CE3502: EMMDA

Soothing
Smoothing
Smoothies

Figures:
Report

1. Figure caption (legend) goes below figure.
2. No Chart Title in excel; title is first component of figure caption;
3. Axes are labeled, units given;
4. All parts of figure large enough to be readable;

Figure 1 Waste Composition at MTU. The figure represents the solid waste distribution (% mass) for a total truck load of 3.14 tons of which about 20-25% was sampled. Sample date was 9/23/97. The “other” category consists of food containers, hardware, and non-recyclable paper and cardboard.
Effects of baffles

Figures:
Presentations
1. All parts visible (font, color scheme);
2. Axes labeled, units given;
3. Title in Chart or above;
4. Options to draw attention

PFR Lab Results: Effects of baffles
Effects of flow rate

![Graph showing the effects of flow rate on dye concentration over time normalized to TH.](image)

**SOOTHING**

**Presentation 1:**
Range: 82-91%

**Lab report 1:**
All in on time
Median: 76%
SMOOTHING

Definition: Smoothing is a technique that reduces the roughness, instability or noise in data in order to help reveal an underlying pattern.

Motivation: Smoothing can help to focus attention on unusual events (e.g., sudden changes), trends, or cyclical patterns.

Example: Noisy data

This figure shows the hourly progression of the temperature gradient above L. Superior in 1997.
Theory: Smoothing

**Moving Average:** an average based on the current and recent historical values (most recent data). The length of time over which the average is computed, k, is determined by the analyst after consideration of the system.

\[
x_t = \frac{1}{k} \sum_{j=t-k+1}^{t} x_j \quad \text{t= k, k+1, \ldots, n}
\]

As a new observation is made, the summation drops one data point and adds the current data point.

![Graph showing data points and trend lines for concentration over time. The equations for the trend lines are y = 0.68x + 9.53 (R² = 0.28) and y = 0.66x + 8.18 (R² = 0.72).]
Increased time window of smoothing from hourly to daily to weekly to monthly.
Theory: Smoothing

The moving average, when plotted, highlights patterns in the data that occur at the frequency of the moving average.
- 7-day average highlights weekly changes
- 30-d average highlights monthly changes

Theory 2: Weighted average

E.g., Exponentially-weighted moving average weights the most recent observations most heavily and the weighting decreases with age of measurement.

\[
\bar{x}_t = \sum_{j=0}^{n} (1-\phi)^j \cdot x_{t-j}
\]

typically, \( n = 2-4 \)

Weighting factor (between 0 & 1)
Pros and Cons

- **Moving average:** lags changes unless future and past observations are averaged;
- **Exponentially-weighted moving average:** does not remove as much noise (unless $\phi > 0.85$) but remains synchronized with data well;
Climate Change

Changes in Greenhouse Gases from ice-Core and Modern Data

IPCC 2007

Radiative Forcing Components

<table>
<thead>
<tr>
<th>RF Terms</th>
<th>RF values (W m⁻²)</th>
<th>Spatial scale</th>
<th>ODSU</th>
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<tr>
<td>Long-lived greenhouse gases</td>
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<td>N₂O</td>
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<td>CH₄</td>
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<tr>
<td>H Halocarbons</td>
<td>0.06 [0.05 to 0.12]</td>
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<td>Low</td>
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<td>Stratospheric water vapour from CH₄</td>
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<td>Surface albedo</td>
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<tr>
<td>Land use</td>
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<td>Black carbon on snow</td>
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<tr>
<td>Total Aerosol</td>
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<tr>
<td>Direct effect</td>
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<td>Cloudalbedo effect</td>
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<td>Linear contrails</td>
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<tr>
<td>Total net anthropogenic</td>
<td>1.6 [0.6 to 2.4]</td>
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</tbody>
</table>
Changes in Temperature, Sea Level and Northern Hemisphere Snow Cover

(a) Global average temperature
(b) Global average sea level
(c) Northern Hemisphere snow cover

Difference from 1981–1990

Global and Continental Temperature Change

[Diagram showing temperature changes across different continents]
FIGURE SPM-4. Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using natural and anthropogenic forcings. Decadal averages of observations are shown for the period 1906–2005 (black line) plotted against the centre of the decade and relative to the corresponding average for 1901–1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5–95% range for 19 simulations from 5 climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5–95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings. [FAQ 9.2, Figure 1]

FIGURE SPM-5. Solid lines are multi-model global averages of surface warming relative to 1980–99) for the scenarios A2, A1B and B1, shown as continuations of the 20th century simulations. Shading denotes the plusminus one standard deviation range of individual model annual averages. The orange line is for the experiment where concentrations were held constant at year 2000 values. The grey bars at right indicate the best estimate (solid line within each bar) and the likely range assessed for the six SRES marker scenarios. The assessment of the best estimate and likely ranges in the grey bars includes the AOGCMs in the left part of the figure, as well as results from a hierarchy of independent models and observational constraints. [Figures 10.4 and 10.29]
Locally observed climate changes

- Warmer (~4°C since 1975);
- Earlier ice-out on lakes;
- Reduced ice coverage on Lake Superior;
- Warming of Lake Superior, earlier stratification;
- Increased evaporation, decreased river flows;
- Decreased lake levels;

![Projected Patterns of Precipitation Changes](image)

**FIGURE SPM-7.** Relative changes in precipitation (in percent) for the period 2080-2099, relative to 1980-1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change. (Figure 10.9)
Myths about Climate Change

- Climate models cannot provide useful information about the real world;
- Global warming stopped 10 years ago;
- Temperatures were higher in pre-industrial times;
- A few degrees of warming won’t hurt;
- Heat islands around cities cause the perceived warming;