INTRODUCTION

Time series modeling has been used to forecast annual nonfumigant Volatile Organic Compound (VOCNF) emissions in Ventura County for five years (Tao, 2013). This method yielded better predictions than the original procedure, which used VOCNF from two years prior as a forecast for the current year (Spurlock, 2009). The model parameters are updated every year with the most-recently available data. The Department of Pesticide Regulation (DPR) has finished calculating the VOCNF emission of Ventura County in 2012. This memo summarizes the model components estimated with the updated data and the prediction of the 2013 and 2014 emissions. The modeling procedure was described in a previous memorandum (Tao, 2009). The model was developed with a classical decomposition algorithm (CDA) method using statistical software package R:

\[ X_t = m_t + s_t + y_t \]  \hspace{1cm} (1)

where \( X_t \) is the monthly VOCNF over the time.
\( m_t \) is the trend estimated from the linear regression of deseasonalized VOCNF on \( t \).
\( s_t \) is the seasonal component, monthly in this study with \( \sum_{j=1}^{12} s_j = 0 \). The detrended VOCNF were averaged for each month over the analyzed time and then centered to obtain the estimate.
\( y_t \) is residues fitted with an autoregressive integrated moving average (ARIMA) process.
\( t \) is the year as time index.

The notation used to denote a specific seasonal ARIMA model is

\[ \text{ARIMA}(p,d,q) \times (P,D,Q)_t. \]
Where \( p = 0 \), the order of nonseasonal autoregressive component; 
\( d = 0 \), the order of nonseasonal differencing; 
\( q = 2 \), the order of nonseasonal moving average process; 
\( P = 0 \), the order of seasonal autoregressive component; 
\( D = 1 \), the order of seasonal differencing; 
\( Q = 1 \), the order of seasonal moving average process; and 
\( L = 12 \), the seasonal length.

**UPDATE TIME SERIES MODEL**

Figure 1 presents the trend of VOC\(_{NF}\) over the past 22 years. The updated linear regression model \( \{m_t\} \) is estimated as Eq. 2:

\[
m_t = 712381.54 - 343.53 \times t \quad (2)
\]

\( R^2 \) of the model is 0.16. It suggests that the regression model accounts for 16% of the variation in the deseasonalized data. The negative slope indicates that the VOC\(_{NF}\) emissions is decreasing, which is consistent with the estimate of last three years.

*Figure 1. Yearly VOC\(_{NF}\) emissions in Ventura County from 1990 to 2012.*
The seasonal component estimates show the same pattern with previous three years (Figure 2).

![Seasonal Component Estimates](image)

*Figure 2. The estimates of seasonal component (lbs) in the VOCNF series of 1990-2012.*

The ARIMA(0,0,2) × (0,1,1)_{12} equation

\[ y_t = \delta + w_t - \theta_1 w_{t-1} - \theta_2 w_{t-2} - \theta_{s,1} w_{t-12} - \theta_{s,1} \theta_1 w_{t-13} - \theta_{s,1} \theta_2 w_{t-14} \]  \tag{3}

Where \( \delta \) is a constant, \( \theta_{s,1} \) is the seasonal moving average coefficient, estimated as -0.732; \( \theta_1 \) and \( \theta_2 \) are the nonseasonal moving average coefficient, estimated as 0.279 and 0.233; and \( w_t \) is a Gaussian white noise term with the distribution \( N(0, \sigma_w^2 = 25960584) \). All of these numbers are very close to the previous estimates in Tao (2010, 2011, 2013).

**PREDICTION FOR NONFUMIGANT VOLATILE ORGANIC COMPOUND EMISSIONS OF 2012-2013**

The time series model \( X_t \) for the VOCNF data is built by the combination of the seasonality \( s_t \) (Figure 2), the trend \( m_t \) (Eq. 2) and the ARIMA (0,0,2) × (0,1,1)_{12} (Eq. 3) for \( y_t \) as Eq. 1. The model predicts the VOCNF of two entire years in Ventura County: 256688 lbs for 2013 and 249723 lbs for 2014. The emission predictions during ozone season, May – October, are shown in Table 1.
Table 1. The prediction of VOC\textsubscript{NF} monthly emissions (lbs) in 2013 and 2014 ozone season.

<table>
<thead>
<tr>
<th>Month</th>
<th>VOC\textsubscript{NF} Prediction (lbs)</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
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<td></td>
</tr>
<tr>
<td>May</td>
<td>23829</td>
<td>23485</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>26237</td>
<td>25893</td>
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<td>August</td>
<td>22552</td>
<td>22208</td>
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<tr>
<td>September</td>
<td>29747</td>
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</tr>
<tr>
<td>October</td>
<td>30072</td>
<td>29728</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>152847</strong></td>
<td><strong>150786</strong></td>
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<tr>
<td><strong>Tons/Day</strong></td>
<td><strong>0.418</strong></td>
<td><strong>0.412</strong></td>
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REFERENCES


