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on
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Timeliness and Impact of Observations in the CMC Global NWP system

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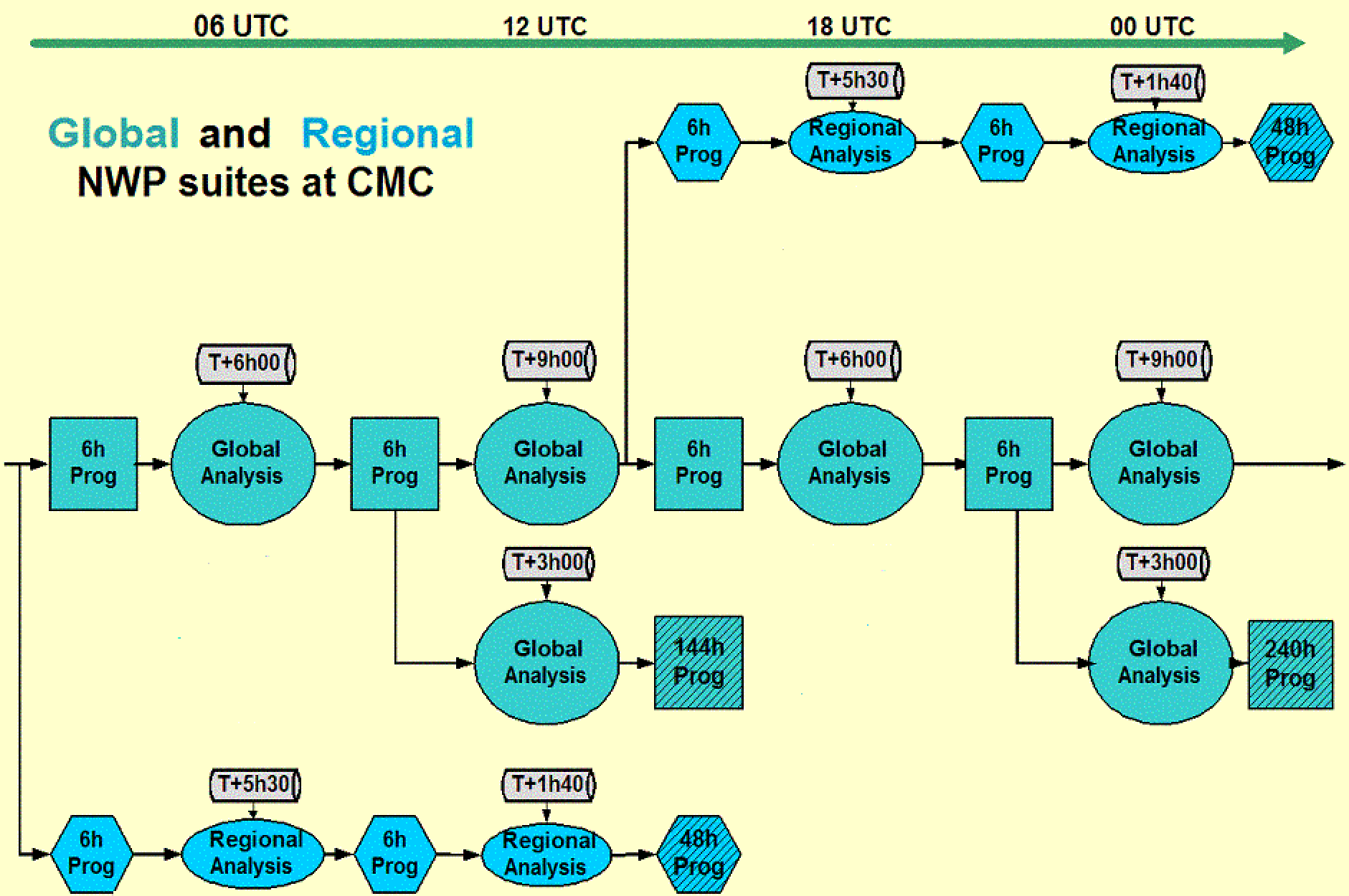
Outline

- CMC current global NWP suite and observations usage
- Impact of observation types from OSEs with the global forecasting system
- Impact of reception delays and short cut-off time constraints
- Outlook of the future CMC NWP system
- Final remarks


06 UTC
12 UTC
18 UTC
00 UTC
Global and Regional
NWP suites at CMC
T+5h30
T+1h40
6h Prog
Regional Analysis
6h Prog
Regional Analysis
48h Prog
T+6h00
T+9h00
T+6h00
T+9h00
6h Prog
Global Analysis
6h Prog
Global Analysis
6h Prog
Global Analysis
6h Prog
Global Analysis
T+3h00
T+3h00
Global Analysis
144h Prog
Global Analysis
240h Prog
T+5h30
T+1h40
6h Prog
Regional Analysis
6h Prog
Regional Analysis
48h Prog

CMC Operational Models

- GEM model (global, regional, meso)
- 3D-Var assimilation on model surfaces (T108)
- Background errors from 24-48 method
- Observations QC with BG check and QC-VAR

Global Model

- Uniform grid
- Resolution of .9º (~100 km)
- 28 eta levels
- Kuo convection scheme
- Sundqvist stratiform scheme
- Force-restore surface module with climatogical soil moisture
- 10 day forecasts at 00Z and 6 day forecasts at 12Z.
- Cut-off of T+3h00

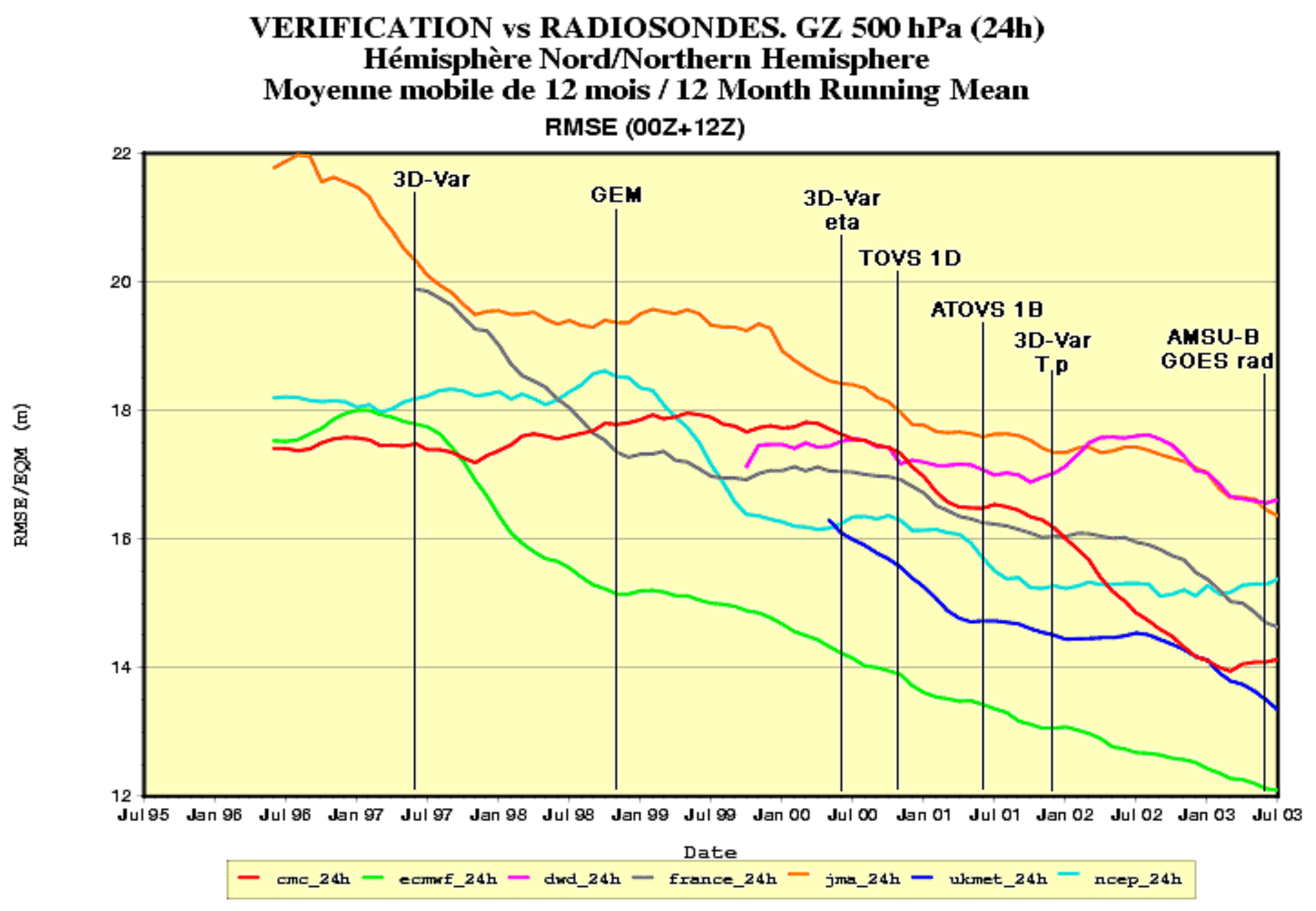
Regional Model

- Variable resolution grid
- Resolution of .22º (~24 km)
- 28 eta levels
- Fritsch-Chappell scheme
- Sundqvist stratiform scheme
- ISBA surface module with soil moisture pseudo-analysis (error feedback, no data)
- 48-hour forecasts (00Z -12Z)
- Cut-off of T+1h40

Observations for 3D analyses

Upper air soundings	• radiosonde • pilot • dropsonde	• land stations • ships • aircrafts	• temperature • moisture • winds • pressure
Surface observations	• synoptic	• land stations • ships • fixed buoys • drifting buoys	• temperature • moisture • pressure • winds
Satellite	• NOAA ATOVS amsu-a & amsu-b	• circumpolar	• radiance
	• GOES imager	• geostationary	• radiance
	• AMVs	• geostationary (METEOSAT & GOES)	• derived winds
Aircrafts	• ACARS / AMDAR • AIREP	• aircrafts	• temperature • winds

Operational Verification



Observing System Experiments

Series of experiments with the exclusion of a type of observation in order to evaluate the importance of the impact of various observation systems in the NWP suite

Two 6 weeks periods:

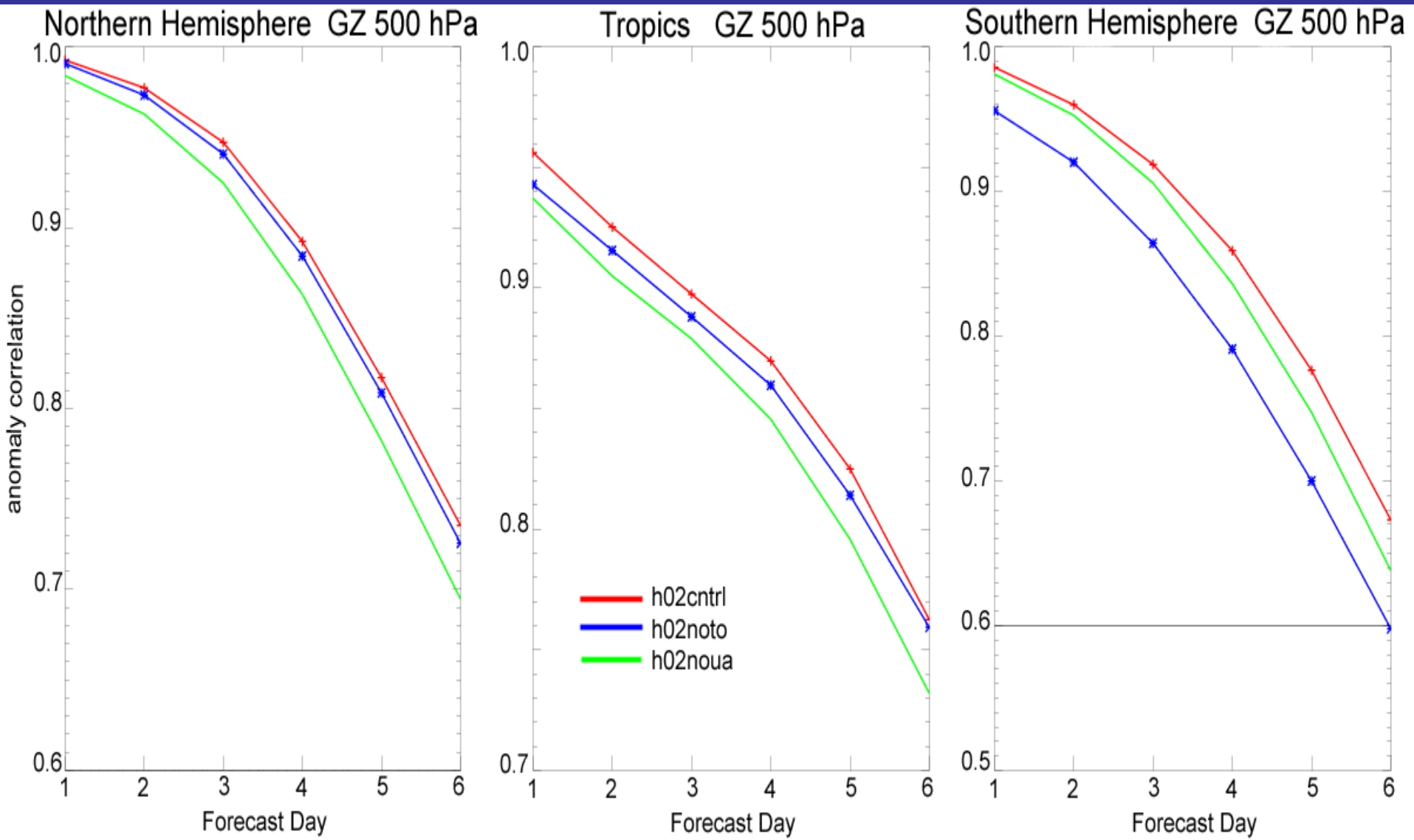
Winter Period: 2001121800 to 2002012712
Summer Period: 2002061700 to 2002073112

6-day forecasts every 12 hours (00UTC and 12UTC) from final analyses

OSE Results

Winter period, impact of the removal of TOVS vs Radiosondes of upper-air network

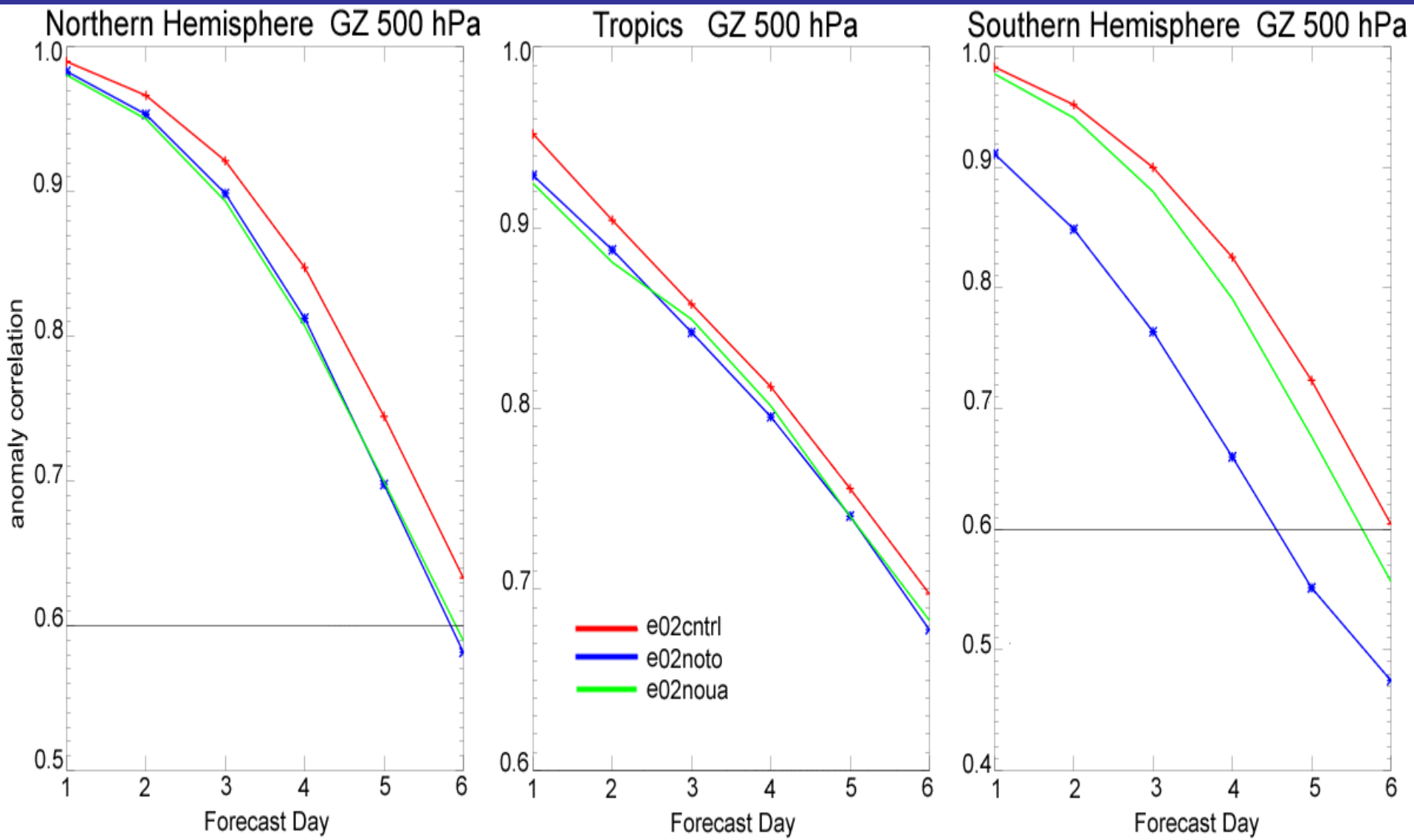
Anomaly correlation Geopotential Heights 500 hPa



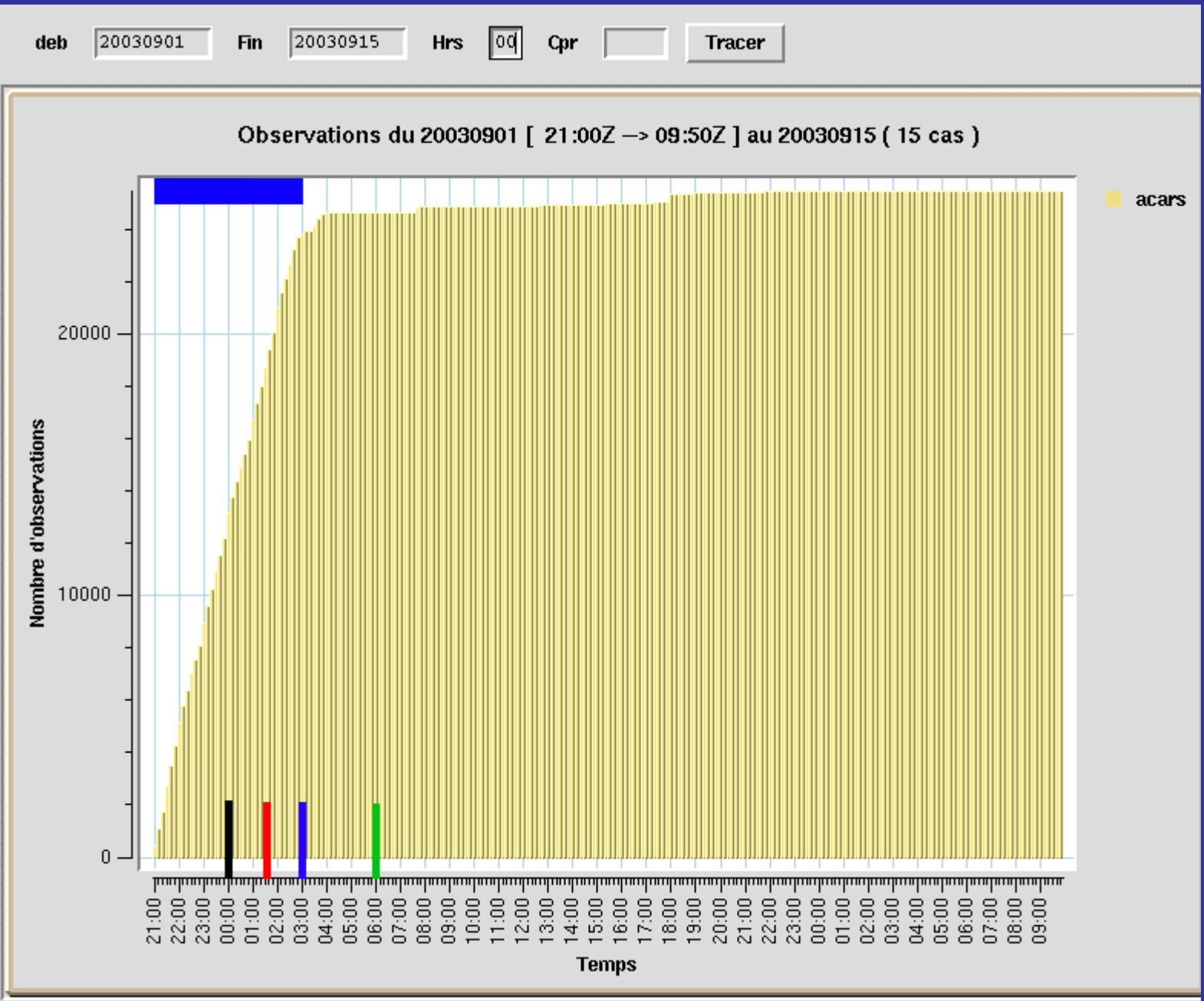
OSE Results

Summer period, impact of the removal of TOVS vs Radiosondes of upper-air network

Anomaly correlation Geopotential Heights 500 hPa



Reception time of BUFR aircrafts observations in CMC database
Period 00 UTC, from 01 September 2003 to 15 September 2003



6-hour validity period

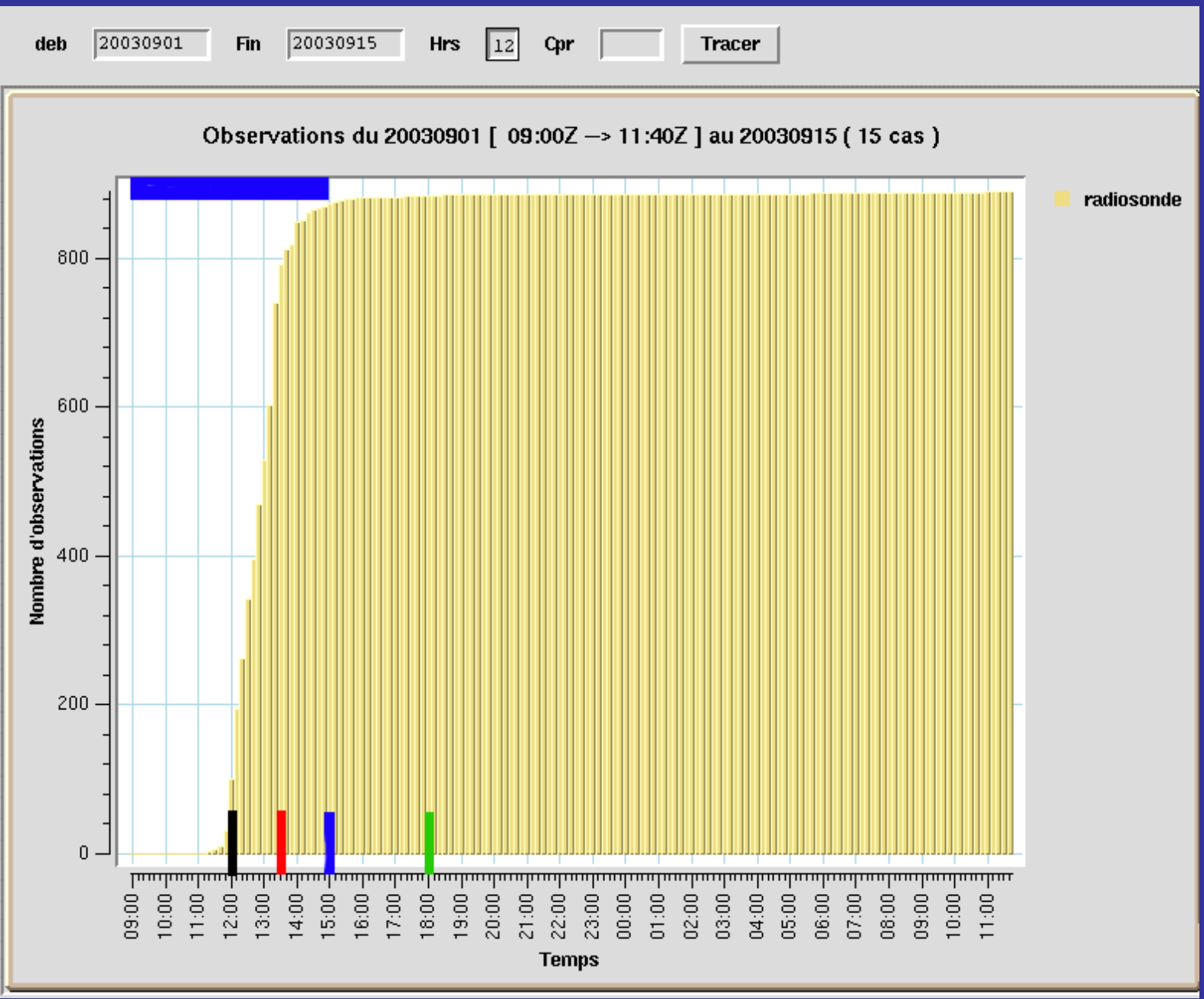
Synoptic time

T+1h30

T+3h00

T+6h00

Reception time of RAOBS observations in CMC database
Period 12 UTC, from 01 September 2003 to 15 September 2003



6-hour validity period

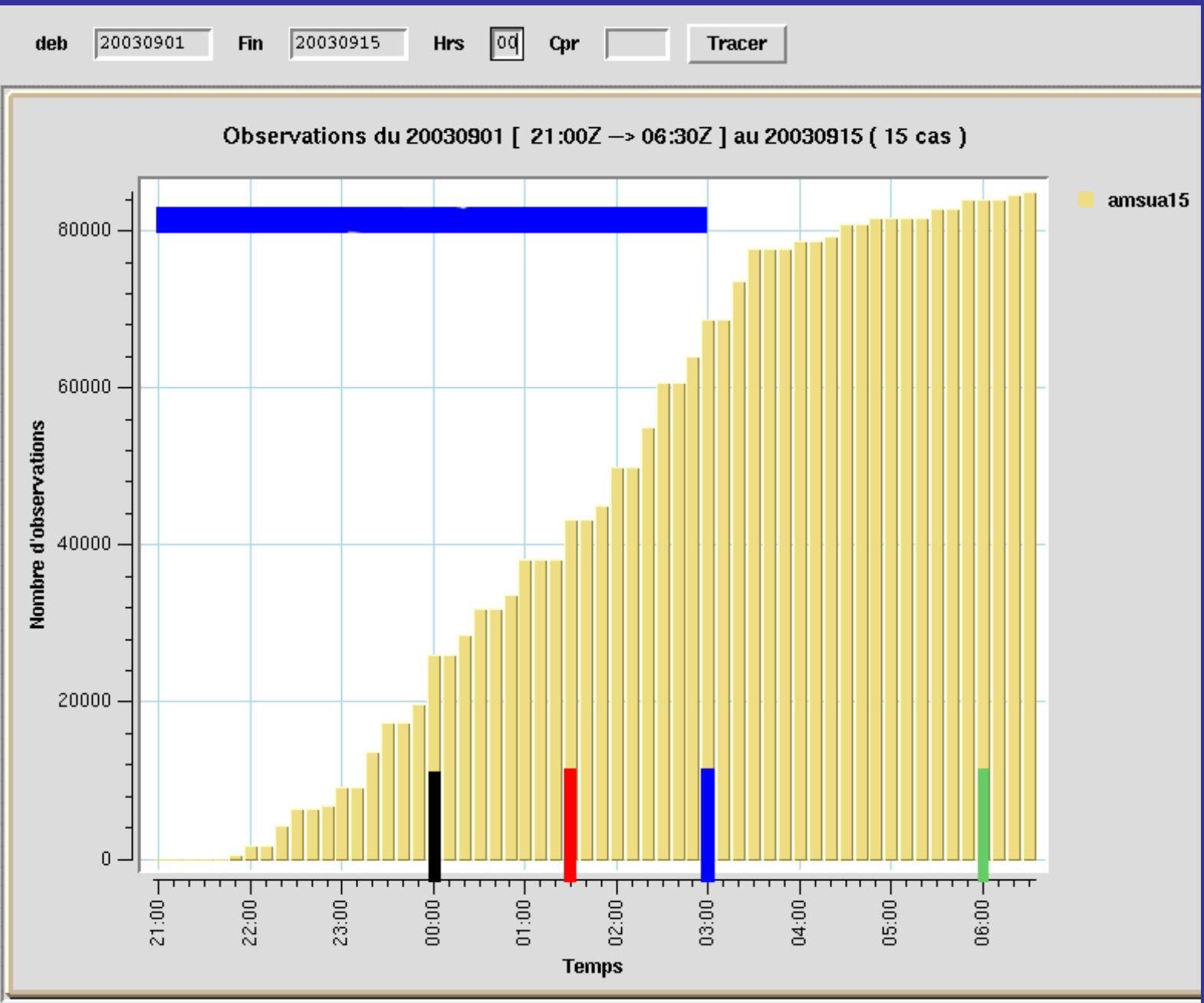
Synoptic time

T+1h30

T+3h00

T+6h00

Reception time of AMSU-A ATOVS observations in CMC database
Period 00 UTC, NOAA-15, from 01 September 2003 to 15 September 2003



6-hour validity period

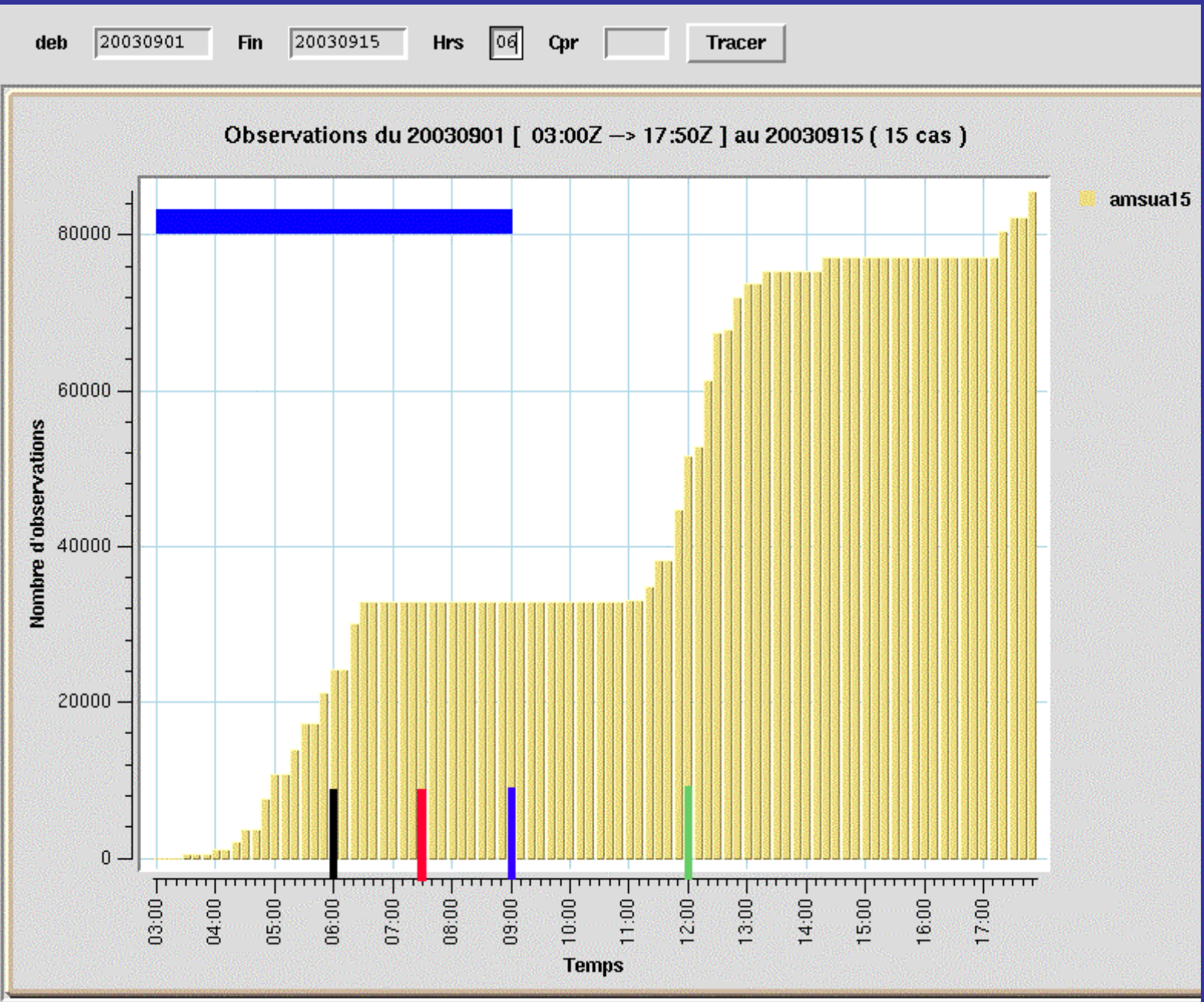
Synoptic time

T+1h30

T+3h00

T+6h00

Reception time of AMSU-A ATOVS observations in CMC database
Period 06 UTC, NOAA-15, from 01 September 2003 to 15 September 2003



6-hour validity period

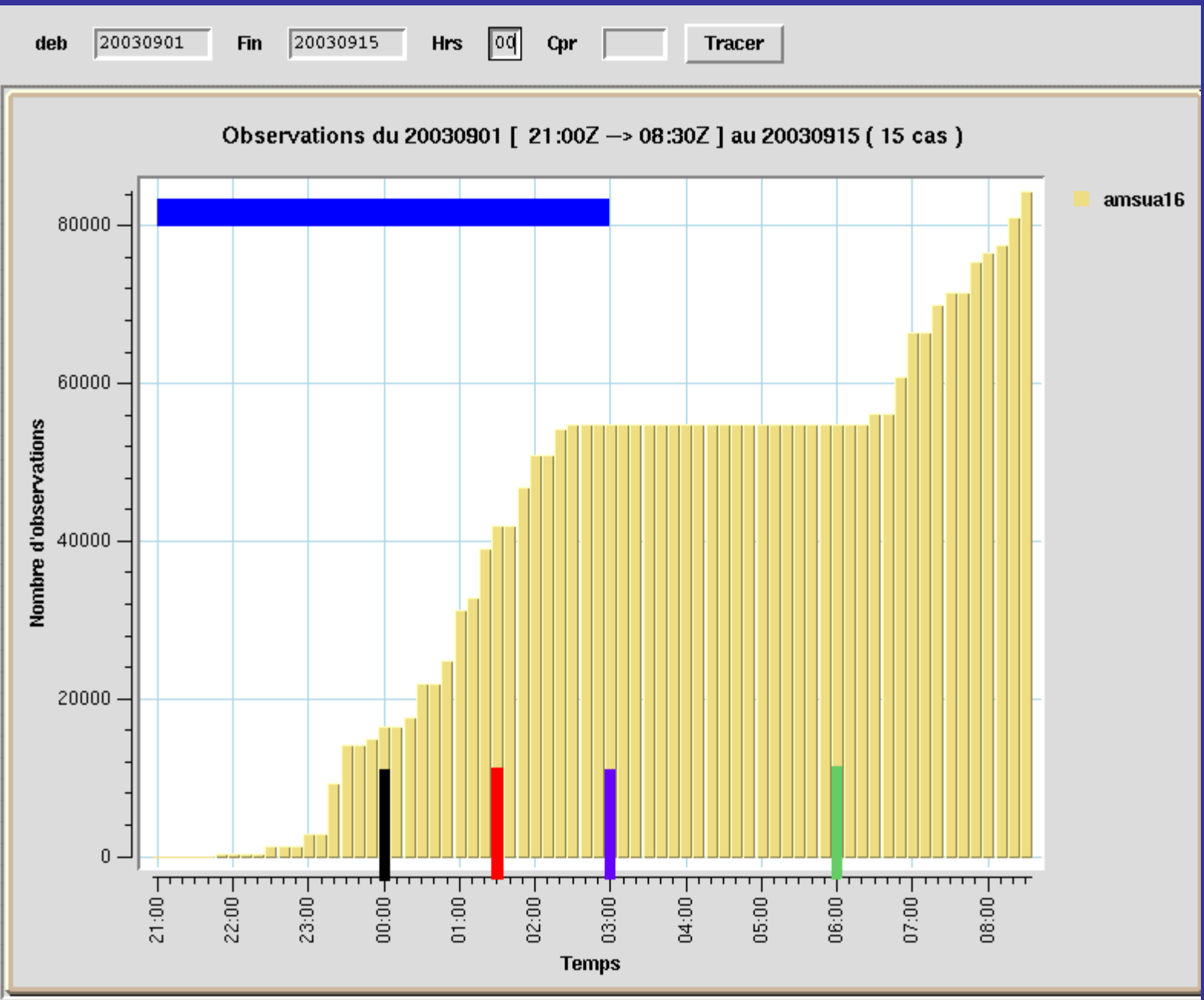
Synoptic time

T+1h30

T+3h00

T+6h00

Reception time on AMSU-A ATOVS observations in CMC database
Period 00 UTC, NOAA-16, from 01 September 2003 to 15 September 2003



6-hour validity period

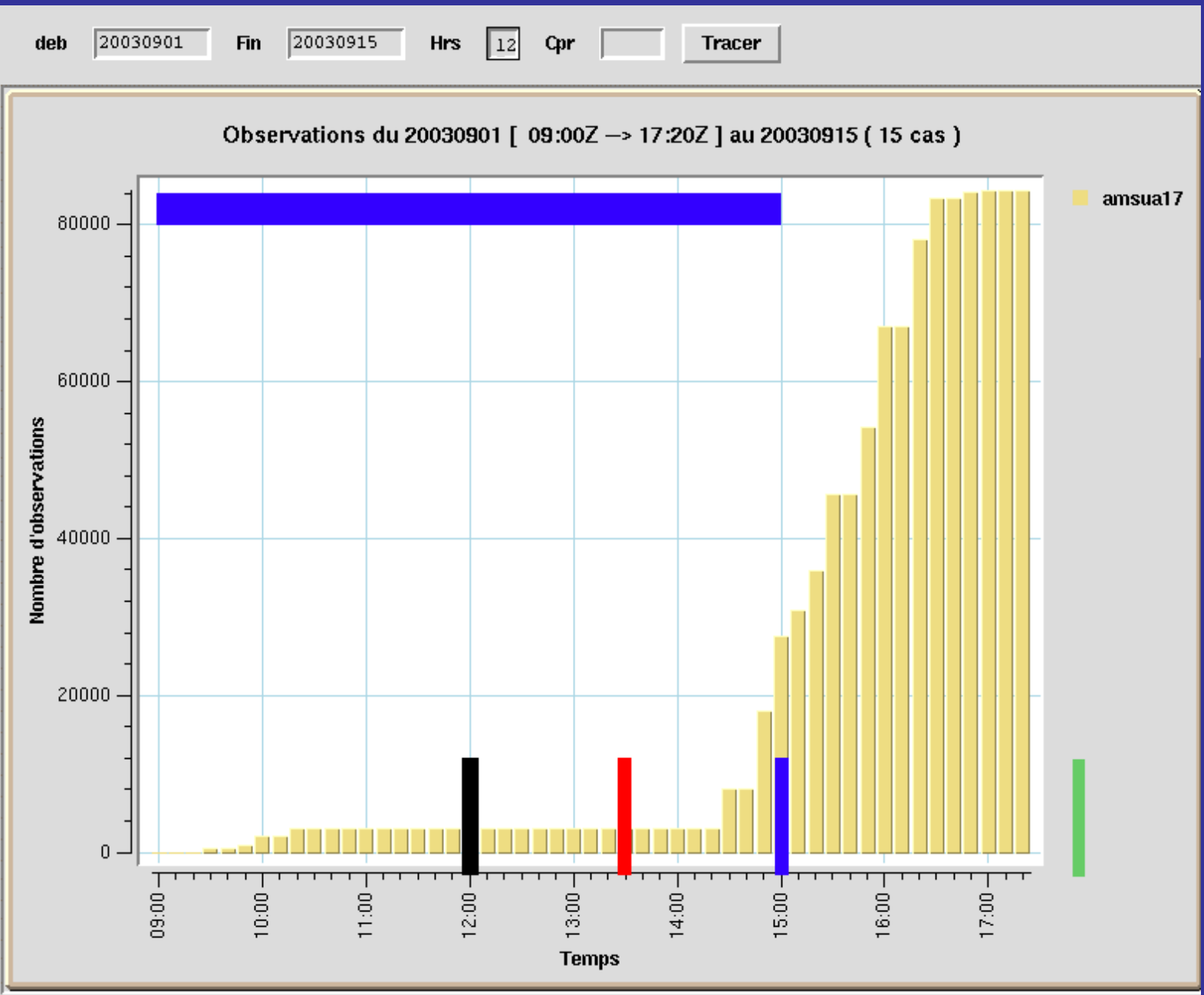
Synoptic time

T+1h30

T+3h00

T+6h00

Reception time of AMSU-A ATOVS observations in CMC database
Period 12 UTC, NOAA-17, from 01 September 2003 to 15 September 2003



6-hour validity period

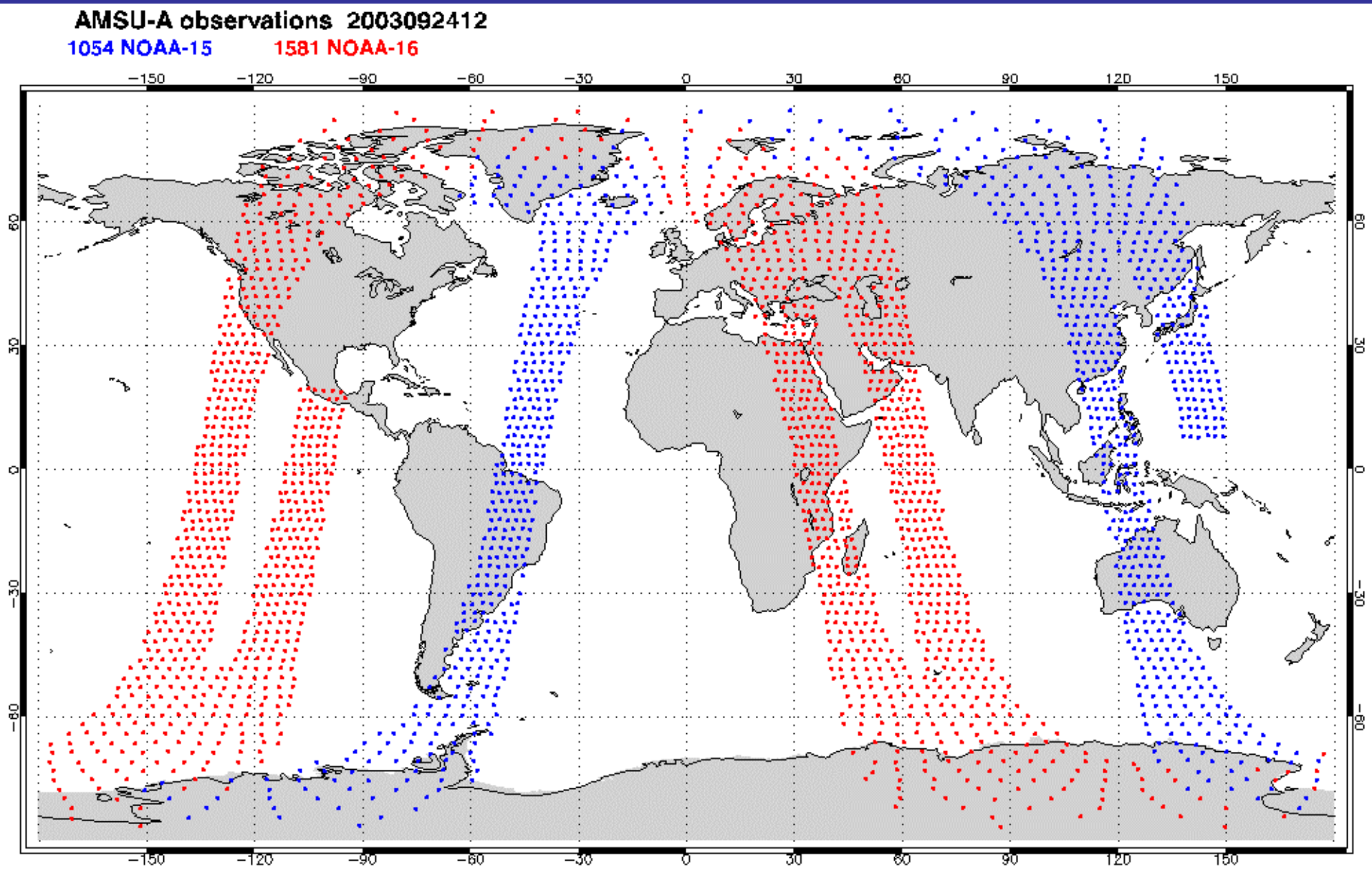
Synoptic time

T+1h30

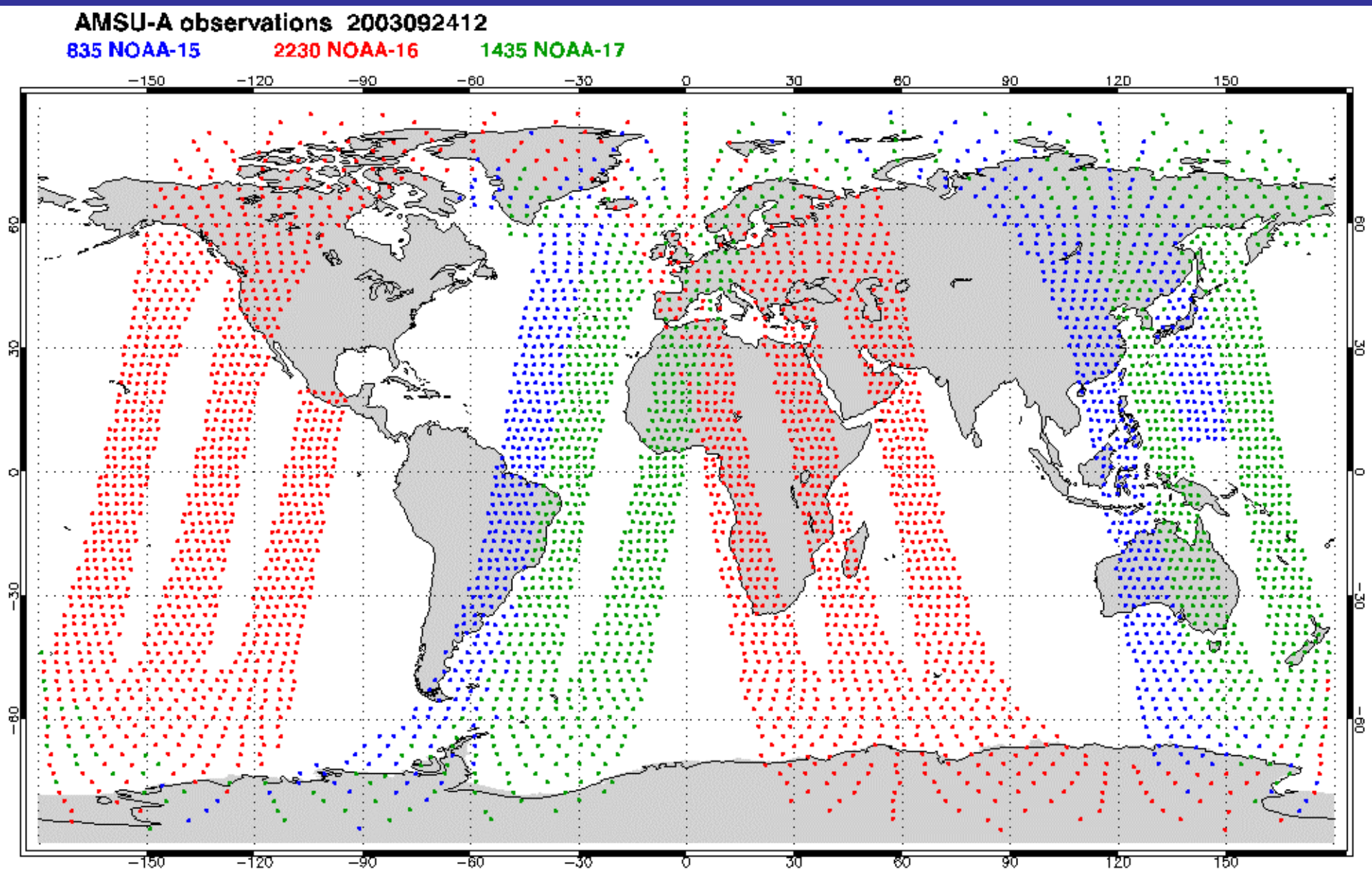
T+3h00

T+6h00

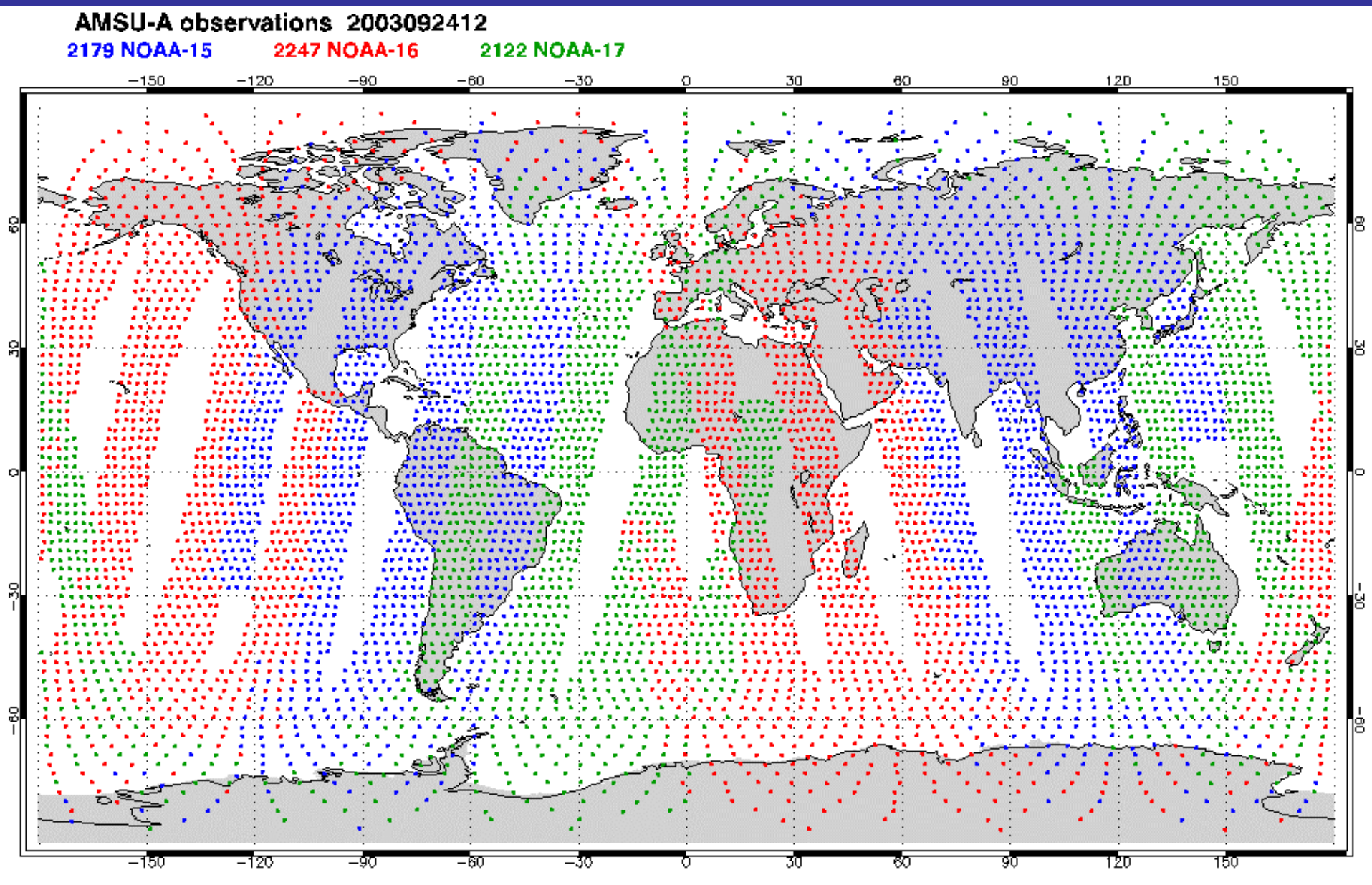
Example of NOAA Satellites AMSU-A ATOVS coverage after thinning, T+1h40 observation cut-off time, 24 September 2003, 12 UTC



Example of NOAA Satellites AMSU-A ATOVS coverage after thinning, T+3h00 observation cut-off time, 24 September 2003, 12 UTC



Example of NOAA Satellites AMSU-A ATOVS coverage after thinning, T+9h00 observation cut-off time, 24 September 2003, 12 UTC



Impact of cut-off time in a 3DVar assimilation cycles

Experiments:
6-hourly assimilation cycles with various cut-off times and
6-day forecasts run every 12 hours (00 UTC and 12 UTC)
during a 5-week verification period from 2003083100 to 2003100412

- **G0:** cut-off time: T+1h40 at 00 & 12 UTC et T+1h20 at 06 & 18 UTC.

- **G1:** cut-off time: T+3h00 at 00 & 12 UTC et T+2h00 at 06 & 18 UTC.

* **G2:** cut-off time: T+9h00 at 00 & 12 UTC and T+6h00 at 06 & 18 UTC.

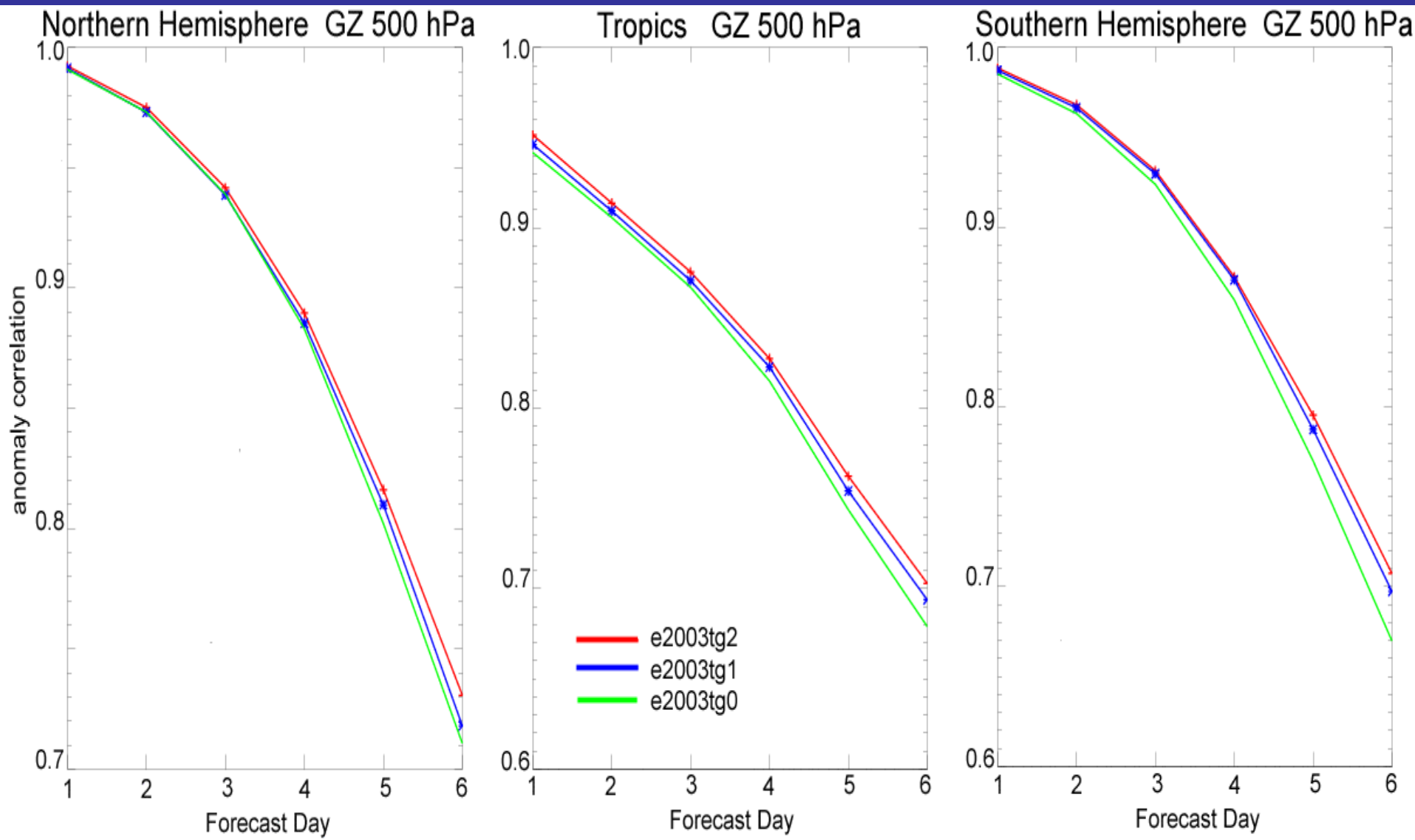
- **G3:** cut-off time: T+24h00 at 00, 06, 12 and 18 UTC.

OPS: operational forecasts, FG from G2 with analysis at T+3h00

Impact of observational data cut-off time in the assimilation cycle

Red line: operational cycle, T+9h00
Blue line: rapid update, T+3h00
Green line: early, T+1h40

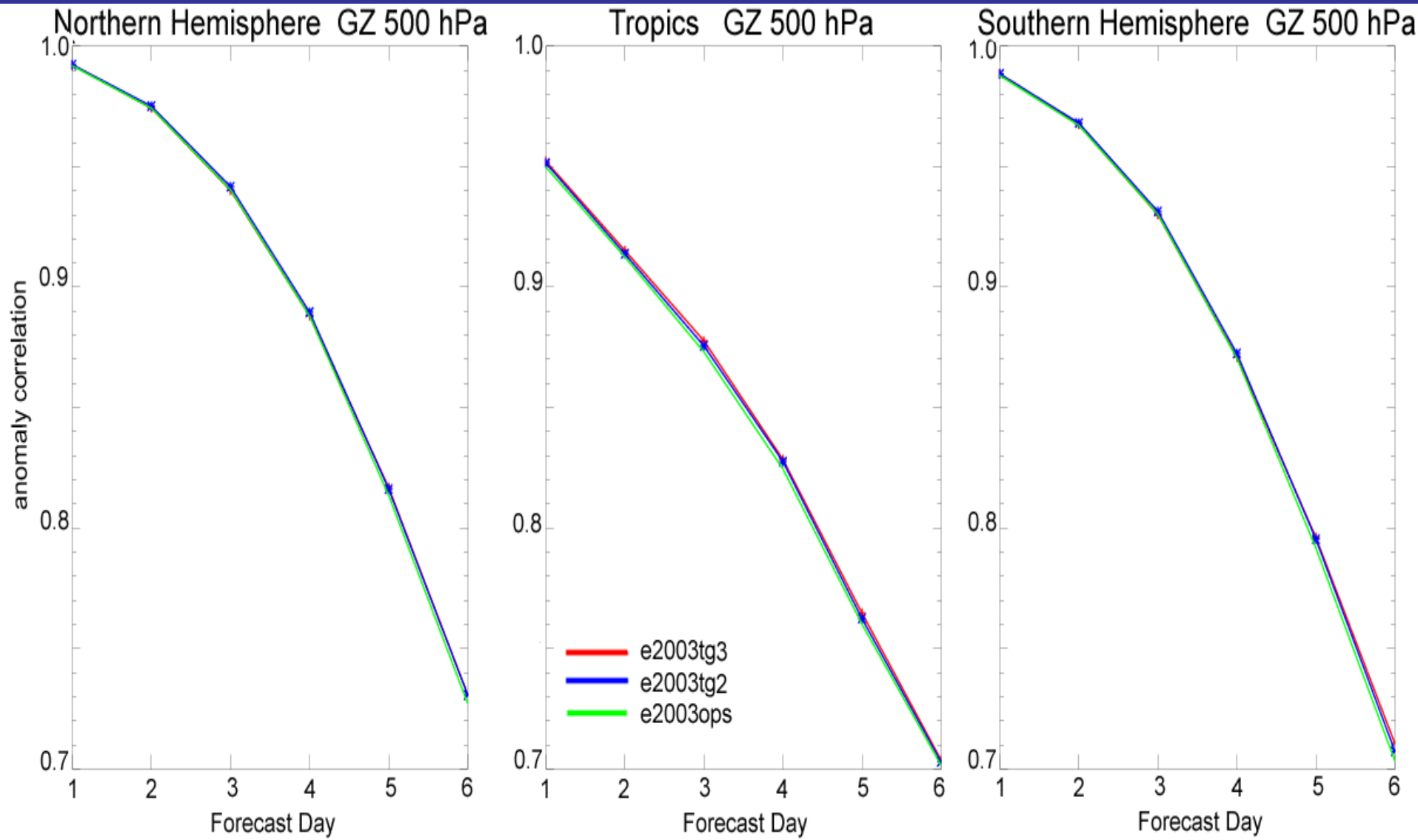
Anomaly correlation



Impact of observational data cut-off time in the assimilation cycle

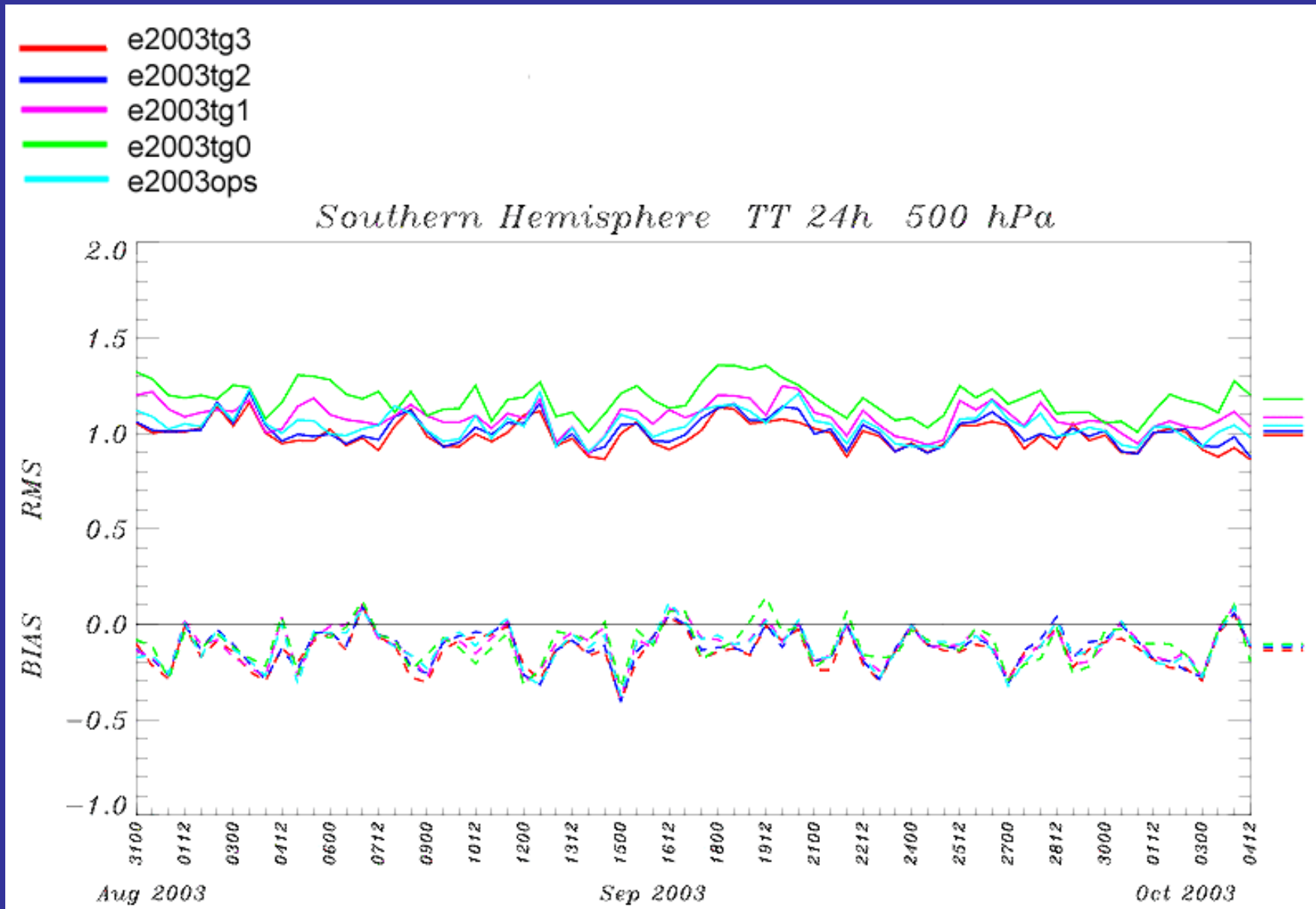
Anomaly correlation

Red Line: T+24h00 cycle Blue line: operational cycle, T+9h00
Green line: operational forecasts from T+3h00 analyses



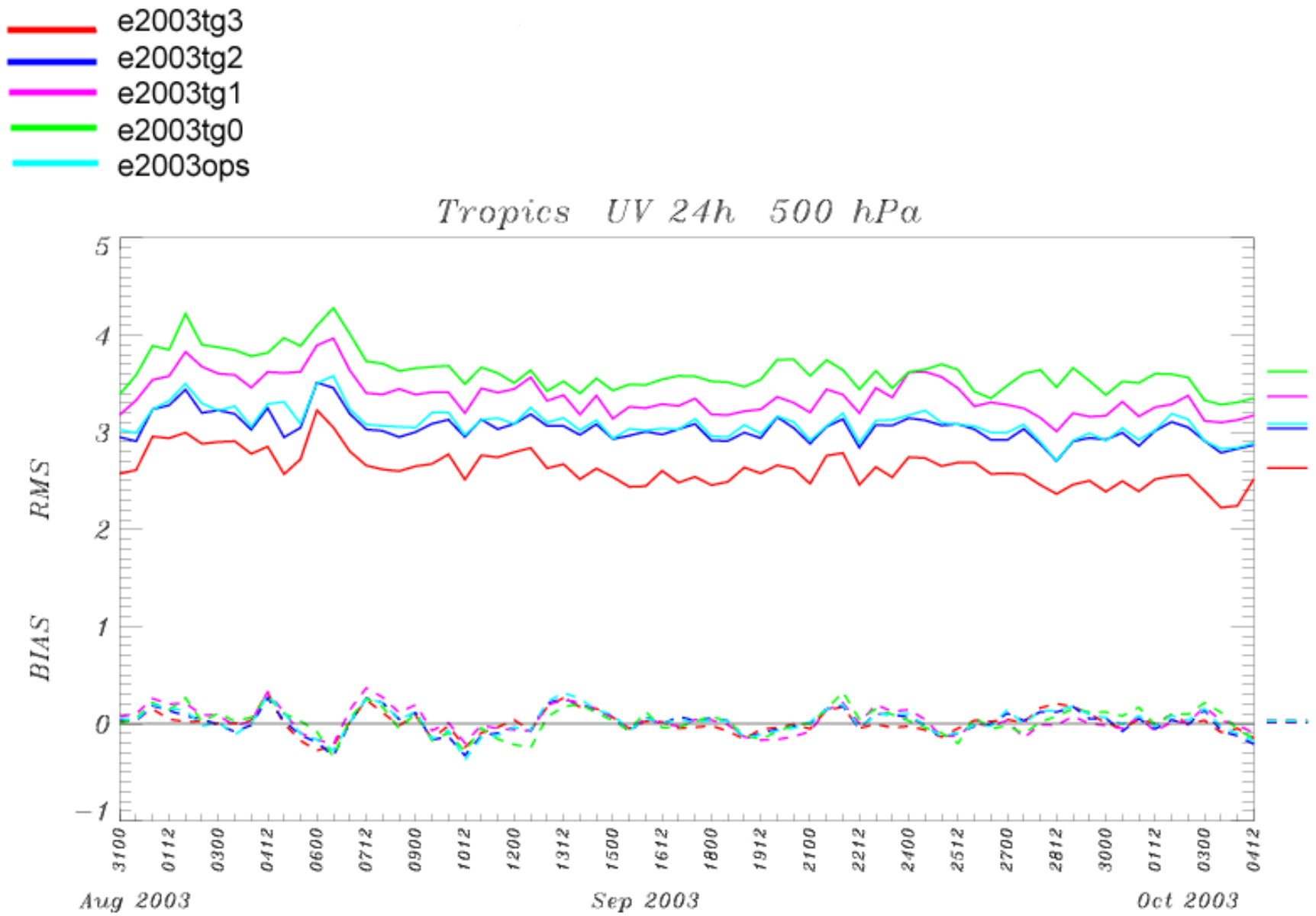
RMSE of Temperature 24-hour forecasts over the Southern Hemisphere

Verification against analyses



RMSE of Wind Speed 24-hour forecasts over the Tropics

Verification against analyses



Global System

- Now: - Uniform resolution of 100 km (400 X 200 X 28)
  - 3D-Var at T108 on model levels, 6-hr cycle, use of raw radiances from AMSUA, AMSUB and GOES

- 2004: - Resolution to 35 km (800 X 600 X 80)
  - Top at 0.1 hPa (instead of 10 hPa) with additional AMSUA and AMSUB channels
  - 4D-Var assimilation, 6-hr time window with 3 outer loops at full model resolution and inner loops at T108 (cpu equivalent of a 5-day forecast of full resolution model)
  - new datasets: profilers, MODIS winds, QuikScat

- 2005: - assimilation of AIRS, MSG, MTSAT
  - revised 4D-Var statistics

- 2006-07: - Additional datasets: IASI, GIFTS, COSMIC…
  - very large increase in volume of assimilated data

Final Remarks

- Satellite observations and the upper air network have a large impact in the quality of CMC NWP products

- Among observing systems in the southern hemisphere, the use of satellite data provides the largest improvement to the forecast quality

- Operational NWP centers, such as the CMC, must maintain an assimilation cycle with relatively long observations cut-off time as the central part of their NWP suite in order to maximize the quality of their products

- Planning and investment in timely reception and processing of satellite data is essential to realise the full potential of satellite observing systems in operational NWP suites with short cut-off times