

Reply to reviewers

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1 Reply to reviewer 1

Many thanks for your time and encouraging feedback. As discussed in the personal note, we appreciate that more work is needed on several fronts, but present this as documentation for an ongoing project, some results of which have already been accepted for publication.

1.1 Major issues

1.1.1 Uncertainty in pandemic parameters

The main criticism, that we did not present a variety of cases for the initial lockdown impacts, is well-made. We will improve the paper by including an additional ‘4-year blip’ scenario (with one year interpolating back to baseline afterwards). This will provide a reasonable upper bound to the timeframe of the direct impact. Comparing projected and recent historical emissions, we see that the 2-year blip assumed the emissions reductions would persist for longer than they have, but would not seek to add a faster-decaying pathway because the results of simulations for the MIP already performed indicate that it is hard to detect any long-term impact from the 2-year blip already, so adding more pathways between this and the baseline would likely just waste computer time.

While it is possible that some countries will maintain lockdowns for more than 5 years, this scenario would be better handled by a dedicated IAM team to produce a model that accounts for the length of time for vaccines to roll out in different regions. We can simplistically justify a 4-5 year lockdown (although won’t in the paper itself) as a crude upper bound considering that almost all developed nations (including China) and the world on average are already vaccinating their population at over 0.06% per day, which gives around 4 years to give at least one injection to everyone. See <https://ourworldindata.org/covid-vaccinations> for the latest. We expect some acceleration in rollout as more vaccines are coming online and production increases. These vaccines should provide at least partial protection against different strains, and rolling out booster shots should not have a notable impact on emissions. More radical situations where the virus mutates and retains high lethality even after vaccination, leading to an essentially indefinite lockdown, both seem unlikely given recent progress and

would probably see some sectors of the economy go back to baseline anyway, even if vehicle use and travel remained suppressed. We have change the text to emphasise that we do not attempt to model the time for the virus to be eliminated/habituated to, but simply for lockdowns to stop interfering with productivity.

This additional scenario obviously involves lots of text being altered across the document, we will not attempt to list all of the changes here.

1.1.2 Green recovery self-consistency

In response to the unclarity over the self-consistency of the SSP-nature of the various green scenarios, we have expanded the table documenting the origin of the scenarios. This was nominally covered in Forster 2020 but in practice a lot of details were omitted. The table detailing the origin of the scenarios has been significantly expanded and citations to the full calculation and the methods used to calculate the values have been added. As detailed in the informal response, you are correct that the strong green recovery involves transitioning to an SSP1-like world. The other scenarios are all based on variation between SSP2 worlds.

The primary motivation of this new set of scenarios is to allow resolution of the impact of a step-change in political behaviour now, rather than gradual trends from the point when the scenarios were constructed. A description of this has been added to the introduction: ‘This aims to establish the scope of changes in climate results to be expected from the direct impacts of lockdown, and the potential impact of changes to investment structure resulting from the recovery packages.’

1.2 Minor issues

Spelling mistakes have been corrected.

- ‘line 54: using SSP2-RCP45 is not self-evidently middle-of-the road. The authors should provide more context on why this scenario is in line with current policy’: We have expanded the section justifying our choice with additional citation as follows: ‘This amount of forcing is consistent with the global level of warming implied by countries’ current NDC pledges (citing ClimateActionTracker) and has most recently projected values closest to the measured emissions (citing Strandsbjerg 2021).’
- ‘line 100 - ”interpolation between the effects of lockdown and the baseline behaviour, so does not need to be interpolated” - sentence is confusing, rewrite.’: This has been rewritten into two sentences: ‘The year 2022 is defined as exactly equaling the value interpolated, month-for-month, between the effects of lockdown and the baseline behaviour. This is the normal default infilling method of climate simulators so explicit values are not usually needed here.’

2 Reply to reviewer 2

Many thanks for your time and your warm review. We will address your minor comments as follows:

1. ‘There are too many typos in the document’: There are indeed, for which we apologise. This paper was caught up in the AR6 deadline and some segments were more reviewed than others! These typos have been corrected.
2. ‘Line 32-34: When I read that I was actually quite excited to review this paper. I feel this paper is far from such a demonstration.’: It doesn’t introduce any fundamentally new nowcasting methods, but the actual data used is updated and the processing for aviation data in recent versions is significantly different to the original. We have changed the sentence to make clear that it is a new use of nowcasting techniques rather than a new demonstration: ‘This paper uses data from near-simultaneous “now-casting” methods based on open-access data’
3. ‘Line 46: this list of species also include ozone precursors’: changed to ‘aerosols and aerosol and ozone pre-cursors’
4. ‘Lines 87-88: what is the justification for that choice?’: (referring to AFOLU treatment - reduced in Forster 2020 but not for emissions fields here.) We don’t really have specific information for AFOLU in any of the data. Agricultural productivity should not be significantly affected by lockdown, so we don’t expect emissions to change much either. While it was hoped that deforestation would reduce in line with mobility, this doesn’t seem to be true - if anything the opposite, although it varies by country. We now cite papers to explain this. ‘This is due to the finding that global deforestation has not slowed down due to lockdown (cite Saavedra2020, Daly2020), and we expect that that agricultural output will remain broadly consistent with pre-lockdown levels.’
5. ‘Where is the information necessary for interpolation at the daily data? To which sectors does this apply? Is there a consideration of the weekend effect? Who are “certain groups”’: No additional information is needed to do daily data other than for aviation. In activity data the weekend effect is removed in most source data. In practice the daily data (with weekday effects removed) has only been used so far by us for making diagrams and animations, so we have removed the reference to it here. Weekly data has been used in one study, now published and cited here: ‘data with every year from 2015 to 2025 is available, as is weekly data for 2020 used by (cite Gettelman2020)’
6. ‘ “We will assume that no changes occurred to these sectors” What is the rationale for this assumption?’: As with AFOLU emissions, we expect there to be a general economic rampdown in the medium term, but no acute

relationship between the production of solvents/waste and the degree of lockdown, as these are protected industries. And similar to forestry, the lockdown has also reduced government inspection and oversight of emissions, with a possible positive effect. The net impact of this on emissions is unclear.

7. ‘“This is assumed to be globally uniform and the same across all altitudes”. Why? Don’t you have all the necessary information from the flight tracking?’: No, not for free. The open-source flight tracking now provides more data than last year for free, meaning that the correction used for 7-day data can be imposed for all situations, but still not regionally disaggregated data/density maps as far as I know.
8. ‘Which “one project”’: Gettelman 2020, now published as mentioned above.
9. ‘Line 147: word missing ”This produces a rather than actual daily factor”. What is ”everything” in ”hence weekly averages are taken of everything”?’: The missing word was weekly-averaged. We debated using ‘pseudo-daily’ for cases where we report the data every day but using weekly averages, but have not done so. This now reads: ‘This produces a weekly-averaged rather than actual daily factor, since it is not possible to decouple seasonal/holiday and weekday effects. Using weekly averages both removes the weekday effects and reduces the intrinsic variability in the data.’
10. ‘Line 155: Is it COVID-MIP or Covid-MIP? Be consistent.’ It should now be CovidMIP always - corrected in several places.
11. ‘Line 206: correct spelling of COVID’: indeed, corrected.
12. ‘Line 199-201: what is the reason for this sentence. It seems relatively uninformative (why do we need to learn about nudging here?).’: It’s quite a useful technique here and we encourage teams to use it where possible. We’ll change ‘allowed’ to ‘preferred’ to make this clearer.
13. ‘Sections 7.1 and 7.2 might be more useful presented in a table.’: good suggestion! We will also include the experiments from 7.3 in this table for one big table of experiments.
14. ‘Line 237: what is the rationale for picking “strong green” as the highest priority?’: It provides the strongest signal and therefore is most likely to have a robustly detectable result. This is now explained. ‘We place the highest priority (tier 1) on the strong green stimulus recovery as it will likely have the highest signal.’
15. ‘line 257: CO is not an aerosol precursor, but it is an ozone precursor. So there is an inconsistency in the protocol if ozone is kept as in SSP2.45’: it’s consistent with the protocol in DAMIP, which does the same thing. This allows a division between the impact of aerosols directly and the

impact of ozone. The nomenclature for experiments is a little confusing but hopefully people will follow.

16. ‘Line 284: Do you mean the diagnostics as in the ScenarioMIP SSP245 simulations?’: correct. Added ‘, reported for the ScenarioMIP.’
17. ‘Section 7.4 is rather un-informative. What is the purpose of listing a few variables of interest? This could be replaced by a list of interesting angles that the authors feel justify the need for a COVID-mip.’: We want to create an impression of where we are going with this investigation, but you’re right that some more teleological comments would be useful here. We have added: ‘This [PM2.5 conc] will allow us to estimate the global impact of lockdown on health effects.’ and ‘We expect this MIP will allow us to estimate the continued relevance of climate projections that do not include the effects of lockdown. If results significantly deviate from baseline projections, then the continued relevance of outdated simulations is questioned; if results are broadly similar, old projections can be used with more confidence.’