



AIRLINES SERVICES

Proposed by <https://www.appsintellect.org/>

6th August 2023

User Manual Version 3.2

GOALS

* Firefox is recommended

Using one unique web based / database tool, accessible from any browser *, Airlines can:

- Configure their fleet, aircraft types, hourly operational costs, crew costs, turn around times
- Plan graphically their routes using a 3 Dimensions map,
- Exploit main results from a 4 Dimensions trajectory such as trip duration, distance flown, fuel consumptions, etc.
- Choose the best aircraft
 - to minimize Costs,
 - to minimize Costs per Available Seat Miles,
 - to maximize Seat Miles
- Support flight leg planning through fuel estimation
- ...

Benefits of a full-fledged interactive 3D Globe with street maps hence runways

BROWSER RECOMMENDATION

AVOID BROWSER ERROR RAISED WHEN TRYING TO ACCESS [OPEN STREET MAP TILES](#)

Context : [open street map](#) is one of the “tile” providers to support displaying geo referenced map over the globe

Problem manifestation : no underlying map appears when the open globus map is displayed

Verification : you are using one the following browser : edge, chrome, others but not using firefox

Confirmation: open the browser web tools and select the console tool

Access to fetch at '<https://c.tile.openstreetmap.org/6/10/23.png>' from origin '<https://airlineservices.eu.pythonanywhere.com>' has been blocked by CORS policy:

No 'Access-Control-Allow-Origin' header is present on the requested resource.

If an opaque response serves your needs, set the request's mode to 'no-cors' to fetch the resource with CORS disabled.
<https://c.tile.openstreetmap.org/6/10/23.png>:l

Failed to load resource: net::ERR_FAILED

To ensure displaying globe with underlying street map , recommendation is to use FireFox

TOOL MAIN CONFIGURATION

3 different airlines have been configured with different parameters – for demonstration purpose

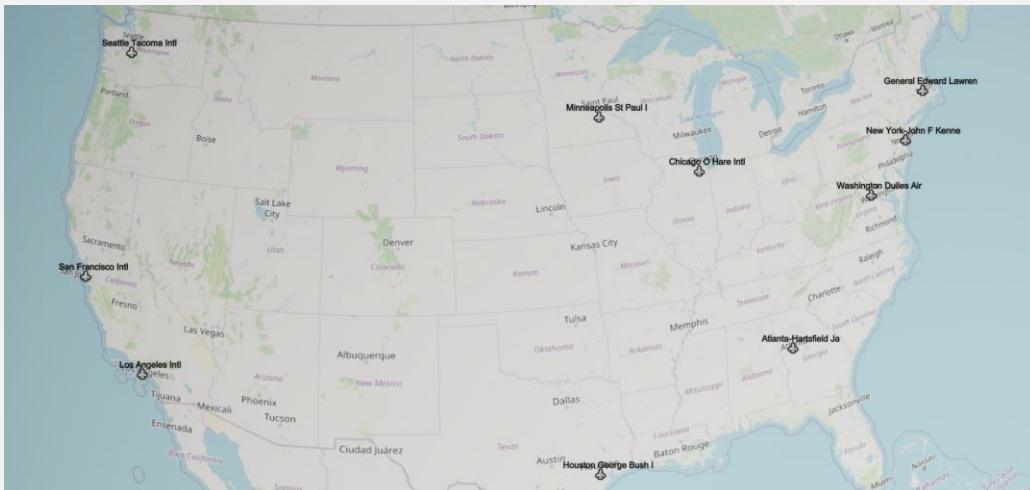
Airline Configuration data is stored in a SQL database

AmericanWings

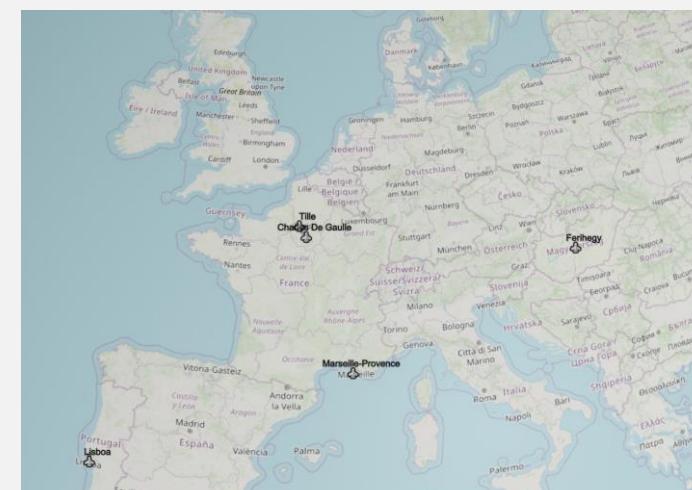
AmericanWings
EuropeanWings
IndianWings

Each airline has its own map initial limits

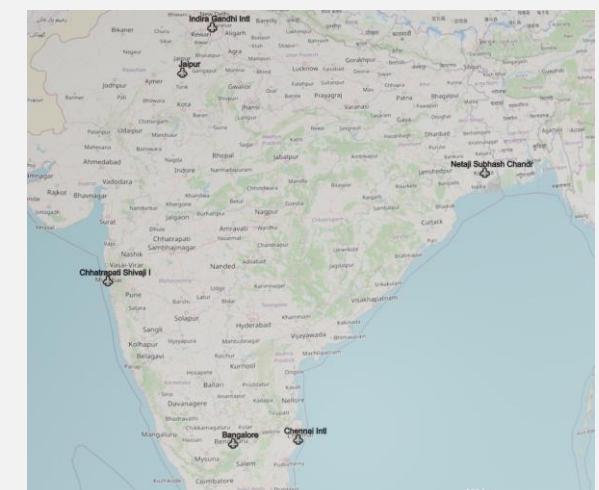
AmericanWings



EuropeanWings



IndianWings



Future: changing the airline will zoom again to see all the airline's airports

(ONLINE) HELP & CONFIGURATION

Click here to move → Main navigation bar → click to download a User Manual → 

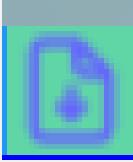
Configuration Informations

Configuration

This help is displayed each time the user clicks on the exclamation mark  available in the upper right corner of the navigation bar.

- ▶ Fleet Configuration
- ▶ Airports & Routes Configuration
- ▶ WayPoints Configuration
- ▶ Costs
- ▶ Airports & Runways Configuration
- ▶ Aircraft Configuration
- ▶ Optimizations

Right end of main menu bar



help

Click to get this presentation in pdf format

Help Informations

Help

This help is displayed each time the user clicks on the question mark  available in the upper right corner of the navigation bar.

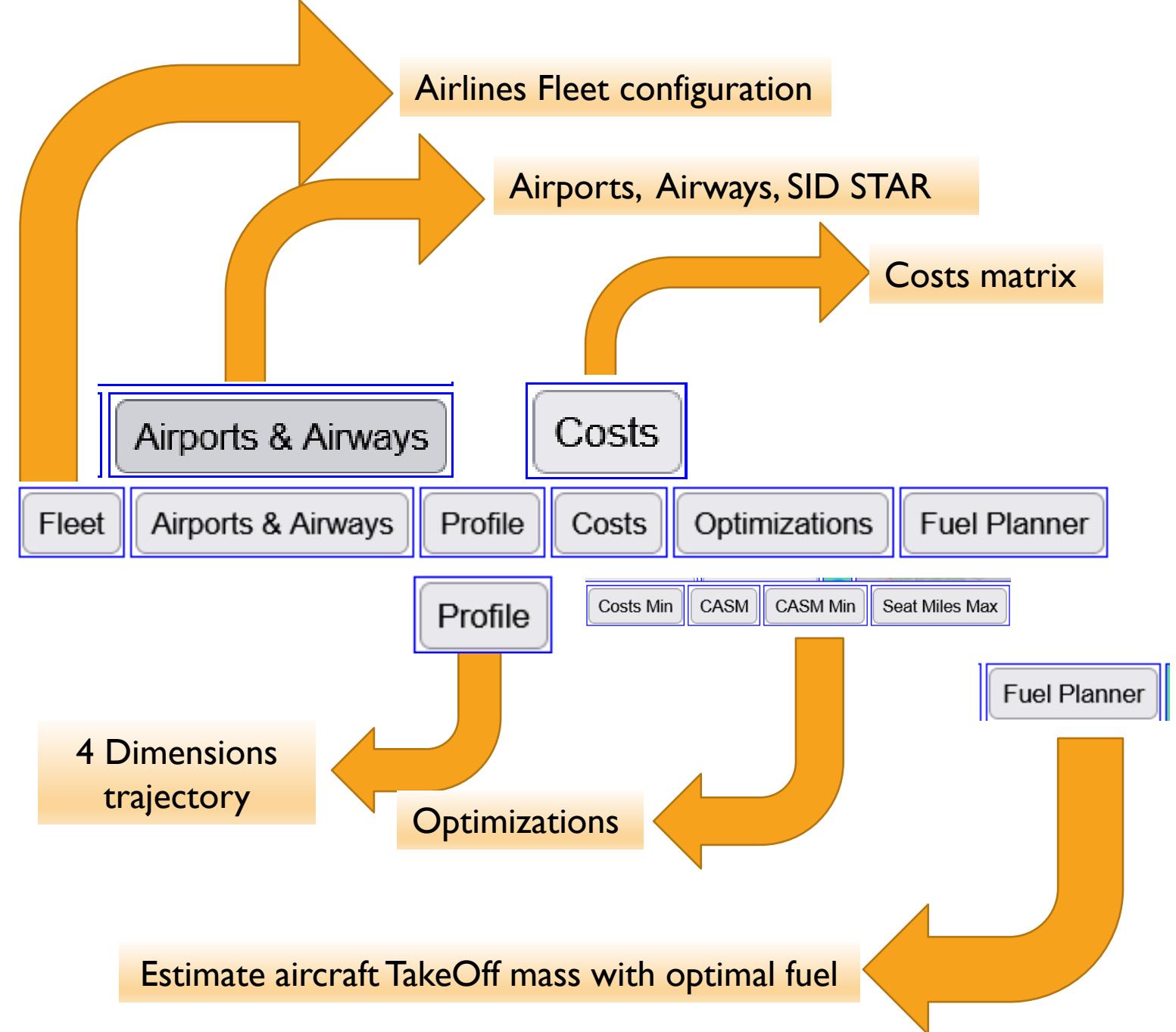
▼Goals

This highly configurable tool allows to build a fleet of aircrafts with departure and arrival airports and their routes. For each flight leg, the tool computes a detailed 4 dimensions lateral and vertical profile. For each leg, it is possible to select a departure and an arrival runway. It is possible also to select a takeoff mass and a cruise level.

For each aircraft, configuration includes hourly operational costs, crew costs. Fuel costs are based upon aircraft mass losses as computed at the end of each simulation. The flight profile provides duration, distance flown and with mass loss, it is allowing to compute overall costs. Current optimizations are focused upon minimizing costs or Cost per Available Seat Mile. Optimizations allow the selection of the best aircraft for each flight leg in order to minimize for instance Costs per Available Seat Miles.

Note: Due to the size of some results table, usability of this tool is optimal on a desktop, laptop computer or a tablet.

MAIN MENU BAR



CONFIGURATION

AIRLINE FLEET CONFIGURATION

Aircraft
ICAO
code

Aircraft ICAO code is used to access aircraft performance data

Values are loaded into a database

Values are specific to each airline

Click here to move -> Airline Fleet Configuration

Click to hide

Airline	Aircraft ICAO Code	Aircraft Full Name	Number of Aircrafts	Number of Seats	Flying Costs per Hour (US\$)	Crew Costs per Hour (US\$)	Minimum Take Off Mass (kg)	Reference Mass (kg)	Maximum Take Off Mass (kg)	Aircraft Turn Around Time (min)
AmericanWings	A320	Airbus A320	2	157	2840	1657	39000	64000	77000	25
AmericanWings	A332	Airbus A330-200	3	234	3300	1857	120600	190000	230000	35
AmericanWings	B738	Boeing 737-800	4	160	3010	1557	41150	65300	78300	25

Not yet used

Used to compute CASM

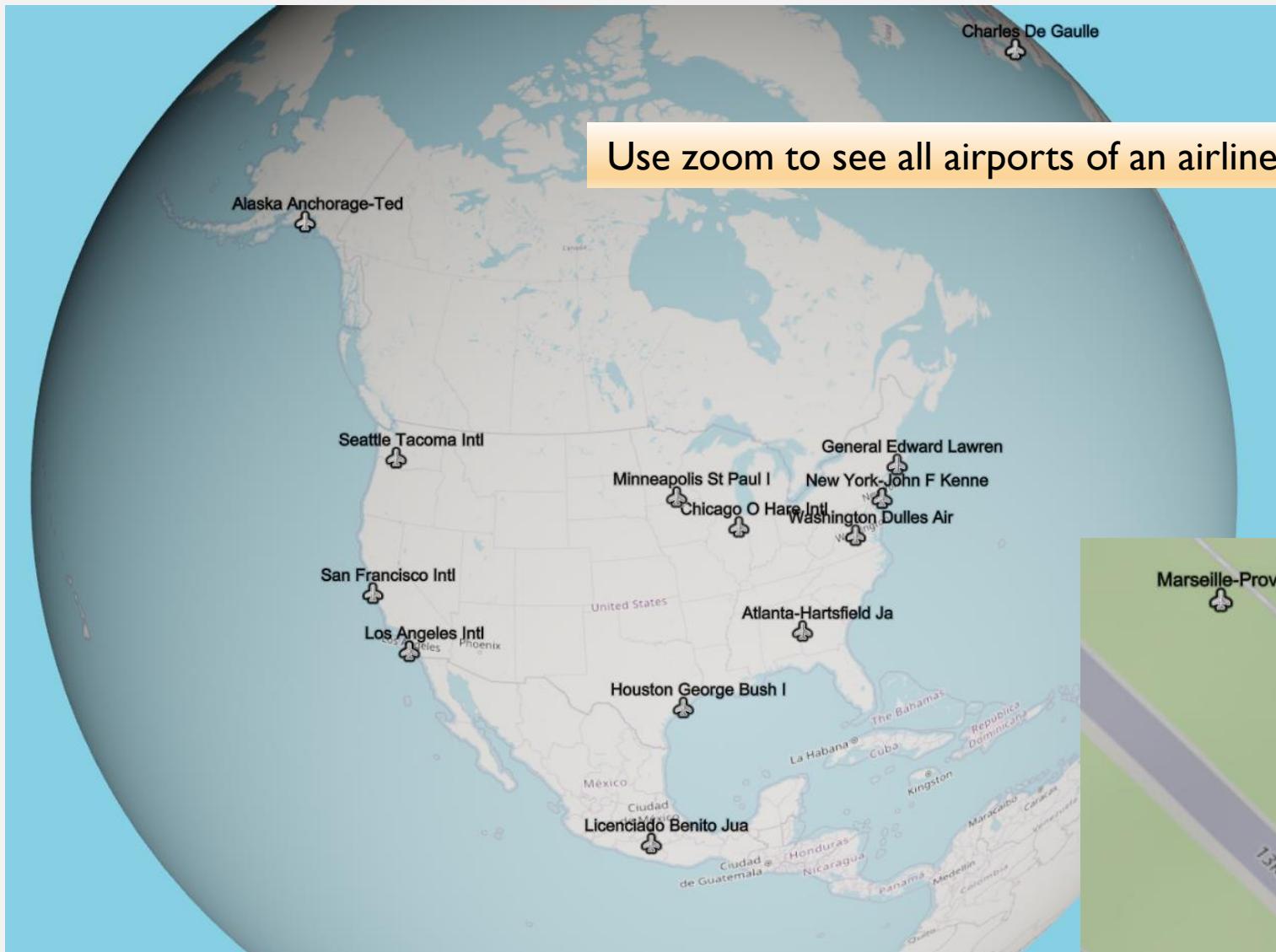
CASM : Cost per Available Seat Miles

Used to compute costs

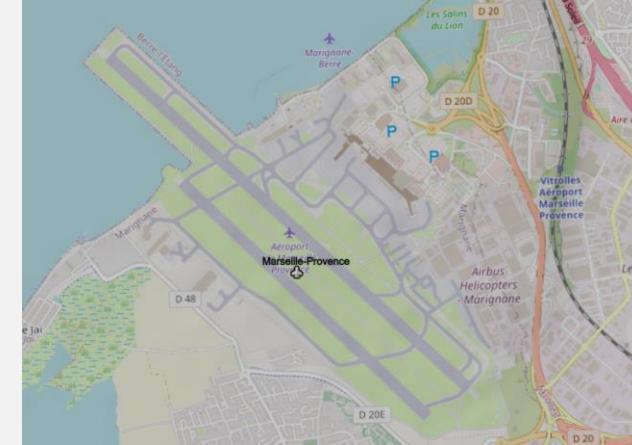
Used to compute profiles

Used to compute airport turn around times -> used to compute Seat Miles

AIRLINE AIRPORTS – MAIN VIEWPORT CONFIGURATION



Street map appears only when « sufficient » zoom is set – street map tile must be available

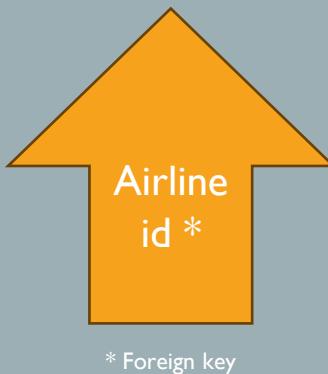
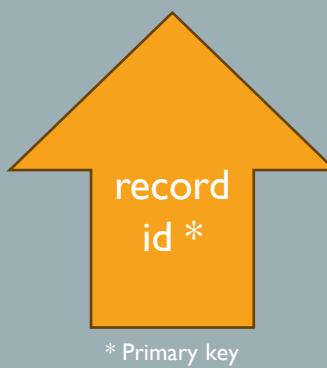


AIRLINES ROUTES

Defines the departure and arrival airports for each airline flight leg / route

Example of database extract for Routes

	id [PK] integer	DepartureAirport character varying	DepartureAirportICAOCode character varying	ArrivalAirport character varying	ArrivalAirportICAOCode character varying	airline_id integer
1	23	Atlanta-Hartsfield Jackson Intl	KATL	Los Angeles Intl	KLAX	4
2	24	New York-John F Kennedy Intl	KJFK	Seattle Tacoma Intl	KSEA	4
3	25	Aeropuerto México Ciudad Intl	MMMX	Seattle Tacoma Intl	KSEA	4
4	26	General Edward Lawrence Logan Intl	KBOS	Atlanta-Hartsfield Jackson Intl	KATL	4
5	27	Houston George Bush Intl	KIAH	Chicago O'Hare Intl	KORD	4
6	28	Washington Dulles Airport Intl	KIAD	San Francisco Intl	KSFO	4



HOW TO ACCESS A ROUTE FROM THE MAIN MENU

Airports & Airways

Click here to move Airline Routes Configuration

Airline	Departure Airport	ICAO	SID	Best RunWay	Destination Airport	ICAO	STAR	Best RunWay	Action
AmericanWings	Atlanta-Hartsfield Jackson Intl	KATL		27R	Los Angeles Intl	KLAX		07L	Show

Best runway also displayed on the map

Best runway computation based upon distance from runway end to first / last waypoint of the route

Click to show / hide the way points on the map

SQL Database table view

	WayPointName [PK] character varying	Type character varying	Latitude double precision	Longitude double precision	Continent character varying
343	VLN	WayPoint	50.66/005555555555	-104.889/1111111111	North America
344	VORIN	WayPoint	41.548002777777775	-89.336375	North America
345	VUZ	WayPoint	33.67013055555555	-86.89983611111111	North America



SID STAR -> CLICK TO SEE AIRPORT PROCEDURES

Click here to move Airline Routes Configuration

Airline	Departure Airport	Adep	SID	Best RunWay	Destination Airport	Ades	STAR	Best RunWay	Action
EuropeanWings	Charles-De-Gaulle-France	LFPG	LFPG/26L/ERIXU	26L	Lisbonne-Lisboa-Portugal	LPPT		02	Show

SID

Click to see the SID on the map

Click here to move Airline Routes Configuration

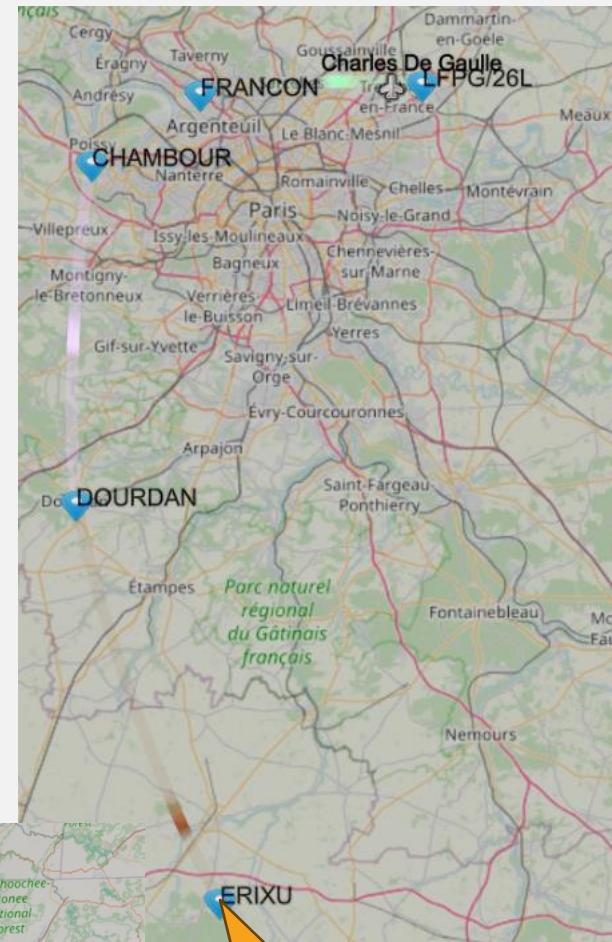
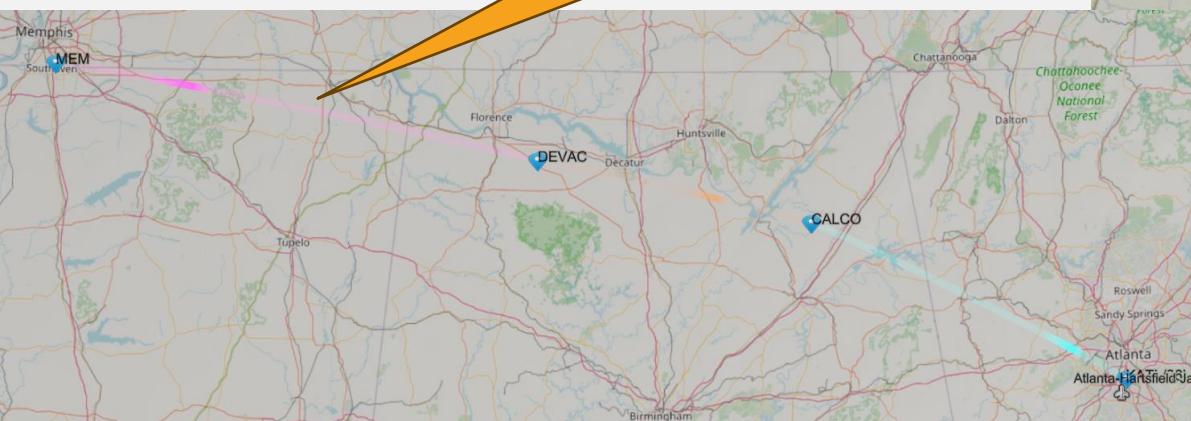
Airline	Departure Airport	Adep	SID	Best RunWay	Destination Airport	Ades	STAR	Best RunWay	Action
AmericanWings	Los Angeles Intl	KLAX	KLAX/24R/SLI	07L	Atlanta-Hartsfield Jackson Intl	KATL	KATL/26L/MEM	27R	Show

SID

Click to see the SID on the map

STAR

Click to see the STAR on the map



STAR starting from LFPG 26L and joining ERIXU first waypoint of the flight leg

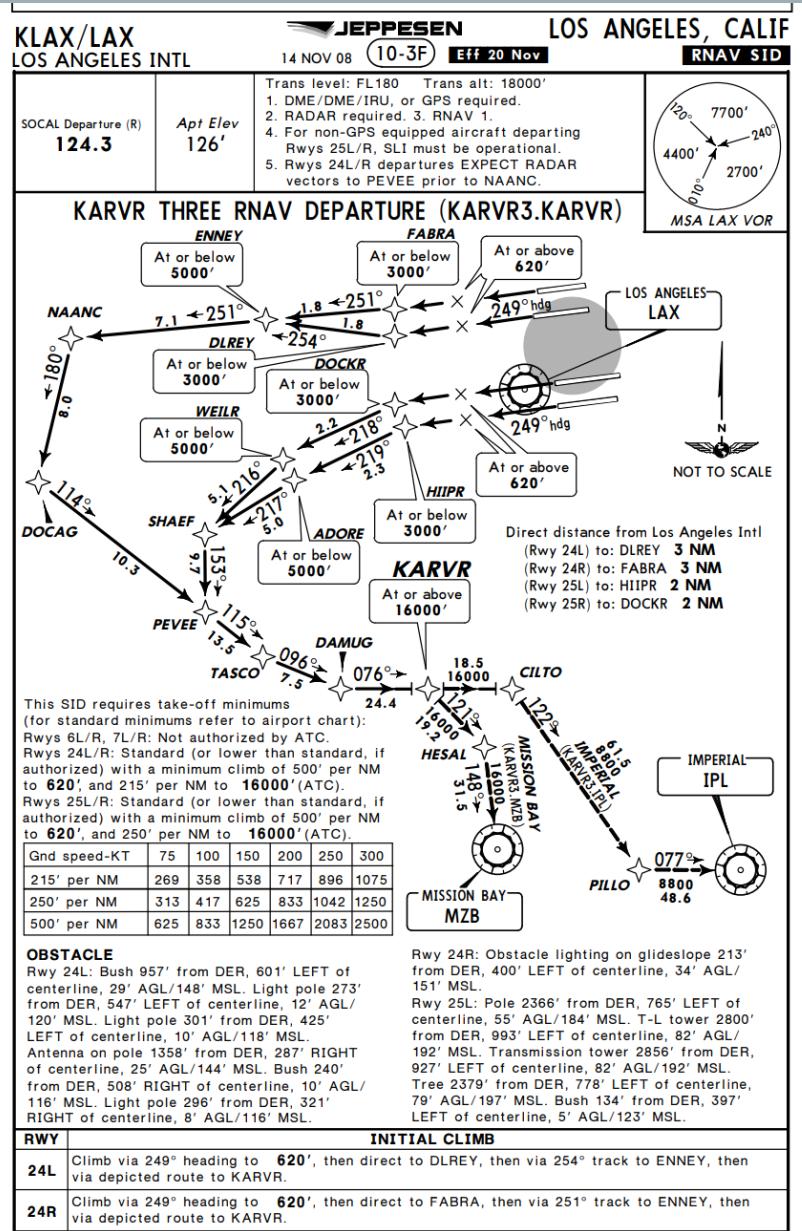
SID PURPOSE

Purpose : avoid noise and air pollution over crowded suburbs

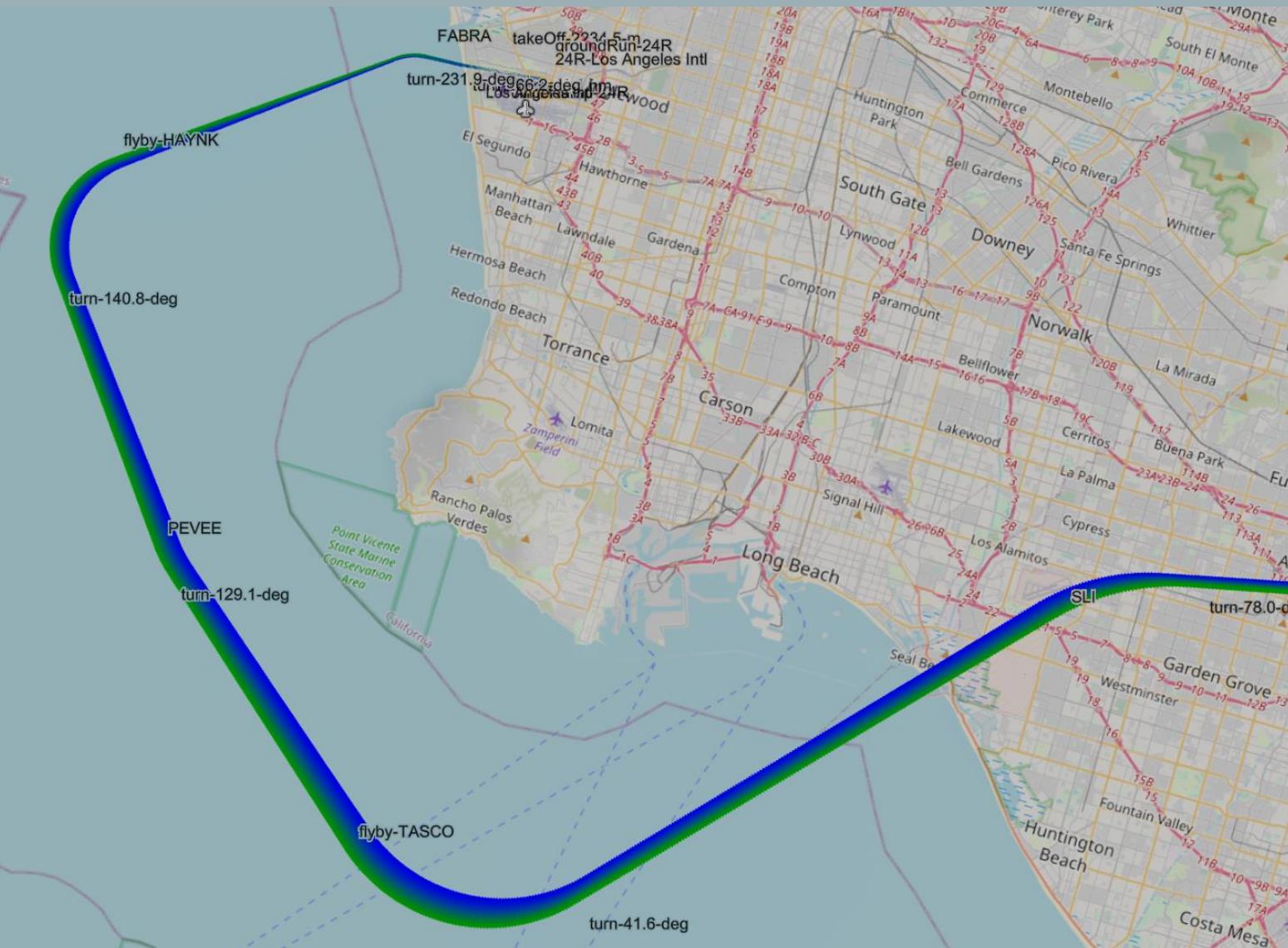
Example : taking off from Los Angeles with sea head wind, aircraft following a SID will climb with reduced speed hence reduced noise pollution over the sea before turning back to the land to join the flight leg first way point

See an example on the next slide

STANDARD INSTRUMENT DEPARTURE SID EXAMPLE : LOS ANGELES KLAX/24R TO SLI



Warning : outdated Jeppesen departure chart for demonstration purpose only



SID & STAR

SID waypoints are inserted in the fix list as soon as :

- 1) Departure airport is matching SID airport
- 2) Departure runway is matching SID runway
- 3) First fix of the route is matching last waypoint of the SID

STAR waypoints are inserted in the fix list as soon as :

- 1) Arrival airport is matching STAR airport
- 2) Arrival runway is matching STAR runway
- 3) Last fix of the route is matching first waypoint of the STAR

Airline Fix list from KLAX to KATL

**SLI-AHEIM-OLLIE-POXKU-EBITE-PDZ-CIVET-RUSTT-
PIONE-TNP-CADEZ-HIPPI-DRK-PYRIT-ZUN-ABQ-TCC-PNH-
CRUSR-IRW-DWINE-KLUBB-KOMMA-LIT-GEEYY-**MEM****

SID from
KLAX/24R
to SLI

KLAX/24R

departure

STAR from
MEM to
KATL/26L

arrival

KATL/26L

SID & STAR DATA

SID & STAR are not related to any airline route

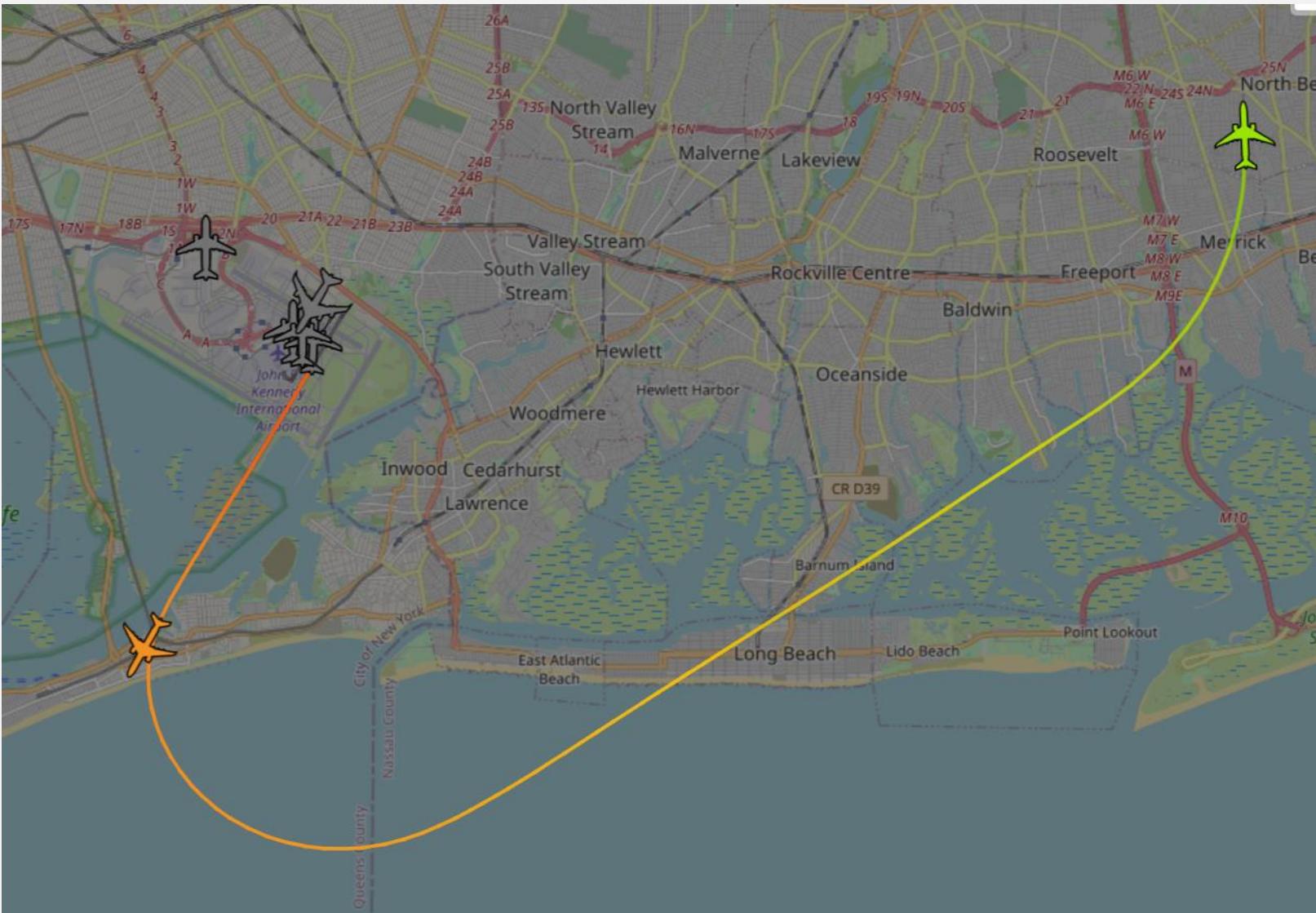
	id [PK] integer	isSID boolean	DepartureArrivalAirport_id character varying	DepartureArrivalRunWay_id integer	FirstLastRouteWayPoint_id character varying
1	19	true	KLAX	1168	SLI
2	20	false	KATL	1122	MEM



Id(s) are allowing to establish Database relationships
between related tables

	id [PK] integer	Order integer	WayPointName character varying	LatitudeDegrees double precision	LongitudeDegrees double precision	Route_id integer
1	25	0	KLAX/24R	33.95209884643555	-118.4020004272461	19
2	26	1	FABRA	33.94638888888888	-118.46708333333333	19
3	27	2	ENNEY	33.94461111111111	-118.5078888888889	19
4	28	3	NAANC	33.93166666666665	-118.6438888888889	19
5	29	4	HAYNK	33.84075000000001	-118.63791666666668	19
6	30	5	PEVEE	33.69722222222216	-118.52083333333333	19
7	31	6	TASCO	33.55361111111111	-118.31277777777777	19
8	32	7	SLI	33.78329722222224	-118.05475555555556	19
9	33	1	MEM	35.01511666666664	-89.98320833333332	20
10	34	2	DEVAC	34.61830555555556	-87.43516666666667	20
11	35	3	CALCO	34.34525777777777	-86.01936666666667	20
12	36	4	HERKO	33.06907500000005	-86.84538055555555	20
13	37	5	KATL/26L	33.64680099487305	-84.40550231933594	20

NEW YORK - JOHN FITZGERALD KENNEDY - 22R - SID



SID is defined to avoid noise and air pollution over crowded suburbs while aircraft is flying low

STANDARD ARRIVAL STAR (ATLANTA KATL/26L)

MEM

turn-100.5-deg

DEVAC

turn-103.1-deg

CALCO

flyby-ERLIN

turn-107.2-deg

turn-123.9-deg

slope-1738.1-NmL
26L-Atlanta-Hartsfield

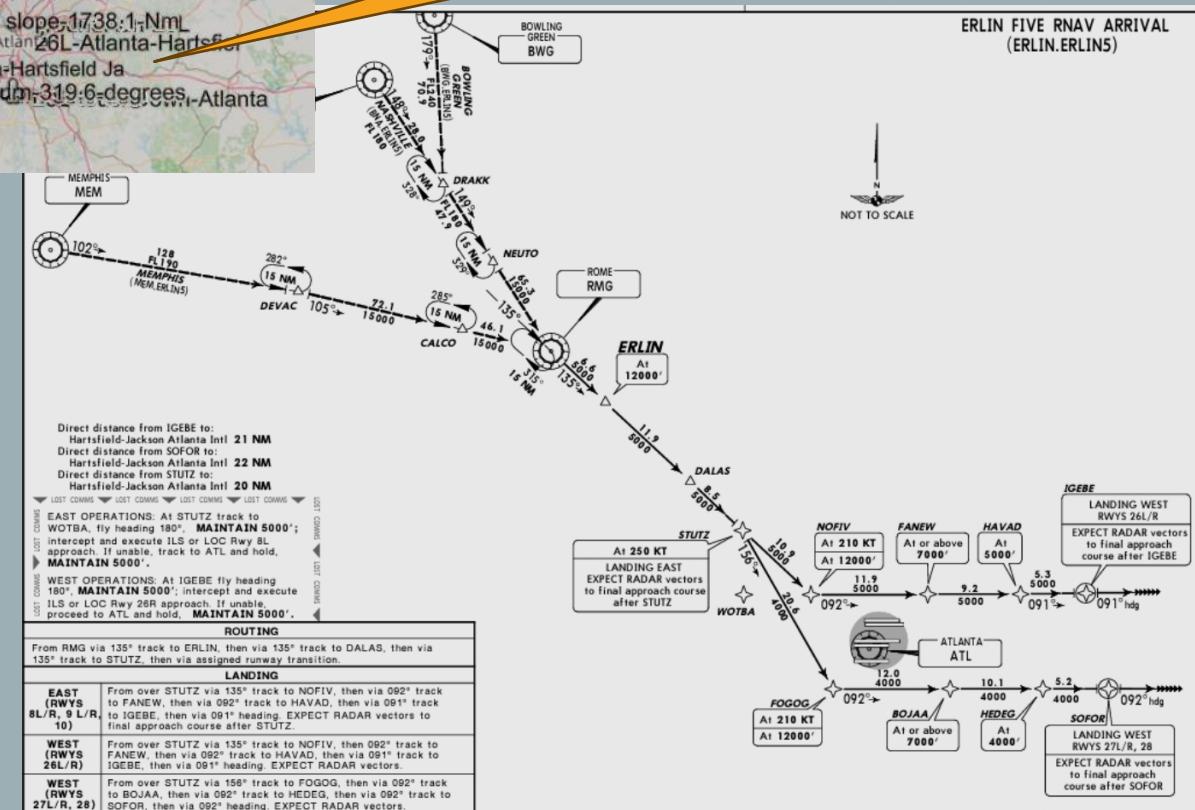
Atlanta-Hartsfield Ja
tdm-319.6-degrees-Atlanta

STAR waypoint

Arrival runway = 26L
~ 270 degrees true heading

Mem – Memphis is the last waypoint of the flight leg

Warning : outdated Jeppesen arrival chart



HOW TO ACCESS A ROUTE FROM THE MAP (USING A RIGHT CLICK ON AN AIRPORT)



Right click on an airport
to see routes starting / ending at this airport

Hover over the airport until mouse pointer changes to "hand", then right click to access a contextual menu

Airline	direction	action	Departure Airport	ICAO	Arrival Airport	ICAO
AmericanWings	⬅	show / hide route	New York-John F Kennedy Intl	KJFK	Seattle Tacoma Intl	KSEA
AmericanWings	➡	show / hide route	Seattle Tacoma Intl	KSEA	New York-John F Kennedy Intl	KJFK
AmericanWings	⬅	show / hide route	Aeropuerto México Ciudad Intl	MMMX	Seattle Tacoma Intl	KSEA

Note: a route is mono directional

Note: the table disappears as soon as the mouse moves leaves the table area

Click on the link to see / hide the location of the waypoints on the map



AIRPORTS CONFIGURATION DATA

Example of database content for Airports



	AirportICAOcode [PK] character varying	AirportName character varying	Latitude double precision	Longitude double precision	FieldElevationAboveSeaLevelMeters double precision	Continent character varying
1	KATL	Atlanta-Hartsfield Jackson Atlanta Intl	33.636719	-84.428067	312.7248	United States
2	KBOS	General Edward Lawrence Logan Intl	42.364347	-71.005181	5.7912	United States
3	KIAD	Washington Dulles Airport Intl	38.944533	-77.455811	95.4024	United States
4	KIAH	Houston George Bush Intl	29.984433	-95.341442	29.5656	United States
5	KJFK	New York-John F Kennedy Intl	40.639751	-73.778925	3.9624	United States
6	KLAX	Los Angeles Intl	33.942536	-118.408075	38.4048	United States
7	KMSP	Minneapolis St Paul Intl	44.881956	-93.221767	256.33680000000004	United States
8	KORD	Chicago O'Hare Intl	41.978603	-87.904842	203.6064	United States
9	KSEA	Seattle Tacoma Intl	47.449	-122.309306	131.9784	United States
10	KSFO	San Francisco Intl	37.618972	-122.374889	3.9624	United States



Name displayed on the map

* PK = Primary key

Each airport is defined by a unique 4 letters ICAO code

RUNWAYS CONFIGURATION DATA

Example of database content for KATL – Atlanta runways

degrees

True heading is the angle computed from the geographical north to the orientation of the runway

	id [PK] integer	Name character varying	LengthFeet double precision	TrueHeadingDegrees double precision	LatitudeDegrees double precision	LongitudeDegrees double precision	Airport_id character varying
1	1	08L	9000	90	33.64950180053711	-84.43900299072266	KATL
2	2	26R	9000	270	33.64950180053711	-84.40950012207031	KATL
3	3	08R	10000	90	33.64680099487305	-84.43840026855469	KATL
4	4	26L	10000	270	33.64680099487305	-84.40550231933594	KATL
5	5	09L	11890	90	33.634700775146484	-84.447998046875	KATL
6	6	27R	11890	270	33.634700775146484	-84.40889739990234	KATL
7	7	09R	9001	90	33.63180160522461	-84.447998046875	KATL
8	8	27L	9001	270	33.63180160522461	-84.41840362548828	KATL
9	9	10	9000	90	33.62030029296875	-84.4478988647461	KATL
10	10	28	9000	270	33.62030029296875	-84.41829681396484	KATL



For one airport, number of Runways contributes to compute the airport turn around time specific part

Future : number of runways per airport will be used to compute Block Hour from trip duration

WAYPOINTS CONFIGURATION DATA

Example of database content for waypoints (one data table for all airlines)

Waypoints configuration are common for all airlines routes

	WayPointName [PK] character varying	Type character varying	Latitude double precision	Longitude double precision	Continent character varying
1	47N050W	WayPoint	47.5	-50	Europe
2	49N040W	WayPoint	49.5	-40	Europe
3	51N030W	WayPoint	51.5	-30	Europe
4	52N020W	WayPoint	52.5	-20	Europe
5	ABQ	WayPoint	35.04379444444444	-106.8163111111112	North America
6	ABR	WayPoint	45.41735277777778	-98.36871944444444	North America
7	ADUKE	WayPoint	31.882430555555555	-94.21646666666666	North America
8	AGROM	WayPoint	22.529163888888885	84.83330555555555	India
9	AHEIM	WayPoint	33.82031388888889	-117.91197222222222	North America
10	ALBED	WayPoint	18.11721944444444	78.6566638888889	India
11	ALEPO	WayPoint	42.343608333333336	-1.963333333333334	Europe
12	AMDID	WayPoint	48.09721944444445	12.396944444444443	Europe
13	ANDAV	WayPoint	17.471666666666664	78.81361111111111	India

Warning: waypoint name (as a key) must be unique for all routes / all flight legs

4 DIMENSIONS TRAJECTORY COMPUTATION

Dimensions are

- 1) Latitude
- 2) Longitude
- 3) altitude above mean sea level
- 4) a relative time stamp for each previous 3D point with time reference defined as start of departure ground

PHASES OF FLIGHT EXTRACT FROM EUROCONTROL SKY LIBRARY

Choice is made to start phases when aircraft is on the runway, and pilot receives clearance to take off from air Traffic controllers

First phase called « ground run » starts when engine power is applied and until aircraft achieves rotation speed -> aircraft nose rises above the runway

Second phase called « take off » when aircraft leaves the ground run until it reaches an altitude of 35 feet above the runway (obstacle clearance) or until landing gear is retracted (whatever comes first)

Third phase called « climb ramp » where aircraft climbs along a 6-8 degrees ramp until its distance from runway is greater than 5 nautical miles or Standard Instrument Departure comes into play

Next phase called « SID » follows Standard Instrument Departure waypoints until first flight leg waypoint is reached

...

REDUCED CLIMB POWER COEFFICIENT

Experimental feature

Warning : this is an experimental feature, hence it could be removed in the future

Click here to move -> Flight Profile Computation

Click to hide

Select the aircraft -> Airbus A320	Enter Reduced Climb Power % -> 15
min -> 39000 TakeOff Mass (kg) -> 64000 max -> 77000	Requested Flight Level (feet) -> 39000 max -> 39000
KATL Route Selector -> Atlanta-Hartsfield Jackson Intl -> Los Angeles Intl	KLAX
Departure RunWay -> 08L -> 90 degrees True Heading	Arrival RunWay -> 06L -> 83 degrees True Heading
Compute Flight Profile	Compute Costs
Download Vertical Profile	Download KML

Reduced Climb Power coefficient

Click here to move -> Flight Leg Costs Computation

Click to hide

Airline	Aircraft	Seats	Adep	RunWay	Ades	RunWay	Is Aborted	TakeOff Mass Kg	Cruise Level ft	Climb Power %	Final Mass Kg	Lost Mass Kg	Fuel Costs US\$	Flight Duration Hours	Flying Costs US\$	Crew Costs US\$	Total Costs US\$
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	15	54707.9	9292.1	9966	4.0675	11552	6740	28257
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	14	54730.4	9269.6	9942	4.0959	11632	6787	28361
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	13	54739	9261	9932	4.1078	11666	6807	28405
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	12	54740.8	9259.2	9931	4.1095	11671	6809	28411
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	11	54739.6	9260.4	9932	4.1128	11680	6815	28427
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	10	54740.1	9259.9	9931	4.1161	11690	6820	28442
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	9	54739.8	9260.2	9932	4.1186	11697	6825	28453
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	8	54737.9	9262.1	9934	4.122	11706	6830	28470
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	7	54736.3	9263.7	9935	4.1253	11716	6836	28487
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	6	54734.9	9265.1	9937	4.1281	11724	6840	28501
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	5	54732.6	9267.4	9939	4.1311	11732	6845	28517
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	4	54729.6	9270.4	9943	4.1339	11740	6850	28533
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	3	54726.1	9273.9	9946	4.1375	11751	6856	28553
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	2	54722.4	9277.6	9950	4.1409	11760	6861	28572
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	1	54718.2	9281.8	9955	4.1439	11769	6866	28590
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	39000	0	54714.2	9285.8	9959	4.1473	11778	6872	28609

Reduced Climb Power coefficient

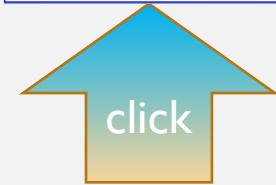
Reduced Climb Power coefficient

Impact analysis of Reduced Climb Power coefficient settings from 0% (full power) to 15% of reduced climb power

4 DIMENSIONS TRAJECTORY (CORE FEATURE)

Click here to move > Flight Profile Computation

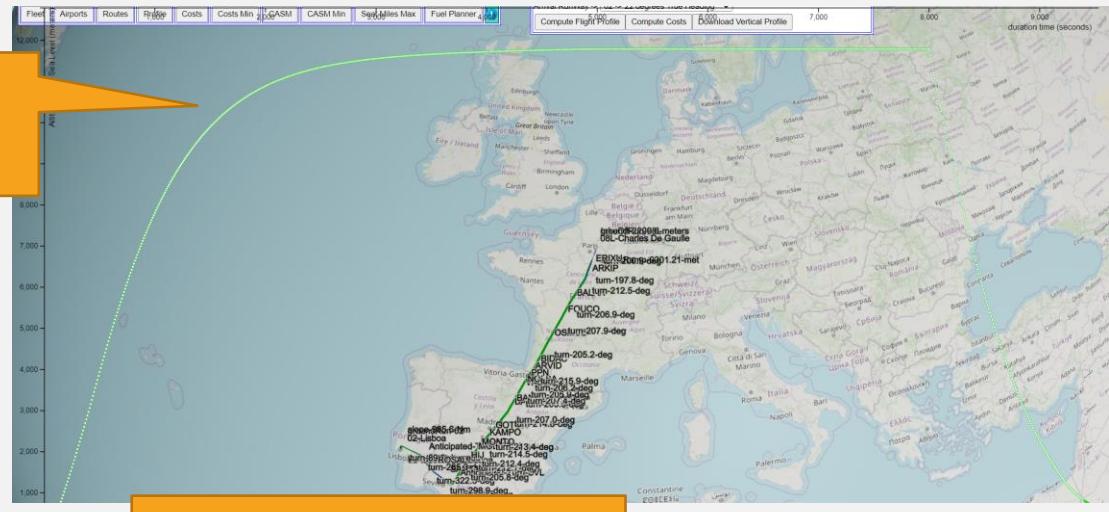
Select the aircraft -> Airbus A320	Enter Reduced Climb Power % -> 0
min -> 39000 TakeOff Mass (kg) -> 64000 max -> 77000	Requested Flight Level (feet) -> 39000 max -> 39000
KATL Route Selector -> Atlanta-Hartsfield Jackson Intl -> Los Angeles Intl	KLAX
Departure RunWay -> 08L -> 90 degrees True Heading	Arrival RunWay -> 06L -> 83 degrees True Heading
Compute Flight Profile	Compute Costs
Download Vertical Profile	Download KML



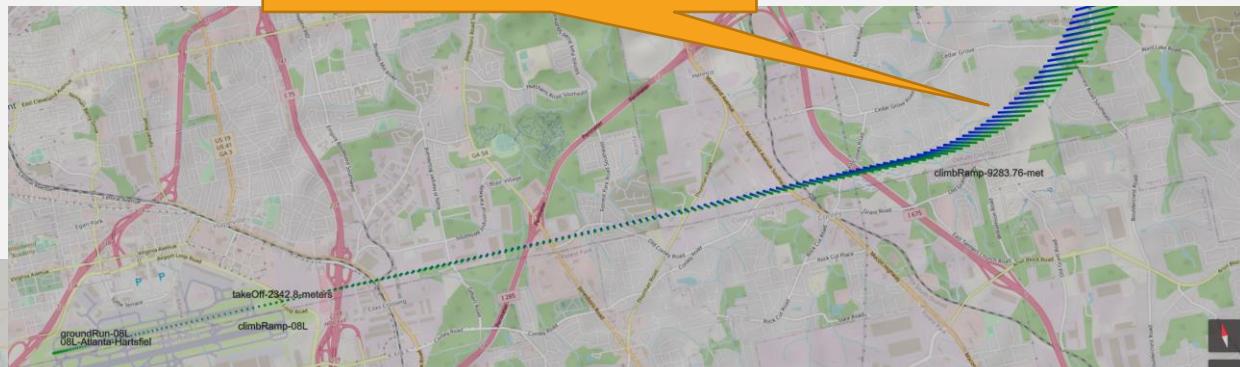
Time Reference

	elapsed-time-seconds	altitude-MSL-meters	altitude-MSL-feet
	57	125,9735776	413,2991396
	58	132,4804677	434,6472044
	59	139,0022023	456,0439714
	60	145,5387129	477,4892162
	61	152,0899309	498,9827137
	62	158,6557876	520,5242384
	63	165,2362141	542,1135641
	64	171,8311411	563,7504639
	65	178,2942447	584,954872
	66	184,7753603	606,2183745
	67	191,2744371	627,540805
	68	197,791424	648,9219957
	69	204,3262696	670,3617778

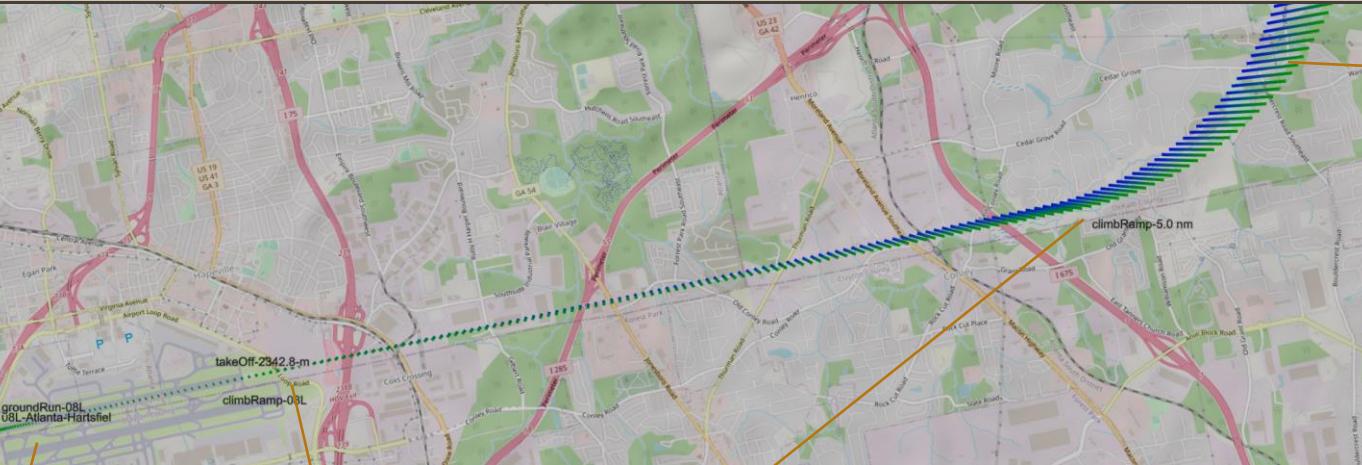
Lateral Route



Ground Track



4 DIMENSIONS TRAJECTORY (CORE FEATURE)



Ground run

Takeoff

8 degrees Climb Ramp on an approx. distance of 5 nautics

First turn – radius dependent of speed



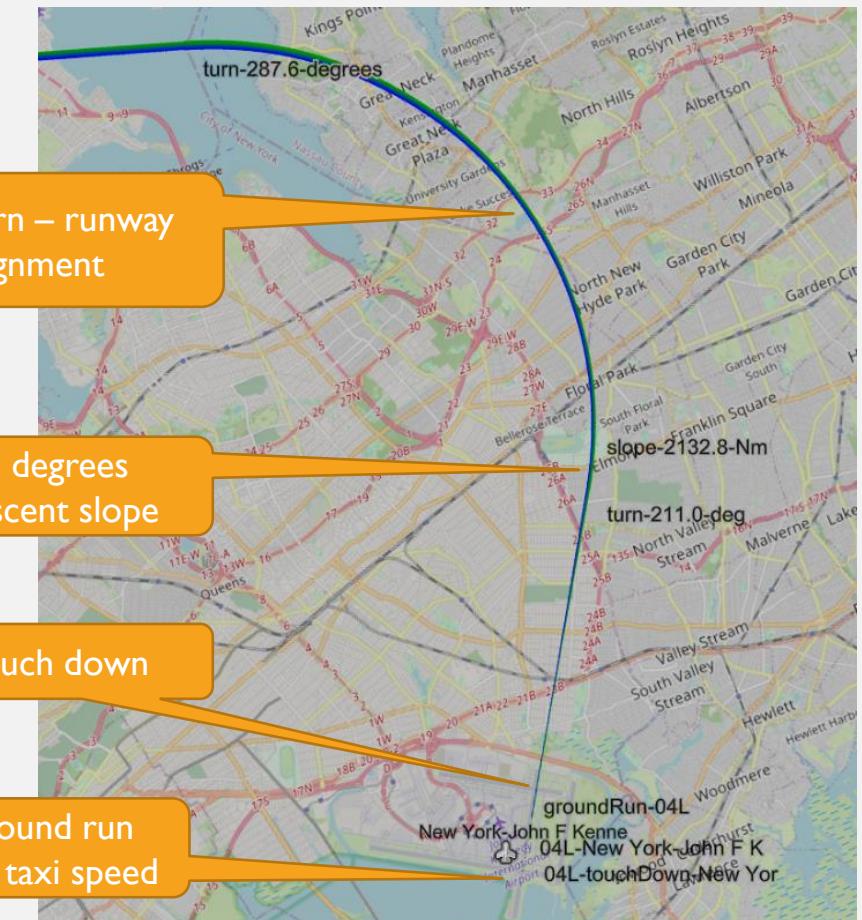
Great circle

turn radius dependent of true speed and bank angle

Great circle

Ground run until taxi speed

Last turn – runway alignment



4 DIMENSIONS TRAJECTORY (GROUND RUN)



Airbus A330-200 - TakeOff Mass = 190 tons

Mexico – Mean Sea Level = 2230 meters

Ground Run = 2661,8 meters

TakeOff Speed CAS = 117 knots

TakeOff True Air Speed = 81.21 m/s

Explanation: Air density is lower at Mexico airport MSL = 2230 meters -> true speed must be higher before the take-off

NB :Temperature not yet used

Airbus A330-200 - TakeOff Mass = 190 tons

JF Kennedy – Mean Sea Level = 4 meters

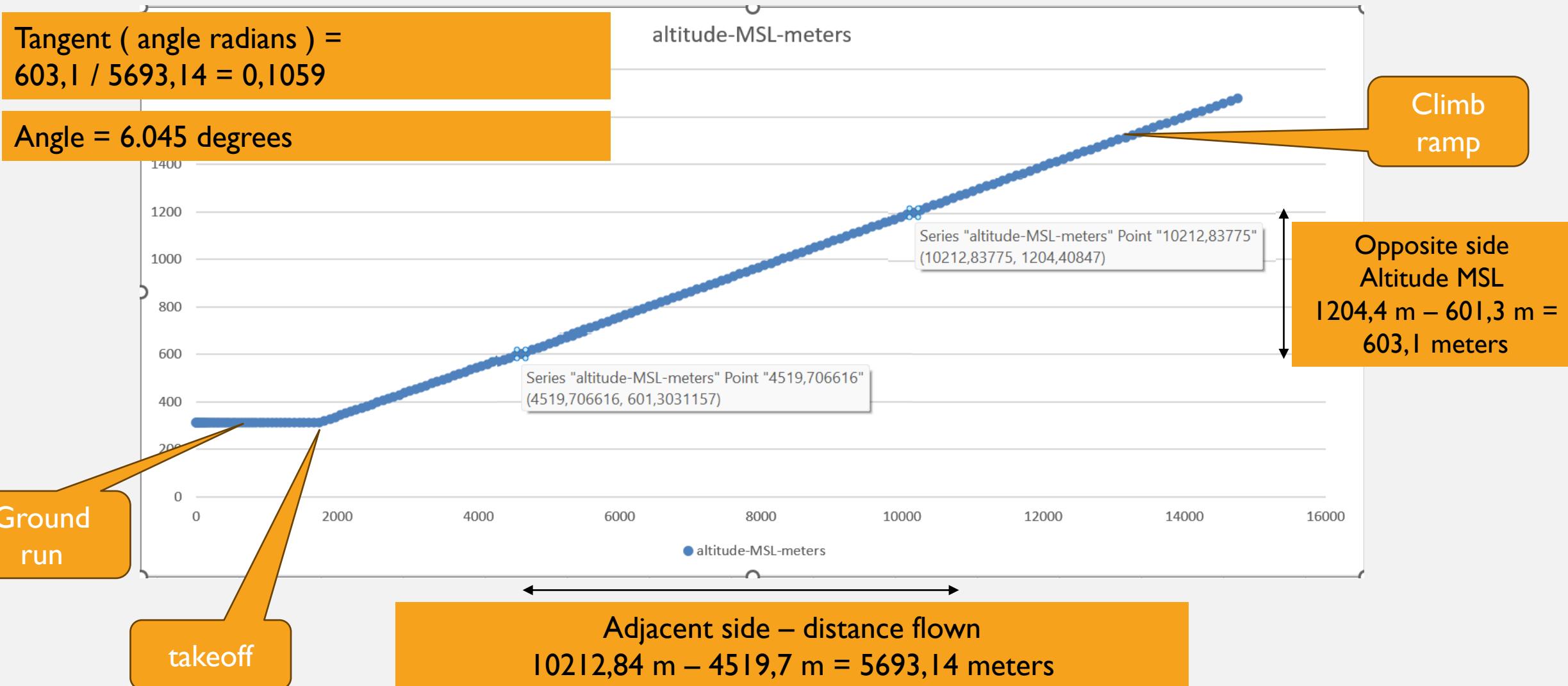
Ground Run = 1779,3 meters

Take Off Speed CAS = 117 knots

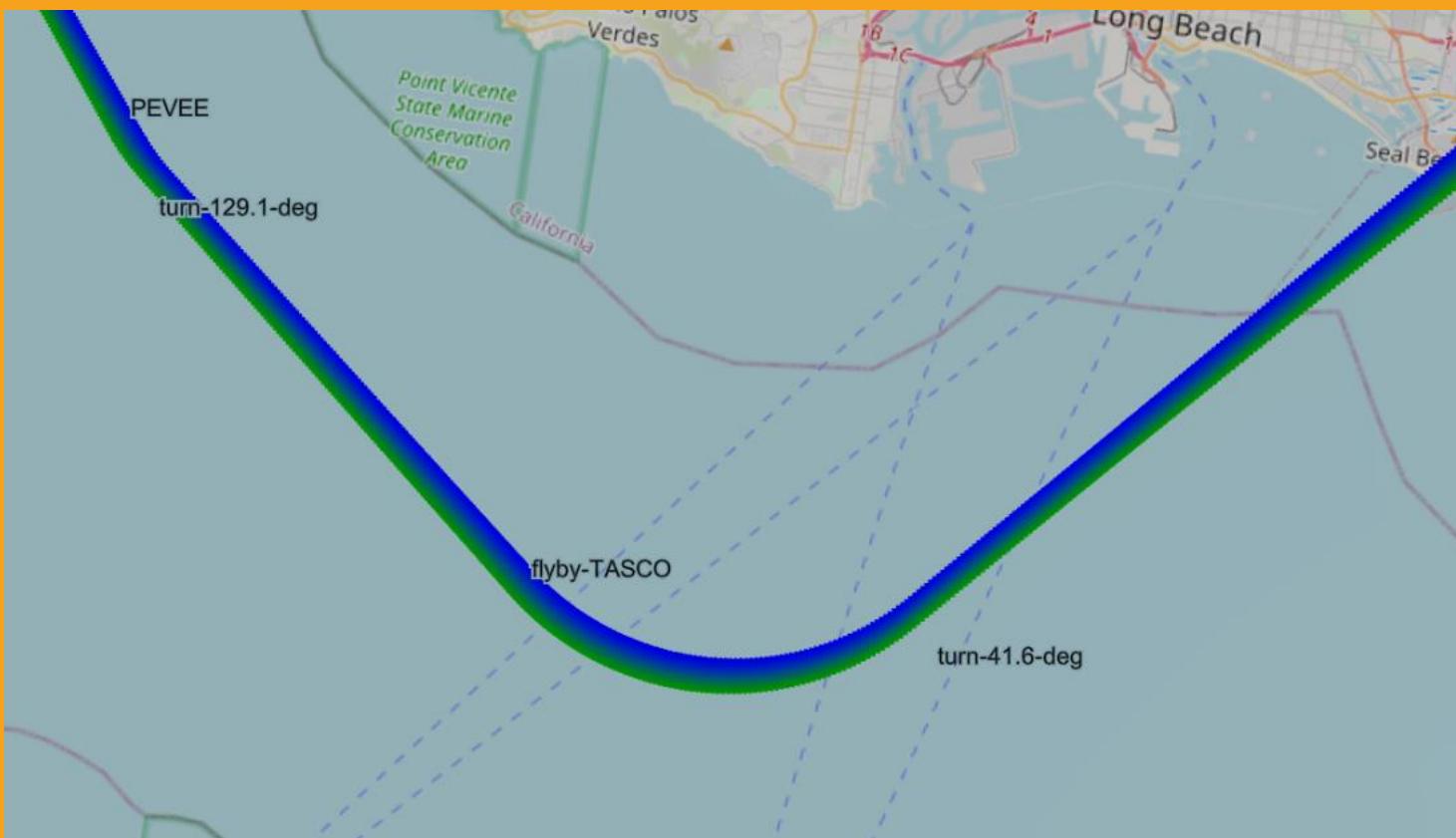
TakeOff True Air Speed = 72,67 m/s



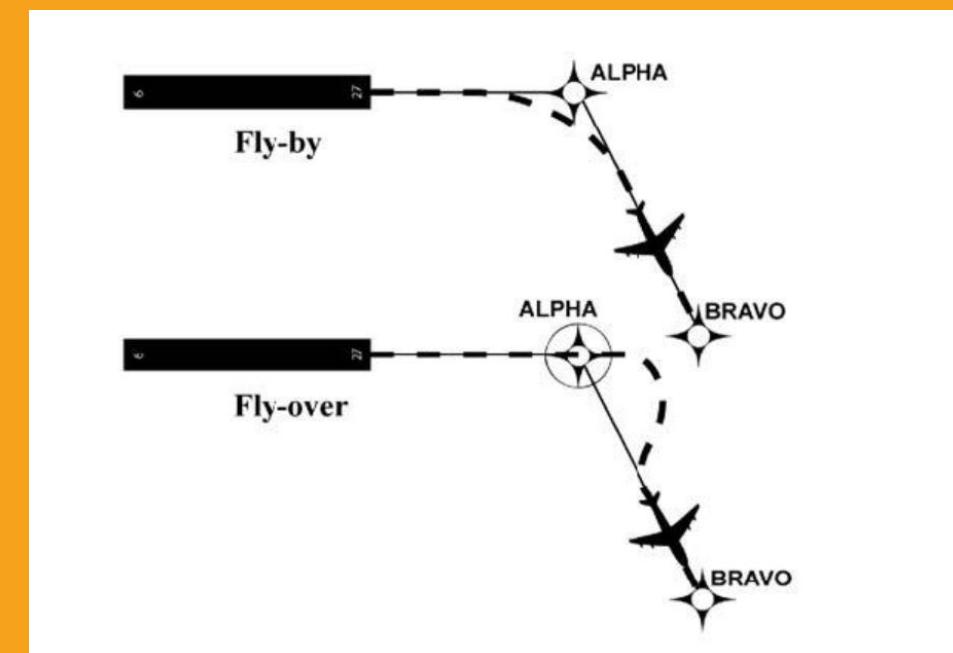
CLIMB RAMP (~6..8 DEGREES – 5 NAUTICAL MILES LENGTH)



TURN LEG



Fly-by waypoints. Fly-by waypoints are used when an aircraft should begin a turn to the next course prior to reaching the waypoint separating the two route segments. This is known as turn anticipation.



TURN LEG

Turn leg radius is a function of True Air Speed and bank angle.

[Aerospaceweb.org | Ask Us - Bank Angle and G's](https://www.aerospaceweb.org/ask-us/bank-angle-and-gs/)

TAS [knots]	Radius in Nautical Miles for a bank angle of 15 degrees	Radius in Nautical Miles for a bank angle of 25 degrees
150	1.2	0.7
180	1.8	1.0
210	2.4	1.4
250	3.4	2.0
300	4.9	2.8
480	12.5	7.2

DOWNLOAD VERTICAL PROFILE (EXCEL FORMAT)

[Click here to move -> Flight Profile Computation](#)

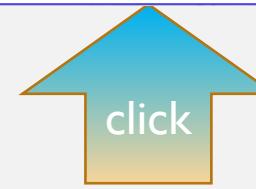
[Click to hide](#)

Future: max fuel load as a constraint

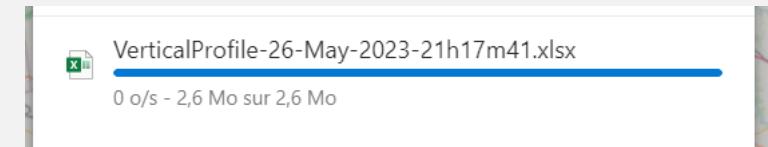
Select the aircraft -> Airbus A320	Enter Reduced Climb Power % -> 0
min -> 39000 TakeOff Mass (kg) -> 64000 max -> 77000	Requested Flight Level (feet) -> 39000 max -> 39000
KATL Route Selector -> Atlanta-Hartsfield Jackson Intl -> Los Angeles Intl	KLAX
Departure RunWay -> 08L -> 90 degrees True Heading	Arrival RunWay -> 06L -> 83 degrees True Heading
Compute Flight Profile	Compute Costs
Download Vertical Profile Download KML	

Inputs in green input cells are checked against acceptable ranges

Hint : Best Runways are available through the Routes tab



Results
available in a
file to
download



In order to obtain these results a full trajectory computation is launched

elapsed-time-seconds	altitude-MSL-meters	altitude-MSL-feet	true-air-speed-meters-second	true-air-speed-knots	calibrated-air-speed-knots	mach	rate-of-climb-descent-feet-minute	distance-flown-nautical-miles	distance-to-fly-nautical-miles	aircraft-mass-kilograms	flight-path-angle-degrees	thrust-newtons	drag-newtons	lift-newtons	load-factor-g	simulation
0	312,7248	1026,000002	0,1	0,194384	0,191647	0,000295	0	0	0	64000	0	0	0	0	0 False	
1	312,7248	1026,000002	1,914728	3,721934	3,669519	0,005647	0	0,001034	1694,945	63998,54	0	138091,5	0,029093	0,07329	1,15E-06 False	
2	312,7248	1026,000002	3,729354	7,249284	7,147198	0,010998	0	0,003048	1694,944	63997,07	0	138091,5	10,66614	26,86957	0,00042 False	
3	312,7248	1026,000002	5,543605	10,77591	10,62416	0,016349	0	0,006041	1694,942	63995,59	0	138091,5	40,46322	101,9327	0,001593 False	
4	312,7248	1026,000002	7,357208	14,30127	14,09989	0,021698	0	0,010013	1694,939	63994,11	0	138091,5	89,40829	225,2325	0,00352 False	
5	312,7248	1026,000002	9,169892	17,82484	17,57387	0,027043	0	0,014965	1694,935	63992,62	0	138091,5	157,4778	396,7095	0,006199 False	
6	312,7248	1026,000002	10,98138	21,3461	21,04558	0,032386	0	0,020894	1694,93	63991,13	0	138091,5	244,6367	616,2755	0,009631 False	
7	312,7248	1026,000002	12,79141	24,86451	24,5145	0,037724	0	0,027801	1694,924	63989,63	0	138091,5	350,8386	883,8134	0,013812 False	
8	312,7248	1026,000002	14,59971	28,37956	27,98011	0,043057	0	0,035684	1694,917	63988,12	0	138091,5	476,0254	1199,177	0,018741 False	
9	312,7248	1026,000002	16,406	31,89071	31,44191	0,048384	0	0,044543	1694,909	63986,61	0	138091,5	620,1282	1562,193	0,024414 False	
10	312,7248	1026,000002	18,21002	35,39745	34,89938	0,053704	0	0,054375	1694,9	63985,09	0	138091,5	783,0664	1972,658	0,03083 False	

State vector

DOWNLOAD KML FILE

KML : Keyhole Markup Language

Click here to move -> Flight Profile Computation

Select the aircraft -> Airbus A320

Enter Reduced Climb Power % -> 0

min -> 39000 TakeOff Mass (kg) -> 64000 max -> 77000

Requested Flight Level (feet) -> 39000 max -> 39000

KATL Route Selector -> Atlanta-Hartsfield Jackson Intl -> Los Angeles Intl

KLAX

Departure RunWay -> 08L -> 90 degrees True Heading

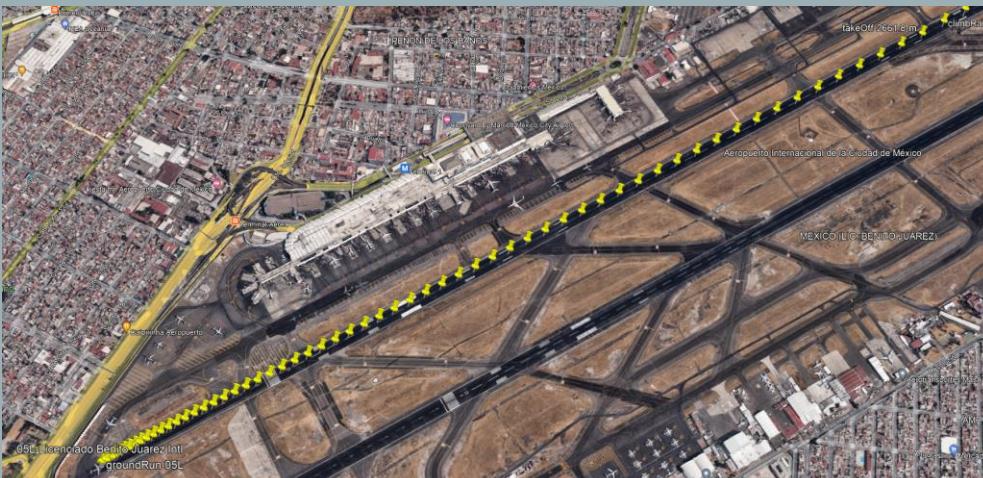
Arrival RunWay -> 06L -> 83 degrees True Heading

Compute Flight Profile Compute Costs Download Vertical Profile Download KML

click

If Google Earth is installed on the PC
downloading will open Google Earth

Hint: Vertical profile on the web OpenGlobus map overlay is shown with x-axis being the time while in Google Earth x-axis shows the ground distance



COSTS & OPTIMIZATIONS

COMPUTE COSTS FOR ONE LEG

Select the
aircraft

Click here to move -> Flight Profile Computation

Select the aircraft -> Airbus A320

Enter Reduced Climb Power % -> 0

Click to hide

min -> 39000 TakeOff Mass (kg) -> 64000 max -> 77000 Requested Flight Level (feet) -> 39000 max -> 39000

KATL Route Selector -> Atlanta-Hartsfield Jackson Intl -> Los Angeles Intl

Departure RunWay -> 08L -> 90 degrees True Heading

Arrival RunWay -> 06L -> 83 degrees True Heading

Compute Flight Profile Compute Costs Download Vertical Profile Download KML

Inputs are checked against acceptable ranges

Take Off Mass and Flight Level can be modified

Hint : Best Runways are available through the Routes tab

click

Get the
results

Click here to move -> Flight Leg Costs Computation

Click to hide

Airline	Aircraft	Seats	Adep	RunWay	Ades	RunWay	Is Aborted	Initial Mass Kg	Final Mass Kg	Lost Mass Kg	Fuel Costs US\$	Flight Duration Hours	Flying Costs US\$	Crew Costs US\$	Total Costs US\$
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	77000	66360.9	10639.1	11410	4.3623	12389	7228	31028
AmericanWings	A320	157	KATL	08L	KLAX	06L	false	64000	54126.7	9873.3	10589	3.8598	10962	6396	27947

Costs are computed for one aircraft type, one leg, selected runways, a takeoff mass and a flight level

In order to obtain these results a full trajectory computation is launched

Fuel Costs US dollars = mass loss kg * kerosene kg to US gallons * US gallon to US dollars

MINIMIZATIONS (COSTS)

All Optimizations are based upon computing costs beforehand – costs are computed offline

Costs are computed once for all defined routes and results are stored in the database

For each aircraft type, each flight leg a trajectory is computed, and a cost matrix is created and stored offline in the database

Costs minimizations compute the minimal SUM of costs for all the defined flight legs

Assumption : have an adequate fleet in order to assign one aircraft type to only one flight leg

Only one aircraft type
assigned to one leg

Leg = oriented pair of departure and arrival airports

airline	Solver Status	aircraft	departureAirport	adepRunway	arrivalAirport	adesRunway	totalCostsUSdollars
AmericanWings	Optimal	A320	PANC	07L	KATL	26R	46607,34
AmericanWings	Optimal	A320	KJFK	13R	LFPG	27L	49660,15
AmericanWings	Optimal	A320	KSEA	16L	KJFK	31L	33997,88
AmericanWings	Optimal	A320	KATL	26R	PANC	07L	46366,89
AmericanWings	Optimal	A320	KSFO	01R	KIAD	30	33886,5
AmericanWings	Optimal	A332	KATL	08L	KBOS	27	23442,15
AmericanWings	Optimal	A332	KATL	26R	KMSP	17	23408,56
AmericanWings	Optimal	A332	KORD	22L	KIAH	08L	23438,39
AmericanWings	Optimal	A332	KIAH	08L	KORD	22L	23003,15
AmericanWings	Optimal	A332	KMSP	12R	KATL	26R	23426,2
AmericanWings	Optimal	B738	KJFK	31L	KSEA	34R	34935,35
AmericanWings	Optimal	B738	KBOS	27	KATL	08L	15615,51
AmericanWings	Optimal	B738	KATL	27R	KLAX	07L	28065,68
AmericanWings	Optimal	B738	KIAD	30	KSFO	10L	34473,85
AmericanWings	Optimal	B738	KLAX	07L	KATL	27R	28436,94
							468764,54

Computation are using the PULP optimization library -> [pulp — PuLP 2.7.0 documentation \(coin-or.github.io\)](https://coin-or.github.io/pulp/)

Objective function - Minimize Sum of Costs -US\$ 468764,54

sum

MINIMIZATIONS (COSTS PER AVAILABLE SEAT MILES)

All Optimizations are based upon computing costs beforehand

For each aircraft type, each flight leg a trajectory is computed and a cost matrix is created

CASM minimizations compute the minimal SUM of CASM for all the defined flight legs

Assumption : have an adequate fleet in order to assign one aircraft type to only one flight leg

Click here to move - Costs per Available Seat Miles											Click to hide	
Airline	Solver Status	Aircraft	assigned	Departure		Arrival		Seats	Flight Distance Miles	Costs US\$	CASM US\$	
AmericanWings	Optimal	A320	yes	General Edward Lawrence Logan Intl		Atlanta-Hartsfield Jackson Intl		157	832.41	15277.38	0.1169	
AmericanWings	Optimal	A320	yes	Minneapolis		Atlanta-Hartsfield Jackson Intl		157	819.99	15049.41	0.1169	
AmericanWings	Optimal	A320	yes	Atlanta-Hartsfield Jackson Intl		General Edward Lawrence Logan Intl		157	829.11	15070.87	0.1158	
AmericanWings	Optimal	A320	yes	Houston George Bush Intl		Chicago O'Hare Intl		157	814.42	14816.56	0.1159	
AmericanWings	Optimal	A320	yes	Chicago O'Hare Intl		Houston George Bush Intl		157	815.24	15047.09	0.1176	
AmericanWings	Optimal	A332	yes	Alaska Anchorage-Ted Stevens Intl		Atlanta-Hartsfield Jackson Intl		234	2996.41	69855.88	0.0996	
AmericanWings	Optimal	A332	yes	New York-John F Kennedy Intl		Seattle Tacoma Intl		234	2128.27	51767.68	0.1039	
AmericanWings	Optimal	A332	yes	Atlanta-Hartsfield Jackson Intl		Minneapolis		234	835.29	23408.56	0.1198	
AmericanWings	Optimal	A332	yes	New York-John F Kennedy Intl		Paris Charles-De-Gaulle France Intl		234	3214.07	74198.29	0.0987	
AmericanWings	Optimal	A332	yes	San Francisco Intl		Washington Dulles Airport Intl		234	2112.14	50876.38	0.1029	
AmericanWings	Optimal	B738	yes	Atlanta-Hartsfield Jackson Intl		Los Angeles Intl		160	1695.85	28065.68	0.1034	
AmericanWings	Optimal	B738	yes	Washington Dulles Airport Intl		San Francisco Intl		160	2114.26	34473.85	0.1019	
AmericanWings	Optimal	B738	yes	Los Angeles Intl		Atlanta-Hartsfield Jackson Intl		160	1706.94	28436.94	0.1041	
AmericanWings	Optimal	B738	yes	Atlanta-Hartsfield Jackson Intl		Alaska Anchorage-Ted Stevens Intl		160	3063.69	48116.39	0.0982	
AmericanWings	Optimal	B738	yes	Seattle Tacoma Intl		New York-John F Kennedy Intl		160	2127.29	34482.87	0.1013	

Only one aircraft type assigned to one leg



MAXIMIZATIONS (SEAT MILES)

All Optimizations are based upon computing costs beforehand

For each aircraft type, each flight leg a trajectory is computed and a cost matrix is created

Seat Miles maximizations compute the Maximal SUM of Seat Miles for all the defined flight legs

Assumption : have an adequate fleet in order to assign one aircraft type to only one flight leg

Only one
aircraft type
assigned to
one leg

Airline	Aircraft	Solver Status	Assigned	Departure	Arrival	nb Seats	Aircraft Turn Around Times Seconds	Leg Duration Seconds	Leg Distance (miles)	Nb Rotations in 20 hours	Seat Miles Flown 20 hours (miles)
AmericanWings	A320	Optimal	yes	KATL	KMSP	157	1500	8288,8	854,8156123	3	805236,3068
AmericanWings	A320	Optimal	yes	KMSP	KATL	157	1500	7396,1	819,9907771	3	772431,312
AmericanWings	A320	Optimal	yes	KATL	KBOS	157	1500	7502,7	829,1098923	3	781021,5186
AmericanWings	A320	Optimal	yes	KIAH	KORD	157	1500	7213	814,4242528	3	767187,6462
AmericanWings	A320	Optimal	yes	KORD	KIAH	157	1500	7362,8	815,2396302	3	767955,7316
AmericanWings	A332	Optimal	yes	PANC	KATL	234	2100	21963,6	2996,40901	1	1402319,417
AmericanWings	A332	Optimal	yes	KJFK	LFGP	234	2100	23340,9	3214,073888	1	1504186,579
AmericanWings	A332	Optimal	yes	KATL	PANC	234	2100	22621,5	3007,623939	1	1407568,004
AmericanWings	A332	Optimal	yes	KATL	KLAX	234	2100	13452,4	1695,882484	2	1587346,005
AmericanWings	A332	Optimal	yes	KLAX	KATL	234	2100	13208,8	1707,433335	2	1598157,602
AmericanWings	B738	Optimal	yes	KJFK	KSEA	160	1500	15892,4	2128,22742	2	1362065,549
AmericanWings	B738	Optimal	yes	KBOS	KATL	160	1500	7096,5	832,4002601	3	799104,2497
AmericanWings	B738	Optimal	yes	KSEA	KJFK	160	1500	15893,3	2127,289211	2	1361465,095
AmericanWings	B738	Optimal	yes	KIAD	KSFO	160	1500	15819,8	2114,261328	2	1353127,25
AmericanWings	B738	Optimal	yes	KSFO	KIAD	160	1500	15688,3	2112,111338	2	1351751,256
											17620923,52

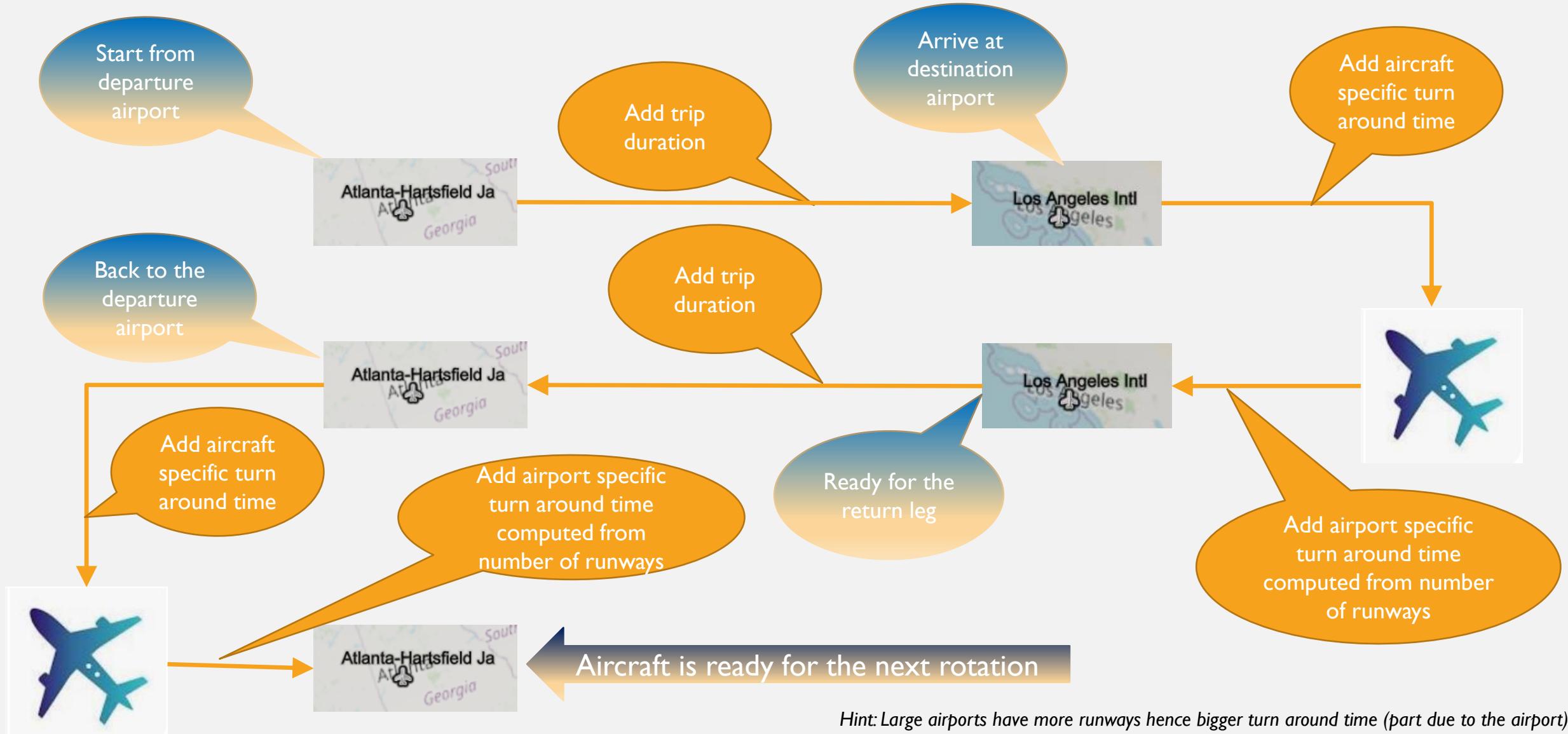
Hint: compute number of rotations in
a day, based upon trip duration, plus
turn around time

Objective function - max Sum Seat Miles 17620923,52

Max
sum

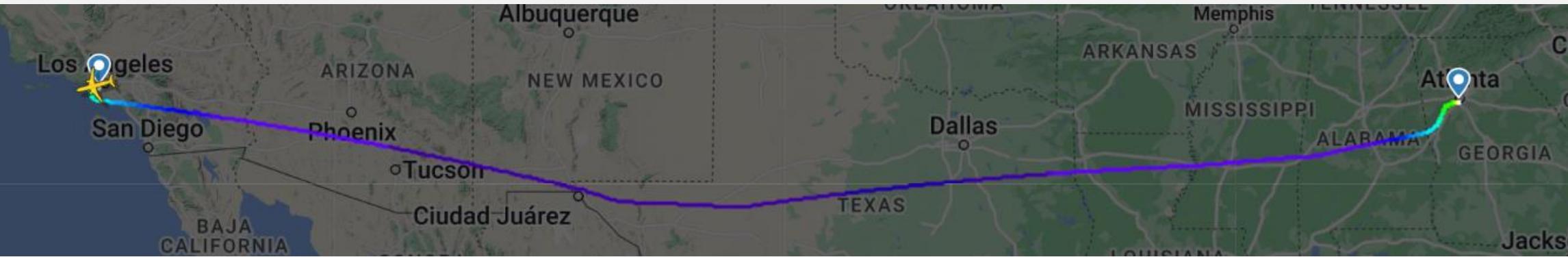
MAXIMIZATIONS (SEAT MILES)

How to compute a rotation – example for a KATL -> KLAX leg



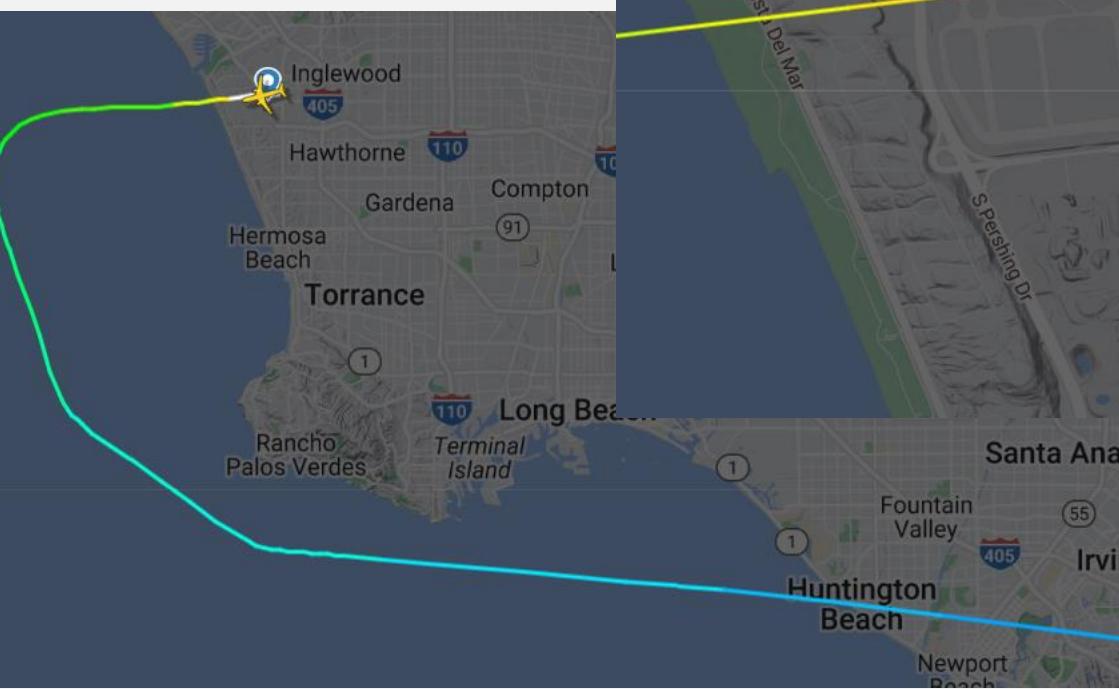
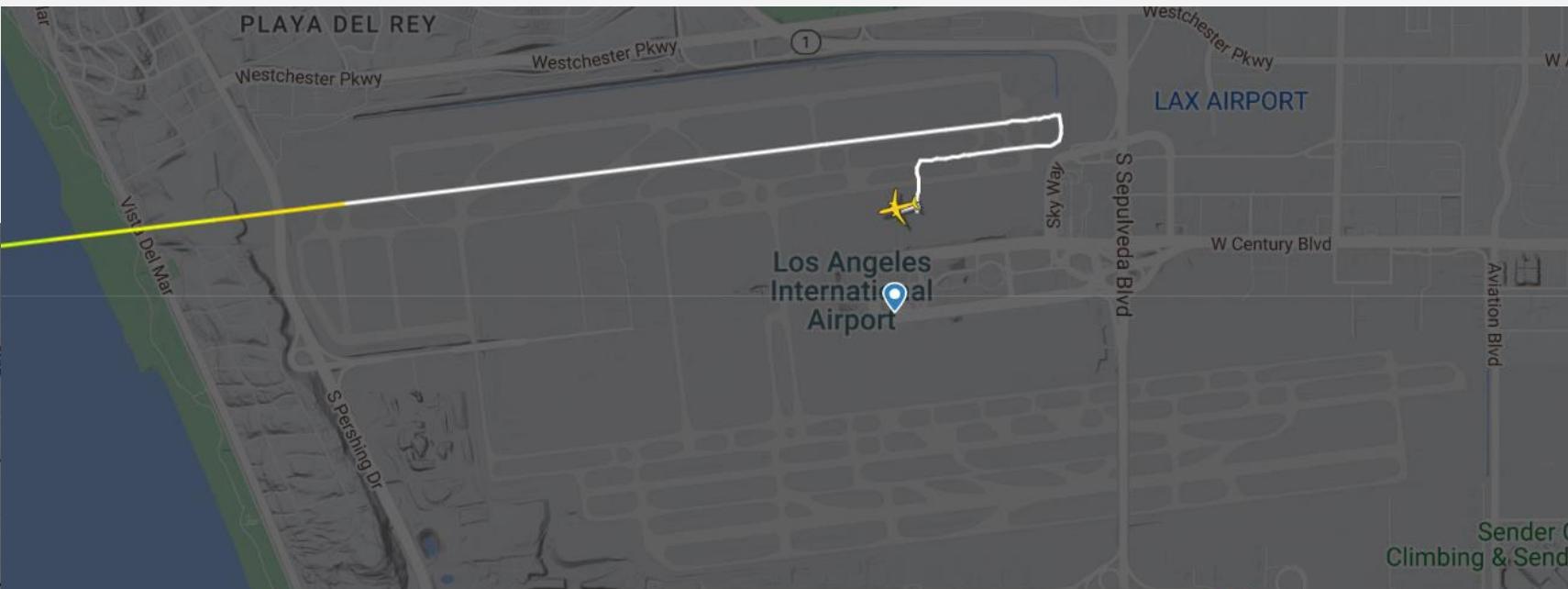
COMPARISON TRAJECTORY PREDICTION VERSUS ADS-B RECORDINGS

COMPARISON KLAX-KATL (FLIGHT RADAR)



DL395
Call sign in flight
radar

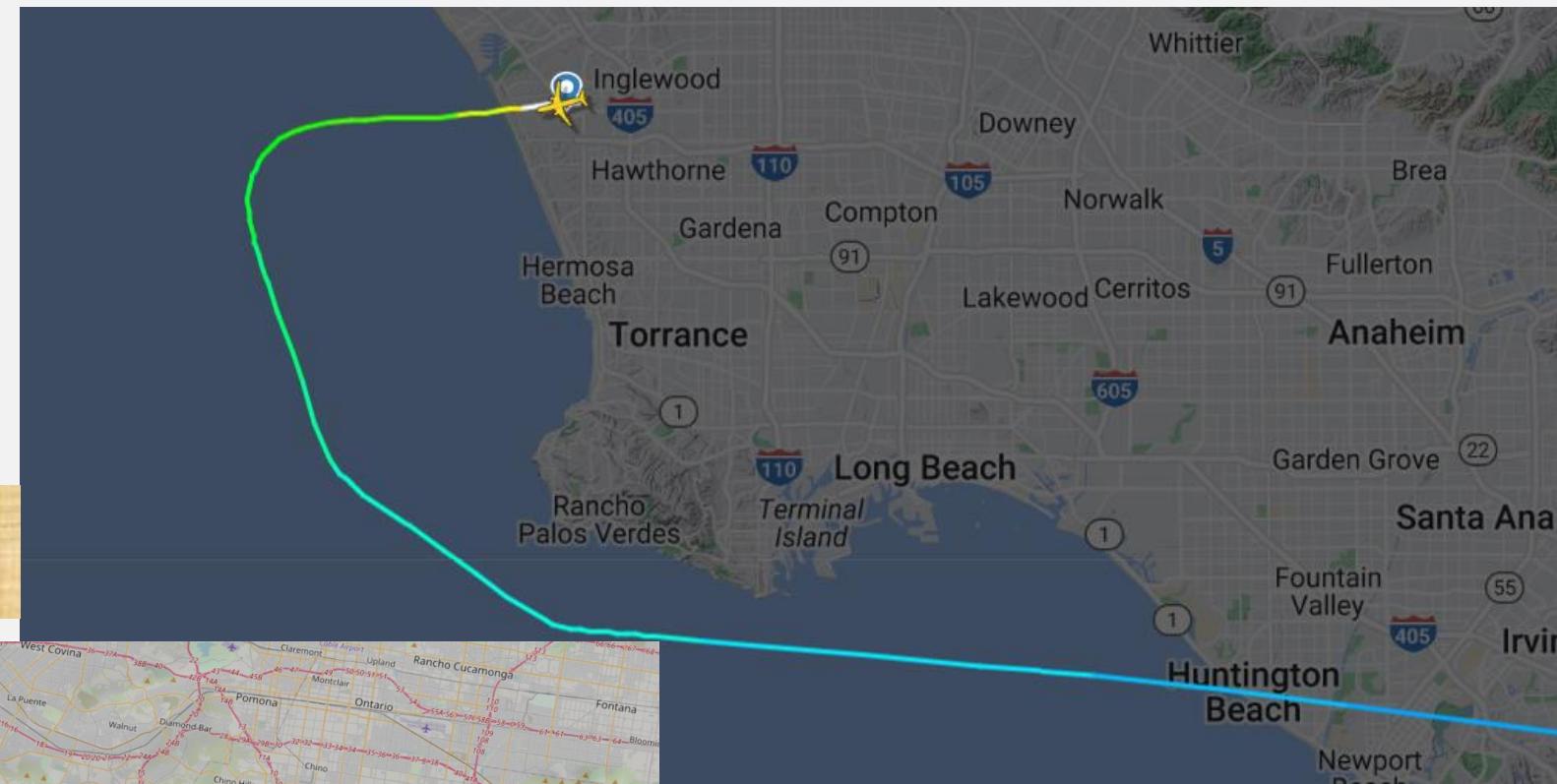
Departure
runway 24L



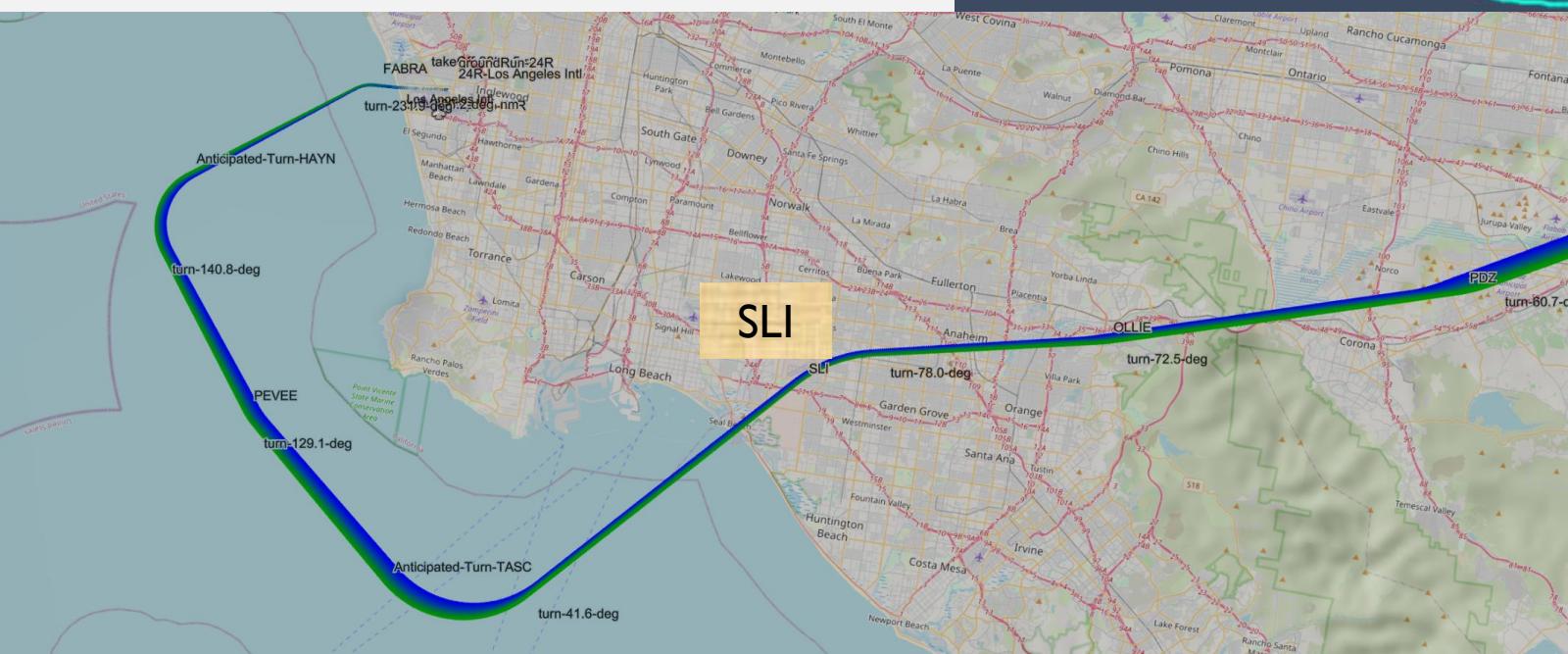
COMPARISON DEPARTURE KLAX-KATL (FLIGHT RADAR)

DL395

KLAX/24L -> SID -> southern route over Huntington Beach



KLAX/24R -> SID -> SLI -> northern route towards MEMPHIS -> ATLANTA



ABORTED COMPUTATIONS

NO MORE FUEL -> ABORTED COMPUTATION

Click here to move -> Flight Profile Computation

Select the aircraft -> Airbus A320

Enter Reduced Climb Power % -> 0

min -> 39000 TakeOff Mass (kg) -> 57000 max -> 77000

Requested Flight Level (feet) -> 39000 max -> 39000

KJFK Route Selector -> New York-JFK Kennedy Intl -> Paris Charles-De-Gaulle France Intl LFPG

Departure RunWay -> 04L -> 04R

Arrival RunWay -> 08L -> 85 degrees True Heading

Compute Flight Profile

Insufficient takeoff mass

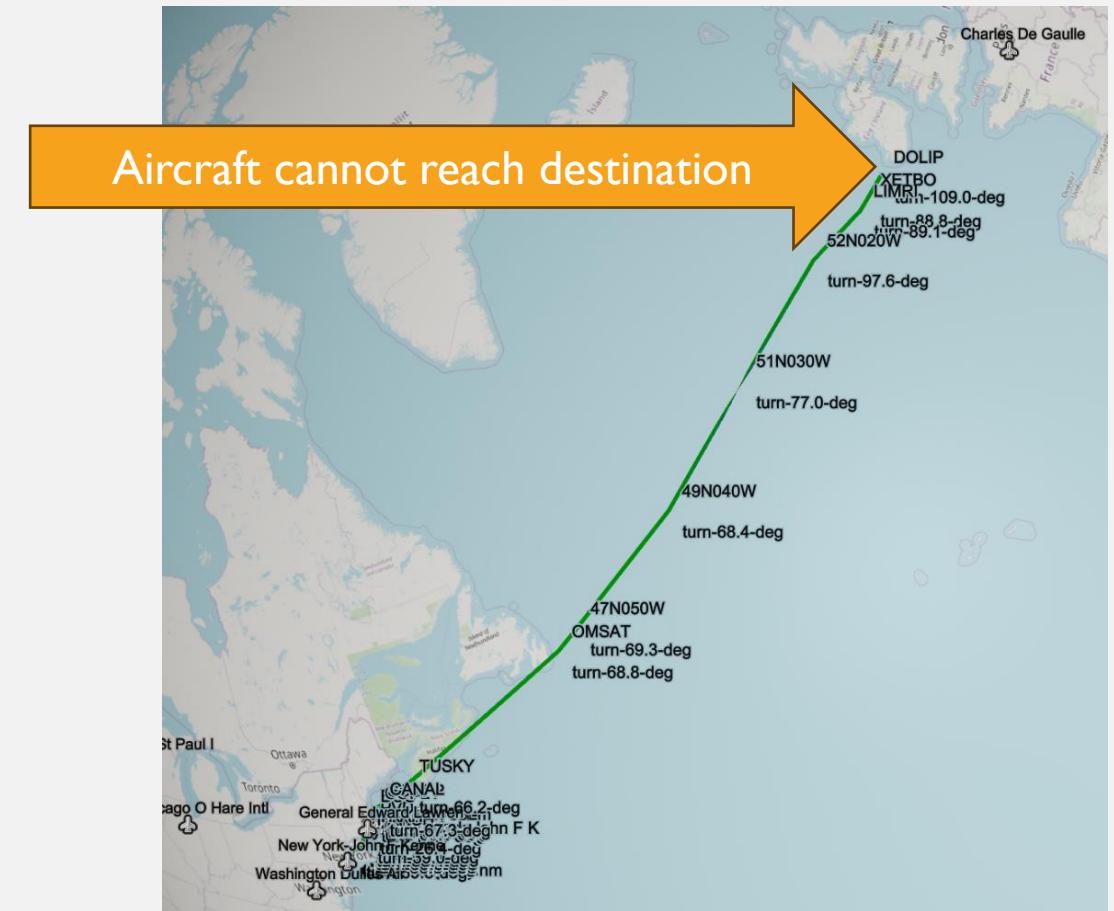
Vertical profile doesn't show the descent phase

Status -> Flight is aborted = True

Click here to move -> Flight Leg Costs Computation

Airline	Aircraft	Seats	Adep	RunWay	Ades	RunWay	Is Aborted	Initial Mass Kg	Final Mass Kg	Lost Mass Kg	Fuel Costs US\$	Flight Duration Hours	Flying Costs US\$	Crew Costs US\$	Total Costs US\$
AmericanWings	A320	157	KJFK	13L	LFPG	26R	true	57000	38999.3	18000.7	19306	5.0228	14265	8323	41893

S 9.29553° W 60.68879° Data @ OpenStreetMap cont



Future enhancement : define configuration data for aircraft available operational fuel liters

RUNWAY OVERSHOOT -> ABORTED COMPUTATION

Takeoff mass

Click here to move -> Flight Profile

Select the aircraft -> Airbus A330-200

min -> 120600 TakeOff Mass (kg) -> 230000 max -> 230000 Requested Flight Level (feet) -> 41000 max -> 41000

KATL Route Selector -> Atlanta-Hartsfield Jackson Intl -> Los Angeles Intl

KLAX

Departure RunWay -> 08L -> 90 degrees True Heading

A330

Compute Flight Profile

Compute Costs

Download Vertical Profile

Download KML

Results for compute profile

click

click

Departure Runway -> length = 2743 meters

Status -> Flight is aborted = True

Results for compute costs

Hint: aircraft does not leave the ground -> it overshoots the runway
All vertical profile points have the same altitude corresponding to the airport altitude

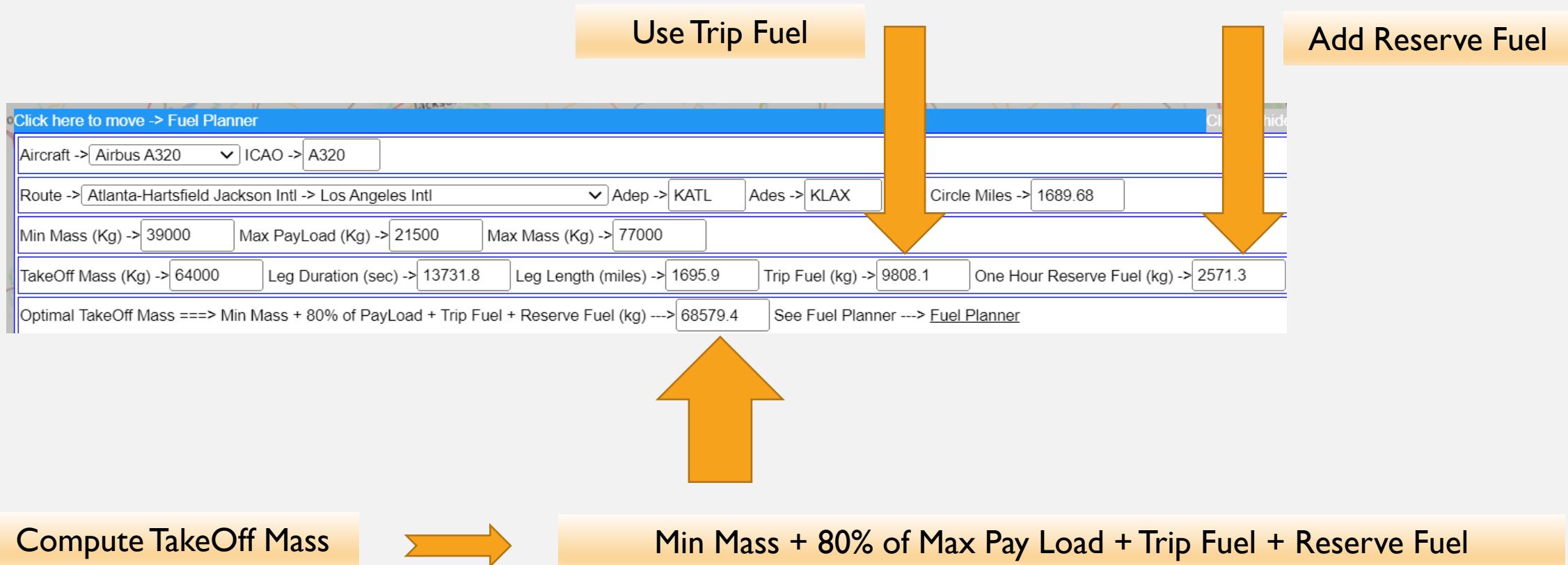
Click here to move -> Flight Leg Costs Computation

Click to hide

Airline	Aircraft	Seats	Adep	RunWay	Ades	RunWay	Is Aborted	Initial Mass Kg	Final Mass Kg	Lost Mass Kg	Fuel Costs US\$	Flight Duration Hours	Flying Costs US\$	Crew Costs US\$	Total Costs US\$
AmericanWings	A332	234	KATL	08L	KLAX	06L	true	230000	229727.2	272.8	293	0.0192	63	36	391

FUEL PLANNER

FUEL PLANNER (TAKEOFF MASS ESTIMATION)



APPLICATION PROGRAMMING INTERFACE

APPLICATION PROGRAMMING INTERFACE

Benefits of API : tool may be queried programmatically & inserted in an eco-system of a more larger tool set



Click on Help Button

In the last Help section, see examples of URL to retrieve a JSON answer in the browser

▼API - Application Programming Interface

It is possible to query programmatically the service and retrieve a result in Json format.

Use the following URL : [Fleet Definition](#) to retrieve the fleet definition.

Use the following URL : [Routes Definition](#) to retrieve the routes.

Use the following URL : [Costs](#) to retrieve the costs.

Use the following URL : [WayPoints](#) to retrieve the wayPoints.

Use the following URL : [Airports](#) to retrieve the airports of the airline.

Use the following URL : [Runway overshoot](#) to retrieve the ground run length.

Links to be clicked

DEPARTURE RUNWAY OVERSHOOT (PROGRAMMATIC FEATURE)

Feature to be used programmatically -> Enter the URL below in the browser
Modify arguments such as aircraft, airport, departure runway, takeoff mass

Aircraft TakeOff mass unit = tons
Aircraft TakeOff mass = 230 tons



<https://airlineservices.eu.pythonanywhere.com/trajectory/computeRunwayOvershoot/A332/KATL/08L/230>

Receive an answer in JSON format

Aircraft ICAO = A332

Departure ICAO = KATL

Departure runway = KATL/08L

```
{  
  "aircraft": "A332-AIRBUS-A330-200",  
  "aircraftReferenceMassKg": "190000.0",  
  "aircraftInitialMassKg": "230000.0",  
  "airport": "Airport: Airport: KATL - Atlanta-Hartsfield Jackson Atlanta Intl - lat= 33.64 degrees - long= -84.43 degrees - field elevation= 312.72 meters",  
  "runway": "RunWay: runway= 08L - airport ICAO code= KATL - length= 9000.00 feet - true heading= 90.00 degrees - latitude= 33.65 degrees - longitude= -84.44 degrees",  
  "runwayLengthMeters": "2743.2",  
  "TakeOffStallSpeedCasKnots": "128.73",  
  "groundRunLengthMeters": "2915.39"  
}
```

Runway length from configuration data = 2743 meters



Runway length from computation of departure ground run = 2915 meters

Ground run computed runway length **is greater** than configured runway length -> Choose another departure runway or reduce the aircraft takeoff mass

PERFORMANCE OF COMPUTATIONS

PERFORMANCES – ON PREMISE (CPU TIME NEEDED TO COMPUTE ONE FLIGHT LEG)

Processor = i3th Gen Intel(R) Core(TM) i7-1360P 2.20 GHz

RAM = 32,0 Go (31,7 Go usable)

Only 4D trajectory computations only

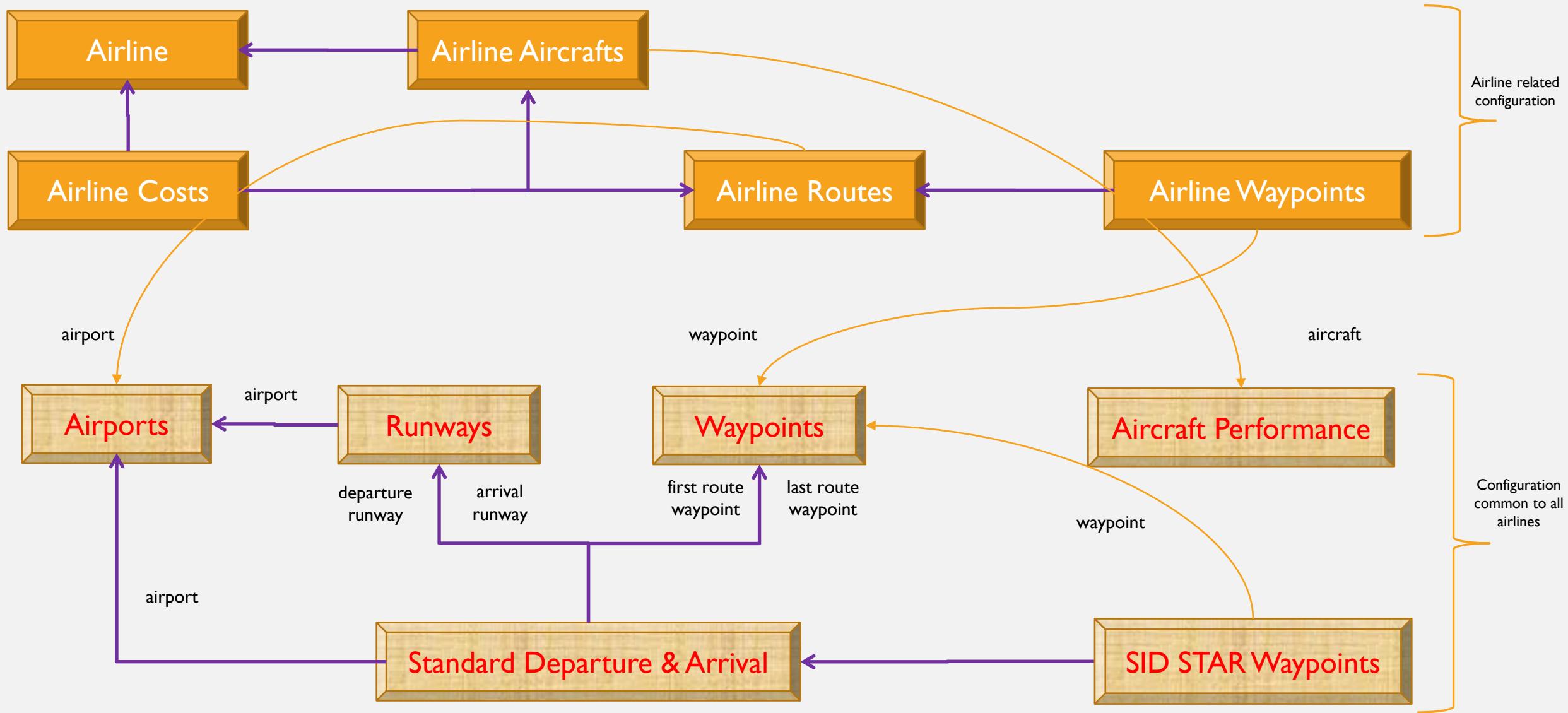
Aircraft	Initial mass	Cruise Mach / Ceiling (feet)	Flight leg	Distance flown (nautical miles)	4D Computation duration	Real time flight duration
A320	67000 kg	0,82 / 39000	Madrid LEMD/36R -> Berlin EDDB/25L	1070 NM	0,86 sec	9664 sec 2 hours 41 minutes
A320	67000 kg	0,82 / 39000	Los Angeles KLAX/24R -> Atlanta KATL/27R	1755 NM	1.0 sec /	15804 sec 4 hours 23 minutes
A320	67000 kg	0,82 / 39000	Mexico MMMX/05L -> Seattle KSEA/16C	2161 NM	2.83 sec	18276 sec / 5 hours 4 minutes

On one leg, performances computation is mostly dependent upon number of waypoints in the fix list

Performances are reduced when code is deployed on PythonAnyWhere

DESIGN

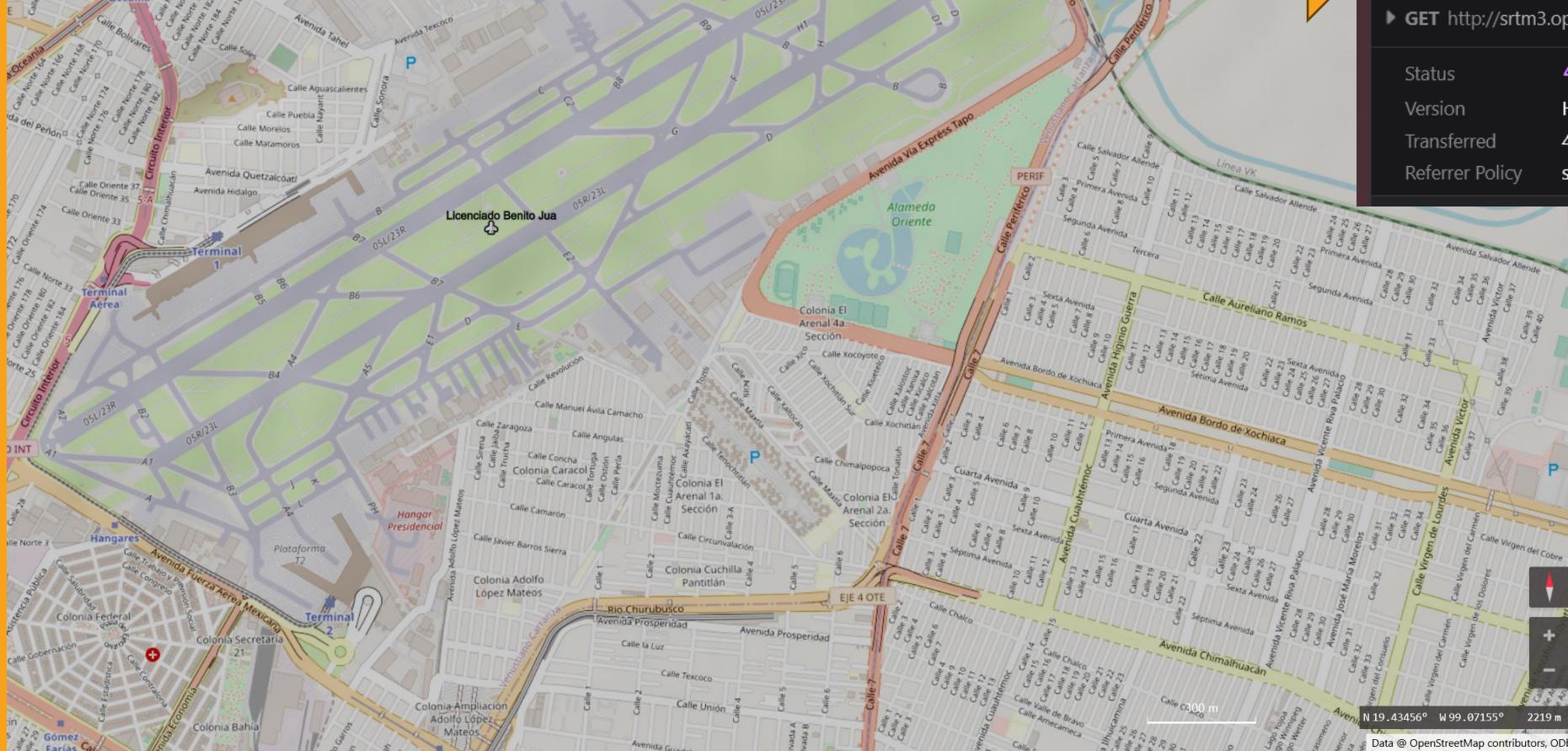
DATABASE SCHEMA



OPENGLOBUS JAVASCRIPT MAP LIBRARY

Featuring : KML format, rays, events, ruler, etc.

Case where there is no data for terrain in the coordinates z=7, y=56, x=30, where z is the zoom level, and x, y - Mercator grid coordinates



XHR GET <http://srtm3.openglobus.org/7/56/30.ddm>

Headers Cookies Request Response Timings Stack Trace

Filter Headers

GET http://srtm3.openglobus.org/7/56/30.ddm

Status 404 Not Found ?
Version HTTP/1.1
Transferred 408 B (178 B size)
Referrer Policy same-origin

Zoom using mouse wheel

control map orientation

Zoom in & out

Ground altitude above Mean Sea Level

Earth model - Wgs84 – Map projection - Universal Transverse Mercator coordinate system

Tile provider

FUTURE IMPROVEMENTS (BACKLOG CONTENT)

- Capacity to compute a flight profile with a Direct Route from departure airport to the destination airport -> to see fuel consumption differences
- Capacity on the Flight Profile menu to click and select automatically the best runways and inform about usage of SID and STAR
- Capacity in the vertical profile to meet speed restrictions (below 10,000 feet above ground) when arriving on a certain airport with applicable noise reduction restriction
- Capacity to compute an optimized vertical profile with a fuel optimization constraint, leading to climb with to reduce power / thrust and apply a continuous descent arrival profile with an idle thrust configuration
- Capacity to compute an optimized vertical profile with a time / duration minimization constraint, leading to climb with max thrust , reach top of climb as soon as possible, reach operational Cruise Mach achieve a minimal flight duration (optimizing the crew costs or ensuring arrival on time)
- Capacity to keep the viewport focused either on a SID / STAR, on the displayed lateral profile, on the waypoints, etc.
- Align airport names -> in the route selector, departure airport is “Aeropuerto Mexico Cuidad” and on the map it is named “Licenciado Benito Juarez”
- Define precisely the amount of available fuel -> case where “no more fuel” event occurs
- Compute “Block Hour” : currently only trip duration is computed (from departure ground run to arrival ground run)
- Number of runways per airport will be used to compute “Block Hour” (time from doors closure to departure runway) from trip duration

KNOWN ISSUE

Cette page ne répond pas

appsintellect.org

Attendre

Quitter la page

Title : Removal of open globus ray layers leads temporarily to “frozen” browser when second flight profile follows same departure & same destination airport

- **Condition :** Open profile menu and select a flight leg between 2 airports.

Compute Flight Profile

Click here to move -> Flight Profile Computation

Select the aircraft -> Airbus A320	Enter Reduced Climb Power % -> 0
min -> 39000	TakeOff Mass (kg) -> 57000 max -> 77000
KJFK	Route Selector -> New York-John F Kennedy Intl -> Paris Charles-De-Gaulle France Intl
Departure RunWay -> 04L -> 31 degrees True Heading	Arrival RunWay -> 08L -> 85 degrees True Heading
Compute Flight Profile	Compute Costs
Download Vertical Profile	Download KML

- **Action :** launch the computation of the profile ->

- **Results :**

- the vertical profile is displayed on top of the map
- a ray layer cleaner window is displayed

Click here to move -> layer cleaner

Airline	Departure	Destination	Layer	Action
AmericanWings	KIAH	KORD	Rays-AmericanWings-KIAH-KORD	Delete

- **Action :** click to close the vertical profile and zoom on the map to the selected departure airport / selected departure runway

- **Action :** without changing the airports, select a different departure runway

- **Action :** click to launch the computation of the profile again

- **Results :** the “FireFox” browser gets stuck / frozen temporarily while trying to delete the previous Open Globus ray layer

- Alternative action (to obtain the frozen browser):

- In the Layer Cleaner menu, click on the Delete action button of the displayed route that you wish to suppress
- Consequence is identical -> Browser freezes temporarily (a couple of minutes)

Click here to move -> layer cleaner

Airline	Departure	Destination	Layer	Action
AmericanWings	KIAH	KORD	Rays-AmericanWings-KIAH-KORD	Delete

HISTORY OF CHANGES

Date	What	Where
25th June 2023	On an airport right click contextual menu show both departing and arriving flight legs	Airport contextual right-click menu
1st July	Display default reference mass in Profile compute menu (instead of Max Takeoff mass)	In Flight Profile menu
8th July 2023	Cleaning of OpenGlobus layer	Additional window to allow for clearing an existing flight leg ray layer (experimental feature)
16th July 2023	Departure Runway overshoot aborts the computation	Computation of departure ground run leg
22nd July 2023	Add browser recommendation to use FireFox	In the pdf presentation file (to download)
22nd July - 30th July 2023	Reduced Climb Power Coeff	Input added in Profile computation menu
6th July 2023	Latitude and longitude shown as degrees & minutes (instead of decimal degrees)	See earth coordinates area in the bottom right of the map



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THANK YOU

For any question, please follow this link
<https://www.appsintellect.org/contact-card>