P4 – Total System Risk Assessment

Wilfred Rouwhorst (NLR) and project partners

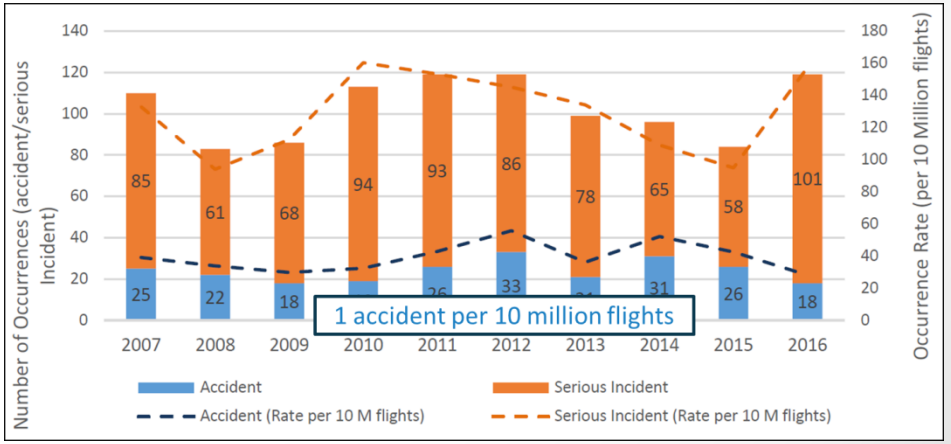
P4 - partners

1. Stichting Nationaal Lucht- en Ruimtevaartlaboratorium (**NLR**)
2. Office National d'Études et de Recherches Aérospatiales (**ONERA**)
3. Centro para a Excelência e Inovação na Indústria Automóvel (**CEiiA**)
4. Centro Italiano Ricerche Aerospaziali (**CIRA**)
5. Instituto Nacional de Técnica Aeroespacial (**INTA**)
6. European Organisation for the Safety of Air Navigation (**EUROCONTROL**)
7. Civil Aviation Authority (**CAA UK**)
8. NAVBLEU (**NavBlue**)
9. Airbus SAS (**AI-SAS**)
10. Airbus Operations SAS (**AI-F**)
11. Thales AVS France SAS (**TAV**)
12. Thales LAS France SAS (**TR6**)
13. Technische Universität München (**TUM**)
14. Deutsche Lufthansa Aktiengesellschaft (**DLH**)
15. Koninklijke Luchtvaartmaatschappij (**KLM**)

Objectives

- Develop **a prototype Risk Observatory (RO)** as an enabling tool for safety management

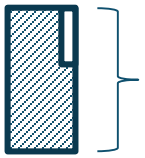
- Develop a **Risk Assessment Framework** that **integrates Risk Assessment Models** specifically developed to represent a certain domain



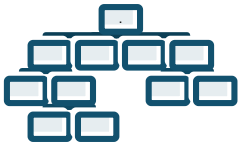
WP4.1

Risk observatory requirements

WP4.2

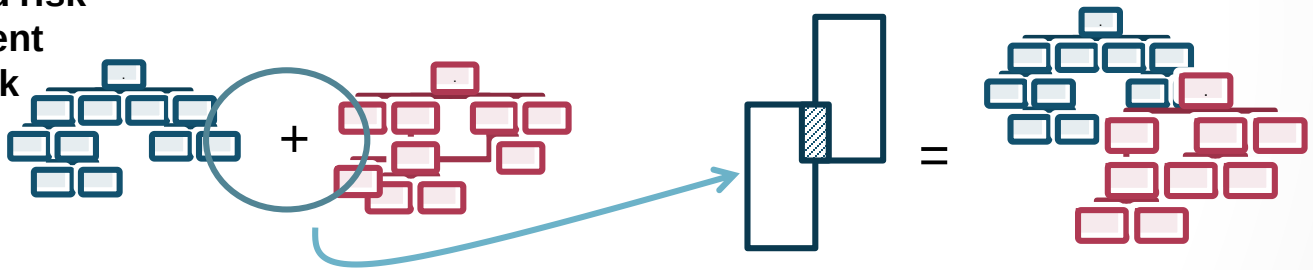


Risk assessment within domains



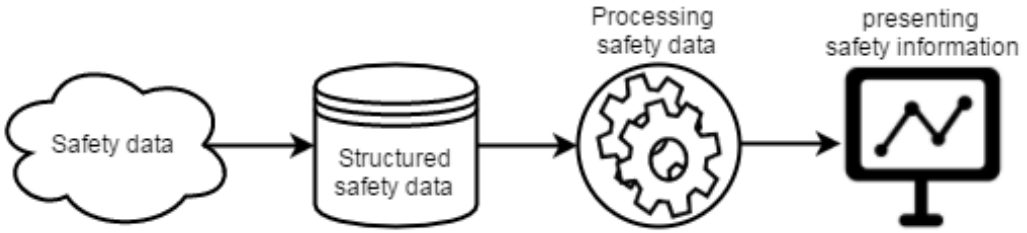
WP4.3

Integrated risk assessment framework

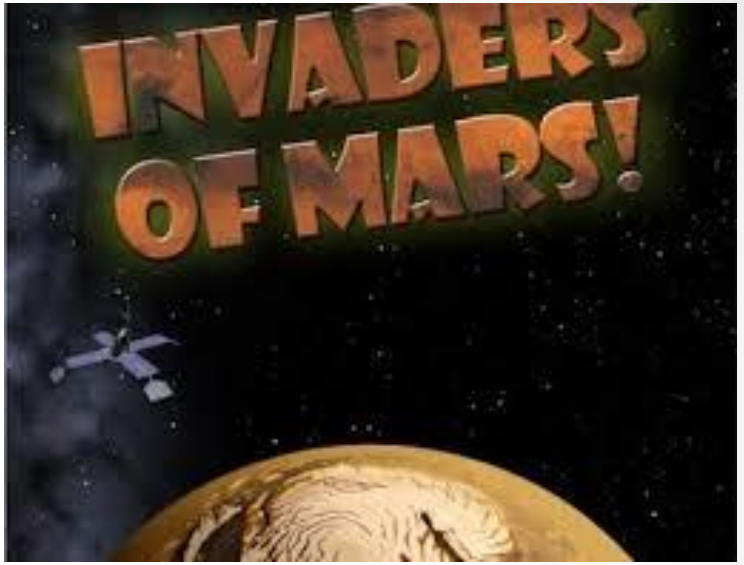


WP4.4

Prototype Risk Observatory



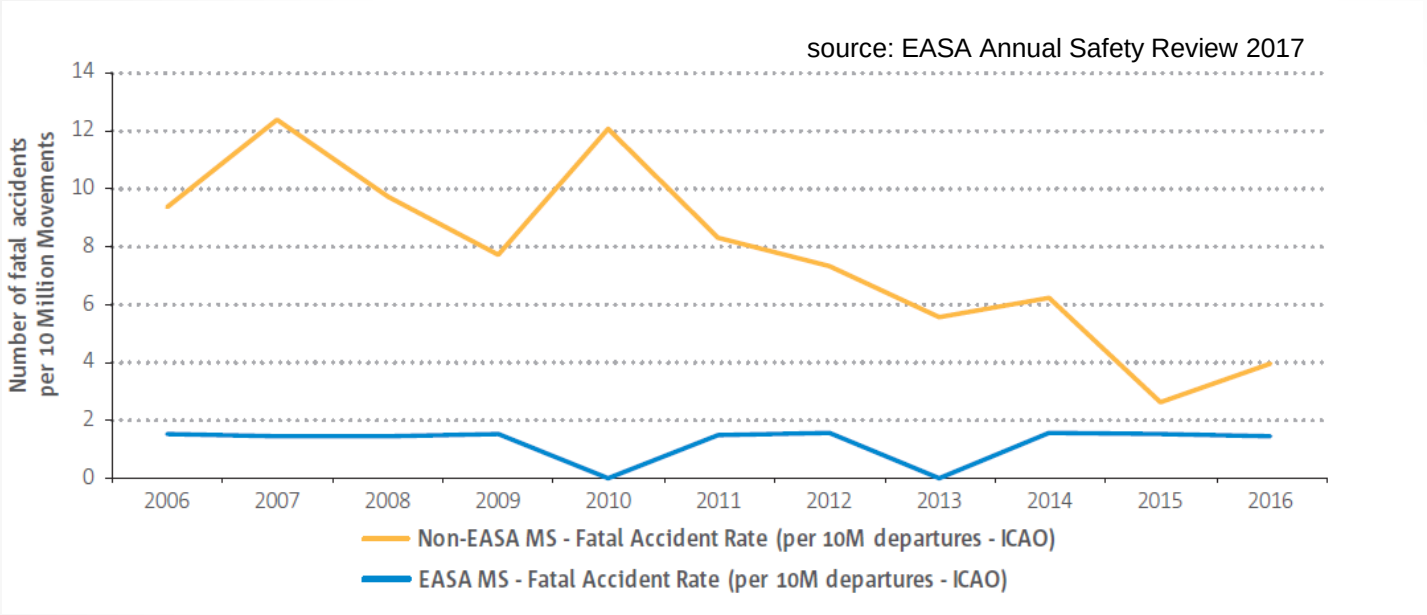
What is a Risk Observatory?



An enabling tool for Safety Management

Why do we want a Risk Observatory?

source: EASA Annual Safety Review 2017



FlightPath 2050 goal: The European ATS has **less than one accident per ten million** commercial aircraft flights

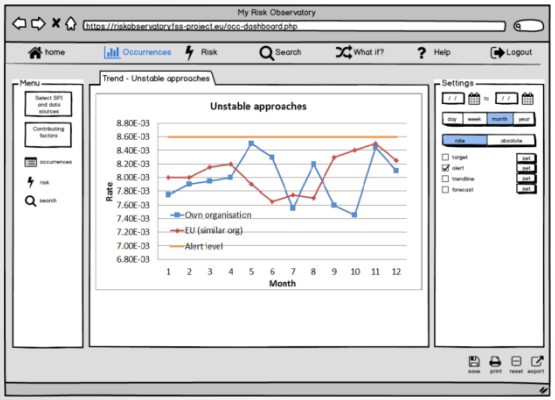
Aim is to reduce the number of accidents by 80% compared to 2000 taking into account increasing traffic volumes (doubling ~ each 15 years)

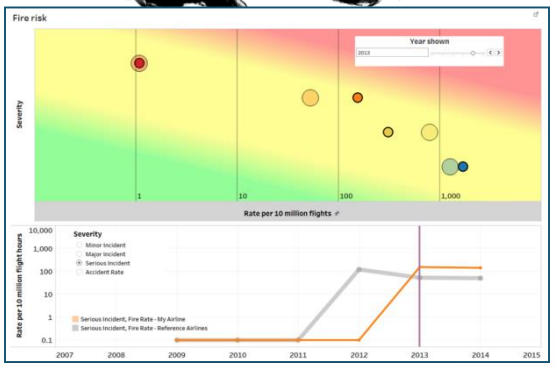
Why stakeholders want a Risk Observatory

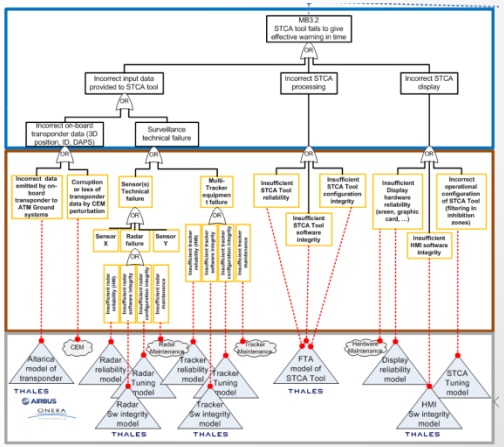
"What is normal performance?"

"We would like to prioritise hazards"

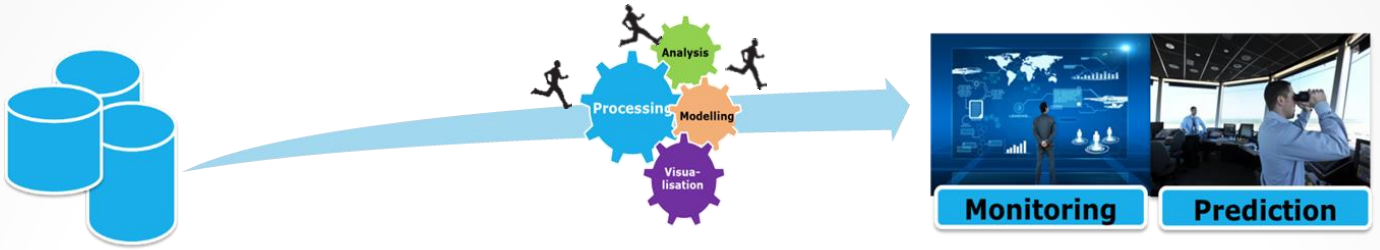
"Ensure interfaces are working together effectively"



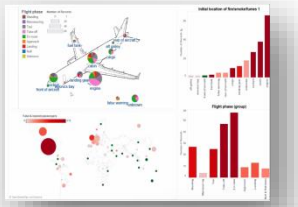




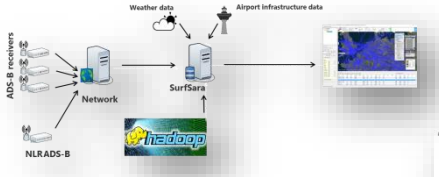
Combining Data Sources

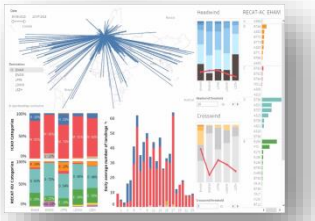


Trusted Data | Techniques | Applications/Information

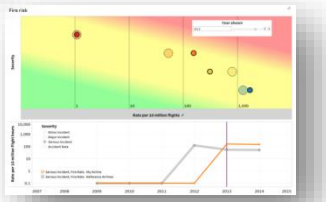


Occurrence data

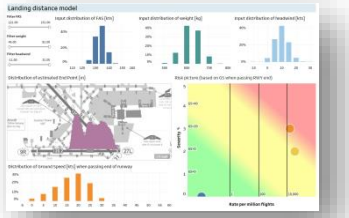




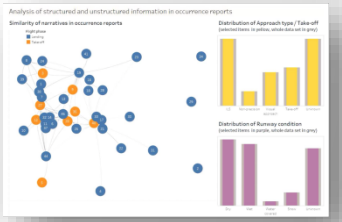
Exposure data



Risk modelling



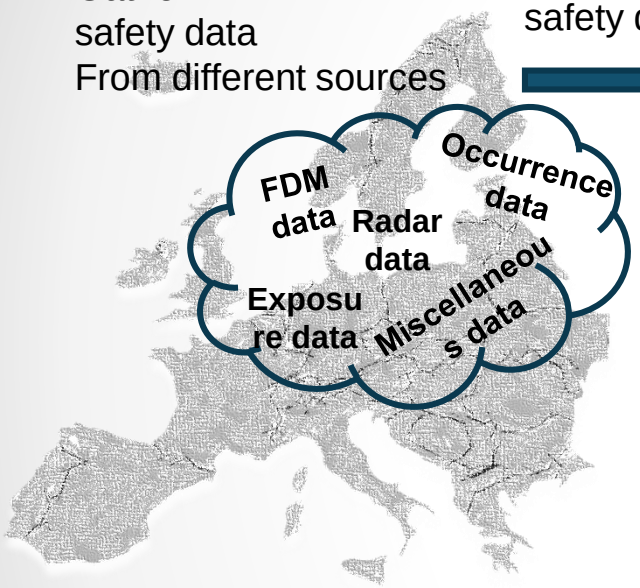
Prediction



Text/Data mining

Introducing the Risk Observatory

Gather
safety data
From different sources



Structuring of
safety data

FDM data
Occurrence data
Exposure data
....

Feed into integrated
risk assessment
framework (models)

Acquire
safety information

User:
Analyst
Manager

Domain:
Operator
ANSP
Manufacturer
Airport
Authority

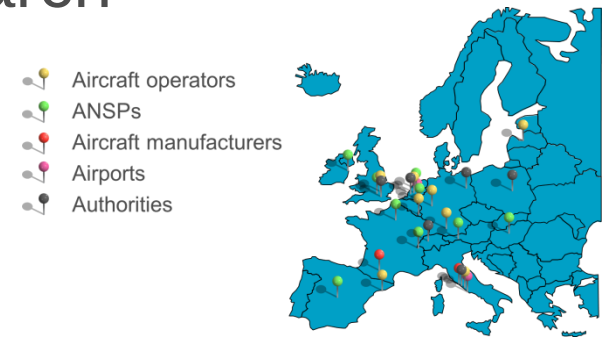
Acquire
safety information

The risk observatory will acquire, fuse and structure safety data and translate it to actionable safety intelligence

Approach to reach objectives (1/2)

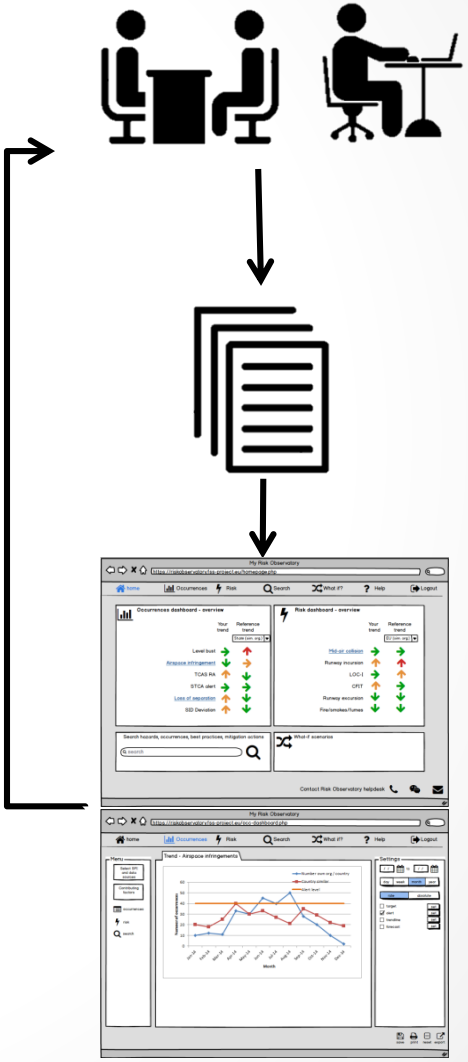
1. Stakeholder Consultation and desktop research

Domain	Interviews
Aircraft operators	12
ANSPs	10
Authorities	7
Aircraft manufacturers	2
Airports	4



2. Drafted requirements

3. Translated requirements into an “early look and feel” RO prototype



Approach to reach objectives (2/2)

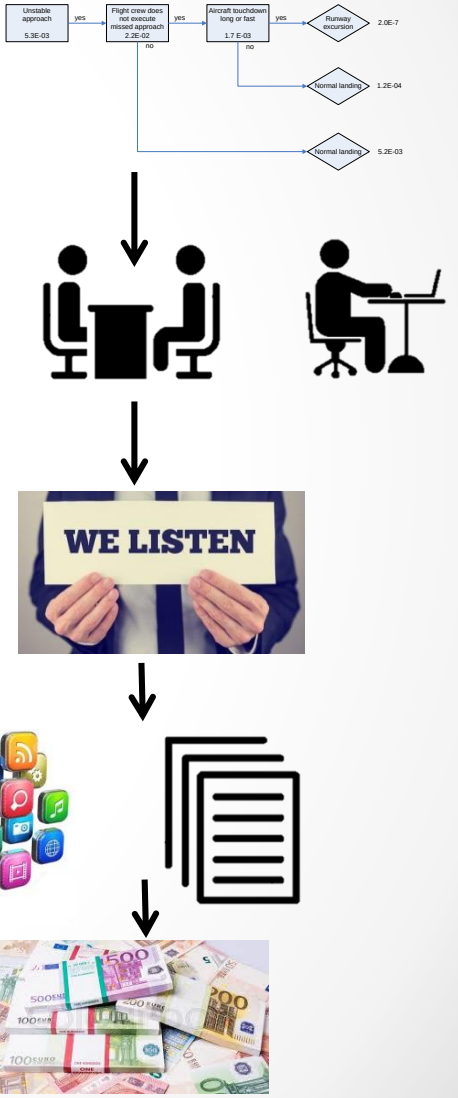
4. Improve RO prototypes
   - Backbone models (RE, MAC, ...)
   - Back end interfaces
   - FDM data
   - Other (specific user) data

5. Technical Verification & Validation of RO prototype
   - Model / Risk outcomes/trends
   - Requirements

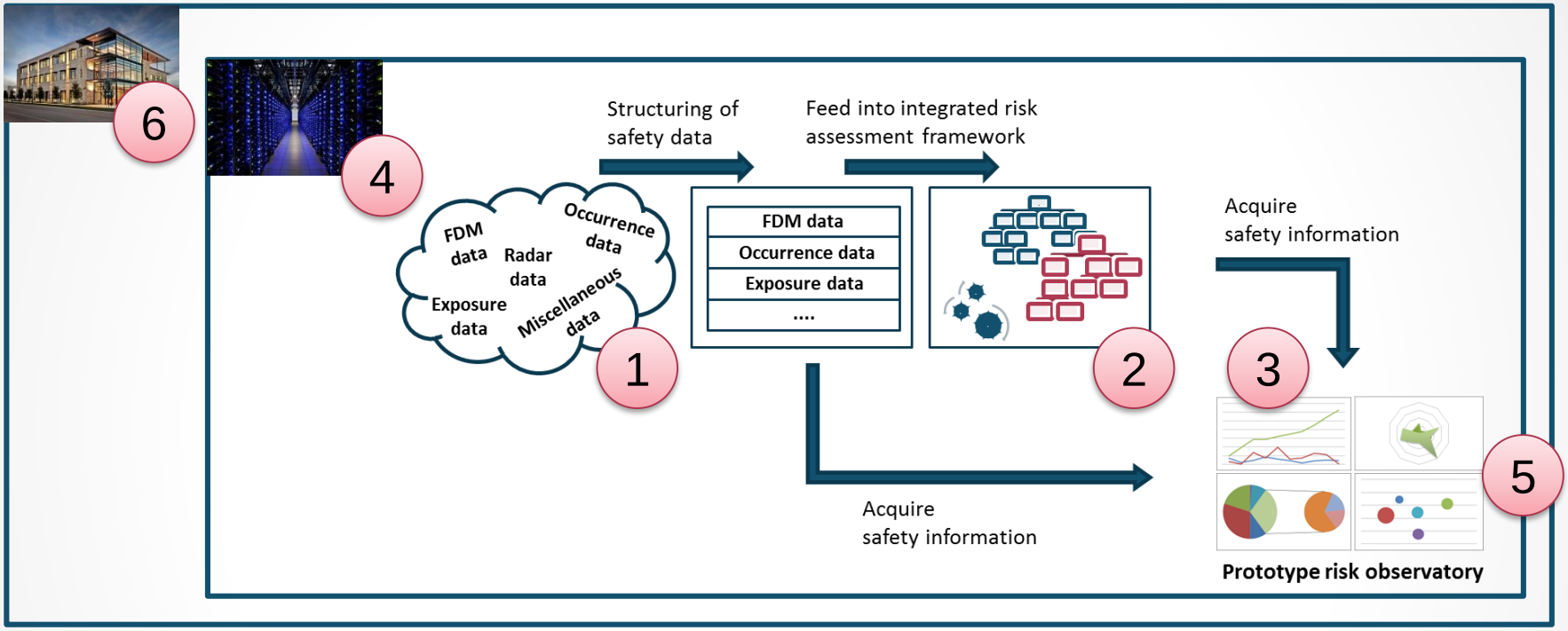
6. User/Stakeholder feedback trials on RO prototypes (Exploitation Actions 2x): with KLM & with Airbus, + potentially others ...

7. Prototype RO s/w & User Manuals update

8. Business Model development

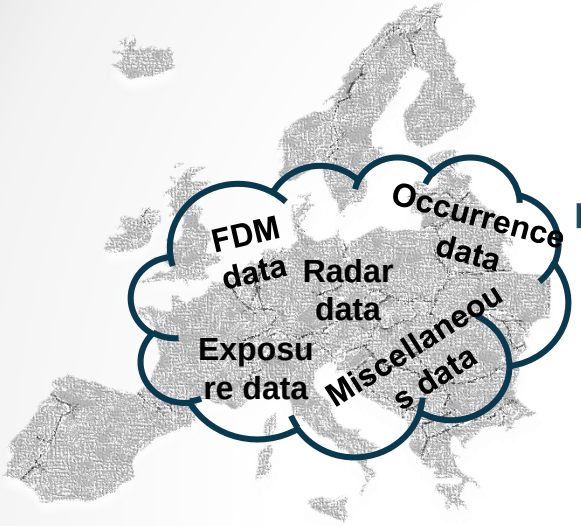


Achievements till Today



1. Research and acquisition of data
2. Model developments
3. Total Aviation System Risk Picture 2016 & 2017
4. Functional design of the Risk Observatory
5. Framework+Prototype development of RO (incl. MAC, RE models & FDM)
6. Preliminary Business Model

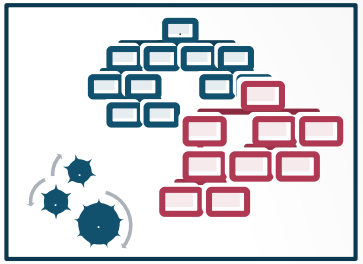
From data to information



Structuring of safety data

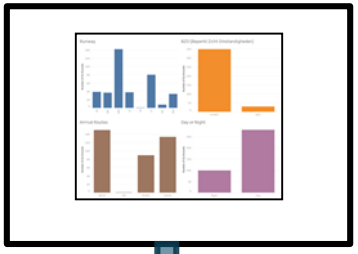
- FDM data
- Occurrence data
- Exposure data
- Weather data etc.

Feed into integrated risk assessment framework

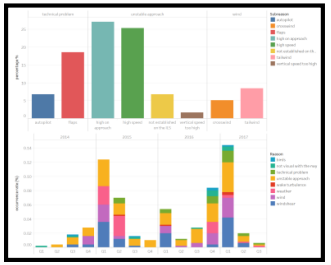


Acquire safety information

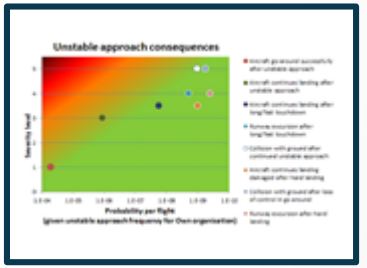
Occurence Dashboard



Occurence Drill Down Dashboard



Risk Dashboard

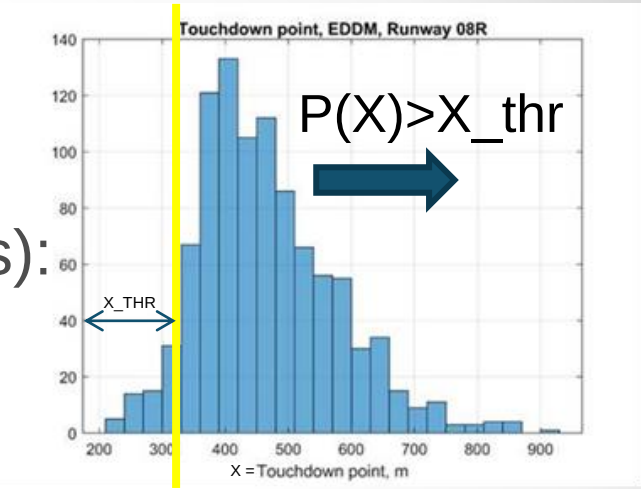


Acquisition of Data

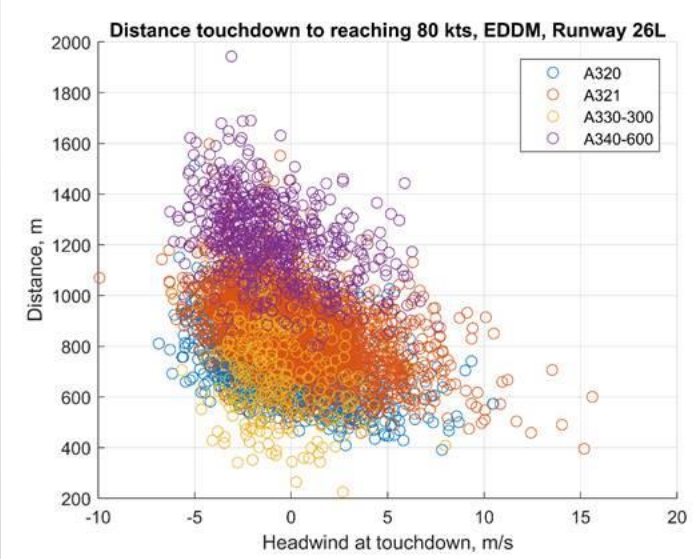
- First set of FDM data processed & interfaced

On RE's Safety Performance Indicators (SPIs):

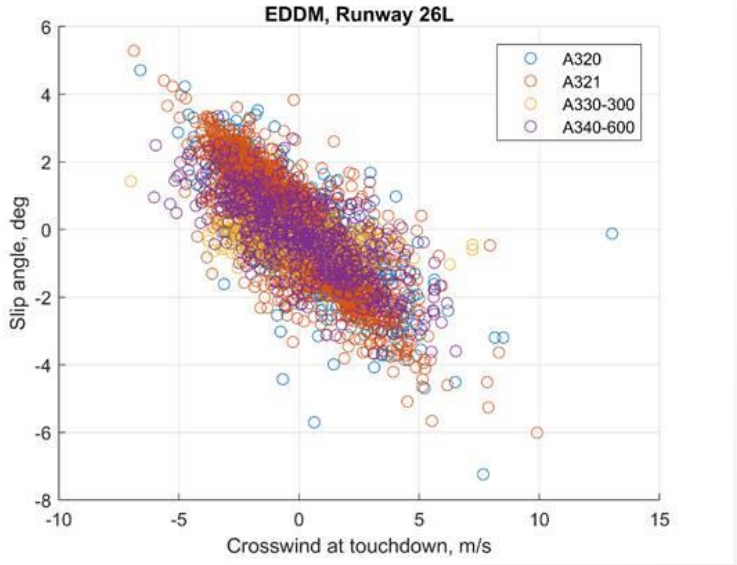
- Short, Hard and Long Landings



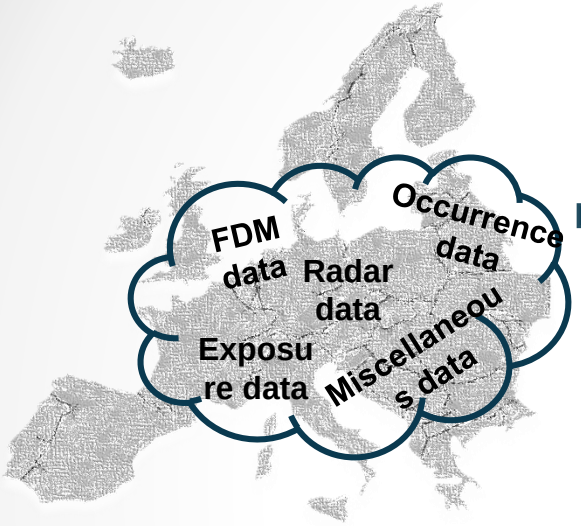
investigation runway overruns (RE's)



investigating runway veer-offs



From data to information



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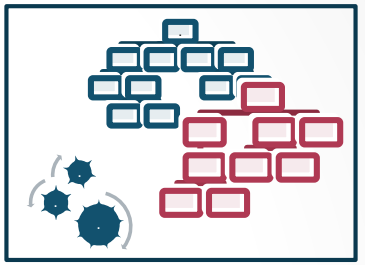
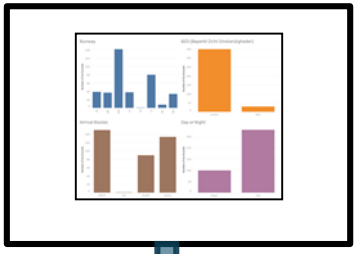
Feed into integrated risk assessment framework

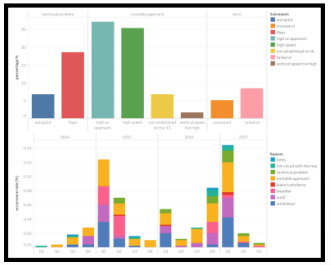


Acquire safety information

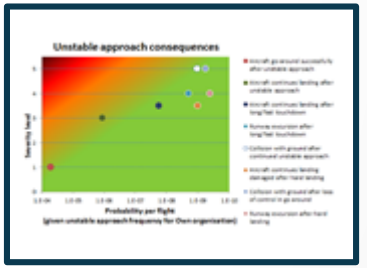
Occurence Dashboard



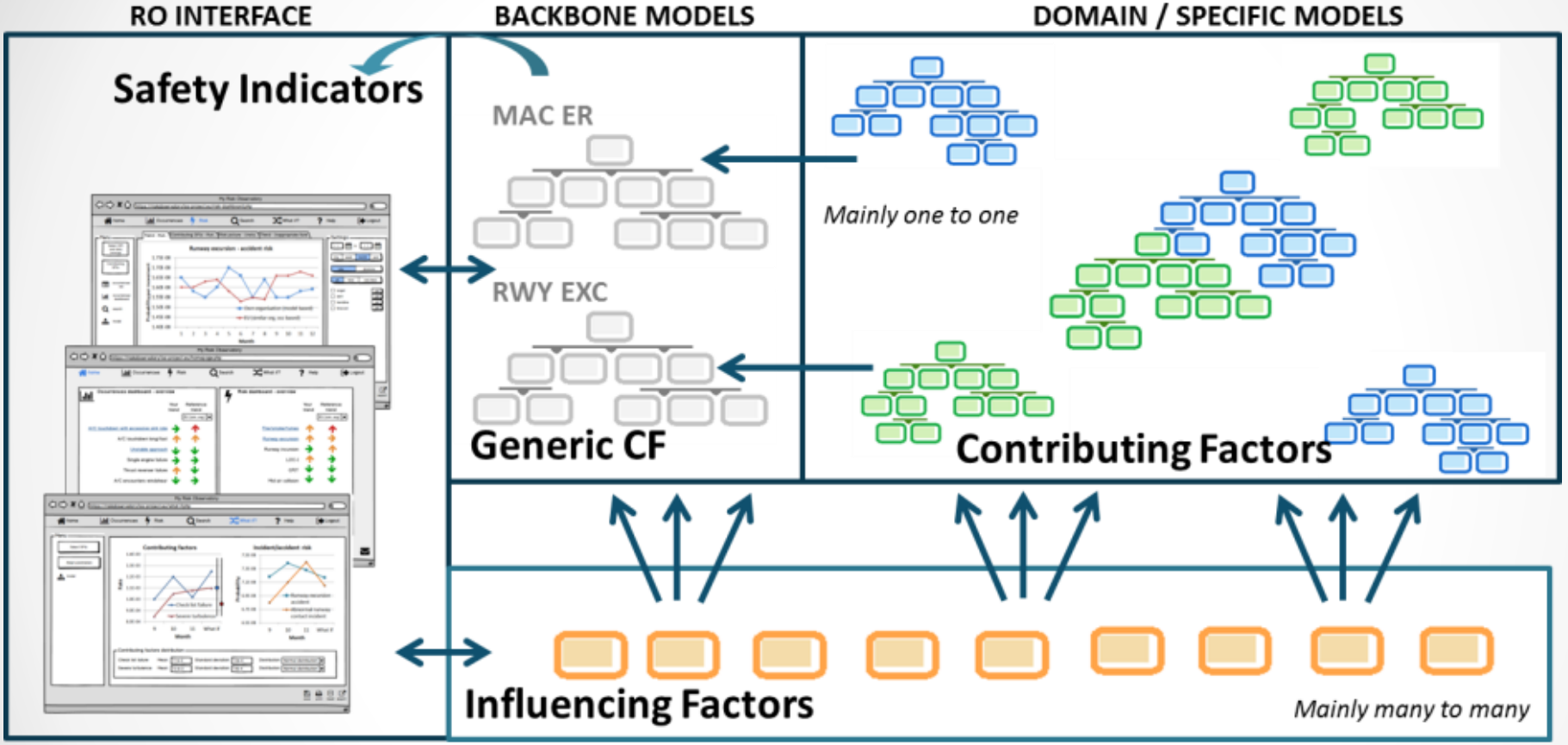
Occurence Drill Down Dashboard



Risk Dashboard



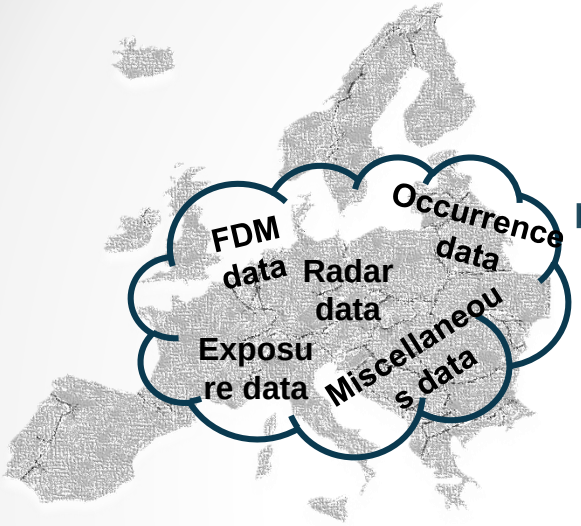
RO Developments: Models & Interfaces



- Runway Excursion (RE) model
- Mid Air Collision (MAC) model
- Loss Off Control In-flight (LOC-I) model
- Other models, like CFIT

} see backbone model presentation of Pierre Bieber (ONERA)

From data to information



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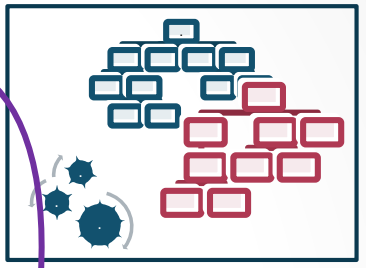
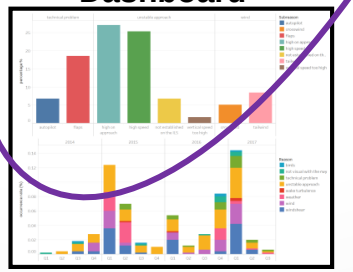
Feed into integrated risk assessment framework



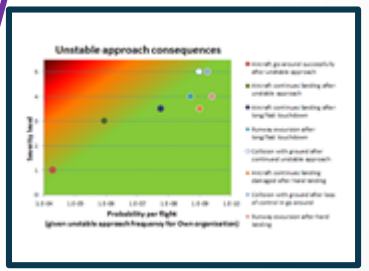
Acquire safety information

Occurence Dashboard

Occurence Drill Down Dashboard



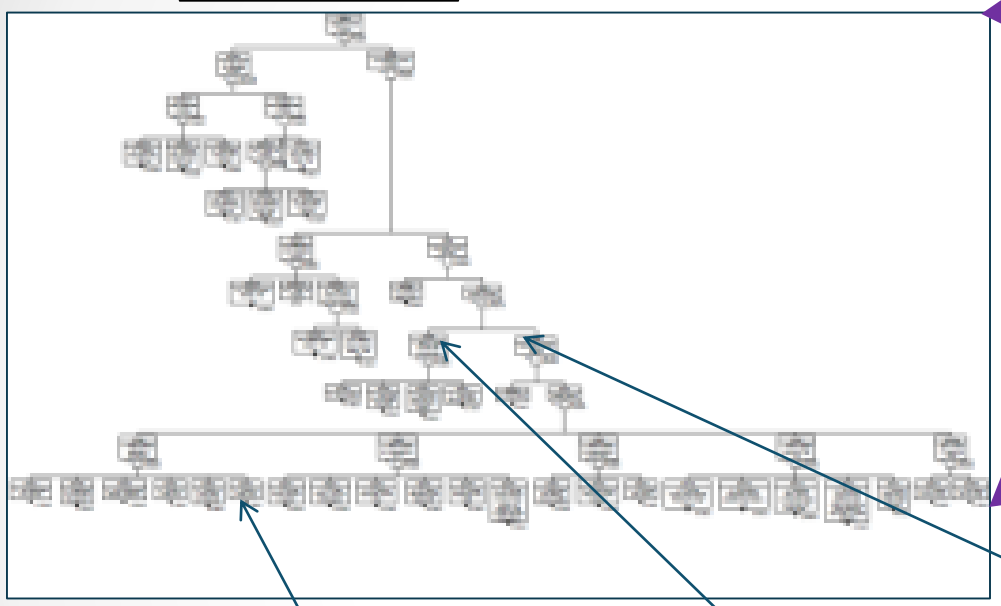
Risk Dashboard

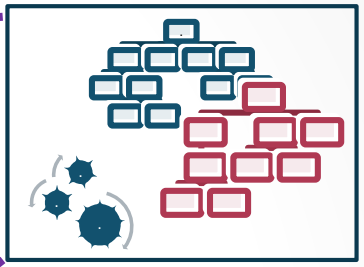


Risk Assessment Framework Example – RE-Model

Feed into integrated risk assessment framework

RE-model



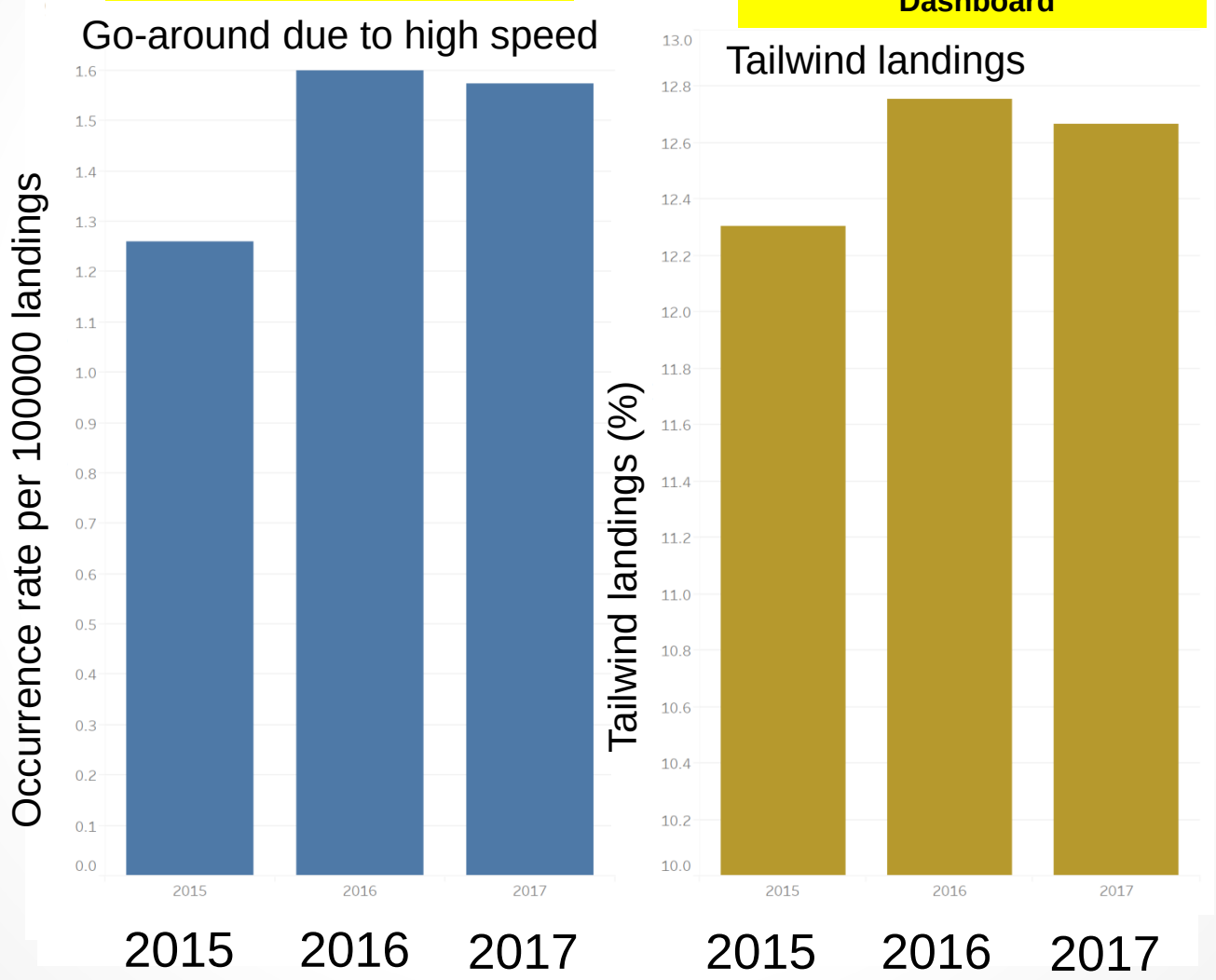


Default values to be checked with own/user data

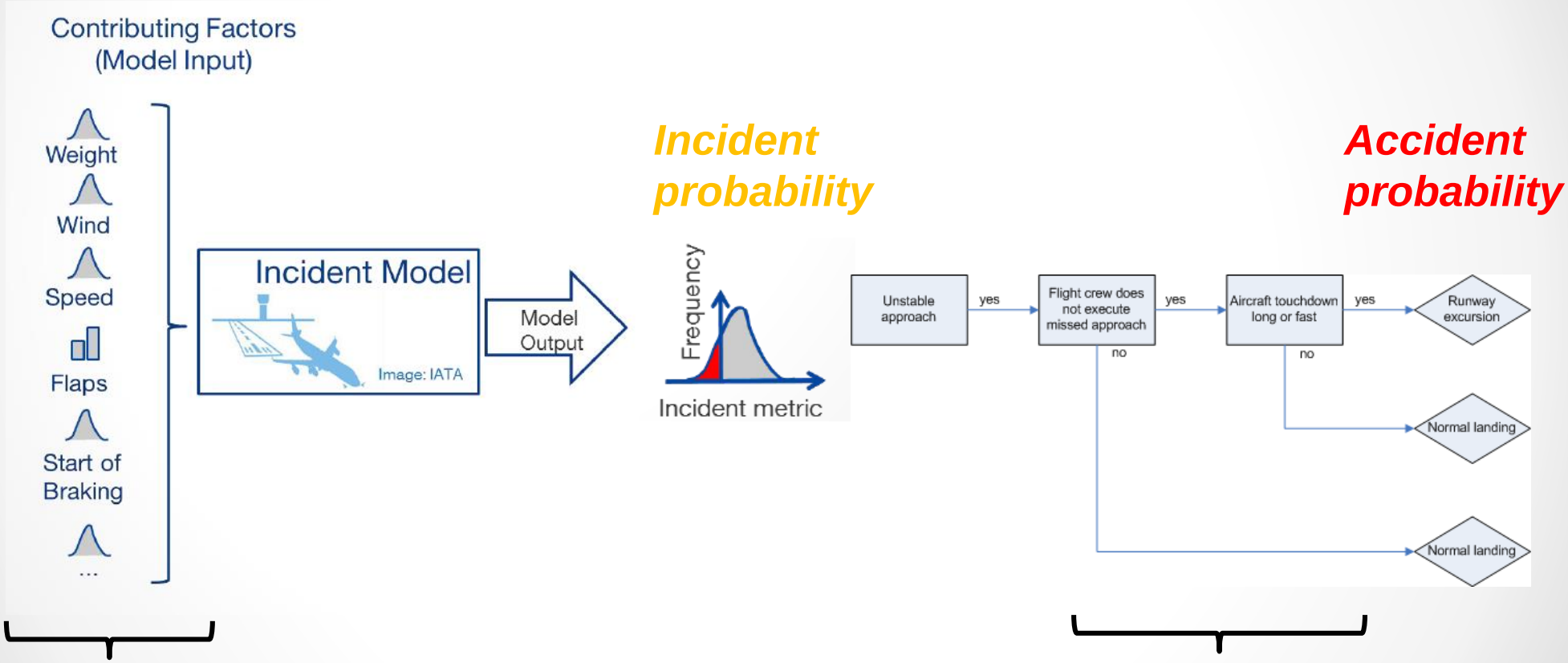
- 4.1 - Excessive or unstable Speeds
- 4.6 – No Go around
- Unstable approach

Example G/A High Speed Occurrence Rate and correlated Influencing Factor

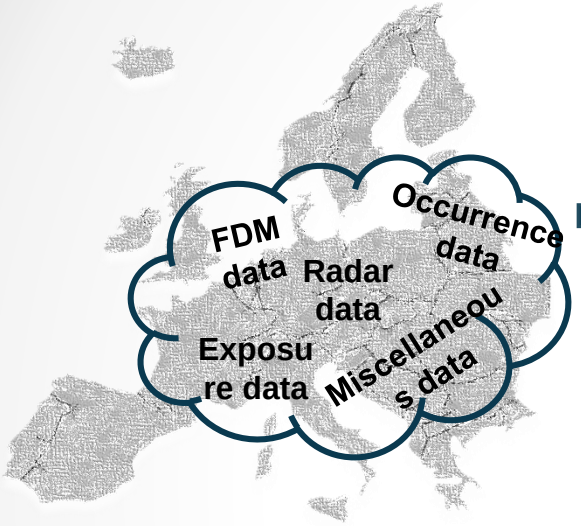
Occurrence Dashboard → **Occurence Drill Down Dashboard**



Combining risk models



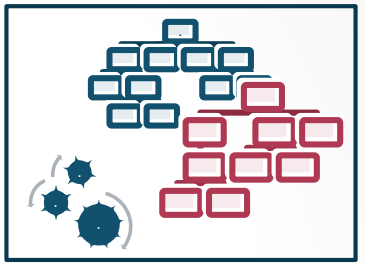
From data to information



Structuring of safety data

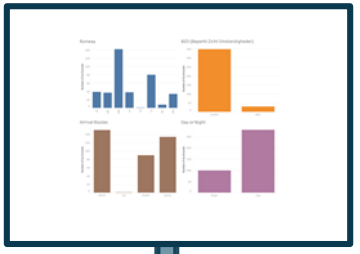
- FDM data
- Occurrence data
- Exposure data
- Weather data etc.

Feed into integrated risk assessment framework

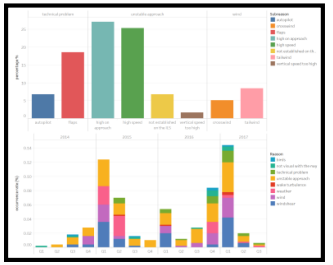


Acquire safety information

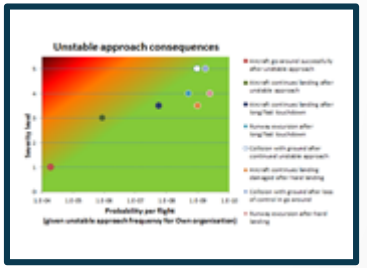
Occurence Dashboard



Occurence Drill Down Dashboard

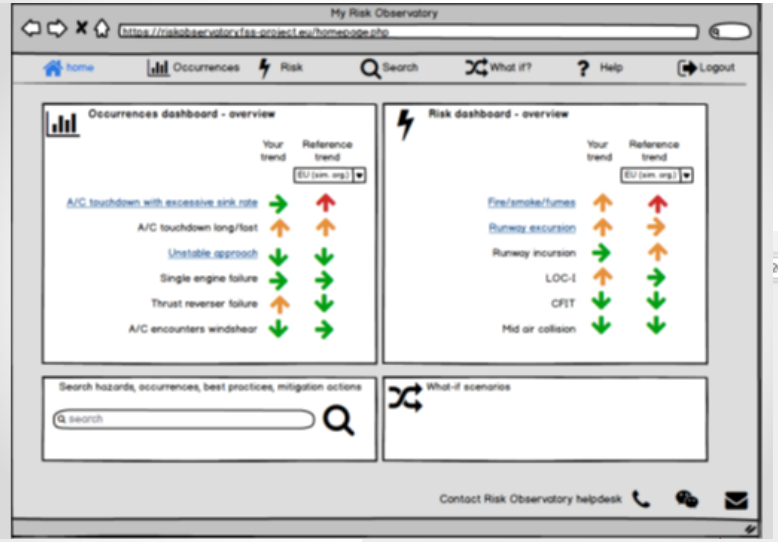


Risk Dashboard



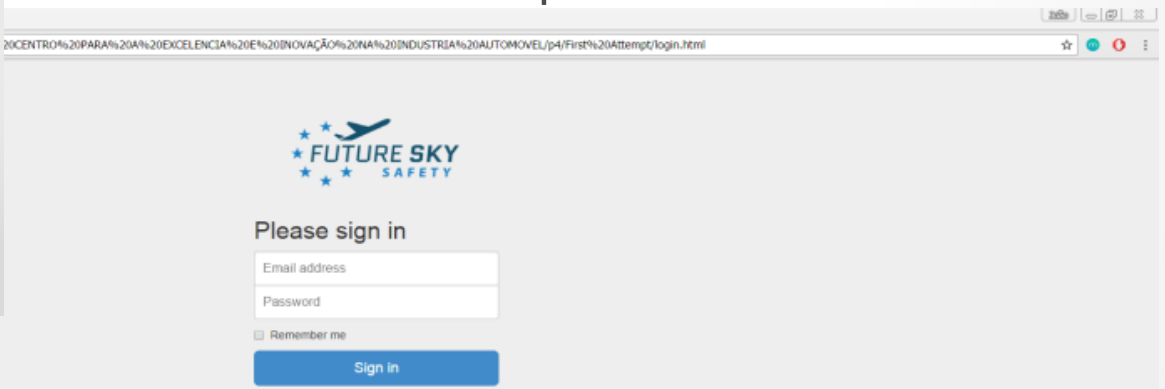
RO prototype 1/

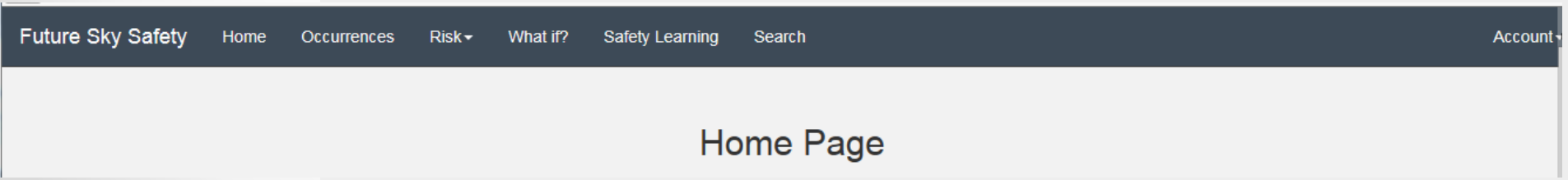
From “early” prototype (HMI front end only, no models behind) to



First prototype :

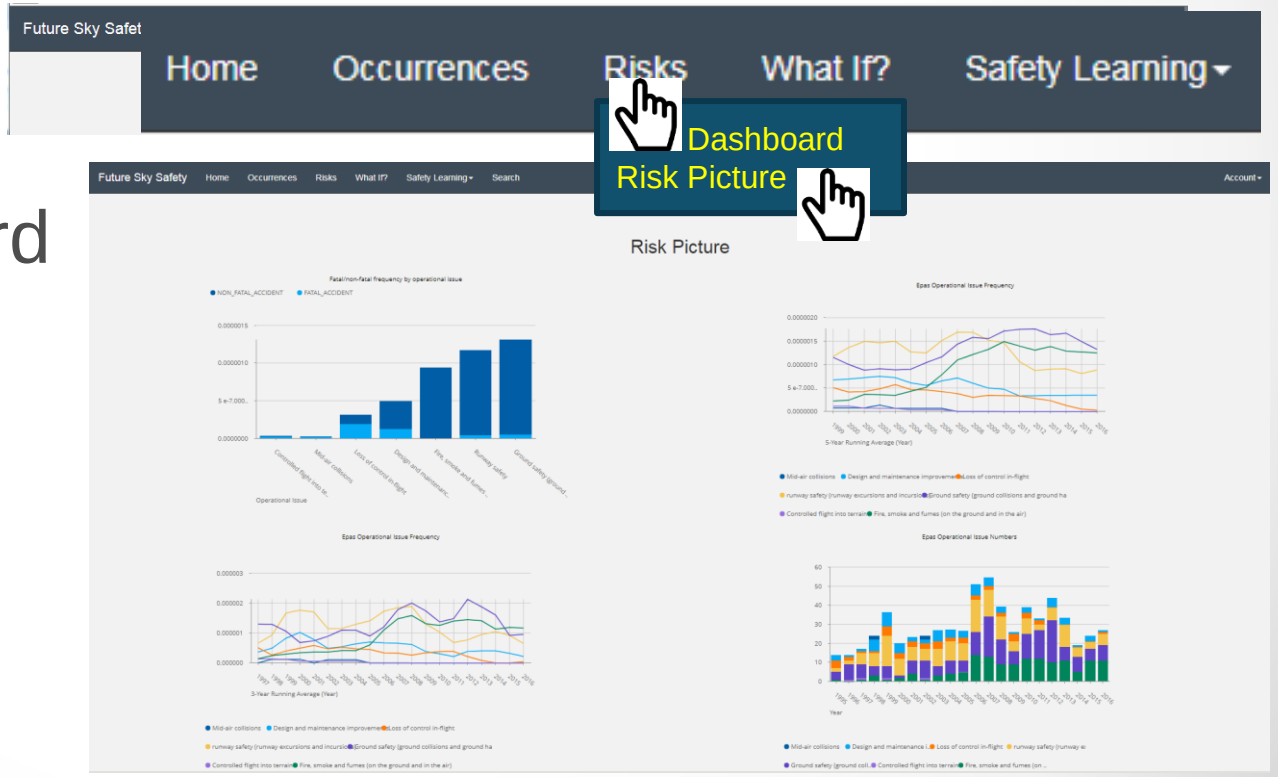
- Risks driven by MAC & RE models and
- Operational data, first SPIs under development
- Available online for partners:





RO prototype 2/

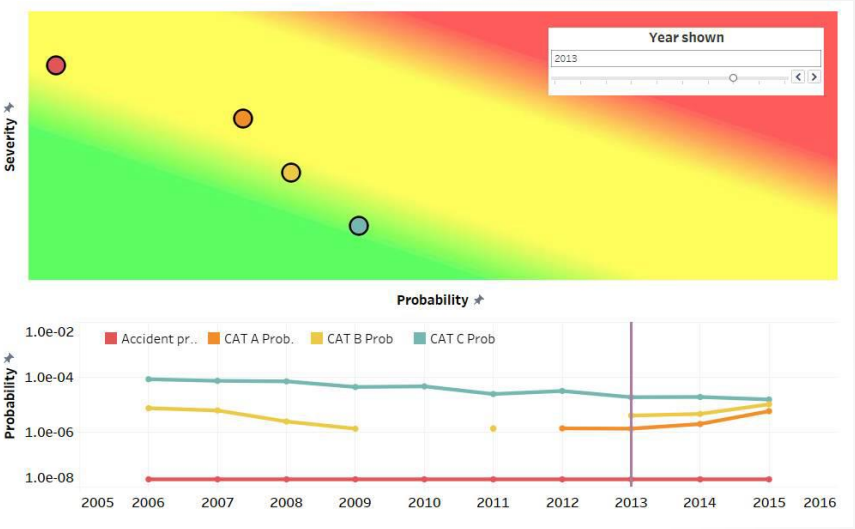
- Available online for partners for Verification & Validation
- Still under Development but intends to allow for:
  - Occurrences dashboard
  - Risks Dashboard
  - What-if-analysis
  - Search Dashboard
  - Learning Centre

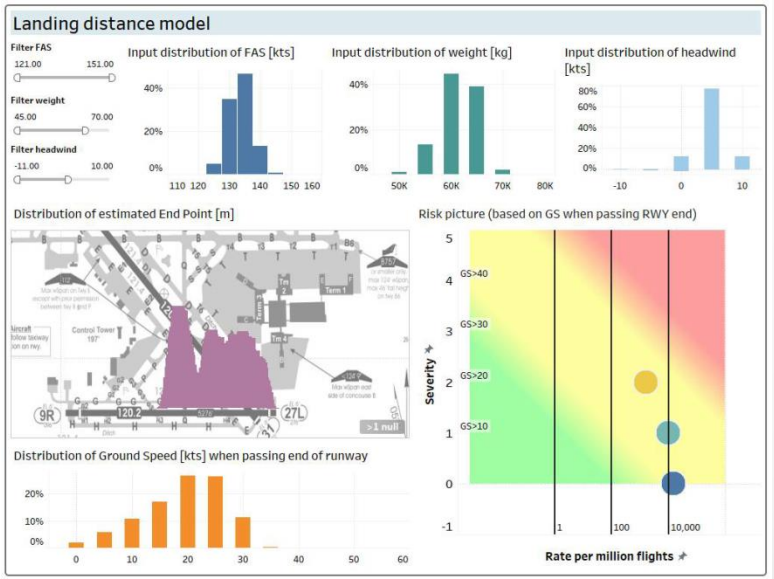


Risk Pictures (RP) 2016 & 2017

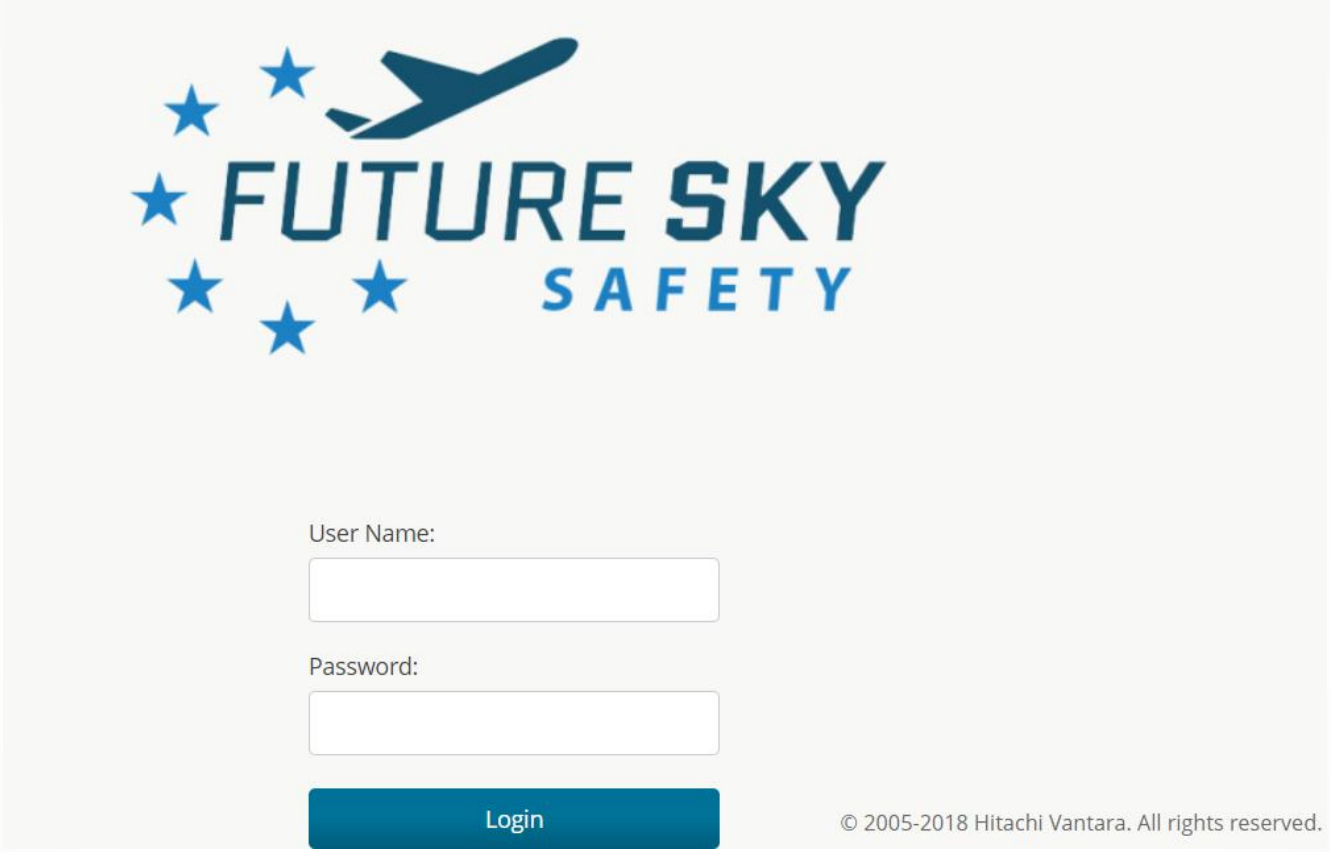
- ***Total Aviation System Risk*** has been defined, composed of
  - Runway Excursions (RE),
  - Mid-Air Collisions (MAC),
  - Controlled Flight into Terrain (CFIT),
  - Loss Of Control In-flight (LOC-I),
  - Runway Incursions (RI),
  - Fire, Smoke & Fumes (FSF)

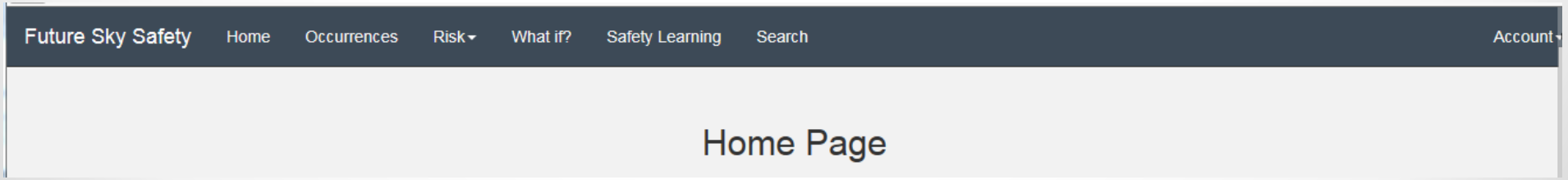
- RP contains *quantified safety performance indicators* that measure the actual progress with respect to main safety issues

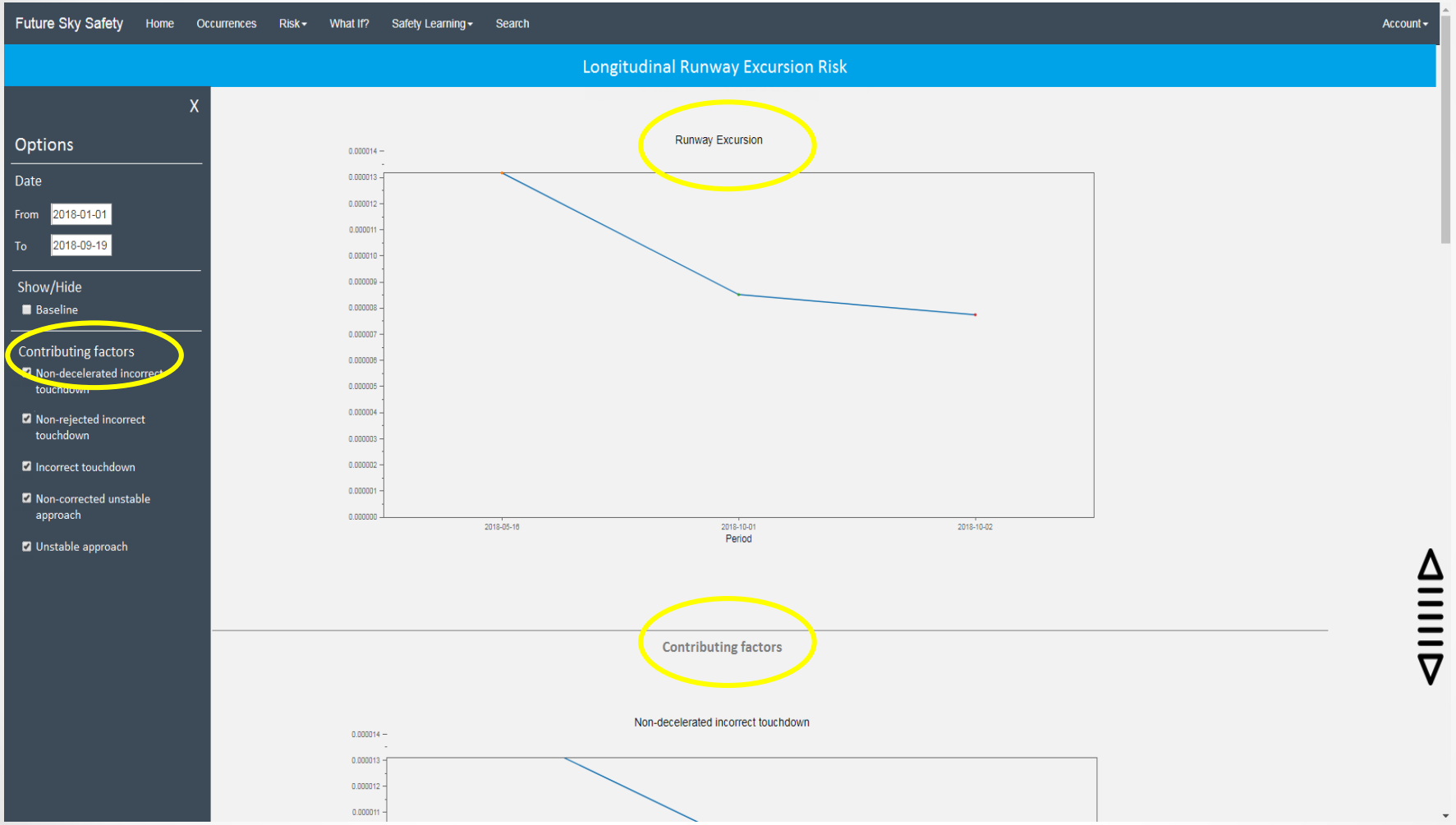




RO prototype “Using it”






Future Sky Safety
Home
Occurrences
Risk
What If?
Safety Learning
Search
Account
Longitudinal Runway Excursion Risk
X
Options
Date
From 2018-01-01
To 2018-09-19
Show/Hide
Baseline
Contributing factors
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Runway Excursion
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2018-05-16
2018-10-01
2018-10-02
Period
Contributing factors
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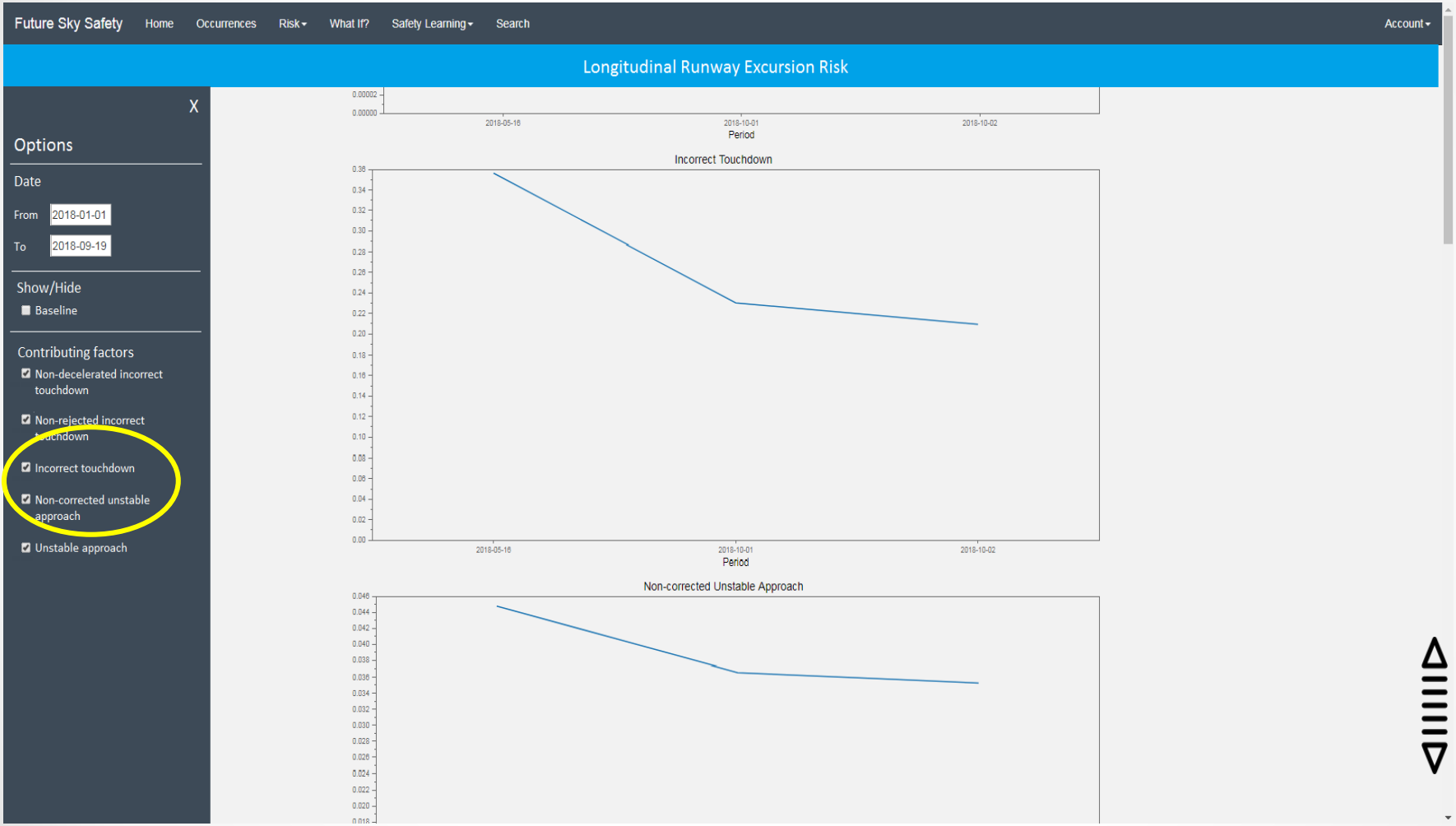
Future Sky Safety
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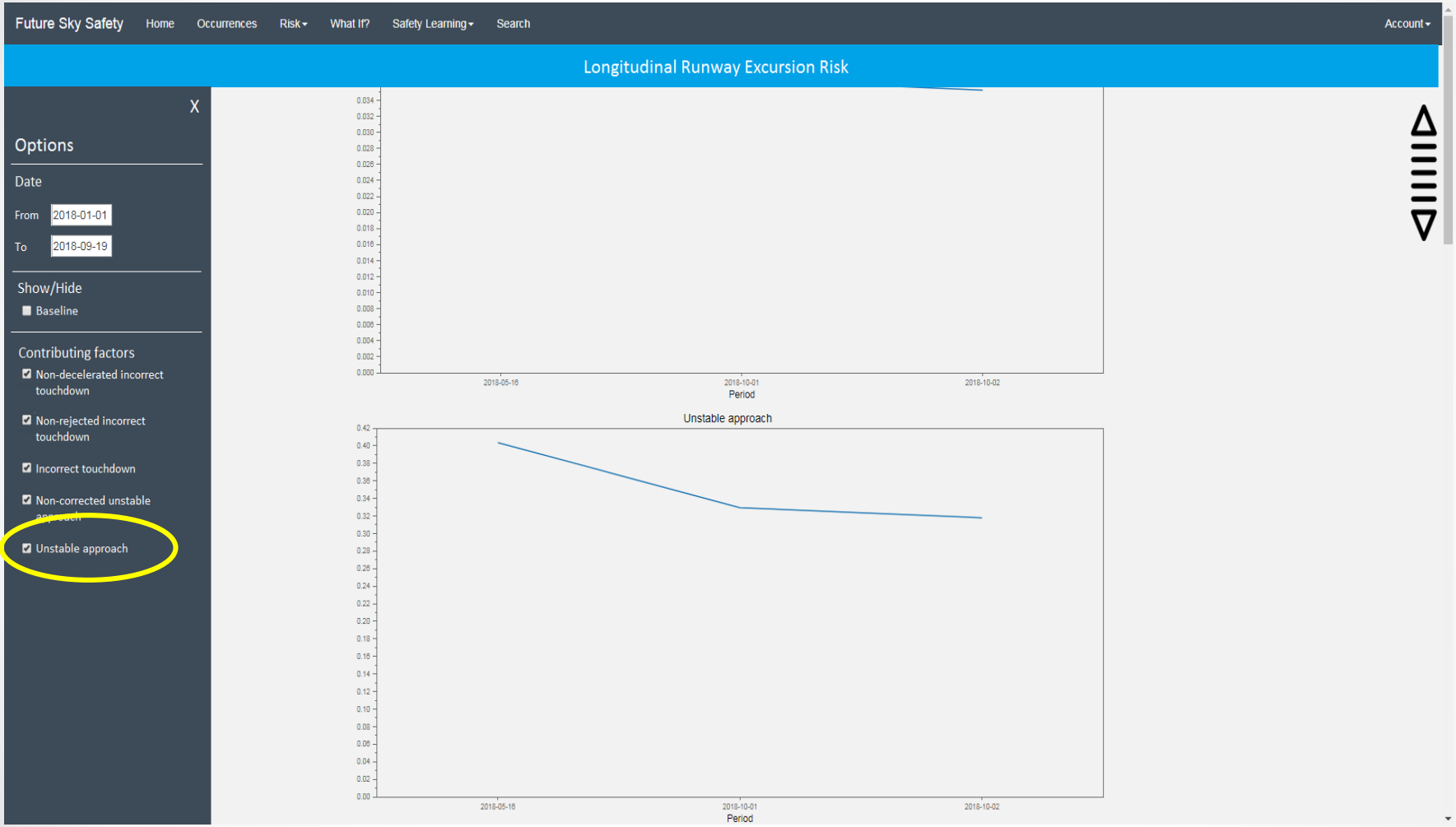
From 2018-01-01
To 2018-09-19
Show/Hide
Baseline
Contributing factors
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Period
Incorrect Touchdown
Period
Non-corrected Unstable Approach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Safety Learning
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Longitudinal Runway Excursion Risk
X
Options
Date
From 2018-01-01
To 2018-09-19
Show/Hide
Baseline
Contributing factors
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable
Unstable approach
0.034
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2018-05-16
2018-10-01
2018-10-02
Period
Unstable approach
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0.40
0.38
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2018-05-16
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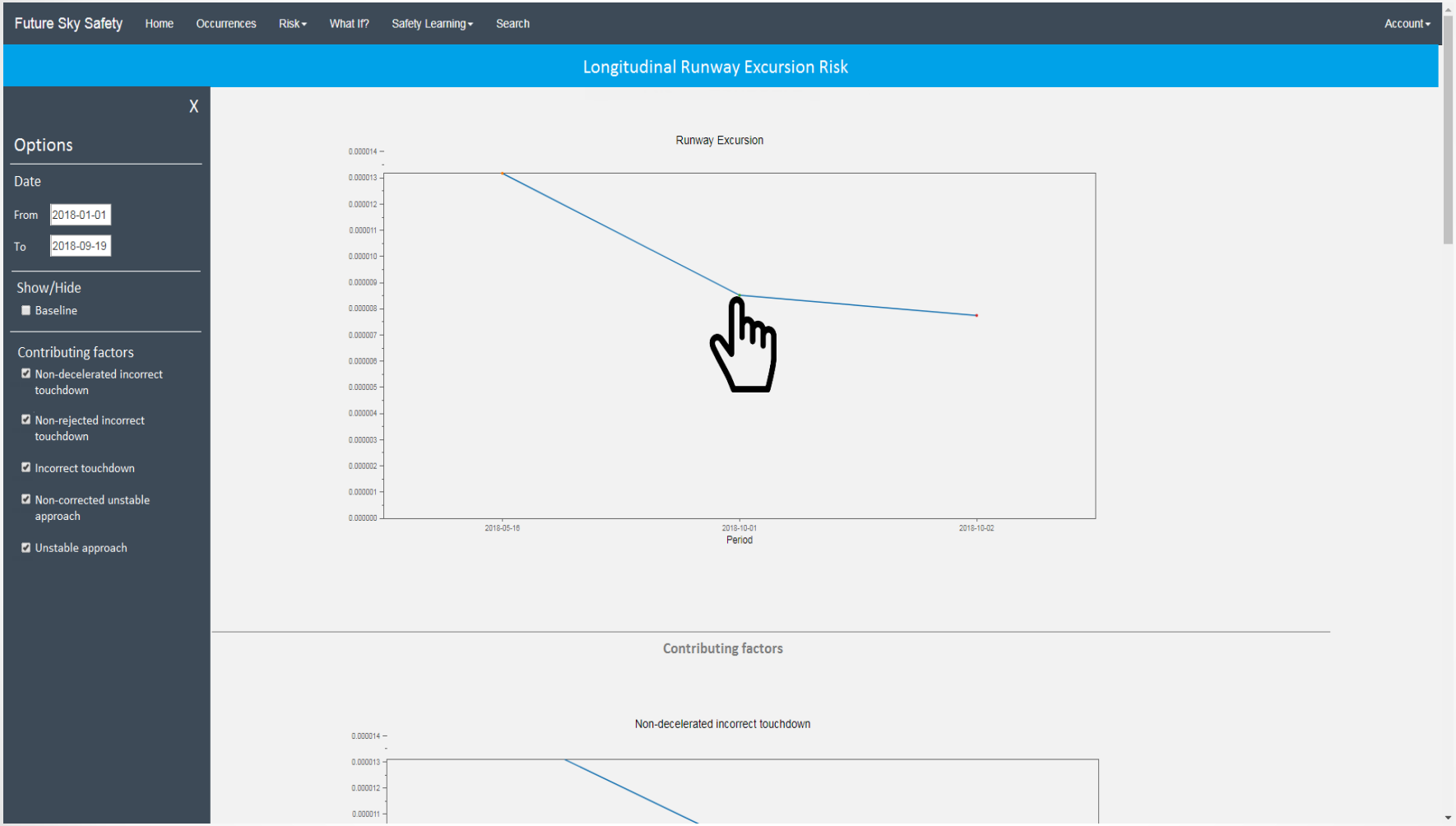
2018-10-02
Period


Future Sky Safety
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To 2018-09-19
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Contributing factors
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Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
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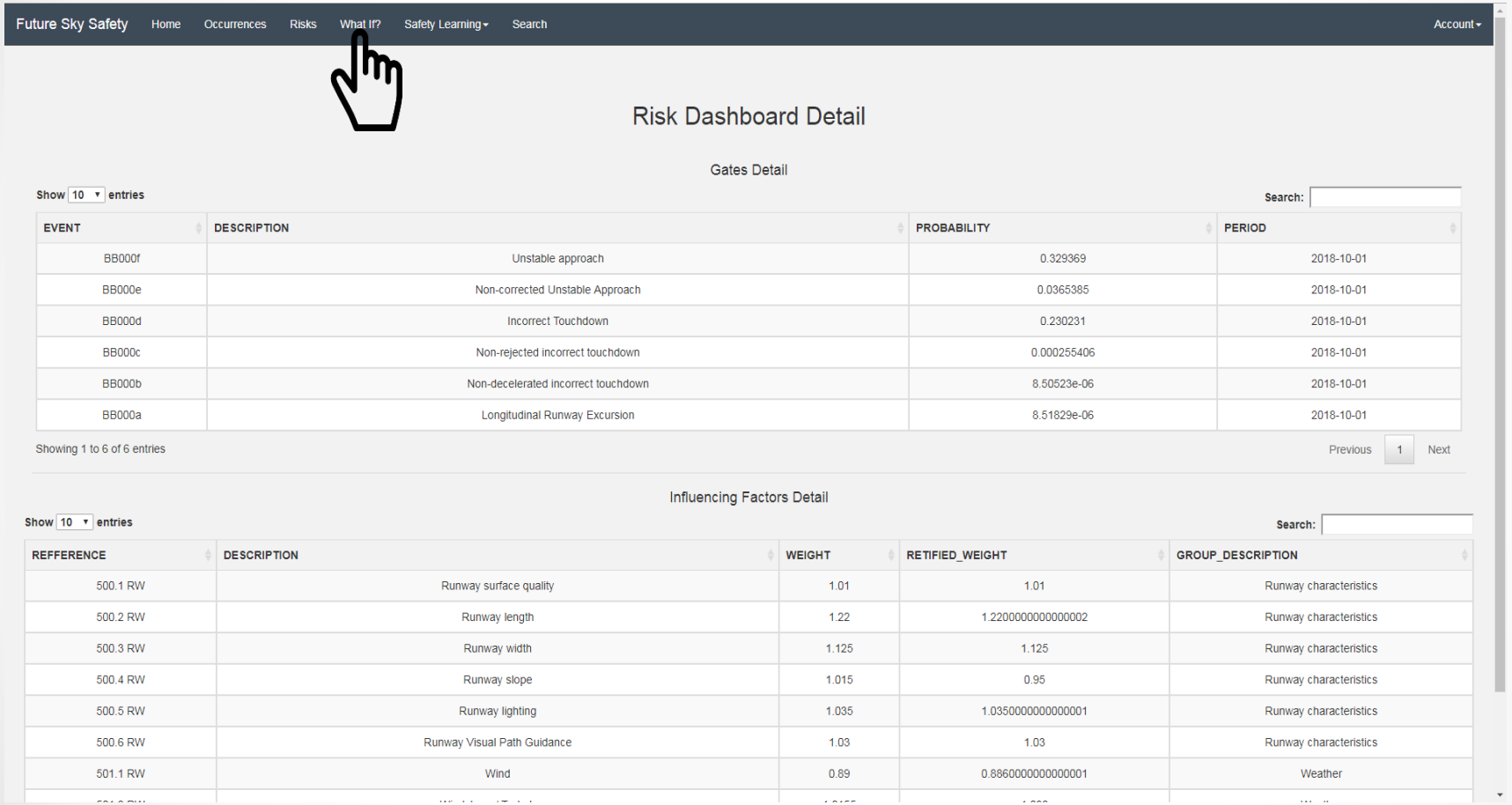
Period
Contributing factors
Non-decelerated incorrect touchdown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Home
Occurrences
Risks
What If?
Safety Learning
Search
Account
Risk Dashboard Detail
Gates Detail
Show 10 entries
Search:
EVENT
DESCRIPTION
PROBABILITY
PERIOD
BB000f
Unstable approach
0.329369
2018-10-01
BB000e
Non-corrected Unstable Approach
0.0365385
2018-10-01
BB000d
Incorrect Touchdown
0.230231
2018-10-01
BB000c
Non-rejected incorrect touchdown
0.000255406
2018-10-01
BB000b
Non-decelerated incorrect touchdown
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2018-10-01
BB000a
Longitudinal Runway Excursion
8.51829e-06
2018-10-01
Showing 1 to 6 of 6 entries
Previous
1
Next
Influencing Factors Detail
Show 10 entries
Search:
REFFERENCE
DESCRIPTION
WEIGHT
RETIFIED_WEIGHT
GROUP_DESCRIPTION
500.1 RW
Runway surface quality
1.01
1.01
Runway characteristics
500.2 RW
Runway length
1.22
1.2200000000000002
Runway characteristics
500.3 RW
Runway width
1.125
1.125
Runway characteristics
500.4 RW
Runway slope
1.015
0.95
Runway characteristics
500.5 RW
Runway lighting
1.035
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Runway characteristics
500.6 RW
Runway Visual Path Guidance
1.03
1.03
Runway characteristics
501.1 RW
Wind
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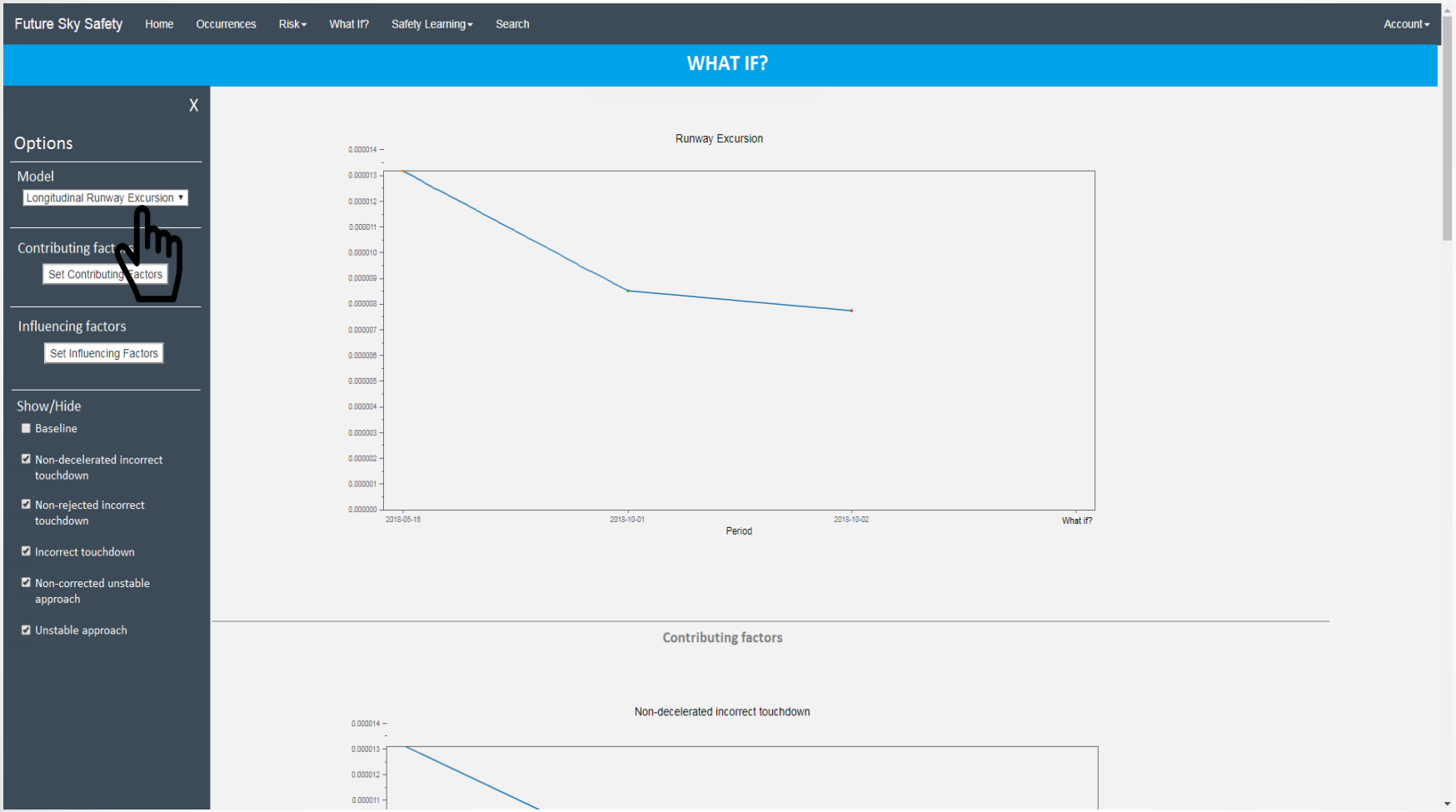
Weather


Future Sky Safety
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Occurrences
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What If?
Safety Learning
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Contributing factors
Set Contributing Factors
Influencing factors
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Non-corrected unstable approach
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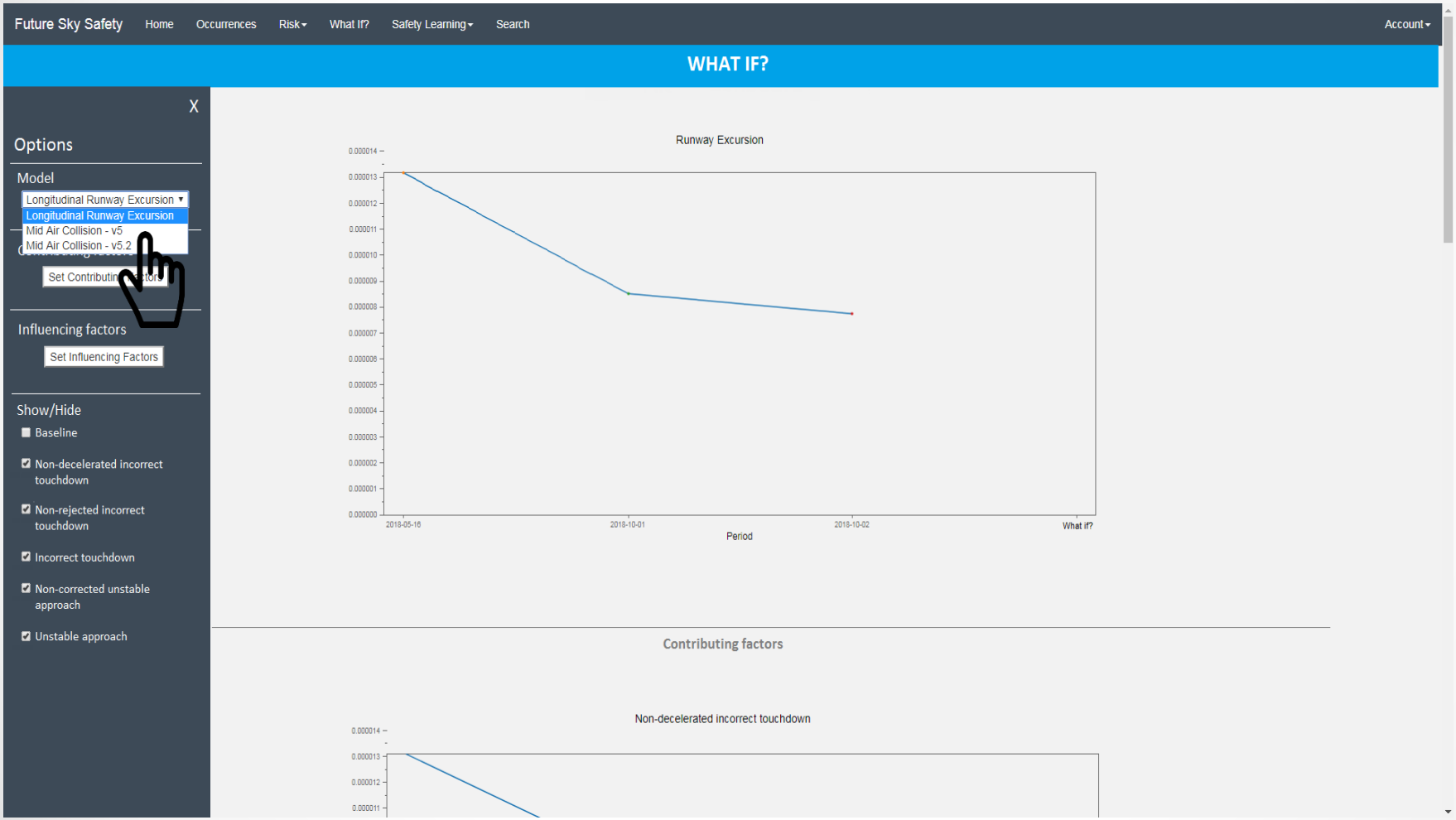
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Occurrences
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What If?
Safety Learning
Search
Account
WHAT IF?
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Longitudinal Runway Excursion
Longitudinal Runway Excursion
Mid Air Collision - v5
Mid Air Collision - v5.2
Set Contributing Factors
Influencing factors
Set Influencing Factors
Show/Hide
Baseline
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Runway Excursion
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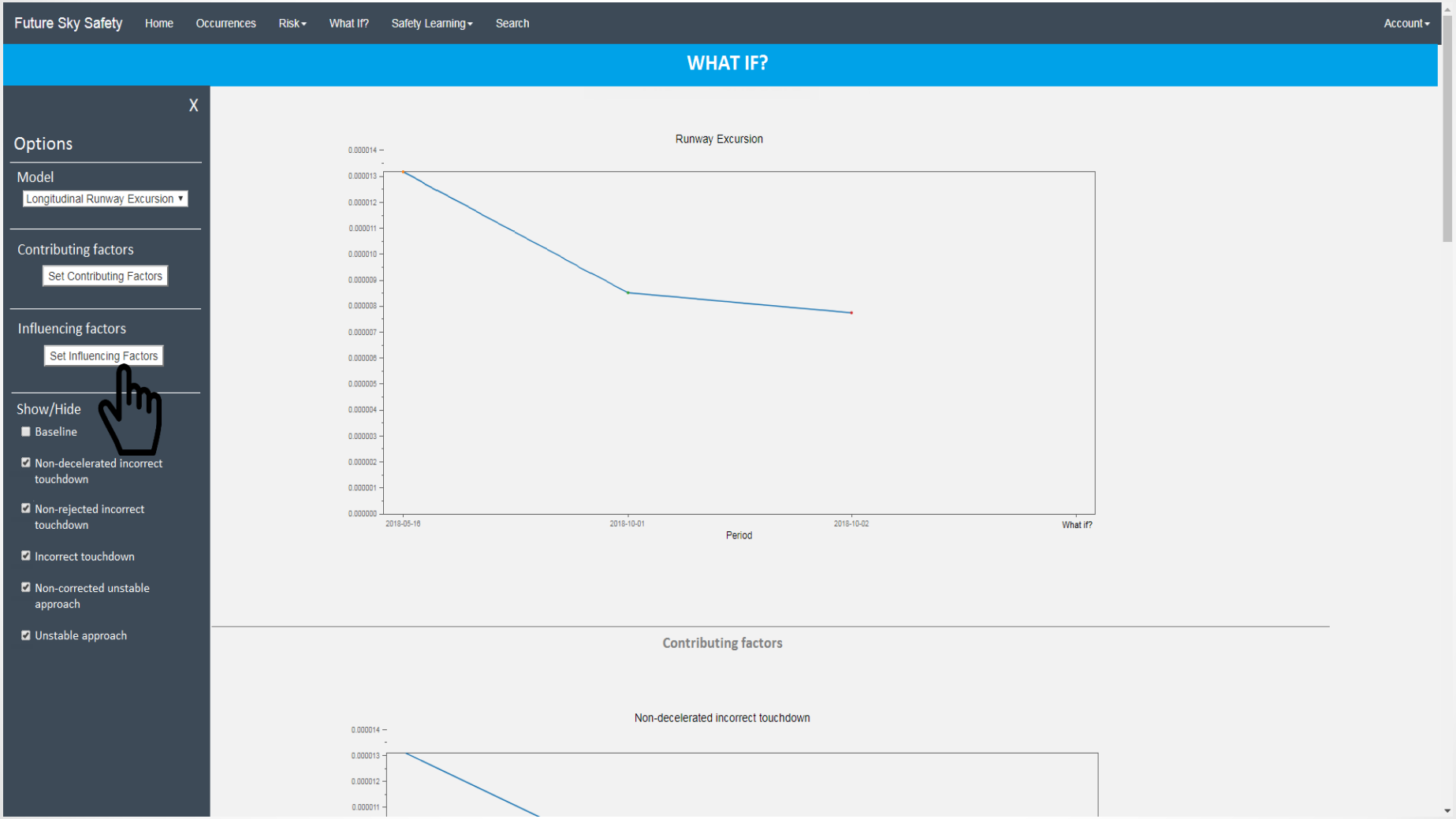
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Influencing factors
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Runway Excursion
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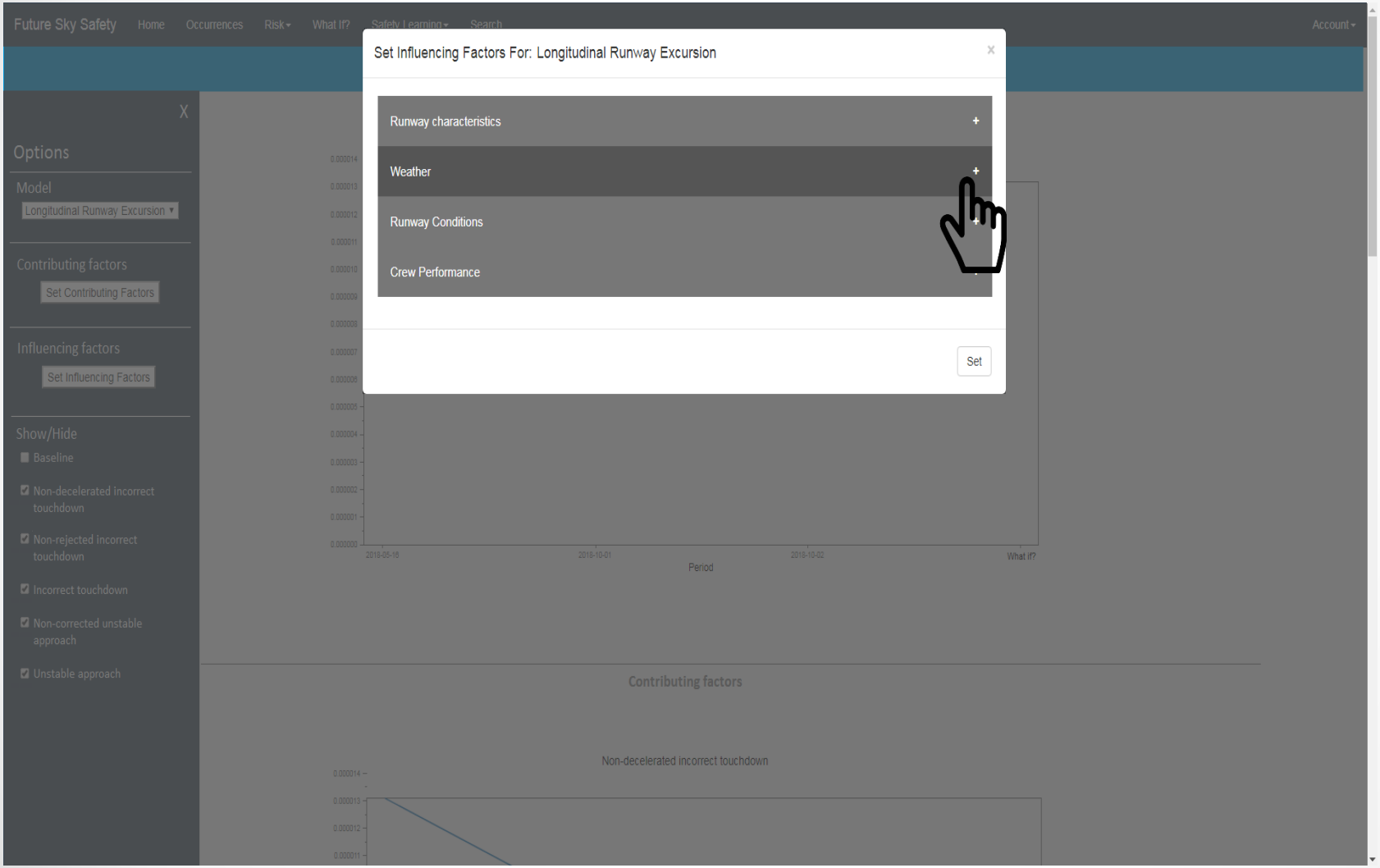
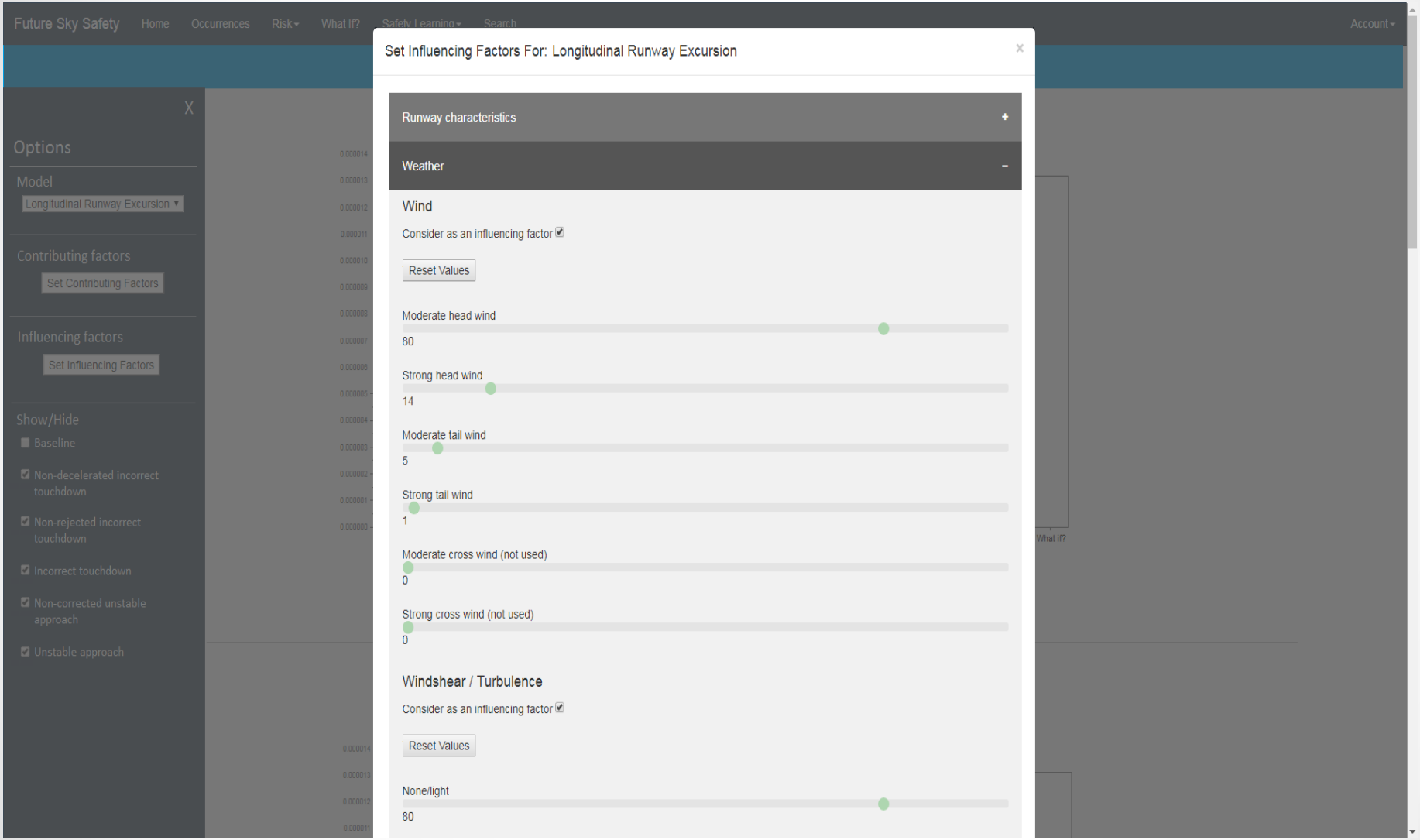

Future Sky Safety
Home
Occurrences
Risk
What If?
Safety Learning
Search
Account
Set Influencing Factors For: Longitudinal Runway Excursion
Runway characteristics
Weather
Runway Conditions
Crew Performance
Set
Options
Model
Longitudinal Runway Excursion
Contributing factors
Set Contributing Factors
Influencing factors
Set Influencing Factors
Show/Hide
Baseline
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Period
Contributing factors
Non-decelerated incorrect touchdown


Future Sky Safety
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What If?
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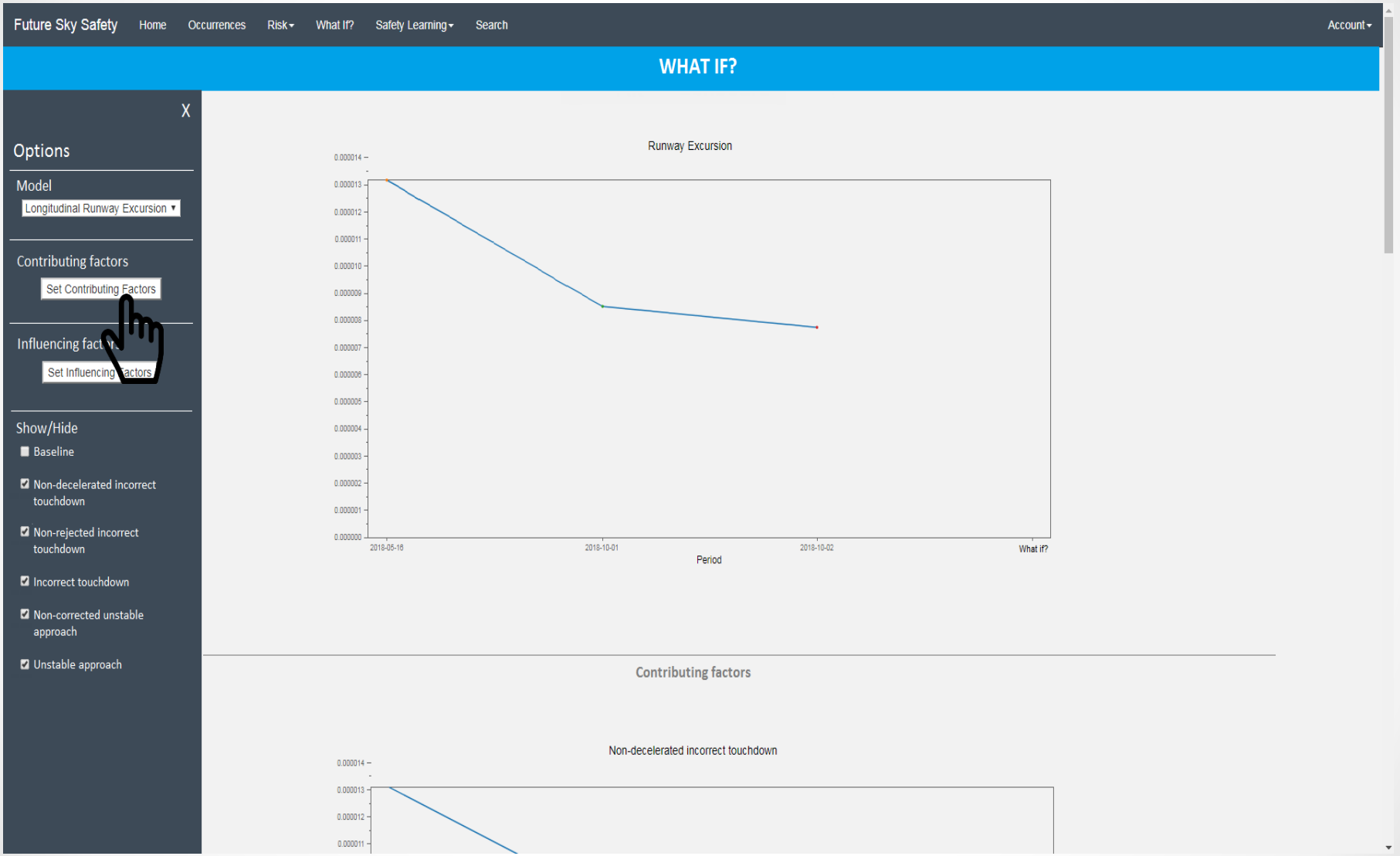
Longitudinal Runway Excursion
Contributing factors
Set Contributing Factors
Influencing factors
Set Influencing Factors
Show/Hide
Baseline
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Set Influencing Factors For: Longitudinal Runway Excursion
Runway characteristics
Weather
Wind
Consider as an influencing factor
Reset Values
Moderate head wind
80
Strong head wind
14
Moderate tail wind
5
Strong tail wind
1
Moderate cross wind (not used)
0
Strong cross wind (not used)
0
Windshear / Turbulence
Consider as an influencing factor
Reset Values
None/light
80


Future Sky Safety
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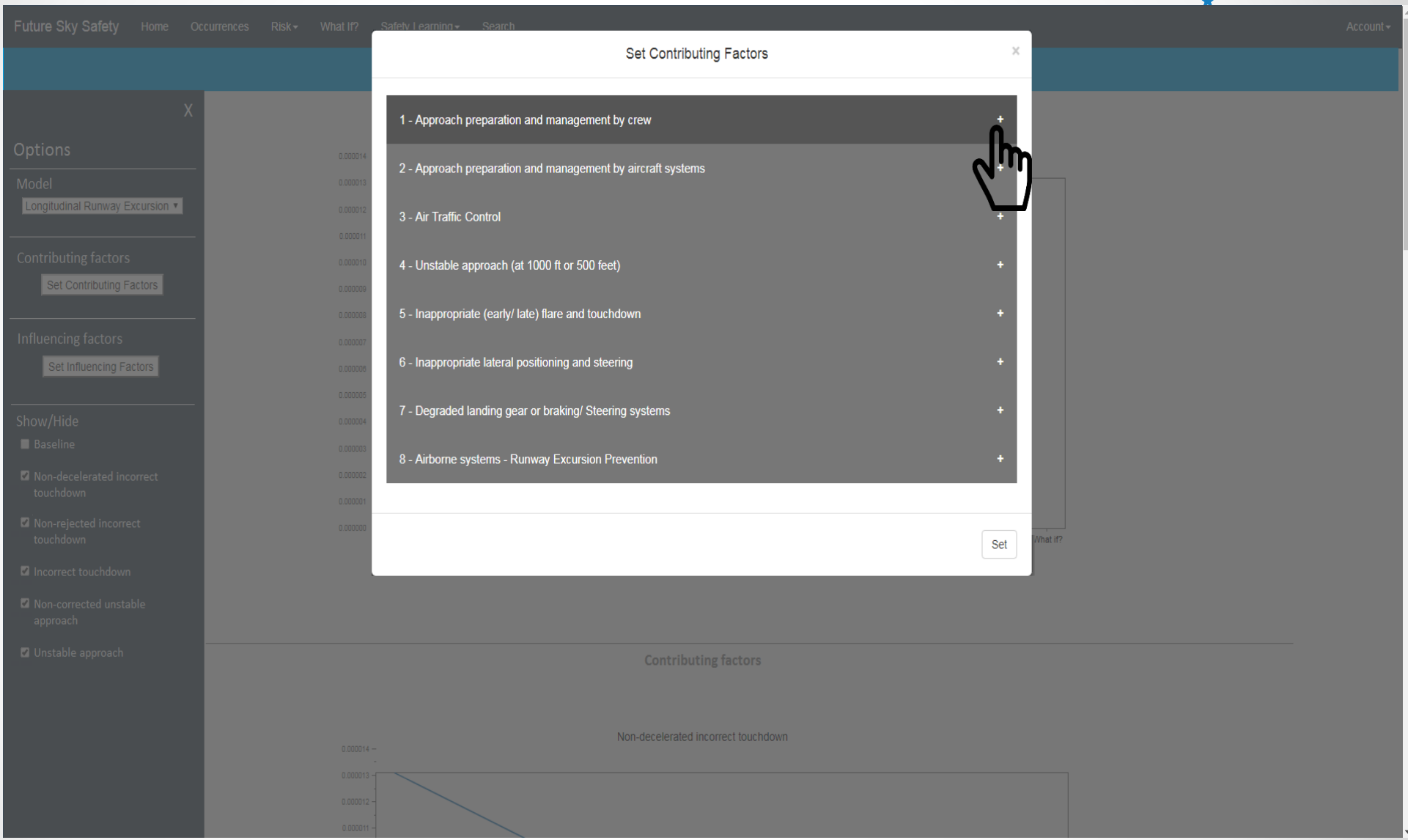
Future Sky Safety
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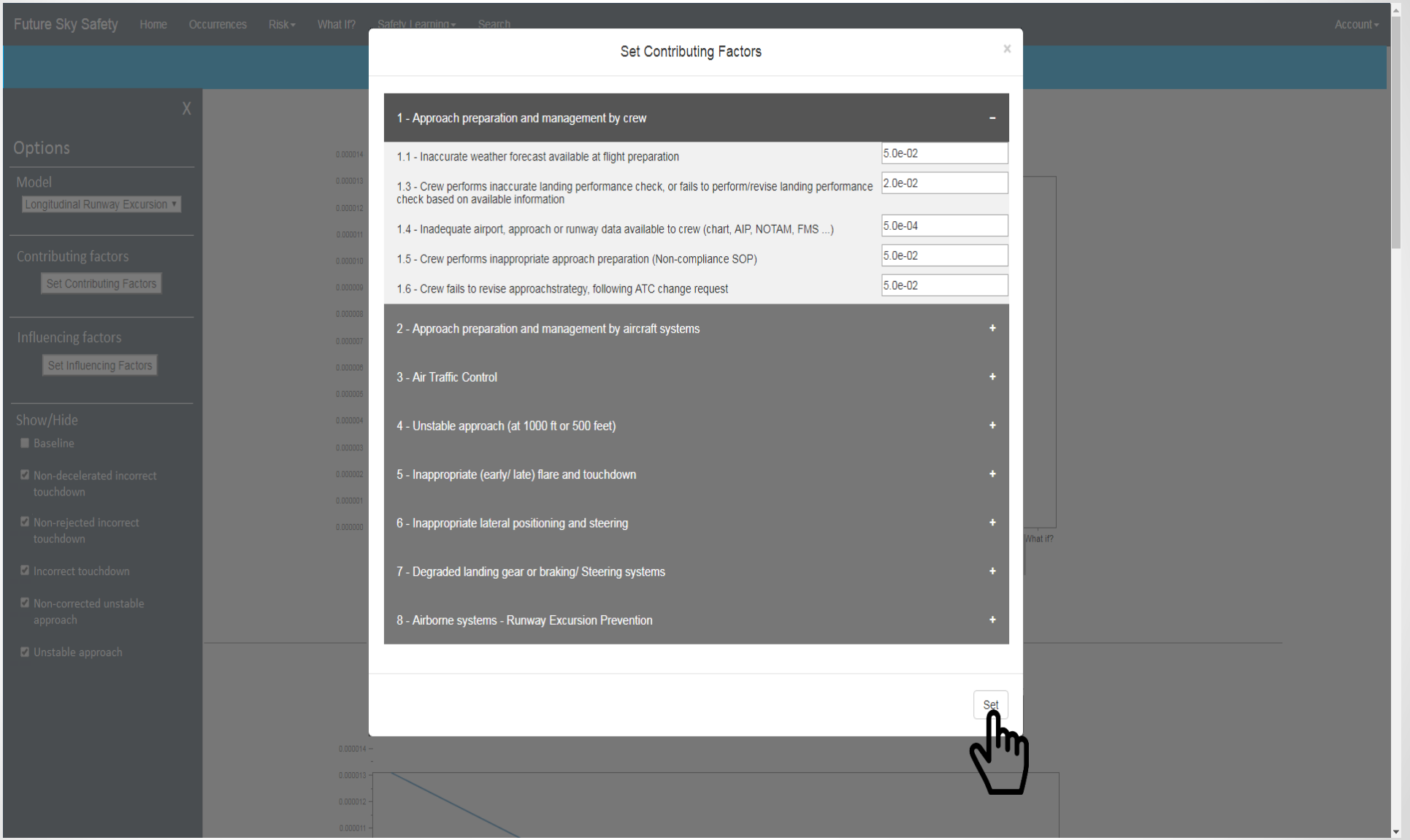
Influencing factors
Set Influencing Factors
Show/Hide
Baseline
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Set Contributing Factors
1 - Approach preparation and management by crew
2 - Approach preparation and management by aircraft systems
3 - Air Traffic Control
4 - Unstable approach (at 1000 ft or 500 feet)
5 - Inappropriate (early/ late) flare and touchdown
6 - Inappropriate lateral positioning and steering
7 - Degraded landing gear or braking/ Steering systems
8 - Airborne systems - Runway Excursion Prevention
Set
Contributing factors
Non-decelerated incorrect touchdown


Future Sky Safety
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What If?
Safety Learning
Search
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Options
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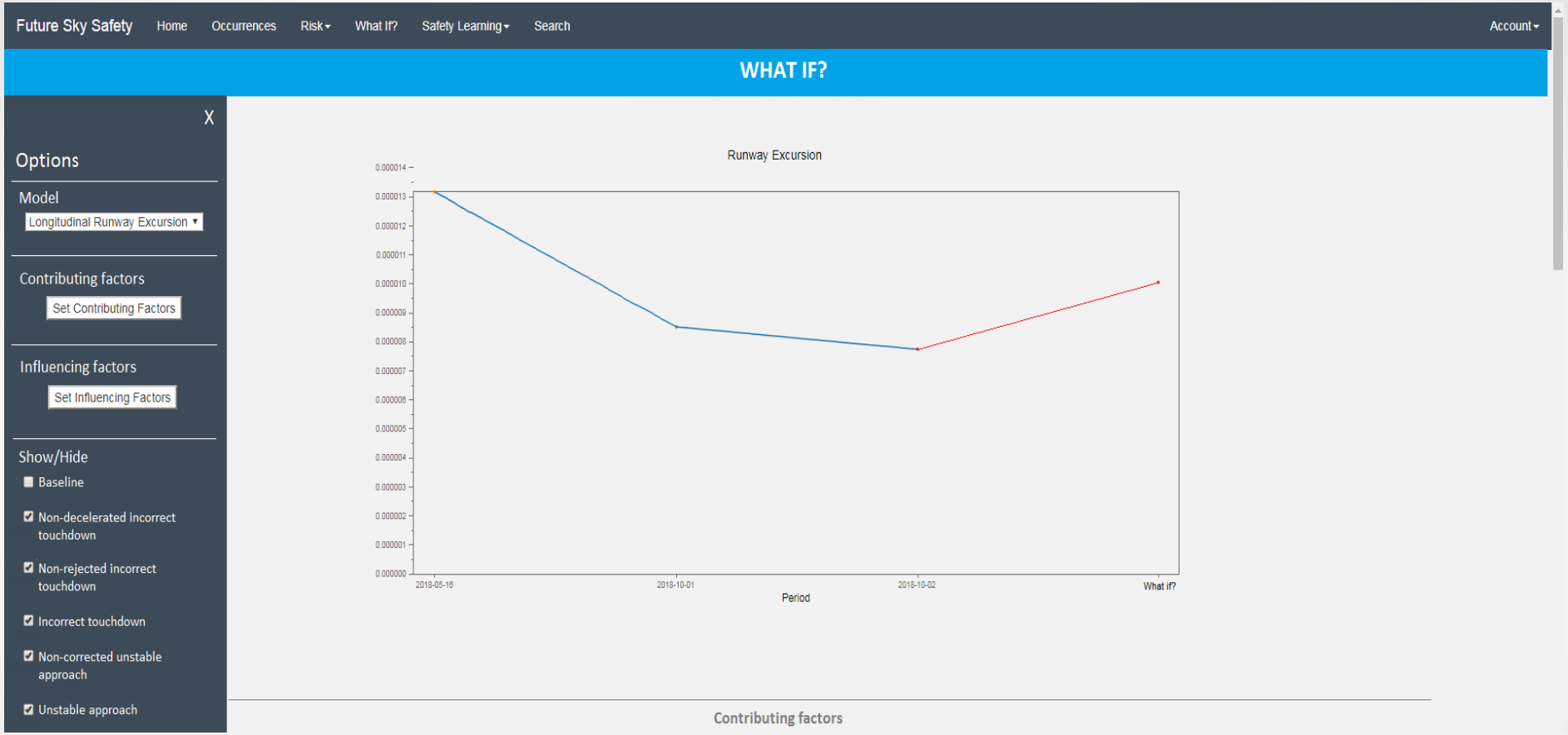
Longitudinal Runway Excursion
Contributing factors
Set Contributing Factors
Influencing factors
Set Influencing Factors
Show/Hide
Baseline
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Set Contributing Factors
1 - Approach preparation and management by crew
1.1 - Inaccurate weather forecast available at flight preparation
5.0e-02
1.3 - Crew performs inaccurate landing performance check, or fails to perform/revise landing performance check based on available information
2.0e-02
1.4 - Inadequate airport, approach or runway data available to crew (chart, AIP, NOTAM, FMS ...)
5.0e-04
1.5 - Crew performs inappropriate approach preparation (Non-compliance SOP)
5.0e-02
1.6 - Crew fails to revise approachstrategy, following ATC change request
5.0e-02
2 - Approach preparation and management by aircraft systems
3 - Air Traffic Control
4 - Unstable approach (at 1000 ft or 500 feet)
5 - Inappropriate (early/ late) flare and touchdown
6 - Inappropriate lateral positioning and steering
7 - Degraded landing gear or braking/ Steering systems
8 - Airborne systems - Runway Excursion Prevention
Set


Future Sky Safety
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What If?
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Account
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Longitudinal Runway Excursion
Contributing factors
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Show/Hide
Baseline
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2018-05-16
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2018-10-02
What if?
Period
Contributing factors

RO prototype - Demo

⇒ RO DEMO available after the P4-session
⇒ at the P4 poster presentation area (but only today)

Preliminary Business Model

- RO intends to be
  - Complementary to other initiatives (e.g. Data4Safety)
  - Eventually run by an independent organisation within the European aviation safety system
  - Structured to be a centre of excellence for aviation safety data analysis
  - With analysis capabilities significantly greater than available within aviation organisations
  - Of sufficient size to conduct the required tasks and staffed with highly qualified, experienced analysts in order to be able to provide better information than currently available

- Work on business model continues in 2019

RO Next steps

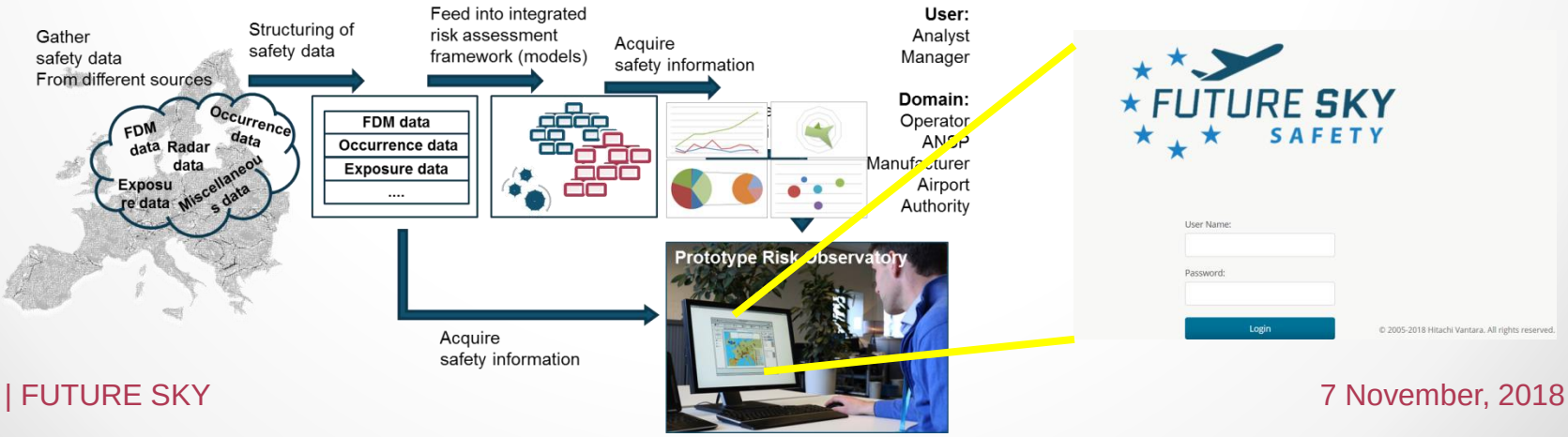
- RO prototype available & online accessible
- RO+integrated risk assessment framework Verification & Validation
- First RO s/w version prototype + user interface description - ready before year ends
- The Exploitation Action is expected to consist of:
  - Trial of prototype at KLM and at Airbus (in 2019)
  - Check other Stakeholder interest
  - Update prototype according to outcomes
- Total Aviation System Risk Picture 2018
  - Showing use cases of prototype RO
- Final RO s/w version ready before project ends
- Complete Business Model

Summary: Why RO?

- Support tool need: acquire safety data and translate it into actionable safety information
- Tailorable for each Stakeholder individually
- Strengthening the ability to monitor safety performance
- Contribute to reaching < 1 accident per 10 million commercial aircraft flights:
  - More safety information available to organisations
  - Support business cases for mitigating overarching risks
  - Focus resources on highest risks
  - Tackle concerns at interfaces

Concluding Remarks
P4 - Total System Risk Assessment

- To deliver a prototype RO, a Proof of Concept, incl. an integrated risk assessment framework, with RE and MAC backbones models.
- Providing a full (Aviation) risk picture
- Showing the contribution to risk from several domains
- Supporting the safety impact assessment of changes within several domains
- Finding best ways to visualize data: the quickest route from safety data to safety information
- Implementation, maintenance and operational use in a real environment are beyond the timeframe of P4



Contact P4

NLR - Netherlands Aerospace Centre

Wilfred Rouwhorst

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FUTURE SKY SAFETY

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 Aerospatiale "Elie Carafoli"
Instituto Nacional de Técnica Aeroespacial
Výzkumný a zkušební letecký ústav, a.s.
Totalförsvarets FOrskningsInstitut
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

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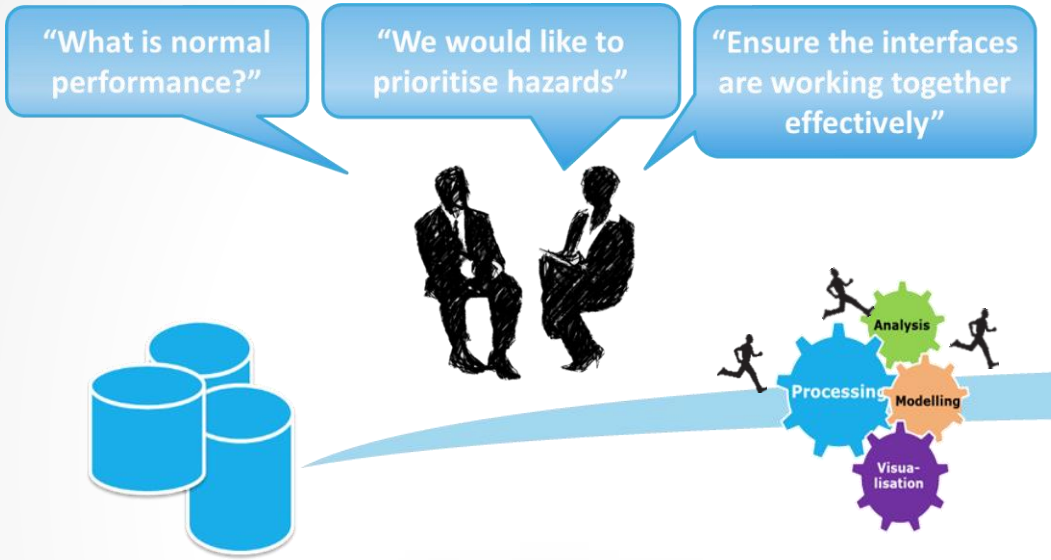
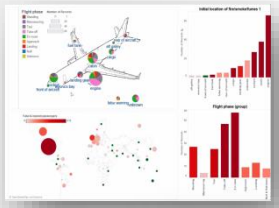
This presentation only reflects the author's view; the European Commission is not responsible for any use that may be made of the information it contains.

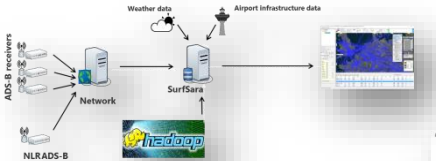
In summary

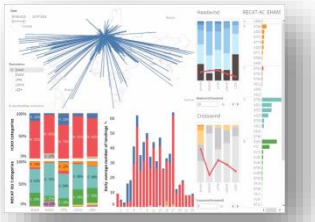


Trusted Data | Techniques | Applications/Information

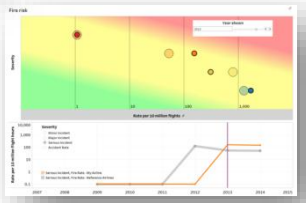


Occurrence data

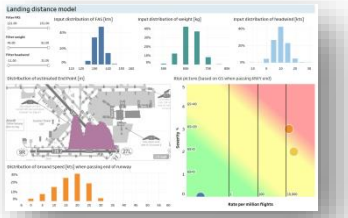




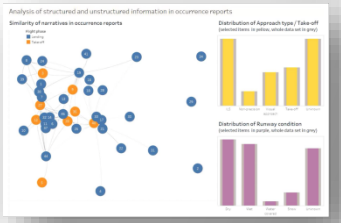
Exposure data



Risk modelling



Prediction



Text/Data mining