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 ...

Ozone at 23 km (10S-10N)

Ozone at 42 km (40N-50N)

Ozone at 32 km (60S-50S)
... and your residuals
Residuals Matter

Total Residuals

Uncorrelated Residuals

Altitude (km)

Latitude

Percent

Altitude (km)

Latitude
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
Trend Comparisons (Decline)
Trend Comparisons (Recovery)
Linear Trend or EESC?

Change from 1985 at 50°N (Piecewise)

Change from 1985 at 50°N (EESC)

Change from 1985 at Equator (EESC)

Change from 1985 at 50°S (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

![Graphs showing volcanic proxy data for different latitudinal bands](image-url)
Final volcanic proxy
Result from regression

![Graph showing the Peak Pinatubo Response with altitude on the y-axis, latitude on the x-axis, and percent of mean on the z-axis. The graph includes contour lines and a color scale.]