

Verification of CH₄ profile retrievals from GOSAT thermal infrared measurements

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Conducted within:

- *GOSAT-RA framework*
- *ESA project SIROCCO*

The logo for SRON (Netherlands Institute for Space Research) is displayed in a large, white, sans-serif font. The 'S' is significantly larger than the other letters, and the 'R' and 'O' are also prominent.

Main message

Bias correction scheme developed for GOSAT TIR CH₄ profile retrieval

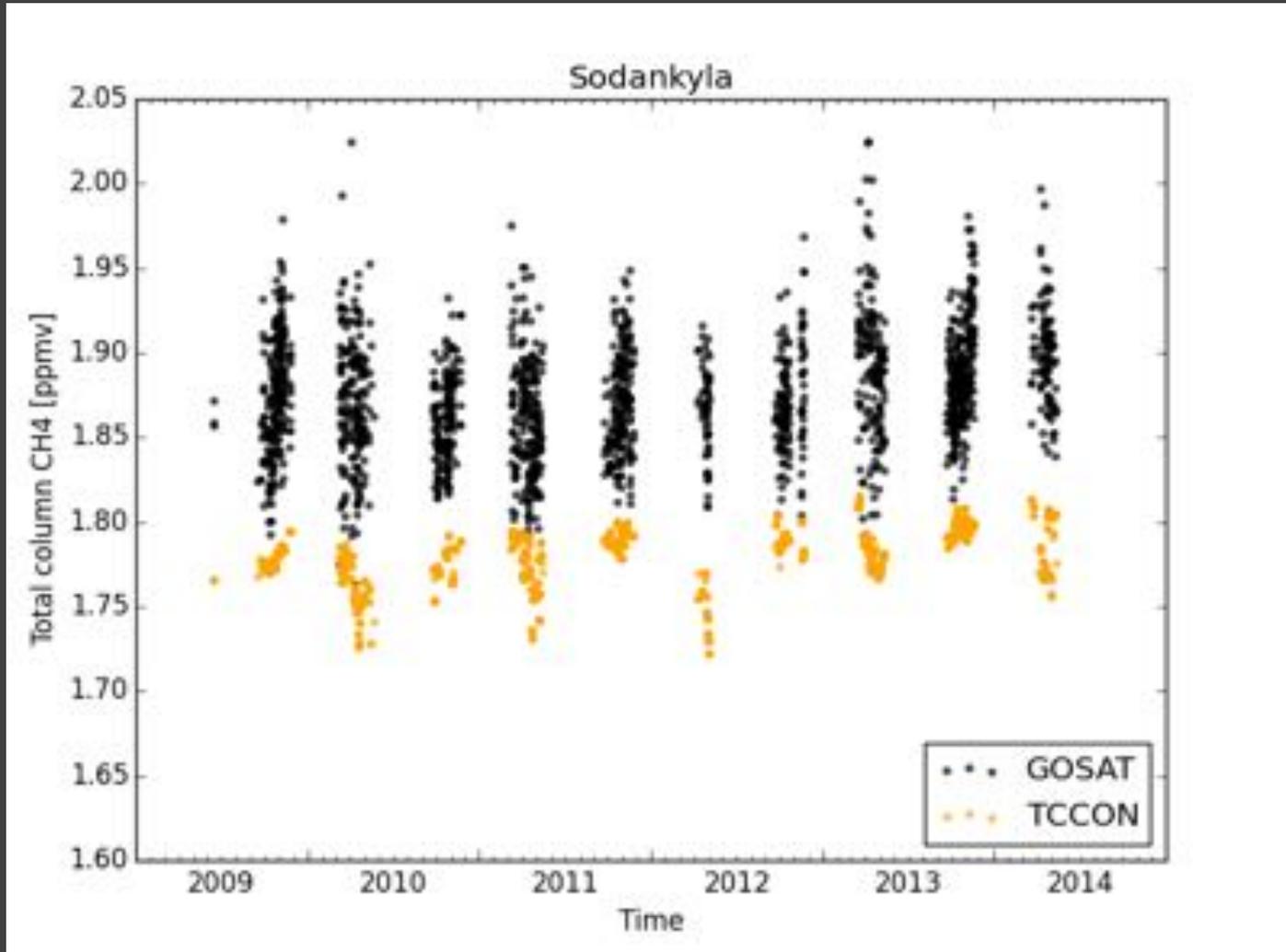
Based on principal components analysis of spectral residuals

- HIPPO data as input

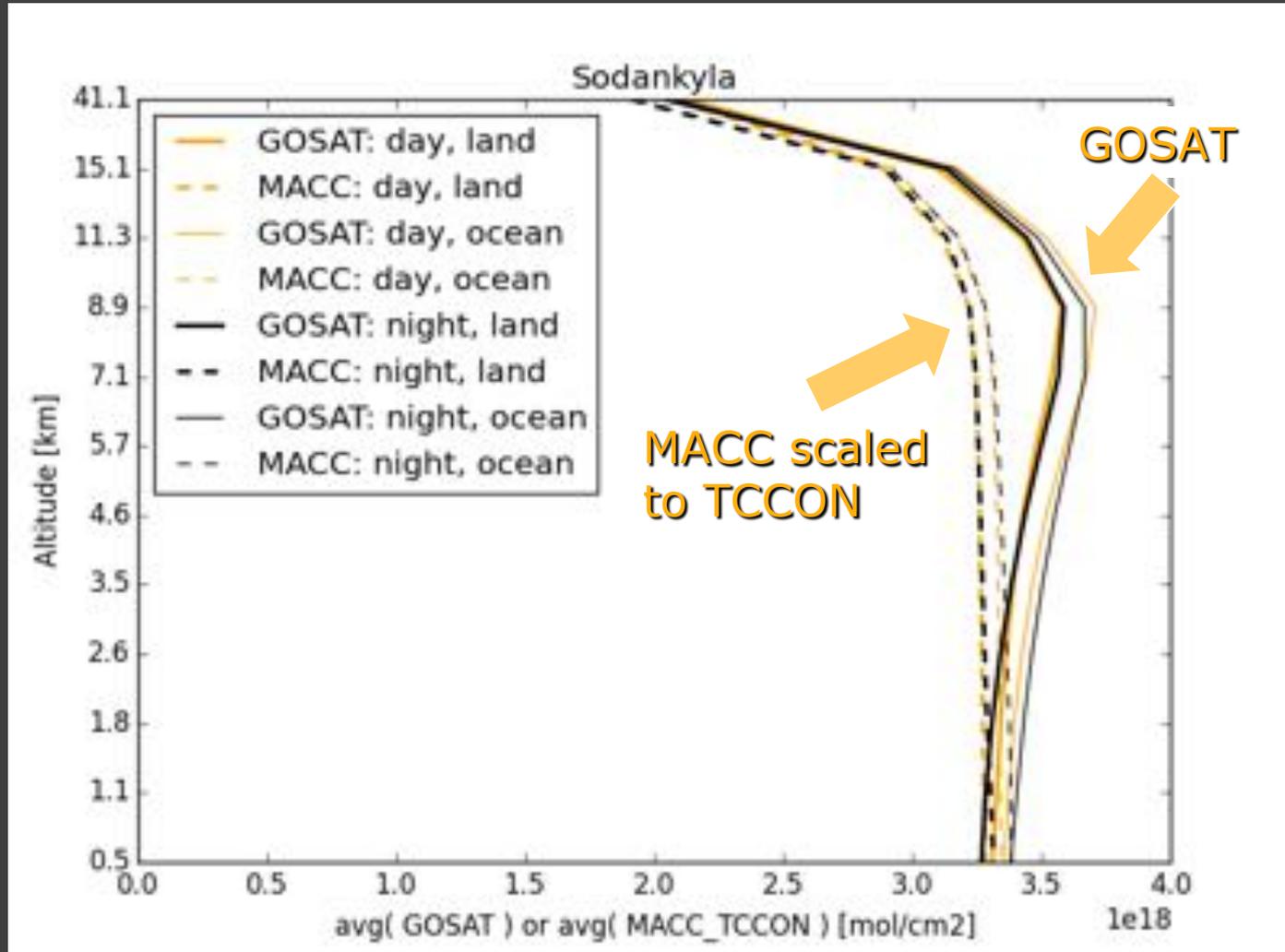
Bias in the retrieved CH₄ profiles is reduced from >10% to <2%

- for all altitudes
- for all 10 considered TCCON stations

Total CH₄ columns, nominal retrieval



Mean CH₄ profile, nominal retrieval



Note, that MACC is scaled to TCCON total column values

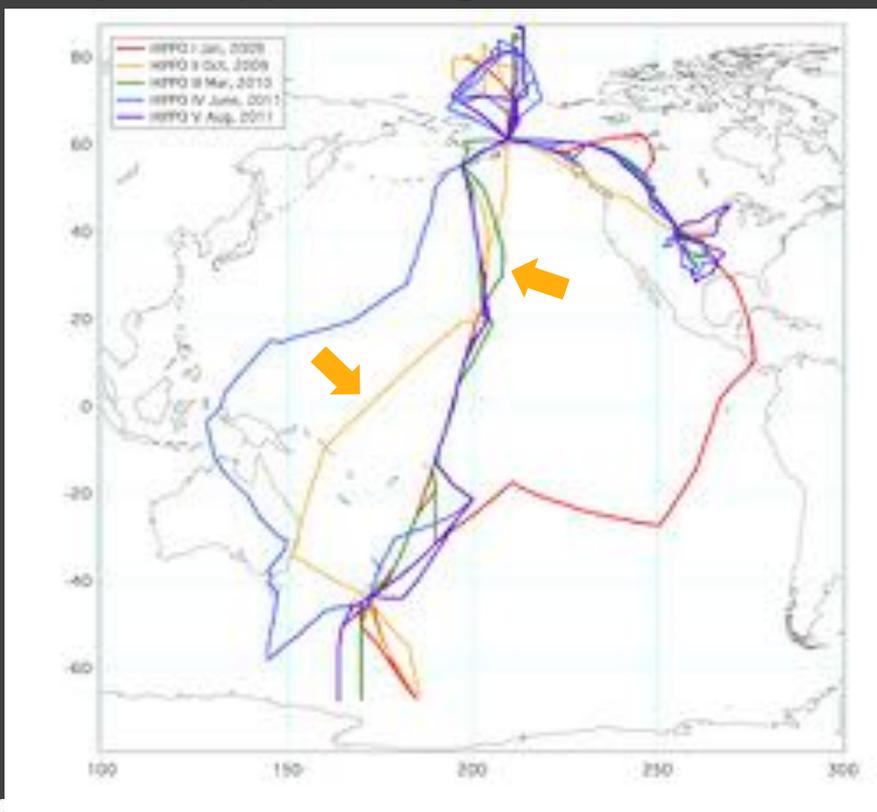
HIPPO: HIAPER Pole-to-Pole Observations

Investigate what spectral structures causes CH_4 bias

→ Need very good estimate of the atmosphere

→ HIPPO Aircraft campaign (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	OPCs, HFCs, and PFCs
Light hydrocarbons and PAN	Sulfur gases and marine emissions	Atmospheric structure data	Navigation and aircraft data

Continuous measurements preferred for most analyses

APO_X <input type="checkbox"/>	APO_AO2 <input type="checkbox"/>	CH4_QCLS <input checked="" type="checkbox"/>
CO_X <input type="checkbox"/>	CO2_X <input type="checkbox"/>	CO2_AO2 <input type="checkbox"/>
CO2_OMS <input type="checkbox"/>	CO2_QCLS <input type="checkbox"/>	CO_QCLS <input type="checkbox"/>
CO_RAF <input type="checkbox"/>	N2O_QCLS <input type="checkbox"/>	O2_AO2 <input type="checkbox"/>

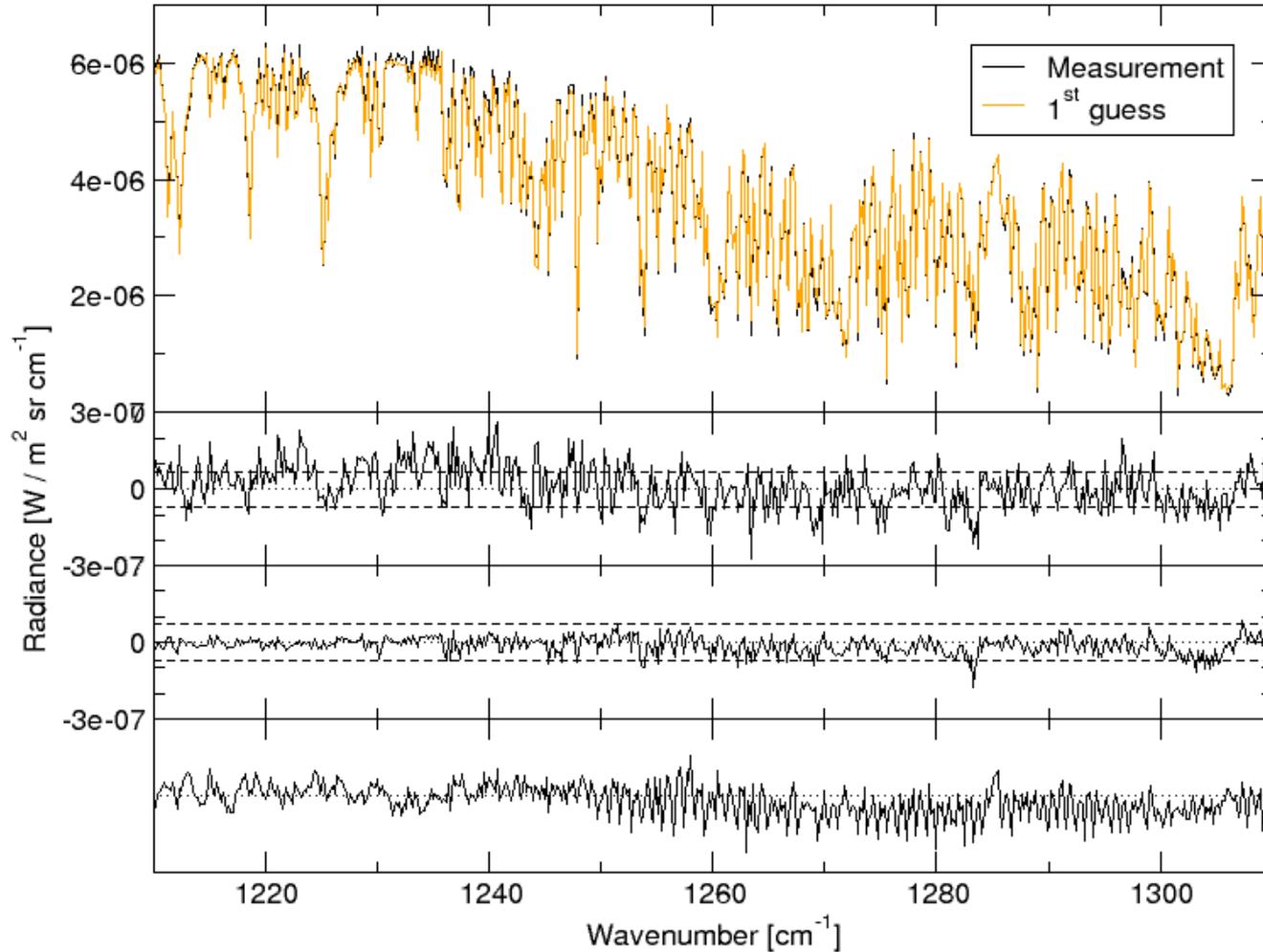
Discrete instrument and flask sample measurements

CH4_CCG <input type="checkbox"/>	CH4_P <input type="checkbox"/>	CH4_UGC <input type="checkbox"/>
CH4e_P <input type="checkbox"/>	CH4e_UGC <input type="checkbox"/>	CH4isoC13_SIL <input type="checkbox"/>
CO2_CCG <input type="checkbox"/>	CO2isoC13_SIL <input type="checkbox"/>	CO2isoO18_SIL <input type="checkbox"/>
CO_CCG <input type="checkbox"/>	CO_P <input type="checkbox"/>	CO_UGC <input type="checkbox"/>
COe_P <input type="checkbox"/>	COe_UGC <input type="checkbox"/>	H2_CCG <input type="checkbox"/>
H2_P <input type="checkbox"/>	H2_UGC <input type="checkbox"/>	H2e_P <input type="checkbox"/>
H2e_UGC <input type="checkbox"/>	N2O_CCG <input type="checkbox"/>	N2O_P <input type="checkbox"/>
N2O_UGC <input type="checkbox"/>	N2Oe_P <input type="checkbox"/>	N2Oe_UGC <input type="checkbox"/>

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'



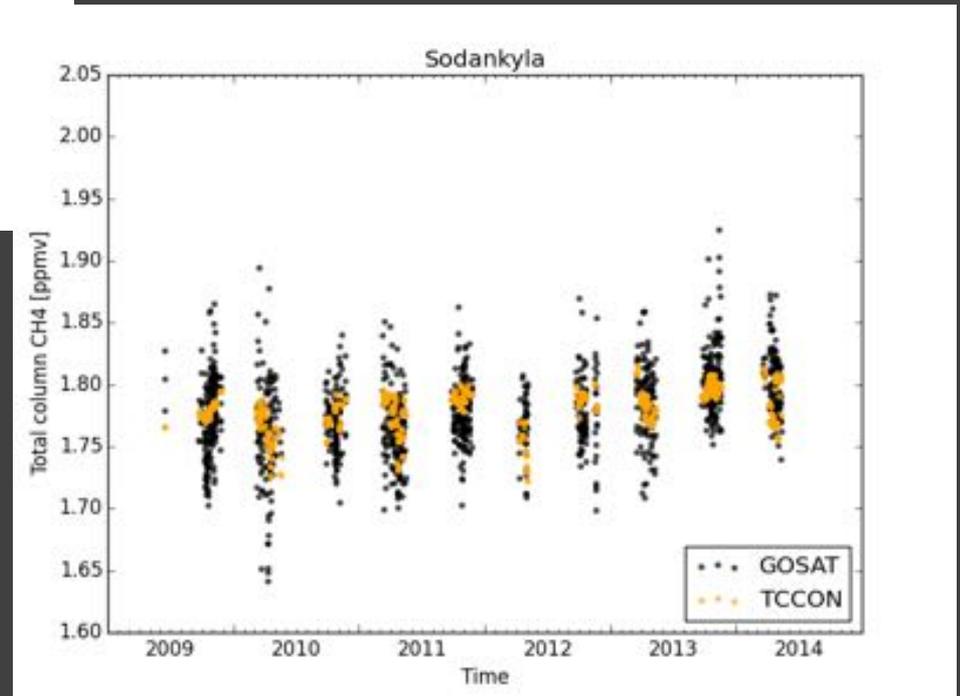
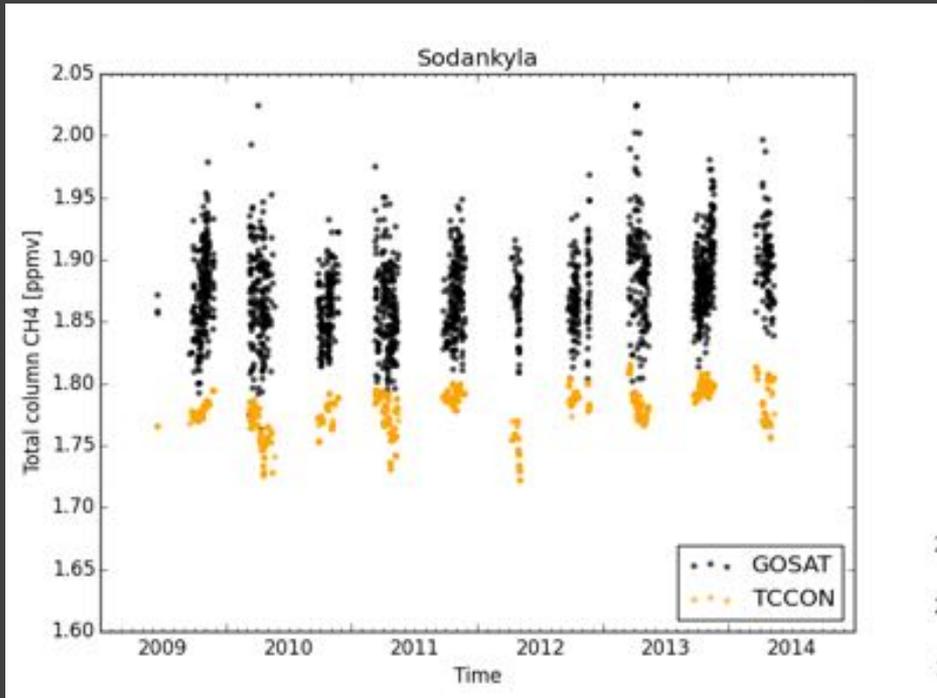
Single spectrum

Residue

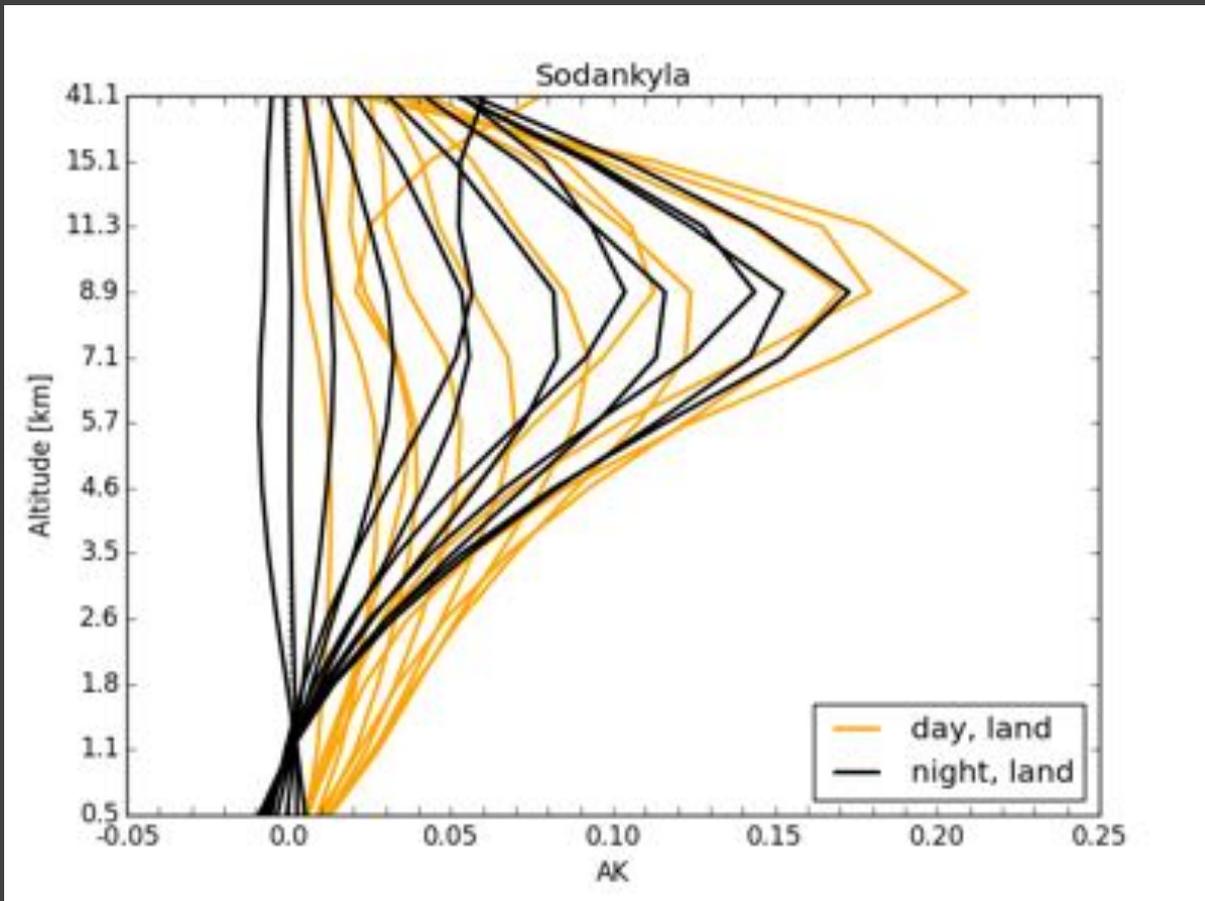
Mean residue

PC1

Total columns, including PC correction



Averaging kernel



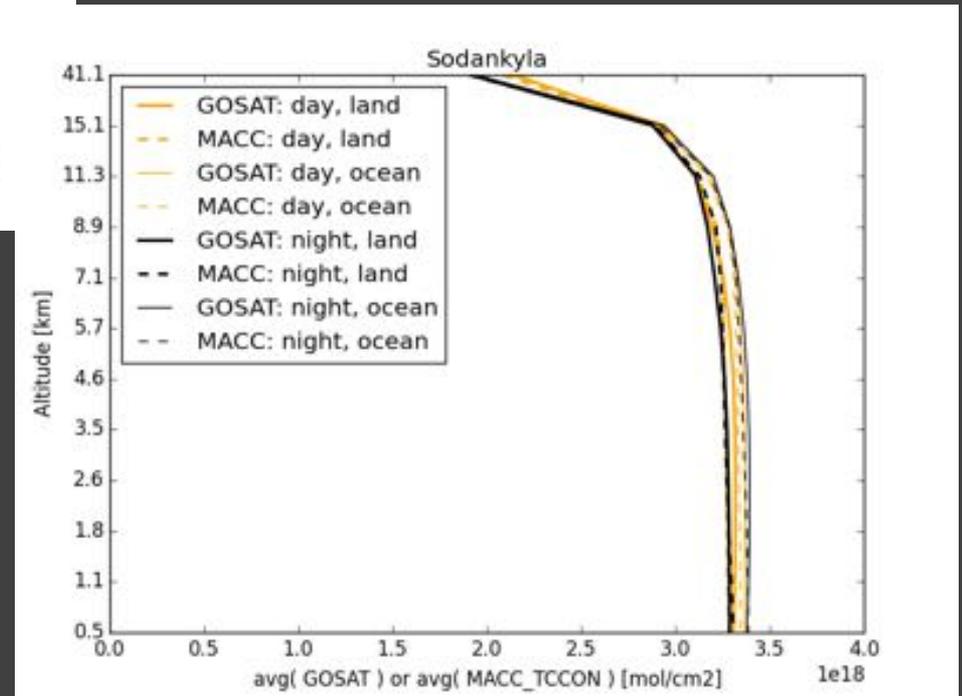
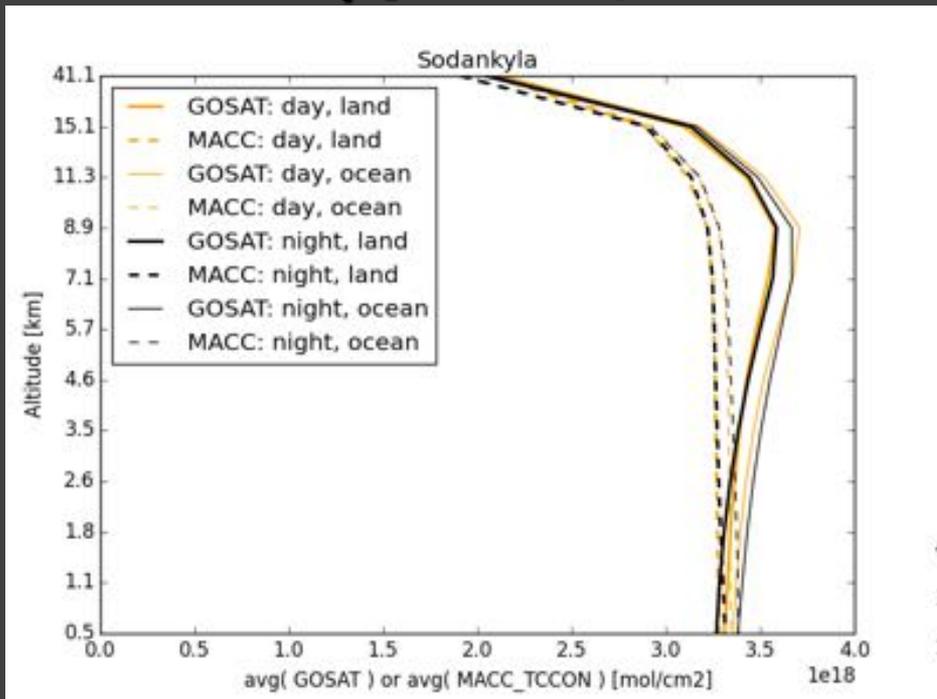
Highest sensitivity between 5 and 15 km

Regularization tuned such that $DFS \sim 1$

Daytime measurements show higher sensitivity than nighttime

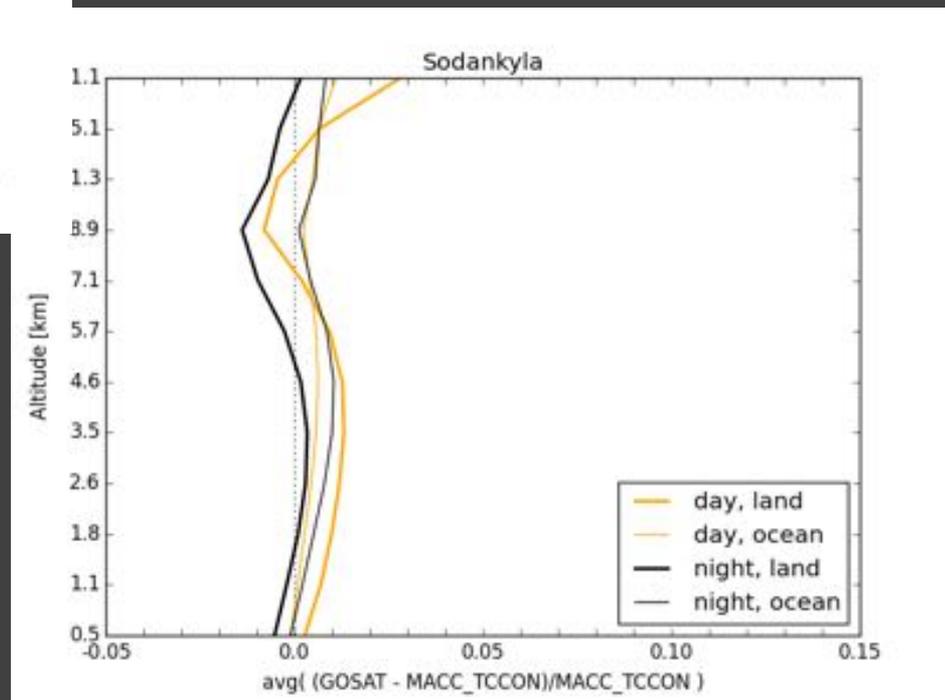
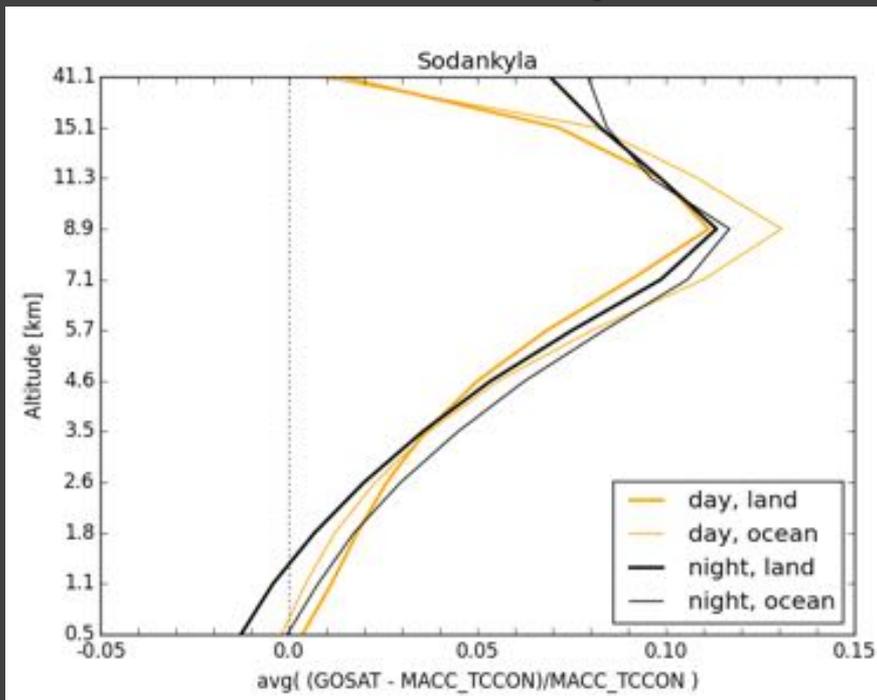
Total columns can only be achieved with *a priori* information (typical contribution = 30%)

Mean CH₄ profile, including PC correction

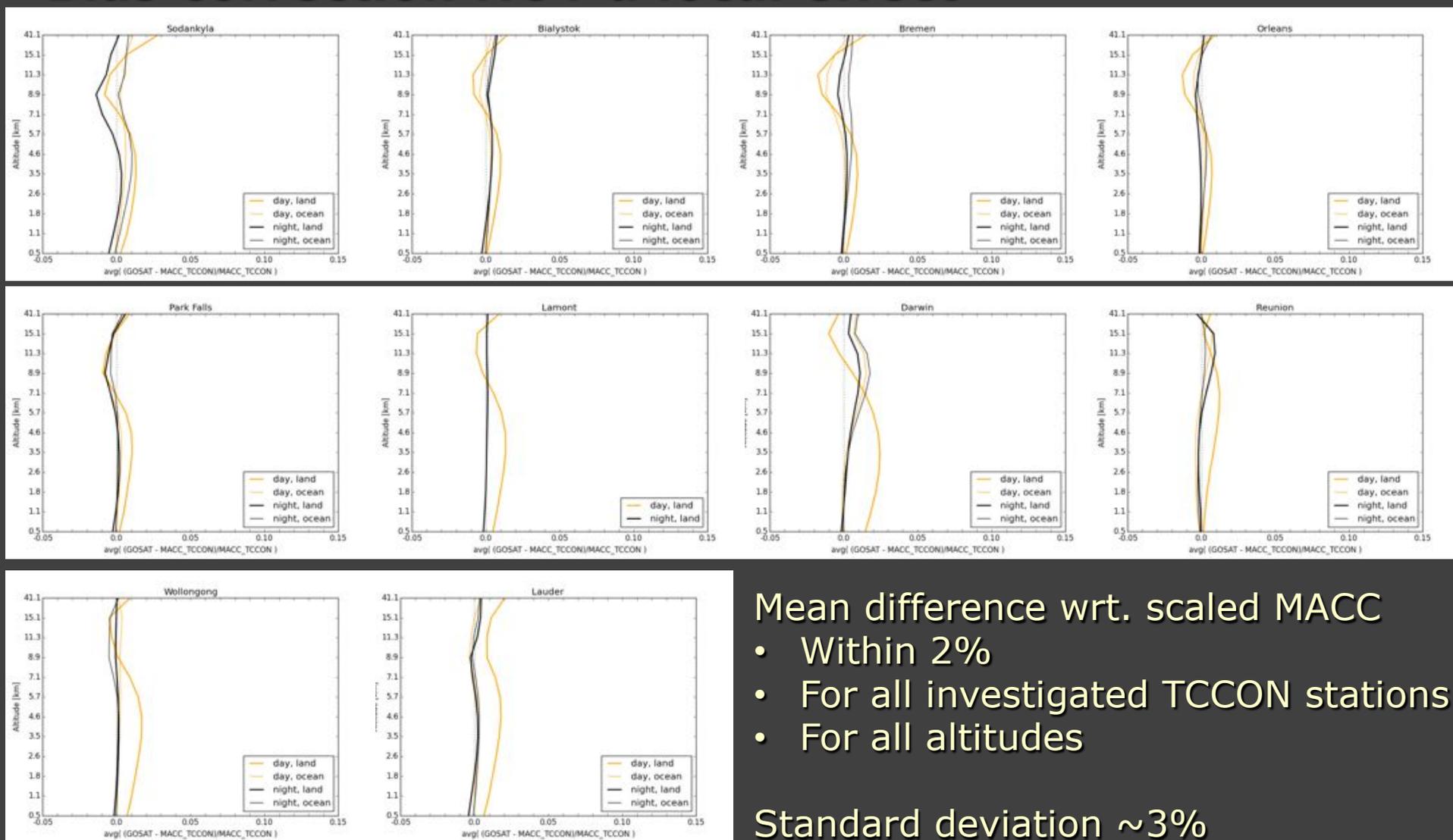


The MACC profile is scaled such that its total column matches TCCON

Mean difference, including PC correction



Bias correction NOT a local effect

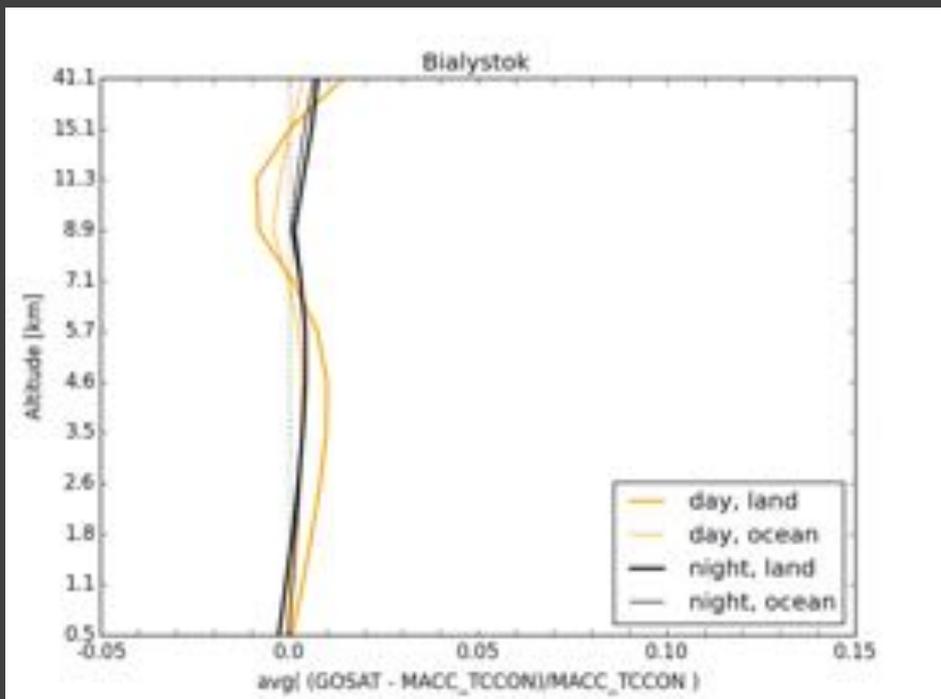


Mean difference wrt. scaled MACC

- Within 2%
- For all investigated TCCON stations
- For all altitudes

Standard deviation $\sim 3\%$

Limit of verification?



Nighttime land
Nighttime ocean
Daytime ocean

} consistent

Daytime land retrievals show systematically largest deviations in the mean difference

How relevant is this and can we improve on this?

GOSAT wrt. scaled MACC profiles

- Mean difference < 2%
- Standard deviation < 4% (2-3% at highest sensitivity)

How good are the model calculations?

- Long-range transport (SH) seems to be an issue

Conclusion and outlook

CH₄ TIR retrieval is sensitive to small spectral features

→ Therefore biases are easily introduced

CH₄ from GOSAT TIR

- Positive bias in retrieved CH₄ profile exceeding 10%

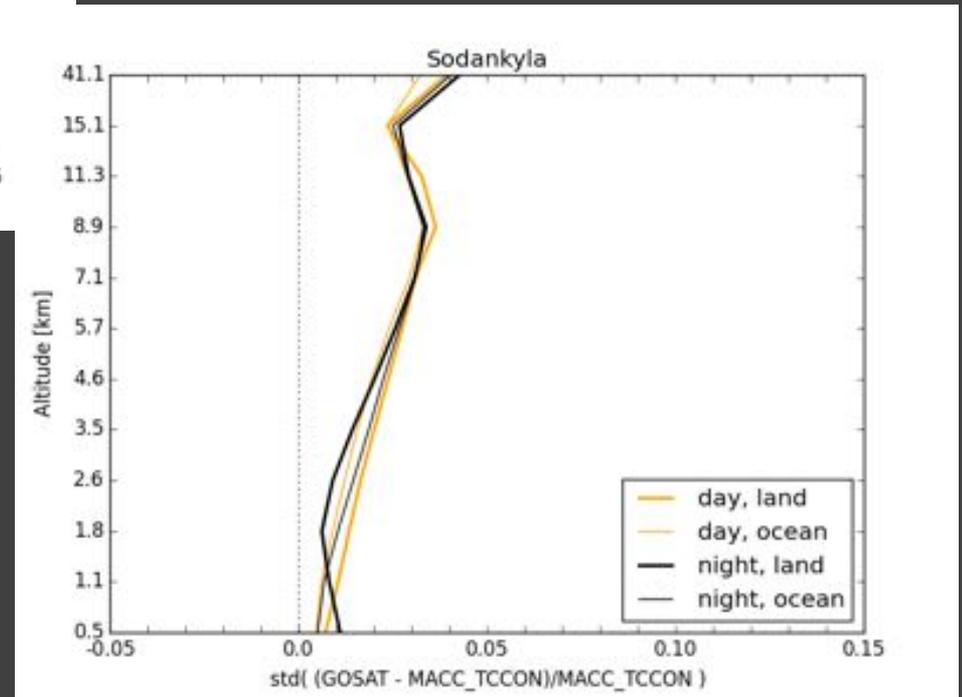
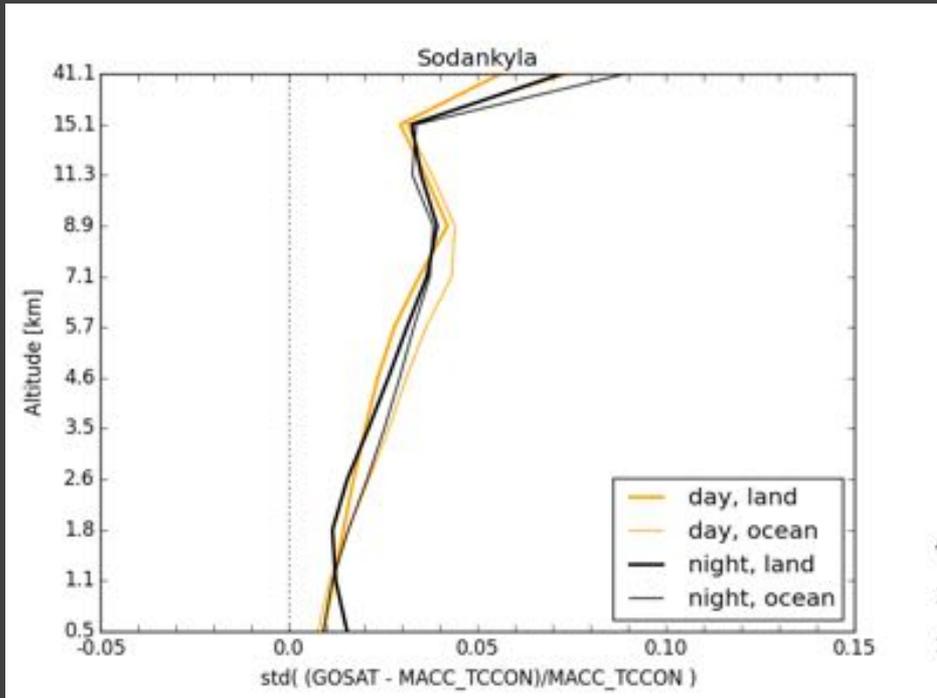
Bias correction based on principal components of spectral residuals:

- <2% deviation wrt. MACC profiles scaled to TCCON total columns
- For all altitudes
- Works globally (for 10 different TCCON stations)

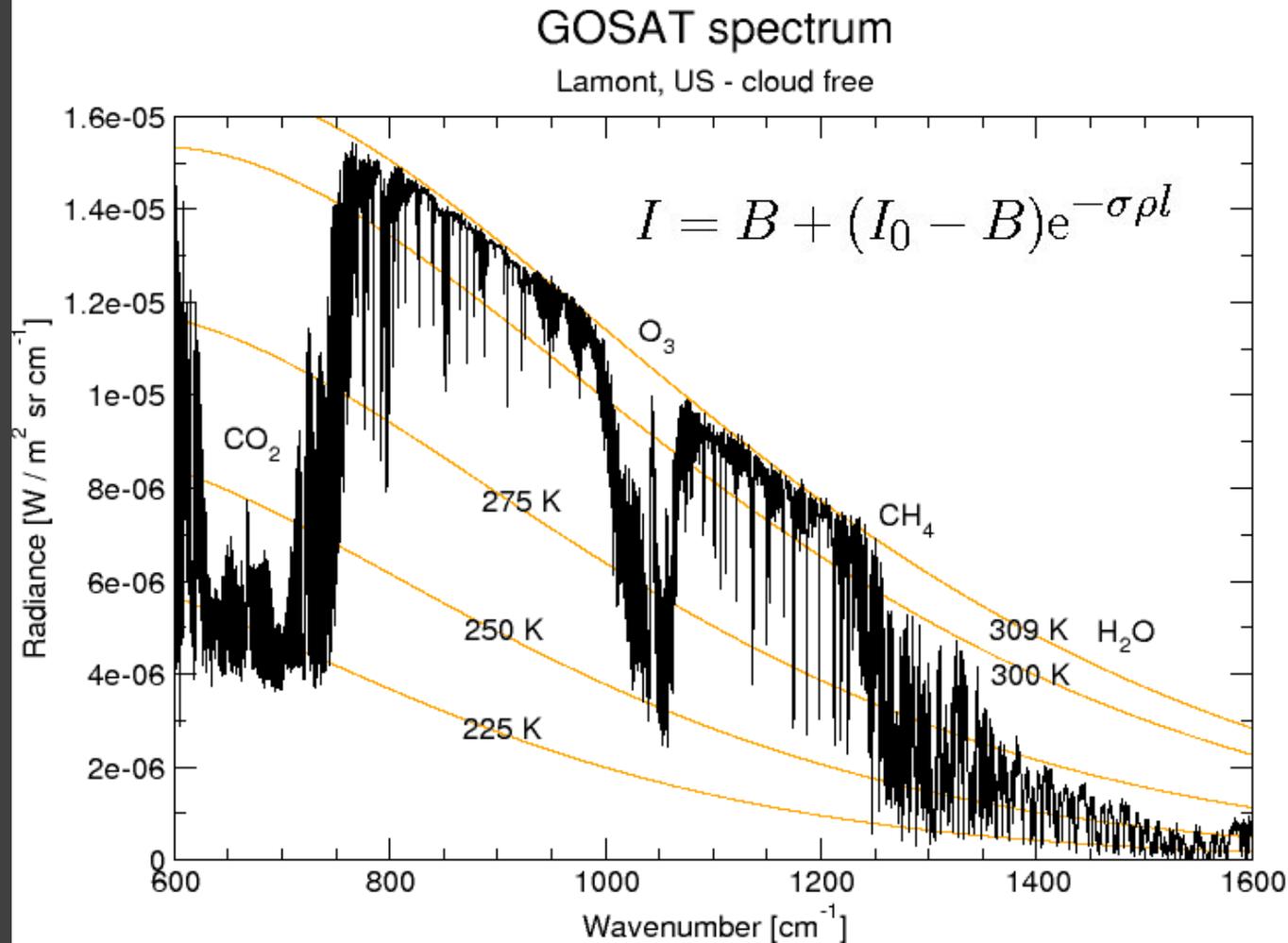
Outlook: Compare retrieved profiles against measured ones

- HIPPO IV and V (<15 km)
- AirCore (sparse)
- Ace (>5 km)

Standard deviation, including PC correction



GOSAT TIR spectrum with Planck curves



Interpretation of PC1

