

Data-driven modeling and validation of aircraft inbound-stream at some major European airports

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1 Introduction

This notebook contains the code for the analysis presented in *Data-driven modelling and validation of aircraft inbound-stream at some major European airports* by Carlo Lancia (Leiden University) and Guglielmo Lulli (Lancaster University). The manuscript shows how to construct point processes for the description of the inbound traffic at 8 important European airports. The processes considered are a time-dependent Poisson process and Pre-Scheduled Random Arrivals. These processes are constructed in a data-driven fashion and are compared on their capability of reproducing the average daily demand.

The dependencies are reported in the next two cells. Please note the requirements of rpy2 and that the the following packages R-packages are installed:

- dgof
- DiscreteWeibull
- changepoint

```
/Users/clancia/anaconda3/envs/interopy/lib/python3.6/site-packages/statsmodels/compat/pandas.py  
from pandas.core import datetools
```

1.1 Load data and set constants

1.2 Data description

The analysis period covers the three summer months of 2016. This choice aims at reducing the chance of weather-induced disruptions in the traffic data.

[2016-06-15 - 2016-09-14]

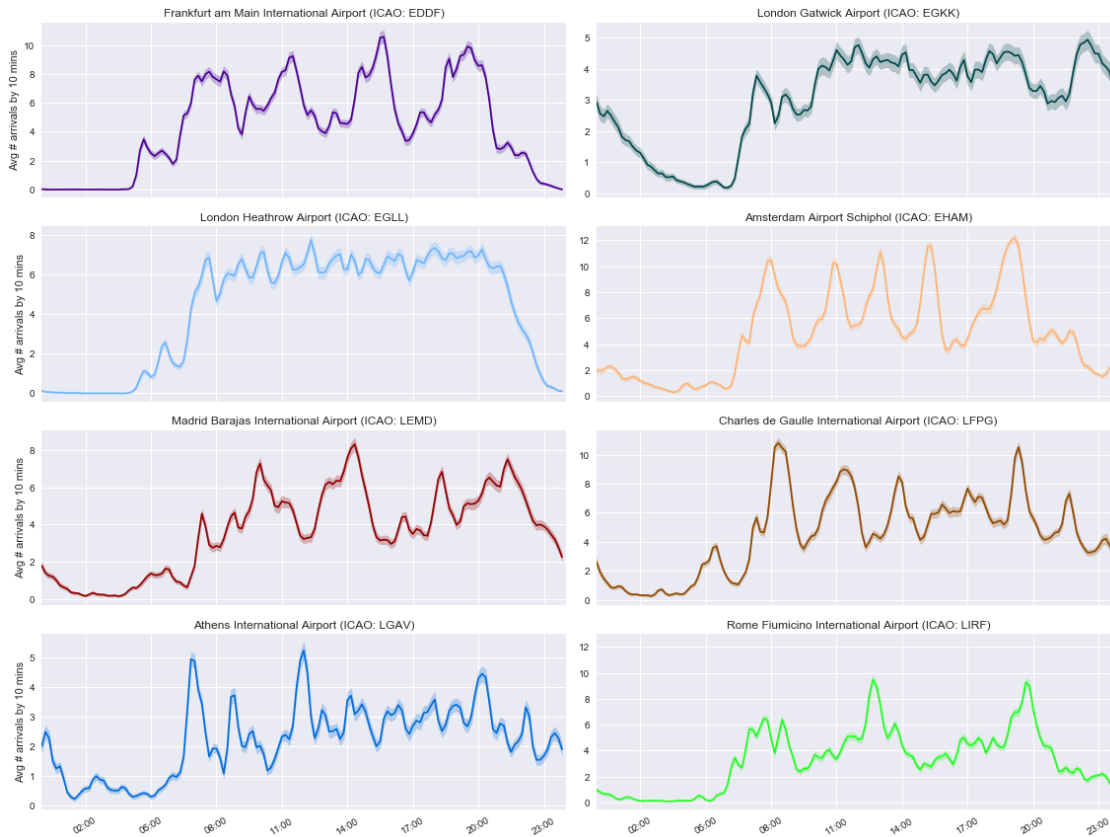
1.2.1 Flight count

```
Out[11]:
```

	ICAO code	sample size
airport name		
Frankfurt am Main International Airport	EDDF	58167
London Gatwick Airport	EGKK	39746

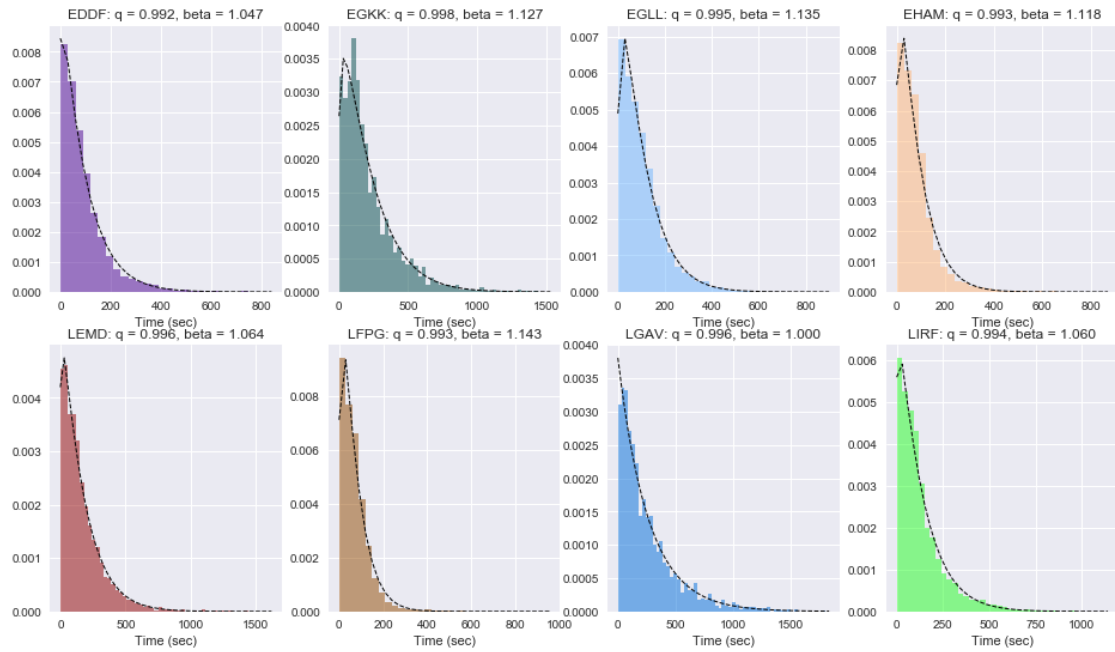
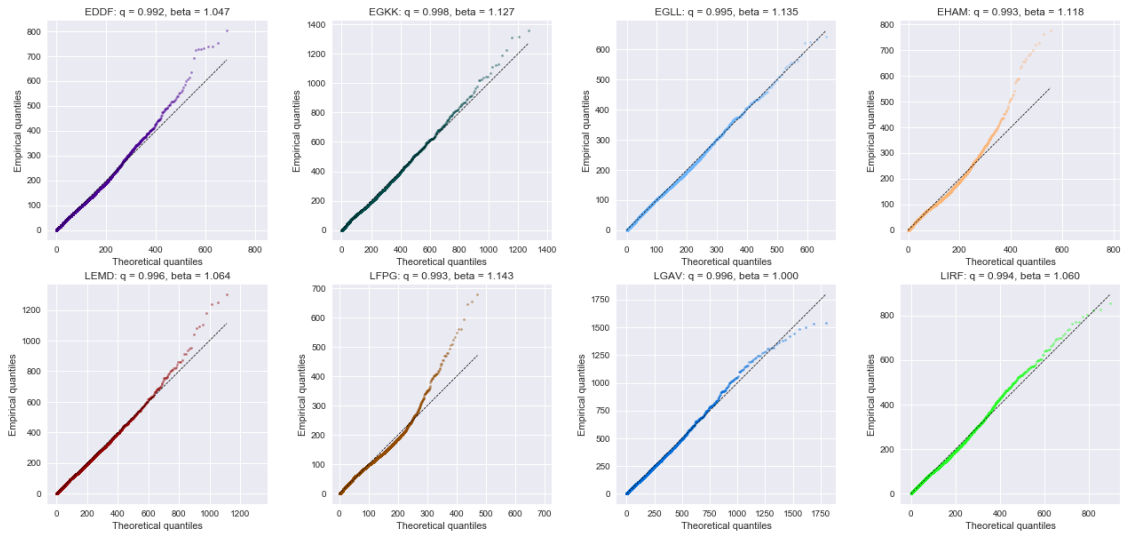
London Heathrow Airport	EGLL	56716
Amsterdam Airport Schiphol	EHAM	63279
Madrid Barajas International Airport	LEMD	48162
Charles de Gaulle International Airport	LFPG	60122
Athens International Airport	LGAV	29503
Rome Fiumicino International Airport	LIRF	43333

1.2.2 Average daily demand

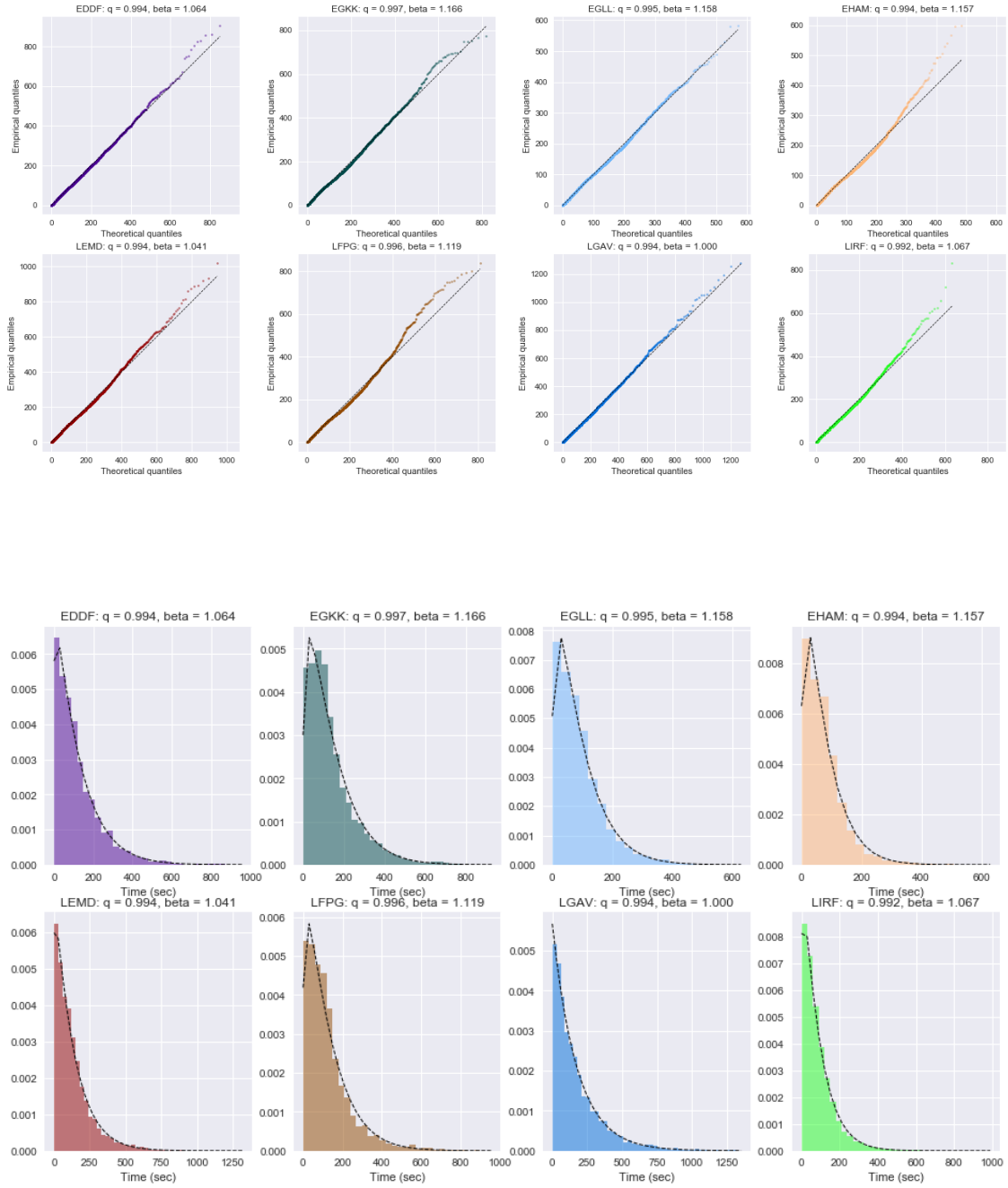


2 Interarrival times

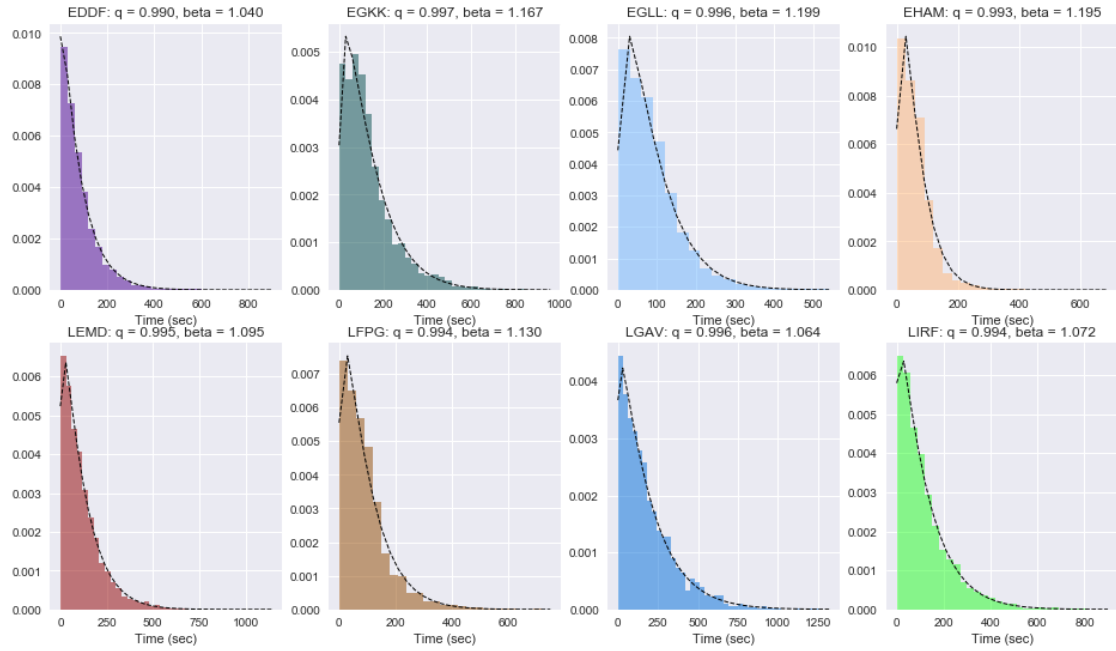
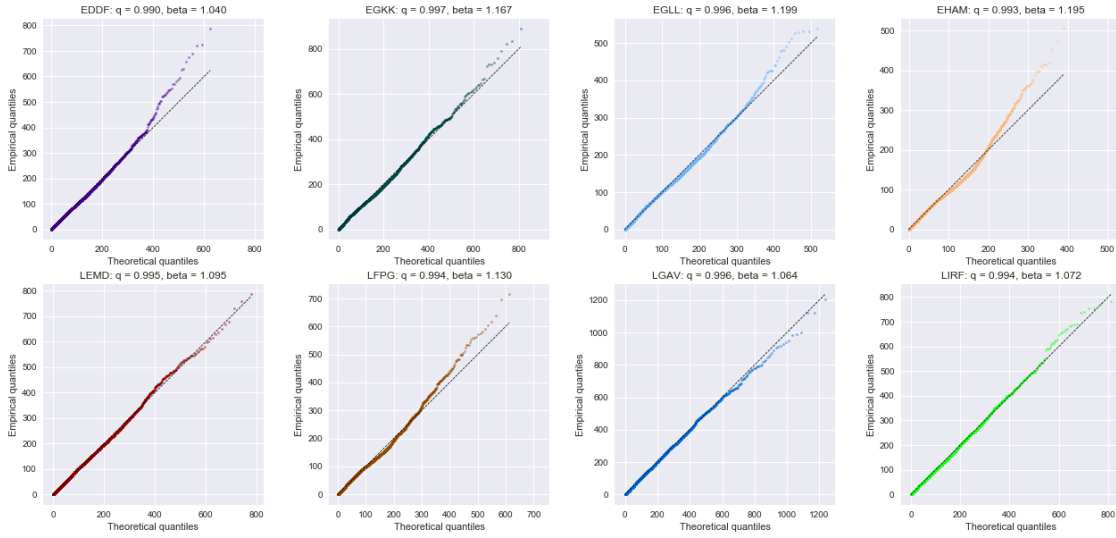
2.1 Period 08:00 - 09:30 local time



2.2 Period 12:00 - 13:30 local time



2.3 Period 18:00 - 19:30 local time



2.4 Overview

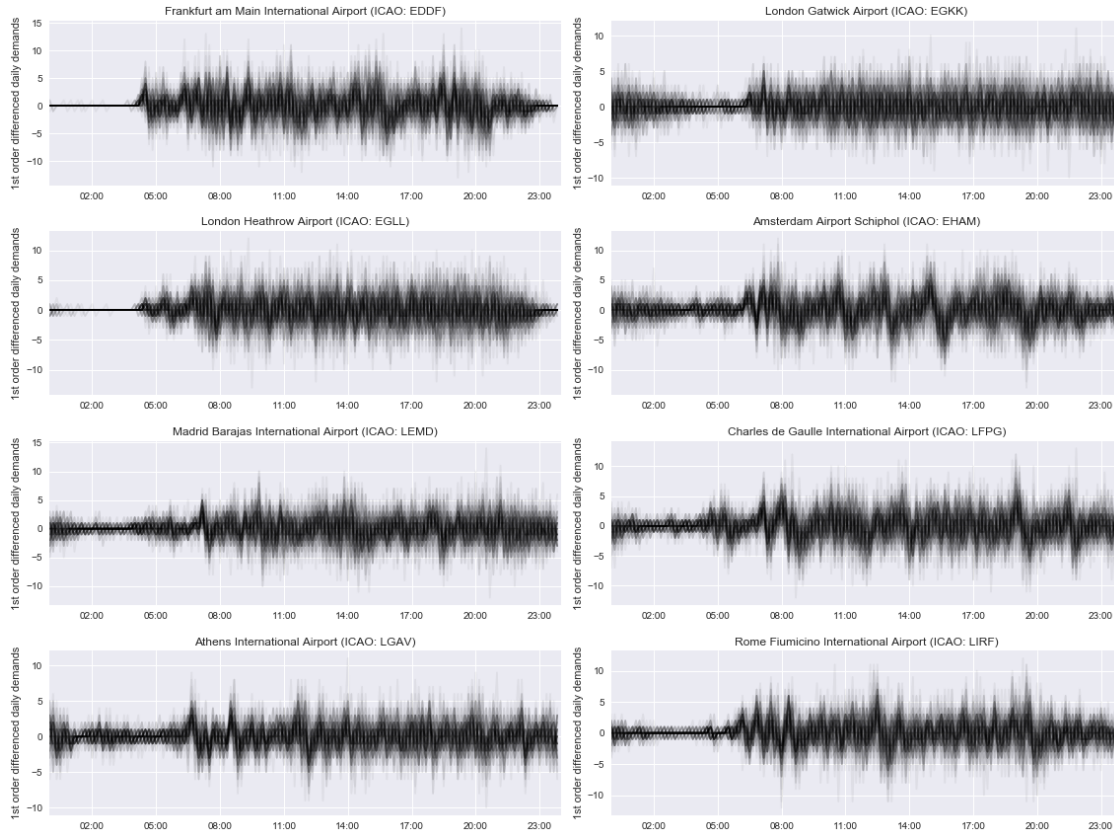
Out [20]:		q	beta	D	p	mean
time	airport					
08:00--09:30	EDDF	0.9916	1.0465	0.019563	0.0349306	93.131
	EGKK	0.9978	1.1273	0.0319529	0.0178117	214.506

	EGLL	0.9951	1.1346	0.0239924	0.00784466	103.273
	EHAM	0.9932	1.1176	0.0329367	4.7186e-06	82.2092
	LEMD	0.9958	1.0639	0.0191429	0.21349	166.54
	LFPG	0.9929	1.1434	0.0327649	7.17522e-07	71.3356
	LGAV	0.9962	1	0.0205498	0.398632	261.533
	LIRF	0.9944	1.0595	0.0234674	0.0335275	129.793
12:00--13:30	EDDF	0.9942	1.0636	0.018467	0.12738	122.668
	EGKK	0.997	1.1658	0.0332991	0.000665603	137.588
	EGLL	0.9949	1.1582	0.0258954	0.00124012	90.2623
	EHAM	0.9937	1.1575	0.0348448	1.95929e-07	74.9903
	LEMD	0.994	1.0414	0.0159557	0.291412	133.073
	LFPG	0.9958	1.1192	0.0274501	0.00575838	127.154
	LGAV	0.9943	1	0.0129628	0.740963	175.291
	LIRF	0.9919	1.0667	0.0209261	0.0145947	88.12
18:00--19:30	EDDF	0.9901	1.0404	0.0151295	0.121215	82.4655
	EGKK	0.997	1.1668	0.0344259	0.000324937	135.505
	EGLL	0.9956	1.1991	0.0312039	2.52668e-05	85.6791
	EHAM	0.9934	1.1954	0.0328509	5.39274e-08	61.8951
	LEMD	0.9948	1.0947	0.0133126	0.43082	116.381
	LFPG	0.9945	1.1304	0.0270682	0.000809749	93.9814
	LGAV	0.9963	1.0639	0.0130277	0.766108	189.09
	LIRF	0.9942	1.0721	0.0162099	0.21182	117.987

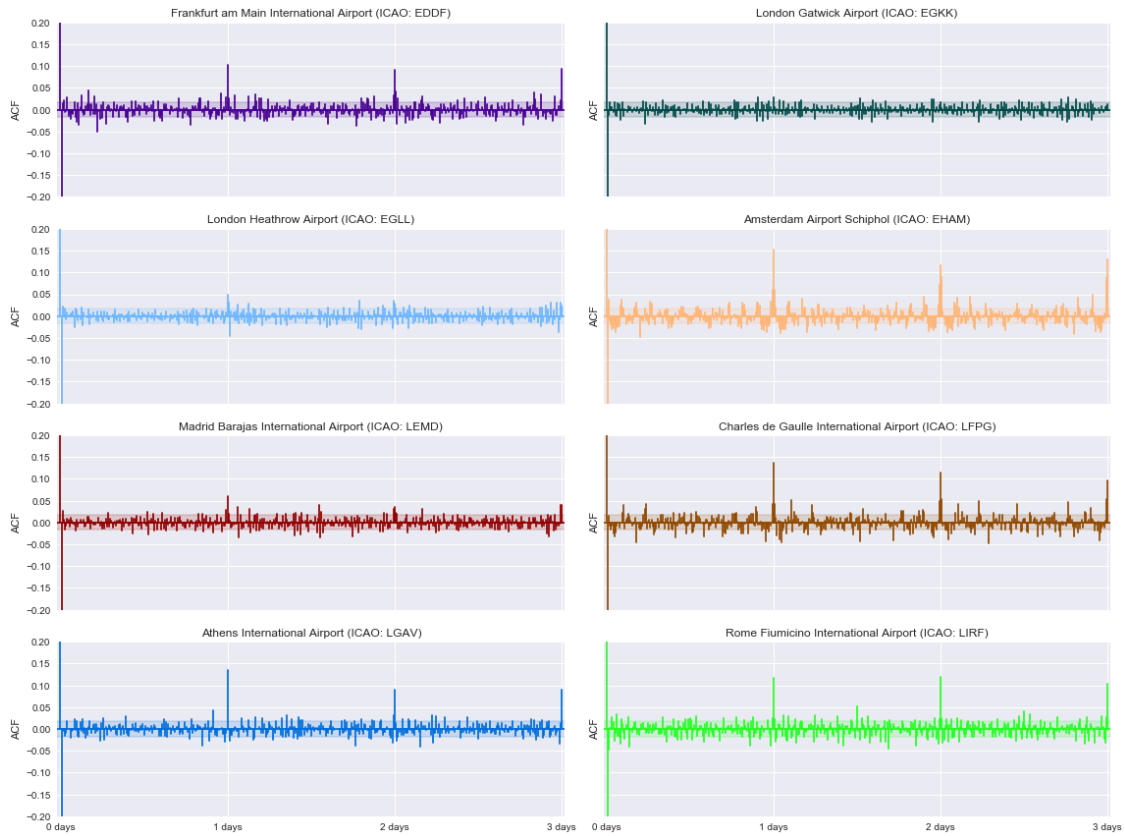
3 Time-series analysis

3.1 Autocorrelations

3.1.1 1st order differenced time series



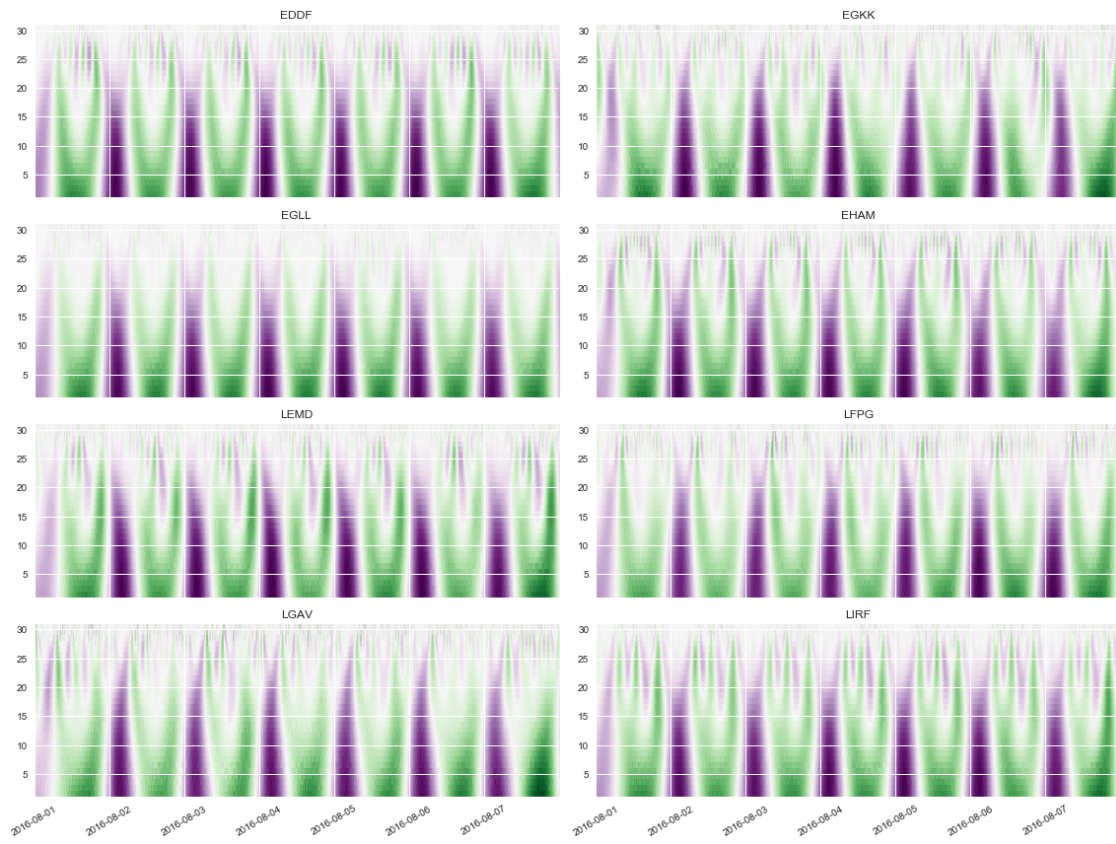
3.1.2 Autocorrelations



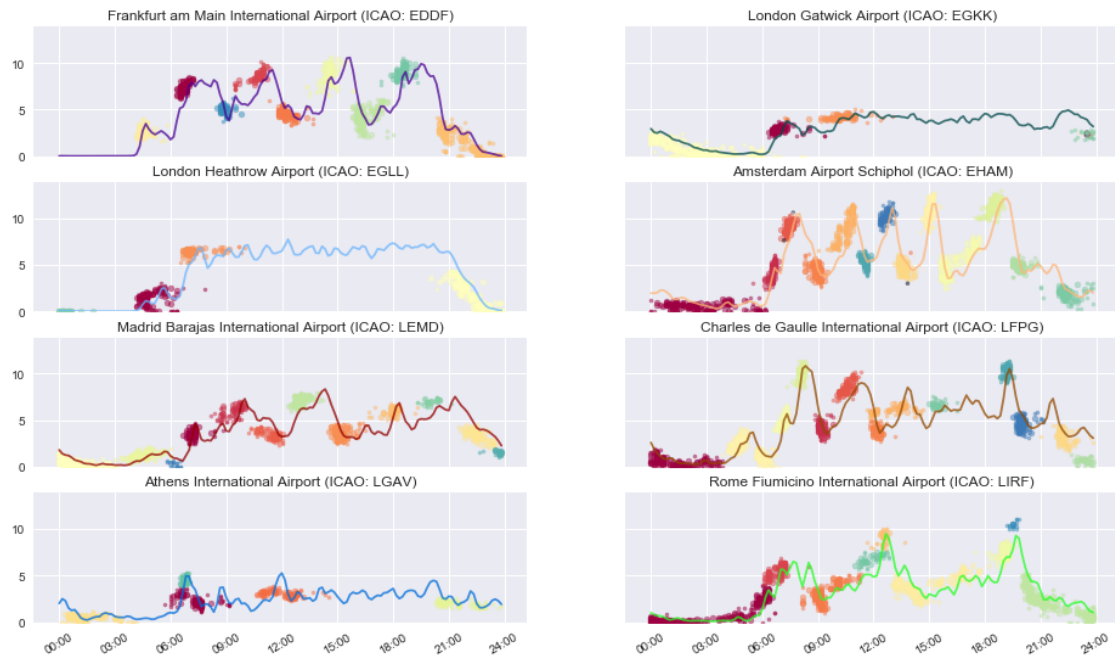
```
Out [24]: EDDF      -0.446755
          EGKK      -0.525782
          EGLL      -0.439940
          EHAM      -0.359222
          LEMD      -0.466047
          LFPG      -0.415393
          LGAV      -0.479257
          LIRF      -0.535114
          dtype: float64
```

```
Out [25]:          adf      adf*      p-val
EDDF -14.6971 -2.58166 2.87371e-26
EGKK  -9.02414 -2.58201 1.51866e-15
EGLL -11.492  -2.58178 7.10354e-21
EHAM -11.0553 -2.58166 5.51914e-20
LEMD -12.7711 -2.58178 2.71072e-23
LFPG -14.976  -2.58166 1.27347e-26
LGAV  -6.22863 -2.58276 3.03741e-09
LIRF -12.5793 -2.58166 5.96601e-23
```


3.2 Time-frequency analysis



4 Data-driven Poisson model

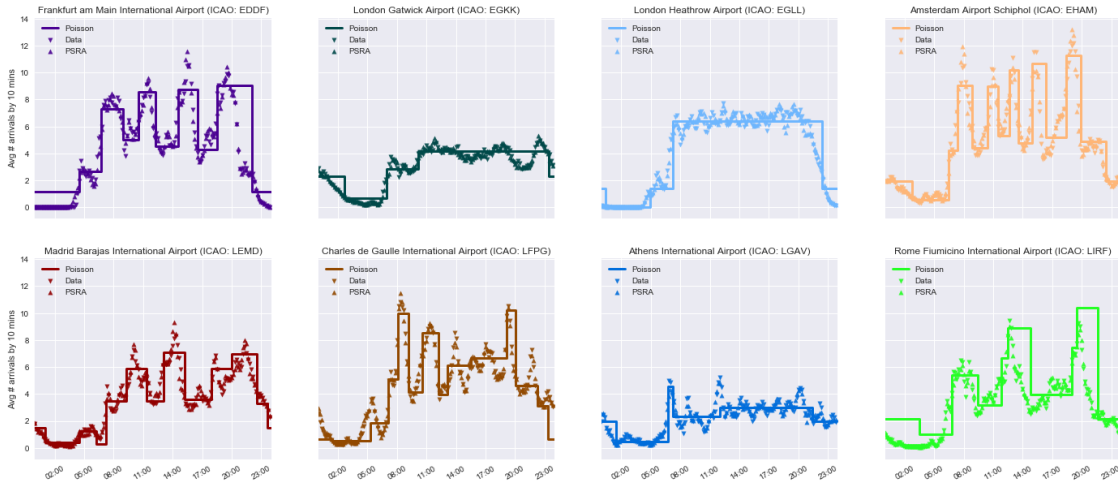


```
Out[29]:
```

	lambda
icao time	
EDDF 04:32 UTC+02	0.2657 aircraft/min
06:41 UTC+02	0.7325 aircraft/min
08:55 UTC+02	0.4991 aircraft/min
10:33 UTC+02	0.8550 aircraft/min
12:14 UTC+02	0.4530 aircraft/min

5 Poisson vs. Pre-Scheduled Random Arrivals

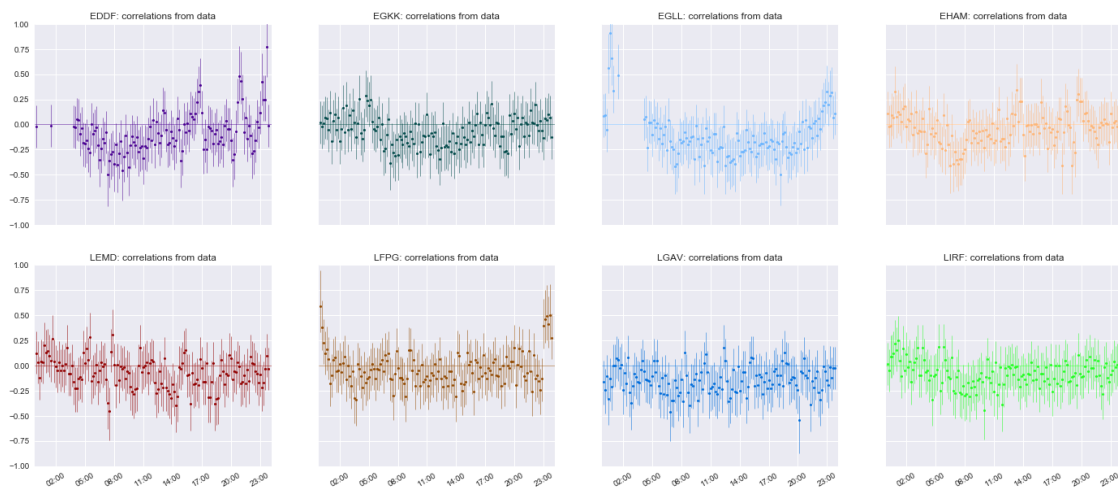
5.1 Average daily demand from data and simulations



5.2 Correlations imposed by capacity constraints

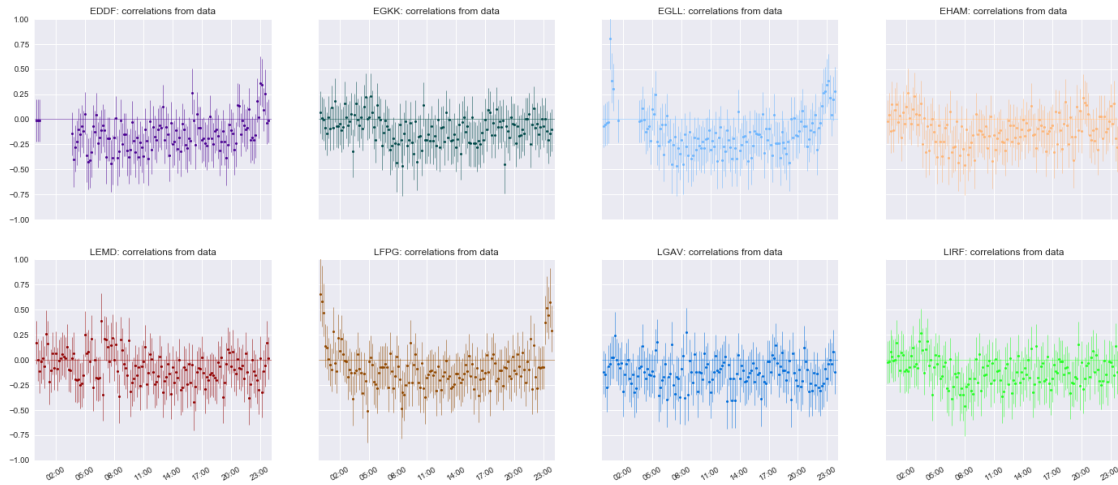
5.2.1 Observed correlations in the *current* flight plan

```
/Users/clancia/anaconda3/envs/interopy/lib/python3.6/site-packages/numpy/lib/function_base.py:
c /= stddev[:, None]
/Users/clancia/anaconda3/envs/interopy/lib/python3.6/site-packages/numpy/lib/function_base.py:
c /= stddev[None, :]
```



5.2.2 Observed correlations in the *regulated* flight plan

```
/Users/clancia/anaconda3/envs/interopy/lib/python3.6/site-packages/numpy/lib/function_base.py:
c /= stddev[:, None]
/Users/clancia/anaconda3/envs/interopy/lib/python3.6/site-packages/numpy/lib/function_base.py:
c /= stddev[None, :]
```



5.2.3 Correlations from simulations of PSRA

```
/Users/clancia/anaconda3/envs/interopy/lib/python3.6/site-packages/numpy/lib/function_base.py:
c /= stddev[:, None]
/Users/clancia/anaconda3/envs/interopy/lib/python3.6/site-packages/numpy/lib/function_base.py:
c /= stddev[None, :]
```

