Climate Change and Aviation:

Risk Management and Environmental Choices

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Issues addressed :

- Overview of state of knowledge on impacts of climate on aviation from a science perspective
- Time lines: Long-term, decadal, interannual, resulting “weather” types
- Summarize state of knowledge regarding climate change risk and resilience – the stakeholder perspective
- A look at extreme phenomena

Confidence in Trends?

- Regional trends may differ significantly from each other (Francis and Vavrus, Screen and Simmonds)
- Observed trends in local scale-phenomena rendered unreliable by automation of observations (hail, tornadoes rarely detected by AWOS)
- Inter-annual variability (ENSO, NAO) very strong, intensity linked to climate state

Emerging consensus on some issues:

1. Temperature: Warming at the surface and upper levels [high confidence], cooling of stratosphere regionally

- More temp extremes at surface , two contributing factors:
  - Gaussian shifted to right (trivial)
  - Complex feedback mechanisms , increase in blocking highs (mid-lat

2. Small changes to jet stream

- Acceleration (obscured by large variance?), Poleward shift
- High-Amplitude low wave-number regimes (Francis and Vavrous, Coumou et al.)
- High uncertainty about CAT (probably shift of affected regions)
- Massive gaps in data over large areas (Africa, S. America,, Pacific)

Expected Changes…details for aviation

3. Storms and Ice

- More extreme thunderstorms (height of Cb tops, ice content) [High confidence]
  - High Altitude Ice Content expected to increase
  - Tornadic storms and hail: Models seem to idicate a positive trend post-2040, observational trend affected by increasing automation of observations)
- Extreme surface precipitation: more large events See Coumou and Lehmann [High confidence]
- Hail and windstorms, ice storm changes:
- Dramatic change of observing system from human to automated systems affecting statistics [Low confidence]

Manufacturers

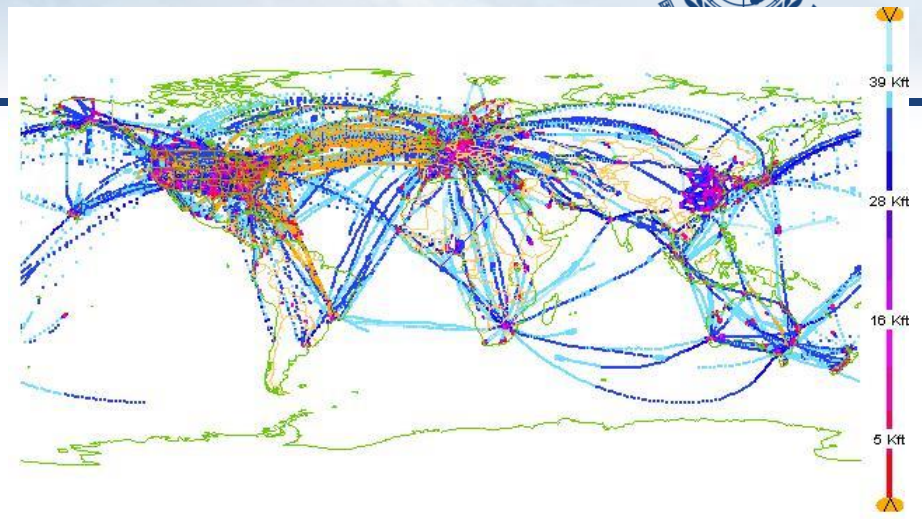
- Strong dependency on regulatory (certification) envelope developed by regulators in response to changing conditions, in particular for:
- Take-off performance in hot&moist conditions
  - High altitude and “classical” icing
  - Frequency of lightning strikes in all climate zones (structural impact, life cycle impact)
  - Heavy hail (e.g. recent Delta incident!) – max impact may have to be re-considered
  - Area and period affected by sand storms, tropical cyclones, other extreme conditions
  - Changes in the location, variability and characteristics of typical flow pattern (jet streams)

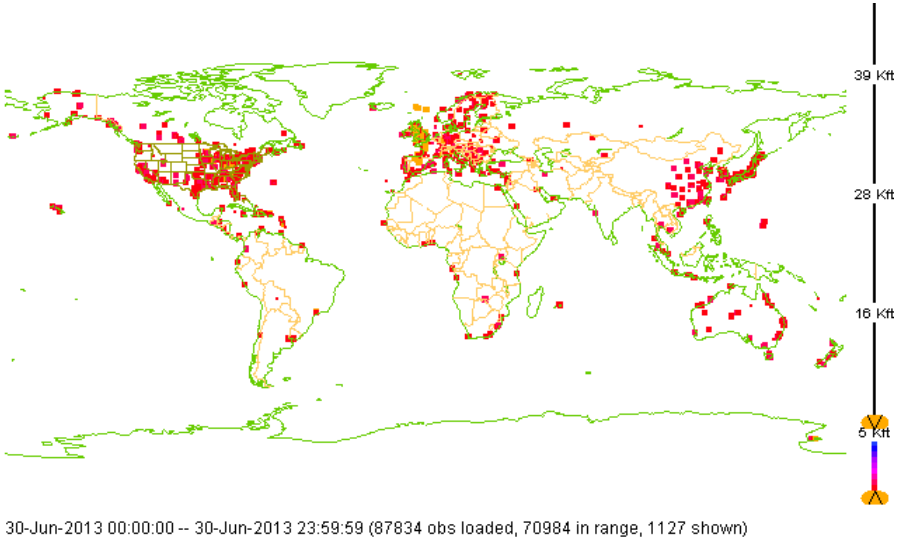
Environmental choices: We need to talk!

- High-density air space and severe weather: Are new systems possibly geared too much towards fuel efficiency – low carbon? (High Altitude Ice content, Volcanic Ash-Dust, Resilience to hail, lightning strike?
- Could new, very quiet aircraft be allowed to optimize approaches over built-up areas?
- How will extended heat waves and stagnant air interact with Nox input, leading to increase ozone?

AMDAR – Coverage

- Coverage very good over USA & Western Europe;
- Coverage good over parts of Asia and Australasia;
- Coverage is poor elsewhere.





Benefits to Airlines

- A recent Study by South African Airways shows the benefits of using AMDAR data:
  1. Pre-departure « Dynamic Fuel Planning » - Use latest possible weather information and forecasts for determination of fuel load.
  2. Pre-departure Flight Planning – Use latest possible forecasts (Flight Plan/Winds Aloft) for latest possible adjustment of flight plan.
  3. In-flight Planning – Request and use updated forecasts for in-flight adjustment and optimisation.

And what about alternative fuel?

- Need to analyze expected changes in agricultural productivity in changing climate
- Could massive increase in AF production impact regional and global climate?
- Could there be increased opportunities for agricultural production in hitherto unproductive regions?

Thanks….

- To the group at Potsdam Institute of Climate Change Impact for generous help and direction (Dim Coumou and Jascha Lehmann)
- Prof. Wuebbles for sharing very helpful insight and remarks at the CAEP Workshop in Washington, Feb 2015
- Rory Clarkson for invaluable technical advice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