**TESTING DIFFERENT SCENARIOS OF EMISSIONS FROM GLOBAL**

**FOSSIL FUEL PRODUCTION USING A MULTI-DECADAL RECORD OF**

**SIMULATED AND OBSERVED ETHANE DATA**

**I - Introduction**

* What is ethane? What is its contribution to the atmosphere?
  + Not a greenhouse gas but is co-emitted with methane and has similar sources.
  + React with hydroxyl radicals
* Motivations of the research:
  + Want an accurate model of ethane emission by comparing it with observed data
  + An accurate model will give a better understanding of anthropogenic fugitive emission
  + Settle the debate of competing ethane models from other works (maybe)
* What data are we using? NOAA, UCI, OGI (brief description of each)
* What simulation are we using? GEOS-Chem (brief description)
* Brief description of the different emission scenarios that we’re using

**II - Method**

1. **Simulation modeling**
2. **Global analysis**
   1. **Observed data**
      1. **Descriptions of the air archives (show map of all sites)**
      * OGI (Khalil et al. 1983)
        1. Number of sites – 6 sites
        2. Temporal and Spatial distribution
           + 1983 – 1986
           + Distributed from NH to SH
        3. Sampling frequency
           + Monthly – although full-year sample is only available from 1985 – 1986 in the NH sites and 1983 – 1986 in the SH sites
        4. Where were the samples analyzed (Khalil et al. 1983)
           + OGI laboratory
        5. How were the samples analyzed?
           + Gas chromatography techniques
      * UCI (Simpson et al. 2012)
        1. Characteristic of UCI data
           + No fixed site
           + Remote surface sample
           + Only have March, June, September and December
        2. Temporal and Spatial Distribution
           + Pacific Basin
           + Mixing ratio is from 1985 to 2008 although only complete full-year record is available in 1985, 1990, 1994, 1996-2008,
        3. Sampling frequency
           + Not very consistent, some year with weekly samples, some year with only 1 – 2 days with samples
        4. Where were the samples analyzed (Simpson et al. 2012)
           + UCI laboratory within 1 month of collection
        5. How were the samples analyzed?
           + Gas chromatography with flame ionization detection
      * NOAA (Helmig et al. 2017)
        1. Number of sites – 39 sites, “/home/excluded-from-backup/ethane/IDL/temp\_file/avail\_coordn\_all\_network.dat”
        2. Temporal and spatial distribution
           + 2006 – 2014
           + Show map
        3. Sampling frequency
           + mostly multiple times per week
        4. Where were the samples analyzed?
           + INSTAAR, Atmospheric Research Laboratory (ARL) in Boulder, Colorado
           + “The INSTAAR NMHC laboratory was audited by the World Calibration Center (WCC) for Volatile Organic Compounds in 2008. All measurement results passed the quality criteria set by the WCC.” ftp://aftp.cmdl.noaa.gov/data/trace\_gases/voc/c2h6/flask/README\_surface\_flask\_voc.html
        5. How were the sample analyzed?
           + Gas chromatography
      1. **Calculations**
      * Why dividing into latitudinal bands?
      * why such bands are chosen? To be able to include the OGI sites, and we don’t have band higher than 50S because UCI doesn’t have data higher than 50S
      * What are we going to get from this analysis? IHR
      * Why do we want the IHR? Eliminate the bias in the absolute calibration differences between different sampling networks
      * Analysis steps:
        1. Divide the observed mixing ratios into latitudinal bands (50S - 30S, 30S - 0, 0 - 30N, 30N – 50N, 50N – 75N)
        2. Deseasonalize each band
        3. Filter data
        4. Calc annual mixing ratio average of each band
        5. Calc annual mixing ratio uncertainty of each band (propagation of error from each month (Mar, June, Sep, Dec))
        6. Calc the weights for each band (Do we need to justify the way that we assign the weight for each band?)
        7. Calc the annual hemispheric mean using weighted mean
        8. Calc the uncertainty of the annual hemispheric mean
        9. Calc annual IHR
        10. Calc uncertainty of the annual IHR (propagation of error from the means)
   2. **Simulated data**

* Constructed from the output of the simulation using temporal and spatial coordinates of the observed mixing ratio.
* Calculation steps are the same as the observed data but without the uncertainty calculations.

1. **Second method to calculate IHR**

* Motivation of this method for calculating the IHR?
* Use Barrow, AK (71.3N, 156.6W) and Cape Grim, Tasmania (40.7S, 144.7E)
* Used the latitude band 38S to 46S to represent Cape Grim for the UCI network since UCI doesn’t have a Cape Grim site.
* The observed annual IHR is calculated using only 2 sites; the IHR uncertainty is also propagation of error from the annual means of each site.
* The simulated IHR is calculated is the same way using simulated mixing ratio at the Barrow and Cape Grim site (not the 38S-46S latitude band)

**III – Results**

* Plots:
  + Time series of observed global ethane mixing ratios and simulated ethane mixing ratios
  + Normalized time series of global ethane mixing ratios and simulated ethane mixing ratios
  + Time series of observed ethane mixing ratio and simulated ethane mixing ratios from the Barrow and Cape Grim sites
  + Normalized times series of global ethane mixing ratios and simulated ethane mixing ratios
* Check the plots to make sure that they have the followings:
  + Proper title
  + X-axis title
  + Y-axis title
  + Legible and accurate legend
  + Matching color in legend
  + Matching symbols
  + Correctly scaled x and y axes

**IV – Discussion**

* What did we learn?
* It is difficult to compare mixing ratio data from different records
* What does the trend show us?
* How are the trends compared to other emission models?
* Were we able to choose an emission model that fits with the observations? If so, why did we choose that model?
* Any limitation in our study?
* Sensitivity study:
  + List of sensitivity that we did:
    - Using different latitudinal boundaries to represent Cape Grim for the UCI data in the calculation for IHR that uses Cape Grim.
    - Using different latitudinal bands in the global IHR analysis
    - Sensitivity of IHR when all year observed mixing ratio is used for NOAA and OGI networks
    - Sensitivity of the simulated IHR when we use different temporal and spatial constraints in the global analysis.

**V - Conclusion**

* tie back to the introduction
* did we achieve what we set out to do?