Monitoring Earthquakes in the Groningen gas field

A new, vast dataset openly available at KNMI

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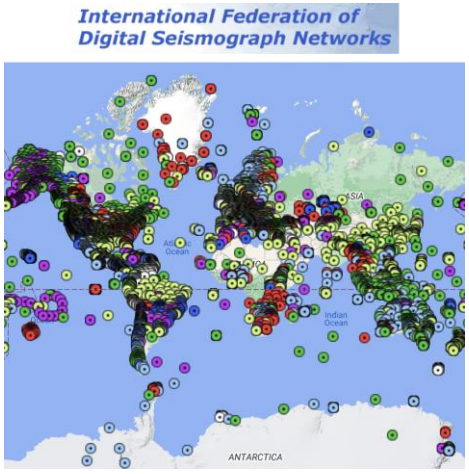
KNMI

2022-11-08

Context

National	Regional	Global
		
~300 stations	~17k stations	>60k stations

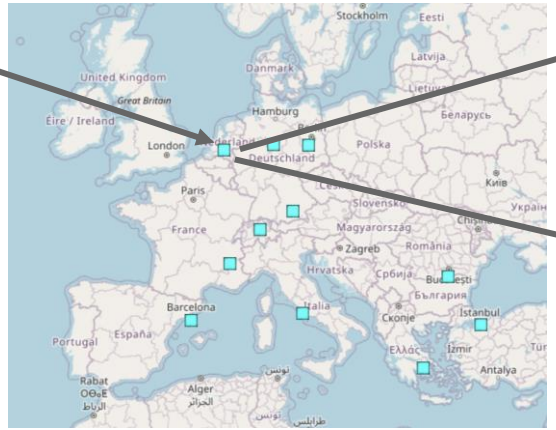
Challenges

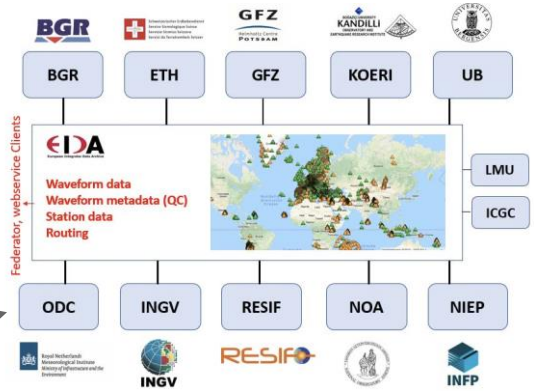
Challenges (random order):

- Standardisation of data and metadata
- Data quality and completeness
- Findability
- Transparent access (e.g. stakeholders, research communities)
- Data archiving
- Standardised (web) services
- Scalability
- New data types

European Integrated Data Archive

KNMI
ORFEUS DC
AWS





EPOS
EUROPEANPLATEOBSERVINGSYSTEM

FDSNWS-Event

rdsa.knmi.nl/fdsnws/event/1/query?eventid=knmi2022urye

```
▼<q:quakeml xmlns="http://quakeml.org/xmlns/bed/1.2" xmlns:q="http://quakeml.org/xmlns/quakeml/1.2">
  ▼<eventParameters publicID="smi:org.gfz-potsdam.de/geofon/EventParameters">
    ▼<event publicID="smi:org.gfz-potsdam.de/geofon/knmi2022urye">
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          <type>nearest cities</type>
        </description>
      ▼<description>
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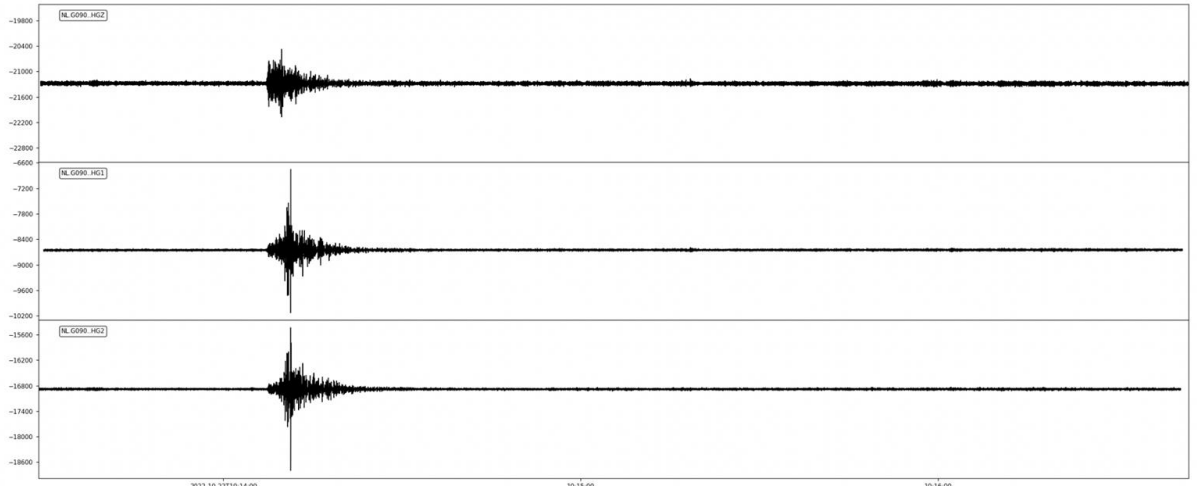
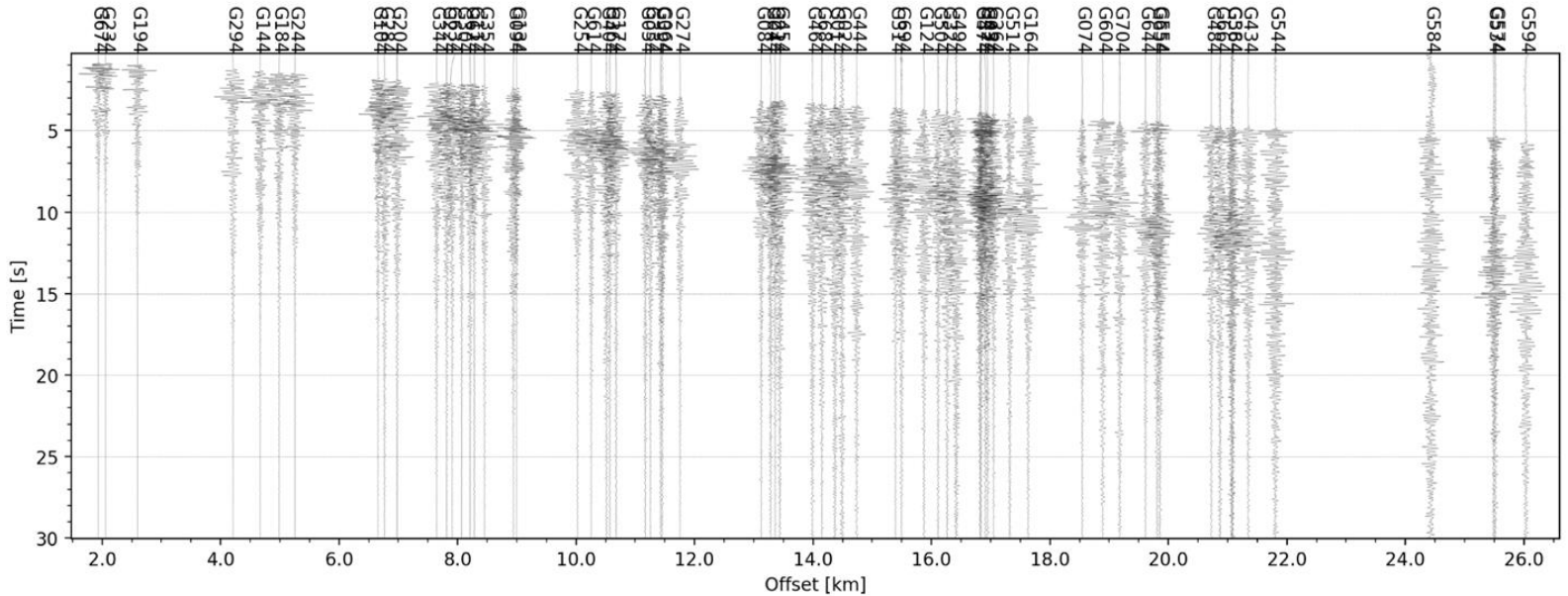
FDSNWS-Dataselect

orfeus-eu.org/fdsnws/dataselect/1/query?network=NL&station=G090&start=2022-10-22T10:14:05&end=2022-10-22T10:14:40



M2.2 Wirdum event (2022-10-22. 10:14:04)



FDSNWS-Station

orfeus-eu.org/fdsnws/station/1/query?network=NL&station=G090&level=channel

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▼<FDSNStationXML xmlns="http://www.fdsn.org/xml/station/1" schemaVersion="1.1">
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    <Description>Netherlands Seismic and Acoustic Network</Description>
   ▼<Station code="G090" startDate="2015-09-18T00:00:00" restrictedStatus="open">
      <Latitude>53.387764</Latitude>
      <Longitude>6.724525</Longitude>
      <Elevation>2</Elevation>
     ▼<Site>
        <Name>Oldenzijl (niveau 0)</Name>
        <Country>The Netherlands</Country>
      </Site>
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     ▼<Channel code="HG1" startDate="2015-09-18T00:00:00" restrictedStatus="open" locationCode="">
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        <Elevation>2</Elevation>
```
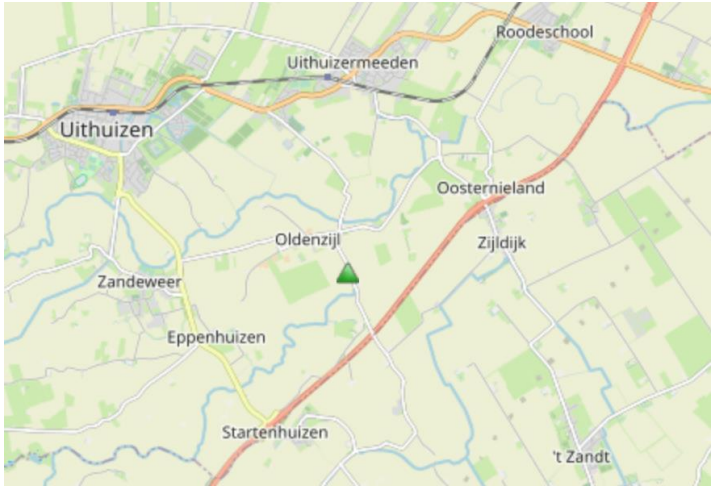
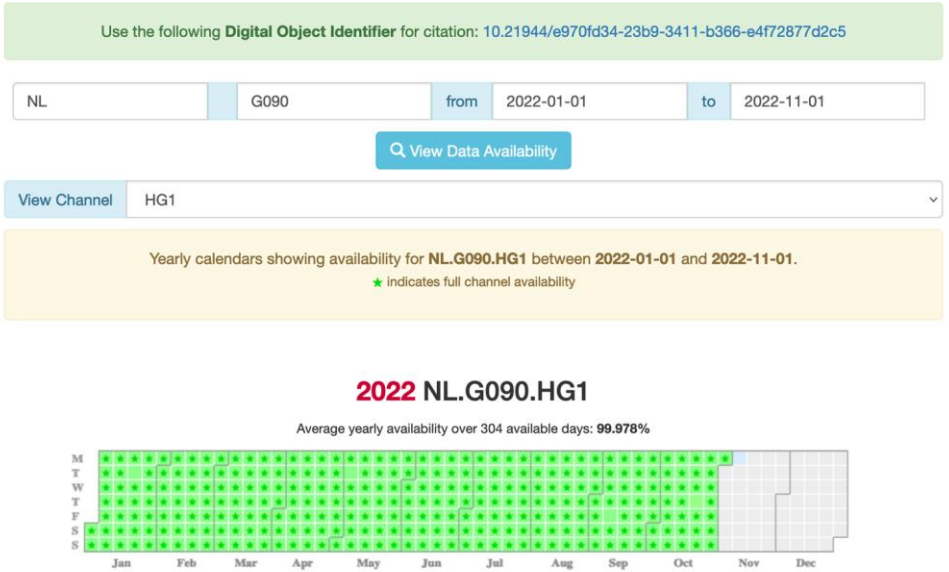

EIDAWS-WFCatalog



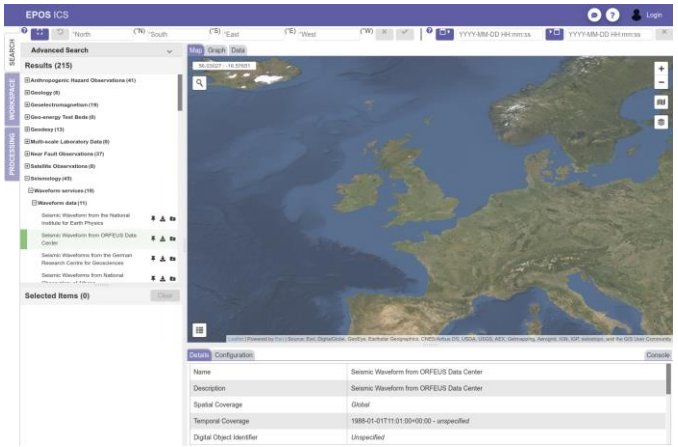


orfeus-eu.org/eidaws/wfcatalog/1/query?net=NL&sta=G090&start=2022-01-01&end=2022-11-01

Other tools and services

- EIDAWS-Routing
  orfeus-eu.org/eidaws/routing
- WebDC3
  orfeus-eu.org/webdc3
- Station Book
  orfeus-eu.org/stationbook
- RRSM
  orfeus-eu.org/rrsm
  rdsa.knmi.nl/rrsm
- Data Quality Tools
  orfeus-eu.org/data/eida/quality

Clients



ics-c.epos-eu.org

ObsPy

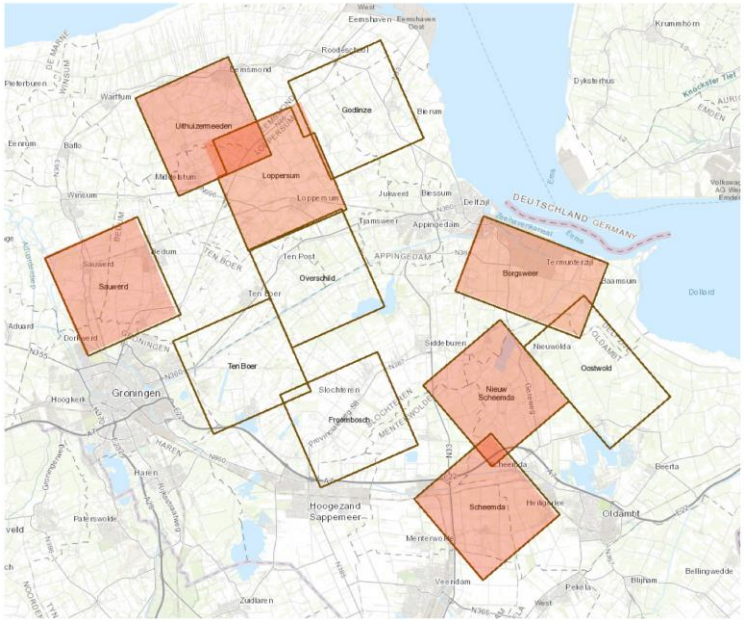
A Python Framework for Seismology

github.com/obspy

NAM Dataset

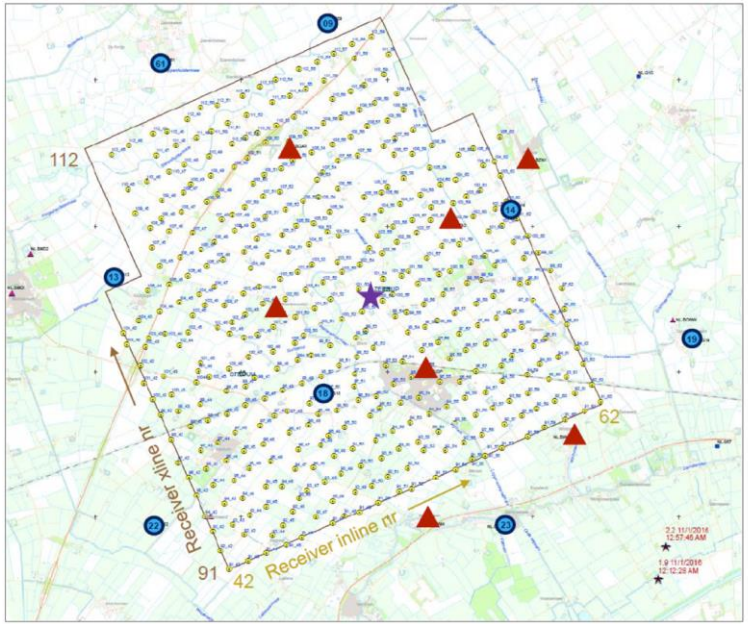
50 TB dataset provided by NAM (Shell) in Groningen

- Flexible geophone network of 400 stations (grid 350 x 350 m); deployed in stages in various areas across the Groningen field
- Recording dynamite refraction shots
- Downhole monitoring arrays in wells at Stedum, Zeerijp and Harkstede, at reservoir depth ~ 3 km
- Time span: early 2014 to late 2018



Overview flexible VS800 spreads

Loppersum deployment



★ ZRP location

● KNMI G station

▲ KNMI B station

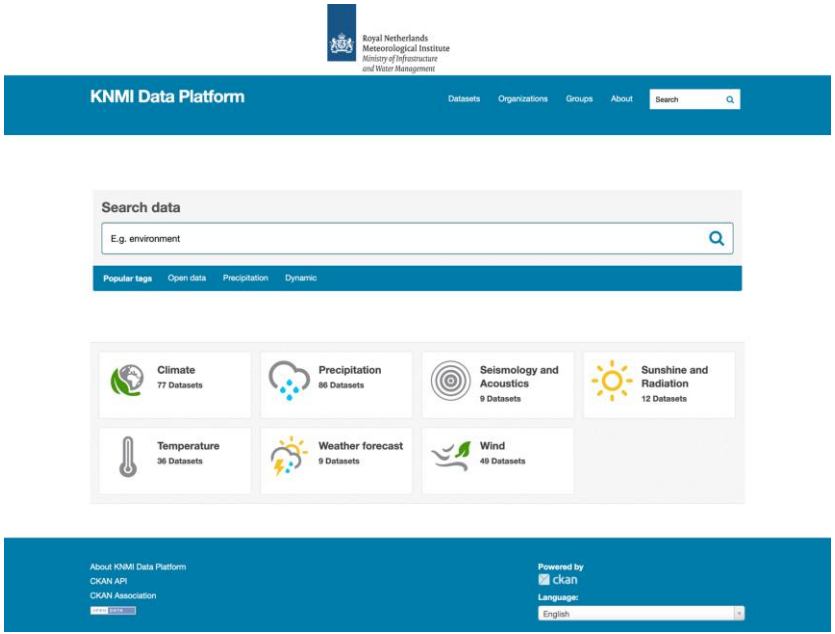
2 recorded earthquakes

The investigation

- Heterogeneous dataset with multiple file formats (SEG-Y, SEG-D, MIRF)
- Rich and specific metadata embedded in the (extended) headers of the files
- Limited compatibility with EPOS
  - Conversion from original data to SEED (time series) and StationXML (metadata) would require information loss (e.g. water depth, weathering velocity)
- Use of commercially licensed software (Avalon)
- Accompanying data sheets, manuals and maps which could not be converted

KNMI Data Platform

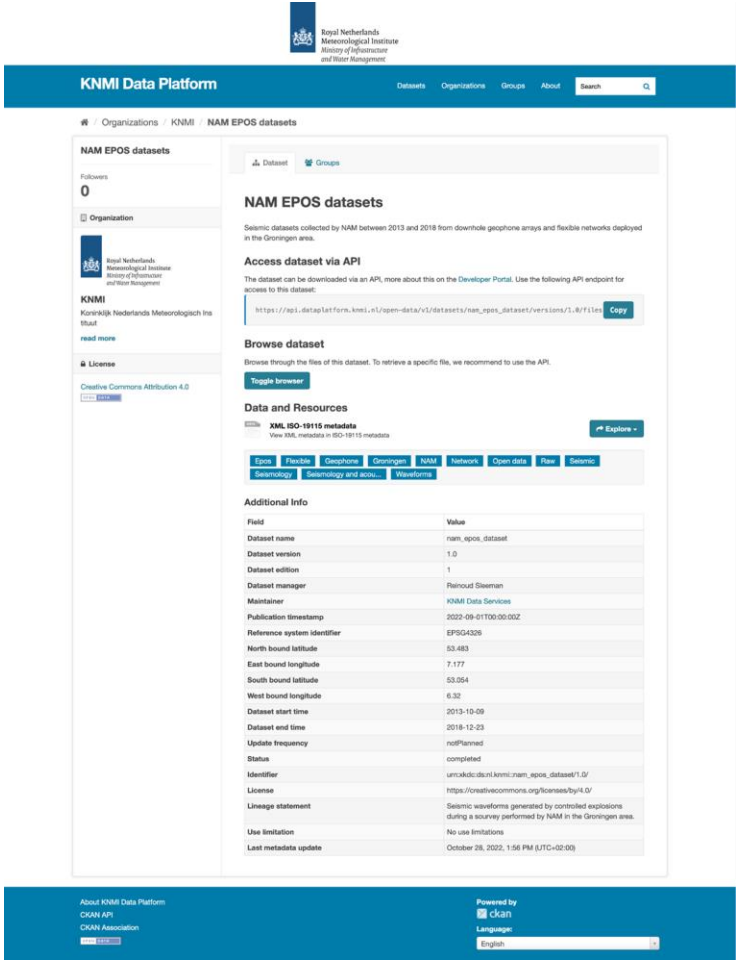
- Access to full, original dataset with all additional resources has been granted using KNMI Data Platform.
- CKAN-based
- Data stored in AWS S3 bucket
- Dedicated KDP team



KNMI Data Platform

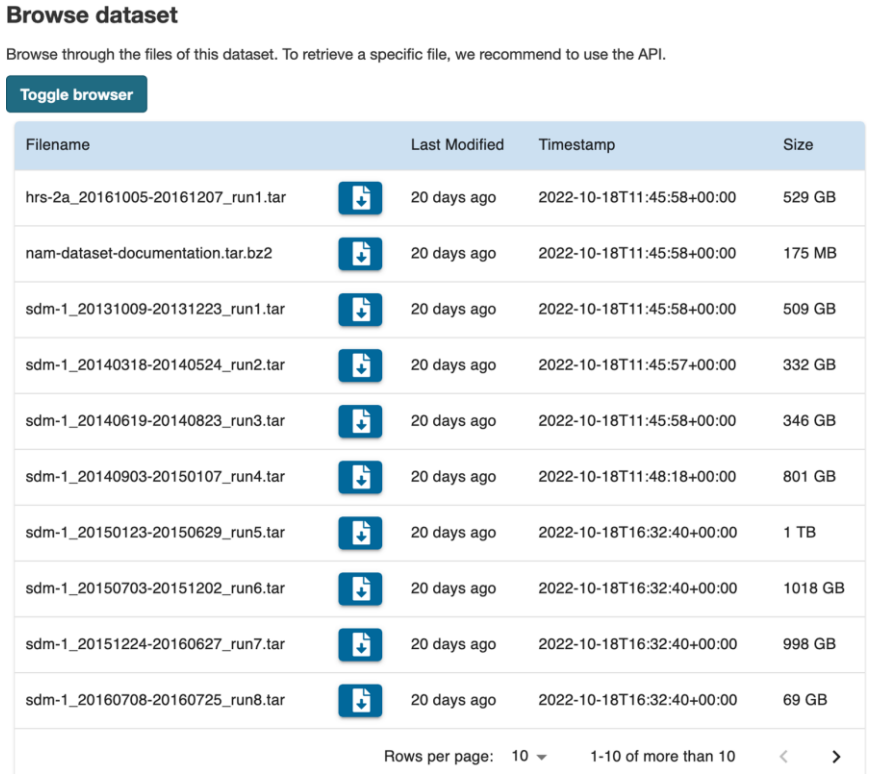
Raw data is openly available at KNMI Data Portal (archives for each survey / experiment):

dataplatform.knmi.nl/dataset/nam-epos-dataset-1-0



KNMI Data Platform

- One archive per experiment phase (27)
- One file with dataset documentation (nam-dataset-documentation.tar.bz)
- Total data volume compressed from >50TB → ~25TB



Browse dataset

Browse through the files of this dataset. To retrieve a specific file, we recommend to use the API.

Toggle browser

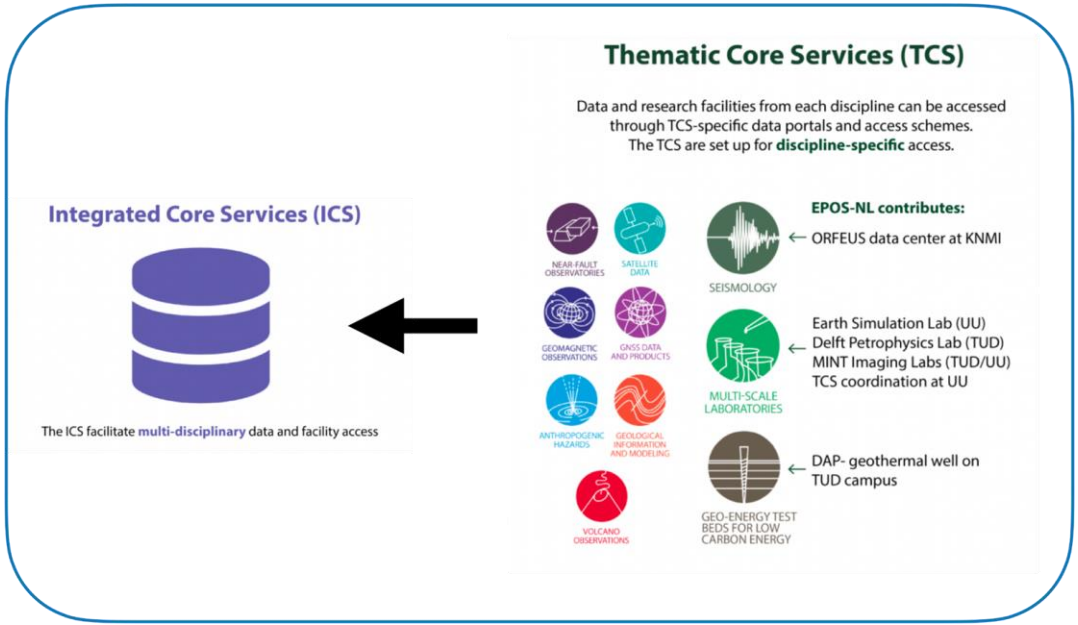
Filename	Last Modified	Timestamp	Size
hrs-2a_20161005-20161207_run1.tar	20 days ago	2022-10-18T11:45:58+00:00	529 GB
nam-dataset-documentation.tar.bz2	20 days ago	2022-10-18T11:45:58+00:00	175 MB
sdm-1_20131009-20131223_run1.tar	20 days ago	2022-10-18T11:45:58+00:00	509 GB
sdm-1_20140318-20140524_run2.tar	20 days ago	2022-10-18T11:45:57+00:00	332 GB
sdm-1_20140619-20140823_run3.tar	20 days ago	2022-10-18T11:45:58+00:00	346 GB
sdm-1_20140903-20150107_run4.tar	20 days ago	2022-10-18T11:48:18+00:00	801 GB
sdm-1_20150123-20150629_run5.tar	20 days ago	2022-10-18T16:32:40+00:00	1 TB
sdm-1_20150703-20151202_run6.tar	20 days ago	2022-10-18T16:32:40+00:00	1018 GB
sdm-1_20151224-20160627_run7.tar	20 days ago	2022-10-18T16:32:40+00:00	998 GB
sdm-1_20160708-20160725_run8.tar	20 days ago	2022-10-18T16:32:40+00:00	69 GB

Rows per page: 10 1-10 of more than 10

EPOS ICS integration

Next milestone:

Enable access to the data via the **EPOS Central Data Portal** (ICS-C), e.g. web service providing information on the data subsets.



Thank you!

www

knmi.nl
orfeus-eu.org

github

github.com/eida
github.com/eida/userfeedback

e-mail

jarek.bienkowski@knmi.nl