Testimony submitted to the Honolulu Climate Change Commission, 9/28/23

The following are comments on the section referencing 'Aviation' in the 'Draft Tourism and Climate Change Guidance Document'.

I begin by thanking the HCCC for allowing consideration of visitor air transportation global warming emissions in its document on Tourism and Climate Change. Though I pushed obstinately for it's inclusion, I completely understood the rationale that the subject bore State rather than County responsibility. Your graciousness is appreciated.

I learned of the inclusion of aviation emissions in your document only Wednesday and thus will make my remarks brief and confined only to that section.

I wish to begin by referencing the excellent presentation by Dr. Coffman to this Commission in August 2021, two weeks after the release of the 4,000 page IPCC 6th Assessment Report. Both her presentation and the IPCC report are pivotal to my comments. Both sources should be considered authoritative. Dr. Coffman's 15 minute report can be seen here at the 1 hr. 16min. 25sec. mark and is highly instructive.
https://www.facebook.com/watch/live/?ref=watch_permalink&v=1078985326264097

The analysis in the HCCC Draft Guidance Document aviation paragraphs is a mirror of the initial statements of Dr. Coffman in 2021. However the Guidance Document relies on 2019 data whereas Dr. Makena's source is from 2017. There is a significant difference in the data between the two years (reflecting I suppose 2022 legislation requiring additional emissions reporting) but within the context of each year's computations the outcome proportions are similar. The same factors are used for 'visitors to residents' and 'passengers to cargo' ratios. Dr. Coffman computes that in 2017 6.78 MMT CO2 emissions were attributable to Visitors. The Guidance Document arrives at a figure of 9.52 MMT in 2019 attributable to visitors.

As is clear from Dr. Coffman's HCCC presentation the above numbers of 6.78MMT and 9.52MMT reflect almost exclusively the CO2 emissions. Dr. Coffman had concurred with my 2021 analysis that, over and above the CO2 emissions, there are other factors which contribute to Aviation's impact on global warming such as Nitrogen Oxide emissions and water vapor and soot, forming contrails and contrail cirrus cloudiness. I had used the factor for computing these 'Non-CO2' emissions as approximately 1:1 with the CO2 emissions. I had been able to find 8 GHG Aviation emissions calculators on the internet on Carbon Offset websites. There was only one calculator found which did not factor in the 'Non-CO2 emissions' - that of ICAO (International Civil Aviation Organization). Using a trial itinerary I found that the emissions calculator of 'My Climate' Carbon Offset website came closest to the <u>average</u> result of using these eight calculators. The 'My Climate' site used a 1:1 proportion of CO2 to 'non-CO2 emissions' in arriving at a total emissions burden. Thus Dr. Coffman multiplied the 6.78 MMT finding of visitors CO2 aviation emissions by 2 in order to account for the 'Non-CO2' emissions. She arrives at a figure of 13.5 MMT CO2(equivalent) of global warming emissions from visitor air transport in 2017.

This is to be compared with the Hawaii State Greenhouse Gas Inventory designation of Hawaii's 2017 total Net (Including Sinks but excluding Aviation) GHG emissions as 13.33 MMT, suggesting Visitor Air Transport emissions as equal to Hawaii's total <u>net</u> emissions without Aviation.

The draft Guidance Document does not allow for computation of the 'non-CO2' emissions. much as the ICAO Carbon Offset Calculator did not so allow. The seven other internet Carbon Offset Calculators all used factors which averaged (including the ICAO calculator) closest to 'My Climate's factor of 2x the CO2 emission, with which Dr. Coffman had concurred, to arrive at a total CO2(e)

The Guidance Document takes its position of ignoring the 'non-CO2 emissions' with the statements: "Aviation has additional short-lived climate forcers, for example from NOx contributions. There are still few definitive studies in this area and therefore *low confidence* IPCC estimates of additional forcing from processes like contrails (IPCC, 2021). The IPCC AR6

states that: “Overall, cirrus and contrail cirrus warming, as well as NOx-induced ozone increase, induce strong but short-lived warming contributions…(*medium confidence*)… while CO2 both gives a warming effect in the near term and dominates the long term warming impact (*high confidence*).”

The fact is that we may never get to ‘definitive’ in our understanding of these processes but it is sometimes necessary to identify what stands as ‘best science’ in an area of investigation. Yes, there are few definitive studies in this difficult area of ‘non-CO2’ aviation emissions but the IPCC identifies that ‘best science’ in the paper of Lee, et al, (referenced by Dr. Coffman) and though it identifies Lee’s conclusions as *low confidence,* it does not assign the stratum below which is *very low confidence.*

The IPCC summary in the ‘Short Lived Climate Forcers’ section of AR6 confirms the Lee et al. finding of ERF 0.1W/sq.m warming from aviation. Lee had reported “0.101 W/sq.m (5-95% likelihood range of 0.055 - 0.145) with major contributions from contrail cirrus 0.057 W/sq.m), CO2 0.034W/sq.m) and NOx 0.017W/sq.m).” (The ‘*low confidence*’ acknowledgement is primarily a reference to the wide 5-95% confidence interval of 0.55 - 0.145W/sq.m. and variability or uncertainty in the fractional component of the contrail cirrus and NOx.) The contrail cirrus + NOx contribution is twice that of CO2. This reflects IPCC endorsement of Lee’s summation statement in the abstract of his seminal paper, ‘The Contribution of Global Aviation to Anthropogenic Climate Climate Forcing, 2000 to 2018” in the Journal Atmospheric Environment (2021). “CO2-warming-equivalent emissions based on global warming potentials (GWP method) indicate that aviation emissions are currently warming the climate at approximately three times the rate of that associated with aviation CO2 emissions alone.”

Again, the HCCC Guidance Document reports only the CO2.

The IPCC endorses Lee’s conclusion above in the Aviation section of ‘Short Term Climate Forcers’ in AR6: “Our assessment builds on Lee et al. 2020.”, citing his paper 6x in this section with little mention of any other authors. The IPCC states, “Their study (Lee, et al.) consists of an updated comprehensive assessment of aviation climate forcing in terms of RF and ERF based on a large number of studies and the most recent air traffic and fuel use datasets available, new calculations and the normalization of values from published modeling studies and combining the resulting best estimates via a Monte-Carlo analysis.”

So what is the conclusion here? Dr. Coffman assented (possibly concurred) to my assignment of a factor of 2x the CO2 emissions themselves to account for the ‘non-CO2’ emissions from visitor air travel, and we arrived at 13MMT CO2(e) in 2017. If we use the IPCC seemingly endorsed Lee et al. calculations then we would factor at 3x the CO2 and arrive at about 20MMT CO2(e) from visitor air travel.

The Guidance Document calculates 9.52 MMT emissions attributable to visitors in 2019, but if we account for the ‘non-CO2’ emissions by the Keeney and Coffman method of factoring x2 we arrive at a figure of 19MMT and if we use the IPCC/Lee method of factoring x3 we have 28MMT CO2(e) of emissions attributable to air transport of visitors in 2019.

The next problem encountered by the Draft Guidance Document is that it calculates only the legs of any itinerary which depart or arrive in Hawaii and does not count any ‘Connecting Legs’ of that itinerary. A Chicago-LA-Honolulu-LA-Chicago itinerary would have only the LA-Honolulu-LA portion of the flight counting toward the Hawaii visitor’s emissions burden. This is an inescapable problem of using the Hawaii State GHG Inventory as the basis of determining the fuel usage, and thus emissions.

In my earlier paper I had avoided this difficulty by using the Hawaii Tourism Authority’s yearly designation of the numbers of visitors from each of eight global ‘Regions of Origin’. Assignment of a representative airport within that region as the origin airport allows calculation of flight emissions of the shortest itinerary to Hawaii using the selected Aviation Emissions Calculator. Though use of this tool has potential of over-calculation of ‘appropriate’ visitor emissions, for instance the New York traveler who wants to see their brother in LA but then goes on to Hawaii for a few days vacation. Should the emissions from that entire trip be

attributable to Hawaii visitation? Or, consider the European traveling around the world. It might be possible, using advanced tools or hard work, to determine appropriate attribution and make this methodology more accurate. I think however that this 'Regions of Origin' method comes closer to real world emissions attribution of Hawaii visitors than just ignoring any connecting flights in travel here other than the Hawaii leg.

One further consideration complicates the picture even more. Dr. Coffman pointed out that the notion of multiplying the CO2 emissions by factors of 2 or by 3 is simplistic as the 'non-CO2' factor is complex involving incompletely understood variables including temperature and altitude. It is known that these short lived climate forcers acquire greater importance in flight above 9,000 meters. In fact in the German Offset website 'Atmosfair' these 'non-carbon' emissions are only calculated in flight above 9,000 meters. Ninety percent flight time to Hawaii is above this altitude, whereas much aviation to other regional destinations does not reach this altitude. Therefore, it is likely that the real GHG burden of visitor travel to Hawaii is higher than that approximated using the average aviation altitude factors we have used to calculate the 'non-CO2' emissions. The 2x (or 3x) the CO2 factor is only the apex (average) of a bell shaped curve reflecting CO2(e) emissions at varying altitudes.

It is my impression that the complexity of these calculations demand that they are addressed by an investigator with deep understanding of these complexities. It is not satisfactory that the Draft Guidance Document simply characterizes these problems as not sufficiently understood to be included in the computations.

In my correspondence with Dr. Lee, leader of the International Aviation and Climate research group and author of the seminal paper above, he indicated that appropriate consideration of the multiple factors in these calculations requires a high level of familiarity with that complexity. I had asked if his group might consider doing an examination of the emissions from Hawaii visitor air transport. His dense 3 or 4 page reply, filled with technical references, culminated with his recommendation of a group CE Delft in the Netherlands as the best group to approach a satisfactory answer to the complex question that is being asked.

I have communicated with the Aviation emissions specialist at CE Delft and he is quite interested in carefully examining this problem.

I along with 8 others were contacted by Senator Rhoads in June stating that he was going to introduce a Bill into legislature next session to do a study of GHG emissions associated with visitor travel here. He requested information, which I did send, (I also sent him Dr. Lee's letter recommending the CE Delft group as consultant.) After a month or two, he wrote back stating that he had decided against introducing this legislation. I suspect, after I learned last night that the HCCC was including an Aviation section in their Tourism Guidance Document, that Senator Rhoads had spoken to someone associated with the Commission. Learning that the Commission was doing this study, he decided to withdraw his Bill. Please consider asking Senator Rhoads to resume work on his Bill, and perhaps the Commission should abandon the Aviation section in the Guidance Document. Consider advising Senator Rhoads of the value of expertise in this area such as might be commanded by CE Delft working perhaps in conjunction with SOEST or UHERO.

I obviously consider it of much importance that leadership and the public understand the true magnitude of this problem of GHG emissions from air transport of visitors to Hawaii. We are facing existential crisis, not because of lack of science but because of lack of leadership. Hawaii now must assume that role of leadership with the help of science. Please be a part of this process and not an obstacle to it.

Thank you for your consideration,
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