

# Trace gas sources and distributions in the tropical troposphere and TTL

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***CONTRAST: L. Pan, R. Salawitch + Science Team***

***ATTREX: E. Jensen, L. Pfister, J. Pittman, E. Hintsä + Science Team***

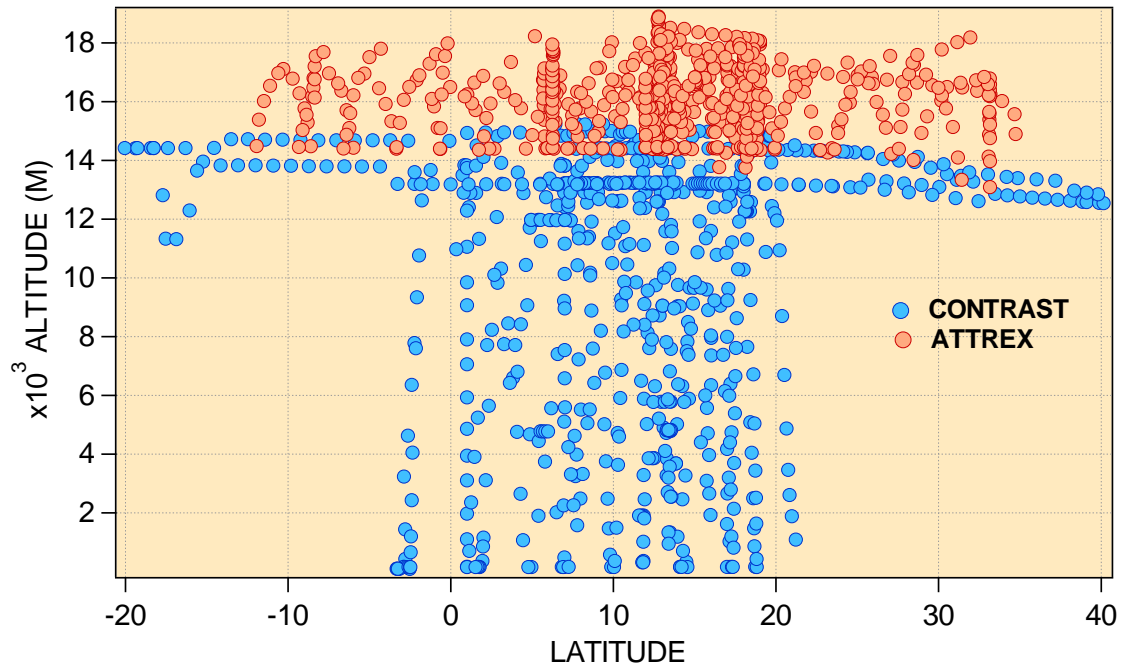
***CAST: N. Harris, L. Carpenter, S. Andrews + Science Team***

***HIPPO: S. Wofsy, S. Montzka, F. Moore, B. Miller, J. Elkins + Science Team***

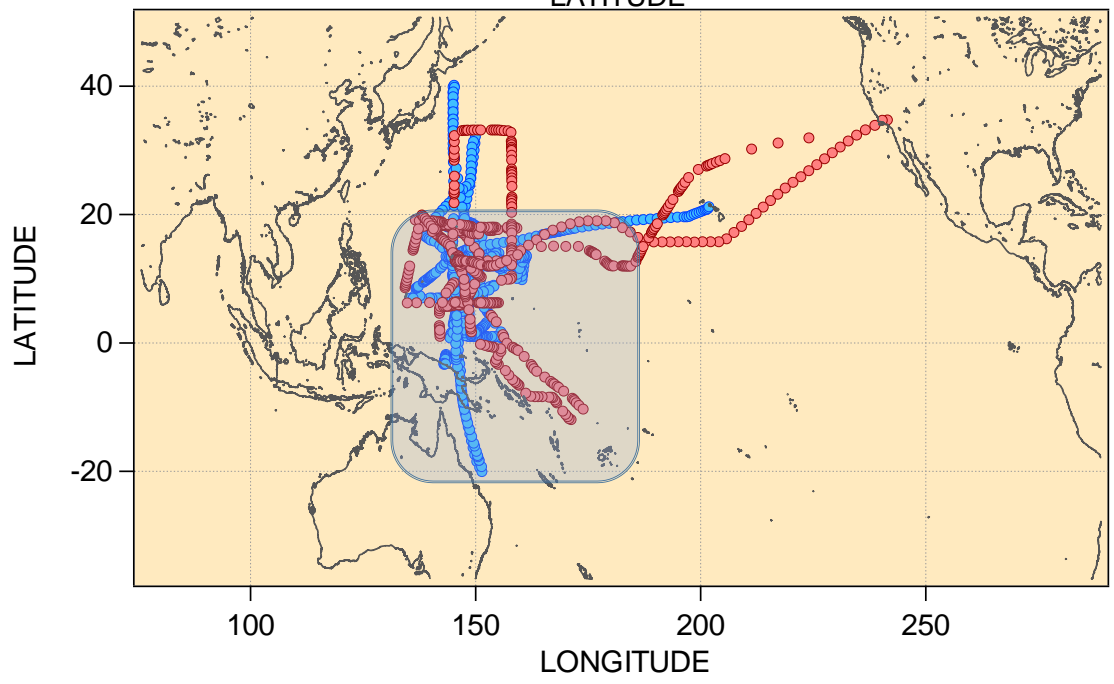
***\$ support from NASA and NSF***

# Motivations

- What is magnitude of halogen input to the tropical lower stratosphere from organic and inorganic species (focus on bromine)?
- How does tropical convection in the West Pacific influence the composition of air entering the stratosphere?
- How can tracers of different lifetime/sources be used to diagnose transport and chemical processes in the TTL?
- What is relationship of tracer distributions to cirrus formation and cloud distributions?
  - **CONTRAST:** define vertical distributions, variations, sources; transport to/into the base of the TTL
  - **ATTREX:** evaluate variation and transport through TTL and into lower stratosphere.
  - **CAST:** define geographic variability of chemical composition in the marine boundary layer and mid-troposphere
  - January – February, 2014; Guam



# AWAS/GWAS Sample Locations



# Focus on AWAS tracers

- Organic Bromine Measurement
  - Vertical Distribution/Composition
- Trace Gas Variability in the TTL
  - Vertical profiles and influence of transport
  - Tracer correlations/source identification
- Impact of strong convection
  - relation to clouds/convective outflow

# Tracer Selection

- **Organic Halogen (VSLs)**

- Br:  $\text{CHBr}_3$ ,  $\text{CH}_2\text{Br}_2$ ,  $\text{CHBrCl}_2$ ,  $\text{CHBr}_2\text{Cl}$ ,  $\text{CH}_2\text{BrCl}$ , + ?

- Marine biogenic emissions; weeks to months

- I:  $\text{CH}_3\text{I}$

- Marine biogenic emission; days

- Cl:  $\text{CH}_2\text{Cl}_2$ ,  $\text{C}_2\text{Cl}_4$

- NH anthropogenic emission; months (changing emissions)

- **Organic Nitrates**

- Methyl nitrate ( $\text{CH}_3\text{ONO}_2$ )

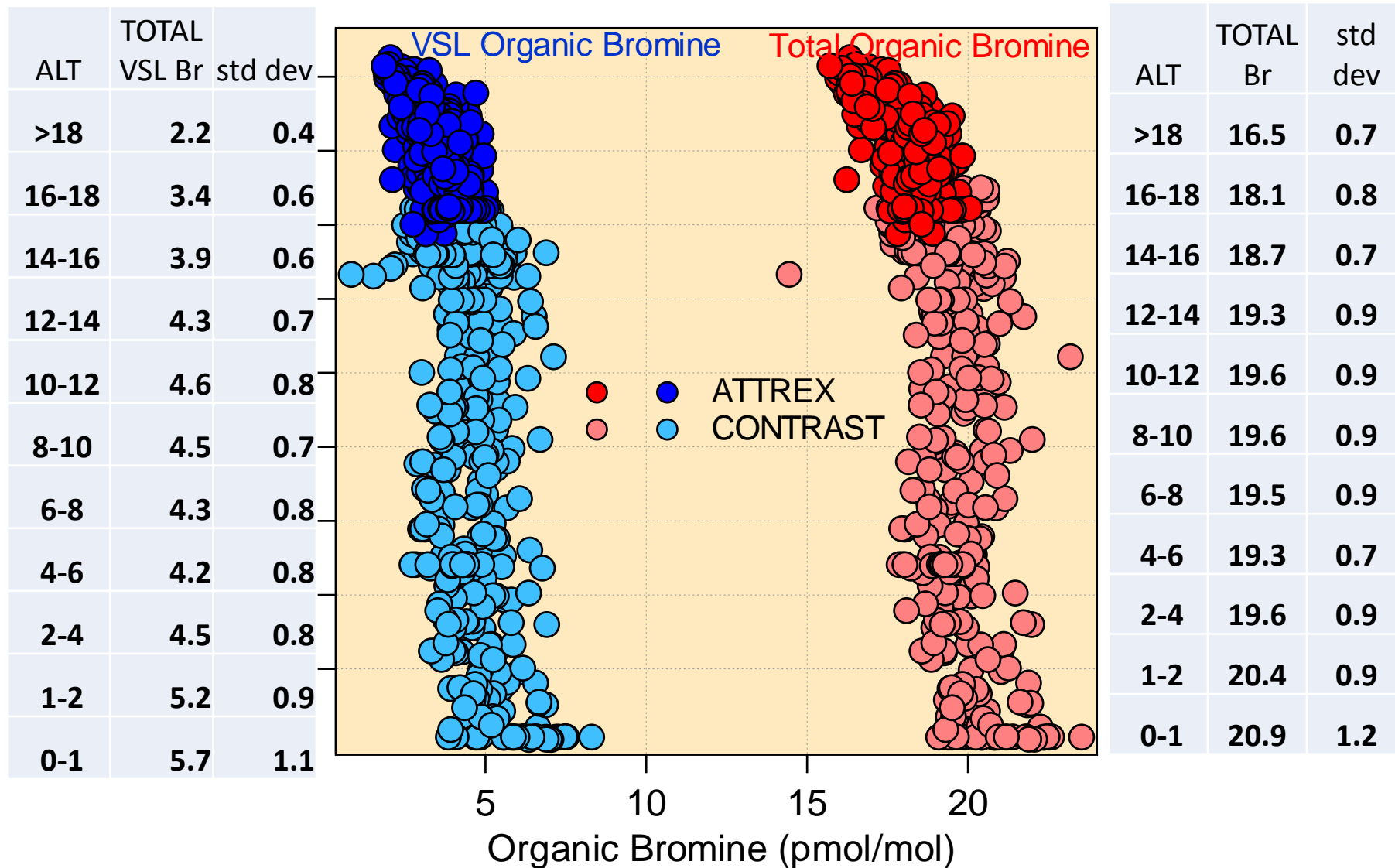
- Equatorial marine photochemical/biochemical emission; weeks

- **Hydrocarbons**

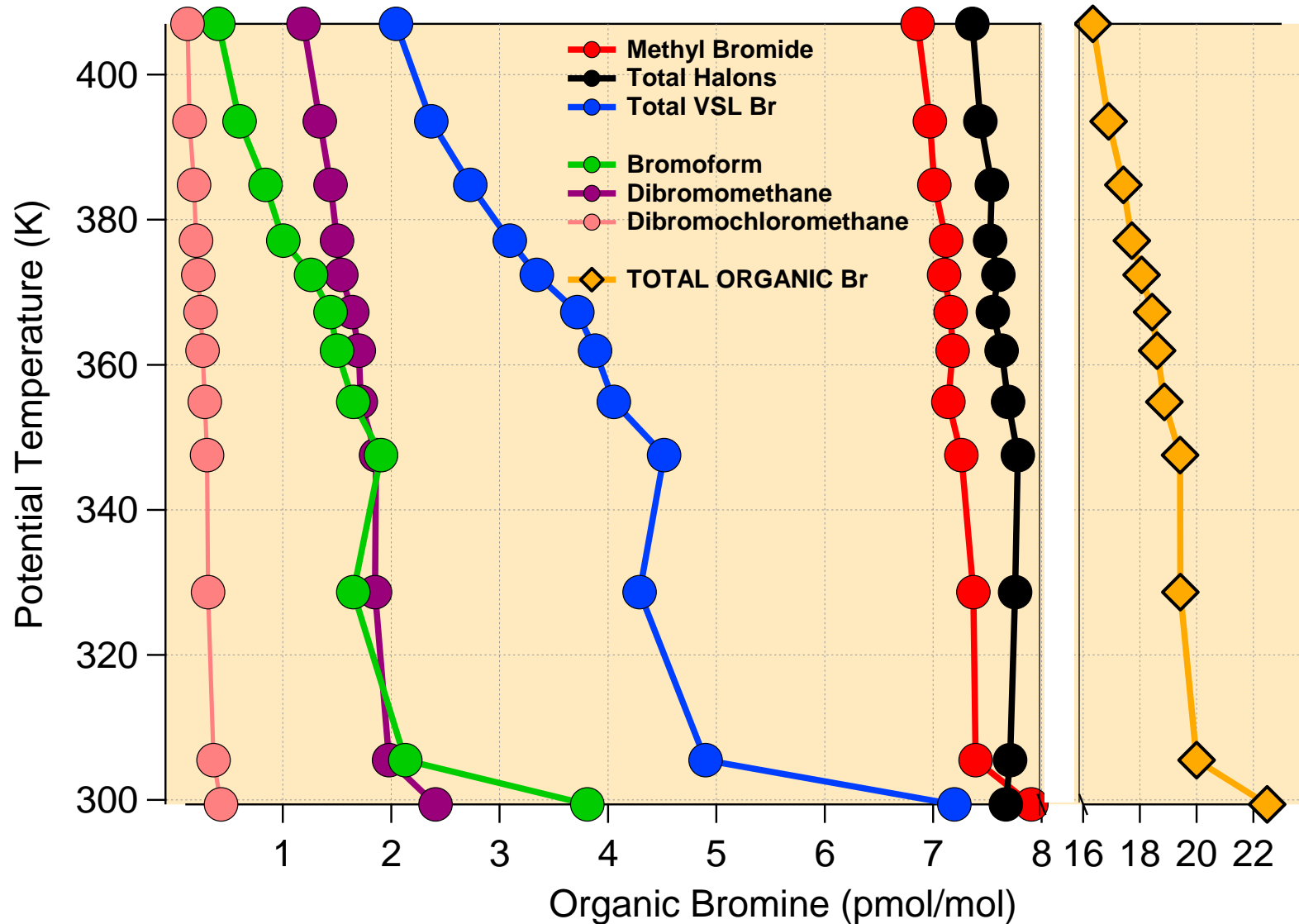
- C2: Ethane ( $\text{C}_2\text{H}_6$ ), Ethyne ( $\text{C}_2\text{H}_2$ )

- NH anthropogenic emission; weeks (ethyne), months (ethane)

# Organic Bromine – CONTRAST/ATTREX



# Variation of Organic Br across TTL

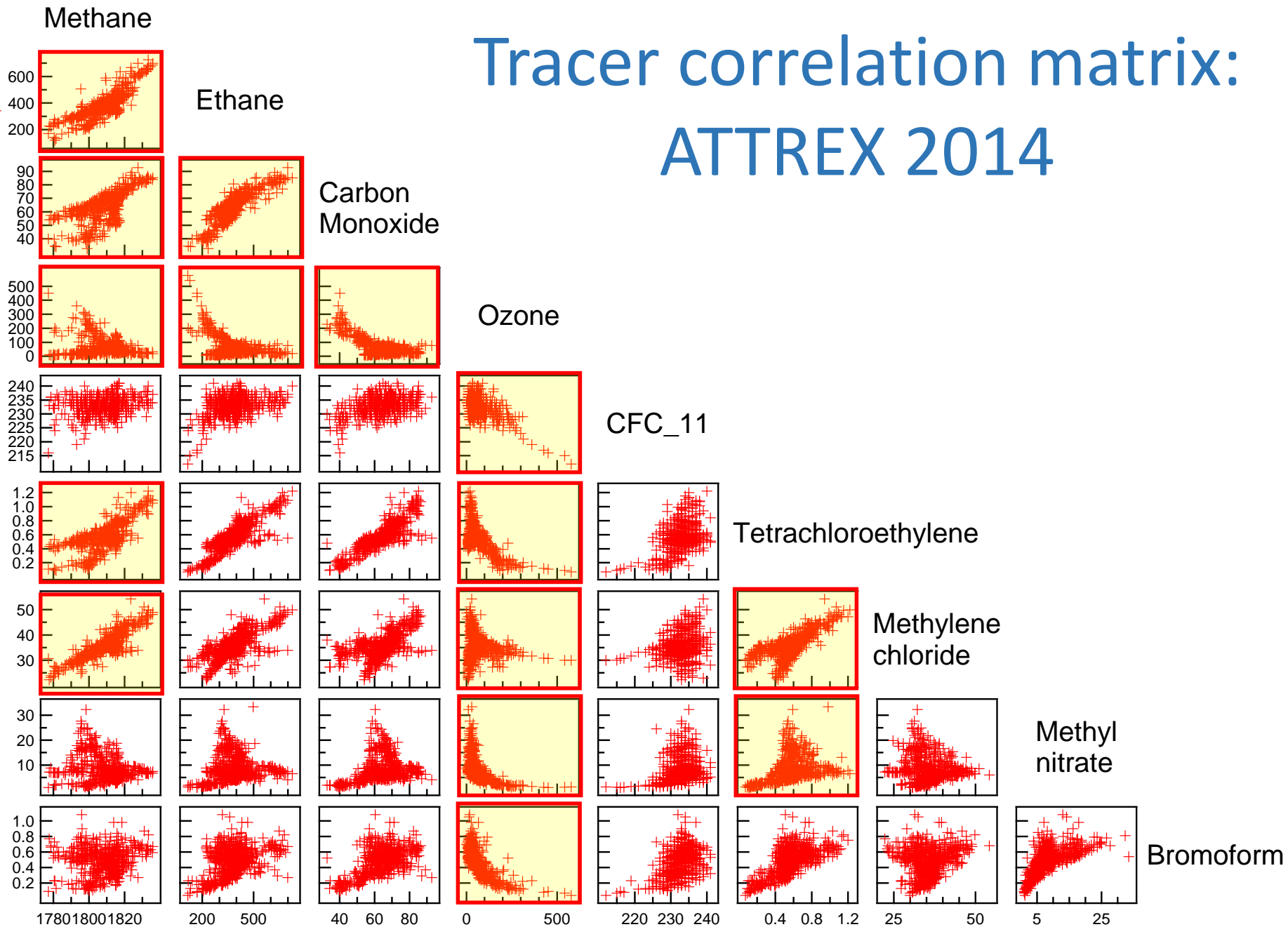


# Total organic Br in the tropics

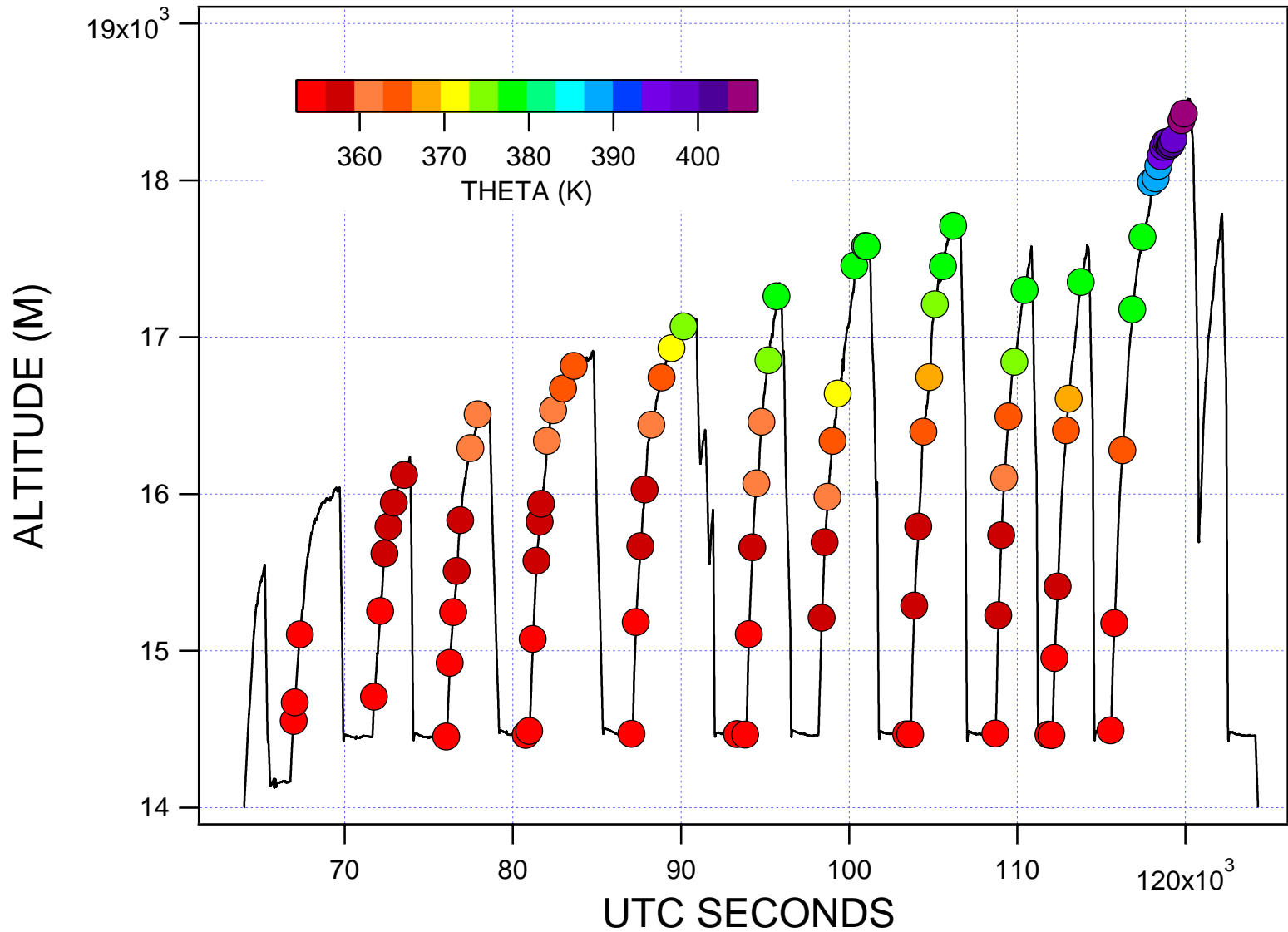
	UPPER Trop (340-360 K)		Tropopause (375 - 380 K)
	This Work	SHIVA	This work
TOTAL Org Br	19.2 (0.8)	20.11 (1.62)	17.9 (0.6)
VSL Br	4.26 (0.72)	4.35 (0.44)	3.16 (0.47)
CH3Br	7.23 (0.33)	7.35 (0.60)	7.12 (0.30)
Halons	7.75 (0.16)	8.31 (0.58)	7.54 (0.10)

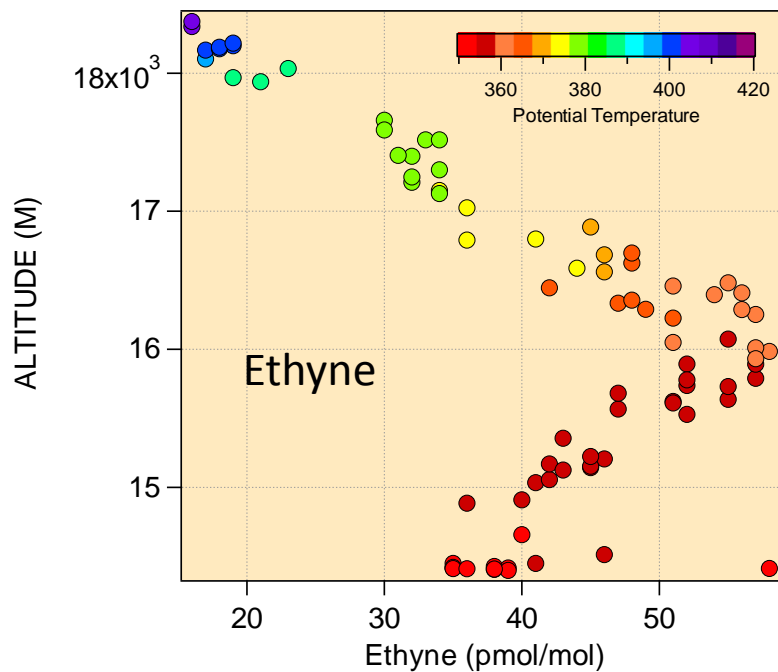
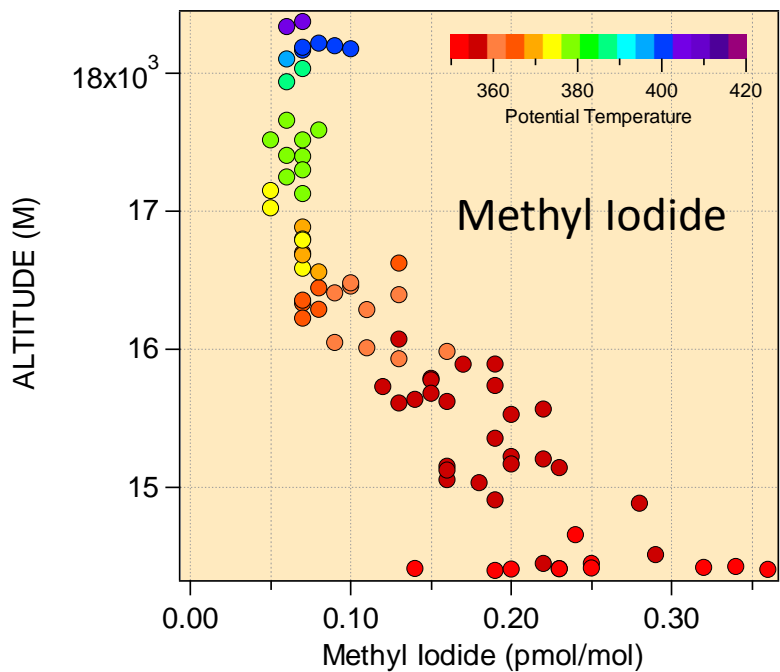
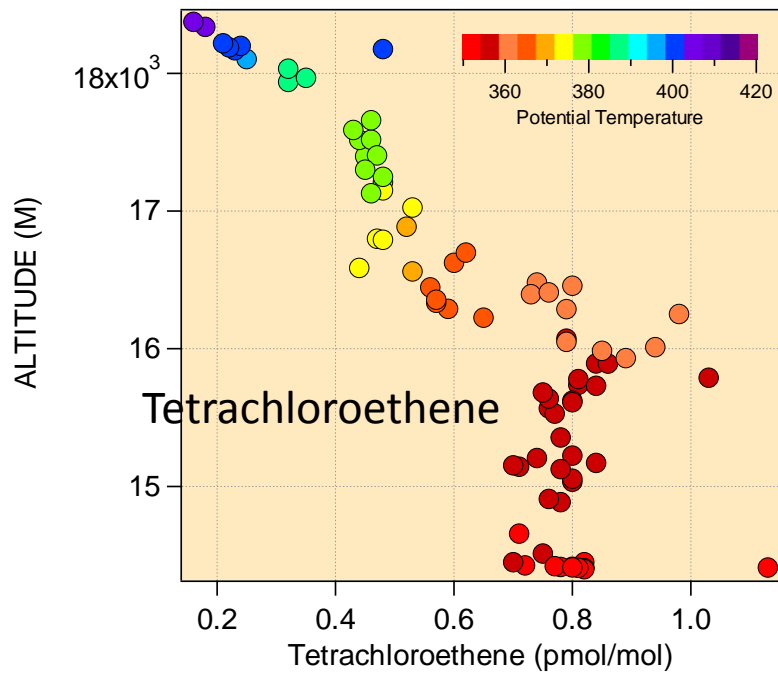
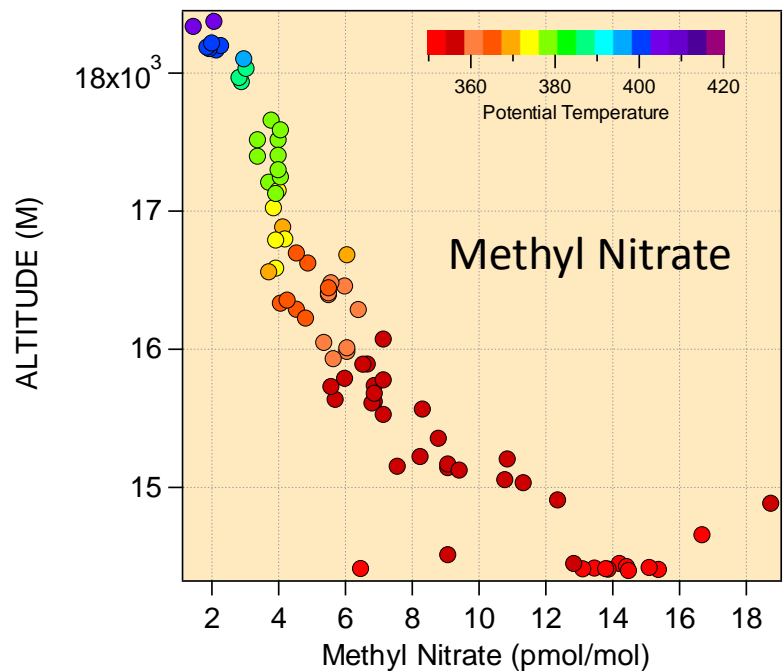


# Tracer correlation matrix: ATTREX 2014

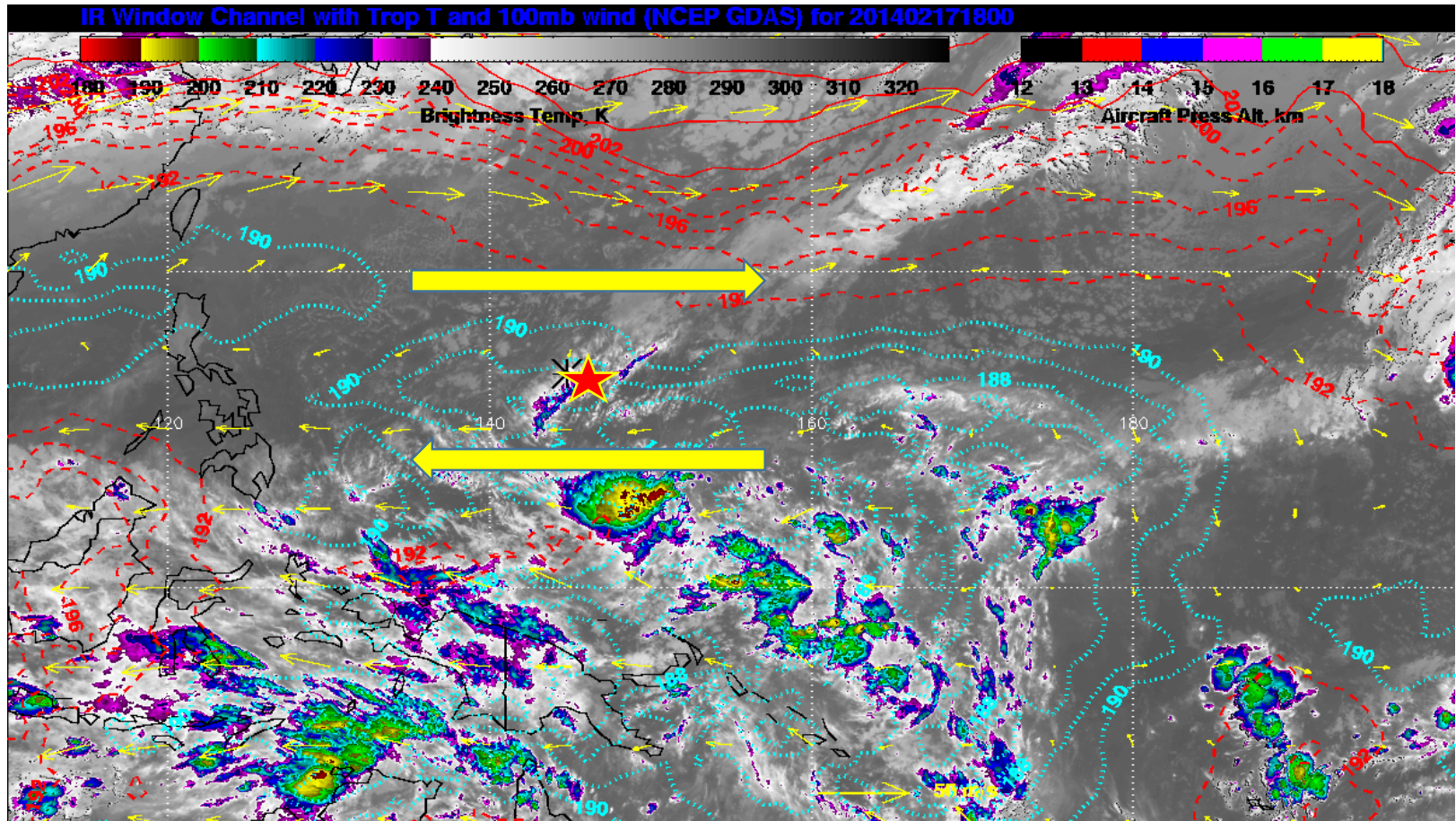


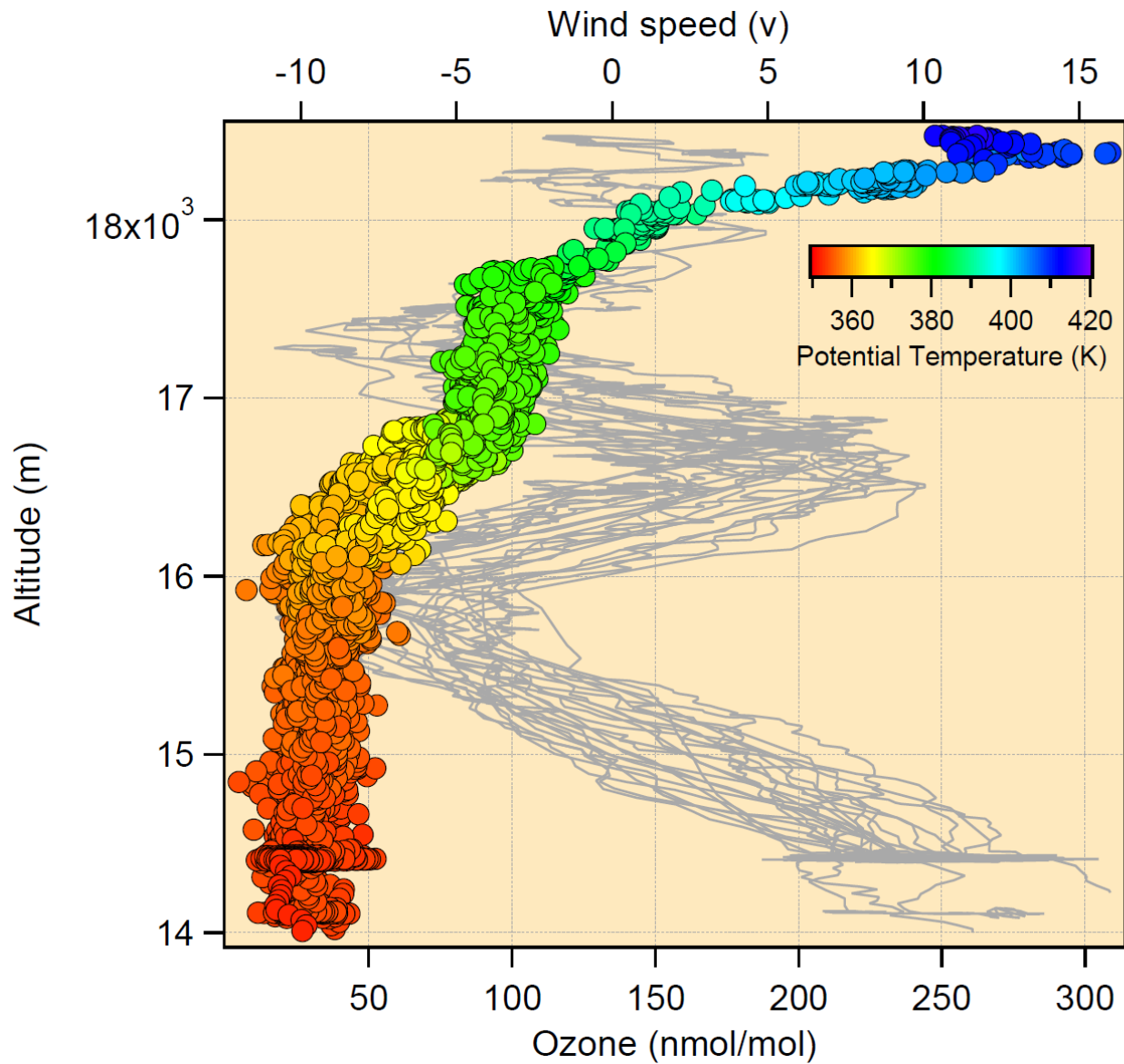
# GWAS SAMPLES RF\_02 (Circle Flight)



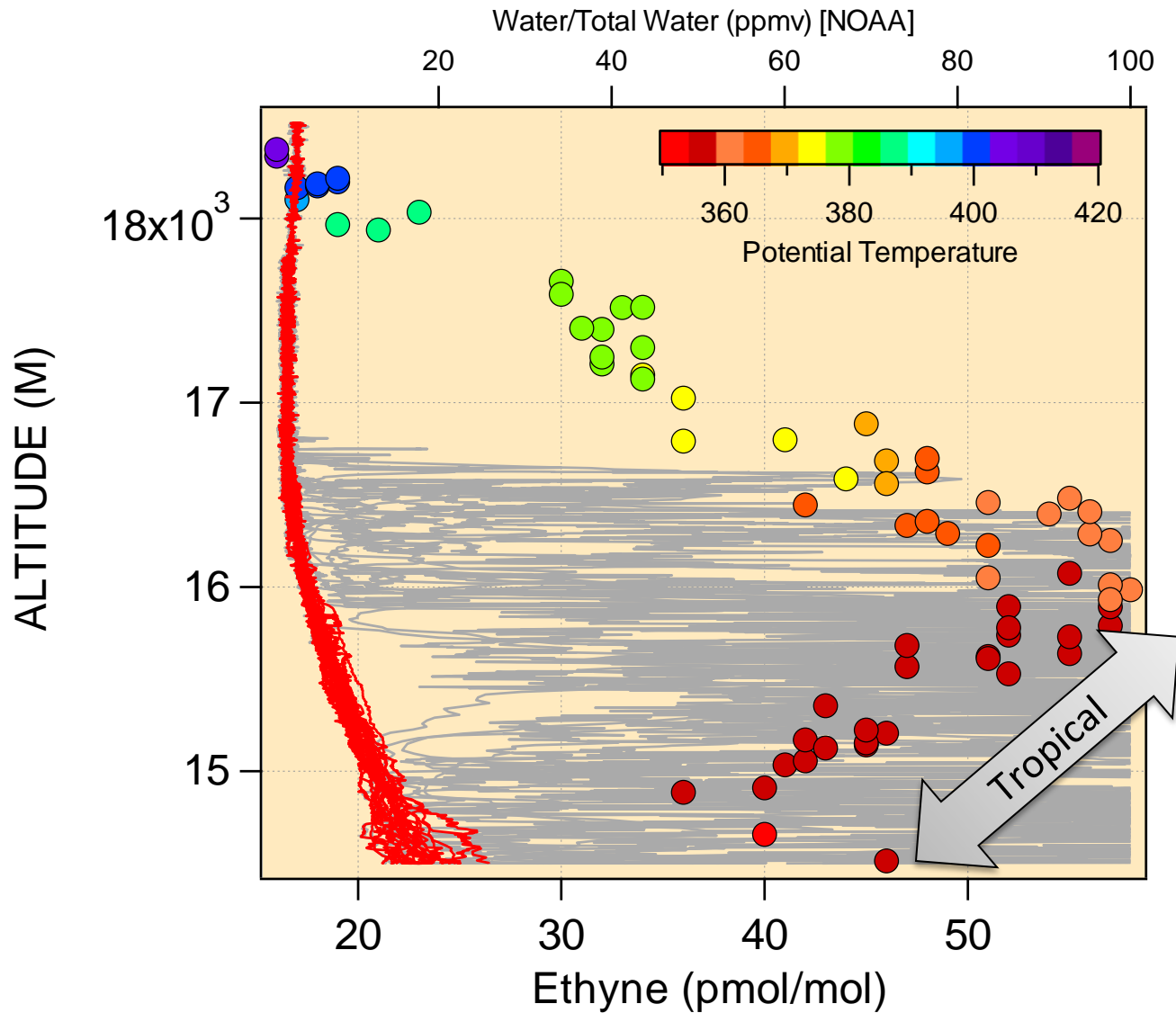


# Winds/WV during ATTREX circle flight near Guam (02/17/14: 0800 UTC)



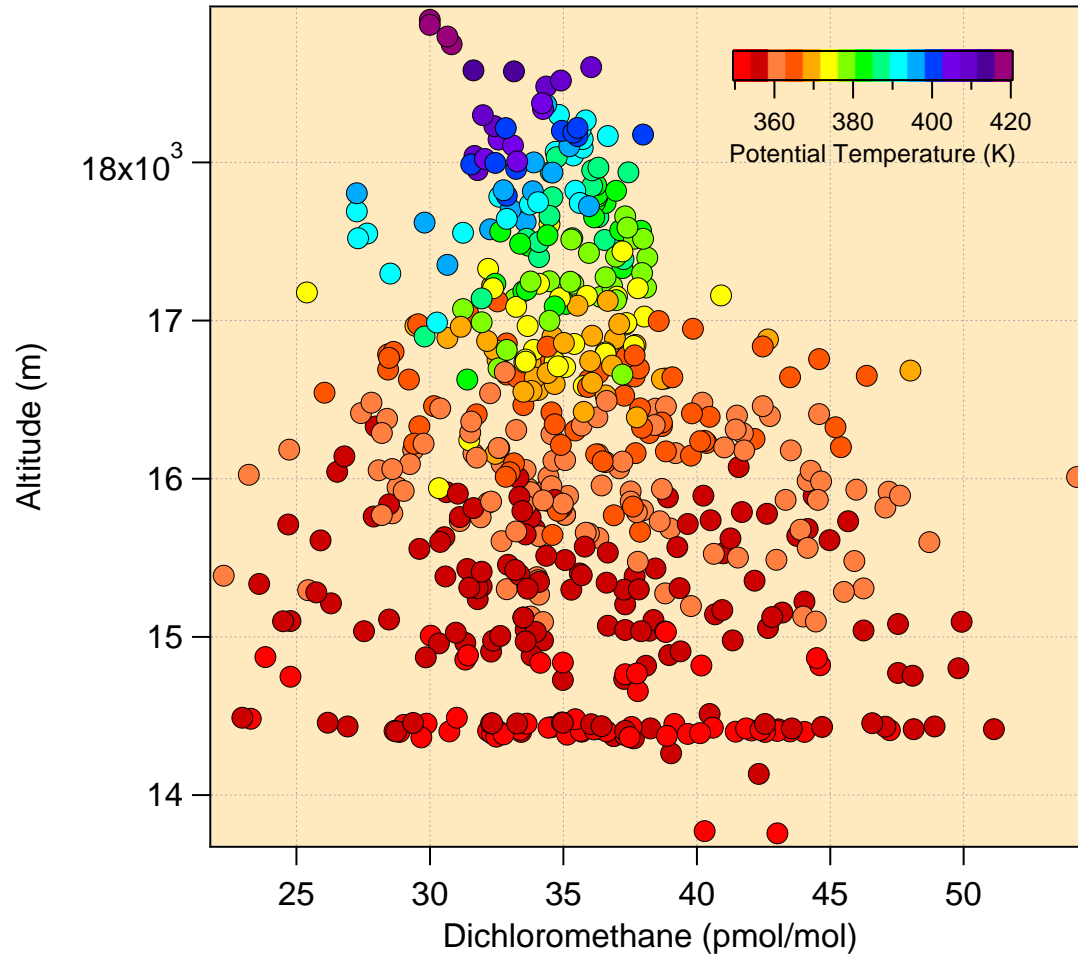


# Ethyne ( $C_2H_2$ ) and Water (vapor & total)

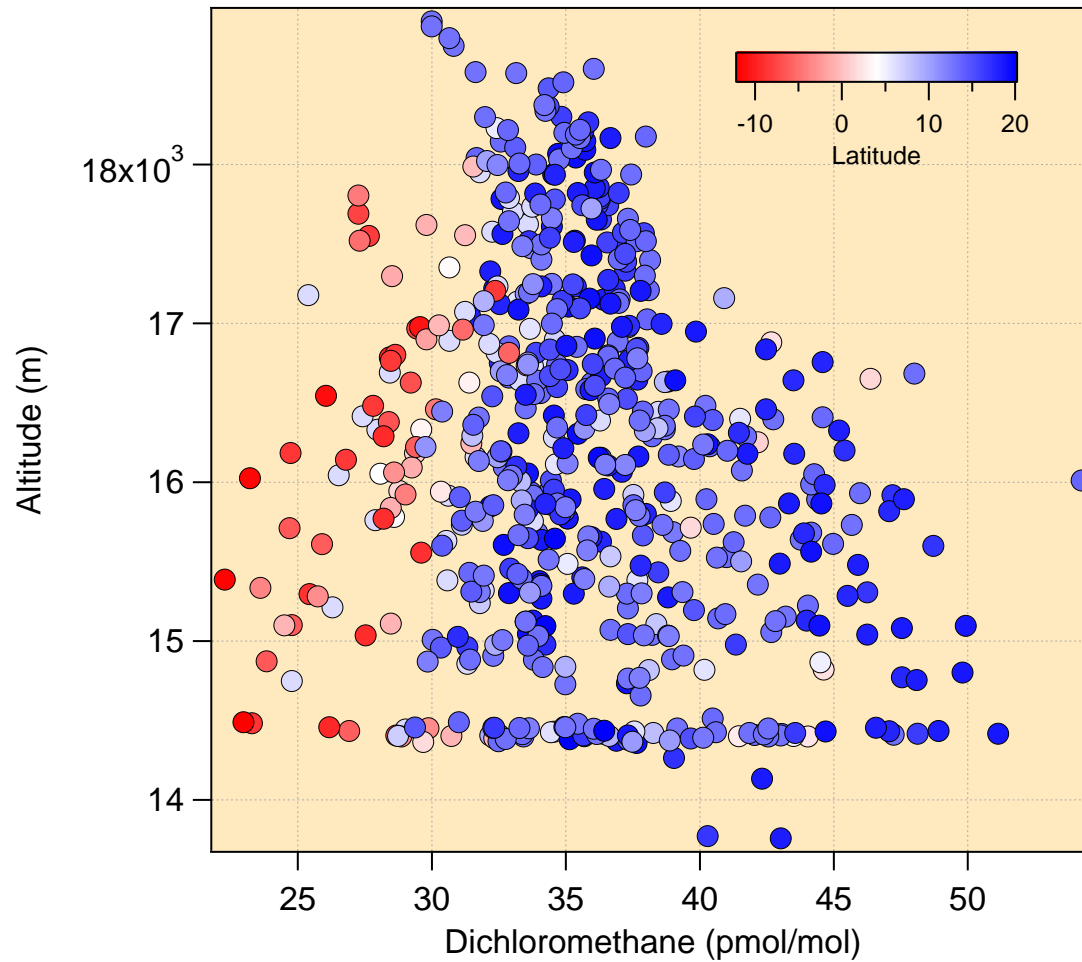




# Vertical distribution of $\text{CH}_2\text{Cl}_2$ in TTL during ATTREX

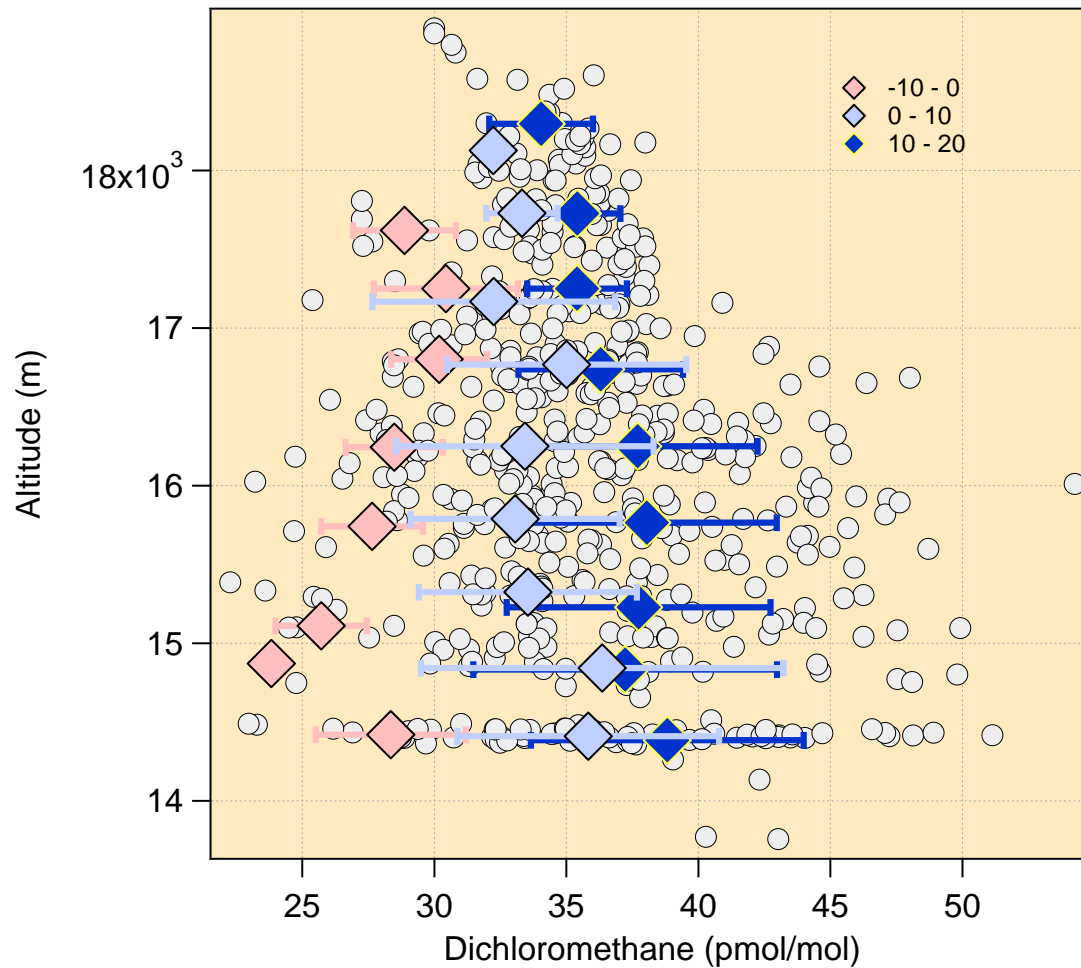


# Vertical distribution of $\text{CH}_2\text{Cl}_2$ in TTL versus latitude

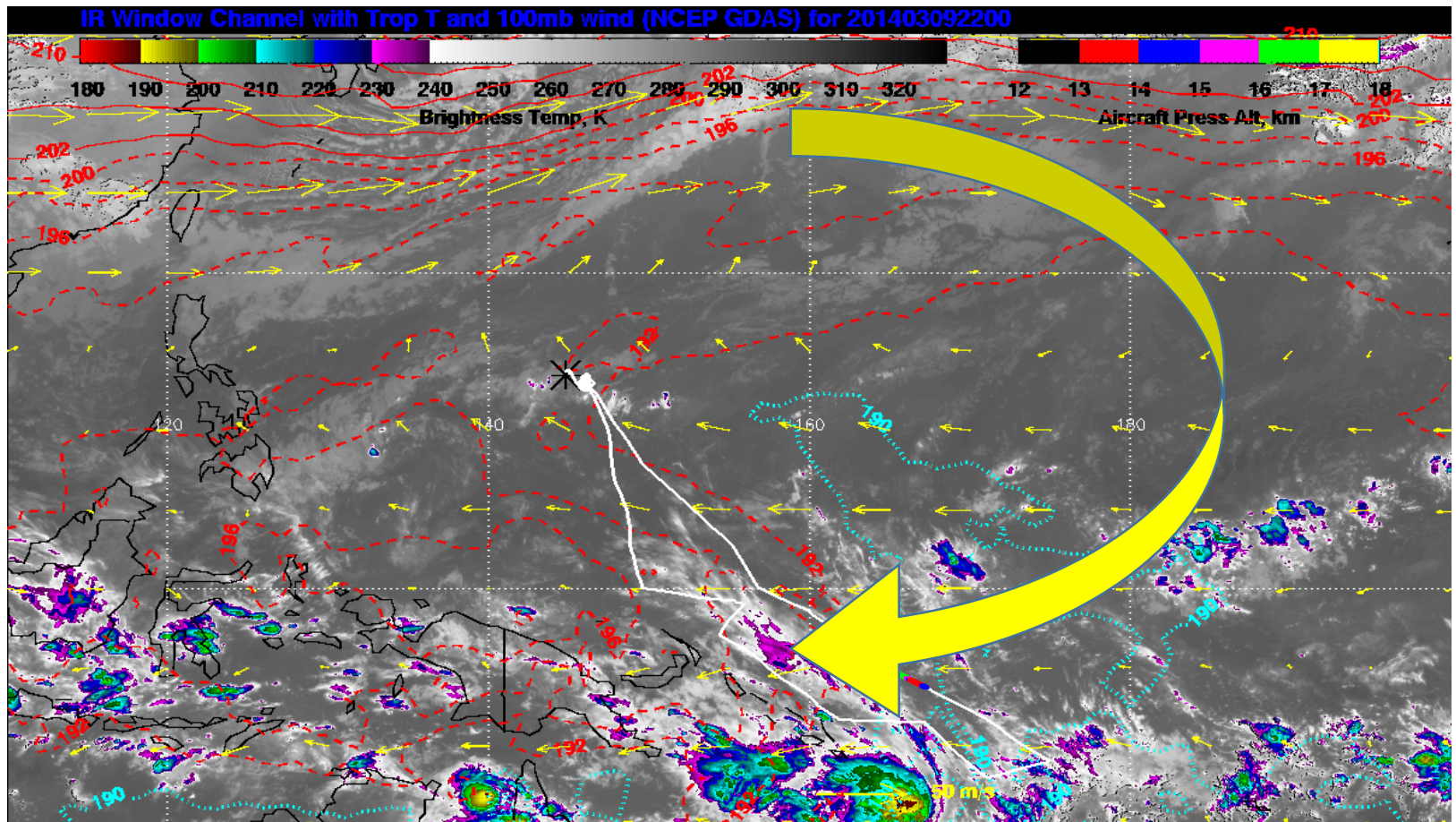


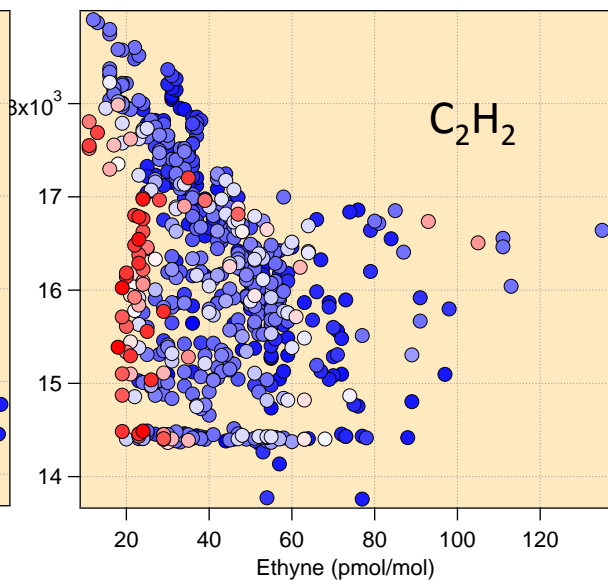
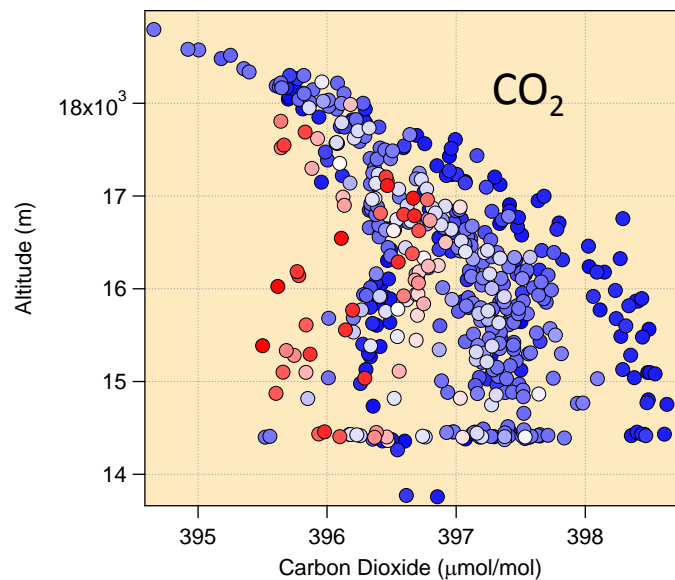


# Vertical distribution of $\text{CH}_2\text{Cl}_2$ in TTL versus latitude

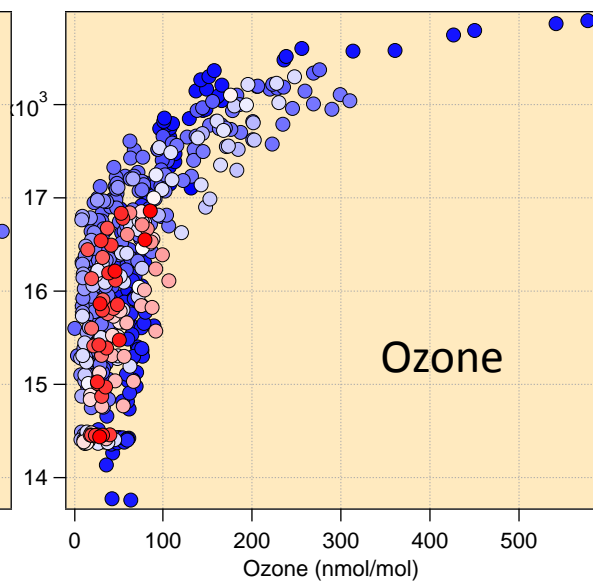
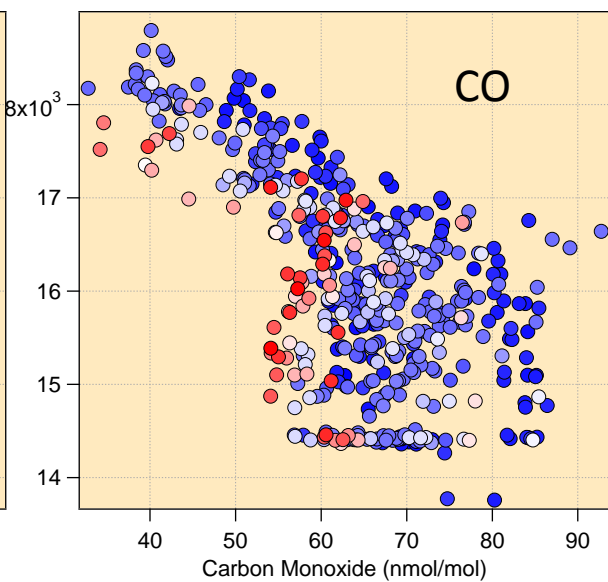
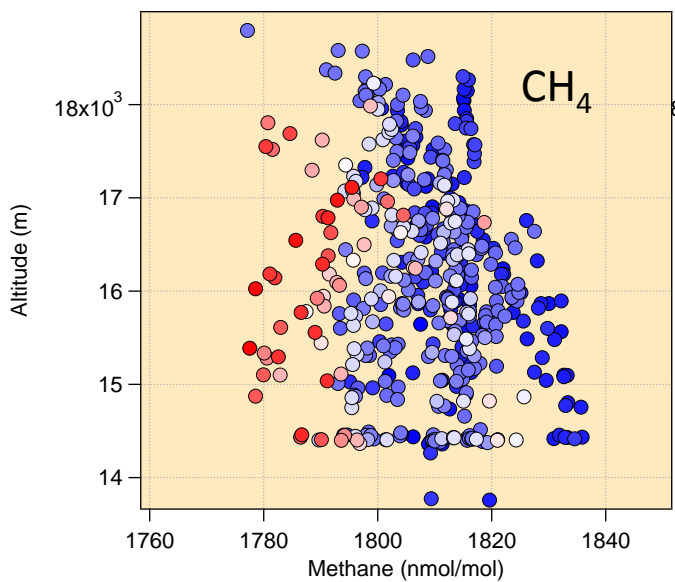


# Winds/WV during ATTREX flight in Southern Hemisphere (03/09/14: 2200 UTC)

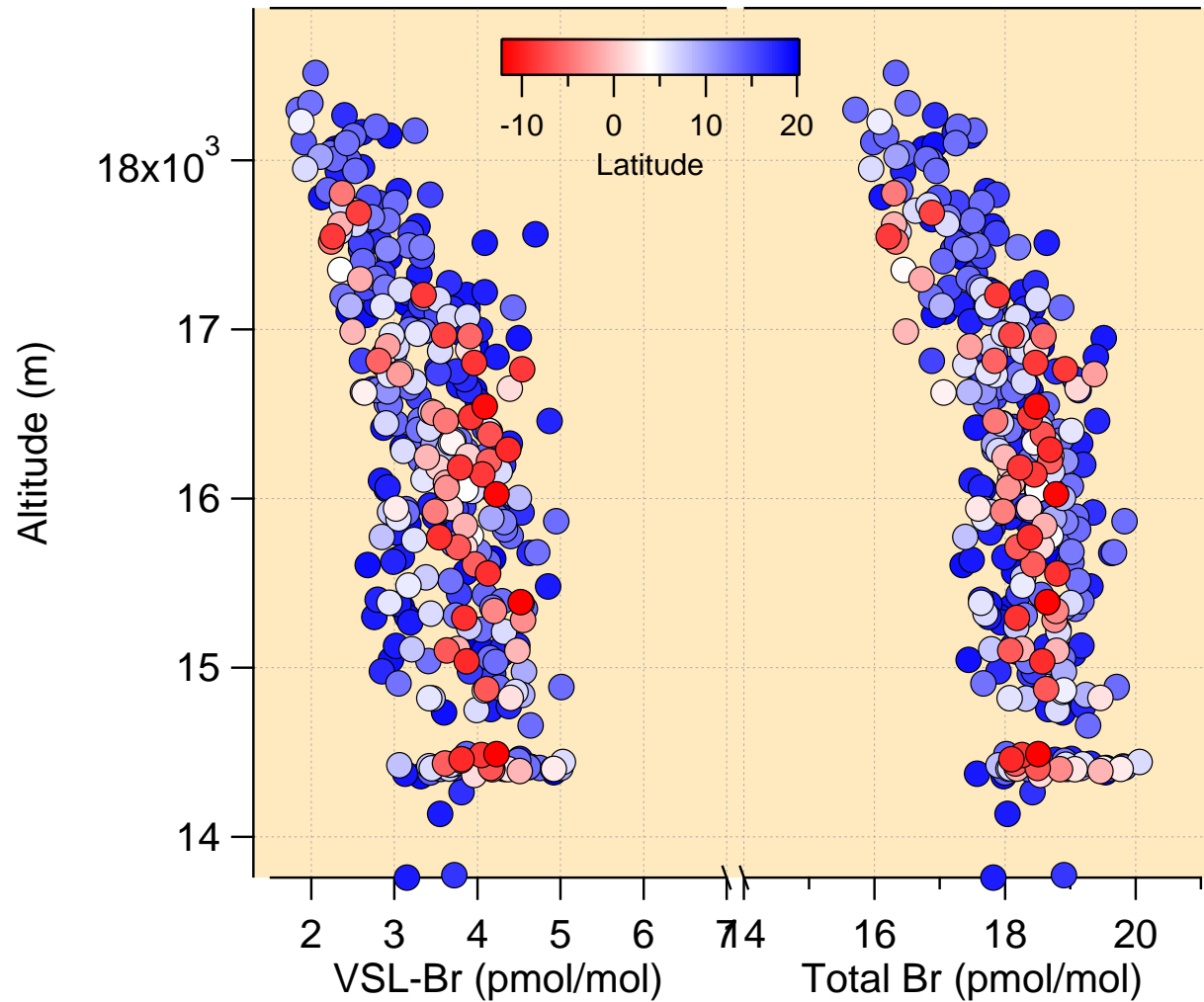




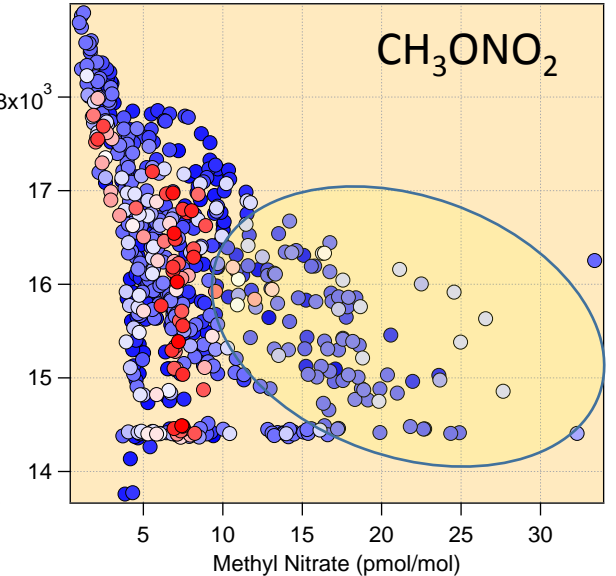
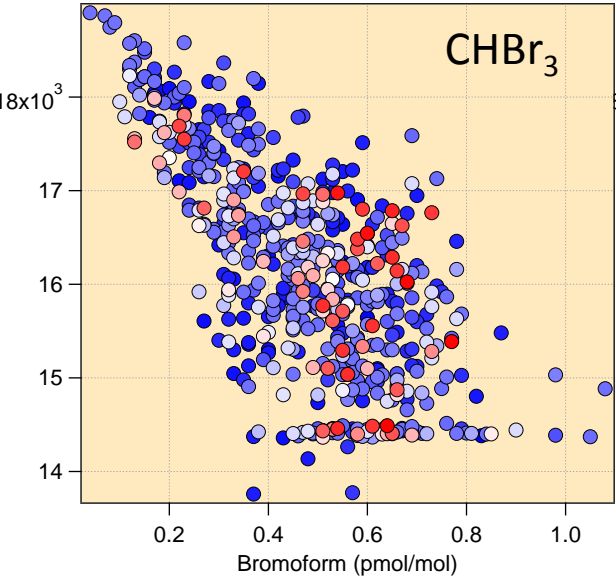
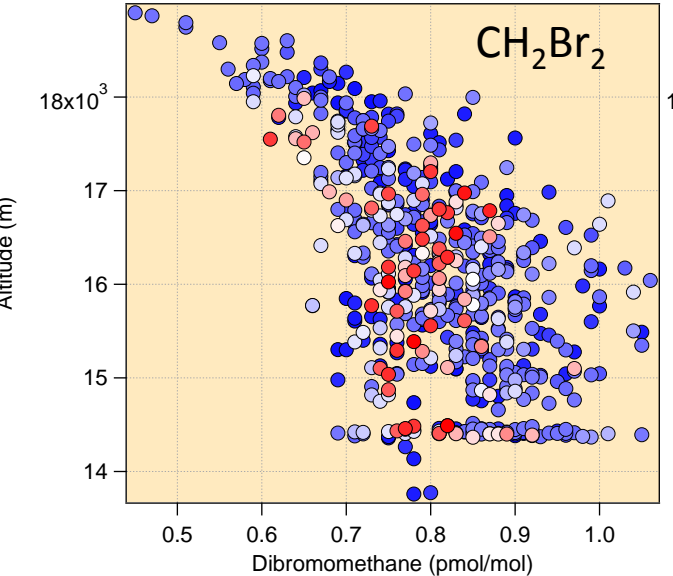
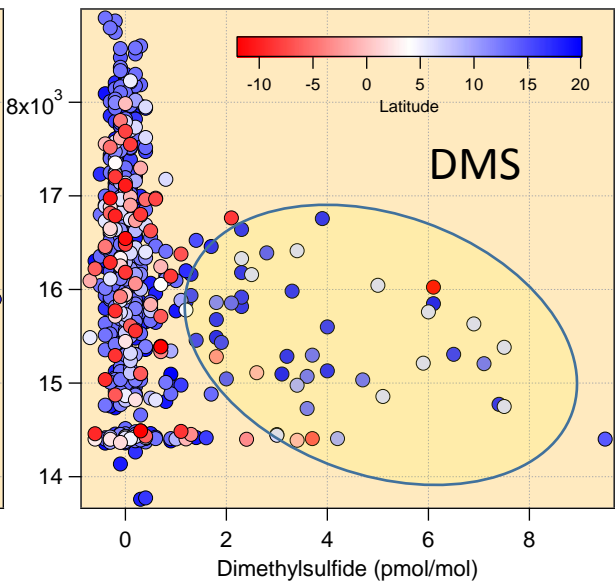
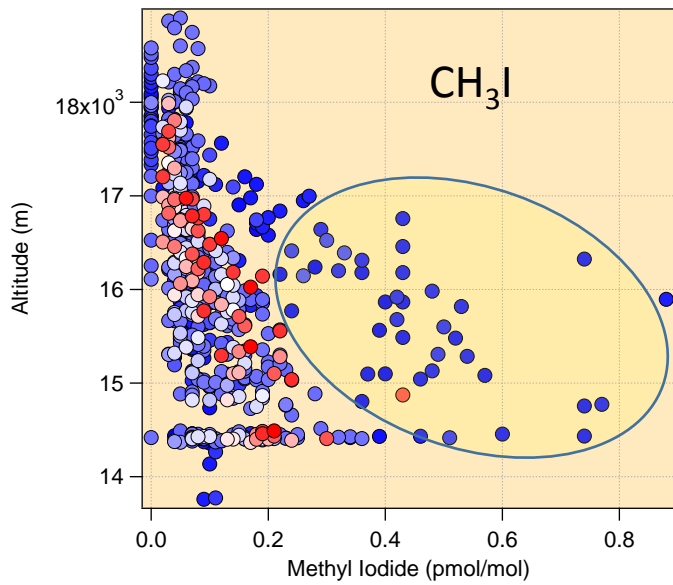
Vertical profiles  
of carbon  
compounds +  
ozone



# VSL and Total Organic Br profiles

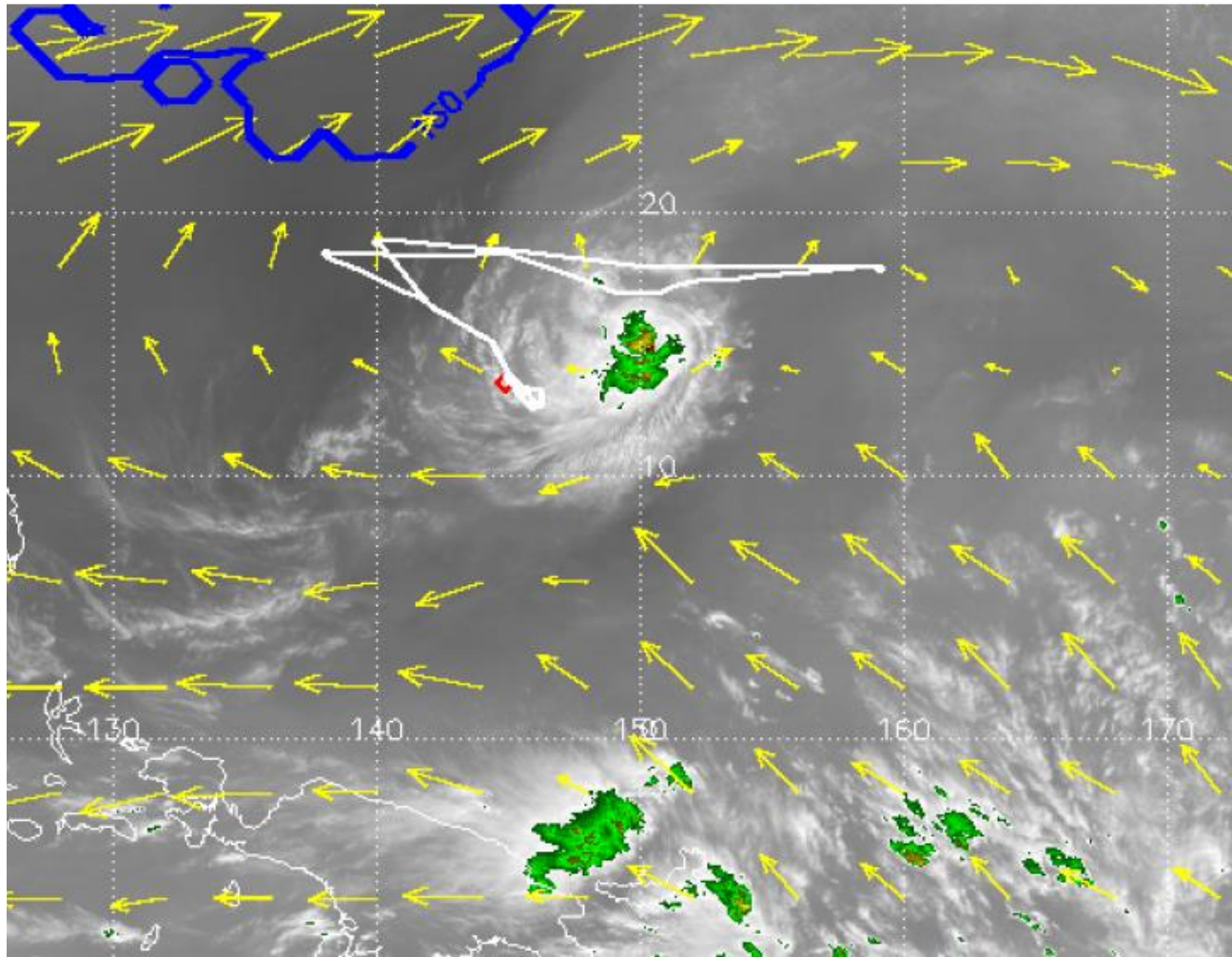


# Vertical profiles of marine trace gas emissions

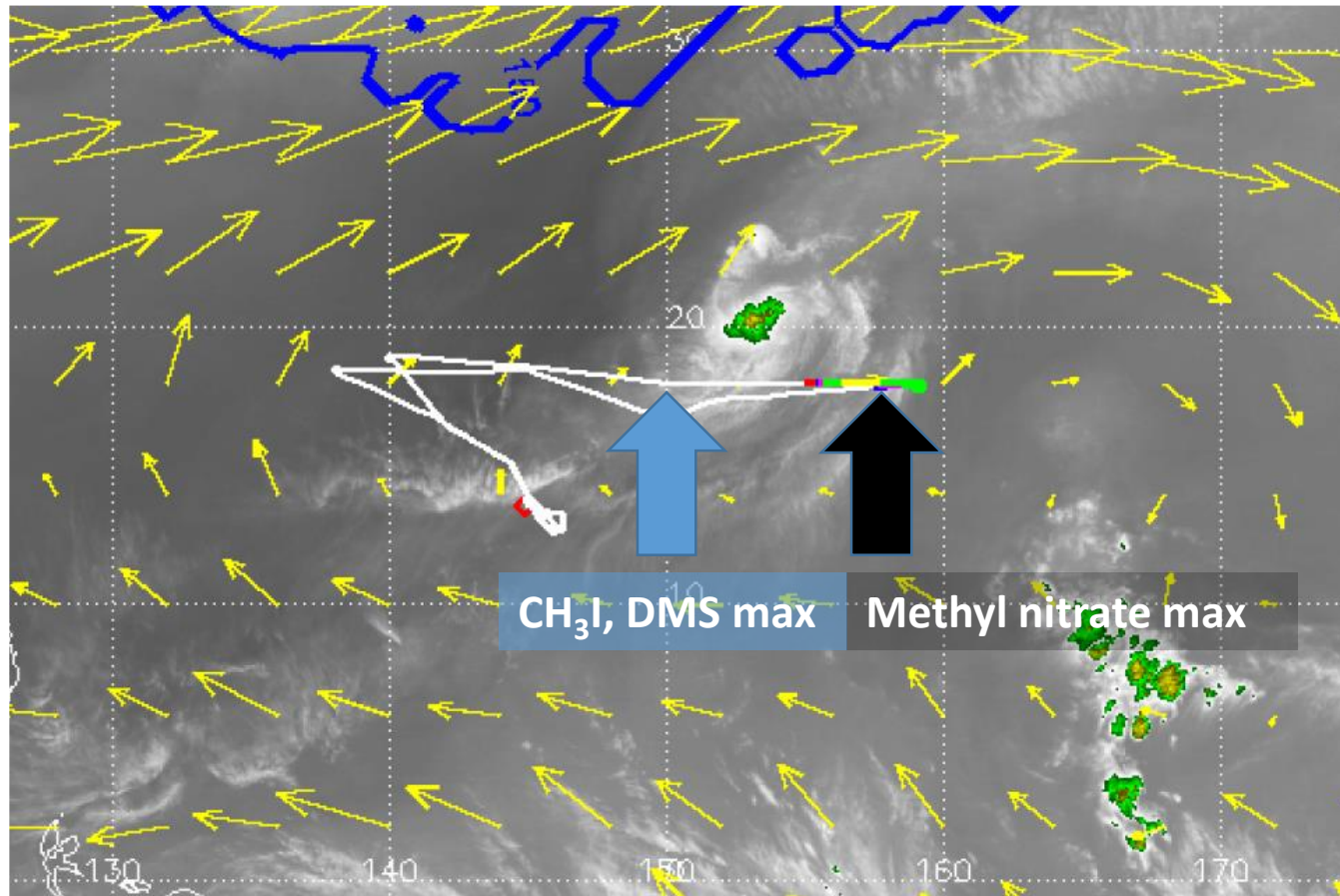




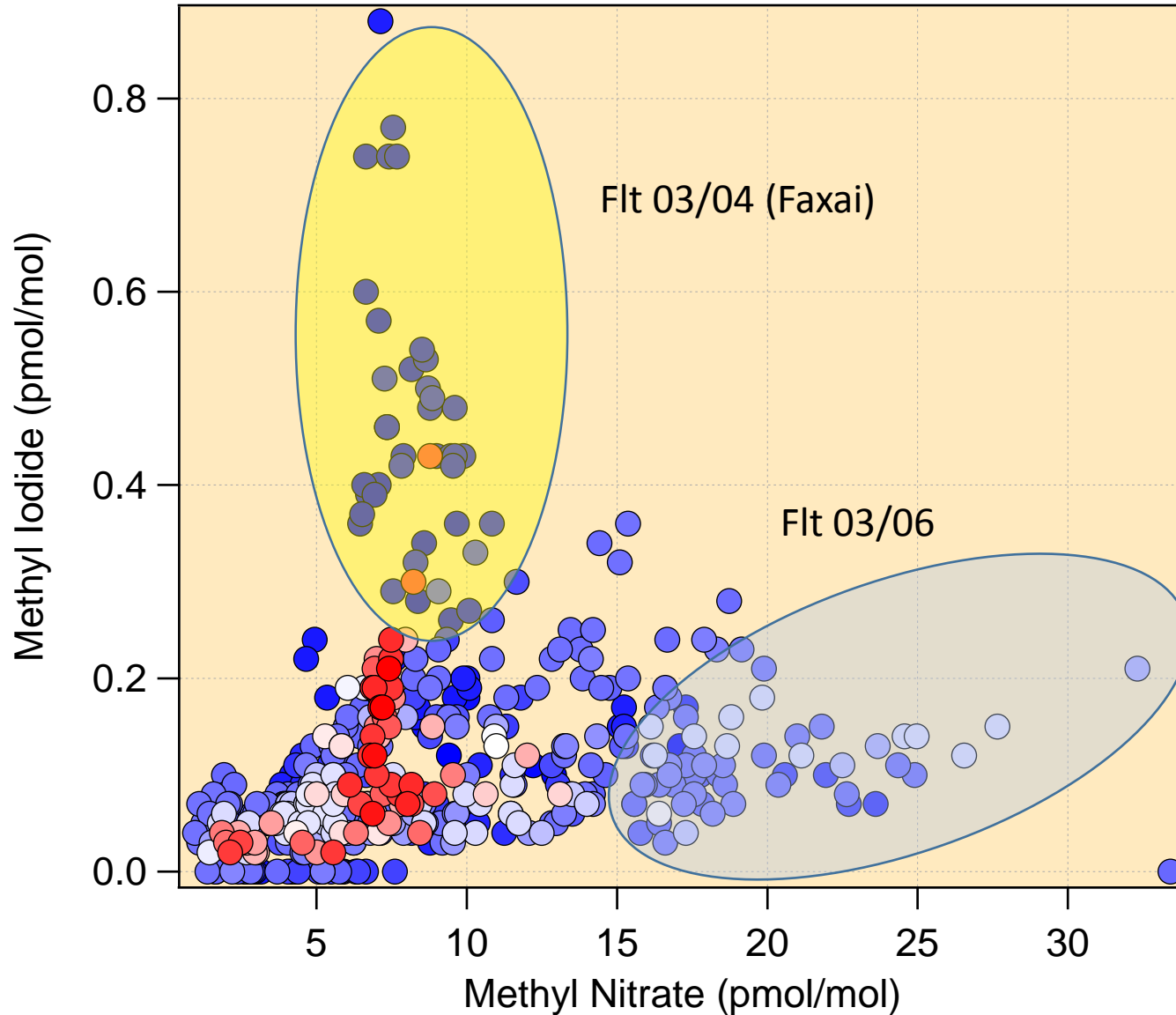
# Flight track: 03/04/2014 (Faxai flight start)



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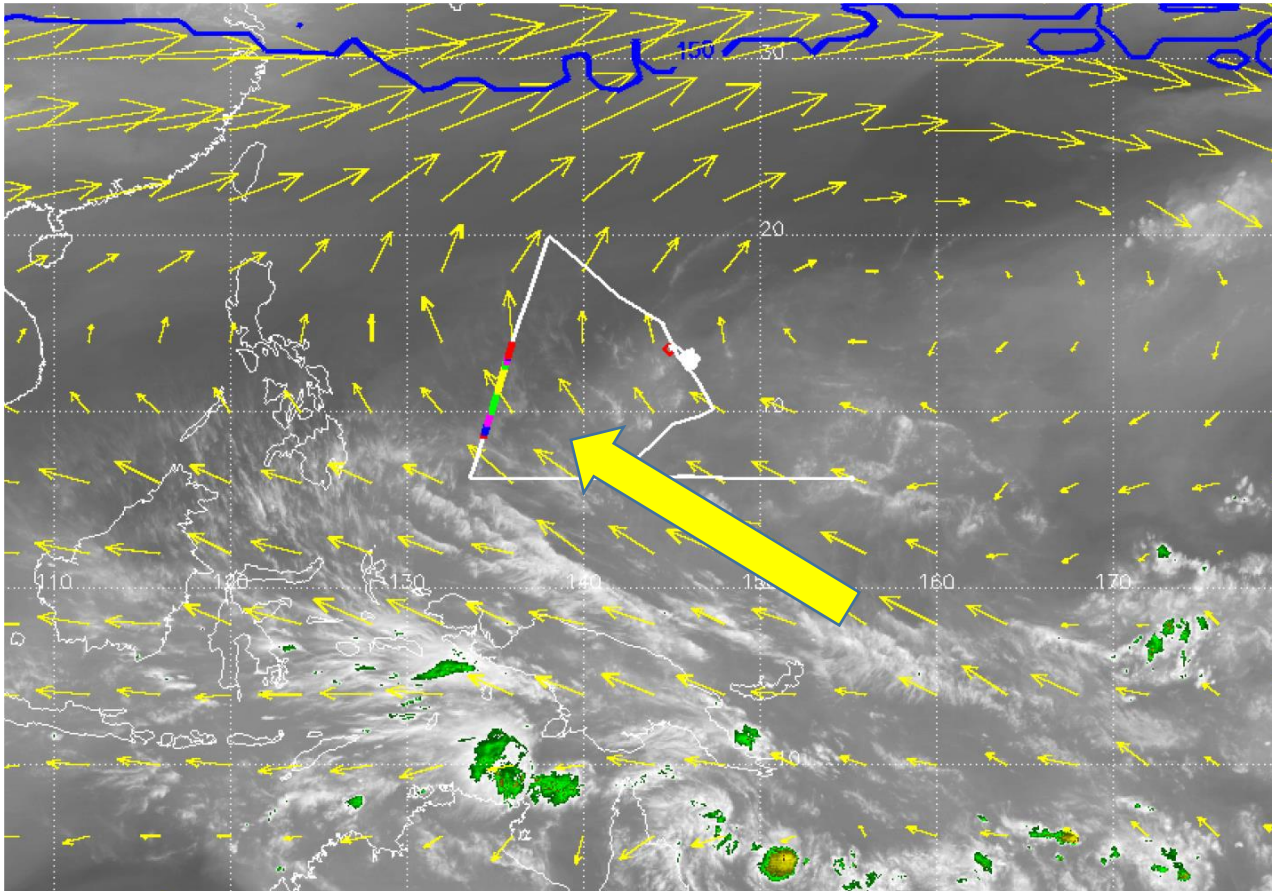


# Methyl Iodide:Methyl nitrate correlation





# Flight track: 03/06/2014 (High methyl nitrate/low methyl iodide)



# Summary

- Extensive measurements of trace gas profiles in the Western Pacific:
  - Define magnitude/composition/gradient of organic bromine in the TTL
  - Use of tracer source/lifetime information to diagnose transport regions
    - Vertical profiles
    - Interhemispheric transport
  - Identified impact of tropical storm convection on magnitude of short-lived species in the TTL