Accessing UERRA data in ECMWF MARS archive and related data services

Richard Mládek, Manuel Fuentes,
Sebastien Villaume, Matthew Manoussakis

ECMWF MARS

Meteorological Archive and Retrieval System

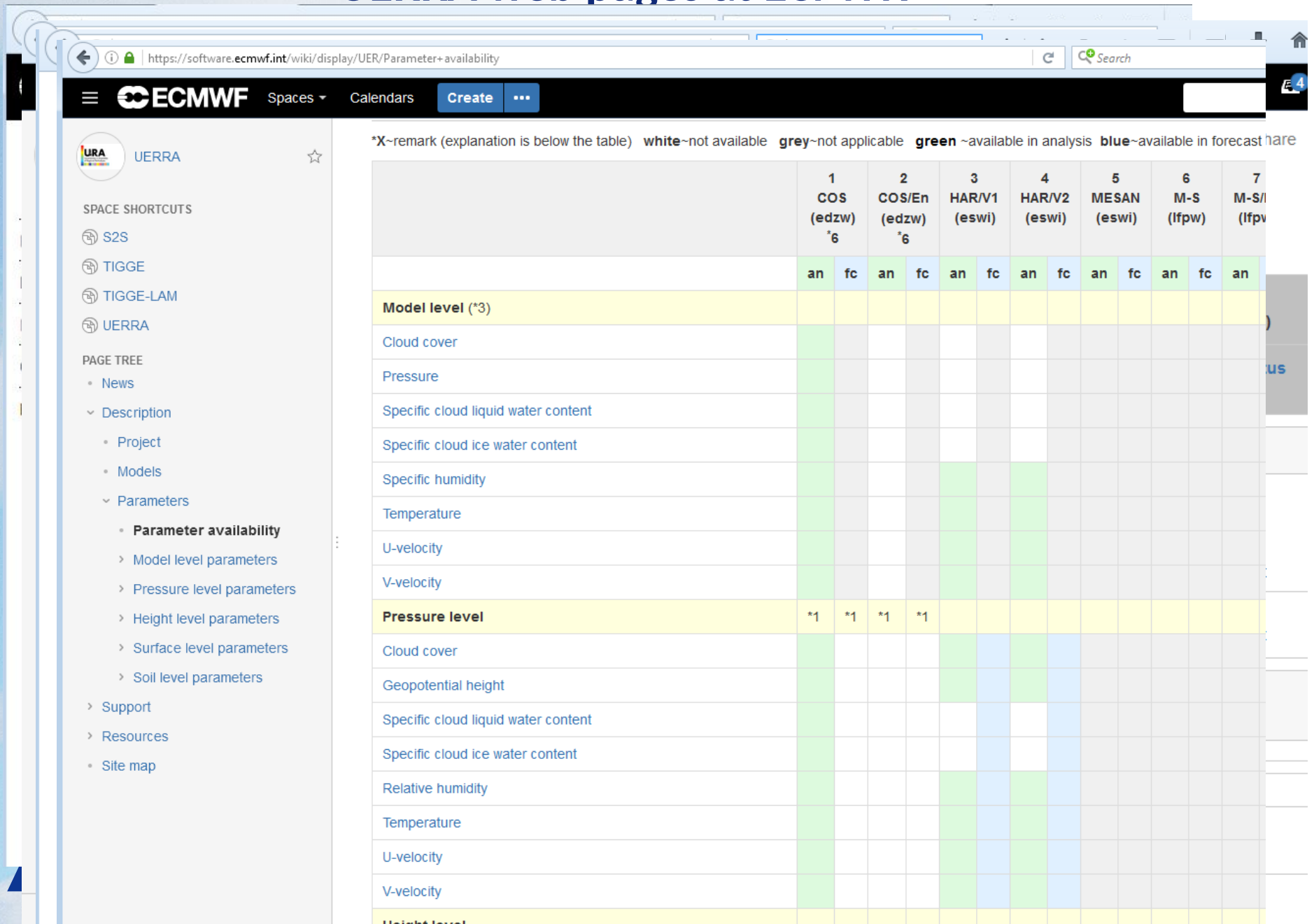
- GRIB, BUFR and ODB (in future NetCDF)
- Contains about 130 PB of data (30% increase since January 2016)
- Easy access to the Archives via a pseudo-meteorological language (MARS keys)
- Managed archive => the data has to follow a certain structure, based on archiving and retrieval patterns (needs to know how the data is going to be produced/used before deciding how to store it)

https://software.ecmwf.int/wiki/display/UDOC/MARS+user+documentation

UERRA web pages at ECMWF

- **Static pages**
  - Official high level project description
  - Wiki like working web space (Atlassian Confluence)
    - Parameters & all details (run times, steps, levels; GRIB2 encoding details)
    - Model & dataset description
    - Support contacts
  - Instructions for data providers
- **Tracking actual state**
  - Progress status (with expected milestones)
  - Parameter availability (based on the received data)
- **UERRA data portal**
  - Data discovery and retrieval
  - Production data only

UERRA web pages at ECMWF



https://software.ecmwf.int/wiki/display/UER/Parameter+availability

ECMWF Spaces Calendars Create

UERRA

SPACE SHORTCUTS
- S2S
- TIGGE
- TIGGE-LAM
- UERRA

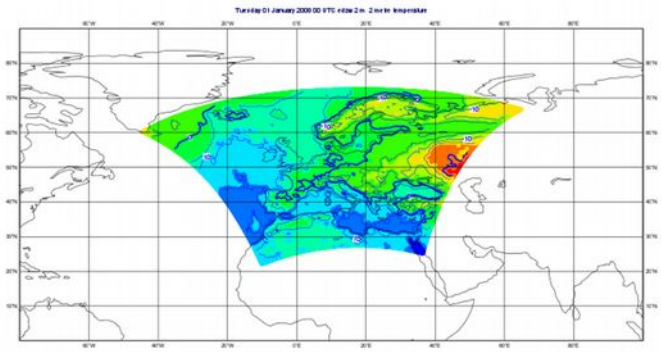
PAGE TREE
- News
- Description
  - Project
  - Models
  - Parameters
    - **Parameter availability**
    - Model level parameters
    - Pressure level parameters
    - Height level parameters
    - Surface level parameters
    - Soil level parameters
- Support
- Resources
- Site map

*X~remark (explanation is below the table) **white**~not available **grey**~not applicable **green** ~available in analysis **blue**~available in forecast

	1 COS (edzw) *6		2 COS/En (edzw) *6		3 HAR/V1 (eswi)		4 HAR/V2 (eswi)		5 MESAN (eswi)		6 M-S (lfpw)		7 M-S/I (lfpv
	an	fc	an	fc	an	fc	an	fc	an	fc	an	fc	an
Model level (*3)													
Cloud cover													
Pressure													
Specific cloud liquid water content													
Specific cloud ice water content													
Specific humidity													
Temperature													
U-velocity													
V-velocity													
Pressure level	*1	*1	*1	*1									
Cloud cover													
Geopotential height													
Specific cloud liquid water content													
Specific cloud ice water content													
Relative humidity													
Temperature													
U-velocity													
V-velocity													

EURO4M testbed

- Sample datasets archived in 2015 before UERRA data was available
  - COSMO (DWD), HIRLAM (SMHI), MESCAN (MF), UM/4DVAR (MO)
  - Common period 2008-9
  - 15 selected surface parameters (much more from UM/MetOffice)
  - Data in original GRIB1 format archived as “it is“ (no common definitions of the parameters)
  - Data available only to users with ECMWF account via standard MARS retrieval tools (no dedicated data portal)



  - Access details: https://software.ecmwf.int/wiki/display/UER/EURO4M+data+in+MARS

UERRA datasets

- 9 production datasets from 5 models and 4 centres
  - Deterministic and ensemble reforecasts and reanalysis outputs
  - Different models have slightly different domains

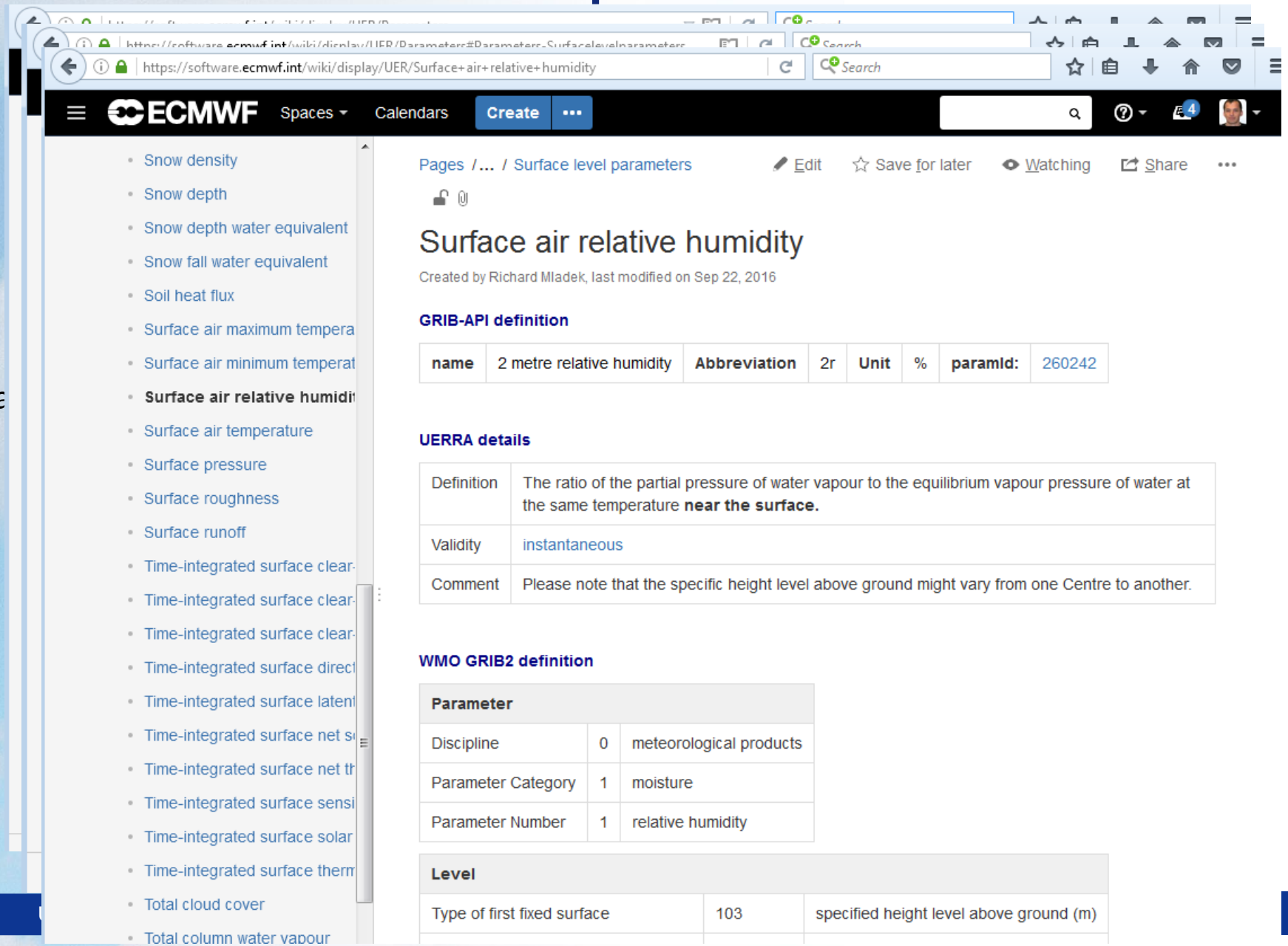
- UERRA common definitions for all parameters
  - Data in WMO compliant GRIB2 format
  - Exact list of run times, steps, levels specified for each output type (an/fc)

- 3 temporary datasets
  - To have some data earlier before full production start
  - shorter period (2008); expver=test in MARS
    - MESCAN-SURFEX already archived (less parameters; fc only +6H)
    - UM (full data but not the final model version)

UERRA datasets

		MARS keys (class=ur)					
		origin	stream	type	number	expver	
Production datasets							
1	**COSMO**	edzw	oper	an/fc	-	prod	
2	**COSMO/En**	edzw	enda	an/fc	1..20	prod	
3	**HARMONIE/V1**	eswi	oper	an/fc	-	prod	**2008 archived**
4	**HARMONIE/V2**	eswi	enda	an/fc	1	prod	2006-2010; not real eps
5	**MESAN**	eswi	oper	TBD	-	prod	1 parameter only (tcc)
6	**MESCAN-SURFEX**	lfpw	oper	an/fc	-	prod	
7	**MESCAN-SURFEX/En**	lfpw	enda	an/fc	1..8	prod	
8	**UM/4DVAR**	egrr	oper	an/fc	-	prod	
9	**UM/En4DVAR**	egrr	enda	an/fc	1..20	prod	
Temporary datasets							
10	**MESCAN-SURFEX**	lfpw	oper	fc	-	test	**2008 archived**
11	**UM/4DVAR**	egrr	oper	an/fc	-	test	2008
12	**UM/En4DVAR**	egrr	enda	an/fc	1..20	test	2008

UERRA parameters



Model specific features

- **COSMO**
  - Model levels above 100 hPa not available
  - Step 0 not available in forecasts ("fc") because of nudging
- **MESCAN-SURFEX**
  - Contains analysis of total precipitation accumulated between 6H of the previous day and 6H of the day encoded in the GRIB2
- **HARMONIE**
  - Only steps up to +6H are available for soil level parameters
- **UM**
  - Model level increases with height MO (opposite to other models)

Model specific features

- **Model levels**
  - **COSMO:** 1..40
  - **HARMONIE:** 1..65
  - **MO:** 1..63
- **Soil levels**
  - **COSMO:** 8 soil layers
    level borders at 0, 0.01, 0.03, 0.09, 0.27, 0.81, 2.43, 7.29, 21.87 m
  - **HARMONIE:** 3 soil levels/layers (sot on levels, vsw on layers)
    level depths are grid dependent
  - **MESCAN-SURFEX:** 14 soil layers (only 6 layers for preliminary shorter re-analysis runs)
    level borders at 0, 0.01, 0.04, 0.1, 0.2, 0.4, 0.6 m
  - **MO:** 4 soil layers
    level borders at 0, 0.1, 0.35, 1 and 3 m

UERRA data in MARS

- **HARMONIE/V1**
  - 1st UERRA production archiving (expver=prod) has started
  - 2006-2008 completed
    - Grand total: 3,527,579,450,865 (3.20831 TiB)
    - Number of fields: 5,052,264
    - Bug found and fixed (two parameters parameter number swapped)
  - 2009 in progress

- **MESCAN-SURFEX**
  - temporary sub-sample (2008 only; expver=test)
    - 5 parameters from reanalyses (2t, 10wdir/ws, 2r, tp)
    - 13 parameters from reforecasts (+6H only)

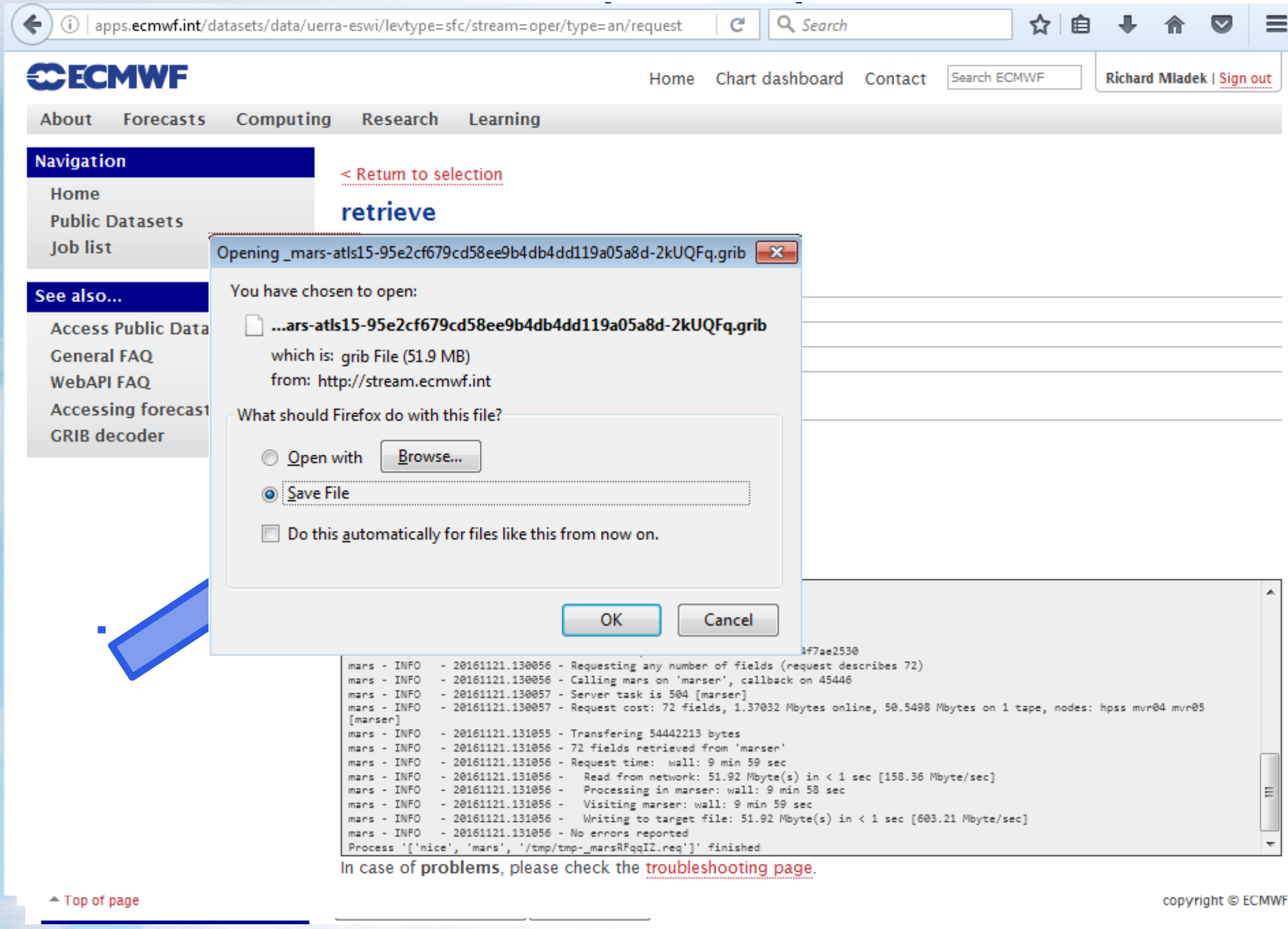
MARS access

Public users

- **Via dedicated web data portal**
  - Data discovery for specific datasets (ERA, TIGGE, UERRA..)
  - Retrieval of smaller samples up to 1 month
- **Via ECMWF Web API**
  - Recommended way for downloading of bigger data amount in a programmatic way via internet for use outside the ECMWF

Restricted access (account at ECMWF needed)

1. **Via web MARS catalogue**
   - Hierarchical access to any data in MARS
   - Retrieval of smaller samples up to 1 month
2. **Via MARS batch requests**
   - Traditional the most common way in the past (unix shell) for bigger retrievals used within ECMWF's LAN

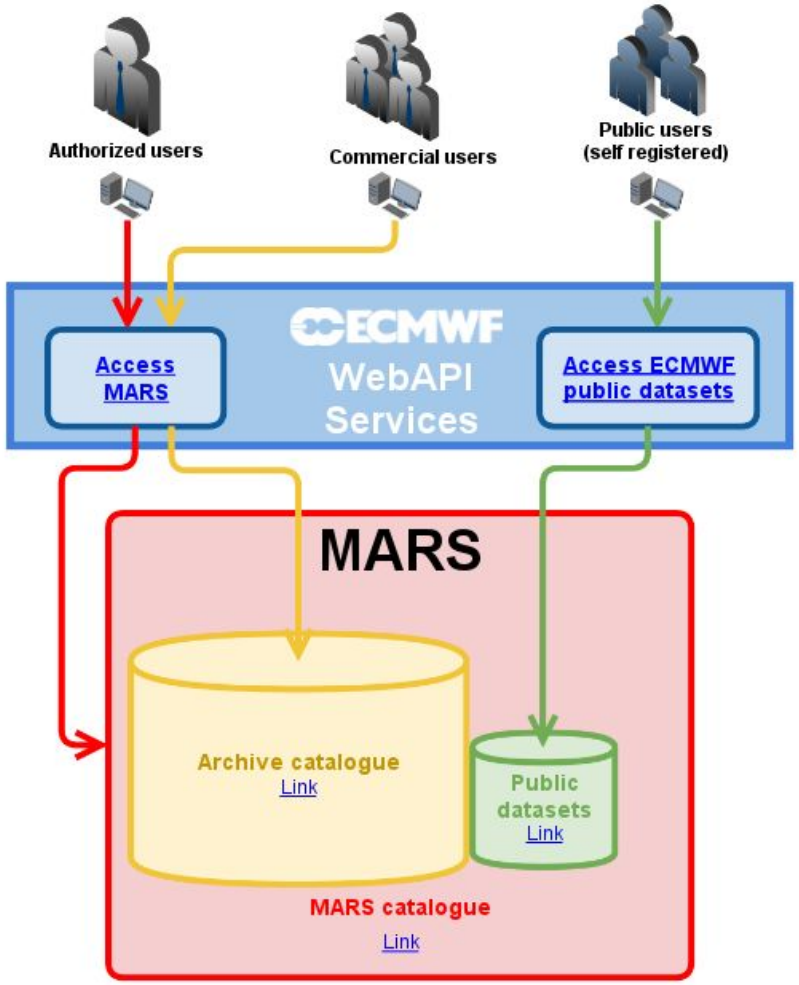

apps.ecmwf.int/datasets/data/uerra-eswi/levtype=sfc/stream=oper/type=an/request
Search
ECMWF
Home
Chart dashboard
Contact
Search ECMWF
Richard Mladek | Sign out
About
Forecasts
Computing
Research
Learning
Navigation
Home
Public Datasets
Job list
See also...
Access Public Data
General FAQ
WebAPI FAQ
Accessing forecast
GRIB decoder
< Return to selection
retrieve
Opening _mars-atls15-95e2cf679cd58ee9b4db4dd119a05a8d-2kUQFq.grib
You have chosen to open:
...ars-atls15-95e2cf679cd58ee9b4db4dd119a05a8d-2kUQFq.grib
which is: grib File (51.9 MB)
from: http://stream.ecmwf.int
What should Firefox do with this file?
Open with
Browse...
Save File
Do this automatically for files like this from now on.
OK
Cancel
mars - INFO - 20161121.130056 - Requesting any number of fields (request describes 72)
mars - INFO - 20161121.130056 - Calling mars on 'marser', callback on 45446
mars - INFO - 20161121.130057 - Server task is 504 [marser]
mars - INFO - 20161121.130057 - Request cost: 72 fields, 1.37032 Mbytes online, 50.5498 Mbytes on 1 tape, nodes: hpss mvr04 mvr05 [marser]
mars - INFO - 20161121.131055 - Transfering 54442213 bytes
mars - INFO - 20161121.131056 - 72 fields retrieved from 'marser'
mars - INFO - 20161121.131056 - Request time: wall: 9 min 59 sec
mars - INFO - 20161121.131056 - Read from network: 51.92 Mbyte(s) in < 1 sec [158.36 Mbyte/sec]
mars - INFO - 20161121.131056 - Processing in marser: wall: 9 min 58 sec
mars - INFO - 20161121.131056 - Visiting marser: wall: 9 min 59 sec
mars - INFO - 20161121.131056 - Writing to target file: 51.92 Mbyte(s) in < 1 sec [603.21 Mbyte/sec]
mars - INFO - 20161121.131056 - No errors reported
Process '['nice', 'mars', '/tmp/tmp-_marsRFqqIZ.req']' finished
In case of problems, please check the troubleshooting page.
Top of page
copyright © ECMWF

Web API

Set of services developed by ECMWF to allow users from the outside to access some internal features and data of the centre.

So far 2 services

1. **Access MARS**
   - Most general
   - Account at ECMWF required
2. **Access ECMWF public datasets**
   - Public access
   - TIGGE, ERA40, S2S, UERRA…



Accessing UERRA via Web API

(using **Access ECMWF public datasets** Web API service)

1.Install ECMWF Web API

- Follow step-by-step guide at https://software.ecmwf.int/wiki/display/WEBAPI/Access+ECMWF+Public+Datasets
- Supported only on UNIX platforms (with Python) but generally might be installed and used on any platform
- Examples how to access various public datasets provided

2.Check data availability

- Browse UERRA data portal to check the content
- Click “View the MARS request button”
- Copy the corresponding data retrieval request (python script)

3.Get the data

- Run the python script from the previous step
- Modify and run it for other data request as needed

Accessing UERRA via Web API – example

```
#!/usr/bin/env python
from ecmwfapi import ECMWFDataServer
server = ECMWFDataServer()
server.retrieve({
    "class": "ur",
    "dataset": "uerra",
    "date": "2008-01-01",
    "expver": "prod",
    "levtype": "sfc",
    "origin": "eswi",
    "param":
"33/134/151/167/172/173/207/235/3073/3074/3075/228002/228141/228164/260057/260242/260260
/260509",
    "stream": "oper",
    "time": "00:00:00/06:00:00/12:00:00/18:00:00",
    "type": "an",
    "target": “out.grib",
})
```

Output: out.grib

ECMWF tools

GRIB-API

- Tool for encoding and decoding WMO FM-92 GRIB1 GRIB2 messages
  - Application program interface accessible from C, FORTRAN and Python programs
  - Contain set of command line tools to give quick access to GRIB messages
- GRIB-API v. 18.0 or higher must be used for UERRA

```
--> grib_ls uerra-sample.grib2
uerra-sample.grib2
edition  centre  date      dataType  gridType  stepRange  typeOfLevel      level  shortName  packingType
2        eswi    20100101  an        lambert   0          hybrid           50     t          grid_simple
2        eswi    20100101  an        lambert   0          heightAboveGround 100   t          grid_simple
2        eswi    20100101  an        lambert   0          isobaricInhPa    500    t          grid_simple
2        eswi    20100101  an        lambert   0          heightAboveGround 2     2t         grid_simple
4 of 4 grib messages in uerra-sample.grib2
4 of 4 total grib messages in 1 files
```

Manuals & installation package: https://software.ecmwf.int/wiki/display/GRIB

ECMWF tools

Data interpolation

- Part of GRIB-API and used by MARS
- Interpolation of rotated lat-lon or Lambert conformal model outputs used in UERRA not fully supported yet
- New ECMWF's MIR (Meteorological Interpolation and Regridding) tool in preparation
- External interpolation package might be used: https://software.ecmwf.int/wiki/display/UER/Data+interpolation+and+visualization

Conversion to NetCDF

- Part of GRIB-API and used by MARS
- Direct conversion UERRA GRIB2 to NetCDF not working yet
  - Ongoing development
  - Will be implemented in some future GRIB-API version

Links

- UERRA at ECMWF: https://software.ecmwf.int/wiki/display/UER
- ECMWF Web API tutorial: https://software.ecmwf.int/wiki/display/WEBAPI
- ECMWF GRIB-API: https://software.ecmwf.int/wiki/display/GRIB
- MARS web catalogue: http://apps.ecmwf.int/mars-catalogue
- MARS documentation: https://software.ecmwf.int/wiki/display/UDOC/MARS+user+documentation
- Parameter list: https://software.ecmwf.int/wiki/display/UER/Parameters
- Parameter availability: https://software.ecmwf.int/wiki/display/UER/Parameter+availability
- Data interpolation and visualization: https://software.ecmwf.int/wiki/display/UER/Data+interpolation+and+visualization
- EURO4M testbed data in MARS: https://software.ecmwf.int/wiki/display/UER/EURO4M+data+in+MARS