Supporting Information for "Parametric Sensitivity and Constraint of contrail radiative Forcing in the Atmospheric Component of CNRM-CM6-1"

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References

Collins, M., Booth, B. B., Harris, G. R., Murphy, J. M., Sexton, D. M., & Webb, M. J. (2006). Towards quantifying uncertainty in transient climate change. *Climate dynamics*, *27*, 127–147.

Sexton, D. M., McSweeney, C. F., Rostron, J. W., Yamazaki, K., Booth, B. B., Murphy, J. M., ... Karmalkar, A. V. (2021). A perturbed parameter ensemble of hadgem3-gc3. 05 coupled model projections: part 1: selecting the parameter combinations. *Climate Dynamics*, *56*(11-12), 3395–3436.

Table S1. Description of the parameters perturbed in our PPE

Name	Minimum	Maximum	Reference	Description	Units
AGRE1	0	10	5.5	Parameter in the boundary-layer-top entrainment parameterization	-
RAUTEFS	0.5×10^{-3}	10^{-2}	5.2×10^{-3}	Inverse timescale for ice autoconversion	s^{-1}
RQICRMIN	0.1×10^{-7}	0.1×10^{-5}	0.1×10^{-6}	Critical ice content for ice autoconversion at low negative temperature	$kg.kg^{-1}$
RQICRMAX	0.05×10^{-4}	1×10^{-4}	0.21×10^{-4}	Critical ice content for ice autoconversion at high negative temperature	$kg.kg^{-1}$
TFVI	0.001	0.2	0.04	Falling speed of cloud ice crystals	$m.s^{-1}$
TFVS	0.1	6.0	0.6	Falling speed of snow	$m.s^{-1}$
RNINTS	10^{-5}	10^{-7}	0.3×10^{-7}	Parameter for size distribution of ice crystals	-
RKDX	8×10^{-5}	6×10^{-4}	10^{-4}	Maximum drag for the convective updraft vertical velocity	Pa^{-1}
RKDN	3×10^{-5}	7×10^{-5}	$5e-05$	Minimum drag for the convective updraft vertical velocity	Pa^{-1}
TENTR	2×10^{-6}	10^{-5}	4×10^{-6}	Minimum turbulent entrainment in the convective updraft	Pa^{-1}
TENTRX	3×10^{-5}	1×10^{-4}	6×10^{-5}	Maximum turbulent entrainment in the convective updraft	Pa^{-1}
VVN	-1	-5	-2	Critical convective updraft Vertical velocity for maximum entrainment and drag	$Pa.s^{-1}$
VVX	-25	-50	-35	Critical convective updraft Vertical velocity for minimum entrainment and drag	$Pa.s^{-1}$
ECMNP	10^{-3}	2×10^{4}	8×10^{3}	Critical cloud thickness for precipitation in cloud model	m
RELFCAPE	0.2	10.0	2.0	Parameter used in the convection scheme Convective Available	-
FNEBC	0	20	10	Parameter for computing the convective cloud fraction	-
GCVRE	0.1	1	1	Parameter for controlling organized fractional entrainment/detrainment	-
GCVTURB	10^{-5}	2×10^{-4}	5×10^{-5}	Parameter for controlling ”stratiform” ice clouds in the presence of deep convection	-
RLWINHF_ICE	0.5	1.0	0.9	Ice cloud heterogeneity coefficient in the longwave spectrum	-
RLWINHF_LIQ	0.5	1.0	0.9	Liquid cloud heterogeneity coefficient in the longwave spectrum	-
RSWINHF_ICE	0.5	1.0	0.71	Ice cloud heterogeneity coefficient in the shortwave spectrum	-
RSWINHF_LIQ	0.5	1.0	0.71	Liquid cloud heterogeneity coefficient in the shortwave spectrum	-

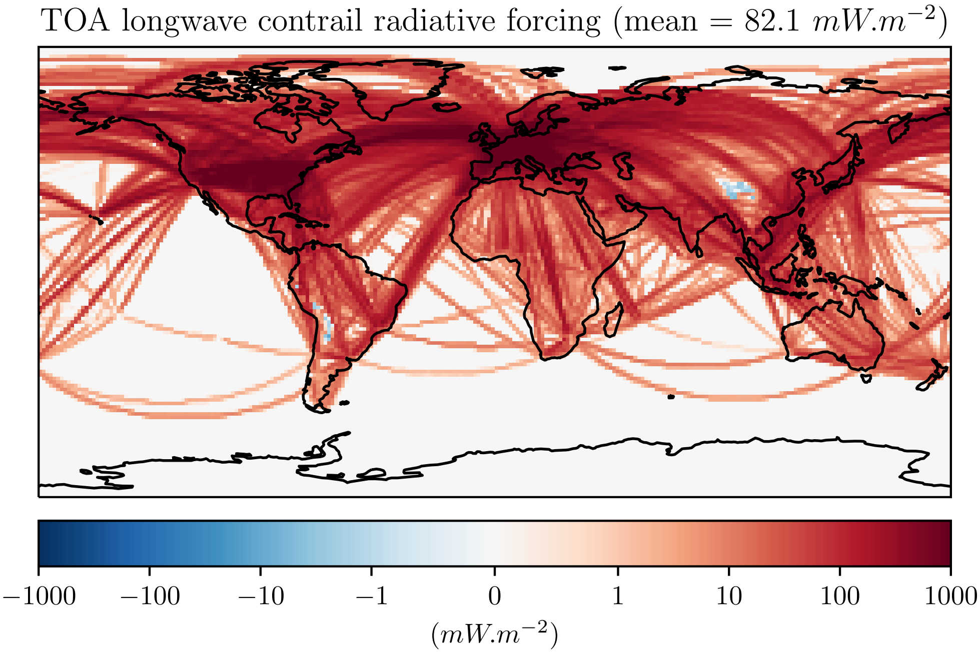

Figure S1. Annual mean of the short wave contrail radiative forcing at the top of atmosphere.

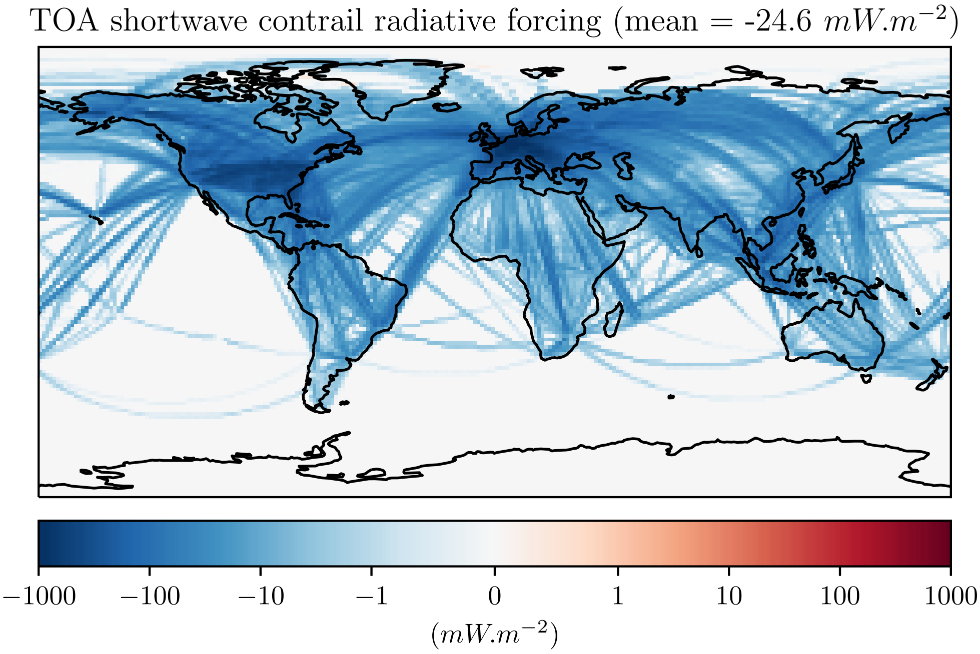

Figure S2. Annual mean of the short wave contrail radiative forcing at the top of atmosphere.

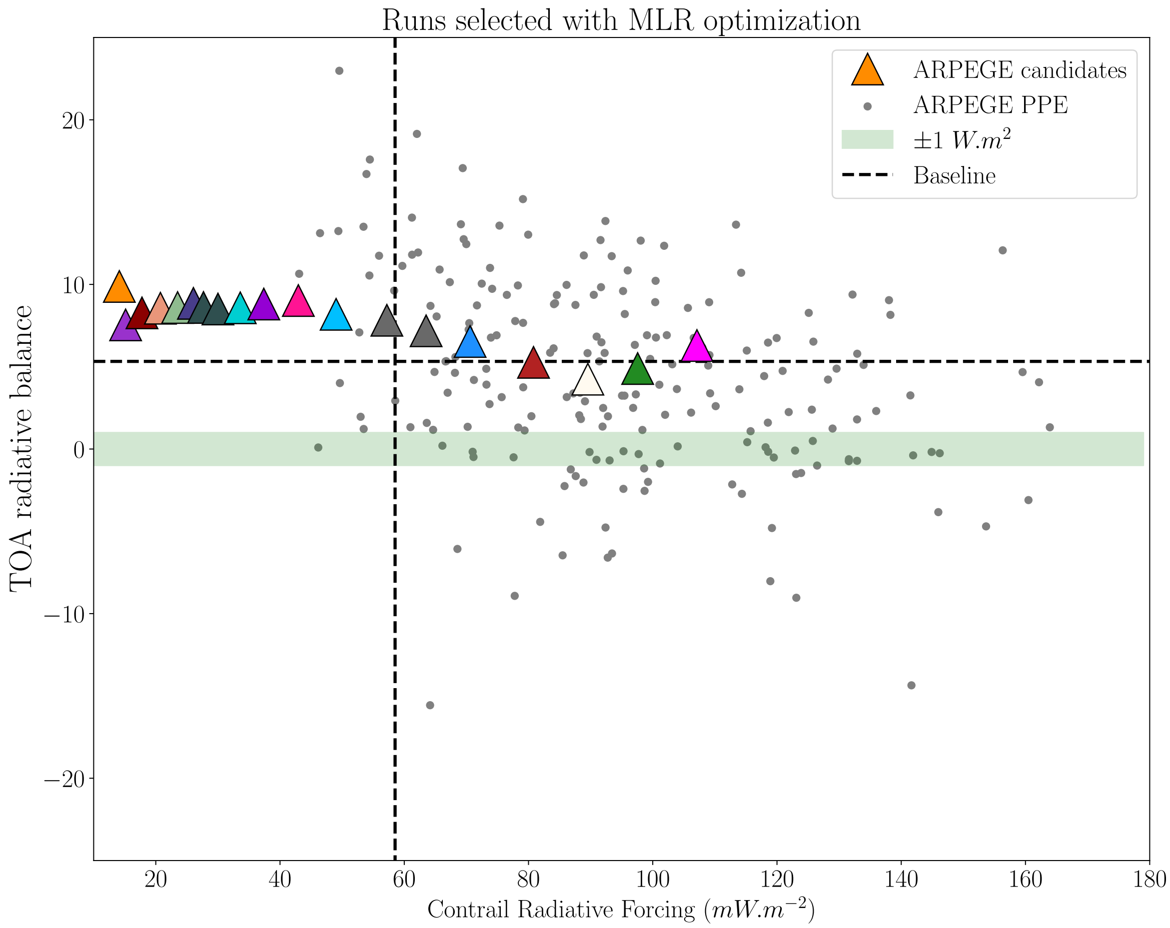

Figure S3. Top of atmosphere radiative budget of the ARPEGE-Climat runs calibrated with the nineteen optimal calibrations along the contrail radiative forcing range. Doing the modification on the existing cloud scheme, the top-of-atmosphere radiative budget of the model has became imbalanced. Since the study focuses on parametric uncertainty, a non-zero top-of-atmosphere radiative budget is permitted (Sexton et al., 2021; Collins et al., 2006). The tuning to solve this problem could be addressed in another study.