

Develop computer code that can be used to analyze mesoscale data.

1. First, consider a “nearest neighbor” analysis approach, whereby

$$\phi_A(x_i, y_i) = W_{i,k} \phi_O(x_k, y_k) , \quad (1)$$

where ϕ_A is the analysis value at a grid point (x_i, y_i) , subscript O denotes an observation, and W are the weights. Here $W = 1$ for the data point k that satisfies

$$\min \left[\sqrt{(x_i - x_k)^2 + (y_i - y_k)^2} \right],$$

and $W = 0$ for all other data points. Literally, only the observation nearest to the analysis point affects the analysis value.

Use this approach to interpolate the sample data set to the following grid:

$x_i = 0, 10, 20, \dots, 100$ km
 $y_i = 0, 10, 20, \dots, 100$ km

where the grid points have a uniform spacing of 10 km. The sample data set (<http://web.ics.purdue.edu/~jtrapp/dataset1.dat>) can be downloaded, as can an NCL script (<http://web.ics.purdue.edu/~jtrapp/contour.ncl>). The data file contains a string of real numbers in the format $\phi_o \ x_k \ y_k$:

```
10.2   35.   96.
⋮
25.    15.   0.5
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2. Next, consider the analysis equation:

$$\phi_A(x_i, y_i) = \frac{\sum_{k=1}^N w_{i,k} \phi_O(x_k, y_k)}{\sum_{k=1}^N w_{i,k}} , \quad (2)$$

where ϕ_A is the analysis value at a grid point (x_i, y_i) , the subscript O denotes an observation at data point (x_k, y_k) , N is the number of observations, and w is the weight function.

a. Use the Cressman form of the weight function in Eq. (2):

$$w_{i,j} = \begin{cases} \frac{R^2 - r_{i,k}^2}{R^2 + r_{i,k}^2}, & r_{i,k}^2 \leq R^2 \\ 0, & r_{i,k}^2 > R^2 \end{cases},$$

where $r_{i,k}^2 = [(x_i - x_k)^2 + (y_i - y_k)^2]$. Choose the radius of influence R that seems most appropriate, and comment on the resulting analysis.

b. Use the Barnes form of the weight function in Eq. (2):

$$w_{i,k} = \exp[-r_{i,k}^2 / \kappa].$$

Similarly, choose the smoothing parameter κ that seems most appropriate for these data, and again comment on the resulting analysis.