Simulation of the Red Sea Tides

A.A. Androsov, A.V. Nekracov, D.A. Romanenkov*, N.E. Voltzinger
St.Petersburg Branch, Institute of Oceanology, Russian Academy of Sciences
30, Pervaya Liniya, 199053 St.Petersburg, Russia
* Corresponding author. *E–mail addresses:* roman@gk3103.spb.edu (D.A. Romanenkov).

Modelling the tides in the Red Sea requires a satisfactory description of its complicated relief and shore line configuration (Morcos, 1970; Prat et al, 1999, 2000). Also, the local tidal characteristics may, to a considerable extent, be formed by the sharp seasonal changes of stratification with its typical structure in different parts of the Sea.

For computation of the tides in the Red Sea, a 3-D boundary–value problem for the equations of motion, continuity, temperature, salinity and characteristics of turbulence is formulated in a domain with an open boundary south of the Gulf of Aden to the northern end of the Gulf of Suez (Fig. 1).

The boundary–value problem is transformed to the boundary–fitted curvilinear coordinates. The equations in the form of contravariant fluxes are integrated by the difference method. The numerical method uses conservative schemes for the split operators, allowing one to control the scheme viscosity and the solution behavior in the locality of its sharp gradients (Androsov et al., 2002).

Below are given some results obtained in a computation of the 3–D barotropic tide for the northern part of the Red Sea and the Gulf of Suez. The boundary conditions at a cut of $24^o N$ are found by data interpolation of the level oscillation at Stations 1 ($35.5^o E$, $23.967^o N$) and 13 ($37.1^o N$, $24.967^o N$). The horizontal curvilinear grid contains 65×69 points for the north Red Sea and 33×129 points for the Gulf of Suez with a step that varies from 0.4 km to 14 km. In the vertical direction, 50 horizons were used; the time step is 232.875 s. In Fig. 2, the M_2–tidal chart in the Gulf of Suez is presented. In Fig. 3, a comparison of the results with data at 11 stations for the M_2–wave computation is given. The rms error of level computation for the tidal period (12.42 h) is 1.6 cm.

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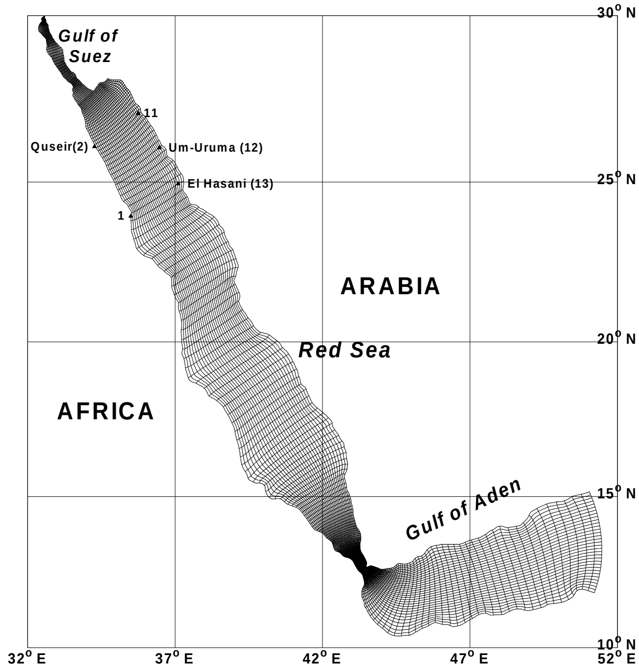

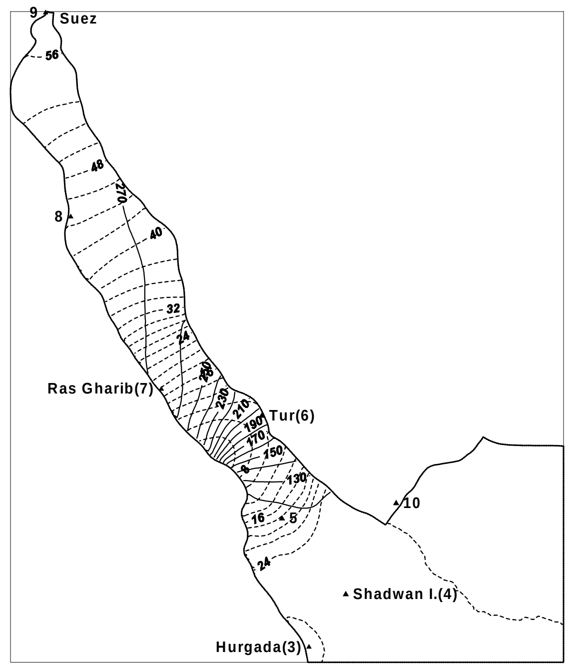

Figure 1: Curvilinear grid of the Red Sea and the Gulf of Aden. The grid is coarsened for illustration.

Figure 2: M_2–tidal map of the Gulf of Suez. Isophases (in deg.) —— ; isoamplitudes (in cm) - - -.

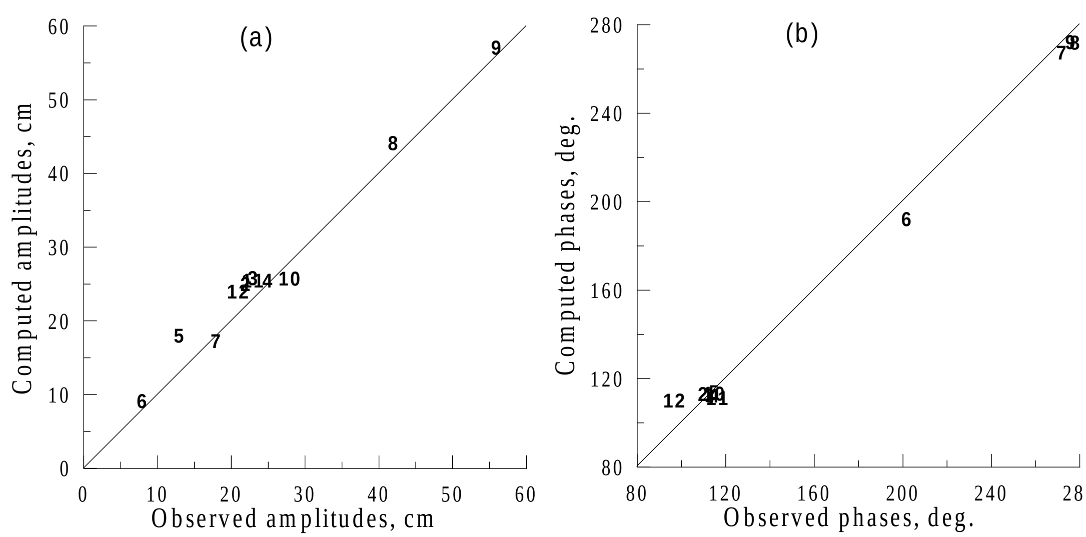

Figure 3: Correlation between the data and computed values of amplitudes and phases of the sea–level oscillations for the M_2–constituent; (a) – amplitudes, (b) – phases. Stations location see in Fig. 1 and Fig. 2.