**A-B** Interactions from G-1 data in CARES

Whereby the presence of **A** enhances the conversion of **B** VOCs to Aerosol

13 flights with SW winds, 56 transects of SAC plume from T0 to Foothills

A-B Interaction found by Setyan et al using CARES data from T1

Also by Shilling et al using G-1 data with winds from SW and NW

We are working with CARES data in ways that are the same and ways that are different.

Ari Setyan et al., Characterization of submicron particles influenced by mixed biogenic and anthropogenic emissions using high-resolution aerosol mass spectrometry: results from CARES, ACP, 2012

John Shilling et al, Enhanced SOA formation from mixed anthropogenic and biogenic emissions during the CARES campaign, ACP, 2013
Why do we need A-B interactions? Why do we care?

Why Needed?

Most models predict too little SOA and not enough modern carbon.

There are reasonable processes whereby presence of A promotes SOA formation from B.

- Effect of A on oxidant levels, including NO₃.
- Low vs. high NOₓ oxidation pathways for B VOCs.
- Effects of A acids on aerosol phase chemistry.
- Organo sulfates and nitrates from A S and N.
- A effects on aqueous phase pathways.
- Increased partitioning of B-VOC to aerosol because of A-aerosol volume.

Why Care?

Biogenic VOCs >> Anthropogenic VOCs
A way for anthropogenic aerosols to have a disproportionate influence on climate.
What is **A** and What is **B**?

**A** is a tracer of Anthropogenic emissions
It’s source should be co-located with **A VOCs** that form **A SOA**
CO is a good choice. Long lifetime. Used to normalize for dilution

**B** is a tracer of Biogenic emissions
It’s source should be co-located with **B VOCs** that form **B SOA**
$^{14}$C in an aerosol would be a great choice – but ~ 2 hours for sample
We are stuck with what we can measure:
- Isoprene, MVK+MACR, terpenes (often below LOD)
We used MVK+MACR

- Lifetime ~ 4 hours at OH = 3$x10^6$
  Barely adequate to address SOA formation between T0 and T1
What Was Found in CARES?

• SOA increase with A
• SOA increases slightly with B
• SOA increase a lot when both A and B are present i.e., synergism

(Shilling et al 2013)                                      (Setyan et al 2012)

Arrows indicate the increase in SOA at ~ constant A, due to increasing B
Three Methods to Look for $A$-$B$ Interactions

1. On each transect, correlation of OA with CO, MVK+MACR, isoprene, $O_3$, $A \times B$, Bi-linear models i.e. OA vs. CO & MVK+MACR
   Correlations between explanatory variables i.e., CO vs. MVK+MACR

2. Define plume perturbations on a transect: $90^{\text{th}}\% - 10^{\text{th}}\% = \Delta OA, \Delta CO$, etc
   Correlations amongst $\Delta$’s on 56 transects

3. Parse transect $\Delta$’s into subsets with high $\Delta CO$ and quartiles of $\Delta$MVK+MACR
$R^2$ for 4 Regressions on T1 Transect

**Method 1**

A and B explanatory variables can be highly correlated (gray symbols)

$r$ (OA vs. MVK+MACR) $\sim r$ (CO vs. MVK+MACR)

The bivariate correlation of OA with MVK+MACR is usually spurious
Transect over T1 on flight 628a

Almost perfect correlation between OA, CO, and O₃
No correlation between OA and MVK+MACR
A and B variables independent

Plumes have long auto-correlation distances
Most statistical tests are useless.
Relations amongst transects for Δvariables

Method 2

(a) Delta OA vs Delta CO

(b) Delta OA vs Delta MVK+MACR

(c) Delta OA vs Delta Ozone

(d) Delta CO vs Delta MVK+MACR
Relations amongst transects for $\Delta$ variables

**Method 2**

(a) $R^2 = 0.69$

(b) $R^2 = 0.15$

(c) $R^2 = 0.88$

(d) $R^2 = 0.06$
Effect of Biogenics on High CO Transects

Method 3

Graph shows averages and inter-quartiles ranges for 4 levels of ∆MVK+MACR

- OA increases with MVK+MACR (and O₃), CO ~ Constant
- At low CO, only trend of OA is with O₃
- This satisfies requirement for an A-B effect
- But previous graph showed that the trends come from data with almost no correlation
Thank you

Impressionist

Post Impressionist

Actual Atmospheric Data from Igor

Abstract

Abstract Expressionism