EXERCISE 2: I4D-Var with Multiple Outer-loops

Introduction

It is often advantageous to run 4D-Var using multiple outer-loops. During each outer-loop the circulation about which the tangent linear and adjoint models are linearized is updated by rerunning the nonlinear model using the increments from the end of the previous outer-loop. Using this approach 4D-Var proceeds as a sequence of linear least-squares minimizations, which (hopefully) approximate minimization of the nonlinear cost function:

$$J_{NL} = \frac{1}{2}\left(\mathbf{z}-\mathbf{z}_\mathbf{b}\right)^{\mathrm{T}} \mathbf{D}^{-1}\left(\mathbf{z}-\mathbf{z}_\mathbf{b}\right) + \frac{1}{2}\left(\mathbf{y}-H(\mathbf{x})\right)\mathbf{R}^{-1}\left(\mathbf{y}-H(\mathbf{x})\right)$$

Running I4D-Var with multiple outer-loops

This exercise is essentially a repeat of Exercise 1, except that you will use a different number of outer-loops.

To run this exercise, go first to the directory **WC13/I4DVAR**. The only change that you need to make is to **roms_wc13_2hours.in**, where you need to select new values for **Ninner** and **Nouter**. Go ahead and choose a new combination of **Ninner** and **Nouter** that you feel might be appropriate so that **Ninner*Nouter**~*25*.

Now go ahead and run I4D-Var as described in the **Readme** file.

Create a new subdirectory **EX2**, 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 EX2
mv Build_roms i4dvar.in *.nc log EX2
cp -p romsM roms_wc13_2hours.in EX2
```

where log is the ROMS standard output specified

Plotting your results

Plot the I4D-Var cost function J and its components J_b, J_o and the theoretical minimum value $J_{min}=N_{obs}/2$ using **WC13/plotting/plot_i4dvar_cost.m**.