An observation-based Southern Hemisphere Annular Mode Index

Last Revised: Wednesday 5 March, 2025

Methodology

*** January 2025 onwards: The South African Weather Service are currently unable to disseminate their data via the WMO. Therefore, the monthly mean sea level pressure data for Marion Island and Gough Island have been interpolated from the ECMWF Operational product. The resultant SAM values in the table are given in cyan. They will be updated if necessary when the original data become available. ***

The methodology is essentially the same as outlined in the paper below:

Marshall, G. J., 2003: Trends in the Southern Annular Mode from observations and reanalyses. *J. Clim.,* **16,** 4134-4143, doi:10.1175/1520-0442%282003%29016<4134%3ATITSAM>2.0.CO%3B2


Go here if you have access to online *J. Clim.* papers.

However, there have been a few subtle changes. Principally, Valdivia has been replaced with Puerto Montt because the former station is no longer operating 24/7. I currently have data for Puerto Montt station for 1960, 11 months of 1961 and then data from April 1967. For missing data a value is calculated using a monthly offset, calculated as the mean for the 1971-2000 period, from the Valdivia data. Efforts are ongoing at the Dirección Meteorológica de Chile to produce accurate monthly data from paper records prior to 1970: much of the early Valdivia data is taken from the World Weather Records dataset, which provides values only to the nearest hPa.

From August 2022 Hobart Airport (WMO 94975) has been replaced by Hobart Airport West (WMO 94619), following parallel observations for ~5 years.

From March 2003 Novolazarevskaya (WMO 89512) ceased sending out CLIMAT messages and the monthly values are calculated from 6-hourly SYNOP data.


Locations of the 12 stations used to compute zonal means at 40°S and 65°S

Also, the mean values and standard deviations are calculated for the 30-year 1971-2000 period. Thus I am now able to update the time-series when the 12 mean sea level pressure values are available. As I am dependent on other sites to obtain data from some of the extra-tropical stations there is typically a two week lag in producing a monthly value. Note that in some cases I have at present been unable to find all the data: monthly values in blue have one out of six station values missing at one or other of the two latitude bands while those in red have two. In these cases, except for early Puerto Montt data (see above), the missing value has been calculated using multiple linear regression from the other stations at the appropriate latitude. It is hoped that some of these missing data may be obtained in the future.

Data

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1957	-0.87	-2.27	0.07	-1.97	-2.50	-0.87	1.00	-1.73	0.72	-3.12	-5.42	-2.63
1958	0.04	-2.84	-2.52	-0.30	-2.72	-0.97	-1.65	0.97	1.90	-0.16	0.30	0.82
1959	1.59	-0.19	-0.54	-1.25	-0.32	-1.12	0.18	-1.64	2.46	-0.46	3.28	-0.38
1960	0.90	0.85	3.40	-0.35	-0.60	-0.17	0.31	0.43	1.41	-1.17	1.18	1.36
1961	0.91	-4.00	-0.40	-0.14	1.12	-0.40	0.98	1.10	-1.21	1.64	1.52	2.32
1962	2.34	-0.50	-0.66	1.65	-0.66	-3.41	0.33	-0.20	-0.15	-0.36	-2.25	1.35
1963	3.26	1.41	2.03	1.41	-1.09	1.82	0.41	-5.03	-1.59	2.05	1.02	-0.04
1964	-3.29	-1.00	-1.52	0.63	2.38	-4.14	-6.15	-2.26	1.61	0.34	-3.34	-1.49
1965	-0.46	-7.65	-1.58	-0.49	-2.08	1.89	0.08	0.08	0.22	1.91	1.71	-1.48
1966	0.59	-2.94	-2.81	-0.49	-1.66	0.53	-1.65	3.66	0.43	1.30	-1.81	-0.67
1967	-3.42	-4.22	1.09	-0.11	-0.39	2.62	1.22	1.01	1.21	0.64	-2.17	-0.48
1968	-0.07	-1.82	-0.90	-2.72	-2.23	-0.13	1.60	0.25	-0.36	-3.15	-3.36	-0.51
1969	-4.13	-3.14	-0.96	-2.36	1.39	-0.88	1.81	2.10	0.58	-0.35	1.52	-0.41
1970	0.76	1.27	-2.26	-1.57	0.24	0.72	-1.22	1.63	-2.02	-2.19	0.45	-0.72
1971	-0.36	0.16	2.02	-1.24	-2.48	1.31	0.68	-0.78	-1.83	-2.23	-0.50	-1.57
1972	-1.44	-0.36	-2.05	-2.94	-0.09	0.42	-1.24	-1.89	-0.91	-1.48	1.39	-1.38
1973	-0.94	1.39	2.16	0.36	-1.94	-0.12	2.57	1.98	-1.15	-1.28	-0.54	2.17
1974	1.18	1.82	2.81	0.05	0.42	0.08	-1.22	-4.02	1.84	-1.33	-2.24	-2.37
1975	-1.68	-1.22	-1.23	0.56	-3.33	-0.35	-2.42	-0.16	1.23	0.59	0.11	0.35
1976	-1.17	1.02	-0.10	1.56	1.75	-0.01	0.60	0.30	1.67	1.19	-2.88	-5.07
1977	-3.22	0.04	-1.17	-1.36	-0.77	-2.09	-1.82	-0.41	2.69	0.21	-0.20	-0.95
1978	1.50	-0.24	-0.99	0.64	-0.91	0.83	-2.13	2.94	1.19	0.68	-0.96	-0.01
1979	0.74	-0.90	1.51	-0.49	1.54	2.52	3.14	1.39	-0.02	0.54	-1.26	-1.88
1980	0.01	-1.75	-2.58	-1.77	-0.51	3.19	-1.68	-1.68	-2.56	0.45	-2.09	-0.10
1981	0.84	1.76	-2.47	-3.52	0.88	0.38	-1.43	-1.99	-1.49	-0.39	2.34	2.21
1982	-0.77	0.70	4.28	2.89	-0.70	2.40	0.01	1.00	1.56	-2.14	-2.32	-2.21
1983	-2.44	0.89	-0.71	-0.60	-0.68	0.38	1.63	0.09	-0.72	2.05	3.79	1.52
1984	-1.96	-1.74	-0.38	-0.23	-0.33	1.08	-0.21	-2.33	-0.16	1.06	0.34	-3.22
1985	-2.38	-0.02	-0.08	0.95	0.38	-2.49	2.64	1.26	1.07	0.57	2.28	1.90
1986	0.37	-4.89	-1.26	-0.57	-2.19	-0.95	-0.02	1.68	2.72	-0.38	0.50	1.31
1987	-2.51	-2.49	-1.11	-0.17	-0.34	0.18	-0.26	1.79	-0.72	0.78	1.77	0.30
1988	0.13	0.12	-2.01	2.11	-2.03	-3.06	0.64	-2.00	-2.70	-6.03	1.77	1.88
1989	-0.02	1.14	0.20	0.00	3.73	2.91	0.88	-1.21	-0.23	-0.16	0.69	-0.05

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1990 -0.23  1.95  0.80 -3.34 -3.35 -0.28 -1.82  0.12  2.08 -0.06  0.29 -0.20
1991  1.50 -1.69  1.07 -1.36  1.02  1.04 -1.56 -0.57 -2.52  1.30 -0.84 -1.23
1992  0.17 -1.89 -1.10  0.53 -2.19 -3.13 -0.80 -0.40  1.06  0.70  1.49  0.58
1993 -2.17  0.77 -0.10  1.80  2.10  0.40  2.82  2.69  1.14  1.21  1.48  1.38
1994  0.53  2.72  1.59 -0.75 -1.50 -2.33 -0.15  1.53 -1.22 -0.47 -2.43  1.91
1995  2.89  0.31 -1.12  0.74  2.64 -0.79 -4.26 -0.51  3.09 -0.69  0.17  1.93
1996  0.55 -1.74  1.31 -0.28  1.90 -1.40  0.22 -2.46 -3.50  2.79 -2.36  0.03
1997  2.37  0.68  1.43  0.15  1.43  0.69  1.82  0.76  0.69 -1.78 -3.17 -0.89
1998  2.65  0.57 -0.05  2.89  1.11  1.31  2.13  2.66  0.74 -0.26  2.84  2.59
1999  2.26  0.56 -1.39  2.44  2.51 -1.81  0.72  1.44  0.16  3.35  1.83  3.12
2000  3.59  2.32  0.74  0.97  1.90 -0.31  0.52 -1.22 -3.20  1.21 -1.32 -2.05
2001  1.43 -2.70 -0.57  3.49 -1.75 -0.02  0.20 -0.15  1.46  1.36  2.54  1.16
2002  2.22  2.80 -4.42  1.60 -1.69 -0.43 -0.67  1.14 -2.18 -5.77  0.03  1.29
2003 -0.52 -0.98 -0.07  2.21  1.04 -2.52  1.20  2.33 -0.99  0.12 -0.15 -0.69
2004  2.56 -3.33  0.74  1.20 -0.15  1.69  2.52  0.00  1.77 -0.59 -1.18 -1.02
2005  1.07  1.59 -0.12  3.46 -0.45 -0.41 -0.50  0.50  0.39 -0.11  0.66 -2.76
2006  0.56 -1.85  1.66 -0.69  2.28  2.05  1.61 -2.64 -0.26  1.79  0.14  1.34
2007  0.03  2.36 -0.77 -0.33 -1.02 -0.65 -2.67 -0.28 -1.88 -0.86  0.03  2.80
2008  2.56  1.09  0.63 -0.81 -0.66  3.00  0.23  0.60  0.46  2.21  1.03  1.01
2009  2.02  0.94  0.50 -0.43 -0.14  0.54 -0.13 -2.44 -0.78  1.47 -1.20  1.09
2010 -0.40 -2.12  0.04  0.08  1.51  3.14  3.37  1.24 -0.33  3.19  3.88  0.25
2011  0.48  0.87 -0.79  1.62  1.37  0.72 -1.52 -0.73 -1.79  0.59 -1.41  3.43
2012  3.08 -1.53  0.48  2.18  0.47  1.46  3.18  1.34  0.09  0.83 -0.84 -0.90
2013  0.71  2.84  2.31 -0.07  0.88  0.23  1.17 -3.25 -2.72 -1.39  1.07  0.77
2014 -0.13  0.36  1.34  1.18 -1.62 -0.21  0.68  1.97 -1.62  1.32  0.35  2.45
2015  1.35  4.92  0.88  2.03  0.41  2.41  2.00  1.86  1.91 -0.66  1.46  0.72
2016  3.13  1.35  4.36  1.06 -0.92  3.66  0.81 -1.28  2.46 -0.89 -3.12 -1.52
2017 -1.12 -1.09 -1.56  1.65  1.82  1.98  0.16  0.31  0.42 -0.64  3.18  1.44
2018  2.72  1.02 -0.03 -1.66  0.01 -1.57  0.55 -0.78  1.83  2.76  2.84  1.44
2019  2.79 -1.87  1.47  0.86 -0.11  2.21 -2.20 -2.04  0.81 -1.97 -4.42 -1.78
2020  0.57 -0.36  2.05 -1.72  1.03  1.18 -0.97 -2.20 -0.25  1.79  1.14  2.28
2021  1.95  2.19 -0.95  0.87  0.75  1.88 -1.06  0.73  1.68  0.80  2.69  2.74
2022  2.19  1.92  1.28  2.49  0.25 -2.34  1.24  0.66  2.25  1.71  3.71  2.94
2023  4.56  0.45  0.15 -0.78  1.80 -1.18 -0.46  1.44 -1.22  1.68  0.52  2.28
2024  2.84  2.74  1.05  1.48  1.70  1.47  0.56 -4.44  0.66 -0.73  3.37 -1.54
2025  1.40  0.31
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Access monthly SAM data in ASCII format

And due to popular demand ...

Access monthly mean zonal MSLP data at 40°S in ASCII format

Access monthly mean zonal MSLP data at 65°S in ASCII format

Annual and seasonal data

These have been calculated using the mean zonal mean sea level pressure for the year or season to derive the SAM rather than simply the mean of the monthly SAM values. Note that for summer (DJF) the year refers to the December.

Access annual and seasonal SAM data in ASCII format

Figures

Month by month: the red line is a 12-month running mean.

Annual and seasonal data: the thick line is the annual data.

Updated version of Figure 3.32 in the IPCC AR4 *Climate Change 2007: The Physical Science Basis*.

Calendar year

Autumn (MAM)

Winter (JJA)

Spring (SON)

Summer (DJF)

Links

 Dataset page at the National Center for Atmospheric Research (NCAR) Climate Data Guide

 A fun way of explaining the impact of the SAM on the climate of Victoria, Australia (thanks to Dale Grey)

 Tropical Cyclone Outlook for the Southwest Pacific, which uses this SAM Index as one of the predictors (thanks to Andrew Magee)

Comments should be addressed to Dr Gareth Marshall at GJMA@bas.ac.uk.