EXERCISE 5: Array Modes

Introduction

As described in Lecture 4, the 4D-Var state-vector increments $\delta\mathbf{x}_\mathbf{a}(t)$ can be expressed as a weighted sum of the array modes:

$$\delta\mathbf{x}_\mathbf{a}(t) = \sum_{i=1}^{M} \lambda_i^{-1} \left(\hat{\mathbf{w}}_i^{\mathrm{T}} \mathbf{R}^{-1/2} \mathbf{d}\right) \mathbf{\Psi}_i(t)$$

where $\left(\lambda_i, \hat{\mathbf{w}}_i\right)$ are the eigenpairs of the preconditioned stabilized representer matrix $\left(\mathbf{R}^{-1/2}\mathbf{GDG}^{\mathrm{T}}\mathbf{R}^{-1/2} + \mathbf{I}\right)$. The array modes corresponding the largest eigenvalue represent the interpolation patterns for the observations that are most stable with respect to changes in the innovation vector **d**, since the array modes depend *only* on the observation locations and not on the observation values.

Running the array mode driver

To compute the array modes, you must first run R4D-Var or 4D-PSAS because the array mode driver will use the Lanczos vectors generated by your dual 4D-Var calculation.

To run this exercise, go first to the directory **WC13/ARRAY_MODES,** and follow the directions in the **Readme** file. The only change that you need to make is to **s4dvar.in**, where you will select the array mode that you wish to calculate (you may only calculate one mode at a time). The choice of array mode is determined by the parameter *Nvct.* The array modes are referenced in reverse order, so choosing *Nvct=Ninner* corresponds to the array mode with the largest eigenvalue, *Nvct=Ninner-1* is the array mode with second largest eigenvalue, and so on. Note that *Nvct* must be assigned a numeric value (i.e. *Nvct=50* for the 4D-Var case you ran in Exercise 3).

NOTE: Before running the array mode driver, you will need to ensure that you copy the file **EX3/wc13_mod.nc** generated during Exercise 3 into **WC13/R4DVAR** or **WC13/PSAS** as appropriate.

Plotting your results

Use **WC13/plotting/plot_array_modes.m** to plot a selection of fields for you chosen array mode.