Time-Series Analysis:
A Cautionary Tale

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What is time-series analysis?

• Useful tool for analysis of long-term data

• Lots of math and statistics

• Common pitfalls (bad assumptions)

• Practical example: Derivation of long-term trends in stratospheric ozone
Ozone is Important

- Earth’s “sunscreen”

- Destruction from CFCs (and other man-made compounds containing Cl and Br)


- Is it recovering?
How has it changed?
Methodology

- Data Resolution
- Regression Model
  - Choosing Predictor Variables
  - Orthogonal Function Analysis
- Multiple Linear Regression
  - Autocorrelation
  - Heteroscedasticity
- Residual Filtering
- Coefficient Filtering
Check your fits ...
... and your residuals
Residuals Matter

![Image of Total Residuals and Uncorrelated Residuals graphs]

- Total Residuals
- Uncorrelated Residuals

- Altitude (km)
- Latitude
- Percent

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ERBS
SAGE II
NAS
Sampling is Critical!

• SAGE observes the same latitude at the same times during the year
• Orbital degradation increases precession and causing a drift in sampling

• Diurnal variability (geophysical or algorithmic) is important at higher altitudes
Sampling Induced Biases

Sunrise Bias (25.0 km)

Sunset Bias (25.0 km)

Sunrise Bias (45.0 km)

Sunset Bias (45.0 km)
Trend Comparisons (Decline)

Trend Comparisons (Recovery)


Linear Trend or EESC?
Conclusions

• Know your limitations! (watch out for pitfalls)
• Can mitigate biases introduced by non-uniform sampling
• Reproduce others’ work before doing something new
• Don’t be afraid to challenge the scientific community

• Want to know more?
  – http://www.atmos-chem-phys.net/14/13455/2014/acp-14-13455-2014.html
Extra Slides
Creation of volcanic proxy
Final volcanic proxy

MLR Volcanic Term

Latitude

LOG$_e$(Relative OD)

Result from regression

![Graph showing peak Pinatubo response over altitude and latitude, with a color scale indicating percent of mean.]

Altitude (km) vs. Latitude with color indicating percent of mean.