Calculations of climate effects from private luxury jets at Hanscom Field

May 1, 2023

There is considerable confusion about how the global warming effects of private jet travel are computed. This document explains the process. The global warming effects of emissions are the result of heat trapping effects. Carbon dioxide is a well-known source of heat trapping and the result of fossil fuel combustion. However, for private jet travel, there are other effects of contrails, ozone, soot, clouds, and other sources which add to the CO2 effect.

The global warming effect of private jet emissions is expressed in carbon dioxide equivalent or CO2e, which includes both the CO2 contribution and the other effects. The contribution of CO2 is the direct result of burning fuel and is exactly 3.16 kg of CO2 for each kg of jet fuel burned. The other contributors to CO2e are the continuing subject of research, but various studies, including by the IPCC, have determined that the total radiative forcing multiplier is between 2 and 4 times that of CO2 alone. Papers suggest a conservative multiplier of 2X to obtain CO2e from CO2 for high altitude jet aircraft.

Therefore, burning fuel at high altitude in a private jet plane is about twice as bad as would be expected from the carbon dioxide alone.

The global warming contribution of private jet flights can therefore be directly computed from the fuel consumption: 6.3 kg of CO2e for each kg of jet fuel. The contribution of a particular flight could be determined by measuring its fuel use, but this is not practical for a general analysis. Instead, there are generally available tables of fuel use for different aircraft, which describe how much fuel is consumed per hour. These tables are made based on averages across a flight, since fuel use varies during takeoff, cruising, and landing.

The fuel consumption of private jets ranges from 150 gallons per hour (very small Citation CJ3), to 500 gallons per hour (full size Gulfstream), depending on size and range of the airplane. A mixed fleet of private jets can be assumed to have a fuel consumption of 330 gallons per hour, which must be multiplied by 3.79 kg/gallon to get kg of fuel per hour.

The average flight duration from a specific airport could be found by tracking and averaging actual aircraft trips. For Hanscom Field, an average duration of 2.5 hours is a reasonable guess, although additional information could move this number up or down. With this information, the kg of CO2e of the average flight of the average private jet from Hanscom Field is computed at 19,700 kg of CO2e per flight, which is roughly 20 metric tons.

There are today 38,100 jet operations per year at Hanscom Field (including night flights).[1] Half are arrivals, and half are departures, each of which is counted as one operation. The airport enables both of these operations, so we can consider both in the calculations of the effects. The 38,100 operations can be directly calculated to result in 752,000 tons of CO2e per year.

If tripling the airport hangar capacity only caused an increase of 50% in flights, the increase in CO2e would be 376,000 tons, for a total of about 1,129,000 tons per year. If tripling the hangar capacity instead resulted in a doubling of flights, the increase in CO2e would be 752,000 tons, for a total of about 1,505,000 tons of CO2e per year. Absent other information, this provides a reasonable range of the expected impacts.

The number of 1,129,000 tons of CO2e, without context, has very little value in describing the magnitude of the impact. Here are some facts which put it in perspective:

A typical car emits 5 tons per year.

A typical 5kw residential solar array offsets 2 tons per year (Massachusetts)

The total installed solar PV in Concord is 11.2MW offsetting 4,100 tons per year [2]

The Town of Concord MA generates 180,000 Tons from all sources [3]

All of these effects are orders of magnitude smaller than the effect of private jets. For example, a *single* private jet flight creates CO2e (20 tons) comparable to the emissions of two typical homes in a whole year! This leads us to a number of remarkable facts regarding the magnitude of private jets at Hanscom Field. To offset the CO2e of the expected jet traffic at Hanscom field would require:

Removing 226,000 fossil cars from the road

Installing 2,800 megawatts of solar power

Eliminating 100% of emissions from about 6 municipalities near the airfield

Our communities are working hard to undertake significant climate-saving actions, which we had fully expected to reduce global warming. **Unfortunately, our actions will only go towards cancelling a tiny amount of the greenhouse gas emissions of the private luxury jet traffic operating at Hanscom Field.** As one commenter wrote: "How quaint that they drive their Tesla S to the runway—as if that makes up for the carbon output of flying directly from Hanscom to St. Bart or the Super Bowl (true examples)."

These values correspond to the impact including hangar expansion. Two thirds of this impact is already occurring. The new project to triple hangar capacity is conservatively estimated to be responsible for one third, but could result in much more. These estimates may be adjusted up or down if the airport releases additional information.

The potential for low-carbon aviation to mitigate these effects in the long term is currently only theoretical; it is discussed in “Private jets with low climate impact?” on this website.

continued

Note: these calculations were updated on May 1, 2023 to include nighttime operations for 2022, to use a more conservative radiative forcing value of 2.0 instead of 2.2 , and to change the assumed solar capacity factor from 14 to 15%.

1. In 2022 Massport reported 36,800 daytime jet operations at Hanscom Field. Nighttime operations figures for 2022 are not published yet but if prior year numbers of 1300 are assumed, the total is 38,100.

2. The amount of solar to offset a CO2 impact is computed with the following assumptions: Solar capacity factor Massachusetts= 15%; avoided CO2e per kwhr= 0.3kg/kwhr (based on Mass electrical supply)

3. Concord Sustainability Report, Greenhouse gas emissions.