Chapter 8

Model Testing and Validation

Before turning to specific simulations of interest, a number of initial tests were carried out in order to assess the accuracy of the simulations and to help determine the appropriate parameters for the fort.15 file.

8.1 Spin up Time

There are many different objectives in carrying out an ADCIRC run. For example, some users use it to determine the tidal constituents at a given location. In this case, a long simulation is carried out and then a harmonic analysis is performed on the time series of predicted elevation at that point. In this case, the origin of the 'time axis' is relatively unimportant.

Other users are interested in performing an ADCIRC simulation for a very specific time period. In this way, the model output can be compared against data from an ADCP or a tidal gage for a specific date and time. Properly setting the origin of the time coordinate for the simulation is therefore of paramount importance.

Related to this is the issue of how much time is required for the model to 'spin up.' When ADCIRC begins a simulation, the initial shape of the water surface must be known. However, it is generally unknown. So, it is common to perform a 'cold start' by simply assuming the water surface in the entire domain to be flat. If this is the case, then it is intuitive to expect that some time will be required for the domain to fully adjust to its boundary forcing. If the model was spun up only one hour before output was to be compared to field data, it seems unlikely that a meaningful comparison would be obtained.

The question, therefore, is how long the model must be run before one can assume that the transients from the cold start have dissipated. Conversations with other researchers suggested that the answer to this question was highly domain-specific, but initial suggestions of one to two weeks were made.

To test this hypothesis, it was decided to perform a simulation for the 0.25 day period beginning at 17:38:51 (GMT) on June 25, 2002. Two ADCIRC runs were performed, the first beginning 7 days before this (total run duration of 7.25 days), the second beginning 14 days before this (total run duration of 14.25 days). If the output from the two simulations differed significantly for the 0.25 day target period desribed above, the conclusion would be that a seven day spin up was not sufficient.

Time series of elevation at a given point for the two runs are given in Fig. 8.1. Note that the time axes of the two simulations are synchronized and that the origin is taken to be 12:00:00 GMT on June 11, 2002. For the first seven days or so, only one time series is observed, since the second trial had not yet begun. Seven days after the commencement of the 14 day run, the 7 day run begins. The lower portion of the figure plots the absolute value of the difference between the two results from this time onward.

First of all, note that, by the end of the simulation periods, the discrepancy between the two results is on the order of 5×10^{-4} m, whic is 0.01% of the tidal wave height of ~ 5 m. The lack of significant discrepancy between a 7 day and a 14 day run suggests that 7 days is more than adequate in terms of initializing the model from an initially flat water surface.

Next, note that, within two days of the 7 day simulation starting up, the discrepancy between it and the 14 day simulation is only 0.1% of the tidal wave height. This suggests that the very modest period of only a few days is an adequate spinup time. The fact that this result is so much shorter than the two week suggestion from other researchers likely has to do with the relatively small physical size of the domain, compared to oceanic scales.

8.2 Validation of Water Surface Elevation Calculations

There are two ways of validating the values of water surface elevation calculated by ADCIRC. First, they may be compared to actual data from a tidal gage. Second, they may be compared to calculations / predictions at a station

with accepted tidal constituents. Extensive repositories of both data and predictions are available from NOAA at http://tidesandcurrents.noaa.gov/. At that site, an interactive map (see Fig. 8.2) will allow the user to select a station from which historical data and / or tidal predictions may be extracted and downloaded. Note that the available information will vary depending upon the selected station.

As a test, predictions were extracted, for the time period corresponding to the 14 day simulation described above. Predictions were obtained for Elfin Cove, Port Althop (Station ID 9452634), which lies near the southwestern portion of the ADCIRC model domain. These predictions are plotted together with the ADCIRC output in Fig. 8.3. As the figure illustrates, the agreement is extremely good, both in terms of phase and amplitude. At lower tidal amplitudes, e.g. near days 8 and 9, some minor discrepancies appear in the predicted crest and trough elevations. Overall, however, Fig. 8.3 is convincing confimation of ADCIRC's ability to predict water surface elevations.

The Elfin Cove station also has historical observtaional data archived for various periods. Therefore, a second test was performed, in order to see how the ADCIRC output, and the NOAA predictions, compared against actual observations. Fourteen days of data were extracted, beginning on 1 January, 2006, 00:00:00 GMT. The ADCIRC run was begun at this same time and a 14 day simulation was carried. out. The results of this comparison are shown in Fig. 8.4. As with the previous comparison, the agreement between the NOAA predictions and the ADCIRC out is exceptional. Both of these sets of predictions are also in good agreement with the observational data. There is a clear systematic offset, with the data being consistently higher than the predictions. Other comparisons for different time periods yielded different results, with the data being consistently lower than the predictions. Recalling that tidal constituents capture only gravitational influences, it is not surprising that there are modest differences between predicted and observed tides. For example, strong meteorological forcing in the form of winds and surface pressure can lead to slight differences between observation and prediction. With this caveat, it is clear that ADCIRC successfully predicts water surface elevations in the Glacier Bay domain.

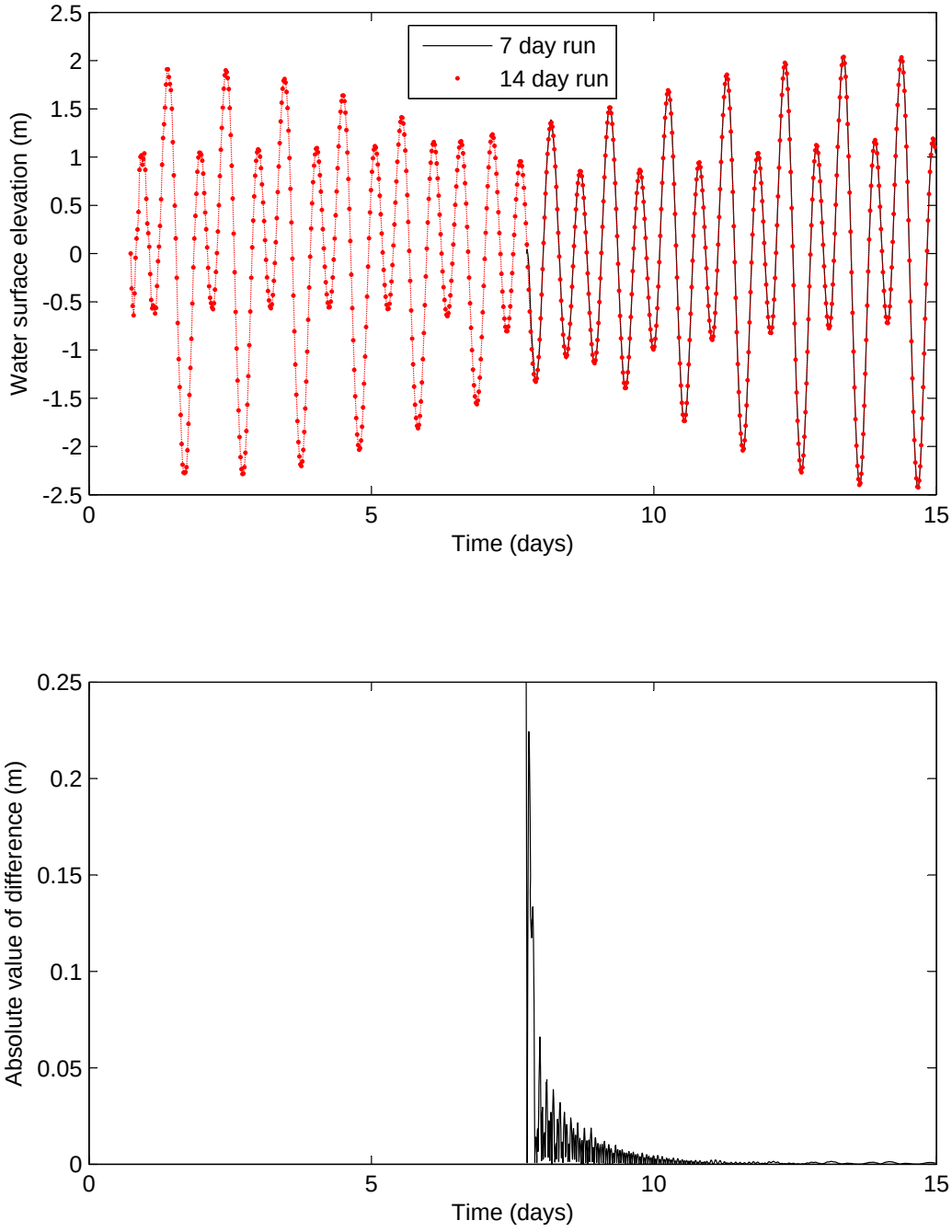

Figure 8.1: Comparison of output from a 7 day and a 14 day simulation. Also shows is the absolute value of the difference between the two runs.

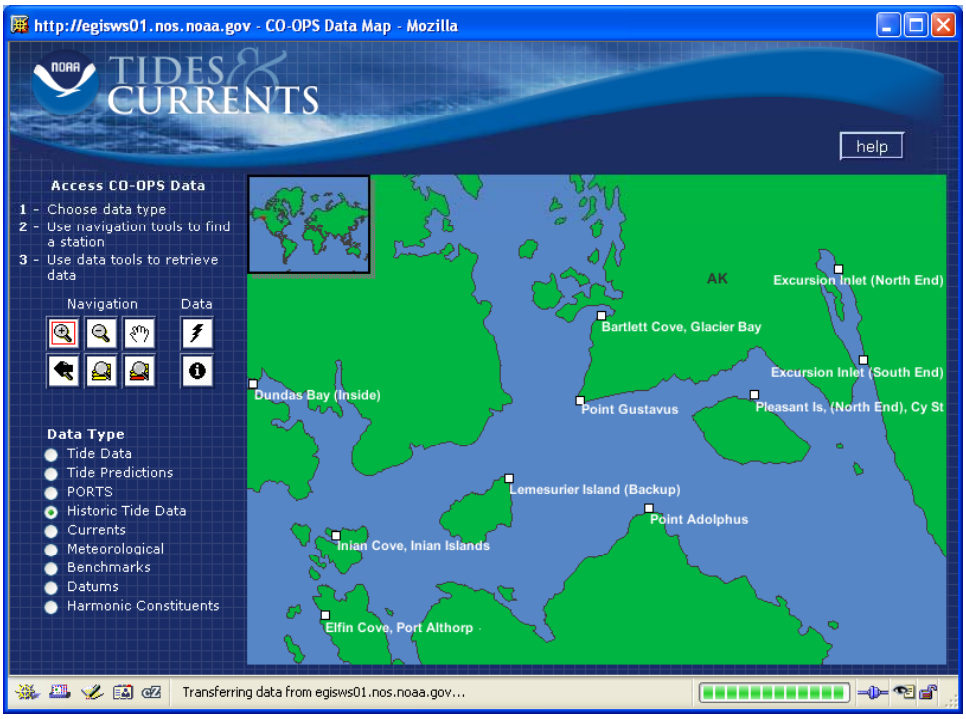

Figure 8.2: Interactive map allowing for the extraction of historic tidal data and tidal predictions.

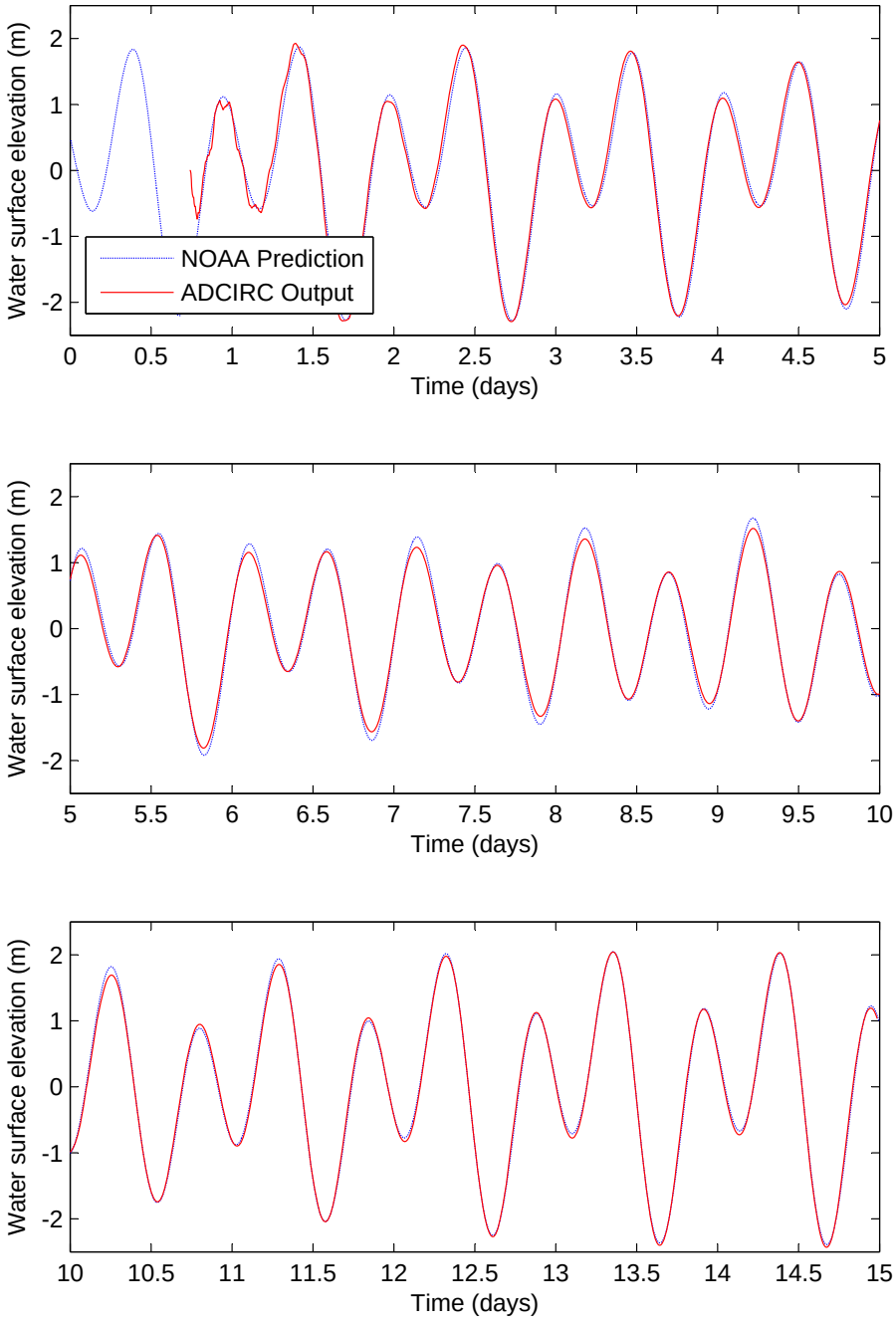

Figure 8.3: Comparison of NOAA predictions and ADCIRC calculations at the Elfin Cove Station for the 14 day period beginning 6/25/2002.

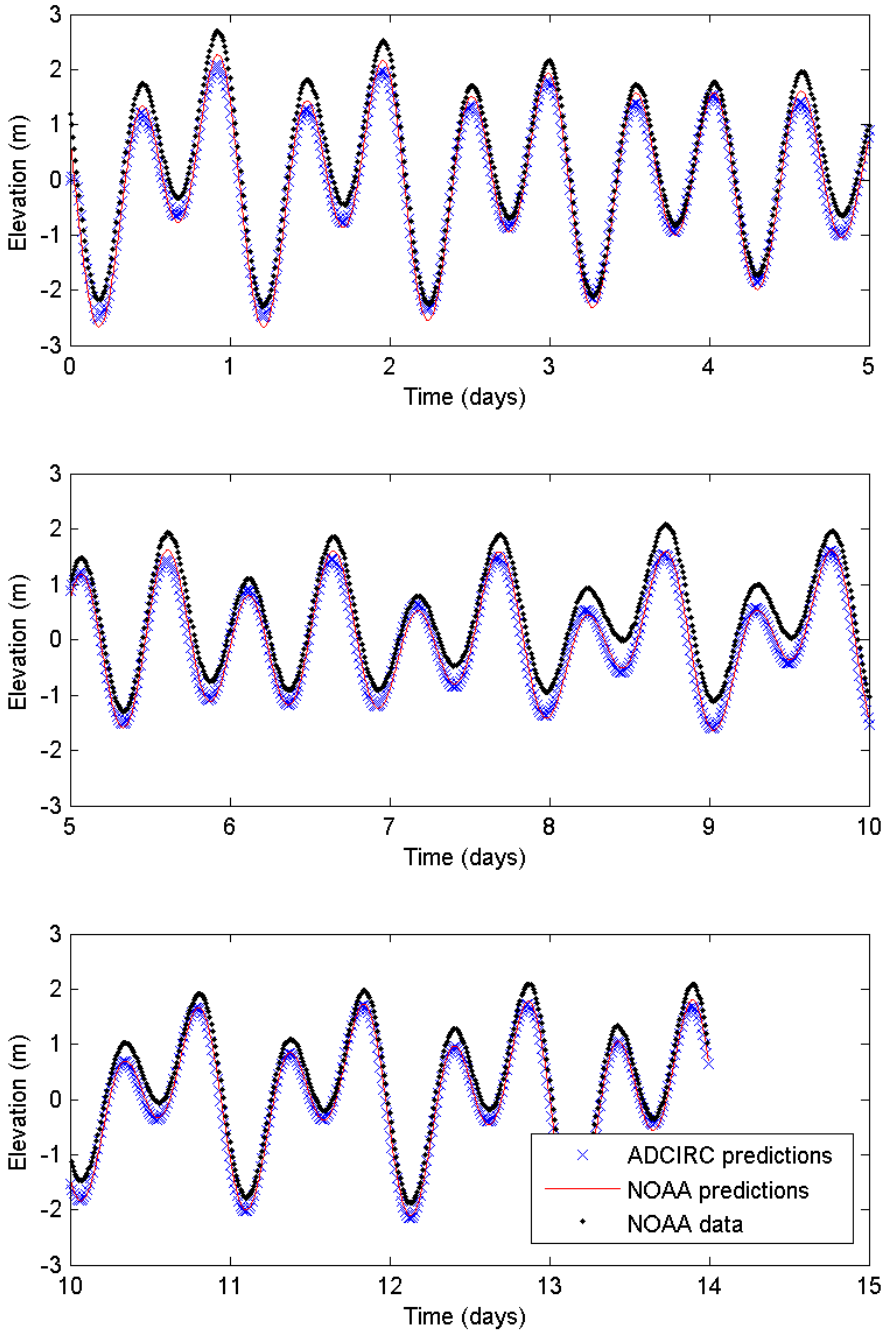

Figure 8.4: Comparison of NOAA predictions, ADCIRC calculations, and observational data at the Elfin Cove Station for the 14 day period beginning 1/1/2006.