Automated Braking Action Report for assessment of the Runway Condition Code

AÉROPORTS DE PARIS

SAFETY LINE
take control of your safety

Symposium on Runway Conditions Assessment and Reporting, DGAC

Paris, 31 March 2016

Keys Objectives

- Enhancing the level of awareness about runway safety for pilots / ATC / Airport Operator

- Enhancing runways capacity while maintaining a high level of safety
- Complying with the regulatory evolutions
- Proving direct reliable and up to date information to pilots about runway condition

- Limiting the drawbacks of the current process : runway occupancy, accuracy, subjectivity, data updating, information transmission

The TALPA Matrix as the starting point

Rwy Friction - μ

Vehicle Deceleration / Directional Control

Contamination Type / Depth

Temperature

RCC

PIREP

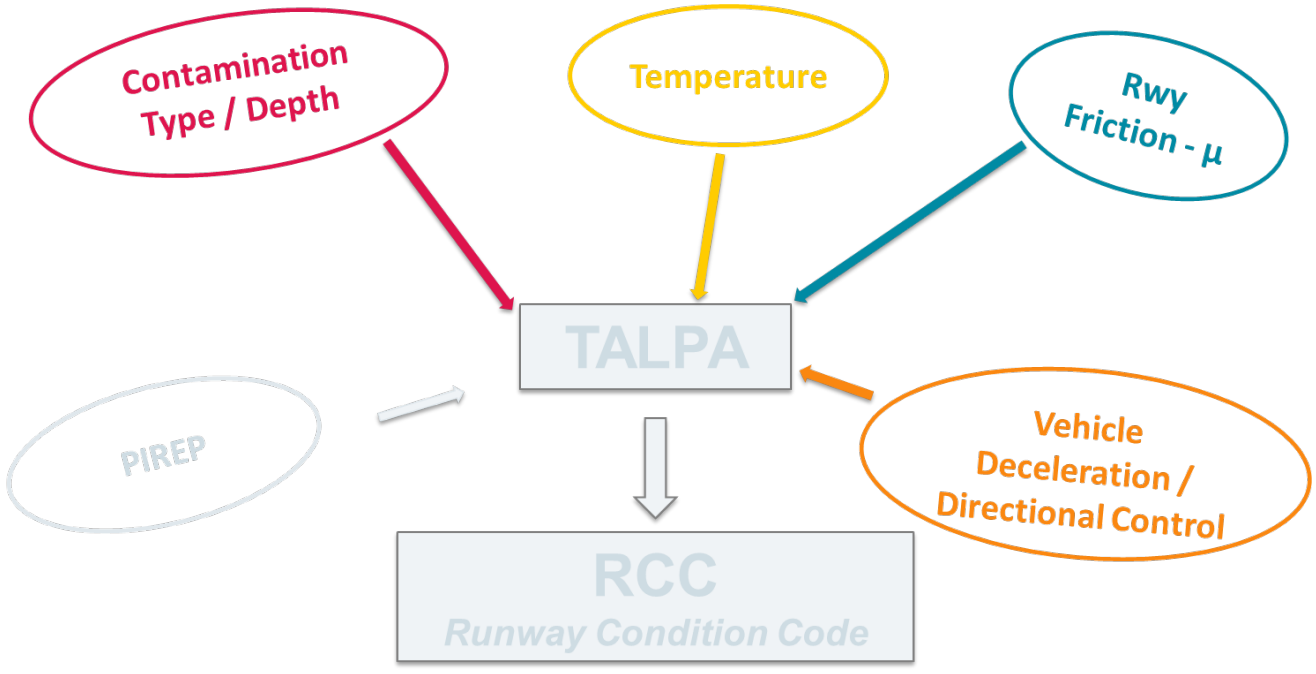
Airport Runway Condition Assessment					
Assessment Criteria		Downgrade Assessment Criteria		Pilot Reports (PIREPs) Provided To ATC And Flight Dispatch	
Code	Runway Condition Description	Mu (μ) [1]		Deceleration And Directional Control Observation	PIREP
6	• Dry	40 or Higher		-	Dry
5	***1/8" or less depth of:*** • Wet (Damp or Water 1/8" or less) • Water (Includes Wet or Damp) • Slush • Dry Snow • Wet Snow			Braking deceleration is normal for the wheel braking effort applied. Directional control is normal.	Good
4	• Frost ***-15ºC and Colder outside air temperature:*** • Compacted Snow	39 to 30		Brake deceleration and controllability is between Good and Medium.	Good to Medium
3	• Wet ("Slippery when wet" runway) • Dry Snow or Wet Snow (Any Depth) over Compacted Snow ***Greater than 1/8" depth of:*** • Dry Snow • Wet Snow ***Warmer than -15ºC outside air temperature:*** • Compacted Snow		29 to 21	Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be noticeably reduced.	Medium
2	***Greater than 1/8" depth of:*** • Water • Slush			Brake deceleration and controllability is between Medium and Poor. Potential for hydroplaning exists.	Medium to Poor
1	• Ice [2]	20 or Lower		Braking deceleration is significantly reduced for the wheel braking effort applied. Directional control may be significantly reduced.	Poor
0	• Wet Ice [2] • Water on top of Compacted Snow [2] • Dry Snow or Wet Snow over Ice [2]			Braking deceleration is minimal to non-existent for the wheel braking effort applied. Directional control	Nil

1.

The aerodrome operator approach
B-ABAR Project

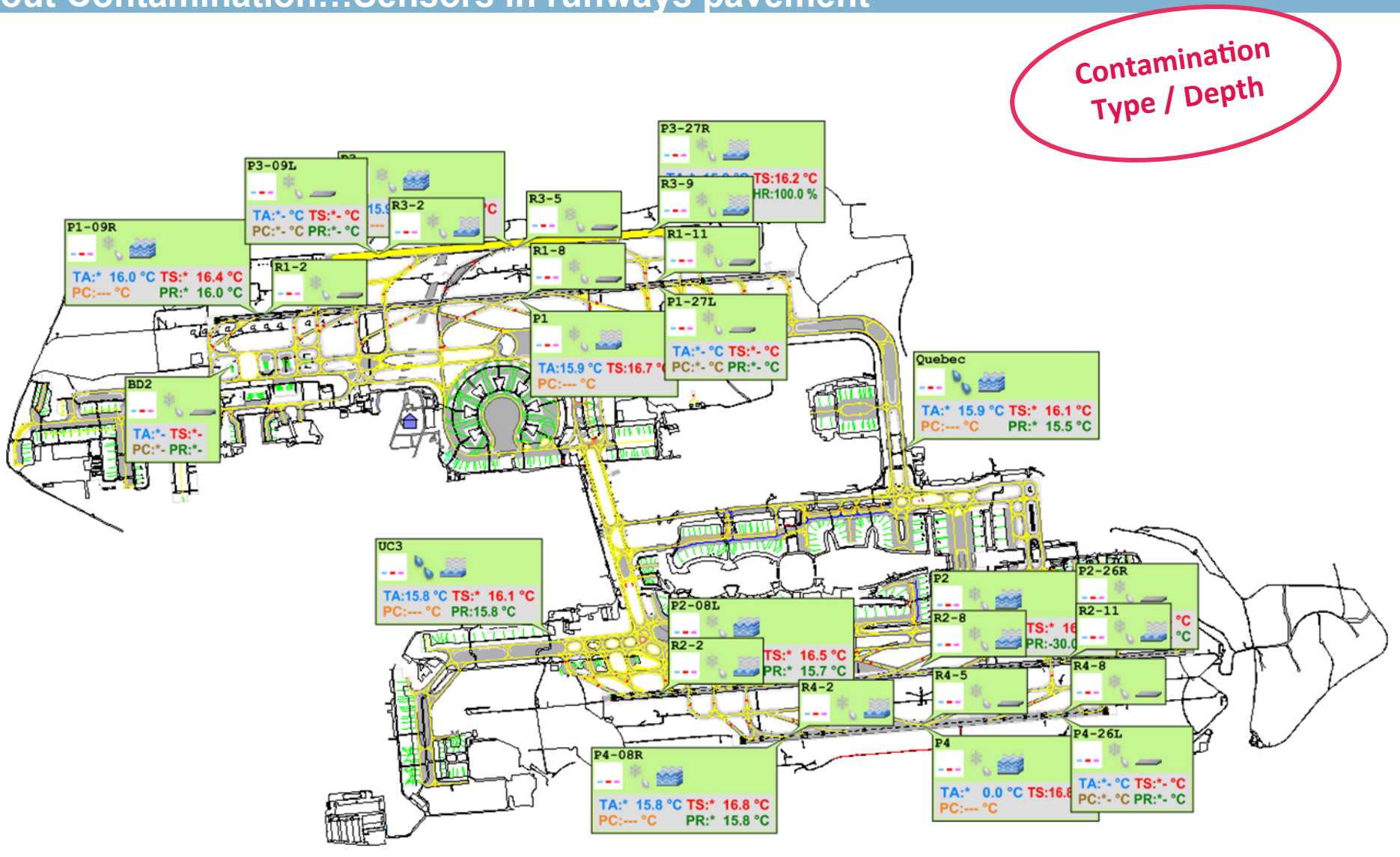
B-ABAR : Basic - Automated Braking Action Report

1.1.



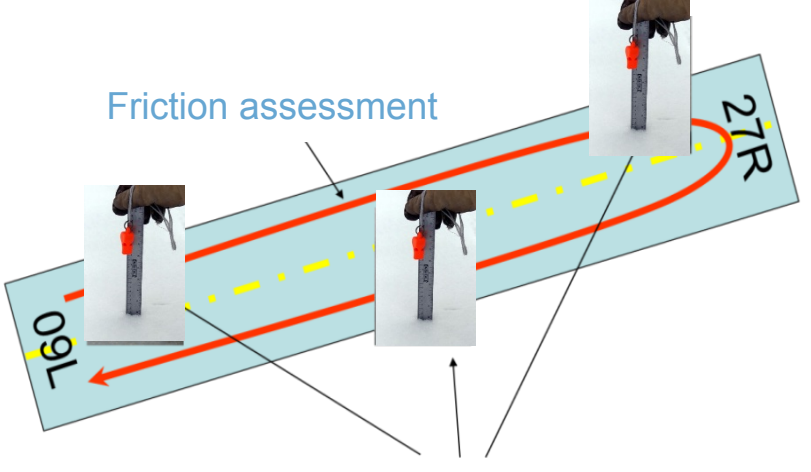
About data acquisition

About Contamination…Sensors in runways pavement



About Runway Friction…Determination of the runway friction coefficient

Rwy Friction - μ



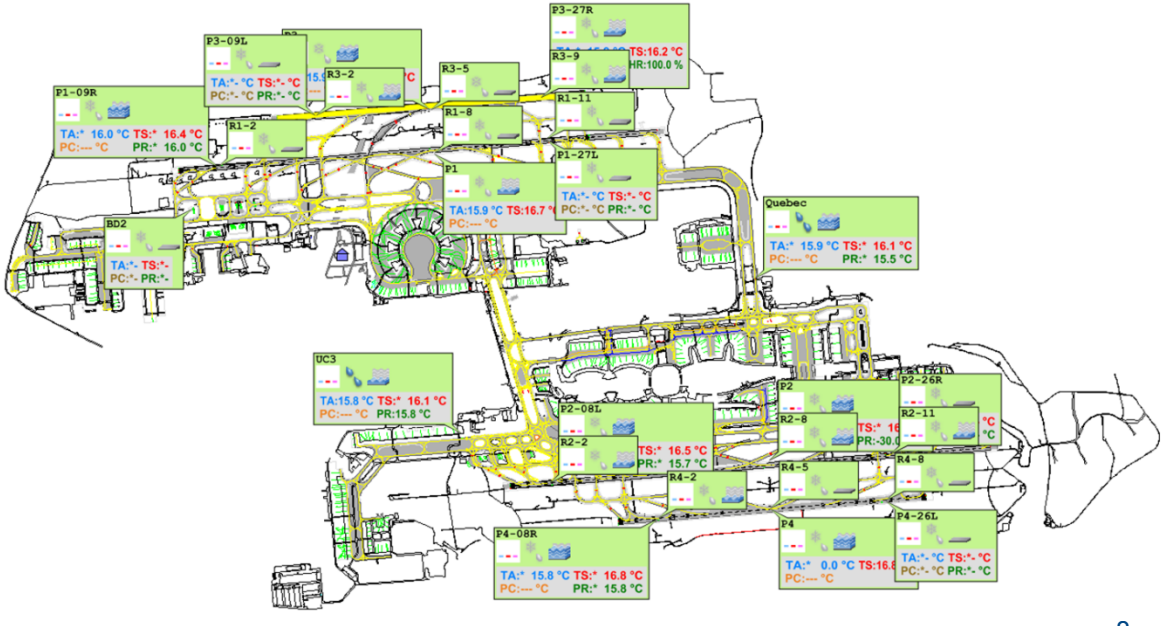
3 manual measures of contamination depth with a rule and type (3 locations predefined in every third)

About Temperature…

Temperature

METAR
METAR LFPG 250930Z 34004KT 300V020 5000 BR FEW006 02/01 Q1016 NOSIG=

TAF
TAF AMD LFPG 250746Z 2507/2612 35005KT 4500 BR FEW040
BECMG 2508/2510 7000 NSW
BECMG 2519/2521 VRB02KT
BECMG 2602/2604 09003KT
PROB40 TEMPO 2600/2604 3000 BR
TX07/2514Z TNM01/2604Z=



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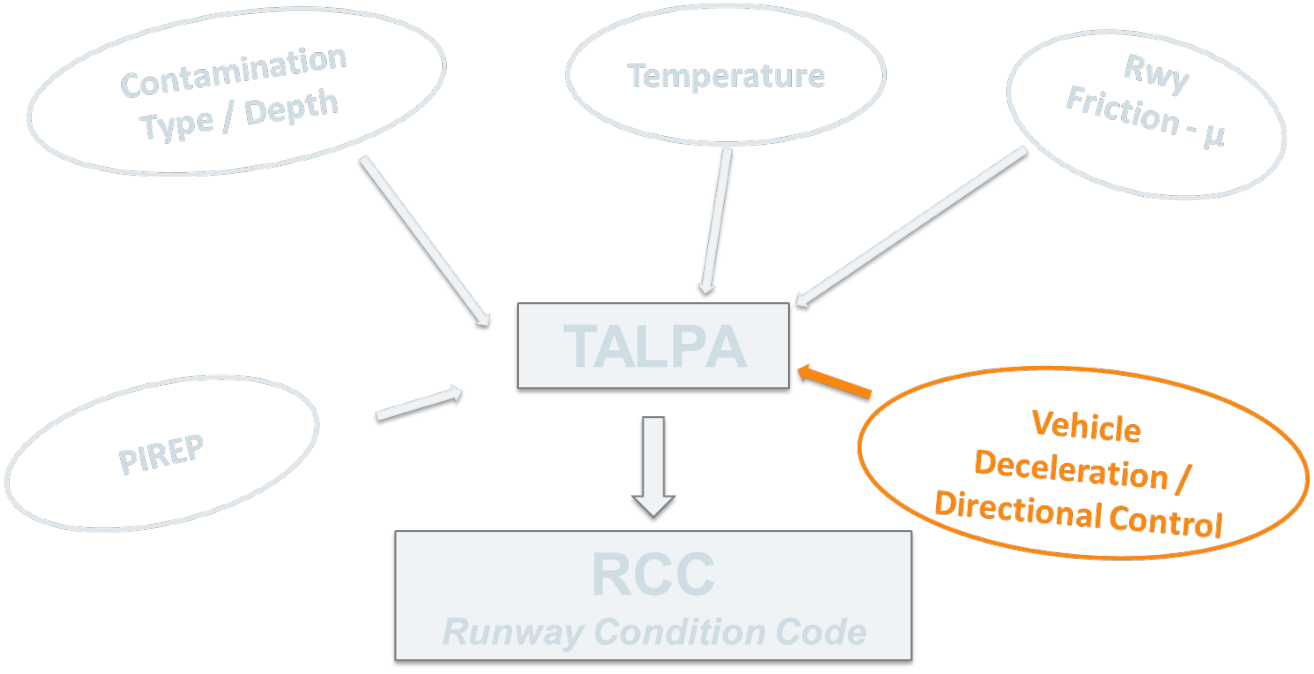


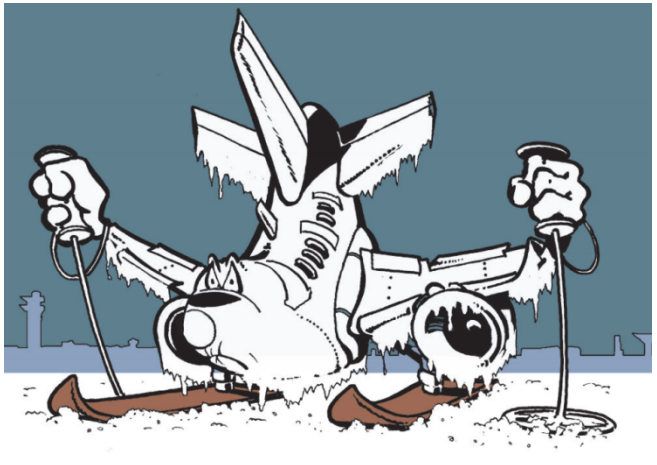
About data acquisition – Focus on vehicle deceleration

Correlating RWY Surface Conditions and A/C Braking Ability

Need: Assess the runway contamination via a measure which is

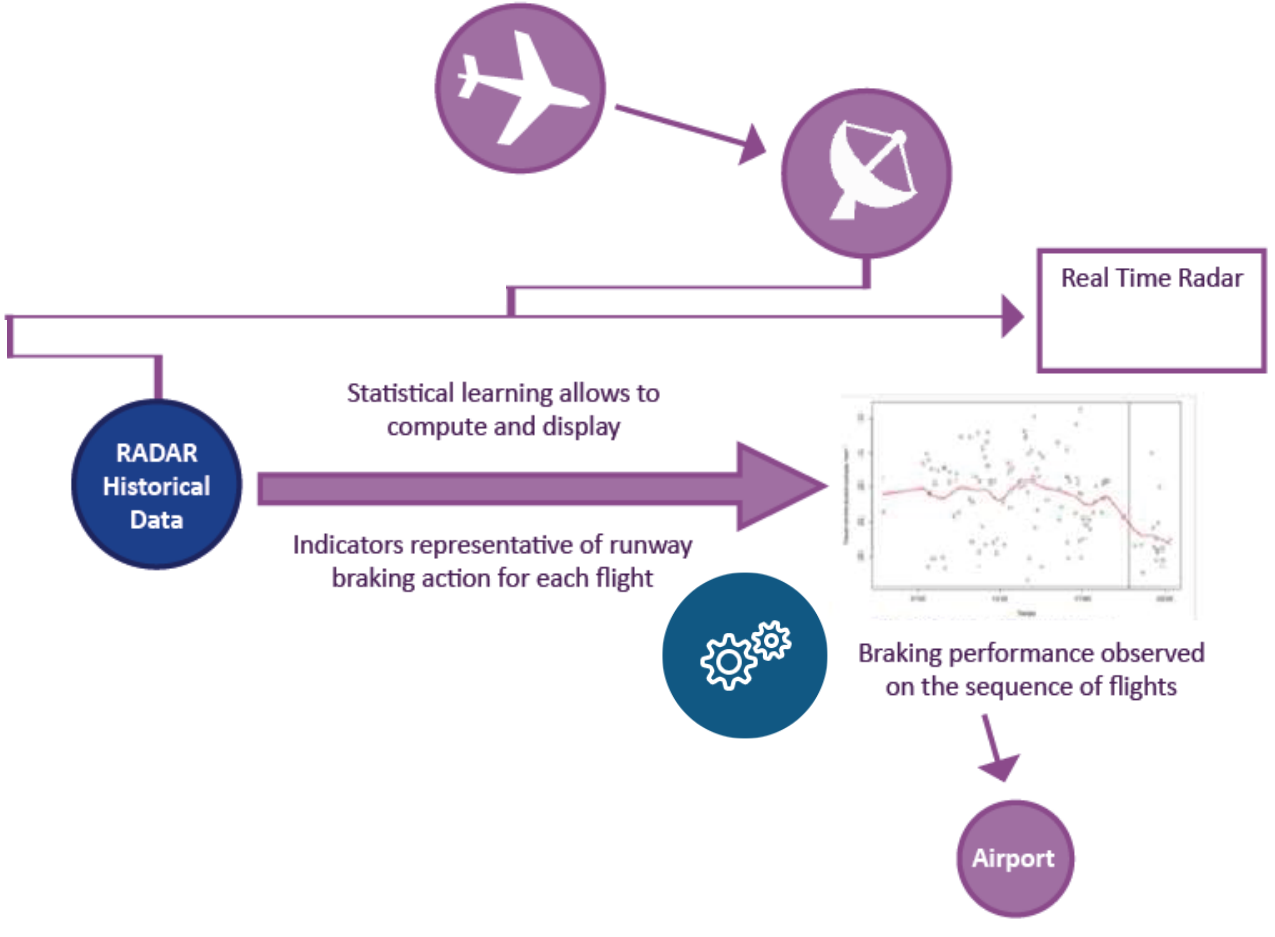
- Reliable
- Regularly updated
- Not requiring to close the runway
- Enabling the airport operator to take accurate decisions
- Enabling ATC to give accurate info to pilots

=> Proposal: calculate an automatic braking action coefficient thanks to ground radar data



Technical Aspects

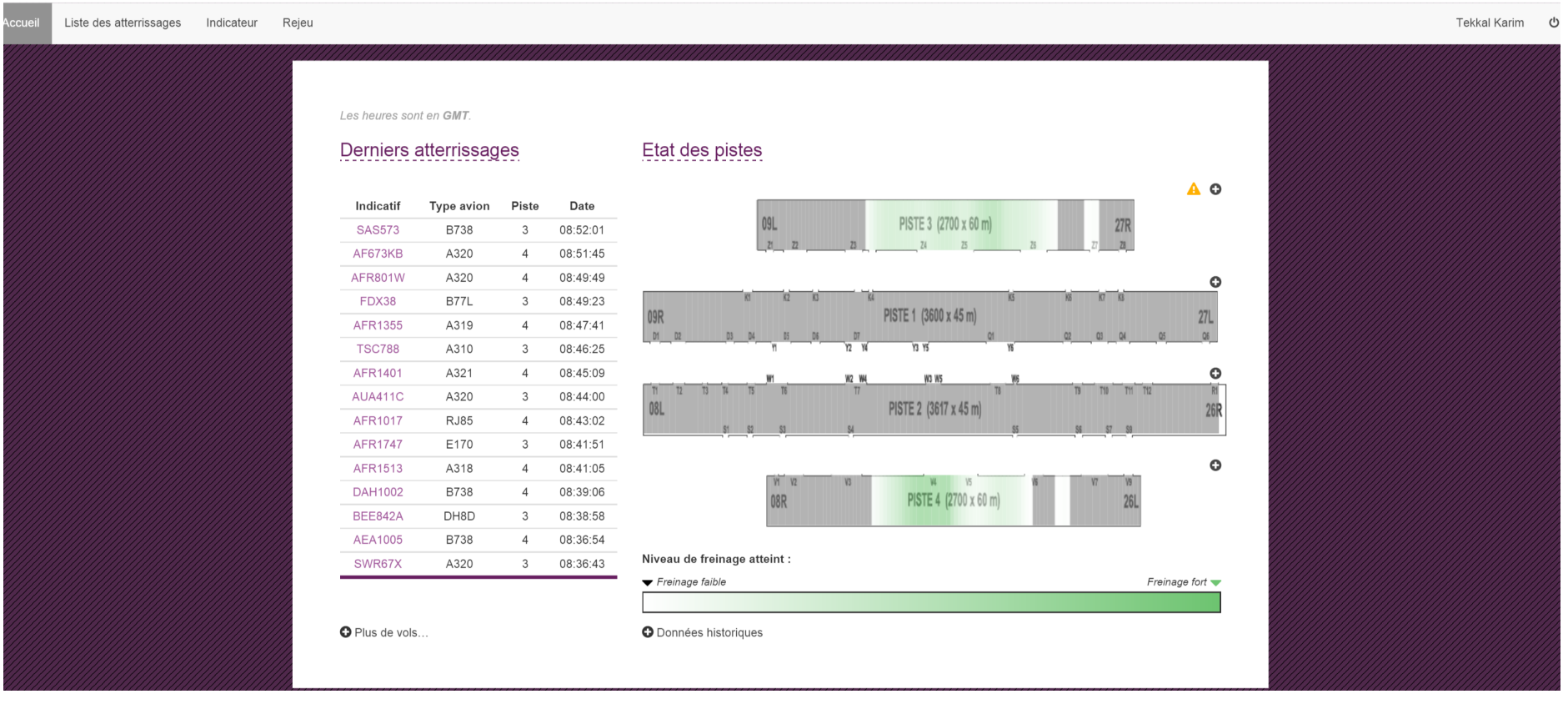
- MACHINE LEARNING ON ALL LANDINGS



The value of data

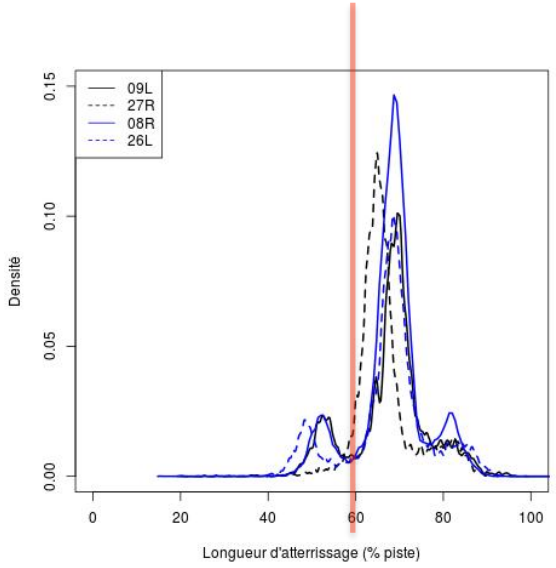
Runway braking condition

OHMAirport

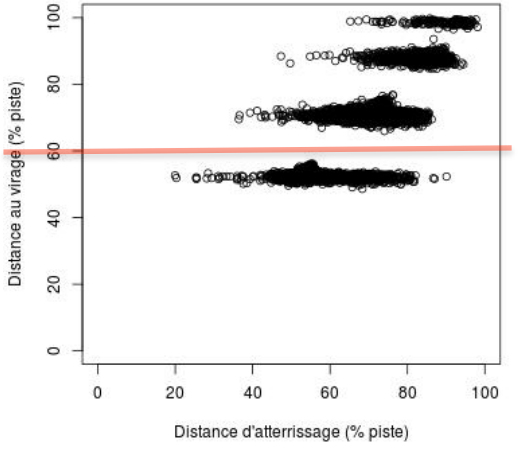


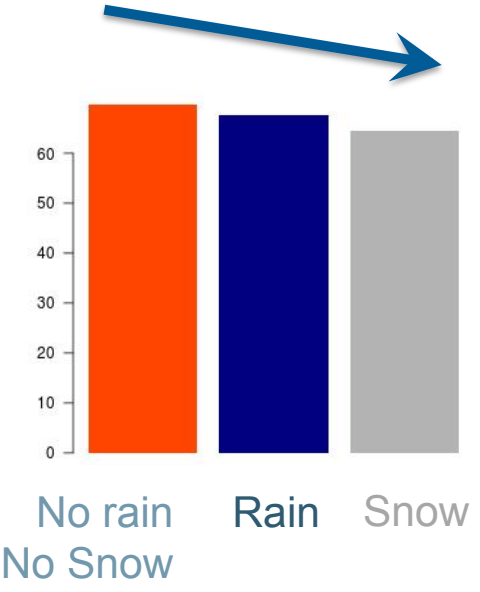
Correlating RWY Surface Conditions and A/C Braking Ability

LANDING DISTANCES* ANALYSIS



Ex. Runway 09L





84% of landing distances are > Threshold
=> 86% of landings exit at the 2nd exit (~ 70% of Runway)

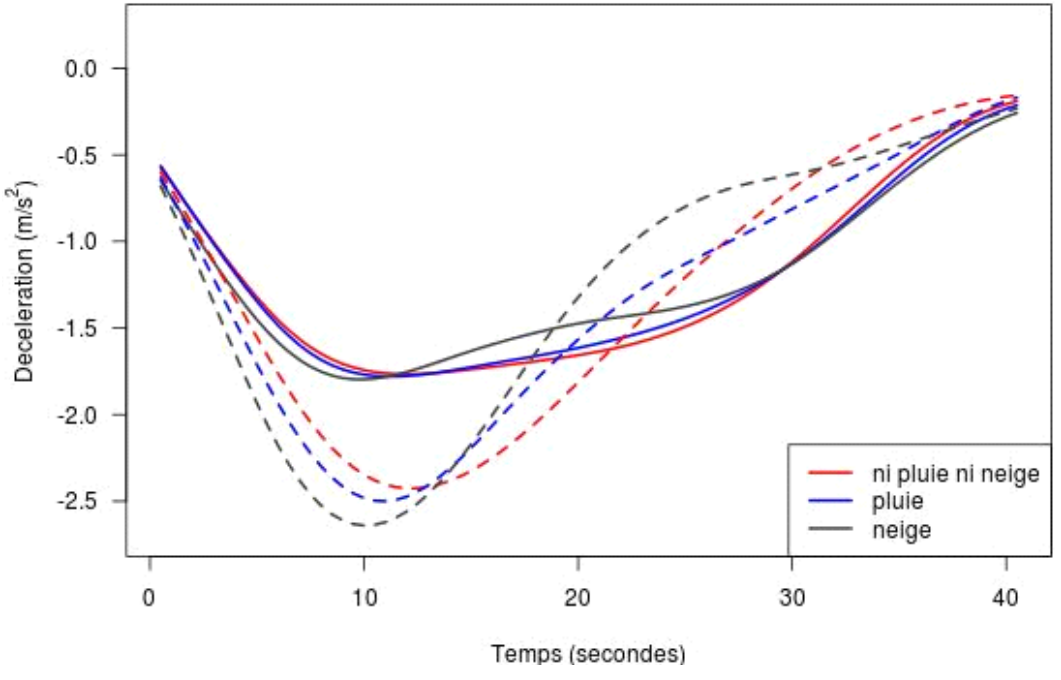
Landing distance is not a good indicator :

- Depends on selected mode
- Depends on the exit strategy

* Distance between the runway threshold and speed less than 20 m/s

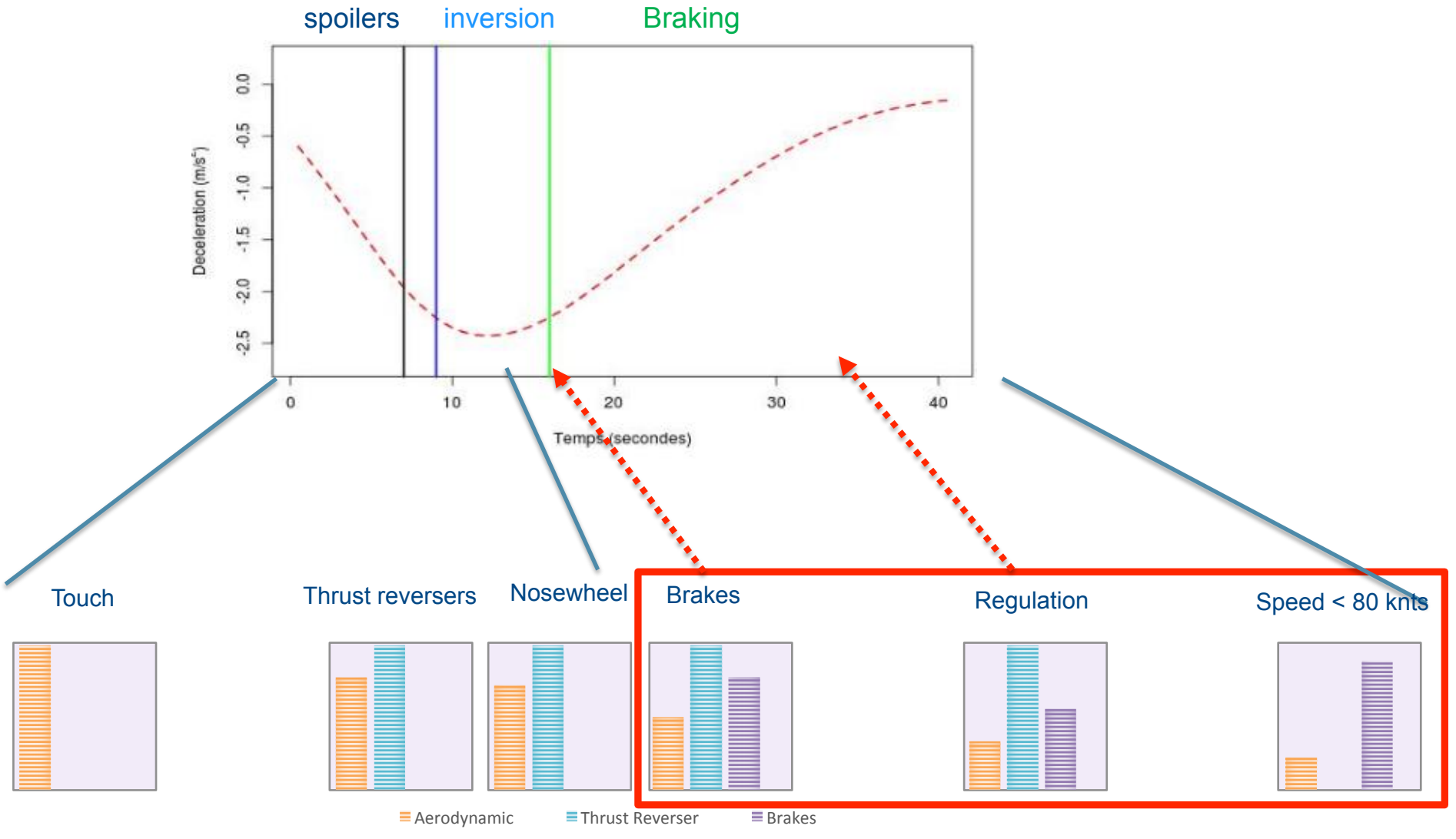
Correlating RWY Surface Conditions and A/C Braking Ability

CHARACTERIZATION OF BRAKING MODE



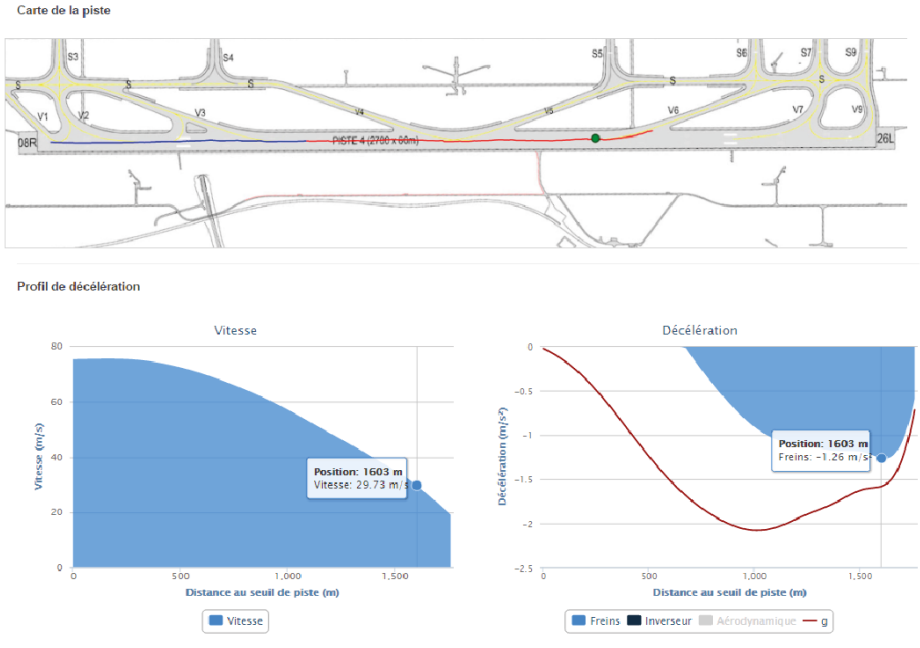
Correlating RWY Surface Conditions and A/C Braking Ability

CONTRIBUTION TO DECELERATION

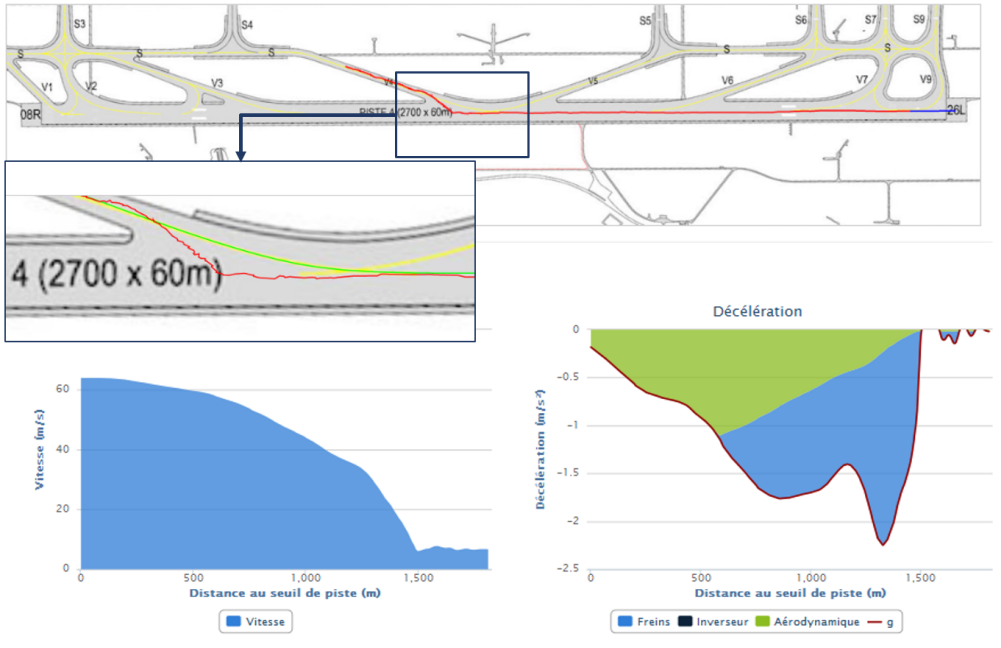


Correlating RWY Surface Conditions and A/C Braking Ability

BY TWO DIFFERENT MEANS



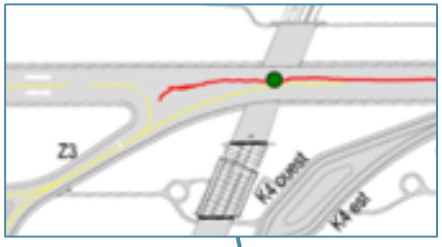
Braking effciency measurement

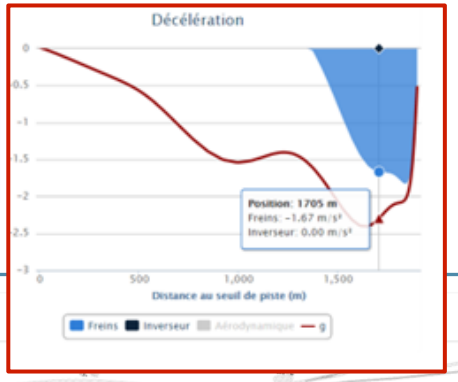


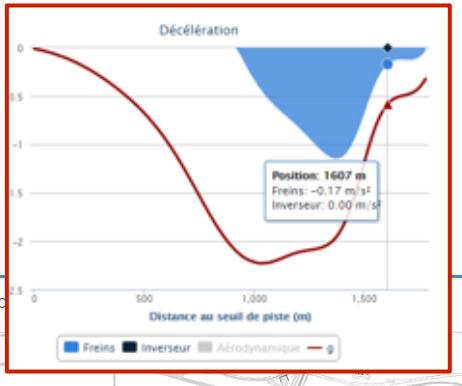
Lateral deviation from trajectory

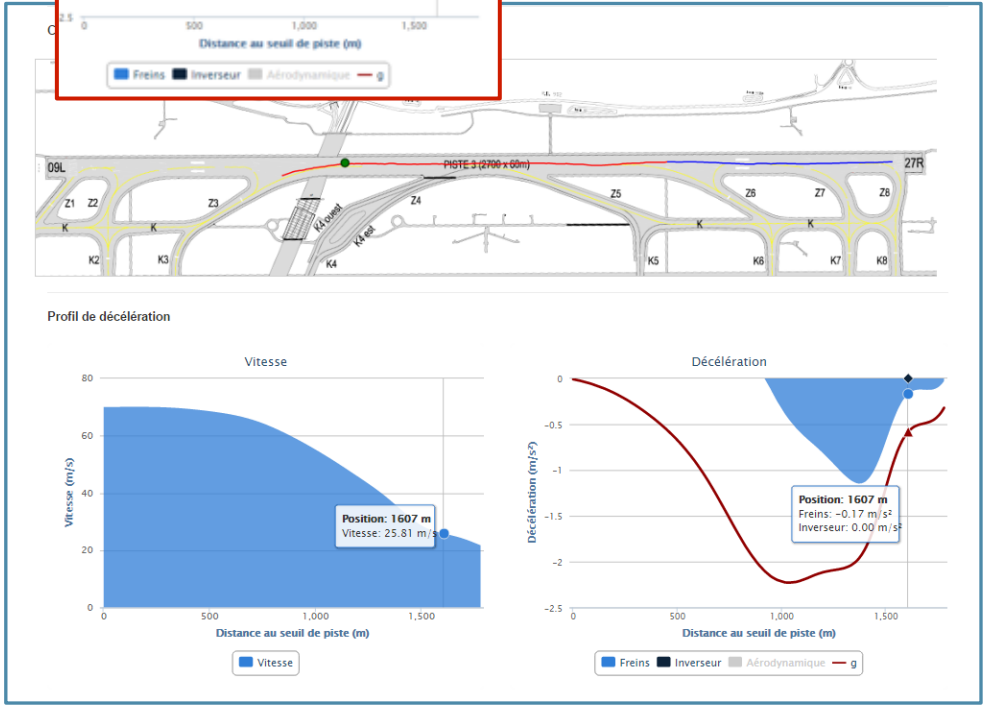
Correlating RWY Surface Conditions and A/C Braking Ability

PIREP : SUBJECTIVE VERSUS OBJECTIVE

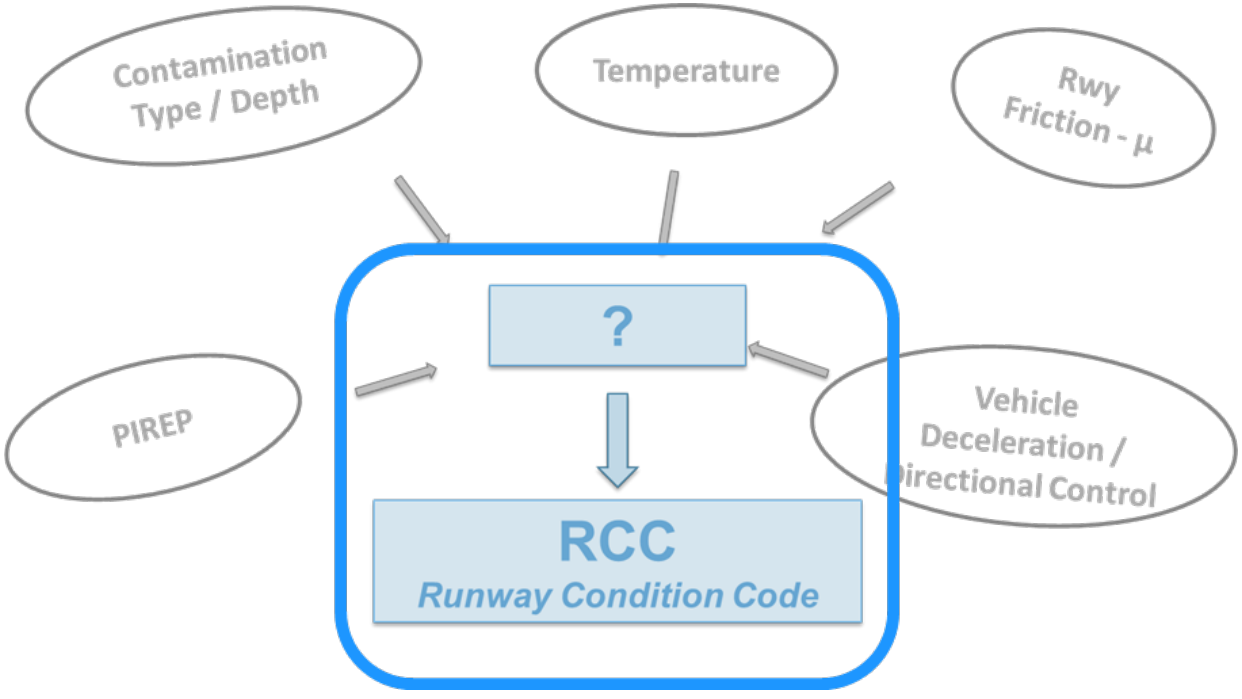








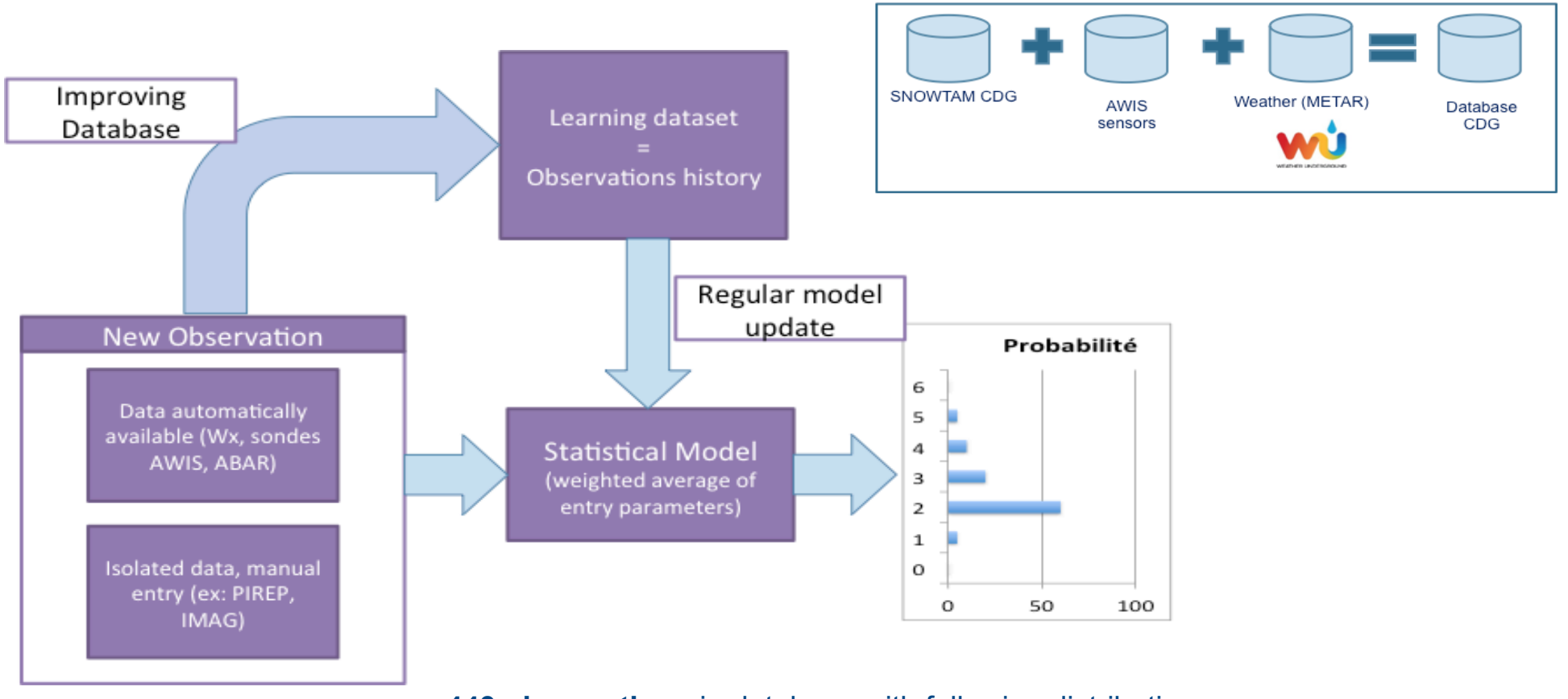
1.3.



About putting all these data together to get a runway condition assessment

B-ABAR with airport raw data

TALPA : Improved RCC using Machine Learning techniques



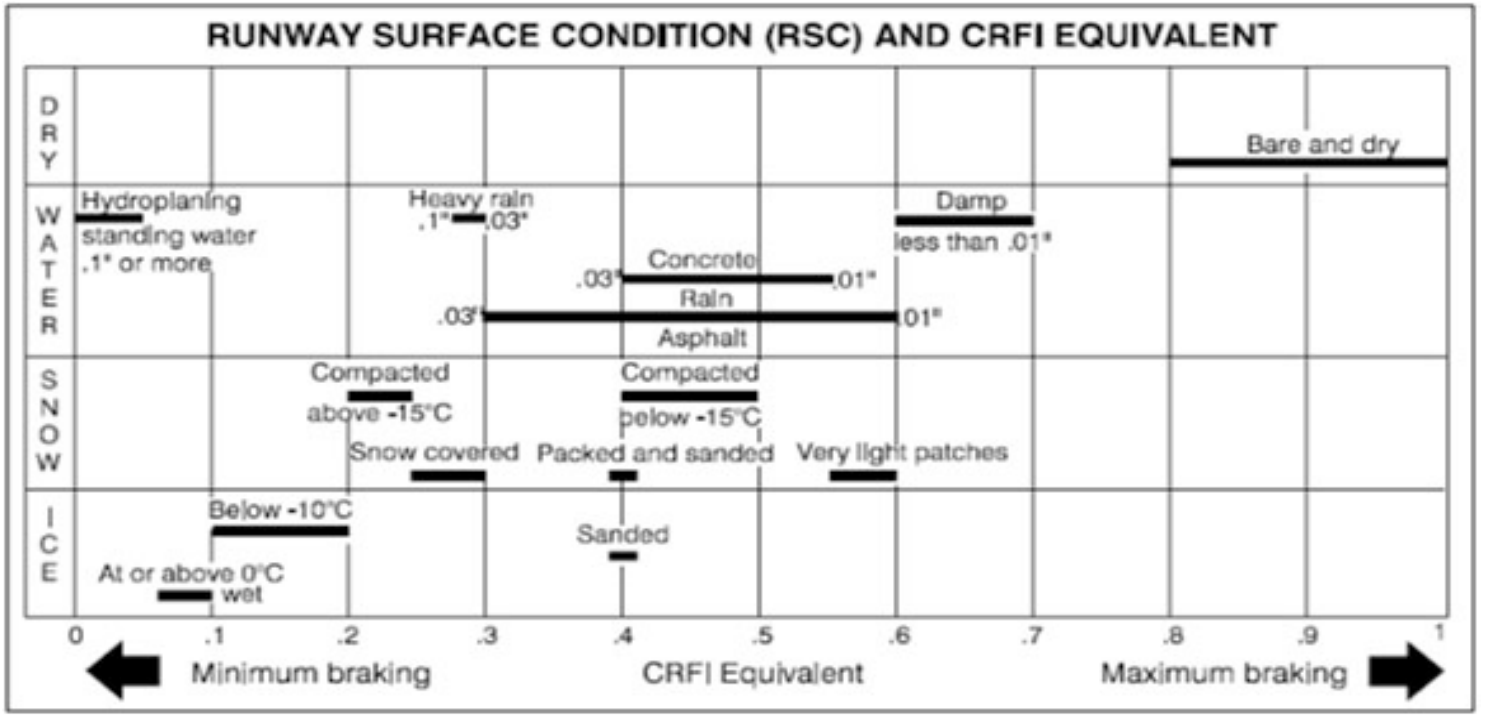
443 observations in database with following distribution:

RCC	6	5	4	3	2	1	0
Nb obs	137	268	7	24	0	6	1

Variable selection representative of runway condition

4 parameters selected (**« varRCC »**):

- **diff_TA_PR** : TA – PR (Air Temperature – Dew Point – source AWIS)
- **diff_TS_PC** : TS – PC (Ground Temperature – Freezing Point– source AWIS)
- **minCRFI**, **maxCRFI** : limits of CRFI interval, with type and depth of contaminant (source SNOWTAM)

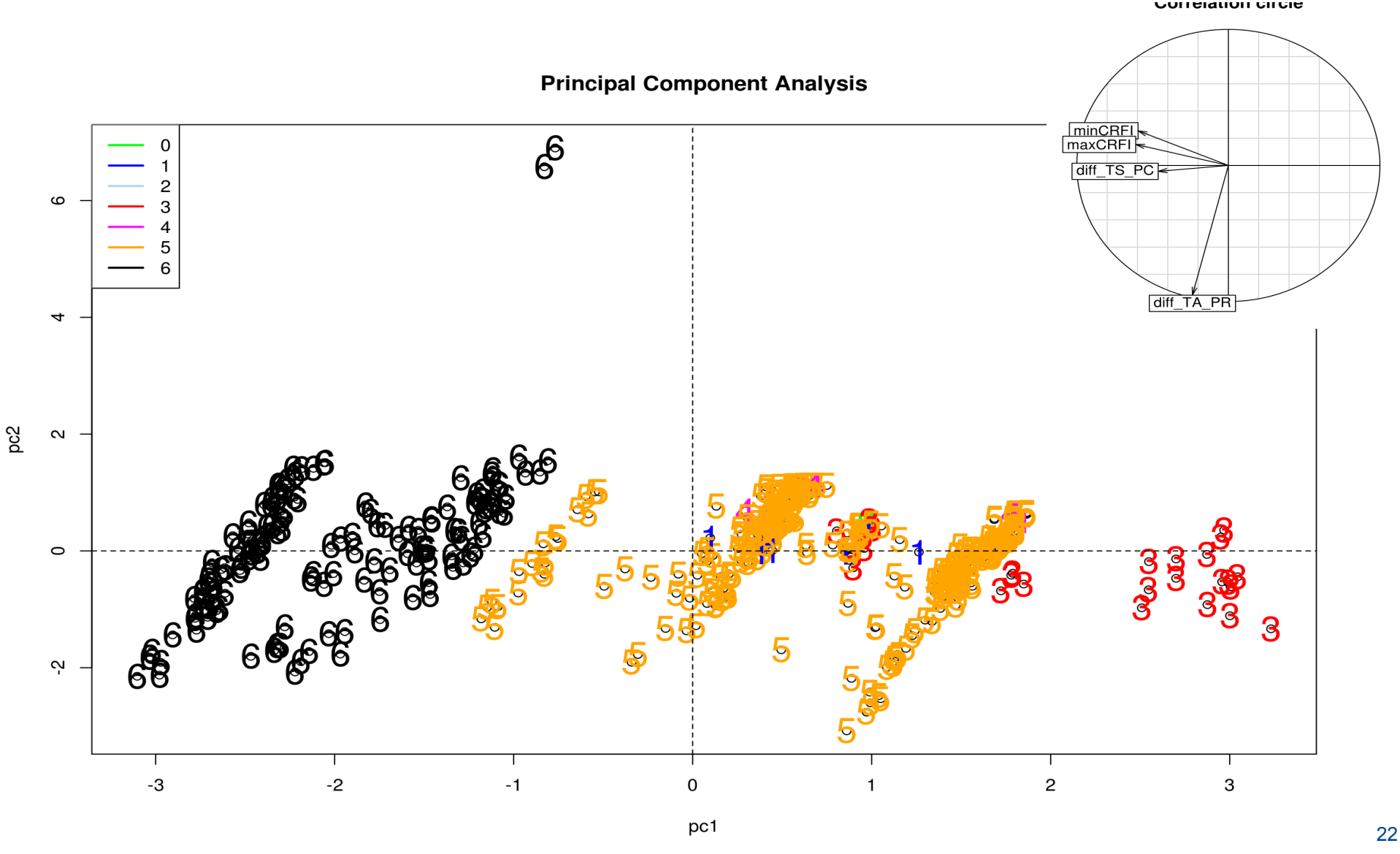


Principal Component Analysis (PCA)

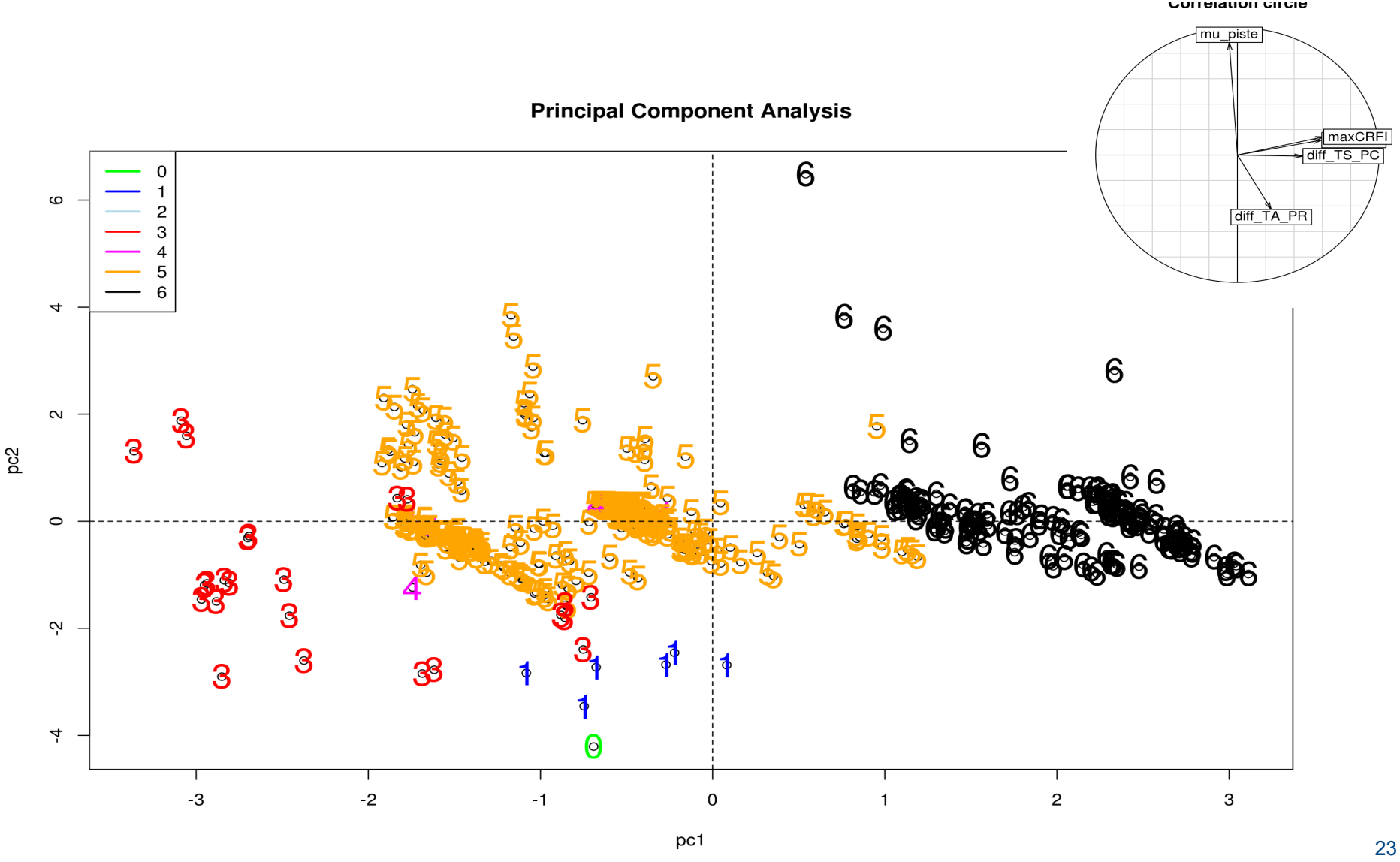
- **Principle :** projection of the data cloud in 2D while keeping the distance bewteen datapoints

- **Objectives :**
  - Visualization of the data cloud in 2D in order to identify groups of individuals
  - Find the most discriminating variables for the different RCC

PCA with the 4 parameters « var_RCC »



PCA with the 4 parameters « var_RCC » + runway friction



Performance of prediction models

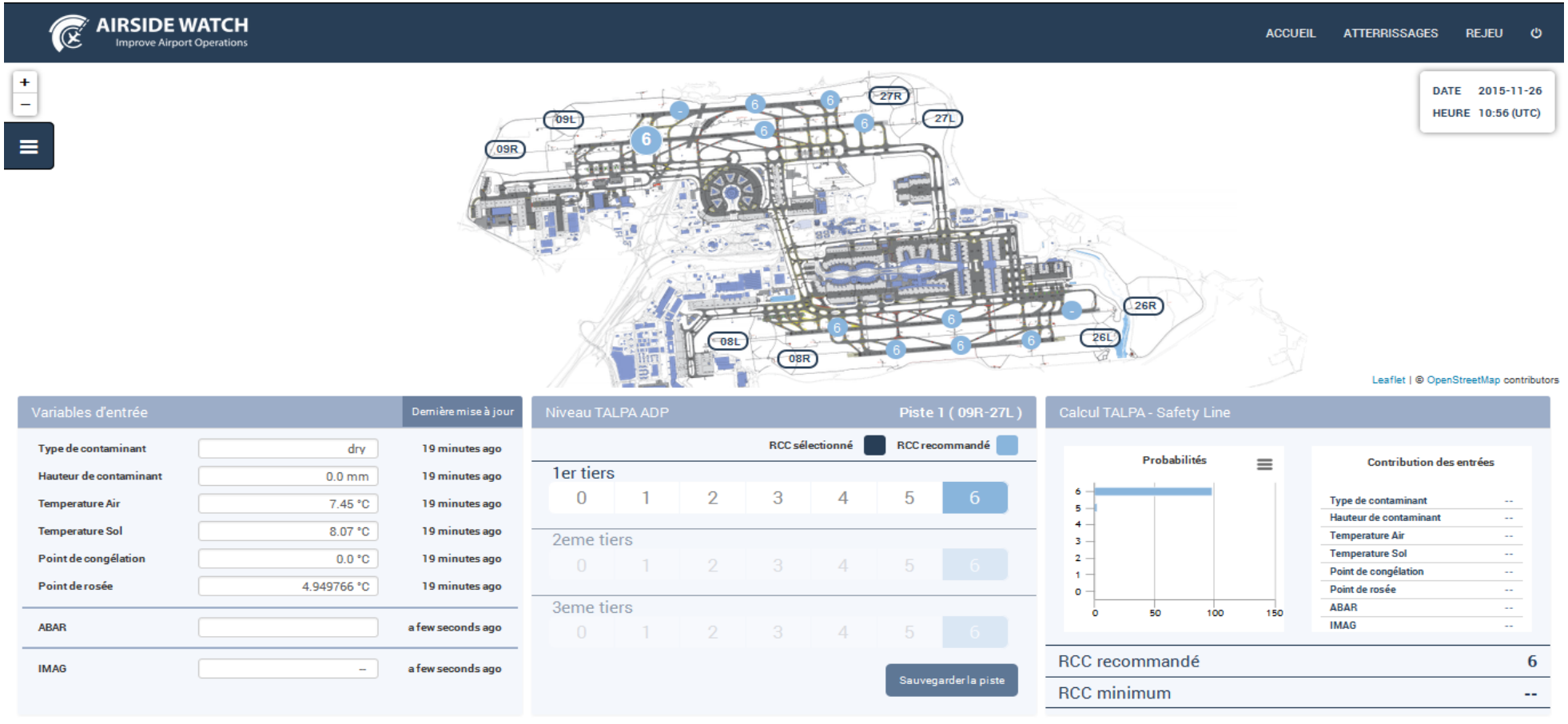
For each RCC, the percentage of observations with a good classification is computed (method of cross validation type « leave-one-out »)

1) Model with 4 parameters « varRCC »

RCC	6	5	4	3	2	1	0	Total
% good category	100	100	0	71	NA	0	NA	**95**

2) Model with 4 parameters « varRCC » + runway friction

RCC	6	5	4	3	2	1	0	Total
% good category	100	99	0	67	NA	0	NA	**95**

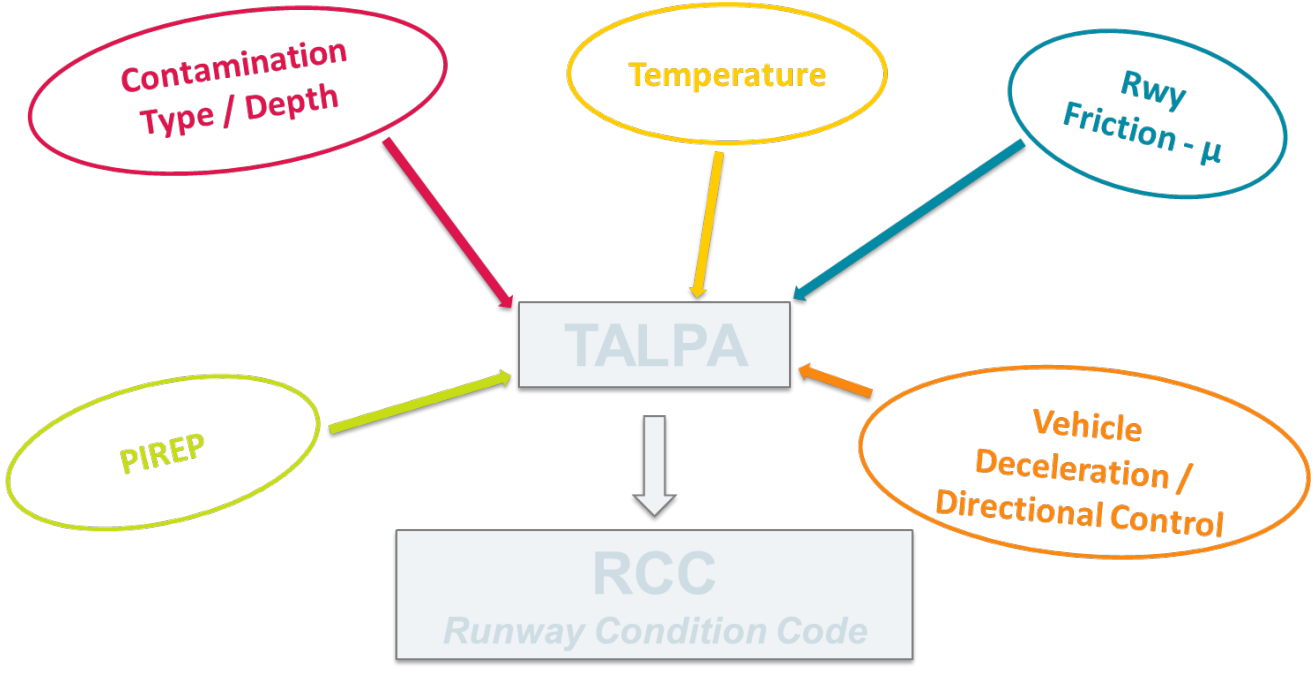

AIRSIDE WATCH
Improve Airport Operations
ACCUEIL
ATTERRISSAGES
REJEU
DATE 2015-11-26
HEURE 10:56 (UTC)
09L
09R
27R
27L
26R
26L
08L
08R
Leaflet | © OpenStreetMap contributors
Variables d'entrée
Dernière mise à jour
Type de contaminant dry 19 minutes ago
Hauteur de contaminant 0.0 mm 19 minutes ago
Temperature Air 7.45 °C 19 minutes ago
Temperature Sol 8.07 °C 19 minutes ago
Point de congélation 0.0 °C 19 minutes ago
Point de rosée 4.949766 °C 19 minutes ago
ABAR a few seconds ago
IMAG – a few seconds ago
Niveau TALPA ADP
Piste 1 (09R-27L)
RCC sélectionné
RCC recommandé
1er tiers
2eme tiers
3eme tiers
0 1 2 3 4 5 6
Sauvegarder la piste
Calcul TALPA - Safety Line
Probabilités
Contribution des entrées
Type de contaminant --
Hauteur de contaminant --
Temperature Air --
Temperature Sol --
Point de congélation --
Point de rosée --
ABAR --
IMAG --
RCC recommandé 6
RCC minimum --

2.

The global approach
A-ABAR Project

A-ABAR : Advanced - Automated Braking Action Report

2.1.



About acquiring data from other stakeholders

Adding data from other stakeholders

Aerodrom Operator

AÉROPORTS DE PARIS

- Inherent runway surface conditions
- Runway Contamination : nature, depth, coverage
- Runway Friction Coefficient
- Weather data
- Air and Ground temperature
- Radar data

On board system

AIRBUS

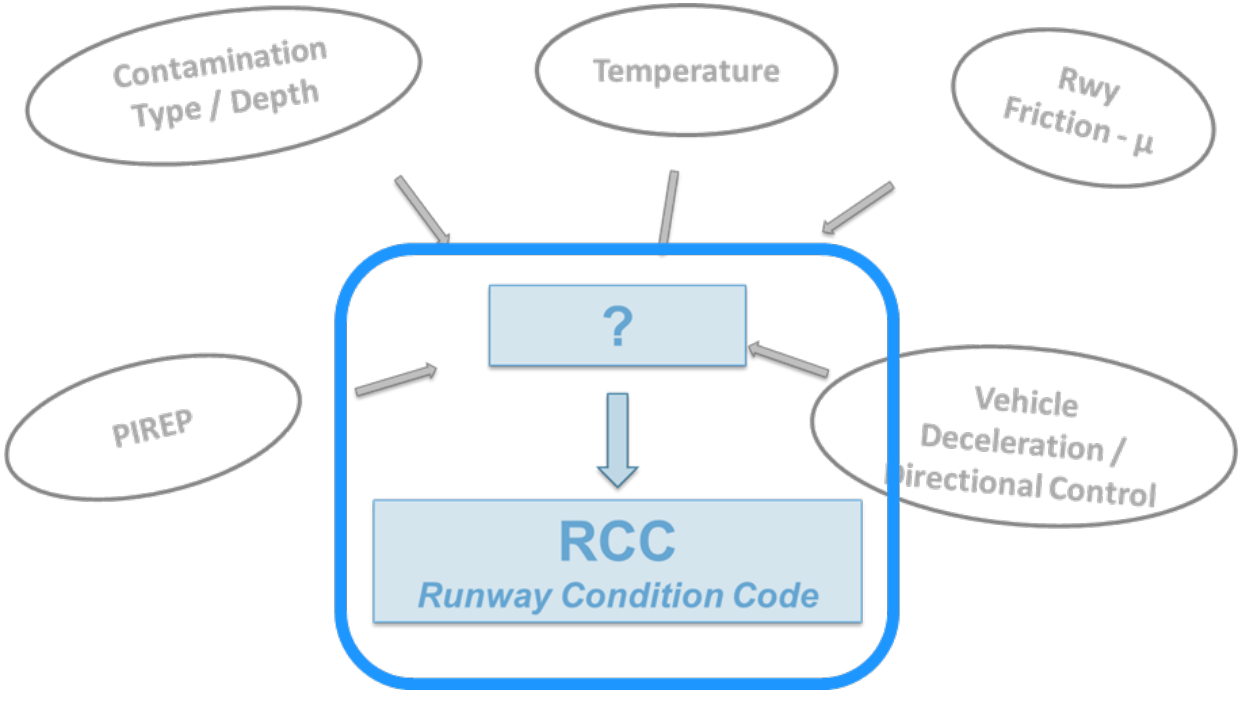
- Braking Action identified from Braking Data :
  - engine settings
  - aircraft weight
  - aerodynamic braking
  - speed
  - deceleration
  - directional control
  - antiskid activation

ANSP

dgac DSNA

- PIREP
- Radar plots

2.2.



About putting all these data together to get a runway condition assessment

A-ABAR

A-ABAR Operational Concept : Intermediate Vision

Using output of each system

Aerodrome Operator

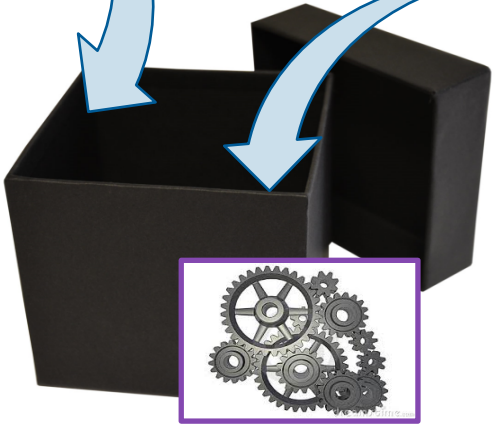
- Inherent runway surface conditions
- Runway Contamination : nature, depth, coverage
- Runway Friction Coefficient
- Weather data
- Air and Ground temperature
- Radar data

CORSAIR
(Airbus)

On-board system

- Braking action identified from braking data

B-ABAR



A-ABAR

ANSP

- PIREP
- Radar plots

SESAR 2020
PJ03 : Airport Safety Nets