Watchberg

WHITE PAPER, LOOK-BACK NO. 2

Langtang Lirung, 26 August 2026: seven satellite tests on one flank

The Watchberg method applied after the event to the Langtang Lirung collapse in Nepal, with six further tests, their rules fixed in advance, and the learnings for regional screening

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Version 1.0, 2026-10-24
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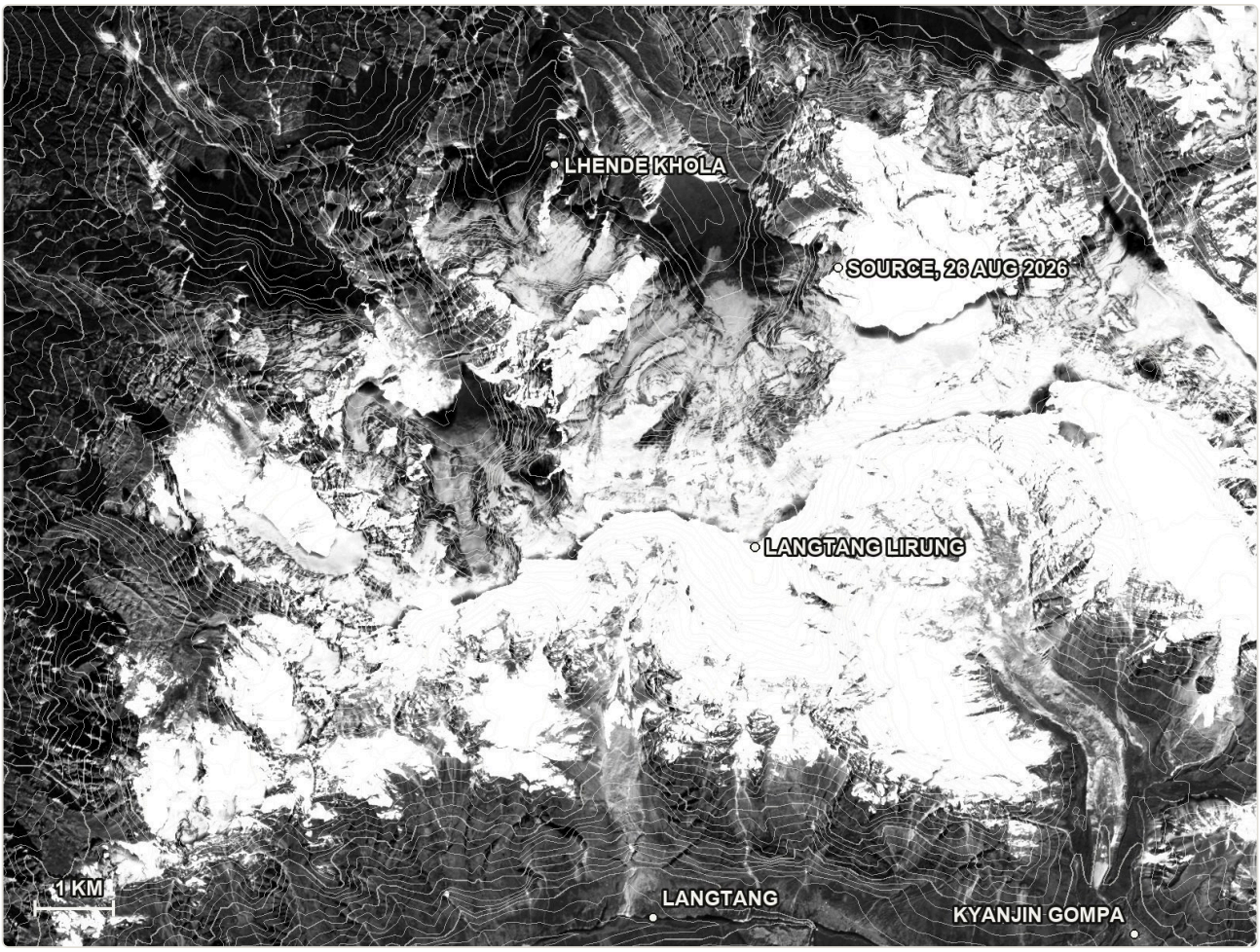
This is the second look-back and the harder one. The first, on Blatten, showed the chain from raw radar images to one flagged unit of terrain on a slope that short-wavelength radar could still follow. This one takes the same chain, the same parameters and the same three rules to the north-west flank of Langtang Lirung in Nepal, where a rock-and-ice mass fell on 26 August 2026, and then goes further: five more tests with other data and other signals, each with its rule written down before a single value was read. The honest summary first: with a rule fixed in advance, none of the seven tests flagged this flank before the collapse. One test, radar feature tracking at 20 m that sees through the monsoon, put two of the five source units into the lowest class, “above normal”, in the final window; one measurement singled the source out on one day with one instrument. The rest of this article explains what was seen, what was missed, why, and what we are changing because of it.

Three things to keep in mind throughout. It is a look-back at a past case, computed after the event, and no assessment of any slope today. Every number comes from the processing files; the parameters sit in a timestamped decision log written before each run. And the conclusions about the product are projected until the pilot programme of 2027 validates them.

1. The case

At 08:37 local time on 26 August 2026 (02:52 UTC) a large mass of rock and glacier ice broke away from the north-west flank of Langtang Lirung, a 7,227 m peak in Langtang National Park, about 64 km north of Kathmandu. The mass fell about 1,200 m into the valley of the Lhende Khola, entrained moraine, sediment and water, and turned into a debris flow that briefly dammed the river and then surged downstream. It destroyed the border crossing at Gyirong Port in China and Rasuwagadhi in Nepal, then Timure, Syabrubesi and settlements along the Trishuli over about 100 km. The seismic signal was first reported as an earthquake; the USGS later concluded it was produced by the collapse itself. The death toll in Nepal exceeds 1,400, with thousands missing; the official figures differ between sources and are still being revised.

A preliminary reconstruction from satellite images places the source between about 4,350 and 5,200 m, facing west to north-west, with a changed surface of about one square kilometre. The week before the collapse was the warmest of its kind in 25 years of weather records for the site. The warning chain downstream had nothing to work with: the national hydrology office learned of the flood about 28 minutes after the seismic signal, and the first public alerts went out about 38 minutes after it. The river gauges were designed for gradual rises; a mountain collapse is outside what the existing systems detect.



The Langtang Lirung area from above: the Sentinel-2 image of 15 December 2025 in greyscale with 100 m contour lines. The source of the 26 August 2026 collapse is marked on the north-west flank; the summit lies 3.6 km to the south; Langtang and Kyanjin Gompa sit in the valley at the bottom. North is up, the bar shows one kilometre.

FOR SPECIALISTS

Source centroid 85.52701 E, 28.28858 N; elevation range 4,355 to 5,221 m; circular mean aspect 281 degrees; changed surface area 1.0 km2 (range 0.5 to 1.8) (arXiv 2609.04563v1). Event time 02:52:10 UTC; USGS Ms 5.2, GFZ Mw 5.7. ERA5-Land seven-day mean temperature and positive-degree-day total at the site ranked above all 25 matched years 2001 to 2025 (same preprint). Area of interest 16 by 12 km, E 344900 to 360900, N 3121400 to 3133400 in UTM zone 45N (EPSG:32645), fixed before processing. Warning chain: ICIMOD synthesis of 13 Oct 2026 (DOI 10.53055/ICIMOD.1150) and the Kathmandu Post via AsiaNews for the 28 and 38 minutes.

2. What others found afterwards

Within weeks, several groups went back into the archives, knowing where to look.

- ICIMOD's synthesis of 13 October reports up to 40 cm of line-of-sight deformation in Sentinel-1 radar interferograms between 7 July and 24 August 2026, and adds that the movement could not have predicted when the collapse would occur.
- Manoochehr Shirzaei's group at Virginia Tech, quoted in Nature on 2 September, measured about 10 mm per month on the glacier-rock system from 8 January to 18 August 2026, accelerating in the final days, and said that the acceleration matters more than the velocity and that Sentinel-1 works best as an automated pre-screening tool.

- Wang, Sassa, Yang and colleagues, in the journal Landslides, tracked the hanging glacier under the source with optical pixel offset tracking on hundreds of Sentinel-2 and Landsat scenes from 2017 to 2026. Their abstract reports over 100 m of pre-failure deformation and a clear change of regime from January 2026; Dave Petley's summary on the Landslide Blog gives the rates as rising from about 7.4 to about 55 m per year. The paper is paywalled and the footprint of their glacier polygon is not public, so those two numbers are quoted here from the summary.
- A preprint by Rui Li did not attempt interferometry on this flank, tested offset tracking without a result that met its quality criteria, and found no unambiguous change in Sentinel-2 at 10 m before the event; Petley's reading of Planet images of 12 and 25 August found surprisingly few signs of incipient failure.

Two things are common to all of these. They were done after the event with the source location known. And none of them claims that a warning could have been issued, only that a signal existed somewhere in the data.

3. The question we asked

Our question is different and narrower: would a service that screens every unit of terrain in a region, after every new image, with a rule written down in advance, have put this flank on an expert's list before 26 August? That is the question a cantonal geologist or a railway operator will ask of any screening service, and it has to be answered on cases where the outcome is known, with no look-ahead.

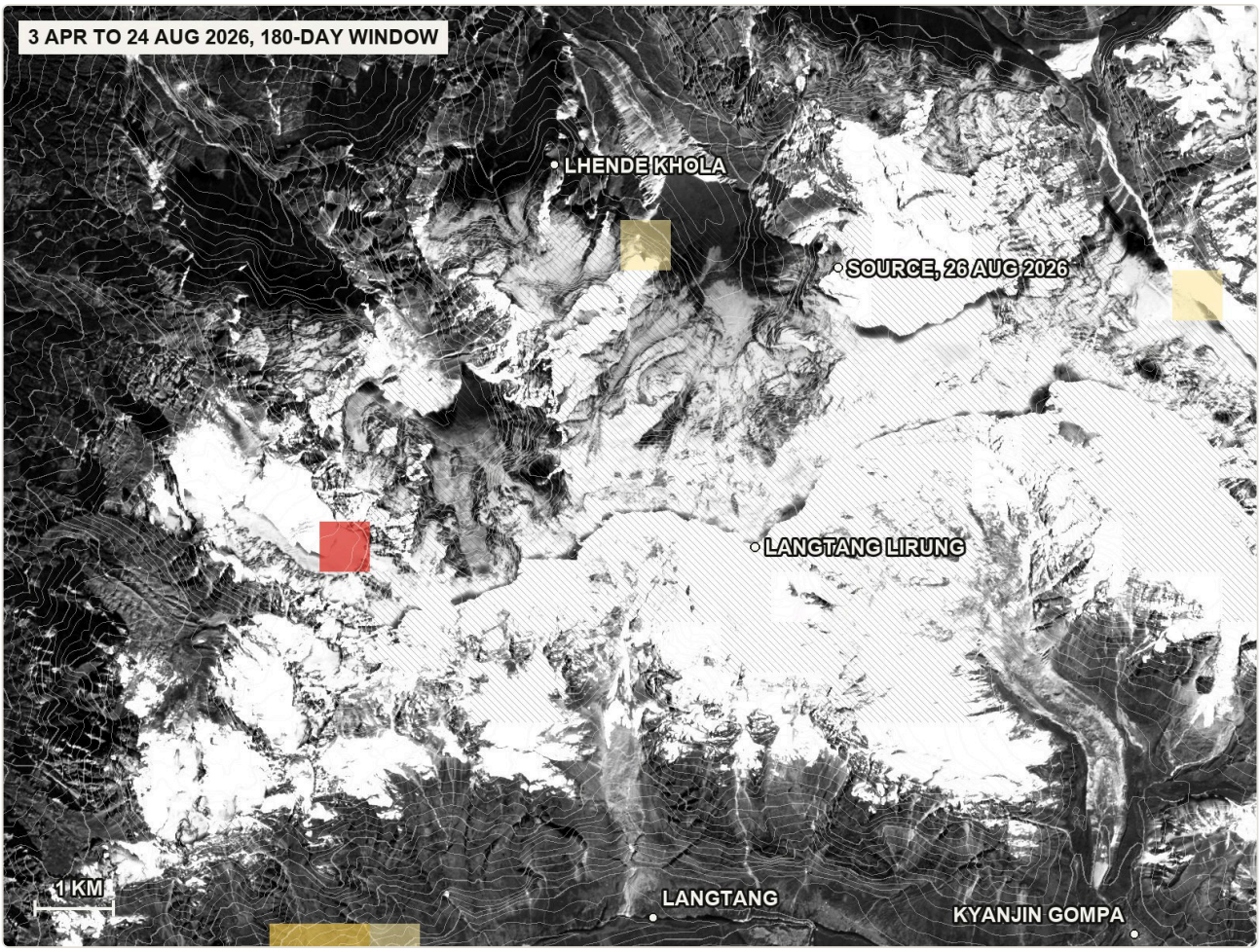
The answer has three parts that stay the same for every test below: the area of interest, 16 by 12 km around the source, chosen before processing; the own-history rule, under which a unit of terrain is compared with its own past and coloured only when its recent rate of movement departs from its normal rate by a statistically clear margin that holds for two consecutive windows; and the record, a decision log in which every parameter is written with a timestamp before the product it governs exists. Diagnostics run after a classification are allowed, but they are labelled as such and change nothing.

The colour classes used on all maps in this article: within the normal range (no colour), above normal (1.2 to 1.5 times), clearly above (1.5 to 2), well above (2 to 3), flagged for expert review (more than 3). Hatched: no usable signal.

4. Test 1: short-wavelength radar phase, the Blatten chain unchanged

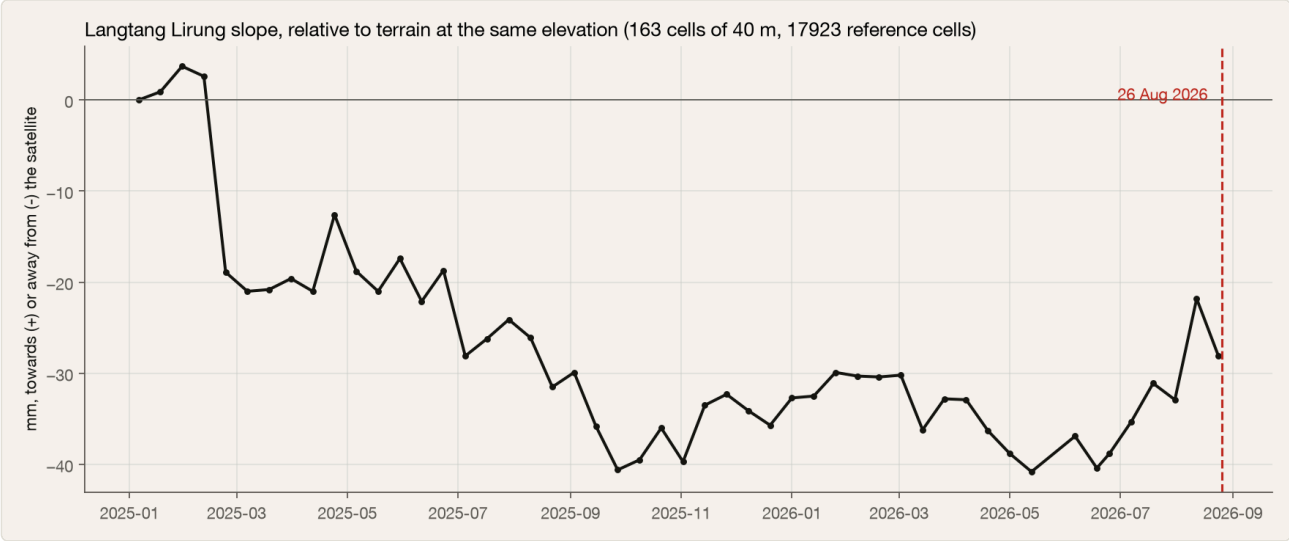
Sentinel-1 passes over Langtang on three tracks every 12 days. A coherence test on eleven short pairs per track, inside a 600 m circle at the source, ranked the tracks at 0.30, 0.27 and 0.24, all at the usable limit; the rule fixed beforehand chose path 19, which is also the track whose dates the published interferometric analyses used. The full stack holds 95 image pairs from 6 January 2025 to 24 August 2026, two days before the collapse, processed with ASF HyP3 and MintPy exactly as for Blatten.

The outcome is a map of 952 units of 640 m, of which 763 carry a usable signal. The source is mostly hatched: only 23 percent of its pixels keep coherence through the chain, because the moving ice and the west-facing foreslope seen from a west-looking descending pass lose the phase. The three usable units at the source stay within their normal range in all seven quarterly windows. In the final window, 3 April to 24 August 2026, their recent rate is a tenth of their 2025 normal. Five units elsewhere in the frame are flagged in that window; they are the cost of the rule and are reported as such.



The final window, 3 April to 24 August 2026, on the terrain backdrop: the units around the source stay within their normal range or are hatched; five flagged units lie elsewhere in the frame.

The evidence series behind the map tells the same story. The coherent part of the source, 163 pixels of 40 m, moved about 40 mm away from the satellite during 2025 relative to terrain at the same elevation, in steps, and then held between 30 and 40 mm through 2026: minus 31, minus 39 and minus 31 mm in the three windows of 2026, minus 28 mm on 24 August. The slower surroundings that the radar could follow decelerated before the collapse. The 40 cm reported by ICIMOD is not in these pixels; at this wavelength 40 cm in 12 days is about 14 colour cycles over a kilometre, which a 40 m pixel cannot unwrap, so such motion appears as lost signal, which is what the hatching shows.



Median movement of the coherent part of the source (163 pixels in a 600 m circle) relative to 17,923 coherent pixels at the same elevations, one point per satellite image from 6 January 2025 to 24 August 2026. Negative values are movement away from the satellite. The dashed line marks the collapse.

A second run extended the stack back to January 2024, so that the normal rate came from a quieter year. It changed nothing at the source (ratios of 0.3 to 0.5 in 2026) and removed the five flags of the last window; it also showed a cost of long stacks in the Himalaya, where a gap of five weeks in the archive at the end of 2024 splits the network and fewer pixels survive the chain.

FOR SPECIALISTS

Test 1: Sentinel-1 IW SLC, path 19 descending, frame 497, 50 dates 6 Jan 2025 to 24 Aug 2026 (Sentinel-1A to 18 Jun 2026, Sentinel-1D from 25 Jun), 95 pairs of up to 24 days, HyP3 at 40 m (10 by 2 looks), 4 pairs with average coherence below 0.3, 92 in the inversion; MintPy 1.6.4, reference point by maximum coherence at E 353640 N 3131920, temporal coherence threshold 0.5, height-correlated tropospheric correction, linear deramp. Classification: 640 m units (16 x 16 pixels of 40 m, at least 51 usable pixels), median of usable pixels, elevation-band reference (200 m bands from 1800 m), coherence-weighted least squares, normal rate over 2025-01-01 to 2025-12-31, 180-day recent window, 3-sigma significance, two-quarter persistence. Units 952, usable 763; counts of classes 0 to 4 per window: 2025-Q1 762/0/0/0/1; 2025-Q2 759/3/0/1/0; 2025-Q3 731/26/6/0/0; 2025-Q4 710/19/33/0/1; 2026-Q1 741/8/11/3/0; 2026-Q2 726/11/26/0/0; 2026-Q3 743/6/9/0/5. Coherent source pixels 163 of about 700 in the 600 m circle, reference 17,923 same-elevation pixels; quarterly medians of the source minus its peers, mm along the line of sight: 2025 minus 9, minus 19, minus 29, minus 36; 2026 minus 31, minus 39, minus 31; last epoch minus 28. Quiet-baseline run: 144 pairs from 12 Jan 2024, 141 kept, 77 dates, 712 usable units, two usable source units, ratios to the 2024 normal 1.06, 0.87, 1.14, 0.44, 0.29, 0.47, 0.51; counts per window 2025-Q1 703/0/1/2/6; 2025-Q2 701/2/9/0/0; 2025-Q3 626/26/56/0/4; 2025-Q4 697/8/6/1/0; 2026-Q1 699/5/8/0/0; 2026-Q2 695/4/12/1/0; 2026-Q3 709/1/2/0/0; no acquisition between 19 Nov and 25 Dec 2024, network in two components.

5. Test 2: three variants of the rule

Three variants were defined in one night, each written down before its run, and each run on Blatten and Langtang together so that any gain at one site shows its cost at the other.

- A class for lost signal, under which a unit whose usable share of pixels falls well below that of its elevation band, compared with the same season of the baseline year, is marked “signal lost, watch”. It did not fire at the Langtang source, because the source’s poor coherence is chronic, and it marked at most nine units per quarter at Blatten.
- A short 36-day window combined with the quarterly one by maximum. It kept the Blatten flag but added 50 flagged units elsewhere in the quarter of that collapse, against seven with the standard rule, and 71 in an

earlier quarter where the standard rule flagged nothing. At Langtang it still showed nothing at the source. Rejected.

- A per-pair anomaly test at unit level, on both wavelengths. Single-pair anomalies at the source exist, but between 2 and 6 percent of all units show such anomalies in any pair, and the source does not stand out of that population. Not adopted.

The lesson of that night is about method rather than data: every rule change has a cost side that only a second case reveals, and a rule that makes Blatten noisier to gain nothing at Langtang is a step backwards.

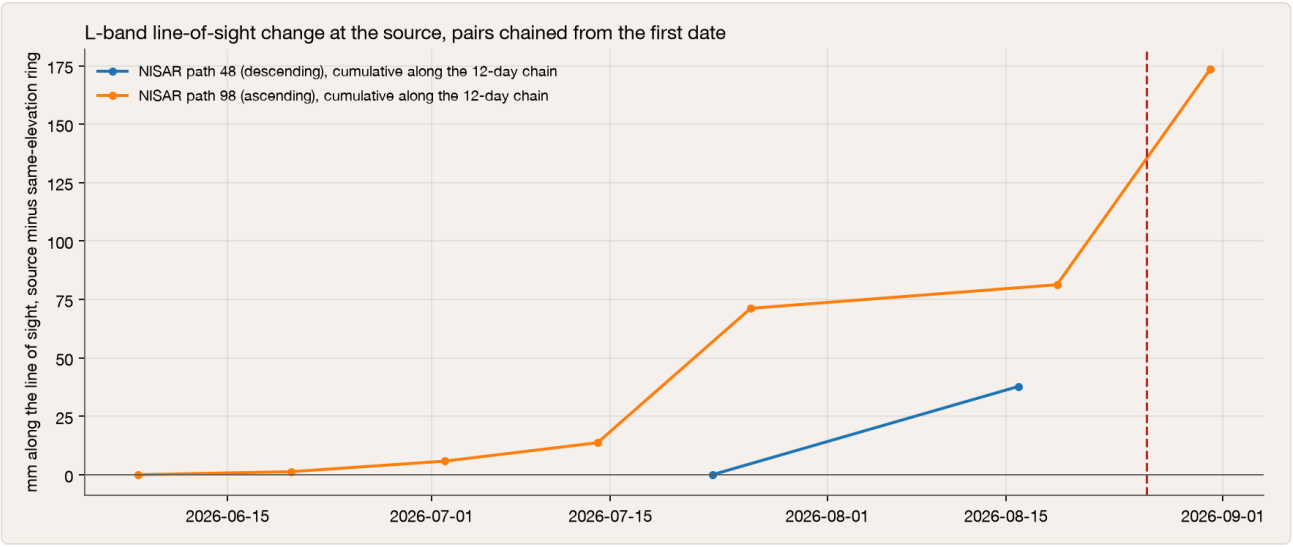
FOR SPECIALISTS

Rule A (signal lost, class 5): per-pair usable share of a unit relative to its 200 m elevation band, matched to the same season of the baseline year, class 5 below 0.5; Blatten 0 to 9 units per quarter, none at the Nesthorn (0.61 to 0.71 in 2025-Q2); Langtang 0 to 3 per quarter, source 0.85 to 1.08 in 2026-Q3. Rule B (36-day window combined by maximum): Blatten 50 class-4 units elsewhere in 2025-Q2 against 7, 71 in 2023-Q4 against 0; Langtang 28 and 30 units elsewhere in 2025-Q2 and 2026-Q2, source class 0 throughout. Rule C (per-pair unit anomaly against the band median, 3 sigma): Sentinel-1 7 to 19 Jul 2026 one source unit at z 6.6 with 49 units elsewhere above 3 sigma (5.4 percent); NISAR descending 23 Jul to 16 Aug two source units at z 5.5 and 5.7 moving less than their band; ascending pairs within 1 sigma with band-wide offsets up to minus 90 mm in 14 to 26 Jul. Decision log 20 Oct 23:30 and 23:45.

6. Test 3: long-wavelength radar, NISAR

NISAR, the L-band mission of NASA and ISRO, has imaged the area since April 2026 and its 12-day interferograms and offset products over the source are public. Fourteen interferograms and four offset products were read as window subsets. Frame-wide, the L-band coherence in summer equals or exceeds that of Sentinel-1. On the source itself, geometry matters more than wavelength: the ascending pass, which looks west onto this west-facing flank, keeps 0 to 34 coherent pixels of 179 per pair; the descending pass, which looks east, keeps 87 on the one clean pair of 23 July to 16 August, where it measures 38 mm of movement in 24 days. A centimetre-scale signal in the final six weeks exists in the pixels L-band keeps, an order of magnitude above the C-band series and an order of magnitude below the published 40 cm. No classification was applied to NISAR, because no baseline year exists yet.

The offset products are the exception mentioned at the start. Read per 640 m unit with a correlation filter, they resolve a few centimetres per pair, and on the ascending pair of 26 July to 19 August the unit nearest the source moved 0.67 m in 24 days: the third largest offset of 857 usable units in the frame, with the two larger ones 6 km away on other glaciers. The descending pair of the same weeks saw nothing there. One pair, one unit, sign convention still to verify, and no rule under which it would have become a flag. It is the one pre-event measurement of all these tests that singles out the source.



L-band against C-band on the same dates: cumulative line-of-sight change at the source from the NISAR pairs the chain could read, and the Sentinel-1 series over the same weeks. Shown for comparison only; no classification on NISAR.

FOR SPECIALISTS

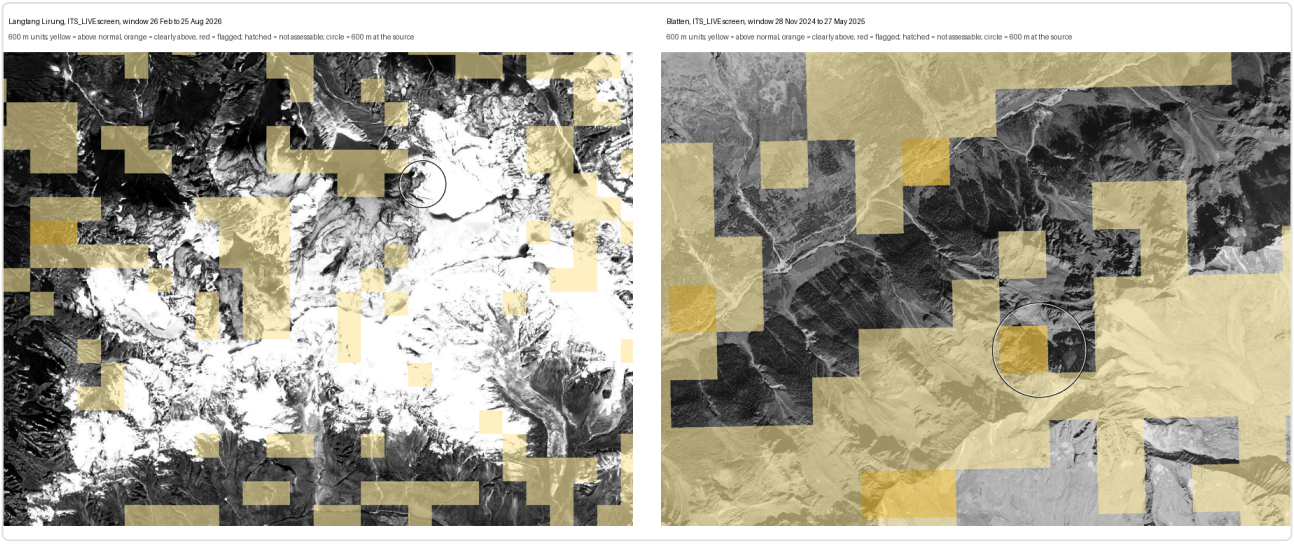
14 GUNW and 4 GOFF products read as 22 by 18 km window subsets over HTTP; source circle 179 pixels of 80 m. Ascending path 98 frame 16 (12-day pairs 21 Apr to 19 Aug 2026 plus the pair across the collapse): 0 to 34 coherent pixels per pair at the source, mean coherence 0.10 to 0.20; line-of-sight change source minus ring 1.3, 4.5, 7.9, 57.5 and 10.1 mm for the pairs from 8 Jun to 19 Aug, 81 mm chained, 92 mm across the collapse; the 57.5 mm of 14 to 26 Jul is a band-wide offset in the rule C reading. Descending path 48 frame 74: 23 Jul to 16 Aug 87 coherent pixels (49 percent), 37.8 mm; the other pairs keep no source pixel. Frame-wide coherence 14 to 26 Jul: L-band 0.59, C-band 0.56. GOFF per 640 m unit (8 by 8 pixels, correlation peak at least 0.5, at least 16 of 64 valid, values relative to the frame median): ascending 26 Jul to 19 Aug, unit at 373 m from the centroid 0.53 m slant range and 0.41 m along track (z 14.5 and 8.3), 0.67 m total, rank 3 of 857; descending 23 Jul to 16 Aug 0.03 and minus 0.09 m, rank 355 of 744. Sign convention and units of the GOFF layers to verify.

7. Test 4: public feature tracking at 120 m

A fast mover needs a signal that measures metres rather than millimetres. NASA's ITS_LIVE product does that for every glacier on Earth: surface velocities from feature tracking on Landsat, Sentinel-2 and Sentinel-1 image pairs, on a 120 m grid, public and free. We screened it with the own-history rule on 600 m units: 33,322 pairs over the area, the years 2018 to 2024 as the seasonal normal, the same windows, significance and persistence as the radar rule. The same rule ran on Blatten as a cross-check.

At Langtang the five source units stay within normal range in all seven windows, at 60 to 90 percent of their seasonal normal in 2026, and no unit anywhere in the frame reaches "flagged". At pixel level within 1.5 km of the source, no pixel doubles its normal in 2026. The published acceleration of the hanging glacier is not in this product at this resolution before the last pre-event pair.

At Blatten the Birch Glacier units reach "above normal" to "clearly above normal" from autumn 2024 to the collapse, at 1.2 to 1.7 times their normal, never "flagged", and by the spring of 2025 more than half of the frame's units sit in those classes: a window median over 180 days is too slow a statistic for a glacier whose decisive acceleration came in its final weeks.



The ITS_LIVE screen at both sites: the last four windows at Langtang (top) and the four windows before the Blatten collapse (bottom), own-history classes per 600 m unit.

FOR SPECIALISTS

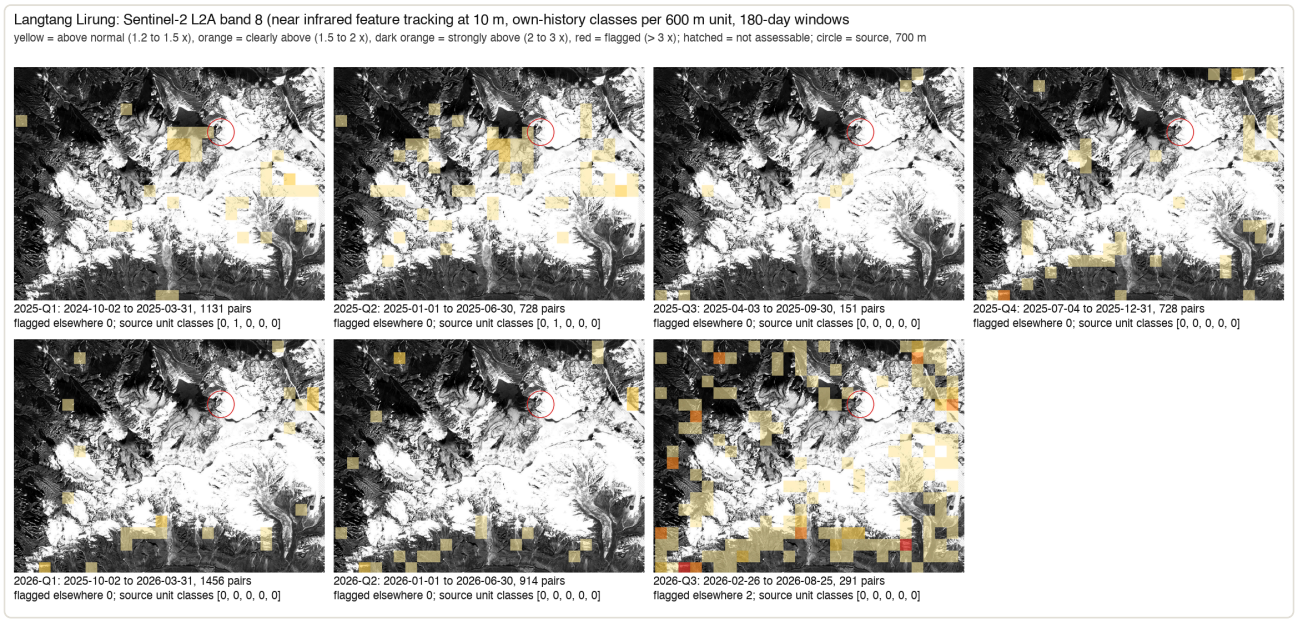
ITS_LIVE version 2: datacube N20E080 EPSG:32645 (mid-dates to 20 May 2025) for 2018 to 2024, 4,682 granules from the ITS_LIVE STAC catalogue for 2025-01-01 to 2026-08-25 of which 1,389 carry data over the AOI; 33,322 pairs in all (31,933 cube, 1,389 granules); pairs 5 to 180 days, second image on or before 25 Aug 2026. Units 5 by 5 pixels (600 m), 616 units, 5 within 700 m of the centroid; unit value the weighted median of velocity over pixel-pair samples with weights 1/max(error, 1), at least 10 samples from 3 pairs; windows, normal (same calendar window 2018 to 2024), floor 3 m per year, 3-sigma on 1.4826 MAD over the square root of the pair count, ratios and persistence as in the radar rule. Source ratios per window: 2025-Q1 0.96 / 1.08 / 1.08 / 0.89 / 1.15; 2025-Q2 0.92 / 1.36 / 1.15 / 0.92 / 1.08; 2025-Q3 0.80 / 1.33 / 1.08 / 0.84 / 1.00; 2025-Q4 0.85 / 1.09 / 0.85 / 0.88 / 0.88; 2026-Q1 0.62 / 0.69 / 0.62 / 0.86 / 0.62; 2026-Q2 0.62 / 0.71 / 0.69 / 0.86 / 0.69; 2026-Q3 0.77 / 1.08 / 0.92 / 0.88 / 0.80. Counts of classes 0 to 4: 2025-Q1 485/114/15/2/0; 2025-Q2 383/190/42/1/0; 2025-Q3 424/121/66/5/0; 2025-Q4 502/102/10/2/0; 2026-Q1 573/43/0/0/0; 2026-Q2 583/33/0/0/0; 2026-Q3 459/155/2/0/0. Blatten cross-check (cube N40E000 EPSG:32632, baseline 2018 to 2022, windows 2023-Q1 to 2025-Q2, last image 27 May 2025): 28,852 pairs, 192 units, source ratios 2023-Q1 0.81 / 1.08 / 1.00 / 0.92; 2023-Q2 1.17 / 1.17 / 1.00 / 0.92; 2023-Q3 0.88 / 0.93 / 0.93 / 0.92; 2023-Q4 0.80 / 0.87 / 0.81 / 0.93; 2024-Q1 0.78 / 0.92 / 0.93 / 1.00; 2024-Q2 0.94 / 1.08 / 1.00 / 1.00; 2024-Q3 1.24 / 1.21 / 1.13 / 1.08; 2024-Q4 1.60 / 1.47 / 1.44 / 1.21; 2025-Q1 1.33 / 1.69 / 1.43 / 1.33; 2025-Q2 1.12 / 1.54 / 1.20 / 1.42; counts 2023-Q1 192/0/0/0/0; 2023-Q2 180/12/0/0/0; 2023-Q3 186/6/0/0/0; 2023-Q4 184/8/0/0/0; 2024-Q1 181/11/0/0/0; 2024-Q2 177/15/0/0/0; 2024-Q3 170/21/1/0/0; 2024-Q4 101/79/12/0/0; 2025-Q1 101/63/26/2/0; 2025-Q2 82/102/8/0/0. Decision log 22 Oct 09:33 and 09:46.

8. Test 5: our own feature tracking at 10 m

The remaining explanation for the gap between the published optical result and the two negative tests was resolution: a body of about one square kilometre, averaged into 120 m cells together with its surroundings. So the next test used the images at their native resolution. All Sentinel-2 scenes over the area from 2017 to 25 August 2026 were read from the Planetary Computer mirror of the ESA archive, 1,338 scenes, of which 602 have at most half of the area under cloud or shadow; the last clear image is from 12 August 2026, two weeks before the collapse. Our own feature tracking correlates 320 m chips of the near-infrared band on a 160 m grid between images of the same orbit 10 to 180 days apart, with a self-test on a synthetically shifted image recovering the shift to 0.02 px. The screen is the same rule on the same 600 m units: 9,807 pairs, 6,236 of which pass the stable-terrain gate.

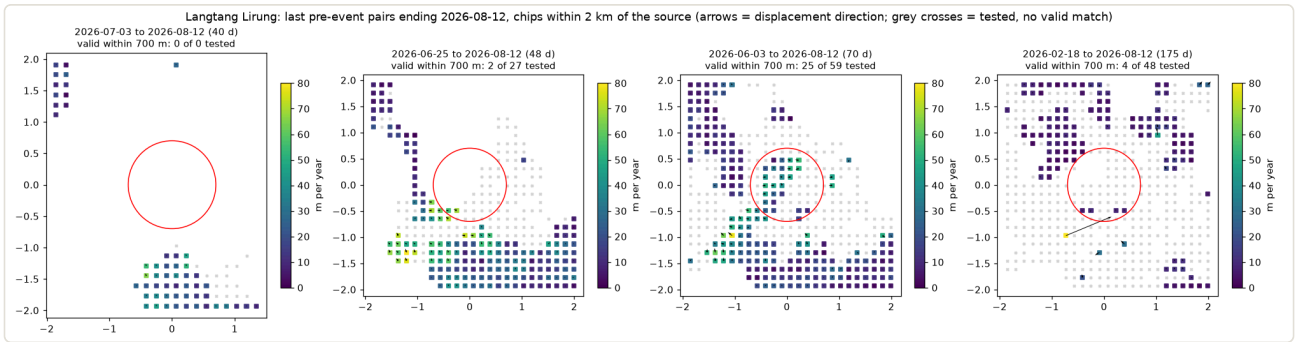
The five source units stay within normal range in all seven windows, at 0.6 to 1.3 times their seasonal normal in 2026, with none of the departures statistically clear. Two units elsewhere are flagged in the last window, at 7.6 and 12.4 km from the source. That last window, 26 February to 25 August 2026, is also broadly “above normal”

across the frame, with 134 units in the lowest class against 8 to 48 in the other windows; a check with long pairs only gives the same picture, so the pair mix does not explain it, and we record it as observed.



Seven windows of the 10 m screen on the terrain backdrop: the source units stay within their normal range throughout; the last window is broadly above normal across the frame, with two flagged units far from the source.

What the final pairs show is the most instructive part. Of the pairs ending on 12 August 2026, the one starting on 3 July has no valid match inside the 700 m circle at all, the one from 25 June has 2 of 27, the one from 3 June has 25 of 59 at a median of 30 and a 90th percentile of 50 m per year. The source loses its matches in the monsoon, and a check against earlier years shows that it did so in every monsoon since 2022, to the same degree. A hand-picked patch 850 m north-west of the centroid, on the slow ground where single chips read two to three times their normal in the last window, rises to about 26 m per year by mid-2026 on one orbit, inside its own range of earlier years, and shows nothing of the kind on the other orbit. Nothing in these series reaches 55 m per year before 12 August.



The last pre-event pairs ending on 12 August 2026, chips within 2 km of the source: colour is speed, arrows the direction, grey crosses are chips that were tested and found no valid match. Inside the circle the matches are few.

FOR SPECIALISTS

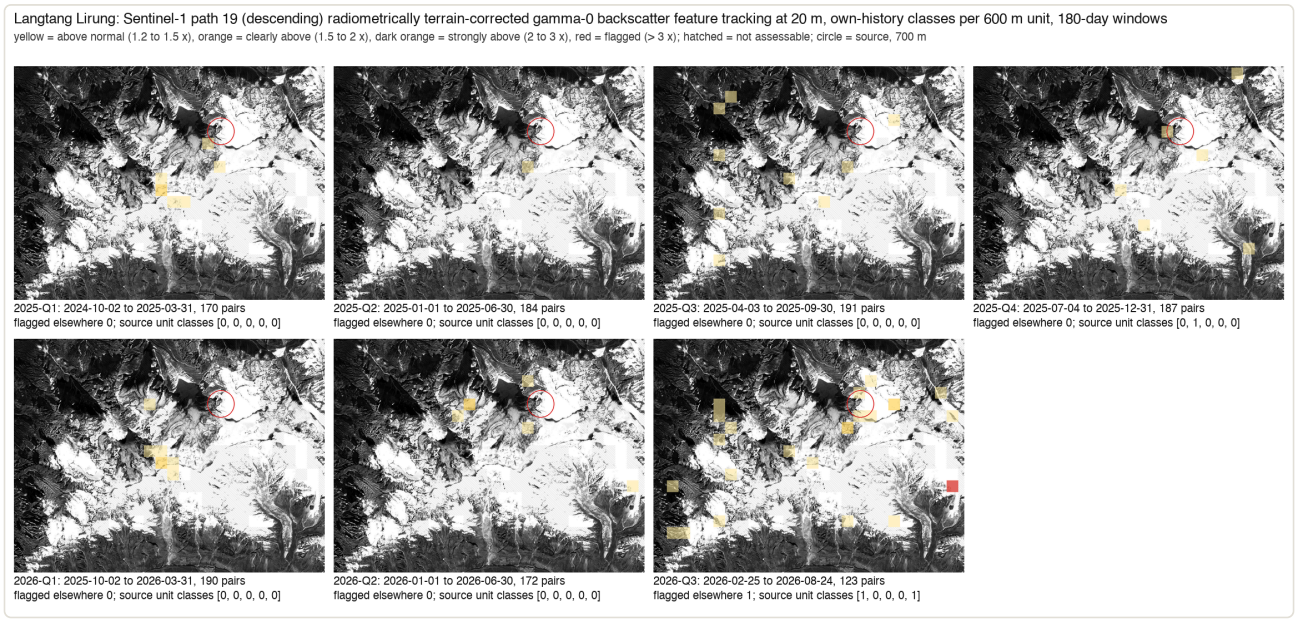
Sentinel-2 L2A band 8, tile 45RUM, relative orbits 76 and 119, 2017-01-01 to 2026-08-25, Planetary Computer STAC and SAS token, GDAL windowed reads; 1,338 scenes after de-duplication, 602 with at most 50 percent of the AOI in scene-classification classes 0, 1, 3, 8, 9, 10. Pre-processing: high-pass (minus a 5 px Gaussian) over the local RMS (8 px); mask dilated 3 px. Normalised cross-correlation of 32 by 32 px chips on a 16 px grid, search plus or minus 16 px, parabolic sub-pixel peak; gates: no masked pixel, peak off the edge, correlation at least 0.5, peak at least 1.2 times the secondary peak; per pair an affine fit over non-ice chips (ITS_LIVE land-ice mask dilated 360 m) with correlation at least 0.7, two passes at 3 MAD; pair dropped below 200 stable chips or above 0.5 px residual. Self-test shift (0.7, minus 0.3) px recovered as (0.689, minus 0.312), spread 0.055 px. Chip error 1.5 m times 365.25 over the separation. 9,807 pairs planned, 6,236 kept; residual median 0.19 px. Units: the ITS_LIVE 600 m grid; source ratios per window 2025-Q1 0.99 / 1.44 / 0.98 / 0.94 / 0.91; 2025-Q2 0.96 / 1.29 / 0.96 / 0.91 / 0.74; 2025-Q3 0.49 / 1.08 / 0.70 / 0.85 / 0.73; 2025-Q4 0.82 / 1.15 / 0.78 / 0.94 / 0.86; 2026-Q1 0.79 / 0.71 / 0.85 / 0.94 / 0.80; 2026-Q2 0.73 / 0.58 / 0.85 / 0.94 / 0.66; 2026-Q3 0.97 / 1.31 / 1.02 / 0.93 / 0.74; counts of classes 0 to 4: 2025-Q1 488/28/4/0/0; 2025-Q2 468/48/4/0/0; 2025-Q3 512/8/0/0/0; 2025-Q4 479/39/1/1/0; 2026-Q1 498/18/4/0/0; 2026-Q2 499/17/4/0/0; 2026-Q3 367/134/9/8/2. Diagnostics after the classification: chips within 2 km above twice their normal, 2026-Q2 0 of 491, 2026-Q3 33; correlation loss at the source relative to the 0.7 to 2 km ring in May or June to August pairs, 2026 median 0.94 (0.13 to 1.19) against 0.12 to 0.45 in 2022, 2023 and 2025; sensitivity with pairs of at least 30 days, last window 143 / 12 / 9 / 2 units in classes 1 to 4; hand-picked patches, robust least squares per orbit, north-west patch to 26 m per year at mid-2026 on orbit 119 within its 2019 to 2023 range. Decision log 22 Oct 12:36, 13:12, 13:25 and 24 Oct.

9. Test 6: radar amplitude at 20 m through the monsoon

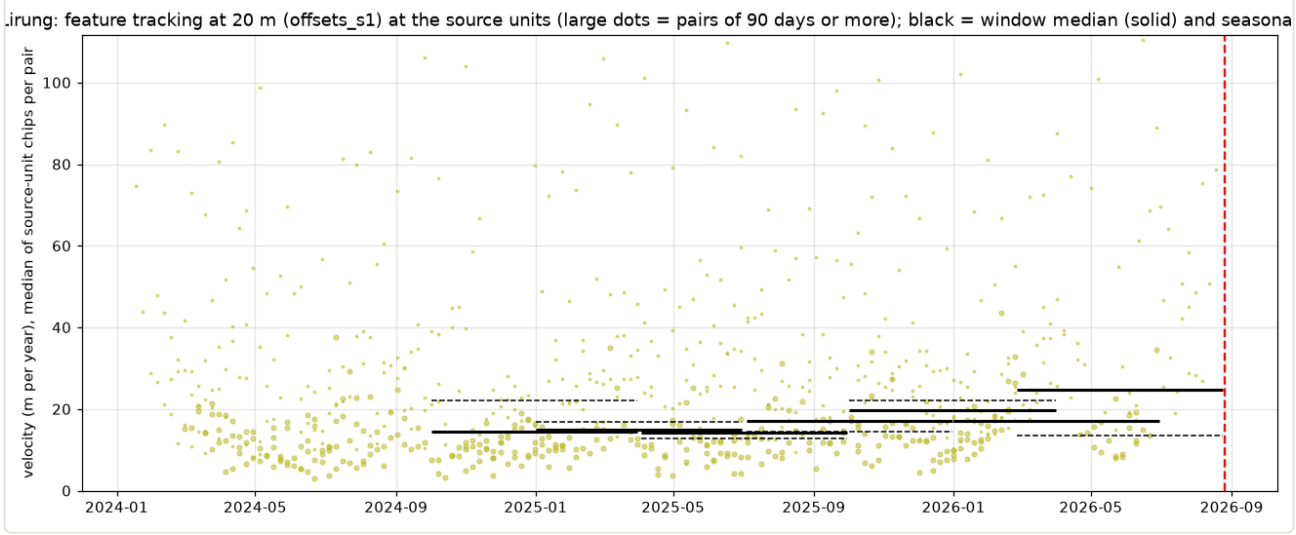
Optical images stop in the monsoon; radar does not. The last test tracks features in the radar brightness of the same Sentinel-1 track at 20 m, the native resolution of its wide-swath mode, on 77 images from 12 January 2024 to 24 August 2026, with the same correlation method, the same rule and the year 2024 as the normal. Layover and shadow on this relief mask about 38 percent of the area on a descending pass, and the open question written into the declaration is whether the crevasse texture of the hanging glacier correlates at all through the monsoon.

One adjustment was needed before any value was read: the rule written for the blob-like cloud masks of optical images allowed no masked pixel in a chip, and under the speckled layover-and-shadow mask of radar that left too few chips for any pair to pass the stable-terrain gate. Chips with up to 30 percent of masked pixels were admitted, the change was written into the decision log, and the chain ran once.

The result is the one departure from the pattern of the other tests. Of 985 pairs, 869 pass the stable-terrain gate, with a co-registration residual of 0.14 px, about 3 m. Only 283 to 293 of the 616 units are assessable, because layover and shadow remove nearly half the area on this pass. In the six windows to June 2026 the five source units stay within their normal range. In the final window, 25 February to 24 August 2026, two of them leave it: 28 against 18 and 25 against 14 m per year, 1.6 and 1.8 times their 2024 normal, shown as “above normal”, the lowest class, because a fresh departure starts two classes lower under the persistence rule. A third unit reads 2.2 times its normal on 25 pairs, short of the significance test. In the same window 19 other units of the frame carry the same class and one unit 6 km away is flagged. At chip level the median within 700 m rises to 1.16 times its normal, and 42 chips within 2 km exceed twice their normal, against 4 to 20 in the earlier windows. The share of chips at the source that find a match, relative to its surroundings, fell from 0.89 in the spring pairs of 2024 to 0.76 in 2025 and 0.56 in 2026, a loss of texture that the optical record could not see under the monsoon clouds.



Seven windows of the 20 m radar amplitude screen: hatched where layover and shadow leave no signal; the source units within their normal range to June 2026 and two of them "above normal" in the final window, with one flagged unit far from the source.



The source units in the 20 m radar amplitude tracking, one dot per image pair: the median speed of the chips inside the units, with the window median (solid) and the 2024 seasonal normal (dashed) per window.

It is a weak signal, and under the rule it would have put the flank on a list of 21 units in the lowest class, without a flag. It is also the first test in which the source moves at all, and it comes from the one record that does not stop in the monsoon.

FOR SPECIALISTS

Sentinel-1 path 19, 77 scenes 12 Jan 2024 to 24 Aug 2026 as HyP3 RTC gamma-0 VV at 20 m (power, unfiltered, no DEM matching, Copernicus DEM; 1,140 credits for 76 scenes), clipped to the AOI (800 by 600 px), 10 log10 of the power, mask = layover or shadow bits, untested pixels and no-data, dilated 2 px; chips 16 px (320 m) on an 8 px grid, search plus or minus 8 px, otherwise the Sentinel-2 parameters with at least 100 stable chips; chip error 3 m times 365.25 over the separation; baseline calendar 2024. Pairs 869 kept; units 616, source 5; source ratios per window 2025-Q1 1.13 / 0.76 / 0.61 / 0.49 / 0.63; 2025-Q2 1.27 / 0.97 / 0.99 / 0.87 / 0.89; 2025-Q3 1.07 / 1.59 / 1.06 / 1.18 / 1.21; 2025-Q4 0.92 / 1.48 / 1.18 / 0.79 / 1.36; 2026-Q1 1.10 / 1.07 / 0.89 / 0.58 / 0.64; 2026-Q2 1.22 / 1.11 / 1.31 / 1.33 / 0.88; 2026-Q3 1.58 / 2.18 / 1.31 / 1.36 / 1.83; counts of classes 0 to 4: 2025-Q1 277/5/1/0/0; 2025-Q2 292/1/0/0/0; 2025-Q3 278/9/0/0/0; 2025-Q4 283/6/0/0/0; 2026-Q1 277/5/1/0/0; 2026-Q2 287/4/1/0/0; 2026-Q3 267/19/2/0/1. Decision log 22 Oct 13:02.

10. What was seen, and what was missed

TEST	DATA	RESOLUTION	SOURCE BEFORE 26 AUG	COST ELSEWHERE
1. Radar phase, baseline 2025	Sentinel-1 path 19, 95 pairs	40 m, 640 m units	within normal range, mostly hatched	5 flags in the last window
1b. Radar phase, baseline 2024	Sentinel-1 path 19, 144 pairs	40 m, 640 m units	within normal range	0 flags in the last window
2. Rule variants	both sites	as above	no change	Blatten noisier
3. L-band phase and offsets	NISAR, 18 products	80 m	centimetres per pair where pixels survive; one offset pair singles out the source unit	no rule applied
4. Public feature tracking	ITS_LIVE, 33,322 pairs	120 m, 600 m units	within normal range, 0.6 to 0.9 in 2026	0 flags
5. Own feature tracking	Sentinel-2, 6,236 pairs	10 m, 600 m units	within normal range, 0.6 to 1.3 in 2026	2 flags in the last window
6. Radar amplitude tracking	Sentinel-1 RTC, 869 pairs	20 m, 600 m units	within normal range to June 2026; two of five units “above normal” in the last window (1.6 and 1.8 times)	19 units in the same class, 1 flag

Three facts survive every test. The slower ground around the source that the radar phase could follow did not speed up before the collapse; where that signal keeps pixels, the flank decelerated. The moving body itself leaves the phase measurements as lost signal and the optical matches as gaps, and it did so in every monsoon, so its absence from those records in August 2026 is normal for this flank. And the only measurements that single out the source are a single L-band offset pair in the last 24 days and the lowest class on two source units in the final window of the 20 m amplitude tracking; neither is a flag under a rule fixed in advance.

11. Learnings

Resolution and cadence decide, before any rule does. The published signal lives in a body of about a square kilometre that moves metres per year and accelerated in its final months. Products at 80 to 120 m average it with its surroundings; a 180-day median hides an acceleration that took weeks; the monsoon removes the optical matches exactly when they would matter. The honest unit of analysis for such a body is the native pixel, and the honest window is shorter than a quarter.

All-weather tracking at native resolution is where the signal begins to show. Of the seven tests, the one that measures metres rather than millimetres, at 20 m rather than 120, and through cloud rather than between clouds, is the one in which the source left its normal range. It did so late, in the lowest class, together with 19 other units, and with a one-year normal. Whether a shorter window or a second baseline year would have raised it further is exactly the question the next cases have to answer, with the cost at Blatten measured alongside.

Lost signal is a signal only against the slope’s own history. The source decorrelates every monsoon. A rule that treats lost coherence as a warning would have fired on this flank every summer since 2022; a rule that compares the loss with the same season of earlier years, as our test variant did, stays quiet because nothing changed. Both are correct, and only the second is usable.

A hand-picked polygon and a fixed rule are different exercises. The published optical result draws a polygon on a glacier whose failure was known and reads its displacement curve. That curve cannot be drawn before one knows where to look; a rule that runs on every unit can, and it did not fire here. The gap between the two is the whole problem of regional screening, and it is where the research has to go.

Every rule change has a cost side. Each variant that could have helped at Langtang was run on Blatten the same night. One made Blatten seven times noisier for no gain. Two cases are the minimum on which a rule can be judged; the validation set has to grow.

Geometry beats wavelength on a flank like this. On a west-facing slope, the pass that looks east keeps the pixels and the pass that looks west loses them, at both wavelengths. L-band helped frame-wide, as expected, and helped at the source only on the descending side.

The downstream chain was the larger gap. Even a perfect flag on 19 August would have reached a warning architecture that learned of the flood 28 minutes after the collapse. Screening is the first link of a chain that, in this valley, did not exist.

12. Next steps for our research

- **Feature tracking at native resolution becomes a standard signal next to phase, the radar amplitude tracker first.** The 10 m optical and 20 m radar trackers built for this case run on open data (the radar one on terrain-corrected images that cost 15 credits per scene); they go into the chain as a third signal per unit, with their own seasonal normal and the same own-history rule, so that a unit carries a phase rate, a speed and a share of usable signal. The radar tracker comes first, because it is the one that kept measuring through the monsoon and the one in which this flank moved.
- **A correlation-loss class defined on own history, tested on both cases.** The variant of test 2 stays, with the loss measured against the same season of earlier years and reported as “signal lost, watch”, once a third case shows what it costs.
- **Shorter windows for fast movers, with the cost measured.** A 60-day window on the speed signal, run on both sites with the quarterly window kept for the phase signal; adopted only if the Blatten and Langtang costs stay below the standard rule’s.
- **L-band offsets per unit, both passes, as soon as NISAR has a baseline year.** The one measurement that singled out the source deserves a rule, and the rule needs a year of normal behaviour before it can be written.
- **A validation set of documented cases with fixed rules.** Blatten and Langtang are two; the Alps have more, and every rule change is run on all of them before it is adopted. The decision log becomes a standard artefact of the service.
- **The warning chain as part of the research question.** What a service could have said, when, to whom, and what would have happened next: each look-back ends with that reconstruction, because a flag without a chain is a result without a use.

All of this is projected and to be validated in the pilot programme; none of it is a claim about any slope today.

13. Limits

Everything here was computed after the event with knowledge of the outcome, which is why the parameters were fixed before each run and recorded, and why no lead time is claimed. The radar tests use one descending track; the ascending track ranked lowest in the coherence test and was not processed. The elevation model is the 30 m Copernicus DEM, which limits the geocoding on a 1,200 m face. The optical record thins to one clear image a month in the monsoon. The published optical result could not be compared polygon to polygon, because the paper’s footprint is not public. The NISAR sign convention and offset units are to be verified before any of its numbers is used beyond this article. And the counts of casualties come from secondary sources that are still being revised.

14. Reproducibility and sources

Data: Copernicus Sentinel-1 and Sentinel-2 (contains modified Copernicus Sentinel data 2017 to 2026), processed with ASF HyP3, MintPy and our own feature-tracking code; NISAR GUNW and GOFF products (NASA and ISRO, via ASF); ITS_LIVE version 2 (NASA JPL); Copernicus DEM GLO-30. Processing ran on one laptop; the HyP3 jobs ran on ASF's servers. The scripts, parameter files and the decision log are available on request.

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- Wang, T., Sassa, S., Yang, W. et al., Precursor of a powerful large glacier landslide causing tsunami floods in the 26 August 2026 Nepal disaster, Landslides, 2026: https://doi.org/10.1007/s10346-026-02842-6
- Petley, D., Precursory deformation for the 26 August 2026 Nepal landslide, The Landslide Blog, Eos: https://eos.org/thelandslideblog/nepal-landslide-precursory-behaviour and Langtang Lirung, 1 October 2026: https://eos.org/thelandslideblog/langtang-lirung-1
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- USGS event page: https://earthquake.usgs.gov/earthquakes/eventpage/us7000tbwb
- AsiaNews, on the timing of Nepal's alert: https://asianews.network/nepal-sent-its-disaster-alert-38-minutes-after-the-glacier-collapse-it-wasnt-enough/
- ITS_LIVE, NASA JPL: https://its-live.jpl.nasa.gov/
- ASF HyP3 documentation: https://hyp3-docs.asf.alaska.edu/
- MintPy: https://github.com/insarlab/MintPy
- NISAR data at ASF: https://nisar-docs.asf.alaska.edu/
- Microsoft Planetary Computer, Sentinel-2 L2A: https://planetarycomputer.microsoft.com/dataset/sentinel-2-l2a
- Copernicus Sentinel data legal notice: https://sentinels.copernicus.eu/documents/247904/690755/Sentinel_Data_Legal_Notice

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About this document. Prepared by Julian Walder with AI assistance for drafting and processing; every number comes from the processing logs and the sources listed. A documented past case, computed after the event; no assessment of any slope today. Decision support for experts; Watchberg issues no public warnings. Data attribution: contains modified Copernicus Sentinel data 2023 to 2025; NISAR data NASA and ISRO; terrain and aerial image swisstopo. Swiss Aerospace Ventures GmbH, Wangenstrasse 68, 8600 Dübendorf, Switzerland. julian@swissaerospace.ventures