Near-real-time measurements of acetylene (C_2H_2) and hydrogen cyanide (HCN) from IASI: method, validation, global distribution and comparison with model.

Duflot V.[1], Clarisse L.[1], Coheur P.-F.[1], Wespes C.[1], Murphy C.[2], Jones N.[2], Hurtmans D.[1], Hadji-Lazaro J.[7], Ngadi Y.[1], R'honi Y.[1], Vigouroux C.[3], De Mazière M.[3], Metzger J.-M.[4], Mahieu E.[5], Servais C.[5], Blumenstock T.[6], Hase F.[6], Schneider M.[6] and Clerbaux C.[1,7]

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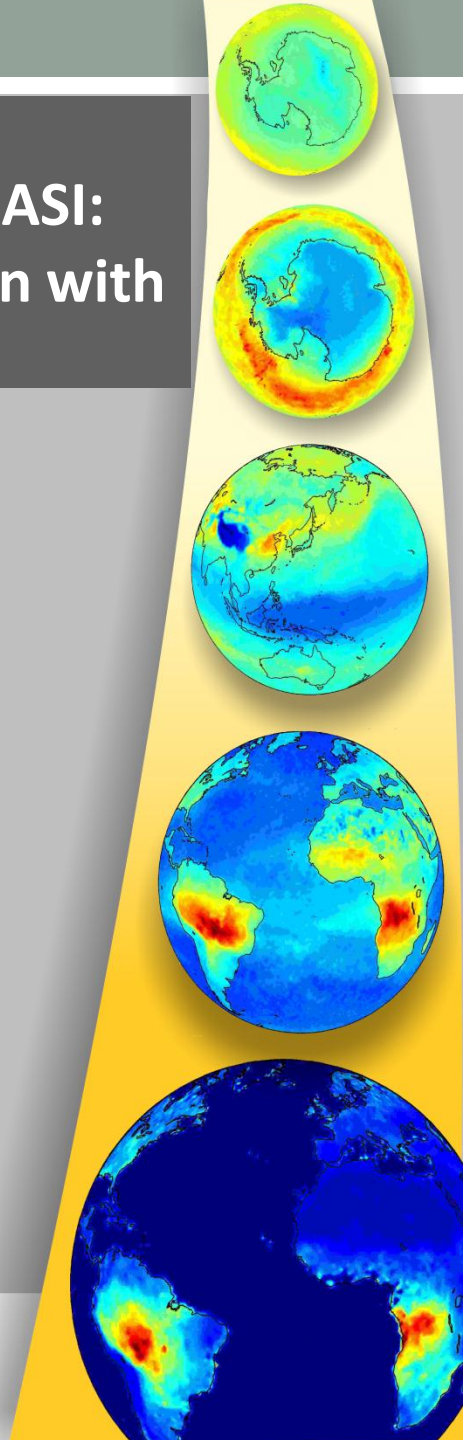
[5] Institut d'Astrophysique et de Géophysique, Université de Liège, 17, Allée du 6 Août, B-4000, Liège, Belgium.
[6] Institut für Meteorologie und Klimaforschung - Atmosphärische Spurengase und Fernerkundung (IMK-ASF), Technical University of Karlsruhe, Karlsruhe, Germany.
[7] Université Paris 06; Université Versailles-St. Quentin; CNRS/INSU, LATMOS-IPSL, Paris, France.



Introduction

HCN

Main sources:

- **Biomass Burning**
- Fossil fuel combustion
- Higher plants, bacteria and fungi

Main sink:

- Ocean uptake

Lifetime: 2-4 months

C_2H_2

Main sources:

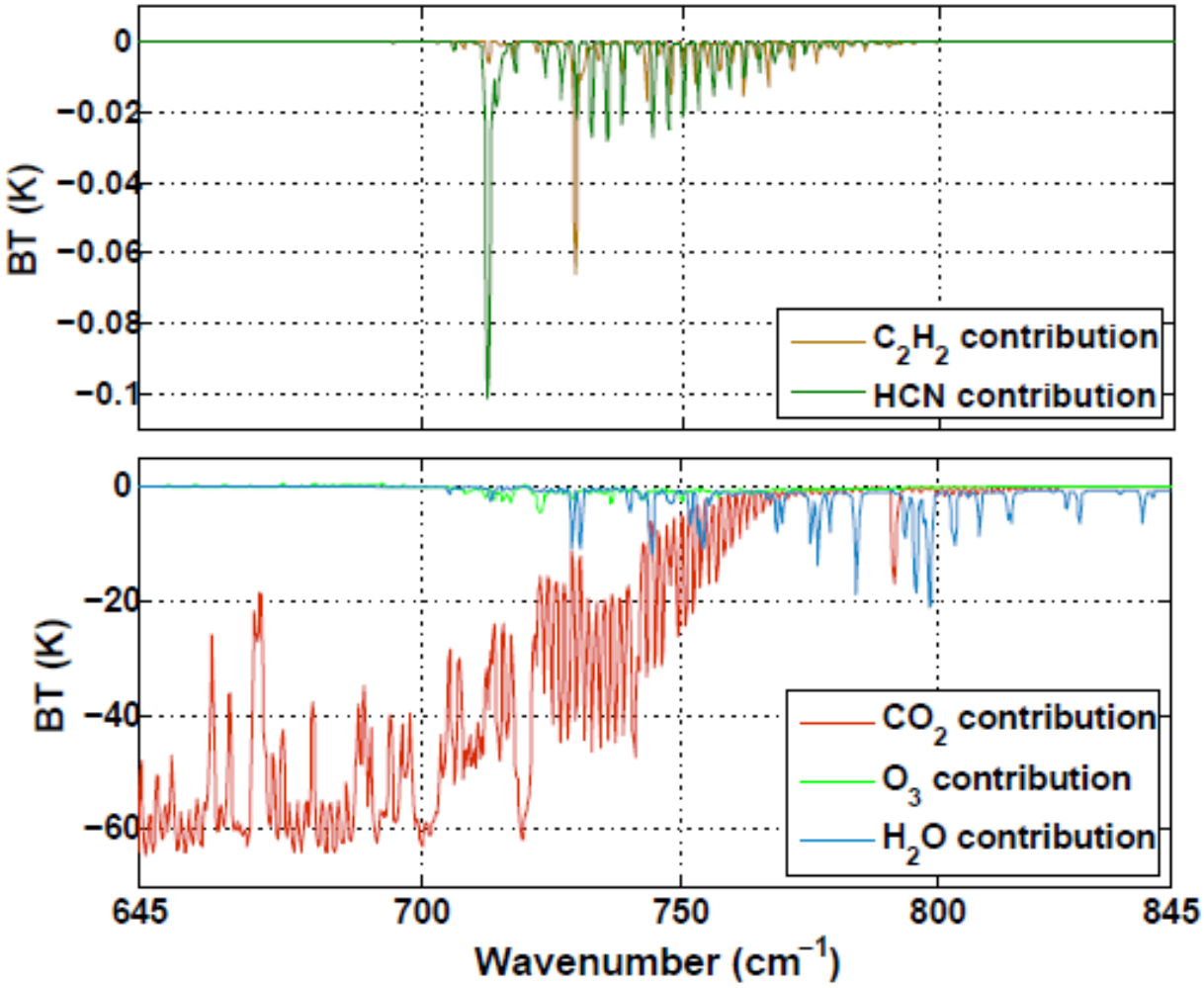
- **Biofuel combustion**
- **Fossil fuel combustion**
- Biomass Burning

Main sink:

- Reaction with OH radical

Lifetime: 2-4 weeks

Method



IASI ability to retrieve HCN and C2H2 background abundances: Duflot et al., AMTD 2012

Method

1 million spectra set

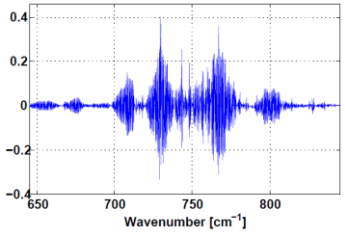
BTD Filter

$$S_\epsilon^{tot} \simeq \frac{1}{N-1}\sum_{j=1}^{N}(y_j-\bar{y})^T = S_y^{obs}$$

Total error covariance matrix

$$G = (K^T S_\epsilon^{tot-1} K)^{-1} K^T S_\epsilon^{tot-1}$$

Measurement contribution function

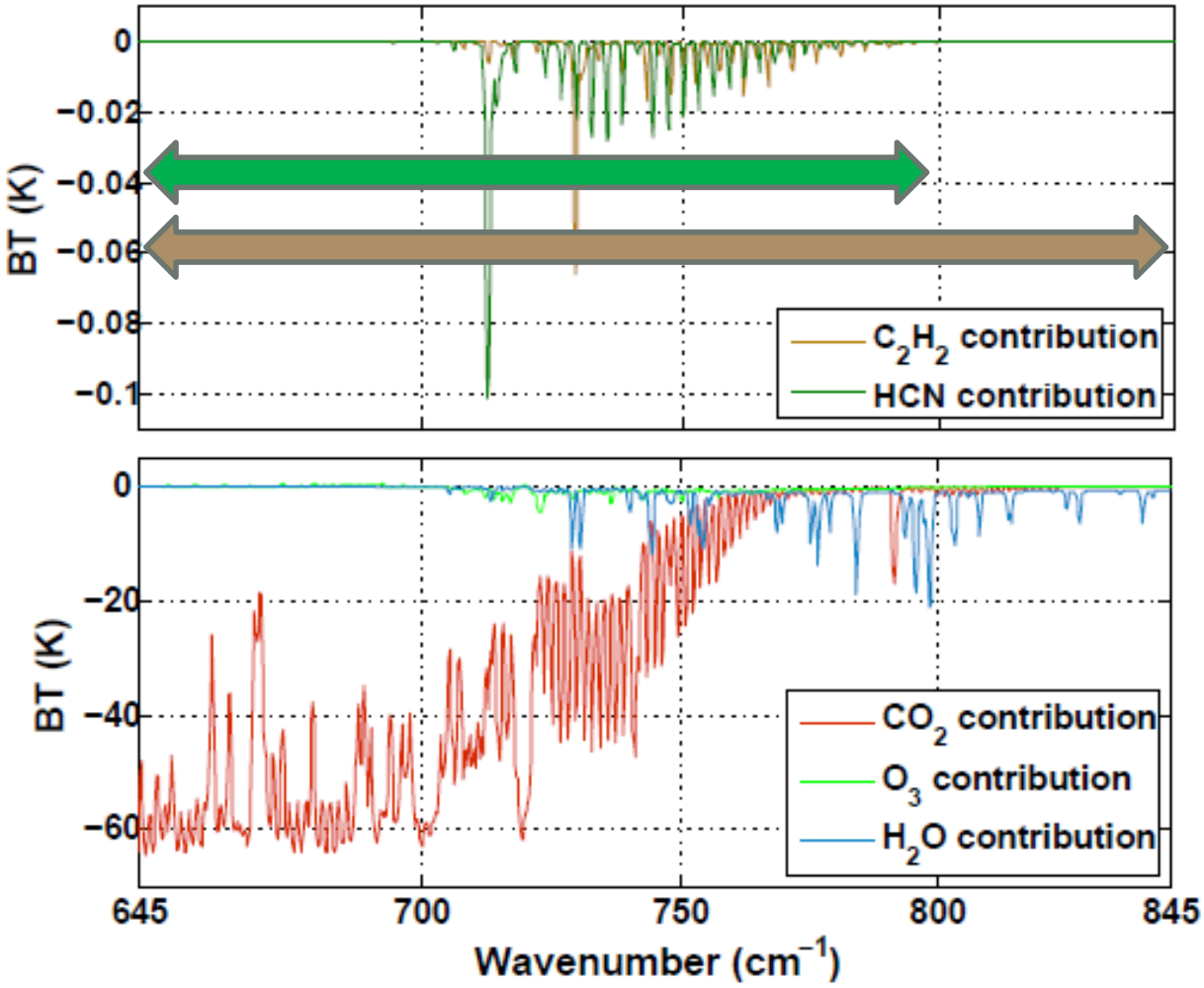


$$\mathrm{HRI} = x_0 + G \times (y-\bar{y})$$

Hyperspectral Range Index

(Walker et al., AMT, 2011)

Method


0
−0.02
−0.04
−0.06
−0.08
−0.1
BT (K)
C2H2 contribution
HCN contribution
0
−20
−40
−60
BT (K)
CO2 contribution
O3 contribution
H2O contribution
645
700
750
800
845
Wavenumber (cm−1)

Method

1 million spectra set

BTD Filter

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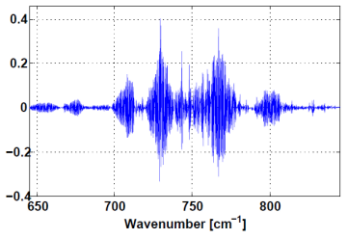
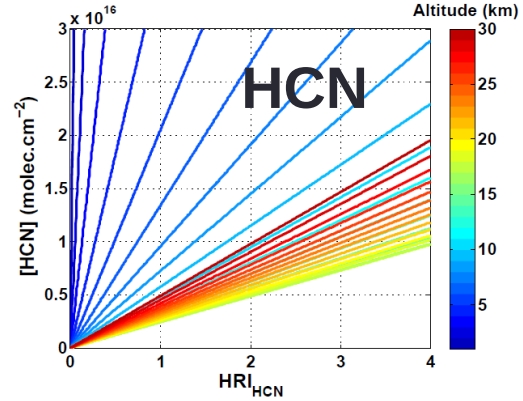
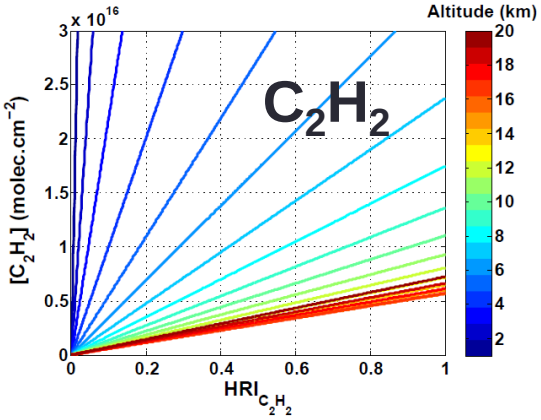
$$G = (K^T S_\epsilon^{tot-1} K)^{-1} K^T S_\epsilon^{tot-1}$$



$$\mathrm{HRI} = x_0 + G \times (y - \bar{y})$$

Forward model





Method

1 million spectra set

BTD Filter

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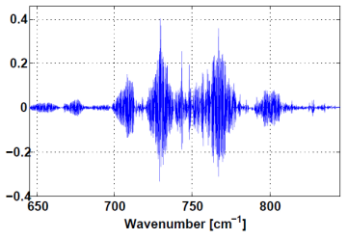
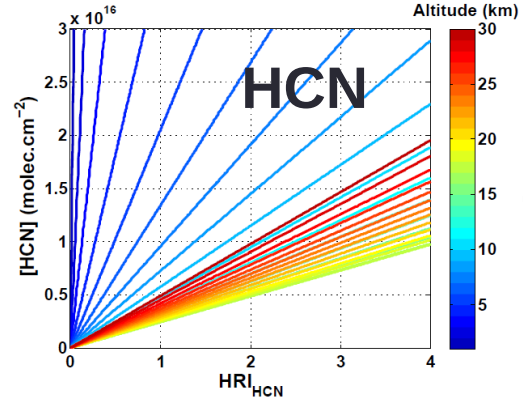
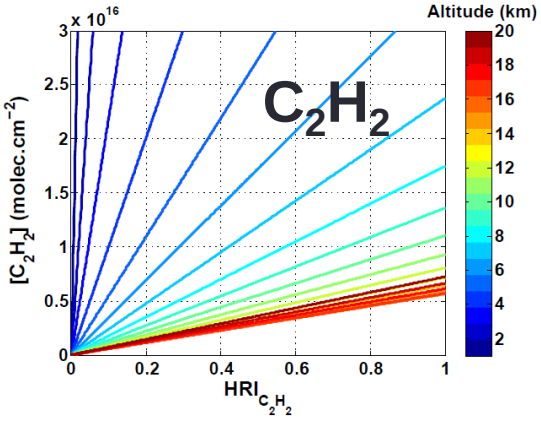
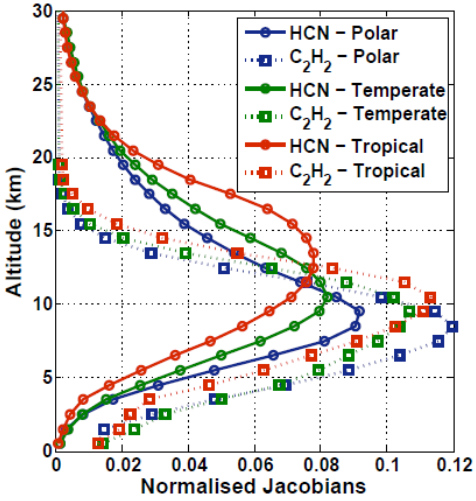


$$\mathrm{HRI} = x_0 + G \times (y - \bar{y})$$

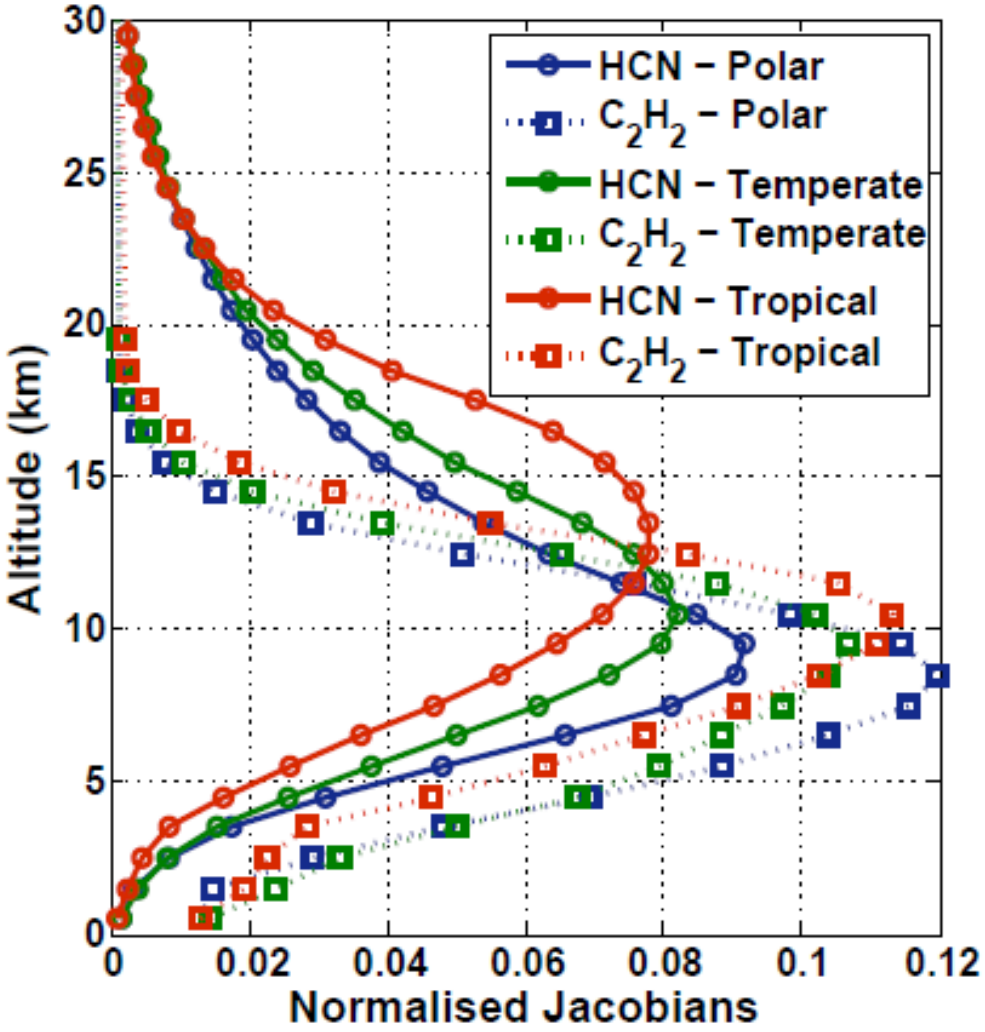
Forward model







Method


HCN – Polar
C2H2 – Polar
HCN – Temperate
C2H2 – Temperate
HCN – Tropical
C2H2 – Tropical
Altitude (km)
Normalised Jacobians
0
5
10
15
20
25
30
0
0.02
0.04
0.06
0.08
0.1
0.12

Method

1 million spectra set

BTD Filter

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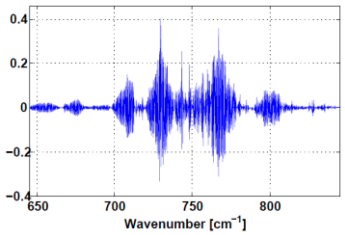
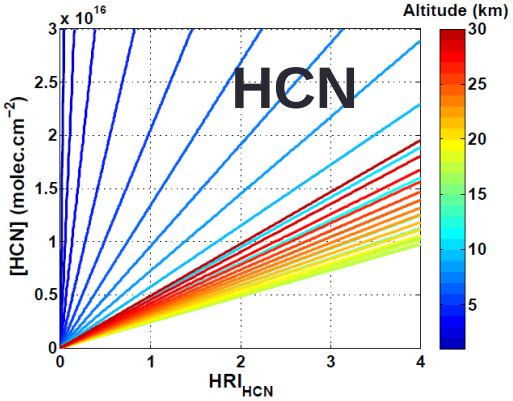
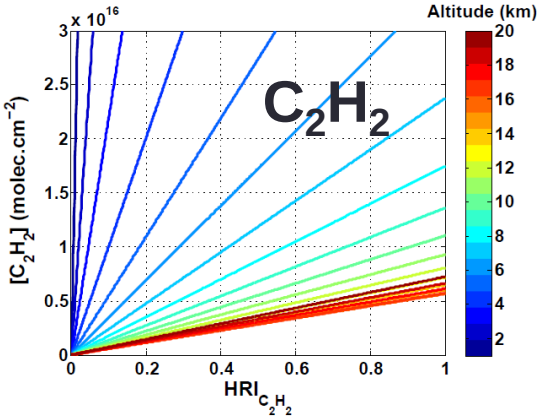
$$G = (K^T S_\epsilon^{tot-1} K)^{-1} K^T S_\epsilon^{tot-1}$$

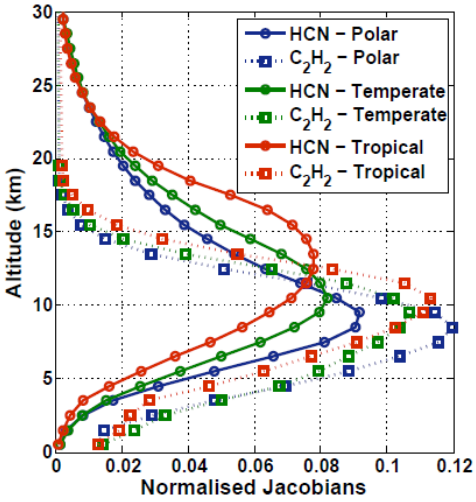


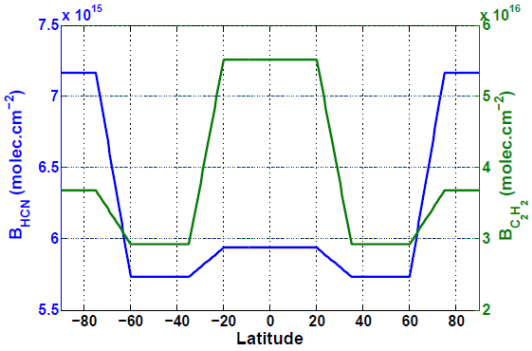
$$\mathrm{HRI} = x_0 + G \times (y - \bar{y})$$

Forward model

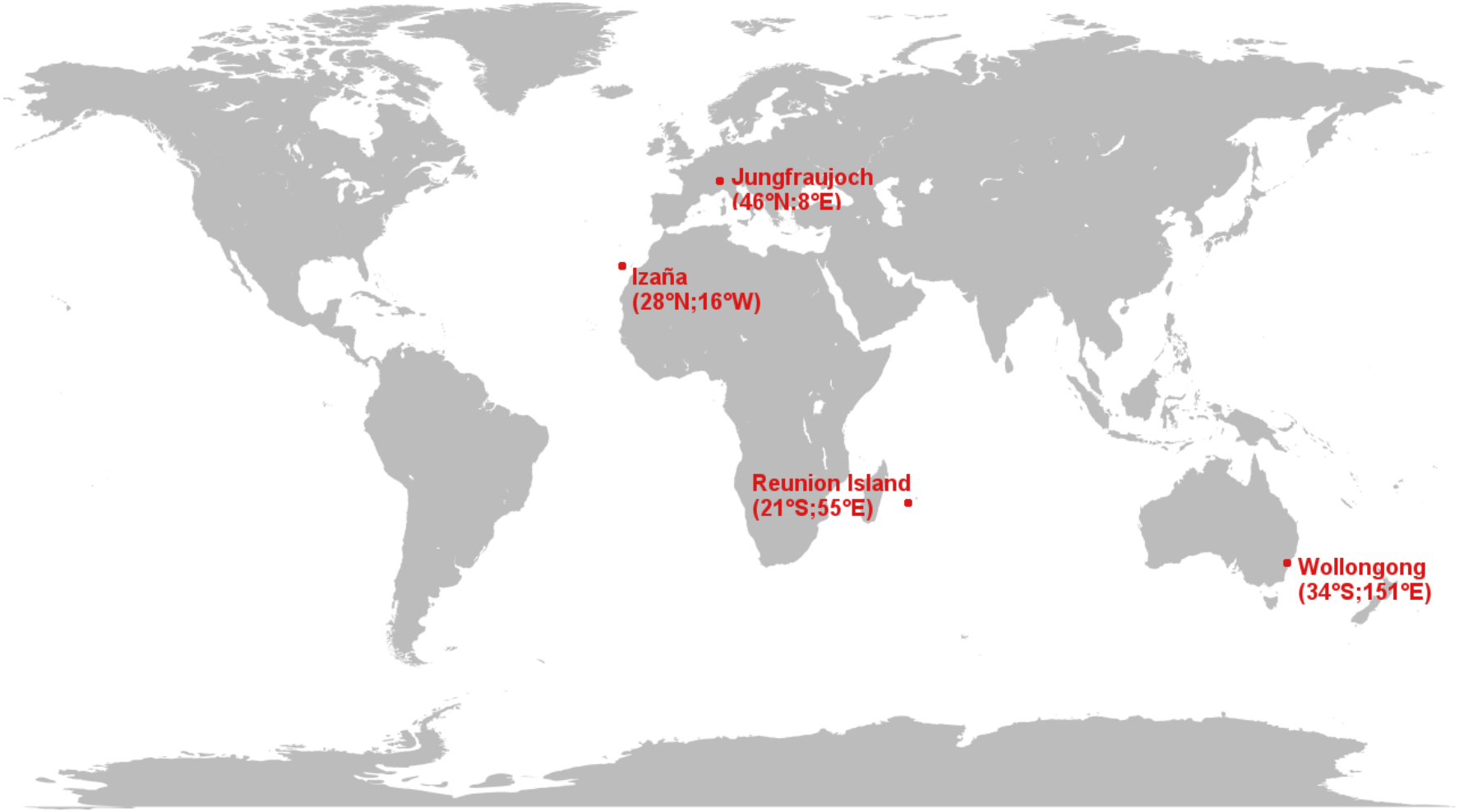




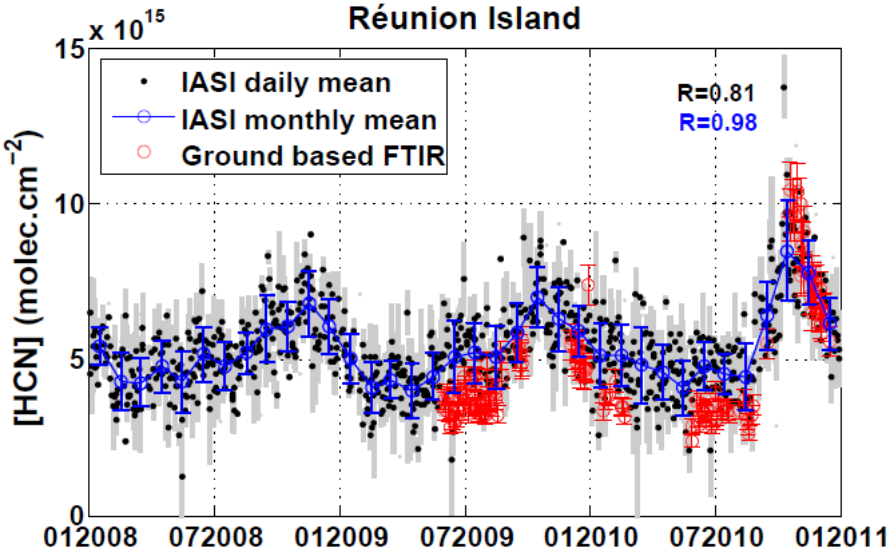


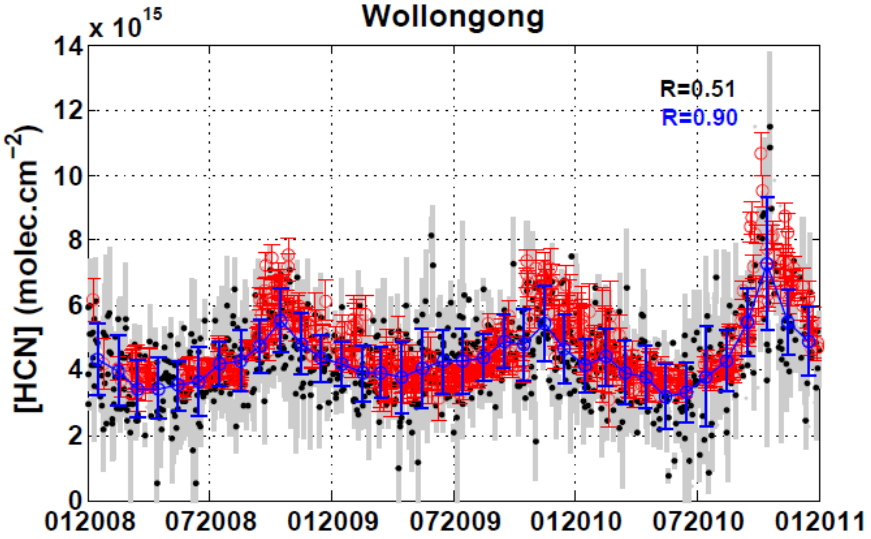


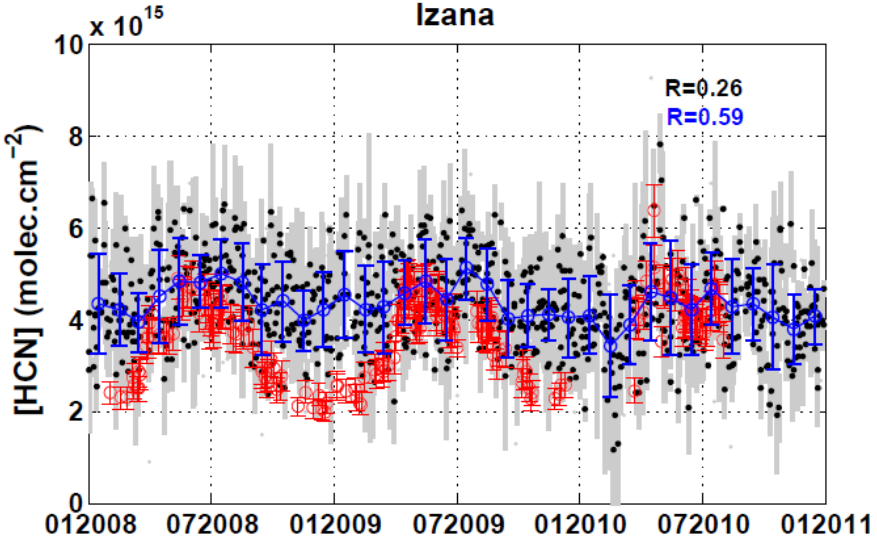
Validation: ground-based FTIR NDACC sites



Validation: ground-based FTIR NDACC sites

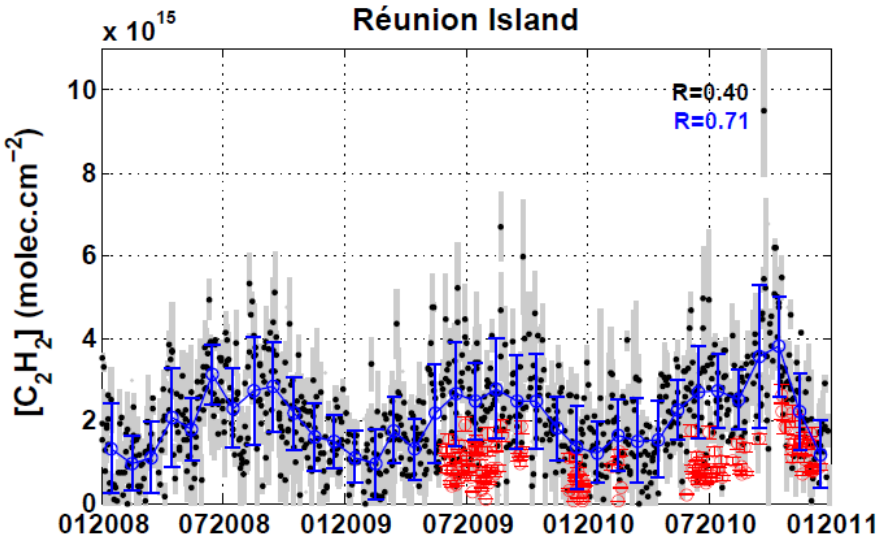


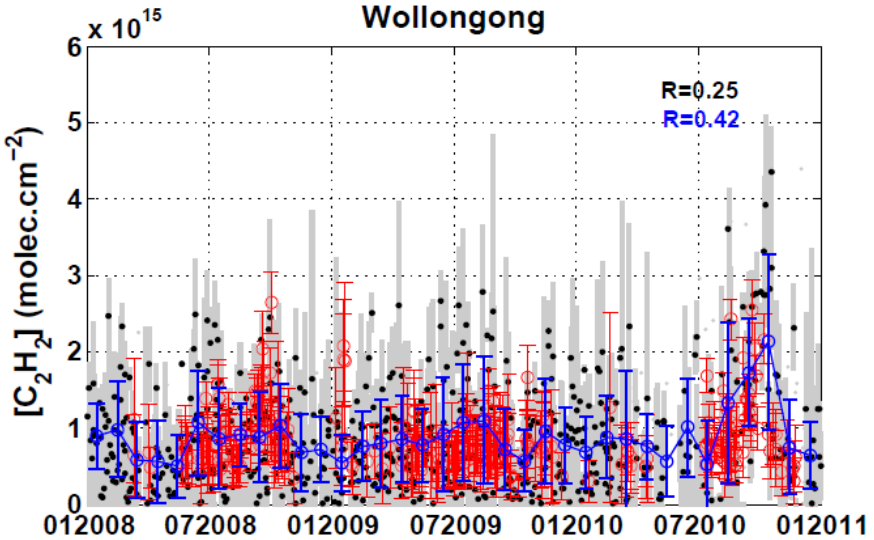


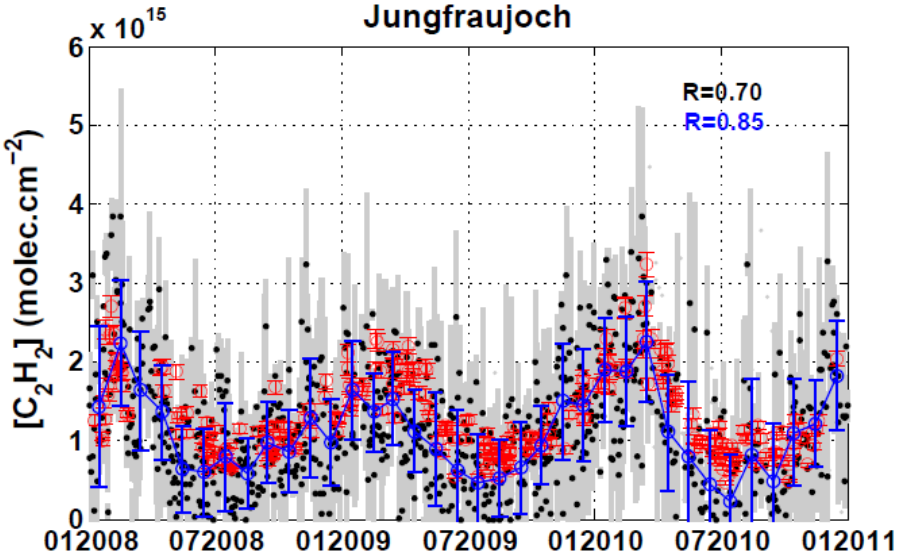


HCN

Validation: ground-based FTIR NDACC sites

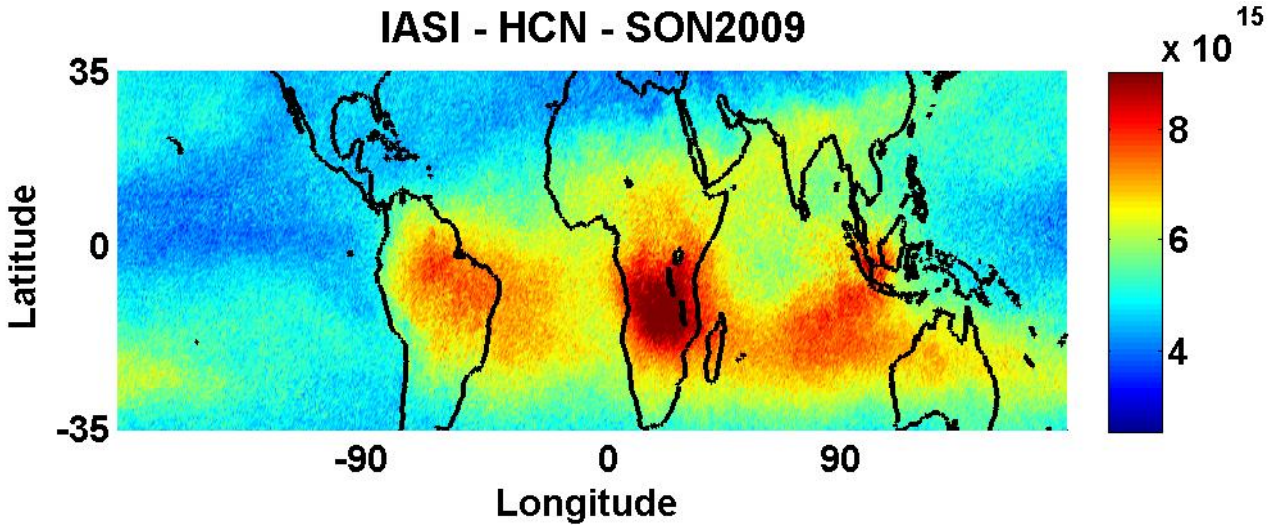




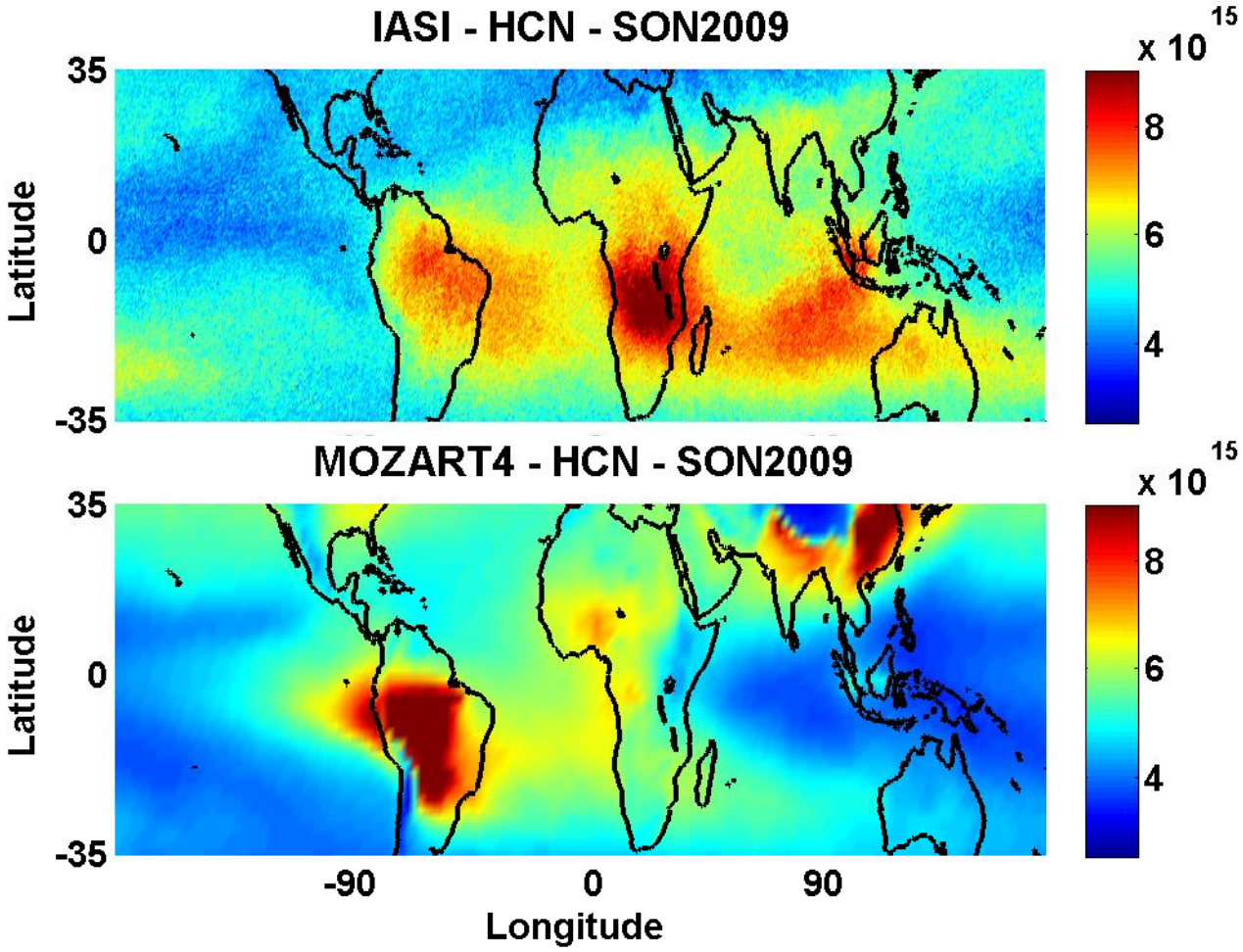


C_2H_2

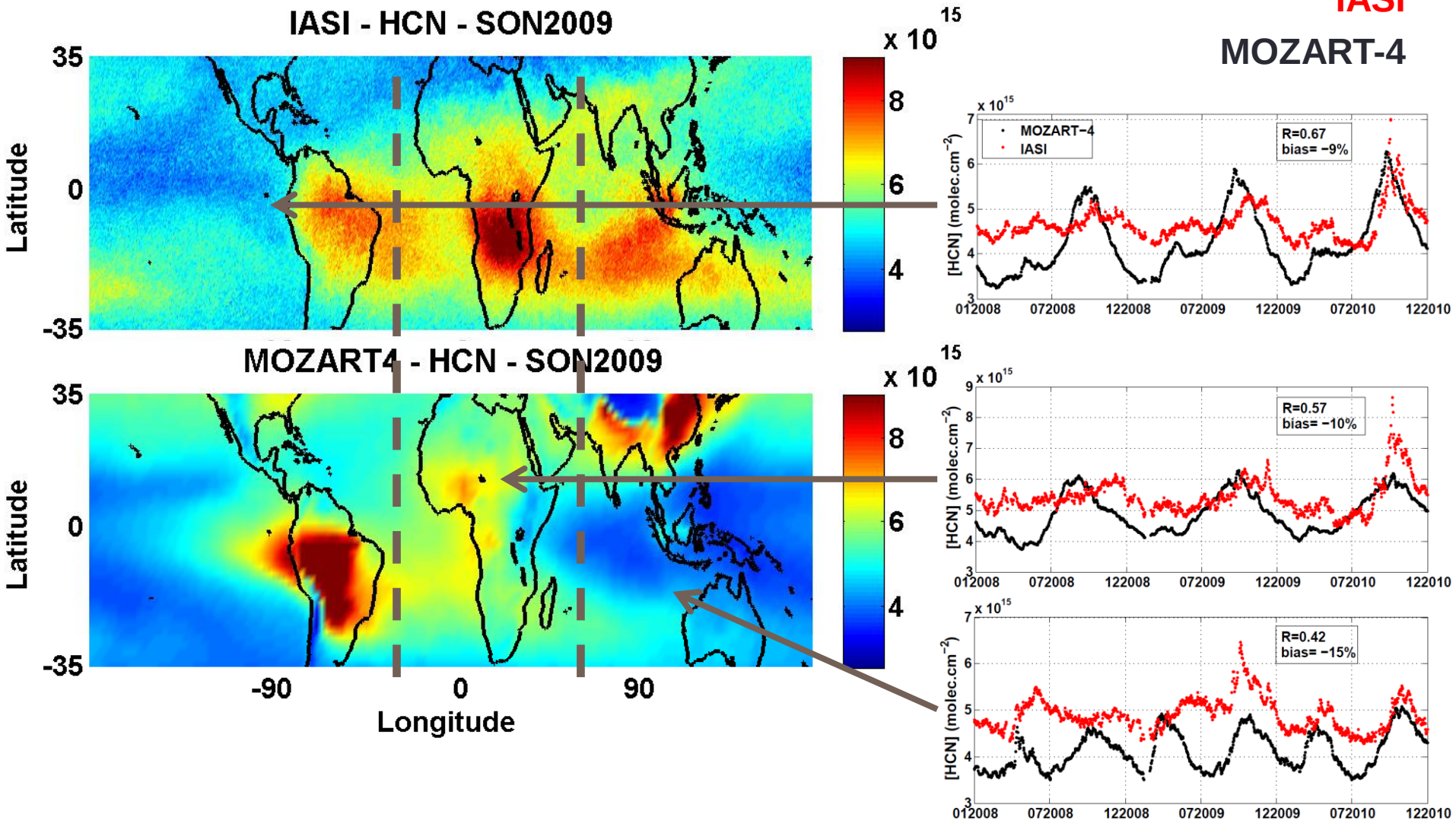
HCN tropical distribution



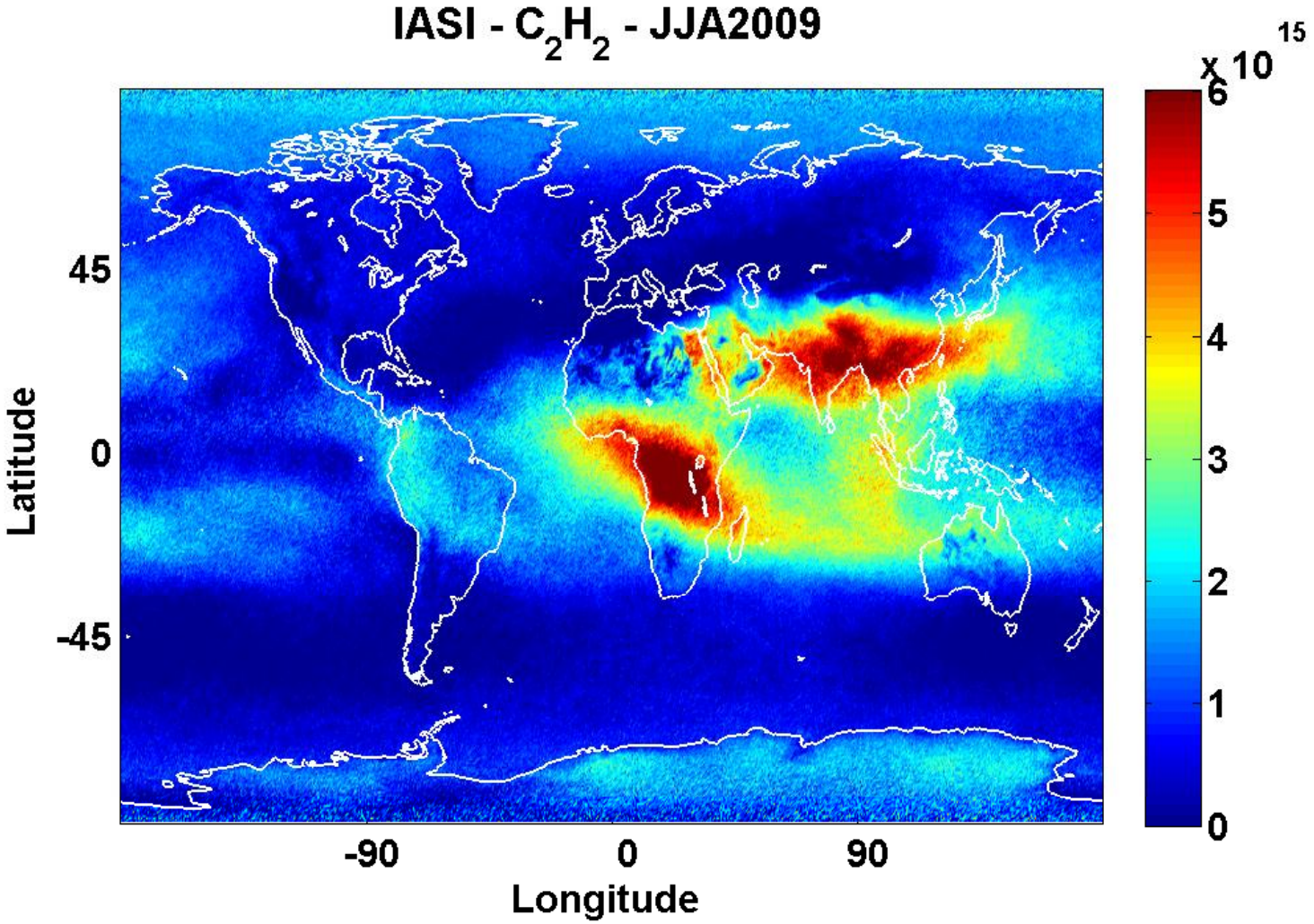
HCN tropical distribution



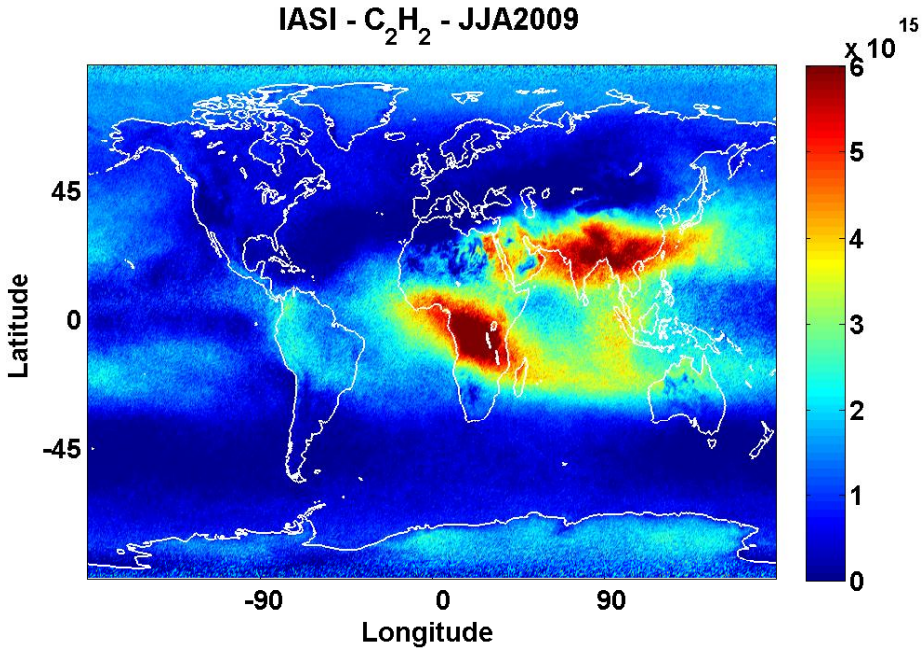
HCN tropical distribution

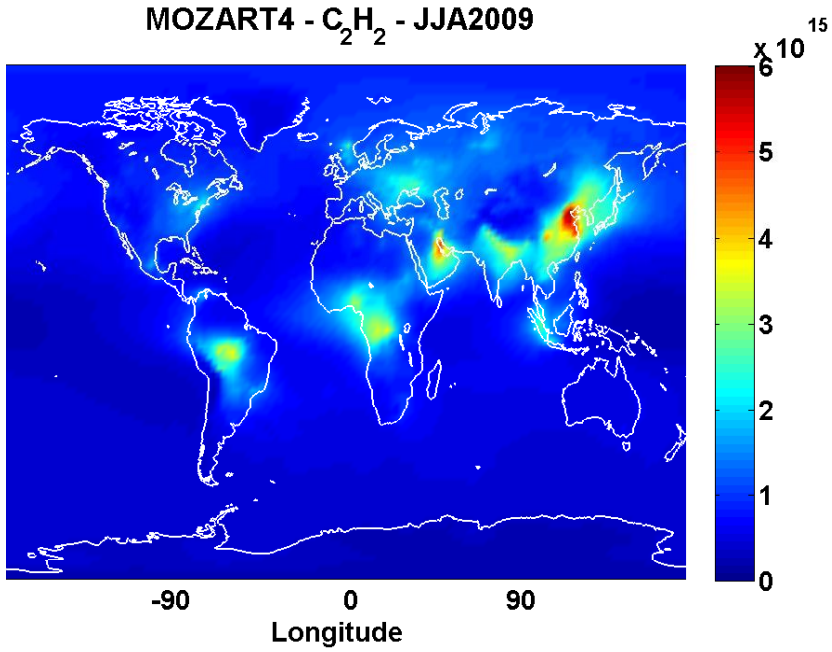


C_2H_2 global distribution



C_2H_2 global distribution

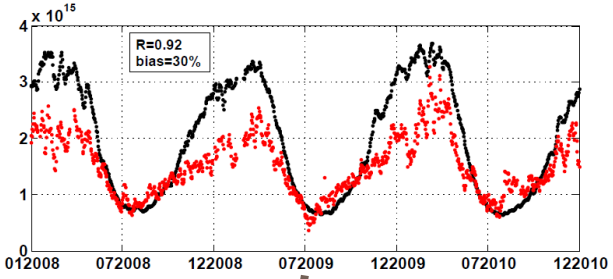


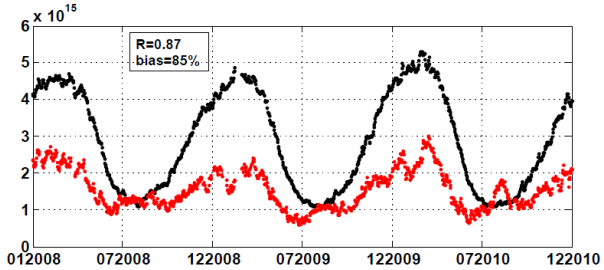


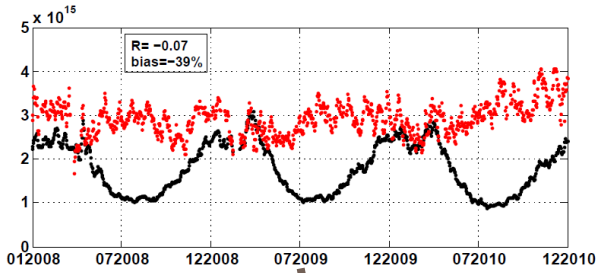
C_2H_2 global distribution

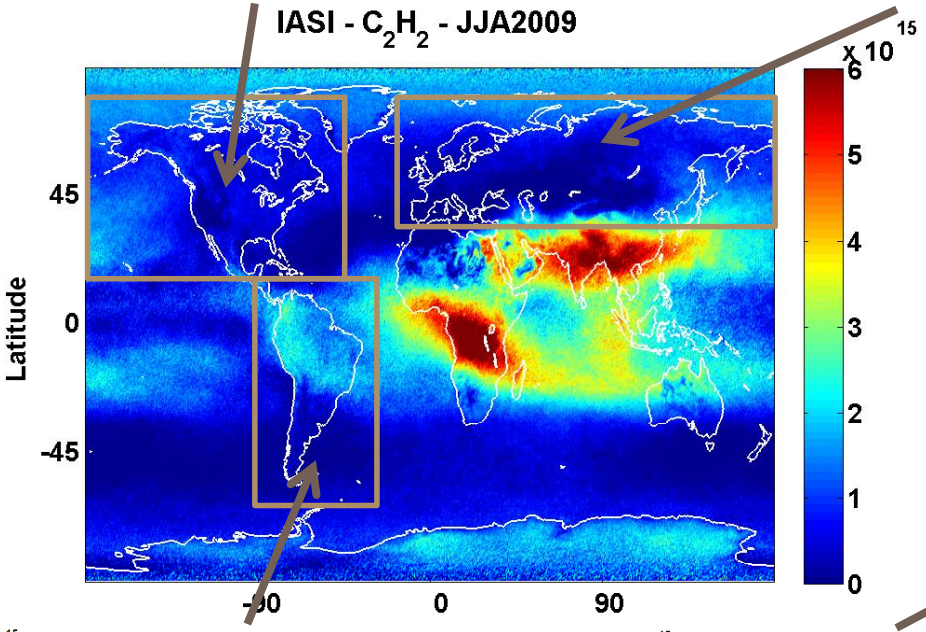
IASI

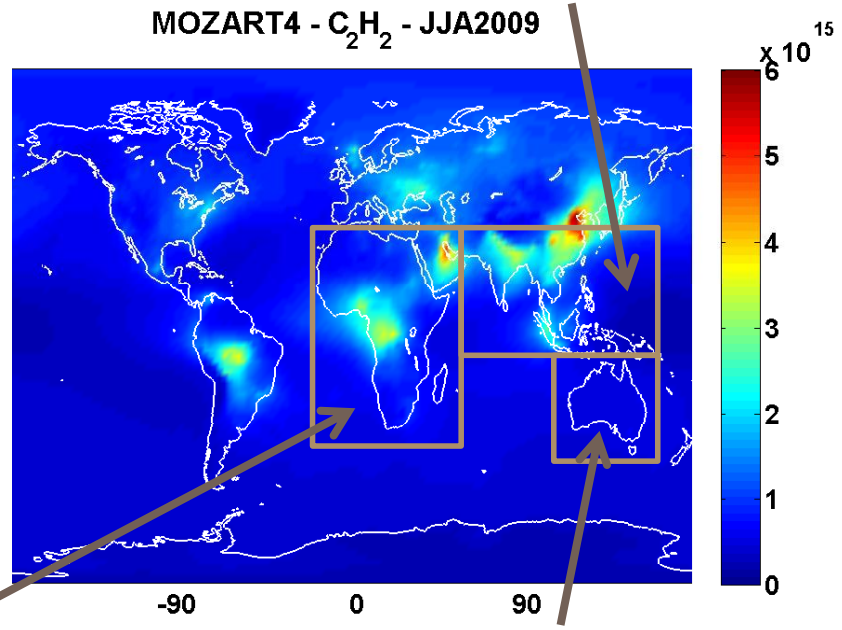
MOZART-4

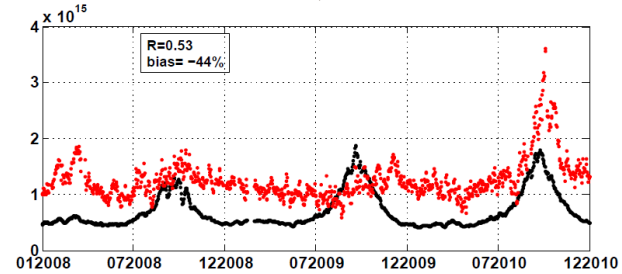


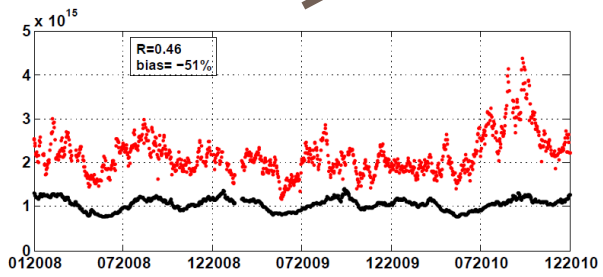


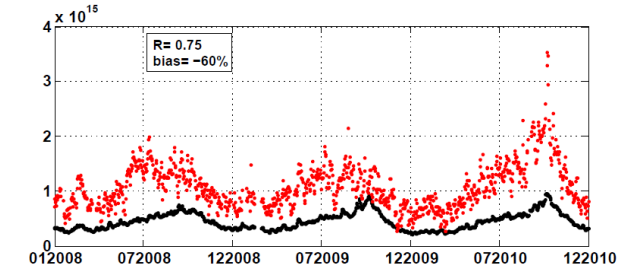








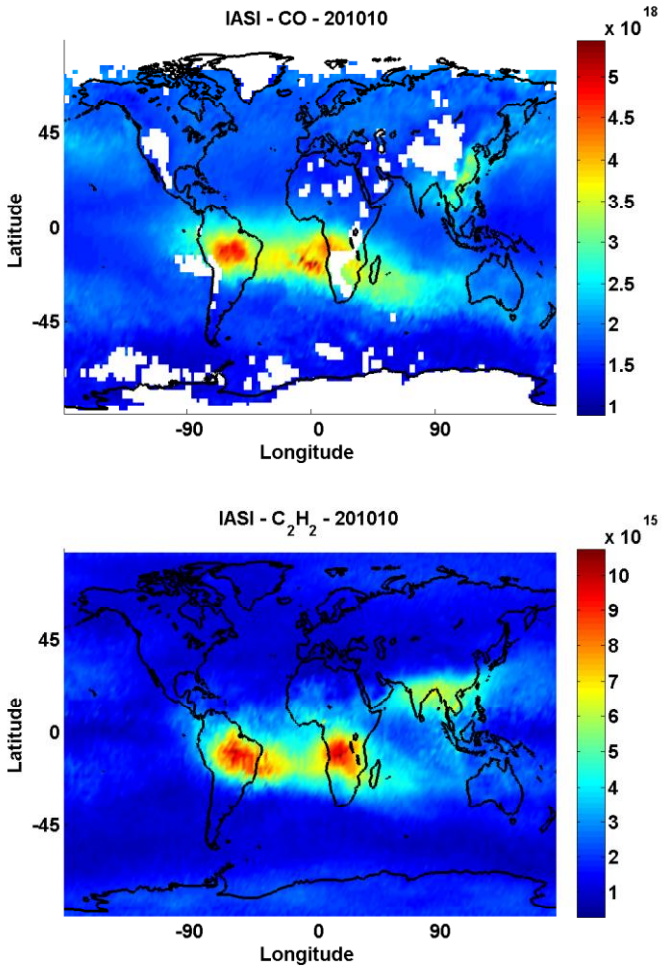


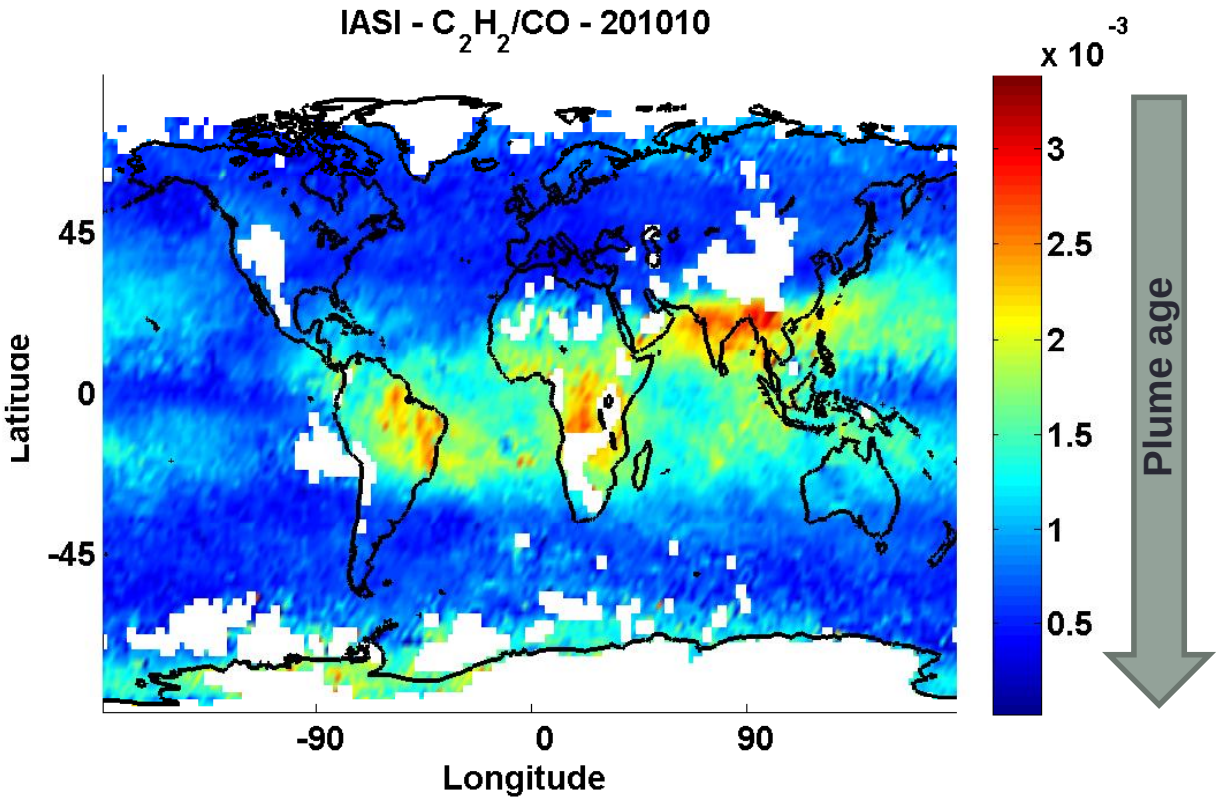
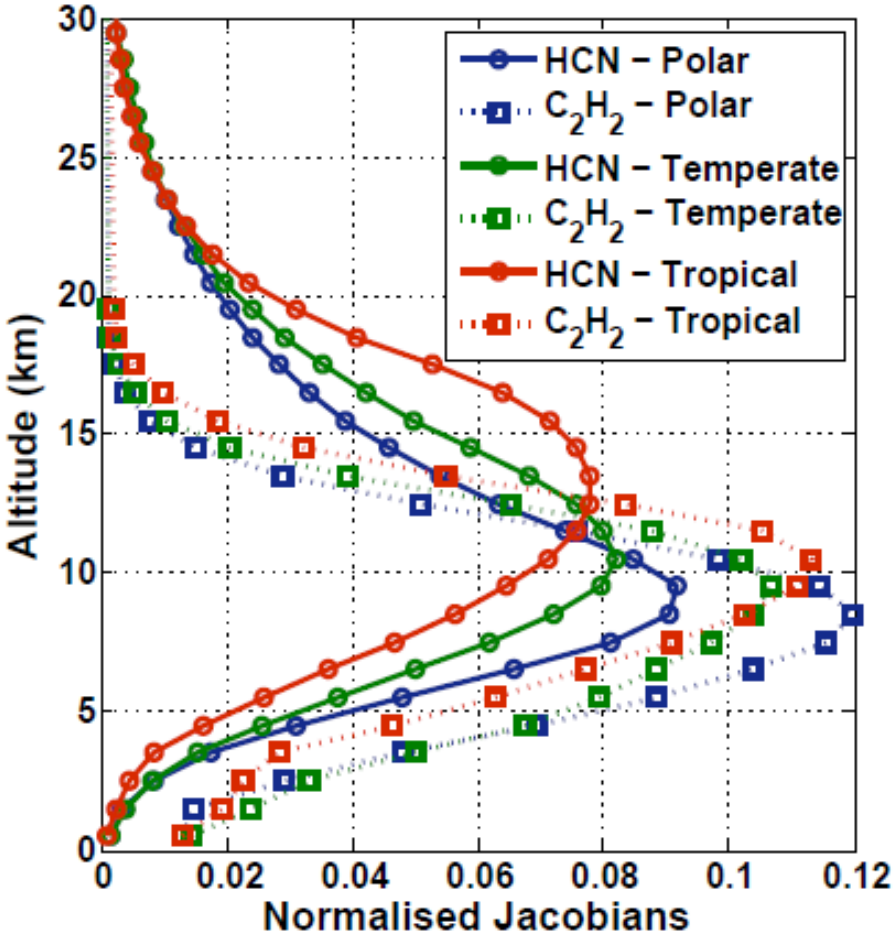
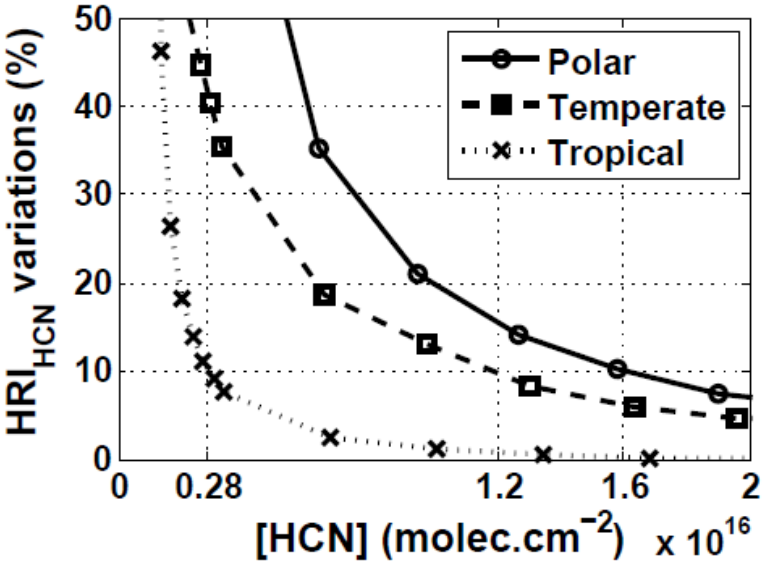


Conclusion

- IASI is able to measure tropical background HCN and global background C_2H_2 in near-real-time.
- A tropical distribution of HCN and a global distribution of C_2H_2 total columns will be provided soon.
- MOZART-4 simulations agree reasonably well with IASI measurements, with possible overestimation of anthropogenic emissions and underestimation of biomass burning emissions.

Outlook: C_2H_2/CO global distribution





Sensitivity and detection threshold