Submission to CCC on emissions metrics and related issues.

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The advice and evidence reports from the Climate Change Commission contain a number of errors and misjudgements on metrics, especially recently developed "warming-equivalent" metrics such as GWP* (Cain et al., 2019), CGTP (Collins et al., 2019) and CO_2-forcing-equivalent emissions (Jenkins et al., 2018). The CCC focusses on GWP* since that is the warming-equivalent metric that has been most extensively discussed in New Zealand, but their points raised, and our responses, would apply equally to these other metrics, or indeed to any metric that sets out to equate CO_2 and methane emissions in terms of warming impact over a broad range of timescales. Here are some excerpts, and replies.

However, GWP is less useful in other accounting, reporting and domestic policy applications, because:*

- *When applied to individual emitters rather than global emissions, its use would inherently benefit those who start with higher emissions, i.e., it would have a grandparenting effect.*
- *It treats changes in the flow of methane emissions as permanent, whereas methane emissions fluctuate from year-to-year, even if there is a long-term trend.*

Neither of these points is correct.

Cumulative warming-equivalent emissions calculated using GWP* affect global temperature in exactly the same way as cumulative CO_2 emissions do - i.e. they determine the contribution of those emissions to human-induced warming from the date you start counting. Neither cumulative GWP* emissions nor cumulative CO_2 emissions reflects warming from before the time-series starts. Climate policy has traditionally focussed on CO_2 emission rates, which determine countries' contributions to the current rate of warming: this benefits those who start with higher emissions, by implicitly ignoring the contribution of their historical emissions to the current level of warming. In general, people don't claim that a focus on CO_2 emissions since 1990 effectively grandparents warming before 1990, but in fact it works exactly the same as GWP*.

This has confused some people, mainly in Europe (e.g. Rogelj and Schleussner, 2019), who have mistakenly formed the belief that GWP* inherently grand-parents warming from earlier times. Cumulative CO_2 and cumulative GWP* emissions say nothing about warming from before the analysis begins. If New Zealand were to decide to undo the warming caused by historical CO_2 emissions using CO_2, then the only option would be to actively remove an equivalent quantity of CO_2 from the atmosphere through reforestation. If New Zealand were to decide to undo the warming

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caused by historical methane emissions using methane, then much of that could be delivered by reducing methane emissions.

It is sometimes argued that this is misleading because it is easier to reduce methane emissions than it is to actively remove CO_2 from the atmosphere. This, however, completely misses the important role of greenhouse gas metrics in identifying the most cost-effective mitigation opportunities. It has also been argued that continuing to emit methane represents an active decision, while failing to remove CO_2 does not. Again, this is predicated on the misconception that all climate policy consists of a series of decisions to emit discrete tonnes of greenhouse gases when it clearly does not. Some decisions (like whether to fly to Hawaii on holiday) result in a one-off emission; most (like whether to invest in transport electrification) have a more or less permanent impact on emission rates.

GWP* provides a basis for doing comparing these efforts, while GWP100 does not: the IPCC has long recognised that cumulative GWP100 emissions comprising a mix of CO_2 and methane over any period are entirely meaningless.

Regarding the second point, there is again a direct analogy with cumulative CO_2 emissions: planting a tree is often regarded as removing CO_2 from the atmosphere, but of course that removal can be reversed if the tree is cut down. Reducing the flow of methane emissions to the atmosphere has a similar impact on global temperature, but can likewise be reversed. "Net zero" as an emissions goal gets its force – its only force – from the assumption that net zero CO_2 is a permanent and enduring state, because only if this is achieved is warming halted (and hence remains "well below" a given temperature level). This embedded assumption does not render the idea of cumulative emissions "less useful in accounting, reporting and domestic policy applications."

"*For example, two emitters with constant, ongoing emissions of 1 tonne and 100 tonnes of methane respectively would both be assessed as having a CO_2e warming effect of zero under GWP*, even though the contribution to warming of the second is 100 times that of the former*."

The CCC appears to be relying on a definition of GWP* that is three years out of date, which is surprising because GWP* was updated (Cain et al., 2019) to address precisely this point in response to concerns about the impact of constant methane emissions raised by, among others, the NZAGGRC. For constant methane emissions, GWP* assigns a value of 7/tCO_2 per year for 1 tonne CH_4 per year, and 700 tonnes/CO_2 per year for 100 tonnes of CH_4 per year (Cain et al., 2019). This accurately reflects their on-going contribution to warming, unlike the Kyoto-era GWP100 metric. There is a similarity with net zero CO_2 emissions and zero CO_2 warming-equivalent emissions. Achieving net zero emissions tells you temperature will be stabilised at that point, but not what temperature it stabilises at. The temperature depends on the past emissions of CO_2. Achieving zero CO_2-warming-equivalent emissions of methane tells you the same thing.

"*If GWP* were used in domestic policy or to determine emission reduction targets on a country-by-country basis, it would entitle those with higher methane emissions initially to keep emitting more than those starting from a lower point*."

Incorrect again. As with cumulative CO_2, it depends on the start date. Brazil has long argued that historical CO_2 emissions ought to be a strong factor in conversations about climate justice because

these determine a country's historical contribution to warming. GWP* simply generalises this point to allow us, cogently, to include shorter-lived GHGs. (This is not possible with the GWP100 metric.)

Developed countries, including the EU and New Zealand, have long been very hesitant to accept Brazil's point. But they appear to want to create an exception for New Zealand's methane contribution. On that very specific issue, there is concern that past warming may not be factored in, and that this may create inequalities. But what's the intellectual case for worrying about past warming from CH_4 but not from CO_2, thereby giving CO_2 a free pass?

Interestingly, the framing of climate policy as a "race to net zero" can be interpreted in just the same that the CCC choose to interpret GWP* here. To focus solely on emissions reductions from some baseline year, thereby ignoring the time-integrated emissions of CO_2 that a country has caused before now is to frame climate change in such a way that previous warming contributions are missing from the picture. This is grand-parenting in exactly the same way that Rogelj and Schleussner use the term in their 2019 paper

Landowners making decisions about increasing or decreasing their production, and consequently their methane emissions, do not make their decisions in perpetuity, but will adjust their activity according to the economic circumstances at the time. This will make the comparison in emissions inaccurate as soon as behaviour changes.

The second sentence is demonstrably not true: GWP* (or other warming-equivalent metrics – CGTP, CO_2-fe etc) remain an accurate way of comparing the temperature impact of methane and CO_2 emissions whether landowners are decreasing their methane emissions gradually (having the same warming impact as zero CO_2 emissions), decreasing them rapidly (having the same warming impact as CO_2 removal by planting trees) or increasing them again (having the same impact as cutting down the trees again and burning them).

Changes to methane emissions that are relatively small under GWP100 are much larger under GWP. This could cause targets to be missed despite a long-term reducing trend and may not send steady policy signals.*

This is because GWP100 misprices the large impact that changes to methane emissions actually have on global temperatures. For example, if a new methane source were introduced (such as a new farm or fracking operation), it would be over 100 years before the impact of those methane emissions was accurately reflected by the nominal CO_2-equivalent emissions calculated under GWP100 associated with that source. The numbers in the following examples suggest that the CCC is applying the GWP* metric to emission changes in a single year. This has only ever been proposed by the metric's critics: the authors, from Allen (2018) onwards, have consistently recommended that emission changes are calculated over 20 years at least.

For example, if a dairy farmer added one cow to their herd in a given year and that cow emitted 100 kg of methane, this would be the equivalent of emitting 250 tCO_2 in that year under GWP, rather than 2.5 tonnes under GWP100. If these emissions were priced, this would incur a one-off liability of $8,750, assuming an emissions price of $35/tonne.*

The actual equivalence, using the formulae in Cain et al (2019), would be 11.2 tonnes CO_2-warming-equivalent over the next 20 years, followed by 0.7 tCO_2-we thereafter, assuming the increase in the

herd size was permanent. This reflects the actual impact of the decision to increase the herd size on global temperatures. Under GWP100 or GWP20, these emissions would be equated with 2.8 tonnes or 8.4 tonnes respectively. So if implemented as recommended by the authors, the impact of the GWP* metric is not nearly as dramatic as the CCC has been led to believe. In fact, adopting GWP* would have a very similar impact to adopting GWP20 with over 90% free allocation based on emissions over the past 20 years: precisely the kind of policy that is widely used without notably destabilising consequences.

That said, no one has actually suggested using GWP* to price and potentially trade emissions in this way: in fact, the metric's authors frequently advocate caution here, noting back in Allen et al (2016) "equating an open-ended commitment to a permanent reduction in an SLCP emission rate with actual avoided emissions of a cumulative pollutant within a commitment period would be a significant policy innovation. Nevertheless, this approximate equivalence may be useful in setting national or corporate climate policy priorities, particularly where decisions involve capital investments committing future emissions". Suggestions for operationalising the split-gas approach in New Zealand have centred on two original and coherent proposals which the Climate Change Commission has ignored: those of the Productivity Commission and the Parliamentary Commissioner for the Environment. These are two-basket approaches, broadly separating cumulative and short-lived climate pollutants. In adopting a two-basket approach, it is helpful to take into consideration the contributions of emissions in the two baskets to global temperature change in setting the relative "size" of the baskets, but it is important to stress that other information, including the cost and feasibility of mitigation and the size of historical contributions to warming to date, can (and, in our view, should) also be taken into account. Knowing how different sectors are contributing to global temperature change does not dictate the policy outcome, but refusing to consider how different sectors are contributing to global temperature change, when the whole point of the policy is the pursuit of a long-term temperature global temperature goal, seems perverse.

GWP100 provides a more stable way of accounting and reporting greenhouse gases and is the metric required for emissions budgets under the Climate Change Response Act. Its use for this purpose is not inaccurate as this does not involve assessing warming impacts.

As a piece of logic this is defective because the conclusion does not follow from the premises. Having accepted that GWP* is much better at simulating temperature responses than is GWP100 (arguably, infinitely better, because GWP100 gets the sign wrong under declining emissions), the report then says that we should ignore this, because estimating budgets doesn't involve assessing warming impacts.

But the budgets are *derived* from warming impacts. The whole point of the Zero Carbon Act was to "create a legal obligation to reduce our climate emissions in this country to keep warming below 1.5 degrees Celsius."[5] To suggest that the relationship between the budgets and warming is incidental shows a lack of awareness of how emissions budgets work. Warming-equivalent emissions allow countries, both individually and collectively, to quantify their contributions to achieving a

[5] James Shaw, to Parliament on the Third Reading of the *Climate Change Response (Zero Carbon) Amendment Bill*, 7 November 2019, available at https://www.parliament.nz/en/pb/hansard-debates/rhr/combined/HansDeb_20191107_20191107_16.

temperature goal, because they actually reflect impact on global temperature. CO2-equivalent emissions based on GWP100 do not.

Alternative lines of reasoning on metrics

Once the errors are corrected, we recommend the Commission rethink its analysis. Here is one alternative line to consider.

Metrics

- What are they and why do we need them?
- The UN Framework Convention requires them to be kept under review in the light of science.
- The GWP100 metric- how it came to be used in the UNFCCC.
- Problem of the misalignment of GWP100 and the warming effect in the case of short-lived gases. Cumulative CO_2-equivalent methane emissions happen, entirely by coincidence, to reflect their warming impact if and only if methane emissions are rising at approximately 1% per year. They completely fail to reflect warming impact as soon as emissions are stabilised or start to fall – a fact only recently recognised in the policy community. Since Paris primarily contains a *temperature* goal and a commitment to reduce emissions, aggregate CO_2-e emissions under GWP100 are not fit-for-purpose for taking stock of progress to this temperature goal, because they cannot accurately chart progress towards this temperature goal under declining emissions. Note that GWP100 is entirely acceptable for reporting purposes, which is the only application on which the UNFCCC has agreed it should be used, provided cumulative and short-lived gases are reported, in consistent CO_2-e terms, separately, as the UNFCCC inventory guidelines stipulate that they should be.
- Is not a major issue for most industrialised countries that don't have significant proportions of methane in their emissions – but it is for New Zealand, and many developing countries.
- Can lead to perverse outcomes, especially where short and long lived gases are in a single basket for trading or otherwise fungible for accounting purposes. New Zealand's two-basket target potentially lessens this risk.

GWP*

- New metric GWP* - essentially an improved way of applying GWP100 to produce warming – equivalent values - solves the misalignment with temperature problem.
- It's widely recognised that the global stocktakes required under Paris will be more accurate under GWP*. But also, any entity's contribution to warming (state, business).
- It is not realistic to expect it to replace GWP100 immediately. Decisions under the Paris Agreement require GWP100 in both inventory and NDC reporting – as does the Zero Carbon Act.
- But these decisions do not permanently resolve the issue, which will become more important over the decades. Note that
    - discussion of 'common metrics continues in the UNFCCC
    - this is reflected in the Paris Agreement decision to allow *supplementary* reporting in alternative metrics

A possible recommendation

- At home: NZ explore the potential uses of GWP* including under the ZCA
- Abroad: continue to engage with other countries within and outside the UNFCCC in the 'common metrics' discussions

Options for New Zealand to consider

a. Status quo - domestic policies under the ZCA, the NDC, inventory all use solely GWP100. (Note that the inventory also contains separate measures of the gases in terms of mass units so different metrics can be applied)
b. Supplementary reporting – NZ reports its NDC additionally in GWP*. Advantages – can accurately estimate NZ's contributions to global temperature; can help socialise warming-equivalent metrics.
c. Legal and reporting distinction: Legal basis for NZ domestic policy is GWP*. Reporting of NDC and inventory is GWP100, supplemented by GWP*
d. Full shift to GWP*.

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