



# Measurements of Short-Lived Organohalogens

## Over the Eastern Tropical Pacific Ocean During TORERO

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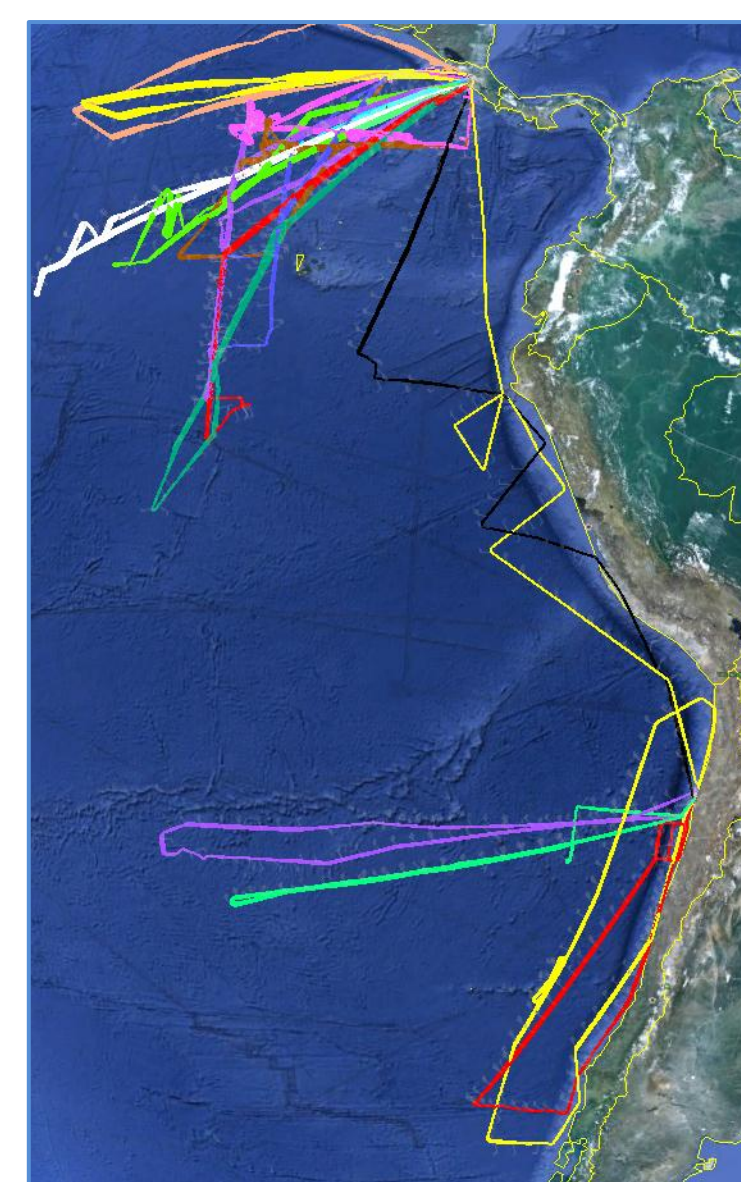
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### TORERO motivation

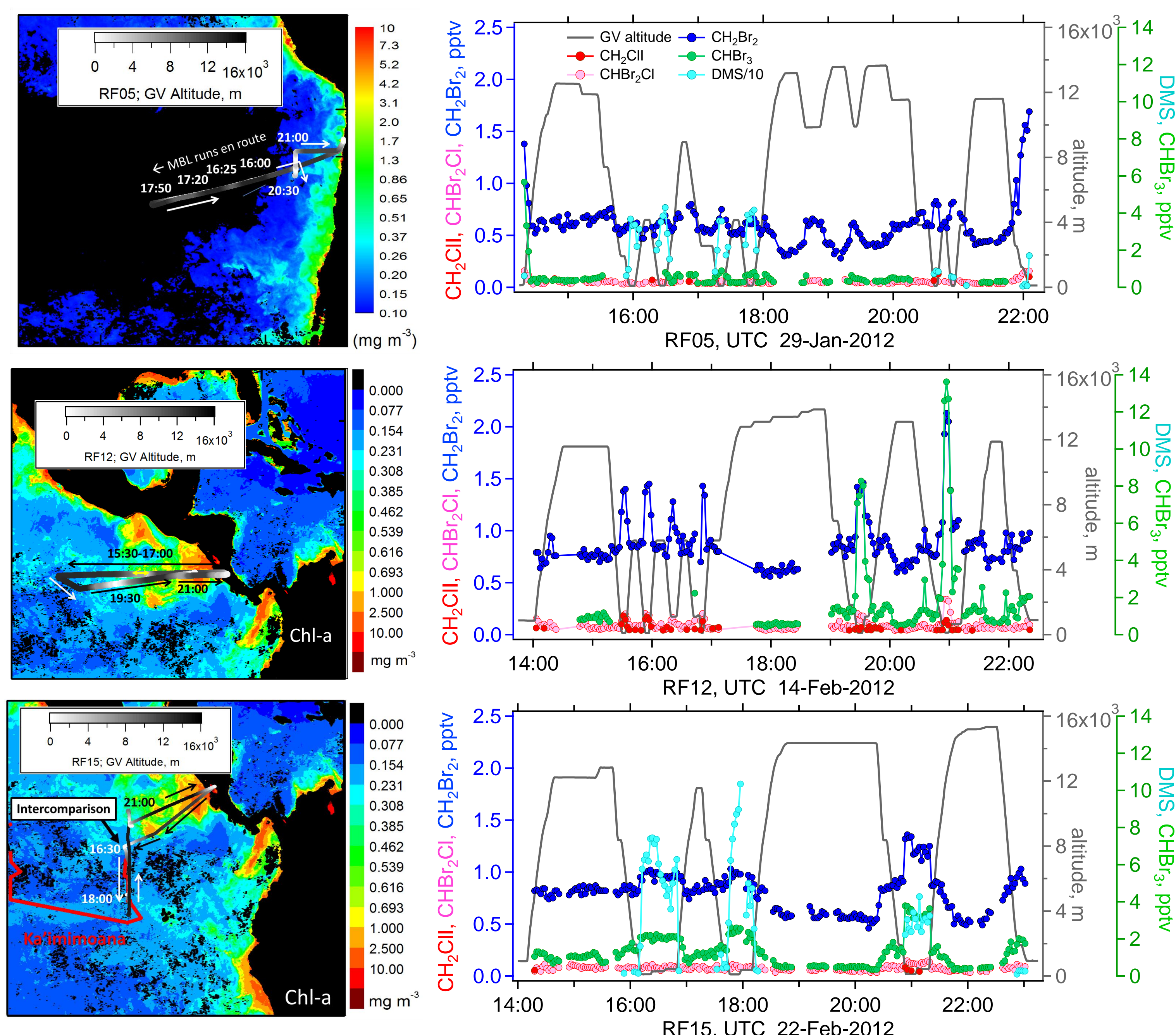
The primary objective of TORERO was to study the release and transport of **halogenated gases** and **oxidized VOCs** in the Eastern Tropical Pacific during the season of high biologic productivity. Many halogenated gases, also called very short-lived species (VSLs;  $\tau < 6$  mo.) are emitted from the ocean and can impact marine boundary layer (MBL)  $O_3$ , as well as stratospheric  $O_3$  due to convection to the UT/LS. Despite efforts to quantify these species, uncertainties remain as to the regional distribution of sources and sinks of these compounds and their impact on MBL chemistry.



**Figure 1.** Flight tracks of the 17 research flights flown from Antofagasta, Chile and San Jose, Costa Rica, 19-Jan to 29-Feb-2012.

### Organohalogen measurements

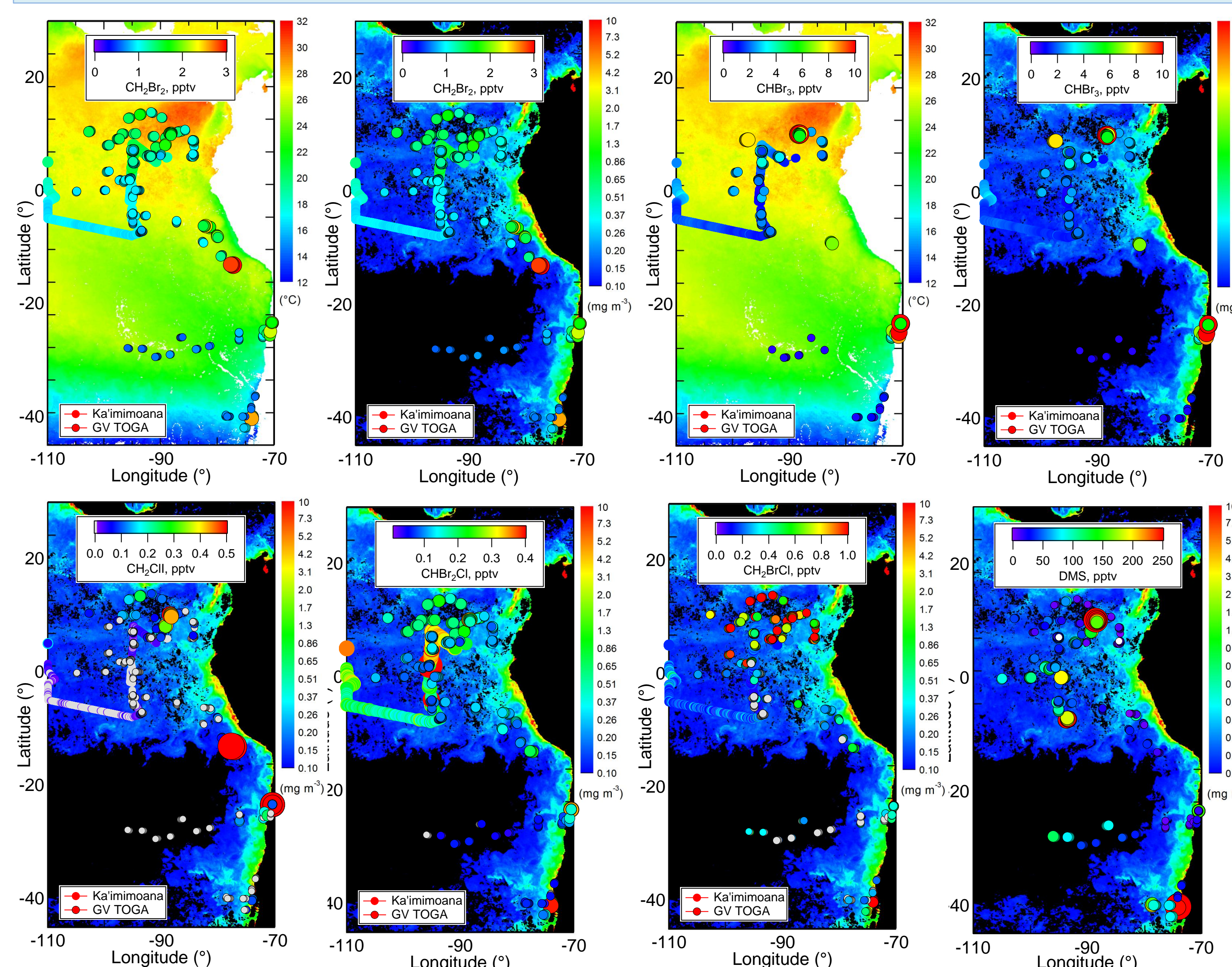
Several VSLs were measured *in situ* using GC/MS on board the NCAR/NSF GV using the NCAR Trace Organic Gas Analyzer (TOGA), and from the NOAA RV Ka'imimoana by the University of York.



**Figure 2.** Observations of DMS and several organohalogens during three TORERO flights in both oligotrophic (RF05) and nutrient-rich environments.

### Marine Boundary Layer Organohalogens

**Figure 3.** TOGA data from the MBL (< 500 m) and U. of York data on surface maps of MODIS sea surface temperatures (SST) and Chlorophyll-a (Chl-a).

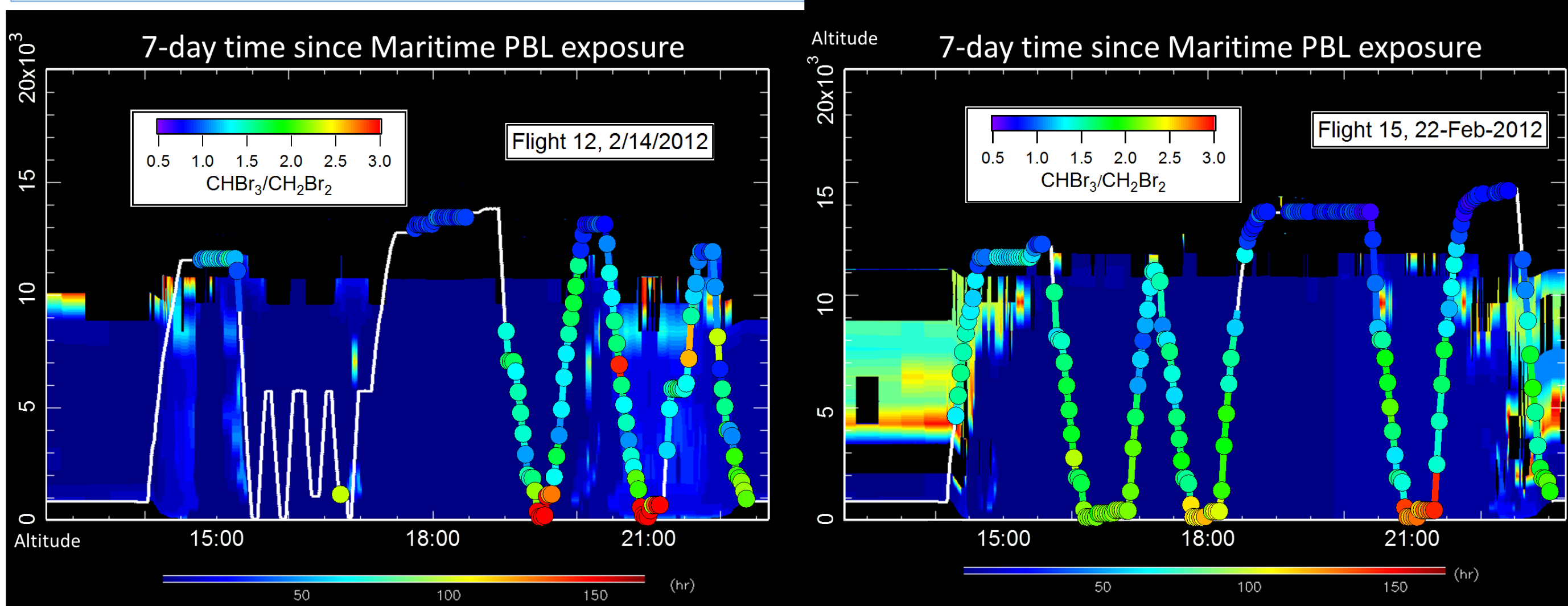


### Ratios of Halogenated Species

Ratios of pairs of halogenated species, i.e.,  $CHBr_3/CH_2Br_2$ , are indicators of MBL influence.

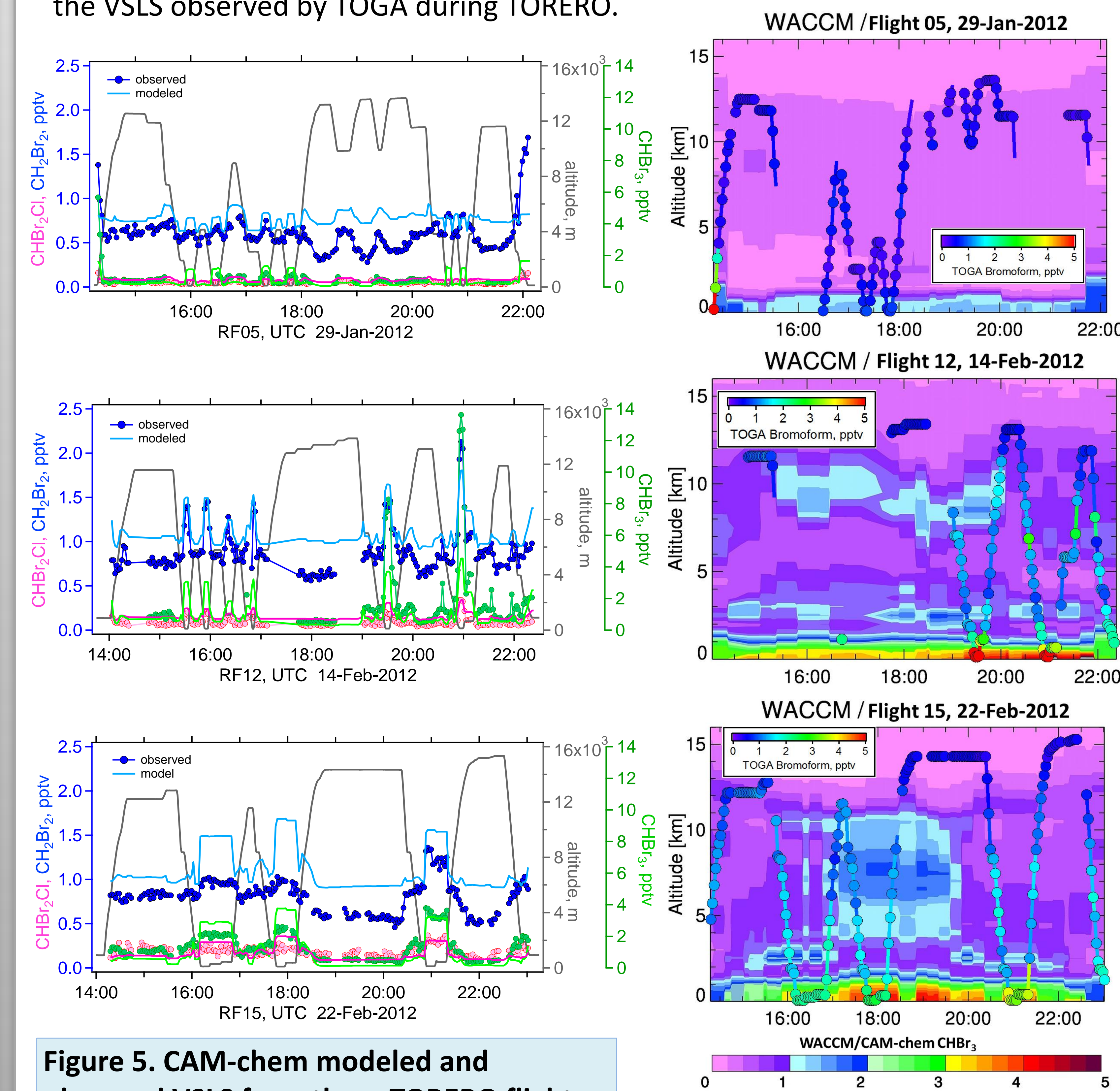
$\tau_{CHBr_3} \approx 1$  mo.      $\tau_{CH_2Br_2} \approx 4$  mo.  
 $\tau_{CH_3I} \approx 1$  week      $\tau_{CH_2Cl} \approx 2$  hours  
 $\tau_{CH_2I_2} \approx 5$  min      $\tau_{DMS} \approx 1$  day

**Figure 4.** RAQMS model curtain plots showing MBL exposure, with observed  $CHBr_3/CH_2Br_2$  ratios.



### Comparison with WACCM/CAM-chem

Model output from the global CAM-chem chemistry-climate model, with recently integrated observations of very short-lived (VSL) halocarbons and reactive iodine and bromine species (Saiz-Lopez et al., 2012), are compared against several of the VSLs observed by TOGA during TORERO.



**Figure 5.** CAM-chem modeled and observed VSLs from three TORERO flights.

**Figure 6.** CAM-chem curtain plots and observed  $CHBr_3$ .

### Summary

- VSL emissions from the east-tropical Pacific Ocean are tied to factors involving SST and biologically active chlorophyll-a production, but differ from DMS.
- MBL ship- and aircraft-based observations of most VSLs are in good agreement.
- Ratios of VSLs are indicators of recent influence of MBL air to the free troposphere and of aging within the free troposphere.
- Initial comparisons of observations to WACCM/CAM-chem model output show reasonable agreement with  $CHBr_3$ ,  $CH_2Br_2$  and  $CHBr_2Cl$ .