

# ORAS4: The ECMWF Ocean Reanalysis System 4

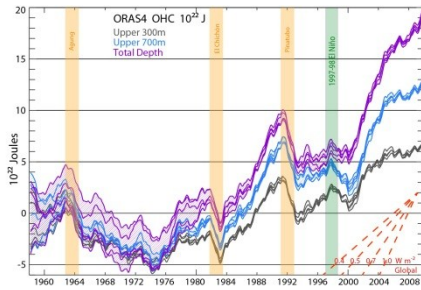


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This poster describes the ECMWF operational ocean re-analysis system, implemented in 2010.

<http://www.ecmwf.int/products/forecasts/d/charts/oras4/reanalysis/>  
It consists of **5 ensemble members**, covering the period **1958-Present, continuously updated. It is used for**

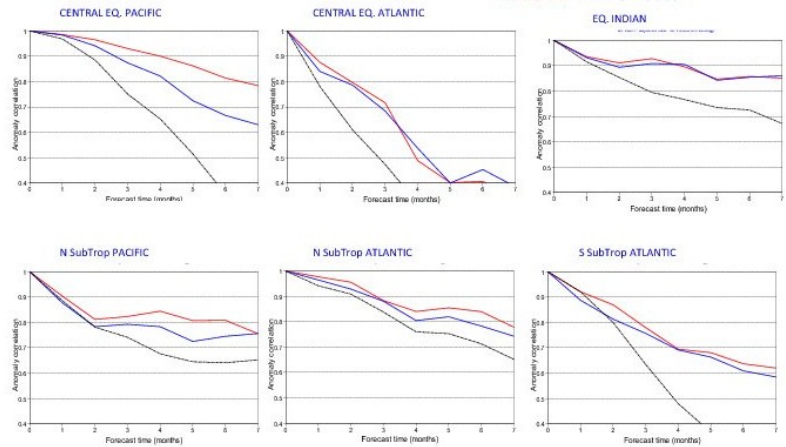
- 1) Initialization of the operational monthly and seasonal forecasts.
- 2) Initialization of decadal forecasts.
- 3) Climate variability studies.



Ocean Heat Content from ORAS4, Balmaseda et al GRL, 2013

## Impact on Of ORAS4 in SST Seasonal Forecasts

Anomaly correlation: **ORAS4** **CNTL** Persistence



## ORAS4 Main Ingredients

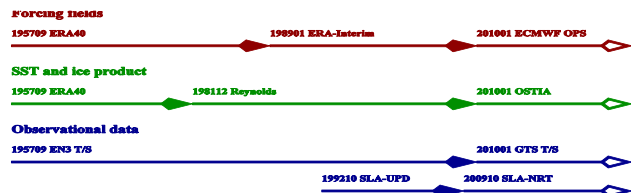
**Ocean Model:** NEMO V3.0 ORCA1 and 42 levels (ocean)

**Data Assimilation:** NEMOVAR (3D-var)

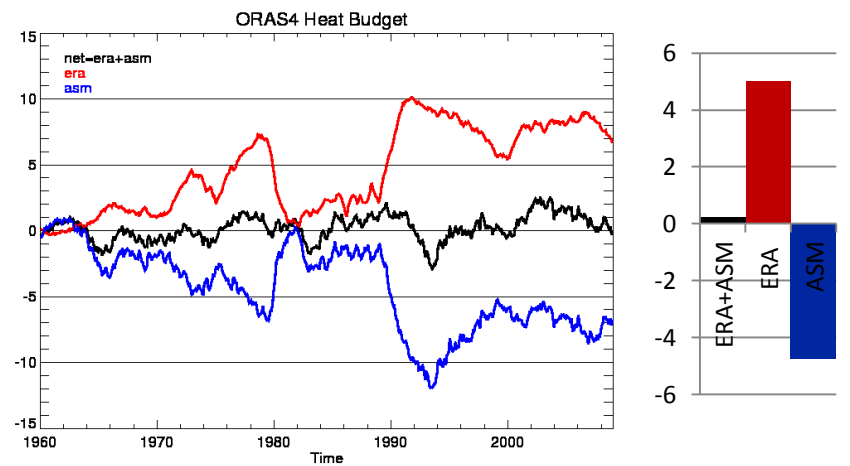
**Data:** Temperature and Salinity Profiles (EN3-XBT corrected and GTS), SST (HADISST/ Oiv21x1 /OSTIA), along track Altimeter Sea Level (AVISO). See figure below

**Forcing:** ERA40/ERA-INTERIM/ECMWF NWP (see figure below)

**Ensemble Generation:** wind perturbations, observation coverage, spin-up



## ORAS4 and Global Heat Budget



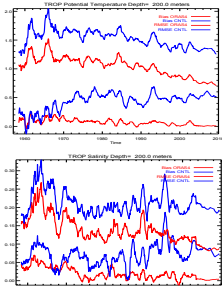
- Large imbalance in the surface heat fluxes from Atmospheric re-analysis. Note jump in the transition to ERA-Interim, due to excessive solar radiation
- Assimilation compensates for errors in the ERA heat flux, in both mean and variability.

## How Good it is ORAS4?

From Balmaseda et al, Quarterly Journal Roy. Met. Soc, 2013

**CNTL:** as ORAS4 but without T/S/SLA assimilation. Only SST and atmospheric forcing

### Fit to subsurface observations (T & S)



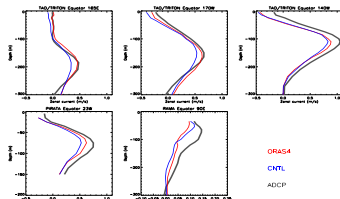
ORAS4 shows reduced RMSE and bias respect the CNTL, in both T and S

The bias in ORAS4 is more stable in time

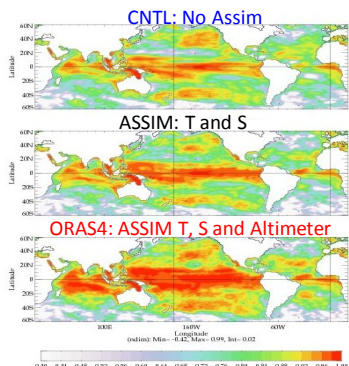
Fit improves with time, both ORAS4 and CNTL  
:Not only more subsurface observations, but better surface forcing and SST data, and different spatial sampling

### Fit to Currents (Mooring ADCP)

The ADCP current data from the moorings are not assimilated, and are a valuable independent data set to validate the reanalysis. Note the positive effect of the Assimilation in the Pacific and Atlantic Undercurrent



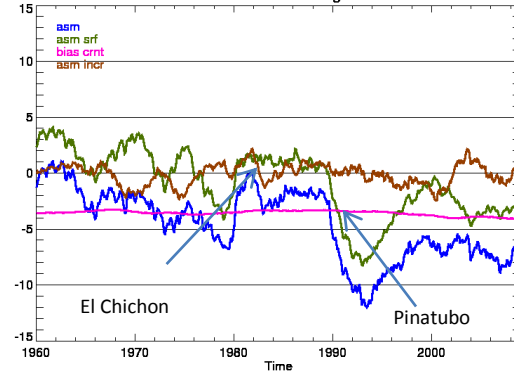
### Fit to Altimeter Sea Level



Time correlation (1993-2008) with Sea Level from altimeter data is used to assess the temporal consistency.

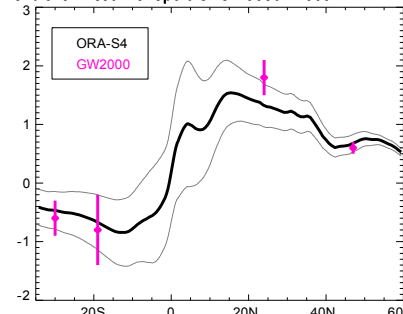
The assimilation of T & S improves the correlation in most of the ocean.  
Assimilation of altimeter improves it even further.

### ORAS4 ASSIM Budget



- The Bias correction is negative and relatively stable .
- The largest variability in the assimilation flux comes from the SST, especially the Pinatubo event.
- The assimilation increment shows little variability. Although small, the advent of Argo is visible. The Pinatubo signal is due to the ocean observations.

### Meridional Heat Transport GLO 195801:200912



ORAS4 could be used to estimate the mean and time variability of the oceanic heat transport.

(GW2000: Ganachaud and Wunsch 2000)

**Acknowledgements:** The NEMOVAR team – the NEMO team – Hadley Centre for the EN3 XBT corrected observational data set – NOC for the ORCA1 configuration – AVISO – Argo, Mooring, XBT and other observational data.

### References:

Balmaseda M.A., K. Mogensen, A. Weaver, 2013: Evaluation of the ECMWF ocean reanalysis system ORAS4. *Q.J.R. Meteorol. Soc.*, **139**: 1132–1161. doi: 10.1002/qj.2063  
Balmaseda M.A., K. Trenberth, E. Kallen, 2013: Distinctive climate signals in reanalysis of global ocean heat content, *Geophys. Res. Lett.*, **40**, 1754–1759, doi:10.1002/grl.50382