



WP2 summary report

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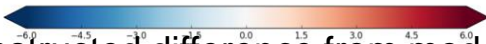
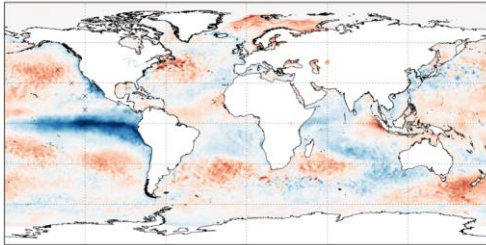
WP2 - Future coupling methods *Overview*

- Research and development in coupled data assimilation for climate reanalysis, for implementation in the CERA (Coupled ECMWF Reanalysis) framework developed at ECMWF.
- This includes work on:
 - T2.1: Coordination and integration
 - T2.2: improving the use of surface observations in coupled data assimilation;
 - T2.3: improving various aspects of the ocean analysis component;
 - T2.4: improving the carbon component of a coupled earth system reanalysis;
 - T2.5: longer term research towards fully coupled data assimilation.
- All tasks in this work package will address:
 - the special requirements for the pre-satellite data-sparse era
 - the requirement to maintain a consistent climate signal throughout the entire reanalysis period.
- The work in this WP is new in ERA-CLIM2. However, the ocean DA system used in CERA is already coordinated with many of the WP2 partners through the NEMOVAR consortium.

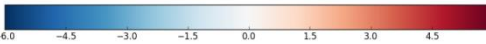
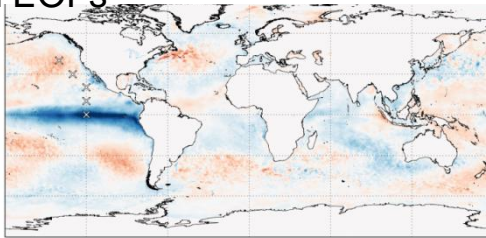
Scientific and technical achievements in WP2

T2.2: development of assimilation techniques for improved use of surface observations [METO, MERCO]

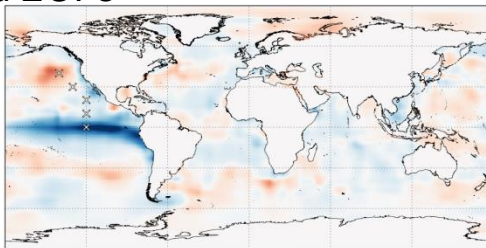
Difference from Truth (2005-1997)



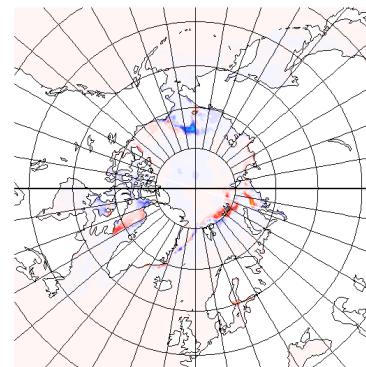
Reconstructed difference from model-based EOFs



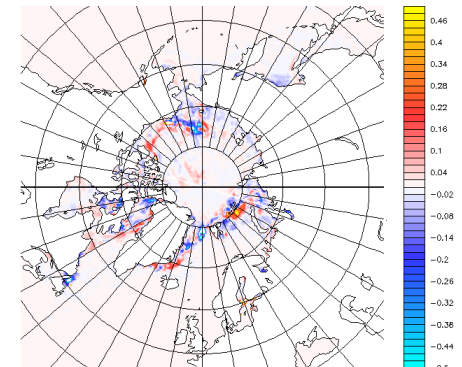
Reconstructed difference from obs-based EOFs



- SST developments [METO]:
 - initial EOFs calculated from both model and observation-based reanalyses;
 - testing of ideas/techniques is progressing;
 - bias correction work has started.
- Tests of multi-variate sea-ice assimilation (SST, SIC, SI thickness) underway [MERCO].
- Initial results of sea-ice assimilation looks promising with consistent thickness changes.



SIC Model update

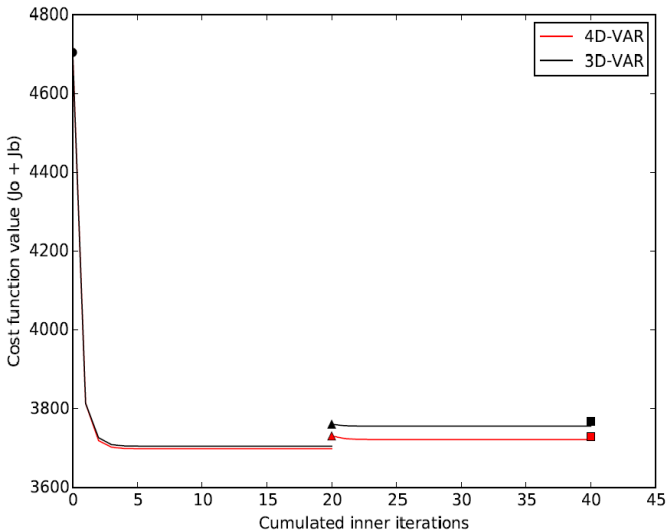


Thickness Model update

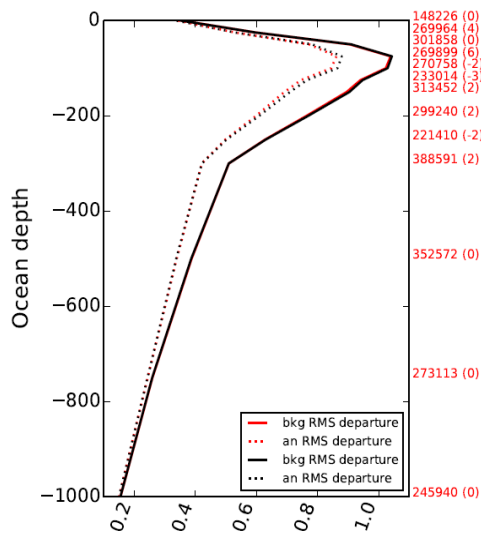
Scientific and technical achievements in WP2

T2.3: Development of the ocean analysis component

[CERFACS, INRIA, CMCC]

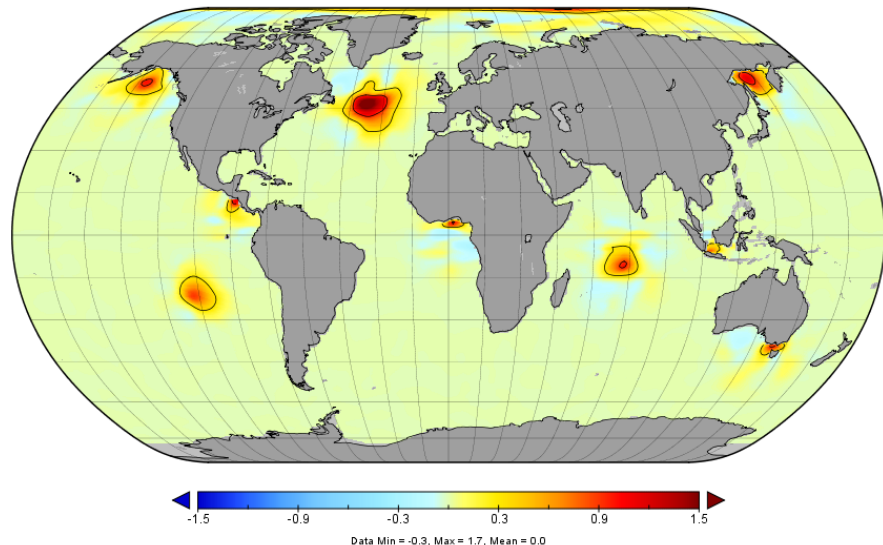


- 4DVar has been implemented in CERA framework and tests carried out [INRIA/ECMWF].
- Positive impact on cost function vs 3DVar, but little impact on innovations. Expect 1-day time-window 4DVar to have larger impact in $\frac{1}{4}^\circ$ resolution model, and 75 levels.
- Ensemble generation method for atmospheric perturbations and physical perturbations was implemented and tested in CMCC reanalysis system.
- Hybrid background error covariances implemented in NEMOVAR [CERFACS].



148226 (0)
269964 (4)
301858 (0)
269899 (6)
270758 (2)
233014 (-3)
313452 (2)
299240 (2)
221410 (-2)
388591 (2)
352572 (0)
273113 (0)
245940 (0)

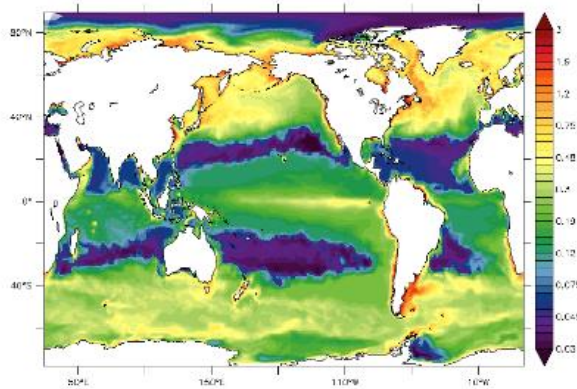
T-T covariance level 1



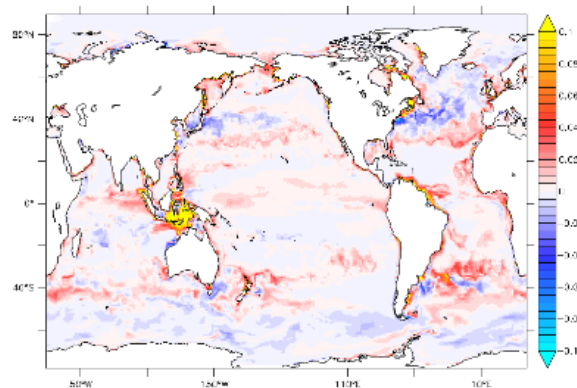


Scientific and technical achievements in WP2

T2.4: development of the carbon component coupled earth system reanalysis of the 20th century [MERCOS, UVSQ]



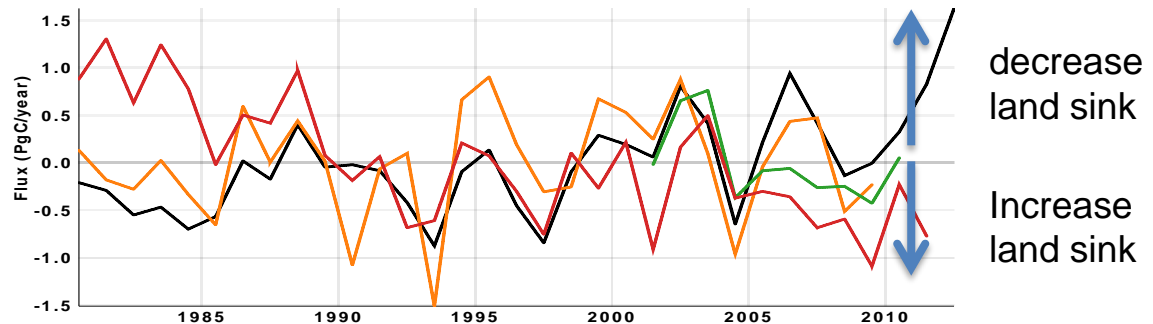
Surface chlorophyll in simulation forced by filtered Kz



Differences in surface chlorophyll : (total-filtered) Kz

- Ocean carbon: set-up of the off-line coupling of CERA surface fluxes and ocean fields with PISCES.
- Tests of the system with different vertical mixing coefficients carried out – last year of 10 year integration shows improvements particularly in Indonesian area.
- Land carbon: first tests with “Earth2Observe” forcing (1979-2010). Next plan to use ERA-CLIM2 forcing.
- Web-Site designed to compare ERA-CLIM2 simulations with other products: <http://transcom.globalcarbonatlas.org>
- Climate-driven flux anomalies are “relatively” coherent

Northern land annual flux anomalies (>45°N)

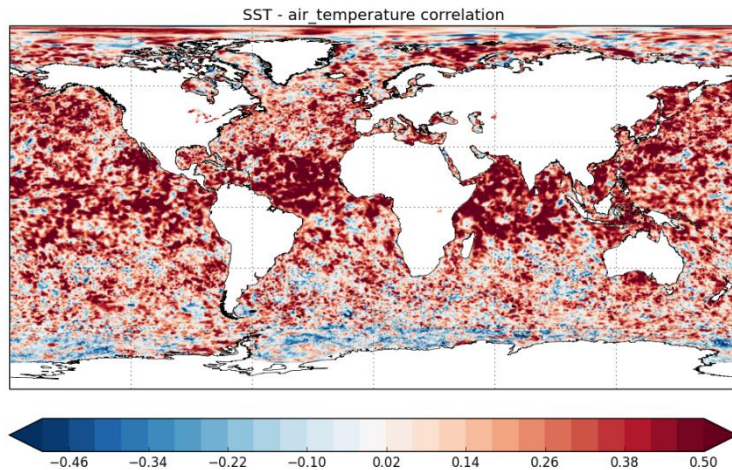


- CTESSEL / Terrestrial flux / 06 Northern Land / Yearly mean anomaly
- ORCHIDEE ERAC / Terrestrial flux / 06 Northern Land / Yearly mean anomaly
- TRACKER EU / Terrestrial flux / 06 Northern Land / Yearly mean anomaly
- LSCE var MACC V12 3 / Terrestrial flux / 06 Northern Land / Yearly mean anomaly

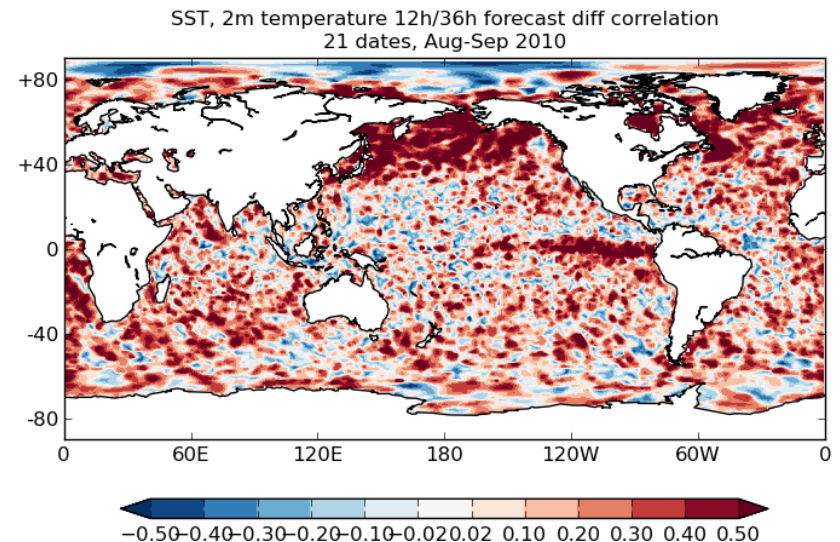
Scientific and technical achievements in WP2

T2.5: research towards development of fully coupled data assimilation methods [UREAD, METO, INRIA]

- Initial results from calculations of coupled error covariances from METO and CERA systems.
- Different methods for the calculation being investigated: model-based methods (NMC) and innovation-based methods.
- NMC results so far based on only limited number of forecasts. Some discrepancies between results from METO and CERA systems will be investigated.



MetO NMC results



CERA NMC results



Met Office

Challenges and problems encountered

- How best to coordinate between the WP2 partners and ECMWF:
 - Tested the coordination through the input of 4DVar developments into the CERA system.
 - Developments of the ocean carbon components of the system are also being directly coordinated with ECMWF.
 - Many of the developments in WP2 are being made to the NEMOVAR system; partners will coordinate developments through the merging of code into a new NEMOVAR release soon.
 - Plan for early integration of some developments.
- How best to demonstrate impact of developments:
 - We have defined a common period for testing developments (2009-2010), with a common set of input observations (HadIOD, ESA CCI data).
 - Plan to simulate historical ocean data coverage during this recent period to make sure system is robust with sparse data coverage.
- Case studies for common periods required from CERA and METO coupled DA systems to ensure robustness of results (of both impact of coupled DA, and for coupled error covariance calculations).
 - METO plan to run the same 2009-2010 period for which CERA has been run.



Planning of activities for the next months

- Development work by the WP2 partners continuing over the next months according to the DoW.
- NEMOVAR merging discussions in Toulouse in December 2014.
- Merge of latest NEMOVAR code developments aimed to be completed by spring 2015.
- Running of METO coupled DA system for common test period started in early 2015.
- WP2 meeting (in coordination with interested parties from other WPs) planned for May 2015 at ECMWF to continue to coordinate the developments being made and to monitor progress.



Overview of the deliverables

- *Month 8: Early status report of WP2 work [D2.12]*
- Month 18: Two reports related to future coupled DA methods [D2.8, D2.9]
- Month 24: Report on ensemble-based covariances in coupled data assimilation [D2.4]
- Month 27: Code/tests for improvements to assimilation of surface variables (SST/sea-ice), and report on use of 4DVar. [D2.1, D2.2, D2.5]
- Month 34: Code/tests for using ensemble error covariances in NEMOVAR; reports on terrestrial and ocean carbon; report on consistent ocean and atmospheric bias corrections in coupled DA framework. [D2.3, D2.6, D2.7, D2.10, D2.11]

Early status report [D2.12] produced for August 2014:

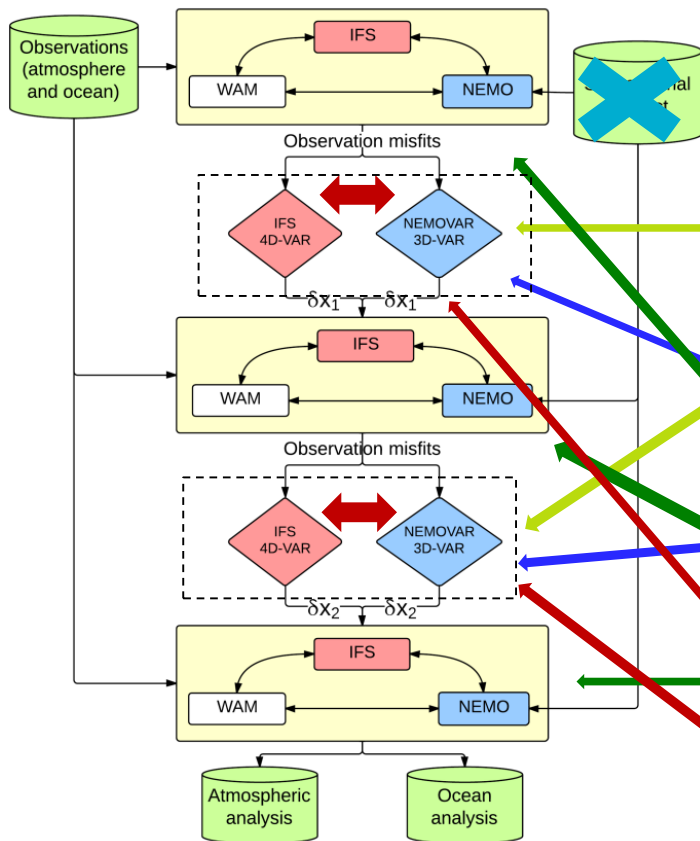
- Contains, from each of the partners: Overview and objectives of each task; Plan of work; Progress and status.
- Available on the ERA-CLIM2 wiki
(<https://software.ecmwf.int/wiki/display/ERC/WP2%3A+Future+coupling+methods>)



Met Office

WP2 - Future coupling methods

Overview of system developments



- Current CERA system

T2.2 to include SST/sea-ice assimilation in NEMOVAR

T2.3 to improve the ocean analysis component including use of ensembles and 4D-VAR

T2.4 Development of the carbon component coupled earth system reanalysis

T2.5 Towards development of fully coupled data assimilation



Delivarables (1)

- D2.1 : Documented code with test results for assimilation and bias correction of satellite SST observations, and for assimilation of sparse in-situ SST observations, in NEMOVAR. [METO; month 27]
- D2.2 : Documented code and test results for sea-ice assimilation in NEMOVAR, based on anamorphosis of control variables [MERC0; month 27]
- D2.3 : Documented code and test results for using ensemble-estimated background error variances and correlation scales in the NEMOVAR system [CERFAC; month 34]
- D2.4 : Report on experimentation with ensemble-based covariances in coupled data assimilation [CMCC; month 24]
- D2.5 : Report on the use of 3D or 4D-Var for the ocean component in the coupled data assimilation context, including a comparison of multi-scale methods in 4D-Var. [INRIA; month 27]
- D2.6 : Report on optimized terrestrial model parameters and carbon fluxes for the 20th century, including requirements for coupling land carbon biogeochemistry in future Earth system reanalyses. [UVSQ; month 34]



Deliverables (2)

- D2.7 : Report on assessments of alternative methods for coupling ocean biogeochemistry in future Earth system reanalysis [MERCO; month 34]
- D2.8 : Report on strengths and weaknesses of weakly coupled data assimilation methods for Earth system reanalysis. [UREAD; month 18]
- D2.9 : Report on techniques for calculating coupled error covariances from outputs of a weakly coupled data assimilation experiment [METO; month 18]
- D2.10 : Report on assessment of coupled-model drift and approaches for obtaining consistent ocean and atmospheric bias corrections. [UREAD; month 34]
- D2.11 : Report on fully coupled data assimilation in simplified systems with implications for Earth system reanalysis. [INRIA; month 34]
- *D2.12 : A status report to allow early assessment of progress in this work package [METO; month 8]*