MARS – Introduction and basic concepts

MS Computing training course

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MARS intorduction, basic concepts, and advance use

Meteorological Archival and *Retrieval* System

- Meteorological data (GRIB: fields, BUFR, ODB: observations)
- Large amount of data (size of archive & number of fields)
- Operational & Research environment
- Batch & interactive modes
- Large number of users with different requirements:

  large datasets rarely ↔ few fields very often

- Heterogeneous environment

# Introduction – MARS components

- Client/Server architecture
- Clients: Atos HPCF and Web MARS virtual machine
- Servers: supercomputers, dedicated servers
- Several databases
- Tape library

request

client → server
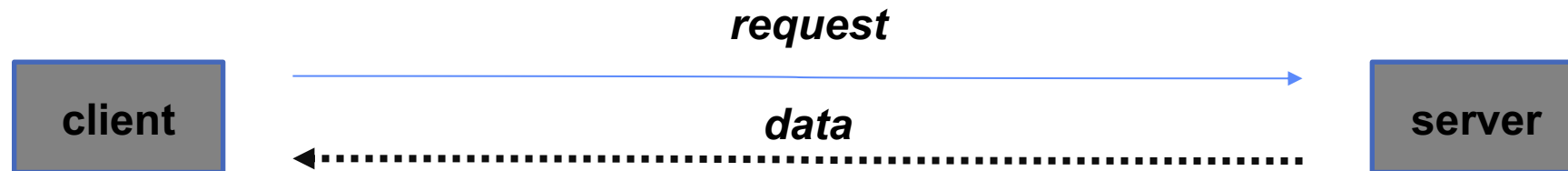
data

MARS Architecture – Servers

- Reports Database (RDB), on-line observations (for Operations only)

- Fields Database (FDB)

  - Data produced by most recent cycles or experiments

  - Very fast access (on-line data)

  - Suitable for model input

- ODB server, on-line ODB on supercomputer

- Main Archives (multiple servers)

  - Dedicated Linux servers / clustered architecture

  - Terabytes of disk space

  - Tape management SW: HPSS

  - Automated Tape Libraries: IBM and SpectraLogic

6 MARS-es (and a few FDBs)

marsrd

marsod

marser

marsms

marsth

marsode

request

data

client

fdb-bc

fdb

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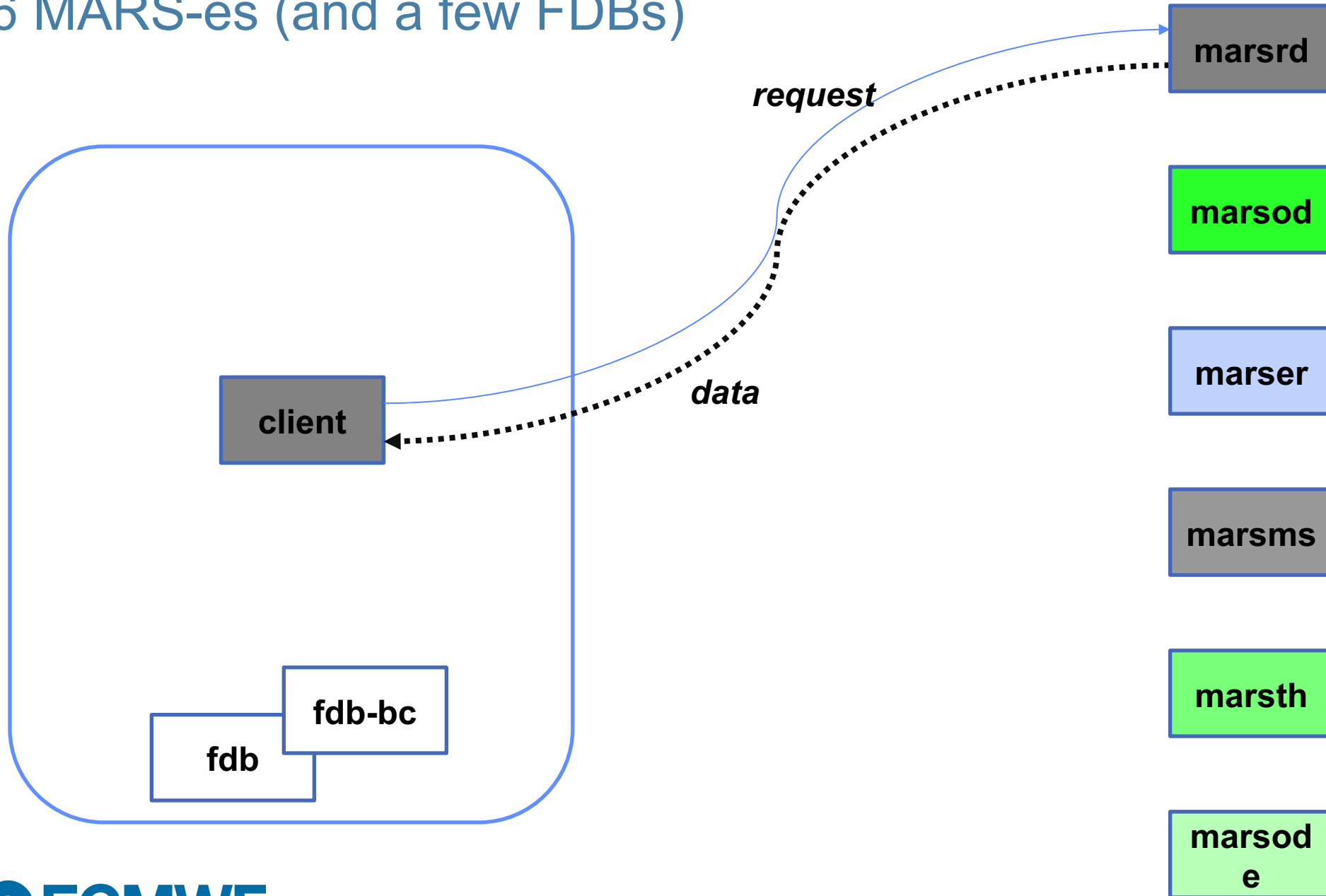
Introduction – Some figures

- > 450 PB of data in

- > 400 TB archived per day

- ~ 8000 users with access to MARS

- 1000 active users/day executing ~ 1.5 million requests/day

- ~ 350 TB retrieved daily on average (100 TB / day in 2017) with

    peaks over 600 TB/day

- Only 2.6 % of the data is on disk

- Operational forecast since 1985

- Analysis, forecast and observations since 1900 (ERA-20C)

What is a PiB?
(Assuming reading from/writing to disk at 100 MiB/s)

	Bytes	Seconds	Days	Months
MiB	1,048,576	0.01		
GiB	1,073,741,824	~10		
TiB	1,099,511,627,776	10,485	0.12	
PiB	1,125,899,906,842,624	10,737,418	124	**> 4**

Copying 1 PiB | ████████ **| 99 days, 13:07:39**
remaining

Tape libraries

Terminology – Forecast lead times

- ## Medium-range

  the high-resolution and the ensemble forecasts of weather, at the space and time-scales represented by the relevant model, up to 10 and 15 days ahead, respectively, and the associated uncertainty

- ## Extended-range (monthly)

  ensembles of individual forecasts and post-processed products of average conditions (e.g. weekly averages) up to 46 days ahead, and the associated uncertainty

- ## Long-range (SEAS)

  ensembles of individual forecasts and post-processed products of average conditions (e.g. monthly averages) up to 13 months ahead, and the associated uncertainty

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Terminology – … more

- ## Re-forecast

  forecasts run for past decades necessary to estimate the model climate

  and the level of skill and to generate some of the operational products

- ## IFS

  `Integrated Forecasting System`, *the system* used at ECMWF

  https://confluence.ecmwf.int/display/DAC/File+naming+convention+and+format+for+real-time+data

  www.ecmwf.int/en/forecasts/documentation-and-support

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Meteorological content – Reanalysis datasets

Access to ECMWF Public DataSets

- TIGGE

- S2S

- Can be download from a web browser or using Web API python client

- https://apps.ecmwf.int/datasets/

- https://confluence.ecmwf.int/display/DAC/Decommissioning+of+ECMWF+Public+Datasets+Service

Meteorological content – Data formats

WMO formats

- Fields in GRIB (GRid In Binary) v 1 and 2, ECMWF local extensions

  - Spherical Harmonics (upper-air fields, $T_{CO}1279$)

  - Gaussian Grid (surface fields, O1280)

  - Latitude/Longitude (wave and ocean products)

- Observations in BUFR (Binary Universal Form Representation)

  - Instrument specific

ECMWF/IFS format

- ODB (Observational Data Base)

  - Observation feedback

MARS language

Mechanism to *name* fields

Request syntax:

```
verb,
    keyword1    = value1,
    …           = value2,
    keywordN    = valueN
```

- verb: action to be taken (e.g. retrieve, list, read)

- keyword: a known MARS variable, e.g. type or date

- value: value assigned to the keyword, e.g. Analysis or temperature

- Description of all keywords is available in Confluence:

https://confluence.ecmwf.int/display/UDOC/Keywords+in+MARS+and+Dissemination+requests

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MARS language

- verb and keyword=value separated by commas, but last one

- Spaces and tab characters are ignored

- *, ! and # comment until end-of-line

- Directives are not case sensitive

- Values: predefined names, numeric values or strings (filenames)

- Abbreviations: enough letters to uniquely identify keyword or value

- Acronyms: usually initial letters of names

- / is used as list separator → specify pathnames in quotes

MARS language – Retrieve request

```
retrieve,                                    action
        class      = od,                     identification
        stream     = oper,
        expver     = 1,

        date       = -3,                     date & time related
        time       = 12,

        type       = analysis,               data related
        levtype    = model levels,
        levelist   = 1/to/137,
        param      = 130,

        grid       = 2.5/2.5,                post-processing

        target     = "analysis"             storage
```

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MARS language – Identification of archive

class ECMWF classification (od, rd, ea, …)

stream originating forecasting system or (oper, wave, enfo, seas, …)

expver version of the experiment (01 operational, 11, aaaa)

domain area covered by the data (Global, Mediterranean, …)

origin originating centre of the data (kwbc, egrr, …)

system seasonal forecast operational system (1, 2, 3)

method to specify how the seasonal forecast is produced, e.g. in System 2,

     method=0 for runs without ocean assimilation (0, 1, …, 3)

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MARS language - Date & time

time   base time or observation time (00, 06, 09:30, …)

date   base date of the model (-1, 20010225, …)

step   forecast time-step [hours] from base time (12, 24, 240, …)

reference   reference forecast time step for EPS tube (96,…)

refdate   date of real-time forecast associated to re-forecast/hindcast (stream=mnfh)

hdate   base date of a re-forecast/hindcast (stream=enfh)

range   observations: period in minutes from base time (360,…)
                  ocean fields: extension of the time series/average

fcmonth   month from seasonal forecast base date (1, 6, …)

fcperiod   period, in days, for an averaged field (26-32)

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MARS language – Fields

type	type of field (an, fc, …)
levtype	type of level (pl, ml, sfc, pt, pv)
levelist	levels for the specified levtype (off if levtype=sfc)
param	meteorological parameter (t, temperature, 130, 30.128)
number	ensemble member (1, 2, …)
channel	brightness temperature frequency band
diagnostic, iteration	sensitivity forecast products
frequency, direction	2-d wave spectra products
product, section, latitude, longitude	ocean products

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MARS language – Observations & images

type   type of observations or images (ob, fb, ai, af, im)

obstype   observation subtype (s, air) or image channel

ident   WMO observation station number or satellite identifier

duplicates   whether duplicated observations are to be kept or not

block   WMO block number for observation

time   analysis time (types ai, af) or observations time (types ob, fb, im)

range   denotes the period, in minutes, starting from time

MARS language – Storage

target   UNIX pathname where retrieved data is stored

source   UNIX pathname from where to read data

fieldset   temporary storage; can be considered a MARS variable

Unix pathnames (using /) have to be enclosed in quotes, e.g.

`target = "/scratch/{uid}/analysis"`

MARS language - Post-processing (1/2)

grid   output grid mesh

- Latitude/longitude increments in degrees (2.5/2.5)

- Type and resolution of Gaussian grid, e.g.

  - grid = F320 – full (or regular) Gaussian grid

  - grid = N320 – ECMWF original reduced Gaussian grid (only selected resolutions supported)

  - grid = O320 – ECMWF octahedral (reduced) Gaussian grid:
    https://confluence.ecmwf.int/display/FCST/Introducing+the+octahedral+reduced+Gaussian+grid

All above with 320 latitude lines between the pole and equator
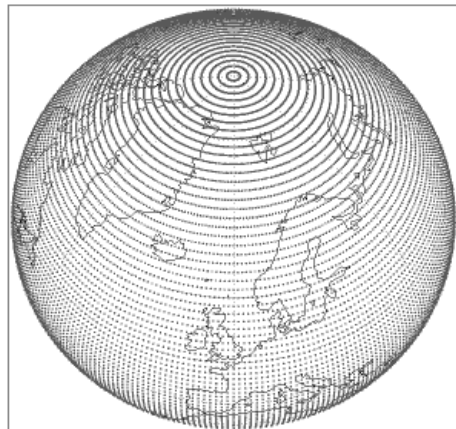
F80 regular (or full)   *N80 original reduced*   *O80 octahedral reduced*
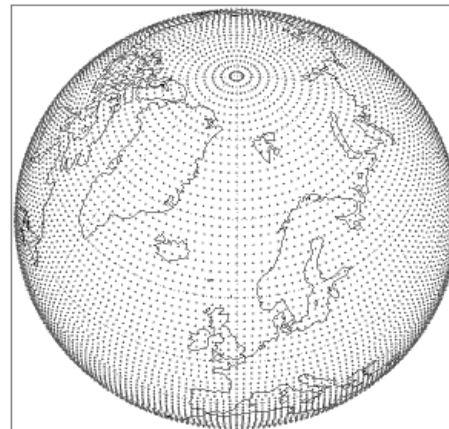
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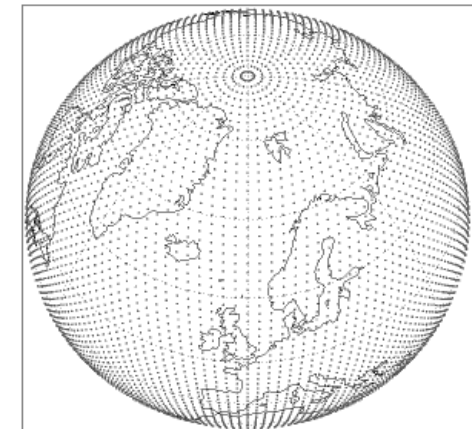
MARS language - Post-processing (2/2)

area desired sub-area in degrees (north/west/south/east) e.g. area=75/-25/10/60

frame number of grid points from sub area inwards (5)

truncation, intgrid
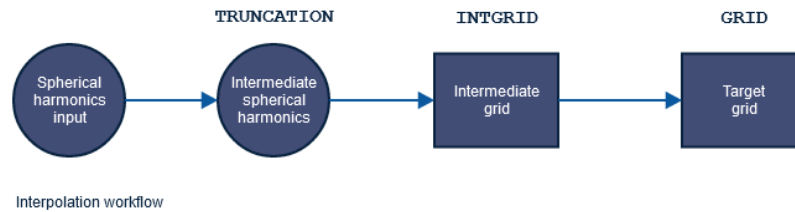
rotation lat/lon of South Pole

accuracy number of bits per data value in GRIB (16)
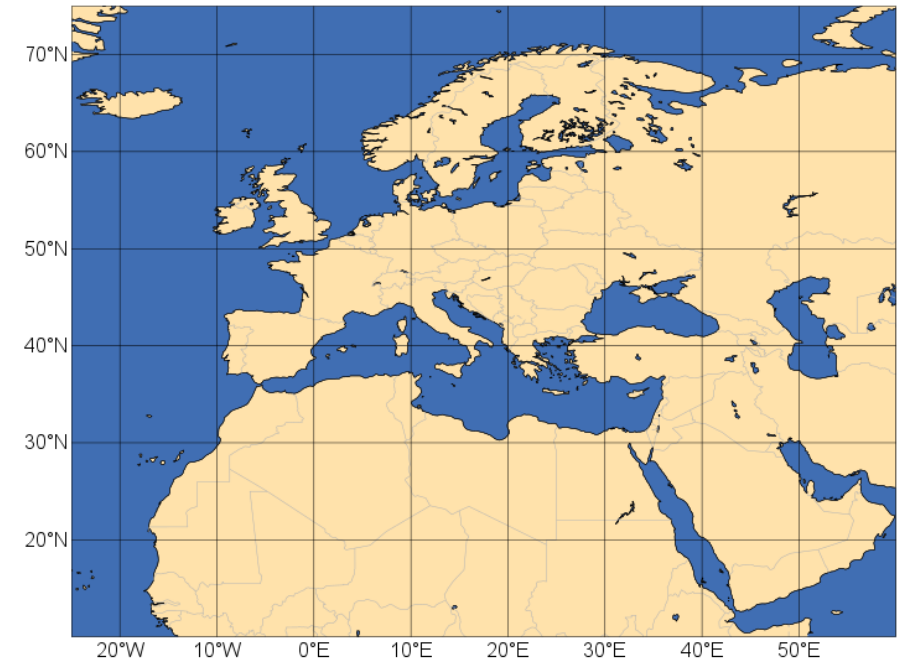
MARS language – Execution control

expect   number of expected fields (1000, any, …)

database   where to look for the data

use   hint about frequency of use (infrequent)

MARS language – Values

- Expected number of fields is computed by multiplying number of values after expansion of ranges

  date = 20020101/to/20020131,   31 days

  param = 165.128/166.128/235.128,   3 parameters

  93 fields in total

- Certain keywords accept all as valid value

  levelist = all

- Most keywords accept off as valid value

  levtype = surface,

  levelist = off

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Request examples – Operational analysis

Retrieval of sea surface temperature for first 10 days of May 2002, all synoptic times. It retrieves 40 fields.

```
retrieve,
      class   = od,
      stream  = oper,
      expver  = 1,
      date    = 2023-10-01/to/2023-10-10,
      time    = 00/06/12/18,
      type    = an,
      levtype = sfc,
      param   = 34.128,
      target  = "an.grb"
```

Retrieving data – Calling MARS in a script

- directives from input stream

```
mars <<EOF
retrieve,
   type   = an,
   date   = -7,
   target = "$SCRATCH/my_an"
EOF
```

- directives from file

```
cat > my_request <<EOF
retrieve,
   type   = an,
   date   = -7,
   target = "$SCRATCH/my_an"
EOF
mars my_request
```

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Retrieving data – Hints

- Default values: minimize their use

- No semantic check (only syntax is checked)

- MARS messages

  - INFO   request execution and <u>report</u>

  - WARNING   unusual aspect of execution

  - ERROR   system or data errors

  - FATAL   terminates execution

MARS Catalogue – apps.ecmwf.int/mars-catalogue/

Web interface to entire archive content

- Content browsing of *every* field in the archive

  - more up to date than static content documentation

- URL based on MARS requests (can be edited & bookmarked)

- Real-time (dynamic access to metadata)

- Create MARS requests (without checking availability)

- Check availability of data

- Retrieval in GRIB and NetCDF for few fields

MARS Catalogue

- **https://apps.ecmwf.int/mars-catalogue/**

MARS Catalogue

MARS activity – apps.ecmwf.int/mars-activity/

Server activity / MARS queue

- Show system activity

- Monitor your requests

- Learn how the queuing system works
  - Reason for queued requests

MARS server activity
195 active jobs / 271 total jobs
Sort by: user

My activity
No activity for user usbk

Other activity

| 1210842581@qq.com | RETRIEVE | TI | SFC | bol-webmars-public-svc-blue-005 | 12 hours 21 minutes 40 seconds |

QUEUED | On marsth-core, the total number of Requests from ECMWF Web API with more than 10 tape mounts [source] is limited to 1

34,100 fields, 3.89262 Gbytes online, 36.8454 Gbytes on 14 tapes warning: accessing damaged tages XD024500, XD033400, nodes: hpss mvr000 mvr001, libraries: ibmlib08

| 3277409407@qq.com | RETRIEVE | TI | SFC | bol-webmars-public-svc-blue-006 | 13 hours 1 minute 10 seconds |

QUEUED | On marsth-core, the total number of Requests from ECMWF Web API with more than 10 tape mounts [source] is limited to 1

600 fields, 26.1764 Mbytes on 17 tapes, nodes: hpss, libraries: ibmlib08

| 18008349012@163.com | RETRIEVE | TI | SFC | bol-webmars-public-svc-blue-004 | 12 hours 54 minutes 9 seconds |

QUEUED | On marsth-core, the total number of Requests from ECMWF Web API with more than 10 tape mounts [source] is limited to 1

161,200 fields, 1.95335 Gbytes online, 6.39095 Gbytes on 33 tapes, nodes: hpss mvr000 mvr001, libraries: ibmlib04 ibmlib08

| camsprod3583 | RETRIEVE | MC | 20170901 | compute-0003.camsprod.copernicus-atmosphere.eu | 34 minutes 25 seconds |

240 fields, 61.274 Mbytes on 1 tape, nodes: hpss, libraries: ibmlib07

Reading retrieved data - tools

Some useful tools

- `ecCodes`

   - `grib_ls, grib_dump,…`

- Metview examiners

   - `metview -e <grib|bufr|netcdf|odb> <file>`

- CDO - Climate Data Operators

   - See https://code.zmaw.de/projects/cdo

MARS Architecture - Request execution

1) Check syntax (MARS language and request syntax)

2) Print request to be processed

3) Query all Supercomputer's FDB

4) Query main archives (if data not in FDB)

5) Transfer data

6) Post-processing while transferring (if needed)

7) Report on result

Request execution (1/3) – checking MARS language and request syntax

```
mars - INFO  - 20231029.192717 - Welcome to MARS
mars - INFO  - 20231029.192717 - MARS_HOME=/usr/local/apps/mars/configs/prod
mars - INFO  - 20231029.192717 - MARS Client build stamp: 20231005140652
mars - INFO  - 20231029.192717 - MARS Client bundle version: 6.33.16.2
mars - INFO  - 20231029.192717 - package mars-client version: 6.33.16
mars - INFO  - 20231029.192717 - package mir version: 1.18.0
mars - INFO  - 20231029.192717 - package odc version: 1.4.6
mars - INFO  - 20231029.192717 - package fdb version: 5.11.23
mars - INFO  - 20231029.192717 - package metkit version: 1.10.15
mars - INFO  - 20231029.192717 - package eckit version: 1.24.4
mars - INFO  - 20231029.192717 - package eccodes version: 2.32.0
retrieve,
    class=od,
    date=-7,
    expver=1,
    levtype=sfc,
    param=165.128/166.128,
    step=24,
    stream=oper,
    time=12:00:00,
    type=fc,
    area = europe,                 # As the area is not compatible with the grid,
    grid = 0.57/0.57,              # MARS will expand the area to make it fit.
    target = "/ec/res4/scratch/usbk/10u_10v.grb"


mars - INFO  - 20231029.192717 - Processing request 1
```

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Request execution (2/3) – print request

```
RETRIEVE,
     CLASS      = OD,
     TYPE       = FC,
     STREAM     = OPER,
     EXPVER     = 0001,
     REPRES     = GG,
     LEVTYPE    = SFC,
     PARAM      = 165.128/166.128,
     DATE       = 20231022,
     TIME       = 1200,
     STEP       = 24,
     DOMAIN     = G,
     TARGET     = "/ec/res4/scratch/usbk/10u_10v.grb",
     RESOL      = AUTO,
     AREA       = 73.5/-27/33/45,
     GRID       = 0.57/0.57
```

MARS intorduction, basic concepts, and advance use

Request execution (3/3)

```
                      mars – INFO   – 20231029.192717 – Requesting 2 fields
    Query FDB  {      mars – INFO   – 20231029.192717 – FDB home /home/fdbprod
                      mars – INFO   – 20231029.192717 – FDB home /home/fdbbc
                      mars – INFO   – 20231029.192717 – Setting SO_SNDBUF to 33554432 (32.00 M)
                      mars – INFO   – 20231029.192717 – Current value is 32768 (32.00 K)
                      mars – INFO   – 20231029.192717 – Setting SO_RCVBUF to 33554432 (32.00 M)
                      mars – INFO   – 20231029.192717 – Current value is 43690 (42.67 K)
                      mars – INFO   – 20231029.192717 – Calling mars on 'marsod-core', local port is 48587
    Query main        mars – INFO   – 20231029.192717 – Callback at address 10.100.192.202, port 48587
    archive because   mars – INFO   – 20231029.192717 – Mars client is on ac6-202.bullx (10.100.192.202) 48587
    the data wasnot   mars – INFO   – 20231029.192717 – Mars server is on 10.112.5.10 42673
    found in FDB      mars – INFO   – 20231029.192717 – Server task is 270 [marsod]
                      mars – INFO   – 20231029.192717 – Request cost: 2 fields, 25.1858 Mbytes online, nodes: mvr004 [marsod]
                      mars – INFO   – 20231029.192717 – The efficiency of your requests in the last 12 hours is 100% [marsod]
    Transfering data  mars – INFO   – 20231029.192717 – Transfering 26409176 bytes
    and postprocessing mars – INFO  – 20231029.192718 – 2 fields retrieved from 'marsod'
                      mars – INFO   – 20231029.192718 – 2 fields have been interpolated on 'ac6-202.bullx'
                      mars – INFO   – 20231029.192718 – Request time:  wall: 1 sec
                      mars – INFO   – 20231029.192718 –   Read from network: 25.19 Mbyte(s) in < 1 sec [140.77 Mbyte/sec]
    Reporting results mars – INFO   – 20231029.192718 –   Writing to target file: 36.09 Kbyte(s) in < 1 sec [26.19 Mbyte/sec]
                      mars – INFO   – 20231029.192718 – Memory used: 114.19 Mbyte(s)
                      mars – INFO   – 20231029.192718 – No errors reported
```

Retrieving data

Request scheduling

- Queuing system
  Priorities: user, request age, request cost (number of tapes and fields)

Data collocation

- MARS tree
- Archive objects (for OD data)

  - 1 file per month of AN (1 level type, all times, levels, params)

  - 1 file per forecast (1 level type, all steps, levels, params)

  - 1 file per EPS (1 level type, all steps, members, levels, params)

  - 1 file per month of ERA 5 FC (1 level type, all levels, times, steps, params)

Retrieving data – Efficiency

- Explore data in archive catalogue - collocation

- Estimate amount of data (list command)

  - Number of fields (up to hundreds of thousand / request)

  - Data size (up to 100 Gigabytes / request)

- Check computing resources: quota, CPU time, …

- Use local target disk (e.g. $SCRATCH)

- Retrieve as much data from the same tape as possible

- **Avoid constantly accessing the same tape**

- Do not create unnecessary sub-archives in ECFS

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Retrieving data – Data access

- Archived data

  - Available to all registered users

- Current (valid) data, i.e. data for which the value of

$$(DATE + TIME + STEP) + 24 \text{ hours } \geq \text{ current date/time}$$

  - Needs special registration

  - Contact your Computing Representative

- Boundary Conditions Project & COSMO-LEPS

  - Restricted to participating MS / individual users

- Restrictions for Observations, TIGGE, EUROSIP…

- Data is available according to dissemination schedule, see

  - https://confluence.ecmwf.int/display/DAC/Dissemination+schedule

  - For time-critical retrievals, use time-critical framework (option 1)

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Web API

- To access MARS and ECMWF Public Datasets in batch

  - Delivers data directly to the users' machine

- Alternative to retrieve – transfer jobs on the HPC

- Requirements

  - Computer or Web User ID

  - client library, e.g. Python

  - API key

See https://confluence.ecmwf.int/display/WEBAPI/Access+MARS

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Web API

The Web API is a thin client

- Does not use ecCodes nor any interpolation library
  - therefore any functionality requiring decoding of fields (e.g. compute, read, write, multi-target) is not supported

- Only one request per MARS call is recommended. Only one/two active request allowed currently.
- Target file cannot exceed 75GB and 600,000 fields
- Provides access to full MARS archive to users with the access

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Data Server – Web API

Who	Data discovery	Access method
Public user	Public Datasets	Access ECMWF Public Datasets
Commercial user	Archive catalogue	Access MARS
Authorized user	MARS catalogue	Access MARS

https://confluence.ecmwf.int/display/WEBAPI/ECMWF+Web+API+Home

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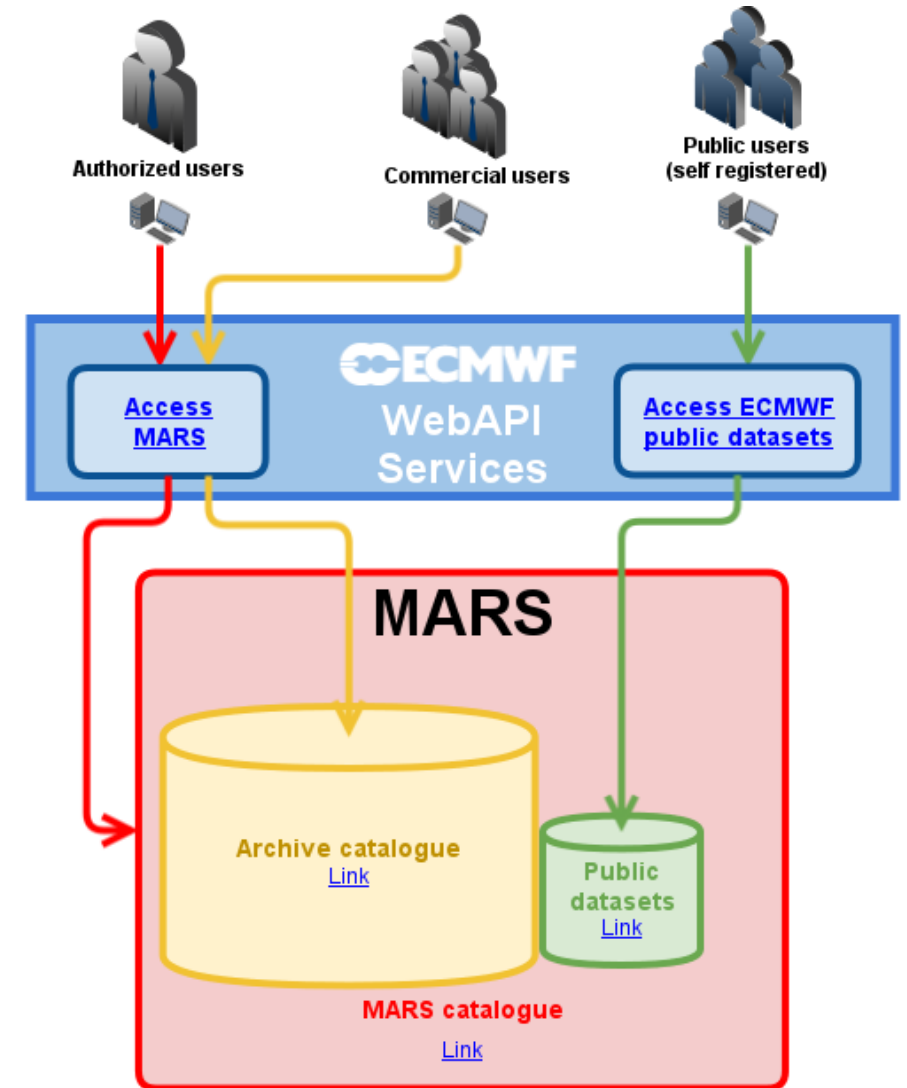
Web API Python example

```python
#!/usr/bin/env python
from ecmwfapi import ECMWFService

server = ECMWFService("mars")
server.execute(
        {
        "class": "od",
        "date": "20231015",
        "expver": "1",
        "levtype": "sfc",
        "param": "167.128",
        "step": "0/to/240/by/12",
        "stream": "oper",
        "time": "00",
        "type": "fc"
        },
        "target.grib")
```

Examples for retrieving large datasets efficiently:

https://confluence.ecmwf.int/display/WEBAPI/Retrieval+efficiency

Additional resources

- MARS documentation
  https://confluence.ecmwf.int/display/UDOC/MARS+user+documentation

- Web Applications
  apps.ecmwf.int/mars-catalogue/
  apps.ecmwf.int/mars-activity/

- FAQ
  https://confluence.ecmwf.int/display/UDOC/MARS+FAQ

- ECMWF real-time datasets
  www.ecmwf.int/en/forecasts/datasets

- IFS Documentation
  www.ecmwf.int/en/forecasts/documentation-and-support/changes-ecmwf-model/ifs-documentation

- ecCodes Documentation
  https://confluence.ecmwf.int/display/ECC/ecCodes+Home

MARS Practical

Point your browser to

      https://confluence.ecmwf.int/display/UDOC/MS+computing+training+courses

or on https://confluence.ecmwf.int/ navigate to

      User Documentation > MARS user documentation > MS computing training course

and follow the instructions

More examples are available on:

https://confluence.ecmwf.int/display/UDOC/MARS+example+requests

if you wish to practice later at home.

MARS – Advanced use

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List

- Alternative to the archive catalogue on the web:

  - Amount of data

  - Number of fields

  - Number of tapes. (directive 'output=cost' required)

  - Suitable for batch mode

- Default is all, except for class, expver, stream, type and date.

- It does list only the archive, not the Fields Database.

- Can keep a report specifying target.

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List – an example

```
    list,
#    output = cost,
    class = od,
    date = 20200101,
    expver = 1,
    levtype = sfc,
    param =
8.128/22.228/29.228/33.128/45.128/57.128/59.128/134.128/136.128/
141.128/151.128/164.128/165.128/166.128/167.128/169.128/186.128/
187.128/188.128/205.128/206.128/246.228/247.228,
    step =
0/3/6/9/12/15/18/21/24/27/30/33/36/39/42/45/48/51/54/57/60/63/66
/69/72/75/78/81/84/87/90/93/96/99/102/105/108/111/114/117/120/12
3/126/129/132/135/138/141/144/150/156/162/168/174/180/186/192/19
8/204/210/216/222/228/234/240,
    time = 00/12,
    type = fc,
    stream = oper
```

List output

```
class   = od
date    = 2020−01−01
expver  = 1
file[0] =
hpss:/mars/prod/od/o/oper/fc/sfc/marsodoper/0001/fc/20200101/sfc/1200/973003.20200206.0150
29
id      = 973003
levtype = sfc
month   = 202001
stream  = oper
time    = 12:00:00
type    = fc
year    = 2020
file length    missing offset       param   step
0    13204588 .        30376750     8.128   0
0    13204588 .        188831806    22.228  0
0    13204588 .        280684868    29.228  0
0    13204588 .        320298632    33.128  0

…
0    13204588 .        254639830208 205.128 240
0    13204588 .        254653034796 206.128 240
0    13204588 .        255068976704 246.228 240
0    13204588 .        255082181292 247.228 240

Grand Total:
============
Entries      : 2,990
Total        : 40,339,676,520 (37.5693 Gbytes)
mars − INFO   − 20231031.155352 − Request performed on database 'marsod'
mars − INFO   − 20231031.155352 − Memory used: 31.47 Mbyte(s)
mars − INFO   − 20231031.155352 − No errors reported
```

Use directive 'output=cost' for summary report.

With "output = cost" option

```
size=40339676520;
number_of_fields=2990;
online_size=40339676520;
off_line_size=0;
number_of_tape_files=0;
number_of_disk_files=47;
number_of_online_fields=2990;
number_of_offline_fields=0;
number_of_tapes=0;
```

Read: filtering

- Read requests can be used to filter/manipulate already retrieved data.

- Read UNIX file specified by source.

- Data written to a file specified by target .

- Read doesn't need all directives.

```
read,
      source        = "myfile",
      levelist      = 1000,
      grid          = 2.5/2.5,
      target        = "only_1000"
```

Not available with
the MARS WebAPI.

ECMWF

Multi-target

- Can organise GRIB target files depending on values of MARS language keywords or of ecCodes key

- MARS Keyword (as echoed by MARS) enclosed in square brackets:

```
retrieve,
    type        = an,
    expver      = 1,
    levtype     = sfc,
    date        = 20010101,
    time        = 00/06/12/18,
    target      = "analysis.[time]"
    …
```

Not available with the MARS WebAPI.

mars - INFO - 20020515.1237 - Creating target name: analysis.0000
mars - INFO - 20020515.1237 - Creating target name: analysis.0600
mars - INFO - 20020515.1237 - Creating target name: analysis.1200
mars - INFO - 20020515.1237 - Creating target name: analysis.1800

Set env. variable **MARS_MULTITARGET_STRICT_FORMAT=1** to use directive values as reported by MARS.

ECMWF

Multi-target

- ecCodes key name enclosed in curly brackets:

```
retrieve,
     type          = an,
     param         = t/u/v,
     expver  = 1,
     levtype = sfc,
     date          = 20010101,
     time          = 00/06/12/18,
     target        = "analysis.{shortName}"
...
```

Not available with
the MARS WebAPI.

mars - INFO   - 20140222.164526 - Creating target name: analysis.t

mars - INFO   - 20140222.164527 - Creating target name: analysis.u

mars - INFO   - 20140222.164527 - Creating target name: analysis.v

Multiple requests

- More than one request in a single call to MARS.

- Append to target:

```
retrieve,
    date        = 20010101,
    time        = 12,
    type        = an,
    target      = "analysis"

retrieve,
    date        = 20000101,
    time        = 12,
    type        = an,
    target      = "analysis"
```

Available with the MARS WebAPI and client.

Multiple requests

- Parameter inheritance

  - Parameters not set in the second request (and subsequent ones) are inherited from the previous one:

    ```
    retrieve,
            class           = od,
            expver          = 1,
            stream          = oper,
            date            = -10,
            time            = 12,
            type            = an,
            target          = "analysis"

    retrieve,
            type            = fc,
            step            = 24/to/72/by/24,
            target          = "forecast"
    ```

- **Unwanted inherited parameters are removed by specifying "off",**

Fieldset

- Temporary storage for further processing:

```
retrieve,
        class        = od,
        expver       = 1,
        stream       = oper,
        date         = -10,
        levtype      = ml,
        levelist     = 1/to/60,
        param        = t,
        time         = 12,
        type         = an,
        fieldset     = analysis
```

Not available with the MARS WebAPI.

ECMWF

MARS intorduction, basic concepts, and advance use

Fieldset

- '**analysis**' above can be seen as a variable to be referenced in a further request.

- At the end of the call to MARS, all fieldsets are released.

- Write requests save fieldsets into UNIX files:

write,
    fieldset   = analysis,
    target   = "data.grb"

Not available with
the MARS WebAPI.

Compute

- Computations on GRIB fields with same shape:

  - fieldset

  - formula

  - Scalar values allowed

  - Predefined functions in formula, e.g.

  ```
  compute,
      formula        = "x/2+log(y)*x",
      fieldset       = z
  ```

  where x and y are two fieldsets which have been initialised beforehand.

Not available with the MARS WebAPI.

Compute

- Mixing fields and scalars:

  - Compute on 2 fields is a field

  - Compute on a field and a scalar is a field

  - Compute on 2 scalars is a scalar

- Bitmaps and missing values:

  - Not considered on computations but copied

- GRIB headers on result of compute are incorrect. They are copied from the first fieldset!

Not available with
the MARS WebAPI.

MARS intorduction, basic concepts, and advance use

Compute: example

```
retrieve,
    class = od,
    expver = 1,
    stream = oper,
    type = analysis,
    date = -10,
    time = 12,
    levtype = sfc,
    param = 165.128, # u
    grid = 1/1,
    fieldset = u
retrieve,
    param = 166.128, # v
    fieldset = v
compute,
    formula = "sqrt(u*u + v*v)",
    fieldset = speed write,
    fieldset = speed,
    target = "windspeed"
```

Not available with the MARS WebAPI.

ECMWF

How to ask for help with data download from MARS

- Use: https://support.ecmwf.int

- Always provide your MARS request and the full output

- If you are planning to download large amount of data (e.g., forecasts for an entire year or longer period), you can get in touch to make sure the data is download efficiently

- We are monitoring MARS activities. Users with very inefficient activity might be contacted by us to improve the efficiency.

ECMWF

MARS intorduction, basic concepts, and advance use

Practicals: Advanced MARS usage

- **https://confluence.ecmwf.int/display/UDOC/MS+computing+training+courses#MScomputingtrainingcourses-AdvancedMARSusage**

ECMWF

MARS intorduction, basic concepts, and advance use