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UK Research
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Horizon Europe

(HORIZON-CL5-2021-D1-01)

Non-CO2 Forcers and their Climate, Weather, Air Quality and Health Impacts

FOCI

Deliverable 7.1

Comparison of historic and baseline emissions and sectors and emission reduction potential

Grant agreement No 101056783

<table>
<tr><td>Grant Agreement No.</td><td colspan="2">101056783</td></tr>
<tr><td>Project acronym</td><td colspan="2">FOCI</td></tr>
<tr><td>Project full title</td><td colspan="2">Non-CO2 Forcers and their Climate, Weather, Air Quality and Health Impacts</td></tr>
<tr><td>Call</td><td colspan="2">HORIZON-CL5-2021-D1-01</td></tr>
<tr><td>Deliverable name</td><td colspan="2">D7.1 Comparison of historic and baseline emissions and sectors and emission reduction potential</td></tr>
<tr><td>WP contributing to the deliverable</td><td colspan="2">WP7</td></tr>
<tr><td>Task producing the deliverable</td><td colspan="2">Task 7.1</td></tr>
<tr><td rowspan="4">Type</td><td>X</td><td>Report</td></tr>
<tr><td></td><td>Prototype</td></tr>
<tr><td></td><td>Demonstrator</td></tr>
<tr><td></td><td>Other: Data</td></tr>
<tr><td rowspan="3">Dissemination level</td><td>X</td><td>Public</td></tr>
<tr><td></td><td>Sensitive</td></tr>
<tr><td></td><td>UE/EU-Restricted</td></tr>
<tr><td>Due date of deliverable</td><td colspan="2">Month 18</td></tr>
<tr><td>Actual submission date</td><td colspan="2">Month 18</td></tr>
<tr><td>Lead beneficiary</td><td colspan="2">SEI</td></tr>
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<tr><td>Reviewer(s)</td><td colspan="2">Leilani Dulguerov (WMO)</td></tr>
<tr><td>Keywords</td><td colspan="2">FOCI, deliverables, dataset, catalogue, global emissions, regional emissions</td></tr>
</table>

ACKNOWLEDGEMENTS

This project has been co-funded by the European Union with funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101056783 and from UKRI under the UK Government's Horizon Europe Guarantee (UKRI Reference Numbers: 10040465, 10053814 and 10050799).

Version	Date	Modified by	Comments
1.0	19 Feb 2024	Chris Malley	First order draft written
2.0	3 Mar 2024	Chris Malley	Revisions made to incorporate reviewer's comments
3.0	3 Mar 2024	Chris Malley	Final draft ready

	Name	Date
Verification Final Draft by WP leaders	Chris Malley (SEI) Johan Kuylenstierna (SEI)	03/03/2024
Check before upload by project Coordinator	Tomas Halenka (CU)	06/03/2024

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EXECUTIVE SUMMARY

This document is the deliverable “D7.1 “Comparison of historic and baseline emissions and sectors and emission reduction potential” for the European Union project “FOCI: Non-CO2 Forcers and their Climate, Weather, Air Quality and Health Impacts” (hereinafter also referred to as FOCI, project reference: 101056783).

The observations described in this document compose the Milestone M13 (Baseline emissions ready for analysing benefits of non-CO_2 mitigation) and Deliverable D7.1. WP7 is also working on the Deliverable D7.2 and D7.3, which also contributes to the Milestone M13 due month 24 and 42 respectively.

The overall aim of FOCI is to understand the impacts of non-CO_2 climate forcers on present and future climate as well as other impacts such as air quality. To undertake the atmospheric modelling necessary to explore this, emission projections are necessary. The Shared Socioeconomic Pathways are a widely used framework for the development of emission scenarios. Here, we compare the emission projections under different SSPs available in the SSP database. The report highlights that i) for the same SSP, models can produce substantially different estimates of climate forcer emissions (CO_2 and non-CO_2), ii) for the same SSP, models can embed substantially different assumptions about the drivers of emissions (e.g. energy use, energy mix, agricultural production), and iii) that there is substantial uncertainty in understanding the reasons for differences in emission results between SSPs and models due to a lack of transparency in the changes in many of the variables that determine future emission projections. This report briefly describes the SSPs and information available on them within the SSP database. It then compares the SSP emission results and extent to which differences in emissions can be explained through information available in the SSP database. Finally, recommendations are made for use of SSPs.

CONTRIBUTION TO THE FOCI OBJECTIVES

The overall aim of the project is to improve our knowledge of individual and cumulative contribution of non-CO2 radiative forcers and their precursors. The proposal states that this will be achieved through targeted research on those species where there is the greatest uncertainty in determining their impact on climate change and the associated influence on weather patterns (e.g., atmospheric and ocean circulation and extreme weather events), air pollution episodes and health impacts.

Multiple sub-objectives, implemented through distinct work packages, are addressed in whole or in part through quantitative assessments of the health impacts of ambient air pollution exposure, including:

- Objective 5: To improve tailored emission inventories for non-CO2 radiative forcers and scenarios for detailed, high resolution, multiscale climate, and associated impact projections for specific regions (e.g., Europe, South Asia, Africa, and Arctic) with the use of innovative coupled modelling frameworks (WP5 and WP7).
- Objective 6: To undertake innovative and regionally relevant integrated analysis of optimised mitigation strategies to support climate policy, deriving multiple benefits (e.g. climate mitigation and adaptation, human health, social, economic, and developmental), quantifying the sensitivity of climate system tipping points to nonCO2 forcers and meeting the global challenge of stabilising global temperatures and minimising the associated impacts on climate, weather, air quality and health (WP6, WP7).
- Objective 7: To implement a global outreach, dissemination and stakeholder engagement strategy targeted at providing updated scientific evidence on the impact from key non-CO2 radiative forcers for supporting national and international policy and operational services, including formulating recommendations and briefing papers on the most efficient pathways to stabilising global temperatures supported by integrating climate, health, urban and energy services (WP8).

1. INTRODUCTION

The Deliverable D7.1. “Comparison of historic and baseline emissions and sectors and emission reduction potential” consists of this report describing comparison of Shared Socioeconomic Pathways scenarios being considered for use within other FOCI Work Packages (Task 7.1).

WP7 is organised in three major tasks:

> Task 7.1: Assessment of detailed emission projections in WP6 and comparison with SSPs and other inventories/projections (Lead beneficiary: SEI)
>
> Task 7.2: Quantification of broader implications of implementing non-CO2 climate forcing mitigation measures. (Lead beneficiary: SEI)
>
> Task 7.3: Making the benefit quantification methods available to the emission policy modelling community (Lead beneficiary: TAU)

The emissions dataset (global and regional from D5.1 and D5.2) has been gathered and made accessible for the regional and urban multiscale climate impact (WP6) and to identify, evaluate and quantify the multiple benefits from the implementation of nationally appropriate mitigation measures targeting non-CO_2 climate forcers (WP7).

The Shared Socioeconomic Pathways (SSPs) are a framework for the development of scenarios (O’Neill et al. 2017). The five SSPs describe overarching storylines as to how countries may develop over the 21st Century. These storylines are then converted into quantitative changes in key drivers of emissions and used within Integrated Assessment Models (IAMs) to project future emissions of long- and short-lived climate forcers (Rao et al. 2017).

The FOCI project seeks to fill the knowledge gap concerning the impact of non-CO_2 radiative forcers. To achieve this, FOCI is undertaking atmospheric modelling at global and regional scales, and therefore requires emission projections as input to this modelling. Work Package 5 will produce new emission projections for specific regions, but emissions based on the SSP frameworks will also be used.

The aim of this report is to make clear the implications of selecting different SSP emission scenario within the FOCI project. To do this, an overview of the SSP emissions scenarios taken from the SSP scenario database is made to show what type of emission scenarios are included, and what information is reported for each emission scenario. Next, the drivers for each SSP are compared to show how different SSPs, when represented in different integrated assessment models, can represent substantially different visions of a future society in terms of economic development, energy use, agricultural production etc. Finally, the emission implications of these different SSPs are presented to show that for the same SSP, due to how it is modelled in an IAM, can contain very different emission results.

2. IMPORTANCE OF SCENARIO COMPARISON

Scenario analysis is fundamental tool to explore how different indicators may change in response to different drivers of change in the future. In the context of climate change, scenario analysis has been used to link socioeconomic changes and changes in human activities to projected changes in emissions of long and short-lived climate forcers, and resultant impacts of these emission changes. Scenarios are not intended to make future predictions, but instead to outline likely consequences different future pathways may have. Scenario analysis is commonly used by researchers to explore different climate change mitigation pathways, as well as decision makers to define climate change mitigation targets, and climate change mitigation policies and measures (Kuylenstierna et al. 2020; UNEP 2021; Wiebe et al. 2015).

The typical process for the development of emission scenarios involves the following steps:

1. Building a modelling framework: This step involves the development of a model that represents the human activities that produce long- and short-lived climate forcer emissions. Many different models have been developed, each with different levels of integration of different economic and emitting sectors. Integrated Assessment Models are widely used modelling frameworks that attempt to explicitly link different economic sectors and sources of emissions. Simpler modelling frameworks, e.g., based on international emission inventory guidance (e.g., IPCC or EMEP/EEA) have also been used, but these may not represent linkages between sectors as explicitly.
2. Develop historic emission estimates using actual data: The modelling framework is initially parameterized using actual data to estimate historic emissions of climate forcers from all major sectors.
3. Development of future projections for different types of future scenarios: For quantitative emission scenarios, it is necessary that each input variable be projected into the future within a physically plausible, internally consistent storyline. Common narratives for future projections include baseline, or ‘without measures’ scenarios which represent a possible future without implementation of policies and measures designed to reduce emissions. Mitigation scenarios that represent a future where a specific set of policies and measures are implemented are also commonly constructed.

Comparing scenarios is essential for scenario analysis to inform decision making and to provide insights into feasible mitigation pathways. In greenhouse gas mitigation assessments, e.g., to inform Nationally Determined Contributions, the comparison of future greenhouse gas emissions in a baseline or reference scenario to different policy scenarios is often the basis for the level of a greenhouse gas mitigation target. This comparison of scenarios generally benefits from there being a consistency modelling framework and set of data used in the development of baseline and mitigation scenarios.

Within the FOCI project, the aim is to evaluate the impact of non-CO_2 climate forcers on future climate change, and the benefits that reducing non-CO_2 climate forcers could have on climate change and other issues, such as air quality. Within FOCI, Work Package 5 will develop updated emission inventories and projections for particular regions (e.g., Latin America, Africa), and sectors (agriculture and waste), but existing global emission inventories and projections (i.e., Shared Socioeconomic Pathways) will also be used as input to the atmospheric modelling. In this case, the aim of comparing different emission scenarios is to ensure consistency between FOCI-developed scenarios and existing emission projections such as those derived from SSPs.

To assess the consistency between existing emission projections and those derived in FOCI, there are different levels at which a comparison can be made that provide different levels of understanding of the consistency of the future scenarios. Often, scenarios are compared in terms of the emission projections that are output from the scenario modelling. This comparison provides an understanding of whether two (or more) scenarios produce similar emission projections, but doesn't provide an understanding of whether the future narrative, and its quantitative representation, are consistent between the two scenarios. In FOCI, the selection of the SSP emission projections will determine the climate and air quality impacts modelled. This report aims to outline the SSPs, and to highlight the variability within the set of SSP emission projections to provide greater context for the decision of emission projections to use. Section 3 provides an introduction to the SSPs, while the main SSP drivers are compared in Section 4. Finally, the emission results for each SSP are compared in Section 5, alongside the initial emission projections for the agriculture and waste sector for FOCI.

3. OVERVIEW OF SHARED SOCIOECONOMIC PATHWAYS

Shared Socioeconomic Pathways (SSPs) began their development in 2014. Prior to the SSP framework, researchers developed Representative Concentration Pathways (RCPs) to describe a selection of possible changes in radiative forcing scenarios, from which future climates could be modelled (O'Neill et al. 2017). The RCPs were defined by different atmospheric concentrations of greenhouse gases. The SSP framework was designed to describe different narratives about the future from which integrated assessment models translate these narratives into quantitative estimates of greenhouse gas emissions, from which atmospheric concentrations and climate impacts can be estimated.

Five SSP narratives were developed which represent different types of societal development from 2015 to 2100. These were titled 'Sustainability' (SSP1), 'Middle of the Road' (SSP2), 'Regional Rivalry' (SSP3), 'Inequality' (SSP4), and 'Fossil-fueled Development' (SSP5). The narratives highlight different aspects of socioeconomic changes in each SSP, including population growth, migration, urbanisation, education, health sector investments, access to safe water and sanitation etc. In relation to climate change, these narratives are framed in terms of challenges for adaptation (relatively less for SSPs 1 and 5) and mitigation (relatively less for SSPs 1 and 4) (Figure 1) (O'Neill et al. 2017).

SSP-derived scenarios have been widely applied to evaluate future emission projections, and as a result the label of a particular SSP has expanded beyond the title of a particular future narrative to encompass a wide range of possible emission pathways. For example, within the SSP database, maintained by IIASA, each SSP has been paired with a Representative Concentration Pathway (i.e., a radiative forcing) so that for each SSP there are between four and six scenarios which represent a particular pathway of societal development (i.e. the SSP) that results in a particular level of radiative forcing (i.e. RCP). Moreover, these SSP-RCP combinations have been processed through multiple integrated assessment models, resulting in emission projections for each SSP-RCP combination for at least five integrated assessment models. Hence while SSPs have become a label for scenarios used to provide decision makers with information about possible future warming under different scenarios, these labels now contain a wide range of future predictions based on the underlying assumptions made in the models representing them. For example, with the IPCC AR6, five scenarios (SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, SSP5-8.5) were used to assess potential future warming impacts (IPCC 2021). However, this labelling is increasingly problematic as it combines under that label an increasing number of scenarios that contain lots of different representations of the future. In many cases scenarios under each SSP have fundamentally different projections and drivers of emissions like energy consumption, agricultural production, and carbon capture and storage. Section 4 contrasts the different drivers underpinning each of the SSPs to demonstrate the breadth of socioeconomic projections which are commonly labelled as a particular SSP.

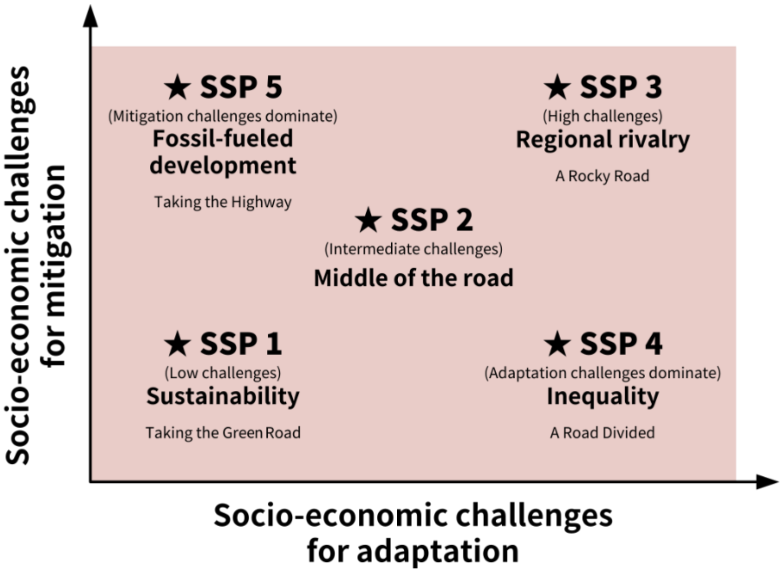

Figure 1: Overview of Shared Socioeconomic Pathways storylines and challenges for mitigation and adaptation

4. COMPARISON OF SSP DRIVERS

4.1 Common drivers in all versions of an SSP

The five shared socioeconomic pathway (SSP) narratives are described in detail in O'Neill et al. (2017), with attributes such as population growth, economic growth, level of education, access to safe water and sanitation, level of urbanisation, health care provision, gender equality and social cohesion contrasted qualitatively between the different SSPs. In translating SSPs into quantitative emission scenarios, the SSP database specifies only 3 variables per shared socioeconomic pathways: population, Gross Domestic Production (GDP) and urbanised fraction of the population, which are the same for every version of each SSP. These three variables differ between each of the five SSPs, but when a particular SSP is used in an analysis, only these three variables are consistent when a particular SSP is applied. For other variables whose values are quantified for each SSP, the RCP variable paired with the SSP and the integrated assessment model used influence the value of these additional variables, resulting in them differing for scenarios which fall under a particular SSP number.

The population projections underpinning each SSP show that for SSP1, 2, 4 and 5, global populations peak in the middle of the 21st Century then slowly (SSPs 2 and 4), or more rapidly (SSPs 1 and 5) declining for the rest of the century (Figure 2). SSP3 has a global population that continues to grow throughout the 21st Century, with almost 13 billion people in 2100, compared to 9 billion (SSPs 2 and 4), and 7 billion (SSPs 1 and 5) people in 2100 in the other SSPs. While differences are smaller in 2050 between the global populations for each SSP, there are still approximately 1 billion fewer people in SSPs 1 and 5 compared to SSPs 2 and 4, which have 1 billion fewer people compared to SSP3.

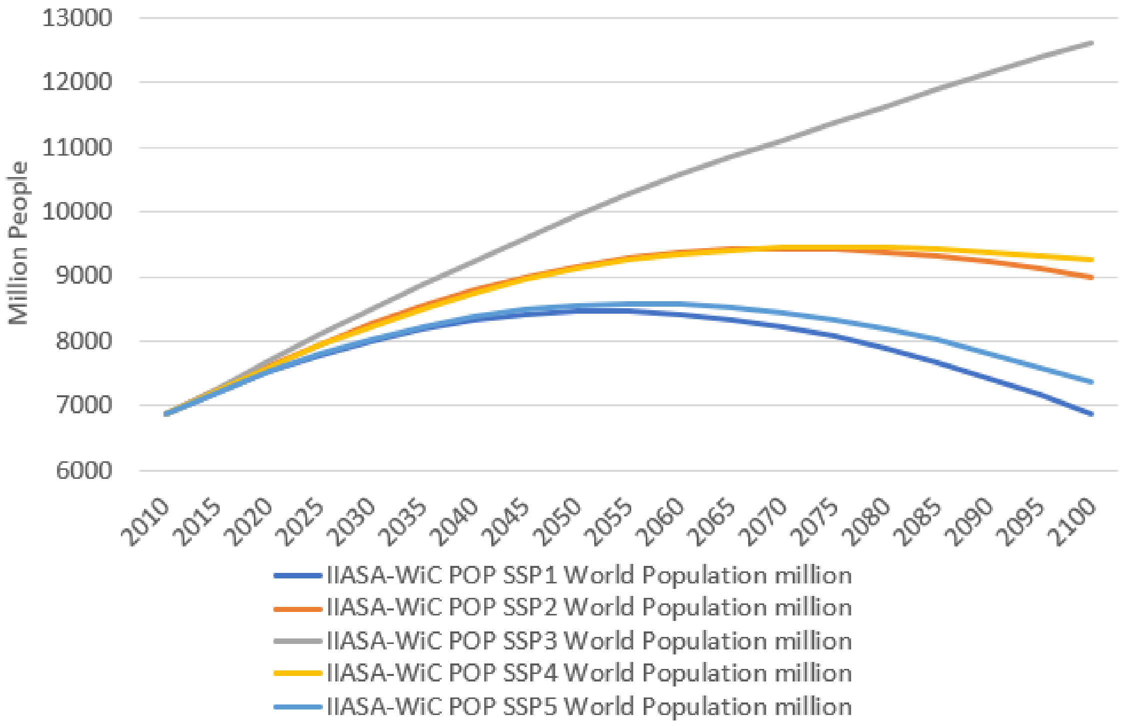

Figure 2: Global population projections for each Shared Socioeconomic Pathways

Gross Domestic Product varies substantially between the SSPs. SSP5, fossil-fuel driven development, has the largest GDP increase (and among smallest population increases), with almost double the GDP in 2100 compared to any other SSP. SSP3 has the smallest GDP increase. In 2050, there is a factor of 2 difference between GDP estimates between the SSPs (Figure 3). Finally, the fraction of urban population is highest for SSPs 1, 4 and 5, with up to 90% of the population living in urban areas by 2100. For SSP3, there is a substantially lower fraction, with an urban fraction less than 60%. SSP 2 is somewhere in the middle.

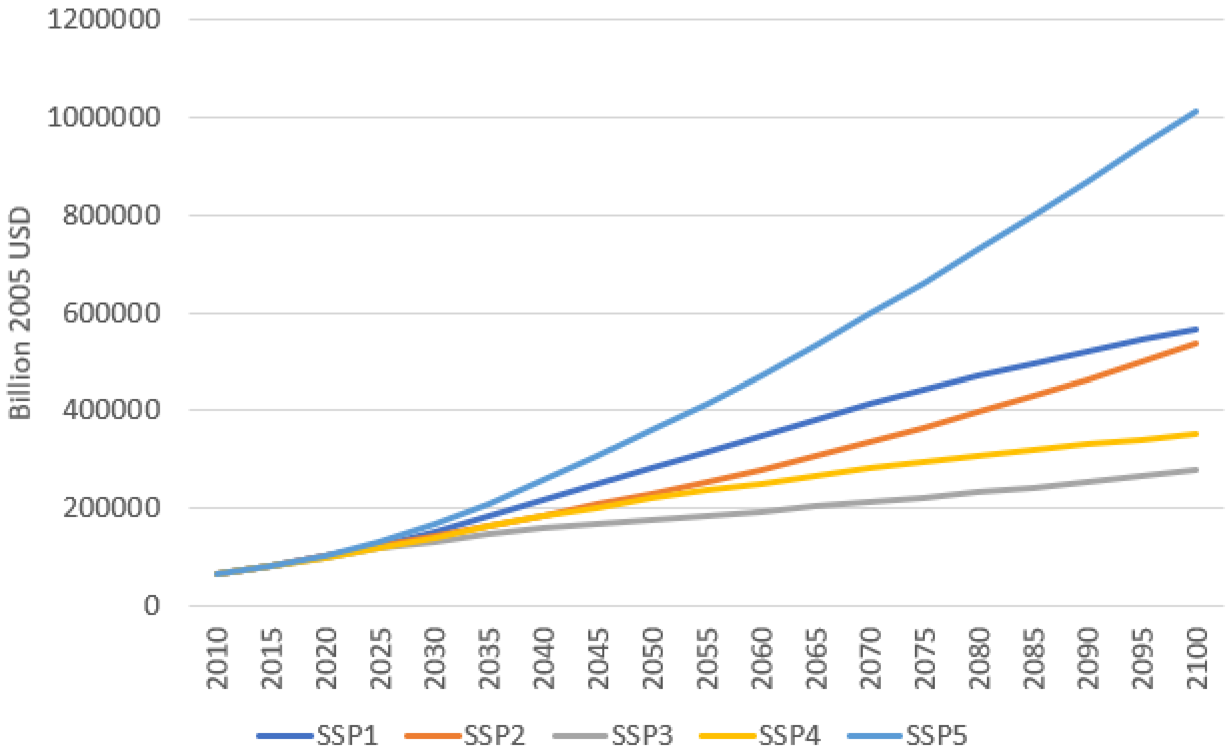

Figure 3: Global GDP estimated by OECD for each Shared Socioeconomic Pathway

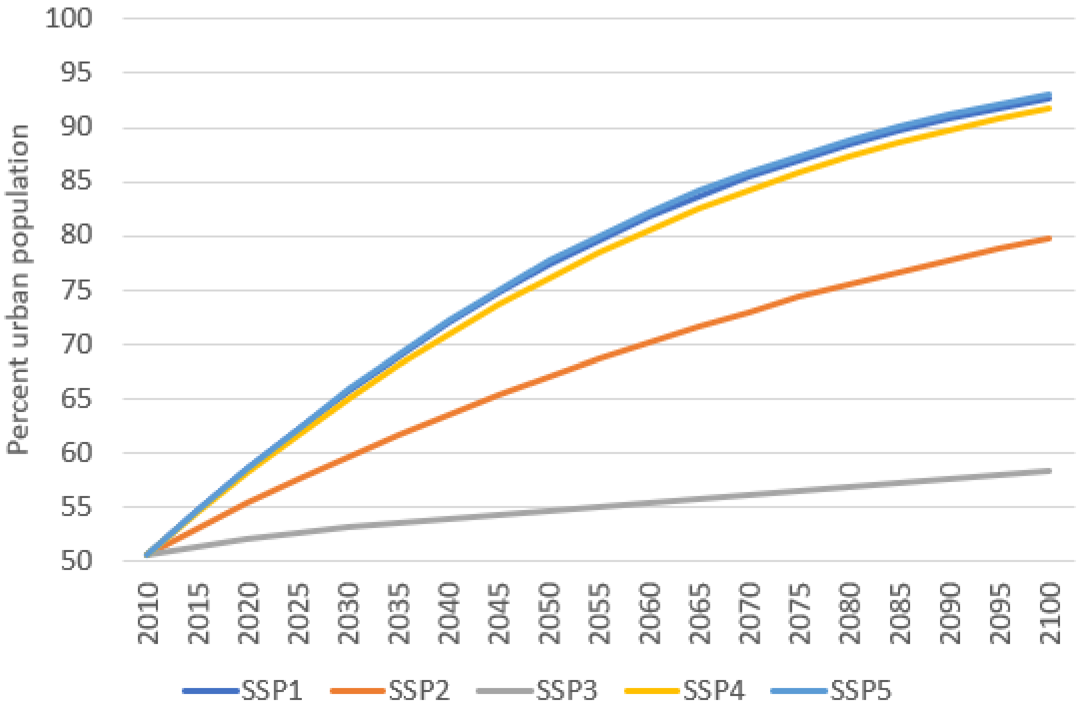

Figure 4: Percentage of global population living in urban areas in each Shared Socioeconomic Pathways

Other drivers of climate forcer emissions in the SSPs vary depending on the RCP they are paired with and the integrated assessment model into which the SSP narrative is represented. To demonstrate the variability within scenarios labelled as the same SSP, we have chosen to highlight the results from the SSP database for SSP1-1.9, as one of the most ambitious SSP scenarios which is broadly consistent with limiting global temperature increases to below 1.5 °C by 2100. It was also one of the scenarios included in the IPCC 6th Assessment Report. We have also contrasted these results with SSP2-3.4 as one of the scenarios being considered for use within FOCI. Within both scenarios, the drivers show substantial variations depending on the Integrated Assessment Model chosen to represent the SSP. This limits the specificity with which a particular SSP label can be used to describe a particular future, given the substantial variation in how each narrative is quantified within Integrated Assessment Models.

4.2 Drivers which vary for a particular SSP

Among the drivers of emissions that are quantified within Integrated Assessment Models that represent SSP narratives are energy statistics, land use, agricultural production, and levels of deployment of carbon capture and storage. For energy consumption, different IAMS can estimate substantial differences in overall energy consumption as well as the contribution of different energy sources to the energy mix for the same SSP. For SSP2-3.4 and SSP1-1.9, in 2050, there is a ~40% and ~60% difference in total primary energy consumption between Integrated Assessment Model results (Figures 5 and 6). In both SSP2-3.4 and SSP1-1.9, fossil fuel-derived energy consumption decreases, but the magnitude of the decrease and remaining fossil fuel energy consumption without carbon capture and storage varies between Integrated Assessment Models (Figures 7-10). As a result, in some IAM results for SSP1-1.9, there remains substantial unabated fossil fuel use for energy consumption in 2050, when carbon dioxide emissions should reach net zero. These differences in fossil fuel energy consumption within the same SSP have large ramifications for the implementedpolicies and measures to mitigate climate change. For example, for SSP1-1.9 represented in the IAM WITH-GLOBIOM, there remains relatively little (but not zero) fossil fuel energy consumption in 2050. For the same SSP, the IAM GCAM4 estimates almost the same fossil-fuel derived energy consumption in 2050 as there is in 2010, suggesting a much stronger level of carbon capture and storage, or enhancement of carbon sinks to achieve net zero emissions. Similarly, the extent to which carbon capture and storage is deployed in fossil fuel energy use also varies substantially across IAMs, highlighting the very different development and energy pathways labelled as the same SSP (Figure 7-10).

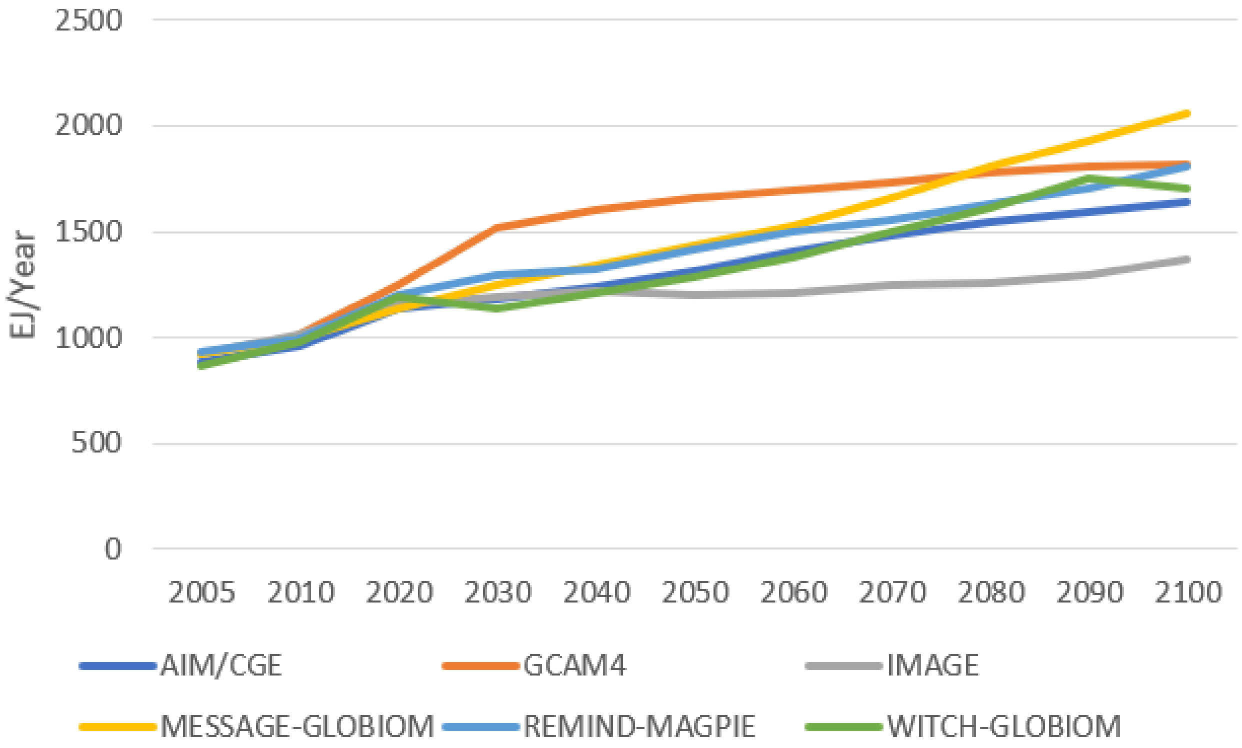

Figure 5: Total Primary Energy consumption in SSP2-3.4 estimated using different Integrated Assessment Models

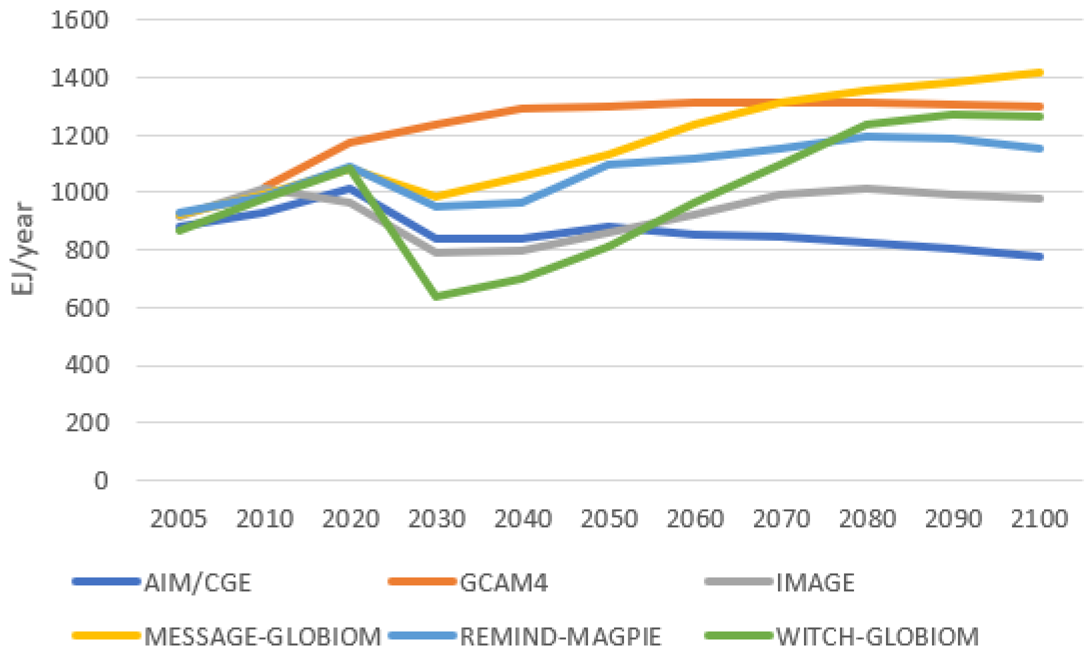

Figure 6: Total Primary Energy Consumption in SSP1-1.9 estimated using different Integrated Assessment Models

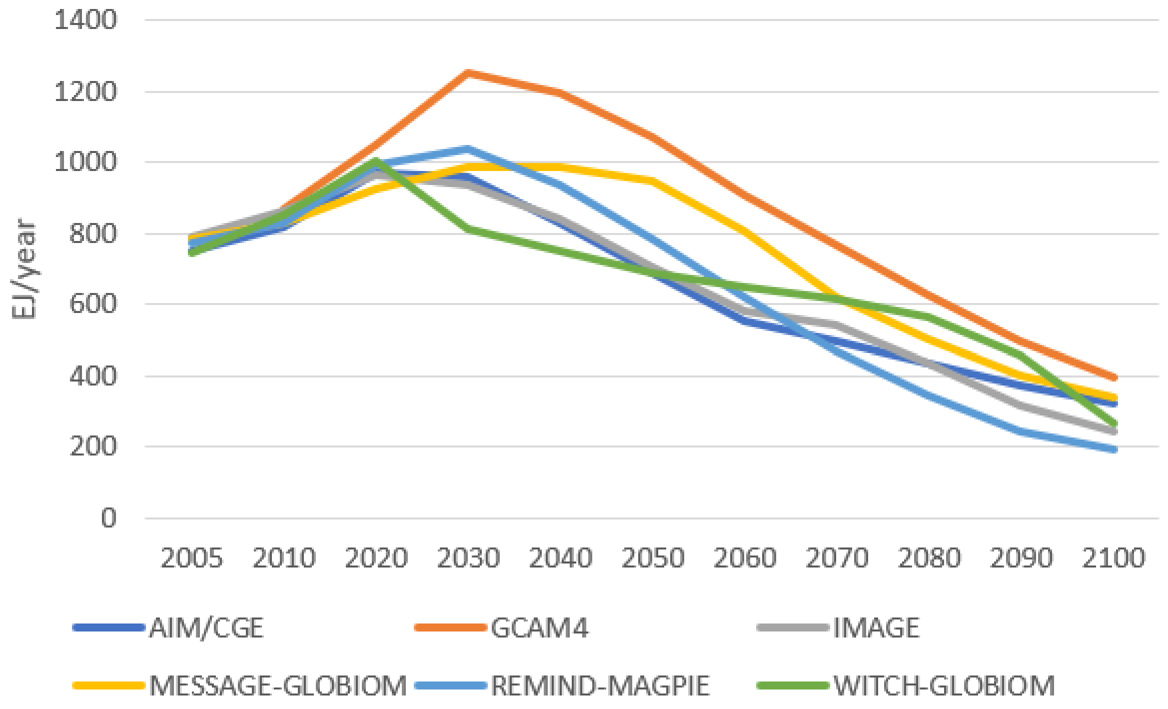

Figure 7: Fossil fuel primary energy consumption without carbon capture and storage in SSP2-3.4 using different Integrated Assessment Models

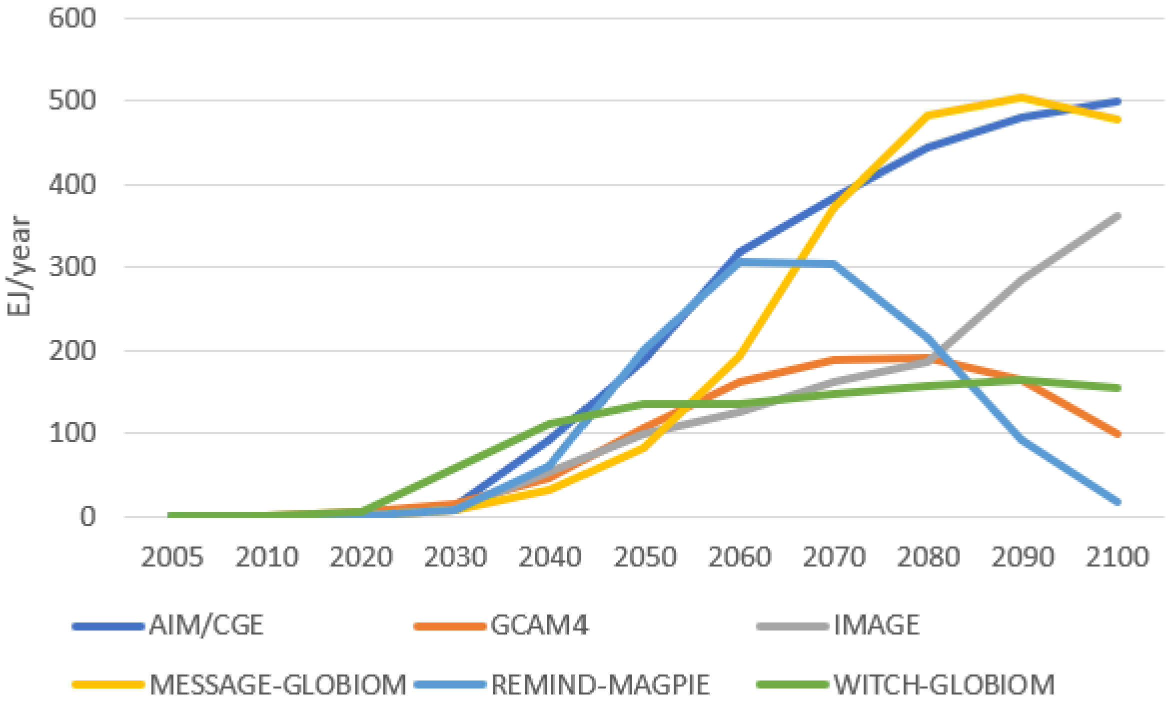

Figure 8: Fossil fuel primary energy consumption with carbon capture and storage in SSP2-3.4 using different Integrated Assessment Models

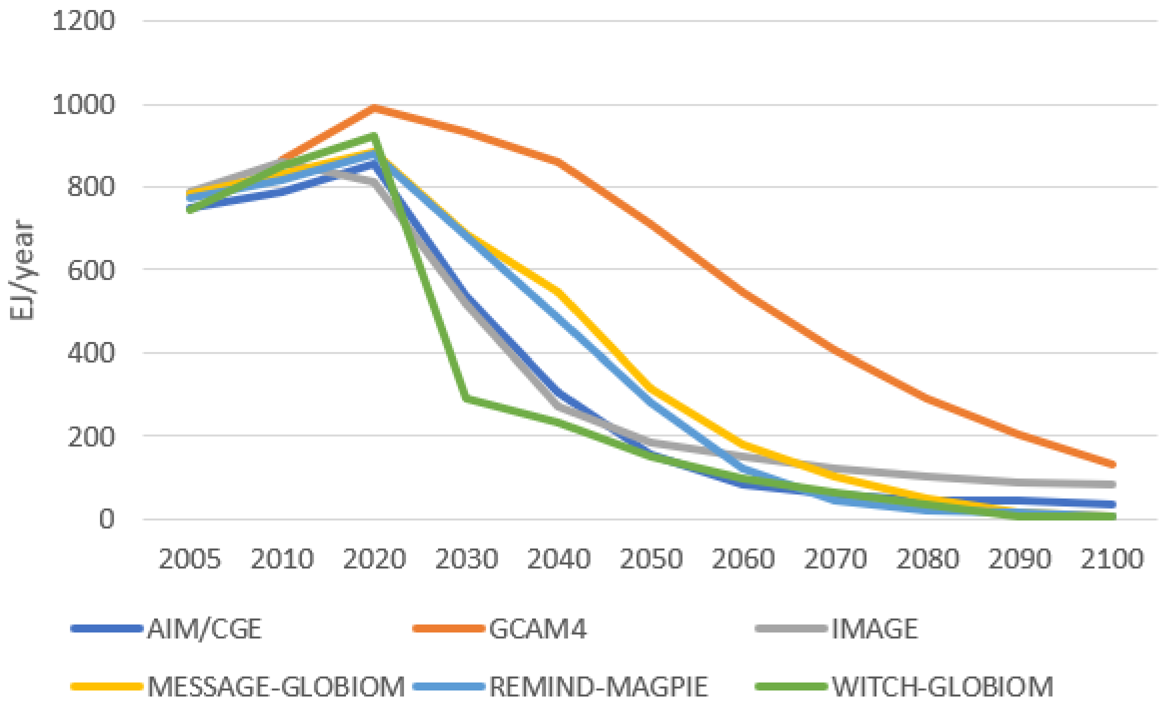

Figure 9: Fossil fuel primary energy consumption without carbon capture and storage in SSP1-1.9 using different Integrated Assessment Models

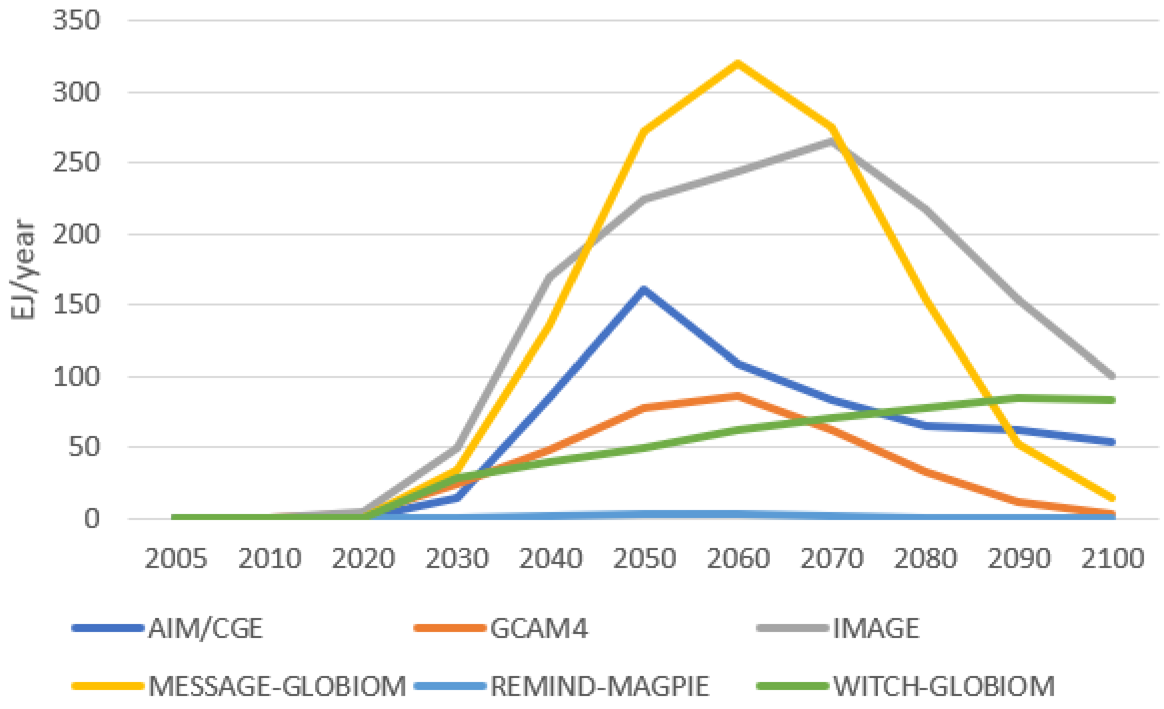

Figure 10: Fossil fuel primary energy consumption with carbon capture and storage in SSP1-1.9 using different Integrated Assessment Models

Of the other indicators that are provided for each SSP and integrated assessment model within the SSP database, many relate to the agriculture sector, which is responsible for approximately one third of global greenhouse gas emissions. As for energy consumption, the same SSP implies substantially different levels of agricultural production when represented in different IAMs. For example, livestock production in SSP2-3.4 and SSP1-1.9 are ~50% different in 2050 across the IAMs, with similar variations in crop production (Figures 11-14). The different SSP assumptions of the mass of crops produced for energy use has even more substantial implications for land use and other attributes. By 2100, all IAMs assume for both SSPs considered here that crop production for energy use will be at least as large as crop production for non-energy use. However, there is a four-fold difference in the amount of energy crop production across the different modelled representations of each SSP (Figure 15-16).

Therefore, from a decision maker and climate change mitigation planning perspective it is unclear what implementation actions a particular SSP entails to achieve the given level of radiative forcing. Some include huge expansions of biomass as an energy source, others substantially less. This analysis yields many differences between SSPs. For example, some scenarios include huge expansions of biomass as an energy source, others substantially less. This lack of consistency in the mechanism to achieve a particular level of emissions or warming could make climate change mitigation and planning challenging. The implementation actions entailed under a specific SSP might be unclear to decision makers.

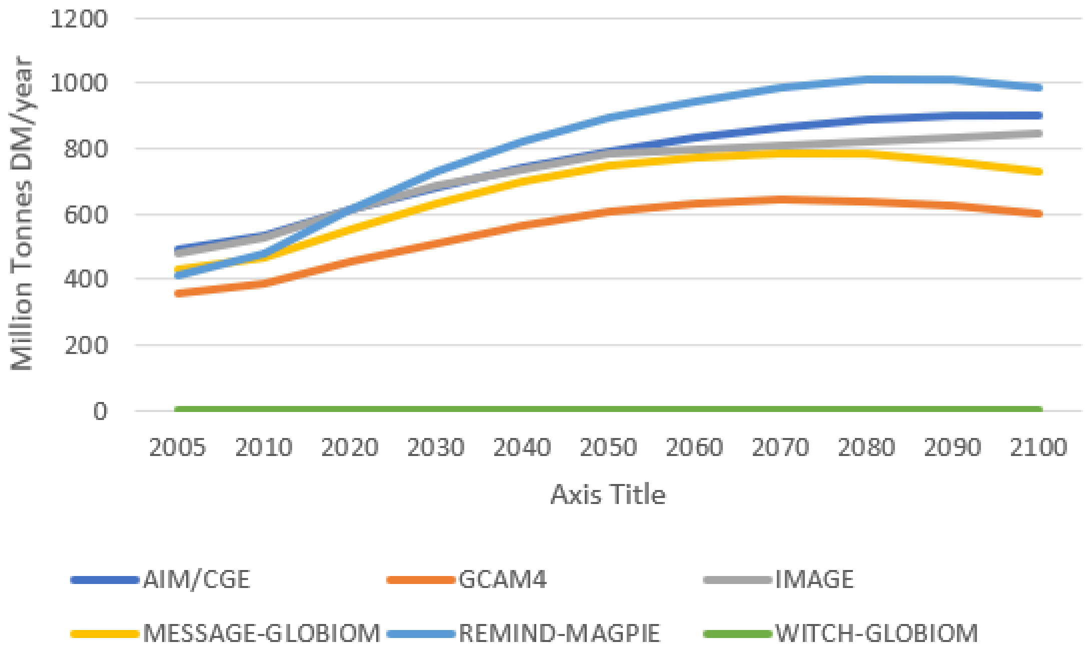

Figure 11: Total livestock production globally in SSP2-3.4 using different integrated assessment models

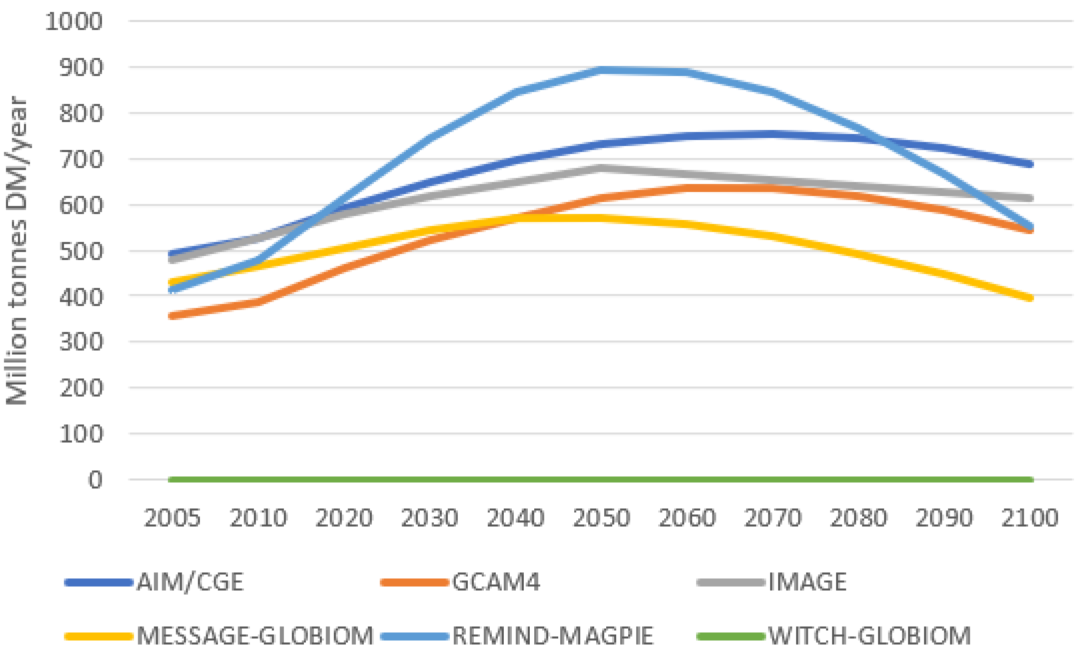

Figure 12: Total livestock production globally in SSP1-1.9 using different integrated assessment models

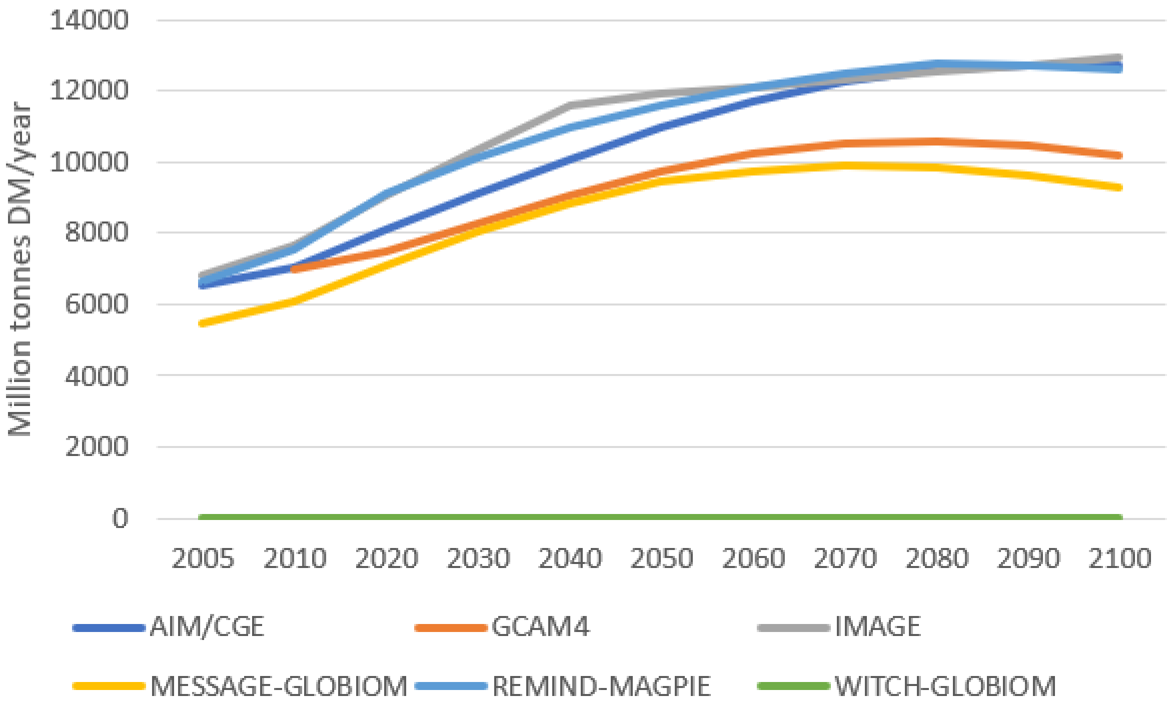

Figure 13: Total non-energy crop production globally in SSP2-3.4 using different integrated assessment models

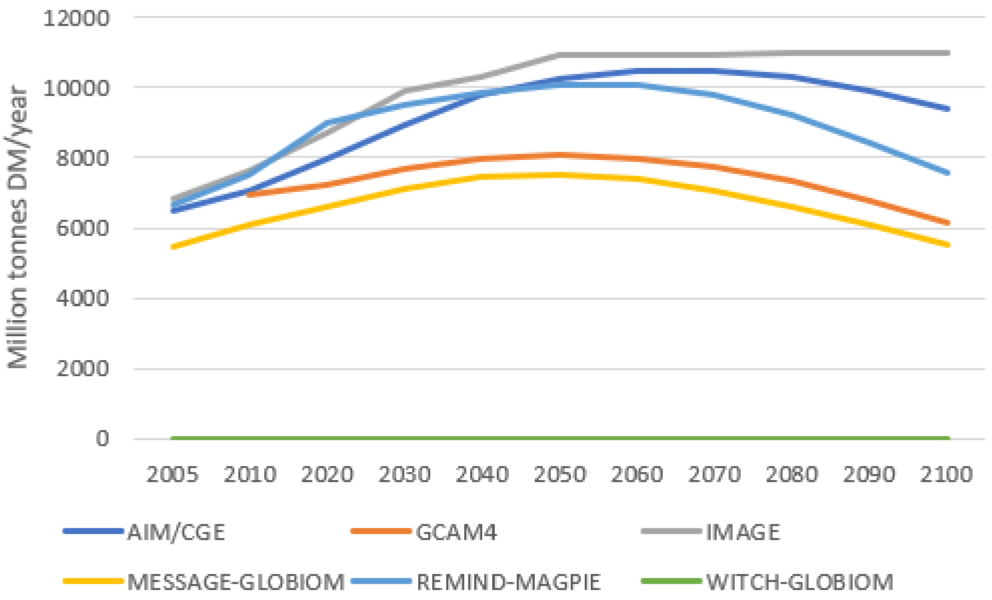

Figure 14: Total non-energy crop production globally in SSP1-1.9 using different integrated assessment models

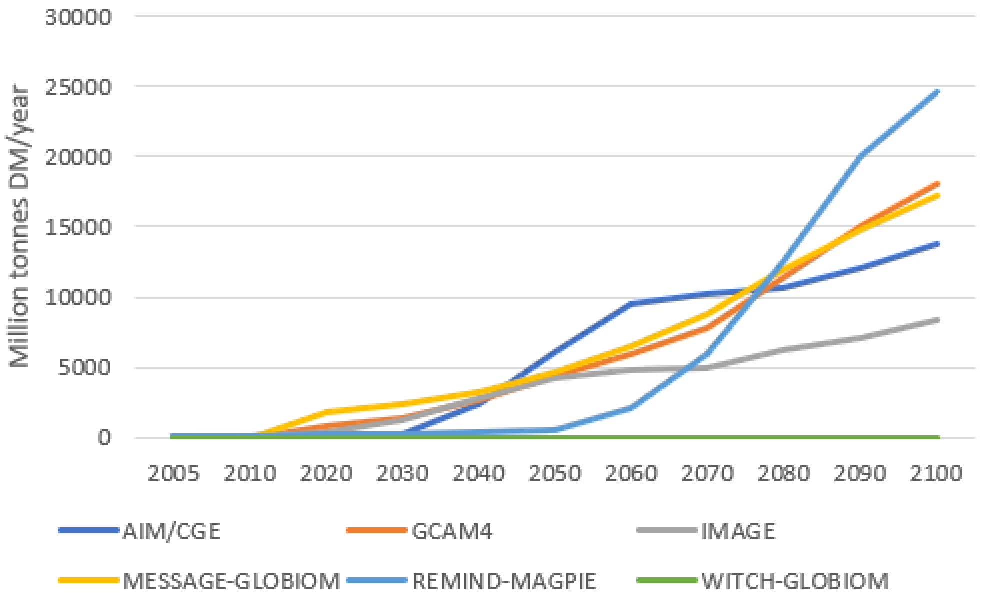

Figure 15: Total crop production for energy use globally in SSP2-3.4 using different integrated assessment models

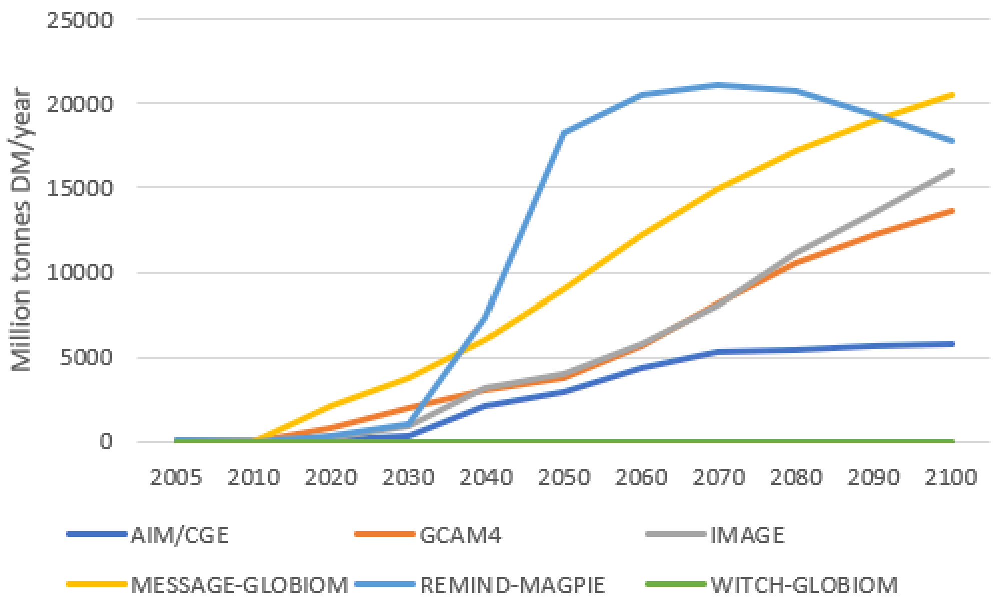

Figure 16: Total crop production for energy use globally in SSP1-1.9 using different integrated assessment models

5. COMPARISON OF SSP EMISSIONS

As outlined above, the level of activities that emit greenhouse gases vary substantially within scenarios that are commonly labelled as a particular SSP. As a result, the emissions of different greenhouse gases also vary substantially across scenarios within the same SSP, depending on the integrated assessment model used to derive them.

For carbon dioxide, there is relatively greater consistency in future emission pathways (Figures 17 and 18) compared to other greenhouse gases like methane (Figures 19-24). Despite the relative consistency for CO_2 emissions, there are still differences between IAMs in the estimated CO_2 emissions. Firstly, by 2100 there are differences in total CO_2 emissions between the IAM representation of the SSPs, with some IAMs estimated net negative CO_2 emissions, and some with continued positive CO_2 emissions. There are also large differences in the amount of CO_2 estimated to be captured and stored between IAMs (Figure 18), with some IAMs estimating as little as 5 billion tonnes CO_2 sequestered per year, up to 20 billion tonnes with other IAMs.

For non-CO_2 GHGs, which are the specific focus for FOCI, there is more variation in emissions for the same SSPs coming out of the IAMs. For methane, in SSP1-1.9, global methane emissions vary between 75 million tonnes to 225 million tonnes in 2050, i.e. this SSP includes a reduction of between 32% or 73% compared to current methane emission levels. This implies very different levels of implementation of policies and measures to reduce methane from agriculture, waste, and fossil fuel production to reduce methane for different representations of the same SSP. For other non-CO_2 GHGs, there is similar variation in the emissions of nitrous oxide across different IAMs for the same SSPs. For black carbon and cooling substances like SO_2, there is more consistency in the emission reductions within each SSP for each IAM (Figures 18-24).

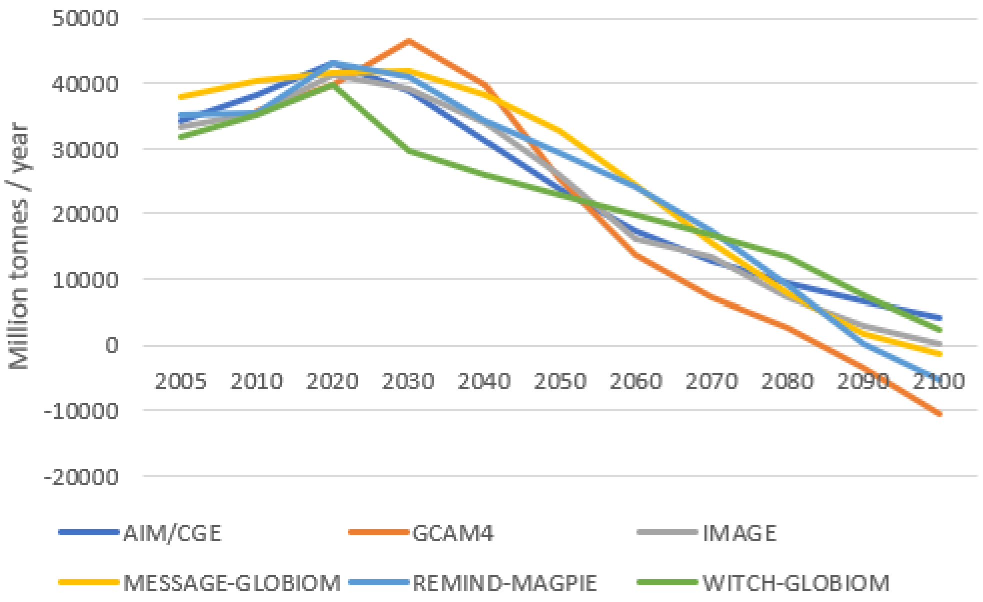

Figure 17: CO_2 emissions in SSP2-3.4 estimated using different Integrated Assessment Models

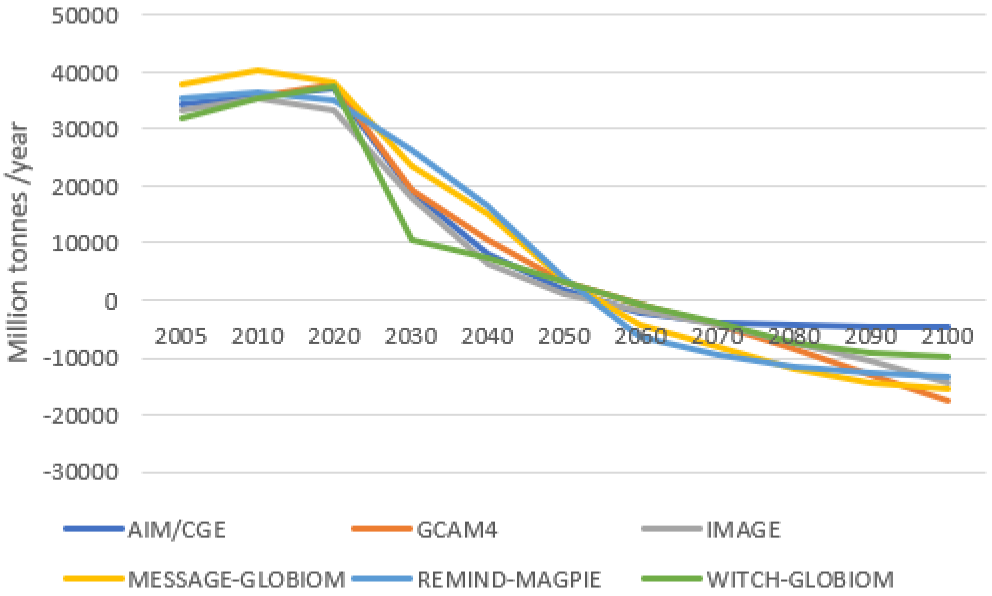

Figure 18: CO_2 emissions in SSP1-1.9 estimated using different Integrated Assessment Models

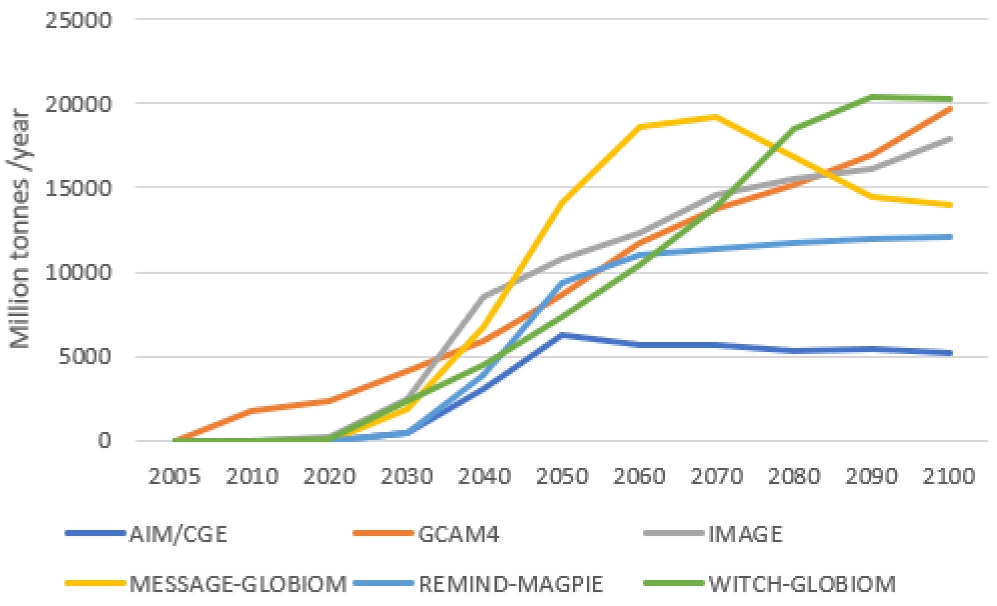

Figure 18: CO_2 emissions captured and stored in SSP1-1.9 estimated using different Integrated Assessment Models

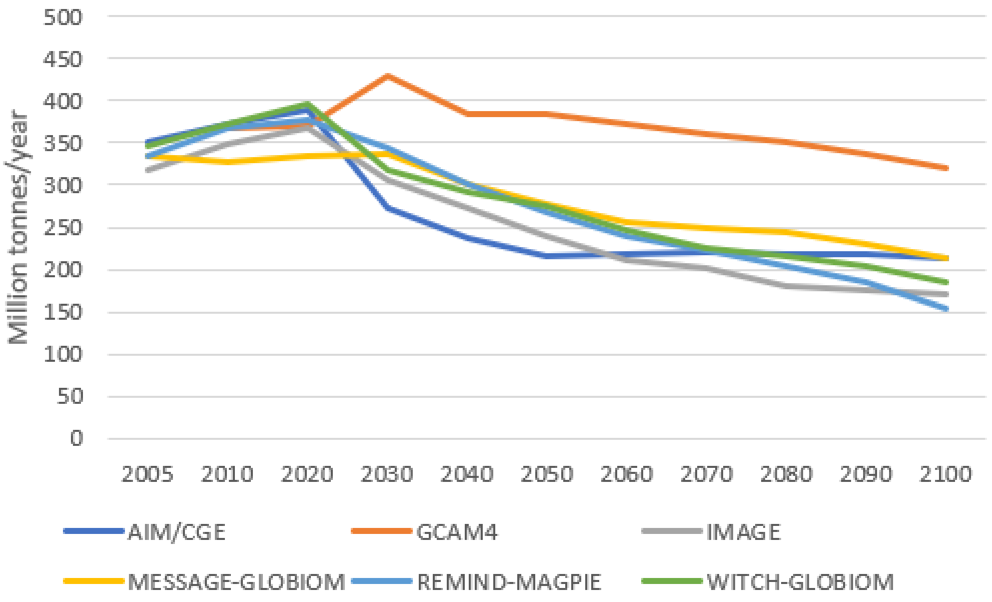

Figure 19: CH_4 emissions in SSP2-3.4 estimated using different Integrated Assessment Models

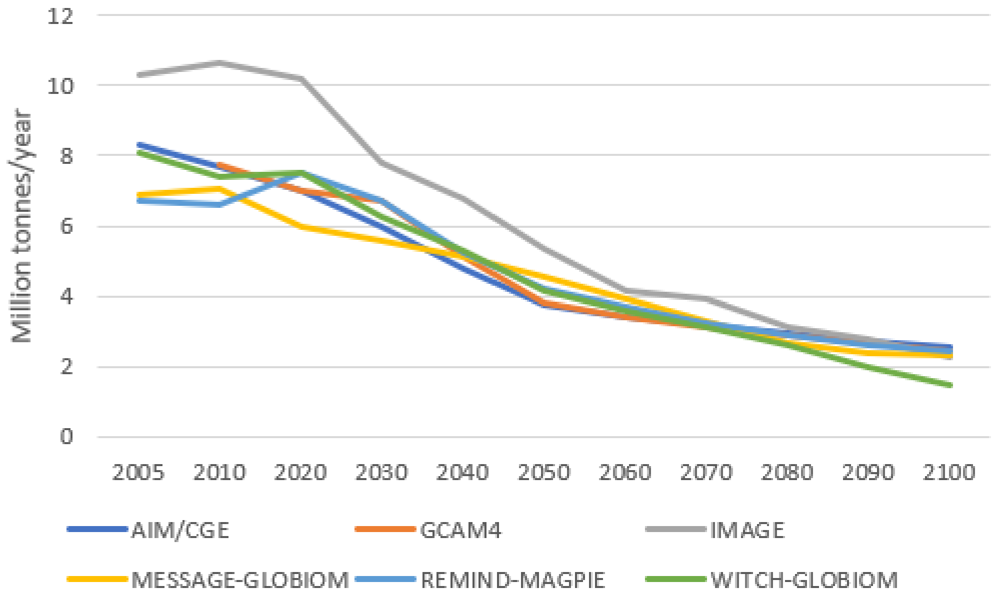

Figure 20: BC emissions in SSP2-3.4 estimated using different Integrated Assessment Models

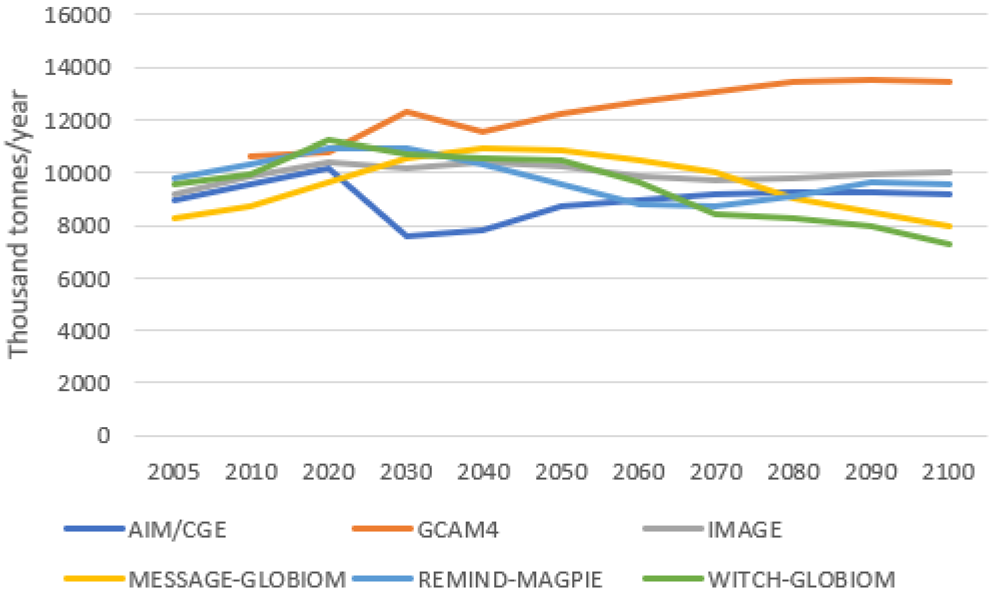

Figure 21: N_2O emissions in SSP2-3.4 estimated using different Integrated Assessment Models

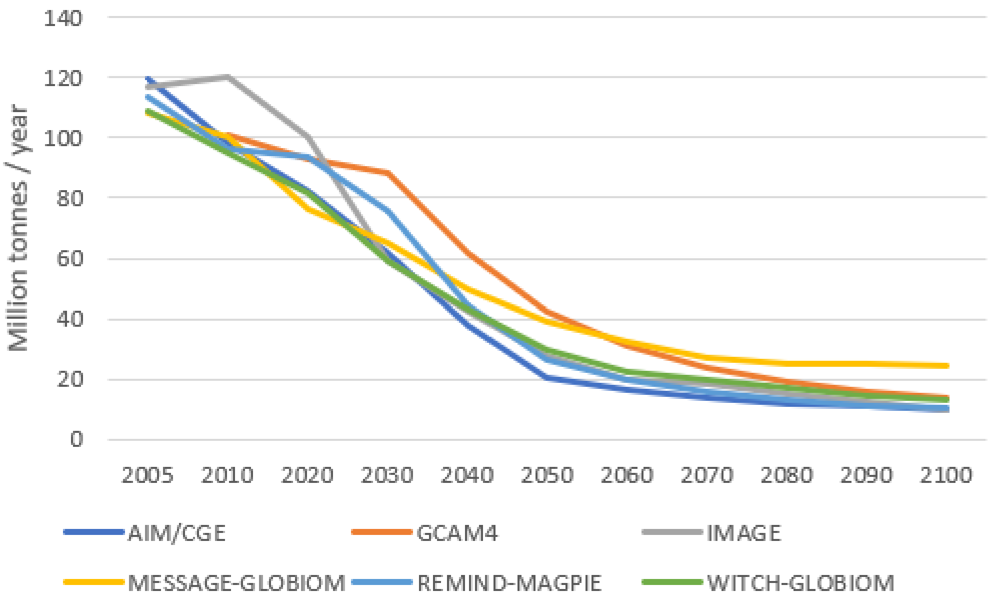

Figure 22: SO_2 emissions in SSP2-3.4 estimated using different Integrated Assessment Models

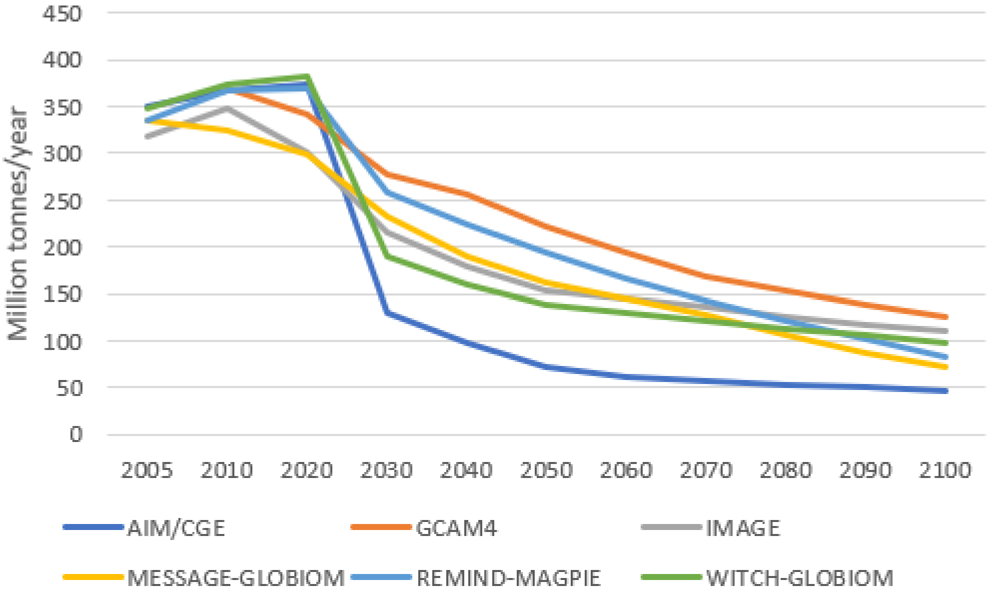

Figure 23: CH_4 emissions in SSP1-1.9 estimated using different Integrated Assessment Models

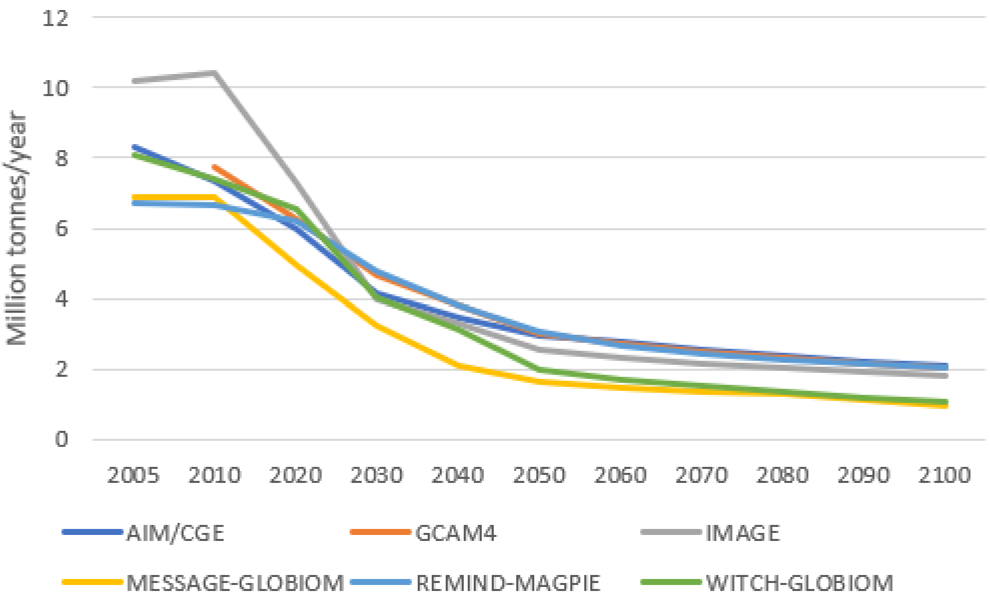

Figure 24: BC emissions in SSP1-1.9 estimated using different Integrated Assessment Models

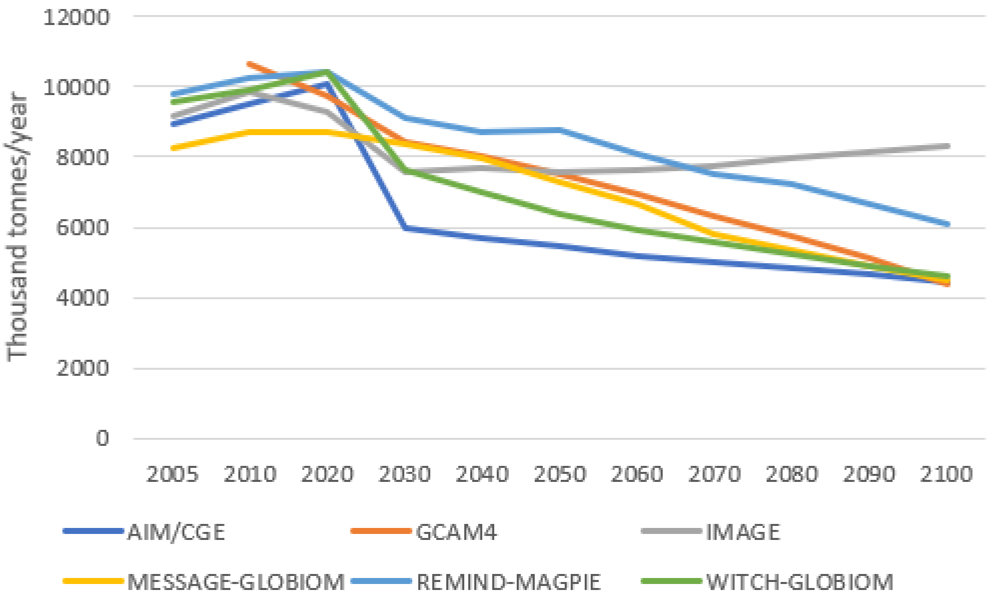

Figure 25: N_2O emissions in SSP1-1.9 estimated using different Integrated Assessment Models

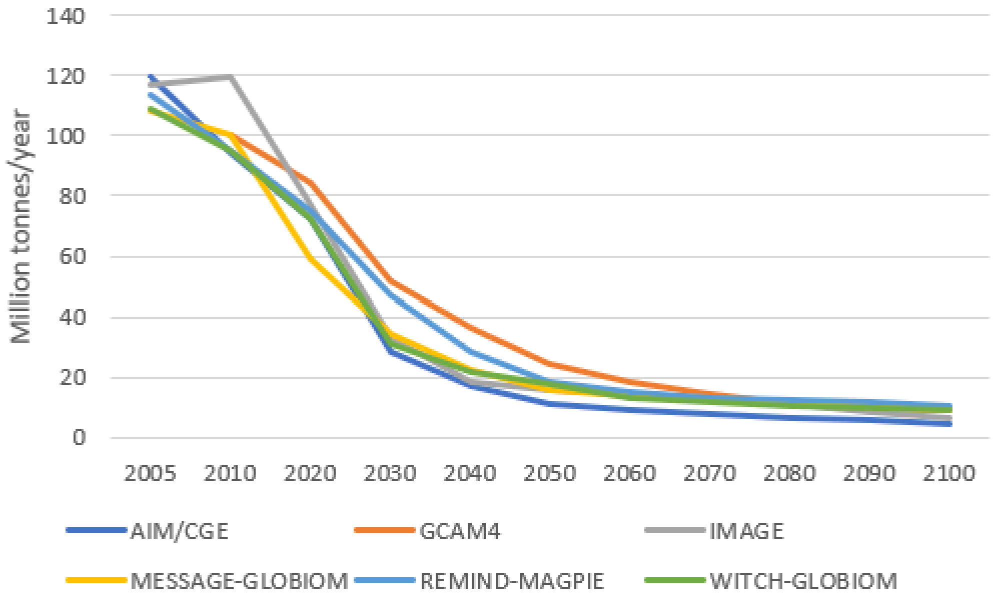

Figure 26: SO_2 emissions in SSP1-1.9 estimated using different Integrated Assessment Models

6. CONCLUSIONS AND RECOMMENDATIONS

The Shared Socioeconomic Pathway are the dominant framing of scenarios to explore future climate change and mitigation, and have been extensively used, e.g., within IPCC Assessment Reports. However, the multiple models used to translate SSP narratives into quantitative emission/forcing/warming scenarios means that each SSP has been represented in multiple quantitative scenarios. As shown here, these multiple scenarios substantially differ not only on impacts, such as GHG emissions and forcing, but in what the same SSP narrative implies for societal development, as manifested in energy, agriculture, and land use statistics. Therefore, while the SSPs were designed to provide a set of contrasting development narratives onto which emission projections could be developed, the development of these emission projections has substantially complicated that design by labelling multiple scenarios with different energy and agriculture development pathways as the same SSP.

Within FOCI, SSP emission scenarios will be used, alongside new independent global and regional emission scenarios developed within FOCI. It is recommended that, when selecting SSP scenarios, they are selected with an understanding not only of the emissions represented by the SSP, but the underlying societal transitions represented within the particular IAM model used to represent the SSP. For example, the global agriculture emissions estimated in the FOCI WP5 baseline scenario, assuming that diets remain constant and population grows according to UN World Population Prospects estimates a 22% increase in methane emissions from agriculture by 2050 compared to 2020 levels. When compared to selected SSP scenarios, the methane emissions from different IAMs for different SSPs contrast with the bottom-up FOCI WP5 inventory. Firstly, in FOCI WP5, using historic data, global methane emissions from agriculture were estimated to be 155 million tonnes in 2020. For the majority of SSPs, where 2020 methane emissions are projected, 155 million tonnes is at the low end of estimates for the majority of SSPs, with the exception of SSP1-1.9 where methane emissions range from 128-206 million tonnes. Therefore, for the majority of SSPs, agricultural methane emissions are already lower in 2020 than the majority of IAMs predicted. For SSP1-1.9, projected emissions in 2030 include the FOCI WP5 2030 emission estimates in its range, but 2050 emission estimates for SSP1-1.9 are too low and do not encompass the 189 million tonnes estimated in FOCI WP5. SSPs that imply a higher level of warming, such as SSP2-3.4, and SSP2-4.5 are more consistent with the range of 2030 and 2050 projected agricultural methane emission estimates. These SSPs, taken from the appropriate IAMs, may therefore be the most appropriate to utilise alongside the global emission scenarios developed in WP5. For the regional emission scenarios being developed for Latin America and Africa, similar comparisons will be made to determine how emissions fit with different representations of SSPs.

Table 1: Agricultural emissions estimated in FOCI WP5 and in different SSPs (units: million metric tonnes)

Variable	Scenario	2020	2030	2050
CH_4 emissions	FOCI WP5 Baseline scenario	155.2	163.5	188.6
CH_4 emissions	SSP1-1.9 (Range in IAM model estimates)	128-206	93-188	55-167
CH_4 emissions	SSP2-3.4 (Range in IAM model estimates)	154-201	141-220	133-246
CH_4 emissions	SSP2-4.5 (Range in IAM model estimates)	155-201	156-220	142-250
CH_4 emissions	SSP1-2.6 (Range in IAM model estimates)	153-206	113-201	92-193
CH_4 emissions	SSP3-6.0 (Range in IAM model estimates)	154-215	161-244	169-240

7. REFERENCES

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