

# First IAGOS-CORE and IAGOS-CARIBIC greenhouse gas observations from commercial airliners



Christoph Gerbig, Stephan Baum  
(MPI-BGC, Jena)

Harald Franke, Ralf Stosius  
(enviscope, Frankfurt)

Florian Obersteiner, Torsten Gehrlein, Andreas Zahn  
(KIT, Karlsruhe)



# Why IAGOS-GHG observations?

- Vertical profiles for better constrained inverse modeling
- Improvement of transport models (Convection, Mixing, Strat-Trop Exch.)
- Validation of remote sensing
- Emission inventory validation

*Verma et al., ACP 2017a*

*Verma et al., ACP 2017b*

*Boschetti et al., Tellus 2015*

*Boschetti et al., ACP 2018*





# Complementary approach

## ➤ IAGOS-Core

- continuous deployment, 15-20 aircraft (STC for Airbus A340 and A330)
- limited to key species



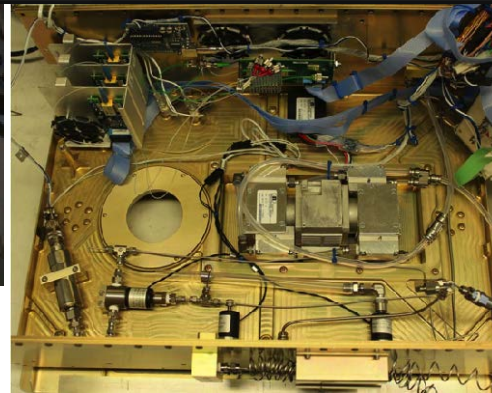
**Both equipped with GHG measurements!**

## ➤ IAGOS-CARIBIC

- once - twice monthly, single aircraft (Airbus A340)
- large suite of species; air samples



# IAGOS-core GHG integration



- Simultaneous measurements of CO<sub>2</sub>, CH<sub>4</sub>, CO and H<sub>2</sub>O
- repackaged picarro G2301-m components + calibration system
- no drying (measured H<sub>2</sub>O to correct for broadening and dilution)

Filges et al.,  
[[L]]  
[[SEP]] Tellus-B 2015

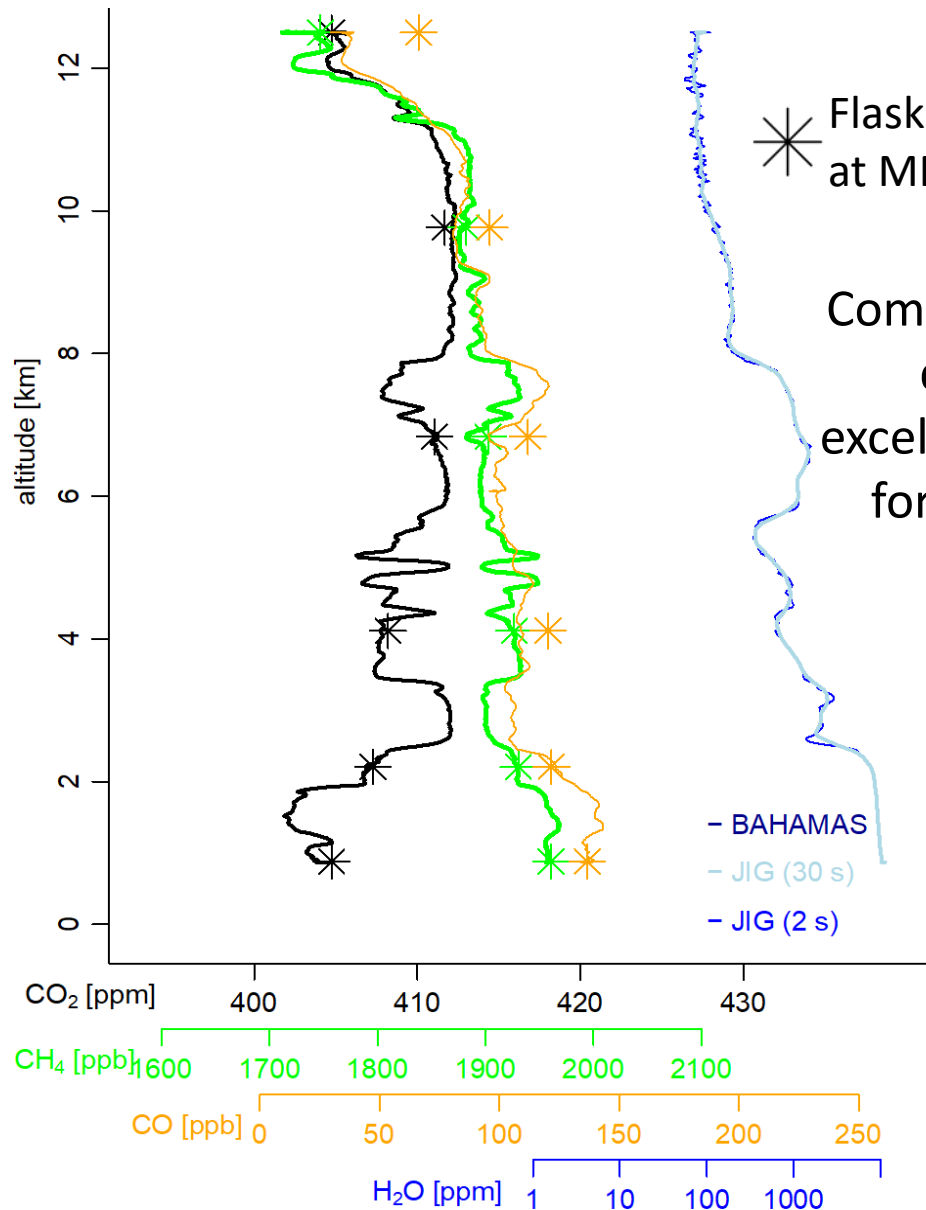
Filges et al., [[L]]  
[[SEP]] 2018

# Deployment on HALO research aircraft

within the CoMet campaign May-June 2018



Photos: A. Fix, DLR



\* Flask samples analysed at MPI-BGC GasLab

Comparison to flask data shows excellent agreement for CO<sub>2</sub> and CH<sub>4</sub>

- BAHAMAS  
- JIG (30 s)  
- JIG (2 s)



# IAGOS-core GHG integration

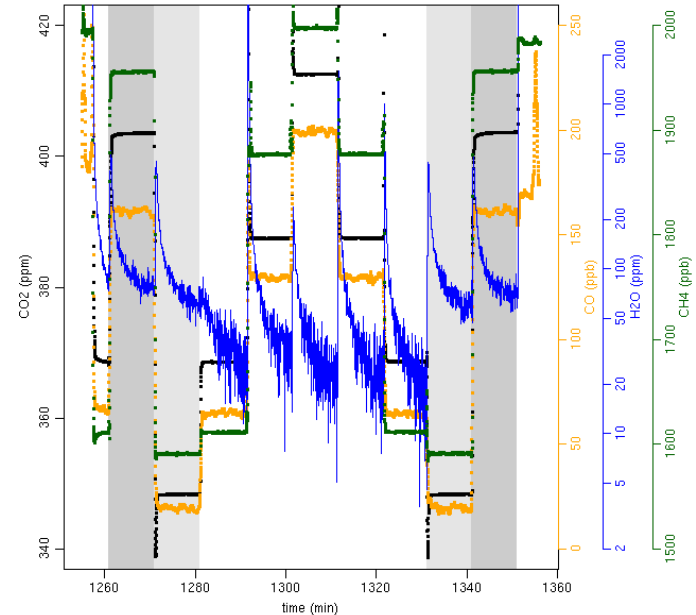
- Dec. 2016:  
STC (supplemental  
type certification)  
for A340/A330
- Since then:  
Integration, first  
flights



Bundesministerium  
für Bildung  
und Forschung



# IAGOS core GHG Operation



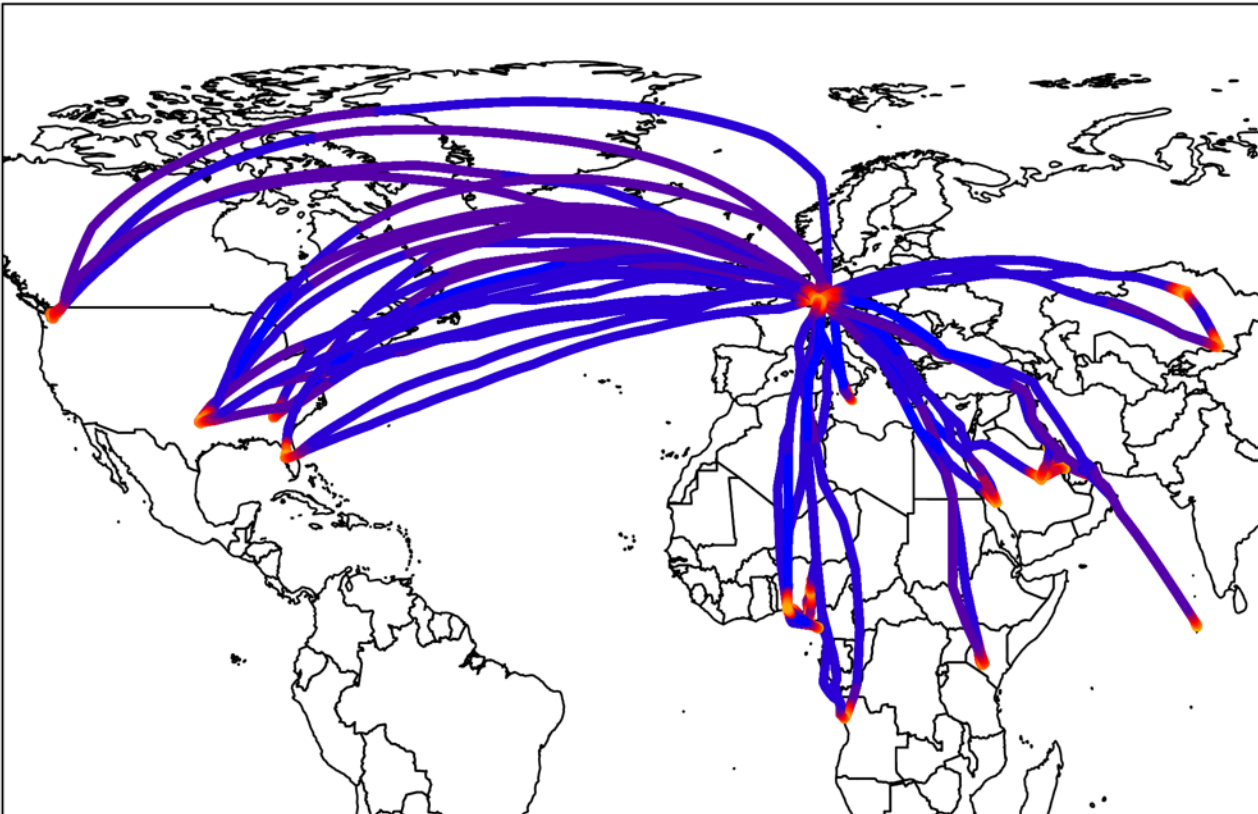
- 6 month deployment cycle
- fully automated
- calibrations during flight and on ground
- data transfer via GSM


Maintenance after each deployment:

- full functional test
- pump membrane replacement
- water correction check
- Calibration gas refill
- Calibration against laboratory standards (reference to WMO scales)

# IAGOS core GHG deployments

IAGOS D-AIKO flight track Sep 11 2018 – Mar 22 2019

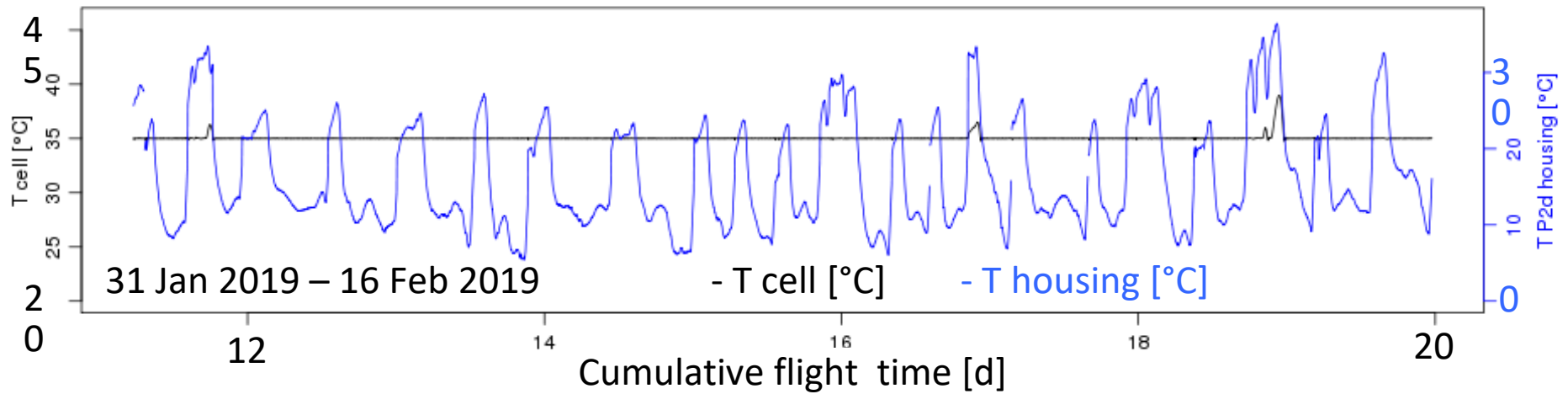
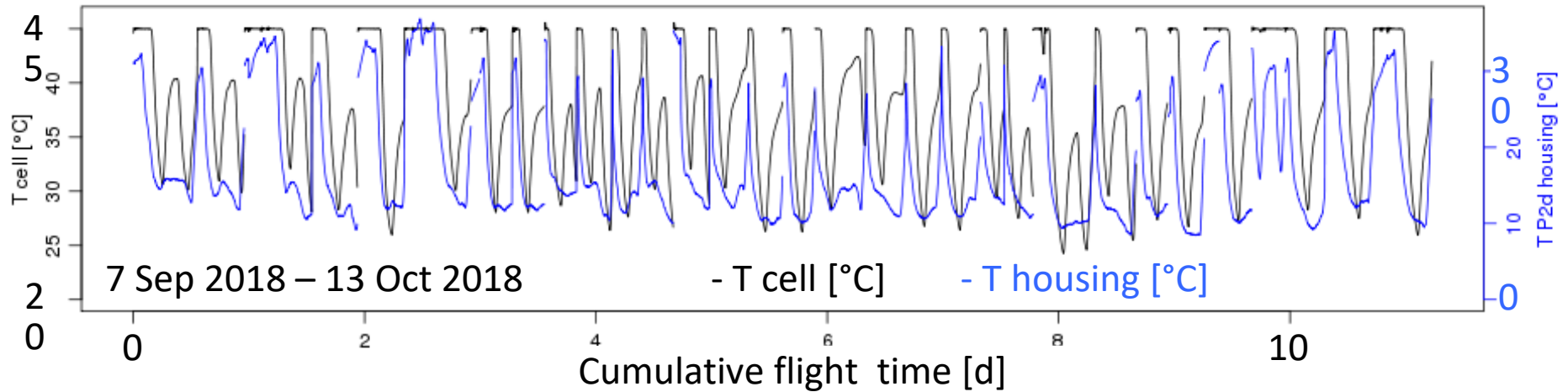


 Bundesministerium  
für Bildung  
und Forschung





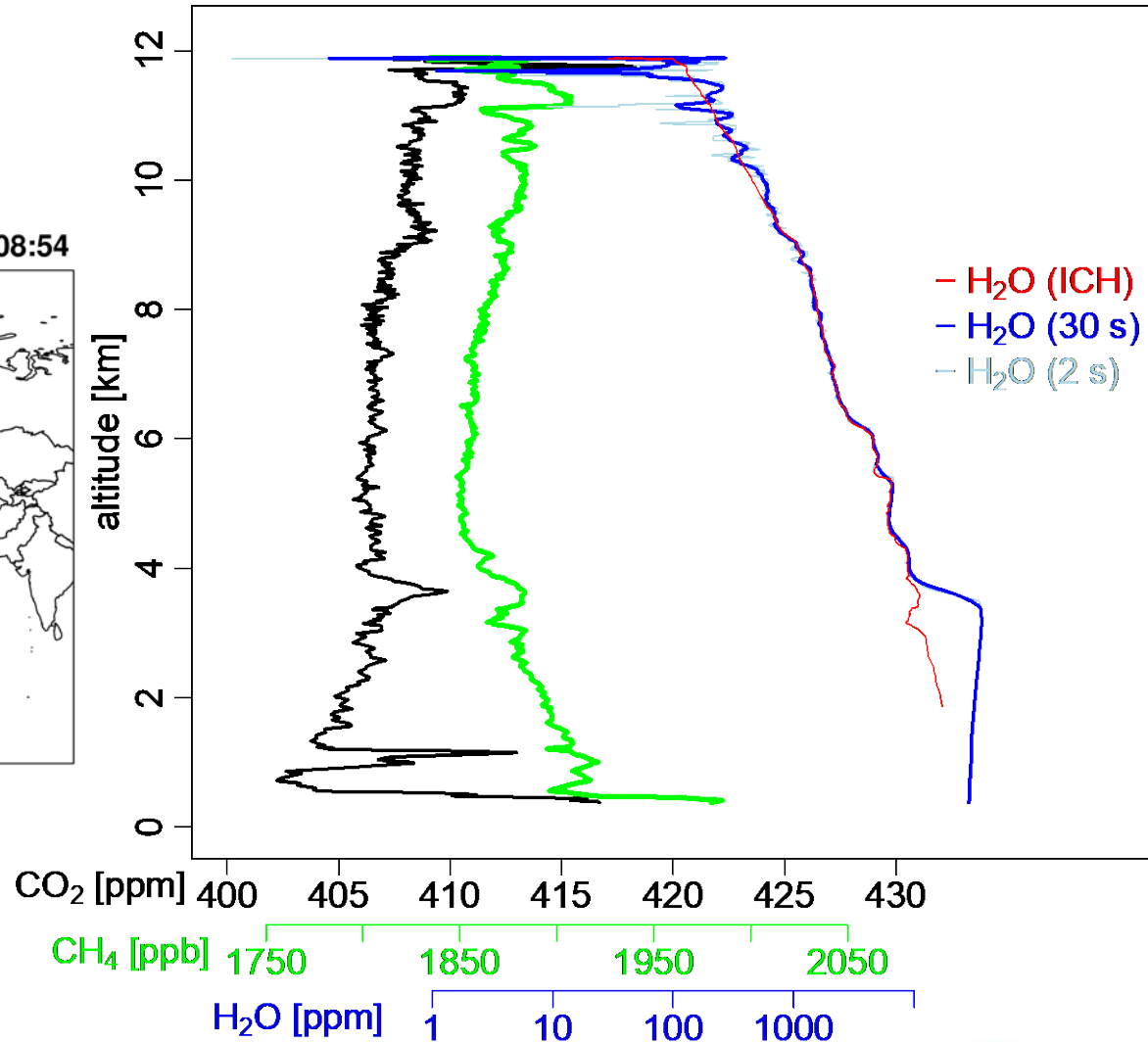
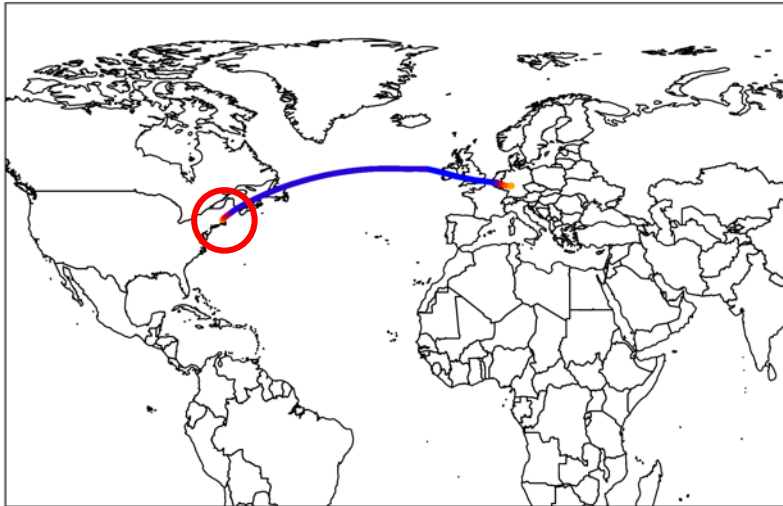
# IAGOS core GHG Temperatures



# IAGOS core GHG 1<sup>st</sup> data

IAGOS P2d SN01 on D-AIKO (Lufthansa)  
Boston – Frankfurt Takeoff 2018-09-12 02:25:47

IAGOS D-AIKO 2018-09-12 02:24 – 2018-09-12 08:54



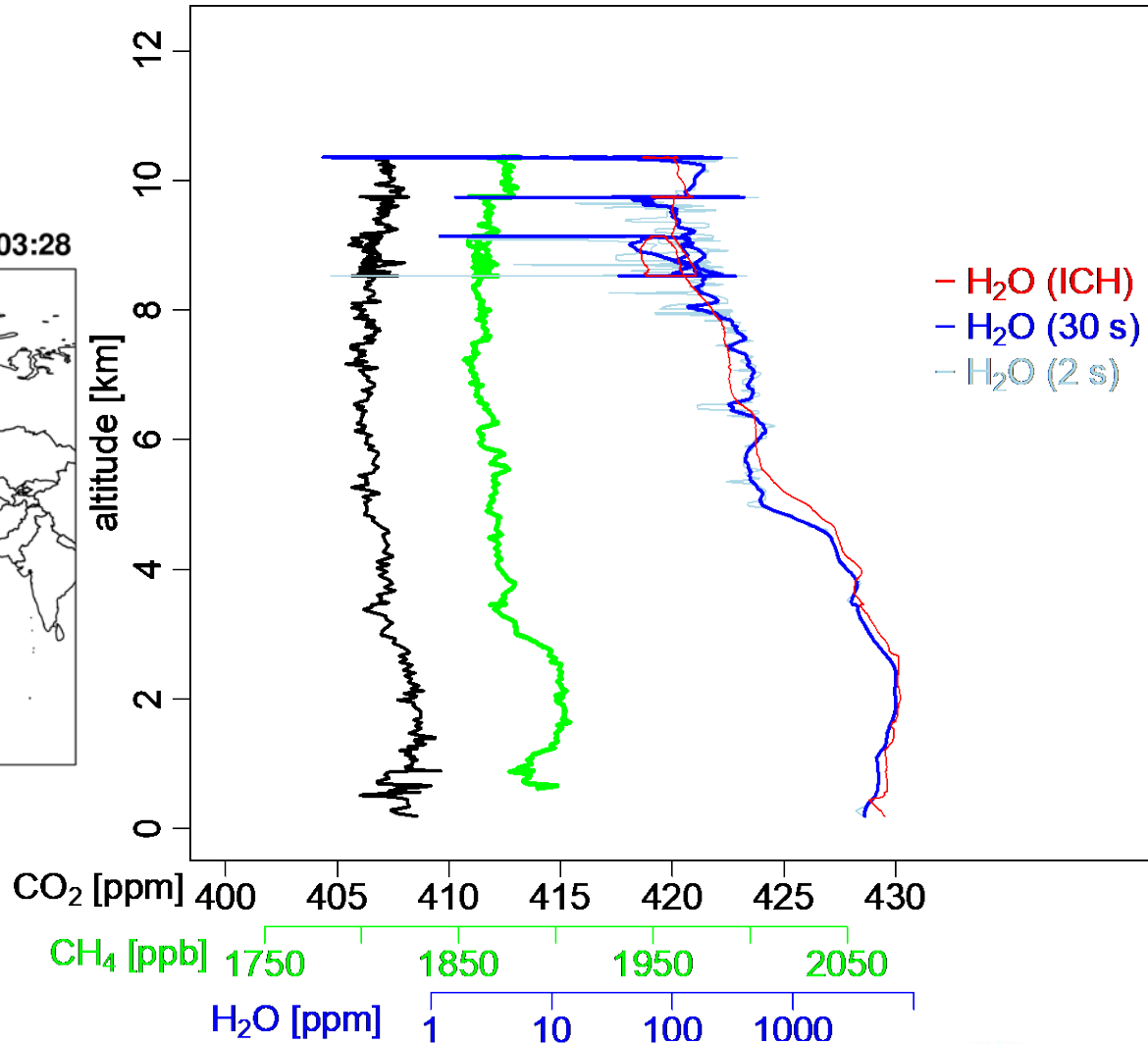
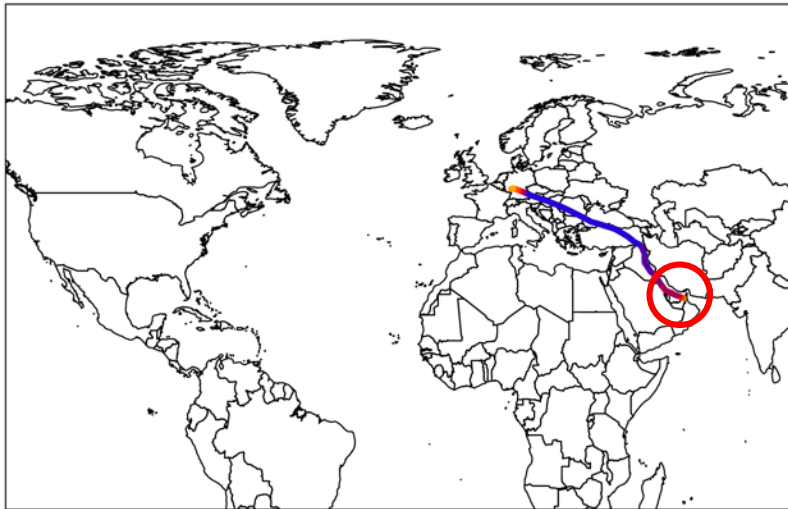
ICH (IAGOS Capacitive Hygrometer)  
data provided by S. Rohs (FZ-  
Juelich)



# IAGOS core GHG 1<sup>st</sup> data

IAGOS P2d SN01 on D-AIKO (Lufthansa)  
Dubai – Frankfurt Takeoff 2018-10-12 21:15:09

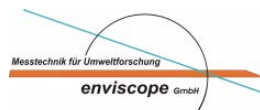
IAGOS D-AIKO 2018-10-12 21:14 – 2018-10-13 03:28



ICH (IAGOS Capacitive Hygrometer)  
data provided by S. Rohs (FZ-  
Juelich)



Bundesministerium  
für Bildung  
und Forschung

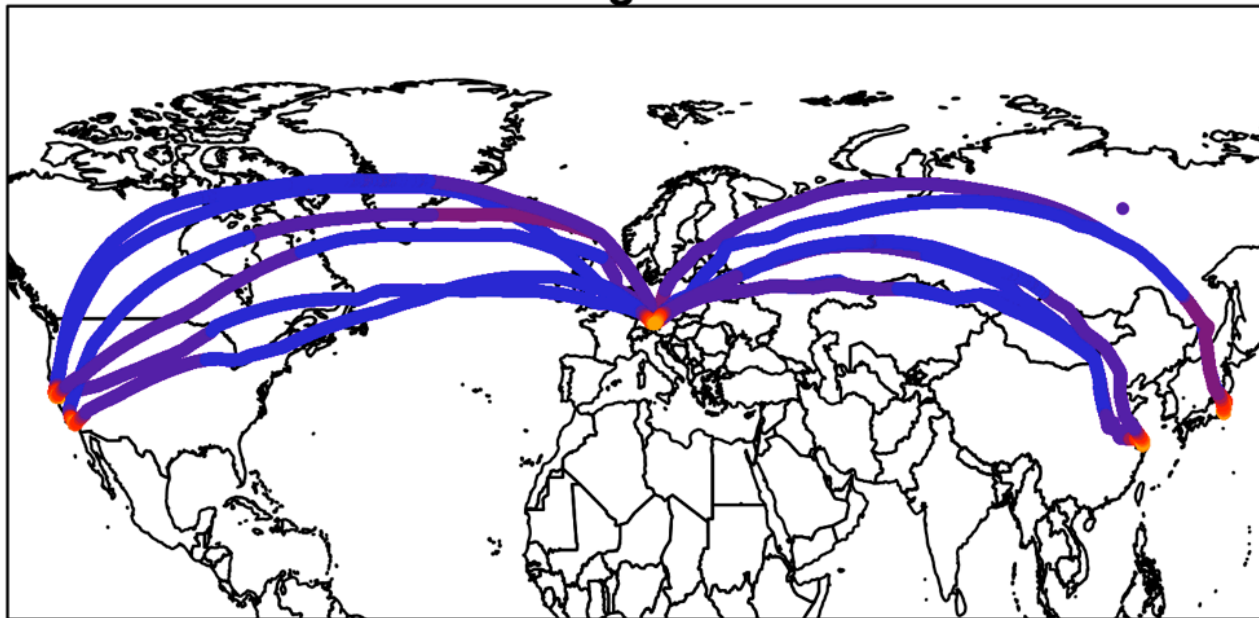


# IAGOS CARIBIC GHG deployments

- First deployment 29 July 2018
- 14 successful flights since



## IAGOS CARIBIC flight tracks with GHGs



# IAGOS CARIBIC GHG data

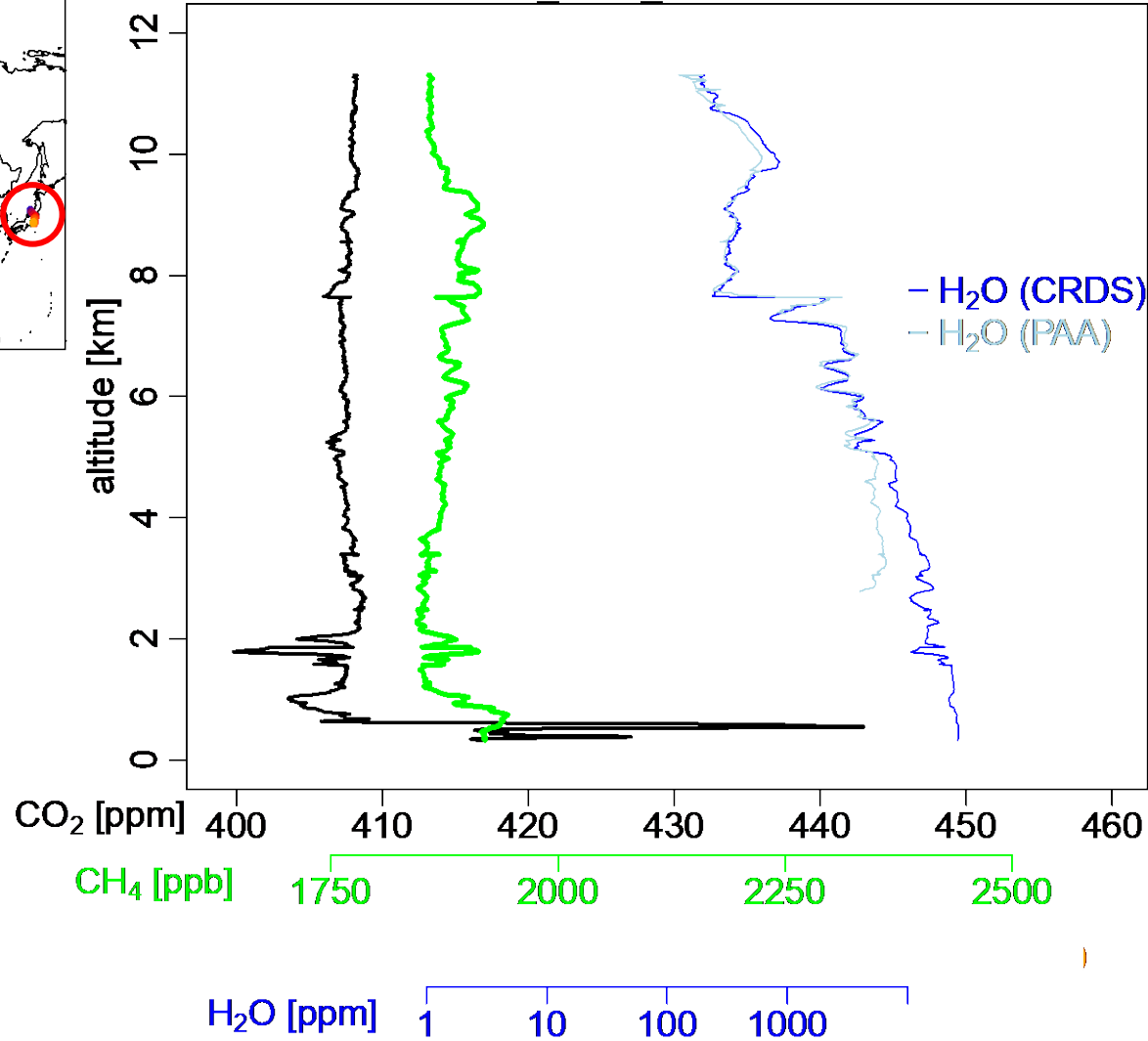
IAGOS CARIBIC 2018-07-30 00:48 – 2018-07-30 01:45



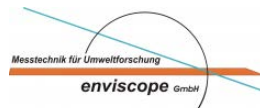
Tokio profile before landing

- Convective signatures
- H<sub>2</sub>O ~ agreement with photoacoustic analyzer (KIT)

IAGOS Caribic 550 MUC\_HND 2018-07-30 01:12:30



Bundesministerium  
für Bildung  
und Forschung



# IAGOS CARIBIC GHG data

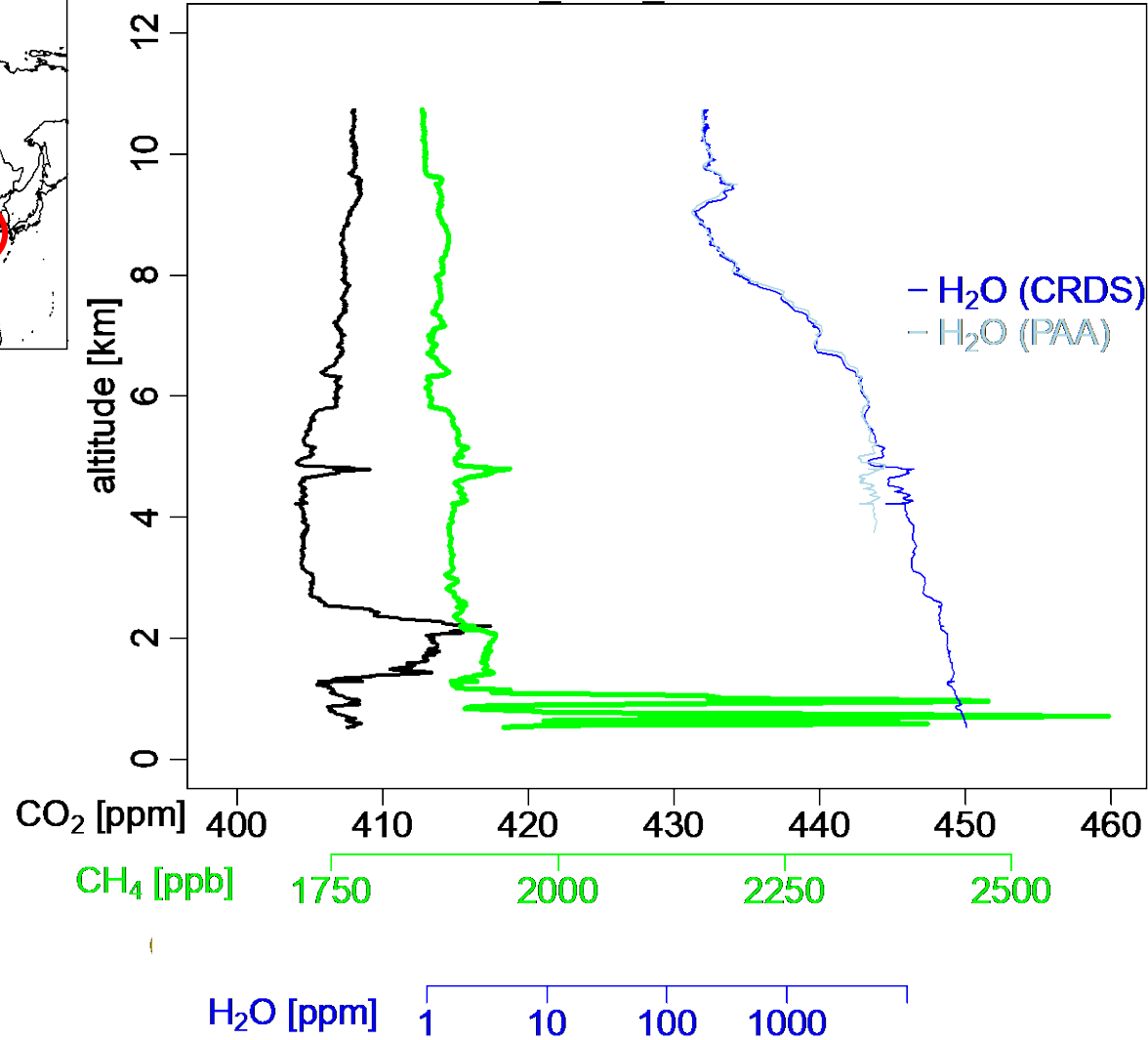
IAGOS CARIBIC 2018-07-31 06:48 - 2018-07-31 07:44



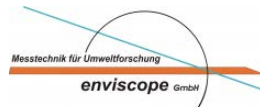
Shanghai profile before landing

- Large CH<sub>4</sub> enhancement

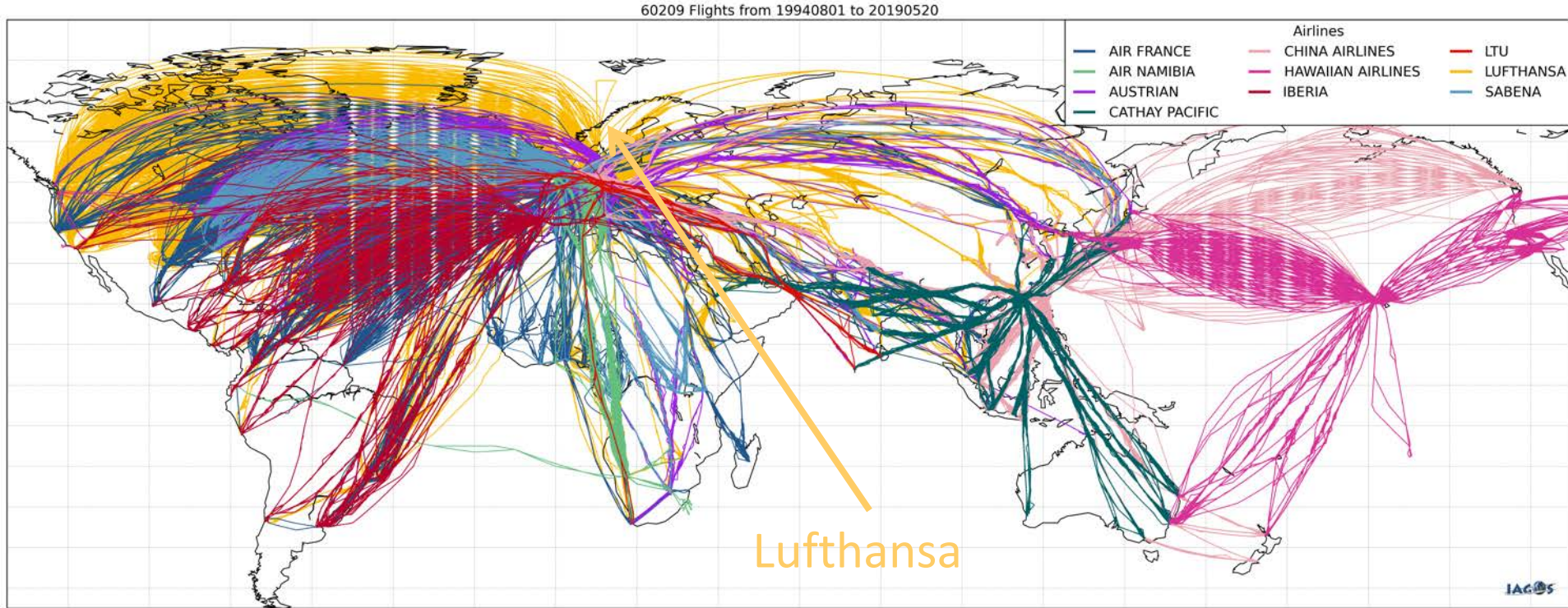
IAGOS Caribic 552\_MUC\_PVG 2018-07-31 07:12:10



Bundesministerium  
für Bildung  
und Forschung

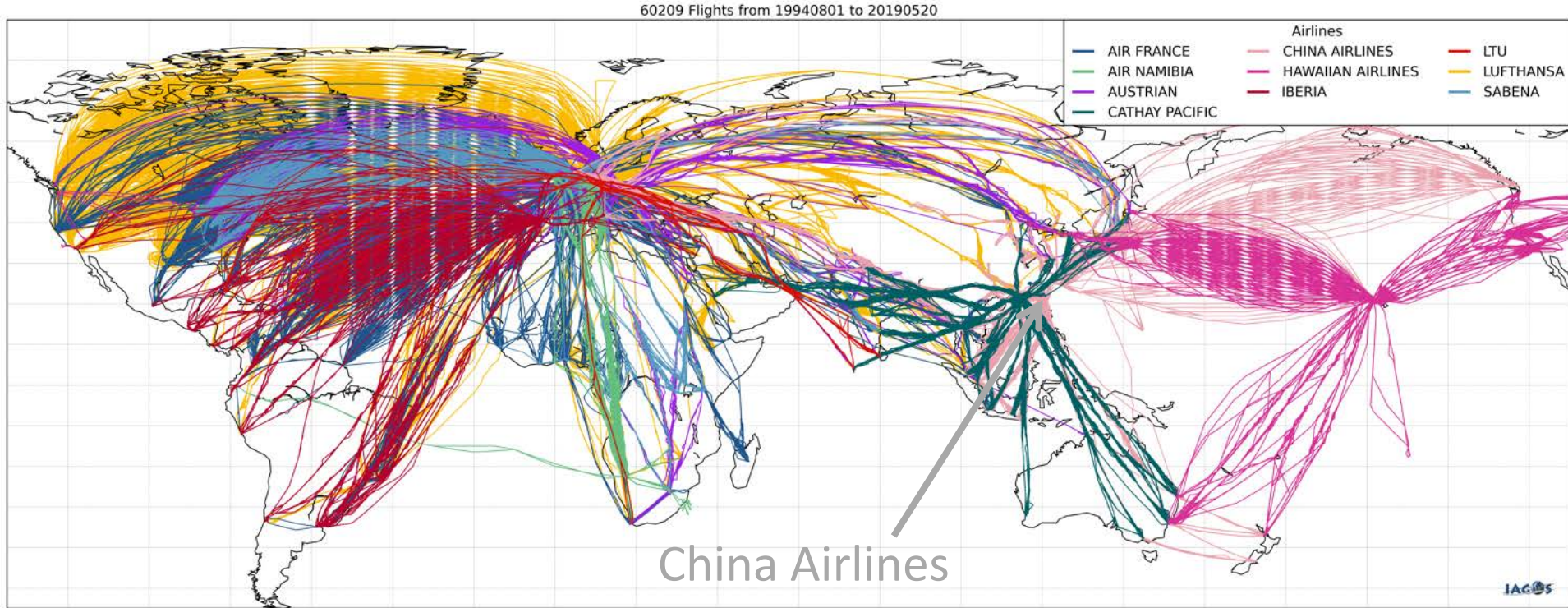


# IAGOS core GHG future deployments



- P2d-SN01: waiting for Form One
- P2d-SN02, SN03, SN04: final assembly
- P2d-SN05, SN06: assembly 2019

# IAGOS core GHG future deployments

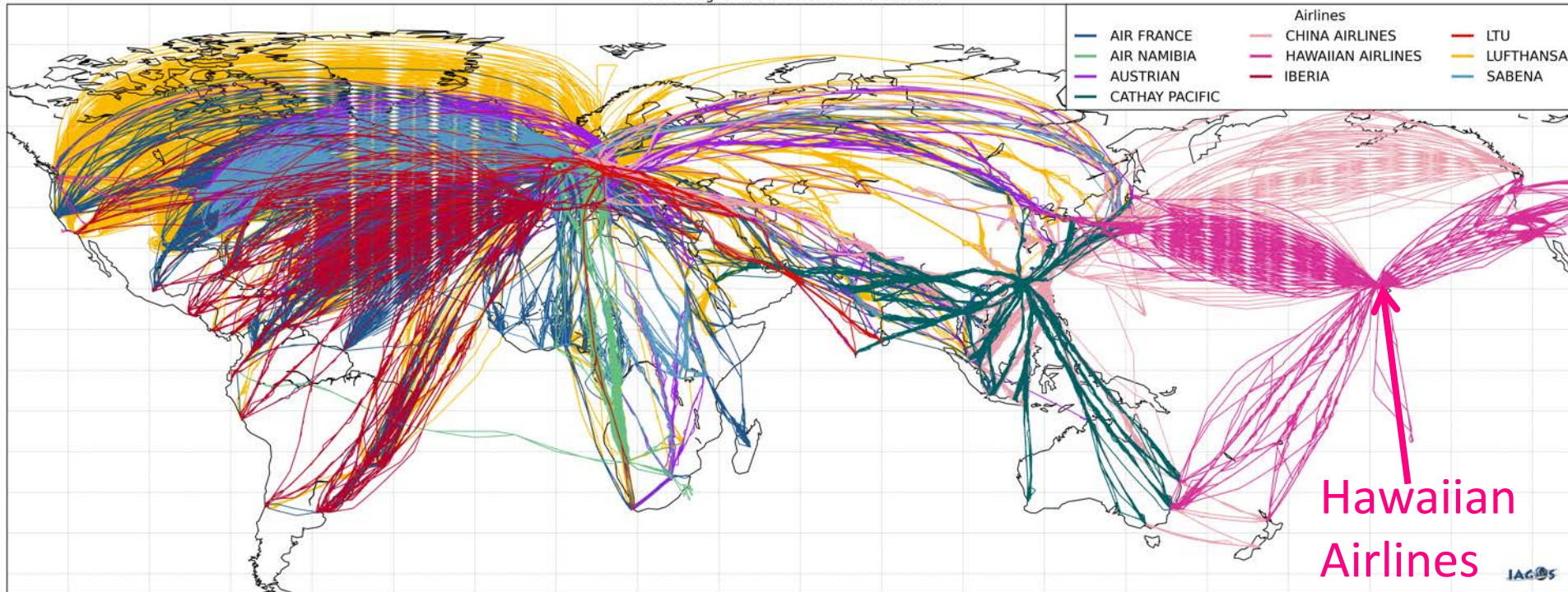


- P2d-SN01: waiting for Form One
- P2d-SN02, SN03, SN04: final assembly
- P2d-SN05, SN06: assembly 2019



# IAGOS core GHG future deployments

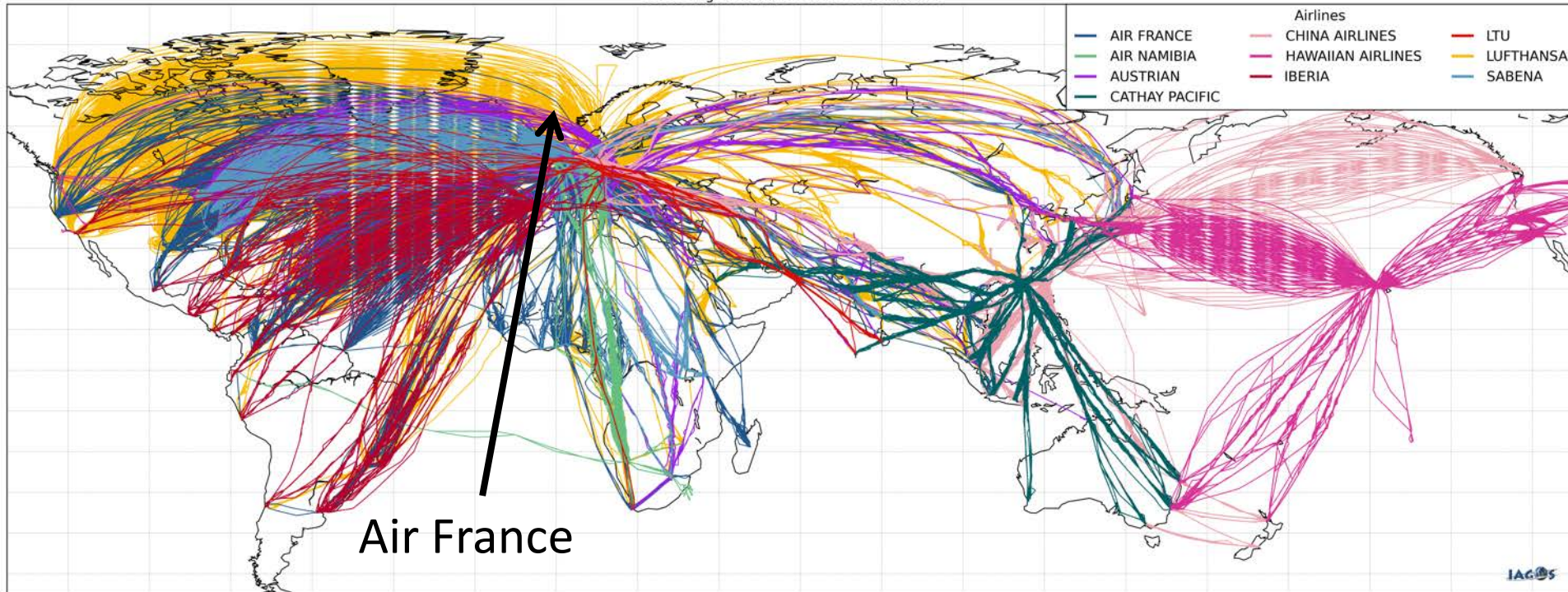
60209 Flights from 19940801 to 20190520



- P2d-SN01: waiting for Form One
- P2d-SN02, SN03, SN04: final assembly
- P2d-SN05, SN06: assembly 2019

# IAGOS core GHG future deployments

60209 Flights from 19940801 to 20190520



- P2d-SN01: waiting for Form One
- P2d-SN02, SN03, SN04: final assembly
- P2d-SN05, SN06: assembly 2019

# Summary

- IAGOS-Core GHG system “P2d” SN01 successfully installed
- 1<sup>st</sup> lessons learned
- Traceability to WMO scales for CO<sub>2</sub>, CH<sub>4</sub>, CO
- Five more P2d’s will follow to equip 4 aircraft
- NRT capability (GSM transfer after landing)
- Two flights per day per aircraft expected



Bundesministerium  
für Bildung  
und Forschung

