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)

- Montreal Protocol (1987)

- Is it recovering?
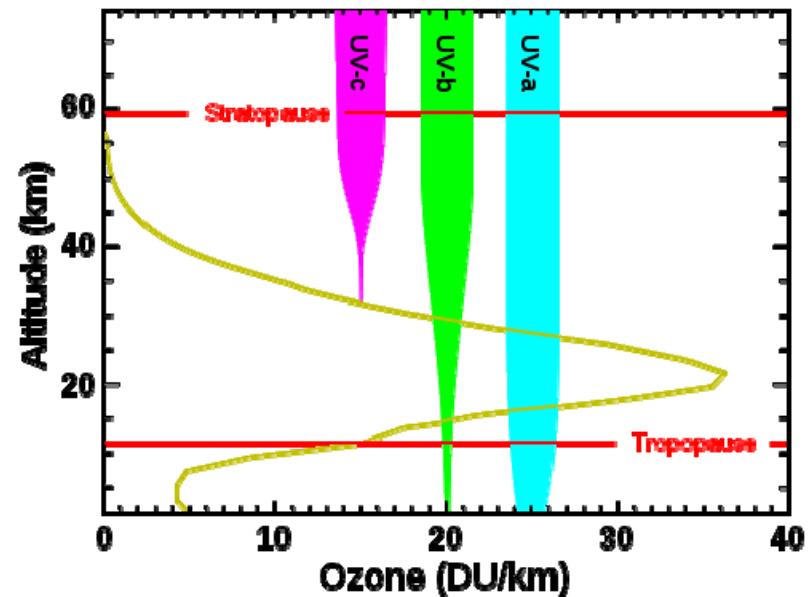
How has it changed?

Linear Trends in SAGE O3 v7 from 84/98 (%/decade)
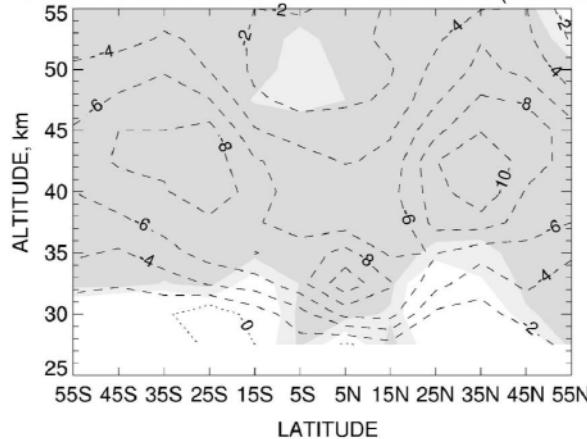
SAGE II / OSIRIS pre-1997 trend (%/decade)
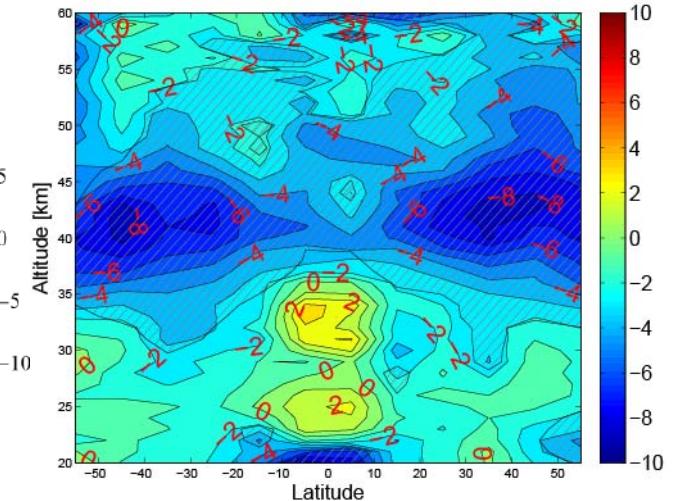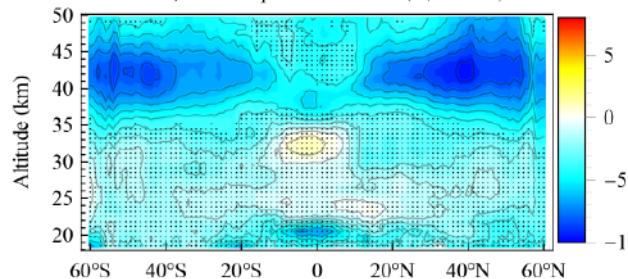
Linear Trends in SAGE O3 v7 from 91/05 (%/decade)
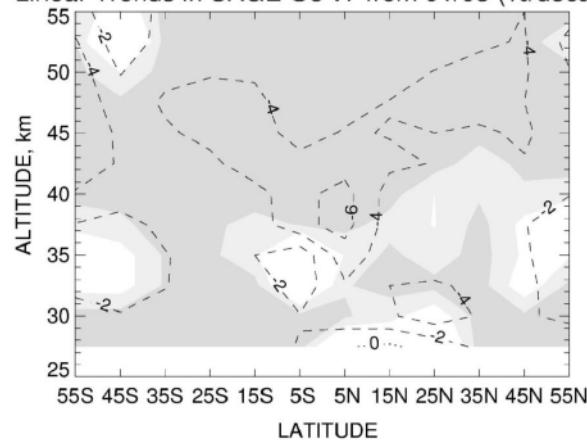

SAGE II / OSIRIS post-1997 trend (%/decade)
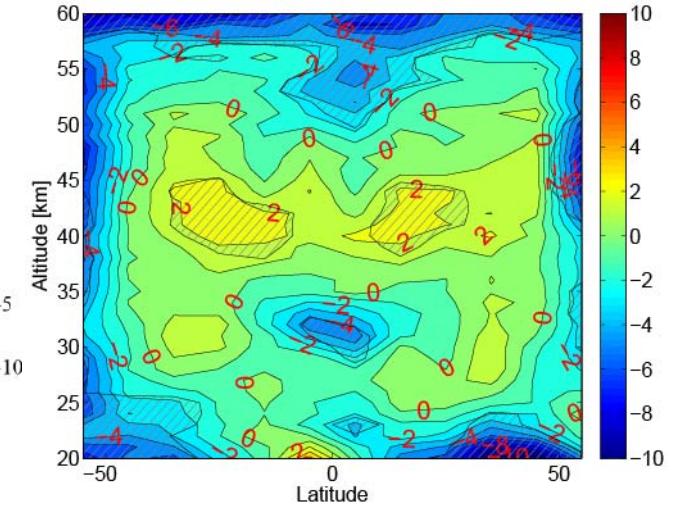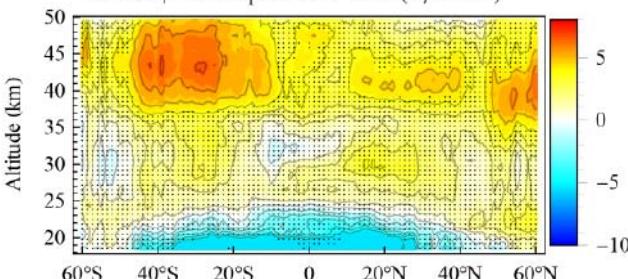
Methodology

- Data Resolution

SAGE II Event Locations (19860215)
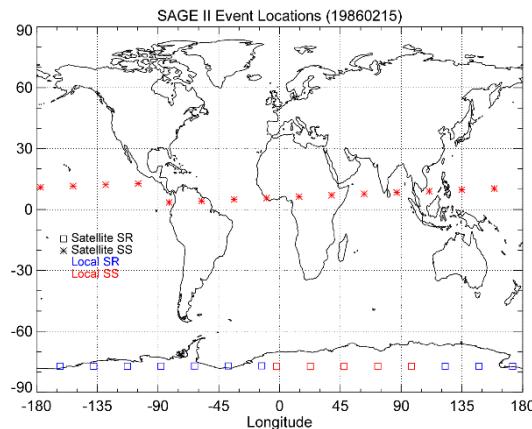
- Regression Model
  - Choosing Predictor Variables
  - Orthogonal Function Analysis
- Multiple Linear Regression
  - Autocorrelation
  - Heteroscedasticity
- Residual Filtering
- Coefficient Filtering

Check your fits …

Ozone at 23 km (10S-10N)

Ozone at 42 km (40N-50N)
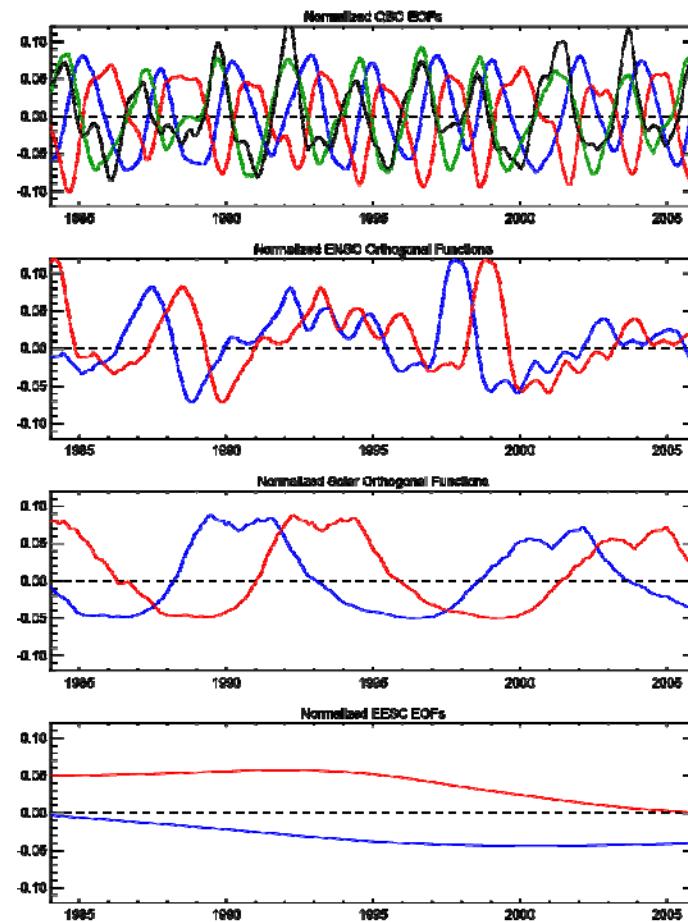
Ozone at 32 km (60S-50S)
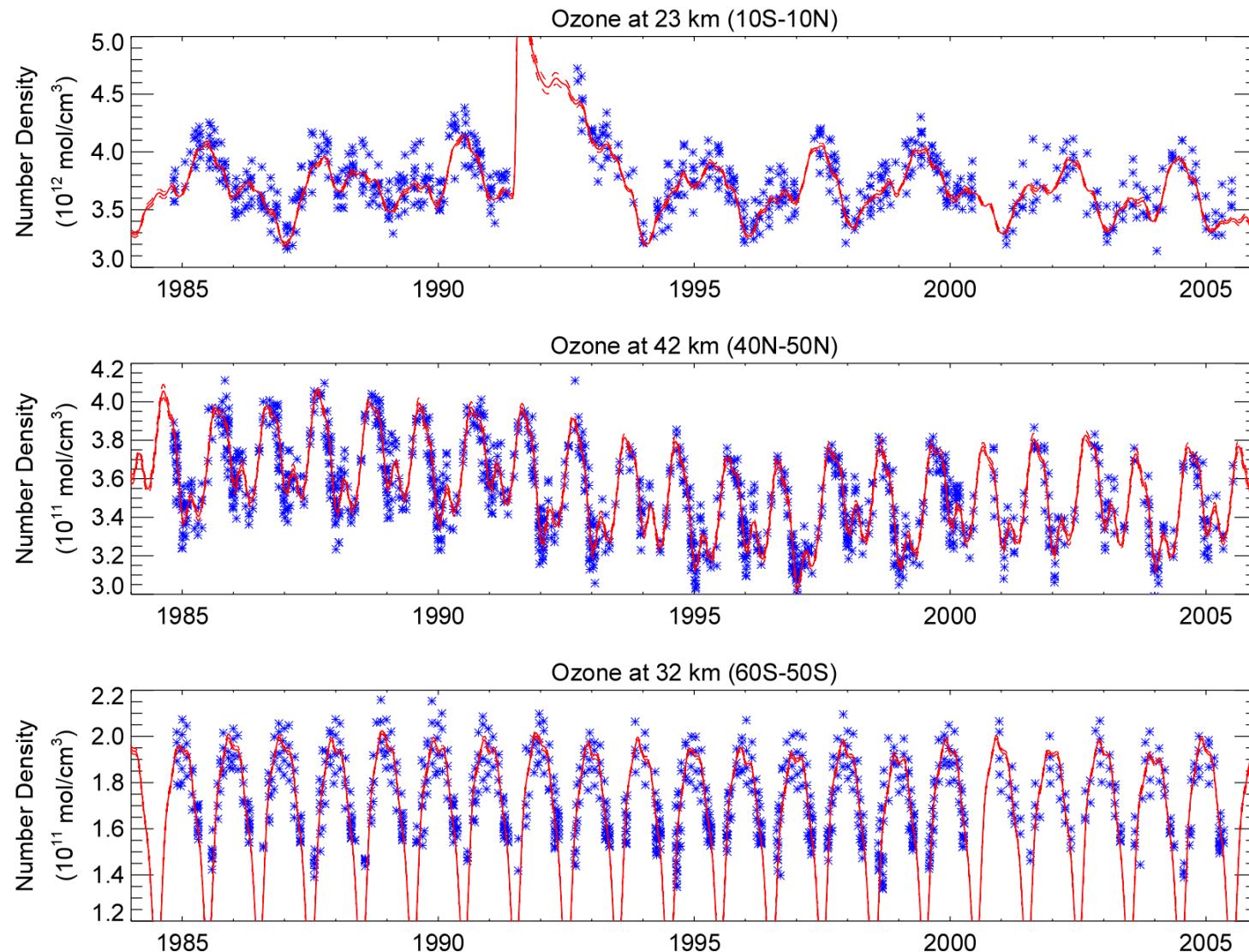
# … and your residuals
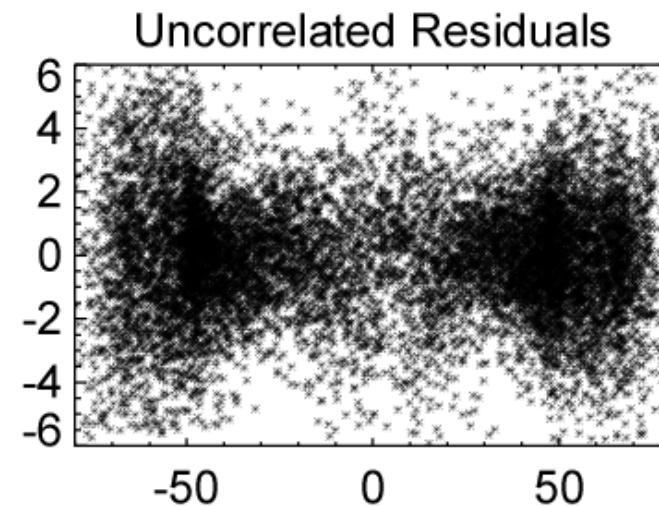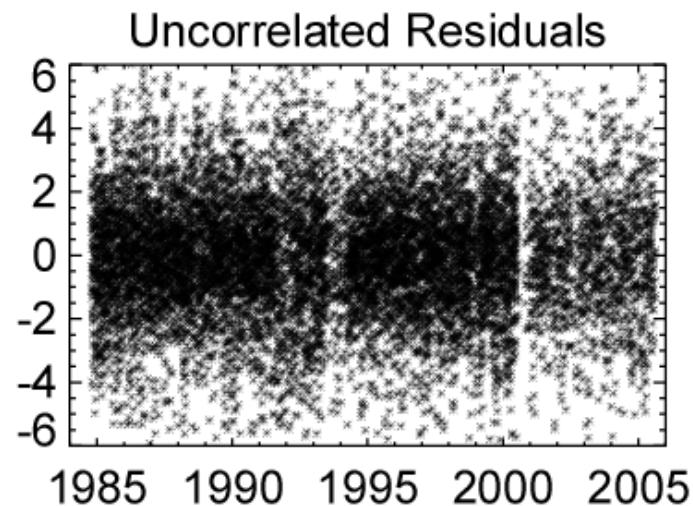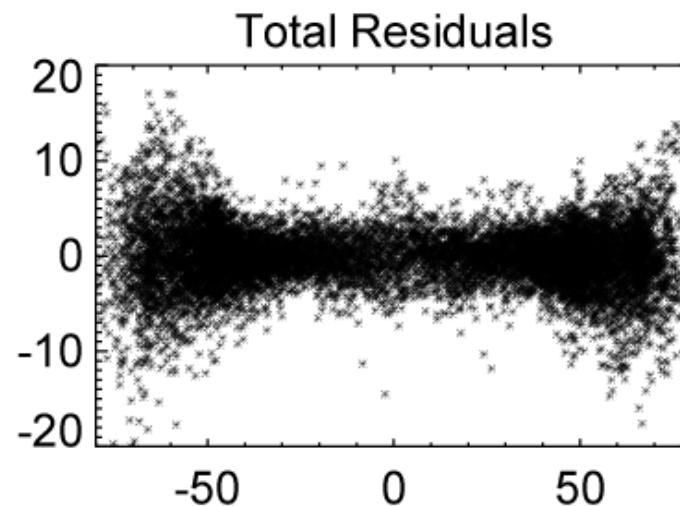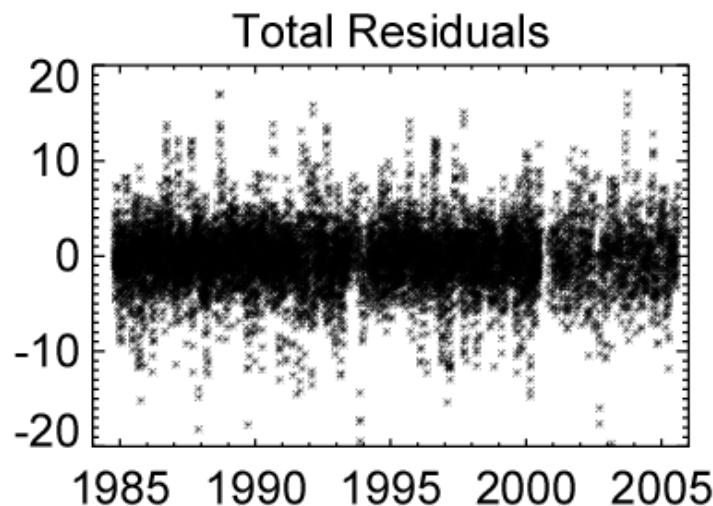
Residuals Matter
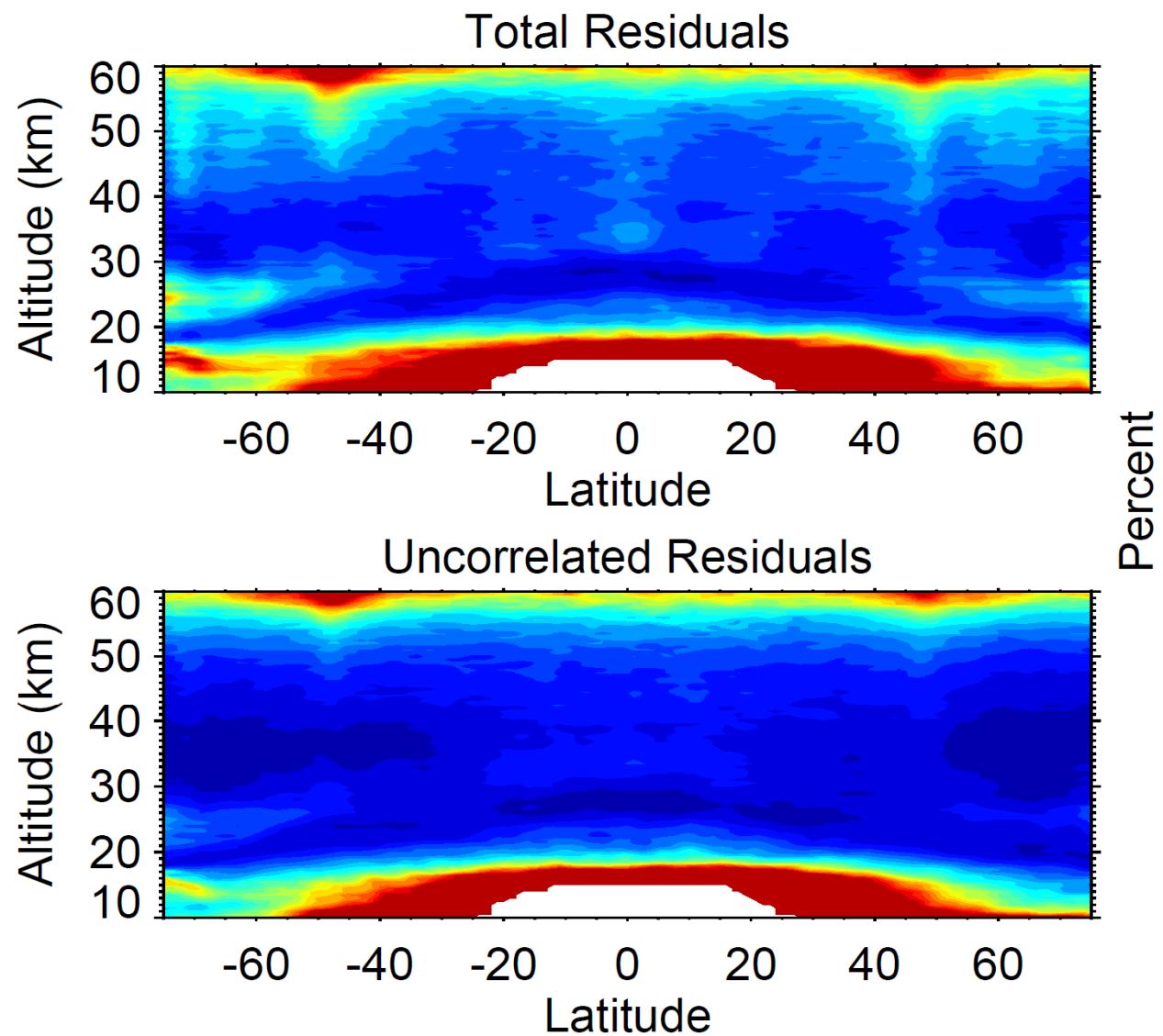
Sampling is Critical!

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

Daily Mean Locations (1985-1989)

Daily Mean Locations (2001-2005)

(SS – SR) / SS
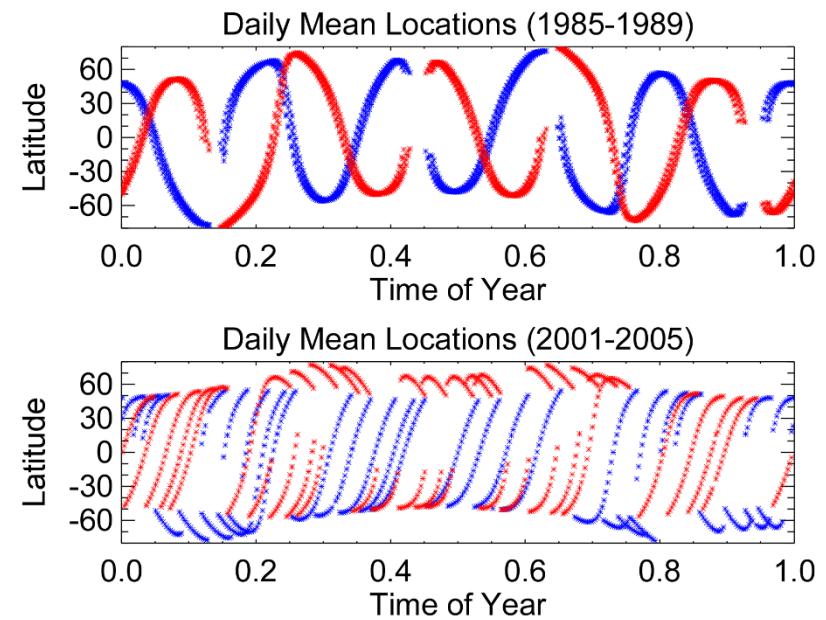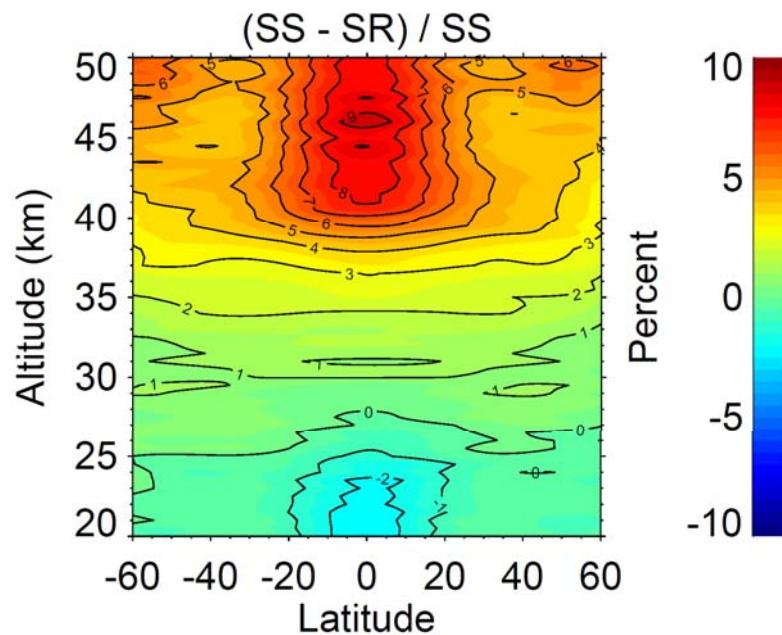
- Diurnal variability (geophysical or algorithmic) is important at higher altitudes

Sampling Induced Biases
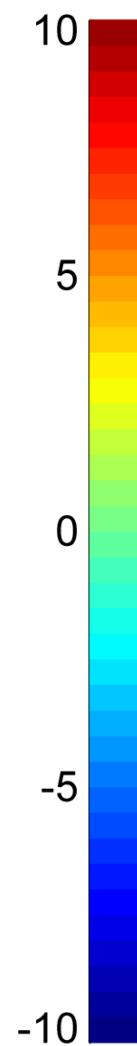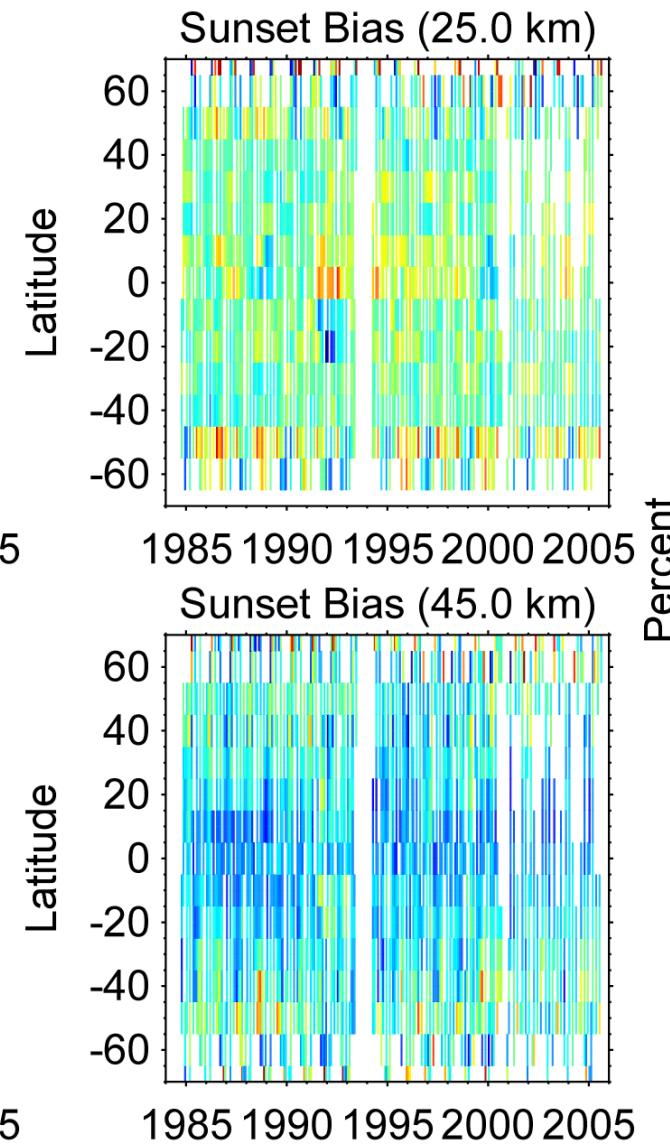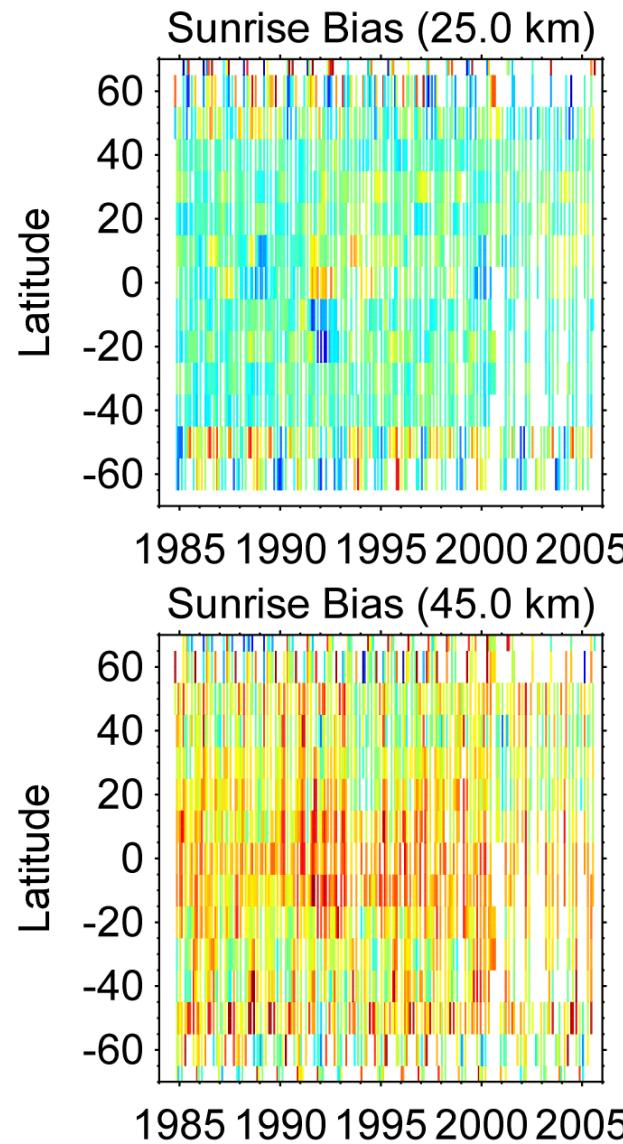
Trend Comparisons (Decline)
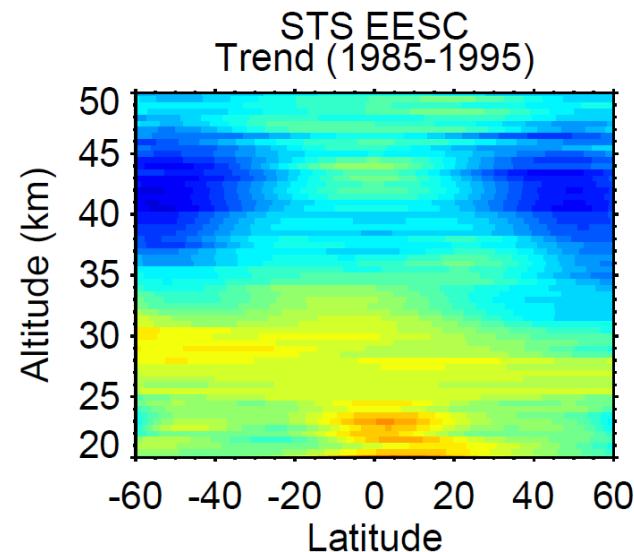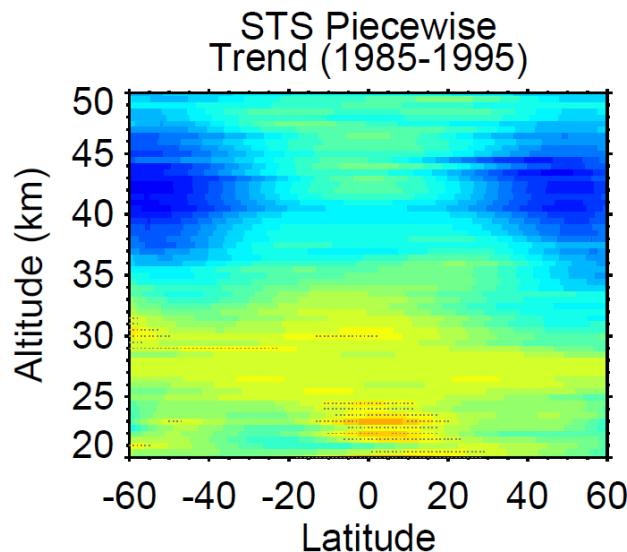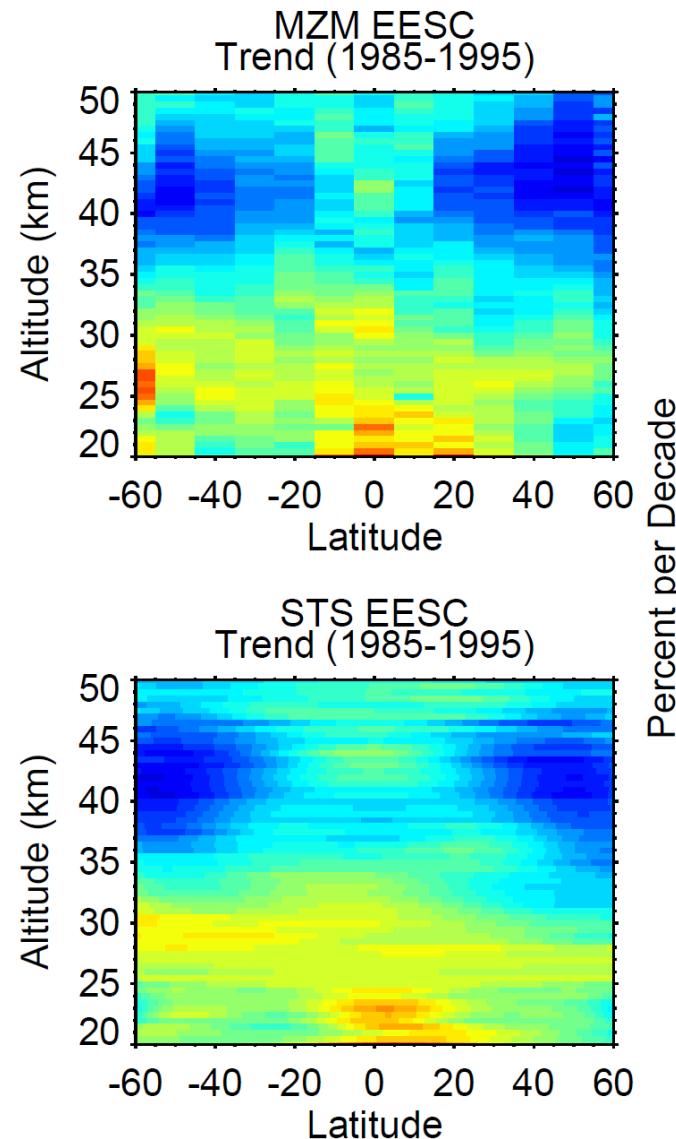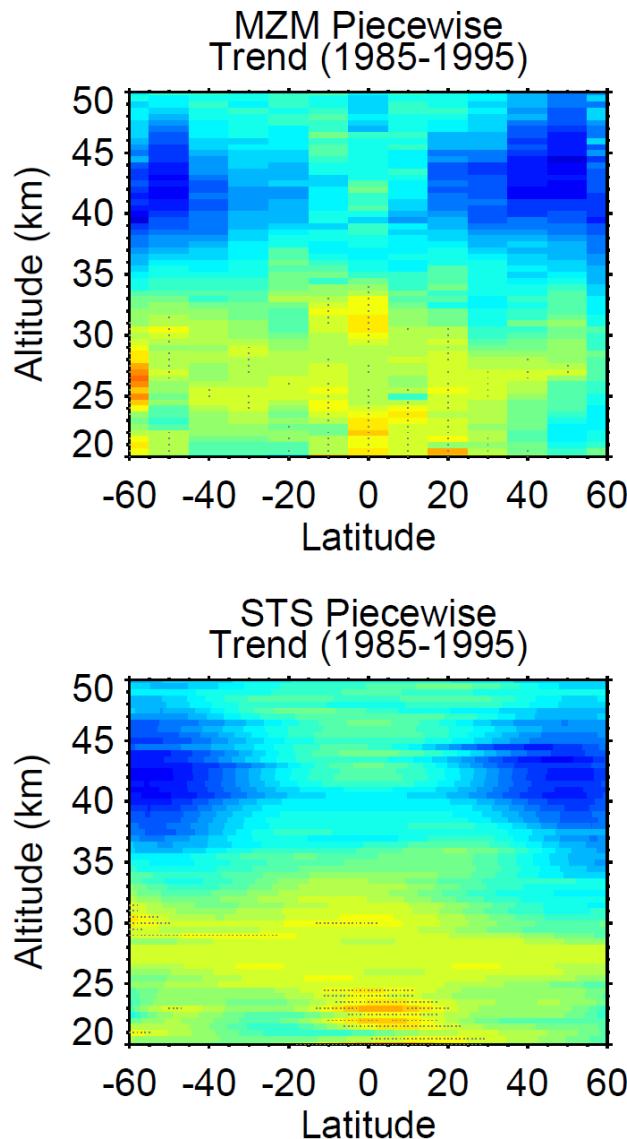
Trend Comparisons (Recovery)
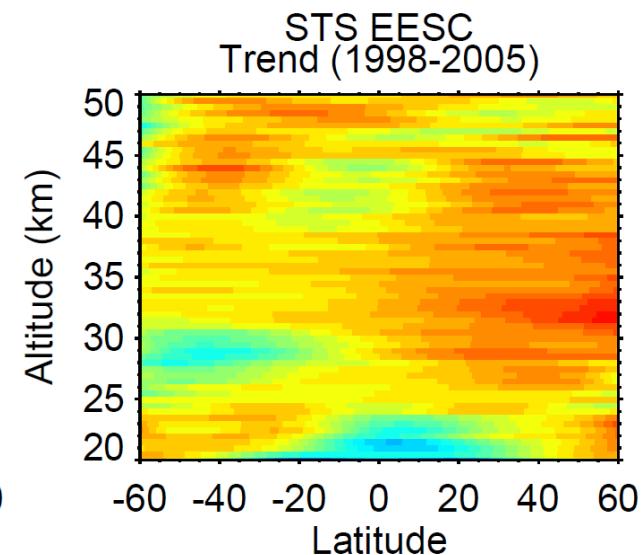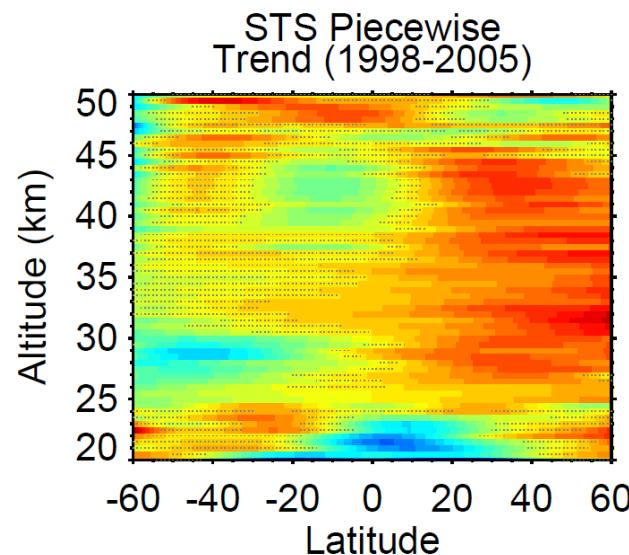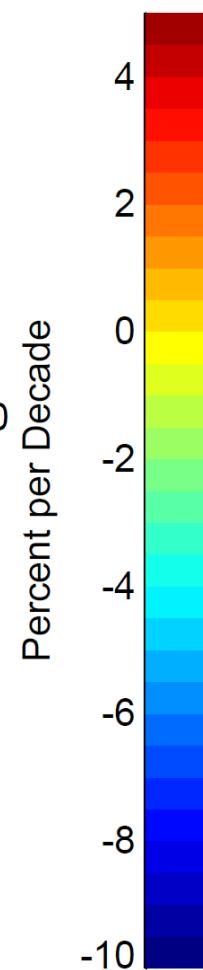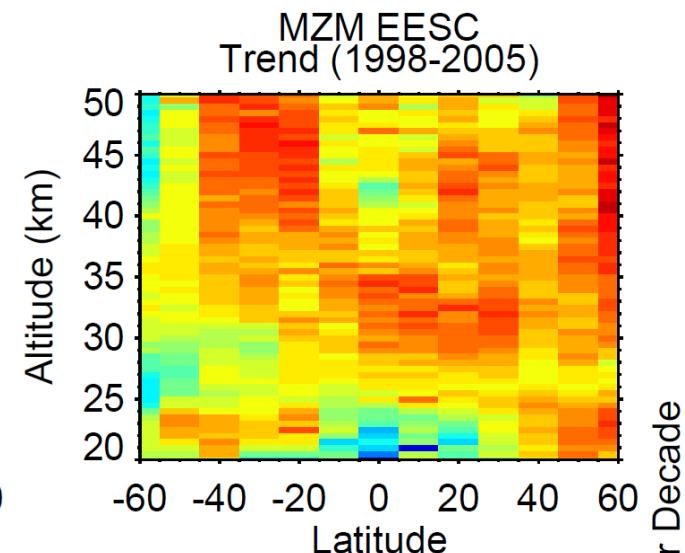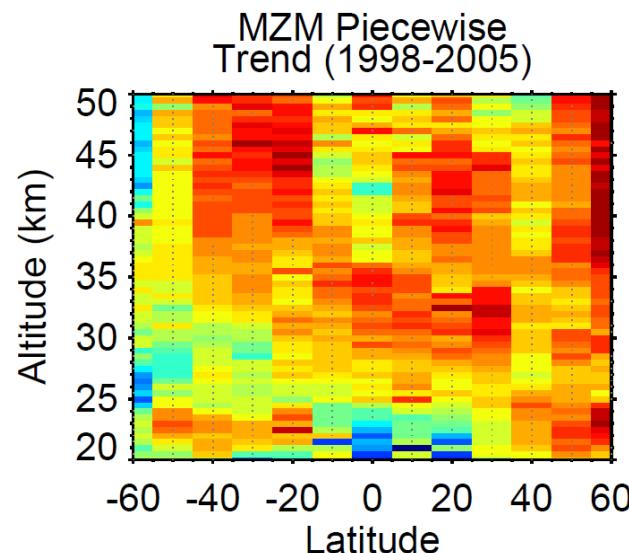
Linear Trend or EESC?
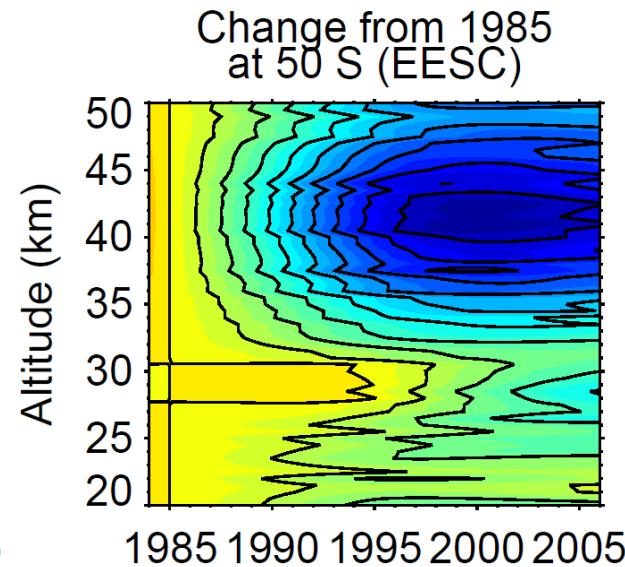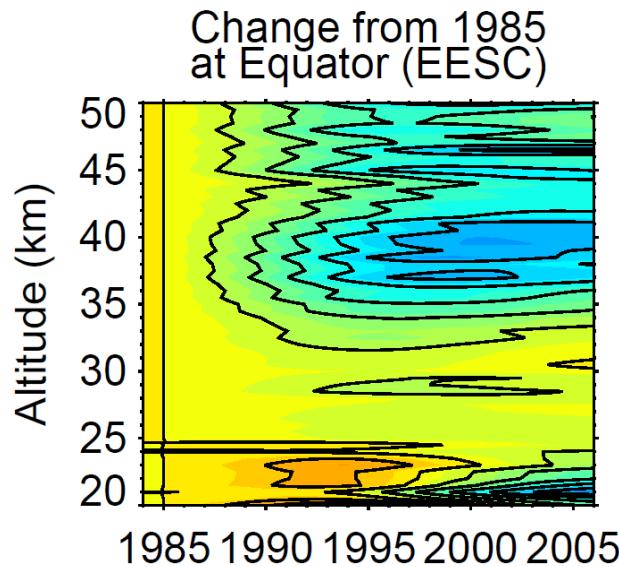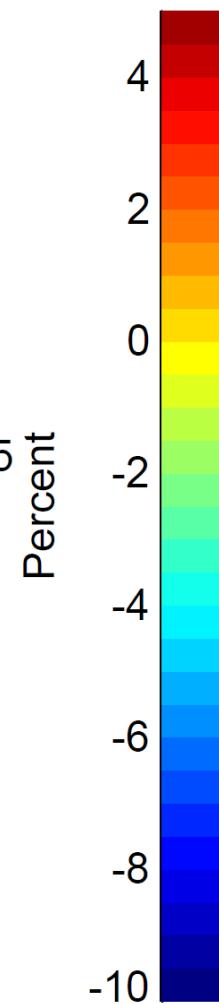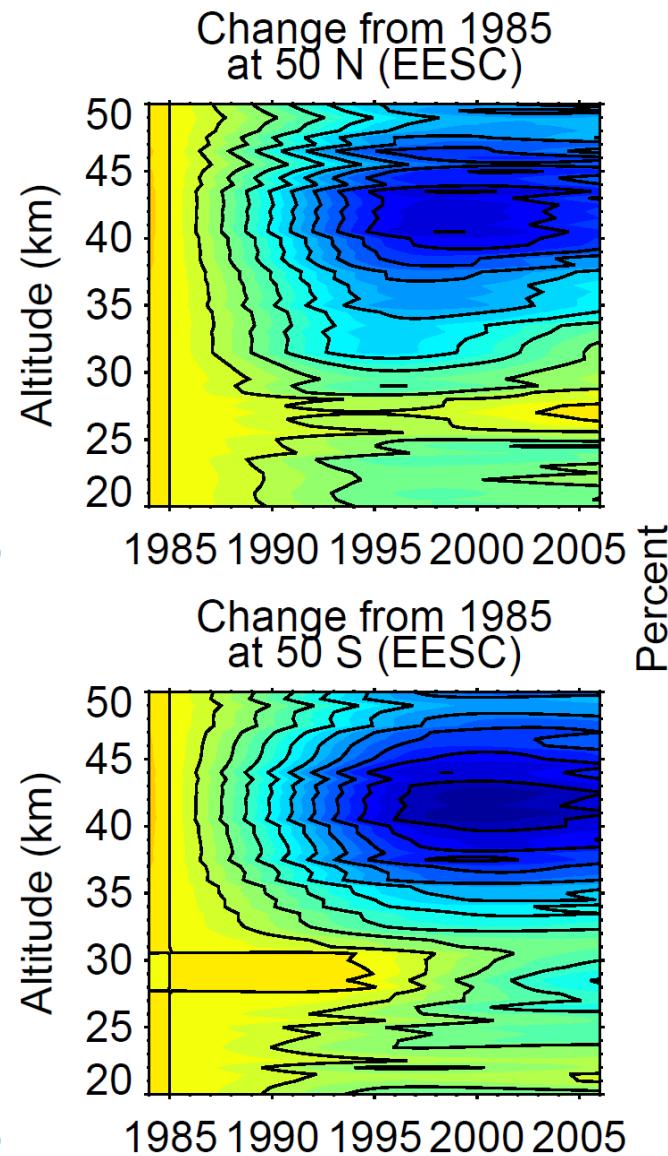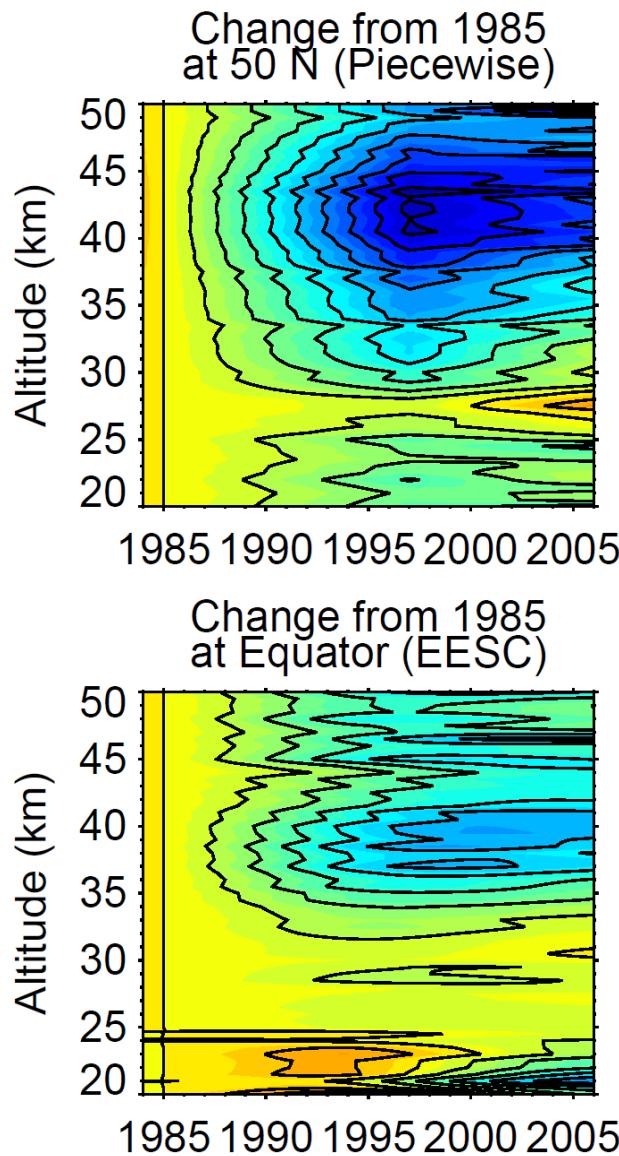
Conclusions

- 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
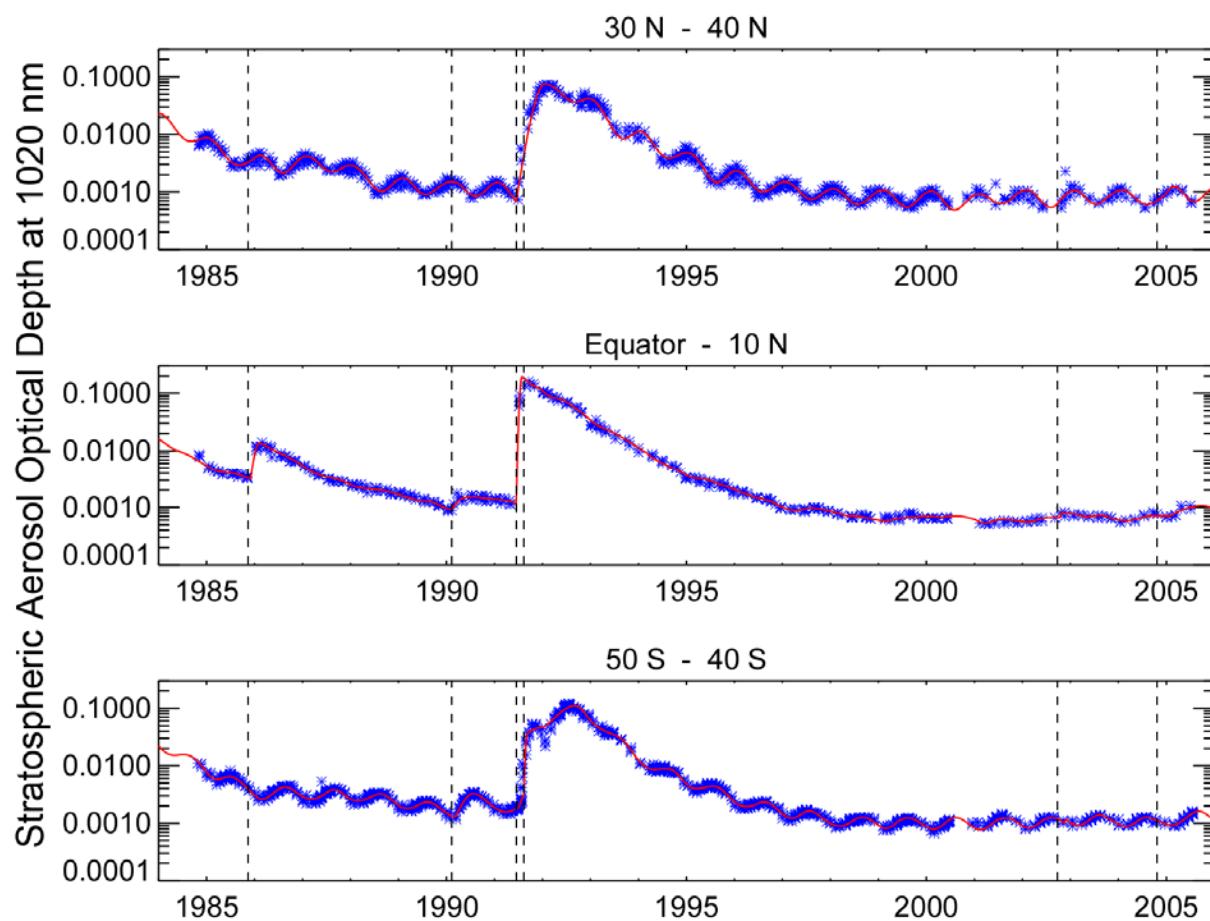
Final volcanic proxy

Result from regression

Peak Pinatubo Response