Characterizing the Dependence Structure of Space-Time Processes using Computer-Model Output and Sparse Observations

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Background: The FLAMES Project

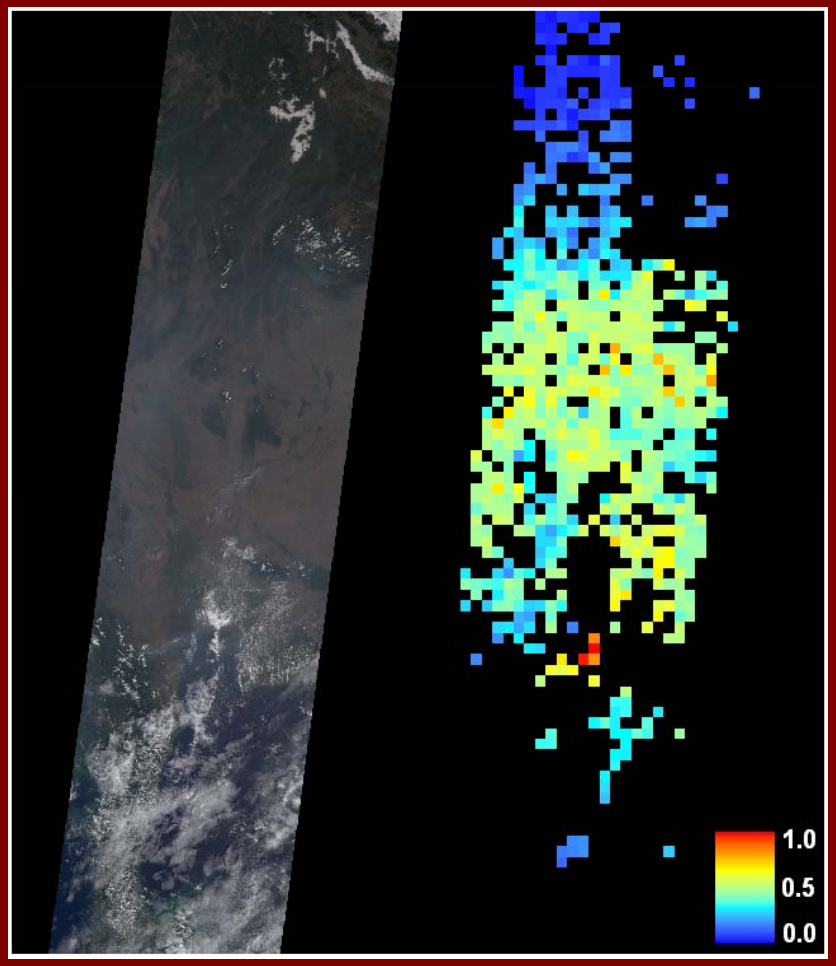
- **F**ire-**L**and-**A**tmosphere **M**odeling and **E**valuation for **S**outheast Asia
- Collaboration between researchers in Geography and Statistics Departments
- Goal is to develop a methodology to determine the contribution of biomass burning and fossil fuel combustion to the increased concentrations of carbonaceous aerosols over Southeast Asia

Background: Modeling Aerosols

Data Sources

- Remote Sensing data from two instruments on the satellites Aqua and Terra
  - MODIS product “Fire and Thermal Anomalies”
    - provides the center point of a 1km resolution pixel where a fire has occurred
  - MISR products for aerosol concentration and composition
    - provides 17.6 km resolution optical depth, size and shape of aerosols, Angstrom component and single-scattering albedo

Missing Data



- Image of MISR aerosol optical depth
- Large portion of the area measurements are missing

MOZART

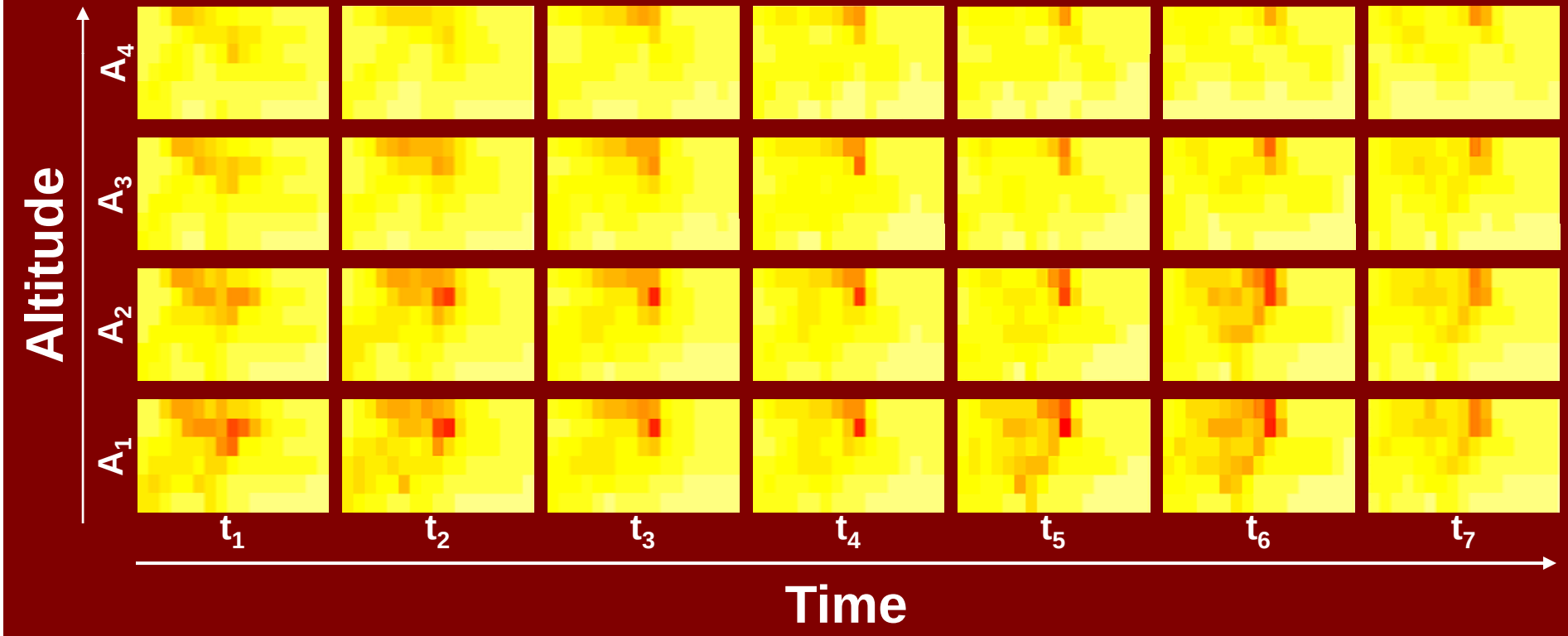
- **M**odel for **OZ**one **A**nd **R**elated chemical **T**racers
- Developed by NCAR (National Center for Atmospheric Research)
- Output from a numerical model designed to simulate the atmospheric chemical processes of the earth

MOZART Data

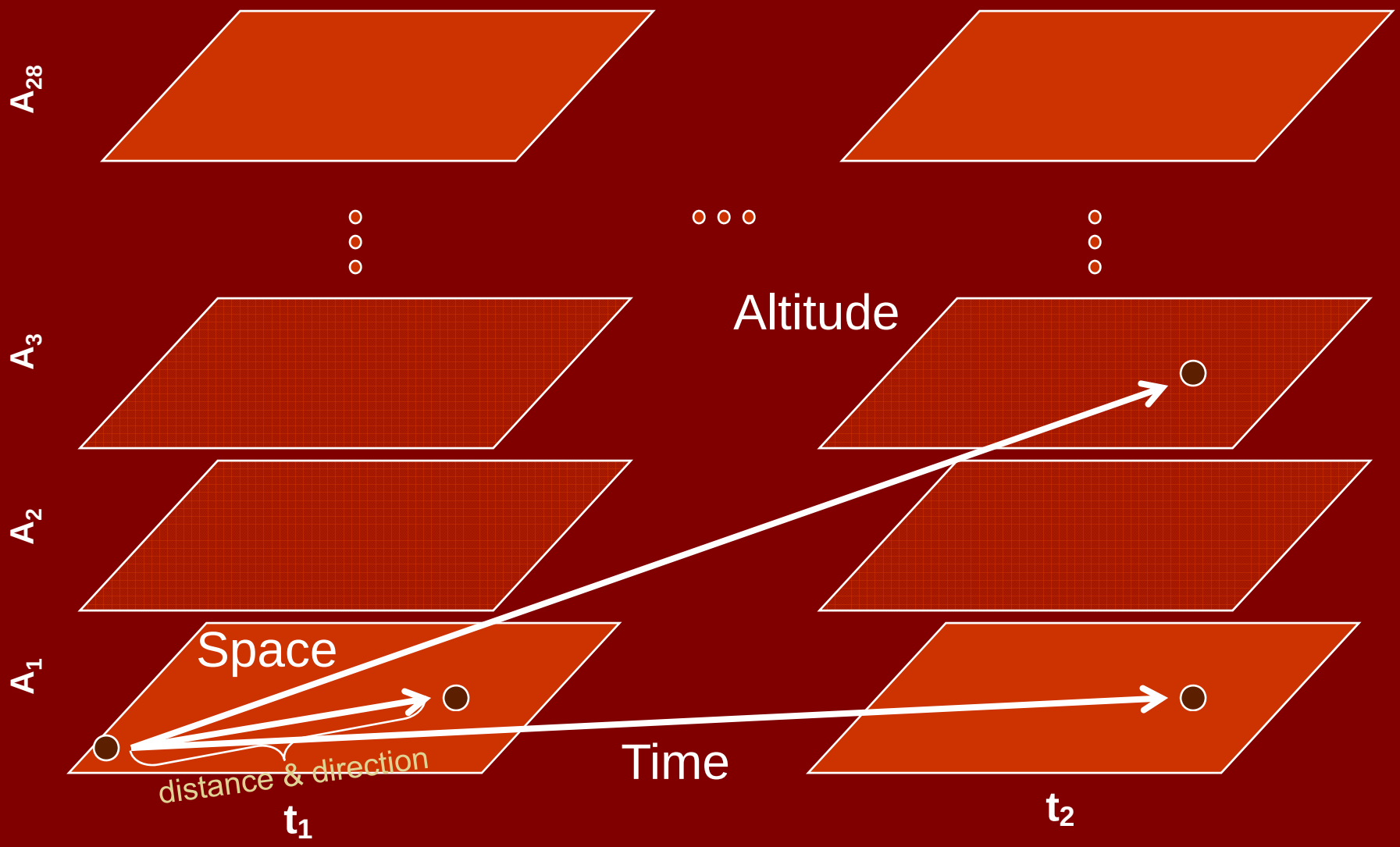
- 10 days of observed data
- 28 atmospheric pressure levels
- Provides aerosol concentrations (ppb) globally at each atmospheric pressure layer
- Use the covariance space-time structure from this aerosol process to predict aerosol optical depth in regions where the satellite is missing data

MOZART Heat Images

- 4 Dimensional Dispersion Process
  - Space (2 Dimensions)
  - Time
  - Altitude (levels of constant atmospheric pressure)



Correlation Across the Dimensions

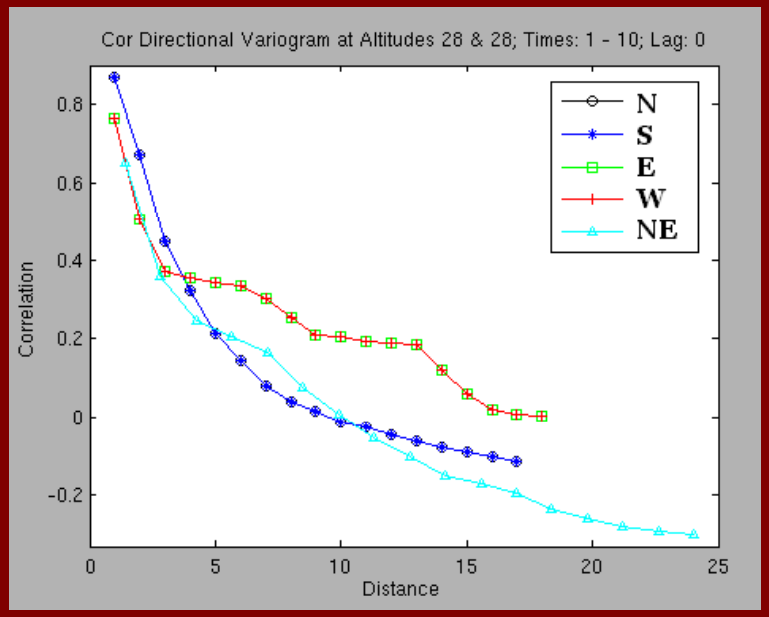


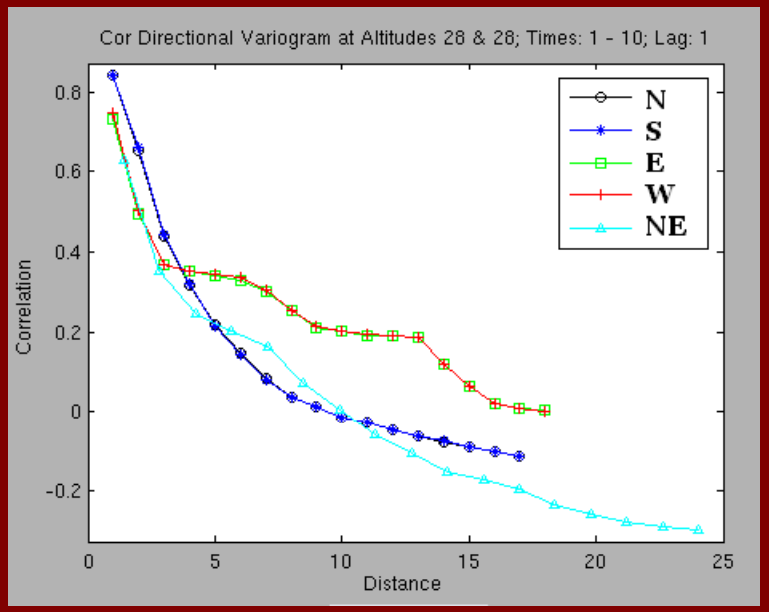
Correlograms by Time

Correlation vs. Distance

All at Lowest Altitude

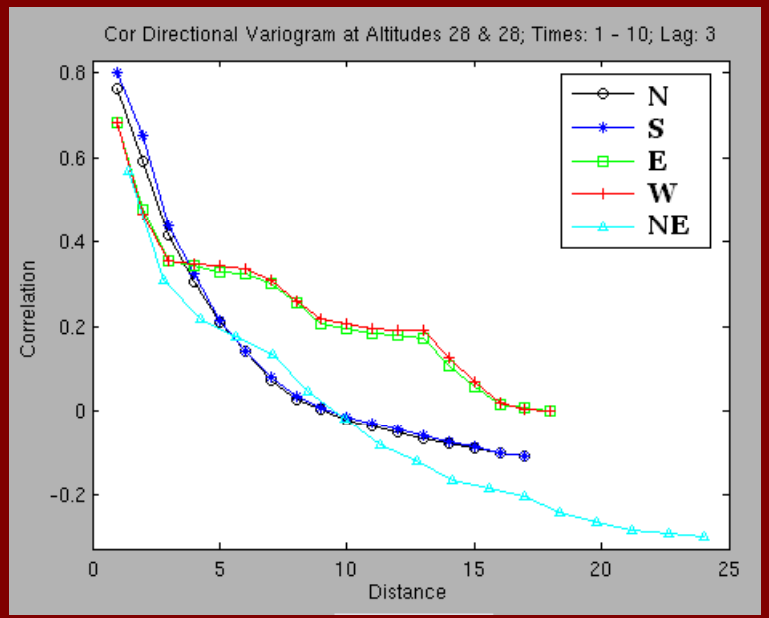
Lag 0

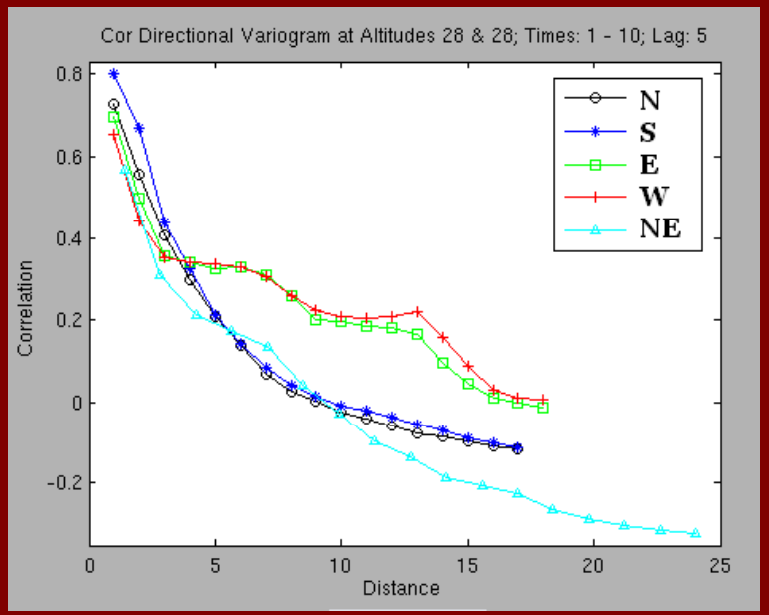




Lag 1

Lag 3





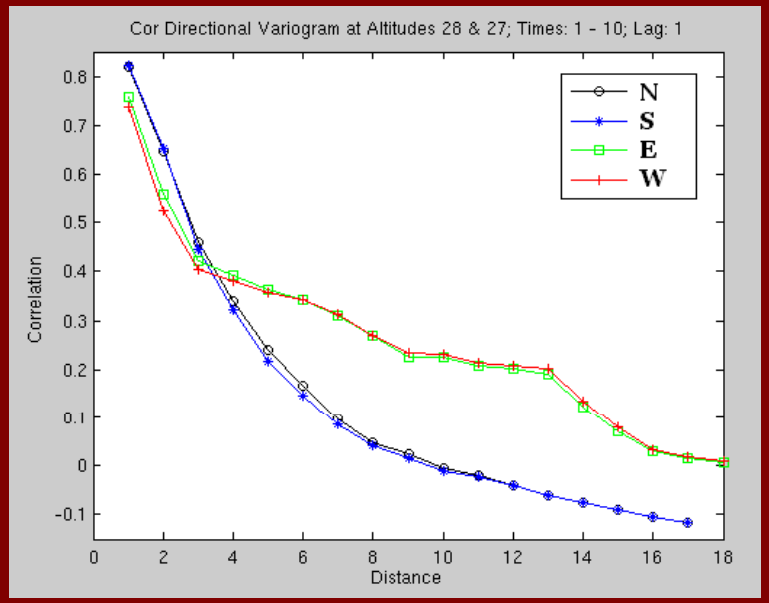
Lag 5

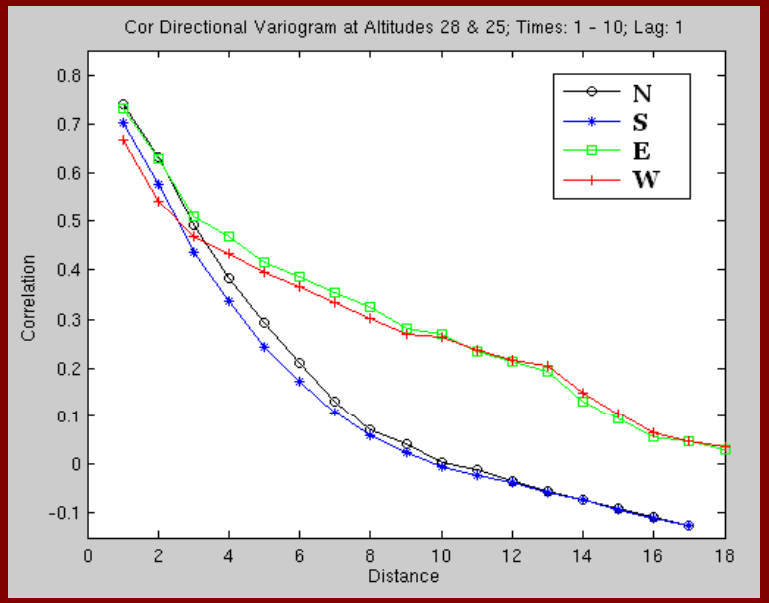
Correlograms by Pressure Level

Correlation vs. Distance

All at Lag 1

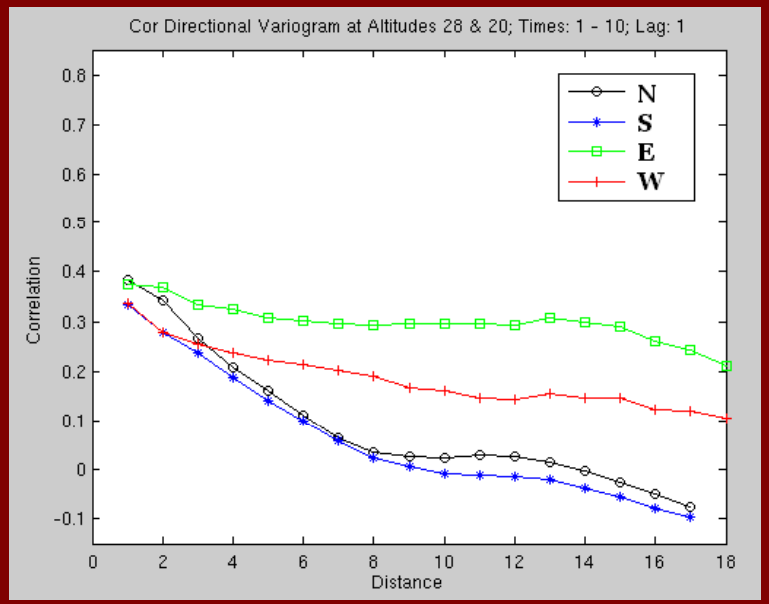
1 Altitude Higher

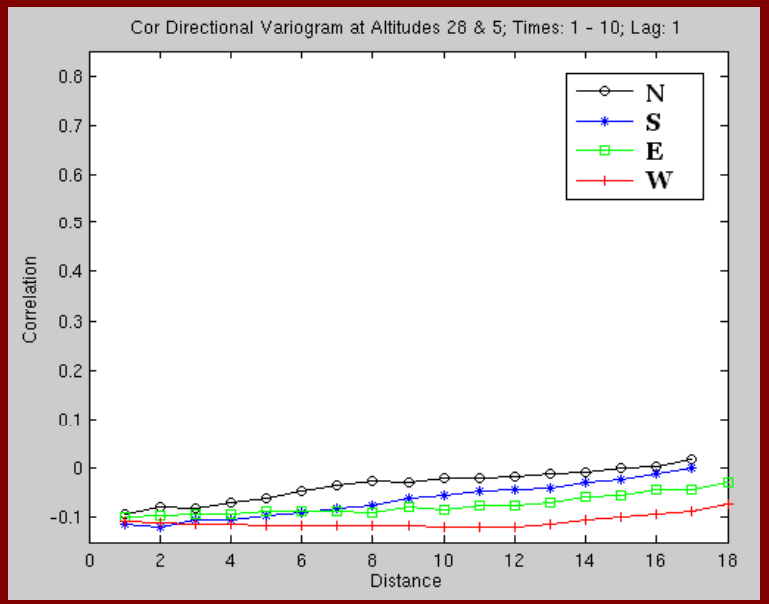




3 Altitudes Higher

8 Altitudes Higher

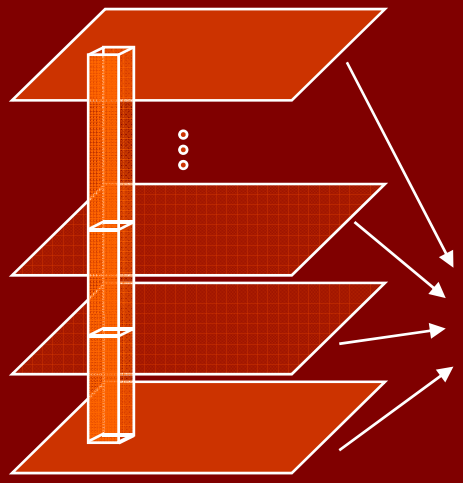


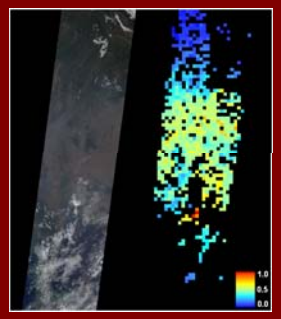


23 Altitudes Higher

Discussion

- Correlational Relationships
  - Directional differences
  - Time differences at large lags
  - Altitude differences
    - How do we combine these levels to provide information for the marginal observation of MISR?





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- WEBSITE: http://www.stat.osu.edu/~flames/

- PUBLICATIONS: Munroe, D.K., Wolfinbarger, S., Calder, C.A., Shi, T., Xiao, N., Lam, C.Q, Li, D. (2007). The relationships between biomass burning, land-cover/use change, and the distribution of carbonaceous aerosols in mainland Southeast Asia: A review and synthesis. Department of Statistics Preprint No. 793, The Ohio State University. *Under Review.*