SEPARATING THE INFLUENCES OF CLIMATE AND CHEMISTRY ON FUTURE ODS LIFETIMES:

NO INDICATION OF MUCH SHORTENED LIFETIMES

Fiona Tummon[1], Andrea Stenke[1], Johannes Staehelin[1], Eugene Rozanov[1,2], and Thomas Peter[1]

[1]Institute for Atmospheric and Climate Science, ETH Zürich

[2]Physical Meteorological Observatory Davos

LIFETIMES

Why do we need to know the lifetimes of ODSs?

- To calculate past and present emissions
- To model future abundances
- To determine Ozone Depleting Potentials and Greenhouse Warming Potentials

How are global steady-state lifetimes determined?

$$T = \frac{B}{L}$$

B ← Burden

L ← Loss

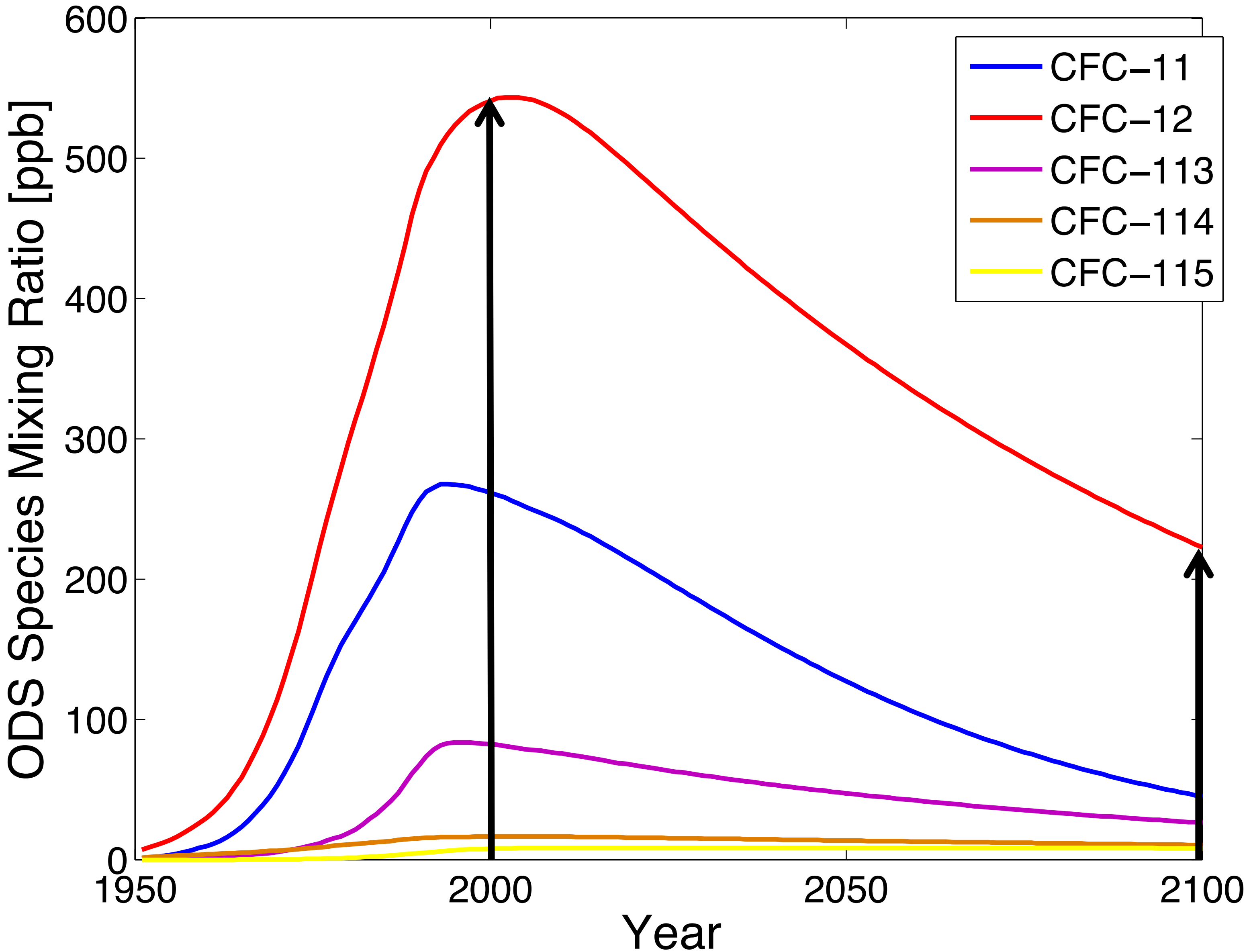
EXPERIMENT SET-UP

- Used the SOCOL (SOlar Climate Ozone Links) chemistry climate model version 3 [Stenke et al., 2013]

- Several 20-year time slice simulations:

Simulation	ODSs	Climate
PRES	Year 2000 (*Table 5A-3 WMO 2010*)	Year 2000 (*with HadISSTs/sea-ice*)
FUTR	Year 2100 (*Table 5A-3 WMO 2010*)	Year 2100 (*NCAR-CCM3 SSTs/GHGs*)
PRES_ODS21	Year 2100 (*Table 5A-3 WMO 2010*)	Year 2000 (*with HadISSTs/sea-ice*)
FUTR_ODS20	Year 2000 (*Table 5A-3 WMO 2010*)	Year 2100 (*NCAR-CCM3 SSTs/GHGs*)
FUTRrcp8	Year 2100 (*Table 5A-3 WMO 2010*)	Year 2100 – RCP8.5 (*RCP8.5 SSTs/GHGs*)

ODS SCENARIO – WMO 2010



LIFETIMES

Years

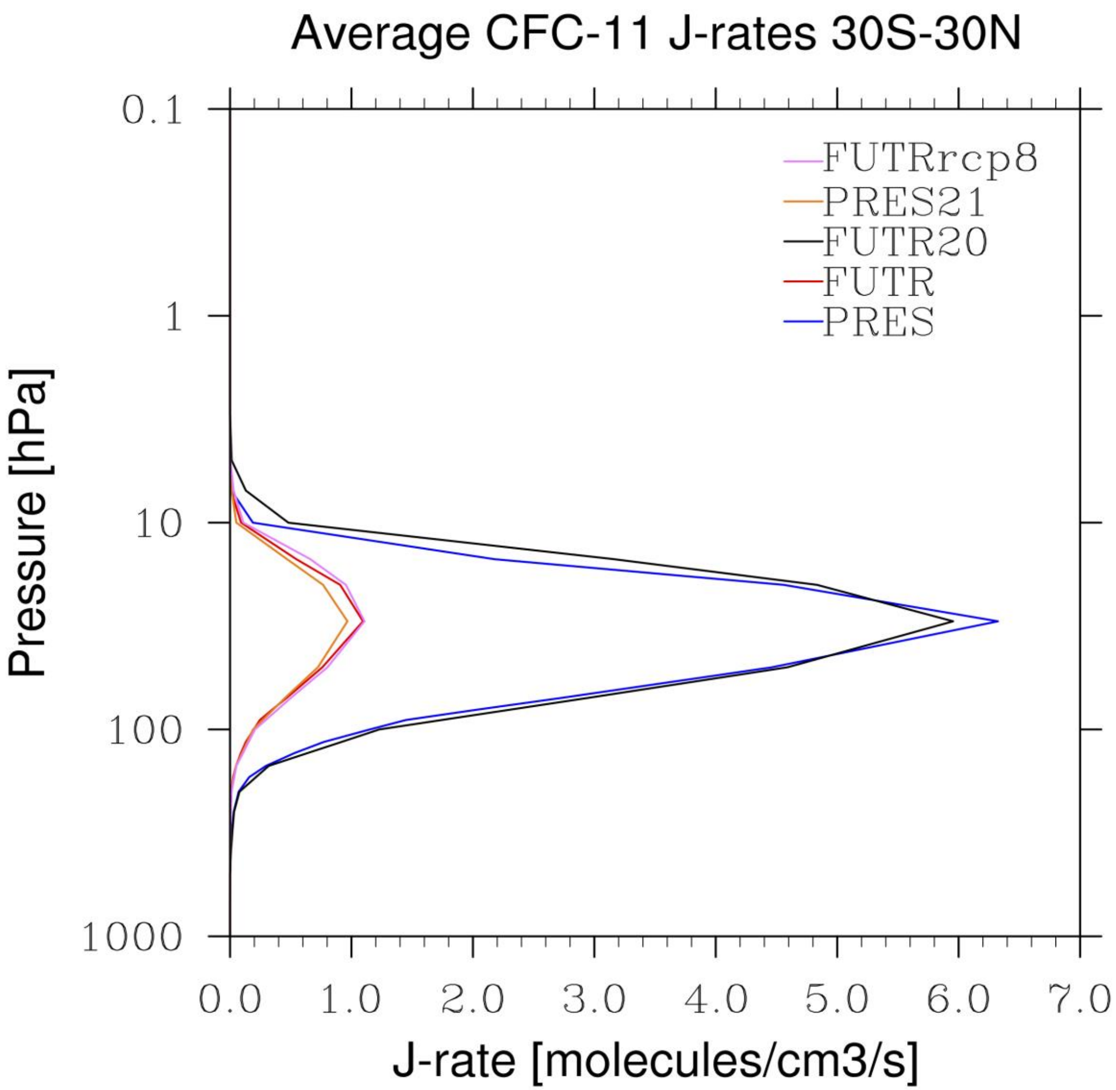
Species	SPARC 2013	PRES	FUTR	%Diff
CFC-11	52 *(35-89)*	**49.6**	**48.7**	-1.8%
CFC-12	102 *(78-151)*	**85.4**	**80.7**	-5.5%
CFC-113	93 *(69-138)*	**81.4**	**78.1**	-4.0%
CFC-114	189 *(153-247)*	**171.4**	**169.0**	-1.4%
HCFC-22	12 *(9.3-18)*	**10.3**	**10.2**	-0.9%
HCFC-141b	9.4 *(7.2-13.5)*	**8.1**	**8.0**	-1.2%
HCFC-142b	18 *(14-25)*	**15.0**	**14.8**	-1.3%

EFFECT OF ODS CHANGES

% Change

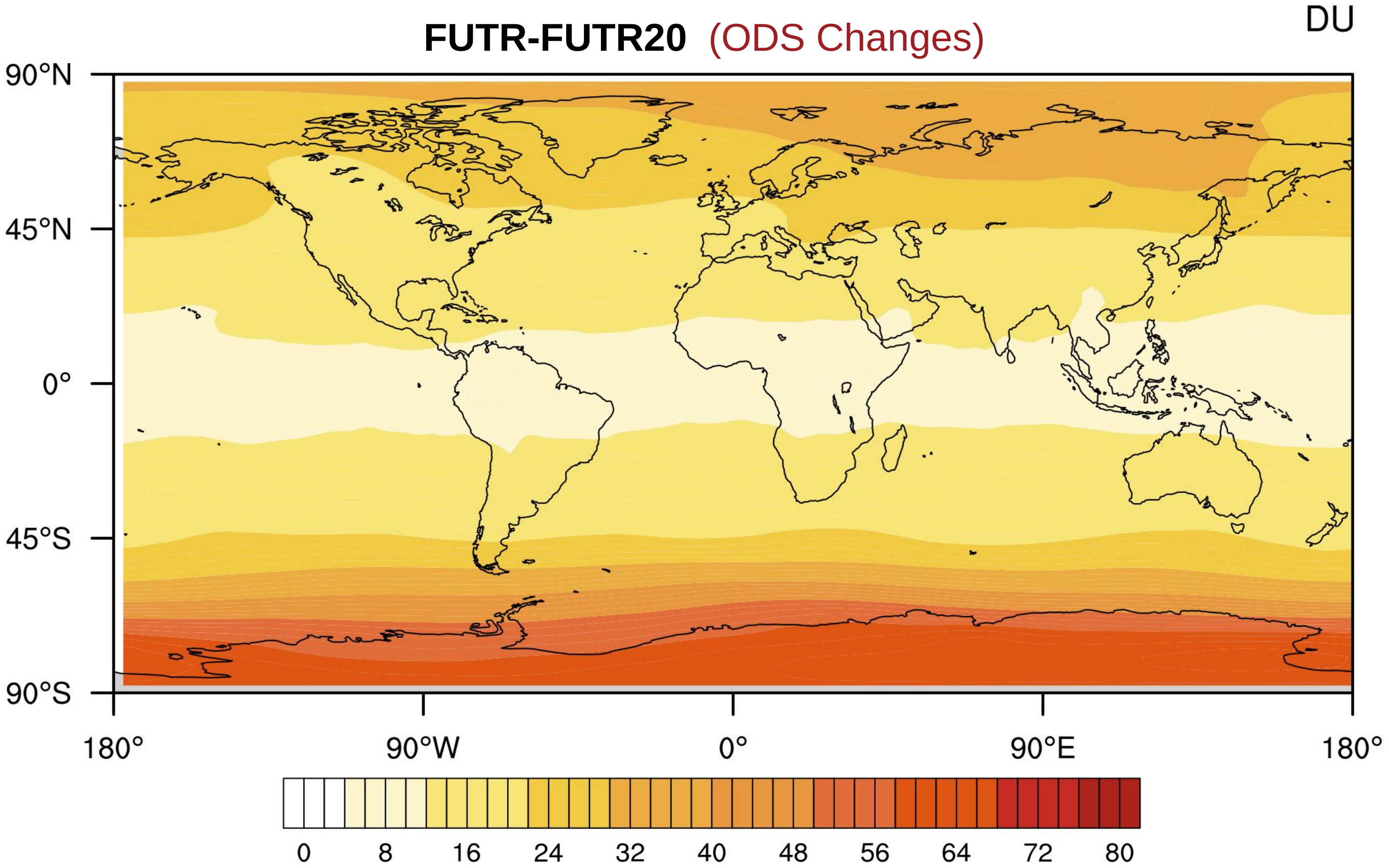
Species	Climate + ODS Effects	ODS Effect
CFC-11	-1.8%	**8.4%**
CFC-12	-5.5%	**-0.4%**
CFC-113	-4.0%	**1.0%**
CFC-114	-1.4%	**0.4%**

TROPICAL (30°N-30°S) FULL PHOTOLYSIS RATES



RESULTS

Column Total Ozone Differences



EFFECT OF ODS CHANGES

% Change

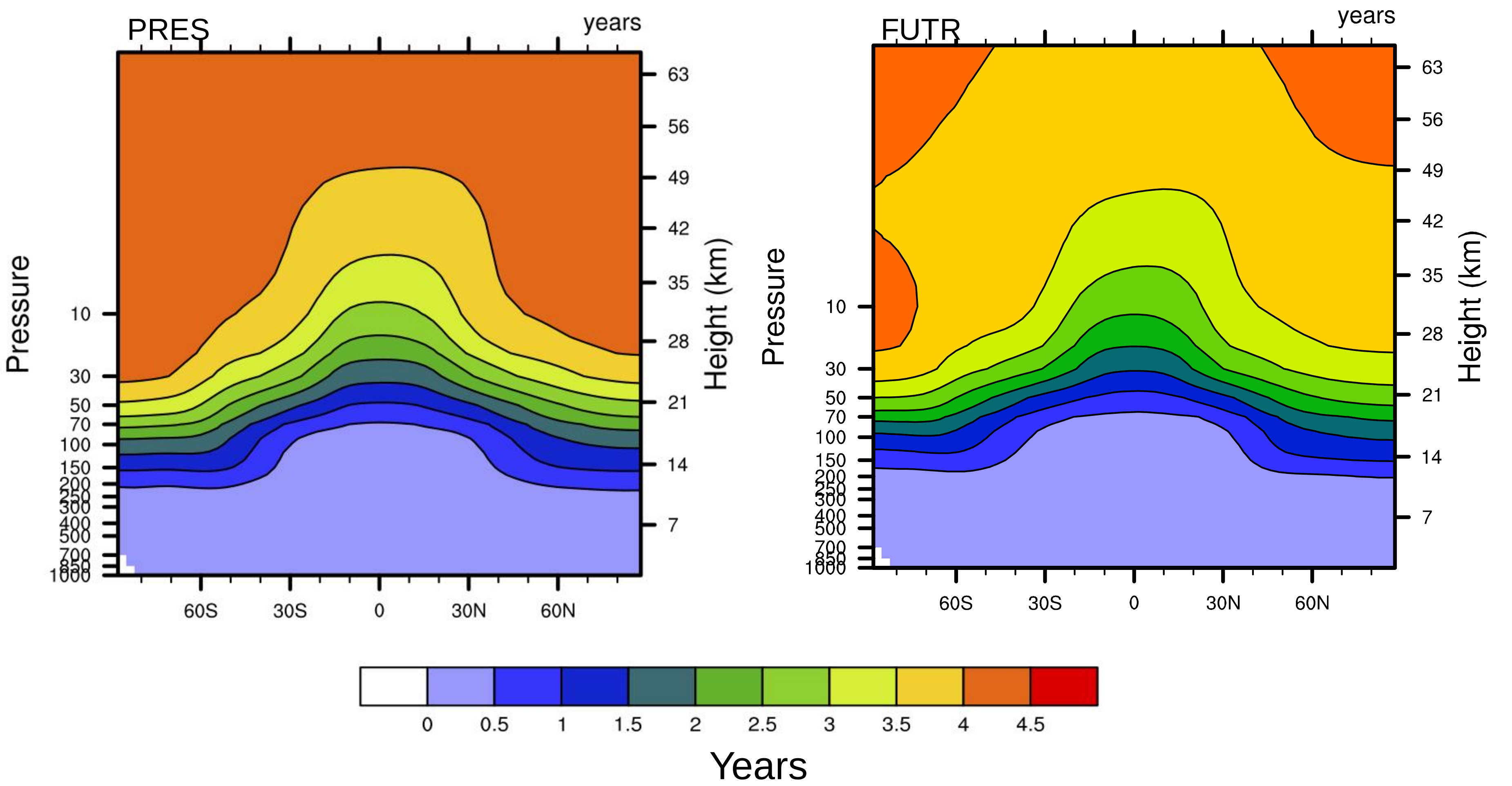
Species	Climate + ODS Effects	ODS Effect
CFC-11	-1.8%	**8.4%**
CFC-12	-5.5%	**-0.4%**
CFC-113	-4.0%	**1.0%**
CFC-114	-1.4%	**0.4%**
HCFC-22	-0.9%	**-9.7%**
HCFC-141b	-1.2%	**-11.1%**
HCFC-142b	-1.3%	**-11.3%**

EFFECT OF CLIMATE CHANGES

% Change

Species	Climate + ODS Effects	ODS Effect	Climate Effect
CFC-11	-1.8%	8.4%	**-10.3%**
CFC-12	-5.5%	-0.4%	**-5.1%**
CFC-113	-4.0%	1.0%	**-5.0%**
CFC-114	-1.4%	0.4%	**-1.8%**
HCFC-22	-0.9%	-9.7%	**8.7%**
HCFC-141b	-1.2%	-11.1%	**9.9%**
HCFC-142b	-1.3%	-11.3%	**10.0%**

MEAN AGE-OF-AIR

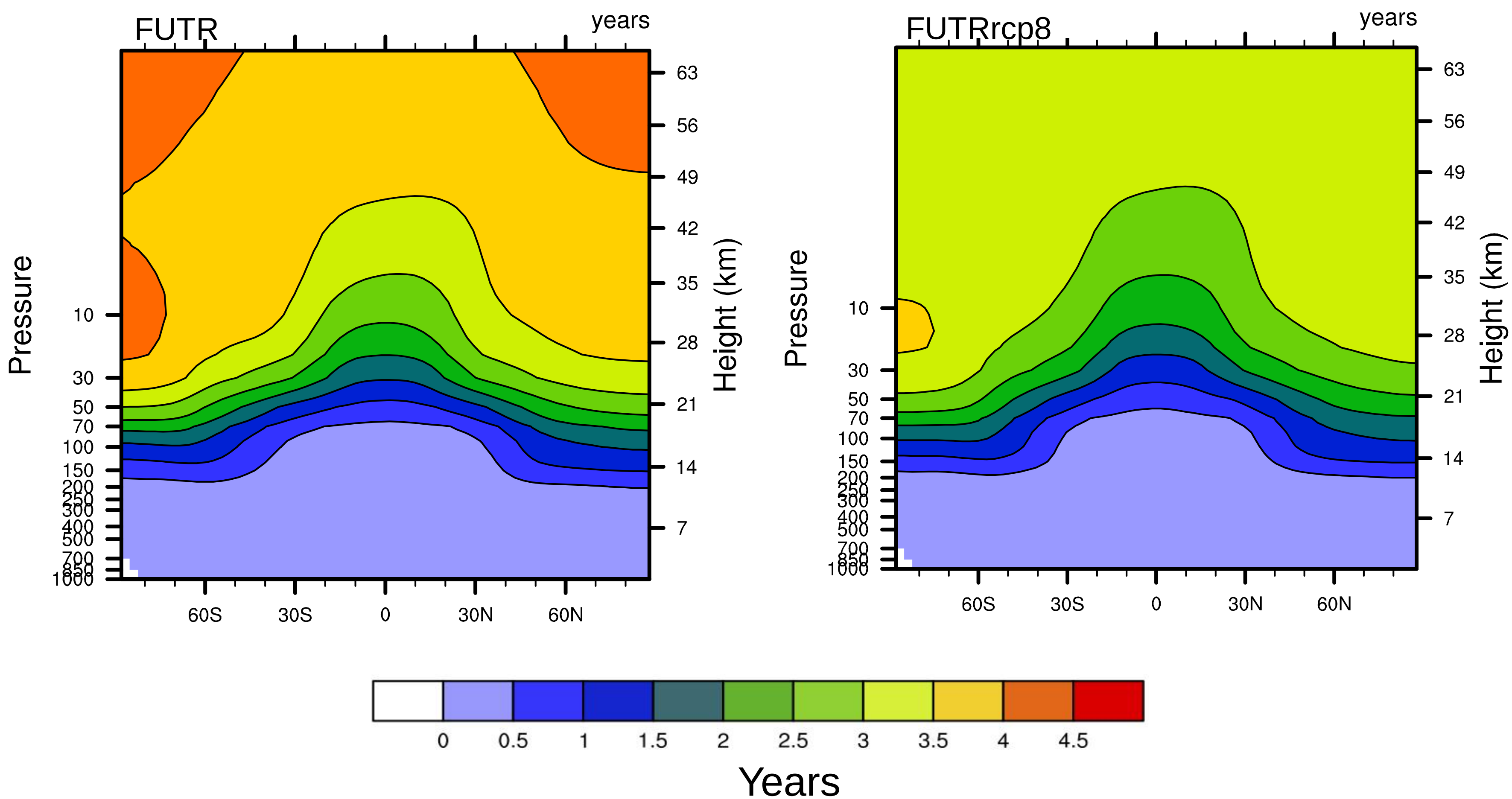


EFFECT OF CLIMATE CHANGES

% Change

Species	Climate + ODS Effects	ODS Effect	Climate Effect	RCP8.5 Climate
CFC-11	-1.8%	8.4%	-10.3%	**-13.9%**
CFC-12	-5.5%	-0.4%	-5.1%	**-11.9%**
CFC-113	-4.0%	1.0%	-5.0%	**-11.4%**
CFC-114	-1.4%	0.4%	-1.8%	**-6.0%**
HCFC-22	-0.9%	-9.7%	8.7%	**12.6%**
HCFC-141b	-1.2%	-11.1%	9.9%	**9.9%**
HCFC-142b	-1.3%	-11.3%	10.0%	**11.3%**

MEAN AGE-OF-AIR

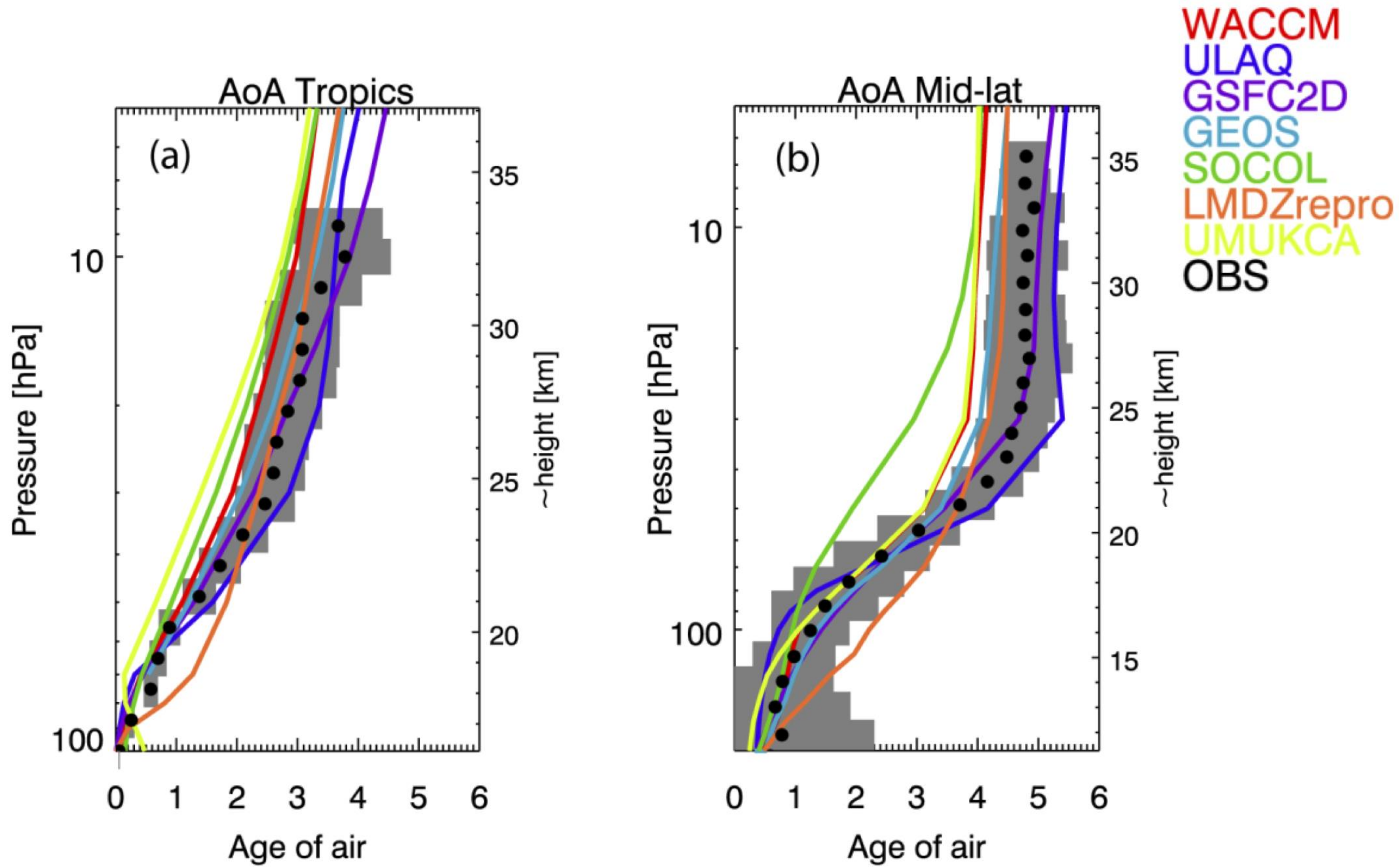


CONCLUSIONS

- **In future, changes in ODS concentrations act to lengthen lifetimes for CFCs (+2 to +12%), while for HCFCs lifetimes decrease (-9 to -12%)**
- **The effect of climate change shortens CFC lifetimes (-1 to -9%), while for HCFCs lifetimes increase (8-10%)**
- **Overall, the two effects compensate and lifetimes are only shorter in future (-1 to -4%)**
- **This has important implications for policy making, since both factors need to be carefully taken into account**

Thanks for your attention!

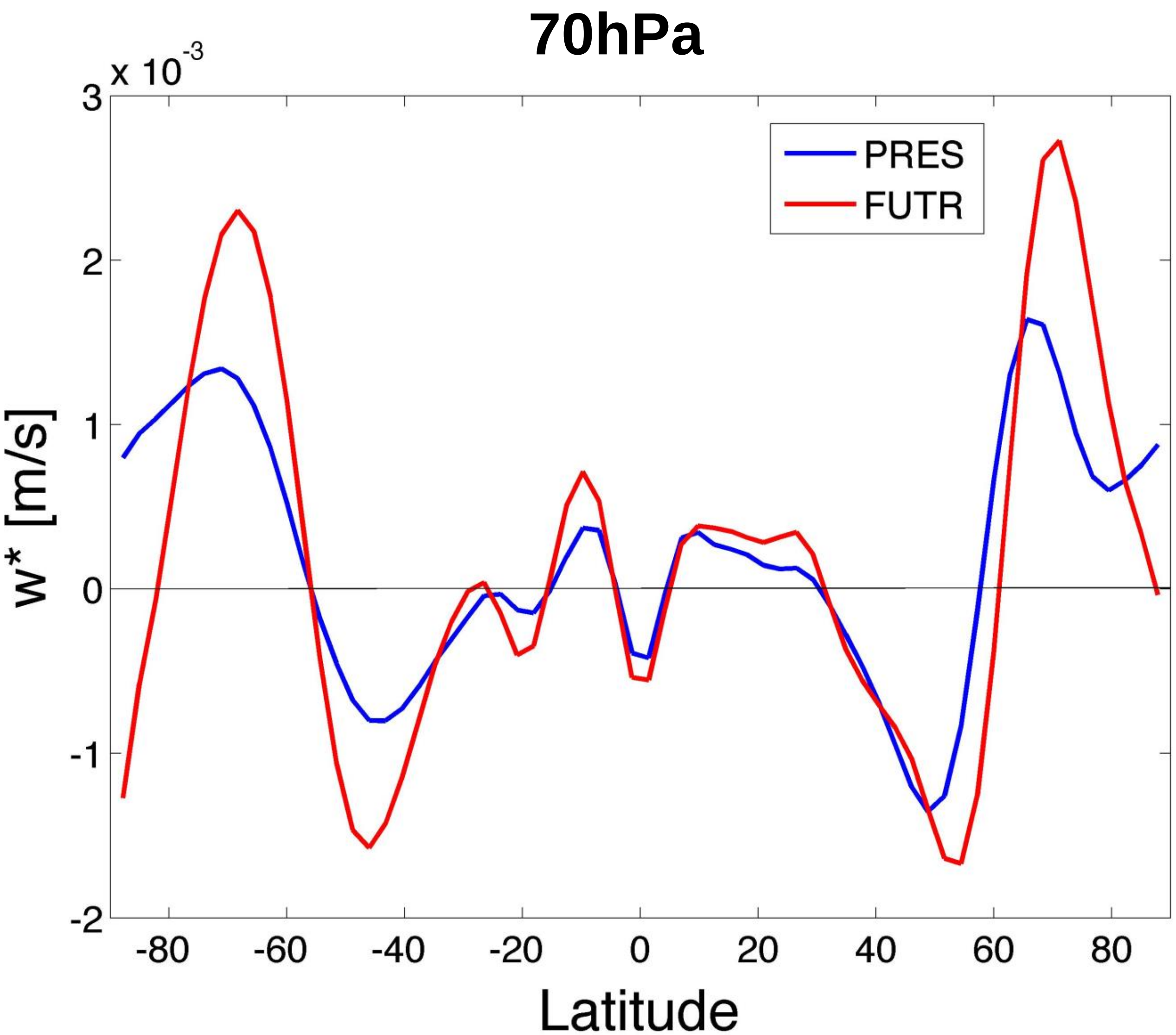
AGE-OF-AIR



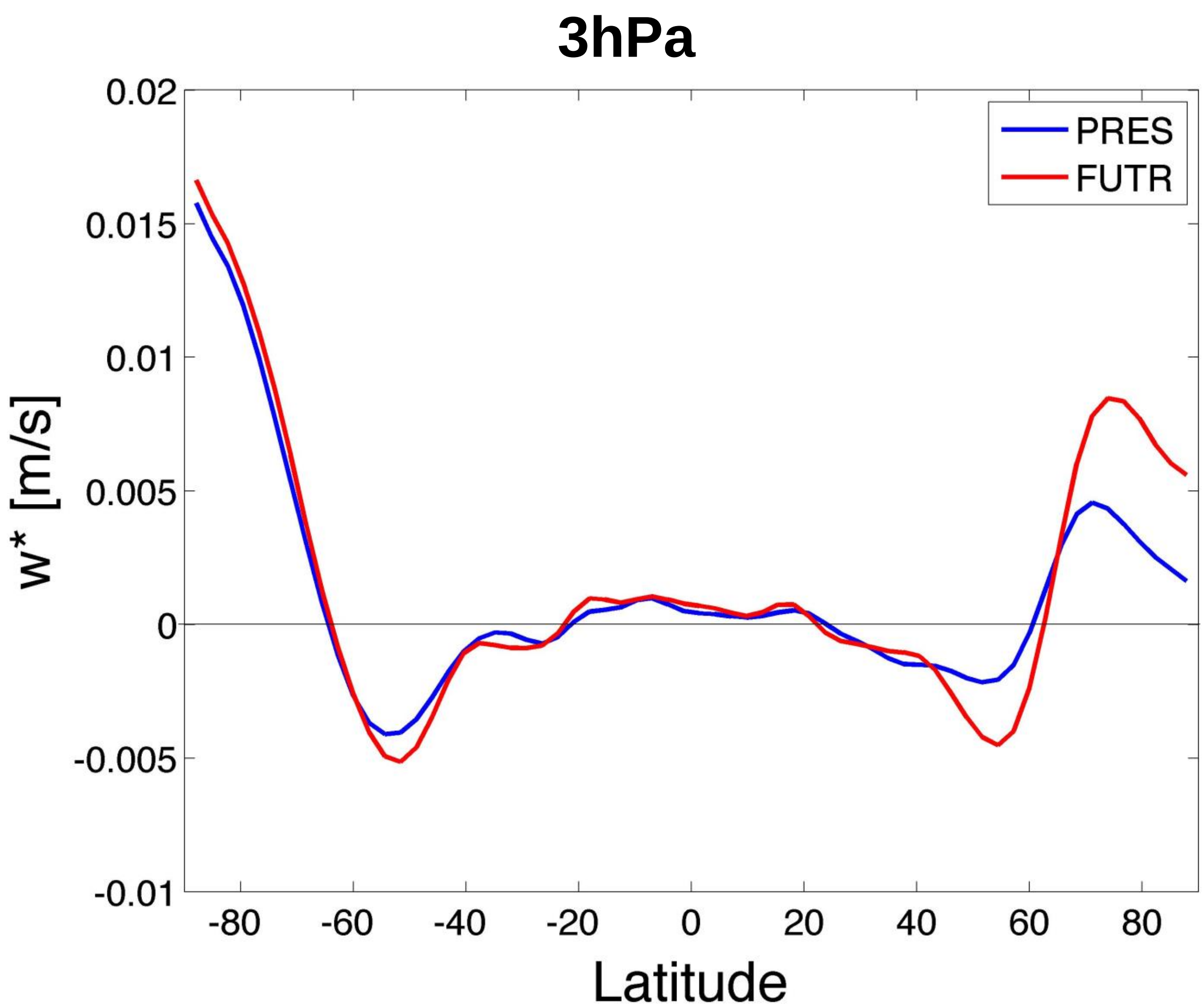
Chipperfield et al., 2014

(Observations from Andrews et al., 2001, and Engel et al., 2009)

ZONAL MEAN RESIDUAL VERTICAL CIRCULATION CHANGES

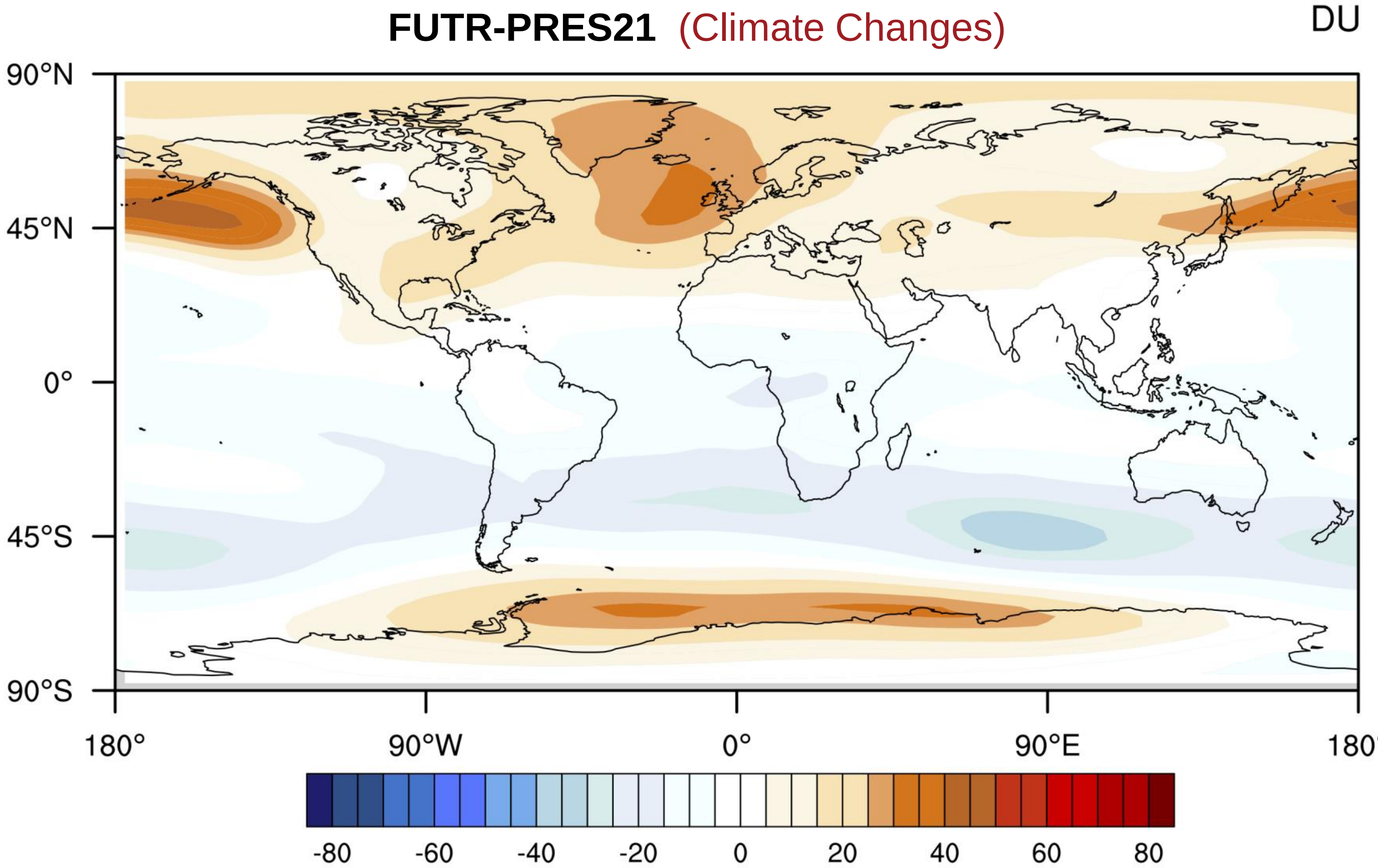


ZONAL MEAN RESIDUAL VERTICAL CIRCULATION CHANGES



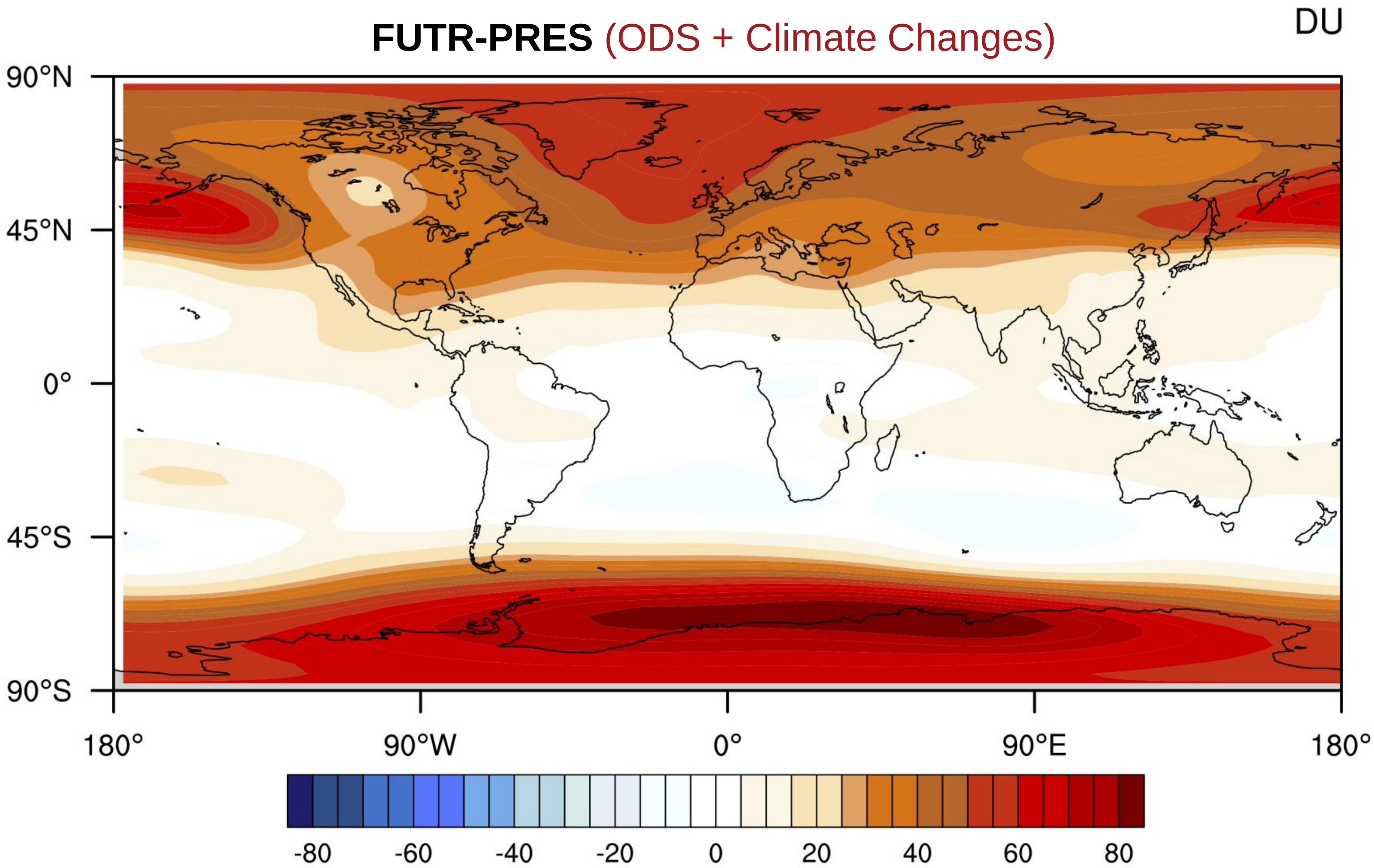
RESULTS

Column Total Ozone Differences



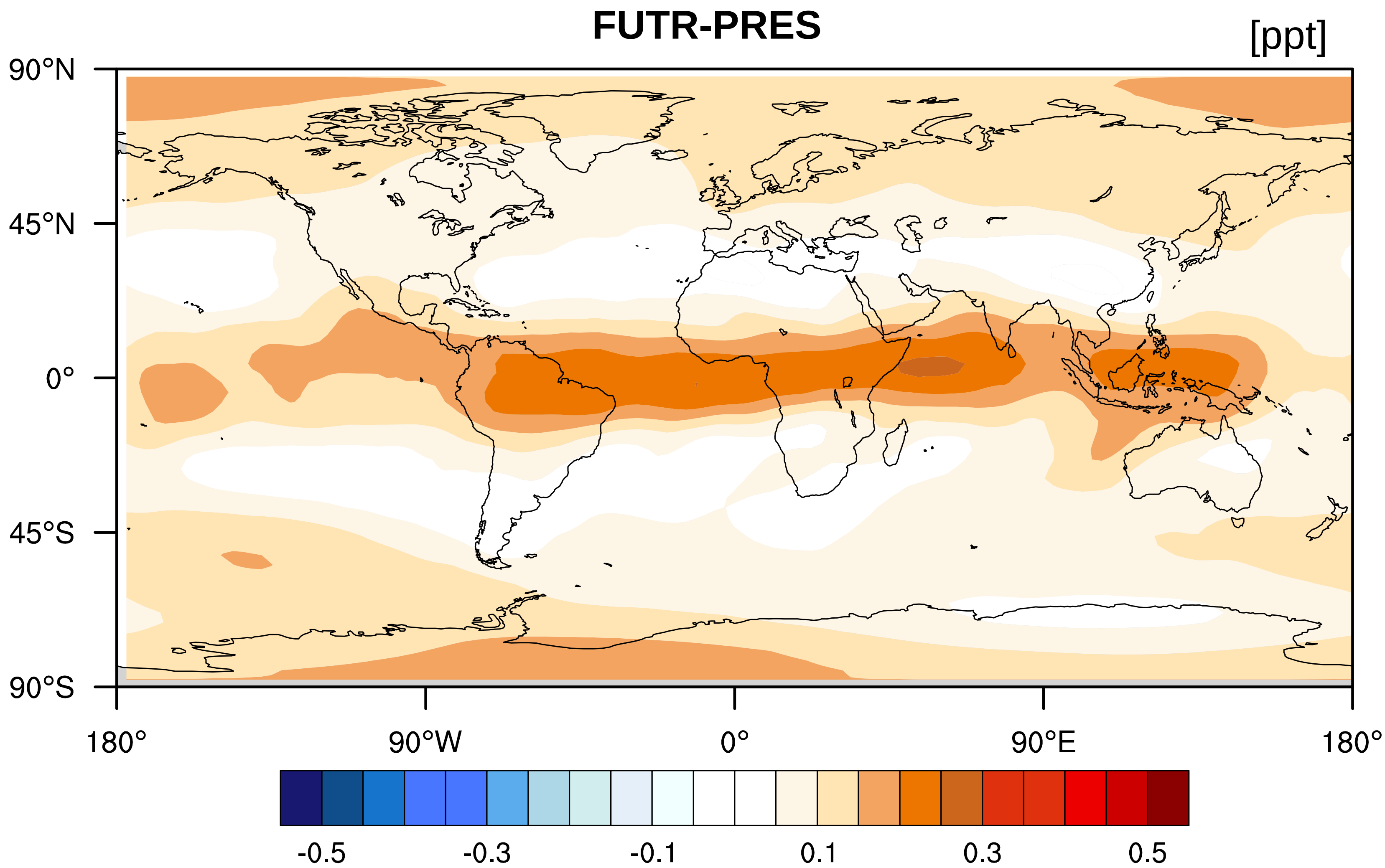
RESULTS

Column Total Ozone Differences

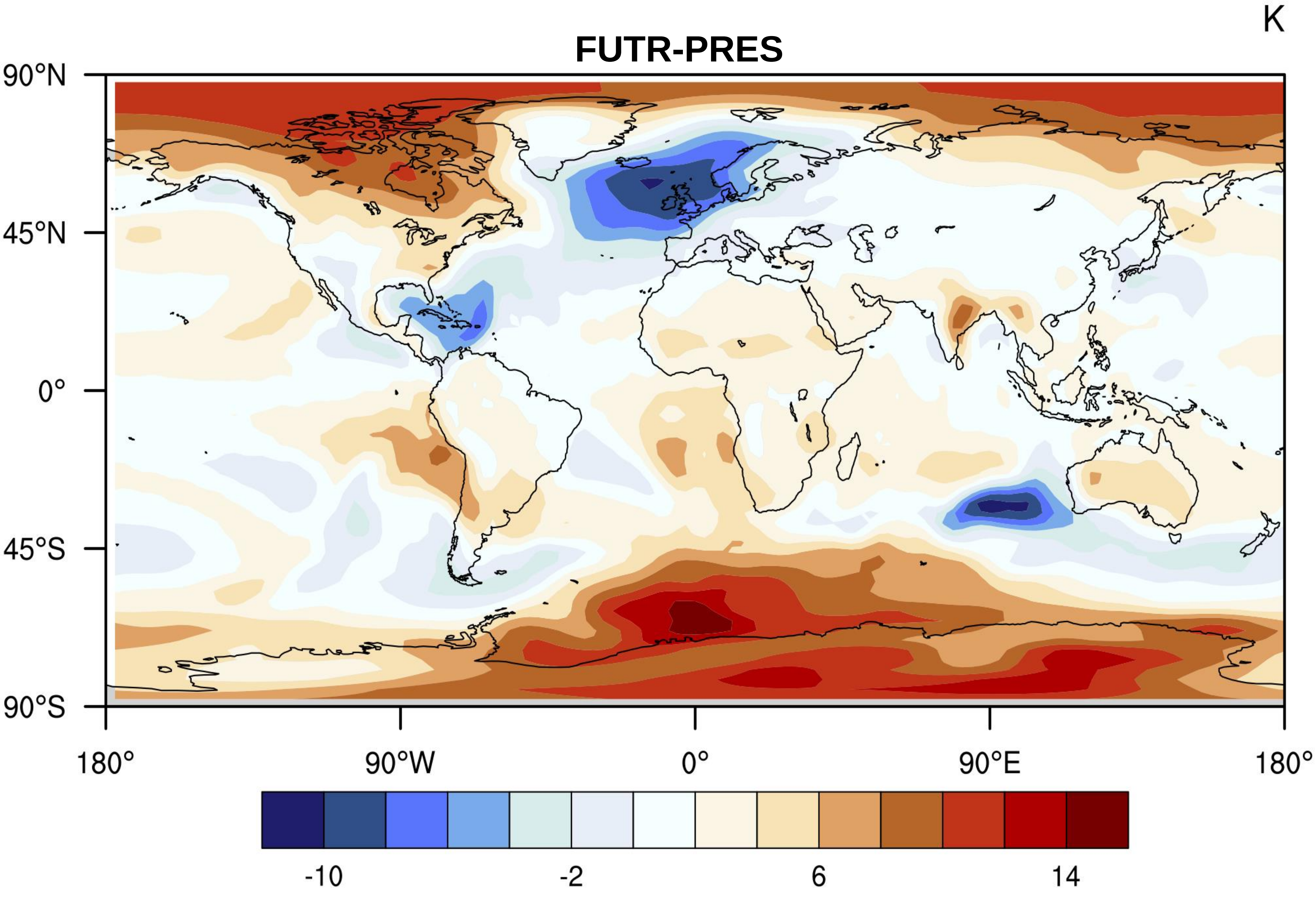


RESULTS

Column Total OH Difference



SURFACE TEMPERATURE DIFFERENCE



ZONAL MEAN Cly