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Projected sea level rise in Florida

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Abstract

Future sea level rise will lead to salt water intrusion, beach/dune recession, and many other coastal problems. This paper addresses a data based forecasting approach to provide relative sea level rise estimates at locations in Florida where historical water level data exist. Many past estimates of sea level rise have treated the rise as a linear straight line trend over the historical data set. The present paper has allowed for acceleration (or deceleration) in sea level rise to account for the possibility of anthropogenic global warming and consequent higher (than linear straight line) future sea levels similar to values noted by global climatic modelers. Results of the present analysis show sea level rise for Florida being higher than past straight line trend results.

Keywords: Forecasting; Sea level; Tides

1. Introduction

Rising sea level has important economic consequences for Florida which has a relatively low lying coastal zone. Rising sea level will inundate low coastal areas of Florida and cause salt water intrusion into coastal aquifers and coastal estuaries. Additionally, beach and dune recession will occur as a result of the rising sea level by creating a sediment budget deficit in the offshore area. This shore recession is a function of the sea level rise rate, the active beach profile width, and the depth of closure as first postulated by Bruun (i.e. see Dean and Dalrymple, 2002) with recession varying from about 50 to 100 times the sea level rise. What sea level in Florida will be in 2080 is an unanswered question but deserving scientific investigation. This paper will address data based methods to providing sea level estimates in the year 2080.

A global rise in sea level was noted by various climatic modeling studies conducted during the 1980s and 1990s as detailed in the following references:Hoffman et al. (1983), National Academy of Sciences (1983, 1985), EPA (1989), Barth and Titus (1984), National Research Council (1987), IPCC (1990), Houghton et al. (1990), National Research Council (1990), Church et al. (1991), Wigley and Raper (1992), Titus and Narayanan (1995), US National Report to IUGG (1995), Peltier and Tushingham (1989), Trupin and Wahr (1990), Church et al. (1991), and Houghton et al. (1990). In more recent findings, the Intergovernmental Panel on Climate Change (IPCC) report Houghton et al. (2001), Church and Gregory (2001), Holgate and Woodworth (2004), Donelly et al. (2004), Gehrels et al. (2005), Douglas and Peltier (2002), Miller and Douglas (2004), and Douglas (2001) have advanced the knowledge of sea level rise, and global climatic sea level rise scenario results have been revised somewhat but with similar upward accelerating prognostications of sea level rise. Most climatic modeling work is predicated on the working basis that global sea level is not only rising but also accelerating due to increasing levels of greenhouse gases in our environment. Just how these global sea level projections translate to Florida is not well known but of vital importance to economic projections for both Florida coastal development decisions as well as population growth decisions.

The overall acceptance of an acceleration in sea level rise may not be an agreeable conclusion to all scientists based on past water level data record analysis.

Church and White (2006) found evidence for weak sea level change acceleration in global records, while Woodworth (1990), and Gornitz and Solow (1991) found weak

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evidence of sea level change acceleration in long European records but not sufficient evidence for overall global acceleration. Other researchers (Donelly et al., 2004; Gehrels et al., 2005) have noted an accelerating trend in sea level via utilizing foraminiferal and salt marsh peat radio carbon dating techniques. Douglas (1991) carried out a systematic global analysis of sea level acceleration with a result that no acceleration of global sea level has occurred over the last 150 years (at least which is statistically significant at the 95% level). It is always possible to provide statistical confidence levels that rule out possible acceleration terms in sea level rise but such findings do not necessarily mean that sea level change acceleration in the future (which is postulated to accompany global warming) will not occur. In fact, it is felt by the author that future prediction should be pragmatic in providing for worst case economic scenarios that include the possibility of sea level rise acceleration and let the data speak for itself when it comes to future projections of sea level.

Previous data based trend estimates of relative sea level rise have assumed a linear trend in sea level with time which does not allow for acceleration/deceleration in relative sea level. In this context, the relative sea level rise denotes the overall change between sea and land (with time) regardless of whether such change is attributed to a rising sea or a falling land surface. Such findings have primarily been based on statistical findings of the entire historical series length that an acceleration component of sea level rise is not statistically different from zero at a given confidence level (see, for example, Zervas, 2001). Although it can always be shown at some level of statistical significance that higher terms in a non-linear trend fit to sea level rise may be insignificant, it is rationalized here that from a pragmatic standpoint due to the physics behind climatic modeling and due to the existing climatic studies suggesting acceleration of sea level, a higher order trend should be considered in sea level modeling to assess forecasts based on the data while allowing for such acceleration/deceleration to be shown via the data. Inclusion of the potential for acceleration/deceleration in sea level rise is additionally justified by the fact that in a relatively tectonically stable area such as Florida, global sea level acceleration as provided by climatic modelers would translate to a relative sea level acceleration trend. It is on this basis that the following forecasts of sea level rise for the year 2080 are estimated (i.e. allowing for the possibility of acceleration/deceleration in sea level).

2. Data sources

The data utilized in the present projected sea level rise scenarios are from the National Oceanic and Atmospheric Administration (NOAA) primary tide gage station network in Florida. Although numerous coastal tide stations exist in Florida, most have operational data for only short record periods and are not suitable for the analysis provided herein. Necessary length of data record to analyze is a consideration in picking which stations to utilize in sea level rise analysis. Too short a record may not provide sufficient data to reflect a proper trend due to series noise having overdue influence on forecast parameter values, while too long a record may not be correctly represented by constant forecast parameters (due to possible parameter change with time). Pugh (1987) demonstrated that 10-year trends at a site can have positive or negative trend, depending on the time interval chosen. In a similar manner, Douglas (1991) used the San Francisco tide gage data (the longest continuous record (140 years) in the US) and found that 30-year trends computed anywhere in the entire series varied from −2 to +5 mm per year using linear trend analysis. His findings are suggestive that a 30-year record would be too short for analysis (and consequent forecasting/extrapolation). In another finding, Emery and Aubrey (1991) noted strong coherence of results for sea level records longer than 40–50 years which might be suggestive that such a period is reasonable for forecasting future sea levels. Roemmich (1992) investigated sea level records at Bermuda and Charleston, SC, and found that coastal and nearby mid-ocean sea level trends differ markedly over several decades. His conclusions suggest that 50-year records of sea level are necessary to understand the fluctuations at a given coastal location. In concurrence with the findings above, the tide stations utilized all have 50 years or longer of available historical data record (Table 1).

Locations of the tide stations are shown in Fig. 1. All of the tide station gages utilized are in somewhat protected water which is the reason for the more complete data records available. Although open coast tidal stations might be expected to have a higher water level due to the effects of wave setup, the analysis herein is aimed at projecting differences in water level from present to the year 2080, hence gage site exposure is not a critical concern. The fact that the data records are less contaminated by wave setup effects is in fact a benefit for the present analysis which aims at projecting the low-frequency water level rise over an approximately 75-year period.

The monthly mean sea level series was utilized from each of the above gages for the analysis herein. The Mayport, FL (Station Number 8720220) gage has a long historical period of record but data were not available for the period 1999–2005, hence this gage was not utilized in final analysis. Additionally, the proximity of the Mayport and Fernandina gages was investigated and it was found that the two gages had a strong linear correlation between the

Table 1
NOAA primary water level recording stations used

Station name	Station number	Record span
Fernandina, FL	8720030	1941–2005
Key West, FL	8724580	1941–2005
St. Petersburg, FL	8726520	1947–2005
Cedar Key, FL	8727520	1941–2005
Pensacola, FL	8729840	1941–2005

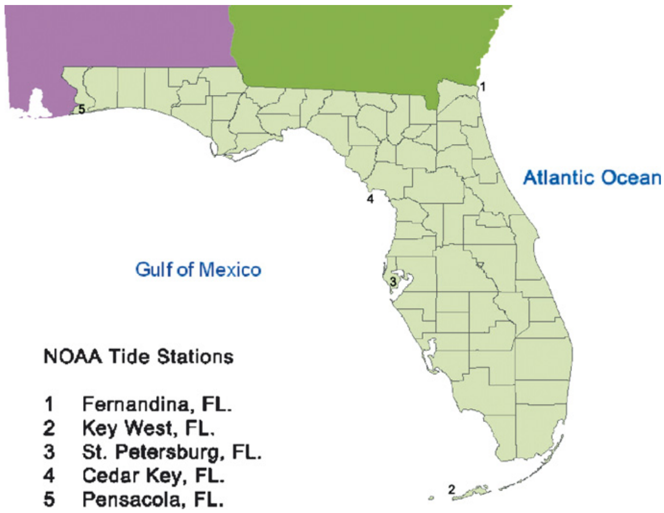

Fig. 1. NOAA tide station locations.

data sets showing that either of the gages could be utilized (with proper adjustment) as a proxy for the other. The Fernandina gage also had an extended period of data missing (1960–1969) but as the data were missing from the middle portion of the historical series rather than at the end of the series it was felt that the Fernandina record would provide a more meaningful analysis period than the Mayport historical series.

3. Methodology for sea level forecasts

To keep the sea level rise scenario projections on the same time period, a starting date of January 1941 was used to provide the historical parameter fit (except for the St. Petersburg gage for which the earliest acquired verified data were for January 1947). January 1941 was the earliest monthly mean verified data available for the Key West tide gage station and hence the other series records were accordingly shortened for the analysis provided herein. The fit historical series period of record was from January 1941 through December of 2005 [1947–2005 for St. Petersburg], while the forecast period of record was from 2006 to 2080 with the projected estimates at year end 2080 provided. Since the historical period of record utilized in fitting spanned approximately 65 years [59 years for St. Petersburg], it is believed that projection (extrapolation) to a forecast period of approximately 75 years is reasonable (i.e. roughly equal periods of historical fit and future forecast). The series length of 65 years is long enough to fulfill the minimal length requirement of 50 years while at the same time short enough to provide the most recent industrial period including the war years when industrial output and consequent man induced warming might be expected to peak.

Although the investigated station series are complete for the most part, there are missing values in station records for some months (as shown in later graphics) which do not allow for analysis techniques such as linear or non-linear filtering which typically require complete data series. Rather than attempt to provide estimates of unmeasured data to fill in the incomplete series (i.e. see Walton, 1996), techniques utilized in this analysis were limited to both linear and non-linear least squares along with seasonal mean estimation which can be applied to incomplete series data. Other forecast methods which required data fill-in (and provided similar final results) were tested and are discussed herein but were not utilized to provide the finalized forecast values.

As noted previously, the model fitting is predicated on a working assumption that global sea level (and consequently for Florida relative sea level) is not only rising but possibly accelerating in rise due to climatic influence of greenhouse gases. This scenario will later be compared using the same model fitting technique and data to standard linear trend least squares estimation for the non-acceleration assumption. Tectonic activity in Florida is believed to be rare and of far less importance than localized ground movement due to the karst nature of the underlying limestone which makes up the Florida platform.

As climatic modelers have provided the global sea level rise to be an exponential rise in form, the nature of the model for relative sea level rise for the Florida sea level stations was chosen of a similar form, i.e.

$$y(t) = p_1 + p_2\,e^{(p_3 t)} + \text{error}, \tag{1}$$

which can be expanded in series form to

$$y(t) = p_1 + p_2\left(1 + p_3 t + \frac{p_3 t^2}{2} + \cdots \text{hot}\right) + \text{error}, \tag{2}$$

where p_i with $i = 1, 2, 3$ are model parameter constants, t represents the time component (i.e. the monthly mean sea level index, where the initial value of the monthly mean sea level series starting in January 1941 would be $t = 1$), hot: higher order terms, and where the modeled $y(t)$ is a seasonally pre-processed water level developed by either signal filtering (to be discussed later) or by removal of the monthly means from the original monthly average mean sea level series consisting of the average hourly readings of sea level for a given month and year. Removal of the monthly means was accomplished by obtaining the average of all January, February, etc. monthly average series values (in accord with proper time index) to provide a set of 12 monthly means which were then subtracted from the corresponding original series in accord with proper monthly index. Alternative pre-processing via signal filtering techniques is discussed in later paragraphs. It should be emphasized that the $y(t)$ series fit is not the raw data but rather the de-seasonalized data residual, that is, $y(t)$ is the actual mean sea level with the seasonal (monthly) portion of the signal removed by either signal filtering or by removal of the monthly means. As projected sea level rise is a difference between existing sea level and a future level, the actual forecast mean sea level would be the projected $y(t)$ at time t with either the monthly averages or filtered (removed) seasonal portion of the original mean sea level data series added back in. The use of either monthly average removal or signal filtering was to reduce the noise of the fit and hence provide more parameter stability. The removal of the monthly means was eventually used as the pre-processing step of choice (in lieu of direct signal filtering of the original monthly mean sea level data) to allow missing data in the raw data series which does not allow for typical linear or non-linear filtering techniques without making a priori "estimates" about missing data. The removal of the monthly means pre-processing technique makes no a priori assumptions regarding missing (unavailable) data and is strictly data based. Additional discussion and comparison of the pre-processing via monthly mean removal or via signal filtering is made in later paragraphs. Although the model to be fit is assumed to be of a non-stationary exponential form, a series expansion of a stationary harmonic model can also be shown to lead to a higher order polynomial model with dependent coefficients.

By reformulating Eq. (2) and dropping higher order terms potential data based models can be reformulated as a linear higher order polynomial which in the case provided has been terminated with the second order as

$$y(t) = p_{1a} + p_{2a}t + p_{3a}t^2 + \text{error}, \quad (3)$$

where p_{1a}, p_{2a}, p_{3a} are constants to be fitted with use of the data and the time origin of the data is at the start of the historical data. For the standard ordinary linear (straight line trend) least squares model, the p_{3a} term is dropped. The methods utilized for model fitting of the pre-processed or filtered mean sea level series involved both a linear least squares approach to model parameter estimation as well as a non-linear least squares approach to model parameter estimation in the case of the exponential model. In the comparison of these two model fittings shown herein, the pre-processing of the mean sea level data series to remove seasonal effects was accomplished by removing monthly means as noted previously. The signal filtering approaches to pre-processing are discussed in more detail in later paragraphs. As non-linear estimation routines require information regarding starting parameter values, a linear method was utilized to formulate estimated starting values for model fitting in the non-linear least squares model fitting. It should be noted that non-linear estimation techniques are not guaranteed to provide stable fit parameter values but as will be seen, in many of the water level gage series fits to the data, the non-linear forecast sea level rise was found to be very close to the linear second order forecast sea level rise thus confirming the validity of the final forecast mean sea level differences estimated. Due to the fact that most of the gages fit provided comparable values by the two techniques, the linear second order forecast sea level rise was chosen for projecting final sea level rise scenarios in the year 2080. The linear first order sea level rise forecast is also provided for comparison purposes (see Table 2).

Table 2
Forecast relative sea level rise from 2006 to 2080

Station	Relative sea level rise (m)		
	1st order	2nd order	Exponential
Fernandina, FL	0.16	0.25	0.27
Key West, FL	0.15	0.31	0.28
St. Petersburg, FL	0.18	0.35	0.36
Cedar Key, FL	0.11	0.27	—[a]
Pensacola, FL	0.13	0.34	—[a]

[a]Parameter estimation convergence problems.

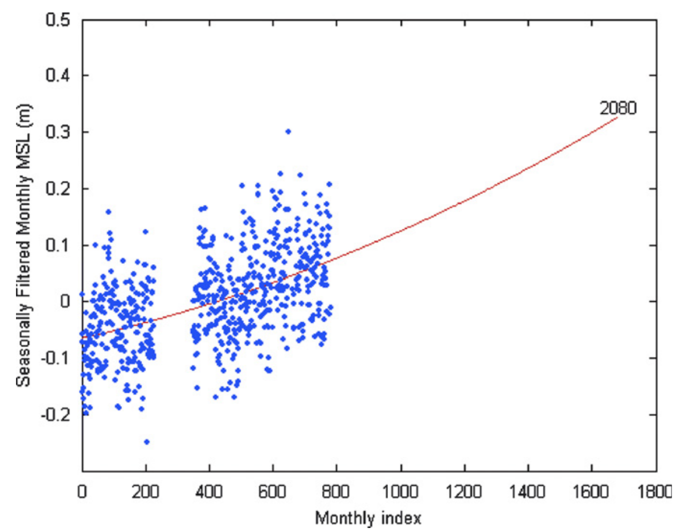

Fig. 2. Fernandina, FL—forecast filtered sea level rise.

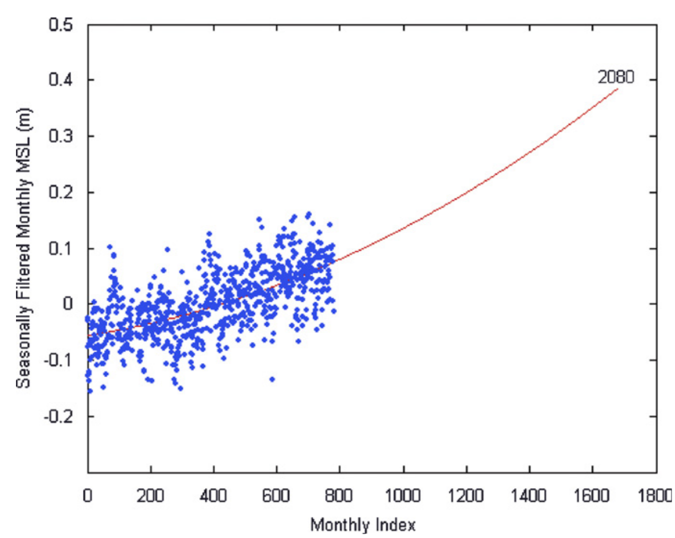

Fig. 3. Key West, FL—forecast filtered sea level rise.

The fit $y(t)$ series are shown as the ordinate values in Figs. 2–6 where the abscissa is the time index as before (i.e. 1 = January 1941 [1 = January 1947 for St. Petersburg]). The de-seasonalized monthly mean sea level data during the historical period are shown as points on the graphs and

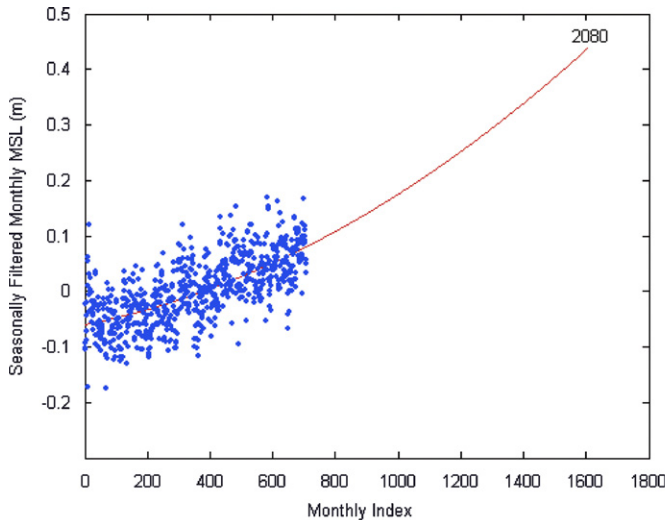

Fig. 4. St. Petersburg, FL—forecast filtered sea level rise.

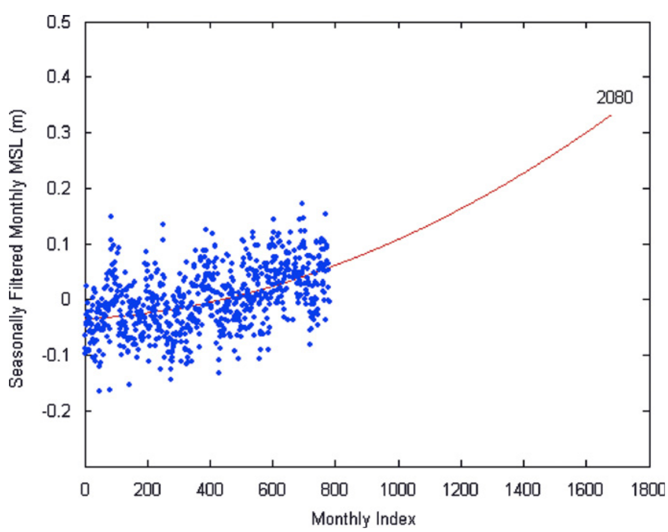

Fig. 5. Cedar Key, FL—forecast filtered sea level rise.

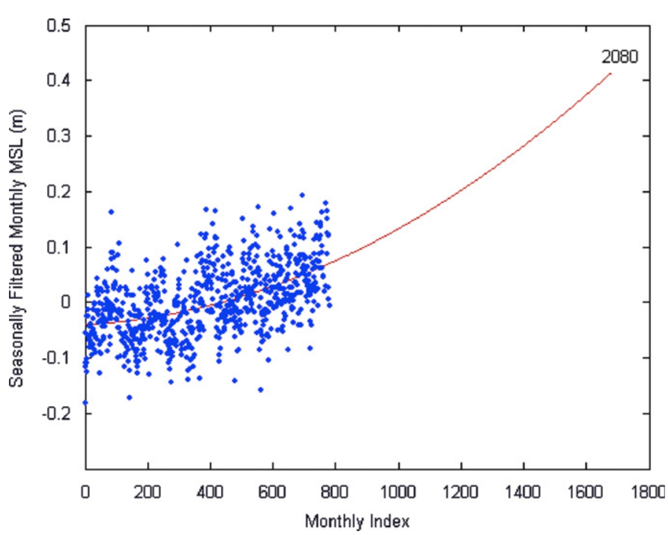

Fig. 6. Pensacola, FL—forecast filtered sea level rise.

the solid line represents the de-seasonalized historical sea level data fit during the span of the historical data and the de-seasonalized sea level forecast curve during the forecast period. The estimate of sea level rise from years 2006 to 2080 is the difference in the solid line between the final forecast time (2080) and the final historical time (2005) and is summarized in Table 2.

An interesting result from the analysis is that for the different gage sites which are widely spaced over the Florida Peninsula, the projected sea level rise in year 2080 does not vary by much with the largest value being 0.35 m in St. Petersburg, FL, while the smallest value is 0.25 m in Fernandina, FL.

In addition to the monthly average removal pre-processing utilized for the second order polynomial and non-linear exponential models in the forecast values noted above, a number of other potential filtering methods were tested on the Key West mean sea level (MSL) series since it was the most complete data series (i.e. only a small number of missing data for the historical fitting period time span). One alternate filtering technique tested for pre-processing was to band pass the original MSL data series. To accomplish the following task, a complete data series (i.e. no missing data) was required. To fill in the missing data for the Key West series, a cubic spline interpolation method was utilized. Although more sophisticated fill-in methods might be utilized (see, for example, Walton, 1996), this fill-in method appeared reasonable for the Key West historical fitting time span. The band pass filtering was accomplished in the frequency domain via utilizing a fast Fourier transform to: (1) transform data to frequency domain; (2) selectively eliminate the fundamental (1 year period) frequency energy and first higher harmonic energy (6 month period) at the selected frequencies corresponding to the yearly cycle (as represented by spikes in the Fourier series at those frequencies); (3) inverse transform the modified frequency data (with the energy in the primary and secondary harmonics removed) back into the time domain. Utilizing this band passed filtering, a reconstituted band passed signal was available to forecast the "de-seasonalized" MSL as per the second order model. Results of forecasting this band passed signal for the Key West series provided a rise in MSL at the year 2080 horizon within 0.01 m of the reported MSL rise previously provided (i.e. within 3% of reported forecast value).

Another alternate filtering technique tested for use in pre-processing (i.e. de-seasonalization) was to utilize low pass zero phase ideal filtering for the original MSL data series, where the low pass frequency cutoff of the data was considered at both frequencies corresponding to periods of 2 and 4 years. Again to accomplish this task, a complete data series (i.e. no missing data) was required and a cubic spline interpolation was used for data fill-in as previously discussed. This particular approach was accomplished in a similar manner as to the previous approach noted but filtered out not only the primary and higher harmonic energy of the annual MSL cycle, but also all highfrequency energy beyond the low pass frequency cutoff values noted. The "de-seasonalized" MSL series constructed from this filtering was again used for forecasting. Results of forecasting this low passed signal for the Key West series provided a rise in MSL at the year 2080 horizon again within 0.01 m of the reported MSL rise previously provided (i.e. within approximately 3% of reported forecast value). As these filter pre-processing methods invoked the need to provide missing data fill-in, they are not further applied nor discussed.

As a check on the utilized pre-processing of the data series by removing monthly means, a harmonic cycle component filtering was also used on the raw Key West data series. In this technique, the monthly means were not removed, but rather, the entire data set was fit utilizing two additional parameters to represent the monthly series as a single harmonic. This approach represents the modeled series as follows:

$$z(t) = \mathrm{Amp}\cos\left(\frac{2\pi t}{T} - \mathrm{Phase}\right) + p_{1\mathrm{m}} + p_{2\mathrm{m}}t + p_{3\mathrm{m}}t^2 \qquad (4)$$

with $T = 12$ (months) for the yearly cycle and the two unknowns being Amp the fit amplitude of seasonal cycle (m), and Phase the fit phase lag of cycle (radians), and where the $z(t)$ series in this method is the original mean sea level series rather than the de-seasonalized series. For the Key West series, a forecast to the year 2080 produced the same sea level rise forecast result (to two decimal places) as the previous de-seasonalized via removal of monthly means approach and additionally produced similar Gaussian residual magnitudes. This check was provided as additional confirmation of the de-seasonalized (via monthly mean removal) forecast utilized.

A final alternate filtering and forecasting technique was performed on the Key West data series as an additional check on the utilized methods. This technique was accomplished by utilizing Singular Spectrum Analysis (discussed in and described in Keppenne and Ghil, 1992–1995) for filtering the original MSL series. The singular spectrum analysis technique was utilized in this instance to provide a reconstructed data series having a minimal number of orthogonal component vectors that provide the majority of the series variance. In the present situation, only one component vector was utilized providing over 97% of the variance of the series. A forecast was then made utilizing the one component vector SSA reconstructed series by two approaches: least squares utilizing a linear first order and an acceleration/deceleration second order term for fitting, and, an autoregressive technique (see, for example, Box et al., 1994) with one unstable autoregressive component estimated using least squares for fitting. The forecast values obtained in year 2080 for the Key West series via SSA reconstruction using one principal component vector (with 97% of the series variance) were both found to be within 0.04 m of the value provided in Table 2.

Standard deviations for the series fit parameters in Table 2 were found from the diagonal elements of the error matrix (Draper and Smith, 1981) where the error matrix in the second order model is as follows:

$$\text{Error matrix} = s^2(X'X)^{-1} \qquad (5)$$

with s^2 the variance of the errors between the fit and actual data, and X the $n \times 3$ design matrix defined (for the de-seasonalized second order model) as

$$X = \begin{bmatrix} 1 & t_1 & t_1^2 \\ 1 & t_2 & t_2^2 \\ 1 & t_3 & t_3^2 \\ \ldots & \ldots & \ldots \end{bmatrix} \qquad (6)$$

with t_i being the monthly time index. In all but the Fernandina gage data, the second order non-linear terms of the postulated model were found to be significantly (at a 95% significance level) different from zero (and positive). Although the Fernandina series failed to provide justification for the second order term at the noted significance level, it was found to be positive hence providing an indication that at some significance level, the data did show an acceleration (positive value of second order term). It is believed that the Fernandina series provided a less than significant second order term due to the large gap in the data series, and due to the higher tidal range experienced at the site that may be responsible for magnification of error in the residual. Table 2 shows results of the sea level rise by the three basic modeling approaches utilized for all data series (i.e. the linear first order, the linear second order, and the non-linear exponential). Table 2 suggests that for gages where non-linear estimation convergence was obtained, both the second order linear model and the exponential model were comparable as previously noted. The Cedar Key and Pensacola data did not provide convergence in the non-linear least squares estimates hence no parameter values are included for the non-linear least square fitting of these data sets. This table also shows that the linear first order sea level rise estimates were on the order of one half of the linear second order sea level rise estimates. Similar linear first order model forecast estimates can be projected from sea level rise rates provided in Zervas (2001). The fact that the second order forecasts provided greater sea level rise than that provided by the linear "standard" trend method suggests that an acceleration in sea level rise may already be underway and more likely to continue given expected climatic change.

Residuals (in units of meters) from the second order data fitting procedure for the Florida gages are provided in Figs. 7–11, and show that the data residuals provide reasonable Gaussian bell-shaped curves suggestive that the higher order fitting is satisfactory. To further explore potential correlation structure in the residual component, the series was tested for persistence and low frequency structure cyclic activity via calculating the autocorrelation of the data series residual of the Key West second order

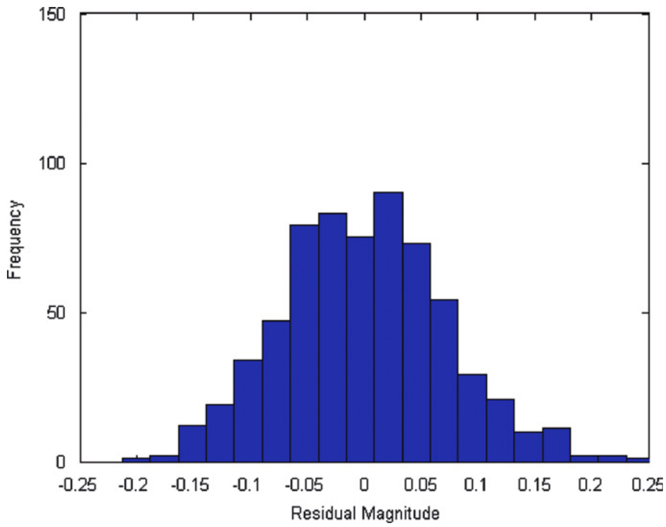

Fig. 7. Fernandina, FL—histogram of fit residuals (m).

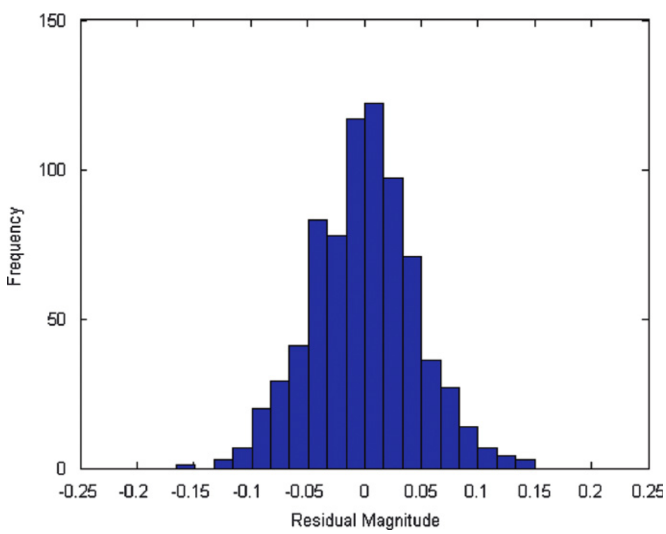

Fig. 8. Key West, FL—histogram of fit residuals (m).

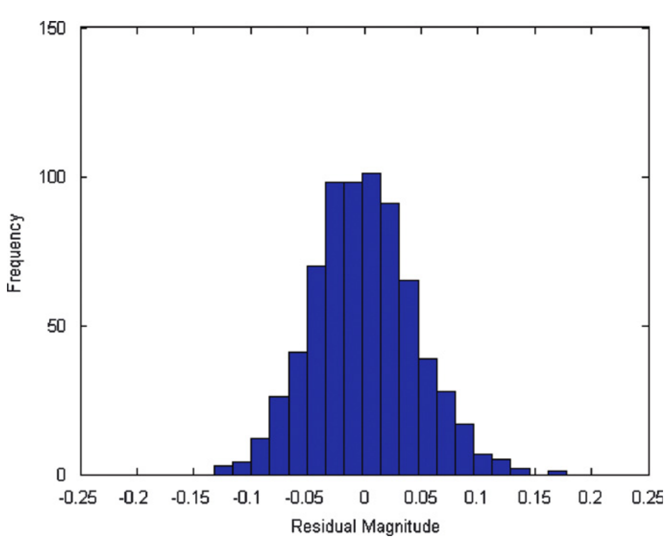

Fig. 9. St. Petersburg, FL—histogram of fit residuals (m).

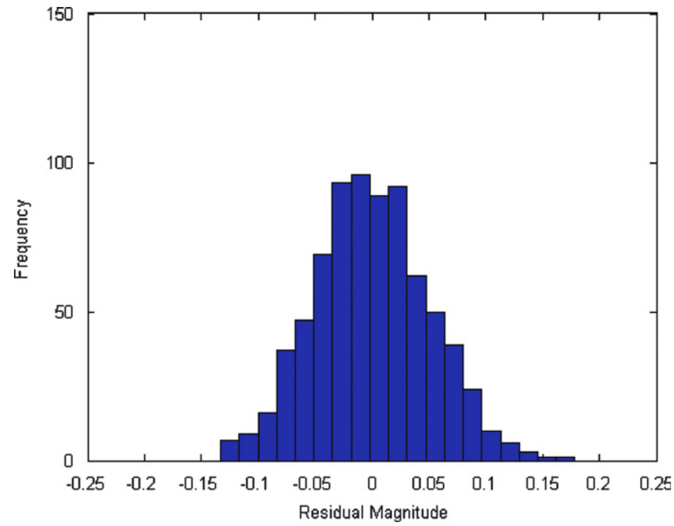

Fig. 10. Cedar Key, FL—histogram of fit residuals (m).

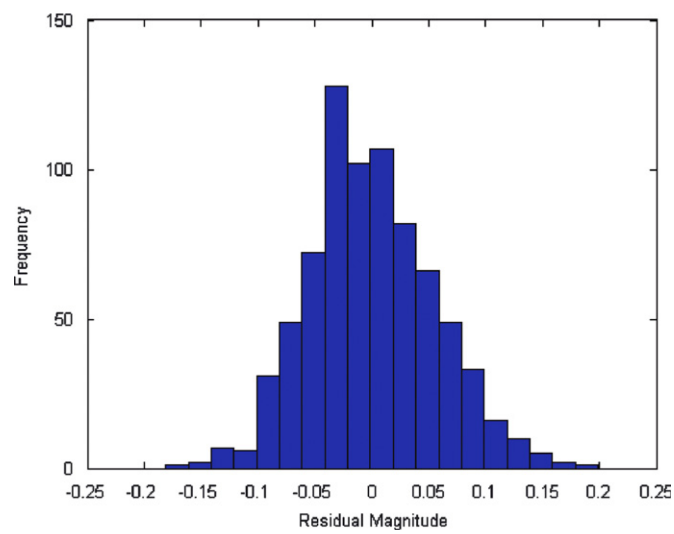

Fig. 11. Pensacola, FL—histogram of fit residuals (m).

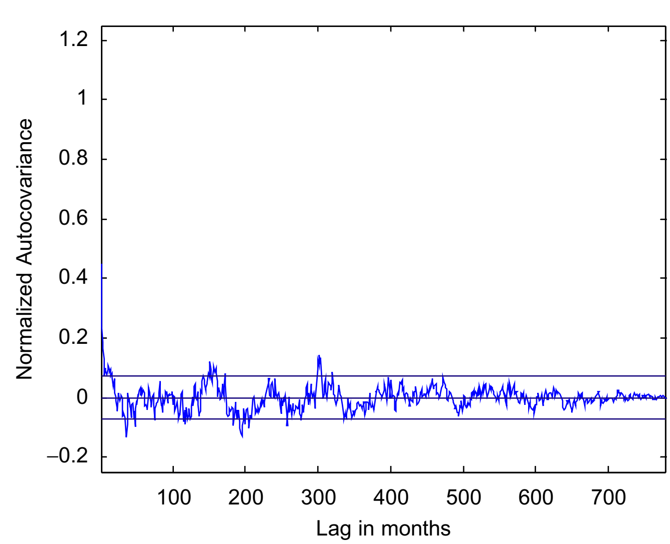

Fig. 12. Key West residual autocorrelation.

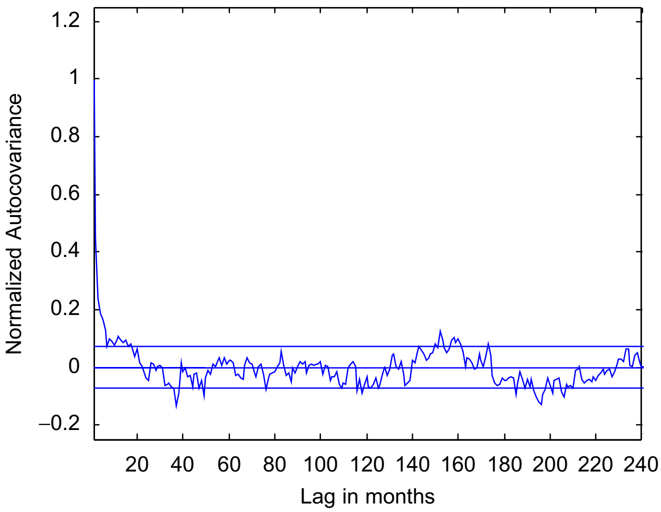

Fig. 13. Key West residual autocorrelation.

model. To provide a complete series in this case, where data were non-existent (20 values), a zero residual was assumed. As the data appear to fit a Gaussian probability distribution (bell shaped) with a mean of zero, such an assumption is believed reasonable when only a small portion of the data are missing. Figs. 12 and 13 show the normalized autocorrelation structure of the residual series for monthly lags through 780 and 240, respectively. It appears from Figs. 12 and 13 that no clearly defined low-frequency cyclic activity appears in the residuals which might be further explored to enhance the water level prediction. Residual structure in the series was also fit with low order autoregressive models but as only short-term forecasting could be addressed through such endeavors, prediction at the forecast horizon chosen (year 2080) would not be improved.

The results of the individual Florida gage site sea level rise estimates provide values that are found to lie within the uncertainty band of the average of 35 climatic scenarios as reported in Church and Gregory (2001) (see Fig. 11.12 of that report). In view of the agreement of the Florida gage sea level rise estimates to the median of these global climatic modeling results, a rational policy to treat future sea level rise in Florida as projected by the global climatic modelers seems prudent although it should be noted that regional trends will not necessarily follow global trend. There are a number of processes (climatic, geological, oceanographic, etc.) that could cause regional or local sea level to differ from that of the global mean. Although the gage data sea level rise estimates represent one possible scenario, it should be recognized that future extrapolation of past trends can be misleading should climate factors change dramatically that are not captured in the historical sea level rise data modeled. An additional consideration in forecasting is the possibility of governing non-linearity in the physics of sea level rise which can lead to chaotic behavior difficult or impossible to predict under any circumstances. As Yogi Berra once noted: "*Predictions are risky, especially when they're about the future*."

4. Summary

Relative sea level rise has been forecast from the present (year 2006) to the future year 2080 for long-term water level gages around the Florida Peninsula by three different methods. The second order linear method is recommended in the final analysis for projecting economic scenarios of future costs due to sea level rise. The inclusion of a higher order term allows for acceleration in sea level rise in accord with climate modeling scenarios that project an exponential sea level rise due to greenhouse gas effects. Although the present work is not definitive in regard to an accelerating sea level rise, it is clear from the data available that trends are consistent and that there is not a deceleration in sea level rise (over the time period forecast). A pragmatic approach to future economic planning should be in tune with climatic model scenarios that suggest the strong possibility of an accelerating sea level rise in Florida and future values of sea level rise on the order of the magnitude herein. As Yogi Berra also noted: "*The future ain't what it used to be*."

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