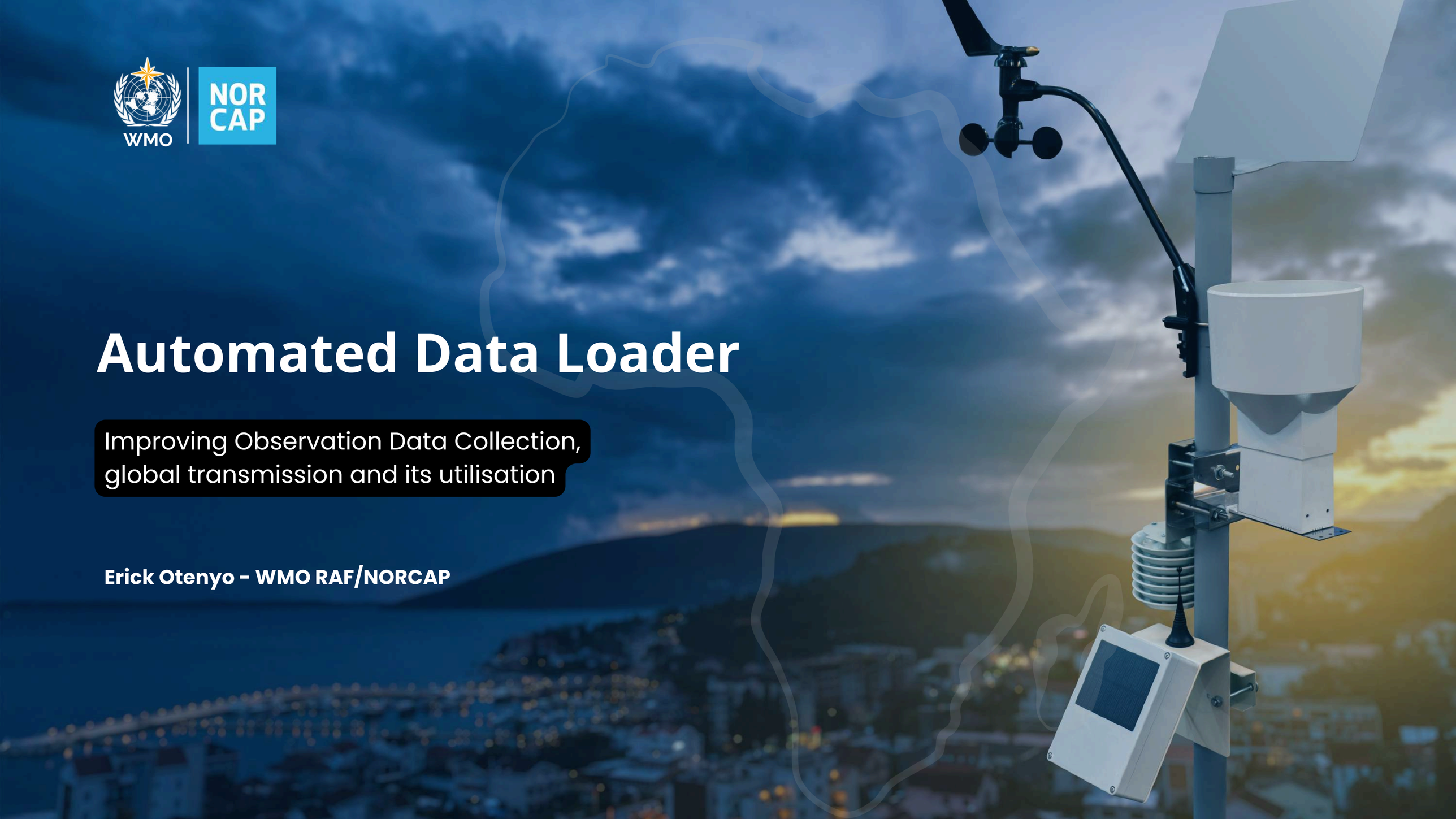
Automated Data Loader

Improving Observation Data Collection, global transmission and its utilisation

Erick Otenyo - WMO RAF/NORCAP



Grace Amondi

Geo Developer

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Stella Ndagire

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Innovation and Climate Services Expert

Abubakr Babiker

Infrastructure Coordinator

Strengthening the **Digital transformation** of the National Meteorological and Hydrological Services in Africa

WORLD METEOROLOGICAL ORGANIZATION

NOR CAP

PART OF NORWEGIAN REFUGEE COUNCIL

Stepwise Approach

Areas of support

A stepwise approach was adopted to solve challenges and capacity gaps of NMHSs in data transmission and service delivery.

Focal Points Verification & Update
OSCAR Surface, WIGOS, WDQMS, WIS2, CAP

OSCAR Surface Station Metadata Update

Data transmission Challenges
Identify and resolve data transmission challenges

Website & Content Management System

CAP Activation and Dissemination
Identify and address CAP Activation and Dissemination challenges

Social Media, Email Marketing and User Management systems

Co-development of Open Source Software Solutions with public institutions

Climweb

Open-source software designed to empower climate and environmental institutions to deliver impactful services.

ClimWeb is an innovative platform built on free and open-source standards, featuring a modern design, seamless marketing integrations, an intuitive weather warnings publisher (in CAP format), and advanced tools for visualizing weather, climate, and environmental data.

CAP Composer

Modern, user-friendly CAP Alert publisher

A comprehensive solution designed to support Alerting Institutions in seamlessly issuing and communicating CAP alerts across multiple channels, developed to enhance the adoption and effectiveness of the CAP standard.

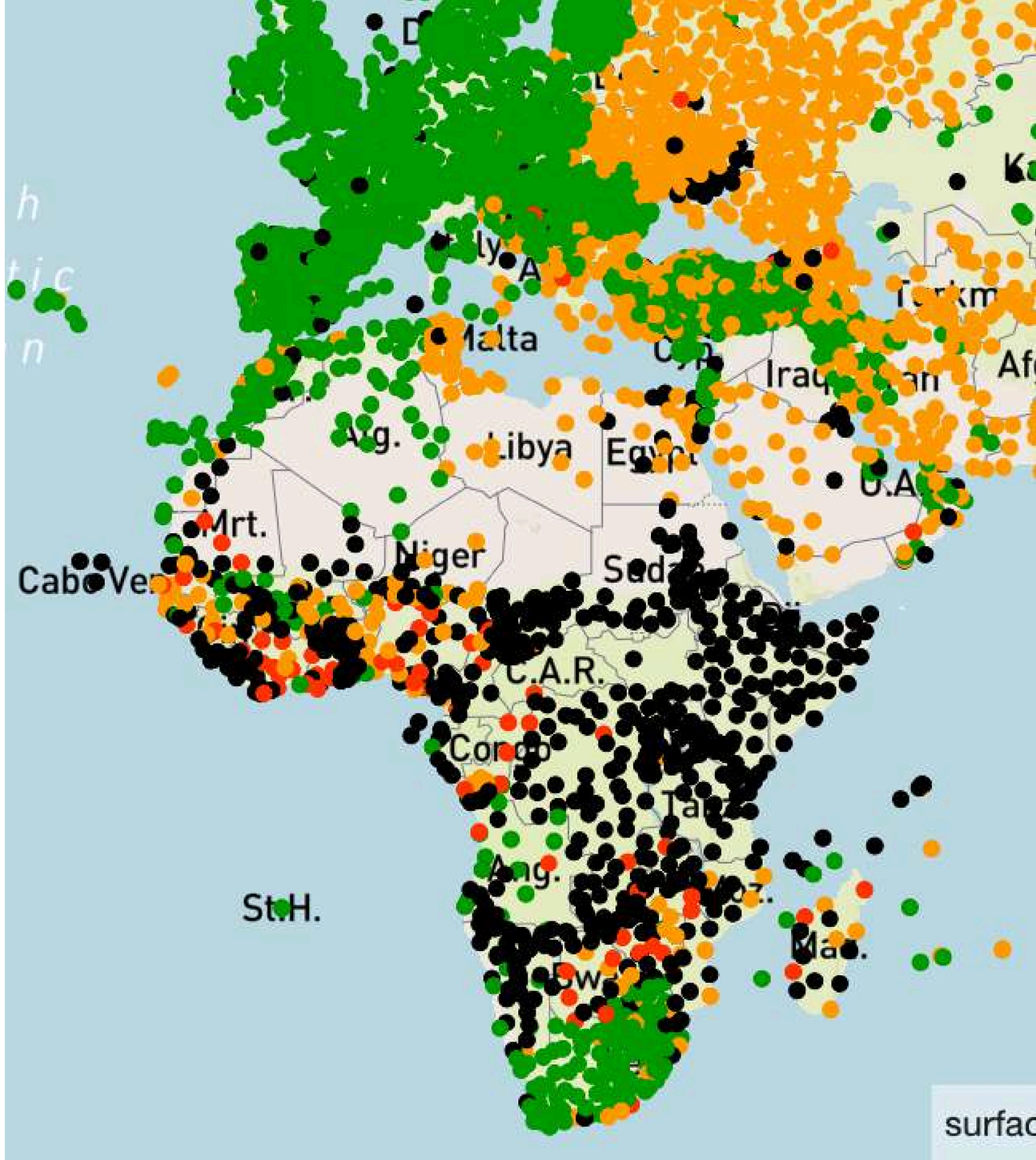
Automated Data Loader

Automating periodic Observation data ingestion into WIS2Box node

WIS2Box Automated Data Loader (ADL) is a plugin based system that defines an architecture for implementing wis2box data loaders for different AWS vendors.

Challenges

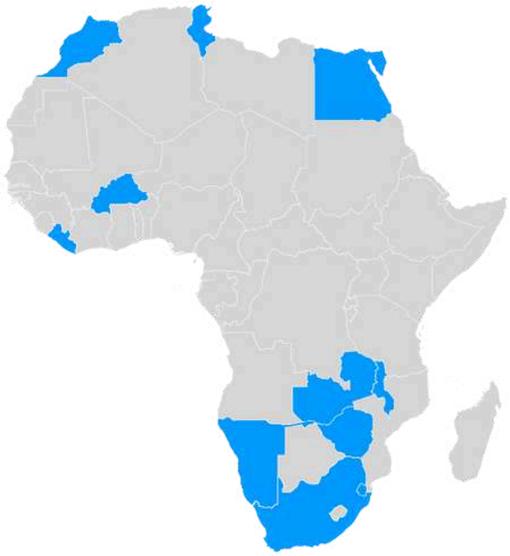
- A cocktail of **different Automatic Weather Stations vendors** with incompatible software solutions in each country
- Very **few AWS** in Africa are currently s**ending data** internationally
- **Stations not logged-in in global database** to log in station metadata (OSCAR surface), **stations not “marked” to send data internationally (GBON),** F**ocal Points not updated, software incompatibility** problems (different vendors), i**nternet connectivity** of stations, **maintenance issues**

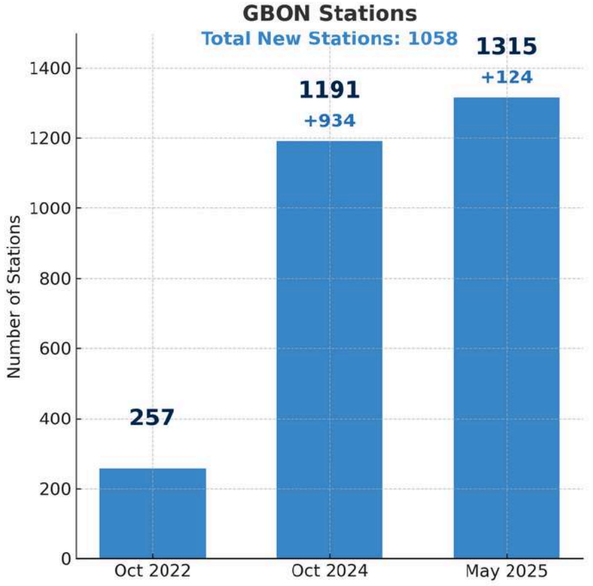


Increase in listing Stations on OSCAR

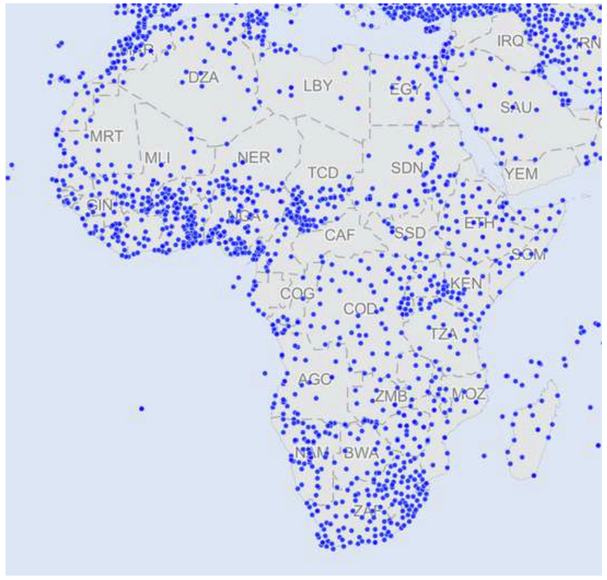
January 2025

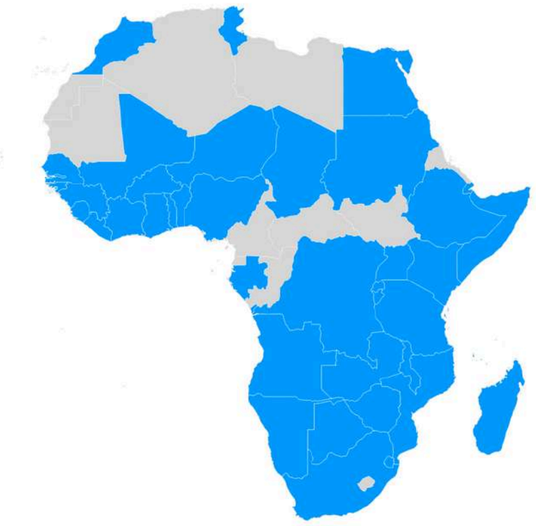
January 2023

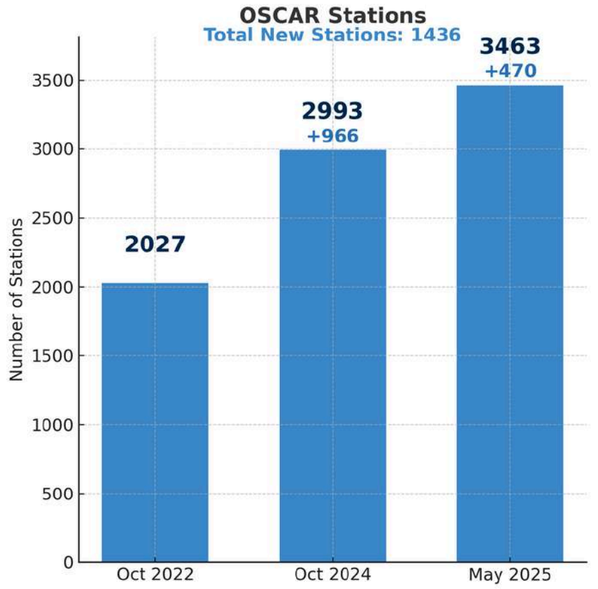




May 2025



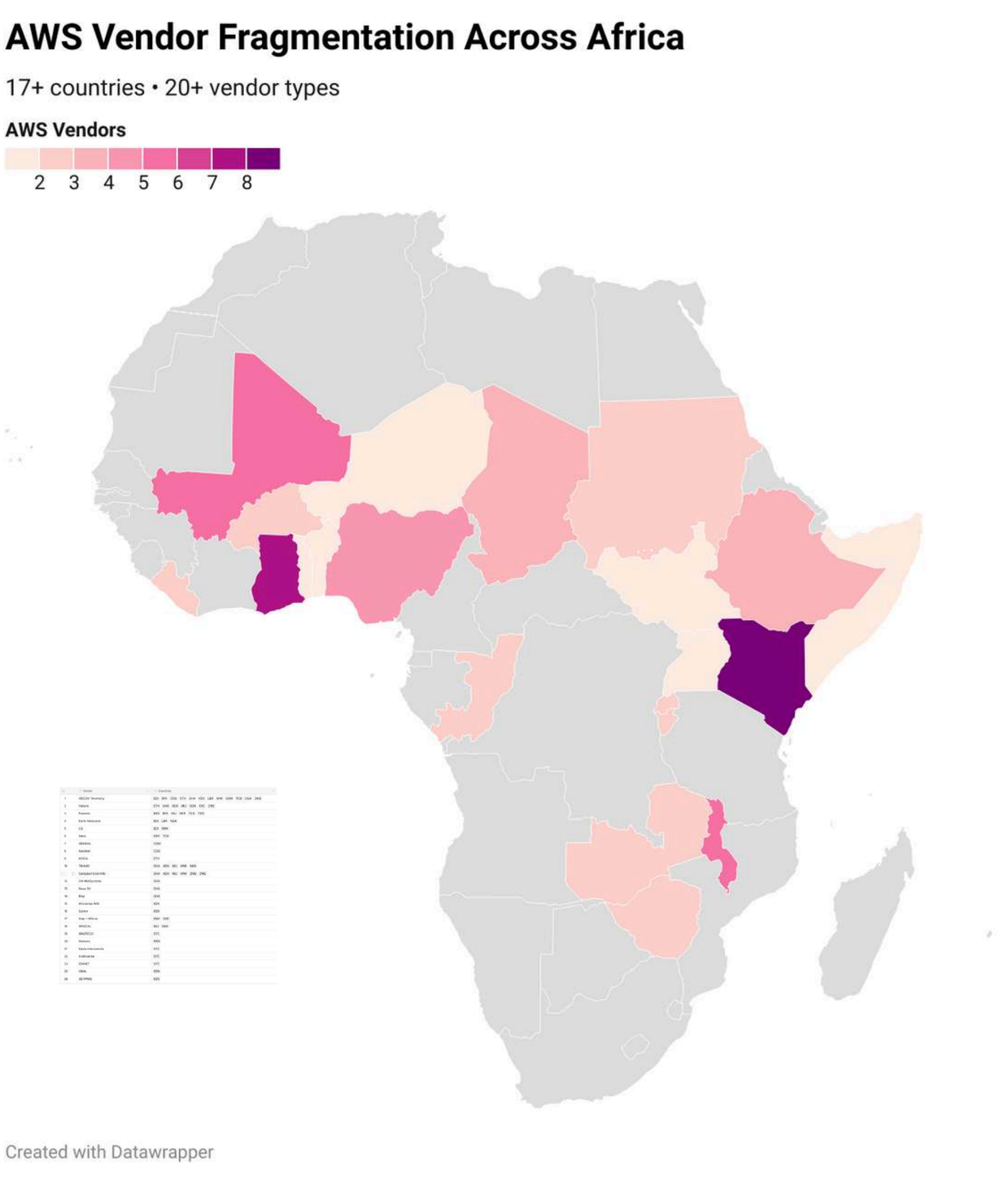




Africa's Weather Data Infrastructure is Fragmented

- ✔ National Meteorological Services across Africa operate networks of **automatic weather stations from different vendors**, deployed through various donor projects over the years.

- ✔ Each vendor has its **own way of storing and transmitting data.**



WORLD METEOROLOGICAL ORGANIZATION

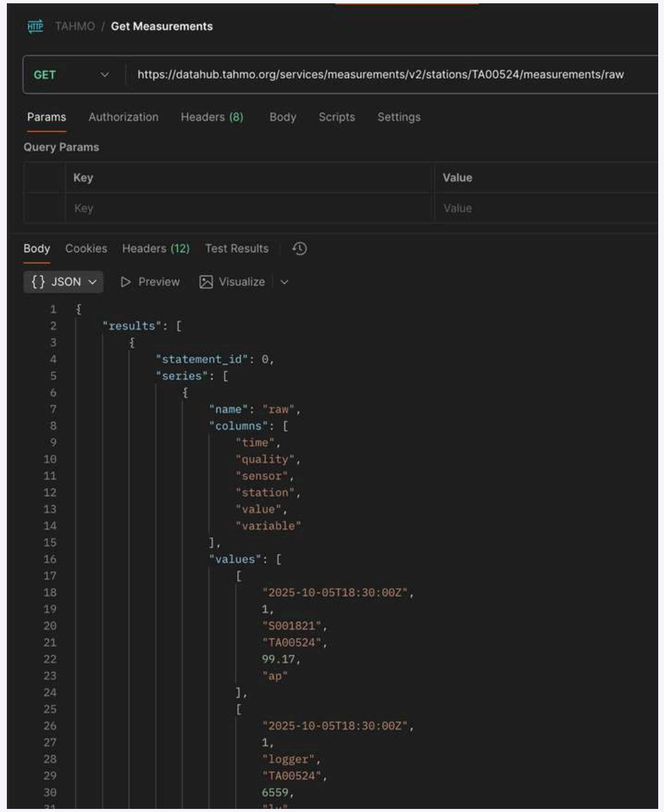
	Vendor	Countries
1	ADCON Telemetry	BDI BFA COG ETH GHA KEN LBR MWI SOM TCD UGA ZMB
2	Vaisala	ETH GHA KEN MLI SDN SYC ZWE
3	Pulsonic	BEN BFA MLI NER TCD TGO
4	Earth Networks	BDI LBR NGA
5	LSI	BDI RWA
6	Seba	KEN TCD
7	ADASSA	COM
8	Navimet	COG
9	KOICA	ETH
10	TAHMO	GHA KEN MLI MWI NGA
11	Campbell Scientific	GHA KEN MLI MWI ZMB ZWE
12	Ott MetSystems	GHA
13	Nesa Srl	GHA
14	Rika	GHA
15	Microstep-MSI	KEN
16	Sutron	KEN
17	Siap + Micros	MWI SSD
	WASCAL	MLI NGA
19	WAGTECH	SYC
20	Netsens	RWA
21	Davis Instruments	SYC
22	Intellisense	SYC
23	IOSNET	SYC
25	CIMA	SDN
26	3D PAWS	KEN
27	Degreane AWOS	KEN
28	Berani	NGA

Common AWS Vendors

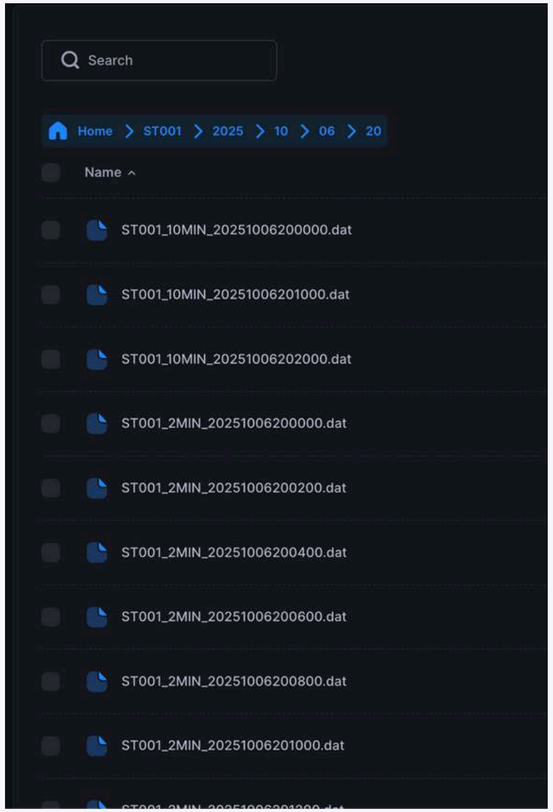
- Adcon Telemetry
- Vaisala
- Pulsonic
- TAHMO
- Campell Scientific
- ...

Same Data, Different Worlds

Different update frequencies **Different formats** **Different units** **Different timezones**



Remote REST API- TAHMO



FTP Server - Encoded records
SIAPS + Micros

TOA5	42724	CR800	42724	CR800.Std.32.05
TIMESTAMP	RECORD	StationID	LoggerSerialNumber	ProgramName
TS	RN			
		Smp	Smp	Smp
2025-09-22 16:00:00	32793	ST7_Uhuru_Chiefs_Camp	42724	CPU:TAHMO_ST7_Uhuru_Cl
2025-09-22 17:00:00	32794	ST7_Uhuru_Chiefs_Camp	42724	CPU:TAHMO_ST7_Uhuru_Cl
2025-09-22 18:00:00	32795	ST7_Uhuru_Chiefs_Camp	42724	CPU:TAHMO_ST7_Uhuru_Cl
2025-09-22 19:00:00	32796	ST7_Uhuru_Chiefs_Camp	42724	CPU:TAHMO_ST7_Uhuru_Cl
2025-09-22 20:00:00	32797	ST7_Uhuru_Chiefs_Camp	42724	CPU:TAHMO_ST7_Uhuru_Cl
2025-09-23 05:00:00	32798	ST7_Uhuru_Chiefs_Camp	42724	CPU:TAHMO_ST7_Uhuru_Cl
2025-09-23 06:00:00	32799	ST7_Uhuru_Chiefs_Camp	42724	CPU:TAHMO_ST7_Uhuru_Cl
2025-09-23 07:00:00	32800	ST7_Uhuru_Chiefs_Camp	42724	CPU:TAHMO_ST7_Uhuru_Cl
2025-09-23 08:00:00	32801	ST7_Uhuru_Chiefs_Camp	42724	CPU:TAHMO_ST7_Uhuru_Cl
2025-09-23 09:00:00	32802	ST7_Uhuru_Chiefs_Camp	42724	CPU:TAHMO_ST7_Uhuru_Cl
2025-09-23 10:00:00	32803	ST7_Uhuru_Chiefs_Camp	42724	CPU:TAHMO_ST7_Uhuru_Cl
2025-09-23 11:00:00	32804	ST7_Uhuru_Chiefs_Camp	42724	CPU:TAHMO_ST7_Uhuru_Cl
2025-09-23 12:00:00	32805	ST7_Uhuru_Chiefs_Camp	42724	CPU:TAHMO_ST7_Uhuru_Cl

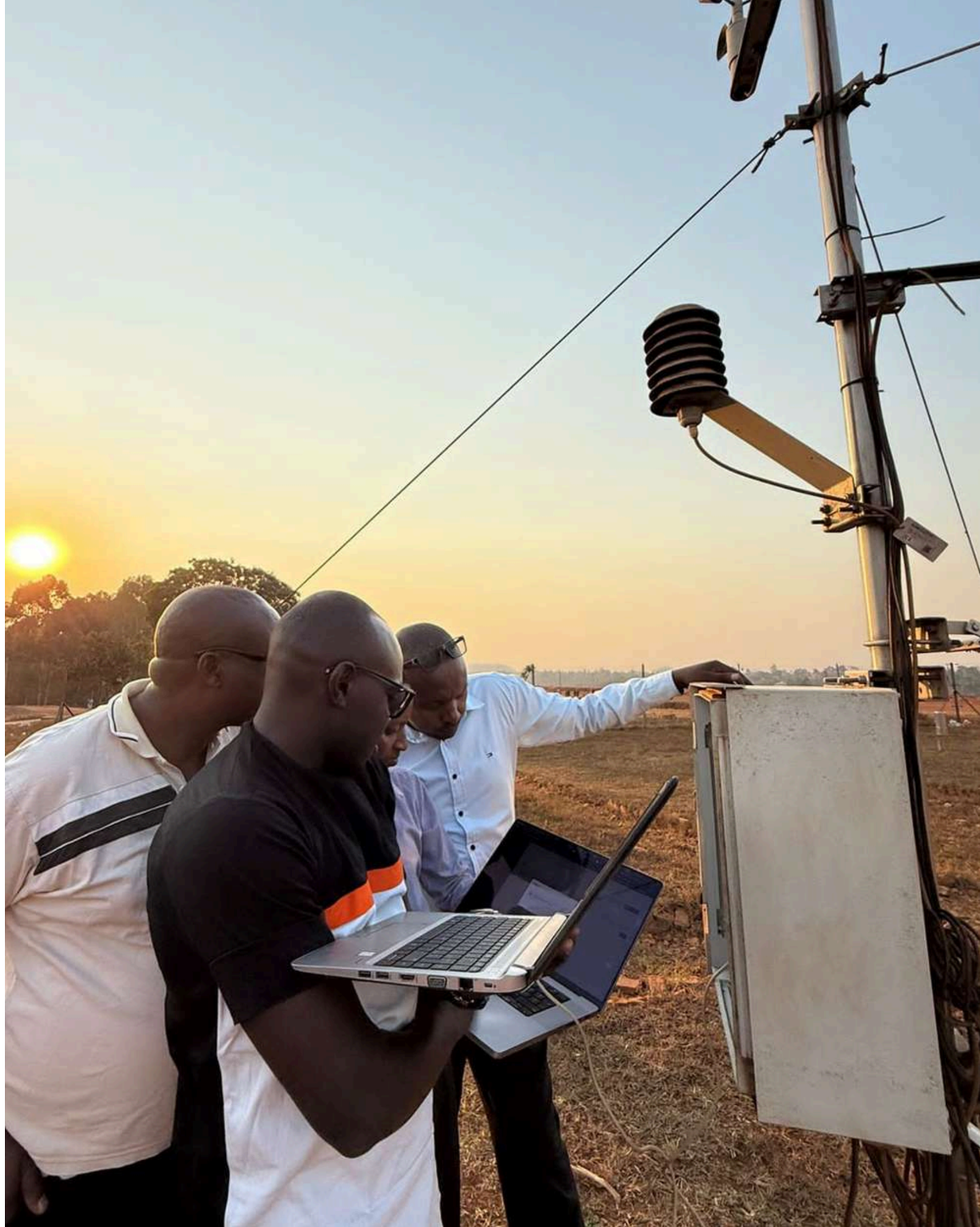
Custom CSV Files - Cambell TOA5 Format

WORLD METEOROLOGICAL ORGANIZATION

Why This Matters

The Problem

- Meteorologists spend hours on manual data wrangling
- Isolated national systems
- Difficult to share data globally for forecasting
- Delayed weather warnings



WORLD METEOROLOGICAL ORGANIZATION

Why This Matters

The Technical Burden

- Custom scripts for each vendor
- Timezone conversions by hand
- Unit conversions prone to errors
- No automation = No real-time data

Countries with limited technical capacity struggle most.
They need weather data for forecasts and early warnings,
but spend resources just getting the data into a usable format.

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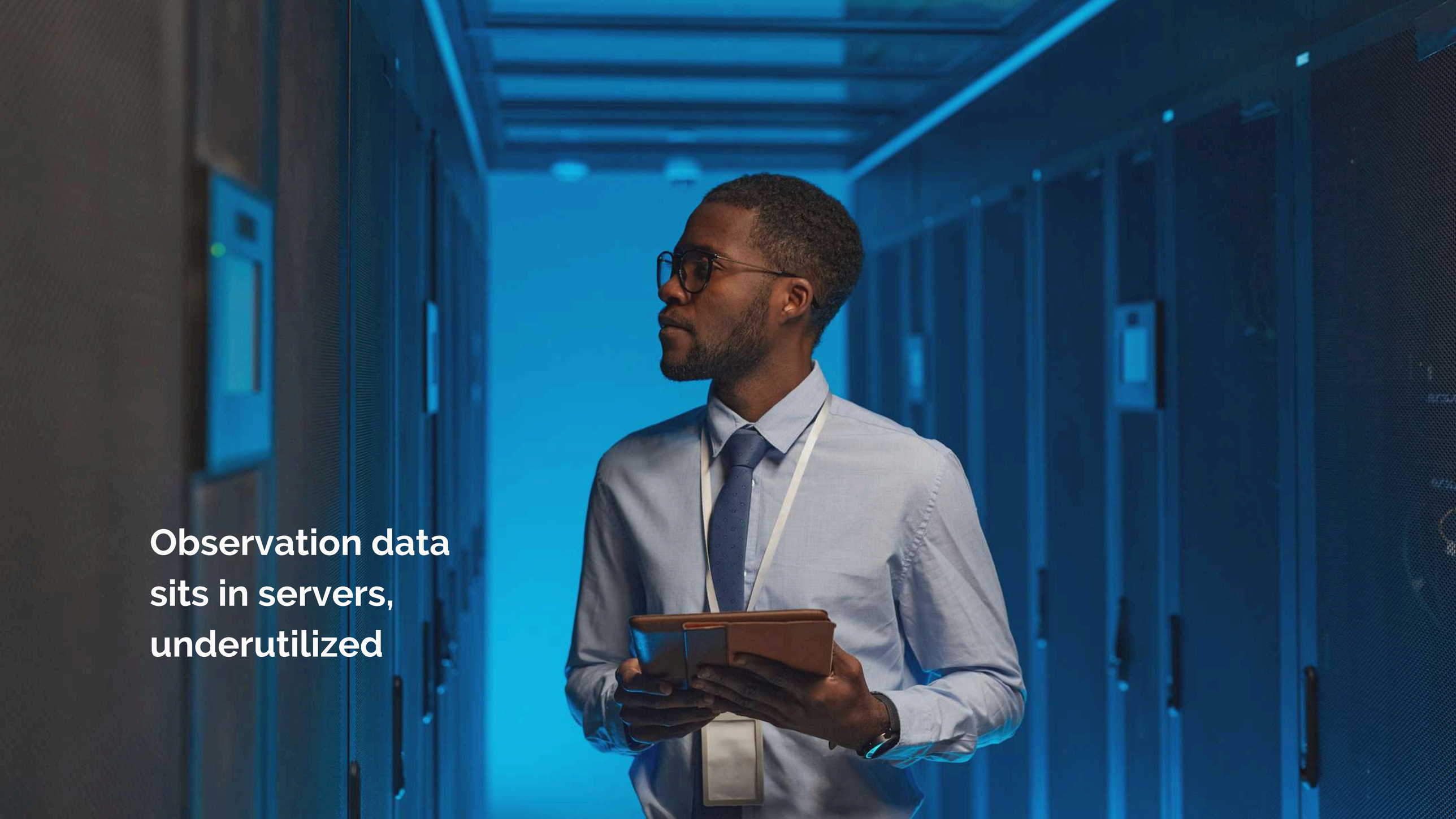
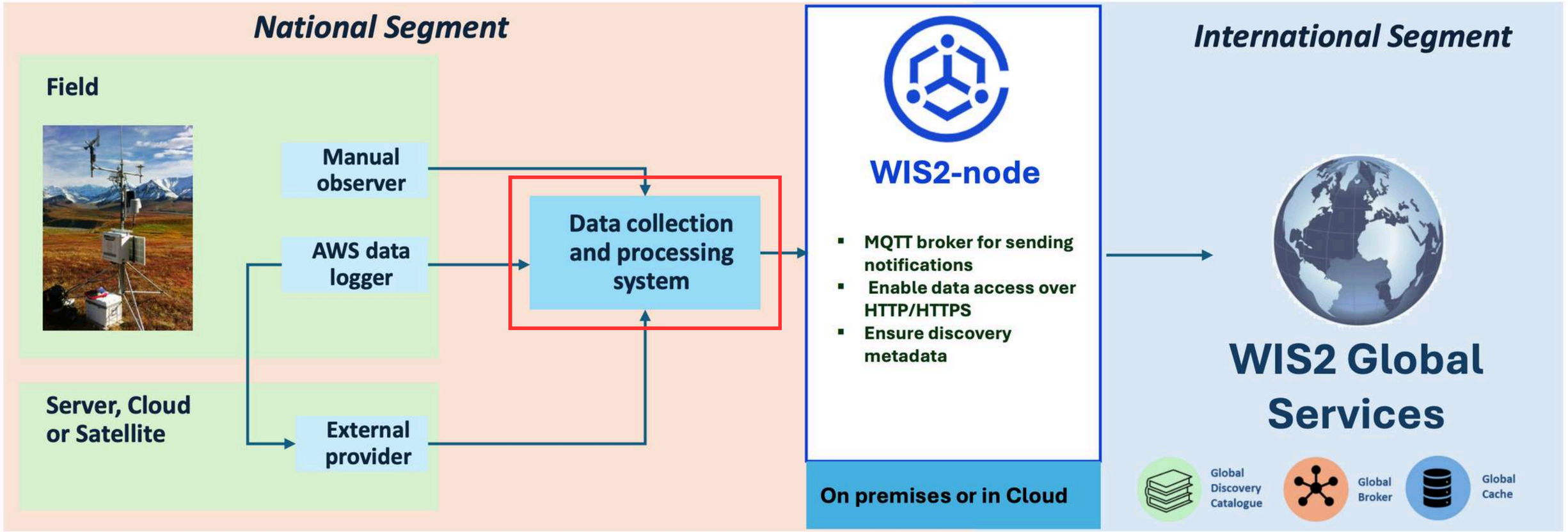


Observation data sits in servers, underutilized

Role of a Data Collection and Processing System

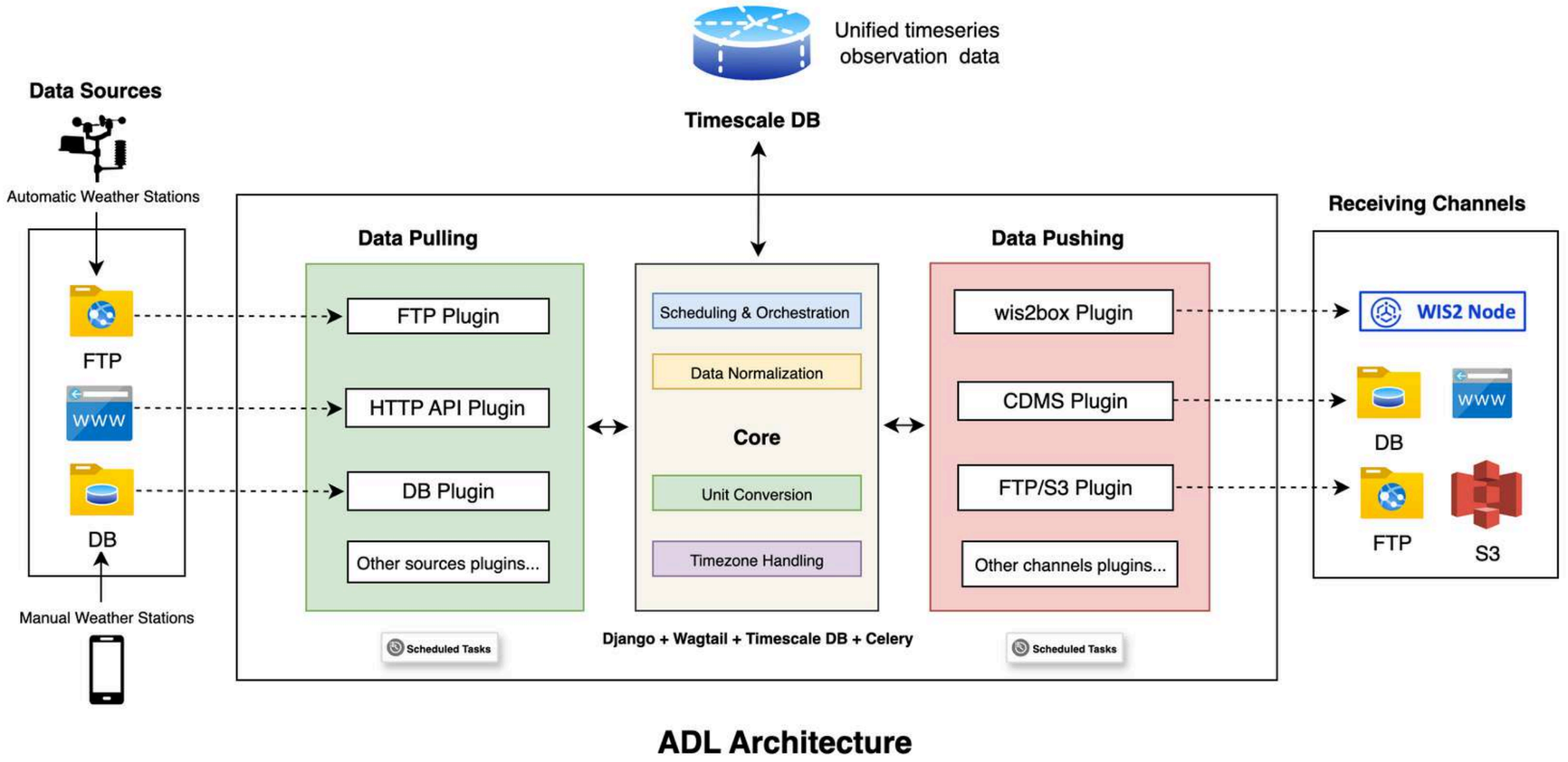
WIS2 Node as a gateway between National MET systems and the WIS 2.0 Network



A data collection and processing system ensures a WIS2-node gets the data

ADL: The Automated Data Loader

The Solution



ADL Architecture

Plugins: Vendor-specific adapters

Core: Django + Wagtail admin + TimescaleDB

Dispatch: WIS2, FTP, APIs, S3, databases

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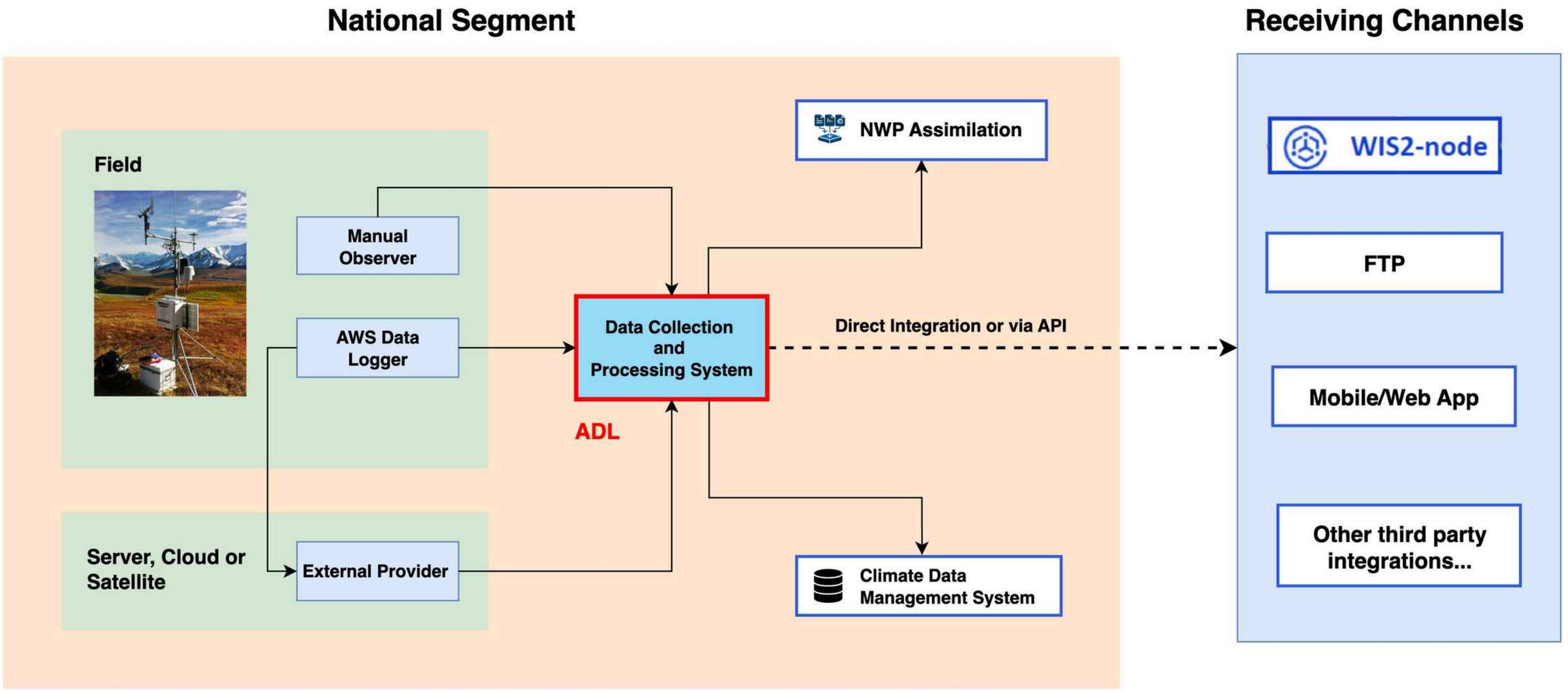


ADL as a Data Collection and Processing System

Technology Stack - Open Source

Component	Technology	Purpose
Web Framework	Django, Wagtail	Core backend and customizable admin interface - Python
Database	PostgreSQL, TimescaleDB	Relational DB with time-series support
Tasks & Background Jobs	Celery, Redis	Asynchronous task queue and message broker
Plugins	Django/Wagtail apps with Wagtail Hooks	Modular extension system
Web Server	Nginx	Static file serving and reverse proxy
Containerization	Docker, Docker Compose	Environment setup and service orchestration

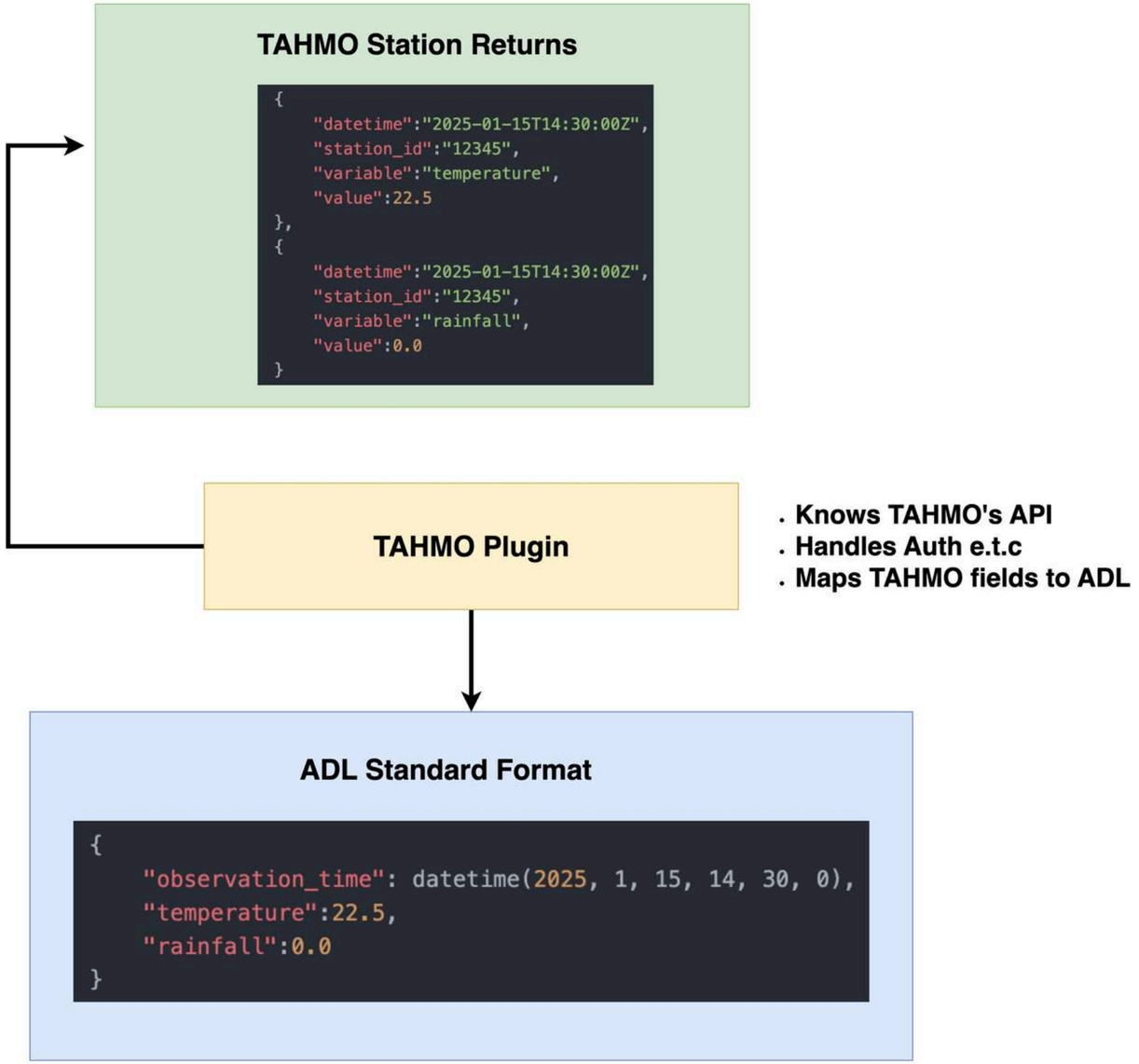
ADL on Github

github.com/wmo-raf/adl

https://adl-tool.readthedocs.io/en/latest/technology.html

AWS Vendor Plugins: One Job, Done Well

- **Each plugin knows ONE vendor** (TAHMO, ADCON, Campbell...)
- **Core knows ALL plugins** through a registry
- **Result**: Add new vendors without changing core code



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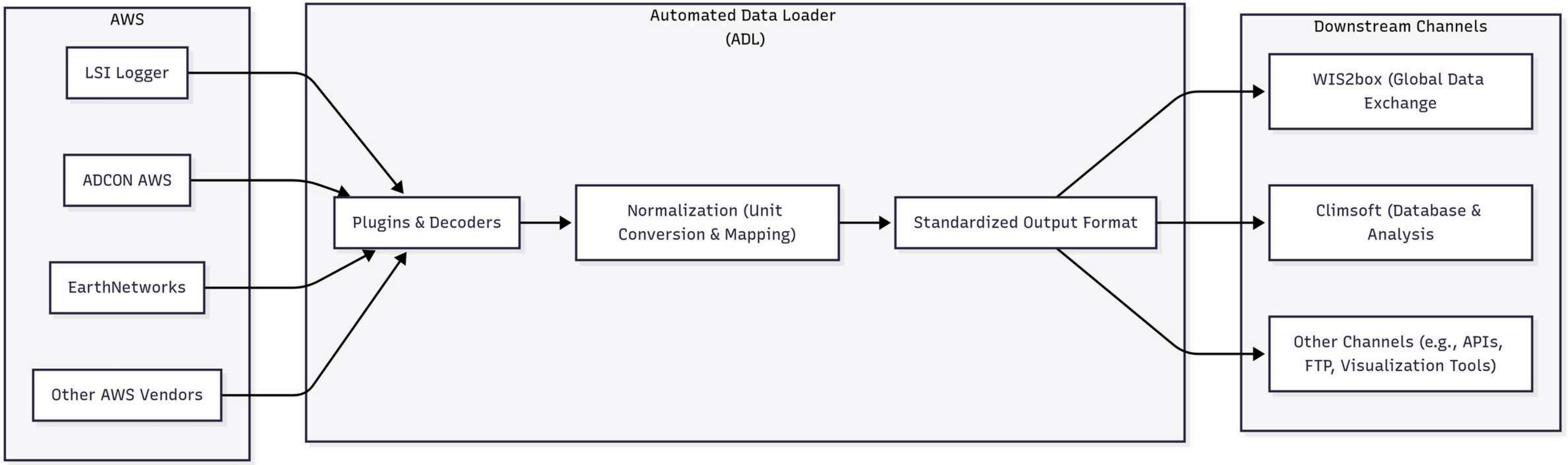
OBSERVATION DATA FLOW WITH ADL

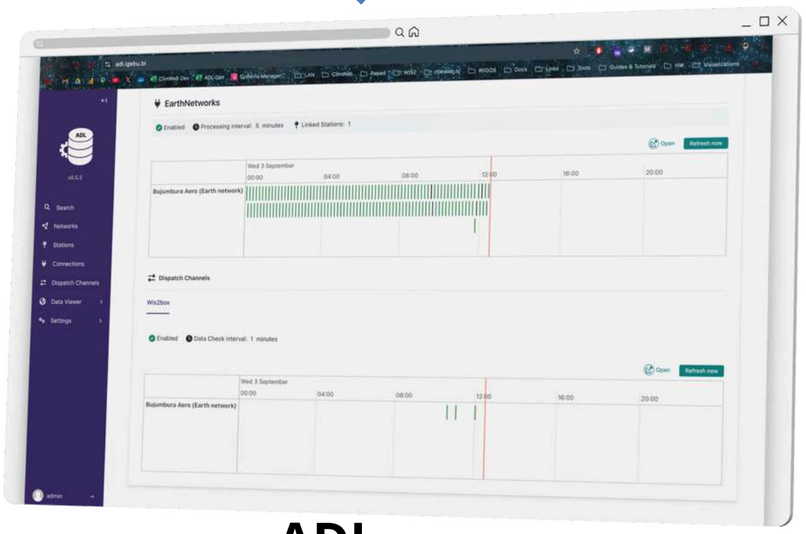


Sample Data Flow for Burundi - From stations to use in Global Forecastion

AWS

SERVER

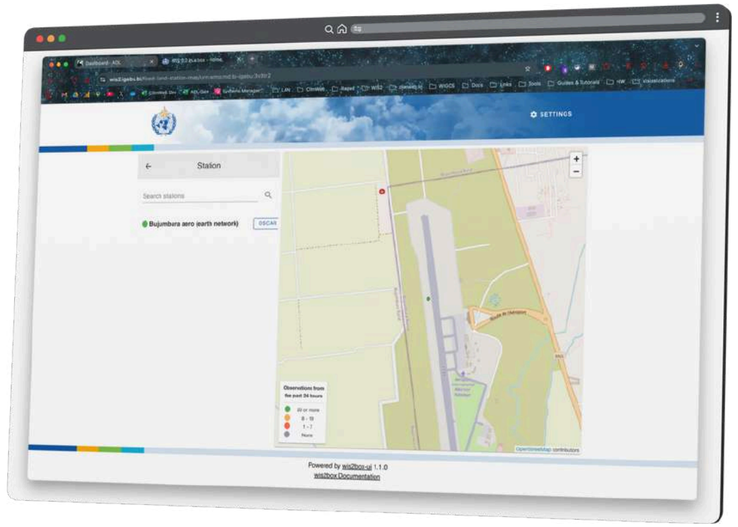
FORECASTING



ADL

Data Processing and Collection System

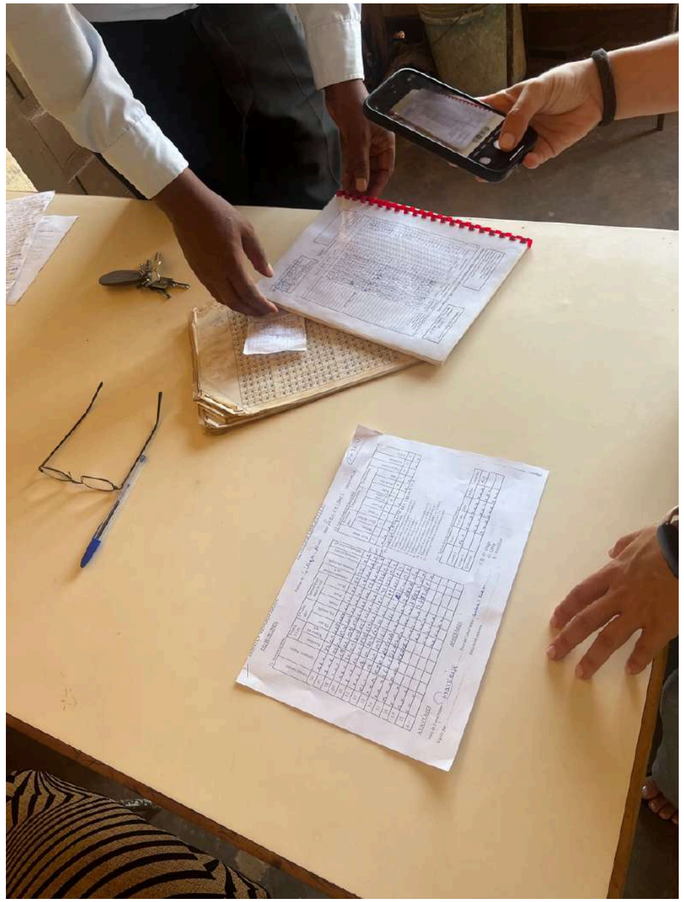
https://adl.igebu.bi



WIS2box

https://wis2.igebu.bi

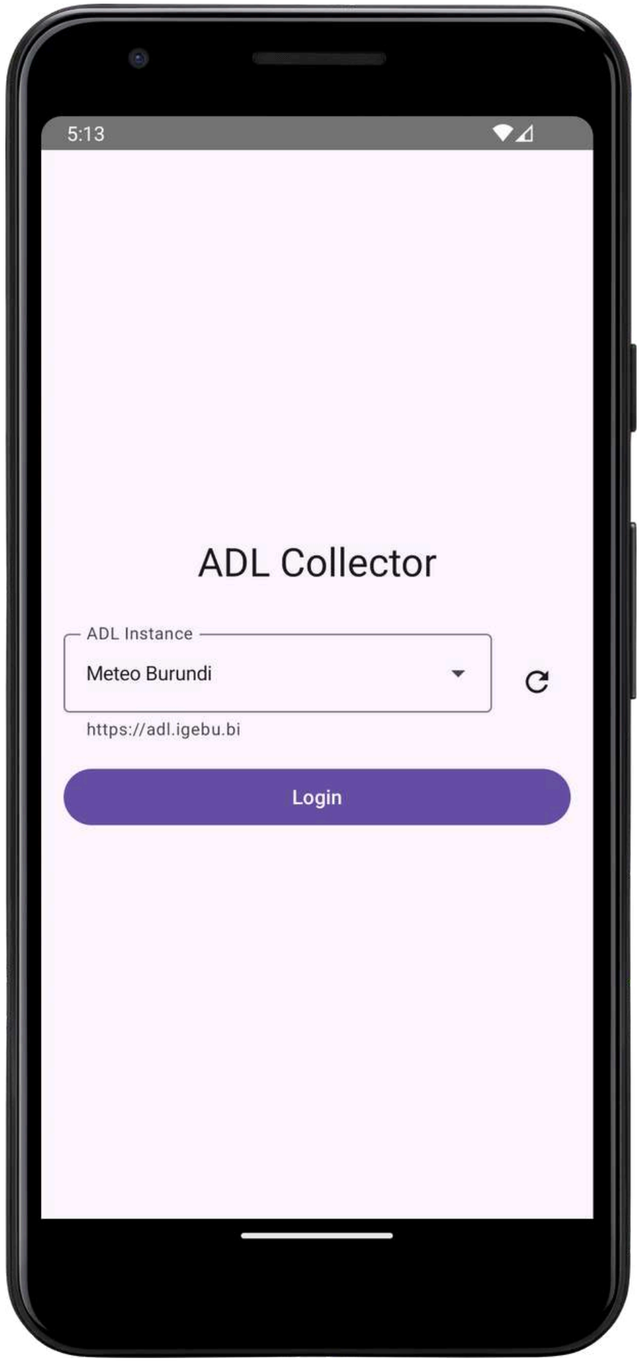
Current Data Collection from Manual Stations



Burundi

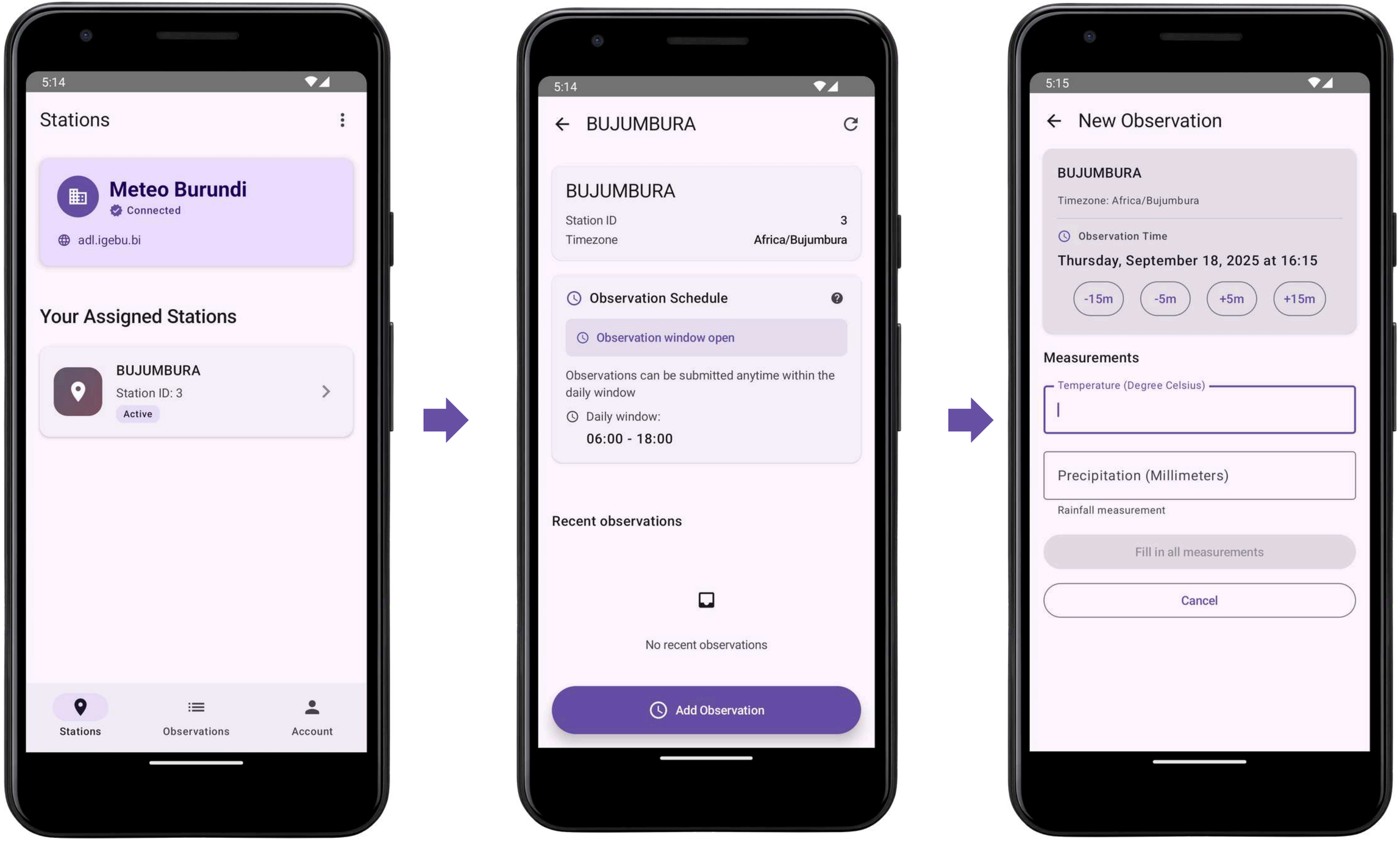
DRC

- Observers use different ways to collect and send data
- Some completely manual, others semi-digital
- But still someone has to take the records and manually enter into digital systems like wis2box, CDMS (Climsoft etc)

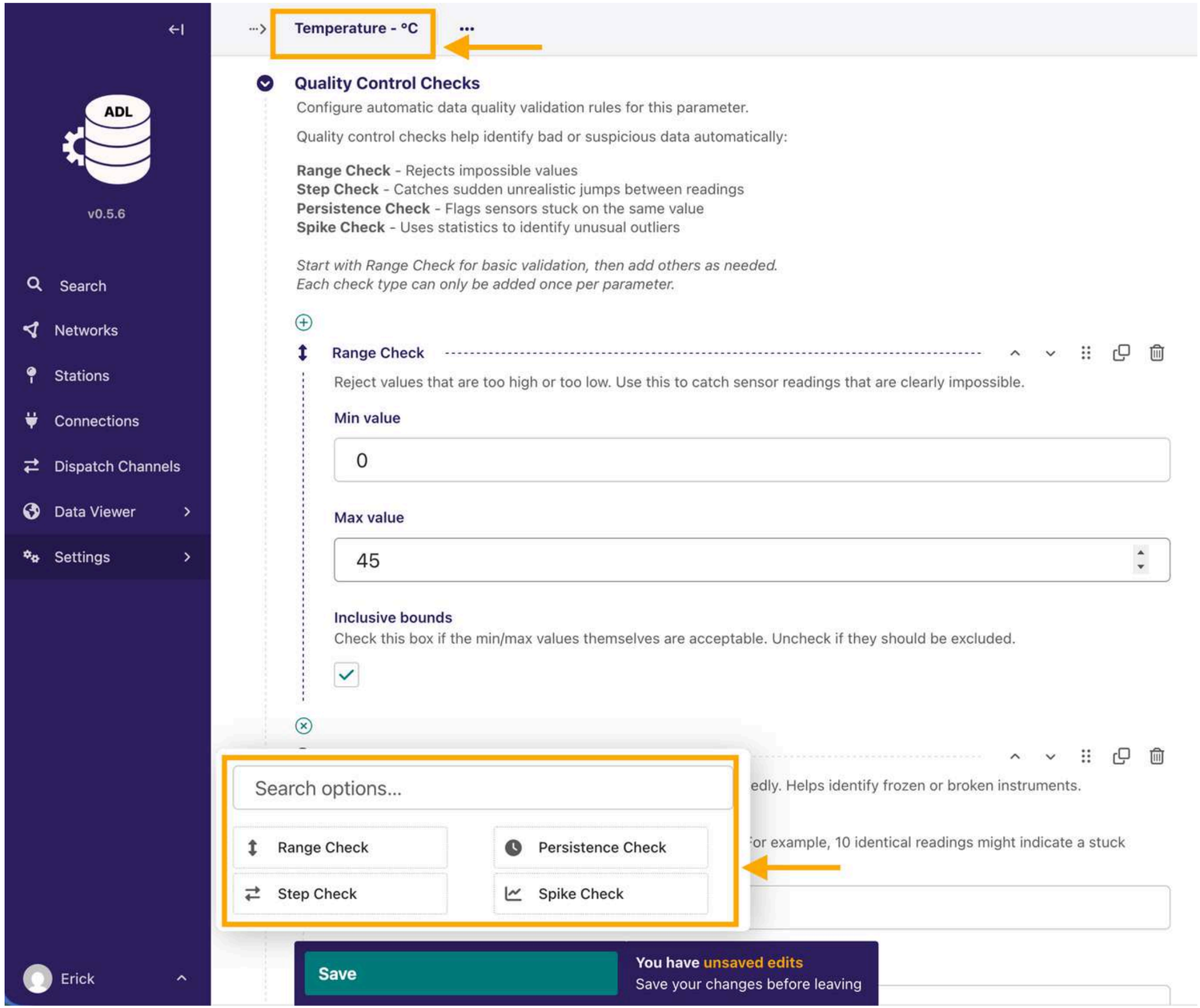


Introducing ADL Collector

- Offline-first mobile app for manual stations data collection
- Optimized for low end devices, with limited internet connectivity
- Small app size ~ 16 MB
- Data values limits checks - (Min, Max) - More Quality Checks done on ADL
- Directly Integrates with ADL instance of an NMHS. No additional backend systems required.


5:14
Stations
Meteo Burundi
Connected
adl.igebu.bi
Your Assigned Stations
BUJUMBURA
Station ID: 3
Active
Stations
Observations
Account
5:14
BUJUMBURA
BUJUMBURA
Station ID 3
Timezone Africa/Bujumbura
Observation Schedule
Observation window open
Observations can be submitted anytime within the daily window
Daily window:
06:00 - 18:00
Recent observations
No recent observations
Add Observation
5:15
New Observation
BUJUMBURA
Timezone: Africa/Bujumbura
Observation Time
Thursday, September 18, 2025 at 16:15
-15m
-5m
+5m
+15m
Measurements
Temperature (Degree Celsius)
Precipitation (Millimeters)
Rainfall measurement
Fill in all measurements
Cancel

Quality Control

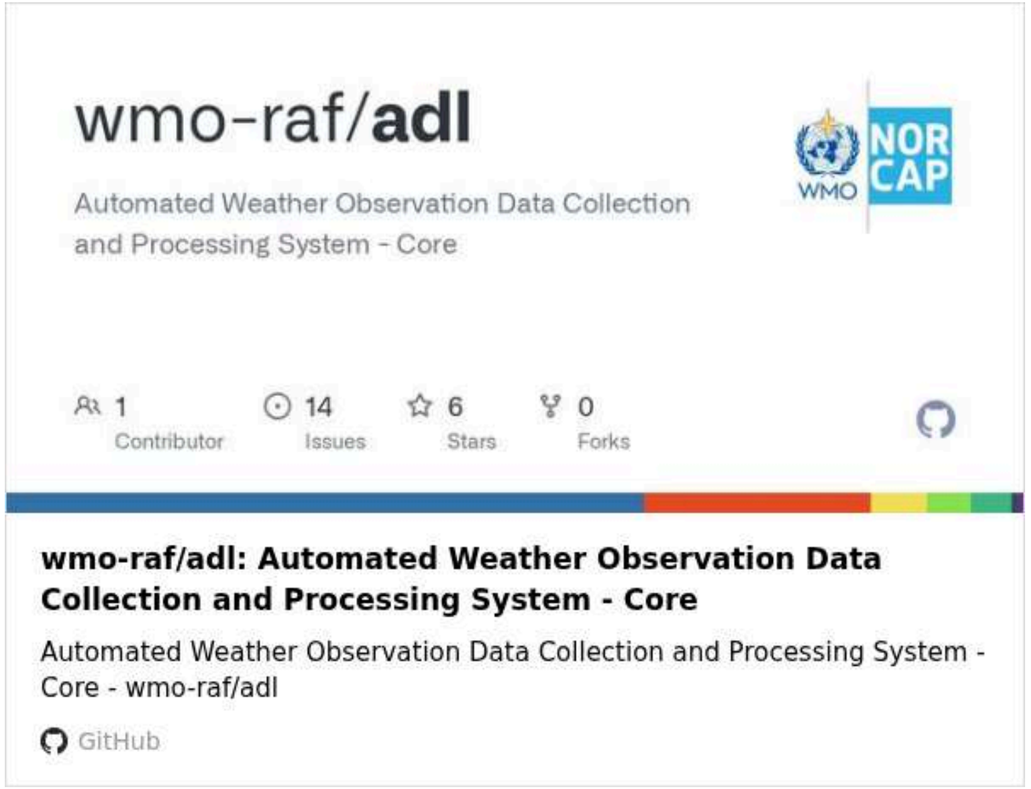


Implemented Checks

- **Range Check** - Rejects impossible values
- **Step Check** - Catches sudden unrealistic jumps between readings
- **Persistence Check** - Flags sensors stuck on the same value
- **Spike Check** - Uses statistics to identify unusual outliers

Can be extended for advanced checks

No.	Country	AWS/Plugins	Push Channels	Status
1	Chad	ADL ADCON DB Plugin	Chad Wis2box	✅ Operational
2	South Sudan	ADL FTP Plugin, using inbuilt Siap + Micros Decoder	South Sudan Wis2box	✅ Operational
3	Burkina Faso	ADL FTP Plugin with custom ADCON Decoder ADL FTP BF Adcon Decoder	Burkina Faso Wis2box	✅ Operational
4	Seychelles	ADL WeatherLink Plugin	Seychelles Wis2box	⏳ In Progress
5	Ghana	ADL ADCON DB Plugin	Ghana Wis2box	⏳ In Progress
6	Malawi	ADL FTP Plugin, using inbuilt Campbell TOA5 Decoder	Malawi Wis2box	⏳ In Progress
7	Togo	ADL Pulsonic Plugin	Togo Wis2box	⏳ In Progress
8	Niger	ADL Pulsonic Plugin	Niger Wis2box	⏳ In Progress
9	Benin	ADL Pulsonic Plugin	Benin Wis2box	⏳ In Progress
10	Nigeria	TAHMO Plugin	Nimet Wis2box	⏳ In Progress
11	Guinea	Siap + Micros, ADCON	Guinea wis2box	⏳ In Progress
12	Ethiopia	ADL ADCON DB Plugin	Ethiomet wis2box	⏳ In Progress
13	Senegal	ADCON, ADL Pulsonic Plugin	Anacim wis2box	⏳ In Progress



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Deployment & Real-World Impact

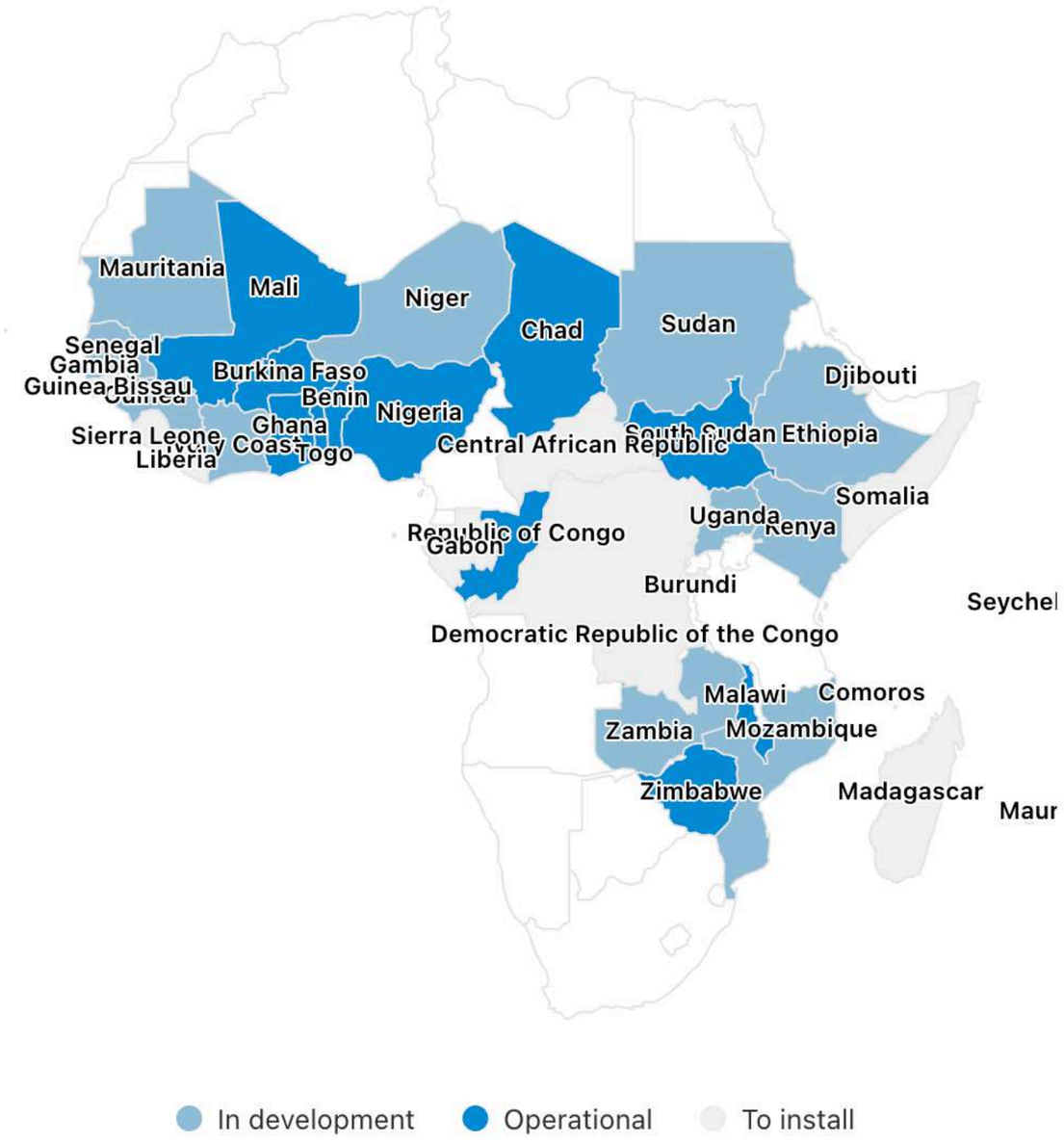
10+ Different AWS vendors integrated

~100+ Stations actively monitored

Millions of observations processed monthly

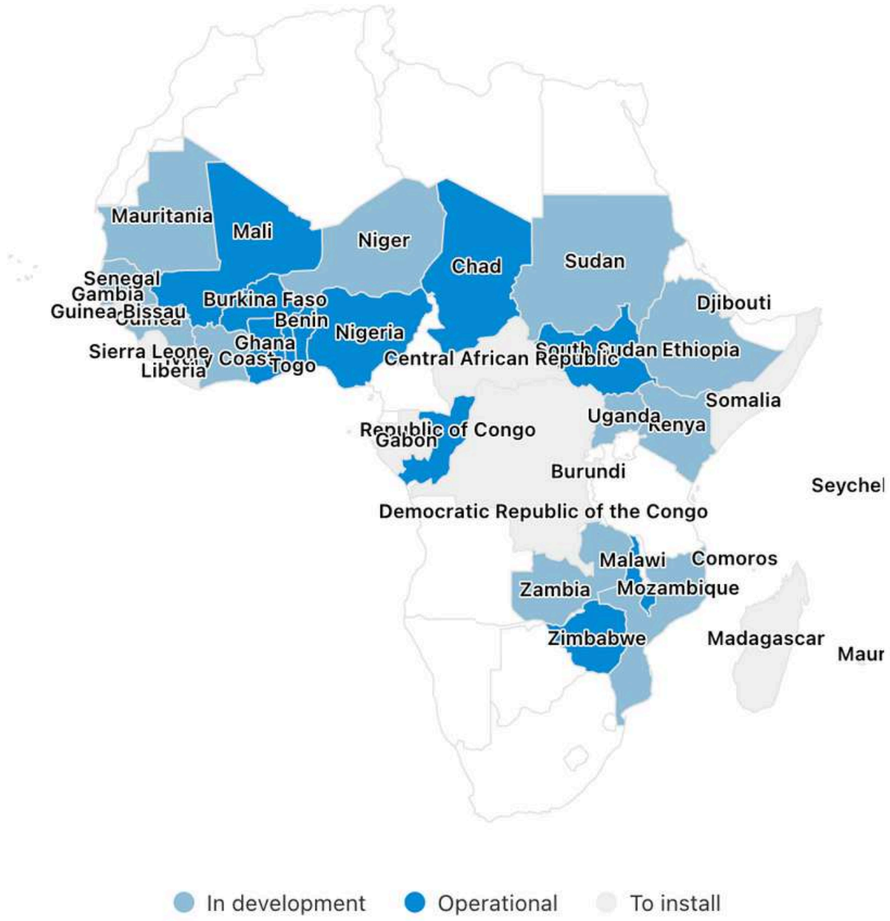
99%+ Uptime for operational deployments

A number of countries sharing data globally for the first time



Before ADL: Meteorologists manually downloading CSVs, converting units, uploading to WIS2—hours of daily work

With ADL: Automated end-to-end—observations reach WIS2 within minutes of being recorded



Powering Automated Data Transmission

A Smart Pipeline for Weather and Climate Data transmission

The Automated Data Loader (ADL) is an open-source system designed to unify and automate the collection and transmission of meteorological data from diverse weather station networks—resolving one of the biggest data transmission challenges facing NMHSs across Africa.

🔵 **Live instances (11):**
Chad, South Sudan, Burkina Faso, Seychelles, Togo, Malawi, Mali, Nigeria, Ghana, Zimbabwe, Burundi.

🔧 **Under customisation instances (8):**
Sudan, Kenya, Benin, Guinea, Ethiopia, Senegal, Côte d'Ivoire, Mozambique.

⚪ **To install (17):** Democratic Republic of Congo, Somalia, Sao Tome, Mauritius, Gabon, Ethiopia, Central African Republic, Comoros, Djibouti, Uganda, Sierra Leone, Mauritania, Madagascar, Guinea-Bissau, Gambia, Liberia, Niger.

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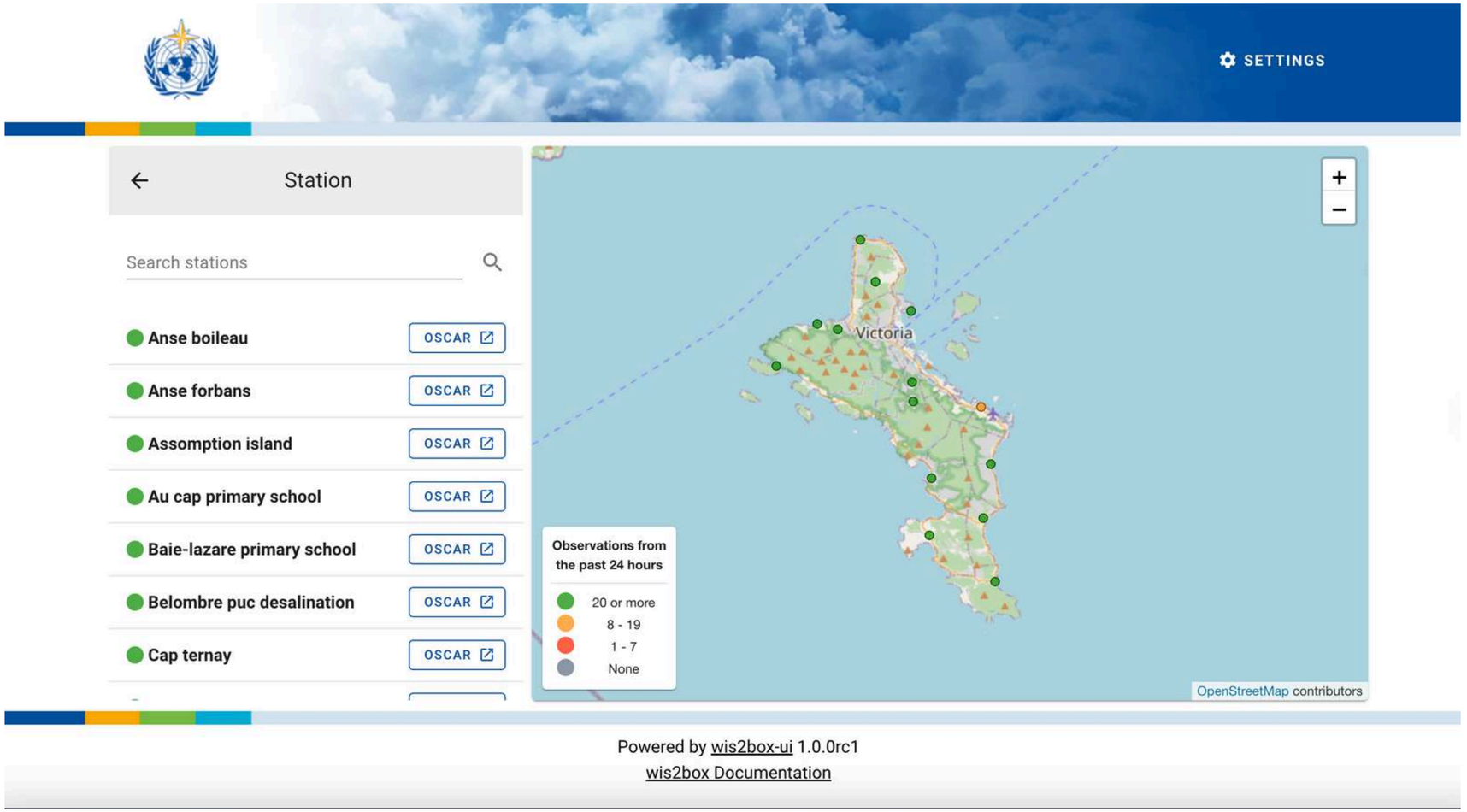
WORLD METEOROLOGICAL ORGANIZATION


July 2023
Malta
Iraq
Libya
Egypt
Mauritania
Chad
Djibouti
Liberia
Sao Tome and Pr.
Tanzania
Saint Helena
Madagascar
Botswana


July 2025
Malta
Iraq
Libya
Egypt
Mauritania
Chad
Djibouti
Liberia
Sao Tome and Pr.
Tanzania
Saint Helena
Madagascar

Automated Data Loader in Action

Chad, Seychelles, South Sudan, **Burkina Faso, Togo, Mali, Ghana for the first time**, were able to share data from their AWS for the first time.

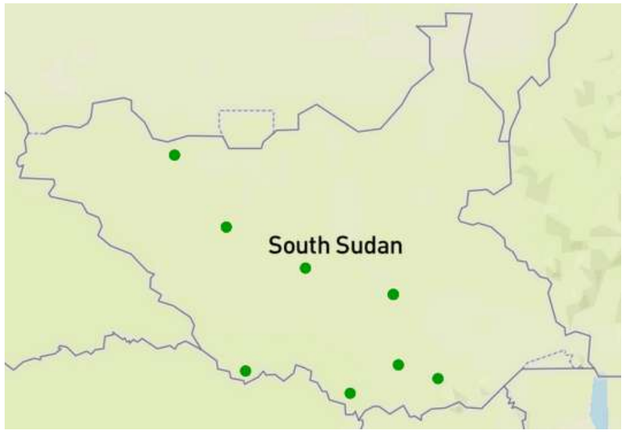


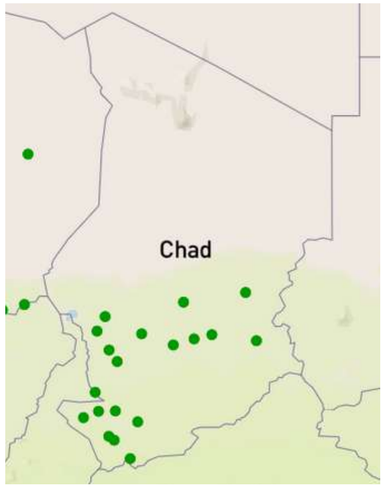
Burkina Faso

South Sudan

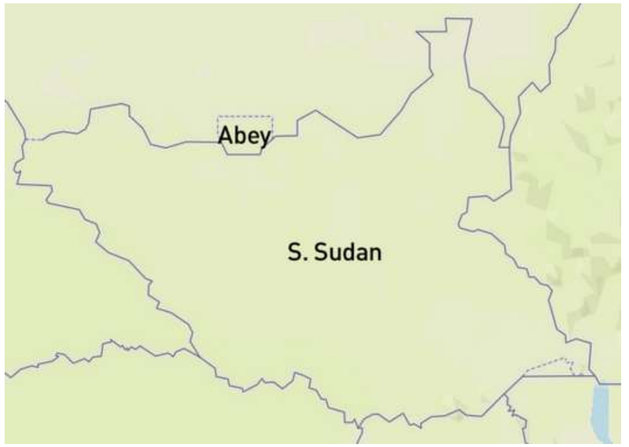
Chad

February 2025





February 2022

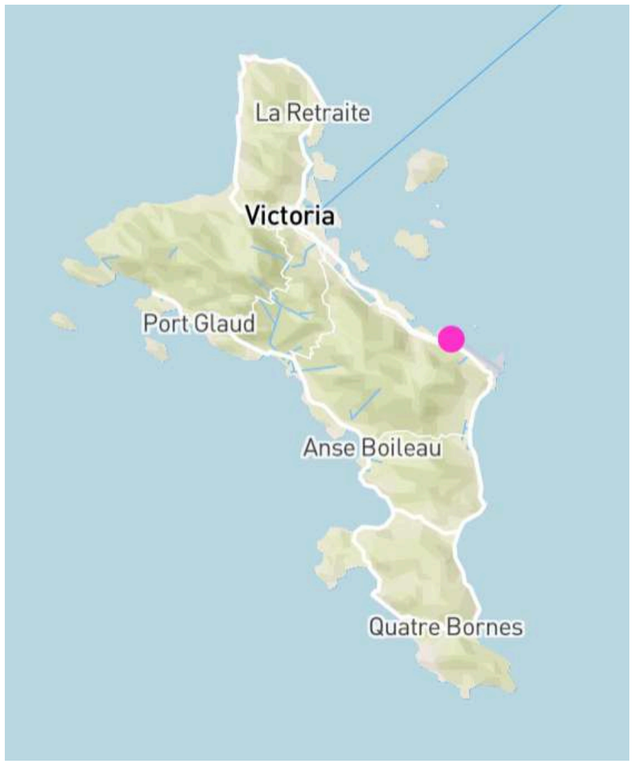


Togo

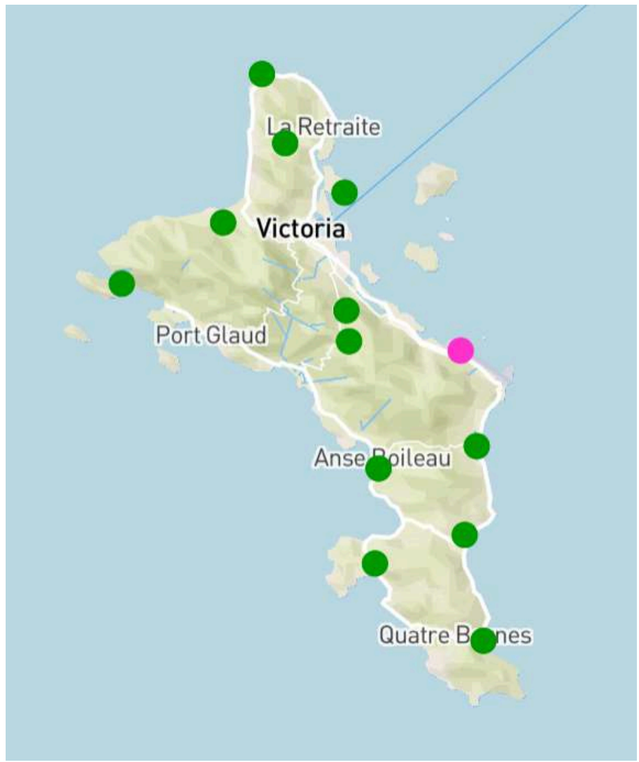
February 2022

February 2025

Seychelles

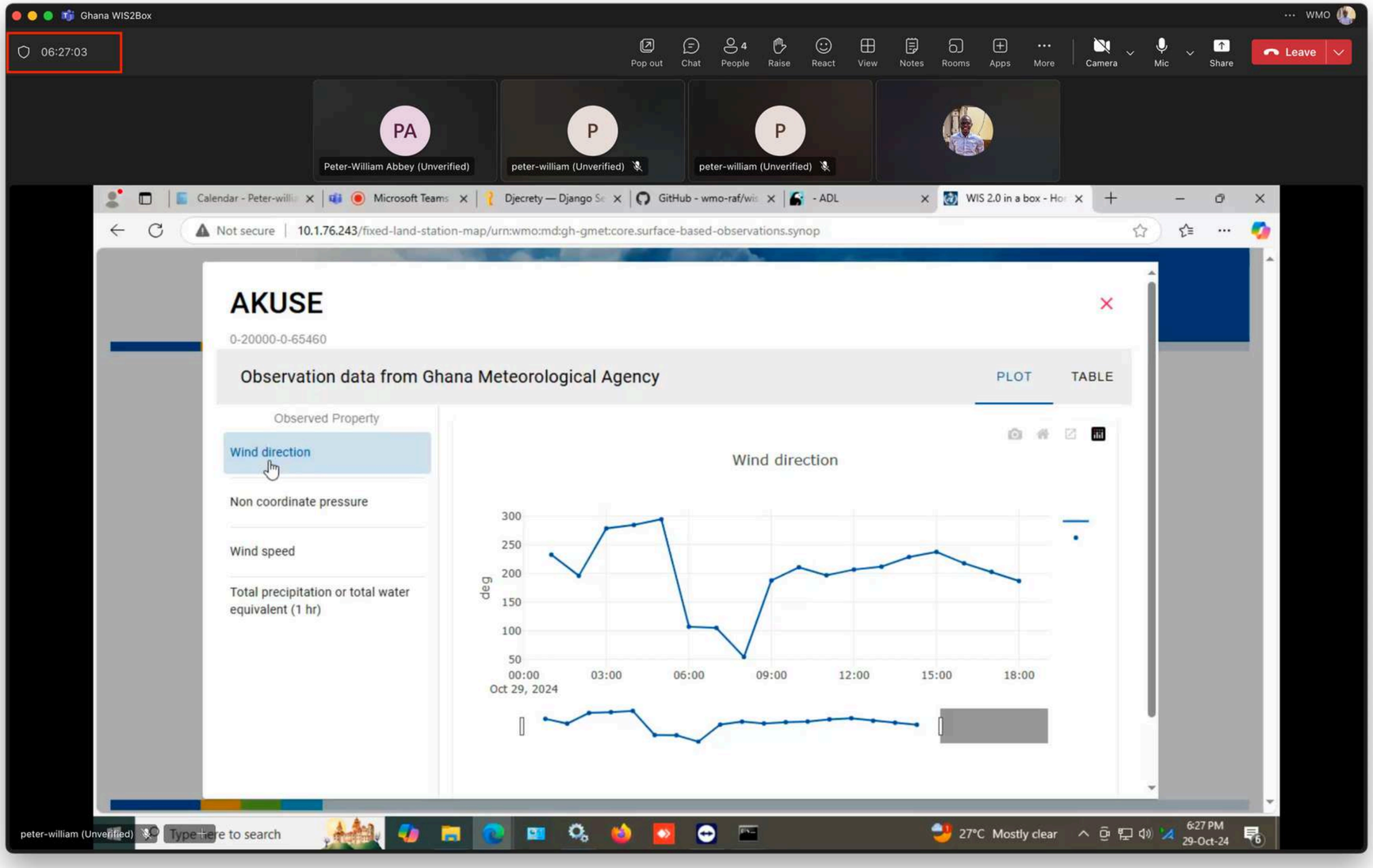


February 2022



February 2025

One-on-one technical support, with NMHSs



WORLD METEOROLOGICAL ORGANIZATION

Resources

📦 Core Repository

github.com/wmo-raf/adl

📚 Documentation

adl-tool.readthedocs.io

Docs


Thank You