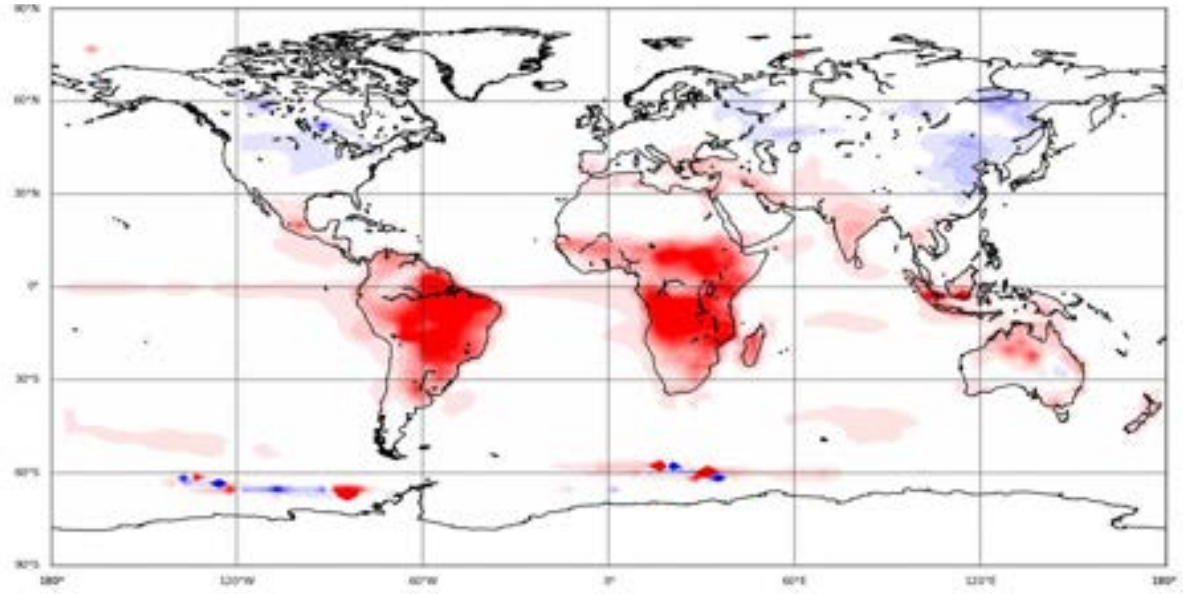
Nitrous Oxide (N_2O) Surface Fluxes Derived from IASI Space-Borne Observations

Ricaud Philippe
CNRM, Météo-France
Attié Jean-Luc
LAERO, Univ. Toulouse
Pison Isabelle, Martinez Adrien
LSCE, CEA

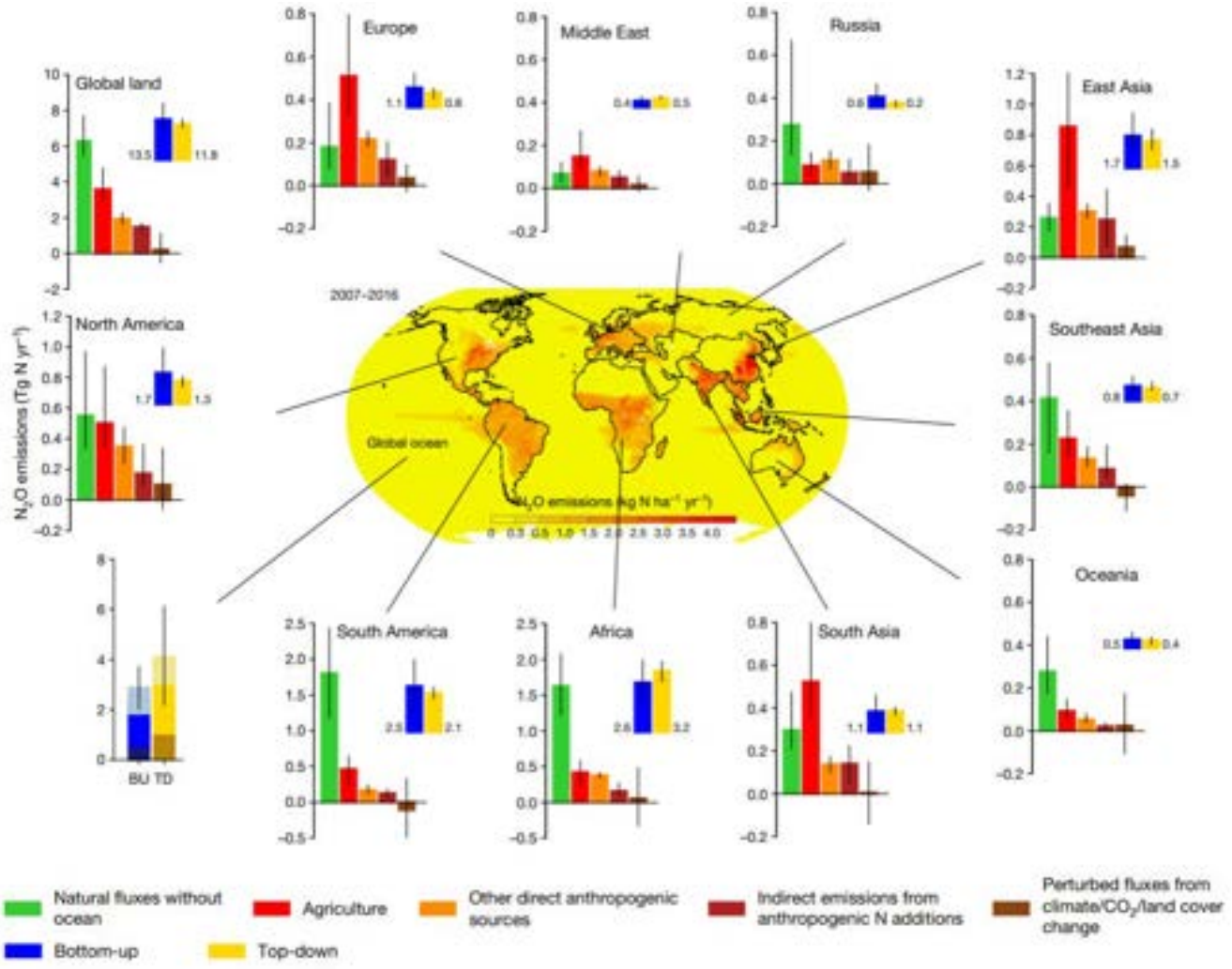


Support from

Our project

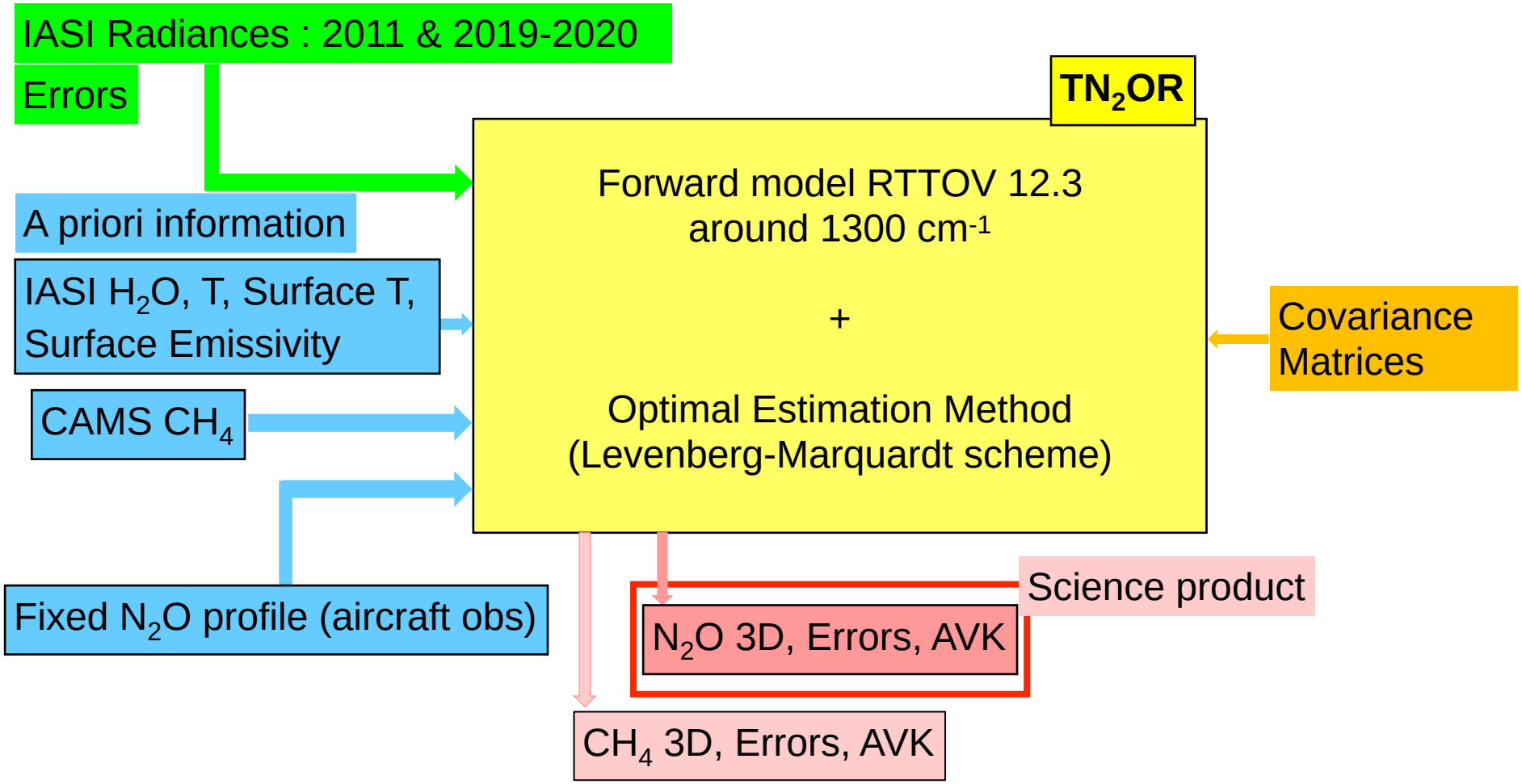
- N_2O emissions mainly come from natural sources (55-61%) and the rest from human activities (agricultural and industrial sectors)
- N_2O emissions through a "top-down" approach relies on sparse surface observations to estimate monthly sources of N_2O on a global scale
- N_2O emissions and sources are highly uncertain over land and ocean
- Our project aims to use N_2O observations from space to estimate N_2O sources on a global scale.
- We started with GOSAT observations (Kangah et al., JGR, 2017), continued with IASI observations (Chalinel et al., 2022) and the use of GOSAT-2 observations is ongoing
- This project brings together French and international scientists also involved in defining a MIN_2OS satellite mission (Ricaud et al., 2021) submitted to ESA EE12 in 2023 but not selected.
- We use the Community Inversion Framework (CIF) model, developed at LSCE, to invert N_2O surface fluxes

N_2O Source Distribution



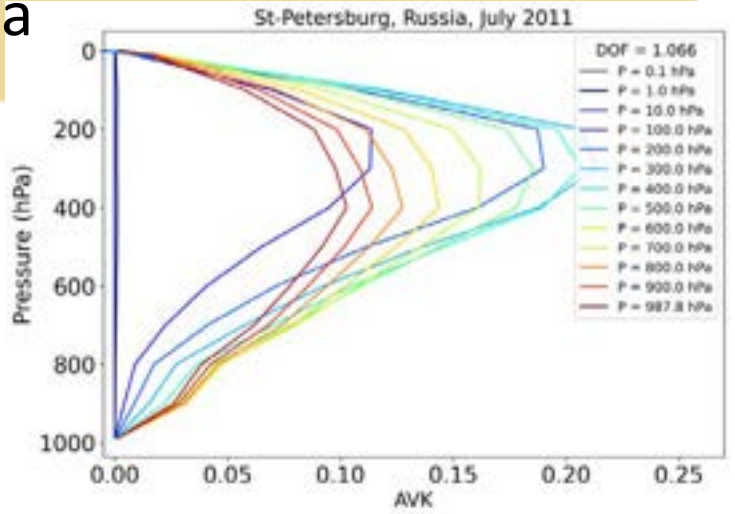
Tian et al., 2020

Methodology : TN_2OR (Toulouse N_2O Retrieval) V2.01

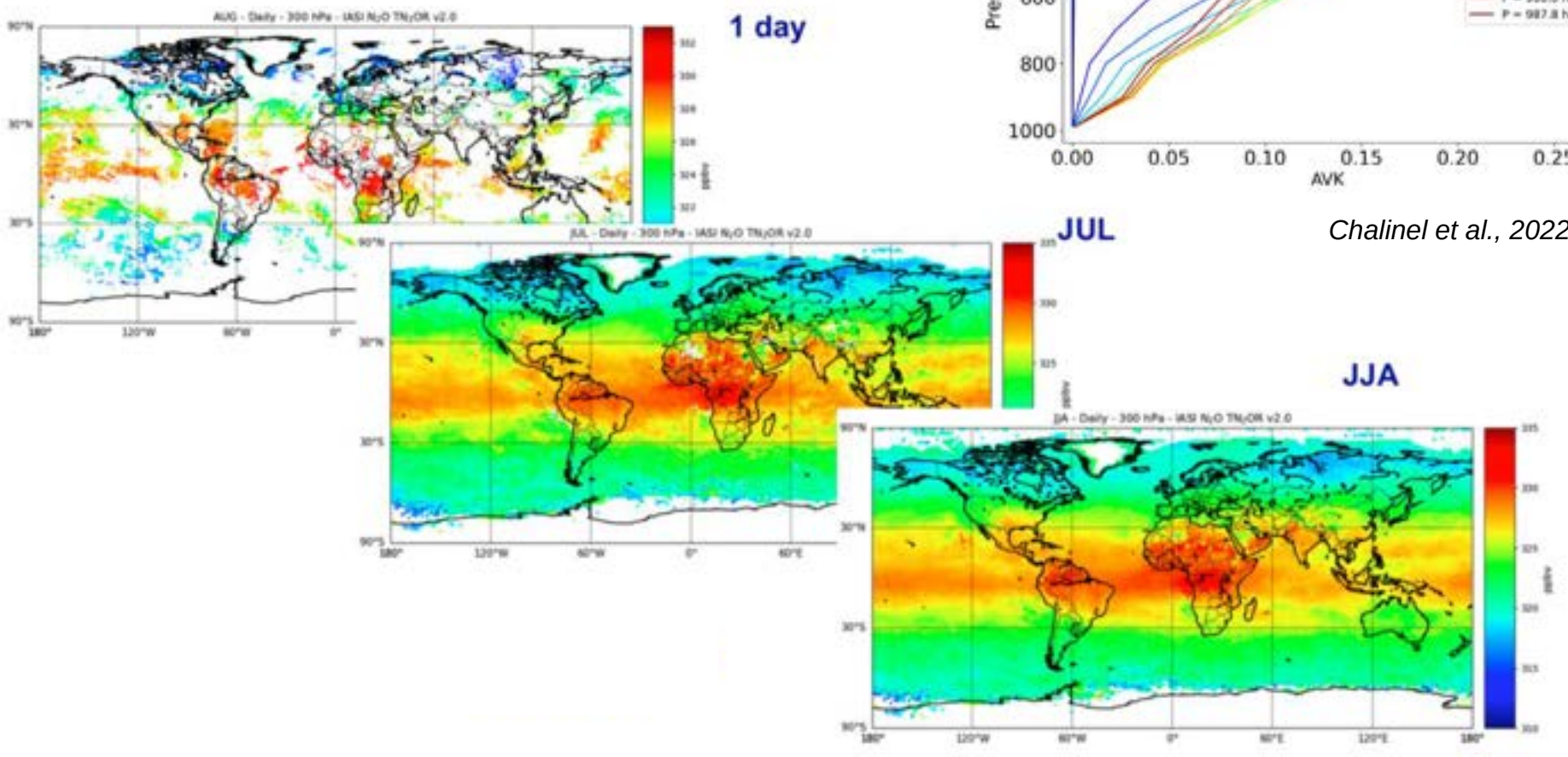


Validation : airborne, NDACC, TCCON

IASI N_2O fromTN_2OR V2.0 @ 300 hPa

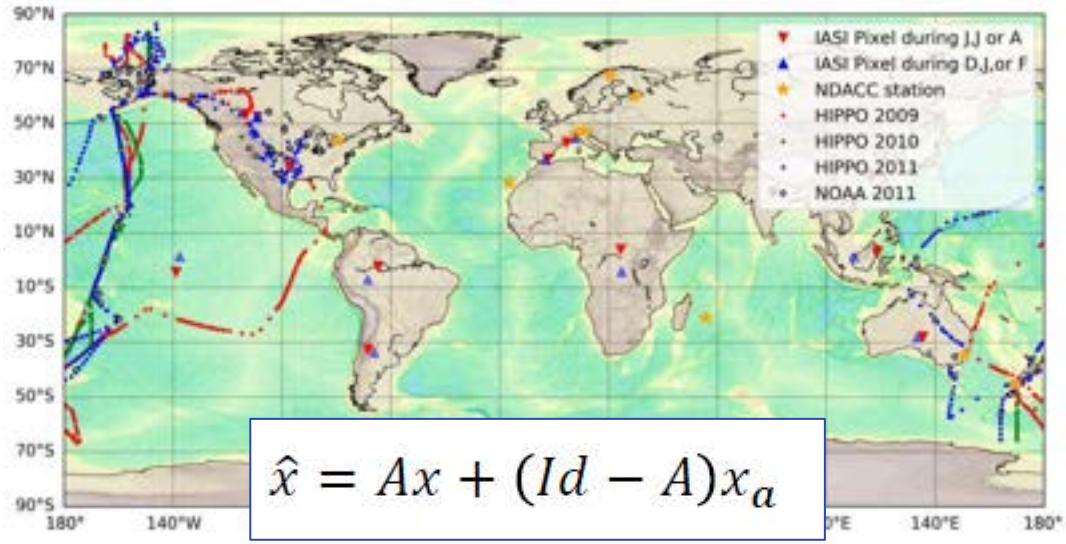


Chalinel et al., 2022

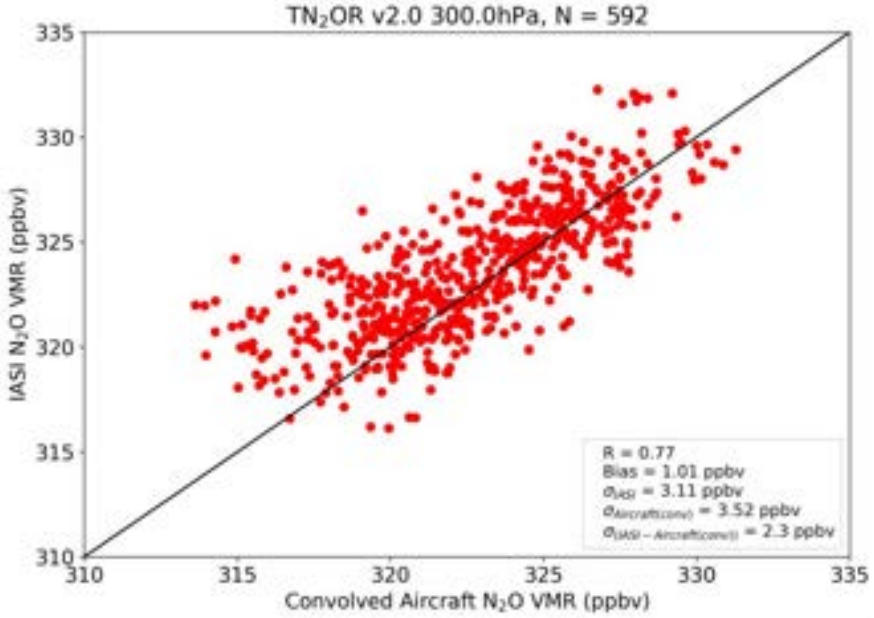


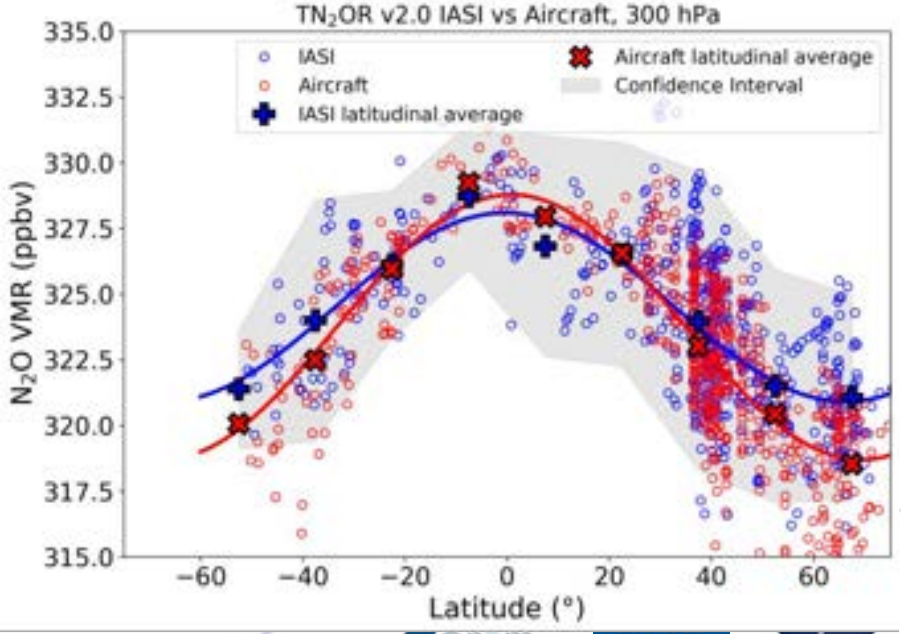
Tropical Maxima: Sources & African convergence zone
High Latitude Minima: Weak Sources & Stratospheric Impact

Validation with airborne HIPPO & NASA observations

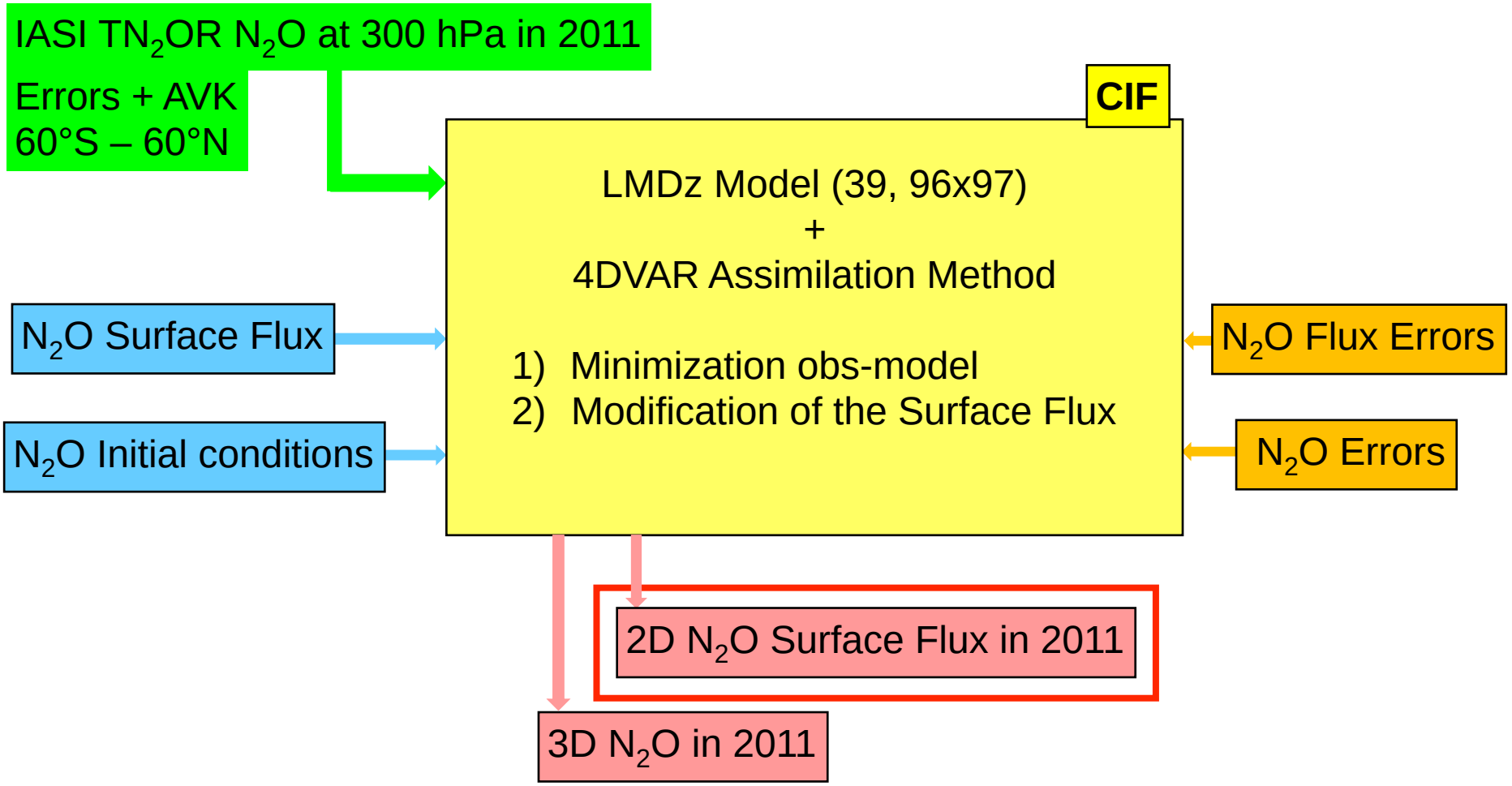


$$\hat{x} = Ax + (Id - A)x_a$$



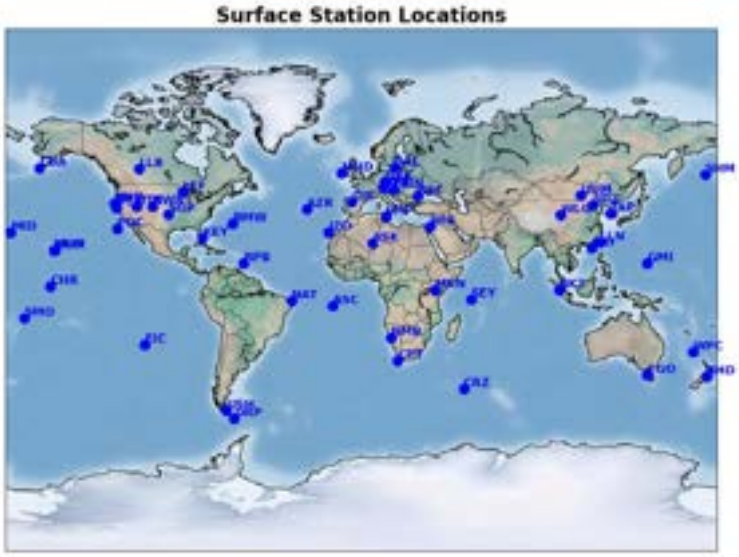


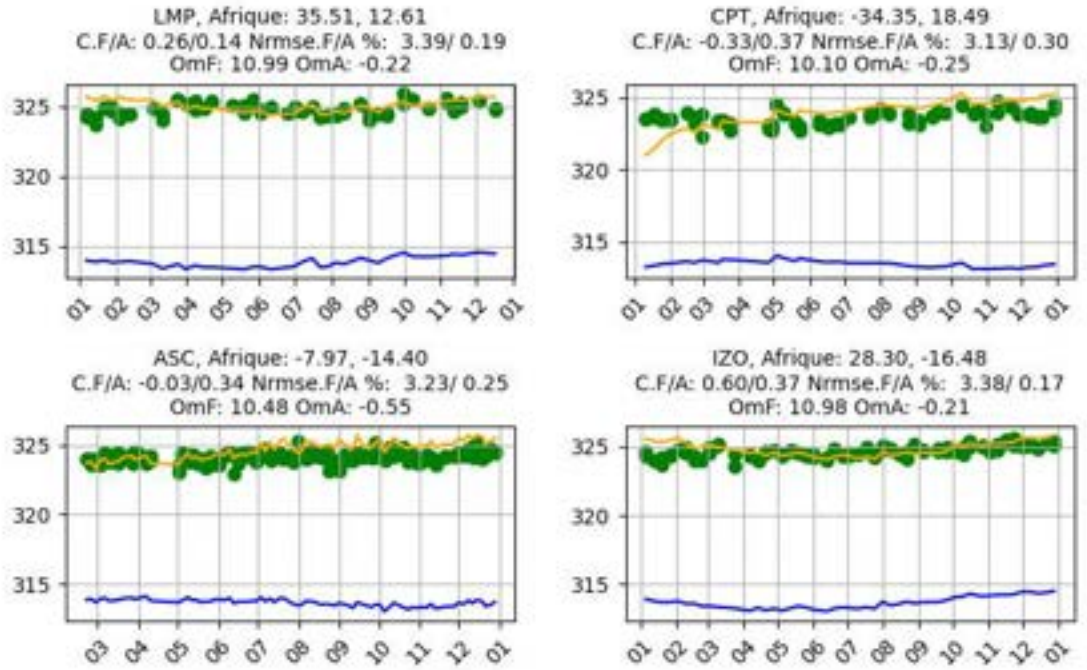
Methodology : Community Inversion Framework (CIF)



Validation: impossible for surface flux → surface mixing ratio

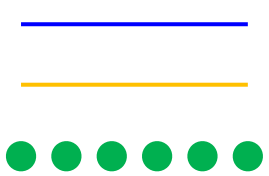
Validation : Surface Stations



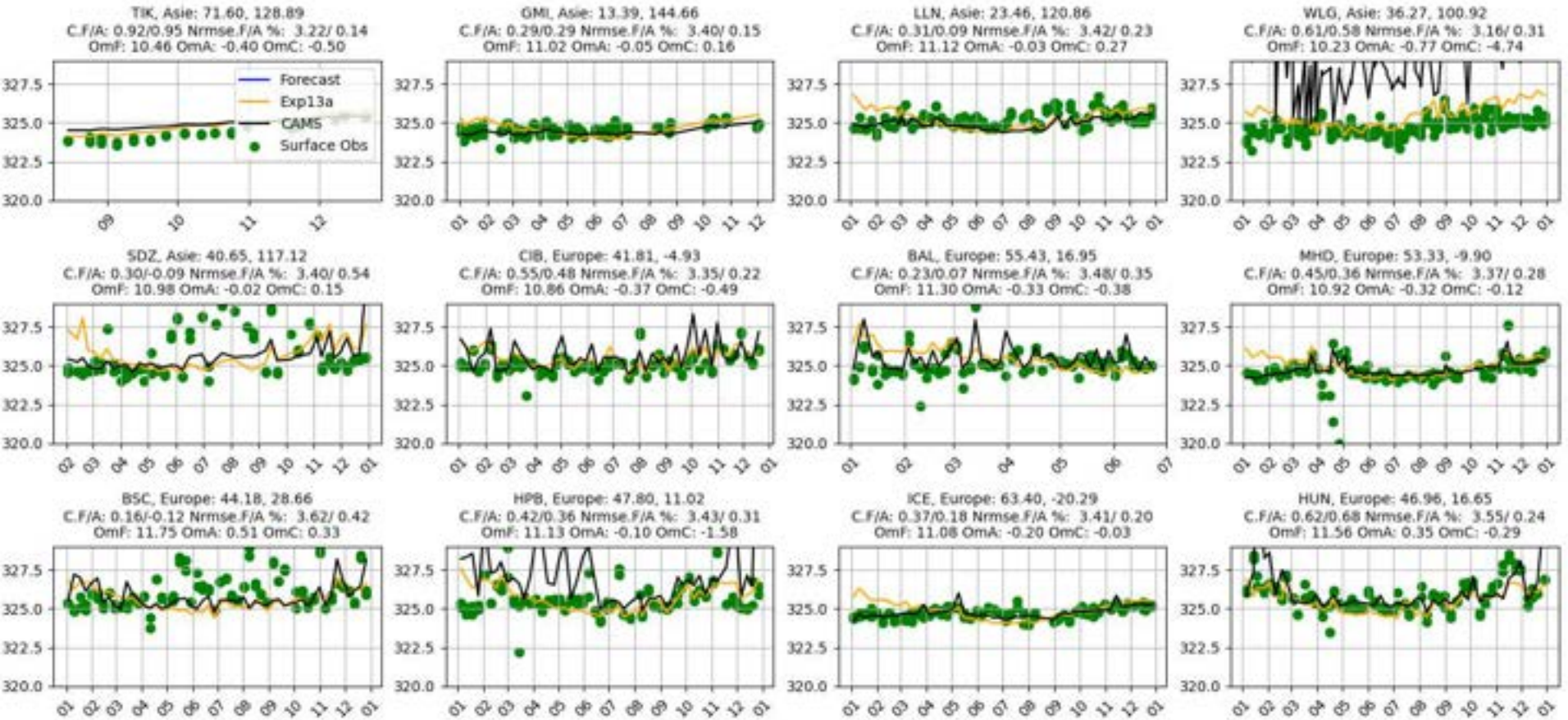


Forecast mean bias : -10 ppbv
Assimilated mean bias : ~0.0 ppbv
Bias reduction with assimilation

Assimilation of IASI TN_2OR N_2O at 300 hPa improves N_2O at the surface



Validation : Surface stations & CAMS

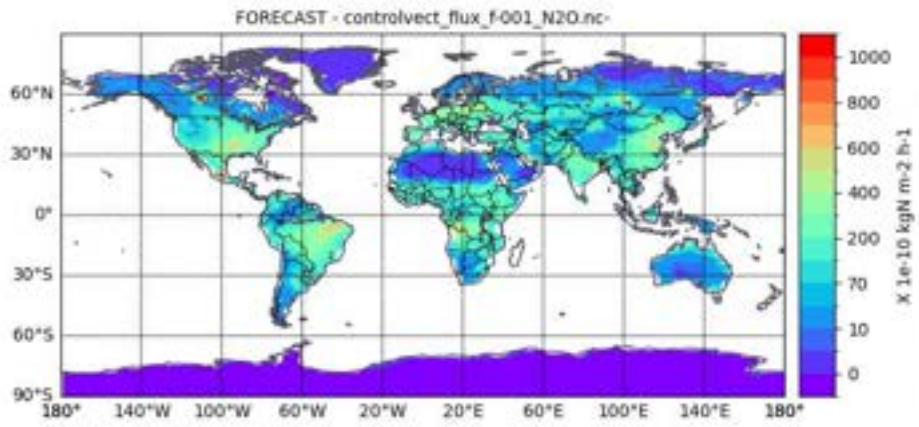


CAMS assimilates Surface N_2O mixing ratio (Thompson, CAMS Report, 2020)

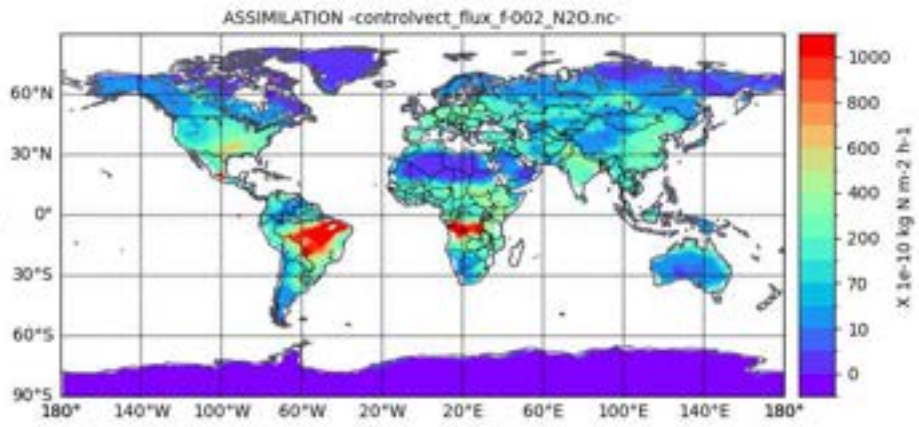
CIF-assimilated N_2O consistent with obs.

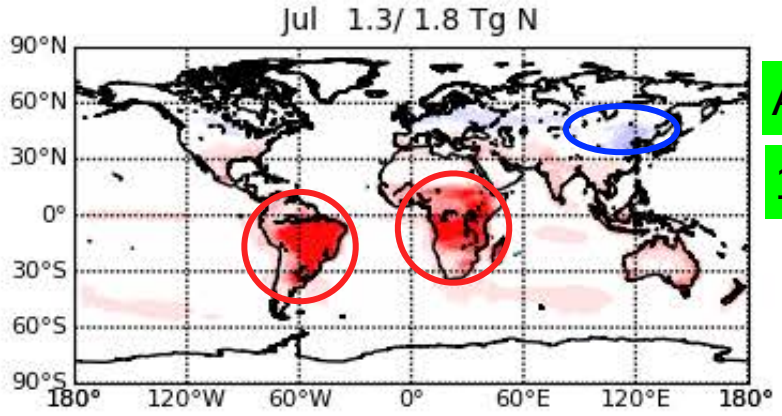
Surface Flux in July 2011

Lmdz Forecast (F)



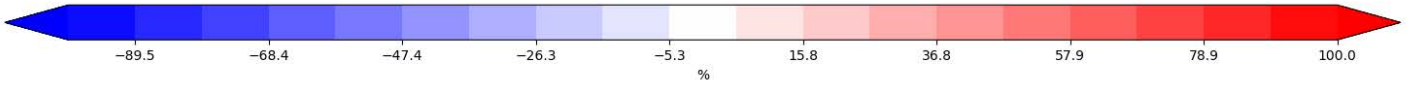
Assimilation (A)



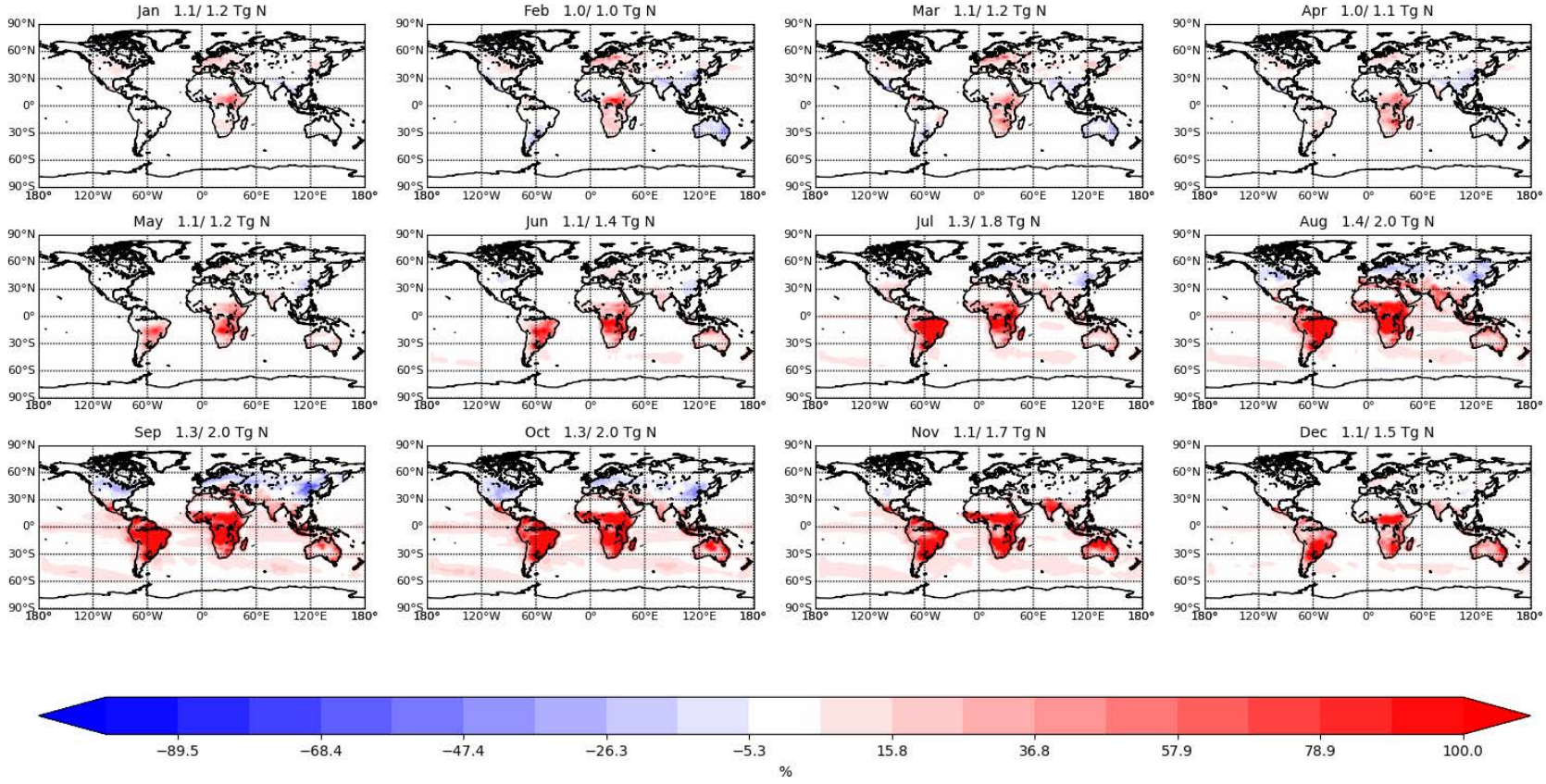


A minus F

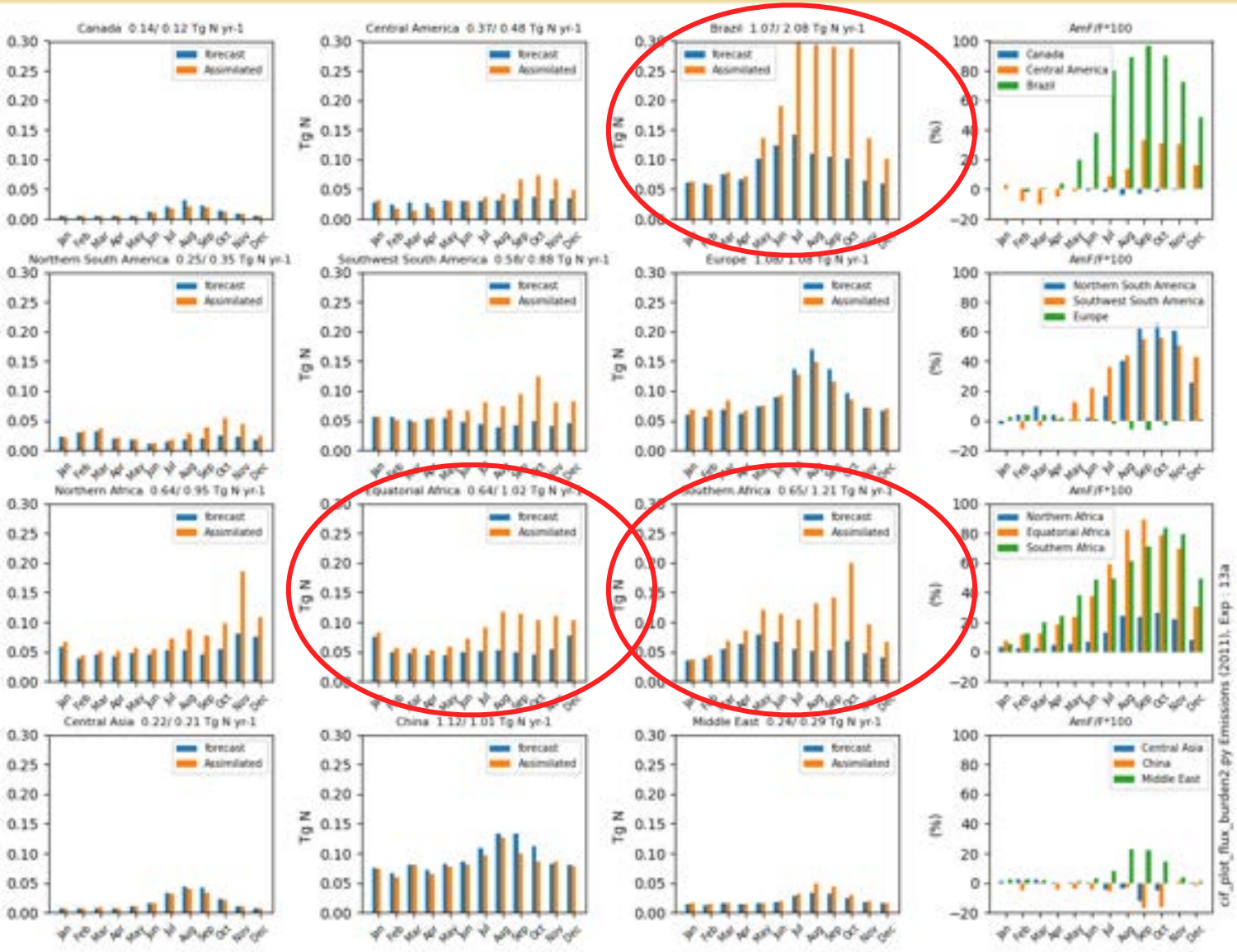
100 x AmF/F



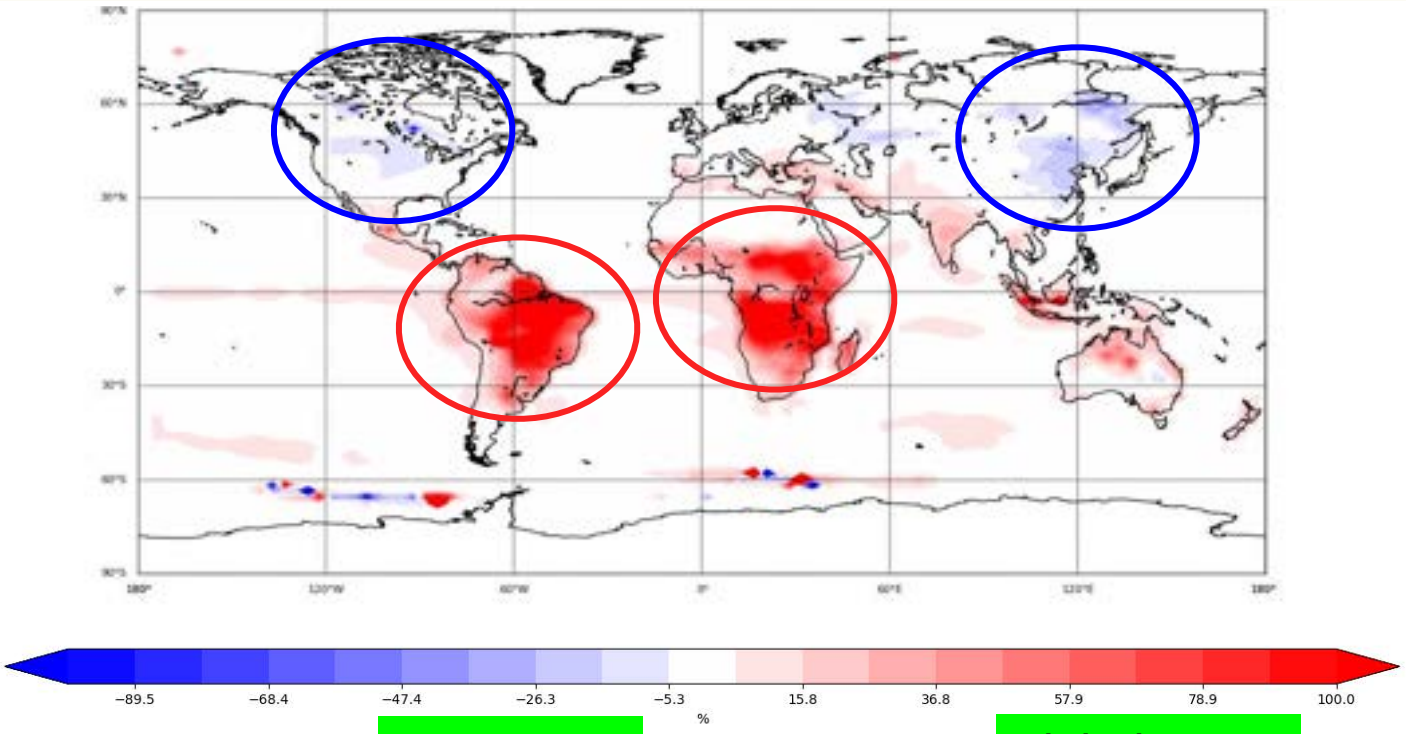
Surface Flux AmF/F: Monthly Variation in 2011



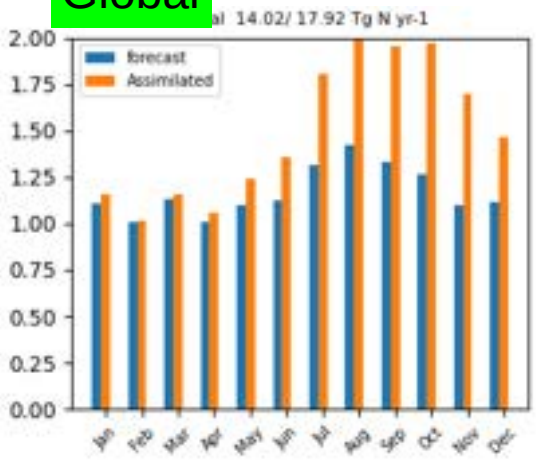
Monthly Emissions in 2011



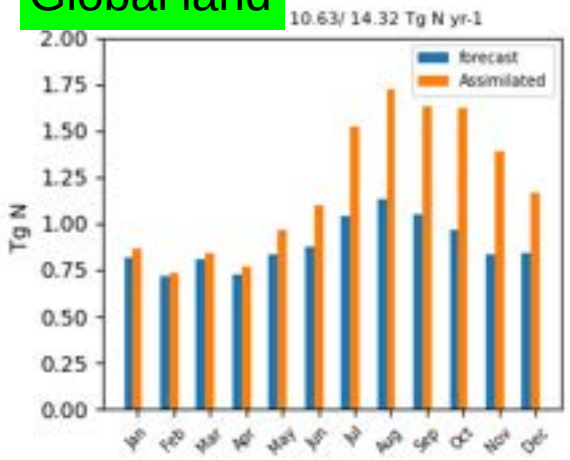
Global Surface Flux & AmF/F in 2011



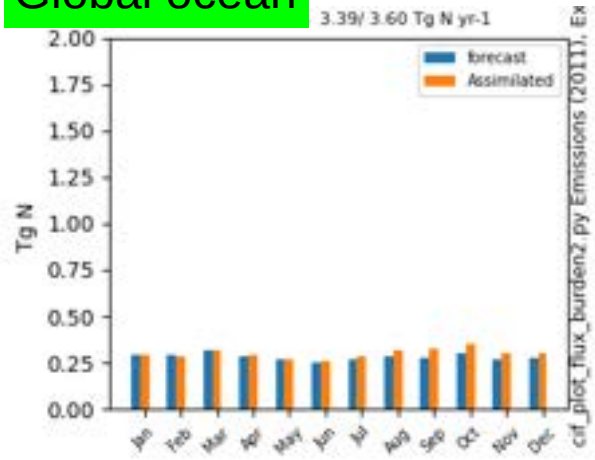
Global



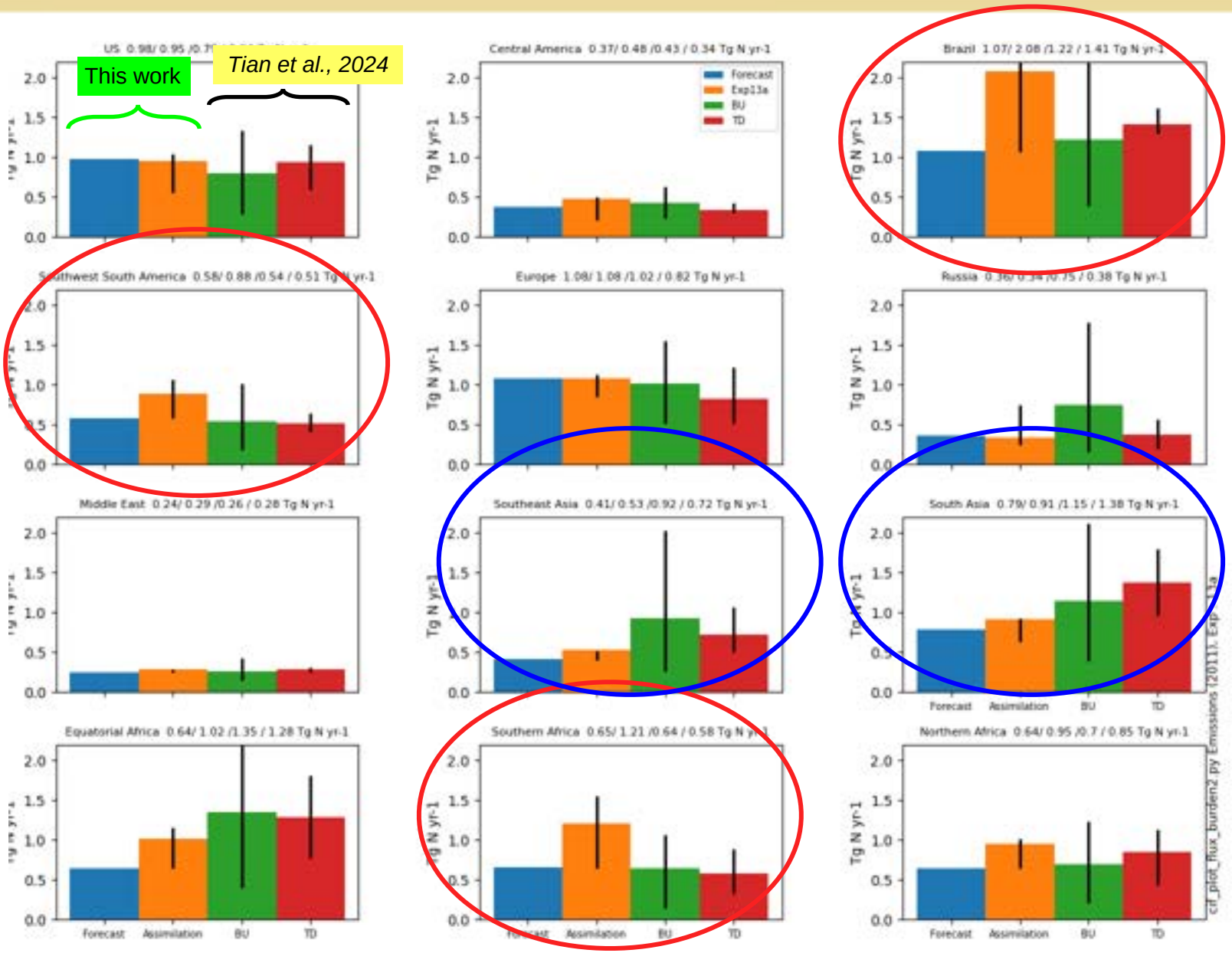
Global land



Global ocean



Global Surface Flux by Regions in 2011



Synthesis

- We made the first global-scale estimation of N_2O emissions for 2011 using IASI observations at 300 hPa and the CIF model.
  - 4DVAR & LMDz model
- We validated the CIF N_2O surface mixing ratio against surface observations
  - Agreement with the surface observations
  - Consistent with CAMS assimilated fields in 2011 (surface)
- Surface fluxes estimated from our study
  - Greater than prior information and literature over Africa and South America
  - Less than prior information and literature over South East Asia

Visit Adrien Martinez's poster for more information on the CIF model!