AFI Flight Operations Safety Awareness Seminar (FOSAS)

Operations linked to weather

ICAO/Airbus
Nairobi, 19-21 Sep. 2017

AIRBUS

Agenda

Operations linked to weather

Weather

A hazard

Use of radar

Prevention

AIRBUS

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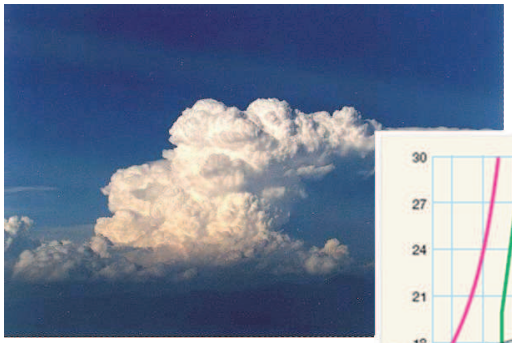
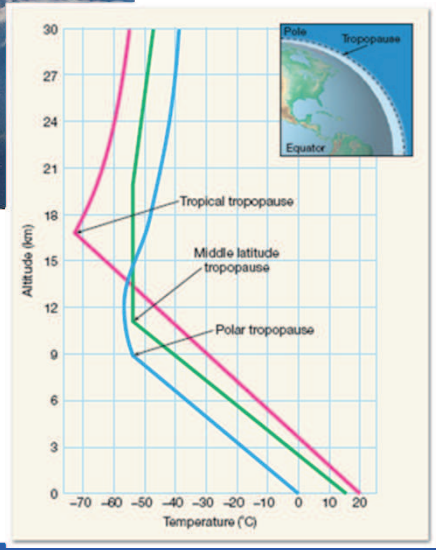
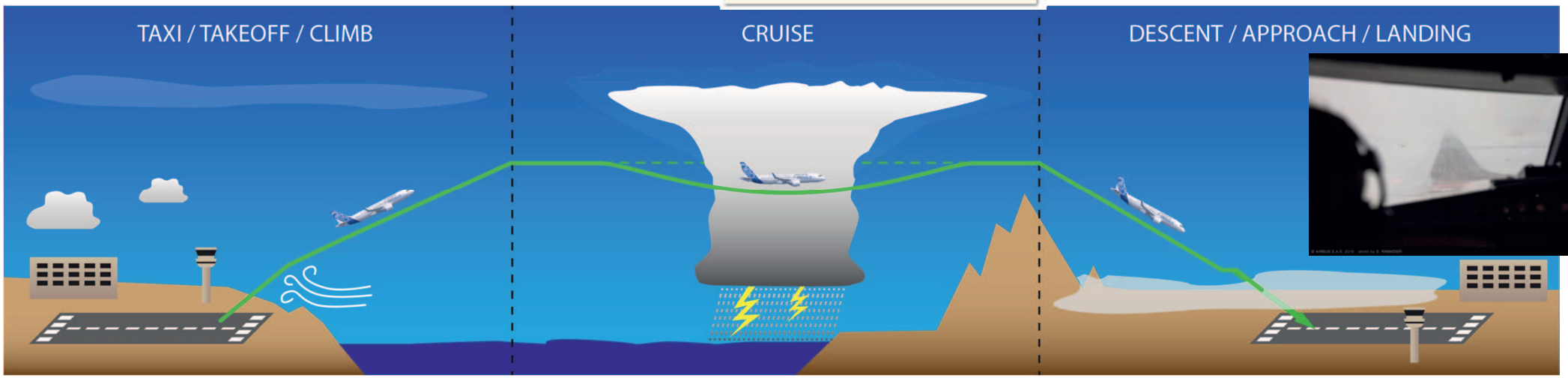
AIRBUS

Introduction

Weather: a hazard?







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Taxi and takeoff

- Low visibility
- Windshear at take-off

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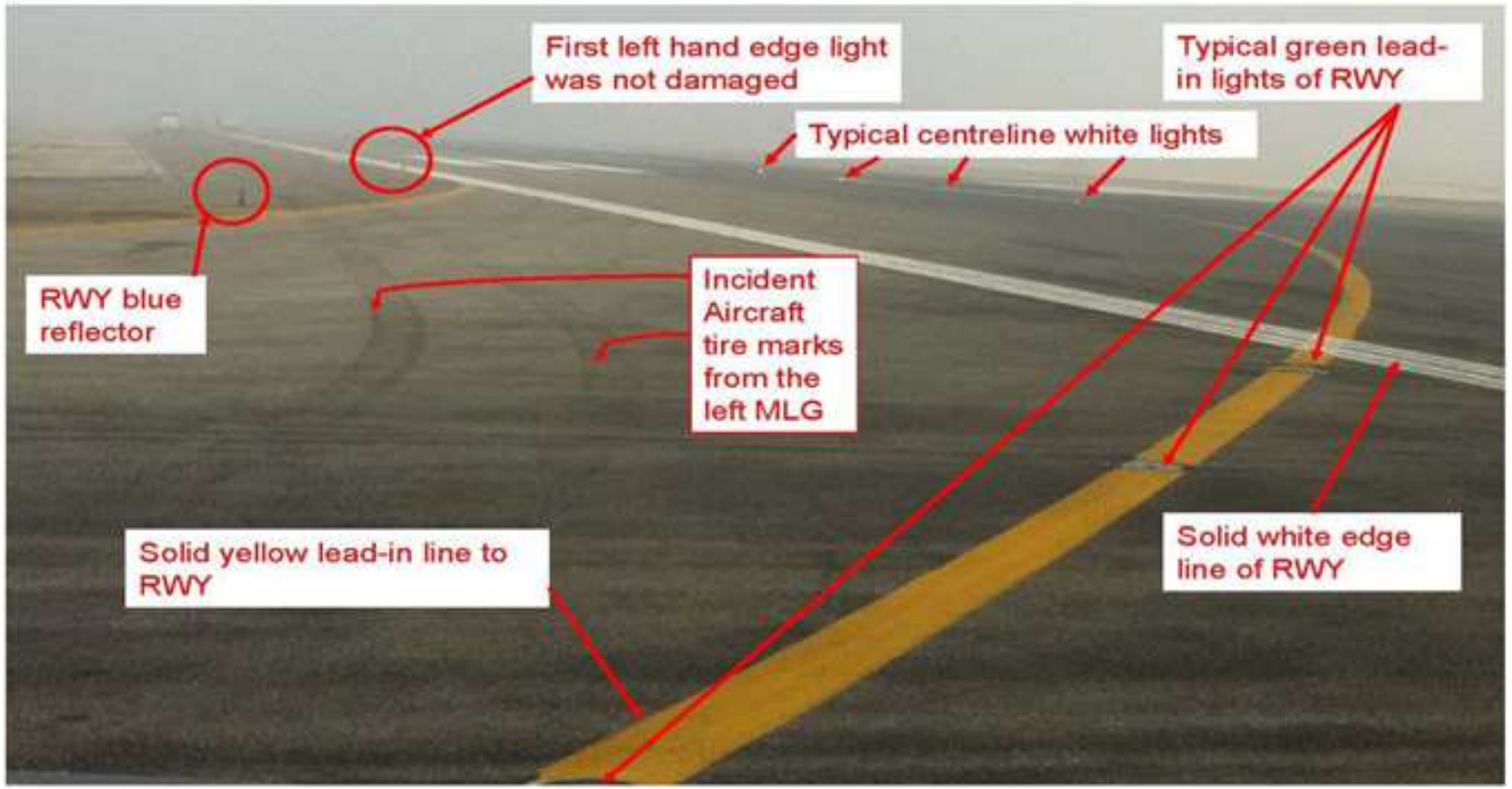
A330 incident



The aircraft aligned with the left edge of runway instead of the centreline

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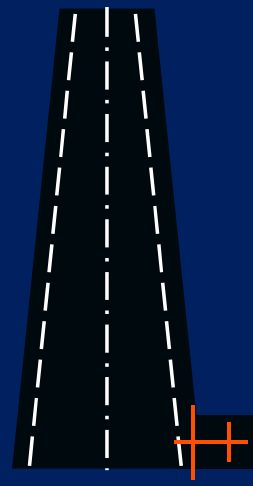
A340 incident

Rolling take-off



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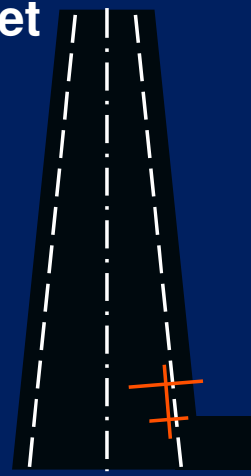
A340 incident

Aircraft aligned on runway edge

Take-off thrust was set



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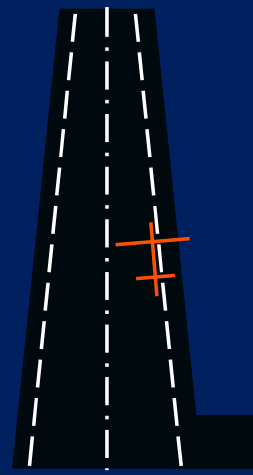
A340 incident

Aircraft entered the high speed regime



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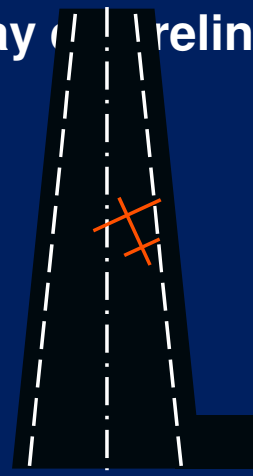
A340 incident

Sidestep manoeuvre was performed in order to regain the runway centreline



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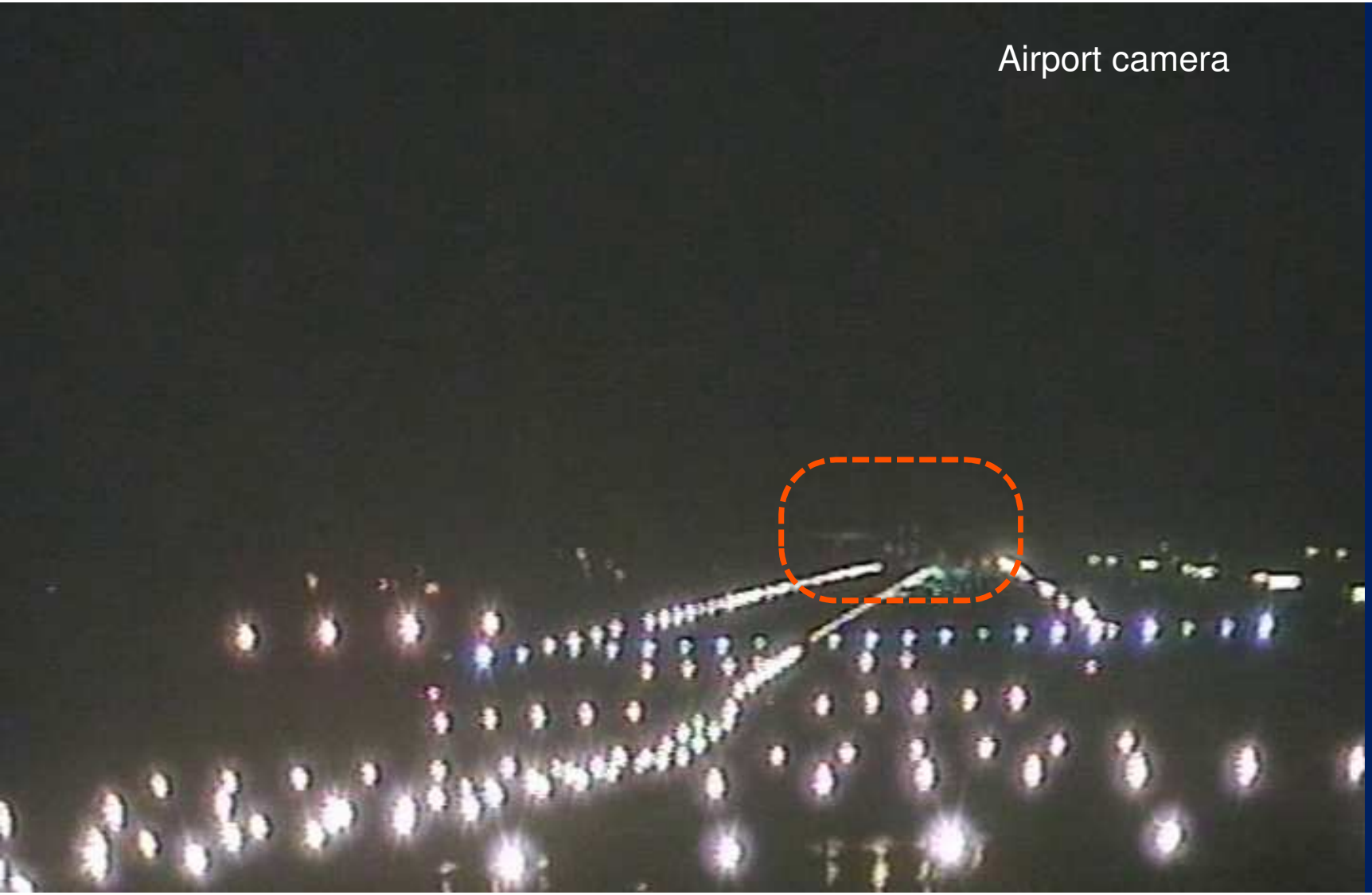

A340 incident

Rotation was performed

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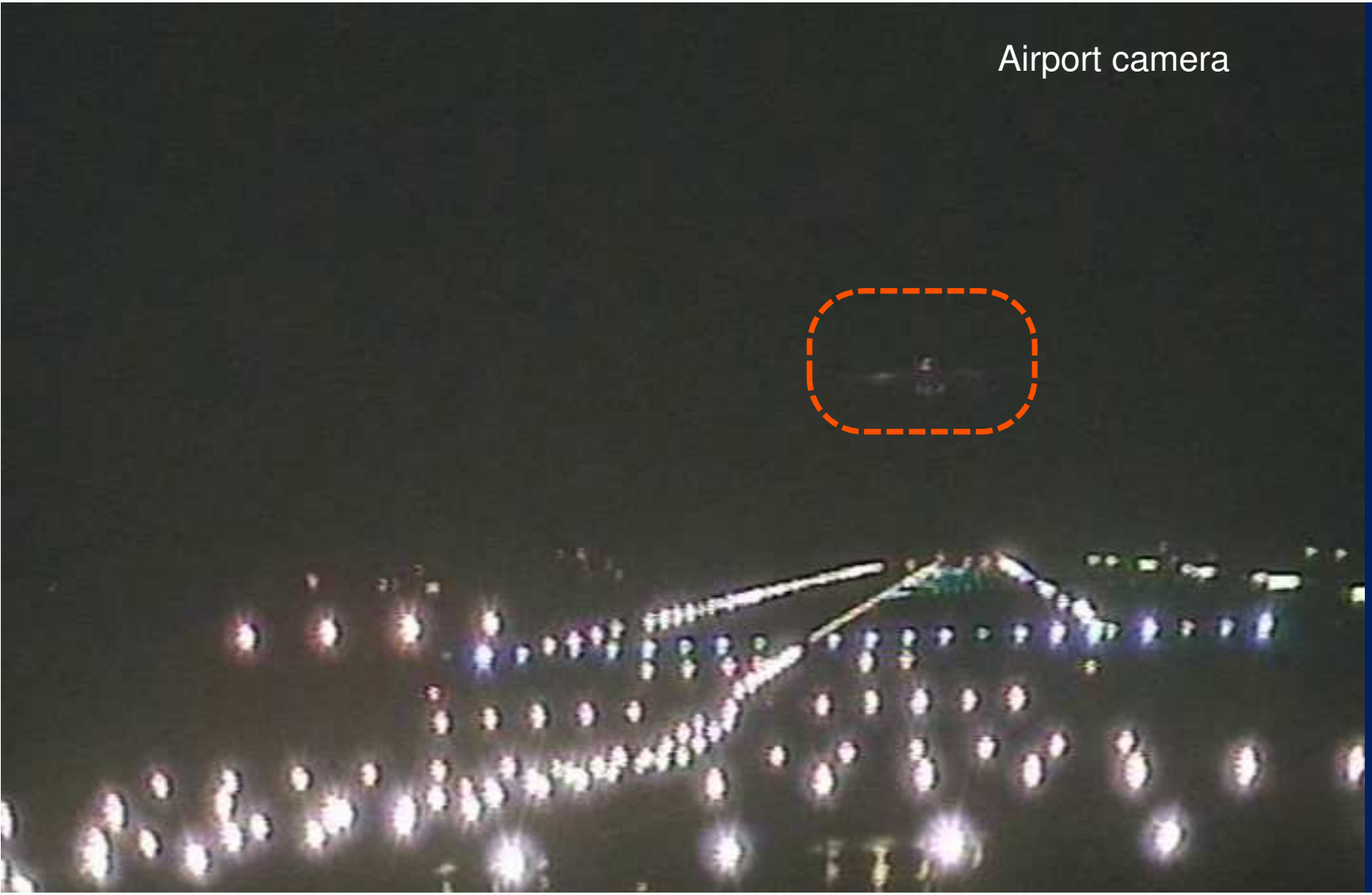
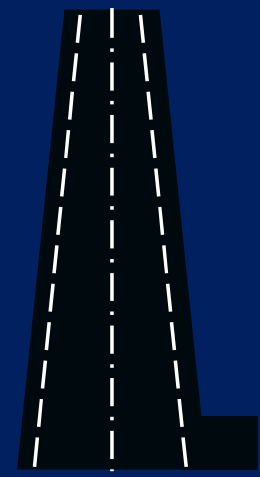


A340 incident

The aircraft flew away



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Takeoff

Thrust	Pitch	Climb rate	Speed	CONF
TOGA	Up to 27°	Up to 5400ft/min	Up to 210kt	1+F VFE=215kt
CLB	17°	decreasing	Down to 140kt	0 transient speed lock

WINDSHEAR AHEAD after lift-off

Crew reacted with significant back stick

SRS orders were not followed

The climb phase became unstable

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Cruise

- Substantial airframe damage : radome, wing/VTP/HTP leading edges
- Loss of weather radar
- AP and autoland remained available
- Flight controls remained in normal law
- Diversion to the closest airport
- Due to lack of forward visibility, an autoland was performed

Event #2 description

- Substantial airframe damage :
  Slats & HTP leading edges,
  engines nose cowls
- Air data sensors measurements were affected ➔ all ADR were rejected
- AP, FD and ATHR were lost
  ➔ AUTOLAND not available
- Flight controls reverted to alternate law
  ➔ direct law after landing gear extension on SA family
- An emergency was declared
- Approach with radar vectors guidance

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Event #2 summary

- Extreme severity of the hail stones encounter
- Significant structural damage and systems impacts
- Challenging manual flight : approach, two go-arounds and landing

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Landing

- A321 experienced a runway overrun at ~20:00 LT (UTC+2hrs)
- Aircraft came to rest as the nose wheel collided with the basement of the LOC monitor antenna

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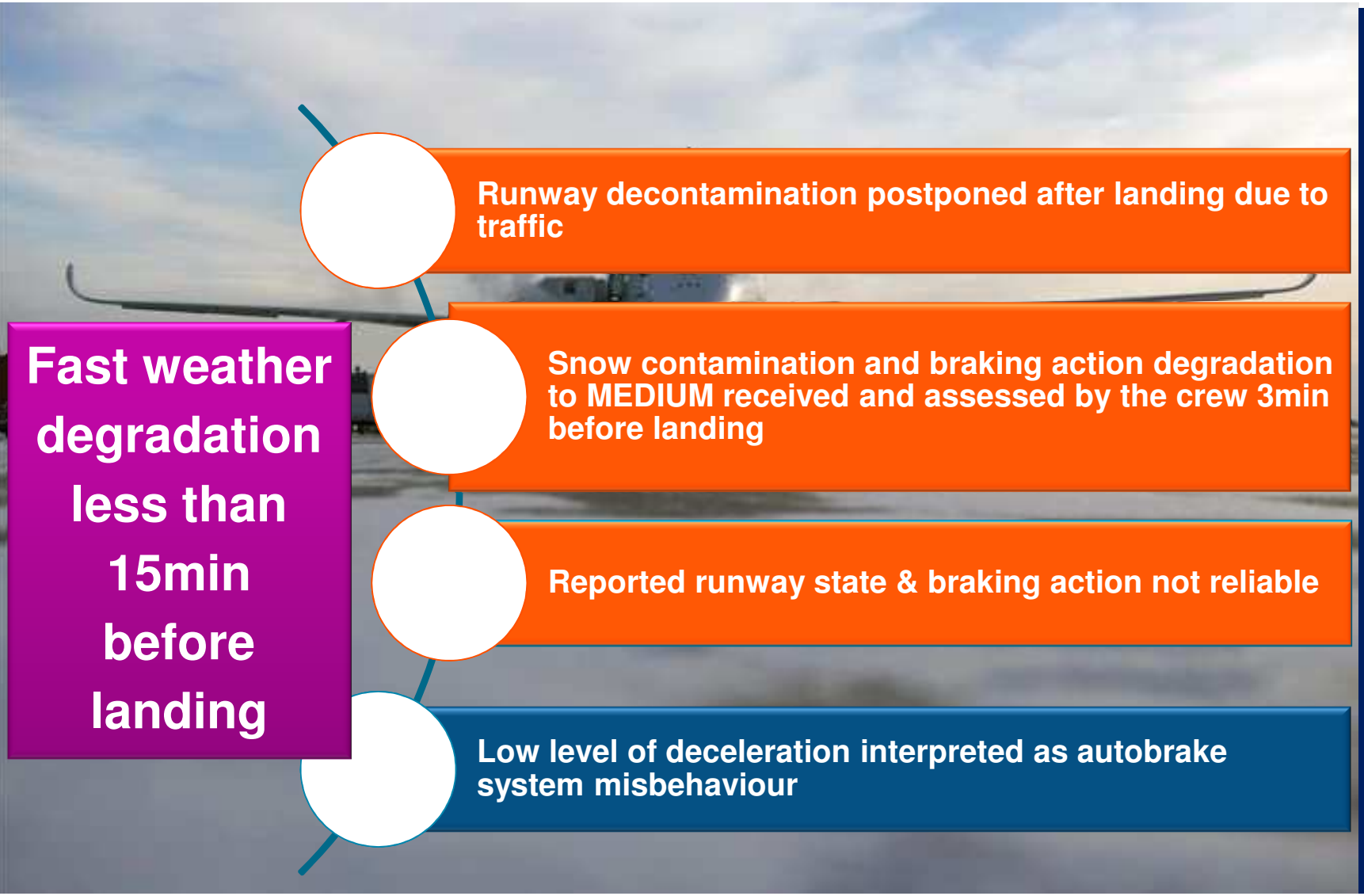
Landing

Summary



Agenda

Operations linked to weather

Weather

A hazard

Use of radar

Prevention

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Use of radar

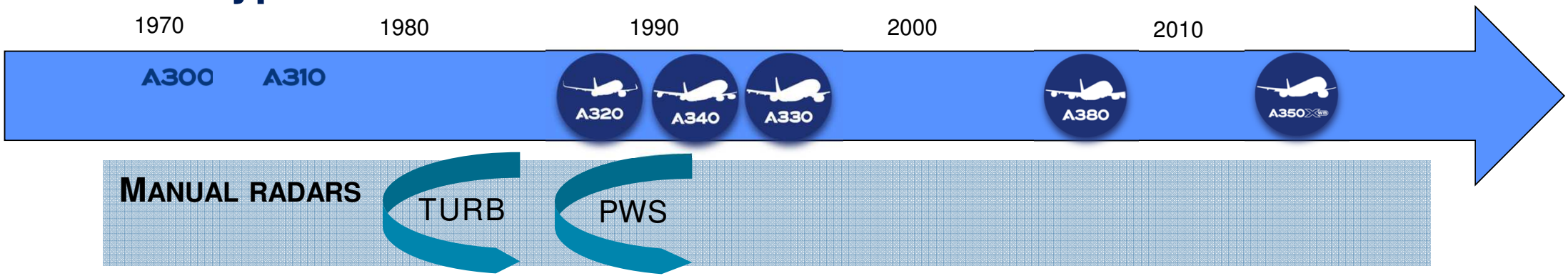
Very different types of weather radar systems throughout Airbus fleet

+Need to understand the system to mentally build a correct image of the weather, from the radar display

Common recommendations on the use of the weather radar

+ No health risk related to the use of the radar
+ Avoidance decision and technique
+ Interpretation of the displays

Different types of radars



MANUAL RADARS

TURB

PWS

AUTO-TILT RADARS
TURB + PWS

ROCKWELL COLLINS
MULTISCAN

HONEYWELL
RDR-4000

HONEYWELL
A380/A350 RADARS

AUTOMATIC RADARS
TURB+PWS

TURB: Turbulence
PWS: Predictive Windshear

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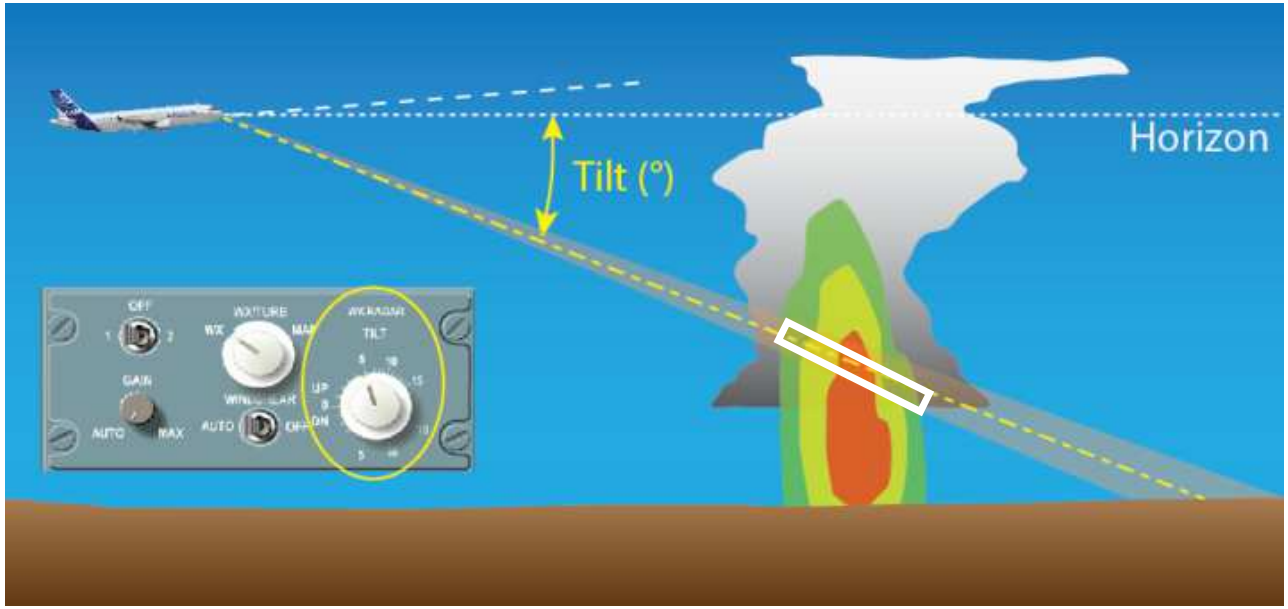
Different types of radars

Manual Radars

Display only a “slice” of weather for a single tilt angle:

+ Fully manual
+ No default value for the tilt
+ Beam is 3.5° wide => Slice increase with the distance



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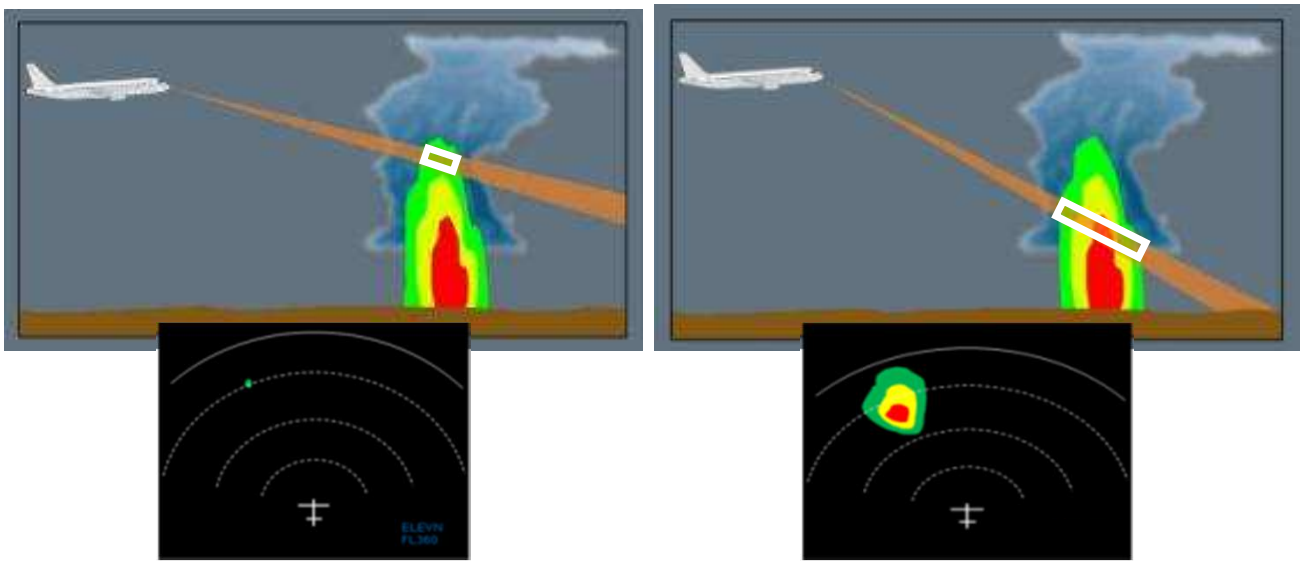
Different types of radars

Manual Radars

Tilt has to be manually adjusted to find & correctly see the weather

+ Perform a periodical scan of the whole space
+ When the weather scan is completed, adjust the tilt so that the ground returns appear on the top of the ND



FCTM Aircraft Systems/Weather Radar

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Different types of radars

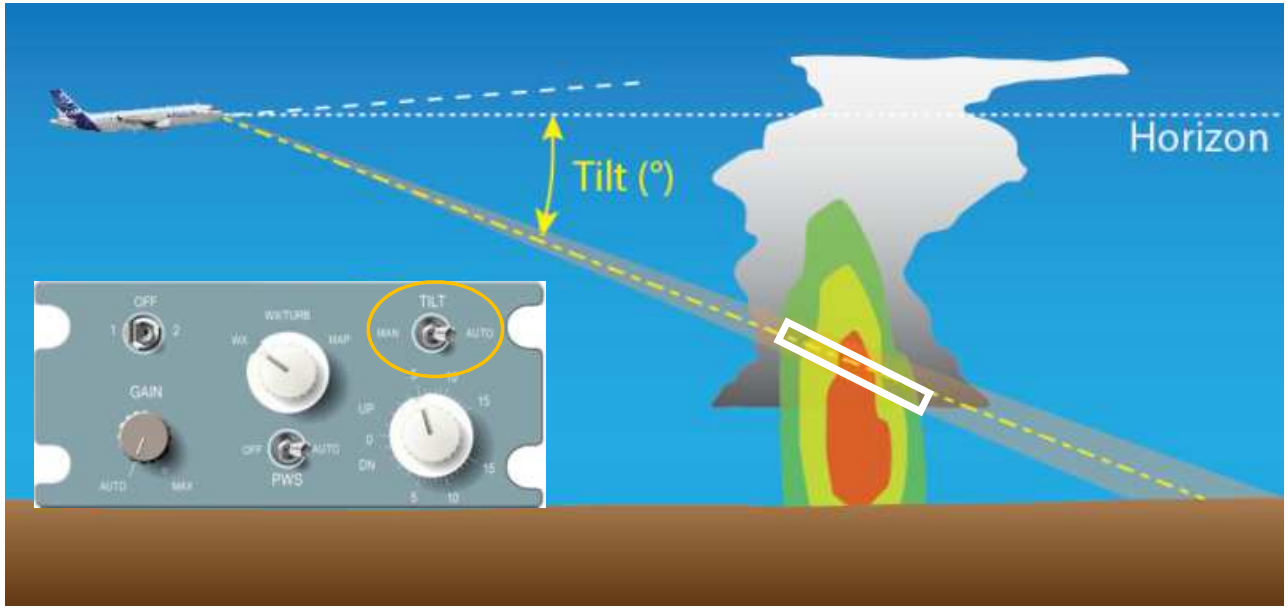
Auto-Tilt Radars

A320 A330 A340

Auto-Tilt Radars display a unique “slice” of weather for a single tilt angle…

… In AUTO Mode they provide a “default” tilt value, optimized as a function of:

+ ND range
+ Aircraft Position
+ Altitude
+ Terrain Database



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Different types of radars

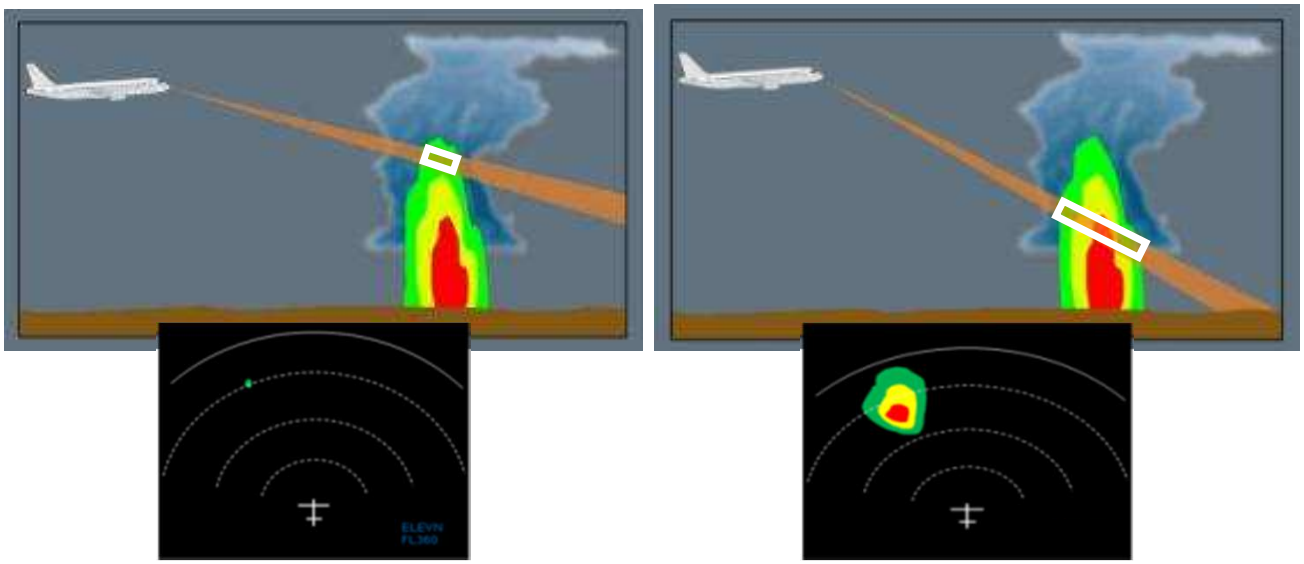
Auto-Tilt Radars

A320 A330 A340

TILT AUTO mode is the default mode…

… However, manual tilt is still necessary:

+ For further storm cells analysis
+ Regularly, to enhance weather awareness



Manual and Auto-Tilt Radars are very similar in terms of operation

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Aircraft Systems/Weather Radar

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Different types of radars

Automatic Radars: Rockwell-Collins Multiscan

Two radar beams (tilt values) super-imposed on ND

Tilt and gain automatically adjusted based on:

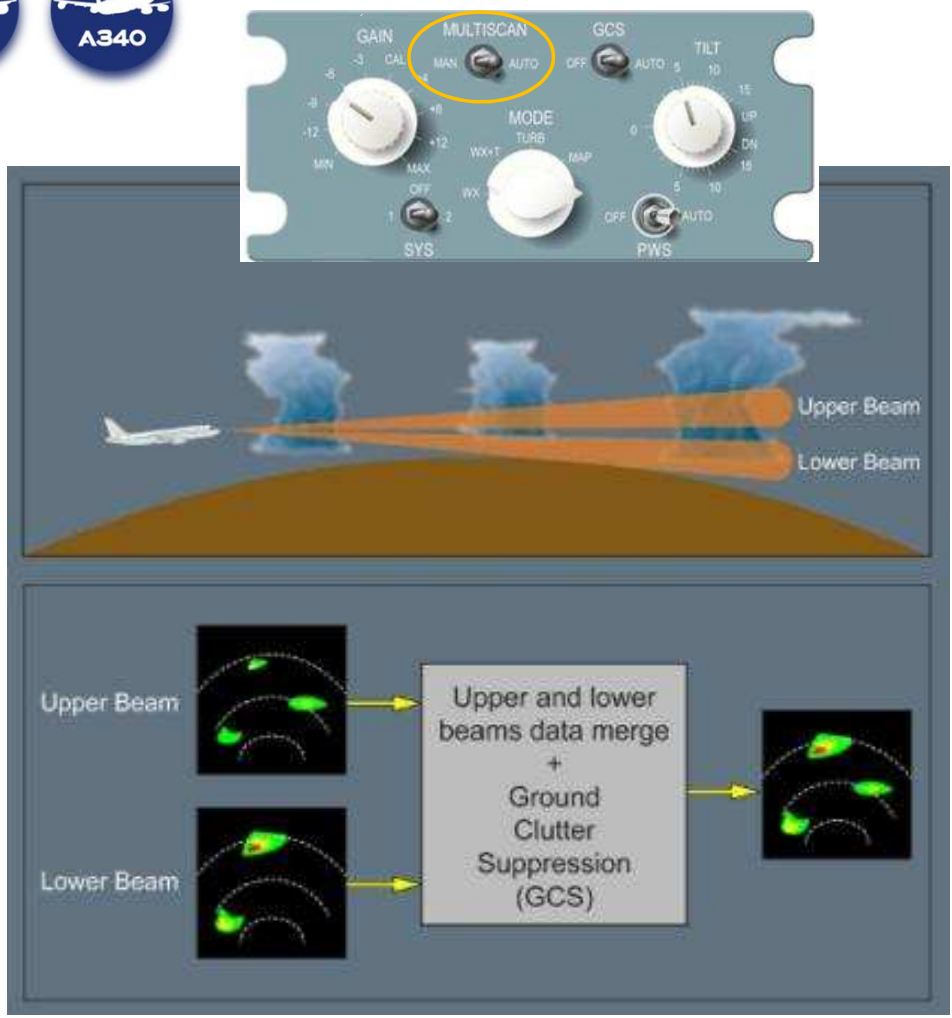
+Aircraft position

+Altitude

+Terrain

+Time and season

+"V2" functions: Hail, lightning



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Different types of radars

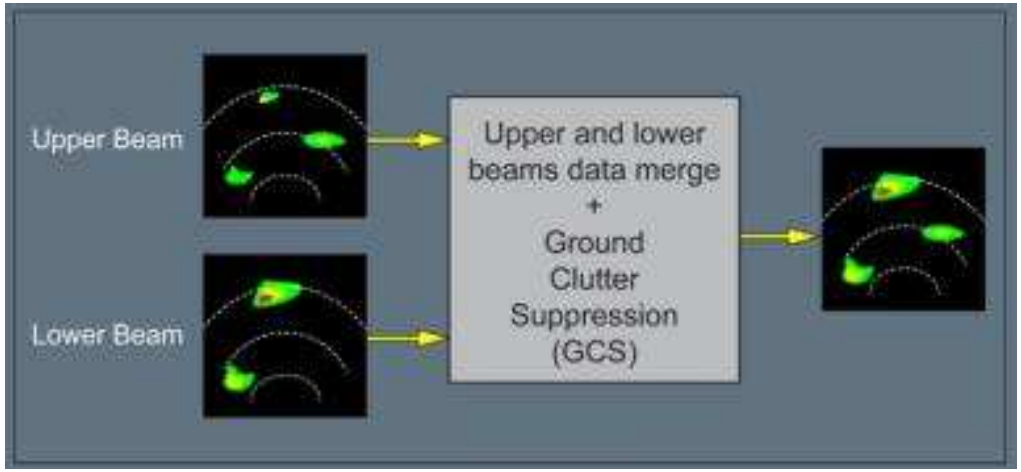
Automatic Radars: Rockwell-Collins Multiscan

A320 A330 A340

Use manual tilt to:

+ Display a single beam and better understand ND display

+ Make a mental image of the real shape of the cell



FCTM Aircraft Systems/Weather Radar

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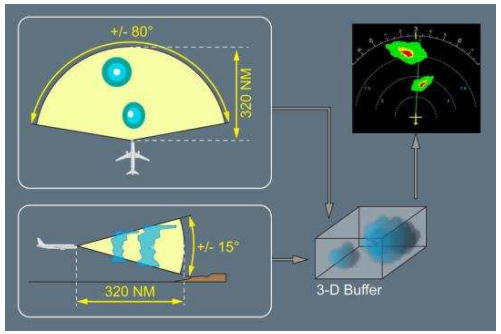
Different types of radars

A320 A330 A340



Automatic Radars: Honeywell RDR-4000

+ Continuous scan stored in a 3-D buffer

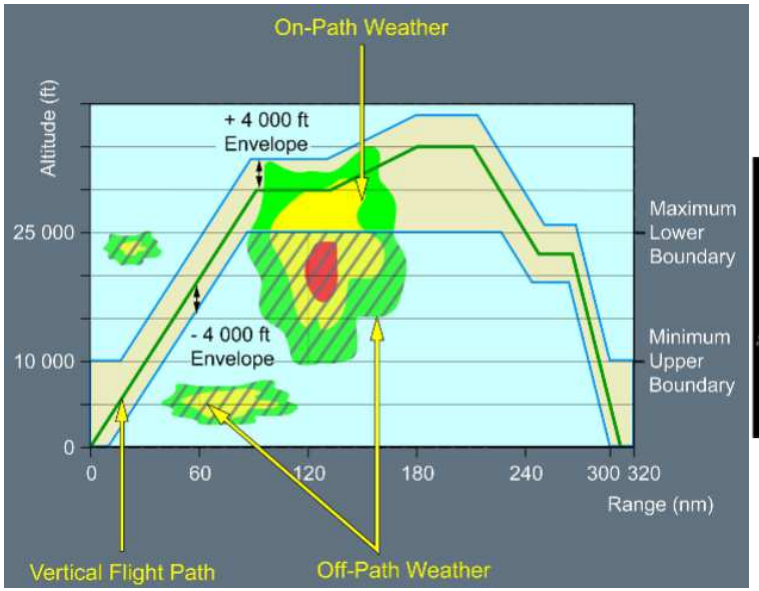
+3-D buffer relevant features “flattened” on a 2-D ND

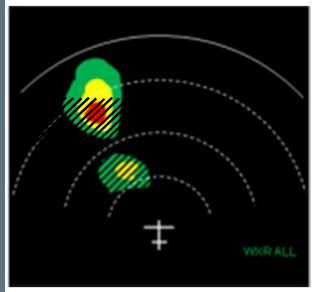
+ On-path/Off-path logic:

A/C altitude +/- 4000 ft

Min FL250 (CRZ)/FL100 (TO & LDG)

+Possibly 2 different displays on CAPT and F/O sides





+“V2” functions: Hail, lightning, WEATHER AHEAD

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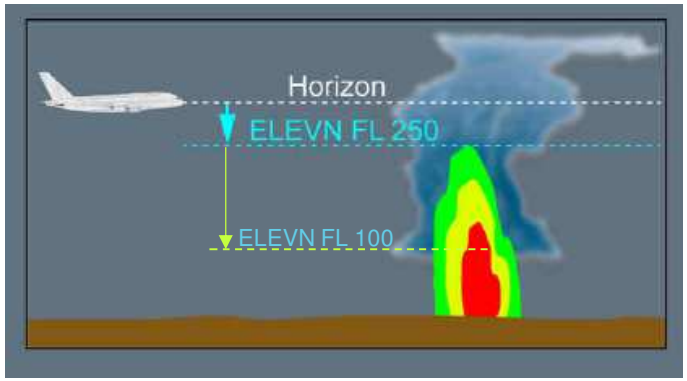
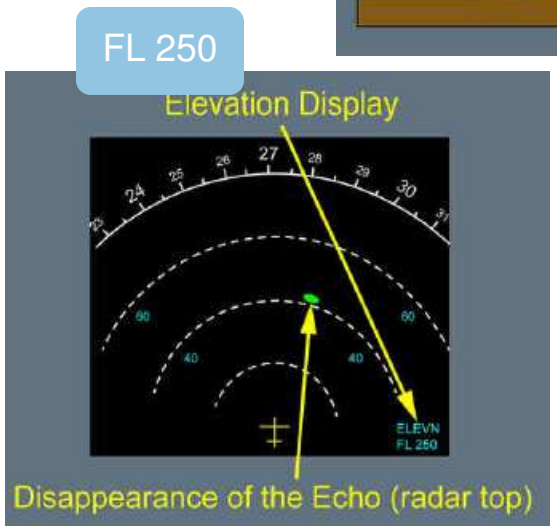
Different types of radars

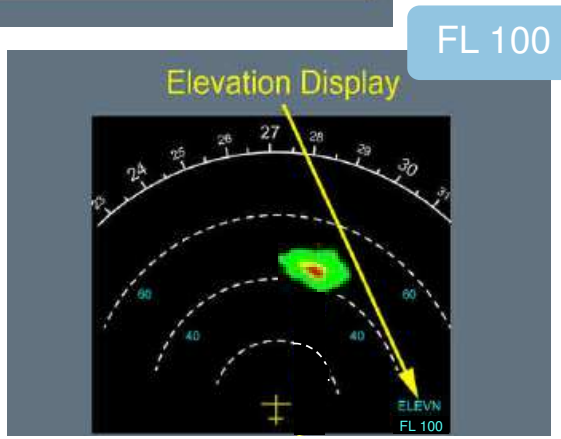
Automatic Radars: Honeywell RDR-4000 (& A380/A350 Radars)

The 3-D buffer enables to display more weather:

+ AUTO: Superimposition of weather for all FL
+ Use ELEVATION mode to analyse the precise vertical structure of the cell on the ND (horizontal cuts along FMS F-PLN)







FCTM Aircraft Systems/Weather Radar

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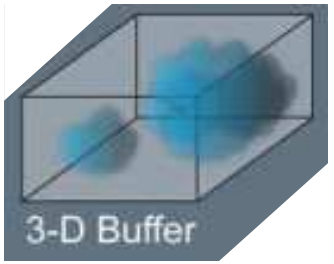
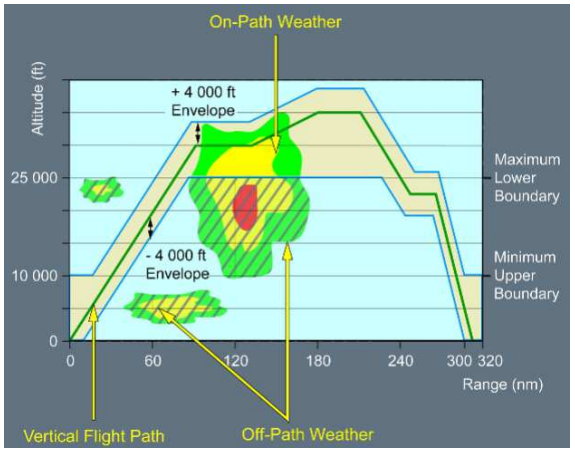
Different types of radars

Automatic Radars: Honeywell A380/A350 Radars

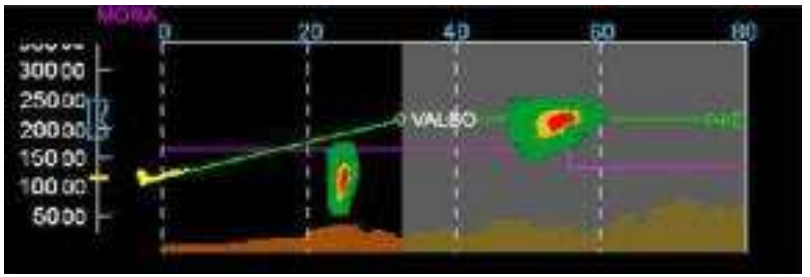
+ Same principle as RDR-4000:
  - ➢ 3-D buffer
  - ➢ On-path/off-path displays
  - ➢ CAPT/FO sides





+ Integration in Aircraft Environmental Surveillance System (AESS)

+ Weather info also on the Vertical Display (VD)



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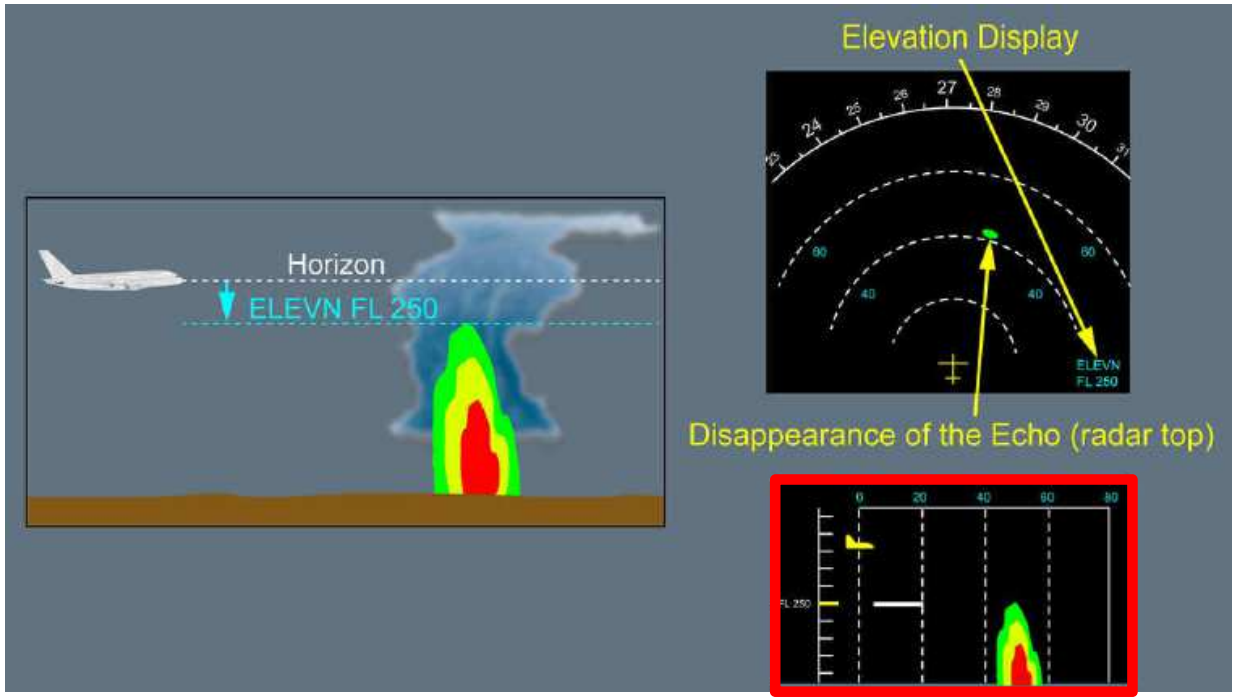
Different types of radars

Automatic Radars: Honeywell A380/A350 Radars

+Use the Vertical Display to get an image of the vertical structure of the cell

+ELEVATION mode only for precise analysis



FCTM Aircraft Systems/Weather Radar

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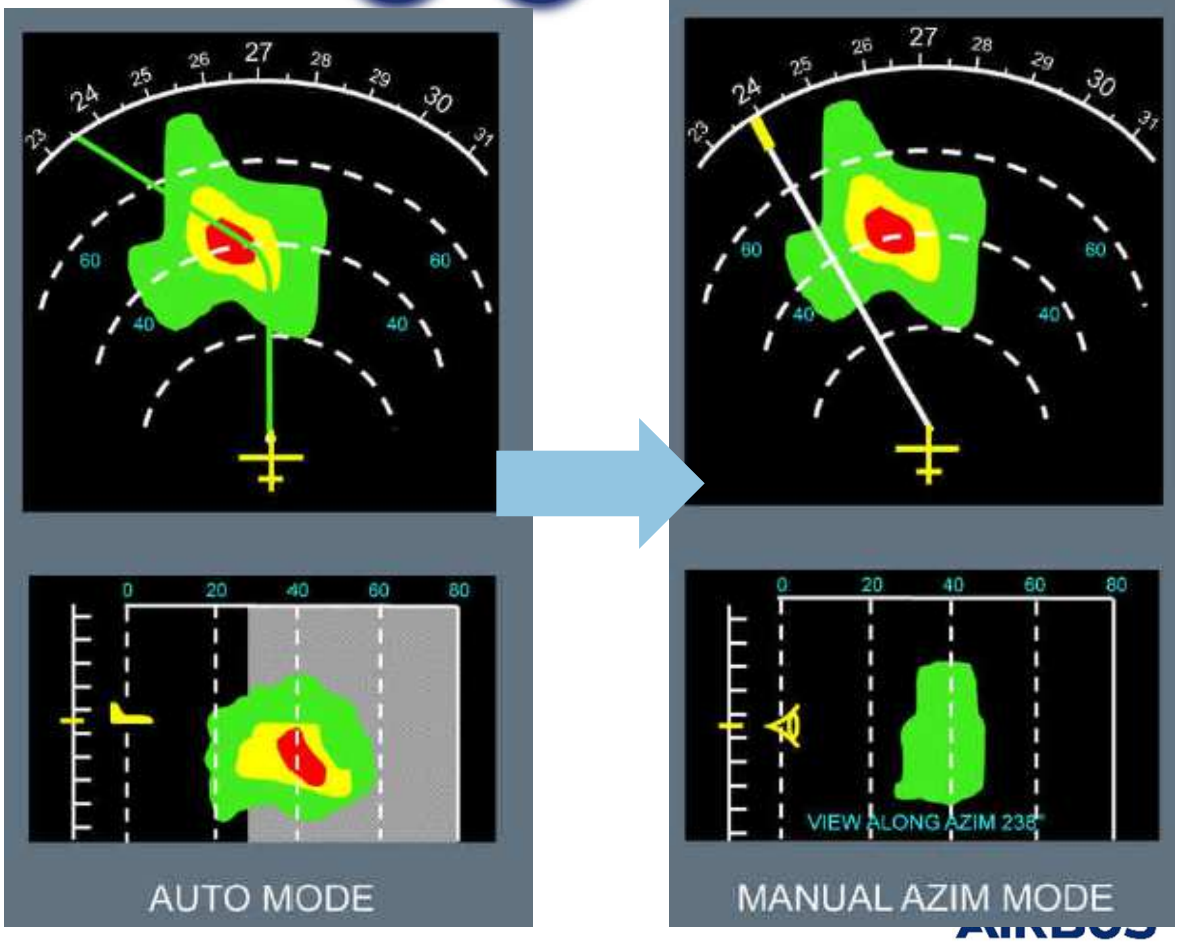
Different types of radars

Automatic Radars: Honeywell A380/A350 Radars

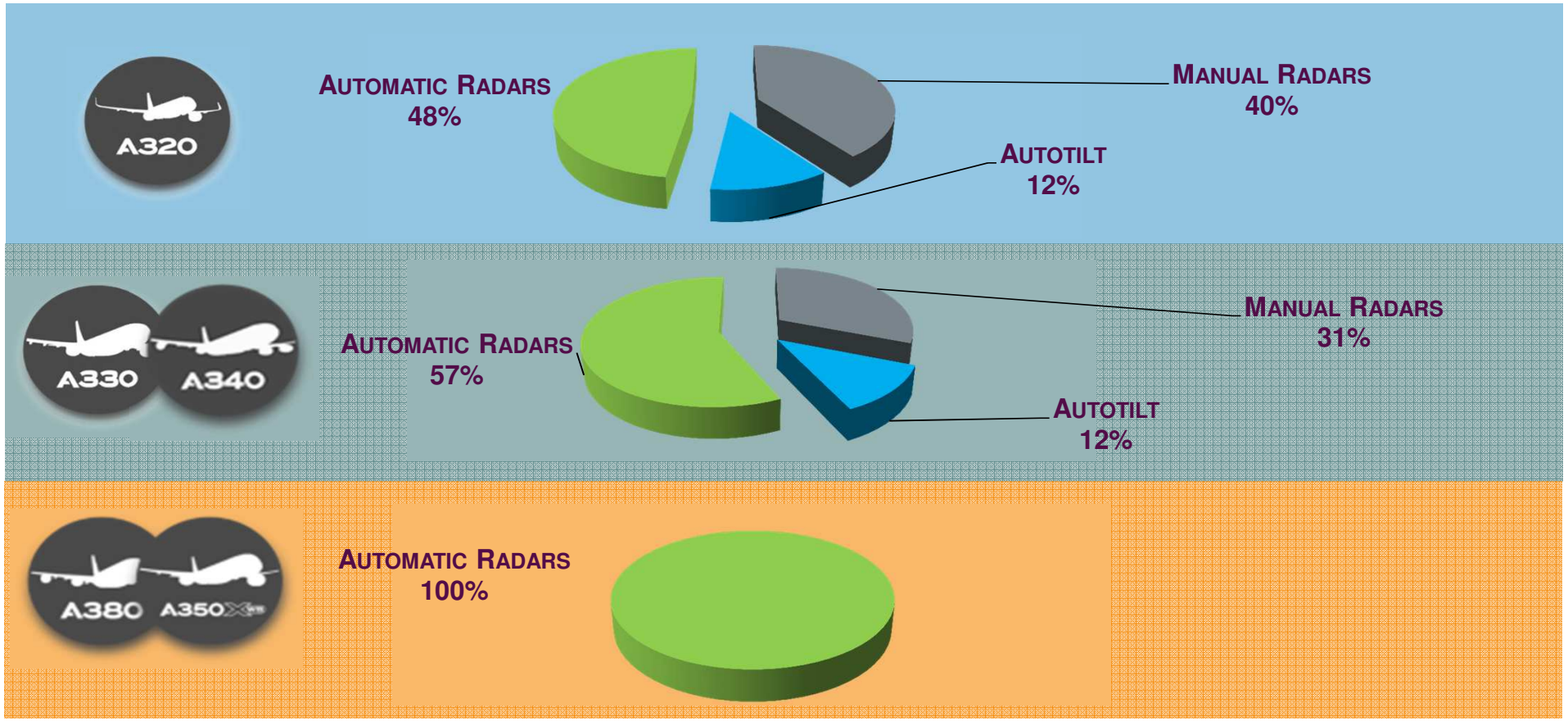
+AZIM mode to display a vertical cut along a specified azimuth



FCTM Aircraft Systems/Weather Radar

Different types of radars

Fleet Status



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Different types of radars

A320/A330/A340 Families Mix-Fleet Flying

Which Radar do I have on-board?

Manual Radar

RDR-4000

Auto-Tilt Radar

Multiscan Radar

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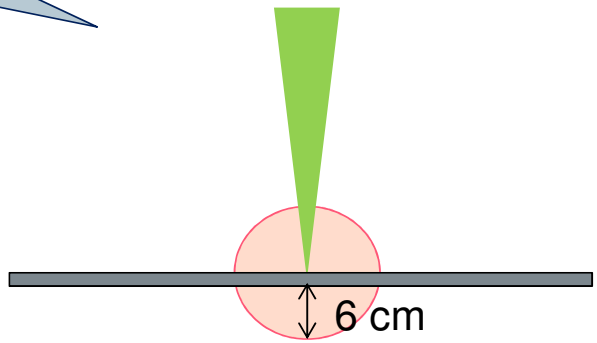
Common recommendations

Use of the Weather Radar

+ The Radar should be ON before takeoff



+ No risk for pilot's health:
  - ➢ Compliance to FAA AC 20-68B: area for emission up to 10 mW/cm2 is 6 cm behind antenna (far before cockpit)
  - ➢ Cockpit = Faraday cage

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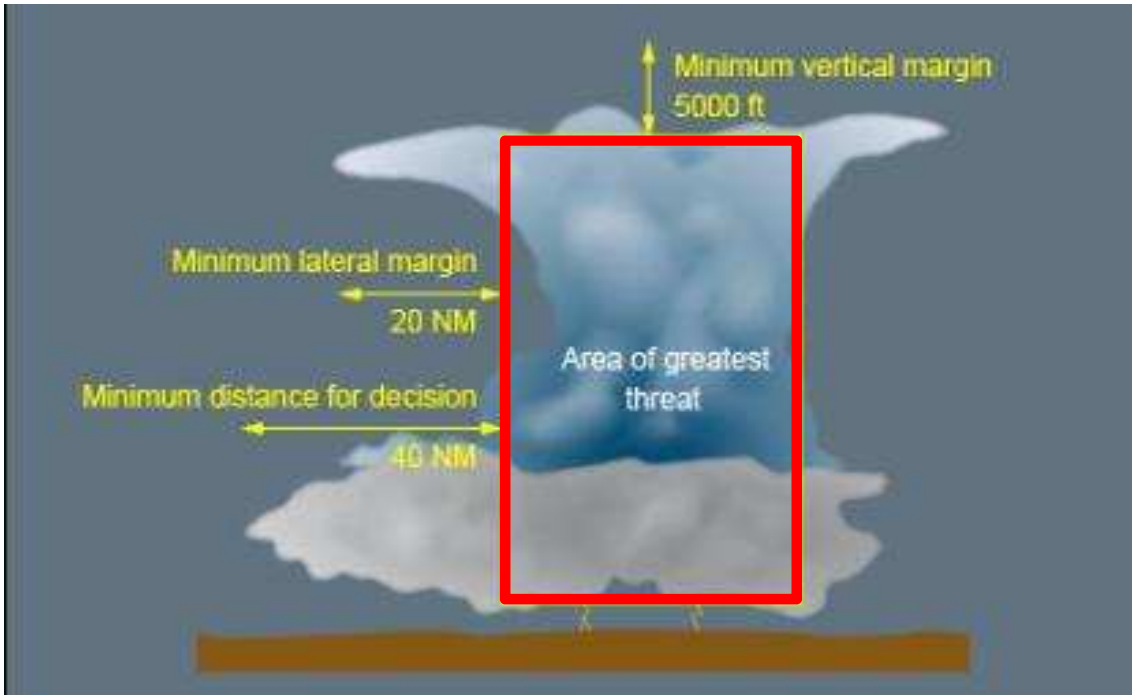
Common recommendations

New Operational Recommendations in FCTM

Avoidance Decision:

+ No longer linked to the height of cells
+ Does not rely only on colours
+ "Area of greatest threat" based on:
  - ➢ Location and shape of the strongest weather radar echoes
  - ➢ Meteorological knowledge of the flight crew
  - ⇒ Zone where the flight crew estimates that the weather conditions are too dangerous to fly in
  - ⇒ Empowers crew's expertise



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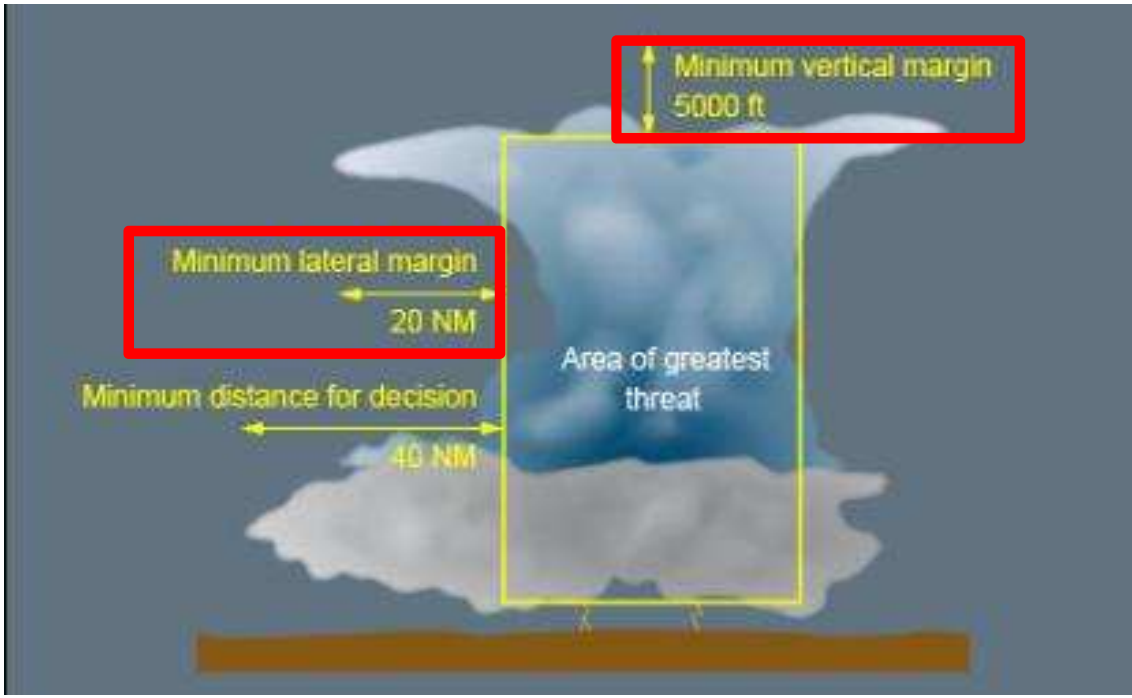
Common recommendations

New Operational Recommendations in FCTM (cont'd)

Avoidance Technique:

+ Take margins around the "area of greatest threat"
+ Increase the margin if the cloud is very dynamic
+ Still applicable:
  - Analyze the weather in details
  - Prefer upwind and lateral avoidance



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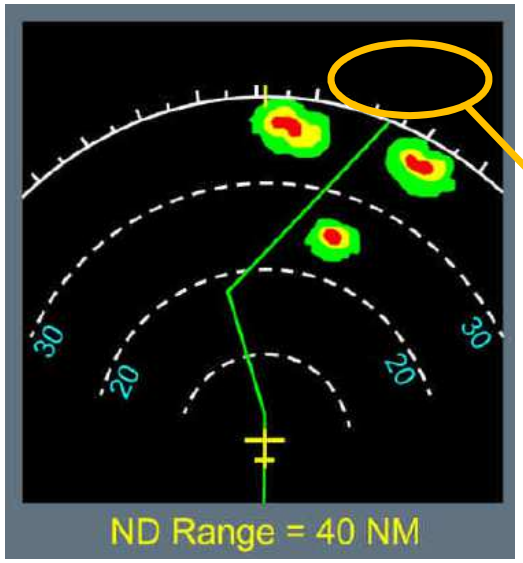
Common recommendations

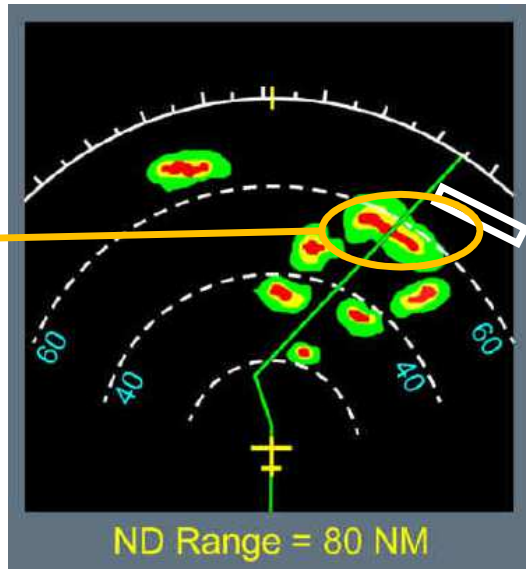
ND Range

Use low ND ranges
(radar more precise but blind alley effect…)

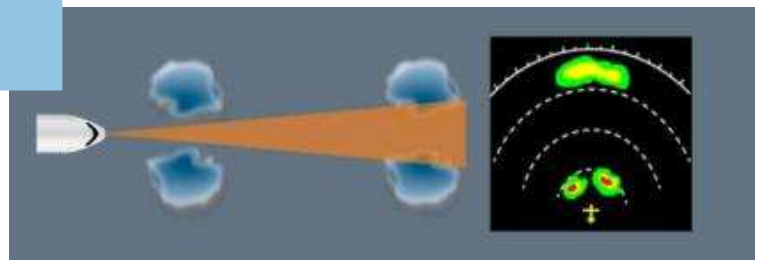
… And high ND ranges
(better long-term vision but radar less precise)



Blind Alley Effect



Long-distance Decreasing Accuracy



+ Combine two different ND ranges at the same time

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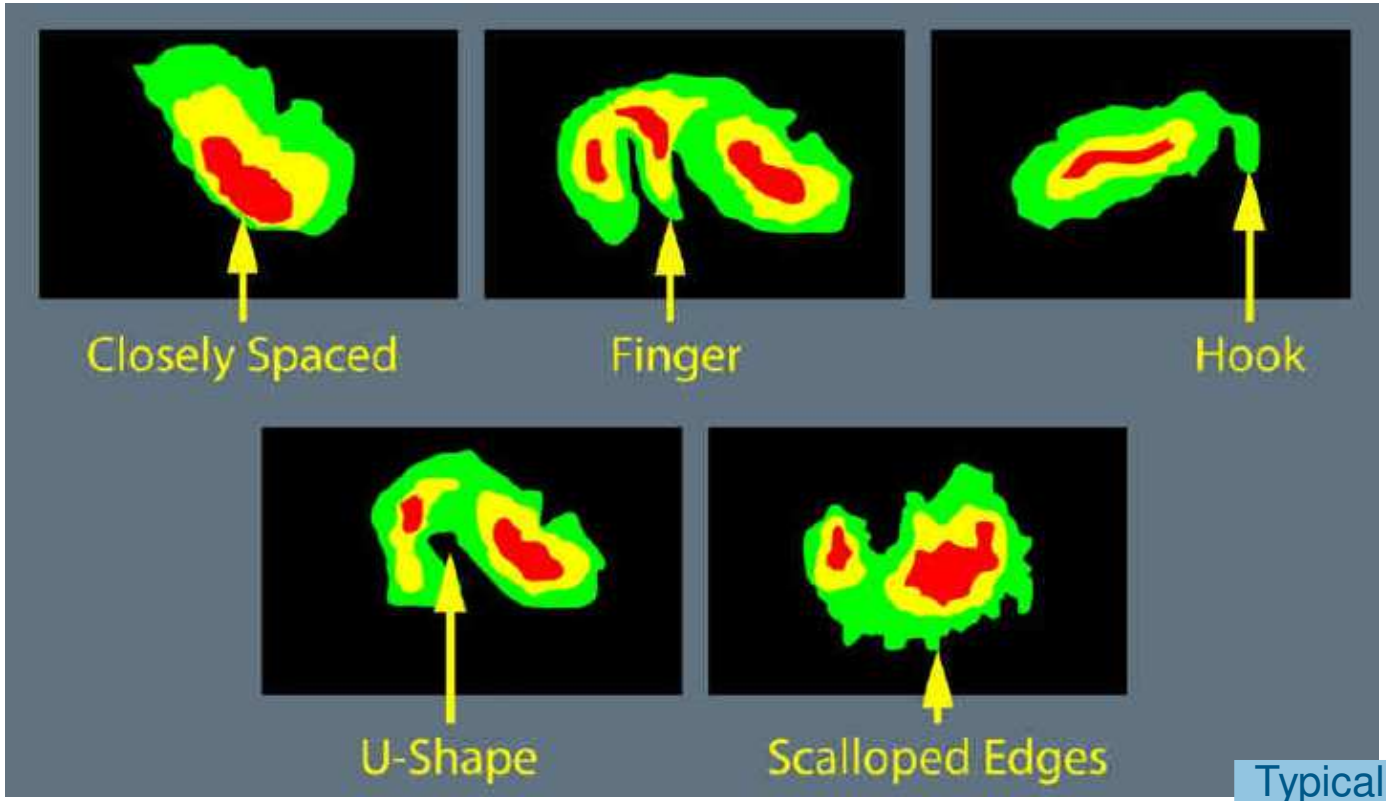
Common recommendations

Shapes

Analyse shapes combined to colours (and not only colours)



Typical Weather Shapes

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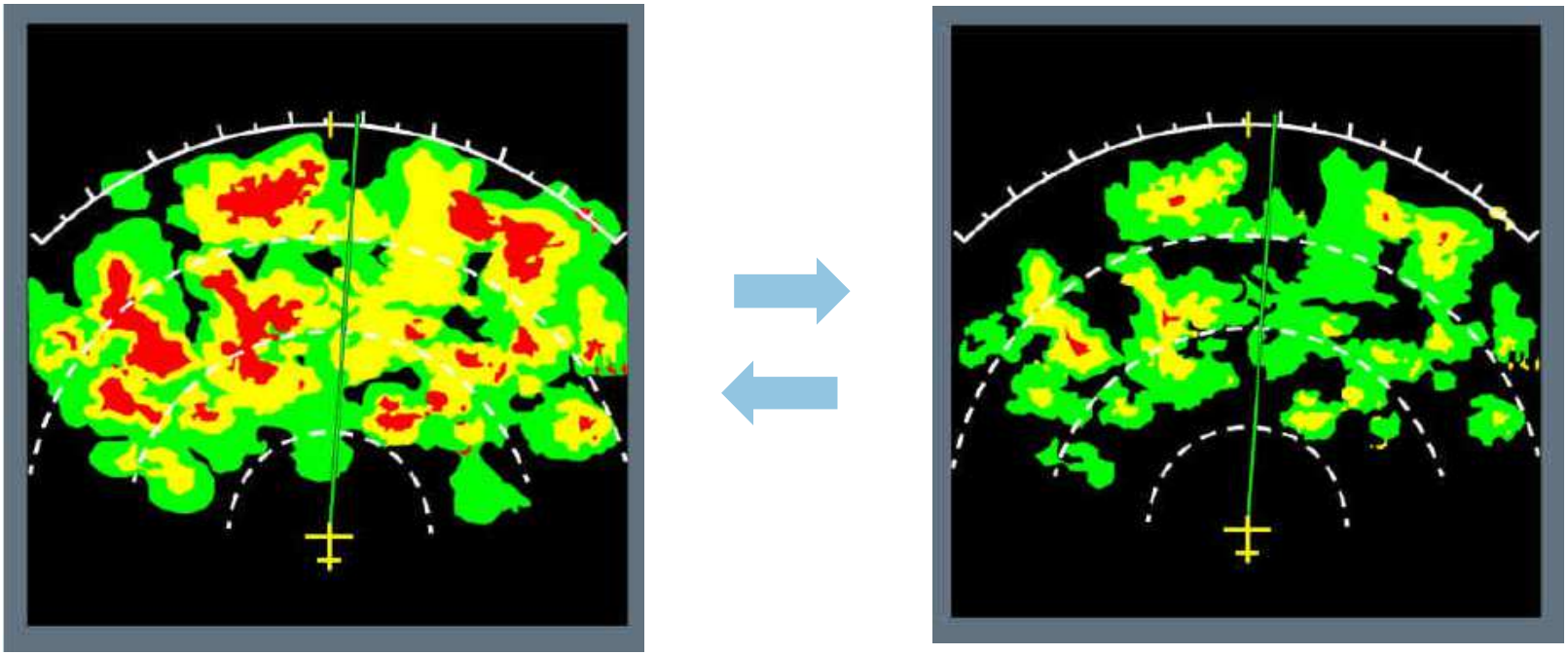
Common recommendations

Gain

Reduce gain to identify zones with highest precipitation…

… And increase gain to improve long-term accuracy or for deeper analysis of a cell



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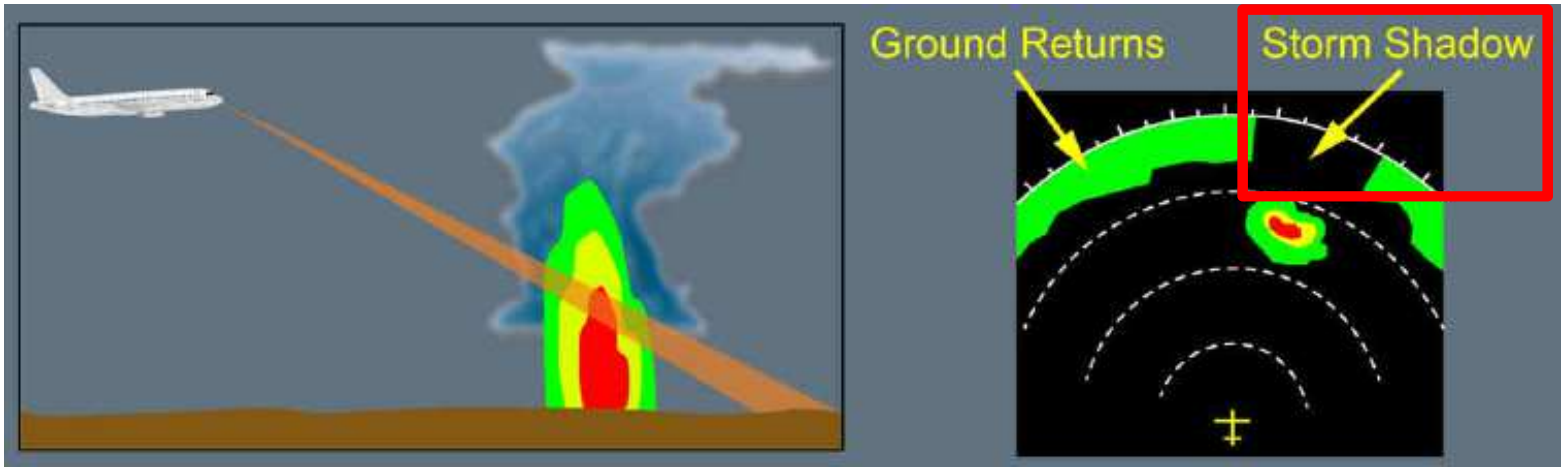
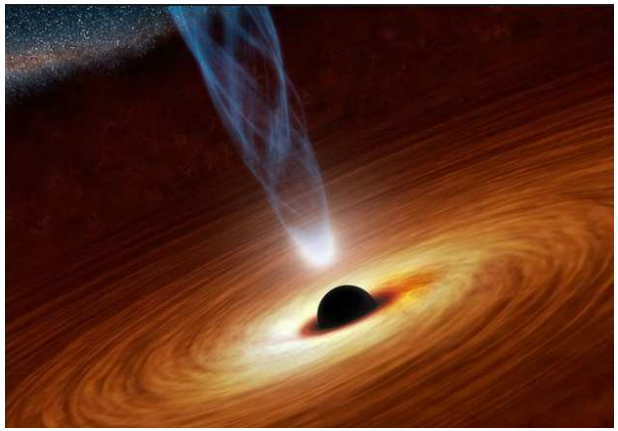
Common recommendations

Storm Shadows

Consider <u>black holes</u> behind red areas as very active





Improvements implemented in Multiscan & RDR-4000 V2

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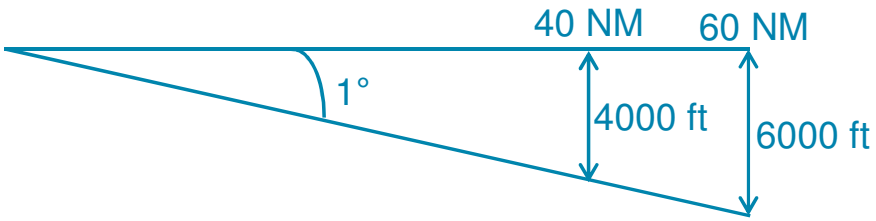
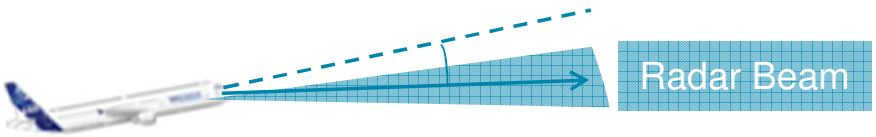
Common Recommendations

Tips for Tilt

+ 1/60 rule of thumb



+ Remember that a tilt of 0° means that the radar beam is referenced to the horizon…



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Conclusion

Know your radar:

+ What does the display represent? (one or several slice(s) or buffer?)
+ Use manual gain or modes to better assess and understand the situation

Apply Operational Recommendations:

+ Use your weather knowledge in addition to the radar
+ Use all clues, and not only colours: shapes, cell dynamism, lightning…
+ Use recommended avoidance margins and methods (upwind & lateral…)

Talk and train by experience:

+ Encourage experience sharing within crews
+ Seminar: planned round table