Analysis and Prediction Operations Bulletin No. 63

Operational Upgrade of TXLAPS_PT375 to 51 Levels

19 May 2006

Introduction

The operational tropical region Extended Limited Area Prediction System known as TXLAPS_PT375 was upgraded from a 29 to a 51 vertical-level version on 19 April 2006. The upgraded version was developed by BMRC's Model Development and the Data Assimilation groups. These groups are led by Dr Kamal Puri and Dr Bill Bourke respectively.

In mid 2005 51 level TXLAPS_PT375 (hereafter referred to as L51 TXLAPS_PT375) was tested in BMRC. Between November 2005 and April 2006 the 51 level version underwent a parallel trial with the then operational 29 level version (hereafter referred to as L29 TXLAPS_PT375). Objective assessments were conducted. Skill scores indicate that L51 TXLAPS_PT375 shows slight/neutral changes in forecast skill over the L29 version. Objective rainfall verification indicates improvements in the forecast of rain area, average intensity, rain volumes and rain intensity. Other rainfall verification results show slight/neutral changes in skill. The results of surface weather verification were mixed.

The move from a L29 to L51 model is a step in the longer term plan to move to 60 level assimilation and prediction. At 60 levels TXLAPS will use global and direct read-out satellite radiances during data assimilation along with enhanced surface grid fields and physics.

The operational LAPS_PT375 system was upgraded in early May. The high resolution TCLAPS model will continue to use the existing 29 level structure for the time being. It is expected that the new 51 level TCLAPS will become operational prior to the start of the next Australian region cyclone season (1 November 2006).

System Description

The original configuration of TXLAPS_PT375 was described in the Analysis and Prediction Operation Bulletin (APOB) No 59 of May 2005. Much of the underlying structure of the L51 TXLAPS_PT375 system remains as described in APOB No 59 so only a brief system outline will be presented here.

The system continues to be based on the 3-cycle analysis/forecast scheme, in which observational data are inserted at 6 hourly intervals from –12 hours to 0 hours.. At each data insertion, an analysis is performed followed by a soil-moisture adjustment and then an initialisation and prediction. During cycles 1 and 2 the prediction model is integrated forward 6 hours until the next analysis time. During cycle 3 the model is integrated to the end of the forecast period. Cycle 3 includes a nudging phase from 12 hours prior to the run time to the run time. During this phase predetermined synthetic moisture/heating profiles are input into the model at 2 hourly intervals in observed cloudy regions. A schematic representation of the basic structure of the scheme is shown in Figure 1 below. Table 1 documents the operational configuration of L51 TXLAPS_PT375

A “cold start” is used at the commencement of cycle 1, in other words the GASP analysis provides the first guess for the L51 TXLAPS_PT375 analysis. The 6-hour forecasts from the L51 TXLAPS_PT375 prediction model are used as the first guess fields for the L51 TXLAPS_PT375 analysis in the second and third cycles. GASP (at present the T239/29L version) provides the boundary conditions for L51 TXLAPS_PT375.

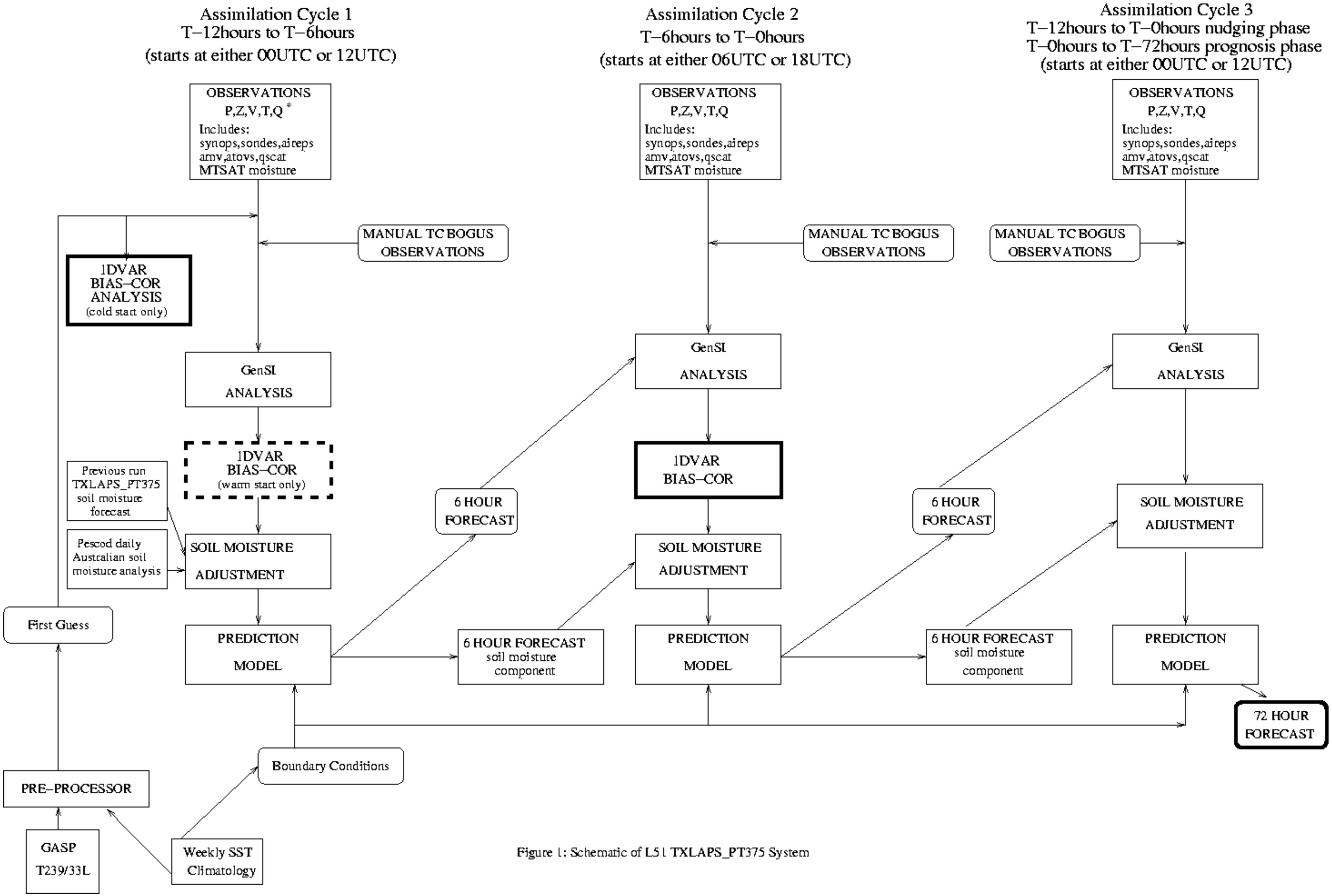


Figure 1: Schematic of L51 TXLAPS_PT375 System

Domain: Australian Tropical Region	48.75°N-45.0°S, 60.0°E-142.5°W
Horizontal resolution (analysis and prognosis)	0.375° (250x420 latitude-longitude grid)
Vertical resolution (analysis and prognosis)	51 sigma levels, top level at ~10 hPa *See Table 2 for levels and approximate heights.*
Topography:	derived from a 0.1° resolution data set
Data insertion frequency:	at T-12, T-6 and T-0
Data cut off:	approximately 3.5 hours at 00 and 12UTC, 4.75 hours at 06 and 18UTC
Manual intervention:	TC bogus observations
Initialisation:	digital filtering technique
Diabatic Nudging	12 hours
Timestep:	40 seconds
Nesting:	lateral boundary conditions derived from +0 to +84 hour GASP
Output:	6 hourly analyses. 3 hourly forecasts out to 72 hours from 00 UTC and 12 UTC daily
Climatology:	Albedo
Soil Moisture Analysis:	Daily 0.25°x 0.25°
Sea Surface Temperature Analysis:	Weekly 1° x 1° O.I (generated in NMOC Melbourne)
MTSAT CTT data	1 hourly 0.5°x 0.5°
Bogused synthetic moisture profile	2 hourly 0.5°x 0.5°
NEC SX-6 supercomputer resources:	
Analysis	elapsed time: 2 min (real), 12 min (virtual)
	number of processors: 7, memory: 7.5 GB
84 hour prognosis:	elapsed time: 49 min (real), 4 hr 35 min (virtual)
	number of processors: 7, memory: 6.0 GB
NMOC products driven by L51 TXLAPS_PT375:	Provides initial and boundary conditions for 10.0km TCLAPS (currently running in test mode). Volcanic ash dispersion and trajectories, ERR
Backup:	GASP will be used. If the expected T-12 GASP output is not available for the model run, then L51 TXLAPS_PT375 will use the previous GASP output (T-24), otherwise it will be run in a fixed boundary mode without nudging.

Table 1: Operational Configuration of L51 TXLAPS_PT375

New L51 Level Structure

The L51 TXLAPS_PT375 has 51 levels compared with the 29 levels for the previous operational version. The new vertical levels were selected by Dr Greg Roff (BMRC Model Development Group) based on a literature search followed by modelling experiments using various level configurations. This study suggested that the best procedure for vertical level placement is based on the following points which were adhered to when selecting the final configuration.

- raise lid well above region of interest - this removes errors associated with the artificial top boundary;
- always have higher vertical resolution where large gradients exist in the model fields (eg top of the planetary boundary layer, tropopause, stratopause and mesopause) - this will enable a better ability to capture these gradients;
- always vary vertical resolution smoothly - sudden jumps in resolution lead to errors in finite difference schemes;
- let the stratospheric resolution be equi-distant in ln(p) - as this will satisfy the need to reduce the number of levels but still leave these levels equally spaced in height
- near the model top let the resolution linearly increase in ln(p) - this makes for a reduced number of levels but retains a smooth change in resolution;
- let the top two layers of the model be symmetric in p - this was found to reduce the top boundary errors associated with the top boundary condition.

Graphical and tabular level comparisons of the new and old level structures are shown below.

Equivalent L29 level number	Sigma level value	Approx. height (m)	L51 level number	Sigma level value	Approx. height (m)
-	-	-	51	0.0098	31100
-	-	-	50	0.0145	28600
-	-	-	49	0.0207	26200
-	-	-	48	0.0284	24200
-	-	-	47	0.0375	22400
~ 29	0.05	20500	46	0.048	20800
-	-	-	45	0.0594	19600
~ 28	0.07	18360	44	0.0715	18300
-	-	-	43	0.0845	17250
~ 27	0.10	16100	42	0.099	16250
-	-	-	41	0.115	15300
-	-	-	40	0.133	14400
~ 26	0.15	13520	39	0.1535	13500
~ 25	0.175	12550	38	0.176	12600
24	0.200	11700	37	0.200	11700
23	0.225	11000	36	0.225	11000
22	0.250	10300	35	0.250	10300
21	0.275	9650	34	0.275	9650
20	0.300	9070	33	0.300	9070
-	-	-	32	0.325	8530
19	0.350	8030	31	0.350	8030
-	-	-	30	0.375	7550
18	0.400	7090	29	0.400	7090
-	-	-	28	0.425	6660
17	0.450	6250	27	0.450	6250
-	-	-	26	0.475	5850
16	0.500	5480	25	0.500	5480
-	-	-	24	0.525	5110
-	-	-	23	0.550	4770
-	-	-	22	0.575	4430
15	0.600	4100	21	0.600	4100
-	-	-	20	0.625	3790
-	-	-	19	0.650	3490
-	-	-	18	0.675	3190
14	0.700	2910	17	0.700	2910
-	-	-	16	0.725	2630
13	0.75	2360	15	0.750	2360
-	-	-	14	0.775	2100
12	0.800	1840	13	0.800	1840
-	-	-	12	0.825	1590
11	0.850	1350	11	0.850	1350
10	0.875	1110	10	0.875	1110
9	0.900	880	9	0.900	880
8	0.925	650	8	0.925	650
7	0.950	430	7	0.950	430
~ 6	0.9625	320	6	0.972	240
~ 5	0.9750	210	5	0.9841	135
~ 4	0.9875	106	4	0.9911	75
~ 3	0.9943	48	3	0.9950	42
2	0.9974	22	2	0.9974	22
1	0.9988	10	1	0.9988	10

* A grey background indicates modified/non-matching levels

* Red indicates the 31 level subset included in the TXLAPS McIDAS sigma-level grid files (GRID2401-2413) which are generated by and sent to NTRO. Users requiring additional levels will need to obtain them via the McIDAS ADDE server.

Table 2: Comparison of model sigma (P/Psurf) levels and approximate corresponding heights used TXLAPS_PT375 for L29 and L51 model configurations.

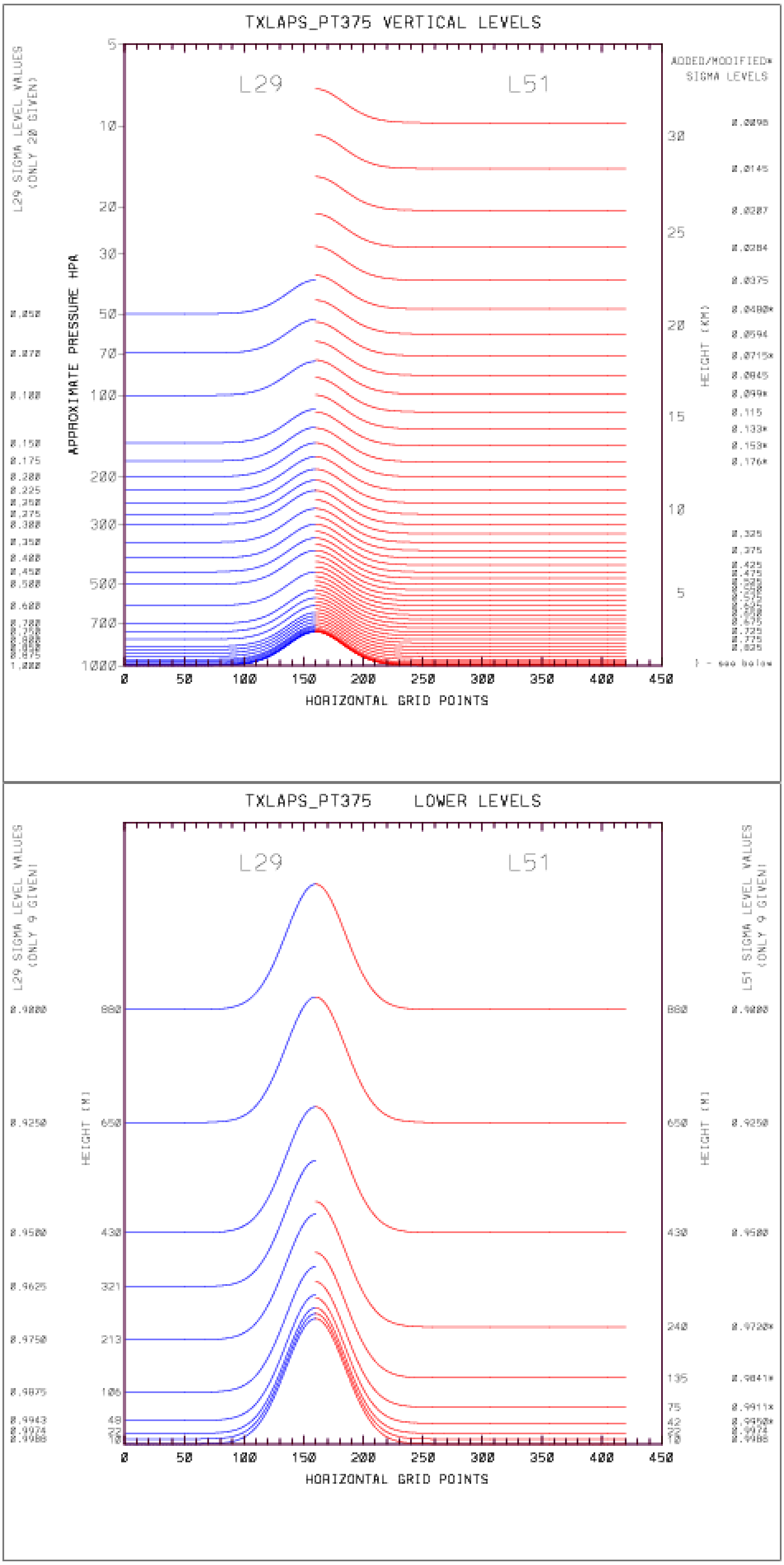


Figure 2: Vertical level distributions used in TXLAPS_PT375 for L29 and L51 model configurations.

Model Changes

Forecast model changes with this upgrade include:

- 51 sigma levels
- model program using bam physics 4.0

Data Analysis Changes

Significant analysis program changes with this upgrade include:

- analysis program version gen2b_21
- extraction program version 6.5
- boxfile version 6.5
- Use of Atmospheric Motion Vector (amv) satellite wind obs

Model Performance

1. Objective Assessment

Darwin RSMC conducted an assessment of L51 TXLAPS_PT375 in a parallel trial during October 2005 - April 2006 prior to operational implementation. The results for the period 25 December 2005 to 24 March 2006 are discussed below.

2. S1 Skill Score, Bias and Root Mean Square error for MSLP and HGHT

Table 3 below presents the mean S1 skill score, bias and root mean square (RMS) error of the L29 LAPS_PT375 and the new L51 TXLAPS_PT375 for the period over the Australian verification region. The overall result shows little significant change.

			Australian Region			Australian Tropics		
Forecast Period	**Verification statistics**	**Field**	**L29 TXLAPS**	**L51 TXLAPS**	**Improvement**	**L29 TXLAPS**	**L51 TXLAPS**	**Improvement**
+24HRS	S1 Skill Score	MSLP	30.1	30.4	-0.3	42.4	42.5	-0.1
		850hpa U,V	92.0, 93.6	91.8, 93.6	0.2, 0.0	71.0, 79.2	70.3, 79.8	0.7, -0.6
		500hpa U,V	89.4, 92.0	88.5, 91.7	0.9, 0.3	66.2, 82.4	62.3, 80.1	3.9, 2.3
		200hpa U,V	83.6, 88.9	83.2, 88.2	0.3, 0.4	70.6, 88.5	68.1, 86.7	2.5, 1.8
	BIAS	MSLP	0.1	-0.1	0.0	-0.2	-0.2	0.0
		850hpa U,V	0. 0, -0.2	0.1, -0.1	-0.1, 0.1	0.0, 0.0	0.1, 0.0	-0.1, 0.0
		500hpa U,V	-0.1, -0.1	0.0, -0.1	0.1, 0.0	0.0, 0.0	0.0, 0.1	0.0, 0.1
		200hpa U,V	-0.1, 0.2	-0.3, 0.2	-0.2, 0.0	0.5, 0.3	0.4, 0.2	0.1, 0.1
	RMS	MSLP	1.2	1.2	0.0	0.8	0.8	0.0
		850hpa U,V	2.4, 2.4	2.4, 2.5	0.0,-0.1	2.4, 2.3	2.5, 2.3	-0.1, 0.0
		500hpa U,V	3.0, 3.1	3.0, 3.1	0.0, 0.0	2.7, 2.7	2.7, 2.7	0.0, 0.1
		200hpa U,V	4.6, 4.8	4.6, 4.7	0.0, 0.1	4.4, 4.6	4.2, 4.4	0.2, 0.2
+48HRS	S1 Skill Score	MSLP	39.2	39.4	-0.2	48.4	48.6	-0.2
		850hpa U,V	94.0, 95.5	93.9, 95.6	0.1,-0.1	77.7, 85.7	77.3, 86.0	0.4, -0.3
		500hpa U,V	92.0, 94.3	91.2, 94.3	0.8, 0.0	72.7, 89.1	70.0, 87.9	2.7, 1.2
		200hpa U,V	86.5, 91.5	86.3, 91.1	0.2, 0.4	73.2, 92.3	71.3, 91.0	1.9, 1.3
	BIAS	MSLP	0.2	0.1	0.1	0.0	0.0	0.0
		850hpa U,V	0.0, -0.3	0.1, -0.3	-0.1, 0.0	0.0, 0.0	0.3, 0.0	-0.3, 0.0
		500hpa U,V	-0.2, -0.2	0.0, -0.2	0.2, 0.0	0.0, 0.0	0.0, 0.1	0.0,-0.1
		200hpa U,V	-0.2, -0.2	-0.4, -0.1	-0.2, 0.1	0.3, -0.1	0.0, -0.3	0.3, -0.2
	RMS	MSLP	2.0	2.0	0.0	1.0	1.0	0.0
		850hpa U,V	3.1, 3.3	3.2, 3.3	-0.1, 0.0	3.0, 2.8	3.1, 2.8	-0.1,0.0
		500hpa U,V	4.2, 4.3	4.2, 4.3	0.0, 0.0	3.4, 3.2	3.4, 3.2	0.0, 0.0
		200hpa U,V	6.3, 6.5	6.3, 6.5	0.0, 0.0	5.0, 5.1	5.0, 5.0	0.1, 0.1
+72HRS	S1 Skill Score	MSLP	46.7	47.1	-0.4	52.4	52.8	-0.4
		850hpa U,V	95.2, 96.7,	95.1, 96.8	0.1, -0.1	81.0, 88.7	80.5, 89.0	0.5, -0.3
		500hpa U,V	93.5, 95.8	93.1, 95.8	0.4, 0.0	75.9, 92.3	73.3, 91.3	2.6, 1.0
		200hpa U,V	88.5, 93.2	88.3, 92.9	0.2, 0.3	74.3, 93.7	72.5, 92.8	1.8, 0.9
	BIAS	MSLP	0.5	0.3	0.2	0.1	0.3	-0.2
		850hpa U,V	-0.1, -0.3	0.1, -0.3	0.0, 0.0	0.1, 0.1	0.4, 0.1	-0.3, 0.0
		500hpa U,V	-0.3, -0.2	-0.1, -0.2	0.2, 0.0	-0.1, 0.1	-0.2, 0.2	-0.1, -1.0
		200hpa U,V	-0.2, -0.2	-0.6, 0.0	-0.4, 0.2	-0.2, -0.1	-0.4, -0.3	-0.2, -0.2
	RMS	MSLP	2.7	2.7	0.0	1.3	1.3	0.0
		850hpa U,V	3.8, 3.9	3.9, 4.0	-0.1, -1.0	3.4, 3.1	3.6, 3.1	-0.2, 0.0
		500hpa U,V	5.1, 5.3	5.2, 5.2	-0.1, 0.1	3.8, 3.5	3.9, 3.6	-0.1, -0.1
		200hpa U,V	7.7, 8.0	7.8, 8.0	-0.1, 0.0	5.5, 5.6	5.6, 5.5	-0.1, 0.1

S1 skill scores are non-dimensional. Units for bias and RMS:- MSLP (hPa) for U& V wind (ms^{-1}).

Table 3 Mean S1 Skill Score, Bias and RMS Error for MSLP and WIND comparing L29 TXLAPS_PT375 and L51 TXLAPS_PT375

Regions:
1. Australian Region (45S - 15S, 100E - 170E)
2. Australian Tropics (25N - 25S, 100E - 160E)

Total Period: 00Z 25 Dec 2005 - 12Z 24 Mar 2006 using both 00 and 12 UTC runs

Verifying Analyses: Self

Improvement: The absolute value of L29 TXLAPS_PT375 minus absolute value of L51 TXLAPS_PT375. Where a positive(blue) value indicates an improvement in L51 version as compared with the L29 version, and a negative(red) value indicates a degradation.

3. Rainfall Verification

The following rainfall verifications were performed using the RAINVAL statistical verification package, which verifies daily quantitative precipitation forecasts for NWP models against daily rainfall analyses. RAINVAL was developed by Beth Ebert and John McBride of BMRC (McBride & Ebert, 2000). A variety of statistical scores are available from this system for judging aspects of rainfall forecast performance. Further details, including a glossary that explains the strengths and weaknesses of the various statistical scores presented here, can be found at http://www.bom.gov.au/bmrc/mdev/expt/rainval/rainval_gui/rainval_gui.shtml.
Table 4 shows RAINVAL statistics for L29 TXLAPS_PT375 and the L51 TXLAPS_PT375 model forecasts averaged over all Australian gridpoints for the period from 25 December 2005 to 24 March 2006.
Rainfall verification indicates improvements in the forecast of area of rain, average rainfall intensity, rain volumes and rain intensities during most time periods. Other rainfall verification results show slight/neutral changes in skill.

	Observed	**L29 TXLAPS**			**L51 TXLAPS**		
		00-24 hr	**24-48 hr**	**48-72 hr**	**00-24 hr**	**24-48 hr**	**48-72 hr**
Rain Area (km^2 * 10^3)	1982	2473	2472	2455	2459	2403	2374
Avg Intensity (mm/d)	11.7	11.4	11.1	9.2	11.4	11.5	11.1
Rain Volume (km^3)	29.0	28.2	27.3	21.4	28.1	27.5	26.2
Max Intensity (mm/d)	84.7	76.0	74.9	77.7	78.0	78.6	76.9
Mean Abs Error (mm/d)	-	4.0	4.3	4.5	4.0	4.3	4.5
RMS Error (mm/d)	-	9.0	9.6	10.2	9.1	9.7	10.1
Correlation Coefficient	-	0.52	0.45	0.39	0.50	0.44	0.38
Bias Score	-	1.25	1.25	1.24	1.24	1.21	1.20
Probability of Detection	-	0.82	0.78	0.74	0.81	0.76	0.72
False Alarm Ratio	-	0.35	0.37	0.41	0.35	0.37	0.40
Critical Success Index	-	0.57	0.54	0.49	0.57	0.53	0.49
Hanssen & Kuipers Score	-	0.61	0.56	0.50	0.60	0.55	0.49
Equitable Threat Score	-	0.40	0.36	0.30	0.39	0.35	0.30

Table 4: Average RAINVAL stats for all available days (83) and all gridpoints during the period 25 December 2005 to 24 March 2006. Verification done on a 0.75° grid, number of gridpoints - 1094. Blue coloured results indicate an improvement in L51 over L29, red indicates a degradation.

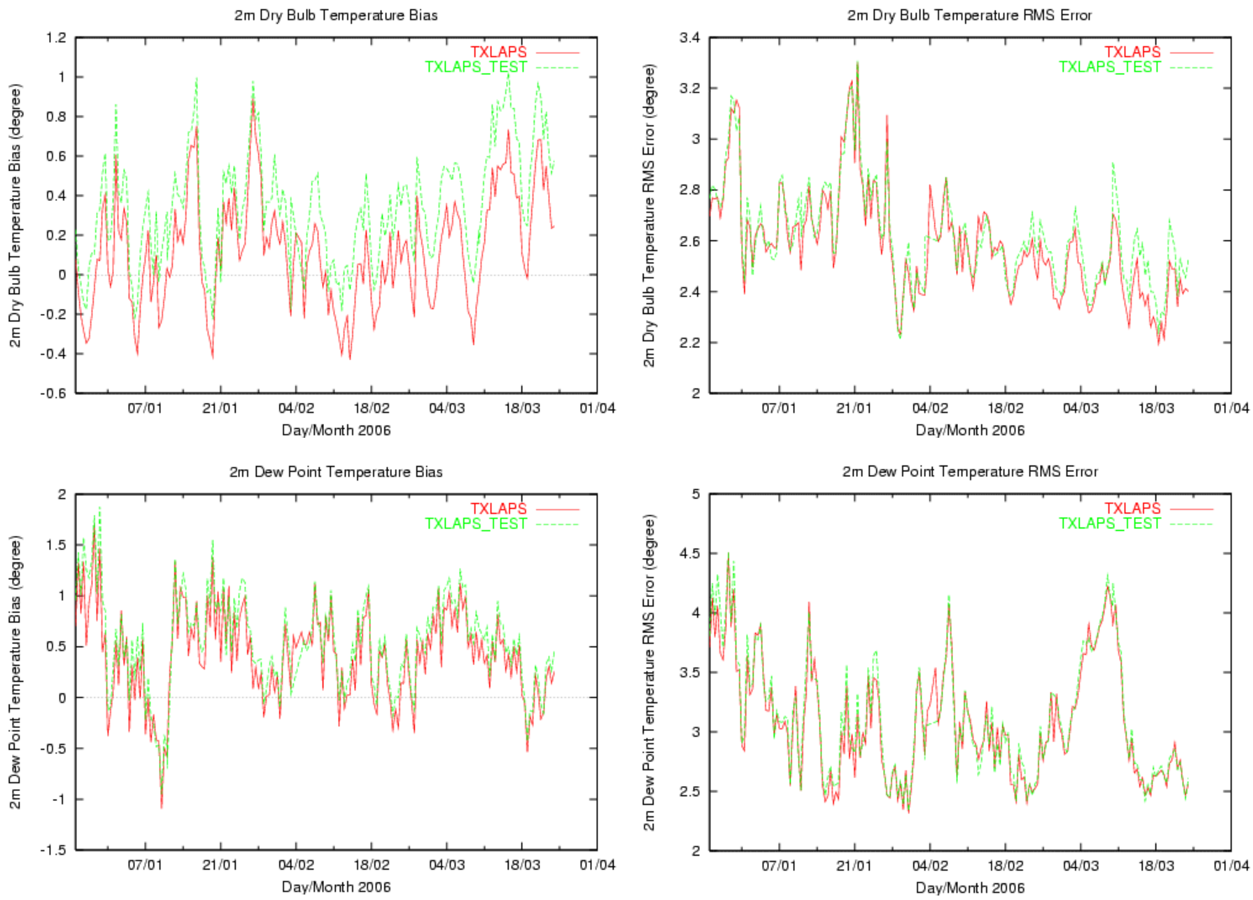
4. Surface Weather Parameter Verification against the Aviation METAR Observations

Model forecast surface weather elements such as surface (2m, or screen level) temperature and dewpoint and surface (10m) wind direction and speed are routinely verified in NMOC against METAR observational data. RMS errors and biases are calculated at regular intervals out to a specified forecast period using all available Australian METARS (approximately 177).

Figure 3 shows time series plots of the mean bias and RMS errors in surface temperature and dewpoint averaged over all METAR sites and over all hourly model forecast periods out to +48 hrs. Table 5 below summarizes the overall time average of these statistics. It can be seen that overall there is very little change in the RMS error. Results for the temperature and dewpoint showed worse bias, while there was a slight improvement in the bias for wind speed and direction.

	bias		rms	
	L29 TXLAPS	L51 TXLAPS	L29 TXLAPS	L51 TXLAPS
Temperature(2m)	0.120	0.338	2.588	2.623
Dewpoint (2m)	0.410	0.526	3.084	3.113
Wind speed	-0.641	-0.586	2.379	2.372
Wind direction	-2.180	-2.099	50.592	50.733

Table 5: Average surface weather element statistics for 177 cases over period 20051225 00z to 20060324 12z. Positive improvements in the L51 TXLAPS results compared to the L29 version are coloured blue, worse results are coloured red.



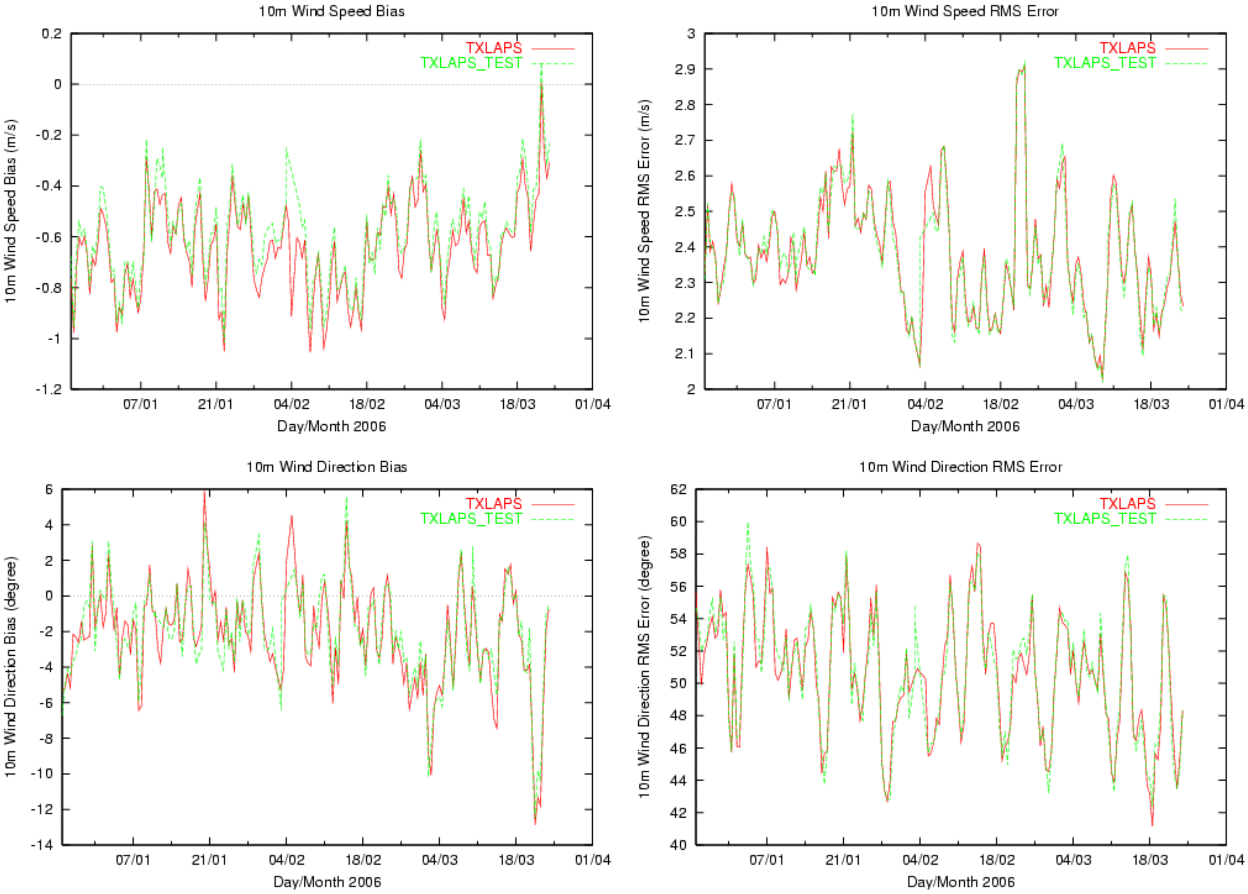


Figure 3. Surface weather element comparison between the L29 TXLAPS_PT375 (TXLAPS) and the L51 TXLAPS_PT375 (TXLAPS_TEST) errors averaged over all (approx. 297) available METAR sites and over all hourly model forecast periods out to +48 hrs for a) Bias and b) Root Mean Square (RMS) Error.

Product Availability

3 products which are available on the Bureau of Meteorology web pages have changed name

Old Name	New name
IDYTX107.050.*HHH*.gif	IDYTX107.048.*HHH*.gif
IDYTX107.9943.*HHH*.gif	IDYTX107.9950.*HHH*.gif
IDYTX108.9943.*HHH*.gif	IDYTX108.9950.*HHH*.gif

Where *HHH* is 000, 006…. 072

Real-Time Database (rtdb)

Sigma and pressure level data from TXLAPS_PT375 is written to the real time database (rtdb) during each model run. Forecast fields out to +72 hours are available for the full domain, in 6 hourly intervals. The database currently holds TXLAPS_PT375 model fields for the last 8 days and analysis fields for the past 32days.

TXLAPS_PT375 runs on a 420x250 horizontal grid and on 51 sigma levels in the vertical. However due resource limitations (both in terms of CPU power and disc storage), the multi-level fields are put into NMOC's real-time data base (rtdb3) at a coarser horizontal resolution of 210x125 and only a small number of single-level fields are available in rtdb3 at the full horizontal resolution of 420x250. Tables 6a and 6b show the TXLAPS_PT375 fields which are available through rtdb3.

FIELD (Common Name)	FIELD (rtdb Name)	surface	isbr_lvl	sgma_lvl	UNITS
air temperature	air_temp	Yes	Yes	Yes	K
wind u-component	wnd_ucmp	Yes	Yes	Yes	$m\ s^{-1}$
wind v-component	wnd_vcmp	Yes	Yes	Yes	$m\ s^{-1}$
wind speed	wnd_spd	No	Yes	No	$m\ s^{-1}$
pressure	pres	Yes (and MSL)	No	No	pa
precipitation	prcp	Yes	No	No	mm
geopotential height	geop_ht	No	Yes	Yes	m
mixing ratio	mix_rat	No	Yes	Yes	$kg\ kg^{-1}$
vertical velocity	omega	No	Yes	Yes	$pa\ s^{-1}$
dew point temperature	dwpt	No	Yes	No	K
vorticity	vor	No	Yes	No	s^{-1}
relative humidity	rel_hum	No	Yes	No	%
total-totals index	tot_tot	Yes	No	No	-
topography	topg	Yes	No	No	m

Table 6a: Coarse resolution TXLAPS_PT375 fields in the NMOC rtdb3.
Horizontal Resolution: 210x125 lat-lon grid
Vertical Resolution: 51 sigma levels (sgma_lvl), as shown in table 2.
12 pressure levels (isbr_lvl): 1000, 950, 900, 850, 700, 500, 400, 300, 250, 200, 150, 100 hPa (Note: Dew point temperatures, Mixing Ratio and Relative Humidity are only ingested to 300hpa.)
Temporal Resolution: 6-hourly from 00 to +72 (at 00 and 12UTC)

FIELD (Common Name)	FIELD (rtdb Name)	surface	isbr_lvl	sgma_lvl	UNITS
screen air temperature	air_temp	Yes	No	No	K
surface (10m) wind u-component	wnd_ucmp	Yes	No	No	$m\ s^{-1}$
surface (10m) wind v-component	wnd_vcmp	Yes	No	No	$m\ s^{-1}$
precipitation	prcp	Yes	No	No	mm
screen dew point temperature	dwpt	Yes	No	No	K

Table 6b: Full resolution TXLAPS_PT375 fields in the NMOC rtdb.
Horizontal Resolution: 420x250 lat-lon grid
Vertical Resolution: At present, only selected single level fields are ingested at high resolution.
Temporal Resolution: 1-hourly from 00 to +72 (at 00 and 12UTC)

McIdas & KENNY

ADDENAME	Gridfiles copied to NTRO	Comments
ANWPR/TXLAPS	2201-2213	Pressure level fields
ANWPR/TXLAPS-SIGMA	2401-2413	31 sigma level fields*
ANWPR/TXLAPS-HR	2001-2072	Hourly surface fields
ANWPR/TXLAPS-ISEN	2601-2613	Isentropic surfaces

Web

Under the Meteorological and Oceanographic Analyses & Prediction Information page..
http://www.bom.gov.au/nmoc

Archives

Data from TXLAPS_PT375 will continue to be archived on SAM-FS with the same name format as before:

BIAS files	*[1]	/samnmc/trop/bias/yyyy/yyyymmddhh/*
Observational boxfiles		/samnmc/trop/box/yyyy/tropbox.tropx375.mmdd.hh.nN.ieeeseq
TC Bogus file		/samnmc/trop/bogus/yyyy/tropbogus.tropx375.mmdd.hh.n1.asc
TD Bogus files		/samnmc/trop/bogus/yyyy/tropbogus.tropx375.mmdd.hh.td.asc
CTT nudging files		/samnmc/trop/cttnudg/yyyy/cttnudg.tropx375.mmdd.hh.n1.cray
Climate files:		/samnmc/trop/climate/yyyy/climate.tropx375.mmdd.hh.n1.nc
boxfiles	*[2]	/samnmc/trop/box/yyyy/tropbox.tropx375. mmdd.hh.n1.ieeeseq
Output boxfiles	*[1]	/samnmc/trop/box/yyyy/tropbox.tropx375.box1_qc_N_mmdd.hh.ieeeseq
Boundary files	*[1]	/samnmc/trop/anal/yyyy/tropprep.txlaps375. mmdd.hh.ncM.nc
Analysis output	*[2]	/samnmc/trop/anal/yyyy/tropanal.tropx375.mmdd.hh.nN.nc
Model output	*[2]	/samnmc/trop/prog/yyyy/tropprog.txlaps375.mmdd.hh.0ii. nN.nc

Variables in the names above are:

yyyy	4 digit year, i.e. 2006
mmdd	4 digit month and day, i.e. 0805 is 5th August
hh	2 digit hour of model/analysis run, either 06, 12, 18 or 00
ii	2 digit hour of model output, 00 to 72
M	1 or 2 digit integer counter (1 to 17) for six-hourly boundary files
N	N=1,2 or 3 for the assimilation cycle.

*[1] *Note: these files were not available for L29 TXLAPS_PT375*

[2] Note: these files are approximately twice the size of the files for the L29 version of TXLAPS_PT375.

Future Developments

- Upgrade L51 TXLAPS_PT375 and L51 TCLAPS (running in test mode) to run across multiple nodes. Once L51 TCLAPS is running across multiple nodes process for installing it as operational version can begin.
- Upgrade of TCLAPS model including
    - Increase vertical resolution from 29 levels to 51 levels.
    - Increase grid resolution from 0.15 degrees to 0.10 degrees
    - Enlarge model domain from 27degrees to 30 degrees.
    - upgrade of data assimilation, analysis and model as per L51 TXLAPS_PT375
    - Use of TXLAPS_PT375 as large scale environment (current version generates its own large scale environment).
- Test and operationally implement new L29 level TC Genesis LAPS(TCG-LAPS). Testing in BMRC has indicated that this new LAPS configuration provides encouraging forecast guidance on developing and non-developing tropical depressions.
- Upgrade 51 level TXLAPS_PT375 to 60 level assimilation and prediction, with enhanced surface grid fields and physics, and the use of global and direct read-out satellite radiances during assimilation. Uncertain at this stage if TCLAPS will move to 60 levels. TXLAPS may also move to a 0.250 degree grid spacing after the move to 60 levels.
- Introduction of the new scripts developed by Ilia Bermous in BMRC to allow a common environment (scripts, file names, environment variables, etc) to handle running of GASP and the LAPS suite(including TXLAPS and TCLAPS) in research and operational modes. Introduction of these is expected to come with the move to 60 sigma levels.
- UKMO access model.

References

Davidson, N.E. and Weber, H.C. “The BMRC High-Resolution Tropical Cyclone Prediction System: TC-LAPS” *Mon.Wea.Rev*,. 128, 1245-1265, 2000.

Dare, R., “Bulk Explicit Microphysics in the LAPS models”, *BMRC Research Report No. 90,* 95-98, 2002.

Harris B. A., Steinle P. and Paevere J., 2000, “Use of ATOVS Radiances in the 1DVAR/GASP Data Assimilation System”, Tech. Proc. ITSC-XI Budapest, Hungary 20-26 September 2000.

Viterbo, P., 1996: “The representation of surface processes in general circulation models”, PhD Thesis, University of Lisbon, 201 pp

McBride, J. and Ebert, E “Verification of Quantitative Precipitation Forecasts from Operational Numerical Weather Prediction Model over Australia”, Weather and Forecasting, Vol 15, 103-121, Feb 2000.