Taking some heat off the INDCs? The potential of short-lived climate forcers´ mitigation

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Motivation

The main focus of this study is to understand:

What are the potential short-term climate benefits of Short-Lived Climate forcers in the context of the intended nationally determined contributions (INDCs)?

First studies show that ambitions in the INDCs are too low to reach greenhouse gas (GHG) reduction levels consistent with a cost-optimal pathway towards a 1.5 or 2 degree target. Due to this delayed action, a steady short-term global mean temperature (GMT) rise can be expected, with potentially adverse effects. The temperature rise can be mitigated by increasing the ambition of the INDCs, but in the short term there might also be a role for intensified reduction of short-lived climate forcers (SLCFs): methane (CH_4), ozone (O_3), black carbon (BC) and hydrofluorocarbons (HFCs)

Approach

This study describes the EMF30 (30th modelling forum) work that goes into the relation between potential SLCF mitigation and the climate benefit in the INDCs. Eight models have taken part in the subset of INDC scenarios (see table "**models**"), with a large variety in modeling approaches (representation of the economy, level of foresight, representation mitigation options, and technological detail). Five scenarios from the project are particularly relevant in that context (see table "**scenarios**").

The model comparison provides an assessment of regional and sectoral implications for emissions and the resulting global implications on the short-term climate. The aim of this assessment is to understand to which degree additional SLCF policy on top of the INDCs can limit climate change. Secondly, the contribution of the individual forcers to the cooling effect is determined by estimating the reduced radiative forcing per SLCF. In a second assessment, we have tried to determine What can we already expect from the INDCS without additional SLCF policy. To that end, the INDCs and national plans of the G20 countries have been assessed in terms of expected (pledged) SLCF emission controls.

Models

Model	Institute	Type	Scenarios *
AIM-CGE	NIES, Japan	Partial equilibrium	All
DNE21+	RITE, Japan	General equilibrium	All
ENV-Linkages	OECD, France	General equilibrium	1,2
IMAGE	PBL/UU, The Netherlands	Partial equilibrium	All
MESSAGE-GLOBIOM	IIASA, Austria	General equilibrium	All **
POLES	ENERDATA, France	General equilibrium	1,2,3,4
REMIND	PIK, Germany	General equilibrium	All
WITCH	FEEM, Italy	General equilibrium	All

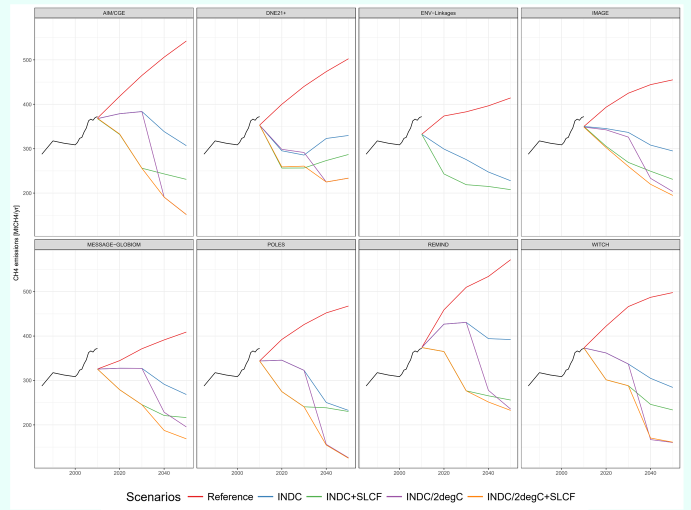
* See numbering from scenario table below

Scenarios

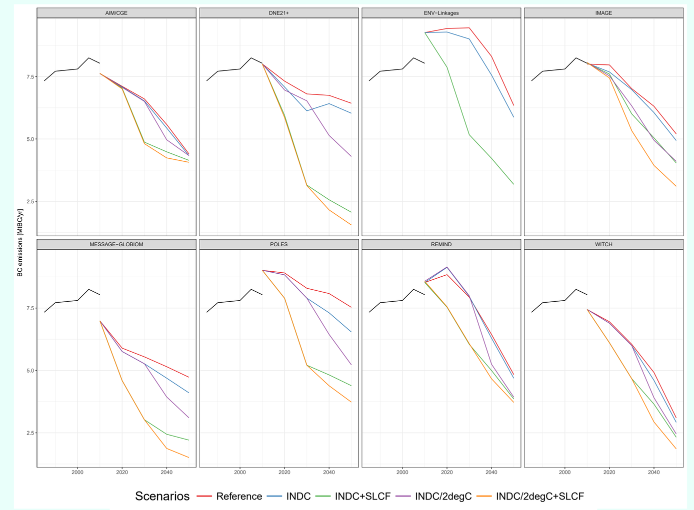
Scenario	2015-2030	2030-2100	Other policies
1) INDC	Implementation INDCs	INDCs based extrapolation	
2) INDC+SLCF	Implementation INDCs	See INDC scenario	SLCF policy = Strong methane (CH_4) and black carbon (BC) mitigation in the short term. CH4: High, increasing methane abatement price BC mitigation predominantly in the residential and transport sector
3) INDC/2degC	Implementation INDCs	Towards 2 degrees in 2100	See above
4) INDC/2degC+SLCF	Implementation INDCs	Towards 2 degrees in 2100	See above
5) INDC/2degC+SLCF+HFCs	Implementation INDCs	Towards 2 degrees in 2100	See above + maximum feasible reductions for HFCs in 2030

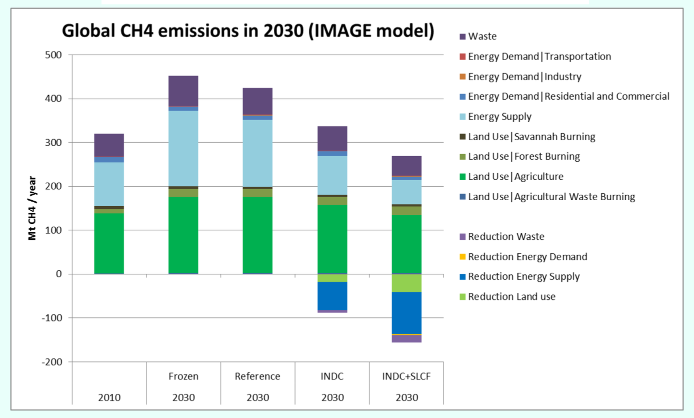
Emissions

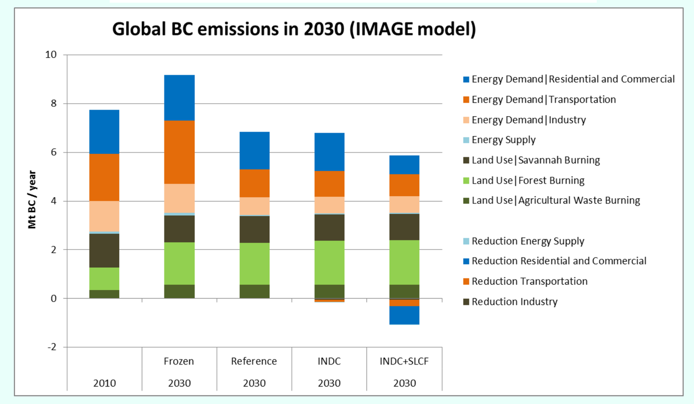
Methane



Black Carbon







Several factors limit the reduction potential of the two main SLCFs: Methane and Black Carbon

Methane emissions in the INDCs are expected to decrease considerably compared to the no-policy reference case, even in the absence of additional SLCF policy. Partly this is the result of CO2 policy which indirectly reduces methane. Partly this may be an overestimation of the models if the INDC targets are more focussed on CO2 mitigation (see block ¨SLCF policy in the INDCs¨) The largest mitigation potential in the short term is found in fossil fuel production.

Black Carbon emissions are expected to strongly decrease in all scenarios as a result of air pollution policy. This reduces the reduction potential in 2030 somewhat in the INDC scenario. The residual mitigation measures are limited to energy supply and demand, since land-use related sources have relatively large co-emitted organic carbon emissions which acts as a climate cooler. The largest mitigation options are the reduction of coal and traditional biomass in the residential sector.

This study is part of the 30th energy modelling forum (EMF30)

Discussion and Conclusions

The proposed SLCF measures are found to have only a small effect (<1%) on reducing the maximum temperature before 2100, mostly because in the second half of the century these gases are already significantly reduced, either directly or indirectly via changing the energy system.

However, maximizing SLCF mitigation can reduce the maximum temperature rate of change in the short term, by up to 23%. All models show that the short-term reduction in temperature rate of change is particularly relevant in an INDC + 2 degree C case. In a continued INDC case the effect is less certain, and some models project a delay, but not a decrease in the temperature rate of change.

All three SLCF groups can potentially contribute to this effect, methane has the largest impact. Additional HFC reduction is likely to be limited, especially if the recent inclusion of HFC reduction under the Montreal protocol will prove successful.

The temperature reducing potential from SLCFs as found in this study can be considered limited compared to earlier studies for several reasons: 1) Considerable CH_4 reductions are already expected from the INDCs, partly due to CO_2 reduction 2) The maximum emission reduction potential from CH_4 and BC is assumed lower in the short-term 3) Radiative forcing from BC is assumed lower with less favourable BC/OC (organic carbon) ratios.

If CH4 reduction resulting from the INDCs is limited, due to the fact that it is not sufficiently embedded in national policies, the short-term climate effect of additional SLCF policy could prove to be higher. However, even with this study's assessment of the national plans one cannot be sure if 1) Countries will pursue additional SLCF reduction efforts in a later stage to reach INDC goals, or 2) Countries would use additional SLCF policy as a substitution for CO_2 policy.SLCF policy can only be beneficial if it is additional to long-lived climate forcer (LLCF, i.e. CO_2) policy. If CO_2 reduction would be substituted by SLCF reduction it would mean that long-term climate goals are more difficult to reach. Therefore, the conclusions from this study only hold if additionality can be assured. However, there is legitimate concern that substitution could take place.

SLCF policy in the INDCs

	INDCs	National plans
	Included GHGs?	*Explicit direct non-CO₂ policies?*
Argentina	all	None
Australia	all	HFC (85% reduction in 2036)
Brazil	all	None
Canada	all	None
China	CO2-only	HFC (partly). Reduction of HCFC22 (68% in 2025), leading to reduced HFC23 emissions
European Union	all	All (Reduction compared to 1990, 72%-73% (in 2030) and 70% -78% (in 2050))
India	all *	None
Indonesia	all	None
Japan	all	HFC (partly) (Reduction of fluorinated gases: 9.7-15.6 MtCO2e in 2020 compared to BAU, is +/- 10%)
Mexico	all	Black Carbon (51% - 70% reduction in 2030)
Republic of Korea	CO2-only	None
Russian Federation	all	None
Saudi Arabia	all	None
South Africa	all	None
Turkey	all	None
United States of America	all	CH4: 40-45% reduction in oil & gas production by 2025, HFC: 85% reduction by 2033

* India excludes land-use policies, so also land-use related non-CO_2 measures

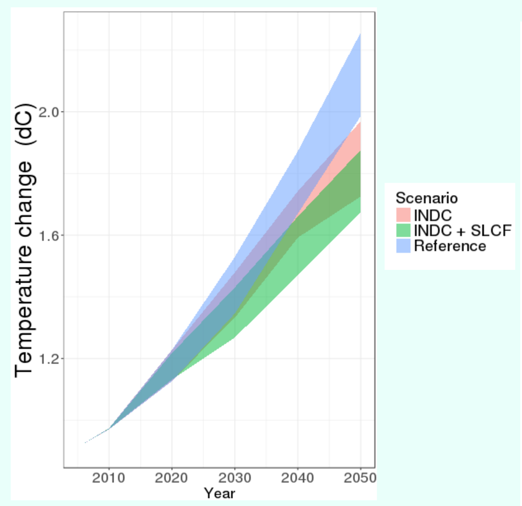
National plans of the G20 countries are mainly focussed on reducing CO_2. This could increase the short-term potential of SLCF policy.

While most of the INDCs are defined in terms of total GHG reduced compared to a baseline or base year value, most national plans are aimed at CO_2 only. With relatively little non-CO_2 policies in the national plans, it is likely that in the short term, INDC targets will mainly be met with CO_2 policies. If this will remain the case until 2030, there is a larger potential for additional SLCF policies. However, these then need to be additional to CO_2 policies and not result in substitution.

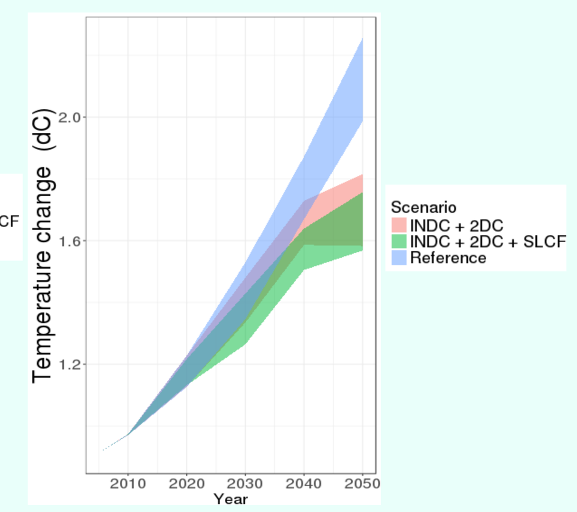
Climate impacts

Global mean temperature

INDC

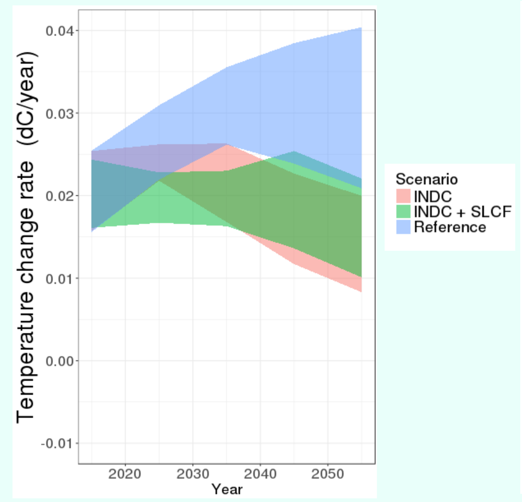


INDC + 2 degree

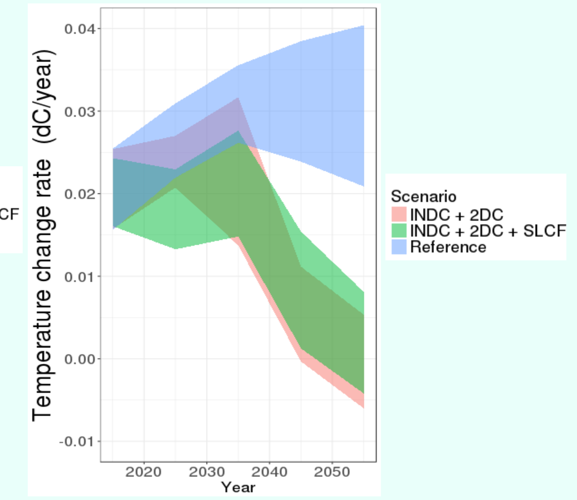


Temperature change rate

INDC



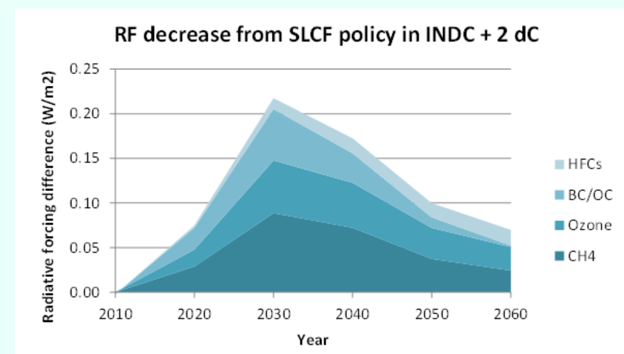
INDC + 2 degree



	INDC Effect SLCF policy	INDC + 2 degree Effect SLCF (+HFC) policy	
	Max T/yr change	*Max T/yr change*	*Max T change*
AIM/CGE	-13%	-15%	-3%
DNE21+	-3%	-13%	0%
ENV-LINKAGES	-1%		
IMAGE	-13%	-15%	-3%
MESSAGE	-10%	-14%	-3%
POLES	-23%	-22%	-3%
REMIND	1%	-12%	-2%
WITCH	-17%	-17%	-1%

Addtional SLCF policy has little effect on reducing the maximum temperature before 2100, but it does reduce the temperature change rate at the beginning of the century.

In an INDC-to-2degree scenario, SLCFs are found to have a relatively small effect (0 % – 3 %) on reducing the maximum temperature before 2100. The main reason is that SLCF reductions are already high in the normal INDC-to-2degree case because of direct and indirect emission reduction. Direct reduction is maximized several years before the peak temperature year in most models (2050-2065). SLCF policy can contribute to lowering the maximum global temperature change rate particularly in the INDC + 2 degree scenario (-12% to -22% reduction in the eight IAMs). Reduction of the temperature change rate is also likely in the continued INDC scenario (1% to -23% reduction) although some models project a delay but not a decrease in the maximum change rate as a result of SLCF policy (see figures) .



All three SLCF groups can contribute to reducing the temperature change rate. Methane reduction has the largest effect

This figure shows the average RF difference between "INDC/2degC" and "INDC/2degC+SLCF+HFCs" The largest RF reducing effect occurs in 2030. In that year, the relative impact of additional methane reduction is 41%, of BC/OC reduction 26% and of HFC reduction 6%. A large share of the decrease in RF can be accounted to a reduction in ozone (27%), which can be attributed to the reduction of the ozone precursors methane and NOx The impact of HFC reduction appears to be limited, but the model differences in terms of emission reductions are relatively large (in some models, HFCs contribute to a maximum of 15%)

Acknowledgements
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