Impact of light-path angle on emission estimation

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Introduction

Light path geometry

Perspective on the emission rate retrieval error in highly resolved scenes.

Should we change our assumptions of a Nadir Solar Path for a mission with 50m x 50m resolution ?



I Noticeable effect on simulations

1. Berlin Simulations

Coarser resolution simulation (200m x 200m)

No real background



I Noticeable effect on simulations

2. Indianapolis Simulations

Simulations of CO_2 Image pixels (50m x 50m)

Multiple *CO*₂ Plumes

Real Background



 XCO_2 "Nadir" of a simulation in Indianapolis with a 50m x 50m resolution

Error made on the XCO_2 between the two assumptions ("Nadir-Angle" case)



Integrated Mass Enhancement (IME) Method

Error I take into account affect :

→ A, <u>L</u>

> IME

 $\rightarrow Q \alpha \frac{IME}{L}$

IME Method

$$ext{IME} = \sum_{j=1}^N \Delta \Omega_j A_j.$$

$$Q = rac{1}{ au} ext{IME} = rac{U_{ ext{eff}}}{L} ext{IME} = rac{U_{ ext{eff}}}{L} \sum_{j=1}^N \Delta \Omega_j A_j$$



Choice of the mask

- Student t-test
- Median filter
- Gaussian filter

Source : Varon et al. (AMT, 2018)



After the median filter

After the gaussian filter

Errors

- An error due to the fact that we account for the solar light path : called thereafter *angle error*
- 2. An error due to the fact that the satellite has a threshold of detection : called thereafter *threshold error*



Difference in *XCO*₂

Threshold error



Difference in XCO_2

Angle error

III IME and emission rate - Results

1. Berlin Simulations

Contribution to error in Q due to angle and threshold error (not taking the *Ueff* error into account)

200m x 200m resolution

The *angle error* seems contained by the *threshold error* and to be small.



Mean absolute values of threshold errors and angle errors in Q, obtained from 25 random realisations of measurement noise



III IME and emission rate - Results

2. Indianapolis Simulations

Contribution to error in Q due to angle and threshold error (not taking the *Ueff* error into account)

50m x 50m resolution

The *angle error* is in mean below 1% of the emission rate.



What have we learnt ?

Conclusion

- 1. Angle error seems small (~1%)
- 2. Threshold error: ~1% error at 50m resolution, ~2% at 200m

Outlook

- 1. Importance of the *Ueff* retrieval
- 2. Impact of plume height
- 3. Impact of satellite angle



Choices for the emission retrieval

1. Different Methods :

- IME retrieval \rightarrow Compute τ
- 2. U_{eff} and L determination ?





ANNEX

Choice of the mask

1. Student t-test

- 2. Median filter
- 3. Gaussian filter

Source: Varon et al. (AMT, 2018)







After the median filter

After the gaussian filter