MARS – Introduction and basic concepts

Computer User Training Course 2015

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User Support

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ECMWF

Contents

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: workstations, supercomputers**
- **Servers: supercomputers, dedicated servers**
- **Several databases**
- **Tape library**

Introduction – Some figures

- **65 PiB of data in ~ 12 million files, for more than 140 billion ($1.4 \cdot 10^9$) meteorological fields**
- **~ 600 GiB of metadata**
- **$150 \cdot 10^6$ fields added daily (110 TiB)**
- **700 active users/day executing 1.5 million requests/day**
- **~ 200 TiB retrieved daily**
- **Operational forecast since 1985**
- **Analysis, forecast and observations since 1900 (ERA-20C)**

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 1 month 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

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

http://www.ecmwf.int/en/what-naming-convention-ecmwf-real-time-products

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

Meteorological content – Operational Analyses

- **4DVAR (T1279 / 16km, T255 inner loops, input to HRES)**
  - **At synoptic hours 00, 06, 12 and 18 UTC**
  - **Surface**
  - **Model levels (137)**
  - **Pressure levels (25)**
  - **Isentropic levels (15 PT, 1 PV)**

- **EDA (T399 / 50 km, T159 inner loops, input to ENS)**
  - **At synoptic hours 00, 06, 12 and 18 UTC**
  - **26 members**
  - **Surface**
  - **Model levels (137)**
  - **Pressure levels (25)**
  - **Isentropic levels (16 PT, 1 PV)**

Meteorological content – HRES

- **Atmospheric Forecast (10 day forecast based on 00/12 UTC Analysis) at T1279L137 (16 km)**
  - **Surface**
  - **Model levels (137)**
  - **Pressure levels (25)**
  - **Isentropic levels (16 PT, 1 PV)**
  - **1 hourly steps from 0 to 90, 3 hourly from 93 to 144 and 6 hourly from 150 to 240 hours**

Meteorological content – ENS

- **Medium-range forecasts to 15 days, 91 Levels**
- **26 member Ensemble of Data Assimilations (EDA, stream elda)**
- **1 control forecast (as HRES but with lower resolution)**
- **50 different forecasts with perturbed initial conditions**
- **Truncation at day 10 from T639 (~32 km) to T319 (~64 km)**
- **Two additional calibration/validation runs were added**
- **Leg 3: 00 UTC FC extended Mondays & Thursdays to day 32**

	# FC	Leg 1 day 0-10	Leg 2 day 11-15	Leg 3 day 16-32
ENS-CF	1	T639	T319	
ENS-PF	50	T639	T319	
CV-T639	1	T639		
CV-T319	1	T319		

old.ecmwf.int/products/changes/vareps-monthly/

Meteorological content – ENS products

- **Control forecast**
- **Calibration/Validation forecasts**
- **50 perturbed forecasts / 26 EDA members**
- **Initial condition perturbations**
- **Ensemble mean and standard deviation**
- **Extreme forecast index**
- **Event probabilities**
- **Cluster mean, cluster representatives and standard deviation**
- **Trajectories (of tropical cyclones)**

Meteorological content – Ocean-Wave component

	Forecast/ Analysis	Domain	Number of members	Horizontal resolution	Number of directions	Number of frequencies
LAM WAM (LAW)	Analysis + forecast 0–5 days	Limited: 5° N-90° N, 98° W-54° E	1	11 km	36	36
WAM HRES	Analysis and forecast 0–10 days	Global	1	28 km	36	36
WAM ENS	Forecast 0–10 days	Global	51	55 km	24	30
WAM ENS	Forecast 10–32 days	Global	51	55 km	12	25
WAM SEAS	Forecast 0–13months	Global	51	111 km	12	25

Meteorological content – BC

Boundary condition forecast (Short cut-off forecast T1279L137 at 06/18)

- **Analysis (4DVAR)**
- **Forecast (to 90 hours) in hourly steps**
- **00/12 UTC AN/FC is taken from HRES**
- **Full fields are available**

Valid data only available for participating MS.

Meteorological content – Seasonal System 4

SEAS – atmosphere-ocean coupled model (51 members)

- **Global forecasts from 00 UTC to 7 months: (once a month)**
  - **atmosphere: ~75 km resolution, 91 levels (T255 L91)**
  - **ocean: NEMO – ORCA1 grid (~1˚x1˚ with equatorial refinement), 42 levels**
- **In February, May, August and November, 15 of the 51 members are extended to 13 months**
- **Re-forecasts: 15 members (0-13m) covering 30 years (1981-2010)**
- **Part of the EUROSIP system, with UK Met Office, Météo France and NCEP**
- **Availability of products: 12:00 on the 8th of each month**

http://www.ecmwf.int/en/forecasts/tools-and-guidance/documentation-and-support/long-range

Meteorological content – Monthly Means

Averaged over each calendar month

- **Atmosphere / Wave**
  - **Analysis**
- **Surface / pressure levels**

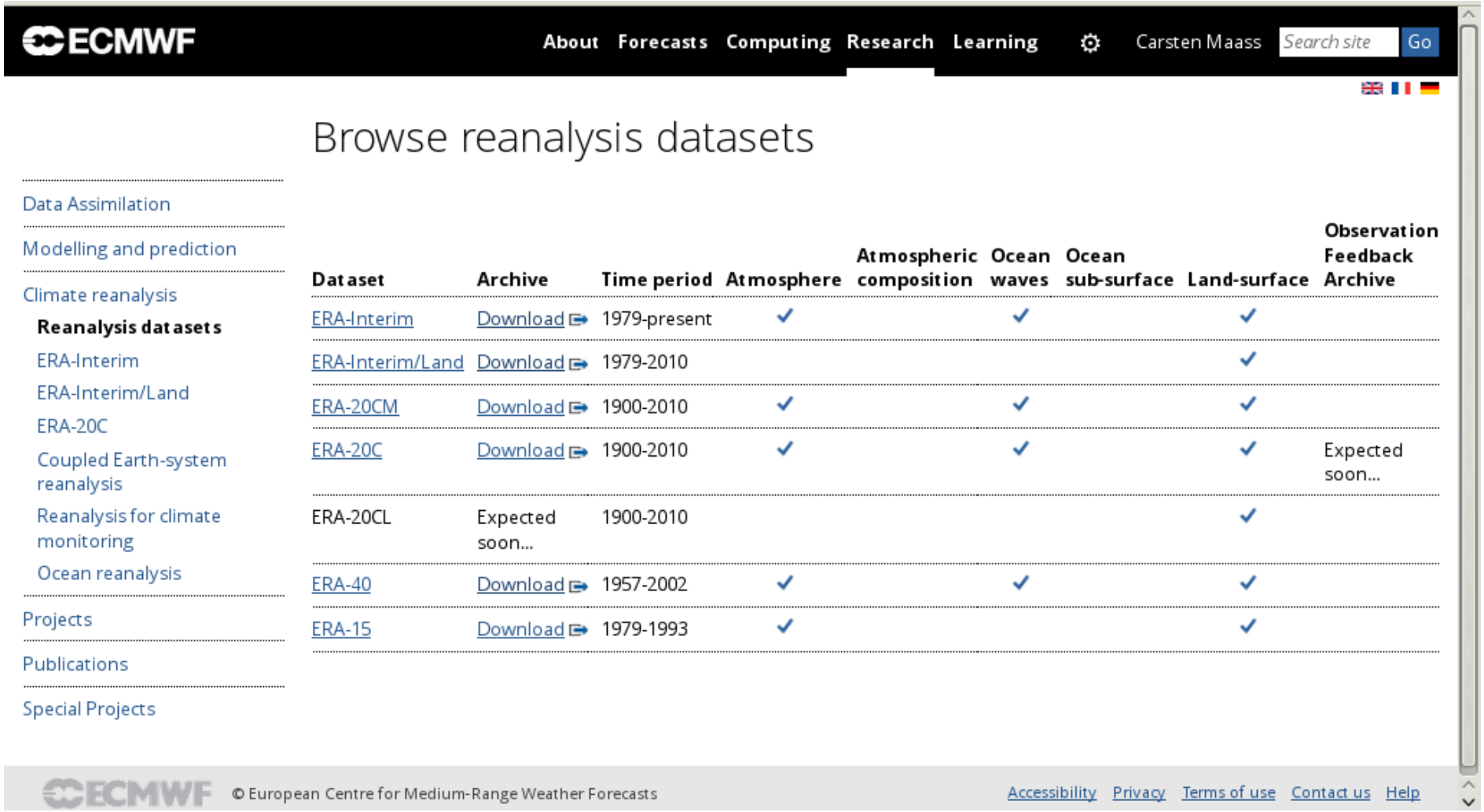
Meteorological content – Special datasets (1/2)

- **Special Projects**
  - **DEMETER: Multimodel Ensemble for seasonal to Interannual prediction**
  - **Data targeting system**
  - **ENSEMBLES**
  - **EURO4M**
  - **MACC**
  - **PROVOST**
  - **ECSN-Hyretics**
  - **…**

Meteorological content – Special datasets (2/2)

- **IFS Research experiments**
  - **ECMWF**
  - **Member States**
- **Member States' Projects**
  - **COSMO-LEPS**
  - **Aladin-LEAF**
  - **…**

Meteorological content – Reanalysis datasets



ECMWF About Forecasts Computing Research Learning Carsten Maass Search site Go

Browse reanalysis datasets

- Data Assimilation
- Modelling and prediction
- Climate reanalysis
  - **Reanalysis datasets**
  - ERA-Interim
  - ERA-Interim/Land
  - ERA-20C
  - Coupled Earth-system reanalysis
  - Reanalysis for climate monitoring
  - Ocean reanalysis
- Projects
- Publications
- Special Projects

Dataset	Archive	Time period	Atmosphere	Atmospheric composition	Ocean waves	Ocean sub-surface	Land-surface	Observation Feedback Archive
ERA-Interim	Download	1979-present	✓		✓		✓	
ERA-Interim/Land	Download	1979-2010					✓	
ERA-20CM	Download	1900-2010	✓		✓		✓	
ERA-20C	Download	1900-2010	✓		✓		✓	Expected soon...
ERA-20CL	Expected soon...	1900-2010					✓	
ERA-40	Download	1957-2002	✓		✓		✓	
ERA-15	Download	1979-1993	✓				✓	

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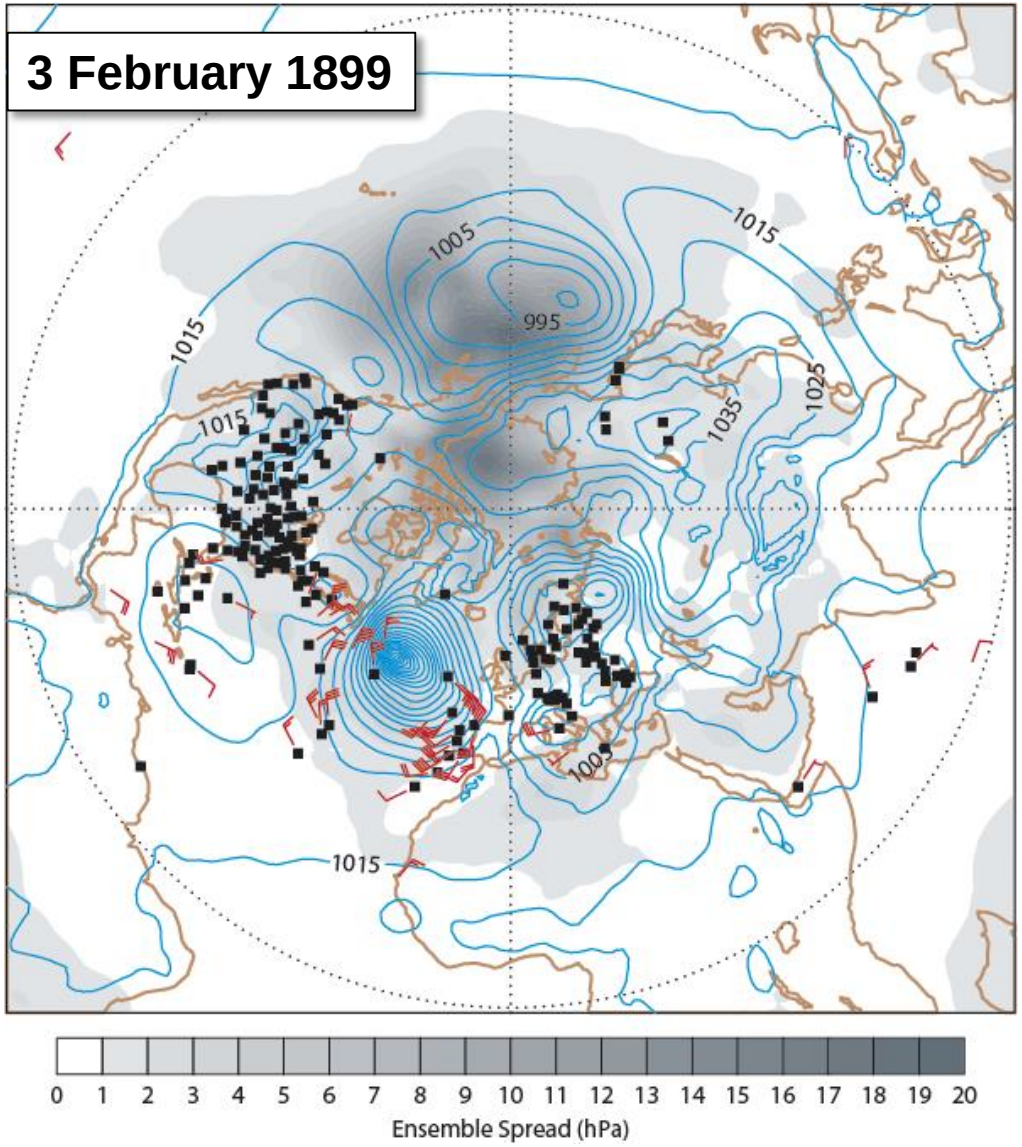
Meteorological content – ERA-Interim

- **36 years (1/1979 – 12/2014) of validated ERA-Interim analysis products are available**
- **Continued in near real-time (with ~2 months delay)**
- **Uses IFS Cycle 31r2, and 12h-4DVar**
- **Resolution:**
  - **Horizontal: T255, N128 (~0.7º)**
  - **Vertical: 60 ML, 37 PL, 16 PT, PV=±2**
- **Analyses at 00/06/12/18, Forecasts at 00/12 to 240 h**
- **Subset of products also publicly available on the ECMWF Data Server at full resolution**

Meteorological content – ERA-CLIM reanalysis products

Atmospheric reanalysis for the 20th-century (1900-2010) Using an ensemble of 10 plausible SST/sea-ice evolutions Assimilating observations of surface pressure and marine wind 125/25 km global resolution, 91 vertical model levels		
ERA-20CM	Ensemble of model integrations *(mainly monthly products)*	IFS Cy38r1 + CMIP5 data + HadISST v2.1
ERA-20C	Assimilation of surface observations *(3-hourly products)*	+ ICOADS v2.5.1 + ISPD v3.2.6 *(incl. ERA-CLIM)*
ERA-20CL	High-resolution land surface *(25km global)*	+ CHTESSEL
Final ERA-20C/M/L datasets (~200 Tb) are slowly becoming available at http://apps.ecmwf.int/datasets		

ERA-20C: A terrific storm at sea



TERRIFIC STORMS AT SEA

Steamships from All Quarters Report Extremely Rough Voyages.

ALL MORE OR LESS BATTERED

Vessels Sighted in Distress and Abandoned — Blinding Snow and Waves Like Mountains.

All the steamers that came in yesterday were coated with ice from the tops of the masts down to the water line, and all had passed through storms of blinding snow and mountainous waves. The British steamer Ethelgonda, from Bristol and Swansea, which left the latter port on Jan. 19, ran into a gale of hurricane force, and seas swept her decks repeatedly. So fierce was the wind that the boat drifted before the gales and was barely able to keep steerage way. She anchored outside the bar late Sunday afternoon. The cable parted and she lost her anchor, together with 100 fathoms of chain. Then the great snowstorm drove her 150 miles off the shore. She succeeded in getting back late on Tuesday night.

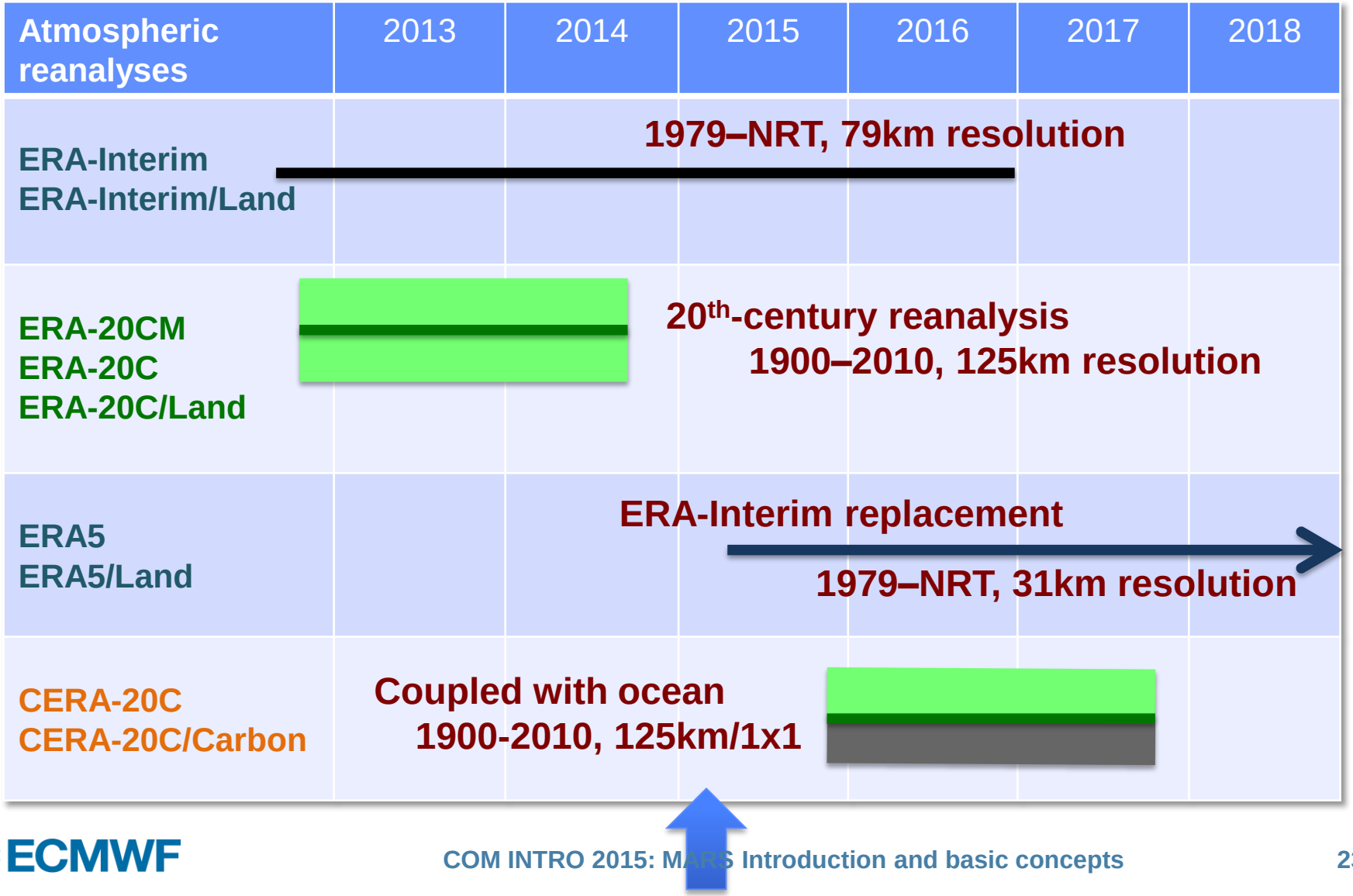
The French liner La Bretagne, from Havre, came in a little before noon yesterday, with 58 cabin and 225 steerage passen-

The New York Times
Published: February 16, 1899

Meteorological content – Next ERA-Interim

	ERA-Interim	ERA5
Start of production	August 2006 IFS Cy31r2	June 2015 IFS Cy41r1
Model input	As in operations *(inconsistent SST)*	Appropriate for climate (CMIP5, HadISST.2)
Spatial resolution	79 km global 60 levels to 10 Pa	31 km global 137 levels to 1 Pa
Time period	1979 - present	1979 - present (extension to ~1950)
Dissemination	Monthly	Monthly for ERA5; daily for ERA5T
Observations	Mostly ERA-40, GTS	Various reprocessed CDRs
Radiative transfer	RTTOV7	RTTOV11
Analysis method	4D-Var 1D+4DVar rain	10-member ensemble 4D-Var (EDA) All-sky MW
Variational bias corrections	Satellite radiances	Also ozone, aircraft, surface pressure (radiosondes)

Meteorological content – Reanalysis outlook



Meteorological content – TIGGE

- **THORPEX Interactive Grand Global Ensemble**
- **Global ensemble forecasts to around 14 days generated routinely at different centres around the world**

  ECMWF, JMA (Japan), Met Office (UK), CMA (China), NCEP (USA), MSC (Canada), Météo-France (France), BOM (Australia), CPTEC (Brazil), KMA (Korea)

- **Data archived in GRIB 2**
- **TIGGE-LAM data since 1/1/2013**

http://tigge.ecmwf.int

Meteorological content – Observations & Feedback

- **Observations**
  - **Surface data**
  - **Vertical soundings**
  - **Upper-air data**
  - **Satellite**
- **Feedback**
- **Analysis Input**
- **Analysis Feedback (superseded by ODB feedback)**

Meteorological content – Data formats

WMO formats

- **Fields in GRIB (GRid In Binary), ECMWF local extensions**
  - **Spherical Harmonics (upper-air fields, T1279)**
  - **Gaussian Grid (surface fields, N640)**
  - **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 – ODB

- **In the IFS observations are handled by ODB (Observational Data Base)**
- **ODB is a**
  - **Hierarchical in-core database with a data definition and query language: ODB/SQL**
  - **A data format**
  - **. . .**
- **ODB Observation Feedback (ofb) data is archived in MARS**
  - **Improve the representation of feedback data in MARS meta data**
  - **Introduce SQL capabilities to request feedback data**
- **To improve the handling of observations, ODB will be further integrated into ECMWF systems**

MARS – ODB

Metview can be used to

- **Retrieve**
- **Examine and**
- **Plot**

ODB data

See

https://software.ecmwf.int/wiki/display/METV/Tutorials

MARS – future development

- **Content**
  - **ERA-CLIM**
  - **S2S (subseasonal-to-seasonal)**
  - **UERRA (Uncertainties in Ensembles of Regional Re-Analysis)**
  - **JRA-55**

- **Architecture**
  - **New interpolation package**
  - **Alignment with new Product Generation**

MARS language

Mechanism to *name* archived 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**

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,
    class     = od,
    stream    = oper,
    expver    = 1,

    date      = -3,
    time      = 12,

    type      = analysis,
    levtype   = model levels,
    levelist  = 1/to/137,
    param     = temperature,

    grid      = 2.5/2.5,

    target    = "analysis"
```

action

identification

date & time related

data related

post-processing

storage

MARS language – Identification of archive

class	**ECMWF classification (od, rd, e4, …)**
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)**

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 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)**

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**

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**

MARS language – ODB

reportype	**classification to index ODB data (16020)**
obsgroup	**Grouping of report types**
type	**Type of ODB information, ofb (ODB Feedback), mfb (MONDB Feedback), oai (ODB Analysis Input)**
time	**time represents the analysis time (ODB column antime)**
filter	**SQL filter query ("select lat,lon,obsvalue where varno=39“)**

ODB Governance database: http://data-portal.ecmwf.int/odbgov/

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/ms/gb/uid/analysis"
```

MARS language - Post-processing (1/2)

grid	**output grid mesh** • **Latitude/longitude increments in degrees (2.5/2.5)** • **Number of latitude lines from Pole to Equator (160)**
gaussian	**type of Gaussian grid (regular, reduced)**
area	**desired sub-area in degrees (north/west/south/east)**
frame	**number of grid points from sub area inwards (5)**
resol	**triangular truncation (319, auto, av)**

MARS language - Post-processing (2/2)

rotation	**lat/lon of South Pole**
accuracy	**number of bits per data value in GRIB (16)**
style	**specify post-processing style (dissemination)**

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

- **Single value, predefined names, numbers, mnemonics**

  param = temperature

- **List of values, separated by /**

  step = 12/24/48

- **Range of values, using keywords: to, / and by**

  date = 20020101/to/20020131

  step = 24/to/240/by/24

MARS language – Values

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

  date = 20020101/to/20020131 31 fields

- **Certain keywords accept all as valid value**

  levelist = all

- **Most keywords accept off as valid value**

  levtype = surface,

  levelist = off

- **Not all possible combinations keyword = value name an archived field**

Request examples – Interim Reanalysis

Retrieval of snow depth from the ERA-Interim archive for December 2007, for all analysis base times. It retrieves 124 fields.

```
retrieve,
      class     = ei,
      stream    = oper,
      expver    = 1,
      date      = 20071201/to/20071231,
      time      = 00/06/12/18,
      type      = an,
      levtype   = sfc,
      param     = sd,
      target    = "era-int.200712.sd"
```

Request examples - Ensemble forecast

Retrieval of surface temperature and 10-m wind components (U and V), 20 first members of the EPS for 2nd Jan 2001 for time steps 12, 36 and 60. It retrieves 180 fields.

```
retrieve,
        class   = od,
        stream  = enfo,
        expver  = 1,
        date    = 20010102,
        time    = 12,
        step    = 12/36/60,
        type    = pf,
        levtype = sfc,
        param   = st/10u/10v,
        number  = 1/to/20,
        target  = "perturbed.sfc"
```

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    = 20020501/to/20020510,
        time    = 00/06/12/18,
        type    = an,
        levtype = sfc,
        param   = sea surface temperature,
        target  = "sst"
```

Request examples – ODB observation feedback

Retrieval of 2mt observation feedback from conventional data for 12 UTC analysis run on 1 February 2015.

```
retrieve,
     class    = od,
     stream   = oper,
     expver   = 1,
     date     = 20150201,
     time     = 12,
     type     = ofb,
     obsgroup = conv,
     filter   = "select lat,lon,obsvalue where varno=39",
     target   = "2mt.odb"
```

Retrieving data – Calling MARS

- **directives from input stream**

```
mars <<EOF
retrieve,
  type   = an,
  date   = -1,
  target = "$SCRATCH/my_an"
EOF
```

- **directives from file**

```
cat > my_request <<EOF
retrieve,
  type   = an,
  date   = -1,
  target = "$SCRATCH/my_an"
EOF
mars my_request
```

MARS Practical

Point your browser to

software.ecmwf.int/wiki/display/UDOC/MARS+example+requests

or on software.ecmwf.int navigate to

User Documentation > MARS > MARS example requests

and follow the instructions

Retrieving data – Hints

- **Default values: minimize their use**
- **No semantic check (only syntax is checked)**
- **MARS messages**
  - **INFO** **request execution and report**
  - **WARNING** **unusual aspect of execution**
  - **ERROR** **system or data errors**
  - **FATAL** **terminates execution**

Web-MARS – apps.ecmwf.int/services/mars/catalogue/

Web interface to archive catalogue

- **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**

Web-MARS – http://apps.ecmwf.int/services/mars/activity/

Server activity / MARS queue

- **Show archive activity**
- **Monitor your requests**
- **Learn how the queuing system works**
  - **Reason for queued requests**

Parameter database

https://software.ecmwf.int/wiki/display/GRIB/GRIB+API

- **GRIB table based view**
- **Links to IFS documentation**
- **Links to comprehensive list of class, stream and type**

Retrieving data – Helpers

Some useful tools

- **`grib_ls, grib_dump, ...`**
- **Metview examiners**
  - **`metview -e grib <filename>`**
  - **`metview -e bufr <filename>`**
  - **`metview -e netcdf <filename>`**
  - **`metview -e odb <filename>`**

- **CDO - Climate Data Operators**

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

Retrieving data – Conversion to NetCDF

GRIB API tool **`grib_to_netcdf`**

- To convert a GRIB file to NetCDF format
- GRIB must be a regular lat/lon grid or a regular Gaussian grid
  - i.e. the key "typeOfGrid" should be "regular_ll" or "regular_gg"
- Example

```
> grib_to_netcdf -o output.nc input.grib1
```

See https://software.ecmwf.int/wiki/display/GRIB/grib_to_netcdf

MARS Architecture

- **Client/Server**
- **Protocol: MARS request**
- **Clients, C program + GRIB API + libemos library (Interpolation)**
  - Supercomputers
  - Workstations and Servers
  - Applications like Metview (local / at ECMWF)
  - Remote client for Member States (security mechanism)
  - WebMARS
  - Data Server
  - Web API

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 supercomputers**
- **Main Archives (multiple servers)**
  - **Dedicated Linux servers / clustered architecture**
  - **Terabytes of disk space**
  - **Tape management SW: HPSS**
  - **Oracle (Sun) SL8500 Automated Tape Libraries**

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)

```
MARS - INFO - **
MARS - INFO - **

PPDIR is /ppdir/data/rs60005
mars - INFO   - 20090225.102926 - Welcome to MARS
retrieve,
   class    = od,
   type     = an,
   expver   = 1,
   date     = -7,
   time     = 00/to/18/by/6,
   param    = t,
   levtype  = model level,
   levelist =  1/to/91,
   area     = E,
   grid     = 2.5/2.5,
   target   = "t.ll"
```

mars - INFO - 20090225.102942 - Processing request 1
mars - WARN - 20090225.102942 - Area not compatible with grid
mars - WARN - 20090225.102942 - Area changed from 73.5/-27/33/45 to 75/-27.5/32.5/45

Request execution (2/3)

```
RETRIEVE,
    CLASS       = OD,
    TYPE        = AN,
    STREAM      = DA,
    EXPVER      = 0001,
    REPRES      = SH,
    LEVTYPE     = ML,
    LEVELIST    = 1/2/3/4/5/6/7/8/9/10/11/12/13/14/15/16/17/18/19/20/21/22/23/
24/25/26/27/28/29/30/31/32/33/34/35/36/37/38/39/40/41/42/43/44/45/46/47/48/49/50/5
1/52/53/54/55/56/57/58/59/60/61/62/63/64/65/66/67/68/69/70/71/72/73/74/75/76/77/78/
79/80/81/82/83/84/85/86/87/88/89/90/91,
    PARAM        = 130,
    DATE        = 20090218,
    TIME        = 0000/0600/1200/1800,
    STEP        = 00,
    DOMAIN      = G,
    TARGET      = "t.ll",
    RESOL       = AUTO,
    AREA        = 75/-27.5/32.5/45,
    GRID        = 2.5/2.5,
    PROCESS     = LOCAL
```

Request execution (3/3)

```
mars - INFO   - 20090225.102942 - Requesting 364 fields
819480 FDB; INFO;   DB$_    Fields DataBase 4.2
mars - INFO   - 20090225.102942 - Calling mars on 'marsod', callback on 61767
mars - INFO   - 20090225.104347 - Mars client is on ecgate.ecmwf.int (136.156.240.111) 61767
mars - INFO   - 20090225.104347 - Mars server is on hdr16.ecmwf.int (136.156.228.176) 57793
mars - INFO   - 20090225.104347 - Server task is 526 [marsod]
mars - INFO   - 20090225.104347 - Request cost: 364 fields, 445.507 Mbytes online [marsod]
mars - INFO   - 20090225.104347 - Transfering 467148136 bytes
mars - WARN   - 20090225.104348 - INTFB: Resolution automatically set to   63
mars - INFO   - 20090225.104423 - 364 fields retrieved from 'marsod'
mars - INFO   - 20090225.104423 - 364 fields have been interpolated on 'ecgate'
mars - INFO   - 20090225.104423 - Request time:  wall: 14 min 42 sec  cpu: 12 sec
mars - INFO   - 20090225.104423 - Read from network: 445.51 Mbyte(s) in 24 sec  [18.43 Mbyte/sec]
mars - INFO   - 20090225.104423 - Processing in marsod: wall: 14 min 6 sec
mars - INFO   - 20090225.104423 - Visiting marsod: wall: 14 min 42 sec
mars - INFO   - 20090225.104423 - Post-processing: wall: 11 sec cpu: 9 sec
mars - INFO   - 20090225.104423 - Memory used: 13.48 Mbyte(s)
mars - INFO   - 20090225.104423 - No errors reported
```

Retrieving data

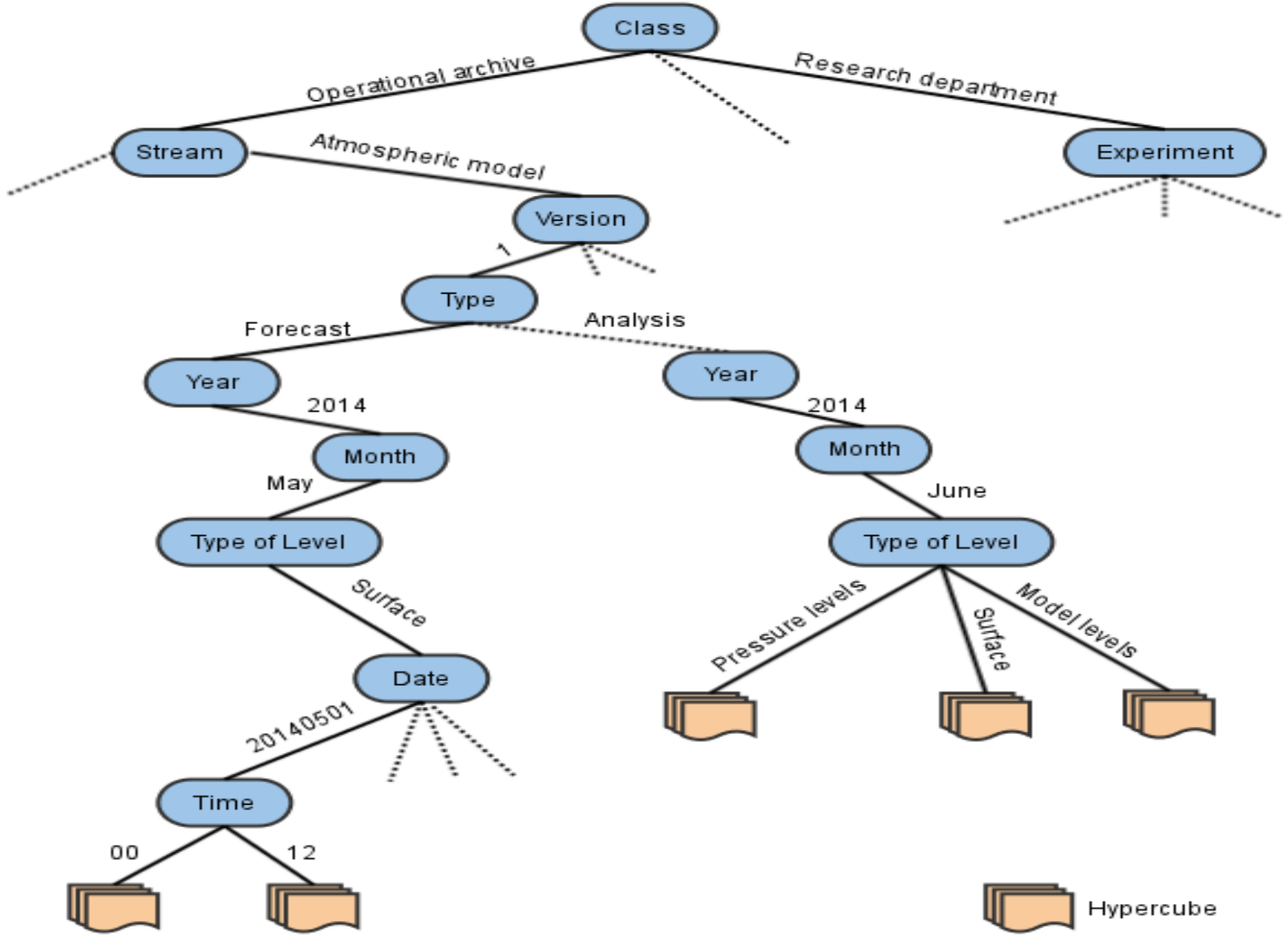
Request scheduling

- **Queueing 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 Interim FC (1 level type, all levels, times, steps, params)**

Retrieving data - MARS tree



Retrieving data - Post-processing

- **Conversions**
  - **SH ⟶ SH (reduced truncation), GG, LL**
  - **GG (reduced) ⟶ GG (lower resolution or regular), LL**
  - **LL ⟶ LL (lower resolution)**
- **Sub-area extractions (GG, LL, waves), reduces data volume**
- **Derived fields (e.g. U and V from vorticity and divergence)**
- **Rotation**

Retrieving data - Post-processing

Truncation before interpolation, reduces necessary resources

Grid increment	Truncation
2.5 ≤ Δ	T63
1.5 ≤ Δ < 2.5	T106
0.6 ≤ Δ < 1.5	T213
0.4 ≤ Δ < 0.6	T319
0.3 ≤ Δ < 0.4	T511
0.15 ≤ Δ < 0.3	T799
0.09 ≤ Δ < 0.15	T1279
0.0 ≤ Δ < 0.09	T2047

Retrieving data – Efficiency

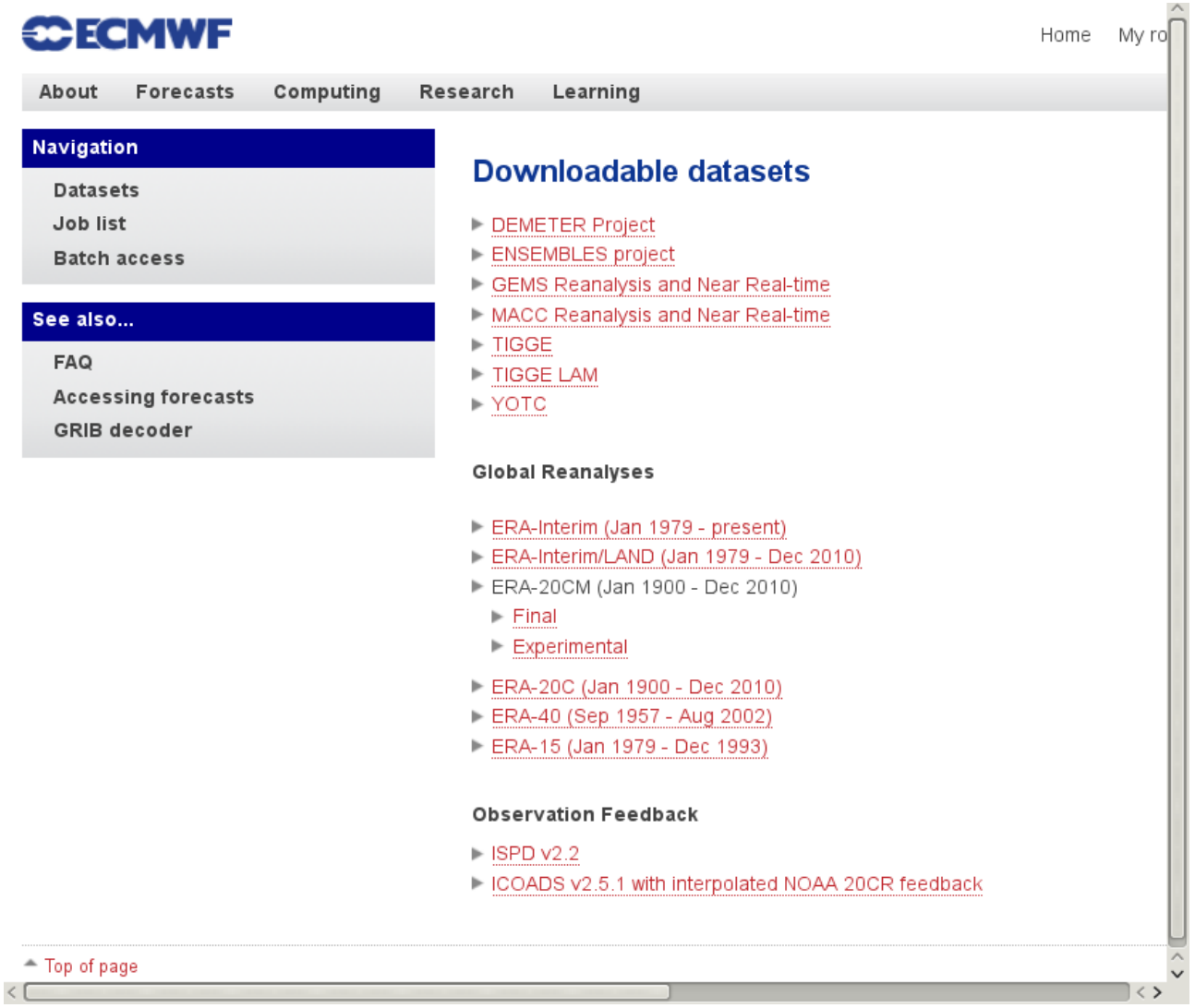
- **Use local disk ($SCRATCH)**
- **Estimate amount of data (list command)**
  - **Number of fields (up to tens of thousands / request)**
  - **Data size (up to several Gigabytes / request)**
- **Check computer resources: quota, CPU time, …**
- **Reduce number of tapes involved (better scheduling)**
- **Retrieve as much data from the same tape as possible**
- **Avoid constantly accessing the same tape**
- **Do not create unnecessary sub-archives**

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 hours ≥ 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**
  - **www.ecmwf.int/en/forecasts/datasets**
  - **www.ecmwf.int/search/site/%22dissemination%20schedule%22?solrsort=sort_label%20asc&retain-filters=1**
- **For time-critical retrievals, use the framework provided**

Data Server – http://apps.ecmwf.int/datasets/

- **Public distribution of data (licensing depends on datasets)**
  - **Self-registration**
- **Based on ecCharts framework**



Data Server – Web API

- **To access ECMWF data servers in batch**
- **Requirements**
  - **User account**
  - **client library, e.g. python**
  - **API key**

See
https://software.ecmwf.int/wiki/display/WEBAPI/Accessing+ECMWF+data+servers+in+batch

Additional resources

- **MARS documentation**
  software.ecmwf.int/wiki/display/UDOC/MARS
- **Web-MARS**
  apps.ecmwf.int/services/mars/catalogue/
- **FAQ**
  http://www.ecmwf.int/search/faqs
- **ECMWF datasets**
  www.ecmwf.int/en/forecasts/datasets
- **IFS Documentation**
  www.ecmwf.int/en/forecasts/documentation-and-support/changes-ecmwf-model/
- **GRIB API Documentation**
  software.ecmwf.int/wiki/display/GRIB/Home