Introduction to computing resources

Paul Dando

User Support

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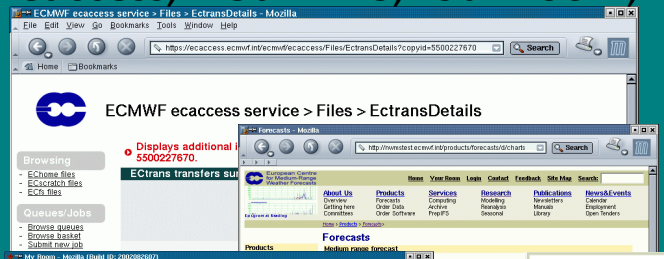
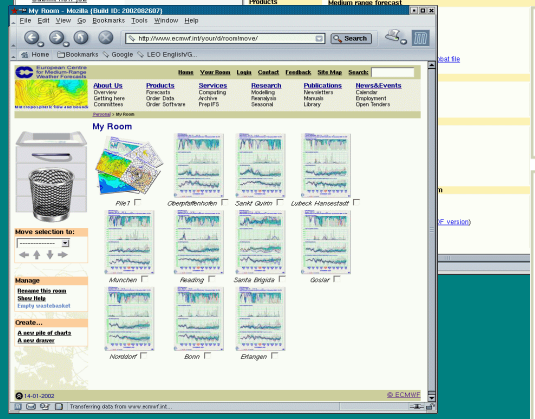
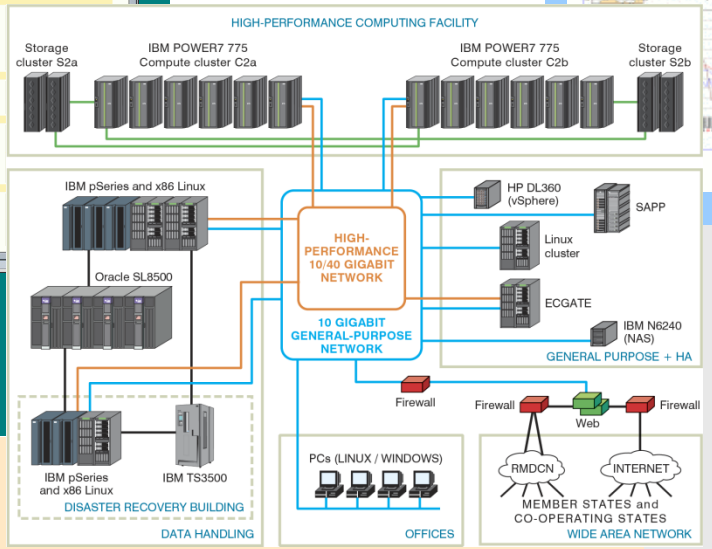
Overview

Web services (ECaccess, webMARS, Your Room,..)

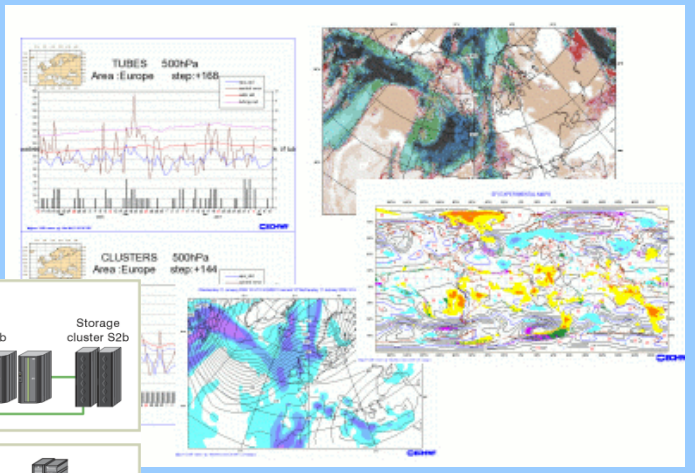




Computer facilities



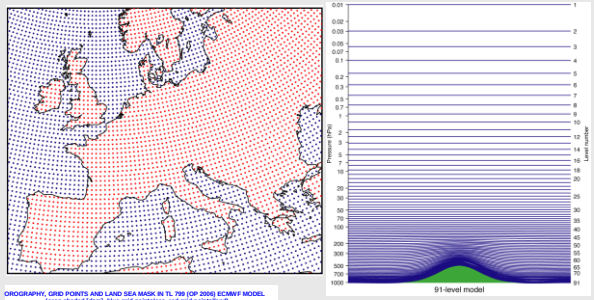
Meteorological software & libraries

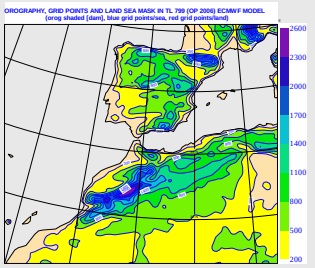


mars, EMOS, grib_api, Metview, Magics++, etc.

Call Desk { *Fault reporting, Service queries*

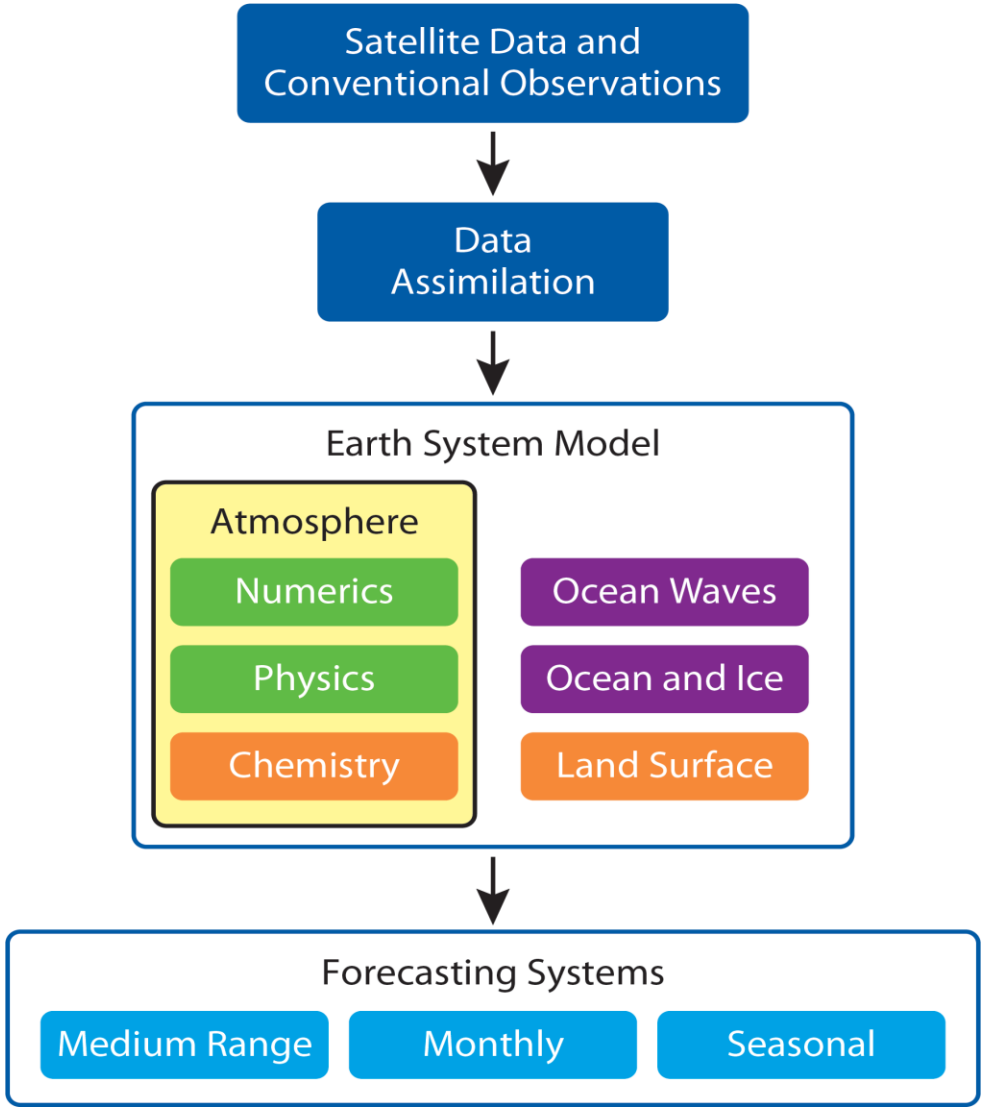
User Support { *Advice on the use of ECMWF computers*





IFS model

The forecast process



ECMWF main meteorological products (1/3)

- 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)
- 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)

ECMWF main meteorological products (2/3)

- 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

- Ensemble forecast (ENS) with 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 (3/3)

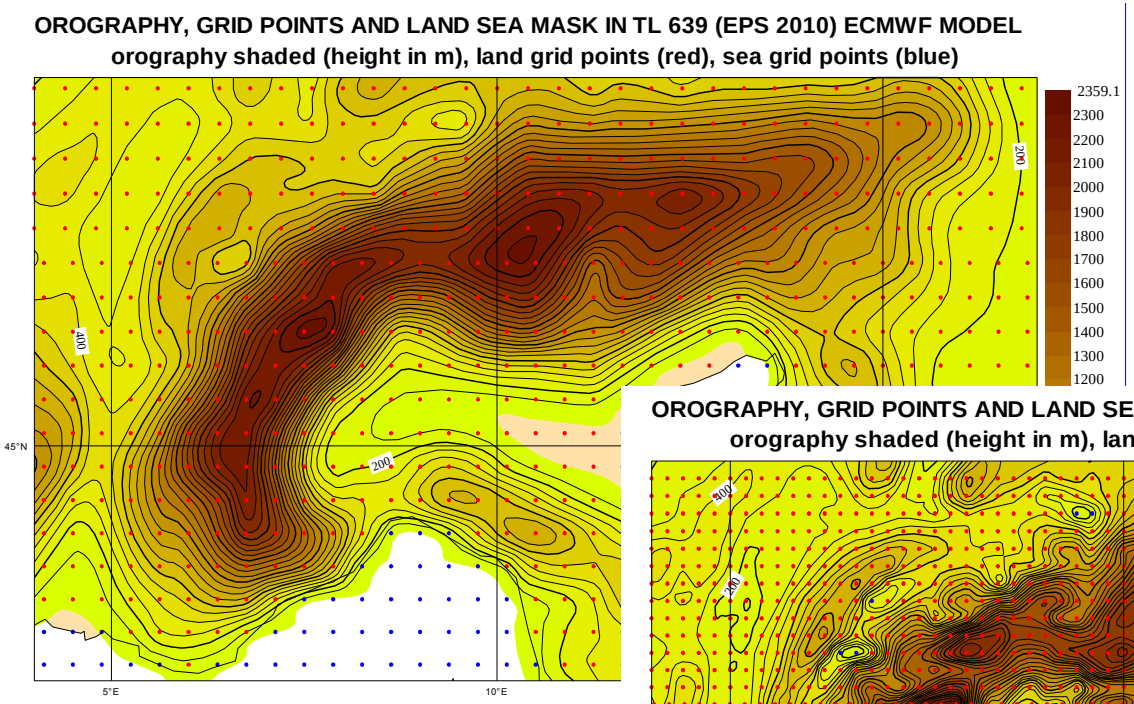
- Seasonal System 4 (SEAS) – atmosphere-ocean coupled model (51 members)
  - Global forecasts from 00 UTC to 7 months: *(once a month)*
    - atmosphere: ~75 km resolution, 91 levels (T255 L91)
    - ocean: NEMO – ORCA1 grid (~1˚x1˚ with equatorial refinement), 42 levels
  - In February, May, August 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

- Monthly Means – atmospheric and wave averaged over each calendar month

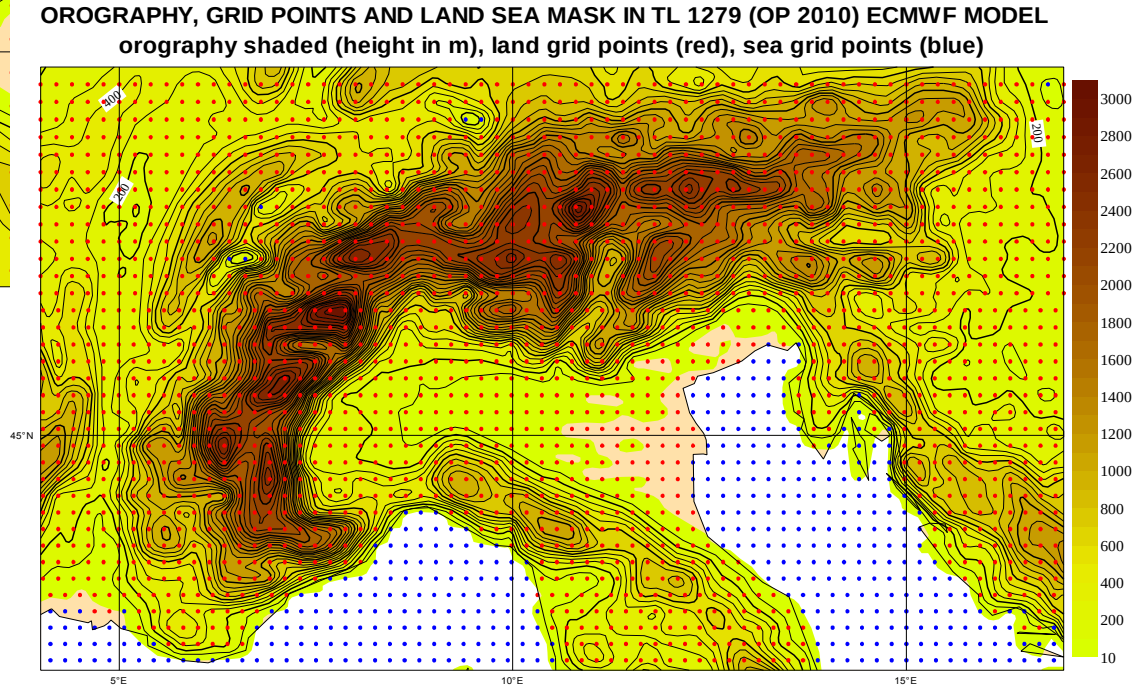
- ECMWF Re-Analysis (ERA-15, ERA-40, ERA-Interim)
  - ERA-Interim: covers 1 Jan 1979 to 31 Dec 2013

Operational upgrades – www.ecmwf.int/products/changes

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

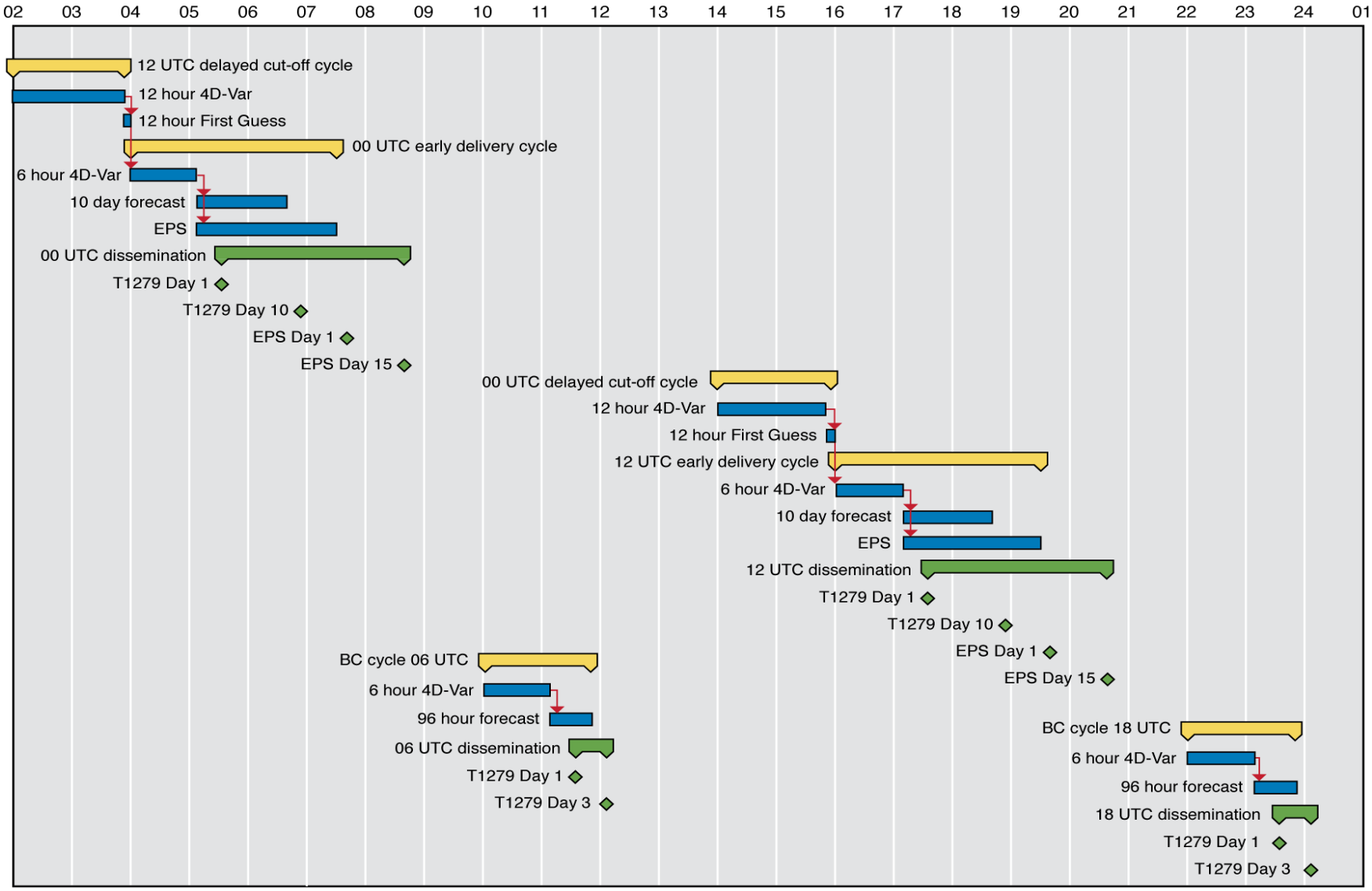


ENS: 91 x 542,080 = 49,329,280 grid points



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

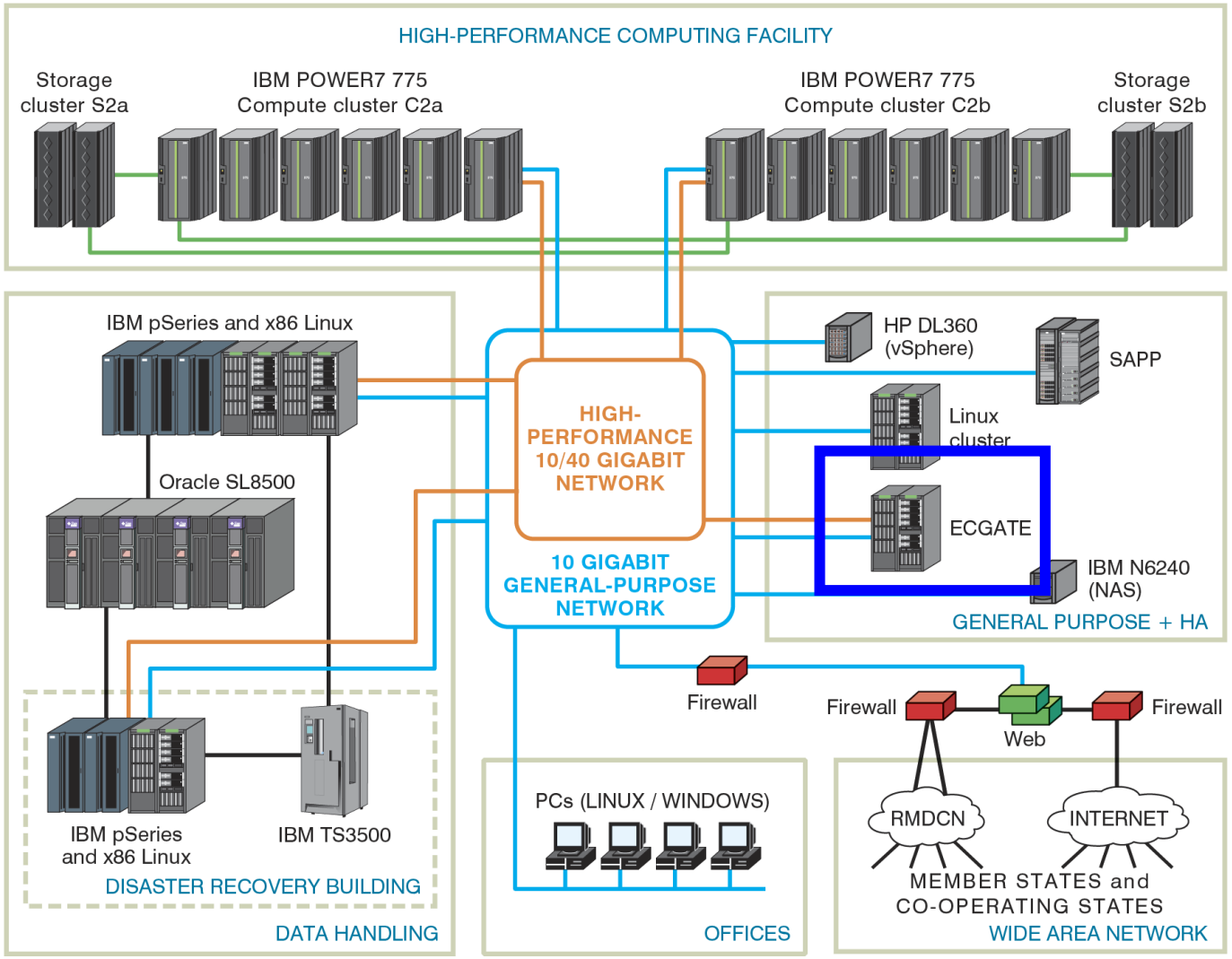
The main operational suites on ECMWF's HPCF




Computing
Services

Unix server – ecgate

Web documentation: www.ecmwf.int/services/computing/ecgate/



ecgate – configuration

- 8 compute nodes each with
  - 2 Intel Xeon processors (Sandy Bridge-EP): 16 core at 2.7 GHz
  - 128 GB memory
  - 2 x 900 GB SAS HDD
- Hyper threading is used providing 32 virtual CPUs per node
- One (+one as backup) of these nodes serves as a "login" node
- RedHat Enterprise Linux Server 6.4
- 4 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

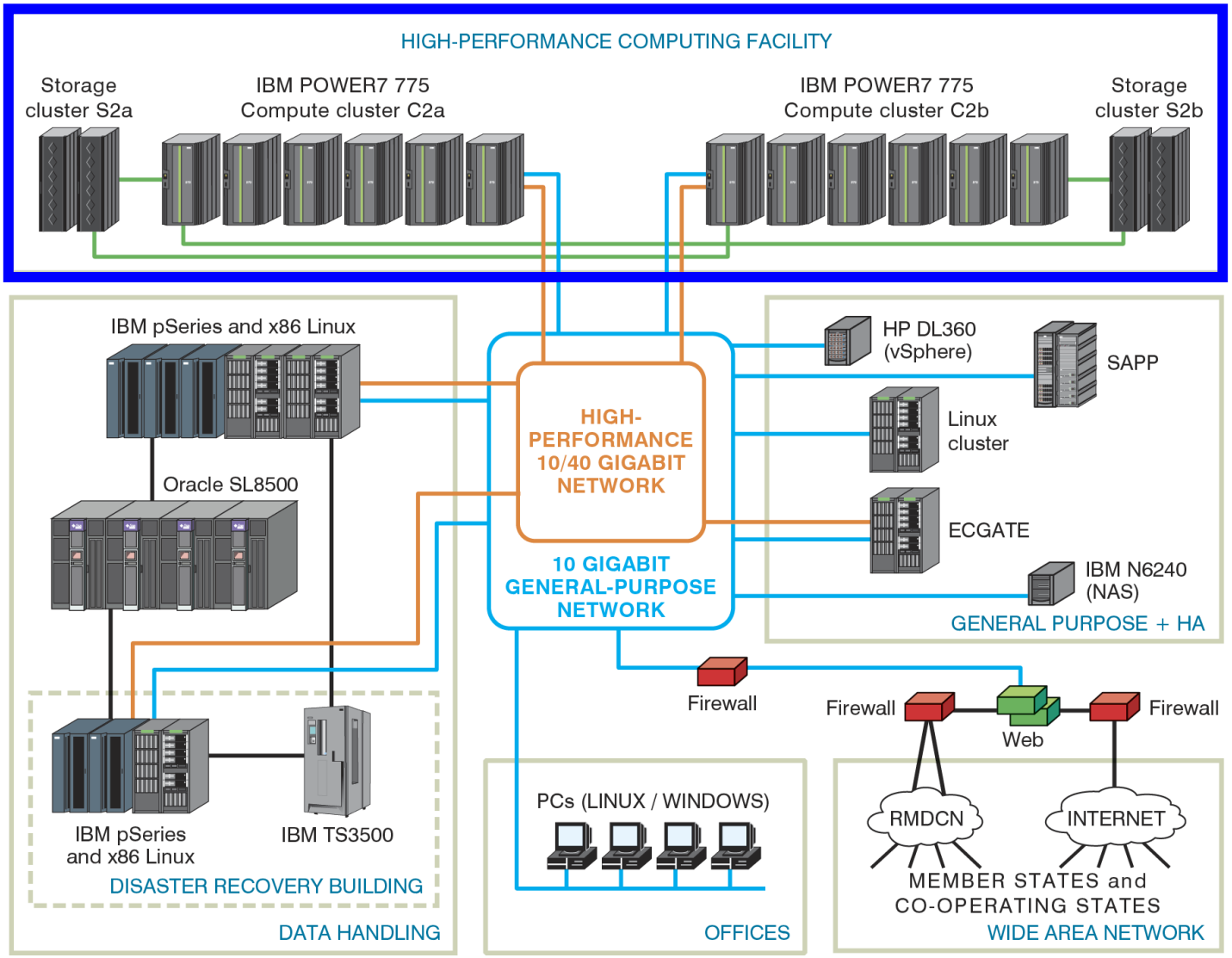
- Access to archives (MARS & ECFS)
- Batch job submission (SLURM, ECaccess tools)
- Data transfer between ECMWF and MS: ectrans, ftp, sftp
- Program development
- Visualization
- Submission and control of “time-critical” applications
  - Jobs under option 1
  - Suites under option 2
    - e.g. COSMO-LEPS,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

ecgate – software environment

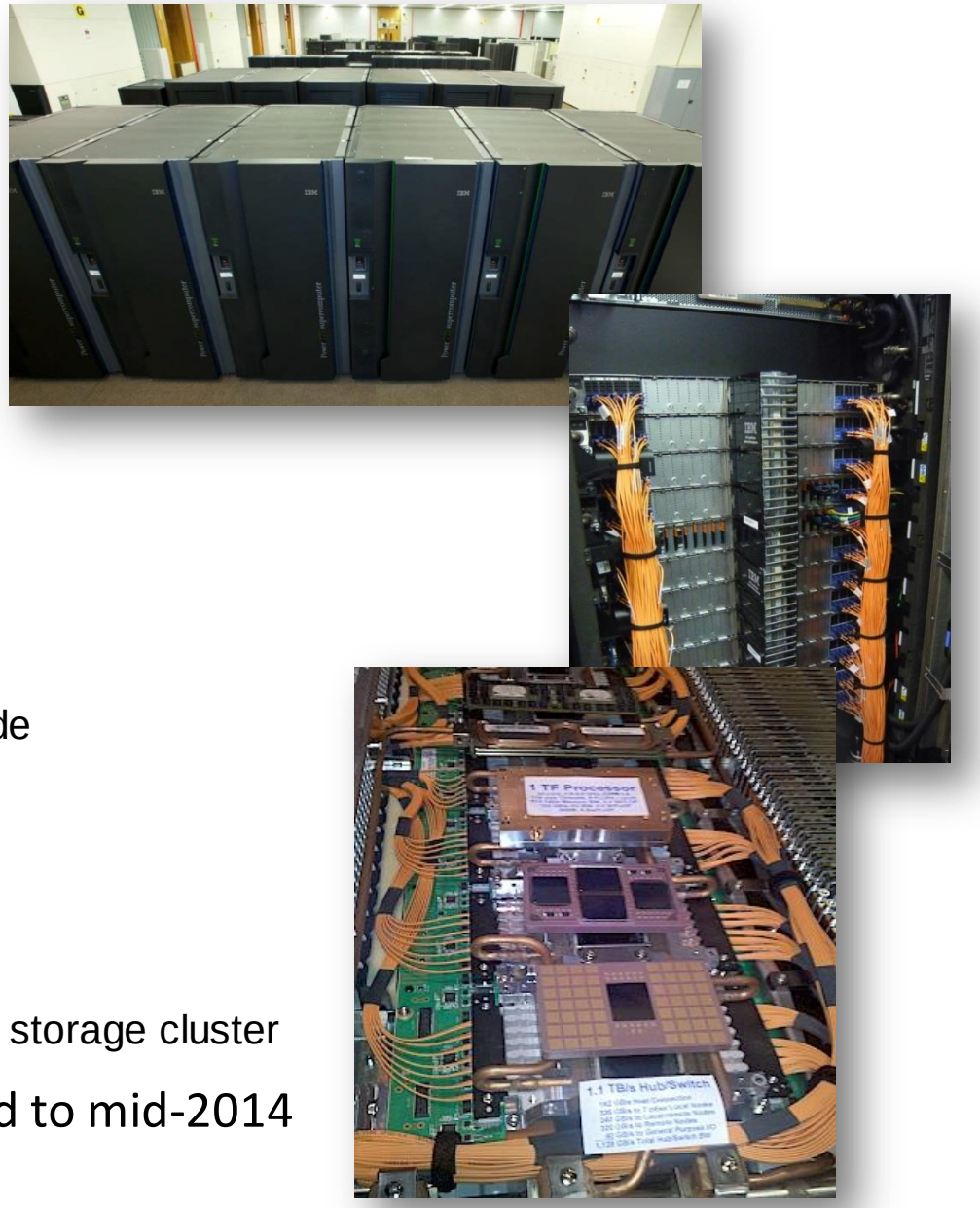
- General software and libraries: ECLIB, EMOSLIB, GRIB_API
- Numerical Libraries: NAG, GSL
- Data Formats tools and libraries: netCDF, HDF, HDF5
- Archives: MARS, ECFS
- Graphics: www.ecmwf.int/services/computing/docs/graphics/
  - ECMWF: Metview, Magics++
  - External data analysis and Visualization 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/services/computing/hpcf/



Current HPCF – IBM POWER7



- 2 identical clusters IBM Cluster 1600
  - 2 x compute cluster
  - 2 x storage cluster
  - water-cooled
  - ~1,500 Teraflops peak (in total)
- Per cluster
  - 752 p7 compute nodes
  - 32 POWER7 processors (at 3.8 GHz) per node
  - ~24,000 processor cores
  - 50 TB memory
  - proprietary HFI interconnect
  - 1.5 PB of usable disk space attached to each storage cluster
- Service contract with IBM covers the period to mid-2014

Cray XC30 HPCF

- Contract with Cray
  signed on 24 June 2013
- 2 compute clusters
  2 storage clusters
- 3x sustained performance on ECMWF codes as existing HPCF
- Performance coming from more rather than faster cores
  - ~3,500 nodes each with 2x 12-core Intel Ivy Bridge processors and 64GiB memory per node
  - ~84,000 cores per cluster
  - Ivy Bridge about 20% less sustained performance than POWER7 per core

Current *versus* New HPCF

Per Cluster	Current IBM POWER7	New CRAY XC30
Compute nodes	739	~3,500
Compute cores	23,648	~84,000
Total memory	46 TiB	~210 TiB
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
High performance storage	1.5 PB	> 3 PB
Filesystem technology	GPFS	Lustre
General purpose storage	N/A	38 TB
Filesystem technology	GPFS	NFS via NetApp

HPCF – purpose

- Running meteorological models
  - Member State models (HIRLAM, Harmonie, COSMO, UM, WRF, …)
  - ECMWF's IFS via prepIFS
- Batch job submission
  - Using LoadLeveler (IBM), PBSpro (Cray) 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!

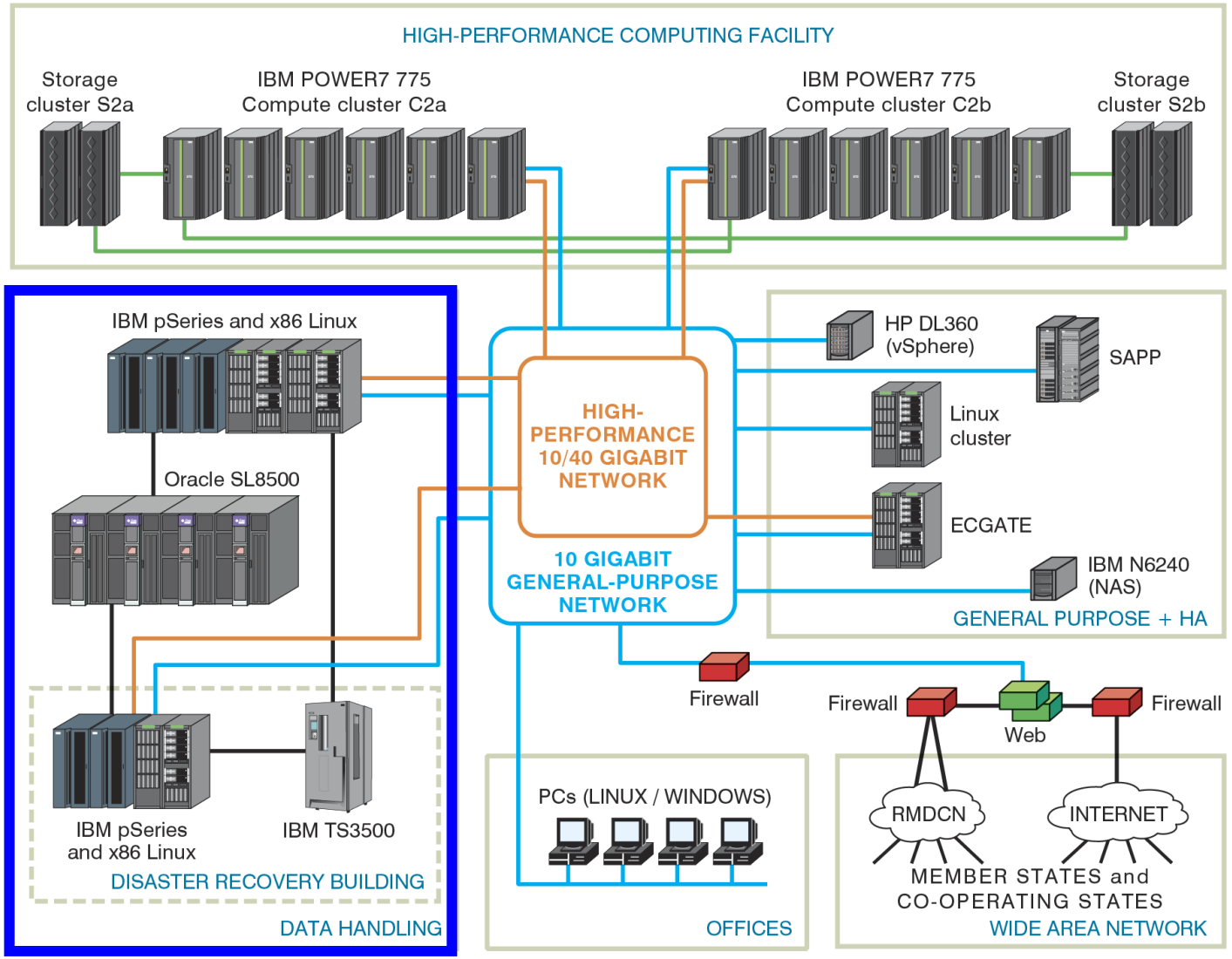
HPCF – software environment

- General software and libraries:
  - ECLIB, EMOSLIB, GRIB_API
- Archives:
  - MARS, ECFS
- Data Formats tools and libraries:
  - netCDF, NCO, HDF, HDF5
- Debugging:
  - Totalview www.ecmwf.int/publications/manuals/totalview/
- Numerical Libraries: www.ecmwf.int/services/computing/docs/libraries/
  - essl, (p)essl, MASS (IBM only)

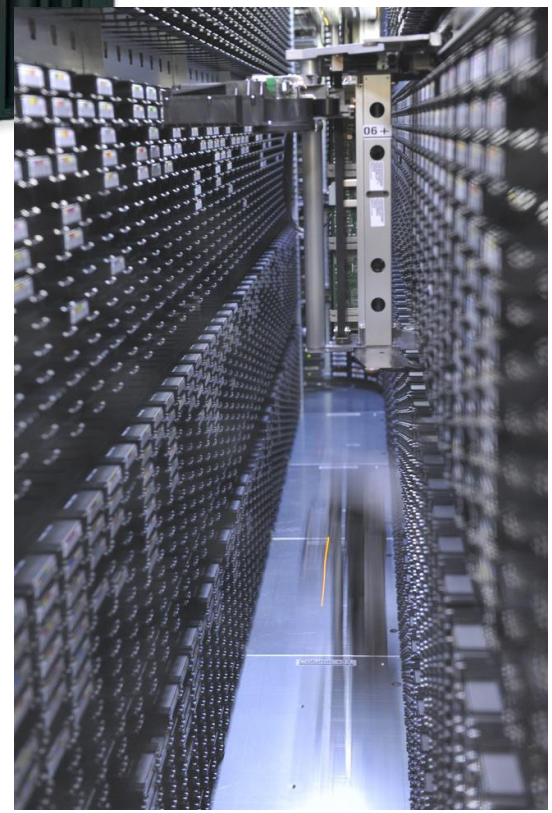
NO GRAPHICS!

Data Handling System (DHS)

Web documentation: www.ecmwf.int/services/computing/overview/datahandling.html



DHS – configuration

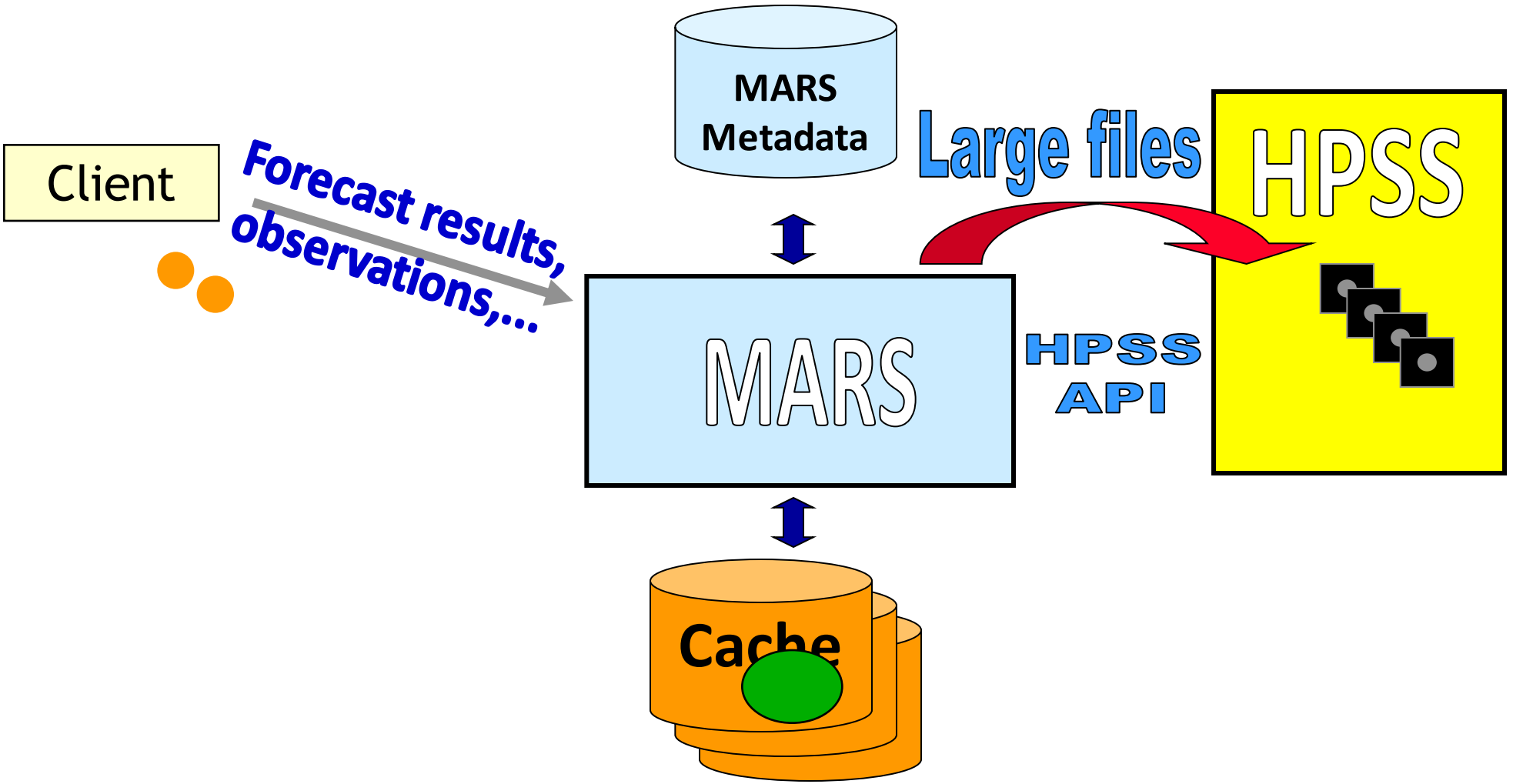


- DHS Hardware
  - Intel-based Linux servers
  - Some IBM p650/p660 servers
  - 4 Sun SL8500 automated tape libraries
- DHS Software
  - Based on HPSS (High-Performance Storage System)
- Comprises two archives
  - MARS Meteorological archive
  - ECFS User archive

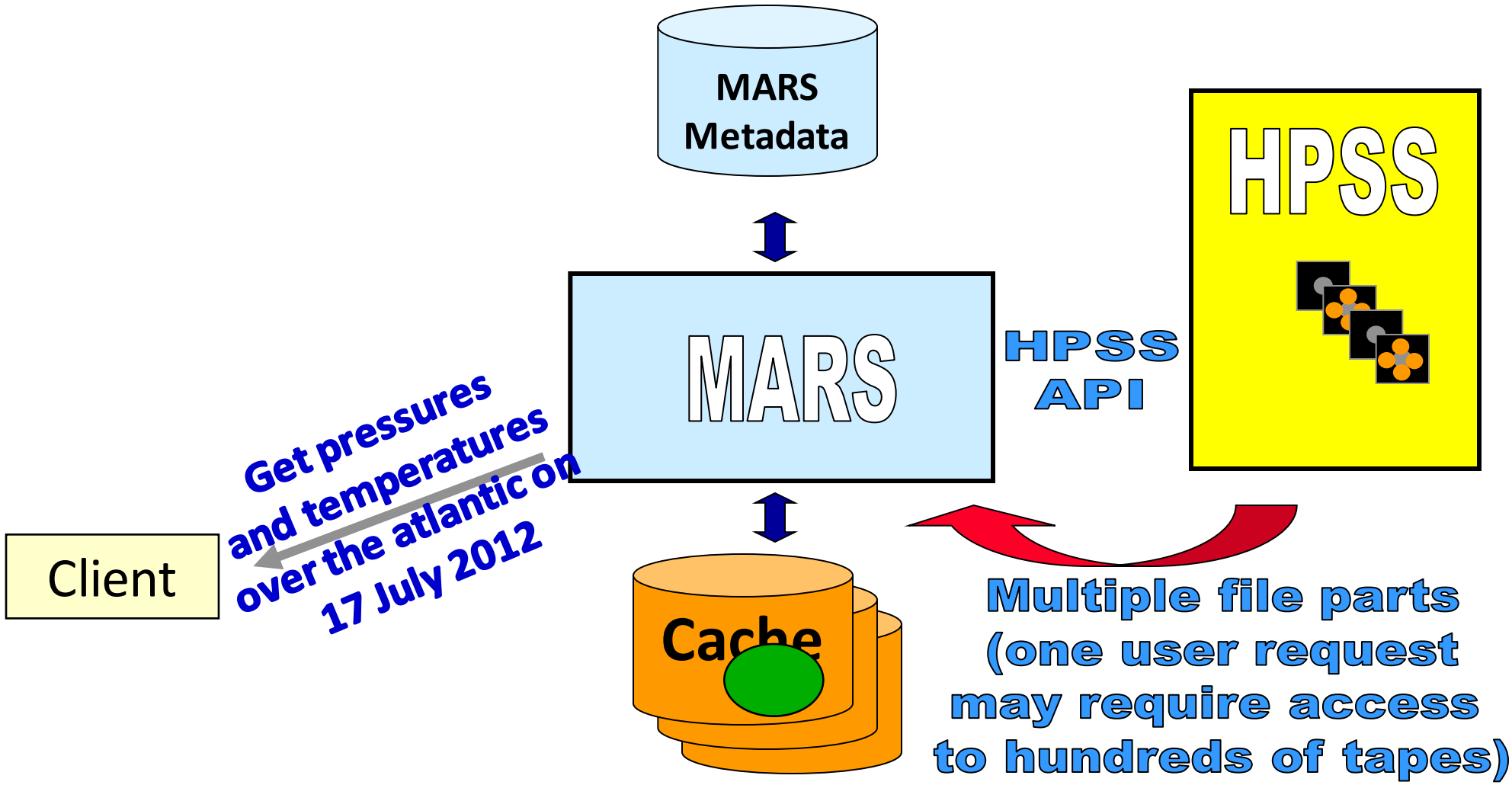
DHS Services

- 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

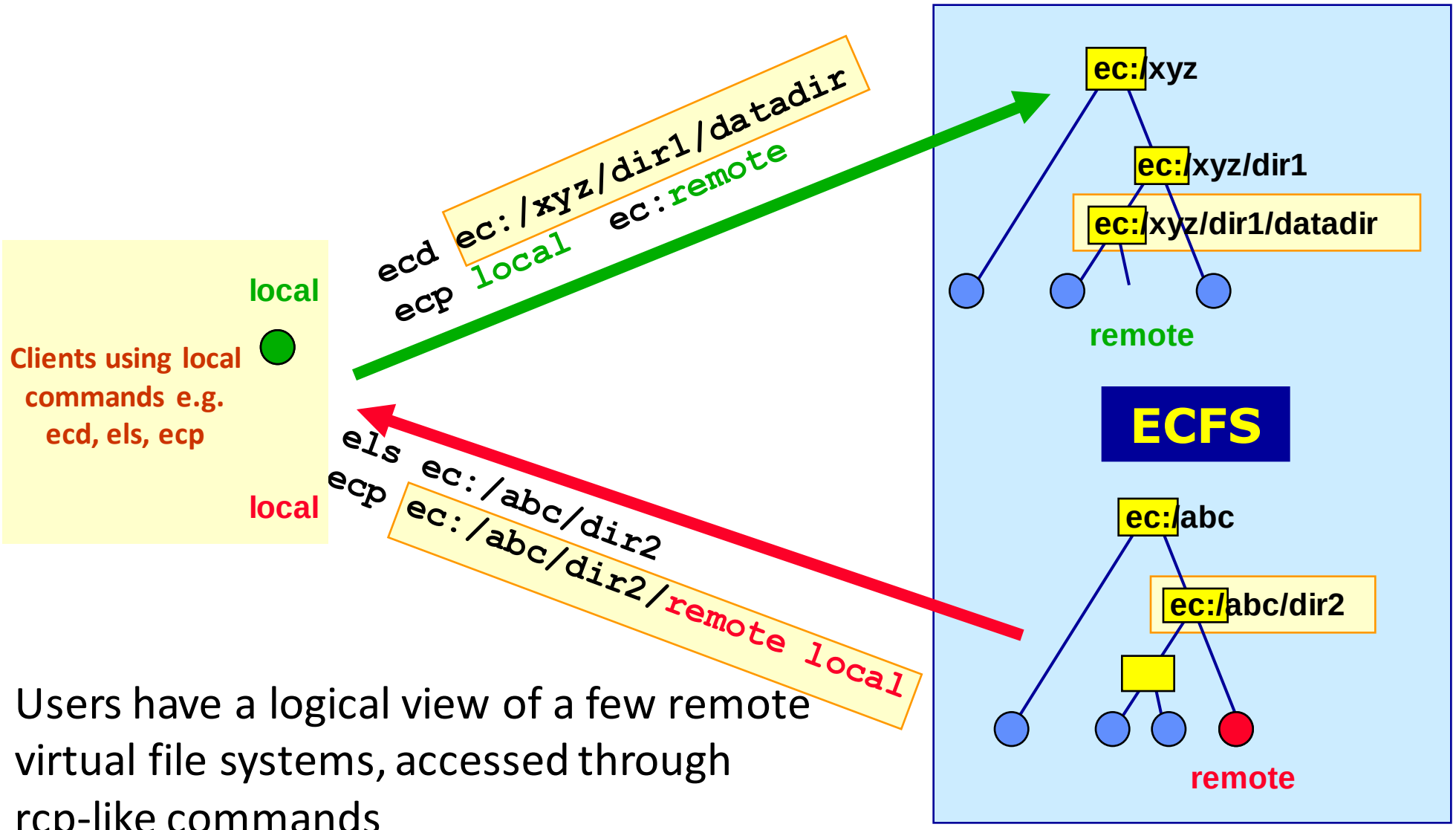
MARS archiving



MARS retrieval



ECFS – the user's view



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

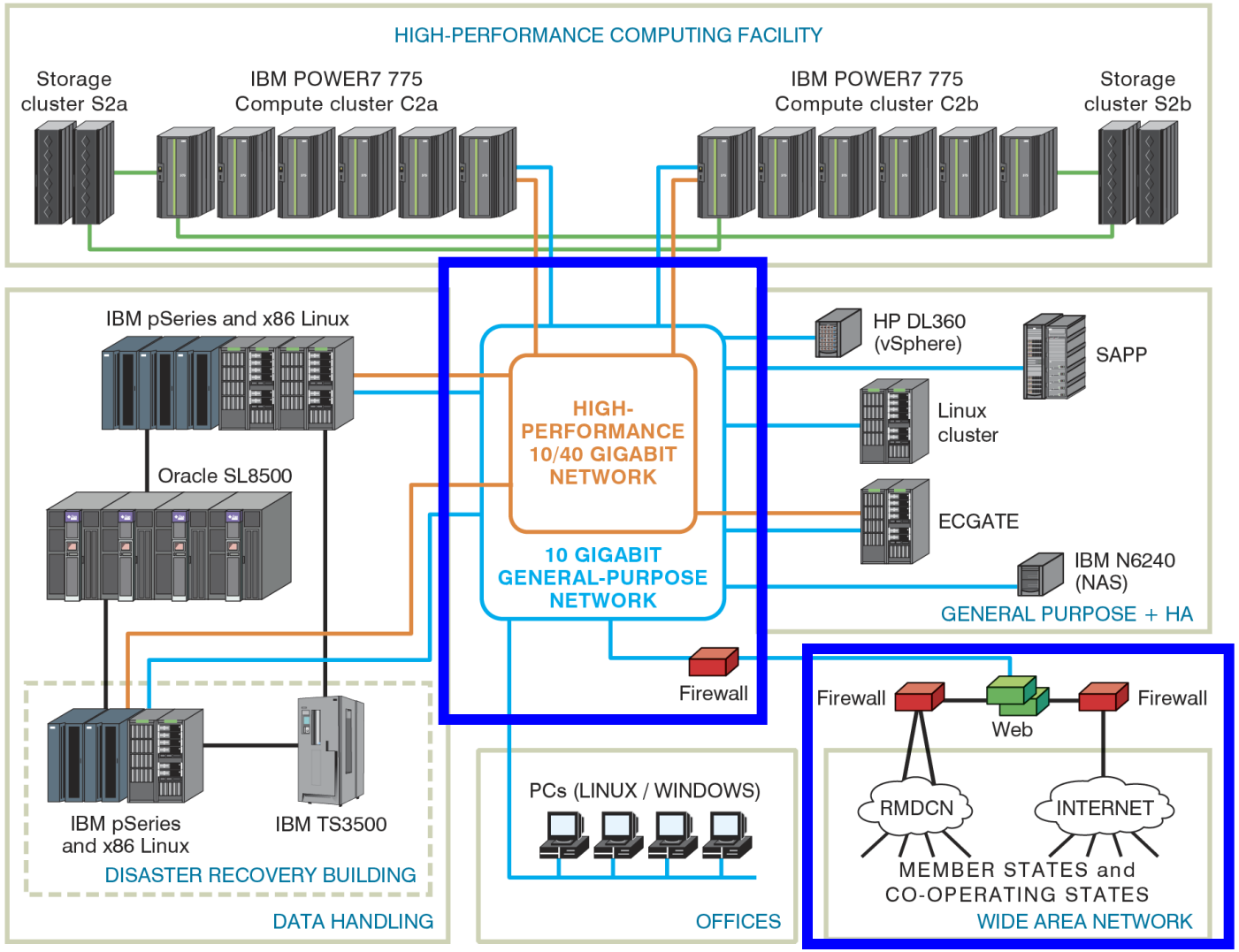
The ECMWF Archive – statistics

- The DHS provides access to over 59PB of primary data
- An additional 14.5PB of backup copies of part of the primary data are stored in the DRS
- In a typical day the archive grows by ~65TB
- ~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 12 million files)
  - ~75% of the data volume
- ECFS data:
  - ~90% of the files (over 134 million files)
  - ~25% of the data volume

Networks

www.ecmwf.int/services/computing/overview/local_area_network.html

www.ecmwf.int/services/computing/overview/wide_area_network.html

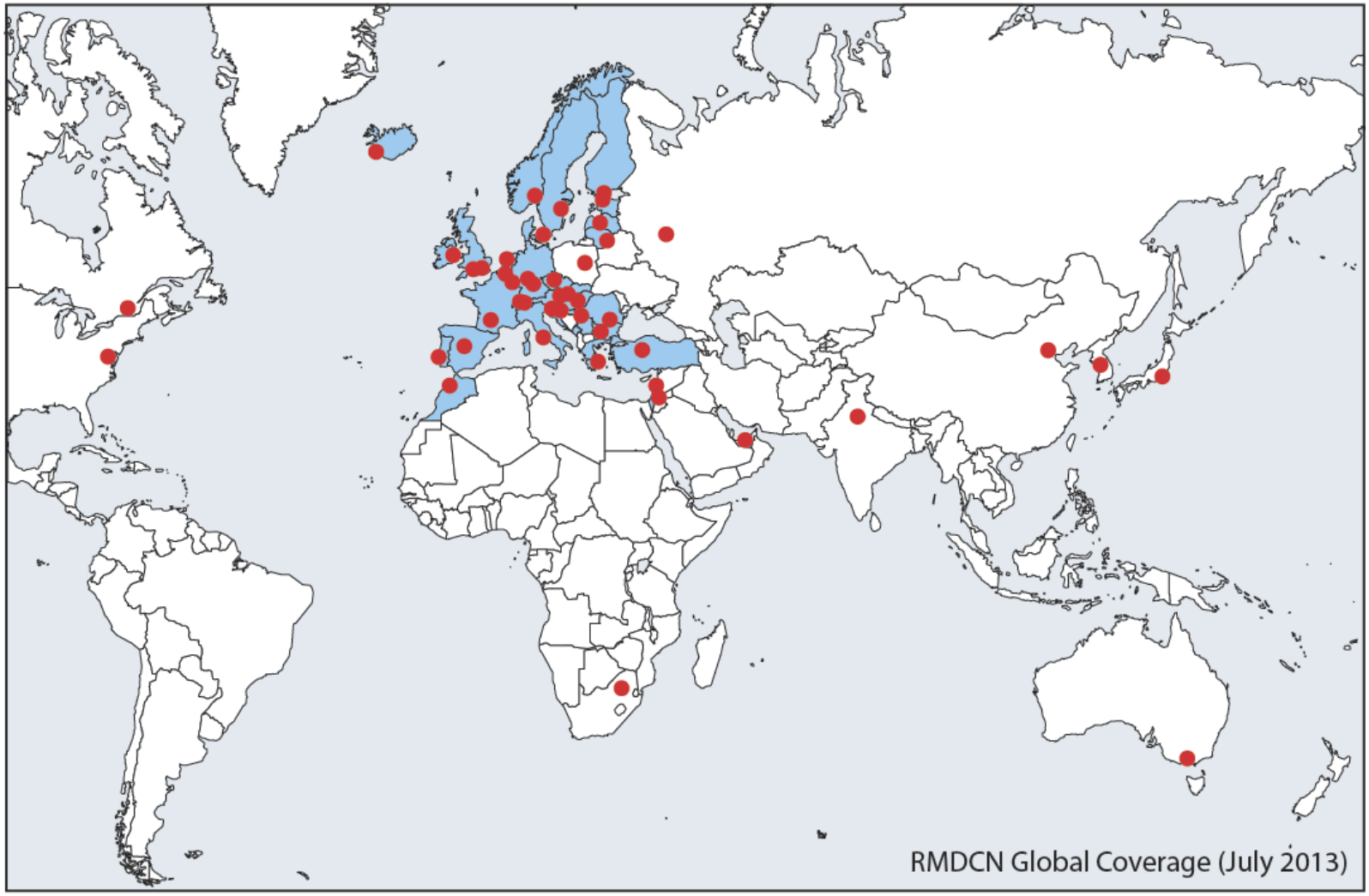


Networks

- Internal (LAN)
  - High Performance Network: 40 Gbit/s
  - General Purpose Network: 10 Gbit/s

- External (WAN)
  - Internet
    - Dual 10 Gbit/s connection to SuperJANET, the UK Education and Research Network
  - RMDCN (Regional Meteorological Data Communications Network):
    - Secured VPN provided through MPSL (Multi Protocol Label Switching)

RMDCN Connections



- 49 sites currently connected (July 2013)

Access to ECMWF resources

All interactive login access to ECMWF requires security token authentication

Interactive access via Internet link

ssh –X –l <UID> ecaccess.ecmwf.int

or with FreeNX 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

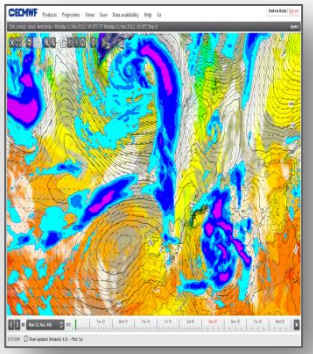
Access to the ECMWF website can happen using the same token, a password or a certificate


Web Services
www.ecmwf.int

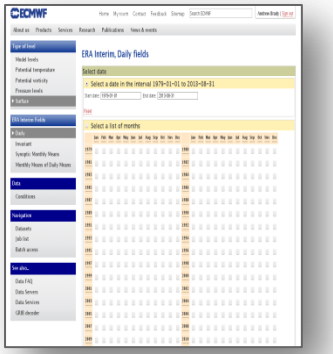
Web Services – Overview

- **Five key service areas:**

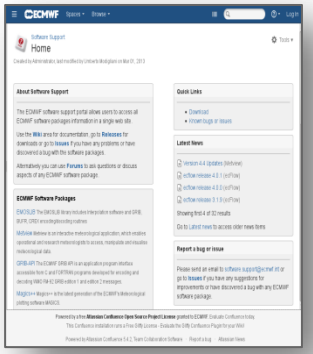
www
Everyone



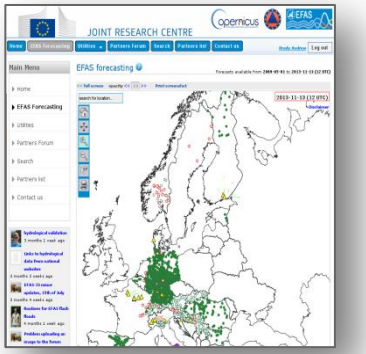
ecCharts
Forecasters



Data
Web data users



Software
Everyone

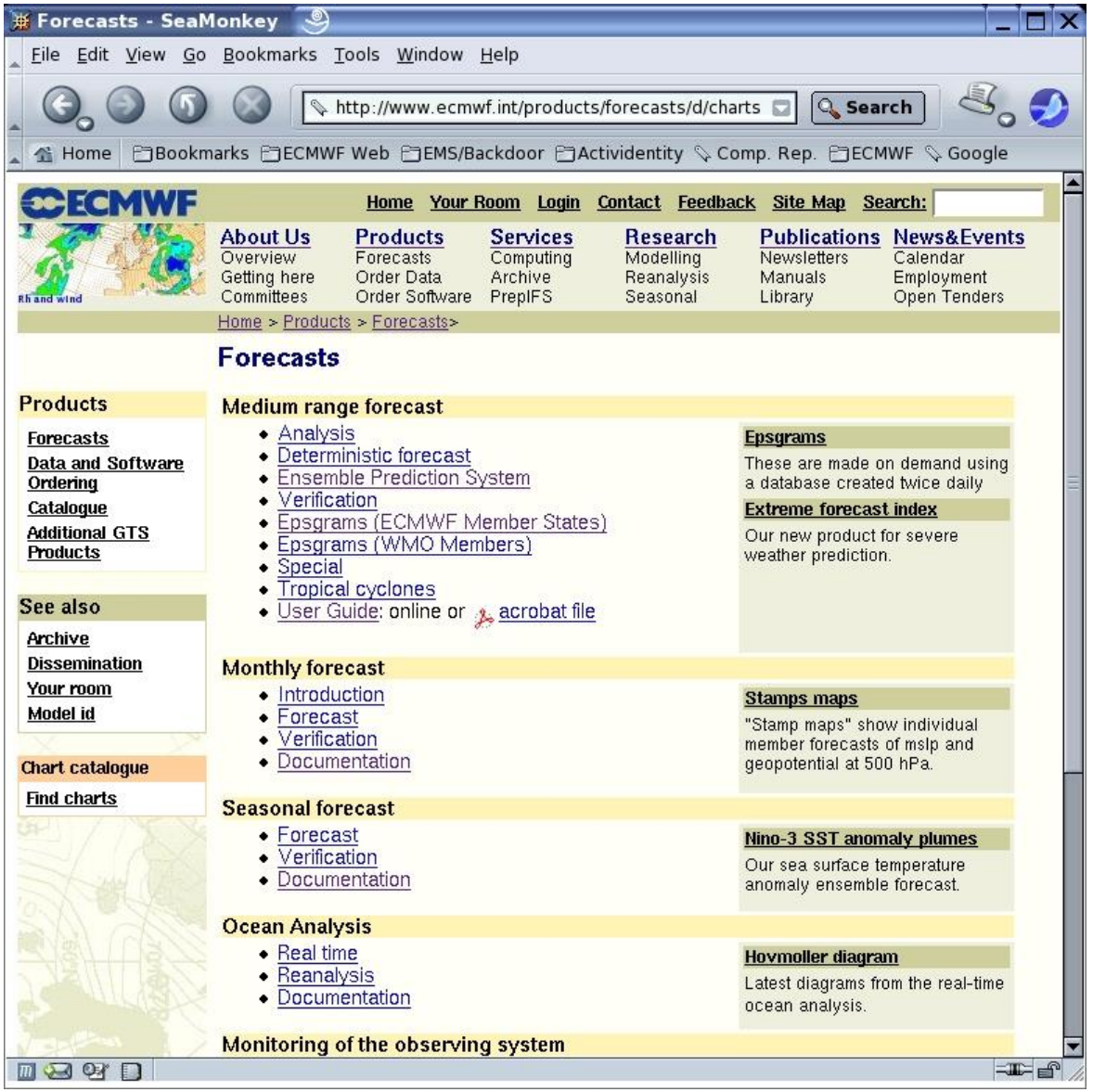


EFAS
EFAS Partners

Web Services – www.ecmwf.int/products/forecasts

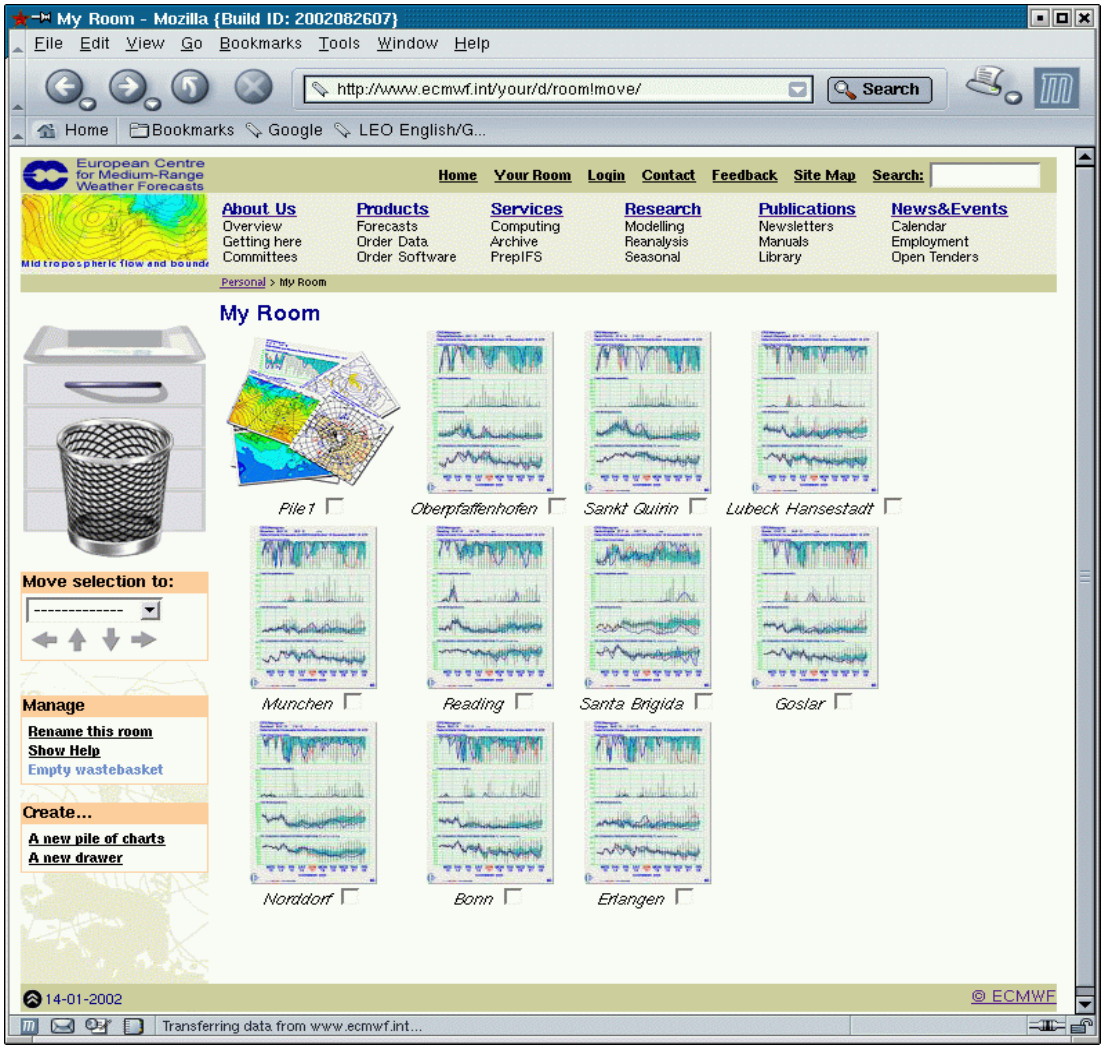
This page will look different depending on the user who is viewing it and possibly WHERE from.

The page is currently being viewed by an *NMS domain user*.



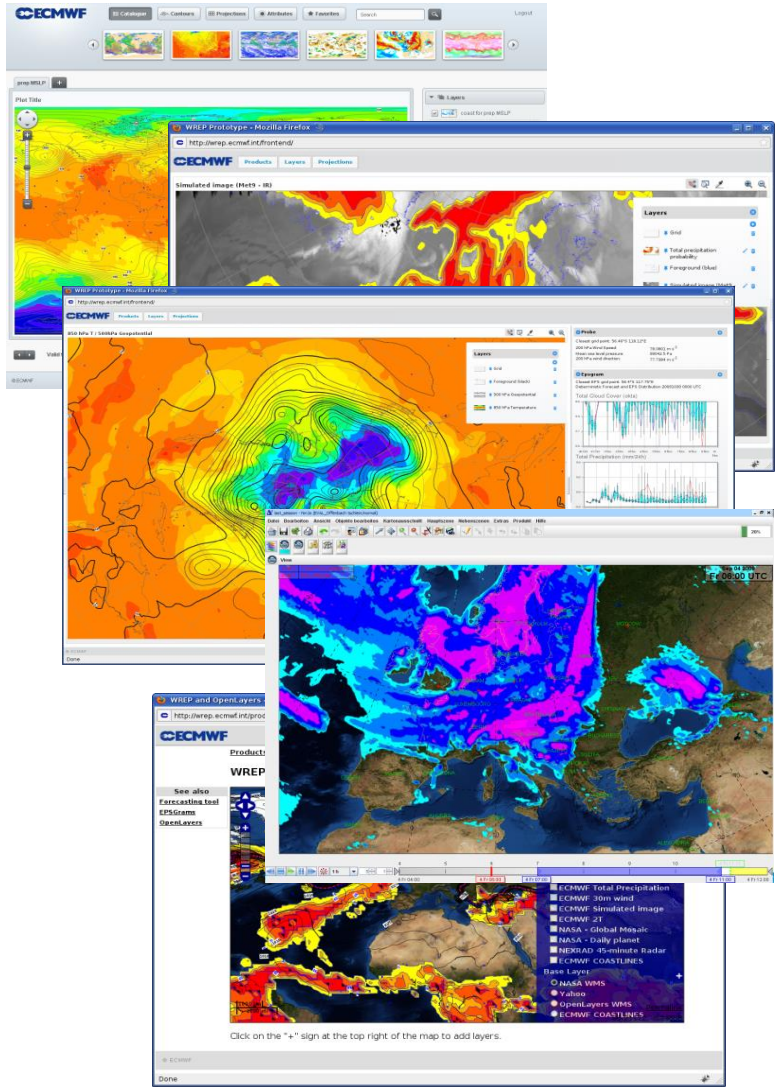
Web Services – My Room

"My Room" is not available to unregistered users e.g.:
- External users
- Anonymous domain users (started web browser from NMS but did not identify themselves)



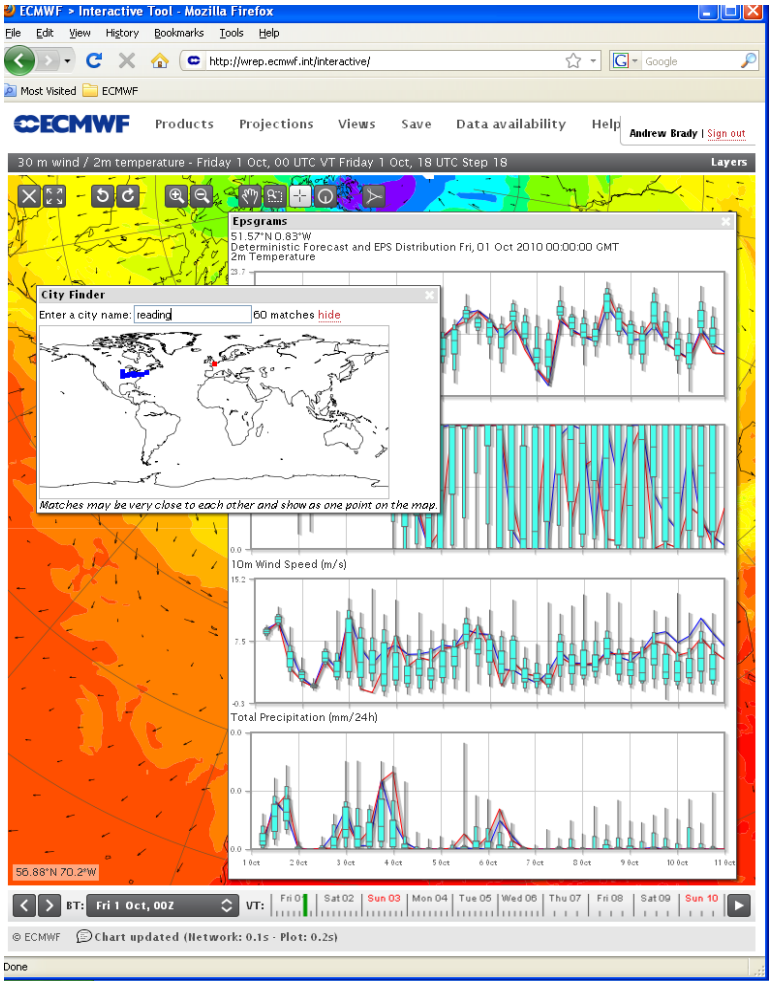
Web services – ecCharts

- 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

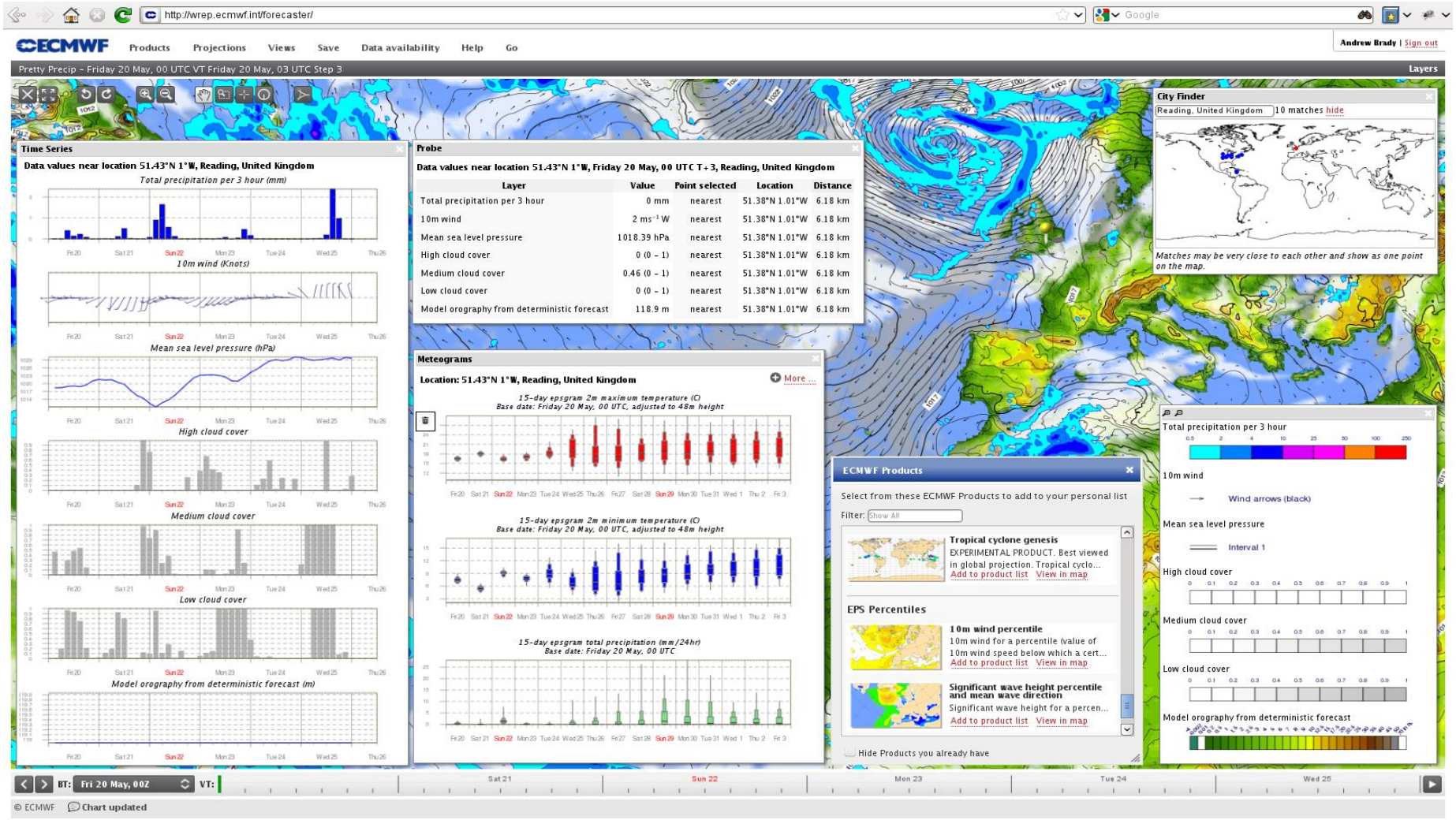


ecCharts – overview

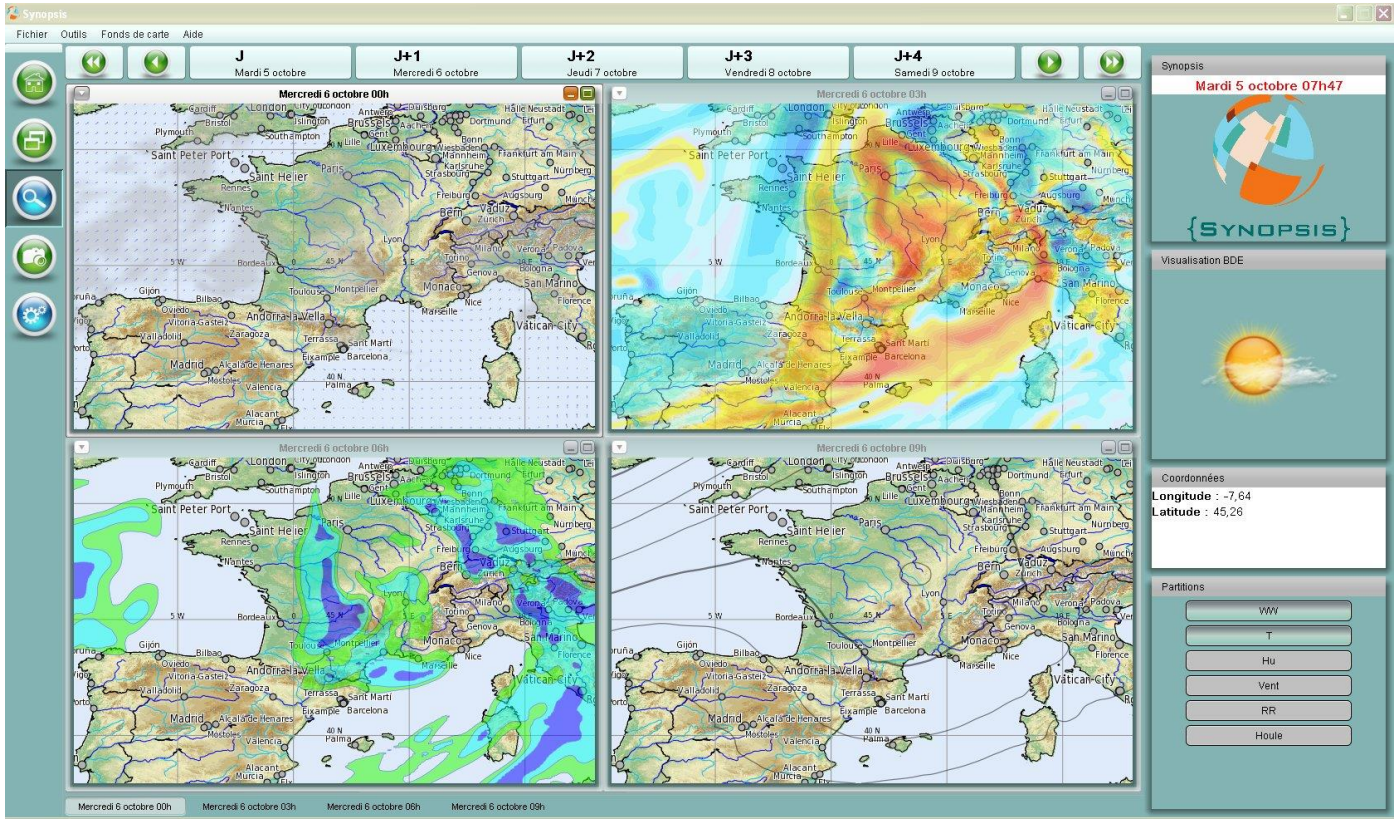
- Features:
  - Interactivity (zoom-pan)
  - Layer customisation (e.g. thresholds)
  - Charts with bespoke layers
  - Optional styles for layers
  - Animation of charts
  - HRES, ENS, WAM products
  - Standard and bespoke EPSgrams
  - Extreme Forecast Indices (EFI)
  - Point probing to explore data
- Use of agreed dissemination schedule
- OGC WMS standards for machine-to-machine access



ecCharts/forecaster

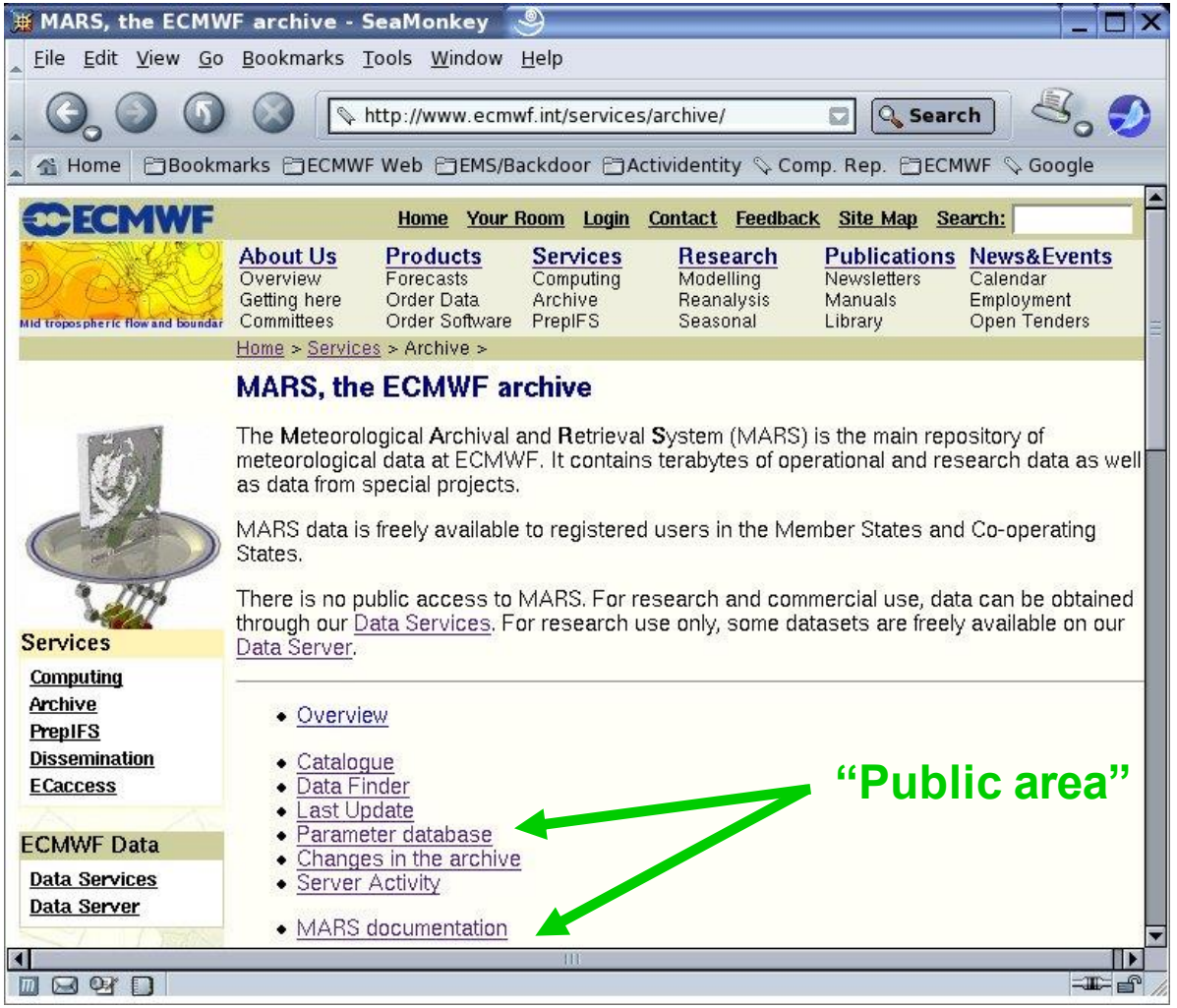


ecCharts – OGC Web Map Service (WMS) Charts : from ecCharts to Synopsis



- 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 – webMARS www.ecmwf.int/services/archive/

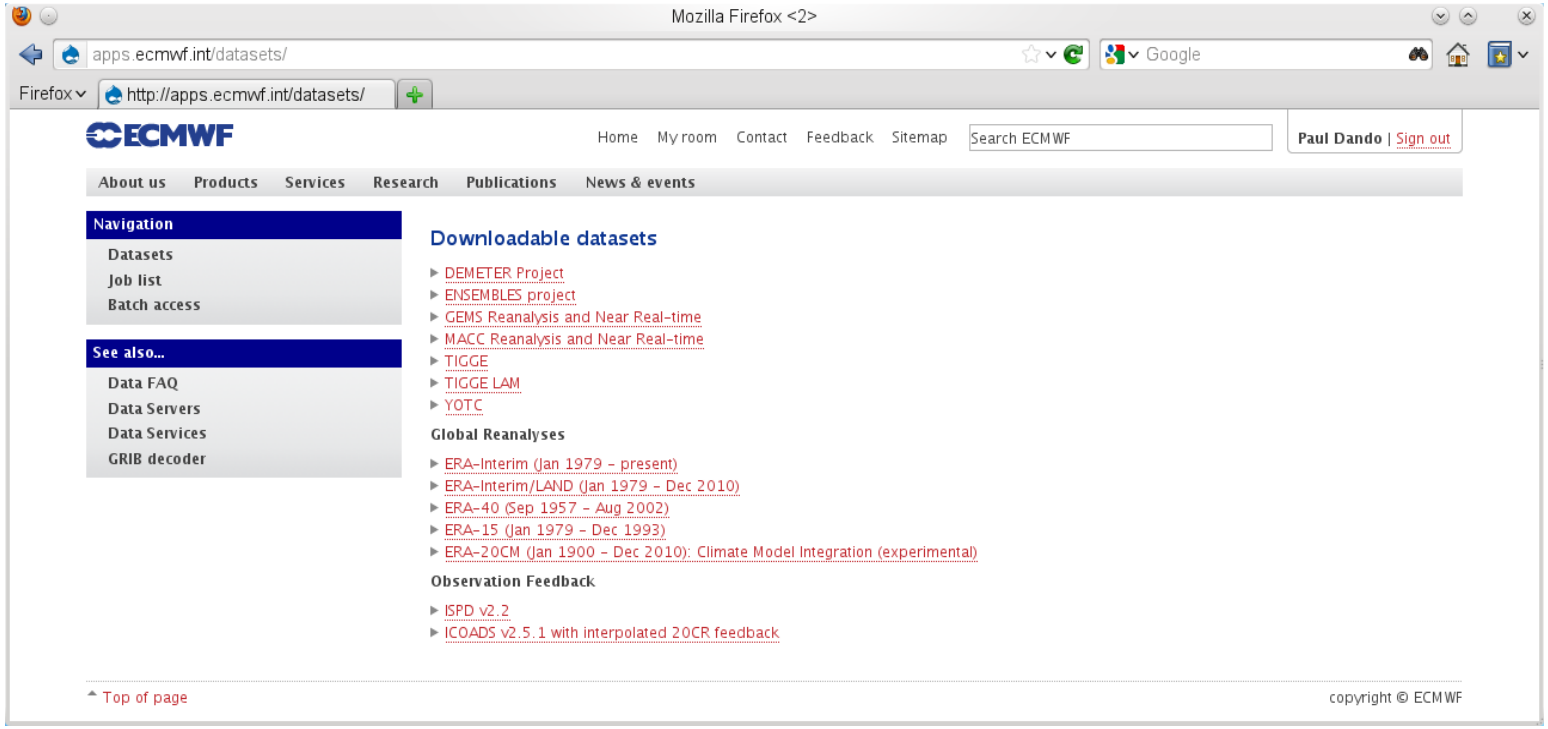


- Web based interface to MARS
- Content browsing via "views" (not available to the public)
  - Overview, Catalogue, Data Finder, Last Update, Parameter database, Archive history/changes, etc.
- Retrievals (GRIB and netCDF), available to registered users
- Plots (limited functionality)
- Monitoring of activity
- Documentation

- New interface has been developed and is undergoing beta testing

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

- A standalone system outside the firewall
- Public (non-commercial) distribution of data
  - Self-registration
- Batch access possible with Python, Perl, Java
- GRIB or netCDF



TIGGE Data Portal – http://tigge.ecmwf.int

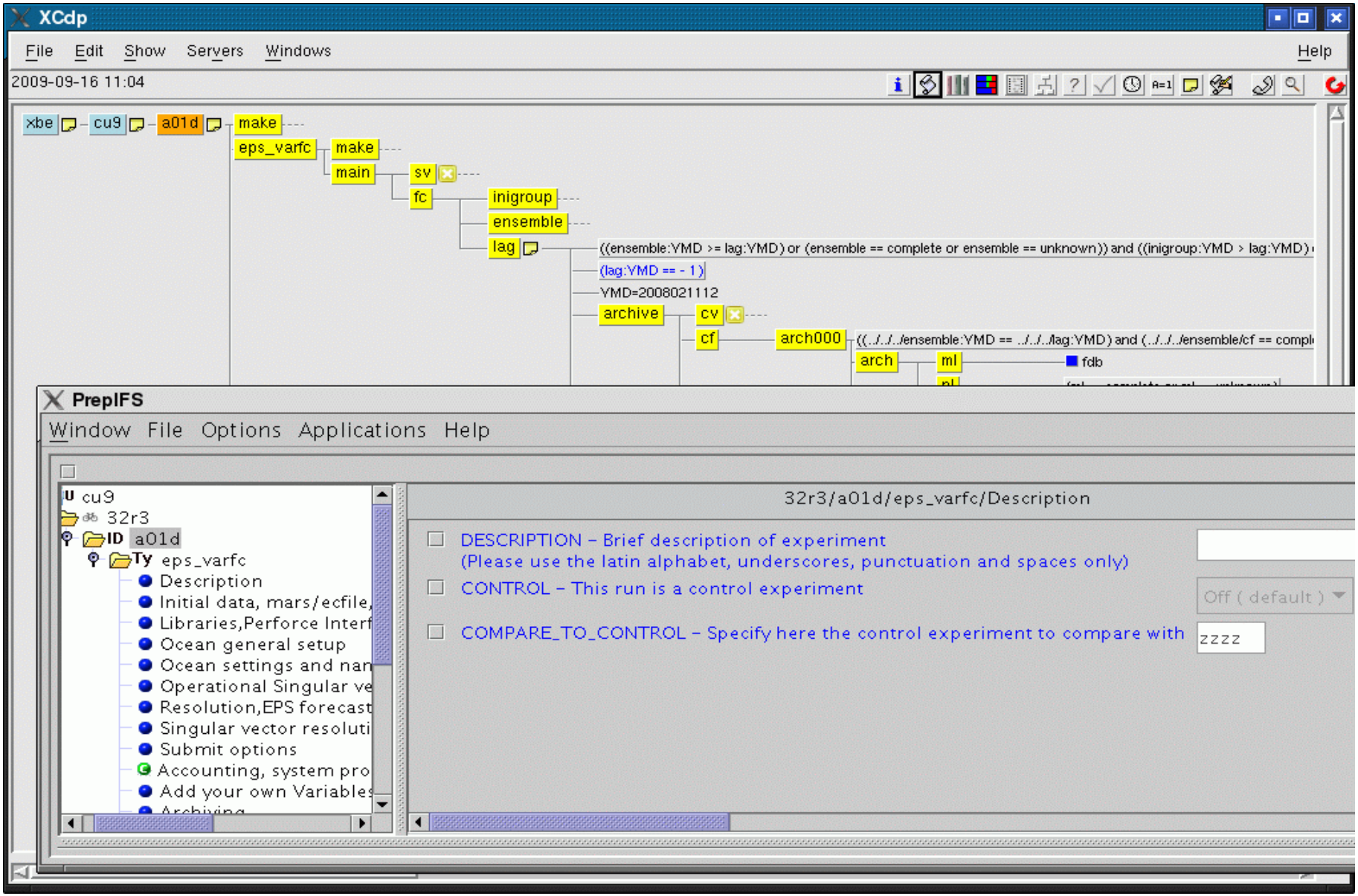
- THORPEX Interactive Grand Global Ensemble

- Global ensemble forecasts to around 14 days generated routinely at different centres around the world
  - Already sending data routinely: 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

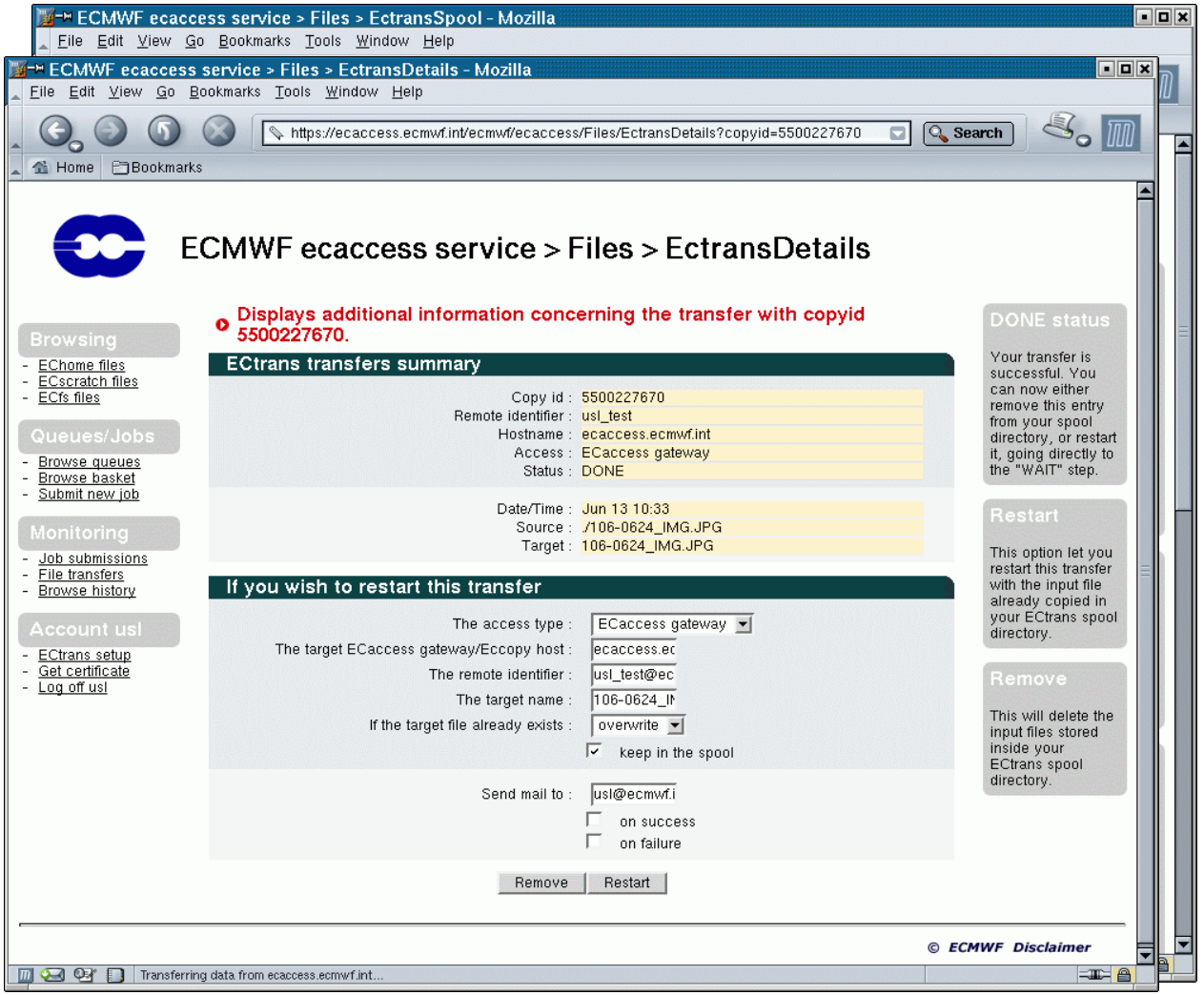
- Data portal based on webMARS
- Data archived in GRIB edition 2 format

Web Services – prepIFS



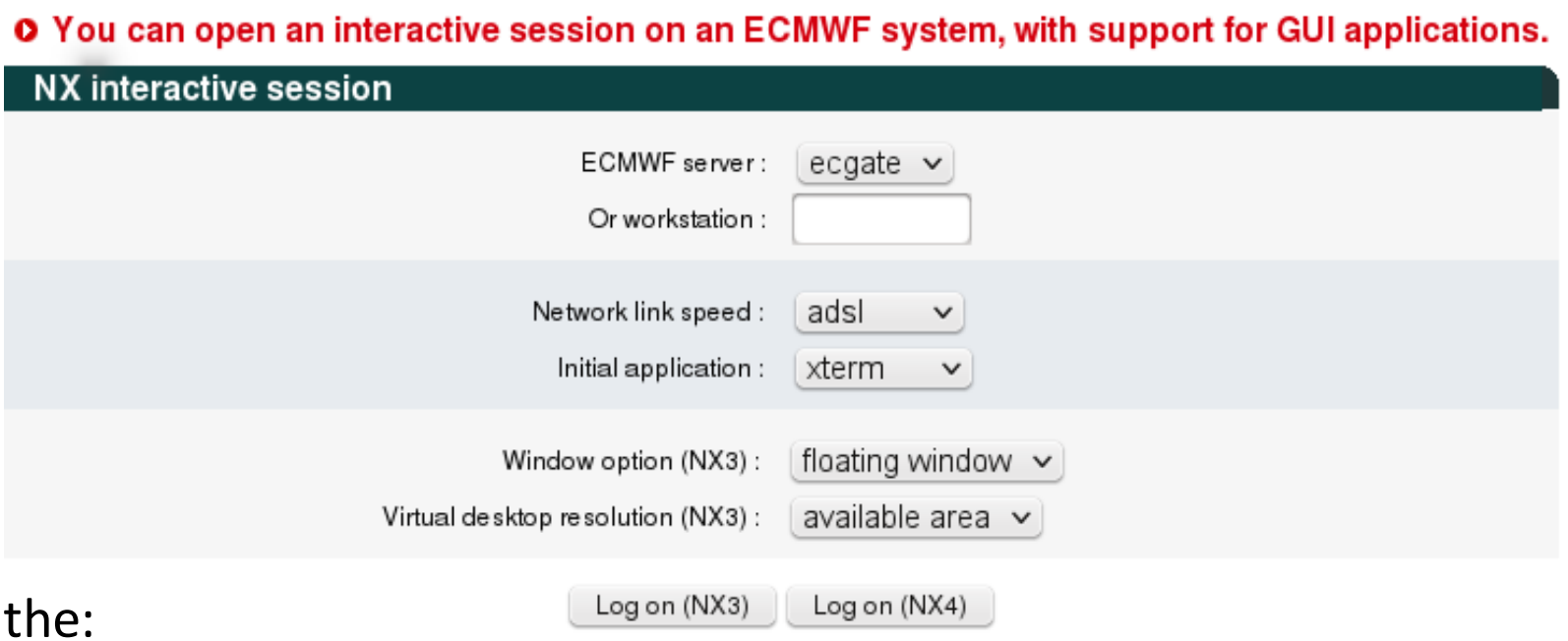
Web Services – http://ecaccess.ecmwf.int

- 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 / c2a)
  - Internet connection speed
  - Type of window (“virtual desktop” or “floating window”)
  - Application
  - Virtual desktop resolution

Login requires a token

Web Services – documents and documentation

- Official documents (restricted access)
  www.ecmwf.int/about/committees/

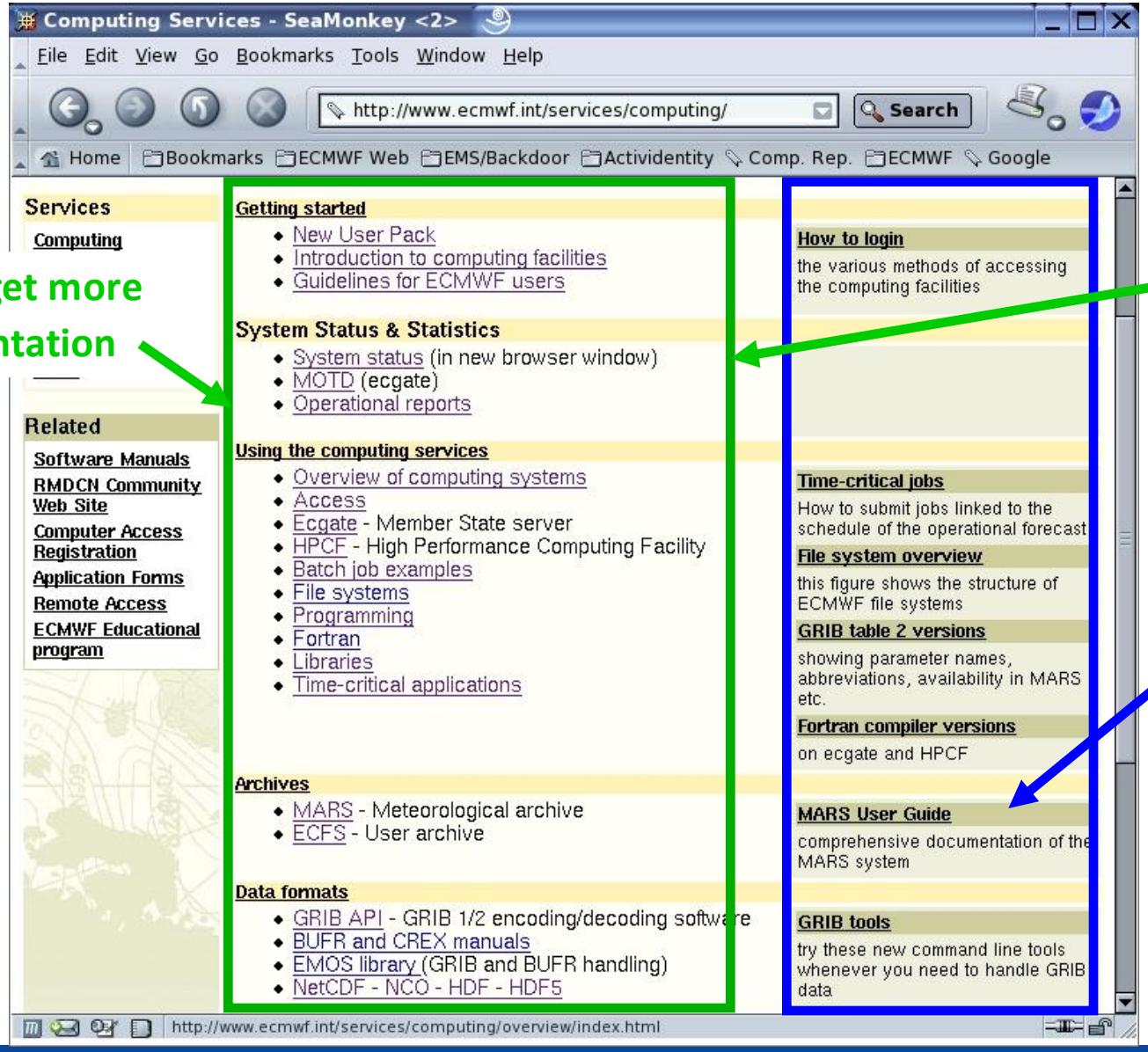
- ECMWF publications
  www.ecmwf.int/publications

- Research at ECMWF
  www.ecmwf.int/research

- Computing Services
  www.ecmwf.int/services/computing

- And much more …

Web Documentation – www.ecmwf.int/services/computing

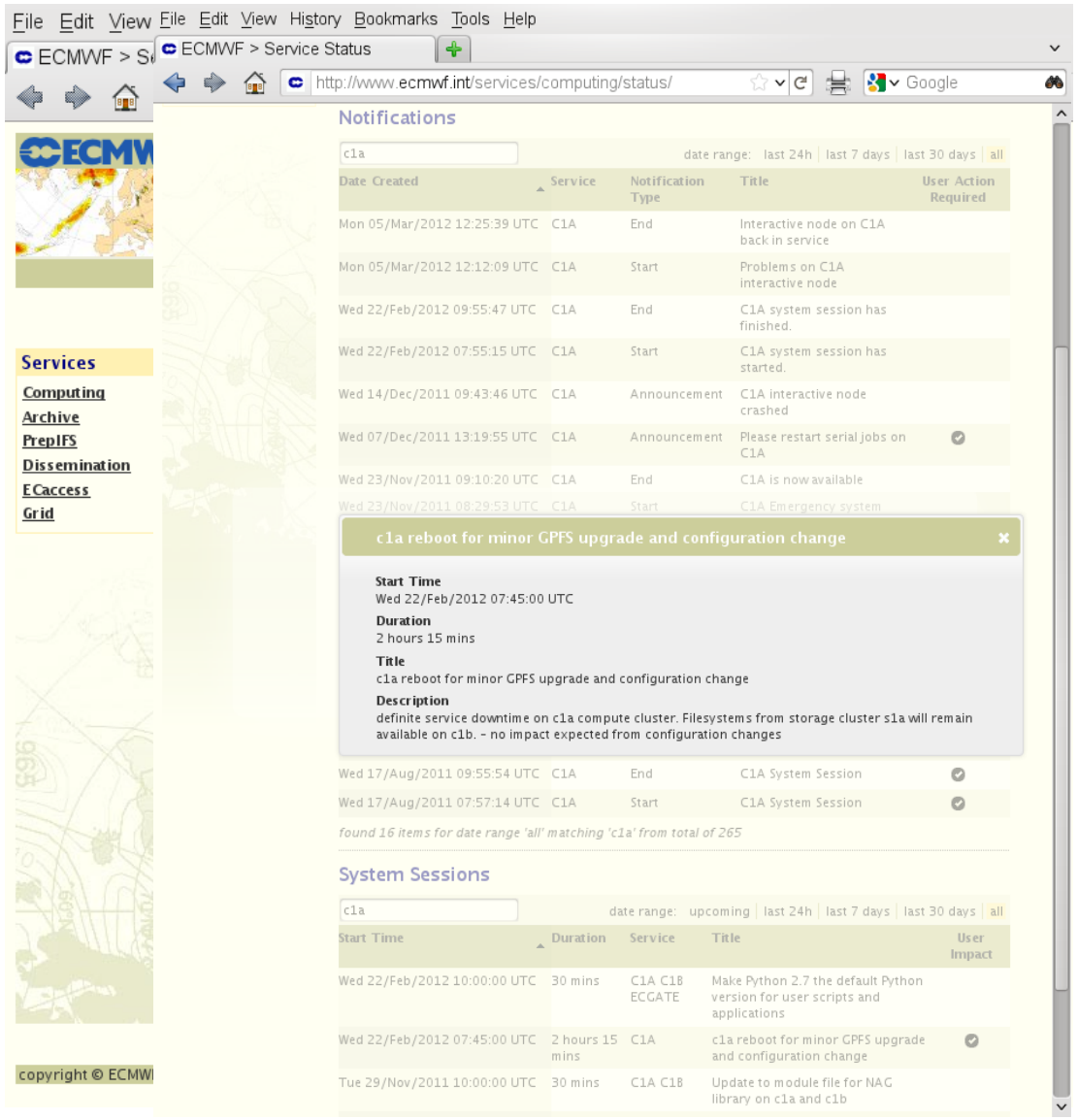


Click to get more documentation

Main list of computing services

Shortcuts to highlight important and useful documents

Service status: www.ecmwf.int/services/computing/status/



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

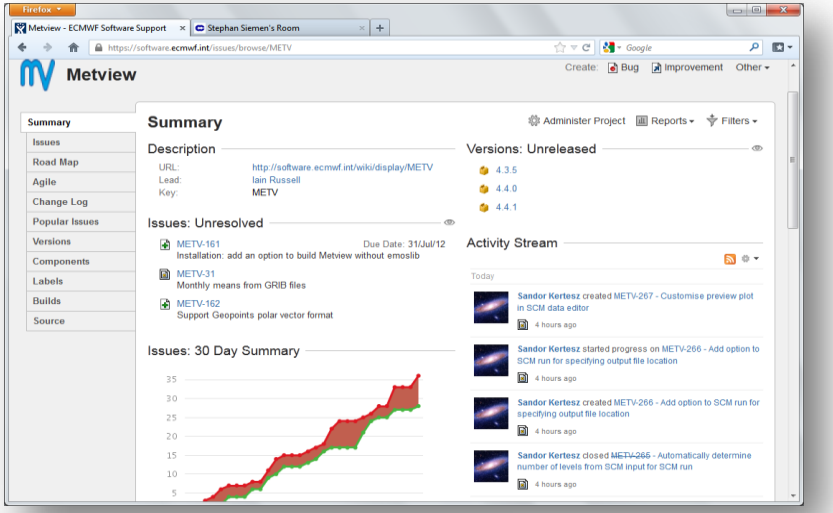
Software Support

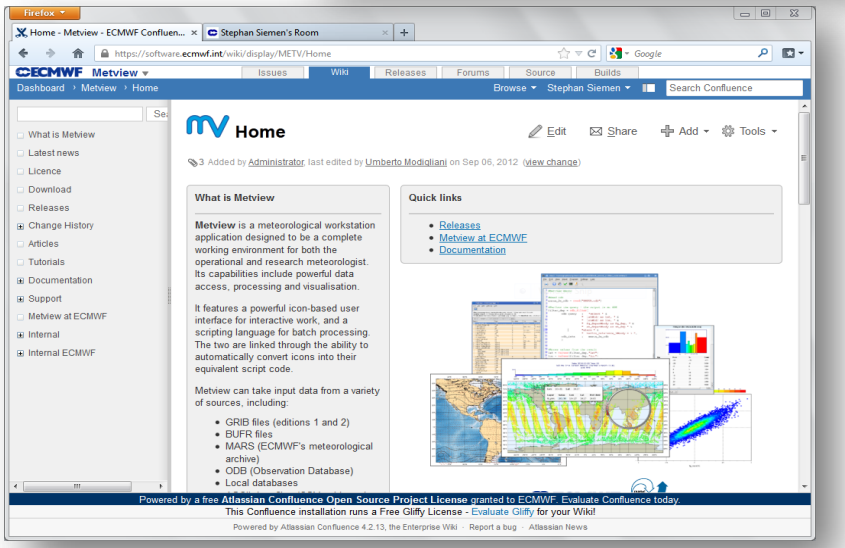
- Available at

  http://software.ecmwf.int/

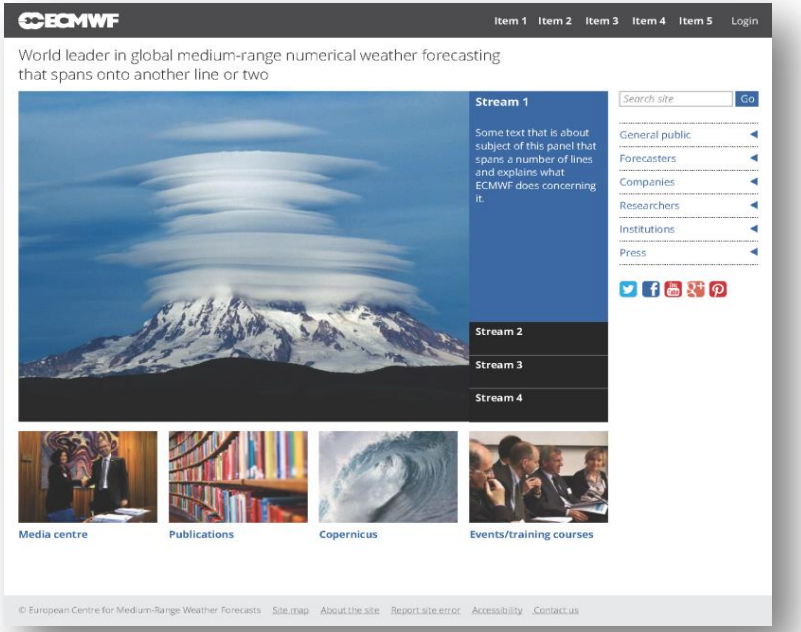
- Aim is to improve support for external users
  - Keep track of issues in a central place
  - Spread knowledge throughout the Centre

- Based on Atlassian Suite
  - JIRA (issues)
  - Confluence (documentation wiki)
  - Bamboo (Builds)





Web2013 – ECMWF's new website



Release dates
(to be confirmed)

1 Feb 2014	Public beta
1 Apr 2014	Official release

Key changes

New web content management system

New design and content organization

New web search

New charts functionality

Revised and updated content

Release strategy

Start with minimum viable release

Progressively migrate areas after release

Maintain old content for one year

User impact

Bookmarks, references to URLs not redirected

curl, wget service to be replaced

Enhanced "your room" service (but not migrated)

ECMWF Help & Support – who to contact?

Reason to contact	Who	Availability	How
Urgent 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	Data & Services	8h/5d	Email: data.services@ecmwf.int
Requests for software	Data & Services	8h/5d	Email: software.services@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?