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Optimisation of ERA-Interim Heat and Precipitations Surface Fluxes for Oceanic Reanalysis Purposes

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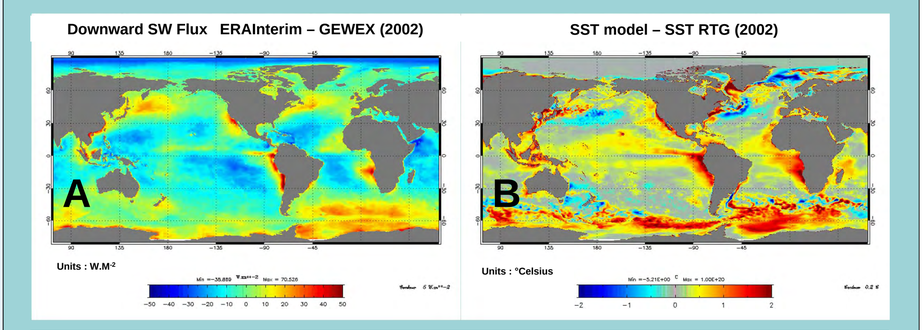
Mercator-Ocean developed several operational forecasting systems of the 3D-Ocean and produces also oceanic reanalysis. The strategy of atmospheric forcing is essential to improve the oceanic forecasts and analysis skills. All Mercator systems use the NEMO OGCM model and the atmospheric forcing from the European Centre for Medium Range and Weather Forecasts (ECMWF) together with a bulk formulation methodology to calculate all the air-sea fluxes (radiative, turbulent, freshwater and momentum).

In this study, we have estimated the main biases of the ERA-Interim radiative and precipitations fluxes at the global ocean surface by comparing them with fluxes issued from satellite measurements. From these results, a method has been developed to correct both the ERA-Interim radiative and precipitation fluxes for hindcasts (reanalysis) purposes. This method, fully described in the poster, has been designed in order to correct only the mean spatio-temporal bias of the ERAinterim surface fluxes.

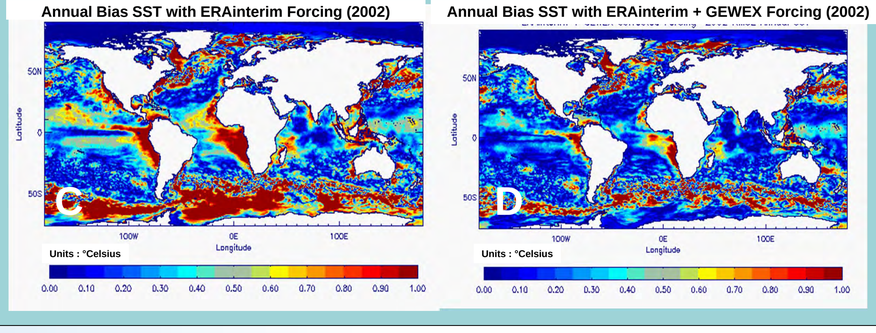
Corrected fluxes are then used to drive 21 years (1989-2009) inter annual experiments with the Mercator Ocean global ¼° configuration with no assimilation. With a general reduced amount of downwelling heat, the impact of the corrected radiative fluxes cools the global ocean by 0.3°C in average and reduces by 0.1°C (20 % of error) the mean global sea surface temperature bias. Similarly and with globally less precipitation, the corrected rainfalls lead to the increase and more realistic modelled sea surface salinity.

1 ERAinterim radiative fluxes and SST spatial errors structures.

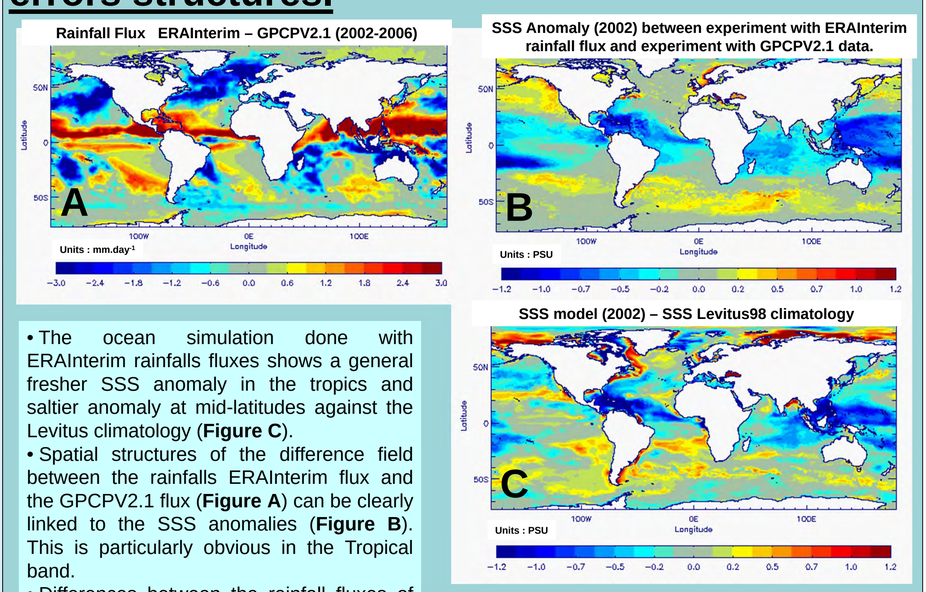


• The ocean simulation done with ERAInterim fluxes forcing shows a general warmer SST anomaly against the SST RTG (example for the year 2002 in **Figure B**).
• Spatial structures of the difference field between the downward ShortWave (SW) EraInterim and the SW Gewex fluxes (**Figure A**) can be linked to the SST anomalies. This is particularly obvious in the Austral ocean and in the upwelling eastern regions.
• Differences between the SW and LongWave (LW) fluxes of ERAInterim and Gewex are linked to misrepresentation of the clouds in the reanalysis (not shown).

Major SST improvements occur when using the Gewex data instead of the ERAInterim one (**Figures C and D** showing bias with SST RTG).



2 ERAinterim rainfalls fluxes and SSS spatial errors structures.



• The ocean simulation done with ERAInterim rainfalls fluxes shows a general fresher SSS anomaly in the tropics and saltier anomaly at mid-latitudes against the Levitus climatology (**Figure C**).
• Spatial structures of the difference field between the rainfalls ERAInterim flux and the GPCPV2.1 flux (**Figure A**) can be clearly linked to the SSS anomalies (**Figure B**). This is particularly obvious in the Tropical band.
• Differences between the rainfall fluxes of ERAInterim and GPCPV2.1 are also linked to misrepresentation of the clouds in the reanalysis (not shown).

Major SSS improvements occur when using the GPCPV2.1 data instead of the ERAInterim one (**Figure B**).

3 ERAInterim radiative and rainfalls fluxes correction

ERAInterim: daily 28-days mean Climatology

Satellite Observations: daily 28-day mean Climatology

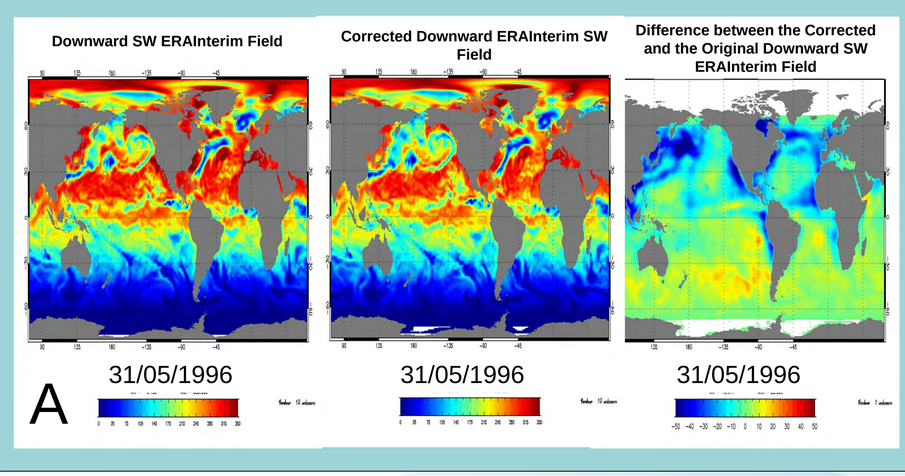
Daily Climatology of the corrective factor X **Daily ERAInterim field: large scale**

Daily Corrected ERAInterim: large scale + **Daily ERAInterim field: small scale**

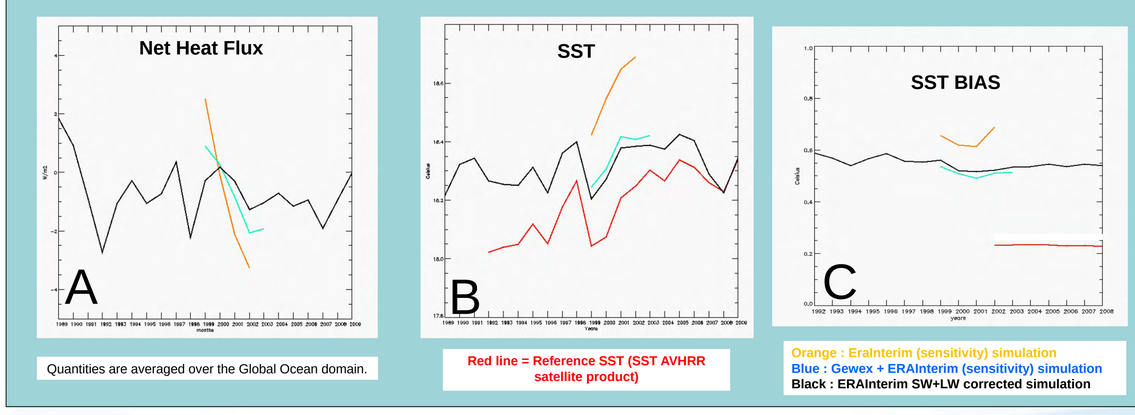
Daily Corrected ERAInterim field

• Daily ERAInterim radiative (resp. rainfalls) fluxes are corrected with the Gewex's (resp. GPCPV2.1) fields.
• The correction is local, i.e. in each (i,j) grid point.
• We correct only the large scales of the daily ERAInterim fields towards the ones of the satellite observations
• Gewex SW (3% reduction) and LW (6% reduction) downward fluxes are also corrected between 40°N and 40°S. Climatology of Gewex covers the 1999-2006 period only due to the Indian satellite Gap over the 1984-1998 period.
• Climatology of GPCPV2.1 covers the period 1997-2008.
• No correction of ERAInterim rainfalls fields is applied north of 65°N.
• ERAInterim climatology values less than 1 unit ($W.M^{-2}$ or $mm.day^{-1}$) are not corrected.

• The method does not change the interannual signal of the ERAInterim field.
• The method does not affect the ERAInterim synoptic patterns (such cyclones for instance). (**Figure A** below).
• The method can be applied outside the satellite climatology period.



4 Global improvement with corrected ERAInterim radiative fluxes



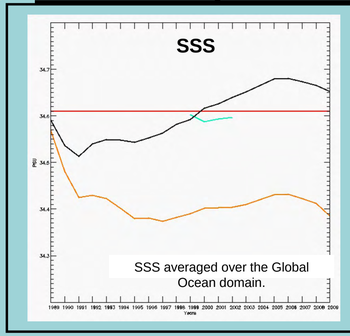
Quantities are averaged over the Global Ocean domain.

Red line = Reference SST (SST AVHRR satellite product)

Orange : ERAInterim (sensitivity) simulation
Blue : Gewex + ERAInterim (sensitivity) simulation
Black : ERAInterim SW+LW corrected simulation

- The use of the GEWEX radiative fluxes instead of the ERAInterim forcing in the ocean simulation reduces the global averaged SST bias of 0.1°C (**Figure C**) and makes the surface heat flux closer to the equilibrium (< $2W/M^{-2}$) (**Figure A**).
- The experiment performed with the SW and LW corrected ERAinterim fields over the 1989-2009 period gives similar results than the experiment with GEWEX radiatives fields (**Figures A, B and C**).

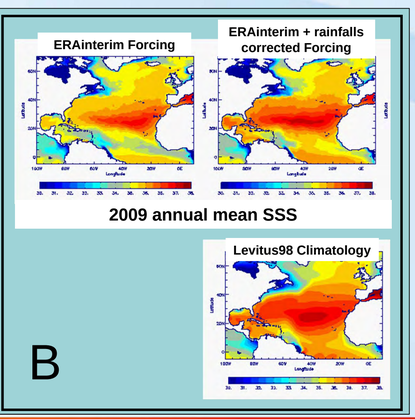
5 Global improvement with corrected ERAInterim rainfall fluxes



Red line = SSS Reference (Levitus Climatology)

Orange : ERAInterim simulation
Blue : GPCPV2.1 + ERAInterim (sensitivity) simulation
Black : ERAInterim rainfalls corrected simulation

- The use of the GPCPV2.1 rainfalls flux instead of the ERAInterim forcing in the ocean simulation reduces the global averaged fresher water anomaly (**Figure A**) and gives SSS closer to Levitus98 climatology.
- The experiment performed with the rainfalls corrected ERAinterim field over the 1989-2009 period exhibits a (fresher) smaller drift at the beginning of the period but a saltier drift at the end of the simulation (**Figure A**).
- The experiment performed with the rainfalls corrected ERAinterim field gives more realistic SSS spatial distribution in the Northern Atlantic Basin than the experiment with no rainfalls correction (**Figure B**), especially in the subtropical gyre.
- The saltier global ocean obtained with the rainfalls corrected ERAInterim experiment shows however that this first rainfalls correction attempt needs to be improved.



6 Future Plans

✓ Improvment of the rainfalls correction method. This will concern first a realistic detrending process on the ERAInterim rainfalls flux.
✓ The updated rainfalls correction will be used in the next version of the Mercator Océan global ocean reanalysis GLORYS2 (see poster XY624 EGU2011-3516 in Open Session on Operational Oceanography).
✓ This method of correction will be implemented and adapted to the atmospheric IFS ECMWF forecasts and analysis which drive all the Mercator Océan operational systems.

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