Altimetric lagrangian advection to reconstruct fine scale tracer fields in the Pacific Ocean

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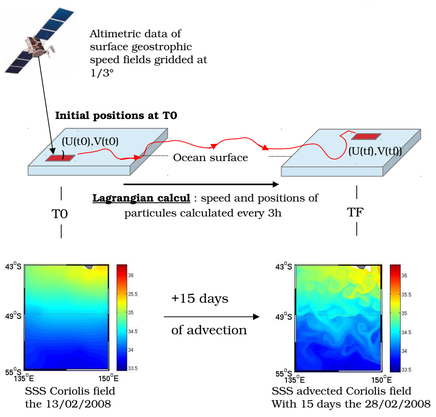
Lagrangian lateral advection with altimetric geostrophic velocities can be used to stir large scale tracer fields at the ocean surface, and reconstruct mesoscale fronts and eddies. Dencausse et al, (2013) have tested this technique in the energetic Southern Ocean region south of Tasmania. Here we apply and evaluate the technique's performance in the tropical and subtropical Pacific Ocean.

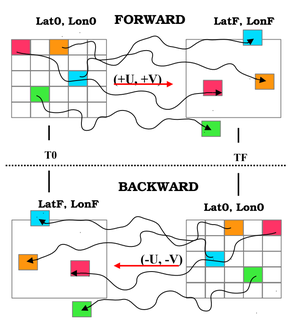
Data and methods

Technique, 1- way advection

Technique: passive horizontal stirring of tracer fields with altimetric velocities.
- Initial fields: large scale tracer fields interpolated on high resolution grid
- Lagrangian calculation of particle trajectories (*D'Ovidio et al*)
- Passive horizontal stirring

Backward or forward advection?



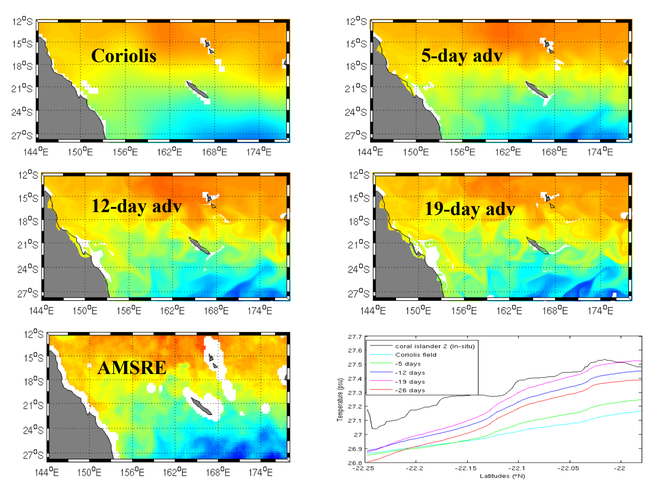


Advection « backwards » in time gives a regular grid at final time.

Data

Data:

- SSS and SST Coriolis derived from an objective analysis of in-situ data for large scale tracer fields (http://www.coriolis.eu.org).
- Altimetric geostrophic speed from AVISO (http://www.aviso.oceanobs.com/duacs/) to compute Lagrangian advection.
- Underway in-situ thermosalinograph data (TSG (http://www.legos.obs-mip.fr/recherches/projets-en-cours/projet-survostral/data-products/data-surface-salinity)) to and high resolution satellite data (AMSR-E (http://www.ghcc.msfc.nasa.gov/AMSR/)) to evaluate advections.

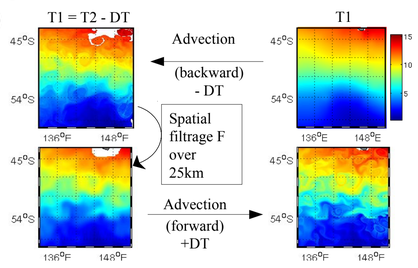


All panels correspond to SST on 27 February 2006. Large scale SST from Coriolis, final SST after -5 days advection, final SST after -12 days advection, final SST after -19 days advection, AMSR-E high resolution image, and latitudinal profil of TSG measurements with final SST advected fields with different advection times for the same day 27 February 2006.

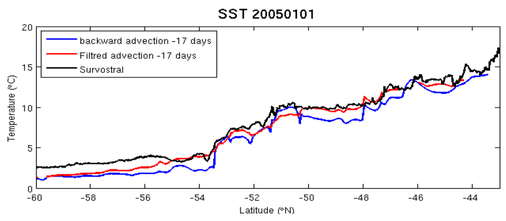
Limitations and solution … 2- way advection

Limitations:
1) Tracer bias: depends of accuracy of initial conditions
2) Advection bias: passive stirring can introduce bias due to missing physics (air-sea fluxes, mixing...)

➡ Reduce advection bias with backward-forward method with a spatial filtrage



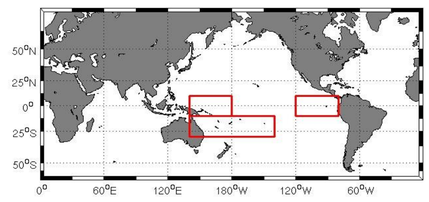
First results in the south of Tasmania are promising. Dencausse et al (in press)



Comparaison with in-situ TSG data and SST advected Coriolis fields with -17 days of advection for the 2-ways advection

Dencausse et al, (2013): optimal advection time to best represent the finer scales: ~2 weeks in the Southern Ocean region south of Tasmania.

What is the optimal advection time in the subtropical Pacific ocean?

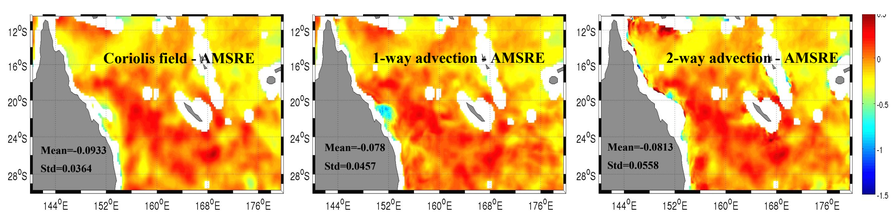


Pacific results: 1-way or 2-way advection?

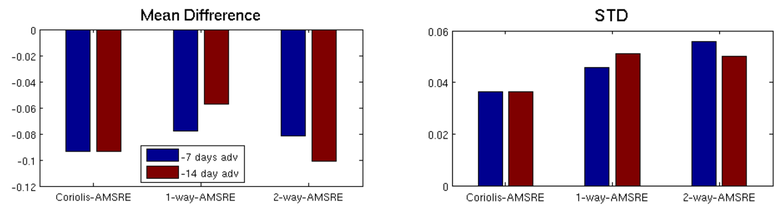
Does the 1-way or 2-way advection work best?

comparaison advected SST w AMSRE SST

Example 2006 :



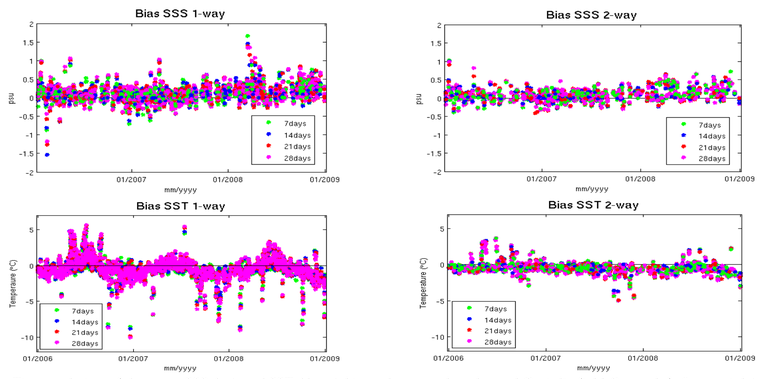
Difference (mean bias) between : (left) initial Coriolis tracer field – AMSRE SST fields, (centre) 1-way 7 days advection – AMSRE SST fields, (right) 2-way 7 days advection – AMSRE SST fields for year 2006.Mean values and standard deviation are marked on each plot.



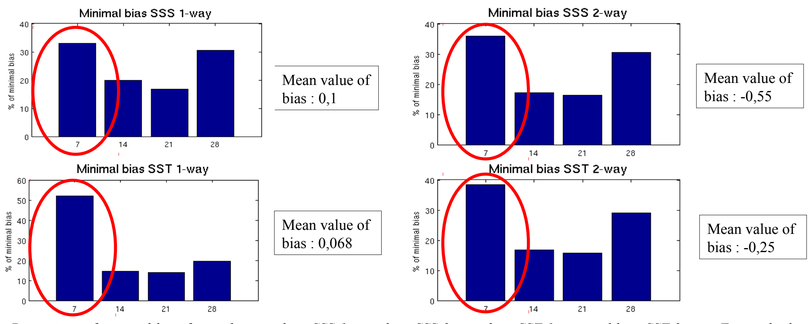
Mean values and standard deviation for year 2006 for the three diferences : 1) initial Coriolis tracer field – AMSRE SST field, 2)1-way advection – AMSRE SST fields, 3) 2-way advection – AMSRE SST fields for two different days of advection (-7 and -14 days).

The backward – forward method is not very conclusive for this kind of comparison. However, the filtering window used (that *Dencausse et al. (in press)* found most suitable for the region south of Tasmania) can be changed because the dynamics of the region is different.

Comparaison with in-situ TSG SST and SSS



Time evolution of the mean SSS (up) and SST (down) biases between the advected Coriolis field (1 way left, 2 way right) and thermosalinograph measurements.



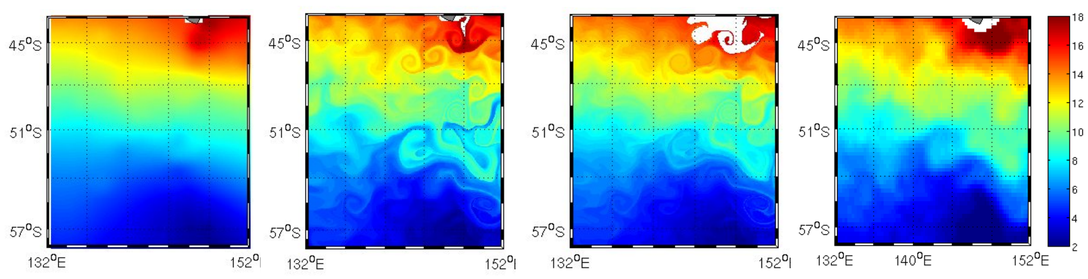
Percentage of minimal bias for each case : bias SSS 1-way, bias SSS 2-way, bias SST 1-way and bias SST 2-way. For each plot, the mean value of bias.

The backward – forward method seems to decrease seasonal biases and the the value of the bias.

Optimal advection time here seems to be 7 days with this comparison.

Conclusion and perspectives

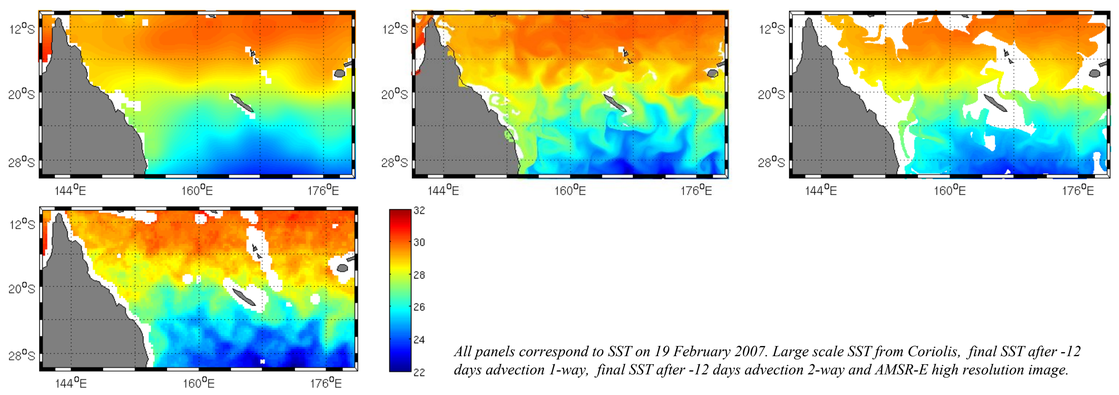
Results south of Tasmania



All panels correspond to SST on 20 February 2007. Large scale SST from Coriolis, final SST after -13 days advection (1-way), final SST after -13 days advection (2-way), AMSR-E high resolution image.

Mean bias reduced by a factor of ~ 10 with the backward – forward method
Optimal paramters for this region :
Advection time : ~14 days
Filtrage : 25km

Results subtropical Pacific Ocean



All panels correspond to SST on 19 February 2007. Large scale SST from Coriolis, final SST after -12 days advection 1-way, final SST after -12 days advection 2-way and AMSR-E high resolution image.

Reduction of seasonal bias with the backward – forward method.
Optimal paramters for this region are not yet refined. Tropical and subtropical Pacific regions have a different dynamic.

➡ More investigation and improvement needed.