

WIS2 in a box (wis2box) introduction and architecture

12 December 2024

Maaike Limper
Scientific Officer, WIS division
Infrastructure Department, WMO



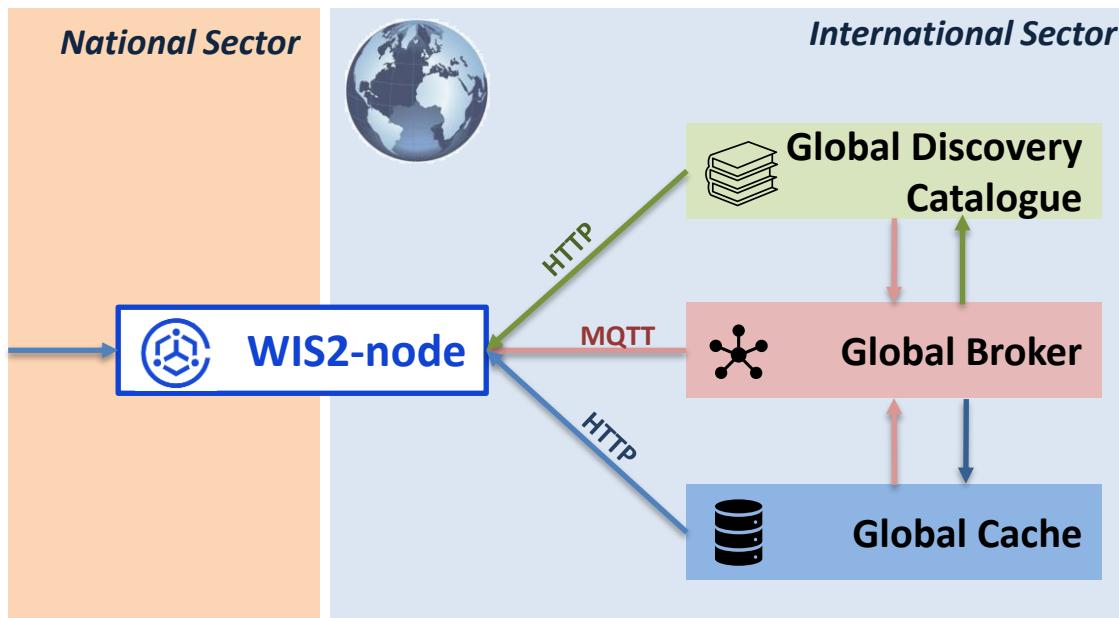
WMO OMM
World Meteorological Organization
Organisation météorologique mondiale

Reminder: What is a WIS2 Node ?

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

A WIS2 node is composed of 2 endpoints that need to be exposed over the public internet:

- **MQTT broker**: to publish WIS2-notifications for metadata and data
- **HTTP endpoint**: to enable the download of data and metadata records



Global Discovery Catalogues download all valid WCMP2 records from the HTTP-endpoint for notifications on topic=`origin/a/wis2/+/metadata`

Global Brokers subscribe to topic=`origin/a/wis2/<centre-id>/#` on the WIS2 Node MQTT broker, and republishes all valid WIS2-notifications

Global Caches download data from the HTTP-endpoint for all notifications on topic=`origin/a/wis2/+/data/core/#`

MQTT topic defined by the [WIS2 Topic Hierarchy](#) standard
Discovery Metadata records defined by [WCMP2](#) standard
MQTT payload defined by the [WIS2 Notification Message](#) standard



WMO OMM

What is WIS2 in a box?

- WIS2 in a box (wis2box) is a **Reference Implementation of a WIS2 Node**
- Developed as Docker Compose stack using existing Free and Open Source implementations and wis2box-specific components
- Free Open-Source Software (FOSS) <https://github.com/wmo-im/wis2box>
- Designed to be cost-effective and low-barrier to operate
- Developed by WMO to help accelerate the implementation of WIS 2.0



WMO OMM

wis2box hosting requirements:

- minimum 2 vCPUs with 4GB Memory and 24GB of local storage
- requires Python, Docker and Docker Compose pre-installed
- HTTP and MQTT ports routed to a publicly accessible address
- See documentation at <https://docs.wis2box.wis.wmo.int>

WIS 2.0 Training workshops

wis2box is used to enable practical exercises on exchanging data using WIS2.0 standard during training workshop

During the training each participant gets access to one virtual machine to setup their own **WIS2 Node** so they can practice preparing WIS2 datasets and publishing WIS2 data notifications



wis2box is Free and Open

Free and Open Source Software



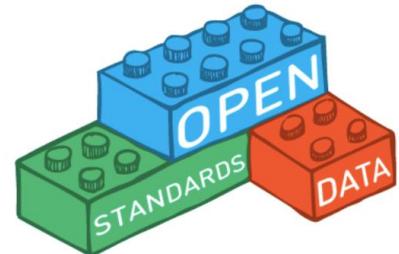
Open Standards



- MQTT
- GeoJSON
- OGC APIs



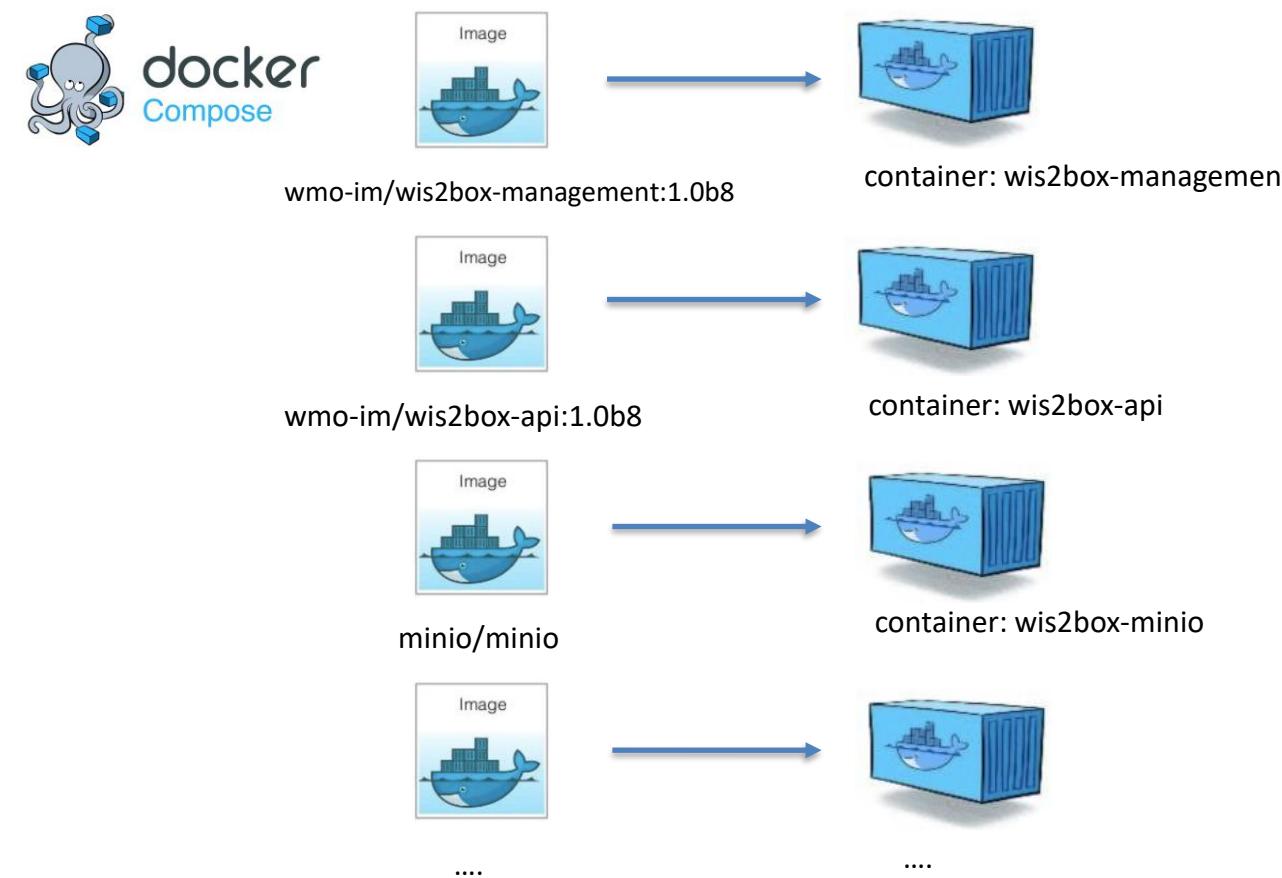
WMO OMM



wis2box and docker

wis2box uses Docker and Docker Compose

- Using pre-built Docker images to create containers each providing a specific service running on the wis2box-instance
- Python script 'wis2box-ctl.py' provides a wrapper around Docker Compose commands to interact with wis2box



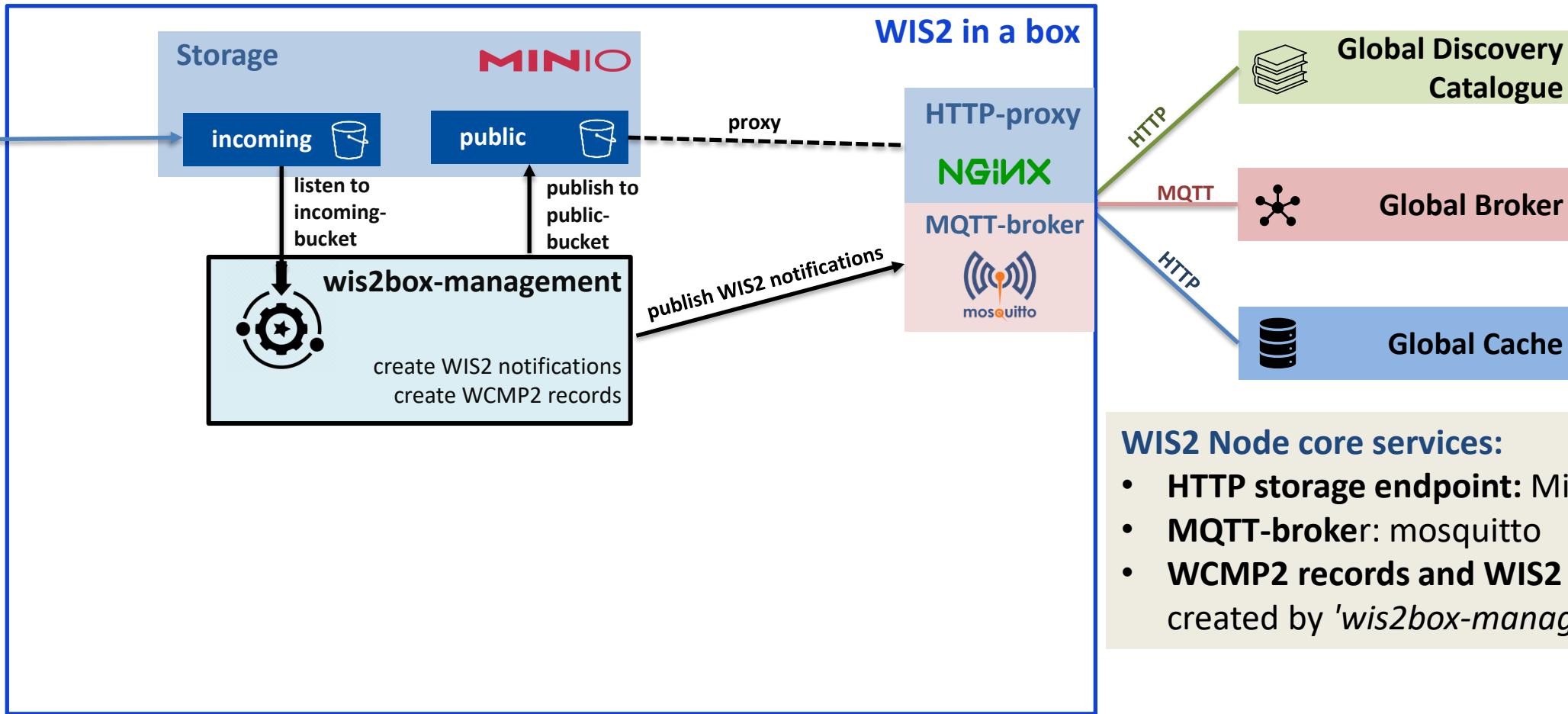
Why is wis2box composed as a set of Docker containers?

- Docker containers contain all necessary dependencies, libraries, and binaries required to run the service
- Docker containers run on any system with Docker installed, regardless of underlying hardware or operating system
- Docker containers provide process and resource isolation, enhancing security

Software requirements on the host:

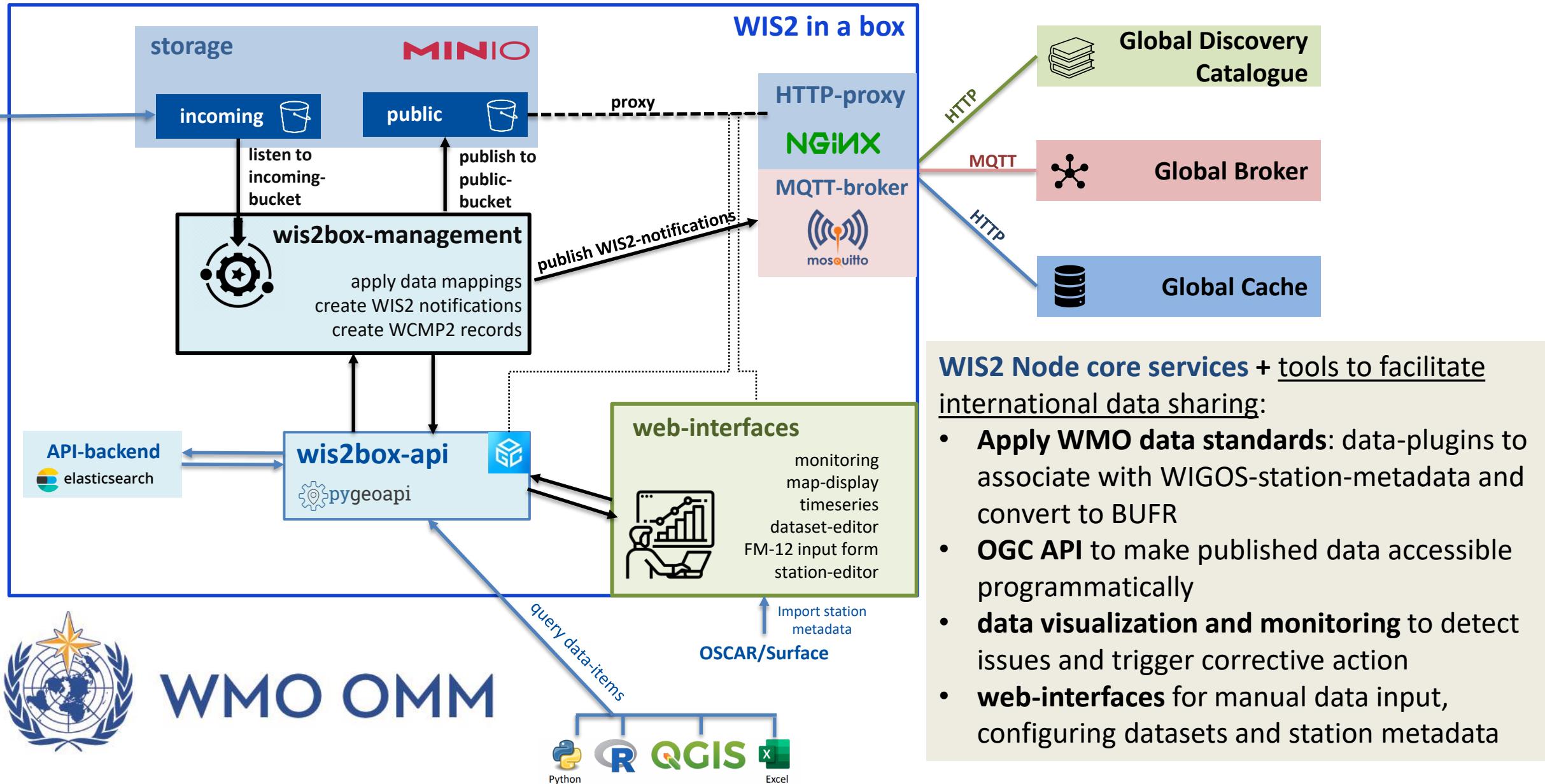
- Python: 3.8 or higher
- Docker Engine: 20.10.14 or higher
- Docker Compose: 2.0 or higher

wis2box core services



WMO OMM

wis2box additional services



Datasets in the wis2box

Two ways to configure a new dataset in the wis2box:

- Use the **dataset-editor** in the wis2box-webapp
- ... or share an MCF file with the wis2box-management container and execute '**wis2box dataset publish <file-path>**'

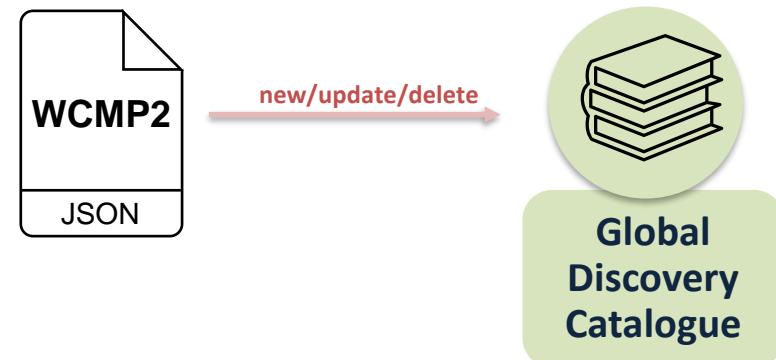
**new WCMP2 notification on origin/a/wis2/<centre-id>/metadata
for every new dataset published**

**update WCMP2 notification on origin/a/wis2/<centre-id>/metadata
for every updated dataset published**

**delete WCMP2 notification on origin/a/wis2/<centre-id>/metadata
whenever a dataset is unpublished**



WMO OMM



Dataset Editor in wis2box-webapp

Dataset Editor Form

Please choose a dataset

Dataset loaded successfully.

Metadata Editor

Dataset Identification

Title: Hourly synoptic observations from fixed-land stations (SYNOP) (br-inmet)

Description: Observation data from automatic weather stations

Identifier: urn:wmo:md:br-inmet:surface-based-observations.synop

Centre ID: br-inmet

WMO Data Policy: core

Topic Hierarchy: br-inmet/data/core/weather/surface-based-observations/synop

Earth System Disciplines: Weather

Keywords (3 minimum): + observations, temperature, visibility, precipitation, pressure, clouds, snow depth, evaporation, radiation, wind, total sunshine, humidity

Temporal Properties

Start Date: 2024-06-05

End Date in UTC:

Dataset ongoing:

Resolution: 1 hour(s)

Spatial Properties

Choose an automatic bounding box (optional): Brazil

Your country may not have an automatic bounding box

North Latitude: 5.24448639

East Longitude: -34.7299934

West Longitude: -73.9872354

South Latitude: -33.7683777



Dataset Mappings Editor

Plugins in use	File extension	File pattern	Actions
BUFR data converted to BUFR	bin	^.+\.bin\$	<button>UPDATE</button> <button>DELETE</button>
FM-12 data converted to BUFR	txt	^.+\(\d{4}\)(\d{2}).+\.txt\$	<button>UPDATE</button> <button>DELETE</button>
BUFR data converted to BUFR	b	^.+\.b\$	<button>UPDATE</button> <button>DELETE</button>
CSV data converted to BUFR	csv	^.+\.csv\$	<button>UPDATE</button> <button>DELETE</button>
BUFR data converted to GeoJSON	bufr4	^WIGOS_+(\d-\d+\d+-\w+)_+\.bufr4\$	<button>UPDATE</button> <button>DELETE</button>

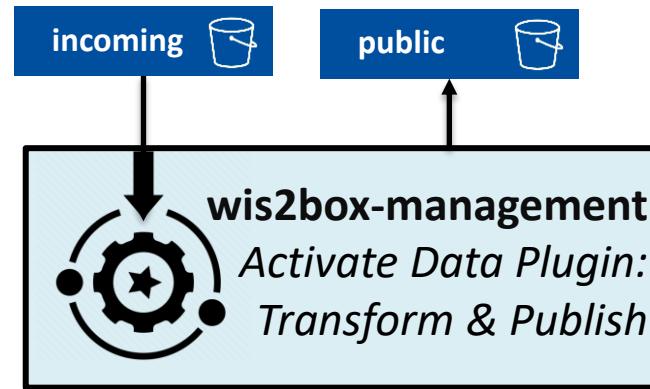
On "submit", the wis2box-management container creates a new WCMP2 record and/or publishes an update

EXPORT AS JSON

SUBMIT

- Step 1. Define metadata and validate form
- Step 2. Define data plugins
- Step 3. Submit the dataset for publication

wis2box data plugins



In wis2box each dataset is associated to one ore more Data Plugins

A data plugin defines the actions taken to **transform** and **publish** the data

Data plugins use an abstract model/approach to enable extensibility and reuse

See github.com/wmo-im/wis2box/tree/main/wis2box-management/wis2box/data

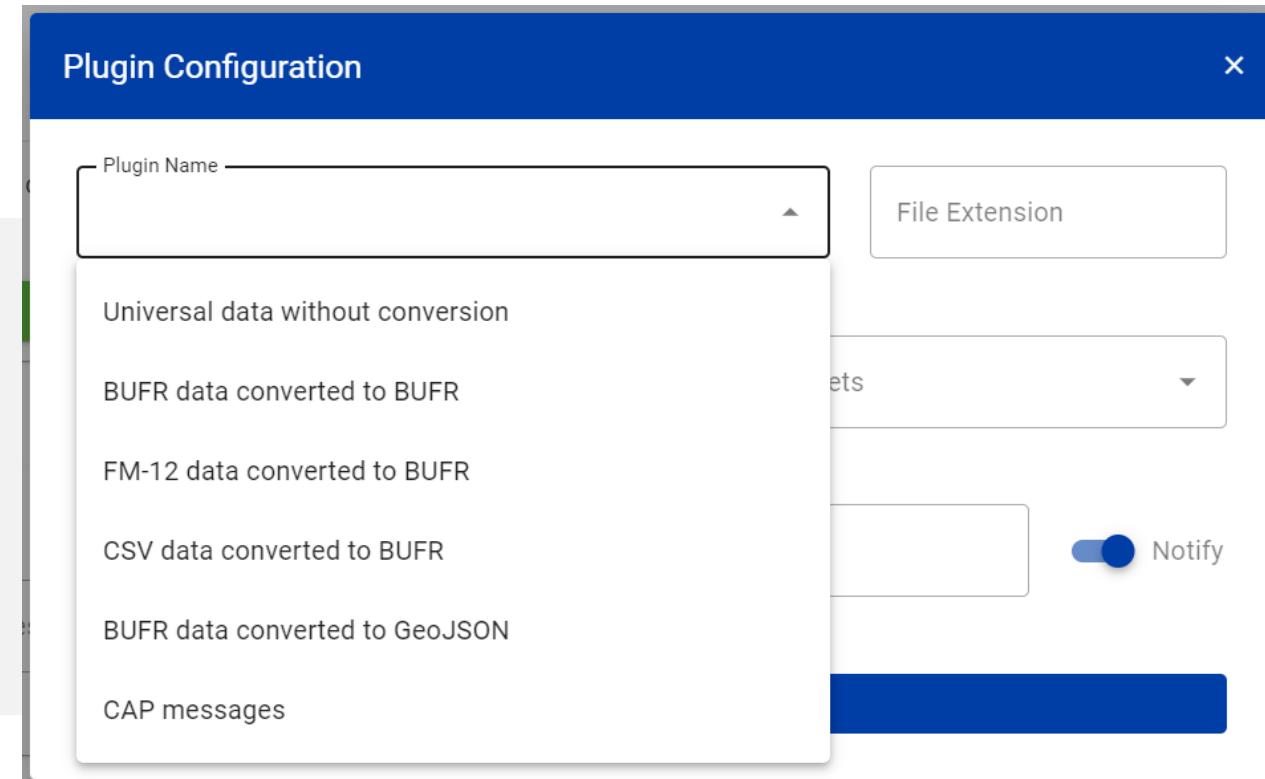


WMO OMM

wis2box data plugins

wis2box contains the following built-in data plugins:

- wis2box.data.universal.UniversalData
- wis2box.data.cap_message.CAPMessageData
- wis2box.data.bufr4.ObservationDataBUFR
- wis2box.data.synop2bufr.ObservationDataSYNOP2BUFR
- wis2box.data.csv2bufr.ObservationDataCSV2BUFR
- wis2box.data.bufr2geojson.ObservationDataBUFR2GeoJSON



Developers are encouraged to contribute new data plugins to wis2box!



WMO OMM

BUFR tools in wis2box



wis2box uses ECMWF's [ecCodes](#) software library to perform the BUFR encoding

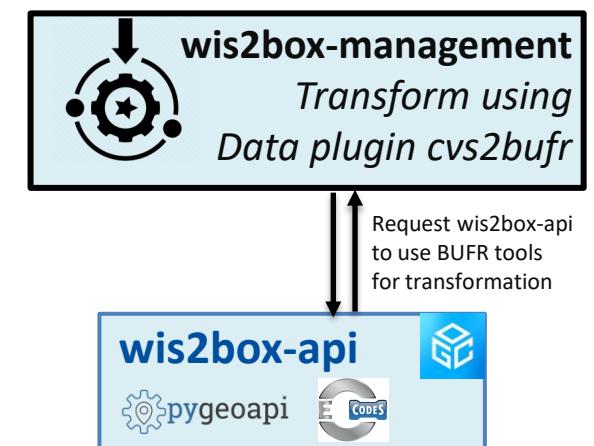
'wis2box-api' container is based on a Docker image containing *ecCodes*

BUFR-conversion tools used by wis2box available as standalone python modules:

<https://github.com/wmo-im/csv2bufr>

<https://github.com/wmo-im/synop2bufr>

<https://github.com/wmo-im/bufr2geojson>



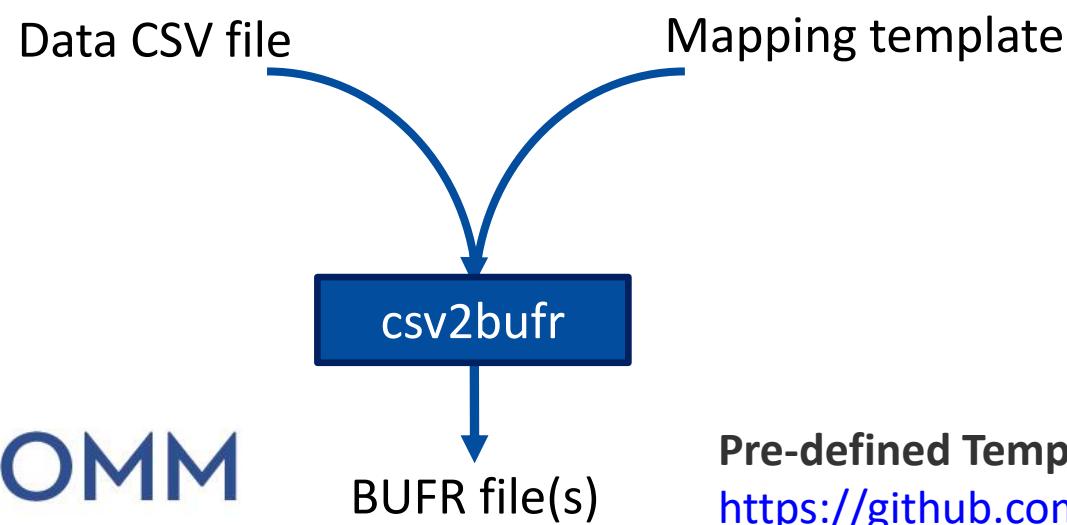
WMO OMM

csv2bufr mapping template

csv2bufr uses a Mapping Template: JSON file defining the mapping between columns in the input CSV data to codes encoded in the output BUFR data

... using the human-readable eccodes_key rather than the 6 digit BUFR FXXXXXX code

```
"data": [  
    ....  
    {"eccodes_key": "#1#nonCoordinatePressure", "value": "data:station_pressure", "valid_min": "const:50000", "valid_max": "const:150000"},  
    {"eccodes_key": "#1#pressureReducedToMeanSeaLevel", "value": "data:msl_pressure", "valid_min": "const:50000", "valid_max": "const:150000"},  
    {"eccodes_key": "#1#nonCoordinateGeopotentialHeight", "value": "data:geopotential_height", "valid_min": "const:-1000", "valid_max": "const:130071"},  
    {"eccodes_key": "#1#heightOfSensorAboveLocalGroundOrDeckOfMarinePlatform", "value": "data:thermometer_height", "valid_min": "const:0", "valid_max": "const:655.35"},  
    {"eccodes_key": "#1#airTemperature", "value": "data:air_temperature", "valid_min": "const:193.15", "valid_max": "const:333.15"},  
    ... ]
```



Pre-defined Templates used in wis2box can be found here:
<https://github.com/wmo-im/csv2bufr-templates>
... or custom templates can be defined by the user

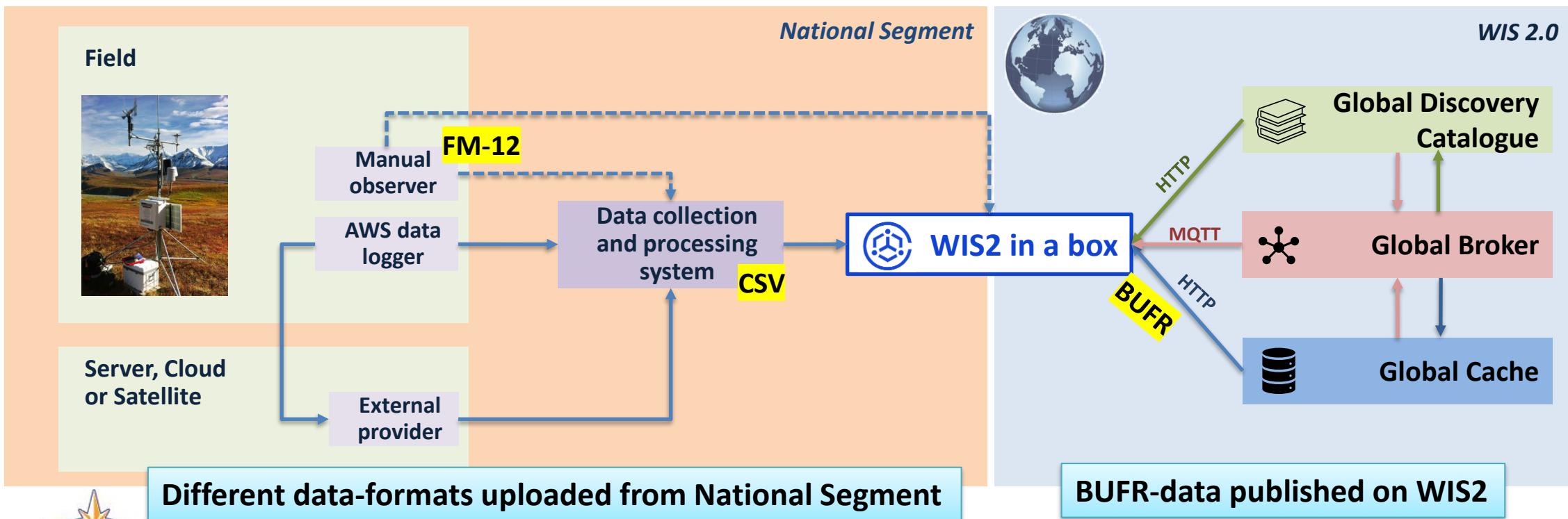


WMO OMM

wis2box data plugins

csv2bufr enables any system to prepare a data-extract for publication without needing local BUFR conversion tools

synop2bufr enables publication of FM-12 synop reports from manual observers



WMO OMM

SYNOP FORM in wis2box web-application

Submit FM 12-XIV Ext. SYNOP Bulletin

See the WMO [Manual on Codes, Volume I.1](#), for a description of the FM 12-XIV Ext. SYNOP format

select month/year

 X

Month and year in UTC

Enter or copy-paste FM-12 SYNOP



FM 12

```
SMR001 YRBK 121200
AAXX 17121
15015 01597 71702 10057 20036 39390 42628 50004 60021 78082 87300 333
4/000
55304 0/// 20643 3/// 69977 91003 91108=
```

Raw FM 12 bulletin

Dataset Identifier —

urn:wmo:md:io-wis2dev-test2:core.surface-based-observations.synop

testing csv2bufr

wis2box auth token for 'processes/wis2box' —

.....

SUBMIT

Publish on WIS2

provide wis2box auth token for processes/wis2box



select dataset-id from dropdown



Turn off "Publish on WIS2" to test conversion without publishing



SYNOP FORM in wis2box web-application

open output list

Result: success

WIS2 notifications published: 0

! Warnings: 0

✗ Errors: 0

✓ Output BUFR files: 1

Result: success

WIS2 notifications published: 0

! Warnings: 0

✗ Errors: 0

✓ Output BUFR files: 1

WIGOS_0-1234-5-WMOHQ_20240817T120000.bufr4

DOWNLOAD

INSPECT

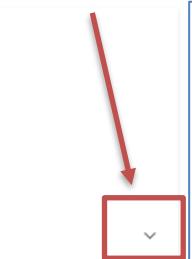
Buttons for each generated BUFR-file

DOWNLOAD: download the file

INSPECT: display the content of the BUFR



WMO OMM



WIGOS Station Identifier: 0-1234-5-WMOHQ

Station name: 0-1234-5-WMOHQ

Station latitude: 46.22335

Station longitude: 6.14365

Station elevation: 422.00 (m)

Barometer height above mean sea level: 123.00 (m)

Nominal report time: 2024-08-17T12:00:00Z

A map showing the location of the WIGOS station near Geneva, Switzerland, with surrounding towns like Nyon, Veytaux, and Annemasse labeled.

observedProperty	value	units	description
non coordinate pressure	939	hPa	
3 hour pressure change	0.4	hPa	
characteristic of pressure tendency	0	CODE TABLE	INCREASING, THEN DECREASING; ATMOSPHERIC PRESSURE THE SAME OR HIGHER THAN THREE HOURS AGO
non coordinate geopotential height	628	gpm	
air temperature	5.7	Celsius	
dewpoint temperature	3.6	Celsius	
relative humidity	86	%	
horizontal visibility	10000	m	
total snow depth	0	m	
cloud cover total	0	%	
cloud amount	0	CODE TABLE	0
cloud type	30	CODE TABLE	NO CL CLOUDS
cloud type	20	CODE TABLE	NO CM CLOUDS
cloud type	10	CODE	NO CH CLOUDS

Use the INSPECT-option to check if the content of the BUFR is correct

wis2box monitoring tools

Grafana, Prometheus and Loki included in wis2box-stack to enable monitoring the wis2box data publication and enable log access for debugging and corrective action

<http://<wis2box-host-address>:3000>



```
2023-10-04 10:00:59 [2023-10-04T08:00:59Z] {/usr/local/lib/python3.8/dist-packages/wis2box-1.0b4-py3.8.egg/wis2box/data/csv2bufr.py:95} ERROR - Station 0-894-2-ChisambaGA not in station list; skipping
2023-10-04 10:00:54 [2023-10-04T08:00:54Z] {/usr/local/lib/python3.8/dist-packages/wis2box-1.0b4-py3.8.egg/wis2box/data/csv2bufr.py:95} ERROR - Station 0-894-2-FeiraDaySS not in station list; skipping
2023-10-04 09:57:07 [2023-10-04T07:57:07Z] {/usr/local/lib/python3.8/dist-packages/wis2box-1.0b4-py3.8.egg/wis2box/data/csv2bufr.py:95} ERROR - Station 0-894-2-LuanshyaCentralSS not in station list; skipping
2023-10-04 09:57:02 [2023-10-04T07:57:02Z] {/usr/local/lib/python3.8/dist-packages/wis2box-1.0b4-py3.8.egg/wis2box/data/csv2bufr.py:95} ERROR - Station 0-894-2-ChadizaFTC not in station list; skipping
2023-10-04 09:57:01 [2023-10-04T07:57:01Z] {/usr/local/lib/python3.8/dist-packages/wis2box-1.0b4-py3.8.egg/wis2box/data/csv2bufr.py:95} ERROR - Station 0-894-2-MukulaikwaSS not in station list; skipping
2023-10-04 09:56:58 [2023-10-04T07:56:58Z] {/usr/local/lib/python3.8/dist-packages/wis2box-1.0b4-py3.8.egg/wis2box/data/csv2bufr.py:95} ERROR - Station 0-894-2-RiverViewSC not in station list; skipping
2023-10-04 09:56:57 [2023-10-04T07:56:57Z] {/usr/local/lib/python3.8/dist-packages/wis2box-1.0b4-py3.8.egg/wis2box/handler.py:105} ERROR - Failed to transform file http://minio:9000/wis2box-ingress/
```

Summary

wis2box is an Open Source Reference Implementation of a WIS2 Node

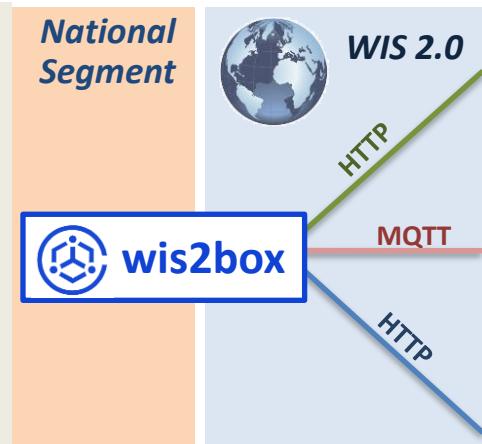
- Based on docker and docker-compose using pre-built images
- Using existing Open Source components: minio, mosquitto, nginx, pygeoapi
- Source code publicly available: <https://github.com/wmo-im/wis2box>
- Developed by WMO to help accelerate the implementation of WIS 2.0

wis2box provides additional tools to facilitate international data sharing

- Data conversion to BUFR (using extensible plugin-structure)
- Web-interfaces:
 - to visualize data content and monitor data publication
 - FM-12 input form for uploading manual observations
 - Enable configuring datasets and station metadata
- Monitoring using Grafana, Loki and Prometheus

wis2box is software not hardware

- requires a hosting solution: recommend to use **cloud** (public or private)
- host needs to be accessible via public IP address to function as WIS2 Node
- documentation: <https://docs.wis2box.wis.wmo.int>





Thank you
Merci
谢谢

WMO OMM
World Meteorological Organization
Organisation météorologique mondiale