

Introduction to computing resources

Computer User Training Course 2015

Paul Dando

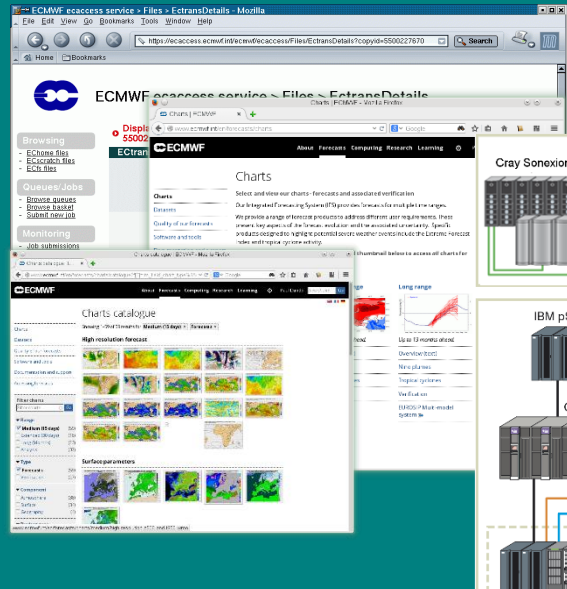
User Support

advisory@ecmwf.int

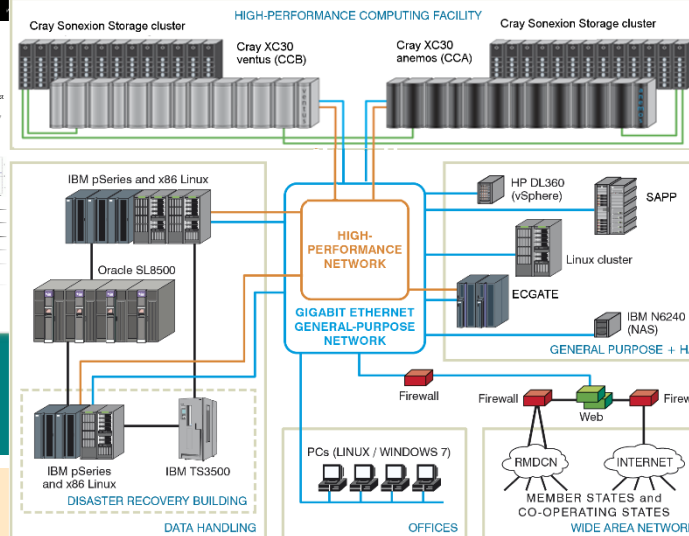


Overview

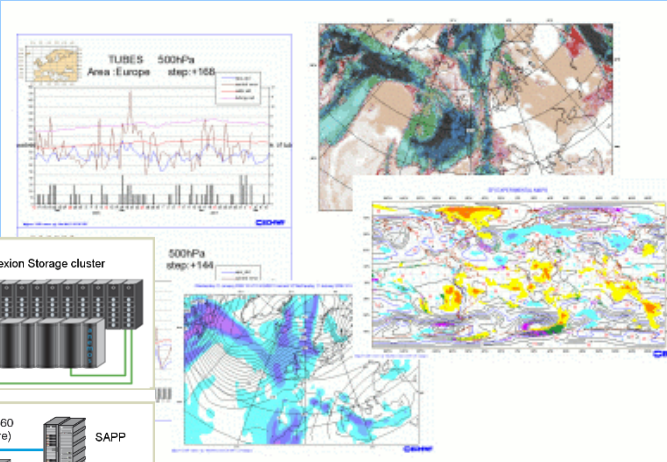
Web services
(ECaccess, ecCharts, APPS,..)



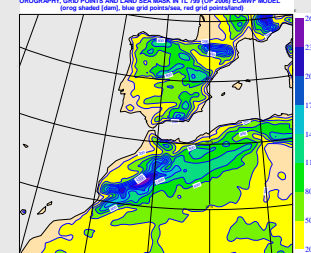
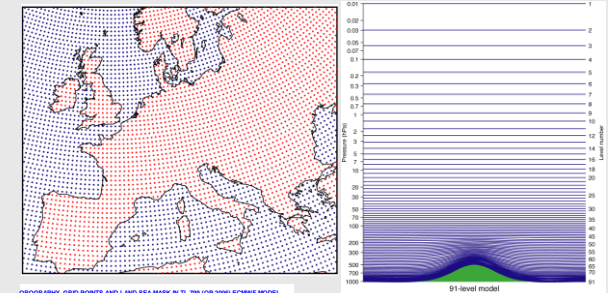
Computer facilities



Meteorological software & libraries



mars,
EMOS,
grib_api,
Metview,
Magics++,
etc.



IFS model



Call Desk { Fault reporting,
Service queries
User Support { Advice on the use
of ECMWF computers

ECMWF main meteorological products – HRES / BC

- High resolution forecast and analysis (HRES, 4DVAR, EDA)
 - ~16 km resolution and 137 levels (T1279 L137)
 - Analysis at 00, 06, 12 and 18 UTC
 - Forecast to 10 days at 00 and 12 UTC
 - Availability of products: 5:35-6:55 for run at 00 UTC (17:35-18:55 for 12 UTC)
- Boundary conditions for Limited Area Models - Optional Programme (BC)
 - Short cut-off forecast at ~16 km resolution (T1279 L137) at 06 and 18 UTC to 90 hours
 - 00 and 12 UTC analysis and forecast taken from the main deterministic model
 - Hourly steps up to 90 hours and *Full fields* are available
 - Availability of products: 5:40-6:08 for run at 00 UTC
- Monthly Means
 - atmospheric and wave averaged over each calendar month

ECMWF main meteorological products – ENS

- Ensemble forecast (ENS)

- 50+1 members at 00 and 12 UTC
- With ocean coupling from initial time (since 19 Nov 2013)
- Day 1-10 at ~32 km (T639 L91)
- Day 11-15 at ~64 km (T319 L91)
 - Availability of products: 7:40-8:40 for run at 00 UTC
- Extension of 00 UTC ENS to 32 days (T319 L91 from day 11) twice a week (*on Monday & Thursday*)
 - Availability of products: 22:00 UTC for real-time data, 10:00 UTC for re-forecasts

ECMWF main meteorological products – WAM

- **Global ocean wave forecast and analysis (WAM HRES)**
 - Coupled with atmospheric model
 - Analysis at 00, 06, 12 and 18 UTC
 - Global forecast to 10 days from 00 and 12 UTC at ~28 km resolution
 - Availability of products: 5:35-6:55 for run at 00 UTC (17:35-18:55 for 12 UTC)
- **European shelf (Mediterranean) limited-area wave forecasts (LAM WAM)**
 - ~10 km resolution
 - Analysis plus forecast to 5 days from 00 and 12 UTC
 - Availability of products: 7:20-7:35 for run at 00 UTC (19:20-19:35 for 12 UTC)
- **Ensemble Wave (WAM ENS)**
 - 50+1 members at 00 and 12 UTC
 - Day 1-15 at ~55km resolution (extended to day 32 for 00UTC on Monday & Thursday)
 - Availability of products: 7:40-8:40 for run at 00 UTC

ECMWF main meteorological products – SEAS / ERA

● Seasonal System 4 (SEAS)

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

● ECMWF Re-Analysis

- ERA-15, ERA-40, ERA-Interim, ERA-Interim/LAND, ERA-20CM, ERA-20C,
- ERA-Interim: covers 1 Jan 1979 to 31 Dec 2014

Operational upgrades for 2015

- April 2015: implementation of IFS cycle 41r1
 - New land-sea masks and climate files
 - Lake model (FLAKE)
 - New model output parameters
 - Extension of the Ensemble reforecasts
 - Larger ensemble size (11 members, twice per week)
 - LAM WAM becomes global and extended to 10 days
 - ...
- First half 2015: add 06 and 18 UTC runs of ENS for BC
 - 50+1 members to T+138
- Later this year:
 - E-suite for upgrade of horizontal resolution for HRES and ENS

Operational upgrades –

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

ECMWF About Forecasts Computing Research Learning Paul Dando Search site Go

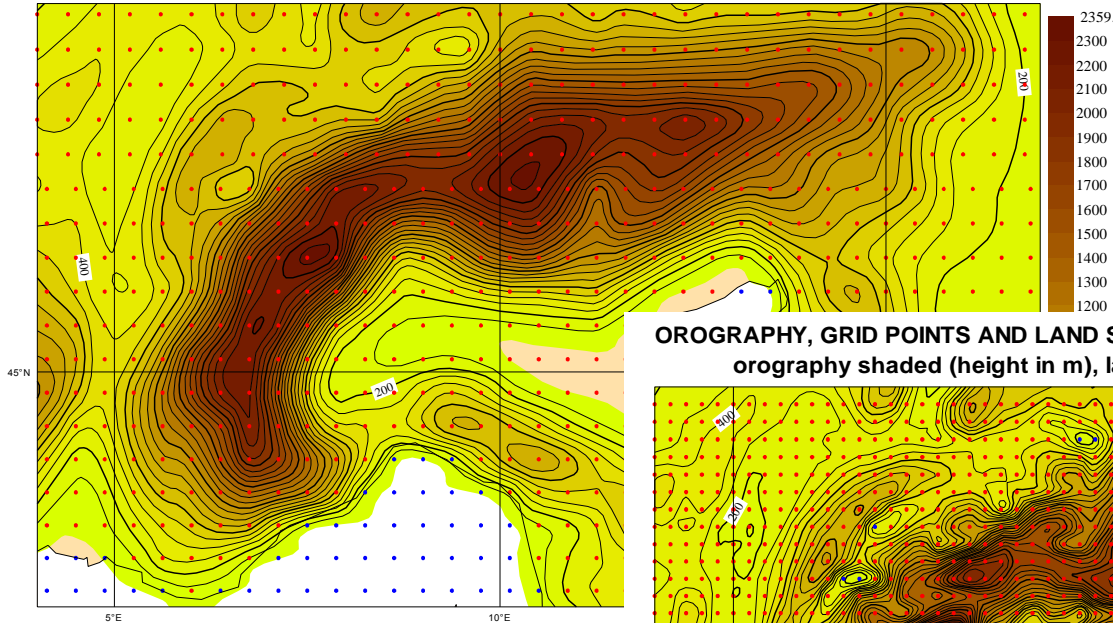
Changes in ECMWF model

Note: we are in the process of migrating the history of the changes in our new website, some links still point to our old website until the migration is complete.

Date	ECMWF model cycle	Atmospheric model id	Ocean model id	Limit ed-area ocean wave model id	Resolution change
22-Nov-13	IFS Cycle 40r1	144	110	210	Vertical for ENS
25-Jun-13	IFS Cycle 38r2	143	109	209	
19-Jun-12	IFS Cycle 38r1	142	109	209	
15-Nov-11	IFS Cycle 37r3	141	108	208	
18-May-11	IFS Cycle 37r2	140	107	207	
09-Nov-10	IFS Cycle 36r4	139	106	206	
22-Jun-10	IFS Cycle 36r2	137	105	205	
26-Jan-10	IFS Cycle 36r1	136	104	204	HRES/ENS/Ocean
13-Oct-09	IFS Cycle 35r3	135	120	220	
08-Sep-09	IFS Cycle 35r3	135	120	220	
10-Mar-09	IFS Cycle 35r2	134	119	219	
30-Sep-08	IFS Cycle 35r1/33r2	133	118	218	
03-Jun-08	IFS Cycle 33r1	132	117	217	
11-Mar-08	IFS Cycle 32r3	131	116	216	
06-Nov-07	IFS Cycle 32r3	130	116	216	
05-Jun-07	IFS Cycle 32r2	129	116	216	
12-Sep-06	IFS Cycle 31r1	128	116	216	

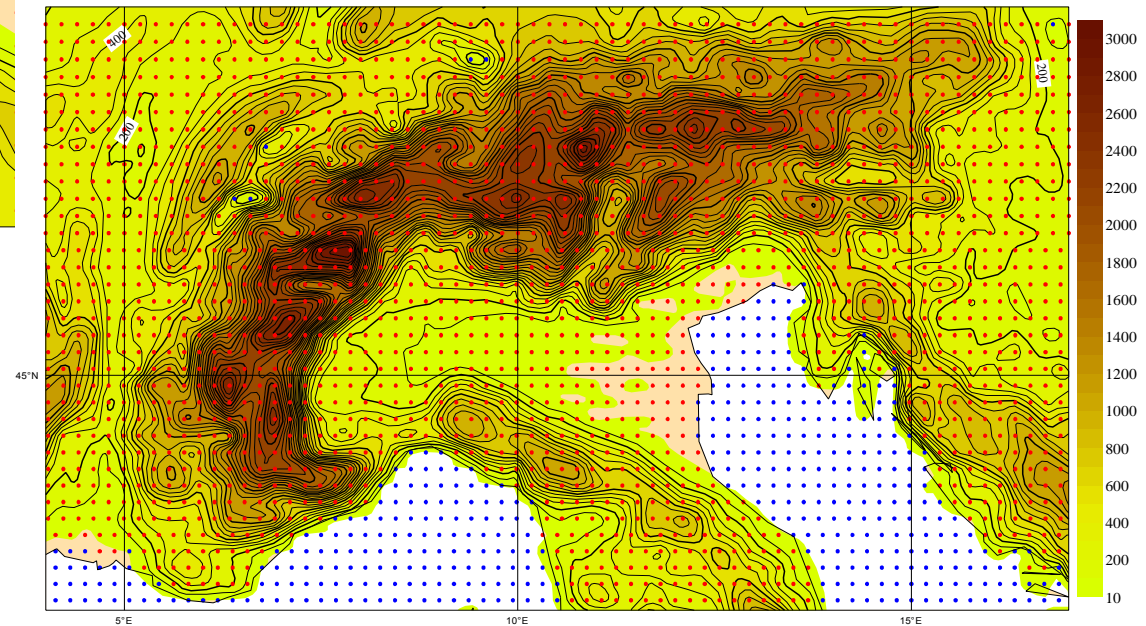
Model grids for ENS (32 km) and HRES (16 km)

OROGRAPHY, GRID POINTS AND LAND SEA MASK IN TL 639 (EPS 2010) ECMWF MODEL
orography shaded (height in m), land grid points (red), sea grid points (blue)



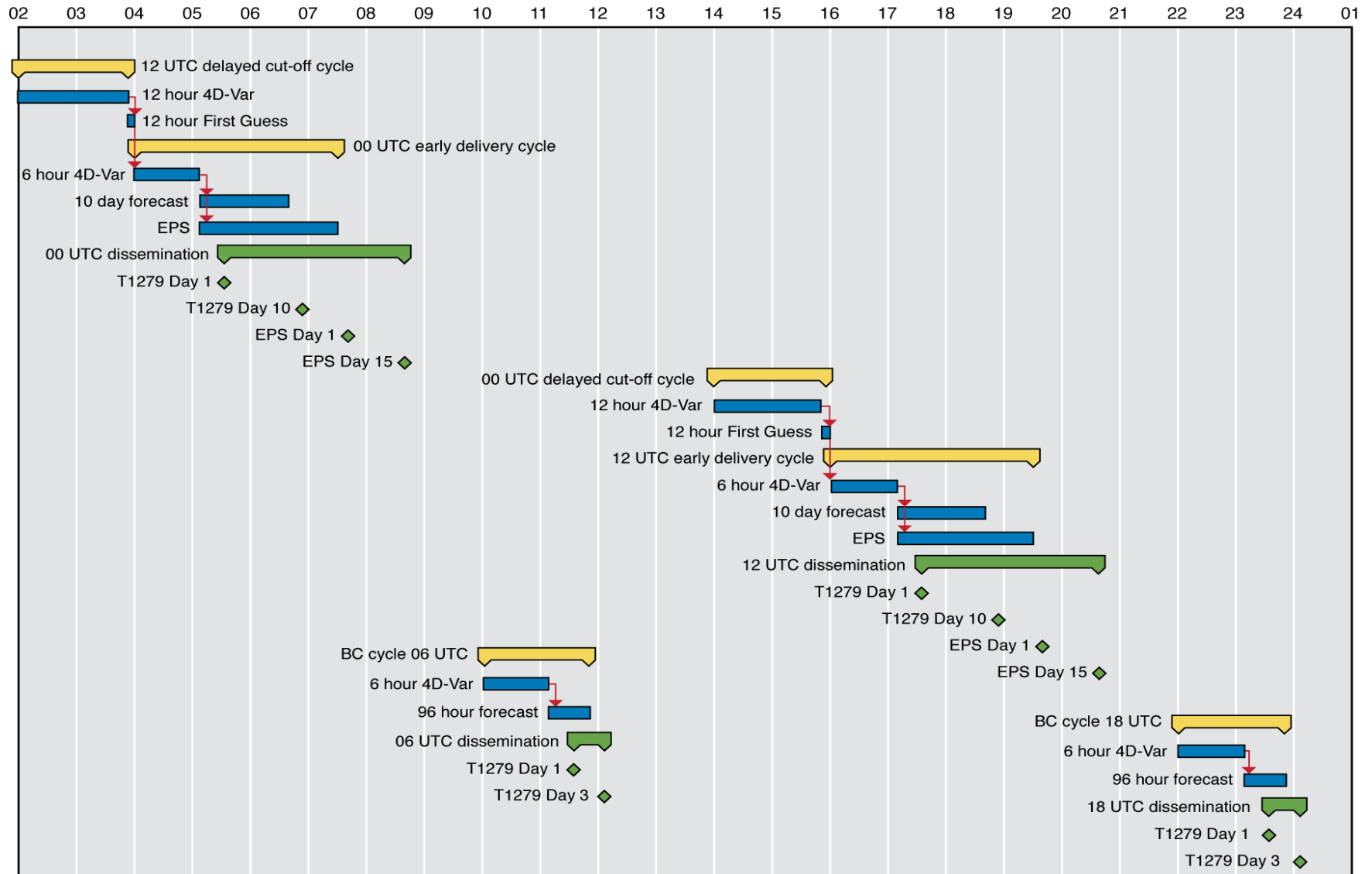
ENS: 91 x 542,080
= 49,329,280 grid points

OROGRAPHY, GRID POINTS AND LAND SEA MASK IN TL 1279 (OP 2010) ECMWF MODEL
orography shaded (height in m), land grid points (red), sea grid points (blue)



HRES: 137 x 2,140,702
= 293,276,174 grid points

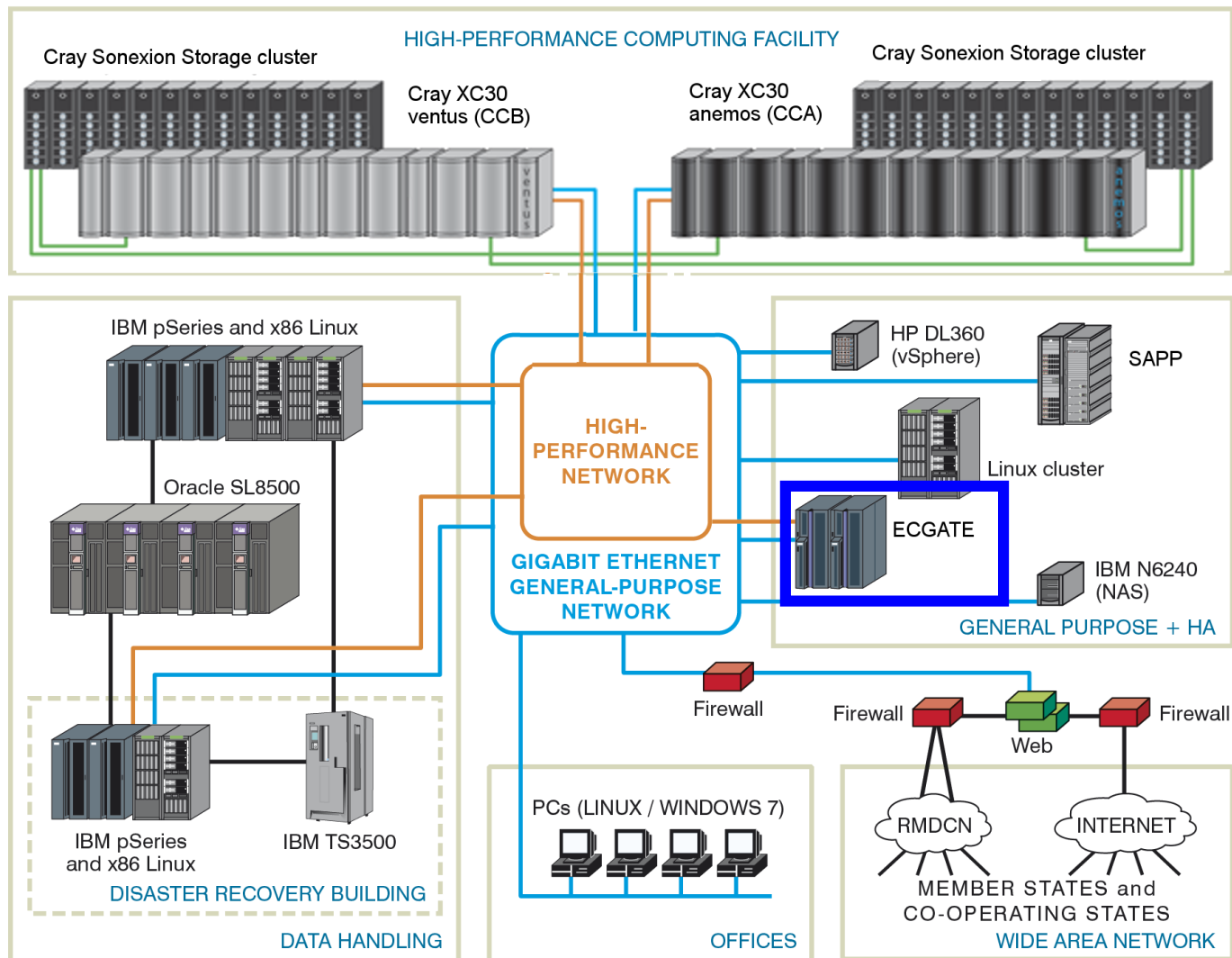
The main operational suites on ECMWF's HPCF



Computing Services

Unix server – ecgate

Web documentation: www.ecmwf.int/en/computing/our-facilities/ecgate



ecgate – configuration

- 12 compute nodes each with
 - 2 Intel Xeon processors (Sandy Bridge-EP): 16 core at 2.7 GHz
 - Hyper threading is used providing 32 virtual CPUs per node
 - 128 GB memory
 - 2 x 900 GB SAS HDD
- One (+one as backup) node used as a "login" node
- RedHat Enterprise Linux Server 6.4
- 6 I/O server nodes
- 8 DS3524 with 24 x 3 x 300 GB 10k SAS HDD storage subsystem
 - provides 172.8 TB raw disk space
- Available to ~2700 users at more than 300 institutions



ecgate – file systems and user quotas

- About **130 TB** of usable disk space
 - Not all allocated as user space !
 - All file systems are GPFS (General Parallel File Systems)
 - File systems use RAID 5 for speed and resilience
- User quotas
 - **3 GB** on \$HOME
 - **300 GB** on \$SCRATCH
 - **30 GB** on \$PERM
 - These quotas CAN be increased on request
- Select / delete
 - running on **\$SCRATCH** whenever a threshold is reached
 - runs once per month to remove files older than one year

ecgate – purpose

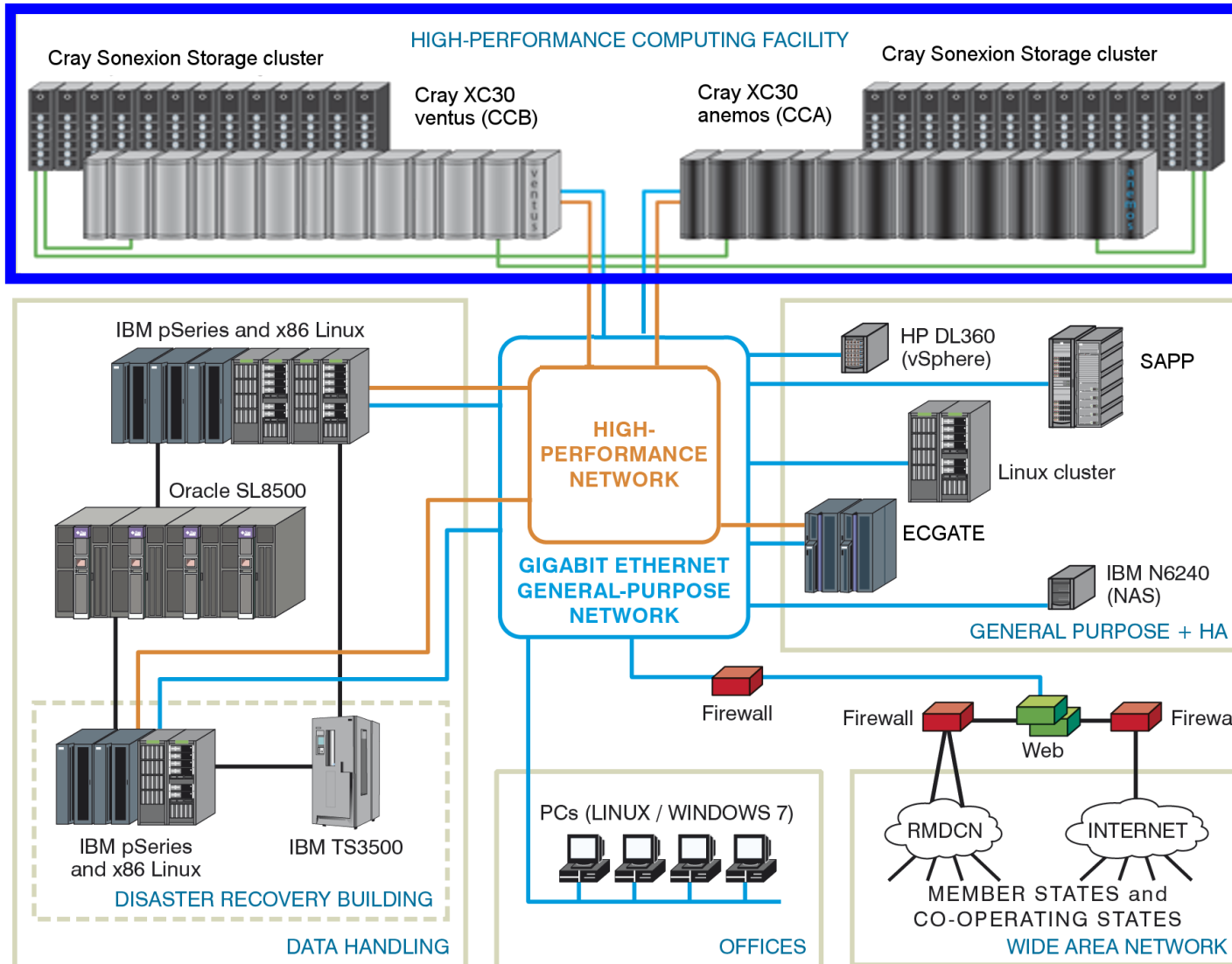
- Access to archives (**MARS** & **ECFS**)
- Batch job submission (SLURM, ECaccess tools)
- Data transfer between ECMWF and MS: **ectrans**, **ftp**, **sftp**
- Program development
- Visualization
- Submission and control of “time-critical” applications
 - Jobs under option 1
 - Suites under option 2
 - e.g. COSMO-LEPS, UKMO MOGREPS-15, ALADIN LAEF, BCEPS-MUMO, ...

ecgate – software environment

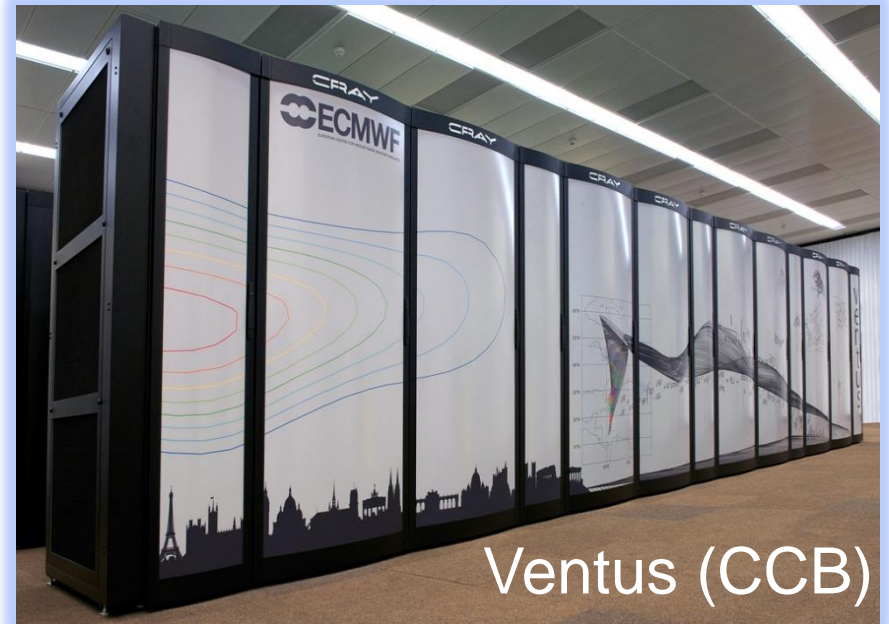
- General software and libraries: ECLIB, EMOSLIB, GRIB_API
- Numerical Libraries: NAG, GSL
- Data Formats tools and libraries: netCDF, HDF, HDF5
- Archives: MARS, ECFS
- Graphics:
 - ECMWF: Metview, Magics++
 - External data analysis and Visualization tools:
 - ncview, view_hdf, panoply
 - IDL, PV-Wave (limited number of licenses)
 - CDO, NCO, R, NCL, GrADS, gnuplot
- Debugging: Totalview
- Supervisor Monitor Scheduler: SMS/CDP/XCdp ecFlow

HPCF

Web documentation: www.ecmwf.int/en/computing/our-facilities/supercomputer



HPCF – Cray XC30



Operations moved to the Cray	19 September 2014
End of service of IBM	30 September 2014

CRAY configuration

	IBM Power7	Cray XC30
Sustained performance	~70 teraflops	~ 210 teraflops
Peak performance	~1500 teraflops	~3500 teraflops
Compute clusters	2	2
Each compute cluster		
Compute nodes	739	~3,500
Compute cores	23,648	~84,000
Cores per node/CPU per node	32/64	24/48
Total memory (TiB)	46	~210
Pre-/post-processing nodes	20	~64
Operating System	AIX 7.1	SUSE Linux/CLE
Scheduler	IBM LoadLeveler	Altair PBSpro/ALPS
Interconnect	IBM HFI	Cray Aries
Each storage system		
High performance storage (petabytes)	1.5	Over 3
Filesystem technology	GPFS	Lustre
General purpose storage (terabytes)	N/A	38
Filesystem technology	GPFS	NFS via NetApp FAS6240 filer

HPCF – purpose

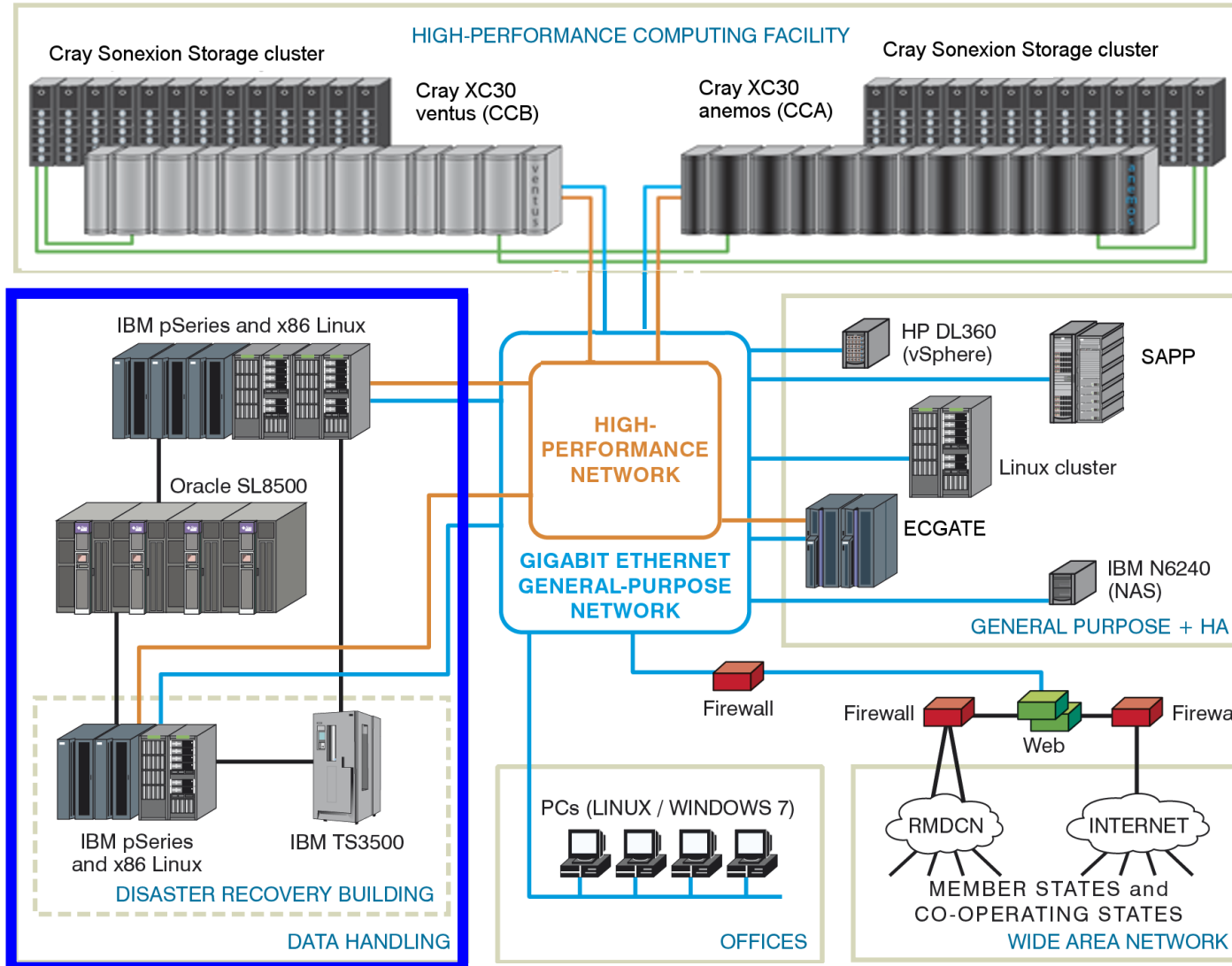
- Running meteorological models
 - Member State models (HIRLAM, Harmonie, COSMO, UM, WRF, ...)
 - ECMWF's IFS via prepIFS
- Batch job submission
 - Using PBSpro or ECaccess tools
- Time-critical activities ([options 1, 2 and 3](#))
- Access to archives ([MARS](#) and [ECFS](#))
 - Use serial batch jobs!
- Data transfer between Member States and ECMWF
 - [ectrans](#), [ftp](#), [sftp](#)
 - Use serial batch jobs!

HPCF – software environment

- General software and libraries:
 - ECLIB, EMOSLIB, GRIB_API
- Archives:
 - MARS, ECFS
- Data Formats tools and libraries:
 - netCDF, NCO, HDF, HDF5
- Debugging:
 - Allinea DDT
- Numerical Libraries:
 - LIBSCI (CRAY), GSL, NAG

Data Handling System (DHS)

Web documentation: www.ecmwf.int/en/computing/our-facilities/data-handling-system



DHS – configuration

- DHS Hardware

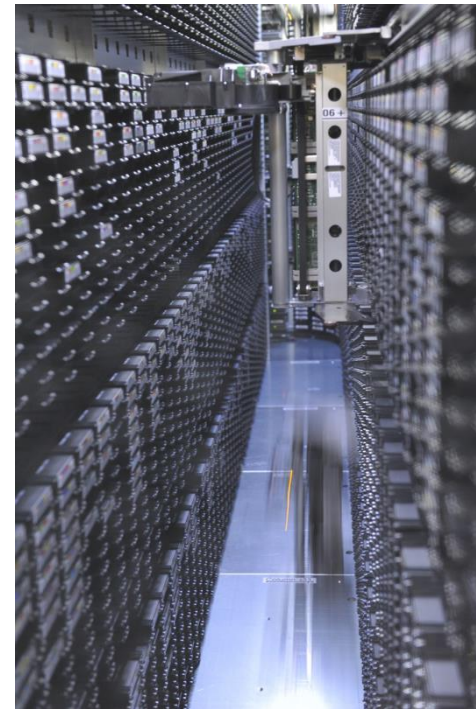
- Intel-based Linux servers
- Some IBM p575/p620 servers
- 4 Sun SL8500 automated tape libraries

- DHS Software

- Based on HPSS (High-Performance Storage System)

- Comprises two archives

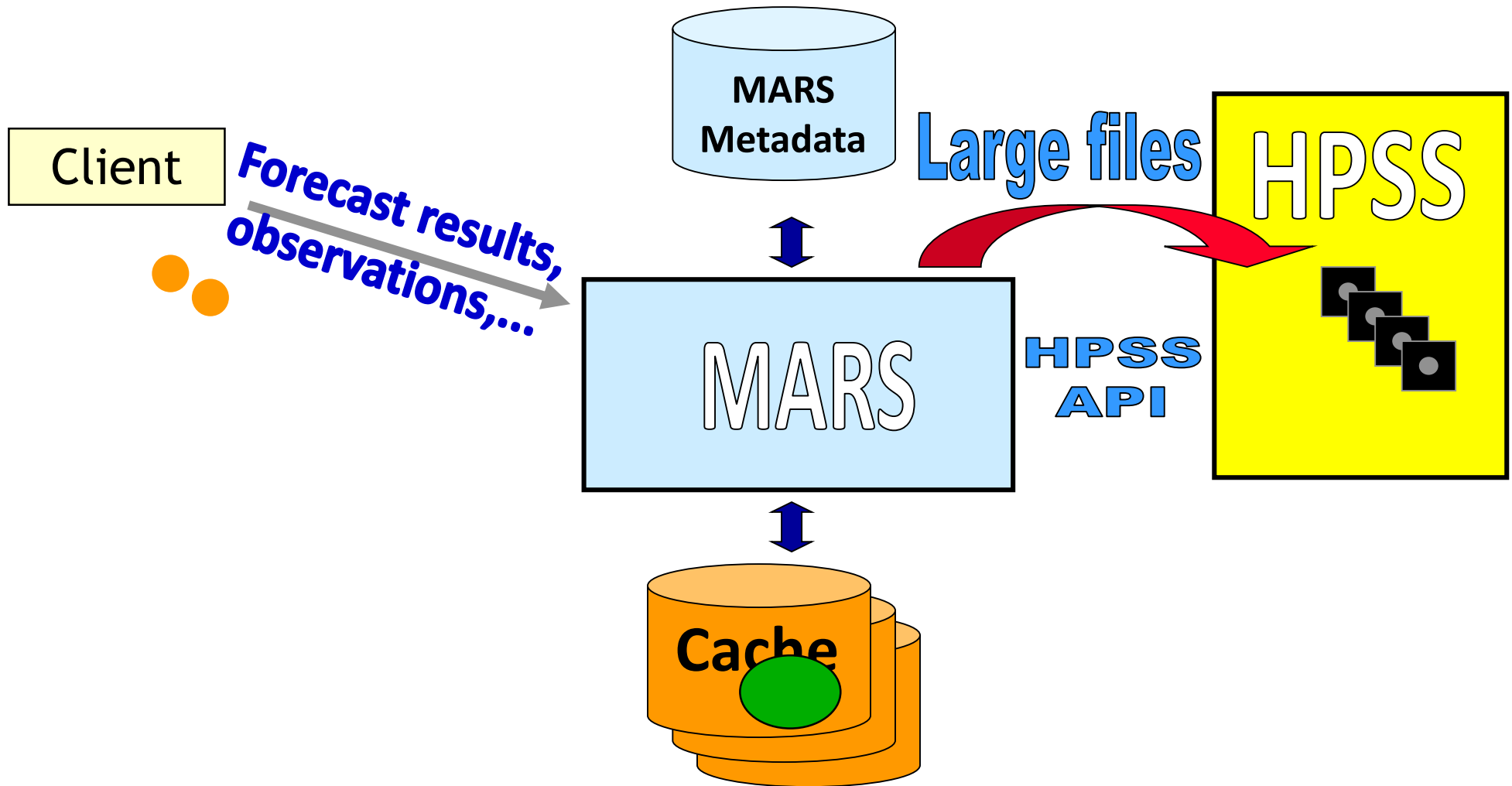
- **MARS** – Meteorological archive
- **ECFS** – User archive



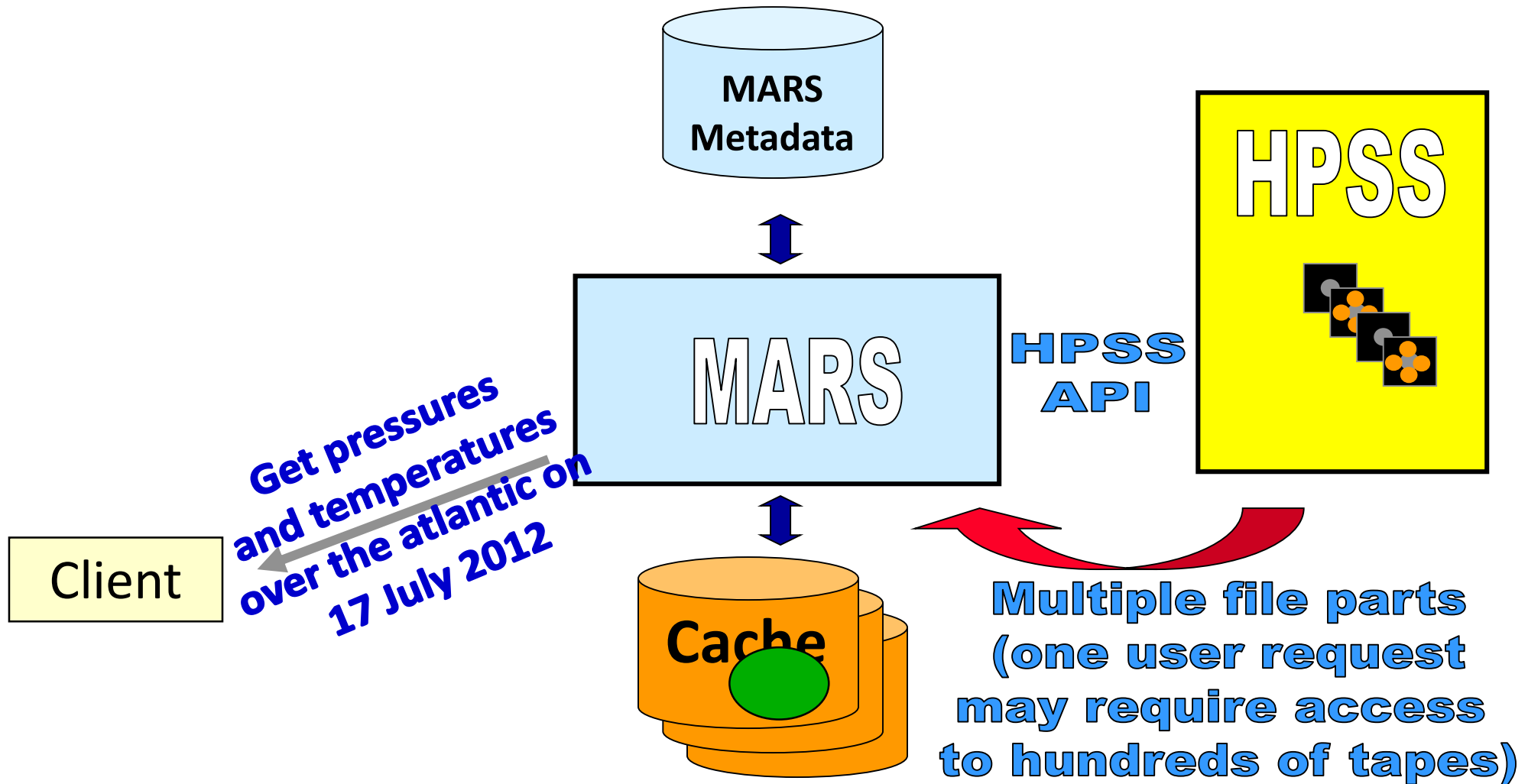
DHS Services

- MARS – Meteorological Archive and Retrieval System
 - Data is accessed via a meteorological meta-language interface
 - Bulk of the data, few files (but holding billions of fields in total)
 - Relies upon excellent tape drive performance when retrieving lots of small parcels of data from tape
- ECFS – ECMWF File System
 - HSM-like (Hierarchical Storage Management) service for “ad-hoc” files that are not suitable for storing in MARS
 - Data is accessed via an rcp-like interface
 - Millions of files, many very small
- HPSS
 - Both MARS and ECFS rely on HPSS as the underlying data management system that is used to store the data
 - Users do not have direct access to HPSS, only via MARS and ECFS

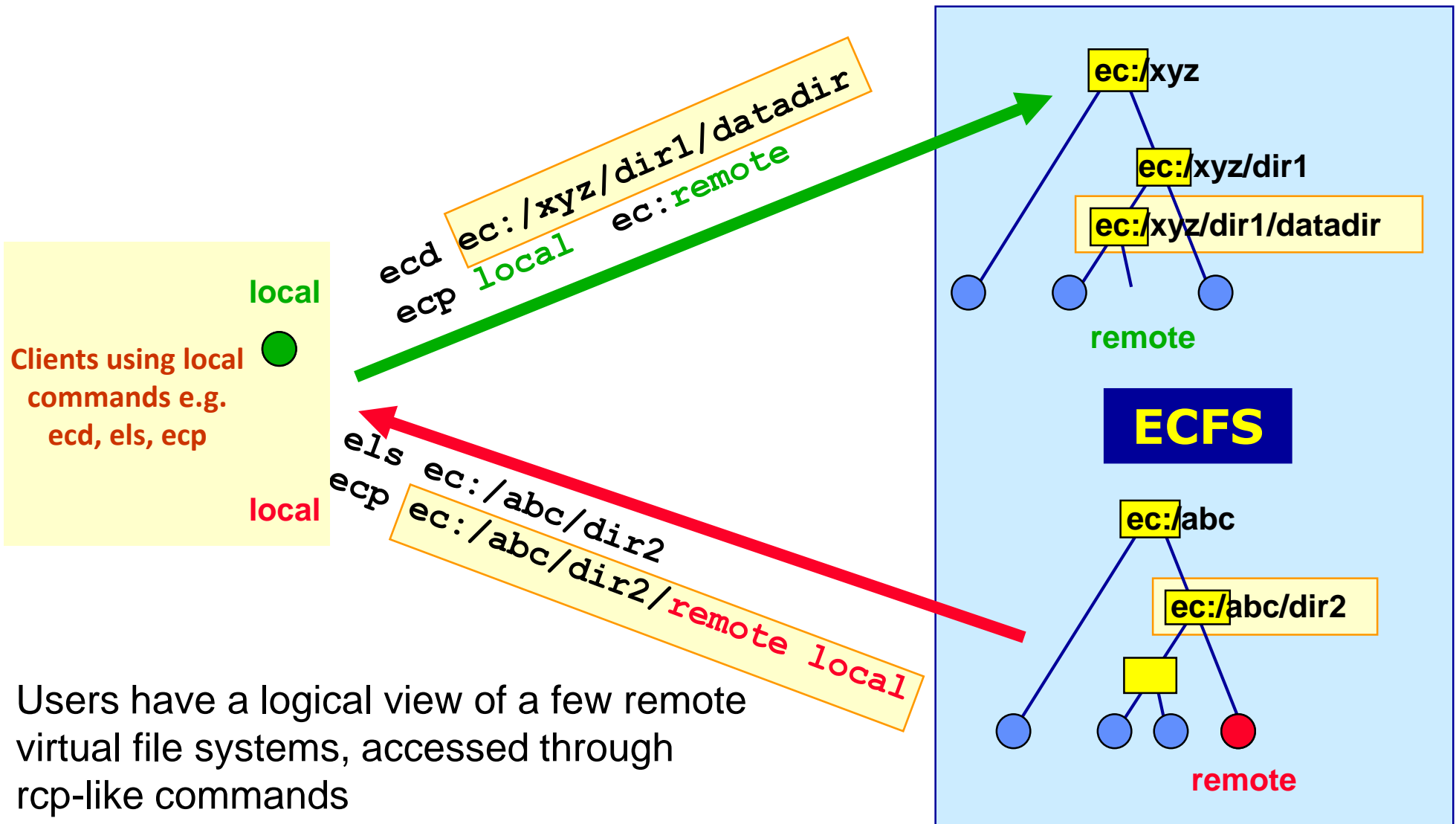
MARS archiving



MARS retrieval



ECFS – the user's view



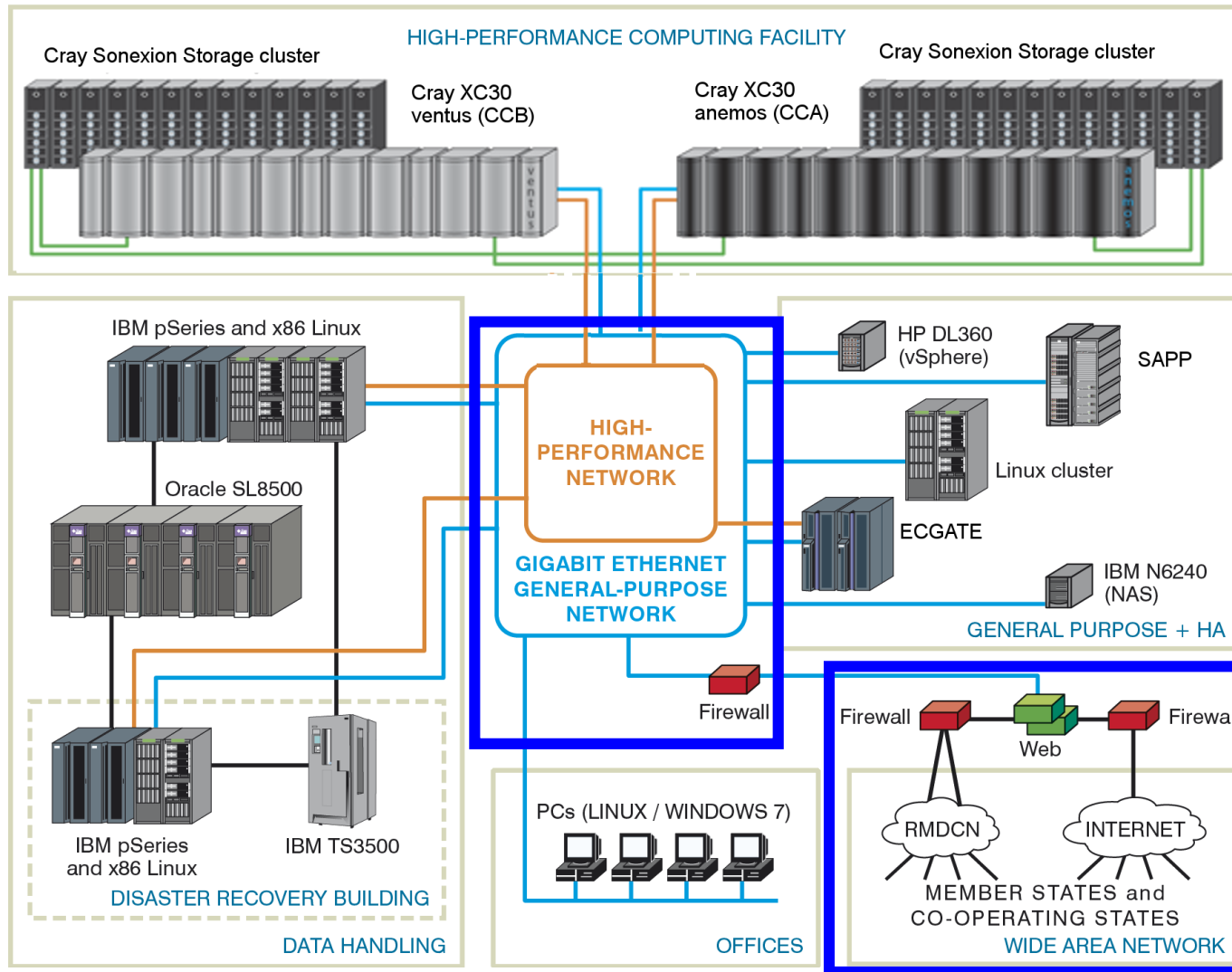
Users have a logical view of a few remote virtual file systems, accessed through rcp-like commands

The ECMWF Archive – statistics

- The DHS provides access to ~100 PB of primary data
- An additional ~20 PB of backup copies of part of the primary data are stored in the DRS
- In a typical day the archive grows by ~150 TB
- ~9,000 tape mounts on average per day
 - On some days this can peak at around 15,000
- MARS data:
 - ~10% of the files (over 14 million files)
 - ~75% of the data volume
- ECFS data:
 - ~90% of the files (over 172 million files)
 - ~25% of the data volume

Networks

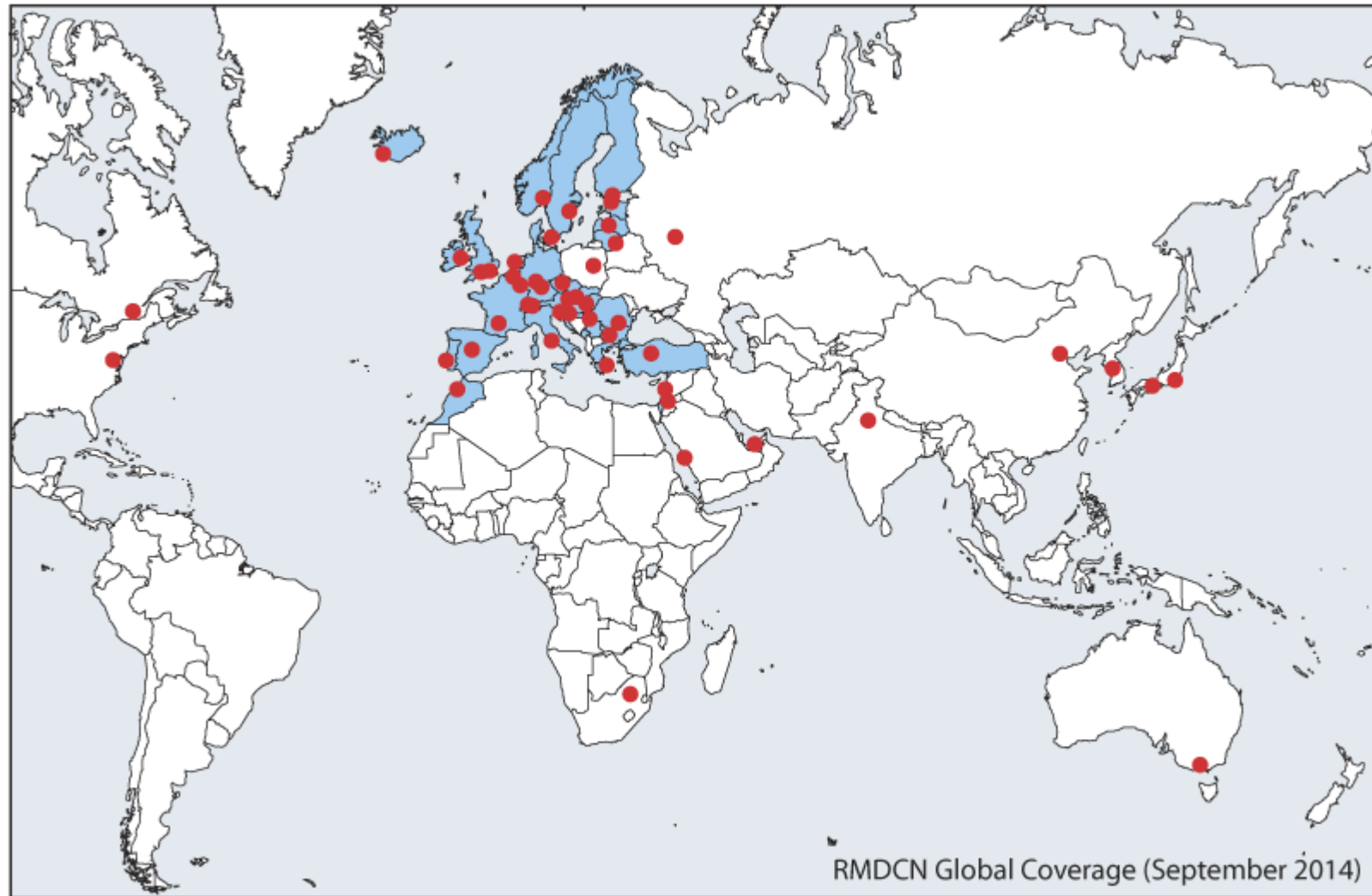
Web documentation: www.ecmwf.int/en/computing/our-facilities/networks
www.ecmwf.int/en/computing/our-facilities/rmdcn



Networks

- Internal (LAN)
 - High Performance Network: 40 Gbps
 - General Purpose Network: 10 Gbps
- External (WAN)
 - Internet
 - Dual 10 Gbps connection to SuperJANET, the UK Education and Research Network
 - RMDCN (Regional Meteorological Data Communications Network):
 - Secured VPN provided through MPLS (Multi Protocol Label Switching)

RMDCN Connections



- 53 sites currently connected (September 2014)

Access to ECMWF resources

*All interactive login access to ECMWF requires **security token authentication***



Interactive access via Internet link

```
ssh -X -I <UID> ecaccess.ecmwf.int
```

or with **NX** from NoMachine (the desktop Virtualization Company)

Through your Web browser at <http://ecaccess.ecmwf.int/> (or local gateway)

Or by installing **nxclient** on your local machine

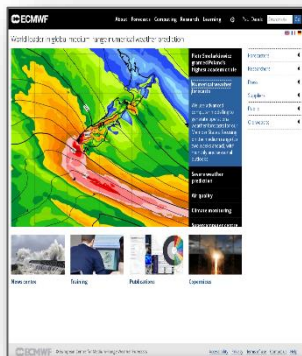
*The same **token**, or a **password** or a **certificate** can be used to access the **ECMWF website***

Web Services

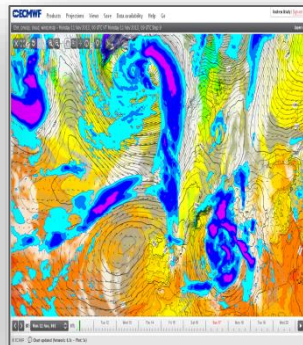
www.ecmwf.int

Web services – overview

- Five key service areas:



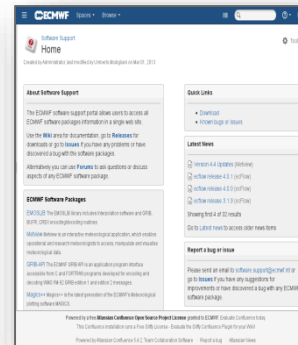
www
Everyone



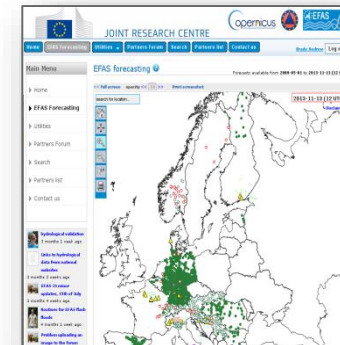
ecCharts
Forecasters

Date	Time	Variable	Value
2015-01-01	00:00	Pressure	1013.25
2015-01-01	00:00	Temperature	15.00
2015-01-01	00:00	Humidity	0.75
2015-01-01	00:00	Wind	10.00
2015-01-01	00:00	Cloud	0.50
2015-01-01	00:00	Surface	0.00
2015-01-01	00:00	Q1000	1000.00
2015-01-01	00:00	Q500	500.00
2015-01-01	00:00	Q100	100.00
2015-01-01	00:00	Q50	50.00
2015-01-01	00:00	Q10	10.00
2015-01-01	00:00	Q5	5.00
2015-01-01	00:00	Q1	1.00

Data
Web data users



Software
Everyone



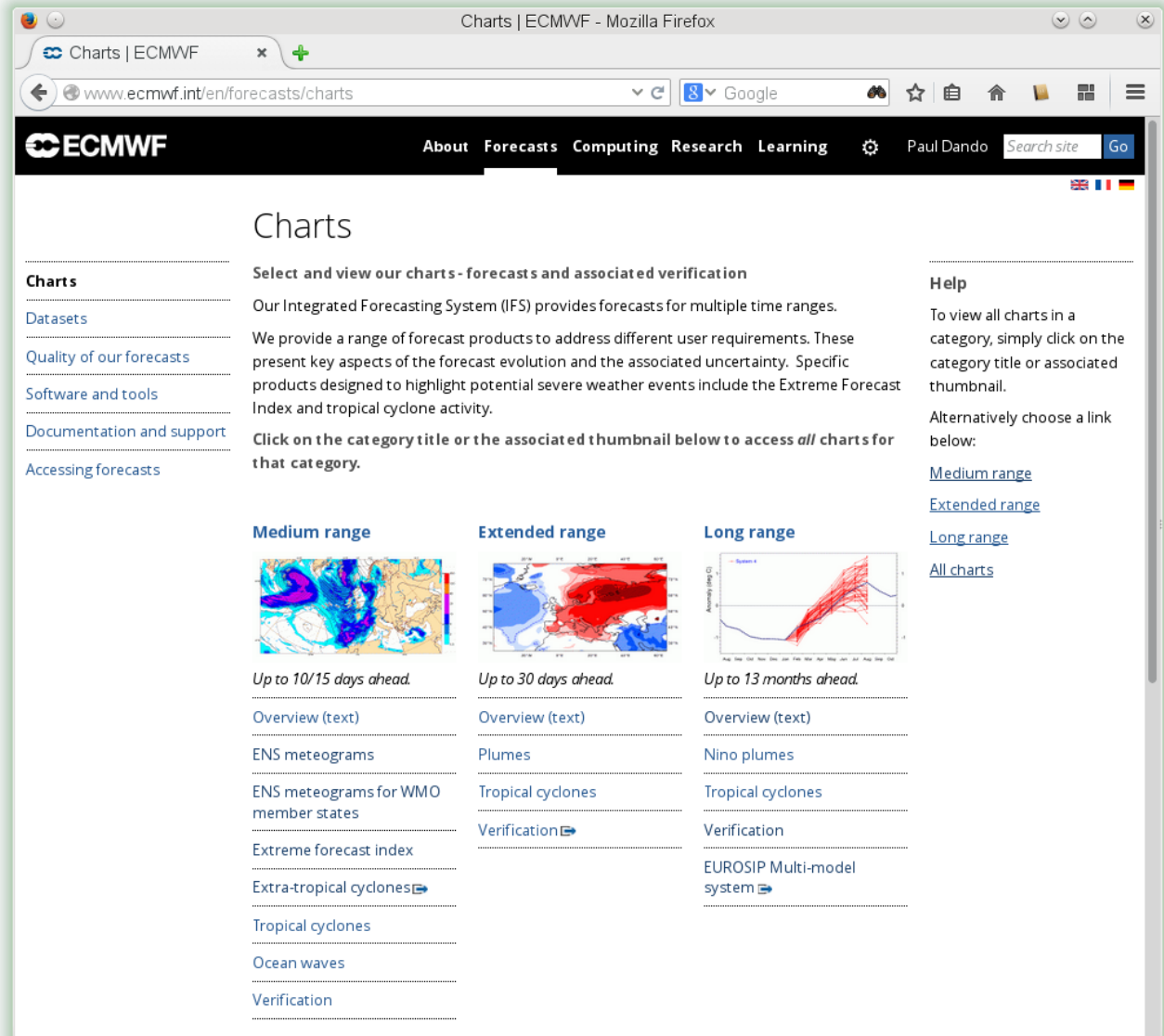
EFAS
EFAS Partners

Web services - www.ecmwf.int/en/forecasts/charts

Charts accessible depend on the user

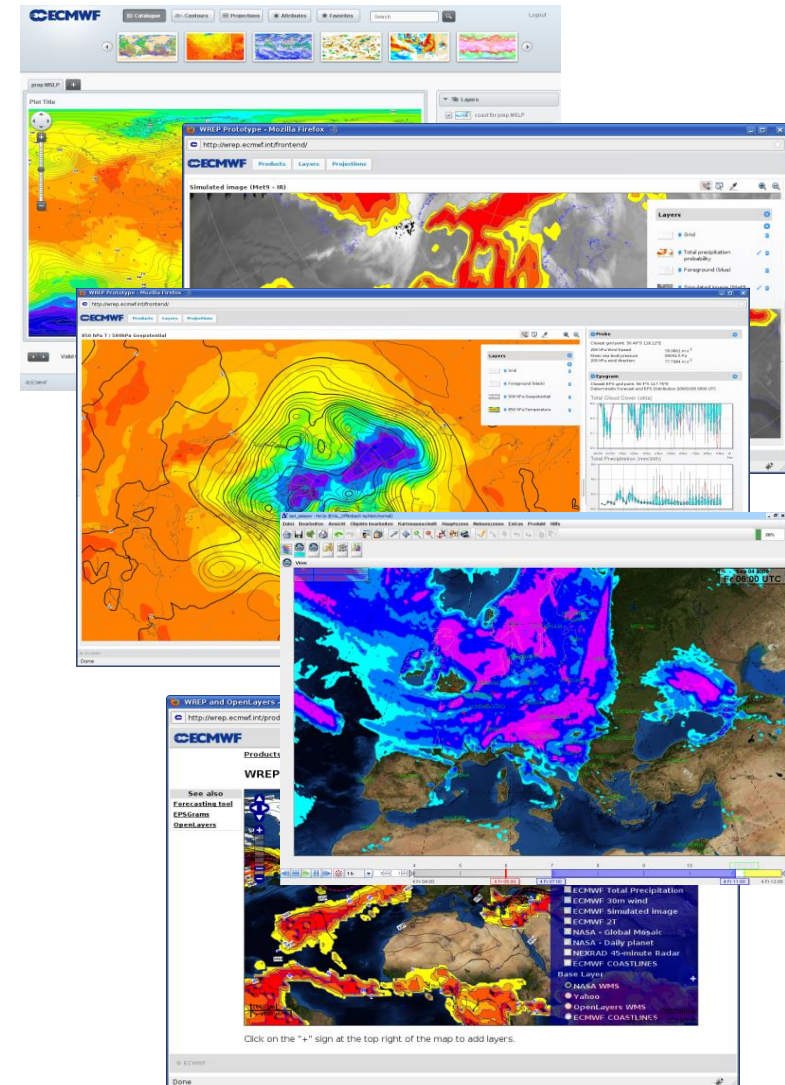
Users need to log in to access charts that are not accessible to the public

All users that register from a NMS of a MS or CS get access to the full set of charts



Web services – ecCharts: <http://eccharts.ecmwf.int/>

- Highly interactive (products created on-demand)
- Highly available
- Operationally supported (24x7)
- Appropriate for bench forecasters
- Suitable to deploy as standard web services
- Operational status since 15.10.2012
- Access approved by Comp Reps



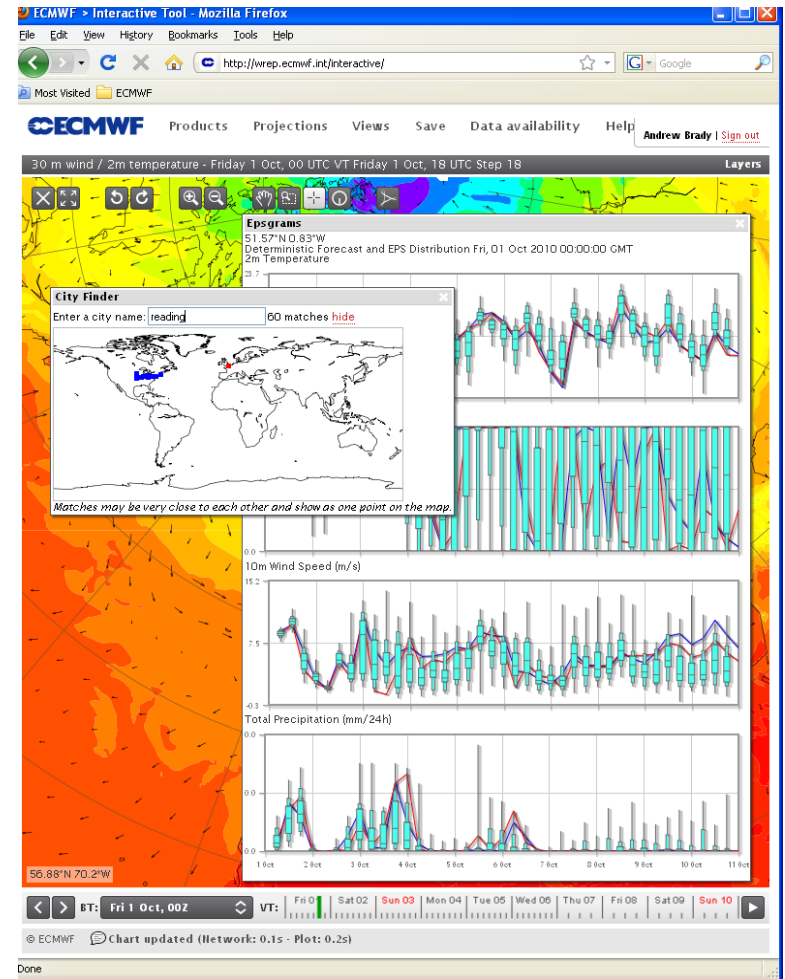
ecCharts – overview

- Features:

- Interactivity (zoom-pan)
- Layer customisation (e.g. thresholds)
- Charts with bespoke layers
- Optional styles for layers
- Animation of charts
- HRES, ENS, WAM products
- Standard and bespoke ENSgrams
- Extreme Forecast Indices (EFI)
- Point probing to explore data

- Use of agreed dissemination schedule

- OGC WMS standards for machine-to-machine access



ecCharts/forecaster

http://wrep.ecmwf.int/forecaster/

CECMWF Products Projections Views Save Data availability Help Go

Andrew Brady | Sign out

Pretty Precip - Friday 20 May, 00 UTC VT Friday 20 May, 03 UTC Step 3

Layers

City Finder

Reading, United Kingdom 10 matches [hide](#)

Matches may be very close to each other and show as one point on the map.

Total precipitation per 3 hour

10m wind

Wind arrows (black)

Mean sea level pressure

Interval 1

High cloud cover

Medium cloud cover

Low cloud cover

Model orography from deterministic forecast

Time Series

Data values near location 51.43°N 1°W, Reading, United Kingdom

Total precipitation per 3 hour (mm)

10m wind (Knots)

Mean sea level pressure (hPa)

High cloud cover

Medium cloud cover

Low cloud cover

Model orography from deterministic forecast (m)

Probe

Data values near location 51.43°N 1°W, Friday 20 May, 00 UTC T+3, Reading, United Kingdom

Layer	Value	Point selected	Location	Distance
Total precipitation per 3 hour	0 mm	nearest	51.38°N 1.01°W	6.18 km
10m wind	2 ms ⁻¹ W	nearest	51.38°N 1.01°W	6.18 km
Mean sea level pressure	1018.39 hPa	nearest	51.38°N 1.01°W	6.18 km
High cloud cover	0 (0 - 1)	nearest	51.38°N 1.01°W	6.18 km
Medium cloud cover	0.46 (0 - 1)	nearest	51.38°N 1.01°W	6.18 km
Low cloud cover	0 (0 - 1)	nearest	51.38°N 1.01°W	6.18 km
Model orography from deterministic forecast	118.9 m	nearest	51.38°N 1.01°W	6.18 km

Meteorgrams

Location: 51.43°N 1°W, Reading, United Kingdom

15-day epsgram 2m maximum temperature (C)

Base date: Friday 20 May, 00 UTC, adjusted to 48m height

15-day epsgram 2m minimum temperature (C)

Base date: Friday 20 May, 00 UTC, adjusted to 48m height

15-day epsgram total precipitation (mm/24hr)

Base date: Friday 20 May, 00 UTC

ECMWF Products

Select from these ECMWF Products to add to your personal list

Filter: Show All

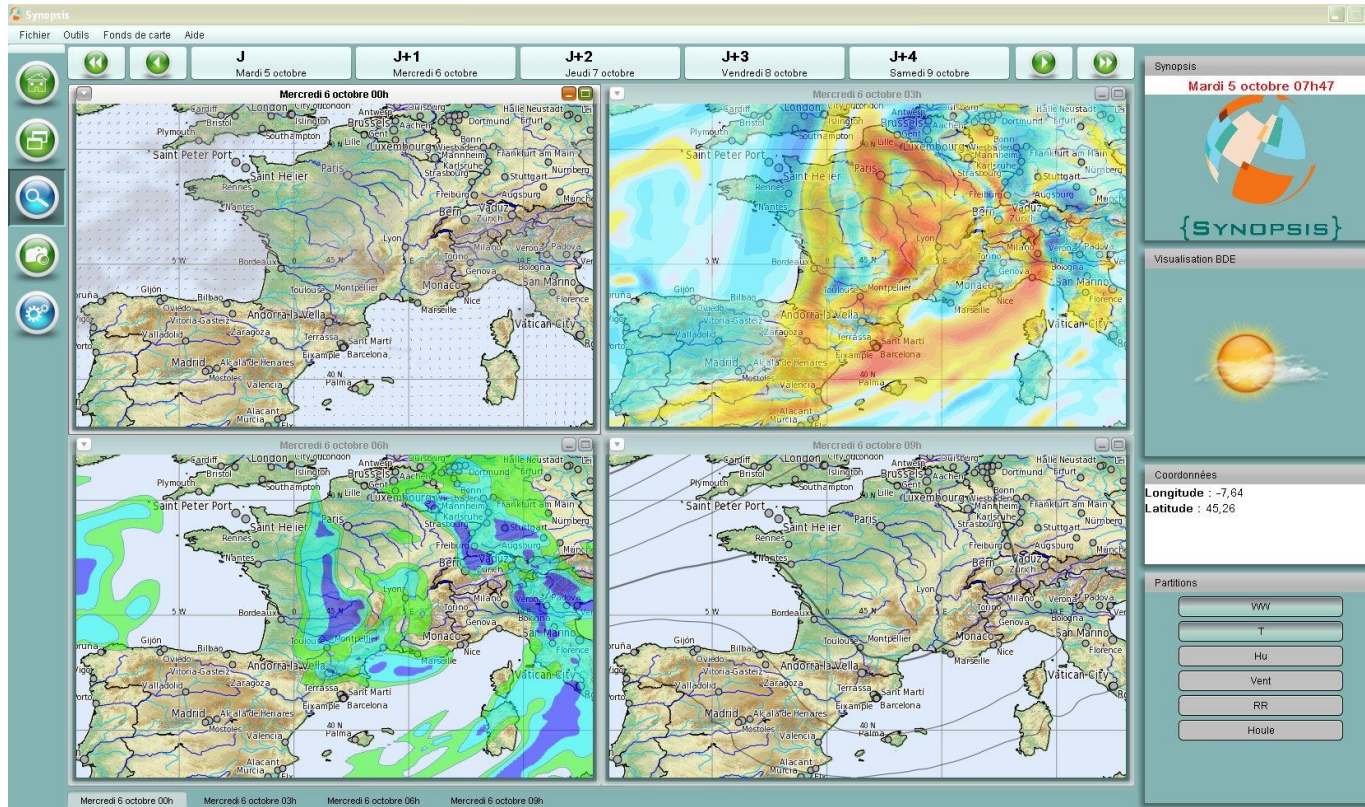
- Tropical cyclone genesis**
EXPERIMENTAL PRODUCT. Best viewed in global projection. Tropical cyclone...
[Add to product list](#) [View in map](#)
- 10m wind percentile**
10m wind for a percentile (value of 10m wind speed below which a cert...
[Add to product list](#) [View in map](#)
- Significant wave height percentile and mean wave direction**
Significant wave height for a percen...
[Add to product list](#) [View in map](#)

Hide Products you already have

BT: Fri 20 May, 00Z VT: Sun 22

© ECMWF Chart updated

ecCharts – OGC Web Map Service (WMS) Charts: from ecCharts to Synopsis

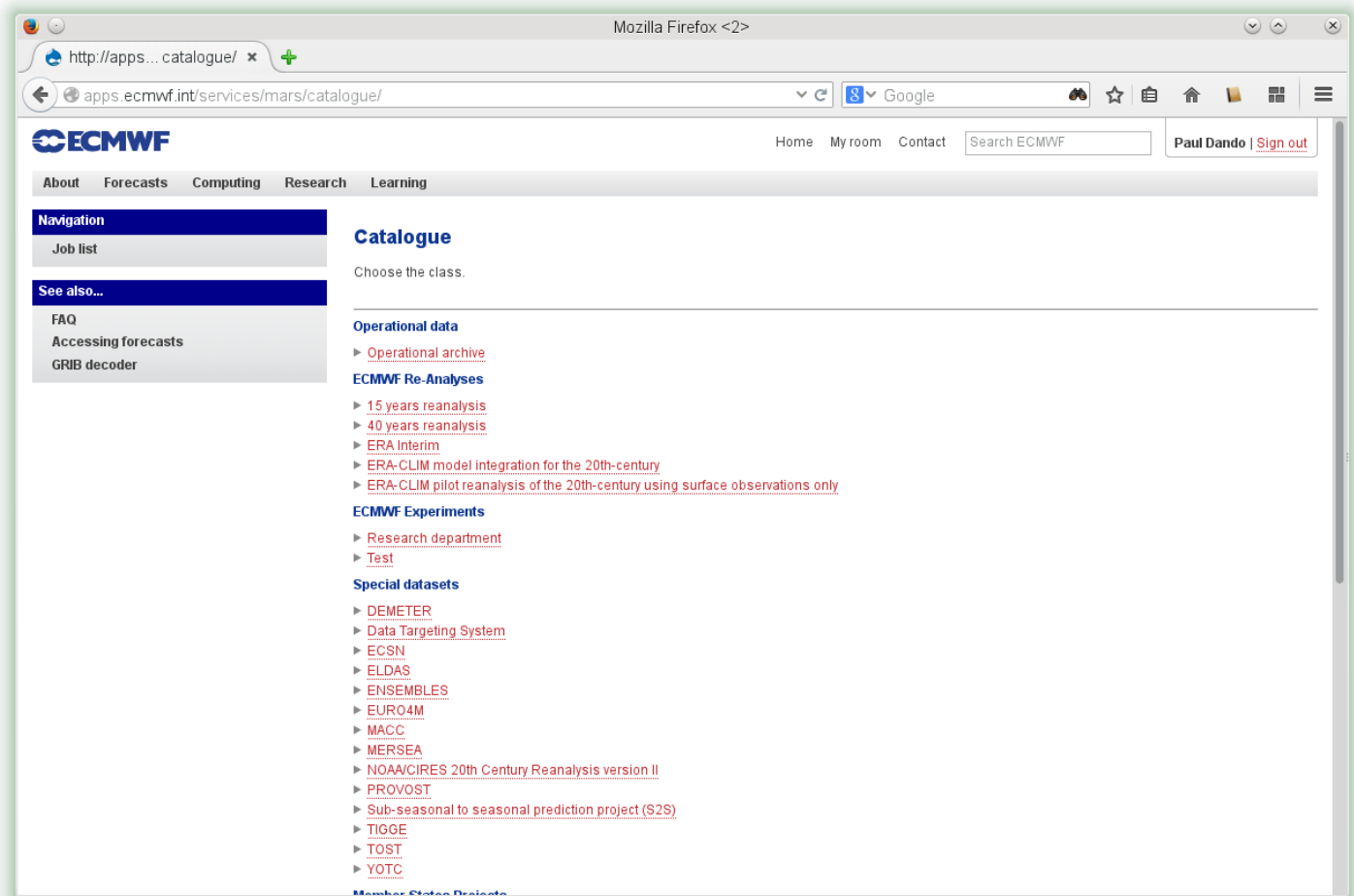


- Easy to implement
- Uses embedded access control tokens checked against IP domain of request
- Response is very good
- Applicable to IBL Visual Weather, Ninjo, Synopsis, etc

Web Services – MARS

<http://apps.ecmwf.int/services/mars/catalogue/>

- Web based interface to MARS
- Available to registered users only
- Retrievals (GRIB and netCDF),

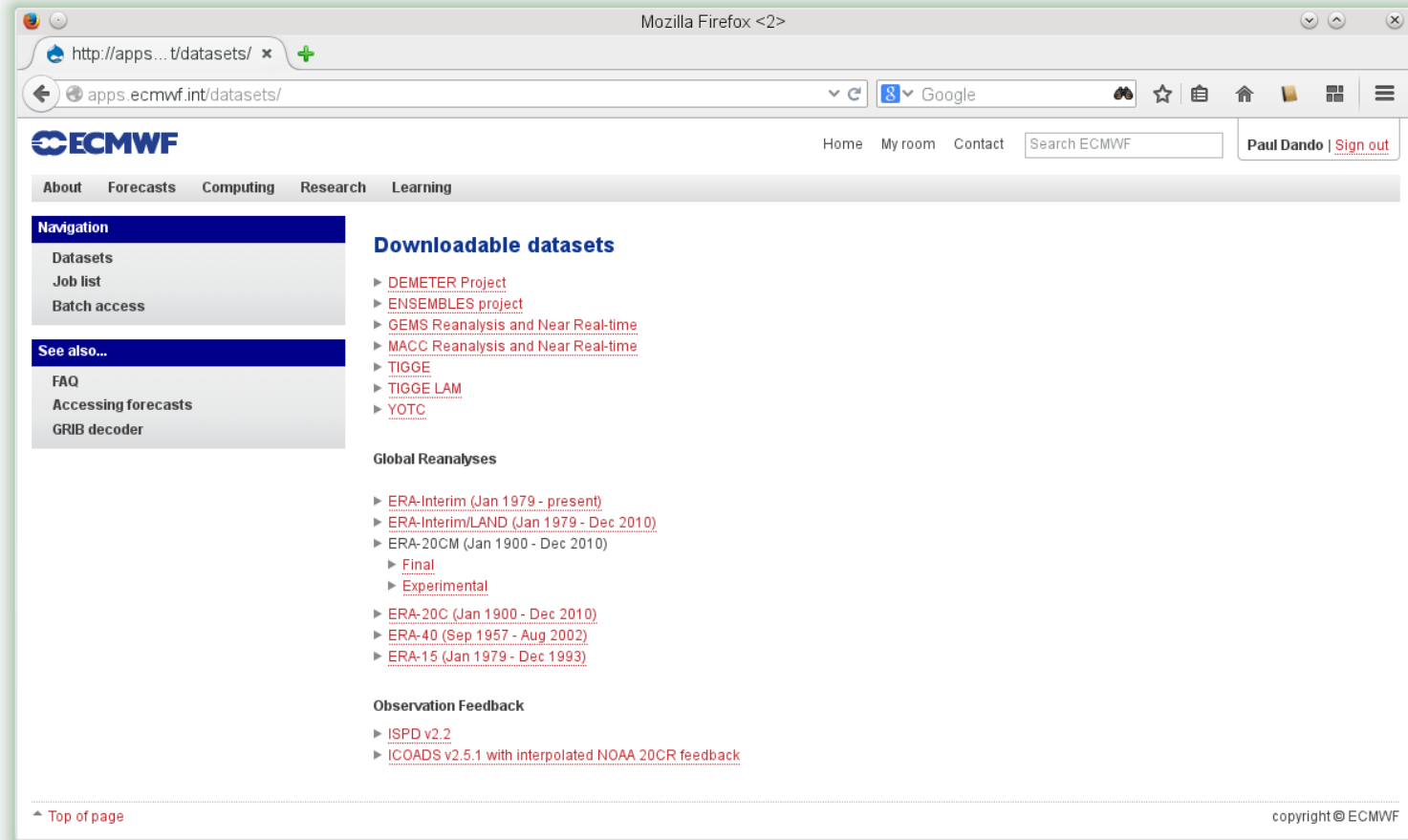


Data Server – <http://apps.ecmwf.int/datasets/>

- Public (non-commercial) distribution of data
 - Self-registration

- Batch access possible with Python, Perl, Java

- GRIB or netCDF



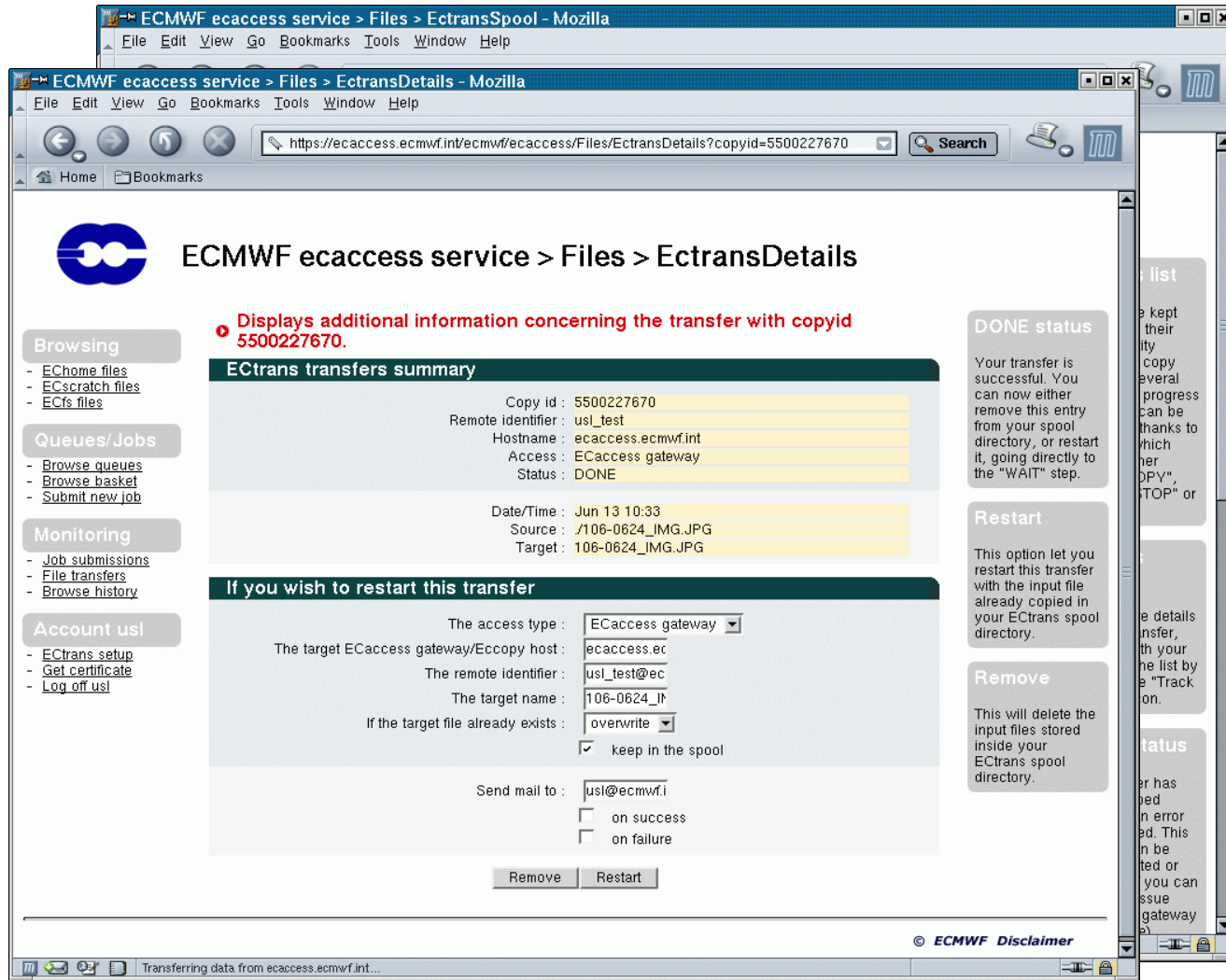
TIGGE Data Portal –

<https://software.ecmwf.int/wiki/display/TIGGE/Home>

- THORPEX Interactive Grand Global Ensemble
- Global ensemble forecasts to around 14 days generated routinely by 10 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 is available to Research and Education after 48 hours
 - Self registration by agreeing to the terms and conditions
- Data portal based on MARS web interface
- Data archived in GRIB edition 2 format

Web Services – <http://ecaccess.ecmwf.int>

- Interface to browsing, transfers, editing, submission of files to ECMWF
- Online help
- Security token needed



ECMWF ecaccess service > Files > EctransDetails

Displays additional information concerning the transfer with copyid 5500227670.

ECtrans transfers summary

Copy id :	5500227670
Remote identifier :	usl_test
Hostname :	ecaccess.ecmwf.int
Access :	ECaccess gateway
Status :	DONE
Date/Time :	Jun 13 10:33
Source :	/106-0624_IMG.JPG
Target :	106-0624_IMG.JPG

If you wish to restart this transfer

The access type :

The target ECaccess gateway/ECcopy host :

The remote identifier :

The target name :

If the target file already exists :

keep in the spool

Send mail to :

on success

on failure

DONE status

Your transfer is successful. You can now either remove this entry from your spool directory, or restart it, going directly to the "WAIT" step.

Restart

This option let you restart this transfer with the input file already copied in your Ectrans spool directory.

Remove

This will delete the input files stored inside your Ectrans spool directory.

Account usl

- Ectrans setup
- Get certificate
- Log off usl

Monitoring

- Job submissions
- File transfers
- Browse history

Queues/ Jobs

- Browse queues
- Browse basket
- Submit new job

Browsing

- EChome files
- ECscratch files
- ECfs files

© ECMWF Disclaimer

NX – web access – <http://ecaccess.ecmwf.int/>

- You can access NX through your Web browser

● You can open an interactive session on an ECMWF system, with support for GUI applications.

NX interactive session

ECMWF server :

Or workstation :

Network link speed :

Initial application :

Window option (NX3) :

Virtual desktop resolution (NX3) :

- You can select the:
 - Host (ecgate / cca)
 - Internet connection speed



Login requires a token

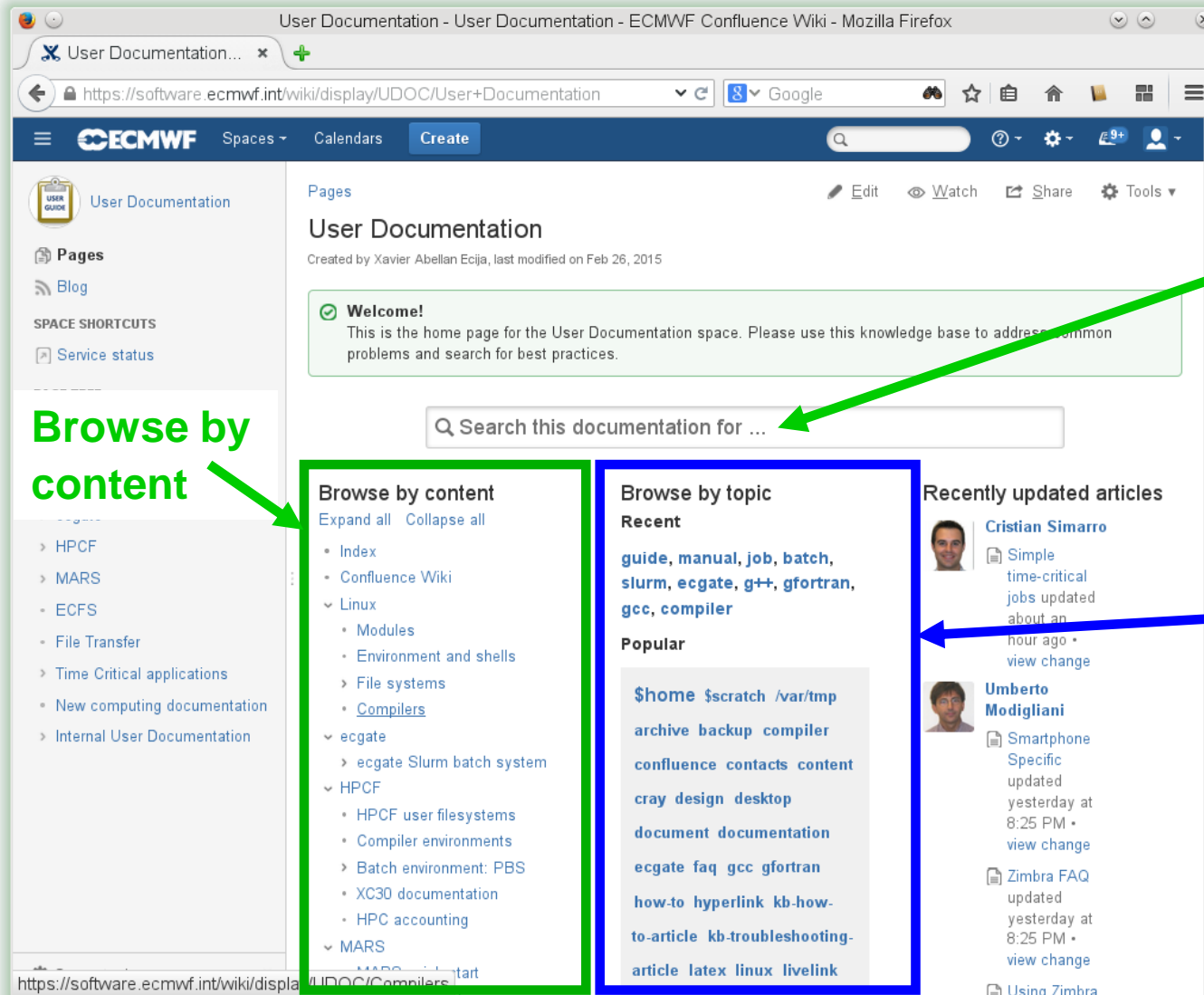
Web Services – documents and documentation

- Official documents (restricted access)
www.ecmwf.int/en/about/who-we-are/governance
- ECMWF publications
www.ecmwf.int/en/research/publications
- Research at ECMWF
www.ecmwf.int/en/research
- Computing Services
www.ecmwf.int/en/computing
- And much more ...



Web Documentation –

<https://software.ecmwf.int/wiki/display/UDOC/User+Documentation>



Search

Browse by content

Browse by topic – recently updated or most popular

Operational status

<http://www.ecmwf.int/en/service-status>

Service status

Service Status

CCA	CCB	DISSEMINATION	ECACCESS
ECFS	ECGATE	EFAS	EMAIL
INTERNET	MARS	MSACCESS	prepIFS
RMDCN	TELEPHONY	WEB-SERVICES	

Notifications

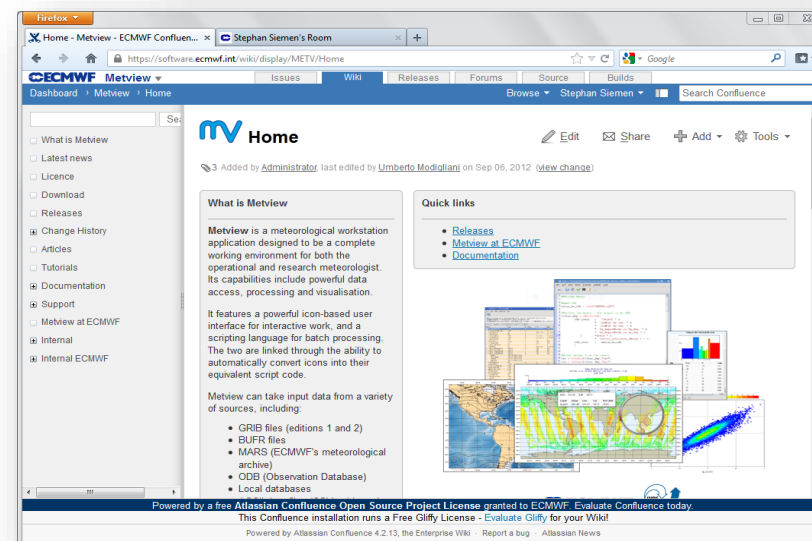
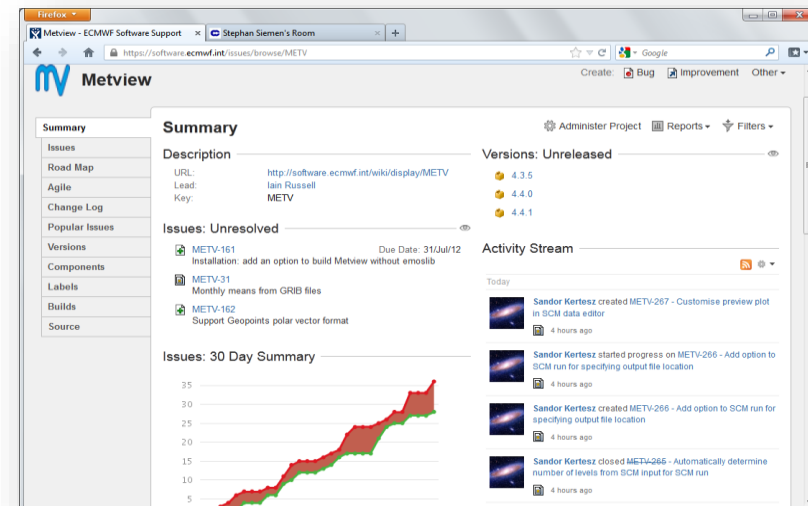
Search date range: last 24h | last 7 days | last 30 days | all

Date Created	Service	Notification Type	Title	User Action Required
Wed 07/Jan/2015 14:37:27 UTC	ECFS	End	System Session complete - UPDATE: ECFS HPSS CORE server process restart	☑
Wed 07/Jan/2015 14:36:20 UTC	ECFS	In Progress	Clone of System Session - UPDATE: ECFS HPSS CORE server process	☑

- Email sent only if user action is required
- For announcements of upcoming system sessions see also /etc/motd on ecgate

Software Support

- Available at <http://software.ecmwf.int/>
- Aim is to improve support for external users
 - Keep track of issues in a central place
 - Spread knowledge throughout the Centre
- Based on Atlassian Suite
 - JIRA (issues)
 - Confluence (documentation wiki)
 - Bamboo (Builds)



ECMWF Help & Support – who to contact?

Reason to contact	Who	Availability	How
<i>Urgent</i> Dissemination problems, issues with model output	Call Desk	24h/7d	Email: calldesk@ecmwf.int Tel: +44 118 9499 303
Generic fault reporting, general service queries etc.	Call Desk	24h/7d	
Specific advice or user query	User Support	8h/5d	Email: advisory@ecmwf.int Tel: +44 118 9499 000 (switchboard)
Changes in dissemination requirements	Dissemination administrators	8h/5d	Email: diss_admin@ecmwf.int
Requests for software	Software Support	8h/5d	Email: software.support@ecmwf.int
Software problems / bug reports	Software Support	8h/5d	Email: software.support@ecmwf.int
Specific graphics queries	Development Section	8h/5d	Email: metview@ecmwf.int magics@ecmwf.int

Questions?