☑ Fact-Checked Science

EVIDENCE REVIEW · S0 NEWS RESEARCH NOTE

S0 News's Amundsen Sea Low note: its sunspot correlation adds up, but not to solar forcing

S0 News's research note 008, credited to an "internal GrokBot Team", finds that five-year means of the sunspot number and of the Amundsen Sea Low's pressure track each other at r = 0.803 with a 33-month lag, and concludes that "the sun drives ASL sector pressure" [1]. Every number in it reproduces from public files [5] [12]. But the lag and smoothing were picked in 2017 from 392 options on most of the same data: allowing for that, the evidence is borderline (p ≈ 0.05); on the data since 2016 the recipe beat the long-term average but not simple persistence, with every forecast 1.7–2.7 hPa high; and before 1979 the link reverses (our analysis). The low's documented drivers are the Southern Annular Mode, ozone depletion, greenhouse gases and the tropical Pacific [9] [7].

By Fact-Checked Science · Published November 15, 2026

OUR ANALYSIS marks our own reasoning and calculations: the recomputation of the note's numbers from public files, the tests of its lag search, the out-of-sample test of the 2017 recipe, the checks of the pre-1979 flip and of the SAM, and the sizes we give. Each test's rules were written and hashed before it ran; "post hoc" marks checks chosen afterwards. The verdicts are our assessment. Everything else comes from the numbered sources. For the note [1], locators are its own headings and figures: the subtitle, Claims 1 to 5, Figures 1 to 3, Methods and Sources. ASL is the Amundsen Sea Low; SAM, the Southern Annular Mode; SSN, the sunspot number; hPa, hectopascals; r, a Pearson correlation.

Every number reproduces. Once the 2017 search is counted the link is borderline, it reverses before 1979, and the data since 2016 haven't confirmed it

OUR ASSESSMENT

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of the note's numbers that we checked reproduce from BAS's and SILSO's public files, by our analysis [5] [12]. The 2017 manuscript's whole table of 392 correlations reproduces from its own workbook [3]

p ≈ 0.05

for the 1979–2026 correlation once the 2017 choice of lag and smoothing, the best of 392, is allowed for: the note's own 0.046 [1 Claims 1], and our 0.045 and 0.051 under two nulls

+1.8 hPa

is how far the 2017 recipe's forecasts ran above the five-year means built only from data after 2016, about as far as persistence (+1.7) and a straight-line trend (+1.8). It beat the 1979–2016 average (+2.7) but not persistence, on fewer than two independent values, by our analysis

THE NOTE'S CLAIMS

OVERSTATED

The Sun drives ASL pressure

The subtitle: "r=+0.803 (n=479) at a 33-month lag — the sun drives ASL sector pressure" [1 Subtitle]; Claims 1: "the sun forces ASL sector pressure" [1 Claims 1]

The correlation is real, but weaker evidence than that. Its lag and smoothing were picked in 2017 as the best of 392 combinations on four-fifths of these data, and allowing for that gives p ≈ 0.05. Over the whole ERA5 record it isn't significant, before 1979 it reverses, and the data since 2016 haven't confirmed it. Much of it is shared with the Southern Annular Mode (sunspots against NOAA's SAM index, r = −0.67), whose trend is put down to ozone depletion and greenhouse gases [7 §6]. See sections 3 to 7.

TRUE

r = 0.803 at a 33-month lag

Claims 1: "ASL lagging SSN by 33 months — r=+0.803, n=479. Full-ACF Bretherton n_eff=10.33, p_eff=0.00425." [1 Claims 1]

Our own code gets the same from the public files: r = 0.8032, n = 479, n_eff = 10.33 and p_eff = 0.00425 [5] [12]. So do the note's lag and width optima and its surrogate p values. The p of 0.004 isn't a fair test of the recipe, which was fitted to most of these data; the note's own grid p, 0.046, is. See section 2.

TRUE

2017 result replicates

Claims 1: "The 2017 manuscript window on ASL v2 ERA-Interim SectorPres (1979–2016) replicates at the same 5y/33m recipe: r=0.903, n=363 (manuscript claimed r=0.904, n≈360)" [1 Claims 1]

It reproduces: r = 0.9029, n = 363 [6] [12]. The manuscript's 0.904 comes from its 61-month windows; with those, all 392 correlations in its table reproduce from its own workbook (our analysis) [3 §4]. It is the same data, so it confirms the arithmetic, not the link. See section 2.

TRUE

1959–2026: positive but weaker

Claims 2: "Full ERA5 record (1959–2026) is positive but weaker." r = 0.391, n = 719, p_eff = 0.138 [1 Claims 2]

It reproduces, and the note says plainly that the fixed recipe is "not significant" on this record [1 Claims 2]. Our tests agree: p = 0.06–0.08 at the fixed recipe, and 0.13–0.16 once the search is allowed for (our analysis). See section 3.

UNSUPPORTED

Sign flip: a changing field

Claims 3: "Pre-1979 flips sign — a changing geomagnetic field finding." [1 Claims 3]

The flip reproduces. A station-based SAM index also changes sign, though its pre-1979 correlation (+0.46) isn't significant on its own; with ERA5 tracking that index nearly as well before 1979, this hints that the flip isn't only the early reanalysis (our analysis) [14]. But the note gives no data on the field, no mechanism and no test, and Earth's dipole weakened smoothly, by 0.8%, in the decade the sign changed [32]. We found nothing linking the sign to the field. See section 5.

MISLEADING

The SAM keeps the Sun in play

Claims 5: "Explaining the ASL with SAM does not remove the sun, because SAM is itself solar-modulated." [1 Claims 5]

The southern papers it cites do find a solar modulation of the SAM's spring structure, as the note says: how far up it reaches and how long it lasts [23] [24]. What they don't show is a solar-cycle effect on the SAM's multi-year level, or a lag of two to three years. And the SAM's trend is put down to ozone depletion and greenhouse gases [7 §6], which the note leaves out. See section 6.

1 · THE NOTE

A research note from S0 News that re-runs a 2017 manuscript on newer data

S0 News's research note 008 is a public Google Doc, a "Space Weather News Research Note from internal GrokBot Team 008" [1]. S0 News linked it from the YouTube page of its November 15, 2026 episode [4]. It builds on an unpublished 2017 manuscript by Davidson, Cleckner and Mendez, which reported the same link on 1979–2016 data [3]. Neither has been peer reviewed.

THE PRESSURE

BAS's Amundsen Sea Low index

The Amundsen Sea Low is the deep, mobile low-pressure area off West Antarctica. The note uses the "sector pressure" of the British Antarctic Survey's index: the average sea-level pressure over 60–80° S and 170–298° E, monthly from 1959, computed from the ERA5 reanalysis [5] [1 Methods].

THE SUN

The monthly sunspot number

Sunspot numbers come from SILSO, the World Data Center at the Royal Observatory of Belgium, from 1749 to October 2026 [12] [1 Methods].

THE RECIPE

Five-year means, 33 months apart

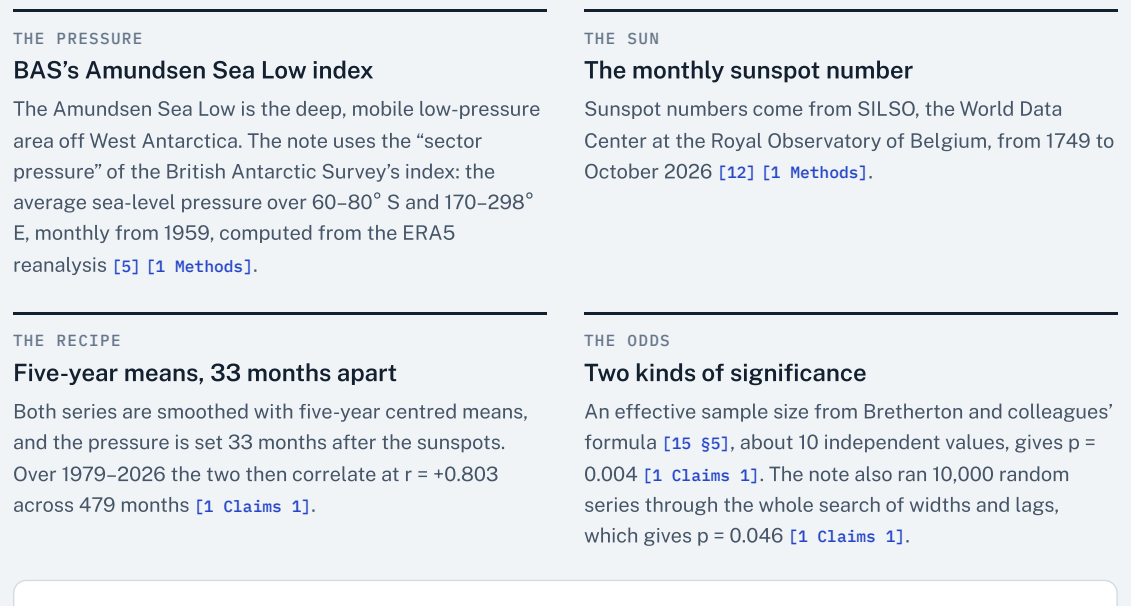
Both series are smoothed with five-year centred means, and the pressure is set 33 months after the sunspots. Over 1979–2026 the two then correlate at r = +0.803 across 479 months [1 Claims 1].

THE ODDS

Two kinds of significance

An effective sample size from Bretherton and colleagues' formula [15 §5], about 10 independent values, gives p = 0.004 [1 Claims 1]. The note also ran 10,000 random series through the whole search of widths and lags, which gives p = 0.046 [1 Claims 1].

The two series as the note pairs them, rebuilt from the public files OUR ANALYSIS



Our own computation, not a redrawing of the note's figures. Pressure: BAS's ASL index, version 3, by J. S. Hosking, computed from ERA5; contains modified Copernicus Climate Change Service information 2026 [5]. Sunspots: WDC-SILSO, Royal Observatory of Belgium, Brussels, CC BY-NC 4.0, used non-commercially [12]. From the early 1980s to about 2010 the pressure rises and falls with the shifted sunspot curve; before 1979 it moves against it; after 2016 both fall until about 2021, then the sunspots rise while the pressure stays near 982 hPa.

What the note does well

It states its method precisely enough that every number can be rebuilt from public files (section 2). It reports the result that cuts against it: over the whole ERA5 record the fixed recipe is "not significant" [1 Claims 2]. It gives the p value that allows for its search as well as the one that doesn't, and calls its own best lag and width "exploratory" [1 Methods]. And it checks the known error in ERA5 over the Amundsen Sea in 1996: masking those months leaves r = 0.789, which reproduces [1 Claims 4] [16].

OUR ANALYSIS

Where the 33 months came from

The 2017 manuscript tried every smoothing width from one to eight years against every lag from 0 to 48 months, 392 combinations, on January 1979 to November 2016, and picked the best: five years and 32–34 months, r = 0.904 [3 §3] [3 §4]. It reported "a p-value < 0.0001" for n = 360 [3 §4], which treats 360 overlapping five-year means as independent. The note calls the 33 months "inherited from the 2017 manuscript" [1 Methods], which is true, but the years it was fitted to make up four-fifths of the note's 1979–2026 window. We found no published or posted version of the manuscript [3].

2 · IT REPRODUCES

Every number reproduces from the public files, and so does the 2017 table

We rebuilt the note's numbers with our own code from BAS's index [5] [6] and SILSO's sunspots [12], following its stated method: restrict both series to the window, take full five-year centred means, and correlate the sunspots with the pressure L months later [1 Methods]. We never ran S0 News's code, and its data pack asked for a sign-in [2].

The note's numbers, recomputed from the public files OUR ANALYSIS

NUMBER	THE NOTE	OUR RECOMPUTATION
1979–2026: r, n, n_eff, p_eff	0.803, 479, 10.33, 0.00425 [1 Claims 1]	0.8032, 479, 10.33, 0.00425
Best lag, five-year means; best width and lag	34 months, 0.803; 7 years and 30 months, 0.812 [1 Claims 1]	34 months, 0.8034; 7 years and 30 months, 0.8121
1959–2026: r, n, n_eff, p_eff	0.391, 719, 15.7, 0.138 [1 Claims 2]	0.3914, 719, 15.71, 0.138
1959–2026: best lag; best width and lag	29 months, 0.394; 8 years and 19 months, 0.515 [1 Claims 2]	29 months, 0.3943; 8 years and 19 months, 0.5151
1959–1978: r, n, n_eff, p_eff	−0.815, 148, 4.6, 0.12 [1 Claims 3]	−0.8152, 148, 4.62, 0.120
Rolling 11-year r	negative before mid-1984; +0.98 in 1997; −0.47 for 2012–2015; +0.82 by 2018 [1 Claims 3]	last negative mid-1984; +0.976 in 1997; −0.472 in 2013, negative mid-2012 to early 2015; +0.818 in 2018
May–October 1996 masked: r, n	0.789, 414 [1 Claims 4]	0.7890, 414
2017 window on version 2: r, n, n_eff, p	0.903, 363, 7.79, 0.00258 [1 Claims 1]	0.9029, 363, 7.79, 0.00258
Surrogate p: lag search; full grid (absolute)	0.012 (0.025); 0.046 (0.094) [1 Claims 1]	0.015 (0.029); 0.051 (0.100)

The 30 values the note prints for 1979–2026, 1959–2026, 1959–1978, the 1996 mask and version 2 (in the rows above, with two n's not shown) all agree to the precision it gives; the rolling correlations match its description, and the surrogate p values agree within chance. The pressure is BAS's version 3 to July 2026, the note's freeze; the file now runs a month longer [5]. n_eff is Bretherton and colleagues' Eq. 30 with sample autocorrelations at every lag, as the note says [15 §5]. Our surrogates are 10,000 phase-randomised copies of the pressure, as the note's were, so their p values agree within chance, not digit for digit.

OUR ANALYSIS

The 2017 table, cell by cell

We transcribed the 392 correlations of the manuscript's Figure 3 and recomputed them from its workbook, whose columns match BAS's version 2 and today's SILSO file month for month [3] [6]. With windows one month longer than the nominal width, centred on the month (61 months for five years), every cell reproduces to the third decimal, including 0.904 at 32–34 months. The note's 60-month windows give 0.903 [1 Methods]. So the small differences the note mentions come from the window, not the data.

OUR ANALYSIS

Two reanalyses, two answers

The 2017 work used version 2 of the index, built from ERA-Interim; the note uses version 3, from ERA5 [6] [5]. Month by month they agree closely (r = 0.994), but ERA5 runs 0.14 hPa higher on average and drifts upward against ERA-Interim by 0.15 hPa a decade, and their five-year means stray from a constant offset by up to 0.64 hPa. On version 3, the same 1979–2016 months give r = 0.870 rather than 0.903. Part of the correlation's fall since 2017 comes from the change of reanalysis.

3 · WHAT THE SEARCH COSTS

Once the 2017 search is counted, the 1979–2026 link is borderline

The 33-month lag wasn't a prediction: it was the best of 392 tries on most of the years the note now tests [3 §4]. The fair question is how often a series unrelated to the pressure, put through the same search, does as well. The note asked it one way; we added a second, fixed in advance (our analysis).

1979–2026, THE WHOLE SEARCH ALLOWED FOR

OUR ANALYSIS

p ≈ 0.05

0.051 with random pressure series, as the note did, and 0.045 with random sunspot series. Counting negative correlations too, 0.09–0.10

THE SAME, WITH STRAIGHT-LINE TRENDS REMOVED

OUR ANALYSIS

0.06–0.12

Both series fall over 1979–2026: the pressure by 0.63 hPa a decade, the sunspots as the cycles weakened. Without the trends r drops to 0.70

1959–2026, THE WHOLE SEARCH ALLOWED FOR

OUR ANALYSIS

0.13–0.16

Over the full ERA5 record the link is what chance often gives, as the note's own figures say [1 Claims 2]

How often unrelated series do as well (10,000 of each random kind) OUR ANALYSIS

YEARS, AND WHAT WAS SEARCHED	OBSERVED R	RANDOM PRESSURE (THE NOTE'S TEST)	RANDOM SUNSPOTS (OURS)	REAL SUNSPOTS OF 1749–1958
1979–2026, fixed recipe	0.803	p = 0.004	p = 0.006	0.3%
1979–2026, 49 lags	0.803	p = 0.015	p = 0.026	2.0%
1979–2026, 8 widths × 49 lags	0.812	p = 0.051	p = 0.045	1.6%
1959–2026, fixed recipe	0.391	p = 0.059	p = 0.076	18%
1959–2026, 8 widths × 49 lags	0.515	p = 0.13	p = 0.16	33%
1979–2016 on version 2, 8 widths × 49 lags	0.903	p = 0.001	p = 0.003	0%

One-sided p for a positive correlation at least as large, with the search repeated on every random series. "Random pressure" keeps the pressure's own rhythms and shuffles their timing, as the note's test did [1 Methods]; "random sunspots" does the same to the sunspot series and keeps the pressure as it is. The last column puts real sunspot records from other centuries in place of the modern ones; those stretches overlap heavily, so it is a share, not a p value. The rules were written before any of these ran.

OUR ANALYSIS

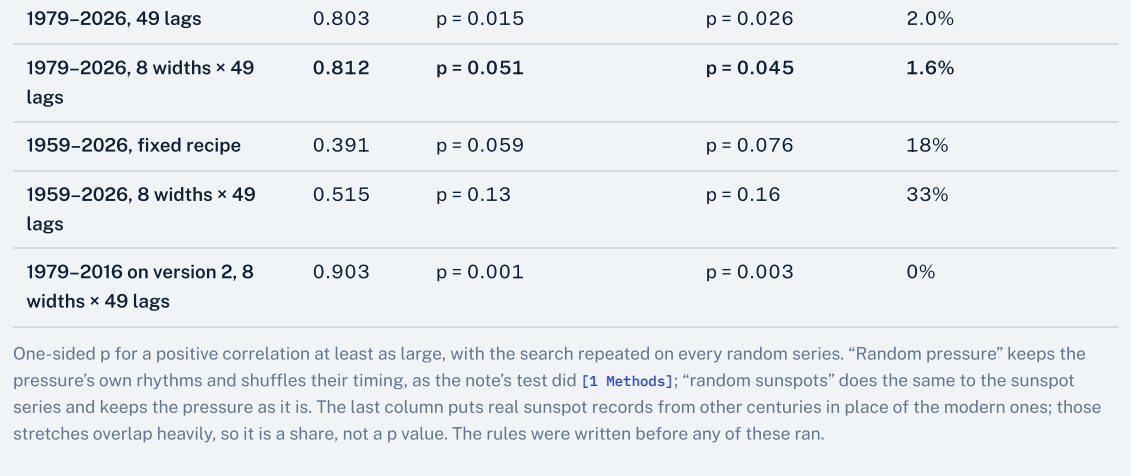
Read together: on the 1979–2016 data the 2017 manuscript used, the correlation was strong even allowing for its search (p = 0.001–0.003). It has weakened since, partly because ERA5 replaced ERA-Interim and partly because of what happened after 2016. On the note's own 1979–2026 window, allowing for the search, it sits at the edge of conventional significance, and over the whole ERA5 record it doesn't reach it. That is the profile of a correlation found in one stretch of data that has weakened as more data came in, which the next two sections test directly.

4 · SINCE 2016

On data it had never seen, the 2017 recipe beat the long-term average but not persistence

Everything after November 2016 is new data for the 2017 recipe. We fixed a test before scoring it: fit the recipe's straight line on 1979–2016, forecast every five-year mean built only from later months, and compare with three simple forecasts (our analysis) [5] [12].

The new five-year means came in below every forecast OUR ANALYSIS



Our own analysis. Pressure: BAS's ASL index, version 3, by J. S. Hosking, computed from ERA5; contains modified Copernicus Climate Change Service information 2026 [5]. Sunspots: WDC-SILSO, Royal Observatory of Belgium, Brussels, CC BY-NC 4.0, used non-commercially [12]. The shaded span holds the 57 five-year means whose 60 months all fall after November 2016.

How each forecast did on the 57 wholly new five-year means OUR ANALYSIS

FORECAST	TYPICAL ERROR (RMSE)	MEAN ERROR	THE RECIPE'S SKILL AGAINST IT
The 2017 recipe, refitted on 1979–2016	1.83 hPa	+1.82 hPa	–
The 1979–2016 average	2.73 hPa	+2.72 hPa	+0.55, better
Persistence: the last five years, 2011–2016	1.69 hPa	+1.67 hPa	−0.18, worse
A straight-line trend from 1979–2016	1.82 hPa	+1.80 hPa	−0.02, worse

Skill is one minus the ratio of the recipe's mean squared error to the other forecast's. Our rules, fixed in advance, counted a pass as beating both the average and persistence; the trend was a second benchmark.

OUR ANALYSIS

What happened

Over the new means the recipe expected a dip of about half a hectopascal two to three years after the 2019 solar minimum, then a recovery as cycle 25 rose. The pressure did fall, from 983.1 to about 982.0 hPa, by more than that dip, but then stayed near 982 hPa instead of recovering. Every forecast started too high: the first new mean, 983.1 hPa, was already 1.3 hPa below the recipe's, because the low had deepened before 2019. The recipe did better than the long-term average because it, too, expected the pressure to be lower than its 1979–2016 average.

OUR ANALYSIS

Why this can't settle it

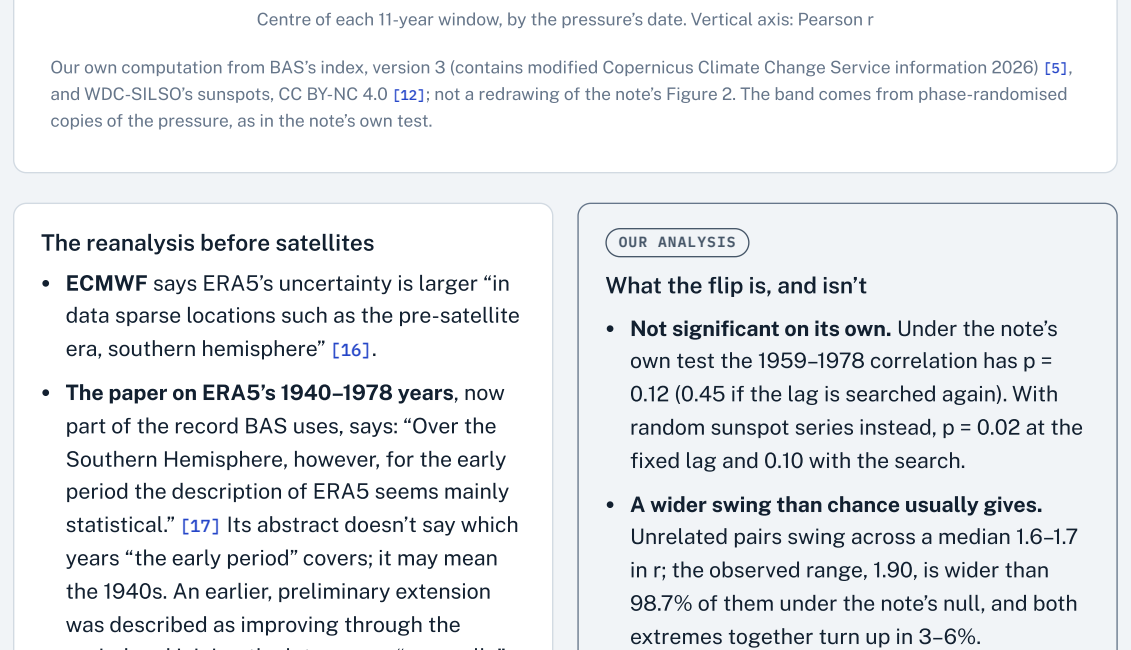
The new data are 116 months, fewer than two independent five-year means, so no score here is a firm test either way, and every simple forecast missed by about as much. For scale, we ran 10,000 random series with the Sun's rhythm through the same fit: the real sunspots beat 95% of them, mainly through their strong 1979–2016 fit and the low sunspots of 2016–2021; 3% beat both simple forecasts, which the real sunspots didn't. The 2017 fit itself, on version 2, ties persistence. What the new data do show: from mid-2016 to mid-2021 the pressure fell by 1.36 hPa with the sunspots, about as much as the recipe implies (1.05 hPa), but from late 2021 to early 2024 it stayed near 982 hPa as the sunspots rose, where the recipe implies a recovery of about half a hectopascal (post hoc).

5 · BEFORE 1979

Before 1979 the link reverses, and nothing ties that to Earth's field

Over 1959–1978 the same recipe gives r = −0.815, and in sliding 11-year windows the correlation is negative until mid-1984 and peaks at +0.98 in 1997 [1 Claims 3] [1 Figure 2]. Both reproduce; the windows centred 1970–1980 run between −0.7 and −0.9 (our analysis). The note reads the change as "a changing geomagnetic field finding", which "fits a changing geomagnetic field", and adds: "It is a finding on the early product and the modern forcing, not a reason to discard the satellite-era result." [1 Claims 3]

The correlation in sliding 11-year windows, and where unrelated series fall OUR ANALYSIS



Our own computation from BAS's index, version 3 (contains modified Copernicus Climate Change Service information 2026) [5], and WDC-SILSO's sunspots, CC BY-NC 4.0 [12]; not a redrawing of the note's Figure 2. The band comes from phase-randomised copies of the pressure, as in the note's own test.

The reanalysis before satellites

- **ECMWF** says ERA5's uncertainty is larger "in data sparse locations such as the pre-satellite era, southern hemisphere" [16].
- **The paper on ERA5's 1940–1978 years**, now part of the record BAS uses, says: "Over the Southern Hemisphere, however, for the early period the description of ERA5 seems mainly statistical." [17] Its abstract doesn't say which years "the early period" covers; it may mean the 1940s. An earlier, preliminary extension was described as improving through the period and joining the later years "generally" seamlessly [18].
- **Older reanalyses** "must be used with caution over high southern latitudes during the nonsummer months prior to the assimilation of satellite sounding data" [20]. One carried spurious falling pressure at high southern latitudes, while ERA-40 "can be used with high confidence at least as far back as 1973" and "with more confidence than the NNR right back to 1958" [14 p. 4134]. One of the papers the note cites used reanalysis for the south only from 1979, since it "is not recommended for SH use prior to 1979" [27 §2].
- **BAS's file** flags only May–October 1996; NCAR's guide to the index warns of "spurious variability and trends" from reanalysis [5] [21].

Our check of S0 News's note 010 tested two older reanalyses against 12 Antarctic stations before 1979. JRA-55's drift met its rule (a median −1.8 hPa a decade); NCEP–NCAR's (a median −0.85) did not, because the test was underpowered. And at 65° S NCEP–NCAR fell about three times as fast as Marshall's stations over 1957–2025, −1.14 against −0.37 hPa a decade, an exploratory check (our check of note 010). Neither page tested ERA5 itself.

OUR ANALYSIS

What the flip is, and isn't

- **Not significant on its own.** Under the note's own test the 1959–1978 correlation has p = 0.12 (0.45 if the lag is searched again). With random sunspot series instead, p = 0.02 at the fixed lag and 0.10 with the search.
- **A wider swing than chance usually gives.** Unrelated pairs swing across a median 1.6–1.7 in r; the observed range, 1.90, is wider than 98.7% of them under the note's null, and both extremes together turn up in 3–6%.
- **A hint from station data.** Marshall's index, built from 12 stations without reanalysis [14], also changes sign against sunspots: +0.46 over 1959–1978 and −0.57 over 1979–2026, the mirror of the pressure's −0.82 and +0.80. But its pre-1979 value isn't significant on its own (p ≈ 0.23), and a chance correlation takes either sign. ERA5's pressure tracks the station index nearly as well before 1979 as after (r −0.64 against −0.73 on five-year means). Together these hint that the flip isn't only an artefact of the early reanalysis.
- **Nothing ties it to the field.** Earth's dipole moment fell smoothly: 1.5% from 1960 to 1980, 0.8% from 1980 to 1990, while the correlation went from about −0.9 to +0.9 [32]. We checked the dipole moment. Geomagnetic jerks, abrupt changes in the field's acceleration, are recorded around 1969, 1978 and 1991 (our check of a paper on jerks), but nothing in the note, or that we found, connects them to how the low tracks sunspots.

OUR ANALYSIS

So something did change around 1980–85 in how the five-year means of the pressure line up with sunspots. The note offers the geomagnetic field without data, mechanism or test. The literature documents other changes in those years, which we didn't test: the rise of the Southern Annular Mode, "most pronounced since the mid-1970s" [14 p. 4134], which is put down to ozone depletion and greenhouse gases [7 §6]; tropical Indo-Pacific variability, the main driver of the low's decade-to-decade swings [11]; and the start of satellite data in the reanalyses. Solar–climate correlations that come and go are a known pattern elsewhere: the North Atlantic Oscillation shows no solar signal before the mid-1960s and a marginal one after [30].

6 · THE SAM PATHWAY

Much of the link is shared with the Southern Annular Mode, and the papers cited don't make the Sun its driver

The Southern Annular Mode (SAM) is the see-saw of pressure between Antarctica and the mid-latitudes. BAS notes that the low's central pressure is "strongly modulated" by it [6]. The note grants that the low's pressure "closely tracks" the SAM, and answers that "SAM is itself solar-modulated" [1 Claims 5].

ASL PRESSURE AGAINST NOAA'S SAM INDEX, FIVE-YEAR MEANS

OUR ANALYSIS

r = −0.88

The note gives −0.883 [1 Claims 5], which NOAA's index [13] reproduces over the months of its lagged pairs (post hoc): −0.879 over all five-year means, and −0.73 with Marshall's station index [14]

SUNSPOTS AGAINST THE SAM, 33 MONTHS LATER

OUR ANALYSIS

r = −0.67

Reproduces the note's −0.667. It weakens to −0.47 with trends removed, is −0.57 on the station index, and +0.46 on that index before 1979

SUNSPOTS AGAINST THE PRESSURE WITH THE SAM TAKEN OUT

OUR ANALYSIS

r = 0.46

NOAA's index explains 78% of the pressure's five-year variance; what is left still correlates with sunspots 33 months earlier, though not significantly on its own (p ≈ 0.15; post hoc)

What the note's five citations say OUR ASSESSMENT

PAPER	WHAT IT FOUND	DOES IT SHOW THE NOTE'S PATHWAY?
Kuroda and Kodera 2005, south	From data for 1968–2001, in years of high solar activity the October–November SAM reaches the upper stratosphere and lasts into autumn; in low years it stays in the troposphere and fades by January [23].	A change in how the spring SAM behaves, as the note says; not a SAM level set by sunspots 2–3 years earlier.
Kuroda 2018, south	The modulation, in ERA-Interim for 1979–2015, comes from wave–mean flow interaction in the stratosphere [24].	The mechanism of the same seasonal modulation; the same answer.
Ineson et al. 2011, north	A climate model driven by satellite ultraviolet data responds to solar minimum with a negative North Atlantic or Arctic Oscillation, "If the updated measurements of solar ultraviolet irradiance are correct" [25].	Northern winters, in a model, as the note says.
Lu et al. 2008, north	December–January solar wind pressure correlates with the Northern Annular Mode "At solar maxima" [26].	Northern, and "possible" in its own title.
Seppälä et al. 2009, both hemispheres	Winter polar temperatures differ between high- and low-geomagnetic years by up to about ±4.5 K in the north, and by up to about 5 K in southern winter in the Antarctic Peninsula and Amundsen Sea; the authors "cannot conclusively show" a physical link [27] [27 para. 10].	Geomagnetic activity and temperature, not sunspots and pressure. The note files it under the north; its southern results use reanalysis only from 1979 [27 §2].

What drives the SAM's trend

BAS's Hosking and colleagues write: "Rising concentrations in GHG and stratospheric ozone depletion are the main drivers of the observed decreasing pressure around Antarctica which has driven the SAM to become more positive" [7 §6]. A review of the low notes one line of research holding that "polar stratospheric ozone depletion has been the major driver of atmospheric circulation trends in the SH over the past few decades" [9 p. 114]. The low deepened in January by 1.7 hPa a decade over 1979–2008 "as the SAM has become more positive" [10]. The station index has risen by about 0.5 a decade on its standardised scale since 1957 (our check of note 010).

OUR ANALYSIS

Why "it doesn't exclude the Sun" isn't enough

It is true that explaining the low by the SAM doesn't rule the Sun out, and the papers cited do find the Sun changing the SAM's spring structure. But they don't show the Sun setting the SAM's five-year level 33 months later, and a review calls the evidence for solar signals in the annular modes mixed and mostly from simple correlations, and warns that the eruptions of 1982 and 1991 are easy to confuse with the Sun [22 §3.2.3]. Over 1979–2026 the SAM's five-year means rise with its ozone-and-greenhouse trend while the solar cycles weaken, so the two would correlate even if neither drove the other. The SAM accounts for most of the pressure's slow changes but not clearly for all of the sunspot link: with the index taken out, the rest correlates +0.46 (post hoc). One check can't help here: BAS's relative central pressure, which removes much of the SAM's influence [8], shows no link (r = 0.13), but it subtracts the whole sector's pressure, so it would show none whatever drove that pressure. It only says the correlation is in the sector-wide pressure.

7 · WHAT DRIVES THE LOW

The low answers to the SAM, the tropical Pacific, ozone and greenhouse gases; southern solar signals are unsettled

The Amundsen Sea Low is where the Southern Hemisphere's pressure varies most, which makes its local changes hard to separate from larger shifts [6]. Here is what the literature says drives it, and what it finds for the Sun.

Its drivers

- **The SAM and ENSO.** The low's depth "is strongly influenced by the phase of the southern annular mode" [9 p. 113], and ENSO "plays a significant role in determining the depth of the ASL": it is deeper in La Niña years [9 p. 114] [10].
- **Tropical seas and radiative forcing.** In model runs, tropical sea temperatures drive much of the deepening, and the trends are "likely … explained by a combination of factors, including tropical SSTs, radiative forcing, as well as unforced, internal variability" [9 p. 115].
- **Decades.** A reconstruction back to 1870 finds tropical Indo-Pacific variability the main driver of the low's decade-to-decade swings, and human forcing a dominant contributor to its deepening since the mid-20th century [11].
- **The future.** Most model projections deepen the low as greenhouse gases rise [9 p. 119], outside summer [9 p. 118], and move it poleward or eastward in some seasons [7].

None of what we read names the Sun as a driver.

Solar signals in high-latitude pressure

- **The south.** A major review finds some studies reporting a solar signal in the annular modes "though others such as Moore et al. [2006] have not", and concludes that solar-cycle influences "in summertime and in the SH also require further study" [22 §3.2.3] [22 para. 161]. The southern results the note cites are the seasonal modulation of the SAM above [23] [24].
- **The North Atlantic, a few years late.** An 11-year signal appears over Europe and the North Atlantic "provided that the data are lagged by a few years" [28], with a proposed route through ocean heat [29]. But another study finds no such signal before the mid-1960s and a marginal one after, possibly "a chance occurrence" [30]. One 155-year analysis finds its significant solar signal in sea-level pressure in the North Pacific [31].

Our check of a 2026 forum report on space weather and the lower atmosphere rates the Sun's ultraviolet route to the North Atlantic Oscillation, a few years later, as supported but still debated (our check of that forum report).

8 · WHAT IT WOULD MEAN

A Sun-paced Amundsen Sea Low would be slow and small, not sudden

A catastrophist reading might take the note as a sign that the Sun steers Antarctic weather, or that a changing magnetic field is shifting how the Sun reaches us. This is our reading of what the note, if right, would mean.

OUR ANALYSIS

If the 2017 recipe held, the low's five-year mean pressure would differ by about 2.3 hPa between the quietest and the busiest five years of sunspots since 1979, two to three years later. Month to month the pressure swings by 4.5 hPa (one standard deviation), and its five-year means by 1.1 hPa. That would make West Antarctic winds and sea ice a little more predictable years ahead. It is a slow, regular modulation of the kind that would show up only in averages, not a sudden change.

OUR ANALYSIS

Nothing here bears on a sudden shift, a pole flip or a solar outburst. Earth's field has weakened by about 4% since 1960, smoothly [32], and the note offers no data on it. The low has been deepening by about 0.6 hPa a decade since 1959 (our check of note 010), a deepening the literature puts down mainly to human forcing, with tropical Pacific variability [11] [9 p. 115]; none of the sources we read names the Sun.

9 · REPEAT OUR NUMBERS

The rules, the scripts and our derived numbers; the data stay with their owners

Each rules file was written, and its SHA-256 logged, before the scripts it governs first ran; the hashes and times are our own log. One script fetches every input by URL under a plain client name and checks it against the copies we used. We ran it into an empty folder and re-ran every script there: the outputs matched ours line for line, apart from file paths, run times and 01's cell-by-cell check of the 2017 table, which needs our transcription of it. Checks added after the fresh review are marked post hoc.

PY **fetch_inputs.py** and **input_period_hashes.json**
Fetches the seven inputs and checks their SHA-256 against ours. Most are updated in place every month, so when a hash differs it compares the values we used, year by year, and says whether any were revised. Standard library only · 9 KB and 17 KB

PY **01_reproduce.py** and **its output**
Every number in the note recomputed, the 2017 table, and the checks of version 2 against version 3 · 12 KB and 7 KB

PY **02_search_cost.py** and **its output**
The surrogate tests of the search, under both nulls, the real sunspots of other centuries, and the trend check · 9 KB and 4 KB

PY **03_oos.py**, **its output** and **03_oos_targets.csv**
The out-of-sample test, with every forecast for each new five-year mean · 8 KB, 3 KB and 3 KB

PY **04_signflip.py** and **its output**
The pre-1979 tests, the rolling correlations against chance, the station-index check and the field · 9 KB and 2 KB

PY **05_sam.py**, **its output**, and the post hoc **05b_sam_posthoc.py** with **its output**
The SAM numbers and the checks of the SAM-independent part; 05b looked for the note's −0.883 among lags and windows · 11 KB in all

PY **05c_posthoc_review.py** and **its output**
The checks prompted by the fresh review (post hoc): the note's −0.883 over the months of its pairs, the link with the SAM taken out, and what the data did after 2016 · 5 KB and 2 KB

PY **06_shared_facts.py** and **its output**
The low's trend and the sizes used in section 8 · 4 KB and 1 KB

PY **07_chart_data.py** and its outputs **chart_series.csv**, **chart_rolling.csv** and **chart_oos.csv**
The numbers behind the charts (post hoc, descriptive): five-year means and correlations we derived, not the providers' monthly values · 4 KB and 44 KB in all

PY **asl_lib.py** and **surr_lib.py**
The shared code: readers, moving means, Bretherton's effective sample size, phase randomisation · 8 KB and 4 KB

TXT **RULES_reproduce.txt**, **RULES_search_cost.txt** and **RULES_oos.txt**
The reproduction, the search test and the out-of-sample test, each fixed before it ran · 12 KB in all

TXT **RULES_signflip.txt**, **RULES_sam.txt**, **RULES_shared.txt** and **RULES_chartdata.txt**
The flip, the SAM checks, the descriptive numbers and the chart numbers (post hoc) · 8 KB in all; and RULES_posthoc_review.txt, the post hoc checks after the fresh review · 2 KB

TXT **rules_sha256.txt** and **HASHES.txt**
The hash and logged time of each rules file, and the hash of every file here · 1 KB and 3 KB

Run it

`python3 -I fetch_inputs.py <folder>` fetches about 0.36 MB from seven addresses. Then run the scripts in order with the same folder, for example `python3 -I -B 01_reproduce.py <folder>`; outputs go to `<folder>/out/`. They need Python 3.10 or later with numpy and scipy, and the RULES files, `asl_lib.py` and `surr_lib.py` beside them. Script 02 runs 100,000 random series and takes about four minutes; 06 and 07 need 03's output, and 05c needs 03's and 07's. Script 01's cell-by-cell check of the 2017 table needs a transcription of the manuscript's Figure 3, which we don't host; without it, 01 prints our own values only.

The data and their terms

BAS's ASL index: by J. S. Hosking, British Antarctic Survey, computed with BAS's asli software from ERA5; the file states no licence, so we host only numbers derived from it, with credit to the index, Hosking and colleagues' paper and ERA5 (contains modified Copernicus Climate Change Service information 2026) [5] [7]. **Sunspots:** "Source: WDC-SILSO, Royal Observatory of Belgium, Brussels", CC BY-NC 4.0; this site is non-commercial [12]. **NOAA's AAO index:** US government work [13]. **Marshall's SAM index:** British Antarctic Survey [14]. **S0 News's note, its data pack and the 2017 manuscript and workbook:** no licence is given, so we quote the sentences we rate, link the rest, host nothing of them and redraw none of their figures [1] [2] [3].

10 · LIMITS

What this check could and couldn't see

Not the note's own code

The note's data pack asked for a sign-in [2], so we rebuilt every number from the public files rather than its tables, and matched its surrogate p values within chance rather than draw for draw.

Few independent values

Five-year means of 47 years hold about ten independent values, and the new data since 2016 under two. Every p value here is approximate, and no test on the post-2016 data can be decisive.

Causes of the flip untested

The station index hints that the pre-1979 reversal isn't only the reanalysis, but its own pre-1979 correlation isn't significant. We didn't test the ozone, Pacific or reanalysis explanations the literature points to, and neither our page nor our check of note 010 tested ERA5 itself against stations.

Abstracts only

The ERA5 papers [17] [18] and [19], Bromwich and Fogt, Hosking et al. 2013, Turner et al. 2013, Dalaiden et al., Kuroda and Kodera, Kuroda, Ineson et al., Lu et al., Gray et al. 2013, Scaife et al. and Chiodo et al. were read as abstracts only.

What would change these verdicts

01
Another solar cycle of new data. If the five-year means after 2024 follow cycle 25's sunspots 33 months later, beating persistence and the trend, the recipe would earn real out-of-sample support.

02
A test that separates the Sun from the SAM's known drivers: a regression of the low's pressure on sunspots alongside ozone, greenhouse gases, ENSO and the Pacific's decadal swings, or climate-model runs with and without the solar cycle.

03
Any data tying the 1979–1985 change to Earth's field, rather than to the reanalysis or the circulation's other drivers.

OUR ANALYSIS

Bottom line: the note's arithmetic is right, and a strong correlation did turn up in the 1979–2016 data. It has weakened since, and it doesn't show forcing.

Allowing for how its lag was chosen, the 1979–2026 correlation is borderline; over the whole ERA5 record it isn't significant; before 1979 it reverses; and on the data since 2016 the recipe didn't beat persistence. Much of it is shared with the Southern Annular Mode, whose trend the literature puts down to ozone depletion and greenhouse gases.

Sources

Bracketed numbers refer to this list. For S0 News's research note [1], which has no page numbers, locators are its own headings: the subtitle, Claims 1 to 5, Figures 1 to 3, Methods and Sources. For the 2017 manuscript [3], § gives its own section numbers. For papers, § gives a section, p. a page and para. a numbered paragraph, as in the version the entry names; where only an abstract was read, the entry says so. Numbers marked "our analysis" are ours, not the sources'. Links checked November 15, 2026.

1 S0 News (Space Weather News), "internal GrokBot Team 008" (undated, 2026). Solar Cycle Forcing of Amundsen Sea Low Pressure. A "Space Weather News Research Note from internal GrokBot Team 008", a public Google Doc headed "SPACE WEATHER NEWS & RESEARCH PUBLICATIONS 2026". The note is undated; its data run to July 2026 for the pressure and October 2026 for the sunspots. Retrieved November 15, 2026, at 18:54 UTC, as a text export (SHA-256 `9ac0cee03137efd778d310d8a1bef4acc2ed410fed93eb910396385e44ca5b05`) and as an HTML export with its three figures. Read in full. Not peer reviewed. No licence is given, so it is linked, not hosted, and none of its figures is redrawn.

2 S0 News (2026). The note's data pack, a Google Drive folder. On November 15, 2026, it answered our client with a Google sign-in page, so its scripts, tables and checksums were not read. We never sign in.

3 Davidson, B., Cleckner, T., and Mendez, O. (2017). Solar Cycle Forcing of Amundsen Sea Low Pressure. An unpublished manuscript headed "SpaceWeatherNews 2017", a public Google Doc, with its support workbook of 455 months (January 1979 to November 2016). Both read in full on November 15, 2026. We found no published or posted version in Crossref, OpenAlex or a web search. No licence is given, so they are linked, not hosted.

4 SpaceWeatherNews (S0) (November 15, 2026). Solar Electromagnetic Earth Dance | S0 News Nov.15.2026. YouTube video, https://www.youtube.com/watch?v=gzYwpyefO5g. Linked the source; no transcript was available, so nothing it says is rated here.

5 Hosking, J. S., British Antarctic Survey. Amundsen Sea Low index, version 3 (ERA5), product version 3.20240813, file asli_3.20240813_20261110, January 1959 to August 2026, fetched November 15, 2026 (SHA-256 `876642028a80437de8547ab3a207b7d8b927ec445ee6fe384c9f8e8a08838535`). Computed with the asli software (Wyld, Zwagerman and Hosking; MIT licence) from ERA5 (Copernicus Climate Change Service, doi:10.24381/cds.adbb2d47). The file states no licence; we host only numbers derived from it. We also read the index's page and the software's method notes.

6 Hosking, J. S., British Antarctic Survey. Amundsen Sea Low index, version 2 (ERA-Interim), January 1979 to March 2018, fetched November 15, 2026, with BAS's page on the indices.

7 Hosking, J. S., Orr, A., Bracegirdle, T. J., and Turner, J. (2016). Future circulation changes off West Antarctica: Sensitivity of the Amundsen Sea Low to projected anthropogenic forcing. *Geophysical Research Letters* 43(1), 367–376. Read in full, in the published version in BAS's repository, NORA.

8 Hosking, J. S., Orr, A., Marshall, G. J., Turner, J., and Phillips, T. (2013). The influence of the Amundsen–Bellingshausen Seas low on the climate of West Antarctica and its representation in coupled climate model simulations. *Journal of Climate* 26(17), 6633–6648. Abstract only, as deposited with Crossref.

9 Raphael, M. N., Marshall, G. J., Turner, J., Fogt, R. L., Schneider, D., Dixon, D. A., Hosking, J. S., Jones, J. M., and Hobbs, W. R. (2016). The Amundsen Sea Low: Variability, change, and impact on Antarctic climate. *Bulletin of the American Meteorological Society* 97(1), 111–121. Read in full, in the published version in BAS's repository, NORA.

10 Turner, J., Phillips, T., Hosking, J. S., Marshall, G. J., and Orr, A. (2013). The Amundsen Sea low. *International Journal of Climatology* 33(7), 1818–1829. Abstract only, as deposited with Crossref.

11 Dalaiden, Q., Abram, N. J., Goosse, H., Holland, P. R., O'Connor, G. K., and Topál, D. (2024). Multi-decadal variability of Amundsen Sea Low controlled by natural tropical and anthropogenic drivers. *Geophysical Research Letters* 51, e2024GL109137. CC BY 4.0. Abstract only, as deposited with Crossref.

12 WDC-SILSO, Royal Observatory of Belgium, Brussels. Monthly mean total sunspot number, version 2.0 (doi:10.24414/qnza-ac80), January 1749 to October 2026, fetched November 15, 2026 and checked against SILSO's own checksum (SHA-256 `1cf8a1f6f28ff9ee479783d72fa323eb70a824056450ccf60d0152fa28abd72f`). CC BY-NC 4.0; used non-commercially, with this credit.

13 NOAA Climate Prediction Center. Monthly Antarctic Oscillation (AAO) index, January 1979 to October 2026, fetched November 15, 2026. A work of the US government.

14 Marshall, G. J. An observation-based Southern Hemisphere Annular Mode index, British Antarctic Survey, from 12 stations, January 1957 to September 2026, fetched November 15, 2026. Its method is that of Marshall, G. J. (2003). Trends in the Southern Annular Mode from observations and reanalyses. *Journal of Climate* 16(24), 4134–4143, read in full in the published PDF, supplied by the site's owner because AMS's site answers our client with a refusal (403); © American Meteorological Society, quoted only.

15 Bretherton, C. S., Widmann, M., Dymnikov, V. P., Wallace, J. M., and Bladé, I. (1999). The effective number of spatial degrees of freedom of a time-varying field. *Journal of Climate* 12(7), 1990–2009. Read in full, in the copy on a co-author's University of Washington page; the publisher's site refused our client.

16 European Centre for Medium-Range Weather Forecasts. ERA5: data documentation, read November 15, 2026: its notes on uncertainty and on the known issue over the Amundsen Sea in May–October 1996.

17 Soci, C., Hersbach, H., Simmons, A., Poli, P., Bell, B., Berrisford, P., et al. (2024). The ERA5 global reanalysis from 1940 to 2022. *Quarterly Journal of the Royal Meteorological Society* 150(764), 4014–4048. CC BY 4.0. Abstract only, as deposited with Crossref.

18 Bell, B., Hersbach, H., Simmons, A., Berrisford, P., Dahlgren, P., Horányi, A., et al. (2021). The ERA5 global reanalysis: Preliminary extension to 1950. *Quarterly Journal of the Royal Meteorological Society* 147(741), 4186–4227. CC BY-NC-ND 4.0. Abstract only, as deposited with Crossref.

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20 Bromwich, D. H., and Fogt, R. L. (2004). Strong trends in the skill of the ERA-40 and NCEP–NCAR reanalyses in the high and midlatitudes of the Southern Hemisphere, 1958–2001. *Journal of Climate* 17(23), 4603–4619. Abstract only, as deposited with Crossref.

21 NCAR Climate Data Guide. Amundsen Sea Low indices, read November 15, 2026.

22 Gray, L. J., Beer, J., Geller, M., Haigh, J. D., Lockwood, M., Matthes, K., et al. (2010). Solar influences on climate. *Reviews of Geophysics* 48(4), RG4001. Read in full, in the published version in GEOMAR's repository, OceanRep.

23 Kuroda, Y., and Kodera, K. (2005). Solar cycle modulation of the Southern Annular Mode. *Geophysical Research Letters* 32(13), L13802. Abstract only, as deposited with Crossref.

24 Kuroda, Y. (2018). On the origin of the solar cycle modulation of the Southern Annular Mode. *Journal of Geophysical Research: Atmospheres* 123(4), 1959–1969. Abstract only, as deposited with Crossref.

25 Ineson, S., Scaife, A. A., Knight, J. R., Manners, J. C., Dunstone, N. J., Gray, L. J., and Haigh, J. D. (2011). Solar forcing of winter climate variability in the Northern Hemisphere. *Nature Geoscience* 4(11), 753–757. Abstract only, on the publisher's page.

26 Lu, H., Jarvis, M. J., and Hibbins, R. E. (2008). Possible solar wind effect on the northern annular mode and northern hemispheric circulation during winter and spring. *Journal of Geophysical Research: Atmospheres* 113(D23), D23104. Abstract only, as deposited with Crossref.

27 Seppälä, A., Randall, C. E., Clilverd, M. A., Rozanov, E., and Rodger, C. J. (2009). Geomagnetic activity and polar surface air temperature variability. *Journal of Geophysical Research: Space Physics* 114(A10), A10312. Read in full, in the published version in BAS's repository, NORA.

28 Gray, L. J., Scaife, A. A., Mitchell, D. M., Osprey, S., Ineson, S., Hardiman, S., et al. (2013). A lagged response to the 11 year solar cycle in observed winter Atlantic/European weather patterns. *Journal of Geophysical Research: Atmospheres* 118(24), 13405–13420. Abstract only, as deposited with Crossref.

29 Scaife, A. A., Ineson, S., Knight, J. R., Gray, L., Kodera, K., and Smith, D. M. (2013). A mechanism for lagged North Atlantic climate response to solar variability. *Geophysical Research Letters* 40(2), 434–439. Abstract only, as deposited with Crossref.

30 Chiodo, G., Oehrlein, J., Polvani, L. M., Fyfe, J. C., and Smith, A. K. (2019). Insignificant influence of the 11-year solar cycle on the North Atlantic Oscillation. *Nature Geoscience* 12, 94–99. Abstract only, on the publisher's page.

31 Roy, I., and Haigh, J. D. (2010). Solar cycle signals in sea level pressure and sea surface temperature. *Atmospheric Chemistry and Physics* 10(6), 3147–3153. CC BY 3.0. Read in full.

32 Fact-Checked Science (2026). Earth's magnetic field is weakening slowly; storms, not a flip, are the near-term risk. Our guide to Earth's magnetic field, whose analysis of the IGRF-14 model gives the dipole moments we quote for 1960, 1980, 1990 and 2025.

METHOD

How this was checked

On November 15, 2026, we checked every claim of S0 News's research note 008 [1] against two kinds of evidence. The first was the public files it was built from: BAS's Amundsen Sea Low index in versions 3 and 2 [5] [6] and SILSO's monthly sunspot number [12], with the 2017 manuscript and its workbook [3]. The second was independent: NOAA's and BAS's Southern Annular Mode indices [13] [14], ECMWF's documentation [16], our guide to the field [32], and 22 papers, reviews and data guides on the low, the reanalyses and solar signals. We read the note in full, with its figures, and the 2017 manuscript. We read seven papers in full, one of them from a copy the site's owner supplied, and the other papers as abstracts; the data guides and documentation were read as web pages, as the source list says. The note's data pack asked for a sign-in, so we didn't read it [2].

The verdicts and the items tagged "Our analysis" are our own assessment, built on the cited sources. No transcript of the episode in which S0 News linked the note was available, so the page reviews the note on its own [4]. The rules of each test were written, and their SHA-256 logged, before it ran: the reproduction, the cost of the lag search under two nulls, the out-of-sample test of the 2017 recipe, the pre-1979 flip and the SAM checks. The checks chosen afterwards, on the SAM numbers, on the data since 2016 and for the charts, are marked post hoc.

All 30 of the note's numbers that we checked reproduced from the public files, and so did all 392 correlations in the 2017 manuscript's table, from its own workbook. Our surrogate tests agree with the note's within chance. We couldn't read the note's own scripts or tables, and we never run S0 News's code. Our hosted scripts, run again from an empty folder with freshly fetched inputs, gave the same outputs. Several papers were read only as abstracts, among them the three ERA5 papers, whose publisher we don't fetch from. A co-author's copy stood in for Bretherton and colleagues' paper, which its publisher refused us. A fresh reviewer then recomputed the numbers with independent code and read the built page against its sources; that review led us to correct how the page described the data since 2016, to stop citing BAS's relative central pressure as a test of the SAM pathway, to re-rate that claim as Misleading under a new label, and to make about twenty smaller fixes.

This page was researched and written with Claude, an AI assistant made by Anthropic, and then re-checked against its sources in a separate verification pass.

The verdicts on this page

MISLEADING	Contains something true but leaves a false impression, usually by leaving out key context.
OVERSTATED	Has some basis but claims much more than the evidence supports.
UNSUPPORTED	No evidence we could find backs it up, though it hasn't been strictly disproven.
TRUE	The evidence supports the claim.

All ten verdicts, and how we check

CORRECTIONS

Corrections and changes

If we get something wrong, we fix it and record the change below with the date. If a correction changes a verdict, the log says what the old verdict was.

Change log

Nov 15, 2026	Published on factchecked.science after a full check against the sources: S0 News's research note 008, the 2017 manuscript and its workbook, BAS's Amundsen Sea Low index in versions 3 and 2, SILSO's sunspot number, NOAA's and BAS's Southern Annular Mode indices, and the literature on the low, the reanalyses and solar signals. Every number in the note reproduces. Our pre-registered tests cover the cost of the lag search, the 2017 recipe out of sample, the pre-1979 flip and the SAM pathway; the scripts, rules and derived numbers are hosted. None of the note's figures is redrawn, and nothing of S0 News's is hosted.

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Last updated Nov 15, 2026