FaIR v2.0: a generalised impulse-response model for climate uncertainty and future scenario exploration, integrated assessment, and teaching

Nicholas J. Leach[1⋆]
Stuart Jenkins[1]
John Lynch[1]
Michelle Cain[1,2]
Junichi Tsutsui[3]
Christopher Smith[4]
Zebedee Nicholls[5]
Myles R. Allen[1,2]

[1]Department of Physics, Atmospheric Oceanic and Planetary Physics, University of Oxford, United Kingdom.
[2]Environmental Change Institute, University of Oxford, Oxford, UK.
[3]Environmental Science Laboratory, Central Research Institute of Electric Power Industry, Abiko-shi, Japan.
[4]School of Earth and Environment, University of Leeds, Leeds, UK.
[5]Australian–German Climate and Energy College, University of Melbourne, Australia
⋆contact email: Nicholas.leach@stx.ox.ac.uk

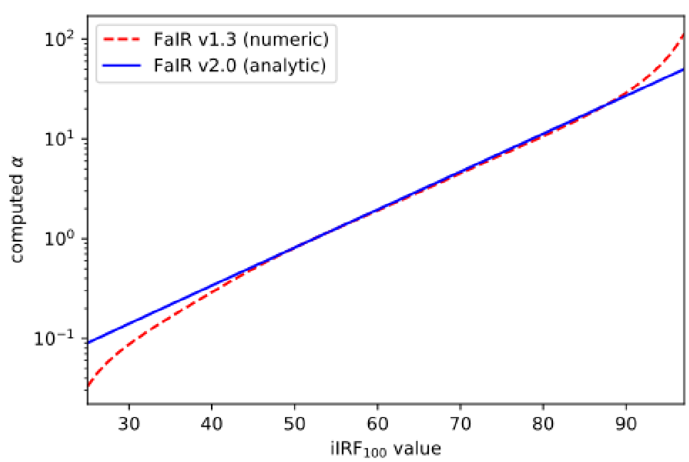

Figure 1: Numerical solution for α in FaIR v1.3 versus analytic solution in FaIR v2.0. This highlights the reason for the lowered r_0 parameter in FaIR v2.0 compared to FaIR v1.3 (Smith et al., 2017) or v1.0 (Millar et al., 2017), as we see that for pre-industrial α values (0.12 in v1.0 or 0.16 in v1.3), the analytic solution requires a lower iIRF_{100} than the numeric. Since both solutions are near identical once iIRF_{100} values reach 45 (close to the present-day value), this could lead to FaIR v2.0 systematically simulating lower CO_2 concentrations through a lower α than FaIR v1.3 or v1.0. However, this will be compensated to a certain degree by the slight increase in default r_t and r_u parameters.

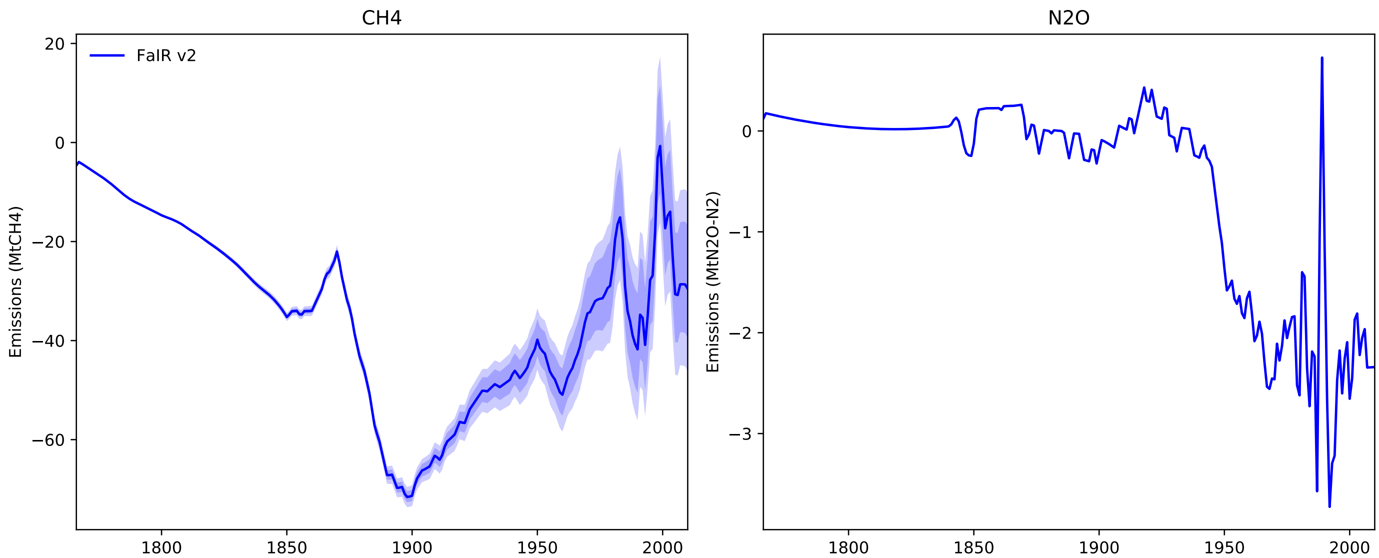

Figure 2: Differences between historical diagnosed emissions in FaIR v2.0 and the RCP database emissions for CH_4 and N_2O. This displays high similarity to Figure 2 from Smith et al. (2017), demonstrating that FaIR v2.0 and v1.3 are not systematically very different, but have simply been approached differently.

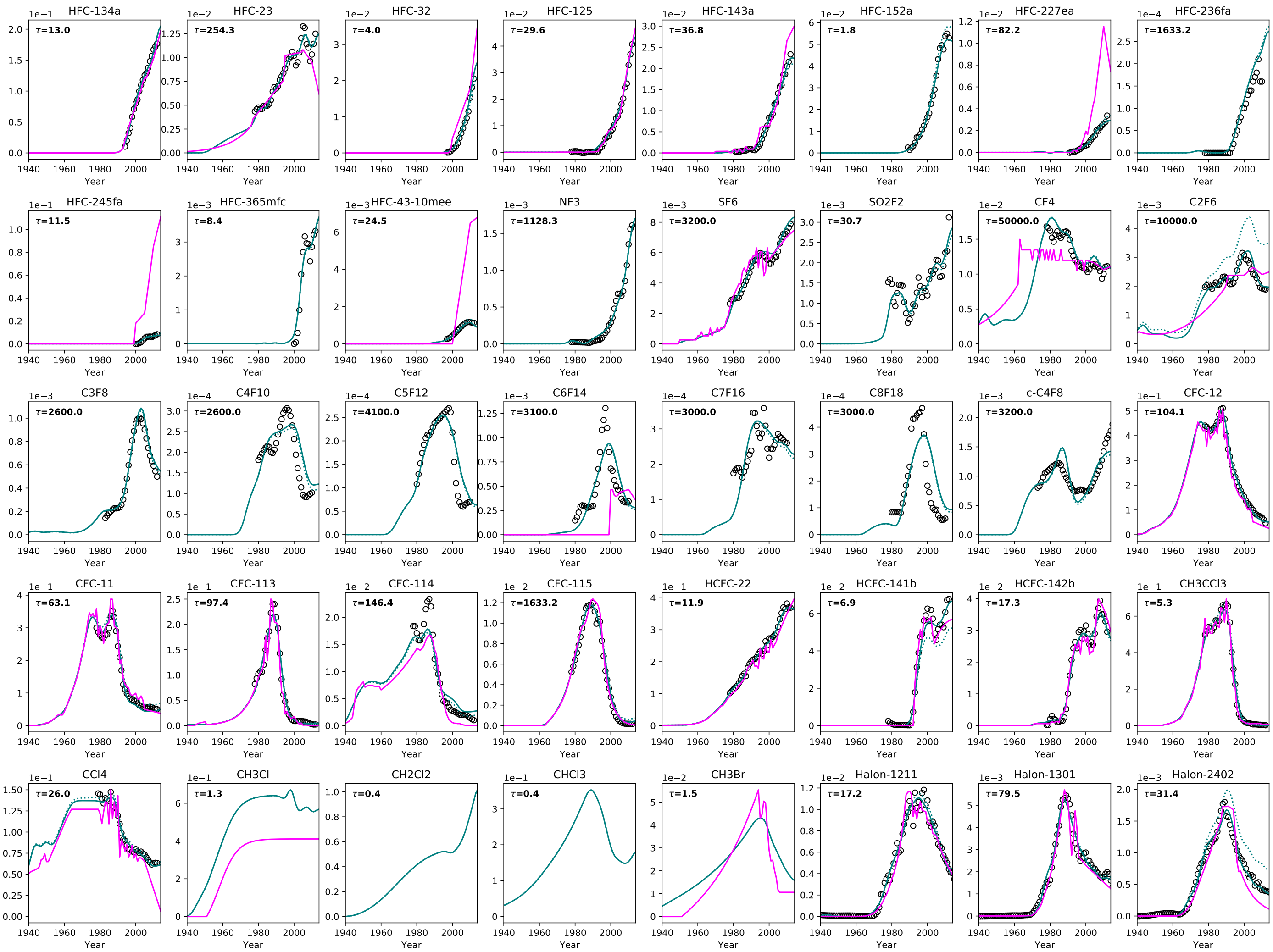

Figure 3: Best-estimate annual emissions from a more complex atmospheric model inversion Rigby et al. (2014), FaIR v2.0 inverse emissions and RCP database emissions from inversion of the MAGICC6 SCM. Open black circles show inverse emissions from a 12-box model Cunnold et al. (1994); solid green lines show inverse emissions from FaIR v2.0 with tuned parameters; dotted green lines show inverse emissions from FaIR v2.0 with lifetimes taken from Hodnebrog et al. (2013), and solid pink lines show emissions from the RCP database. Inset text shows the tuned species lifetime.

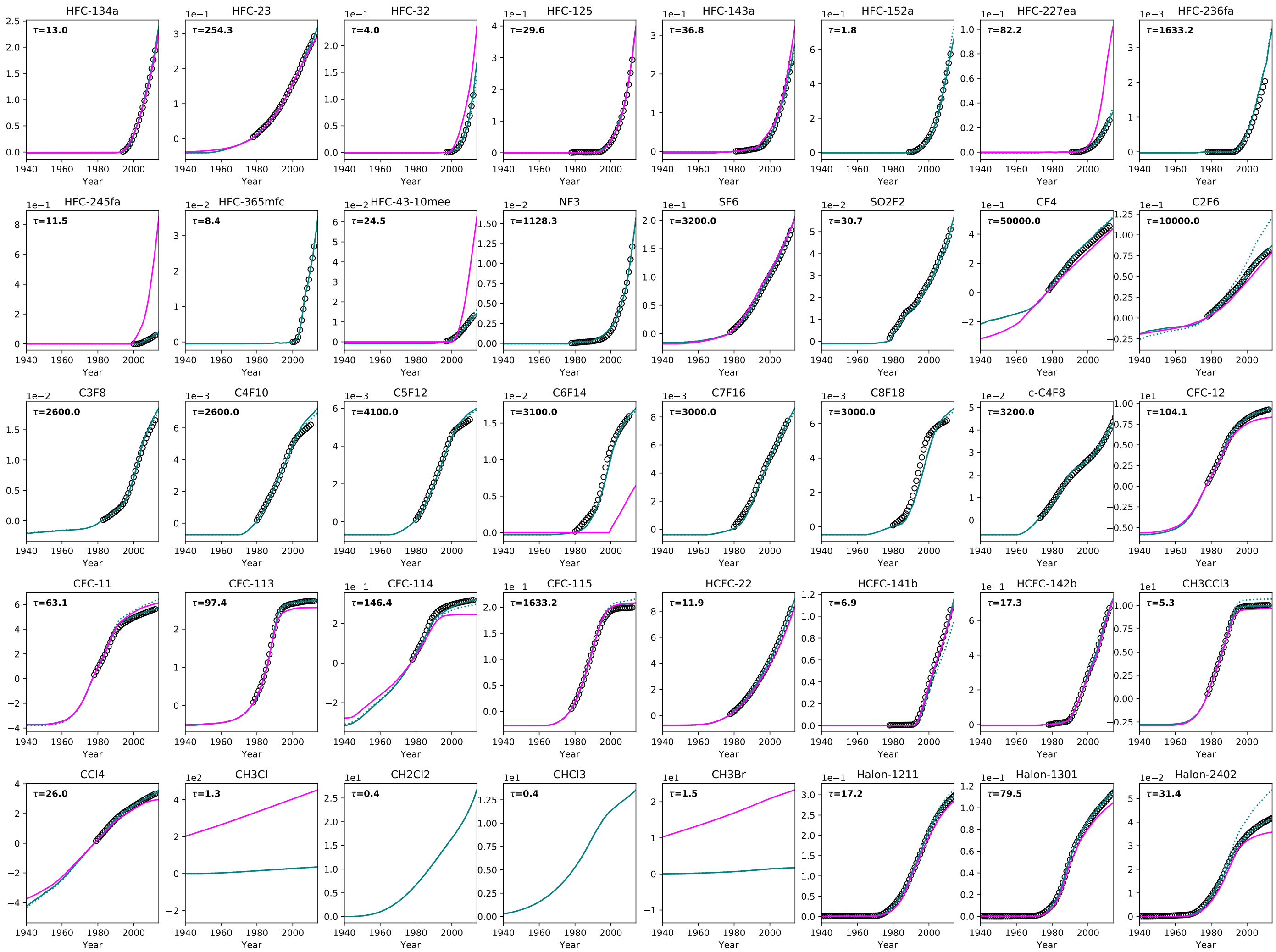

Figure 4: As Figure 3, but for cumulative emissions which are more relevant for the long lived ($\tau > 50$ years) species.

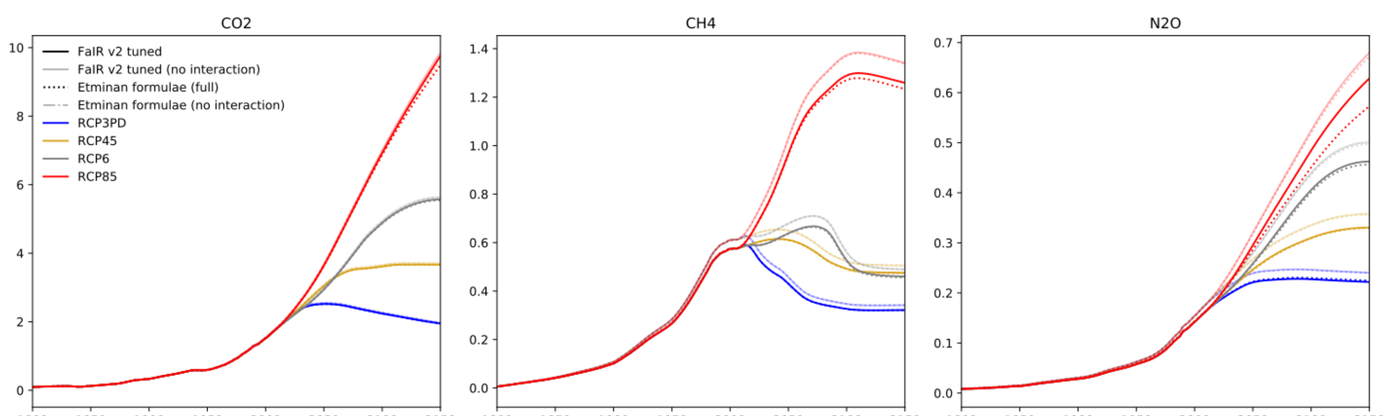

Figure 5: Comparison of the effective radiative forcings equation used in FaIR v2.0 versus the simple formulae derived from spectral measurements given in Etminan et al. (2016).

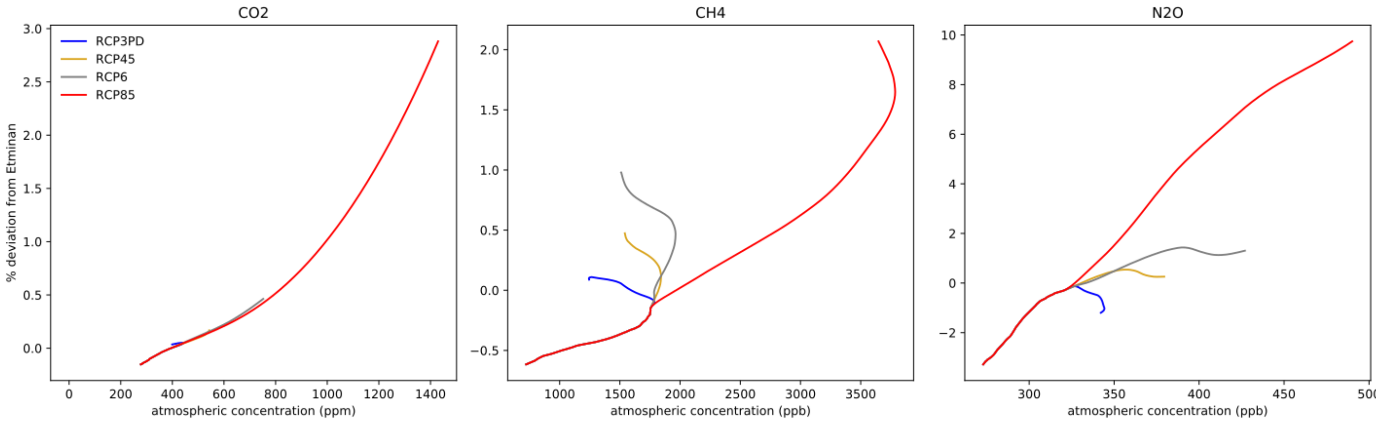

Figure 6: Associated deviations of FaIR v2.0 from Etminan over the RCPs. These are plotted as % deviations against gas concentration, illustrating the impact of the interaction terms which causes the separation of these deviations at the present-day concentration values.

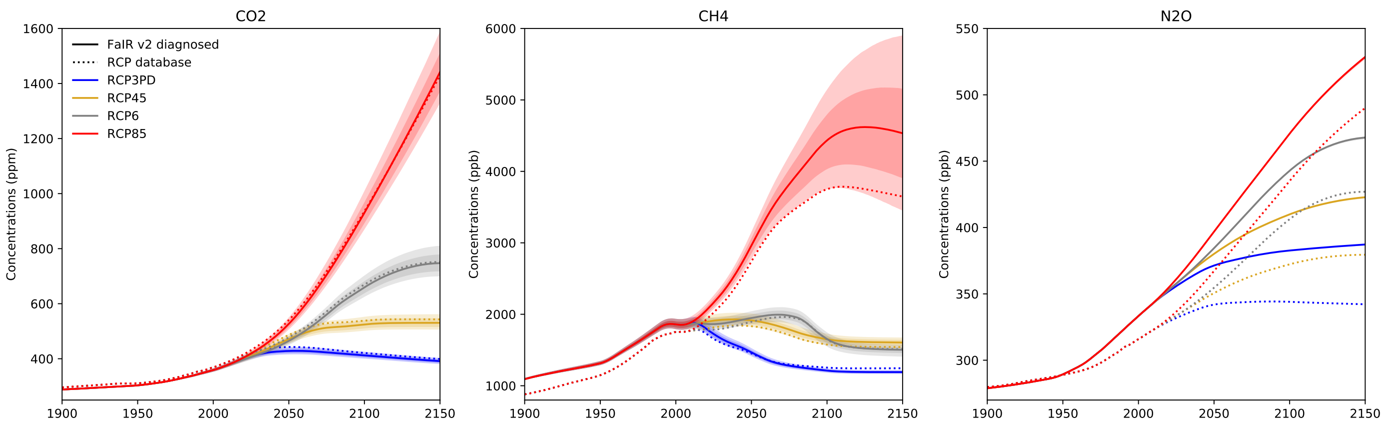

Figure 7: Simulated concentrations when RCP database emissions and other forcings drive FaIR v2.0.

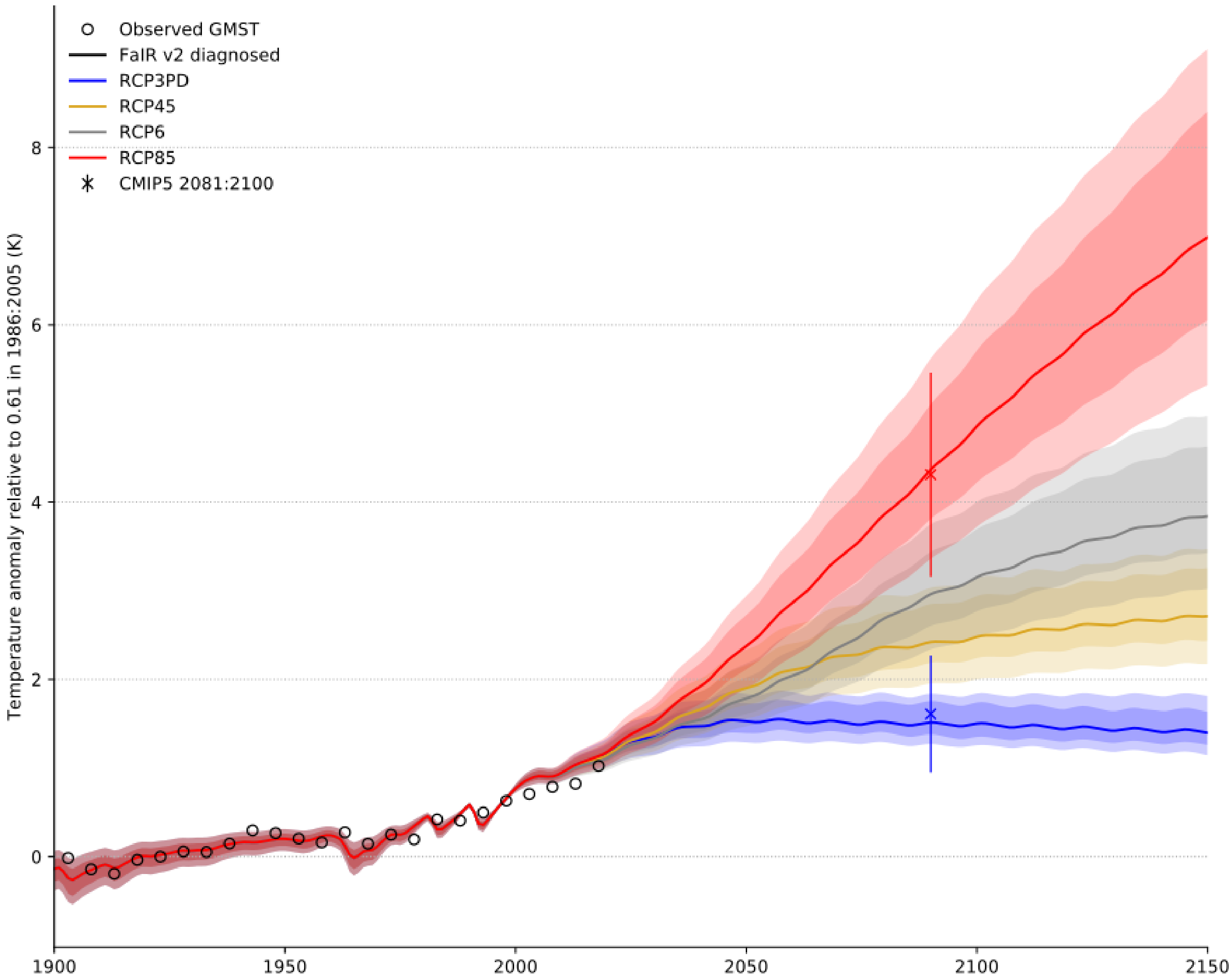

Figure 8: FaIR v2.0 temperature response to RCP emissions, when CMIP5 multi-model mean parameters from Tsutsui (2017) are used.

References

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