EXERCISE 6: Observation Impacts

Introduction

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

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

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.
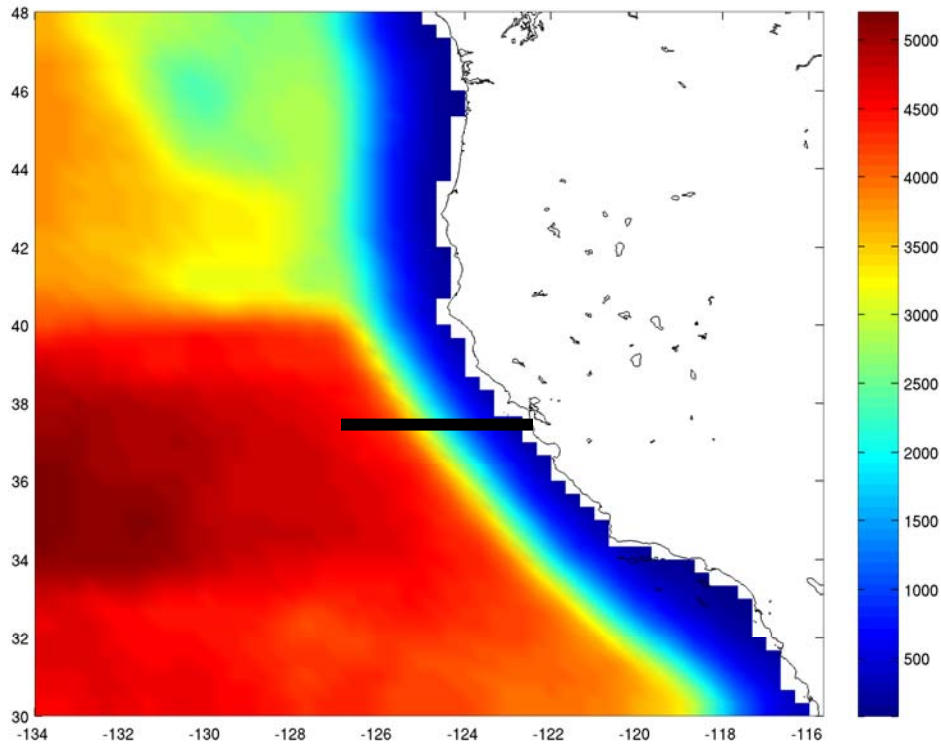

Figure 1: The 37N section along which the time averaged transport is computed from the surface to a depth of 500m.

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

$$\Delta I \simeq \mathbf{d}^{\mathrm{T}}\tilde{\mathbf{K}}^{\mathrm{T}}\sum_{i=1}^{N}\frac{1}{N}(\mathbf{M}_{\mathbf{b}})_i^{\mathrm{T}}\mathbf{h}$$

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where $\sum_{i=1}^{N} \mathbf{M}_b^T \mathbf{h}$ represents ADROMS forced by **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 observations on I_{37N}, you must first perform a 4D-Var data assimilation calculation using I4D-Var, R4D-Var, or 4D-PSAS.

Before running this exercise, choose one of your 4D-Var calculations, either the I4D-Var calculation of Exercise 1, or the strong constraint R4D-Var or 4D-PSAS of Exercise 3.

- If you selected I4D-Var, then before running the observation impact driver, copy the file **WC13/I4DVAR/EX1/wc13_adj.nc** into **WC13/I4DVAR**.

- If you selected R4D-Var, then before running the observation impact driver, copy the file **WC13/R4DVAR/EX3/wc13_mod.nc** into **WC13/R4DVAR**.

- If you selected 4D-PSAS, then before running the observation impact driver, copy the file **WC13/PSAS/EX3/wc13_mod.nc** into **WC13/PSAS**.

Then go first to the directory **WC13/I4DVAR_impact**, **WC13/RDVAR_impact**, or **WC13/PSAS_impact** as appropriate, and follow the directions in the **Readme** file.

Plotting your results

To plot the results of your observation impact calculation, use **plot_i4dvar_impact.m**, **plot_r4dvar_impact.m**, or **plot_psas_impact.m** as appropriate. In any case, you will need to edit the pathname to point to **I4DVAR/EX1**, **R4DVAR/EX3**, or **PSAS/EX3** as appropriate.