CONVERSION ALGORITHMS FOR THE CALCOFI STATION GRID

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ABSTRACT
This note presents algorithms which may be used to convert station positions expressed in geographic coordinates (latitude and longitude) to the California Cooperative Oceanic Fisheries Investigations (CalCOFI) station grid coordinates and vice versa. Clarke's spheroid of 1866 is used as an estimate of the geoid off the west coast of North America.

INTRODUCTION
The CalCOFI station pattern (Figure 1) was designed originally in the development of a systematic sampling program to determine the major spawning areas of the Pacific sardine off the coasts of the United States and Baja California, Mexico. Surveys were conducted along lines extending seaward approximately normal to the coast and spaced 120 miles apart from the Columbia River to Sebastian Vizcaino Bay. As the program progressed and spawning areas were delimited, additional lines of stations were added between the cardinal lines, and the surveys became concentrated off the coasts of California and Baja California.

The pattern was based on line 80 off Point Conception, California. Other lines were numbered using increments of 10, decreasing northwestward to line 10 off the U.S.-Canadian border, and increasing southeastward to line 157 off Cape San Lucas, Baja California (Kramer et al. 1972). It was originally intended that the 120-mile spacing would allow for additional lines to be plotted 12 miles apart between the cardinal lines, and the surveys became concentrated off the coasts of California and Baja California.

The stations on the lines were laid out on the basis of a perpendicular to line 80, through a point designated Station 80.60. The original stations were plotted 40 miles apart and were numbered by increments of 10, which allowed additional stations between the 40-mile points to be plotted as close to 4 miles and still be designated by whole numbers.
Figure 1. Schematic representation of the geometrical components used to compute latitude and longitude at a point P, given the CalCOFI grid coordinates (Station No.) of P and O and the latitude and longitude at O (see text).
1. \( RLA = 34.25 - 0.2(PLN - 80)\cos(30) \)
2. \( PLA = RLA - (1/15)(PSN - 60)\sin(30) \)
3. \( L1 = (MCTR(RLA) - MCTR(34.15))\tan(30) \)
4. \( L2 = (MCTR(RLA) - MCTR(PLA)) \div \left(\cos(30)\sin(30)\right) \)
5. \( PLO = L1 + L2 + 121.15 \)

**CONVERSION OF GEOGRAPHICAL COORDINATES TO CALCOFI COORDINATES**

The computation of CalCOFI line and station numbers for a given location where latitude and longitude are given requires determination of a latitude when its Mercator transform is known, i.e. given \( MCTR(LA) \), find \( (LA) \). There is no simple algebraic solution to this problem; however, \( (LA) \) can be approximated with as much precision as desired with a simple iterative procedure in which \( MCTR(LA) \) is entered as the first approximation to \( (LA) \). The algorithm for the inverse Mercator transform is as follows:

1. Set \( I = 0 \)
2. Set \( LA = MCTR(LA) \)
3. \( LA = 2(\arctan(\exp(MCTR(LA)\cdot I/180 + 0.00676866\cdot \sin(LA))) - 45) \)
4. \( I = I + 1 \)
5. IF \( I < 3 \) GO BACK TO STEP 3
6. STOP

The CalCOFI grid coordinates for a station at a given location can be computed with the following sequence:

1. \( L1 = (MCTR(PLA) - MCTR(34.15))\tan(30) \)
2. \( L2 = PLO - L1 - 121.5 \)
3. \( MCTR(RLA) = (L2\cos(30)\sin(30) + MCTR(PLA)) \)
4. \( RLA = \text{INVERSE}(MCTR(RLA)) \)
5. \( PLN = 80 - (RLA - 34.15)5/\cos(30) \)
6. \( PSN = 60 + (RLA - PLA)15/\sin(30) \)

**DISCUSSION**

The two conversion procedures presented here are mutually consistent in that when executed consecutively, using the output from one run as input for the next, the original coordinate values can be recovered with a precision of at least four decimal places. For example, Station 50.120 converts to 37° 20.7692'N, 129° 16.7727'W. With these values as input, the reciprocal conversion yields 50.0000 and 120.0000 for line and station, respectively. However, if the geographical coordinates are rounded to tenths of minutes, as is common in CalCOFI work, the conversion to line and station becomes 49.9969 and 120.0004.

We should point out that the correspondence between CalCOFI and geographical coordinates as computed from the numerical procedures is not in exact agreement with that given in the standard reference tables used by CalCOFI. The discrepancies are generally less than 2 minutes of latitude or longitude for given CalCOFI station numbers except out on the fringes of the pattern. They may possibly be due to accumulative errors incurred when laying out the station pattern on the navigational charts.

It should further be noted that even greater discrepancies are found when the computed locations for CalCOFI stations are compared with the actual locations occupied on individual cruises, as reported in the CalCOFI Physical and Chemical Data Reports. Deviation from standard station positions may have occurred during CalCOFI cruises to avoid navigational hazards or other reasons and nearby alternate locations accepted as representing the designated station. The conversion procedures can provide a convenient way to determine the CalCOFI coordinates of the actual locations occupied in such instances.

**REFERENCES**
