Report on Geographic Scope of Market-based Measures (MBMS)

Analysis of proposed approaches for the coverage of international aviation emissions under a market-based measure

This report is intended to address the ICAO Assembly request to study the possible application of a global MBM scheme to international aviation (per Resolution A37-19). This is a document prepared exclusively for the internal deliberations of ICAO and should be used for no other purpose.

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International Civil Aviation Organization

POTENTIAL APPROACHES

During the consideration of a framework for market-based measures (MBMs), as required by Assembly Resolution A37-19, many MBM design features were considered including "geographic scope", that is, the area of coverage/application of a specific MBM.

Three approaches to geographic scope were defined:

1) national airspace;

2) flight information regions (FIRs); and

3) departing flights.

This report explores the implications of these approaches, including the international aviation emissions covered by each approach. Due to limited availability of data, only a first order assessment of the coverage using 2010 data for scheduled international aviation traffic was possible. The distance flown is based on scheduled flight operations from the 2010 Official Airline Guide (OAG). The data was filtered to consider only international flights and the results were aggregated to determine coverage within the boundaries of States or FIRs, including with and without overflight[1] traffic. Traffic levels are used as a proxy for emissions coverage.

1) NATIONAL AIRSPACE

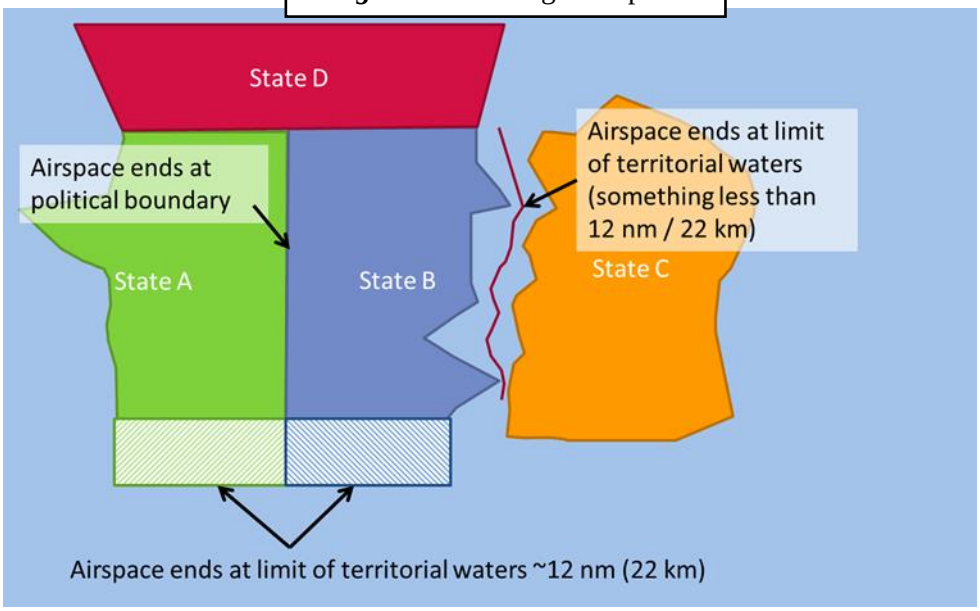
The national airspace, or a sovereign airspace is defined in the *Convention on International Civil Aviation* as follows:

> ***Article 1. Sovereignty***
>
> *The contracting States recognize that every State has complete and exclusive sovereignty over the airspace above its territory.*
>
> ***Article 2. Territory***
>
> *For the purposes of this Convention the territory of a State shall be deemed to be the land areas and territorial waters adjacent thereto under the sovereignty, suzerainty, protection or mandate of such State.*

The diagram (Figure 1) and map (Figure 2) below demonstrate how national boundaries are defined both with and without territorial waters.

[1] Overflight is defined as flights which travel through the sovereign airspace of a State without taking off or landing in that State.

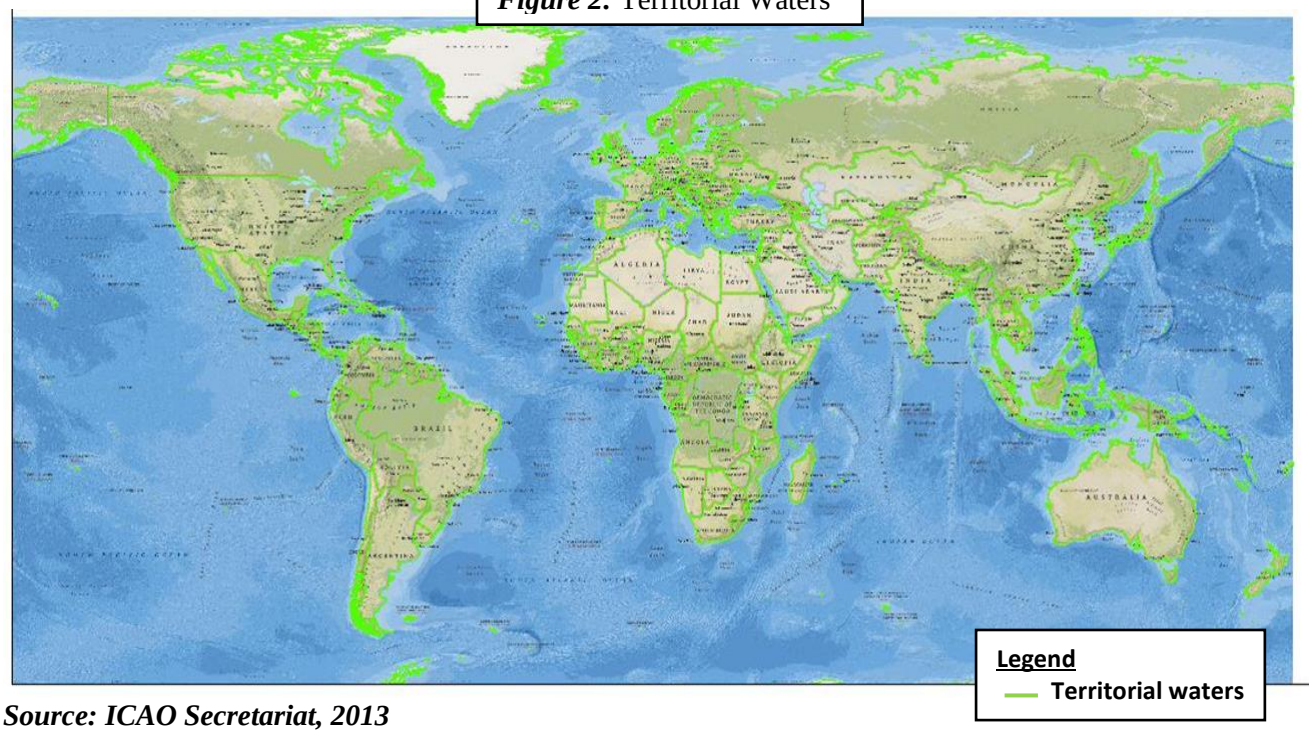
Figure 1: Sovereign Airspace



Source: ICAO Secretariat, 2013

The map below shows national boundaries including territorial waters.

Figure 2: Territorial Waters



Source: ICAO Secretariat, 2013

To calculate the amount of international aviation emissions covered in the national airspace approach, the political boundaries of each State were used. The "territorial waters" portion of the airspace was not included as it was found to cause a minor error to global results. It affected only States bordered by water,

at most, a 12 nautical mile (22 km) underestimation for those States. This amounted to less than 2 minutes of flight time which was within the overall margin of error for the analysis.

A national airspace approach to MBMs would restrict the application of MBMs to the sovereign territory of a State, thereby avoiding most questions related to international jurisdiction (application of measures outside their territory). The size, and the number of States adopting the MBMs, would determine the total amount of CO_2 emissions covered by this approach.

For the purposes of this analysis, it was assumed all States would implement MBMs in their respective sovereign territories. The map in Figure 3 illustrates the coverage for flights arriving and departing in States' airspace based on the distance within the political boundaries of each State. This calculation does not include overflights or any portion of flights outside sovereign airspace.

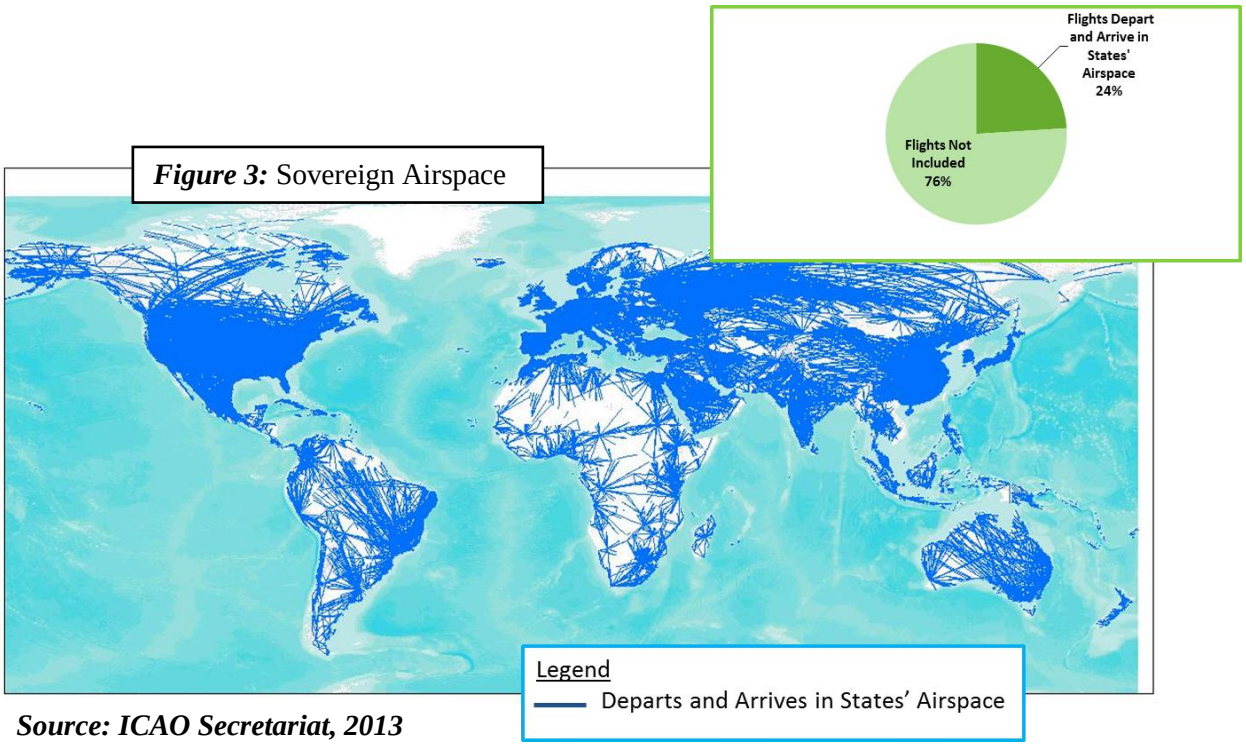


Figure 3: Sovereign Airspace

Source: ICAO Secretariat, 2013

Approximately 24 per cent of international aviation traffic is covered by the national airspace approach. However, if overflights were included in the calculation, an additional 32 per cent of traffic would be captured, resulting in a total coverage of 56 per cent (see Figure 4). To put this in perspective, in 2012, it was estimated that international aviation emitted approximately 500,000,000 tonnes of CO_2. An MBM applied to national airspace, not including overflights, would result in covering a maximum of 1,250,000,000 tonnes of the emissions from international aviation.

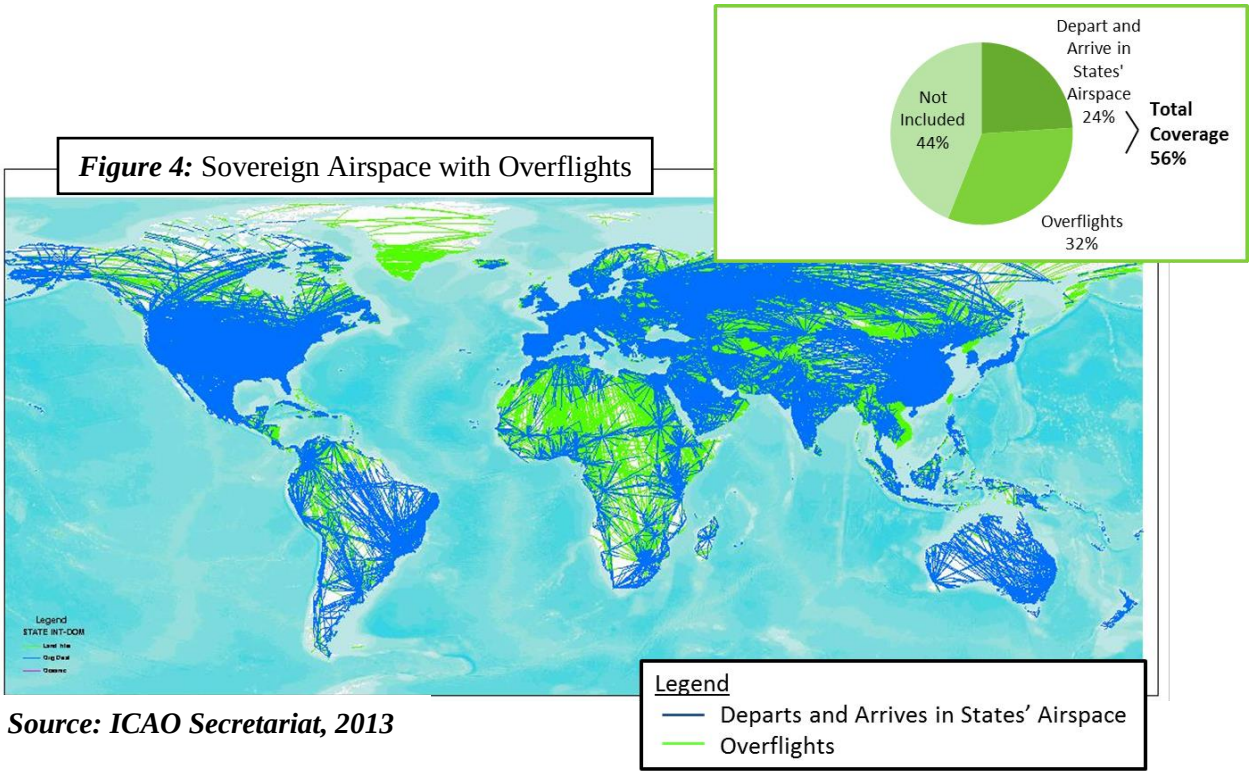


Figure 4: Sovereign Airspace with Overflights

Source: ICAO Secretariat, 2013

In cases where MBMs are not universally adopted, there could be a risk of carbon leakage[2] under a national airspace approach, as air carriers could route flights to avoid stops in airspace where MBMs are implemented. Also, air carriers would be tempted to establish their hubs outside of a State where an MBM is implemented. This could increase the level of emissions as a result of airlines flying additional distances to avoid the cost of MBMs. Theoretically, there would be no double counting of emissions using the national airspace approach.

2) FLIGHT INFORMATION REGIONS (FIRs)

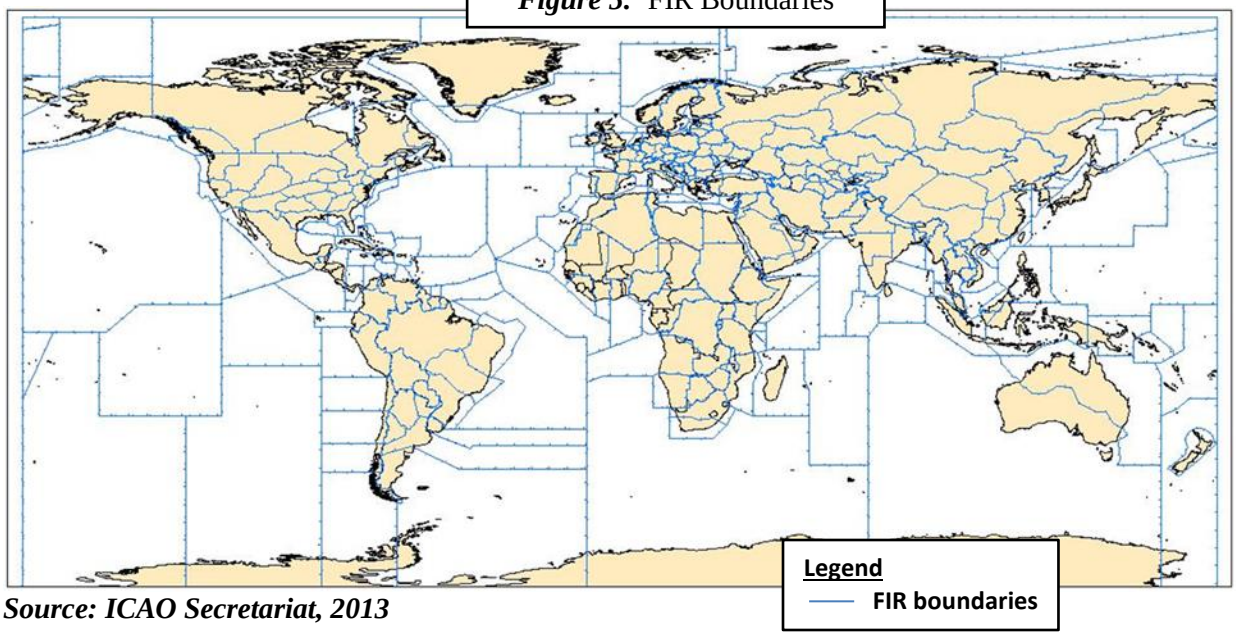
FIRs can extend beyond a national airspace. Annex 2[3] to the Chicago Convention provides the following definition:

> ***Flight information region***. *An airspace of defined dimensions within which flight information service and alerting service are provided.*

Approximately 344 FIRs provide air traffic control services which cover 99 per cent of the world, see Figure 5. The FIR approach considered the geographic scope of MBMs be established within the boundaries of FIRs.

[2] The indirect effect of emission reduction policies or activities that lead to a rise in carbon emissions elsewhere (e.g., fossil fuel substitution leads to a decline in the price of fossil fuels and a rise in their use and a rise in carbon emissions elsewhere).
[3] Annex 2 to the Convention on International Civil Aviation. Rules of the Air. Tenth Edition, July 2005.

Figure 5: FIR Boundaries

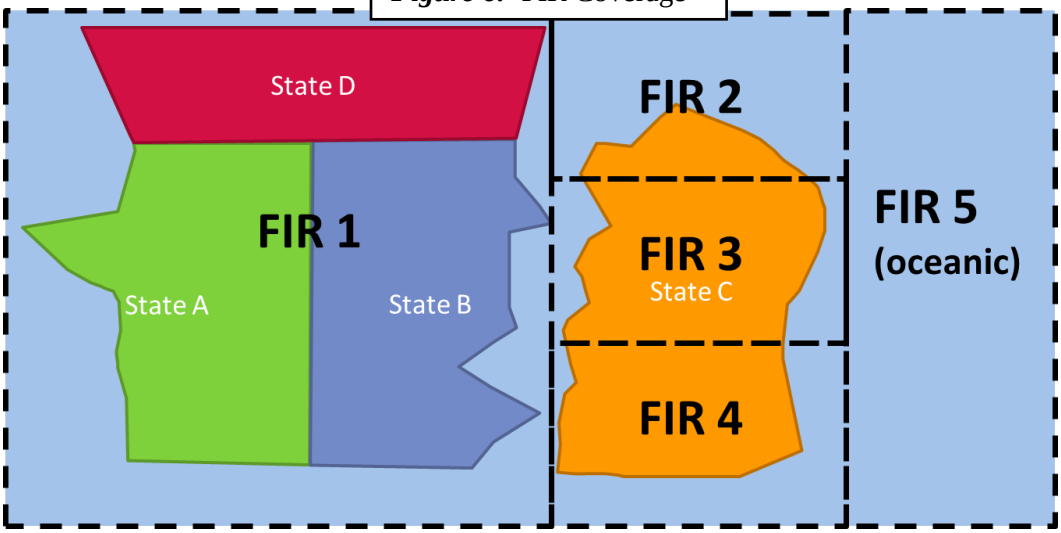


Source: ICAO Secretariat, 2013

FIRs are established on a regional basis and may reflect State (political) boundaries or may cross multiple boundaries. In regions with small States or regions with limited air traffic, FIRs can cover several States. For example, six Central American States established the CENEMAR FIR which makes the provision of air traffic services more efficient. In western and central Africa, where traffic densities are low, States have collaborated to form the ASECNA FIR. Alternatively, a large State may have many FIRs (Russia, China, Brazil, Canada and US, are examples) and States may have separate continental (state-based) and high seas FIRs.

The high seas airspace is subdivided into a limited number of FIRs. The responsibility for providing air traffic services in these "oceanic" areas are delegated by the Council of ICAO to specific service providers. Examples of the possible divisions of FIRs are explained in Figure 6 below.

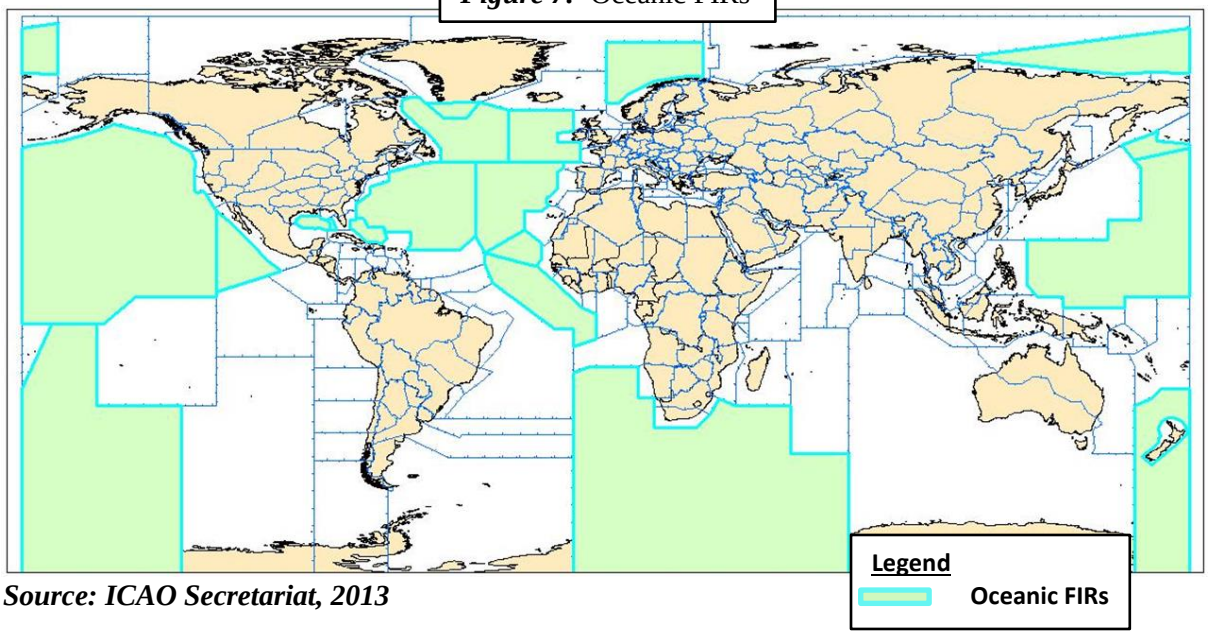
Figure 6: FIR Coverage



Source: ICAO Secretariat, 2013

In order to assess the emissions captured by the FIR approach, distance flown was calculated within the boundaries of each FIR for flights departing and arriving as well as for overflights. FIRs designated as "oceanic" were aggregated separately. For the purposes of assessing CO_2 coverage, it was assumed that all States adopted MBMs. Figure 7 below, with areas shaded in green, illustrates the FIRs considered oceanic.

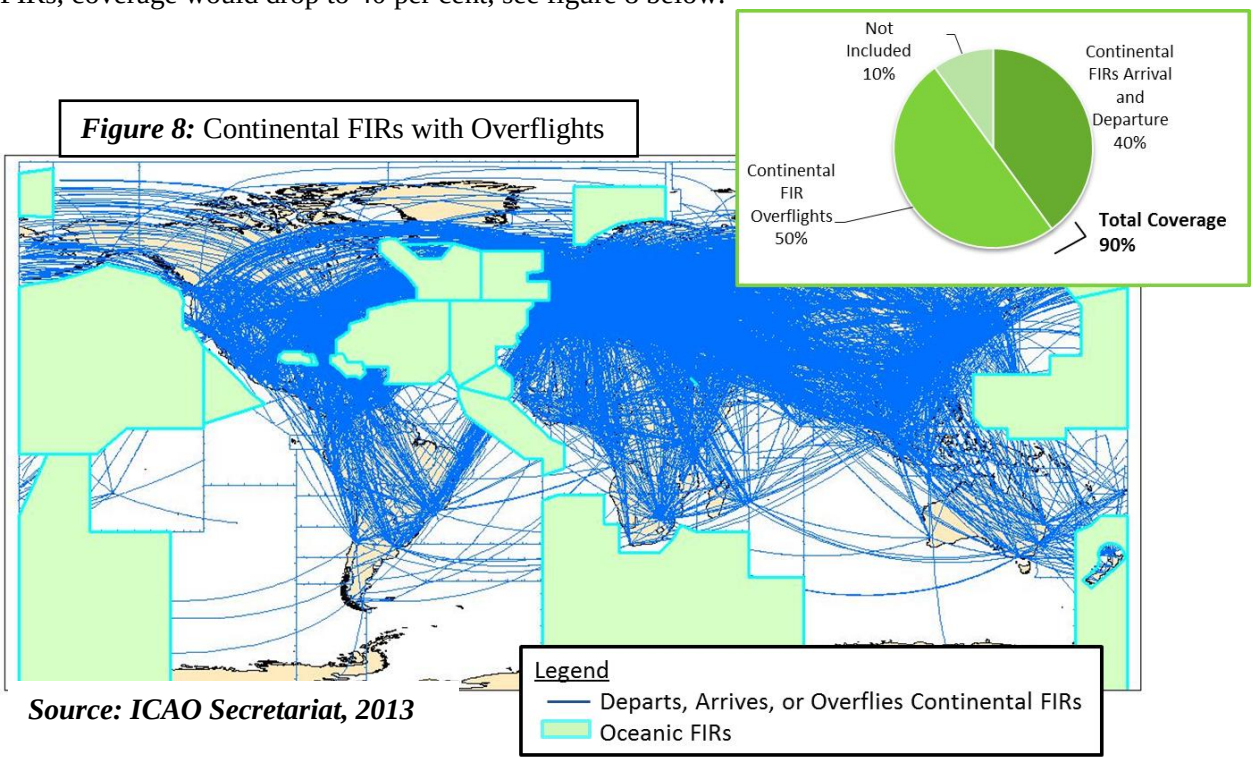
Figure 7: Oceanic FIRs



Source: ICAO Secretariat, 2013

Under a continental FIR approach, where oceanic FIRs over the high seas are excluded, emissions coverage is reduced to 90 per cent of international traffic. If overflights were excluded from continental FIRs, coverage would drop to 40 per cent, see figure 8 below.

Figure 8: Continental FIRs with Overflights



Source: ICAO Secretariat, 2013

As mentioned, a single flight will often cross many FIRs or several State boundaries. Establishing a method to allocate international aviation emissions using an FIR approach could be challenging due to the collaboration required between States and the need to divide and account for emissions between multiple boundaries. As in a national airspace approach, there could also be a risk of carbon leakage with less than 100 per cent coverage as air operators could route flights to avoid FIRs subject to MBMs.

The complexity of FIR coverage was not considered the only challenge to using an FIR approach. There are a number of questions regarding the application of MBMs on the basis of FIRs. States may not have the appropriate legal authority to apply MBMs outside their sovereign territory. FIRs can extend beyond territorial boundaries to the airspace above another State, the high seas or territory of undetermined sovereignty; this adds to the complex of this approach.

3) DEPARTING FLIGHTS

There is no commonly agreed definition of a departing flight in the ICAO literature although one can be found for international flights. For the purposes of discussion, the following definition was proposed:

> *A departing flight is defined as a flight that departs from one State and arrives in another State.*

The departing flight approach would capture all international aviation emissions from a flight from its departing point until its first landing, regardless of the airspace in which emissions occur and regardless of the nationality of the aircraft operator. If all States implemented MBMs, 100 per cent of international aviation emissions would be captured. However, without a global application, the level of emissions captured by the departing flight approach would depend on the international aviation activity within the State adopting an MBM. The share of each of the top ten States in terms of operations (distance) and departures is indicated in Table 1, below.

***Table 1**:* Top 10 States in terms of distance, for international departures.

State of origin	Distance[4] (million Nautical miles)	Share of total international traffic - %
United States	1,601	12.6
United Kingdom	1,019	8.0
Germany	799	6.3
China	690	5.4
France	523	4.1
Spain	427	3.4
United Arab Emirates	406	3.2
Japan	331	2.6
Italy	328	2.6
Canada	319	2.5

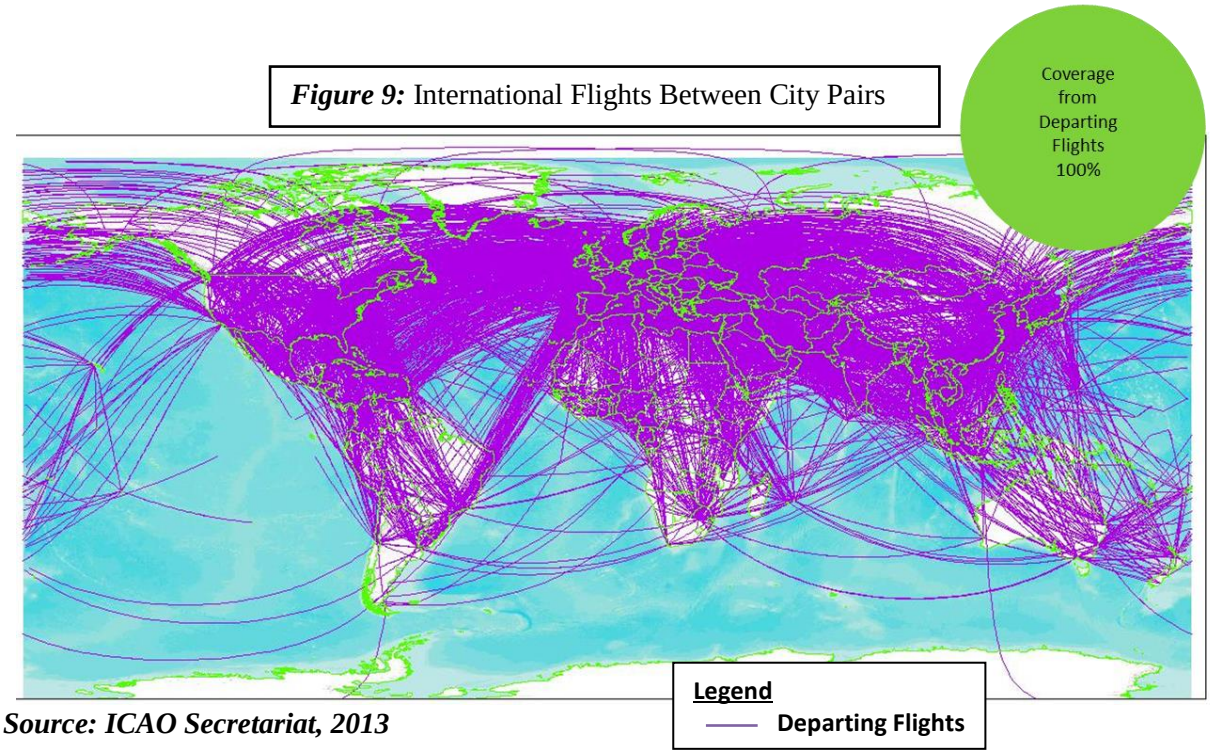
Source: Official Airline Guide (OAG), 2010

As the emissions from departing flights are calculated only up to the first stopover, there is no double counting of emissions for any given city pair. There could be a risk of carbon leakage with less than

[4] Distance covered by all departing flights from within the State, landing outside the State

100 per cent participation as flights may create the same, or more, carbon emissions by being routed to areas where no measures are in place. Figure 9 below shows all international flights between city pairs.

Figure 9: International Flights Between City Pairs



Source: ICAO Secretariat, 2013

SUMMARY

The coverage of emissions by each of the approaches considered in the analysis is summarized in Table 2 below. Where there is less than 100% participation under any of the approaches, there will be a possibility for carbon leakage to result.

Table 2: Summary of Approaches assuming 100% participation of States.

Coverage	**National Airspace**	**Flight Information Regions (FIRs)**	**Departing Flights**
Continental – No Overflights (within State / non-Oceanic FIR)	24%	40%	N/A
Continental – overflights only (within State / non-Oceanic FIR)	32%	50%	N/A
Continental – with overflights (within State / non-Oceanic FIR)	56%	90%	N/A
Oceanic – with overflights	N/A	10%	N/A
Maximum possible	**56%**	**100%**	**100%**

— END —