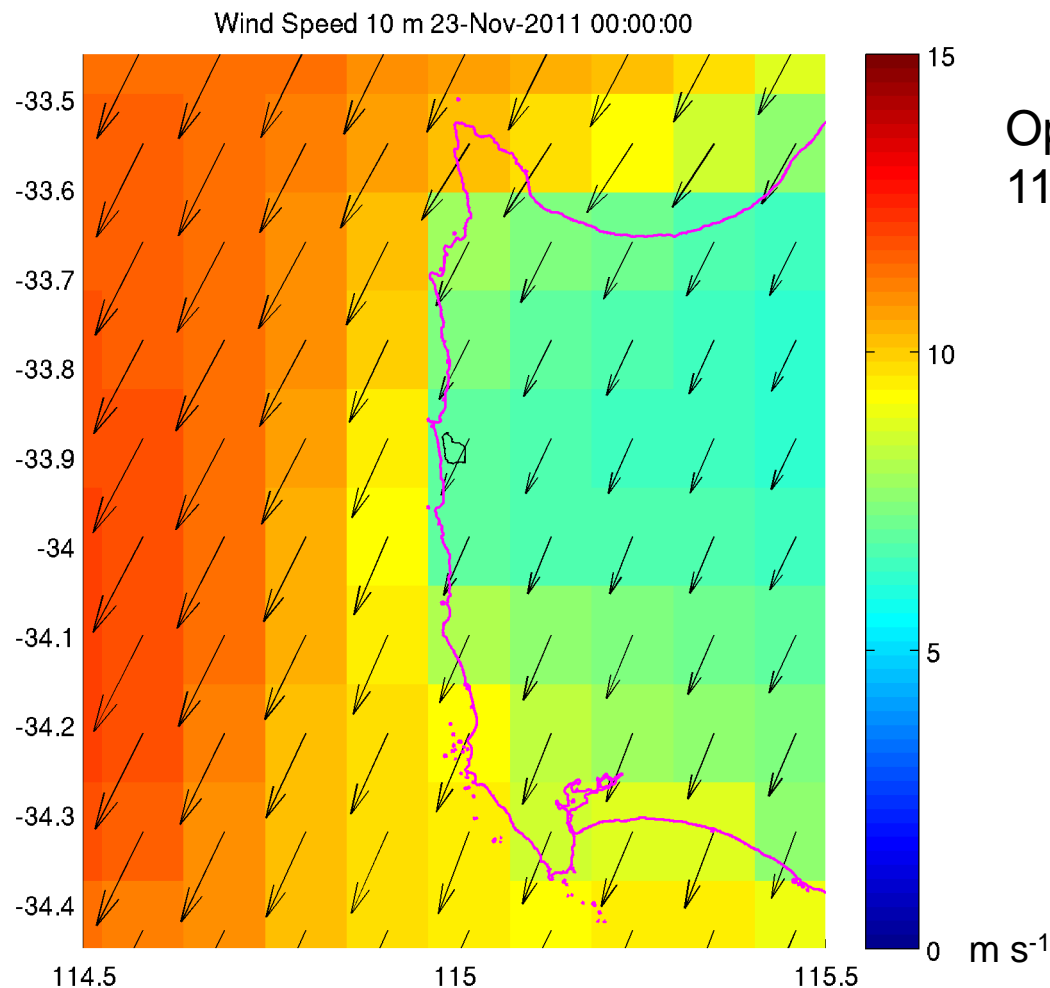


Operational ACCESS-Global  
80-km resolution

# Drilling down to higher resolution ...



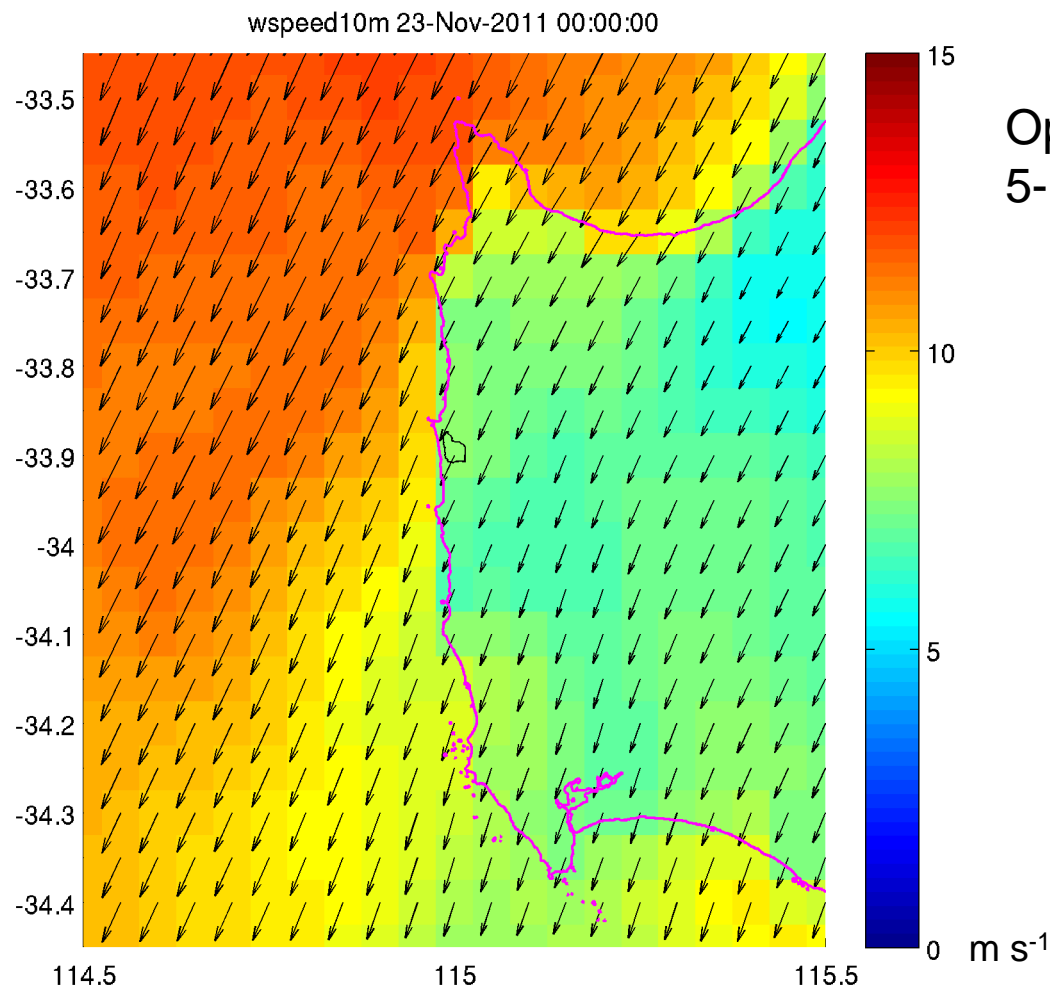
# Drilling down to higher resolution ...



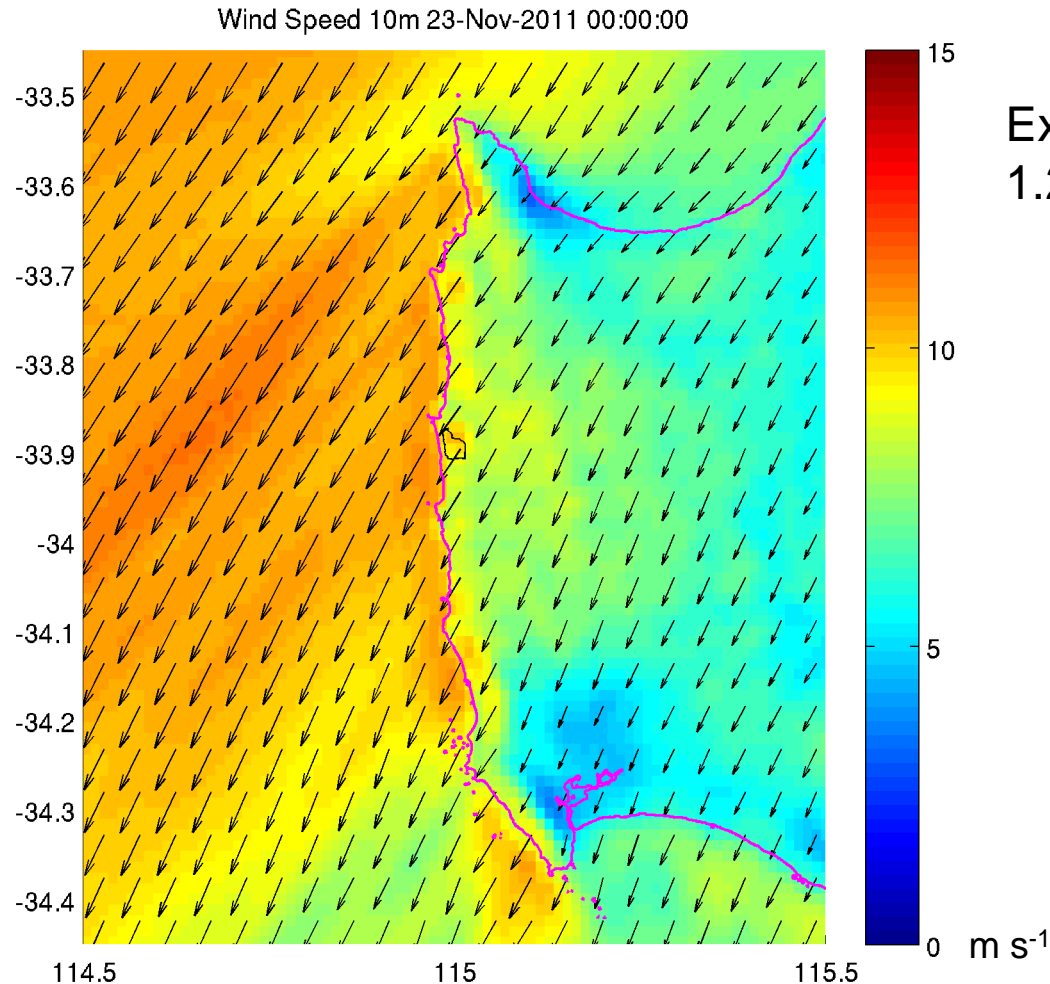
Operational ACCESS-Australia  
11-km resolution



# Drilling down to higher resolution ...

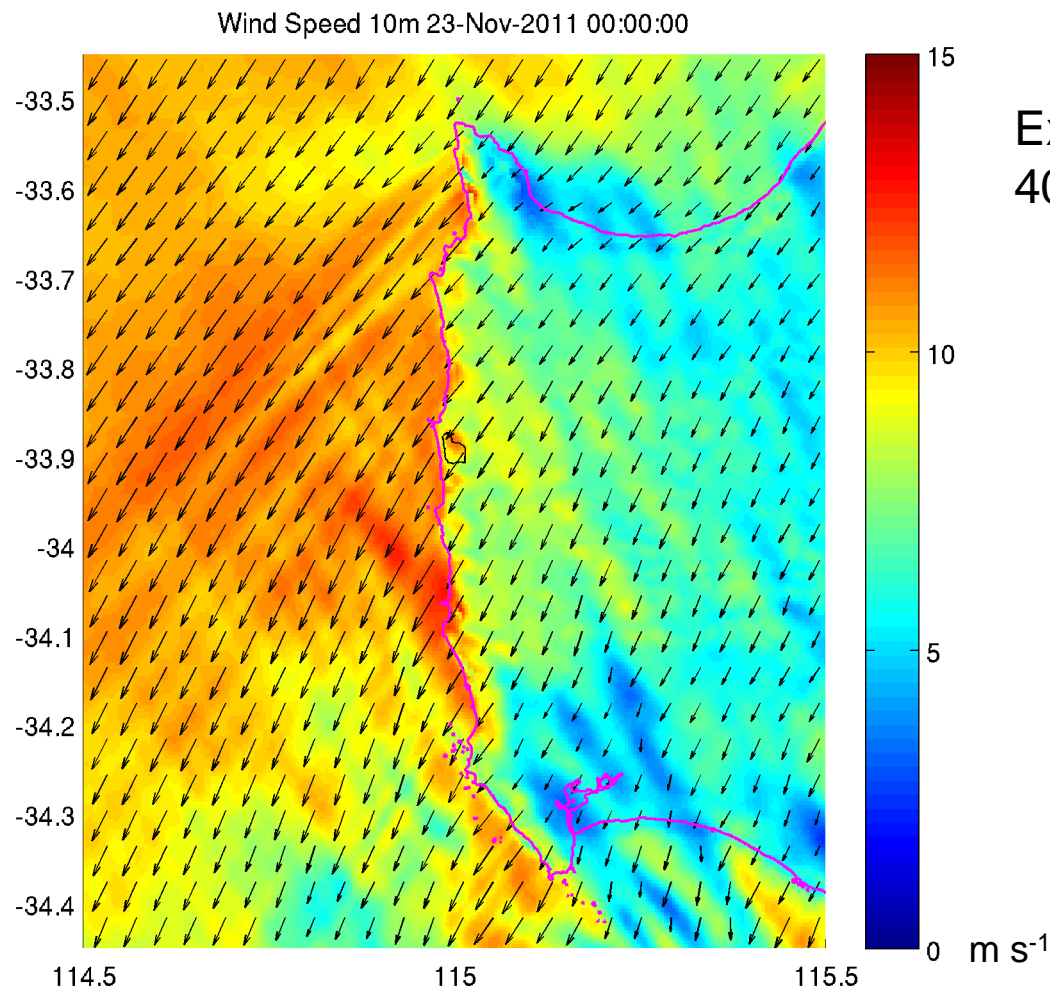


# Drilling down to higher resolution ...



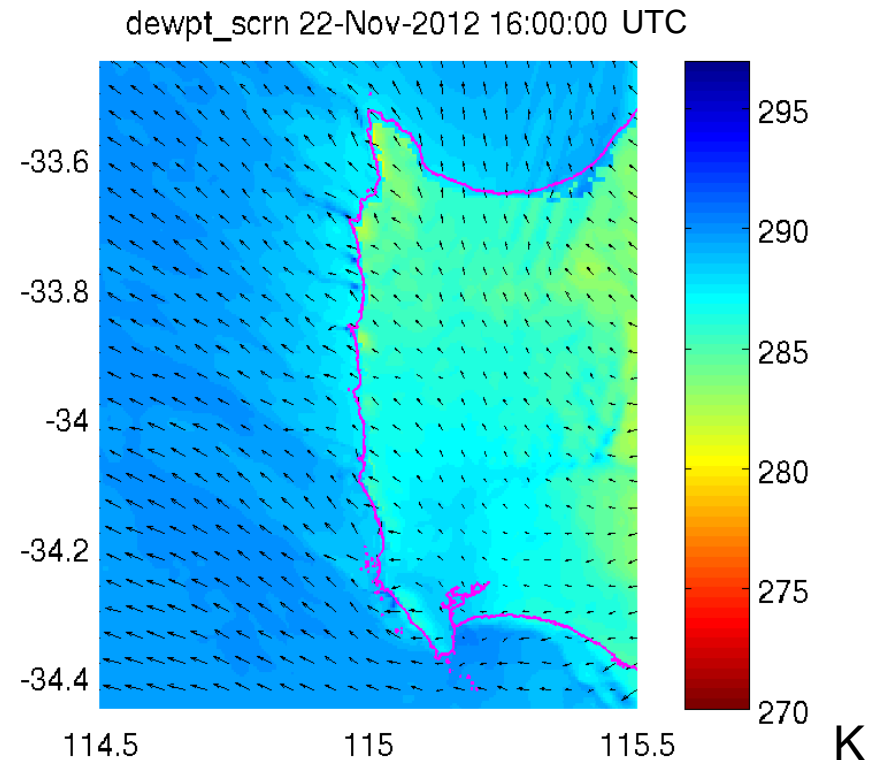
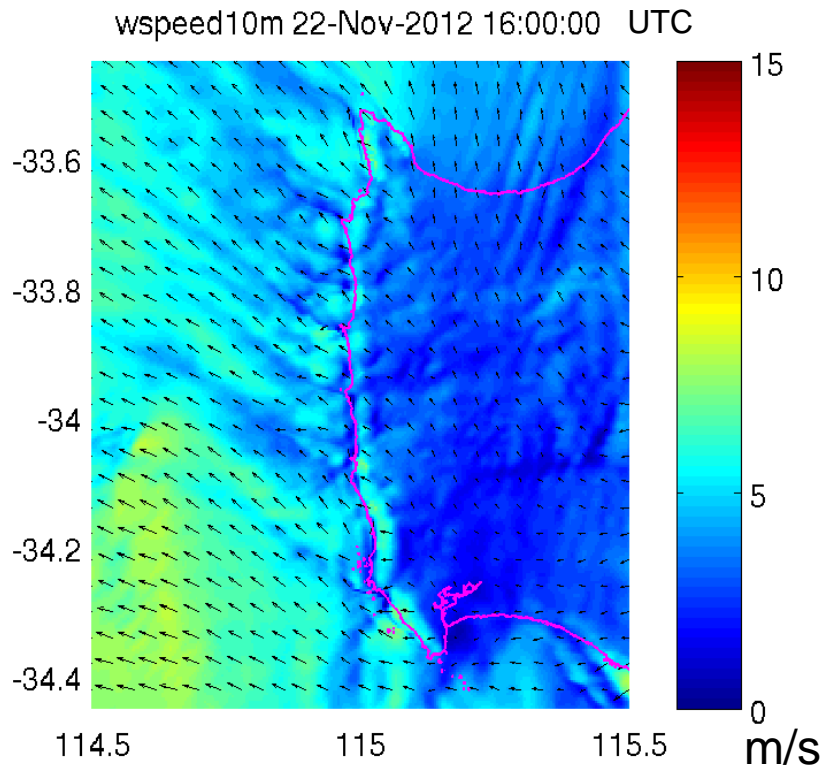
Experimental ACCESS-research  
1.2-km resolution

# Drilling down to higher resolution ...



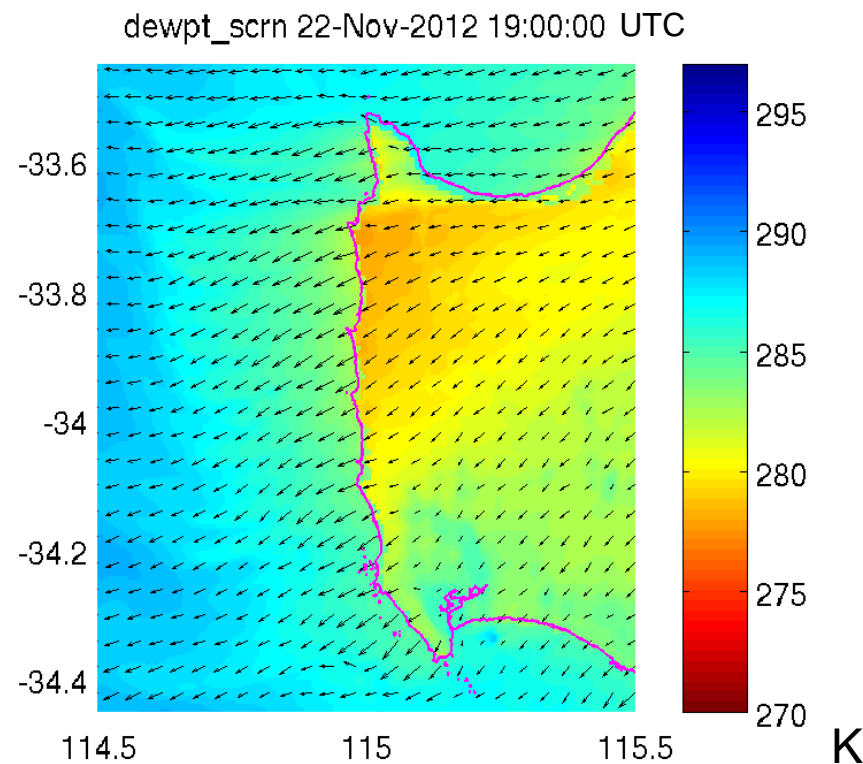
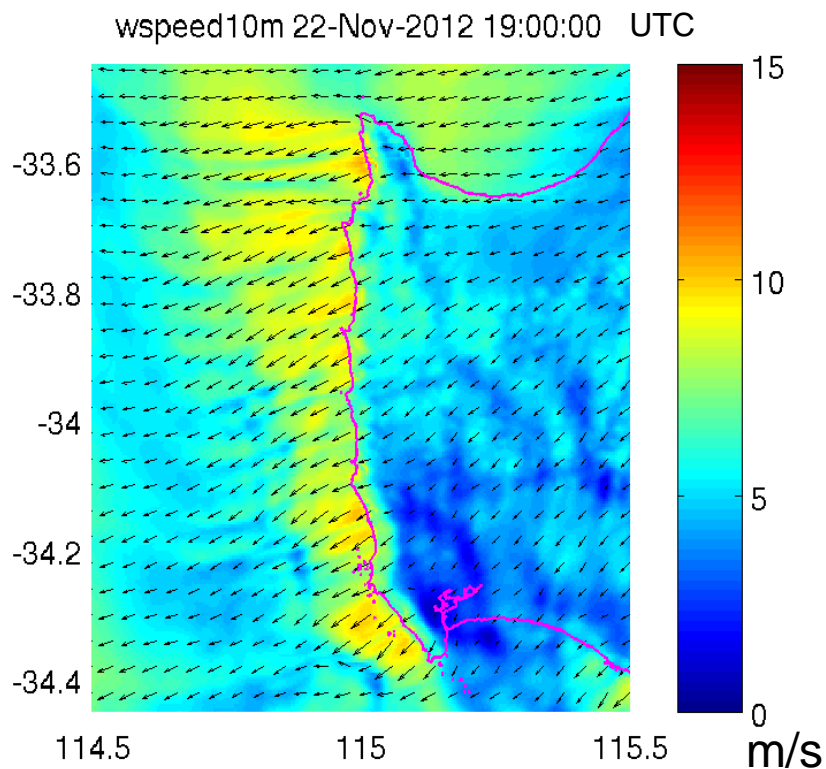
Experimental ACCESS-research  
400-m resolution

# Wind speed and dewpoint, midnight





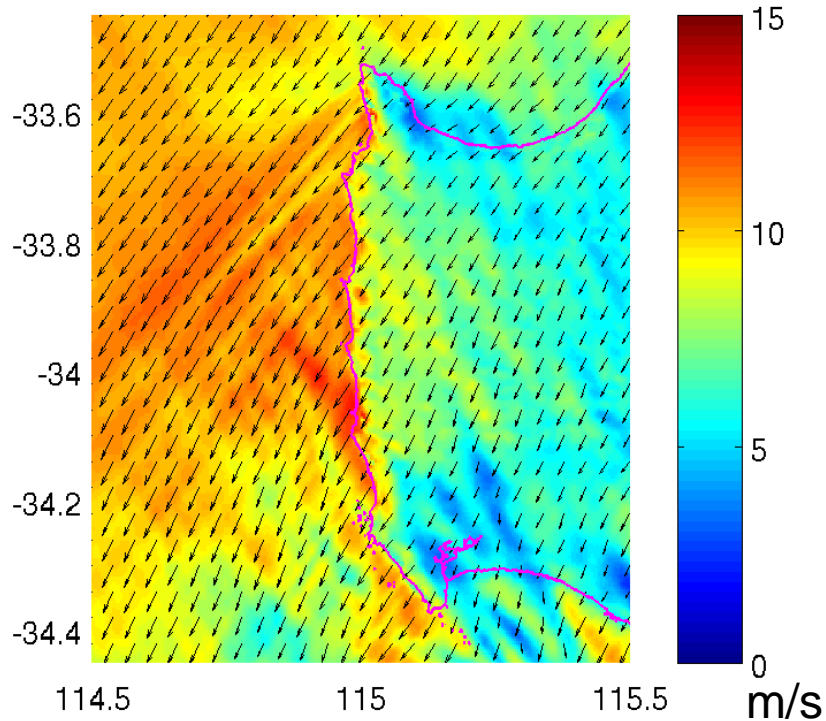
# Wind speed and dewpoint, 3 am



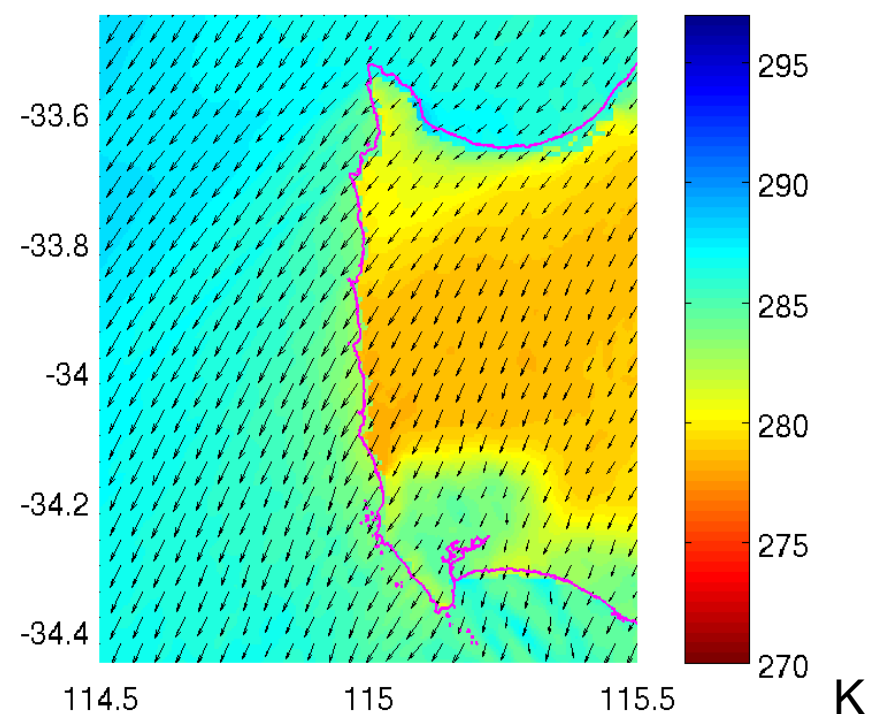
# Wind speed and dewpoint, 8 am



wspeed10m 23-Nov-2012 00 UTC



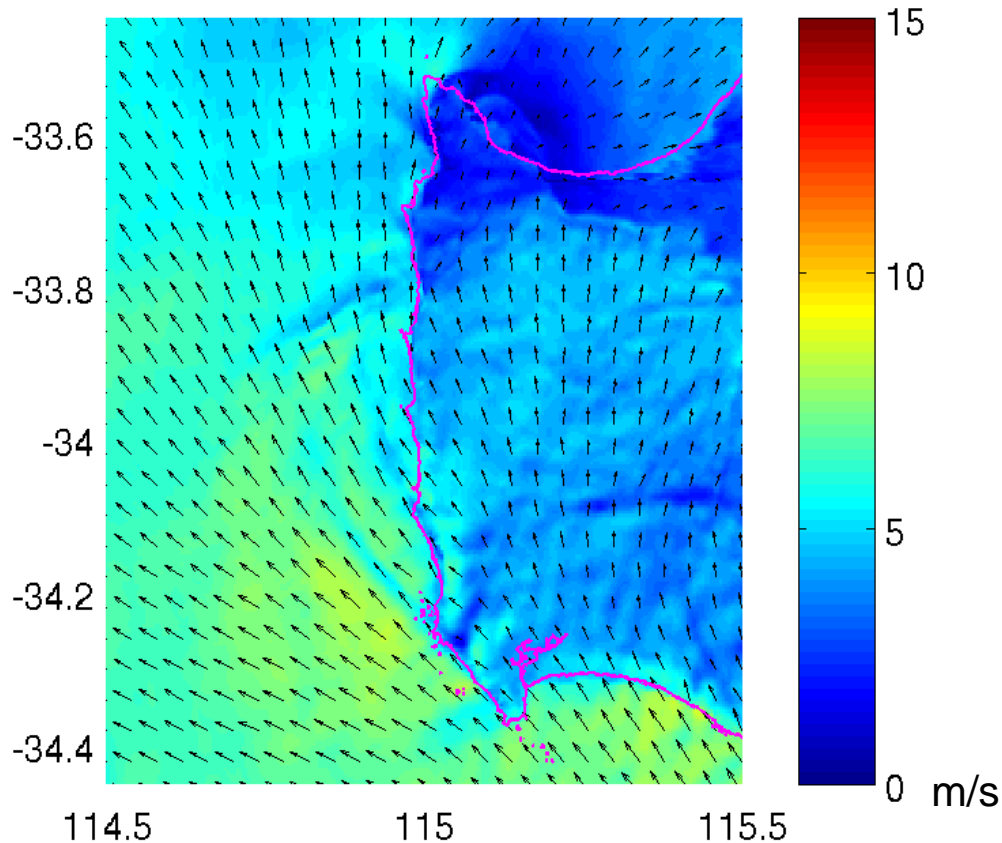
dewpt\_scrn 23-Nov-2012 00 UTC



# Surface wind speed (shade, m/s) + vector



wspeed10m 22-Nov-2012 10:00:00 UTC



- 6 pm LST Tues to 6 pm Weds

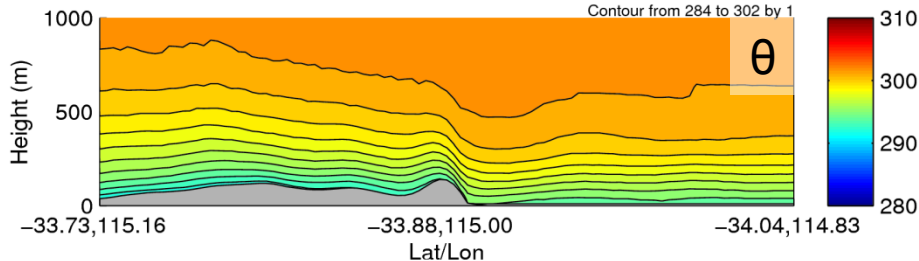
# Cross-sections



(b) 4 am

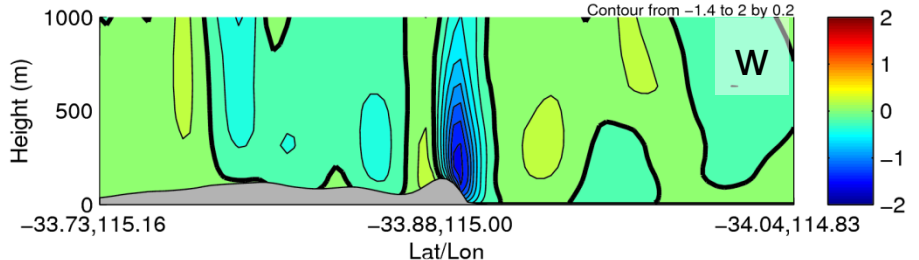
xsec  $\theta$  22-Nov-2011 20:00:00

Contour from 284 to 302 by 1



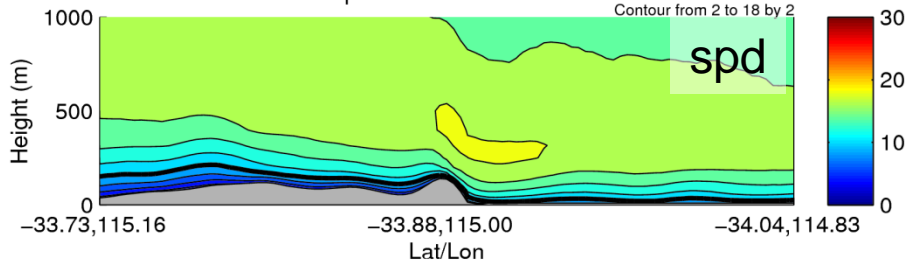
xsec w 22-Nov-2011 20:00:00

Contour from -1.4 to 2 by 0.2



xsec spd 22-Nov-2011 20:00:00

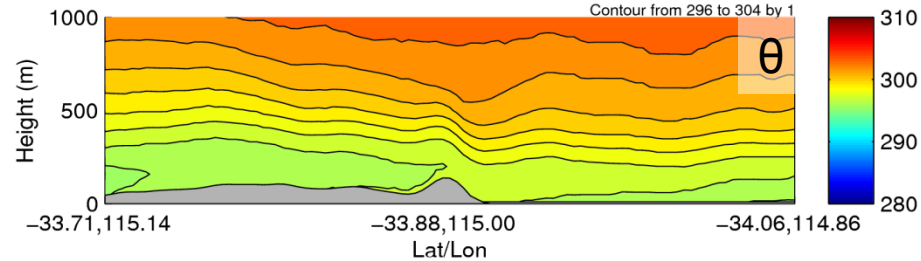
Contour from 2 to 18 by 2



(c) 8 am

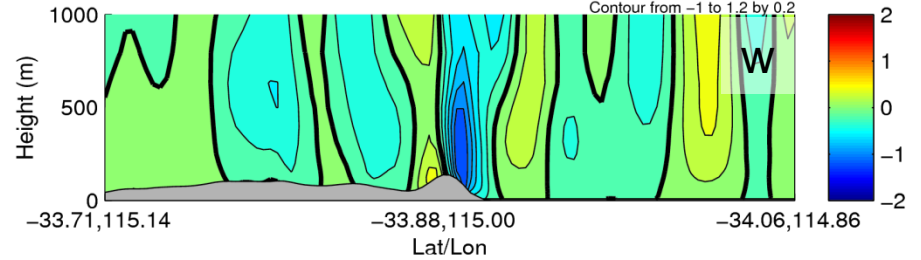
xsec  $\theta$  23-Nov-2011 00:00:00

Contour from 296 to 304 by 1



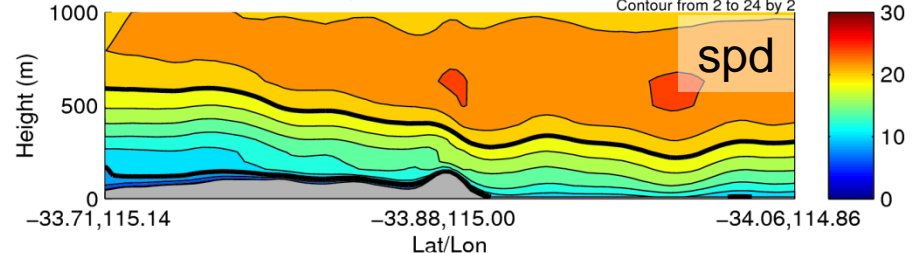
xsec w 23-Nov-2011 00:00:00

Contour from -1 to 1.2 by 0.2



xsec spd 23-Nov-2011 00:00:00

Contour from 2 to 24 by 2

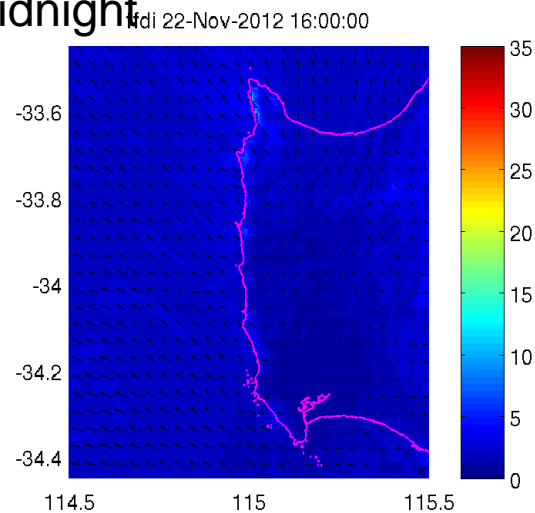




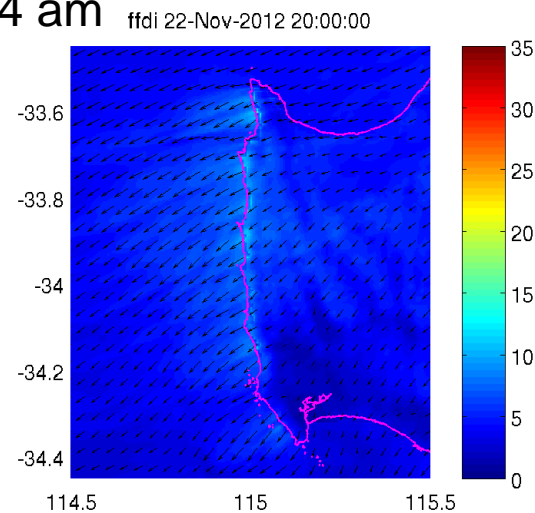
# FFDI



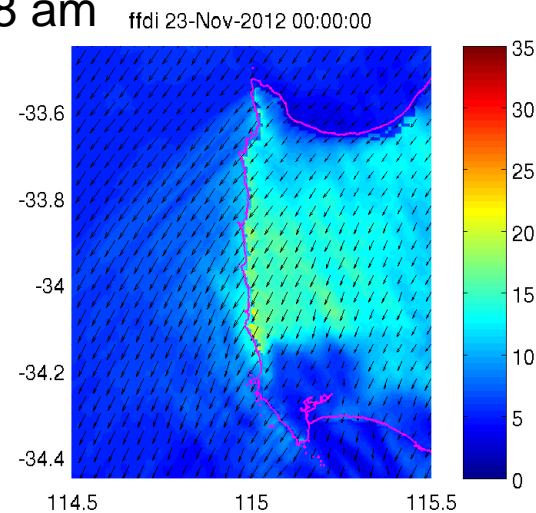
midnight



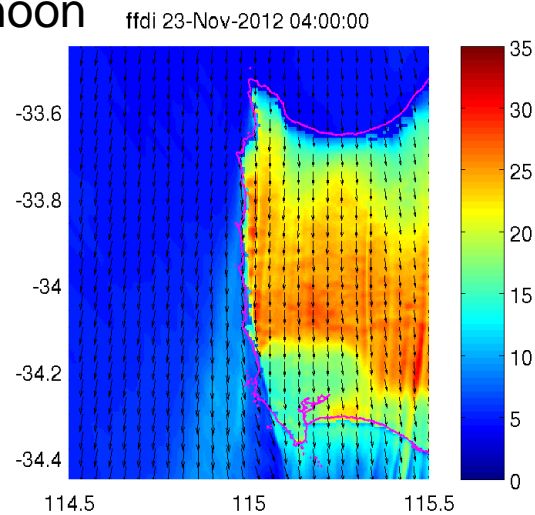
4 am



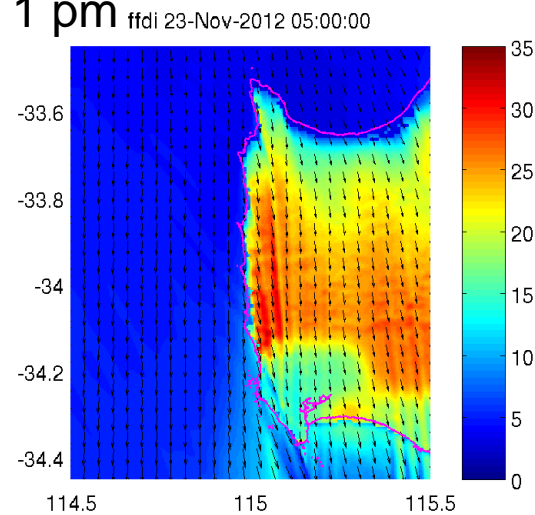
8 am



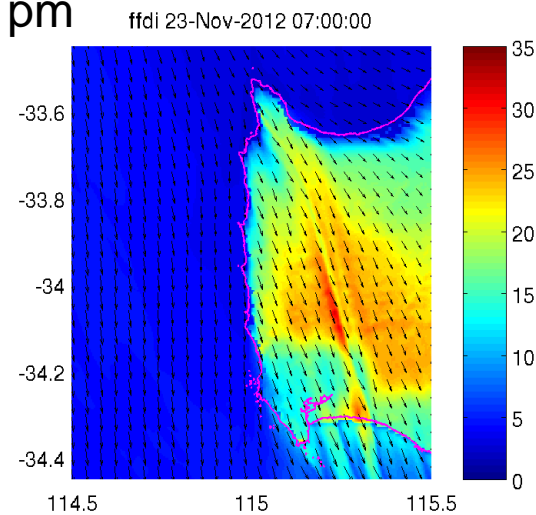
noon



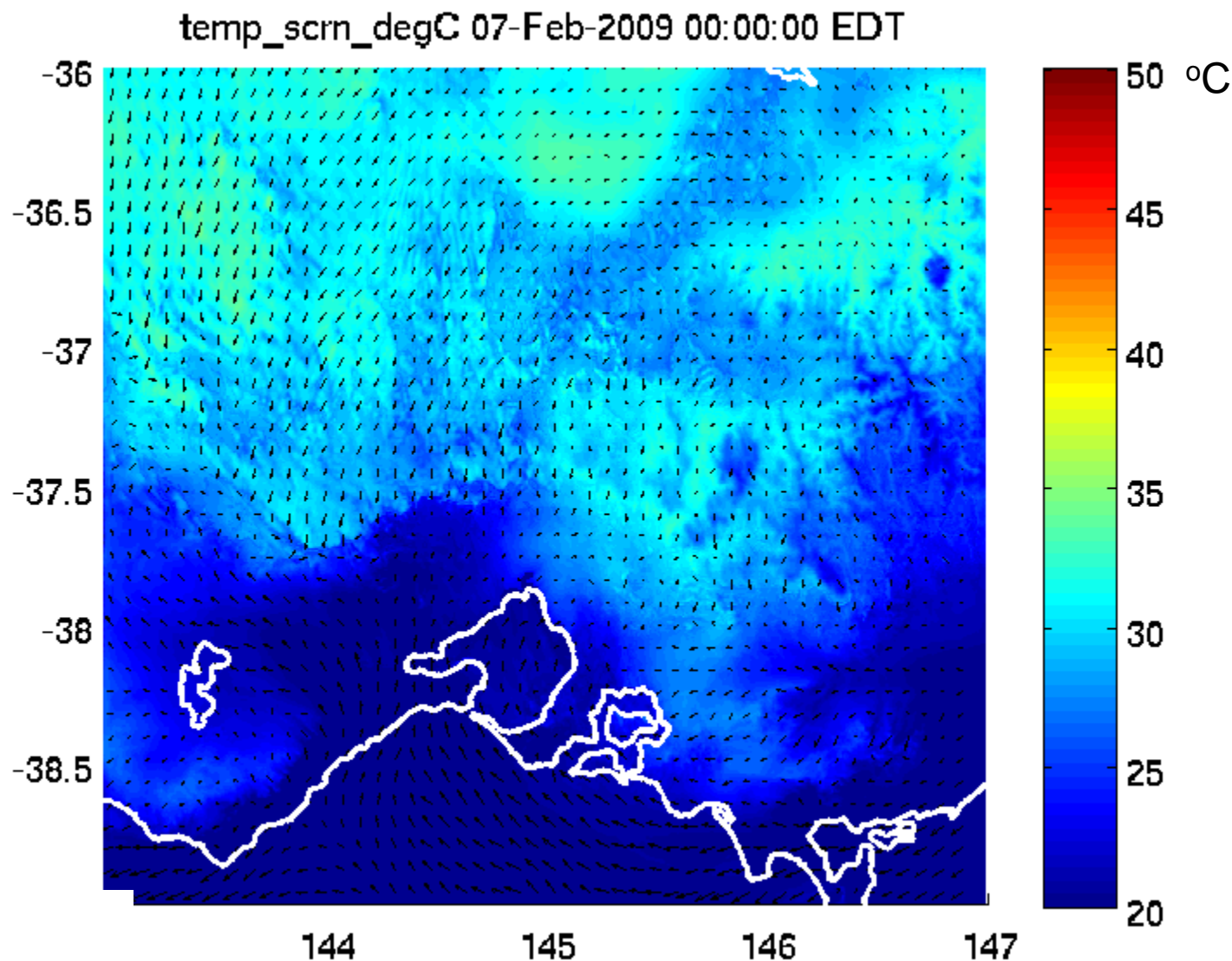
1 pm



3 pm



# Black Saturday: surface air T and wind

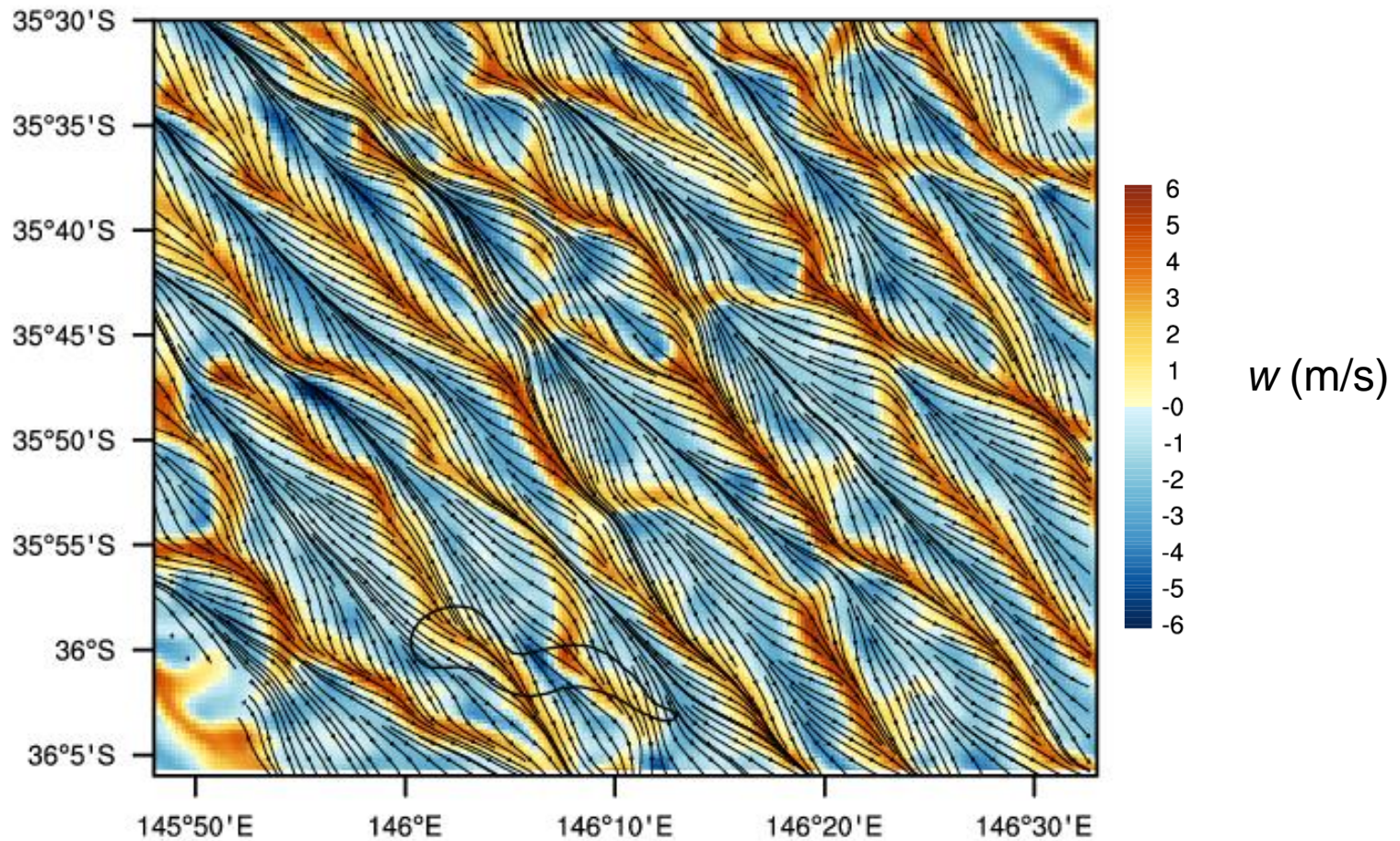


# Vertical velocity and surface streamlines



2009-02-07 03:00 UTC - 980 m AGL

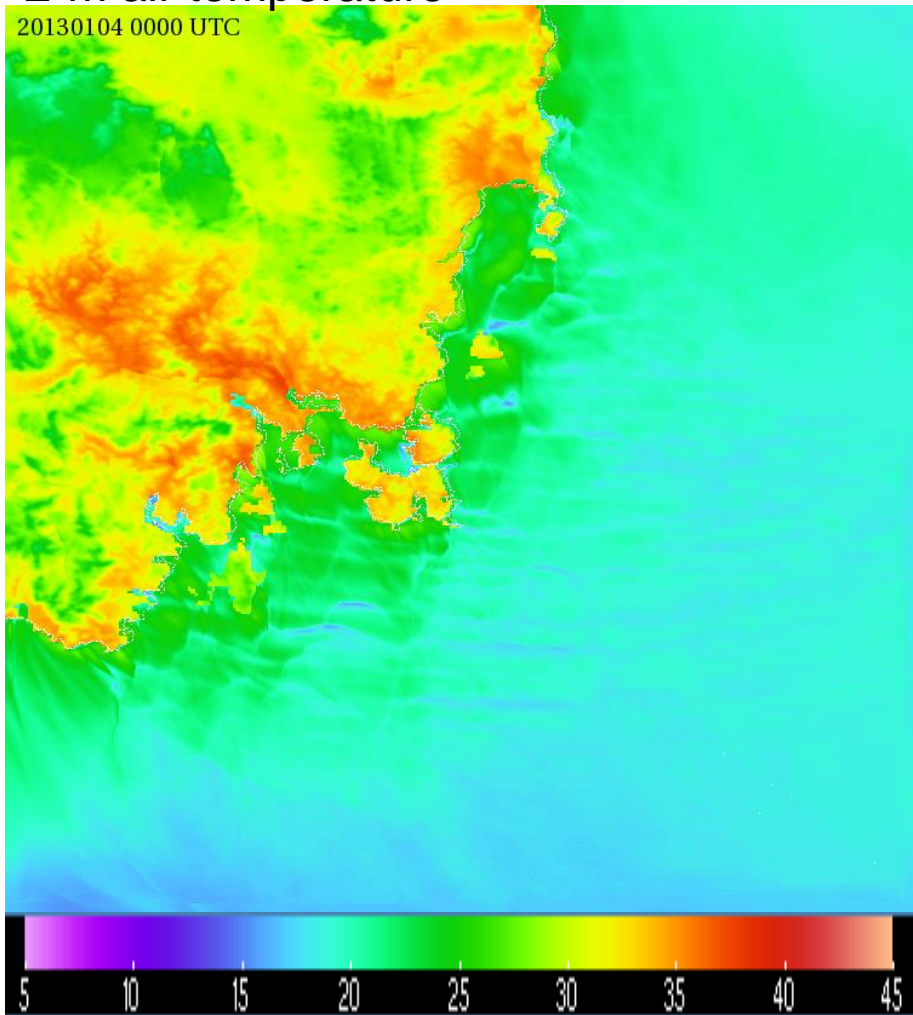
14:00 EDT



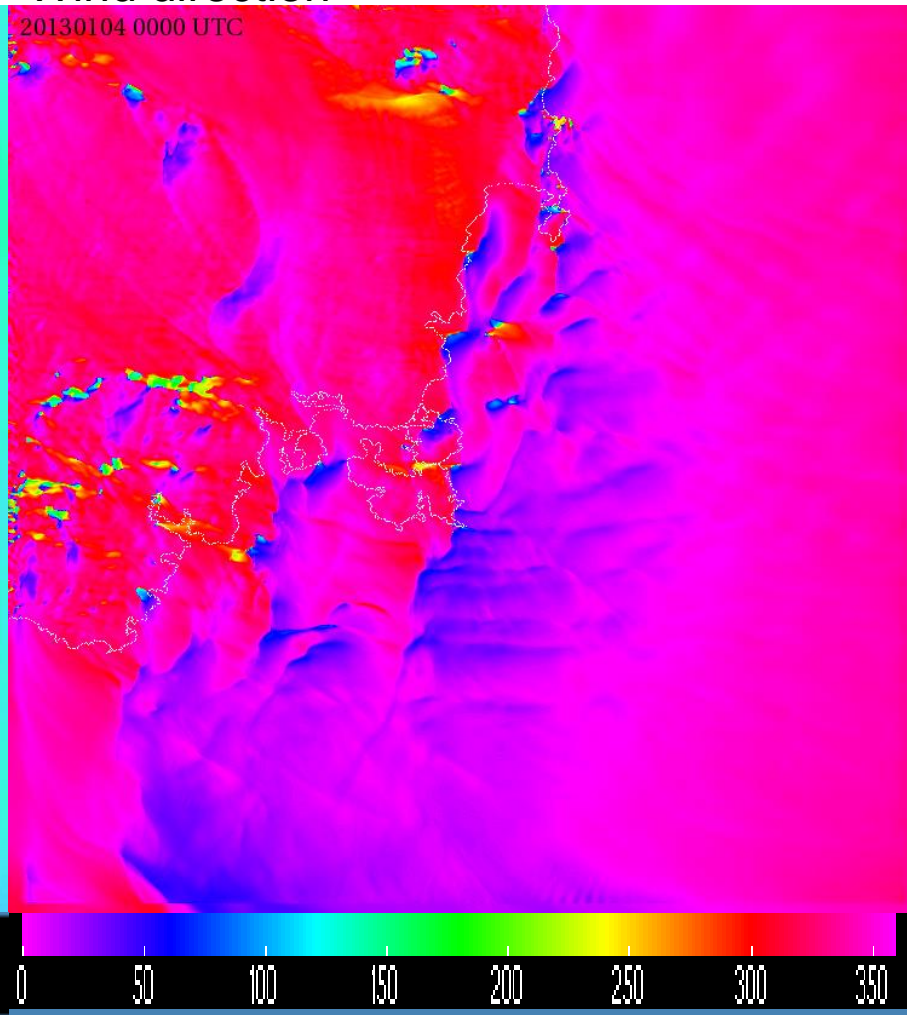


# Dunalley (400-m simulation)

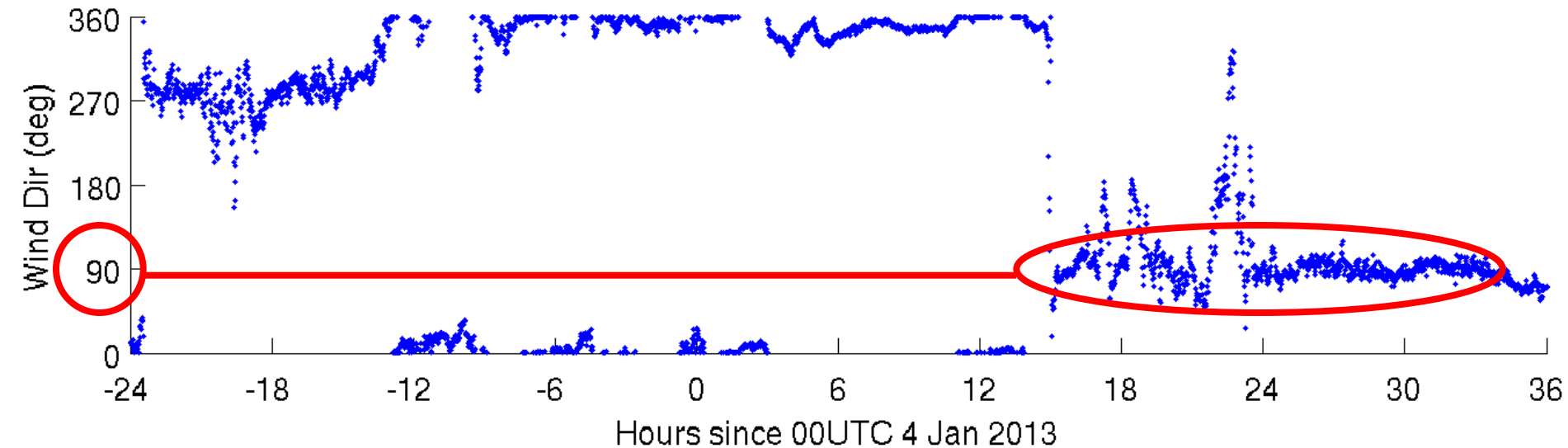
## 2-m air temperature



## Wind direction



# Maria Island: Observed Wind Direction





# Cases simulated so far



- 2013
  - Dunalley fire
  - Coonabarabran fire
  - Yarrawonga tornado
  - Dereel fire / Swanston St wind storm
- 2011
  - Margaret River fire
- 2009
  - Black Saturday
  - Sydney dust storm
- 2005
  - Eyre Peninsula fire (see Robert Fawcett's talk)
- 2007
  - Boorabbin fire
- 2003
  - Canberra fire
- 2001
  - Blue Mountains fire
- 1983
  - Melbourne dust storm

# The future?



- Higher-resolution operational
- Severe-weather ACCESS
  - Run-on-demand
  - Put the resolution where the weather is
- SWAT (Severe weather analysis team)
  - Post-event analysis (e.g. see Robert Fawcett's talk)
  - Lessons learned
- Coupled fire-atmosphere modelling
  - See Mika Peace's talk
- Ensembles and probabilistic prediction
  - Because we have to manage uncertainty

# Summary

- Margaret River: Escape due to combination of synoptic-scale and very small-scale meteorology
  - Overnight drying
  - Downslope winds
  - Low level jet
  - Very local effect
- Hi-res modelling great tool for understanding extreme events
  - Supports our need to “learn lessons”
- Part of FIRE-DST project
  - Input to Phoenix
  - Input to impact modelling

