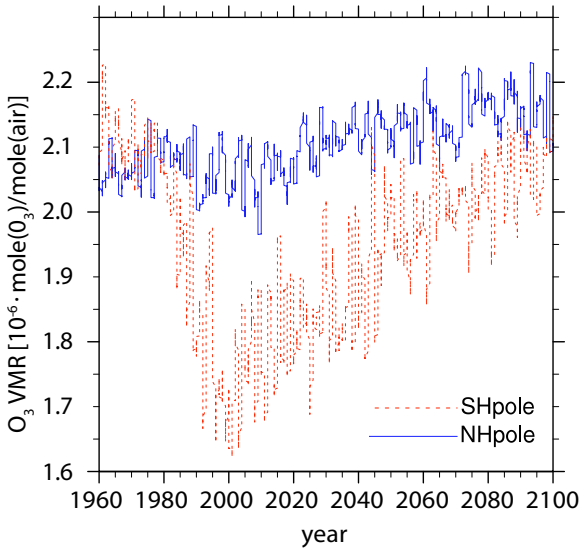

Figure 1S. Time evolution of CMAM zonal mean ozone volume mixing ratio [mole(0_3)/mole(air)] averaged between 12 and 22gpkm and 60°- 90°N (blue solid) and 60°- 90°S (red dashed) smoothed by 12-month running average.

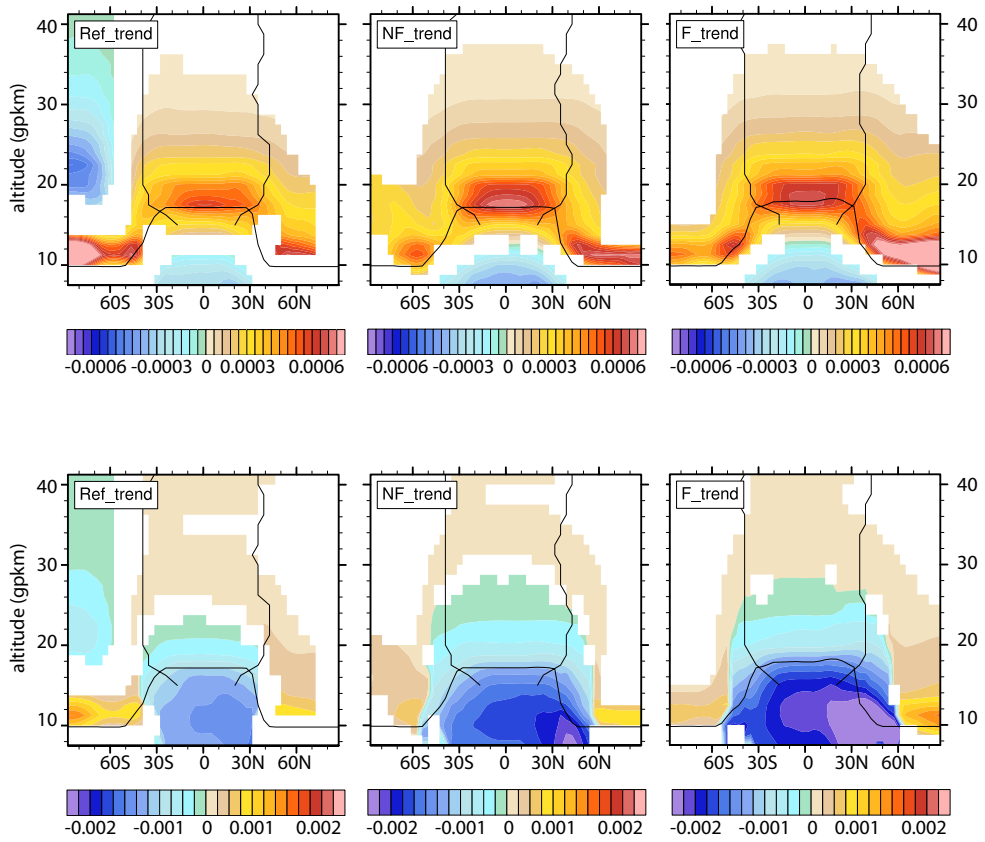

Figure 2S. CMAM trend of dry density [kgm^{-3} / *decade*].Top: Density trends in geopotential height vertical coordinate. Bottom: Density trends in vertical coordinate corrected to the vertical shift of pressure levels. The mean tropopause and turnaround latitude positions in the given period are marked

with black lines. Only the trends in the regions where they exceed the statistical significance of 95% confidence level are plotted.

Table 1S. Annual trends of the residual circulation strength (RC) in $10^{-3} kgm^{-2}s^{-1} / decade$, aging by mixing (AbM), AoA and RCTT (*days/decade)* averaged over the Ex regions in the Ref, NF and F period. AbM and RCTT trends are computed in a reduced Ref period (1970-2000). Presented are trend values significant at least at the 90% confidence level and also at least at the 80% confidence level (denoted by superscript $^{+}$), otherwise the cell is left blank.

				ExNH				
Period	**AoA**	**AbM**	**RCTT**	**RC**	**AoA^{c}**	**AbM^{c}**	**RCTT^{c}**	**RC^{c}**
Ref	-32	-24	-6^{+}	0.19	-30	-23		0.17^{+}
NF	-17	-6	-11	0.17	-11	-3	-9	
F	-31	-21	-10	0.22	-23	-16	-7	
				ExSH				
Ref	-41	-50			-38	-49		
NF	-15	-3	-11	0.14	-11		-9	0.01^{+}
F	-33	-25	-9	0.15	-28	-22	-7	0.01^{+}

Table 2S. The net tropical upwelling proxy (UP) annual trend in $10^{7} kgs^{-1} / decade$ in the Ref, NF and F period. Presented are trend values significant at least at the 90% confidence level and also at least at the 80% confidence level (denoted by superscript $^{+}$), otherwise the cell is left blank. The superscript ^{c} denotes a trend computed in the geopotential height corrected to the vertical shift of pressure levels, the superscript ^{rel} denotes a trend computed in the geopotential height corrected to the tropopause shift.

Period	**UP**	**UP^{c}**	**UP^{rel}**
Ref	8.6^{+}		
NF	9.7	7.6	8.4
F	12.2	9.1	7.6

Table 3S. The net tropical upwelling (UPd) annual trend (including density trend in contrast to UP) in $10^{7} kgs^{-1} / decade$ in the Ref, NF and F period. Presented are trend values significant at least at the 90% confidence level and also at least at the 80% confidence level (denoted by superscript $^{+}$), otherwise the cell is left blank.

Period	**UPd**	**UPd^{c}**	**UPd^{rel}**
Ref	11.6		
NF	13.6		9.7
F	17		

Table 4S. Seasonal values of correlations between spatial avergaes of total drag (TD, EPFD + GWD) and v^* ($C^{Td\text{-}Rc}$), EPFD and v^* ($C^{EP\text{-}Rc}$), GWD and v^* ($C^{Gw\text{-}Rc}$) and correlations of EPFD and GWD ($C^{Gw\text{-}Rc}$) in the Ref, NF and F period. For the description of spatial average areas please refer to the main text. Presented are only correlation values significant at least at the 90% confidence level, otherwise the significance is given.

	ExNH					ExSH				
Season	**DJF**	**MAM**	**JJA**	**SON**	***Ann***	**DJF**	**MAM**	**JJA**	**SON**	***Ann***
					Ref					
$C^{Td\text{-}Rc}$	-0.95	-0.95	-0.81	-0.89	*-0.92*	0.95	0.9	0.92	0.94	*0.66*
$C^{EP\text{-}Rc}$	-0.84	-0.87	-0.58	-0.72	*-0.84*	0.77	0.84	0.82	0.86	*0.68*
$C^{Gw\text{-}Rc}$	-0.82	-0.72	-0.36	-0.52	*-0.9*	0.64	0.37			*0.31*
					NF					
$C^{Td\text{-}Rc}$	-0.97	-0.94	-0.93	-0.92	*-0.92*	0.93	0.92	0.89	0.93	*0.64*
$C^{EP\text{-}Rc}$	-0.87	-0.81	-0.86	-0.82	*-0.83*	0.78	0.87	0.69	0.85	*0.7*
$C^{Gw\text{-}Rc}$	-0.67	-0.61	-0.63	-0.36	*-0.88*	0.56	0.45		-0.28	*0.21*
					F					
$C^{Td\text{-}Rc}$	-0.97	-0.95	-0.93	-0.88	*-0.91*	0.91	0.92	0.93	0.96	*0.64*
$C^{EP\text{-}Rc}$	-0.75	-0.79	-0.78	-0.72	*-0.83*	0.85	0.83	0.85	0.87	*0.71*
$C^{Gw\text{-}Rc}$	-0.62	-0.69	-0.56	-0.39	*-0.88*	0.4	0.24		-0.26	*0.19*

Table 5S. Upward shift corrected trend values of total drag (TD, EPFD + GWD) and its components EPFD and GWD multiplied by ρ (all in $10^{-5} kgm^{-2}s^{-2}/decade$) and RC ($10^{-3} kgm^{-2}s^{-1}/decade$) averaged over the Ex regions in the Ref, NF and F period. Presented are trend values significant at least at the 90% confidence level and also at least at the 80% confidence level (denoted by superscript $^+$), otherwise the cell is left blank.

Period	**Ref**					**NF**					**F**				
Season	**DJF**	**MAM**	**JJA**	**SON**	***Ann***	**DJF**	**MAM**	**JJA**	**SON**	***Ann***	**DJF**	**MAM**	**JJA**	**SON**	***Ann***
							ExNH								
TD	-3.5	-1.4^+	-0.6	-1.3			-1	-0.9							
EPFD	-1.4						-0.6^+	-0.7	-0.3+						
GWD	-3	-1.5					-1.1^+	-0.3					0.3^+		
RC	4	1.3^+	1	2.2	*0.2*		0.1^+	0.7	0.7^+	*0.2*		1.4		2	*0.3*
							ExSH								
TD	-2.3	-1.1	1.5	2.2		-1.7			-0.9^+	*-0.7*	-1				*-0.6*
EPFD		-0.7	1			-0.9				-0.4^+	-0.5^+		-0.5^+		-0.4^+
GWD	-0.5	-0.4^+	-1.2		*-0.6*	-0.5			-1.7	*-0.6*	-0.3^+			-0.8	-0.3^+
RC	3.2	1.6		-4		1^+	1.3	1		*0.2*	0.8^+	0.9^+	1.8		*0.2*

Table 6S. UPd^{c} and UPd^{rel} trends in the Ref, NF and F period computed directly by integrating ρw^{*} between the turn-around latitudes (UPd^{c}_{wstar}), indirectly by evaluating the residual mean stream function at the turn-around latitudes using $\int_{20\,gpkm}^{45\,gpkm} \rho v^{*} dz$ (UPd^{c}_{vstar}) and using $-\int_{20\,gpkm}^{45\,gpkm} \rho \frac{TD}{f} dz$ (UPd^{c}_{DC}). The trends are given in $10^{7} kgs^{-1} / decade$. Presented are trend values significant at least at the 90% confidence level and also at least at the 80% confidence level (denoted by superscript $^{+}$), otherwise the cell is left blank.

Upwelling

Period	**Ref**					**NF**					**F**				
Season	**DJF**	**MAM**	**JJA**	**SON**	***Ann***	**DJF**	**MAM**	**JJA**	**SON**	***Ann***	**DJF**	**MAM**	**JJA**	**SON**	***Ann***
UPd^{c}_{DC}							0.4^{+}	0.4				0.5	0.6		
UPd^{c}_{vstar}	24.4	7.6				10.6	4.6	3.6^{+}			6.9	8.2	5.3^{+}	6.9^{+}	5.3^{+}
UPd^{c}_{wstar}	26.5	7.4				12.8					7.5	8.7	5^{+}		
UPd^{rel}_{wstar}	8.1^{+}	-37	-37.6	-70.1		16.8	-4.2^{+}	-6.2	-12.8	*9.1*	-93.3	-44.7	-49.1^{+}		