



CAMAERA

IMPLEMENTATION AND FIRST EVALUATION OF ONLINE BVOC EMISSIONS IN IFS-COMPO

Vincent Huijnen, Jhilik Majumdar, Miró van der Worp (KNMI)



PROGRAMME OF
THE EUROPEAN UNION



IMPLEMENTED BY



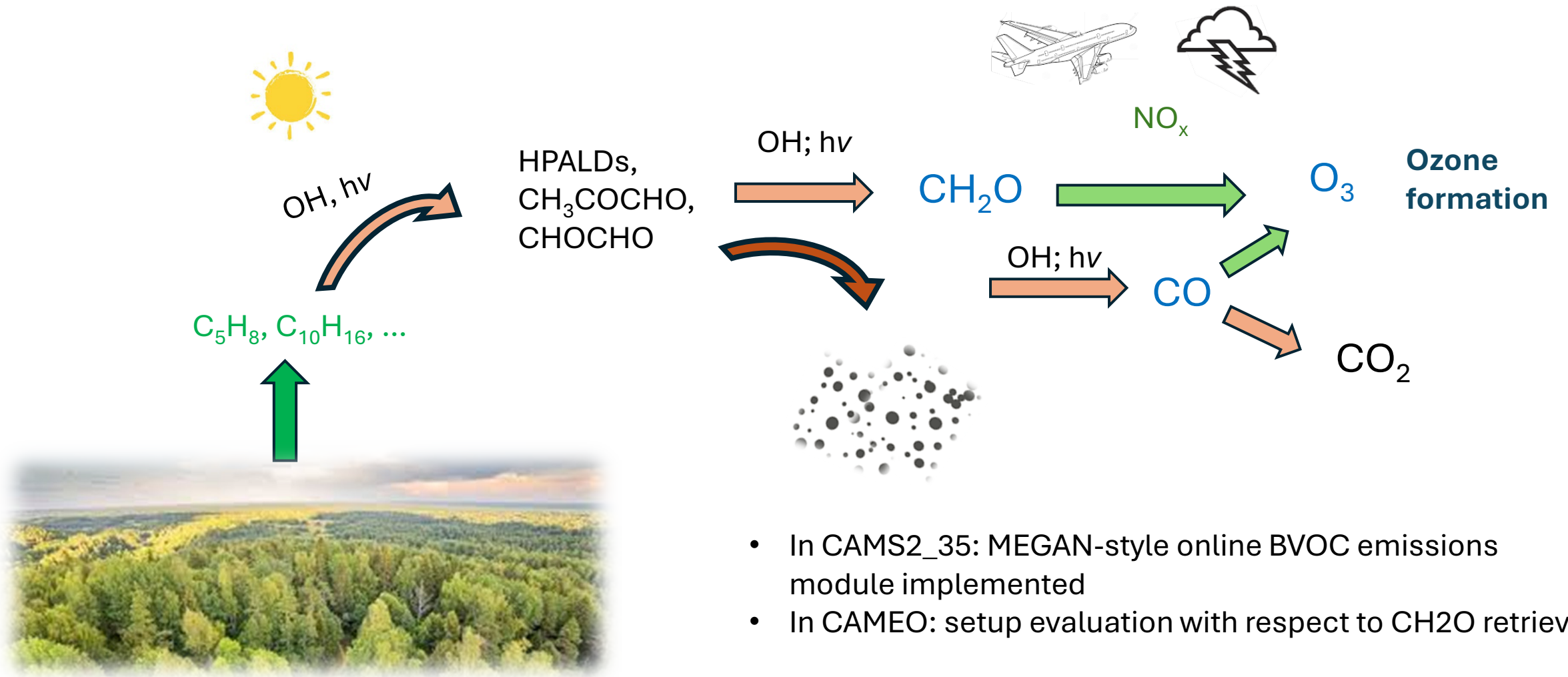
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Coordinated by





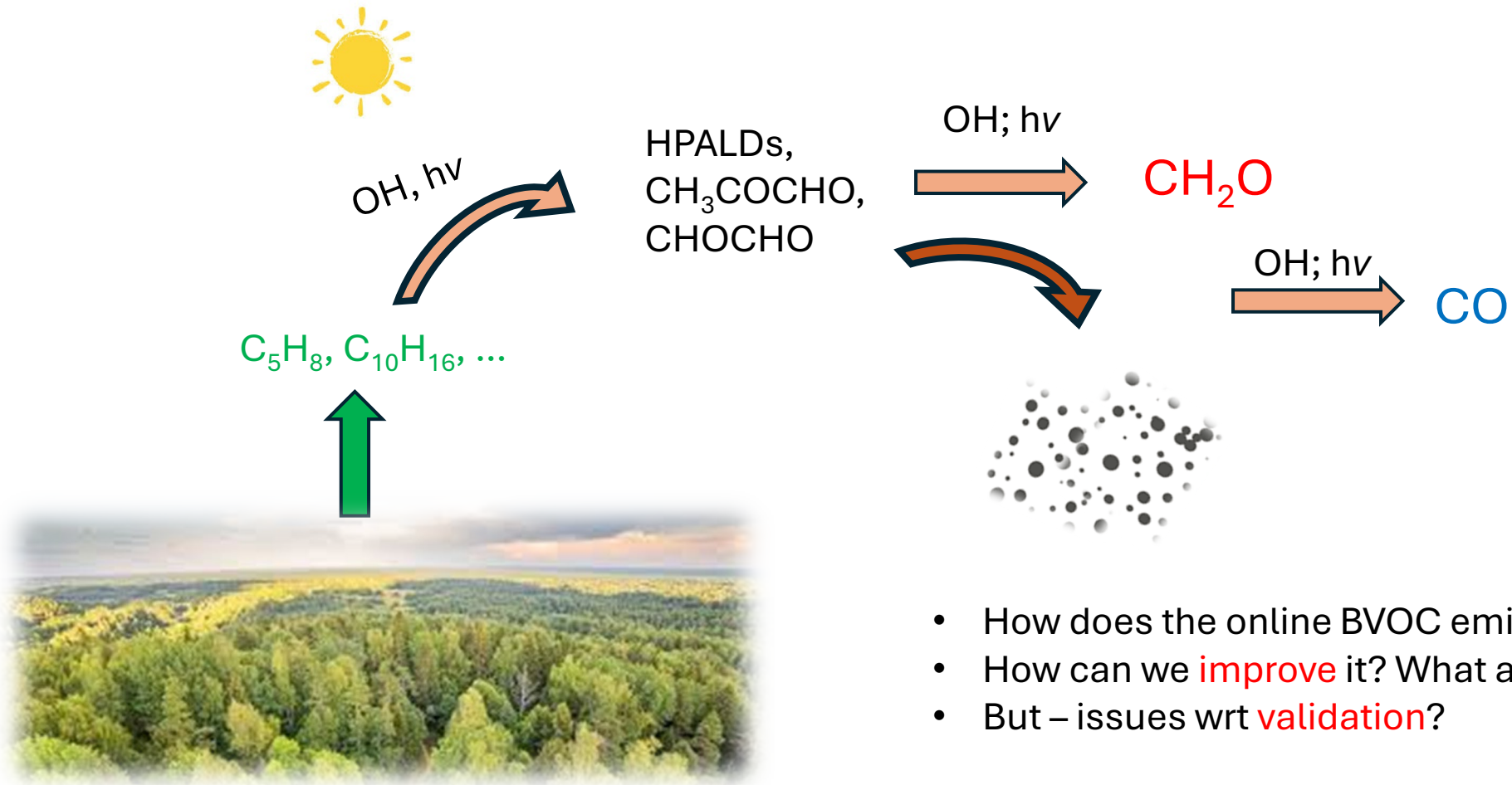
BACKGROUND



- In CAMS2_35: MEGAN-style online BVOC emissions module implemented
- In CAMEO: setup evaluation with respect to CH_2O retrieval



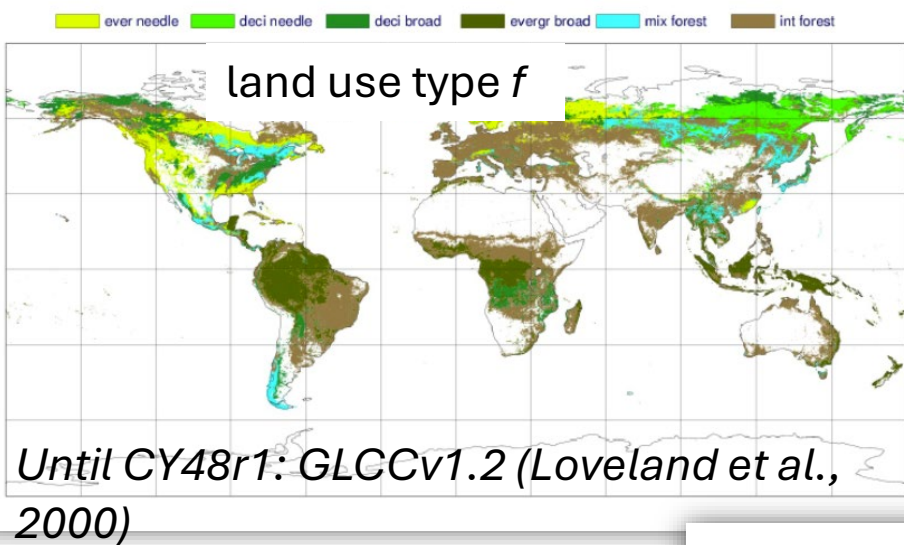
IN CAMAERA:



- How does the online BVOC emissions module **perform**?
- How can we **improve** it? What are uncertainties?
- But – issues wrt **validation**?



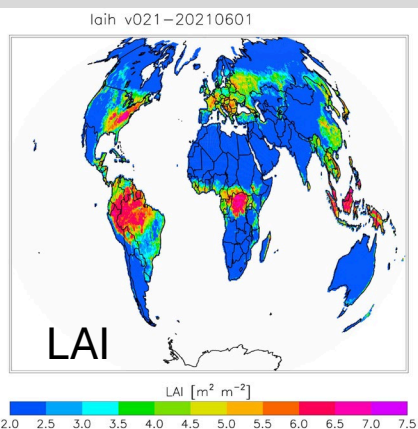
ONLINE BVOC EMISSIONS IN IFS-COMPO



Emission factor ϵ_{ij}

Compound Class	EF1	EF2	EF3	EF4	EF5	EF6
Isoprene	600	1	3000	7000	10000	7000
Myrcene	70	60	70	80	30	80
Sabinene	70	40	70	80	50	80
Limonene	100	130	100	80	80	80
3- Δ -Carene	160	80	160	40	30	40
trans- β -ocimene	70	60	70	150	120	150
β -pinene	300	200	300	120	130	120
α -pinene	373	698	373	386	380	386
Other Monoterpenes	180	170	180	150	150	150

$$E_j = \gamma_j \sum_i^{PFT} f_{PFTi} \epsilon_{ij}$$



activity factor γ_j

$$\gamma = \gamma_{CE} \gamma_{age} \gamma_{CO_2}$$

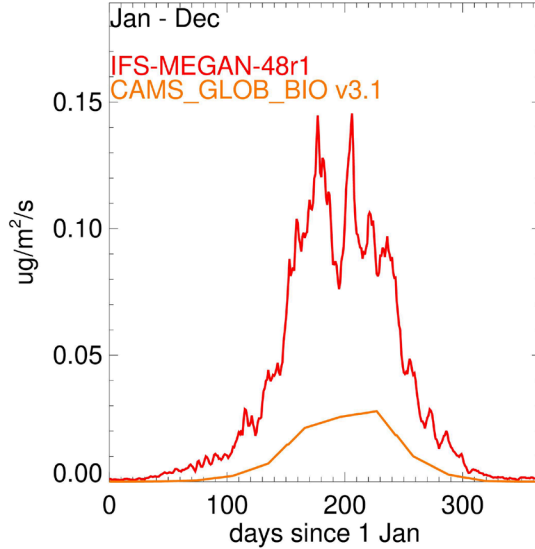
$T, PAR, CO_2,$
 ..., ...

MEGANv2.1 (Guenther et al., 2012), following suggestions by K. Sindelarova

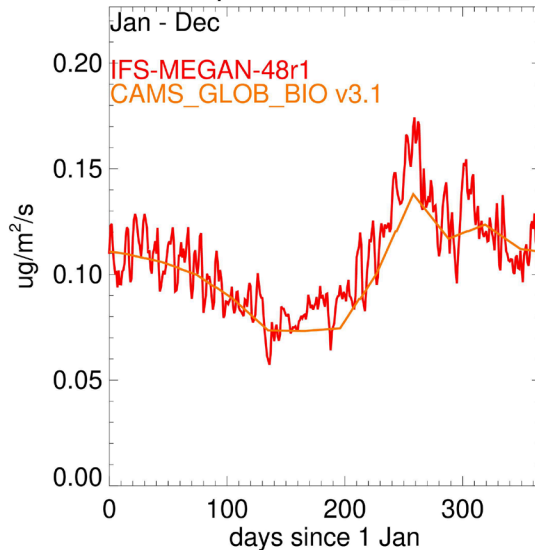


OVERALL PERFORMANCE:

bio isoprene Europe



bio isoprene South_America



Region	CAMS-GLOB-Bio-v3.1	Online IFS-MEGAN CY48r1
World	472	467
Europe	4.0	16.5
N. America	32	35
S. America	154	164

- Day-to-day variability in online BVOC
- Globally emission totals very similar
- Regionally larger differences



ISSUES ENCOUNTERED

Parameterization of online emissions:

- fixed EF per land-use category ignores much of variability
- ECMWF LAI input data towards activity factors is hard to interpret
- Parameterization of activity factors in itself is outdated

Evaluation:

- Dependencies to chemistry describing isoprene degradation scheme
- Uncertainties in TROPOMI HCHO retrievals



ISSUES ENCOUNTERED

Parameterization of online emissions:

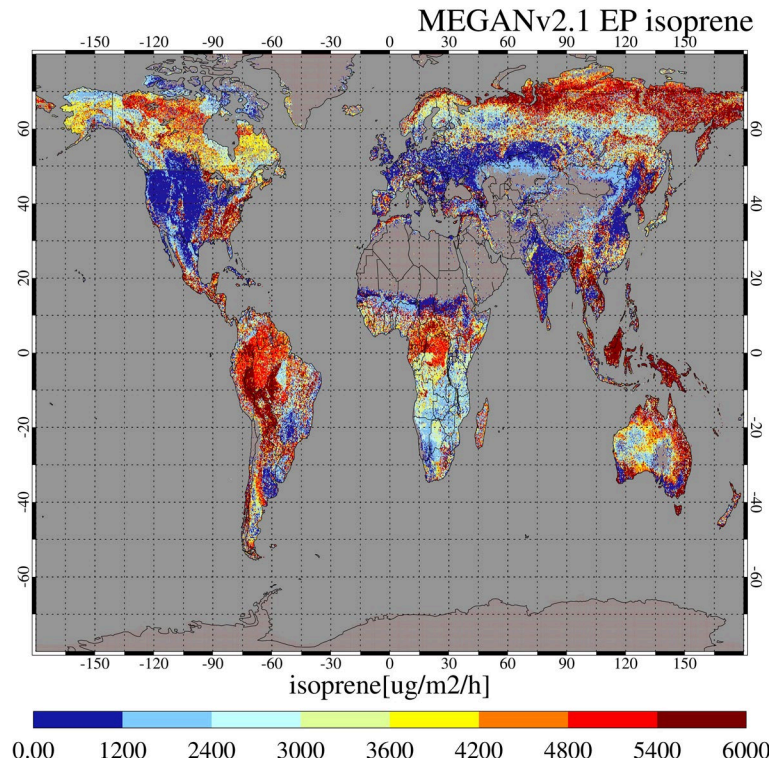
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Evaluation:

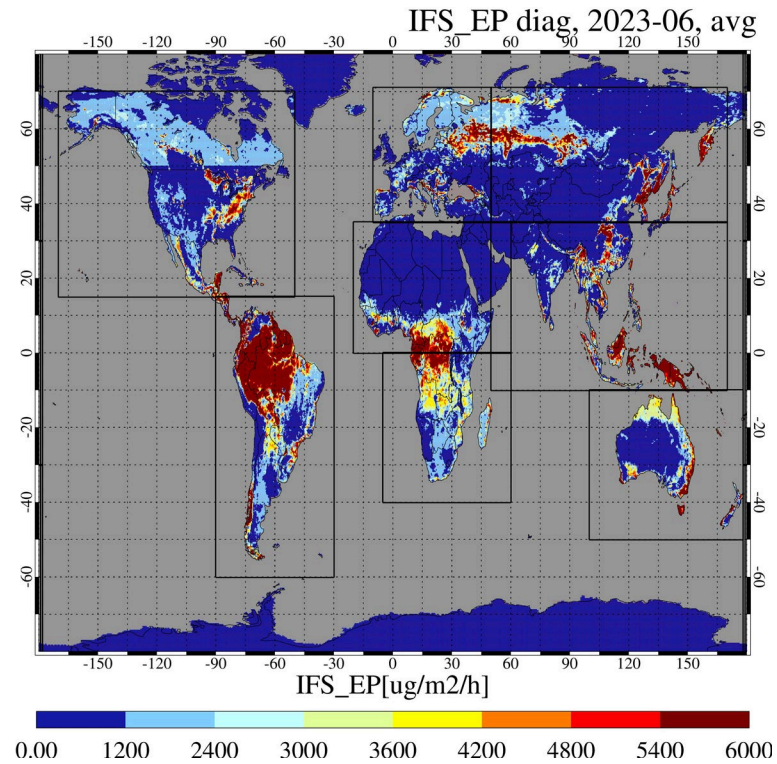
- Dependencies to chemistry describing isoprene degradation scheme
- Uncertainties in TROPOMI HCHO retrievals



USE OF ISOPRENE EMISSION POTENTIAL



Annual avg MEGAN-based
Emission Potential
(as CAMS-GLOB-BIO v3.0)

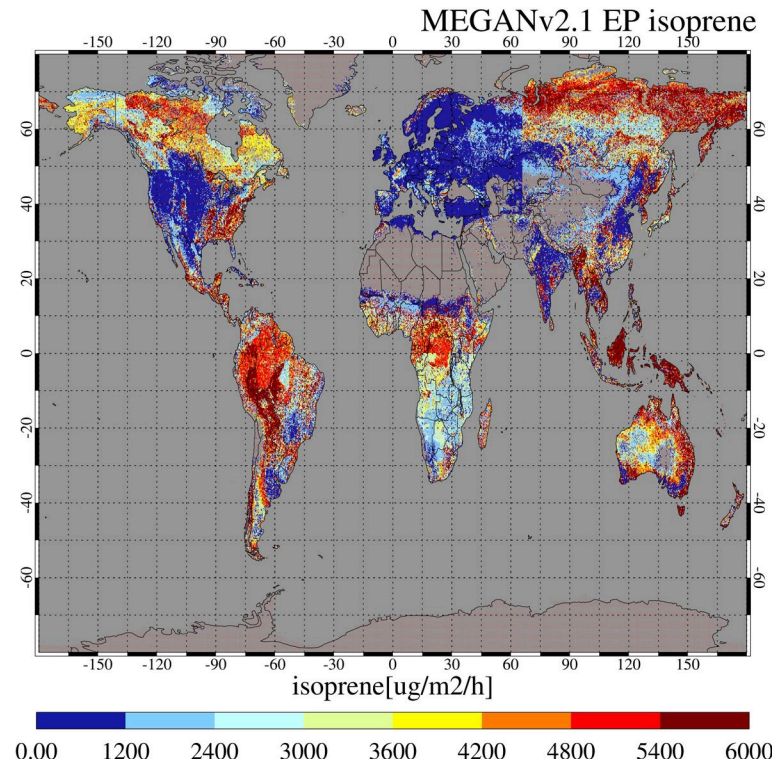


EP output from IFS;
fixed EF per LU type

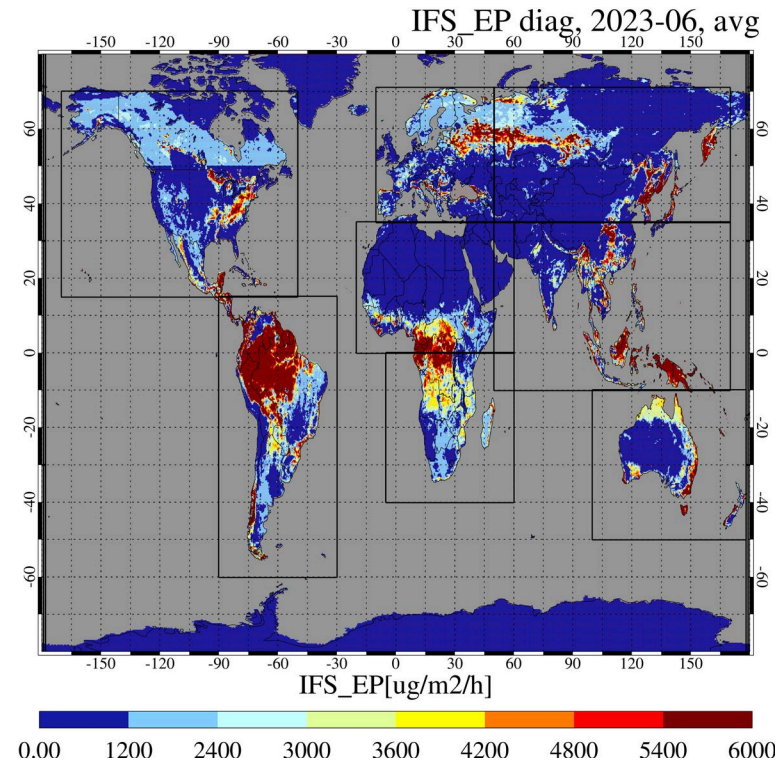
Thanks to K. Sindelarova



USE OF ISOPRENE EMISSION POTENTIAL



Annual avg MEGAN-based
Emission Potential;
Updated over Europe
(as CAMS-GLOB-BIO v3.1)



EP output from IFS;
fixed EF per LU type

Thanks to K. Sindelarova



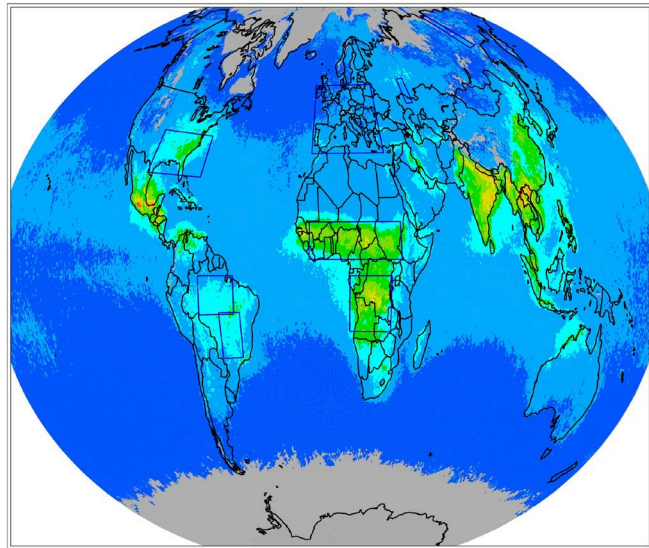
EVALUATION OF PERFORMANCE

Expid	Description
b2mh	experiment using offline CAMS-GLOB-BIO v3.1
b2n5	Reference online ; EP similar to CAMS-GLOB-BIO v3.1
b2nj	As b2n5 but EP as used in CAMS-GLOB-BIO v3.0.
b2nj_no_ISOP	As b2nj but Isoprene emissions were accidentally turned off in this experiment.
b2o6	As b2n5 but modified C5H8 degradation chemistry, and inclusion of C2H2 chemistry.



USE OF TROPOMI HCHO RETRIEVALS

TROPOMI mean HCHO - 1-31 May

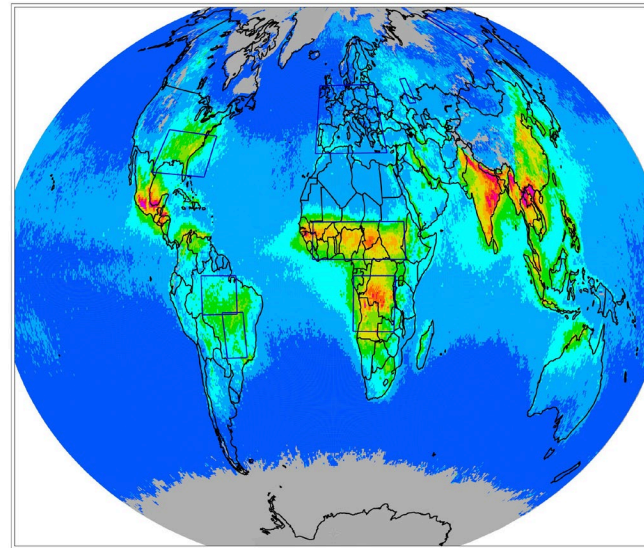


HCHO column density [10^{15} molec/cm 2]

0.0 3.0 6.0 9.0 12. 15. 18. 21. 24. 27. 30. 33.

Default

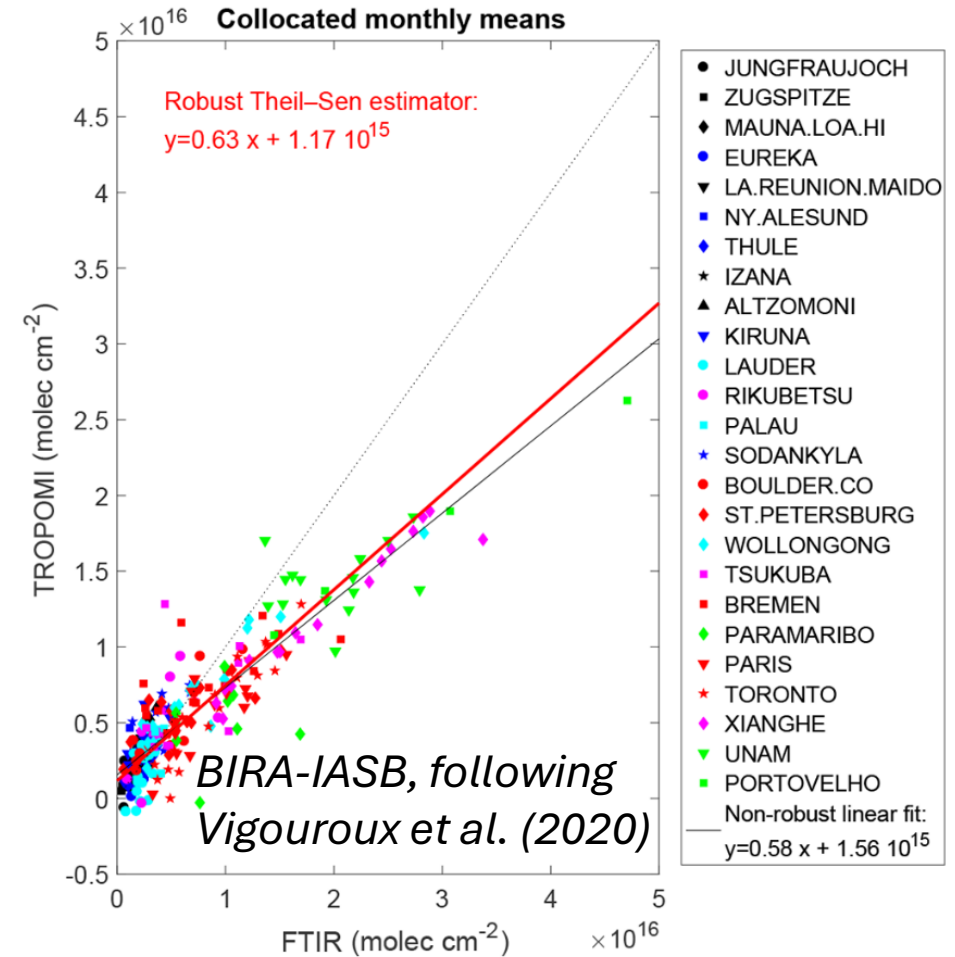
corr TROPOMI mean HCHO - 1-31 May



HCHO column density [10^{15} molec/cm 2]

0.0 3.0 6.0 9.0 12. 15. 18. 21. 24. 27. 30. 33.

With bias correction:
increases by up to 30%
for high columns ($>10 \times 10^{15}$)

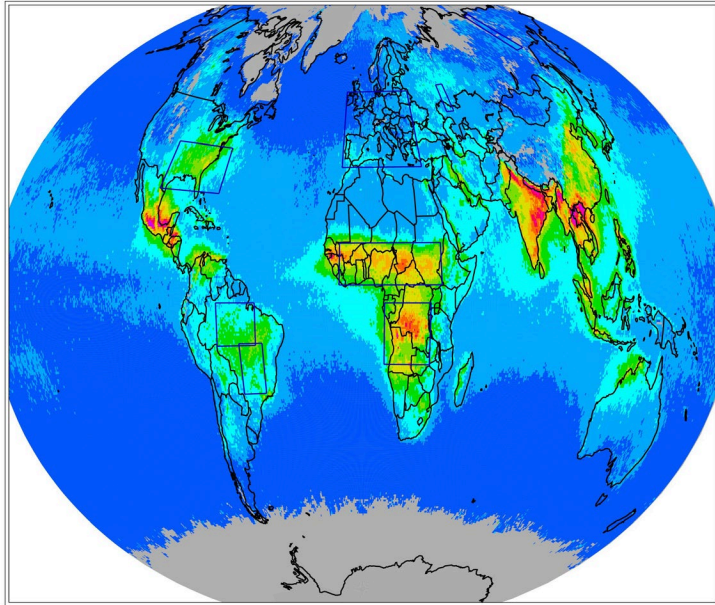




EVALUATION OF ONLINE EMISSIONS

TROPOMI

corr TROPOMI mean HCHO - 1-31 May

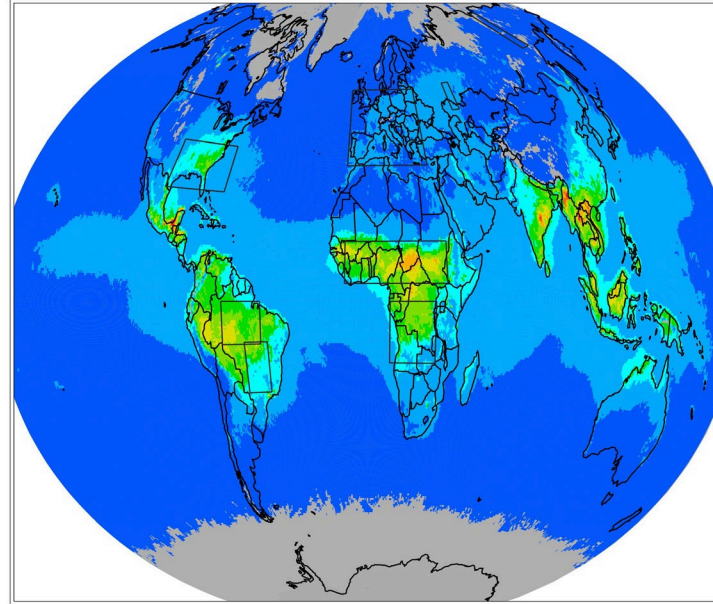


HCHO column density [10^{15} molec/cm²]



Offline, CAMS-GLOB-BIO v3.1

Offline trop. HCHO - 1-31 May

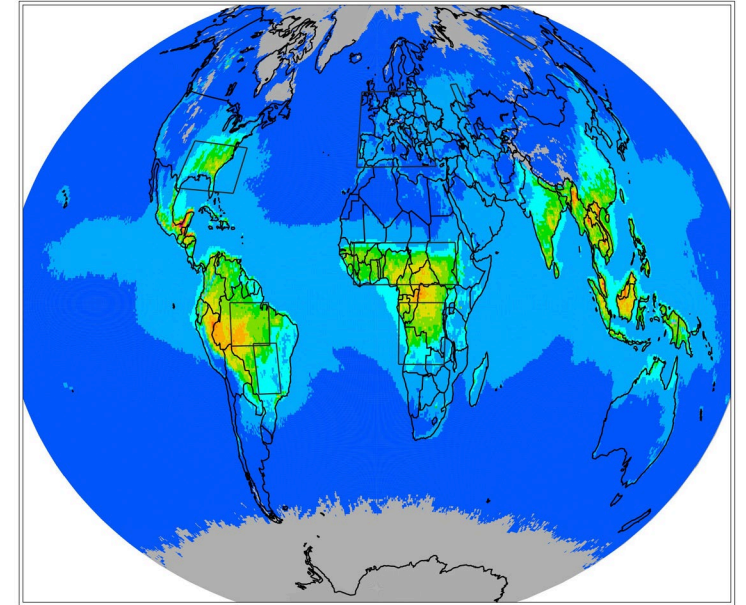


HCHO column density [10^{15} molec/cm²]



Online, EP as in v3.1

REF trop. HCHO - 1-31 May



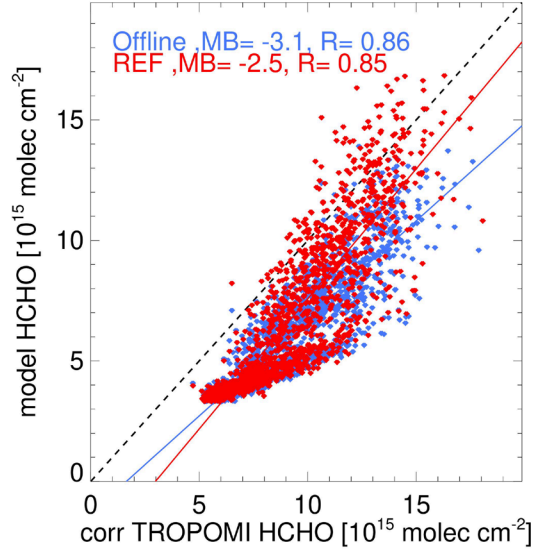
HCHO column density [10^{15} molec/cm²]



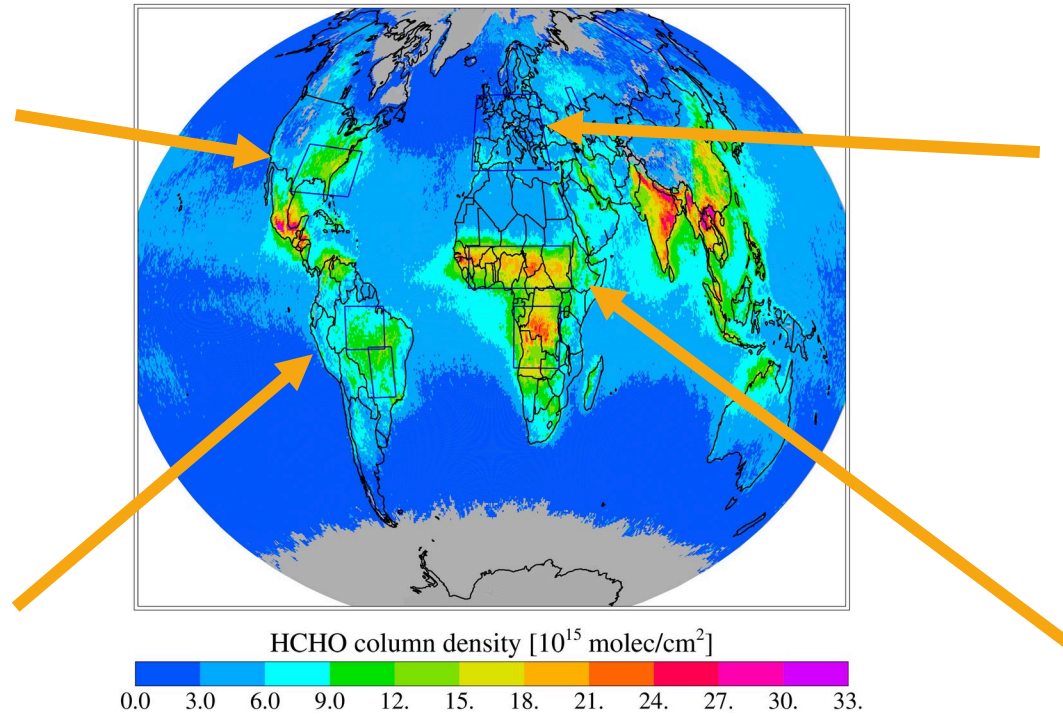


LOOKING AT A FEW INDIVIDUAL REGIONS; MAY 2019

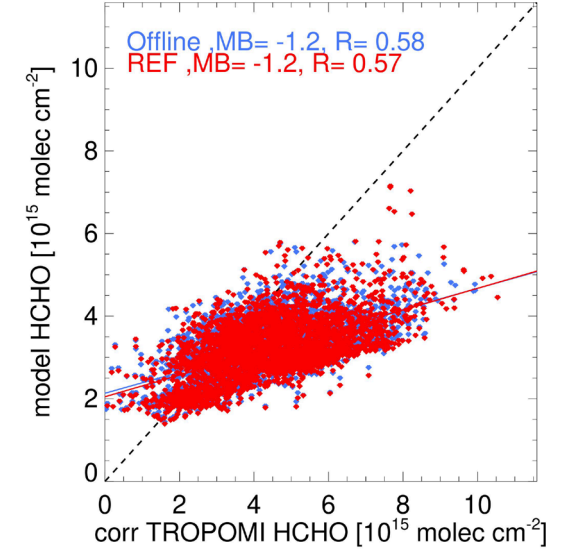
South-East US, May



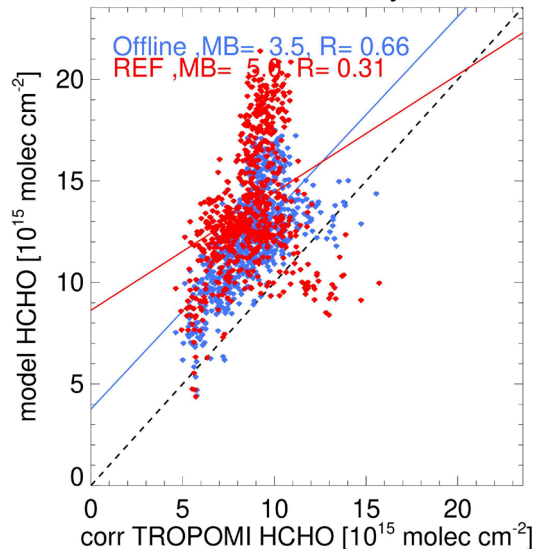
corr TROPOMI mean HCHO - 1-31 May



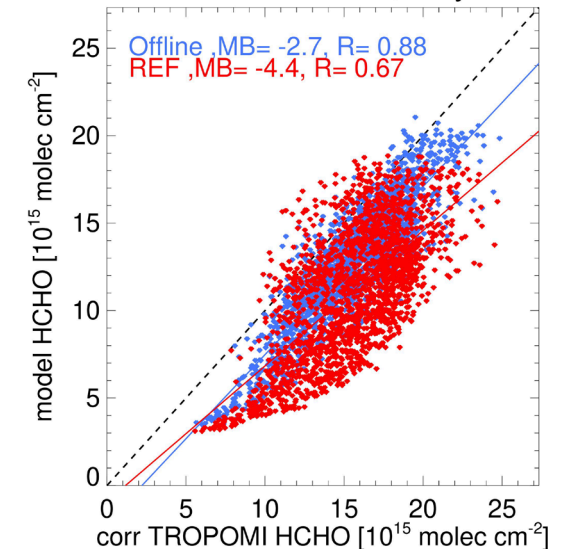
Europe, May



Amazon, May



Northern Africa, May

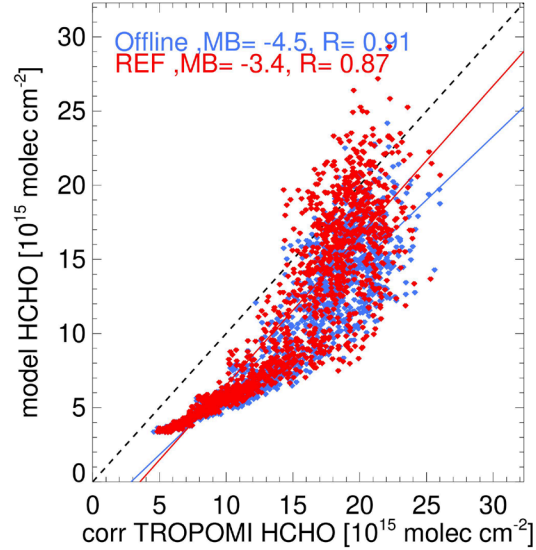


- **Online:** similar performance as **offline**
- **Online:** Degradation over Amazon region

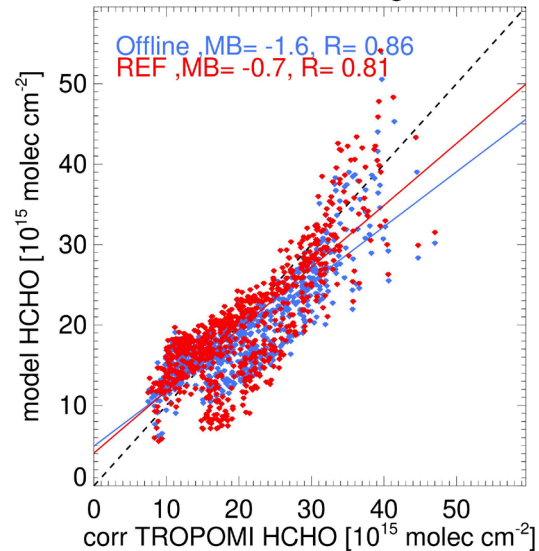


LOOKING AT A FEW INDIVIDUAL REGIONS; AUGUST 2019

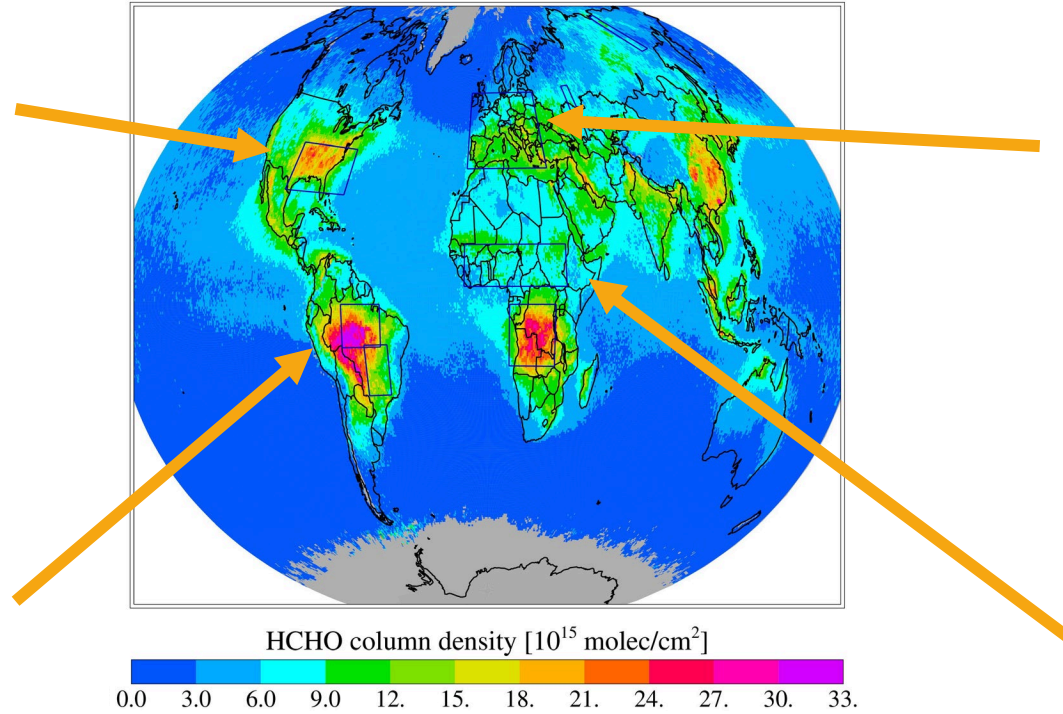
South-East US, Aug



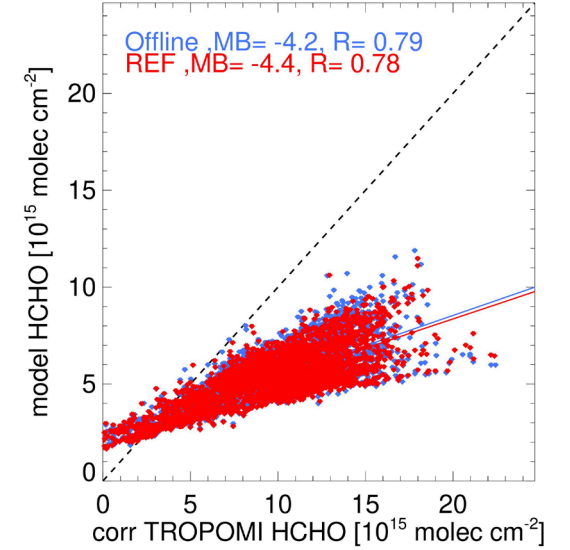
Amazon, Aug



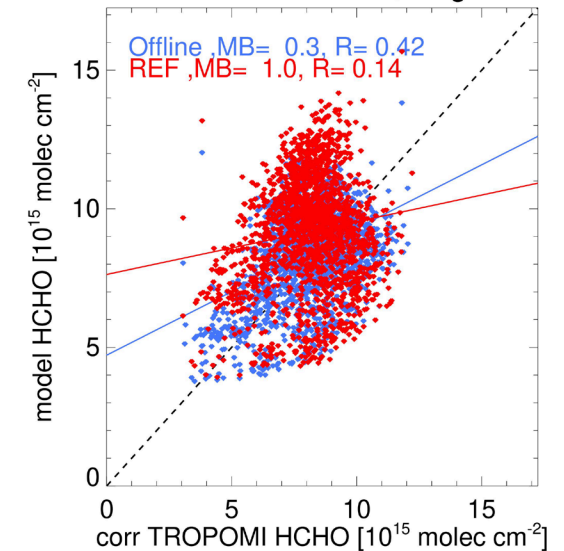
corr TROPOMI mean HCHO - 1-31 Aug



Europe, Aug



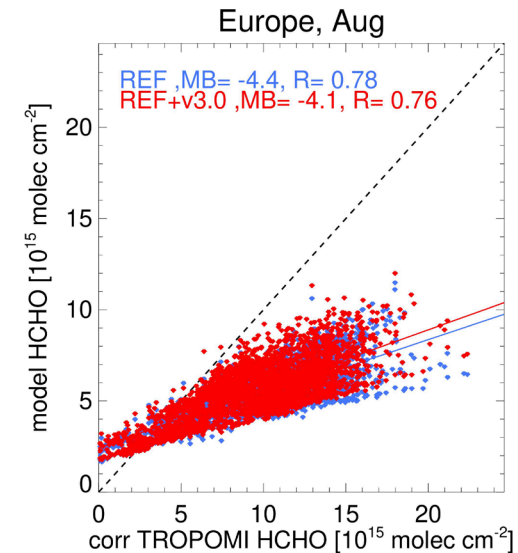
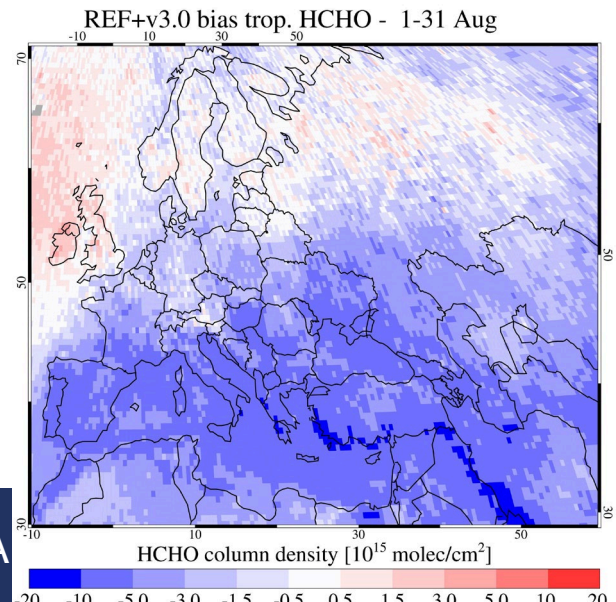
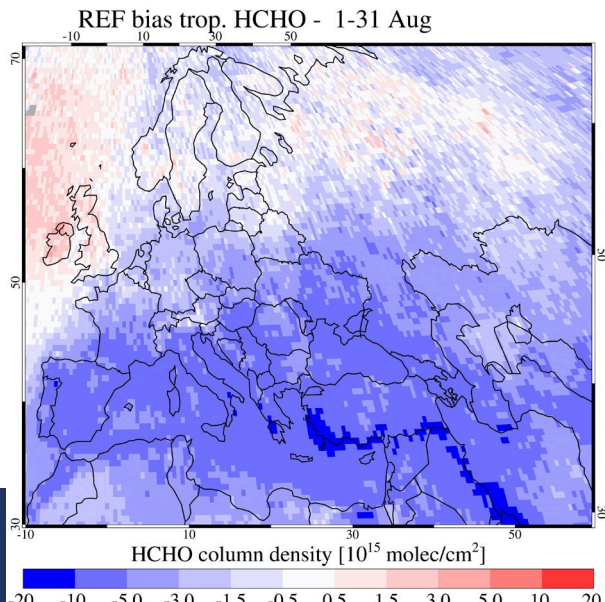
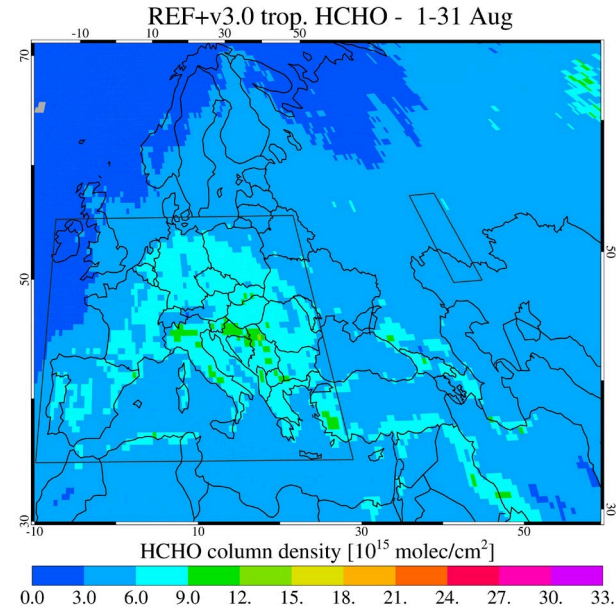
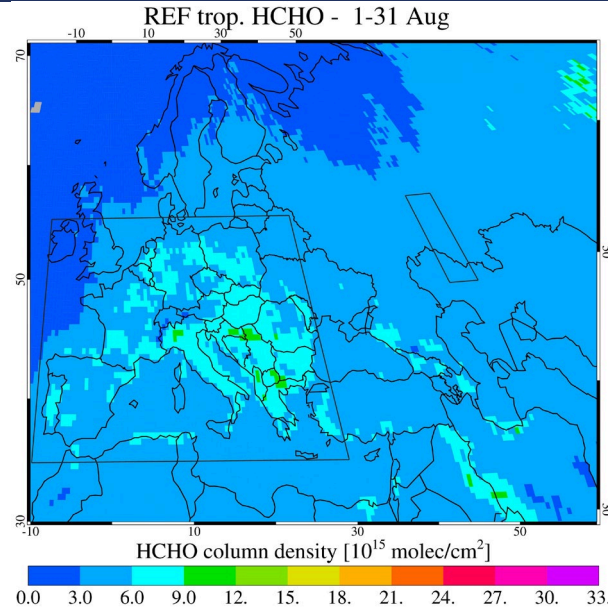
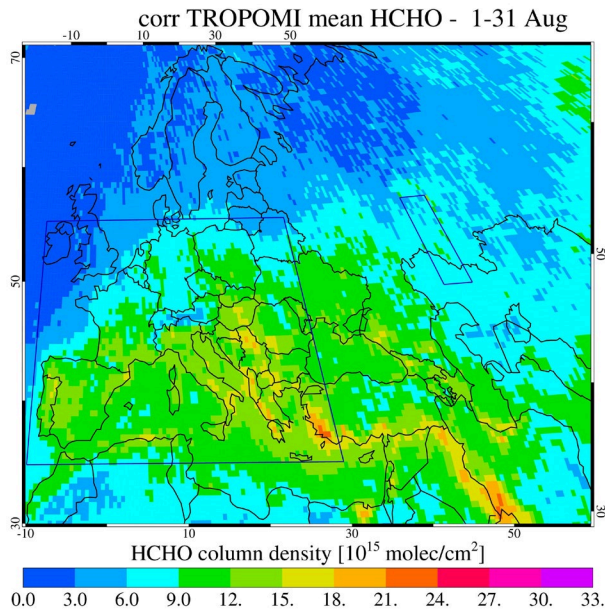
Northern Africa, Aug



- **Online:** similar performance as **offline**
- **Online:** Degradation over Northern Africa region



IMPACT OF EP CHANGE OVER EUROPE



- Large under-estimate over Europe,
- independent of assumed EP



CHEMISTRY UPDATES

- Low NO_x: Updated (decreased) 1,5 H-shift rates in reaction $\text{ISOPBO}_2 \rightarrow \text{ISPD} + \text{HCHO} + \text{OH}$ (*suppresses HCHO yield*)

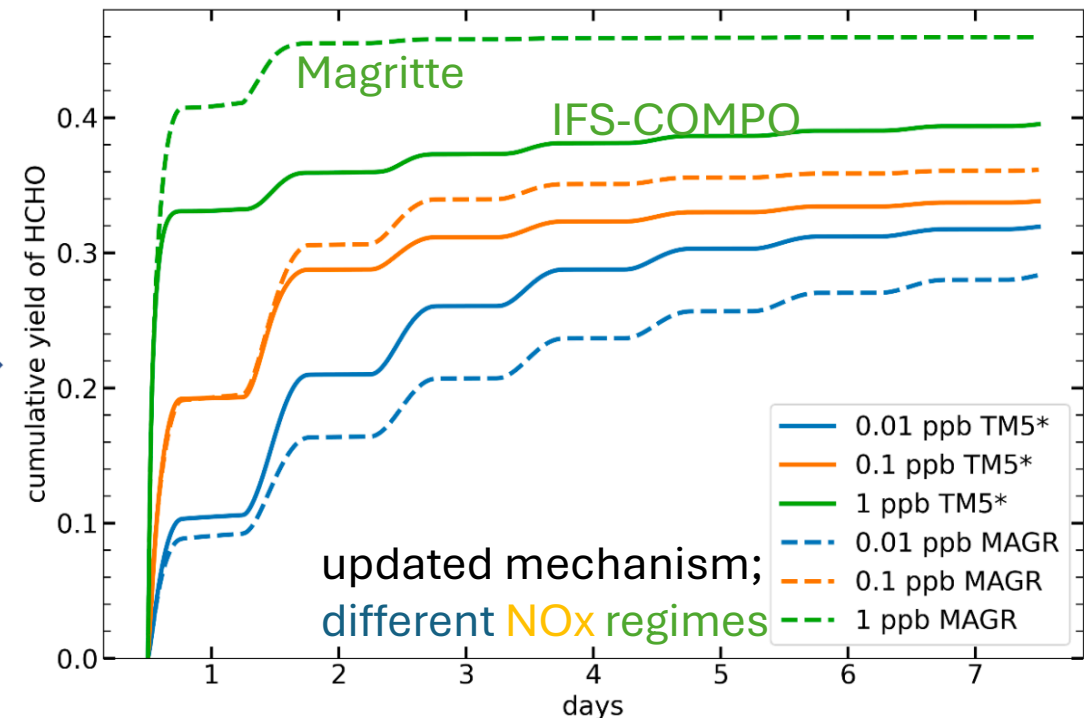
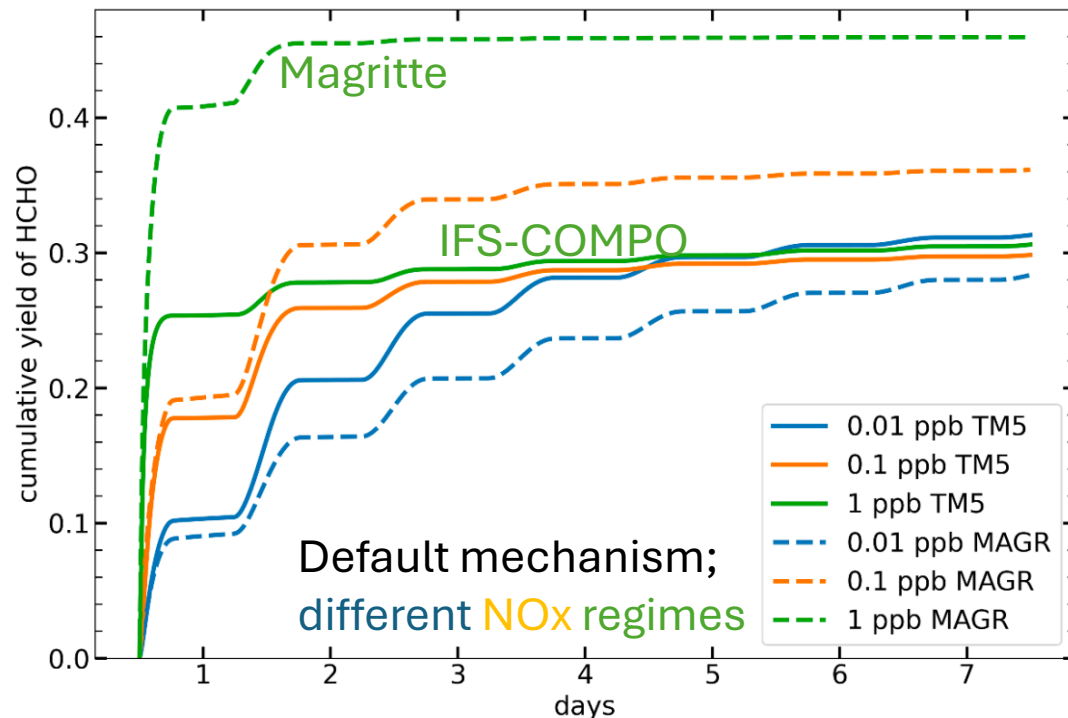
Thanks to G. Oomen, BIRA-IASB



CHEMISTRY UPDATES

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- High NO_x: increase HCHO yield from ISOPBO₂+NO reaction; reduce reaction rate (*increases HCHO yield*)

Thanks to G. Oomen, BIRA-IASB





CHEMISTRY UPDATES

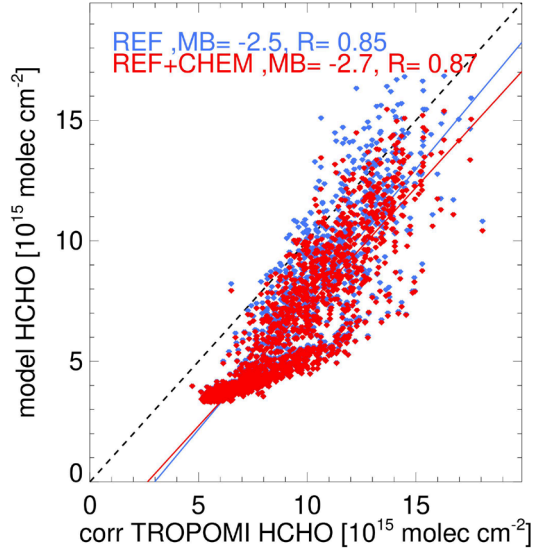
- Low NO_x: Updated (decreased) 1,5 H-shift rates in reaction ISOPBO₂->ISPD + HCHO + OH (*suppresses HCHO yield*)
- High NO_x: increase HCHO yield from ISOPBO₂+NO reaction; reduce reaction rate (*increases HCHO yield*)
- Inclusion of C₂H₂ emissions and chemistry (small impact)

Thanks to J. Williams

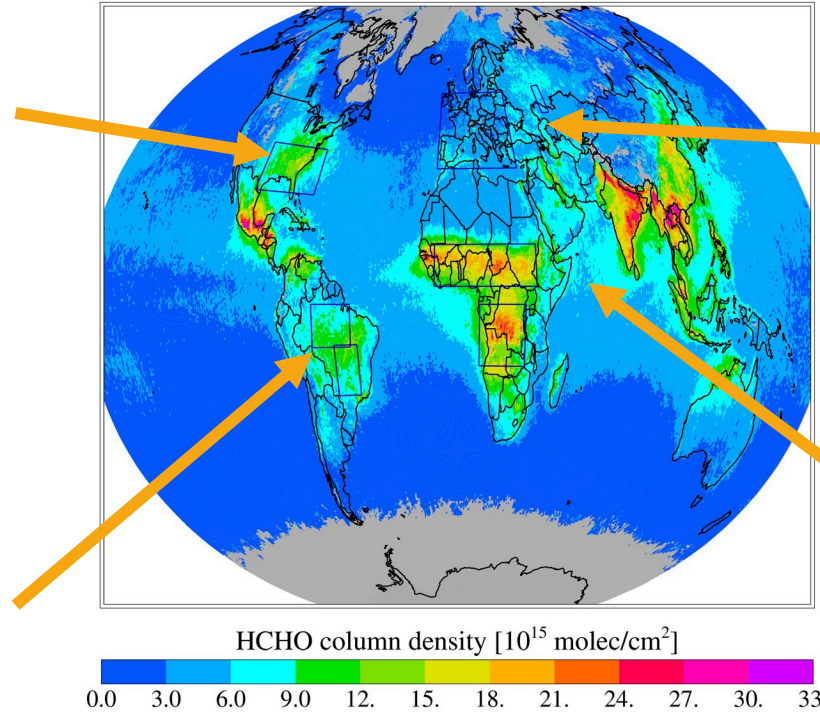


IMPACT OF CHEMISTRY UPDATE: MAY

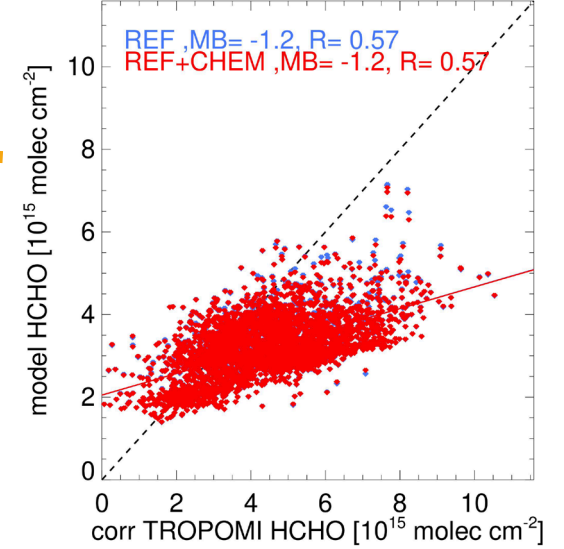
South-East US, May



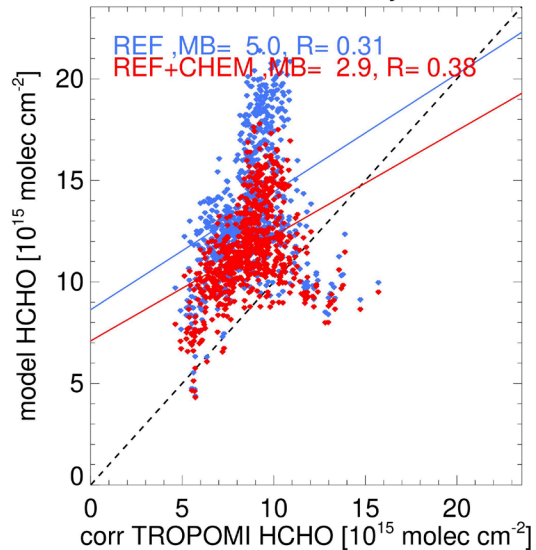
corr TROPOMI mean HCHO - 1-31 May



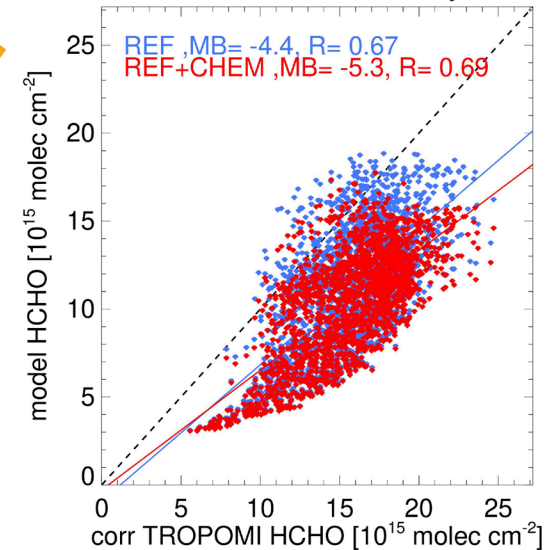
Europe, May



Amazon, May



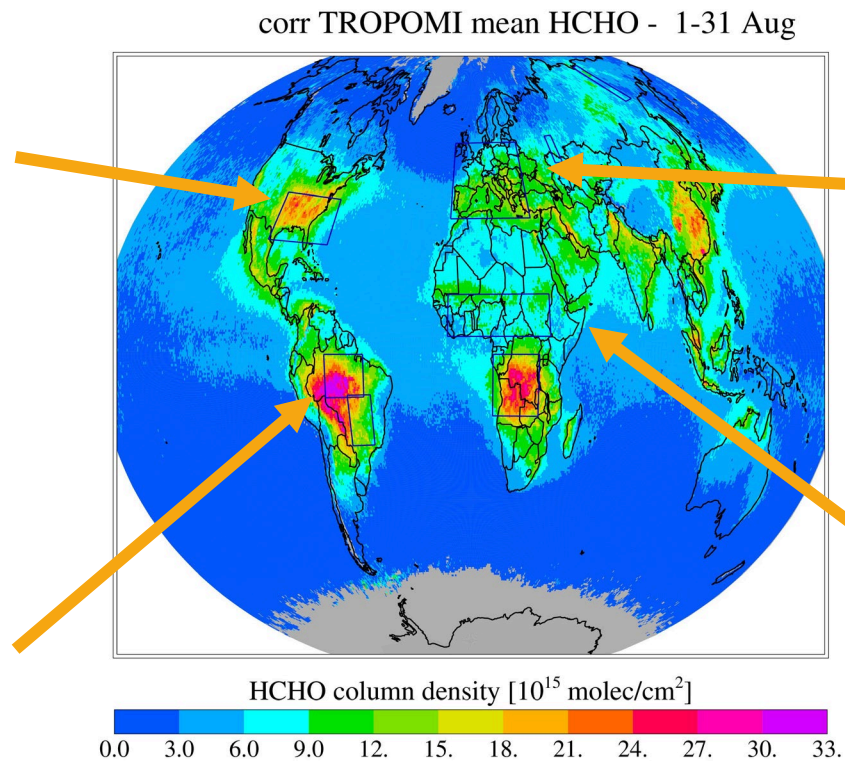
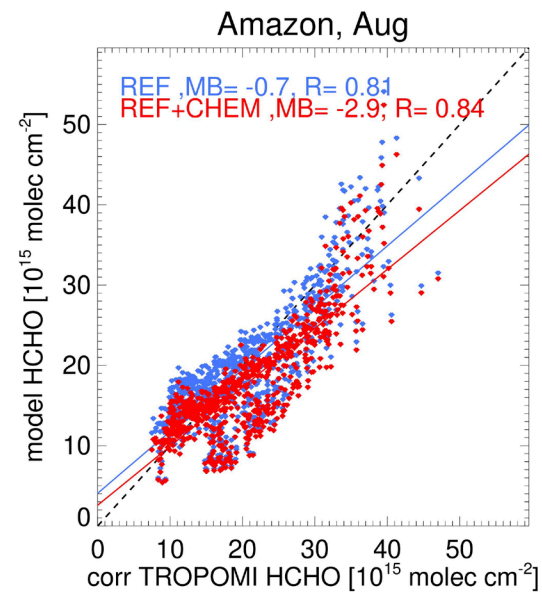
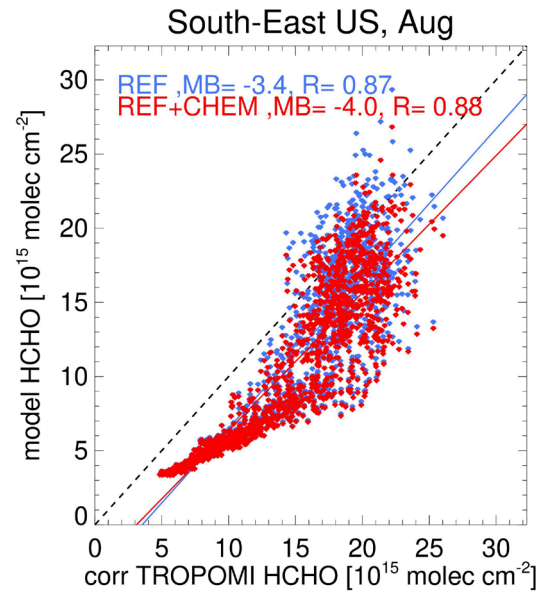
Northern Africa, May



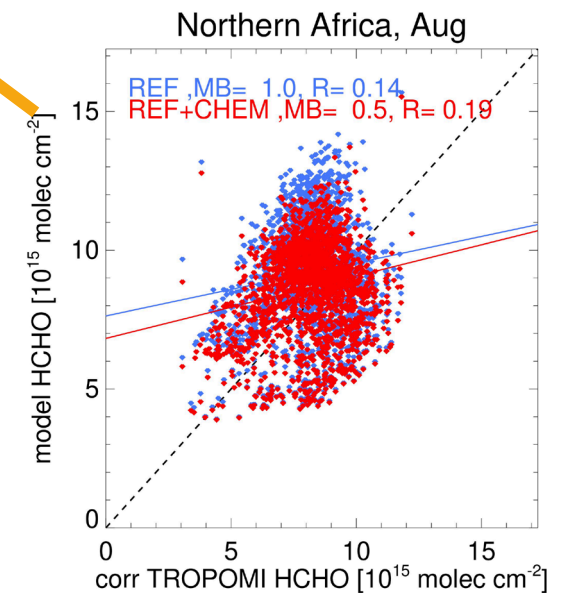
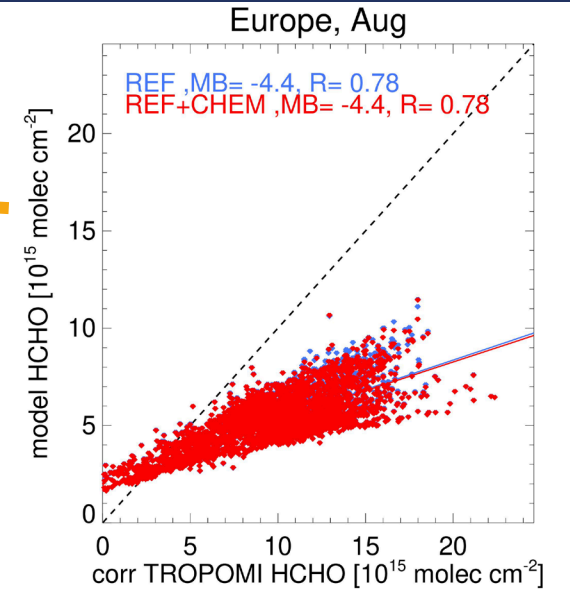
- **Chem update:** Reduces columns regionally (10-15%)



IMPACT OF CHEMISTRY UPDATE: AUGUST

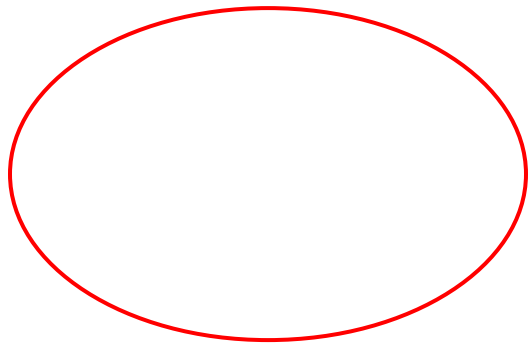


- **Chem update:** Reduces columns regionally (10-15%, but not Europe)



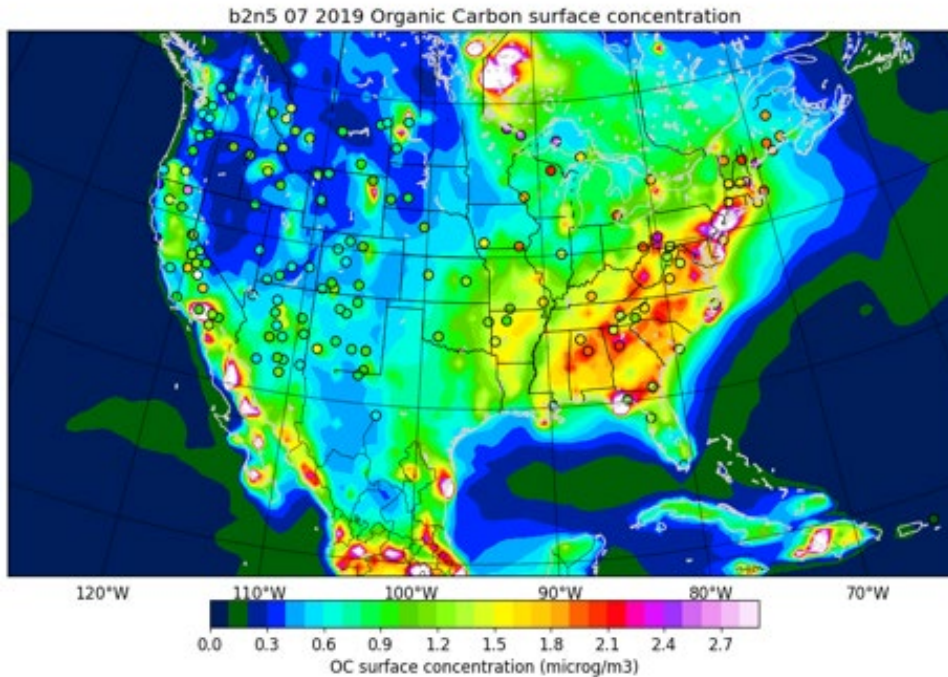


IMPACT ON SECONDARY AEROSOL FORMATION

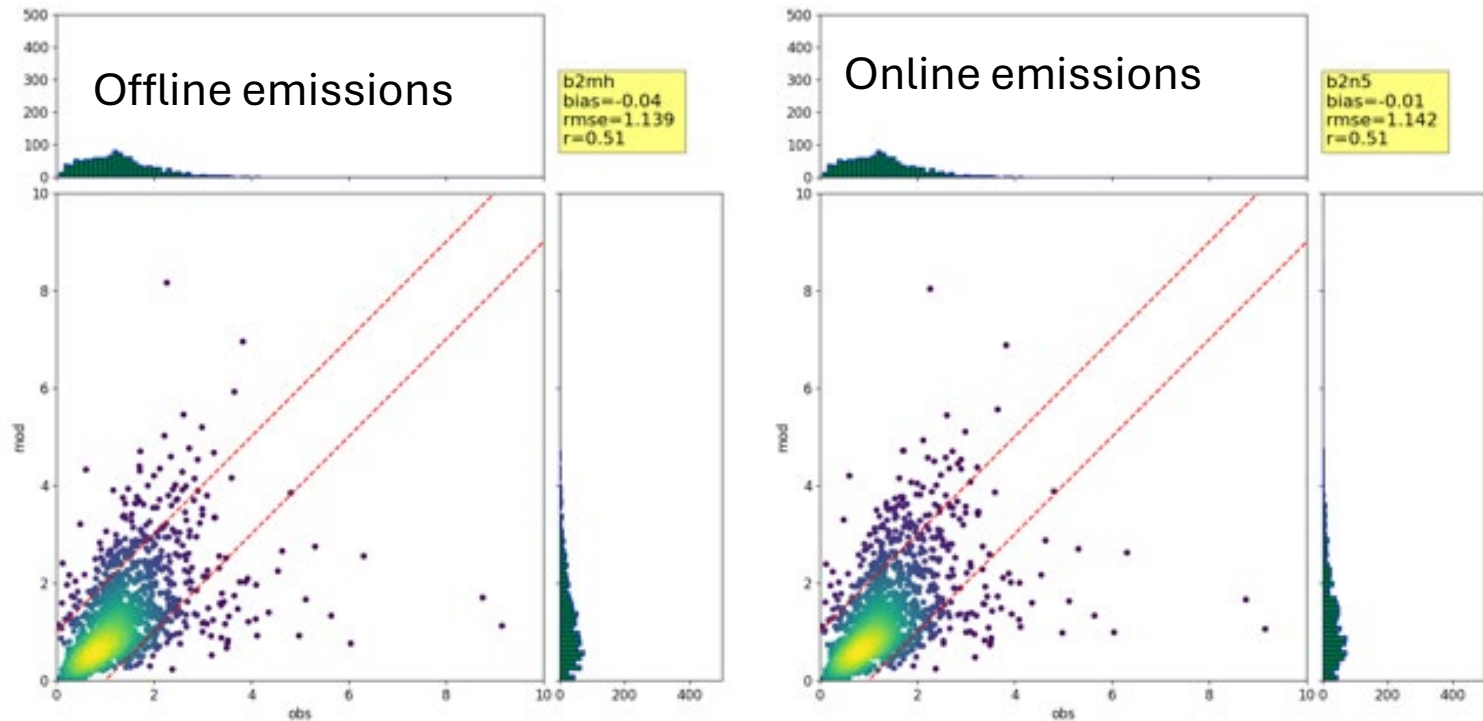




IMPACT ON ORGANIC AEROSOL



Evaluation of OM
against the IMPROVE network;
May - August 2019

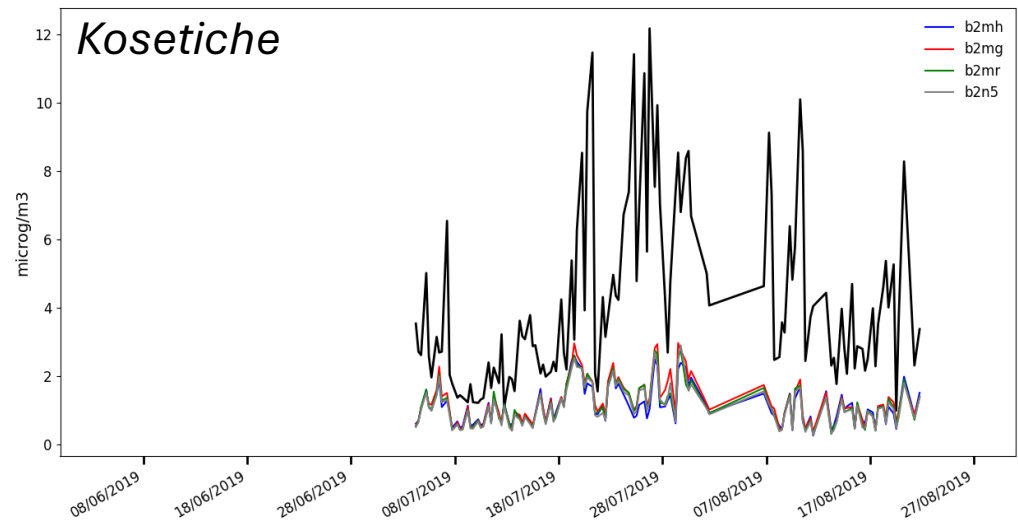
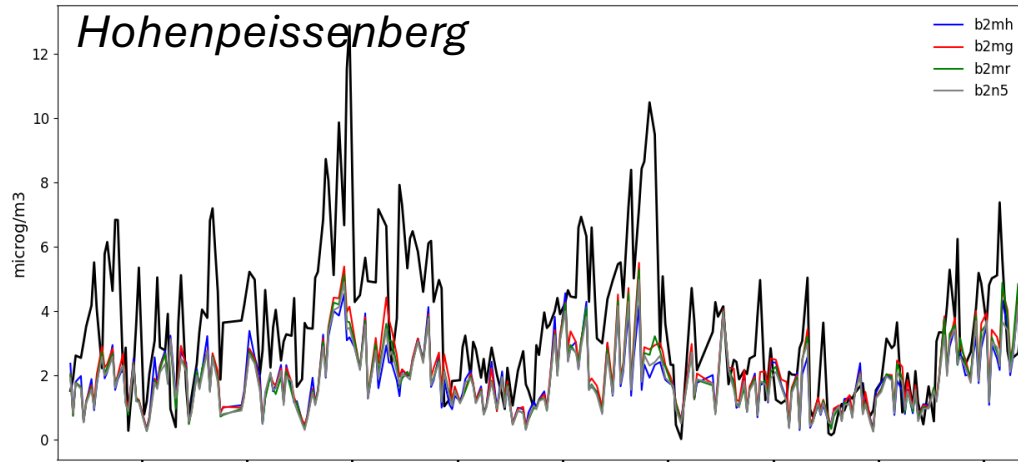


Similar performance
(consistent with HCHO eval)

Thanks to S. Rémy, HYGEOS



IMPACT ON ORGANIC AEROSOL



Evaluation against PM1 attributed to SOA obs (PMF)
For Europe:

Also mostly a bit of an under-estimate
Consistent with HCHO evaluations

Thanks to S. Rémy, HYGEOS



CONCLUSIONS

- First version of IFS-COMPO with online BVOC evaluated against TROPOMI HCHO and surface OM / SOA obs.
 - *Reasonable performance compared to offline*
 - *More observations would be desirable*
- Uncertainties in chemistry and retrievals cannot be neglected..



CONCLUSIONS

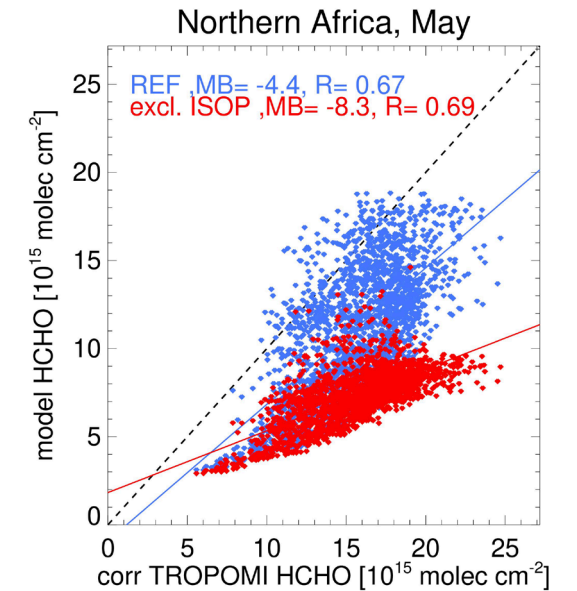
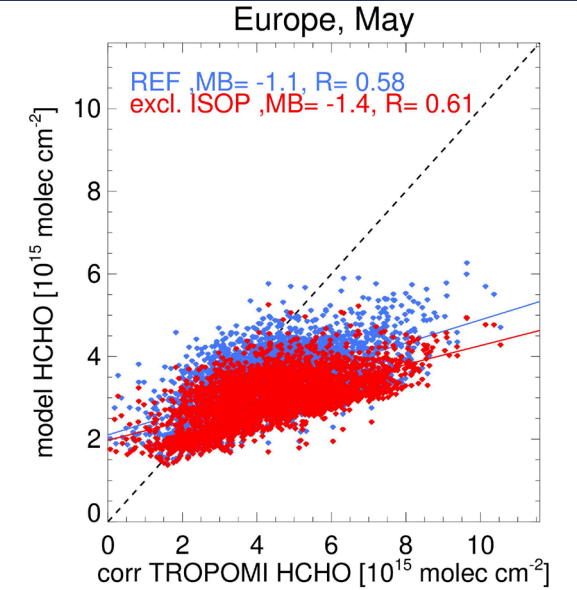
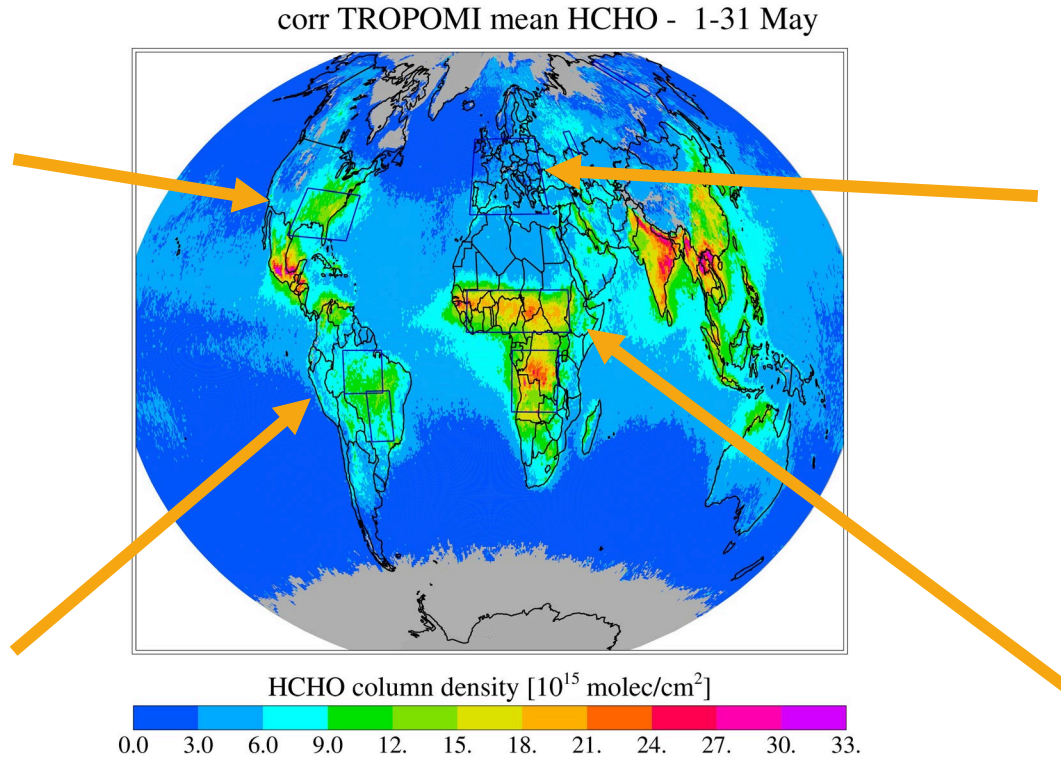
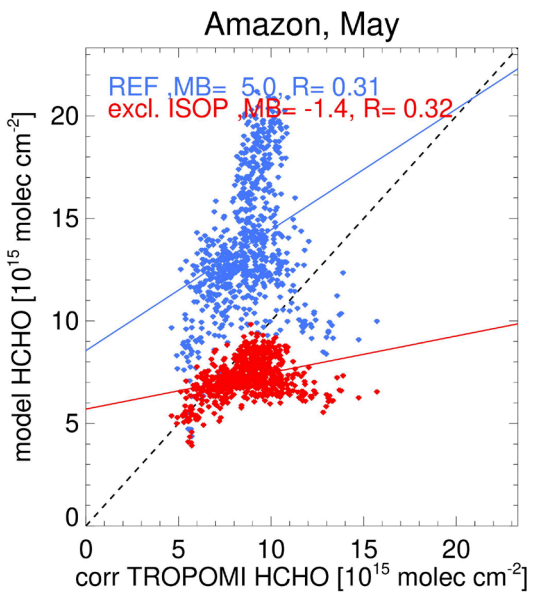
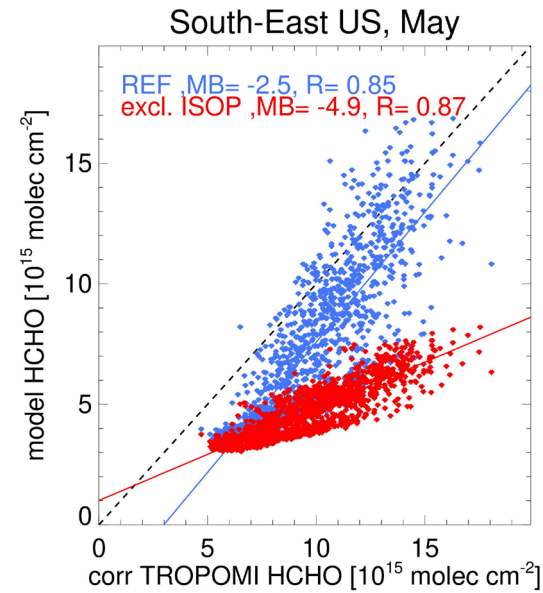
- First version of IFS-COMPO with online BVOC evaluated against TROPOMI HCHO and surface OM / SOA obs.
 - *Reasonable performance compared to offline*
 - *More observations would be desirable*
- Uncertainties in chemistry and retrievals cannot be neglected..
- **Large differences in performance for different regions:**
 - Southeast US: good performance (OM and HCHO)
 - South America / Africa: poor correlation wrt HCHO
 - *EP to be revisited?*
 - Europe: strong negative bias for HCHO, larger EP does not help.
 - *Missing (anthropogenic) sources?*



THANK YOU!

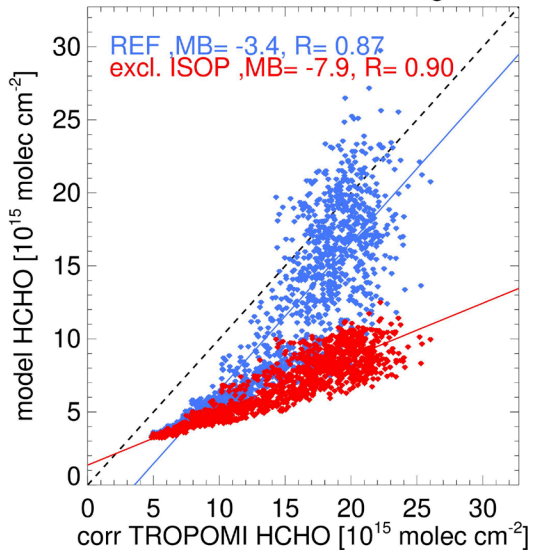


EXCLUDING ISOPRENE EMISSIONS...

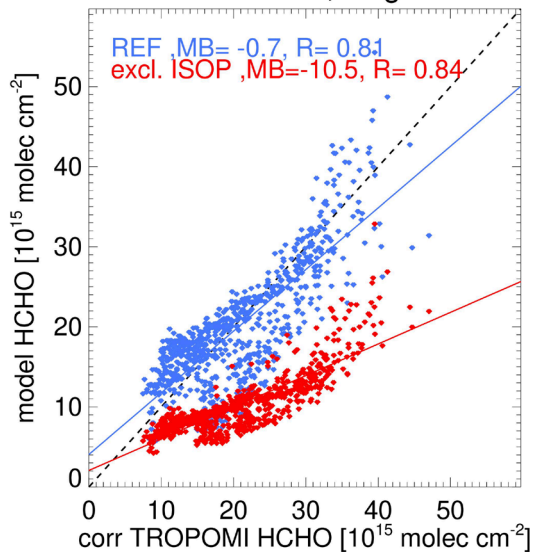




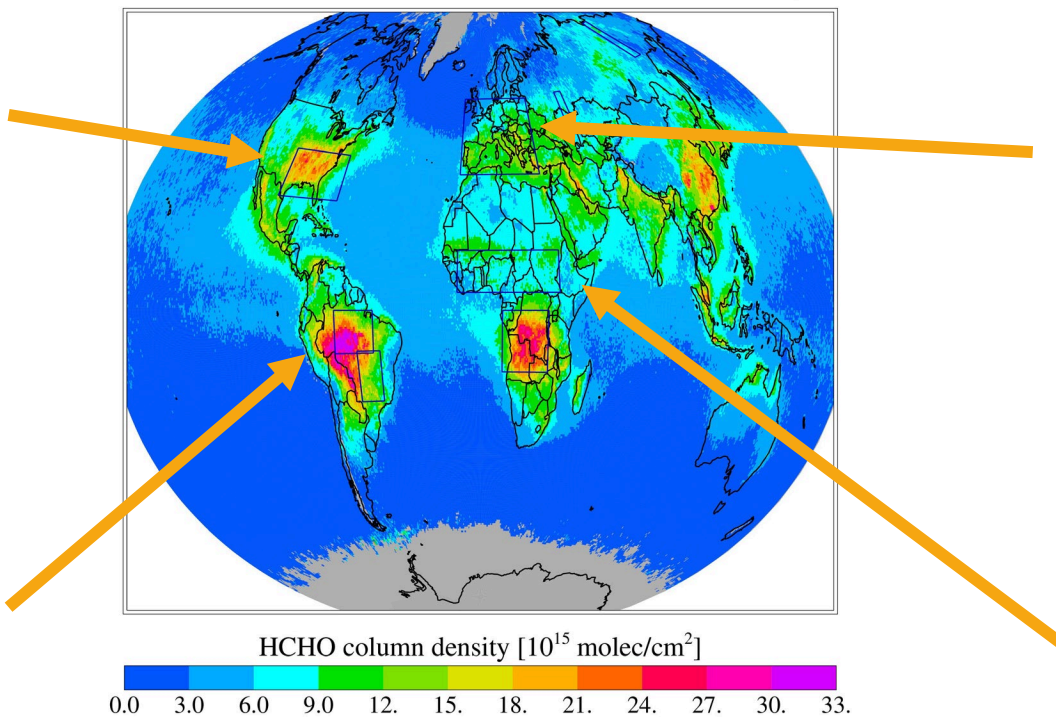
South-East US, Aug



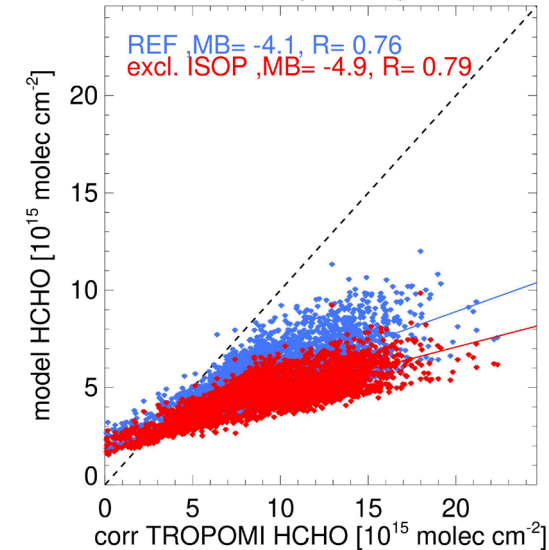
Amazon, Aug



corr TROPOMI mean HCHO - 1-31 Aug



Europe, Aug



Northern Africa, Aug

