Palmer LTER: Comparison between a global tide model and observed tides at Palmer Station

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Direct measurements of tidal currents around Antarctica are sparse (Lutjeharms, Stavropoulis, and Koltermann 1985), and most of the available measurements are from sites at shore-based laboratories. A recent global tidal model (Egbert, Bennett, and Foreman 1994), however, provides an alternative approach for estimating tides around Antarctica, provided the simulated tides are representative of the actual tides. The objective of this article is to compare the simulated tidal structure with that measured at Palmer Station.

The global tide model is a generalized inverse model in which the crossover differences from the TOPEX/Poseidon altimeter are fit to the Laplace tidal equations. The model solution provides the amplitude and phase of eight tidal constituents (M2, S2, N2, K2, K1, O1, P1, Q1) on a latitude-longitude grid with a spatial resolution of about 40 by 65 kilometers (km) at the latitude of Palmer Station. The surface elevation and tidal velocity are calculated using the eight basic tidal constituents and estimated amplitudes for nine minor constituents (2N2, MU2, NU2, L2, T2, J1, NO1, OO1, RHO1) and three long-period constituents (MF, MM, SSA). The global tidal solution and analysis software are available via the Internet through Oregon State University (Egbert et al. 1994).

The first analysis of the tidal solution examines the corange of each of the components to assess the general structure of the tides along the Antarctic Peninsula. The amplitude of the major semidiurnal components (M2 and S2) have a range of 0.2 meters (m) along the peninsula. The M2 corange lines are perpendicular to the peninsula and increase from 0.2 to 0.4 m toward the north. The S2 corange lines are parallel to the coast and increase from 0.15 m at the shelf break to 0.25 m at the coast. The major diurnal components (O1 and K1) have a range of 0.3 m along the peninsula, increasing slightly onshore; the corange lines are parallel to the coast. Thus, the tides along the Antarctic Peninsula are mixed with about equal amplitudes of diurnal and semidiurnal components. The F ratio (O1+K1/M2+S2) is 1.4, which indicates a mixed tide with a slight diurnal dominance.

The tidal elevation records (figure 1*A*) calculated from the global tidal solution for June 1992 at 64.93°S 64.40°W, which is Long-Term Ecological Research (LTER) station 600.040 (Waters and Smith 1992), show dominance of the diurnal tide but with nearly equal semidiurnal tides at about 2-week intervals. The tidal record measured at Palmer Station (Amos 1993), which is close to 600.040, has the same general character (figure 1*C*). Note that a constant elevation has been removed from the observations so that the average difference between the observed and model elevations is 0. The difference between

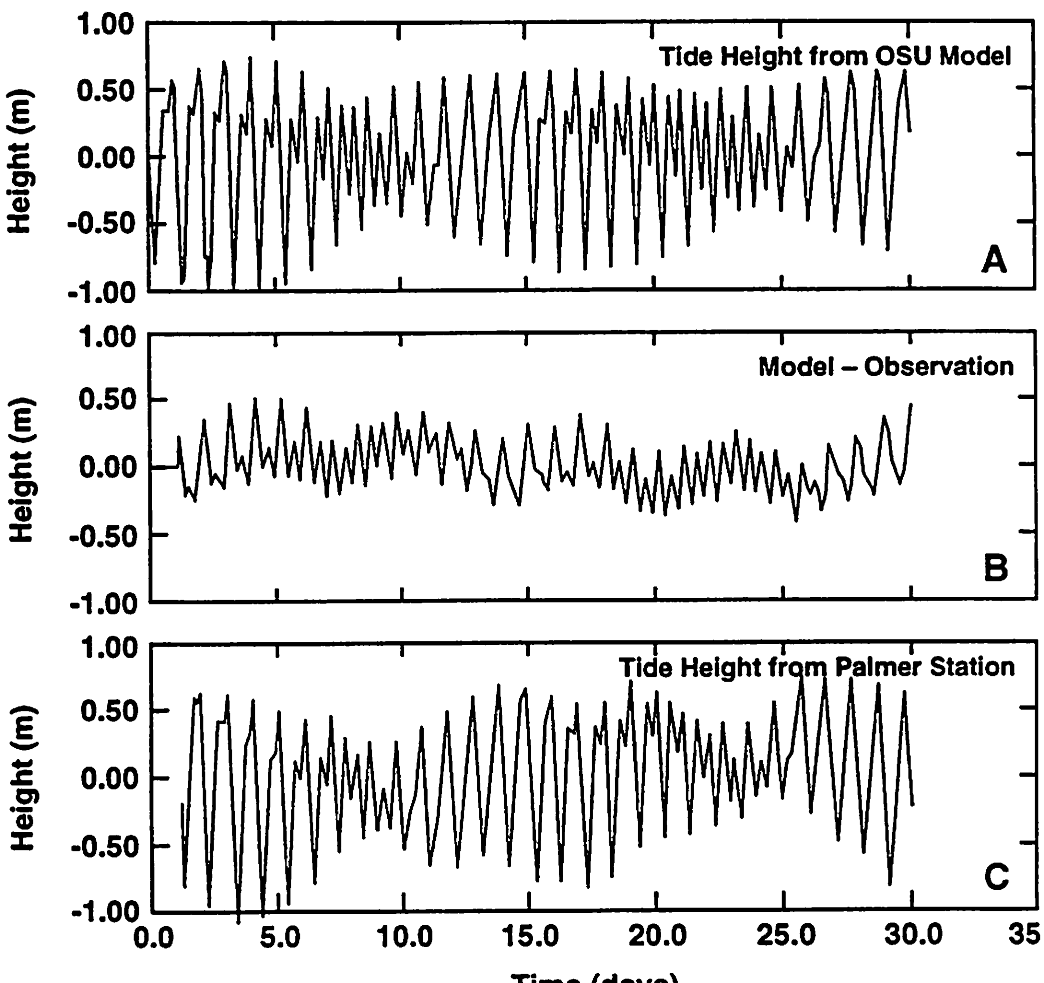

Figure 1. Tidal elevation for June 1992. *A*. Elevation from the global tide model at LTER grid location 600.040. *B*. Difference between model estimated elevation at 600.040 and observed tides at Palmer Station. *C*. Observed water elevation at Palmer Station.

the observed and modeled elevations (figure 1*B*) has a range of +0.5 and –0.4 m and a root mean square difference of 0.18 m. Thus, the model reproduces the correct timing of the transition between the diurnal and semidiurnal tides. The simulated tides have a larger semidiurnal amplitude, however, and the measured record contains nontidal variations, probably caused by wind and atmospheric pressure effects, which are not reproduced by the tidal model.

Comparisons between simulated tides for February 1993 (figure 2*A*) and observed tides (figure 2*C*) for the same period show good general agreement. The difference between observed and modeled values (figure 2*B*) has a range of +0.4 and –0.5 m and a root mean square difference of 0.28 m. The periods of semidiurnal and diurnal tides agree, although the simulated semidiurnal amplitude is larger than that measured.

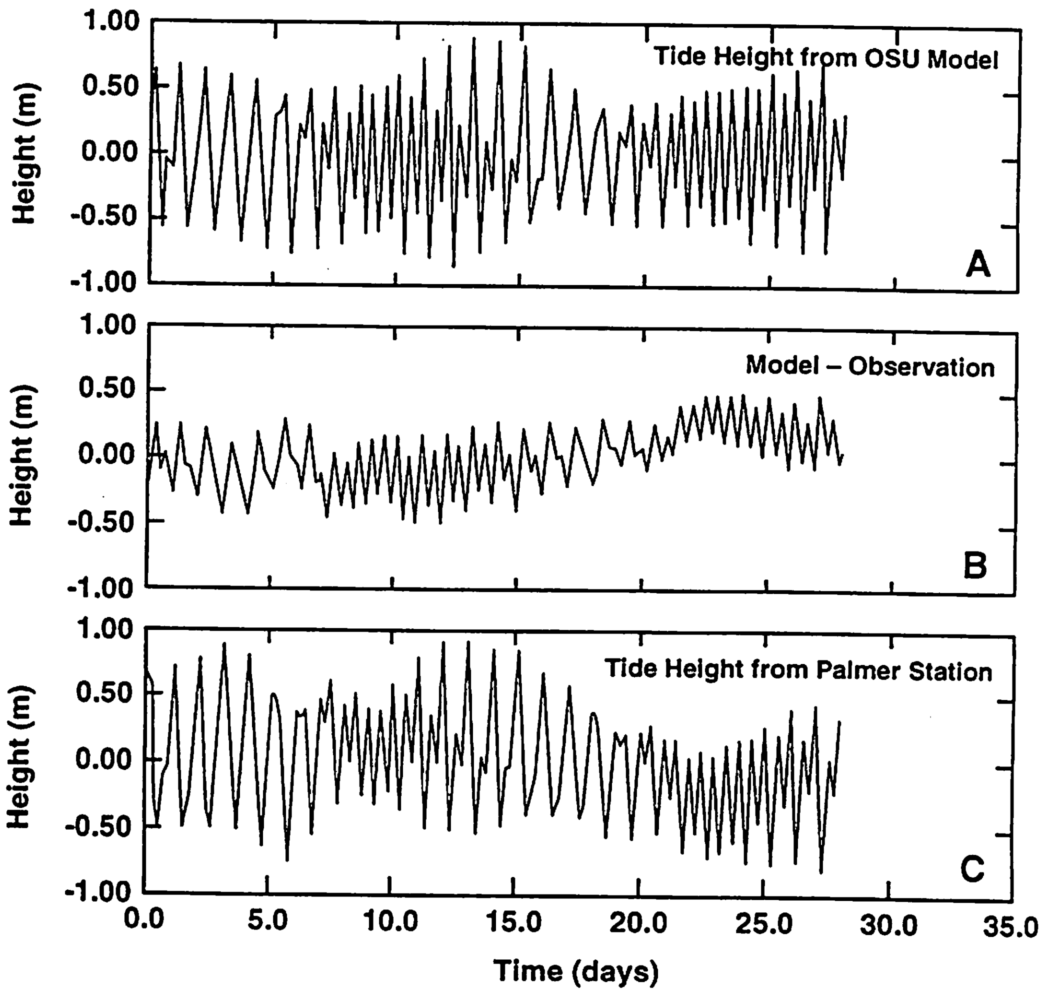

Figure 2. Tidal elevation for February 1993. *A*. Elevation from the global tide model at LTER grid location 600.040. *B*. Difference between model estimated elevation at 600.040 and observed tides at Palmer Station. *C*. Observed water elevation at Palmer Station.

The good agreement between observed and simulated tides suggests that the model can be used to calculate the tidal flow over the continental shelf west of the Antarctic Peninsula. The flow speed for each of the eight principal tidal components (table) was calculated at LTER stations 600.040, 600.100 (64.58°S 65.34°W), and 600.200 (63.97°S 66.86°W), which are at the coast, middle shelf, and in deep water off the continental shelf, respectively. The largest tidal speeds are 0.02 to 0.03 meters per second (m s^{-1}), and the combined speed for all tidal components could, at times, be as large as 0.1 m s^{-1}. Tidal speeds tend to be largest over the midshelf and could potentially displace particles 2 to 3 km over one tidal cycle. Thus, tidal currents on the continental shelf west of the Antarctic Peninsula can potentially have an effect on the distribution and dispersal of properties.

Cospeed (m s^{-1}) amplitudes from the inverse model for eight tide harmonics at three locations across the shelf near Anvers Island

Location	M2	S2	N2	K2	K1	O1	P1	Q1
600.040	0.0199	0.0239	0.0041	0.0068	0.0204	0.0255	0.0064	0.0057
600.100	0.0336	0.0337	0.0066	0.098	0.0236	0.0316	0.0078	0.0071
600.200	0.0230	0.0164	0.0050	0.0049	0.0110	0.0113	0.0032	0.0030

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