

EXERCISE 5: Analysis Cycle Observation Impacts

Introduction

During Lecture 5, we explored how the impact of each observation assimilated during a 4D-Var analysis cycle on scalar functions of the circulation can be computed using the adjoint of the gain matrix, $\tilde{\mathbf{K}}^T$. Specifically, we considered the time average transport across 37N over the upper 500 m, denoted by I_{37N} , and given by:

$$I_{37N}(\mathbf{x}) = \frac{1}{N} \sum_{i=1}^N \mathbf{h}^T \mathbf{x}_i$$

where \mathbf{h} is a vector with non-zero elements corresponding to the velocity grid points that contribute to the transport normal to the 37N section shown in Fig. 1, N is the number of time steps during the assimilation interval, and \mathbf{x}_i is the model state-vector at time $i\Delta t$. For convenience, we will consider this same illustrative example in this exercise.

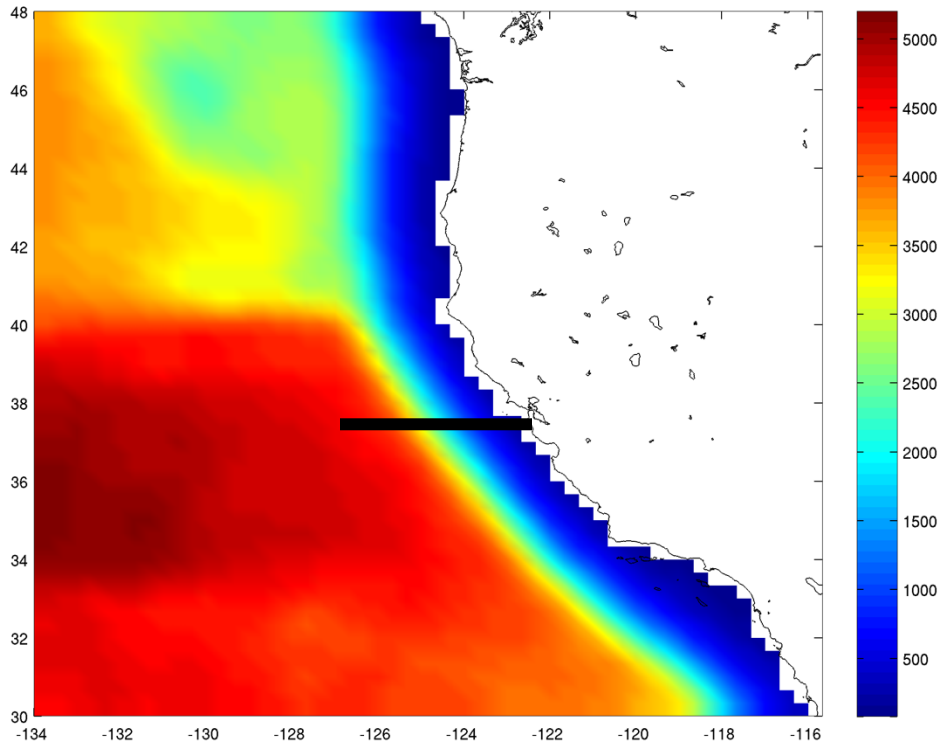


Figure 1: The 37N section along which the time averaged transport is computed from the surface to a depth of 500m.

The increment $\Delta I = I(\mathbf{x}_a) - I(\mathbf{x}_b)$ in 37N transport due to assimilating the observations is given by:

$$\Delta I \approx \mathbf{d}^T \tilde{\mathbf{K}}^T \sum_{i=1}^N \frac{1}{N} (\mathbf{M}_b)^T \mathbf{h}$$

where $\sum_{i=1}^N (\mathbf{M}_b^T)_i \mathbf{h}$ represents ADROMS forced by \mathbf{h} . Once a 4D-Var cycle has been performed, the Lanczos vectors can be used to reconstruct $\tilde{\mathbf{K}}^T$ and ΔI computed with a few additional runs of the tangent and adjoint models.

Running the observation impact driver

To compute the impact of each observation on I_{37N} you must first perform a 4D-Var data assimilation calculation using RBL4D-Var.

Go first to the directory [WC13/RBL4DVAR_analysis_impact](#) and follow the directions in the **Readme** file. Also, be sure to change **Ninner** and **NHIS** in **roms_wc13_2hours.in** to be the same as you used for Exercise 3.

Create a new subdirectory **EX5**, and save the solution in it for analysis and plotting to avoid overwriting solutions when playing with different CPP options and rerunning and recompiling:

```
mkdir EX5
mv Build_roms rbl4dvar.in *.nc log EX5
cp -p romsM roms_wc13_2hours.in EX5
```

where log is the ROMS standard output specified.

Plotting your results

To plot the results of your observation impact calculation, use the Matlab script **plot_rbl4dvar_analysis_impact.m**. You may need to edit the pathname for **Inp0** and **Inp1** to point to your [RBL4DVAR/EX3_RPCG](#) directory.