Sharklets
The innovating wing to fly

Presented by
MA JUN/ Flight Operation Support Director

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What is this?

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What is this?

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And how about this one?

Today we focus on this!

Sharklets

Content

Sharklets General

- New industry challenges

- All forecasts predict an increase in **oil price**
  - Oil price could return to 2008 (c. $150/barrel) levels
  - Fuel is the predominant cost item

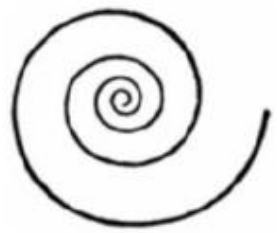
- **Emissions Trading Scheme** starts in 2012
  - Additional charges with emissions quota
  - Emissions are new risks & costs

New challenges require close monitoring

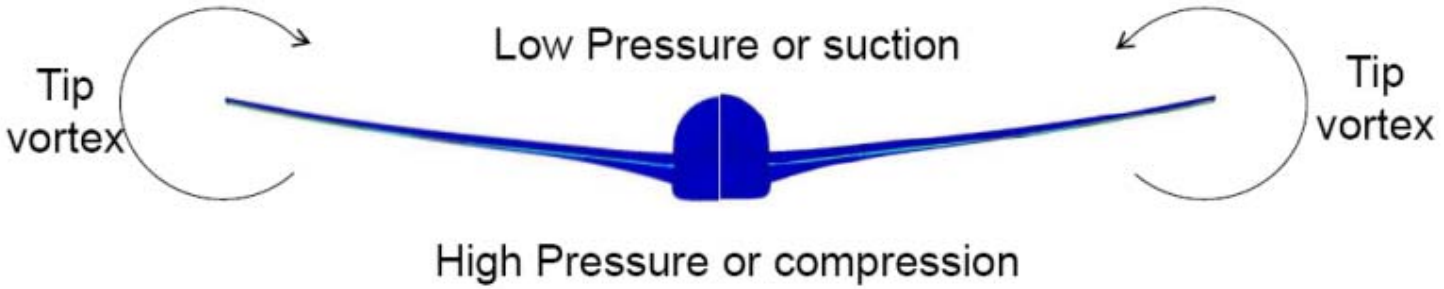
Sharklets General –How ?

- Induced drag is a consequence of the wing producing lift, which is generated by an imbalance between the pressure on upper and lower wing surfaces.

- Air naturally flows from high to low pressure regions, this imbalance results in a tip vortex, which is why the lift-dependent-drag is also called vortex drag.

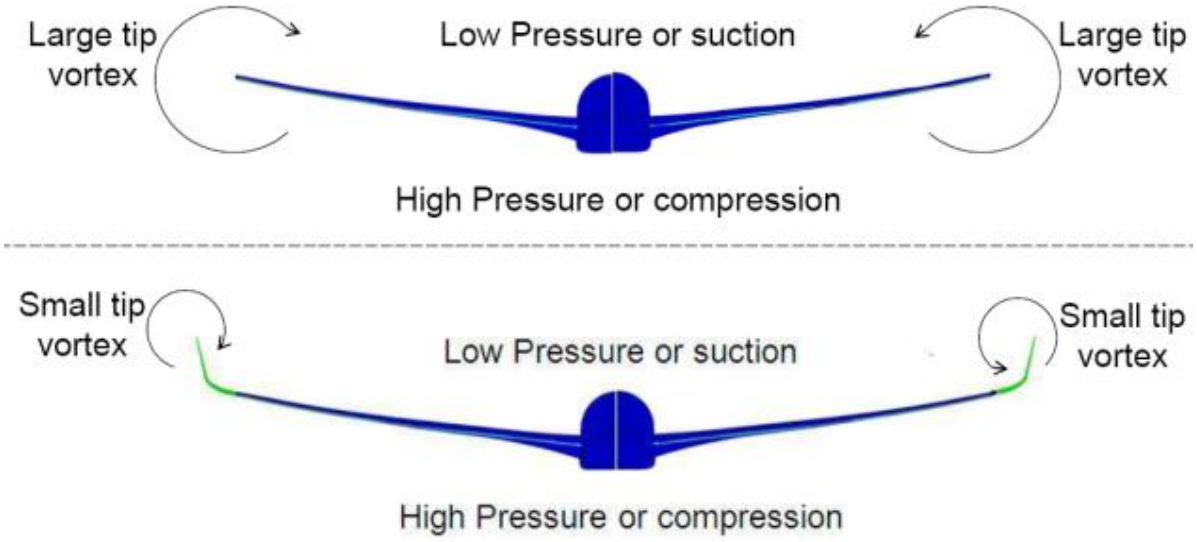


Sketch of a vortex



Sharklets General ---How ?

- The lift-dependent-drag is inversely proportional to the square of the span, thus an obvious way to reduce drag is to increase the span.
- However, this is not always possible, due to gate size category at an airport. Adding a winglet is a way to increase the aerodynamic span while still fitting within span constraints.
  - Adding a winglet reduces the tip vortex.



Sharklets General –How big ?

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S2
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Sharklets General --Strong market driving

Data to end Jan 2013

Content

Content

Sharklets improve take-off performance

- If facing obstacles or climb limitations, Sharklets will increase take-off weight(up to 3 tonnes) by:
  - Improving second segment performance
  - Clearing more obstacles

Better take-off capability

Improved operational efficiency around the world(especially in China)

Sharklets improve take-off performance

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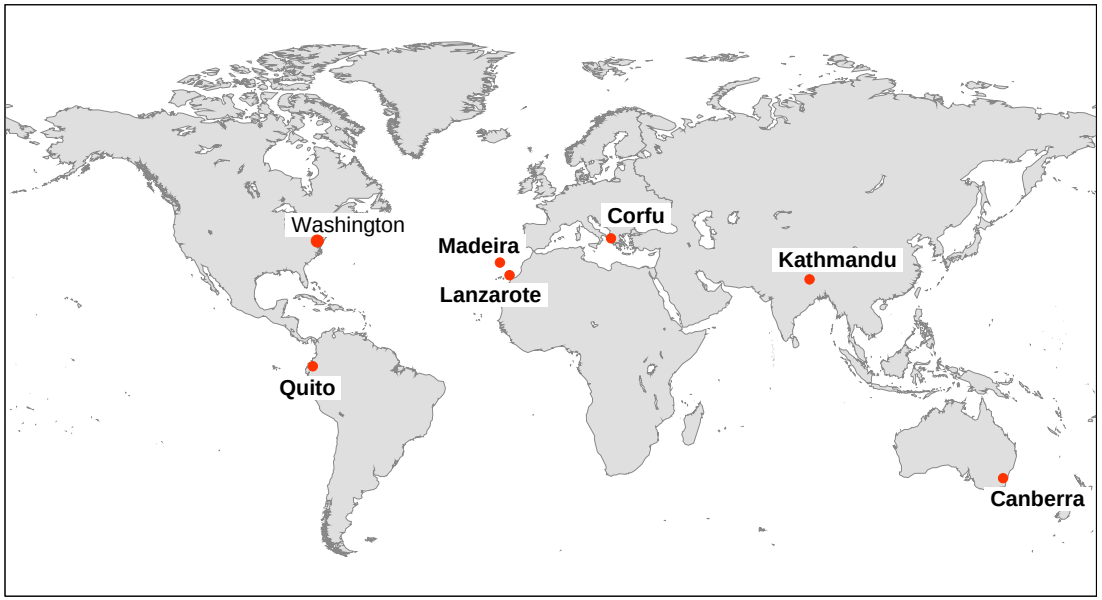
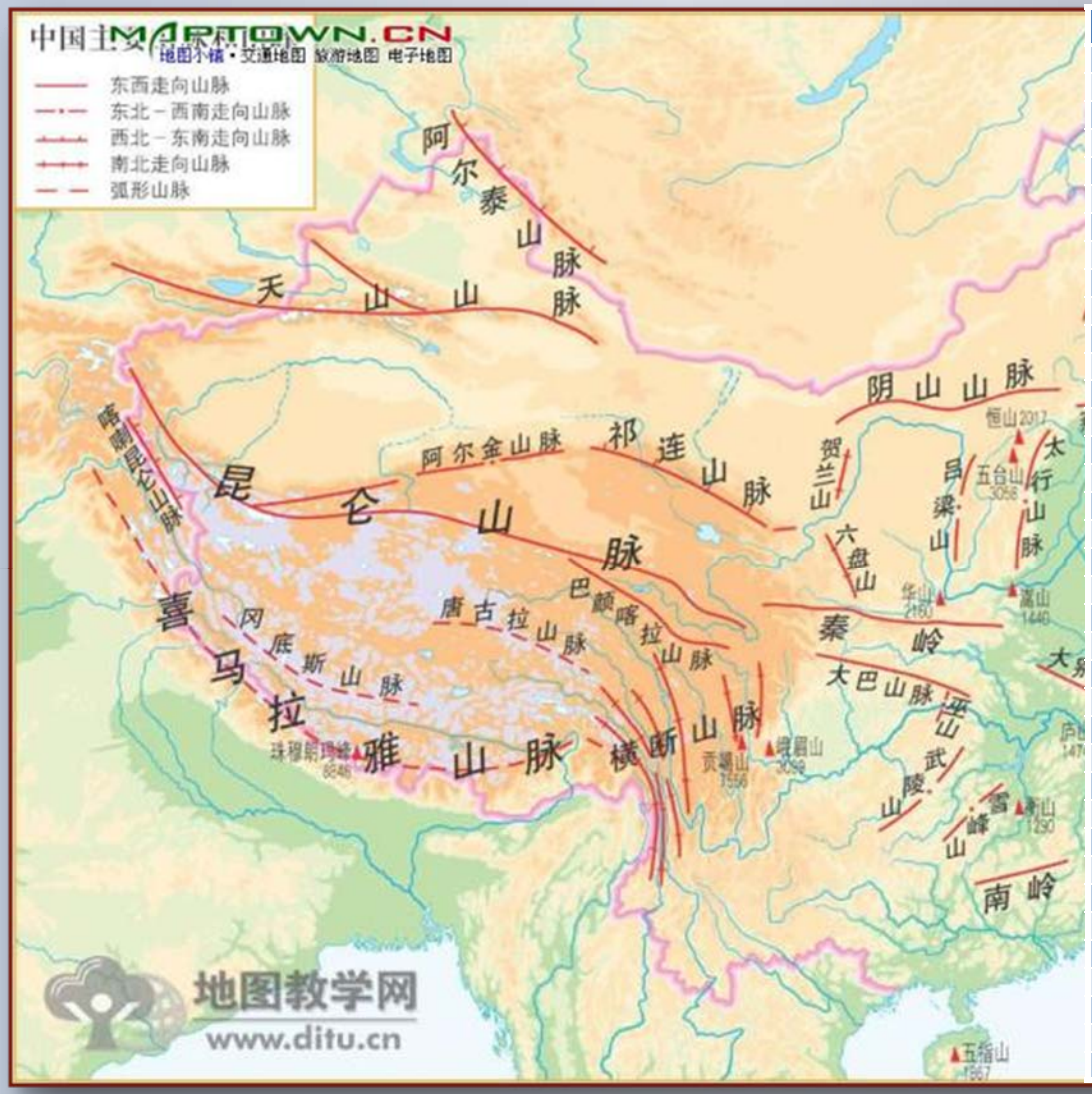
Better take-off capability



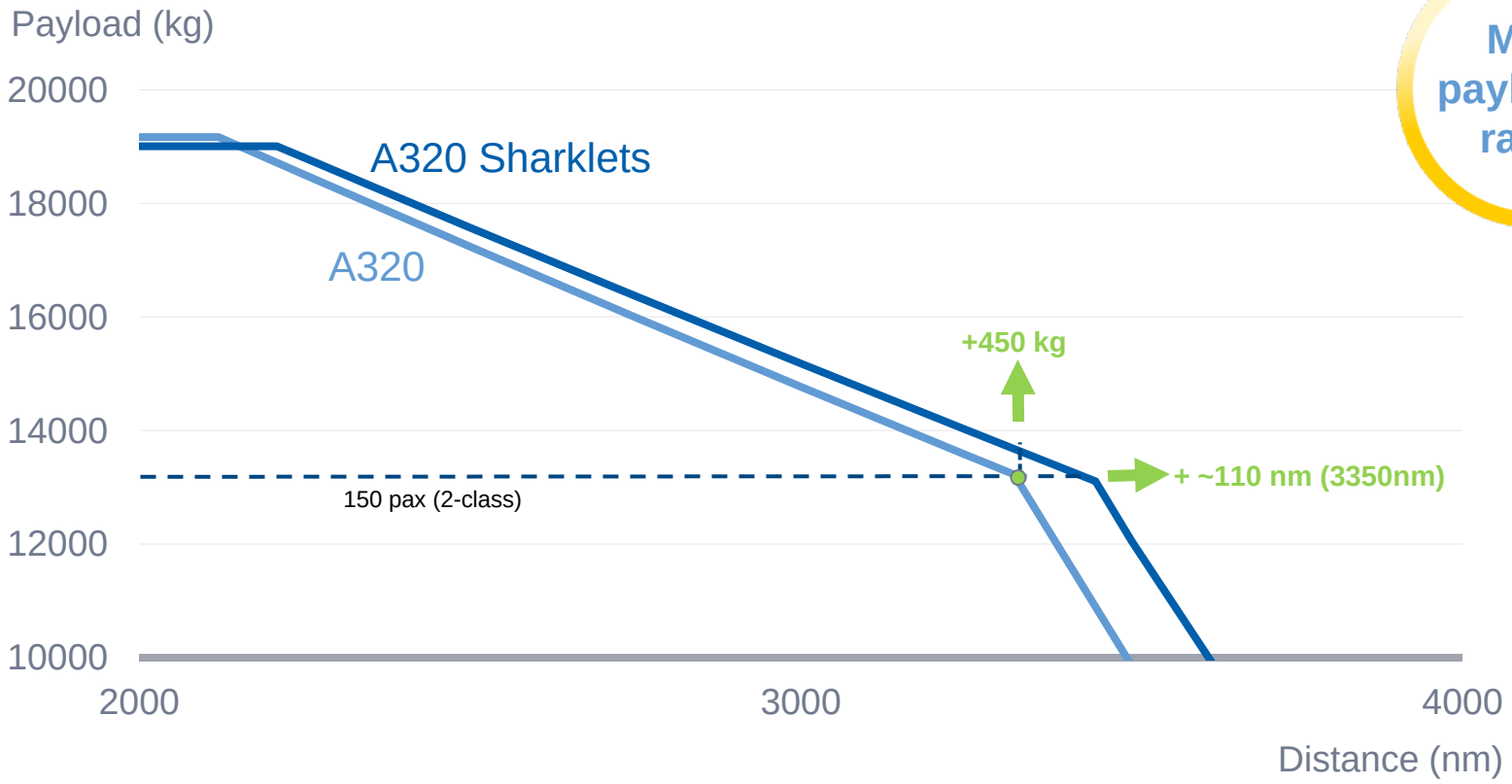
Improved operational efficiency around the world

Sharklets improve take-off performance in China



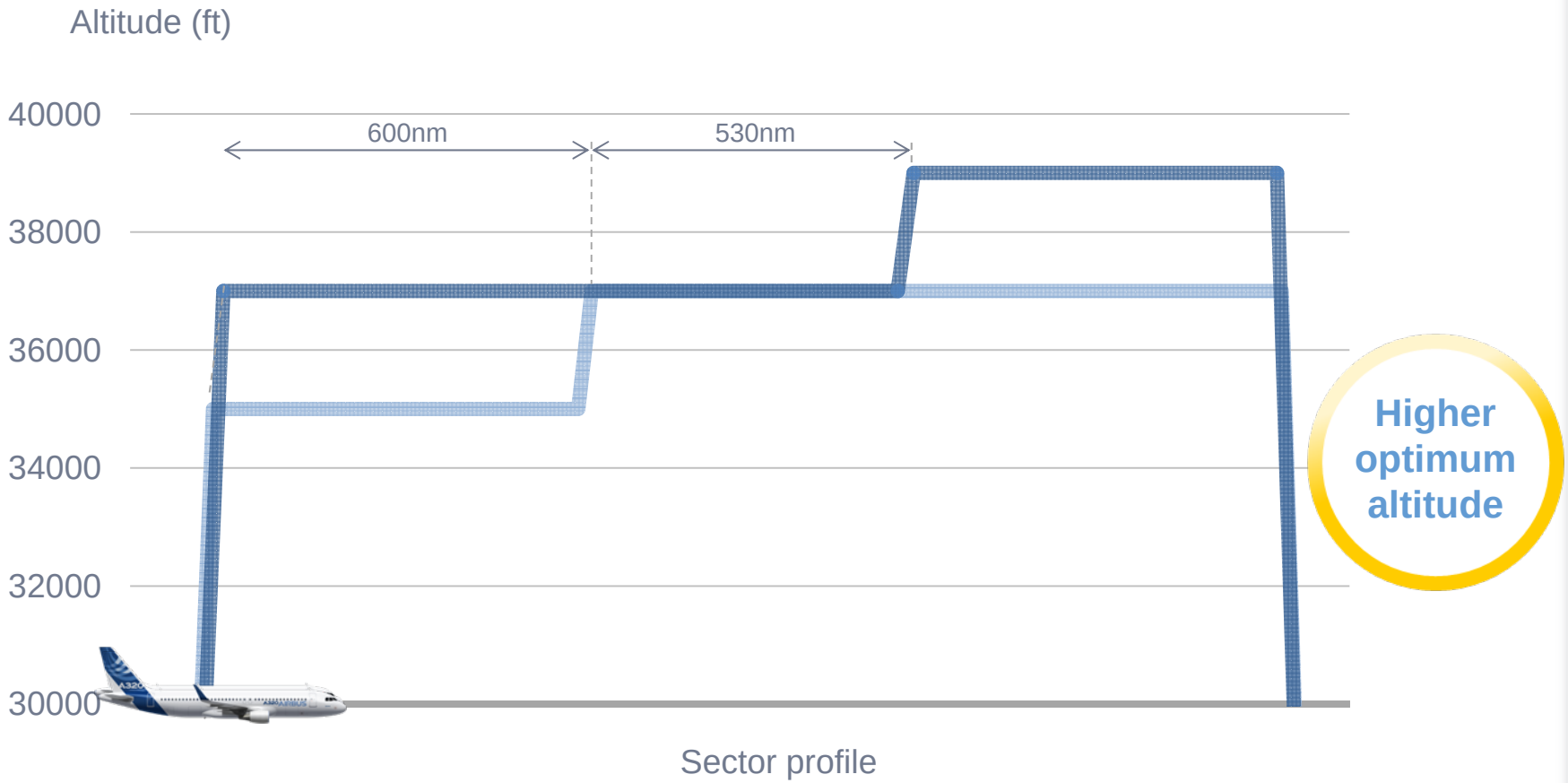
ICAO	City	Country	Province	Elev (ft)
SPRF	San Rafael	Peru	Puno	14422
ZUBD	Qamdo, Bangda	China	Tibet AR	14219
ZUKD	Kangding	China	Sichuan	14042
ZUAL	Gunsa, Ali	China	Tibet AR	14022
VI66	Fukche	India	Jammu & Kashmir	13700
SPVI	Vicco	Peru	Pasco	13461
SLLP	El Alto, La Paz	Bolivia	La Paz	13314
SLCN	Charaña	Bolivia	La Paz	13294
SPNP	Ventilla, Puno	Peru	Puno	13123
SLPO	Potosi	Bolivia	Potosi	12923
ZLYS	Yushu/Batang	China	Qinghai	12812
SPIY	Kauri	Peru	Cuzco	12795
SLCC	Copacabana	Bolivia	La Paz	12595
SPJL	Puno Juliaca	Peru	Puno	12552
ZURK	Shigatse, Heping	China	Tibet AR	12475
SCKP	Coposa	Chile	Tarapacá	12467
SLOR	Oruro	Bolivia	Oruro	12146
TJ0E	Murgab	Tadjikistan	GBAO	11962
ZULS	Lhasa Gonggar	China	Tibet AR	11713
SPHY	Andahuaylas	Peru	Apurimac	11706
SASQ	La Quiaca	Argentina	Jujuy	11414
ZUJZ	Jiuzhai Huanglong	China	Sichuan	11312
SPJJ	Jauja Francisco Carle	Peru	Junin	11034
VNMA	Manang	Nepal	Gandaki	11000
SPZO	Cuzco	Peru	Cuzco	10860
ZPDQ	Deqen Shangri-la	China	Yunnan	10761
VILH	Leh	India	Jammu & Kashmir	10682
KLXV	Leadville (Lake Co)	United States	Colorado	9927
SKIP	Ipiales San Luis	Colombia	Nariño	9740
ZUNZ	Mainling,Linzhi	China	Tibet AR	9675
SETU	Tulcan Luis A Mantilla	Ecuador	Carchi	9649
SLSU	Sucre	Bolivia	Chuquisaca	9527
VNLK	Lukla	Nepal	Sagarmatha	9334
ZLGM	Golmud	China	Qinghai	9324
VNST	Simikot	Nepal	Karnali	9246
SEQU	Quito Mal Sucre Intl	Ecuador	Pichincha	9228
SELT	Latacunga Cotopaxi Intl	Ecuador	Cotopaxi	9207

Sharklets increase revenue potential



More range + more payload = increased revenues

Improved climb performance

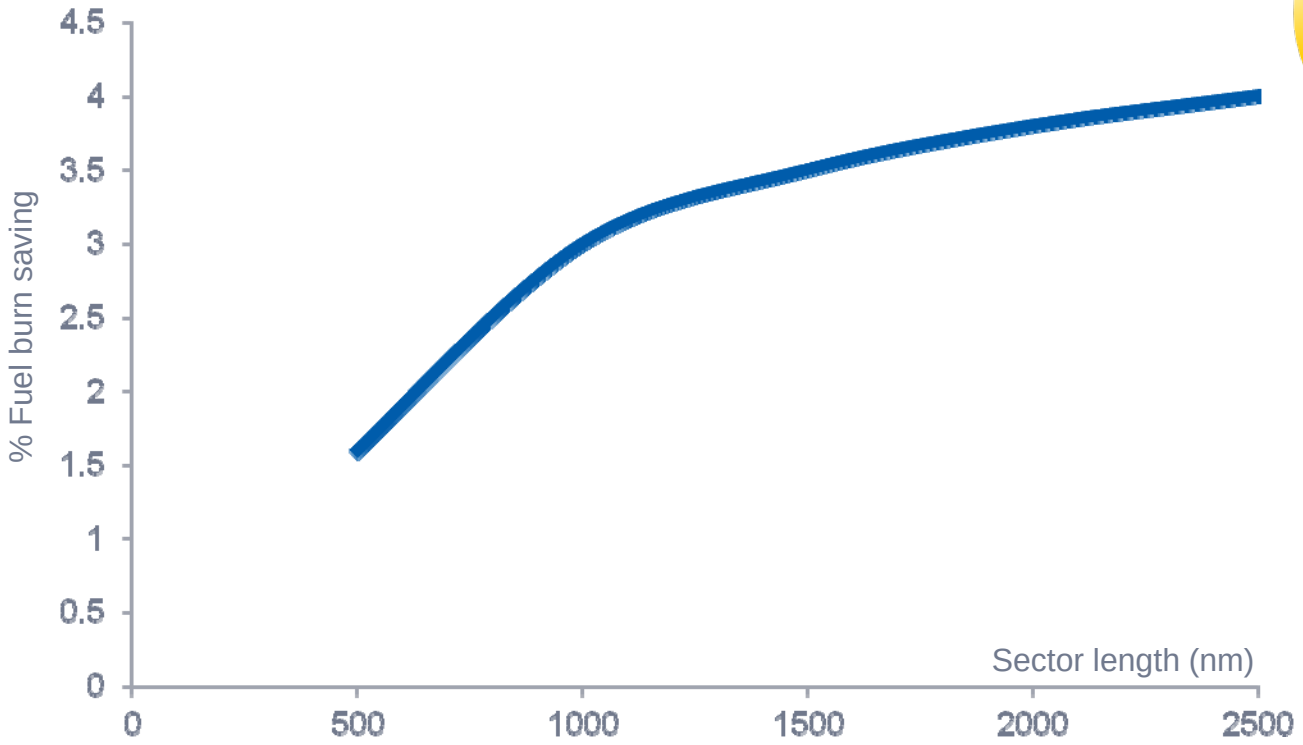


Higher initial cruise altitude

Example on a 2000nm sector

Sharklets reduce fuel burn

A320 Block fuel improvement
vs. current Wingtip fences



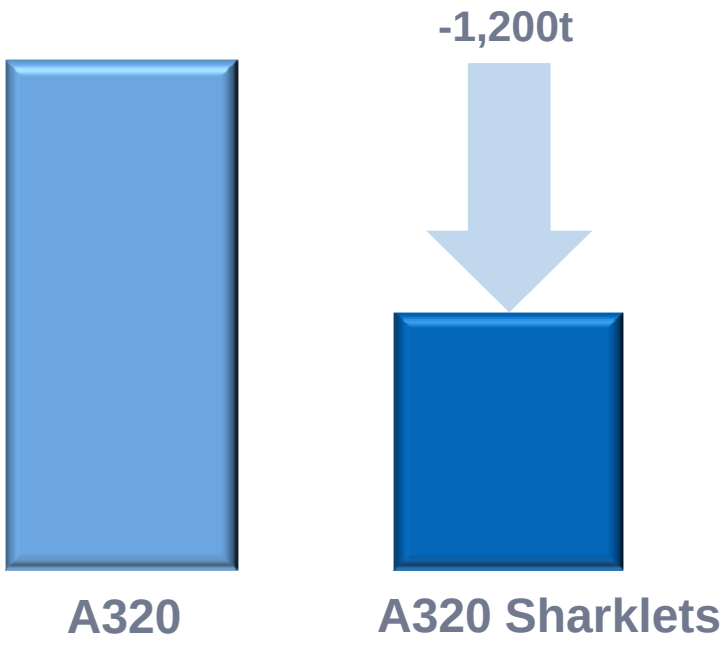
Fuel burn reduction

Hunting Down Fuel Burn up to 4 %

A320 in 2-class layout. Nominal performance level

Sharklets reduce emissions

Annual CO_2 emissions



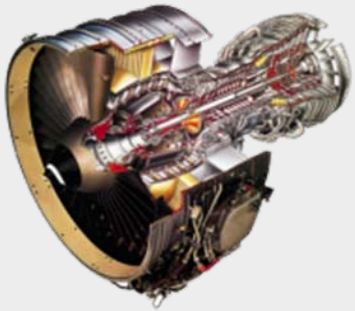
Lower CO_2 emissions

Annual CO_2 emissions reduced by over 1,000 tonnes

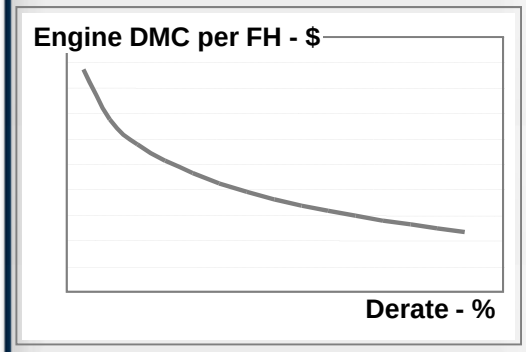
A320 in 2-class layout. Nominal performance level. Typical airline rules. 2000nm sector. 3500 hrs/year.

Sharklets reduce engine maintenance costs

Reduce take-off thrust for same take-off weight



Up to 4% additional take-off derate



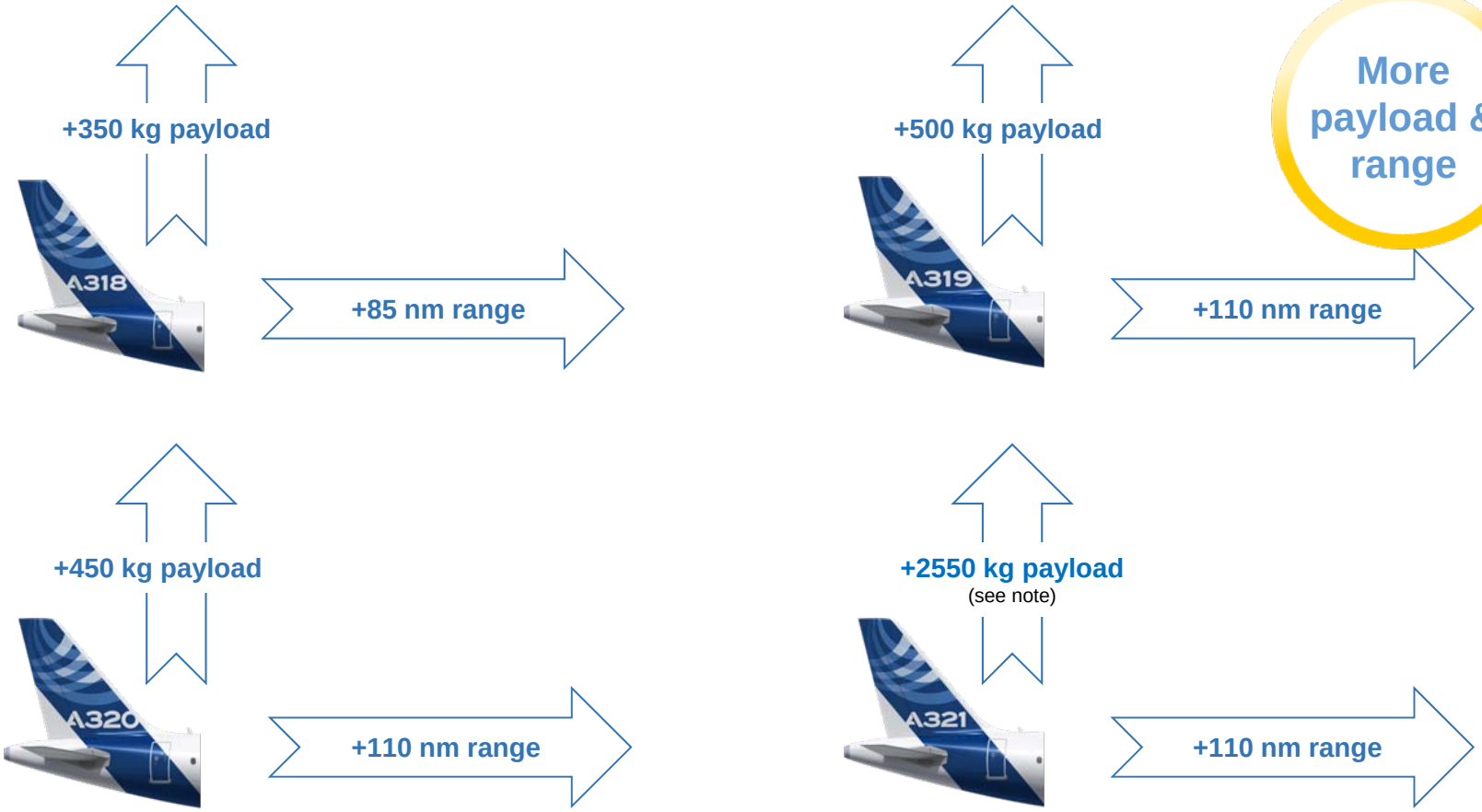
Longer Time on Wing

Reduced engine maintenance cost

Lower engine DMC

Up to 2% reduction in engine maintenance costs
thanks to improved take-off performance

Sharklets benefits for all



Improved payload and range for entire A320 Family

Typical 2-class layouts. Max pax payload

Content

Dimensions

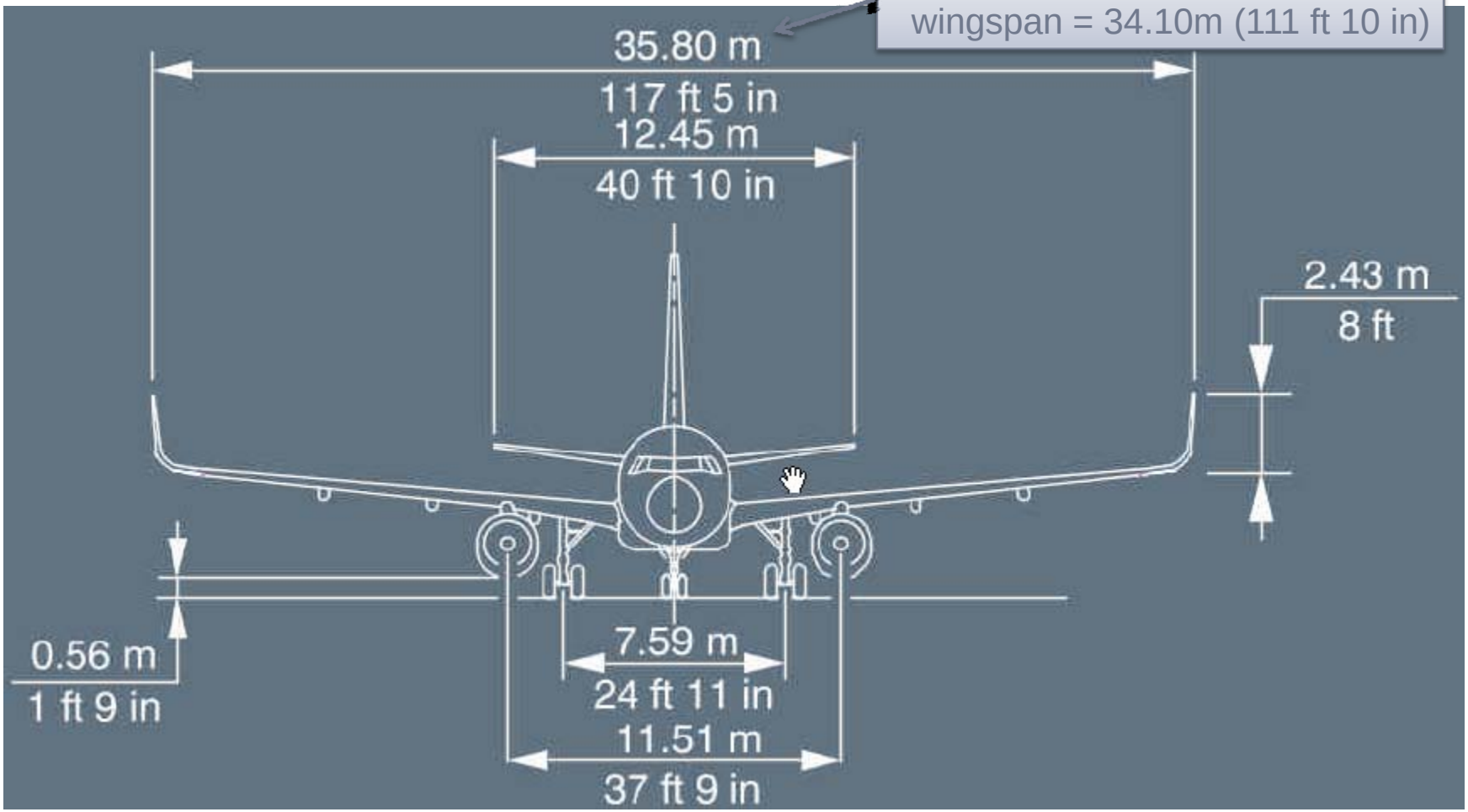
Wing span increased by 1.70m (5ft 7in)

A320 with Sharklets remains ICAO code C aircraft.

No ground operations impact

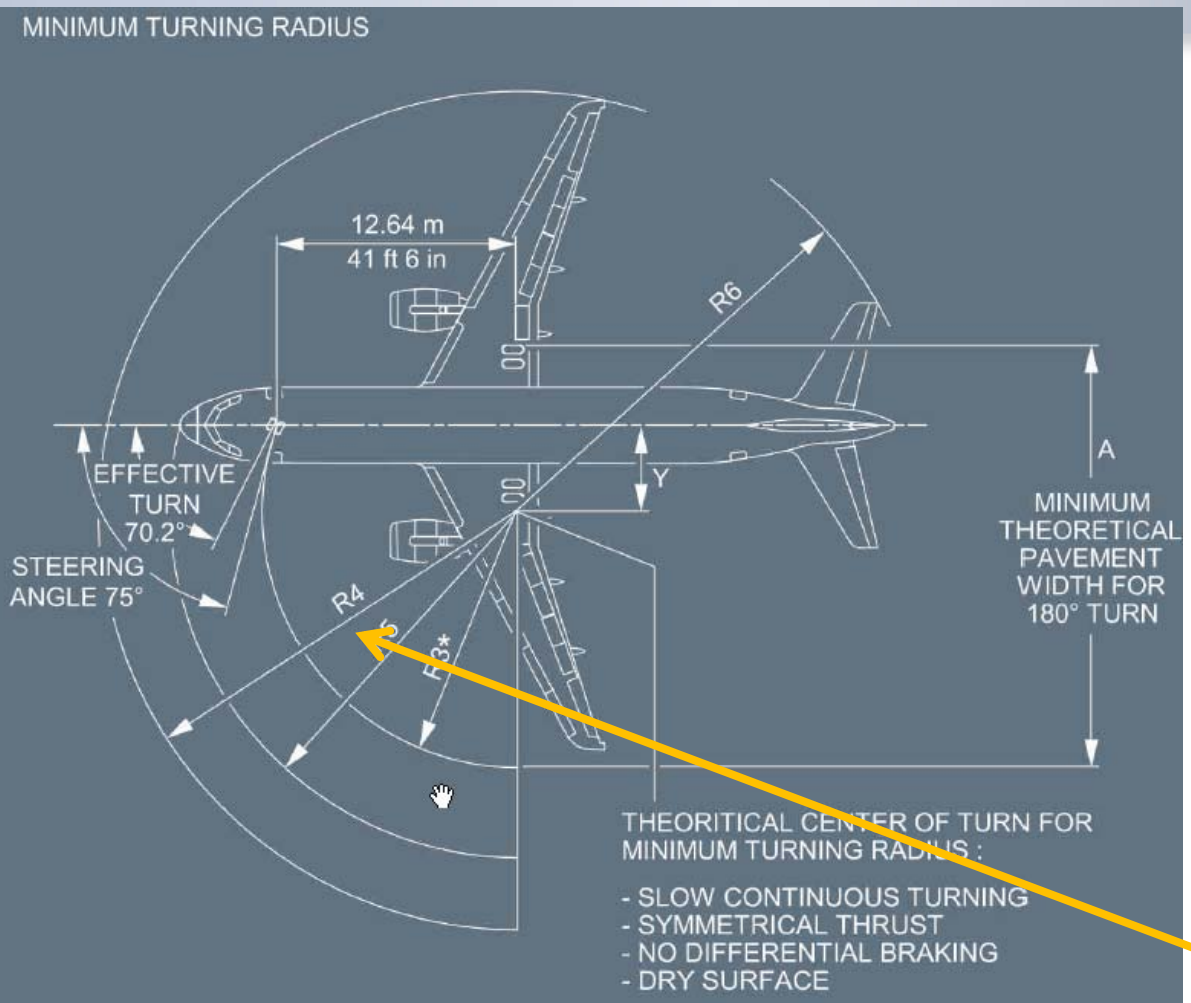
Dimensions

FCOM DSC-20-20



Ground Maneuvering

FCOM DSC-20-20



	Y	A	R3	R4	R5	R6
FT	15	75	44	75	60	72
M	4.5	22.8	13.6	22.9	18.3	21.8

*NOSE GEAR RADIUS (R3) MEASURED FROM OUTSIDE FACE OF TIRE

	Non-Sharklet (m)	Sharklet (m)
R4	21.99	22.90

R4: Minimum turning radius

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Flight Operational considerations

Introduction of new imbalance limitations for takeoff

- Fuel imbalance limitations in flight and at landing unchanged

CAT II and CAT III Autoland capability

- Automatic rollout crosswind limitations: 15kt (already on A318/319/321)

Enhanced flight control law

- In case of yaw damper loss, when the landing gear is extended, the yaw damper remains in alternate law (previously: switched to direct law)

CDL Static discharger

- Only one static discharger may be missing per Sharklets if the hole is covered with high speed tape.

Flight Operational considerations

New LED design strobe & navigation lights

- Blue light below the strobe & nav lights flashes when the replacement of the LED is required by the maintenance personnel

Load Alleviation Function (LAF)

- Wing load reduction through upward deflection of ailerons/spoilers
- MTOW limited to 76 400kg (168 430 lbs) in case of failure of spoilers 4 or 5 (MMEL items updated accordingly)

FCOM/QRH Performance tables updated

- The following tables were updated to reflect the Sharklets performance improvement:

FCOM section	Reference
Takeoff	PER-TOF-TOD
Automatic landing increment on dry runway	PER-LDG-DIS-RLA
Go around performance	PER-GOA
Wet and contaminated runways penalties	PER-TOD-CTA-40
Overweight landing	PRO-ABN-80
ETOPS performance	PRO-SPO-40-60
Severe turbulence thrust setting	PRO-SUP-91-10
Unreliable Speed Indication	PRO-ABN-34
Flight with gear down performance	PRO-SPO-25-40
QRH Fuel penalty factors	FPE-FPF

Performance Data Simplification: Objectives

To maintain a Simple documentation

- No multiplication of the performance pages (mixed fleet)

To Promote the use of performance programs

- More accurate calculations
- Optimized results
- Reduced error risk

Performance Data Simplification

- A first step in the global flight ops documentation simplification project

Performance data simplification: FCOM/QRH tables

FCOM/QRH section	Reference
Cruise performance	PER-CRZ & QRH FPE-AEO
Holding performance	PER-HLD
One engine inoperative performance	PER-OEI & QRH FPE-OEI
Flight without cabin pressure performance	PRO-SPO-20 & QRH FPE-CAB
Gear down performance (partially)	PRO-SPO-25-40

Airbus recommends the use of performance programs

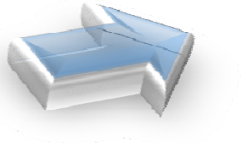
Performance data simplification: MMEL

MMEL section	MO Reference
Spoiler 1 or 3	MO-27-64-02A
Spoilers 1 and 2	MO-27-64-04A
Ground Spoiler Control System	MO-27-92-02A
Wing Anti-ice Control Valve	MO-30-11-01A
Main Wheel Brake	MO-32-42-01A
Minimum Idle on Ground	MO-73-20-05A

Content

Summary

- **Airbus Patented design**
- Optimized for drag reduction and overall weight
- Retrofit possible on existing wing-tip fence (WTF)
- The first Air Asia A320 EIS 21st Dec 2012.
- Common design for all A320 Family aircraft
- Minor weight impact thanks to airframe weight savings



Sharklets hunting down up to 4% Fuel Burn

summary

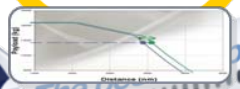
Fuel burn reduction up to 4%

Attractive savings

efficient family

Lower CO_2 emissions

More payload & range



Better take-off capability

Lower engine DMC

Higher optimum altitude

Sharklets increase A320 Family value

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Summary

Flight test data as of February 2013

Summary

- The use of performance program (PEP or equivalent) enables:
  - Reduced risk of errors
  - Optimized and Accurate results
  - Simplified documentation:
    - Unique MMEL Operational Procedure from Sharklets onwards
    - Documentation homogeneity improved
  - Full benefit of the Sharklets performance


Thank you for
your attention!