ICAO Symposium on Non-CO_2 Aviation Emissions

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Montréal, Canada

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Speaker

Session 2: Enhancing Scientific Knowledge

Part II - Contrails

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ICAO Non-CO_2 Symposium | *September 16, 2024*

Impacts of Contrails – how large and what to do about it?

Florian Allroggen

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What’s the size of contrail impacts relative to CO_2?

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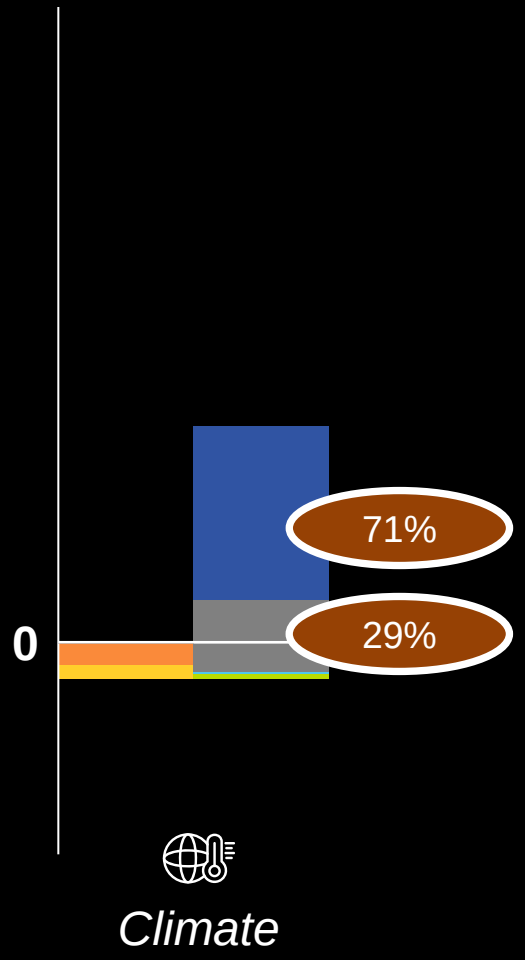
Impacts
($ per tonne of fuel burn)

0

Climate

Impacts
($ per tonne of fuel burn)



% of warming component

- CO_2
- NO_x
- Contrail-Cirrus
- Fuel Sulfur

These ratios may change due to:

Uncertainty in impacts
formation, persistence, contrail properties, and radiative forcing

Variability in valuation:
Short-term contrail impacts (~hours) vs. long-term CO_2 impacts (centuries)

Requires detailed analysis

Higher significance of future impacts

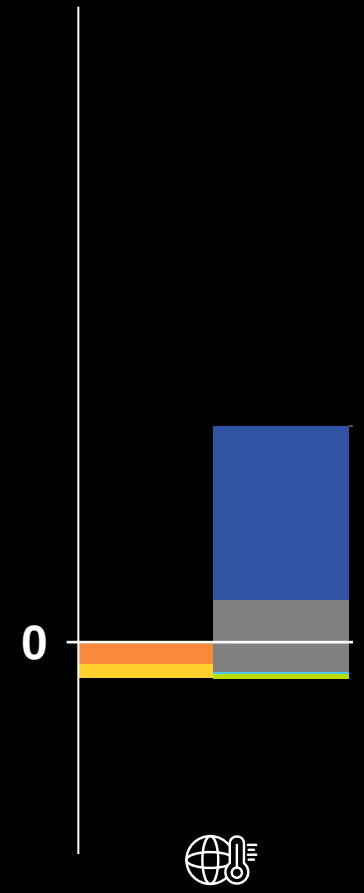
Lower significance of future impacts

Discount Rate = 2%

Discount Rate = 3%

Discount Rate = 7%

Impacts
($ per tonne of fuel burn)



Climate

CO_2
NO_x
Contrail-Cirrus
Fuel Sulfur

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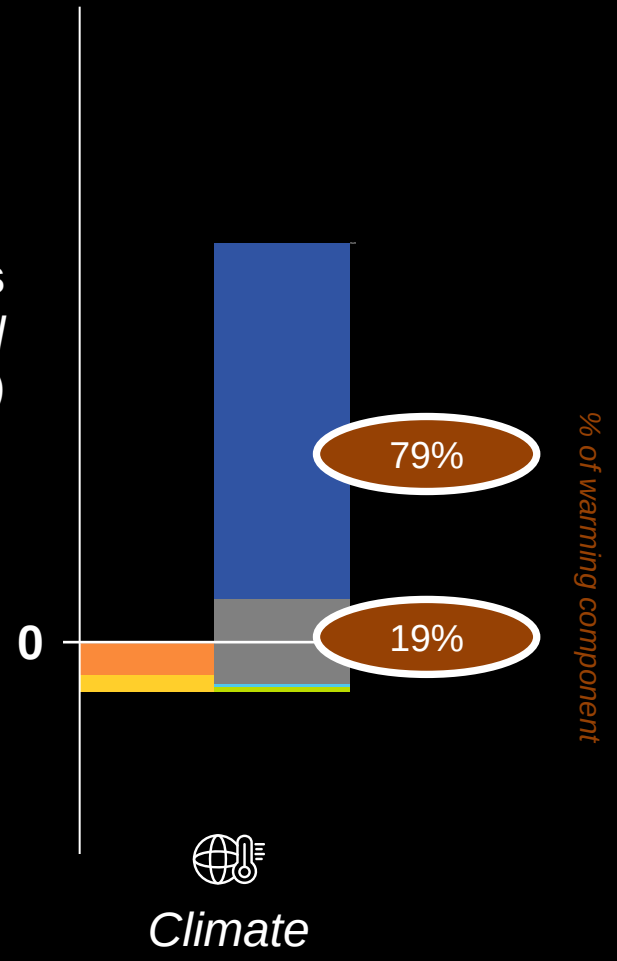
Higher significance of future impacts

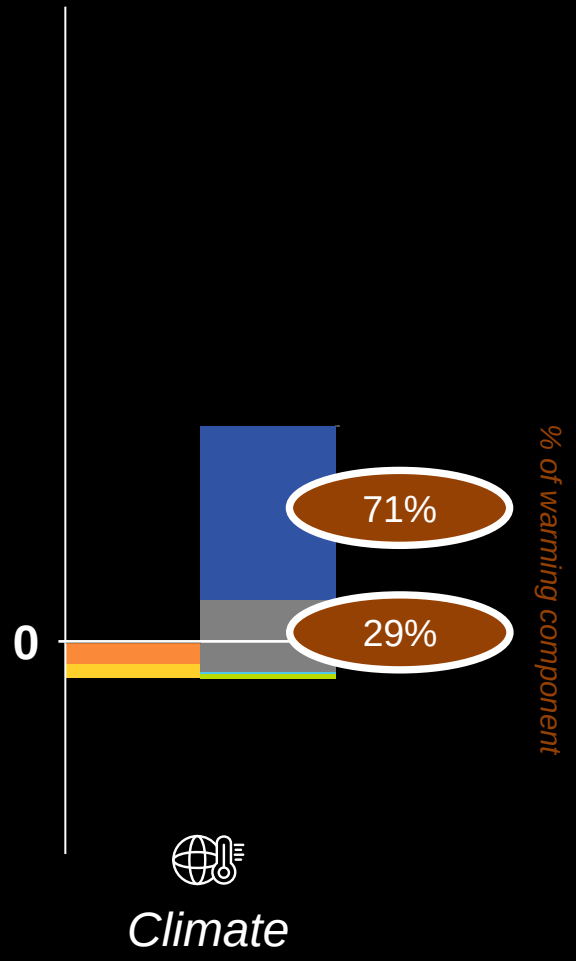
Lower significance of future impacts

Impacts
($ per tonne of fuel burn)

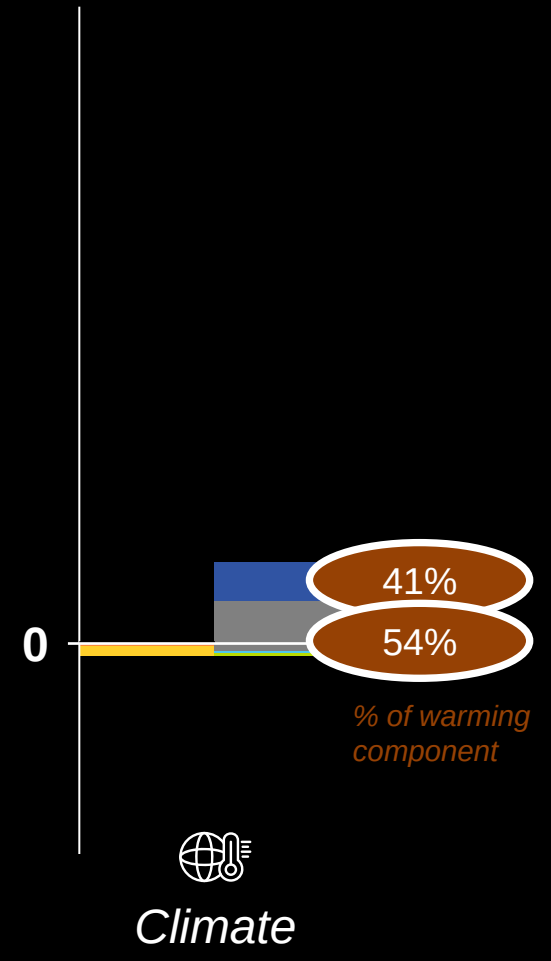
Discount Rate = 2%



Discount Rate = 3%



Discount Rate = 7%



- CO_2
- NO_x
- Contrail-Cirrus
- Fuel Sulfur

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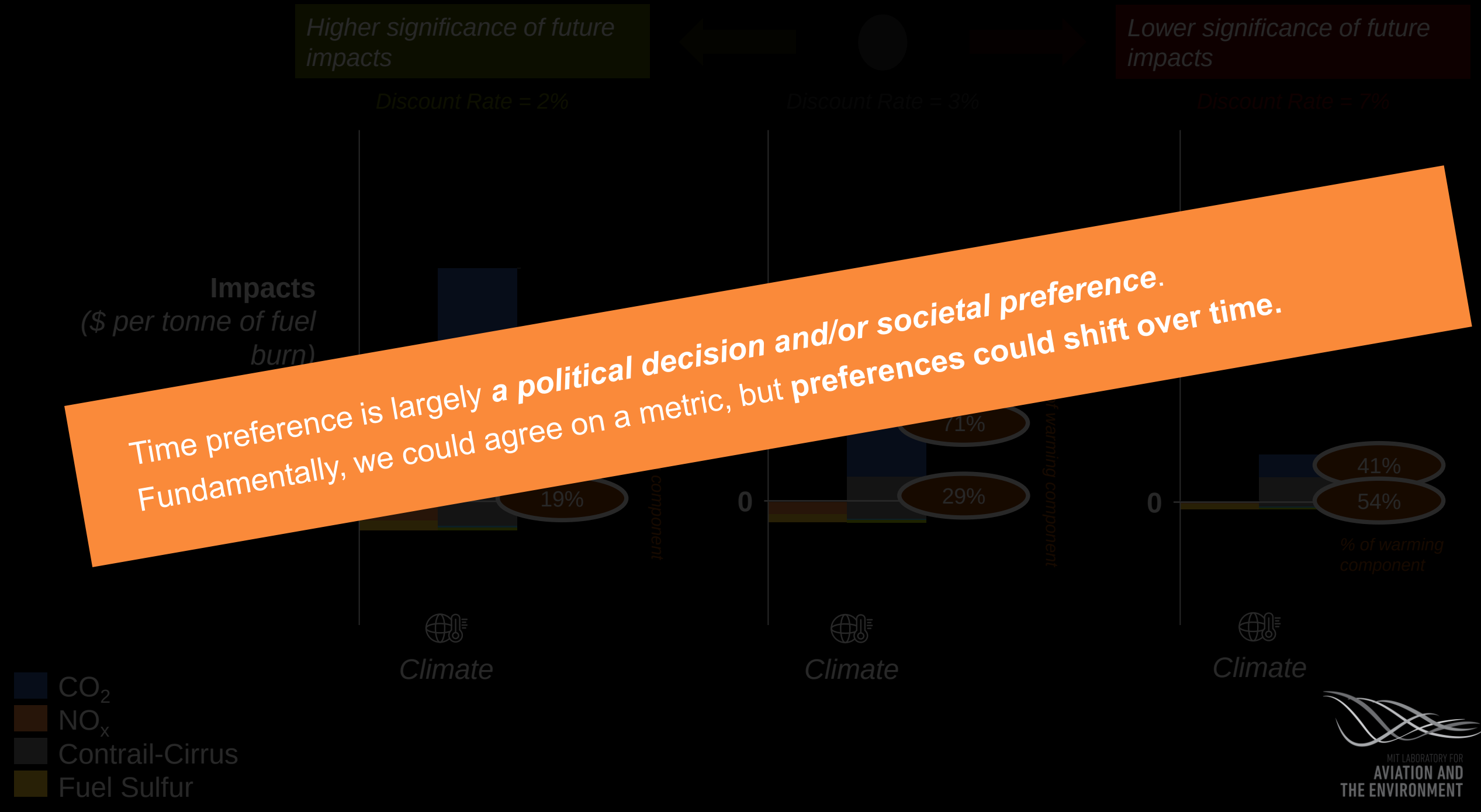

Time preference is largely ***a political decision and/or societal preference***.
Fundamentally, we could agree on a metric, but **preferences could shift over time.**

What about action to mitigate these impacts?

Mitigation

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Engine modifications

Fuel switching

Flight path deviations

...

Mitigation

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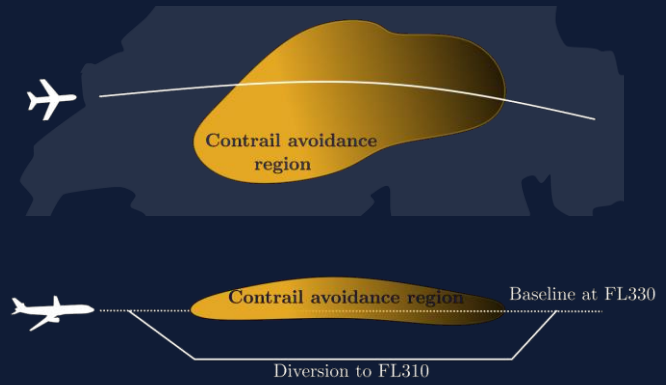
Engine modifications

Fuel switching

Flight path deviations

...

- Avoidance of “sensitive” air space is an intuitive approach
- Likely focused on vertical deviations (flight path optimization problem!)



At a high level, flight path deviations could provide substantial climate benefits

Assumptions:
- Fossil Jet-A use
- Aviation warming impacts 70% from CO_2, 30% from contrails

	Fuel burn	*Contrail impact*
Studies (idealized)	**~1% additional fuel burn** *(fleet-wide)*	**>90% of contrails avoided**
Trade-off	**+0.7 % of climate impacts from additional CO_2** *(fleet-wide)*	**-27 % of climate impacts from avoided contrails** *(fleet-wide)*

Benefit by factor ~40 larger. Is this robust?

Key challenge - Data informing and validating avoidance

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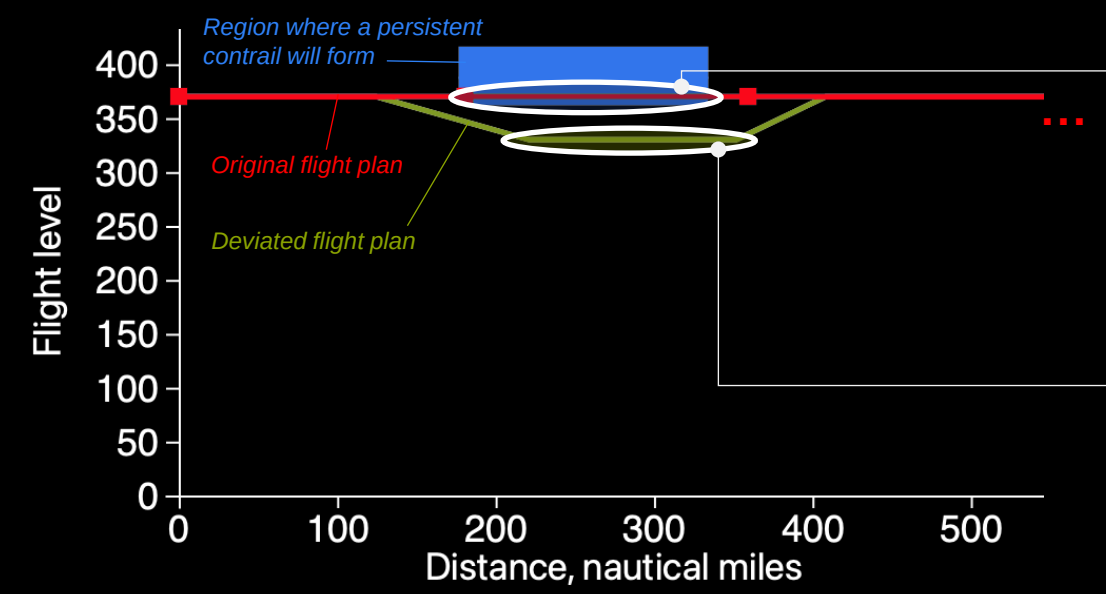
Two main data points are needed to successfully deviate a flight

Vertical "cut" of a selected flight segment



1 On the original flight path, the flight would form a persistent contrail.

2 On the deviated flight path, the flight will not form a persistent contrail. The path regularly needs to be the "closest" path not forming a contrail.

Two key questions:

1. *Which data can help us make these decisions?*
2. *How can we validate the outcomes?*

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