Destination Earth Data Retrieval APIs: Earthkit, Polytope and more

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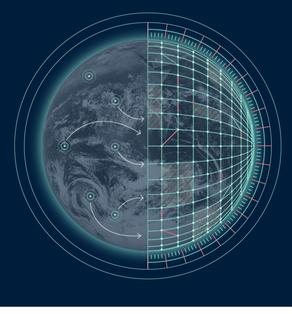
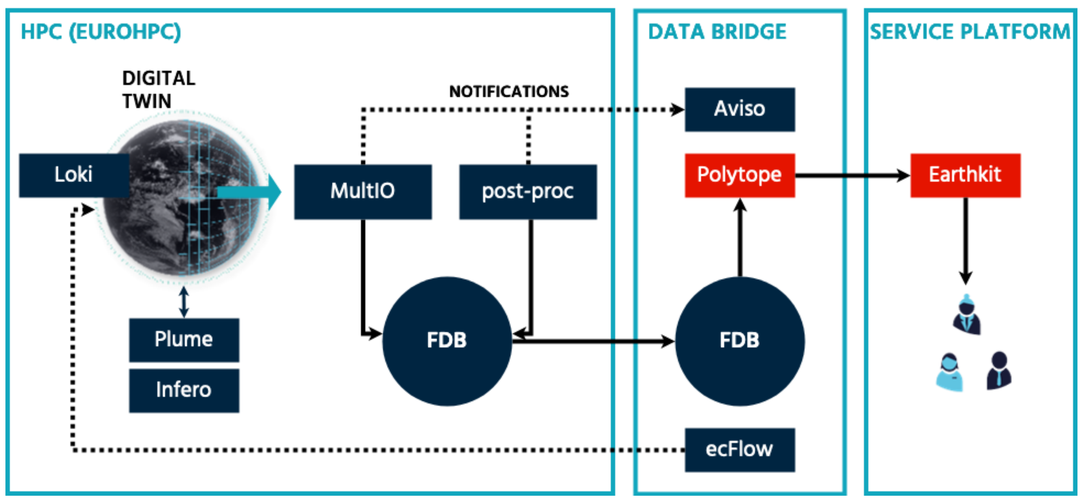


1. Introduction

ECMWF has developed the Polytope data service for data retrieval of the Destination Earth Digital Twin data, as part of the Digital Twin Engine. This poster focuses on the API to retrieve data from the Climate and Extremes digital twins.

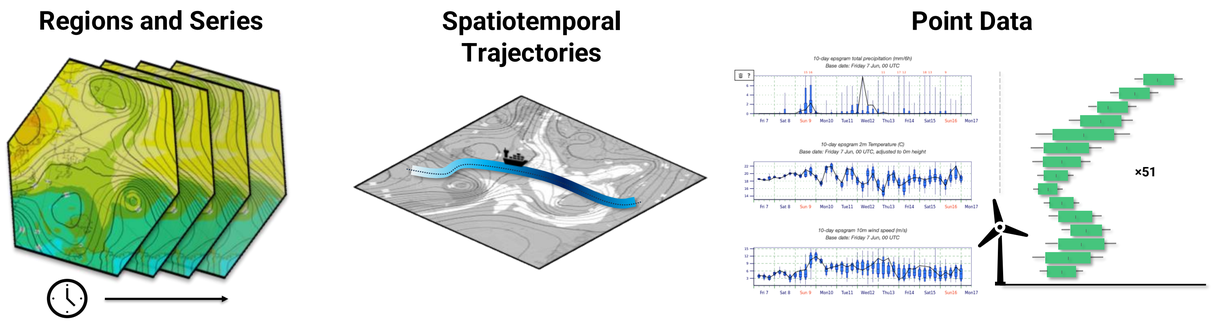
Earthkit, in conjunction with the Polytope Data Service, allows users to access whole fields from the digital twins, as well as extracting subsets of the data via Polytope "feature extraction" such as time series, polygons, and vertical profiles. Earthkit also contains a number of other modules that allow users to interpolate, regrid, plot, map, and process data they have retrieved.



ECWMF Digital Twin Engine (DTE) diagram highlighting Polytope and Earthkits position within the engine.

2. Polytope

Polytope is an open-source web service designed to provide efficient access to hypercubes of data in scientific analysis workflows and is able to federate access between hypercubes in distributed computing resources. It is designed to couple data-centric workflows operating across multiple platforms (HPC, cloud) and across multiple distributed sites. Users can access the Polytope service via the REST API exposed by Polytope, or via the Earthkit Python library.



Example features that polytope feature extraction is able to return.

Polytope has now been deployed to the Data Bridge on LUMI and users can access both Climate and Extremes Digital Twin data via Earthkit, either from their own infrastructure, or by using the Insula notebook service on the DESP.

3. Earthkit

Earthkit (https://github.com/ecmwf/earthkit-data) is a new open-source Python project led by ECMWF, providing powerful tools for speeding up weather and climate science workflows by simplifying data access, processing, analysis, visualisation and much more. Earthkit-Data acts as an access point for many of ECMWF's data retrieval services. It is easy to use and comes as part of an ecosystem including functionality for plotting, mapping, regridding and interpolation.

earthkit

earthkit.data

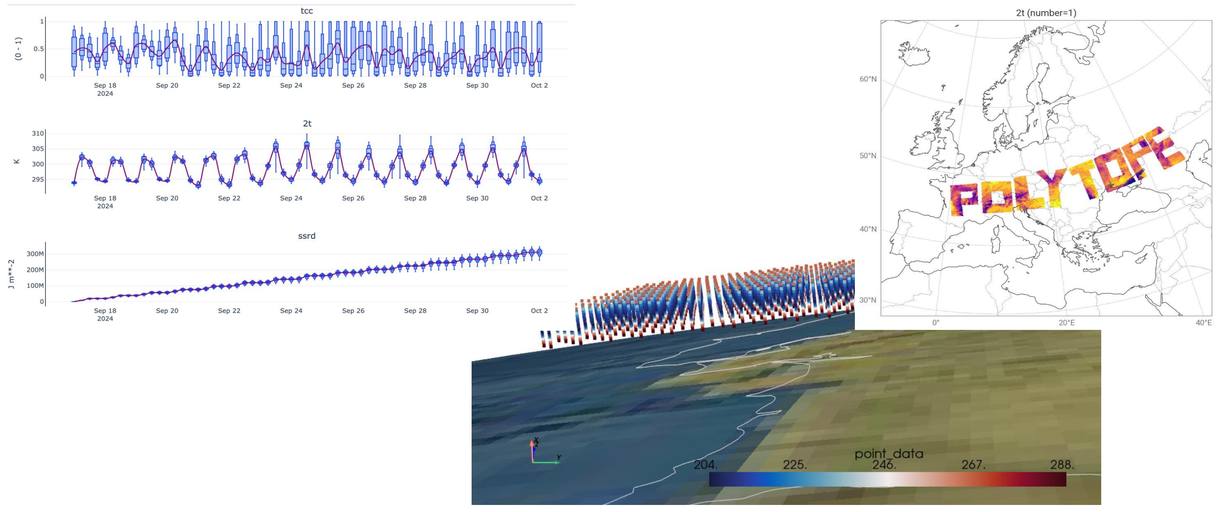
4. Feature Extraction

Polytope will also allow users to perform feature extraction. Feature extraction adds an extra dictionary field to a data request in the form of a feature, these features represent standard meteorological features such as time series, vertical profiles and arbitrary polygons, allowing users to only retrieve the data they need rather than a global field. This improves the speed at which users retrieve their data as well as lowering the size of the data transferred. This will be available for Destination Earth data in the coming weeks.

```
"feature" : {
  "axis" : "timeseries",
  "points": [[-9.10, 38.78]],
  "axis": "step",
}
```

```
"feature" : {
  "axis" : "polygon",
  "points": [[41.48, 1.91], [41.08, 1.91], [41.08,
2.52], [41.46, 2.56], [41.48, 1.91]],
  "axis": "step",
}
```

Examples of features that can be added to the polytope requests to return specific features, in this case a timeseries and a polygon. When using feature extraction a CoverageJSON is returned. CoverageJSON is an OGC community standard that is web friendly, human readable and interoperable. Earthkit provides tooling to handle both GRIB and CoverageJSON.



Plots of example output from polytope feature extraction, including a timeseries, polygon and vertical profiles

5. Installation

Installation of Earthkit is very simple. Detailed instructions can be found on the polytope-examples Destination Earth repository:

https://github.com/destination-earth-digital-twins/polytope-examples

Users require credentials to access Digital Twin data. These credentials can be obtained via the Destination Earth Service Platform:

https://platform.destine.eu

Users can also run Earthkit-Data via insula in a Jupyter notebook on the DESP which sets up much of the necessary software:

https://platform.destine.eu/services/service/insula-code

6. Usage

Using Earthkit-Data is also simple once it has been installed, and you have set your access token. You need to import Earthkit-Data and create a valid climate DT or Extremes DT request. An example of both can be found below.

```
import earthkit.data

# This request matches multiple parameter of the climate DT

request = {
  'class': 'd1',
  'dataset': 'climate-dt',        # Specifies the Climate DT Dataset
  'activity': 'ScenarioMIP',      # Specifies the CMIP Activity
  'experiment': 'SSP3-7.0',       # Specifies the CMIP Experiment
  'model': 'IFS-NEMO',            # Specifies the model used
  'realization': '1',             # Specifies the climate realization
  'generation': '1',              # Specifies the generation of the dataset
  'resolution': 'standard',       # Specifies the resolution high/standard
  'date': '20200102',
  'expver': '0001',
  'levtype': 'sfc',
  'param': '134/165/166',
  'stream': 'clte',
  'time': '0100',
  'type': 'fc'
}

data = earthkit.data.from_source("polytope", "destination-earth", request,
       address="polytope.lumi.apps.dte.destination-earth.eu")
```

```
import earthkit.data

# This request matches a single parameter of the extremes DT

request = {
  "class": "d1",
  "expver": "0001",
  "stream": "oper",
  "dataset": "extremes-dt",     # Specifies the Extremes DT Dataset
  "resolution": "standard",     # Specifies the resolution high/standard
  "date": "-10",
  "time": "0000",
  "type": "fc",
  "levtype": "sfc",
  "step": "0",
  "param": "167"
}
data = earthkit.data.from_source("polytope", "destination-earth", request,
       address="polytope.lumi.apps.dte.destination-earth.eu")
```

Example Climate DT and Extremes DT requests via Earthkit respectively. For further information on the new keys and values go to the ECMWF confluence website.

6. Conclusion

To access data from the Climate or Extremes Digital Twin users can do this via Earthkit-Data. All they require is the Python and the correct Destination Earth credentials. Users can also refine their request with the feature extraction functionality.

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Destination Earth

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