Multiple lagged differences in spatial time series
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\section*{Introduction}

Here we present a graphical examination of spatial time series data sets, each representing a 2 by 2 grid. The goal is to understand how a particular hydraulic variable changes over time. We begin by presenting temperature and surface temperature data sets for a particular region in the US. This region is divided into a 2 by 2 grid, and each grid cell represents a small area of the country. The data are collected at regular intervals, typically monthly, and represent the surface temperature over the entire region. The graphical representation of this data uses a series of stacked bar charts, each representing the temperature changes over time in each grid cell. The bars are color-coded to indicate the magnitude of the change, with darker colors representing larger changes.

\section*{Method}

Using the empirical spatial time series data sets, we employ a lagged difference operator to construct our graphs. This method reveals patterns and trends that are not immediately apparent in the raw data. The lagged difference operator is defined as the difference between a variable at time \( t \) and the same variable at a lagged time \( t - k \), where \( k \) is the lag length. For example, if we use a lag of 1, we compute the difference between the temperature at time \( t \) and the temperature at time \( t - 1 \). This allows us to identify changes that occur over time, which may be due to natural fluctuations or external factors.

\section*{Results}

\subsection*{Temperature Differences}

We begin by examining the temperature differences for the region. The data are aggregated into 2 by 2 grid cells, and the differences are calculated for each cell over a specified time period. The graphical representation of these differences uses a color-coded heat map, with warmer colors indicating larger temperature changes. The heat map reveals areas of the region where temperature changes are most pronounced, which can be further analyzed to identify underlying causes.

\subsection*{Surface Temperature}

Next, we consider the surface temperature data. The data are again aggregated into 2 by 2 grid cells, and the surface temperature is calculated for each cell over the same time period. The graphical representation of this data uses a series of contour plots, with color-coded regions indicating different temperature ranges. The contour plots reveal patterns of temperature distribution across the region, which can be further analyzed to identify seasonal or geographic influences.

\section*{Conclusion}

In conclusion, the graphical examination of spatial time series data sets provides a powerful tool for understanding the dynamics of temperature and surface temperature changes over time. The lagged difference operator allows us to identify changes that occur over time, which may be due to natural fluctuations or external factors. The graphical representations, such as heat maps and contour plots, provide a visual means of understanding these changes, which can be further analyzed to identify underlying causes. This approach offers a useful tool for researchers interested in studying the dynamics of temperature changes over time.