MS8401 课程论文提案

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摘　要：.
关键词：词 1，词 2

Proposal

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Abstract: The purpose of this paper is to compare several commonly used classical decomposition (seasonal adjustment) methods systematically and to provide suggestions for future research.

Keywords: keyword 1, keyword 2

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1 Introduction

A time series of a climate variable can be viewed as a single realization of a stochastic process that represents the mechanism generating it. One goal of the time-series analysis is to figure out (estimate) the underlying mechanism of the time series. It is usually a daunting challenge to accomplish this goal, because of the lack of high-quality observations (limited samples), and the non-linear and non-stationary nature of the process. To alleviate this, climatologists may want to decompose the data generation mechanism into a somewhat deterministic component and a stochastic component. For example, if the time series of a variable exhibits a pattern of annual cycle superimposed on a long-term trend, one may want to do the (*additive*) *classical decomposition*, which decomposes its underlying process into a long-term trend component, a seasonal component, and a residue component. This paper will focus on the analysis of this type of variable.

From the observed time series, an estimate of the first two deterministic components can be drawn. Once the decomposition is done, the removal of the deterministic component from the original time series may facilitate the analysis of the remaining part. However, this decomposition may also produce ambiguous results, since it is not easy to distinguish long-term trends and seasonal components from the residue component. Different decomposition methods may produce different results, which may have implications for the classification and analysis of climate events.

There are at least three kinds of procedures that are commonly used for the classical decomposition of a given time series. The first, which we call *method-1*, is to determine the long-term trend using either moving mean or locally linear regression, and then determine the seasonal cycle by averaging the state of the detrended time series concerning a fixed phase of the cycle, or by fitting the detrended time series to a sum of sines and cosines. The second, which we call *method-2*, is to do method-1 iteratively, that is, update the estimated trend using the deseasonalized series, and then update the estimated seasonal cycle using the newly detrended series, and so on, until convergence criteria are met. The third, which we call *method-3*, is to determine the long-term trend and seasonal components simultaneously, by fitting the time series to a function containing a global linear trend term and some sine and cosine terms.

Previous studies (Chen & Li, 2021; Findley et al., 1998; Narapusetty et al., 2009; Pezzulli et al., 2005; Wu et al., 2007)… (文献综述待补充.). However, few of those ... (研究 gap 待补充). The purpose of this paper is to compare several commonly used classical decomposition (seasonal adjustment) methods systematically and to provide suggestions for future research.

This paper is organized as follows. (the plan of development 待补充)

2 Data and Method

2.1 Data

2.2 Classical decomposition

[方法 1：先局部线性回归决定 trend，再简单平均求 seasonal cycle]
[方法 2：在方法 1 的基础上，再迭代一次]

[方法 3：用全局回归，同时决定 trend 和 seasonal cycle]

2.3 Experiment Setup

2.3.1 Idealized time series

1 第 1 组（理想仿真），对多项式 trend 的次数和余项的敏感性.

（1）线性/二次 trend + 1 年周期信号 + 噪声.（2）线性/二次 trend + 1 年周期信号 + 4.3 年周期信号.（3）线性/二次 trend + 1 年周期信号 + 4.3 年周期信号 + 噪声.

2 第 2 组，对 trend 的增量的敏感性.

（1）….（4）剧烈的线性/二次 trend + 1 年周期信号 + 噪声.

3 第 3 组，对 seasonal cycle 的解释方差的敏感性.

（1）….（5）线性/二次 trend + 大幅度的 1 年周期信号 + 噪声.

2.3.2 Real time-indices

Global SST (Monthly), ….

2.4 Assessment Methodology

2.4.1 Idealized time series

对于按经典分解方式构造的理想时间信号，“真实”分量已知，故可将各方法的输出与“真实”误差比较.

指标 1：输出的余项对“真实”余项的样本均方误差.

指标 2：输出的气候平均态（trend + seasonal cycle）对“真实”原始序列的样本相关系数.

指标 3：气候平均态的交叉验证误差. 原始序列中的其中一年的作为测试集，其余作为训练集. 求输出的测试集上气候平均态对真实气候平均态的均方误差.

2.4.2 Real time-indices

对于实际时间指数，“真实”分量未知. 根据气候平均态的定义，气候平均态是最小化总体均方误差的，故合理期待方法的输出应使得样本均方误差较小.

指标 4：交叉验证误差. 原始序列中的其中一年的作为测试集，其余作为训练集. 求输出的测试集上气候平均态对原始时间序列的均方误差.

3 Results

[结果图 + 分析]

4 Conclusions

本文以三种常用的经典分解方案为例，研究了不同的分解方案对结果的影响. 结果表明，采取不同的分解方法，对结果会造成一定的影响. 在某些情况(趋势强非线性，趋势增量大，

季节信号的解释方差小?)下，影响更明显. 在全球气候变化的背景下，本文的结果值得学界关注.

基于本文的讨论，我们认为，气候态(包括长期趋势，季节周期分量等)应是客观的，但趋势和季节周期的定义，以及相应的分解方案及其参数的选取却带有主观性，这是分解方案选取问题的根源. 因此，我们对后续研究提出以下建议：(1) 后续研究应对气候态各分量建立客观定义，并建立相应的自适应分解方案. (2) 在对气候事件的分类和讨论中，若使用了某种时间序列分解方法，则应增加讨论采取其他分解方法对结果的影响，以避免研究结论被分解方案选取带来的虚假变率误导.

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