

# TCAS & MIXITÉ DE TRAFIC | ÊTRE VU, VOIR ET ÉVITER



direction générale  
de l'Aviation civile

direction  
de la sécurité  
de l'Aviation civile



MINISTÈRE  
DE LA TRANSITION  
ÉCOLOGIQUE  
ET SOLIDAIRE

BEA  
Bureau d'Enquêtes et d'Analyses  
pour la sécurité de l'aviation civile



# Pilotage: Traitement TCAS

C. JACQUET/OCV

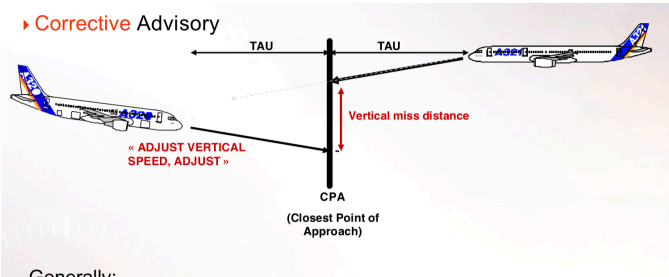
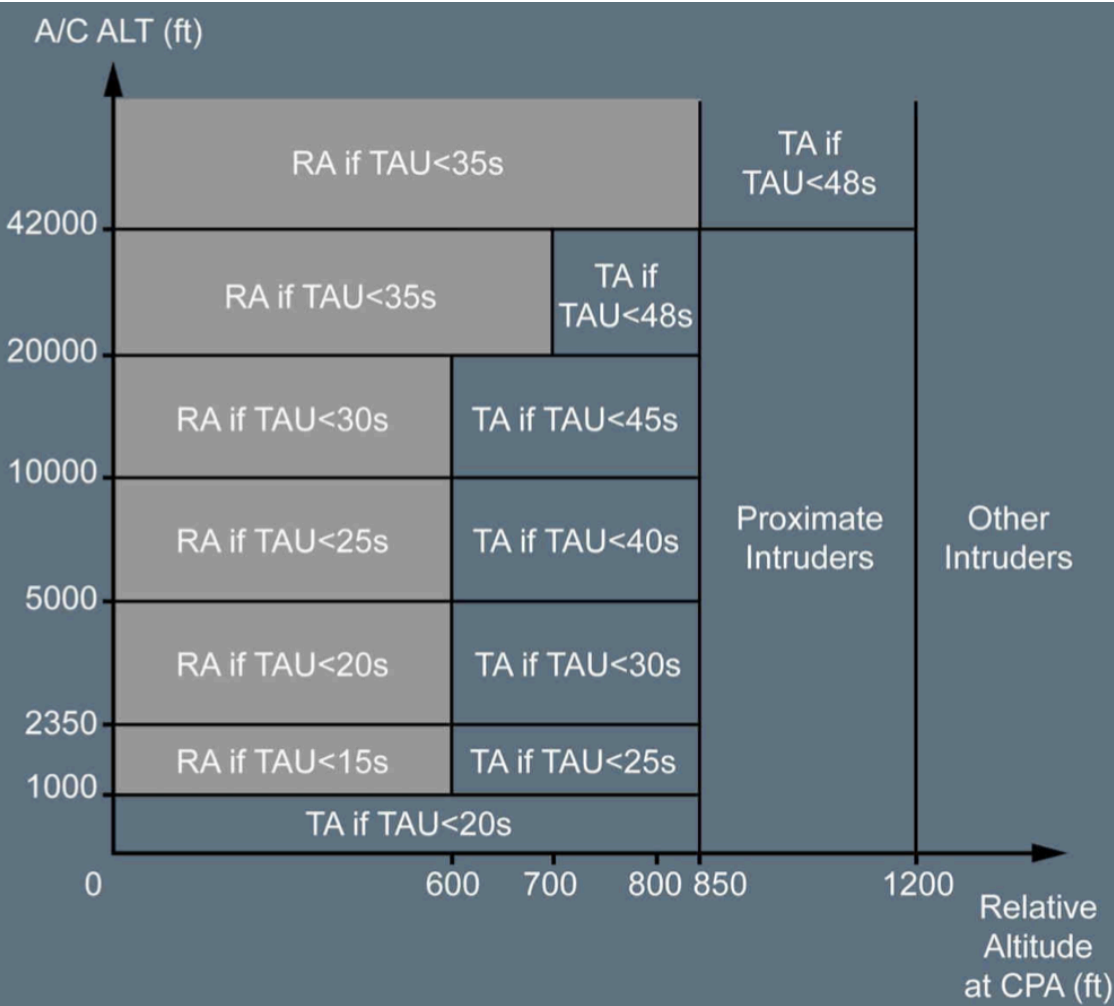


# VIDEO

[https://youtu.be/P7i\\_06vOOWQ](https://youtu.be/P7i_06vOOWQ)



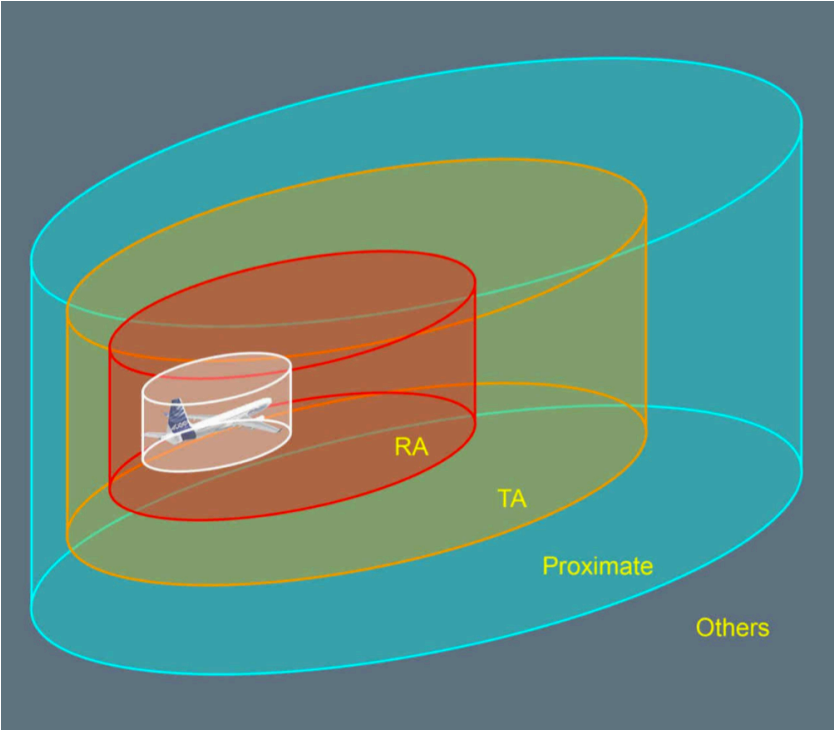
# Domaine de fonctionnement



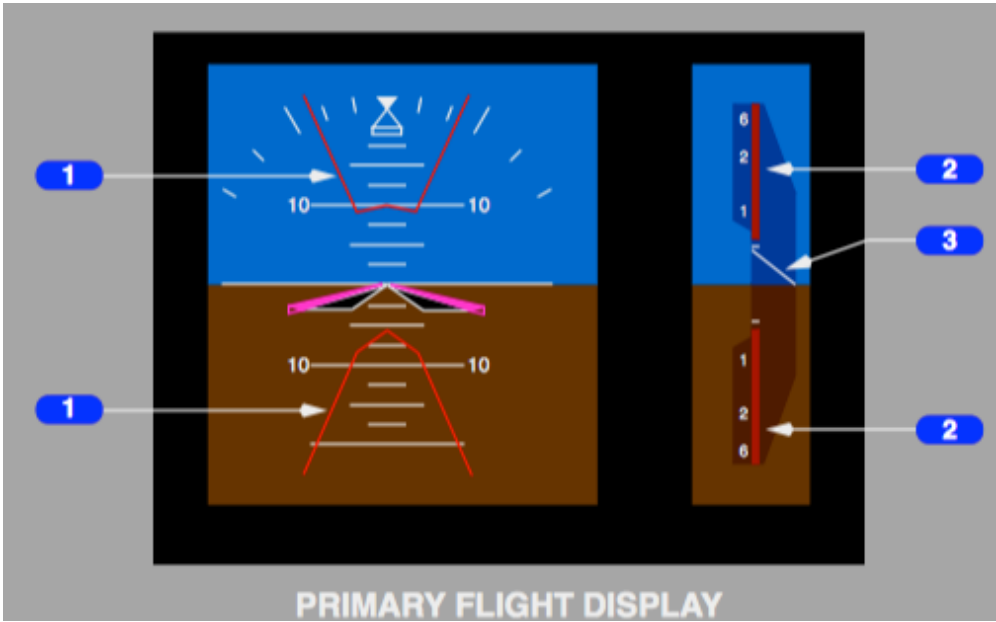
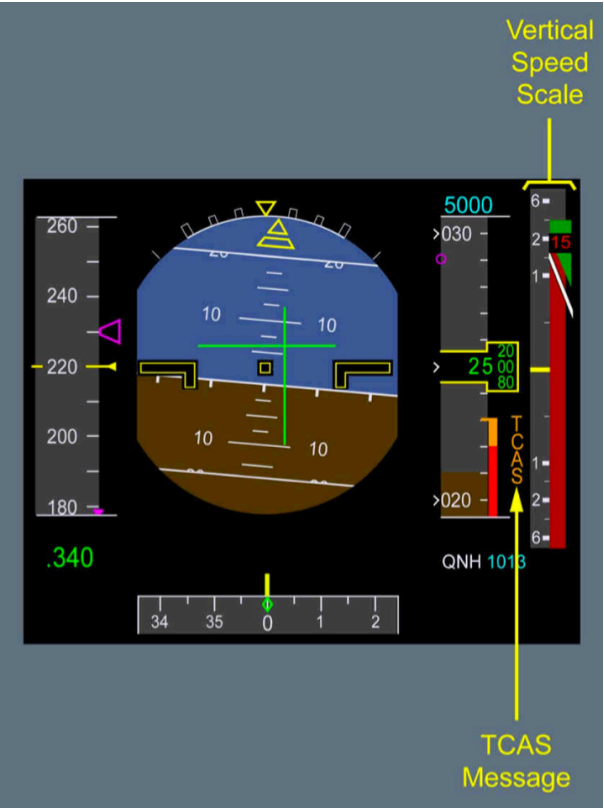


# Domaine de fonctionnement

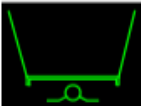
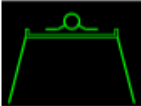
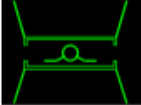
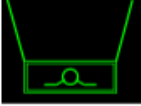
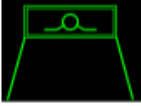
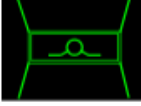
| Intruder                    | Display on ND<br><i>(1)</i> | Type of Collision Threat | Audio Indicator                               | Flight Crew Response  |
|-----------------------------|-----------------------------|--------------------------|---|---|
| No threat traffic, or other | +18 ↑<br>◇                  | No threat                | -   | -   |
| Proximate                   | ◇<br>- 15 ↓                 | Consider as no threat    | -   | -   |
| Traffic Advisory (TA)       | + 15 ↓<br>●                 | Possible threat          | "TRAFFIC"                                     | No evasive maneuver.  |
| Resolution Advisory (RA)    | ■<br>- 05 ↑                 | Collision threat         | Preventive (e.g. MONITOR V/S)                 | Do not alter the flight path. Maintain V/S out of red area.                       |
|                             |                             |                          | Corrective (e.g. CLIMB)                       | Smoothly and firmly (0.25 g) follow the green area of the V/S scale within 5 s.   |
|                             |                             |                          | Corrective (e.g. CLIMB NOW or INCREASE CLIMB) | Smoothly and firmly (0.35 g) follow the green area of the V/S scale within 2.5 s. |



# Présentations



TCAS HUD Vertical Guidance

| SYMBOL  | NAME                   | REMARKS   |
|---|------------------------|---|
|    | Down preventive        | <p>Area(s) inside the lines indicate the pitch region(s) to avoid in order to resolve the traffic conflict.</p> <p>The flight path symbol should be positioned outside the pitch command area(s) to ensure traffic avoidance.</p> <p>A double-lined box indicates a corrective action is required, and represents TCAS maneuver guidance to maintain or increase separation from the traffic.</p> |
|    | Up preventive          |   |
|    | Up and down preventive |   |
|    | Descend corrective     |   |
|   | Climb corrective       |   |
|  | Combined corrective    |   |

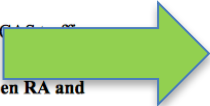


# Ex REACTION ( Boeing, en référence à la documentation compagnie)

## Traffic Avoidance

Immediately accomplish the following by recall whenever a TCAS II advisory (TA) or resolution advisory (RA) occurs.

**WARNING:** Comply with RA if there is a conflict between RA and air traffic control.



**WARNING:** Once an RA has been issued, safe separation can be compromised if current vertical speed is changed, except as necessary to comply with the RA. This is because TCAS II-to-TCAS II coordination may be in progress with the intruder aircraft, and any change in vertical speed that does not comply with the RA may negate the effectiveness of the other aircraft's compliance with the RA.

- Note:** If stick shaker or initial buffet occurs during the maneuver, immediately accomplish the APPROACH TO STALL RECOVERY procedure.
- Note:** If high speed buffet occurs during the maneuver, relax pitch force as necessary to reduce buffet, but continue the maneuver.
- Note:** Do not use flight director pitch commands until clear of conflict.

For TA:

| Pilot Flying  | Pilot Monitoring |
|---|------------------|
| Look for traffic using traffic display as a guide. Call out any conflicting traffic |                  |
| If traffic is sighted, maneuver if needed.  |                  |

**Note:** Maneuvers based solely on a TA may result in reduced separation and are not recommended.

For RA, except a climb in landing configuration:

**WARNING:** A DESCEND (fly down) RA issued below 1000 feet AGL should not be followed.

| Pilot Flying   | Pilot Monitoring |
|--|------------------|
| If maneuvering is required, disengage the autopilot and autothrottle. Smoothly adjust pitch and thrust to satisfy the RA command. Follow the planned lateral flight path unless visual contact with the conflicting traffic requires other action. |                  |
| Attempt to establish visual contact. Call out any conflicting traffic.   |                  |

For a climb RA in landing configuration:

| Pilot Flying  | Pilot Monitoring   |
|---|--|
| Disengage the autopilot and autothrottle. Advance thrust levers forward to ensure maximum thrust is attained and call for FLAPS 20. Smoothly adjust pitch to satisfy the RA command. Follow the planned lateral flight path unless visual contact with the conflicting traffic requires other action. | Verify maximum thrust set. Position flap lever to 20 detent.   |
| Verify a positive rate of climb on the altimeter and call "GEAR UP."  | Verify a positive rate of climb on the altimeter and call "POSITIVE RATE." Set the landing gear lever to UP. |
| Attempt to establish visual contact. Call out any conflicting traffic.  |  |



# Ex REACTION ( Airbus, en référence à la documentation compagnie)

OPERATING TECHNIQUES

Applicable to: ALL

Ident.: AS-TCAS-80-1-00009672.0001001 / 03 SEP 14

**GENERAL**

In all cases, the flight crew must always follow the TCAS RA orders, even if:

- The TCAS RA orders disagree with the ATC instructions
- It results in flying above the maximum ceiling altitude with "CLIMB, CLIMB" or "INCREASE CLIMB, INCREASE CLIMB" TCAS RA orders
- It results in crossing the altitude of the intruder.

Ident.: AS-TCAS-80-1-00009674.0001001 / 09 MAR 18

The AP/FD TCAS mode optimizes the vertical speed for a rapid and appropriate response to an RA, and minimizes the deviation from the latest ATC clearance.

If the TCAS generates a TA, or an RA, the flight crew should use the AP/FD TCAS mode, and apply the associated memory procedure.

**TCAS SELECTION**

**NORM** is the default selection. The flight crew may select another mode depending on the situation.

**12** For more information, Refer to FCOM/DSC-34-SURV-40-10 TCAS Display Selection.

**11** **TRAFFIC ADVISORY**


If a TA is triggered, the flight crew should check the immediate arming of the AP/FD **TCAS** mode, and the engagement status of the AP and A/THR.

For more information on the TA procedure, Refer to FCOM/PRO-ABN-SURV [MEM] TCAS CAUTION - TRAFFIC ADVISORY.

If the AP/FD **TCAS** mode does not immediately arm, the flight crew must be prepared to disconnect the AP in the case of an RA, and manually follow the TCAS guidances.

**RESOLUTION ADVISORY****AP/FD TCAS MODE AVAILABLE**

When an RA is triggered and the AP/FD **TCAS** mode is available:

- If the PF uses the HUD , the PF must refer to the PFD
- If the AP is engaged, the flight crew should keep it ON
- If the AP is not engaged, the flight crew can engage the AP
- If any "CLIMB" audio indicator sounds during the final approach, the flight crew should first apply the AP/FD TCAS procedure. When clear of conflict, depending on the situation, they can consider a go-around.

For more information on the RA procedure, Refer to FCOM/PRO-ABN-SURV [MEM] TCAS WARNING - RESOLUTION ADVISORY.

## AP/FD TCAS MODE NOT AVAILABLE

For more information, Refer to PIR Risks related to System Operations/Failures.

When an RA is triggered and the AP/FD **TCAS** mode is not available, the flight crew must manually fly the TCAS RA.

The flight crew must disconnect the FD as soon as the AP is disconnected, in order to:

- Ensure that the A/THR is in SPEED/MACH mode
- Avoid possible confusion between FD orders, and TCAS audio indicators and vertical speed orders.

The PM monitors the evasive maneuver and does not attempt to see the intruder(s) because:

- The relevant intruder(s) may be difficult to identify, and
- The relative position of the intruder(s) may be difficult to assess.



# LES MESSAGES TCAS

| Audio Indicator  | Condition or Cause   | Duration         |
|--|--|------------------|
| Traffic, Traffic (Synthetic voice)                           | The TCAS triggers a TA.<br>For more information on the procedure,<br><i>Refer to PRO-ABN-SURV [MEM] TCAS CAUTION - TRAFFIC ADVISORY.</i>   | Sounds one time. |
| Climb, climb (Synthetic voice)                               | The TCAS triggers a corrective RA.<br>The aircraft must climb with the vertical speed that is indicated by the green area on the vertical speed scale of the PFD.<br>For more information on the procedure,<br><i>Refer to PRO-ABN-SURV [MEM] TCAS WARNING - RESOLUTION ADVISORY.</i>  | Sounds one time. |
| Climb crossing climb, climb crossing climb (Synthetic voice) | The TCAS triggers a corrective RA, and the aircraft will cross the intruder's altitude.<br>The aircraft must climb with the vertical speed that is indicated by the green area on the vertical speed scale of the PFD.<br>For more information on the procedure,<br><i>Refer to PRO-ABN-SURV [MEM] TCAS WARNING - RESOLUTION ADVISORY.</i> | Sounds one time. |
| Increase climb, increase climb (Synthetic voice)             | The TCAS triggers a corrective RA, and has already triggered a CLIMB alert.<br>The vertical speed is not sufficient to achieve safe vertical separation.<br>For more information on the procedure,<br><i>Refer to PRO-ABN-SURV [MEM] TCAS WARNING - RESOLUTION ADVISORY.</i>   | Sounds one time. |

| Audio Indicator  | Condition or Cause   | Duration         |
|--|--|------------------|
| Climb climb now, Climb climb now (Synthetic voice)                   | The TCAS triggers a corrective RA, and has already triggered a DESCEND alert.<br>The intruder's trajectory has changed.<br>For more information on the procedure,<br><i>Refer to PRO-ABN-SURV [MEM] TCAS WARNING - RESOLUTION ADVISORY.</i>  | Sounds one time. |
| Descend, descend (synthetic voice)                                   | The TCAS triggers a corrective RA.<br>The aircraft must descend with the vertical speed that is indicated by the green area on vertical speed scale of the PFD.<br>For more information on the procedure,<br><i>Refer to PRO-ABN-SURV [MEM] TCAS WARNING - RESOLUTION ADVISORY.</i>  | Sounds one time. |
| Descend crossing descend, descend crossing descend (Synthetic voice) | The TCAS triggers a corrective RA, and the aircraft will cross the intruder's altitude.<br>The aircraft must descend with the vertical speed that is indicated by the green area on vertical speed scale of the PFD.<br>For more information on the procedure,<br><i>Refer to PRO-ABN-SURV [MEM] TCAS WARNING - RESOLUTION ADVISORY.</i> | Sounds one time. |
| Increase descent, increase descent (Synthetic voice)                 | The TCAS triggers a corrective RA, and has already triggered a DESCEND alert.<br>The vertical speed is not sufficient to achieve safe vertical separation.<br>For more information on the procedure,<br><i>Refer to PRO-ABN-SURV [MEM] TCAS WARNING - RESOLUTION ADVISORY.</i>   | Sounds one time. |
| Descend descend now, descend descend now (Synthetic voice)           | The TCAS triggers a corrective RA, and has already triggered a CLIMB alert.<br>The intruder's trajectory has changed.<br>For more information on the procedure,<br><i>Refer to PRO-ABN-SURV [MEM] TCAS WARNING - RESOLUTION ADVISORY.</i>  | Sounds one time. |





## LES MESSAGES TCAS (suite)

| Audio Indicator  | Condition or Cause  | Duration         |
|--|---|------------------|
| Level off, Level off (Synthetic voice)                       | The TCAS triggers a corrective RA.<br>The flight crew must reduce the vertical speed that is indicated by the green area on vertical speed scale of the PFD.<br>For more information on the procedure, Refer to PRO-ABN-SURV [MEM] TCAS WARNING - RESOLUTION ADVISORY.  | Sounds one time. |
| Monitor vertical speed (Synthetic voice)                     | The TCAS triggers a preventive RA.<br>The flight crew must ensure that vertical speed remains outside the red area on the vertical speed scale of the PFD.<br>For more information on the procedure, Refer to PRO-ABN-SURV [MEM] TCAS WARNING - RESOLUTION ADVISORY.  | Sounds one time. |
| Maintain vertical speed maintain (Synthetic voice)           | The TCAS triggers a corrective RA.<br>The flight crew must maintain the vertical speed that is indicated in the green area on the vertical speed scale of the PFD.<br>For more information on the procedure, Refer to PRO-ABN-SURV [MEM] TCAS WARNING - RESOLUTION ADVISORY.  | Sounds one time. |
| Maintain vertical speed, crossing maintain (Synthetic voice) | The TCAS triggers a corrective RA, and the aircraft will cross the intruder's altitude.<br>The flight crew must maintain the vertical speed that is indicated in the green area on the vertical speed scale of the PFD.<br>For more information on the procedure, Refer to PRO-ABN-SURV [MEM] TCAS WARNING - RESOLUTION ADVISORY. | Sounds one time. |
| Clear of conflict (Synthetic voice)                          | The range increases, and separation is sufficient.  | Sounds one time. |



## PILOTAGE

- Répartition des tâches
- Mouvement simple et rapide
- Réaction adaptée
- Problématique des cibles multiples
- Adaptation des automatismes

SUIVRE LE TCAS !!!

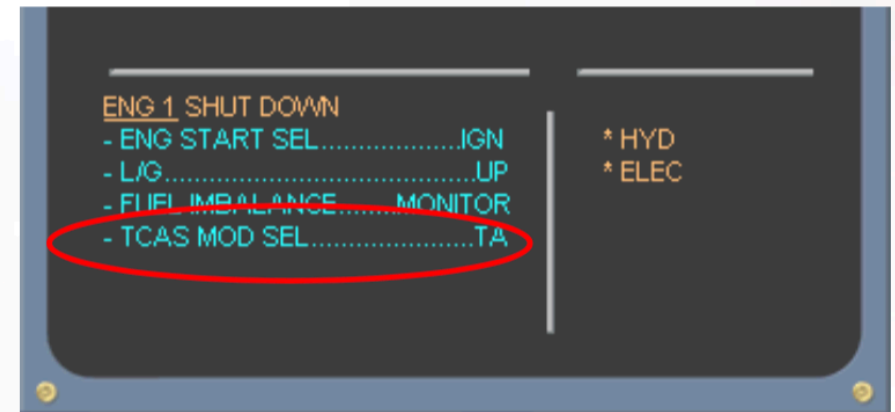
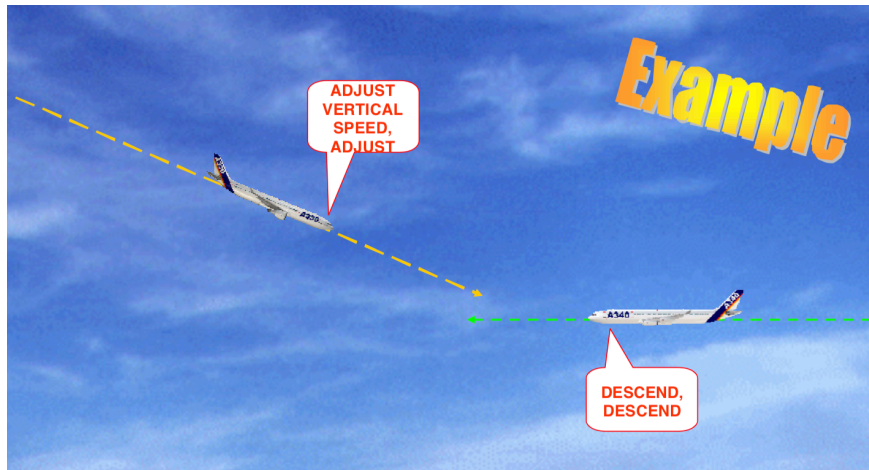


## Différents systèmes TCAS

- TCAS II version 7.0 mandated in Europe since 2000
- Safety issues identified in version 7.0:
  - Unintentional opposite pilot response to "Adjust vertical speed, adjust" RAs
  - Level busts following "Adjust vertical speed, adjust" RAs
  - Flaws in the reversal logic
- TCAS II version 7.1 will address these safety issues
  - "Level off, level off" RA
  - Improvements to reversal logic



## Cas particuliers...



### Aircraft at its Maximum Ceiling Altitude

- AC 20-131A defines the maneuvers that the aircraft must be able to perform.
- In particular, the aircraft must prove that it can respond to a TCAS RA CLIMB order, even when it is at its maximum altitude.



## Pour aller plus loin...

- Evolution TCAS Latéral...
- Site Eurocontrol...
- Manuel constructeur...
- Site OACI...



# MERCI DE VOTRE ATTENTION

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