



Trace Gases in Whole Air Samples Collected on the DC-8 for INTEX-NA

Donald R. Blake (PI), Nicola J. Blake, Simone Meinardi, Angela Young, Andreas Beyersdorf, Lambert A. Doezema, Brian Novak, Barbara Barletta, Jason Midyett, Michael A Kamboures, Henry Fuelberg (and team), Stephanie Vay, Melody Avery....and the rest of the INTEX Science Team



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Analysis by GC/ECD/FID/MS at UC-Irvine



Main NMHC/CFC/AN System - 2936 samples

Analysis by GC/ECD/FID/MS at UC-Irvine



Main NMHC/CFC/AN System - 2936 samples



CH₄ System - 2263 samples

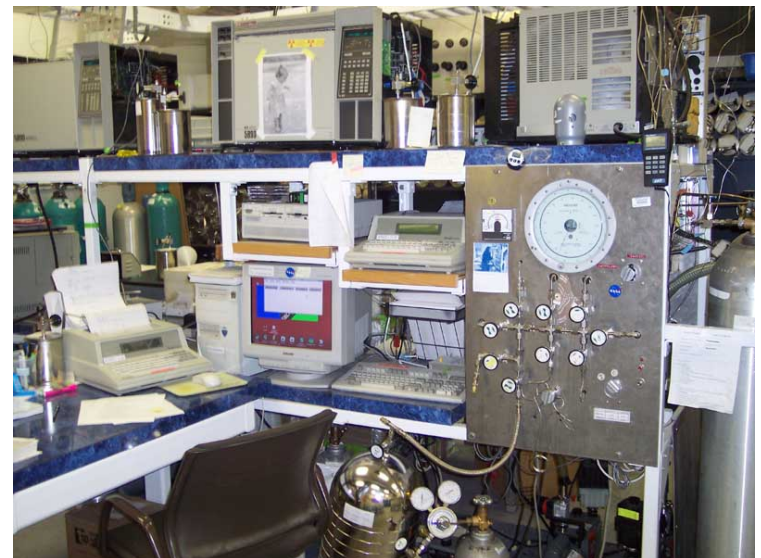
Analysis by GC/ECD/FID/MS at UC-Irvine



Main NMHC/CFC/AN System - 2936 samples

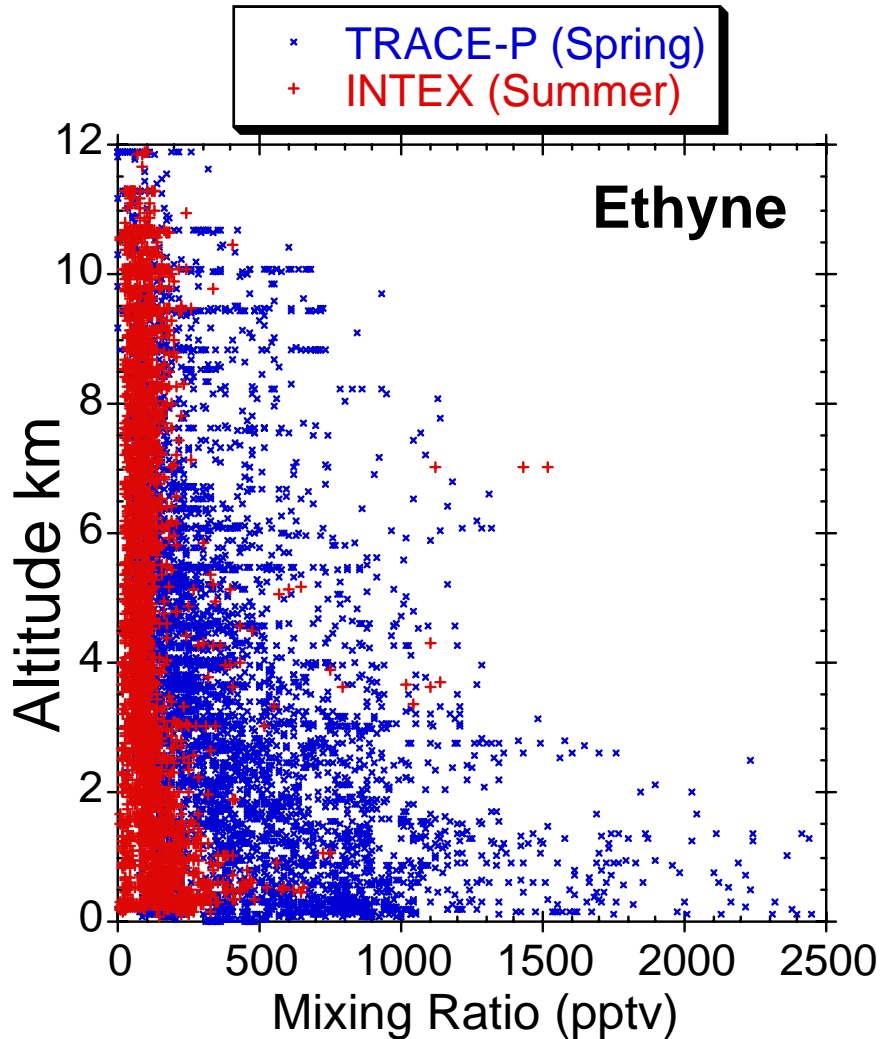


CH₄ System - 2263 samples



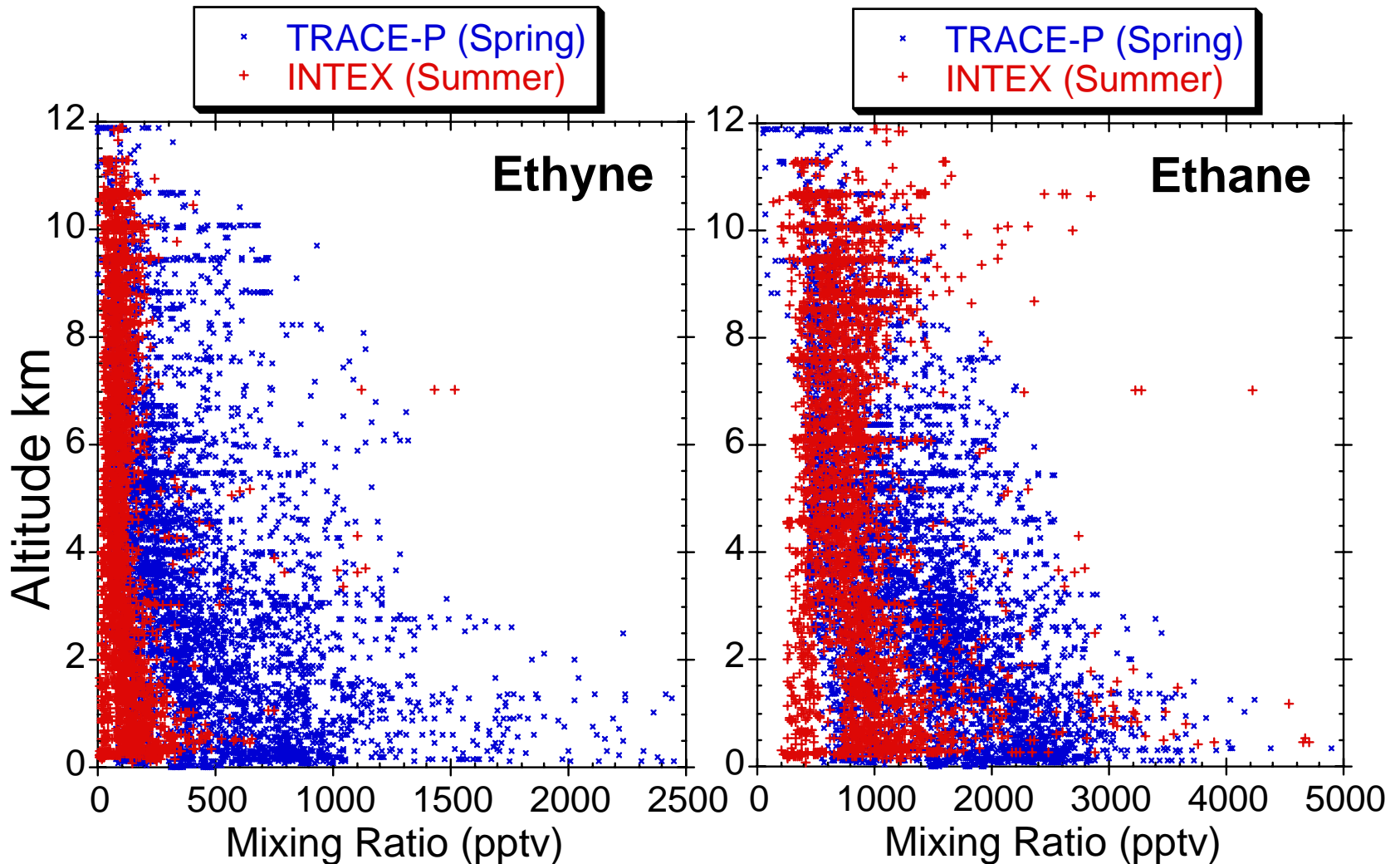
CO System - 586 samples

Comparison of TRACE-P and INTEX



Expect lower summer levels (OH consumption) - as see for ethyne

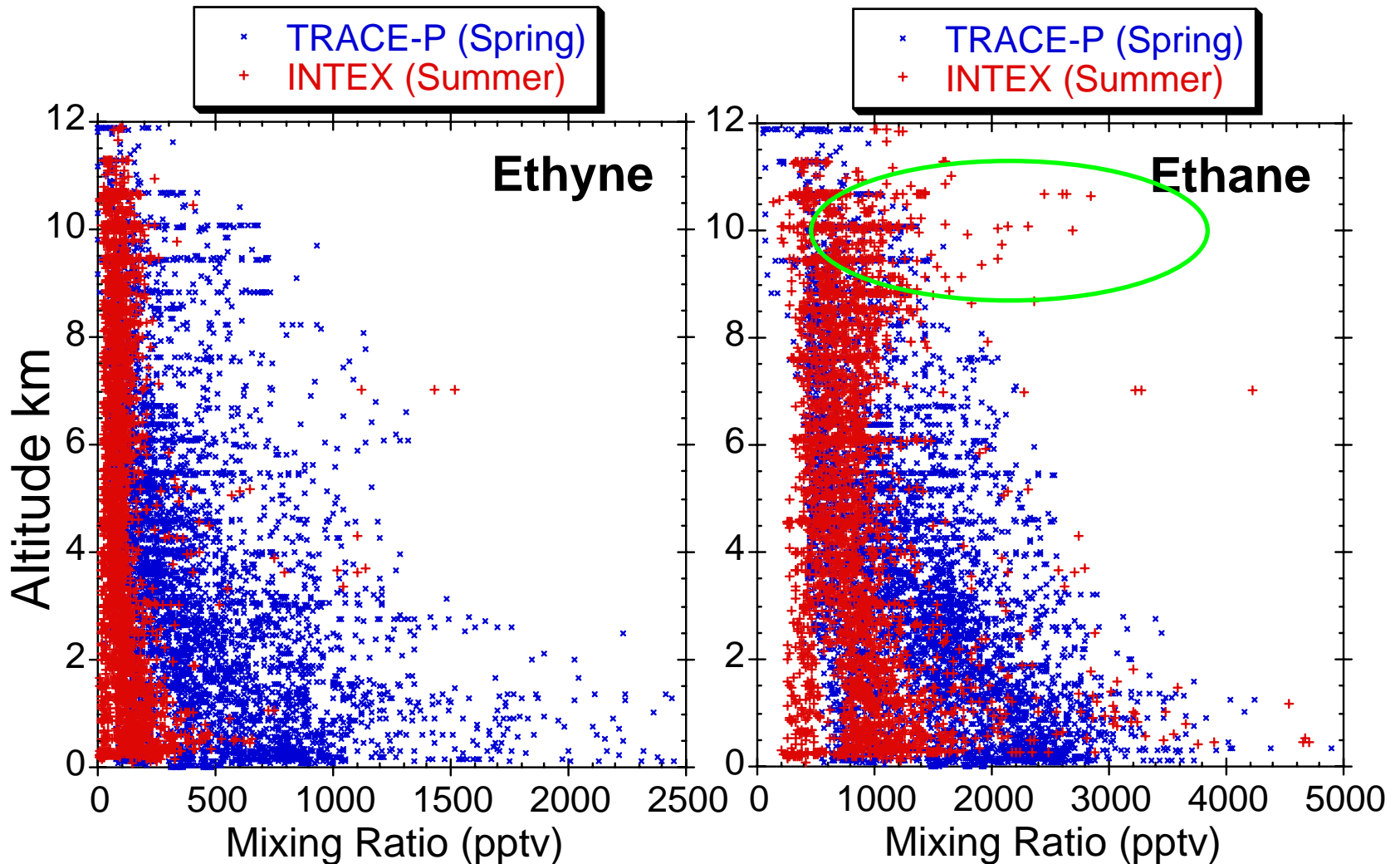
Comparison of TRACE-P and INTEX



Expect lower summer levels (OH consumption) - as see for ethyne

- **But** - relatively more ethane for INTEX
(Less combustion/compared to alkane sources?)

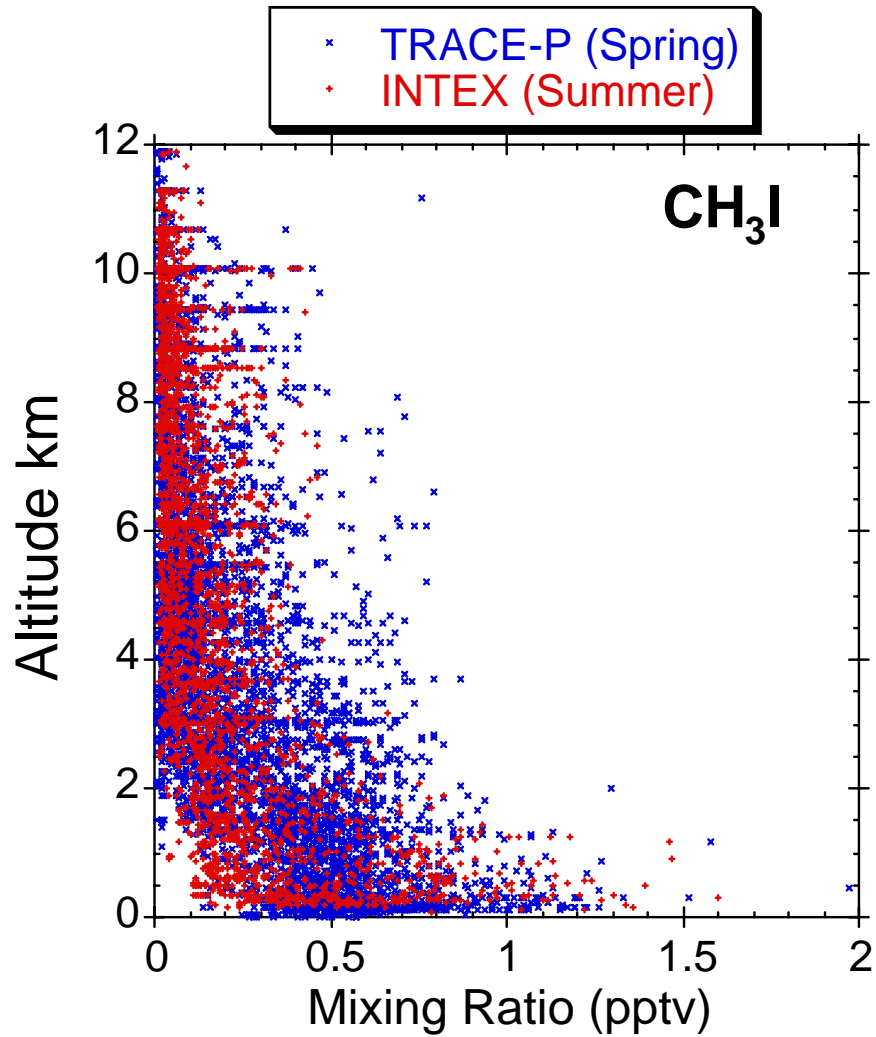
Comparison of TRACE-P and INTEX



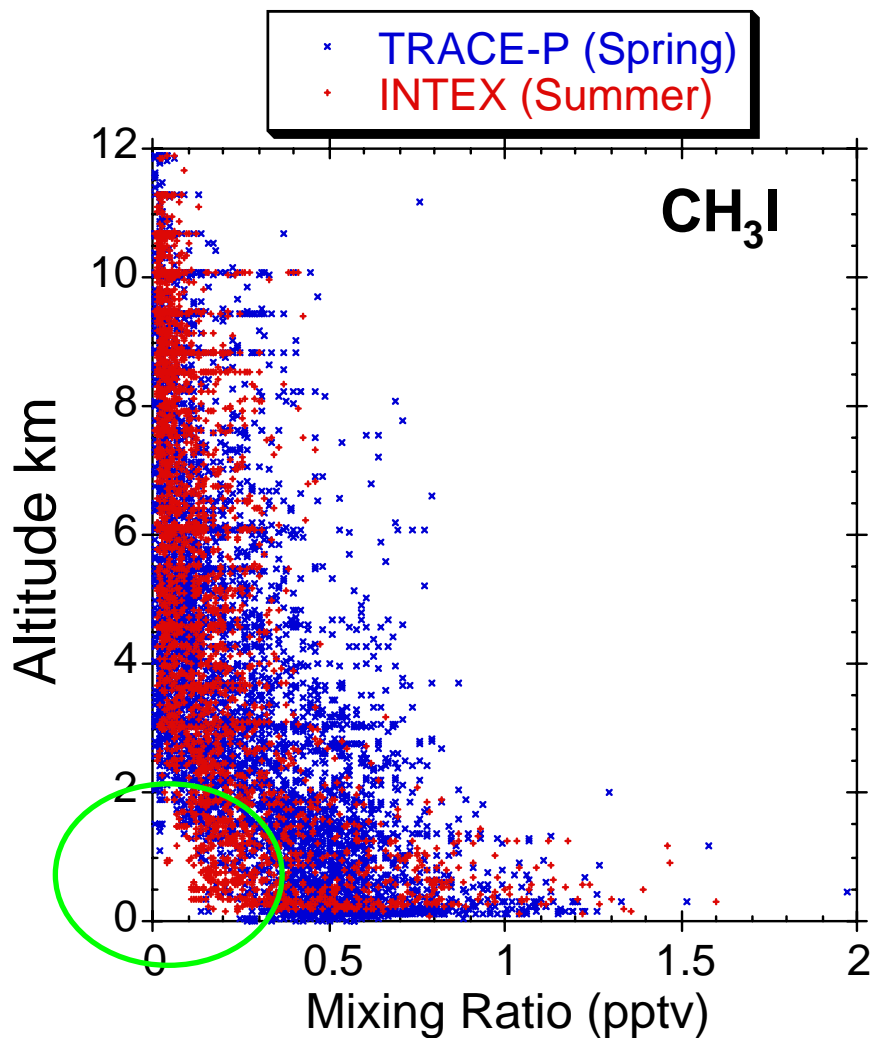
Expect lower summer levels (OH consumption) - as see for ethyne

- **But** - relatively more ethane for INTEX
(Less combustion/compared to alkane sources?)
- **Also** - INTEX ethane “pumped up”!

Comparison of TRACE-P and INTEX

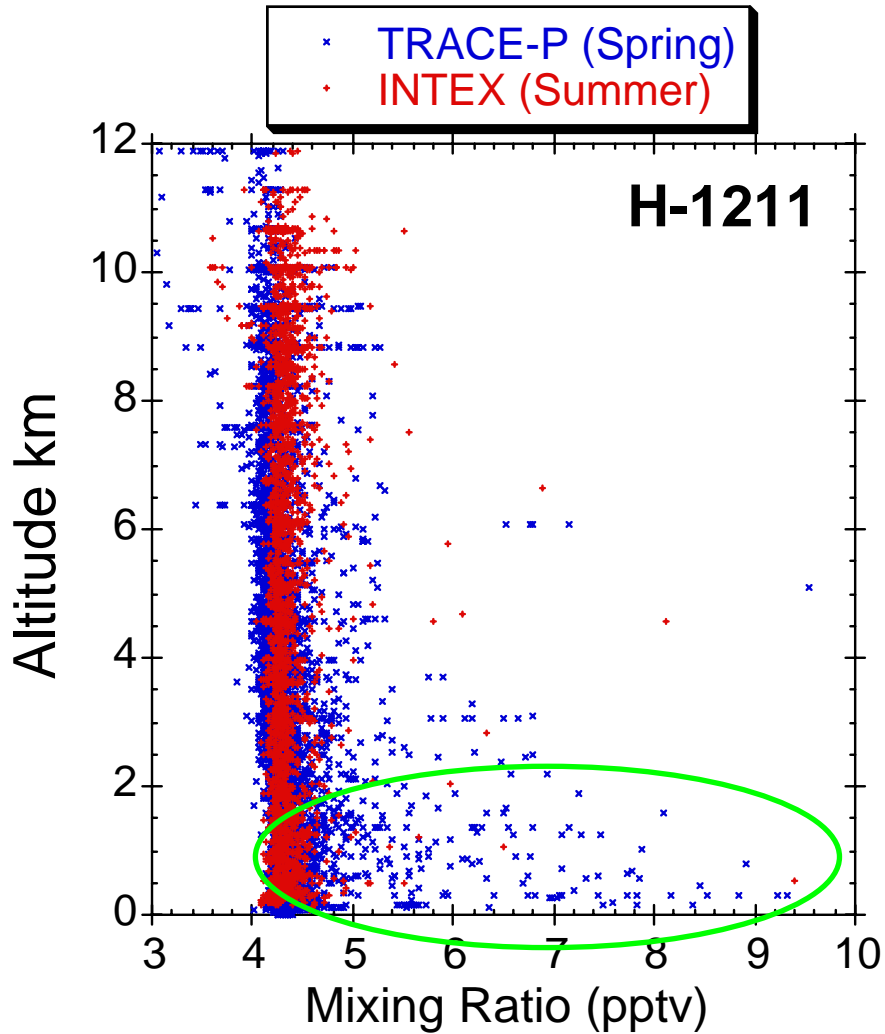


Comparison of TRACE-P and INTEX



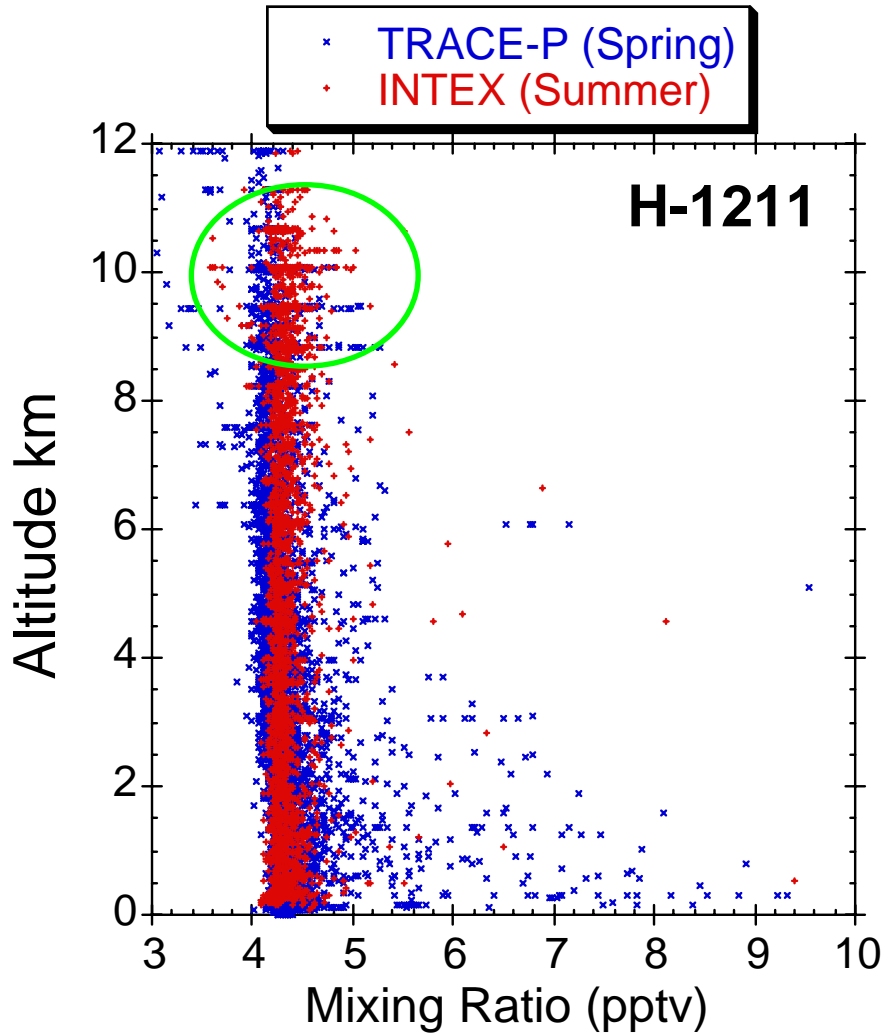
Surprisingly high levels over the
continent during INTEX
- terrestrial as well as ocean sources?

Comparison of TRACE-P and INTEX



- Fewer low alt plumes than TRACE-P

Comparison of TRACE-P and INTEX

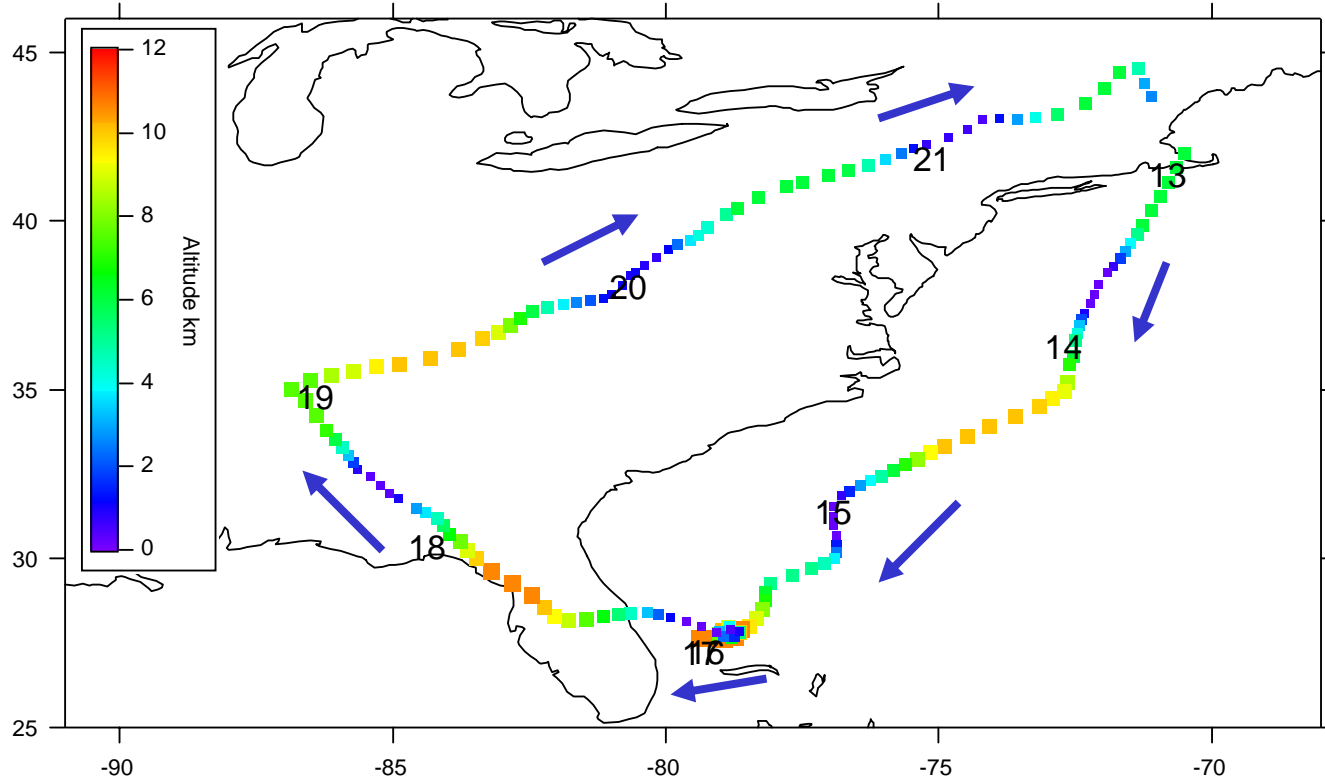


- Fewer low alt plumes than TRACE-P
- High altitude enhancement during INTEX
-> long range transport from Asia??

Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)

Flight Track with Color-coded Altitude

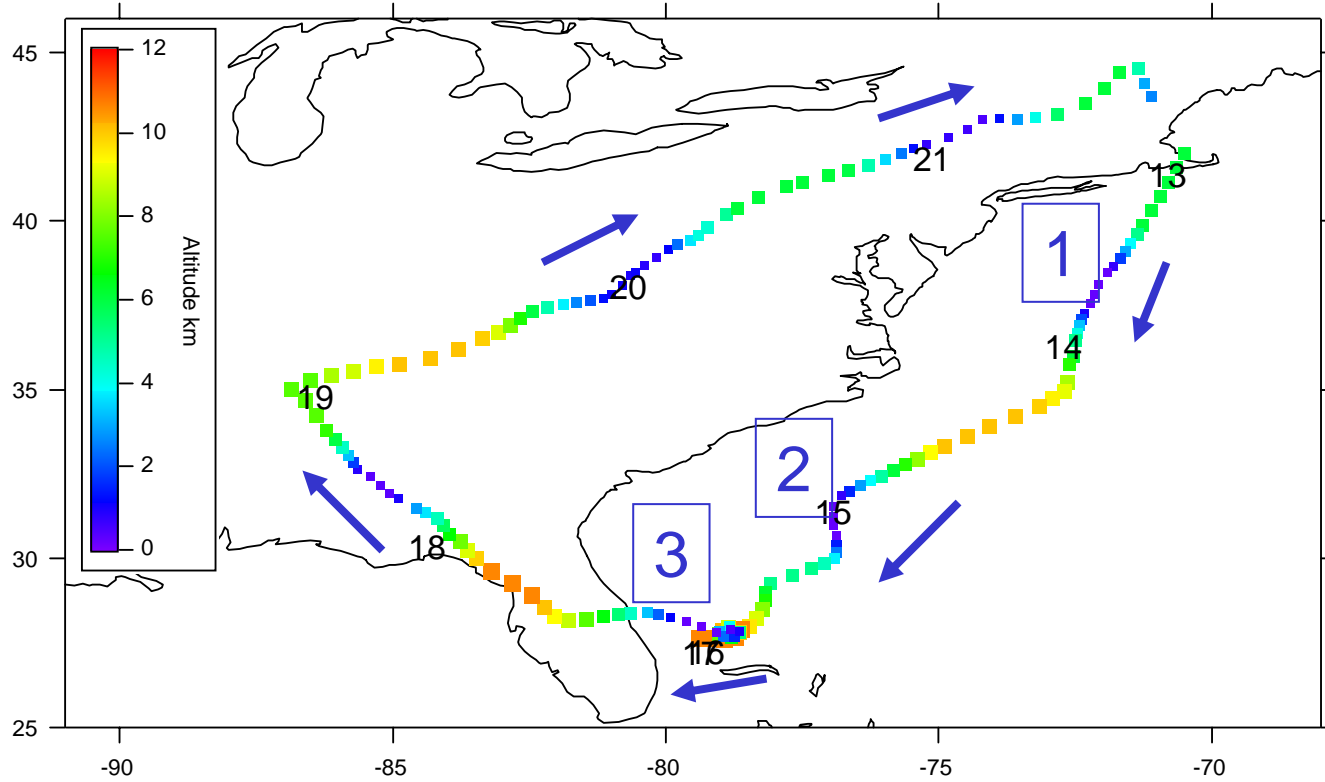


Smaller blue squares correspond to the 6 BL runs

Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
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Flight Track with Color-coded Altitude



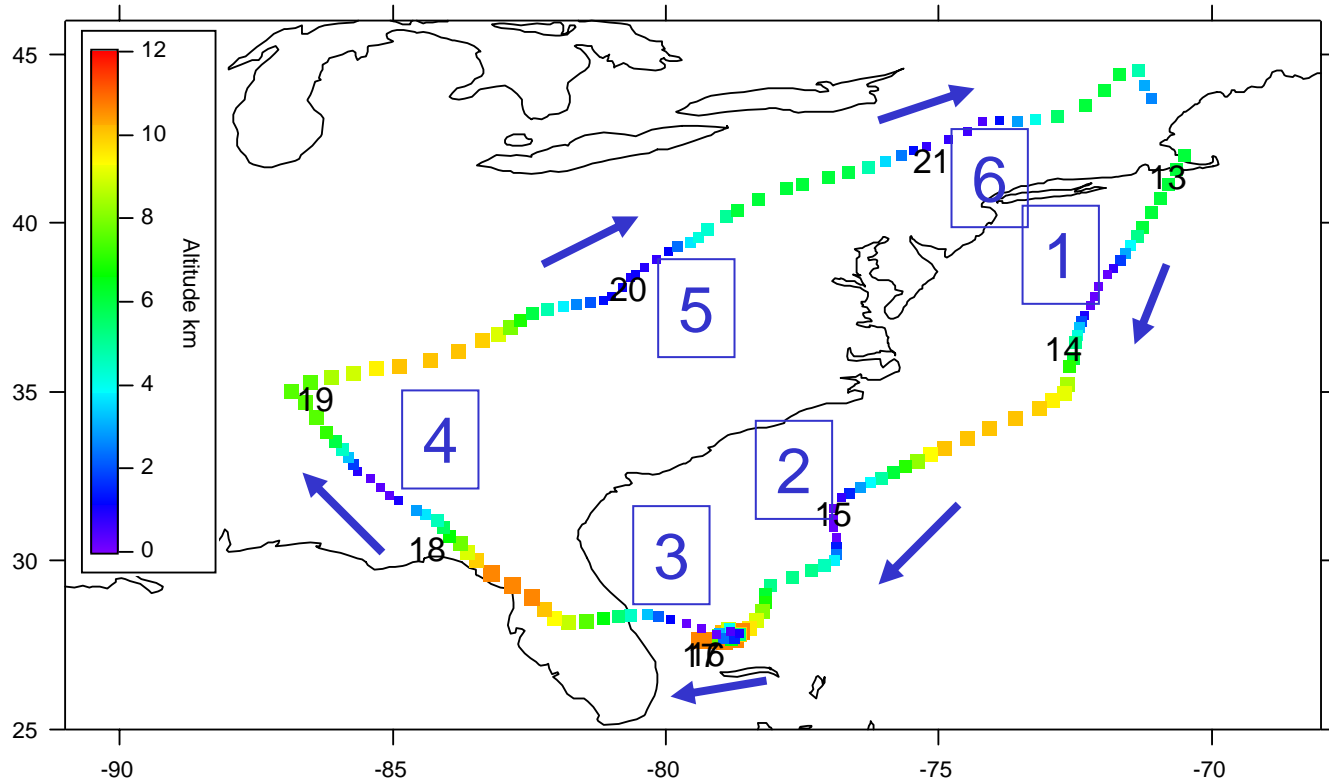
Smaller blue squares correspond to the 6 BL runs

- First 3 over Atlantic

Contrast between Ocean and Land BL Data

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Flight Track with Color-coded Altitude

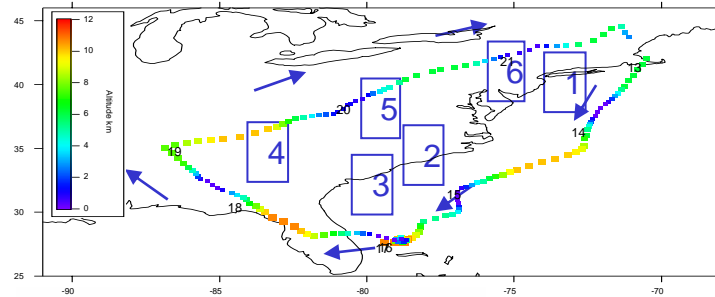


Smaller blue squares correspond to the 6 BL runs

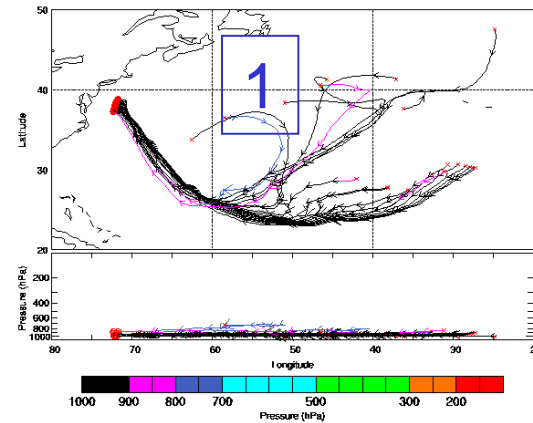
- First 3 over Atlantic
- Last 3 over Land

Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)

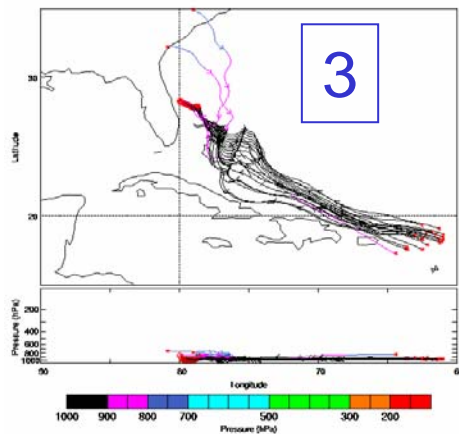


INTEX-NA 1-MINUTE TRAJECTORIES - FSU METEOROLOGY
10 DAYS BACK FROM FLIGHT ON 25 JUL 2004
INITIATED AT FLIGHT LEVEL FOR FLIGHT LEG 7



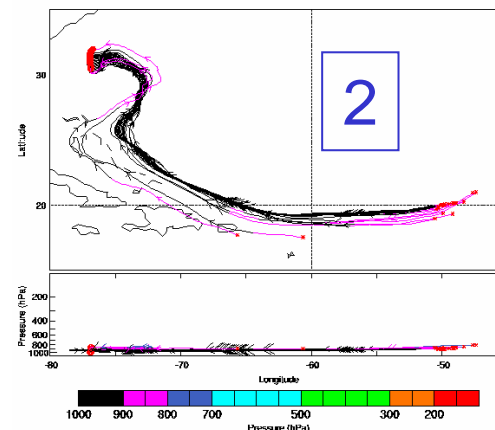
INTEX-NA 1-MINUTE TRAJECTORIES - FSU METEOROLOGY

05 DAYS BACK FROM FLIGHT ON 25 JUL 2004
INITIATED AT FLIGHT LEVEL FOR FLIGHT LEG 23



INTEX-NA 1-MINUTE TRAJECTORIES - FSU METEOROLOGY

07 DAYS BACK FROM FLIGHT ON 25 JUL 2004
INITIATED AT FLIGHT LEVEL FOR FLIGHT LEG 15

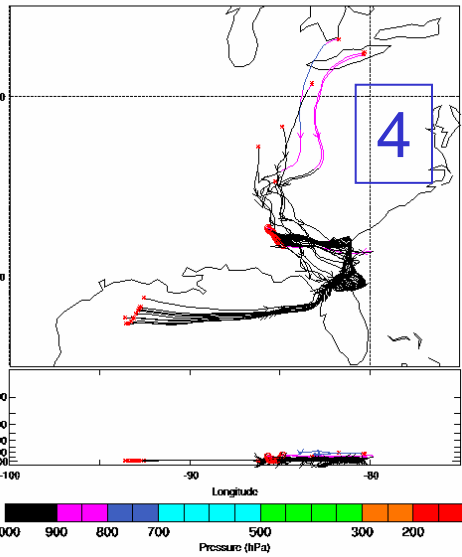


Contrast between Ocean and Land BL Data

INTEX-NA Flight 12 July 25, 2004 (4th Pease Local)

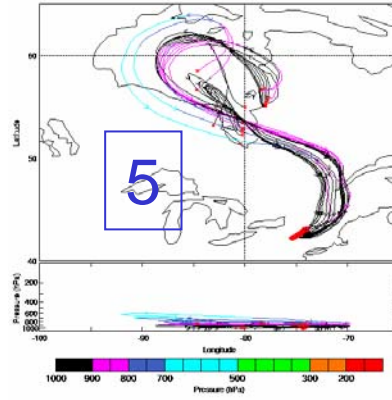
INTEX-NA 1-MINUTE TRAJECTORIES - FSU METEOROLOGY

07 DAYS BACK FROM FLIGHT ON 25 JUL 2004
INITIATED AT FLIGHT LEVEL FOR FLIGHT LEG 31



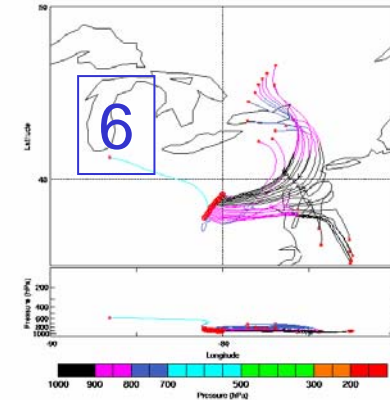
INTEX-NA 1-MINUTE TRAJECTORIES - FSU METEOROLOGY

05 DAYS BACK FROM FLIGHT ON 25 JUL 2004
INITIATED AT FLIGHT LEVEL FOR FLIGHT LEG 45



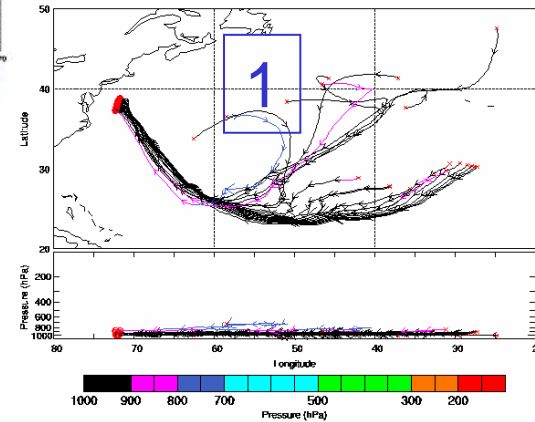
INTEX-NA 1-MINUTE TRAJECTORIES - FSU METEOROLOGY

02 DAYS BACK FROM FLIGHT ON 25 JUL 2004
INITIATED AT FLIGHT LEVEL FOR FLIGHT LEG 39



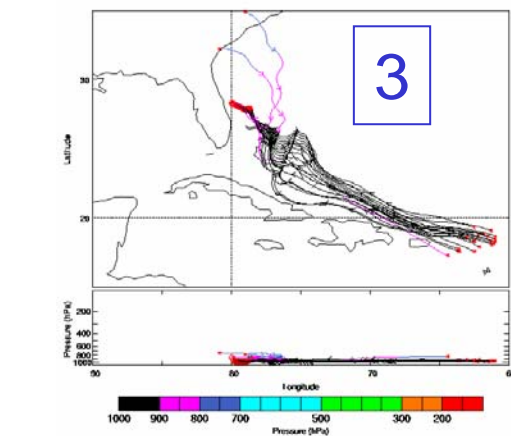
INTEX-NA 1-MINUTE TRAJECTORIES - FSU METEOROLOGY

10 DAYS BACK FROM FLIGHT ON 25 JUL 2004
INITIATED AT FLIGHT LEVEL FOR FLIGHT LEG 7



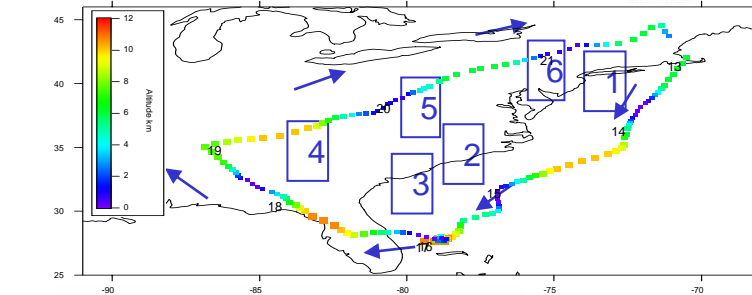
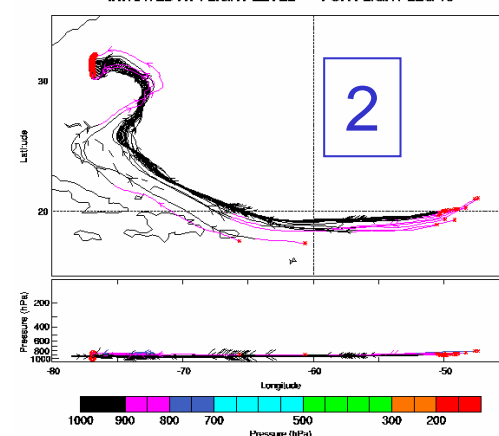
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INITIATED AT FLIGHT LEVEL FOR FLIGHT LEG 23



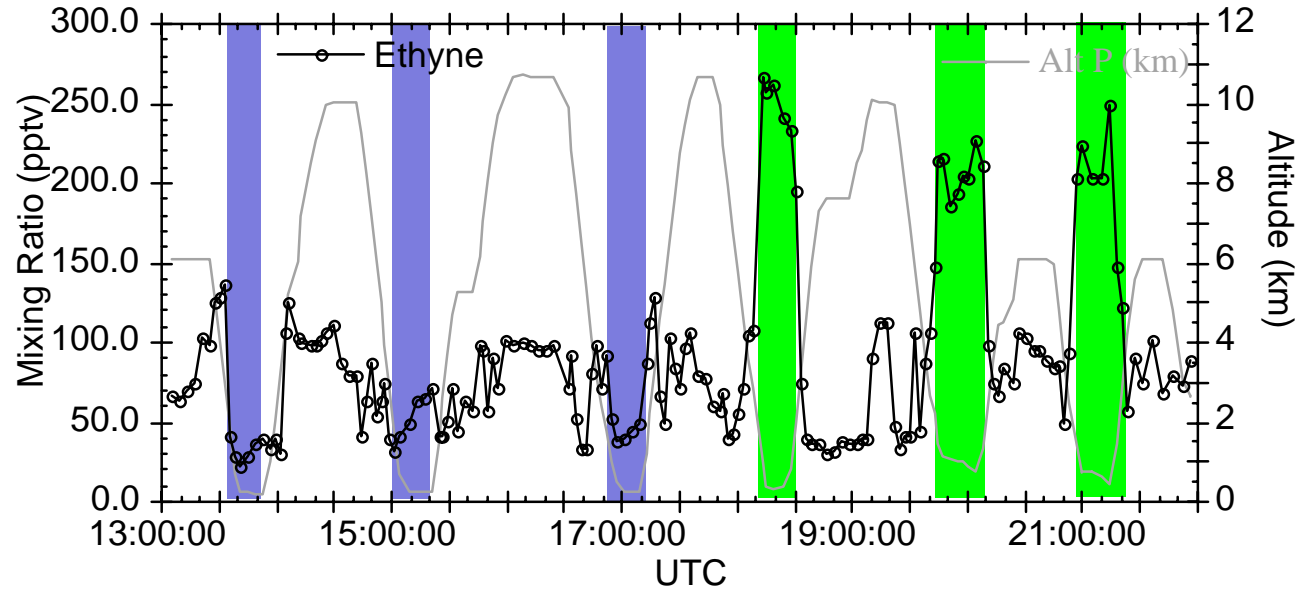
INTEX-NA 1-MINUTE TRAJECTORIES - FSU METEOROLOGY

07 DAYS BACK FROM FLIGHT ON 25 JUL 2004
INITIATED AT FLIGHT LEVEL FOR FLIGHT LEG 15



Contrast between Ocean and Land BL Data

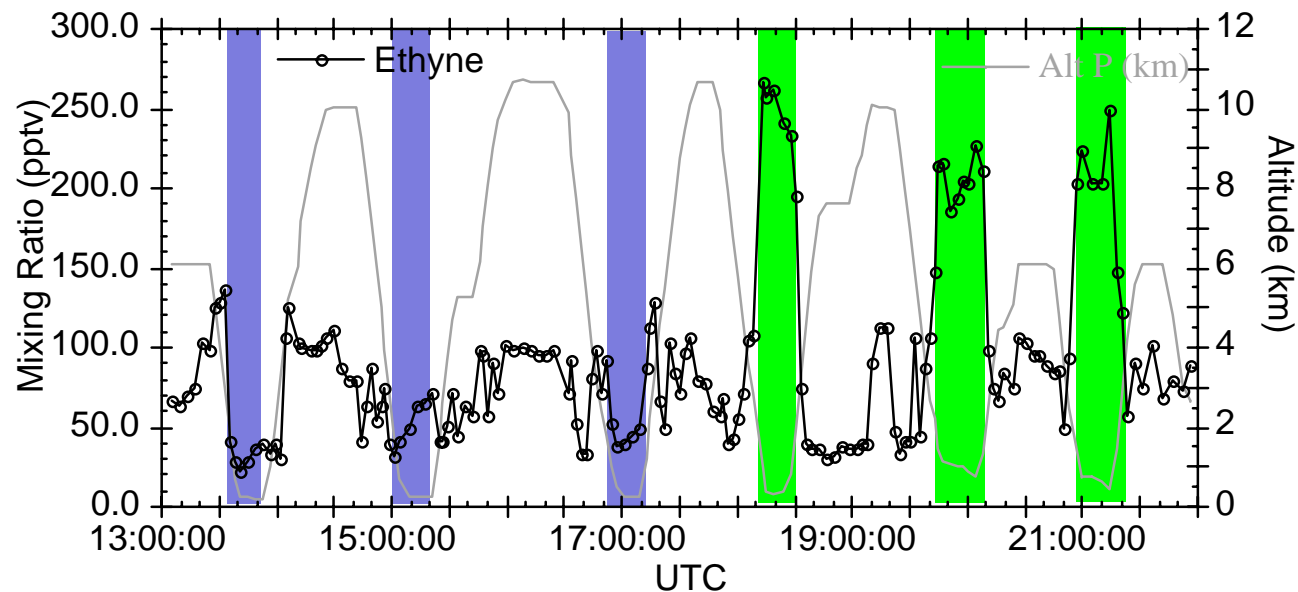
INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)



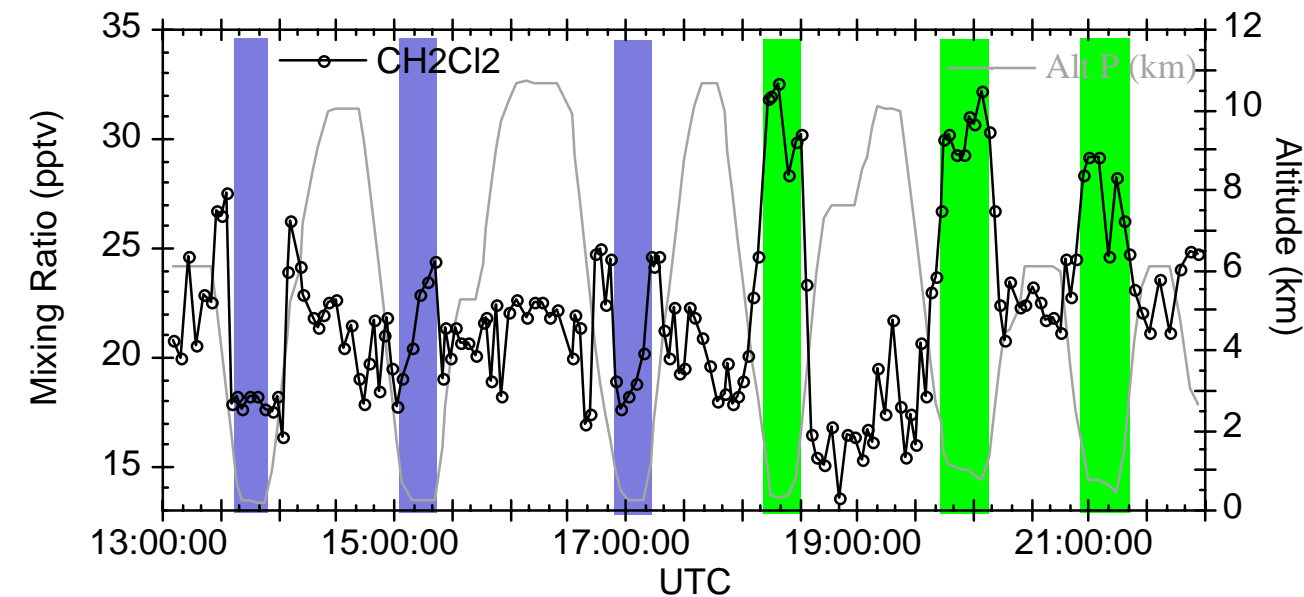
Tracers: Combustion
(ethyne)

Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)

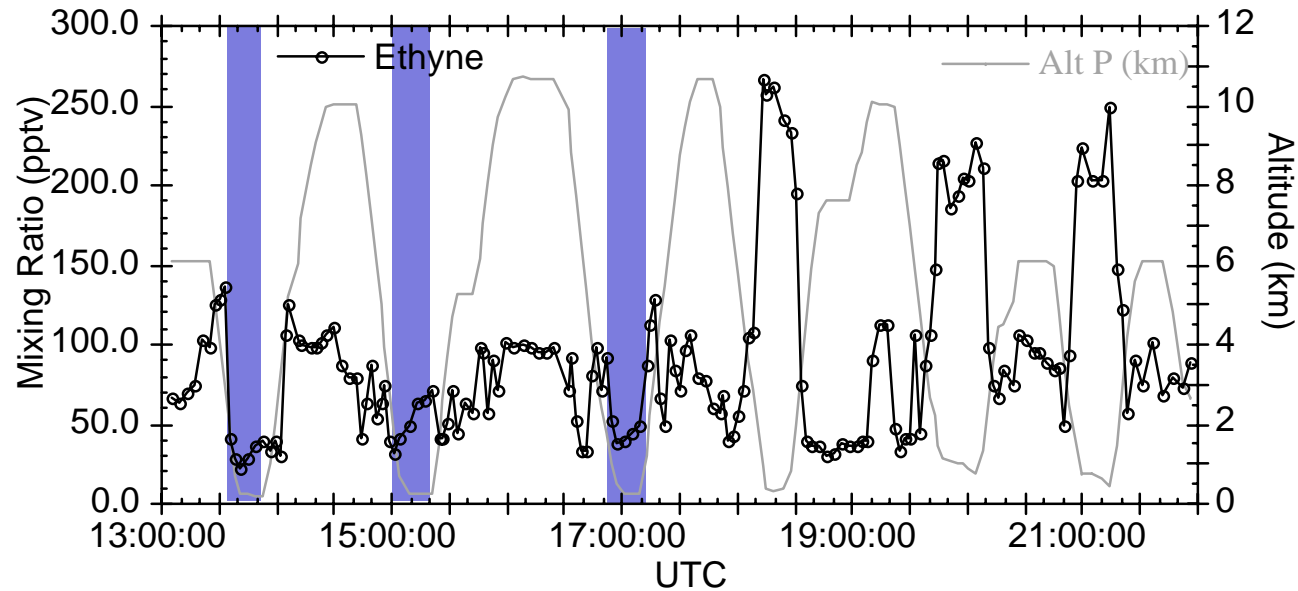


Tracers: Combustion
(ethyne)
& industrial
(CH₂Cl₂)



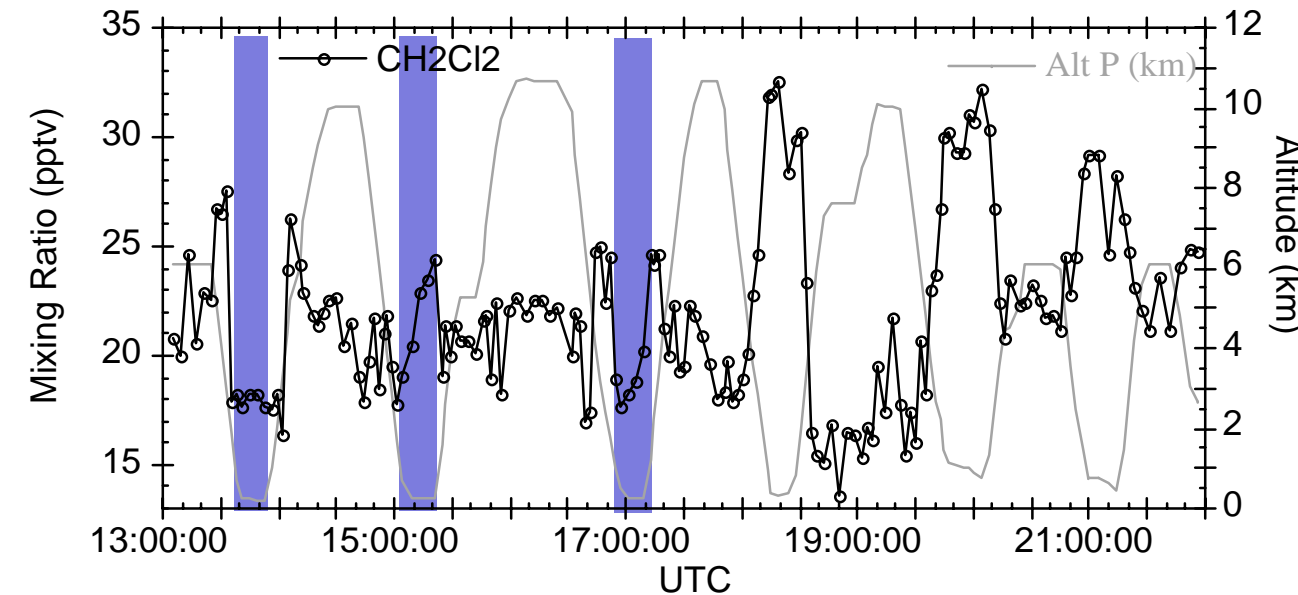
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July 25, 2004 (4th Pease Local)



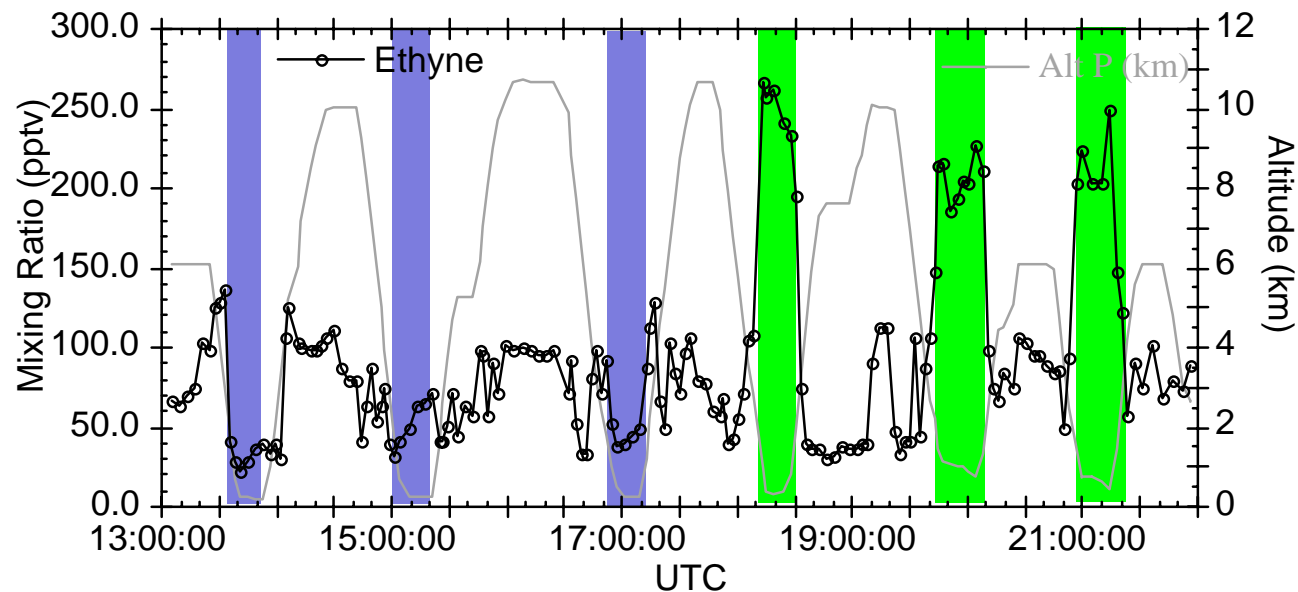
Tracers: Combustion
(ethyne)
& industrial
(CH₂Cl₂)

- clean MBL



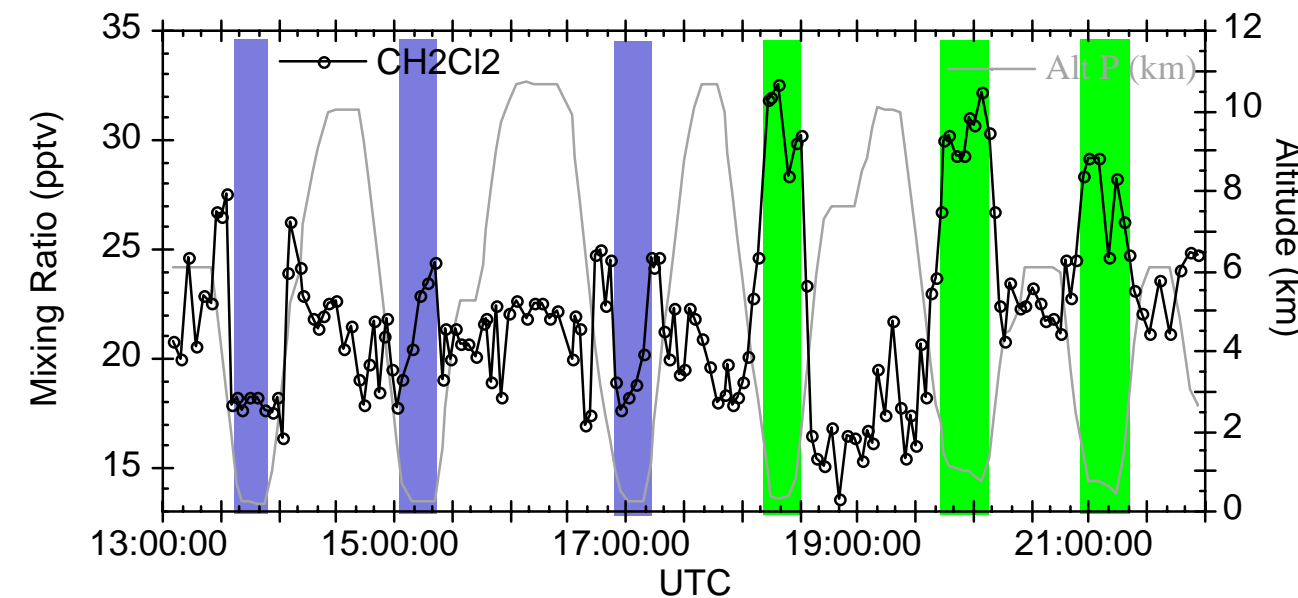
Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)



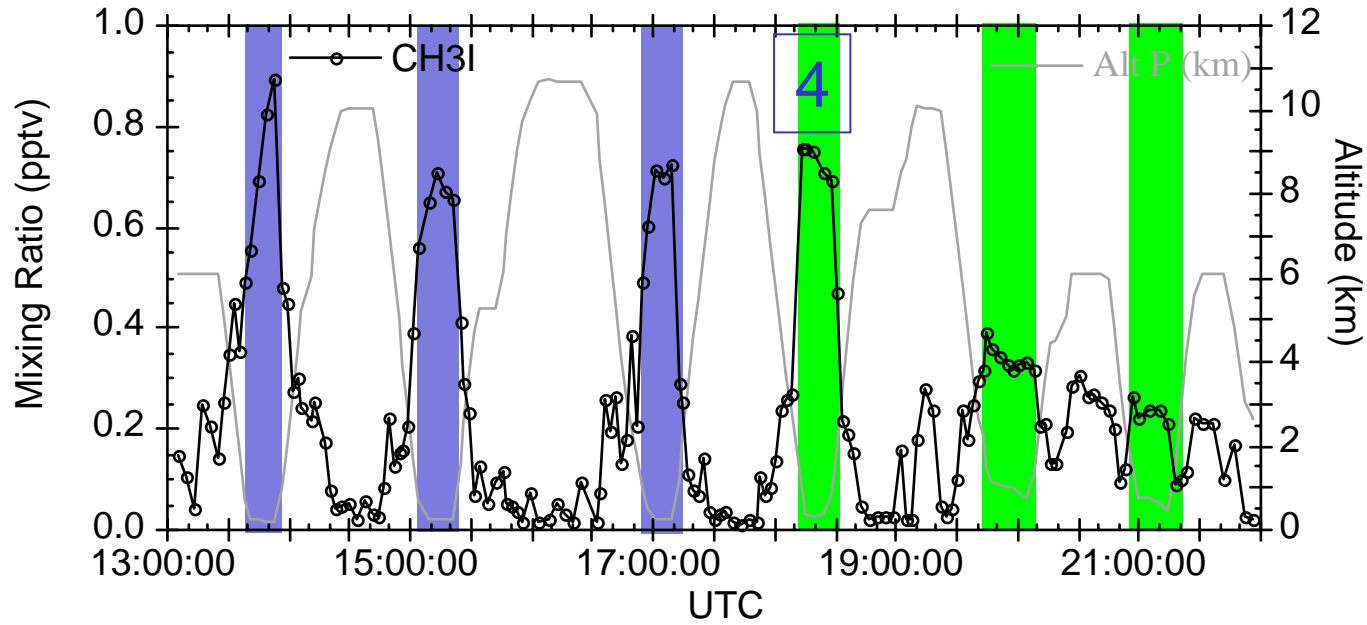
Tracers: Combustion
(ethyne)
& industrial
(CH₂Cl₂)

- clean MBL
- similar enhancements in the polluted CBL



Contrast between Ocean and Land BL Data

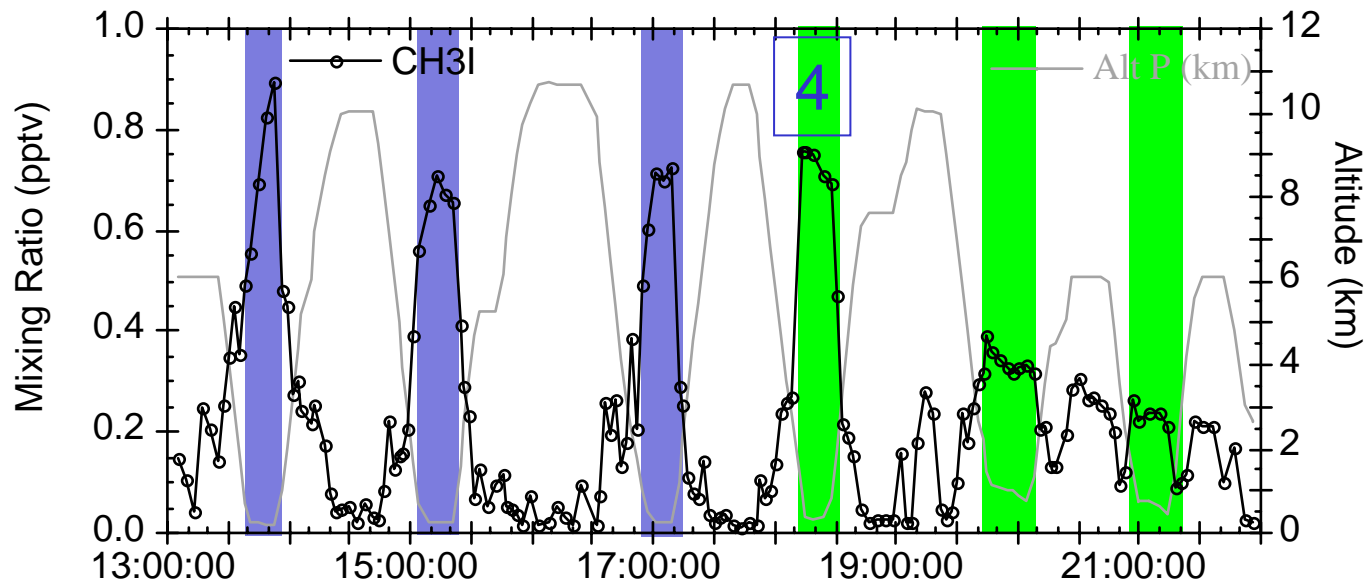
INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)



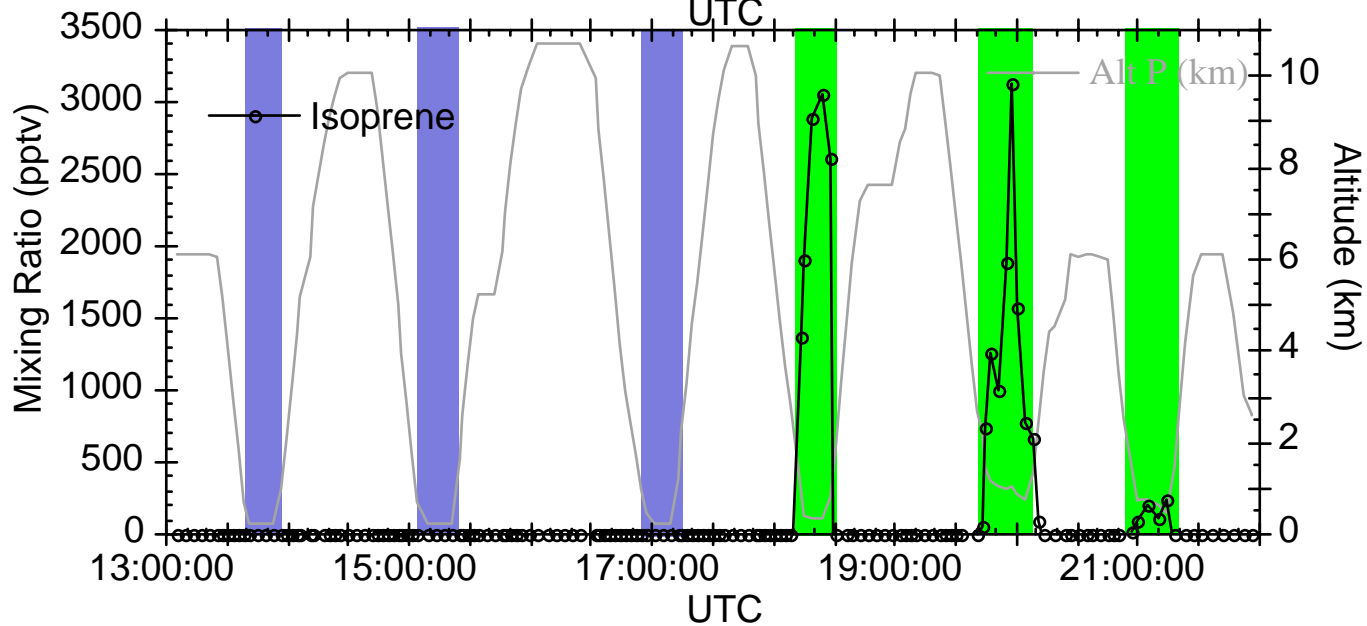
BL leg #4 shows
influence from
ocean

Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)

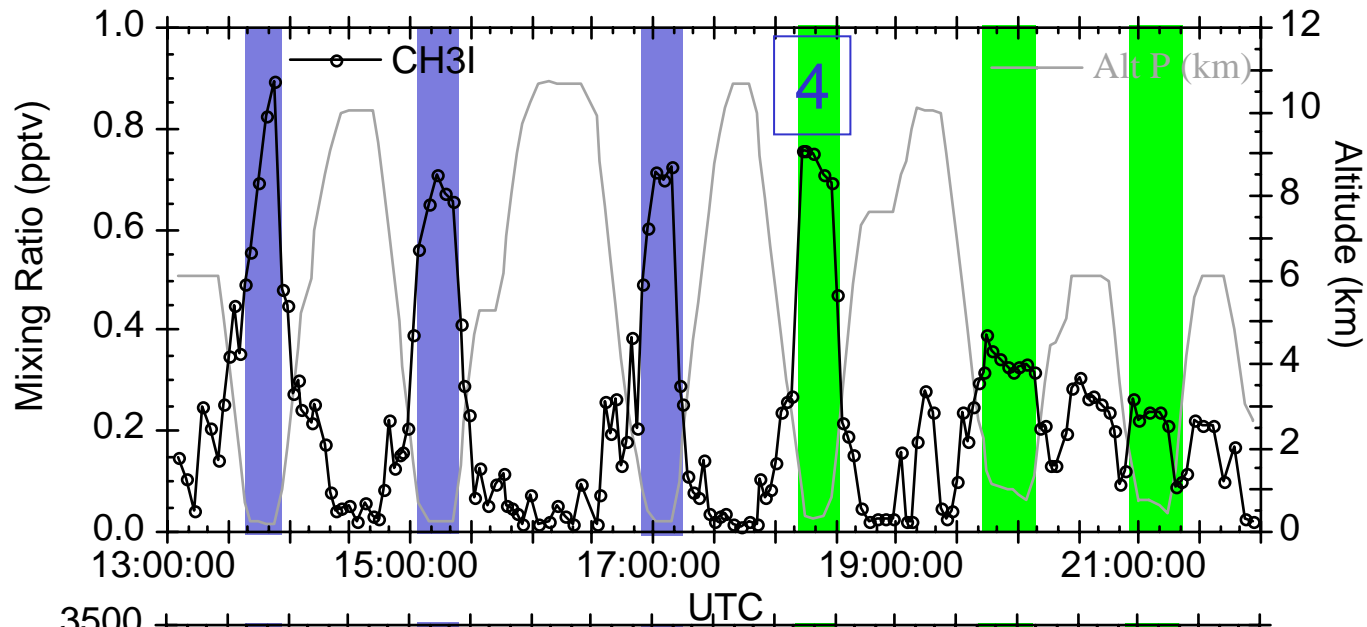


BL leg #4 shows influence from ocean and land

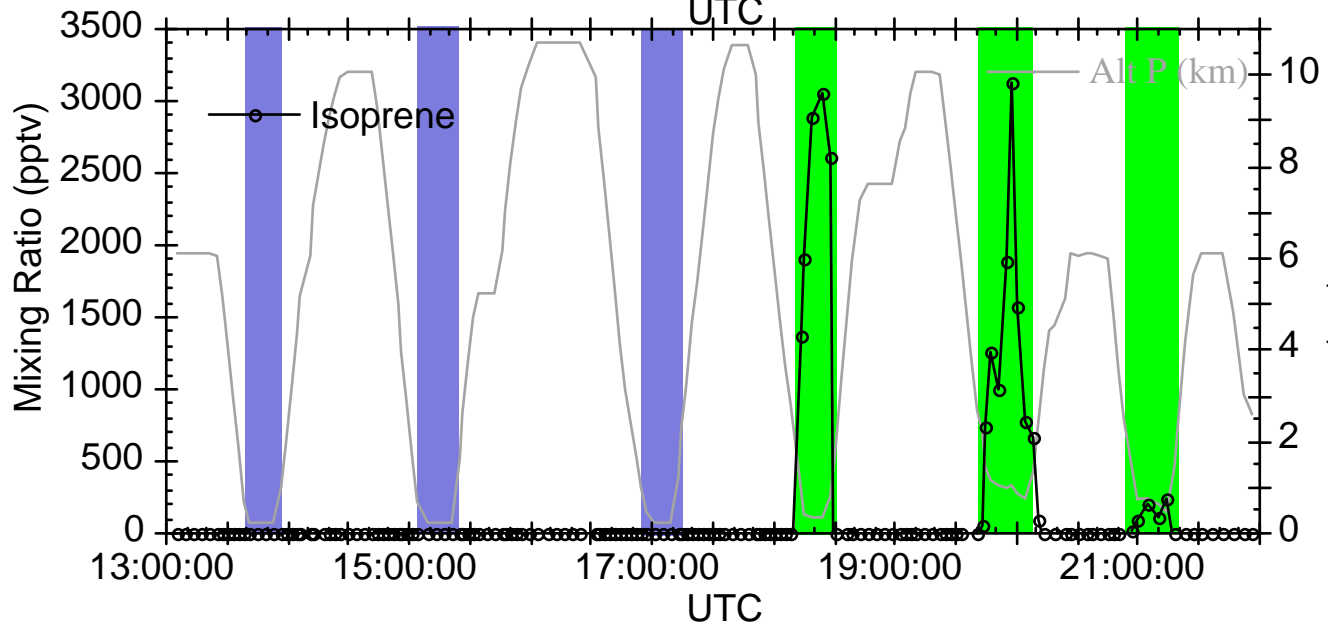


Contrast between Ocean and Land BL Data

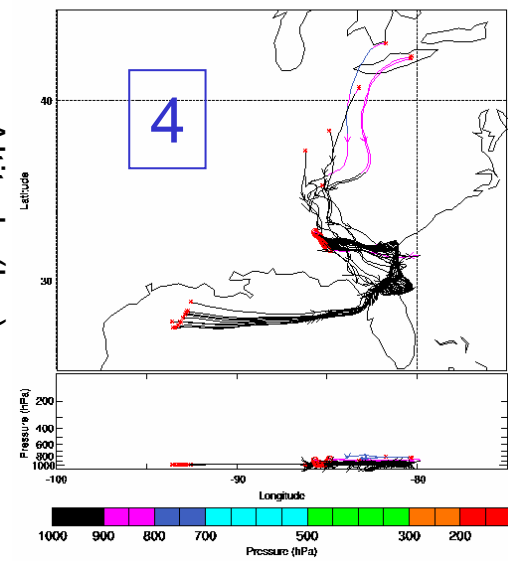
INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)



BL leg #4 shows influence from ocean and land - as in trajectory

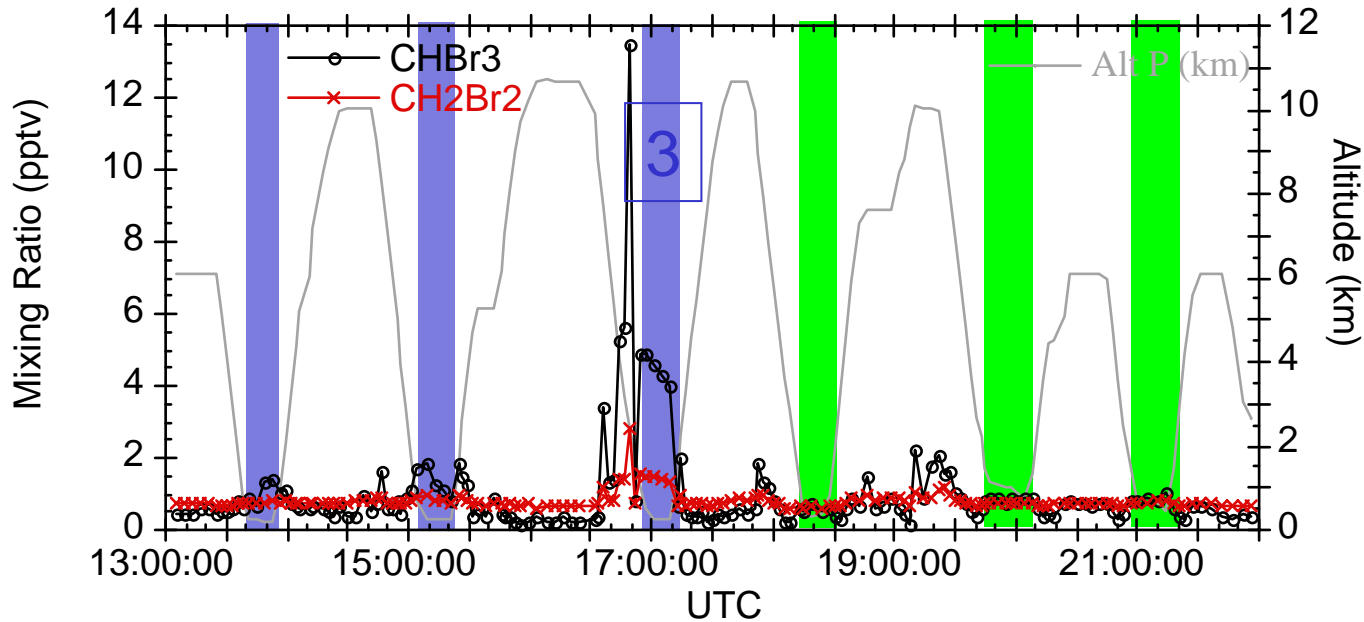


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07 DAYS BACK FROM FLIGHT ON 25 JUL 2004
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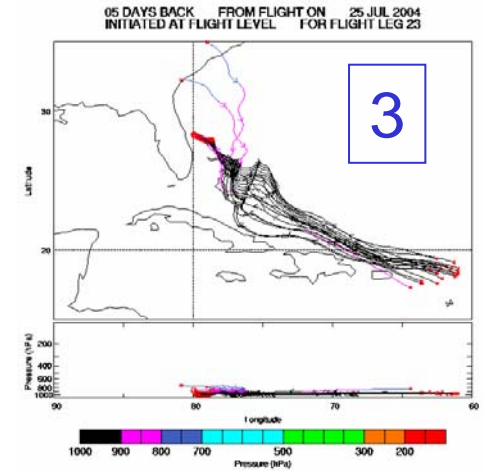


Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)

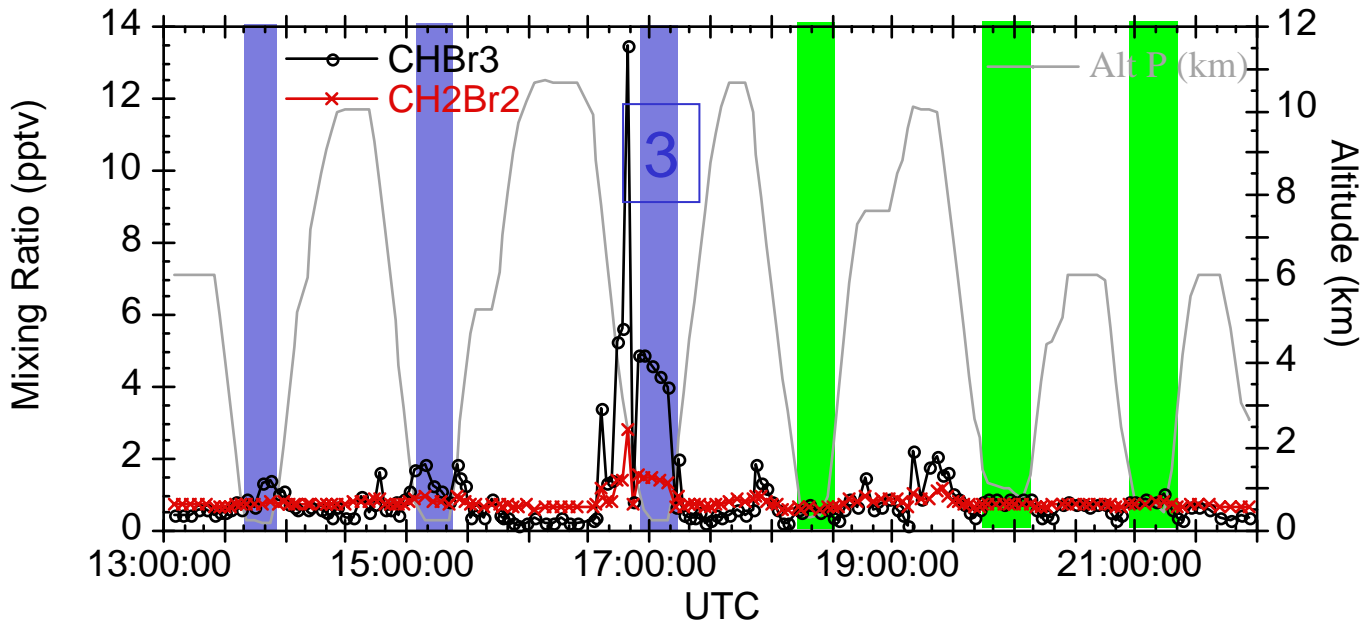


High Levels of organic Br gases from Caribbean

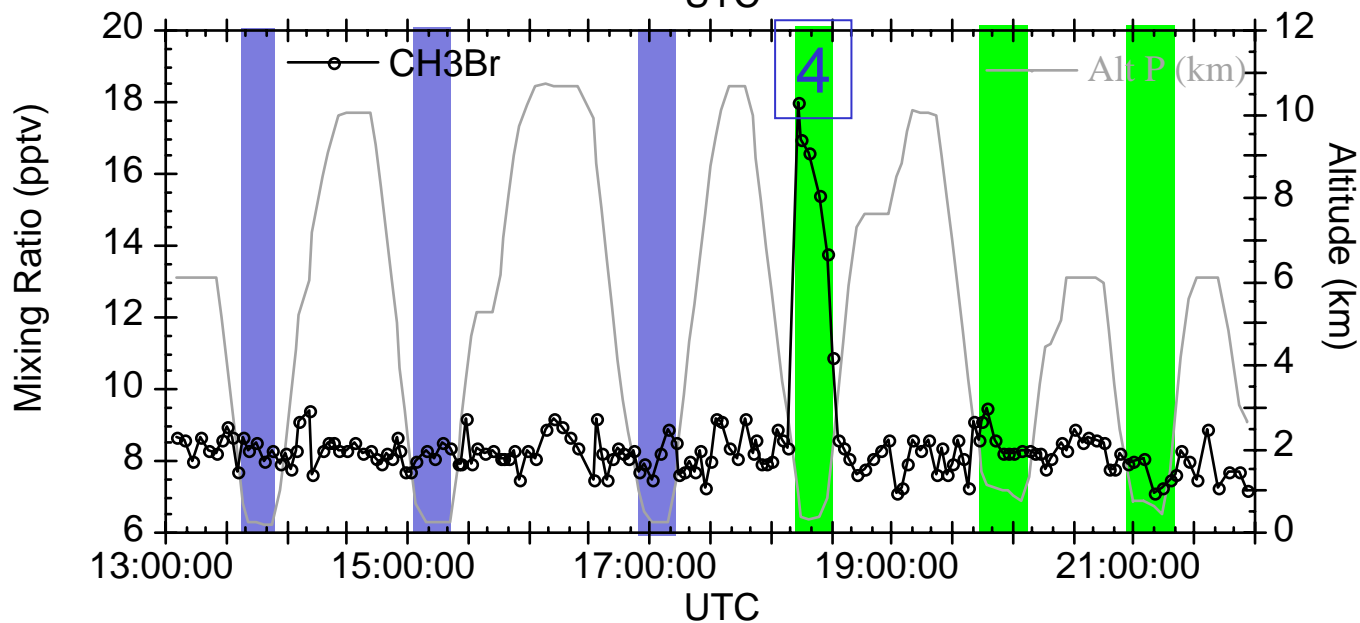
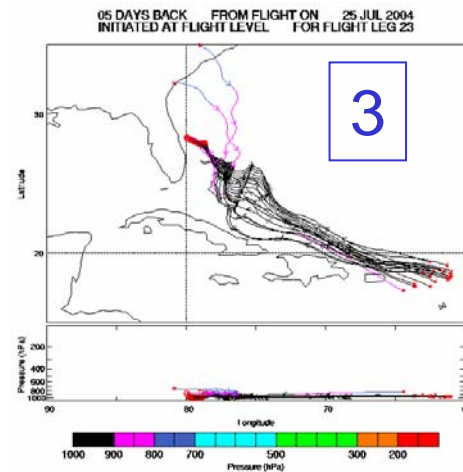


Contrast between Ocean and Land BL Data

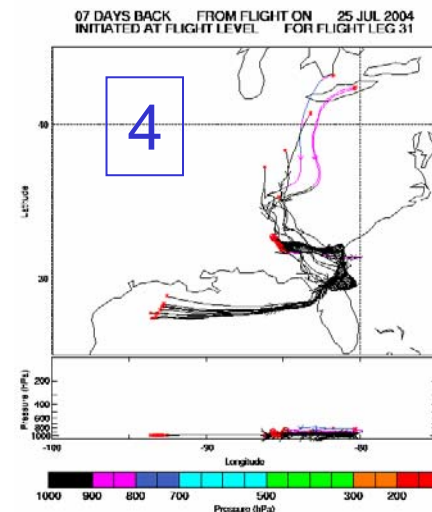
INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)



High Levels of organic Br gases from Caribbean

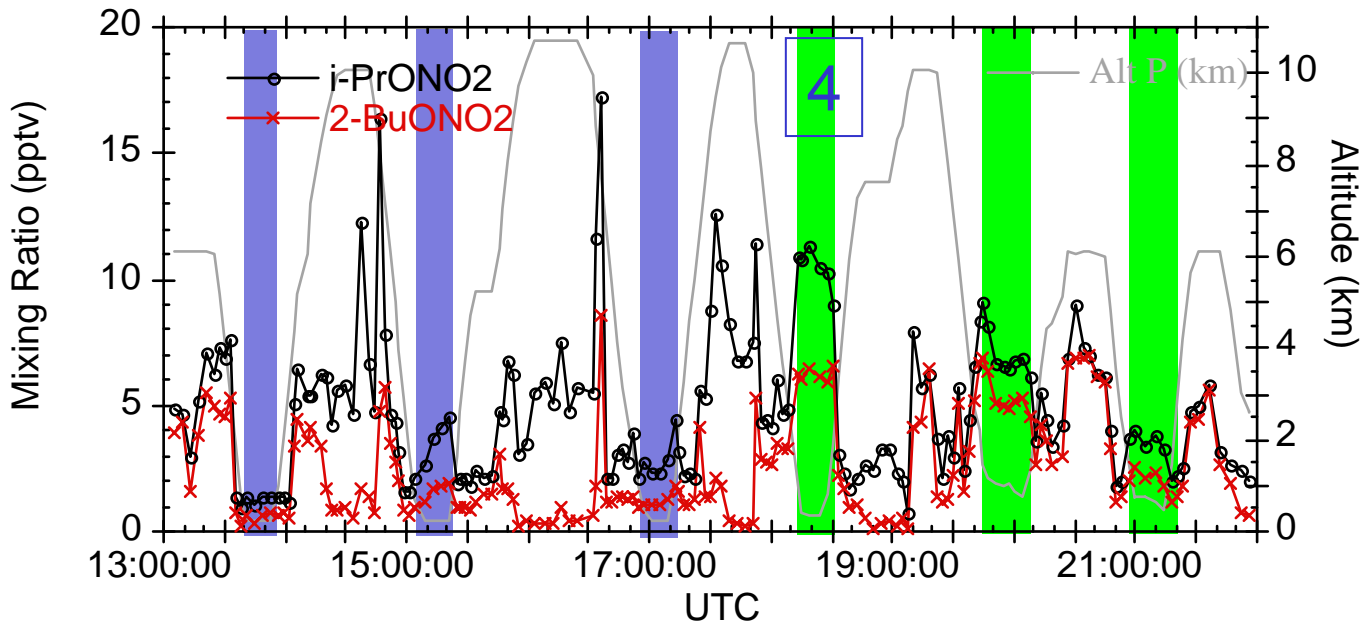


High MeBr associated with ag. regions of FL



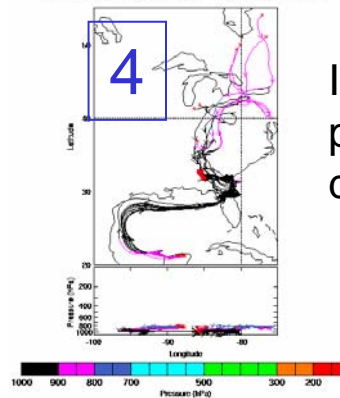
Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)



Leg 4 also has high levels of secondary pollutants

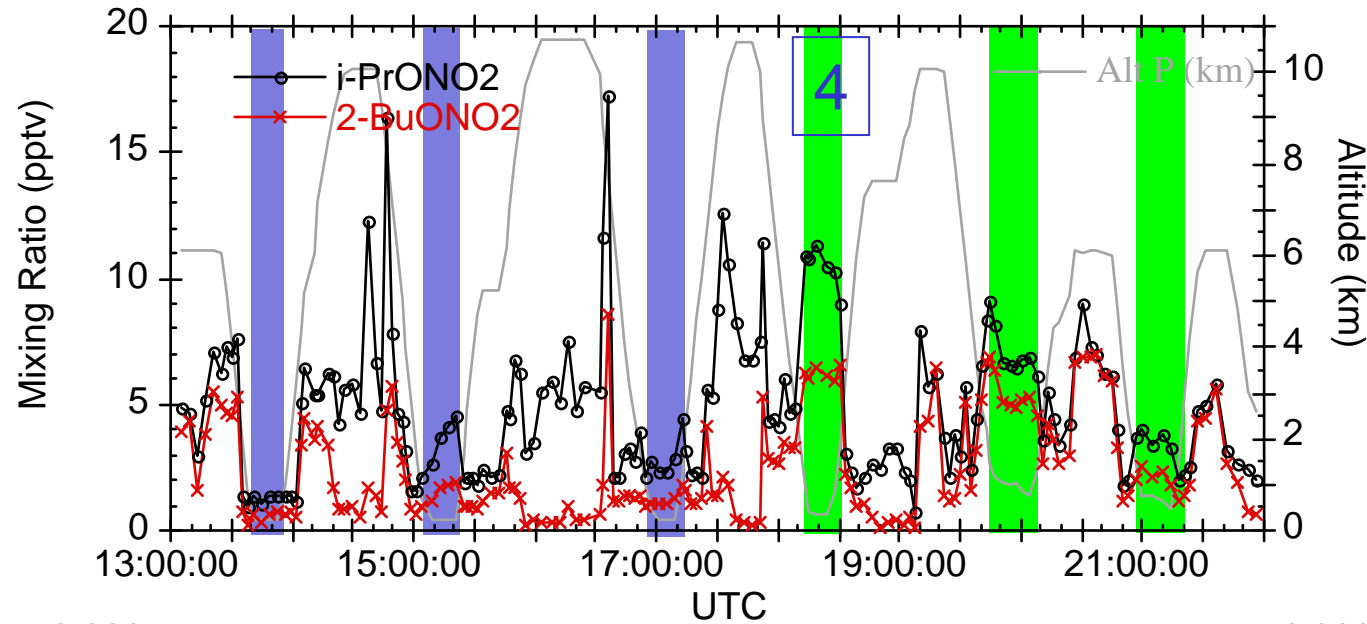
10 DAYS BACK FROM FLIGHT ON 25 JUL 2004
INITIATED AT FLIGHT LEVEL FOR FLIGHT LEG 31



In BL for past 10 days

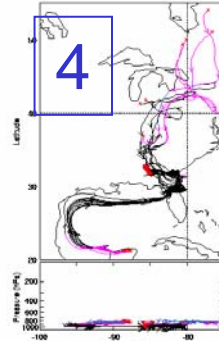
Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)

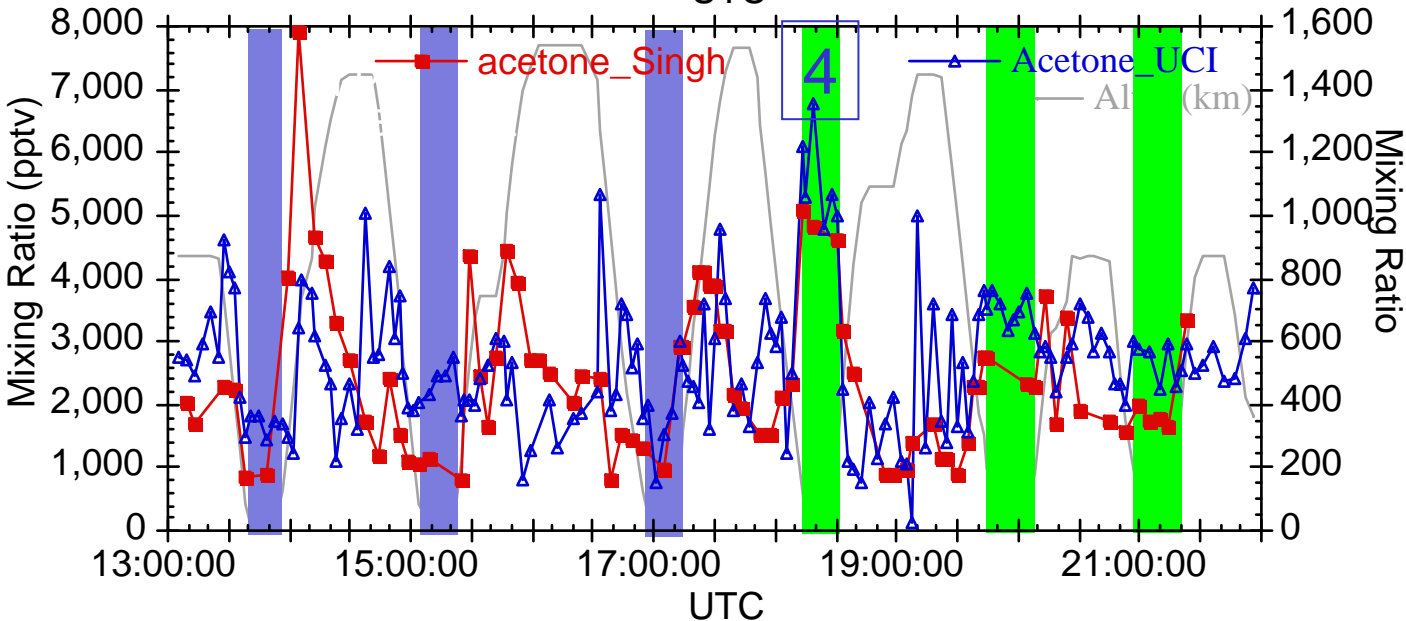


Leg 4 also has high levels of secondary pollutants

10 DAYS BACK FROM FLIGHT ON 25 JUL 2004 INITIATED AT FLIGHT LEVEL FOR FLIGHT LEG 31



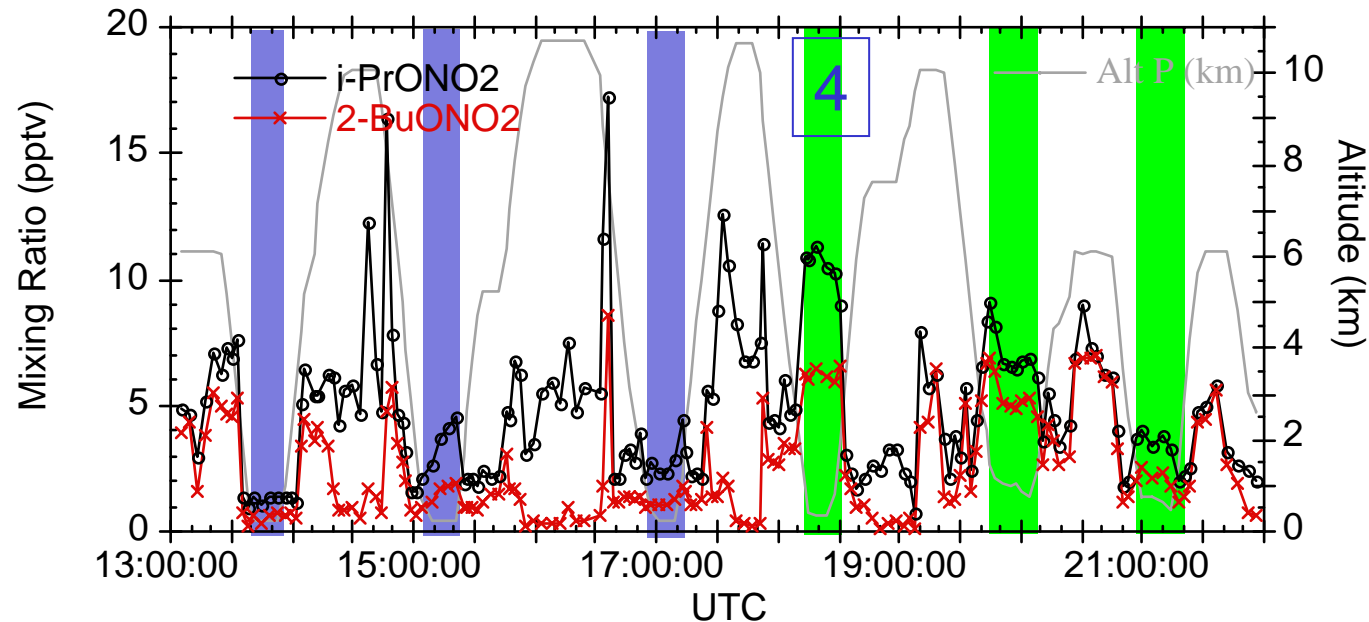
In BL for past 10 days



New UCI acetone data (unarchived) - compare to Singh group acetone

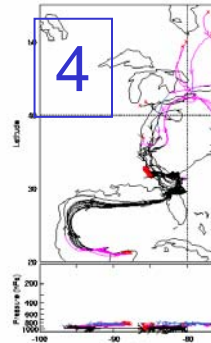
Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)

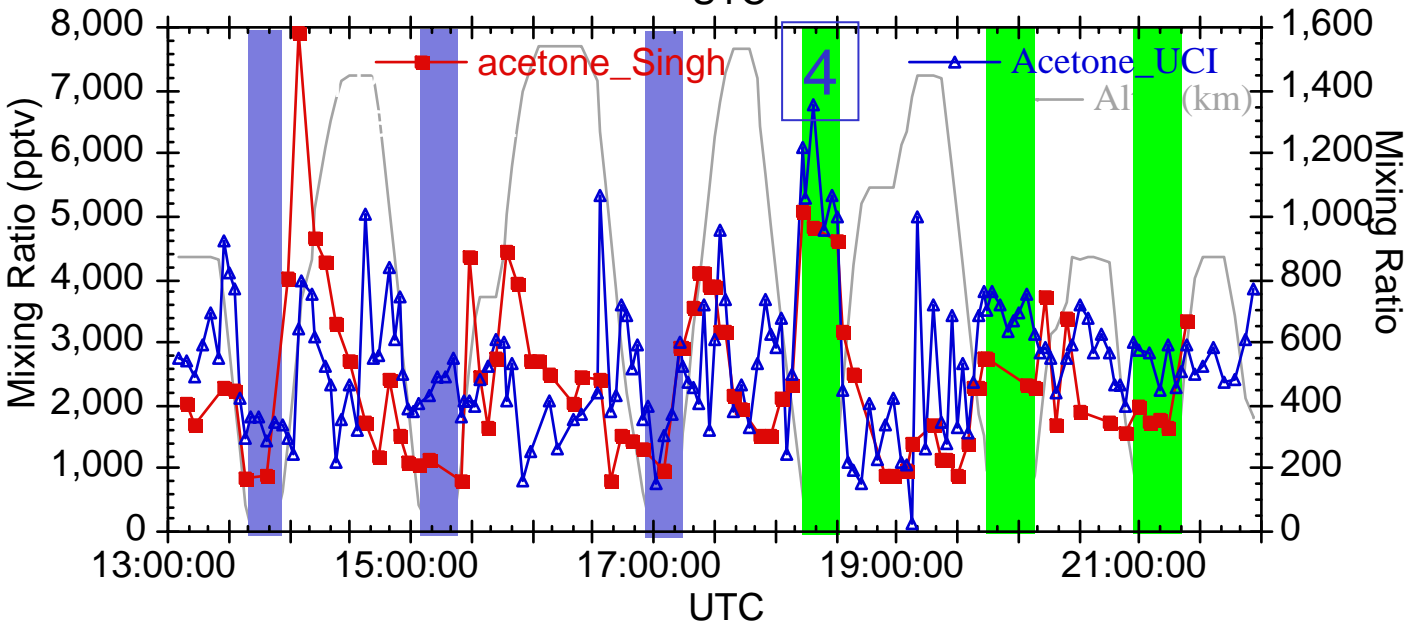


Leg 4 also has high levels of secondary pollutants

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In BL for past 10 days

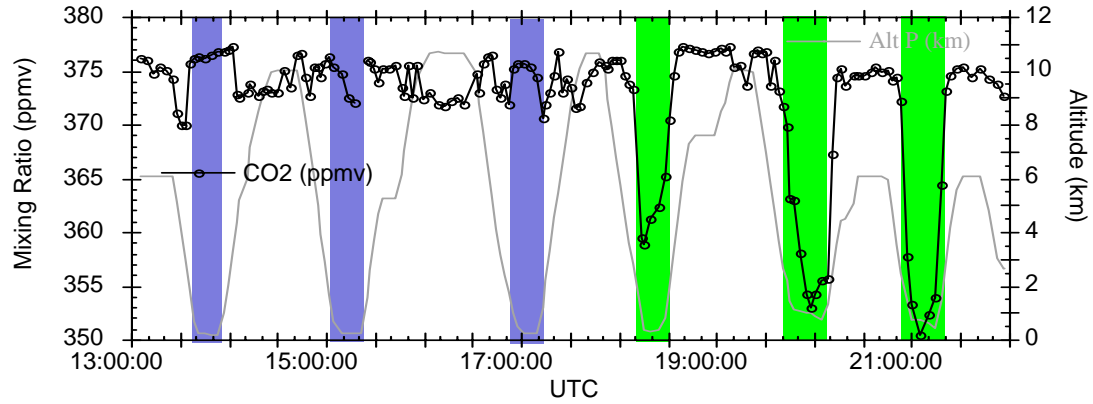


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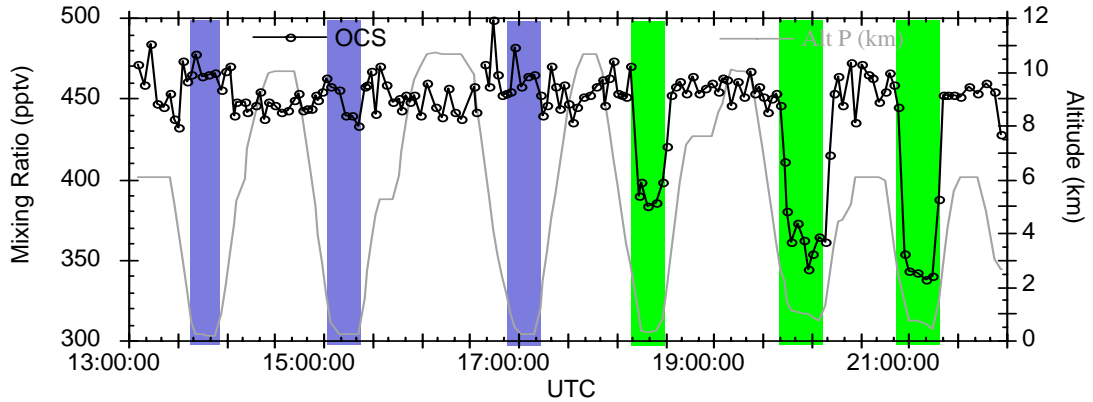
- strong similarities with i-PrONO₂
- both high in Leg #4

Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)

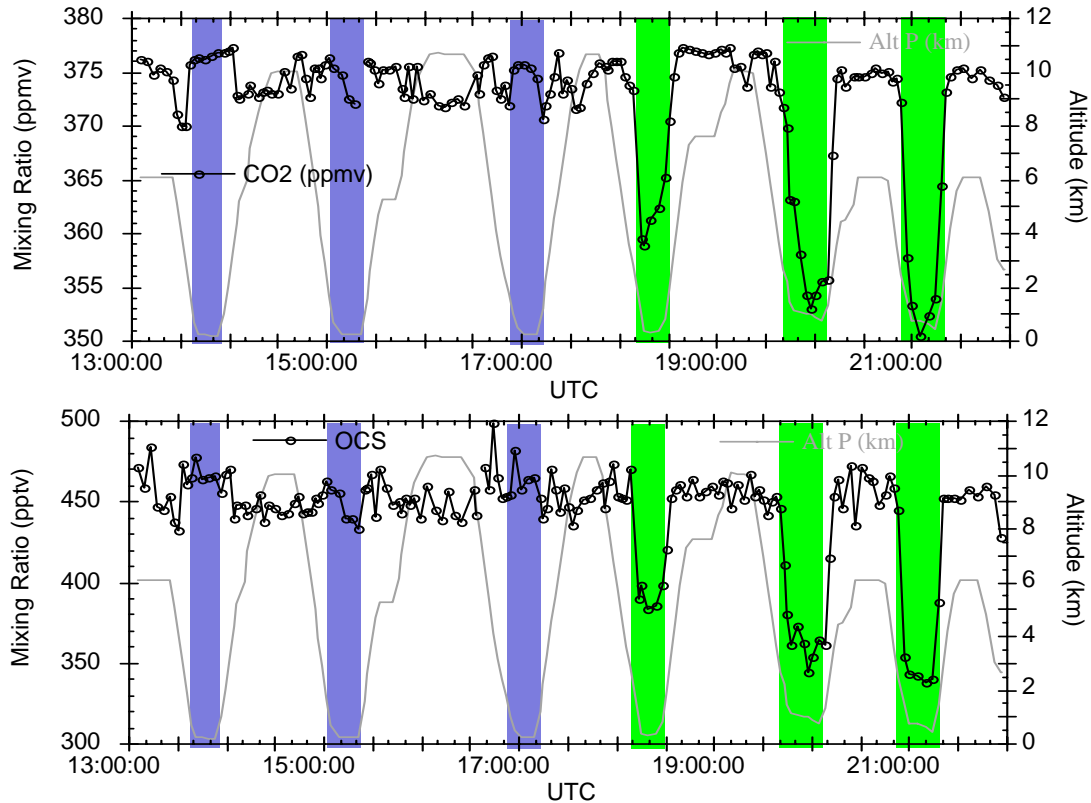


Both CO₂ and OCS show draw-down over land



Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)



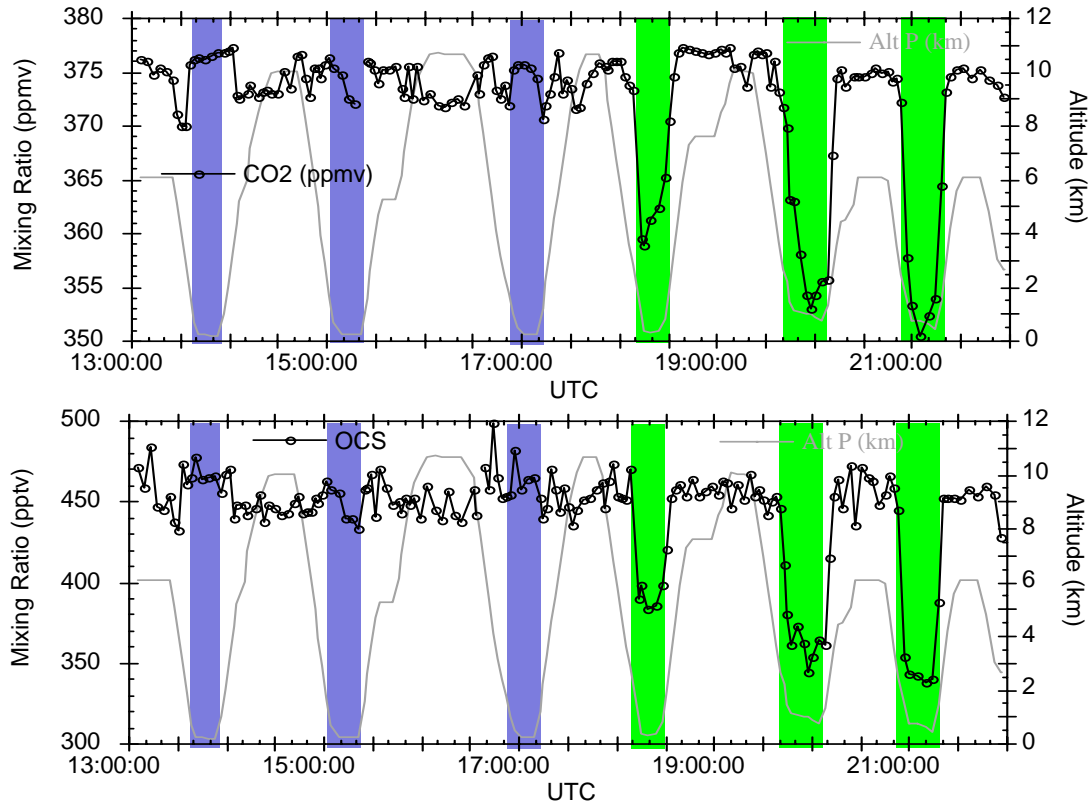
Both CO₂ and OCS show draw-down over land

Uptake of **OCS** and **CO₂** has common pathway

- through open stomata
- transport resistances virtually the same. [*Goldan et al. 1988*]

Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)

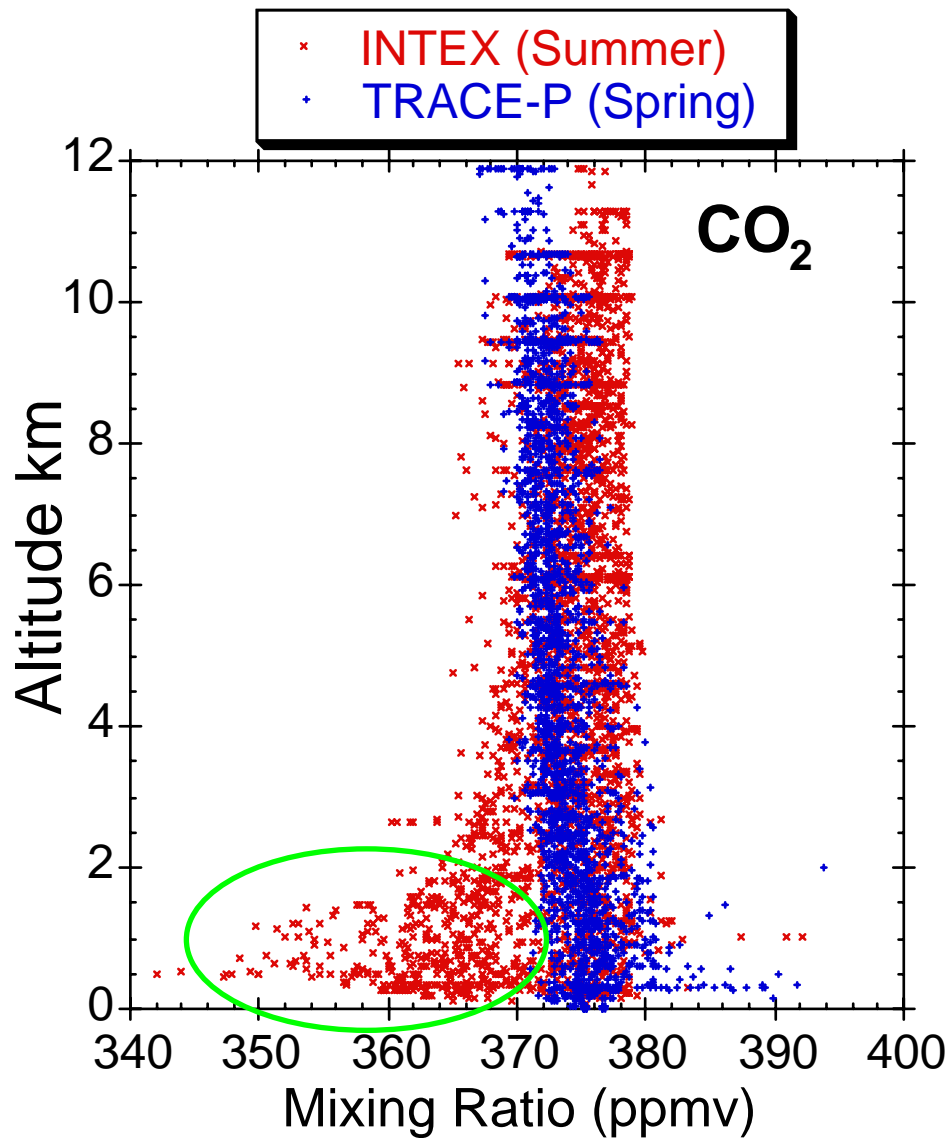


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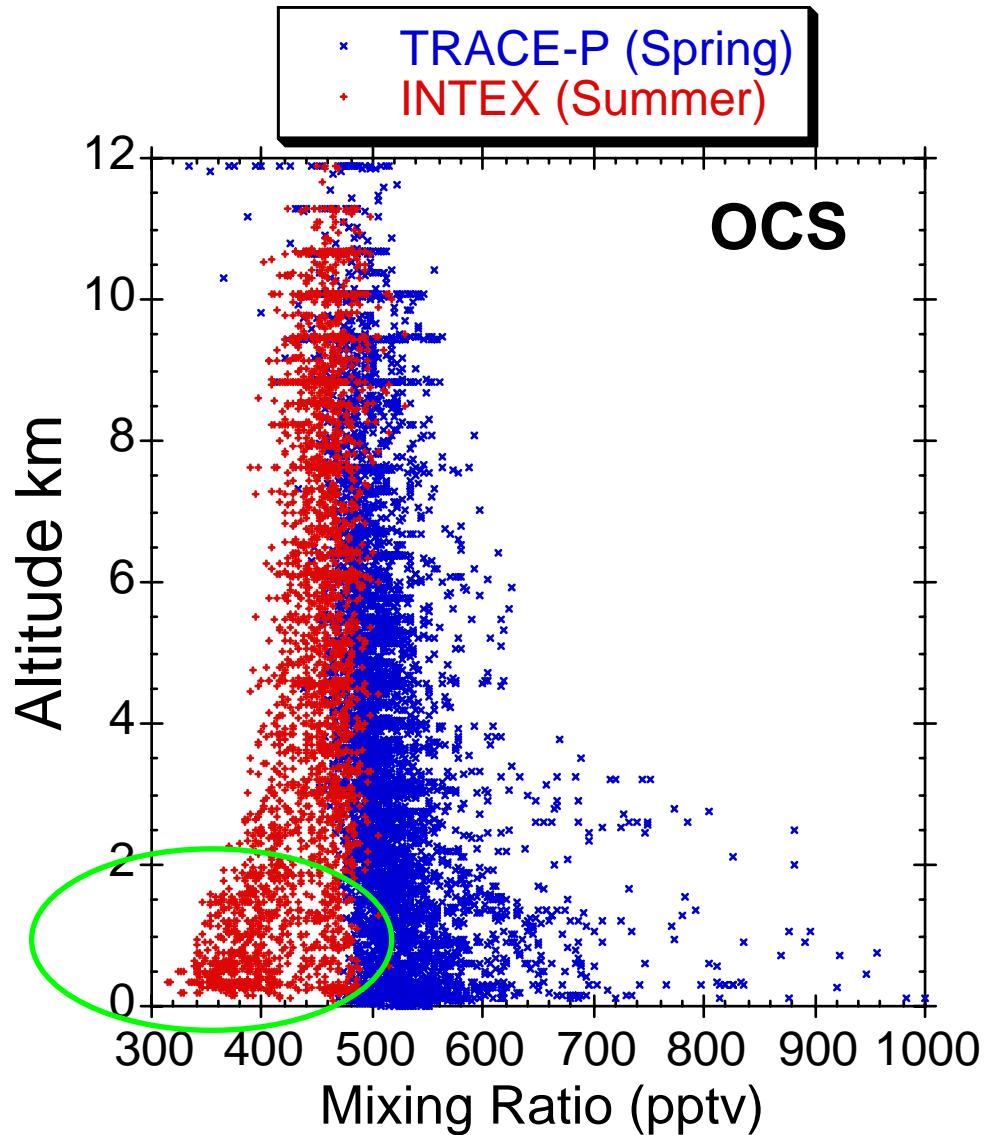
- through open stomata
- transport resistances virtually the same. [*Goldan et al.* 1988]
- Regional variation of **OCS** uptake uncertain [*Kettle et al.*, 2002]

Comparison of TRACE-P and INTEX



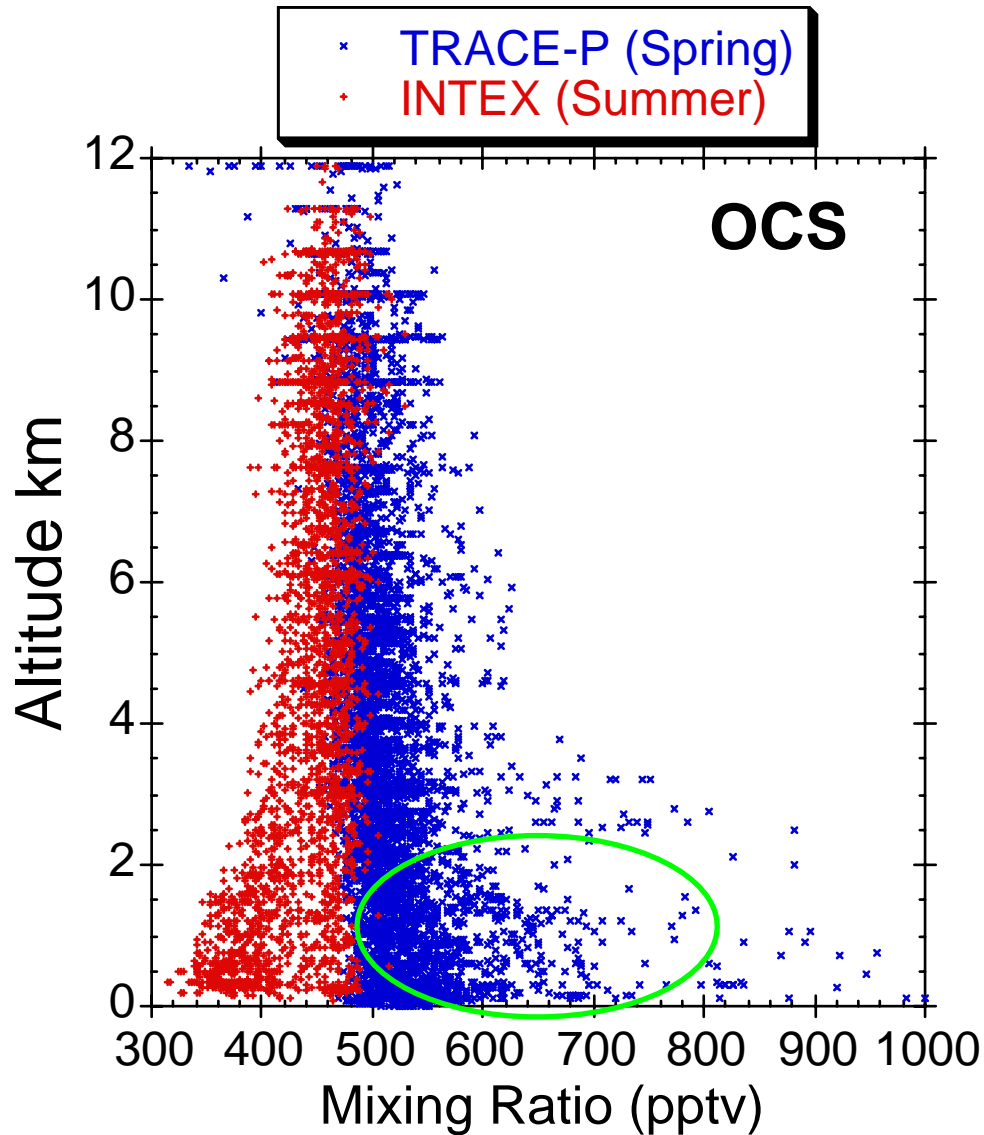
Summer vegetation sink
for CO₂ main difference
between missions?
(Stephanie/Melody???)

Comparison of TRACE-P and INTEX



Like CO₂ see vegetation sink for OCS in summer over the US

Comparison of TRACE-P and INTEX



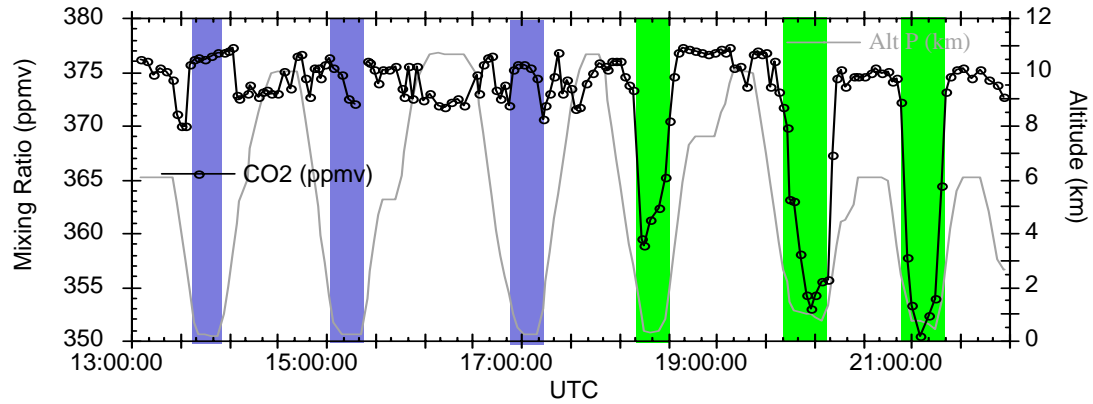
Like CO₂ see vegetation sink for OCS in summer over the US

Also:

- US much smaller source for OCS?? (much less and cleaner coal burning)?

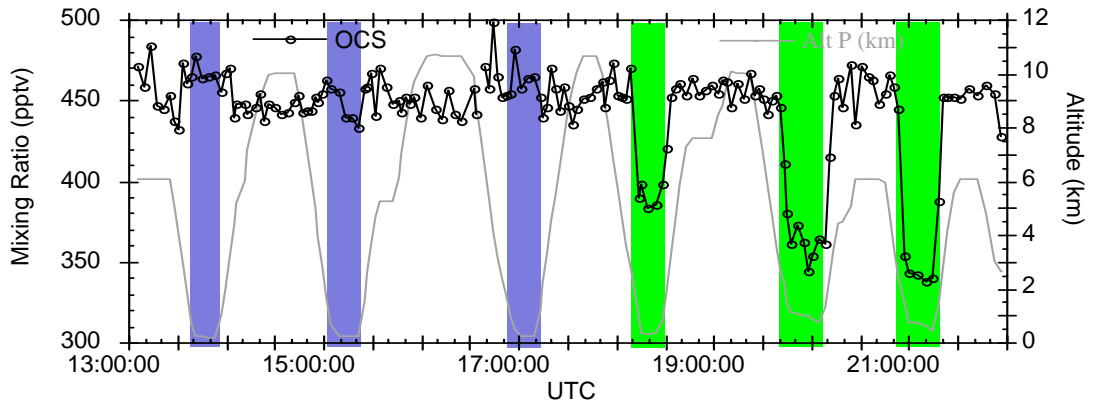
Contrast between Ocean and Land BL Data

INTEX-NA Flight 12
July 25, 2004 (4th Pease Local)



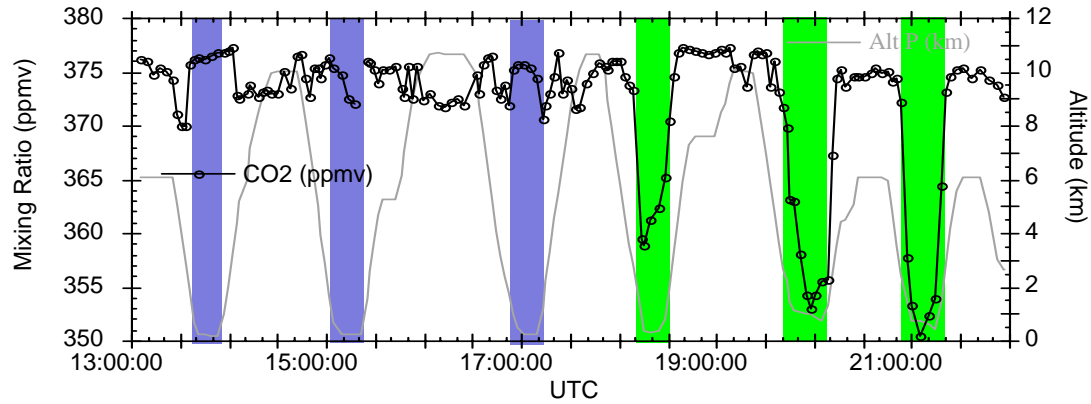
Both CO₂ and OCS show draw-down over land

- Revisited!



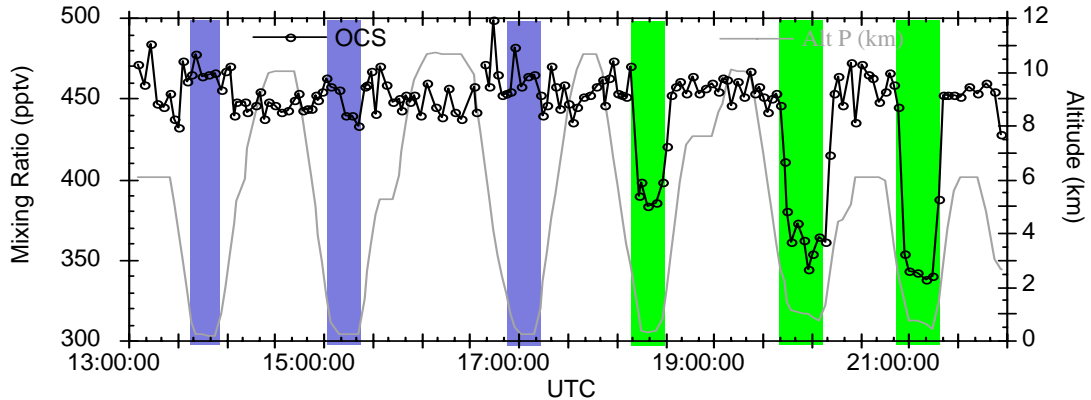
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Both CO₂ and OCS show draw-down over land

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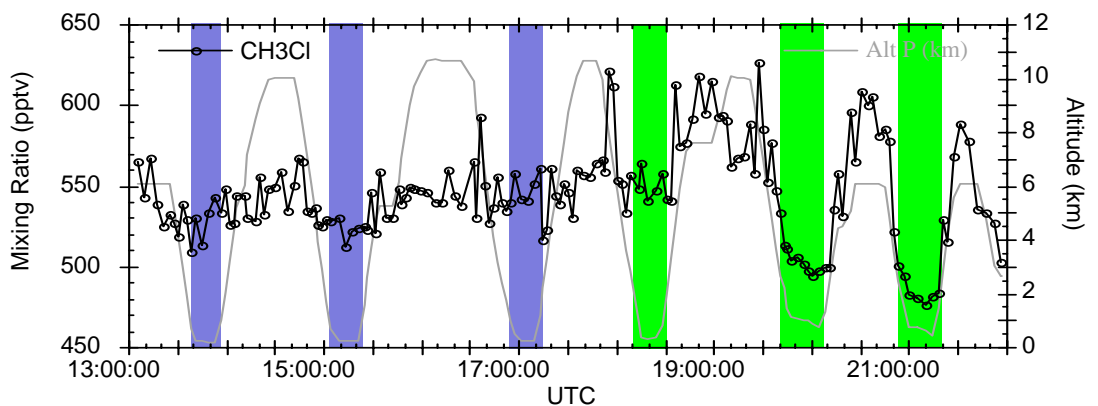


MeCl also shows clear evidence of uptake over land

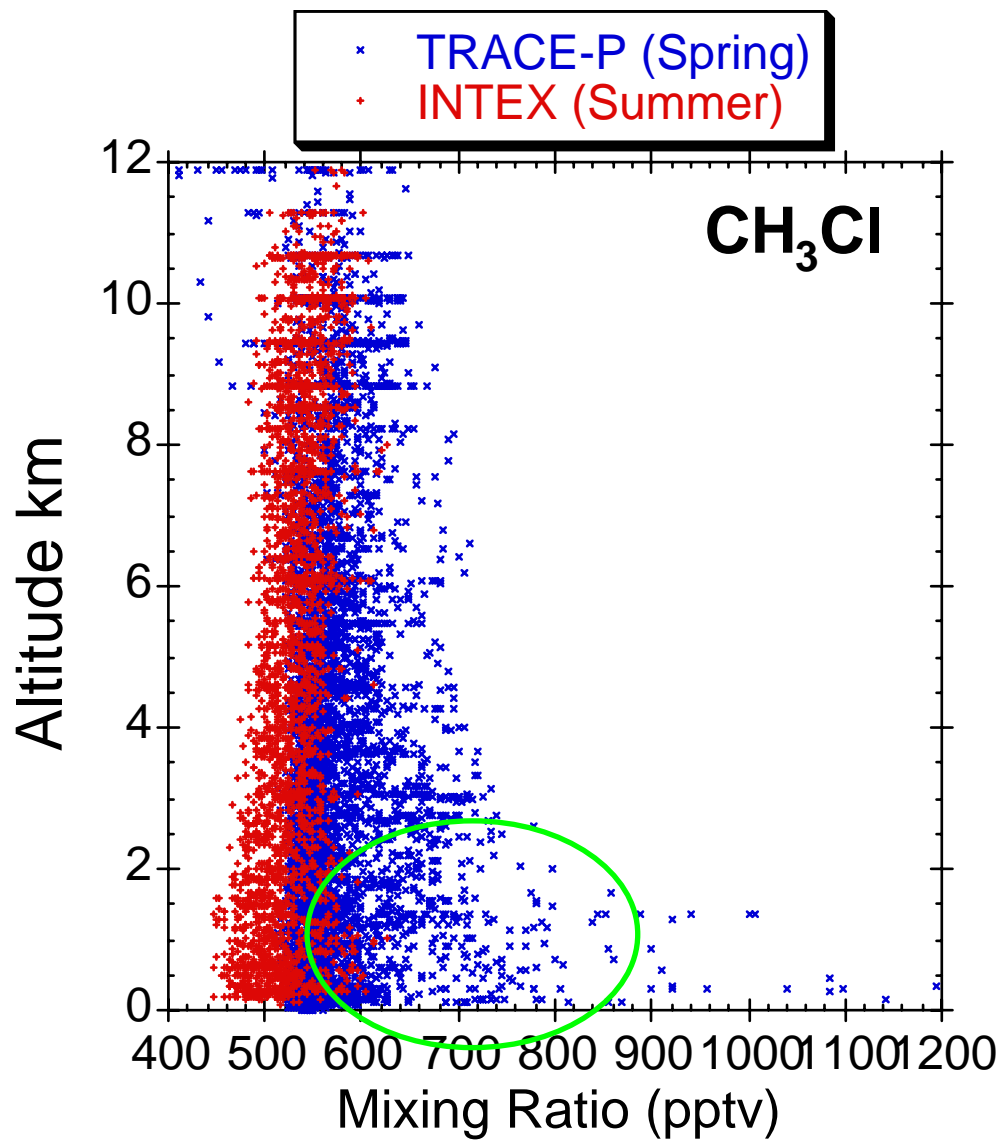
- This pathway less well known

> Soil sink?

> Vegetation sink?

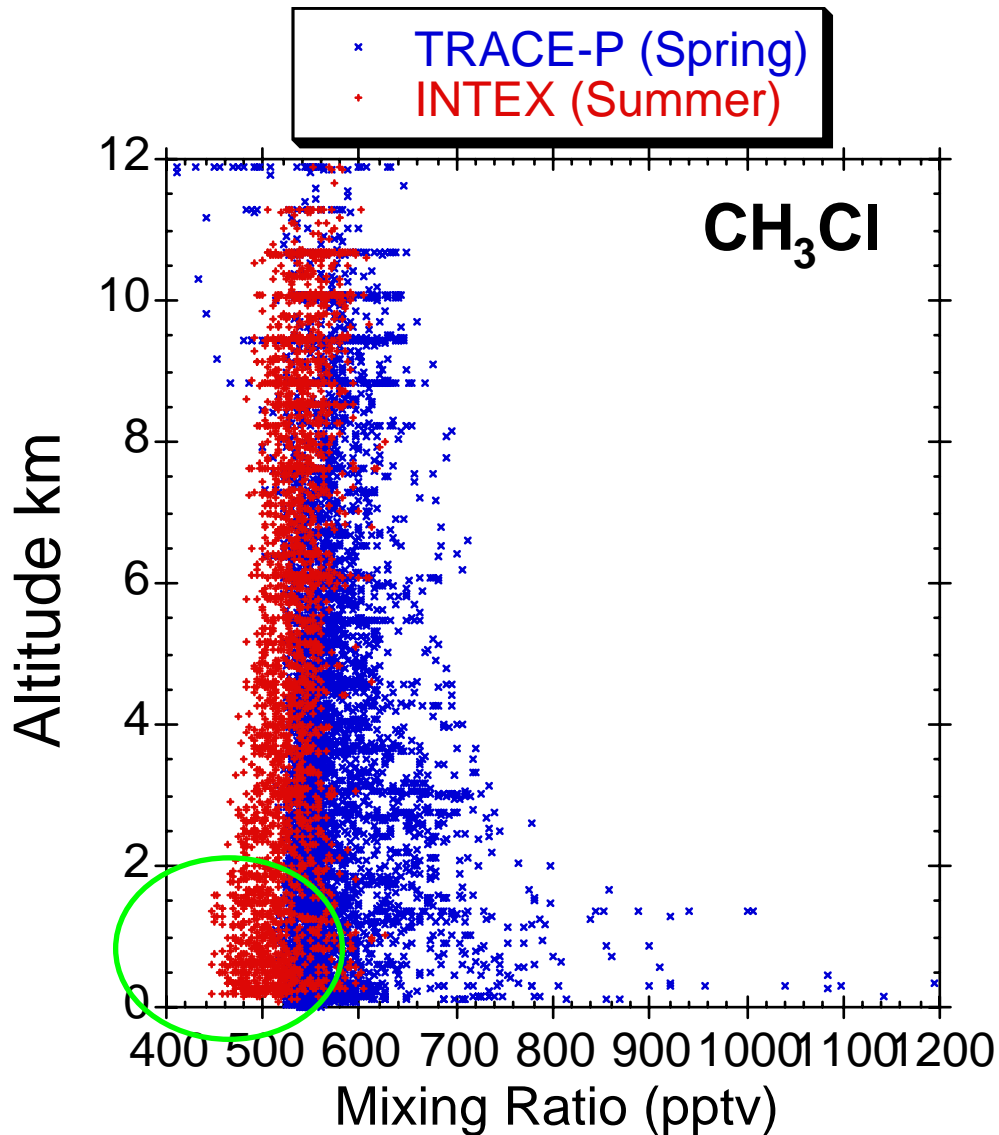


Comparison of TRACE-P and INTEX



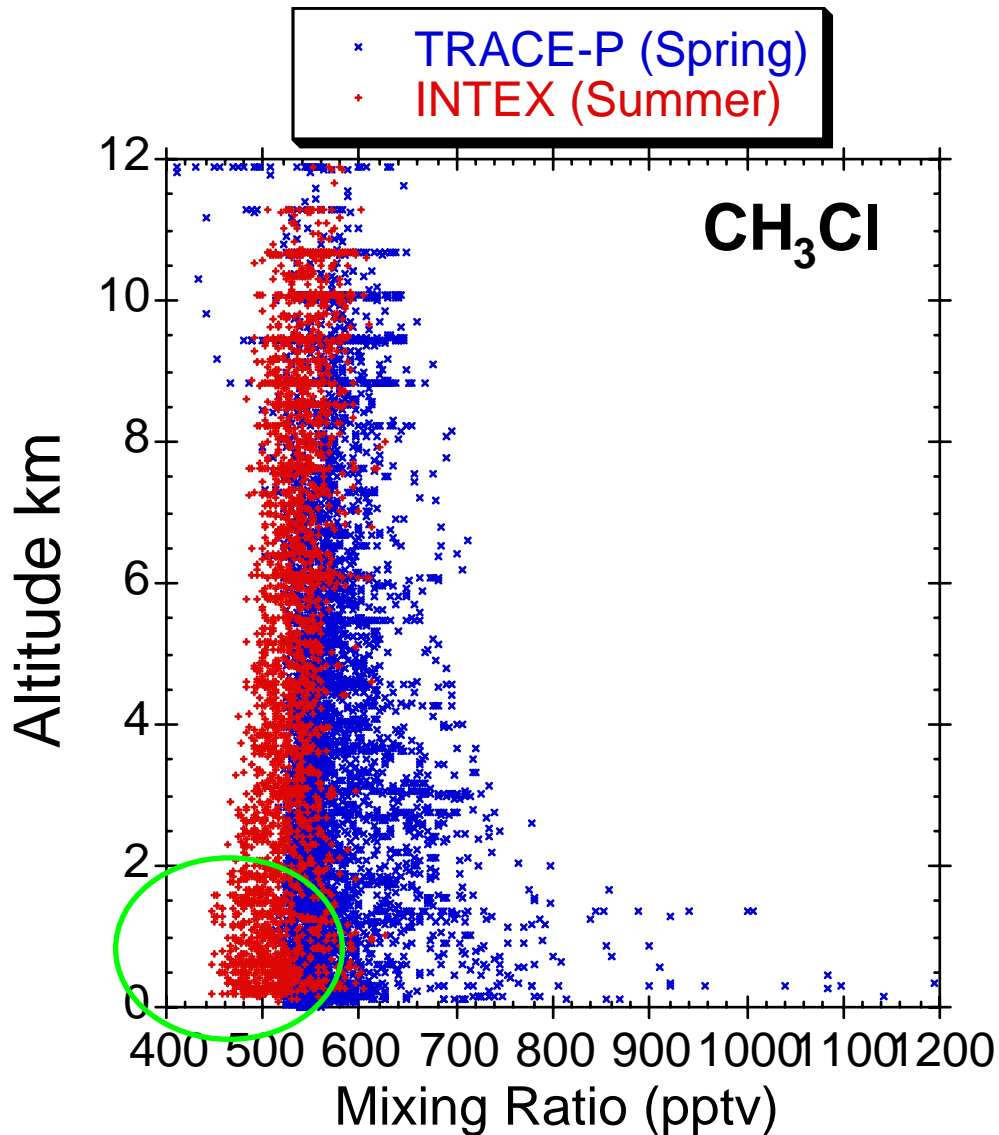
- US much smaller source for MeCl than Asia (much less biomass/biofuel/coal burning)??

Comparison of TRACE-P and INTEX



- US much smaller source for MeCl than Asia (much less biomass/biofuel/coal burning)??
- MeCl frequently influenced by PBL draw-down

Comparison of TRACE-P and INTEX

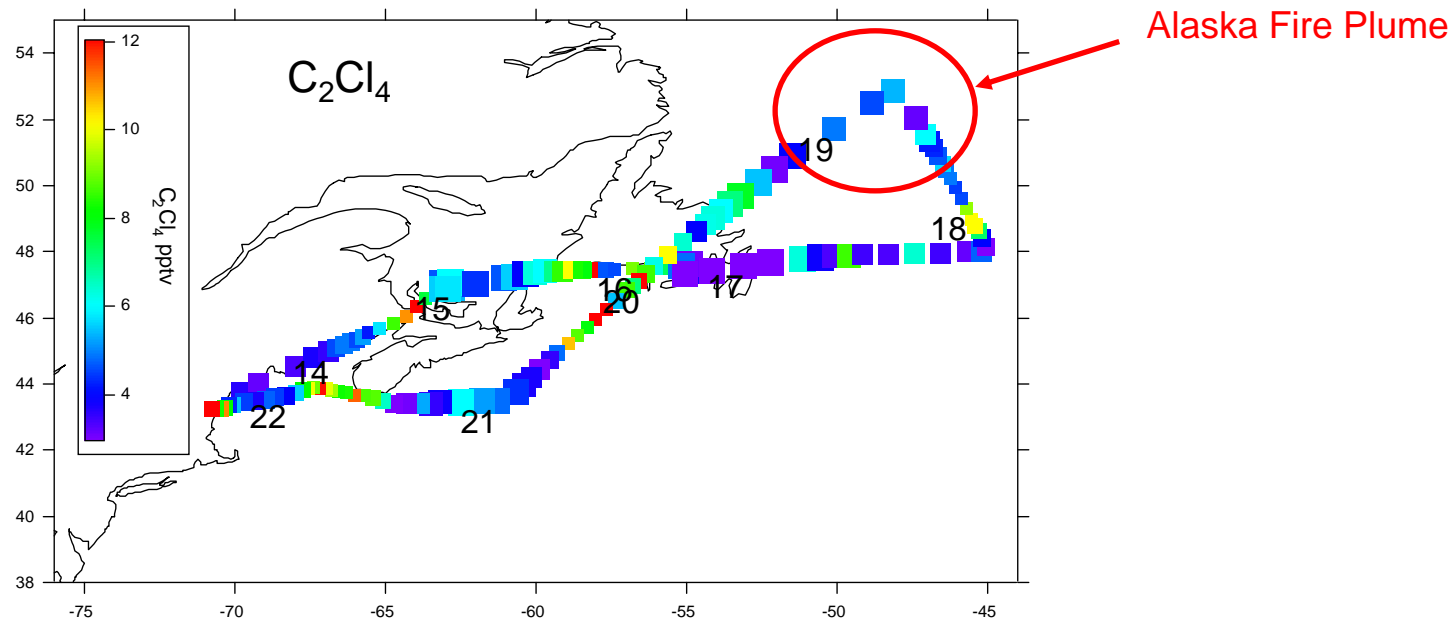
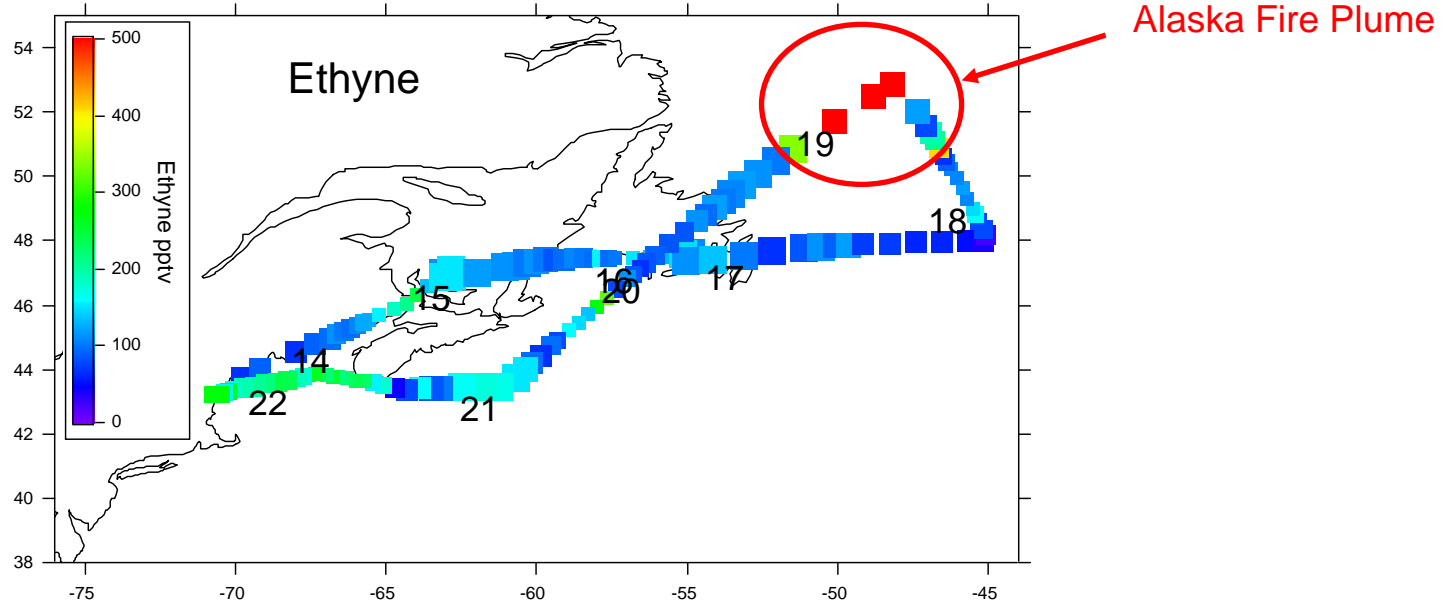


- US much smaller source for MeCl than Asia (much less biomass/biofuel/coal burning)??
- MeCl frequently influenced by PBL draw-down
- **less useful as a biomass burning tracer**

Biomass Burning Tracers

INTEX-NA Flight 9

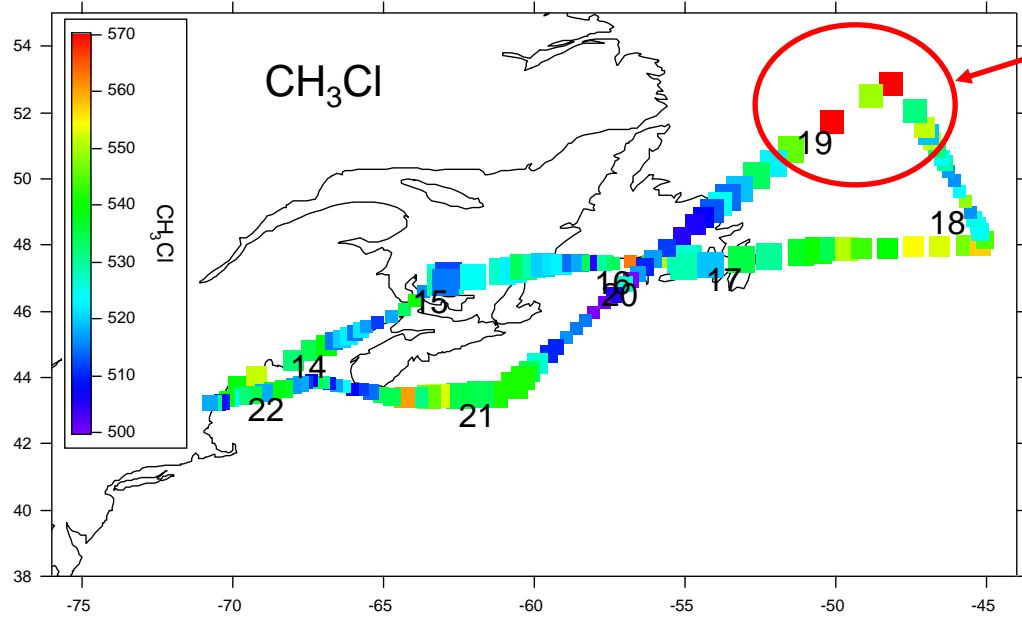
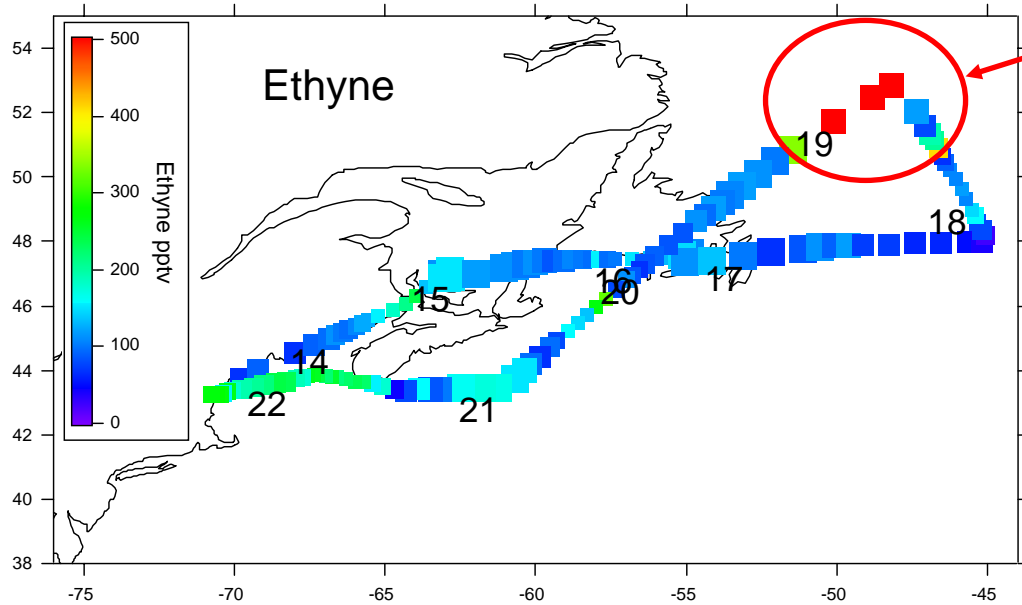
July 18, 2004 (1st Pease Local)



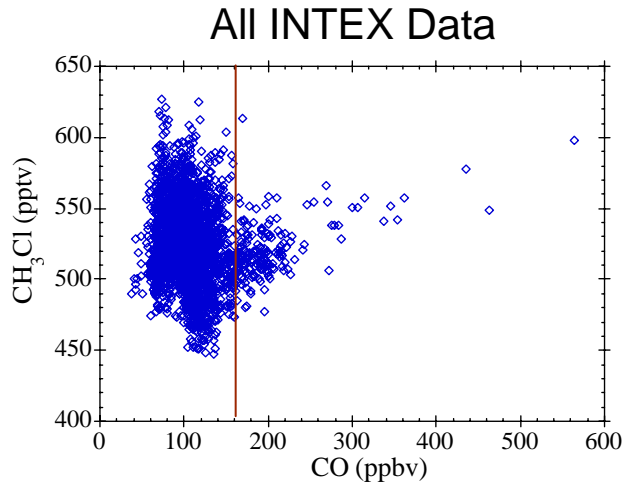
Biomass Burning Tracers

INTEX-NA Flight 9

July 18, 2004 (1st Pease Local)



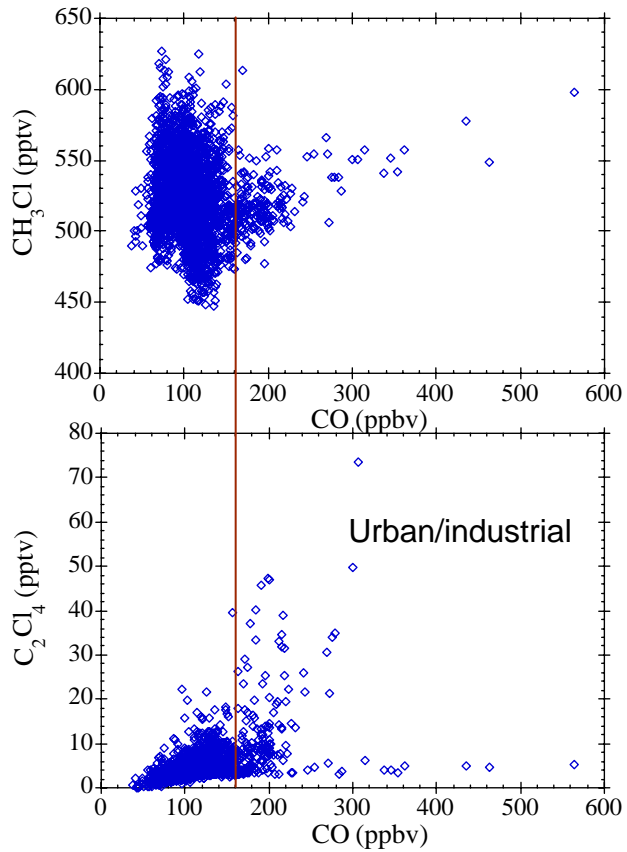
Biomass Burning Tracers



- CO: high in major BB Influence
(CO >160 ppb)

Biomass Burning Tracers

All INTEX Data

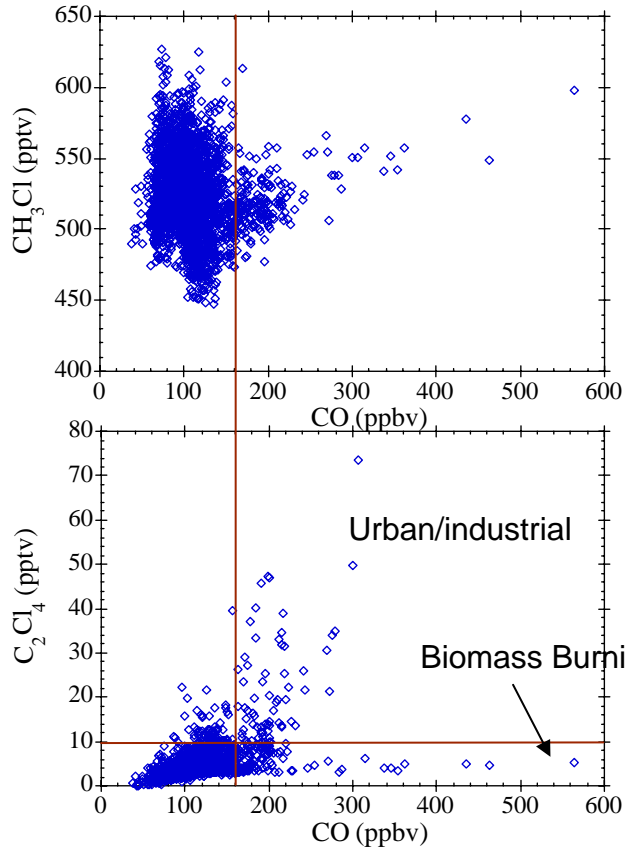


- CO: high in major BB Influence
(CO >160 ppb)

- C₂Cl₄: high for urban/industrial

Biomass Burning Tracers

All INTEX Data

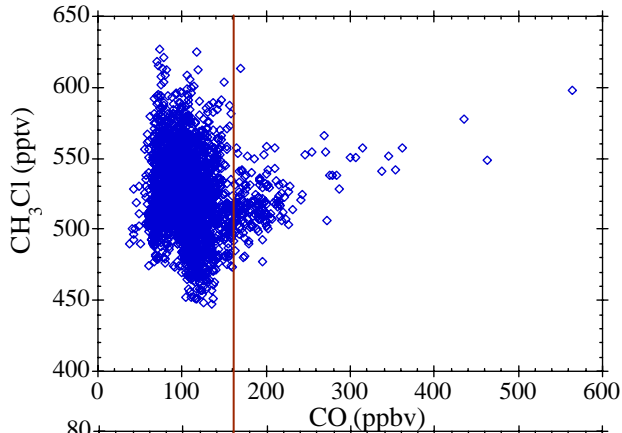


- CO: high in major BB Influence
(CO >160 ppb)

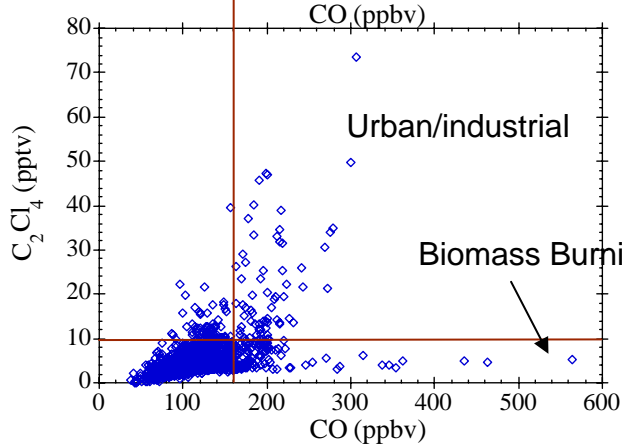
- C_2Cl_4 : high for urban/industrial
low for pure BB
(select for C_2Cl_4 <10 pptv)

Biomass Burning Tracers

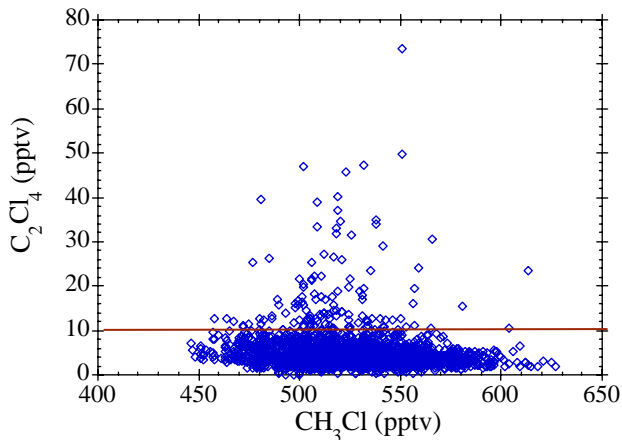
All INTEX Data



- CO : high in major BB Influence
($\text{CO} > 160$ ppb)



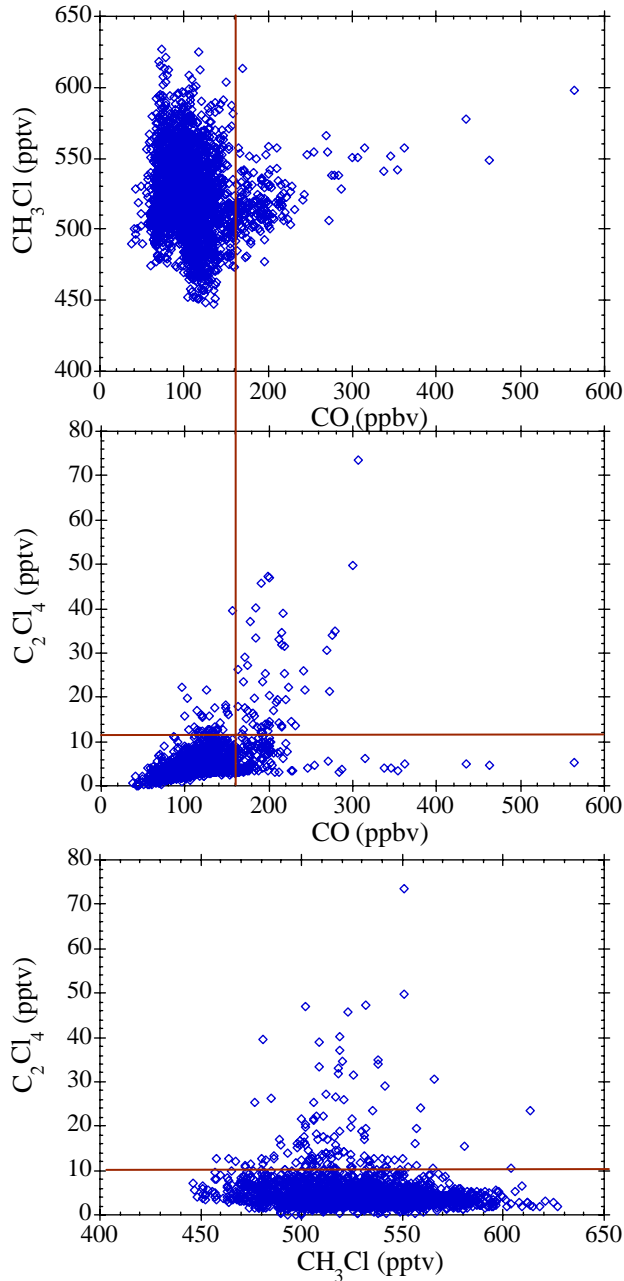
- C_2Cl_4 : high for urban/industrial
low for pure BB
(select for $\text{C}_2\text{Cl}_4 < 10$ pptv)



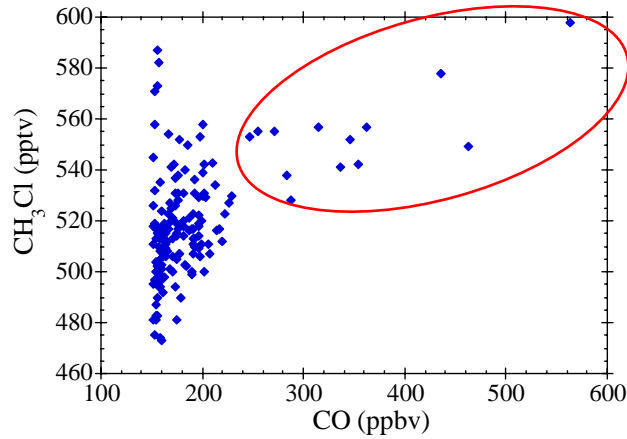
- Large range of CH_3Cl for low C_2Cl_4

Biomass Burning Tracers

All INTEX Data



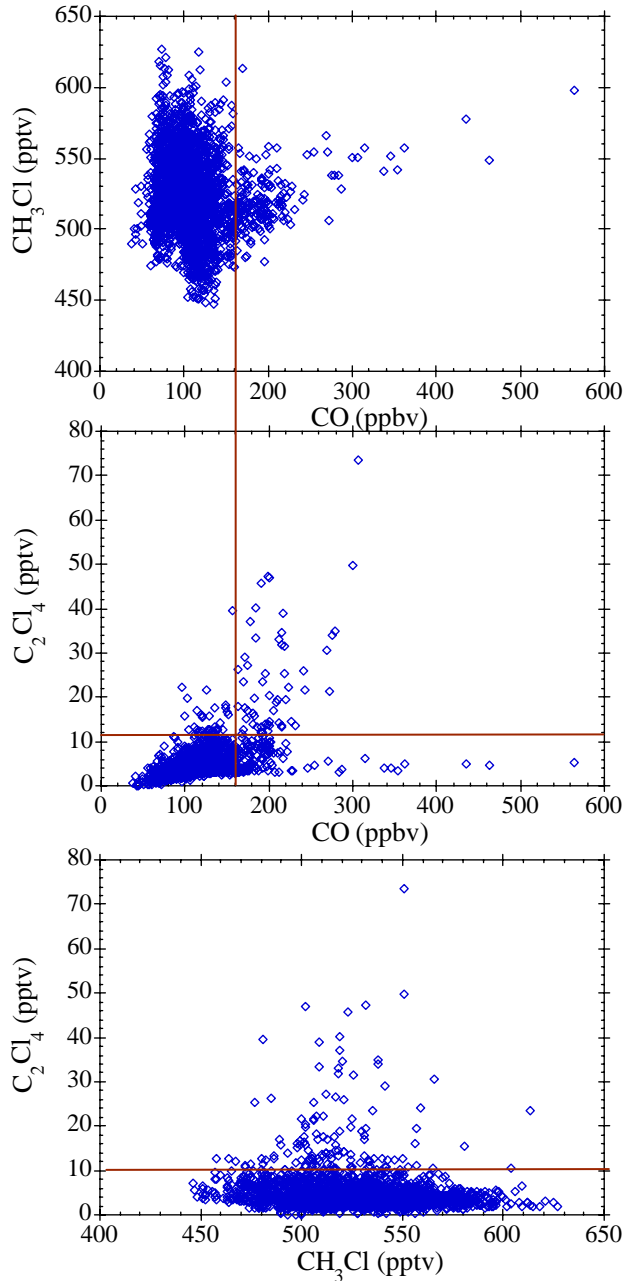
Data Subset: $\text{CO} > 160$ ppb, $\text{C}_2\text{Cl}_4 < 10$ pptv



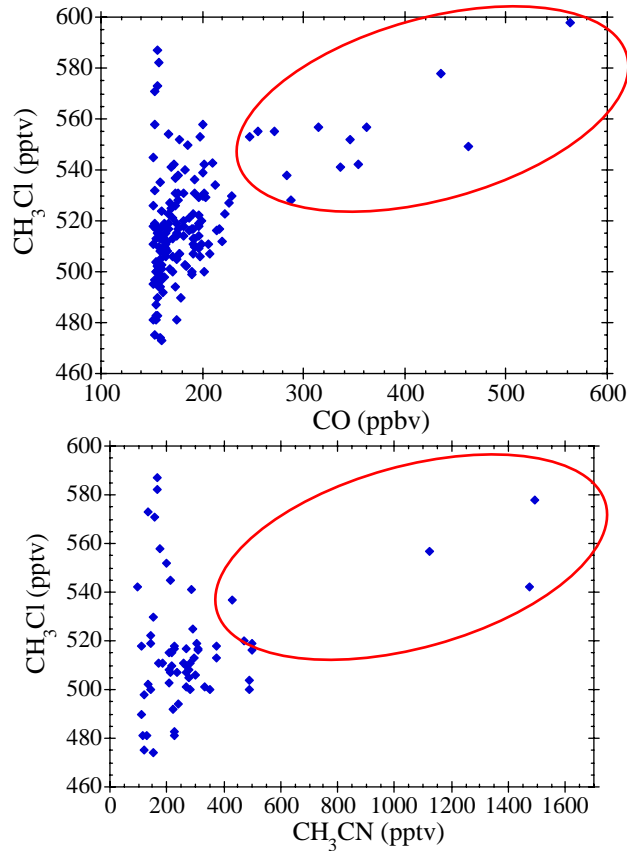
Few data that look like BB

Biomass Burning Tracers

All INTEX Data



Data Subset: $\text{CO} > 160$ ppb, $\text{C}_2\text{Cl}_4 < 10$ pptv



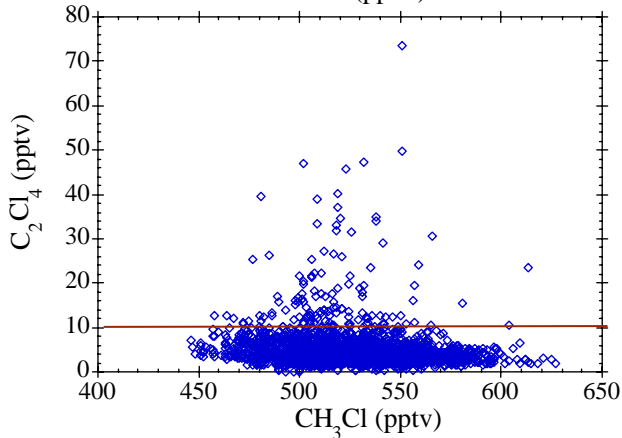
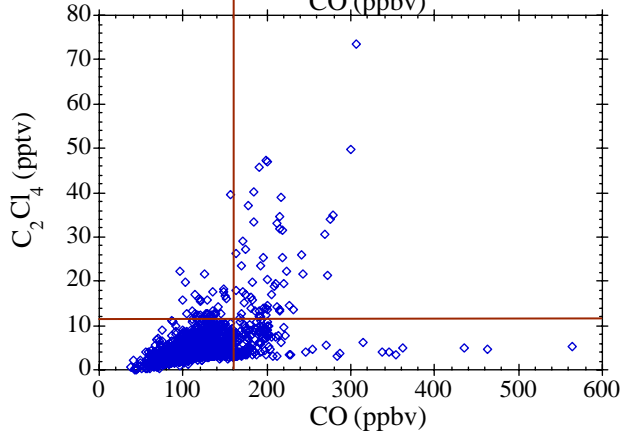
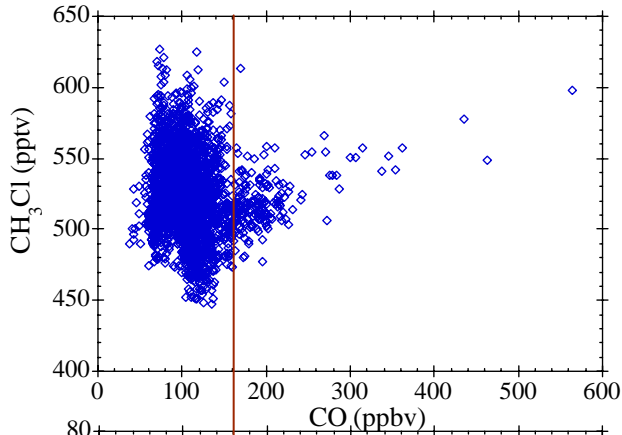
Few data that look like BB

Other Tracers:

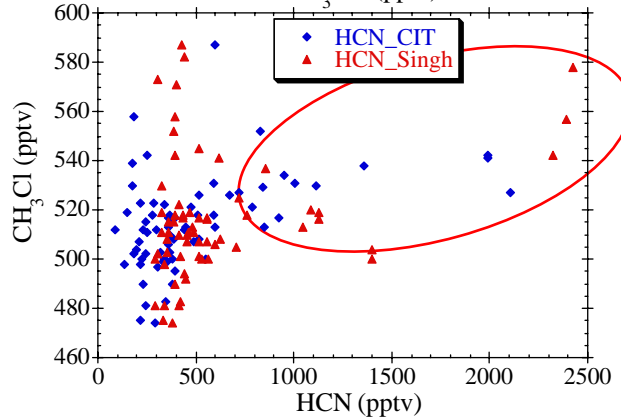
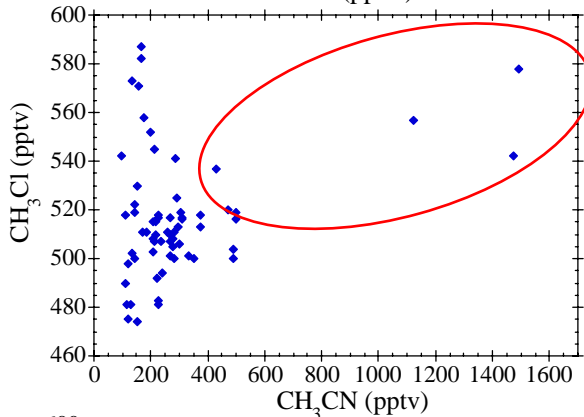
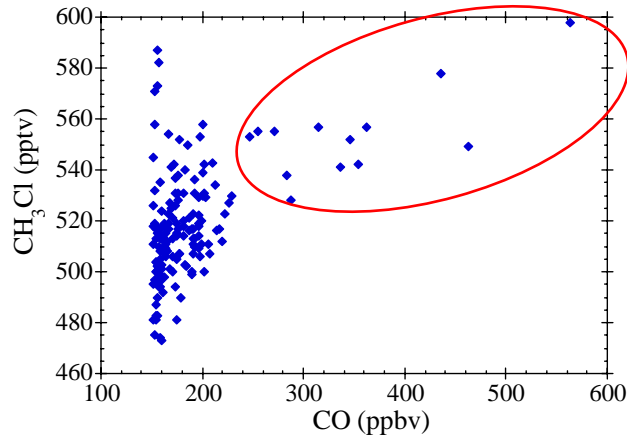
MeCl vs. Acetonitrile

Biomass Burning Tracers

All INTEX Data



Data Subset: CO >160 ppbv, C₂Cl₄ <10 pptv



Few data that look like BB

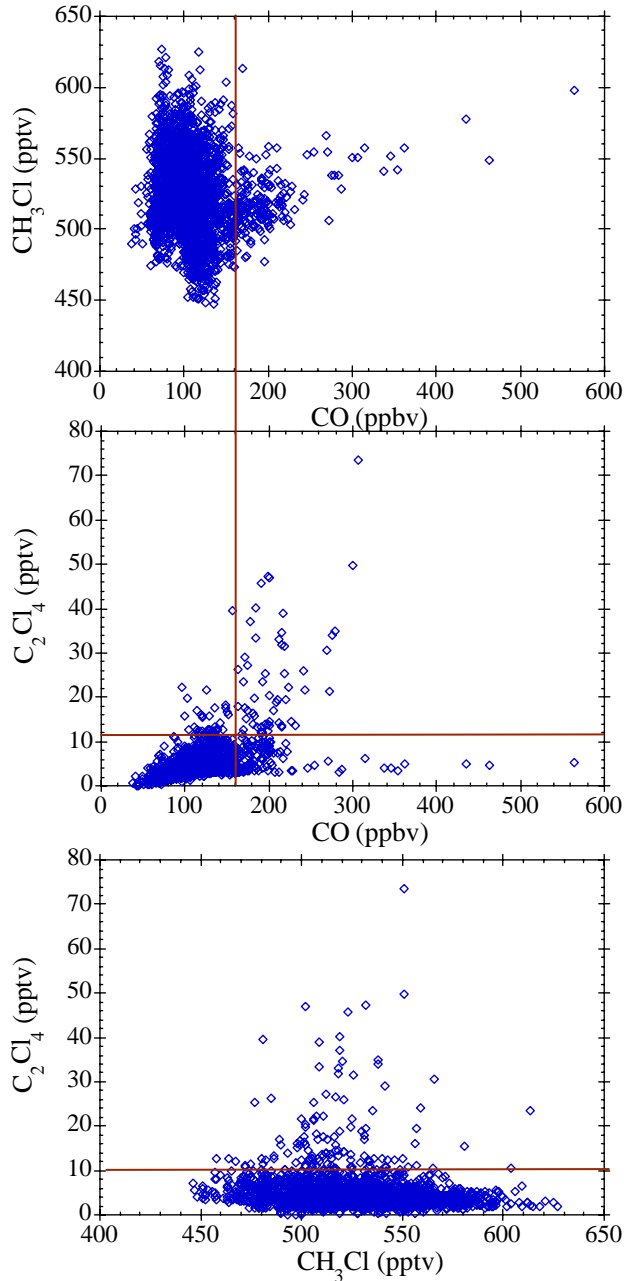
Other Tracers:

MeCl vs. Acetonitrile

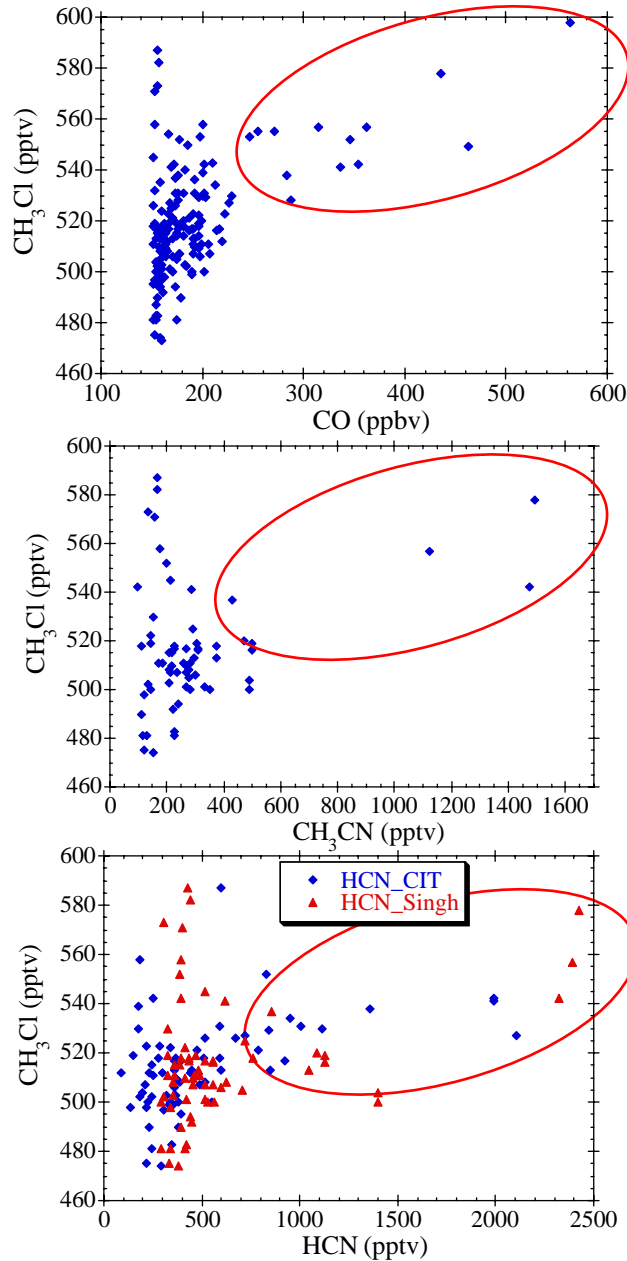
MeCl vs. HCN

Biomass Burning Tracers

All INTEX Data



Data Subset: CO >160 ppb, C₂Cl₄ <10 pptv

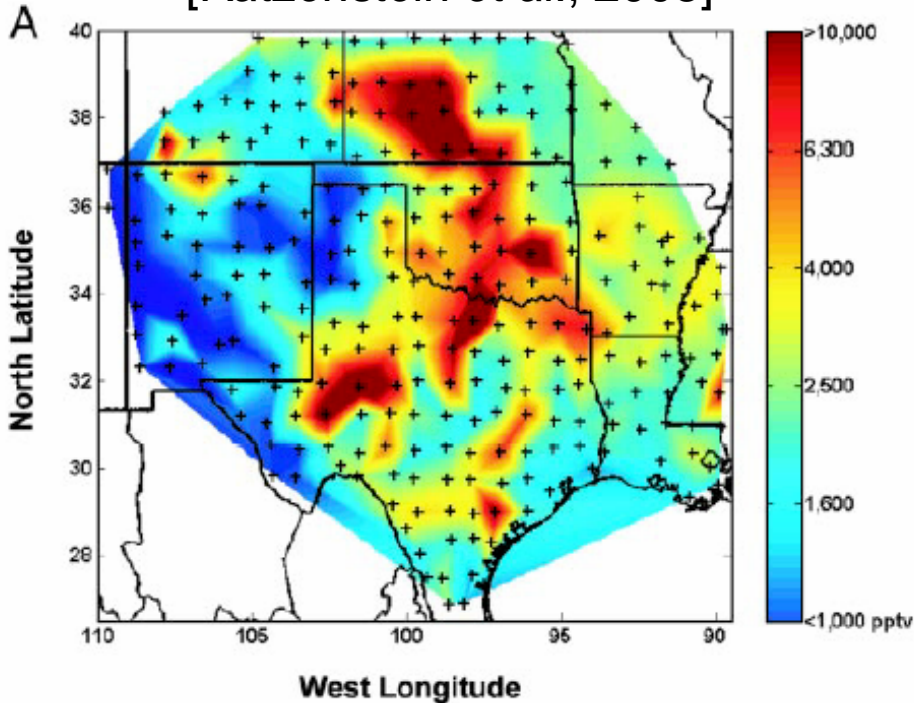


Bottom Line:

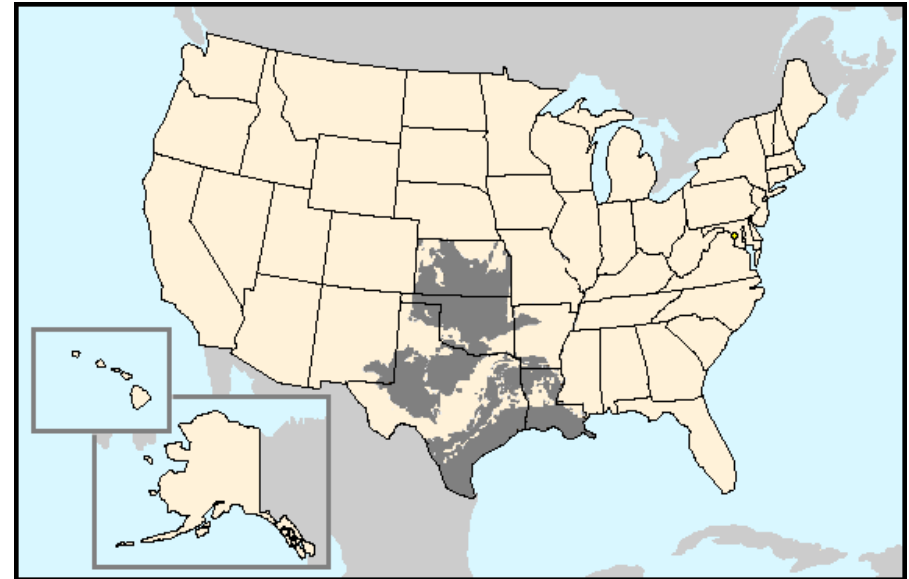
- No really great BB tracers during INTEX (?)
- Not much BB influence directly sampled during INTEX

“SW” Pollution

Ethane from surface study
[*Katzenstein et al., 2003*]



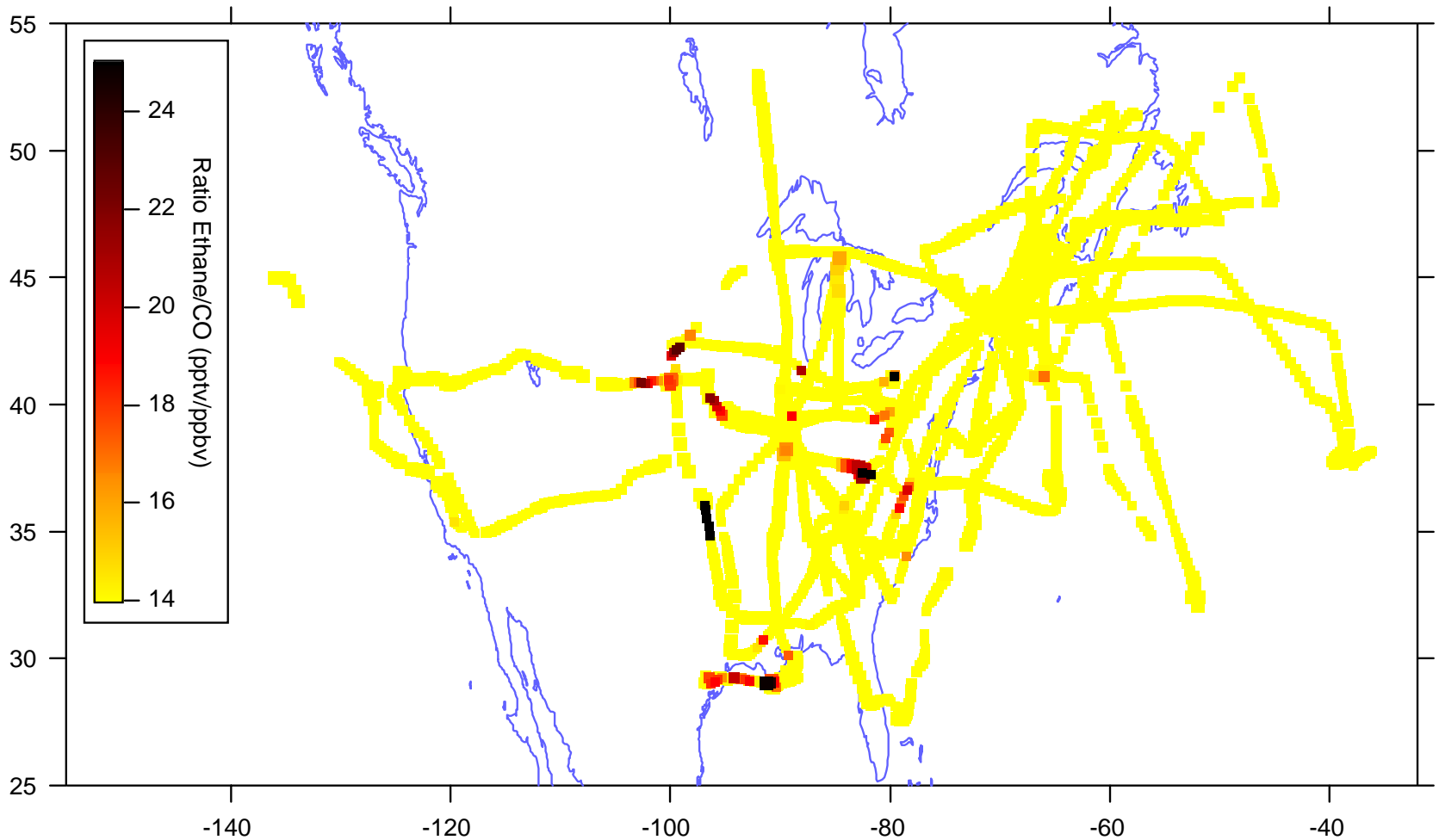
Mid-Continental Oil Field



SW pollution characterized by:

- High levels of alkanes and daughter alkyl nitrates
- Low levels of urban tracers (such as CO)

“SW” Pollution

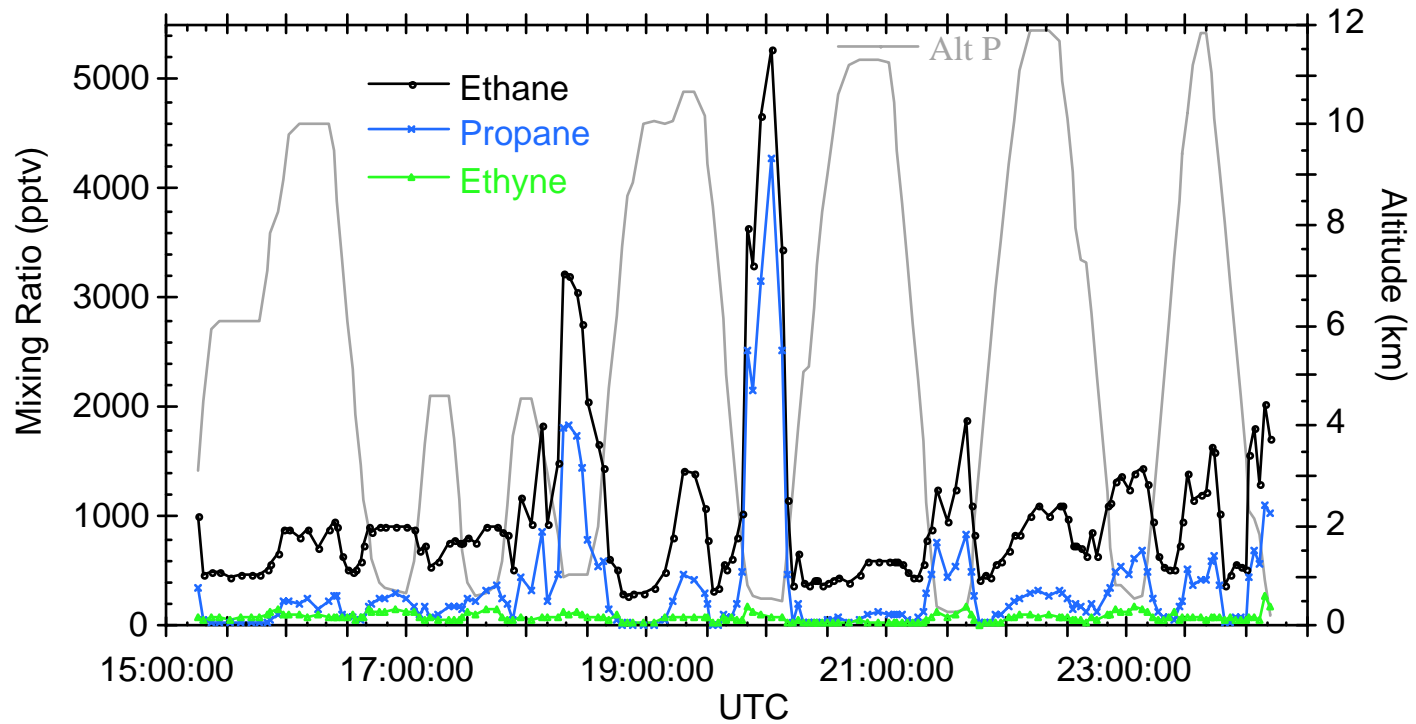


Air masses with “SW” style oil and gas pollution were widespread during INTEX-NA

- sampled on >15 legs on 10 flights

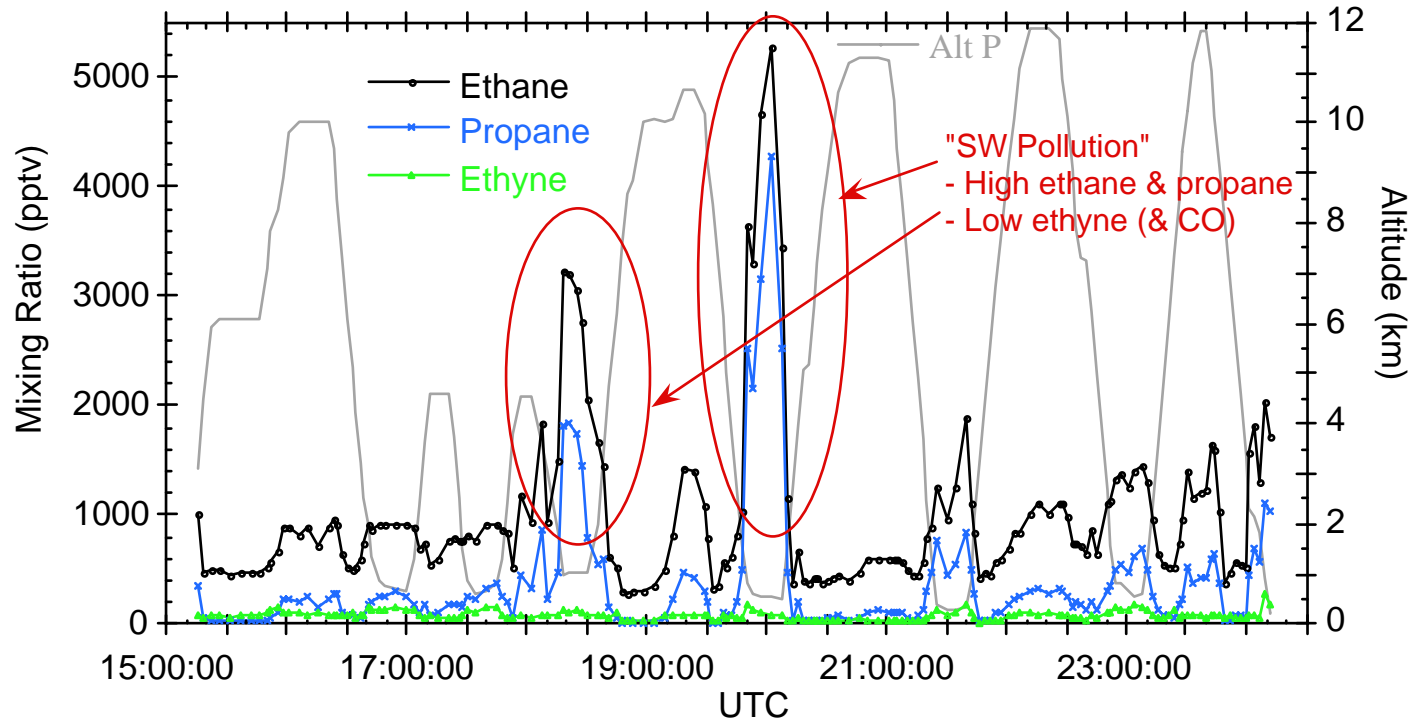
“SW” Pollution

INTEX Flight 7
July 12, 2004



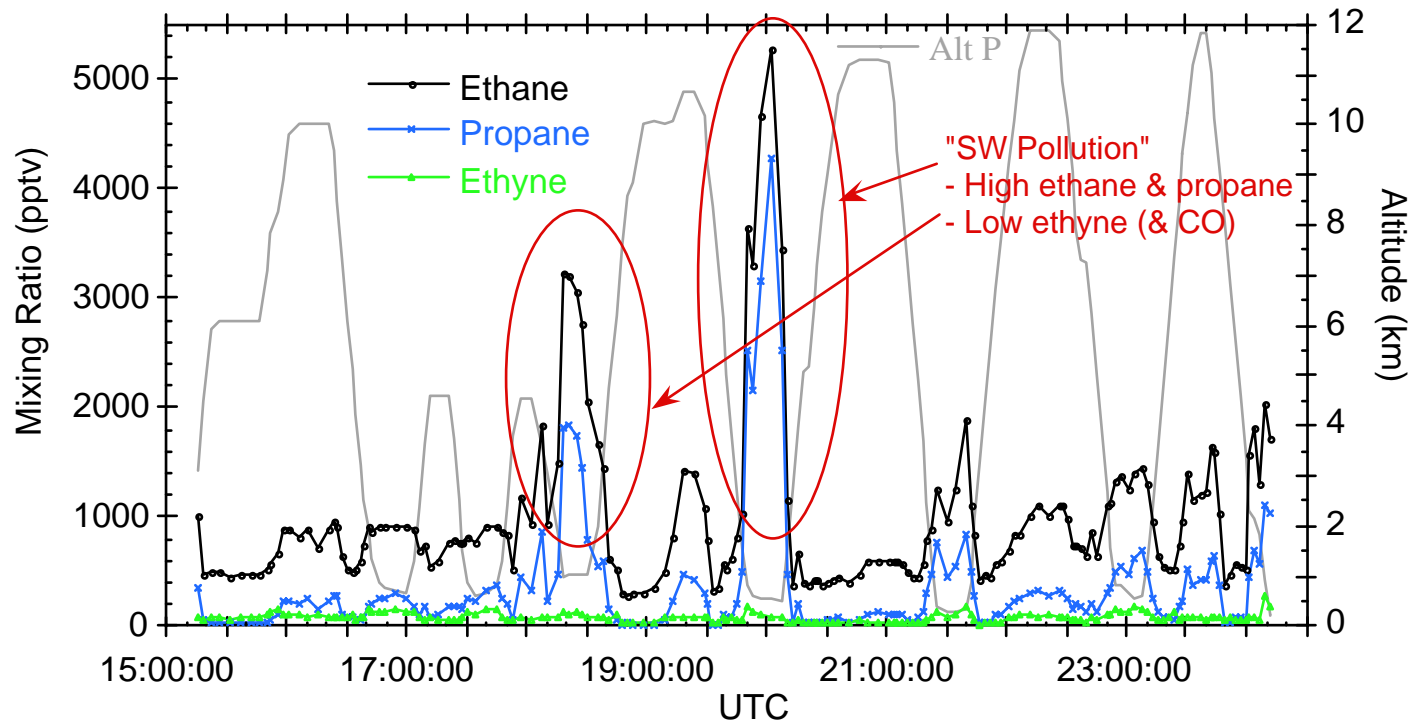
"SW" Pollution

INTEX Flight 7
July 12, 2004



"SW" Pollution

INTEX Flight 7
July 12, 2004



See Poster

First Cut Papers List

Terrestrial Influences on Atmospheric Carbonyl Sulfide and Methyl Chloride over the US during Summertime”, Blake and Blake et al.,

”More Evidence for the Widespread Transport of Light Alkane Pollution from the Southwestern US”, Young, Blake and Blake, Model group, et al.,

”Gaseous Tracers of Convective Uplift during INTEX NA”, Blake and Blake and Fuelburg et al.,

”Coastal Emissions of Bromoform and Dibromomethane during INTEX NA”
Blake and Blake et al.,

”Evidence for Long-range Transport of Asian Emissions to the US During Summer”,
Blake and Blake and Fuelburg et al.,