CHALLENGE · BE AN EARTH SYSTEM TREND DETECTIVE!

Orbit to Ground

One connected Earth-change intelligence system, from orbit to decision. It **detects** fire, **confirms** floods through cloud and night, and helps farms **adapt**, then tests every trend for significance.

TEAM

GeoAI Toronto

MEMBER

Parsa Riahi

LIVE SYSTEM

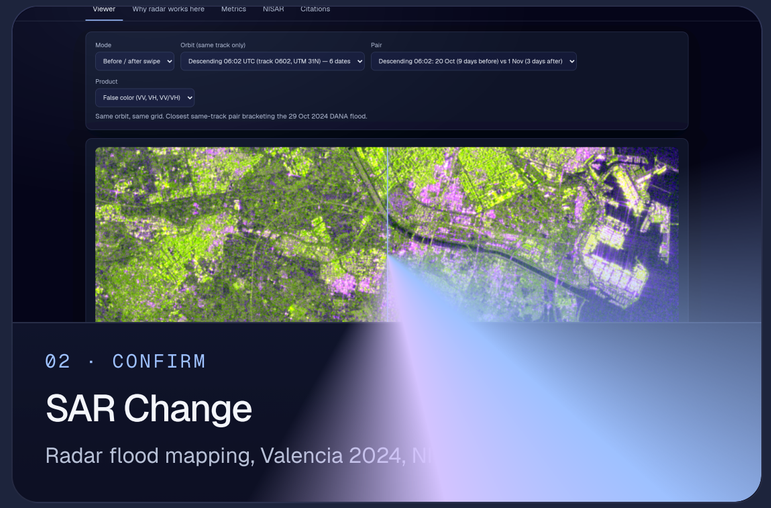
nasa-spaceapps-2026.pages.dev



01 · DETECT

Hot Spots

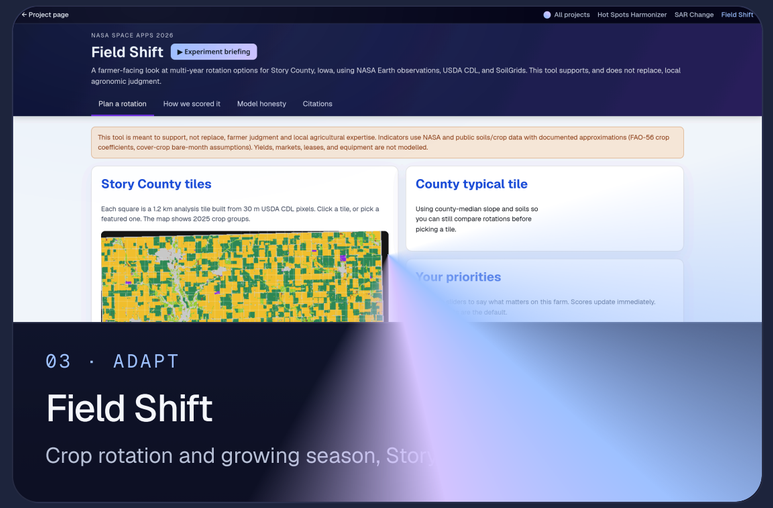
MODIS + VIIRS fire record on one scale,



02 · CONFIRM

SAR Change

Radar flood mapping, Valencia 2024, N



03 · ADAPT

Field Shift

Crop rotation and growing season, Stor

REAL SCREEN CAPTURES OF THE LIVE TOOLS

Earth is changing. The evidence is scattered across sensors.

Satellites already see these changes, but the evidence rarely reaches a decision intact.

01 · DETECT · FIRE

The fire record is split in two.

MODIS (1 km, 2000–) and VIIRS (375 m, 2012–) count fire differently. Over Canada, VIIRS reports about **5.6 detections per MODIS detection**, so 2005 and 2023 can't be compared directly.

14.6 Mha

of Canada's forest burned in 2023; over 230,000 people evacuated. Natural Resources Canada

02 · CONFIRM · WATER

Floods arrive with the clouds.

Optical satellites see cloud during the storm. Radar sees through cloud, day and night, but is hard to read. And one flood raises the real question: **trend, or one event?**

230 deaths

confirmed after the Oct–Nov 2024 DANA floods in Spain, 222 in the Valencia region. Government of Spain

03 · ADAPT · FARMS

Farm plans lag the climate.

A rotation shapes the soil for years while frost, heat and moisture keep shifting. Farmers need to know **which shifts are real** before the next plan.

33%

of the world's land is moderately to highly degraded. FAO, Status of the World's Soil Resources (2015)

QUESTION 1

What is changing?

Fire, rain, water storage, season

QUESTION 2

Where?

Region, province and grid cell

QUESTION 3

How much?

Sen's slope per year, 95% CI

QUESTION 4

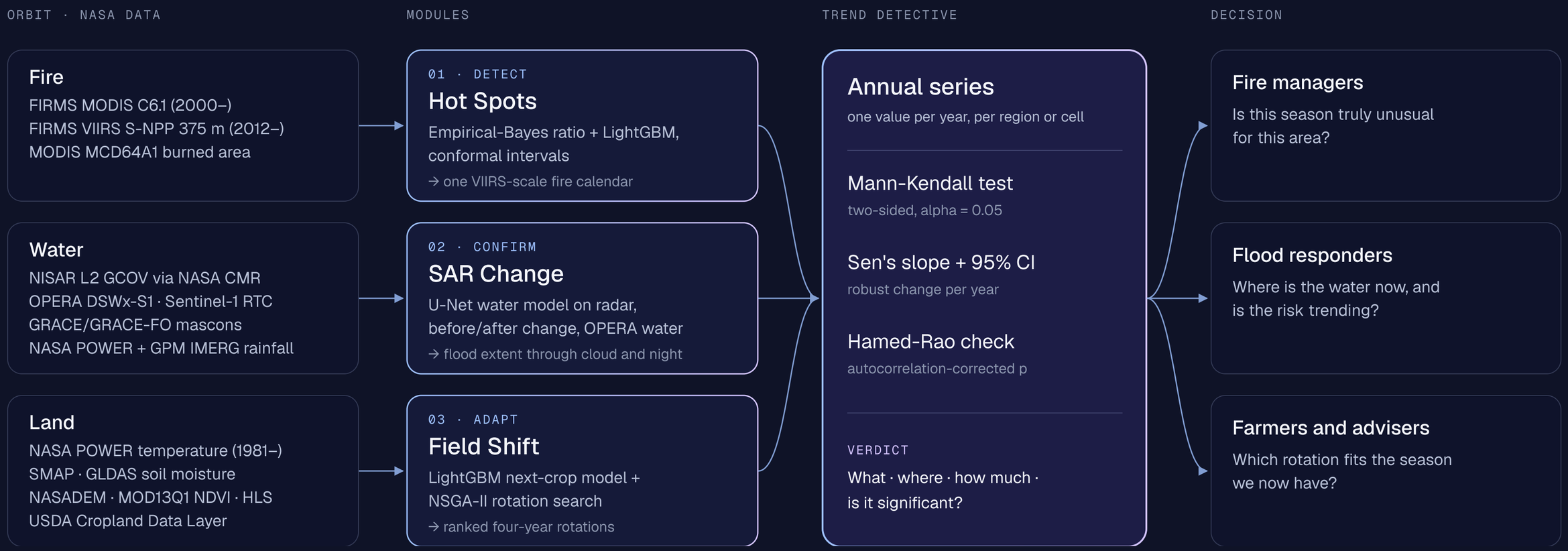
Is it significant?

Mann-Kendall p, autocorrelation check

5.6× RATIO: OUR COUNT FROM NASA FIRMS ARCHIVES, CANADA 2012-2025

Detect. Confirm. Adapt. Then test the trend.

Three working modules share one Trend Detective engine: NASA observations in, a verdict you can check out.



Is fire activity in Canada increasing? Yes.

Rising on all three MODIS-era series, and an independent burned-area product agrees. **Argentina falls.**

WHY

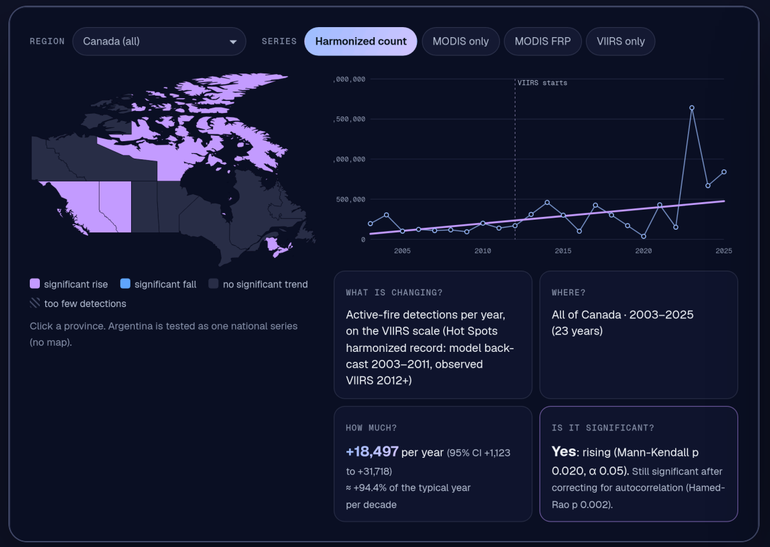
MODIS and VIIRS count fire on **different scales**, so the 25-year record breaks in 2012.

WHAT

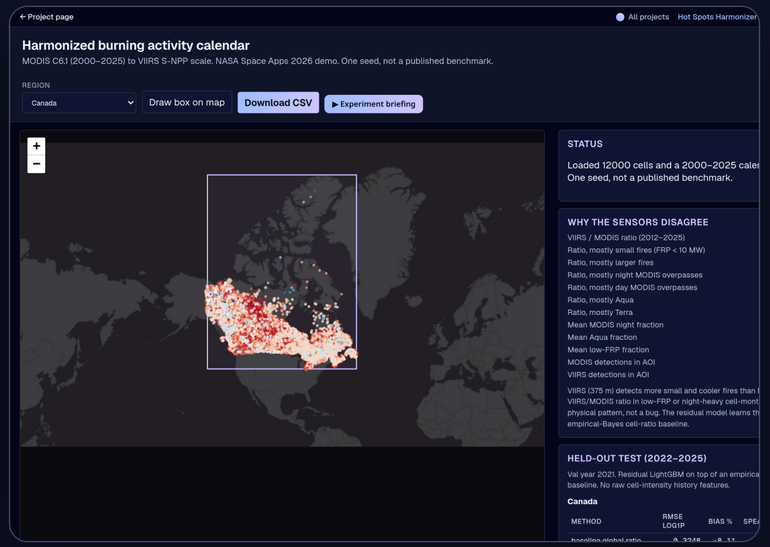
A **harmonized 2000–2025 fire calendar** for any area, with calibrated uncertainty and a per-province trend test.

HOW

11,616,131 FIRMS detections on a 0.25° grid.
Empirical-Bayes ratio + LightGBM, tested on 2022–25.
Province calls are tentative: significant on the harmonized series only.



/HOTSPOTS/ TREND WIDGET · FIRMS 2003-2025



/HOTSPOTS/APP/ LIVE TOOL · HARMONIZED CALENDAR

CANADA · MODIS COUNT

+3,019/yr

95% CI +81 to +5,184
p = 0.035

BURNED AREA · MCD64A1

+272 km²/yr

Boreal tile h11v03 (BC/AB/SK)
p = 0.004

ARGENTINA · MODIS

−1,909/yr

Falling
p < 0.001

MODEL VS BASELINE

−8.5% RMSE

0.2844 vs 0.3109, Canada 2022–25
88.6% coverage (target 90%)

HONEST MISS

39.4%

Canada monthly-total error
vs 16.7% for the baseline

Was the Valencia flood a trend? No. The water was real.

NASA POWER (45 yr) and GPM IMERG (27 yr): **no rain trend** around Valencia. GRACE/GRACE-FO: water storage falling.

WHY

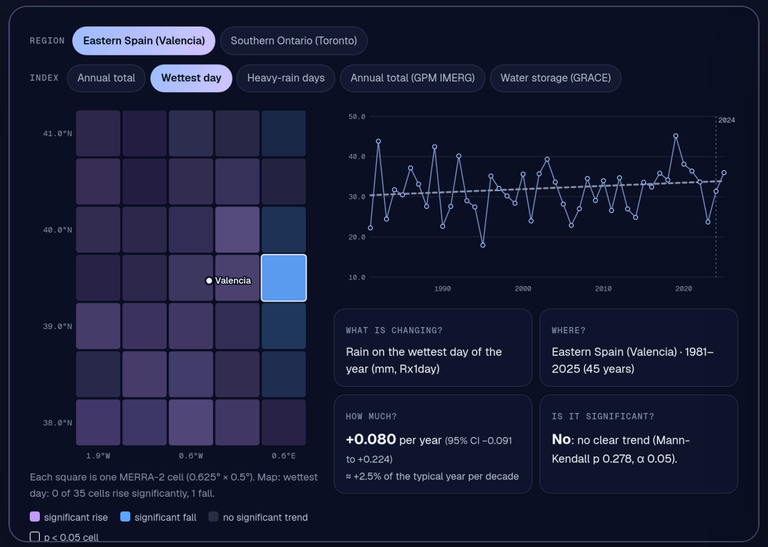
The 29 Oct 2024 DANA flood came under cloud. **Radar sees through cloud and night**, but it's hard to read.

WHAT

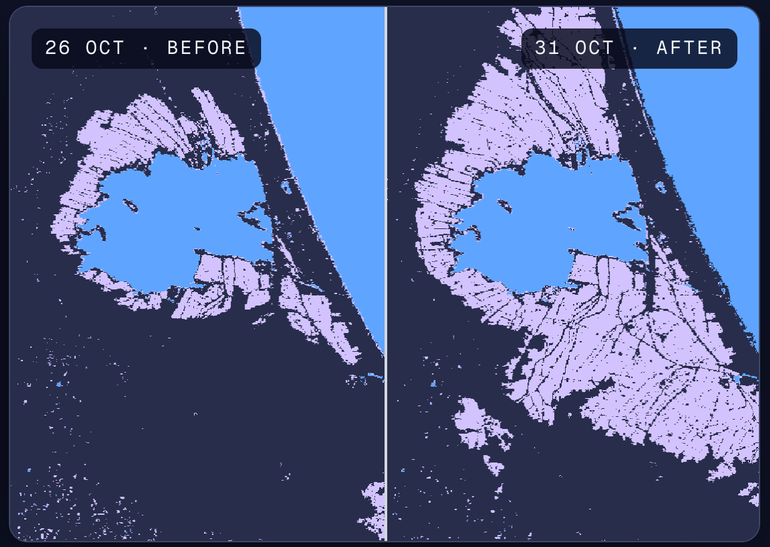
A radar flood viewer: swipe, time-lapse, change map, a water model and OPERA water maps. **NISAR-ready** for the next flood.

HOW

26 Sentinel-1 RTC passes, a U-Net trained on Sen1Floods11, OPERA DSWx-S1 as an independent check, and 198 NISAR GCOV granules (2025–26) via NASA CMR.



/SAR-CHANGE/ TREND WIDGET · NASA POWER 1981–2025



OPERA DSWX-S1 · LILAC = WATER OUTSIDE USUAL

NEW WATER · OPERA

30.7 → 77.7 km²

26 → 31 Oct 2024
mostly Albufera rice belt

WATER MODEL

66.4% IoU

U-Net vs 21.8% per-chip Otsu
Sen1Floods11 test split

VALENCIA · WETTEST DAY

No trend

+0.08 mm/yr · p = 0.28
1981–2025

VALENCIA · GRACE STORAGE

−0.39 cm/yr

p = 0.002
2003–2025

RAIN CHECK · GPM IMERG

No trend

Valencia annual total · p = 0.62
1998–2024

Is Iowa's growing season changing? Yes, it's longer.

The **first autumn frost comes later** in all 35 grid cells. Spring frost, summer rain and soil moisture show no trend.

WHY

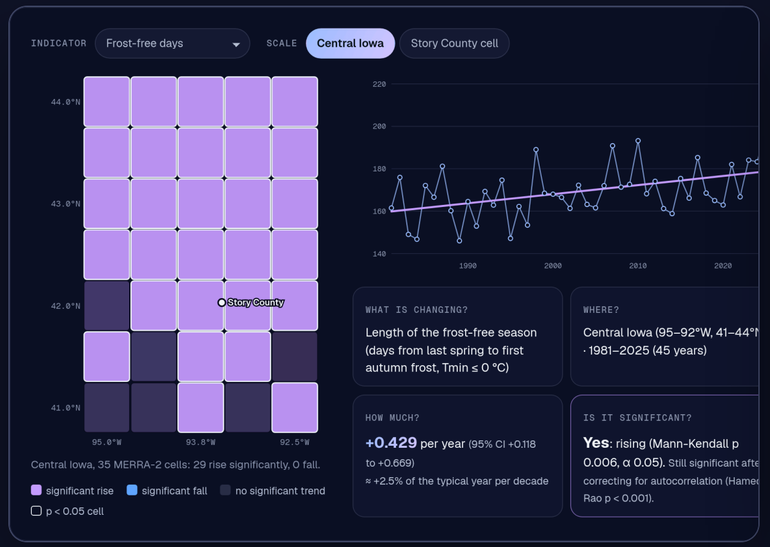
A rotation shapes the soil for years, while **frost, heat and moisture shift** underneath it.

WHAT

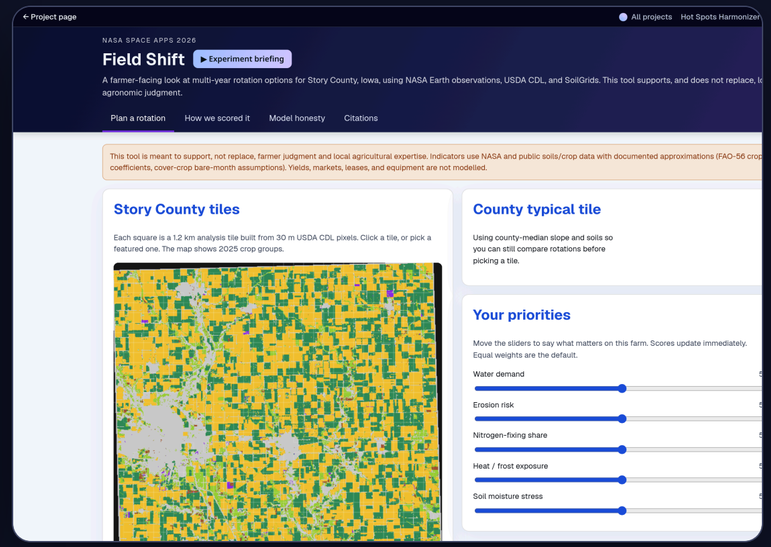
A rotation explorer for Story County, Iowa: predict next season's crop, then **rank four-year rotations** by the farmer's priorities.

HOW

USDA CDL 2009–2025, NASADEM, NASA POWER, MODIS NDVI and SoilGrids feed LightGBM (tested 2024–25) and an NSGA-II search: 36 non-dominated rotations.



/FIELD-SHIFT/ TREND WIDGET · NASA POWER 1981–2025



/FIELD-SHIFT/APP/ LIVE TOOL · ROTATION EXPLORER

FROST-FREE SEASON	FIRST AUTUMN FROST	MAY–SEP CORN GDD	NEXT-CROP MODEL	HONEST MISS
+0.43 d/yr	**Later**	**+4.6 /yr**	**0.8176**	**ECE 0.0351**
Central Iowa · p = 0.006 1981–2025	+0.40 d/yr · p < 0.001 35/35 cells	p < 0.001 1981–2025	Accuracy · macro-F1 0.5012 vs Markov-2 0.8136 / 0.4633	Temperature scaling hurt calibration (raw 0.016), so raw is kept

Same test everywhere. Shown even when the answer is no.

WHAT	WHERE	HOW MUCH / YR	SIGNIFICANT?
Active fires (MODIS)	Canada 2003–25	+3,019	Yes · p = 0.035
Active fires (MODIS)	Argentina 2003–25	−1,909	Yes · p < 0.001
Burned area (MCD64A1)	Boreal BC/AB/SK 2003–25	+272 km²	Yes · p = 0.004
Wettest-day rain	E. Spain 1981–25	+0.08 mm	No · p = 0.28
Annual rain (GPM IMERG)	E. Spain 1998–2024	+1.78 mm	No · p = 0.62
Water storage (GRACE)	E. Spain 2003–25	−0.39 cm	Yes · p = 0.002
Water storage (GRACE)	S. Ontario 2003–25	+0.55 cm	Yes · p = 0.014
Frost-free season	Central Iowa 1981–25	+0.43 days	Yes · p = 0.006
May–Sep corn GDD	Central Iowa 1981–25	+4.6 °C·days	Yes · p < 0.001
Water storage (GRACE)	Central Iowa 2003–25	−0.12 cm	No · p = 0.57
Soil moisture (SMAP)	Central Iowa 2015–25	−0.0015 m³/m³	No · p = 0.21

HELD-OUT YEARS

Every model is trained on earlier years and scored on later ones, against simple baselines.

SECOND SOURCE

Fire counts vs MCD64A1 burned area; reanalysis rain vs GPM IMERG; soil water vs SMAP and GLDAS.

AUTOCORRELATION

Ontario's reanalysis rain drop (p = 0.006) fails the Hamed-Rao check (p = 0.052) and GPM IMERG doesn't confirm it, so we don't call it.

NOT CAUSE

Significance shows change, not why. Sensor and reanalysis changes are disclosed.

TRY IT LIVE

nasa-spaceapps-2026.pages.dev

/hotspots/app/ · /sar-change/app/ · /field-shift/app/

Next: rain-gauge checks, NOAA-20/21 VIIRS, [illegible]-band floods, more regions.