

Supplementary Material

A historical monthly upper-air humidity dataset for Australia

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Table S1. The potential causes for inhomogeneities in upper-air temperature data series that were found in station history files.

Station number	Astor 402 MHz	Philips Mark I	Philips Mark II	Philips Mark 2.5	Philips Mark III	Vaisala RS 80	PC Cora	Autosonde/ DigiCora	Vaisala RS92	Vaisala RS41
3003	Jun-1965	1976–77	Jul-1979	Aug-1982	Feb-1983	Mar-1988	May-1991	Jun-2004	Jul-2006	Jun-2018
4032	1964	1976–77	May-1979	Jul-1982	Feb-1983	Mar-1988	Nov-1990	May-1998	Aug-2005	Nov-2017
5007	1964	1976–77	Nov-1978	Aug-1982	Jan-1983	Jul-1988	May-1991	Dec-1997	Oct-2005	Nov-2017
9021	1964	1976–77	Nov-1979	-	Apr-1983	Jun-1987	Mar-1991	Jun-2004	Aug-2006	Apr-2018
9741	Jul-1965	1976–77	Nov-1978	Aug-1982	Aug-1983	Sep-1987	Mar-1991	Feb-2005	Sep-2006	Mar-2018
9789	Jun-1969	1976–77	Nov-1978	Aug-1982	Dec-1982	Oct-1987	Mar-1991	Sep-2005	Aug-2006	Mar-2018
12038	1964	1976–77	Nov-1978	Aug-1982	Feb-1983	Nov-1987	Apr-1991	Oct-2000	Jun-2006	-
13017	1964	1976–77	Jan-1980	-	Mar-1983	Jul-1988	Aug-1991	-	Jul-2006	Mar-2019
14015	1964	1976–77	Nov-1978	Aug-1982	Dec-1982	Jun-1987	May-1991	Jun-2004	Jan-2006	Jul-2018
15590	1964	1976–77	May-1979	Feb-1983	Aug-1983	Aug-1987	May-1991	Jun-2004	Jun-2006	Aug-2018
23034	1964	1976–77	Apr-1979	^A	Nov-1982	Jun-1987	Apr-1991	Jun-2004	Aug-2006	Mar-2018
29127	May-1975	1976–77	Oct-1978	Feb-1983	Jul-1983	Jan-1988	Apr-1991	Oct-1998	Jun-2006	Jul-2017
32040	1964	1976–77	Aug-1979	Aug-1982	Feb-1983	Jan-1988	Jul-1991	Jul-2004	May-2006	Mar-2018
39083	Feb-1974	1976–77	Oct-1978	Jul-1982	Apr-1983	Oct-1987	Apr-1993	Jan-2005	Jun-2006	Jun-2018
40842	1964	1976–77	Oct-1978	-	Mar-1983	Jun-1987	Apr-1991	Sep-2004	Mar-2007	Apr-2018
44021	1964	1976–77	Feb-1980	Aug-1982	Feb-1983	Jun-1987	May-1991	Dec-2000	Sep-2005	Apr-2018
48027	1964	1976–77	Oct-1978	Jul-1982	Oct-1983	Sep-1987	Apr-1991	May-1997	Apr-2006	Jan-2018
53115	Apr-1964	1976–77	Oct-1978	Sep-1982	Mar-1983	Oct-1987	Apr-1991	Jun-2000	May-2006	Jun-2017
61078	1964	1976–77	Oct-1978	-	Apr-1983	Feb-1988	Mar-1991	-	Mar-2006	May-2017
72150	Nov-1965	1976–77	Sep-1978	Jul-1982	Feb-1983	Feb-1988	May-1991	Aug-2005	Aug-2006	Sep-2018
86282	1964	1976–77	Sep-1978	Jul-1982	Mar-1983	Jun-1987	Oct-1990	Aug-2004	Jun-2006	Mar-2018
94008	1964	1976–77	Aug-1979	-	May-1983	Aug-1988	Mar-1991	Jun-2004	Jun-2006	Aug-2018
200283	1964	1976–77	1978–79	-	Mar-1983	Dec-1987	Jul-1991	-	Oct-2006	Apr-2019
200284	Dec-1972	1976–77	1978–79	-	-	Jan-1987	Nov-1990	Oct-1997	Nov-2006	Sep-2018
200288	1964	1976–77	Aug-1979	Aug-1982	Apr-1983	Dec-1987	Jun-1991	Oct-2005	Nov-2006	Jul-2018
200839	1964	1976–77	Aug-1979	Aug-1982	Feb-1983	Mar-1988	Jun-1991	May-2005	Oct-2006	Mar-2018
300004	1964	1976–77	Dec-1979	-	Dec-1983	Jan-1988	-	Sep-2005	Apr-2006	Oct-2019

Indicated are the month and year in which new radiosonde types or models and new procedures were introduced. Types of radiosondes: Astor, models 72 and 402 MHz; Mark, models I, II, 2.5 and III; Vaisala, models RS80, RS92 and RS41, PC-Cora and Austosonde/Digicora: automated systems.

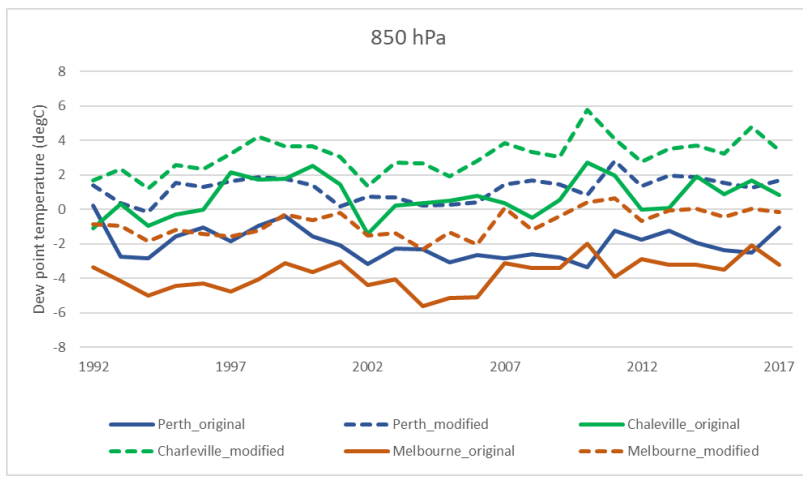
^AFor Adelaide: from Jun-1980 to Mar-1981: Vaisala RS21; then back to Mark II.

Table S2. Trends (based on annual data) estimated from the unhomogenised modified and homogenised modified DWPT data for the period 1965–2017.

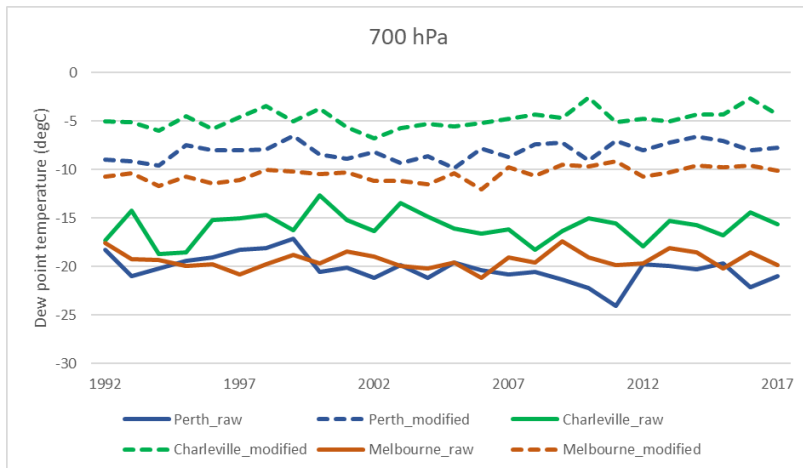
Station number	DWPT 850 modif.		DWPT 700 modif.		DWPT 500 modif.		DWPT 400 modif.	
Broome 3003	0.484		0.622		0.713		-	
	0.40*	1983 (+0.4)	0.30*	1983 (+1.3)	0.24	1988 (+1.7)		
Port Hedland 4032	0.537		0.789		0.904		0.525	
	0.35*	1983 (+0.8)	0.49*	1983 (+1.2)	0.43*	1988 (+1.7)	0.12	1988 (+1.4)
Learmonth 5007	0.789		1.253		1.22		0.971	
	0.01	1983 (+1.1), 1994 (+1.8)	0.31*	1983 (+1.5), 1988 (+2.0)	0.14	1988 (+3.7)	0.24	1988 (+2.5)
Perth 9021	0.535		0.899		0.741		0.472	
	-0.11	1983 (+1.9), 2006 (+0.9)	0.38*	1983 (+2.0)	0.07	1987 (+1.9), 2011 (+1.4)	0.08	1987 (+1.1), 2011 (+0.7)
Albany 9999	0.520		0.816		0.676		0.495	
	-0.09	1983 (+1.5), 2006 (+1.1)	0.21	1983 (+2.1), 2011 (+0.6)	0.10	1983 (+2.6), 2011 (-0.7)	0.10	1983 (+1.6), 2011 (-0.3)
Esperance 9789	0.506		0.845		0.638		0.385	
	0.10	1983 (+0.9), 2006 (+0.8)	0.13	1983 (+0.8), 1988 (+1.3), 2006 (+0.7)	0.37*	1983 (+1.0)	0.17	1987 (+0.7)
Kalgoorlie-Boulder 12038	0.498		0.866		0.718		0.438	
	0.06	1983 (+1.3), 2006 (+0.6)	0.11	1983 (+2.1), 2006 (+1.2)	0.38*	1987 (+1.1)	0.10	1987 (+0.5), 2011 (+1.6)
Giles 13017	0.391		0.643		0.718		0.514	
	0.19	1983 (+0.3), 2006 (+0.7)	0.31*	1983 (+0.8), 2010 (+0.9)	0.18	1988 (+2.1)	0.12	1988 (+1.5)
Darwin 14015	0.405		0.499		0.801		0.583	
	0.10	1983 (+1.2)	0.20	1983 (+1.2)	0.27*	1987 (+1.6), 2006 (+0.4)	0.27*	1987 (+0.9), 2006 (+0.3)
Alice Springs 15590	0.437		0.718		0.818		0.489	
	0.14	1983 (+0.3), 2006 (+1.2)	0.27*	1983 (+0.8), 2010 (+1.6)	0.21	1987 (+2.1)	0.06	1987 (+1.5)
Adelaide 23034	0.481		0.785		0.597		0.373	
	0.04	1983 (+1.2), 2006 (+0.8)	0.21	1987 (+1.7), 2011 (+1.0)	0.26*	1987 (+0.7), 2011 (+1.2)	0.06	1987 (+0.9), 2011 (+0.7)
Mt Isa 29127	0.387		0.528		0.698		0.688	
	-0.13	1983 (+1.1), 2006 (+1.0)	-0.17	1983 (+1.2), 2006 (+1.6)	0.34*	1983 (+1.7)	0.33*	1988 (+1.2)
Townsville 32040	0.382		0.553		0.694		0.635	
	-0.19	1983 (+1.5), 2006 (+2.1)	0.03	1983 (+1.3), 2006 (+1.0)	-0.07	1988 (+1.9), 2006 (+1.3)	-0.07	1988 (+1.5), 2006 (+1.4)
Rockhampt. 39083	0.486		0.750		0.674		0.496	
	-0.19	1983 (+1.2), 2006 (+1.5)	0.02	1987 (+1.3), 2006 (+1.3)	0.21	1987 (+1.6)	0.20	1987 (+1.0)
Brisbane 40842	0.464		0.728		0.645		0.389	
	-0.10	1983 (+1.3), 2006 (+1.6)	0.24	1987 (+1.8)	-0.05	1987 (+2.5)	0.02	1987 (+1.3)
Charleville 44021	0.50		0.723		0.798		0.595	
	0.11	1983 (+0.7), 2006 (+1.1)	0.25	1983 (+1.3), 2006 (+0.7)	0.38*	1987 (+1.5)	0.19	1987 (+1.5)
Cobar 48027	0.478		0.889		0.698		0.462	
	0.22	1983 (+1.0)	0.38*	1983 (+2.0)	0.34*	1987 (+1.4)	0.27*	1987 (+0.7)
Moree 53115	0.530		0.852		0.832		0.505	
	0.10	1983 (+0.8), 2006 (+1.1)	0.09	1983 (+2.2), 2006 (+1.0)	0.11	1983 (+1.6), 1995 (+1.1)	0.15	1987 (+1.2)
Williamtown 61078	0.548		0.795		0.663		0.425	
	0.20	1983 (+1.4)	0.28*	1983 (+1.0), 1988 (+1.0)	0.18	1983 (+0.1), 1988 (+1.6)	0.23	1988 (+0.7)
Wagga Wagga 72150	0.533		0.904		0.736		0.410	
	-0.07	1983 (+1.4), 2006 (+1.3)	0.24	1983 (+1.9), 2006 (+1.0)	0.33*	1988 (+1.4)	0.16	1988 (+0.9)
Melbourne 86282	0.474		0.717		0.565		0.373	
	-0.05	1983 (+1.4), 2006 (+0.9)	0.12	1983 (+1.8), 2006 (+0.8)	0.22	1987 (+1.3)	0.28*	1987 (+0.3)
Hobart 94008	0.450		0.663		0.594		0.352	
	-0.12	1983 (+1.5), 2006 (+0.9)	0.08	1983 (+1.8), 2006 (+0.7)	0.10	1983 (+1.2), 2006 (+0.9)	0.05	1983 (+0.6), 2006 (+0.6)
Willis Is. 200283	0.539		0.572		0.724		0.544	
	-0.06	1983 (+0.9), 2006 (+1.7)	0.15	1983 (+0.2), 2006 (+1.8)	0.04	1983 (+1.6), 2006 (+1.3)	0.06	1983 (+0.9), 2006 (+1.2)
Cocos Is. 200284	0.584		0.680		0.881		0.767	
	-0.20	1983 (+2.3),	0.34*	1987 (+1.2)	0.20	1987 (+2.4)	0.10	1987 (+2.4)

Station number	DWPT 850 modif.		DWPT 700 modif.		DWPT 500 modif.		DWPT 400 modif.	
Norfolk Is. 200288	0.408	2006 (+1.1)	0.731		0.461		0.295	
	-0.002	1983 (+1.2), 2006 (+1.2)	0.08	1983 (+2.4)	0.02	1983 (+2.0)	-0.11	1988 (+1.4)
L. Howe Is. 200839	0.348		0.700		0.518		0.414	
	-0.24	1983 (+1.6), 2006 (+1.0)	0.21	1983 (+2.0)	0.29*	1988 (+1.0)	0.12	1988 (+1.0)
Macquarie Is. 300004	0.43*	-	0.553		0.298		0.245	
			0.16	1988 (+1.4)	0.19	1988 (+1.0)	0.03	1988 (+0.8)

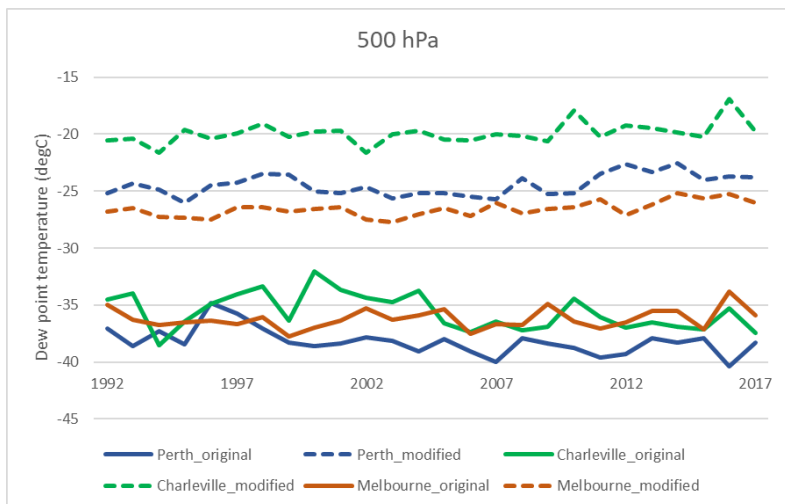
Units are degrees Celsius per decade. Trends estimated from the homogenised modified DWPT data (break points detected with 95% confidence level using log-transformed precipitation data as reference series) are shown in red. The size and year of adjustment is shown in adjacent columns. Probabilities are statistically significant are: *, $P < 0.001$.



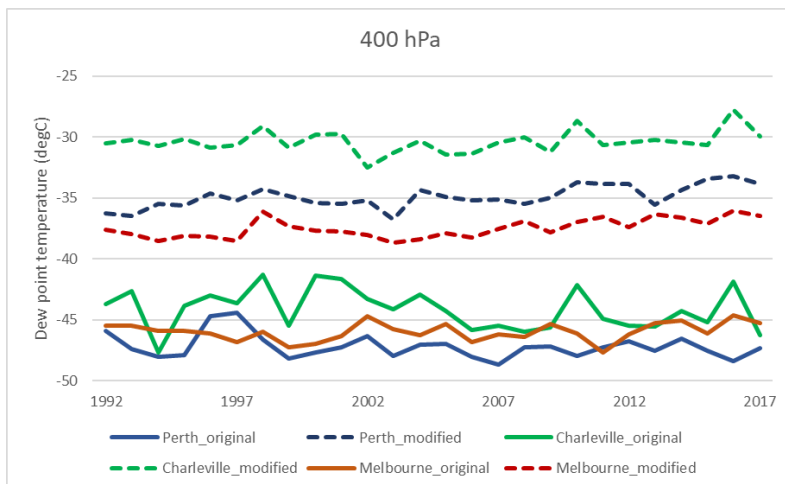
(a)



(b)

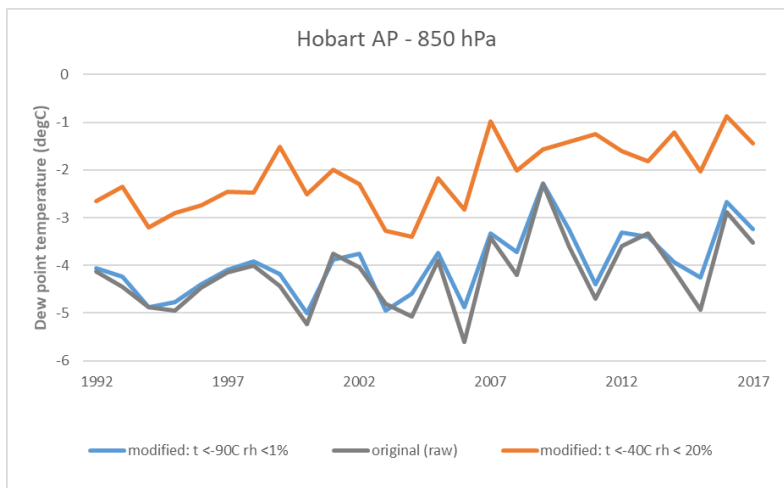


(c)

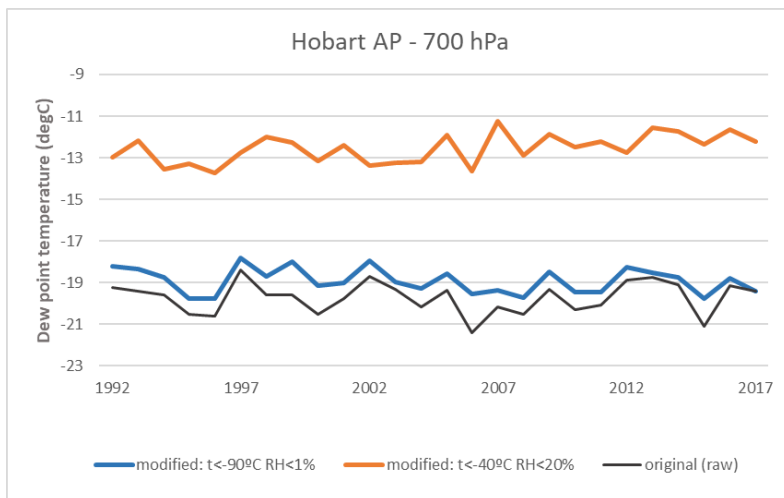
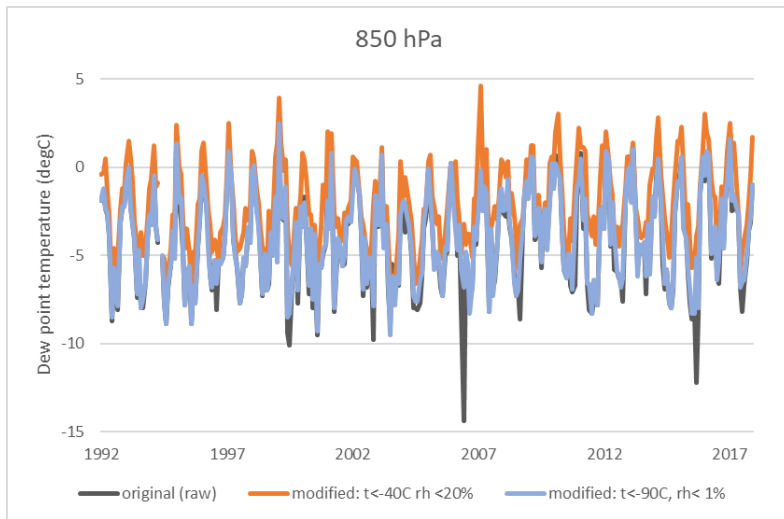


(d)

Figure S1. Comparison over the 1992–2017 period between annual mean DWPT based on the original (raw) and modified ($t < -40^{\circ}\text{C}$, $\text{rh} < 20\%$) data for Perth AP, Charleville Aero and Melbourne AP for (a) 850-, (b) 700-, (c) 500- and (d) 400-hPa levels.



(a)



(b)

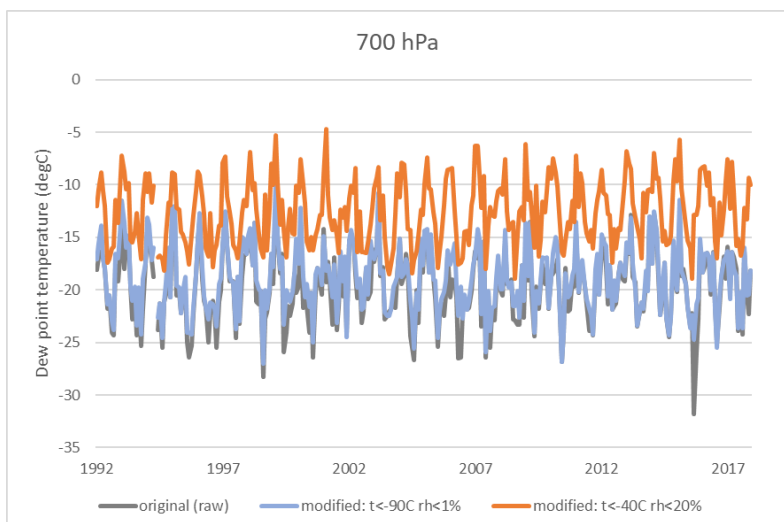
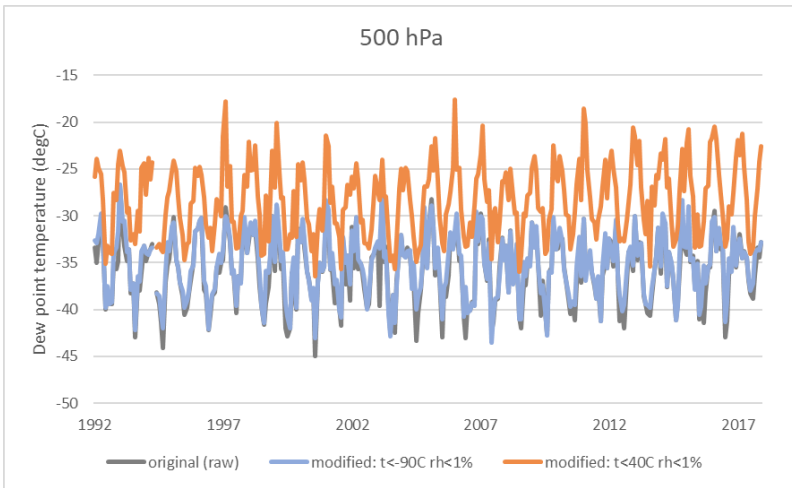
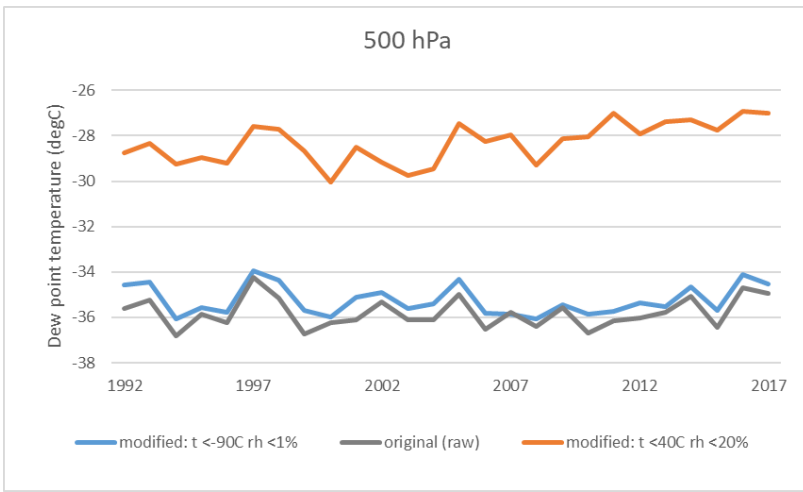


Figure S2. Comparison over the 1992–2017 period between annual mean DWPT based on the original (raw) and modified data for Hobart AP for (a) 850-, (b) 700-, (c) 500- and (d) 400-hPa levels. Modified data were produced for two different cases: $t < -40$ °C, $rh < 20\%$ and $t < -90$ °C, $rh < 1\%$. Also shown are corresponding monthly DWPT data series.

(c)



(d)

