

Introduction to computing resources

Computer User Training Course 2017

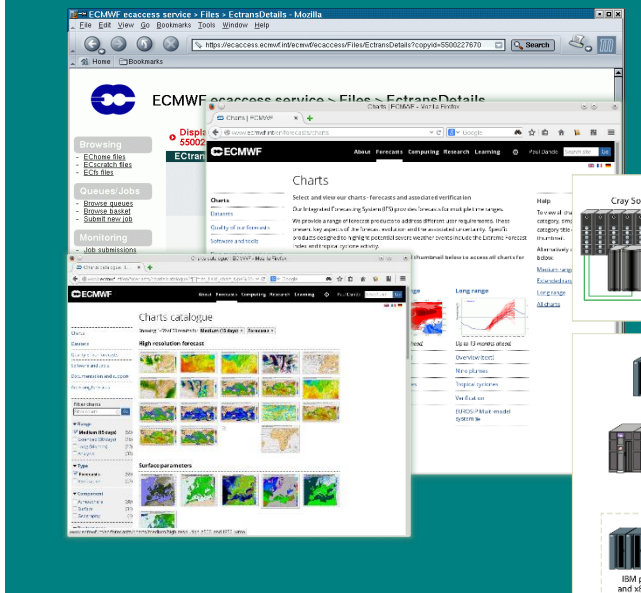
Paul Dando

User Support

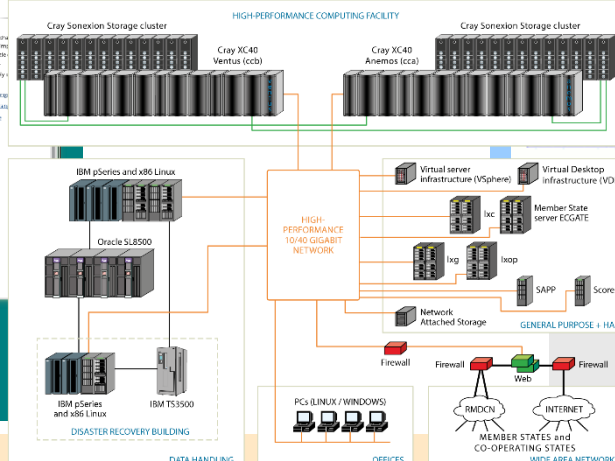
advisory@ecmwf.int

Overview

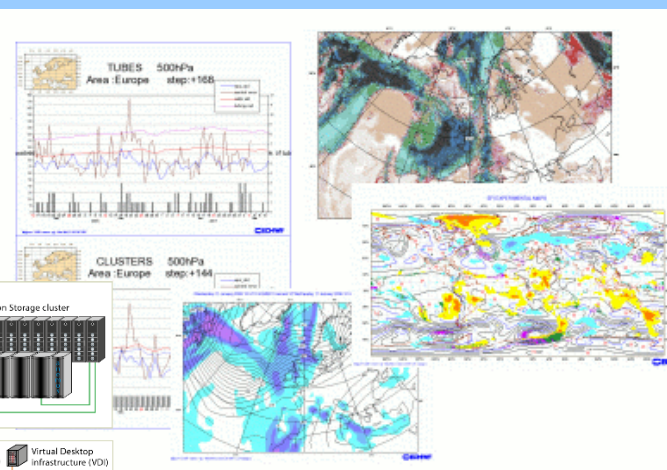
Web services (ECaccess, ecCharts, APPS,..)



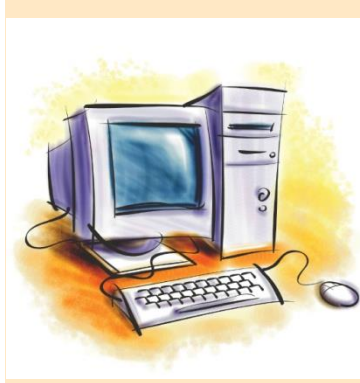
Computer facilities



Meteorological software & libraries



mars,
ecCodes,
Metview,
Magics,
ecFlow
etc.

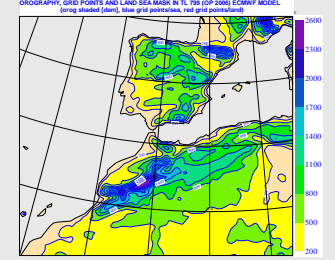
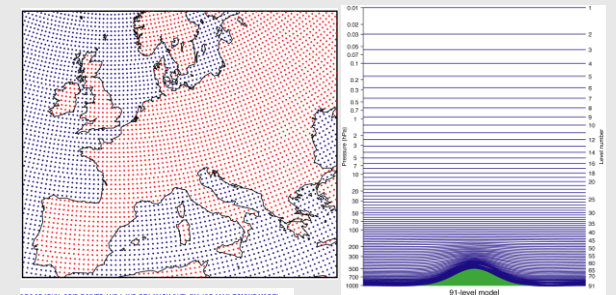


Service Desk

User Support

{ *Fault reporting,
Service queries*

{ *Advice on the use
of ECMWF computers*



IFS model

ECMWF operational forecasting system

- High resolution forecast and analysis (HRES)

- ~9 km and 137 levels ($T_{CO}1279$ L137) to 10 days at 00 and 12 UTC (BC run to T+90 at 06 and 18 UTC)

- Ensemble forecast (ENS) – 51 members

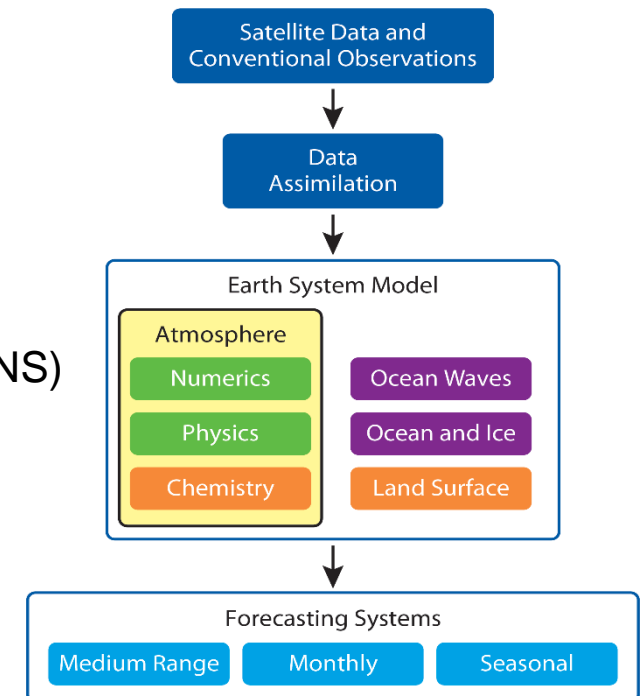
- ~18 km and 91 levels ($T_{CO}639$ L91) to 15 days at 00 and 12 UTC (BC run to T+144 at 06 and 18UTC)
- With ocean coupling from initial time
- Monday / Thursday 00 UTC extended to 46 days at ~36 km (Monthly Forecast)

- Ocean waves

- WAM-HRES: ~14 km to 10 days at 00 and 12 UTC (coupled with HRES)
- HRES-SAW: Stand Alone Wave model : at ~11 km to 10 days at 00 and 12 UTC
- WAM-ENS: 51 members: at ~28 km to 15 days at 00 and 12 UTC (coupled with ENS)

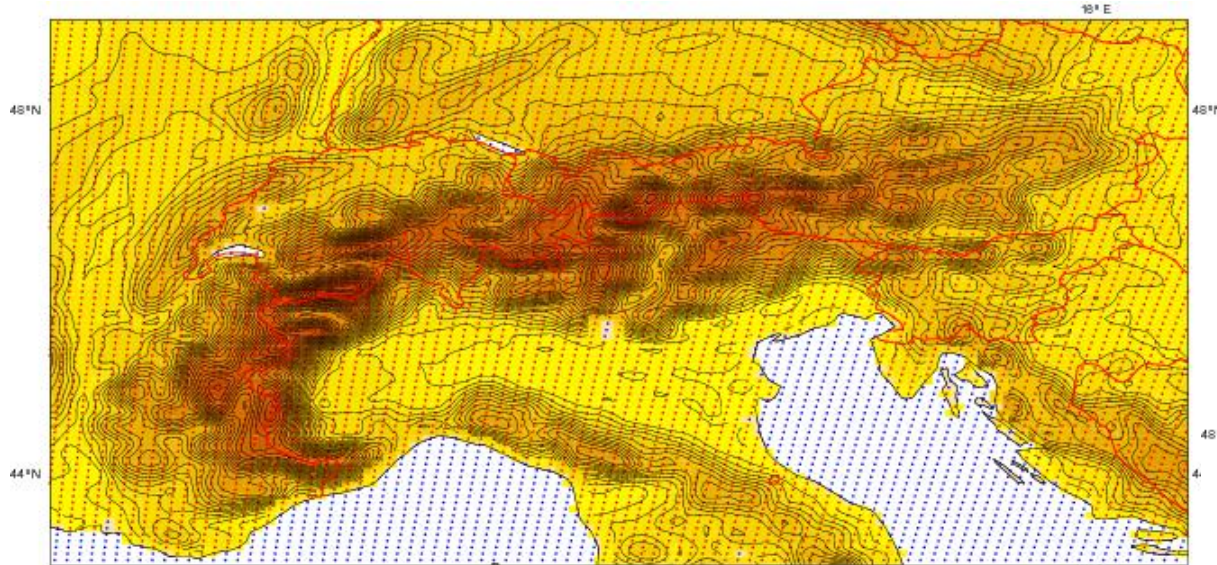
- Seasonal forecast – 51 members

- ~80 km and 91 levels (T_L255 L91), once per month to 7 months ahead
- sub-set of 15 members is run for 13 months every quarter (30 years of hindcasts)



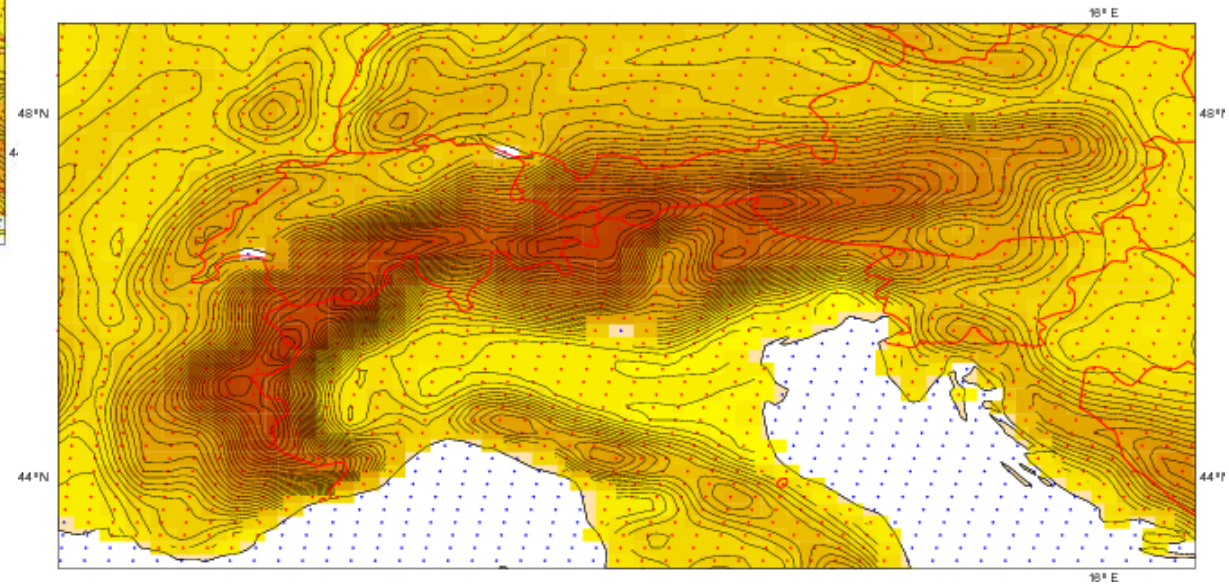
Land-sea mask and orography

HRES: O1280 (~9 km)



137 x 6,599,680 = 904,156,160 grid points

ENS Days 1-15: O640 (~18km)



91 x 1,661,440 = 151,191,040 grid points

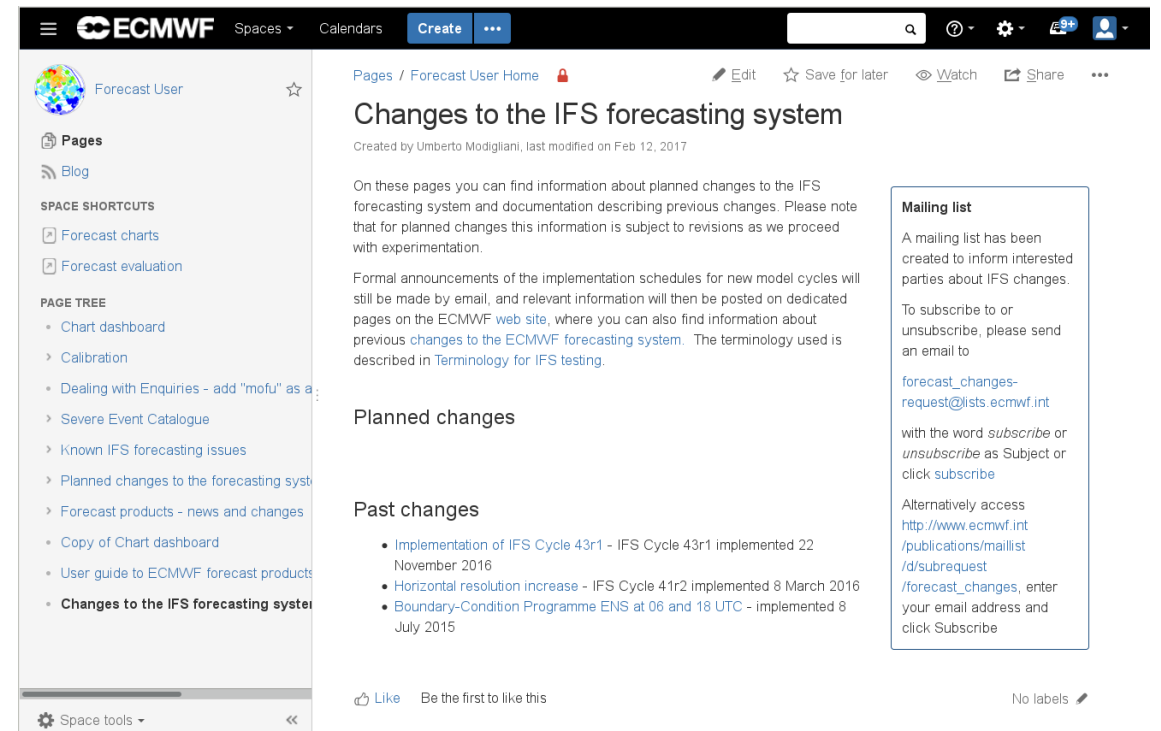
Operational upgrades for 2017

- 7 March 2017: Earlier dissemination of ENS and WAM ENS

- Products will be disseminated 40 minutes earlier starting at 07:00 / 19:00 for 00 / 12 UTC cycles
- Applies also to the ENS BC products at 06 and 18 UTC.

- June 2017: Implementation of System 5

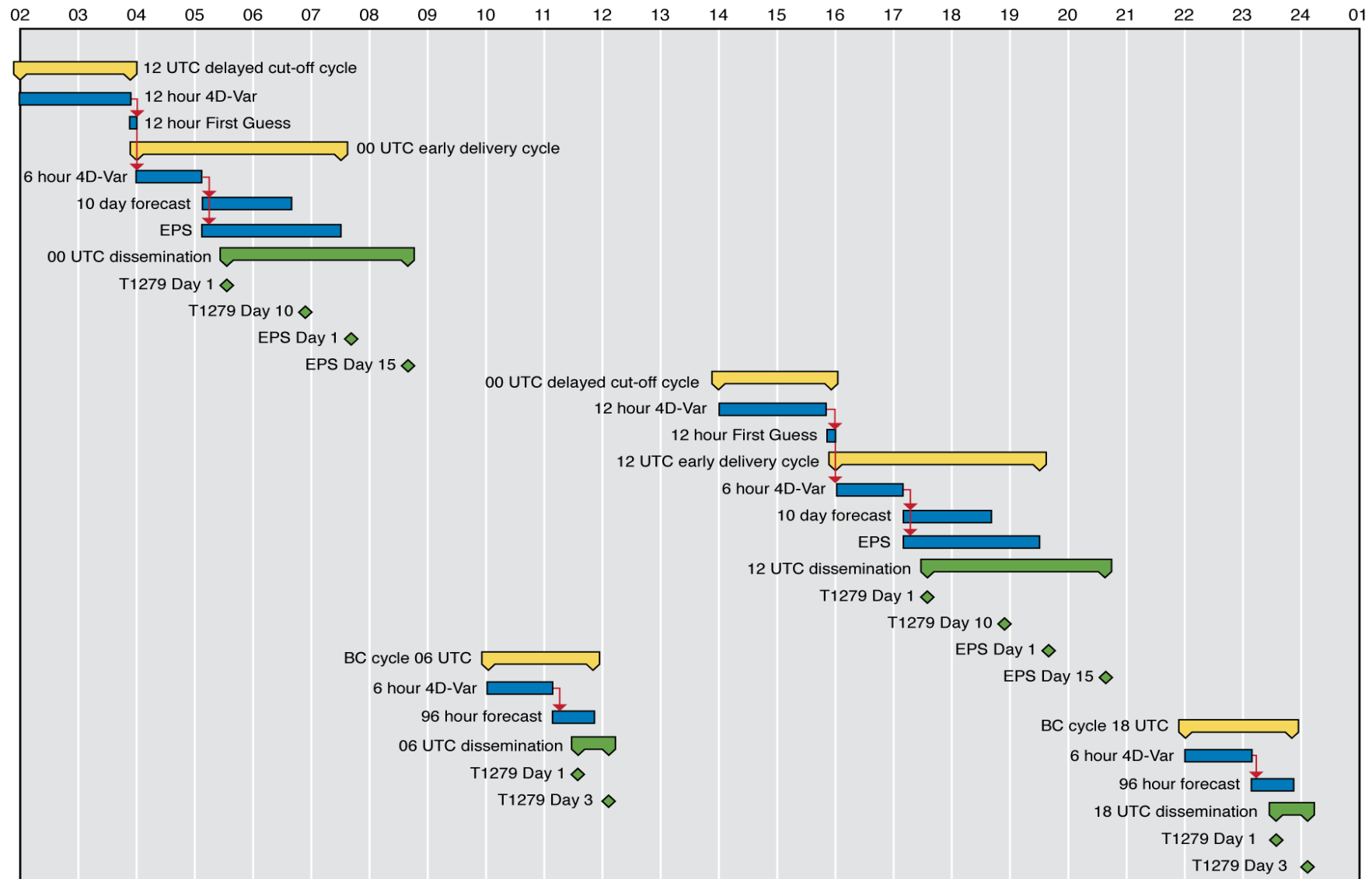
- New seasonal forecast system
- Horizontal resolution increased to ~36 km with 91 vertical levels ($T_{CO}319$ / O320 / L91)
- Increased ocean resolution



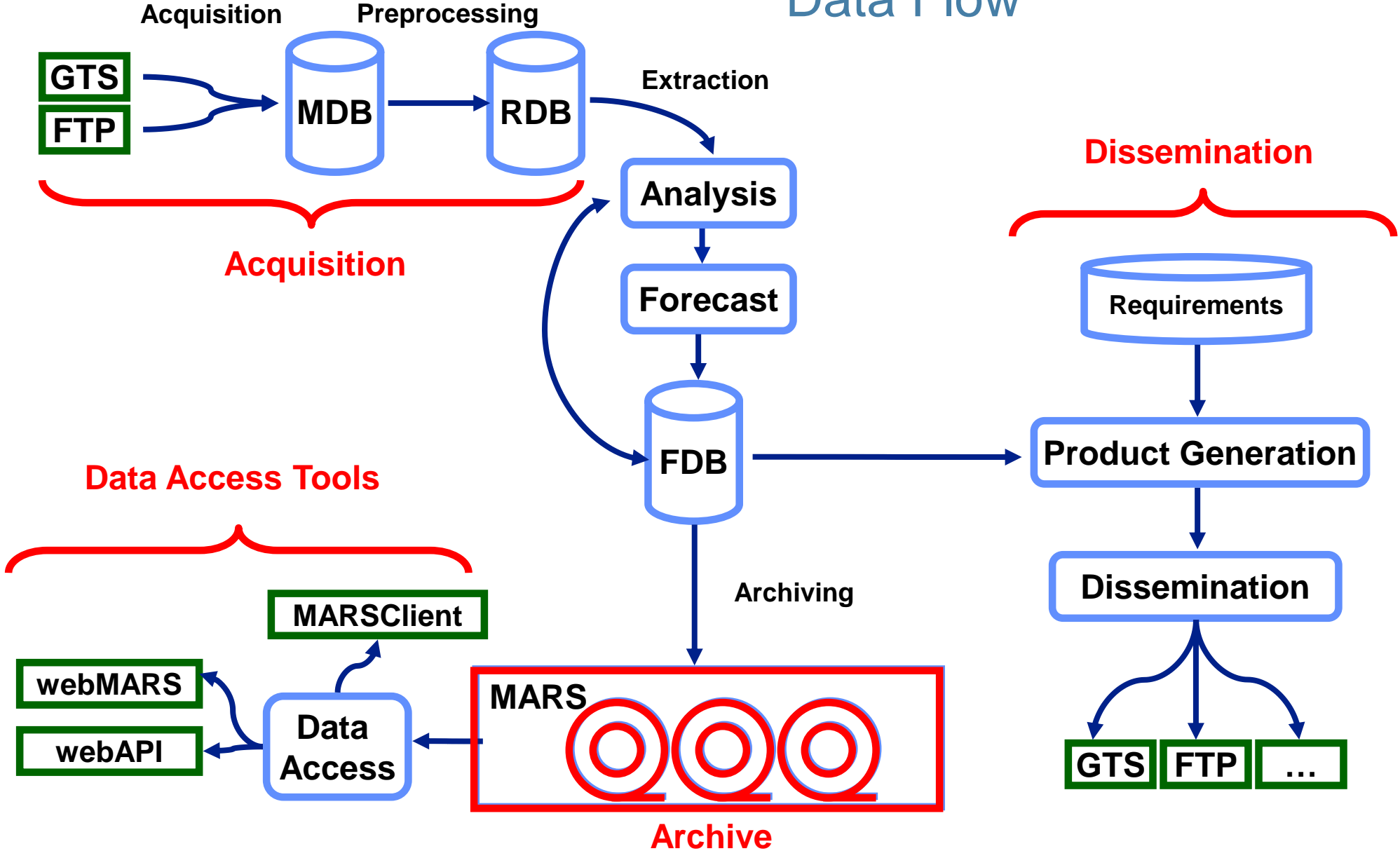
The screenshot shows the ECMWF Forecast User Home page. The main content is a post titled "Changes to the IFS forecasting system" created by Umberto Modigliani on Feb 12, 2017. The post text states: "On these pages you can find information about planned changes to the IFS forecasting system and documentation describing previous changes. Please note that for planned changes this information is subject to revisions as we proceed with experimentation. Formal announcements of the implementation schedules for new model cycles will still be made by email, and relevant information will then be posted on dedicated pages on the ECMWF web site, where you can also find information about previous changes to the ECMWF forecasting system. The terminology used is described in Terminology for IFS testing." Below the text are sections for "Planned changes" and "Past changes". The "Past changes" section lists: "Implementation of IFS Cycle 43r1 - IFS Cycle 43r1 implemented 22 November 2016", "Horizontal resolution increase - IFS Cycle 41r2 implemented 8 March 2016", and "Boundary-Condition Programme ENS at 06 and 18 UTC - implemented 8 July 2015". A "Mailing list" sidebar on the right provides subscription information: "A mailing list has been created to inform interested parties about IFS changes. To subscribe or unsubscribe, please send an email to forecast_changes-request@lists.ecmwf.int with the word subscribe or unsubscribe as Subject or click subscribe. Alternatively access http://www.ecmwf.int/publications/maillist/d/subrequest/forecast_changes, enter your email address and click Subscribe".

<https://software.ecmwf.int/wiki/display/FCST/Changes+to+the+IFS+forecasting+system>

The main operational suites on ECMWF's HPCF



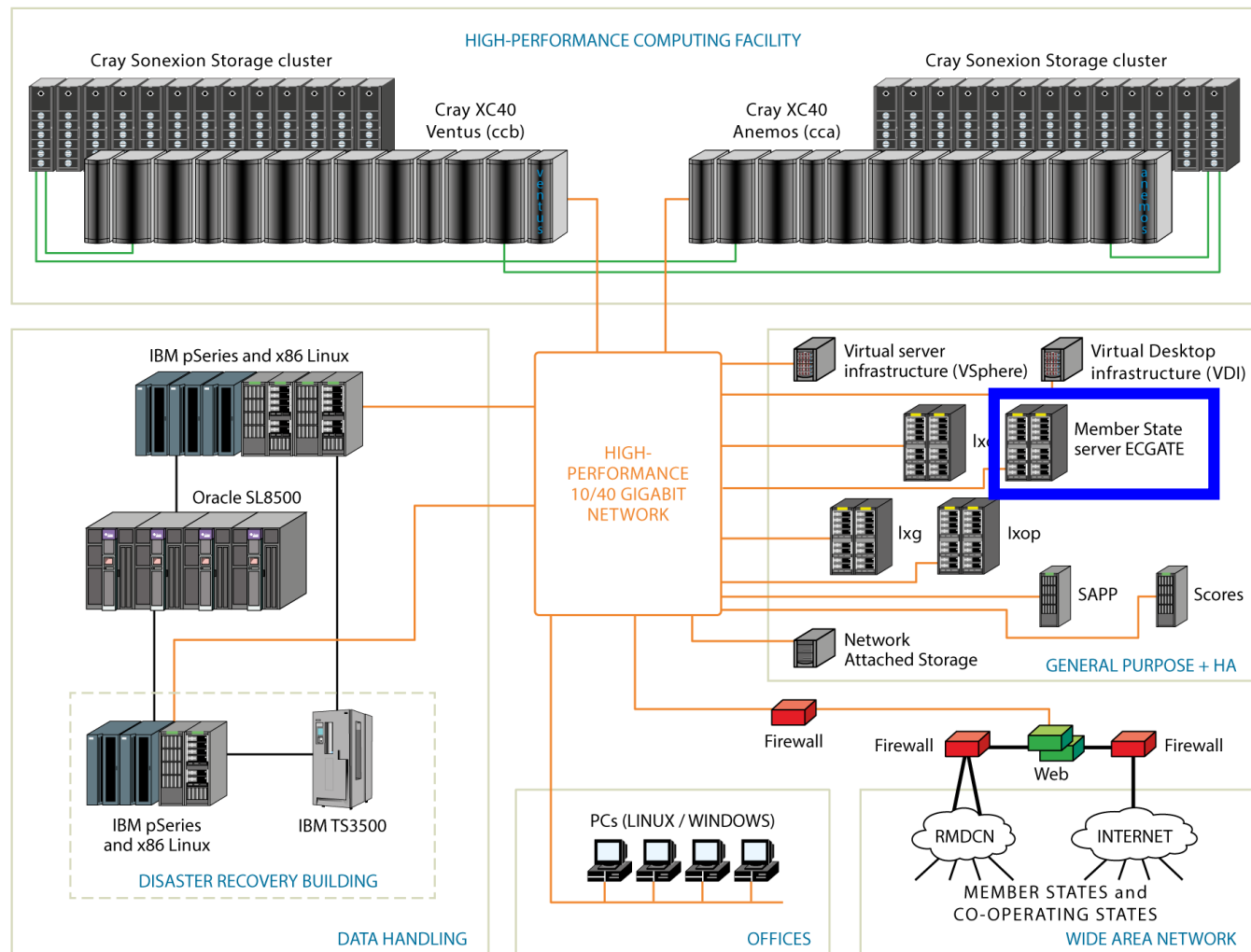
Data Flow



Computing Services

Linux cluster – 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 provides 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 6.8
- 6 I/O server nodes
 - Provides ~275 TB raw disk space (~200 TB of usable space)
 - All file systems are GPFS (General Parallel File Systems)
 - File systems use RAID 5 for speed and resilience
- Available to ~3000 users at more than 350 institutions



ecgate – purpose

Time-critical applications

- Option 1
- Option 2

Batch submission

- SLURM
- ECaccess Tools

Program development

Visualisation

- Metview
- Magics

Data transfer

- ftp / sftp
- ectrans

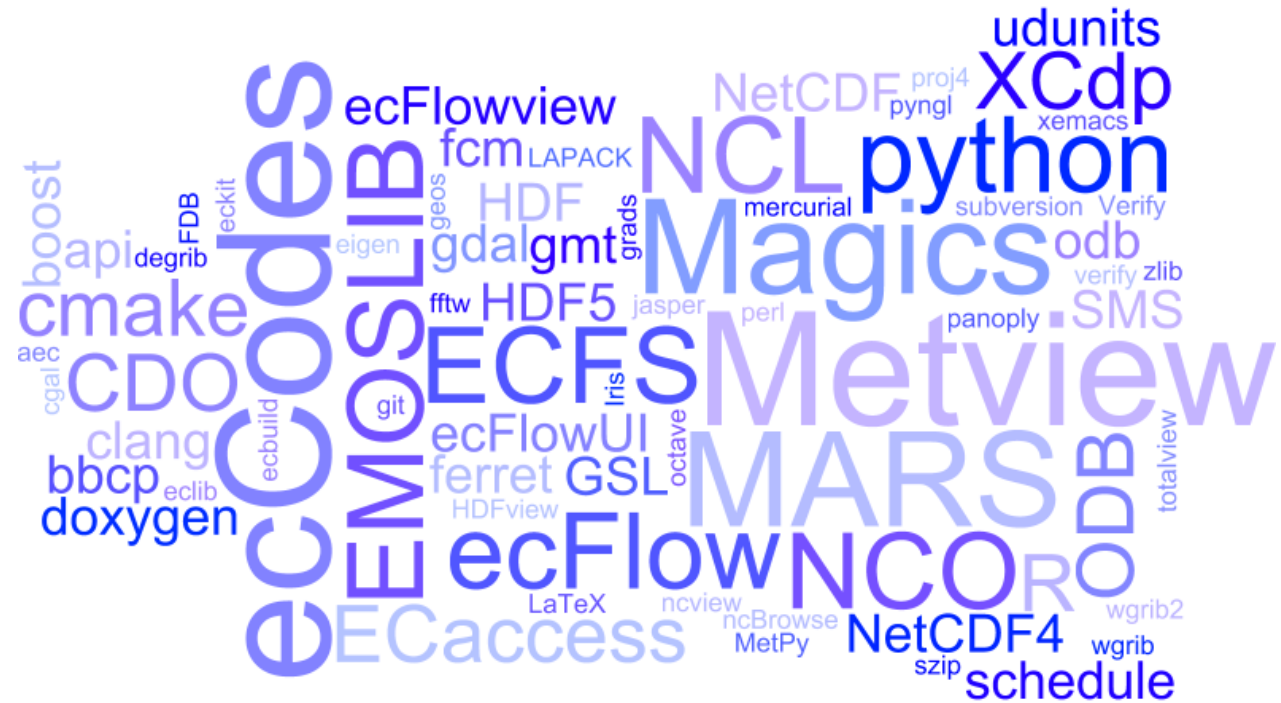
Access to archives

- MARS
- ECFS



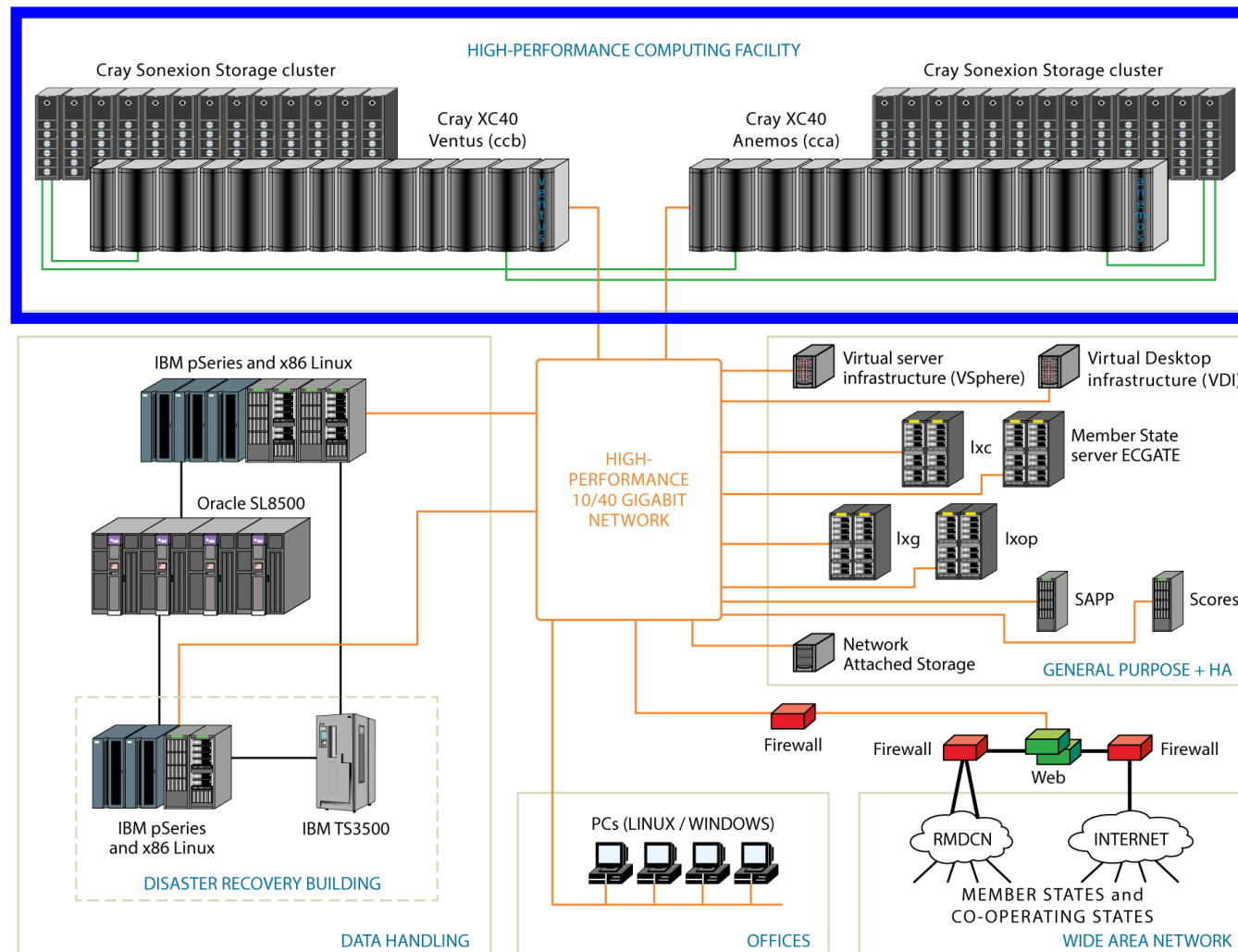
ecgate – software environment

- General ECMWF software and libraries:
 - ECLIB, EMOSLIB, ecCodes, odb_api
- Archives: MARS and ECFS
- Data formats:
 - NetCDF, NetCDF4, HDF, HDF5
- Graphics
 - ECMWF: Metview, Magics
 - External data analysis and visualisation tools
 - ncvview, view_hdf, panoply, GrADS
 - CDO, NCO, R, NCL, gnuplot
- Debugging: Totalview, gdb
- Suite scheduling and monitoring: ecFlow, ecFlowview / ecFlowUI



HPCF

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



HPCF – Cray XC40



- Operational at ECMWF since 19 September 2014
- Phase 2: ~3600 nodes / 130,000 compute cores per cluster
- ~8.5 petaflops peak and ~320 teraflops sustained performance
- Numbers 23 and 24 in the November 2016 Top 500 Supercomputers list
- Contract with Cray extended to 30 September 2020

Cray HPCF Phase 1 vs Phase 2 – a quick comparison

	Phase 1	Phase 2
Sustained Performance (teraflops)	200	320
Peak performance (teraflops)	3,593	~8,500
Processor technology	Intel Ivy Bridge	Intel Broadwell
Parallel application nodes (per cluster)	3,400	3,513
Pre-/Post-processing nodes (per cluster)	104	104
Cores per node / CPUs per node	24 / 48	36 / 72
Total compute cores (per cluster)	84,096	130,212
Memory per node (GiB)	64 (1866 MHz DDR3)	128 (2400 MHz DDR4)
External login nodes	2 x Ivy Bridge	2 x Ivy Bridge, 1 x Haswell
Clock frequency (GHz)	2.7	2.1
Storage capacity (petabytes)	15	20
Floating Point Instruction set	AVX	AVX2
Default compiler	Cray 8.2.7	Cray 8.4.x

HPFC – purpose

Batch submission

- PBSpro
- ECaccess Tools

Time-critical applications

- Option 1
- Option 2
- Option 3

Access to archives

- MARS
- ECFS

Data transfer

- ftp / sftp
- ectrans

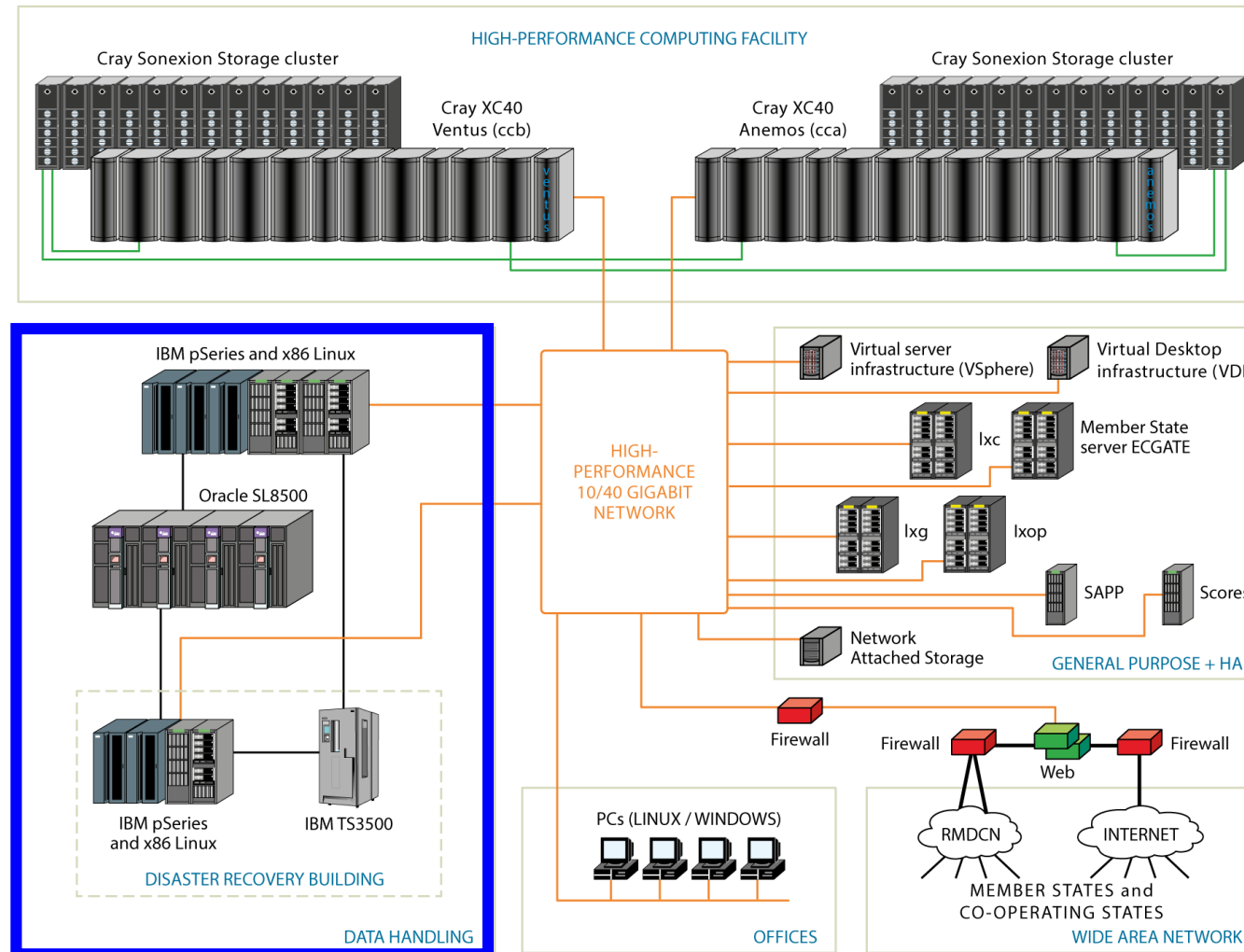


Running meteorological models

- Member State models
- ECMWF's IFS

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 Oracle SL8500 automated tape libraries

- DHS Software

- Based on HPSS (High-Performance Storage System)

- Comprises two archives

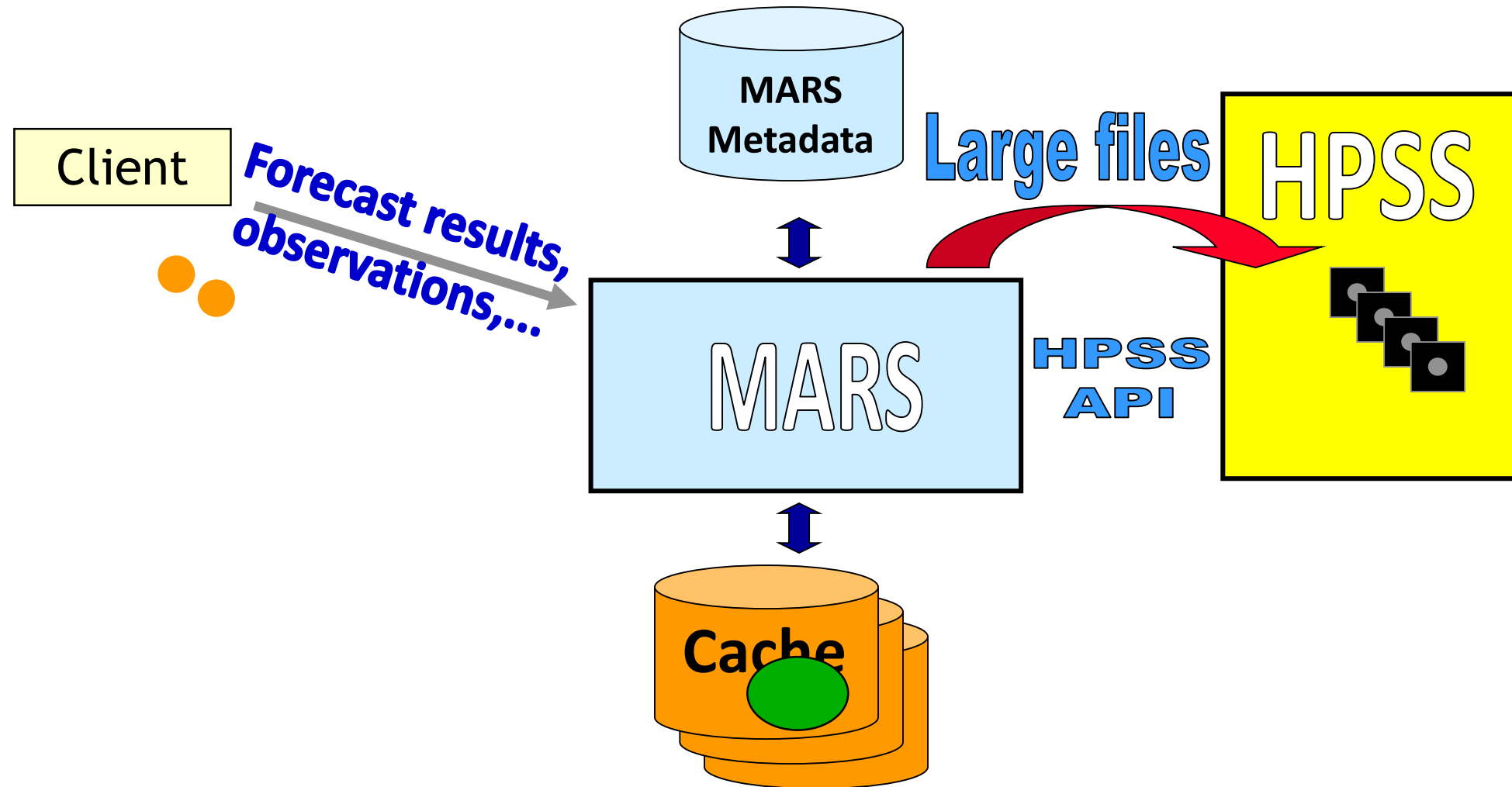
- [MARS](#) – Meteorological archive
- [ECFS](#) – User archive



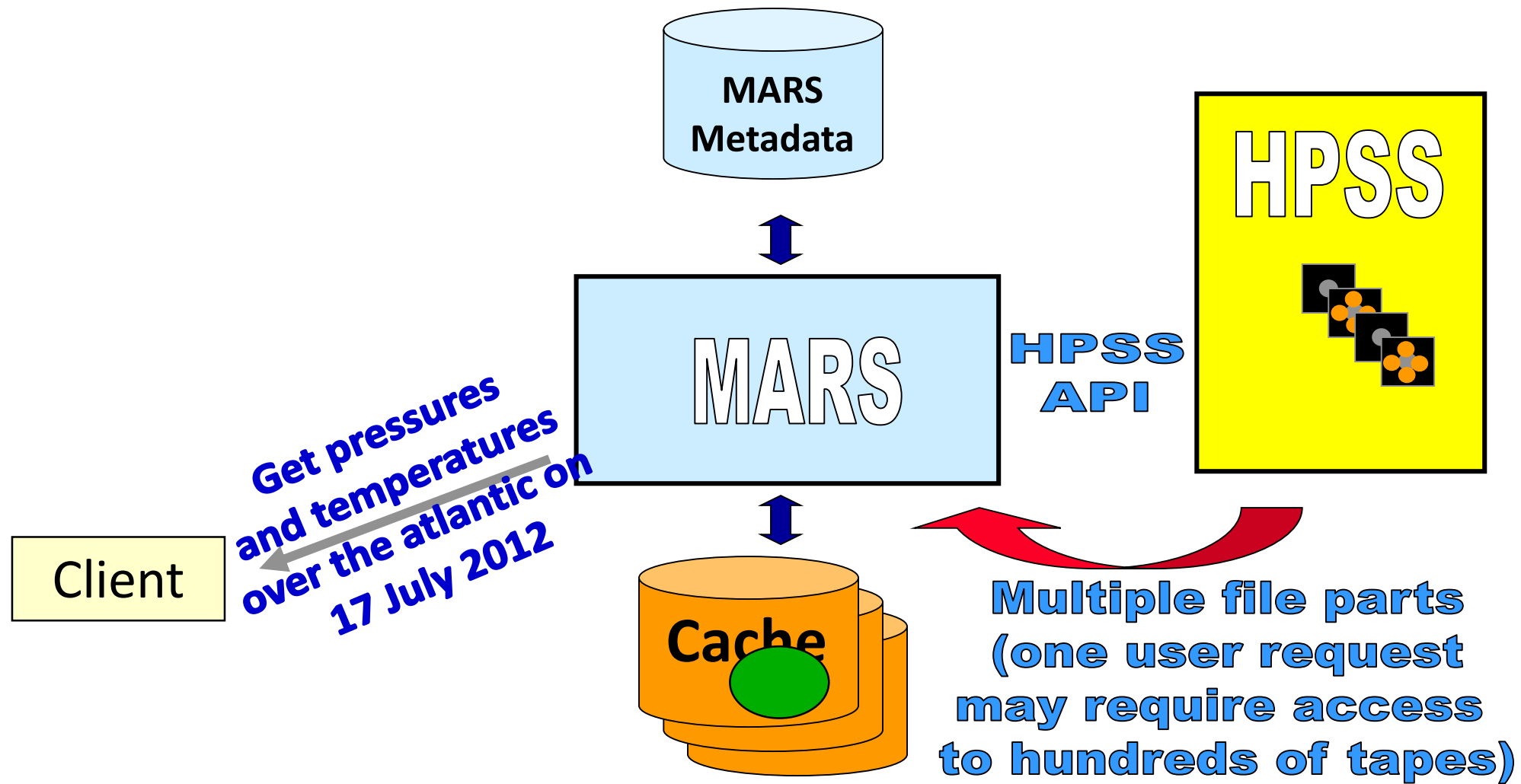
DHS Services

- 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

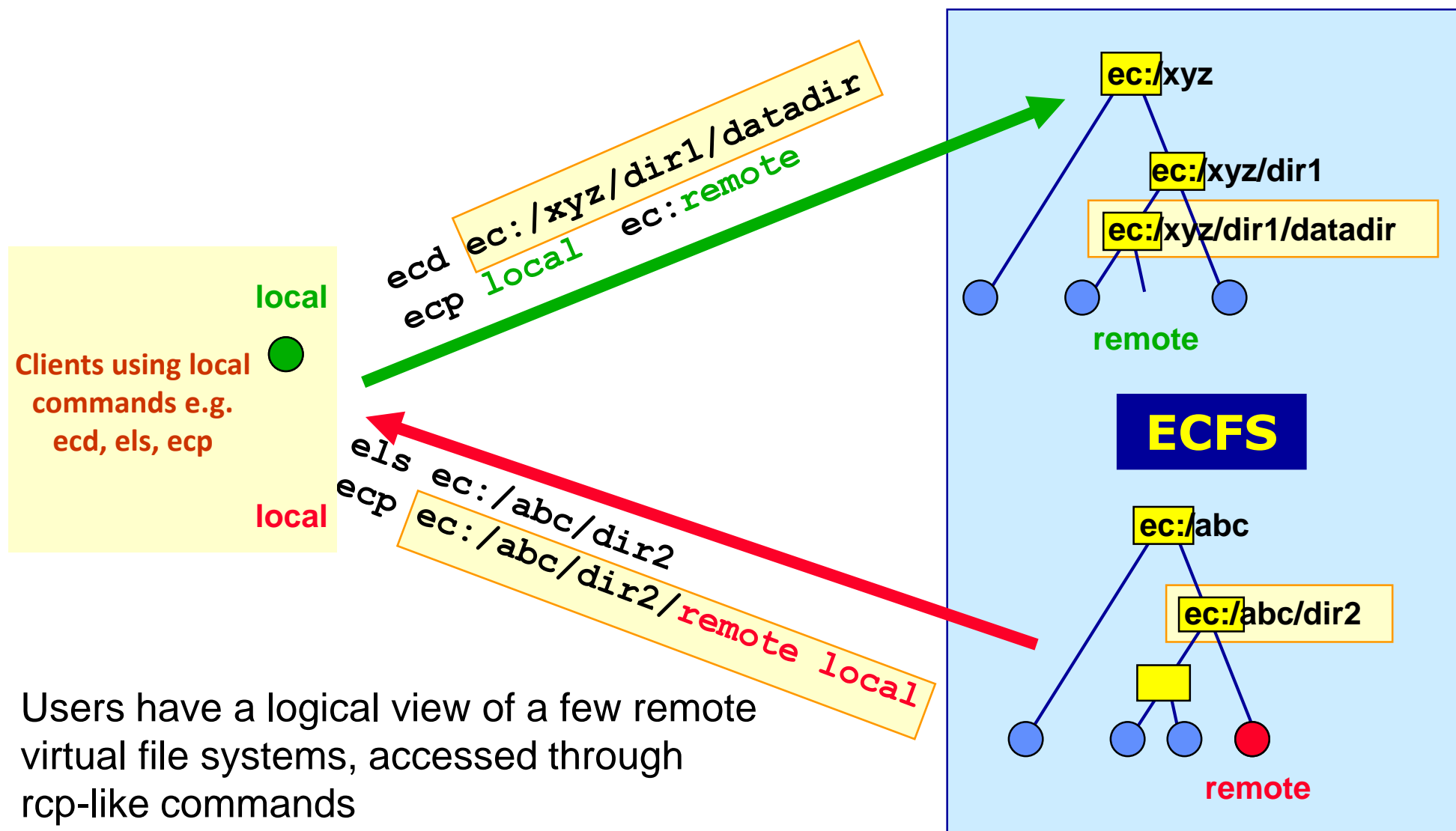
MARS archiving



MARS retrieval

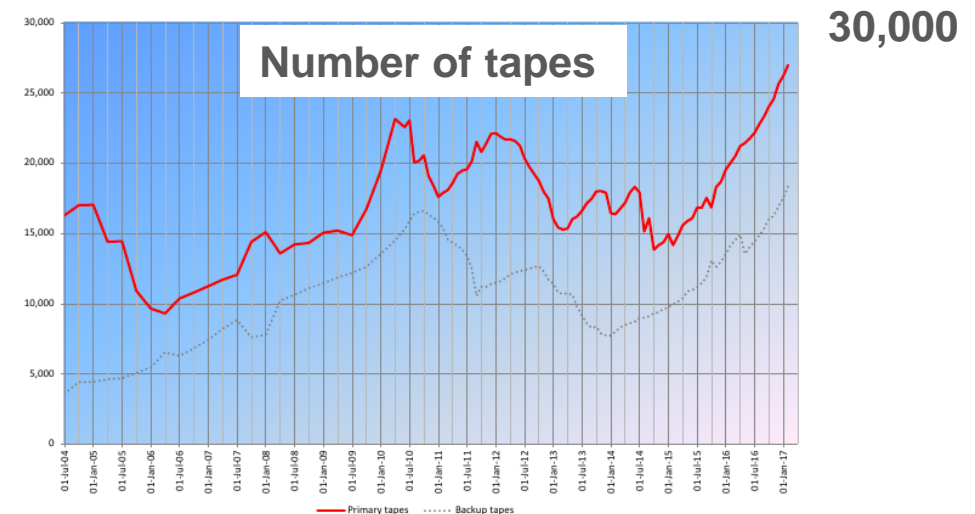
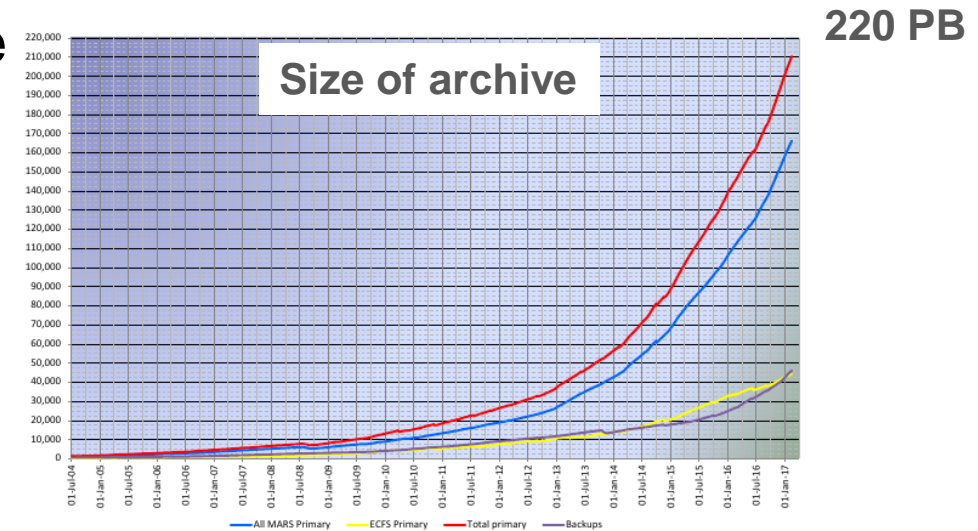


ECFS – the user's view



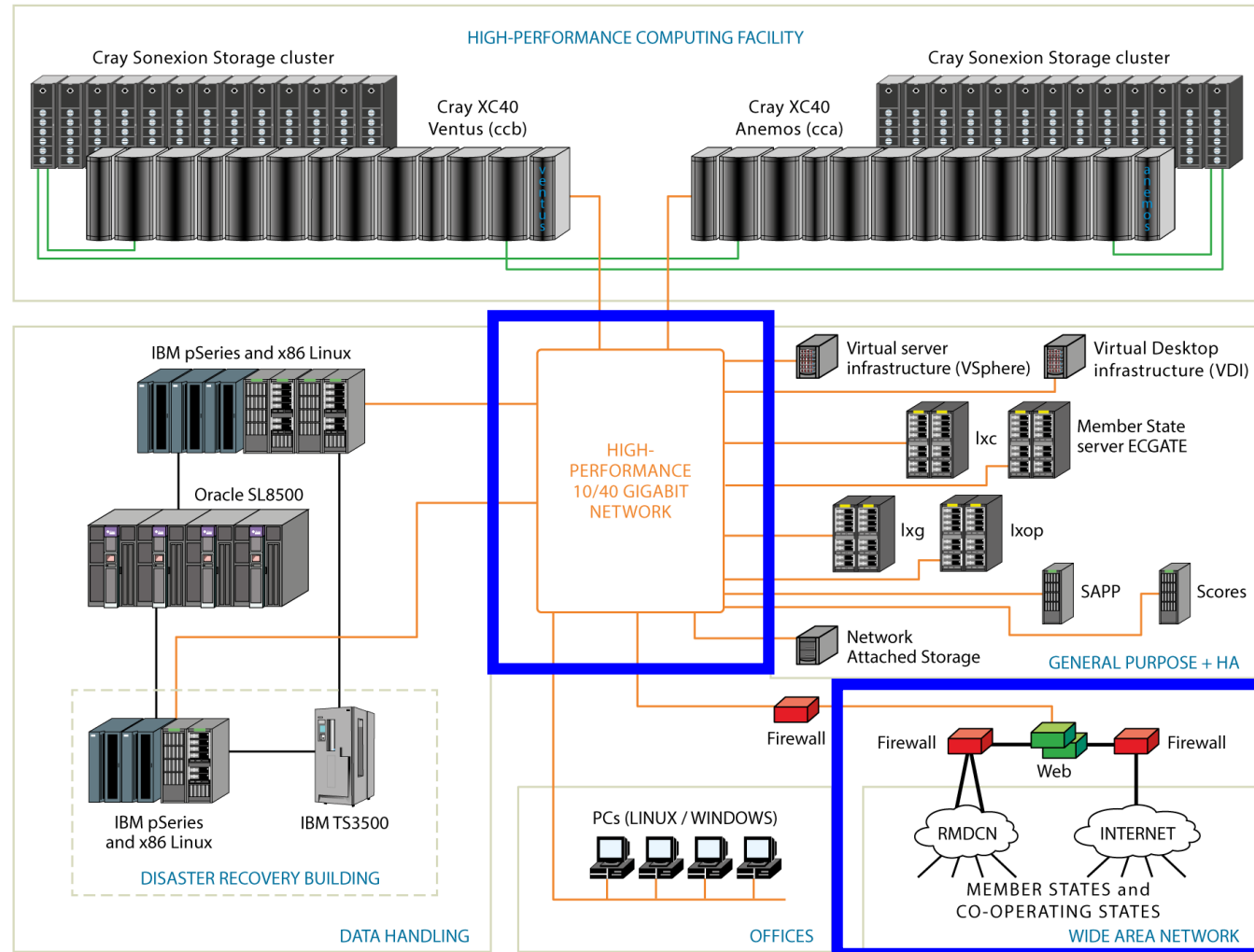
The ECMWF Archive – statistics

- The DHS provides access to ~210 PB of primary data
- An additional ~46 PB of backup copies of part of the primary data are stored in the DRS
- In a typical day the archive grows by ~233 TB
- ~15,500 tape mounts on average per day
 - On some days this can peak at around 25,000
- MARS data:
 - ~6% of the files
 - ~80% of the data volume
- ECFS data:
 - ~94% of the files
 - ~20% of the data volume



Networks

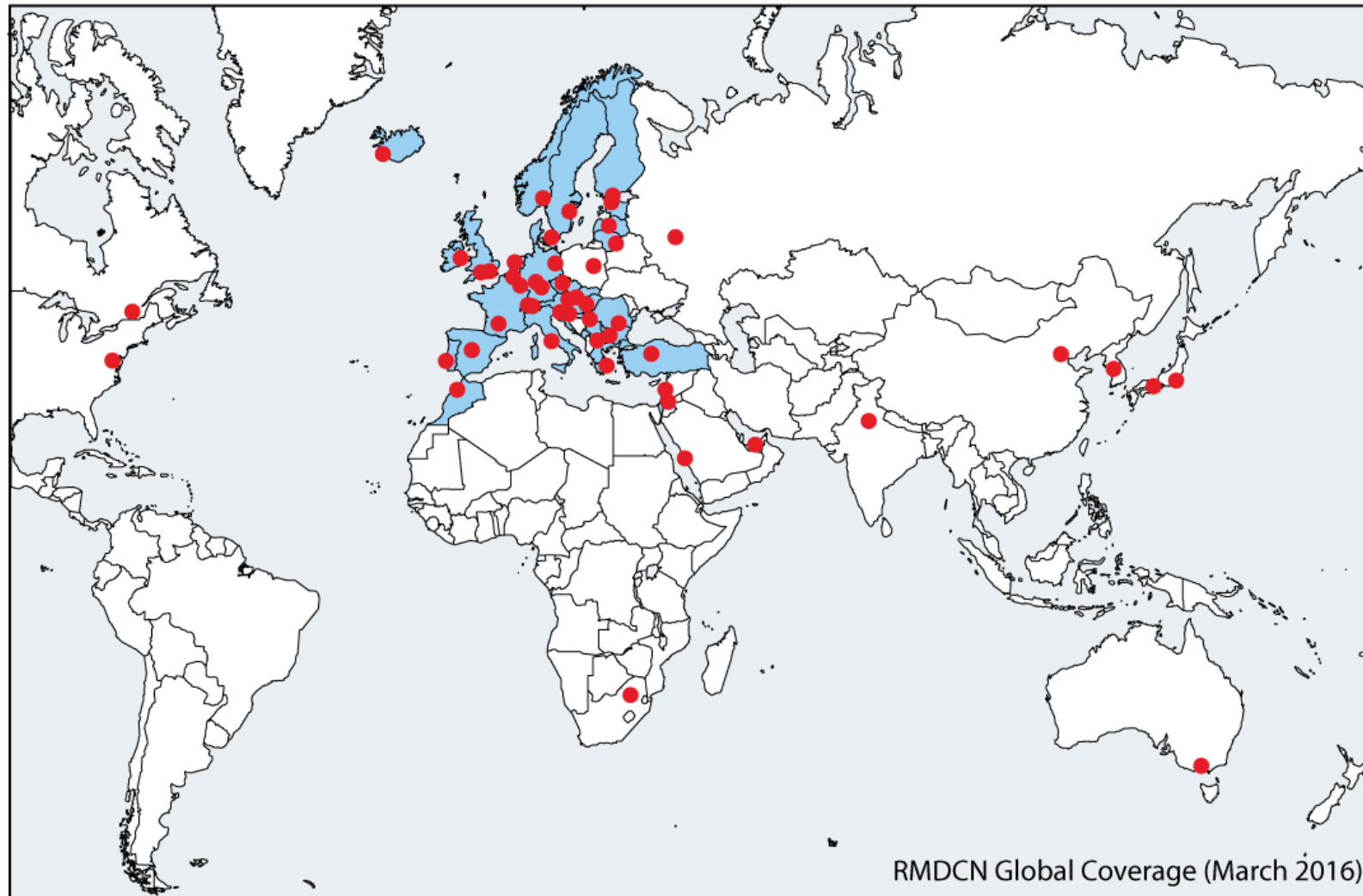
Web documentation: www.ecmwf.int/en/computing/our-facilities/networks
www.ecmwf.int/en/computing/our-facilities/rmdcn



Networks

- Internal (LAN)
 - High Performance Network: 40 Gbps
 - Office Network: 10 Gbps
- External (WAN)
 - Internet
 - Dual 15 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 (March 2016)

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

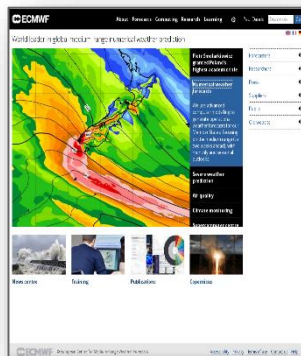
*The same **token**, or a **password** or a **certificate** can be used to access the **ECMWF website***

Web Services

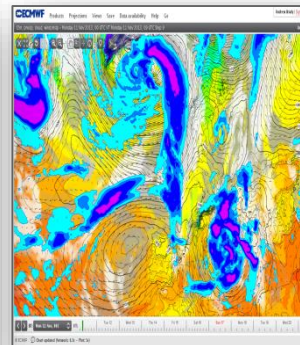
www.ecmwf.int

Web services – overview

- Five key service areas:



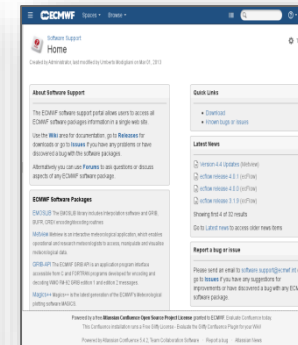
www
Everyone



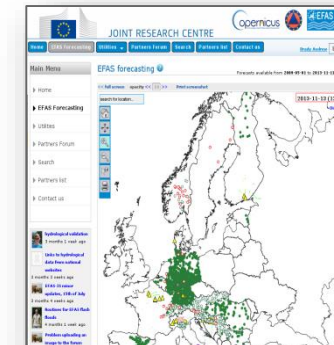
ecCharts
Forecasters



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 publicly accessible

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

Charts | ECMWF - Mozilla Firefox

Charts | ECMWF

www.ecmwf.int/en/forecasts/charts

ECMWF

About Forecasts Computing Research Learning

Paul Dando Search site Go

Charts

Select and view our charts - forecasts and associated verification

Our Integrated Forecasting System (IFS) provides forecasts for multiple time ranges. We provide a range of forecast products to address different user requirements. These present key aspects of the forecast evolution and the associated uncertainty. Specific products designed to highlight potential severe weather events include the Extreme Forecast Index and tropical cyclone activity.

Click on the category title or the associated thumbnail below to access *all* charts for that category.

Charts

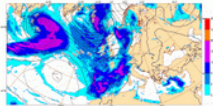
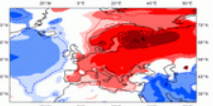
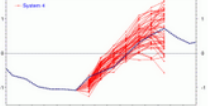
- [Datasets](#)
- [Quality of our forecasts](#)
- [Software and tools](#)
- [Documentation and support](#)
- [Accessing forecasts](#)

Help

To view all charts in a category, simply click on the category title or associated thumbnail.

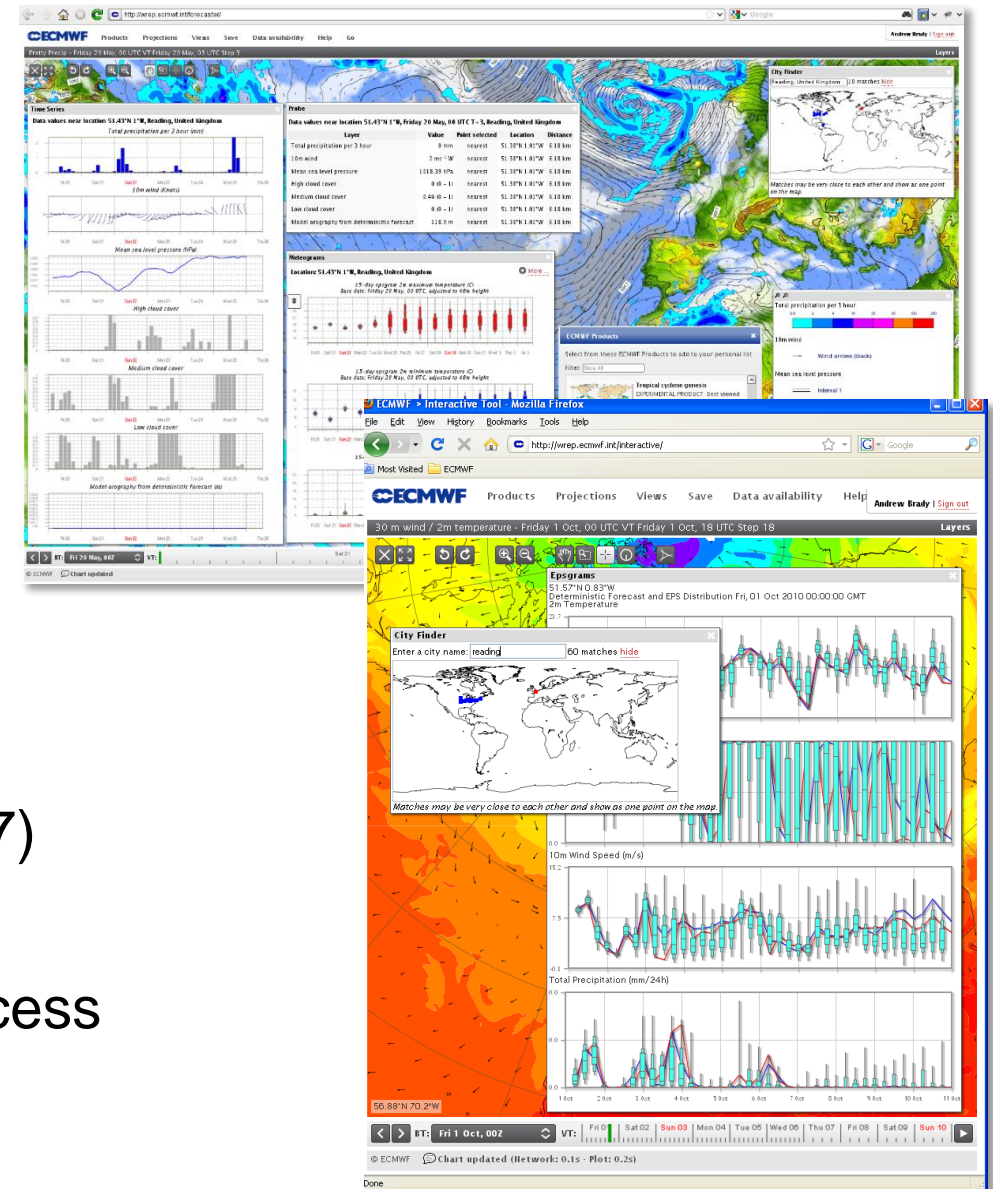
Alternatively choose a link below:

- [Medium range](#)
- [Extended range](#)
- [Long range](#)
- [All charts](#)

Medium range	Extended range	Long range
		
<i>Up to 10/15 days ahead.</i>	<i>Up to 30 days ahead.</i>	<i>Up to 13 months ahead.</i>
Overview (text)	Overview (text)	Overview (text)
ENS meteograms	Plumes	Nino plumes
ENS meteograms for WMO member states	Tropical cyclones	Tropical cyclones
Extreme forecast index	Verification	Verification
Extra-tropical cyclones		EUROSIP Multi-model system
Tropical cyclones		
Ocean waves		
Verification		

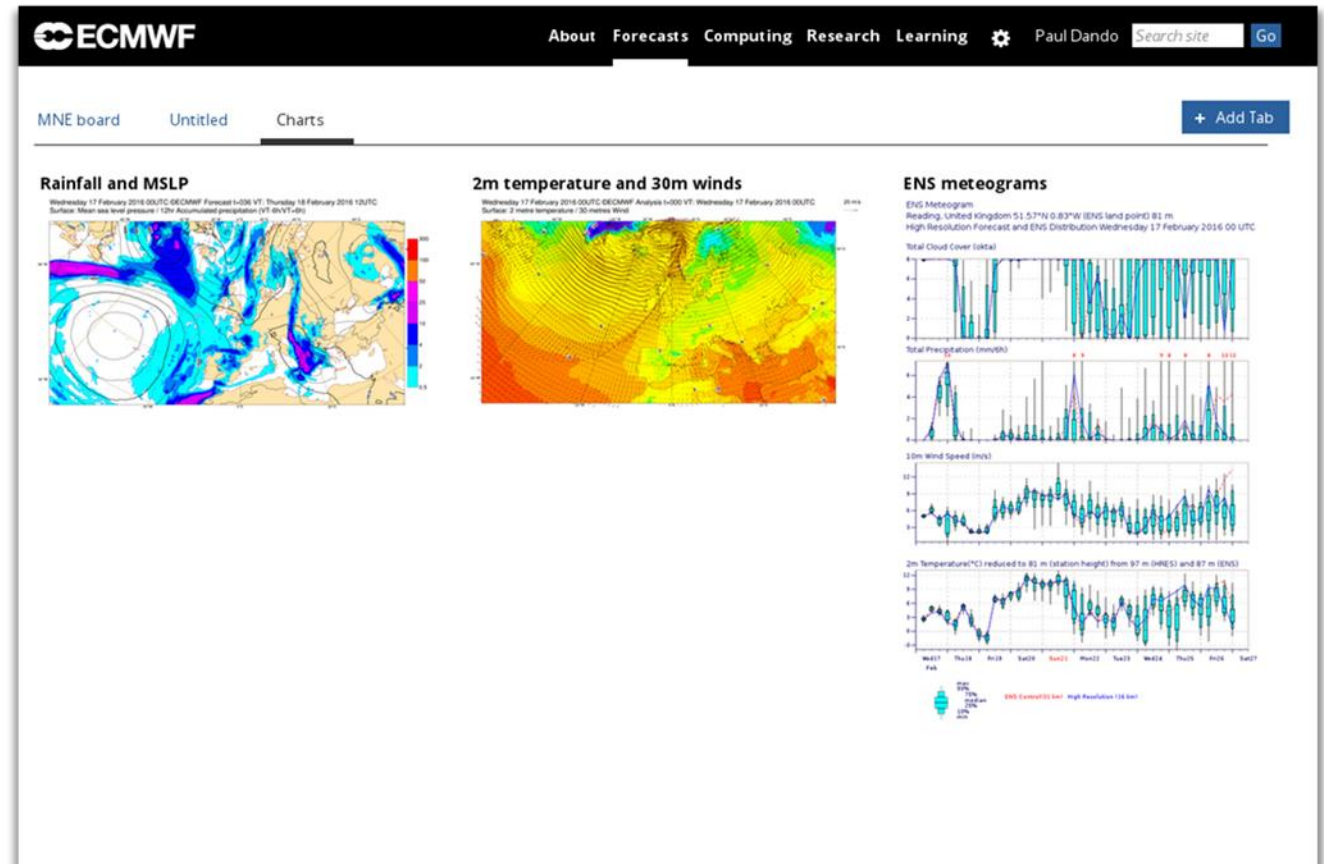
Web services – ecCharts: <http://eccharts.ecmwf.int/>

- Highly interactive (products created on-demand)
 - 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
- Highly available and operationally supported (24x7)
- Use of agreed dissemination schedule
- OGC WMS standards for machine-to-machine access
- Access approved by Comp Reps



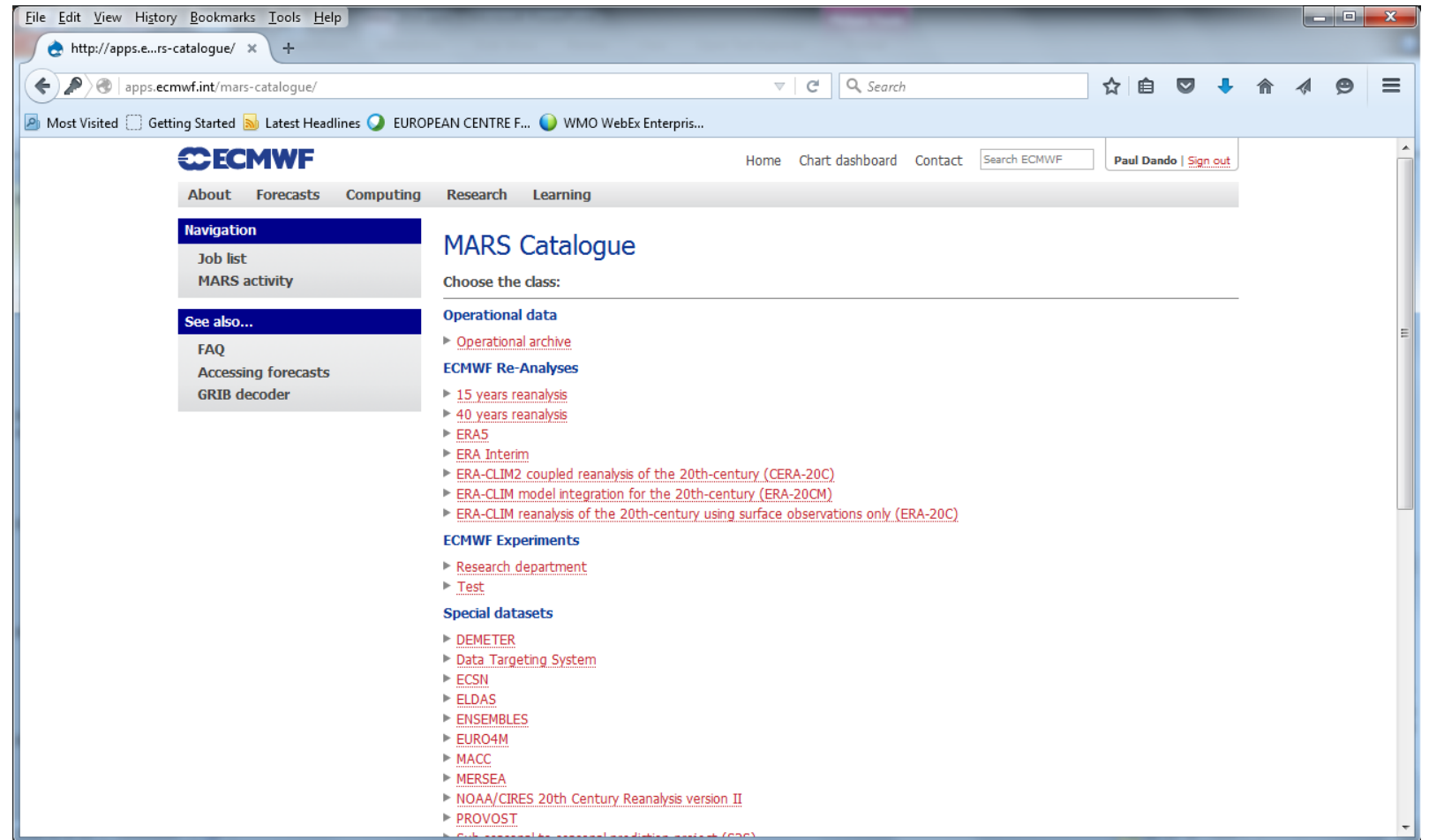
Web chart dashboard

- Documentation: <https://software.ecmwf.int/wiki/display/FCST/Chart+dashboard>
- Place to organise regularly accessed charts
- Shared with the ecCharts dashboard



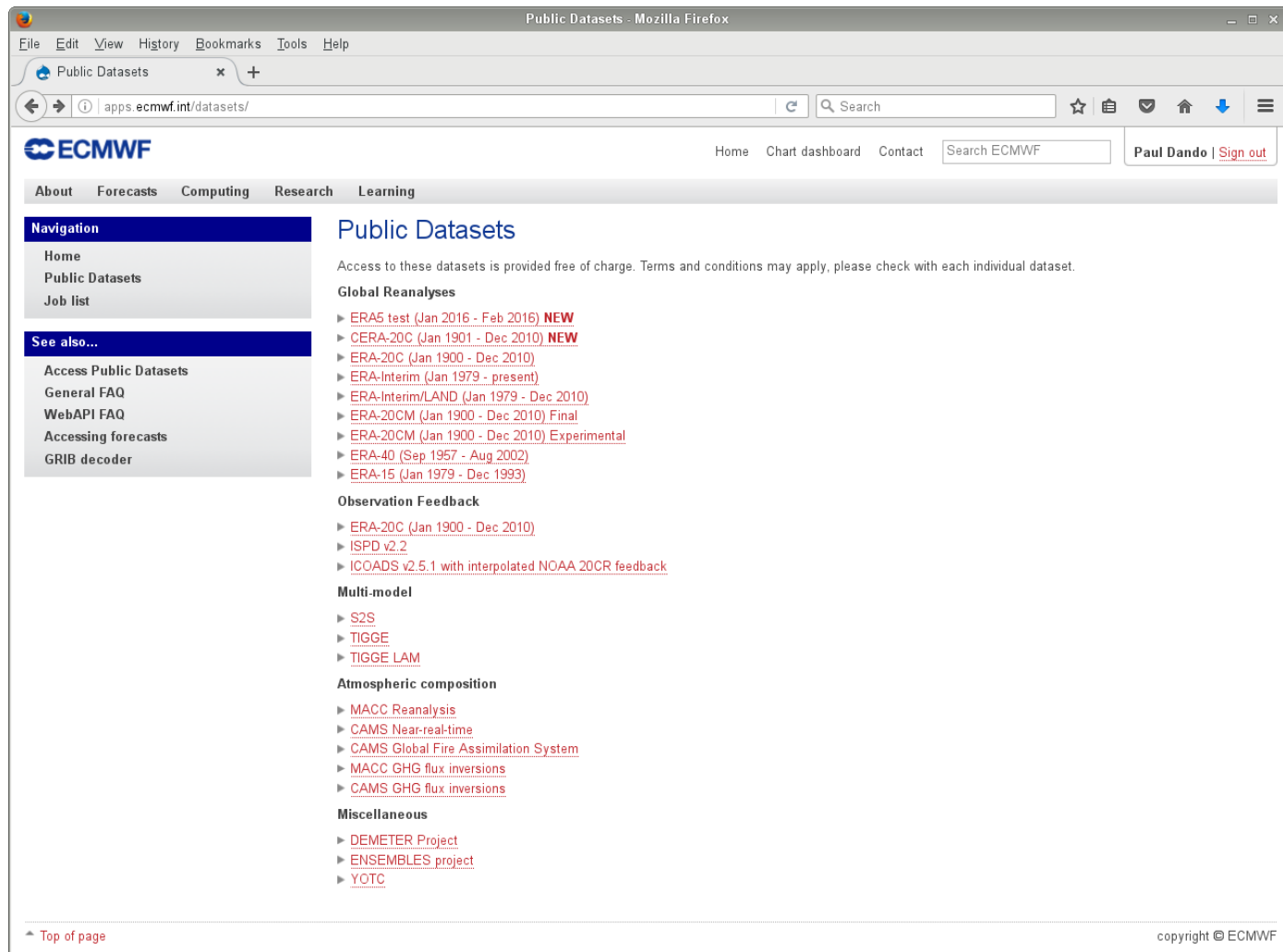
Web Services – MARS <http://apps.ecmwf.int/services/mars/catalogue/>

- Web based interface to MARS
- Available to registered users only
- Retrievals (GRIB and NetCDF)
- Batch access with WebAPI (Python)



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

- Public (non-commercial) distribution of data
 - Self-registration
- Batch access with WebAPI (Python, Perl, Java, Ruby)
- GRIB or NetCDF
- ERA-Interim, ERA5, TIGGE, S2S, CAMS etc



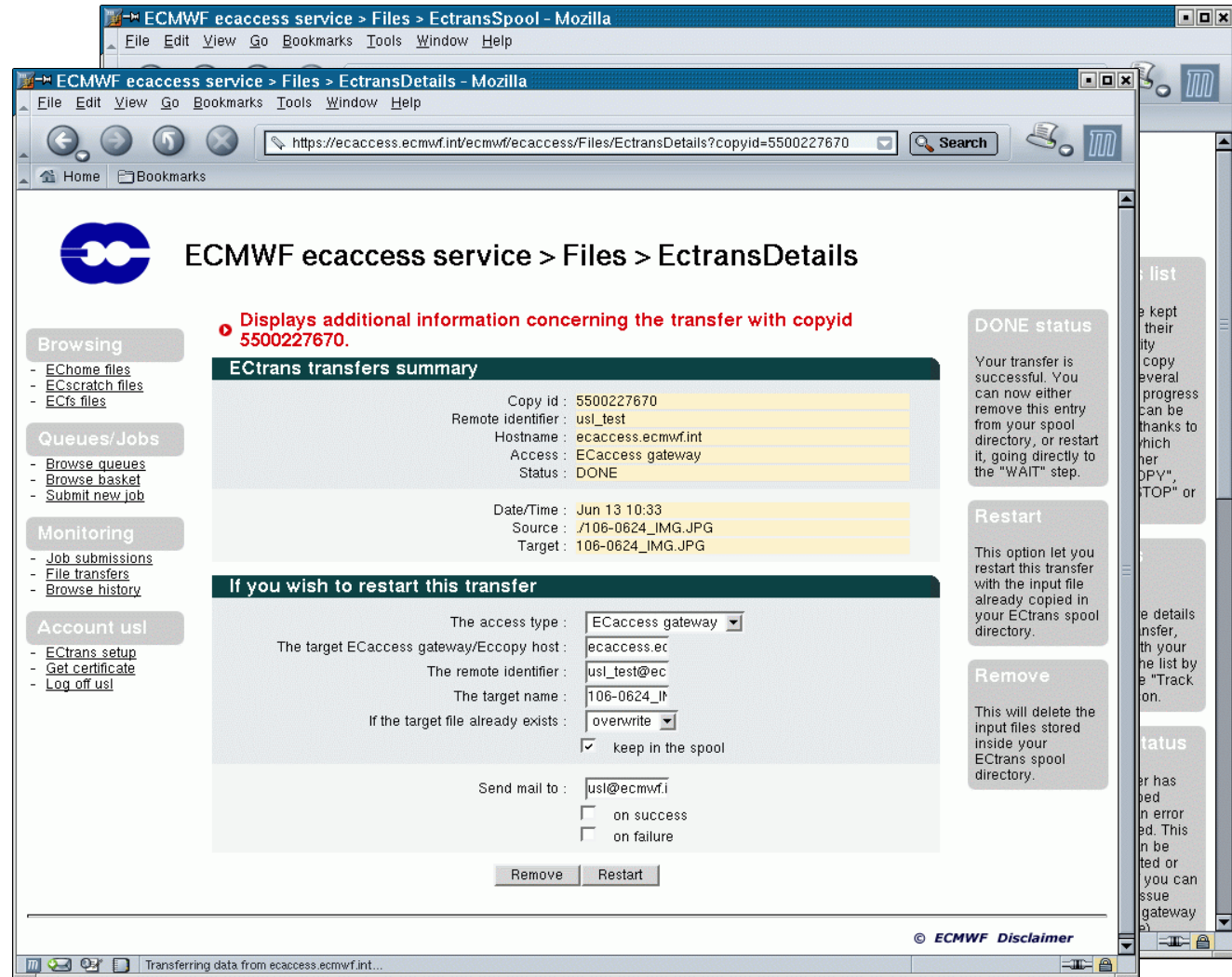
The screenshot shows the 'Public Datasets' page on the ECMWF website. The browser window title is 'Public Datasets - Mozilla Firefox'. The address bar shows 'apps.ecmwf.int/datasets/'. The page features the ECMWF logo and navigation links: Home, Chart dashboard, Contact, and a search bar. A user 'Paul Dando' is logged in. The main content area is titled 'Public Datasets' and includes a sub-header: 'Access to these datasets is provided free of charge. Terms and conditions may apply, please check with each individual dataset.' Below this, there are several sections of links:

- Global Reanalyses**
 - ▶ [ERA5 test \(Jan 2016 - Feb 2016\) NEW](#)
 - ▶ [CERA-20C \(Jan 1901 - Dec 2010\) NEW](#)
 - ▶ [ERA-20C \(Jan 1900 - Dec 2010\)](#)
 - ▶ [ERA-Interim \(Jan 1979 - present\)](#)
 - ▶ [ERA-Interim/LAND \(Jan 1979 - Dec 2010\)](#)
 - ▶ [ERA-20CM \(Jan 1900 - Dec 2010\) Final](#)
 - ▶ [ERA-20CM \(Jan 1900 - Dec 2010\) Experimental](#)
 - ▶ [ERA-40 \(Sep 1957 - Aug 2002\)](#)
 - ▶ [ERA-15 \(Jan 1979 - Dec 1993\)](#)
- Observation Feedback**
 - ▶ [ERA-20C \(Jan 1900 - Dec 2010\)](#)
 - ▶ [ISPD v2.2](#)
 - ▶ [ICOADS v2.5.1 with interpolated NOAA 20CR feedback](#)
- Multi-model**
 - ▶ [S2S](#)
 - ▶ [TIGGE](#)
 - ▶ [TIGGE LAM](#)
- Atmospheric composition**
 - ▶ [MACC Reanalysis](#)
 - ▶ [CAMS Near-real-time](#)
 - ▶ [CAMS Global Fire Assimilation System](#)
 - ▶ [MACC GHG flux inversions](#)
 - ▶ [CAMS GHG flux inversions](#)
- Miscellaneous**
 - ▶ [DEMETER Project](#)
 - ▶ [ENSEMBLES project](#)
 - ▶ [YOTC](#)

At the bottom of the page, there is a 'Top of page' link and a copyright notice: 'copyright © ECMWF'.

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

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



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

- You can access NX through your Web browser
- You can select the:
 - Host (ecgate / cca)
 - Internet connection speed

▶ 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) :

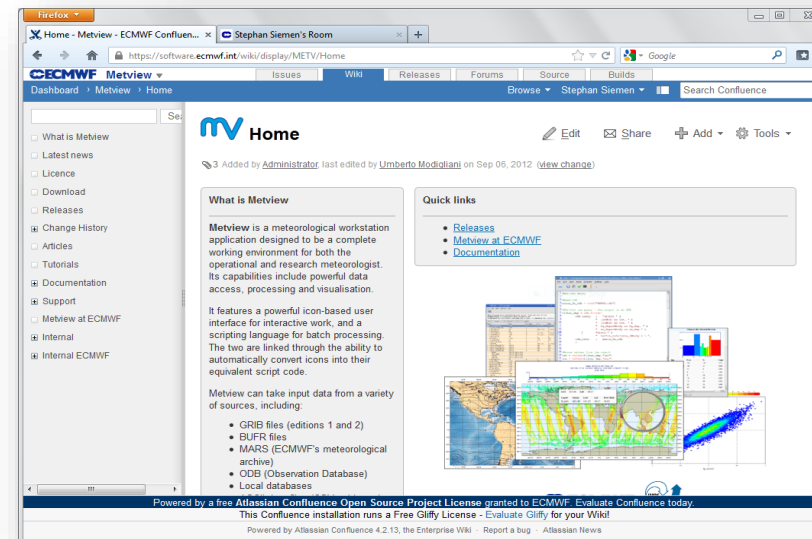
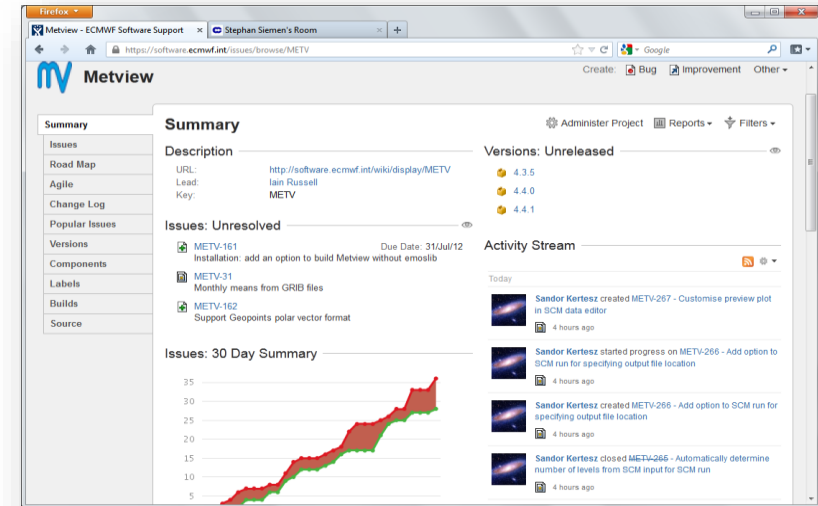
Virtual desktop resolution (NX3) :



Login requires a token

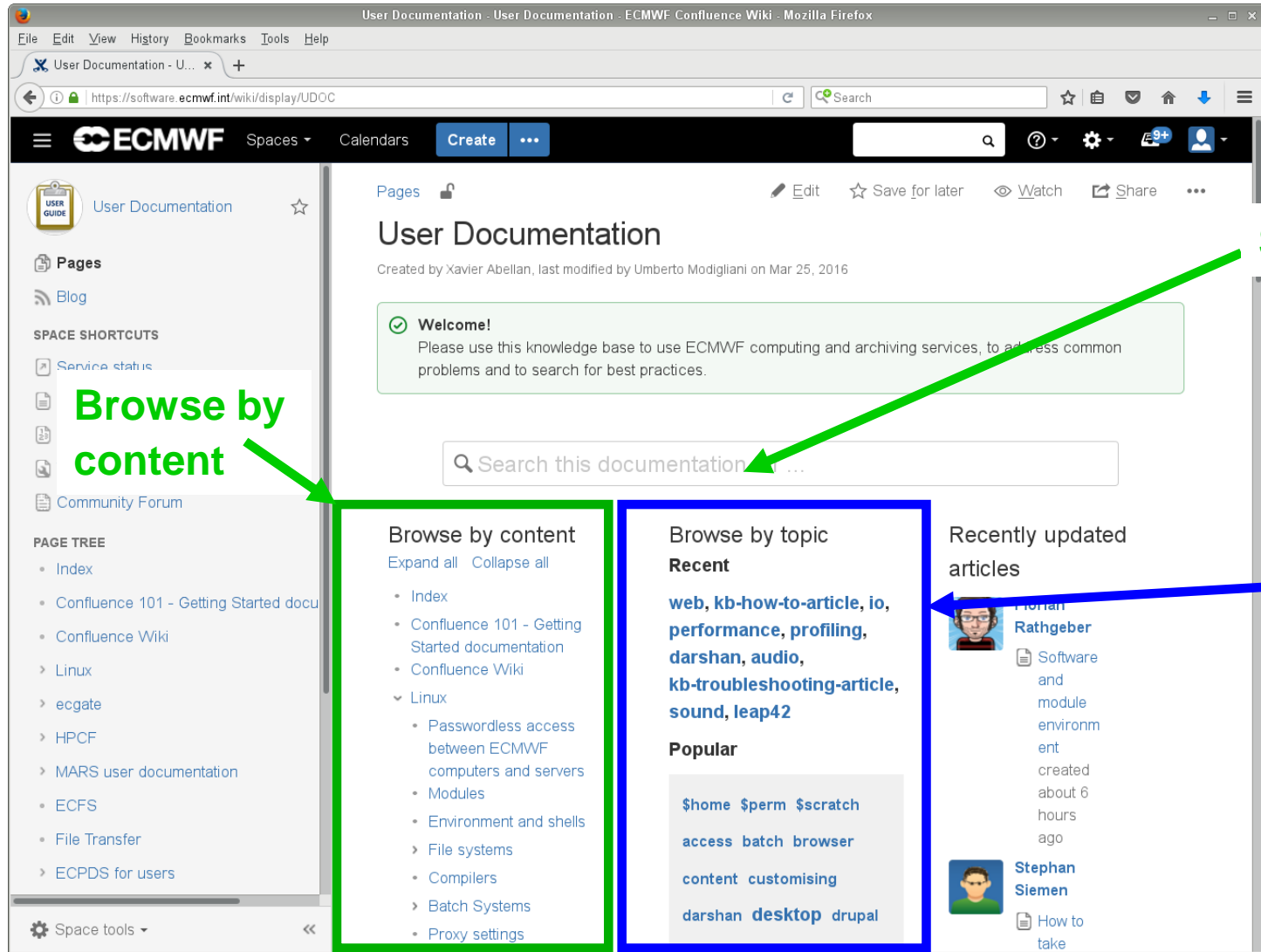
Software Support – <http://software.ecmwf.int/>

- 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)



Web Documentation –

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



Search

Browse by content

Browse by topic – recently updated or most popular

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 ...



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	☑

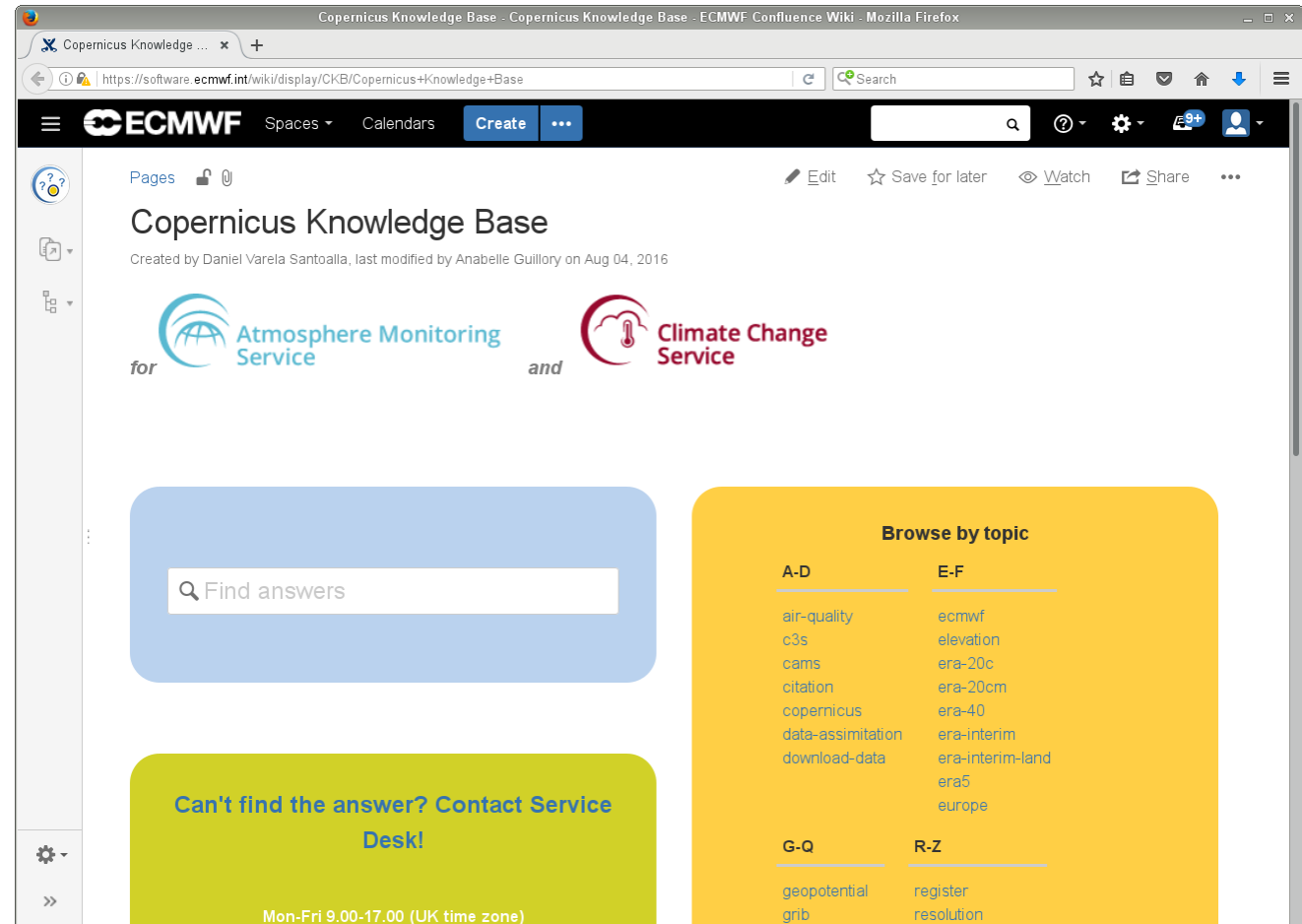
- Email sent only if user action is required
- For announcements of upcoming system sessions see also /etc/motd on ecgate

ECMWF Help & Support – who to contact?

Reason to contact	Who	Availability	How
<i>Urgent</i> Dissemination problems, issues with model output	Service Desk	24h/7d	Email: servicedesk@ecmwf.int Tel: +44 118 9499 303
Generic fault reporting, general service queries etc.	Service 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 ECMWF software, report problems and bugs	Software Support	8h/5d	Email: software.support@ecmwf.int
Copernicus support (including queries about re-analysis data)	Copernicus User Support	8h/5d	Email: copernicus-support@ecmwf.int
Specific graphics queries	Development Section	8h/5d	Email: metview@ecmwf.int magics@ecmwf.int

Copernicus user service desk

- Single Point Of Contact for all user enquiries related to CAMS and C3S products and activities
 - data access, availability, documentation, events, etc
- Web portal for submitting queries
 - Committed to respond within 8 working hours
 - Aim at resolving issues within 5 working days.
- Copernicus Knowledge Base
 - Collection of information and FAQs for “self help”
 - Useful not just for CAMS and C3S !



<https://software.ecmwf.int/wiki/display/CKB/Copernicus+Knowledge+Base>

Questions?