

CH₄ profile retrievals from GOSAT thermal infrared measurements

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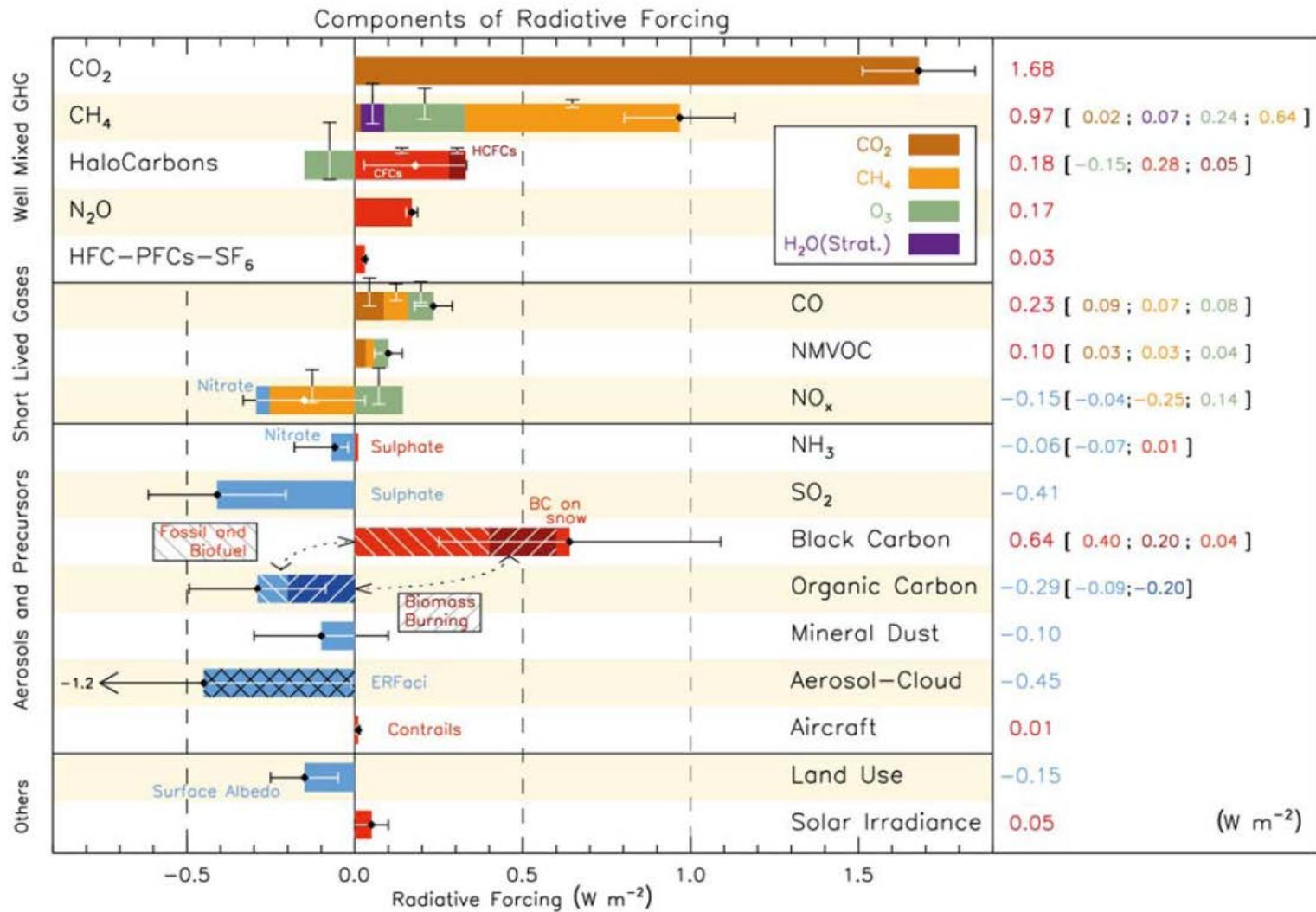
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Partly conducted within the ESA project SIROCCO

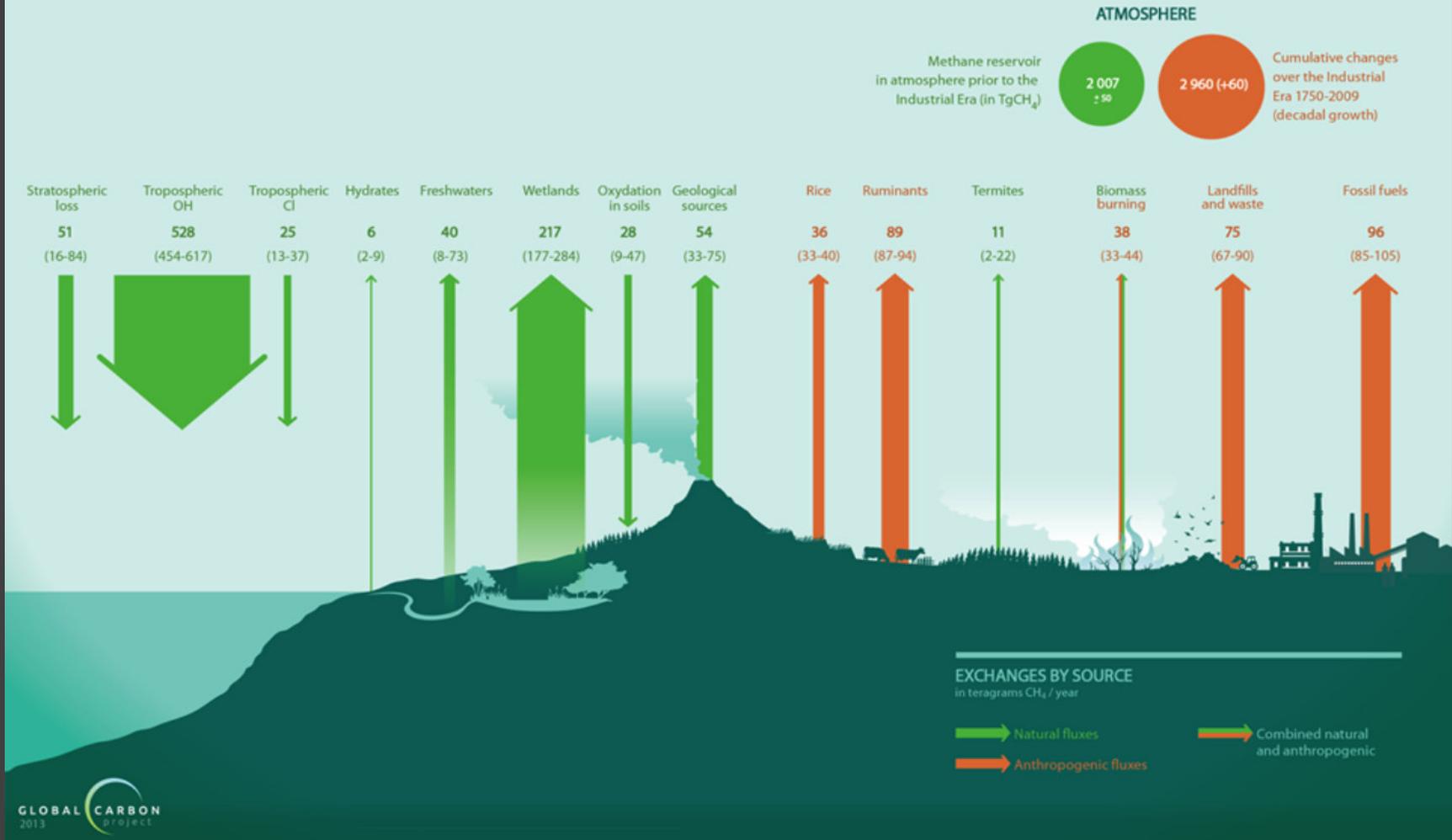


Why methane?



Methane sources and sinks

METHANE BUDGET : 2000-09



PROMISE

Near-surface CH₄ concentrations

TIR

- CH₄ profile information
- Sensitivity peaks ~8 km

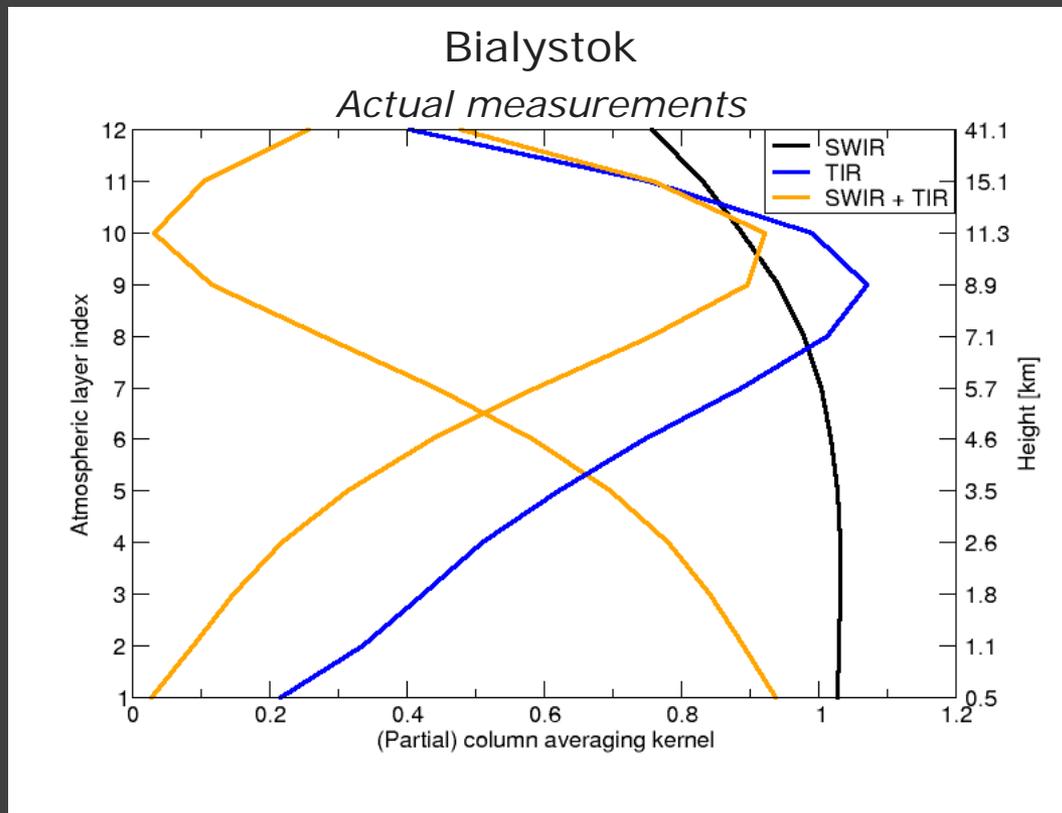
SWIR

- Total CH₄ column

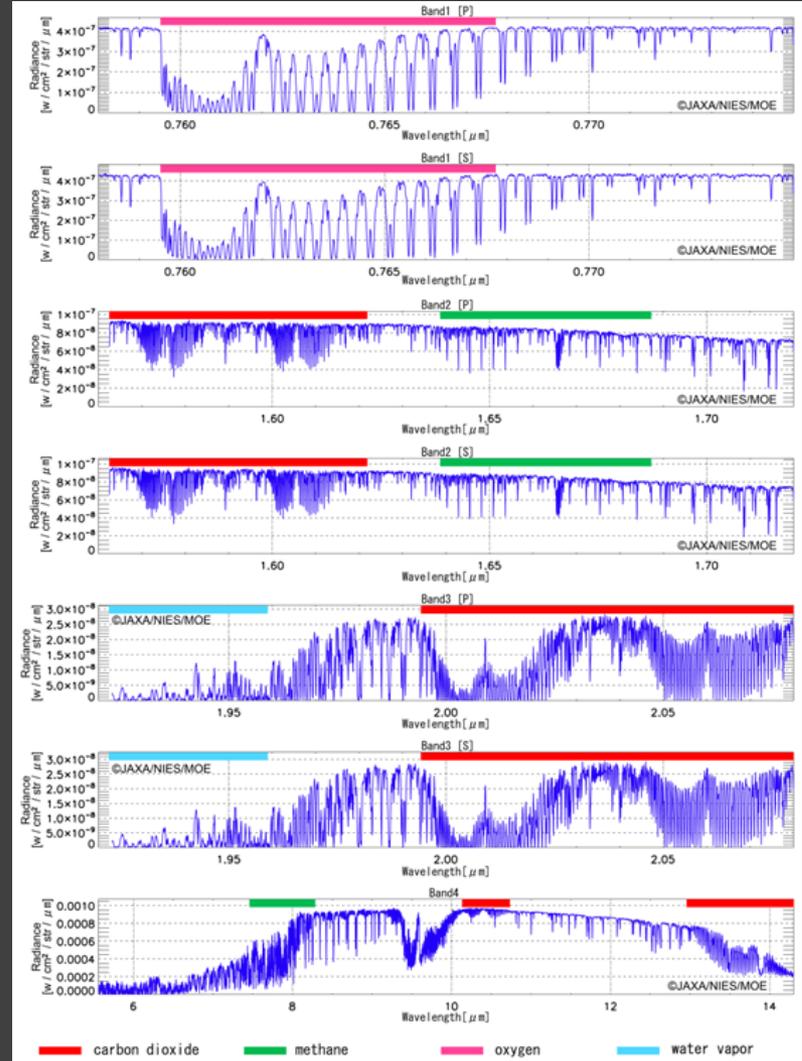
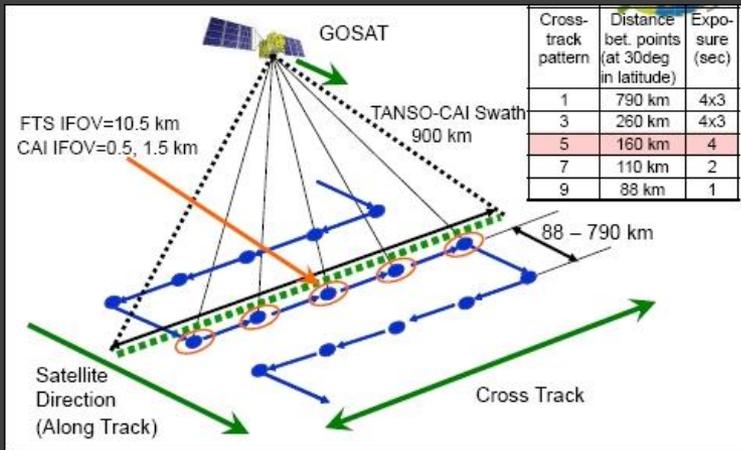
SWIR + TIR

- Partial columns

GOSAT has both SWIR and TIR channels

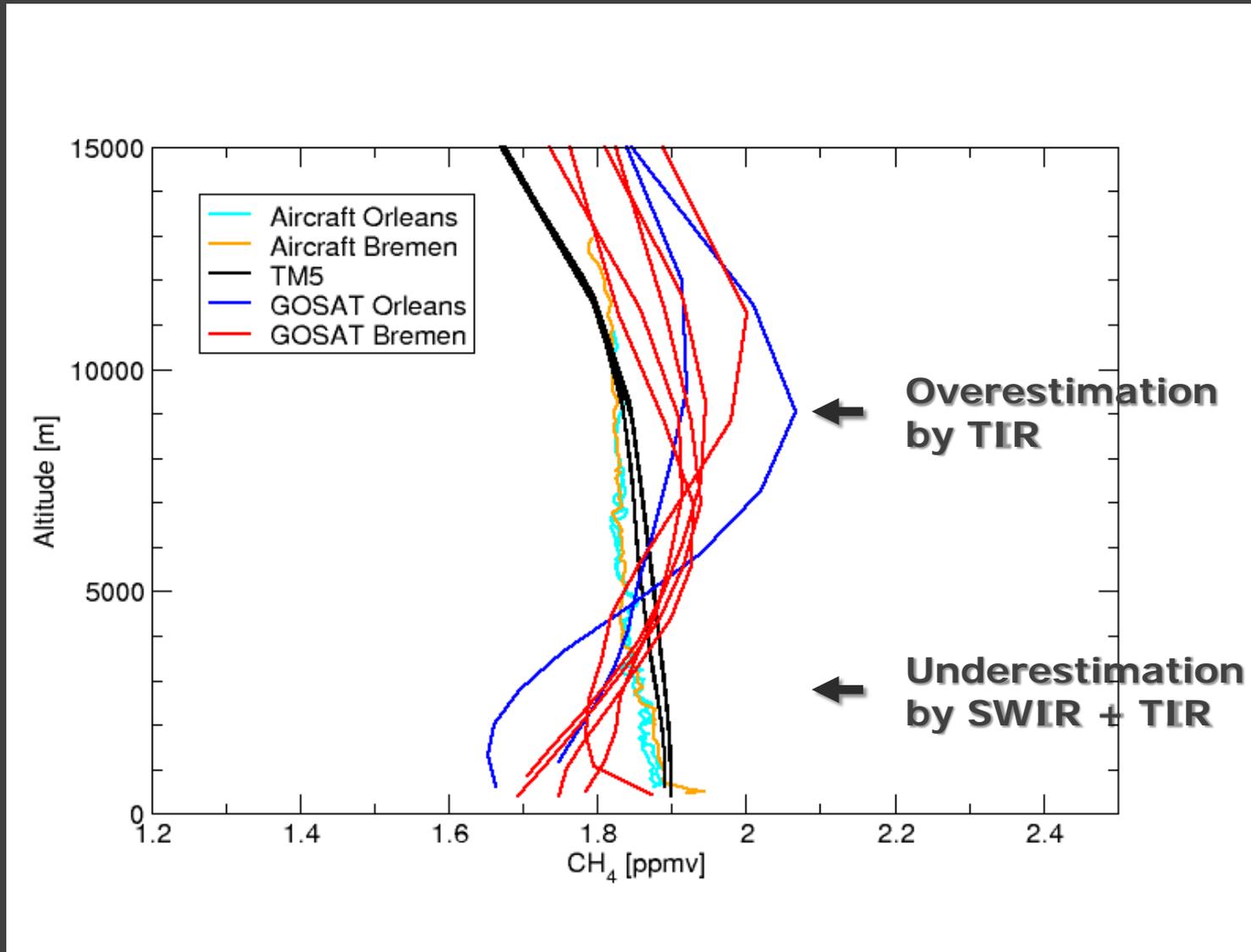


GOSAT in a nutshell

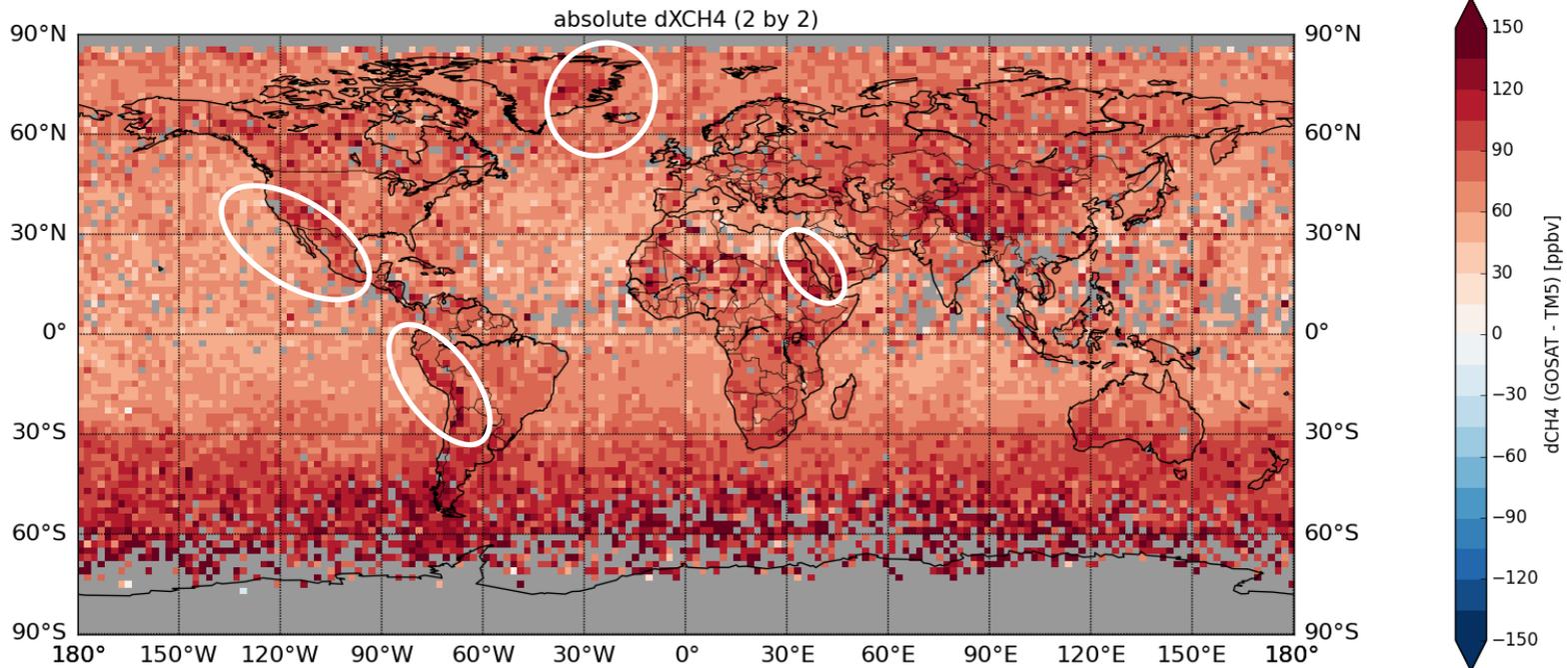


PROBLEM

Synergistic SWIR + TIR CH₄ retrievals – profiles



CH₄ bias from GOSAT TIR spectra



- Global positive bias
- Land/sea differences
- Day/night differences (not shown)

PROGRESS

Bias correction attempts

Spectroscopy

- Integrated X-section
- Line width

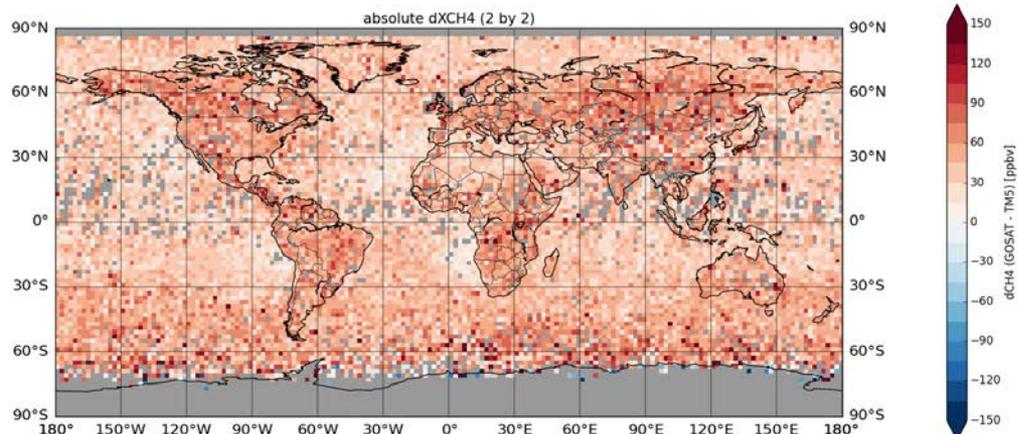
Radiometric

- Intensity scaling
- Polynomial offset

Soft calibration

- Pixel mask
- Subtraction average residue

Pixel mask + fitting 1st order polynomial offset



Investigate what spectral structures causes CH₄ bias

→ Need very good estimate of the atmosphere

→ Aircraft campaign: HIPPO

Aircraft campaign: HIPPO

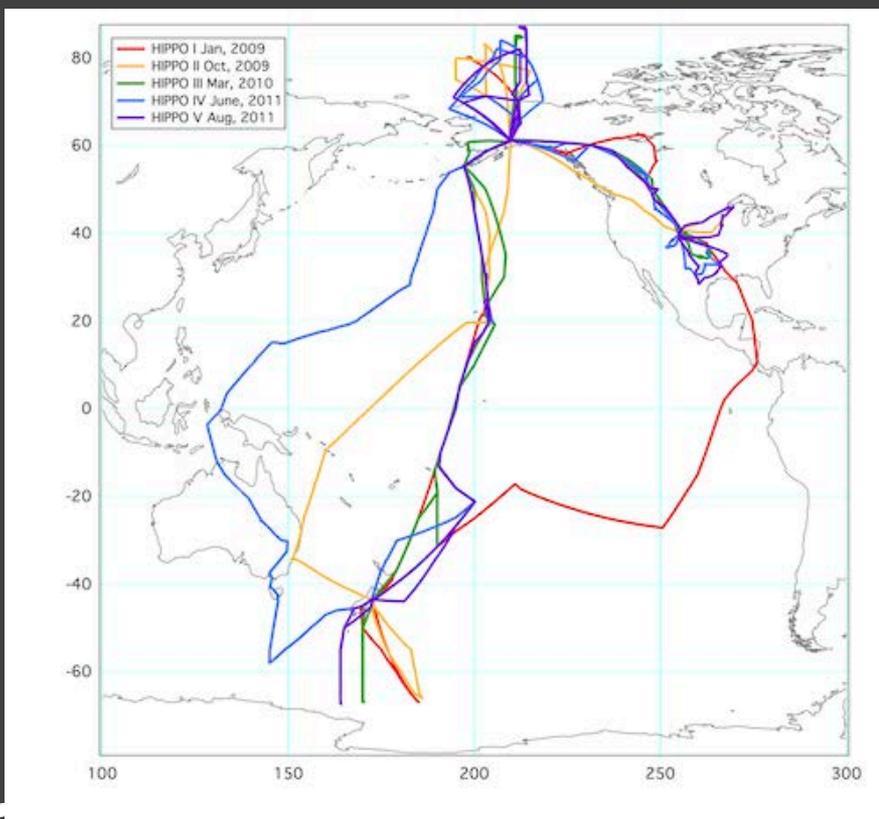


HIPPO: HIAPER Pole-to-Pole Observations



Profiles: 0-15 km

<http://hippo.ornl.gov/>



Select measurements from one or more data types

Greenhouse and carbon cycle gases	Ozone and water	Black carbon and aerosols	CFCs, HCFCs, and HFCs
Light hydrocarbons and PAN	Sulfur gases and marine emissions	Atmospheric structure data	Navigation and aircraft data

Continuous measurements preferred for most analyses

- APO.X APO_AO2 CH4_QCLS
- CO.X CO2.X CO2_AO2
- CO2_OMS CO2_QCLS CO_QCLS
- CO_RAF N2O_QCLS O2_AO2

Discrete instrument and flask sample measurements

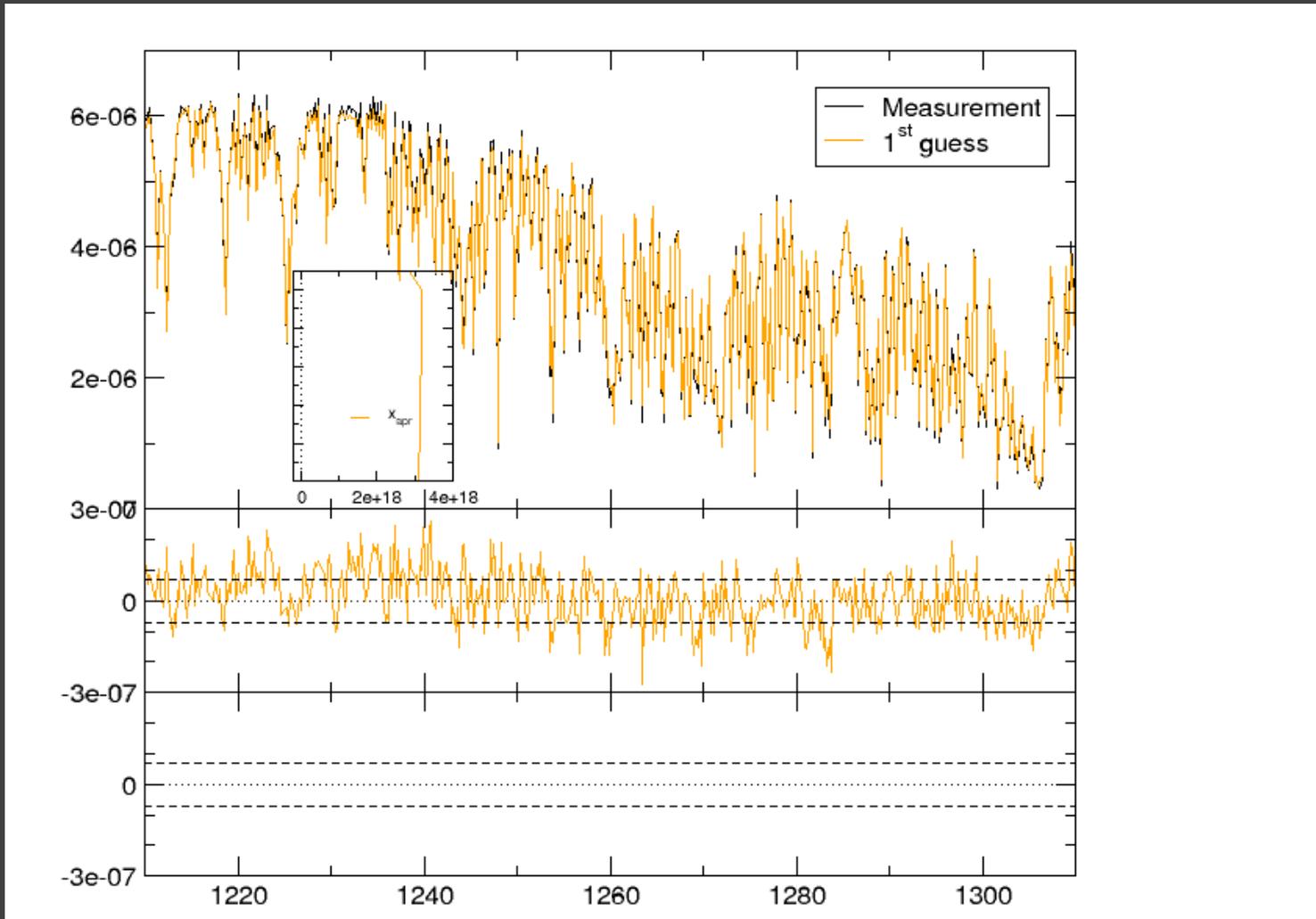
- CH4_CCG CH4_P CH4_UGC
- CH4e_P CH4e_UGC CH4isoC13_SIL
- CO2_CCG CO2isoC13_SIL CO2isoO18_SIL
- CO_CCG CO_P CO_UGC
- COe_P COe_UGC H2_CCG
- H2_P H2_UGC H2e_P
- H2e_UGC N2O_CCG N2O_P
- N2O_UGC N2Oe_P N2Oe_UGC

To download all measurements for all missions please use this [link](#), it is much faster.

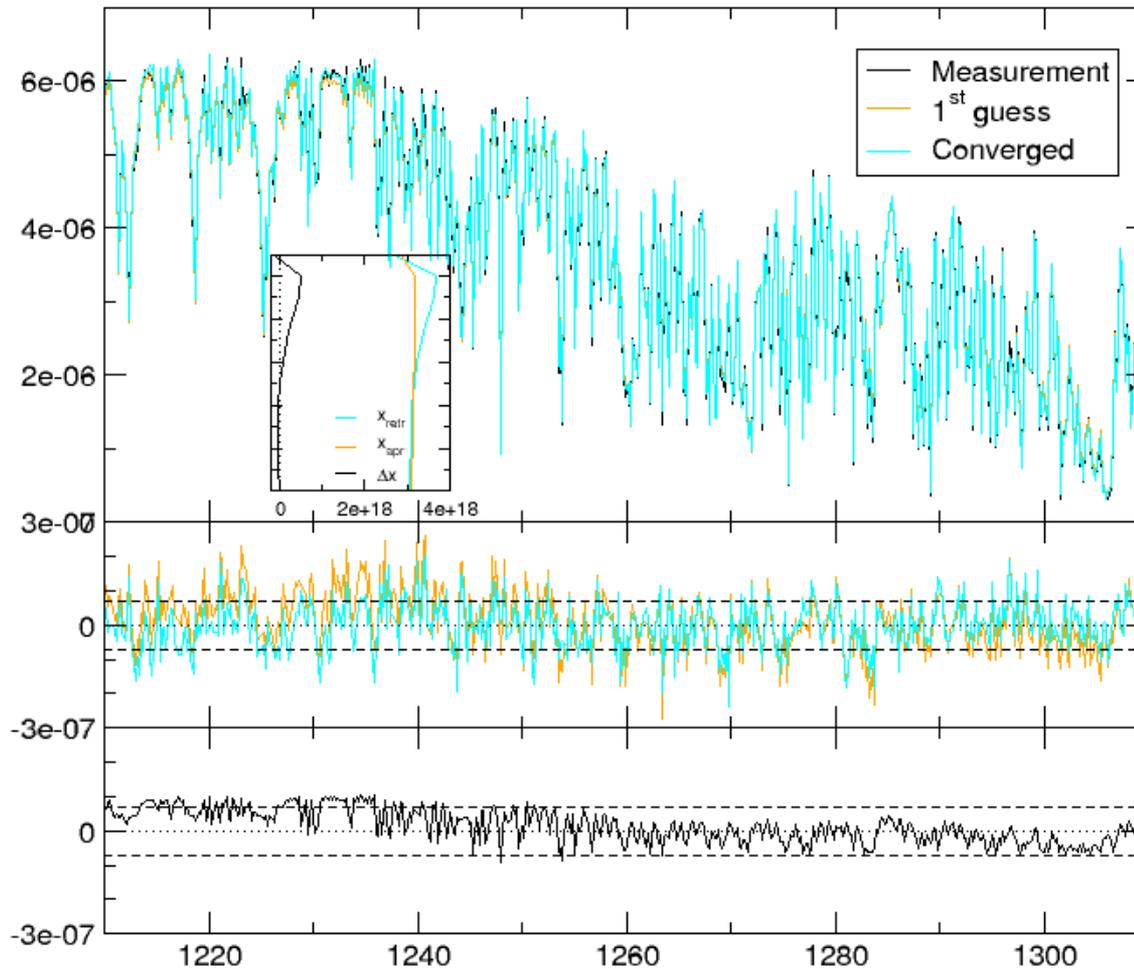
[Access to Data Dictionary](#)



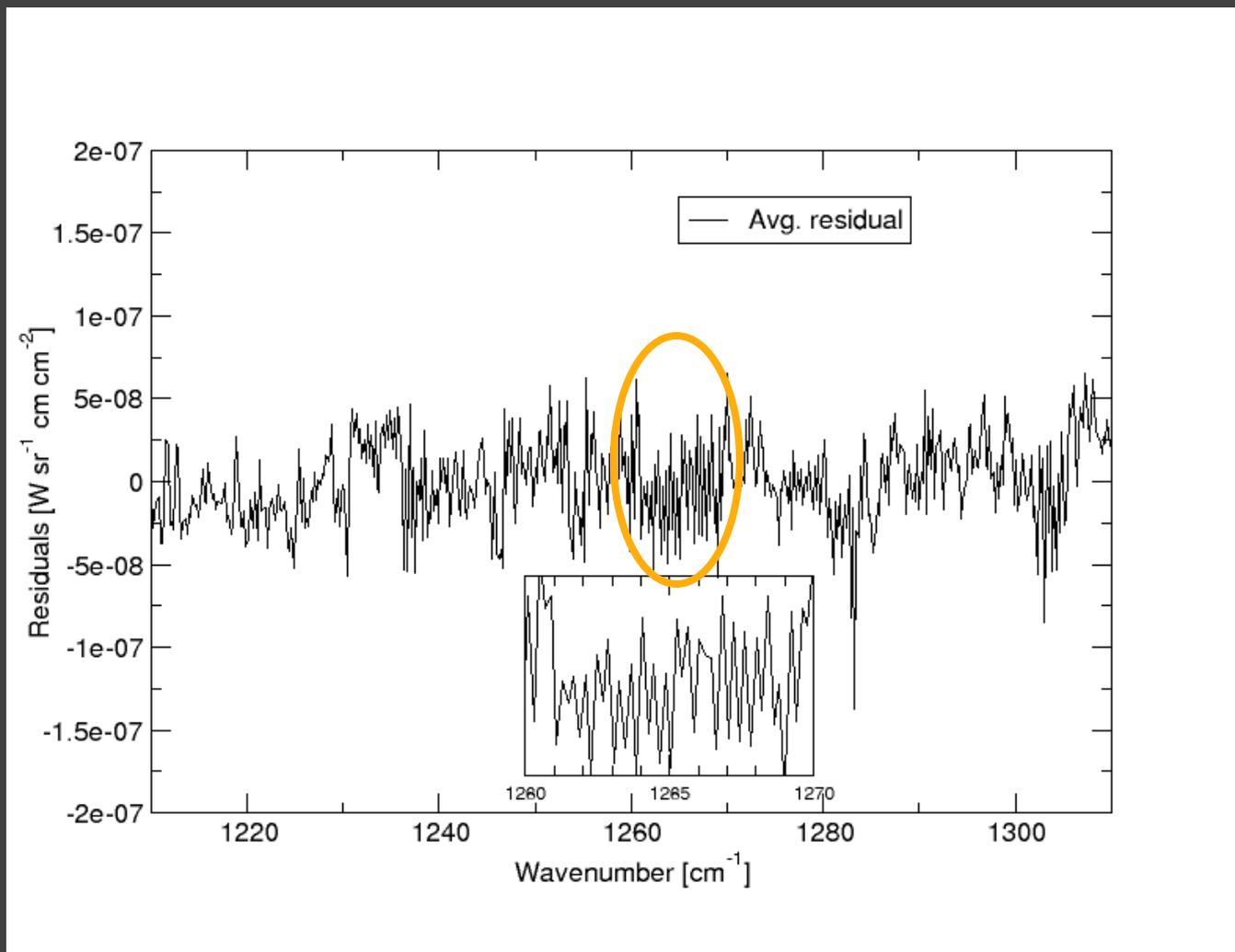
GOSAT TIR spectrum vs '1st guess'



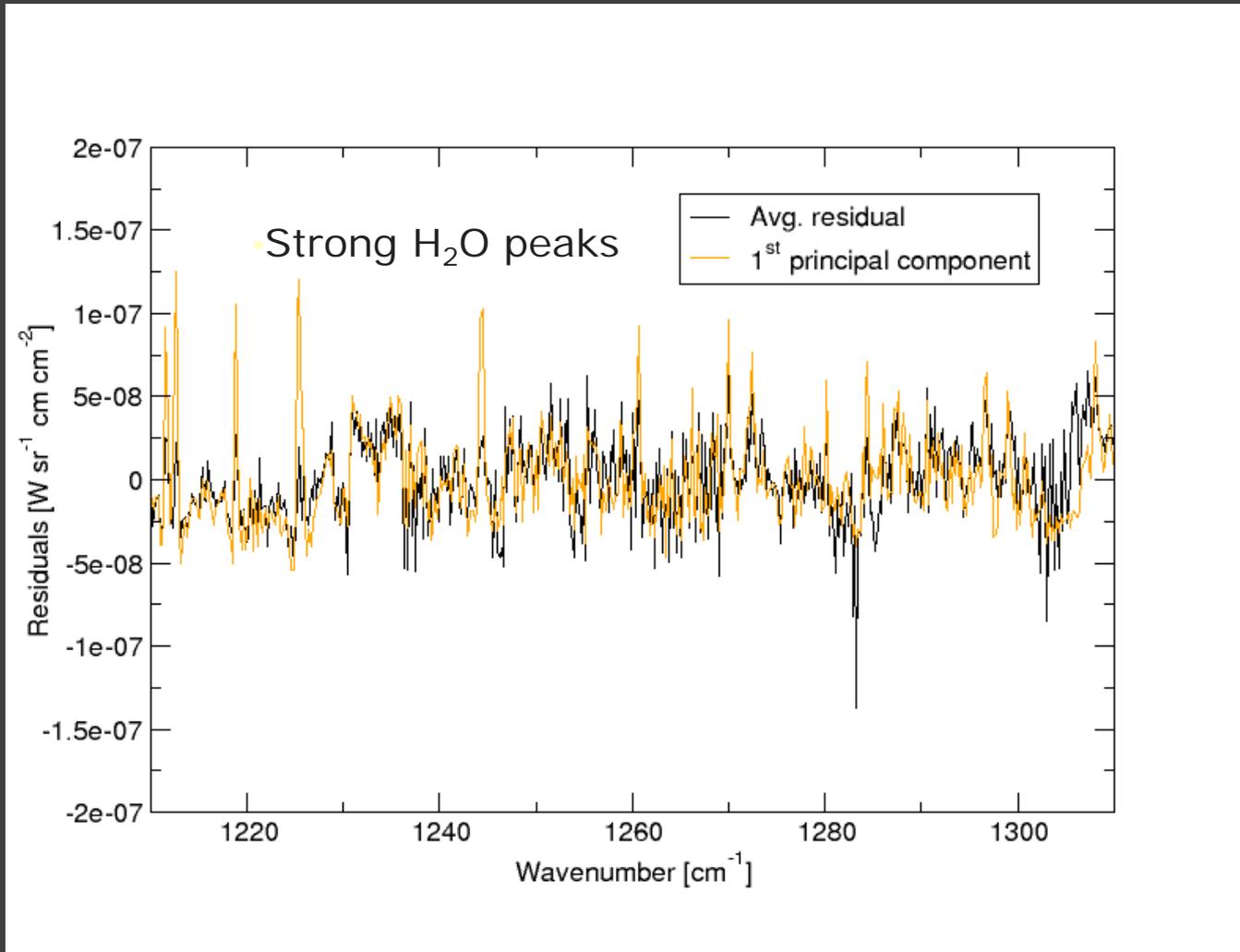
Spectral residues



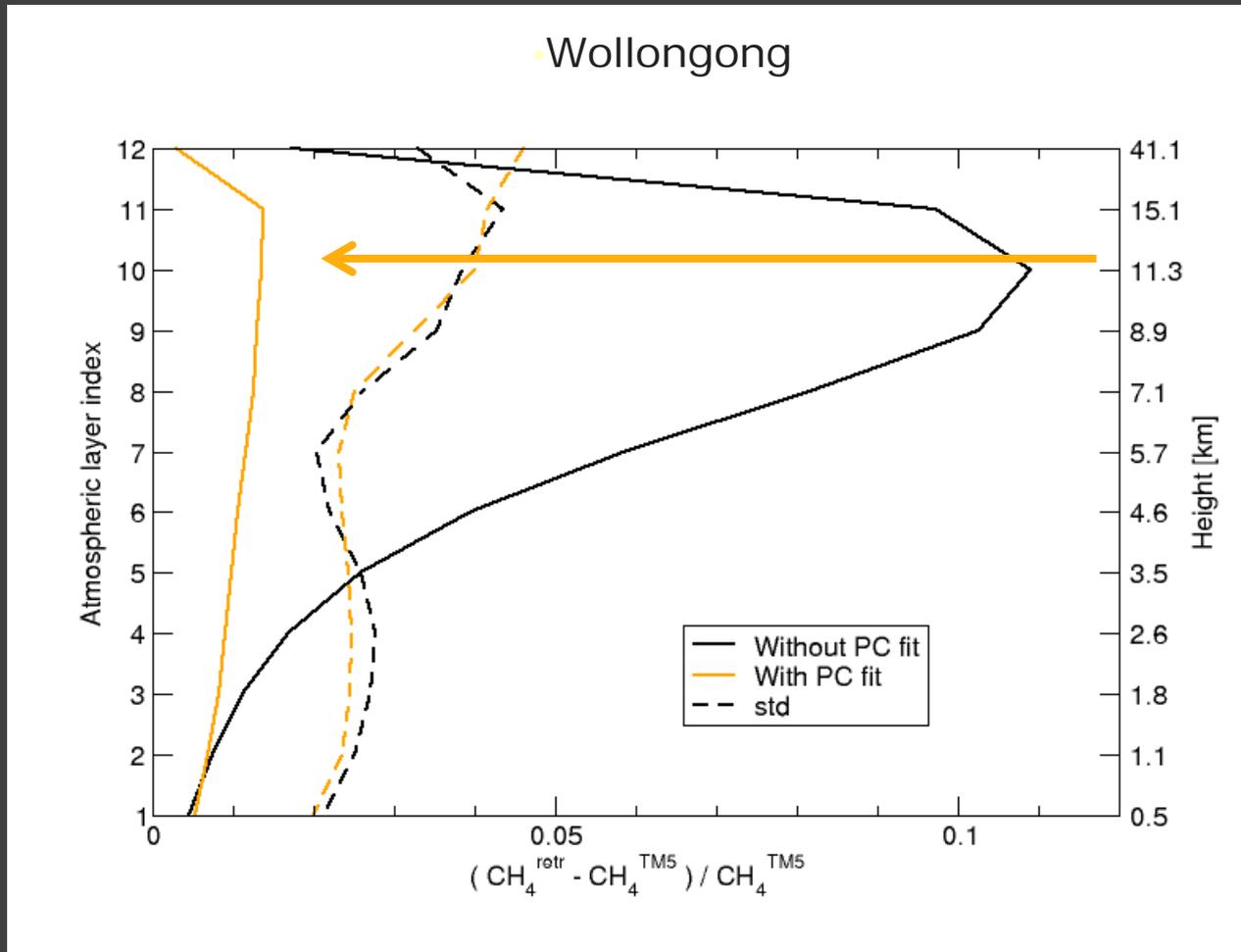
Average residue



Average residue and 1st principal component



Impact of fitting 1st principal component



Huge reduction in bias

Remaining bias is smooth

Standard deviation almost identical

PROSPECT

Conclusion and outlook

CH₄ TIR retrieval is extremely **sensitive** to small **spectral features**

→ **Therefore biases are easily introduced**

CH₄ from GOSAT TIR

- Positive bias in retrieved CH₄ profile up to 10%
- Global effect, with regional differences
- Land/sea and day/night transitions not smooth

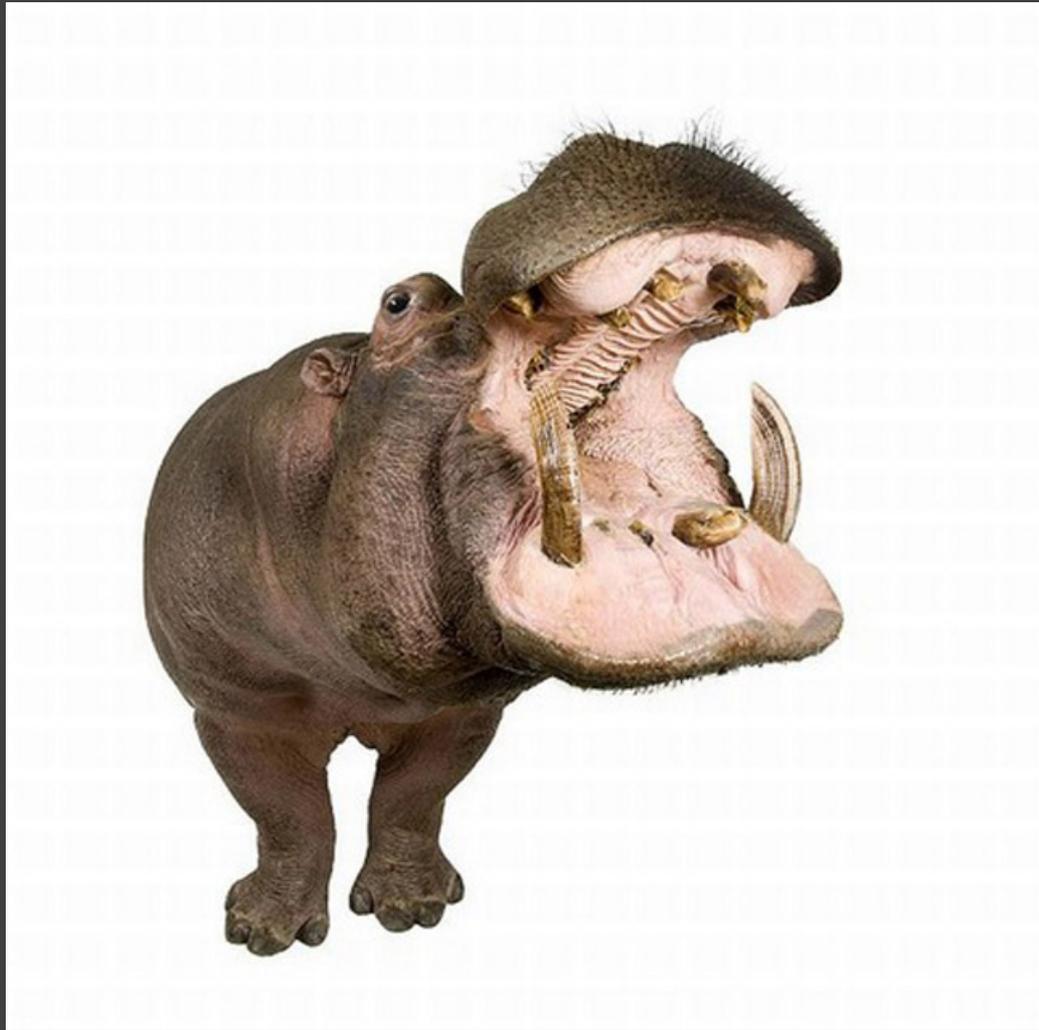
Bias correction

- Straightforward bias correction schemes do not work
- **Principal component analysis of spectral residuals is promising:**
 - Over TCCON station Wollongong bias is reduced by factor of 10

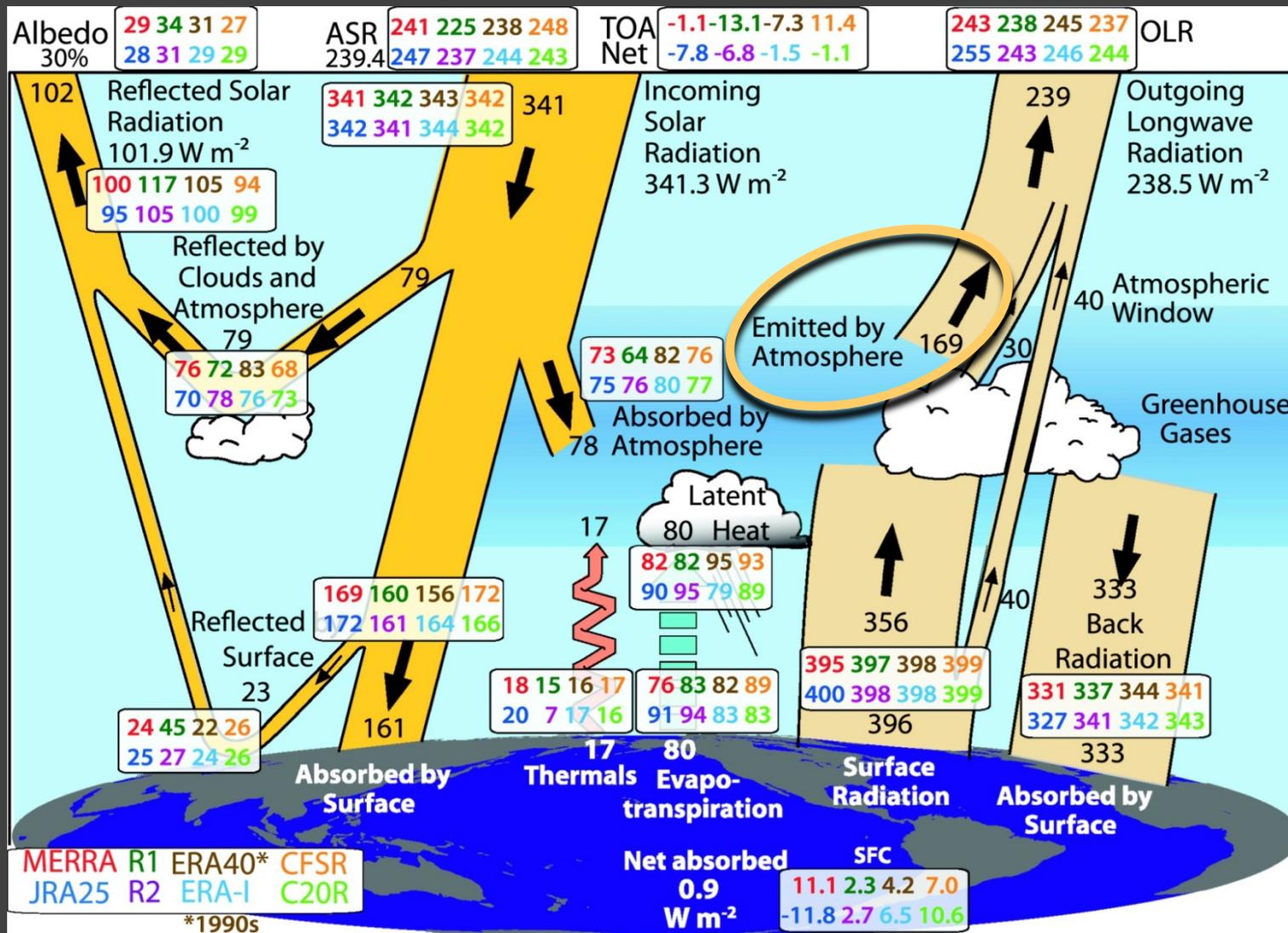
Next steps

- Other TCCON stations
- Global map → check land/sea and day/night transitions

Thank you



Radiative transfer: SWIR vs. TIR



GOSAT TIR spectrum with Planck curves

