NASA Earth System Trend Detective — Australia trends report

Prepared: 14 November 2026 (AEDT)
Region: Australia, with a central Australia comparison point near 25.3°S, 133.8°E
Status: five NASA product analyses and a Meteomatics/ECMWF ERA5 point comparison are complete. This report now also includes a full-grid 1981–2025 NASA POWER/MERRA-2 temperature analysis and state/national comparisons against Bureau of Meteorology ACORN-SAT and AGCD series. A local code/data audit reproduced the main aggregation and trend results and verified both boundary files against pinned official sources; full provenance is included in the analysis metadata. A bounded two-provider Roundtable re-review returned advisory APPROVE from ChatGPT and Claude after assessing the supplied audit summaries; Kimi was not in that completed run, so this is not three-agent consensus and the reviewers did not inspect local files directly. See run_20261114_184208/ and data_analysis_20261114_australia_grid/LOCAL_EXTENSION_AUDIT_2026-11-14.md. Earlier review flags and Kimi timeouts are preserved below.

Main findings

1. **Australia-wide air temperature increased across the full NASA POWER grid, and a separately produced Australian station-based comparison shows the same broad national and regional direction.** Across 2,133 land grid centers over 1981–2025, the area-weighted NASA POWER/MERRA-2 Sen slope is **+0.215°C per decade** (separate OLS/HAC 95% CI +0.098 to +0.304; BY q=0.00076 across the three national POWER outcomes). The Bureau of Meteorology ACORN-SAT regional mean series gives +0.244°C per decade over the same years. All seven state/territory Sen slopes are positive in both products; six of seven POWER state tests and all seven ACORN-SAT tests pass BY q<0.05. This is the strongest Australia-wide result in the project, while still comparing a reanalysis with a station-derived gridded estimate rather than two raw station networks.
2. **The central point result is consistent with warming but is no longer the only evidence.** Its preregistered two-sided Mann–Kendall test with Bonferroni correction across the two planned point outcomes remains valid for that point-only question; it does not supply the national inference.
3. **The Australia-wide POWER precipitation decline is not corroborated by the BoM AGCD rainfall comparison.** For 2000–2025, POWER precipitation is downward while the BoM AGCD Australia series is near-flat and not significant (Sen +5 mm/year per decade, HAC p=0.83). Five of seven state slopes share a downward direction, but none of the seven AGCD state trends passes the regional BY q<0.05 screen. Treat the POWER decline as a model-grid signal needing further investigation, not an established Australia-wide observed rainfall trend. POWER land evaporation and BoM pan evaporation are different quantities and have a shorter common period, so they are not a direct validation pair.
4. **The spatial precipitation/evaporation scans are exploratory.** Grid cells are spatially correlated and not independent replicates; coastline assignment, the short 2000–2025 period, and autocorrelation assumptions affect inference. The 2-year bootstrap p-values are nominal and BY q≈0.070 across its two outcomes; 3–5-year blocks include zero.
5. **The central Australia precipitation and evaporation point series do not establish long-term trends.** POWER precipitation, GPM IMERG, and GLDAS evaporation are highly variable. Their long-run annual intervals include zero. Around 2019 the local precipitation and evaporation products are unusually low, but this is an event-level observation, not causal attribution.
6. **The 500 m MODIS ET point series does not show a significant trend at that pixel.** Its 2001–2024 Sen slope is +0.036 mm/day per decade, with HAC interval −0.032 to +0.066 and q=0.496. This local result cannot validate or contradict a national evaporation pattern.

What the products measure

Dataset	Quantity and units	Coverage and scale	How to interpret it
NASA POWER/MERRA-2 point	T2M, monthly mean 2 m air temperature (°C); PRECTOTCORR, corrected precipitation rate (mm/day)	1981–2025, monthly, one grid point near 25.3°S, 133.8°E	Gridded reanalysis-derived meteorology. It is not a station record or satellite-only measurement.
NASA POWER/MERRA-2 Australia grid	T2M, monthly mean 2 m air temperature (°C)	1981–2025, monthly, 2,133 land grid centers at about 0.5° latitude × 0.625° longitude	Reanalysis grid, area-weighted nationally and aggregated to seven state/territory polygons.
NASA POWER/MERRA-2 Australia grid	PRECTOTCORR corrected precipitation rate and EVLAND land evaporation rate (mm/day)	2000–2025, monthly, 2,133 common land grid centers at about 0.5° latitude × 0.625° longitude	Spatially complete reanalysis comparison. EVLAND is a modeled land-surface flux, not pan evaporation or a flux-tower observation.
BoM ACORN-SAT regional series	Area-averaged mean temperature anomaly (°C)	1910–2025, annual, Australia and seven state/territory regions	Homogenized station-derived, fine-grid analysis; compared with POWER over 1981–2025.
BoM AGCD regional series	Area-averaged annual rainfall (mm)	1900–2025, annual, Australia and seven state/territory regions	Gauge-informed Australian gridded climate analysis; compared with POWER over 2000–2025.
BoM high-quality pan evaporation	Annual pan evaporation total (mm)	1975–2017, annual, Australia and state/territory regions	Observed open-pan water loss, not the same physical quantity as modeled actual land evaporation; compared over 2000–2017 for context only.
GPM IMERG Final GPM_3IMERGM.07	Merged satellite–gauge precipitation estimate (mm/hr)	Jan 1998–Sep 2025, monthly, one 0.1° cell at 133.85°E, 25.25°S	Giovanni's requested small area resolved to one pixel. It is not an area-wide Australia series or a gauge reading.
GLDAS Noah GLDAS_NOAH025_3H_2.1, Evap_tavg	Land-surface model evaporation flux; converted from kg m□² s□¹ to mm/day	Jan 2000–Jul 2026, 3-hourly, 0.25° grid sample near the project point	Model output forced by meteorological inputs; 2026 is partial and excluded from annual trend analysis.
Terra MODIS MOD16A2GF.061, ET_500m	Year-end gap-filled 8-day ET total, kg/m² per composite (water-equivalent mm), converted to mm/day	Jan 2000–Sep 2025, one sampled 500 m pixel in tile h30v11	Algorithm estimate using MODIS land inputs and meteorology, not direct measurement. The MOD16 guide gives a 0.1 scale factor, and LP DAAC confirms AppEEARS CSV exports already apply it; the analysis does not scale a second time.
Meteomatics Weather API / ECMWF ERA5	Daily 24-hour precipitation and evaporation totals, aggregated to mean mm/day	2000-01-01–2025-09-30, 9,405 daily rows, one point at 25.3°S, 133.8°E	A second reanalysis product at one location, not an Australia-wide mean or independent station validation. ERA5 and POWER/MERRA-2 differ in model and inputs but are both reanalysis products.

NASA documents the POWER monthly/regional API, the MERRA-2-based meteorology and T2M source period (1981 onward) in the POWER API documentation and meteorology methodology; its hydrology data-source notes describe the other gridded fields. GPM IMERG Final is a multi-satellite estimate with gauge input; see the NASA GES DISC IMERG product record. GLDAS Noah product details are in the NASA GES DISC product record. MOD16A2GF.061 is described in the NASA/LP DAAC catalog record.

Meteomatics exposes model, station, and observation data through its Weather API. The account status returned a 1,000-request hard limit per UTC day and a historical query window through 2028-11-14. Its API login is a username/password; the project downloader reads those only from local ignored .env settings. Meteomatics documents ERA5 source selection, the precipitation parameters, and the evaporation parameter sign convention (negative values indicate evaporation). The historical daily CSV was successfully fetched over the authenticated API and analyzed separately from NASA products; the resulting point-series trends are inconclusive and are not an Australia-wide validation.

The Bureau of Meteorology ACORN-SAT series is based on homogenized observations from a 112-station network and regional area-average temperature series; its regional means are derived from a fine gridded

analysis. The BoM rainfall series is based on Australian Gridded Climate Data and reports Australia/state area-average annual rainfall. The BoM pan-evaporation series uses a separate high-quality observing network and ends in 2017. These provide separately produced observational context; this comparison does not establish complete independence of all underlying inputs and the products are not interchangeable.

Australia-wide precipitation and evaporation

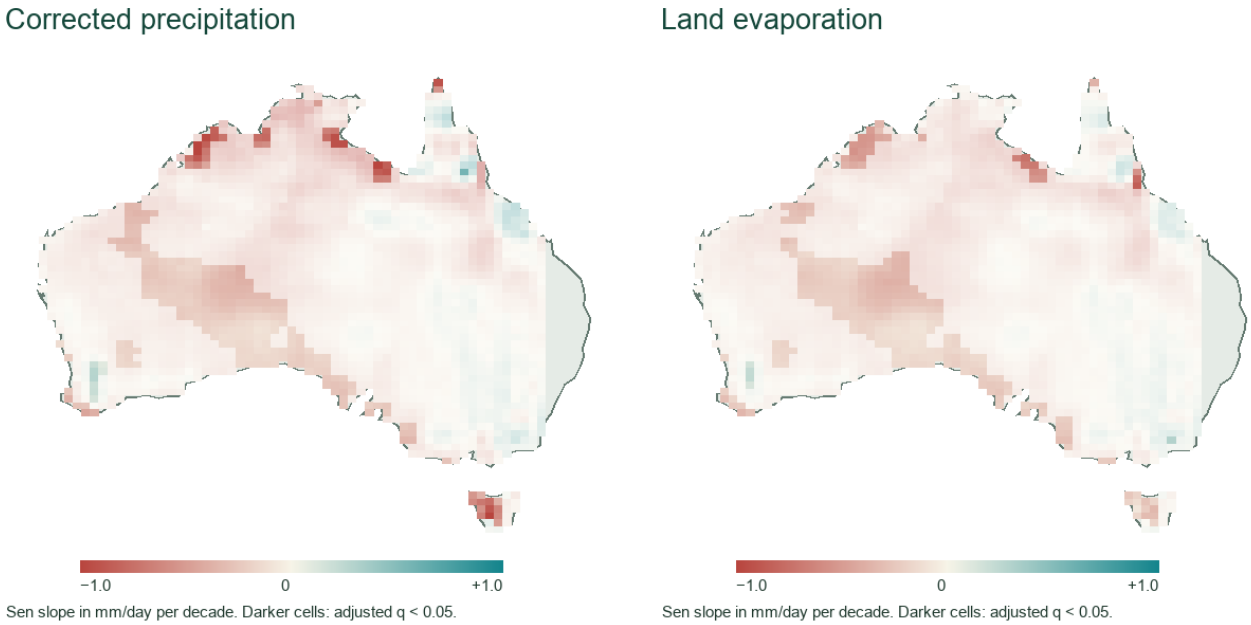
The regional NASA POWER extraction requested PRECTOTCORR and EVLAND in overlapping tiles, then retained the 2,133 common grid centers inside an Australia land polygon. Monthly national means use cosine-latitude weights; annual values use calendar-day weighting. The Natural Earth mask uses center-in-polygon assignment, so islands and mixed coastal cells are approximate. These estimates are from MERRA-2 reanalysis and cover only 26 years.

Variable	Sen slope (mm /day/decade)	OLS slope (m m/day/decade)	HAC 95% CI for OLS	HAC p	BY q, original precipitation + EVLAND family	3–5 year bootstrap intervals include zero?
Corrected precipitation (PRECTOTCORR)	−0.150	−0.188	[−0.347, −0.029]	0.020423	0.030649	Yes
Land evaporation (EVLAND)	−0.129	−0.150	[−0.277, −0.023]	0.020433	0.030649	Yes

Sen's slope is the robust trend estimate. The listed HAC interval and p-value belong to the separate OLS slope; the two estimators are labeled separately because they need not match. The HAC standard error uses Newey–West with lag 2; the confidence interval uses ±1.96 standard errors and the p-value uses the large-sample normal reference, not a small-sample t reference. With n=26 this may be optimistic. Ordinary Mann–Kendall p-values are 0.0136 for precipitation and 0.0120 for evaporation, but ordinary MK does not account for autocorrelation. The annual residual lag-1 correlations are about 0.45 and 0.51. The similar national HAC p-values are not identical: 0.0204225 (precipitation) and 0.0204326 (EVLAND), calculated separately from their own OLS slopes and HAC standard errors; their near equality reflects nearly equal absolute z statistics.

The post-hoc moving-block residual bootstrap targets the OLS slope, using cyclic blocks of residuals from the fitted linear OLS trend; its percentile intervals and empirical two-sided null p-values are unadjusted sensitivity results. It used 5,000 replicates at each block length. At 2-year blocks, the intervals exclude zero and nominal p-values are below 0.05 (0.0466 precipitation; 0.0370 evaporation), but BY adjustment across the two outcomes gives q≈0.070 for both. At 3–5-year blocks, p-values range from 0.0556 to 0.0654 and all intervals include zero. Because the inference changes with block length, the apparent national declines should be treated as suggestive and sensitive, not a stable detection. This bootstrap is not a preregistered confirmatory test.

At grid-cell scale, 1,771/2,133 precipitation Sen slopes and 1,794/2,133 evaporation slopes are negative. BY-adjusted HAC $q<0.05$ for 307 precipitation cells (298 negative) and 304 evaporation cells (299 negative). These tests are spatially dependent; the counts are not hundreds of independent detections.



Australia-wide NASA POWER cell Sen slopes for precipitation and evaporation

Opacity in the map marks cellwise HAC q<0.05 after BY adjustment over the grid. The map is exploratory and should be read with the national bootstrap sensitivity and spatial-dependence caveat.

State and territory summaries

Seven state/territory groups contain 2,120 grid centers; 13 centers do not match the simplified state polygons, and the ACT has no POWER grid center at this resolution. State BY q-values are adjusted over the seven available regional series separately for each variable (catalog field hac_q_by_seven_regions). These are post-hoc exploratory summaries; coastal assignment, limited cells, and the short record remain important limitations. The nationwide spatial scan and all state tests are exploratory, not covered by the single-point preregistration.

Region	Cells	Precipitation Sen slope	Precipitation q	EVLAND Sen slope	EVLAND q
New South Wales	210	+0.053	1.0000	+0.049	1.0000
Northern Territory	350	−0.323	0.0415	−0.205	0.0847
Queensland	442	−0.090	0.9608	−0.132	0.6294
South Australia	301	−0.134	0.0387	−0.121	0.0425
Tasmania	23	−0.368	<0.001	−0.129	0.0033
Victoria	73	−0.022	1.0000	−0.027	1.0000
Western Australia	721	−0.215	0.0031	−0.179	0.0033

The displayed Sen slopes are descriptive robust effect estimates. The p/q values are from a separate OLS linear-trend test with Newey–West HAC standard errors (lag selected by the bandwidth rule) and a large-sample normal reference; q-values use Benjamini–Yekutieli over seven available region series per variable. The underlying state trend catalog records both OLS and Sen slopes. The displayed cells sum to all 2,120 matched state/territory centers. NSW and Victoria do not pass q<0.05 in either variable. These estimates are exploratory; Tasmania needs station validation and a coastline/resolution sensitivity check before use as a regional claim.

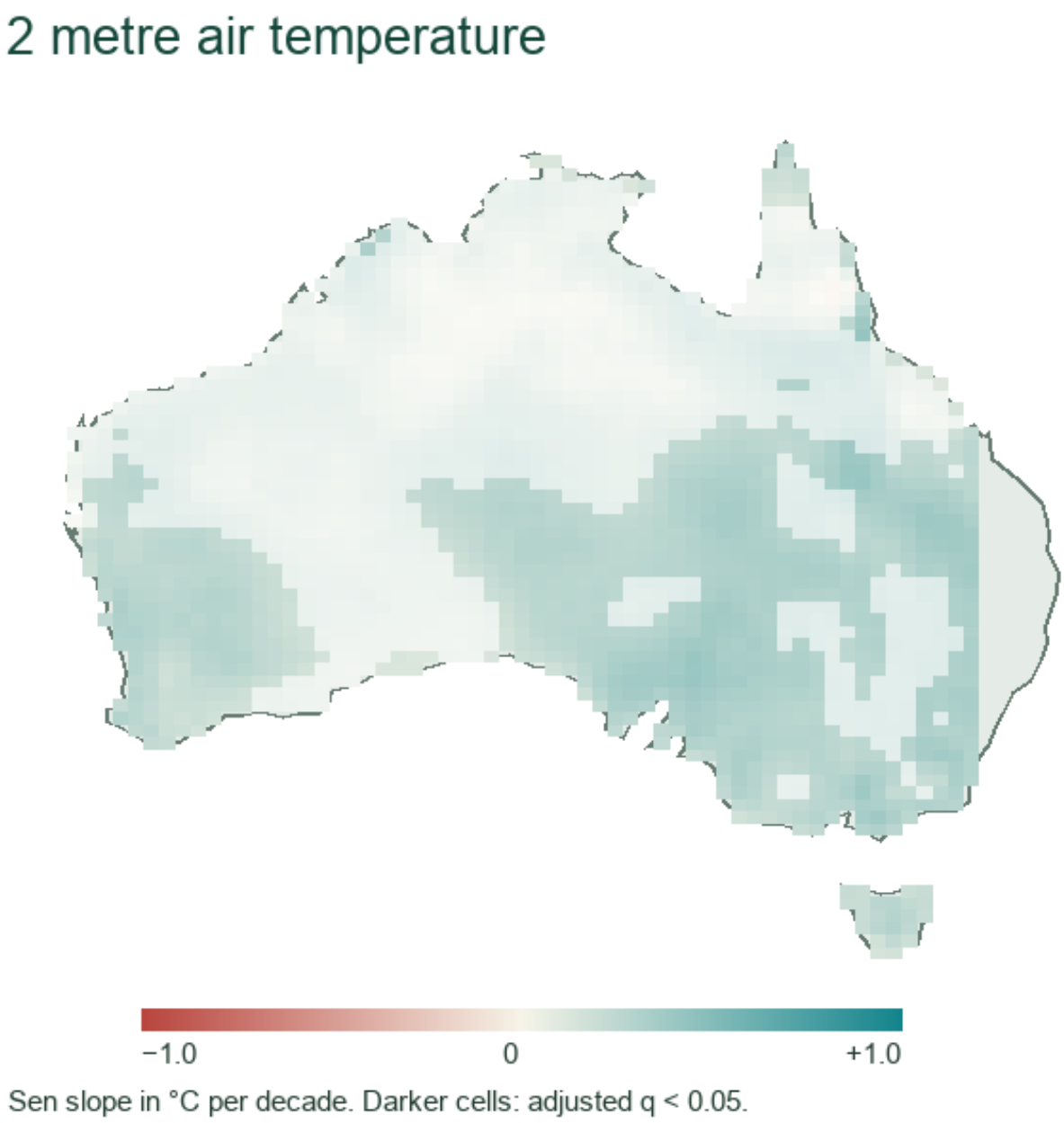
Full-grid temperature and cross-product regional comparison

This full-grid temperature analysis is a post-hoc extension; the preregistration covers only the central Australia POWER point. The NASA POWER/MERRA-2 extraction covers 1981–2025 at all 2,133 Australia land grid centers in the existing mask. Monthly 2 m air temperature is converted to calendar-day-weighted annual means; each annual national/state mean is area-weighted by cosine latitude. The series has 45 complete annual values. The separate central Australia point result is not used as the national estimate.

Dataset and region	Years	Sen slope (°C/decade)	OLS slope (°C/decade)	HAC 95% CI for OLS	HAC p	Multiplicity adjustment
NASA POWER/MERRA-2, Australia	1981–2025	+0.215	+0.201	[+0.098,+0.304]	0.000138	BY q=0.000760 across three national POWER outcomes
BoM ACORN-SAT, Australia	1981–2025	+0.244	+0.242	[+0.179,+0.305]	<0.000001	National comparison p unadjusted; seven-region q reported below

The three-outcome POWER q family is a post-hoc analytical choice spanning T2M (1981–2025), precipitation and land evaporation (2000–2025); it was not part of the point-based preregistration.

The national slopes are close and have the same positive direction. The POWER grid-cell catalogue has 2,130 positive Sen slopes out of 2,133; 948 cells have OLS-HAC BY $q<0.05$ after correction across the grid, and all 948 also have positive Sen slopes. Because neighboring reanalysis cells are spatially dependent, this is a mapped pattern, not 948 independent confirmations; no separate field-significance test was performed. The map and complete grid-cell catalog are preserved below.



Australia-wide NASA POWER MERRA-2 2 m air-temperature trends, 1981–2025

Region	POWER Sen slope	POWER state BY q	ACORN-SAT Sen slope	ACORN-SAT state BY q
New South Wales*	+0.297	0.0044	+0.318	0.000024
Victoria	+0.268	0.0005	+0.222	0.000116
Queensland	+0.244	0.0053	+0.296	<0.000001
Western Australia	+0.167	0.0035	+0.250	<0.000001
South Australia	+0.279	0.0005	+0.285	0.000005
Tasmania	+0.226	0.0002	+0.139	0.000291
Northern Territory	+0.141	0.3011	+0.130	0.0463

Both products show a positive Sen slope in all seven areas, and six regions pass q<0.05 in both; the Northern Territory passes only in the ACORN-SAT series. State-level q-values are Benjamini–Yekutieli adjusted over the seven regions separately for each product using OLS-HAC trend tests; Sen slopes are descriptive robust slope estimates. *BoM's NSW series includes the ACT; the POWER grid has no ACT cell at this resolution. The underlying products use different spatial methods: POWER is a coarse MERRA-2 reanalysis, while ACORN-SAT uses homogenized station observations interpolated to a fine grid. This

agreement supports the broad warming pattern, but is not a comparison of identical measurements or independent station-by-station replication.

The BoM cross-product comparison is less supportive for rainfall. For 2000–2025, the POWER Australia-wide precipitation Sen slope is −55.3 mm/year per decade (HAC p=0.021; BY q=0.0377 across the three post-hoc national outcomes). The slope, raw p-value, and adjusted q-value are drawn from the same calendar-day-annualized series; see data_analysis_20261114_australia_grid/temperature_1981_2025/annualized_national_family.csv. Here, mm/year per decade means the change per decade in an annual precipitation total. The BoM AGCD national rainfall slope is +5.2 mm/year per decade with HAC p=0.833; none of its seven state series passes BY q<0.05. Five of seven state Sen slopes share the downward direction, but the state-scale magnitude and significance do not reproduce the POWER pattern. The previously observed POWER decline should therefore be presented as a reanalysis signal, not as an established observed Australia-wide rainfall trend.

For 2000–2017, POWER EVLAND has a national Sen slope of −42.7 mm/year per decade (HAC p=0.58), while BoM pan evaporation is +18.6 mm/year per decade (HAC p=0.48). Both intervals include zero. Pan evaporation from an open water pan is not equivalent to actual land-surface evaporation, so differences in their regional slope signs are not direct contradictions. The short overlap and the observed network's limitations make this only context, not validation.

The original precipitation/EVLAND table above retains its two-outcome adjustment for reproducibility. For the expanded three-outcome national POWER family, we recalculated raw p-values and BY q-values from the same annualized series used for the quoted precipitation slope; precipitation and EVLAND q-values are each 0.03771, and T2M q=0.000760. This outcome family is a post-hoc analytical choice, combines different variables and record lengths, and was not part of the original point-based preregistration. The bootstrap sensitivity still concerns only the two precipitation/EVLAND outcomes and its BY q≈0.070 remains adjusted within that two-outcome sensitivity family.

Central Australia point results

Temperature

POWER/MERRA-2 has 45 complete annual values (1981–2025). The Sen slope estimate is +0.2556°C/decade. The preregistered two-sided Mann–Kendall test gives p=0.00206 (Bonferroni p=0.00412 for the two planned outcomes). Separately, the post-hoc HAC OLS slope is +0.2166°C/decade (95% CI +0.0913 to +0.3419; BY-adjusted HAC q=0.0021 across the two POWER point outcomes). The deseasonalized monthly series also points upward, while no individual calendar month is a corrected discovery. This supports warming at the selected reanalysis grid point, not a statement about every part of Australia.

Precipitation

POWER corrected precipitation has a Sen slope of −0.0445 mm/day/decade; the separate OLS slope is −0.0412, with normal-reference HAC 95% CI [−0.1103,+0.0279], p=0.2423 and BY q=0.3634 across the two POWER point outcomes. GPM IMERG Final spans 333 monthly samples, Jan 1998–Sep 2025; its 1998–2024 annual Sen slope is −0.0001126 mm/hr/decade, while the OLS slope is −0.004127, with HAC interval [−0.01097,+0.002717], p=q=0.2372 for its single annual outcome. This Sen/OLS difference is retained; skewed, zero-heavy precipitation makes the estimators respond differently to extreme wet years. No scanned GPM annual window survives the multiple-window correction. The local series show substantial variability but do not establish a linear long-term precipitation trend.

GPM's largest annual positive anomaly is 2010 and its lowest is 2019. The July 2010 anomaly has an extreme robust z-score because the dry-month median absolute deviation is near zero; use the raw anomaly, not that z-score, as the description. POWER also shows a high 2010 and low 2019. This is descriptive co-occurrence, not proof of cause.

Evaporation and evapotranspiration

GLDAS Noah has 26 complete annual means (2000–2025); its Sen slope is −0.0812 mm/day/decade and the separate OLS slope is −0.0890, with normal-reference HAC 95% CI [−0.2184,+0.0404], p=q=0.1778 for this single annual outcome. The direction is downward but not statistically established. A lower modelled actual evaporation rate can occur when water availability limits evaporation, even in a warming climate; this analysis does not test that mechanism.

The AppEEARS MODIS request is complete. Its source export has 1,185 dated 8-day records from 2000-01-01 through 2025-09-30 for one 500 m pixel. The analysis has 308 monthly aggregates from February 2000 through September 2025 because all January 2000 composites are QC fill. The primary quality screen retains 1,171 MODLAND-good composites, identifies 3 backup/other composites, and excludes 11 QC-fill composites. It uses full years with at least 95% valid-day coverage; the trend covers 2001–2024 because 2000 has incomplete coverage and 2025 is partial. The annual Sen estimate is +0.0360 mm/day/decade; the separate OLS slope is +0.0170, with normal-reference HAC 95% CI [−0.0320,+0.0661], p=q=0.4961 for its single annual outcome. Including the 3 valid backup/other composites changes the Sen slope only to +0.0353 and leaves the OLS-HAC interval spanning zero. The preregistered POWER test does not apply to this post-hoc product. There is no confirmed trend at this pixel.

The MOD16 Version 6.1 guide defines ET_500m as an 8-day total in kg/m² (water-equivalent mm), gives scale factor 0.1, and notes that the final annual composite covers 5 or 6 days. LP DAAC support confirms AppEEARS CSV exports already incorporate product scale factors. The analysis therefore uses the CSV values as delivered without another 0.1 multiplication. The primary quality screen requires MODLAND bit 0=0 and excludes QC fill 255; a sensitivity that includes the 3 valid backup/other composites does not change the no-trend conclusion. Full-year means require at least 95% coverage. Each composite total is divided by its actual date interval, including the shorter year-end and partial final requested period, then spread evenly across days to form monthly and annual rates. That is a conversion convention, not additional temporal information. The guide notes that MOD16A2GF is year-end gap-filled and cautions about early mission data; we omit incomplete 2000 from trend inference. Original export and decoded QA rows are preserved. See the MOD16 Version 6.1 User Guide and the LP DAAC AppEEARS CSV scaling clarification.

Meteomatics / ERA5 comparison

The API returned a complete 9,405-day daily series for 2000-01-01–2025-09-30 at 25.3°S, 133.8°E. Right-aligned 24-hour totals were assigned to the preceding UTC date; the provider's negative evaporation sign was flipped so positive values consistently mean water loss. Monthly means are complete for all 309 month-keys, with no missing or duplicate months. The source CSV, canonical daily/monthly tables, and request metadata are preserved.

For complete annual means (2000–2024), the point-series Sen slopes are −0.0497 mm/day/decade for precipitation and −0.0293 mm/day/decade for evaporation; the corresponding OLS slopes are −0.0846 and −0.0753. Normal-reference HAC 95% intervals are [−0.2790,+0.1098] and [−0.2268,+0.0761]. The BY-adjusted HAC q-values are both 0.590, adjusted across the two Meteomatics annual outcomes at this point; both Mann–Kendall p-values exceed 0.69. These results do not establish a long-term trend at this one point. Annual precipitation and evaporation are strongly correlated in this paired ERA5 series (Pearson r=0.971), a descriptive, product-internal relationship that does not establish causality or independent confirmation.

Roundtable review

The earlier three-provider and two-provider reviews are preserved under run_20261114_*/. The full-grid temperature and BoM comparison received a focused review continuation in run_20261114_155855/ and run_20261114_162704/; that review returned ISSUES, and Kimi timed out during its cross-review. A subsequent three-provider attempt (run_20261114_174140/) also stopped when Kimi timed out on all three counted attempts. After local code/data and MODIS metadata audits, a bounded five-stage review (run_20261114_184208/) returned APPROVE from ChatGPT and Claude in 11 of 15 permitted attempts; no emergency calls were used. Kimi was not in this review, so this is a two-provider advisory approval, not a three-agent consensus. The agents reviewed the supplied audit summaries and did not inspect local files directly. They found no material error; minor questions about dates, family labels, and periods were checked against the current report and source files. For MODIS, the 308 valid monthly aggregates run Feb 2000–Sep 2025 because the January 2000 records are all QC fill, while the source export itself spans Jan 1, 2000–Sep 30, 2025. The local grid and MODIS audit notes document reproducible checks and external-access limitations. The annualized rainfall family q-values were recalculated from the same series as the quoted slope and raw p-value. See run_20261114_184208/, data_analysis_20261114_australia_grid/LOCAL_EXTENSION_AUDIT_2026-11-14.md, data_analysis_20261114_appeears_modis/MODIS_METADATA_AUDIT_2026-11-14.md, and data_analysis_20261114_australia_grid/temperature_1981_2025/annualized_national_family.csv.

Reading the combined pattern

The strongest Australia-wide finding is warming: the NASA POWER/MERRA-2 full grid and separately produced BoM ACORN-SAT station-based regional series both show positive national and state-level temperature slopes across their matched 1981–2025 period. The POWER precipitation decline is not reproduced by the BoM AGCD rainfall series over 2000–2025, whose national trend is near zero. The NASA POWER precipitation and evaporation fields are coupled within the same reanalysis and should not be treated as independent confirmations. A decrease in modelled actual evaporation could reflect water availability, vegetation response, energy balance, reanalysis forcing, or model structure; these candidate explanations were not tested here.

The broad POWER EVLAND field, BoM pan evaporation and the point MODIS ET series measure different physical quantities or use different algorithms and resolutions. GPM Final includes gauge information; POWER/GLDAS/MODIS rely on model or assimilated inputs. Agreement among products can guide follow-up questions, but it is not automatically independent ground-truth validation. For single-outcome annual analyses (GPM, GLDAS, and MODIS), BY q equals the unadjusted HAC p because each family contains one tested outcome; POWER point and Meteomatics results use two-outcome families.

Methods and safeguards

- The protocol.md file records the single-point POWER question and primary annual T2M outcome before values were reviewed; PRECTOTCORR was secondary. Its planned test was two-sided Mann–Kendall with Bonferroni correction across two variables. Newey–West HAC intervals, the broad grid scan, state summaries, Meteomatics and the other product analyses are added or alternate post-hoc analyses and must remain explicitly exploratory.
- The expanded files retain monthly and annual series, every eligible trend/window row, anomaly catalogues, breakpoint scans, cross-variable statistics, quality summaries, source metadata, and raw source files. Rolling windows and breakpoint scans are discovery aids; they are not independent confirmatory tests.
- Sen slopes and OLS HAC intervals are separate estimators. For the original 2000–2025 national precipitation/EVLAND outcomes, Newey–West uses lag 2, selected by the common bandwidth rule floor(4(n/100)^(2/9)); for the 1981–2025 temperature outcome, the same rule selects lag 3. HAC p-values use an asymptotic normal reference; the temperature grid series has 45 annual values. The expanded

national POWER BY adjustment covers T2M, precipitation, and EVLAND; their different temporal coverage is stated with results. An illustrative t(24)-reference sensitivity for the original n=26 precipitation/EVLAND family is not a formal small-sample HAC correction. The block bootstrap remains more sensitive to block length. Ordinary MK p-values do not handle autocorrelation. The POWER point protocol's preregistered MK/Bonferroni result is distinguished from these post-hoc HAC and spatial results.

- The Australia grid and state analysis aggregate spatial model output; effective independence is lower than the number of grid cells. The national mask is Natural Earth Admin 0 Countries, 1:110m, version 5.1.1. The state polygons are the geoBoundaries gbOpen Australia ADM1 simplified file at pinned commit 9469f09, sourced from the Australian Bureau of Statistics 2021 State and Territory boundaries (CC BY 4.0; attribution: geoBoundaries, sourced from ABS). The bundled geometry files were checked against those official releases; source URLs and SHA-256 hashes are in data_analysis_20261114_australia_grid/source_metadata.json. Center-in-polygon assignment still approximates coastlines/islands; 13 national land centers are not assigned to a state.
- Results are observational/reanalysis associations, not causal attribution. Station validation, a different reanalysis, and a longer baseline are the next steps.

Data and analysis files

- data_analysis_20261114_nasa_power/ — POWER/MERRA-2 single-point source JSON, monthly data, preregistration, trend/anomaly catalogue, and rolling/breakpoint inventory.
- data_analysis_20261114_australia_grid/ — 162 cached regional API tiles for precipitation/land evaporation, 2,133-cell summaries, state and national catalogs, moving-block bootstrap, and map. temperature_1981_2025/ contains 81 cached T2M regional tiles, 45-year full-grid annual/monthly data, cell and state trend catalogs, temperature map, the BoM ACORN-SAT/AGCD/pan-evaporation comparison series, and the aligned annualized national multiplicity family in annualized_national_family.csv, generated reproducibly by recompute_annualized_national_family.py. temperature_2000_2025/ preserves the initial shorter-period extraction and comparison. The analysis metadata records the versioned Natural Earth and geoBoundaries/ABS geometry sources and their checksums.
- data_analysis_20261114_gpm_imerg/ — original Giovanni CSV and exhaustive monthly analysis.
- data_analysis_20261114_hydrology/ — untouched GLDAS source CSV and full analysis.
- data_analysis_20261114_appeears_modis/ — AppEEARS CSV, QA records, monthly and annual tables, and trend inventory.
- data_analysis_20261114_meteomatics_era5/ — Meteomatics raw response, source metadata, daily/monthly/annual tables, exhaustive trend/anomaly/rolling/breakpoint inventory, analysis script, and local credential-safe downloader.
- run_20261114_093534/ — earlier three-agent review, all three final checks flagged issues because the integration draft was empty.
- run_20261114_130025/ — subsequent 10k-cap review; safely stopped when Opus escalated without giving a reason (12/22 standard attempts, no emergency calls).
- run_20261114_131512/ — latest 10k-cap three-provider review, 16 standard attempts, all final checks ISSUES; details and full event log are preserved.
- run_20261114_142923/ — three-provider re-review stopped after Kimi timed out on three counted attempts; no emergency calls.

- run_20261114_144545/ — completed two-provider re-review, 11 attempts, both final checks ISSUES; findings incorporated above.
- run_20261114_150848/ — final two-provider audit of the preceding report, 11 attempts; ChatGPT APPROVE, Claude Opus ISSUES for bootstrap multiplicity wording, now corrected. The full-grid temperature and BoM comparison extension was added afterward; it has a separate local code/data audit, but no completed Roundtable consensus review. The report and its earlier point-only version are both retained. The earlier version is NASA_Earth_System_Trend_Detective_Report_2026-11-14_before_spatial_expansion.md.