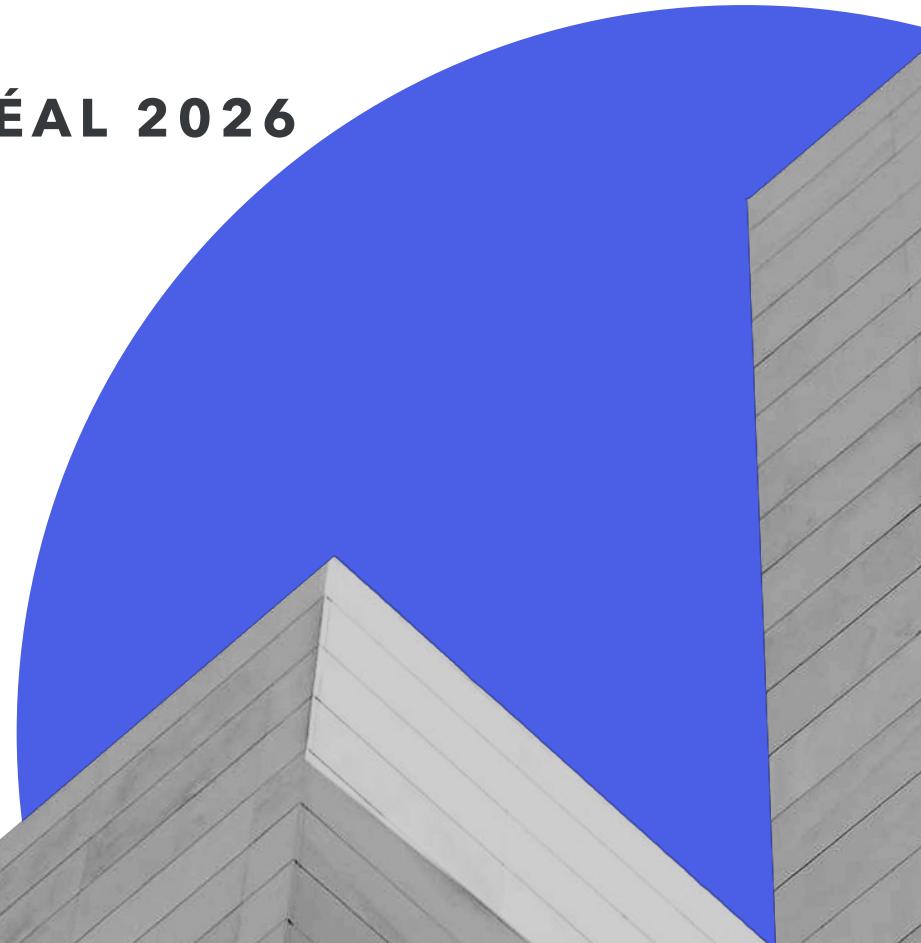


FROM ADDRESS TO DASHBOARD: WEATHER HISTORY AT SCALE

CONFOO MONTRÉAL 2026

LOÏC TRÉHIN

2026/02/28





AGENDA

- I. CONTEXT & THE BUSINESS NEED
- II. THE SPATIAL ILLUSION (GEOCODING & GRIDS)
- III. THE TEMPORAL HELL (TIMEZONES).
- IV. TRUST NO DOCS (REVERSE-ENGINEERING API UPDATES)

ABOUT ME

Loïc Tréhin - Software Developer / Devops



🎓 **Background:** Master's in Computer Science (UdeS) & Software Engineering (EFREI Paris).

💼 **Experience:** Software Developer at Energy Solutions Air (Sherbrooke) & Salt Mobile (Switzerland).

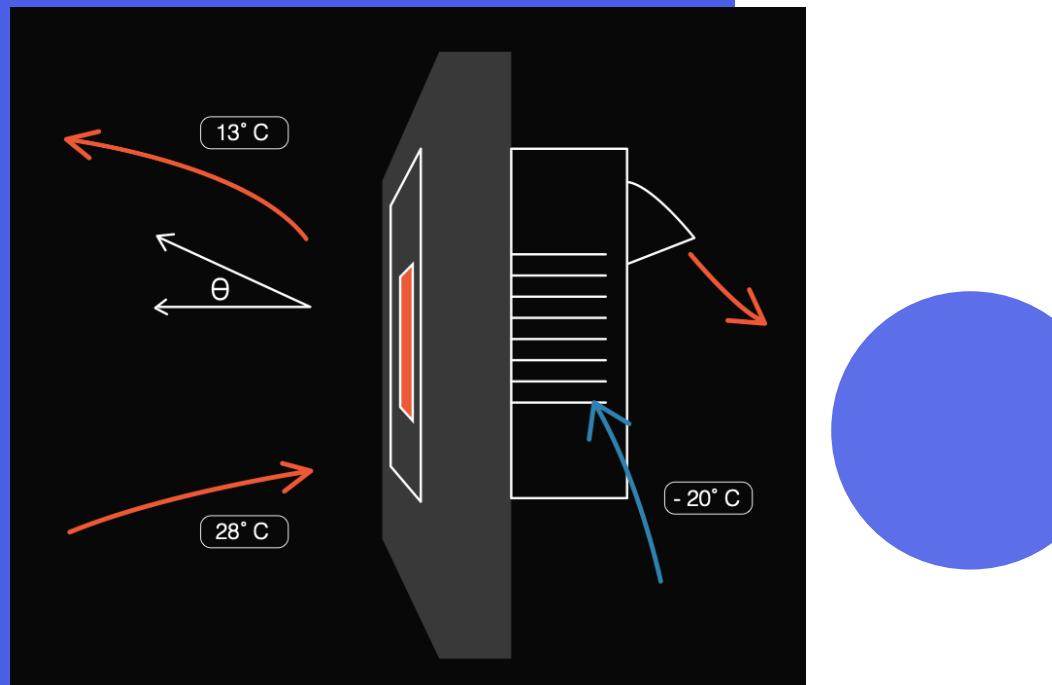
🔧 **Tech Stack:** TypeScript (React/Next.js), Go, Kubernetes, GitHub Actions.

Open to new opportunities!



I. CONTEXT & THE BUSINESS NEED

WHAT IS ESA?

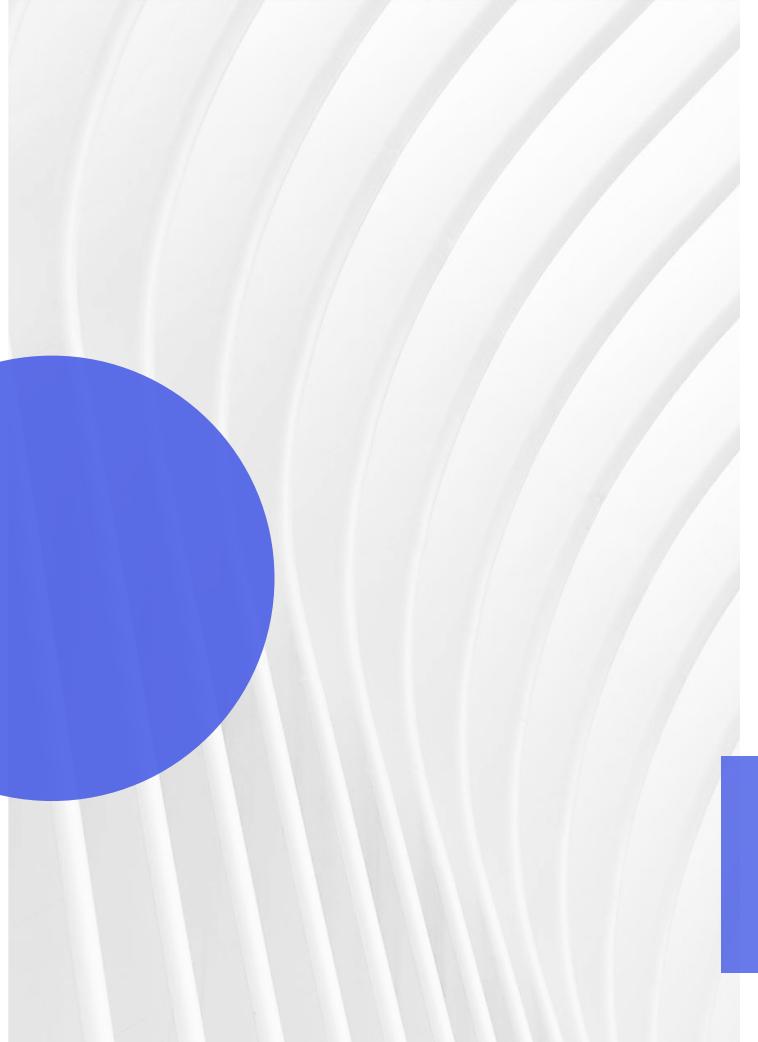


esa SERIES™

- Based in Sherbrooke Canada
- Expert in Livestock air quality
- Sell heat exchangers for farms
- Reduction of CO₂, humidity and ammonia levels for animal welfare.
- Reduce heating costs up to -50%

THE ECOPERFORMANCE CHALLENGE

- Quebec government offer grants for energy savings to companies
- Problem : How to calculate energy savings when we have sensor data gaps ?
- Solutions :
 - 1.Getting hourly weather history for the last 2 years for each client site
 - 2. Build a daily history and forecast recording system to anticipate frost risks.



THE DASHBOARD IN ACTION

□ Q

❄️ Cold Sites Monitor

Sites with temperatures below 0°C, sorted by coldest first.

⌘ Super Cold: 0 (0 units) 🥶 Cold: 6 (12 units) 🥶 Freezing: 194 (1823 units)

Data cached for 1 hour (22:00)

X All Categories ▼ ⟳ Refresh ColumnsMode

Category	Customer	Province	🥶 Temp	Feels Like	↗ Wind	Site	Units
Cold	☒	MB	-13.7°C	-19.1°C	7 km/h S	Site 1 ☒	4
Cold	☒	MB	-12.9°C	-20.3°C	14 km/h S	Demo Unit ☒	1
Cold	☒	MB	-12.9°C	-20.7°C	14 km/h S	Site 1 ☒	3
Cold	☒	MB	-12.9°C	-20.3°C	14 km/h S	Site 1 ☒	1
Cold	☒	MB	-11.0°C	-19.7°C	15 km/h S	Site 1 ☒	1
Cold	☒	MB	-11.0°C	-19.7°C	15 km/h S	Site 1 ☒	2

7

... WITH FORECAST

□ Q

≡ Cold Sites - Next 24 Hours

Hourly forecast for cold sites in the next 24 hours, sorted by wind speed (highest first).

⌘ Super Cold: 0 (0 units) ⌘ Cold: 168 (1639 units) ⌘ Freezing: 41 (309 units)

Data cached for 30 min (22:09)

X All Categories ▼ ⟳ Refresh ColumnsMode

Category	Customer	Province	Min Temp	Cold Hour	Min Feels	Max Wind	Gust	Dir
Freezing	✉	AB	-0.1°C	Tmrw 10:00	-6.1°C	52 km/h	73 km/h	270° (↗ W)
Cold	✉	QC	-13.0°C	Tmrw 22:00	-19.6°C	40 km/h	48 km/h	217° (↖ S)
Cold	✉	QC	-13.0°C	Tmrw 22:00	-19.6°C	40 km/h	48 km/h	217° (↖ S)
Cold	✉	QC	-13.0°C	Tmrw 22:00	-19.6°C	40 km/h	48 km/h	217° (↖ S)
Cold	✉	QC	-13.0°C	Tmrw 22:00	-19.6°C	40 km/h	48 km/h	217° (↖ S)
Cold	✉	QC	-13.0°C	Tmrw 22:00	-19.6°C	40 km/h	48 km/h	217° (↖ S)



❄️ Cold Sites Forecast

7-day forecast for sites expecting temperatures below 0°C, sorted by coldest minimum.

⌘ Super Cold: 145 (1606 units)

🥶 Cold: 57 (324 units)

🥶 Freezing: 36 (351 units)

Data cached for 1 hour (22:08)

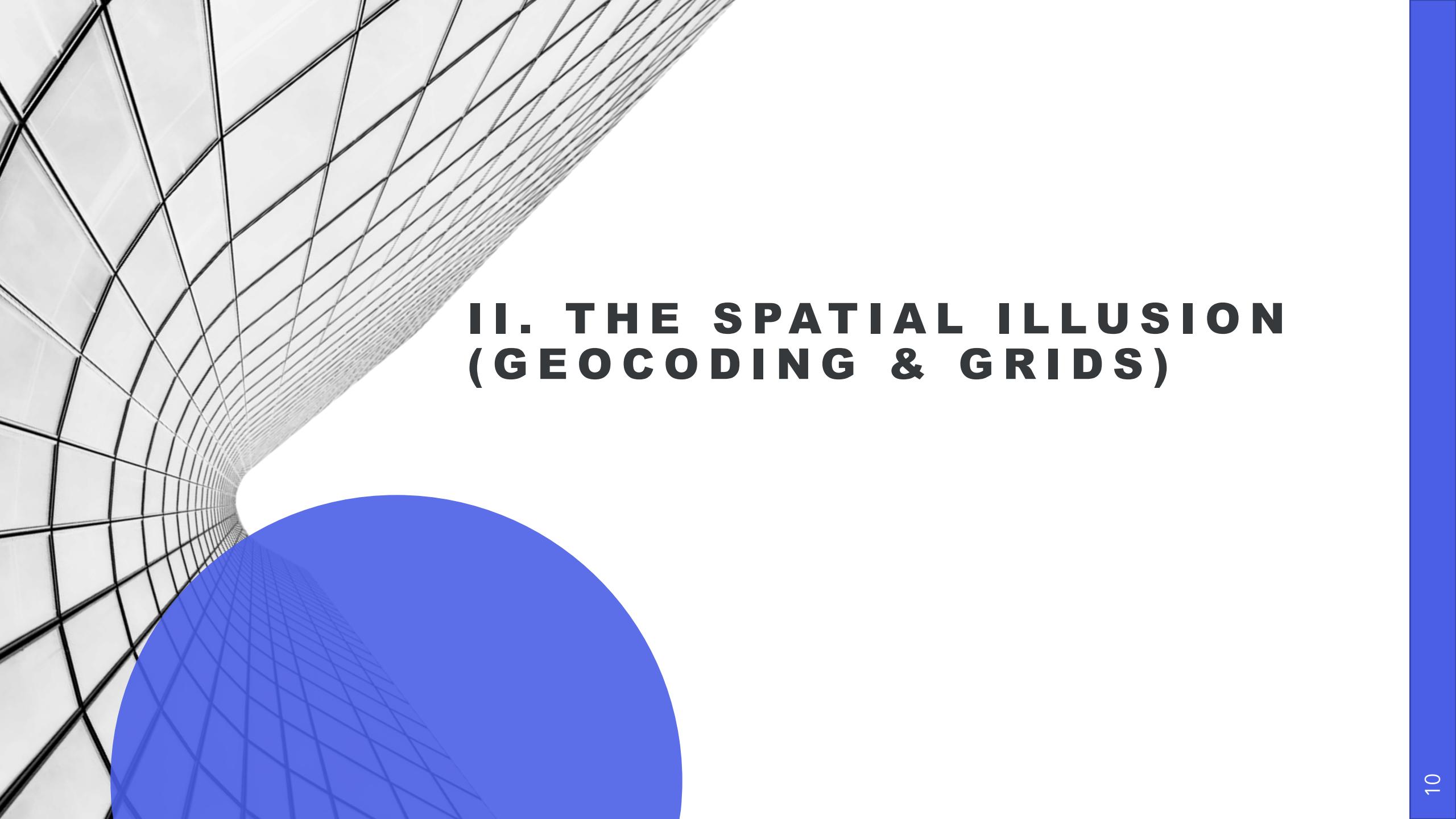
Search site, customer, province...



All Categories



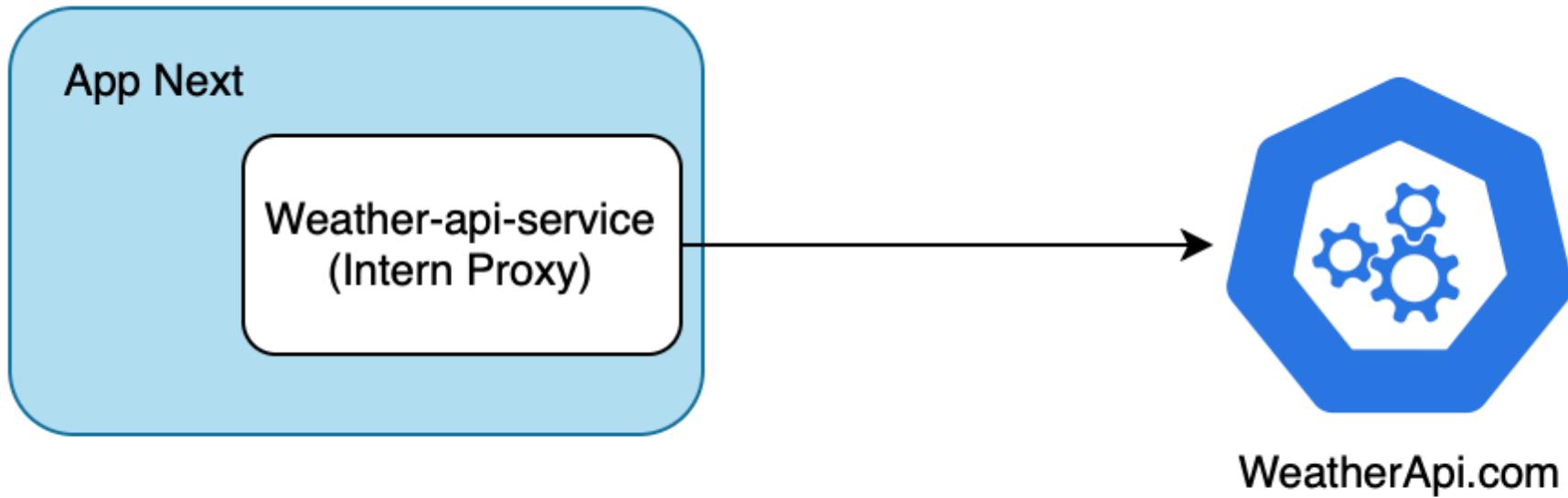
Category	Customer	Province	Min Temp	Date	Min Feels	Max Wind	Date	Site
Super Cold	☒	MB	-33.1°C	Sat 28	-33.1°C	43 km/h	Thu 26	Site 1 ☒
Super Cold	☒	NB	-31.8°C	Sun 01	-31.8°C	32 km/h	Fri 27	☒
Super Cold	☒	QC	-31.2°C	Sun 01	-31.2°C	35 km/h	Fri 27	Site 1 ☒
Super Cold	☒	MB	-30.6°C	Sat 28	-30.6°C	42 km/h	Thu 26	Demo Unit ☒
Super Cold	☒	MB	-30.6°C	Sat 28	-30.6°C	42 km/h	Thu 26	Site 1 ☒
Super Cold	☒	MB	-30.2°C	Sat 28	-30.2°C	37 km/h	Thu 26	Site 1 ☒

The background features a black and white perspective grid that curves and recedes towards the center. A large, solid blue sphere is positioned in the lower-left foreground, partially overlapping the grid. The overall aesthetic is minimalist and architectural.

II. THE SPATIAL ILLUSION (GEOCODING & GRIDS)

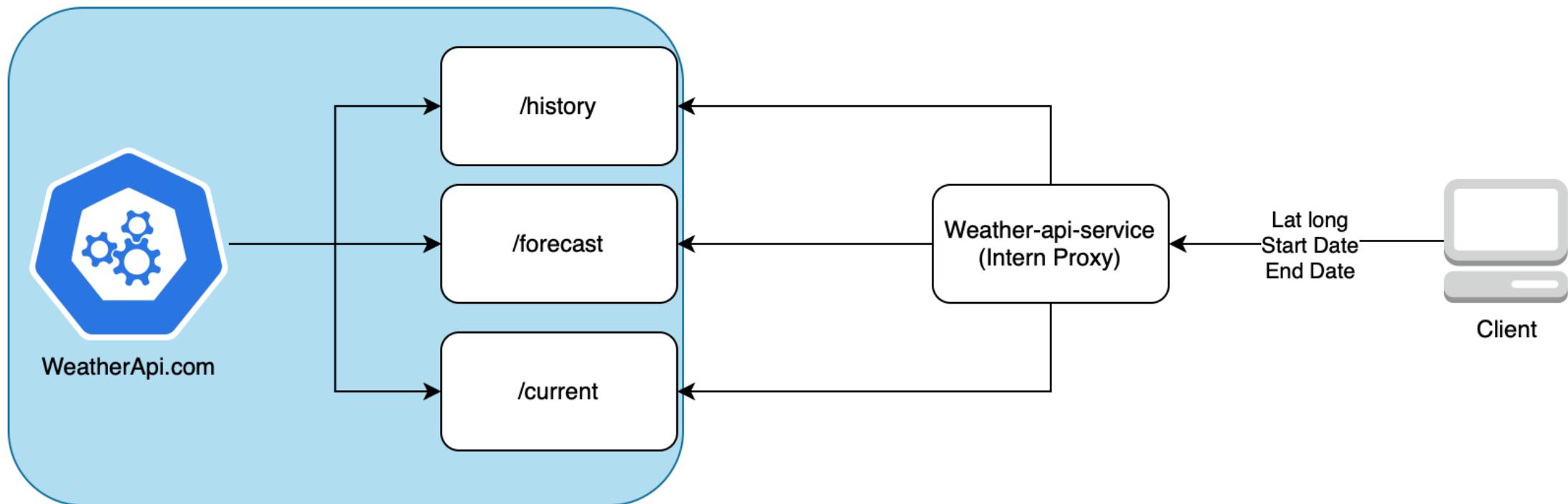
WEATHER-API-SERVICE PROXY

An API proxy that ensures provider independence: switching weather providers requires updating only the proxy, without impacting internal clients.



PROXY WITH ONE ENDPOINT

An architecture to simplify data access for internal clients with date format requests.



A X * 24H RETURN FORMAT

```
// types
export interface ApiResponse {
  HourlyReport: HourlyReport[];
  Meta: Meta;
}

export interface HourlyReport {
  name: string;
  timeZone: string;
  date: string;
  timeEpoch: number;
  tempC: number;
  isDay: boolean;
  conditionCode: number;
  conditionText: string;
  conditionIcon: string;
  windKph: number;
  windDegree: number;
  pressureMb: number;
  humidity: number;
  feelslikeC: number;
  windchillC: number;
  gustKph: number;
}
```

THE ADDRESS NIGHTMARE OF WEATHERAPI.COM

Weatherapi.com struggles to locate rural addresses.



WeatherApi.com

5032 Satcoe County Rd 31, Cookstown, ON L0L 1K0

GEOCODING: OSM VS. HERE

Test and qualify a reliable geocoding provider.



**Open
Street
Map**

Free and open source but not
able to locate all addresses.



Freemium : 1 million request by
month and find all rural addresses



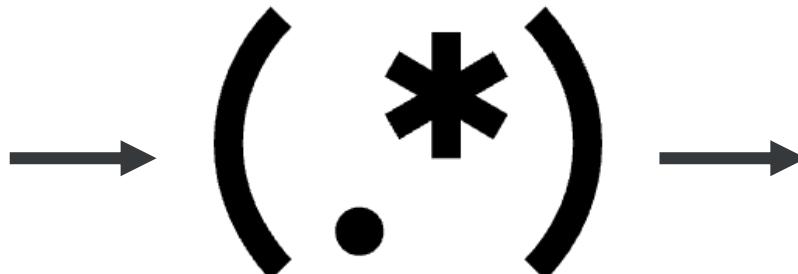
CLEANING THE INPUT

Standardizing postal address formats prior to API calls.

"QC", "Quebec", " Qc "

"H0H0H0", "H0H 0H0", "h0h-0h0"

"123 RGE Rd 4", "10 Main St.", "05
Avenue"

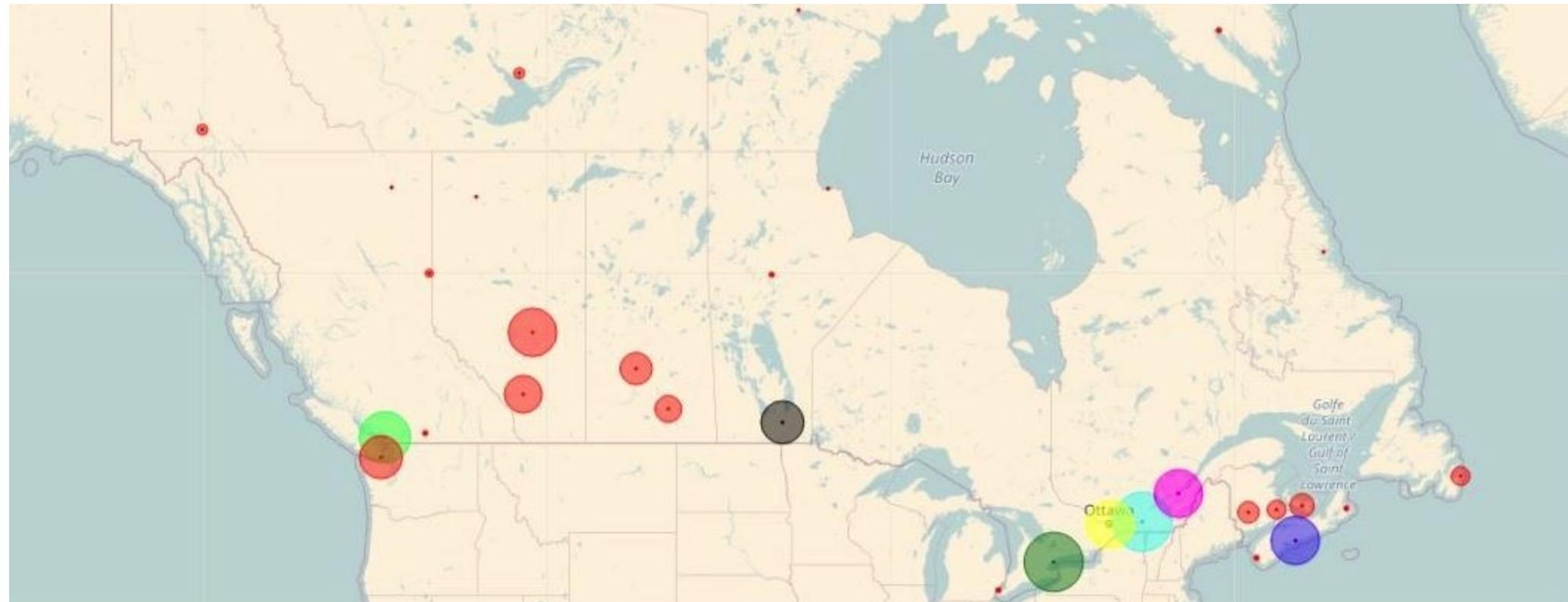


Regex expressions
and mapping

```
{ "state": "Quebec",  
  "postalcode": "H0H 0H0",  
  "street": "123 Range Road 4"  
}
```

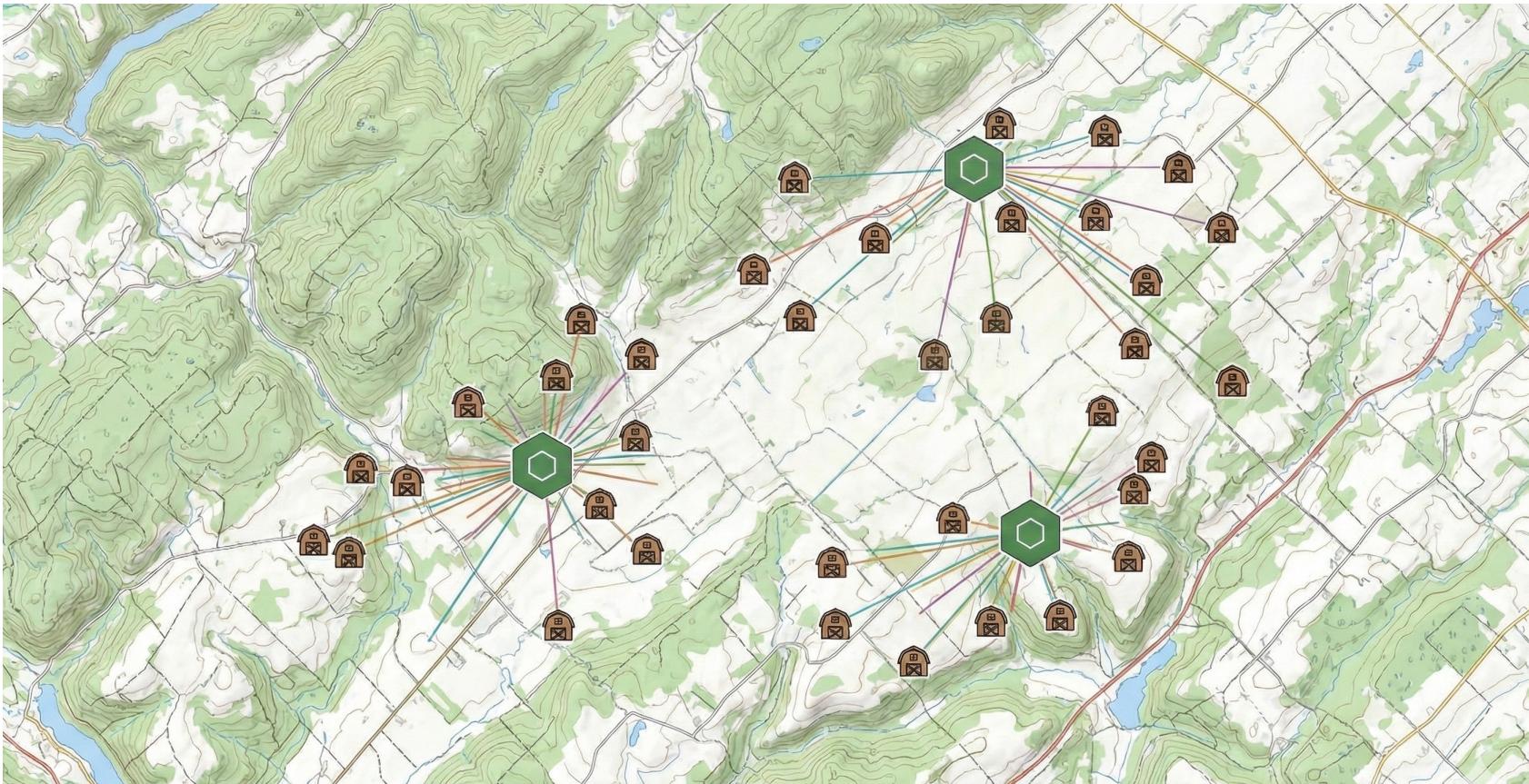
THE POSSIBILITY TO CREATE A CUSTOMER MAP

OpenStreetMap enables us to create clustered maps to easily locate our clients.



THE GRID OPTIMIZATION

The weather service returns data based on a mesh grid and not directly from given coordinates.



Multiple Weather Mesh Points Covering Groups of Farms and Sites.

REDUCE DATA TO INGEST

Linking GPS coordinates to weather reference points to avoid data duplication.

40.713125, -73.945589
40.727026, -73.984982
40.771712, -73.972685

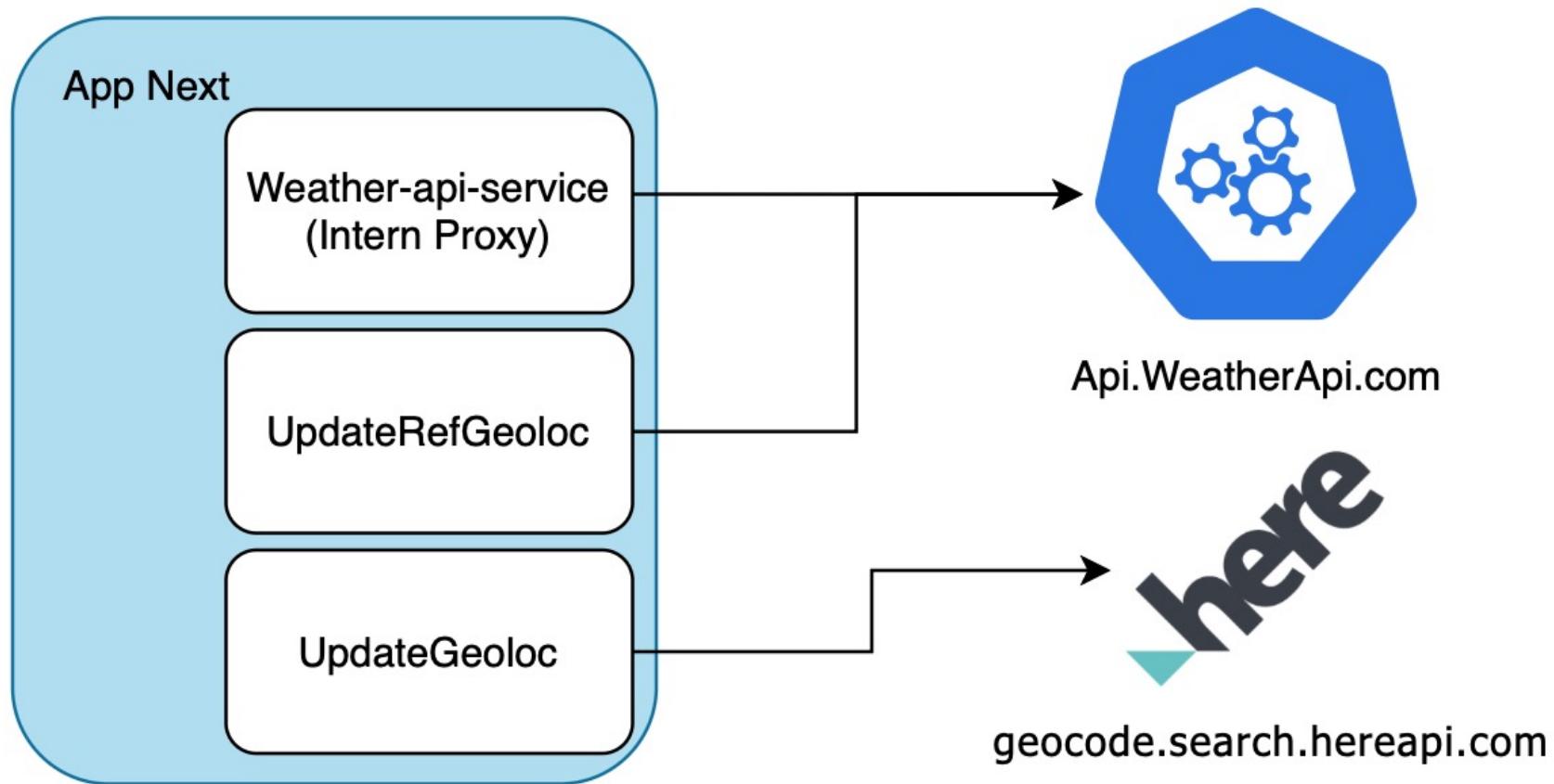


```
{  
  "location": {  
    "name": "New York",  
    "region": "New York",  
    "country": "United States of America",  
    "lat": 40.71,  
    "lon": -74.01,  
    "tz_id": "America/New_York",  
    "localtime_epoch": 1658522976,  
    "localtime": "2022-07-22 16:49"  
  },  
  ...  
}
```

100 references coordinates

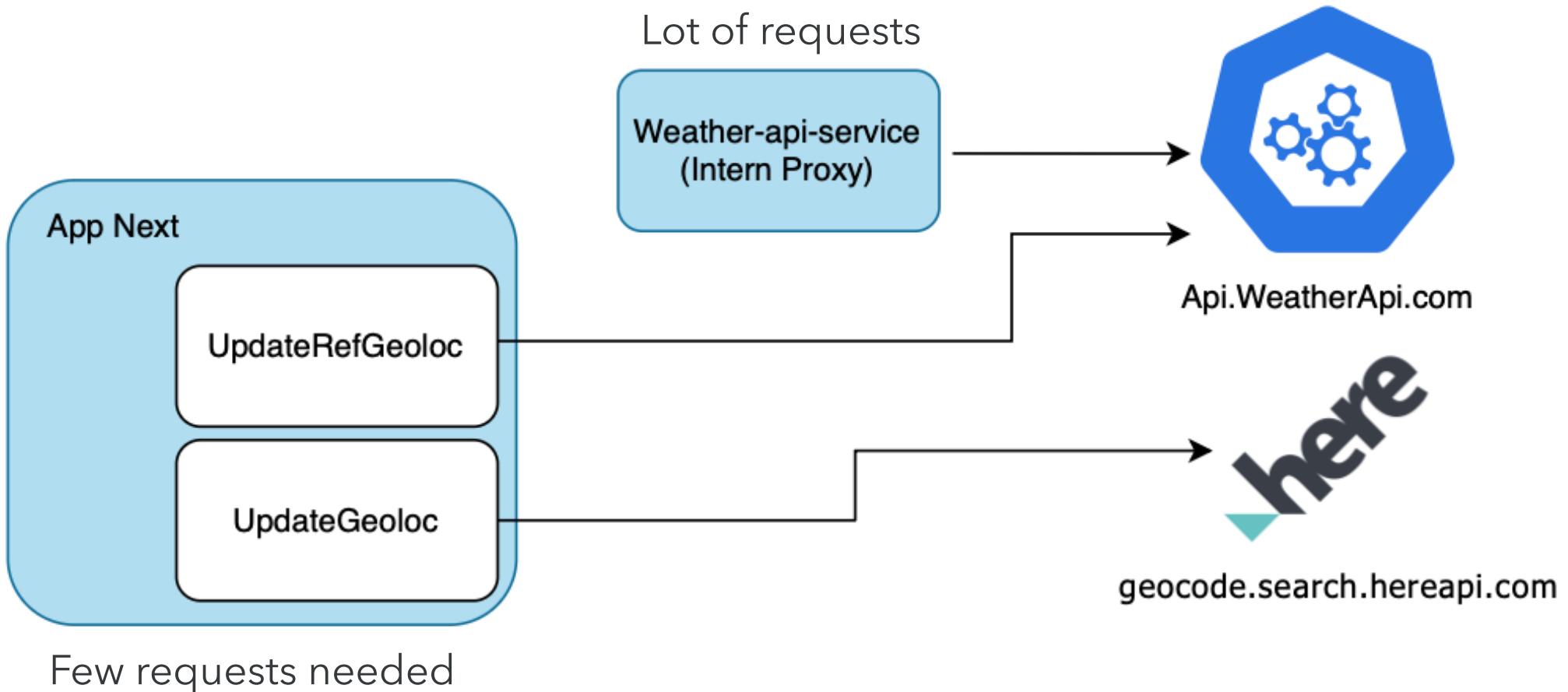
PAUSE ON THE ARCHITECTURE

Updated architecture with the addition of geocoding and reference points.



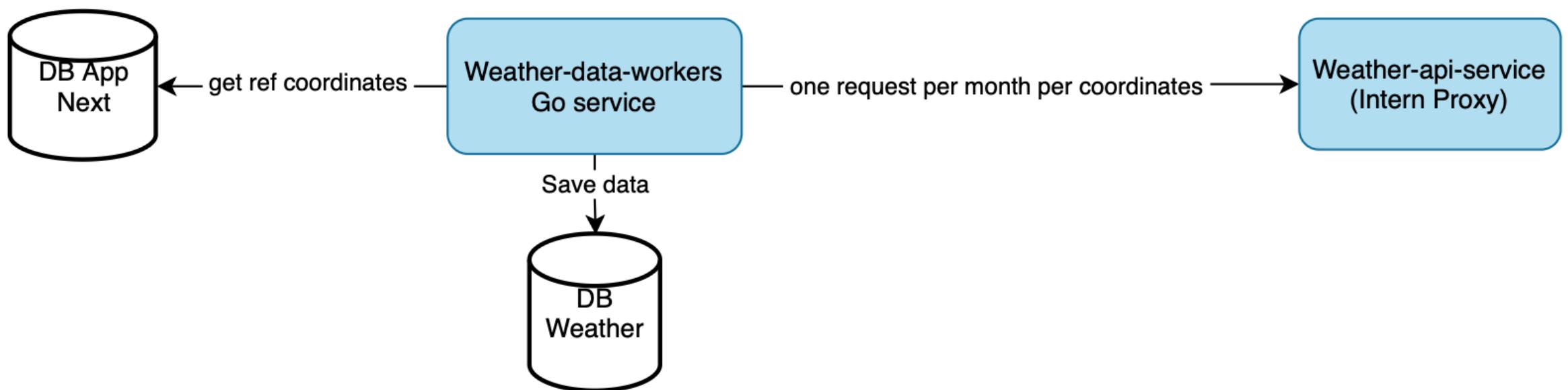
AVOID OVERLOADING NEXT.JS APP

Updating the architecture to prevent overloading the Next app.



THE INGESTION ENGINE: WEATHER-DATA-WORKERS

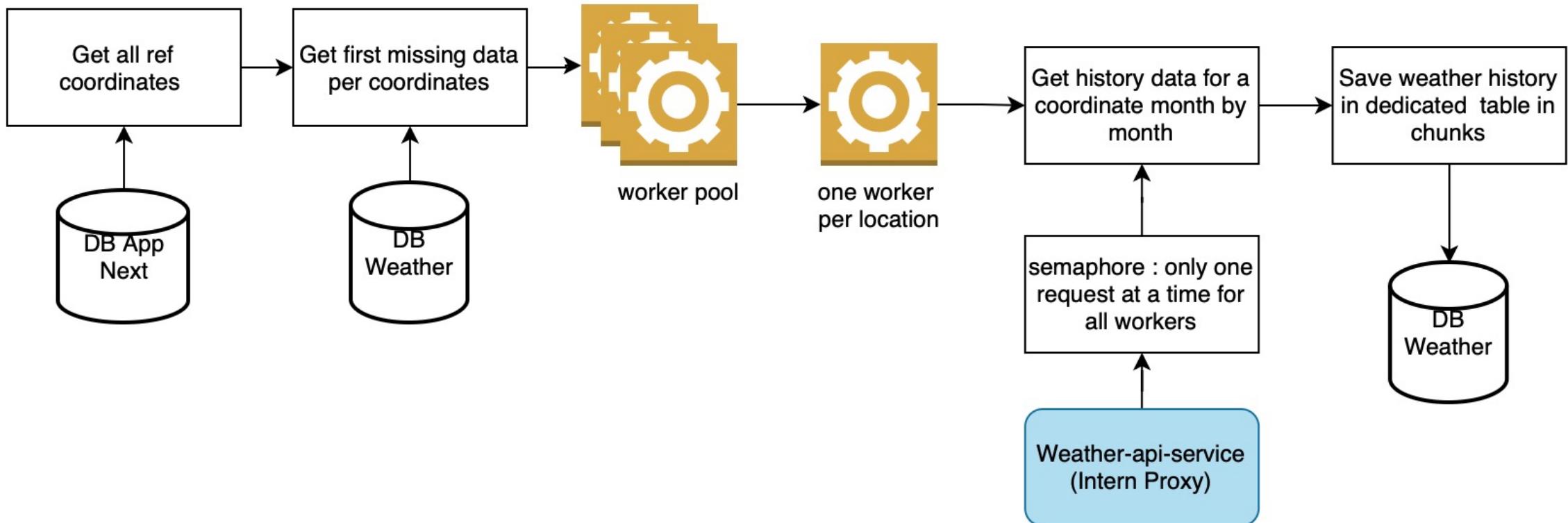
Automating data fetching and storage



A RESILIENT GO SERVICE



Detailed description of the process



AUTOMATION & FALBACK LOGIC

Kubernetes CronJob configuration file for the service deployment

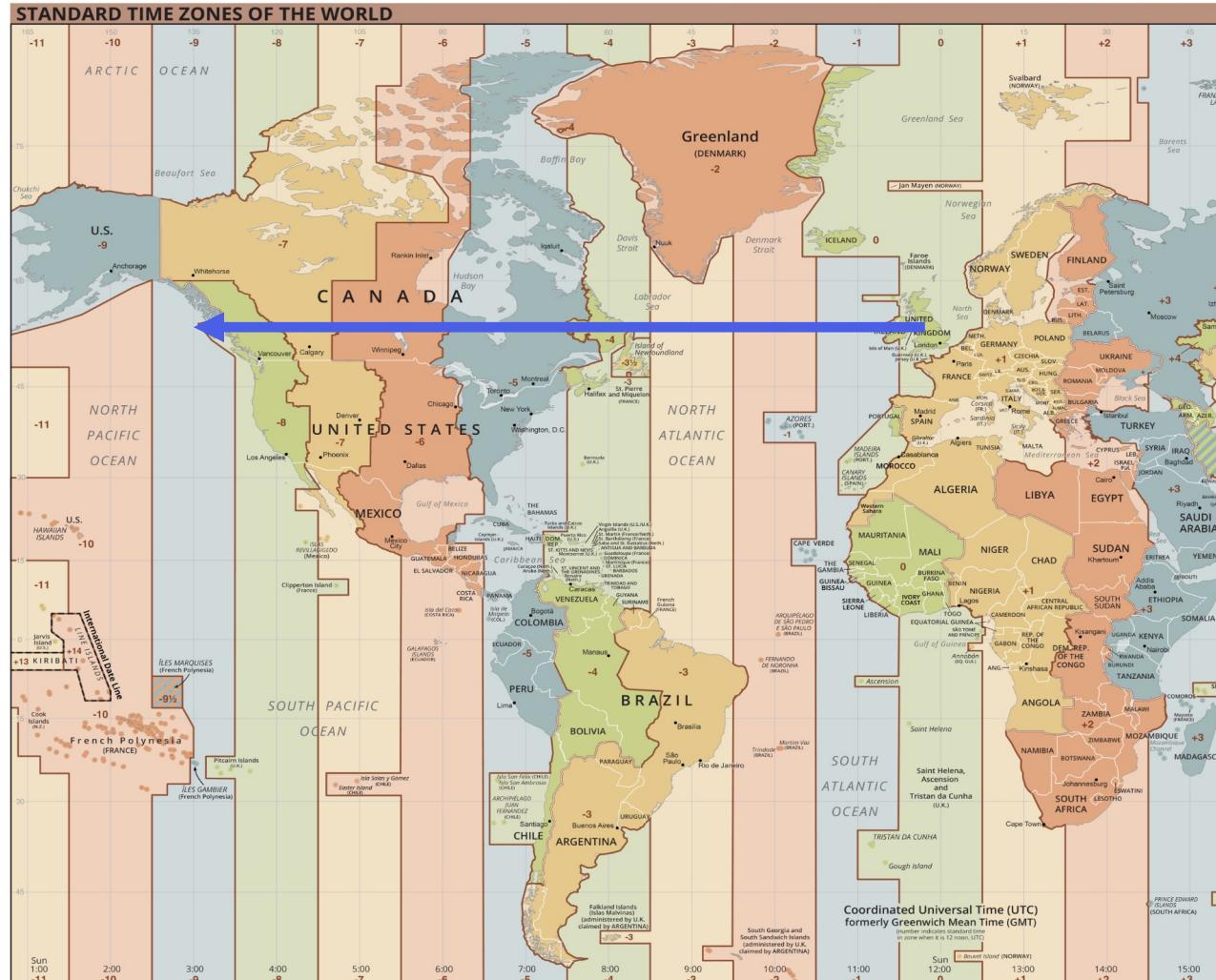
```
apiVersion: batch/v1
kind: CronJob
metadata:
  name: weather-data-workers
spec:
  schedule: "0 9 * * *"  # Each day at 09h00 UTC (1h Vancouver PST)
  jobTemplate:
    spec:
      template:
        spec:
          containers:
            - name: weather-data-workers
              env:
                - name: WORKER_MODE
                  value: "history"
                - name: LOOKBACK_DAYS
                  value: "4"
                - name: WORKERS
                  value: "8"
                - name: MAX_RETRY
                  value: "12"
```

The background features a black and white perspective grid that curves and recedes into the distance, creating a tunnel-like effect. A large, solid blue circle is positioned in the lower-left foreground, partially overlapping the grid. The overall aesthetic is minimalist and architectural.

III. THE TEMPORAL HELL (TIMEZONES).

THE TIMEZONE TRAP 1 (THE SCHEDULER)

Taking each time zone into account when choosing the data archiving time.



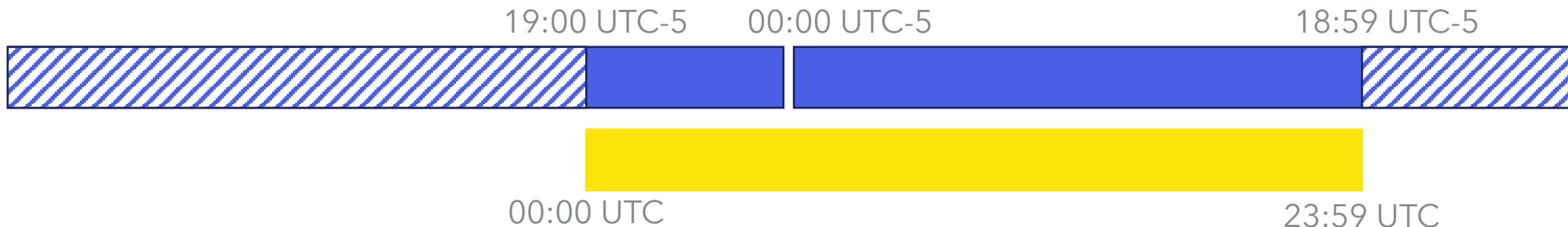
The history endpoint updates at midnight local time, so the backup runs at 1:00 AM Vancouver time (9:00 AM UTC).

THE TIMEZONE TRAP 2 (SAVE 24H UTC)

Problem: How to extract 24 hours of UTC data (00:00 - 23:59) if the API uses local time?



Solution: Request the last 48 hours of data, then filter it to retain a 24-hour UTC window.



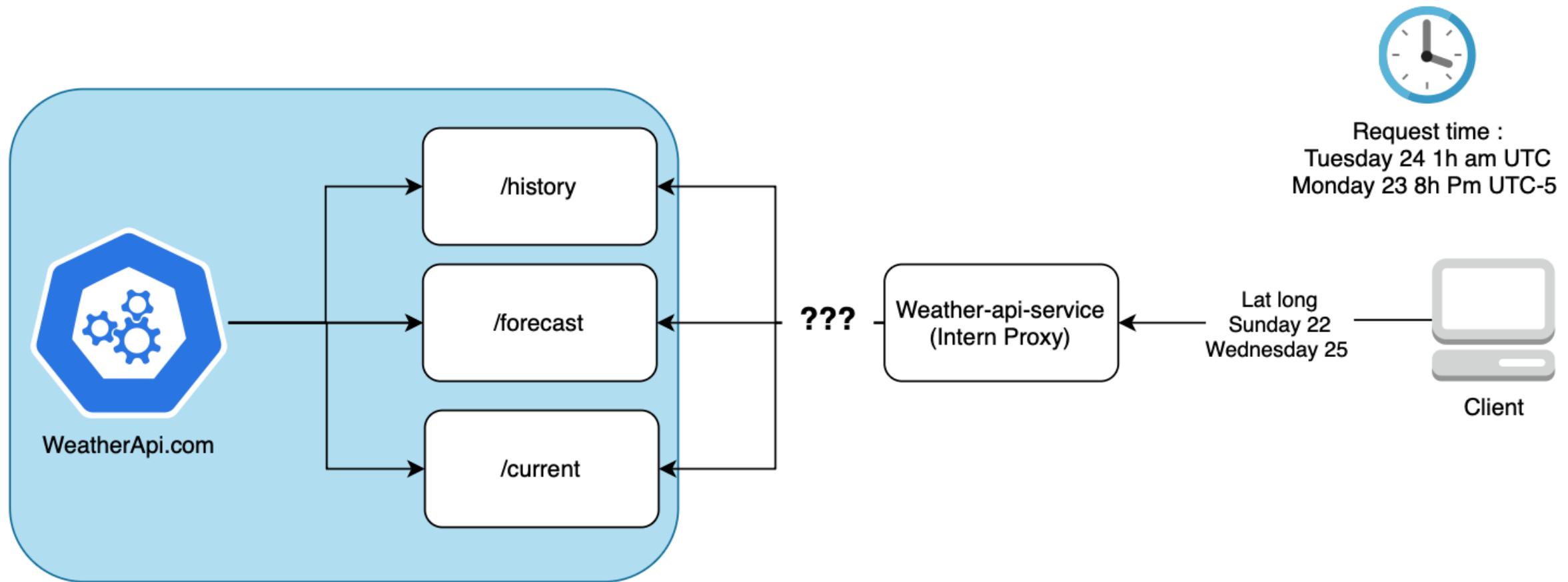
Legend :

- Yellow bar: London timezone
- Blue bar: Toronto timezone

THE TIMEZONE TRAP 3 (THE ROUTER)

Problem:

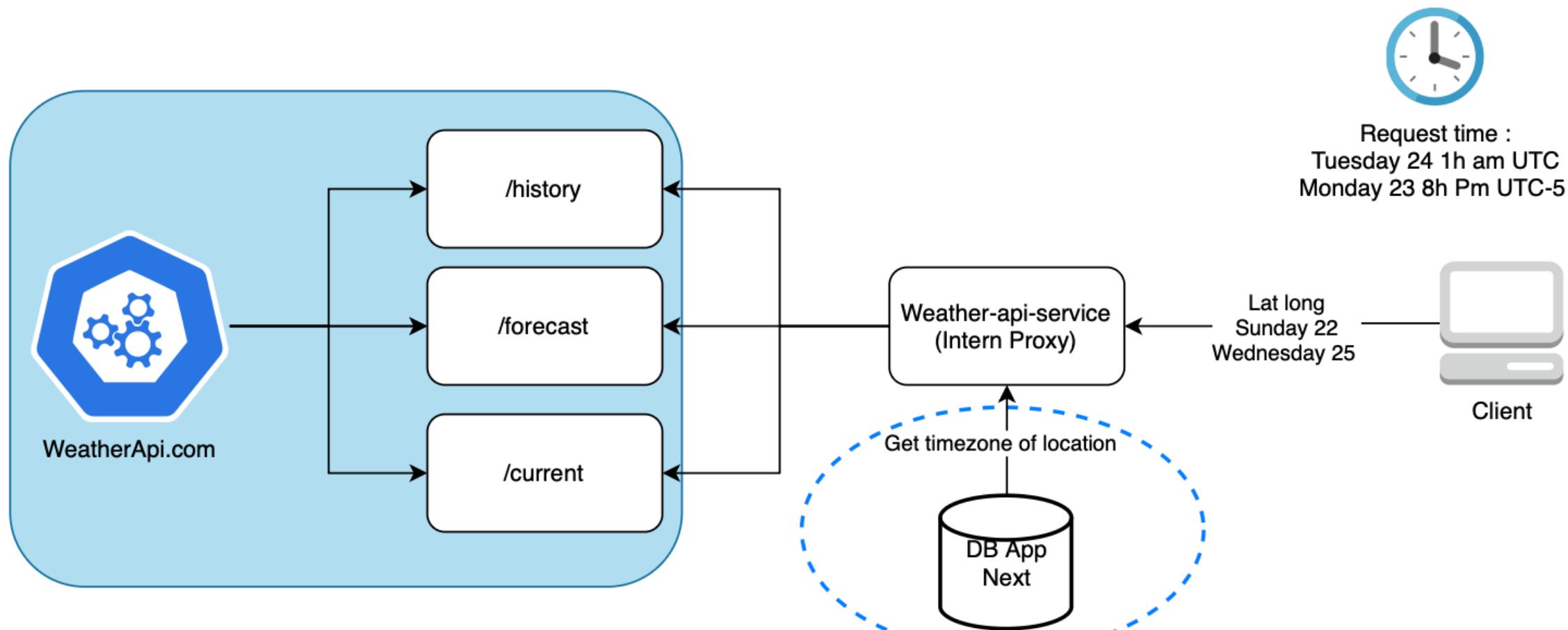
Routing logic based on UTC to choose today date can causes incorrect endpoint selection (History vs. Forecast) when the local date differs from UTC.



THE TIMEZONE TRAP 3 (THE ROUTER)

Solution:

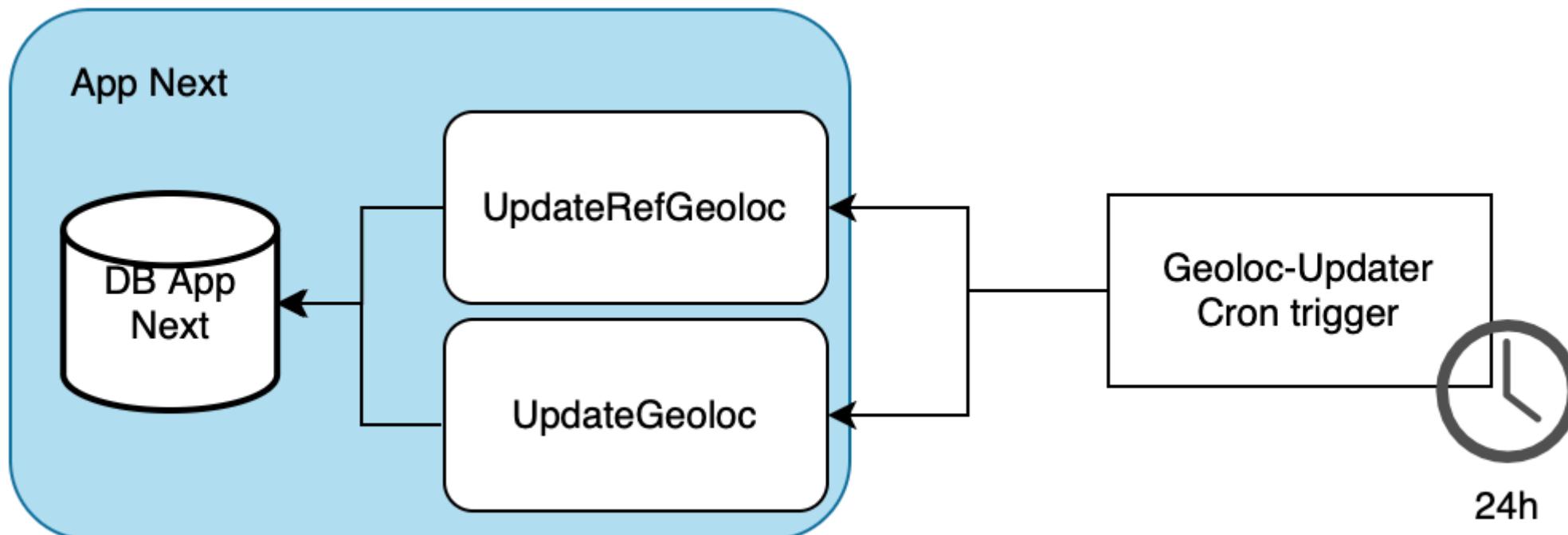
Retrieve the specific timezone from the database to calculate the local current date to routing the request well



THE NEW SITE GAP (GEOLOC UPDATER)

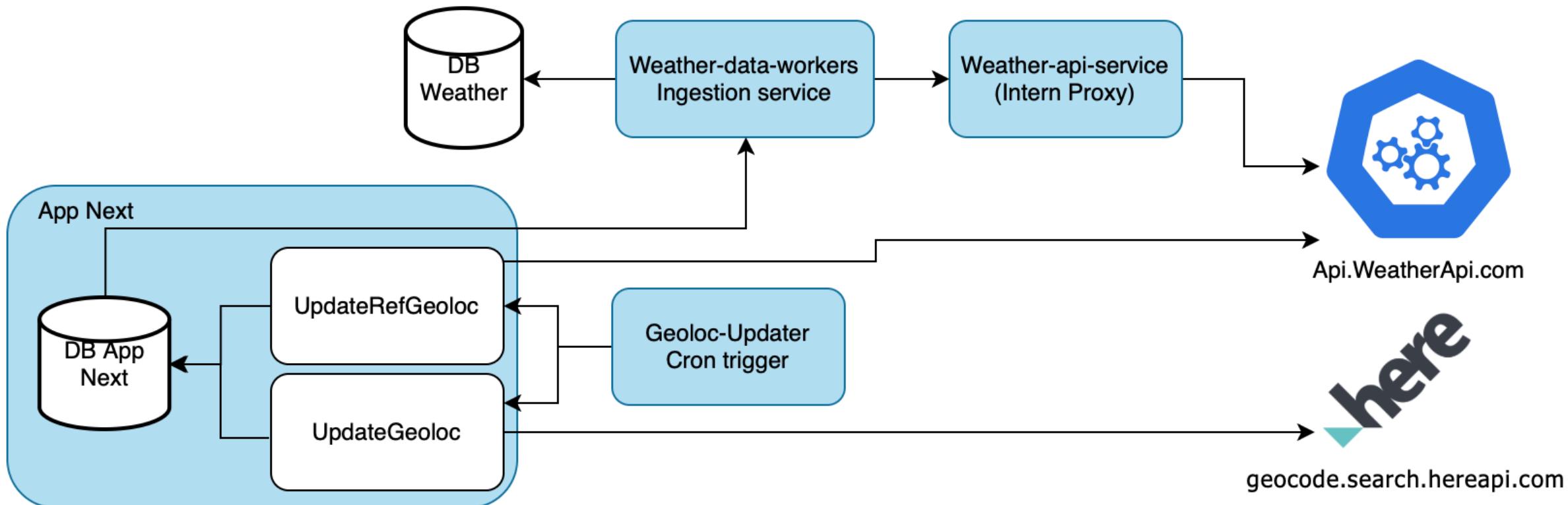
Problem : New client's sites added to the app didn't have GPS coordinates yet, so the worker ignored them.

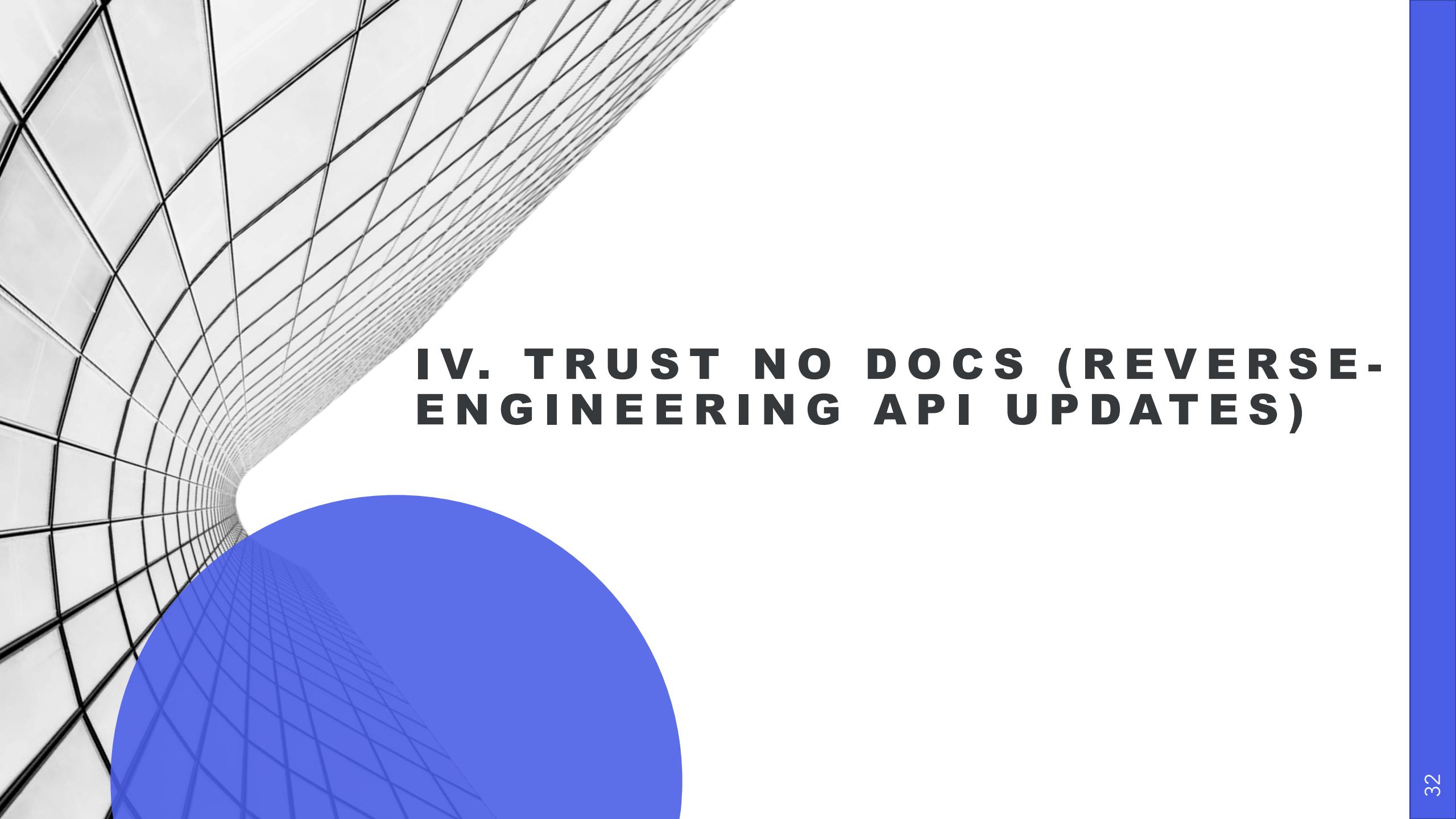
Solution : Runs a daily cron trigger to populate coordinates on new sites.



PAUSE ON THE ARCHITECTURE 2

Updated architecture showing the new ingestion services and the existing database.



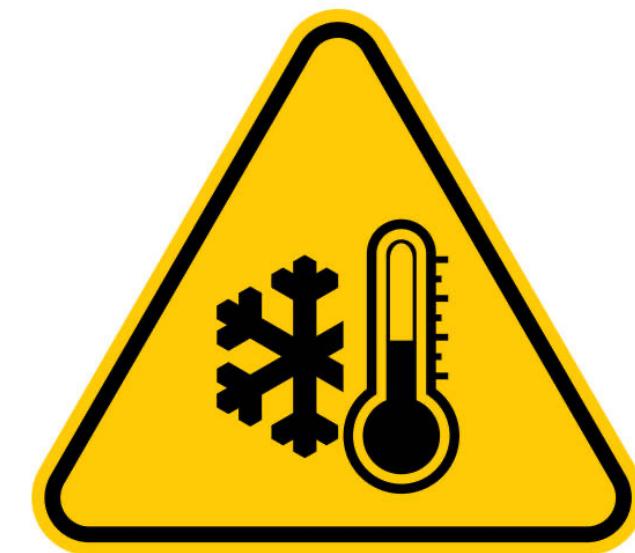


IV. TRUST NO DOCS (REVERSE-ENGINEERING API UPDATES)

WE HAVE HISTORY AND AFTER ?

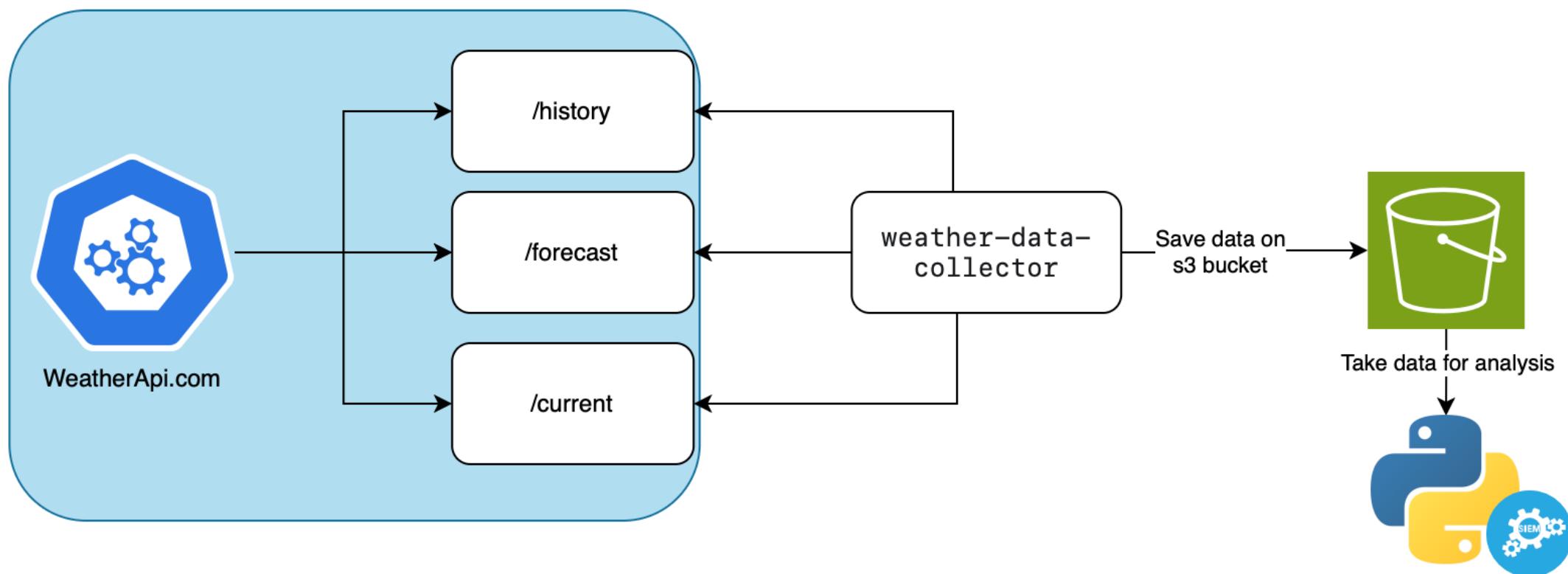
Historical data integration is complete.

We have now to integrate Live and Forecast data to extend the dashboard curves and help clients anticipate critical weather risks like frost.

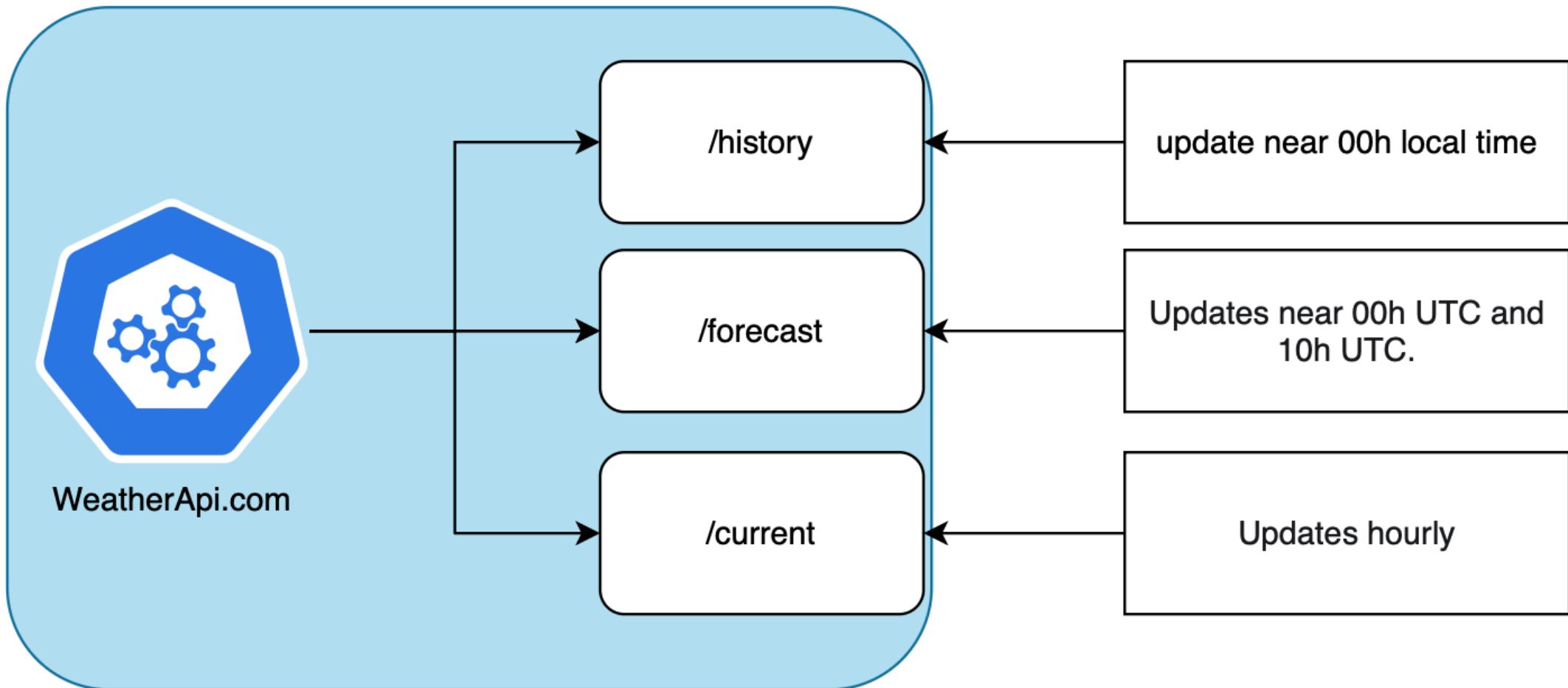


WHEN EXACTLY DOES THE API UPDATE ITS FORECAST VS LIVE VS HISTORY DATA?

Solution: Create a temporary Go service to save raw API responses from each endpoint to a S3 bucket storage, hourly for 72 hours across 4 sites in Canada. After perform data analysis.

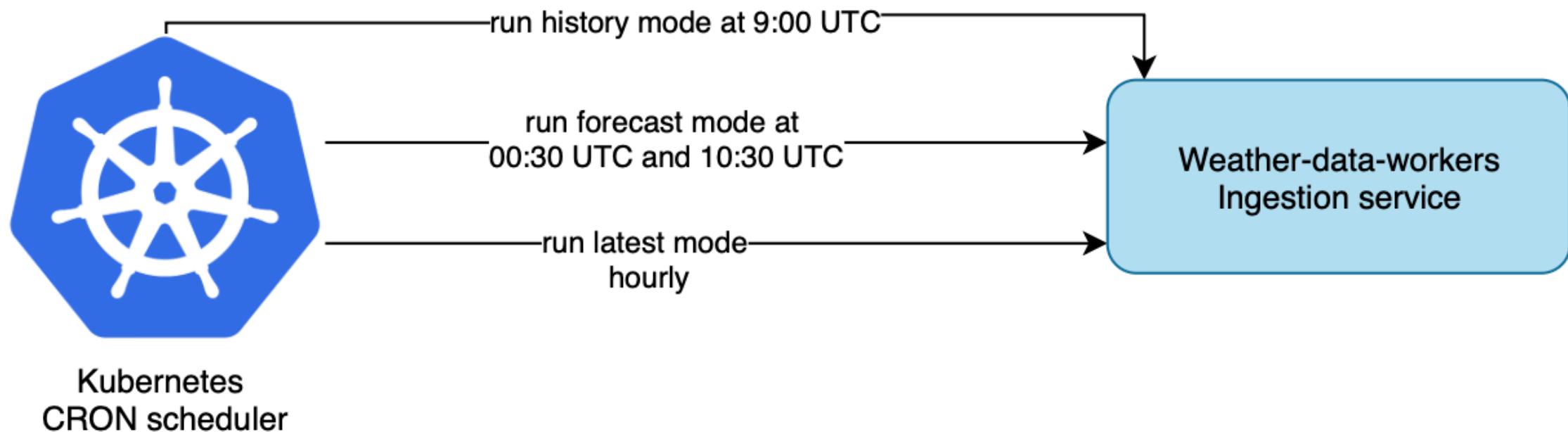


DATA ANALYSIS RESULT



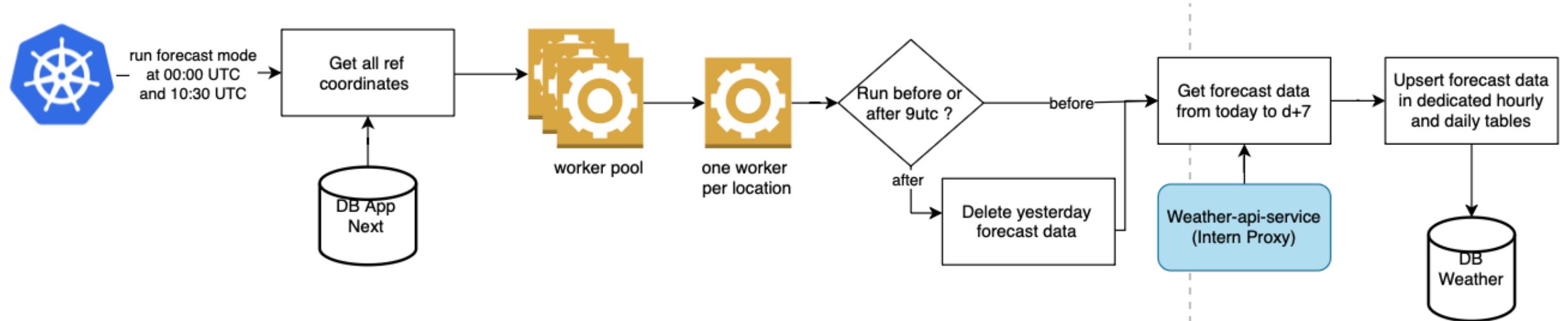
MODIFY WEATHER-DATA WORKERS TO HANDLE CURRENT AND FORECAST DATA

Modify Kubernetes configuration scripts to run the same ingestion app, but with different schedules and environment variables.



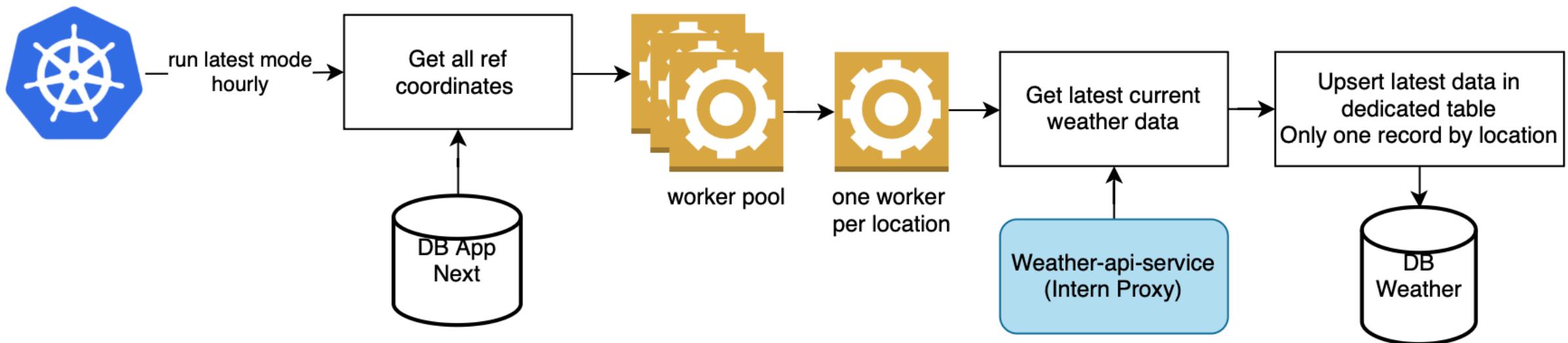
THE FORECAST LOGIC

Similar process than history mode



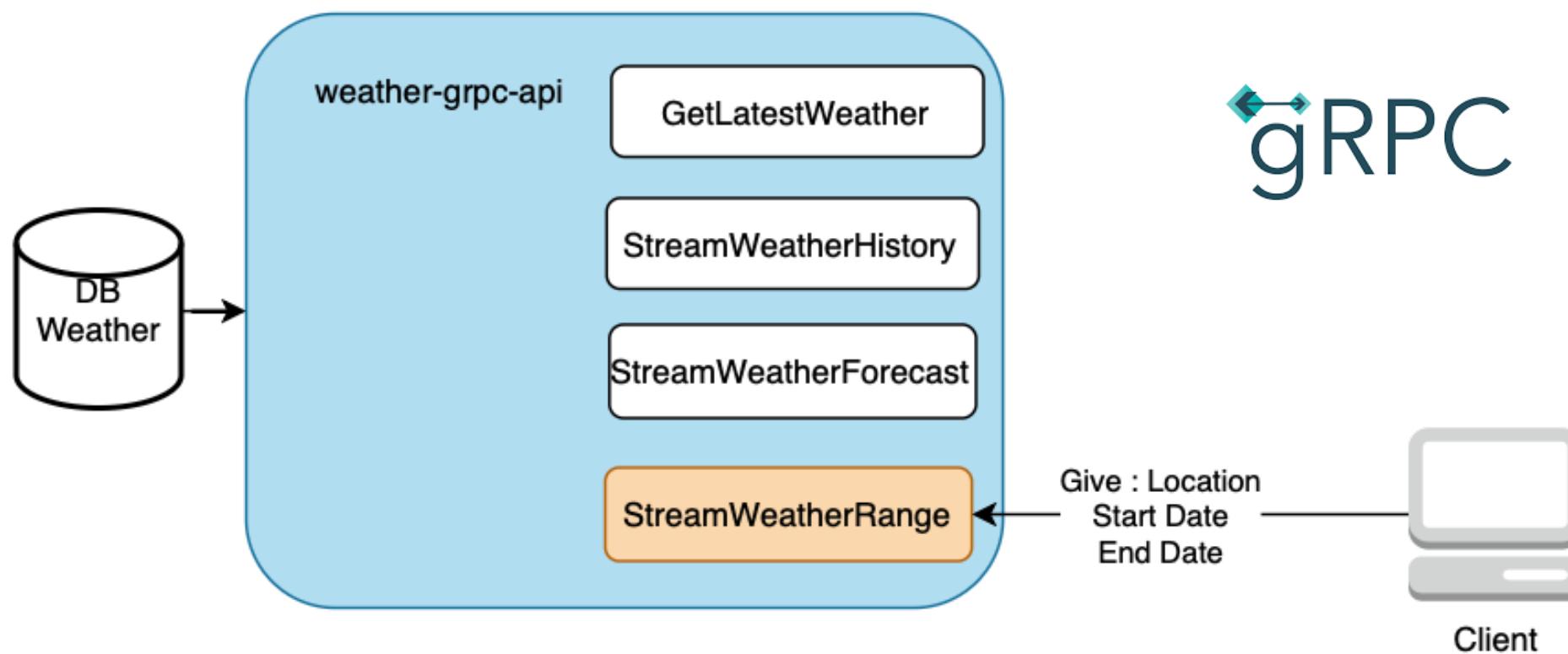
THE LATEST LOGIC

To enable instant refreshes, keep only the most recent forecast per location



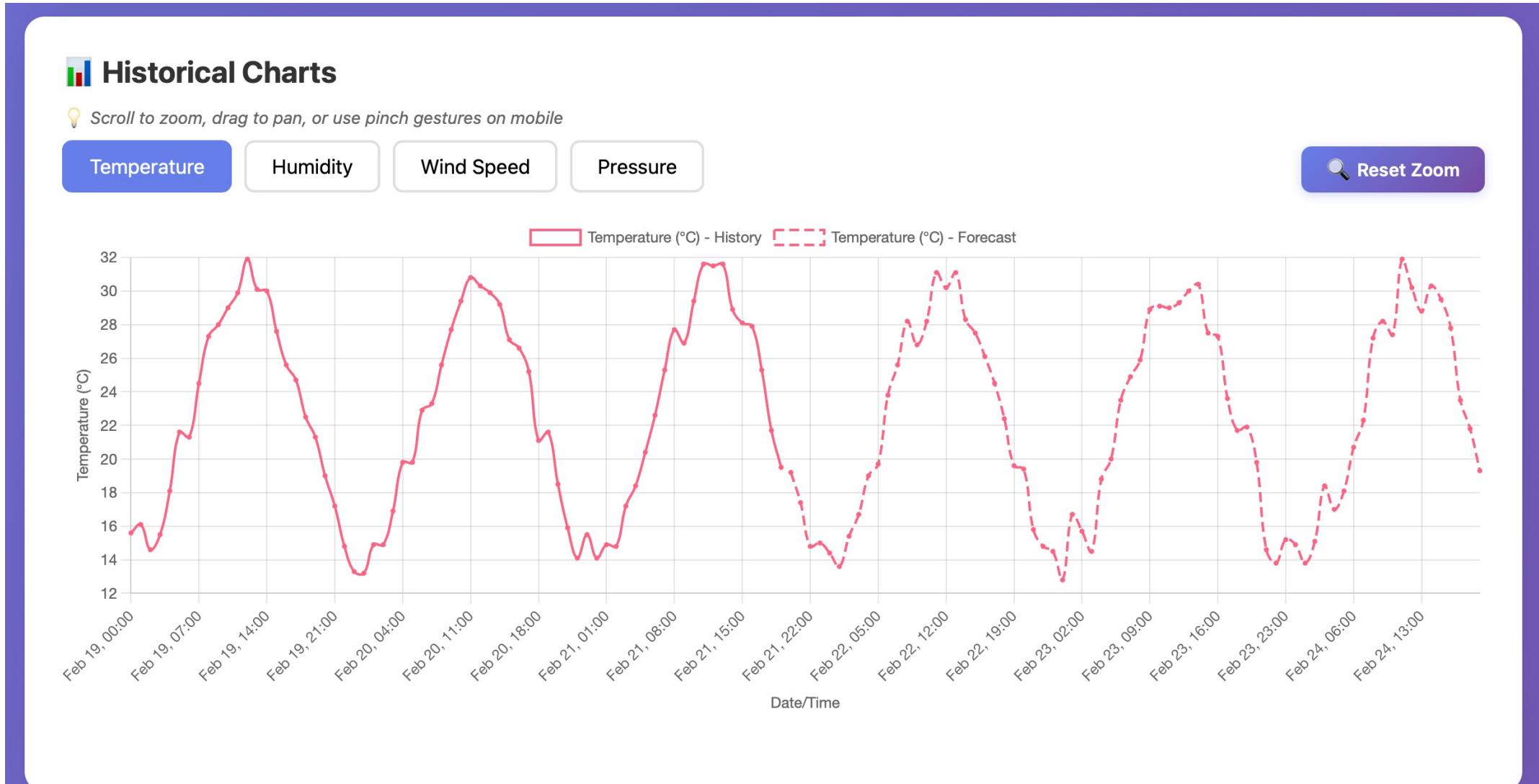
HOW TO DELIVER DATA FROM WEATHER DB TO THE CLIENT EFFICIENTLY ?

Using gRPC : typed contracts (Protobuf) and HTTP/2 Streaming to deliver large history datasets.



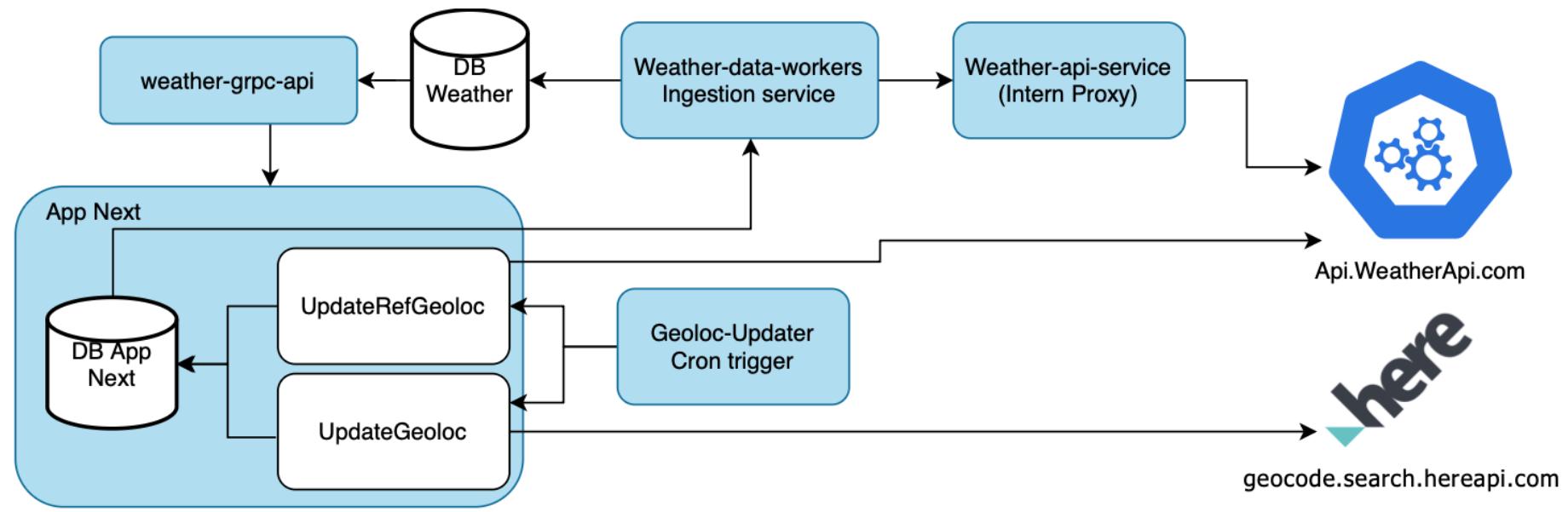
HISTORY AND FORECAST VISUALIZATION

AI client to visualize data from GRPC API

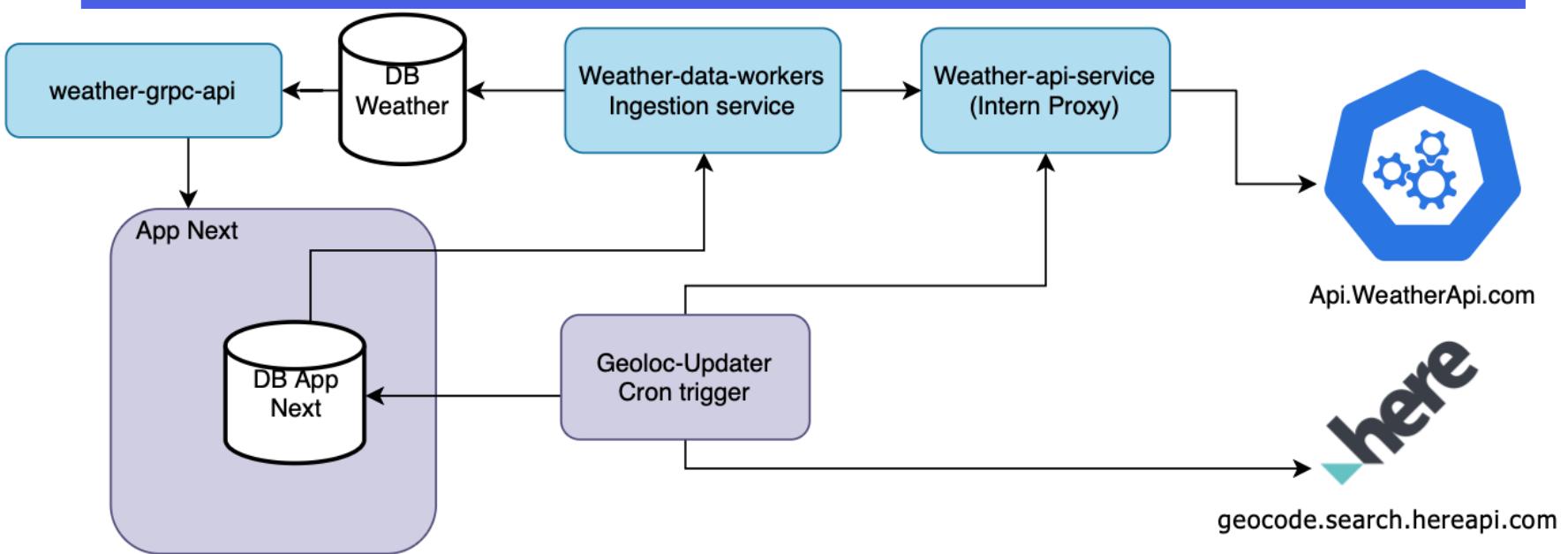


CURRENT ARCHITECTURE & FUTURE STEPS

Current
Architecture :



Proposal of Future
architecture :



LESSONS LEARNED

Never trust raw locations
(Think in Grids)



Temporal Decoupling



Trust data, not documentation



THANKS FOR YOUR ATTENTION !

ANY QUESTIONS ?

Feel free to reach me :

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Linkedin :



Speech Evaluation form :

