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TIGER

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Draft Final Scientific Report

Working paper 17

"Europe and European cities in global airflows"

IGEAT-ULB



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## ***Introduction***

In this working paper, we aim to position Europe in the global space of airflows and to describe and understand intra-European dynamics as regards to air connections with the rest of the world. Gateway functions are in general concentrated at both global and European level, resulting in the existence of several gateway airports that concentrate most connections between European cities and the rest of the world. In this paper, we ask whether this concentration has increased in the two last decades and in favour of which European cities. To put these dynamics into perspective, we also propose a comparison with US cities.

### ***1. Description of the data***

The data of the supply in air service for passengers are based on the OAG's databases. Edited monthly, the database describes the regularly scheduled services<sup>1</sup> for the subsequent months, and does so in a completely disaggregated manner. For each flight, among other information, the operating airline, the partner carriers (code sharing), stopovers, frequency and number of seats are indicated in the databases. The service on offer is thus described exhaustively<sup>2</sup>. Our data are based on the situation of January 1991, 1999 and 2008, which can be considered as normal months and normal years. When a city (LUZ) has several airports, the airports have been added up.

Data on air supply do not allow identifying the real traveller's destination. This means that statistics give the total supply in seats or flights between two airports. This is important because of the importance of hub strategies implemented by companies.

### ***2. The position of Europe in air flows***

In 2008, Europe defined by the ESPON area accounts for 46.4% of all airflows when intra-national airflows are excluded. In these flows, intra-European airflows represent 38.7% of all airflows. Indeed, the share of intra-European flows in all European flows is about 83.3% in 2008, a moderate increase since 1991 when this share was 80.9%.

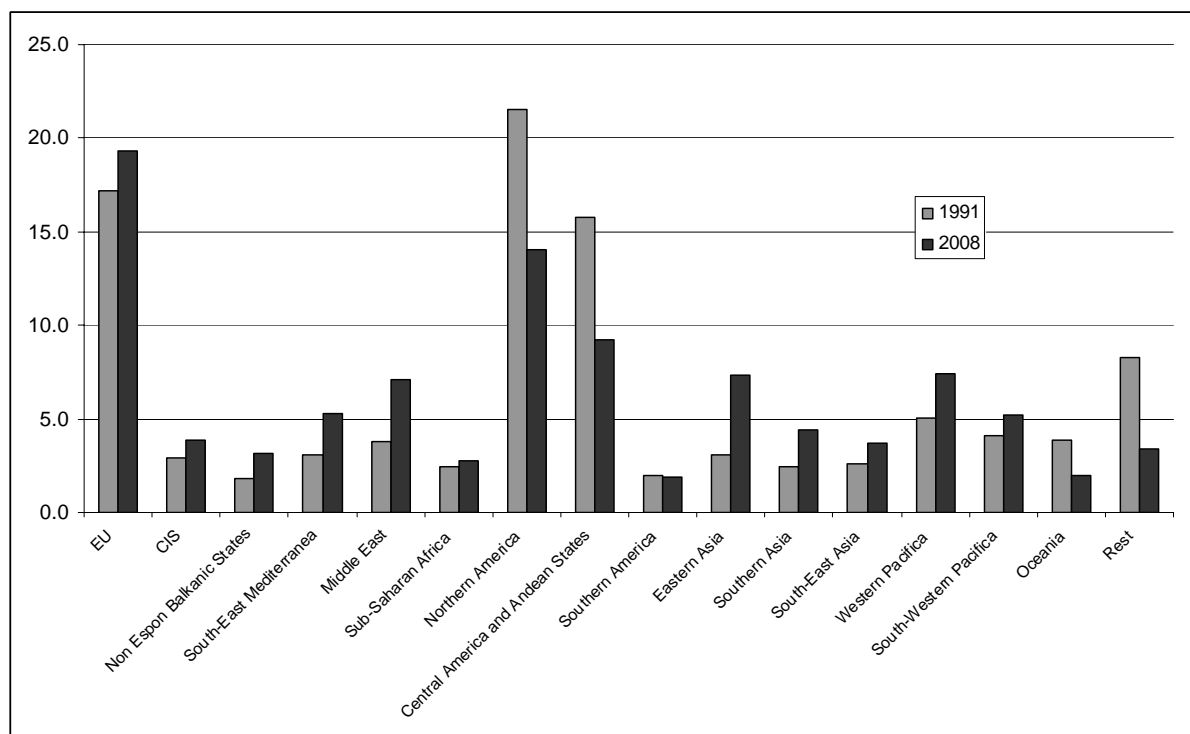
However, there is something artificial to exclude intra-national airflows and not intra-continental airflows, considering that Europe is a totally free airspace. When intra-continental flows are excluded, Europe only accounts for 19.3% of all intercontinental flows in 2008, while it represents around 17% in 1991 (**Figure 1**). In 2008, this is more than Northern America, including Mexico, which represents 14% of all airflows, for a similar economic size. Again, we observe here the higher openness of the European space, notably compared to Northern America.

#### **Figure 1. Share of total intercontinental airflows in number of seats, 1991 to 2008**

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<sup>1</sup> Thus excluding chartered and private flights.

<sup>2</sup> Personal comparisons between the OAG data and the services actually operated (known from national statistics and from the airlines) attest to the quality of these databases.



Source: Own calculations on OAG data.

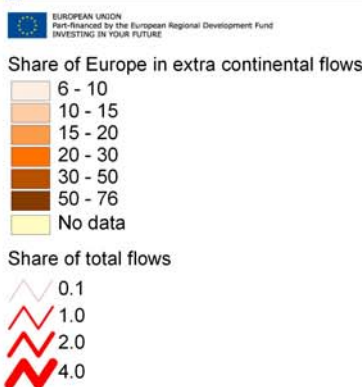
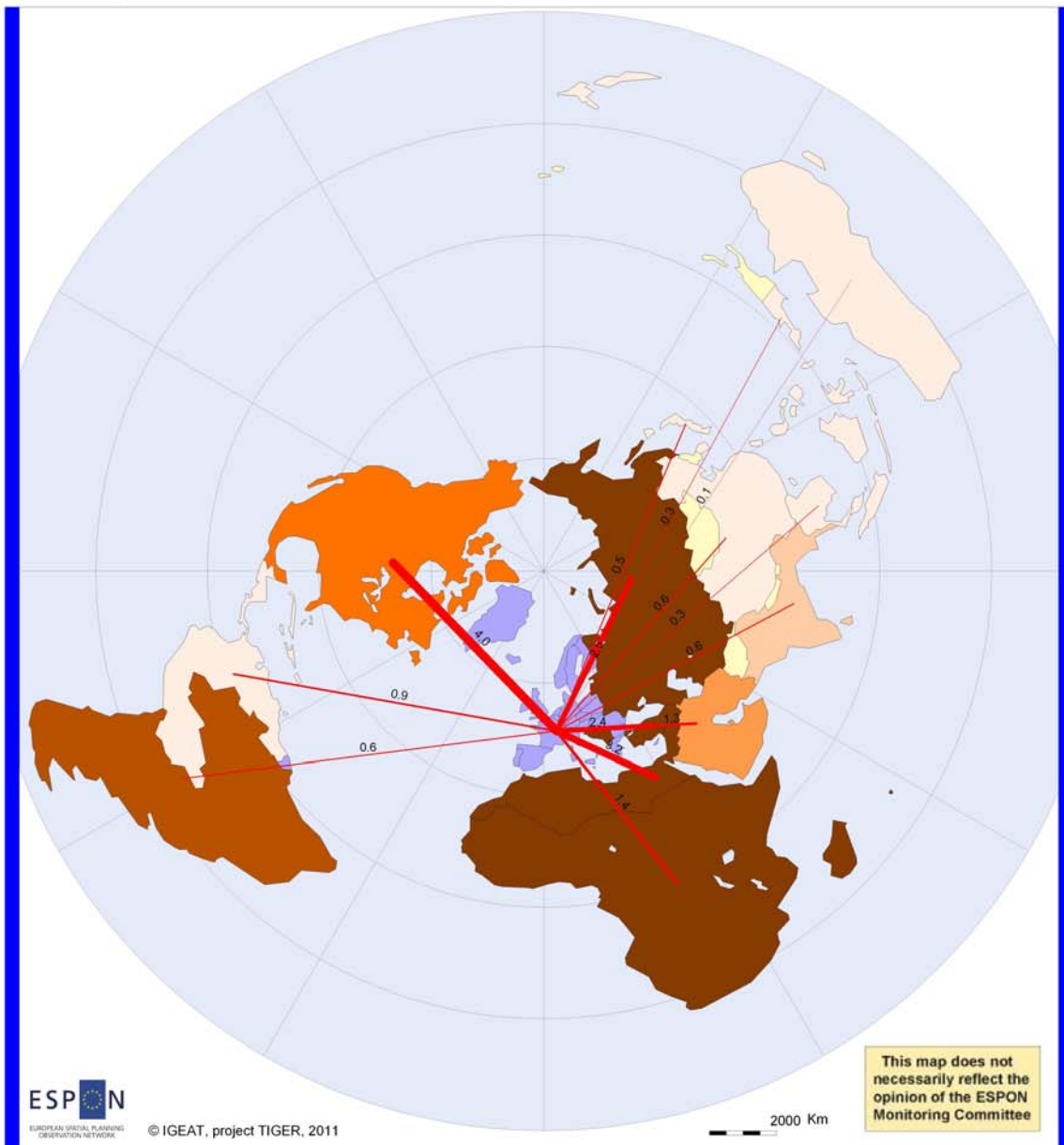
### 3. The geography of airflows for Europe and European countries

Figure 2 shows the extra-continental air flows for Europe. The major flows are toward Northern America, followed by the most nearby areas of former USSR, Balkanic States, and Northern Africa/West Middle East. These relations might be of very different nature: flows toward Middle-east and Northern Africa relate to strong historical links, the share of immigrants – notably from Maghreb and Turkey – and the tourist flows, notably to Morocco, Tunisia, Egypt and Turkey. Interestingly enough, those areas appeared of limited importance as far as trade is concerned, reinforcing thus the hypothesis that the higher importance of these parts of the world for Europe are due to migratory and tourist flows rather than economic relations. In comparison, we make the hypothesis that flows with Northern America – the first partner in terms of trade and investments – are much more related to business travels, and less to other types of motives.

When it comes to the influence of Europe in the world – as measured by the share of Europe in the flows of each macro-region (colors on the map) – the picture is very similar to the one of trade, with the highest influence to be found in neighbourhood regions: former USSR, the Middle-East and Africa. Concerning the latter, in contrast with the trade influence, Europe is by far still the first destination for extra-Subsaharan flights while the Europe’s influence in this part of the world has considerably decreased in terms of trade. The low influence of Europe in the Gulf countries, in Southern and Eastern Asia is also confirmed.

Figure 2. Air flows (in seats) of Europe with the rest of the World, in 2008

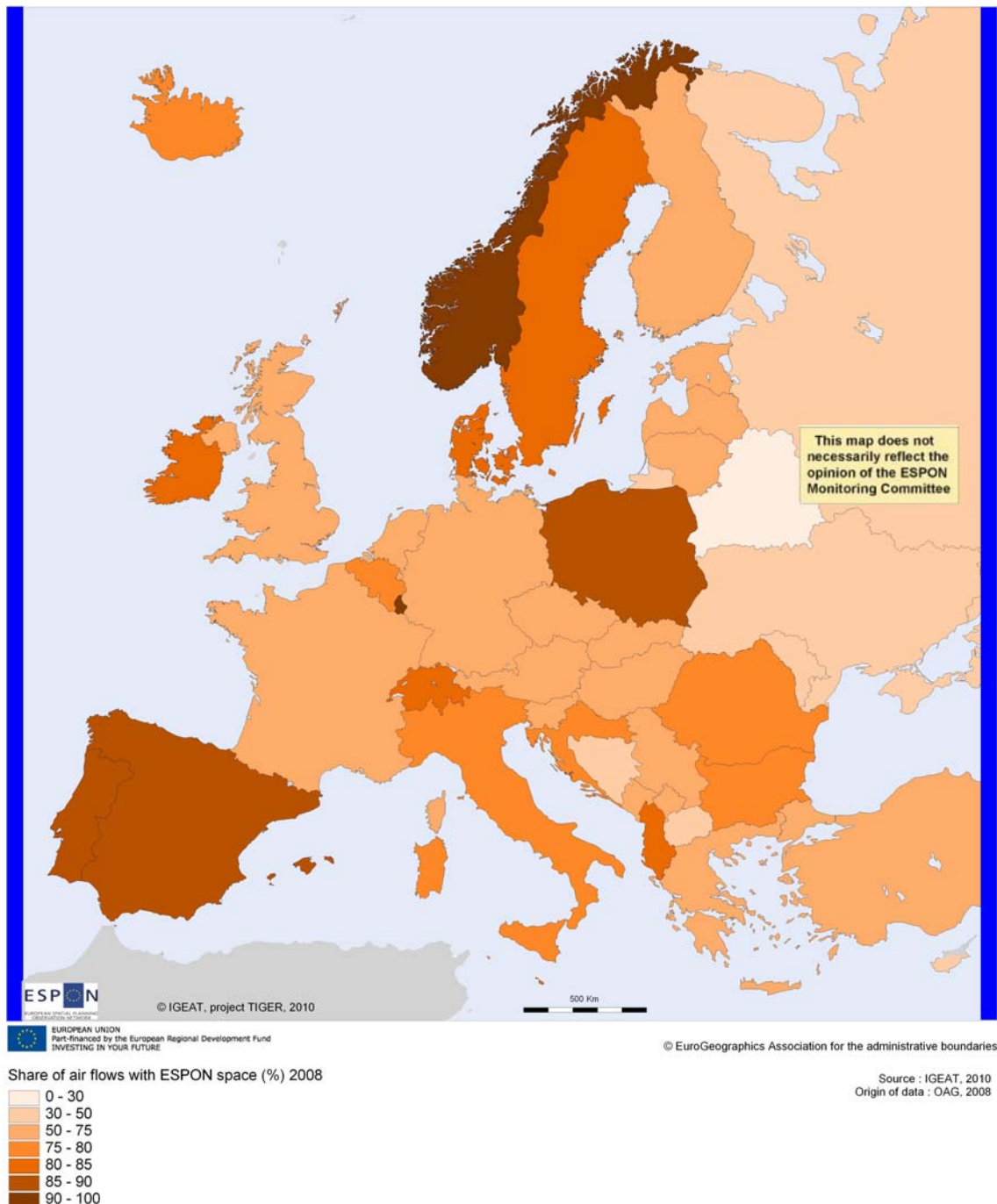
Air flows, 2008



However, this general picture hides major differences between countries (**Figure 3**). First of all, for all countries, Europe is by far the first destinations in terms of flights. But, some countries are less European than others in the air flows. This is notably the case for countries

hosting the major European hubs: Netherland, France, the UK and Germany. Once again, we cannot eliminate this hub effect and are therefore unable to know whether in their final destinations the different national citizens travel more or less within Europe.

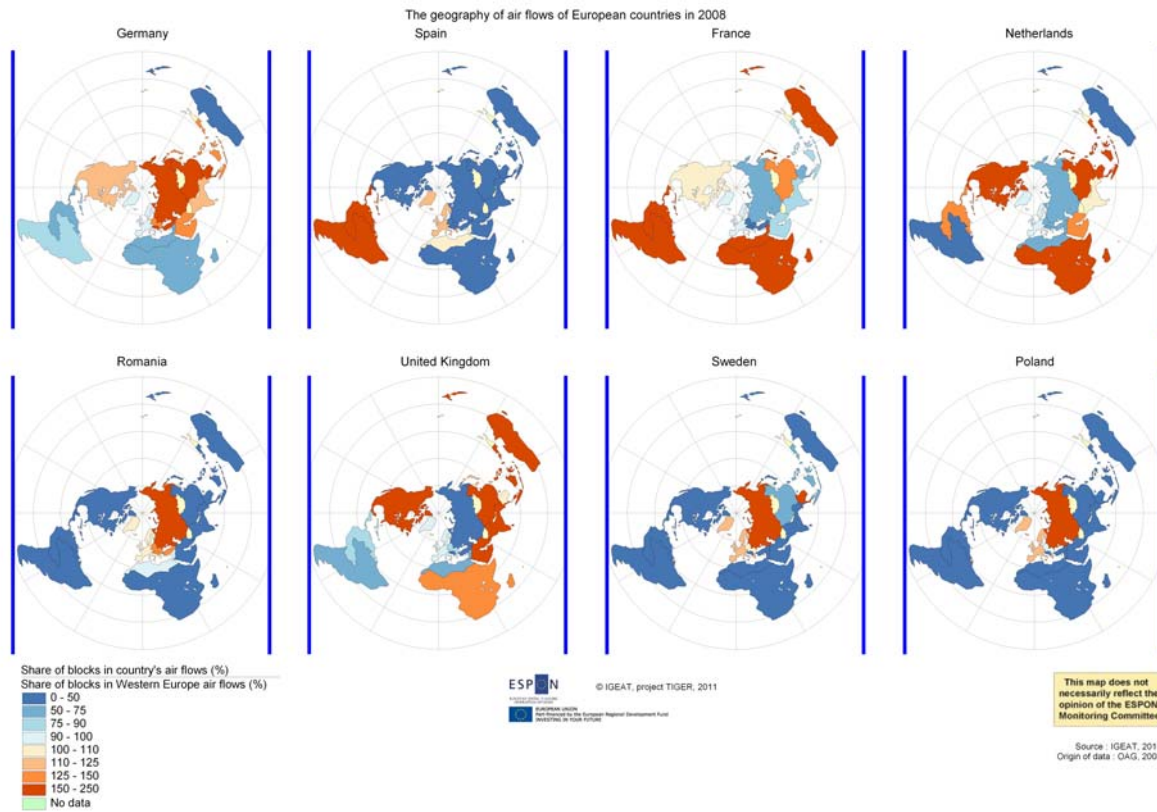
**Figure 3. Share of airflows (in seats) with the Espon space in 2008.**



The extra-continental destinations from selected European countries illustrate very different geographical patterns of extra-European connections (**Figure 4**). They largely confirm the geographical specificities of European countries in terms of extra-European relations as observed for trade: the Eastern bias of Germany; the importance of the commonwealth for UK; the importance of Africa for France and of Latin America for Spain; the importance of

Eastern Europe and former USSR for Poland or Romania. However, some striking differences appear. The low share of Africa for Spain: while Madrid has a hub function toward South America, this is not the case for Africa where this function is devoted to Paris or Amsterdam. We may also note the specific relations of France with Oceania.

**Figure 4. The geography of airflows of selected European countries in 2008**

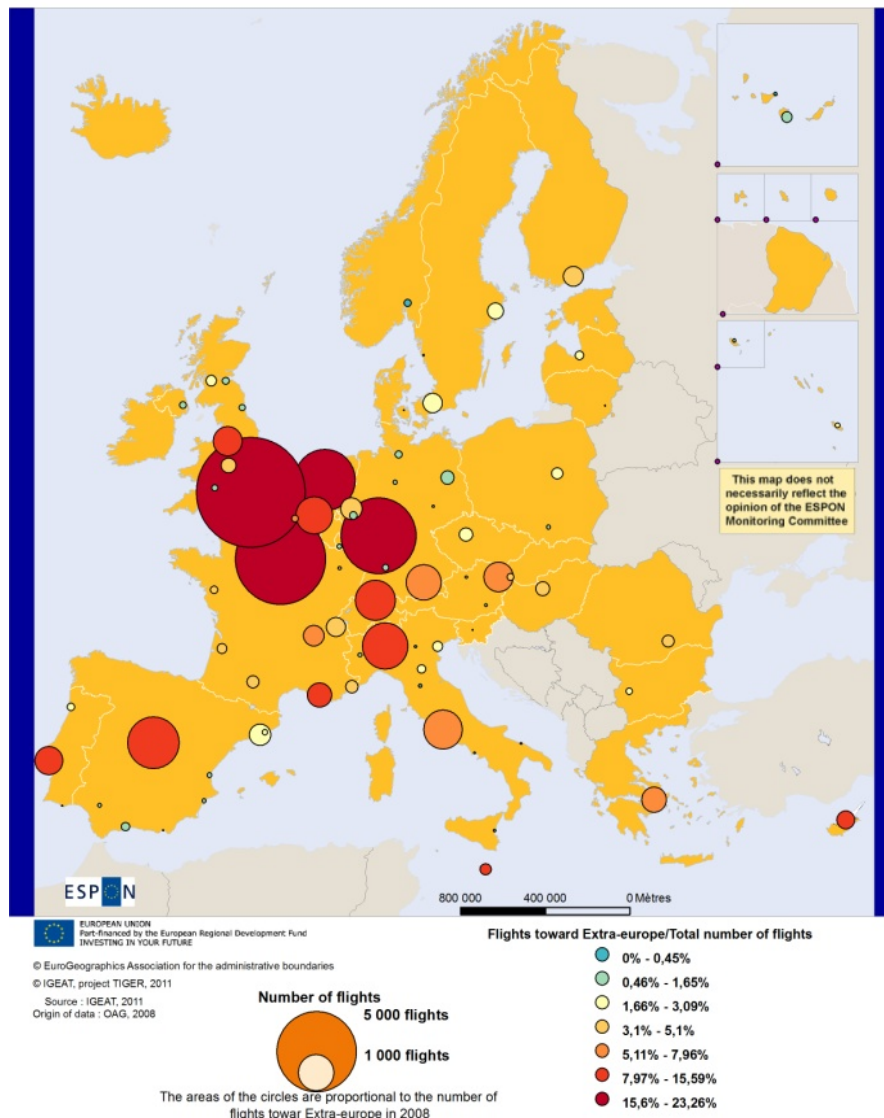


## 4. European cities in the airflows

### 4.1. The position of European cities in global airflows

The map illustrates the high concentration of extra-European connections in a limited number of cities and airports. This concentration is largely the result of air companies' strategies, allowing having better load factor, because European passengers are concentrated to some major hubs before leaving Europe. By far, the most important hubs are London, Paris, Amsterdam and Frankfurt, with London far ahead the others. In these airports, we observe much higher volume of flights toward non European cities but also a higher share of extra-European connections. Regarding the number of flights, these hubs are followed by Madrid, Roma, Milan, Barcelona and Munich. There is an imbalance between East and West Europe. Probably, extra-European flights departing from East Europe pass through the 4 hubs, German airports or Vienna – airports whose have many connections with East Europe.

**Figure 4. Air connections to extra-European cities, 2008**

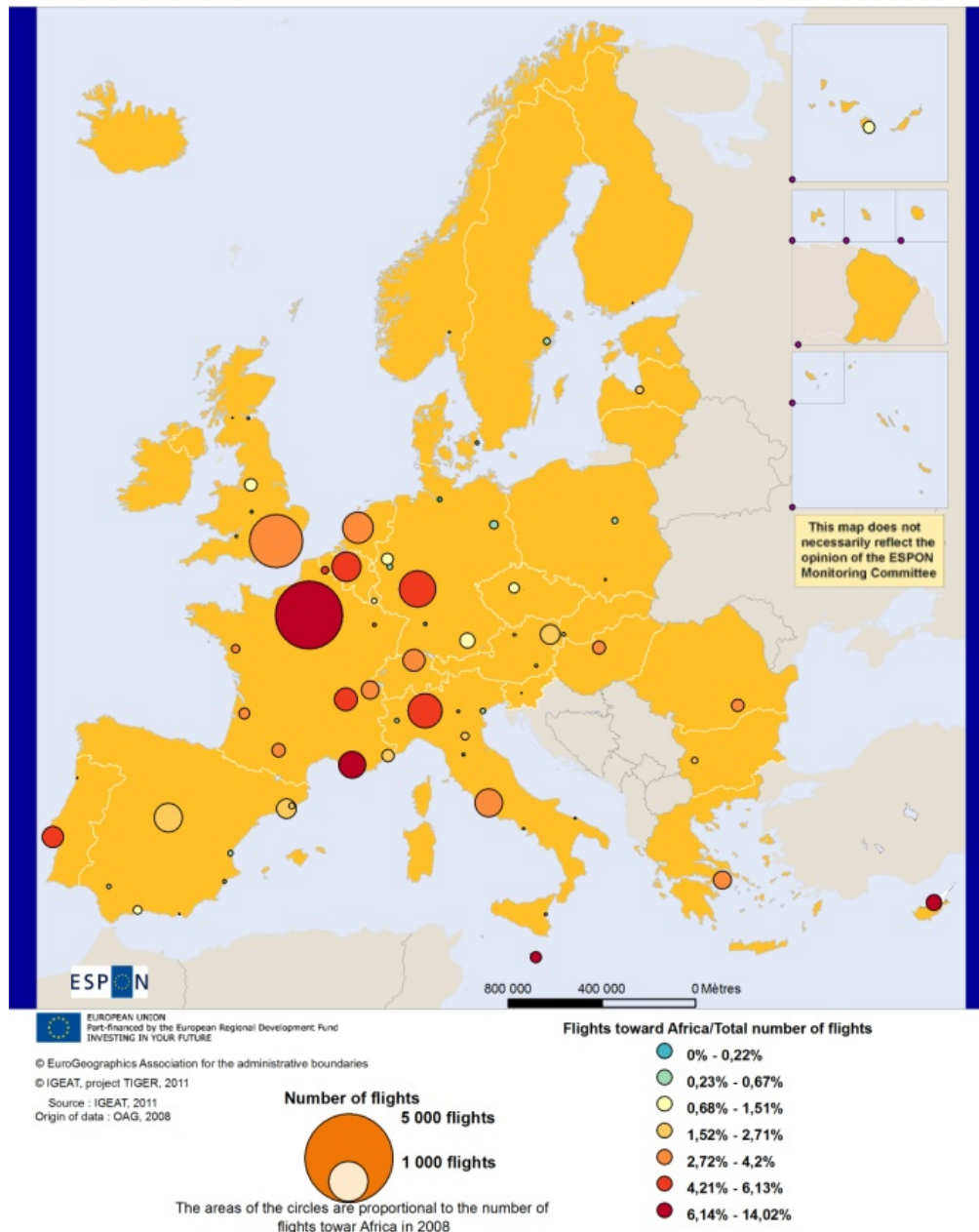




The different hubs have different specializations in extra-European connections. As for Africa (Figure 5), Paris is by far the main European gateway, especially toward Noerthern and Western Africa, while London has most connections toward Eastern and Southern Africa.

We also observe smaller airports with high share of flights toward Africa, often related to proximity or specific historical relations, as it is the case Nicosie, Lisboa or Marseille.

**Figure 5. The share of flights toward Africa in 2008**

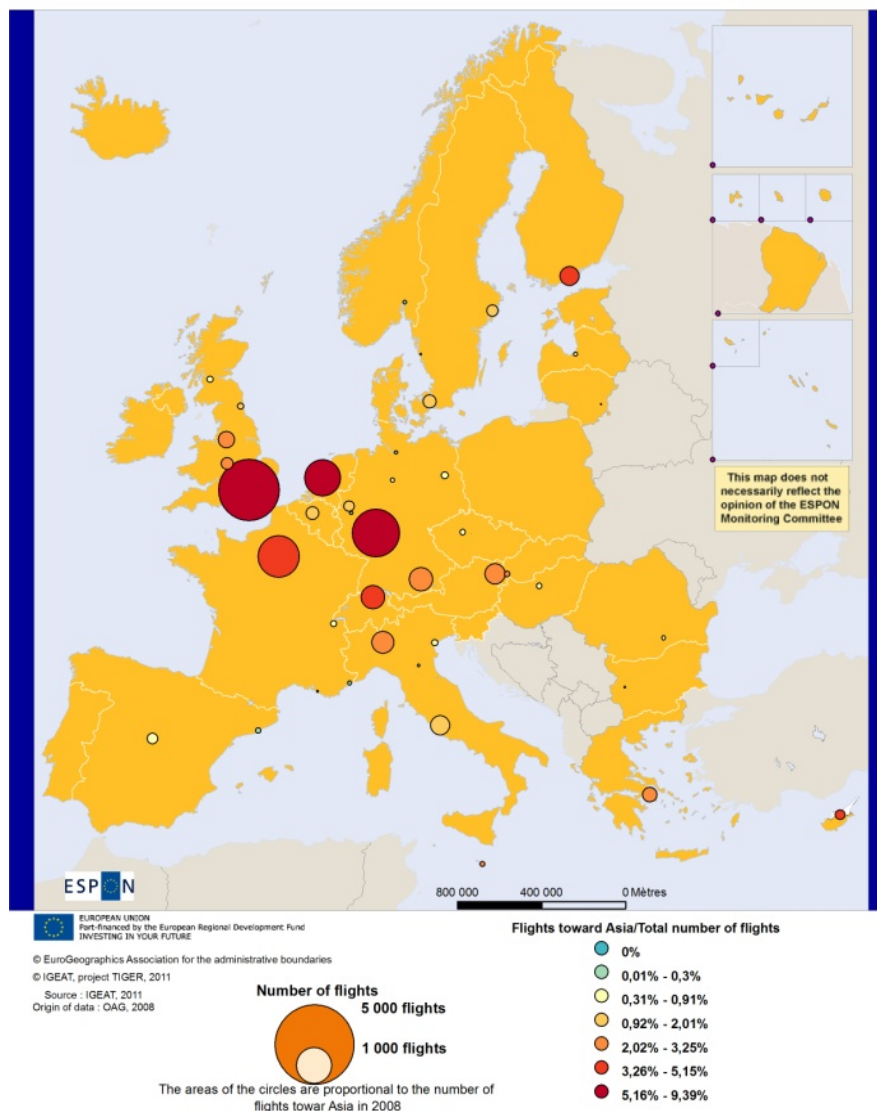


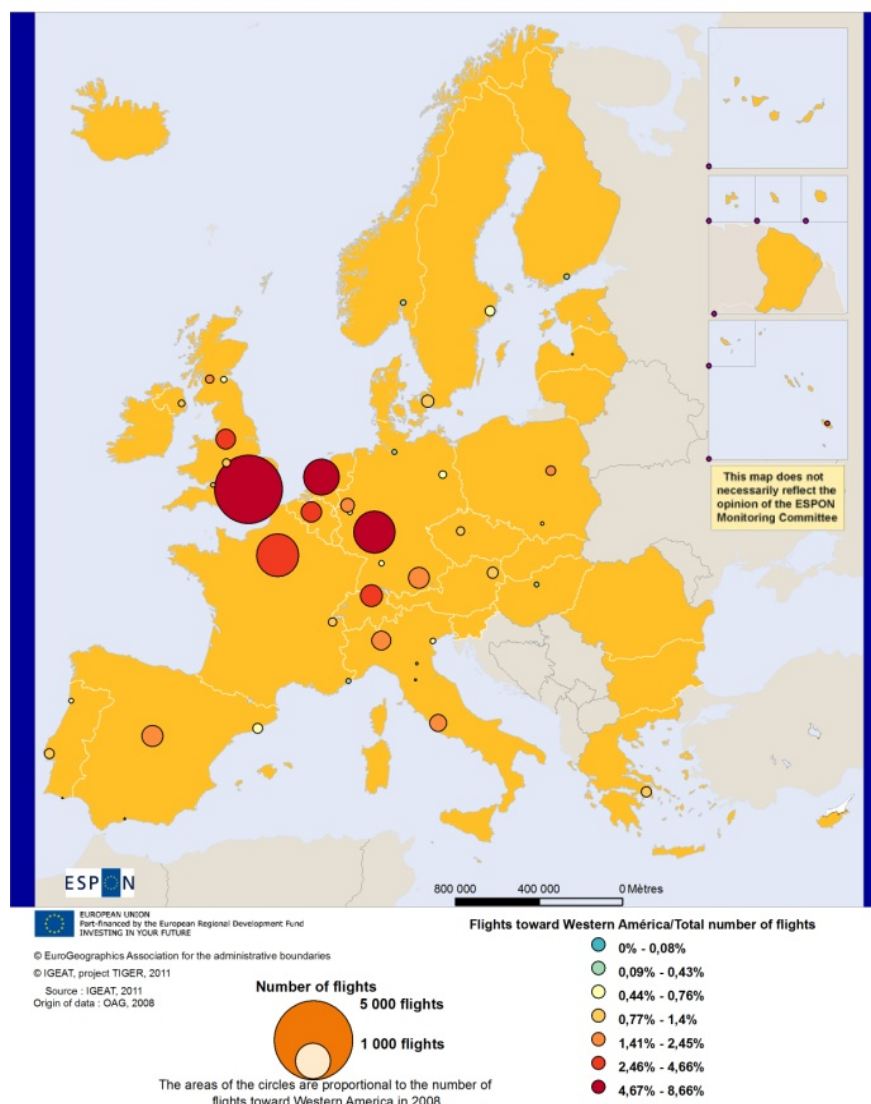


In contrast, Paris plays a much less important role for connections toward Asia (**Figure 6**). London plays here the dominant role, but Masterdam and Frankfurt are aslo highly specialized in connections toward Asia. In contrast to the previous map, southern cities of Western Europe have very limited or no direct connections to Asian cities.

The geography of connections toward Northern America (**Figure 7**) is similar to the one concerning Asia: Paris keeps a lower share of flights toward Northern America than the other hubs. Cities like Brussels, Madrid and Lisbon have more connections with this part of the World than with Asia. It is the opposite for Prague, Athens and Helsinki.

**Figure 6. The share of flights toward Asia in 2008**



**Figure 7. The share of flights toward Northern America in 2008**

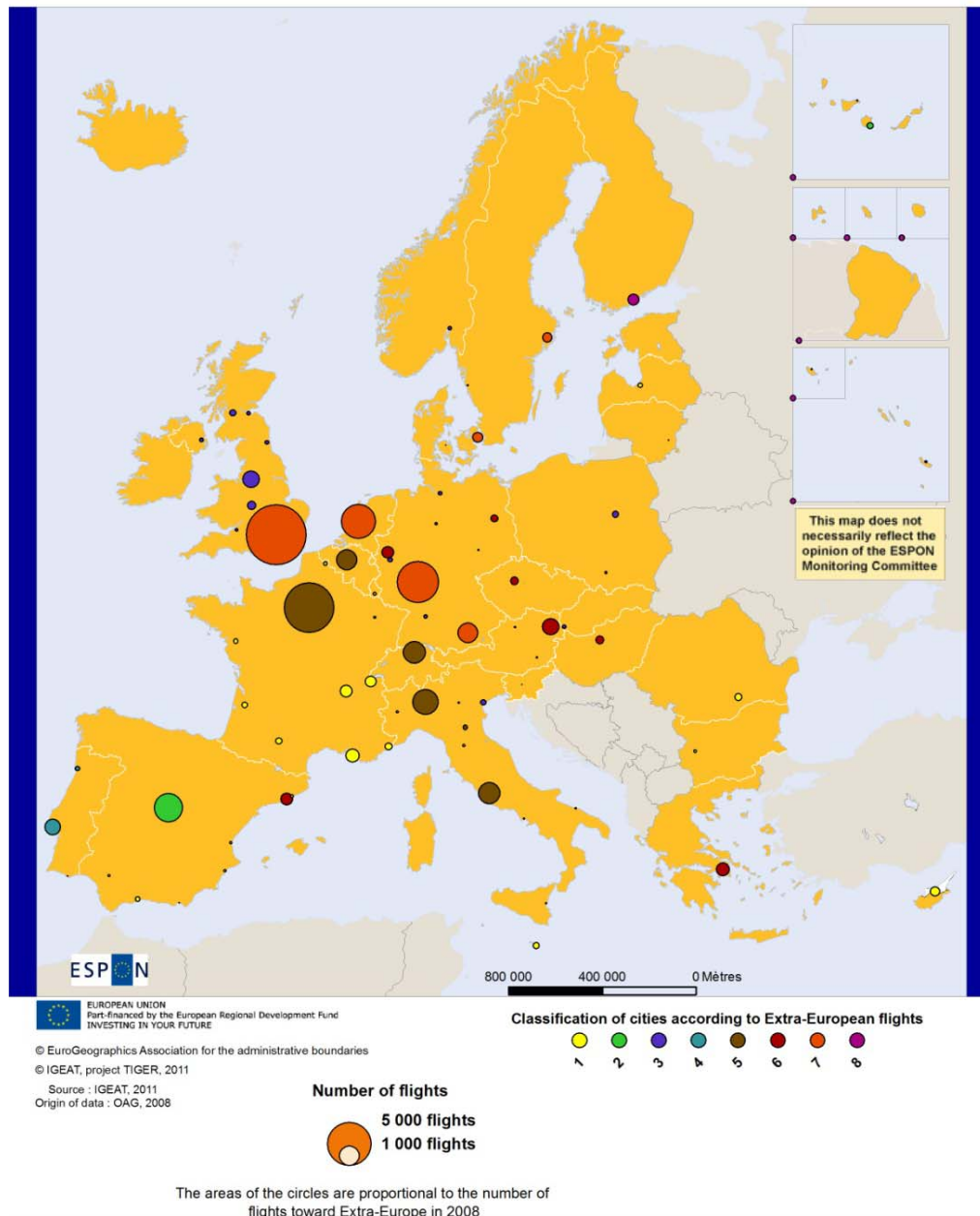
To synthesize this diverse information and identify geographical specialization of air connections, we propose a classification of cities in function of the geography of their air connections. In this classification, we start from a matrix with the share of the different parts of the world in the total connections of each city.

To achieve this typology, we used a two-step methodology. Firstly, we run a principal component analysis (PCA) to keep the most relevant information in a limited number of variables though keeping the maximum of information. Secondly, we did a “hierarchical clustering” on the five first components of the PCA.

A first typology was made taking intra-European flights into account and a second one without them. The first typology mainly distinguishes between European and global cities, and is thus very similar to figure 5 showing the share of extra-European flights in cities’ total connections. We thus only show the map of the second classification, which highlights geographical specialization in extra-European flights (Figure 8). Table 2 shows the geographical profile of extra-European connections of the 8 types identified in figure 8.

Major European airports are divided into two classes (5 and 7). Cities of both types 5 and 7 have connections with all parts of the world, though the group 5 (including Paris, Milan and Zurich) is more specialised in African destinations than the group 7 (London, Frankfurt and Amsterdam), which fly more toward Asia and Northern America. Among major European airports, Madrid has a specific profile because of its gateway function with Central and Southern America. Smaller airports are distributed in the other types with nearly exclusive specialization toward a few world regions.

**Figure 8. Classification of European cities in function of the geography of extra-European connections, 2008**



**Table 2. Geographical distribution of extra-European destinations, in %, per classes**

Classi Europe	Classe 1	Classe 2	Classe 3	Classe 4	Classe 5	Classe 6	Classe 7	Classe 8	% of total (flights)	Nber of flights
Southern Asia	0.00	0.00	7.03	0.00	4.40	2.80	6.16	15.86	4.73	1905
Middle East Central Asia	7.74	2.33	19.60	0.00	6.82	13.91	12.32	1.29	10.06	4048
South East Asia	0.00	0.63	0.00	0.00	1.83	4.19	2.89	26.21	2.37	952
Eastern Asia	0.00	0.58	0.00	0.00	3.76	1.69	5.93	30.74	4.18	1681
Western Pacifica	0.00	0.58	0.00	0.00	3.69	2.91	4.45	18.45	3.47	1397
South West Pacifica	0.00	0.00	1.60	0.00	1.94	2.13	4.08	0.00	2.64	1064
Sout East Mediterraneana	86.29	21.83	10.75	8.98	32.93	44.81	10.26	0.32	24.18	9732
Western Africa	1.38	4.71	0.88	19.29	5.02	0.55	2.48	0.00	3.34	1343
Central Africa	0.00	1.12	0.00	0.74	2.61	0.00	0.05	0.00	0.86	347
Eastern Africa	0.60	0.00	0.10	0.00	4.12	0.40	2.68	0.00	2.49	1003
Southern Africa	0.00	0.94	0.00	14.87	1.14	0.77	3.62	0.00	2.33	939
Northern America	3.78	15.96	57.50	13.25	23.13	22.70	37.40	7.12	29.43	11847
Central America Caribbean	0.21	31.02	2.53	3.83	3.26	2.17	3.75	0.00	4.72	1900
Southern America	0.00	20.30	0.00	39.03	5.37	0.96	2.23	0.00	4.43	1784
Oceania	0.00	0.00	0.00	0.00	0.00	0.00	1.69	0.00	0.77	310
<i>Total Asia</i>	<i>7.74</i>	<i>4.12</i>	<i>28.23</i>	<i>0.00</i>	<i>22.43</i>	<i>27.63</i>	<i>35.83</i>	<i>92.56</i>	<i>27.44</i>	<i>11047</i>
<i>Total Africa</i>	<i>88.26</i>	<i>28.60</i>	<i>11.74</i>	<i>43.89</i>	<i>45.81</i>	<i>46.54</i>	<i>19.10</i>	<i>0.32</i>	<i>33.20</i>	<i>13364</i>
Extra/total	5.78	5.54	4.80	1.69	29.22	6.75	45.44	0.77		
Number of cities	32	6	21	2	6	8	6	1		
Flights per city	72.69	371.83	92.10	339.50	1960.50	339.75	3048.67	309.00		

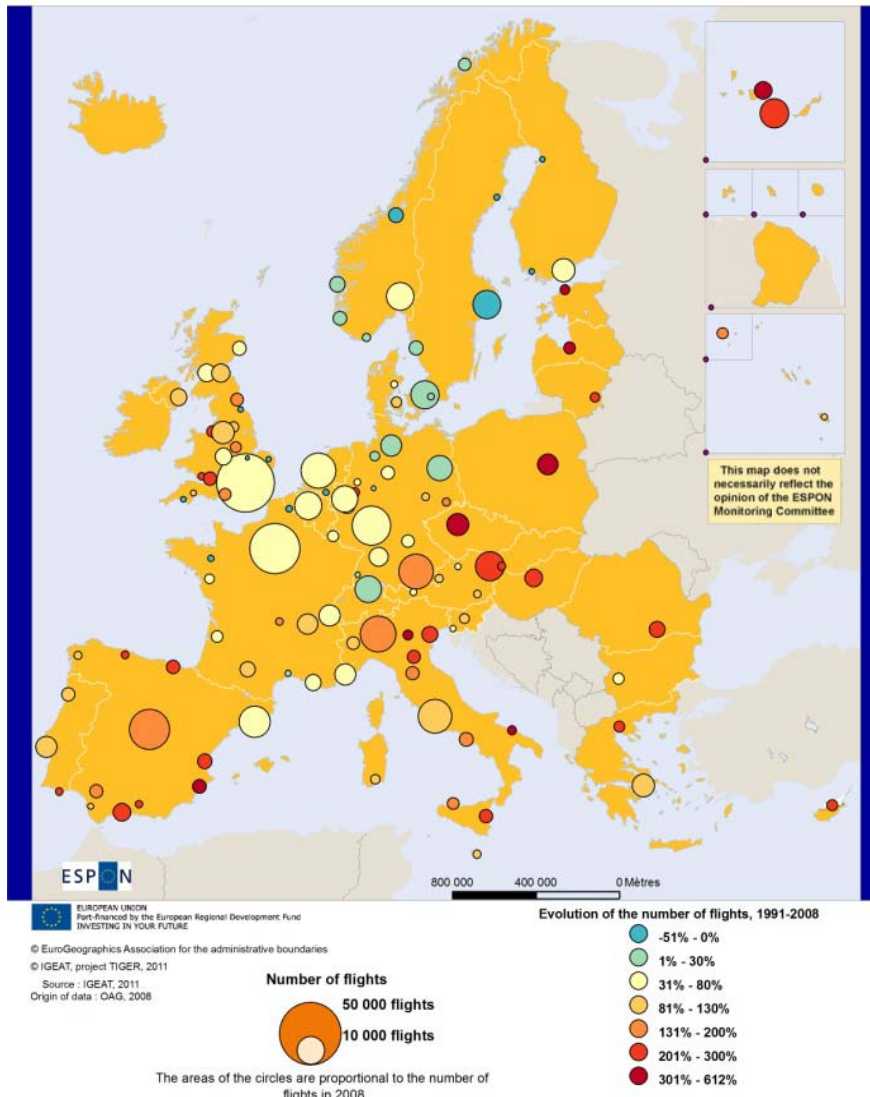
## 4.2. Evolution of European cities in global airflows

The evolution in airflows between two dates is calculated by the following formula:

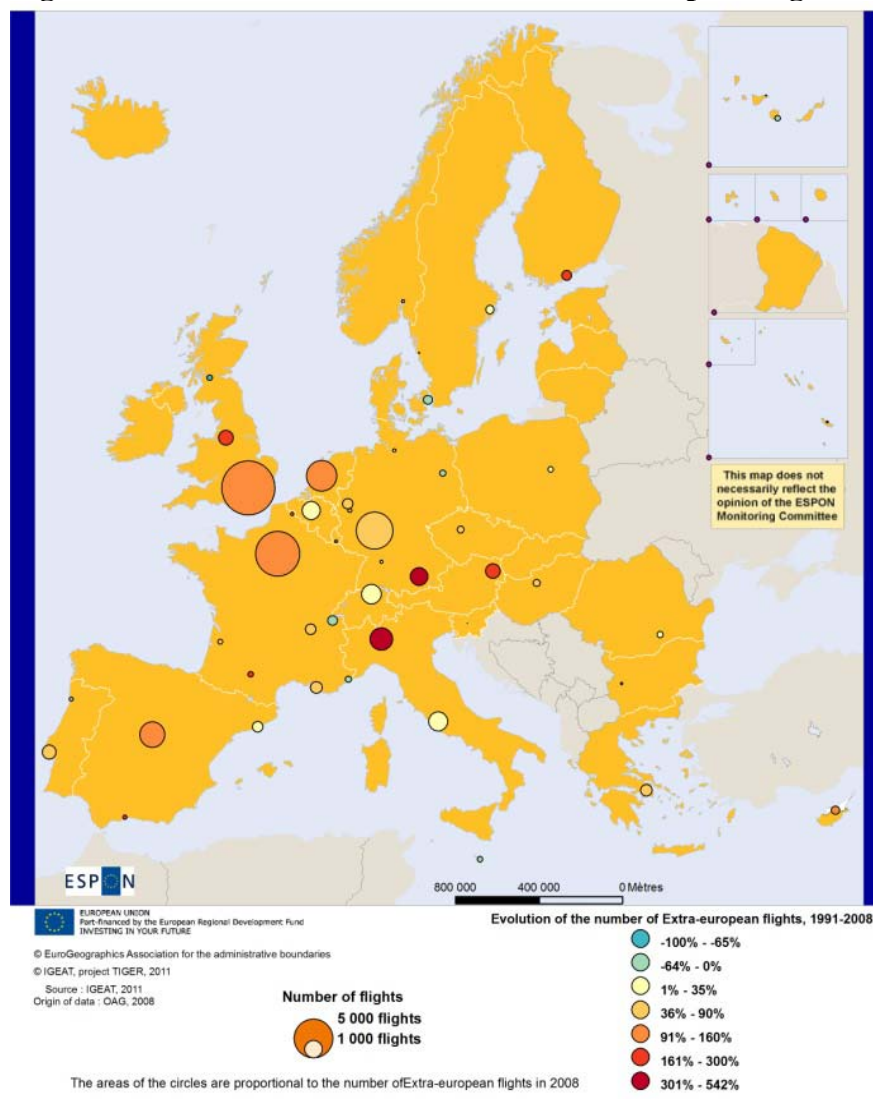
$$\frac{\text{Nbre of flights in 2008} - \text{Nbre of flights in 1991}}{\text{Nbre of flights in 2008}} * 100$$

The evolution of the number of flights is positive for almost every city between 1991 and 2008, highlighting the growth of air transport in Europe on the two last decades. More precisely, the growth of airflows between 1991 and 1999 was so important that it counteracts – possible decrease after 1999 in some cities. The highest growth rates are observed in Eastern and Southern European cities – except Barcelona, which was in 1999 the biggest airport of Spain, and lost 27% of its flights on the last period, illustrating the shift in hub functions in Spain mainly due to strategic choices of the main Spanish company. Finally, the four major hubs have in average similar growth rates than other cities, while there has been a concentration process for extra-European connections since 1991. If we focus on extra-European connections, the major hubs had better growth rates than average especially for London, but with the exception of Frankfurt. Munich and Milan have the highest growth rates in extra-European airflows, while poor performances of Roma (especially since 1999) may be explained by the transfer of the national hub to Milan airport, resulting from the strategic choices of the major national company in favour of one of the two major national airports as it occurred in Spain. Finally, the low growth rates of Brussels and Zurich are to be explained by the difficulties faced by their respective national companies.

**Figure 9. Evolution of the number of flights between 1991 and 2008**





**Figure 10. Evolution of the number of extra-European flights between 1991 and 2008**

### 4.3. Comparison with American cities

Like in Europe, we observe the huge concentration of international flights on a few major hubs: while the 5 major airports concentrate 24% of all flights, they concentrate 64% of intercontinental flights (**Tables 3 and 4**). The six main airports, according to the total number of flights inside and outside United-States, are New-York, Chicago, Washington, Dallas, Atlanta and Los Angeles. The rank of the 5 first American cities changes each year but 4 cities are always present: New York, Chicago, Los Angeles and Washington.

When compared to Europe, extra continental air supply is not more concentrated in the US if we take the 5 first cities (**Table 4**). This is a surprising result considering that the air space has been liberalized and unified more recently in Europe than in the US but also that national (often privatized) companies continue to survive in most European countries. However, when we focus on the first hub, New York concentrates 31% of the intercontinental air supply while London reaches 28%.



**Table 3. Number of flights and share of the total for Europe and the USA**

Europe (ESPON space)						
Rank of cities	Total flights			Share of flights (%)		
	1991	1999	2008	1991	1999	2008
1 to 5	77638	113149	132348	27.86	26.66	26.47
<i>London</i>	24712	35953	43675	8.87	8.47	8.74
<i>Paris</i>	19524	27750	31689	7.01	6.54	6.34
1 to 10	118389	172751	201274	42.49	40.71	40.26
1 to 20	171766	256893	293076	61.64	60.53	58.62
1 to 50	237375	356754	414648	85.19	84.07	82.94
USA						
Rank of cities	Total flights			Share of flights (%)		
	1991	1999	2008	1991	1999	2008
1 to 5	236590	241650	223005	21.96	23.06	23.86
1 to 10	370143	387527	369302	34.36	36.98	39.51
1 to 20	555054	592366	554411	51.53	56.52	59.32
1 to 50	815769	838386	770256	75.73	80.00	82.41

**Table 4. The distribution of extra-continental flights in Europe and the USA**

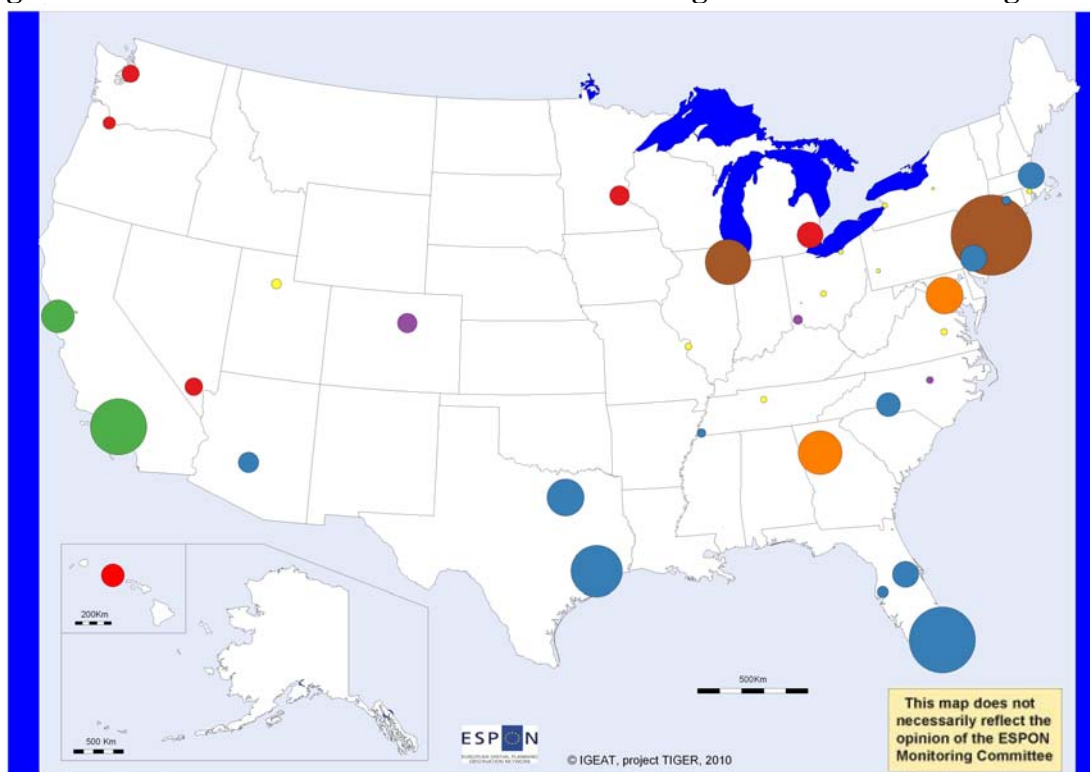
Europe (ESPON space)						
Rank of cities	Total extra european and neighbourhood flights			Share of extra european and neighbourhood flights (%)		
	1991	1999	2008	1991	1999	2008
1 to 5	11043	15258	18481	64.82	68.63	70.18
<i>London</i>	4063	6023	7301	23.85	27.09	27.73
<i>Paris</i>	2445	3125	3865	14.35	14.06	14.68
<i>Frankfurt</i>	2442	2890	3328	14.34	13.00	12.64
<i>Amsterdam</i>	1115	2093	2364	6.54	9.41	8.98
<i>Zurich (Madrid for 2008)</i>	978	1127	1623	5.74	5.07	6.16
1 to 10	13996	18891	22414	82.16	84.97	85.12
1 to 20	15905	21338	25358	93.37	95.98	96.30
1 to 50	17035	22230	26326	100.00	99.99	99.97
USA						
Rank of cities	Total extra US and neighbourhood flights			Share of extra US and neighbourhood flights (%)		
	1991	1999	2008	1991	1999	2008
1 to 5	8798	11151	11408	64.93	65.34	64.19
<i>New York</i>	3613	4668	5439	26.67	27.35	30.61
<i>Los Angeles</i>	1816	2436	2027	13.40	14.27	11.41
1 to 10	11266	14430	15191	83.15	84.55	85.48
1 to 20	13084	16632	17505	96.57	97.45	98.50
1 to 50	13549	17067	17749	100.00	100.00	100.00

Using the same method than for European cities, we propose a classification of American cities in function of the geography of their extra-continental air connections (Figure 11). Like in Europe, we observe a strong geographical specialization in hub functions. But this specialization is much more pronounced and notably, we observe this process also for the most important hubs. The absence of global profile for major hubs is partly due to technical reasons.

But still, major airports have a more diversified geographical supply than the others. It is the case for the group 7 (especially for New York) even if they are flying mainly to Western Europe and Central America. Secondly, we can put in contrast airports on the West coast and those in the Eastern part of USA. Groups 3 and 5 illustrate this idea: Los Angeles and San Francisco have better connections with Asia and Oceania (closer), and less with Europe than Washington and Atlanta. Airports from groups 1 and 3 have similar airflows' distribution – connected principally with Asia and Europe. The main difference is the size of airports, 312 flights per airport in the first group and 1941 for the other group which is compose by San Francisco and Los Angeles. Group 2 (with Miami) and group 6 fly almost exclusively to Central America and Caribbean.

Finally, connections with Africa are insignificant regardless of the airport. It can be explained by the distance that an aircraft can do without stop. Most flights between USA and Africa passes through Europe which has many connections with this part of the World.

**Figure 11. Classification of American cities according to extra-American flights in 2008**



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International flights



Source : IGEAT, 2010  
Origin of data : CEPIL (Chelem data base)

**Table 2. Distribution of extra-North American destinations, in %, per classes**

<b>Classi USA</b>	Classe 1	Classe 2	Classe 3	Classe 4	Classe 5	Classe 6	Classe 7	% of total (flights)	Nber of flights
Southern Asia	0.00	0.00	0.33	0.00	0.00	0.00	3.26	1.01	343
Middle East Central Asia	0.00	0.10	0.00	0.00	2.62	0.00	1.88	0.88	298
South East Asia	0.00	0.00	1.60	0.00	0.00	0.00	0.31	0.27	93
Eastern Asia	0.00	0.00	10.10	0.00	0.86	0.00	3.21	2.20	747
Western Pacifica	41.10	0.93	25.99	0.00	4.28	0.00	4.59	7.80	2646
South West Pacifica	8.79	0.00	5.90	0.00	0.00	0.00	1.05	1.55	527
Sout East Mediterranea	0.46	0.11	0.36	0.00	0.74	0.00	2.19	0.84	286
Western Africa	0.00	0.06	0.00	0.00	2.26	0.00	0.81	0.51	172
Southern Africa	0.00	0.00	0.00	0.00	1.71	0.00	0.31	0.27	93
Western Europe	31.81	17.87	24.09	87.06	37.96	0.00	46.56	30.18	10241
Eastern Europe Northern Asia	0.00	0.00	0.44	0.00	1.19	0.00	2.69	0.98	332
Central America Caribbean	14.51	74.94	17.26	12.94	41.96	100.00	29.45	47.63	16164
Southern America	0.00	5.98	1.85	0.00	6.43	0.00	3.39	4.18	1420
Oceania	3.34	0.00	12.08	0.00	0.00	0.00	0.31	1.69	573
<i>Total Asia</i>	<i>49.89</i>	<i>1.03</i>	<i>43.92</i>	<i>0.00</i>	<i>7.75</i>	<i>0.00</i>	<i>14.29</i>	<i>13.71</i>	<i>4654</i>
<i>Total Europe</i>	<i>31.81</i>	<i>17.87</i>	<i>24.52</i>	<i>87.06</i>	<i>39.14</i>	<i>0.00</i>	<i>49.25</i>	<i>31.16</i>	<i>10573</i>
<i>Total rest of America</i>	<i>14.51</i>	<i>80.93</i>	<i>19.11</i>	<i>12.94</i>	<i>48.39</i>	<i>100.00</i>	<i>32.84</i>	<i>51.82</i>	<i>17584</i>
Number of cities	7	11	2	5	2	20	2		
Flights per city	312	1173	1941	51	1813	49	5055		

## Conclusion

What are the main conclusions about the evolution of the position of Europe and European cities in the world of airflows?

1. The position of Europe has been rather stable in the air flows. However, as for trade, its influence is largely limited to neighbourhood areas (former USSR, near Middle-East and Northern Africa). However, we must note that despite the decreasing role of Europe in Sub-Saharan Africa, Europe is still by far the major destination for African flights. Indeed, the geography of airflows is also highly related to historical relations and migratory flows (both being also strongly interrelated).
2. Europe is a highly integrated and interconnected airspace.
3. Countries' extra-European air flows are very differentiated, illustrating the specific historical relations of the different countries, with similar geographical pattern than the one observed with trade.
4. At the city level, we observe a huge concentration of air gateways into a few major cities, at an even higher level than in the USA. Also, as far as intercontinental flows are concerned, the concentration process has increased between 1991 and 2008, notably to the benefit of London airports. These major hubs show the most global geographical profile of air supply but we do observe specializations between them, for example the role of Paris as a hub for Africa and Madrid as the main hub to Latin America. Less important European airports are far more specialized in average in their extra-continental supply.