Model assessments of atmospheric composition in the UTLS with the IAGOS database; application to the ACACIA EU project

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A bridge between model and obs.

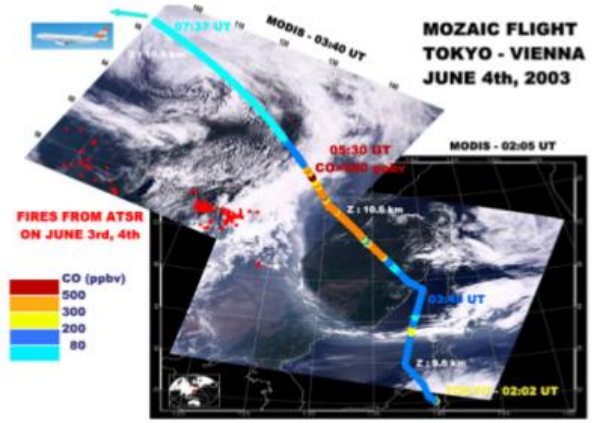
- IAGOS

— Resolution:

▸ Horizontal: 1 km

▸ Vertical: < 30 m

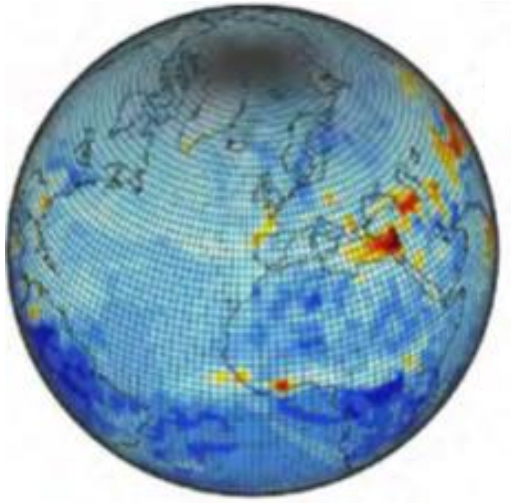
▸ Temporal: 4 s



From Nédélec et al., 2005 (GRL)

Interpol-IAGOS

Cohen et al. (2021, GMD)



- Global chemistry-climate model

— Resolution:

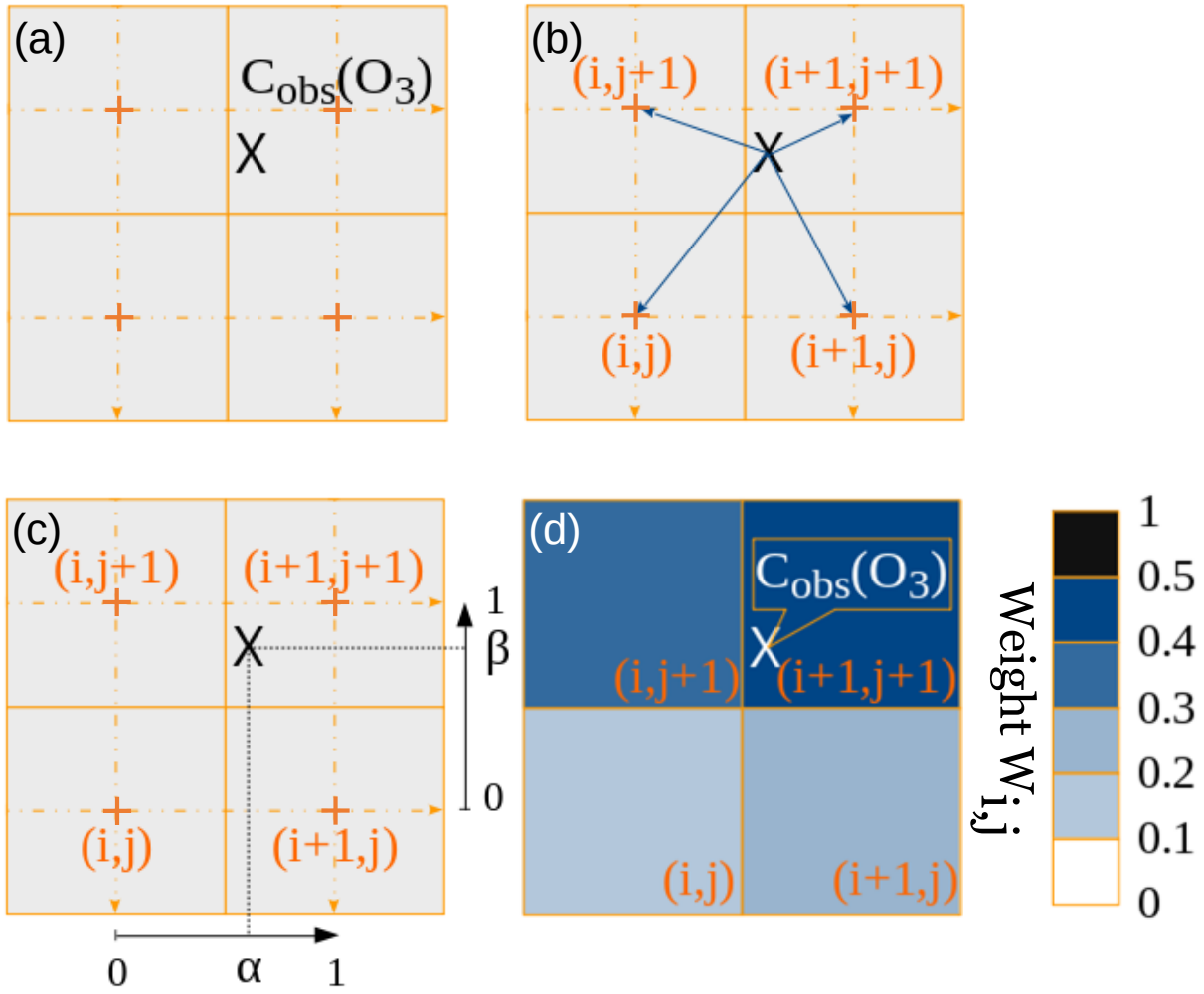
▸ Horizontal: hundreds of km

▸ Vertical: 0.5 – 1 km

- ⇒ Purpose of the *Interpol-IAGOS* software: to make the obs. and the model output directly comparable

Projecting the on-flight measurements onto a common 3D model grid

1)



2) Monthly mean at a given (i,j,k) gridcell:

$$C_{i,j,k}(O_3) = \frac{\sum_{obs} W_{i,j,k} . C_{obs}(O_3)}{\sum_{obs} W_{i,j,k}}$$

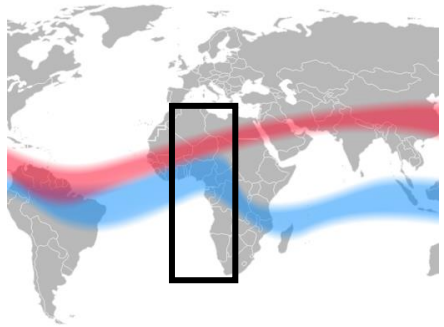
➔ In the end: IAGOS and models products directly comparable

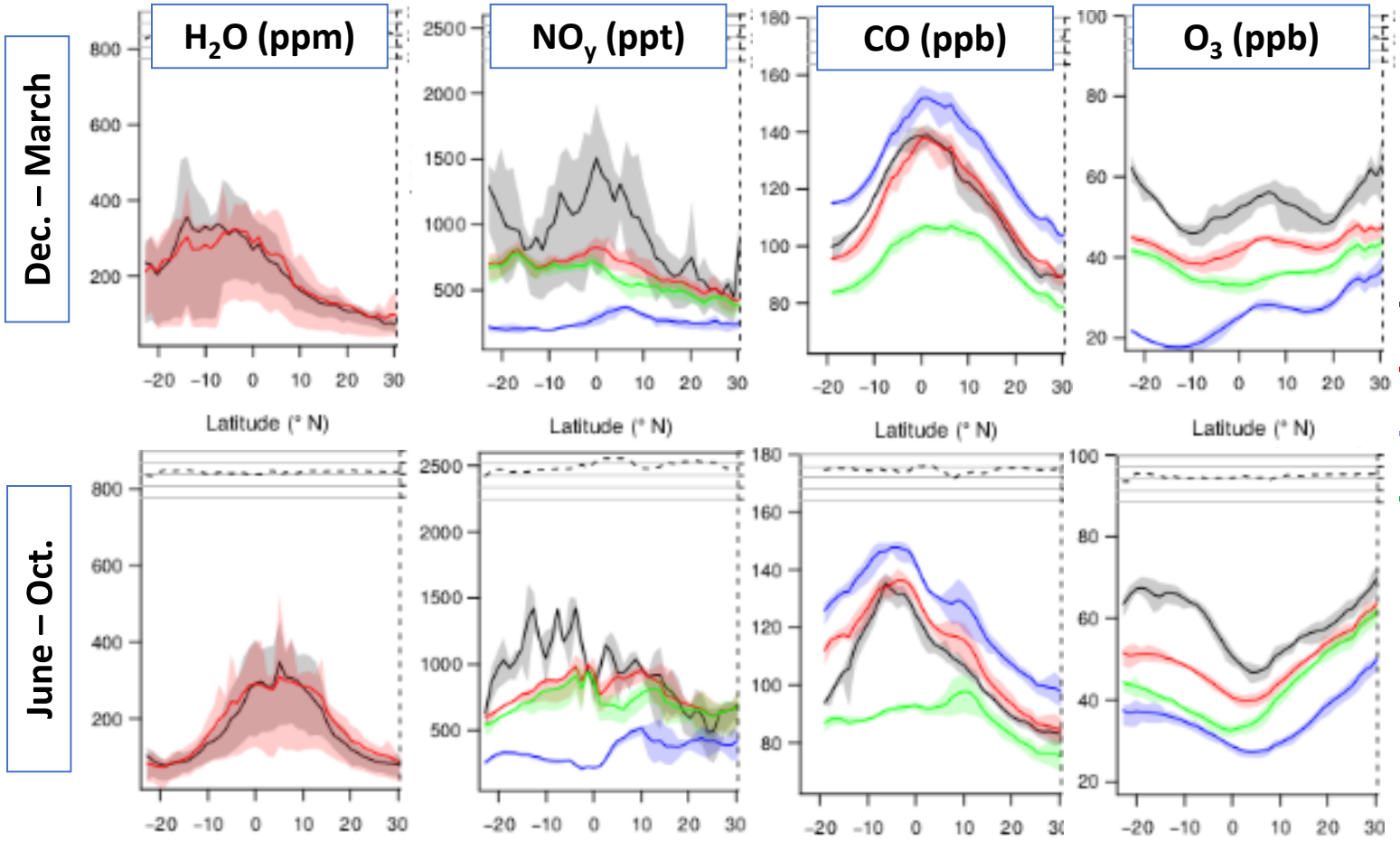
➔ Method presented in *Cohen et al.* (2021, GMD)

The LMDZ-OR-INCA model & simulation setup

- Coupling LMDZ – ORCHIDEE – INCA
- Resolution: 2.5° lon, 1.25° lat, 39 vertical levels (soon 79)
- Chemical scheme:
tropospheric & stratospheric chemistry, aerosols
- Anthropogenic emissions: CEDS
- Biomass burning emissions: BB4CMIP (GFED4s)
- Nudged horizontal winds toward ERA-Interim

Transects over West Africa (1995 – 2017): H_2O, NO_y, CO and O_3





Model assessment:

Realistic H_2O and CO, O_3 negative bias, NO_y negative bias

Sens. test:

CO very sensitive to biomass burning (southern dry season: up to 50 ppb)

O_3 and NO_y mostly sensitive to lightning

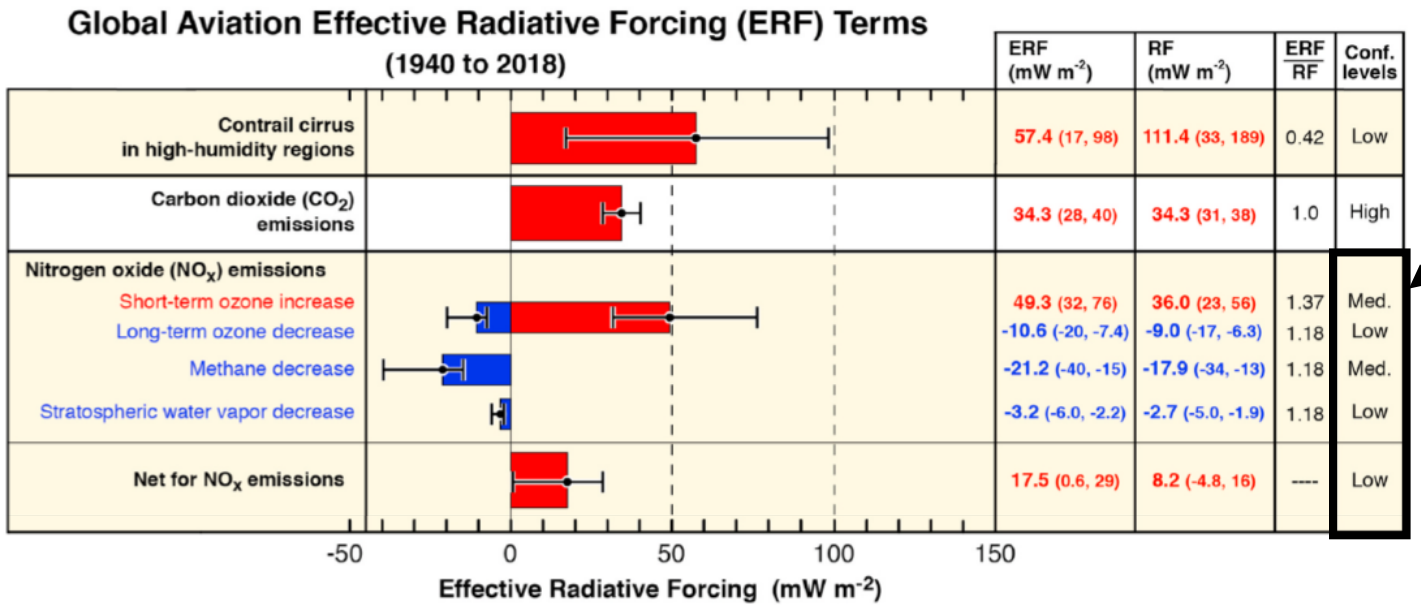
➔ Almost published as *Cohen et al. (2023, ACP)*

Next step: the ACACIA* EU project

Context: For 2018, the aviation **non-CO_2** effects have been characterized as:

- 66% of the total effective radiative forcing (ERF) of aviation emissions
- uncertainties in ERF: 8 times more than CO_2 only

Aim: Improving the knowledge on non-CO_2 effects from subsonic aviation on climate



Limited sci. understanding

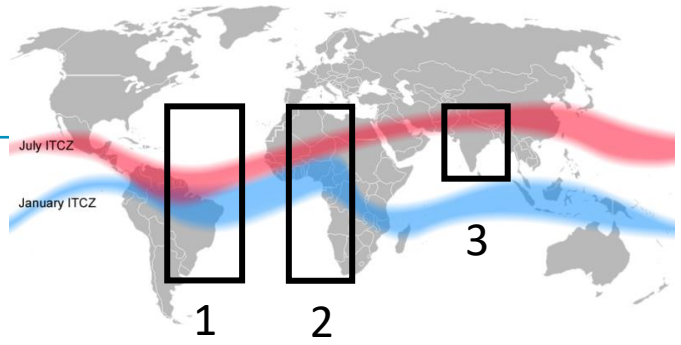
Nitrogen oxides (NO_x)

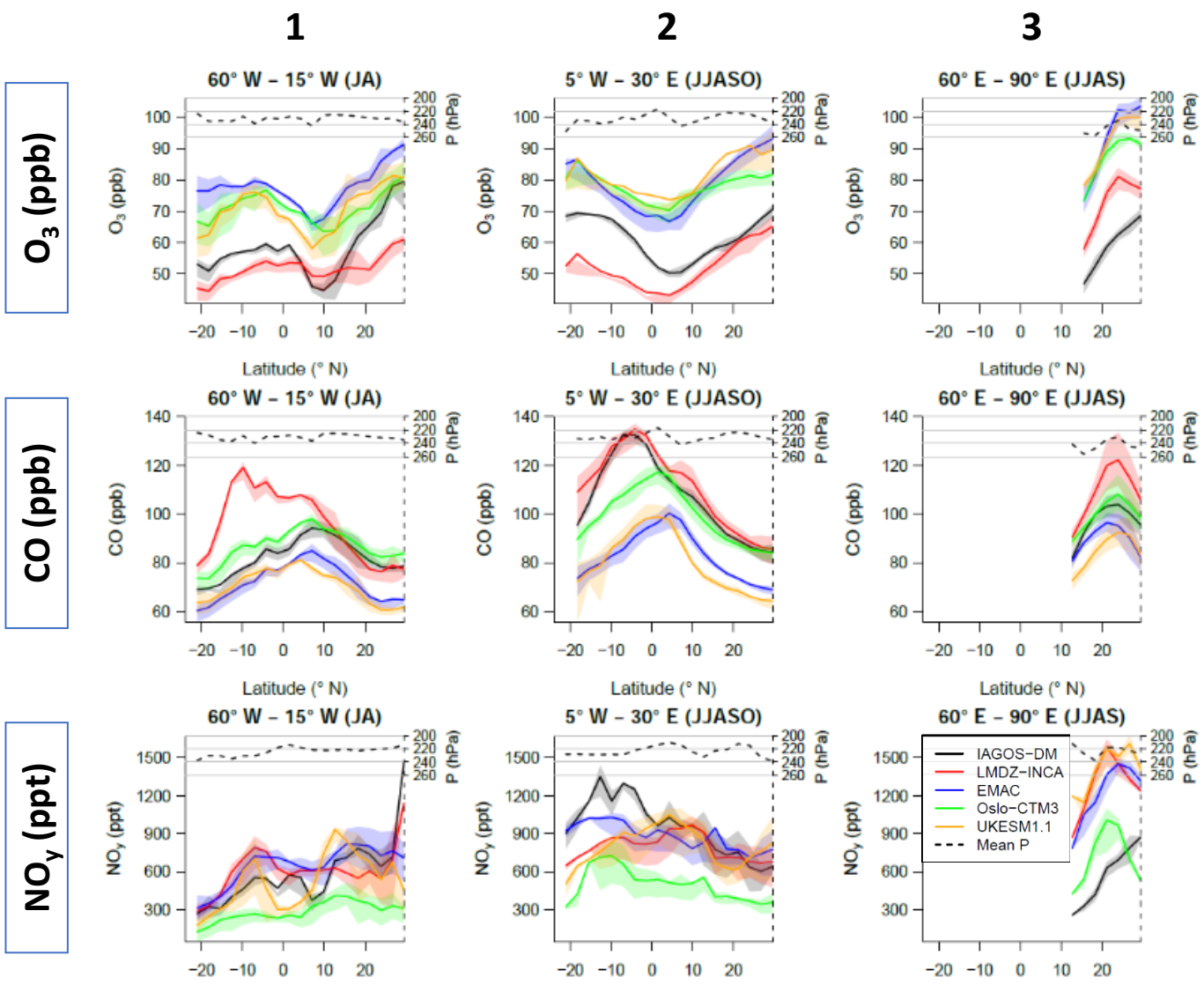
(Adapted from Lee et al., 2021)

→ WP2, Task 2.3: Impact of **NO_x emissions** on atmospheric composition and climate

* Advancing the Science for Aviation and Climate

So next: IAGOS and ACACIA





Obs.
EMAC
LMDZ-INCA
Oslo-CTM3
UKESM1.1

Careful: preliminary results, not robust!

➔ To be written soon

Conclusions, so far

- Interpol-IAGOS: a tool to facilitate global models assessment in the UTLS
- Applied to the LMDZ-INCA model climatologies, complementary to the analysis of the biomass burning and lightning impacts

Next step

- Assessing the models involved in ACACIA:

EMAC, GEOS-Chem, LMDZ-INCA, MOZART3, Oslo-CTM3, UKESM1.1