Status, Plans and first results of CERA-20C

Patrick Laloyaux

Acknowledgements : Hans Hersbach, Paul Poli, Massimo Bonavita, Magdalena Balmaseda, Kristian Mogensen, Eric de Boisseson, Per Dahlgren, Dinand Schepers, Shoji Hirahara, Sami Saarinen, Elias Holm, Lars Isaksen, Jean Bidlot, Hao Zuo, Manuel Fuentes, Oliver Treiber, Will Weir, Christian Weihrauch, Peter Janssen, Jean-Noel Thépaut, Dick Dee, Roberto Buizza

ECMWF
EUROPEAN CENTRE FOR MEDIUM RANGE WEATHER FORECASTS

CRA CLIM 2

SEVENTH FRAMEWORK PROGRAMME

Outline

1. Science behind the coupled assimilation system
2. Configuration for CERA-20C production
3. First results from the monitoring tools

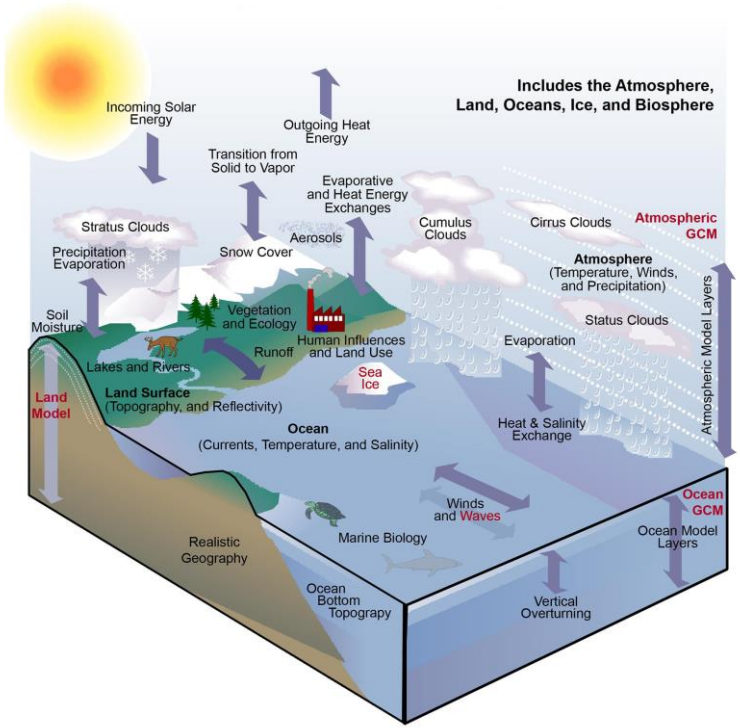
CERA-20C: global coupled reanalysis of the 20th century

Observation selection:

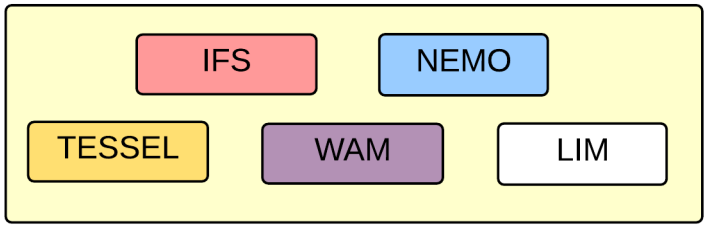
- Atmosphere: conventional surface observations (pressure and marine wind)
- Ocean: temperature and salinity profiles
- Air-sea interface: Sea Surface Temperature analysis product

Methodology for CERA-20C:

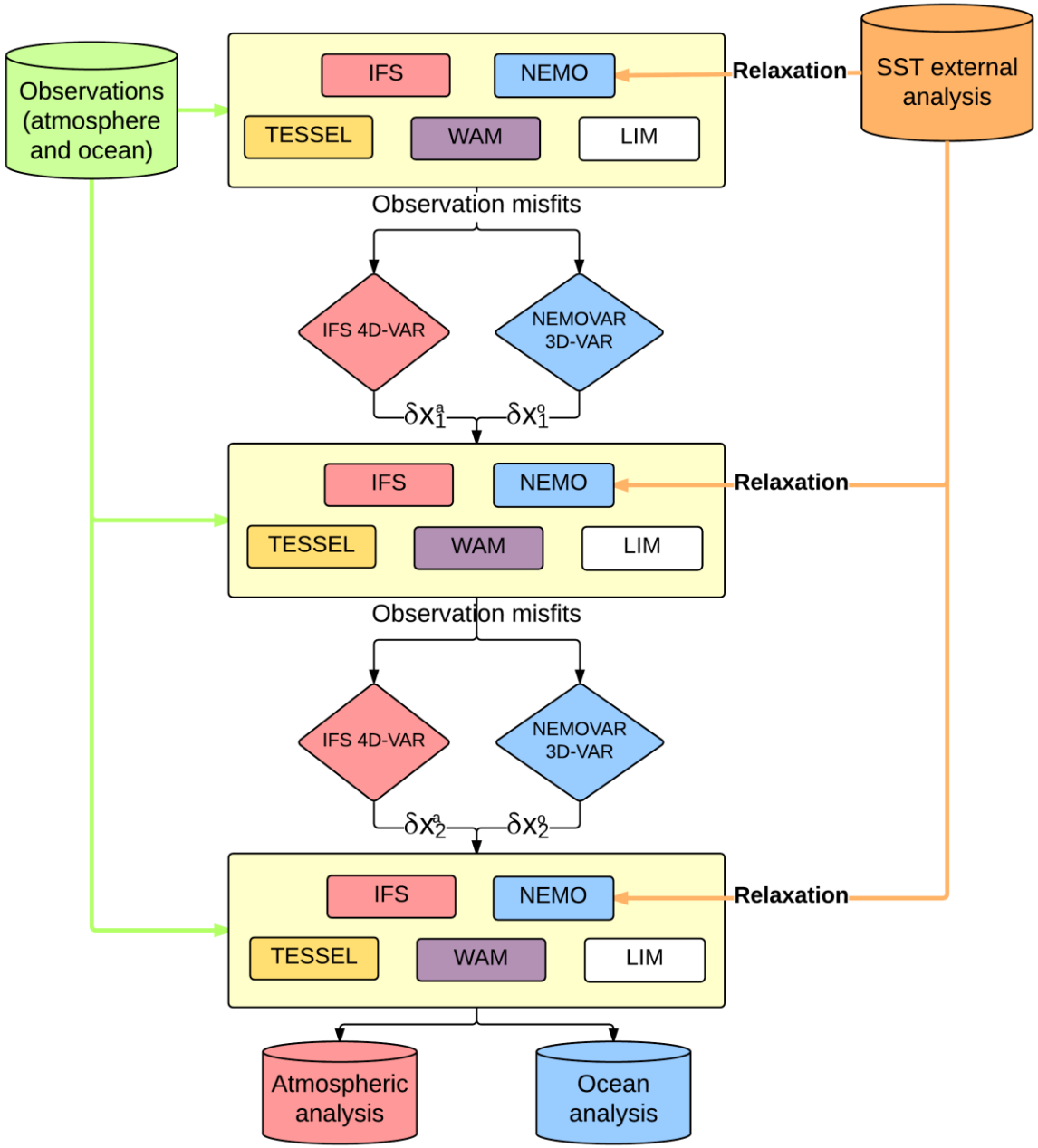
- observations are assimilated by the coupled Earth model developed at ECMWF



ECMWF coupled Earth model



Coupled data assimilation system

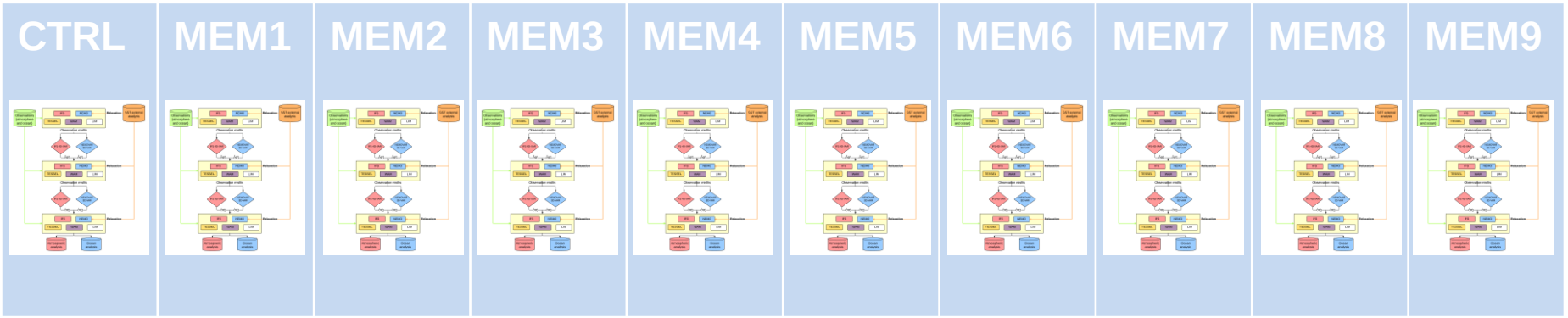


- atmospheric and ocean observations are assimilated simultaneously with a 24-hour assimilation cycle
- observation misfits computed by the coupled model
- atmospheric and ocean increments are computed in parallel
- SST computed in NEMO and constrained by relaxation
- ocean observations can impact atmospheric estimate and conversely

Ensemble of coupled data assimilation systems

10-member ensemble with perturbations:

- atmospheric and ocean observations
- different realisations for HadISST2
- stochastic physics in IFS atmospheric model



Ensemble technique:

- provide a measurement of uncertainty (spread of the ensemble)
- provide flow dependent background error for the atmosphere

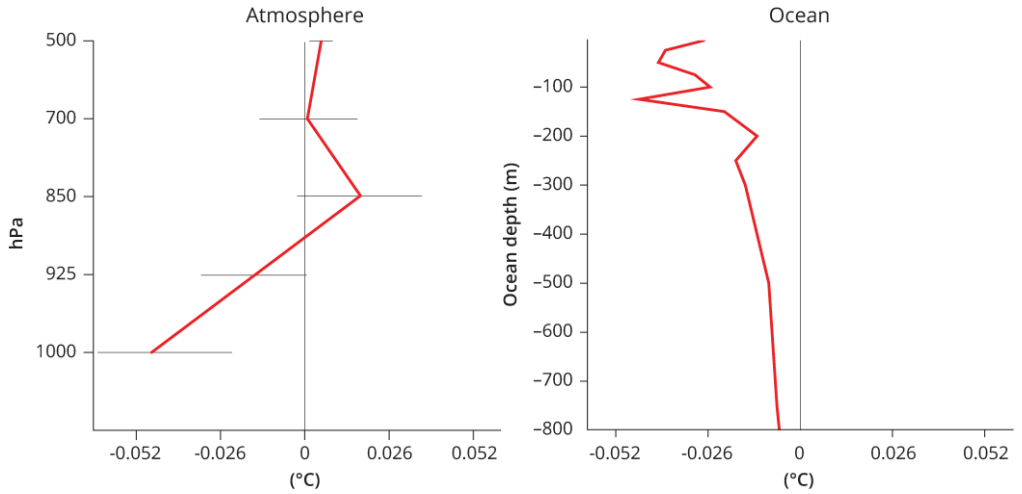
Scientific publications on the coupled assimilation system

A coupled data assimilation system for climate reanalysis

P. Laloyaux, M. Balmaseda, D. Dee, K. Mogensen and P. Janssen. QJRMS. In press.

"Atmosphere-ocean coupling in the assimilation process produces a background closer to observations near the air-sea interface"

(Difference in background temperature RMSE, Tropics, Sept. 2010)

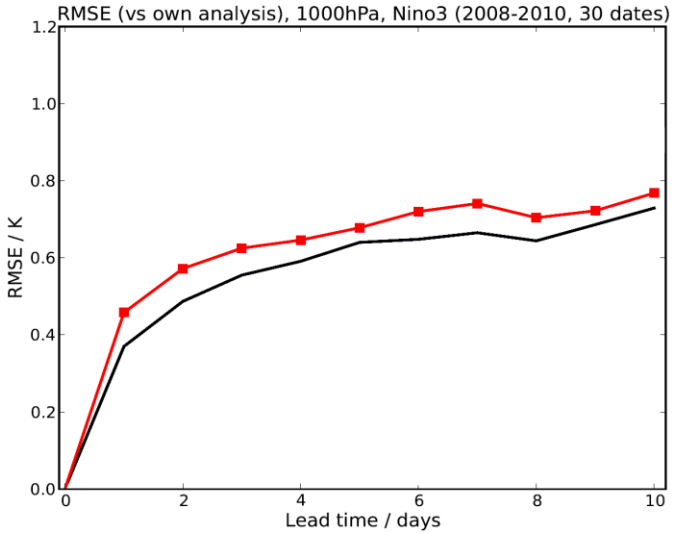


Origin and impact of initialisation shocks in coupled atmosphere-ocean forecasts

D. Mulholland, P. Laloyaux, K. Haines, M. Balmaseda. MWR. In Press.

"Initialising coupled forecasts with a coupled analysis reduces air temperature forecast error near the surface"

(Temperature forecast RMSE at 1000 hPa with respect to their own analysis, Nino3 over 2008-2010)



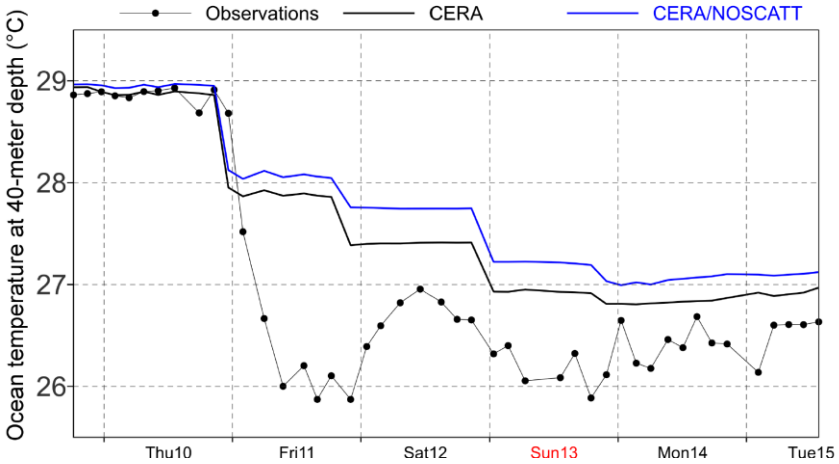
Scientific publications on the coupled assimilation system

Impact of scatterometer wind data in the ECMWF coupled assimilation system

P. Laloyaux, J.-N. Thépaut and D. Dee. MWR. Submitted.

“In the coupled assimilation system, any adjustment due to observations near the surface affect both atmospheric and oceanic variables**”**

(Cold wake estimation at 40-meter-depth, tropical cyclone Phailin)



Outline

1. Science behind the coupled assimilation system
2. Configuration for CERA-20C production
3. First results from the monitoring tools

CERA-20C production

ECMWF HPC system:

- two identical Cray XC30 clusters
- 3,505 compute nodes
- 84,120 compute cores

Shared between Forecast Departement, Research Departement and Member States

Up to 15% of one cluster can be dedicated to CERA-20C

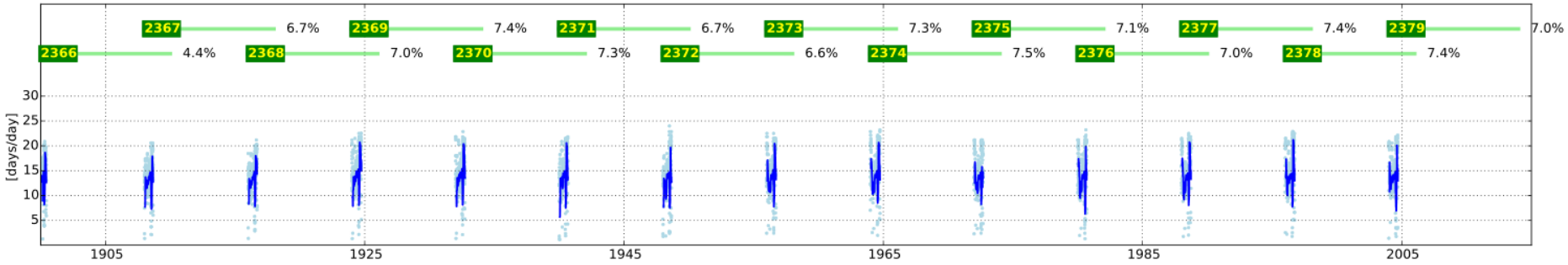
Close collaboration with High Performance Computing (HPC) and Data Handling System (DHS) teams

CERA-20C production

The period 1900-2010 is divided in 14 streams of 9 years

All the streams run at the same time to respect the production schedule

Overlap of one year to prevent discontinuities in the 110-year data set



Initialisation of the streams:

- for the atmosphere: ERA-20C reanalysis from ERACLIM
- for the ocean: no extended ocean reanalysis of the 20th century (see Eric's talk)

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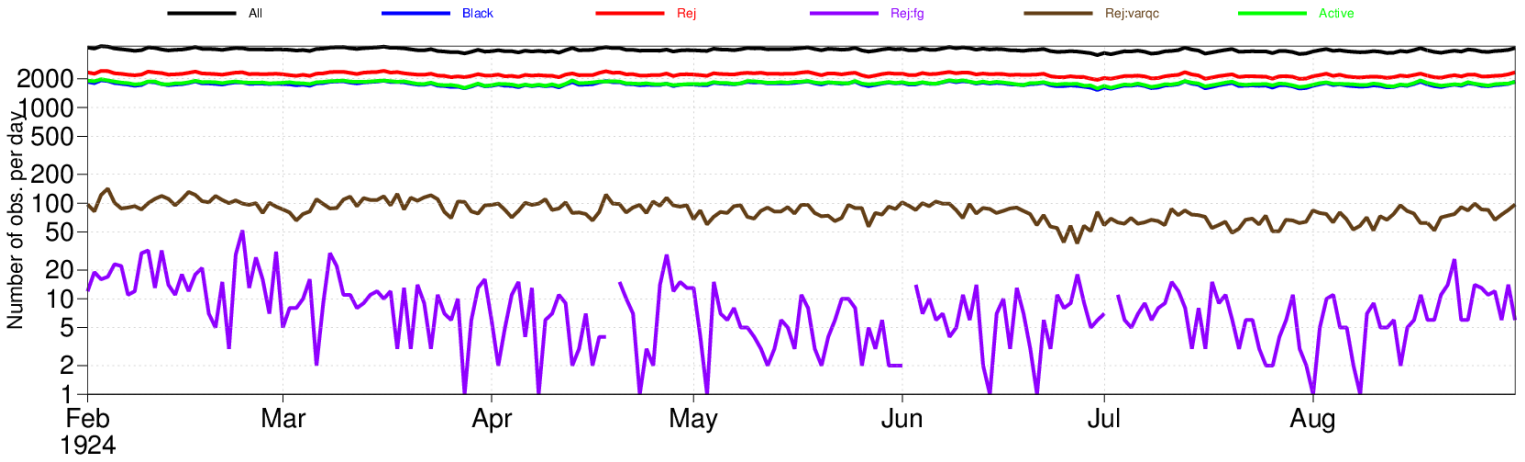
Observation usage: mean-sea level pressure

All

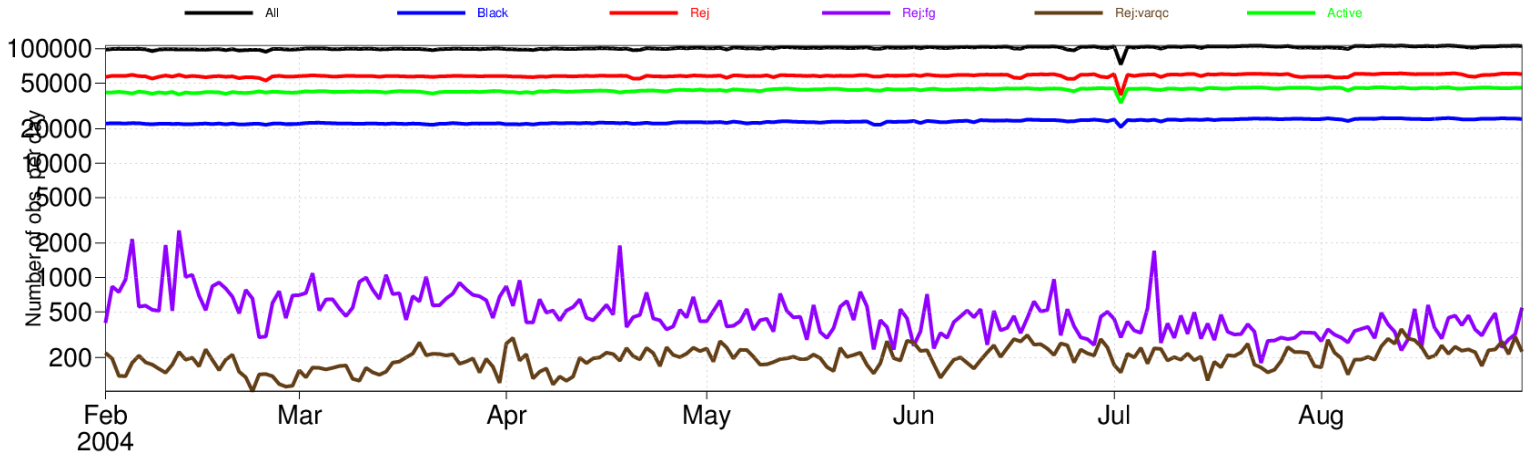
Blacklisted

Rejected (Rejected first guess value too large, Rejected by the variational quality control)

Active



Year 1924
Feb-Jun



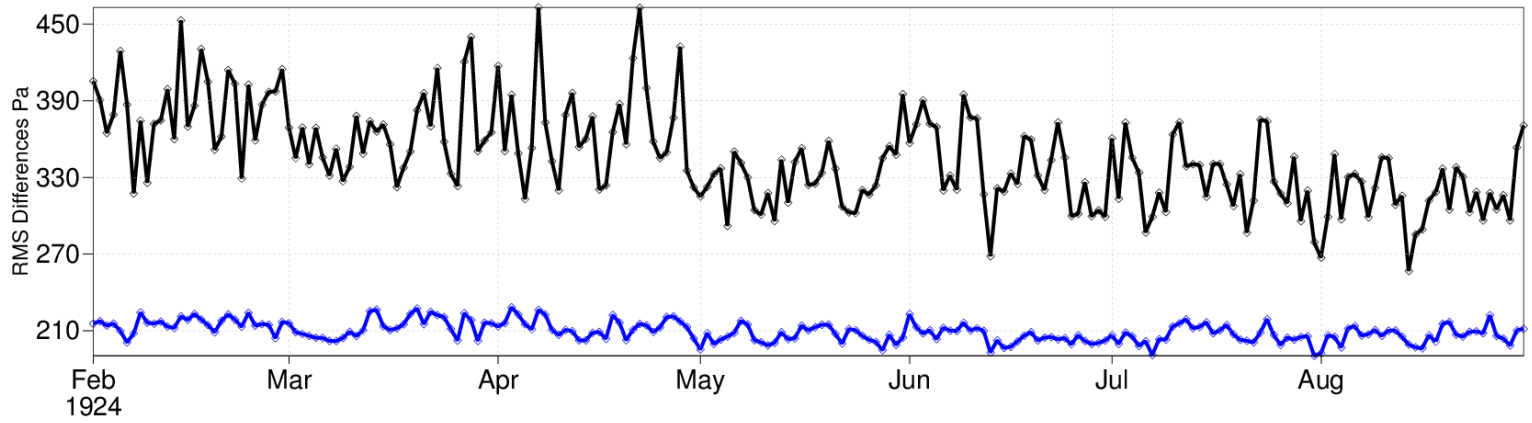
Year 2004
Feb-Jun

Used to spot any issues with input observational datasets

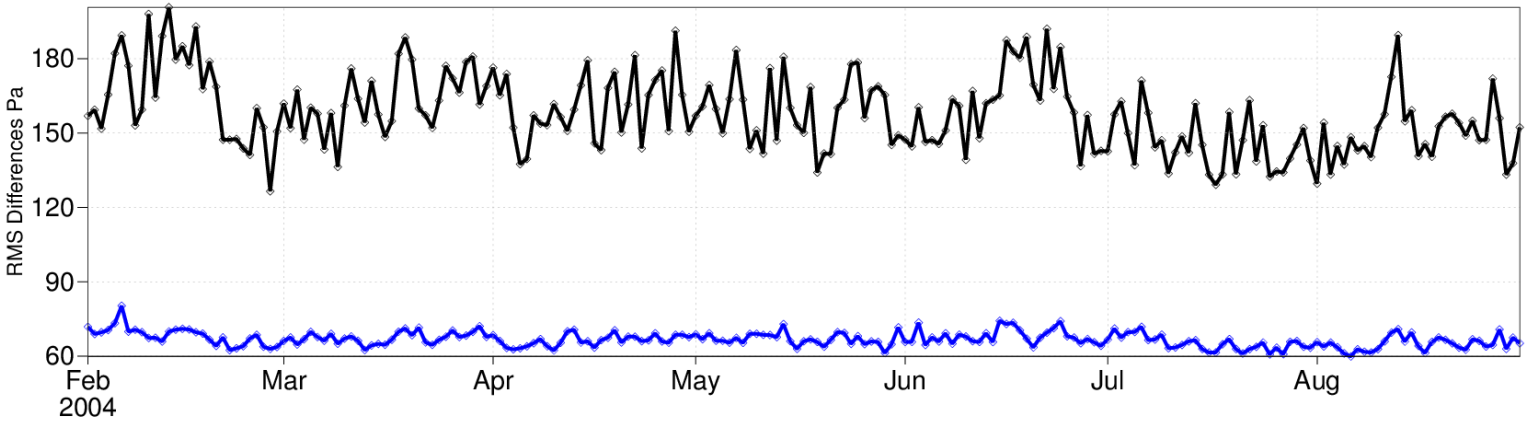
Departure statistics: mean-sea level pressure

Background RMS departure (fit to observations before assimilation)

Analysis RMS departure (fit to observations after assimilation)



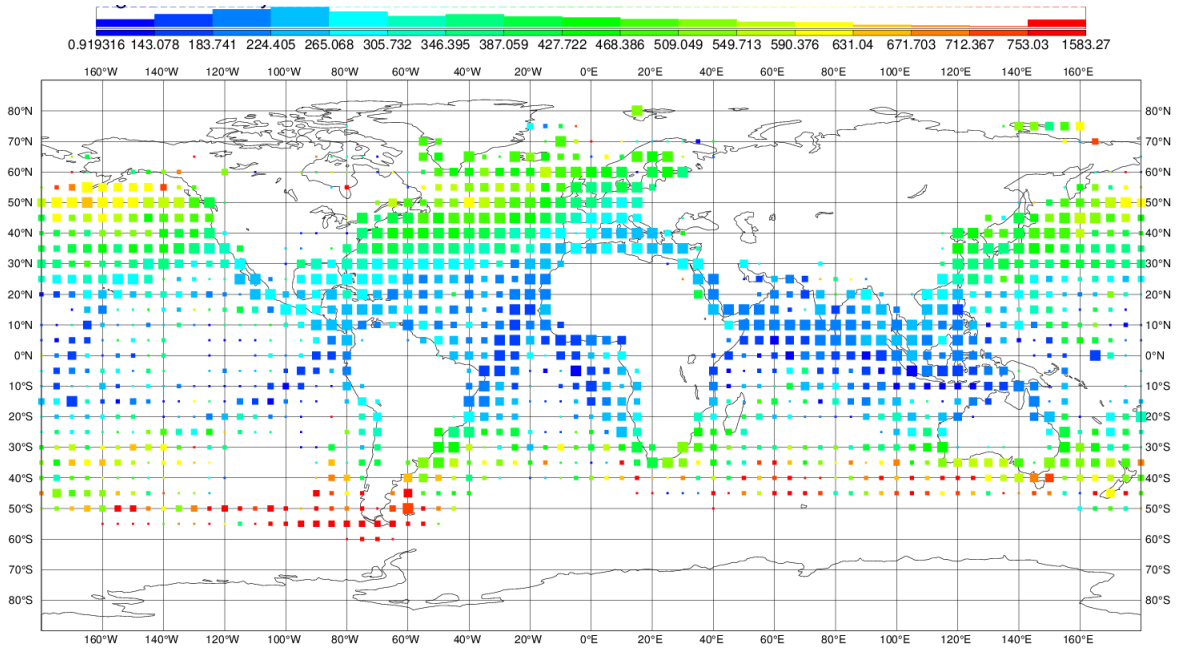
Year 1924
Feb-Jun



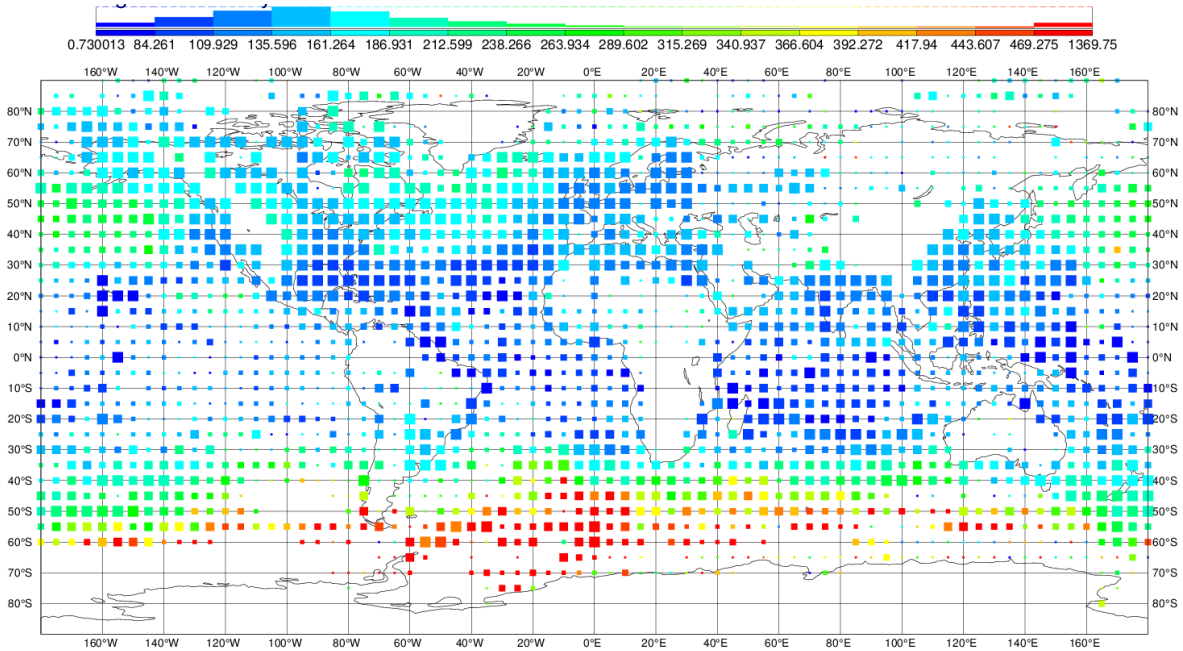
Year 2004
Feb-Jun

Background departure is an important metric showing how much the model is capable of retaining the assimilated information from one window to the next one

Departure statistics: mean-sea level pressure



Background departure
Year 1924 Feb-Jun

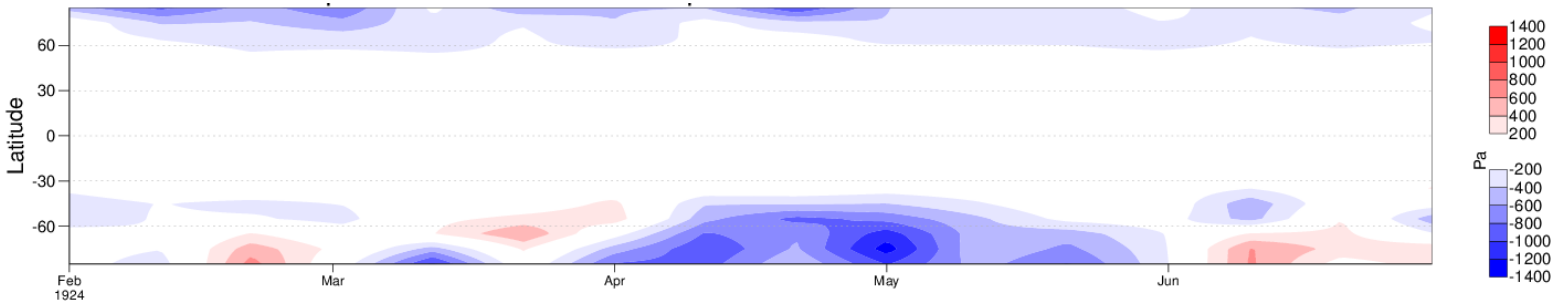


Background departure
Year 2004 Feb-Jun

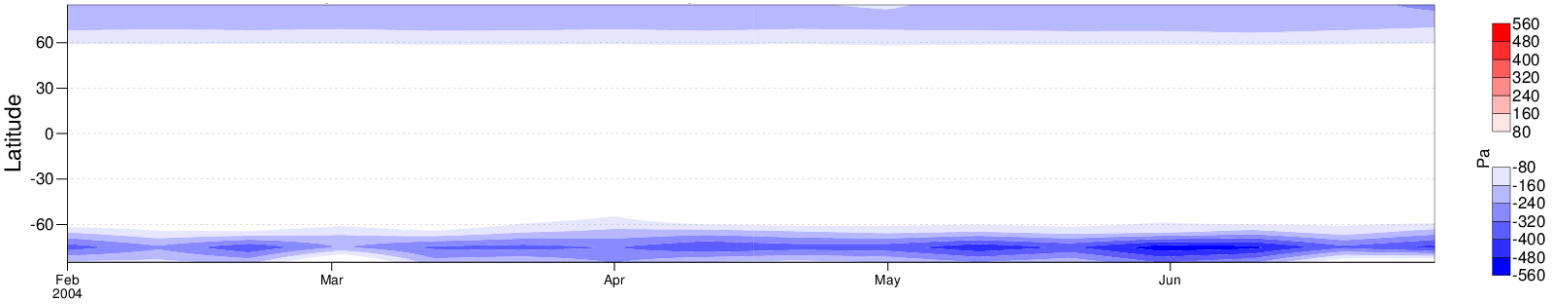
Background departures
larger at the poles

Comparison between CERA-20C and ERA-20C analyses

Mean difference between CERA-20C and ERA20C mean-sea level pressure analysis



Year 1924
Feb-Jun



Year 2004
Feb-Jun

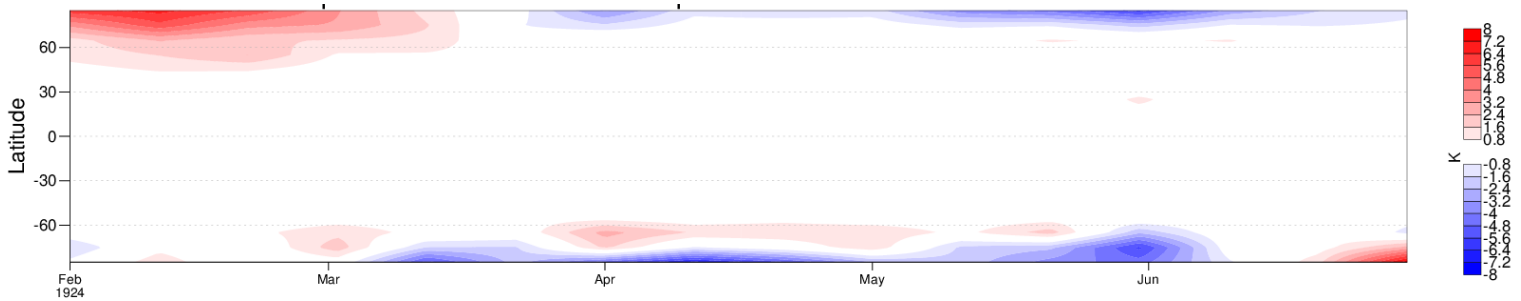
Differences between analyses located at higher latitude

MSLP lower in CERA20C

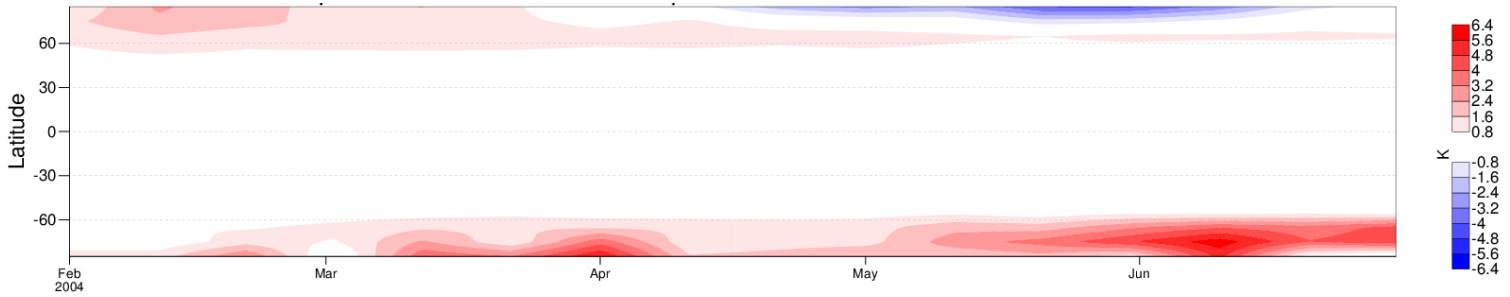
- up to 10hPa in 1924 (daily difference)
- up to 5hPa in 2004 (daily difference)

Comparison between CERA-20C and ERA-20C analyses

Mean difference between CERA-20C and ERA20C 2-meter temperature analyses



Year 1924
Feb-Jun



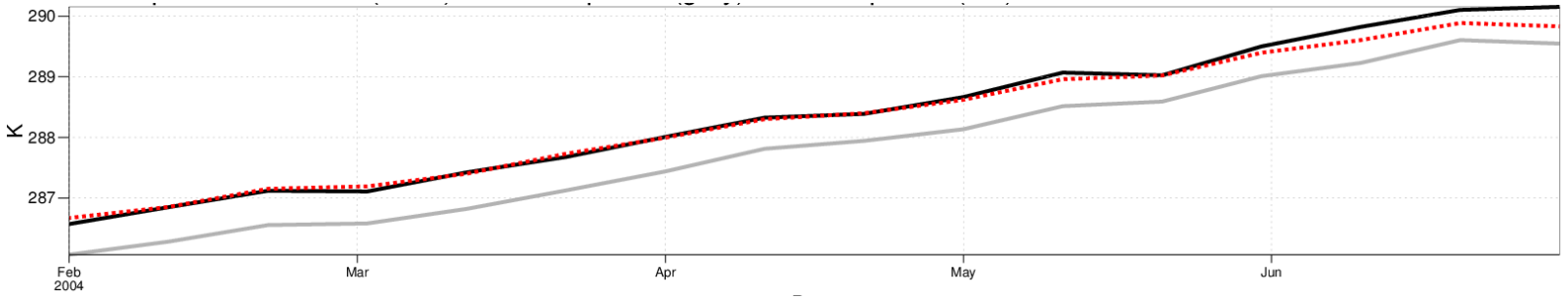
Year 2004
Feb-Jun

Difference between analyses located at higher latitude
2-meter temperature higher in CERA20C for 2004: up to 4°C (daily difference)

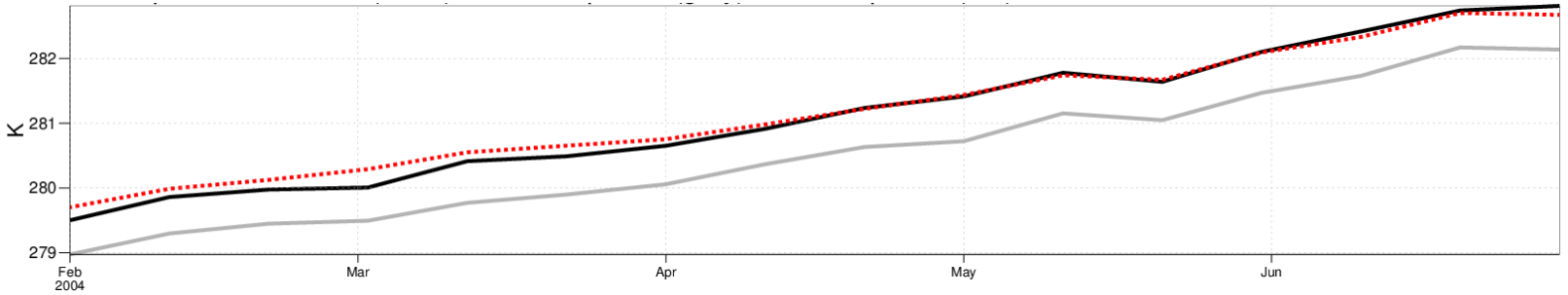
Timeseries for Essential Climate Variables

CERA-20C
ERA-20C
ERA-Interim (assimilating surface, upper air and satellite observations)

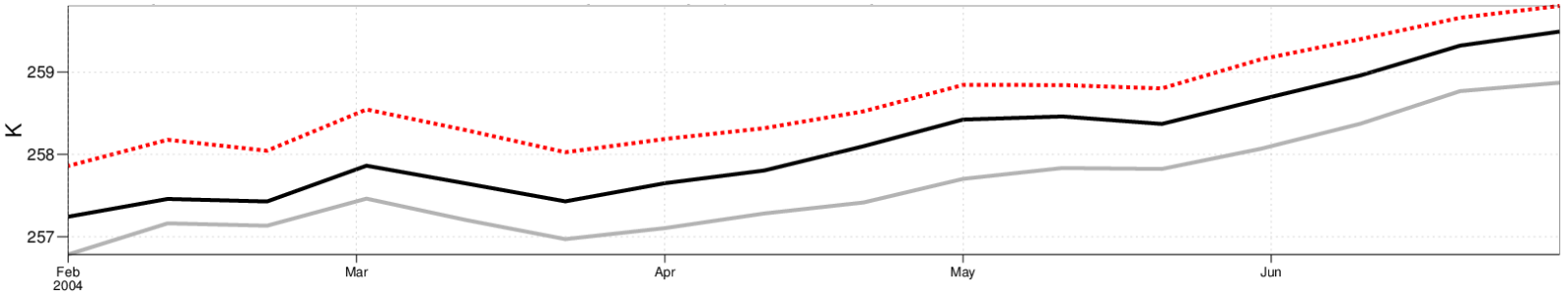
Year 2004
Feb-Jun



T°1000hPa



T°850hPa



T°500hPa

CERA-20C temperature closer to ERA-Interim near the surface and in the troposphere

More monitoring and diagnostics

- 14000 plots already created for monitoring
- monitoring uncertainties and ensemble spread in atmosphere (Per's talk)
- webpage to monitor online the production (Dinand's talk)
- surface observation usage (Shoji's talk)
- ocean monitoring (Eric's talk)

Next steps after CERA-20C production:

- consolidation phase
- dissemination of the data (Patrick's talk on behalf of Manuel Fuentes)


Any questions?