

MARS – Efficient retrievals and best practices



Retrieving data – Request scheduling

Queuing system

Priorities based on:

user

request age

request cost (number of tapes and fields)

Limits on MARS servers

Global limits

- Total number of archive requests
- Total number of retrieve requests
- Total number of requests accessing off-line data (data on tapes)
- Total number of requests accessing X tapes

Per-user limits

- Total number of requests per user
- Total number of requests per user for off-line data
- Total number of requests per user for off-line data accessing X tapes
- Total number of requests from ECMWF Web API per user

Data collocation

MARS tree – archive objects (tape files)

Class	One tape file (archive object) contains	MARS catalogue
class=od Operational data	1 file per month of AN (1 level type, all times, levels, params)	Link to MARS catalogue
	1 file per forecast (1 level type, all steps, levels, params)	Link to MARS catalogue
	1 file per EPS forecast (1 level type, all steps, members, levels, params)	Link to MARS catalogue
class=ea ERA5	1 file per month of ERA5, forecast and analysis (1 level type, all levels, times, steps, params)	Link to MARS catalogue
class=ai Operational AIFS	1 file per month of single forecast (1 level type, all times, levels, params)	Link to MARS catalogue
	1 file per EPS forecast (1 level type, all steps, members, levels, params)	Link to MARS catalogue

class=od: some exceptions exist for surface data produced in IFS ENFO, cycle 48r1 and later. Operational forecasts since 27 June 2023.

Retrieving data – Efficiency

- 1 Explore data in archive catalogue – collocation
- 2 Estimate amount of data (list command)
 - Number of fields (up to hundreds of thousands / request)
 - Data size (up to 10s of terabytes / request)
- 3 Check computing resources on client side:
 - Quota for storage space. Ideally write target file to SCRATCH or HPCPERM
 - Walltime in parent batch job (`#SBATCH --time`)
 - Memory in parent batch job – if interpolation of large grids is specified (`#SBATCH --mem`): [HPC2020 – Writing SLURM jobs](#)

Tapes and ECFS

- 4 Retrieve as much data from the same tape as possible
- 5 **Avoid constantly accessing the same tape**
- 6 Do not create unnecessary sub-archives in ECFS

Archive catalogue – collocation and amount of data

1 Select values, then “Estimate download size”

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MARS Catalogue

Current activity

MARS Catalogue

Step (145 values)	Number (50 values)	Level (14 values)	Parameter (12 values)
16	39	200	Divergence
17	40	250	Geopotential
18	41	300	Ozone mass mixing ratio
19	42	400	Relative humidity
20	43	500	Specific humidity
21	44	600	Stream function
22	45	700	Temperature
23	46	850	U component of wind
24	47	925	V component of wind
25	48	1000	Velocity potential

- Check for availability
- View the MARS request
- Estimate download size
- Retrieve the selection in GRIB
- Retrieve the selection in NetCDF

Note about availability

Some of the fields may not be archived at all levels or all forecast time steps. Before retrieving data you may want to check the availability of the requested fields. For that, follow the [Check for availability](#) link.

Retrieving

In order to retrieve data, you must select at least one item in the lists above. You can select more than one item in each list.

2 The cost page lists tapes and fields

< Return to selection

cost

Final request

Stream:

Ensemble prediction system

Level:

10, 50, 100 to 300 by 50, 400 to 700 by 100, 850, 925, 1000

Type:

Perturbed forecast

Number:

1 to 50

Step:

0 to 24 by 3

Version:

1

See full request

The status of the request is:

complete

Number of tapes:	1
Number of tape files:	1
Number of disk files:	0
Number of online fields:	0
Number of fields:	45000
Online size:	0.0 kB
Number of offline fields:	45000
Off line size:	253.9 GB
Size:	253.9 GB

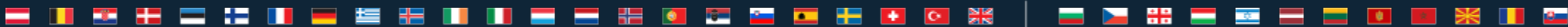
Request output

EXPECT = ANY,
OUTPUT = COST,
DATABASE = marsod

mars - INFO - 20251014.101519 - Web API request id: 68ee22b78167806f9b06e169
mars - INFO - 20251014.101519 - Setting SO_SNDBUF to 33554432 (32.00 M)
mars - INFO - 20251014.101519 - Current value is 8192 (8.00 K)
mars - INFO - 20251014.101519 - Setting SO_RCVBUF to 33554432 (32.00 M)
mars - INFO - 20251014.101519 - Current value is 43690 (42.67 K)
mars - INFO - 20251014.101519 - Calling mars on 'marsod-core', local port is 60524
mars - INFO - 20251014.101520 - Server task is 3217 [marsod]
mars - INFO - 20251014.101520 - Request performed on database 'marsod'
mars - INFO - 20251014.101520 - Memory used: 22.14 Mbyte(s)
mars - INFO - 20251014.101520 - No errors reported
Process '['nice', 'mars', '/tmp/20251014-1010/35/tmp-_mars-pzCeb0-cb9f5a7ec913bdda10c1f8e89dbd56ca.req']' finished

In case of problems, please check the [troubleshooting page](#).

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MARS action: List

Alternative to the archive catalogue on the web:

Information provided

- Amount of data
- Number of fields
- Number of tapes (directive `output=cost` required)

Good to know

- Suitable for batch mode
- Default is **all**, except for class, expver, stream, type and date.
- It only lists the MARS archive by default, not the Fields Database.
- Can keep a report by specifying **target**.

Estimate amount of data – list action

```
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/  
            78/81/84/87/90/93/96/99/102/105/108/111/114/117/120/123/126/129/132/135/138/  
            141/144/150/156/162/168/174/180/186/192/198/204/210/216/222/228/234/240,  
  time     = 00/12,  
  type     = fc,  
  stream   = oper
```

output = cost is commented out above. Remove the # to get the summary report (next slides).

List output

Use directive output=cost for summary report

```
class = od
date = 2020-01-01
expver = 1
file[0] = hpss:/mars/prod/od/o/oper/fc/sfc/marsodoper/0001/fc/20200101/sfc/1200/973003.20200206.015029
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      .         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

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;
```

number_of_tapes = 0

All 2990 requested fields are online – no tape access is needed.

Estimate amount of data – list action

```
list,  
  output = cost,  
  class   = od,  
  date    = 20200101/to/20200131,  
  expver  = 1,  
  levtype = sfc,  
  param   = all,  
  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/  
           78/81/84/87/90/93/96/99/102/105/108/111/114/117/120/123/126/129/132/135/138/  
           141/144/150/156/162/168/174/180/186/192/198/204/210/216/222/228/234/240,  
  time    = 00/12,  
  type    = fc,  
  stream  = oper
```

With “output = cost” option

```
size=8457828631774;  
number_of_fields=648706;  
online_size=7785829941396;  
off_line_size=671998690378;  
number_of_tape_files=30;  
number_of_disk_files=9096;  
number_of_online_fields=596036;  
number_of_offline_fields=52670;  
number_of_tapes=14;
```

number_of_tapes = 14

Access to 14 tapes required for this selection.

1 Select values, then “Check for availability”

2 What is available in the archive

Estimate amount of data – list action

```
list,  
  CLASS      = RD,  
  TYPE       = PF,  
  STREAM     = ENFH,  
  EXPVER     = j339,  
  LEVTYPE    = PL,  
  LEVELIST   = 500,  
  PARAM      = ALL,  
  DATE       = 20261017,  
  HDATE      = ALL,  
  TIME       = 0000,  
  STEP       = 24,  
  NUMBER     = 10,  
  HIDE       = length/offset/file/missing/grand-  
total/id/statlength/statcount/stattotallines/stattotallength/stattotalcount,  
  OUTPUT     = TABLE
```

hdate	levelist	number	param	step	time
2006-10-17	500	10	129.128	24	00:00:00
2006-10-17	500	10	130.128	24	00:00:00
2006-10-17	500	10	133.128	24	00:00:00

Things to avoid when possible in RETRIEVE requests

Using “all”

e.g. “`levelist = all`”, “`step = all`”,
“`number = all`”, etc.

Disables the counter of number of fields and therefore there is no guarantee all requested fields are retrieved. It is better to explicitly specify all values, e.g.

Use “set -e” in your retrieve script to exit when MARS returns an ERROR msg.

```
levelist = 1/to/137/by/1
number   = 1/to/50
step     = 0/to/24/by/3
```

expect = any

It is better to write a clean request which doesn't ask for fields which are not available. You can exploit the MARS catalogue to do this for you.

It disables the counter of number of fields. MARS doesn't know how many fields are requested and even when all requested data is available on FDB/HPC filesystem, the request will still go to a MARS server to check if any requested fields are available there. This inevitably prolongs the retrieve request!

Impact of increased ensemble resolution in cycle 48r1

MARS Catalogue

Current activity

Reference

< Return to selection

cost

Final request

Stream:

Ensemble prediction system

Type:

Perturbed forecast

Number:

1 to 50

Step:

0 to 90, 93 to 144 by 3, 150 to 360 by 6

Version:

1

Type of level:

Surface

Time:

12:00:00

Date:

20241106

Parameter:

2 metre temperature

Class:

Operational archive

The status of the request is: **complete**

Number of tapes:

1

Number of tape files:

1

Number of disk files:

0

Number of online fields:

0

Number of fields:

1625

Online size:

0.0 kB

Number of offline fields:

1625

Off line size:

20.0 GB

Size:

20.0 GB

Request output

EXPECT = ANY,
OUTPUT = COST,
DATABASE = marsod

mars - INFO - 20251014.105545 - Web API request id: 68ee2c30403b4a7288679698
mars - INFO - 20251014.105545 - Setting SO_SNDBUF to 33554432 (32.00 M)
mars - INFO - 20251014.105545 - Current value is 8192 (8.00 K)
mars - INFO - 20251014.105545 - Setting SO_RCVBUF to 33554432 (32.00 M)
mars - INFO - 20251014.105545 - Current value is 43690 (42.67 K)
mars - INFO - 20251014.105545 - Calling mars on 'marsod-core', local port is 33837
mars - INFO - 20251014.105545 - Server task is 7735 [marsod]
mars - INFO - 20251014.105545 - Request performed on database 'marsod'
mars - INFO - 20251014.105545 - Memory used: 22.16 Mbyte(s)
mars - INFO - 20251014.105545 - No errors reported
Process '['nice', 'mars', '/tmp/20251014-1050/da/tmp-_mars-BZsbmA-dc9a0acddb6c1400327a17668be93c9f.req']' finished

In case of **problems**, please check the [troubleshooting page](#).

MARS Catalogue

Current activity

Reference

< Return to selection

cost

Final request

Stream:

Ensemble prediction system

Type:

Perturbed forecast

Number:

1 to 50

Step:

0 to 90, 93 to 144 by 3, 150 to 360 by 6

Version:

1

Type of level:

Surface

[See full request](#)

The status of the request is: **complete**

Number of tapes:

2

Number of tape files:

3

Number of disk files:

5

Number of online fields:

1550

Number of fields:

7250

Online size:

19.1 GB

Number of offline fields:

5700

Off line size:

70.1 GB

Size:

89.2 GB

Request output

EXPECT = ANY,
OUTPUT = COST,
DATABASE = marsod

mars - INFO - 20251014.104710 - Web API request id: 68ee2a2dd730d628e15da716
mars - INFO - 20251014.104710 - Setting SO_SNDBUF to 33554432 (32.00 M)
mars - INFO - 20251014.104710 - Current value is 8192 (8.00 K)
mars - INFO - 20251014.104710 - Setting SO_RCVBUF to 33554432 (32.00 M)
mars - INFO - 20251014.104710 - Current value is 43690 (42.67 K)
mars - INFO - 20251014.104710 - Calling mars on 'marsod-core', local port is 38995
mars - INFO - 20251014.104710 - Server task is 9504 [marsod]
mars - INFO - 20251014.104710 - Request performed on database 'marsod'
mars - INFO - 20251014.104710 - Memory used: 22.16 Mbyte(s)
mars - INFO - 20251014.104710 - No errors reported
Process '['nice', 'mars', '/tmp/20251014-1040/8d/tmp-_mars-VdIoc1-c71a6f0f22841bb460d353beed1ef956.req']' finished

In case of **problems**, please check the [troubleshooting page](#).

Impact of increased ensemble resolution in cycle 48r1

Implemented on 27 June 2023, 06 UTC
[In MARS catalogue](#)

Why does my enfo request take significantly more time for dates after 27 June 2023, even if I request the same grid as before and therefore the size of the target file is the same as in the previous cycle?

Due to increased size, SFC data is distributed across multiple tape files.

In November 2025 we introduced new 50 TB tapes to host ENFO:PF:SFC data which provide quicker access.

MARS Catalogue Current activity+ Reference+

< Return to selection

cost

Final request

Stream:

Ensemble prediction system

Type:

Perturbed forecast

Number:

1 to 50

Step:

0 to 50

Version:

1

Type of level:

Surface

Time:

12:00:00

Date:

20241116

Parameter:

2 metre temperature

Class:

Operational archive

The status of the request is: **complete**

Number of tapes:

1

Number of tape files:

1

Number of disk files:

2

Number of online fields:

250

Number of fields:

2550

Online size:

3.1 GB

Number of offline fields:

2300

Off line size:

28.3 GB

Size:

31.4 GB

Request output

EXPECT = ANY,
OUTPUT = COST,
DATABASE = marsod

mars - INFO - 20251014.105148 - Web API request id: 68ee2b42d730d628e15da717

mars - INFO - 20251014.105148 - Setting S0_SNDBUF to 33554432 (32.00 M)

mars - INFO - 20251014.105148 - Current value is 8192 (8.00 K)

mars - INFO - 20251014.105148 - Setting S0_RCVBUF to 33554432 (32.00 M)

mars - INFO - 20251014.105148 - Current value is 43690 (42.67 K)

mars - INFO - 20251014.105148 - Calling mars on 'marsod-core', local port is 54898

mars - INFO - 20251014.105148 - Server task is 7618 [marsod]

mars - INFO - 20251014.105148 - Request performed on database 'marsod'

mars - INFO - 20251014.105148 - Memory used: 22.16 Mbyte(s)

mars - INFO - 20251014.105148 - No errors reported

Process '['nice', 'mars', '/tmp/20251014-1050/a2/tmp-mars-3FHiN3-7da85bcb629b3a1221c844a545a2cd41.req']' finished

In case of **problems**, please check the [troubleshooting page](#).

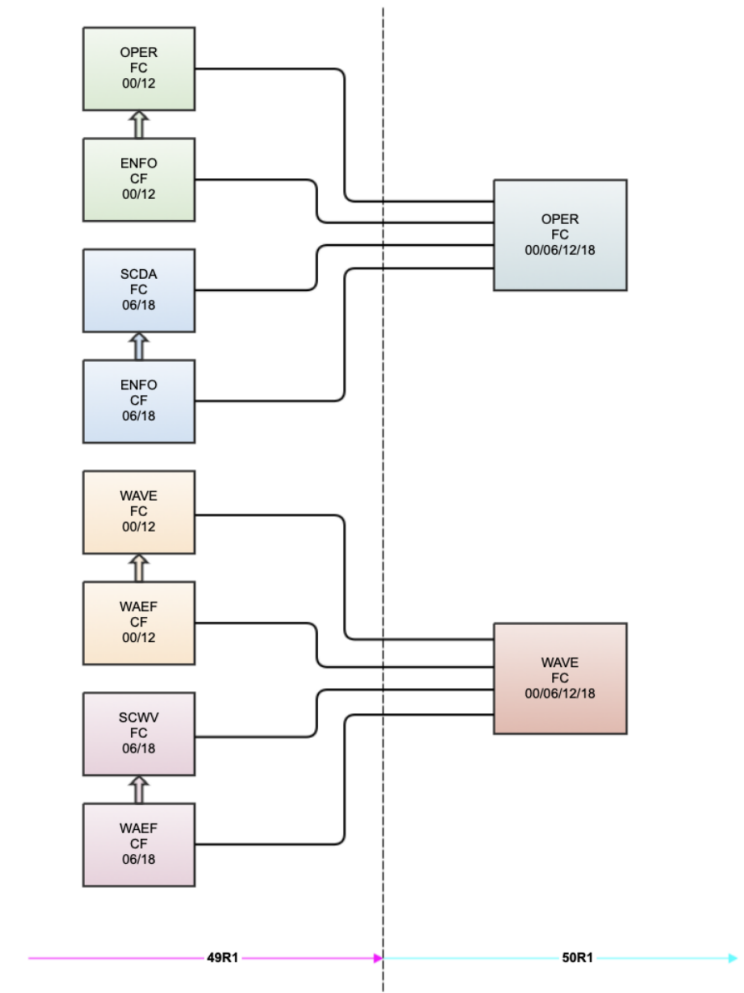
16

Impact of changes introduced with 50r1 cycle – Q1 2026

In 50r1, **stream=enfo**, **type=cf** was discontinued

Deterministic forecasts for 06 and 18 UTC initialisation times were stored under **stream=scda** while 00 and 12 UTC were under **stream=oper**.

All 4 model initialisation times merged to **stream=oper** in 50r1 implemented on **12 May 2026** from the **06 UTC** run



Migration to GRIB2 – 50r2 cycle impact on MARS

Parameters with levtype=sol

```
retrieve,  
  class=od,  
  stream=oper,  
  expver=1,  
  date=-2,  
  time=00:00:00,  
  type=fc,  
  step=0,  
  levtype=sol,  
  levelist=1/2/3/4/5,  
  param=228141,  
  target="output_sd.grib2"
```

Introduced
at IFS cy48r1

Chemical species

```
retrieve,  
  class=mc,  
  stream=oper,  
  expver=1,  
  date=-2,  
  time=00:00:00,  
  type=fc,  
  step=0,  
  levtype=ml,  
  levelist=1/to/137,  
  param=402000, # Mass mixing ratio  
  chem=no2, # Nitrogen dioxide  
  target="output_no2.grib2"
```

Static sample 50r2 test data is already available in MARS

<https://apps.ecmwf.int/mars-catalogue/?class=od&stream=oper&expver=2250>

Example request

```
retrieve,  
  class=od,  
  date=2026-09-01,  
  expver=2250,  
  levelist=100/200,  
  levtype=hl,  
  param=10/131/132,  
  step=12,  
  stream=oper,  
  time=00:00:00,  
  timespan=none,  
  type=fc,  
  target="output"
```

[MARS Catalogue](#) Current activity

MARS Catalogue

Data cube

Step (145 values)	Level (2 values)	Parameter (3 values)
3	100	U component of wind
4	200	V component of wind
5		Wind speed
6		
7		
8		
9		
10		
11		
12		

- [Check for availability](#)
- [View the MARS request](#)
- [Estimate download size](#)
- [Retrieve the selection in GRIB](#)
- [Retrieve the selection in NetCDF](#)

MTG2 impact on MARS requests – parameter identifiers

`param = indicatorOfParameter.table2Version` (such as `param = 129.140`) or `param = indicatorOfParameter` (e.g., `param = 129`) are changed to use the full **paramId** (e.g., `param = 140129`)

Pre-MTG2 request

```
retrieve,  
  expver = 1,  
  param  = 229.140/232.140,  
  # swl/mwp
```

MTG2-test request

```
retrieve,  
  expver = 2250,  
  param  = 140229/140232,  
  # Change to use paramId
```

More information: [Migration to GRIB2 – Test GRIB2 data in MARS and how to use it for testing](#)

MTG2 impact on MARS requests – soil and sea-ice layers

Changes needed for soil temperature, volumetric soil moisture and sea-ice temperature on layers 1 and 2

Pre-MTG2 request

```
retrieve,  
  expver    = 1,  
  class     = od,  
  stream    = oper,  
  type      = an,  
  date      = -2,  
  time      = 12,  
  levtype   = sfc,  
  param     = 139.128/170.128/39.128/  
              40.128/35.128/36.128,  
  # stl1/stl2/swvl1/swvl2/istl1/istl2
```

MTG2-test request

```
retrieve,  
  expver    = 2250,  
  class     = od,  
  stream    = oper,  
  type      = an,  
  date      = 20260901,  
  time      = 00,  
  levtype   = sol,  
  param     = 260360/260199/263024,  
  levelist  = 1/2,
```

MTG2 impact on MARS requests – height-level parameters

Changes needed for parameters on height levels: 100 m and 200 m u and v wind components

Pre-MTG2 request

```
retrieve,  
  expver    = 1,  
  levtype   = sfc,  
  param     = 228246/228247/228239/  
             228240,  
  # 100u/100v/200u/200v
```

MTG2-test request

```
retrieve,  
  expver    = 2250,  
  levtype   = hl,  
  param     = 131/132,  
  # Change to use new paramIds for  
  # wind components  
  levelist  = 100/200,
```

MTG2 impact on MARS requests – statistics over a time interval

Pre-MTG2 request

```
retrieve,  
  expver = 1,  
  step    = 6/to/360/by/6,  
  levtype = sfc,  
  param    = 121.128/122.128,  
  # mx2t6/mn2t6
```

```
retrieve,  
  param    = 228026/228027,  
  # mx2t3/mn2t3  
  step     = 3/to/144/by/3,
```

```
retrieve,  
  param    = 201/202, # mx2t/mn2t  
  step     = 1/to/90/by/1,
```

MTG2-test request

```
retrieve,  
  expver    = 2250,  
  step      = 6/to/360/by/6,  
  param      = 237167/238167,  
  # Change to use new paramIds for max_2t, min_2t  
  timespan  = 6h,  
  # Add timespan keyword to indicate 6-hourly  
  # processing
```

```
retrieve,  
  param      = 237167/238167,  
  timespan   = 3h, # 3-hourly processing  
  step       = 3/to/144/by/3,
```

```
retrieve,  
  param      = 237167/238167,  
  timespan   = 1h, # hourly processing  
  step       = 1/to/90/by/1,
```

MTG2 impact on MARS requests – accumulated parameters

Example – changes for parameters that are accumulated from the start of the forecast

Pre-MTG2 request

```
retrieve,  
  expver  = 1,  
  step    = 6/to/360/by/6,  
  levtype = sfc,  
  param   = 228.228,  # tp
```

MTG2-test request

```
retrieve,  
  expver  = 2250,  
  # Change to use expver=2250 for  
  # testing,  
  step    = 6/to/360/by/6,  
  param   = 228228,  
  # Change to use new paramId for  
  # total precipitation  
  timespan = fs,  
  # Add timespan keyword with value  
  # fs - "from start"
```

How to ask for help with data download from MARS

Use <https://support.ecmwf.int>

Always provide your MARS request and the full output

Planning a large download?

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

User activity is monitored

User activity on MARS servers is monitored. Users with very inefficient activity might be contacted by us to improve the efficiency.

Practicals

MS computing training courses

- **Advanced MARS usage**
 - Efficiency