
In-Service Aircraft for a Global Observing System

# Recent Scientific Highlights

# CHALLENGE : ROUTINE GLOBAL OBSERVATION

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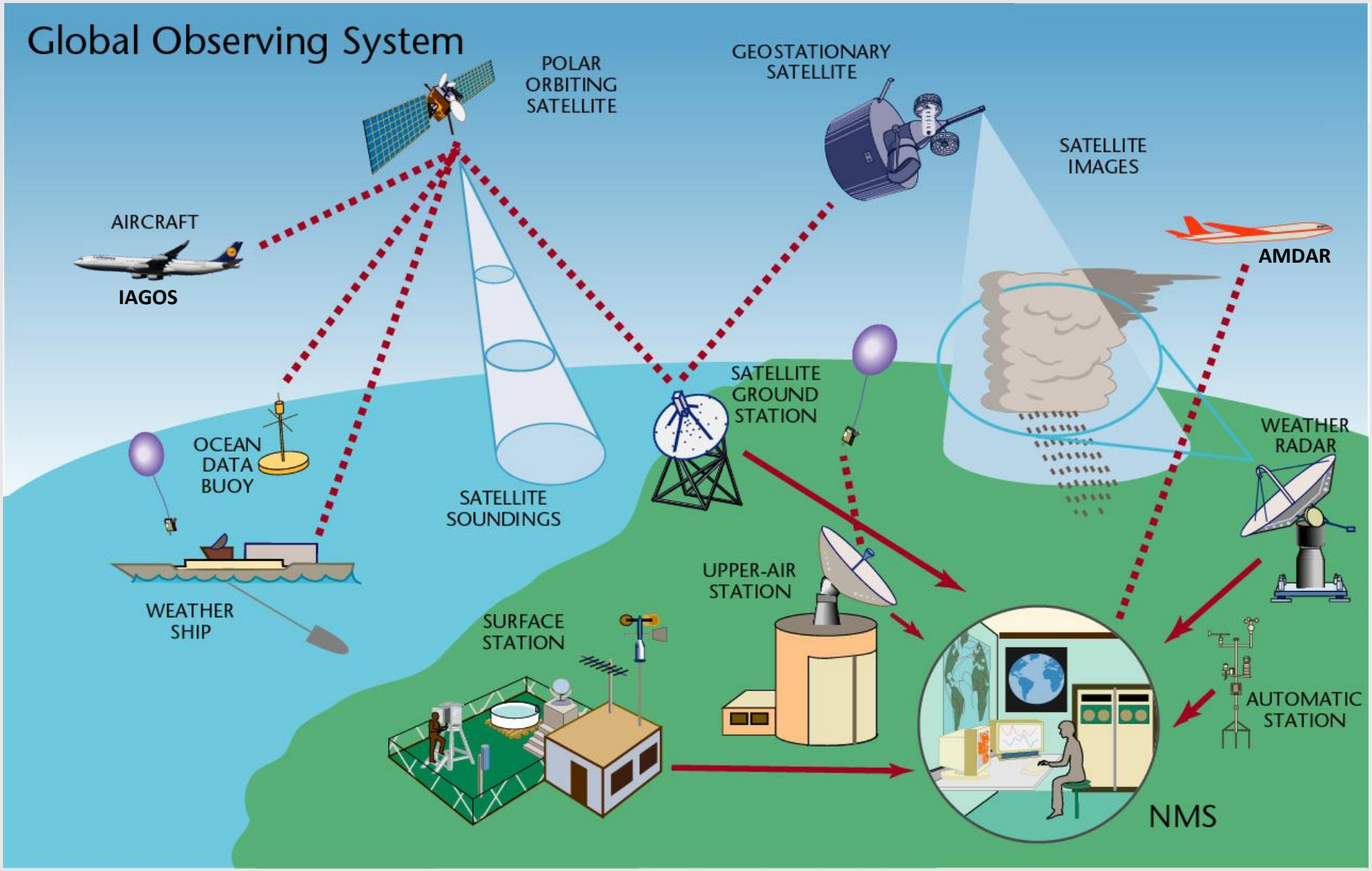


Source: private archive

# Geographic Occurrence of Cirrus Types

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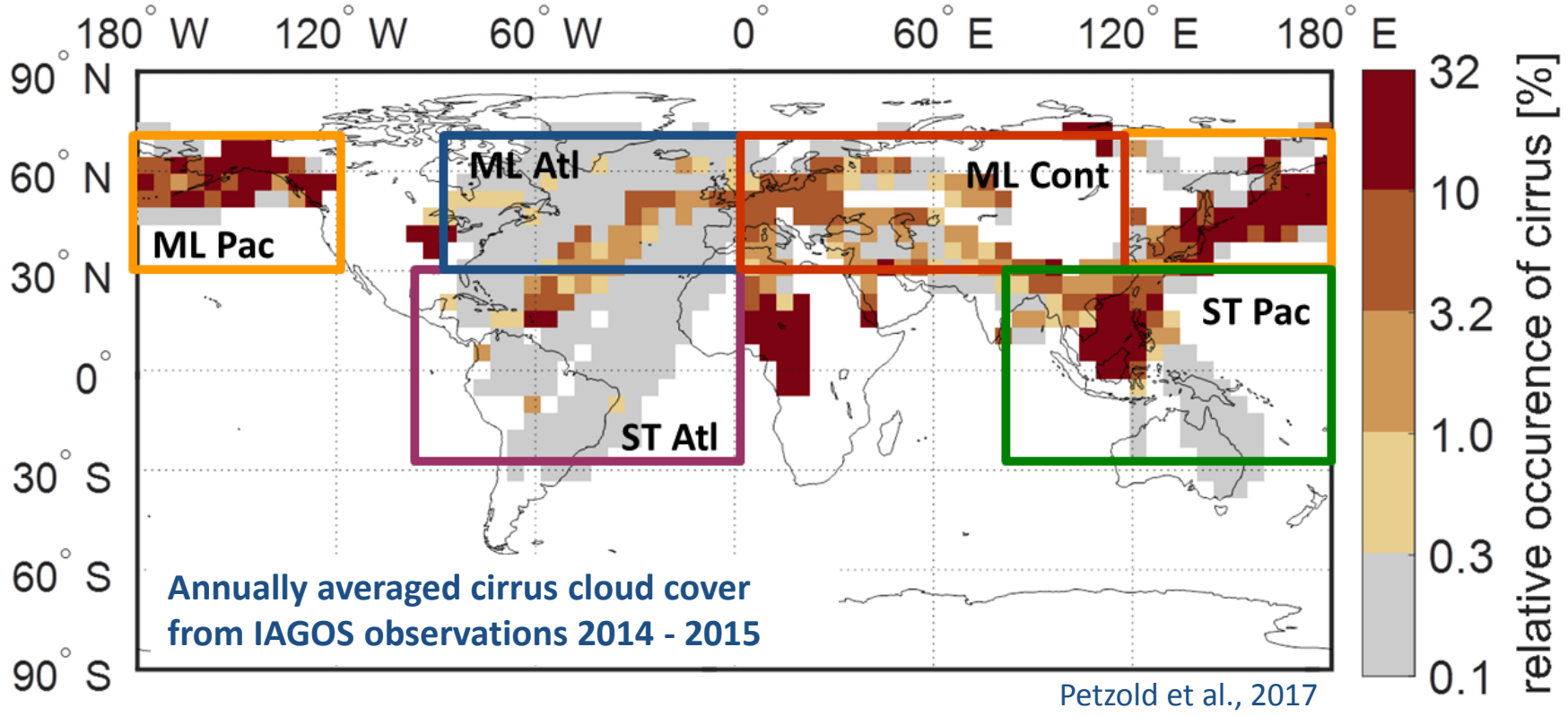


Petzold et al., 2017

- 360 hours of $RH_{ice}$ – $N_{ice}$ observations in 15 months
- Cruise alt. > 8.1 km (p < 350 hPa), $T_{amb}$ < 233 K to exclude supercooled water

| mid-latitude continental | mid-latitude Atlantic | subtropical Atlantic | mid-latitude Pacific | subtropical Pacific |
|---|---|---|---|---|

# Geographic Occurrence of Cirrus Types

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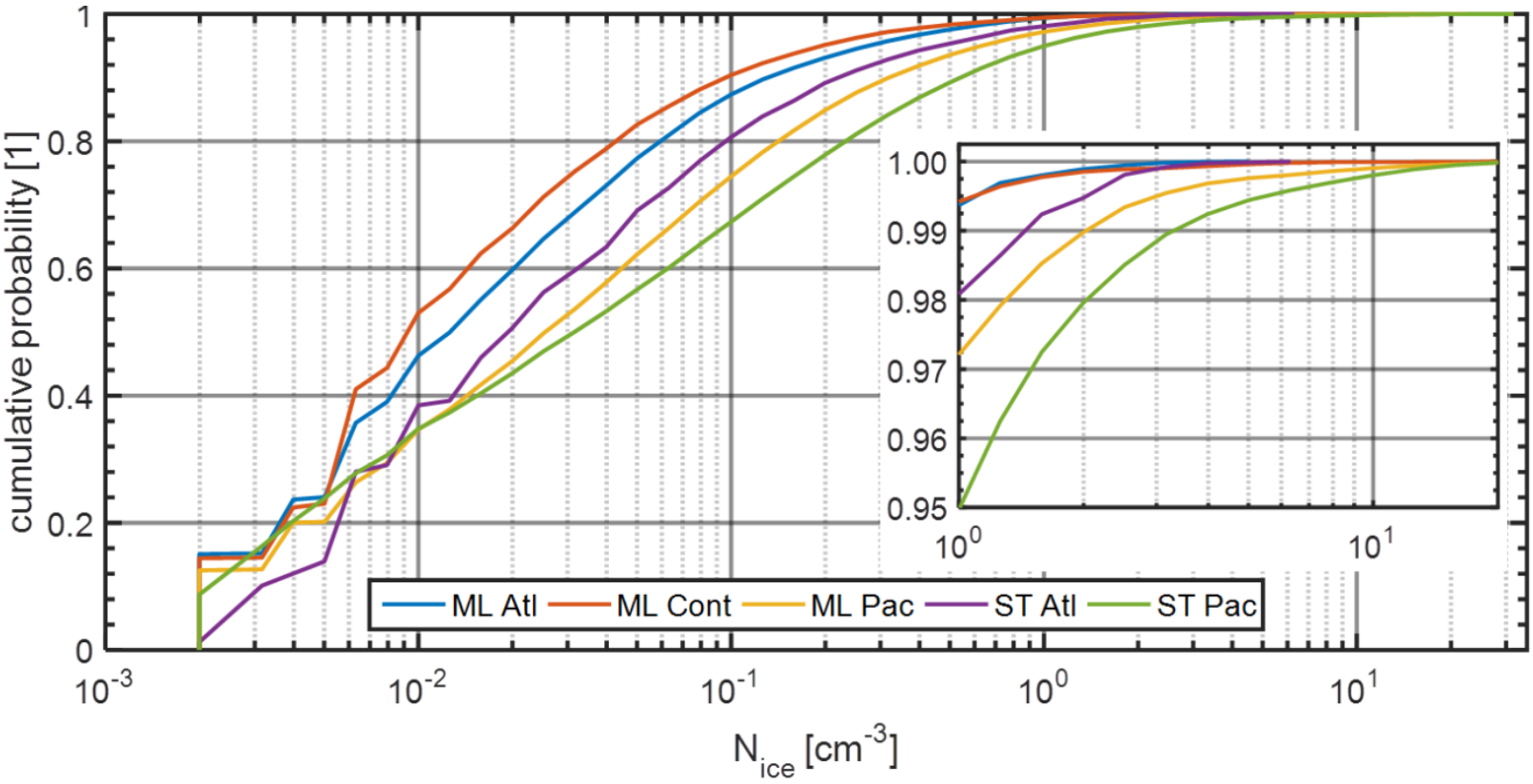
**equilibrium cirrus**
$RH_{ice} \approx 100\%$

**higher updraft cirrus**
$RH_{ice} > 100\%$

**convectively induced cirrus**
$RH_{ice} > 110\%$

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|---|---|---|---|---|

# The Anthropogenic Impact

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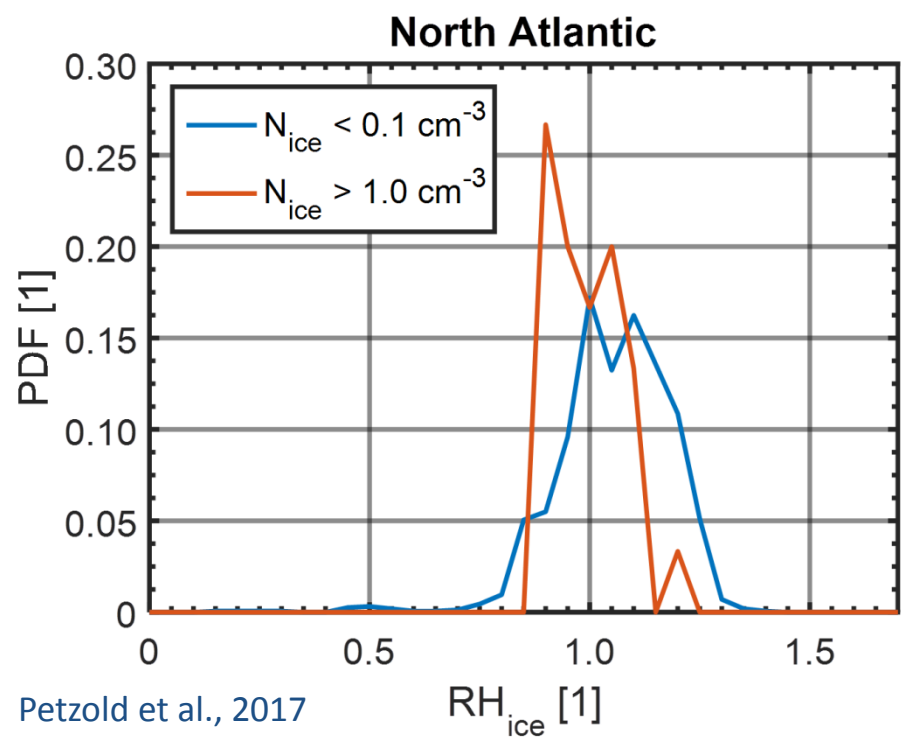
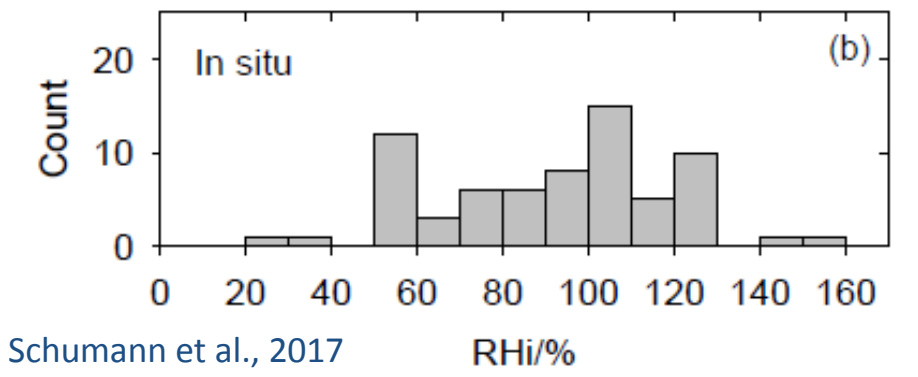



Petzold et al., 2017

## Contrails and Aviation Induced Cirrus

- Dense cirrus ($N_{ice}$ > 1 cm$^{-3}$) over North Atlantic Flight Corridor show contrail-signature
- Aircraft-induced cirrus form from persistent contrails
- Aging processes make AIC indis-tinguishable from natural cirrus
- Fraction of AIC difficult to quantify
  ⇒ subject of further analysis




Schumann et al., 2017

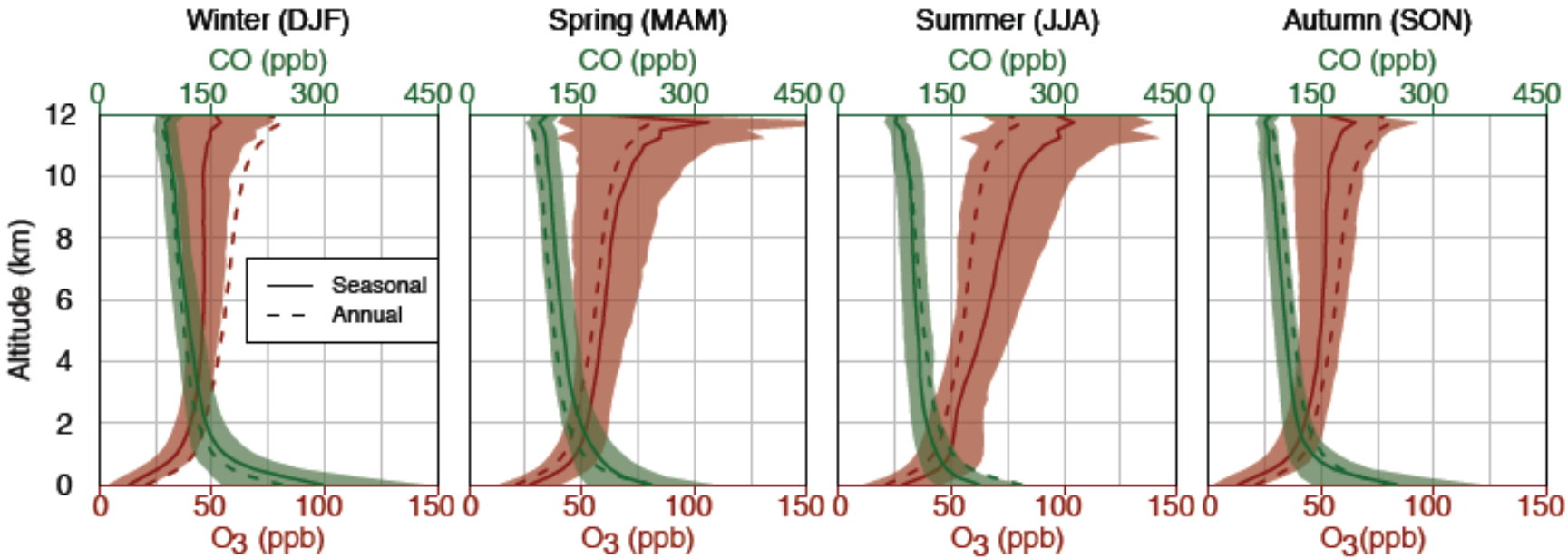
Histogram of relative humidity over ice ($RH_i$) for in-situ observations of contrails from research aircraft studies.

# Air Quality

Source: chemistryworld.com

# AIR QUALITY

www.iagos.org




IAGOS provides essential information on long-term changes around the tropopause (10-13 km). Data record over Frankfurt/Munich covers 20 yrs of $O_3$ and 12 yrs of CO profiles.

Climatological vertical profiles of $O_3$ and CO mixing ratios above Frankfurt/Munich per season.

Petetin et al., ACP 2016

# AIR QUALITY

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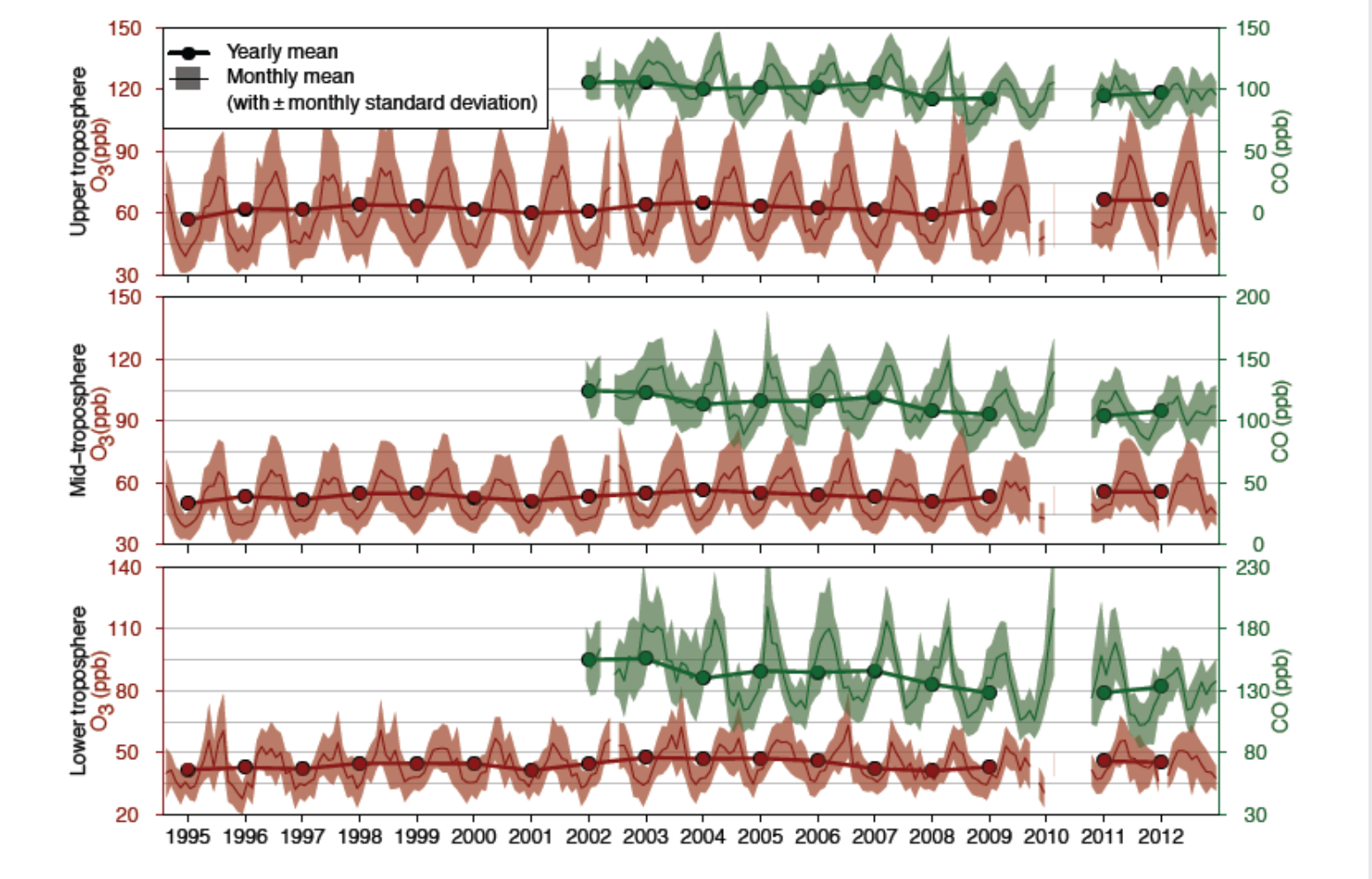



Over Europe, CO concentrations decreased significantly, while ozone remained relatively constant.

Petetin et al., ACP 2016

# LONG-RANGE TRANSPORT OF POLLUTION

www.iagos.org

nature

Vol 463|21 January 2010|doi:10.1038/nature08708

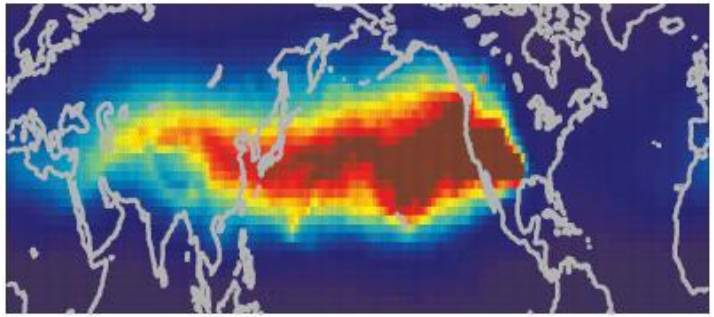
LETTERS

## Increasing springtime ozone mixing ratios in the free troposphere over western North America

O. R. Cooper[1,2], D. D. Parrish[2], A. Stohl[3], M. Trainer[2], P. Nédélec[4], V. Thouret[4], J. P. Cammas[4], S. J. Oltmans[2], B. J. Johnson[2], D. Tarasick[5], T. Leblanc[6], I. S. McDermid[6], D. Jaffe[7], R. Gao[2], J. Stith[8], T. Ryerson[2], K. Aikin[1,2], T. Campos[9], A. Weinheimer[9] & M. A. Avery[10]

Springtime ozone levels in the lower atmosphere over western North America are rising.

The source of this pollution may be Asia, a finding that reaffirms the need for international air-quality control.



# Long-Range Transport of Pollution

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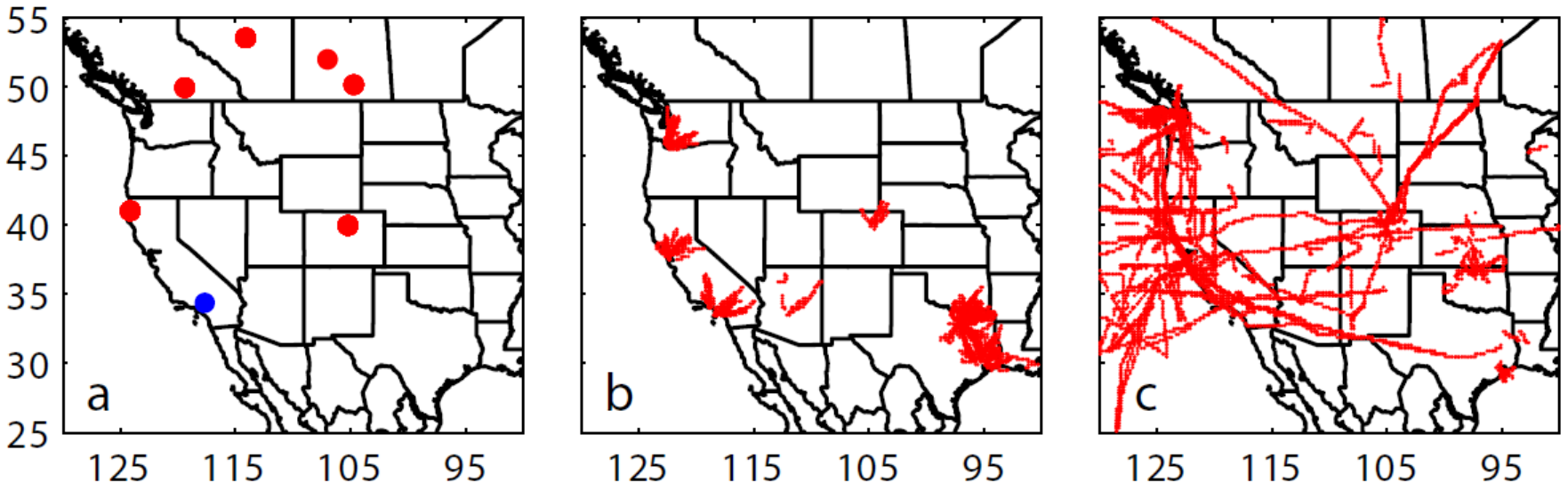


Maps show investigated regions and positions of

a) Ozone sondes (red) and Lidar stations (blue),

b) IAGOS ozone profiles at 3-8 km, and

c) Research aircraft data of ozone at 3-8 km.

O. Cooper et al., Nature 436, 2010

# Volcanic Aerosol

Source: Weinzierl et al., Phys. Chem. Earth 2012

# VOLCANIC AEROSOL

www.iagos.org

nature COMMUNICATIONS

Received 18 Dec 2014 | Accepted 29 May 2015 | Published 9 Jul 2015

DOI: 10.1038/ncomms8692 OPEN

## Significant radiative impact of volcanic aerosol in the lowermost stratosphere

Sandra M. Andersson[1], Bengt G. Martinsson[1], Jean-Paul Vernier[2,3], Johan Friberg[1], Carl A.M. Brenninkmeijer[4], Markus Hermann[5], Peter F.J. van Velthoven[6] & Andreas Zahn[7]

**"We show that half of the global stratospheric aerosol optical depth following the Kasatochi, Sarychev and Nabro eruptions is attributable to lowermost stratosphere aerosol."**

**"… we show that the lowermost stratosphere makes an important contribution to the overall volcanic forcing."**

Andersson et al., 2015

# VOLCANIC AEROSOL

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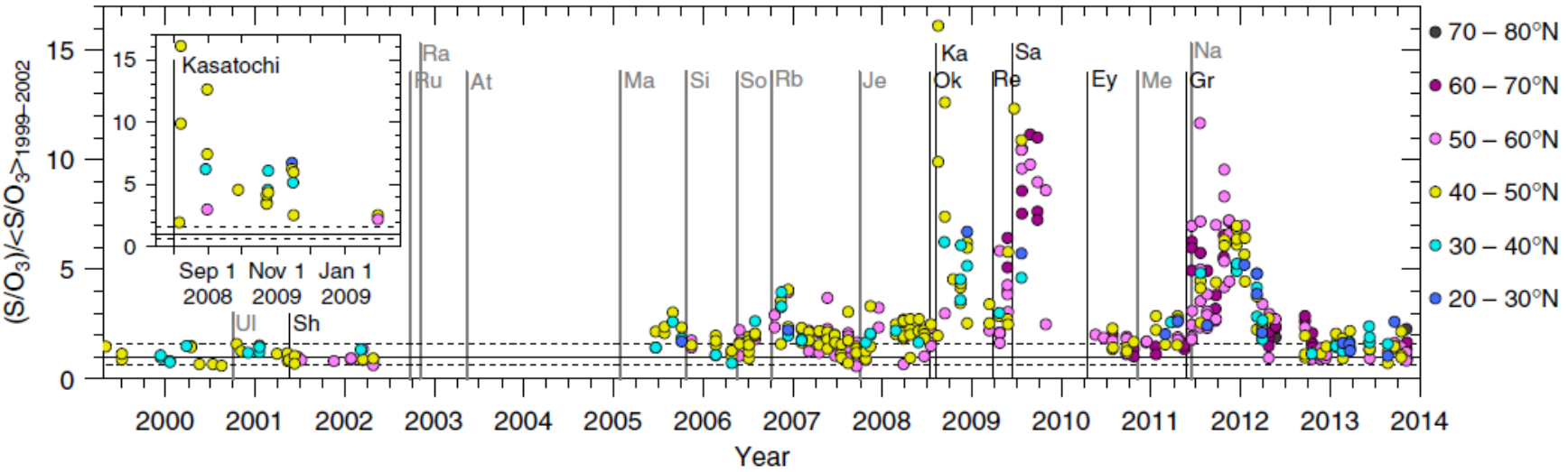


Identification of volcanic aerosol in the lowermost stratosphere by IAGOS-CARIBIC time series of S/O3, normalized by average S/O3 during periods of low volcanic influence.

**"We show that half of the global stratospheric aerosol optical depth following the Kasatochi, Sarychev and Nabro eruptions is attributable to lowermost stratosphere aerosol."**

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Central Pacific

# First Central Pacific Transects

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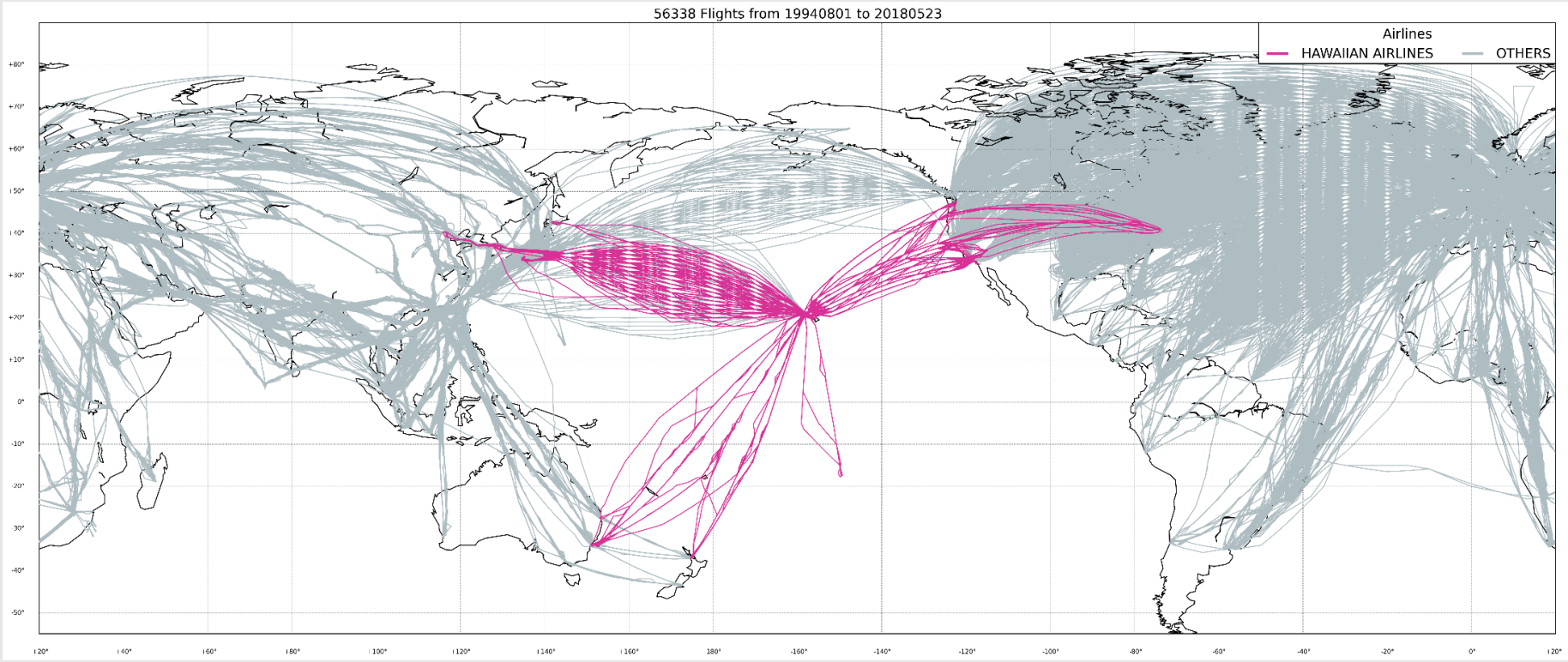


**Hawaiian Airlines joining IAGOS closes a major gap of Earth Observation over the Central Pacific.**

# First Central Pacific Transects

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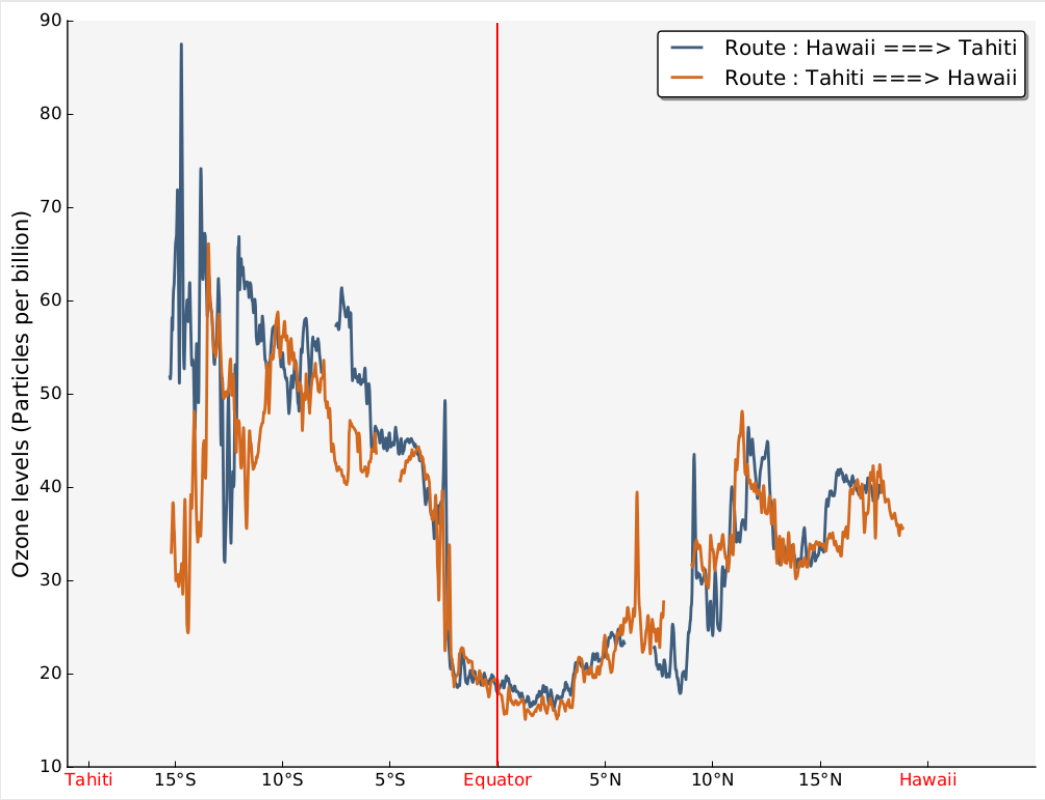
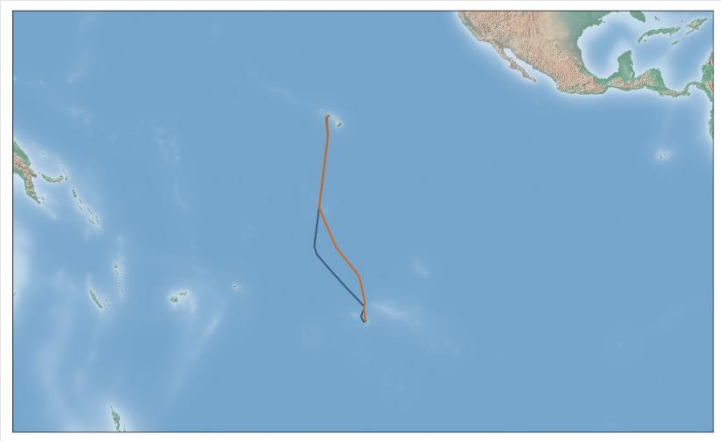
## HAL allows first Central Pacific transects of the Equator from Northern to Southern Hemisphere



Ozone mixing ratio at cruise altitude of 12 – 13 km

**Ozone distribution across the equator ⇒ Important data for comparison of hemispheres.**

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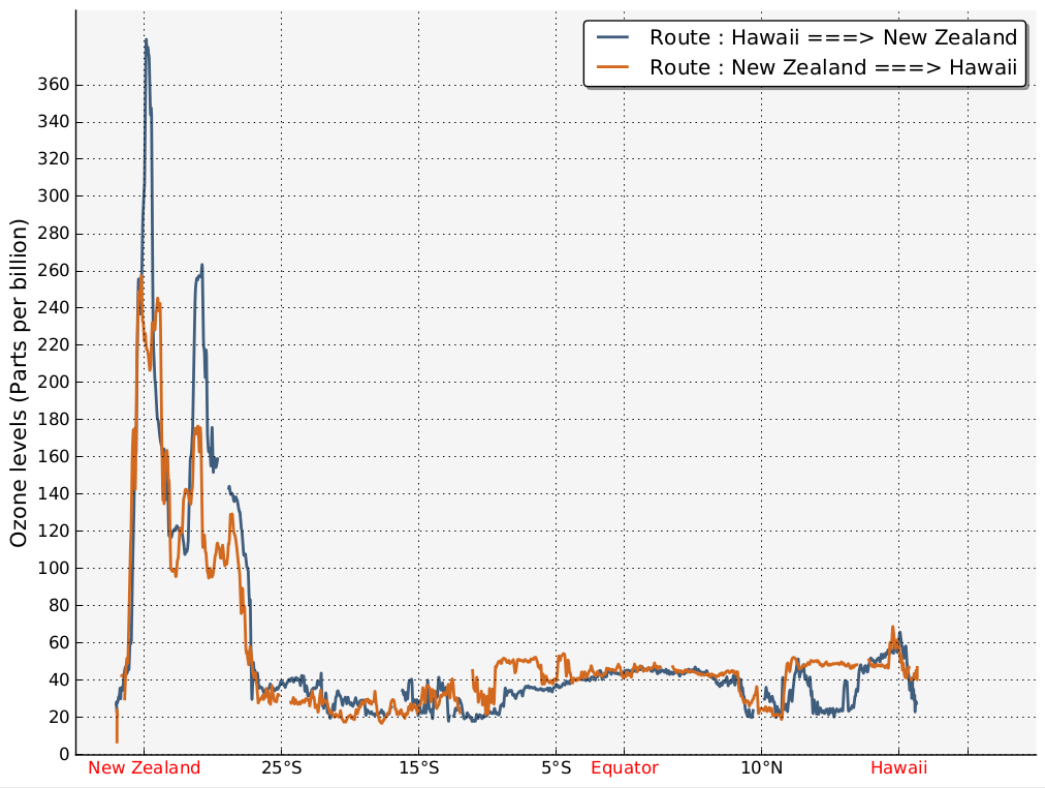


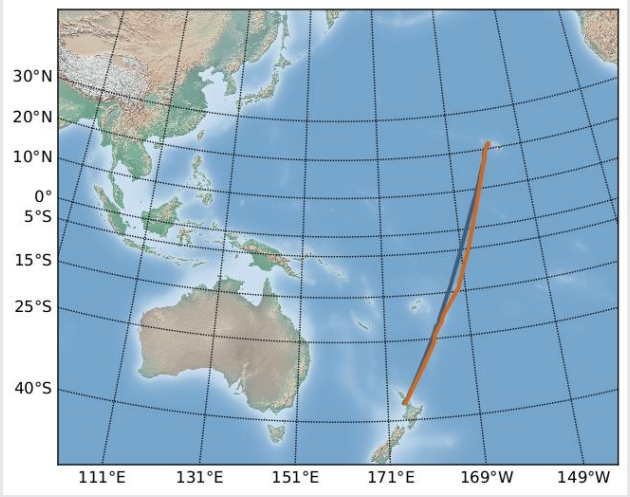


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# We acknowledge the strong support by the airlines

# There is more science to come in the future

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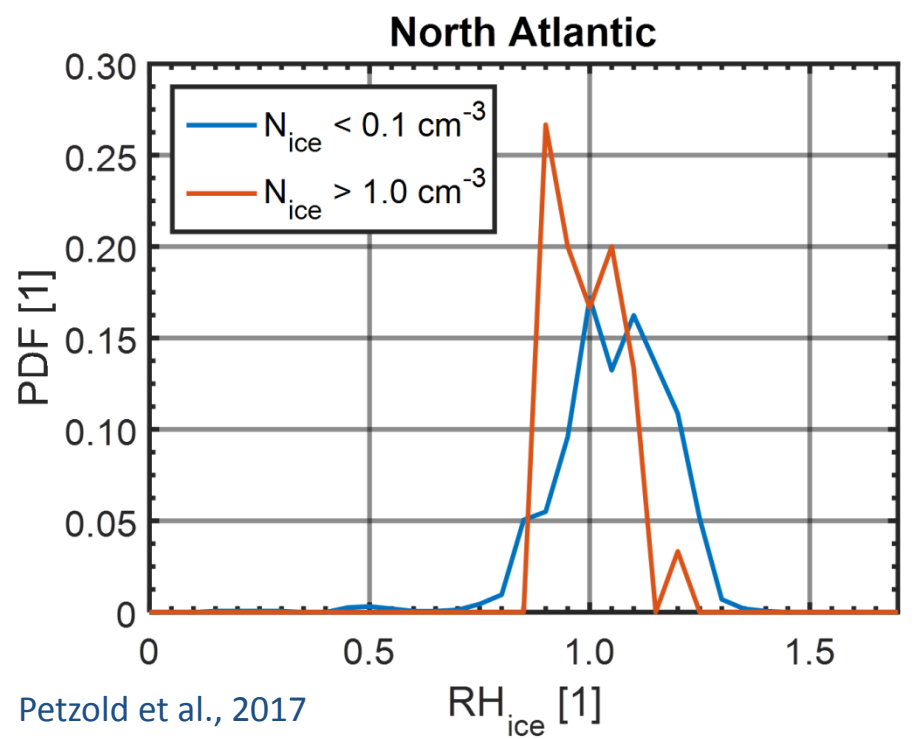


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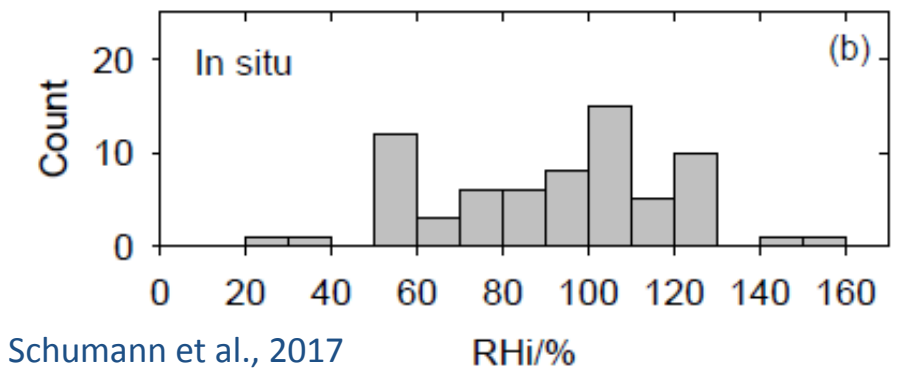


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