DEMETER activities at CERFACS
Global ocean reanalysis and ensembles

P Rogel, E Maisonnave
A Weaver, E Machu, S Ricci, N Daget

- Status on hindcasts
- Global 3D-Var results
- Ocean ICs ensemble generation

DEMETER final meeting, Kiel, 7-8/07/2003

Status on coupled hindcasts

- Stream 1 (1987-2001) completed at ECMWF
- System installed on M-F VPP5K, same version as DEMETER
- Automated transfer system to store outputs on MARS
- Early 80s (1980-81 to date) under production to catch the 82-83 ENSO
- Early tests using 3D-Var ocean ICs

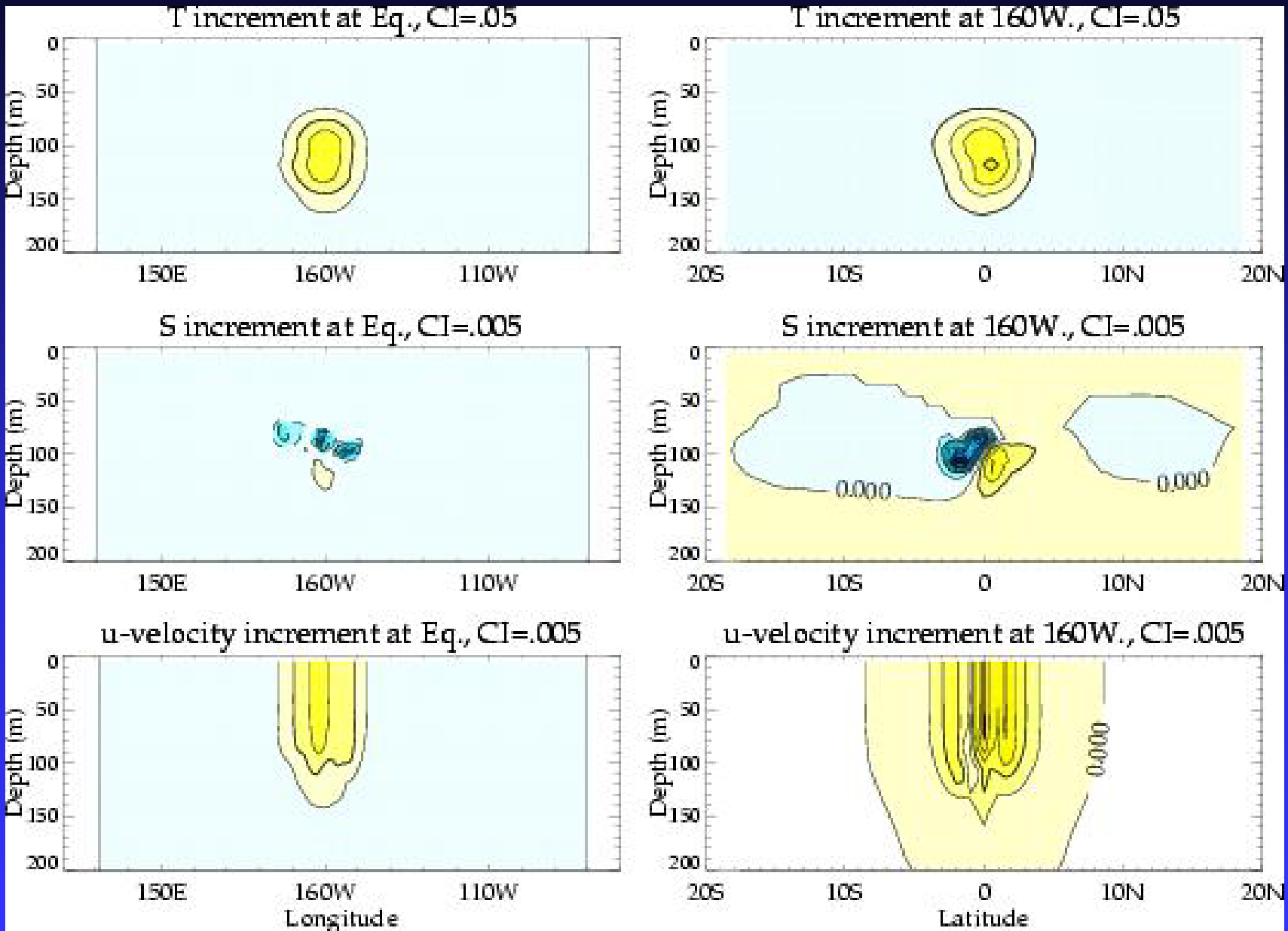
- Production of unassimilated ocean ICs for Stream 2 (1974-1986) for LODyC

- Production of assimilated ICs for Stream 1 under way

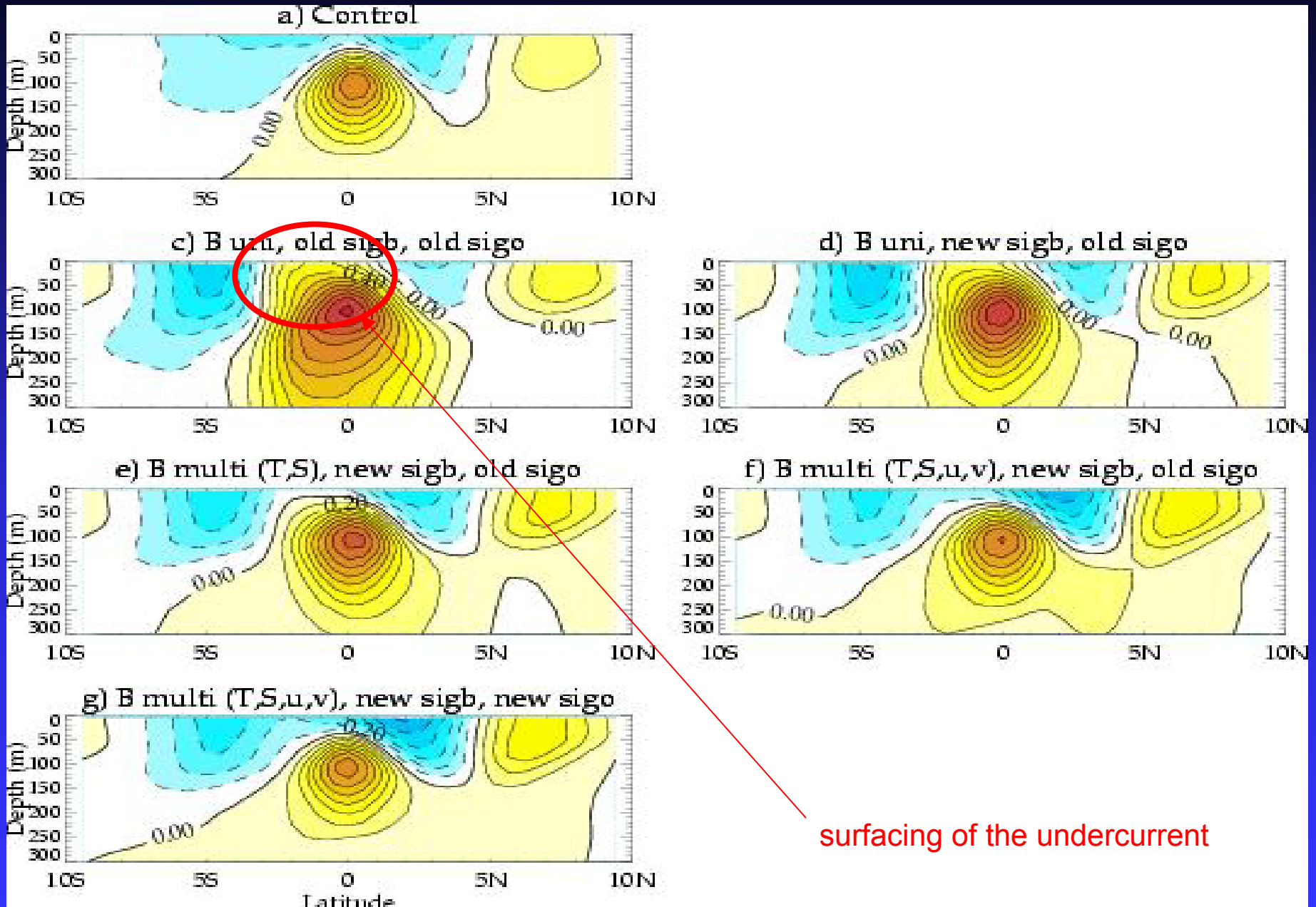
Summary of the global 3D-Var developments

- 3D-Var FGAT formulation, allows for exact innovation computation
- Extension of the original tropical variationnal system to the global case (in particular the observation operator for a stretched grid)
- J_b modelling:
  - Flow dependent error variance
  - Multivariate balanced/unbalanced formalism (Derber and Bouttier)
  - Flow dependent multivariate T-S preservation scheme
  - Flow dependent density/currents scheme (extended geostrophy)
  - Allows for assimilation of altimeter data
- Additional developments (SST assimilation)
- Results illustrated using 1993-96 averages

Single T-observation 3D-Var experiment

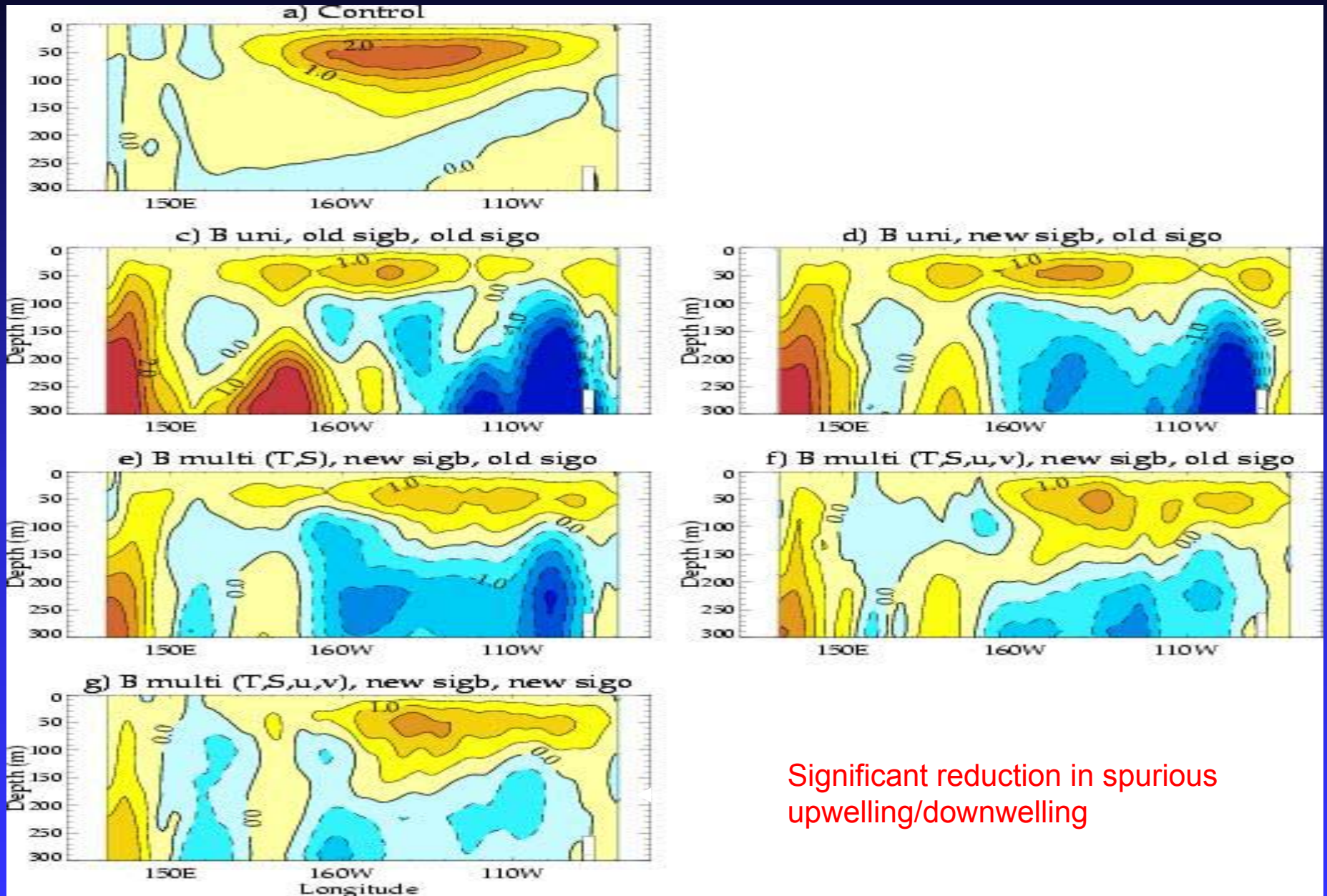


3D-Var sensitivity experiments with improved **B**



surfacing of the undercurrent

3D-Var sensitivity experiments with improved **B**



Significant reduction in spurious upwelling/downwelling

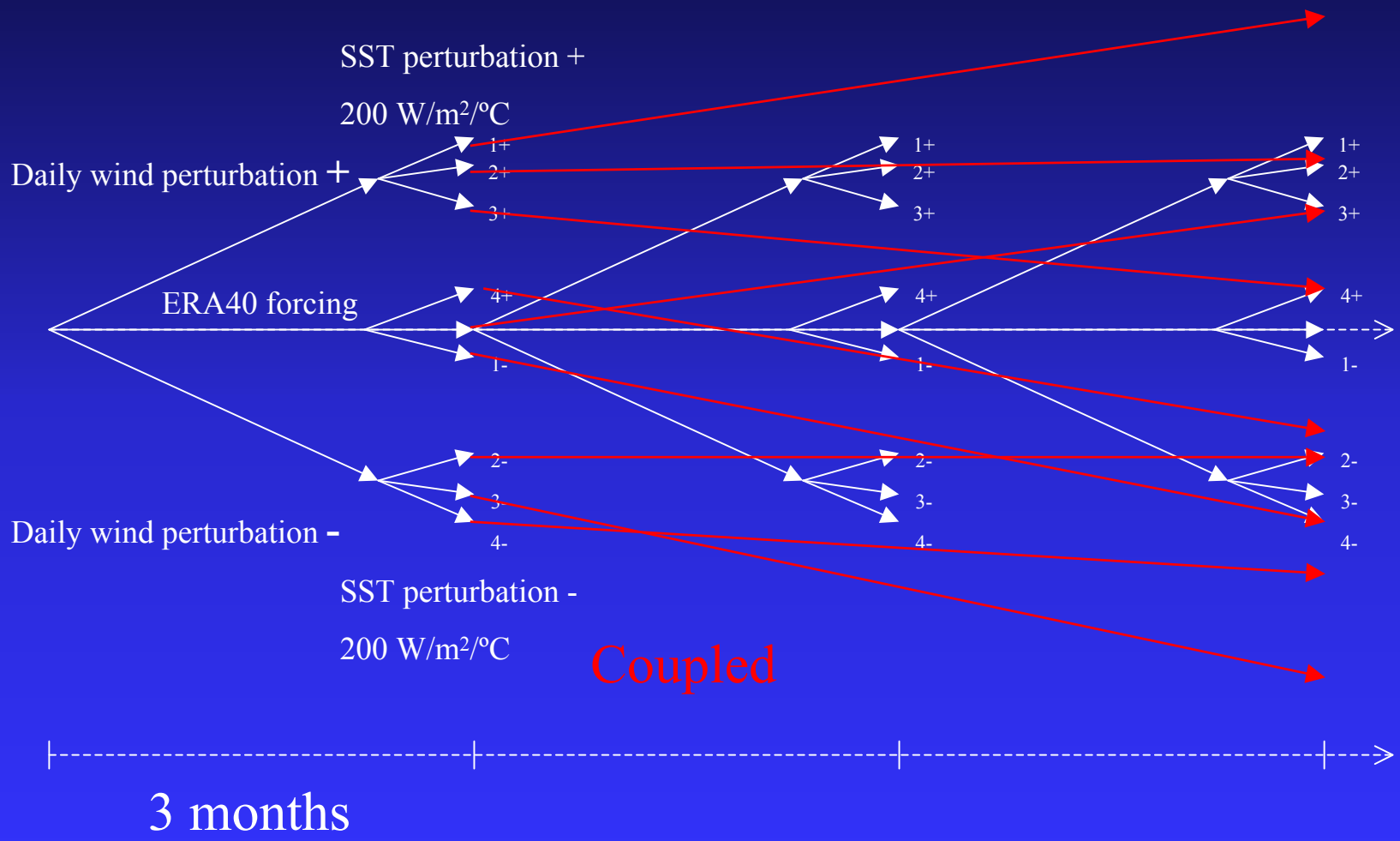
Status of the global reanalyses

- Final reanalysis with a stronger SST restoring term (same as unassimilated experiment)
- Stream 1 (1987-2001) split into two parts due to the ECMWF data base: 1987-89 (no QC); 1990-2001 (QC). Restart in 1990 from the unassimilated experiment
- 8 years (1987-1994) already produced

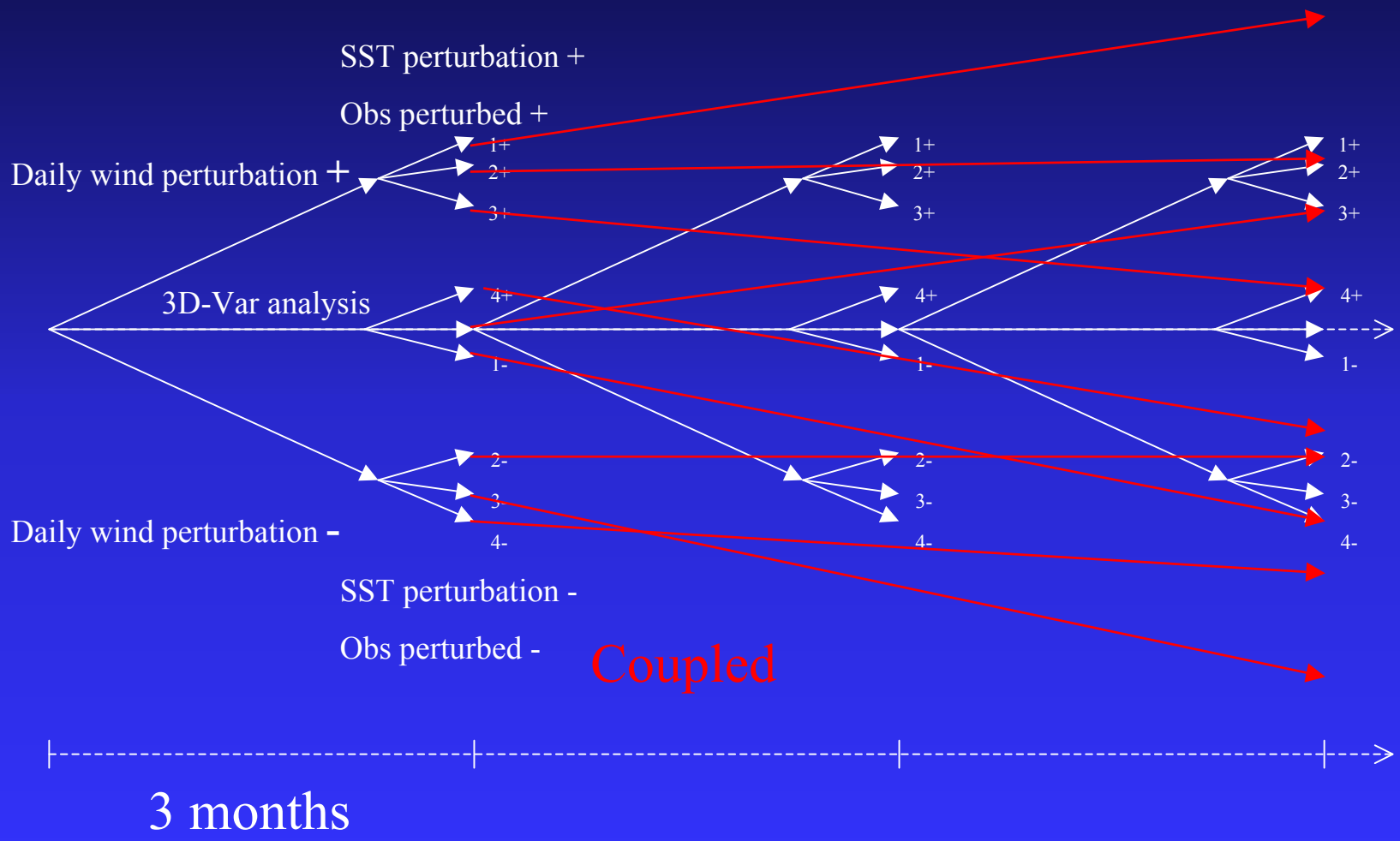
Strategy for ensembles of ocean ICs in presence of data assimilation

- Problem with assimilated ICs: spread is in general lower than using wind/flux forced ICs (see draft circulated by J Vialard at the beginning of the project
- Proposition: using perturbed observations, coherent with other perturbations in the assimilation process

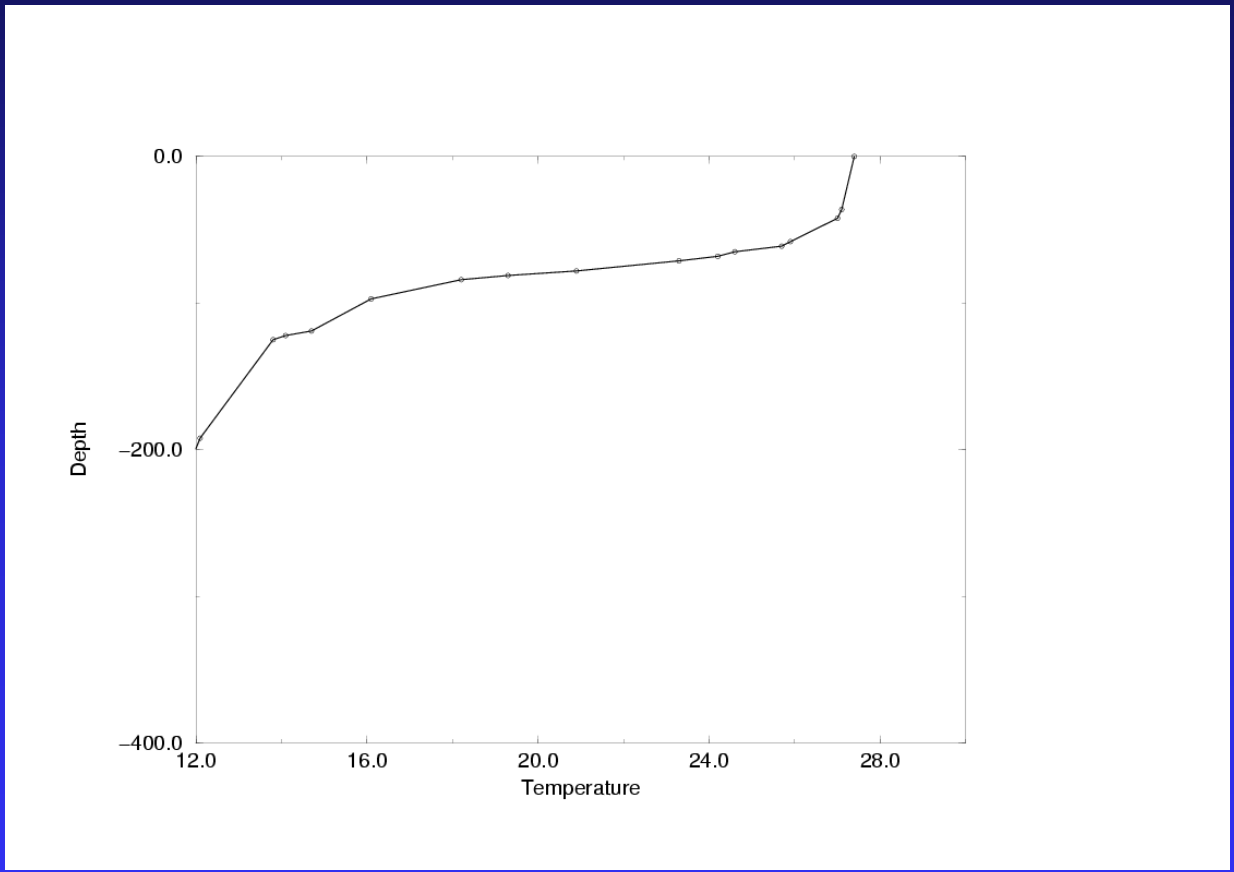
Forced Strategy



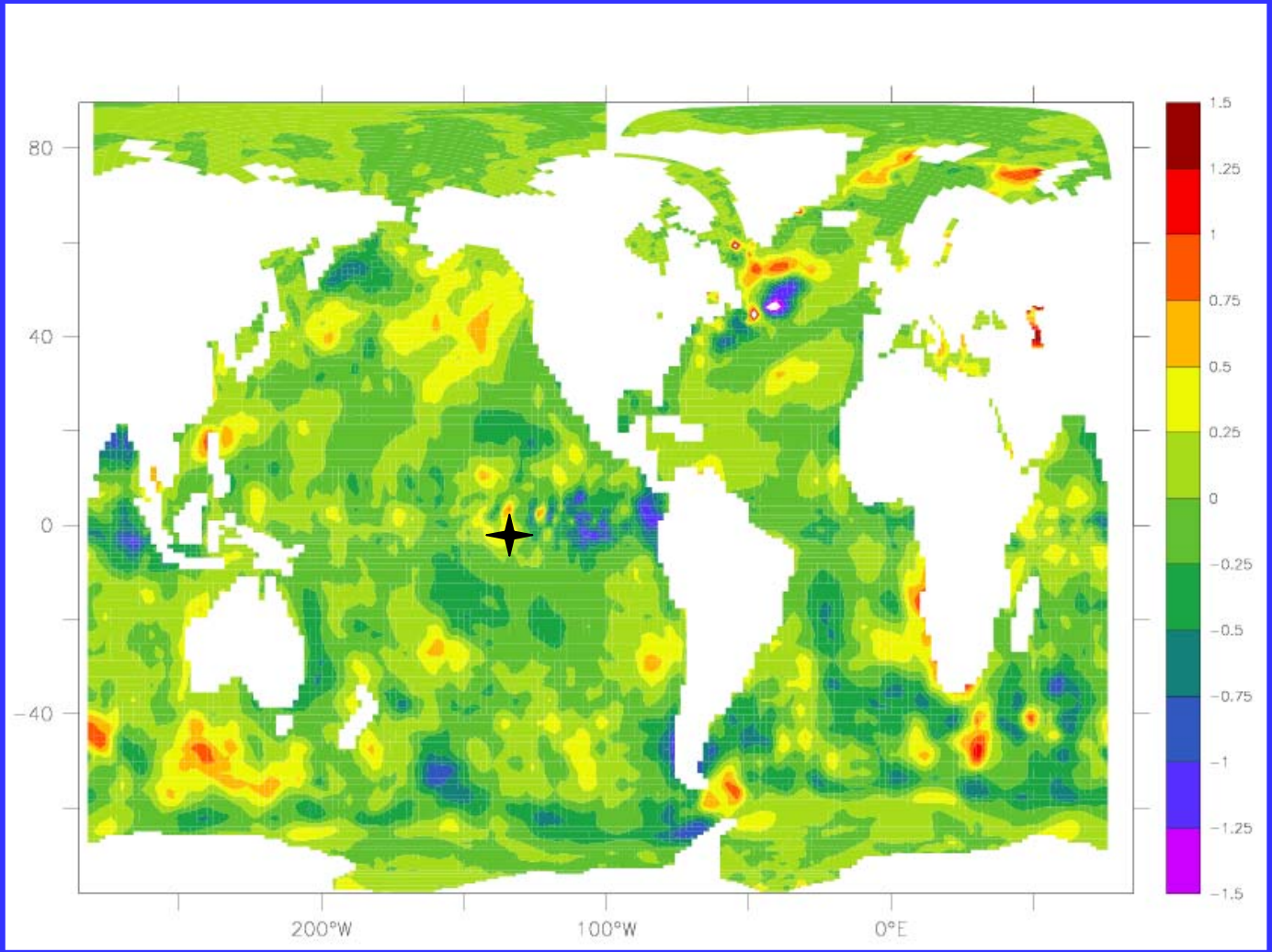
Strategy in presence of ocean DA



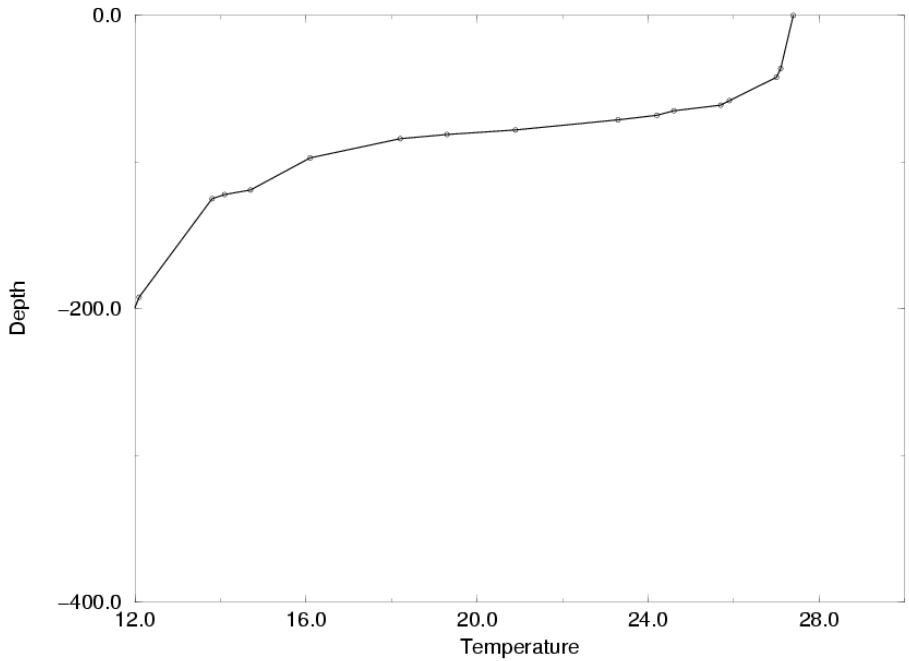
Initial observed temperature profile



SST perturbation interpolated at the observation point



Perturbing observations

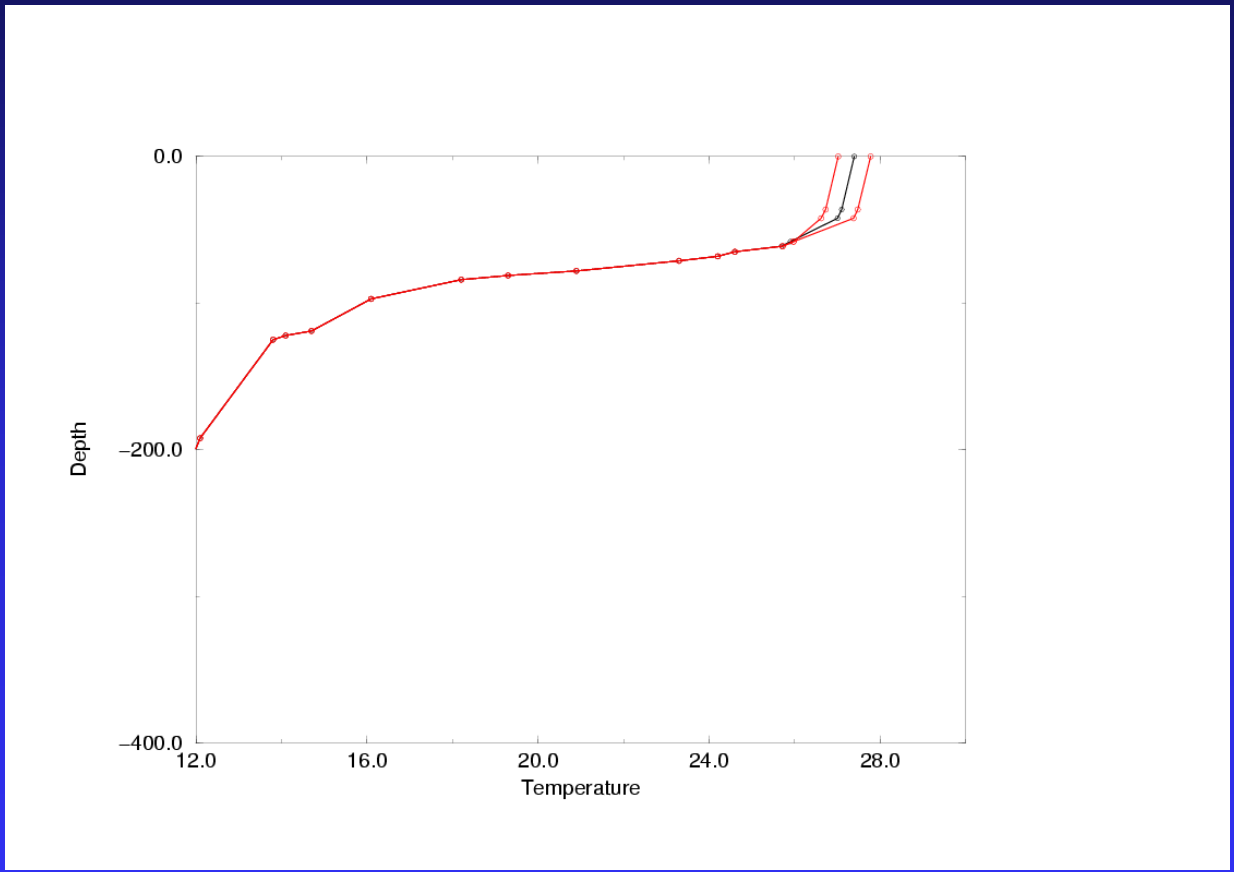


Perturbing observations

Vertical extrapolation of the SST perturbation

Preservation of the mixed layer profile

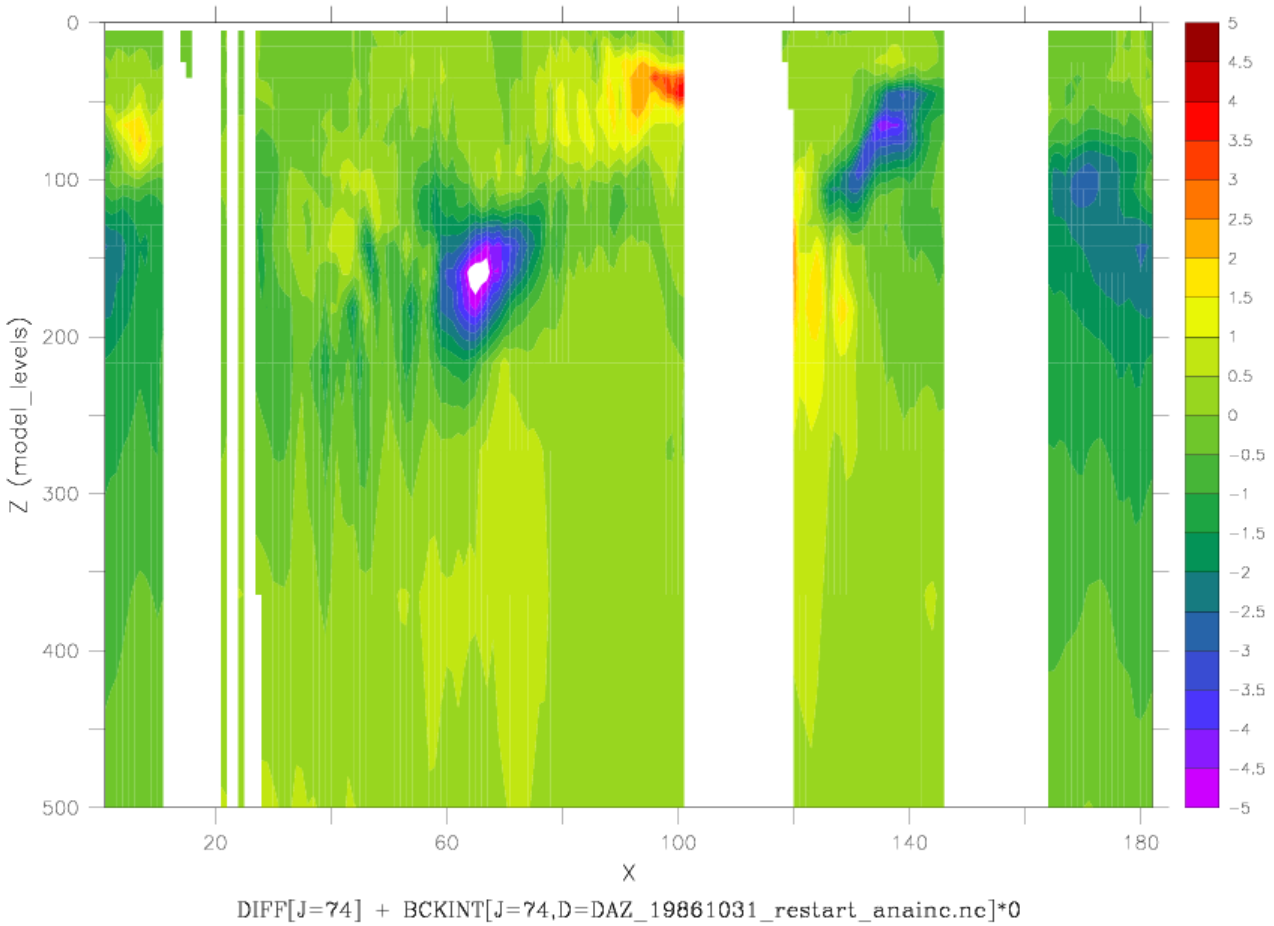
Perturbation set to zero 20 m below the mixed layer



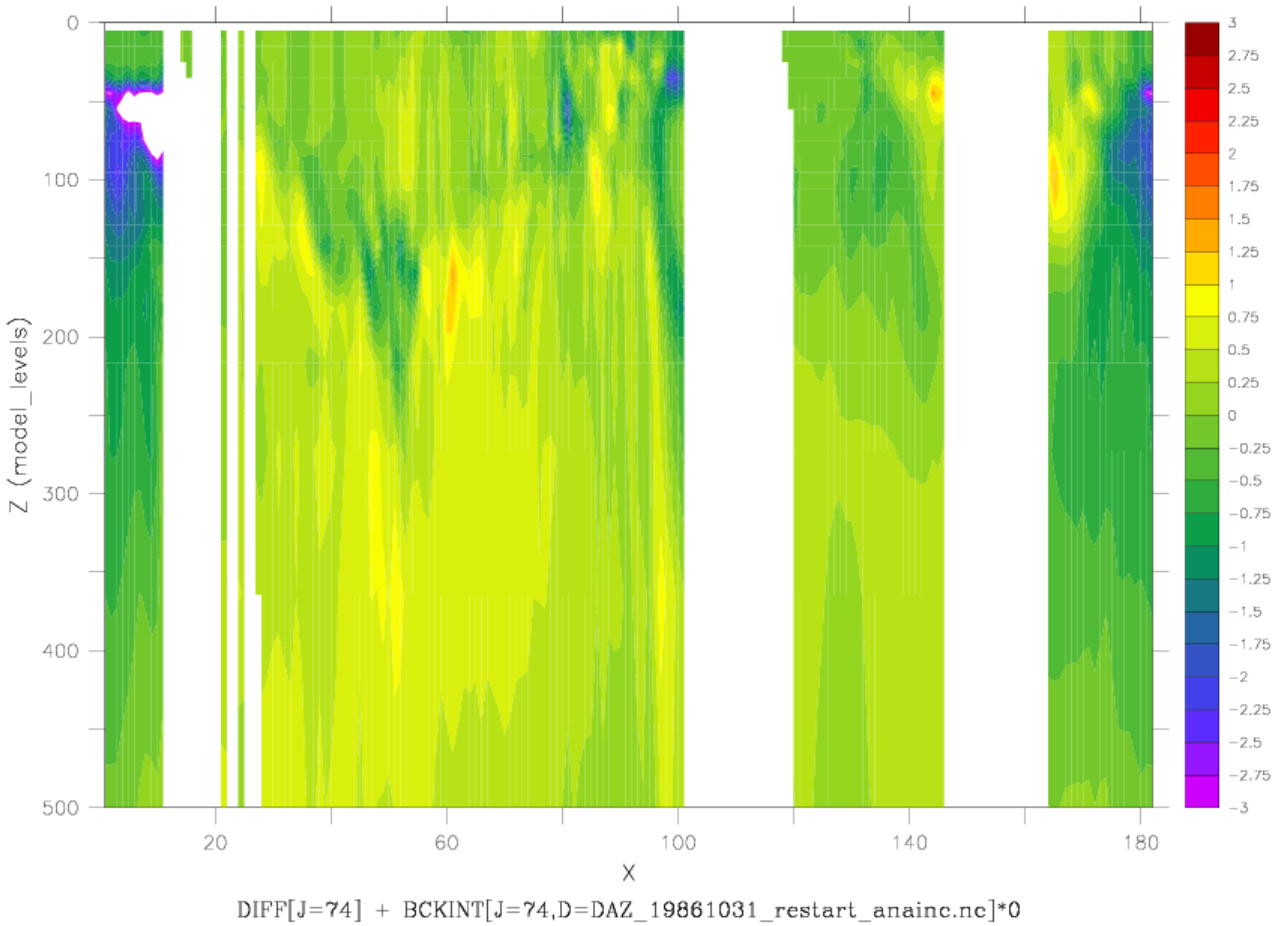
Perturbing observations

Example on one DEMETER starting date (May 1st 1990), one member, after 3 months of wind perturbation, 27 days of temperature perturbation

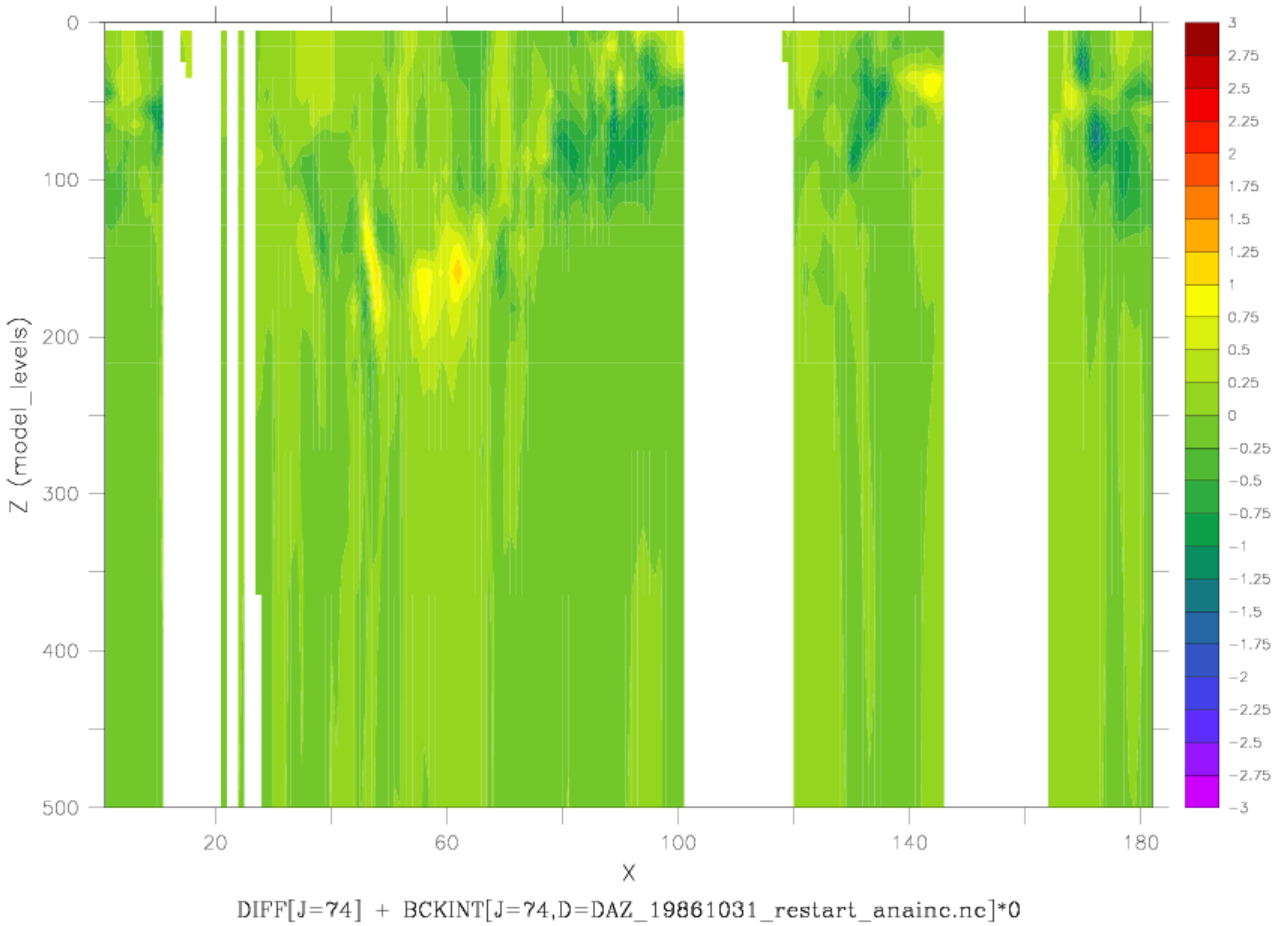
Subsurface Difference
Assim - Forced



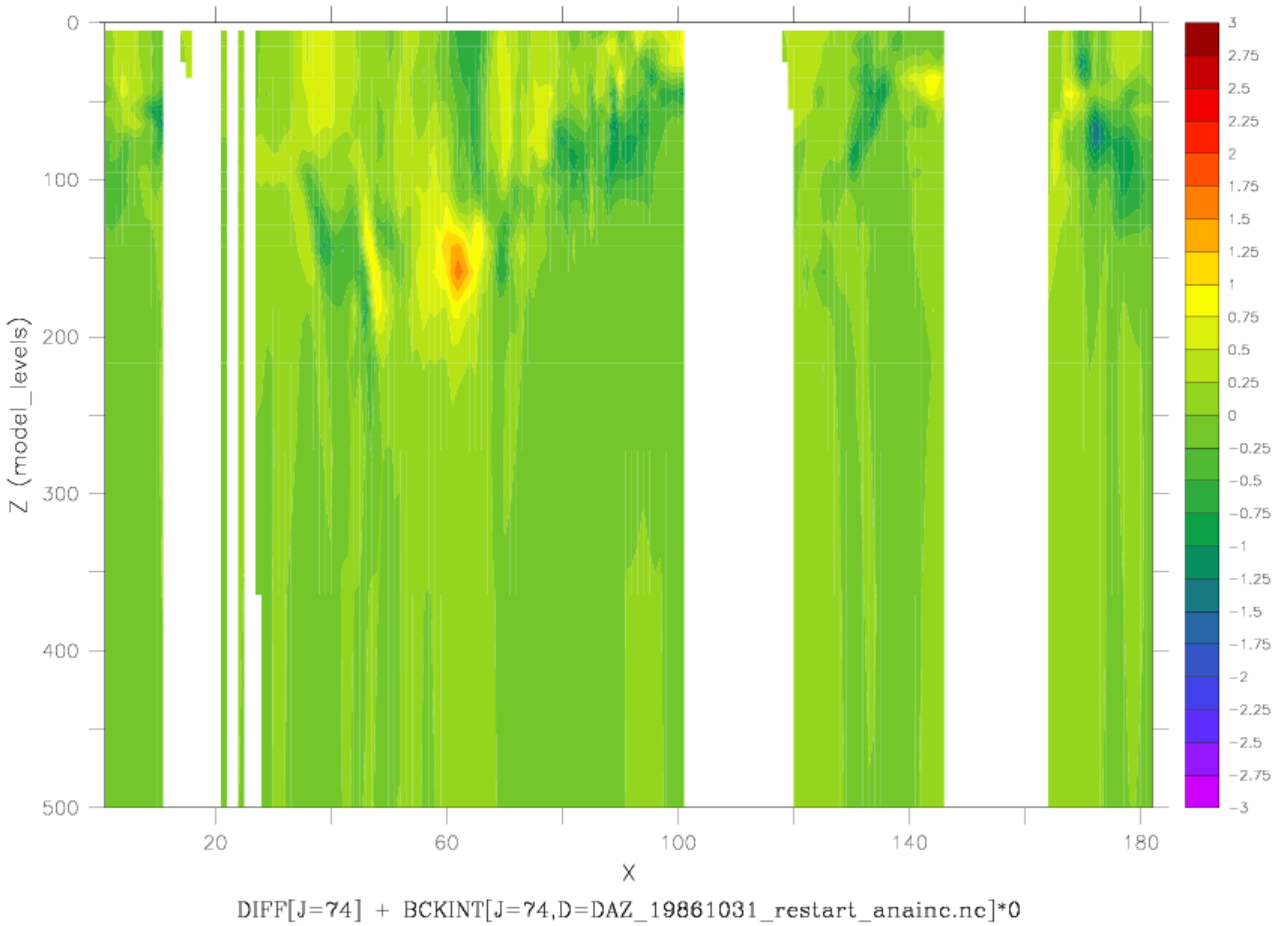
Subsurface perturbation structure
Forced case



Subsurface perturbation structure: Unperturbed observations



Subsurface perturbation structure: Perturbed observations



CONCLUSIONS

Ocean data assimilation

- **3D-Var reanalyses improved by the various developments done in DEMETER (and ENACT)**

- **Choice of an ensemble ICs production strategy that should improve coupled hindcast ensemble spread**

Hindcasts

- **3D-Var initialised hindcasts will be produced by the end of DEMETER . Should feed sensitivity experiments**

- **Ocean archiving software almost ready**

« En Route » to ENSEMBLES

Description of the system

System description:

- Atmosphere model: ARPEGE T63, 31 levels (Déqué, 2001)
- Ocean model: OPA 8.2 global 2° x 1.5°, 31 levels (Delecluse and Madec, 1999)
- Coupler: OASIS 2.4

- Atmosphere initialisation: ERA40
- Ocean initialisation: ER40 winds and fluxes forced experiments

Experiments description:

- 6 month lead time
- 4 seasons (February, May, August, November) starts
- 9 members
- Verification against ERA40

- All experiments run and archived at ECMWF
- Tropical prediction results from 1987 to 1998 (235 years of simulation)