

# DustClim: Aviation climate services

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InDust Aviation workshop, May 2021



**DustClim**





## ▼ OUR STARTING POINT

A high resolution 4D climatology (reanalysis) over the NAMEE region that reproduces the sand-and-dust cycles and patterns within the broader atmospheric patterns. Led by BSC/DustClim.

3-hourly, 10x10km, 14 flight levels, 2007-2016.


The model was iteratively refined in conjunction with technical and regulatory documentation and end-users.

The background of the slide features a series of concentric circles in a light gray color, centered on the left side and extending towards the right. The circles vary in opacity and line style, with some being solid and others dashed. The overall background is a dark gray color.

## ▼ OUR PARTICULAR ANGLE ON PRODUCTS

Research most often focuses on the real-time immediate effects of weather patterns: nowcasting, forecasting, weather services, ...

Operating in risky environments on a regular basis is however another important dimension due to the accumulated costs and mechanical effects: climatology, long-term risks & impacts analysis.

The background of the slide features a series of concentric circles in a light gray color, centered on the left side, creating a ripple effect across the dark gray background.

## ▼ Visibility and mechanical effects, with implications for (a) safety and planning and (b) maintenance and cost optimization

- 1 Ground visibility & IFR/VFR/LVP threshold exceedances
- 2 Flight route exposure to dust concentrations
- 3 Airport resilience classification



# 1 Visibility calculation and thresholds applied

Visibility threshold (meters)	Limit/Range	Procedure
<b>Visual Flight Rules (VFR)</b>		
10000+	over	
10000	below	
8000	below	
5000	below	
3000	below	
1500	below	
<b>Instrument Flight Rules (IFR) according to ICAO/FAA thresholds</b>		
800+	over	CAT I
800–350	between	CAT II
350–200	between	CAT III A
200–50	between	CAT III B
50–0	between	CAT III C
<b>Low Visibility Procedures (LVP)</b>		
550	below	Restricted ground operations
end-user specified values	below	Restricted ground operations

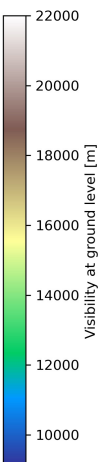
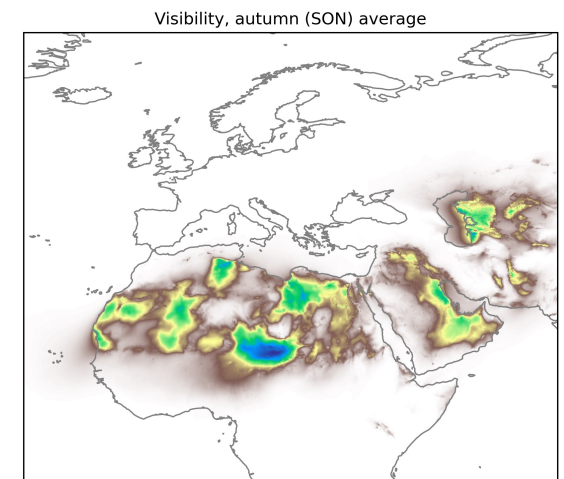
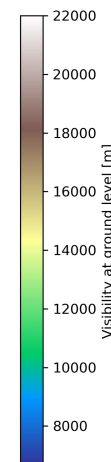
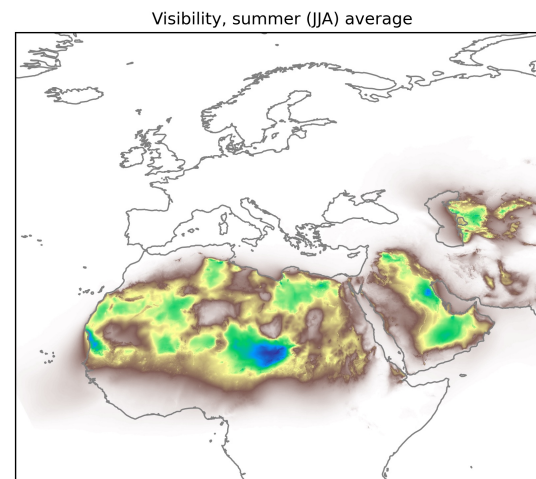
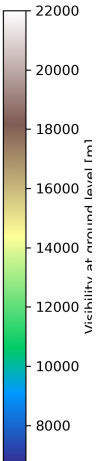
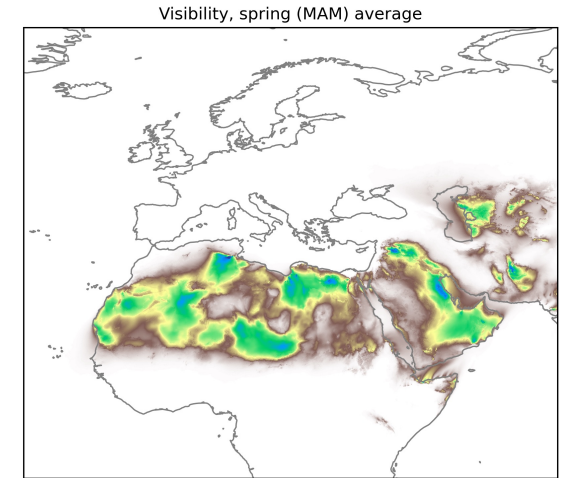
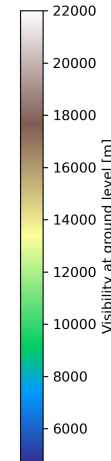
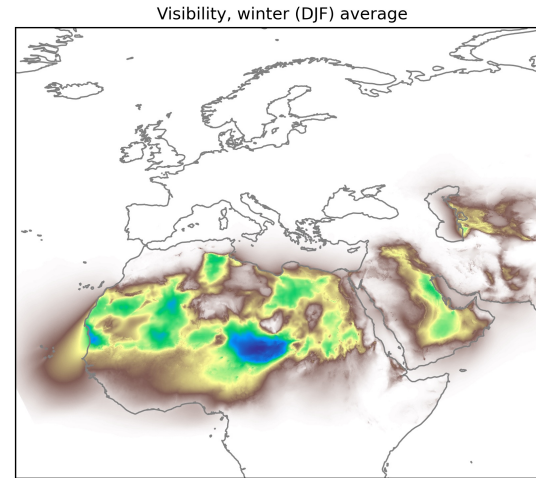
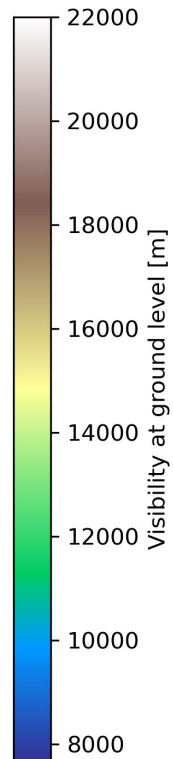
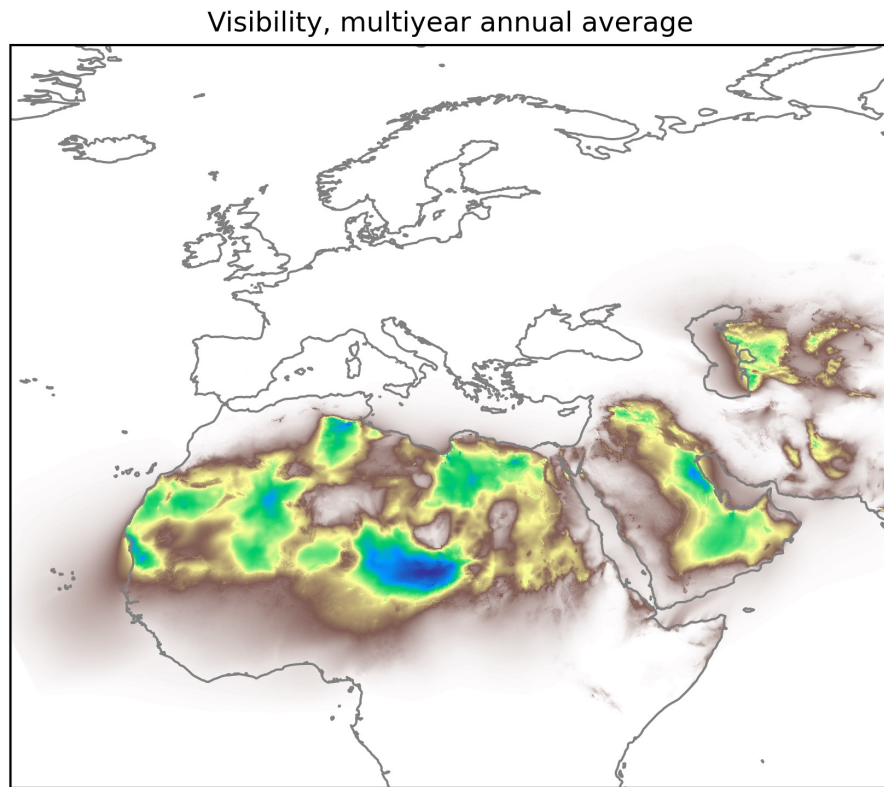
Koschmieder formula that translated surface extinction to visibility (Goldish 1997), corrected by a 0.5 factor (Chouta 2020):

- **VIS** =  $1.96/\text{extinction}_{550\text{nm}}$   
[0:22000 m]
- **Number of exceedances** of each of the 12 thresholds.
- **Probability of exceeding** each of the 12 thresholds.
- **(a)** Gridded output + **(b)** extraction for coordinates of NAMEE airports.



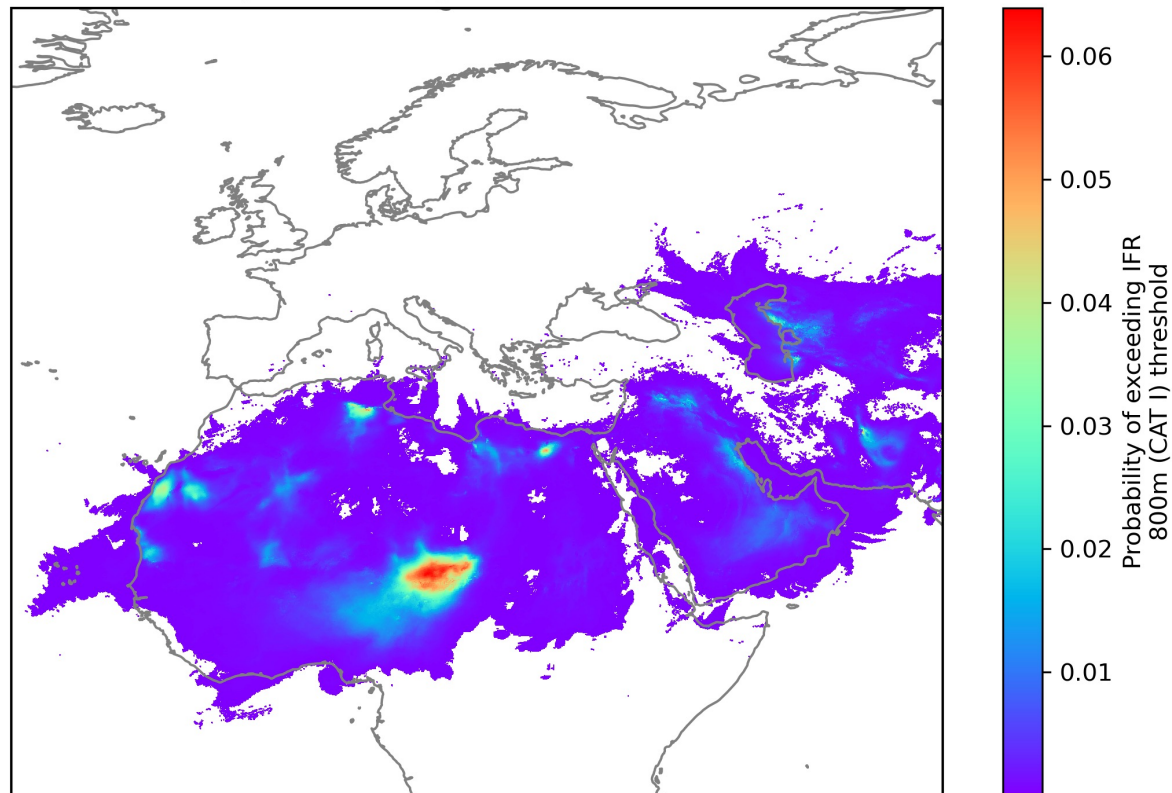
# 1 Climatology of visibility, 2007-2016

= 'prevailing' or 'average' visibility conditions

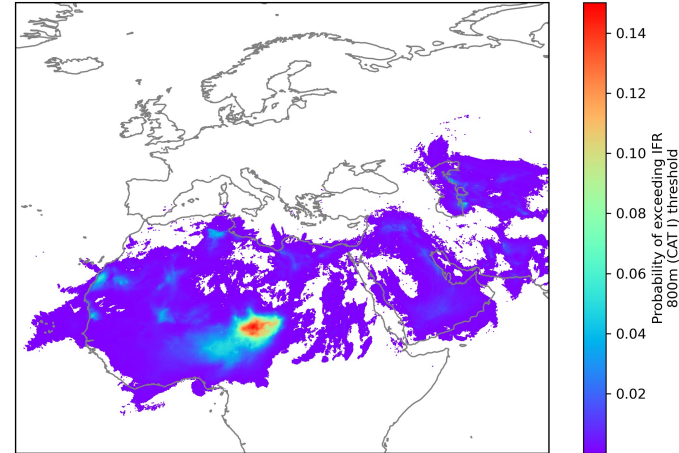


# 1 Climatology of $P(\text{ILS CAT I})$ , 2007-2016

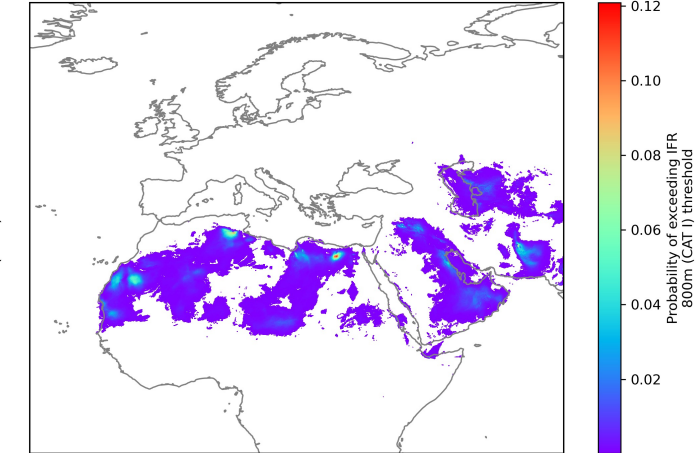
Probability of exceeding IFR 800m (CAT I) threshold



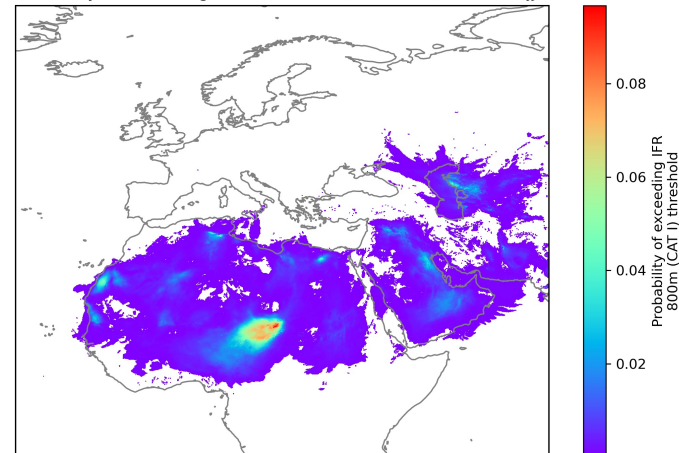
Probability of exceeding IFR 800m (CAT I) threshold, winter (DJF)



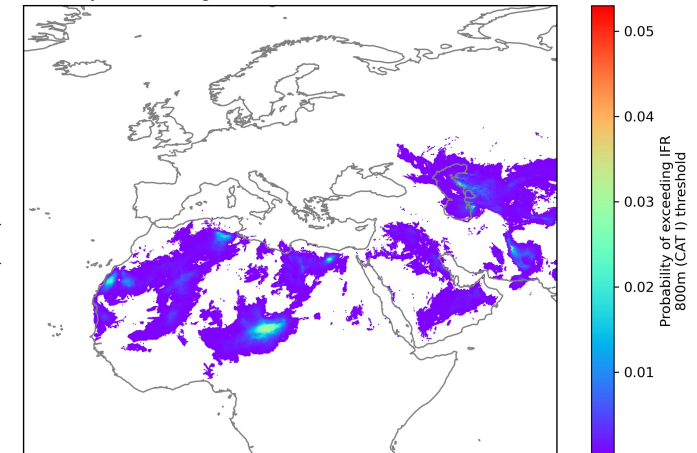
Probability of exceeding IFR 800m (CAT I) threshold, spring (MAM)



Probability of exceeding IFR 800m (CAT I) threshold, summer (JJA)



Probability of exceeding IFR 800m (CAT I) threshold, autumn (SON)



**Note:** a monetized impact analysis could also follow but was out of DustClim's scope. Apply EUROCONTROL's CBA guidelines.



## 2 Flight route exposure

hPa	Flight Level	Critical flight stages
1000	<b>FL000 (ground)</b>	take off, landing, taxiing
975	<b>FL010</b>	min. alt. for light aircraft
850	<b>FL050</b>	initial climb/min WAFS/WAFC
750	<b>FL080</b>	
700	<b>FL100</b>	descent
600	<b>FL140</b>	climb
500	<b>FL180</b>	
400	<b>FL240</b>	climb/initial descent
350	<b>FL270</b>	
300	<b>FL300</b>	
250	<b>FL340</b>	
175	<b>FL410</b>	cruise
150	<b>FL450</b>	
100	<b>FL530</b>	max WAFS/WAFC

- **Spatial join operation:** vectorized hard-coded interpolation of total concentration (Thiessen polygons)  $\cup$  geodetic flight routes in NAMEE.
- **For 13 Flight Levels** (975-100 hPa) following the convention for gridded aviation weather forecasts.
- Accumulation of particle exposure per flight path (with option to compute average exposure per route).

## 2 Climatology of exposure at 3 critical Flight Levels



Initial climb [FL050/850hPa]

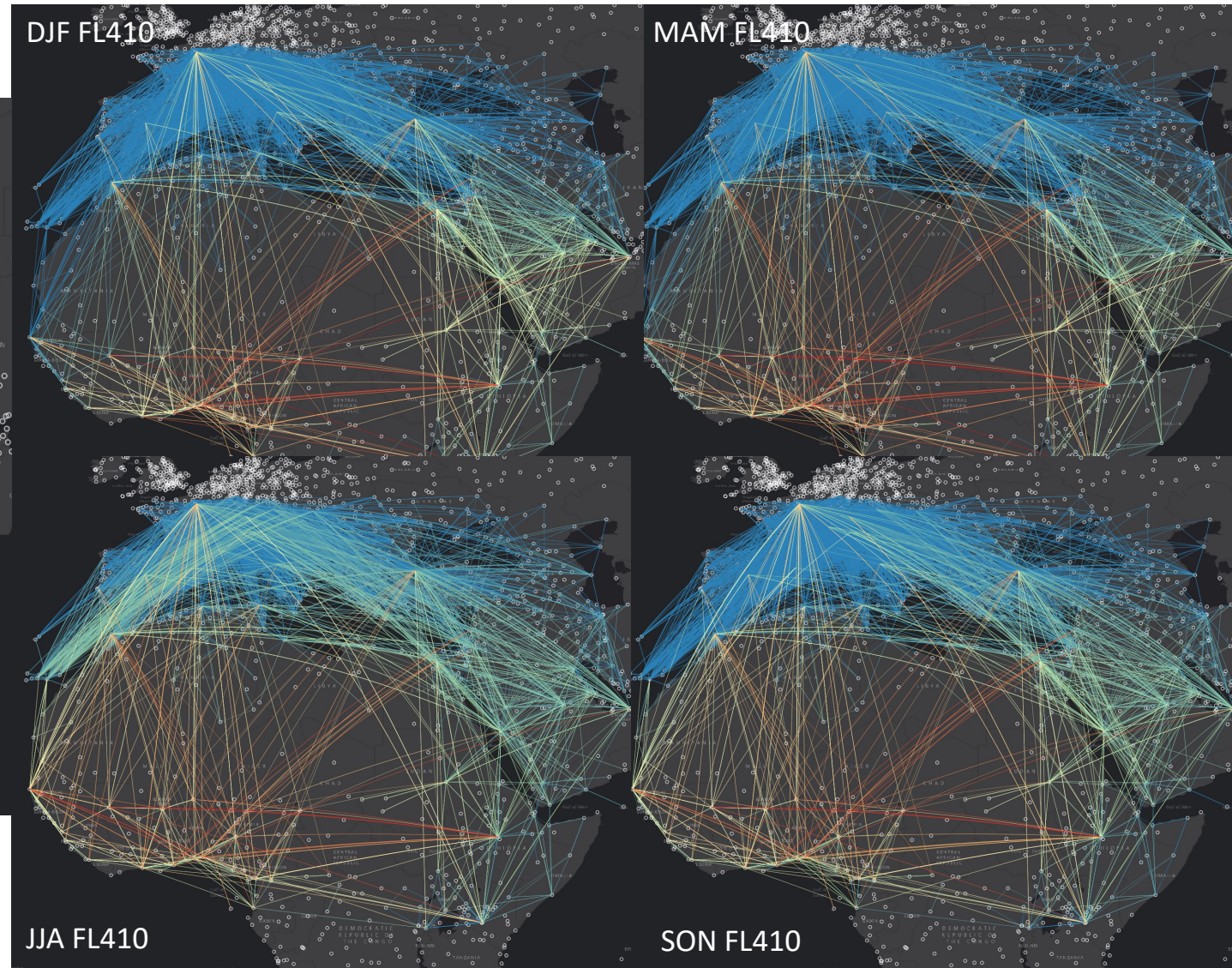
Climb [FL240/400hPa]

Cruise [FL410/175hPa]

**Extension 1:** create 'typical' or 'representative' routes, given altitude and climb/velocity information.



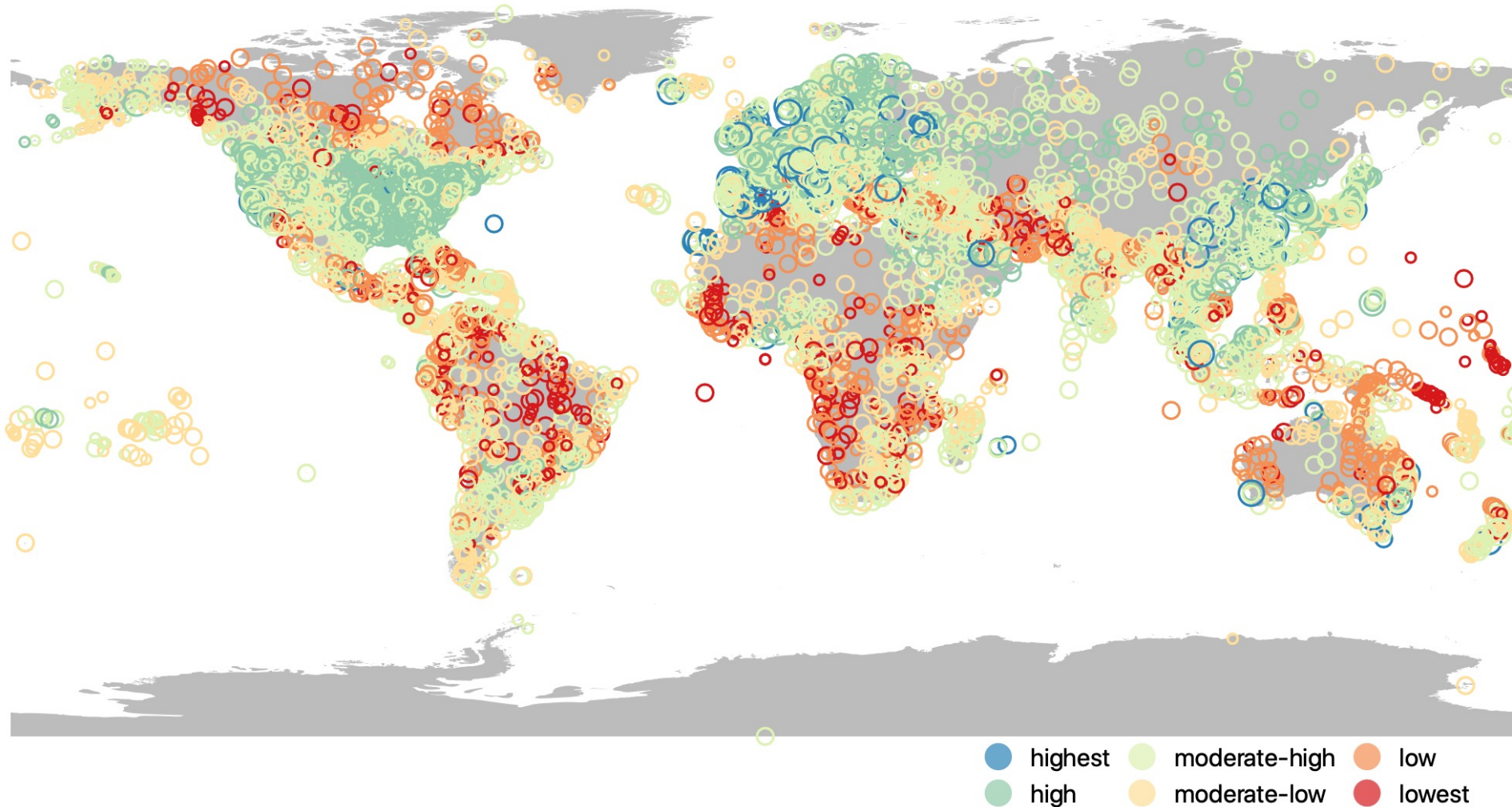
## 2 Climatology of exposure at cruise (FL410/175hPa)



**Extension 2:** add geochemistry and mineralogy,  
connect to engine damage functions.



# 3 Airport resilience



**A novel classification that accounts for:**

- Landing support instrumentation.
- Ability to cope with excessive demand.
- Proximity to alternative airports.
- **Visibility climatology.**
- **Flight route exposure climatology.**