Finding, downloading and decoding data as a WIS2 Data Consumer

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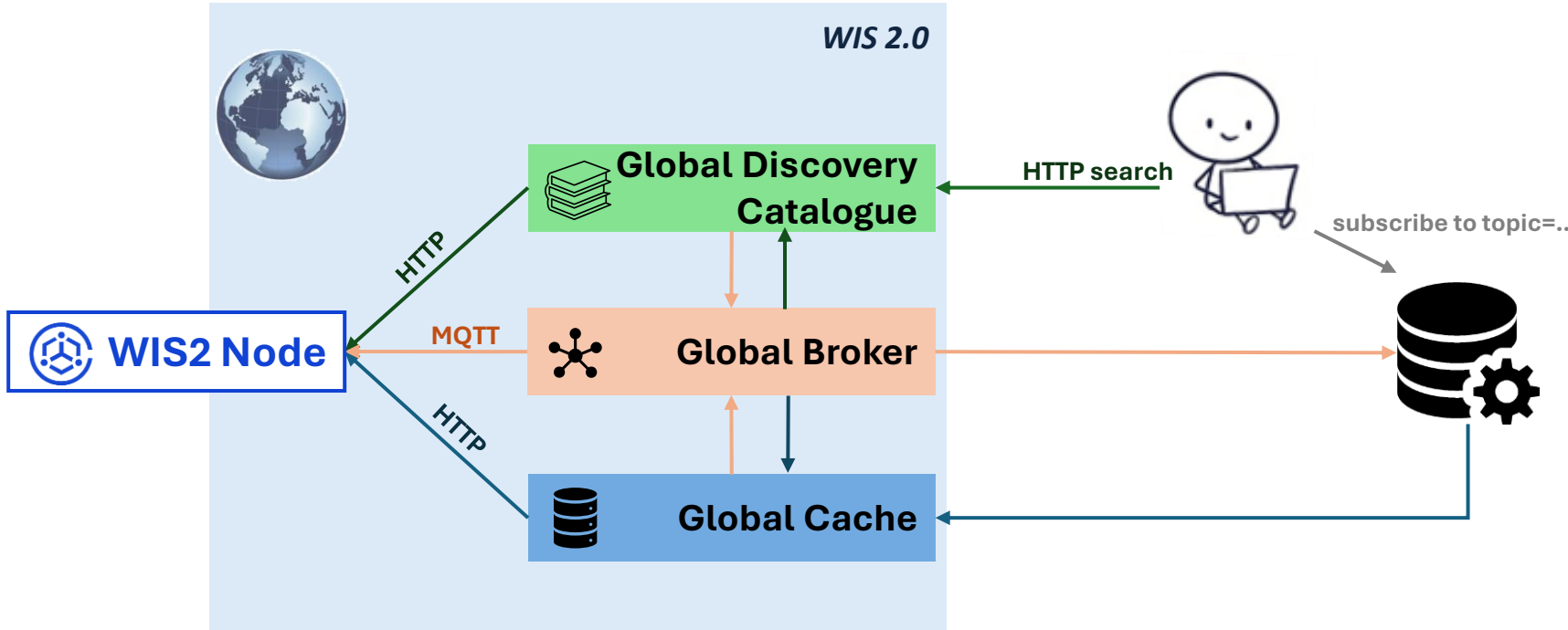
Finding data on WIS2

The Global Discovery Catalogue (GDC) provides cataloguing and discovery capability for WIS2 datasets

- Web-based API facilitating search/browse data published via WIS 2.0 (OGC API - Records)
- Harvests WIS2 discovery metadata from WIS2 Nodes (WCMP2 / OGC API - Records)
- Yellow pages (discovery metadata) gateway into WIS2 data and services
- Provides indexing capability to mass market search engines
- Provides quality assessment services of discovery metadata in support of continuous improvement in alignment with WIS2 metadata Key Performance Indicators (KPIs)



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Access data using OGC API

Each Global Discovery Catalogue provides an OGC API endpoint to query records

GDC CMA, China:

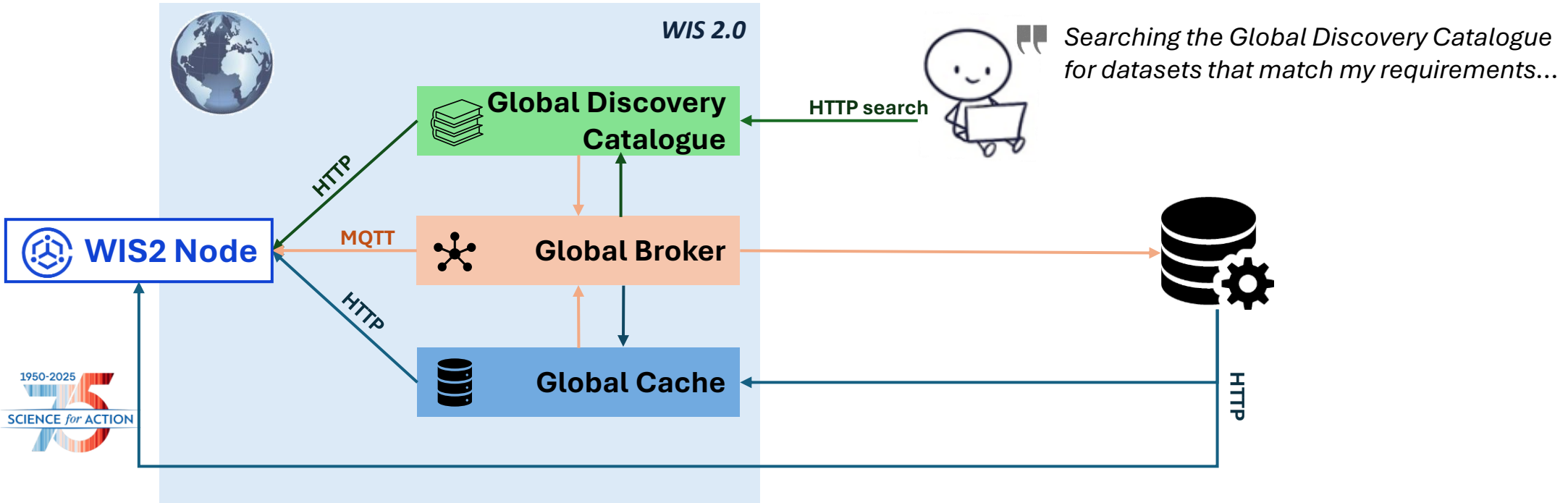
https://gdc.wis.cma.cn/collections/wis2-discovery-metadata/items

GDC DWD, Germany:

https://wis2.dwd.de/gdc/collections/wis2-discovery-metadata/items

GDC ECCC, Canada:

https://wis2-gdc.weather.gc.ca/collections/wis2-discovery-metadata/items



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Searchable Catalogue

Predicate	Example(s)
Spatial	`bbox=minx,miny,maxx,maxy`
Temporal	• `datetime=t1` • `datetime=t1/t2` • `datetime=t1/..`
Freetext	`q=air+temperature`
Attributes	• `title=air+temperature` • `contacts.address.country=Oman`
Sorting/paging	• `sortby=title&limit=100&startindex=11` • `"prev" / "next" link relations`
Filter returnable properties	• `properties=title,description`

pywiscat

pywiscat provides a Pythonic API atop the WMO WIS2 Catalogue in support of reporting and analysis of the WIS2 Catalogue and its associated discovery metadata

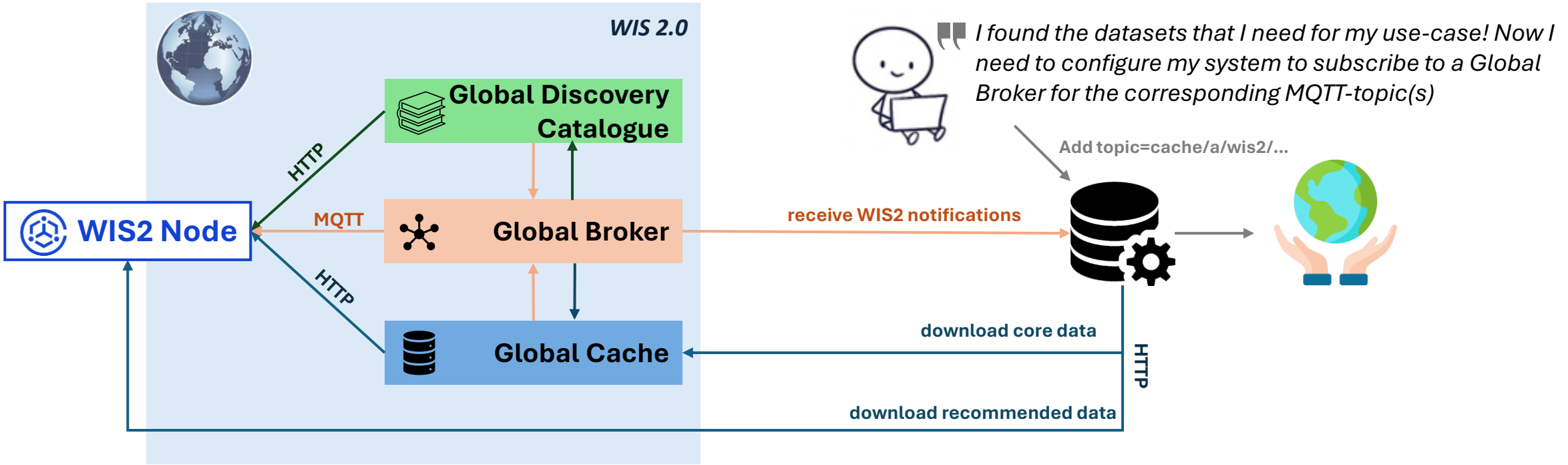
github.com/wmo-im/pywiscat

```
# fetch version
pywiscat --version

## WIS2 workflows

# search the WIS2 Global Discovery Catalogue (GDC)
pywiscat search

# search the WIS2 Global Discovery Catalogue (GDC) with a full text query
pywiscat search --query radar

# search the WIS2 Global Discovery Catalogue (GDC) for only recommended data
pywiscat search --data-policy recommended

# search the WIS2 Global Discovery Catalogue (GDC) with a bounding box query
pywiscat search --bbox -142,42,-52,84

# get more information about a WIS2 GDC record
pywiscat get urn:x-wmo:md:can:eccc-msc:c7c9d726-c48a-49e3-98ab-78a1ab87cda8
```

```
## WIS2 workflows

from pywiscat.wis2.catalogue import search, get

# search catalogue
results = search(q='radar', bbox=[-142, 42, -52, 84]))

# get a single catalogue record
results = get('urn:x-wmo:md:can:eccc-msc:c7c9d726-c48a-49e3-98ab-78a1ab87cda8')
```

Processing WIS2 notifications as a Data Consumer

Data Consumers use MQTT client-software to subscribe to specific channels and process data in real-time



Data access

WIS2 Notifications provide a canonical link to access data

The canonical link is a “one click” link to download data to your laptop/desktop/system

When you subscribe to data notifications, use the canonical link to download the data:

```
{
    "href": "https://example.org/data-file.bufr",
    "rel": "canonical",
    "type": "application/bufr"
}
```

Data publisher can indicate that previously published data has been updated and should be overwritten by using rel=update

```
{
    "href": "https://example.org/data-file.bufr",
    "rel": "update",
    "type": "application/bufr"
}
```

Custom MQTT client scripting

Example Python code using paho-mqtt

```
import json
import paho.mqtt.client as mqtt_client

def on_message(client, userdata, message):
    j = json.load(message.payload.decode('utf-8'))
    for link in j['links']:
        if link['rel'] == 'canonical':
            client_specific_function(link['href'])

client = mqtt_client.Client('MyDataClientID')
client = username_pw_set('everyone', 'everyone')
client.tls_set(tls_version=2)
client.connect('globalbroker.meteo.fr', port=8883)
client.on_message = on_message
client.subscribe('origin/a/wis2/int-ecmwf/data/core/weather/prediction/forecast/cyclone_tracks')
```

Data Consumer can customize their "on_message" code to define the actions specific for their data ingestion

Options to subscribe & download on WIS2

CUSTOM DEVELOPMENT:

Data Consumers may prefer to create a custom MQTT-client based workflow to:

- **Integrate** WIS2 subscriber within **existing data processing system**
- **Parse and process data directly**, without writing to file-system
- **Apply authentication** for restricted datasets (data-policy=recommended)

MQTT clients are available for different software environments

One widely used client for Python is paho-mqtt

EXISTING OPEN-SOURCE SOLUTIONS:

wis2downloader: github.com/wmo-im/wis2downloader

pywis-pubsub: github.com/wmo-im/pywis-pubsub

wis2downloader

wis2downloader:

- Flask-based Python application including MQTT-client
- API to manage subscriptions on MQTT-topics
- Multiple download workers for more efficient data downloading
- Provides statistics via /metrics endpoint for Prometheus

Included in wis2box, can also be installed independently: `pip3 install wis2downloader`

pypi.org/project/wis2downloader

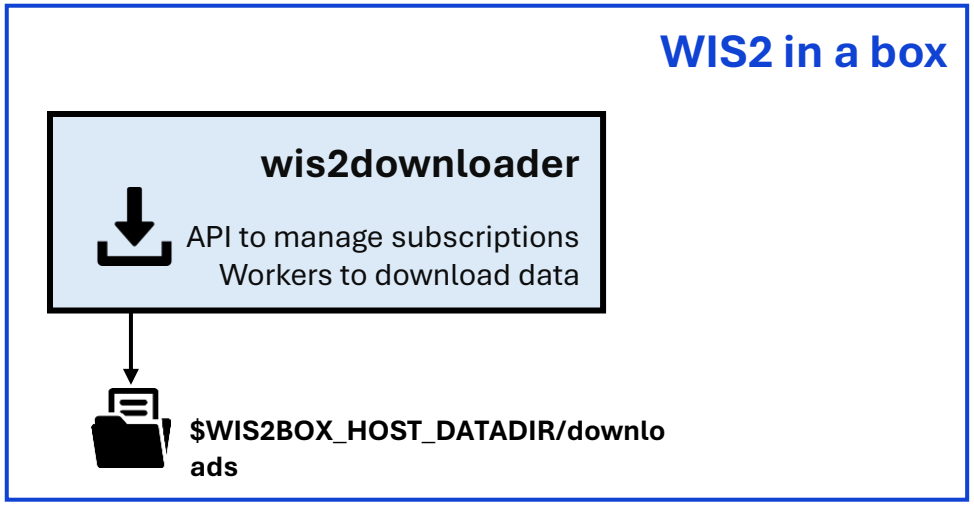
Source code:

github.com/wmo-im/wis2downloader

wis2downloader in wis2box

***wis2downloader* included within wis2box-stack as a separate docker container**

- data is downloaded in $WIS2BOX_HOST_DATADIR/downloads
- additional wis2downloader configuration using wis2box.env



Login to wis2downloader to manage subscriptions using CLI

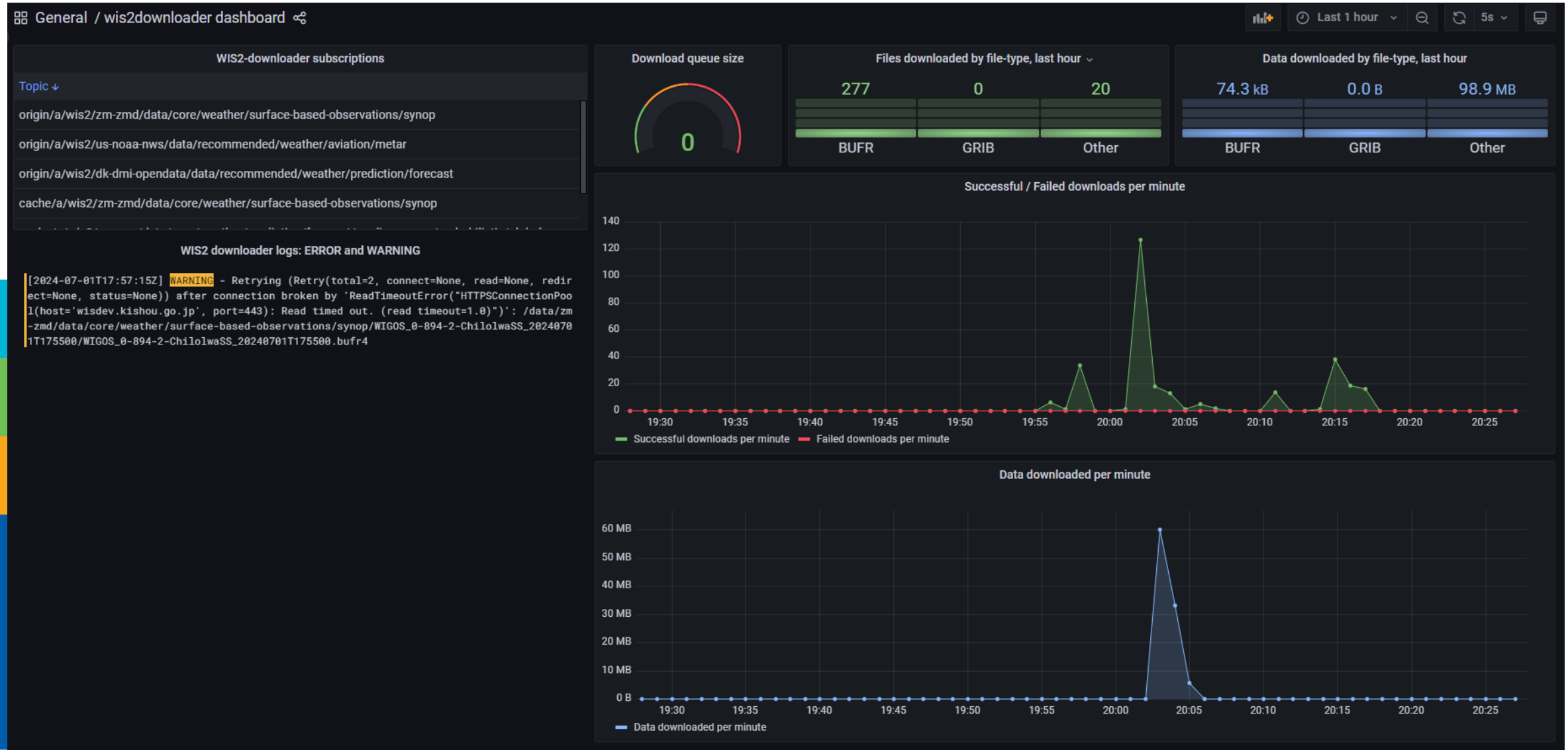
```
python3 wis2box-ctl.py login wis2downloader
```

Commands available in wis2downloader-container:

```
wis2downloader list-subscriptions
wis2downloader add-subscription --topic <topic>
wis2downloader remove-subscription --topic <topic>
```

wis2downloader in wis2box

The monitoring stack in wis2box collects and stores wis2downloader metrics in Prometheus and provides a dashboard for viewing information about the data downloaded:



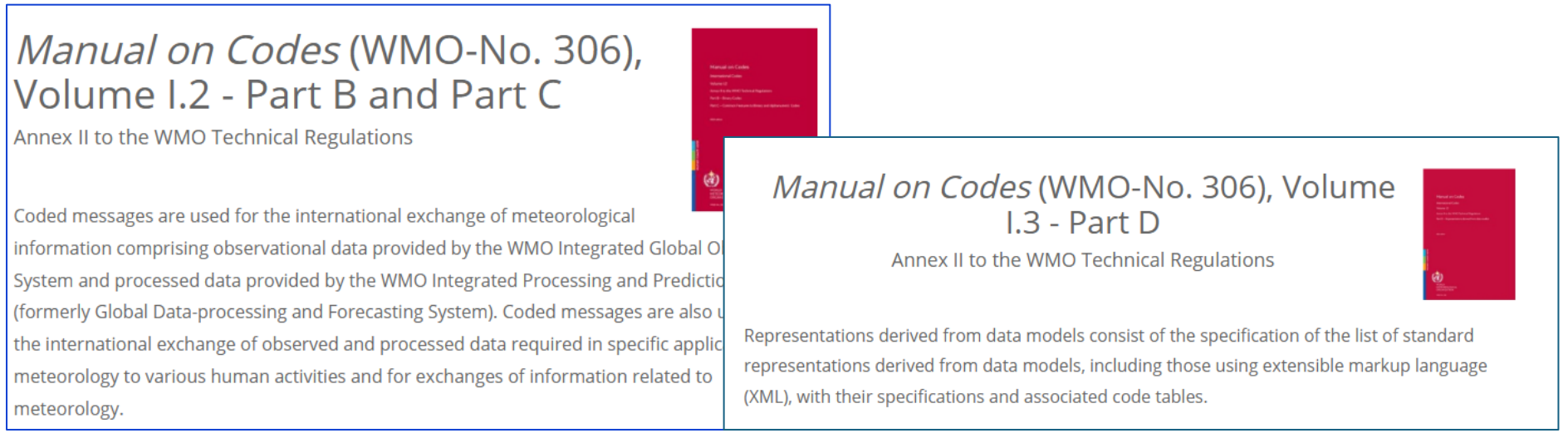
Consuming data downloaded from WIS2: data format and content

Data shared on WIS2 should be formatted with WMO data standards, e.g. BUFR4, GRIB2, NetCDF, WaterML, ...

WMO data standards are described in the *Manual on Codes* (WMO-No. 306), Volume I.2 and the *Manual on Codes* (WMO-No. 306), Volume I.3.

Requirements for data standards are governed by different WMO programs, such as WIGOS for observations and WIPPS for prediction-based products.

Descriptions about these formats and the contents of the dataset should be available in the discovery metadata.



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Tools for decoding WMO data formats

Libraries for decoding BUFR & GRIB2:

ecCodes - ECMWF's official library for decoding/encoding GRIB1/2 and BUFR3/4 **(C, Fortran, Python)**

NCEPLIBS-bufr - NOAA's library for encoding/decoding BUFR messages (**Fortran, C**).

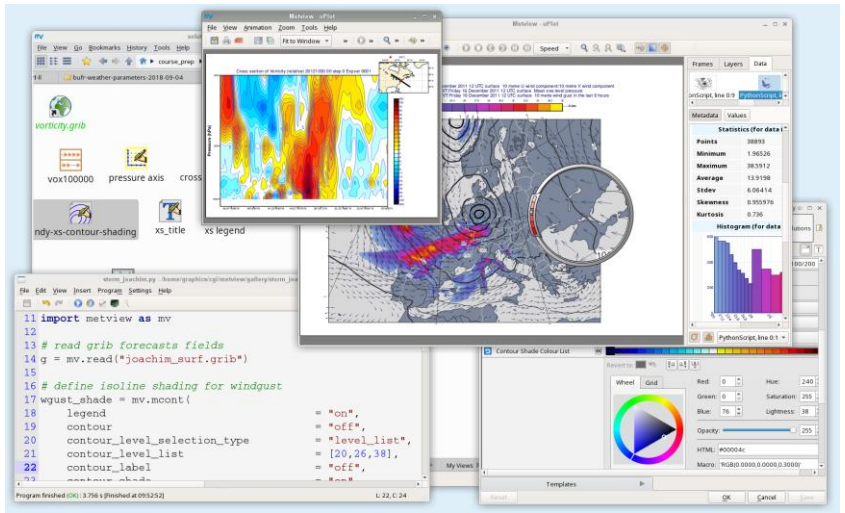
wgrib2 – NOAA's Utility and C library for decoding, subsetting, and regridding GRIB2 data **(C)**

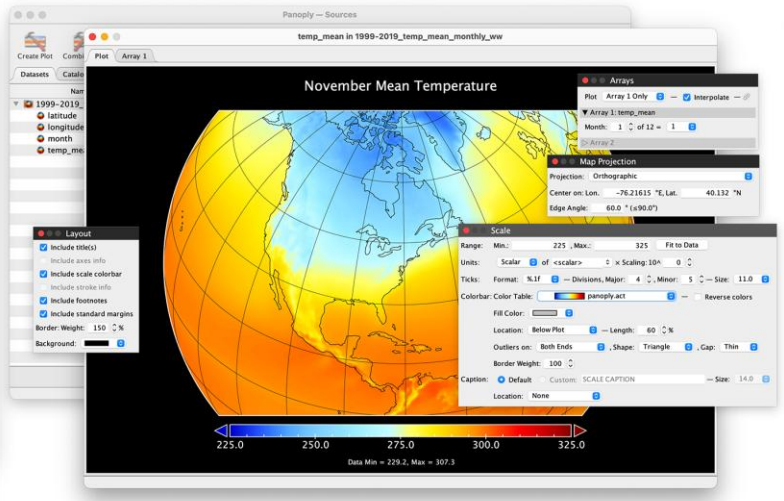
No-code solutions:

Panoply - a cross-platform application that plots geo-referenced and other arrays from NetCDF, HDF, GRIB, and other datasets

Metview - ECMWF's application for data analysis and visualization, which supports GRIB and BUFR formats

Integrated Data Viewer (IDV) - a free Java-based software framework for analyzing and visualizing geoscience data, including support for GRIB and NetCDF formats





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Summary: finding, download and decoding data on WIS2

Find new data by searching one of the Global Discovery Catalogue

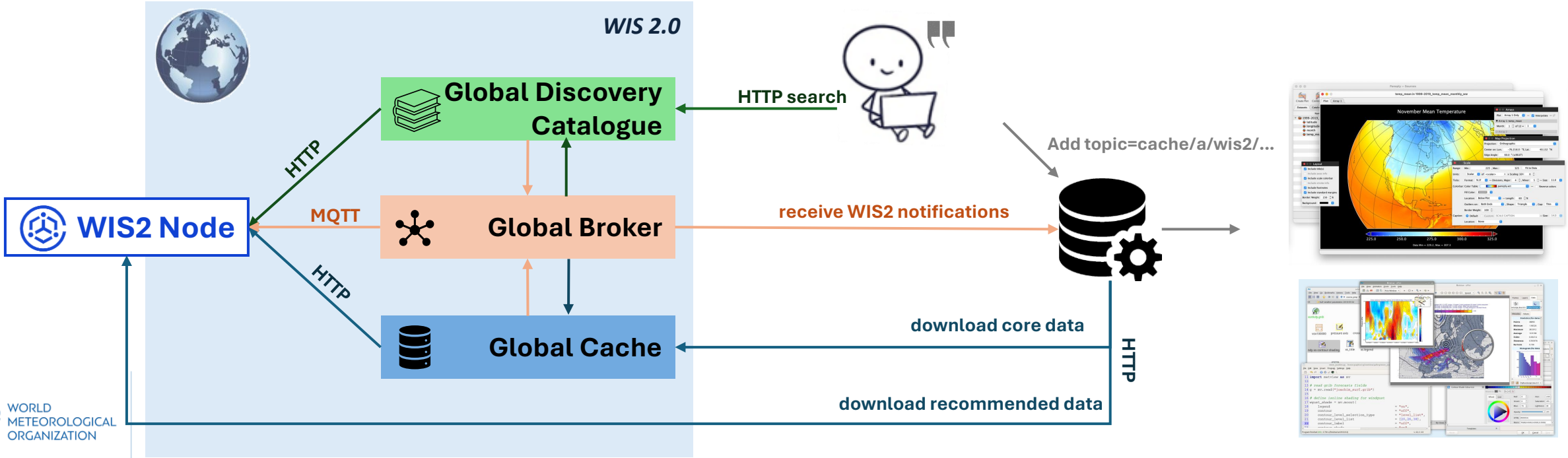
- Query the OGC API endpoint over HTTP or use tools like ‘pywiscat’

Setup an MQTT subscription and use the URL in the WIS2 notification to download the data

- Develop custom code using MQTT client libraries or use tools like ‘wis2downloader’

Process and decode the received data using different tools depending on the format

- Various software available for decoding WMO binary data formats



Practical exercises

PRACTICAL EXERCISES:

Practice working with the wis2downloader:
https://training.wis2box.wis.wmo.int/practical-sessions/downloading-data-from-wis2/

Example notebooks in Jupyter to decode GRIB2, BUFR4 and NetCDF
https://training.wis2box.wis.wmo.int/practical-sessions/decoding-data/

Thank you