Air pollution and its relations to climate change and sustainable development, 2. Climate change and air pollution, 12-14 March, Gothenburg, Sweden

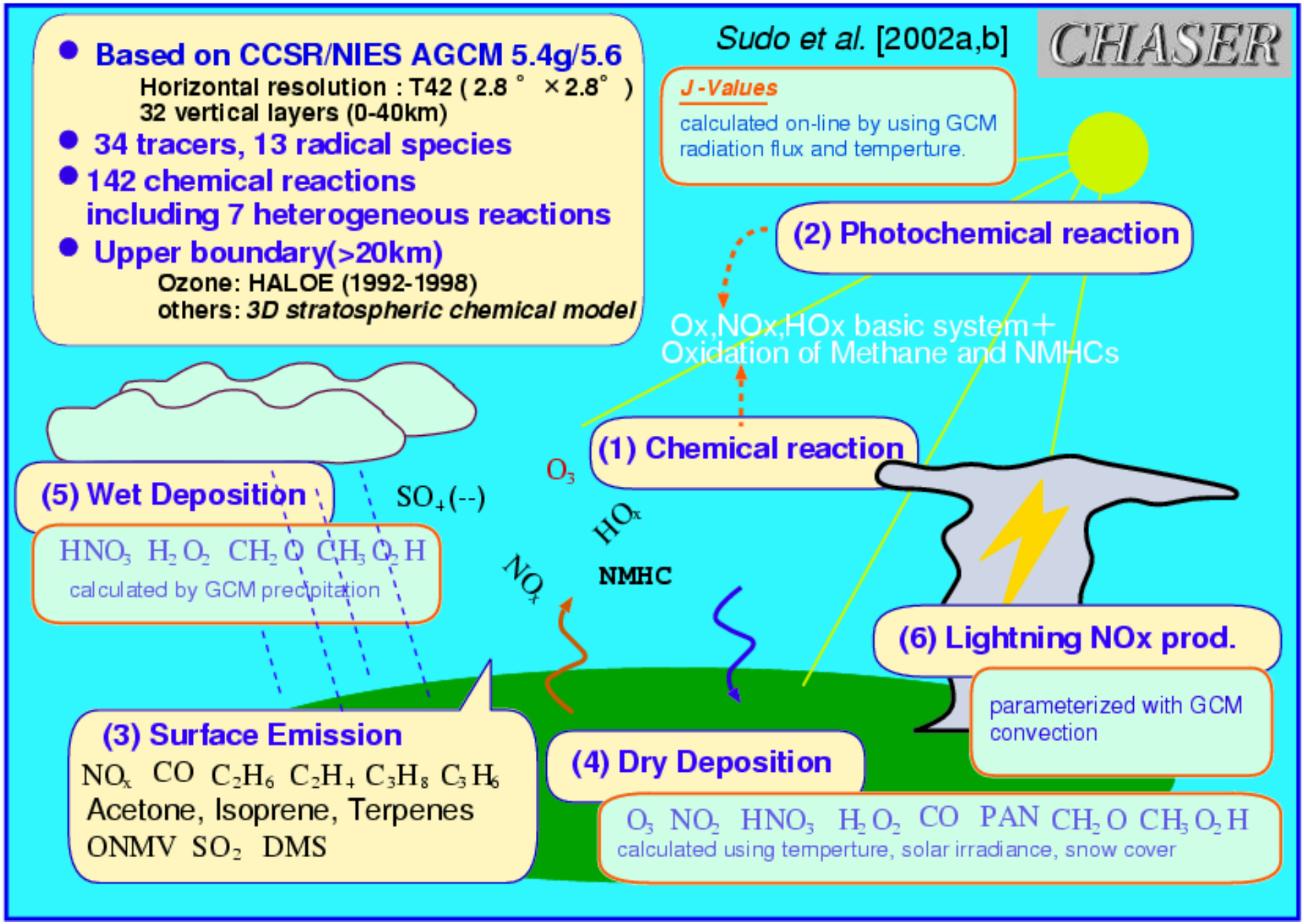
Climate Sensitivity of Ozone

Hajime Akimoto[1] and Kengo Sudo[1,2]

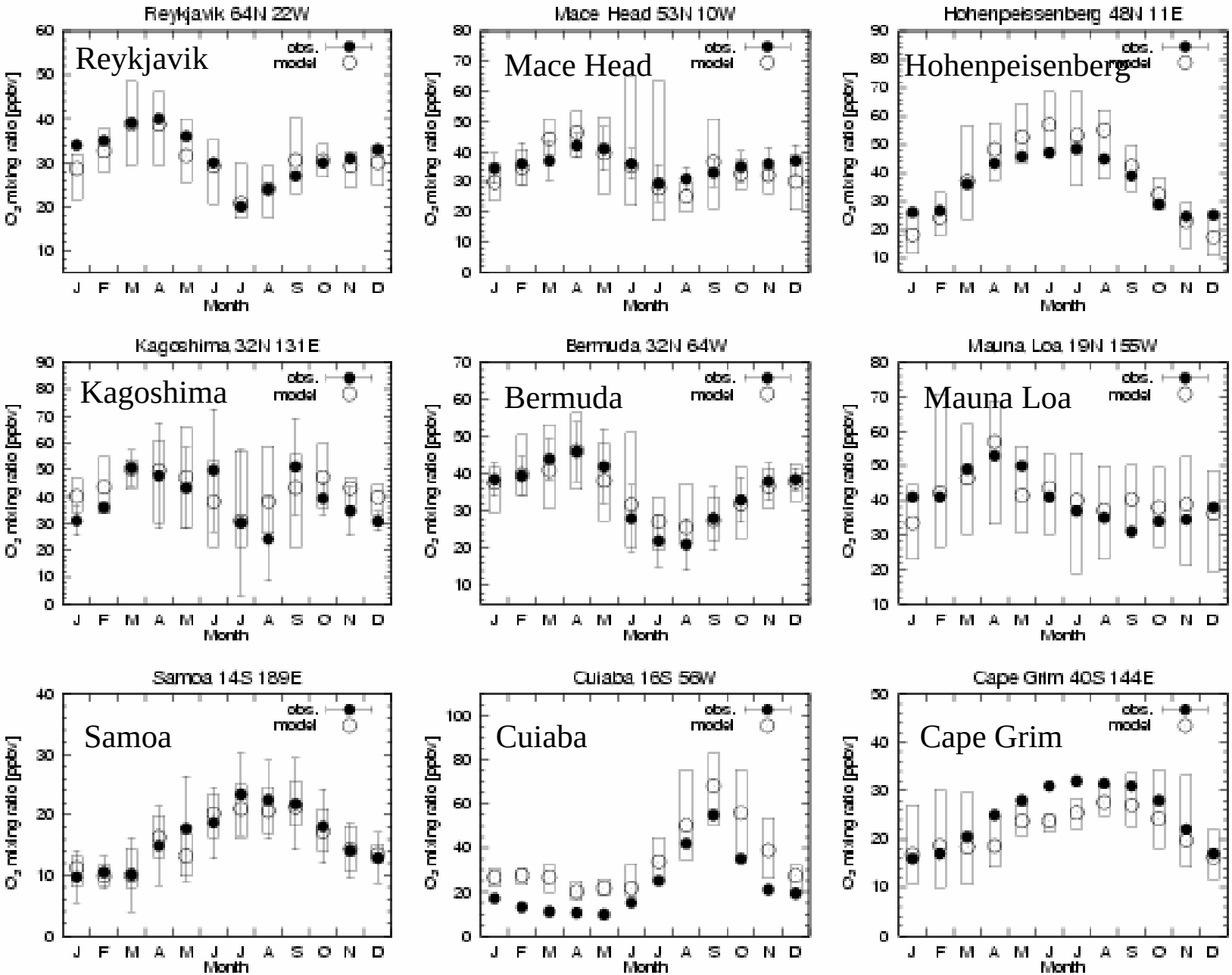
[1] Frontier Research Center for Global Change/JAMSTEC

[2] Nagoya Univeristy

Overview of the CHASER model



Observed & calculated seasonal variations of surface ozone



Radiative forcing (W m^{-2}) due to tropospheric ozone increase calculated by CHASER (preindustrial → present-day)

Tropospheric ozone increase

197 TgO3 (preindustrial)

↓ +10.4 DU (+58%)

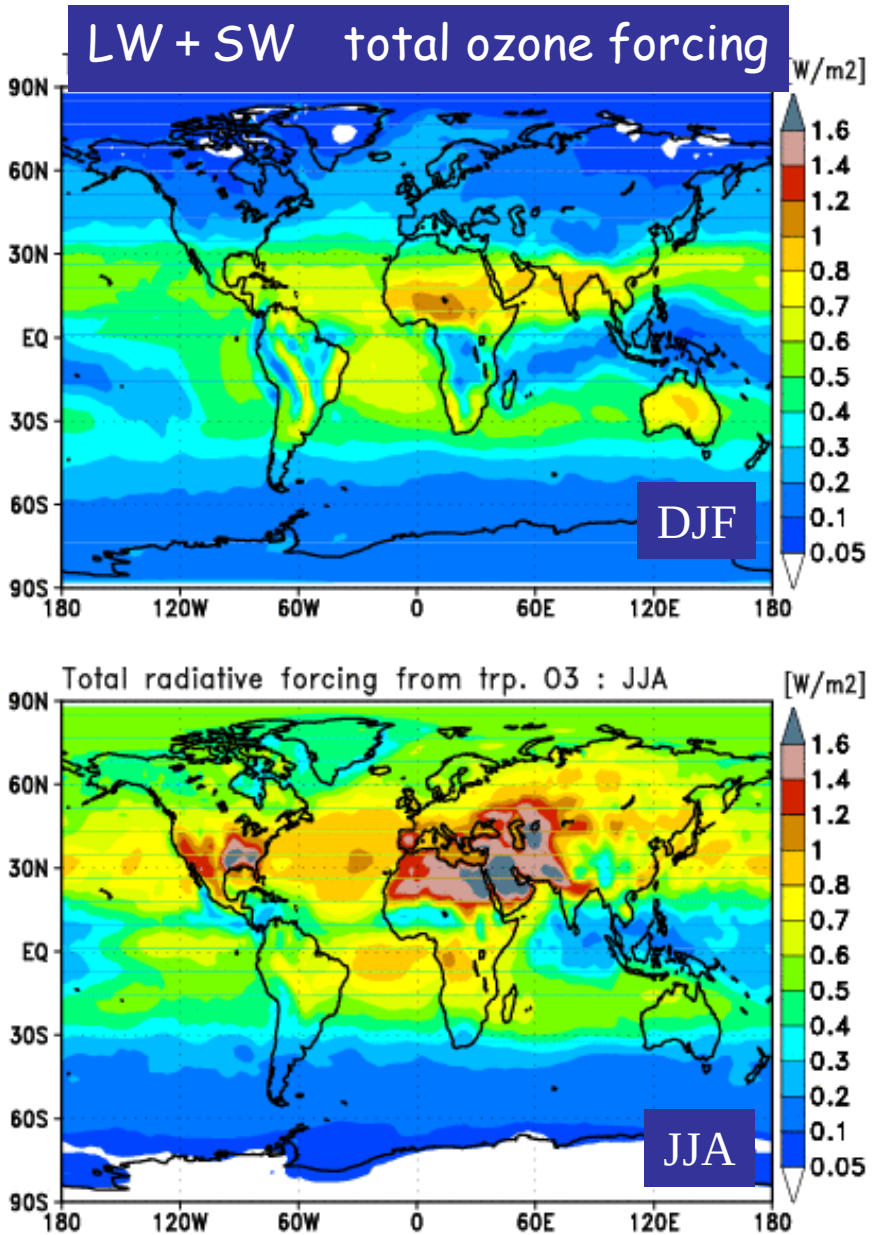
311 TgO3 (present-day)

Tropospheric ozone radiative forcing W m^{-2} (at tropopause, in annual mean)

	Global	NH	SH
LW	0.402	0.485	0.319
SW	0.085	0.107	0.063
LW + SW	0.487	0.592	0.382

Normalized radiative forcing = 0.047 W m^{-2} DU^{-1}

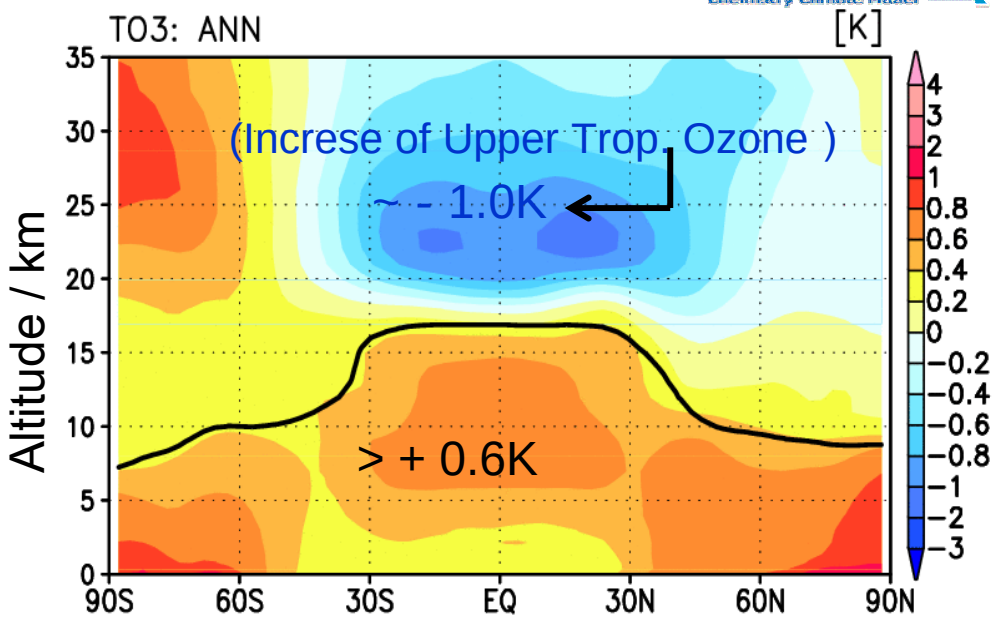
CHASER

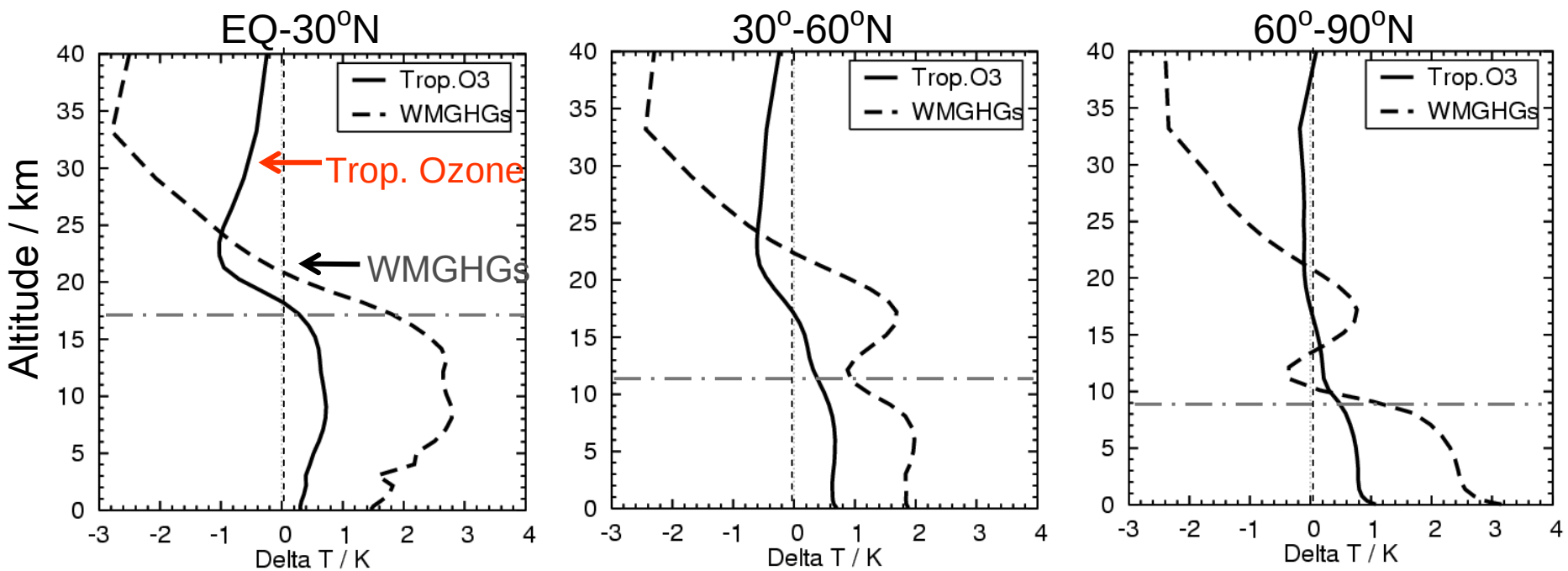


Effect on Temperature Distribution

Variation of Tropospheric Ozone
→Effect onEast/West Average ΔT (K)

~ 25-30% of WMGHGs for Troposphere in the Northern Hemisphere

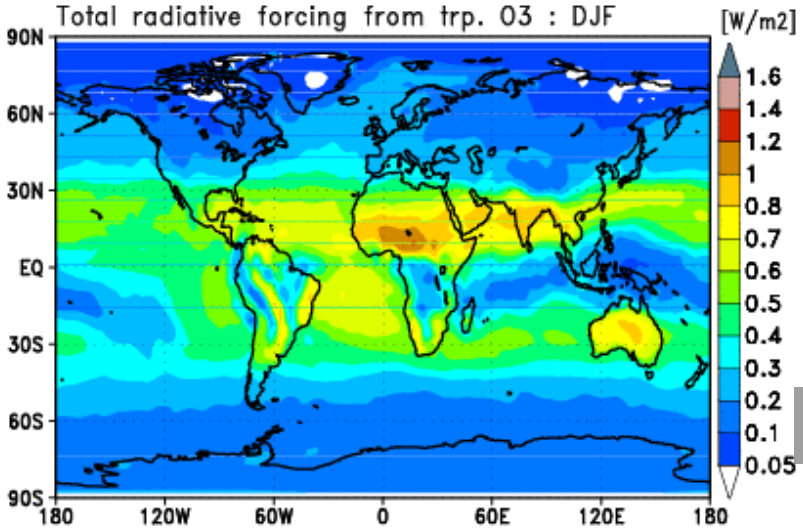




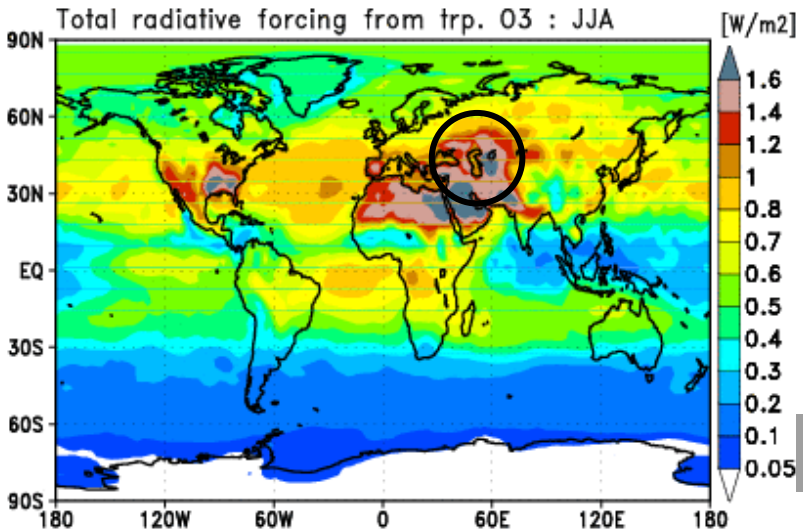
Effect on Surface Temperature (2m) : Tropospheric Ozone Increase

CHASER Chemistry Climate Model

Radiative Forcing

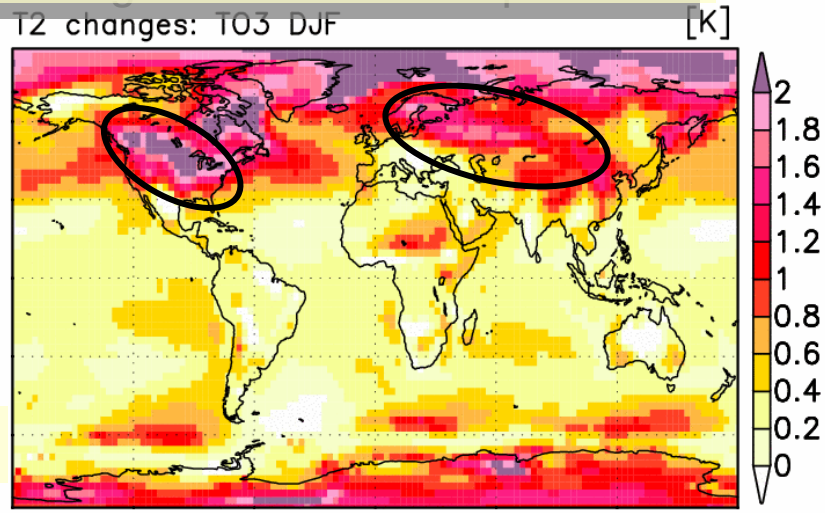


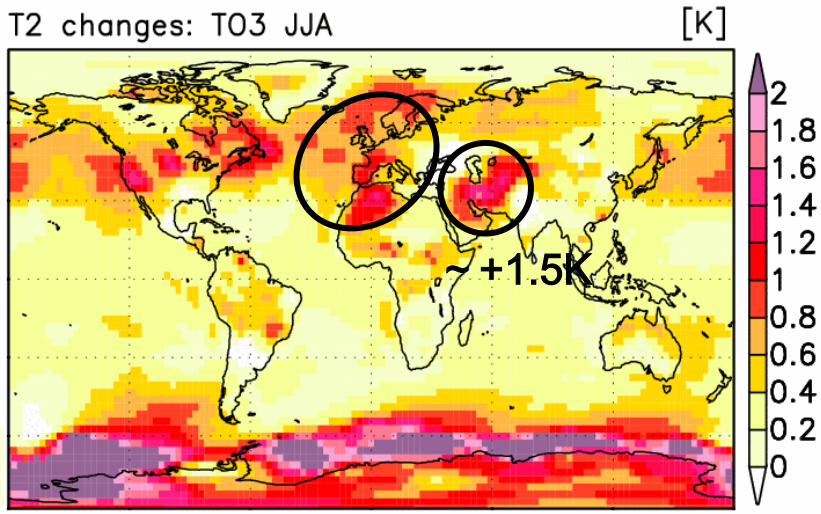
DJF



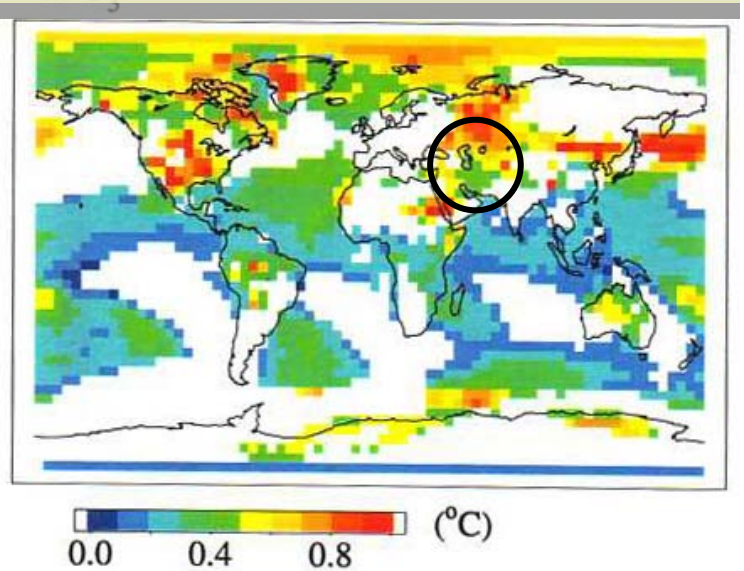
JJA

Change in Surface Temperature

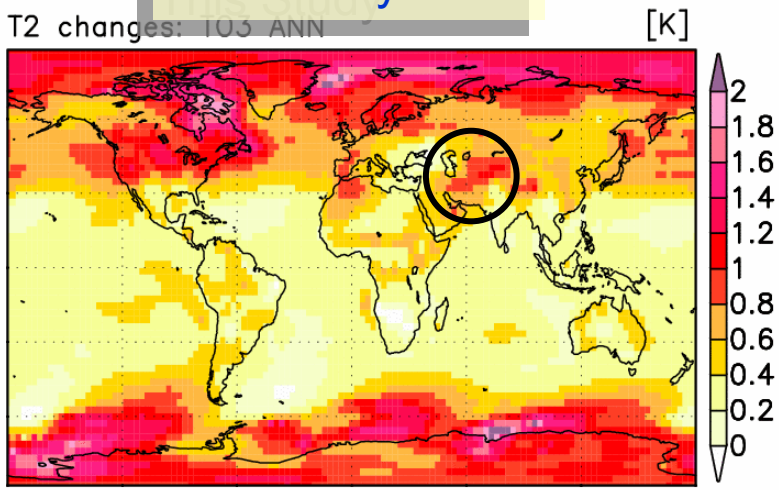




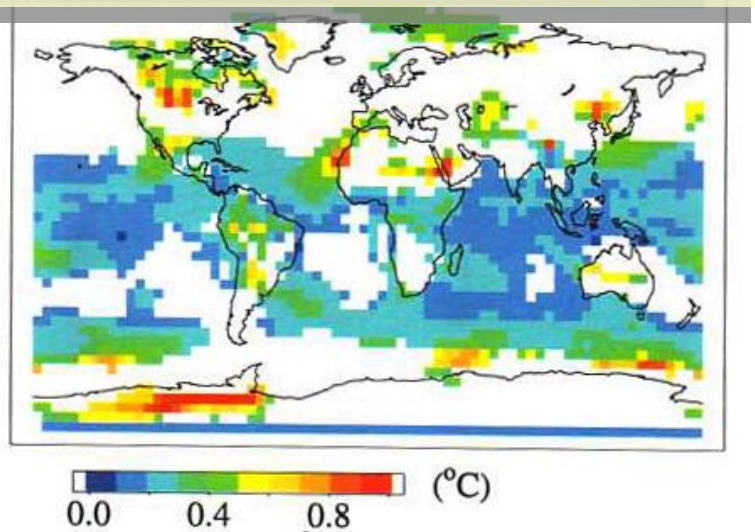
Increse of Surface Temperature due to O3 Increase



This Study



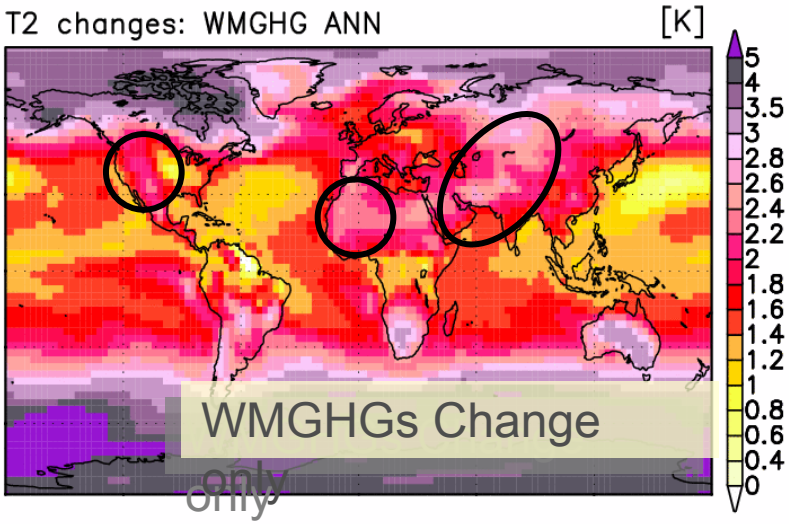
Surface Temperature Increase for Uniform Global Ozone Icrease

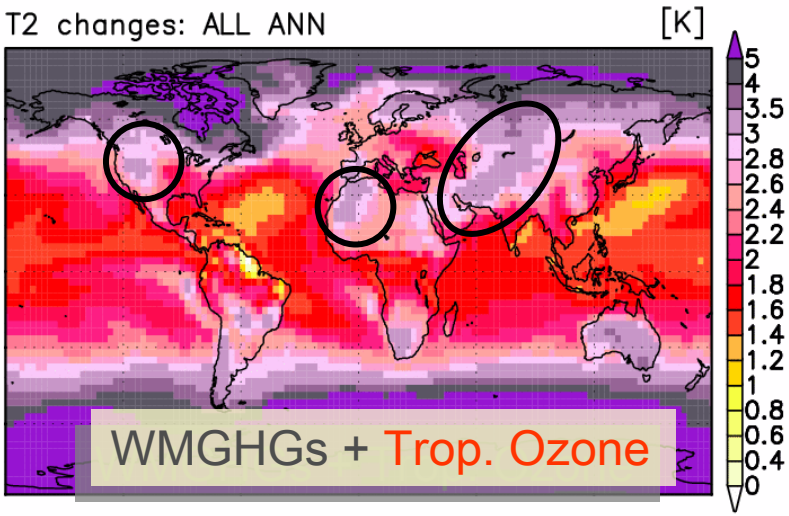


Comparison with Previous Study

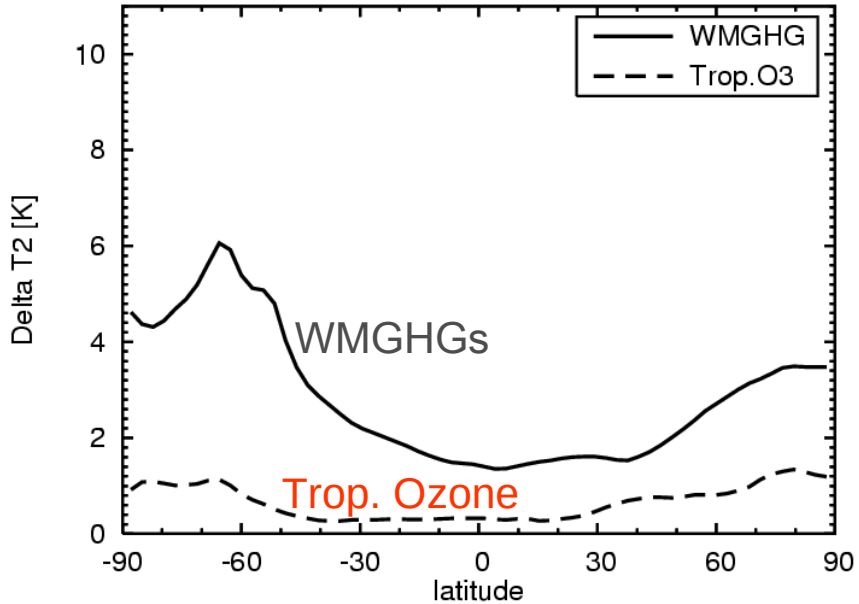
Mickley, et al., J. Geophys. Res., 109, D05106, (2004)

Effect on Surface (2m) Temperature : Tropospheric Ozone and WMGHGs





East-West, Annual Average Surface Temperature Change ΔT



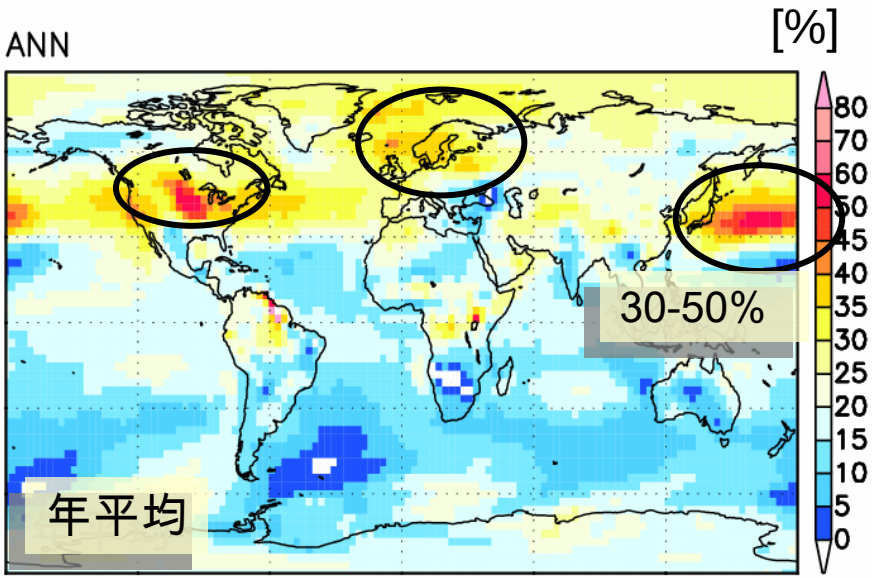
	Global	N.H.	S.H.
Tropo. O3	+0.50℃	+0.56℃	+0.44℃
WMGHG	+2.30℃	+1.85℃	+2.86℃

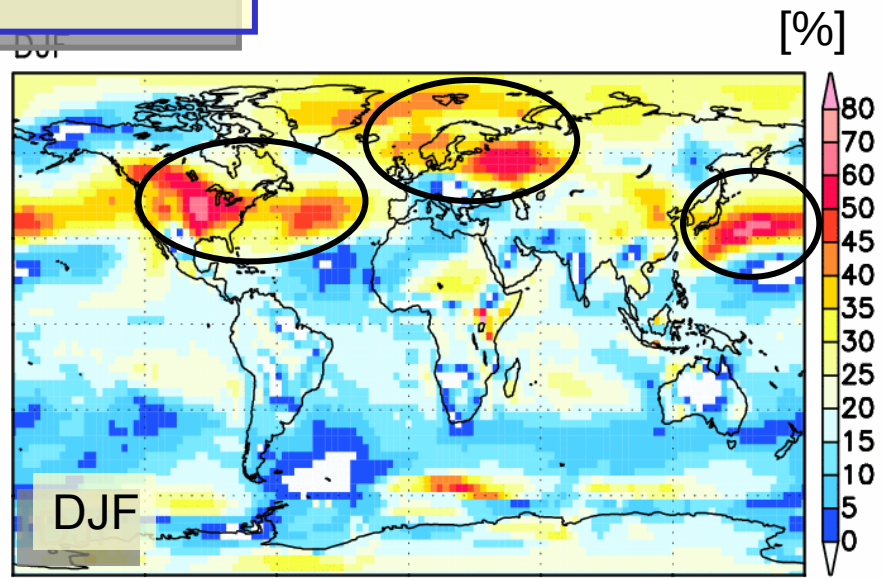
Climate sensitivity for tropospheric O3 Change = 1.04 K m^2 W^{-1}

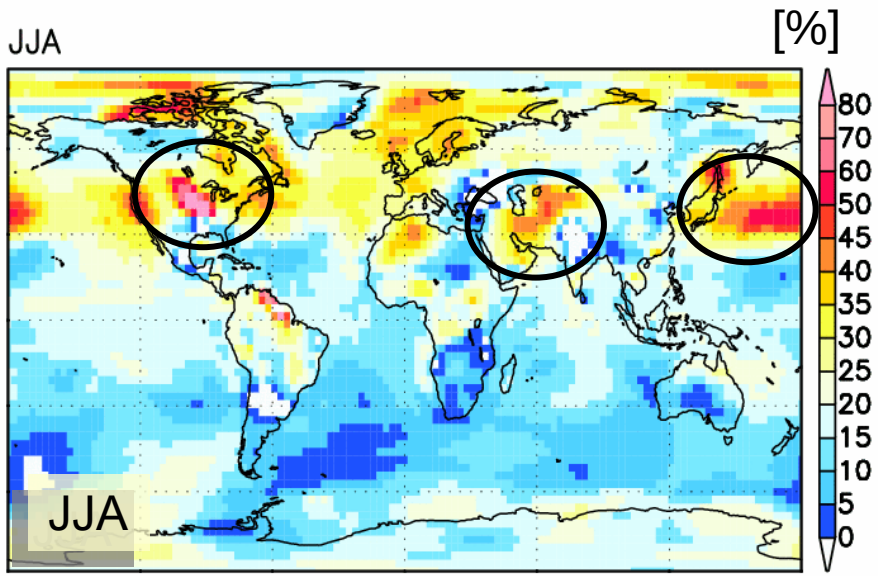
~0.6 K m^2 W^{-1} [Mickley et al., 2004]

Contribution to Surface Temperature (%) : Tropospheric Oozne Increase

$$\frac{\Delta T(\text{Tropo.O}_3)}{\Delta T(\text{WMGHGs+ Tropo.O}_3)} \cdot 100 \quad (\%)$$

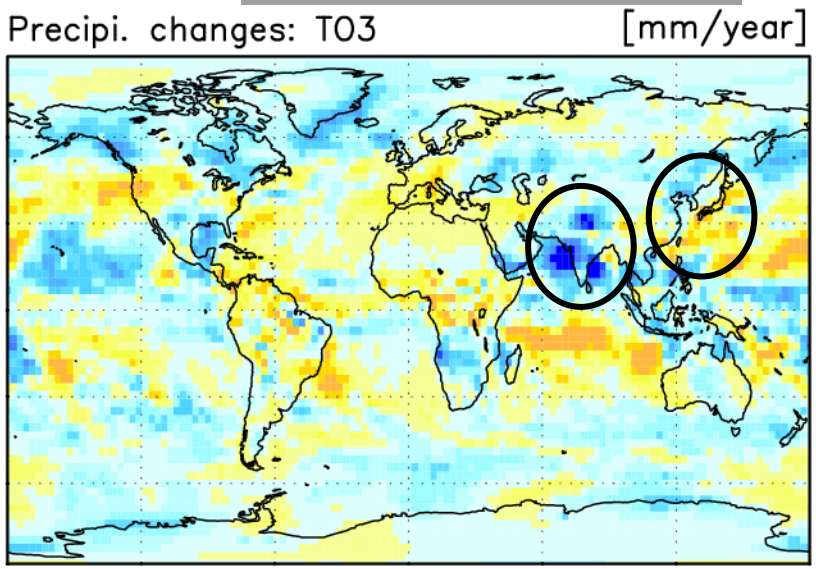




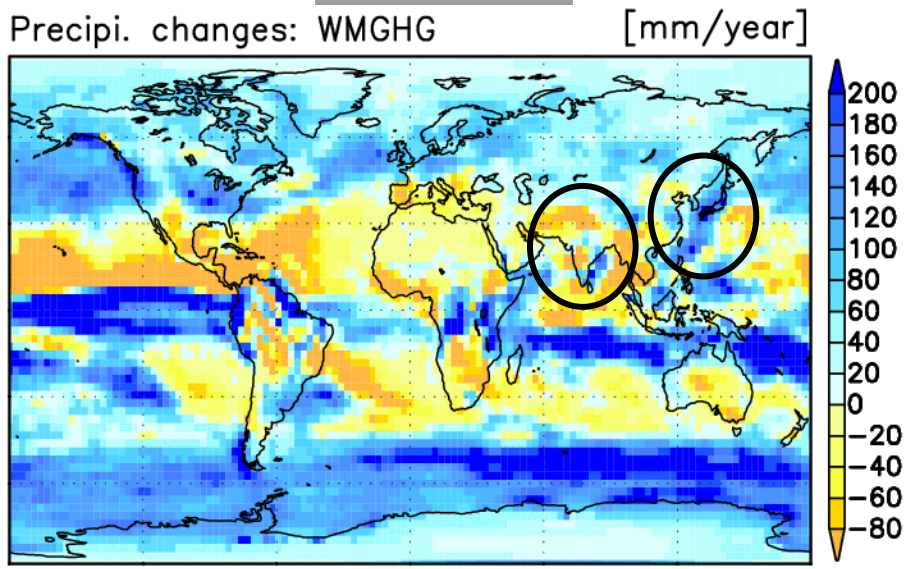


Effect on Annual Precipitation Amount : Tropospheric Ozone Increase and WMGHGs Increse

Tropospheric Ozone



WMGHGs



Summary and Conclusions

① Equilibrated climate response of tropospheric ozone and long-loved GHG (WMGHG) from pre-industrial to present has been evaluated.

② Tropospheric ozone brings more than 0.6 °C increase in the upper troposphere, which contributes 20-30 % of WMGHGs.

③ Temperature decrease up tp1.0 °C by tropospheric ozone was calculated in the stratosphere.

④ Tropospheric ozone and WMGHGs increase will increase global average surface temperature by +0.5℃, ad +2.3℃。Contribution of tropospheric ozone is large in North America, Middle East and Western Pacific including Japan.

⑤ Climate senisitivity of tropospehric ozone is 1.04 K m^2 w^{-1}。

⑥ Impact of tropospheric ozone on cloud and precipitation may not be negligible.