4 Extended 82-year Martinez Planning Tide

4.1 Introduction

As part of the Common Assumptions Long-Term Update Project, the Delta Modeling Section developed a new, full-period planning tide for use in 82-year DSM2 planning studies. The planning tide closely follows the methodology described in Ateljevich (2001). To compensate for past sea level rise, we normalized the tide to a 1993-level using the National Oceanic and Atmospheric Administration's National Ocean Service estimates of trends.

Full period tides are now available for simulations with and without sea level rise adjustment. Without the adjustment, the tide has more of a historical character; with the adjustment, the trends of the last century are frozen at mid-1990s levels. The Common Assumptions team and Delta Modeling Section adopted the sea level-adjusted version as a new standard. For consistency, the Delta Modeling Section bagan to use the new tide for 16-year studies as well. Because the 1975–1991 period of a 16-year planning simulation is very close to the 1990s date upon which the sea level normalization is based, the change during this period is very small.

4.2 Methods

4.2.1 Adjusted Astronomical Tide

The methodology used to develop the standard 82-year adjusted astronomical tide is similar to the methodology outlined in Ateljevich (2001). Specifically, the steps are as follows:

1. Astronomical tides are fitted to both San Francisco and Martinez observed data for a long common period (about 11 years in the original calibration, 16 years in the work presented here).
2. The residual tide (observed minus astronomical) is calculated for both San Francisco and Martinez.
3. Martinez residual, filtered tide is modeled on San Francisco residual, filtered tide using a moving average of two lagged values, as documented in Ateljevich (2001). This component of the model was not recalibrated.
4. Martinez water levels for 82 years are estimated by adding (a) Martinez astronomical estimate for 82 years and (b) an 82-year residual calculated from the San Francisco 82-year residual tide.

The methodology captures most of the longer period variation in the tide using information that is available over the full period: The Martinez astronomical estimate is a model, and data are available at San Francisco for well over 82 years.

The steps outlined above were retained for the new planning tides. The only modification is that the astronomical fits to both stations are calibrated over a longer period (16 years instead of 11). The ideal is to calibrate both stations over a full 18.6-year nodal cycle. However, there is no common period of record that long for both stations. Assuming that the longer the record the better, both stations are calibrated, in this case, about 16 years.

4.2.2 Sea Level Normalization

The historical record over the 82-year Common Assumptions period includes a discernable long-term trend of increasing sea levels. The lower sea levels in the early part of the twentieth century are of historical interest and important for climate change analyses, but are thought to have little relevance for scenarios involving current or future conditions. We decided, therefore, to remove this trend and normalize the tide to a recent sea level.

The trend we removed comes from a long-term sea level change study for San Francisco performed in Zervas (2001); it is linear with an estimated rate of 2.13 mm per year (approximately 0.70 feet per century) increase. The time point of zero adjustment in the NOAA-NOS study is the fractional year 1993.85, which is November 7, 1993, 0600 PST. Times that are close to this point will be adjusted very little; earlier periods such as the 1930s will be adjusted more.

4.2.3 Influence on Boundary EC

Boundary electrical conductivity (EC) estimates for planning studies are based on net delta outflow and pure astronomical tides. As such, the only influence on boundary EC estimates from the present project comes from the slightly extended calibration period. This change is exceedingly small compared to other factors affecting the EC boundary generation process.

4.3 Results

In assessing the new planning tide, the following questions are of interest:

- How realistic is the tide?
- How different is the new tide from that used in previous planning studies?
- Is the difference primarily due to the new astronomical tide calibration or to sea level normalization?
- What is the effect on study results?

The realism of the adjusted astronomical tide is discussed in Ateljevich (2001). Based on its construction, we expect it to capture most of the astronomical variation and medium-term (spring neap and seasonal) variation of a real tide. The results of the planning tide are compared to the observed tide in Figure 4-1. The plot is representative of periods when sea level normalization is not significant. As reported in Ateljevich (2001), the rms estimation error is approximately 0.2 feet.

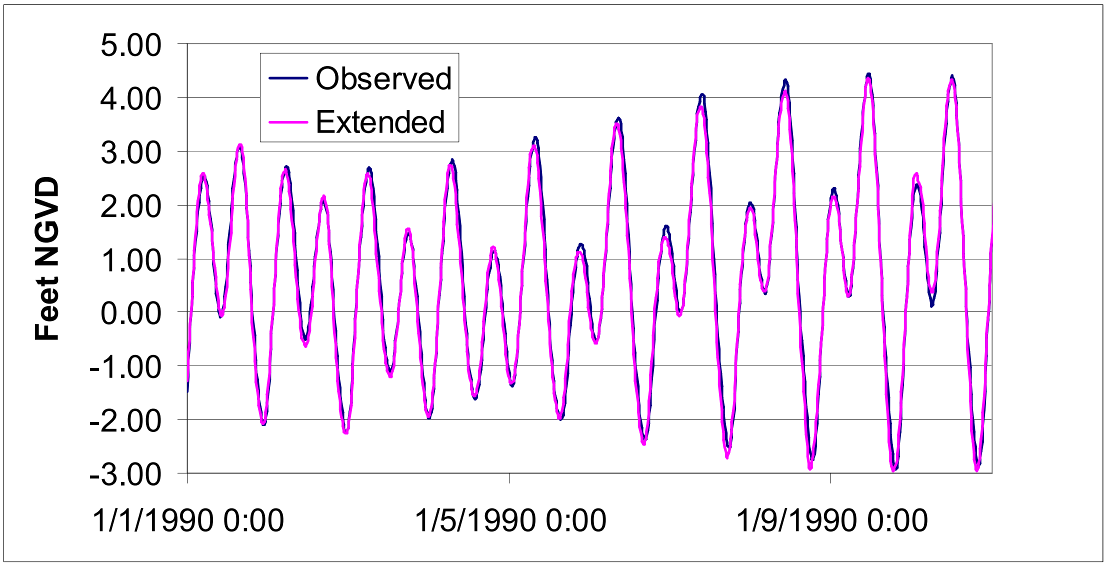

Figure 4-1 Observed and Extended Martinez Tide

Figure 4-2 compares the new 82-year extended tide to the previous planning tide used by the Delta Modeling Section. Two periods are depicted: one in the 1990s where sea level normalization is a very small adjustment and another in the 1960s where sea level adjustment plays a visible role. The figures demonstrate that neither the astronomical recalibration nor the sea level normalization is very significant during the 1974–1991 period, but the sea level normalization is larger.

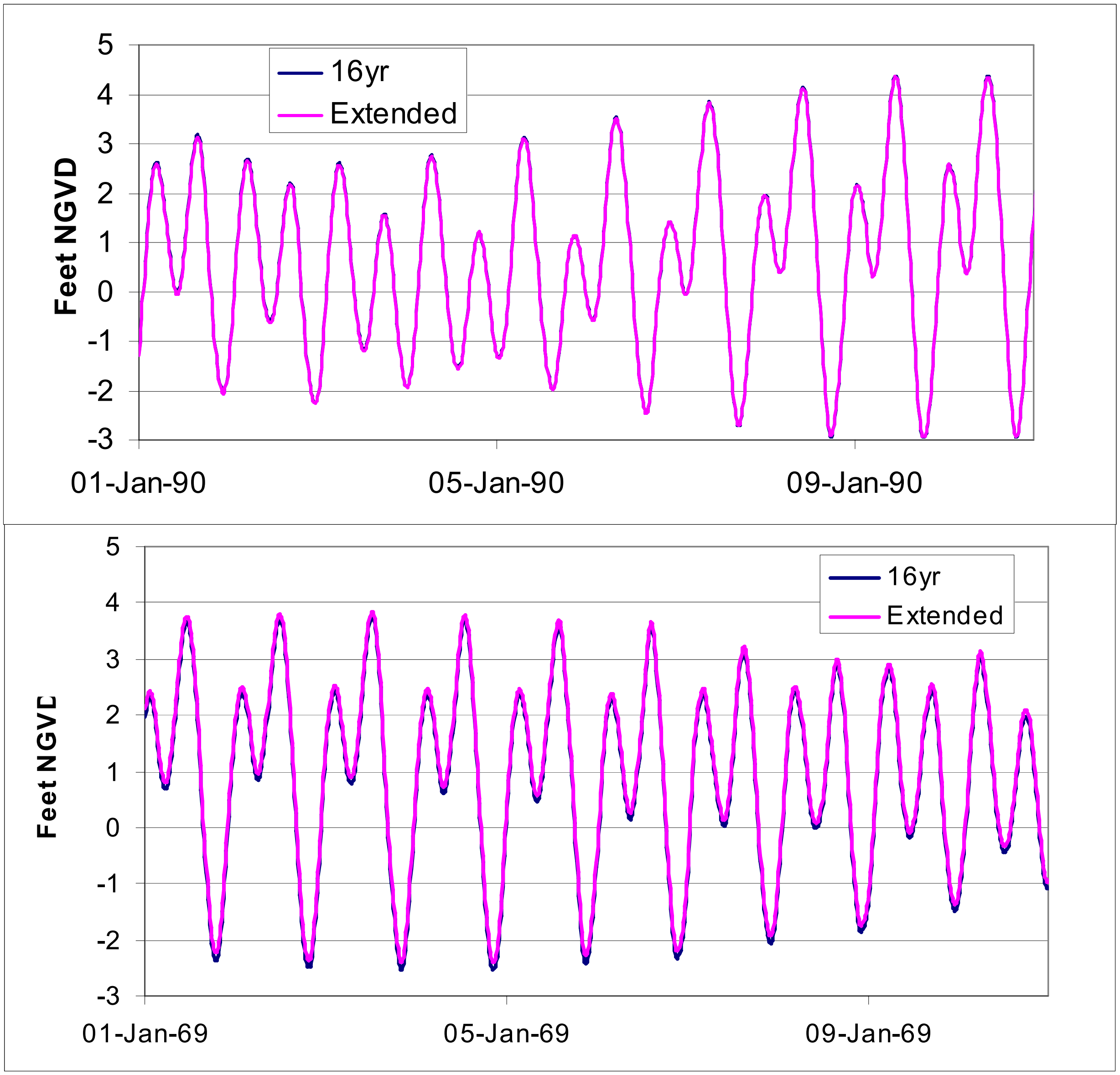

Figure 4-2 Previous and Extended Martinez Tide

To assess the impact of the new tides on studies (net of boundary EC generation and use in DSM2), we compare daily DSM2 EC results at Jersey Point and Clifton Court Forebay (CCF) generated from the previous planning tide and the new tide with and without sea level normalization (Figures 4-3 and 4-4). Differences between the 16-year planning and the extended no-sea-level-rise methodologies are typically less than 0.01%. Differences between these two methodologies and the sea level adjusted methodology are typically less than 2.0%.

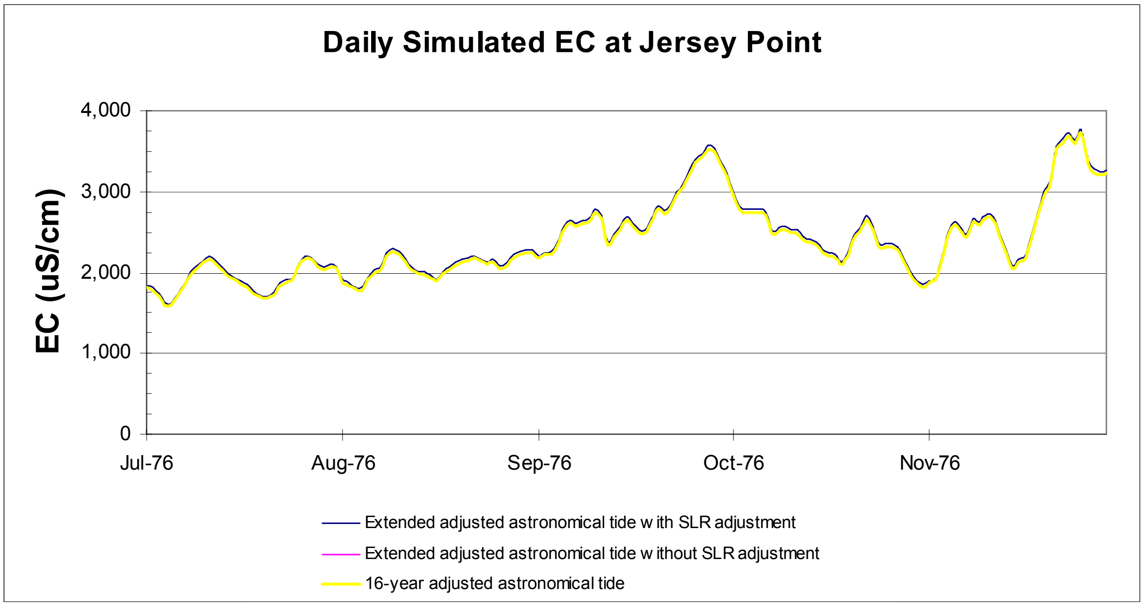

Figure 4-3 DSM2 EC Comparison at Jersey Point

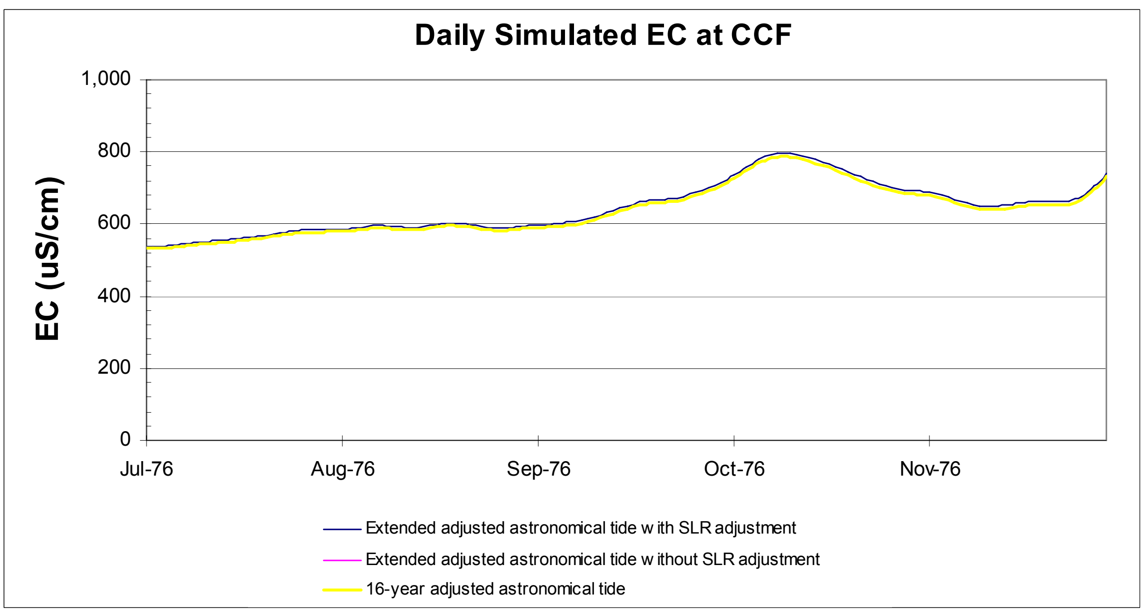

Figure 4-4 DSM2 EC Comparison at CCF

4.4 Summary

The new 82-year tide prepared for Common Assumptions work extends the previous adjusted astronomical tide methodology to a longer period and normalizes it for historical sea level changes. The new methods do not attempt to characterize sea level changes outside of historical adjustments. The new tides are very similar to previous 16-year tides when compared over the original 1974–1991 period because the sea level normalization is small near 1993.

The Delta Modeling Section and Common Assumptions Technical Coordination Team have moved toward the new tide as a standard, and it has been made available to the modeling community. To increase the transparency, the sea level trend, astronomical tide, and a version of the tide without sea level adjustment are packaged with the original tide.

4.5 Reference

Ateljevich, E. 2001. "Chapter 10: Planning Tide at the Martinez Boundary." In: *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh*. 22nd Annual Progress Report to the State Water Resources Control Board. Sacramento: California Department of Water Resources.

Zervas, Chris. 2001. *Sea Level Variations of the United States 1854-1999*. NOAA Technical Report NOS CO-OPS 36. Silver Spring (MD): National Oceanic and Atmospheric Administration.