

WEATHER FI **V2** MIGRATED UPDATED 2026-09-24

Weather Fi — settlement rules and product design

Technical whitepaper · v2 (2026-09-24). Migrated from the simulator's whitepaper and settlement-rules pages; the simulator moves from weathermarket.io to weatherfi.io.

A settlement simulator for weather-contingent products. It lists prediction markets, temperature ladders and parametric covers on 167 cities, prices them from a sixteen-day forecast, and settles every one of them on a determination published by the Weather Data Market oracle — with the oracle's run, its per-source readings and its on-chain anchor on the page before anything settles. All balances are virtual.

This document describes the simulator. The oracle itself is described in the [Weather Market whitepaper \(v3, 2026-09\)](#); where the two differ, the oracle's governs anything about the data.

Abstract

A weather contract is only as good as the number it settles on and the willingness of the losing side to accept it. Weather Data Market answers the first half: every hour it reduces eleven meteorological feeds to one consensus value per metric, checks it against the observation class, hashes the run and anchors it on Flare, and sells determinations — met, not met or withheld — on conditions a buyer opens. This simulator answers the second half by showing what products built on those determinations look like when people actually trade them: how they are priced, how the settlement risk of a city is shown before anyone trades, what a withheld hour does to a position, and whether the evidence on the page is enough for the losing side to accept the outcome.

Nothing is settled here on a number the oracle did not publish. Where the oracle offers an official determination the simulator uses it; where a product needs a value the determinations API does not cover — an index, a station's local day, the METAR reading inside a run — the simulator reads the oracle's own published record for that hour and says so on the settled market.

1. What the simulator is for

Parametric insurance, crop and energy hedges and prediction markets all reduce to the same question: did a condition hold at a time? The engineering of such products is mostly about the edges — hours the feeds cannot corroborate, stations that go quiet, a forecast that moves after listing, a market nobody wants to trade because it opened at 3%. Those edges are what this simulator exercises.

It is a demonstration environment. Every account starts with **10,000 sUSDT**, a unit of account with no monetary value that cannot be deposited, withdrawn, transferred or redeemed. No wager, derivative or insurance contract is formed. Accounts exist only behind a sign-in (email and password).

It also exists to make one thing visible. Many weather markets settle on a single airport METAR and treat it as ground truth, yet METAR reports go missing and arrive late — a fact rarely published by the data suppliers behind those markets. The oracle records every METAR every five minutes and checks every hourly run against the measurement class; this site records, per run and city, whether the METAR was present, usable and current, and publishes the result on its METAR watch page. The simulator's premise is that a market should rest on data anyone can check, not on the reputation of whoever supplies it.

2. The oracle it runs on

Weather Data Market is the official Web3 weather oracle of KWeather Co., Ltd. It collects eleven feeds for 167 cities every hour — three fetched directly (KWeather, METAR, MET Norway) and eight through Open-Meteo (seven national models and the vendor's own blend) — reduces each metric to a consensus value, and publishes two unit-free indices on fixed, versioned weights: WDI, the Weather Data Index (a composite), and TDI, the Temperature Data Index (the temperature component alone). The oracle names its estimator as a median with MAD outlier rejection; its parameters, tolerances, weights and freshness rules are proprietary and are not described here.

Verdict per run

Every run is checked against the observation class — airport METAR and KWeather's station and GTS feed — not against a single station. The oracle grades the run **verified** (more fresh

observations agree than disagree and at least two agree), **single_source**, **mixed**, **mismatch** or **unverified**, and ships the agreeing, disagreeing and abstaining counts with the verdict. Whether an hour is settlement-eligible, overall and per metric, comes from the oracle; this site does not recompute it.

Anchoring

Since **23 September 2026** the anchor of record is the **SnapshotAnchor** contract on Flare mainnet: one transaction per run, never overwritten. A second Flare contract, **DeterminationRegistry**, publishes resolved verdicts and marks one settlement-grade when its run is anchored. Runs before that date also carry first-generation anchors — an **IndexAnchored** event on BNB Chain and a legacy XRP Ledger memo — which remain verifiable; the SHA-256 is the same on each. Payments to the oracle are in native XRP on the XRP Ledger.

What the simulator consumes

Oracle endpoint	Used for
<code>/api/v1/index</code>	The current run per city: consensus, indices, per-source readings, outliers, corroboration, verdict, eligibility per metric.
<code>/api/v1/index/sources</code>	The same per-source readings for recent runs: the run-by-run strip, the ladder's METAR settlement.
<code>/api/v1/index/history</code>	Index history for charts and for pricing index markets.
<code>/api/v1/sub/forecast</code>	Sixteen-day daily and hourly forecast; tz=station cuts it on the station's local day.
<code>/api/v1/station/{icao}/daily</code> , <code>/observations</code>	A station's local calendar day and its raw METAR observations, for station-day markets.
<code>/api/v1/determinations</code>	Official determinations on temperature, humidity, wind and rain conditions.
<code>/api/v1/health</code> , <code>/api/v1/index/snapshots</code>	The latest run id, and the anchor of every run shown on the site.

The simulator holds a subscription token, so everything above is licensed for its cities. The token is a server-side secret; nothing on the site exposes it.

3. System architecture



The oracle allows about sixty credentialed calls a minute before it answers "slow down". Every call the simulator makes is paced to one a second in one place, so ingest, the determination openers and the resolvers stay under the limit instead of retrying into it. The database (Postgres, Seoul) and the functions (Vercel, Seoul) sit in the same region.

Each run the simulator reads is kept per city (consensus, indices, verdict, eligibility, source count) so an index market can settle on the value published for its hour and the charts can show a city's recent runs. This accumulation is licensed by the subscription; it would not be on the free tier, which the simulator does not use for anything that is kept.

4. Products

A city's product board shows eight fixed lines; each line offers a handful of dates, and each date a ladder of prices.

| Product | Question | Settles on | | ----- | -----
 ----- | -----
 ----- | | Hourly YES/NO
 | Temperature, rain, wind or humidity at or above a line at 06:00 UTC, D+1, D+3, D+7 and D+14. | Official oracle determination for the hour. | | Station day | A US station's high or low over its local calendar day (daylight saving applied), whole °F. | The oracle's station record: the METAR extreme in the window, or the official NWS value where chosen and carried. | | Index

(WDI / TDI) | The index published for an hour at or above a line. Opened by the operator. | The value in the oracle's run for that hour, on an eligible hour. | | Pick the temperature | Which whole degree the reading lands in; several degrees per ticket; the buyer picks consensus or METAR as the reference. | Consensus: the run for the hour. METAR: the METAR reading inside that run. | | Events | One question across outcomes — where it rains on a date, what a city reads at an hour. | Each outcome is an ordinary market; the event is a view. | | Parametric cover | Heat, cold, rain, wind or humidity at a chosen threshold and hour; pays the full amount if met. | Official oracle determination for the hour. |

Listing policy

Thresholds come from the forecast, not round numbers: a line is chosen so the market opens where there is something to disagree about. The next-day slot is listed automatically only for cities whose recent hours have been at least 70% settlement-eligible, because a market that voids after a day of trading helps nobody; longer horizons are listed everywhere with the risk badged. Hourly lines that drift outside 8–92% before anyone holds a position are delisted.

5. Pricing

Everything is set automatically from the forecast the oracle publishes per city, which merges KWeather's forecast — built from official stations, METAR and GTS bulletins with several national models, AI methods and terrain data — with Open-Meteo's; each row says how many providers contributed. From it the simulator derives, with no hand-set numbers: the lines each product lists (the line whose probability lands nearest the product's target — about 50% for even-money markets, 25% for tails), each market's opening price, each ladder degree's opening probability, and each cover's premium and payout ratio.

Binary markets use a logarithmic market scoring rule with liquidity $b = 1,000$; ladders use the same rule over all degrees at once with $b = 600$, one pool per reference. A market opens at the probability the forecast implies: an expected value at the hour (a diurnal curve between the day's minimum and maximum for temperature) and a spread that grows with lead time. Index markets open from the index's values at the same hour of day over the last seven days of runs; station-day markets from the forecast re-cut on the station's local day.

$$\begin{aligned}\text{YES price} &= e^{(q_{\text{Yes}}/b)} / (e^{(q_{\text{Yes}}/b)} + e^{(q_{\text{No}}/b)}) \\ \text{ladder price} &= e^{(q_i/b)} / \sum_k e^{(q_k/b)}\end{aligned}$$

```
cover premium = p × coverage × (1 + 0.15) + coverage × 0.005, at least 1 sUSDT
payout ratio   = coverage ÷ premium ≈ 1 ÷ (1.15·p + 0.005)
```

The forecast's own probability is shown beside every price so the gap between them — the edge — is visible before anyone trades. Twenty-four simulated participants trade the board after every ingest, each from its own noisy reading of the same forecast; they are ordinary accounts, labelled as such, with no information the visitor does not have.

6. Settlement

| Outcome | YES/NO market | Ladder ticket | Cover | | ----- | -----
 ----- | ----- | ----- | | Met / lands in the
 degree | YES pays 1 sUSDT a share | That degree pays 1 sUSDT a share | Full coverage paid | |
 Not met / other degree | NO pays 1 sUSDT a share | Nothing | Premium kept | | Withheld / not
 readable | Void, every position refunded at cost | That reference's pool refunded at cost | Void,
 premium refunded |

The simulator adopts the oracle's determination policy unchanged: determinations are final; the same condition at the same hour reads the same anchored run and returns the same outcome; **withheld** is a result, not a loss for either side. A station day with a gap over six hours between observations, or fewer than twelve observations, is withheld. Settlement runs twice an hour; a pass first pays everything whose determination has already resolved, then resolves what is due, and pays each one the moment it resolves.

7. Verifiability

Every value and every verdict on the site carries the oracle's run id and a link to that run's anchor on the Flare explorer (or, for runs before 23 September 2026, on BNB Chain). Anyone can check a settled market without trusting this site:

1. take the run id shown on the settled market
2. GET <https://weathermarket.io/api/v1/index/snapshots?runId=<run>> → sha256 + Flare tx
3. SnapshotAnchor.isAnchored(sha256) on Flare → true, with block time
4. the block time predates the settlement; the canonical bytes (paid) hash to sha256

Settled markets keep the evidence they settled on: the run, the value, the verdict and the counts for official determinations; the run and its index values for index markets; the observation, its raw METAR text, the window and the basis for station days; the run and the METAR line for ladders.

8. What a page shows

A market page leads with the price, a line chart of the last twenty-four runs and the trade panel, then the evidence: the live strip, the consensus feed — every source's reading for the current run against the METAR baseline, excluded outliers struck through, the measured-only figure, the corroboration and the verdict per metric — the last twelve runs source by source, the station day, the forecast, the rules and the determination. The METAR baseline is drawn in red and the consensus in green on every chart. Temperatures follow the reader's country (°F in the United States) and a switch in the header; settlement is always in the oracle's °C.

9. Licence, method and lawful use

Attribution and redistribution

Oracle data is shown under the oracle's terms, section 7, with "Powered by Weather Data Market" linked wherever a value appears. The simulator serves the data to its own pages through its own backend; it does not offer the data to third parties as a feed, API, dataset or bulk download. The JSON routes under `/api/sim` exist for this site's pages and are not a data service.

The oracle's method

The consensus and determination rules are trade secrets of the oracle (its terms, section 7-b). This site names the estimator the way the oracle names it and reports what each run decided; it does not describe, reconstruct or approximate the rule, and nothing here should be read as the oracle's method. The pricing models in section 5 are the simulator's own and have nothing to do with how the oracle decides.

Lawful use

The oracle lists prediction-market settlement as an intended use and prohibits supplying the data to an activity that requires a licence under the gambling laws of the Republic of Korea by a party that does not hold one. The simulator stakes nothing of value: balances cannot be bought, deposited, withdrawn or exchanged, and no prize of value is offered. Using the simulator, its data or its outputs to run a real-money scheme is prohibited by its terms.

10. Parties

KWeather Co., Ltd. (Seoul) is the provider of the oracle's data and the party to any purchase of it. **Wellbian Labs Pte. Ltd.** (Singapore) develops and operates the oracle platform under delegation from KWeather, and operates this simulator. The two are separate companies under common control, a relationship the oracle states in its own terms.

Technical questions: admin@wellbianlabs.io. Questions about the oracle's data licence: KWeather, khelp@kweather.co.kr.

11. Status and limitations

Stated plainly, because a settlement demo that overstates itself teaches the wrong lesson.

- **Working:** ingest of all 167 cities every run; official determinations for hourly markets and covers; station-day, index and ladder settlement on the oracle's published records; Flare anchors shown for every run; reliability-gated listing; simulated participants on every product.
- **Settlement throughput** is bounded by the oracle's rate limit. At one call a second a busy hour can leave determinations for the next pass; they settle on the next pass, not on a different value.
- **Index and ladder settlements are not official determinations.** The determinations API does not take WDI, TDI or "the METAR reading"; these settle on the oracle's published run and per-source record, and are labelled as such.
- **The official NWS climate value** is used for station days only when the oracle carries it; until it does, station days settle on the METAR-derived extreme, which can differ by about a degree.
- **Station-day markets** are listed for US cities only, where the reference convention is established.

- **Flare Confidential Compute** and the oracle's blind settlement path are not used; the simulator reads public runs.
- **The oracle's source diversity** is the oracle's limitation too: eight feeds arrive through one aggregator, and an outage there thins the consensus, which the oracle reports in the source count and the verdict.

12. Changes in v2

- Anchors read from Flare SnapshotAnchor (the oracle's anchor of record since 23 September 2026); BNB Chain anchors shown for earlier runs only.
- The oracle's verdict classes (verified, single_source, mixed, mismatch, unverified) replace the earlier two-feed description.
- The description of the consensus rule is limited to what the oracle publishes, per its terms section 7-b.
- Index names follow the oracle: Weather Data Index (WDI) and Temperature Data Index (TDI).
- New products: station-day highs and lows, index markets, Pick the temperature ladders with a choice of reference, events.
- Per-run records kept under the subscription licence; the live consensus feed and run-by-run source strip on every city and market.
- Accounts behind sign-in only; guest cookies retired.
- Oracle calls paced to its rate limit; settlement twice an hour, paying resolved determinations first.
- METAR watch: the airport METAR in every run is recorded (present, usable, age) and published city by city.
- Ladders offer the METAR baseline only where fewer than 40% of a city's hours were settlement-eligible over seven days.

Settlement rules (formerly /docs)

Everything on the simulator — every market price, every premium, every payout — is a function of one thing: a Weather Data Market determination on a condition like **"Seoul temperature $\geq 30^{\circ}\text{C}$ at 06:00 UTC"**. This part explains the data, the pricing models and the rules that decide who gets paid. Every value is measured, stored and settled in $^{\circ}\text{C}$, mm, m/s and %; temperatures are shown in the unit each city's country reads in and a header switch overrides that; a threshold typed in $^{\circ}\text{F}$ is converted before the oracle sees it.

How products and payouts are set

Nobody sets a line, a price or a payout by hand. Every product on the board is generated, priced and — for covers — given its payout ratio automatically, from one input: the forecast the oracle publishes for each city. Where KWeather's forecast and Open-Meteo's both cover a day the two are averaged and the row carries the number of contributing sources (2); further out Open-Meteo carries the day alone (1). The forecast refreshes every few hours and the catalogue runs every hour.

1. **Expected value at the hour.** From the day's forecast high and low the model draws the day's curve (peaking mid-afternoon local time) and reads the expected temperature at the target hour; humidity runs opposite to temperature; wind is the day's mean; rain is the day's total spread over the hours.
2. **Uncertainty that grows with lead time.** One standard deviation widens by day:
temperature $1.4 + 0.35 \cdot d$ $^{\circ}\text{C}$, humidity $8 + 1.2 \cdot d$ %, wind $1.3 + 0.25 \cdot d$ m/s. A station's daily high or low is priced about 15% wider than a single hour.
3. **A probability for any line.** $P(\text{value} \geq \text{line}) = 1 - \Phi((\text{line} - \text{expected}) / \sigma)$; rain uses the chance the hour is wet times the chance it is wet enough. Every probability is kept between 3% and 97%.
4. **Choosing the lines.** For each city and date the generator tries a ladder of candidate lines and keeps the one whose probability lands nearest the product's target: about 50% for the even-money temperature, humidity and rain markets, about 25% for the hot and cold tails, about 40% for wind. US cities get whole- $^{\circ}\text{F}$ lines.
5. **The opening price.** The market maker is seeded so the first YES price equals that probability. From then on trades move it; the forecast's own number stays beside the price as **Model**, and the gap is shown as **Edge**.
6. **Temperature ladders.** The same expected value and σ spread one unit of probability over whole degrees: each degree opens at the chance the reading lands in it.

7. **Cover premiums and payout ratios.** A cover pays its full amount when the condition is met, so its fair price is the probability times the coverage. The premium adds a 15% loading and a 0.5% fee:

$$\text{premium} = p \times \text{coverage} \times (1 + 0.15) + \text{coverage} \times 0.005 \quad (\text{at least } 1 \text{ sUSD})$$

$$\text{payout ratio} = \text{coverage} \div \text{premium} \approx 1 \div (1.15 \cdot p + 0.005)$$

example: $p = 20\%$, coverage 1,000 sUSD

$$\text{premium} = 0.20 \times 1,000 \times 1.15 + 1,000 \times 0.005 = 235 \text{ sUSD}$$

$$\text{payout} = 1,000 \text{ sUSD if met} \rightarrow 4.26 \times \text{the premium}$$

None of this touches settlement. The forecast decides where a product opens and what a cover costs; what pays is the oracle's published value for the hour — the consensus of eleven feeds — and nothing else.

Prediction markets

The catalogue is generated per city from that city's own forecast at four horizons — next day, 3 days, 7 days and 14 days ahead, each targeting 06:00 UTC. A determination is a unit of work on the oracle, and a market only needs one when it settles; markets are created without one and the settlement job opens the official determination a few hours before the target hour.

Settlement reliability is badged on every market and quote: **settles reliably** at 70% and above, **settlement risk** between 50% and 70%, red below that. Twenty-four simulated participants trade the board twice an hour, labelled as such, with no advantage.

Each market is a binary question on one condition at one whole UTC hour, between 2 hours and 16 days ahead. Prices come from an LMSR automated market maker with liquidity $b = 1000 \text{ sUSD}$; the YES price is $e^{(q_{\text{Yes}}/b)} / (e^{(q_{\text{Yes}}/b)} + e^{(q_{\text{No}}/b)})$, the cost of a trade is the difference in $b \cdot \ln(e^{(q_{\text{Yes}}/b)} + e^{(q_{\text{No}}/b)})$ before and after. There is no order book and no counterparty risk. Trading closes 1 hour before the target hour. Met → each YES share pays 1 sUSD; not met → NO pays 1; withheld → the market is void and every position is refunded at its cost basis.

Parametric insurance

A parametric cover pays the full coverage amount when the condition is met — no loss assessment. Five products are offered; threshold, target hour and coverage can be changed.

| Product | Condition | Default | | ----- | -----
 ----- | ----- | | Heat cover | Consensus temperature at the target hour at or
 above the threshold. | $\text{temp} \geq 33^{\circ}\text{C}$ | | Cold snap cover | Consensus temperature at the target
 hour at or below the threshold. | $\text{temp} \leq -5^{\circ}\text{C}$ | | Rain cover | Precipitation at the target hour at
 or above the threshold. | $\text{rain} \geq 2\text{mm}$ | | Wind cover | Wind speed at the target hour at or
 above the threshold. | $\text{wind} \geq 10\text{m/s}$ | | Humidity cover | Humidity at the target hour at or
 above the threshold. | $\text{humi} \geq 85\%$ |

Coverage 10–10,000 sUSDT per policy; target hour between 2 hours and 16 days ahead; the premium is debited immediately. Met → **paid**, the full coverage is credited. Not met → **expired**, the premium is kept. Withheld → **void**, the premium is refunded in full.

Determinations policy

The simulator inherits the determination policy of Weather Data Market without modification:

- **Determinations are final.** Once an outcome is issued it is not revised, even if a feed later corrects its data.
- **Same condition + same hour → same outcome.** Every market and policy on the same condition shares one determination.
- **The report explains, it does not rule.** The consensus value, verdict and anchor are evidence of how the outcome was reached; the outcome itself is the rule.
- **Withheld is nobody's loss.** When the hour is not verifiable, markets are void and premiums are refunded.
- **The risk is shown, not hidden.** Each city's recent settlement-eligibility rate is on every market and quote.
- **Station-day markets settle on the station's record:** the extreme over the METAR observations in the local calendar day, or the official NWS climate value when chosen and carried. A day with a gap over six hours or fewer than twelve observations is withheld and refunded.
- **Index markets settle on the published run.** An operator's market on WDI or TDI settles on the value the oracle published for the target hour's run; labelled as an index settlement, not an official determination.

- **Credentialed mode** registers an official determination via `POST /api/v1/determinations` and reads its resolution back. **Free tier** produces a **simulated determination** from the public consensus, clearly labelled and never settlement-grade.

Access modes

Mode	Forecast depth	Determinations	Verdict visible	Rate
free	3 days	simulated from public consensus	no (labelled "free tier")	120 req/hour; 10-city sample without a city
metered	16 days	official (x-api-key)	yes	0.04 USD a call, paid in XRP
subscription (in use)	16 days	official (Bearer token), included	yes	25 USD / 30 days or 200 / year per city, in XRP; about 60 calls a minute

Simulator API reference

All routes return JSON. Reading is open; anything that touches an account needs a signed-in session and answers `401` without one. Money fields are sUSDT numbers; times are ISO-8601 UTC.

Method	Route	Purpose
GET	<code>/api/sim/me</code>	Your simulated account: id, balance, displayName.
POST	<code>/api/sim/me</code>	<code>{ action: "reset" }</code> — wipe positions, policies and ledger; balance back to 10,000 sUSDT.
GET	<code>/api/sim/oracle</code>	Oracle status: health, latest anchored snapshot, credential mode, free-tier budget.
GET	<code>/api/sim/cities</code>	City list with latest consensus and open-market counts.
GET	<code>/api/sim/cities/[slug]</code>	City dashboard: latest consensus, anchor, forecast rows, markets.
GET	<code>/api/sim/markets</code>	List markets (status, category, city, continent, sort, page).
POST	<code>/api/sim/markets</code>	<code>{ citySlug, metric, op, threshold, targetHour }</code> — open a market on a condition.
GET	<code>/api/sim/markets/[id]</code>	Market detail: market, recent trades, your positions, anchor for the resolving run.
GET	<code>/api/sim/markets/[id]/quote</code>	LMSR quote without trading.
POST	<code>/api/sim/markets/[id]/trade</code>	<code>{ side, action: "BUY" "SELL", spend?, shares? }</code> — execute against the market maker.
POST	<code>/api/sim/insurance/quote</code>	<code>{ citySlug, productKey, threshold?, targetHour, coverage }</code> → quote with premium, pEvent, payoutRatio.
POST	<code>/api/sim/insurance/buy</code>	Same body → policy. Charges the premium and attaches a determination.
GET	<code>/api/sim/policies</code>	

`/api/sim/policies/[id]` | Your policies. | GET | `/api/sim/portfolio` | Account, summary tiles, positions at the current LMSR price, policies, ledger. |

Operational routes (`/api/cron/ingest` , `/api/cron/markets` , `/api/cron/settle` , `/api/admin/sim`) require a cron secret or the admin password.

Attribution & licence

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Data provider: KWeather Co., Ltd. Operator of the oracle platform and of the simulator: Wellbian Labs Pte. Ltd., under delegation from KWeather. Technical questions: admin@wellbianlabs.io.

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