TOGA/ Fast Gas Chromatograph Mass Spectrometer (FGCMS) – prototype for HIAPER

Eric Apel
Alan Hills
Dan Riemer, U. Miami
Rich Lueb

Gas chromatograph/Mass Spectrometer

Measurement campaigns

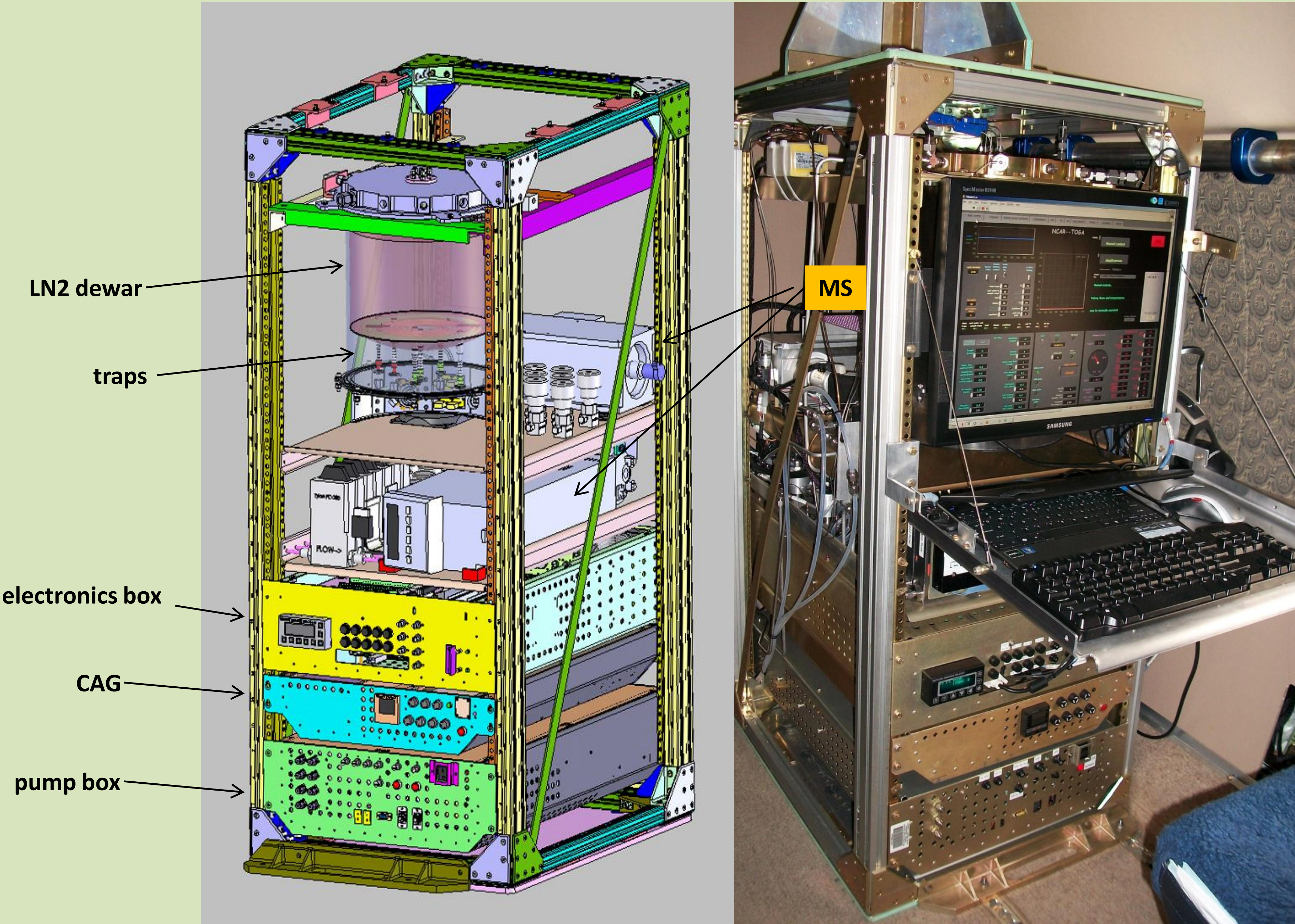
- TRACE-P
- IDEAS
- MIRAGE
- INTEX-B
- ARCTAS
- OASIS
- MIRAGE-Shanghai

The National Center for Atmospheric Research
NCAR
sponsored by NSF

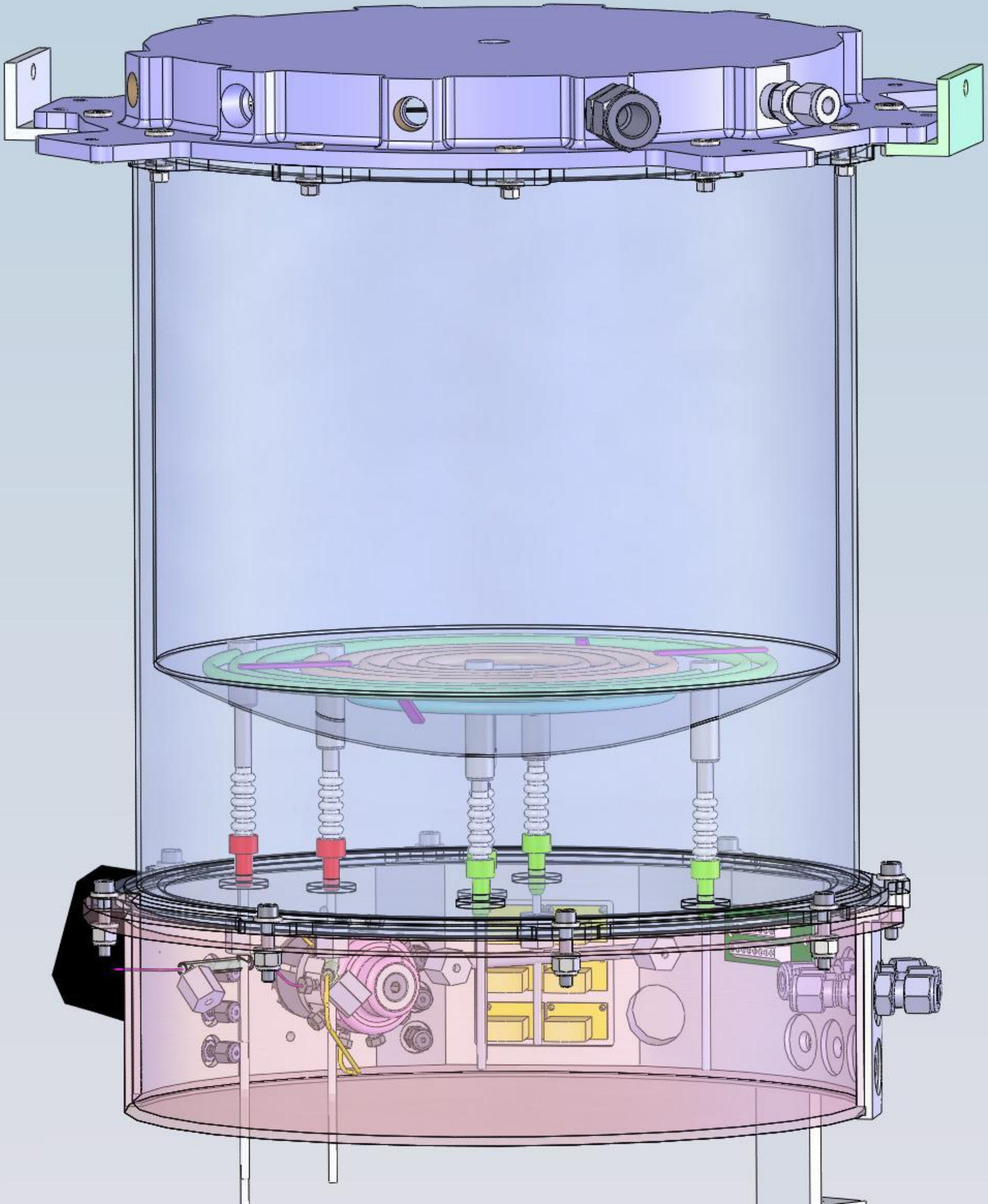
Trace Organic Gas Analyzer (TOGA)

- **High sensitivity VOCs/OVOCs to ppt**
- **High selectivity 2-D GC/MS**
- **Rapid 2 minutes**
- **Altitude independent 0-50,000 feet**
- **semi – Autonomous**

Gulfstream G-V

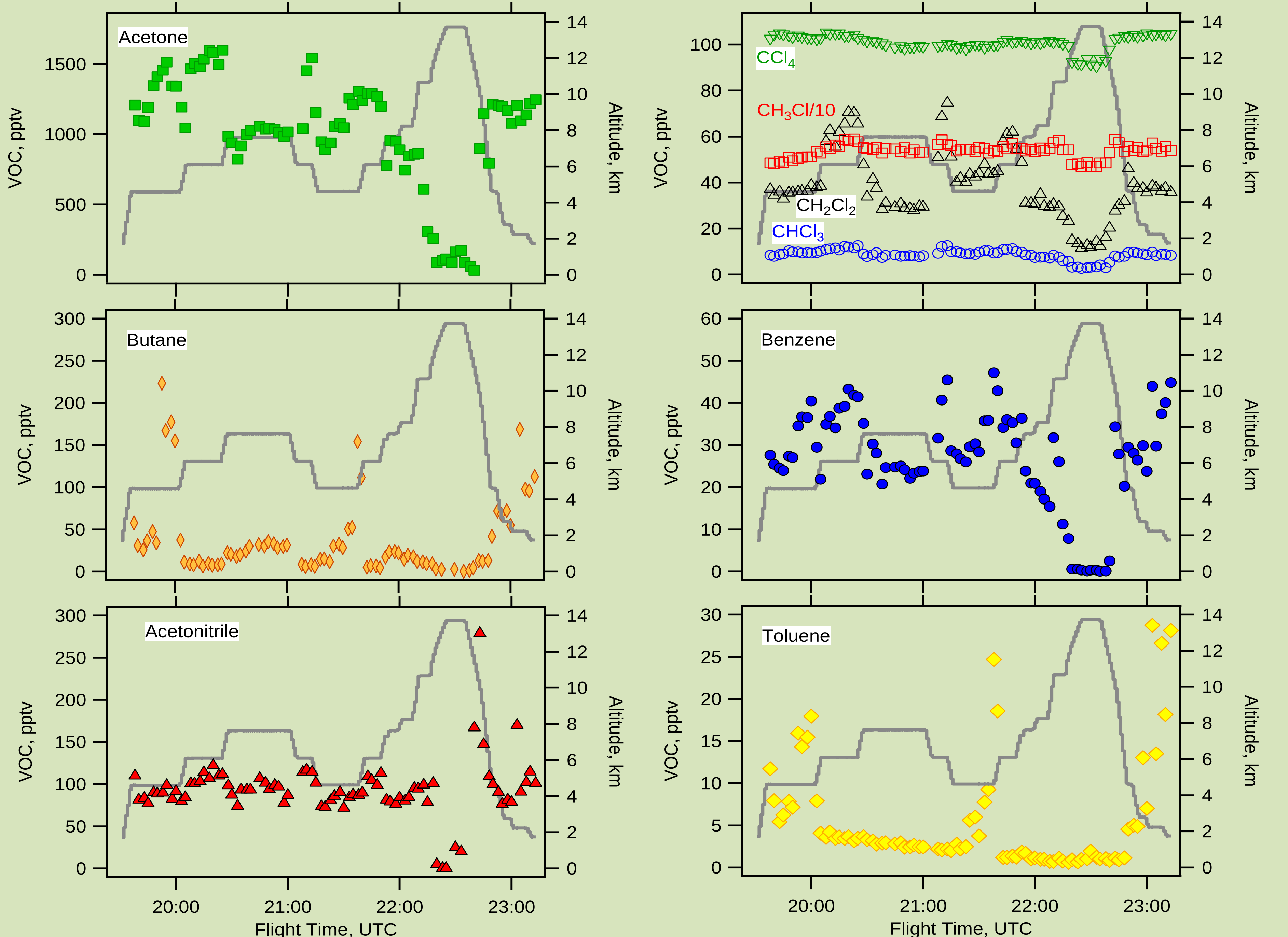

LN2 dewar
traps
electronics box
CAG
pump box
MS
FLOW->
NCAR--TOGA
SAMSUNG

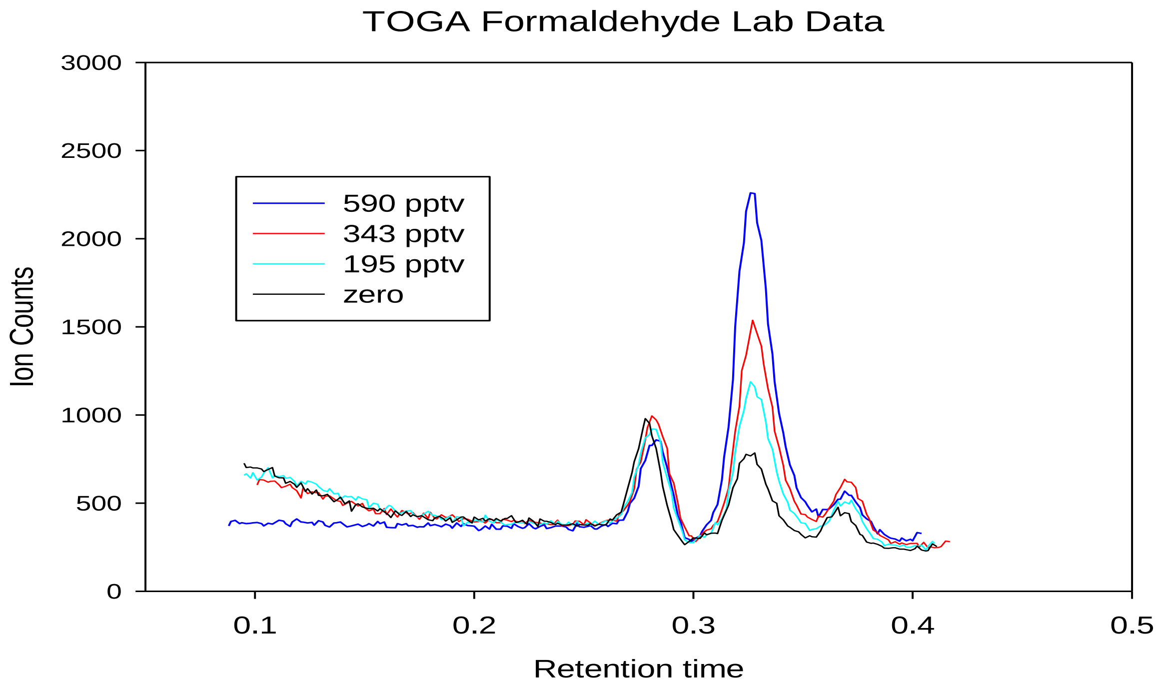
10-L
Cryogenic LN2 dewar



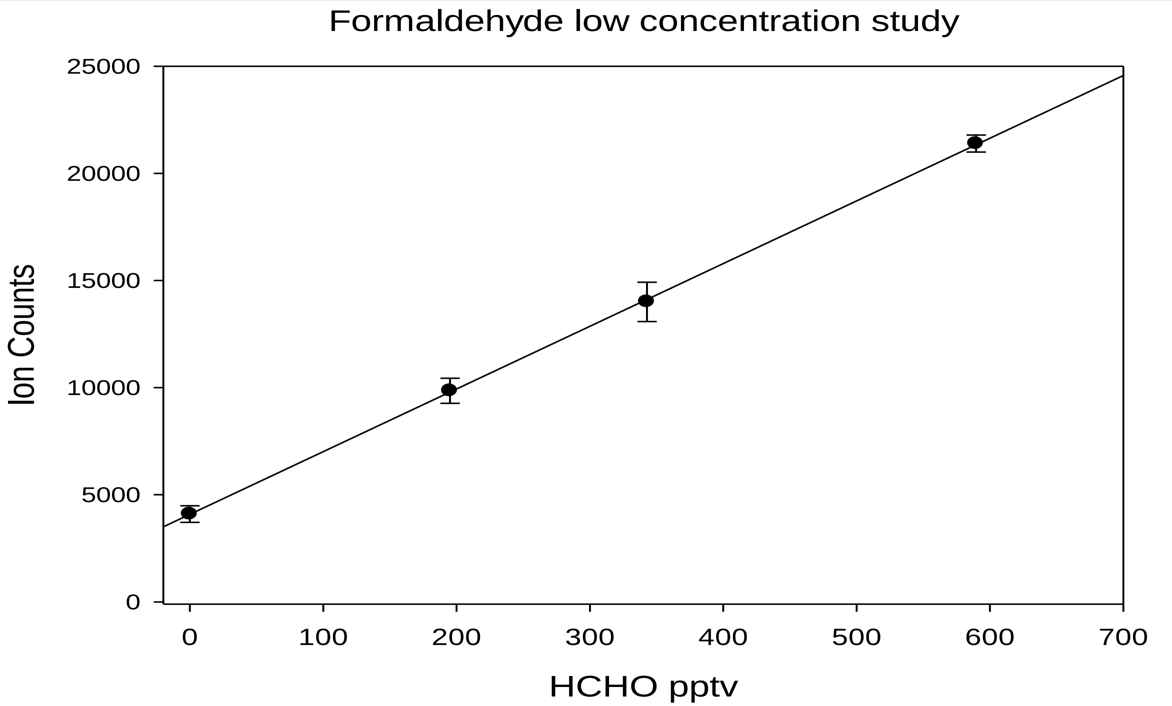
TOGA compounds (may do a subset or switch subsets on the fly)			
Hydrocarbons	Propane	Isoprene	
	1-Butene	*t*-2-Pentene	
	i-Butene	*c*-2-Pentene	
	Butane	*i*-Pentane	
	i-Butane	*o*-Xylene	
	Benzene	*m/p*-Xylene	
	Toluene	1,3,5-Trimethylbenzene	
	Ethyl Benzene	1,2,4-Trimethylbenzene	
	t-2-Butene	α-Pinene	
	c-2-Butene	β-Pinene	
	Pentane	Camphene	
	1,3-Butadiene	Myrcene	
	Limonene		
Oxygenates	Formaldehyde		
	Acetaldehyde	Methanol	
	Propanal	Ethanol	
	Butanal	Acetone	
	Pentanal	Butanone	
	Methacrolein	2-Pentanone	
	Methyl Vinyl Ketone	3-Pentanone	
	Methyl Butenol	Methyl t-Butyl Ether	
Halocarbons	Chloroform ($CHCl_3$)	Tetrachloromethane (CCl_4)	dibromomethane
	Methylene chloride (CH_2Cl_2)	CFC-113	diodomethane
	Methyl chloride (CH_3Cl)	HCFC-141b	bromocjhloromethane
	Methyl bromide (CH_3Br)	HCFC-134a	bromoiodomethane
	Tetrachloroethane (CH_2Cl_4)	1,2-Dichloroethane ($C_2H_4Cl_2$)	chloroiodomethane
	Tetrachloroethylene (C_2Cl_4)	Methyl Iodide (CH_3I)	
	Bromoform	iodoform	
Nitrogen and sulfur compounds	Acetonitrile	DMSO?	
	Dimethyl Sulfide (DMS)		

TOGA flight data, 6 May 2011





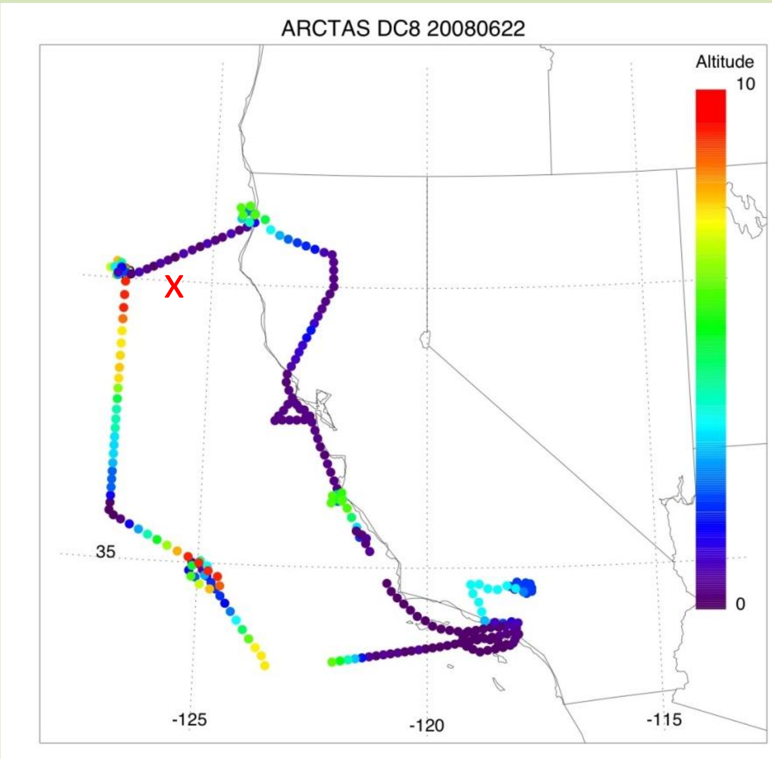
Signal-to-noise (S/N) of 195 peak = 35
LOD for 5 x S/N = 195* 5/35 = 28 pptv, but because the peak we use for the S/N calculation contains some background, the peak used for the S/N calculation is actually ~ 2x larger than it should be relative to the noise so the detection limit at 5x is closer to 50-60 pptv.

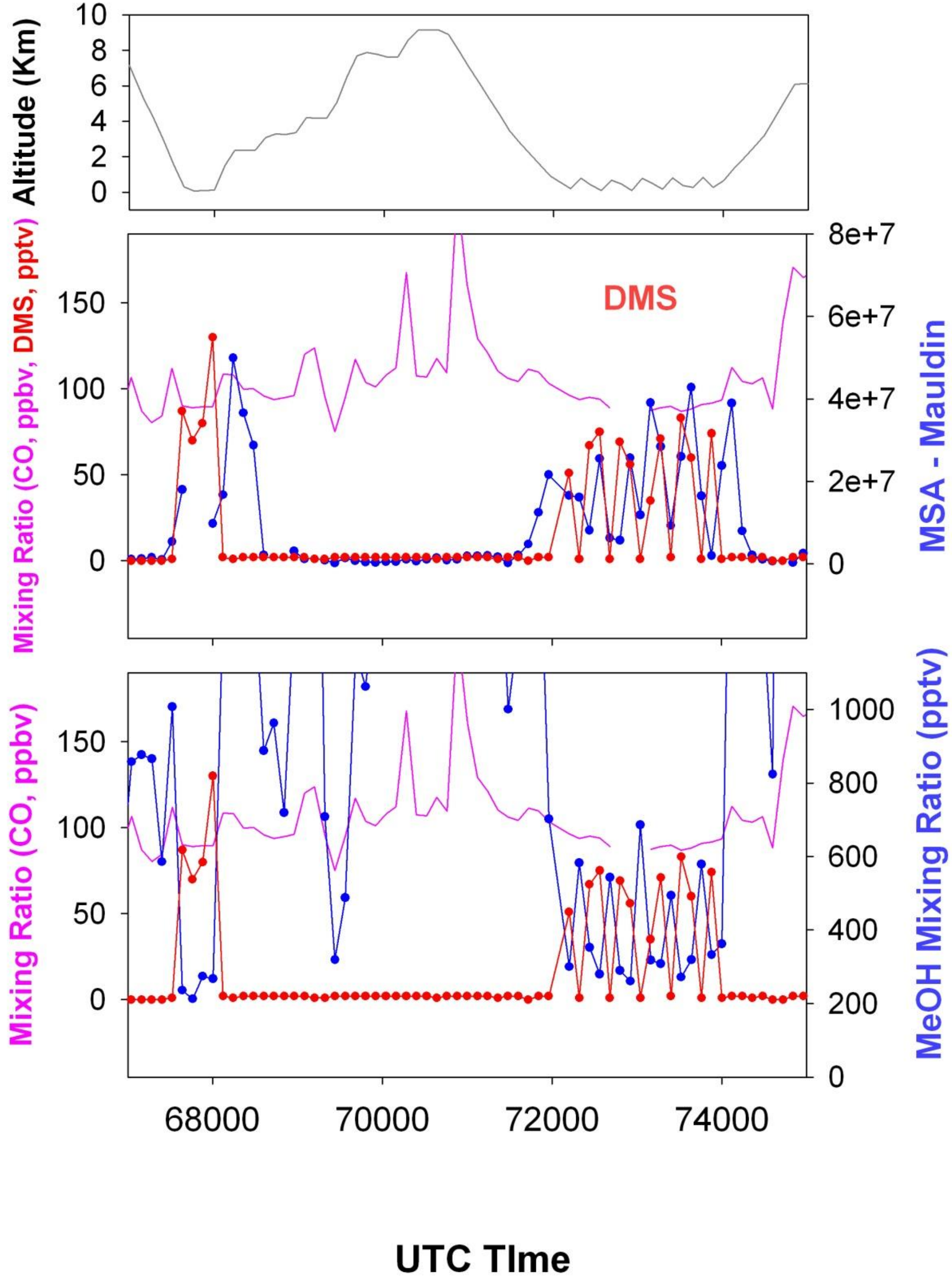


Calibration curve for the TOGA low concentration formaldehyde study. Five measurements were obtained for each data point using formaldehyde standards introduced to TOGA. The standards were generated using the permeation system described in Figure 2 coupled to the dilution apparatus described in Figure 4.

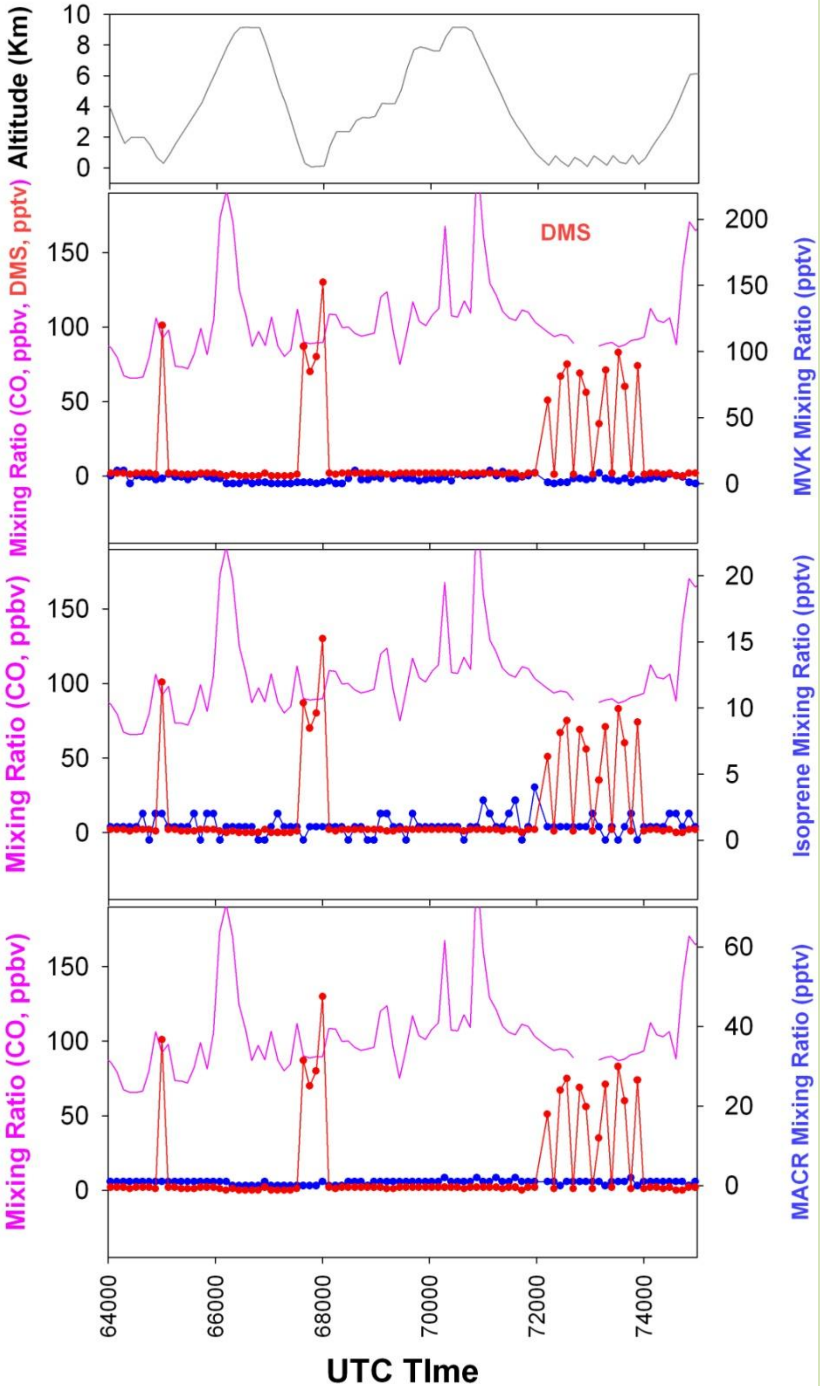
DMS
MSA

ARCTAS-CARB

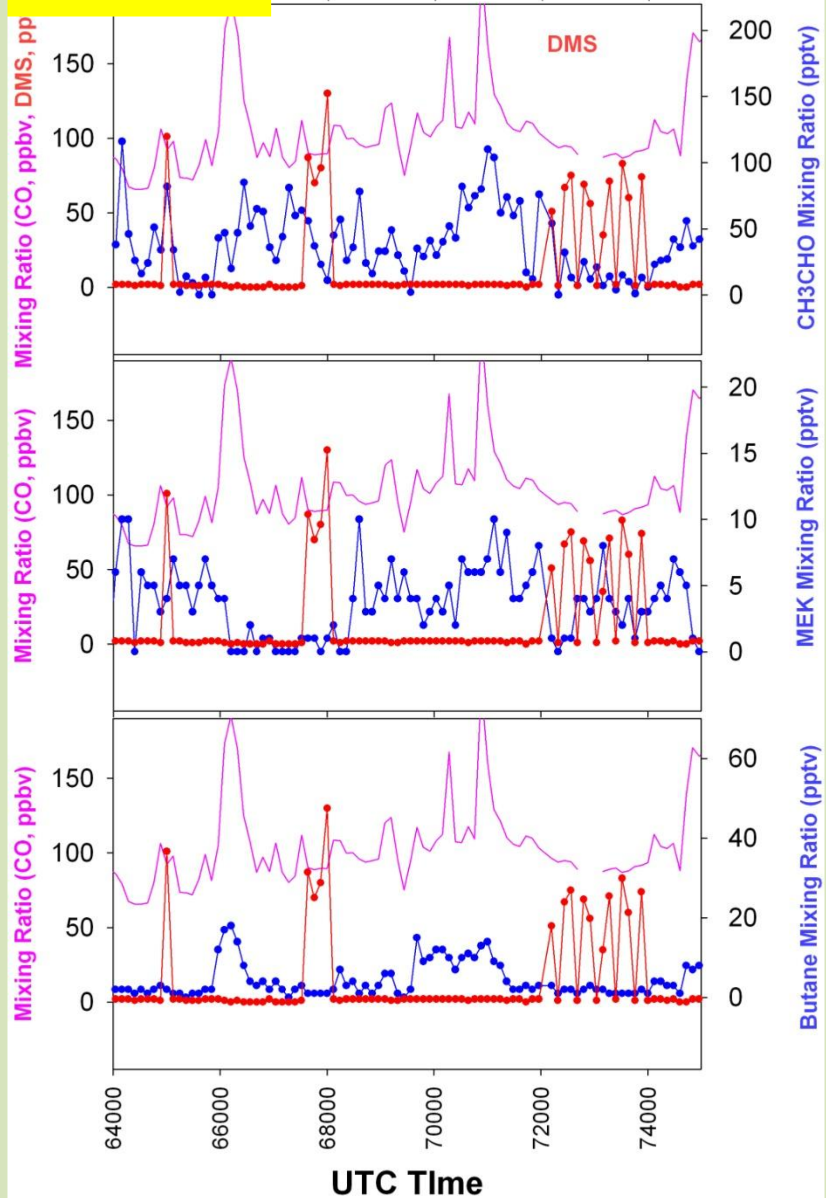




ISO
MVK
MACR

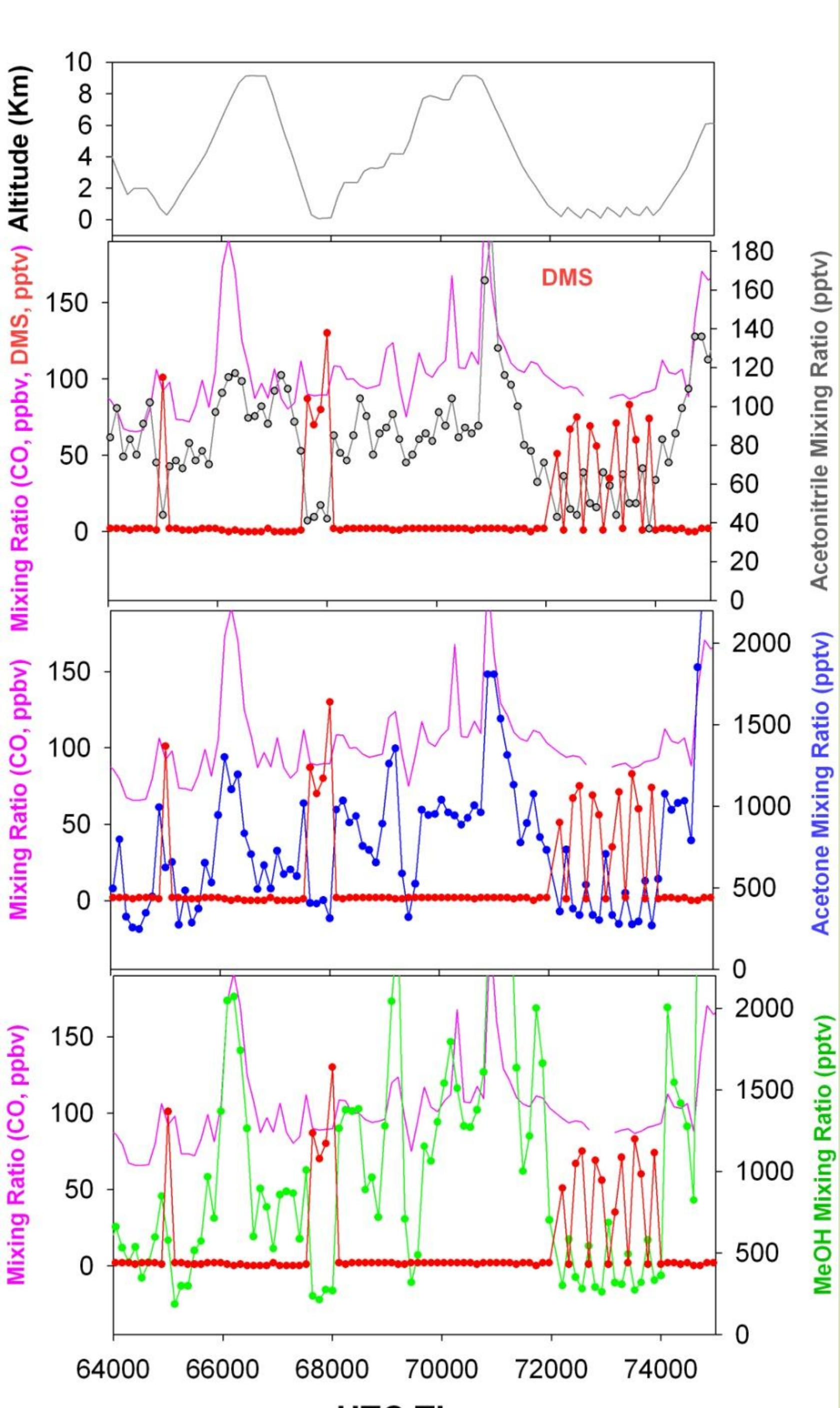


CH3CHO
MEK
Butane



CH_3CN
Acetone
MeOH

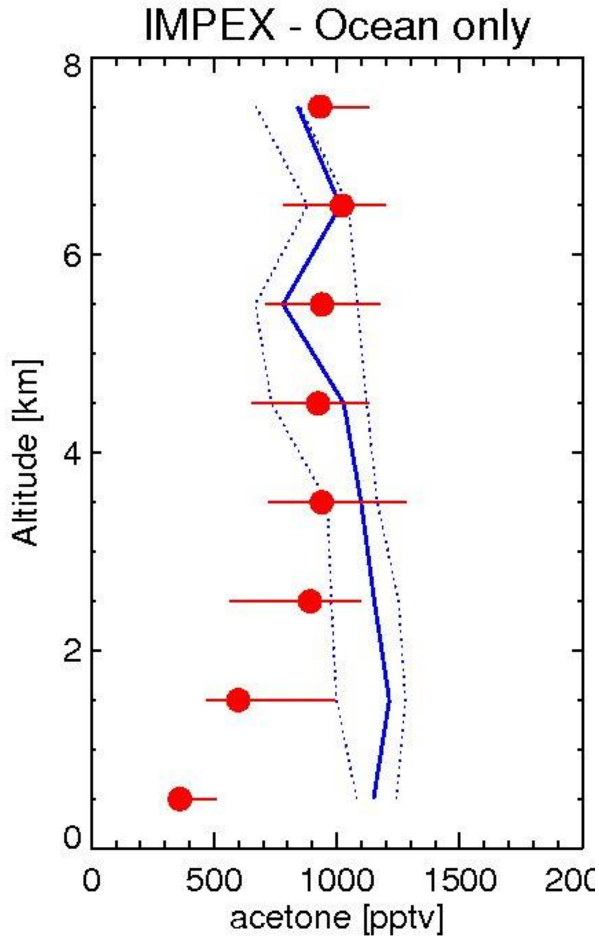
All species depleted in MBL

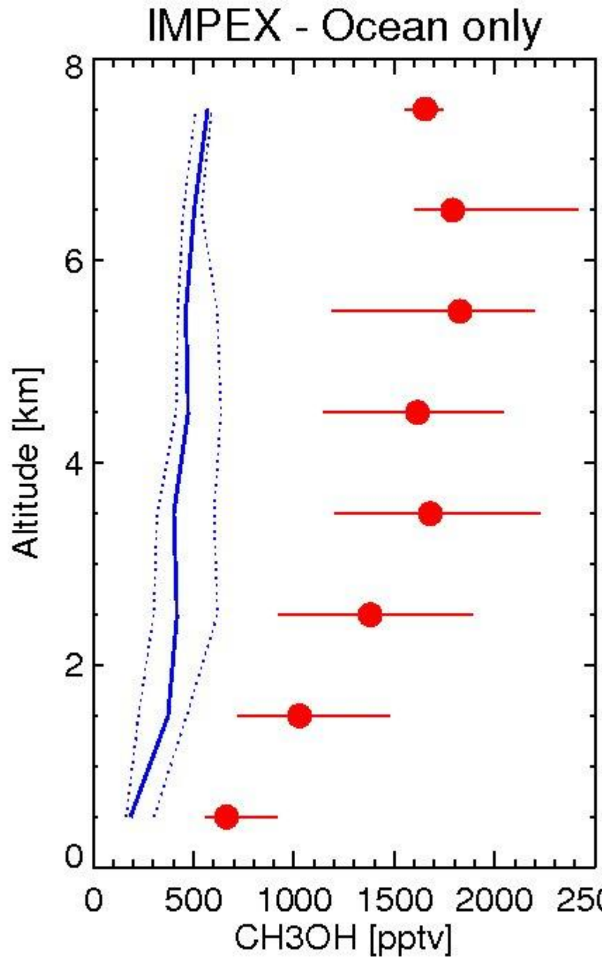


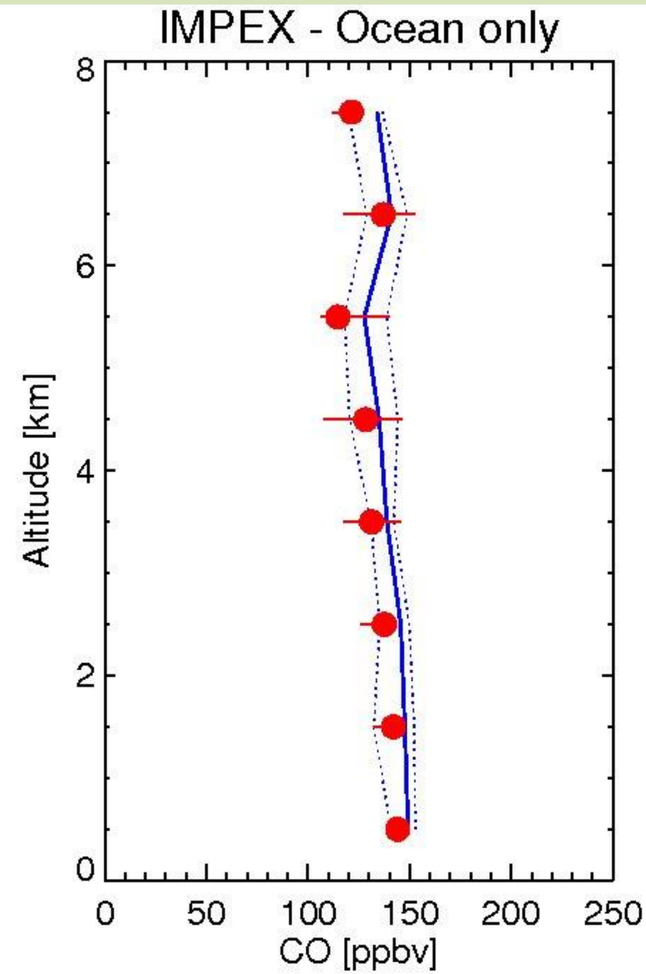
TRACE Organic Gas Analyzer – TOGA – VOC measurements INTEX-B
Role of Ocean in Global Atmospheric Budgets

Oxygenates: acetone, methanol

CO







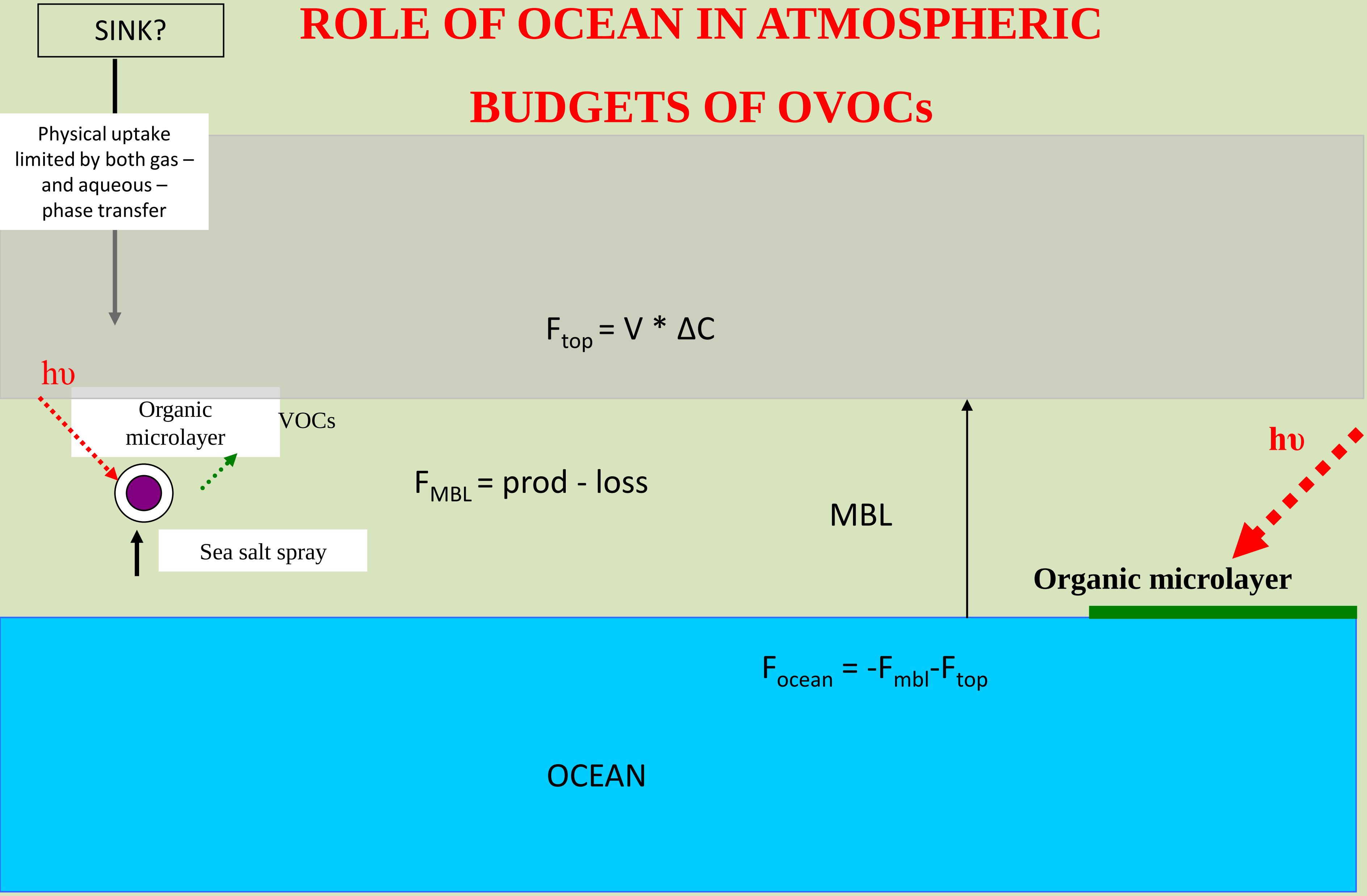
● Median Values – TOGA

— MOZART

Acetone -4.7 um m^2 day^{-1}

Methanol-3.3 um m^2 day^{-1}

ROLE OF OCEAN IN ATMOSPHERIC BUDGETS OF OVOCs



Singh et al., 2003, D. Riemer, I. Faloona, private correspondence

Previous Work:

Methanol, Acetone, etc.. – large ocean source – Nature
Singh et al, 2001

– small ocean sink (Singh et al, 2003)

Acetone: Marandino et al (Saltzman (2005)) – Fluxes of Acetone

- large ocean sink

- Gradient fluxes of ~ -3 -12 um m^2 day^{-1} (Eddy Co-variance)

Preliminary results (back of envelope) here:

Flux (Assume MBLL – MBLP = 0)

Acetone -5.5 um m^2 day^{-1} (Saltztman - ~ - 9 um m^2 day^{-1})

Methanol-8.32 um m^2 day^{-1}

CH3CN ran out of time this morning..

Preliminary results w/ losses:

Flux (without boundary layer loss but not production)

Acetone -4.7 um m^2 day^{-1}

Methanol-3.3 um m^2 day^{-1}

CH3CN ran out of time this morning..