

A3

Yuhan Hu

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CO2

Introduction

We are interested in the changes CO_2 concentration from an observatory in Hawaii. More specifically, we are interested in whether CO_2 concentration is impacted by the following events: 1. the OPEC oil embargo which began in October 1973; 2. the global economic recessions around 1980-1982; 3. the fall of the Berlin wall almost exactly 30 years ago, preceding a dramatic fall in industrial production in the Soviet Union and Eastern Europe; 4. China joining the WTO on 11 December 2001, which was followed by rapid growth in industrial production; 5. the bankruptcy of Lehman Brothers on 15 September 2008, regarded as the symbolic start of the most recent global financial crisis; and 6. the signing of the Paris Agreement on 12 December 2015, intended to limit CO_2 emissions.

Method

We use generalized model from gamma family with log link function to analyze this question.

$Y_i \sim \text{Gamma}(\theta)$ where $\log(E(Y)) = X_i\beta + U(t_i) + V_i$

$X_i\beta = \sum_{j=1}^4 \phi_j(x_i)\beta_j + f(x_i)$ and $\phi_1 = \cos(2\pi x_i), \phi_2 = \sin(2\pi x_i), \phi_3(x_i) = \cos(4\pi x_i), \phi_4(x_i) = \sin(4\pi x_i)$ is B-spline fit to the data.

y_i is the concentration of CO_2 measured. ϕ_1 and ϕ_2 represent yearly fluctuation per half year, ϕ_3 and ϕ_4 represent biyearly fluctuation.

$[U_1 \dots U_T]^T \sim \text{RW2}(0, \sigma_U^2)$ is the random effect.

V_i is the random noise.

Result

All plots related to CO_2 are shown in the CO_2 section of Appendix.

From the sequence plot we can see that though fluctuating, concentration of CO_2 keeps increasing. Since the population of human keeps growing and industrial production never stop, there is no reason that amount of CO_2 reduces. Since the overall concentration keeps increasing, we can not answer the research question by this plot.

Fluctuations on sequence plot can be explained by seasonal effect plot. From this plot, we can see that CO_2 concentration varies within a year. In addition, the pattern of variation matches pattern of fluctuation on sequence plot. So we can conclude that fluctuations on sequence plot is due to seasonal CO_2 concentration variation.

Derivative plot is the plot we are interested in. This plot shows how the rate of change of CO_2 concentration varied during past years; thus it can help us analyze impact of the given events. Overall, besides

Overall, besides China joining WTO in 2010, all events have negative impact on CO_2 concentration. More specifically,

1. OPEC embargo in 1973 reduce the amount of oil consumption, which obviously reduce CO_2 emissions. Rate of change in CO_2 concentration was decreasing after this event. Therefore this event helps decrease CO_2 concentration
2. Global recessions imply reduced industrial activity and consumption, less CO_2 emitted to air from factory and oil consumption, so concentration of CO_2 increase much slowly. Rate of change in CO_2 concentration was decreasing after this event. Therefore this event helps decrease CO_2 concentration
3. Fall of Berlin Wall is preceding by a dramatic fall in industrial production in USSR and eastern Europe, thus reduce CO_2 emissions. Rate of change in CO_2 concentration was decreasing after this event. Therefore this event helps decrease CO_2 concentration
4. Rate of change in CO_2 concentration decrease slightly after China joined WTO. Then a dramatic increase follows, since this event happeded during a decreasing region and this decreasing region is much shorter than others, we may conclude that this event increase rate of change in CO_2 concentration. Therefore this event helps increase CO_2 concentration
5. Though CO_2 concentration rate of change is not decreasing after bankruptcy of Lehman Brothers, since the rate of change was increasing before enter this nearly flat region, we can say that CO_2 concentration increase slower due to this event. Therefore this event helps increase CO_2 concentration
6. CO_2 concentration rate of change does not decrease directly after Paris Agreement. But the rate of change reached its maximum and starts to decrease soon after this events. Since government needs time to accomadate the agreement, it's reasonable to say that Paris Agreement helps reduce CO_2 emissions.

We also generated a prediction plot, from this plot, we may conclude that CO_2 concentration will exceed 420 ppm after 2025.

From the random effect plot, it's clear that random effect is increasing as time Pass, which imply that.

Heat

Introduction

IPCC stated that Human activities are estimated to have caused approximately 1.0°C of global warming above preindustrial levels, with a likely range of 0.8°C to 1.2°C . Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate.

Here we are investigating data from Sable Island, off the coast of Nova Scotia, and trying to figure out whether the data from Sable Island is broadly supportive of this statement from the IPCC

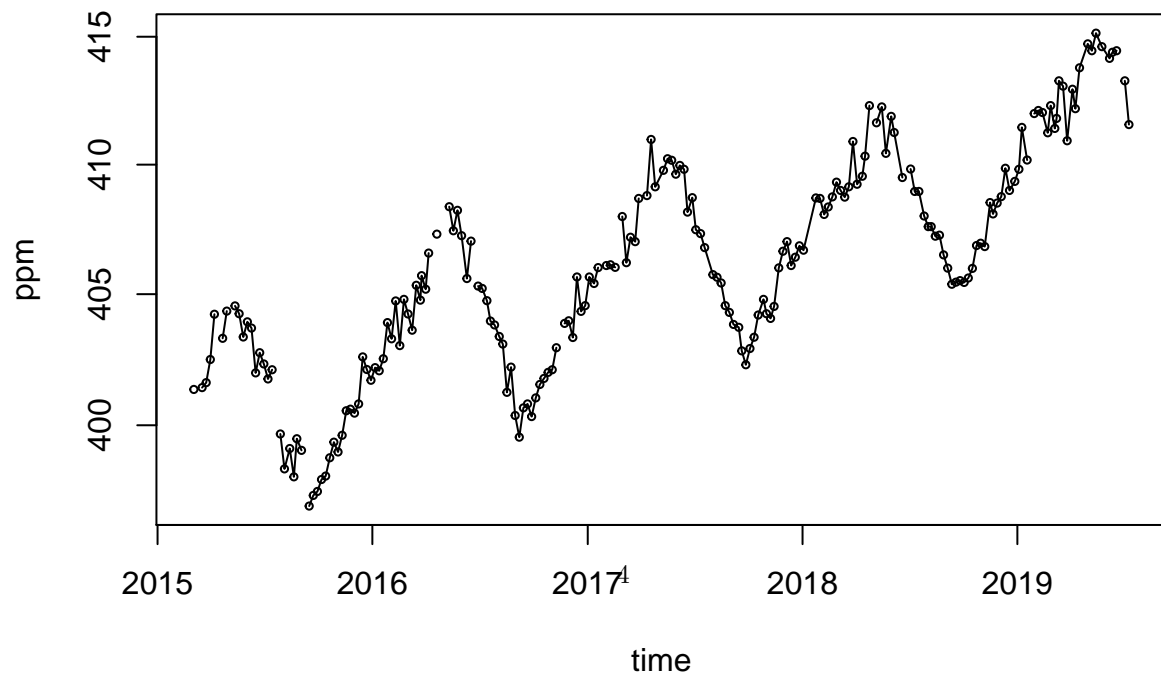
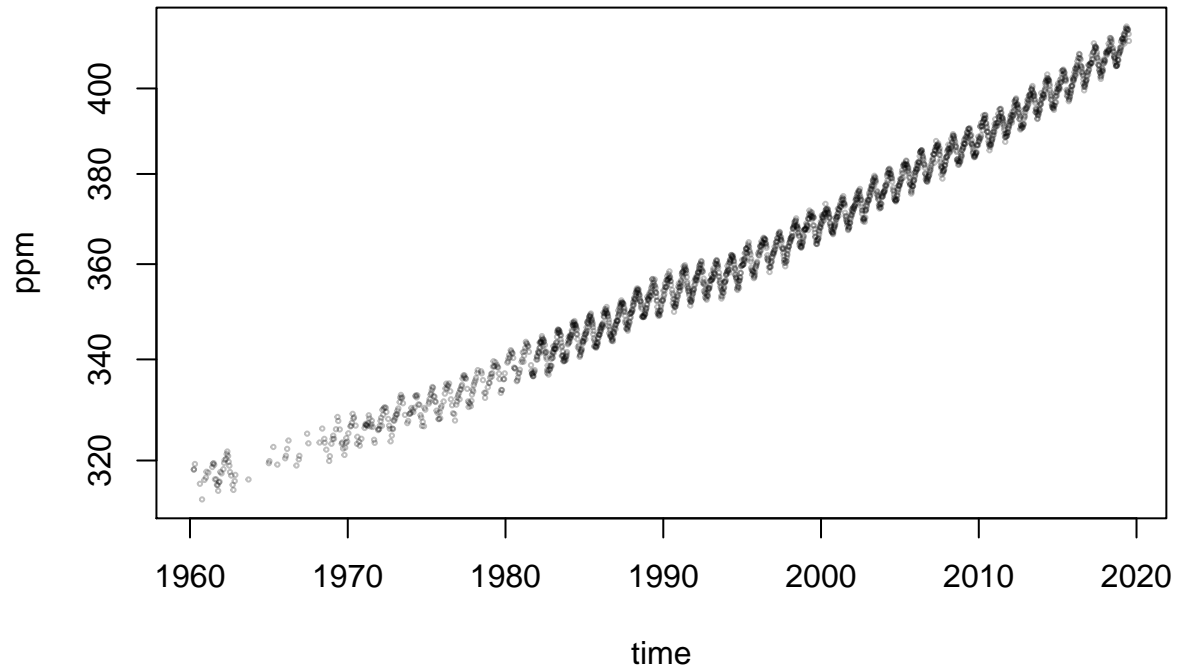
Method

We use generalized model from t-distribution family with log link function to analyze this question.

Result

Appendix

CO2

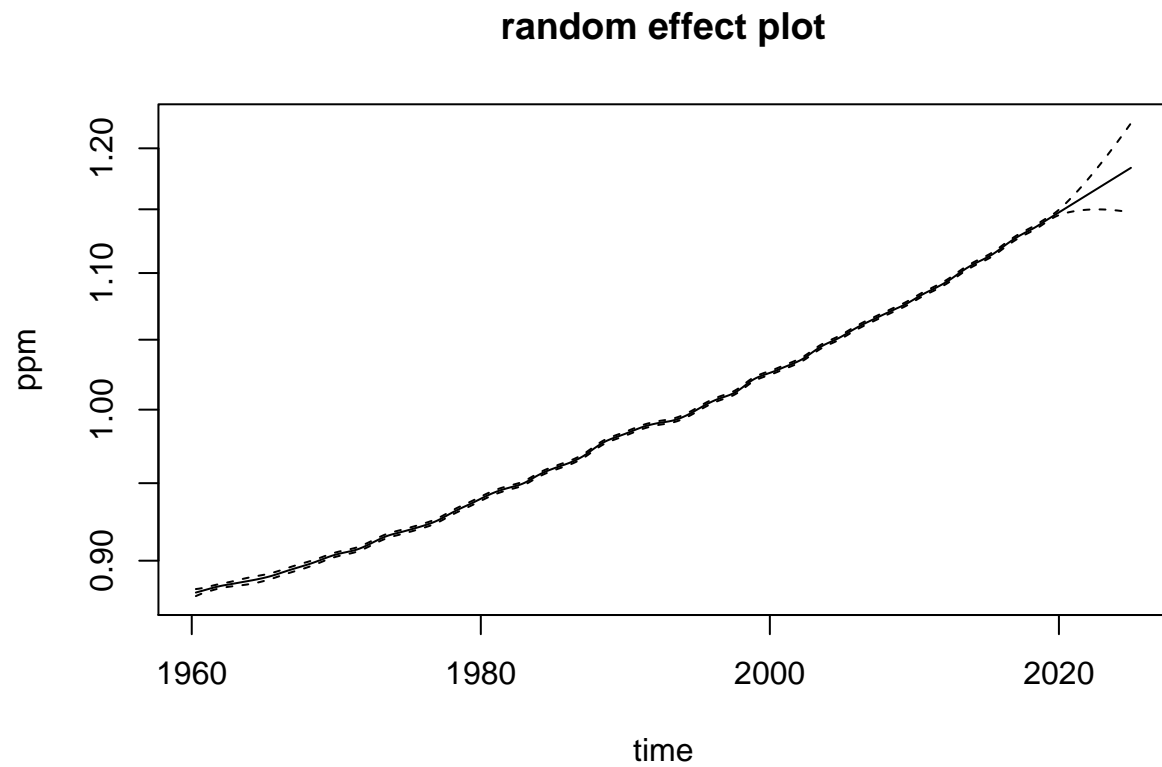


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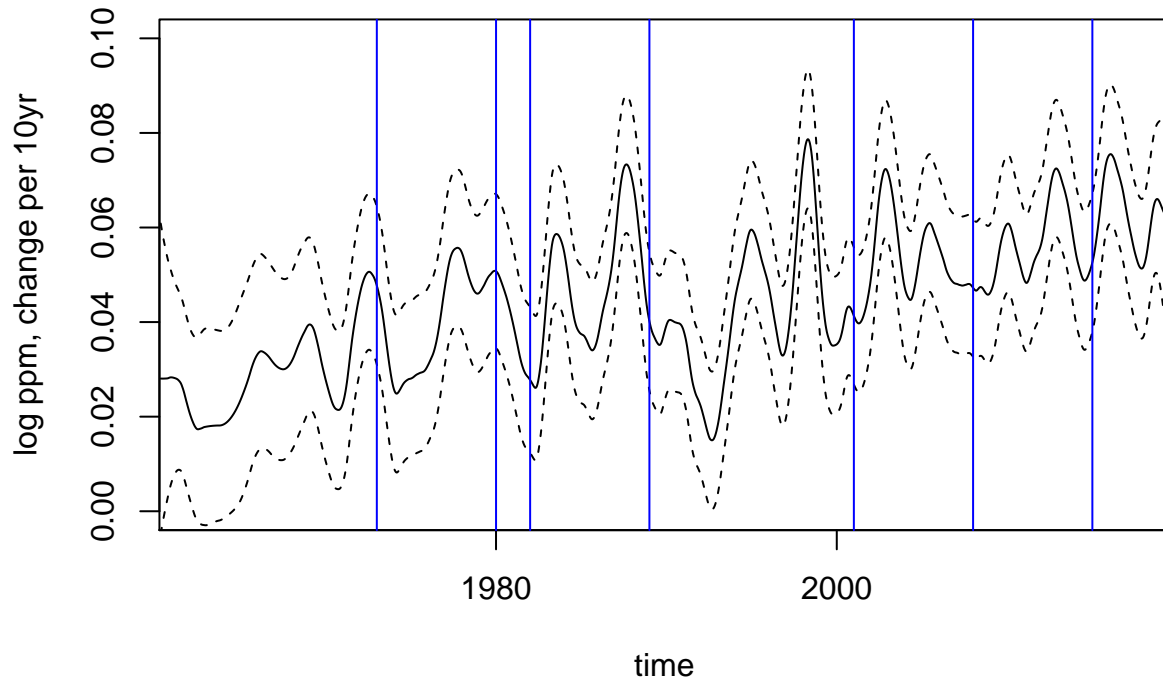
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## Loading required package: parallel

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## See www.r-inla.org/contact-us for how to get help.
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Derivative plot



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```

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```

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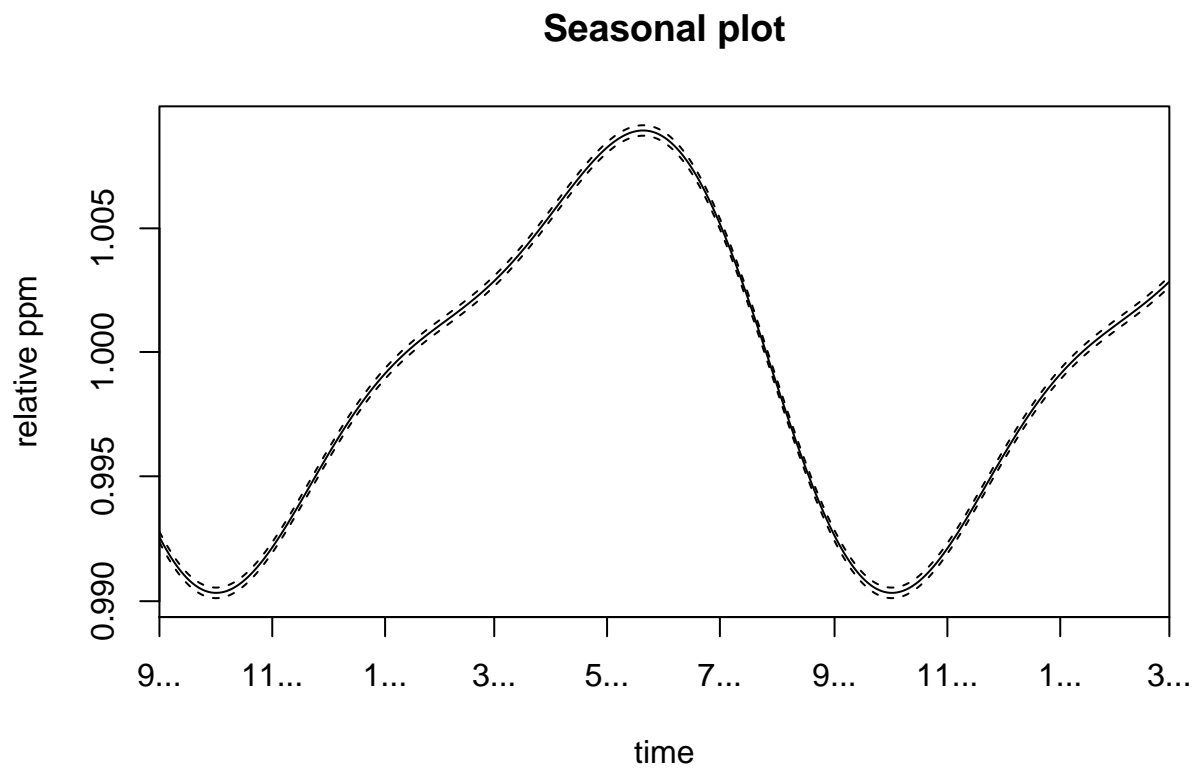
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Prediction plot

