DOC 17

[redacted]

From: [redacted]
Sent: Sunday, 14 March 2010 8:03 PM
To: [redacted]
Cc:
Subject: Intensification of the 6 March southern Vic MCS (Part 1) [SEC=UNCLASSIFIED]
Attachments: intensity1.ppt

Hi all,

I'd like to add to previous comments re the intensification/high intensity phase of the 6 March event.

Depending on one's reference point, feedback from [redacted] and [redacted] has indicated that the main intensification occurred within the Bacchus Marsh to CBD region (i.e. ~0240-0340Z). Largest hail was observed in outer eastern suburbs near 0430Z, but the MCS remained intense beyond 0600Z, as it moved through the Latrobe Valley. There were a number of key factors that appeared to have regulated the intensification phase:

(1) As previously described by [redacted] these included the interaction of the MCS with the sea breeze front, (related) increase in low-level wind shear, and subsequent development of increased aberrant storm motion relative to the steering flow;

(2) As per slides 1-2 (and accompanying notes) in the attached PowerPoint, significantly higher CAPE values (due to warmer and moister surface air) were very likely realised as the supercell moved through the outer eastern suburbs;

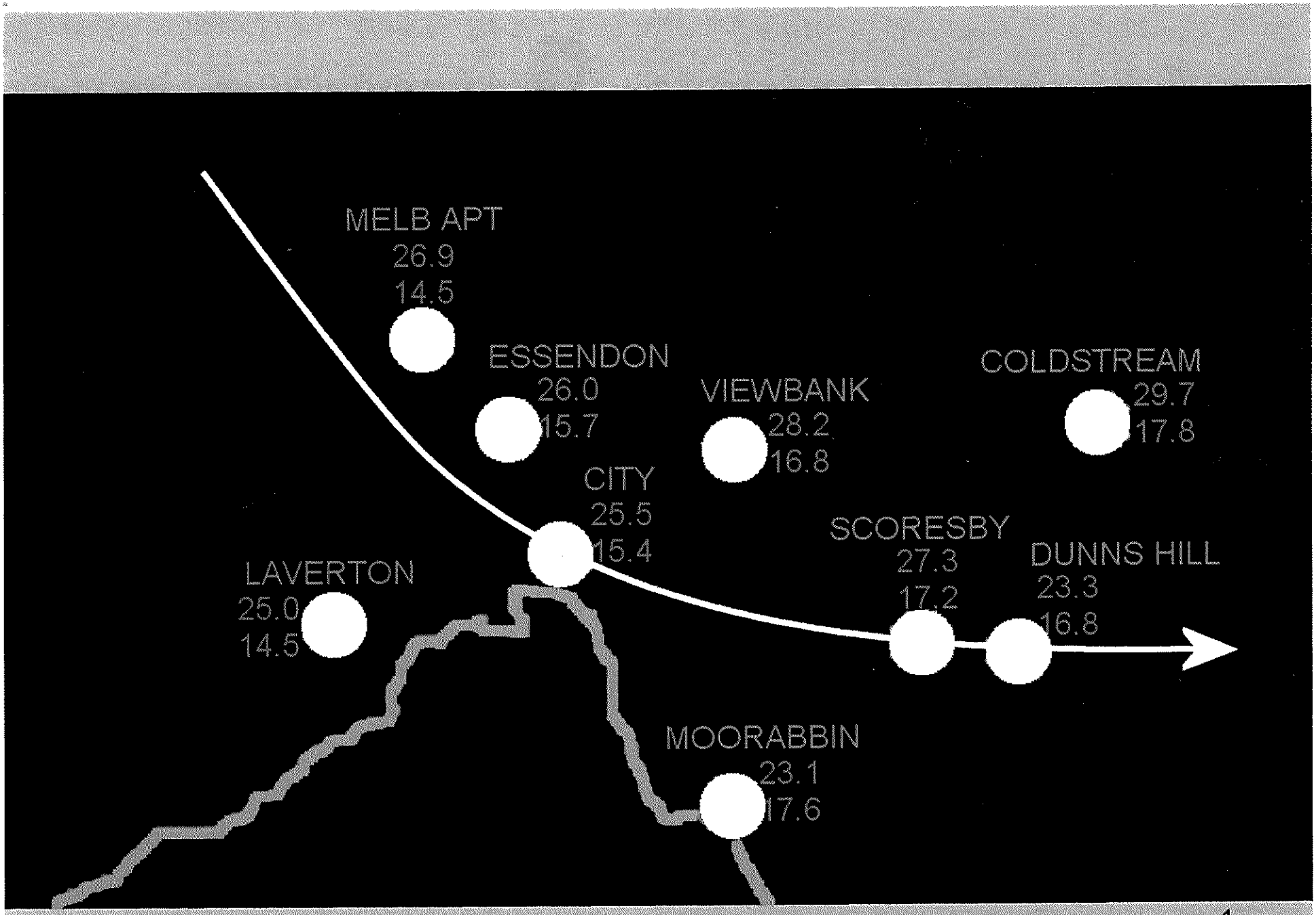
(3) Before addressing the final issue, a digression. Australian severe thunderstorm studies have traditionally focused on thermodynamics (e,g, CAPE, CIN), kinematics (e.g. wind shear, helicity, storm (relative) flow), and boundary layer dynamics/forcing (i.e. convergence at boundaries). Dynamical processes occurring in the upper-troposphere have typically been viewed as no more than a "side show" to the main game, and assumed to only act on synoptic time and space scales. In an email exchange last year with a senior scientist at the NWS Storm Prediction Center, he referred to research that does, in fact, demonstrate that upper jet dynamics can act on the meso/storm scale, and opined that occasionally convection is significantly more intense than would be expected when it occurs within regions presumed to be just associated with "large-scale" forcing.

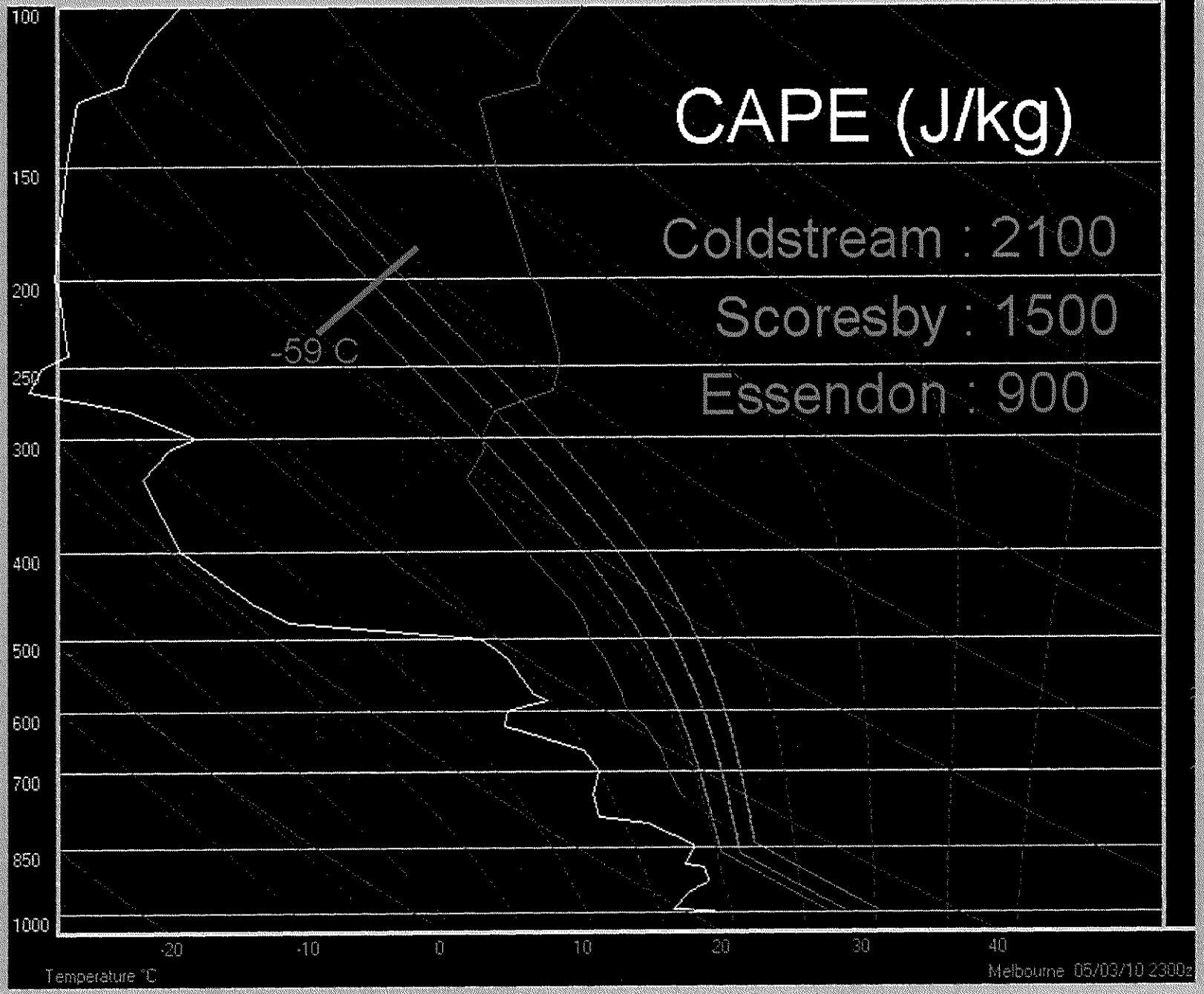
Although somewhat speculative (particularly due to data and NWP resolution/diagnostics limitations), a previous analysis of "The 16/11/08 Gap Storm" pointed to the likelihood that favourable (mesoscale) upper-level phasing contributed to the exceptional intensity of this event. It was argued that a (mesoscale) "jetlet" produced by the previous day's intense upstream convection subsequently propagated over the incipient East Coast convective development, resulting in enhanced lifting via upper divergence, and/or enhanced storm-top outflow from inertial instability (anticyclonic absolute vorticity).

Additionally, and of particular relevance to the 6/3/10 event, it appears that the combination of intense (convective) upwards motion and moderate vertical wind shear beneath the jetlet generated a strong cyclonic/anticyclonic absolute vorticity (CAV/AAV) couplet over SEQ (see slide 3 + notes) via the tilting term in the vorticity equation. This disruption of the ambient airflow would have, in turn, resulted in complex feedback processes in the subsequent evolution of the convective system. Finally re The Gap Storm, it is important to state that the GFS Model predicted this strong SEQ couplet signal (suggestive of intense convection) as much as 24hr prior to the event.

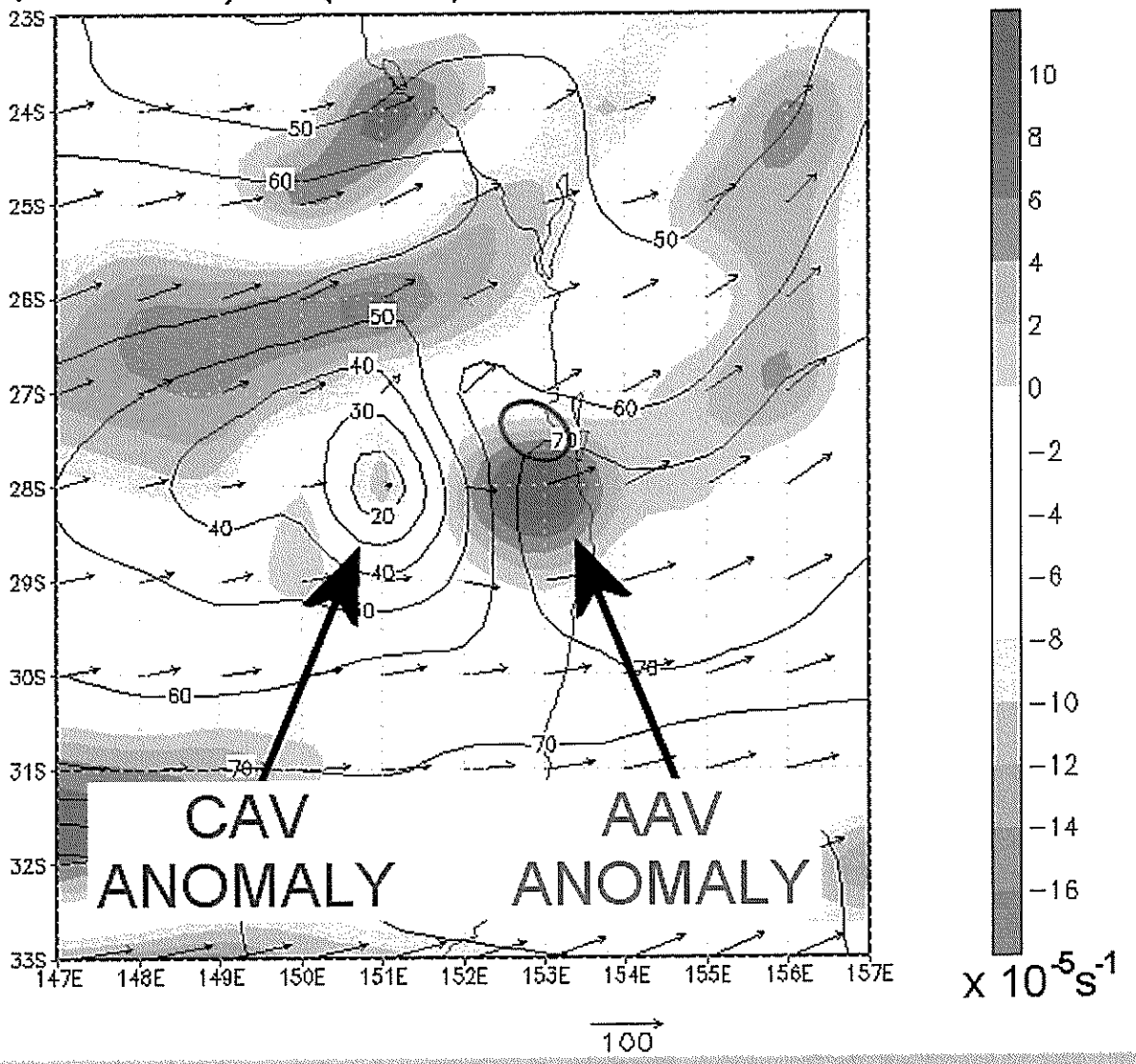
[redacted]

Doc 17A


MELB APT
26.9
14.5
ESSENDON
26.0
15.7
VIEWBANK
28.2
16.8
COLDSTREAM
29.7
17.8
CITY
25.5
15.4
SCORESBY
27.3
17.2
DUNNS HILL
23.3
16.8
LAVERTON
25.0
14.5
MOORABBIN
23.1
17.6


CAPE (J/kg)
Coldstream : 2100
Scoresby : 1500
Essendon : 900
-59 C
100
150
200
250
300
400
500
600
700
850
1000
-20
-10
0
10
20
30
40
Temperature °C
Melbourne 05/03/10 2300z

250 hPa ABSV, winds B/W (knots) at 06Z Sun 16nov2008



DOC 18

[redacted]

From: [redacted]
Sent: Saturday, 6 March 2010 2:52 PM
To: [redacted]
Subject: RE: [synoptic_discussion] Sat 6 March 2010: VIC/NSW [SEC=UNCLASSIFIED]

Me again -

The capping inversion around 800 hPa in the 23z soundings, probably connected to subsidence on the wrong side of the jet, has kept initiation at bay in the better moisture to the east of C VIC and N from there. Instead, a linear convective mode developed out of the initially elevated storms this morning.

Around 2:15pm EDST, W of Melbourne airport I measured 2 cm hail, and guessed that winds almost reached the "damaging"
threshold. Most of the hail was 1 cm in diameter, and it accumulated in various corners beyond an inch in depth. It also stripped leaves of various trees.

[redacted]

From: [redacted] On Behalf Of [redacted]
Sent: Saturday, 6 March 2010 10:18 AM
To: [redacted]
Subject: FW: [synoptic_discussion] Sat 6 March 2010: VIC/NSW [SEC=UNCLASSIFIED]

------ Forwarded Message
From: [redacted]

"I expect the odd low-topped supercell today along convergence boundaries in the insolation-rich parts of the deep moist boundary layers. I shall wait for the 23z/5 soundings to ponder on the low-level rotation potential in some of these storms."

Cheers, [redacted]

While the rest of us go about our daily business of a Saturday, it gives one a feeling of comfort and security to know that [redacted]s busy pondering the 23z soundings to determine whether threshold sources of rotation will be present.

It is a little disturbing, however, to know that [redacted] will be out orienteering in central Victoria instead of following his true role of monitoring statistics and records.... Hopefully, he has a GPS-Iphone-thingy that alerts him out in the bush whenever a meteorological record falls.

I'll get out of your way

[redacted]

Doc 19

[redacted]

From: [redacted]

Sent: Tuesday, 9 March 2010 10:44 AM
To: [redacted]
Cc:
Subject: RE: [synoptic_discussion] Sat 6 March 2010: VIC/NSW [SEC=UNCLASSIFIED]
Attachments: melb_hail_06032010.ppt

Taking one of [redacted] screen grabs, I think we can see TBSSs(three body scatter signatures). See attached.
These are indicative of hail sizes comparable to the wavelength of the radar, which in Laverton's case is ~10cm.
I'm a believer!

Anyone got an idea of the WDSS hail size estimates?

Cheers

[redacted]

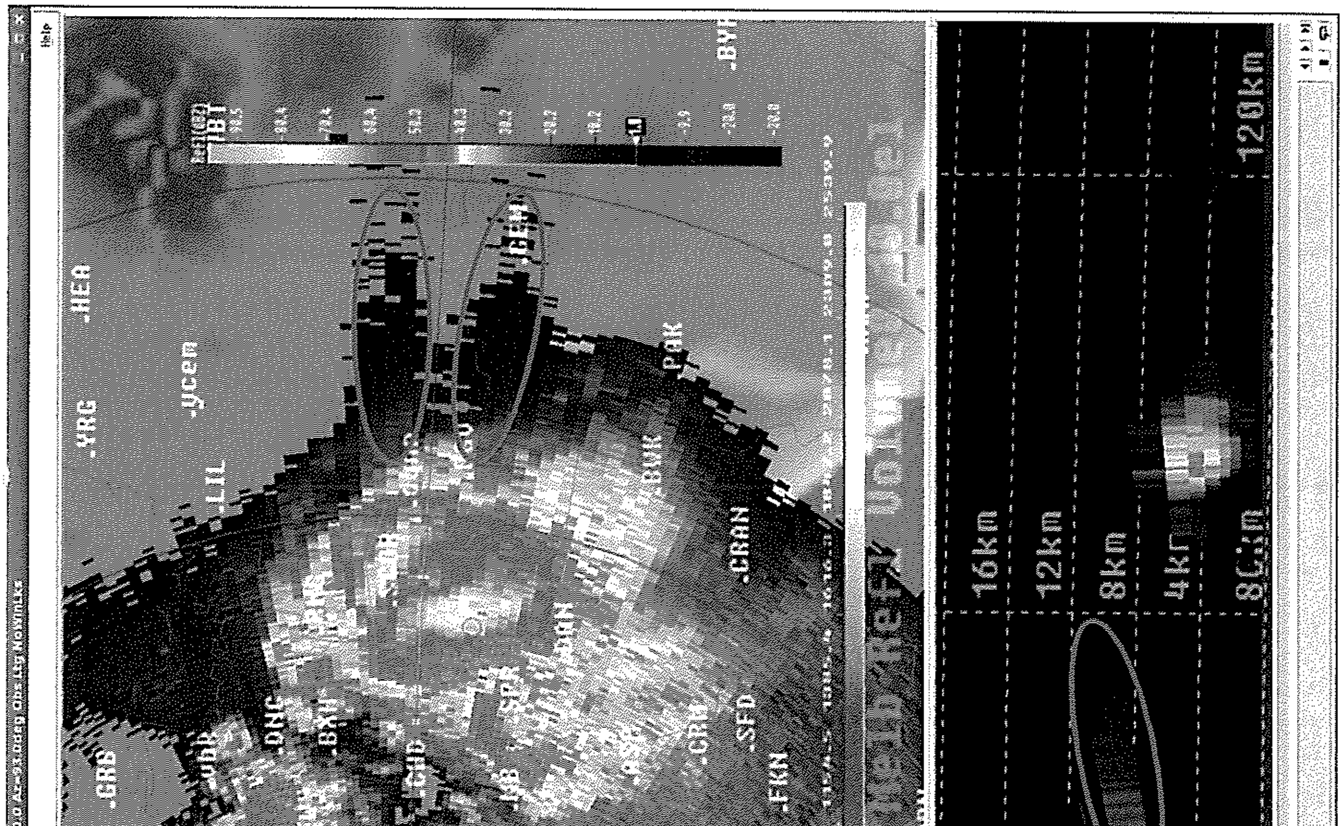
-----Original Message-----
From: [redacted]
Sent: Tuesday, 9 March 2010 8:46 AM
To: [redacted]
Cc: [redacted]
Subject: FW: [synoptic_discussion] Sat 6 March 2010: VIC/NSW [SEC=UNCLASSIFIED]

Grabbing some volumes off one of the nowcast server for a slice and dice.. A very quick inspection and the top return I found was a very impressive 73dBZ.
Attached are:
3dbzat16km: To give an idea of the echo tops.. 3dbz returns at 16km high... Now looking at the morning sounding the tropopause was at ~10km... That is an overshoot!
Bwer: Nice bounded weak echo region
Have to break it into two emails (3mb limit) so the rest of the images are in the next email...

Midlevel_meso: Rotation in the midlevels
appiatminus10: Constant altitude slice at a height the corresponds to -10 degrees, 5km.. To see 70dBZ here is pretty amazing.

Rest of email thread duplicated in Doc 23

DOC 19A



[redacted] DOC 20

From: [redacted]
Sent: Wednesday, 10 March 2010 9:37 AM
To: [redacted]
Cc:
Subject: RE: [synoptic_discussion] Sat 6 March 2010: VIC/NSW [SEC=UNCLASSIFIED]
Attachments: 10cm_hailreps.xls; sevts100306b.ppt

Hi all,

Spurred on by [redacted] recent musings on the significance or otherwise of the importance of upper-level forcing in Saturday's severe weather event, and given a forthcoming, scheduled Guidance Forum on the NTFGS, I'd like to make the following comments:

- Bureau records indicate that there have been 7 eastern Australian >=10cm diameter hail events since the NTFGS was tuned to warn for elevated severe convection - see event list in attached Excel file;
- In 6 cases, available upper-tropospheric NCEP Reanalysis and GFS diagnostics (see slides 1-10 of PowerPoint attachment) indicate coinciding cyclonic exit zones of strong jet streaks and/or strong CVA (just downstream of approaching, amplifying short wave troughs). One example of strong coincident CVA is shown in slide 4;
- In the remaining event, the nature of the upper-level forcing is more ambiguous (see slide 6), however it appears that this development occurred in the diffluent region between 2 diverging jet streaks. Such a pattern has featured in a number of eastern Australian severe thunderstorm events/outbreaks, including the Ferntree Gully storm (slides 9-10), and last Sunday's possibly tornadic/giant hail Shepparton supercell event (where the AWS recorded a gust of 84 kt, and available CIMSS output indicated a coinciding strong upper divergence signature);
- Allowing for an up to 1 degree lat/lon discrepancy between the location of these giant hail reports and Mesoviewer >=2cm hail-threat pixels, the immediate lead-in run of the NTFGS alerted for "favourable" ("very favourable") large hail in 6 (4) of the 7 events (see slides 11-17), including a very favourable threat for last Saturday's event on the 06Z time step;
- Deficient input MLAPS ingredients are obviously a potentially important contributor to deficient NTFGS guidance, and may, for example, help explain the poor NTFGS guidance for the March 2004 event (slide 12). I hope to present a recent, excellent example of some poor MLAPS input in a future email;
- However, it is clear that deficient NWP input is not the only factor that can result in deficient NTFGS output. For example, despite high quality MLAPS input, the 24 October 2004 NTFGS output placed the maximum large hail threat (due to a combination of forecast large CAPE, strong low to mid-level shear, and strong low-level convergent flow and associated strong low-level upwards omega) over far northeastern NSW (see slide 13). Convection was actually strongly suppressed in this region, apparently due to strong upper-level convergence and associated mid-level subsidence, in contrast to the highly favourable upper-level flow that accompanied the 12cm hail report (se slide 5). It needs to be emphasised that the utility of the NTFGS is not merely dependent upon its probability of detection, but also on its false alarm rate.

In summary, I think that last Saturday's event merely reinforces what was already overwhelming evidence that favourable upper-level meteorology (and not just favourable lower-level meteorology) is an essential ingredient of the most intense (eastern Australian) severe thunderstorm events. Furthermore, as previously stated, I believe that access to a range of high resolution upper-jet-related diagnostics is one of the essential requirements to progress in our understanding of, and ability to warn for severe weather developments of the type that impacted upon southeastern Australia last weekend.

Regards,

[redacted]

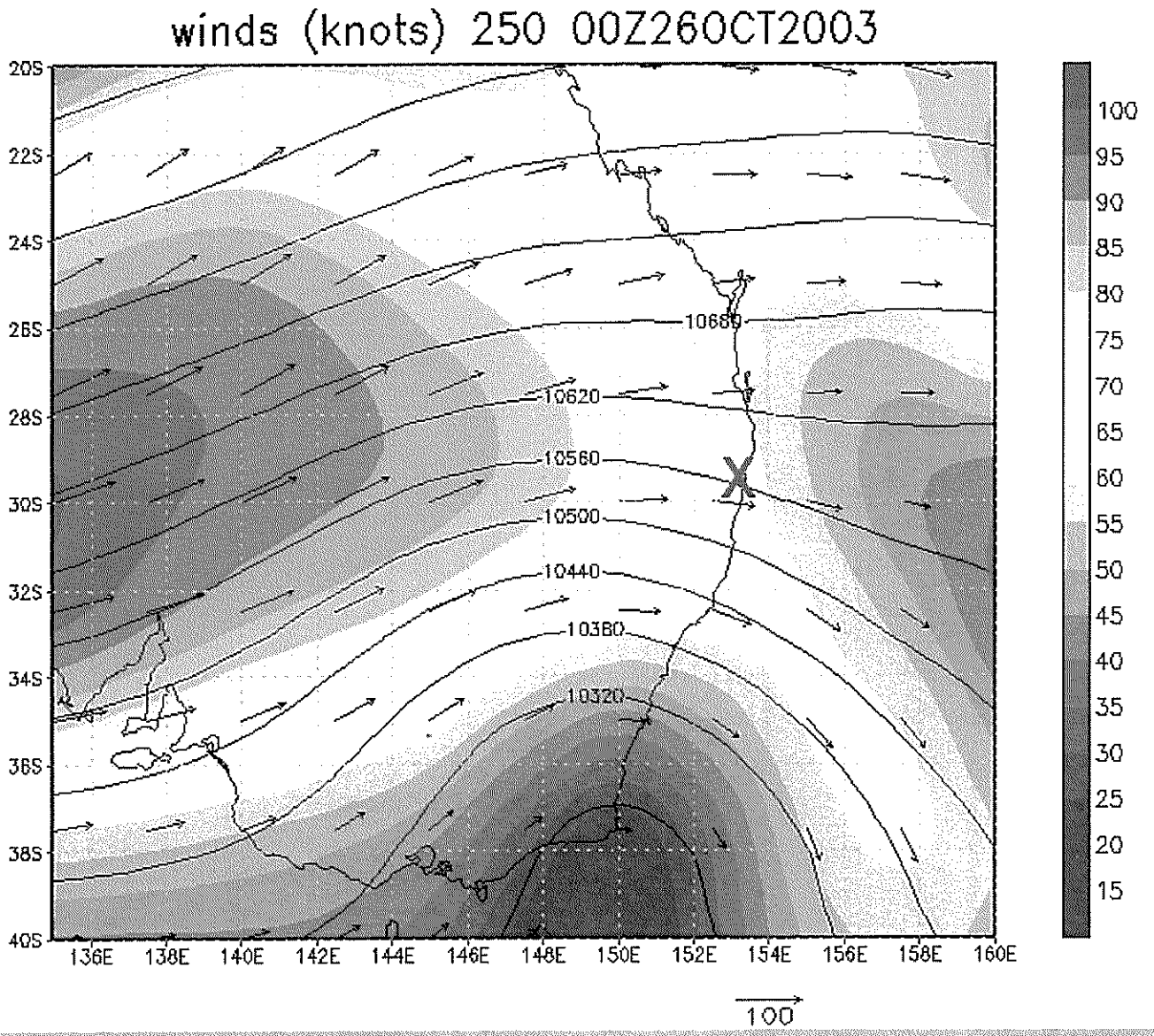
From: [redacted] On Behalf Of [redacted]
Sent: Saturday, March 06, 2010 10:00 AM
To: [redacted]
Subject: Re: [synoptic_discussion] Sat 6 March 2010: VIC/NSW [SEC=UNCLASSIFIED]

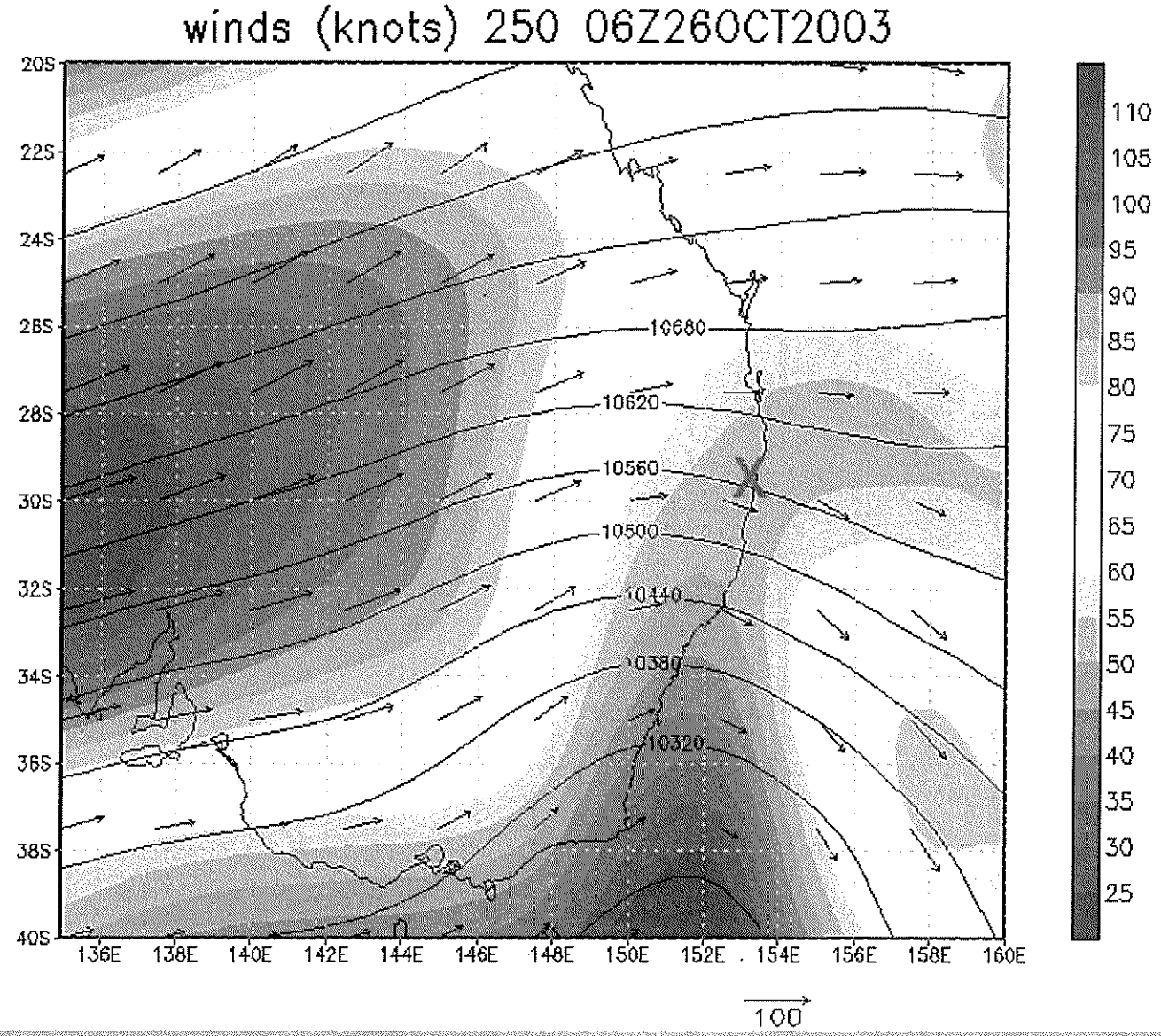
And, if you are a believer in the importance of upper-level support in the shape of an polar exit to a jet streak, today's events will depend very much on the movement of that jet streak across the state, as per the attached sequence of ACCESS-Global 200 hPa progs

[redacted]

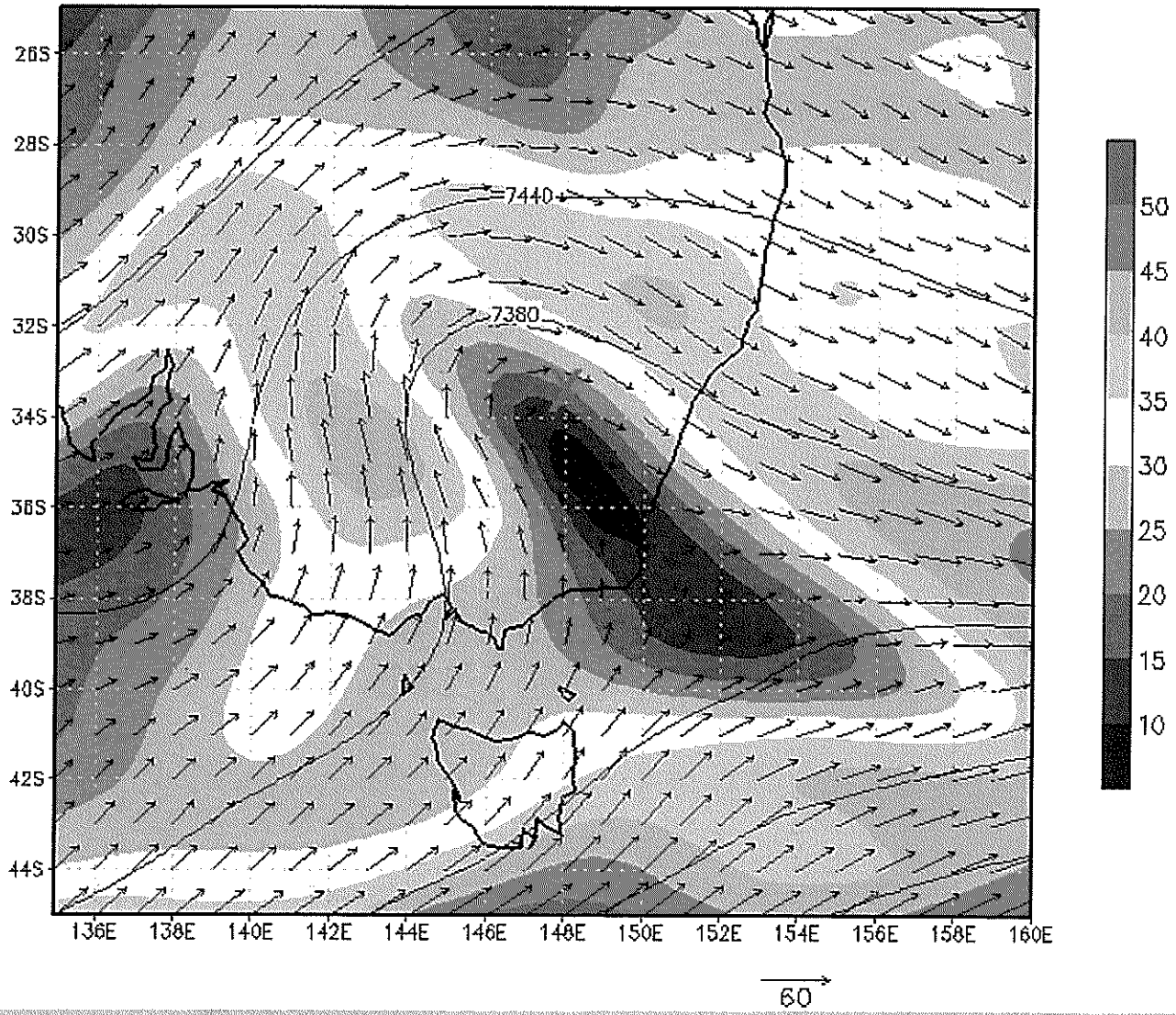
And if you don't want to take [redacted] word, take a squiz at the NTFGS for today, attached.

[redacted]

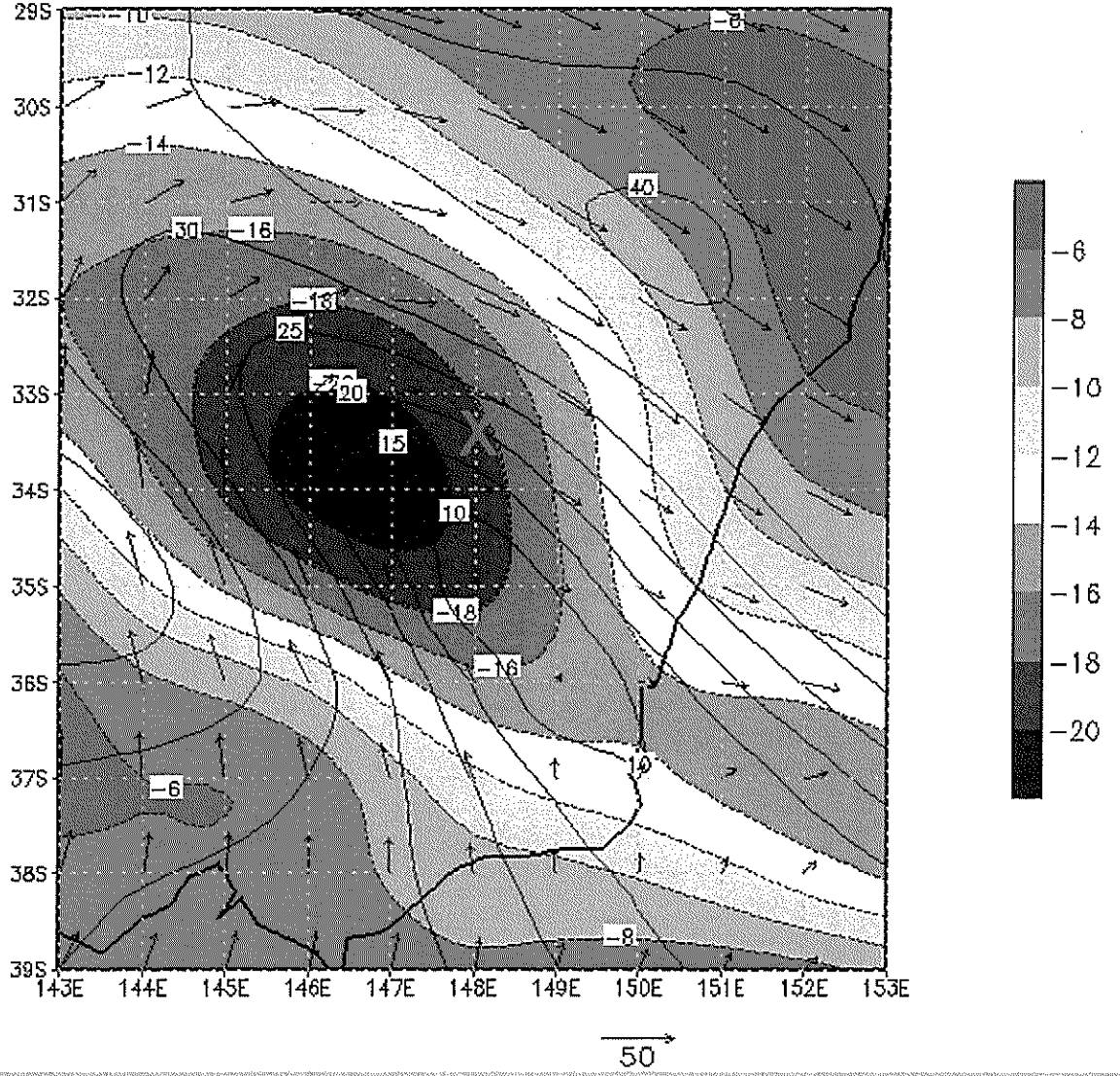

winds (knots) 250 00Z26OCT2003
20S
22S
24S
26S
28S
30S
32S
34S
36S
38S
40S
136E
138E
140E
142E
144E
146E
148E
150E
152E
154E
156E
158E
160E
10680
10620
10560
10500
10440
10380
10320
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
100


winds (knots) 250 06Z26OCT2003
20S
22S
24S
26S
28S
30S
32S
34S
36S
38S
40S
136E
138E
140E
142E
144E
146E
148E
150E
152E
154E
156E
158E
160E
10680
10620
10560
10500
10440
10380
10320
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
100

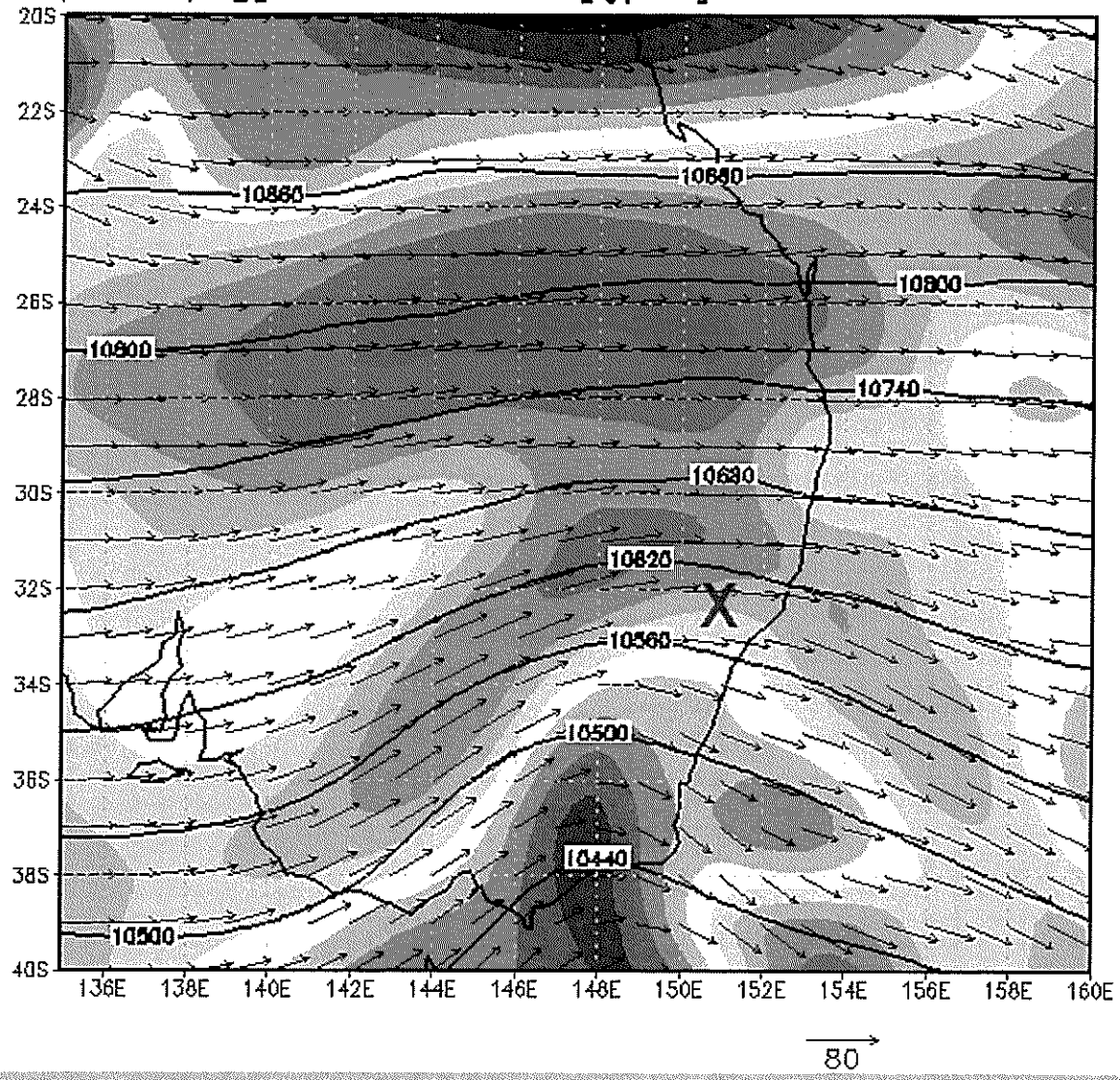
winds (knots) [] – 400 HGT [gpm] at 06Z Sun 21mar2004



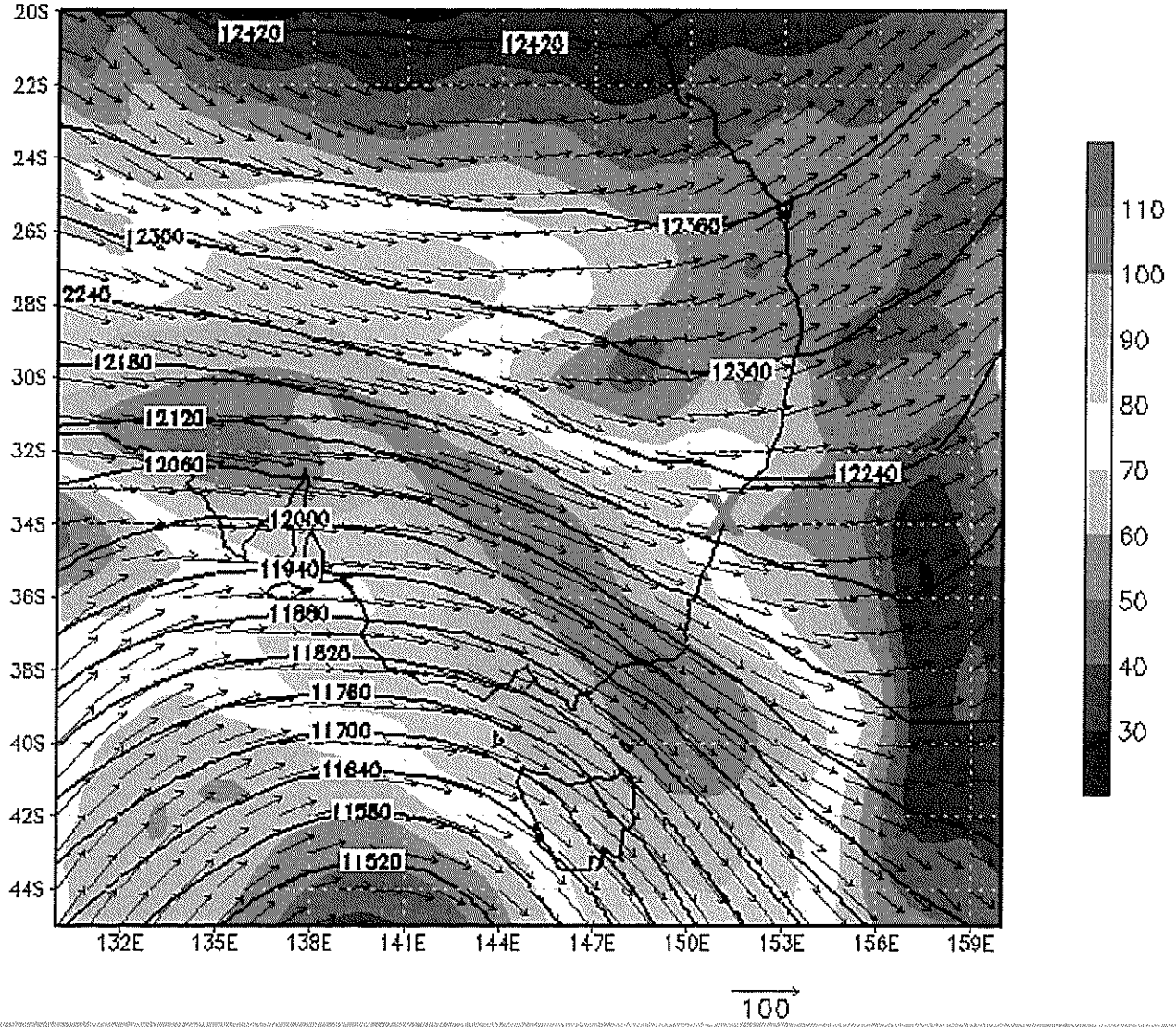
400 ABSV [/s] – winds B/W (knots) [] at 06Z Sun 21mar2004



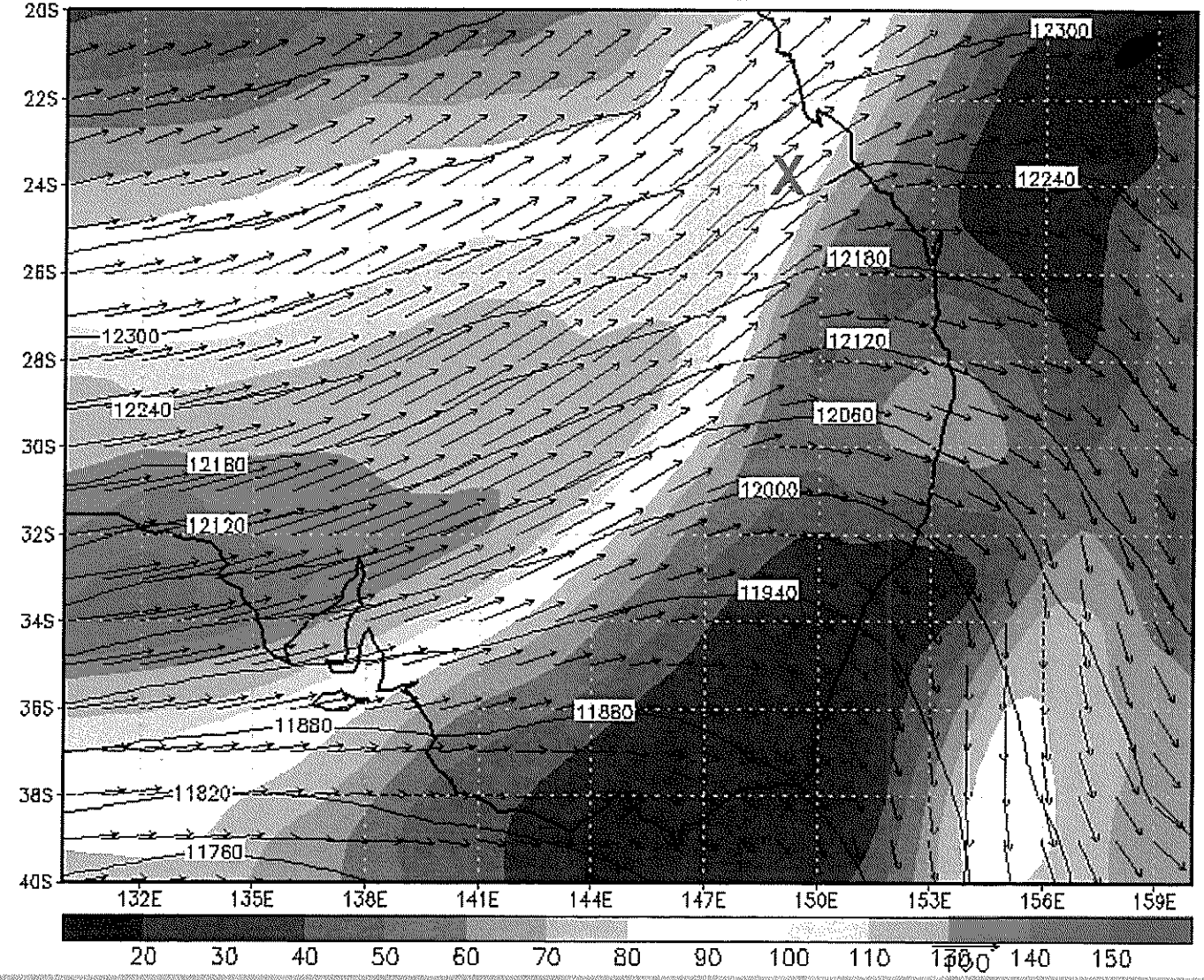
winds (knots) [] – 250 HGT [gpm] at 06Z Sun 24oct2004

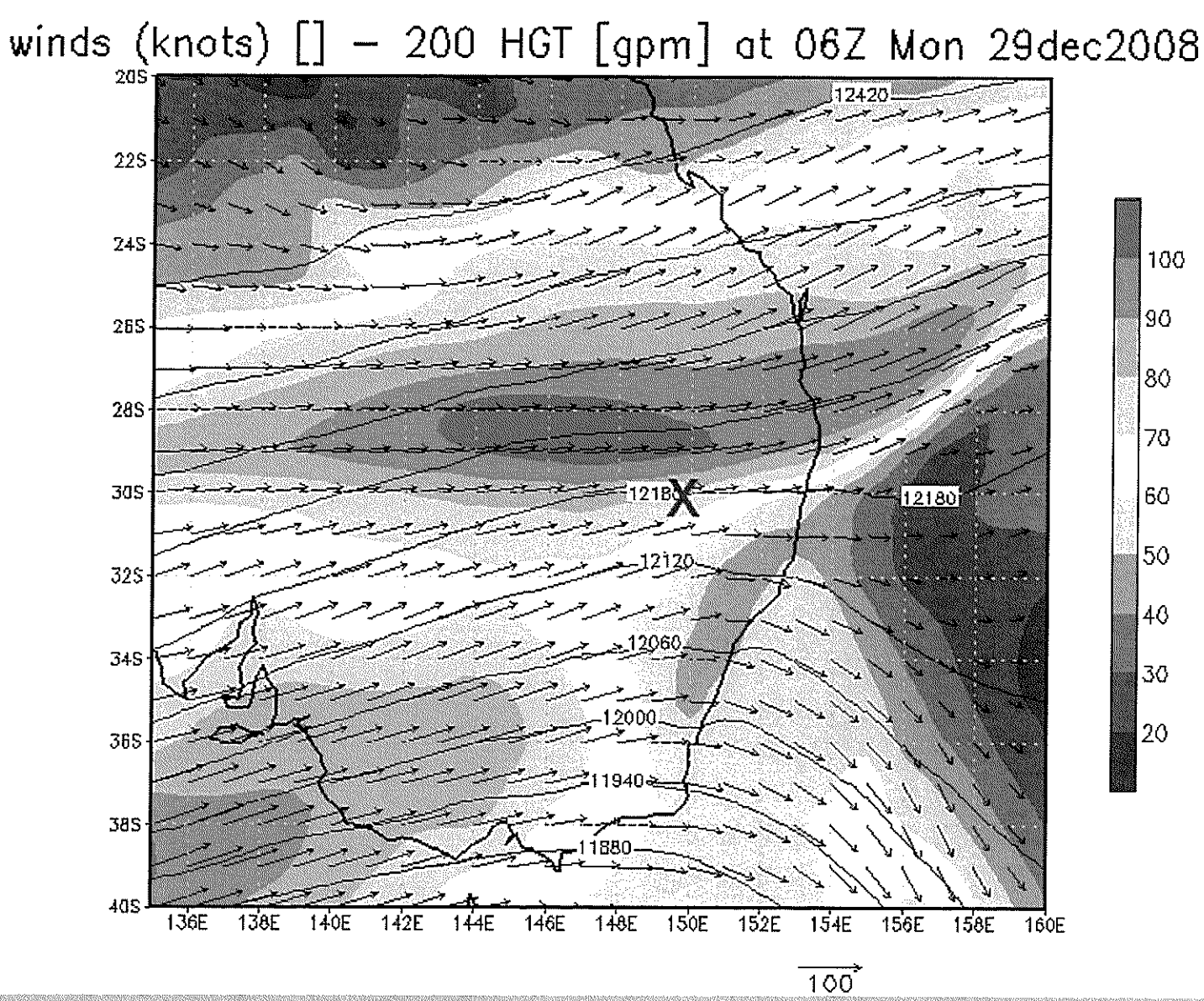


winds (knots) [] – 200 HGT [gpm] at 06Z Sun 09dec2007

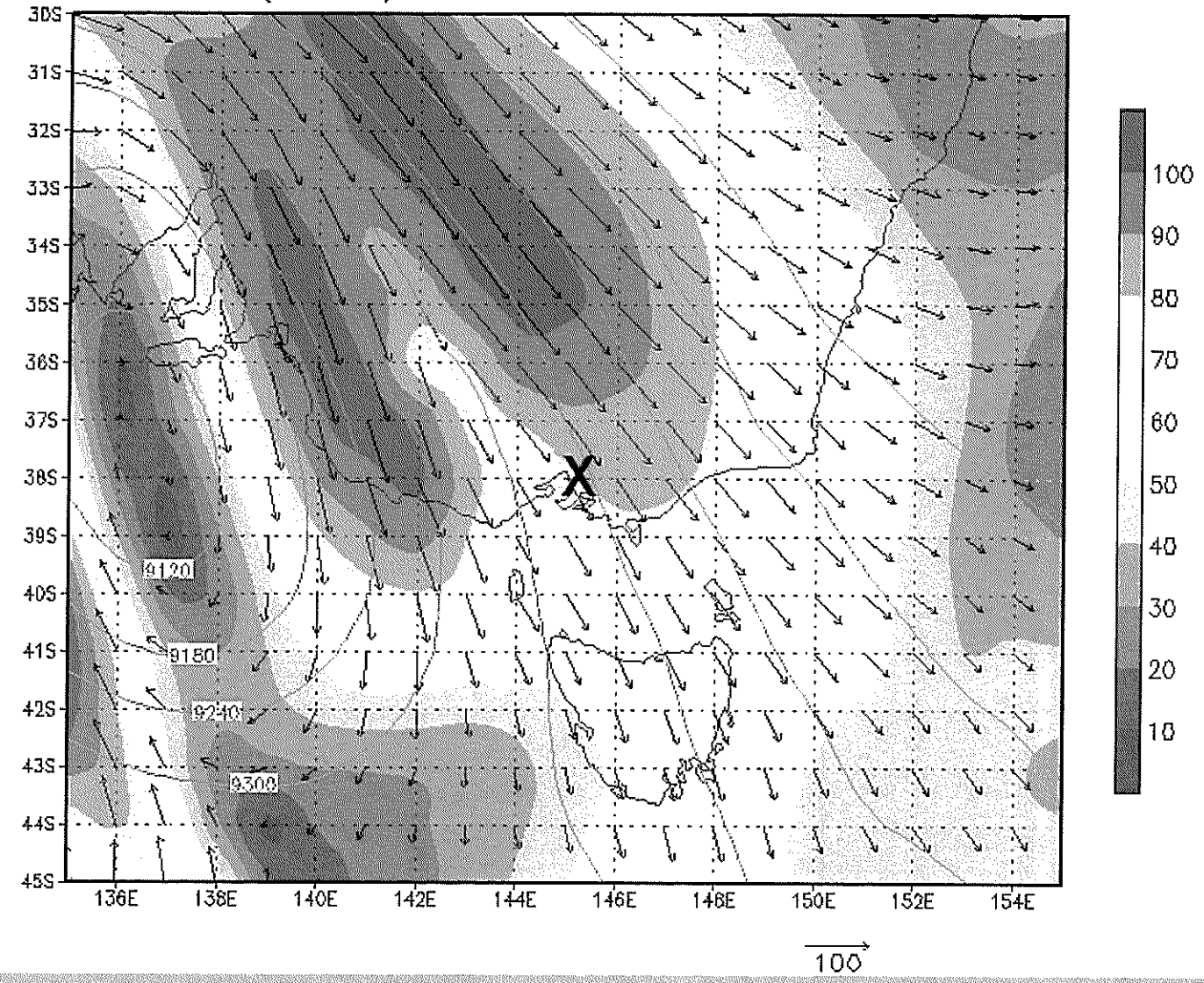


winds (knots) [] – 200 HGT [gpm] at 06Z Thu 20nov2008

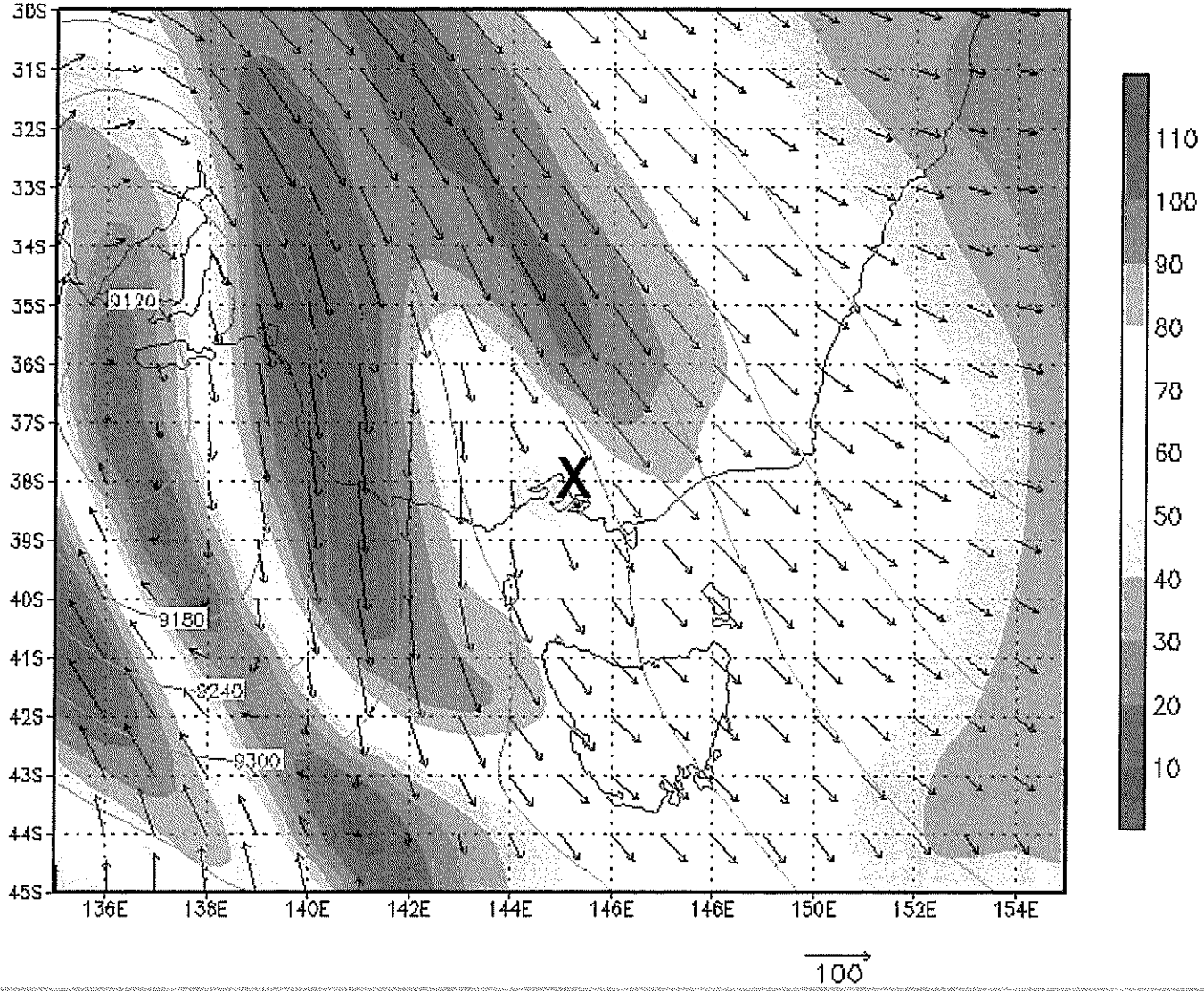


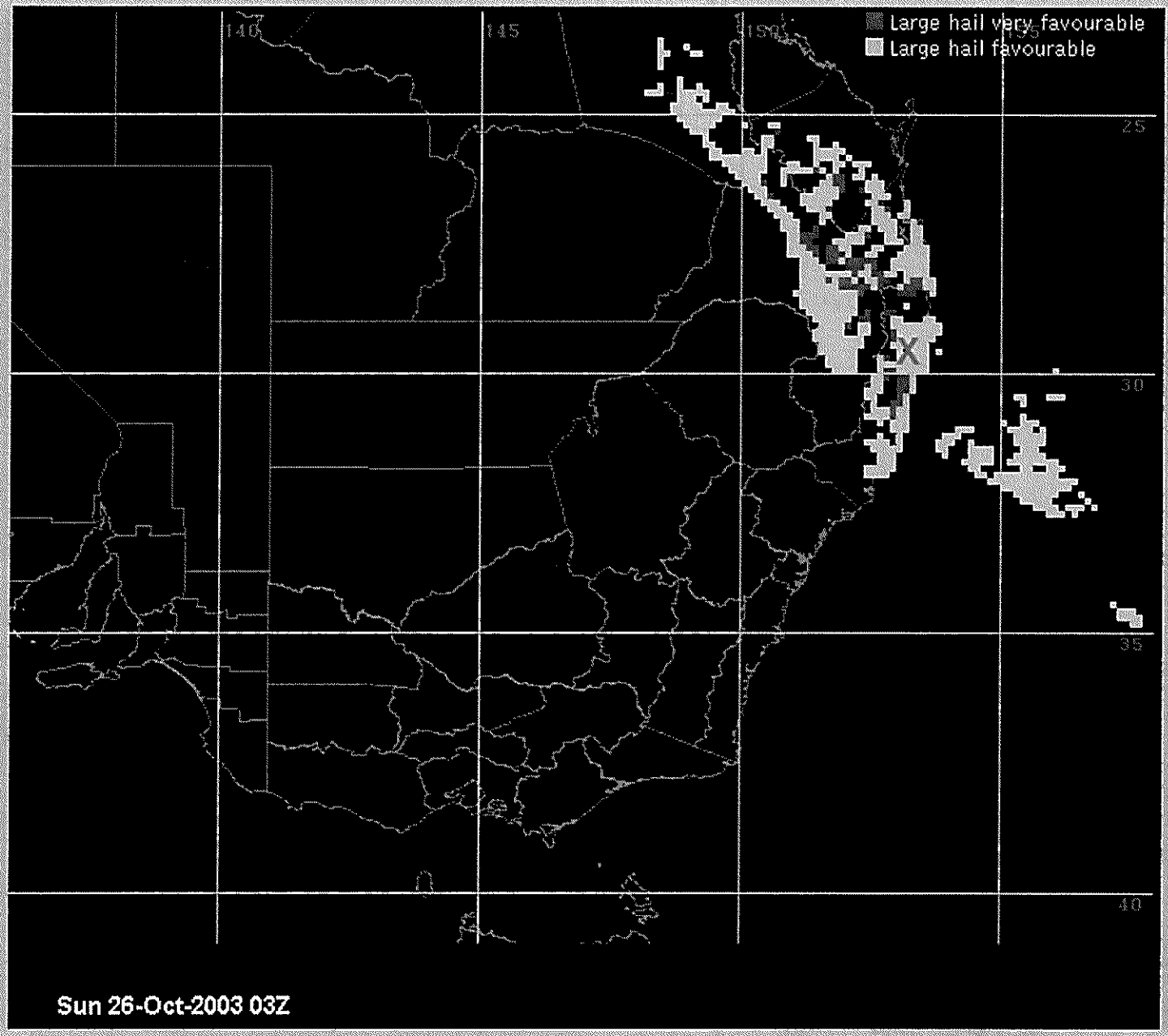

winds (knots) [] – 200 HGT [gpm] at 06Z Mon 29dec2008
20S
22S
24S
26S
28S
30S
32S
34S
36S
38S
40S
136E
138E
140E
142E
144E
146E
148E
150E
152E
154E
156E
158E
160E
12420
12180
12120
12060
12000
11940
11880
100
100
90
80
70
60
50
40
30
20

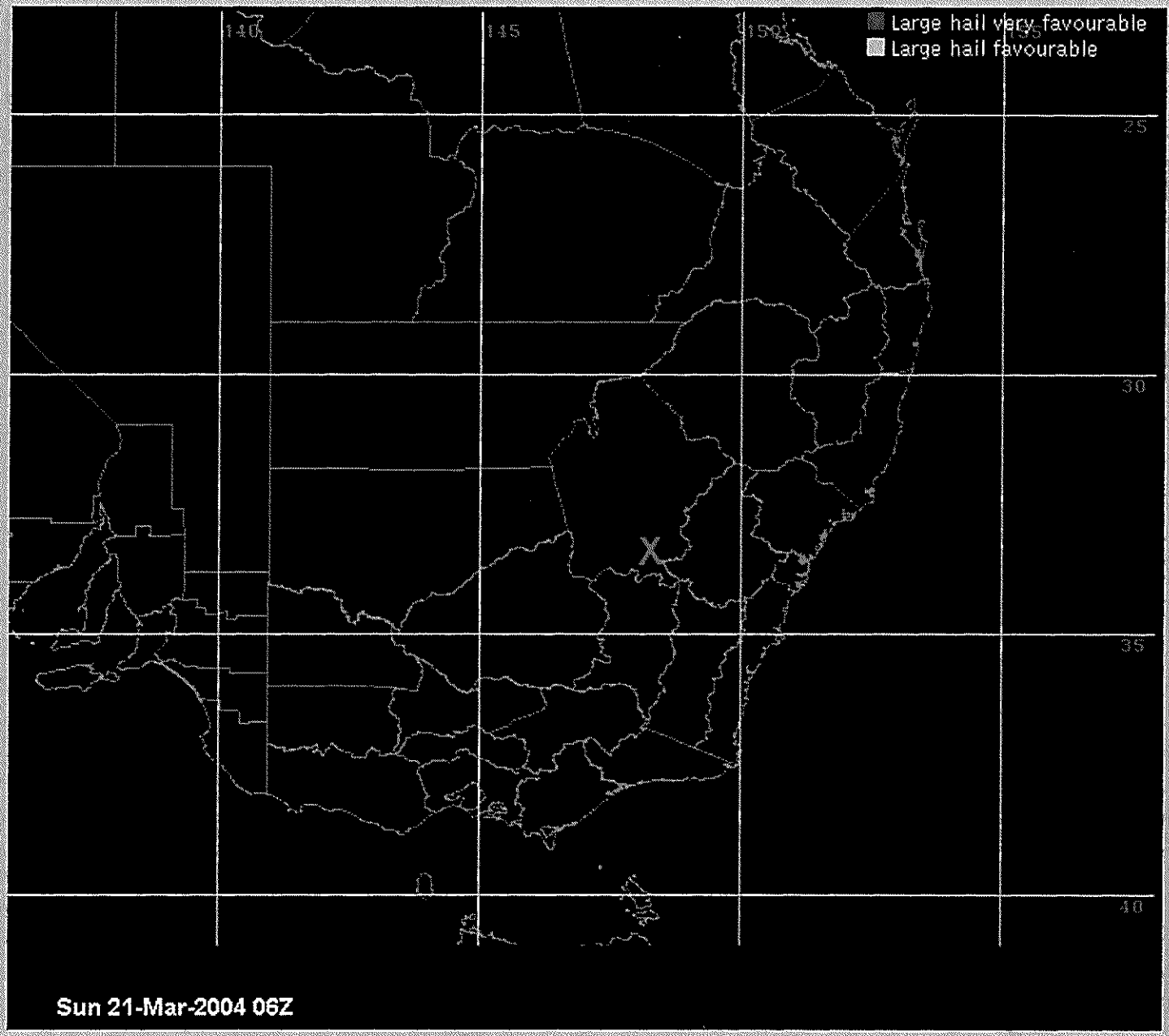
300 hPa winds (knots), HGT at 03Z Sat 06mar2010

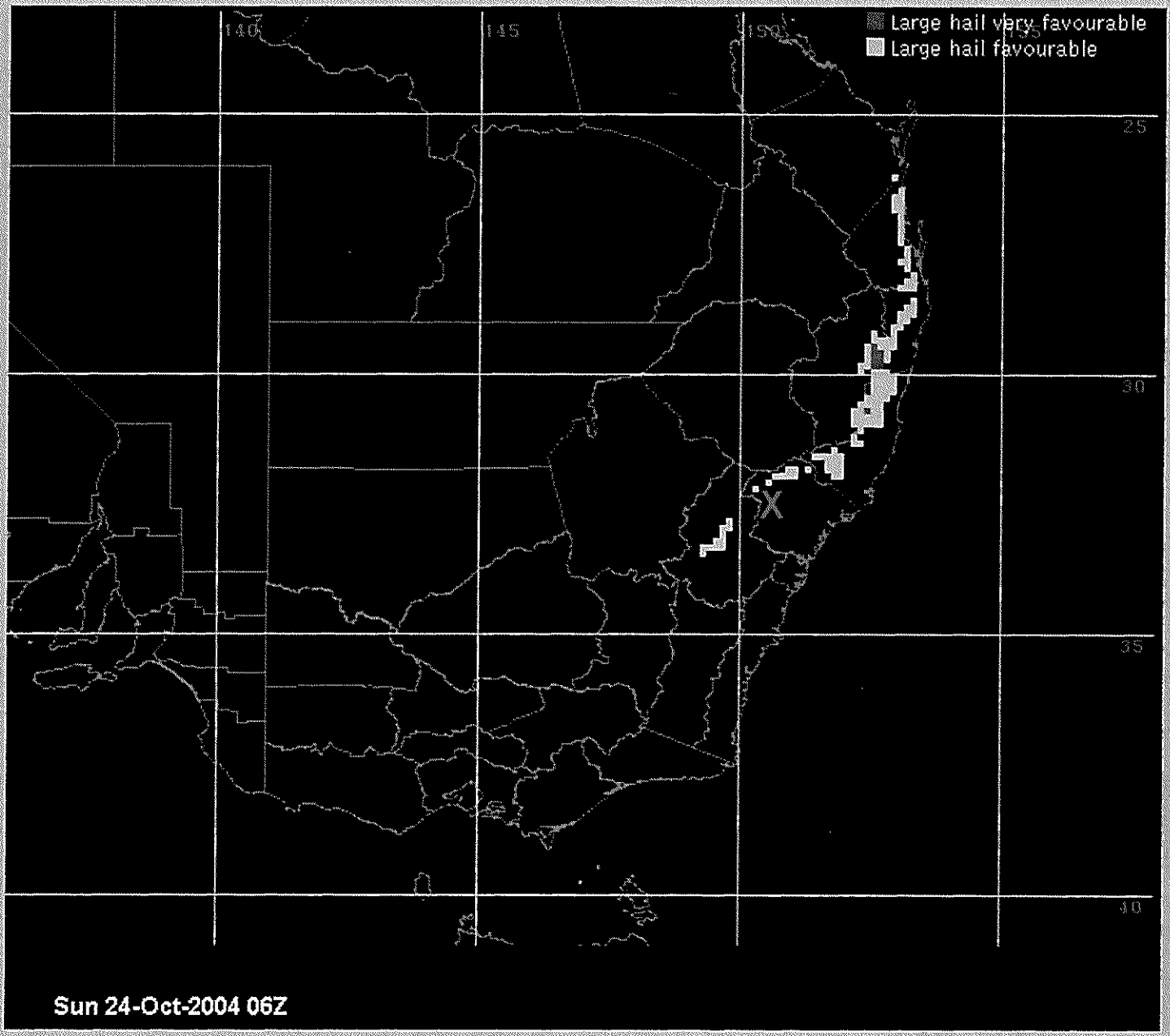


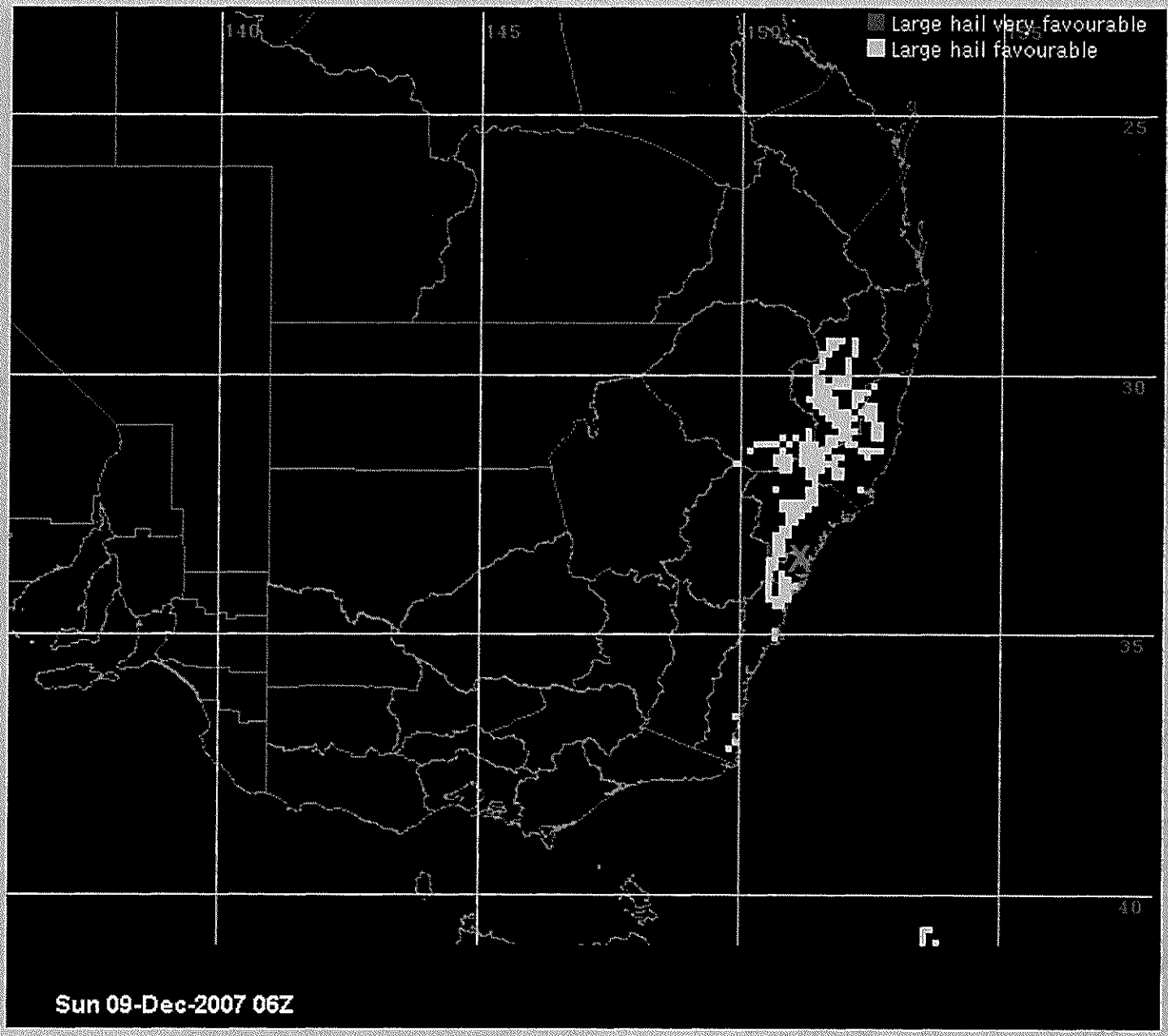
300 hPa winds (knots), HGT at 06Z Sat 06mar2010

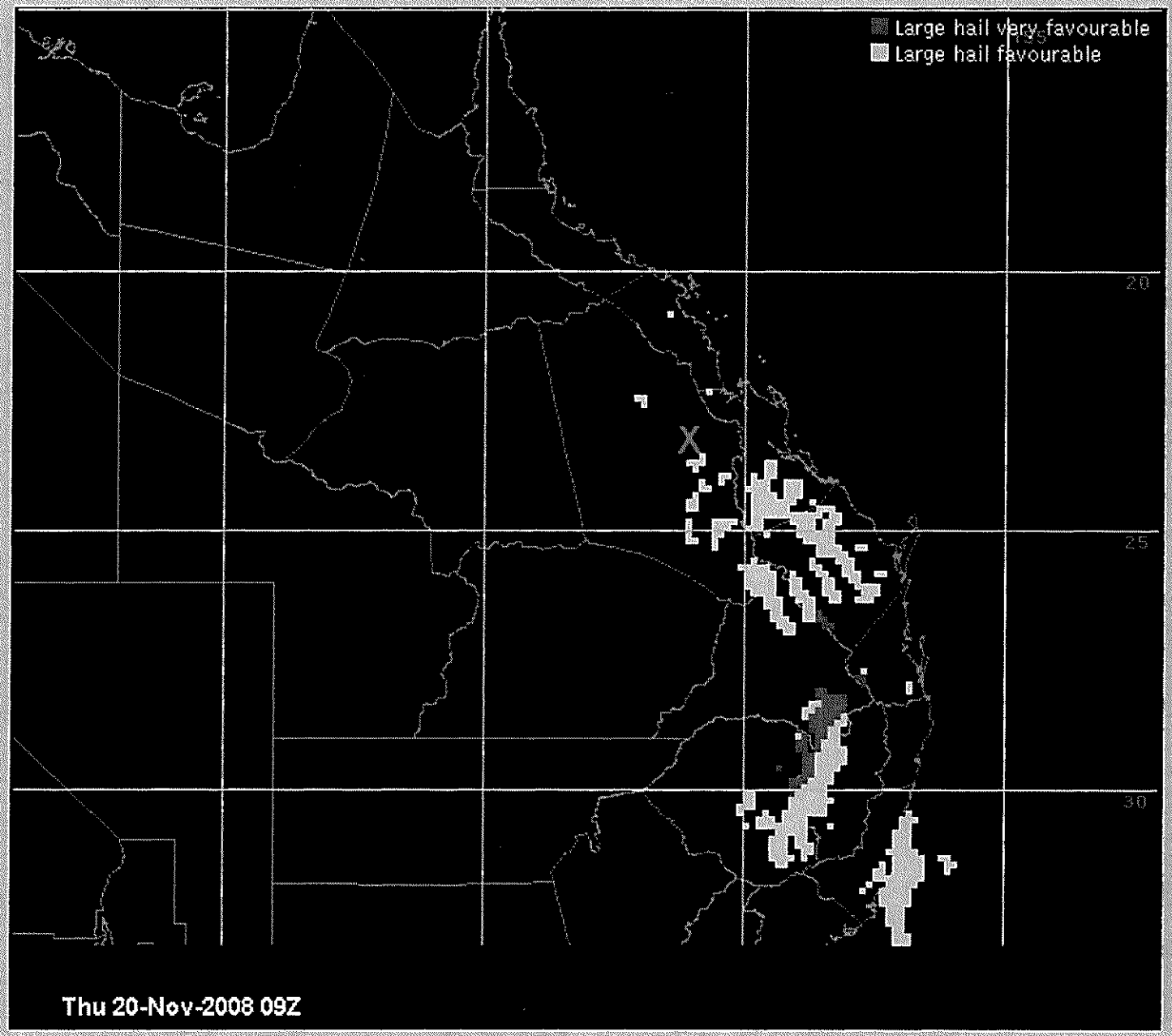


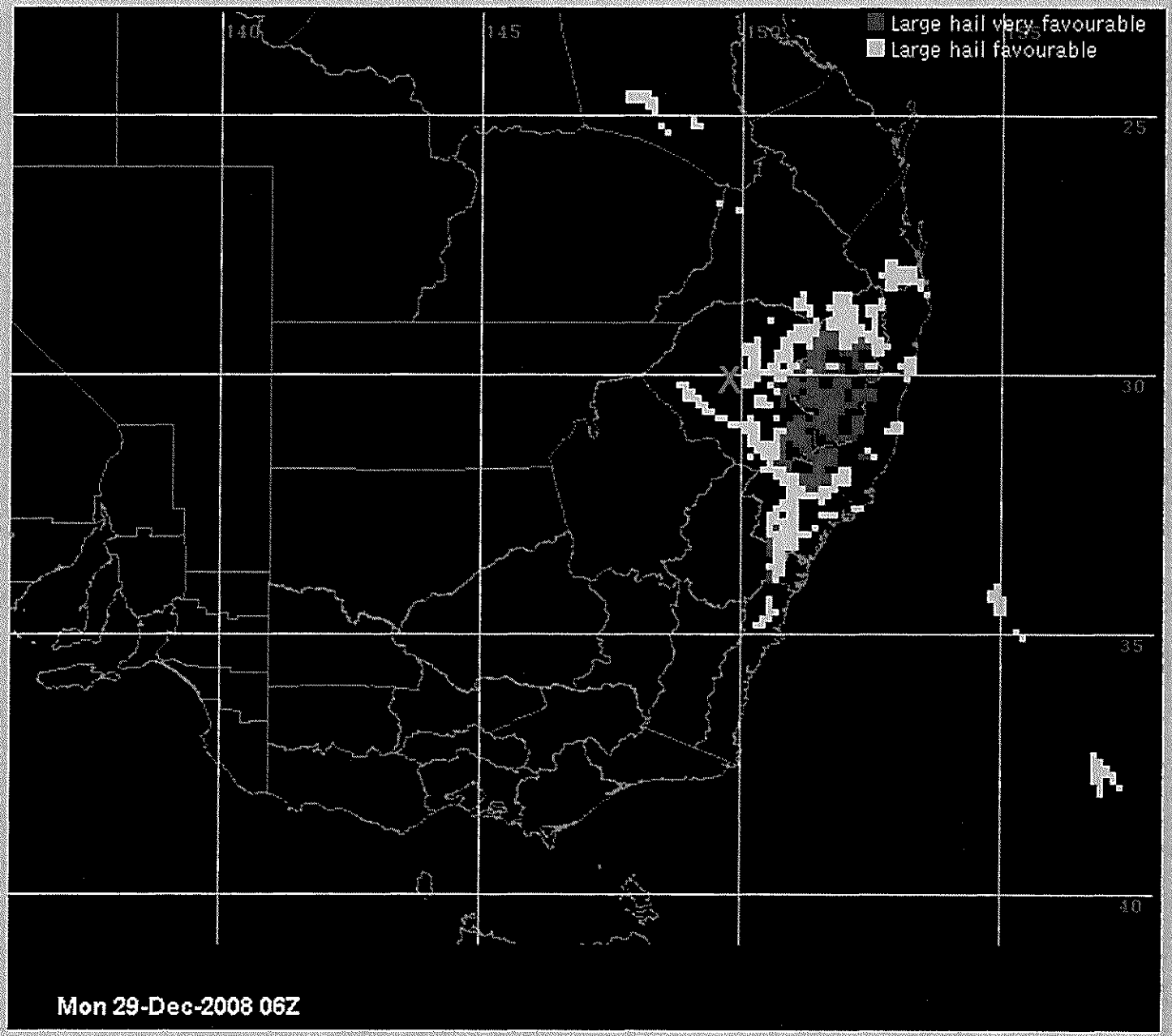

Large hail very favourable
Large hail favourable
140
145
150
155
25
30
35
40
Sun 26-Oct-2003 03Z

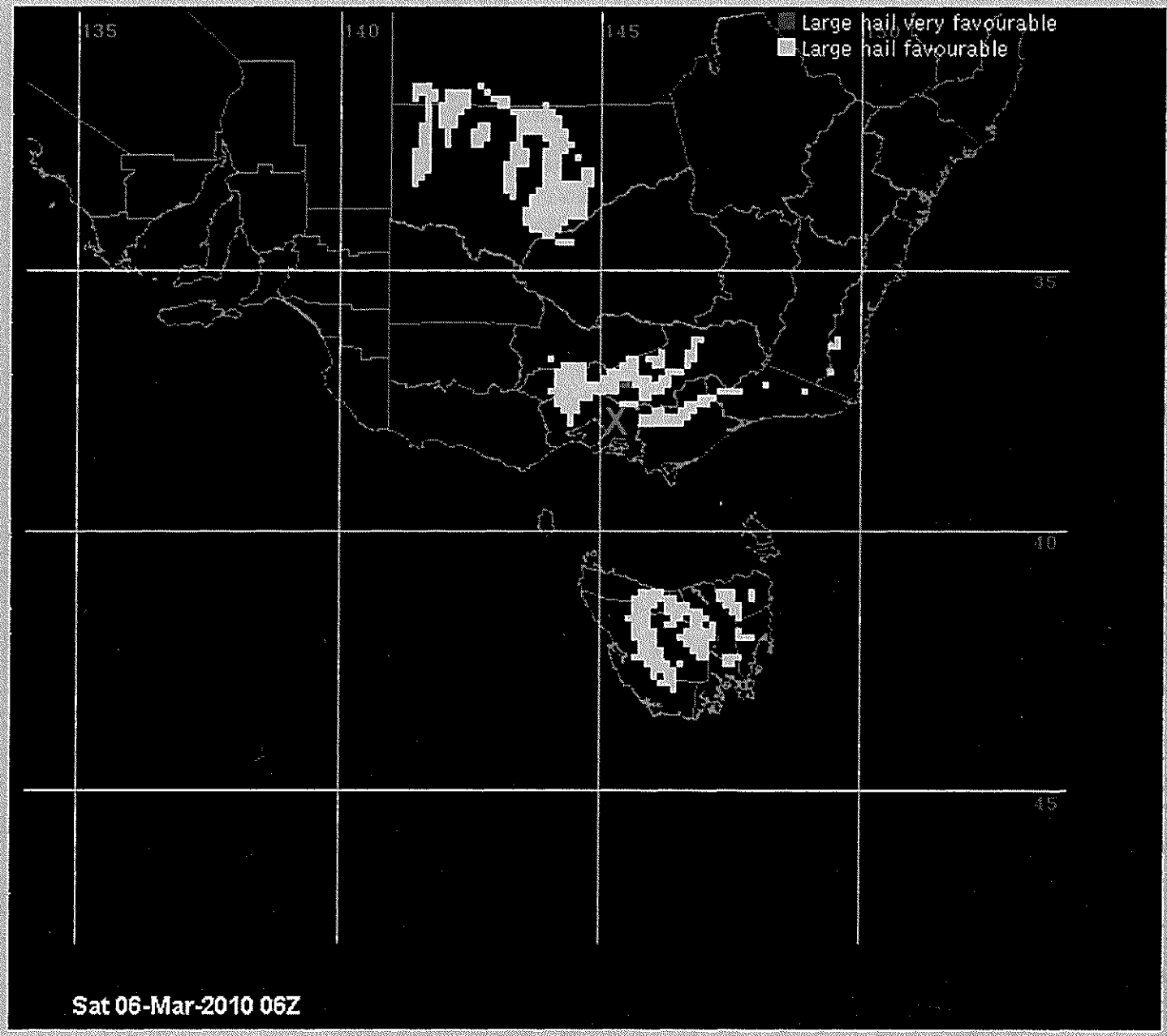

Large hail very favourable
Large hail favourable
140
145
150
155
25
30
35
40
Sun 21-Mar-2004 06Z


Large hail very favourable
Large hail favourable
140
145
150
155
25
30
35
40
Sun 24-Oct-2004 06Z


Large hail very favourable
Large hail favourable
140
145
150
155
25
30
35
40
Sun 09-Dec-2007 06Z


Large hail very favourable
Large hail favourable
20
25
30
Thu 20-Nov-2008 09Z


Large hail very favourable
Large hail favourable
140
145
150
155
25
30
35
40
Mon 29-Dec-2008 06Z


Large hail very favourable
Large hail favourable
135
140
145
35
40
45
Sat 06-Mar-2010 06Z

Time (Z)/Date	Location	State	Hail size (cm)	Source
0425 26/10/03	Tyndale	NSW	10	National Severe TS Database
0700 21/03/04	Forbes	NSW	10	National Severe TS Database
0705 24/10/04	Merriwa-Muswellbrook	NSW	12	National Severe TS Database
0500 09/12/07	Cherrybrook (Sydney)	NSW	11	National Severe TS Database
0800-0900 20/11/08	Blackwater	QLD	18	QRO Wiki Severe Weather reports (unconfirmed?)
0600 29/12/08	Edgeroi	NSW	11	National Severe TS Database
0415-0430 06/03/10	Ferntree Gully	VIC	10	BoM Technical Officer

Doc 20 B

DOC 21

[redacted]

Irrelevant - s.22

From: [redacted]
Sent: Monday, July 12, 2010 1:21 PM
To: [redacted]
Subject: RE: March 6 2010 Hail Storm [SEC=UNCLASSIFIED]

[redacted] thanks!
have also interviewed [redacted] on his own experience

cheers
[redacted]

From: [redacted]
Sent: Thursday, 8 July 2010 5:06 PM
To: [redacted]
Subject: FW: March 6 2010 Hail Storm [SEC=UNCLASSIFIED]

Hi again [redacted]

Sorry I should have mentioned that [redacted]s photos were taken northwest of Calder Park.

[redacted]

From: [redacted]
Sent: Thursday, 8 July 2010 4:22 PM
To: [redacted]
Subject: March 6 2010 Hail Storm [SEC=UNCLASSIFIED]

Hi [redacted]

As per our phone conversation Wednesday, I have attached images that may be of assistance to you for your Weather News report. In terms of statistics, as of 23 June, the insurable damages from the storm was $1,016 million. The SES received over 3200 Requests for Assistance (RFA) between 1200 and 2300 local time. The eastern region of Knox was the worst affected with the VICSES Knox unit recording its highest number of Requests for Assistance ever with in excess of 2775 RFAs.

Effectively, the storm was a High Precipitation (HP) supercell thunderstorm that displayed a clear mesocyclone (mid-level rotation) on doppler radar imagery. Severe thunderstorms affected many parts of the State on the 5th, 6th and 7th due to unstable conditions provided by the build-up of moisture from a northerly gradient flow that directed moisture from over Queensland into Victoria, a surface trough over the State and strong upper-level forcing.

The largest reported hail was 10cm in Ferntree Gully at 1530 local time. I have attached a photograph of large hail from Lysterfield (photographer unknown). Note that the largest hail of 10cm was reported to be 2 x 5cm hail stoned congealed together which seperated upon impact on the ground. However, from this photograph alone, one can see that the largest contiguous hailstone is in excess of 9cm below the ruler in the center. There were also numerous reports of hail between 3 and 5 cm from the city, Mt Waverly to Ferny Creek.

In terms of rainfall, Marybyrnong received 36mm in the 30 min to 1400 (21.6mm in the 6 min to 1348 and 25.2mm in 18min) and 45.8mm in the 60min to 1400. Each of the 18 min, 30 min and hourly rainfall rates exceeded the 100 year recurrence interval (ARI). The highest rainfall totals are as follows:

6 min:

24.4mm	Rockbank	1324	
22.4mm	Tarago Reservoir	1754	
21.6mm	Maribyrnong	1348	
19.0mm	Docklands	1354	

18min:

41mm	Docklands	1406	(ARI >100yrs)
36mm	Rockbank	1330	(ARI >100yrs)
27mm	Upper Pakenham	1500	
26.6mm	Brooklyn	1348	

30min:

45.8mm	Maribyrnong	1400	(ARI >100yrs)
36mm	Rockbank	1330	(ARI >100yrs)
35.2mm	Docklands	1400	(ARI >100yrs)
33.6mm	Brooklyn	1400	

60min:

45.8mm	Maribyrnong	1400	(ARI >100yrs)
45.4mm	Rockbank	1400	(ARI 90yrs)
35.2mm	Docklands	1400	(ARI 93yrs)
34.8mm	Brooklyn	1400	

Daily Rainfall:

69.0mm	Maribyrnong	(ARI 4yrs)
61.4mm	Rockbank	(ARI 3yrs)
55.4mm	Docklands	(ARI 3yrs)
53.8mm	Iona	

In terms of wind gusts, the highest three confirmed wind gusts are as follows:

Melbourne Airport:	102 km/hr	1330	
LaTrobe Valley:	94 km/hr	1614	(10min average: 67 km/hr)
Ben Nevis:	91 km/hr	2320	(10min average: 48 km/hr)

For satellite imagery and radar imagery, I suggest going to http://www.bom.gov.au/inside/services_policy/public/sevwx/vic/20100603_thunder.shtml. Unless you would like radar imagery from 3D-Rapic, however, I have yet to gain access to that data.

Attached are two photos of the wall cloud as taken by storm chaser [redacted] at 1412EST looking SSW into the north east inflow side of the storm. The photos have been provided with the agreement that [redacted] be acknowledged wherever published. Please let me know if you choose to use either of [redacted]s images so that I can let [redacted] know.

IRRELEVANT MATERIAL REMOVED - s. 22.

Hope this helps [redacted] If you need any further information, please do not hestitate to contact me.

Cheers,

[redacted]

DOC 22

[redacted]

From: [redacted] on behalf of [redacted]
Sent: Tuesday, 1 February 2011 9:27 AM
To: [redacted]
Subject: RE: [synoptic_discussion] Melbourne forecast for Monday 31 January [SEC=UNCLASSIFIED]
Attachments: MelbHail.ppt

Agree with you [redacted]

However regarding the Melb Hail storm, thought you may be interested in some results from the UM at 1.5km, but before anyone looks at them please note the following:

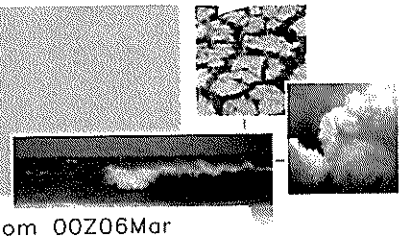
****MEGA-CAVEATS***:**
1. These are first off runs from [redacted] The settings for clouds, PBL etc. are as for the UK
2. There is NO assimilation in this run
3. There is NO assimilation in the run that this was nested in (ACCESS-VT) - which has only had a little of bit of tuning for Aus.
4. These are 20 hour forecasts which may be getting towards the limit of predictability for TS intensity
5. The topography has serious problems

...and we are working on all of these.

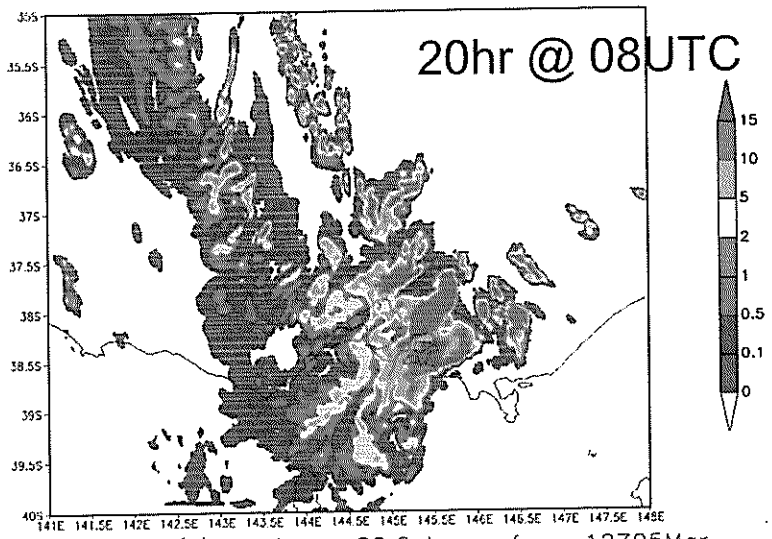
So yes it is 3 hours out in a 20 hour forecast and it is overcooked, but given these limitations and the fact that it was a first try I find these very encouraging. Anyone who has done much modelling will realize it takes quite some time between a first run and a really good run!

REST OF EMAIL IRRELEVANT (s.22)

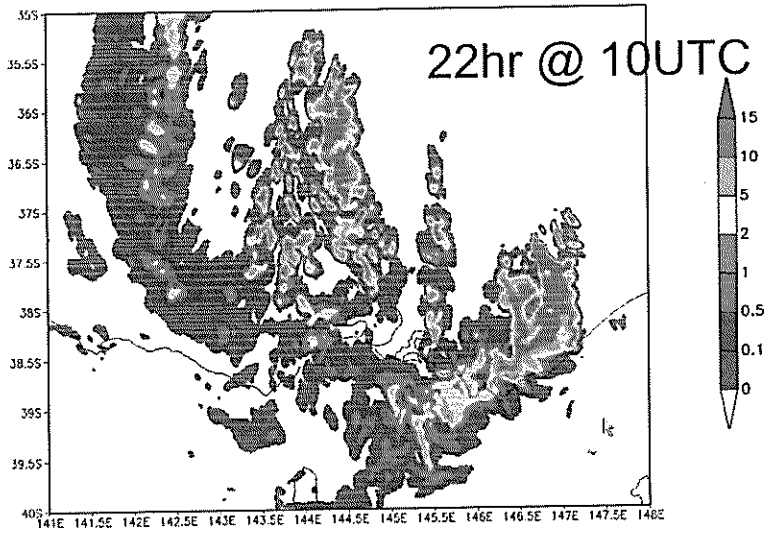
Melbourne Hail storm



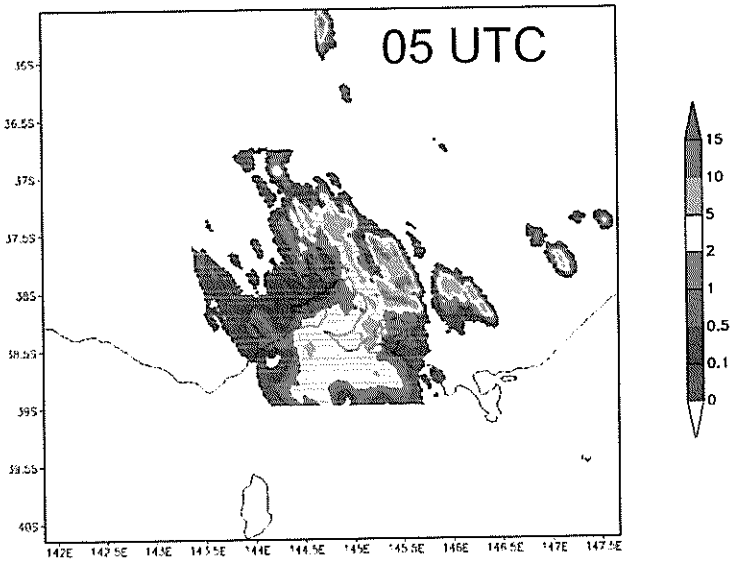
rain rate(mm/h) at time= 20.0 hours from 12Z05Mar



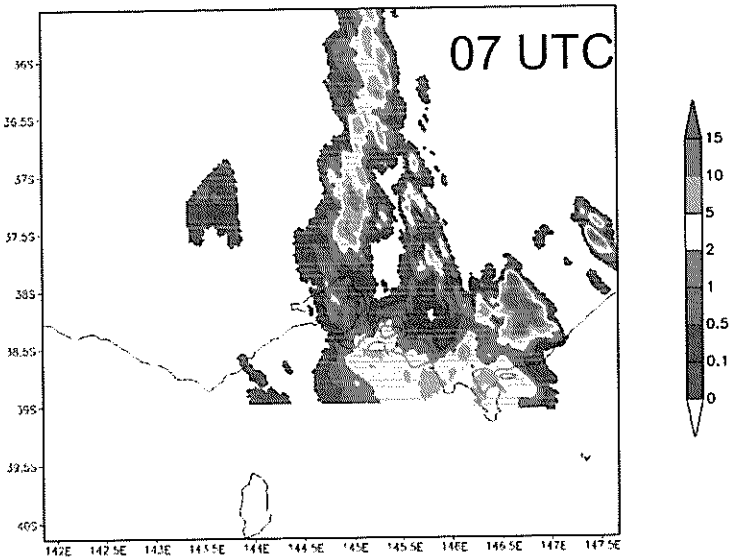
rain rate(mm/h) at time= 22.0 hours from 12Z05Mar



rain rate(mm/h) at time= 5.0 hours from 00Z06Mar



rain rate(mm/h) at time= 7.0 hours from 00Z06Mar



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