



OBTAINING TOTAL CURRENT VELOCITIES FROM RADIALS

Methods employed by the SeaSonde combining software

January, 2004

This document describes the steps used by the combining software to produce total current velocity vector maps from the radial velocities measured by two or more SeaSonde remote sites

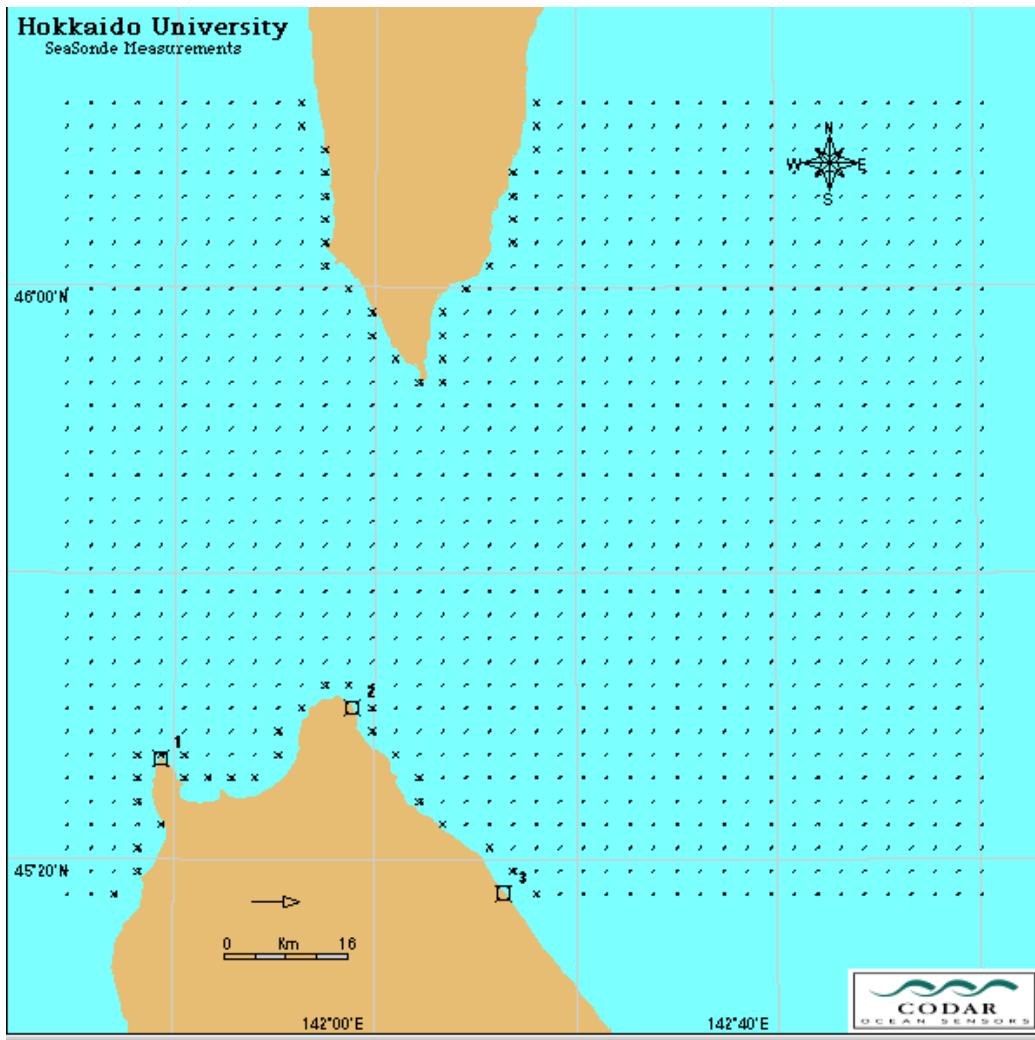


Fig 1: A typical rectangular grid over the common coverage area for three remote radar sites. Coastline points are indicated by the crosses.

The first step is to define a grid over the common coverage area, using the program SDSsetup to create a grid file input to the combine software. Fig. 1 display a typical rectangular grid; however the grid can be of any form and special points (for example buoy locations) can be added. Coastline points, indicated in Fig. 1 by crosses, are identified in the grid file by a special flag.

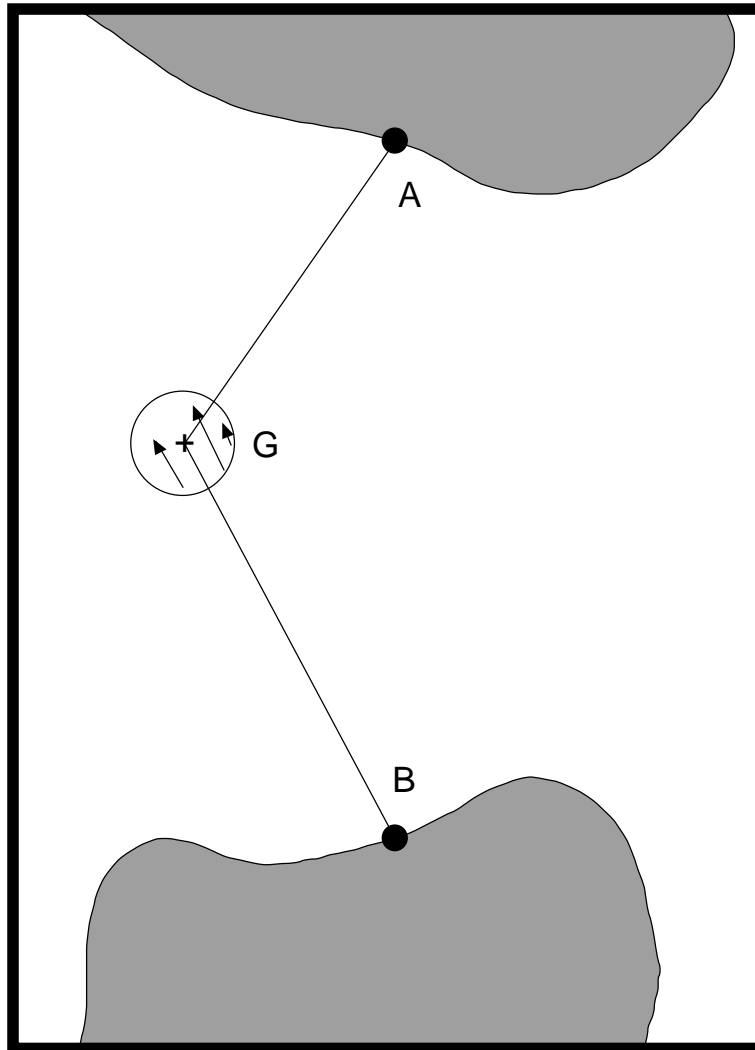


Fig. 2: Radar sites are at points A, B. Grid point G is surrounded by an averaging circle, which contains the radial vectors to be used in the least-squares solution for the total vector. Radial vectors from the Site B radar are drawn.

At each grid point, we want to compute the U, V (i.e. East, North) components of the total velocity vector.

Ideally at each grid point there would be a radial velocity from each radar, which would be used to estimate U, V. In Fig. 2, these ideal radial vectors would lie along the radial lines GA, GB. In practice, an averaging circle with a specified radius, is drawn around each grid point and the radial vectors falling within the circle are collected. If the angle between the radial vector and the corresponding radial line is greater than 10° , the radial vector is discarded. The total velocity components U, V are obtained by least-squares fitting to the radial vectors that remain in the averaging circle.

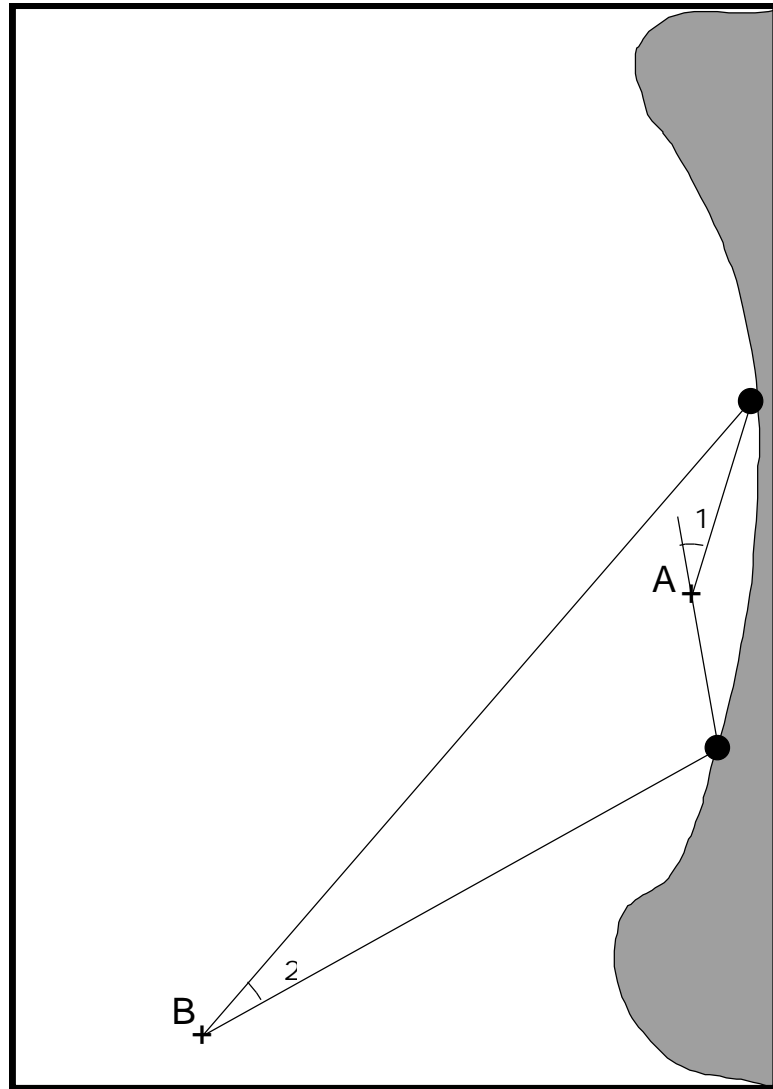


Fig. 3: To ensure a stable solution for the total velocity at a grid point, we impose constraints on angles α_1 and α_2 between the radial lines from the grid point to the radar sites..

The least-squares solution is unstable when the radial velocities within the averaging circle are too close to parallel. For two radar sites, this occurs when the grid point is close to the line joining the two sites (the so-called baseline region), e.g. at grid point A in Fig. 3 and also far from the radar sites, e.g. at grid point B.

We define two limiting stability angles α_{lim} , (normally set between 20° and 30°). To produce a total vector at a grid point, we require at least one pair of radial vectors to have $\alpha_2 > \alpha_{lim}$. The baseline region is defined by those grid points for which $\alpha_1 < \alpha_{lim}$. The baseline region can be left blank, or interpolation can be performed to fill it total vectors.

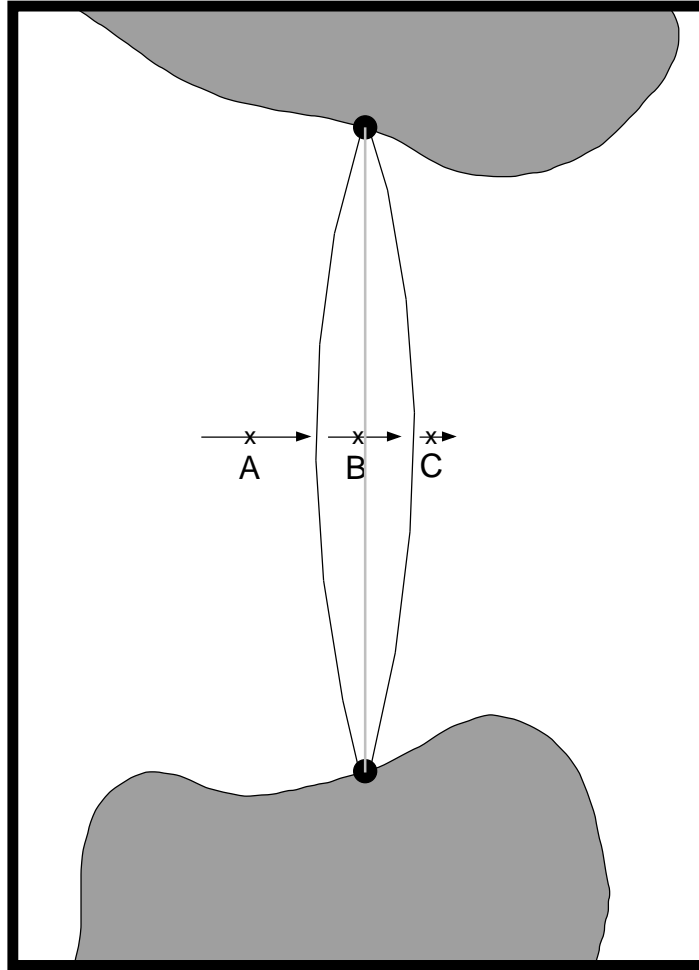


Fig. 4: Illustrates the situation when the baseline lies over open water. The baseline between the radar sites is indicated by the dashed line. The arcs represent the boundaries of the baseline region.

The total velocity vector S is resolved into components S_{par} and S_{perp} that are parallel and perpendicular to the baseline respectively. Within the baseline region, the solution for S_{par} is very stable; it is effectively the mean of the different radial velocities. However the radials provide little information on the perpendicular component.

Therefore we accept the solution for S_{par} produced by the least-squares fit and obtain the value of S_{perp} by interpolation: For each grid point within the baseline region (e.g. point B in Fig. 4), we find the closest grid points outside the baseline region on either side (points A, C in Fig. 4). The value of S_{perp} at B is taken to be the linear interpolation between that at points A and C.

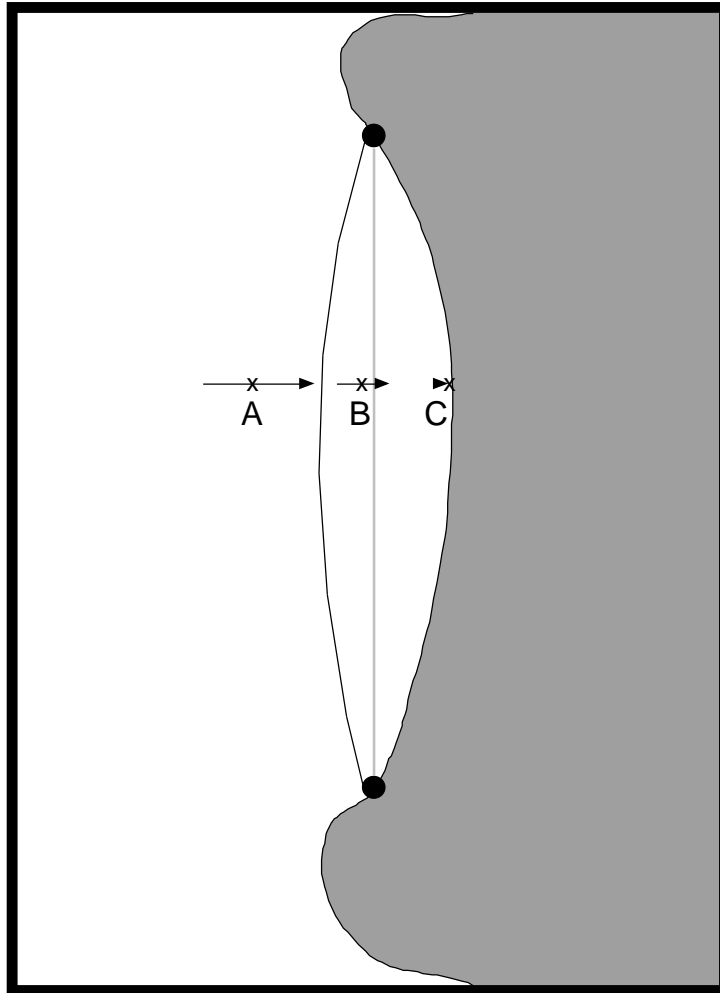


Fig. 5: Illustrates the situation when the baseline lies close to the coastline. The baseline between the radar sites is indicated by the dashed line. The arc and the coastline are the baseline region boundaries.

When the baseline falls close to the coastline, we use the coastline itself as one of the boundaries of the baseline region.

For each grid point within the baseline region (e.g. point B in Fig. 5), we find the closest grid point on the ocean side of the baseline region (point A) and the closest grid point on the coast (point C). We assume that S_{perp} at the coast is zero. The value of S_{perp} at B is taken to be the linear interpolation of the value at point A outside the baseline region and a zero value at point C.

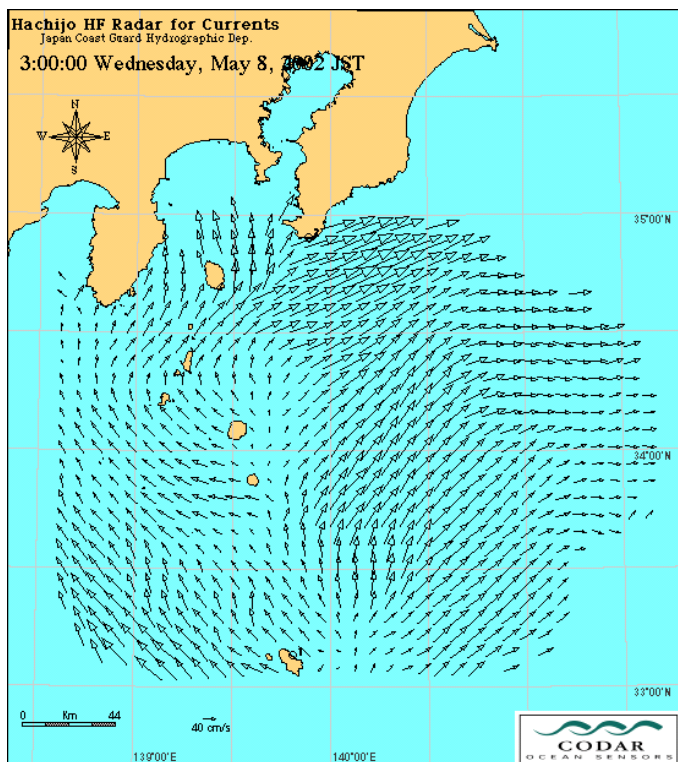
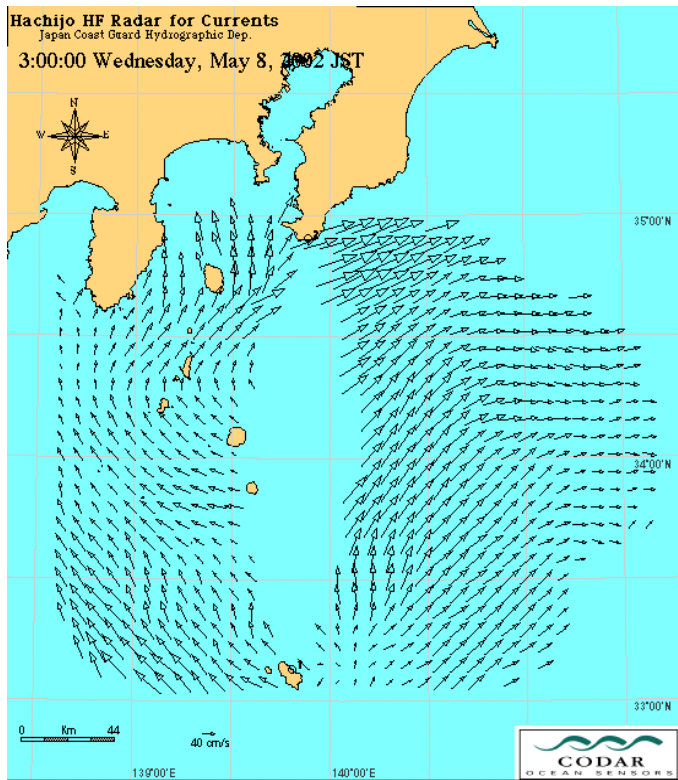


Fig. 6: An example of baseline interpolation when the baseline lies over open water. In the upper figure the baseline region is left blank; in the lower figure it is filled with interpolated vectors. The input parameters α , β were set to 30° .

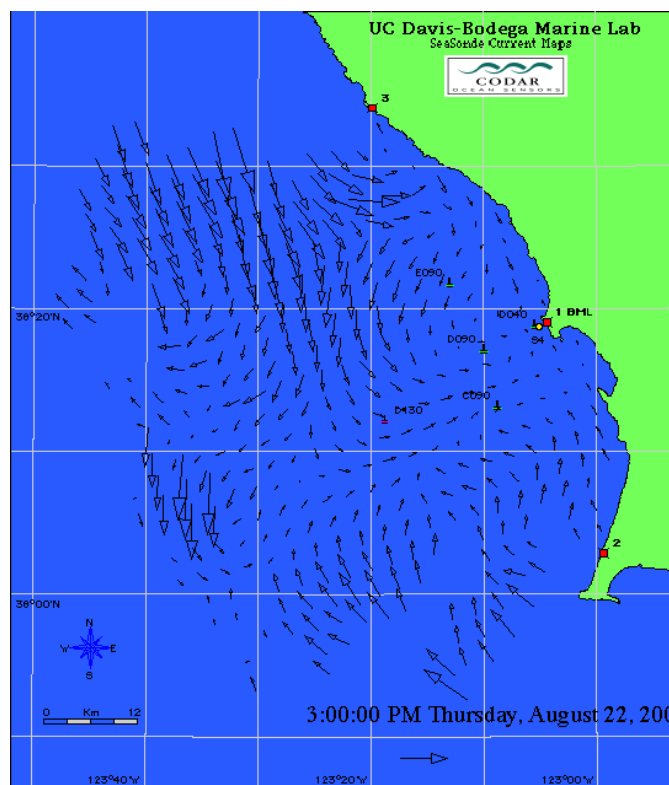
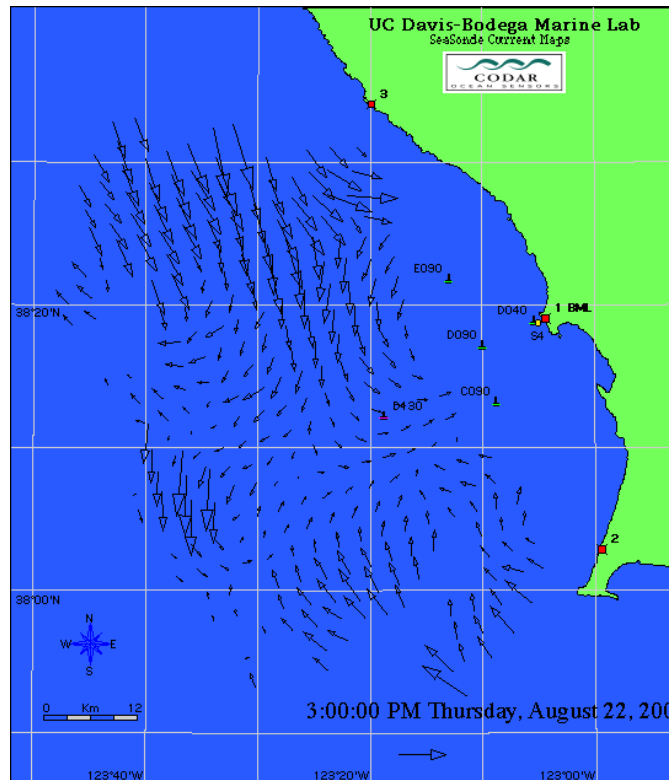


Fig. 7: An example of baseline interpolation when the baseline is close to the coast. In the upper figure the baseline region is left blank; in the lower figure it is filled with interpolated vectors. The input parameters α , β were set to 30° .