TRAINING MODULE · 45 MINUTES

Reading Radar: SAR for Imagery Analysts

Six lessons and one exercise, built on free Sentinel-1 data from August to November 2026, plus one ICEYE open-data scene

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Contains modified Copernicus Sentinel data (2026) and ICEYE Open Dataset imagery (© ICEYE, CC BY 4.0, modified)

WHO IT IS FOR, AND WHAT THEY LEAVE WITH

Analysts who know optical, and have never read radar

By the end, a learner can:

- Say what radar gives you that optical cannot, precisely
- Read water, buildings, vegetation and speckle
- Recognise layover and shadow before and after terrain correction, and explain why look direction is a planning decision
- Read a two-date change composite and state a confidence level

Built around three real places:

- **Berlin** – familiar ground to learn the signatures
- **Sikkim, high Himalaya** – the worst case for radar geometry
- **Port of Hamburg** – a maritime task on a civilian site

> Every number here was measured from the data or quoted from its source. The code reproduces the measured ones.

LESSON 1 · 5 MIN

Radar's real advantage is cloud, not "night"

Central Berlin: the same day under cloud, optical sees nothing, radar sees the city

Optical, 2026-11-11: the top of the cloud



Radar (Sentinel-1 VV), 2026-11-11, one pass



Optical, 2026-11-13 (7% cloud)



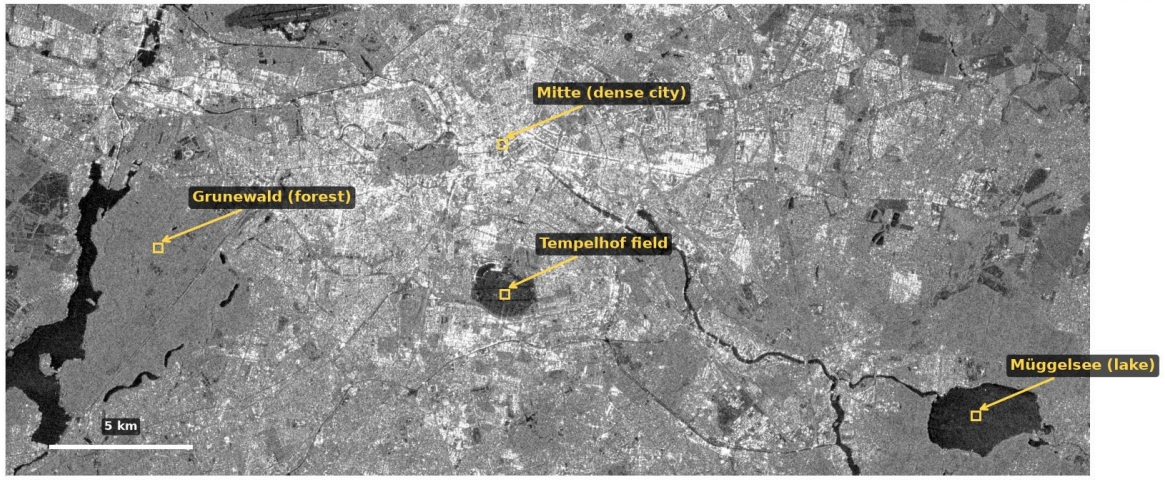
Contains modified Copernicus Sentinel data (2026), via Microsoft Planetary Computer.

Berlin, 11 Nov 2026: optical at 10:21 UTC, scene over 99.9% cloud; radar one pass at ~17:00 UTC, after dark. Thermal sensors also work at night; radar collects through cloud.

LESSON 2 · 8 MIN

Brightness is shape and roughness, not colour

Berlin, Sentinel-1 VV, 2026-11-21: dark water, bright city, mid-grey forest, dark-grey open ground (boxes = 300 m samples)



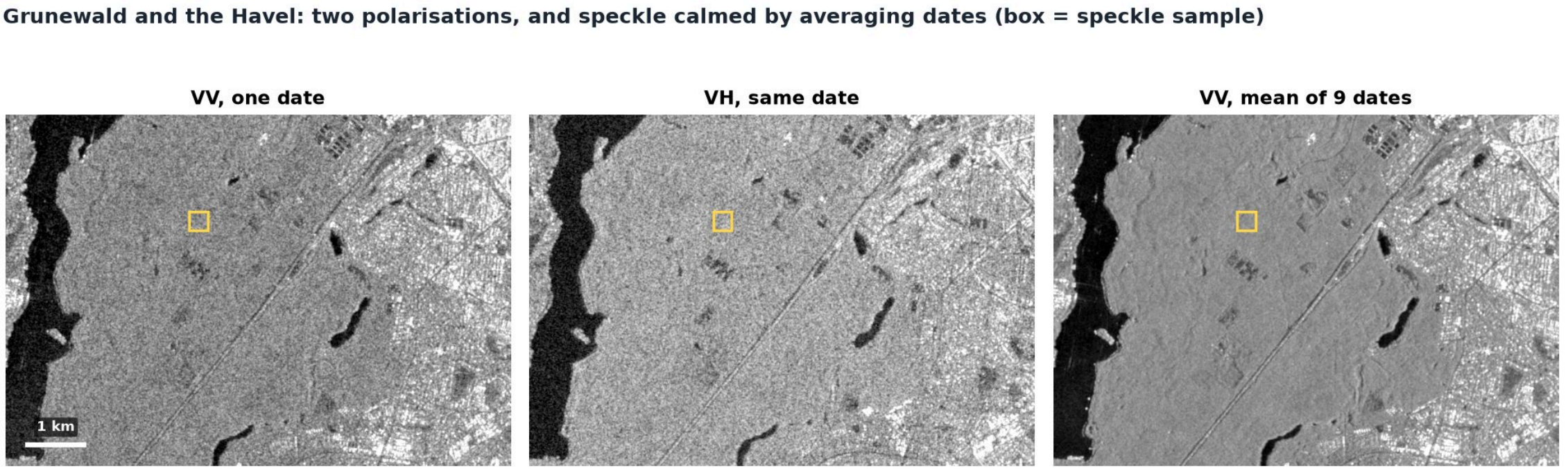
Contains modified Copernicus Sentinel data (2026), via Microsoft Planetary Computer.

Surface	Measured VV
Müggelsee (water)	−16.0 dB
Tempelhof field	−13.7 dB
Grunewald forest	−8.5 dB
Mitte (city)	−5.9 dB

Terrain-corrected gamma0, median of 300 m boxes. Mirror-like water sends the pulse away; walls and streets bounce it straight back.

LESSON 2, CONTINUED

Speckle is physics. And check rules of thumb against the data

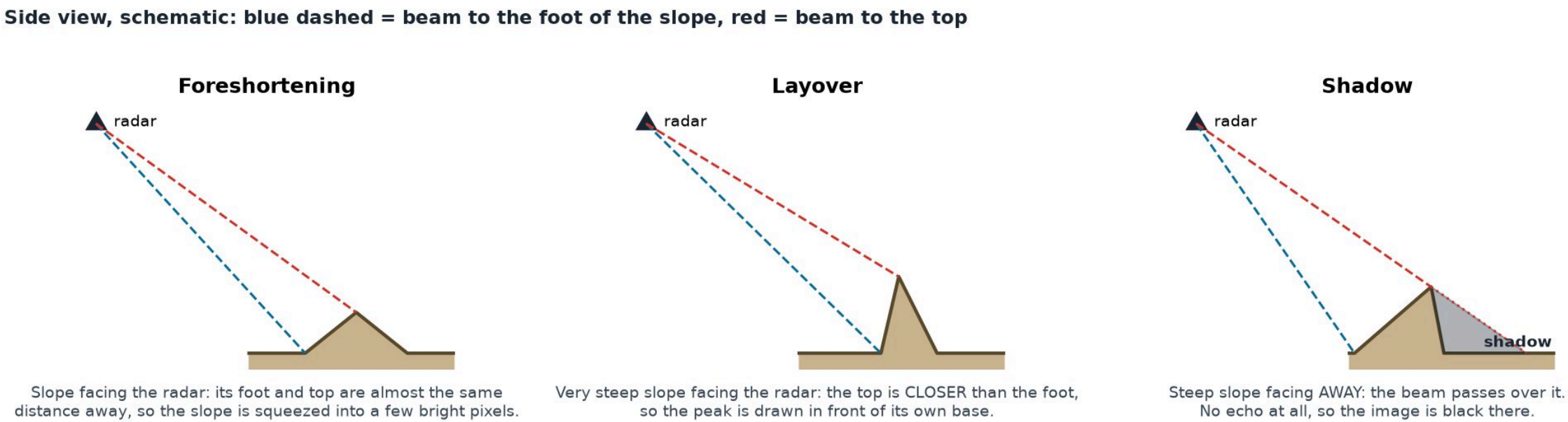


Contains modified Copernicus Sentinel data (2026), via Microsoft Planetary Computer.

Nine dates averaged: speckle variation in the forest sample fell from 0.43 to 0.20. And the VV–VH difference did not separate my three samples: 5.1 dB forest, 5.1 grass field, 5.5 city.

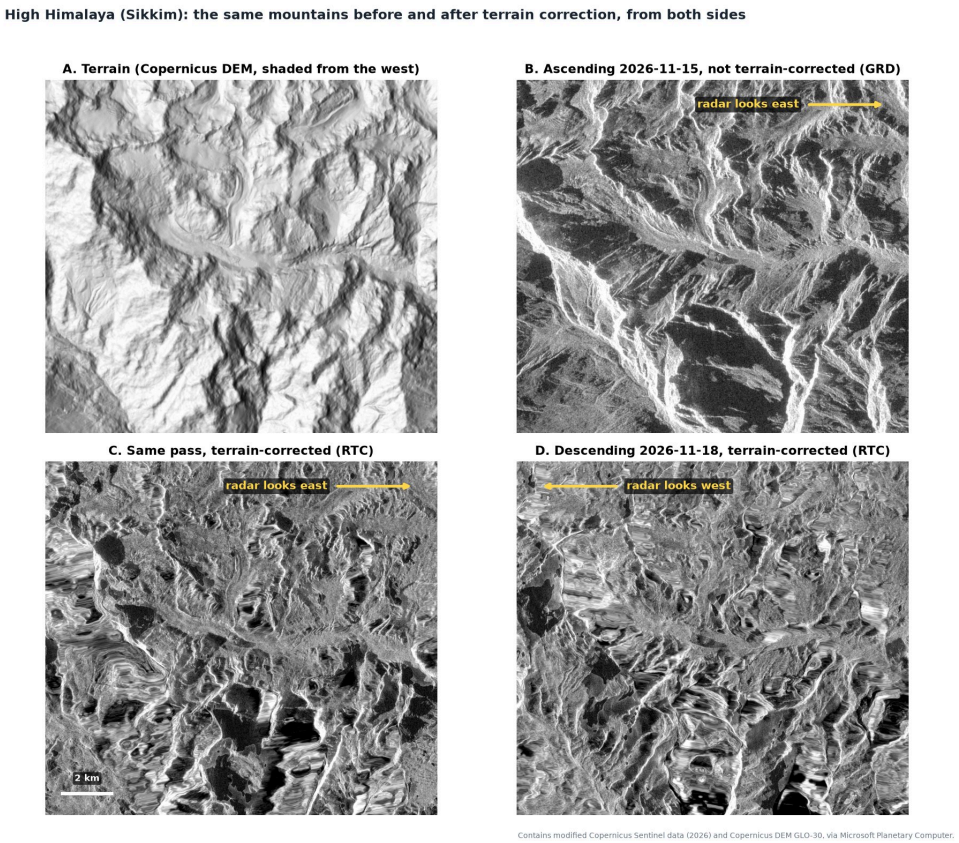
LESSON 3 · 8 MIN

Choosing the pass is collection planning



A valley that matters may be lost from one orbit and readable from the other. Ask "from which pass?" before you task, not after the data comes back unusable.

Without terrain correction you see the distortion; correction hides it but cannot undo it



Sikkim, 2,214–6,778 m. B: 15 Nov ascending, not terrain-corrected (coarse tie-point fit only). C: same pass corrected; the striped bands are layover and foreshortening stretched back out. D: 18 Nov descending.

LESSON 4 · 7 MIN

Same geometry, two dates: red left, cyan arrived

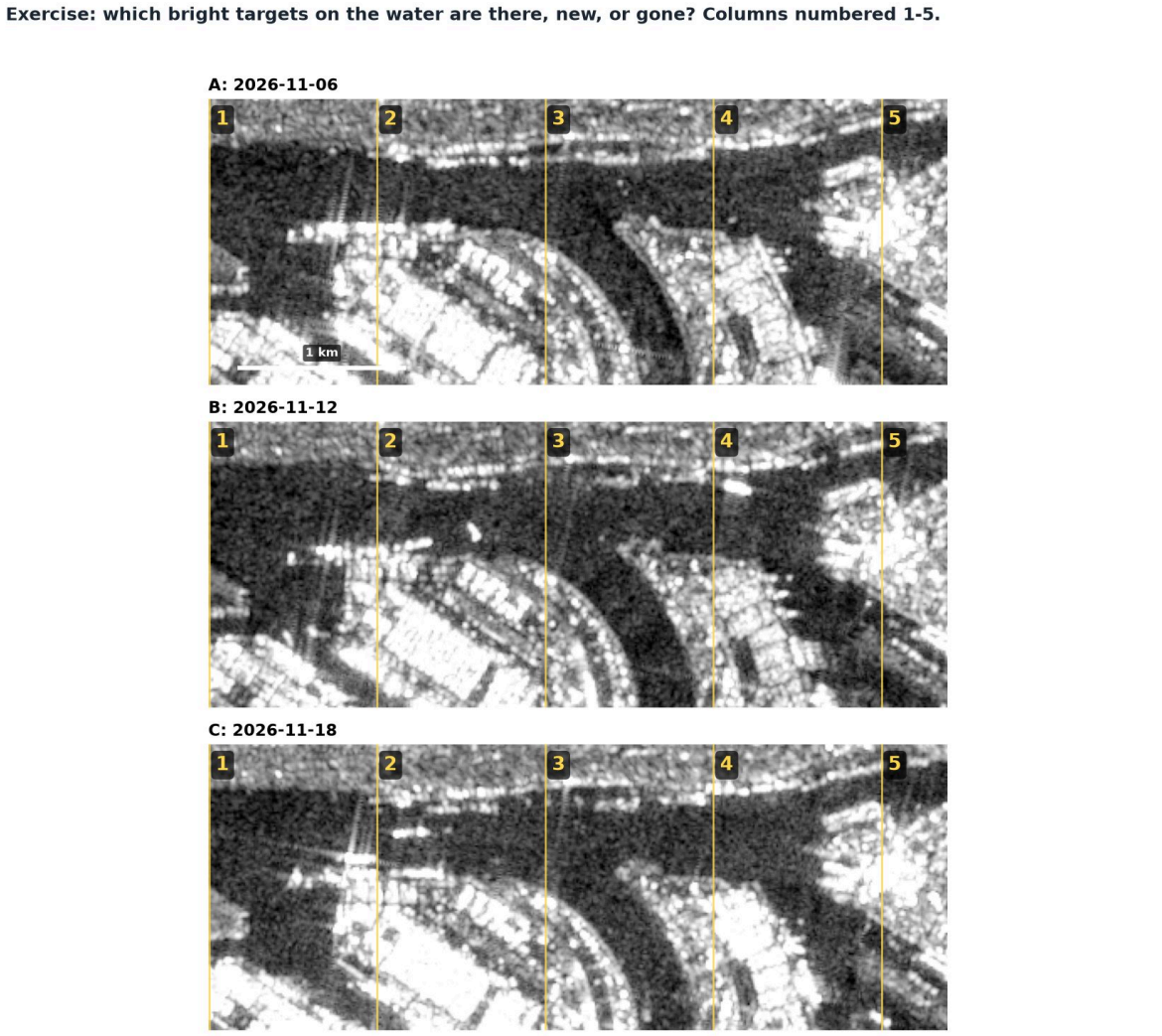


Contains modified Copernicus Sentinel data (2026), via Microsoft Planetary Computer.

Port of Hamburg, orbit 139, 12 and 18 Nov 2026. Streaks along the quays: most likely berthed vessels and cranes; patches in the terminals are consistent with container stacks changing. Not checked against AIS.

LESSON 5 · EXERCISE, 10 MIN

What changed in the channel, and how sure are you?



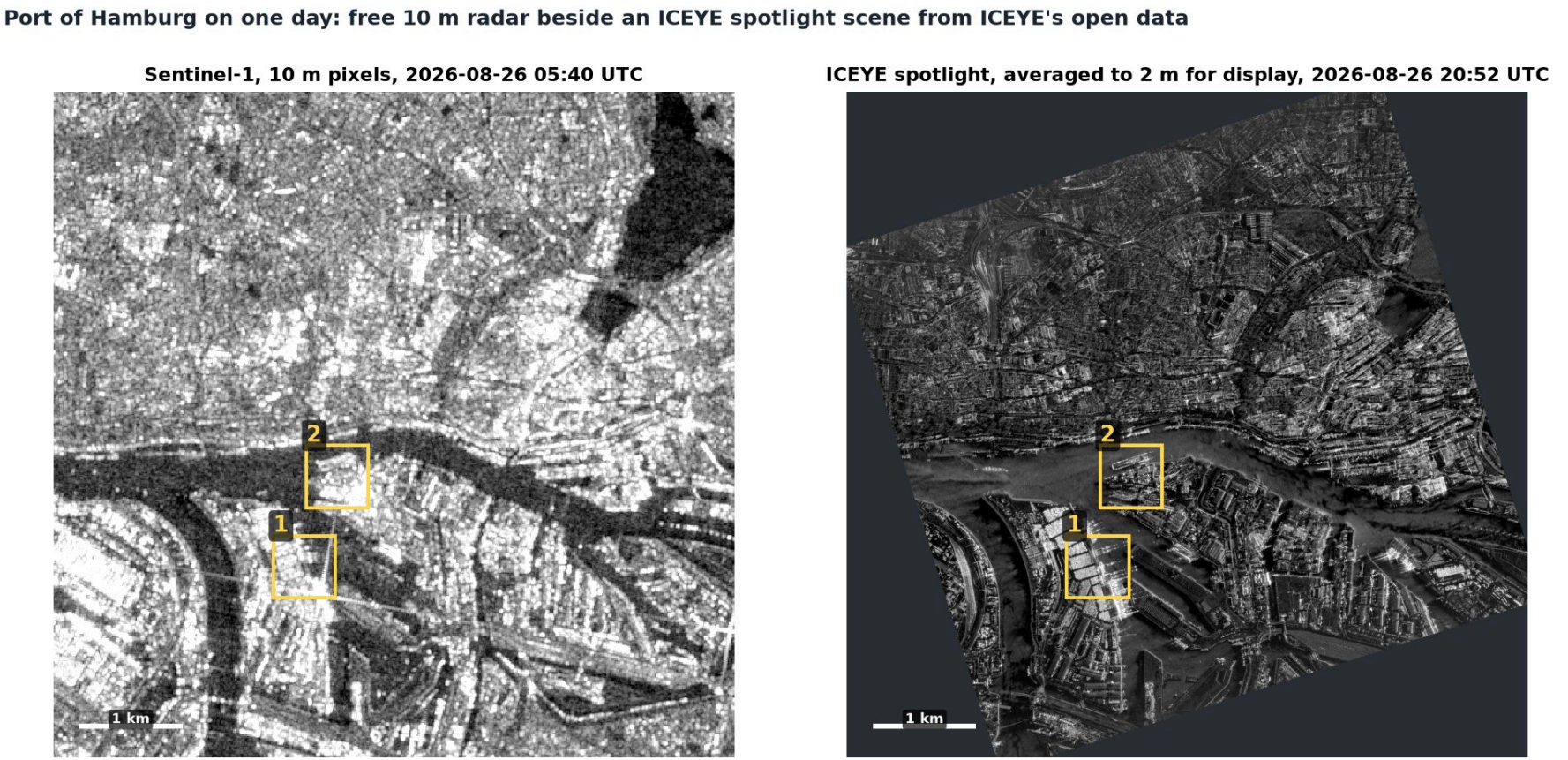
Contains modified Copernicus Sentinel data (2026), via Microsoft Planetary Computer.

	Targets	New	Gone
A · 6 Nov	5	–	–
B · 12 Nov	6	6	5
C · 18 Nov	8	6	4

> The answer to look for: moderate confidence that occupancy changed; low confidence in exact counts. Quay structures leak in, a ship that shifts 60 m scores as gone + new, and at 0 dB the counts become 8, 7, 9. AIS would confirm.

LESSON 6 · 7 MIN

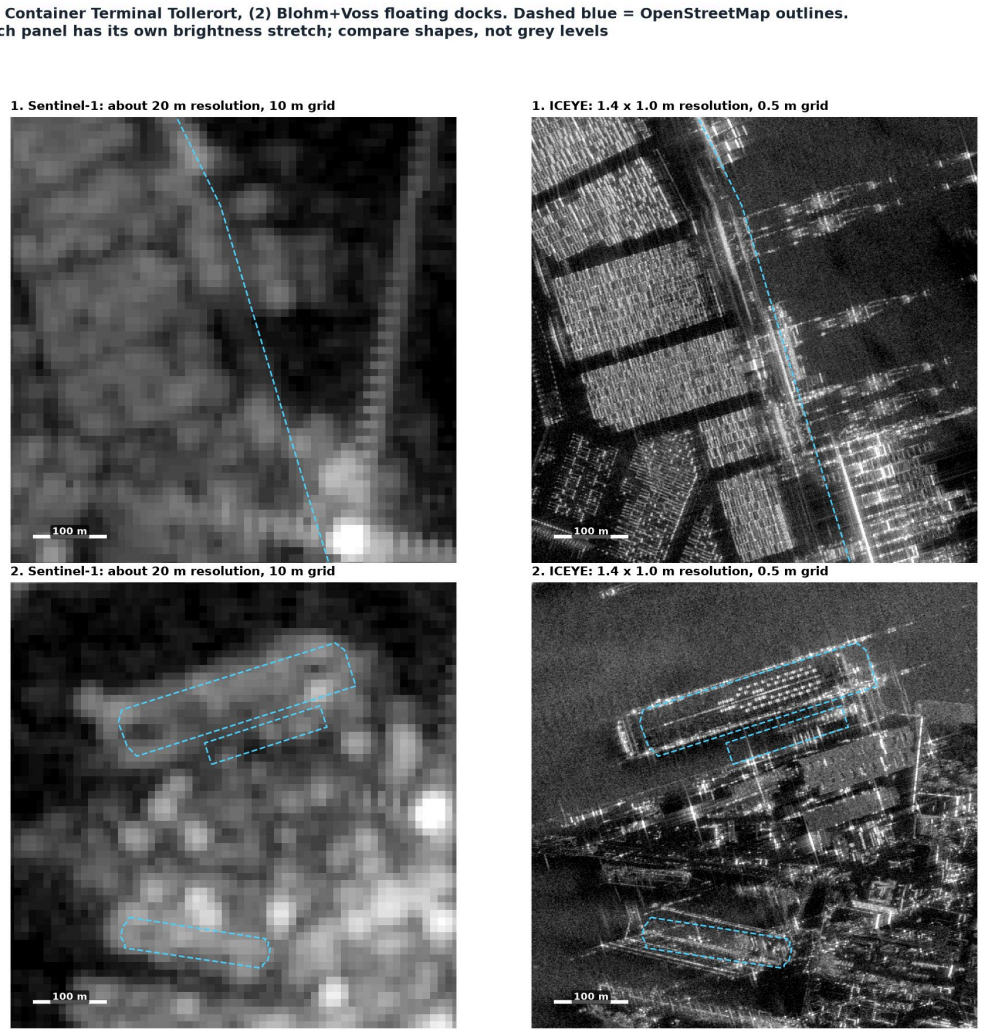
Same port, same day: free Sentinel-1 and an ICEYE spotlight



ICEYE Synthetic Aperture Radar (SAR) Open Dataset, (c) ICEYE, CC BY 4.0, scene ICEYE_U1X0DE_20260826T205215Z_10395144_X61_SLH; resampled, map-projected and annotated by David Reid.
Contains modified Copernicus Sentinel data (2026), via Microsoft Planetary Computer. Outlines (c) OpenStreetMap contributors, ODbL.

Sentinel-1 05:40 UTC, ICEYE 20:52 UTC, 26 Aug 2026. Both look broadly west (33° apart), but ICEYE much more steeply: 20.8° incidence against about 32°. ICEYE: 1.4 × 1.0 m resolution, 5.5 × 5.3 km. Separate stretches; compare shapes only.

Blocks, lanes and dock walls, and cranes laid over the water



ICEYE Synthetic Aperture Radar (SAR) Open Dataset, (c) ICEYE, CC BY 4.0, scene ICEYE_U1X0DE_20260826T205215Z_10395144_X61_SLH; resampled, map-projected and annotated by David Reid.
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- One Sentinel-1 resolution cell holds roughly 300 of this product’s
- Stack blocks and lanes separate; dock walls match the mapped outline to within a few tens of metres
- Bright clusters “on the water” in box 1: most likely quay cranes, laid over 2.6× their height towards the radar
- The trade: a 5.5 km scene tasked at a target, against a 250 km free swath

WRAP-UP · RUNNING IT LIVE

Same reading skills, much sharper questions

	Sentinel-1	ICEYE (published)
Band	C, ~5.5 cm	X, 9.65 GHz, ~3.1 cm
Resolution	~20 m in IW mode (10 m grid)	to 25 cm (Dwell Precise); 1.4 × 1.0 m in the open scene
Repeat / revisit	6 days, same geometry	up to hourly
Tasking	fixed plan	targets defined as little as 40 min before pass

- Lead with a real place the audience knows
- Teach the physics once, then show it every time it matters
- End every lesson with a decision, not a definition
- Grade the confidence statement, not just the count

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