



New concepts to prevent excursions or the consequences of excursions

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THALES

AIRBUS
AIRBUS
DEFENCE & SPACE

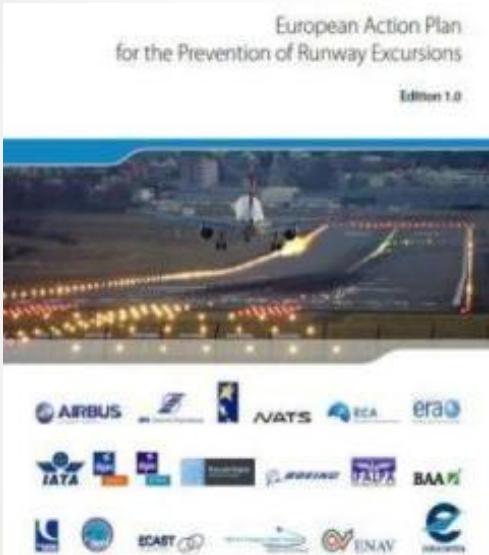
dgac
STAC

ZODIAC
AEROSPACE

DLR

European Action Plan

→ “European Action Plan for the Prevention of Runway Excursions” Report (31/01/2013)



→ **Changing Runway Conditions:**

- If the runway surface becomes contaminated, it is important that the aerodrome operator has **a process for promptly assessing or measuring the amount of contamination, or the operational surface friction.**
- This task should be undertaken at any time there is a change in the nature of the contamination – e.g. depth or type of contaminant.

→ **Information to be transmitted:**

- The information to be transmitted to the flight crew includes:
 - The runway condition code for each third of the runway
 - The type and depth of the contaminant and percentage of coverage in 25% increments
 - The PIREPs (Pilot braking action report) when available

Update Rate/Accuracy/Forecast

Recommendation 3.2.7 Ensure robust procedures are in place for communicating safety significant information regarding changing surface conditions as frequently as practicable to the appropriate air traffic services.

Adapted Update Rate of Runway Surface Conditions

Recommendation 3.2.8 In accordance with ICAO provisions, wind sensors and wind direction indicators (wind socks) should be sited to give the best practicable indication of conditions along the runway and touchdown zones.

Accurate Wind Information along the runway and touchdown zones

Recommendation 3.3.4 Review processes covering the provision of safety significant 'essential' information such as weather, wind and runway surface conditions (e.g. when 'wet' or contaminated):

New processes to provide weather/wind/runway surface conditions

Recommendation 3.4.10 The Commander, shortly before takeoff and landing, shall verify that the actual weather conditions are similar or conservative compared to the weather data used for the takeoff performance calculations and the in-flight landing distance assessment.

Compliance of the actual weather conditions and past conditions used for braking performance assessment

WP3.4.1 Inventory of current developments and new initiatives



D3.1 Deliverables

- Title: Inventory of current developments and new initiatives
- 70 pages
- Contributors:
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 - MAYOLLE M. (AIRBUS F)
 - VECTEL D. (DLR)
 - LARROUTUROU B. (ZODIAC)
 - BARBARESCO F. (THALES AIR SYSTEMS)



Inventory of current developments and new initiatives

BECHENNEC T., MAYOLLE M., KRAJENSKI V.,
LARROUTUROU B., BARBARESCO F.

Short abstract: Future Sky Safety is a Joint Research Programme(JRP) on Safety, initiated by ERRA, the association of European Research Establishments in Aeronautics. The Programme contains two streams of activities: 1) coordination of the safety research programmes of the ERRA institutions; 2) collaborative research projects on European safety priorities.

This deliverable is produced by the Project Pg Runway Scounder. The main objective is an inventory of current developments and new initiatives, including overview of past & current developments and new initiatives, descriptions, solutions and regulatory aspects that affect the application of new technology.

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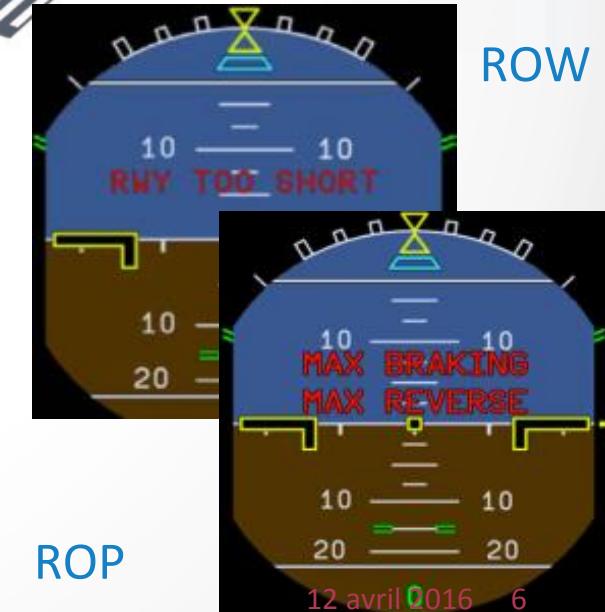
P3 Solutions for runway excursion

D3.1 deliverable = ROPS description

How ROPS Protects



- ✓ ROPS functions by continuously monitoring the aircraft's position and calculating the distance needed to safely stop the aircraft.
- ✓ If at any time, this distance becomes longer than the remaining runway length, ROPS triggers an alert.



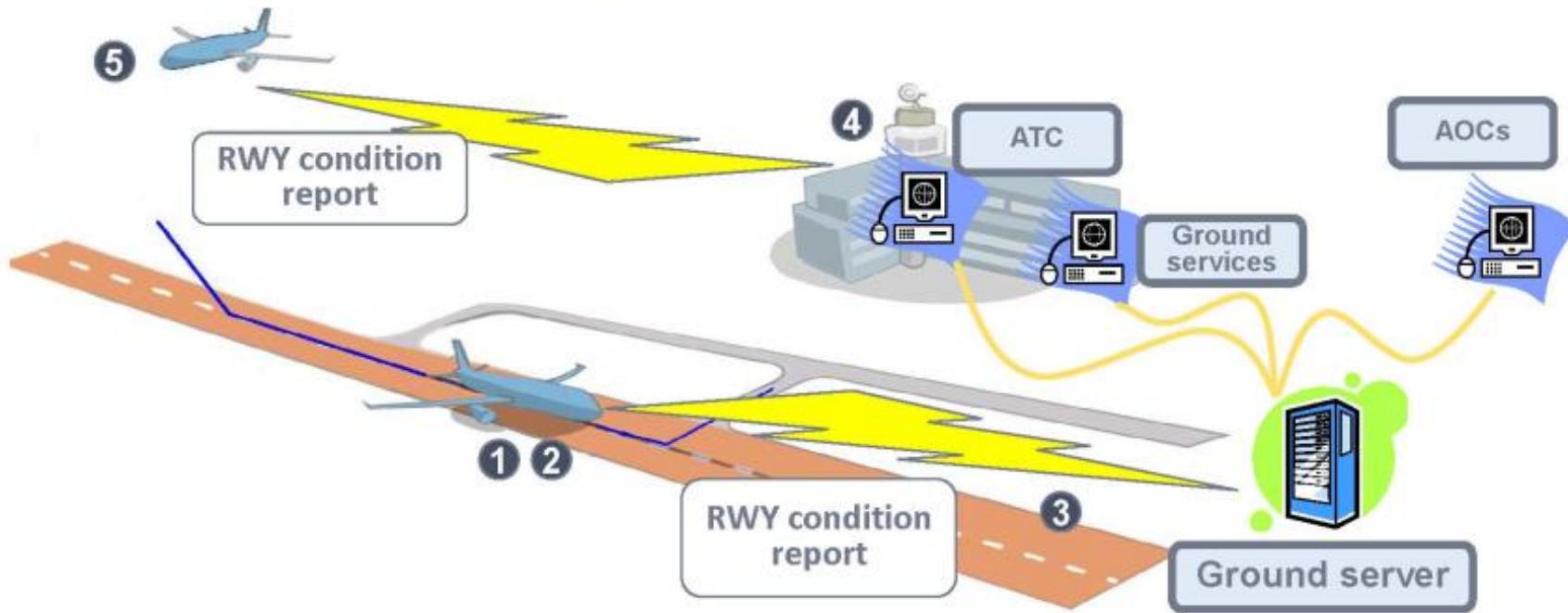
P3 Solutions for runway excursion

CORSAIR (COntaminated Runway State Automatic Identification and Reporting)



Envisioned CORSAIR Operational Concept

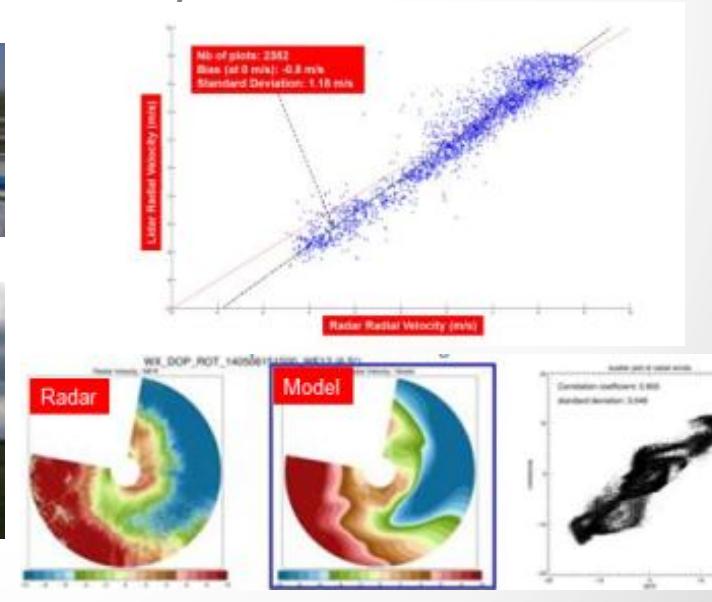
1. CORSAIR runway condition assessment
2. Pilot acknowledges and sends the CORSAIR report
3. Reporting to tower via a ground Server
4. Tower report to incoming aircraft
5. Incoming aircraft to use report of runway condition for Landing Performance evaluation



Weather and Airfield condition reporting

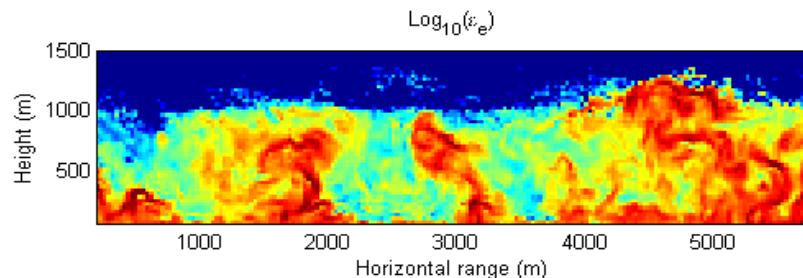
Weather and airfield condition reporting are mainly provided by:

- **Sensors: X-band Radar and Lidar** (not yet available on all airports but requested by ICAO for Wind-Shear and Wake-Vortex)
- **High Resolution Weather Forecast Models** (Resolution should be improved until 500 m: AROME AIRPORT of Meteo-France)
- **Mode-S Downlink** (available on almost main european countries; could be replaced by ADS-B downlink of MET data)



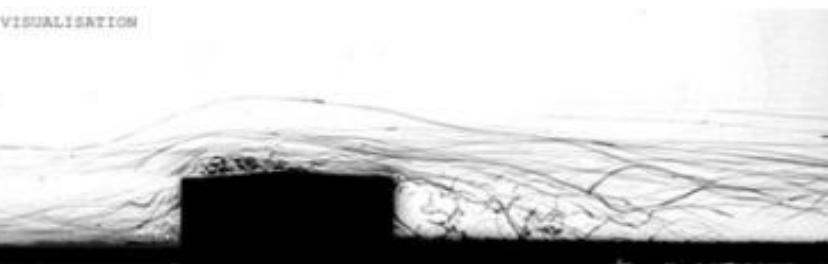
WIND Assessment

- Other parameters could be assessed for runway excursion
 - EDR (Eddy Dissipation Rate) => for Landing veeroff



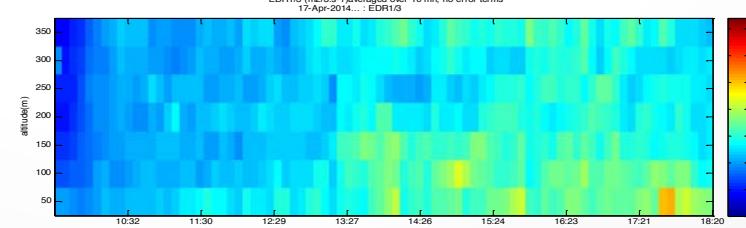
Average EDR value	Peak EDR value									Nil report
	(m ^{2/3} s ⁻¹)	<0.1	0.1 - 0.2	0.2 - 0.3	0.3 - 0.4	0.4 - 0.5	0.5 - 0.8	>0.8		
<0.1	0	1	3	6	10	15	21			
0.1 - 0.2		2	4	7	11	16	22			
0.2 - 0.3			5	8	12	17	23			
0.3 - 0.4				9	13	18	24			
0.4 - 0.5					14	19	25			
0.5 - 0.8						20	26			
>0.8							27			
Nil report									28	

When the earth's surface is heated by the sun, it will generate convective EDR



When strong wind pass over a large obstacle they create turbulence

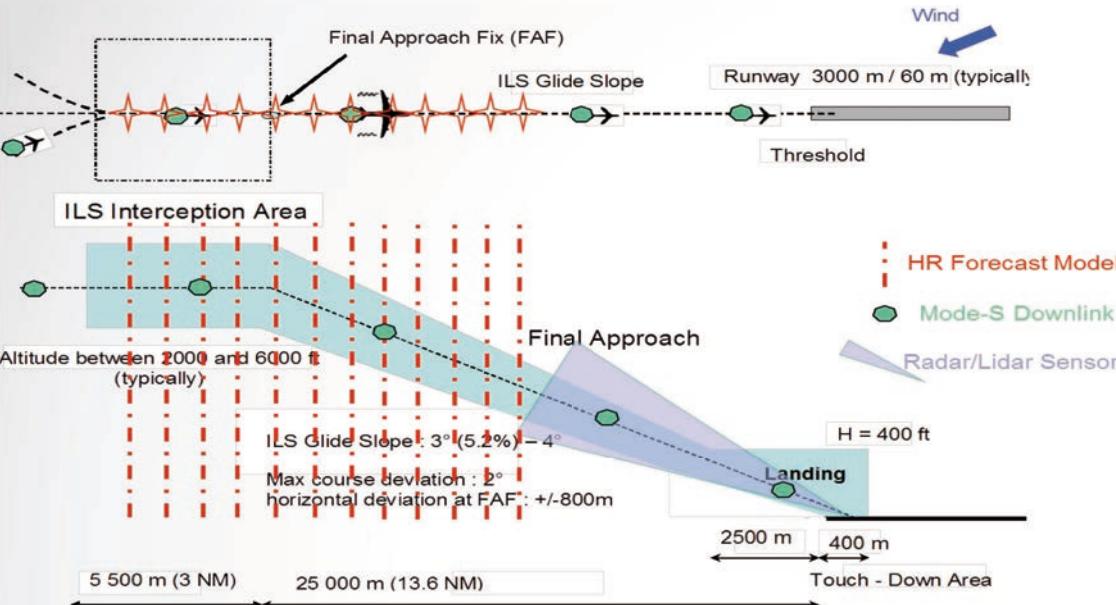
(e.g. EDR monitoring:
FP7 UFO trials at
Toulouse Airport)



ICAO EDR Levels with respect to:

- Peak EDR value
- Average EDR value

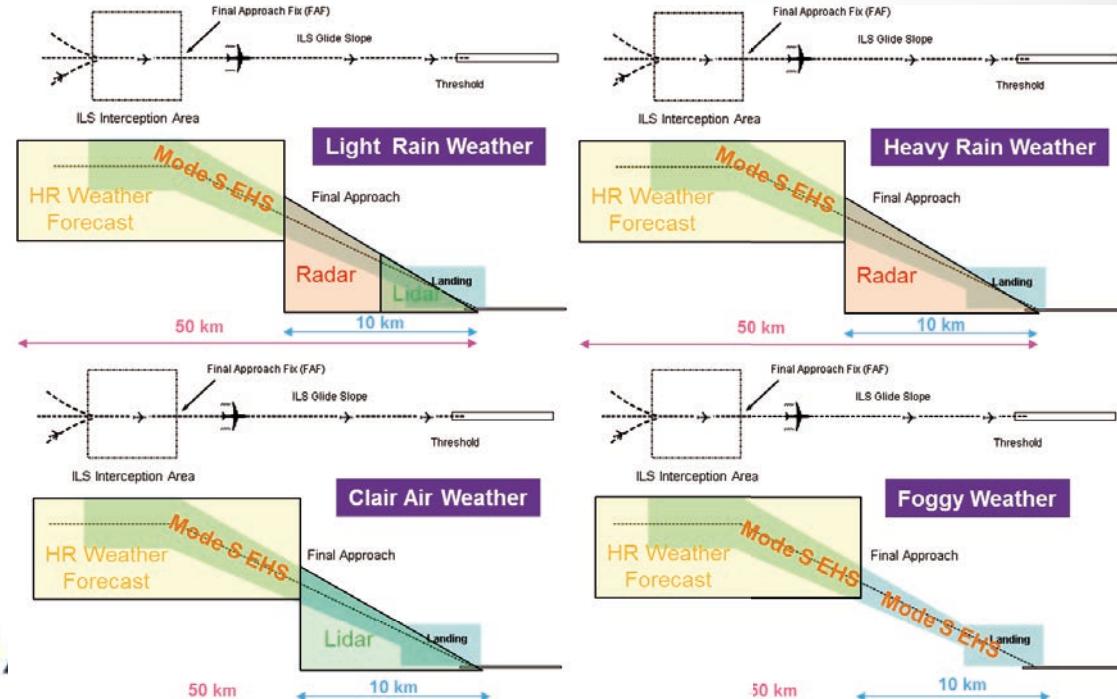
Weather and Airfield condition reporting



Results of FP7 UFO Project
« Ultra-Fast wind sensOrs »

→ FP7 UFO (Wind/EDR Monitoring)

- Website:
<http://www.ufo-wind-sensors.eu/home>
- Flyer:
http://www.wakenet.eu/fileadmin/user_upload/News%26Publications/UFO-Official-Flyer-Sept-2013.pdf
- Video:
http://www.wakenet.eu/fileadmin/user_upload/News%26Publications/Thales%20UFO%20MASTER%20FINAL%20MUET%20LQ.mp4



Wind Assessment Accuracy

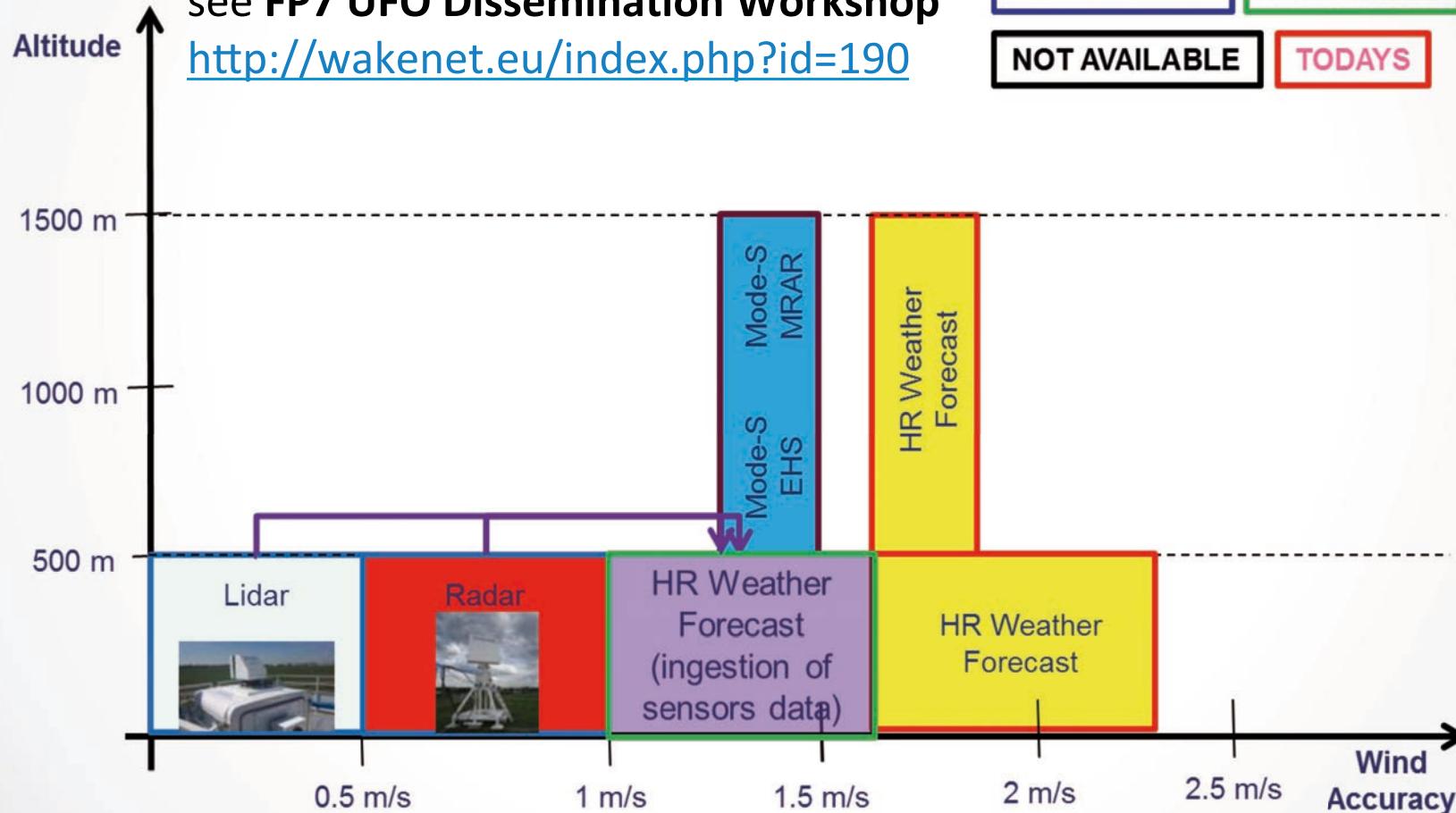
Results of FP7 UFO Project
 « Ultra-Fast wind sensOrs »

More information:

see FP7 UFO Dissemination Workshop

<http://wakenet.eu/index.php?id=190>

AVAILABLE	TOMORROW
NOT AVAILABLE	TODAYS



WP3.4.2 Feasibility study and definition of R&D needed for implementation of identified new concepts



Optimised Braking Systems

→ Optimised Braking System

- Exploiting the ability of the aircraft to brake in an optimum fashion to exit the runway at a predetermined point for :
 - Reduce risks of runway excursion (Increase Safety: Risks Mitigation)
 - Reducing the runway occupancy time (Increase Capacity: Boost runway throughput in context of RECAT deployment)



Runway Surface Conditions Prediction on next 30 minutes



20 -30 mins prior to landing:

- Uplink of Predicted Runway Surface Conditions in 30 mins
- Downlink of Stopping distance
- Selection of Exit Taxiway

RUNWAY CONTAMINANT TO BE FORECASTED 30 MINUTES BEFORE LANDING

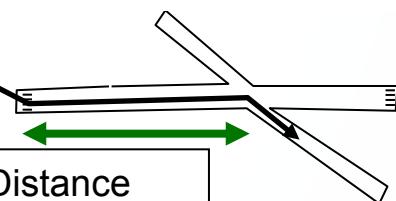
- Initiated by Ground (uplink of Predicted Weather/Wind/Runway Surface Conditions)
- Flight Crew responds (Estimation or Computation of Stopping Distance)
- ATCO made aware that exit is airborne intended
- ROAAS (Runway Overrun Awareness & Alerting Systems) will insure Safety for final landing

**FOR AIRCRAFT NON EQUIPPED WITH OPTIMIZED BRAKING SYSTEMS,
STOPPING DISTANCE COULD BE COMPUTED BY GROUND SYSTEM**



Accurate, predicted Stopping Distance and exit now available for use by AMAN/DMAN and ASMGCS

Airborne and Ground Systems share identical data



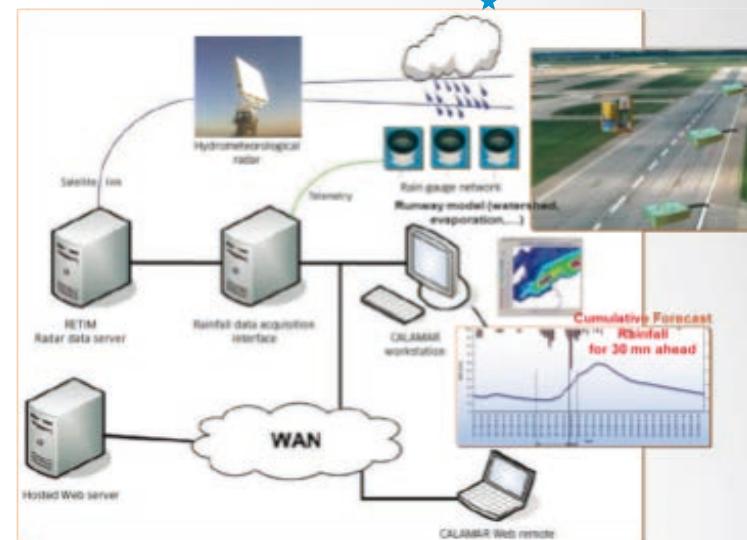
Runway Contaminant Prediction & Wind along Runway (feasibility study)

Cumulative Rain 30 minutes prior before landing

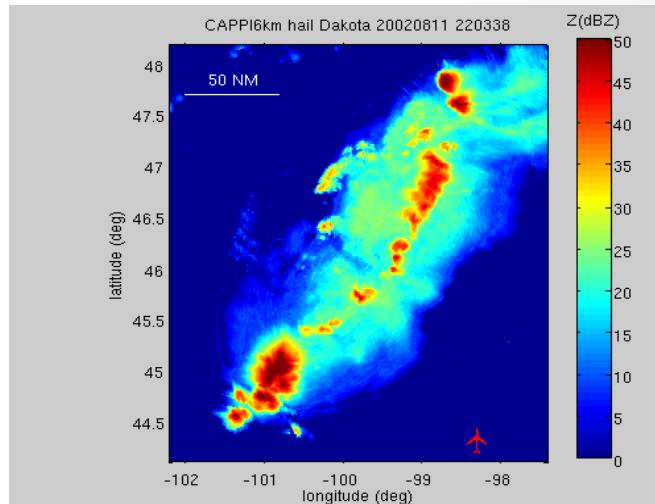
- Rain Rate Retrieval around the airport
 - Radar covering Airport Area
 - Water Level probes if installed on runways
 - Rain gauges data deployed around the airport
- Cumulated Rain Forecasting
 - Cumulative Forecast Rainfall based on data in 1 minute increments for periods up to 30 minutes /1 hour ahead
 - Forecast reliability by the supply of data from rain gauges/ Water level probes (calibration)
- Runway Contaminant Forecasting (usability of STAC Water Depth Prediction model)
 - 3D map of Runway defined by Laser scanning instrument
 - Run-off model based on cumulative rain and runway slope

Wind Monitoring for the last 100 m in altitude

- X-band Radar Data from Météo-France
- Vertical Wind Profiler from Leosphere
- Anemometers mast along the runway

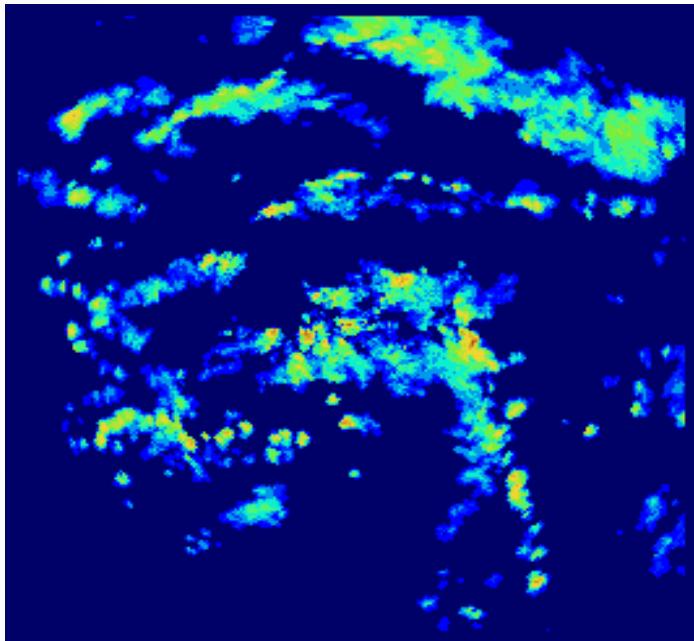


Probes/Sensors ingested Prediction System

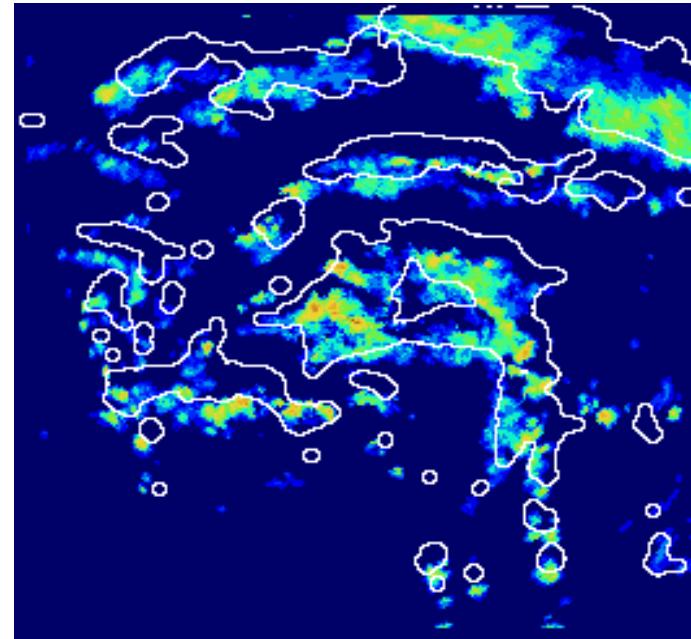


Cumulative Rainfall Forecast for 30 mn Ahead

Cumulate Rain Prediction for the next 30 minutes

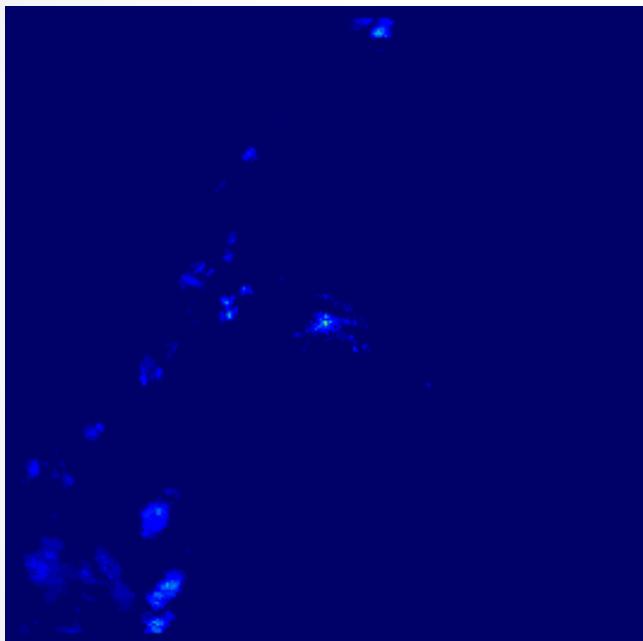


Sequence of Weather Radar

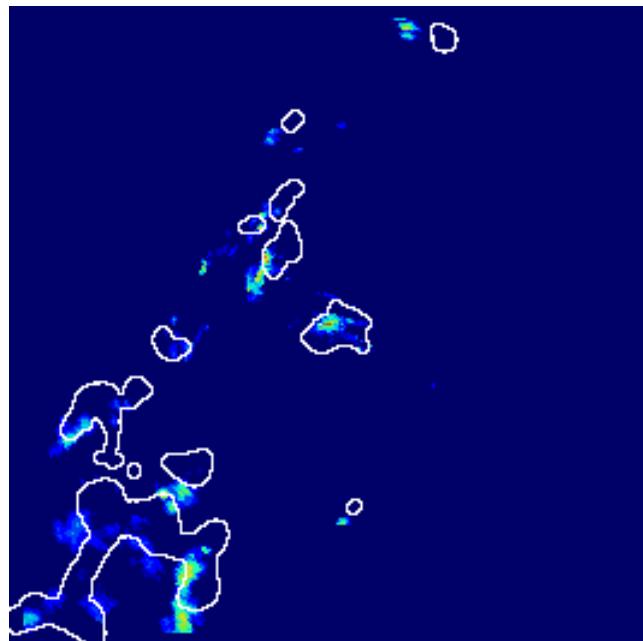


Rain Clouds Forecasting
For the next 30 minutes
and
Current Image

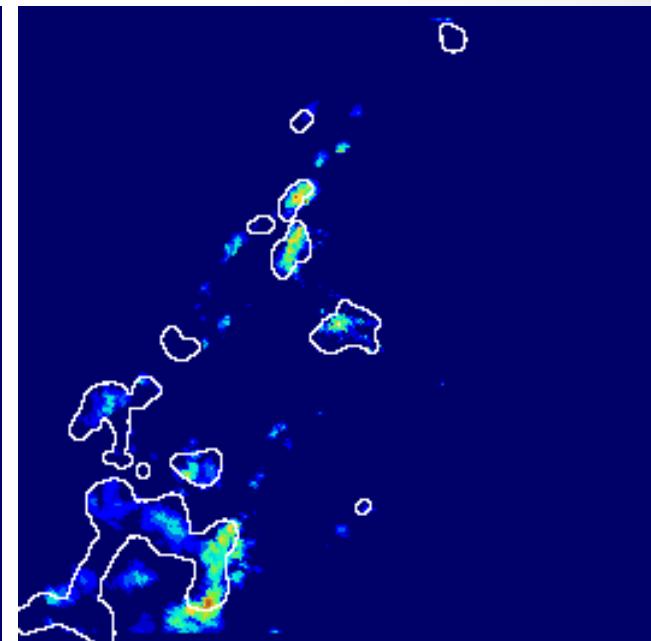
Cumulate Rain Prediction for the next 30 minutes



Sequence of Weather Radar



Rain Clouds Forecasting
For the next 30 minutes
and
Current Image

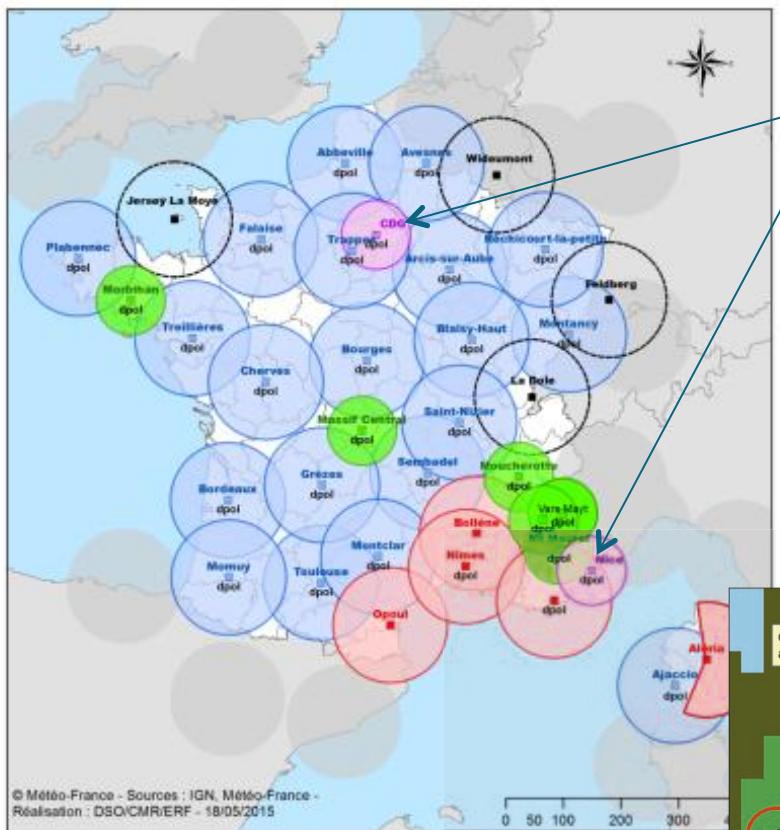


Rain Clouds Forecasting
For the next 30 minutes
and
Image 30 minutes after

Collaboration with METEO-France: Use of « Lame d'eau » Data Product (Cumulate Rain for the next 30 minutes)



Le réseau de radars mi 2018



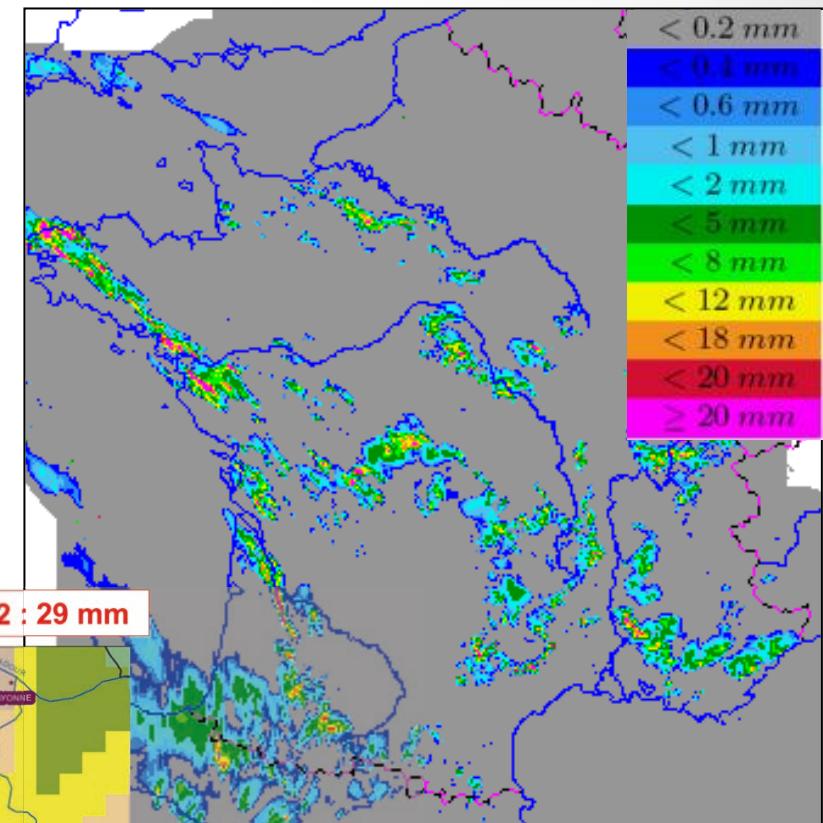
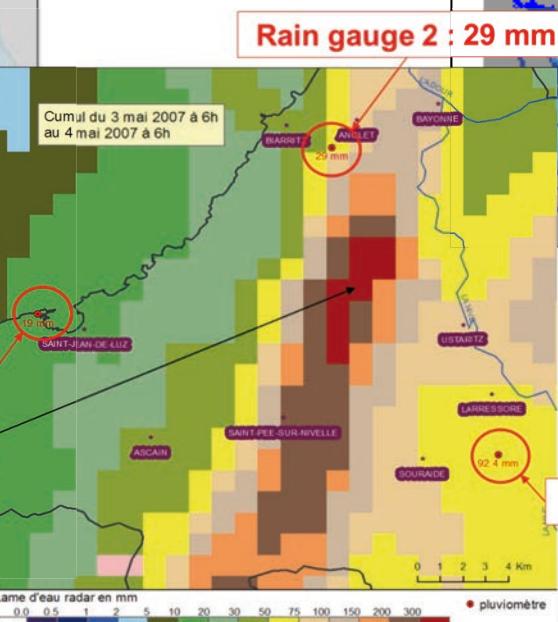
Airport
X-band
Radar
(CDG &
Nice)

Rain gauge 1 :
19 mm

Radar > 300 mm !!!

METEO FRANCE
Toujours un temps d'avance

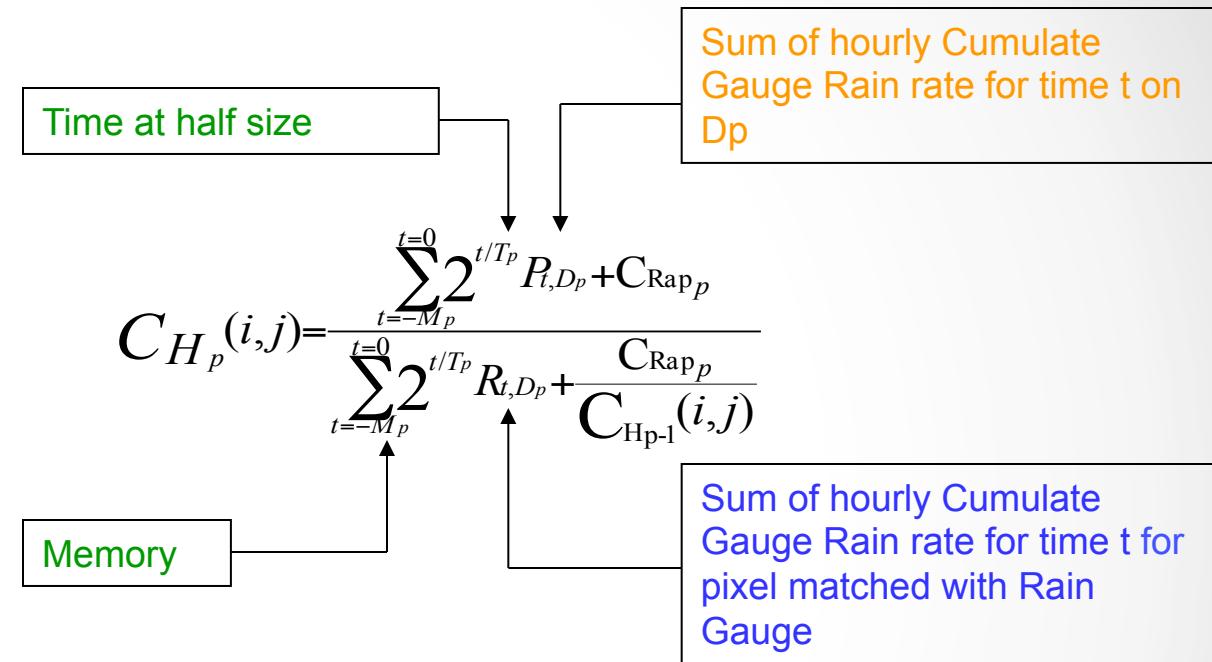
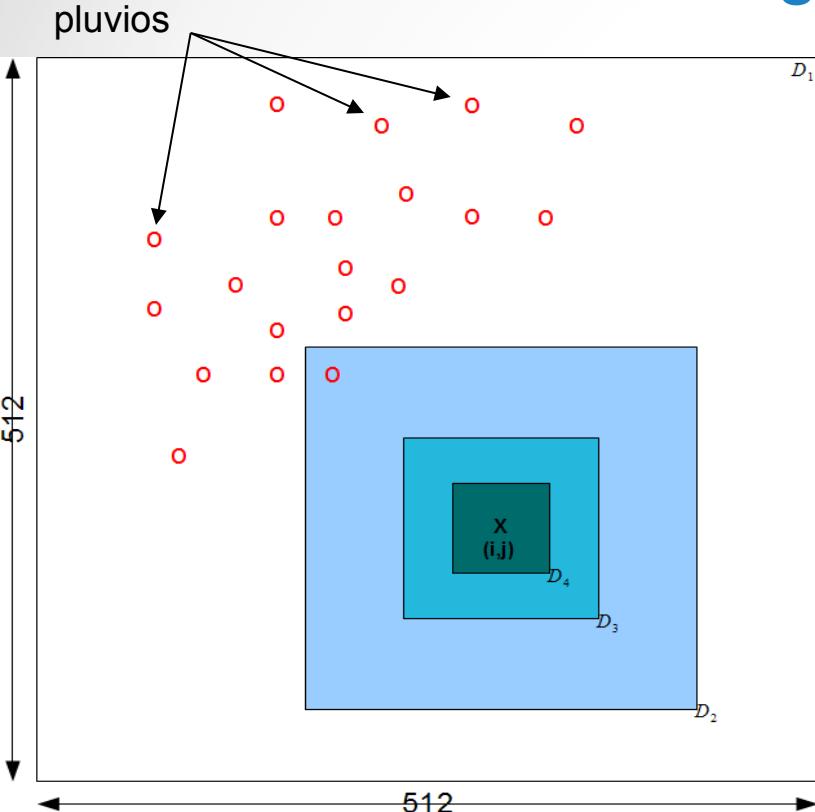
SAFETY | FUTURE SKY



Radar Rain Rate better spatial
coverage & accuracy than rain
gauges network

THALES

Correction of Radar data with Rain gauges data



- Spatial Resolution: 500 m (objective: 250 m for airport)
- Development of probabilistic model: error associated to cumulate Rain rate
- Quality analysis: to be indexed with the statistical error.

LEOPARD Project of Météo-France (weather X-band Radar for CDG Airport)



Rainbow RM - connected to: Nice Radar

File Options Tools Window

Connection: Nice Radar

Configuration Box

Preprocessing

Product

Conversion

Scan

Volume new 75km_test MF_75km MF_75k... MF_75k... MF_75k... MF_75k... MF_75k... MF_75k... MF_75k... D-Azimuth D-Elevation

Volume Scan Definition

SDF Slice List:

Slice 1: 3.0 deg; 75 km
Slice 2: 25.0 deg; 75 km
Slice 3: 50.0 deg; 75 km
Slice 4: 35.0 deg; 75 km
Slice 5: 18.0 deg; 75 km
Slice 6: 3.0 deg; 75 km
Slice 7: 7.0 deg; 75 km
Slice 8: 12.0 deg; 75 km
Slice 9: 5.0 deg; 75 km
Slice 10: 2.0 deg; 75 km
Slice 11: 1.0 deg; 75 km

Sequence:

No.	Slice	Time	AZ1	AZ2	AZ
1	3.0	29	X	○	▶
2	25.0	55		X	○
3	50.0	81			X
4	35.0	107			
5	18.0	133			
6	3.0	159			
7	7.0	185			
8	12.0	211			
9	5.0	237			
10	2.0	263			
11	1.0	289			

METEO FRANCE THALES Toujours un temps d'avance

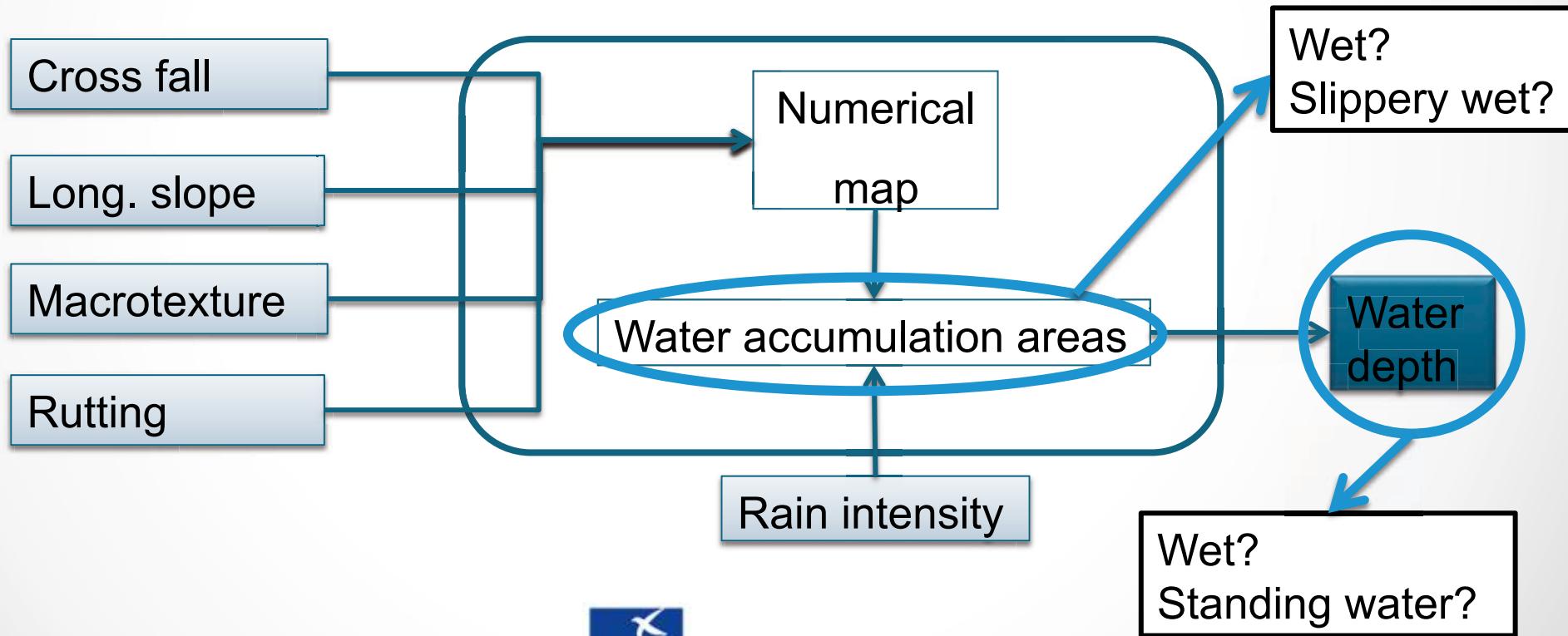


Operational Product at CDG:

- Wind on 15 km/80 km at elevation 3°
- dBZ on 15 km/80 km at elevation 3°
- Windshear on runway at elevation 3°
- Vertical Profil of Wind along runway :
(5 km long x 4 km Altitude)

DGAC/STAC Contribution

Method



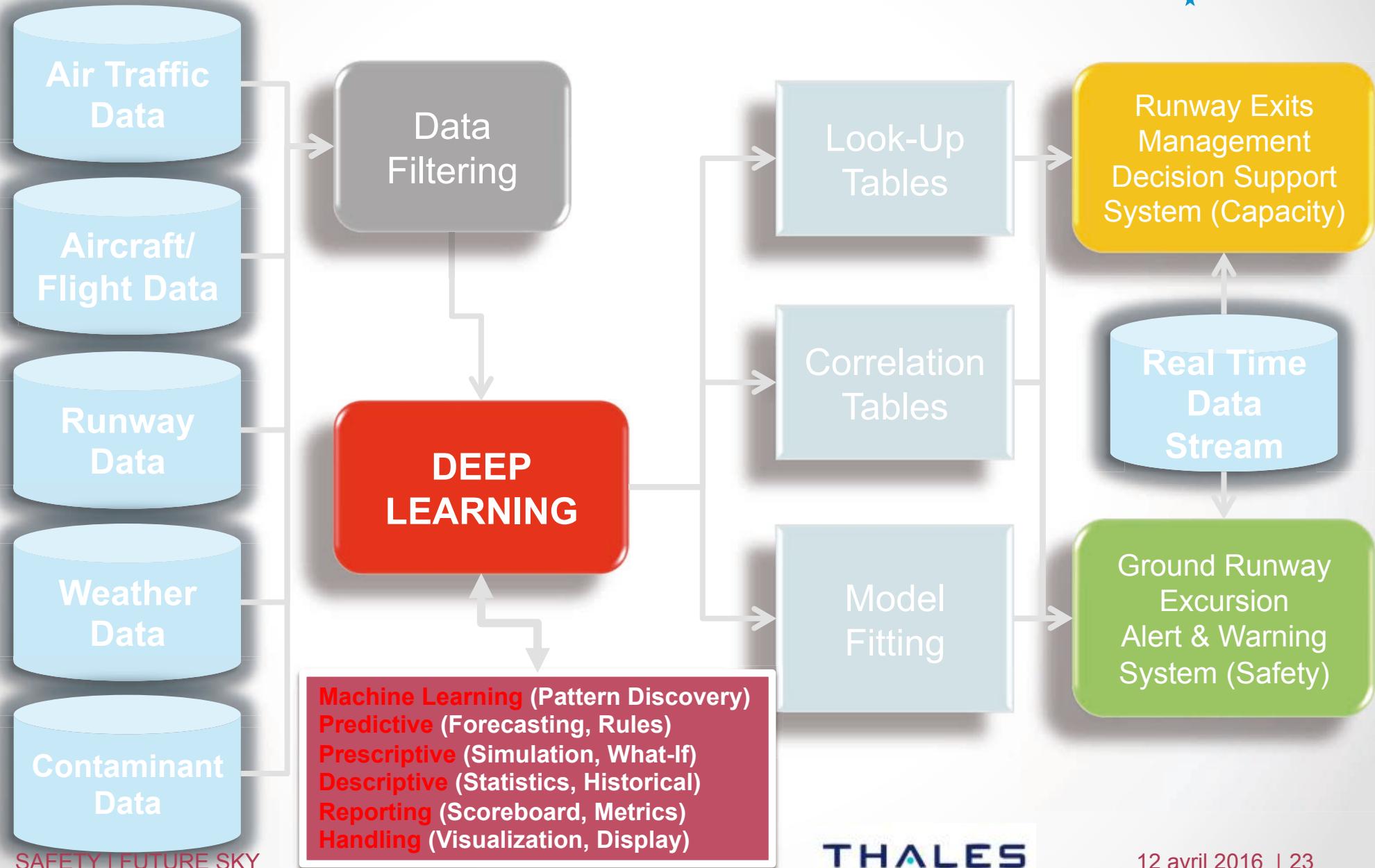
Ground Runway Excursion Alert & Warning System (Safety)

Analytics Tool to extract Pattern for Ground Runway Overrun Awareness & Alerting Systems

Description

- The objective is first to consolidate THALES database on Runway information for CDG Airport:
 - Air Traffic Data (Landing final speed & trajectories, wheels ON time, braking distance);
 - Aircraft/Flight Data (weight, span, ...);
 - Runway Data (layout, Exit positions, contaminant, friction coefficient,...);
 - Weather Data;
- THALES will develop Analytics tool to extract Patterns of inter-correlations between these elements: Braking Distance and Runway Exit indexed by
 - aircraft weight,
 - wheel ON point,
 - head wind and runway contaminant,
 - aircraft characteristics

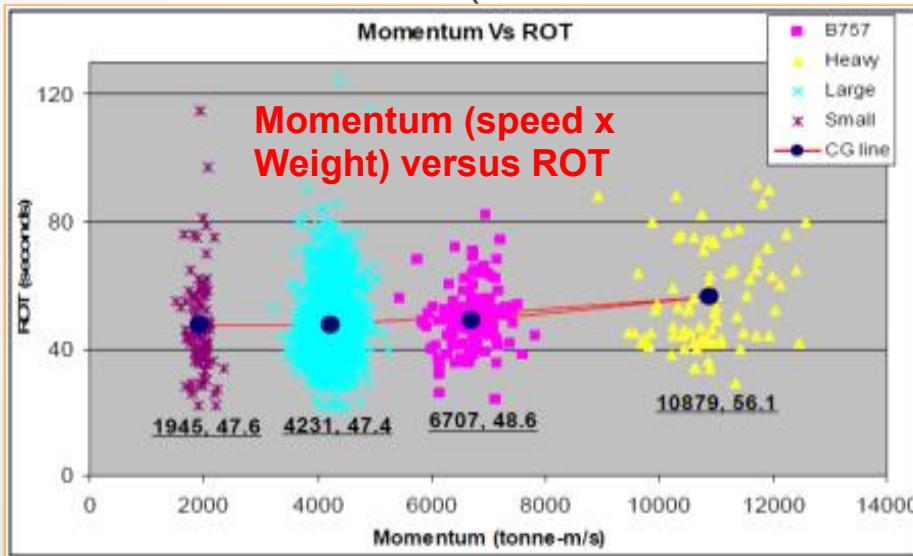
Data Analysis



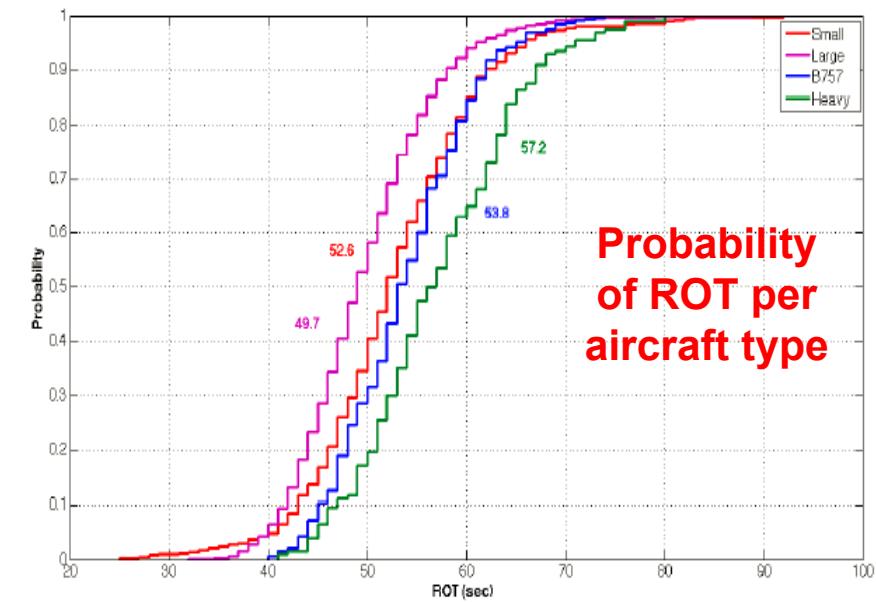
Data Correlation Analysis

Interdependencies and models could be elaborated based on big data analytics

- Air Traffic Data (Landing& Take-Off speed & trajectories,...)
- Aircraft/Flight Data (weight, span, ...)
- Runway Data (layout, Exit positions, contaminant, cross fall, long.slope, macrotexture, rutting, friction coefficient,...)
- Weather Data (from Met Office, Radar/Lidar Sensors)



Report No. ICAT-2013-08
August 2013



BIG DATA BASE @ CDG AIRPORT

Existing Data-base (SESAR P12.2.2), Paris-CDG Airport (6 months recording)

- 10000 aircrafts recorded on CDG North-West Closely spaced parallel runway
- **SQL Structured Database** mixing and correlating:
 - Traffic data (ADS-B, Mode-S)
 - Flight Data (aircraft code, aircraft type, aircraft weight MLW,...)
 - Weather Data (Météo-France CDM 95)

Database Future Extension:

- FP8 Project « Future Sky Safety: Runway Excursion »
 - Head/Tail/Cross Wind and EDR (Eddy Dissipation Rate) along runway
 - Rain Rate and Runway contaminant (radar rain rate/run-off model calibrated with Water-Level gauge)
 - Braking distance (Braking deceleration, speed at wheel-on)

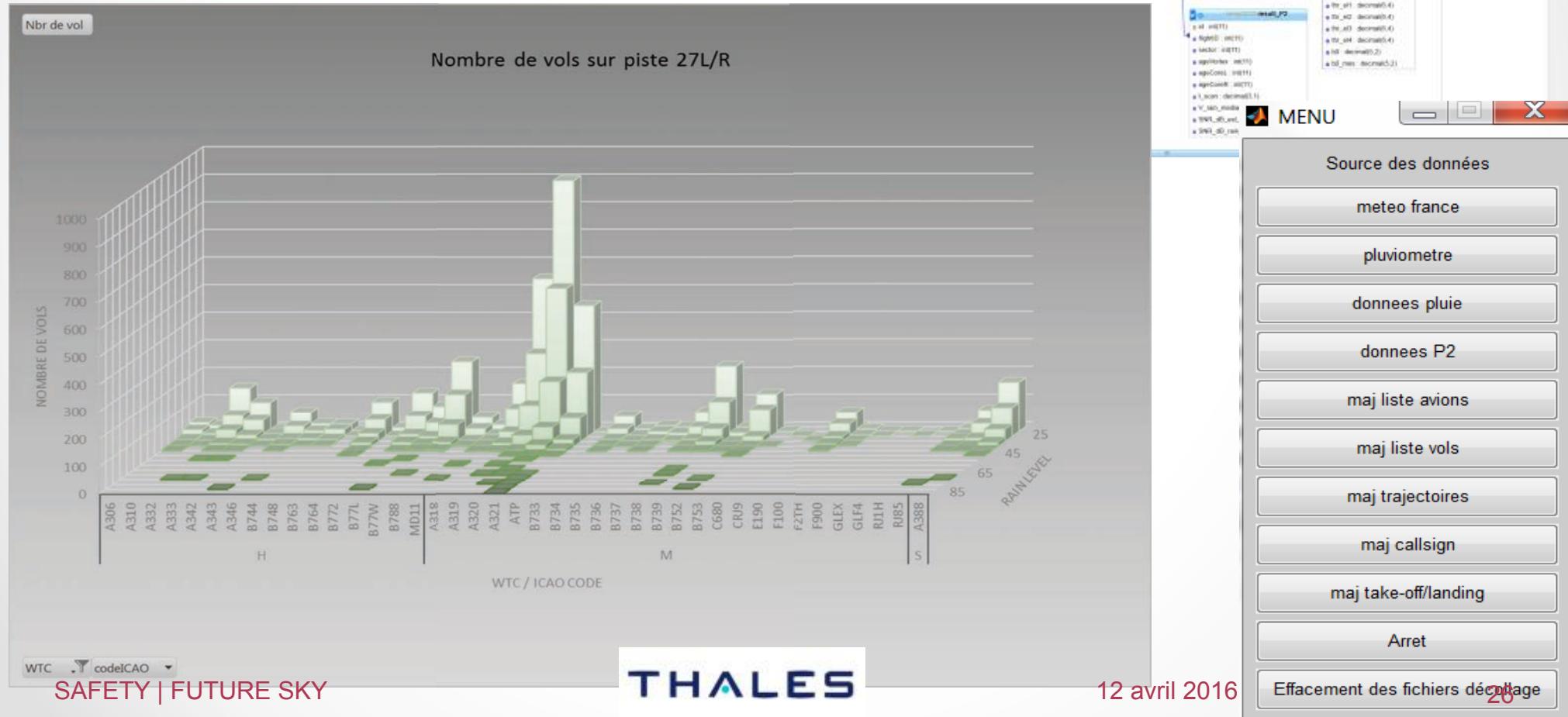


Update of CDG Data base

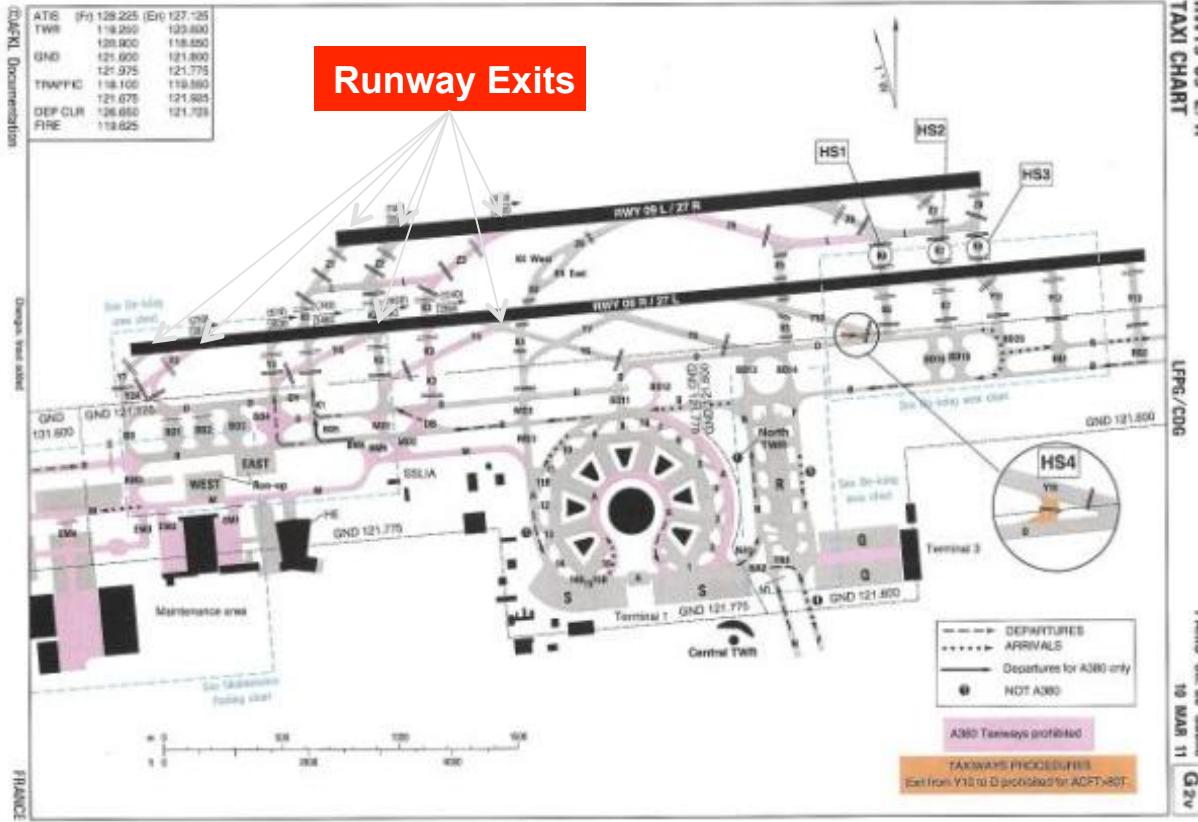


Data Base

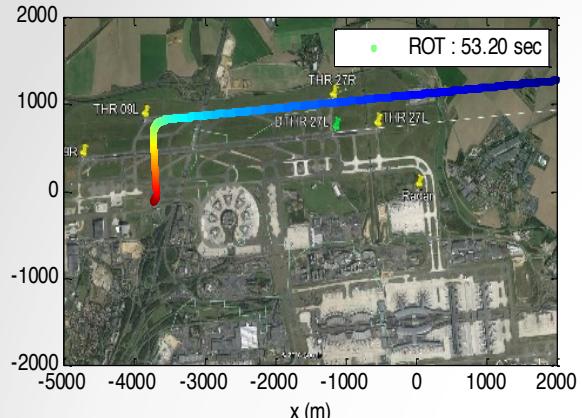
- 26924 flight have been recorded
- 7936 flights in rainy conditions



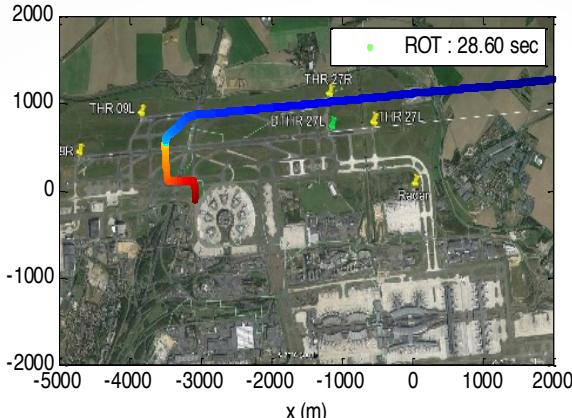
Predictive Braking Distance & Exit Taxiway



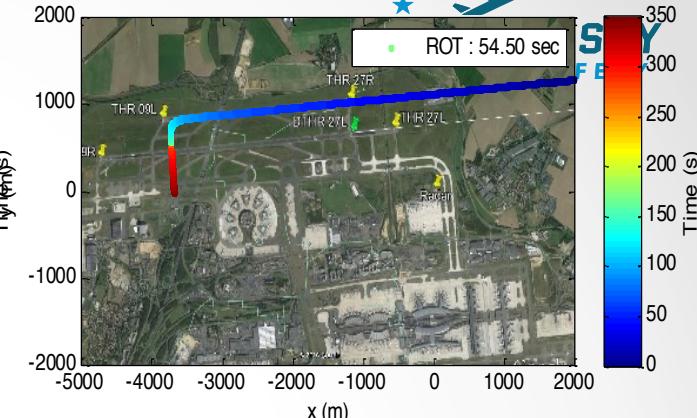
FDX5238 A306
2015-09-11 16:11:17



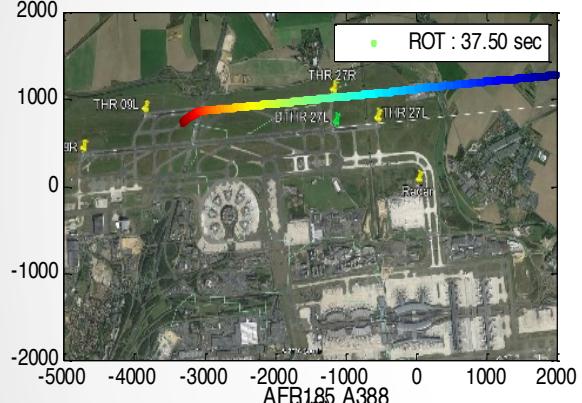
MSR799 A333
2015-09-11 12:21:34



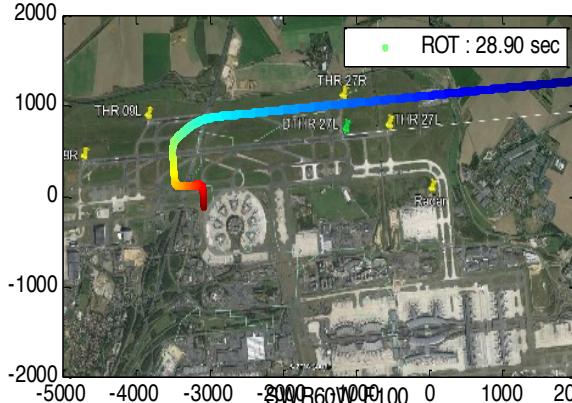
FDX5011 B77L
2015-09-12 18:24:34



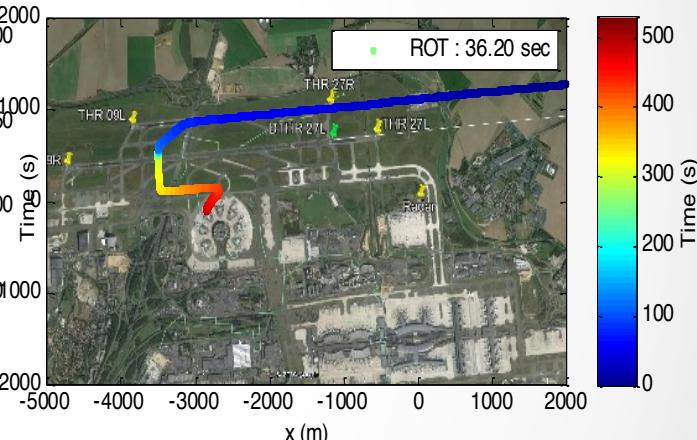
AFR1045 A319
2015-09-13 16:37:31



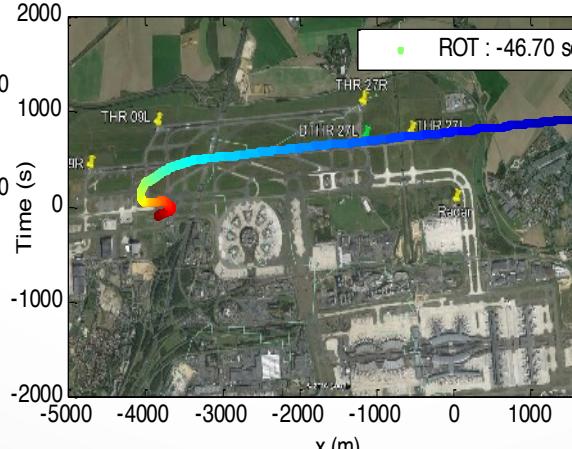
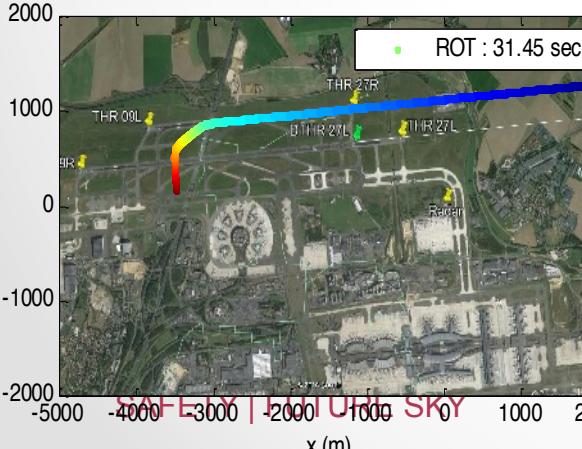
EZY93HP A320
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ICE542 B752
2015-09-11 11:21:31



AFR185 A388
2015-08-30 03:47:55

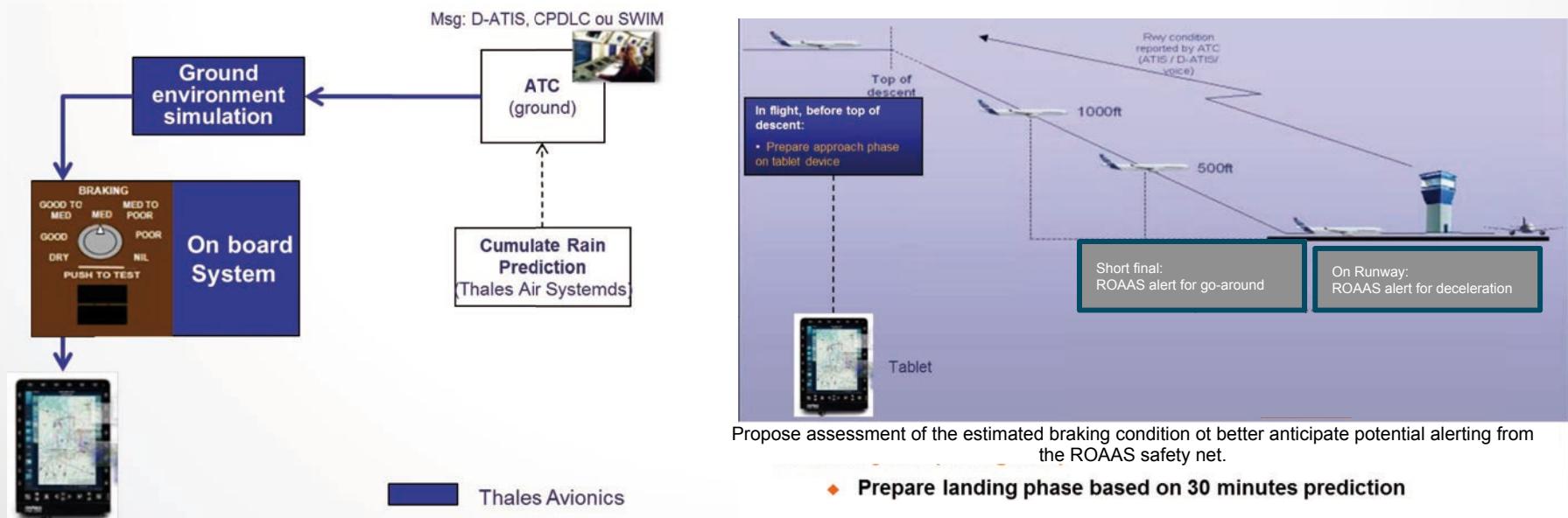


Estimation of
Runway Occupancy Time
(and soon of Braking
distance)

THALES AVIONICS

Landing assessment

- To develop a prototype that provides to the pilot all information for approach phase preparation (predictive mode > 1500 feet)
- The activities will be shared as follows:
 - Identify existing solutions which improve runway overrun systems based on runway contaminant detection automatically transferred to the aircraft.
 - Define the feasibility of a global solution, based on ground/on board systems collaboration, for an improved runway overrun protection
 - In coordination with ground system, develop an application to:
 - Improve pilot awareness of runway contaminant (with 30 min predictions) on a tablet
 - Integrate the application on PC environment (no integration within The Link environment)



THALES AVIONICS

Landing assessment

Technical solution :

The solution simulates onboard use of destination runway friction information reported by ATC

It is based on :

- Predictive solution hosted on an EFB tablet connected to avionics system :
 - Approach parameters coming from FMS (ground speed, weight, etc...)
 - Meteorological parameters of destination airport coming from weather system
 - Runway friction parameters

Flight crew performs a verification of landing capability before TOD on EFB tablet which presents the forecast runway contaminant (30 minutes prediction)



Consortium

Stichting Nationaal Lucht- en Ruimtevaartlaboratorium
Deutsches Zentrum für Luft- und Raumfahrt
Office national d'études et de recherches aérospatiales
Centro para a Excelência e Inovação na Indústria Automóvel
Centro Italiano Ricerche Aerospaziali
Centre Suisse d'Electronique et Microtechnique SA
Institutul National de Cercetari Aerospaciale "Elie Carafoli"
Instituto Nacional de Técnica Aeroespacial
Výzkumný a zkušební letecký ústav, a.s.
Totalförsvarets FörskningsInstitut
European Organisation for the Safety of Air Navigation

Civil Aviation Authority UK
Airbus SAS
Airbus Operations SAS
Airbus Defence and Space
Thales Avionics SAS
Thales Air Systems SA
Deep Blue SRL
Technische Universität München
Deutsche Lufthansa Aktiengesellschaft
Service Technique de l'Aviation Civile
Embraer Portugal Estruturas em Compositos SA

Russian Central Aerohydrodynamic Institute TsAGI
Ente Nazionale di Assistenza al Volo Spa
Boeing Research and Technology Europe SLU
London School of Economics and Political Science
Alenia Aermacchi
Cranfield University
Trinity College Dublin
Zodiac Aerosafety Systems
Institut Polytechnique de Bordeaux
Koninklijke Luchtvaart Maatschappij
Sistemi Innovativi per il Controllo del Traffico Aereo

<http://www.futuresky.eu/projects/safety>