Evaluating Tropospheric OH in Global Models:

The Roles of CONTRAST and CCMI

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CONTRAST Science Team Meeting
Boulder, CO

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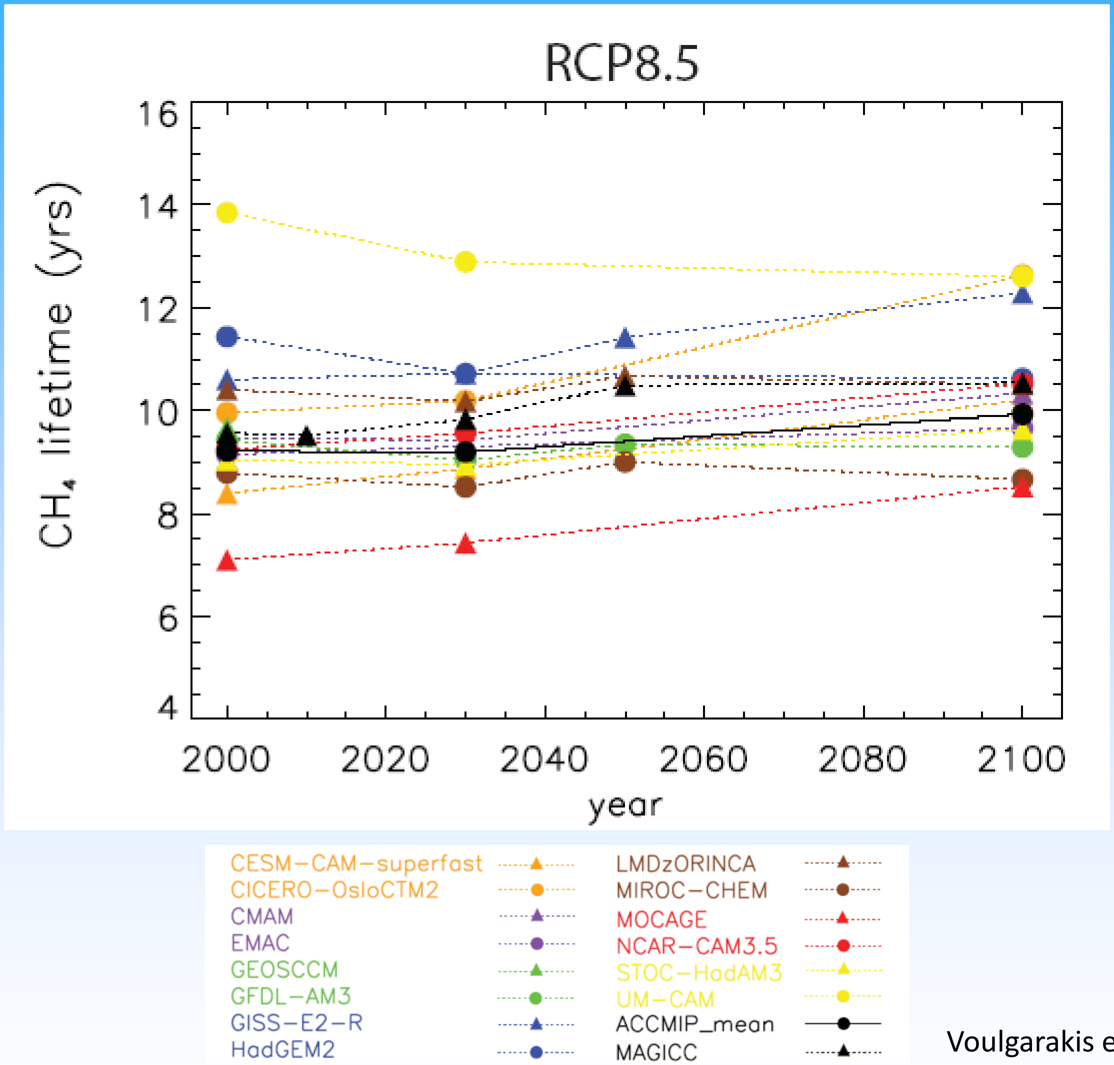
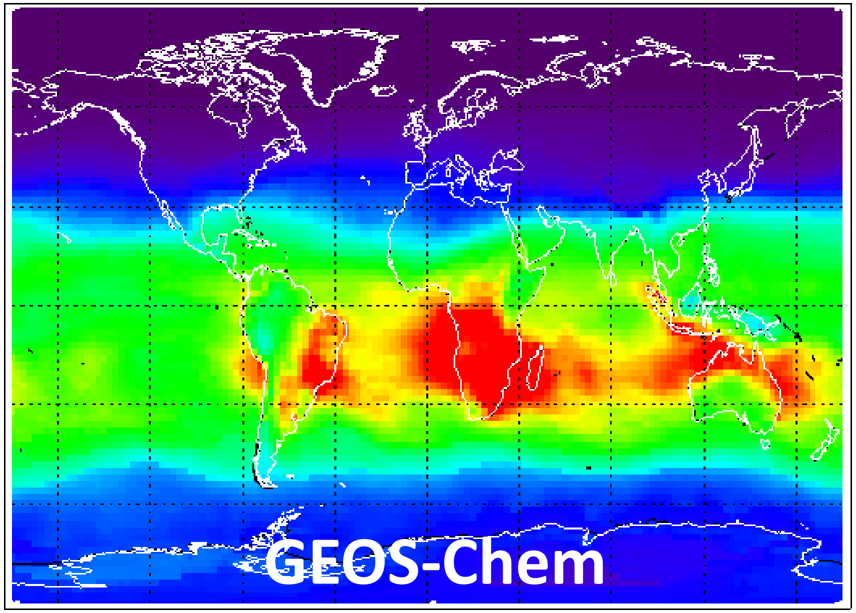
CH_4 lifetimes differ by ±20%

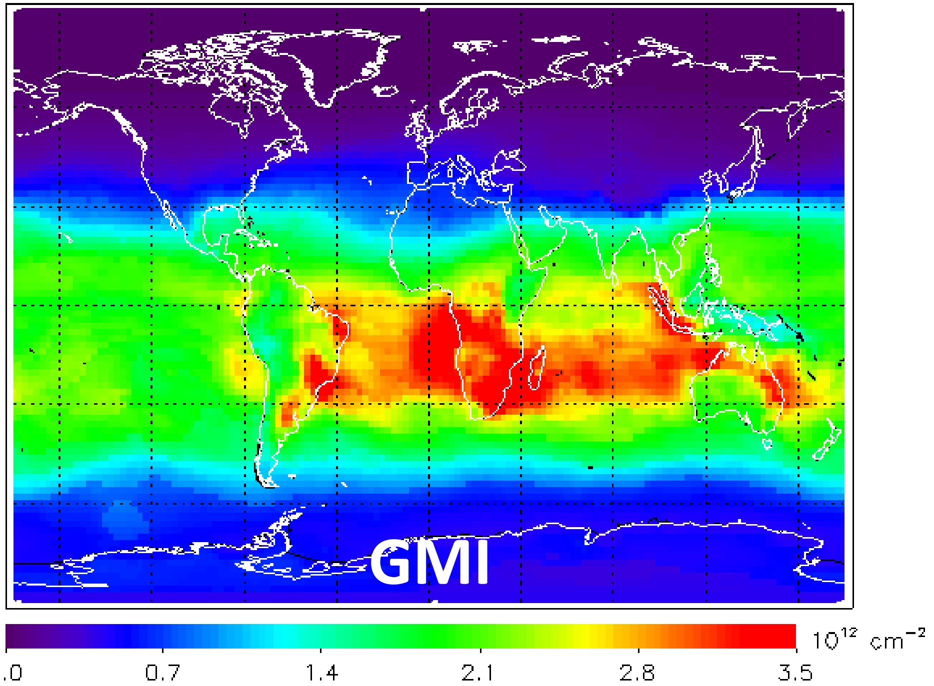


Voulgarakis et al., ACP, 2013

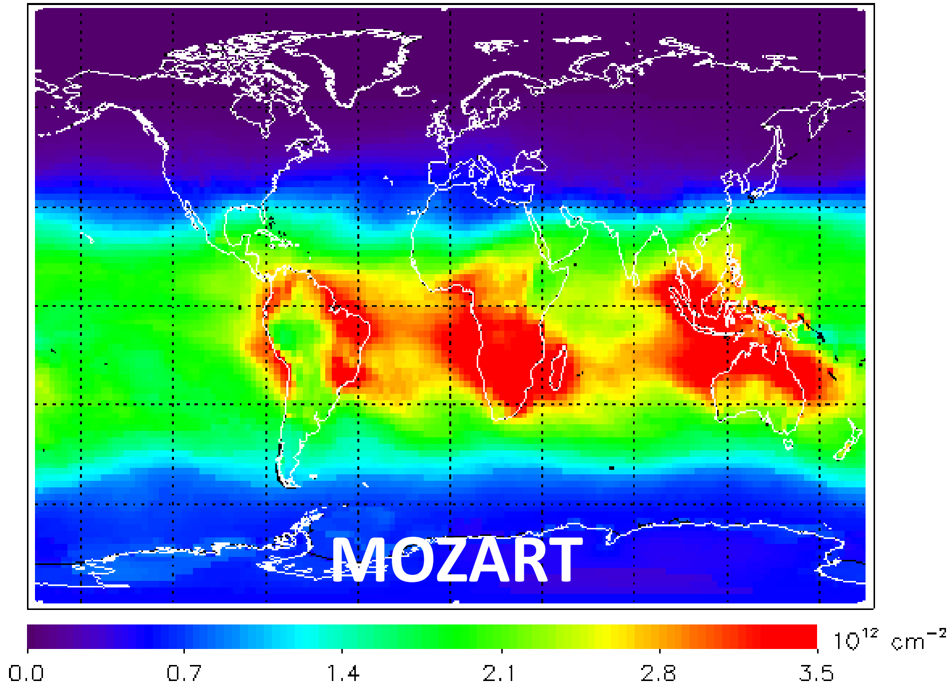
Monthly Trop OH Column, GEOSCHEM, 01/2008



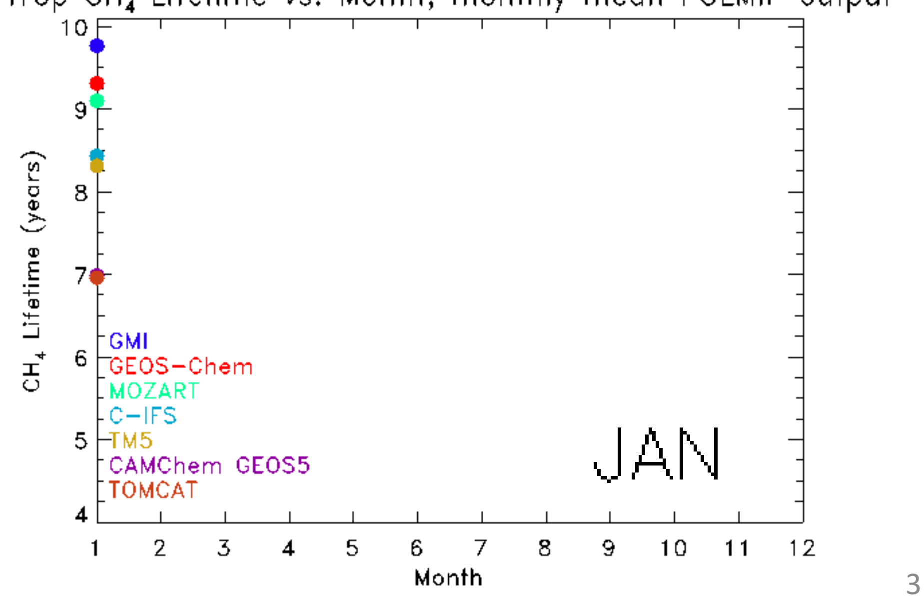
Monthly Trop OH Column, GMI, 01/2008

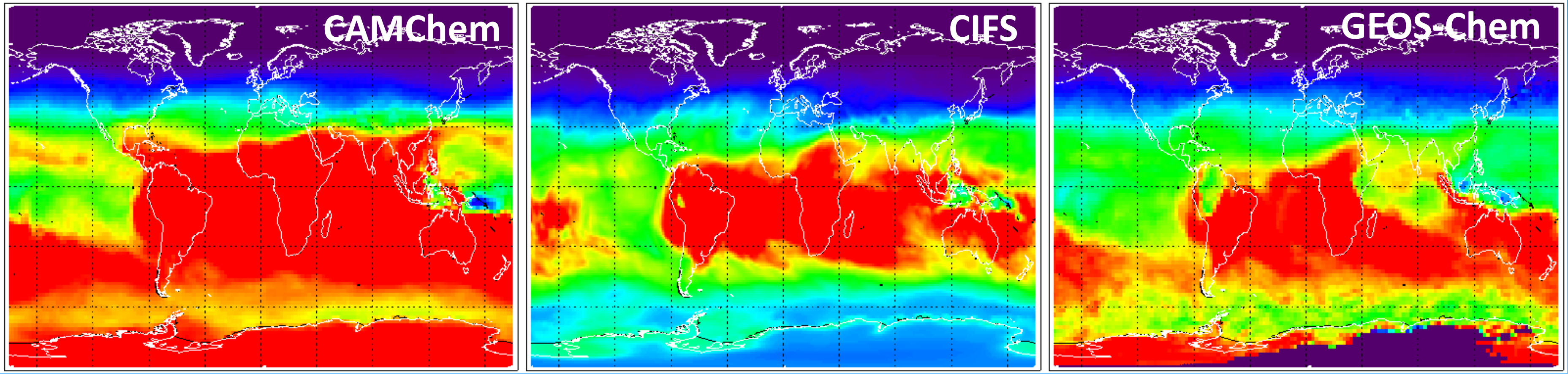


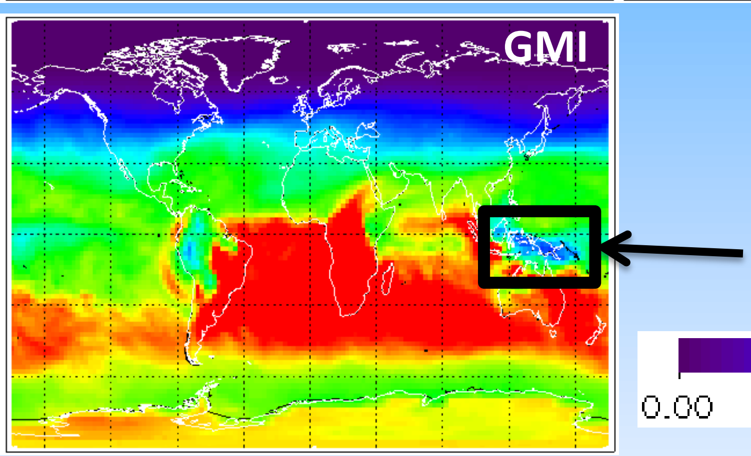
Monthly Trop OH Column, MOZART, 01/2008



Trop CH_4 Lifetime vs. Month, monthly mean POLMIP output



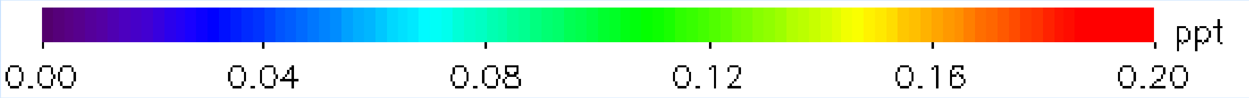


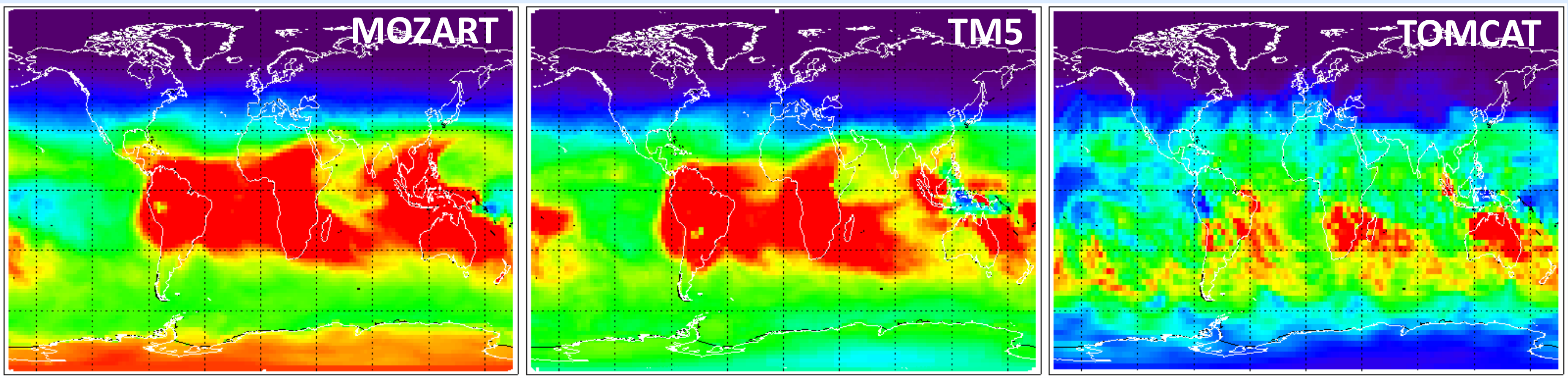


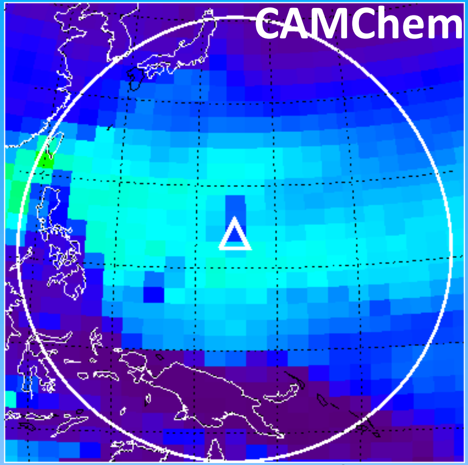
Monthly Mean OH M.R. at ~250 hPa

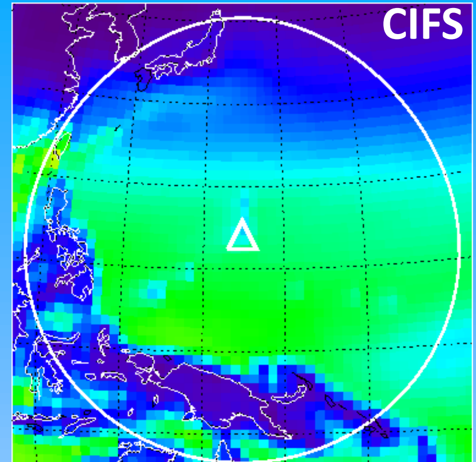
January, 2008

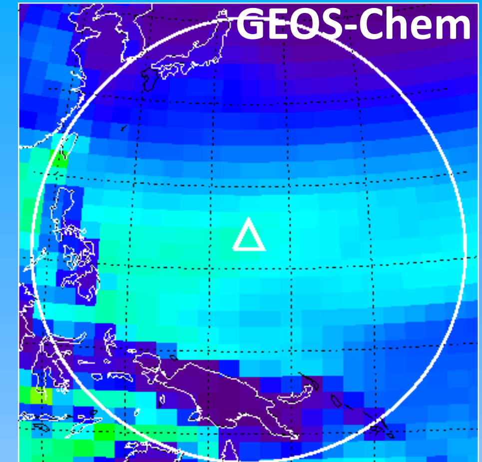
POLMIP

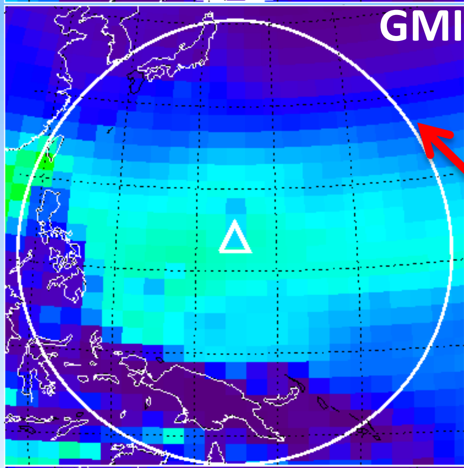








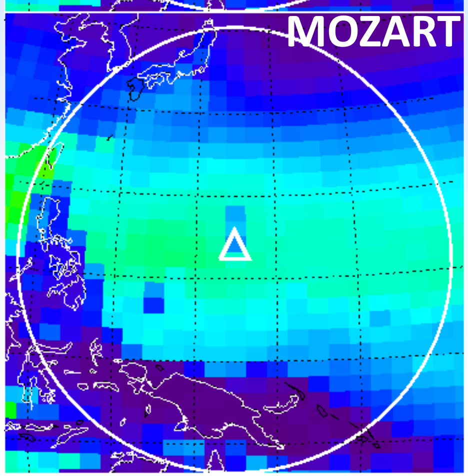


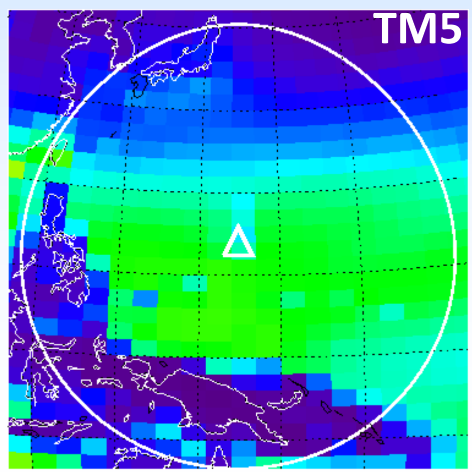


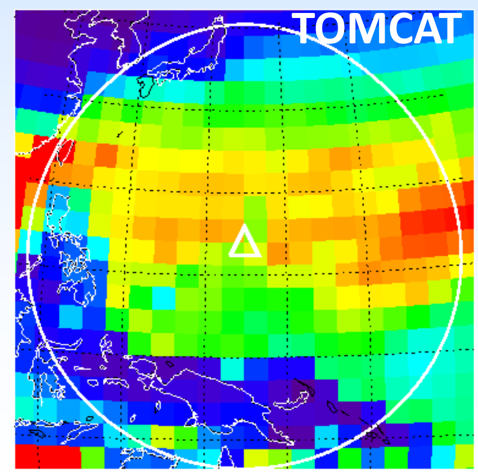
Monthly Mean OH Mixing Ratios at January, 2008 POLMIP

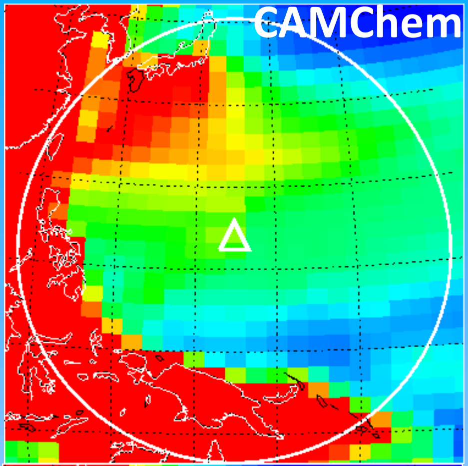
957.7 hPa

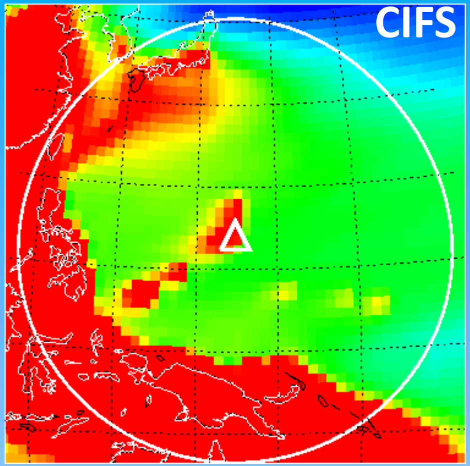
Circles designate
GV flight range

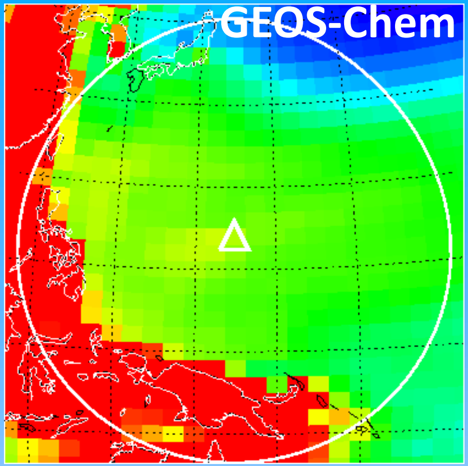


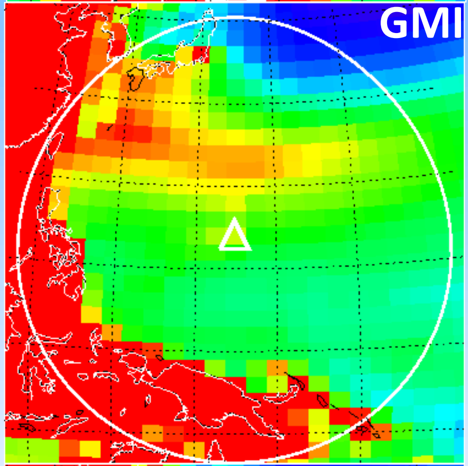




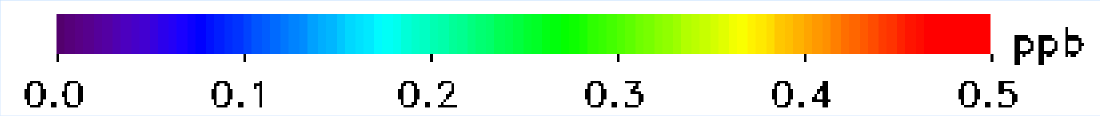


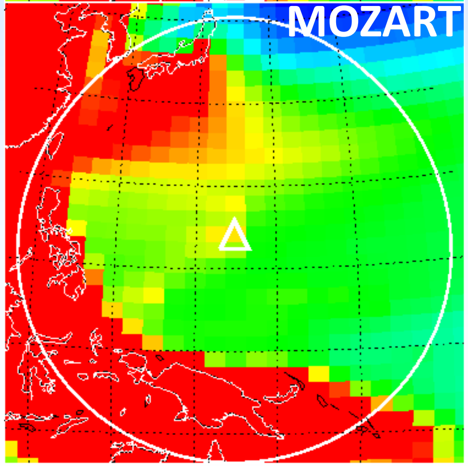


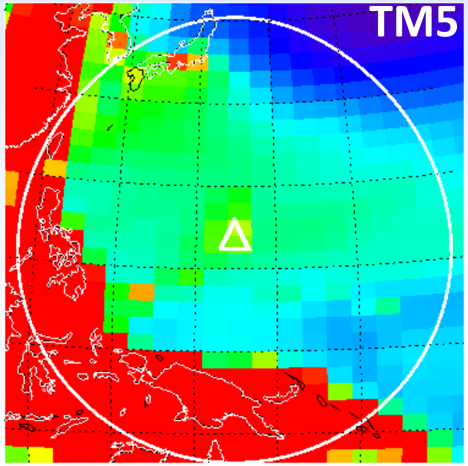


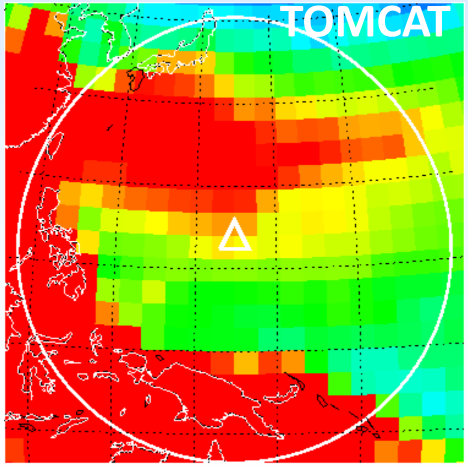


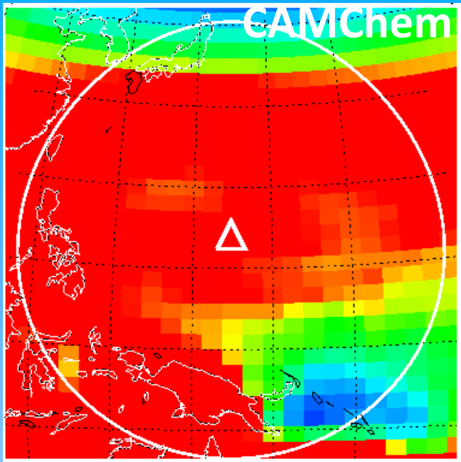
Monthly Mean HCHO Mixing Ratios at 957.7 hPa
January, 2008
POLMIP

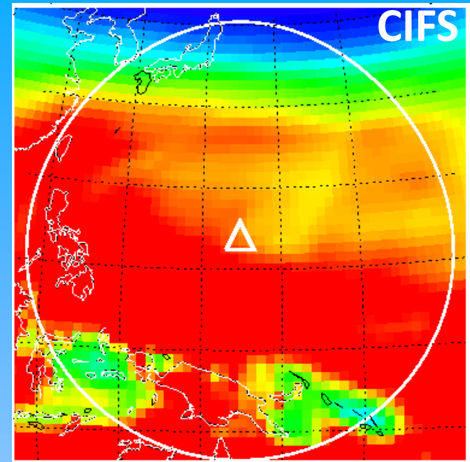


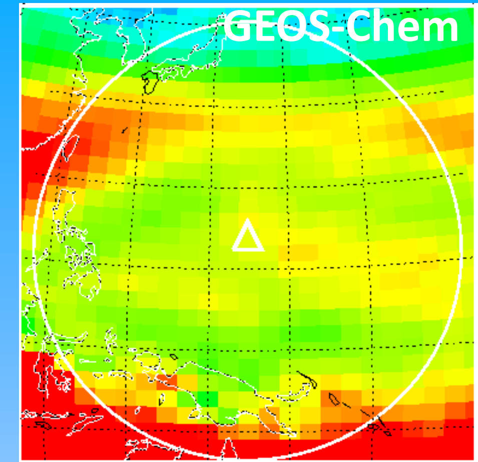


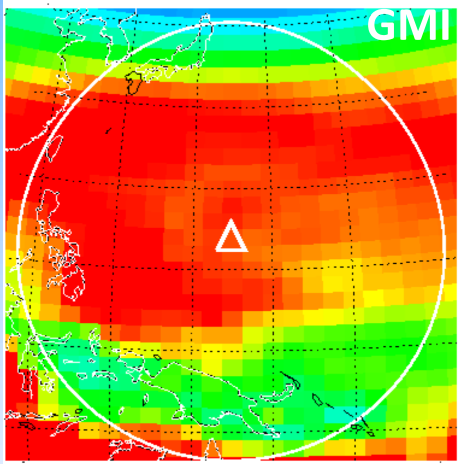




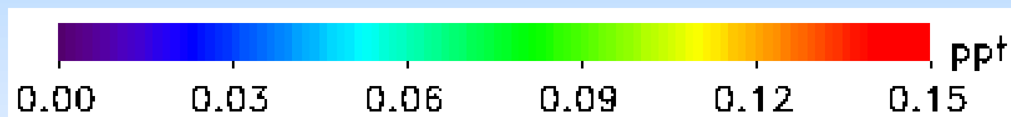


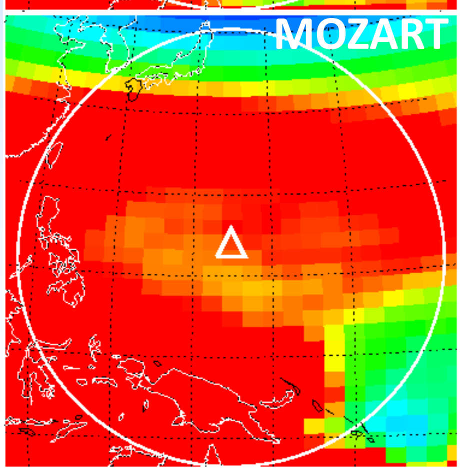


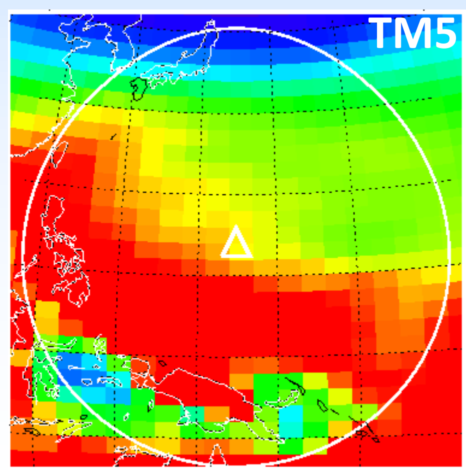


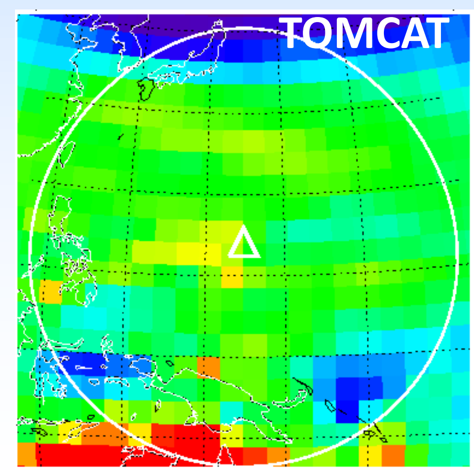


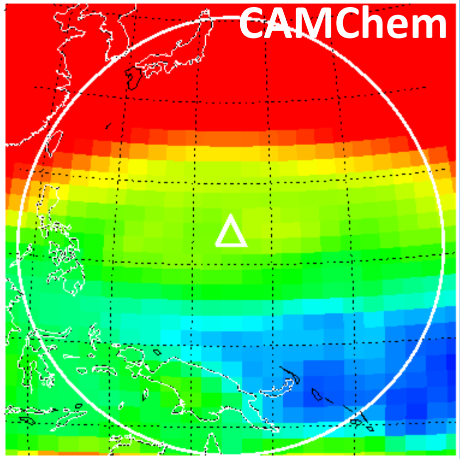
Monthly Mean OH Mixing Ratio
225 hPa
JAN 2008

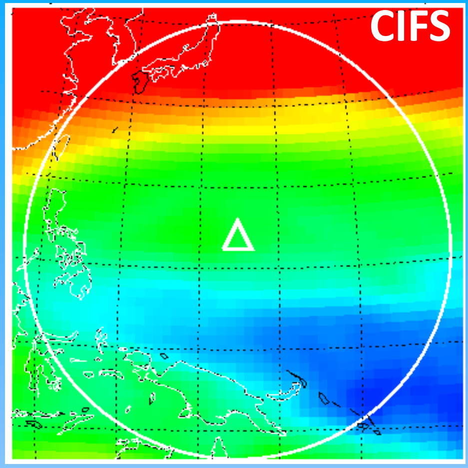


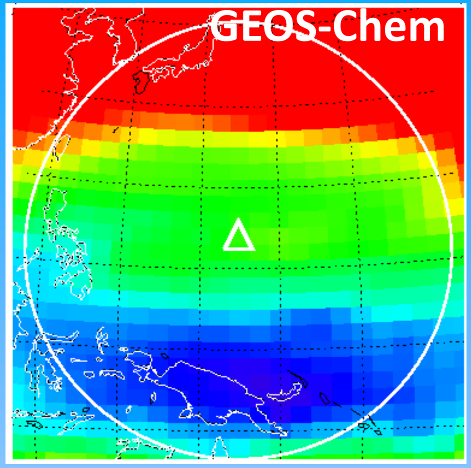


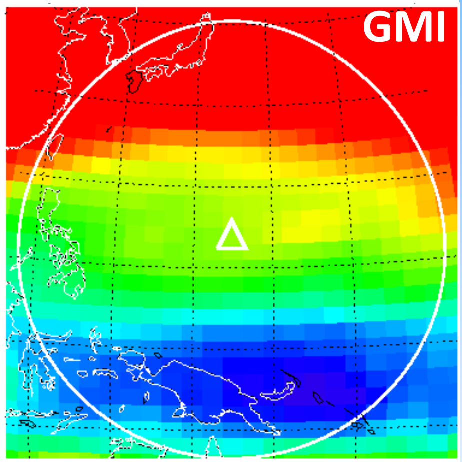




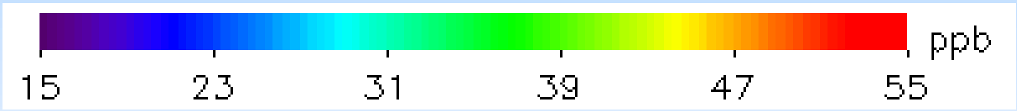


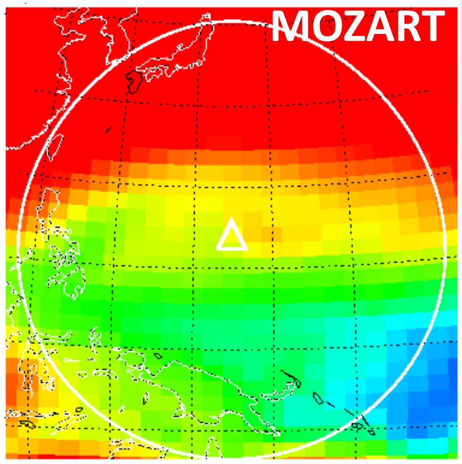


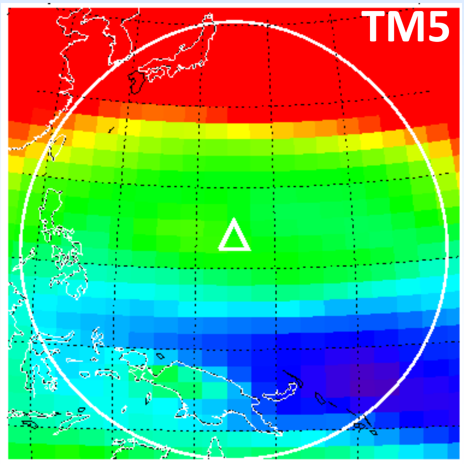


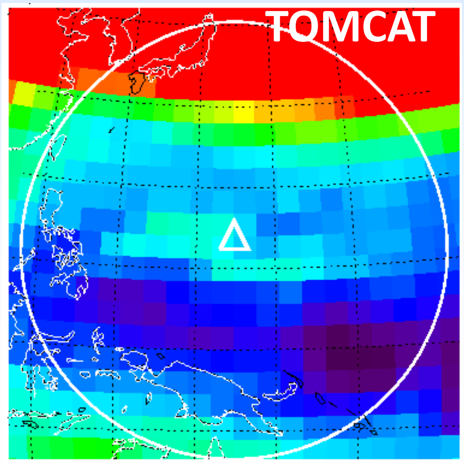


Monthly Mean O_3 Mixing Ratio
225 hPa
JAN 2008









Box Model

DSMACC: Dynamically Simple Model for Atmospheric Chemical Complexity
tropospheric chemistry box model that can interface to various chemical mechanisms

Emmerson and Evans, ACP, 2009

Makes use of the:

KPP (Kinetics PreProcessor)

Damian et al., Computers and Chemical Engineering, 2002.

Leeds Master Chemical Mechanism

Bloss et al., ACP, 2005

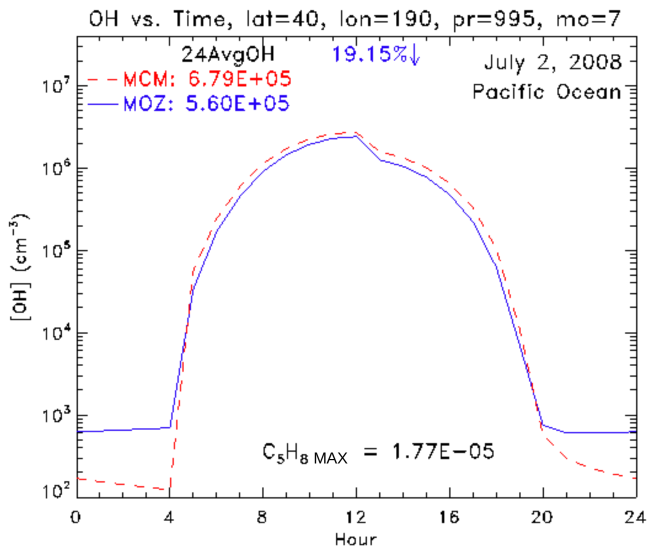
Here the box model constrained by H_2O, O_3, CH_4, CO, C_5H_8, etc from CTM *as well as* NO_2, J_{O1D}, & J_{NO2} from CTM

Focus on a few test cases for clear sky conditions

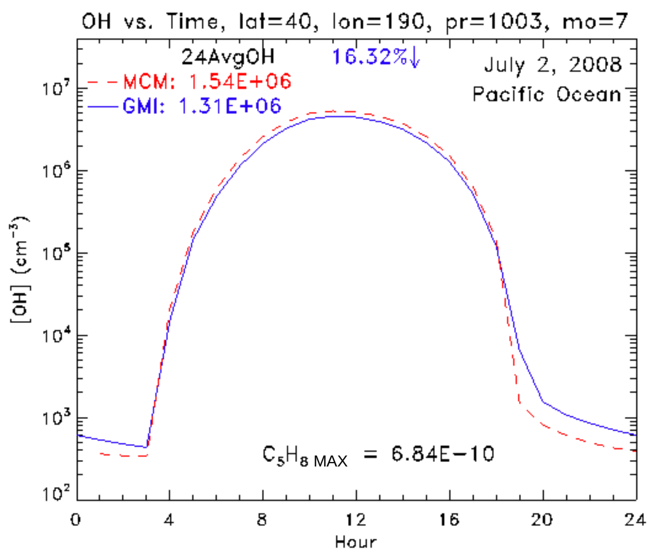
Model framework is amenable to analysis of cloudy conditions !

Box Modeling

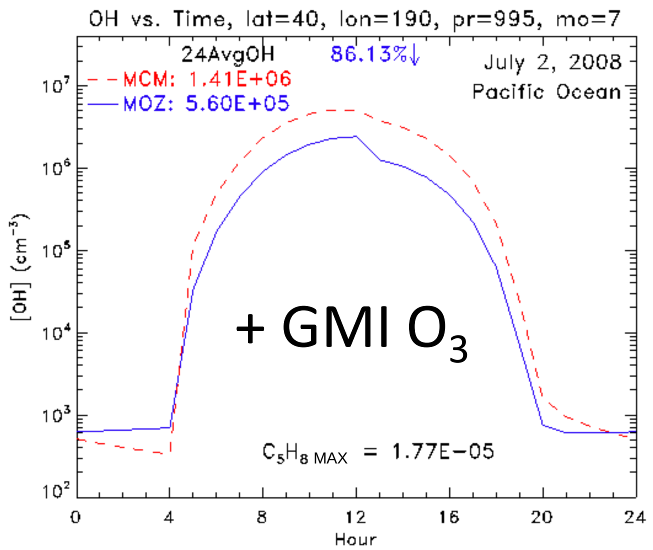
MOZART



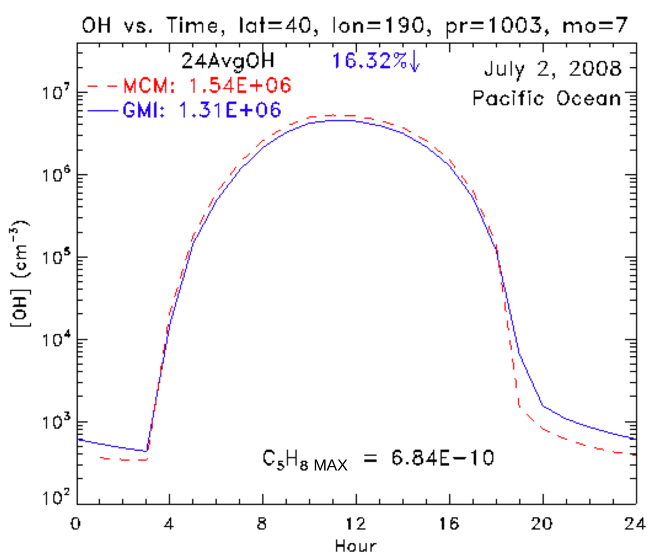
GMI



MOZART

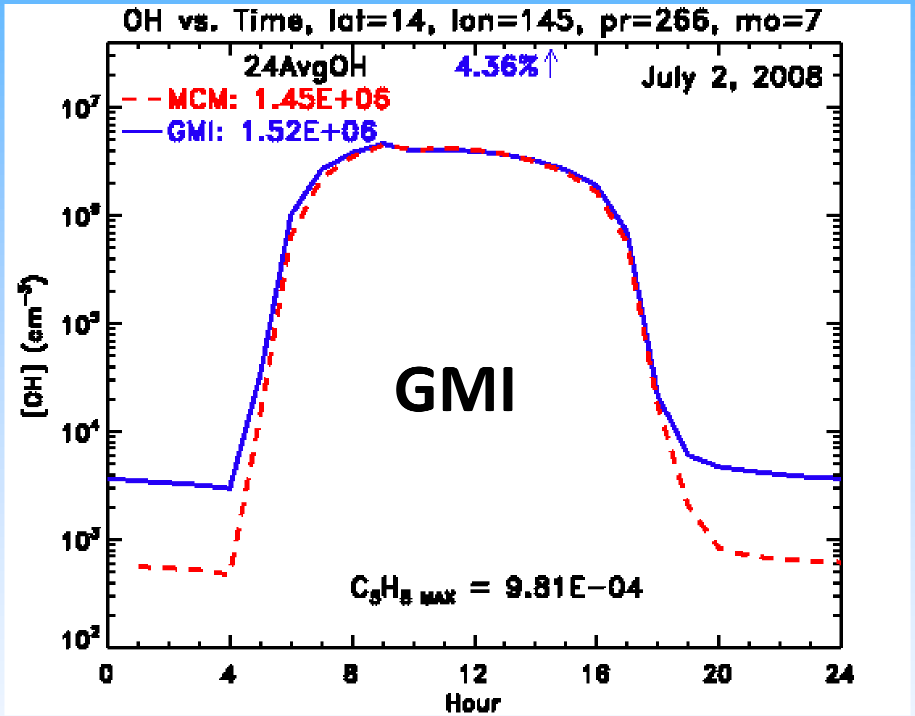


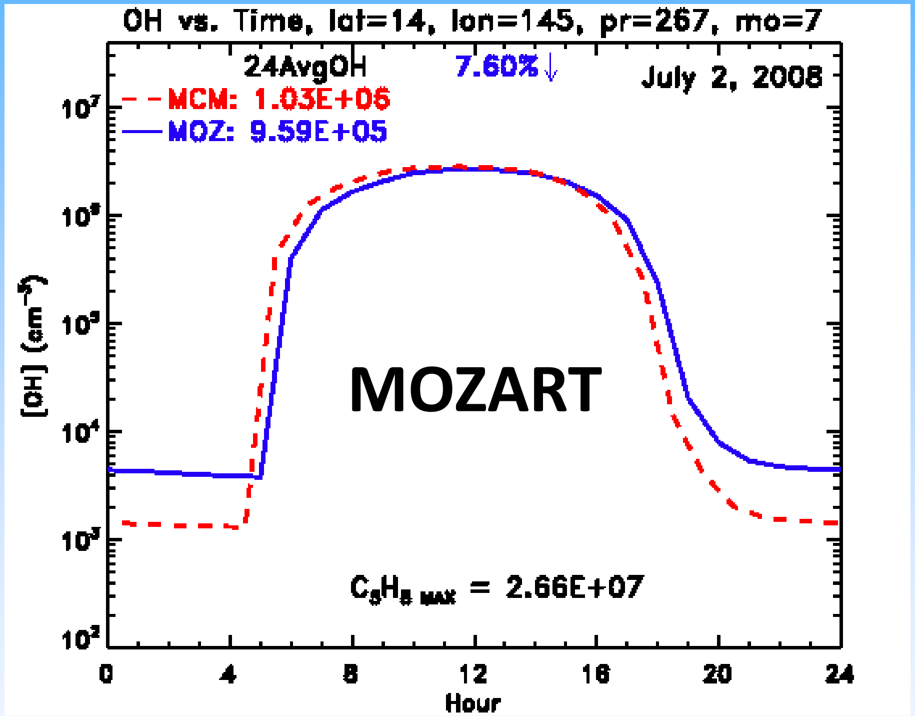
GMI



Variable	Δ MOZART MCM 24AvgOH	MOZART Range	GMI-Clearsky Range
O_3 (ppb)	+107.7%	4.59 – 7.61	13.0 – 16.6
$J(NO_2)$ & $J(O^1D)$ (s^{-1})	+15.76%	0 – 4.69×10^{-5} 0 – 0.0106	0 – 5.05×10^{-5} 0 – 0.0171
NO_x (ppt)	+5.30%	0.330 – 0.574	0.327 – 1.80
H_2O (v.m.r.)	+3.53%	0.0184 – 0.0193	0.0192 – 0.0196
Isoprene (v.m.r.)	+1.18%	6.78×10^{-27} – 7.13×10^{-25}	2.22×10^{-29} – 1.91×10^{-26}
CO (ppb)	-2.50%	68.1 – 69.2	72.3 – 82.2

TTL over Guam





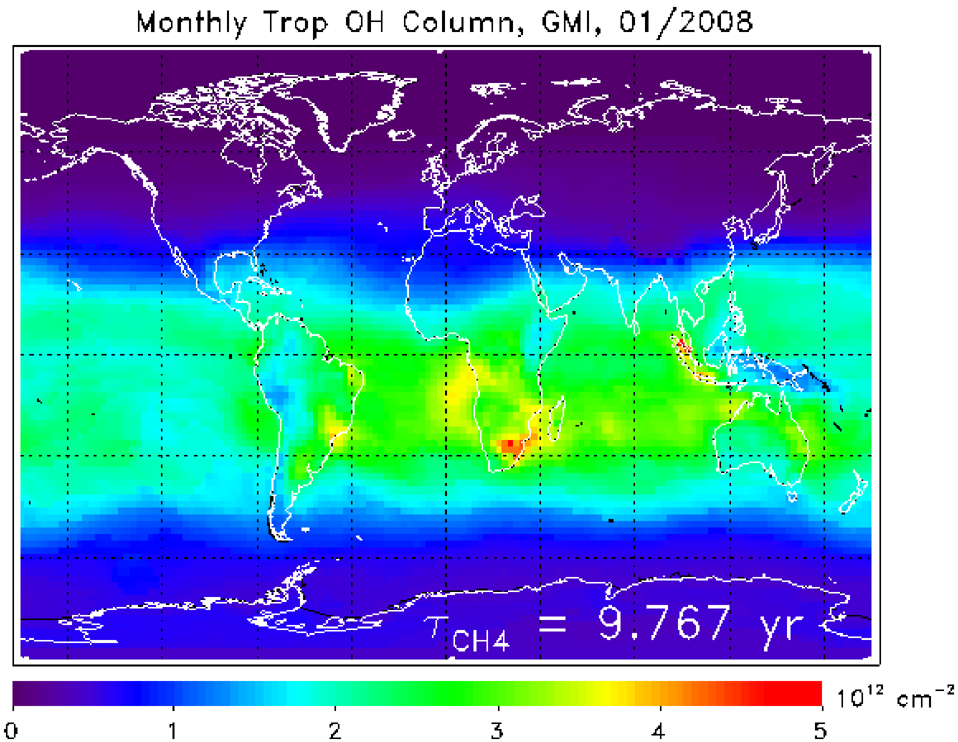
Box Modeling

Box model constraints	Box model output
p	OH and HO_2
T	H_2O_2
Overhead O_3 Column	**NO**
O_3	**HCHO**
CO	**Acetone**
H_2O	**Acetaldehyde**
NO_2	**Methanol**
CH_4	**Ethanol**
C_2H_6	**Methyl vinyl ketone**
C_3H_8	**Methacrolein**
Isoprene	**Methyl butenol**
$J(O^1D)$	**Propanal**
$J(NO_2)$	**Butanal**
Aerosol Surface Area Density	**…**

***Bold, blue text = measured during CONTRAST**

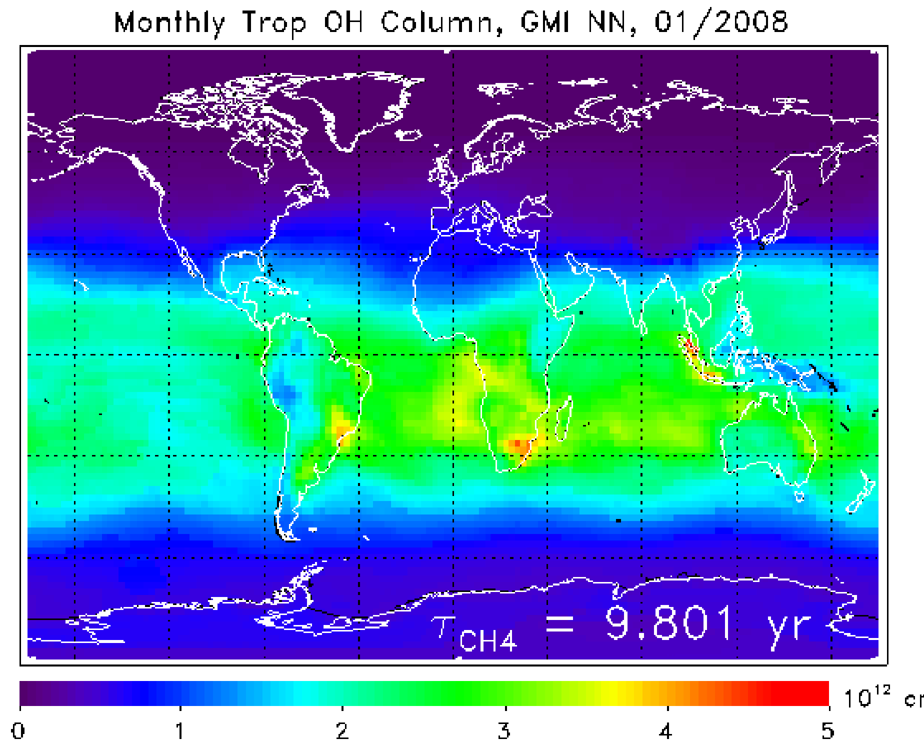
Neural Network Modeling

GMI (Actual Model)



TROP OH COLUMN

Neural Network



TROP OH COLUMN

Mean neural network $\Delta\tau_{CH4}$ values (years) from swapping specified variable between models A/B

Variable	CAM/GMI	MOZ/CAM	GMI/MOZ	Mean Abs. Value
CH_4	**+0.88±0.24**	**−0.51±0.13**	**−0.57±0.32**	0.65
$J(O^1D)$	**+0.93±0.21**	−0.13±0.11	**−0.74±0.20**	0.60
CO	**+0.57±0.03**	**−0.48±0.04**	−0.17±0.001	0.41
O_3	−0.30±0.02	−0.19±0.01	**+0.61±0.02**	0.37
$J(NO_2)$	+0.10±0.05	**−0.32±0.24**	+0.21±0.13	0.21
H_2O	+0.03±0.02	−0.23±0.04	+0.22±0.02	0.16
NO_x	+0.14±0.05	−0.07±0.03	−0.06±0.01	0.09
ISOP	+0.09±0.03	+0.03±0.0045	−0.14±0.01	0.09
T	−0.002±0.001	−0.002±0.002	+0.003±0.002	0.002
Original τ_{CH4}	6.99 / 9.80	9.12 / 6.99	9.80 / 9.12	–
τ_{CH4} + (total Δ)	8.70 / 6.80	6.18 / 8.63	8.45 / 9.06	–

Conclusions

- CTMs and CCMs have τ_{CH4} values that differ by ±20% for reasons that are not well understood
- Box models can identify reasons for differences in OH between 2 CCMs <u>*when the CCMs use similar chemical mechanisms*</u>
- Neural networks provide method of identifying causes of OH differences between 2 CCMs <u>*even when the CCMs use markedly different chemical mechanisms*</u>
- CONTRAST will provide data to evaluate the accuracy of models' precursor fields and chemical mechanisms