ECMWF operational activities and recent developments

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With input from many colleagues

ECMWF

Outline of Presentation

- Amendment of the Convention
- Changes and upgrades in the operational forecast system
- Deterministic and EPS performance
- Monthly/seasonal forecast system
- Products and dissemination
- Computing aspects
- Planned developments

A new Convention for ECMWF

- Amendments to the ECMWF Convention were unanimously adopted by Council at its 62nd extraordinary session on 22 April 2005
- Process of acceptance of the amendments by Member States started immediately after: the procedure varies from one country to the other, but most will need Parliament ratification
- First acceptance was received in July (Finland)
- Finalization of the process is expected by end 2006 at the earliest

Changes to the Convention

- The adopted amendments concern mainly:
  - Allowing new Member States
  - Enlarging ECMWF's mission to environmental monitoring
  - Redefining some decision processes (voting rights)
  - Widening the possibility for externally funded activities (e.g. by the European Union)
  - Extending official languages to all the official languages of the Member States, on a request-and-pay basis
- The amended Convention is available on ECMWF's website

Changes to the forecasting system 2004 – 2005

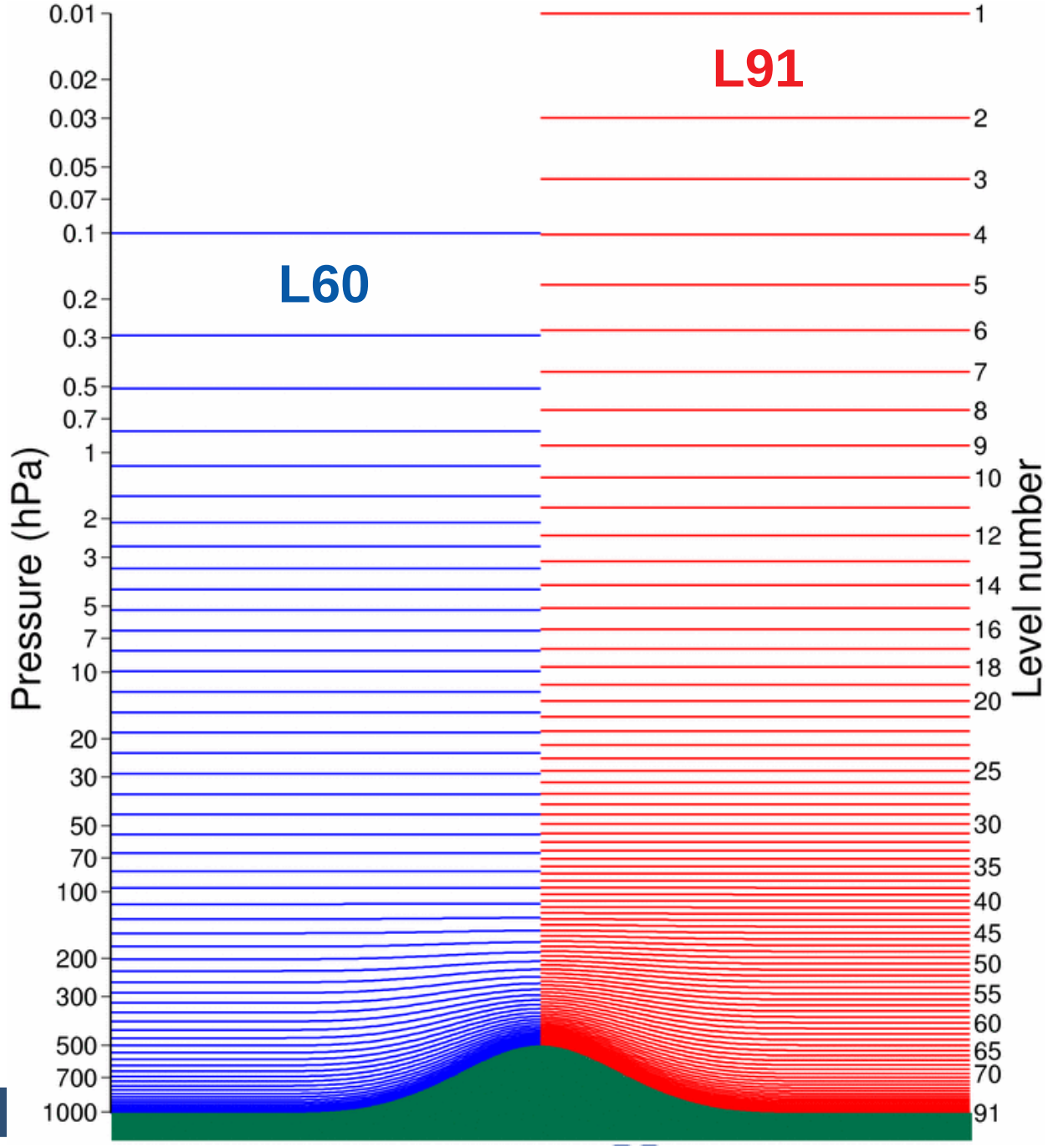
History can be found on web

29 Jun 2004	Cy28r2	Early delivery system
28 Sep 2004	Cy28r3	Wide range of changes affecting physics, use of satellite data, EPS
7 Oct 2004		Monthly forecasts run operationally
10 Oct 2004		Harmonized bias corrections for AMSU and HIRS radiances
9 Nov 2004		All BC analyses use background fields from the latest 4D-Var
5 Apr 2005	Cy29r1	New moist boundary layer scheme, wavelet Jb, adaptive bias correction
28 Jun 2005	Cy29r2	Wide range of changes including rain-affected SSM/I radiances
1 Feb 2006	Cy30r1	High resolution forecasting system

1 February 2006 – IFS cycle 30r1

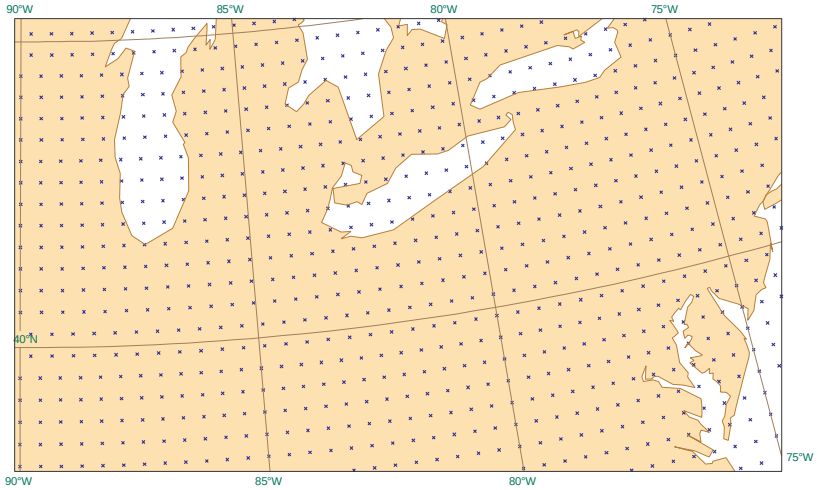
- T_L799 horizontal resolution for deterministic forecast
- 4D-Var increments at T_L255 (30min time step)
- 91-level vertical resolution
- Changes to the wave model
  - Grid spacing reduced from 0.5° to 0.36°
  - Use of Jason altimeter wave height data and ENVISAT ASAR spectra in the wave model assimilation
- T_L399 L62 resolution for EPS
  - Wave model grid unchanged at 1° , but number of frequencies increased from 25 to 30, and number of directions changed from 12 to 24

Increased vertical resolution



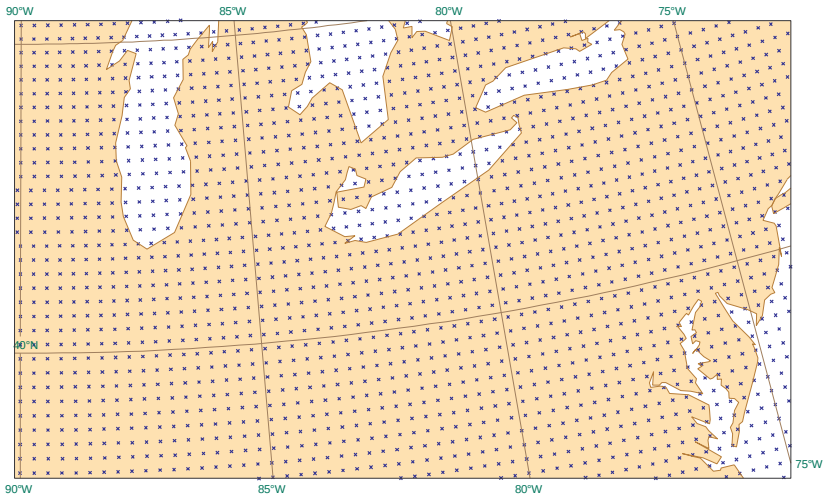
Distribution of grid points over North America

T_L511



Total # of points in T_L511 grid: 348,528

T_L799

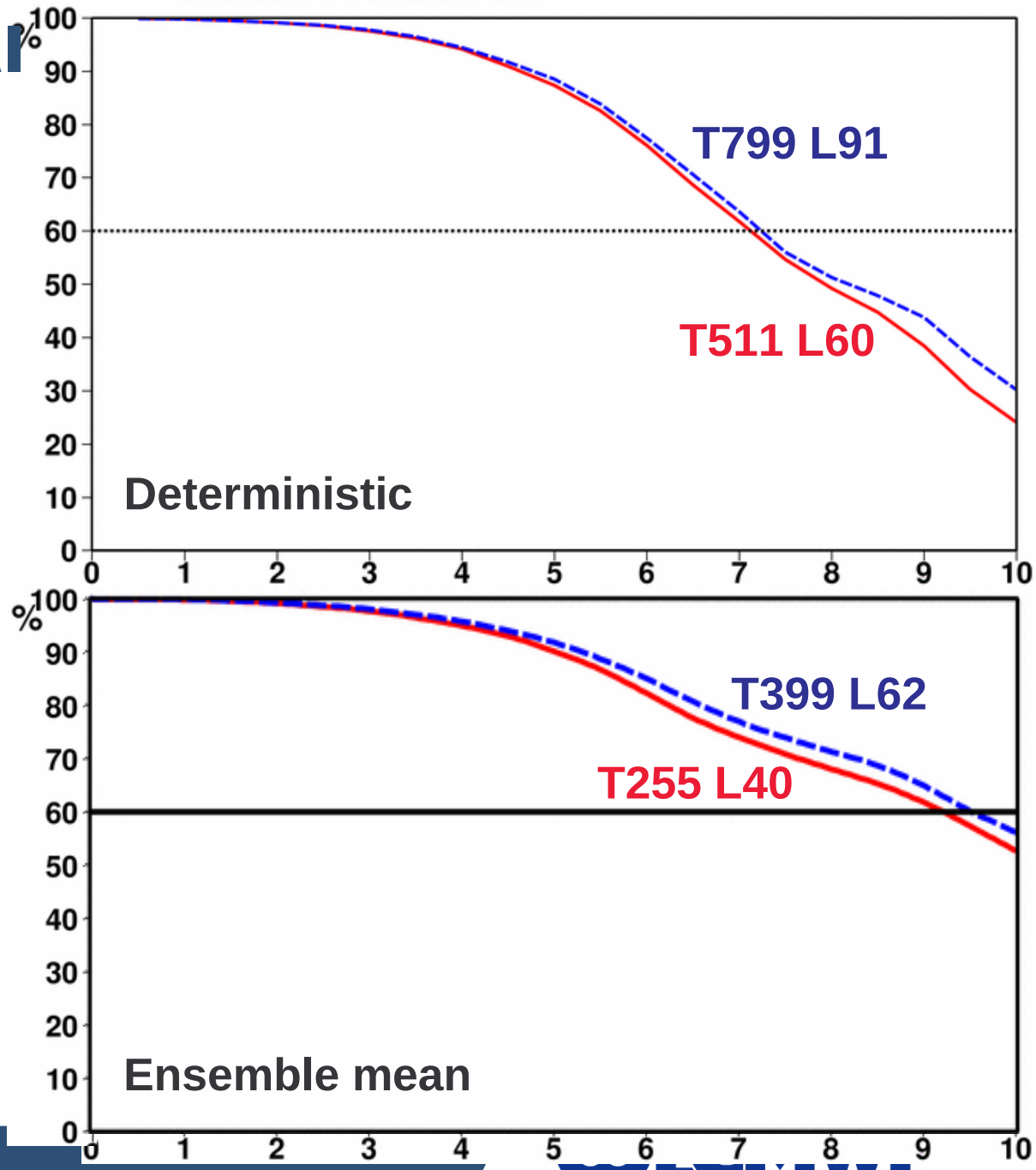


Total # of points in T_L799 grid: 843,490

Higher horizontal and vertical resolution

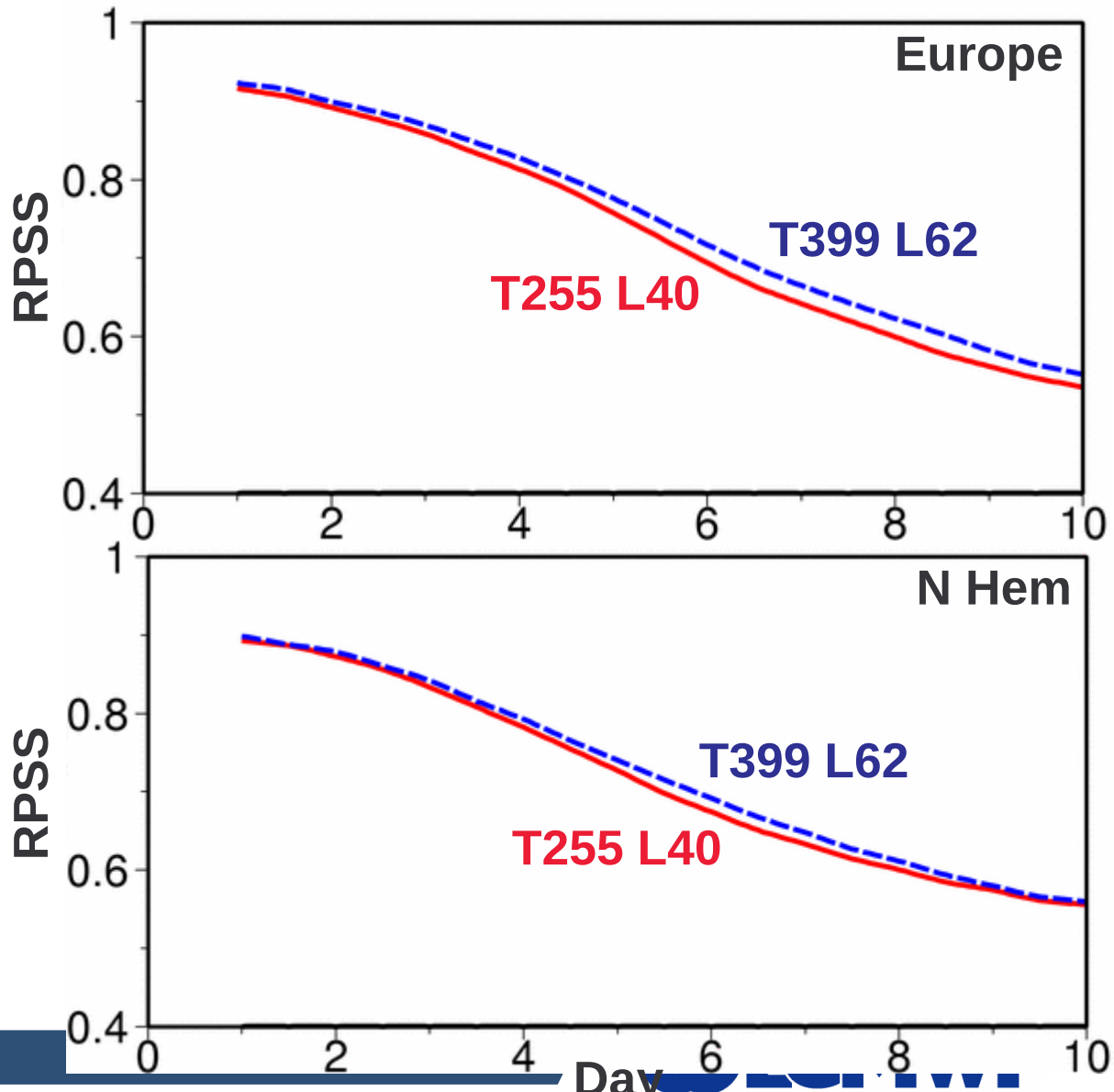
500hPa height anomaly correlation for Europe

47 00UTC cases from 17 October 2005



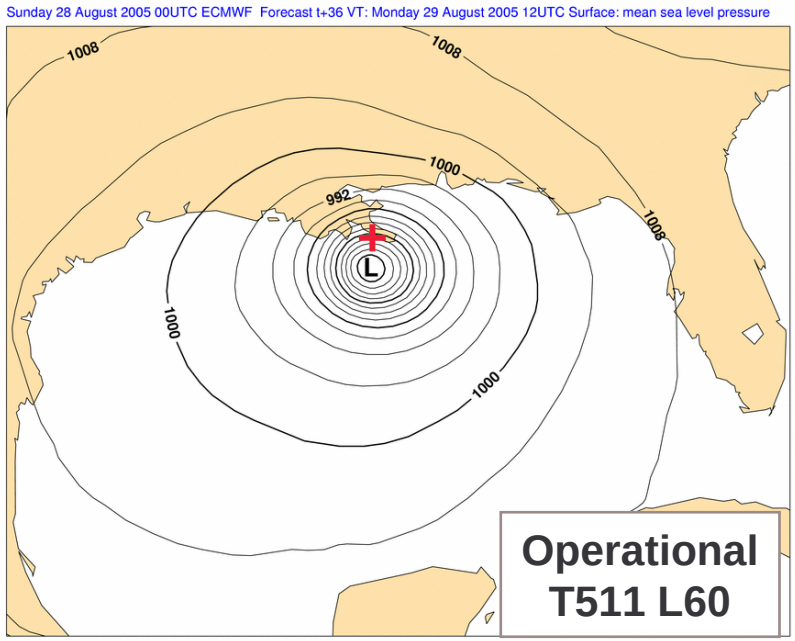
Higher horizontal and vertical resolution

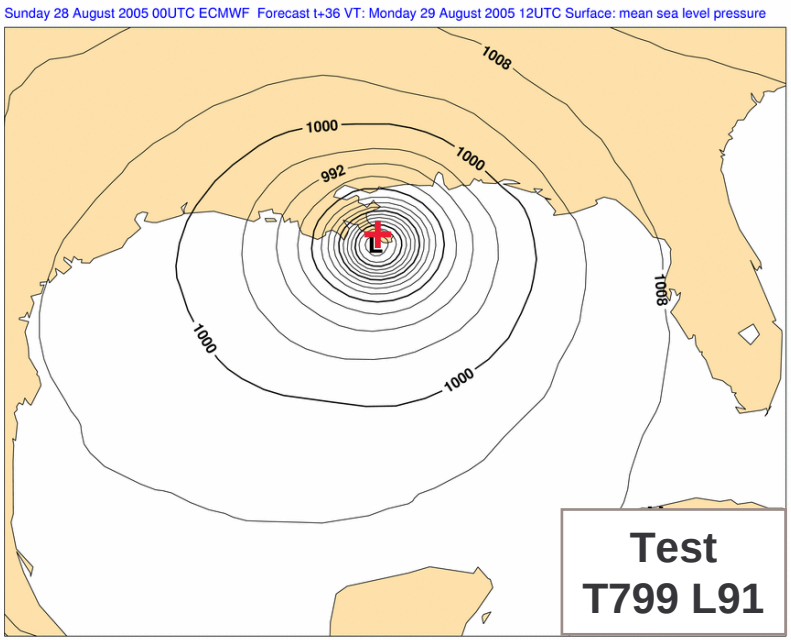
47 00UTC EPS cases from 17 October 2005



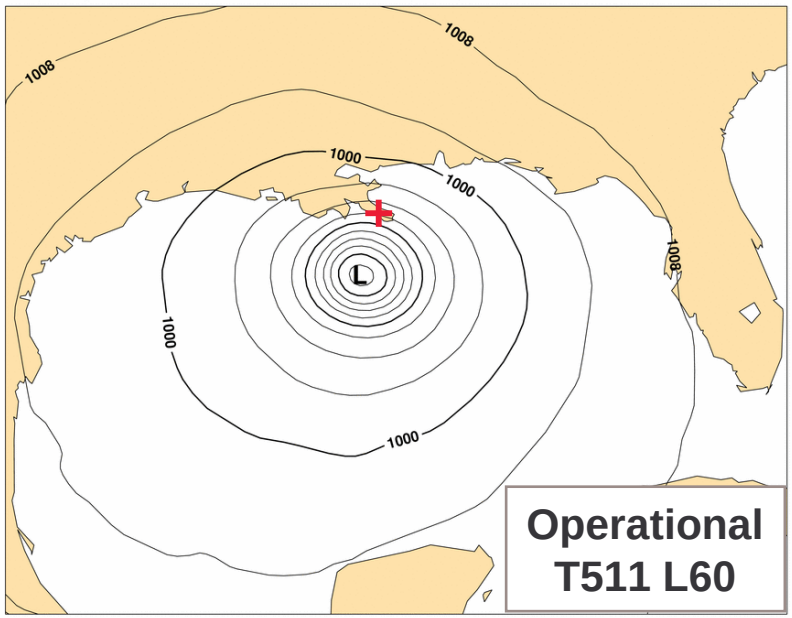
Forecasts of Katrina for 12 UTC, Monday 29 August

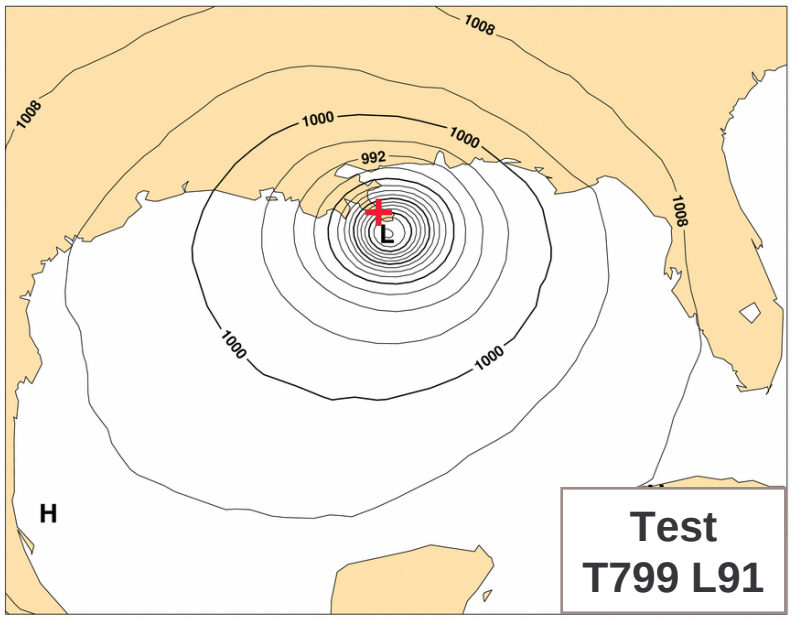
36h forecast





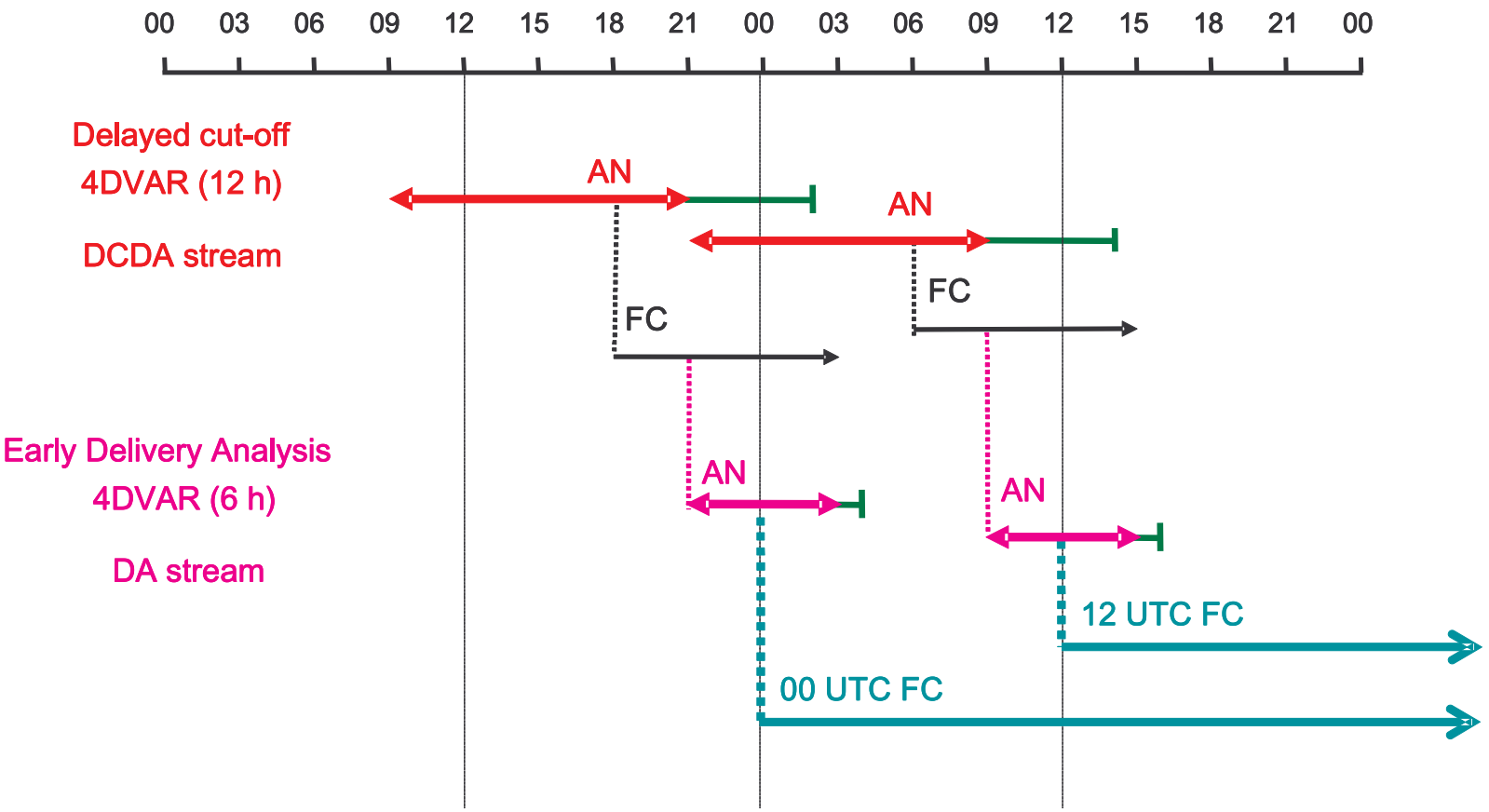
72h forecast





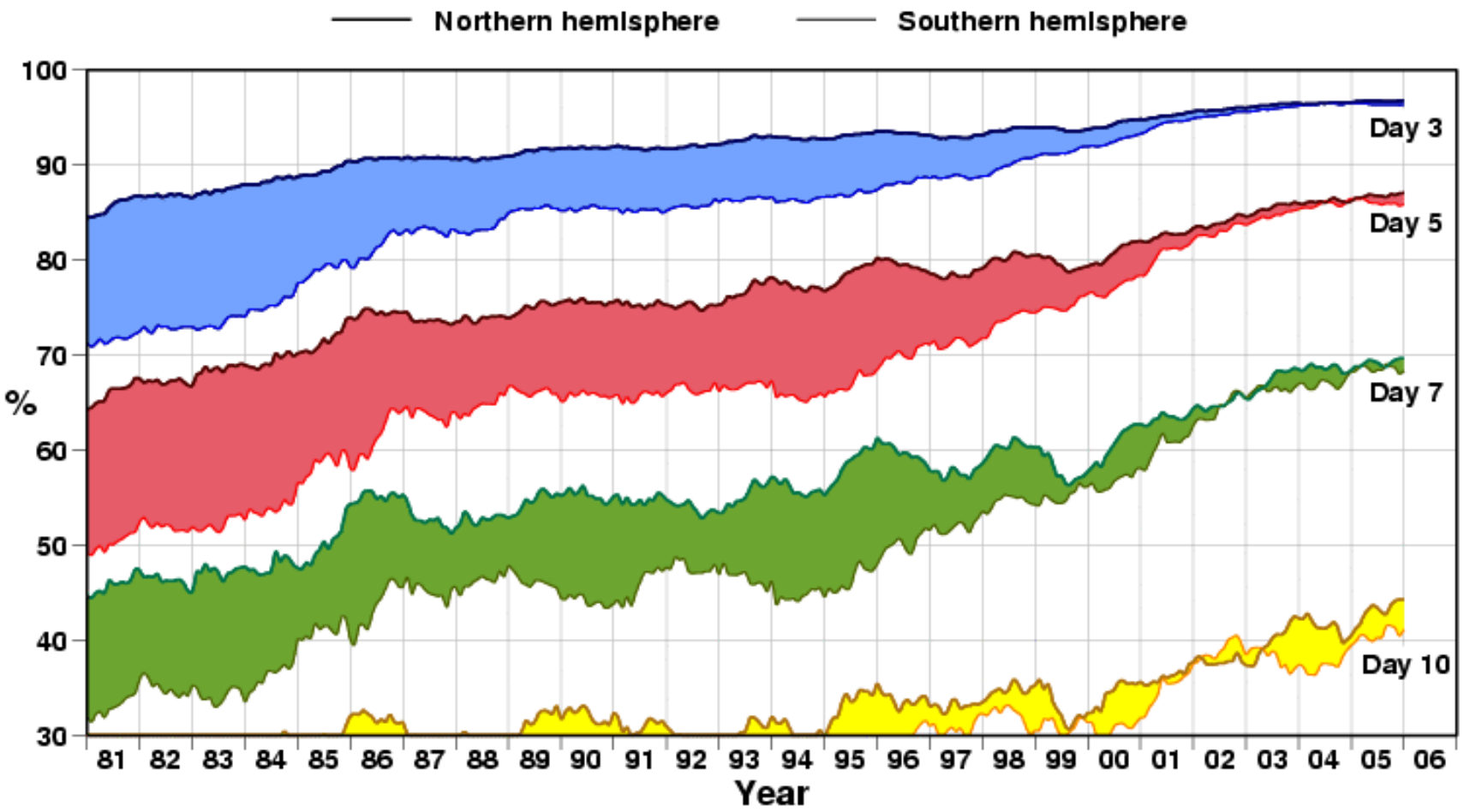
Visit

Early delivery system



Medium-range forecast performance

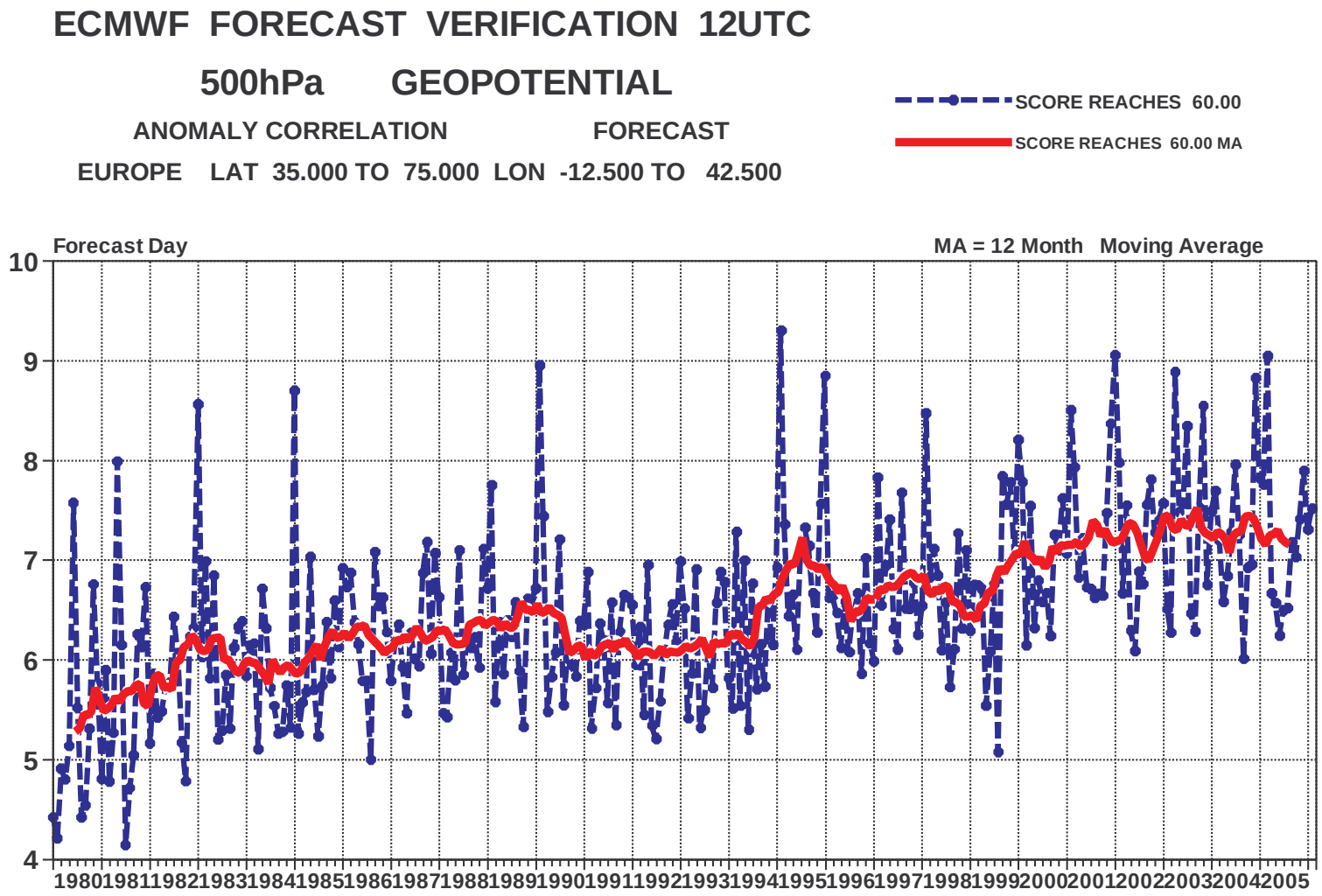
Anomaly correlation of 500hPa height



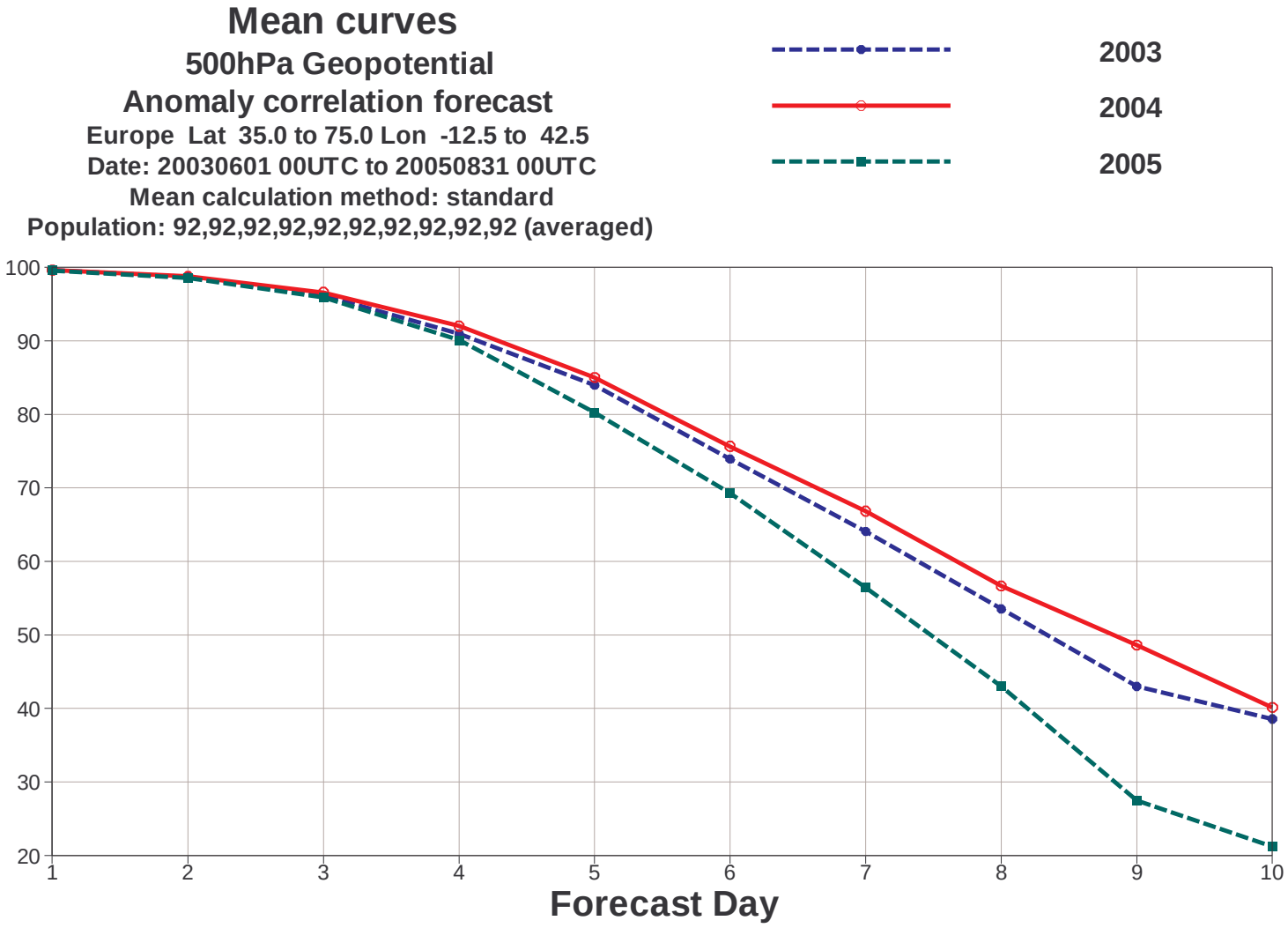
Thanks to Adrian Simmons

ECMWF

Scores (500hPa) from the deterministic forecast model over Europe

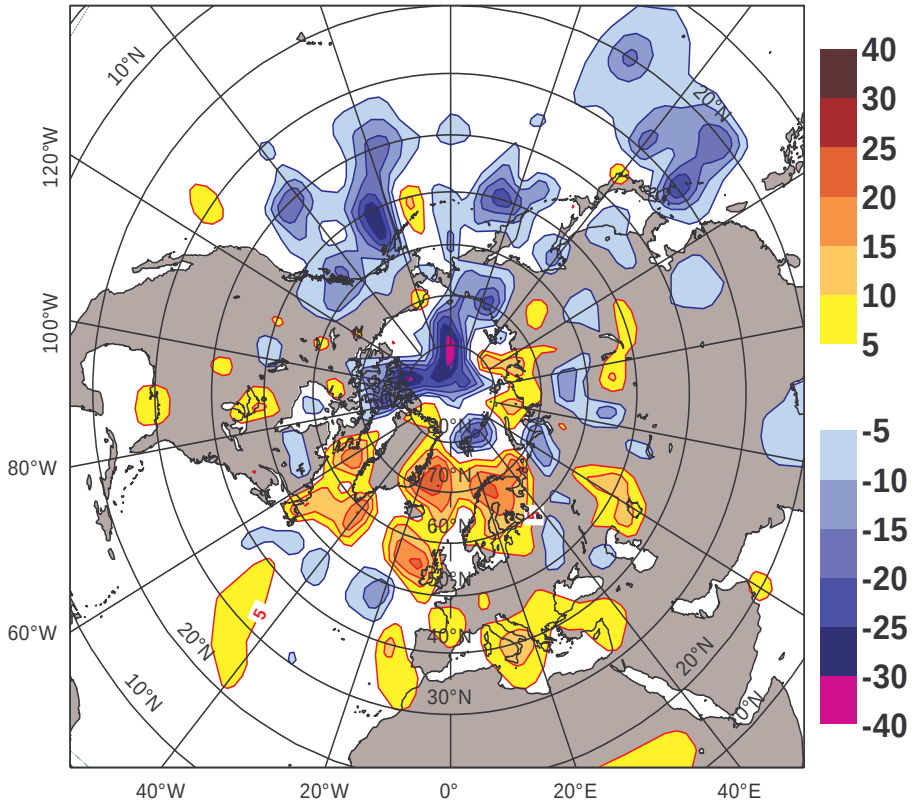


Summer (JJA) 2003/04/05 over Europe

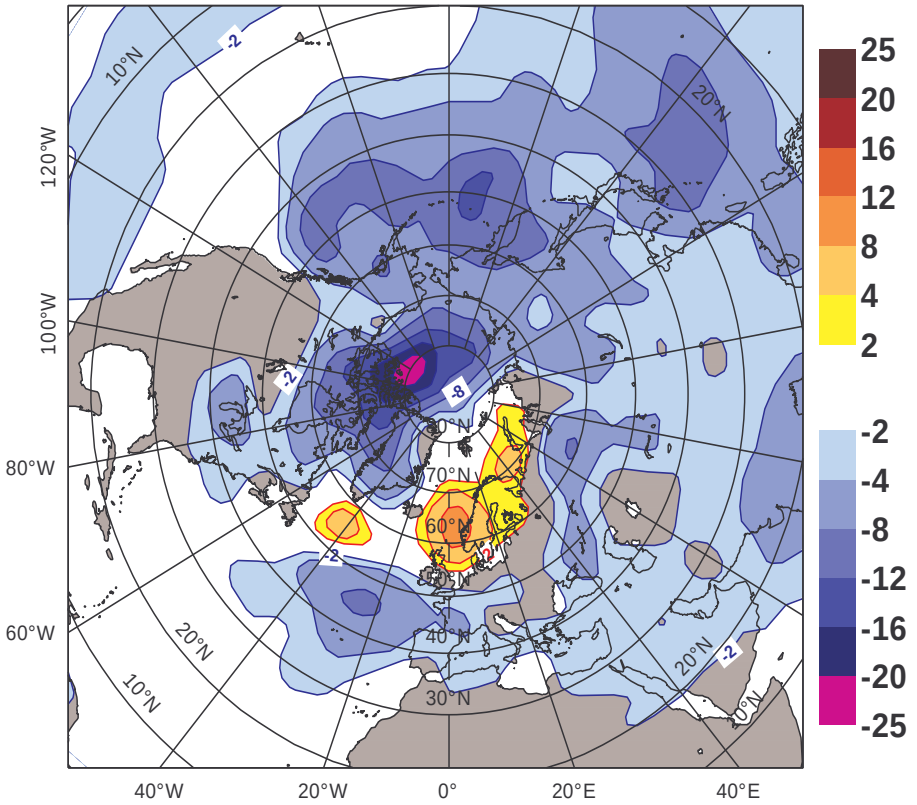


RMSE and spread differences between JJA 2005 and 2004

RMSE Difference Z500 JJA 2005-2004: D+5 FC



EPS Spread Z500 JJA 2005-2004: D+5 EPS Control



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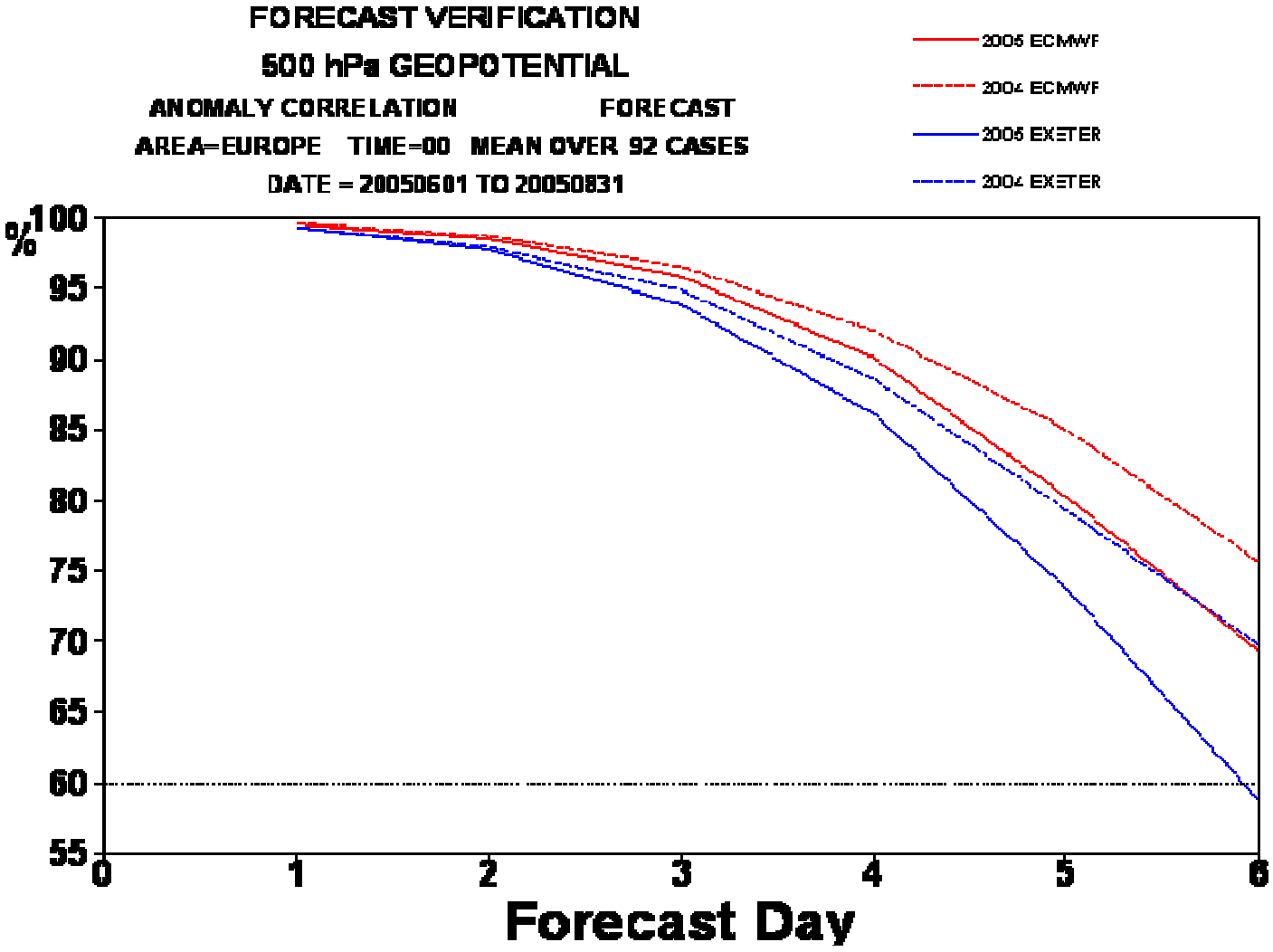
Summer performance 2004 and 2005: Comparison with UK Met Office



Mean curves

500hPa Geopotential

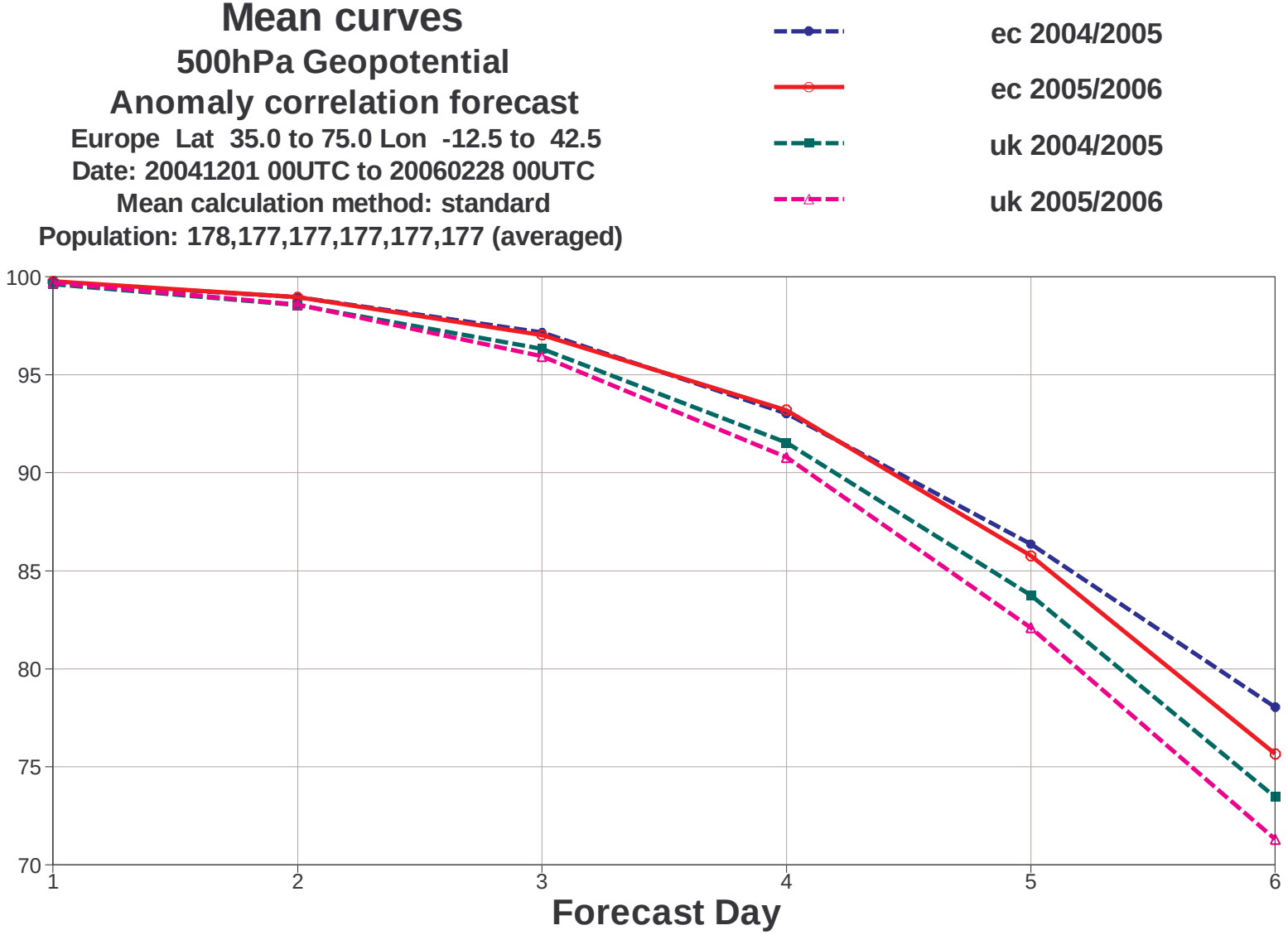
Anomaly correlation forecast

Europe Lat 35.0 to 75.0 Lon -12.5 to 42.5

Date: 20041201 00UTC to 20060228 00UTC

Mean calculation method: standard

Population: 178,177,177,177,177,177 (averaged)



Mean curves

500hPa Geopotential

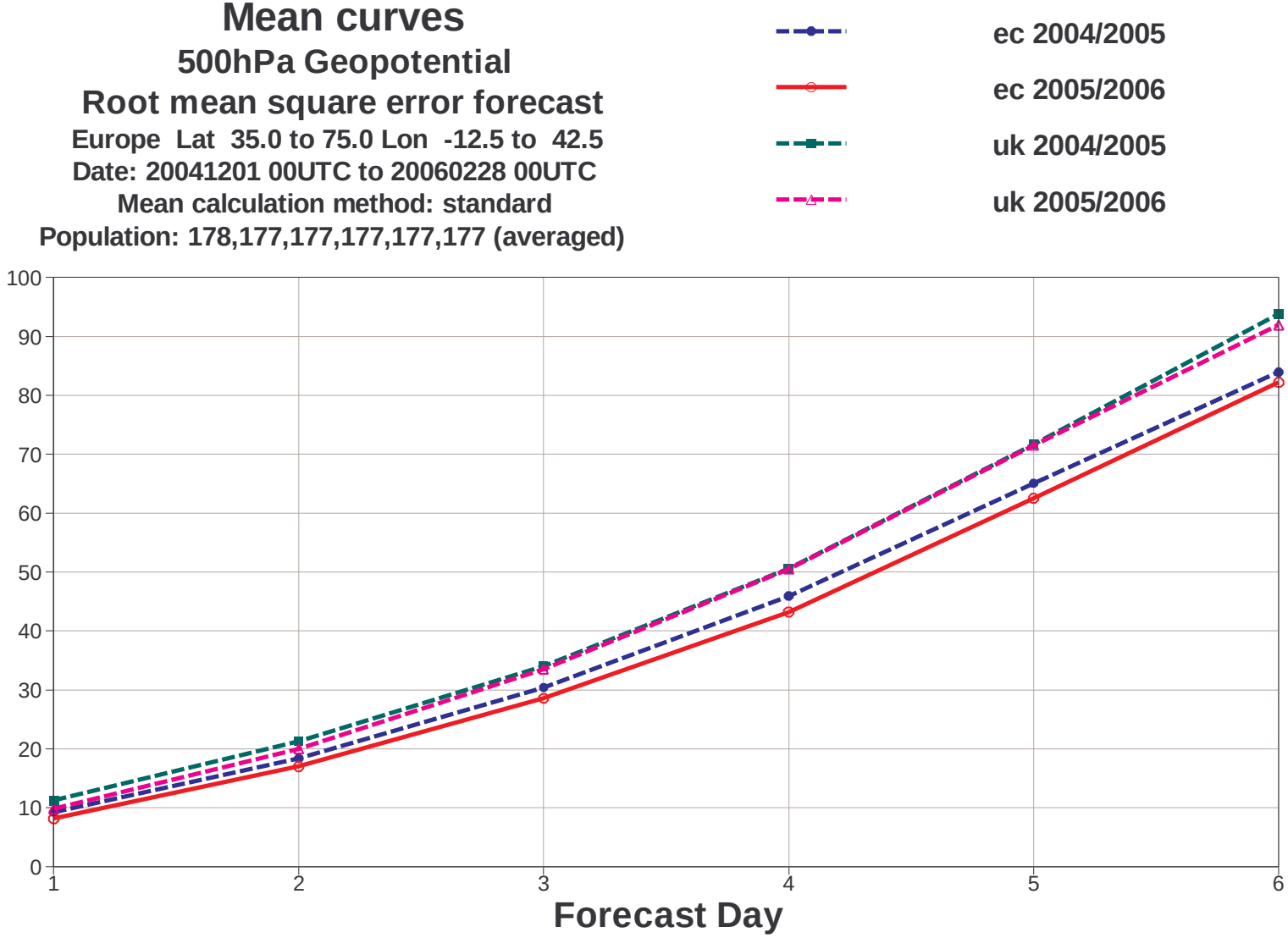
Root mean square error forecast

Europe Lat 35.0 to 75.0 Lon -12.5 to 42.5

Date: 20041201 00UTC to 20060228 00UTC

Mean calculation method: standard

Population: 178,177,177,177,177,177 (averaged)



Mean curves

500hPa Geopotential

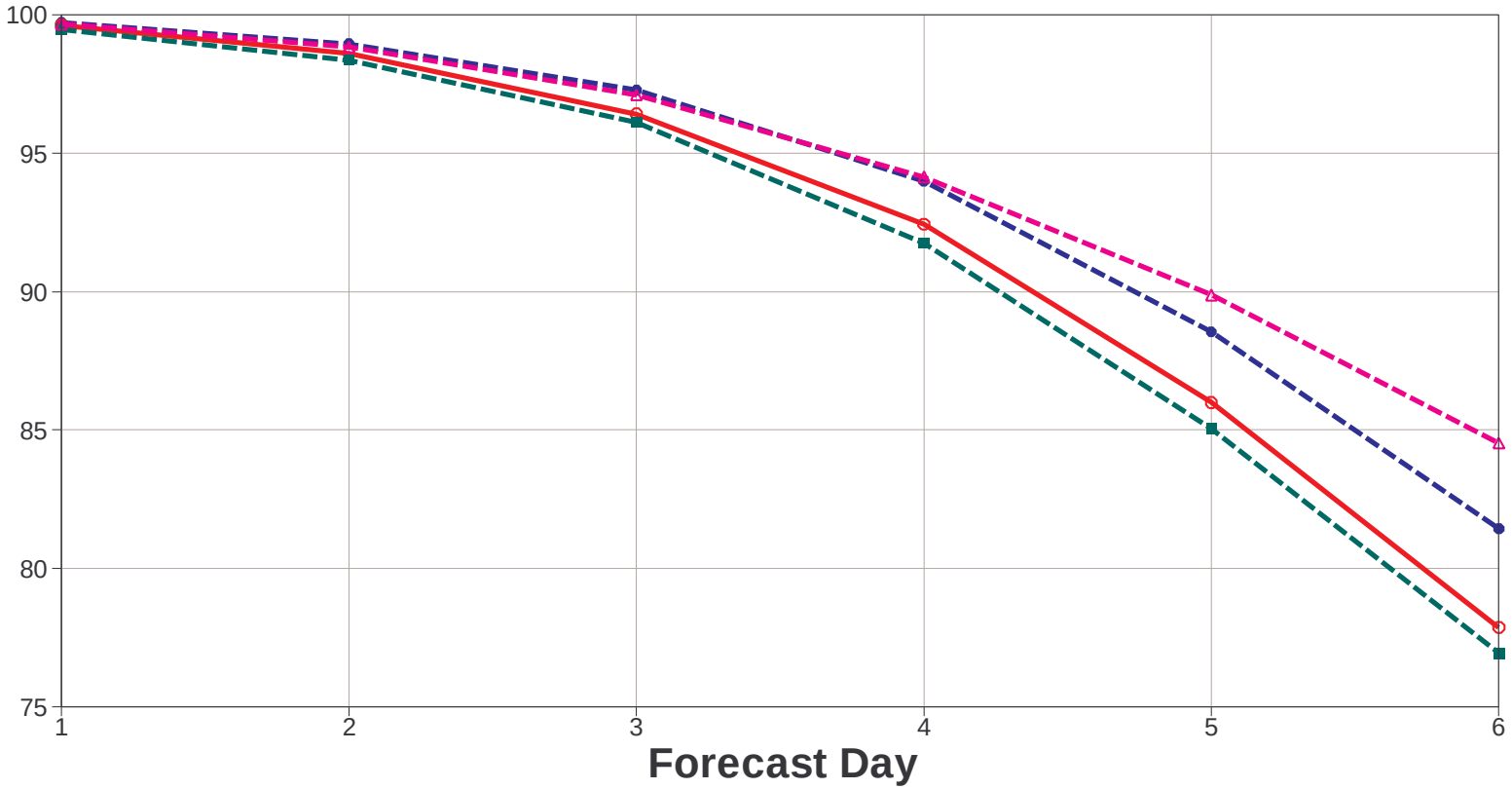
Anomaly correlation forecast

N.hem Lat 20.0 to 90.0 Lon -180.0 to 180.0

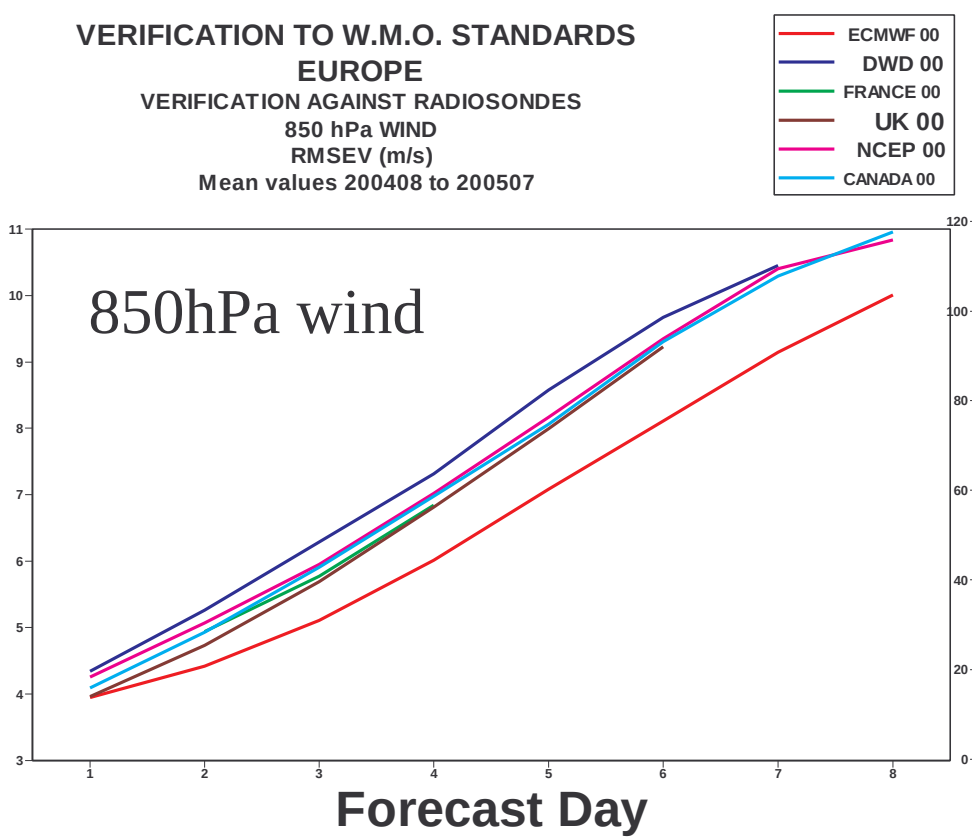
Date: 20060201 00UTC to 20060420 00UTC

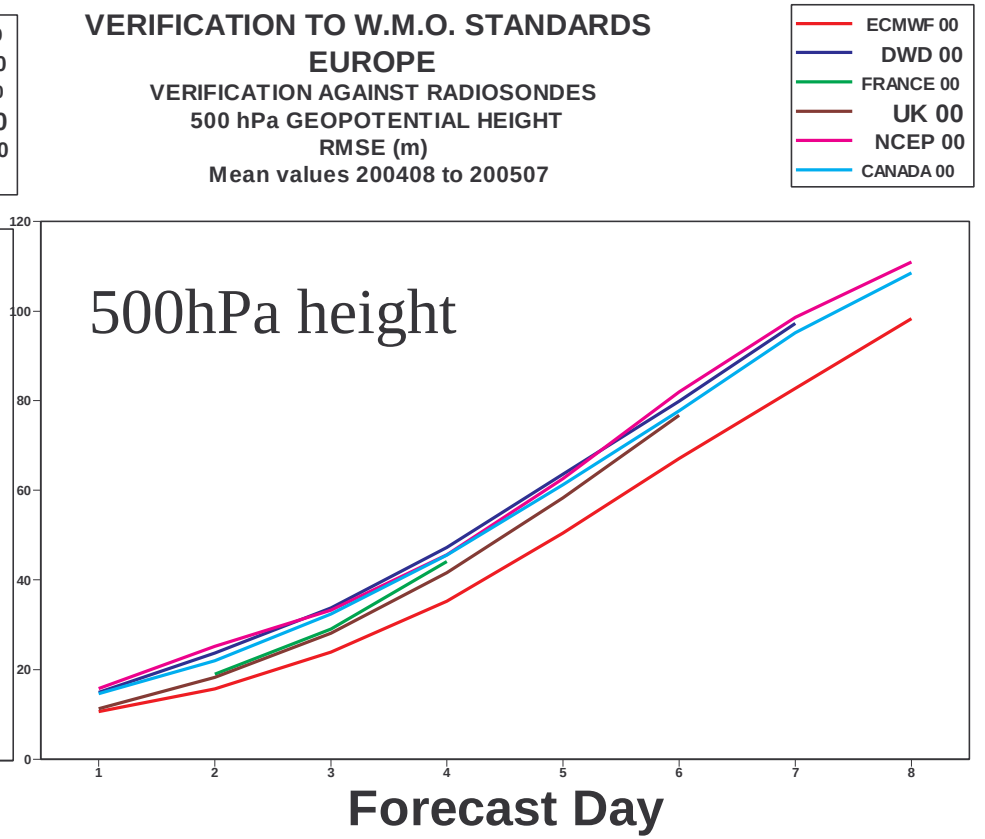
Mean calculation method: standard

Population: 78,78,78,78,78,78 (averaged)

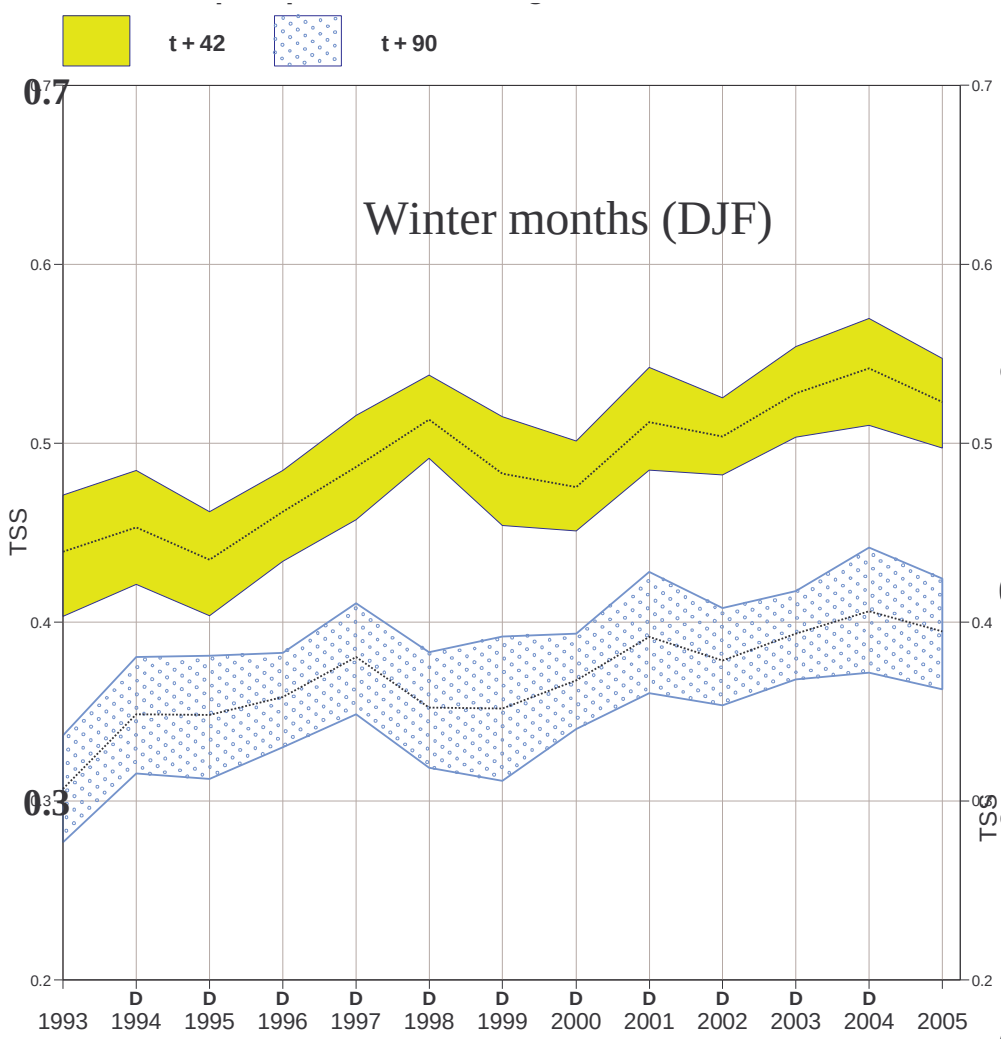


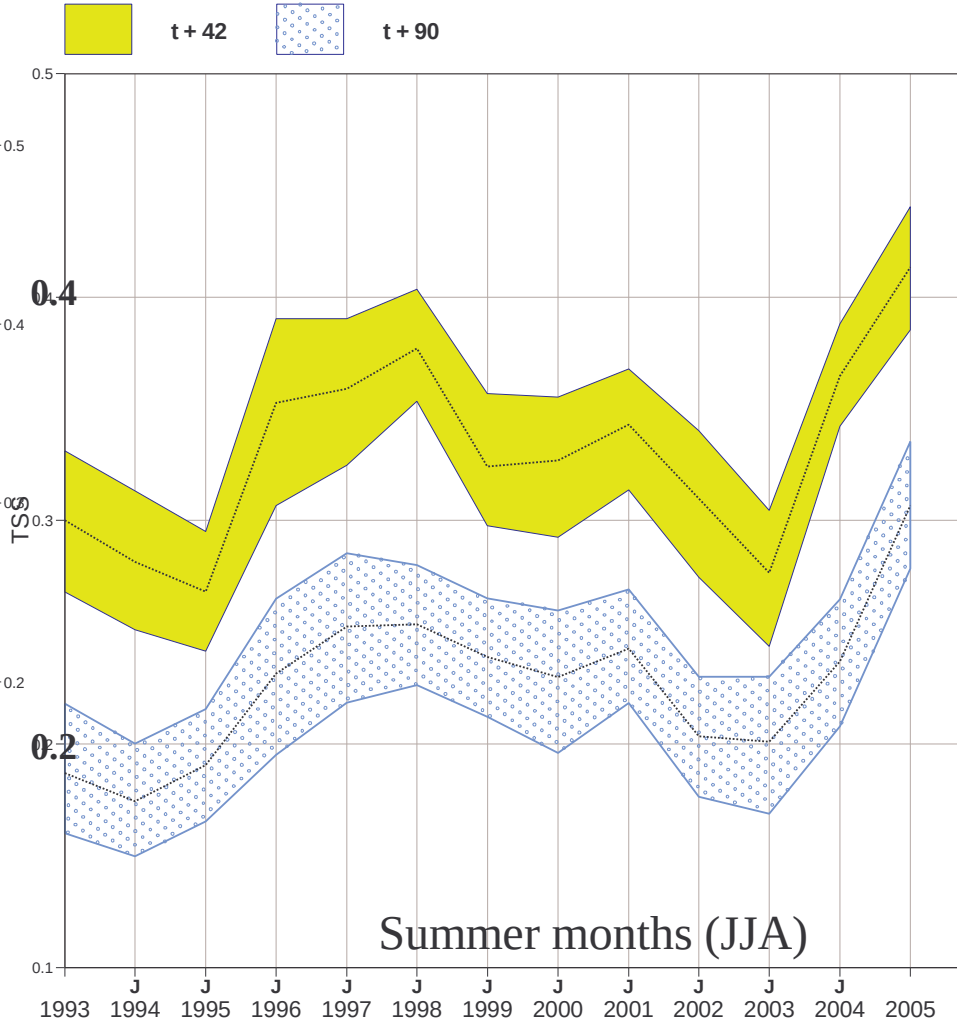
WMO/CBS exchanged scores using radiosondes





Precipitation verification against SYNOP on GTS





TSS = H - F

Europe 10mm/24h

ECMWF

Ensemble Prediction System

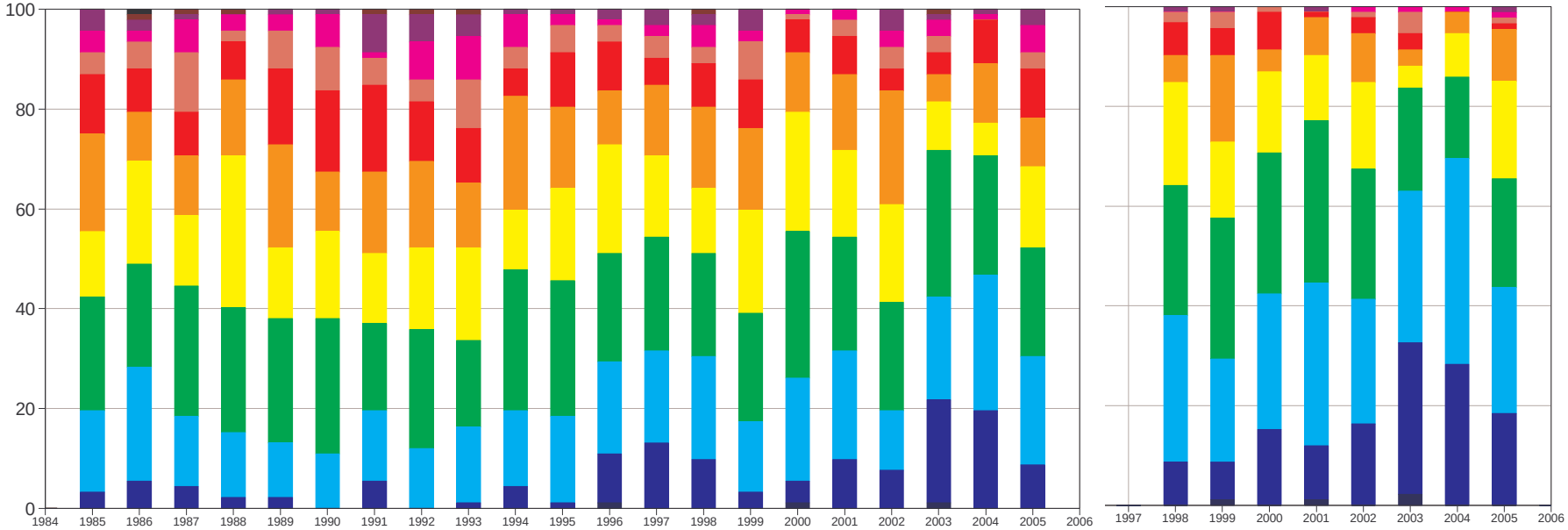
Europe

Summer 2005

Cumulative distribution of
Anomaly correlation forecast
850hPa Temperature
Europe Lat 35.0 to 75.0 Lon -12.5 to 42.5
OPER T+168 12 UTC
JJA

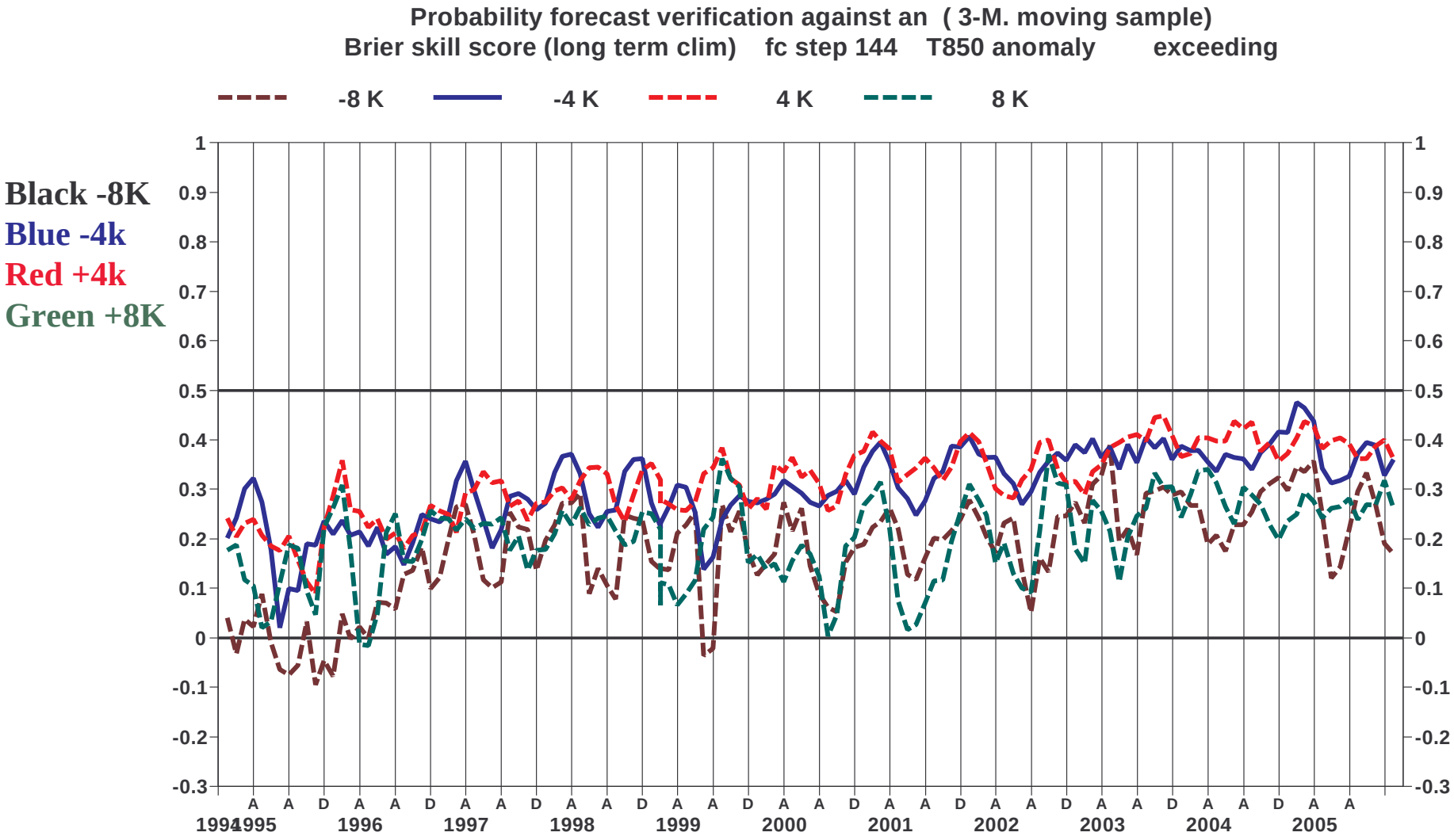
< -40.0
-40.0 to -10.0
-10.0 to 10.0
10.0 to 20.0
20.0 to 30.0
30.0 to 40.0
40.0 to 50.0
50.0 to 60.0
60.0 to 70.0
70.0 to 80.0
80.0 to 90.0
> 90.0

EPS Mean



ECMWF

Brier Skill Score for Europe for 144h EPS forecast of a series of 850hPa temperature anomalies.



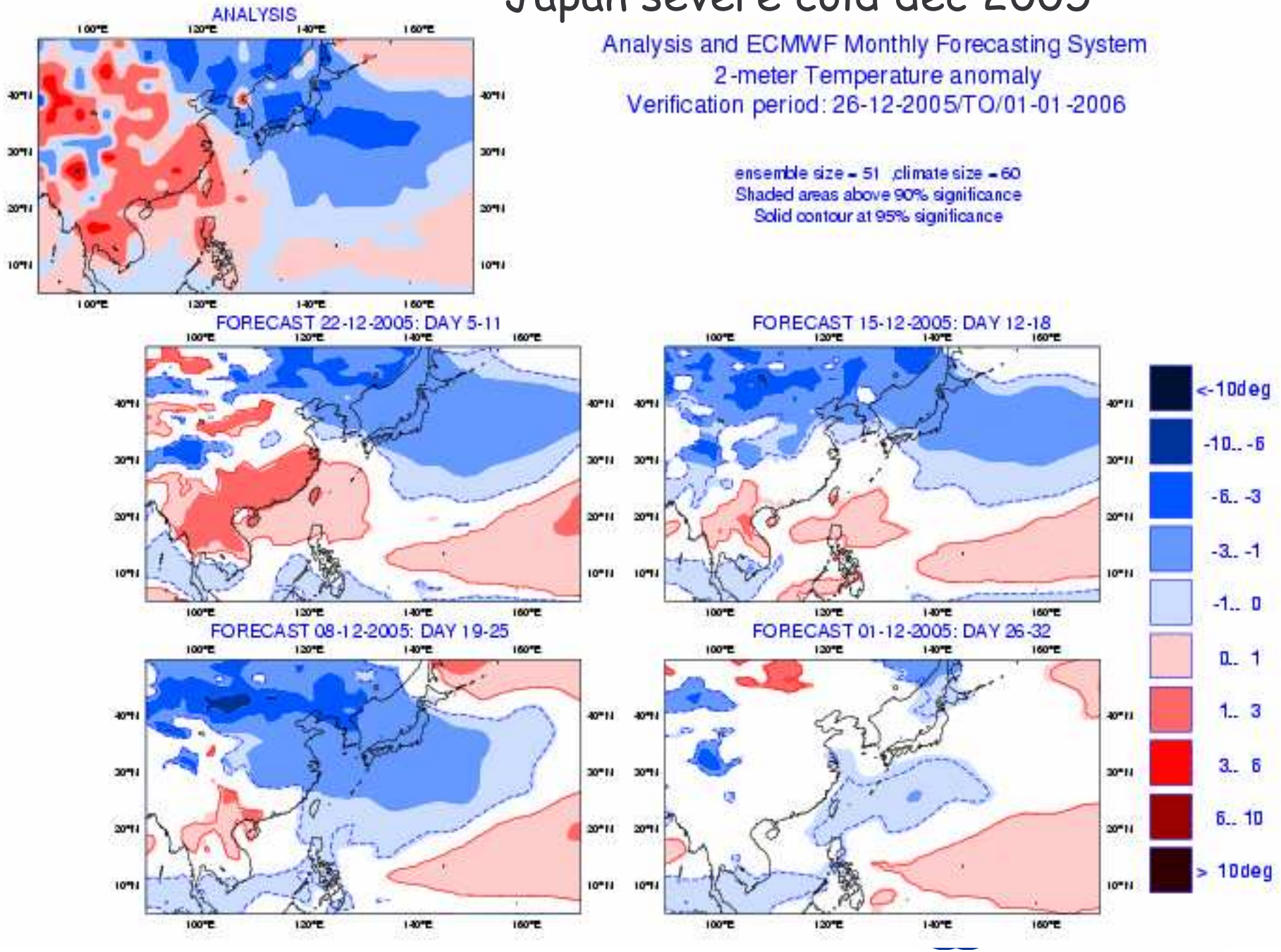
ECMWF

Monthly and Seasonal forecast system

Monthly forecasting

- Weekly 32-day forecasts T159L62For
- Coupled to HOPE ocean model
- 51 member ensemble
- Compared to 5 forecasts for same day over last 12 years
  - 60 member ensemble
- Results interpreted in terms of anomalies
  - For example: probability that 2m temperature averaged over day 12 to 18 is in the upper/middle/lower tercile
- Products become available every Thursday at 22UTC

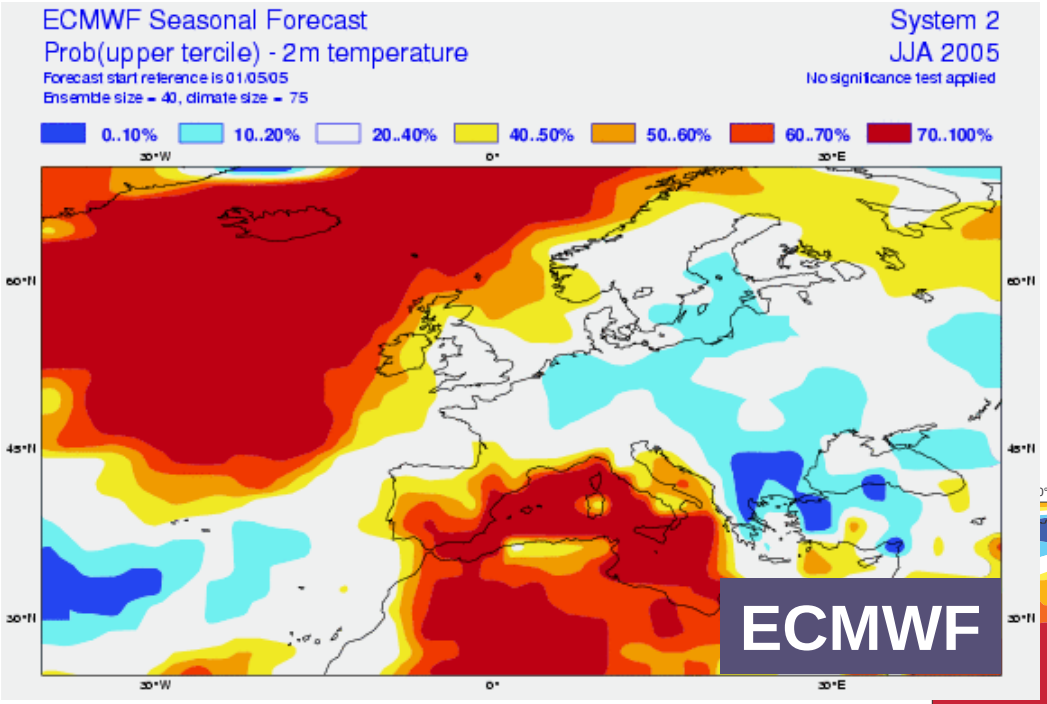
Japan severe cold dec 2005

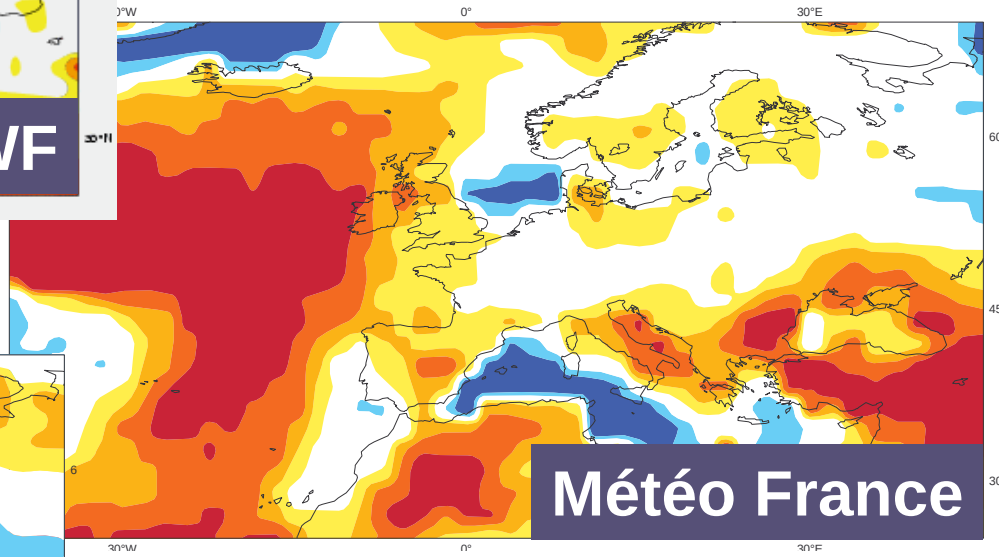


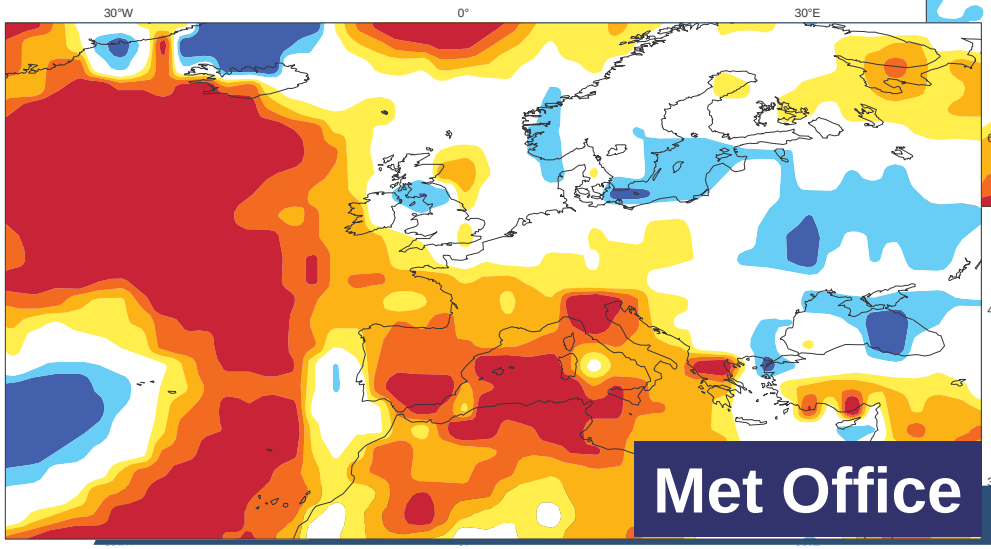
Seasonal forecasting: EUROSIP multi-model ensemble

- Three models running at ECMWF:
  - ECMWF – System 2
  - Met Office – HADCM3 model, Met Office ocean analyses
  - Meteo-France – Arpege/Climat, Mercator ocean analyses
  - Spain + Germany may join
- Unified system
  - All data in ECMWF operational archive
  - Common operational schedule (products released at 12UTC on the 15th of each month)
- Common products will be available soon
  - ECMWF release of web products expected this autumn
- EUROSIP appears to be better than the individual systems

Probability of 2m Temp > upper tercile of the model climate for JJA 2005



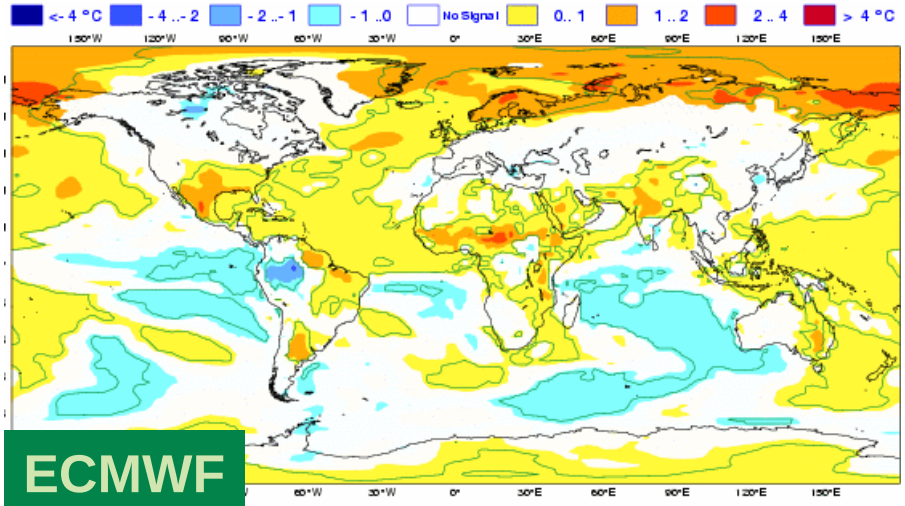




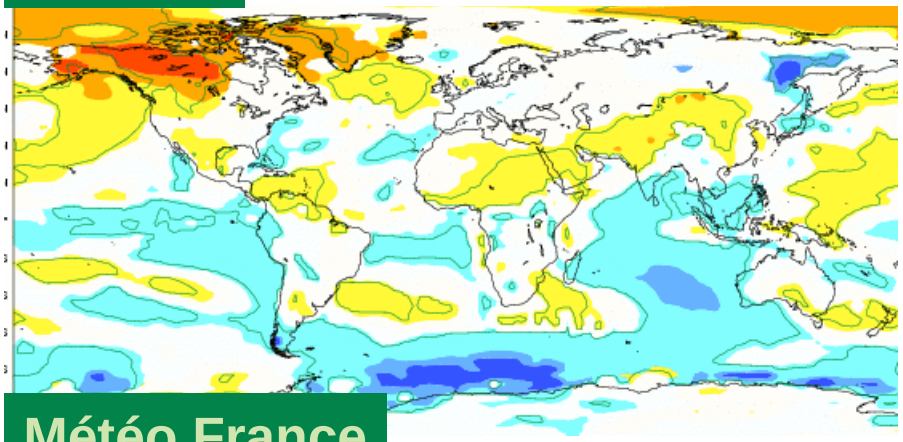
Seasonal forecasts from 1 May 2005

ECMWF

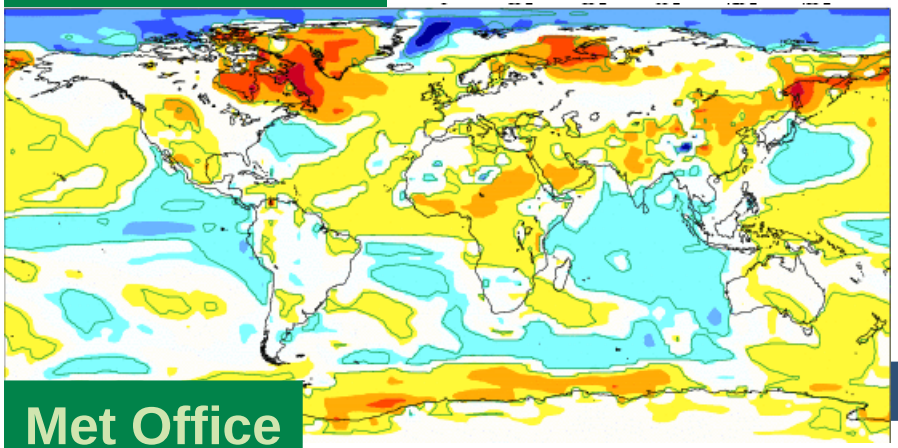
2m temp predictions for DJF 2006: i.c. Nov 05



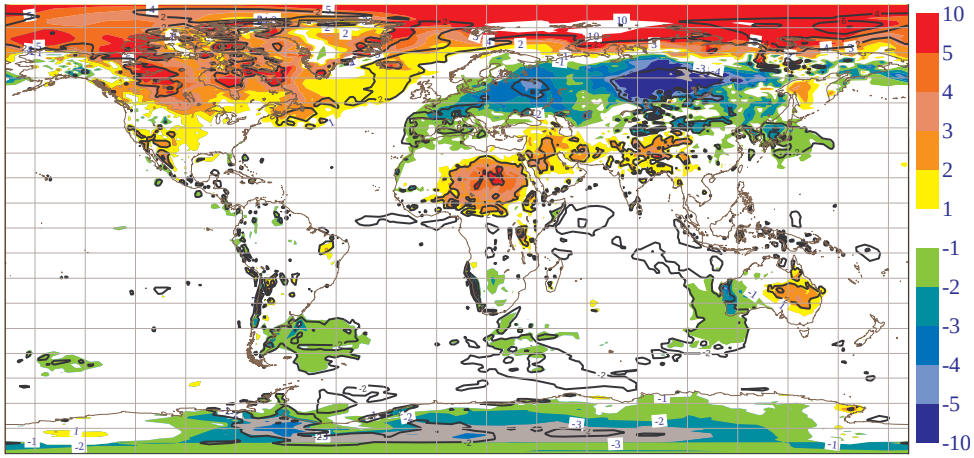
ECMWF



Météo France



Met Office



Observed anomalies

ECMWF

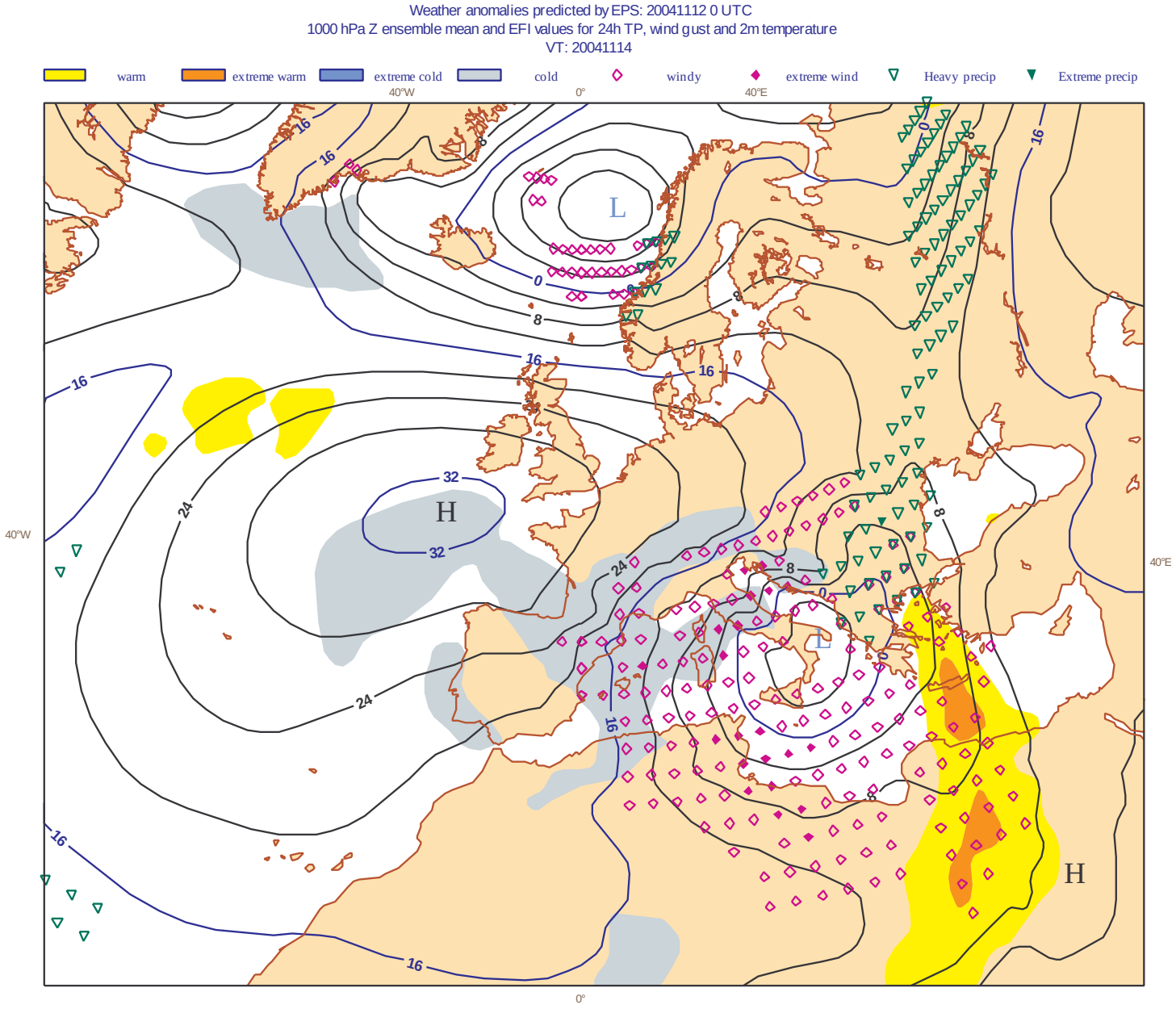
Dissemination and post-processing

Increased range of products
aiming at severe weather events

- **Global Extreme Forecast Index**
  - Anomalies for 2m temperature, 10m wind and precipitation
  - Will be made available as a web product
  - Verification against observations has started
- **Products from the monthly forecasting system were added to the dissemination and the Catalogue**
  - Includes re-forecasts for both atmospheric and wave products
- **Wave kurtosis parameter**
  - Available from deterministic and ensemble system, can be used to estimate the likelihood of a freak wave occurring in the oceans
- **CAPE parameter**
  - Available from deterministic and ensemble system

EFI Europe

14/11/04

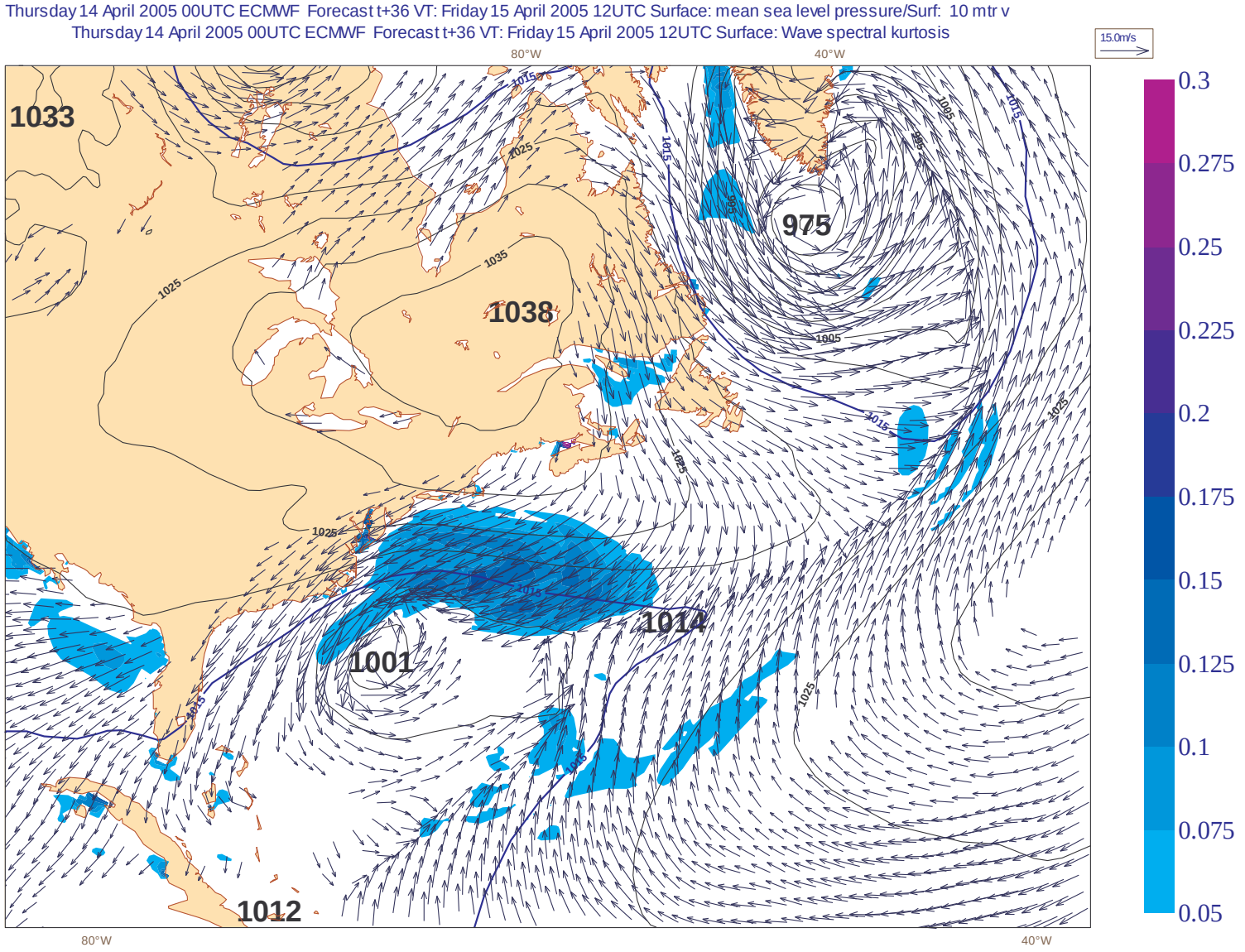


ECMWF

Wave kurtosis

15/4/05

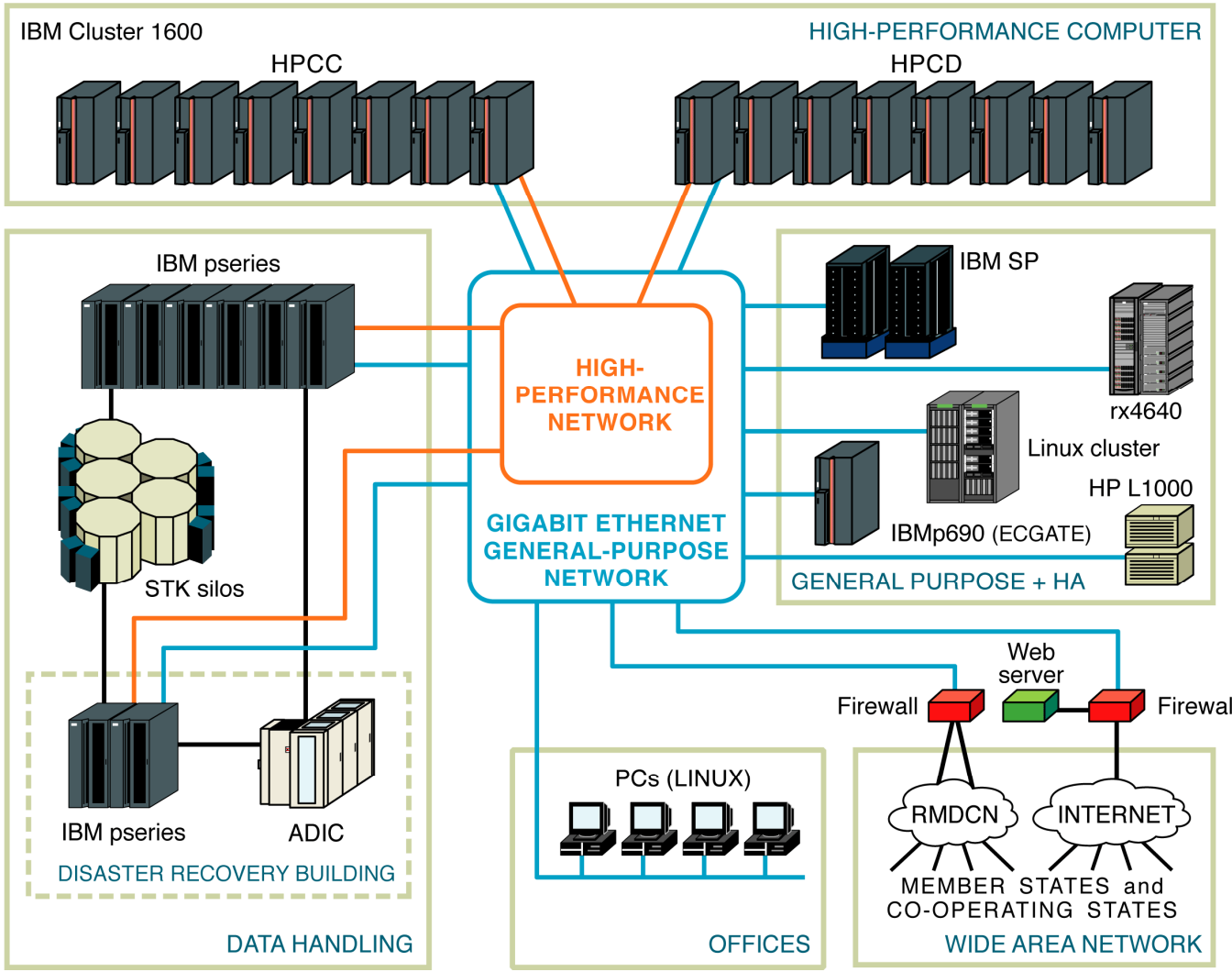
Freak waves



ECMWF

Computing aspects

Current computer configuration



IBM HPCF Phase 3

- Two identical clusters, each one comprising
  - 68 compute nodes
  - Each node has 32 Power4+ processors and 32 GB of memory
- Dual-cluster has been in full production since early 2005
- System reliability is high (99.6% and 98.9% respectively)

IBM HPCF Phase 4 and beyond

- Council approved in December 2004 a two-year extension of the contract with IBM
- The extended contract includes the replacement of the current clusters with two Power5+ based clusters
- The aggregate performance on ECMWF's benchmark codes will increase from 2.5 to 4.5 teraflops sustained
- There are no further upgrades planned under the revised contract and the Phase 4 system will remain at ECMWF until March 2009
- The next HPC procurement will take place in 2007

Planned developments

VAREPS (summer 2006)

- Plan to extend forecast range of EPS to day 15
- Two additional fixed-resolution calibration forecasts will be run
- Current products to day 10 will be unaffected
- T799 deterministic will remain as now (days 1-10 only)

	# fc	day 0-10	day 10-15
VAR-CF	1	TL399	TL255
VAR-PF	50	TL399	TL255
CL-HRES	1	TL399	
CL-LRES	1	TL255	

VAREPS (longer term)

- EPS products to day 15 will be developed
- 15-day VAREPS will be combined with the monthly system (coupling with ocean model)
- Current implementation with change of resolution at day 10 is likely to be revised in the light of experience
- Depending on ongoing research, the change in resolution may be brought forward in time (e.g. to day 7)

Coming next – IFS cycle 30r2 (June 2006)

- Variational radiance bias correction
- Thinning of low-level AMDAR data
- Improved treatment of ice sedimentation and autoconversion to snow in cloud scheme
- Implicit treatment of convective momentum transport
- Includes changes for EPS extension to day 15
  - T255 perturbed forecasts from day 10 to day 15
  - T399/255 control to day 10/15
  - Also uniform T399 control to day 15 and T255 control to day 21
- To be used for T255L91 interim reanalysis for 1989 - ….
- To be used in version 3 of Seasonal Forecasting System?

Also for 2Q or 3Q 2006:

- Introduction of turbulent orographic drag scheme
- Use of albedo fields from MODIS
- Use of high-resolution NCEP SST fields
- Refinements to stratospheric analysis
- Recalibrated radiosonde temperature bias corrections

And for 4Q 2006:

- 4D-Var changes:
  - 3rd inner loop
  - revised trajectory interpolation
  - revised data usage, including modified Var QC
  - new cloud and convection schemes in minimization
- Upgrade fast radiative transfer to RTTOV-9
- Change model short-wave radiation scheme to RRTM-SW
- Unified medium-range/monthly EPS
- Start of GEMS constituent reanalyses for 2003/4

And over course of year:

- Monitoring and later assimilation of data from:
  - AMSR-E, CHAMP, COSMIC, FY-2C, METOP ATOVS + … , MET9, MTSAT, SSMIS, TMI

ECMWF plans for reanalysis

- **The interim reanalysis**
  - will start soon with T255L91, 4D-Var and cycle 30r2 (?)
  - will run from 1989 onwards, and be continued in close to real time
  - will use mostly same pre-2002 data as ERA-40, but will include
    - **reprocessed winds from EUMETSAT**
    - **reprocessed ERS altimeter data**
    - **GOME profile data from RAL**
    - **improved radiosonde bias corrections**

- **European Regional Reanalysis (EURRA)**
  - potential for a European regional reanalysis project (EURRA) is being explored with NMSs and EEA

- **A new major reanalysis (ERA-65 or -75) in due course**
  - funding has to be secured

ECMWF Strategy for 2006-2015

- **The principal goal of ECMWF in the coming ten years will be to maintain the current, rapid rate of improvement of its global, medium-range weather forecasting products, with particular effort on early warnings of severe weather events**
- **Complementary goals are:**
  - **To improve the quality and scope of monthly and seasonal-to-interannual forecasts**
  - **To enhance support to Member States national forecasting activities by providing suitable boundary conditions for limited-area models (and regional CTMs)**
  - **To deliver real-time analyses and forecasts of atmospheric composition**
  - **To carry out climate monitoring through regular reanalyses of the Earth-system**
  - **To contribute towards the optimization of the Global Observing System**

...and that's it, thank you !