

**Intensifying Australian heatwave trends and their sensitivity to observational data**

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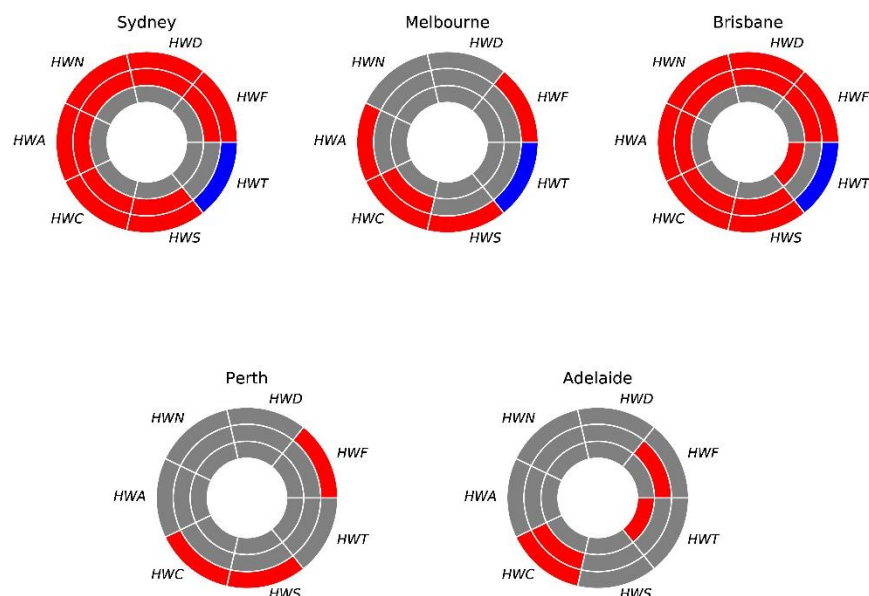
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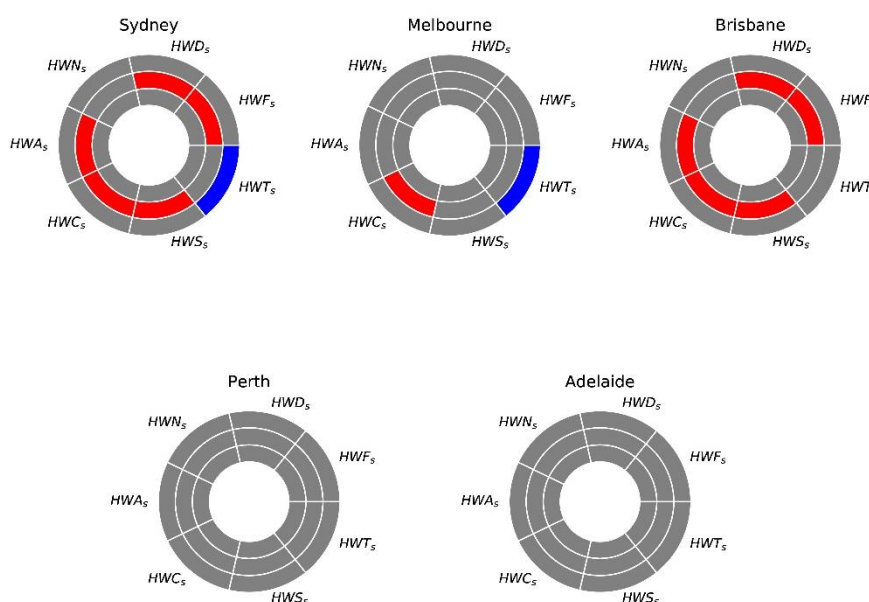
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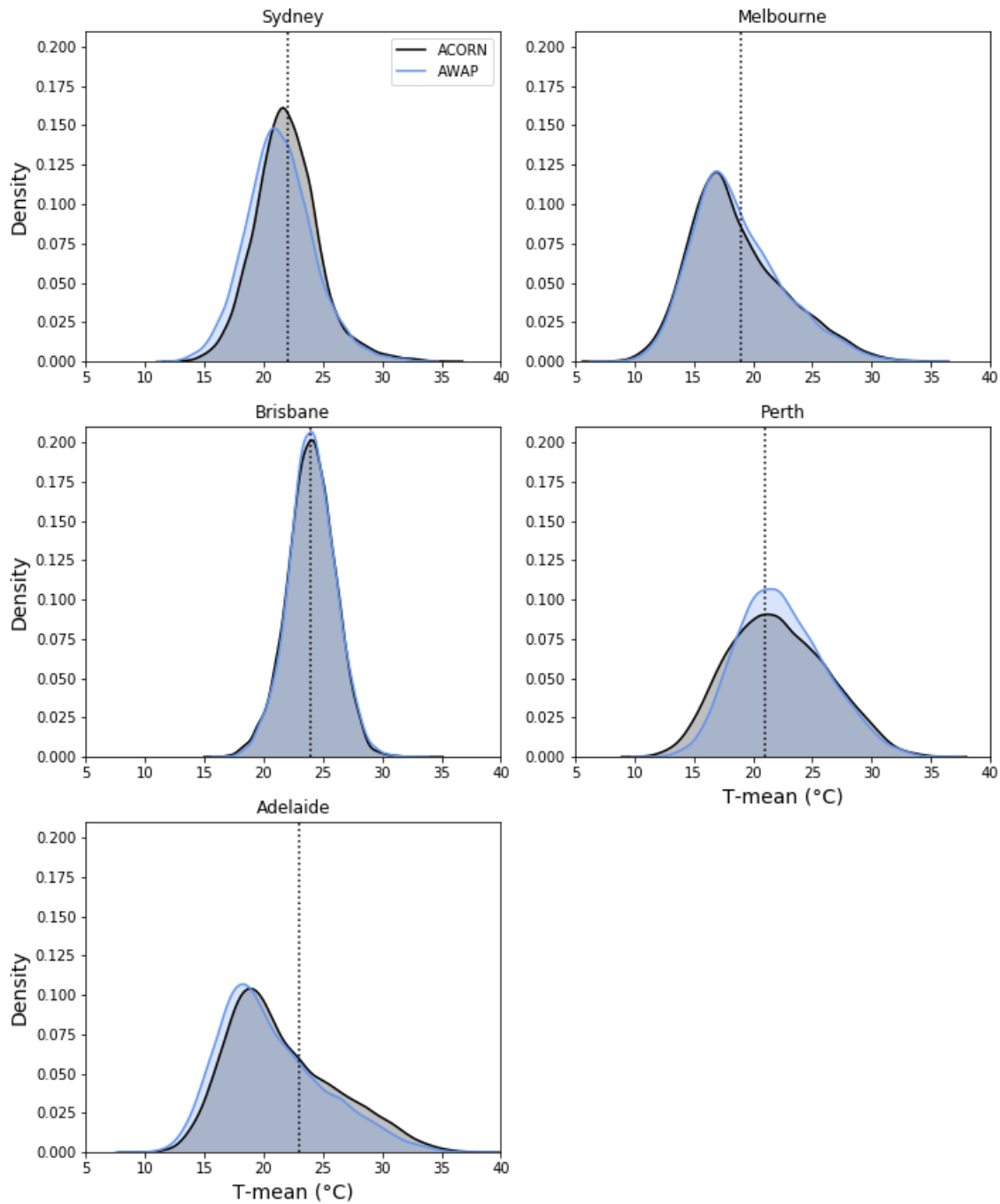
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**Figure S1.** Trend donut plot of heatwave metrics of the corresponding cities using the AWAP data. Sen slope magnitude and Mann-Kendall significance test results of trends are represented as red (statistically significant increasing trend), grey (no statistically significant trend or no trend), blue (statistically decreasing trend), and black (no data). The outermost ring of donut represents the trends for the full study period (1911-2019), the innermost ring represents the trends for the first half period (1911-64), and the middle ring represents the trends for the second half (1965-2019). Each segment represents the respective heatwave metric.

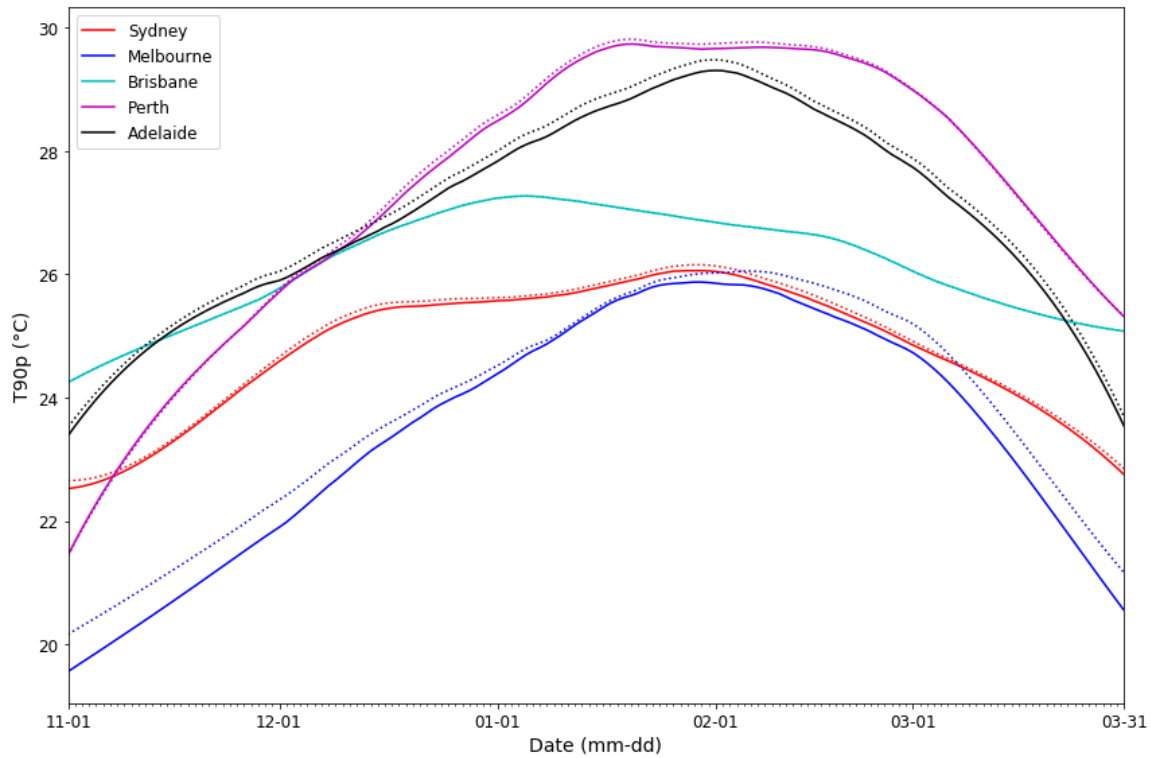


**Figure S2.** Same as fig. S1 but for severe heatwave metrics.



**Figure S3.** The probability distribution plots of extended summer daily mean temperature (T) of ACORN\_SATV2 (black line with grey shading) and AWAP (blue line with blue shading) at various selected cities for the time-period 1911-2019 (from Nov-1911 to Mar-2019) except for Brisbane (1950-2019). The dashed vertical line in each plot

indicates the minimum extended summer daily  $T_{90}$  value in the base period 1961-90 of the respective city.



**Figure S4.** Daily variations of the  $T_{90}$  (90<sup>th</sup> percentile of mean temperature) values of 1961-90 base period at the selected cities calculated from the ACORN\_SATV2 (dotted line) and AWAP (solid line).

**Table S1.** Extended summer season (Nov-Mar) trends of heatwave metrics in various selected cities for the period 1911-2019 (i.e., from Nov 1911 to Mar 2019). The trend magnitudes are calculated using the Sen slope. Red coloured values represent statistically significant increasing trends, blue represents statistically significant decreasing trends and black represents not significant. The significance is tested using M-K test and significance level is set to 0.05.

City	HWF (days/decade)		HWF <sub>s</sub> (days/decade)		HWD (days/decade)		HWD <sub>s</sub> (days/decade)		HWN (#/decade)		HWN <sub>s</sub> (#/decade)	
	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN
Sydney	0.52	0.26	0	0	0.23	0	0	0	0.11	0	0	0
Melbourne	0.10	0	0	0	0	0	0	0	0	0	0	0
Brisbane	0.96	No data	0	No data	0.32	No data	0	No data	0.21	No data	0	No data
Perth	0.42	0.48	0	0	0	0	0	0	0	0.12	0	0
Adelaide	0	0.31	0	0	0	0	0	0	0	0	0	0

City	HWA (°C <sup>2</sup> /decade)		HWA <sub>s</sub> (°C <sup>2</sup> /decade)		HWM (°C <sup>2</sup> /decade)		HWM <sub>s</sub> (°C <sup>2</sup> /decade)		HWC (°C <sup>2</sup> /decade)		HWC <sub>s</sub> (°C <sup>2</sup> /decade)	
	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN
Sydney	<b>0.94</b>	<b>0.32</b>	<b>0</b>	<b>0</b>	<b>0.18</b>	0	<b>0</b>	<b>0</b>	<b>2.89</b>	<b>1.27</b>	<b>0</b>	<b>0</b>
Melbourne	<b>0.03</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2.92</b>	<b>2.29</b>	<b>0</b>	<b>0</b>
Brisbane	<b>0.40</b>	No data	<b>0</b>	No data	<b>0.09</b>	No data	<b>0</b>	No data	<b>2.05</b>	No data	<b>0</b>	No data
Perth	0.10	<b>0.28</b>	0	0	0	0	0	0	<b>2.53</b>	<b>2.85</b>	0	0
Adelaide	0.24	<b>2.04</b>	0	<b>0</b>	<b>0.29</b>	<b>0.81</b>	0	<b>0</b>	<b>3.07</b>	<b>7.34</b>	0	<b>0</b>

City	HWS (days/decade)		HWS <sub>s</sub> (days/decade)		HWT (day of the year/decade)		HWT <sub>s</sub> (day of the year/decade)		HWL (day of the year/decade)		HWL <sub>s</sub> (day of the year/decade)	
	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN
Sydney	<b>0.36</b>	<b>0.25</b>	<b>0</b>	<b>0</b>	<b>-8.29</b>	<b>-6.52</b>	<b>-11.59</b>	<b>-8.33</b>	1.25	1.57	-4.52	-6.15
Melbourne	<b>0.23</b>	<b>0.15</b>	<b>0</b>	<b>0</b>	<b>-6.21</b>	<b>-7.03</b>	<b>-12.16</b>	<b>-12.30</b>	1.66	-0.23	0.50	-1.57
Brisbane	<b>1.33</b>	No data	<b>0</b>	No data	<b>-4.16</b>	No data	-5.71	No data	<b>2.22</b>	No data	2.91	No data
Perth	<b>0.67</b>	<b>0.78</b>	0	<b>0</b>	-2.47	-2.75	-0.89	-2.25	<b>5.87</b>	<b>5.00</b>	3.37	<b>13.00</b>
Adelaide	0	0.23	0	<b>0</b>	-1.81	0.22	-1.47	-1.31	0.39	-1.80	-2.50	-0.75

**Table S2.** Same as table S1 but for the period 1911-64 (i.e., from Nov 1911 to Mar 1964).

City	HWF (days/decade)		HWF <sub>s</sub> (days/decade)		HWD (days/decade)		HWD <sub>s</sub> (days/decade)		HWN (#/decade)		HWN <sub>s</sub> (#/decade)	
	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN
Sydney	0	0	0	0	0	0	0	0	0	0	0	0
Melbourne	0	0	0	0	0	0	0	0	0	0	0	0
Brisbane	0	No data	<b>0</b>	No data	0	No data	<b>0</b>	No data	0	No data	<b>0</b>	No data
Perth	0	0	0	0	0	0	0	0	0	0	0	0
Adelaide	0	0	0	0	0	0	0	0	0	0	0	0

City	HWA (°C <sup>2</sup> /decade)		HWA <sub>s</sub> (°C <sup>2</sup> /decade)		HWM (°C <sup>2</sup> /decade)		HWM <sub>s</sub> (°C <sup>2</sup> /decade)		HWC (°C <sup>2</sup> /decade)		HWC <sub>s</sub> (°C <sup>2</sup> /decade)	
	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN
Sydney	0	0	0	0	0	0	0	0	0	0	0	0
Melbourne	0	0	0	0	0	0	0	0	0	0	0	0
Brisbane	-0.18	No data	0	No data	-0.06	No data	0	No data	-0.05	No data	0	No data
Perth	0	0	0	0	0	0	0	0	0	0	0	0
Adelaide	0	0	0	0	0	0	0	0	0	0	0	0

City	HWS (days/decade)		HWS <sub>s</sub> (days/decade)		HWT (day of the year/decade)		HWT <sub>s</sub> (day of the year/decade)		HWL (day of the year/decade)		HWL <sub>s</sub> (day of the year/decade)	
	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN
Sydney	0	0	0	0	-5.00	8.15	21.18	16.25	-1.25	6.25	-22.93	-6.0
Melbourne	0	0	0	0	4.28	4.54	-11.45	-10	10.55	16.66	-21.04	-10

Brisbane	0	No data	0	No data	13.43	No data	-2.85	No data	5.50	No data	10	No data
Perth	0	0	0	0	9.09	7.55	1	12.25	5.00	4.18	-4.76	17.14
Adelaide	0	0	0	0	13.75	9.54	-6.15	-5.44	14.16	4.00	-18.18	-11.16

**Table S3.** Same as table S2 but for the period 1965-2019 (i.e., from Nov 1965 to Mar 2019).

City	HWF (days/decade)		HWF <sub>s</sub> (days/decade)		HWD (days/decade)		HWD <sub>s</sub> (days/decade)		HWN (#/decade)		HWN <sub>s</sub> (#/decade)	
	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN
Sydney	1.74	0.69	0.88	0	0.54	0	0.58	0	0.32	0	0	0
Melbourne	0.66	0.51	0	0	0	0	0	0	0	0	0	0
Brisbane	3.00	1.36	1.33	0	0.83	0.20	0.83	0	0.66	0.29	0	0
Perth	0	0	0	0	0	0	0	0	0	0	0	0
Adelaide	0.85	1.20	0	0.47	0.19	0.22	0	0	0	0.25	0	0

City	HWA (°C <sup>2</sup> /decade)		HWA <sub>s</sub> (°C <sup>2</sup> /decade)		HWM (°C <sup>2</sup> /decade)		HWM <sub>s</sub> (°C <sup>2</sup> /decade)		HWC (°C <sup>2</sup> /decade)		HWC <sub>s</sub> (°C <sup>2</sup> /decade)	
	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN
Sydney	2.50	1.08	1.91	0	0.36	0.07	0.37	0	11.61	4.41	10.14	0
Melbourne	1.31	2.62	0	0	0.21	0.90	0	0	17.61	16.03	4.32	2.29
Brisbane	1.07	0.40	0.58	0	0.17	0.004	0.08	0	7.84	2.28	4.53	0
Perth	0	0.93	0	0	-0.06	0.30	0	0	1.50	5.06	0	0
Adelaide	2.15	5.36	0	2.60	1.42	2.17	0	1.40	18.81	28.60	0	15.28

City	HWS (days/decade)		HWS <sub>s</sub> (days/decade)		HWT (day of the year/decade)		HWT <sub>s</sub> (day of the year/decade)		HWL (day of the year/decade)		HWL <sub>s</sub> (day of the year/decade)	
	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP	ACORN
Sydney	1.50	0.95	0.83	0	-4.09	-3.38	-8.94	-4.28	8.39	5.77	-1.66	-6.47
Melbourne	1.07	0.68	0	0.15	-13.63	-11.36	-23.46	-19.44	-2.30	-11.08	-4.85	-12.91
Brisbane	7.69	0.82	1.21	0	-3.17	-4.78	3.33	10	2.24	-1.42	5.47	3.33
Perth	1.00	1.17	0	0	-5.29	2.10	-10.21	-10.76	10.76	4.28	-5.63	-3.00
Adelaide	0.86	1.87	0	0.44	-3.00	-7.45	-10.55	-5.38	-1.42	-0.54	-5.14	0

**Table S4.** Some of the days where heatwaves are mismatched between two datasets (ACORN\_SATV2 and AWAP) in Sydney. Red colored highlighted values refer to a heatwave period. The heatwave is identified with the ACORN\_SATV2 data on 16, 17, and 18-02-1982. While there is no heatwave observed using the AWAP data due to negative EHF value on 16-02-1982. This shows that a slight deviation in the daily temperature values can create a difference in the identification of heatwave period.

Date	T <sub>90</sub> (°C)		T-mean (°C)		EHL <sub>sig</sub> (°C)	
	ACORN	AWAP	ACORN	AWAP	ACORN	AWAP
1982-02-14	26.01	25.70	23.95	23.02	-1.60	-1.51
1982-02-15	25.96	25.65	24.75	24.01	-1.51	-1.92
1982-02-16	25.90	25.61	30.15	28.45	<b>0.38</b>	-0.45
1982-02-17	25.84	25.56	24.70	26.15	<b>0.69</b>	<b>0.64</b>
1982-02-18	25.78	25.51	24.80	25.09	<b>0.77</b>	<b>1.05</b>
1982-02-19	25.72	25.46	24.00	22.17	-1.72	-0.99
*****	*****	*****	*****	*****	*****	*****
1988-02-27	25.26	25.03	24.15	25.09	-2.10	-1.72
1988-02-28	25.20	24.97	28.20	26.12	<b>0.01</b>	-0.16
1988-02-29	25.14	24.91	23.85	22.98	<b>0.26</b>	-0.18
1988-03-01	25.14	24.91	24.75	24.80	<b>0.46</b>	-0.28
1988-03-02	25.08	24.85	24.15	24.06	-0.83	-0.91
*****	*****	*****	*****	*****	*****	*****

1996-11-13	23.58	23.11	26.35	24.78	-0.10	-4.01
1996-11-14	23.65	23.18	29.20	28.48	<b>1.41</b>	<b>0.69</b>
1996-11-15	23.72	23.25	21.50	22.40	<b>1.96</b>	<b>1.97</b>
1996-11-16	23.80	23.33	19.65	19.82	-0.35	<b>0.23</b>
*****	*****	*****	*****	*****	*****	*****
1998-12-12	25.59	25.44	24.90	26.43	-0.76	<b>0.13</b>
1998-12-13	25.62	25.47	27.30	27.04	<b>0.21</b>	<b>1.10</b>
1998-12-14	25.64	25.50	26.05	26.63	<b>0.44</b>	<b>1.20</b>
1998-12-15	25.66	25.52	20.35	19.73	-1.10	-1.06
*****	*****	*****	*****	*****	*****	*****
2000-03-18	24.19	23.94	25.15	26.90	<b>0.32</b>	<b>1.58</b>
2000-03-19	24.14	23.87	24.20	24.33	<b>0.76</b>	<b>1.88</b>
2000-03-20	24.08	23.80	22.40	22.15	-0.14	<b>0.66</b>
2000-03-21	24.03	23.72	18.35	17.89	-2.38	-2.27