Quantifying VSLS Emissions Using the TOMCAT CTM

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Martyn Chipperfield, Ryan Hossaini, Wuhu Feng

- Brief description of TOMCAT 3-D CTM
- Previous TOMCAT work on CH_2Br_2 and $CHBr_3$ emissions
- Initial comparisons with CAST data
- Full chemistry iodine simulations

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UNIVERSITY OF LEEDS

TOMCAT 3-D Chemical Transport Model

- Offline global 3-D CTM
- Forced by ECMWF (ERA-Interim) meteorology
- Horizontal resolution = 1^o x 1^o
- 60 σ-*p* levels in model atmosphere (surface to ~60 km)
- Different options for chemistry/aerosol schemes, e.g.
  - Idealised tracers
  - Full stratospheric chemistry (Talk by Jochen Stutz)
  - Detailed tropospheric chemistry
- VSLS emission inventories:

$CHBr_3$	CH_2Br_2	CH_3I	Minor VSLS
4	4	2	1

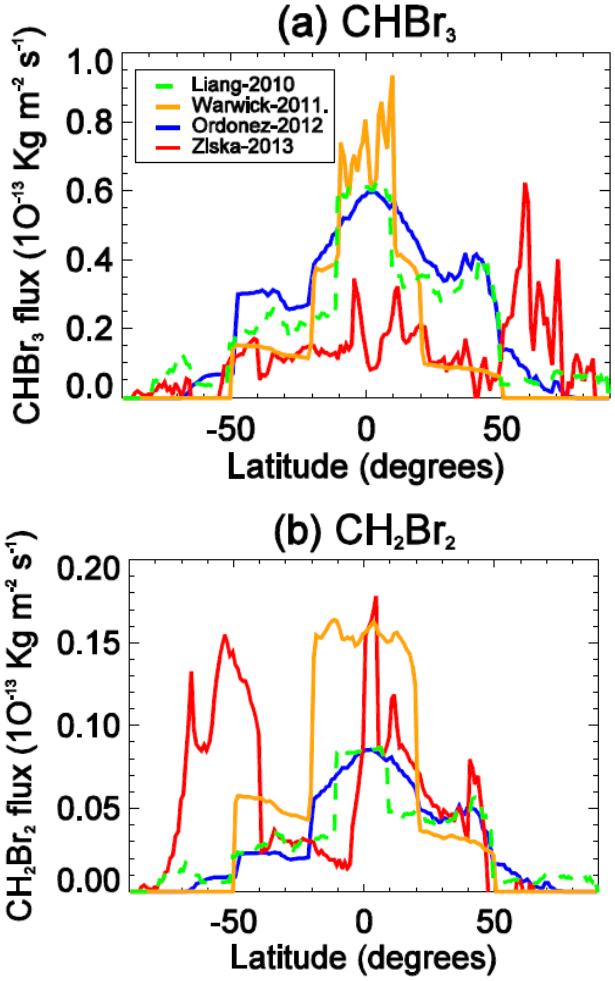
VSLS Emissions in TOMCAT

Inventory	Approach	$CHBr_3$	CH_2Br_2	CH_3I
Liang (2010)	Top-down	450	62	-
Warwick (2006)	Top-down	380	57	-
Ordonez (2012)	Top-down	533	67	303
Ziska (2013)	Bottom-up	183	64	206

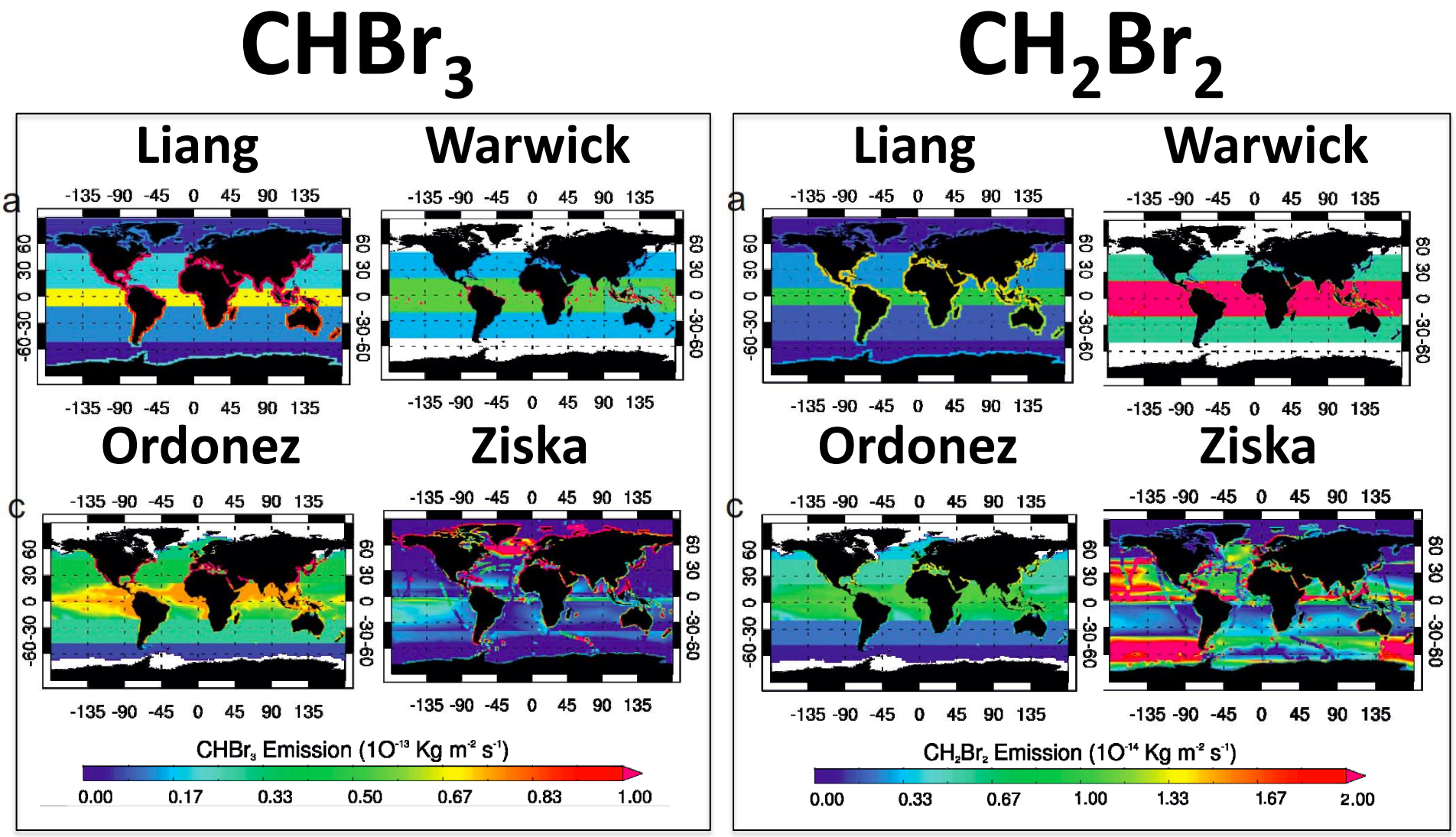
Gg yr^{-1}

- Poorly constrained
- Limited observations
- Emissions not uniform

Bell et al. 2002

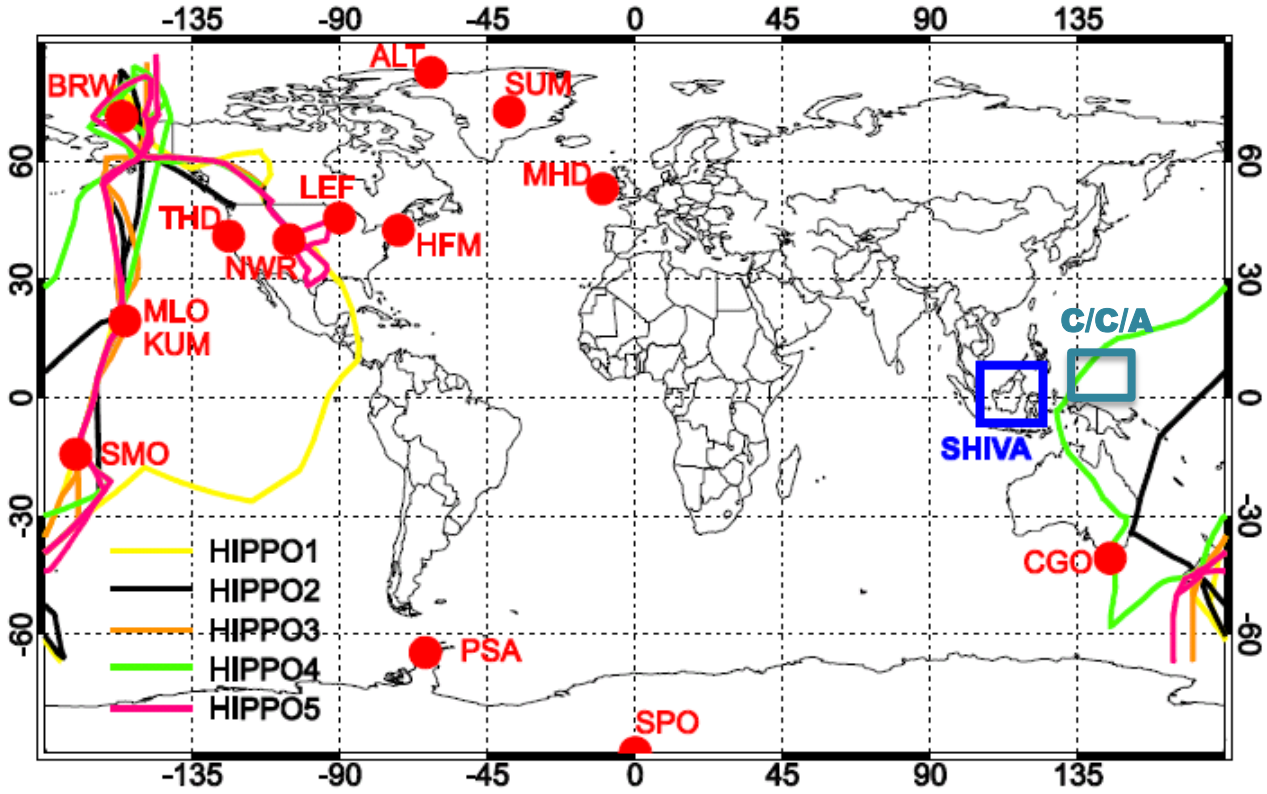


VSLS Emissions in TOMCAT



Previous Emissions Work

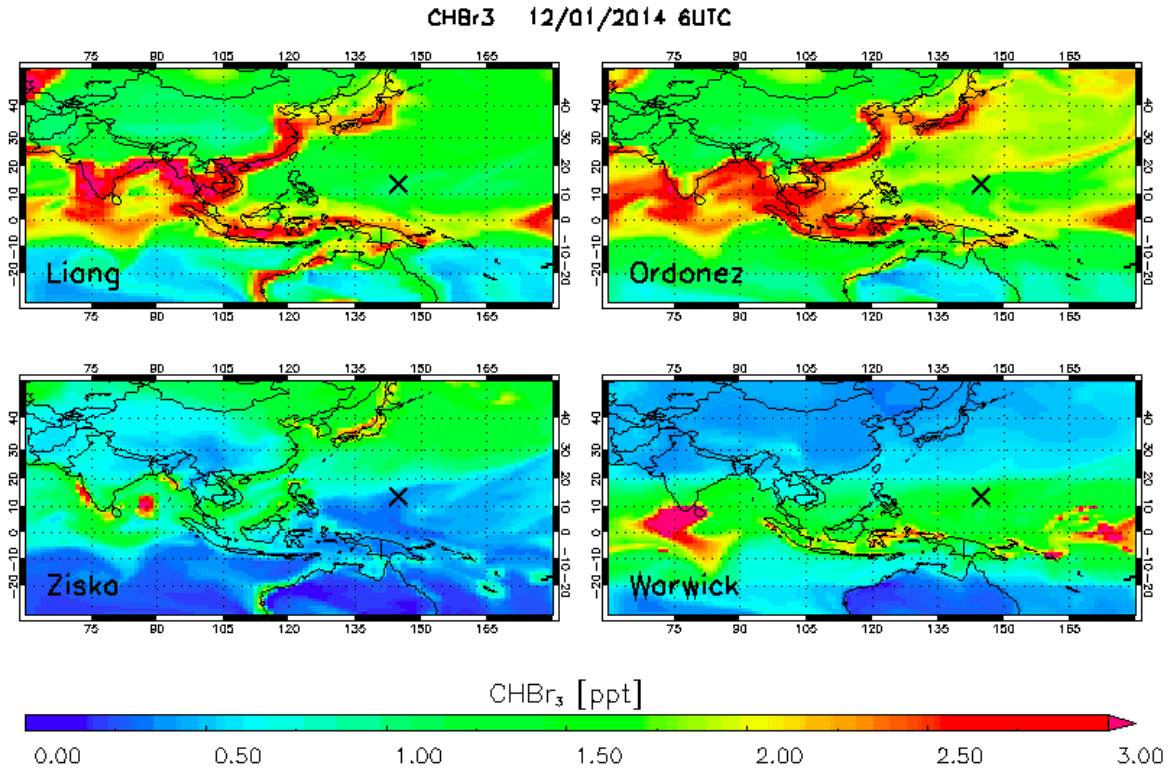
- Hossaini et al., ACP, (2013).
- Tested performance of $CHBr_3$ and CH_2Br_2 inventories in TOMCAT 3-D CTM
- Compared with 3 datasets: NOAA/ESRL, HIAPER Pole-to-Pole (HIPPO) and SHIVA



Near Real-Time Output– $CHBr_3$

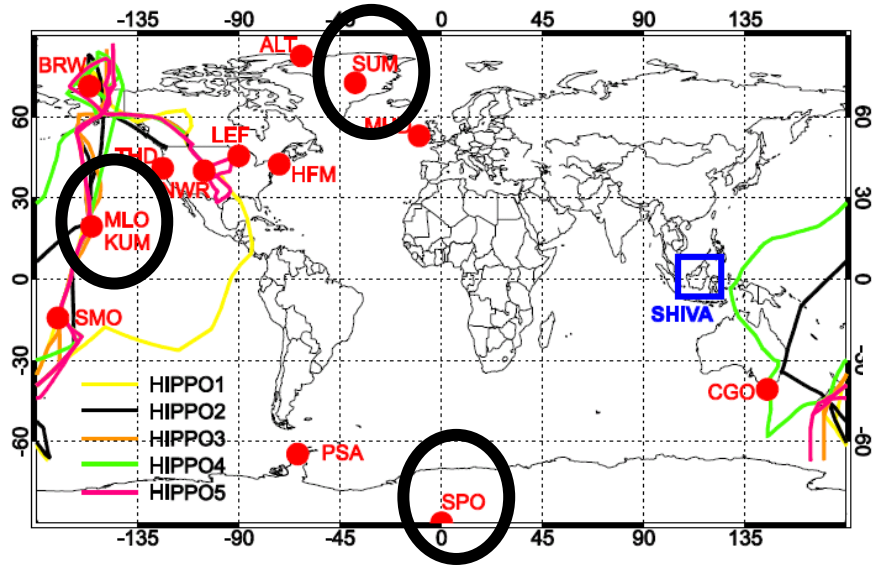
Coordinated Airborne Studies in the Tropics

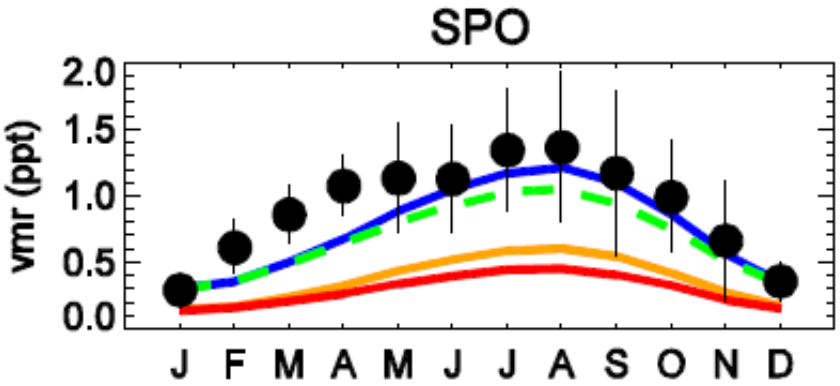
- Model run in 'near real-time' – 1° x 1°
- Global fields and station output (6-hourly)

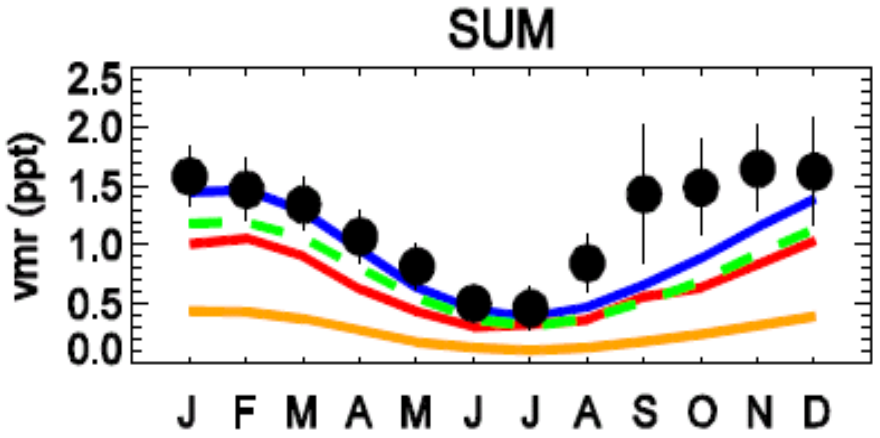


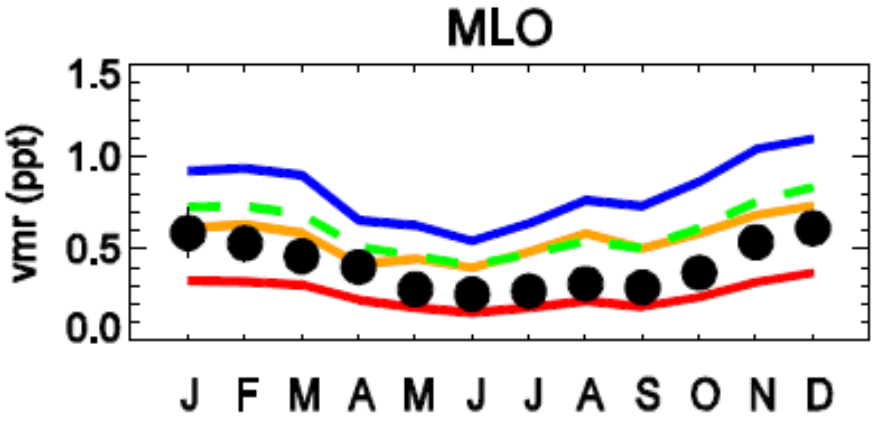
see.leeds.ac.uk/tomcat **Search: TOMCAT Leeds**

NOAA/ESRL Flask Comparisons – $CHBr_3$





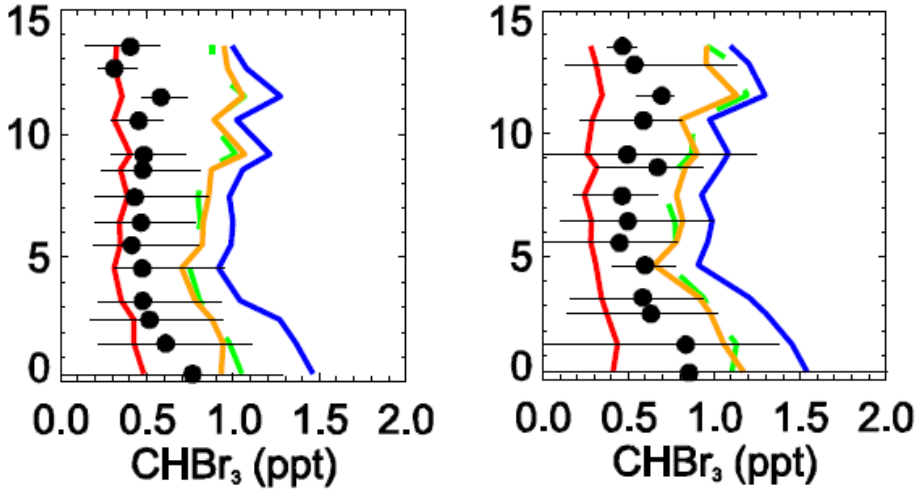




CTM (Liang-2010)
CTM (Warwick-2011)
CTM (Ordonez-2012)
CTM (Ziska-2013)

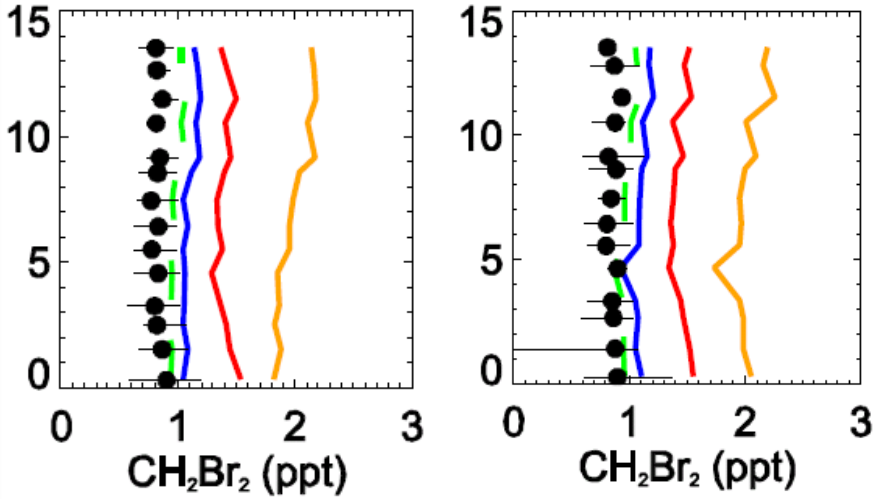
HIPPO Aircraft Comparisons Tropics mean profiles

$CHBr_3$



HIPPO-3 **HIPPO-4**

CH_2Br_2



HIPPO-3 **HIPPO-4**

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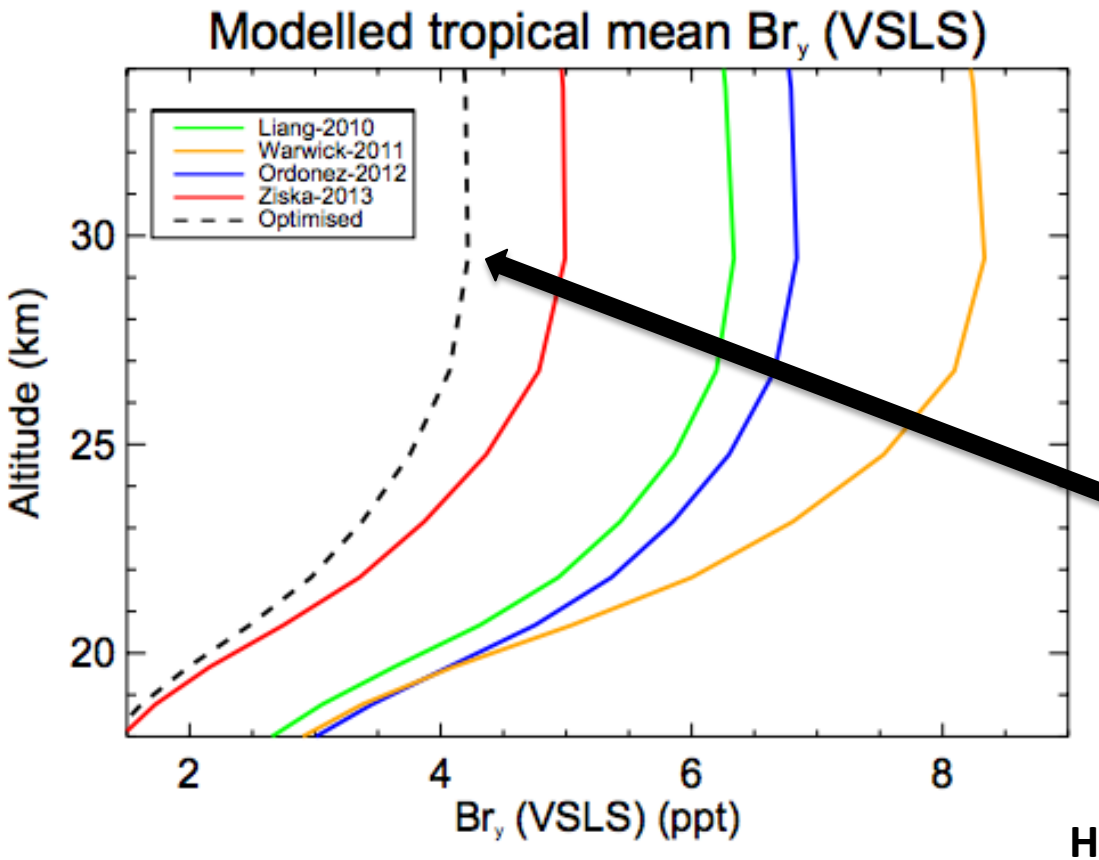
Hossaini et al. 2013
Evaluating global emission inventories of biogenic bromocarbons – ACP

Stratospheric Br_y^{VSLS} Loading



Quantified stratospheric Br_y^{VSLS} loading

Identified factor of 2 discrepancy between emission inventories

Optimised estimate

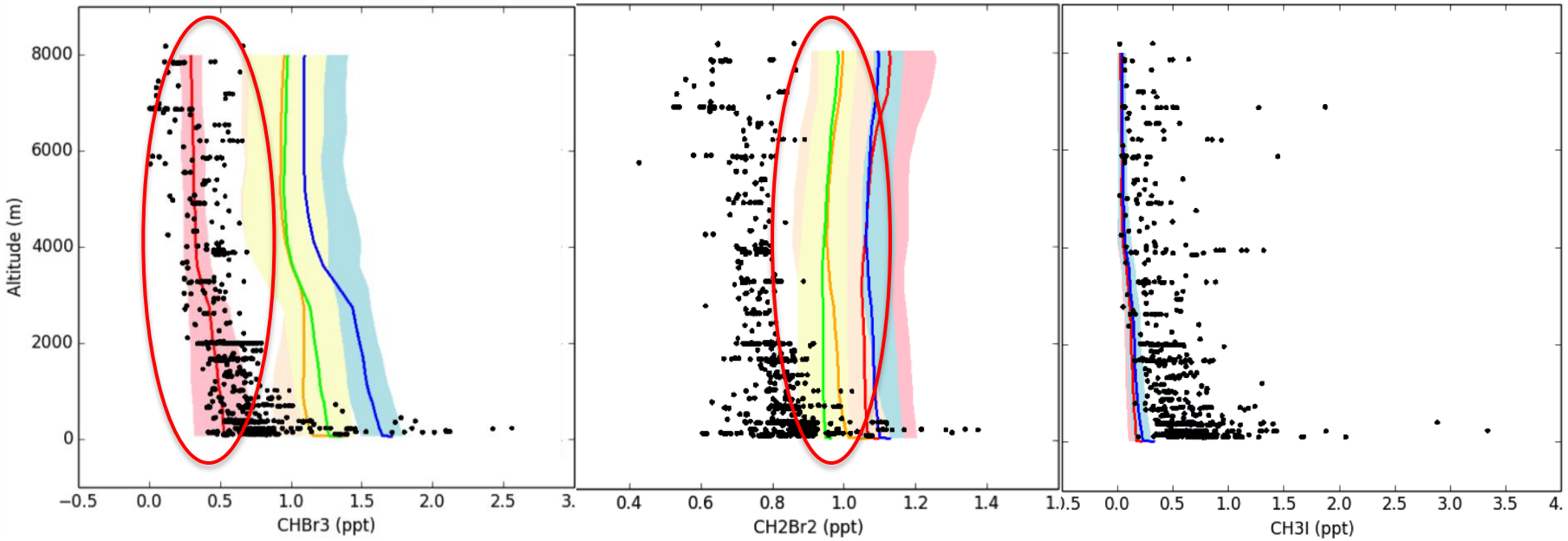
- $CHBr_3$ – Ziska (2013)
- CH_2Br_2 – Liang (2010)

Hossaini et al. 2013,
Evaluating global emission inventories of biogenic bromocarbons - ACP

CAST Campaign Profiles

- 667 WAS canisters collected across campaign - CAST
- Data: Stephen Andrews – University of York

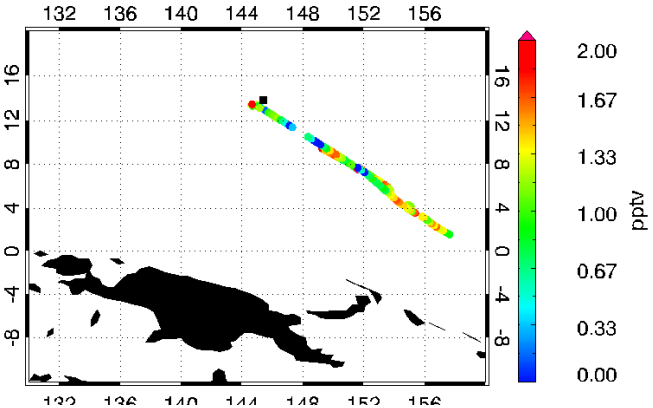
$CHBr_3$ CH_2Br_2 CH_3I

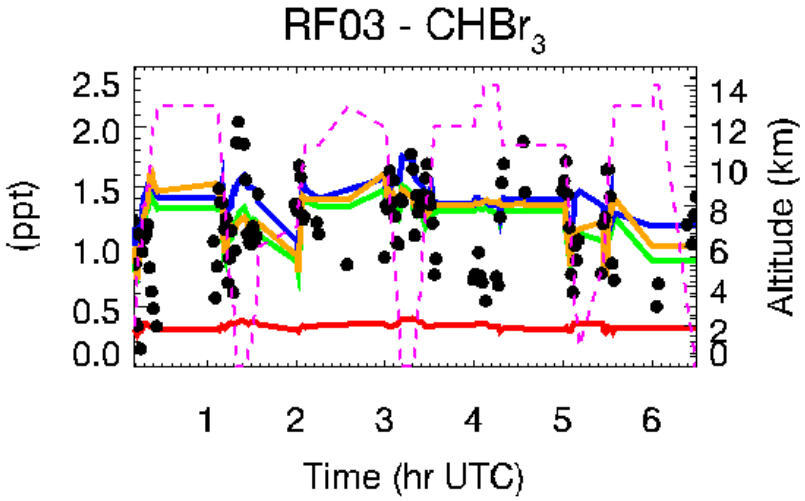


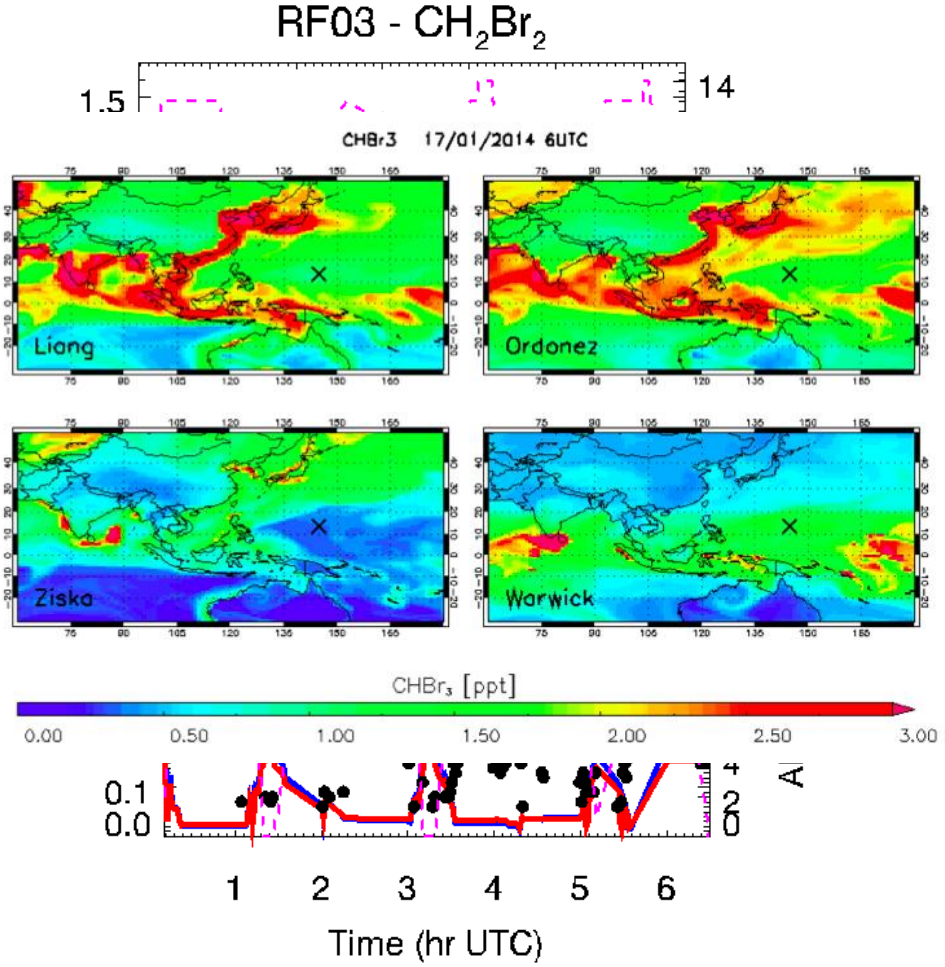
Ziska (bottom-up) **Overestimate. L / W (top down)** **Underestimate**

CONTRAST Flight Track Comparisons

- CONTRAST **PRELIMINARY** TOGA data – B. Hornbrook, E. Apel, D. Riemer
- RF03 example – 17/01/14







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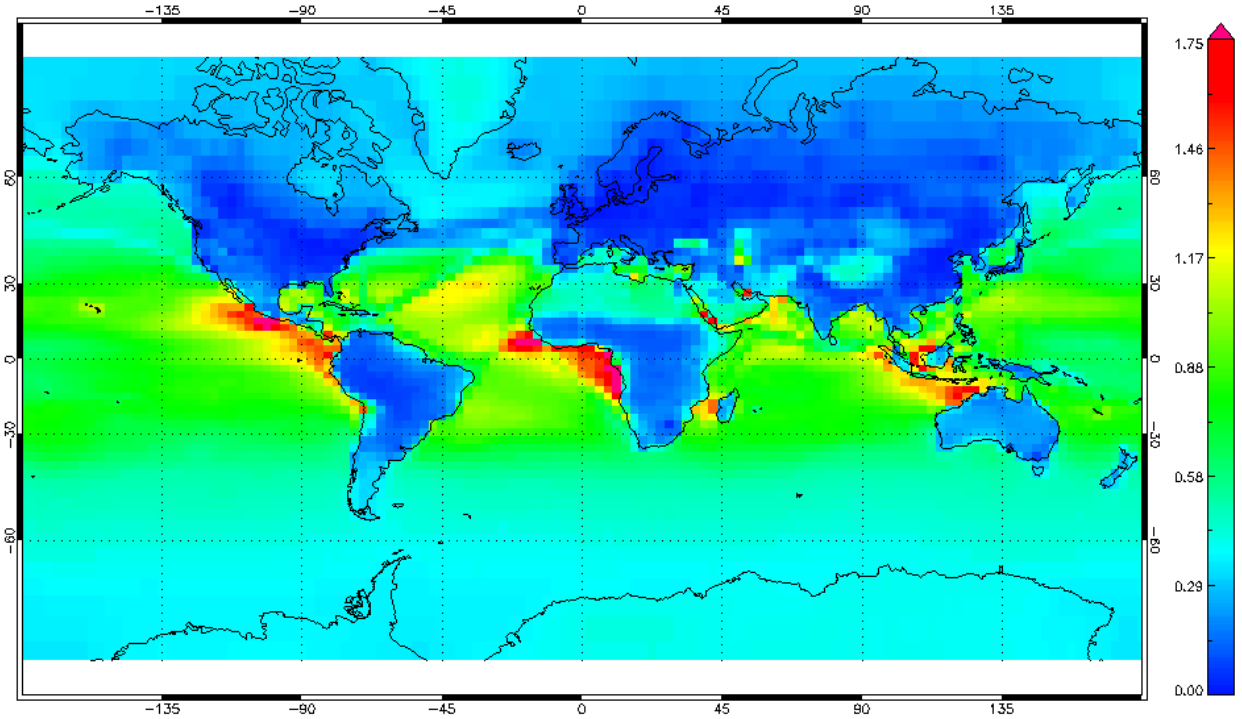
Full Chemistry Halogen Model

- Full gas-phase iodine chemistry and heterogeneous chemistry
- Organic Br/I emissions and inorganic emissions (HOI and I_2)
- Model chemistry scheme includes Ox-NOx-HOx-Cl-C3 with isoprene and detailed tropospheric halogen chemistry



Annual average (2007) IO

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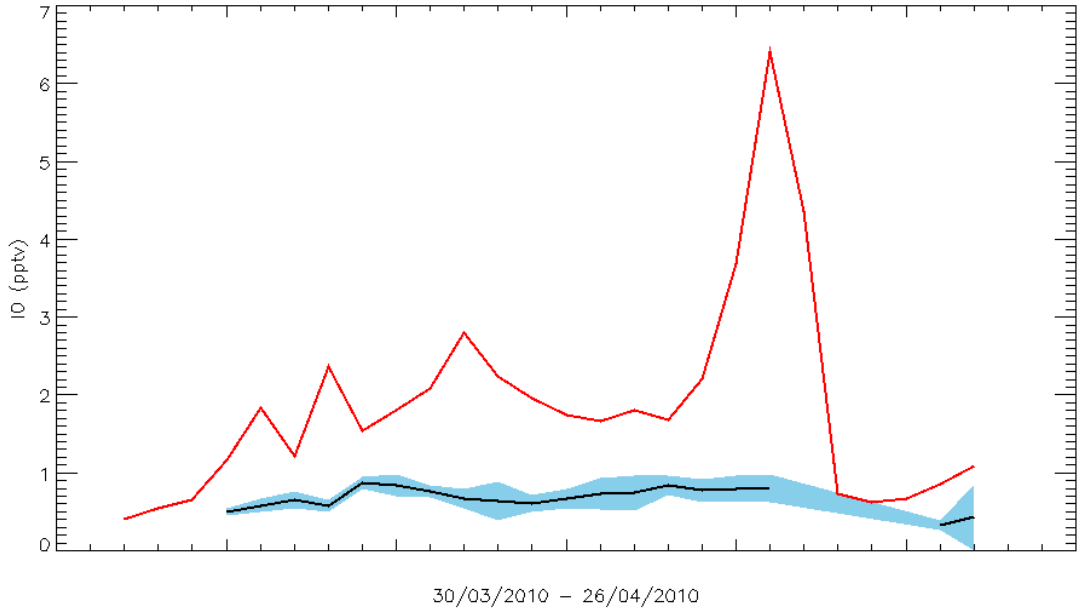
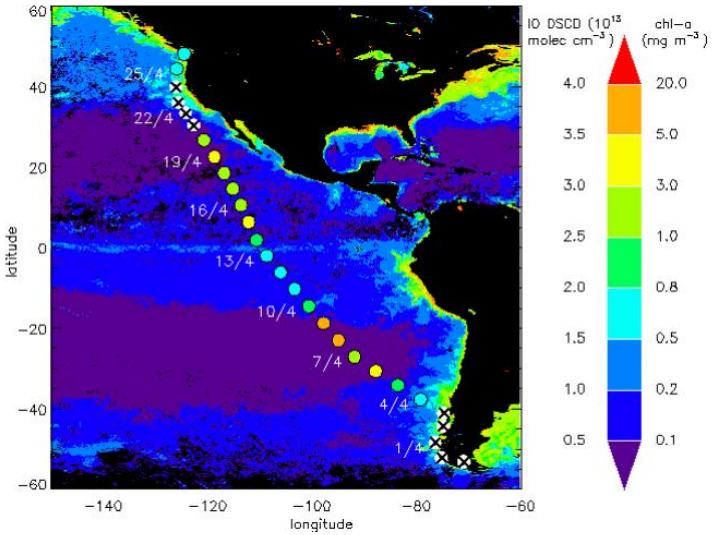
Thanks to Anoop Mahajan and Alfonso Saiz-Lopez

HaloCAST-P IO

- Model - Obs



Mahajan et al., 2012 - ACP



Summary

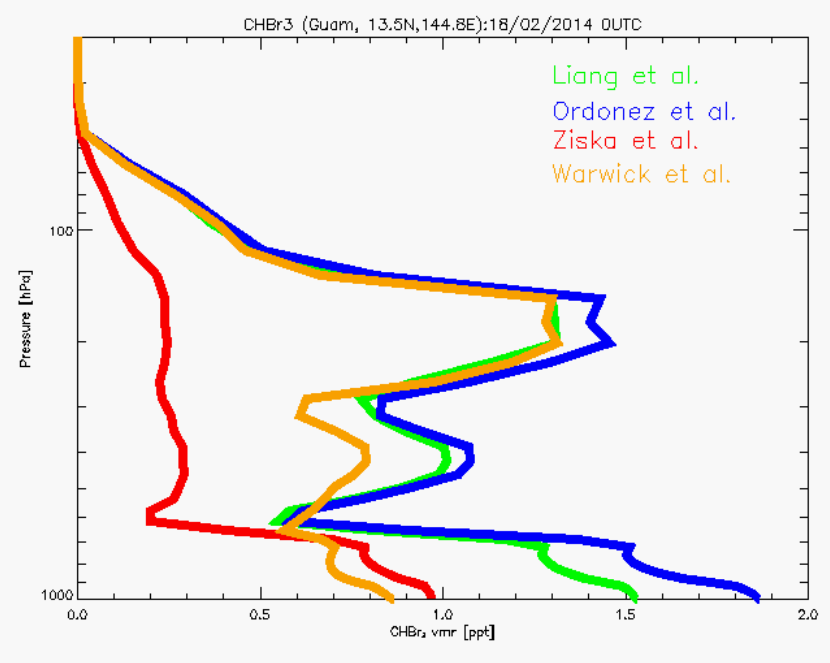
- TOMCAT 3-D CTM run with multiple VSLS emission inventories over campaign period
- High resolution model output available
- Preliminary CAST comparisons agree with previous findings
- CH_3I appears to be underestimated by both available emission inventories

- Next steps: compare with full suite of VSLS observations from all campaigns
- Full chemistry version of model available for collaborations

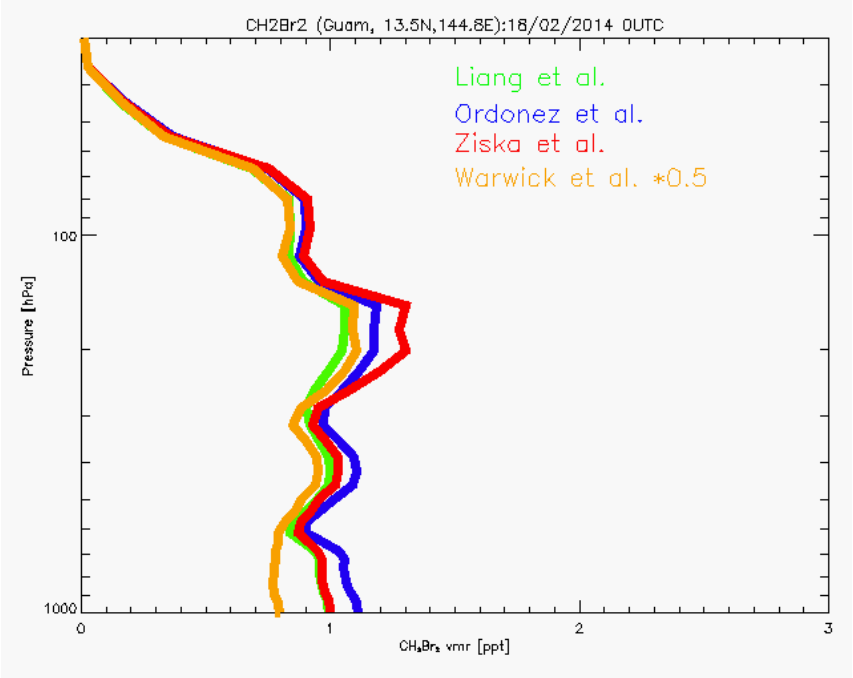
Near Real-Time Output - Profiles

Coordinated Airborne Studies in the Tropics

$CHBr_3$



CH_2Br_2



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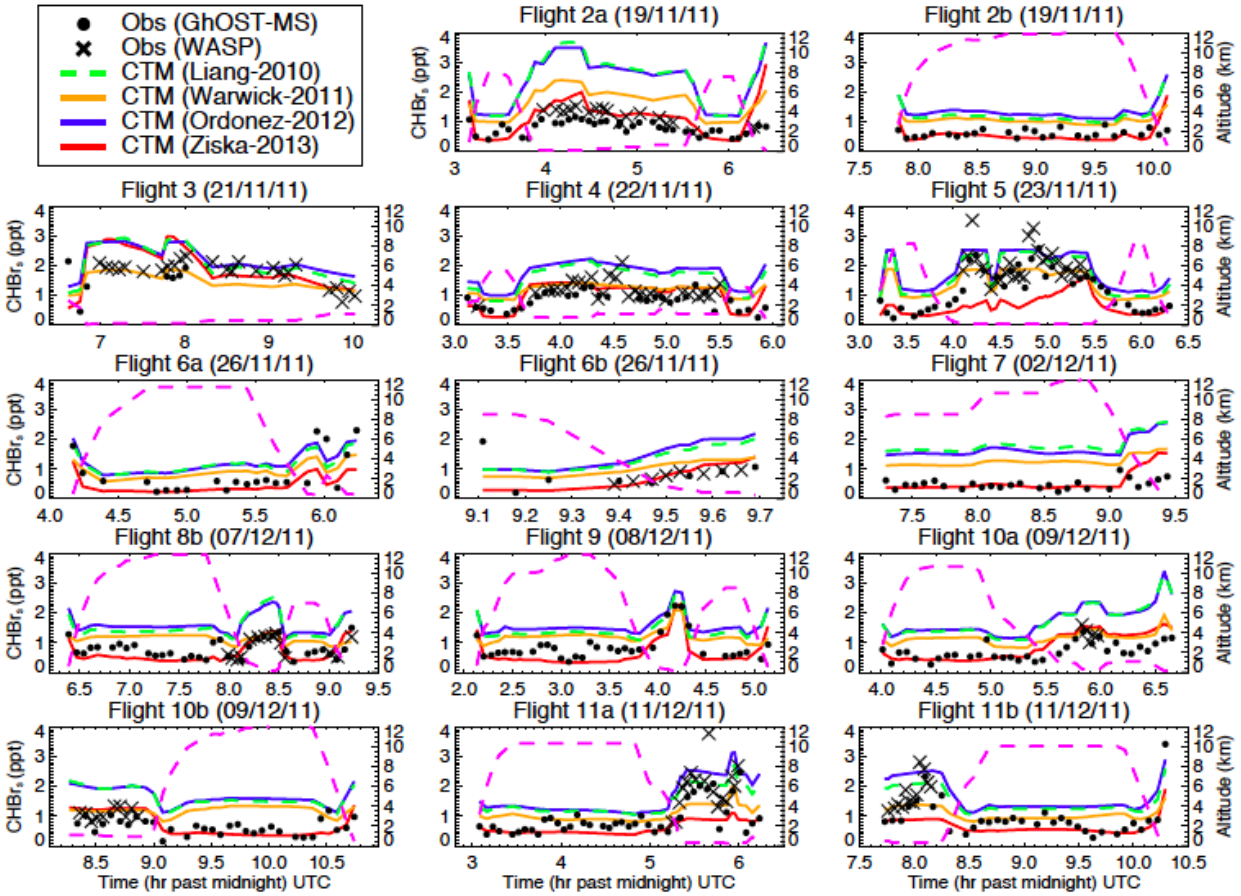
SHIVA Comparisons



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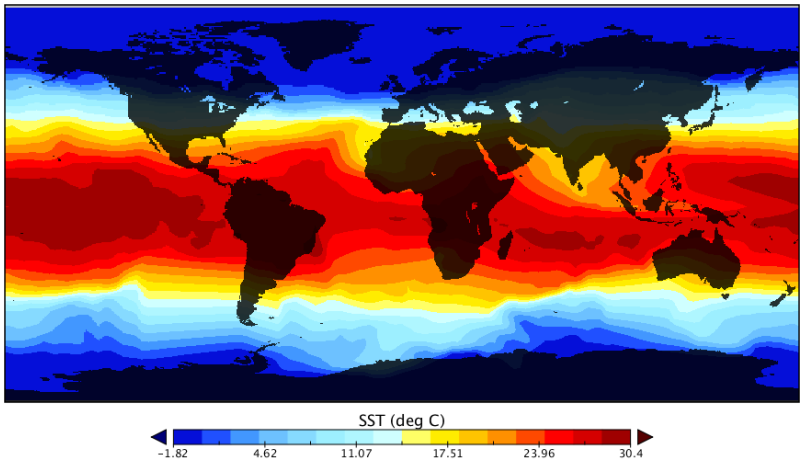
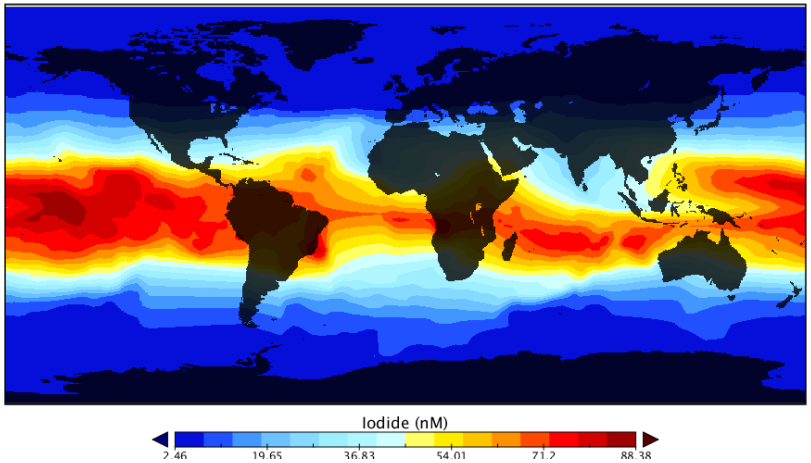
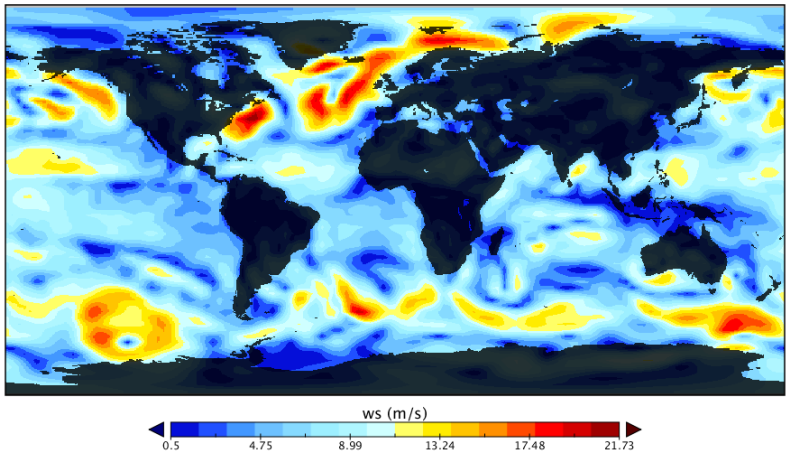
Sea Surface Temperature



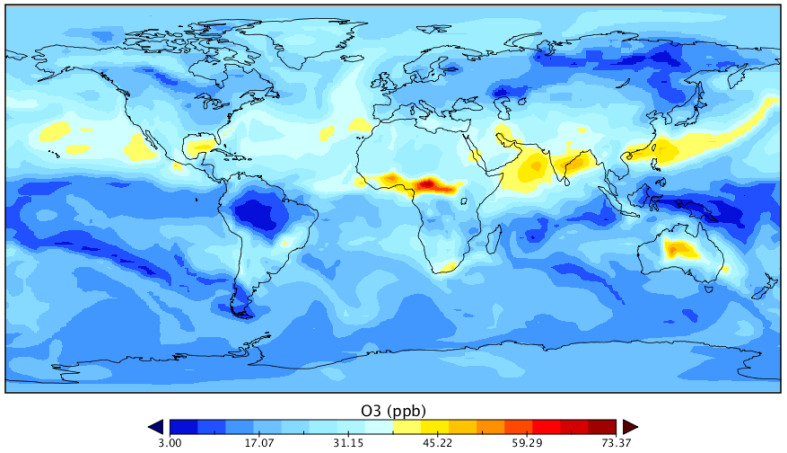
Iodide Concentration

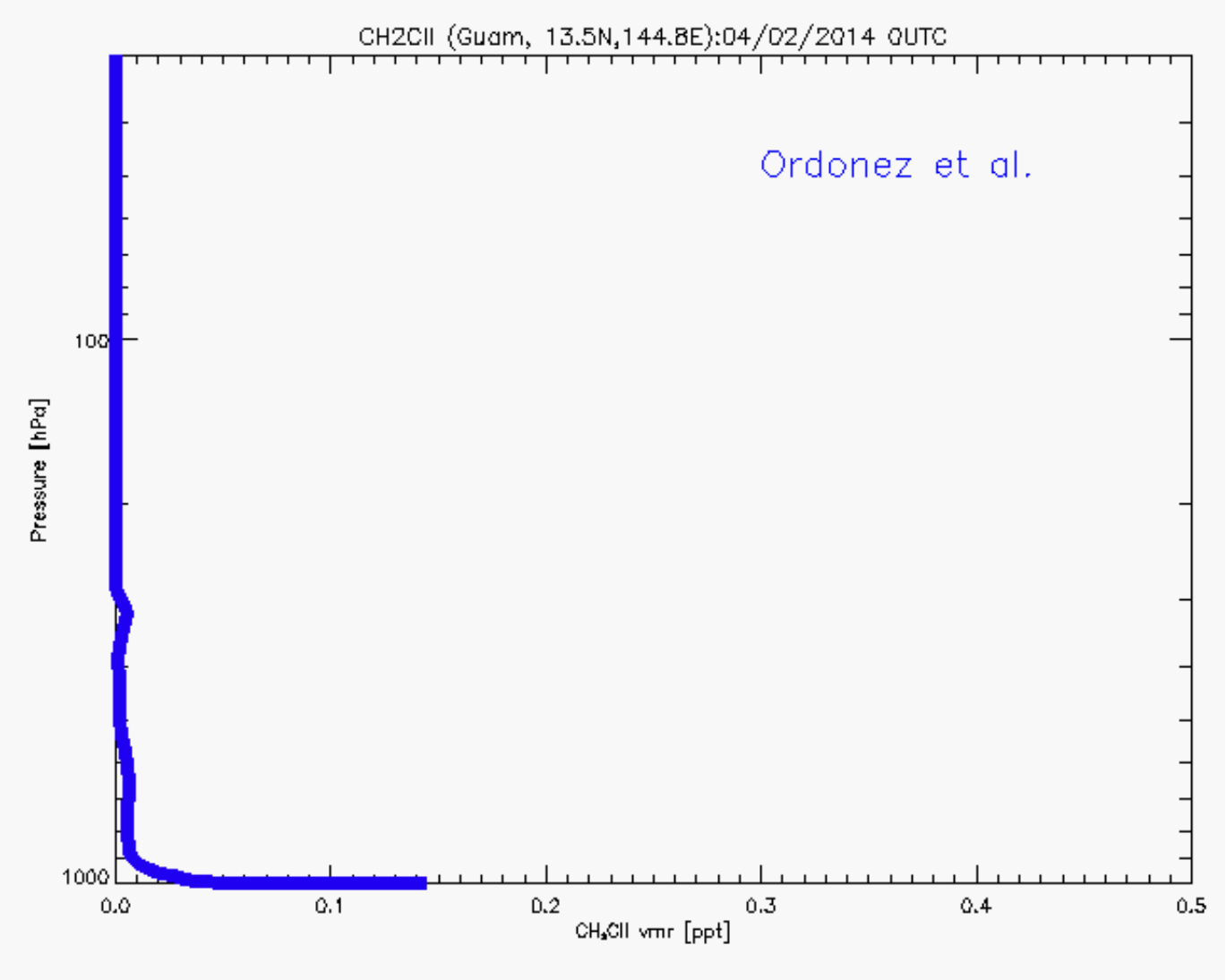


Wind Speed



Surface Ozone




CH2Cll (Guam, 13.5N,144.8E):04/02/2014 0UTC
Ordonez et al.
Pressure [hPa]
100
1000
0.0
0.1
0.2
0.3
0.4
0.5
CH2Cll vmr [ppt]