Verification of CH_4 profile retrievals from GOSAT thermal infrared measurements

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IWGGMS, 7-9 June 2016, Kyoto

Conducted within:

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

SRON

Netherlands Institute for Space Research

Netherlands Organisation for Scientific Research (NWO)

Main message

Bias correction scheme developed for GOSAT TIR CH_4 profile retrieval

Based on principal components analysis of spectral residuals

- HIPPO data as input

Bias in the retrieved CH_4 profiles is reduced from >10% to <2%

- for all altitudes
- for all 10 considered TCCON stations

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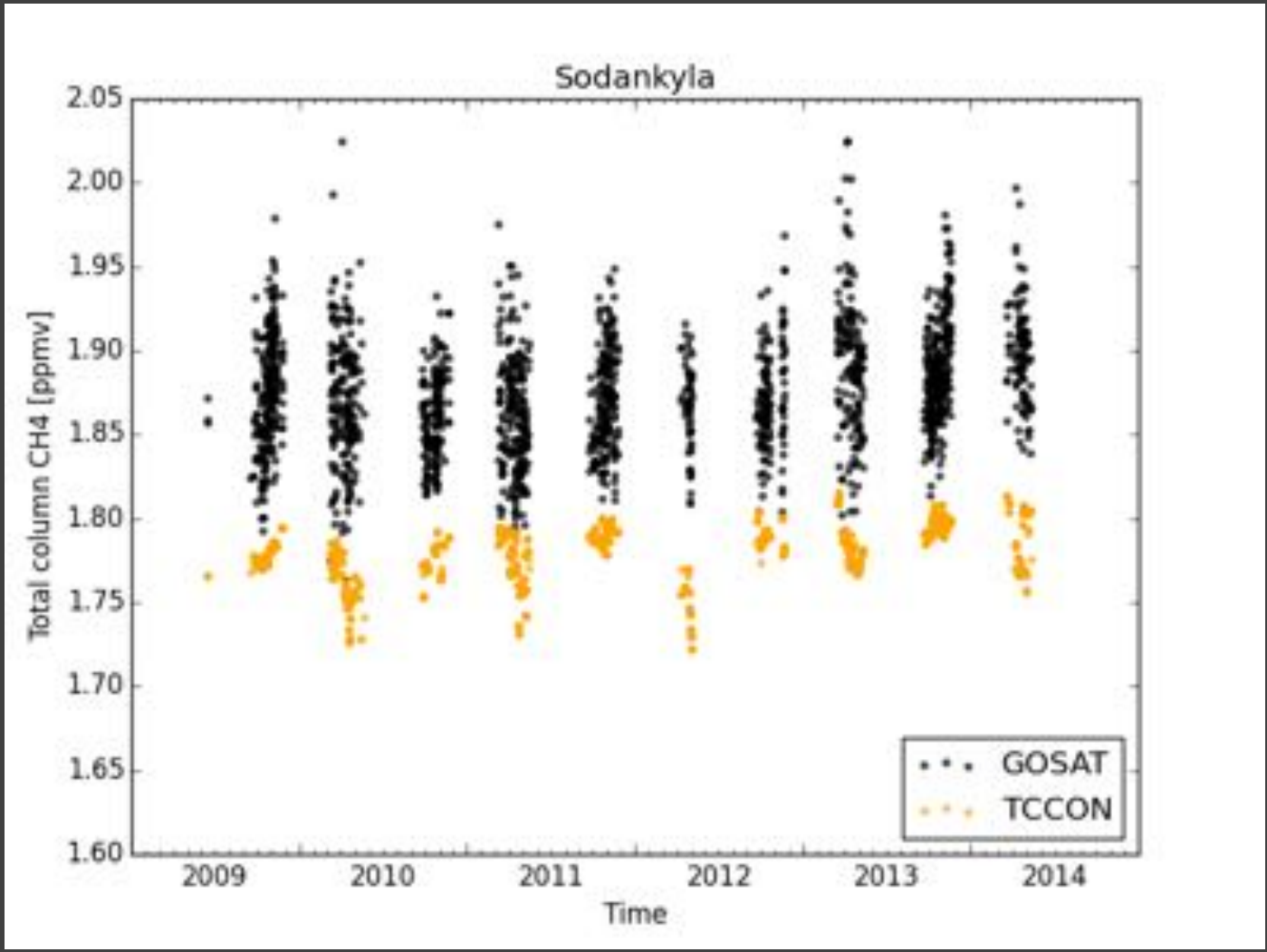
Total CH_4 columns, nominal retrieval



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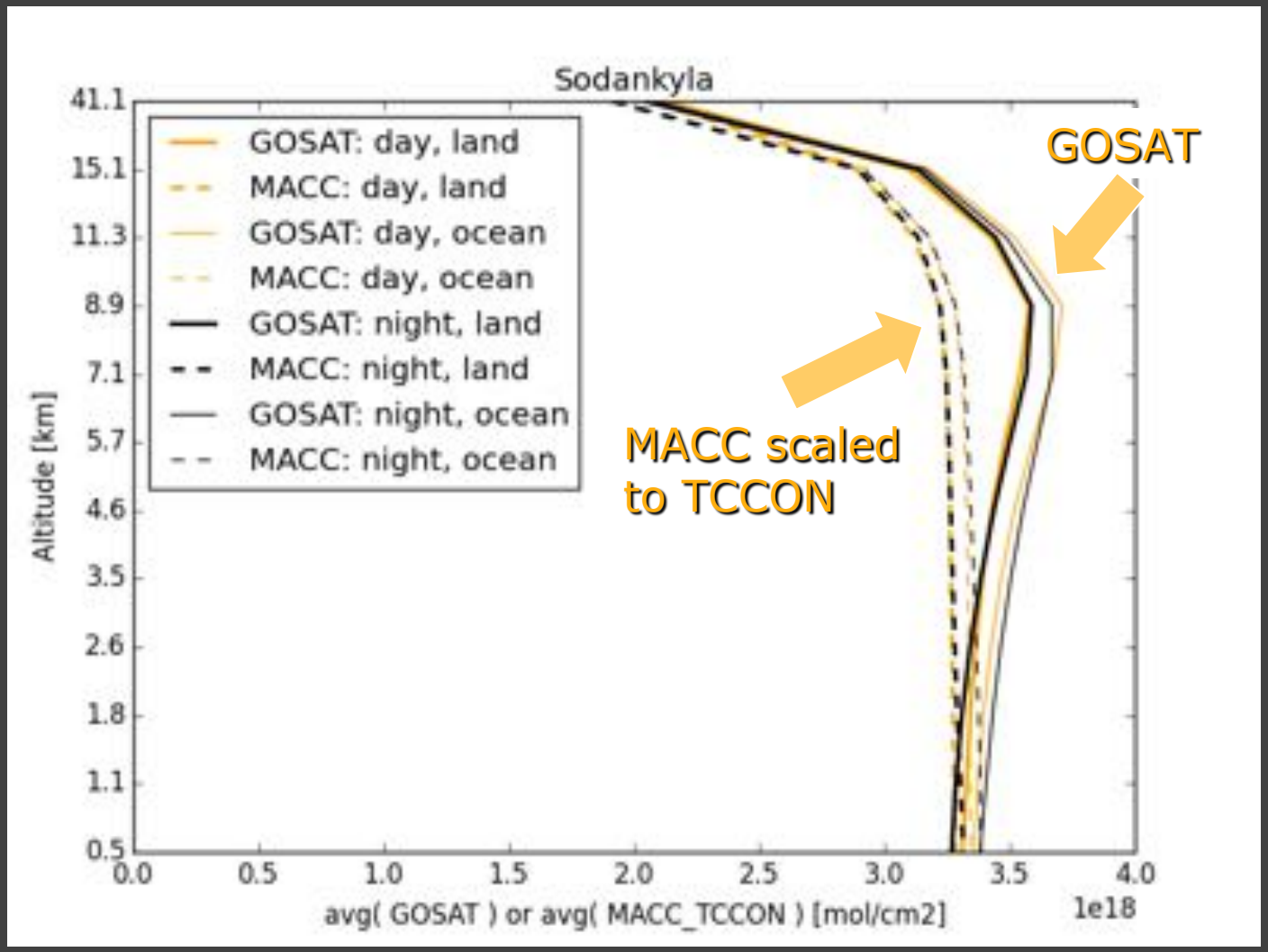
Mean CH_4 profile, nominal retrieval



Note, that MACC is scaled to TCCON total column values

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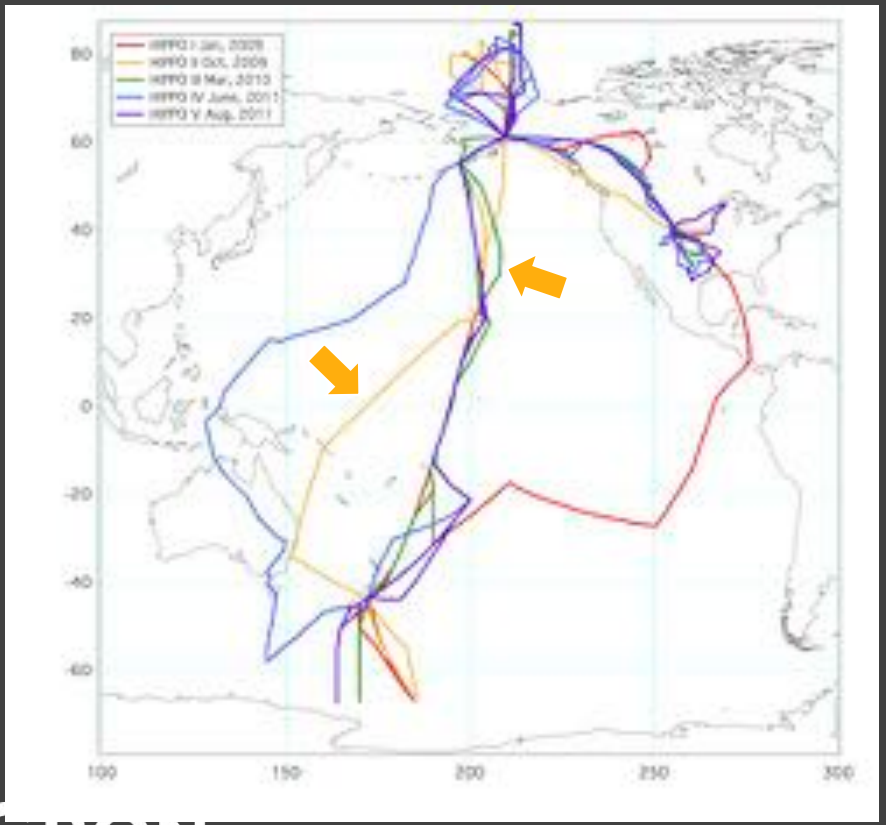
HIPPO: HIAPER Pole-to-Pole Observations

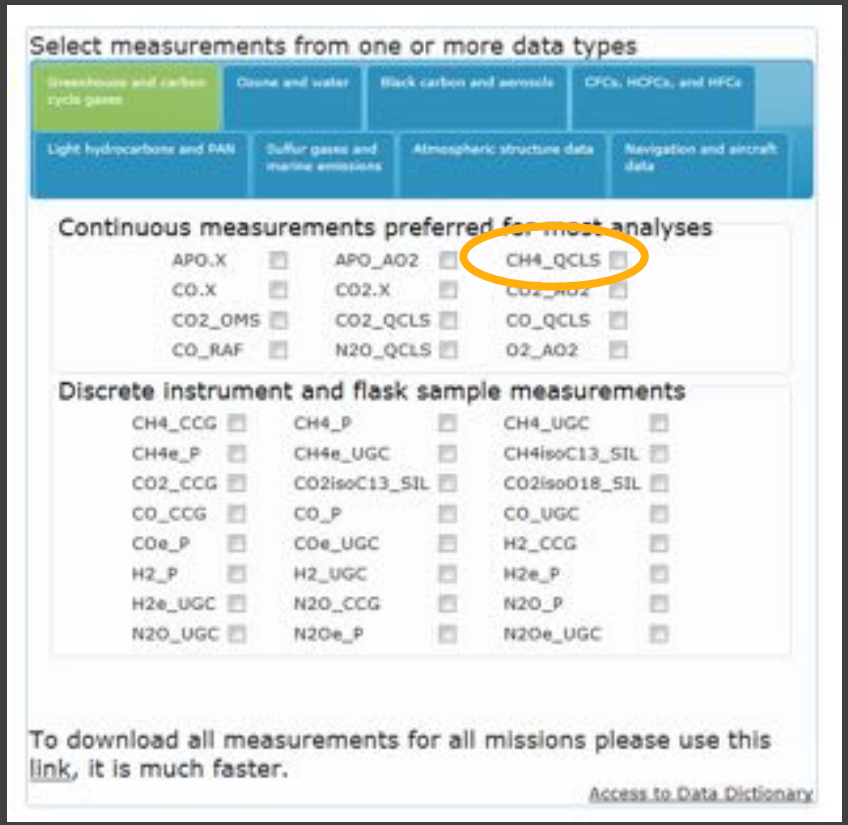
Investigate what spectral structures causes CH_4 bias

➔ Need very good estimate of the atmosphere

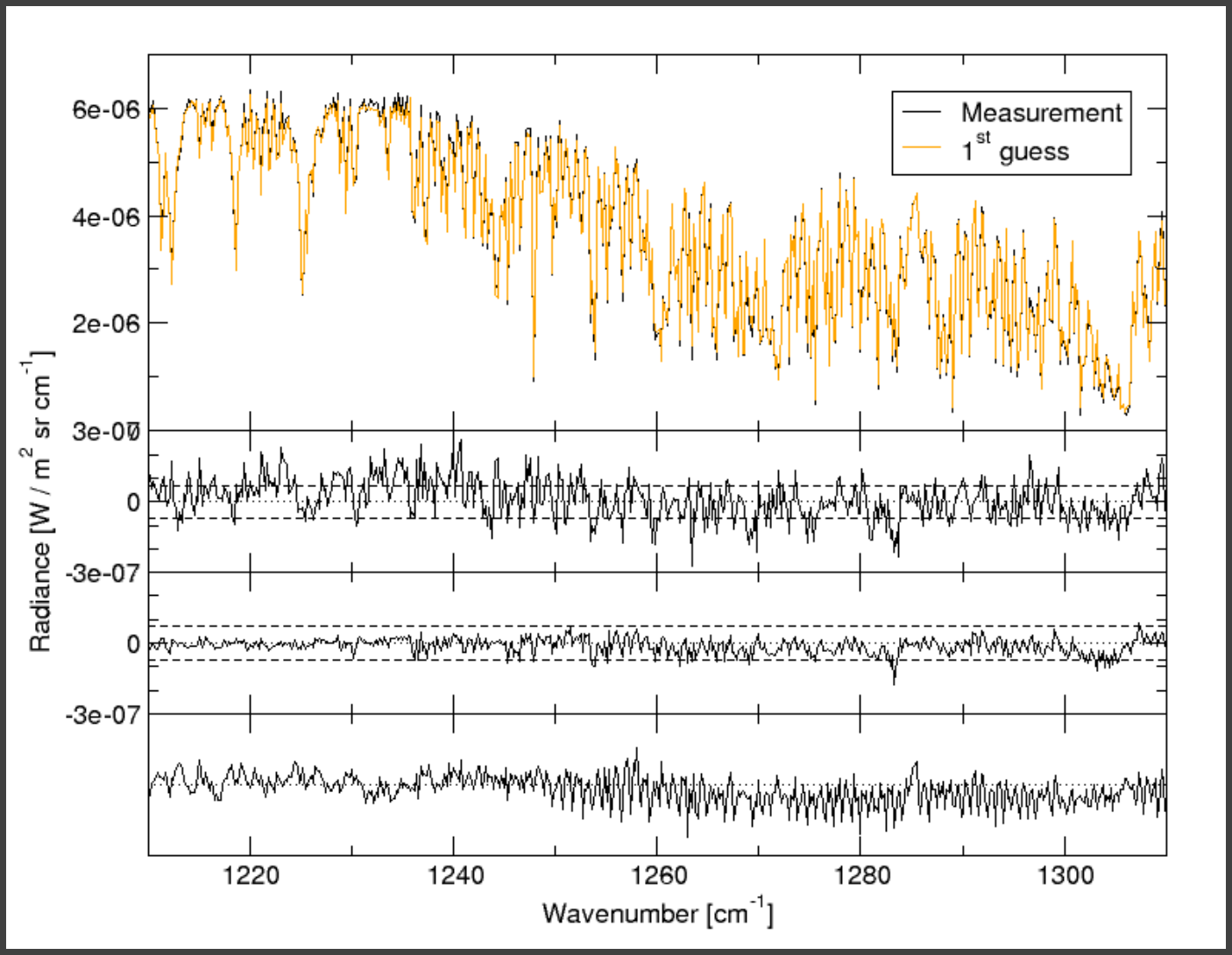
➔ HIPPO Aircraft campaign (profiles: 0-15 km)

http://hippo.ornl.gov/





GOSAT TIR spectrum vs '1st guess'



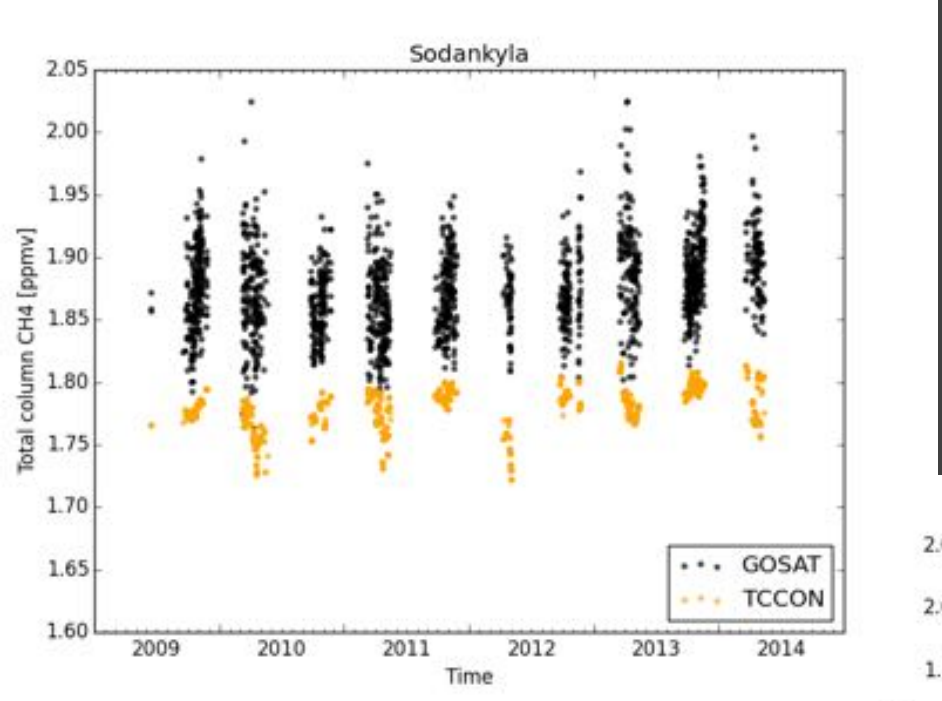
Single spectrum

Residue

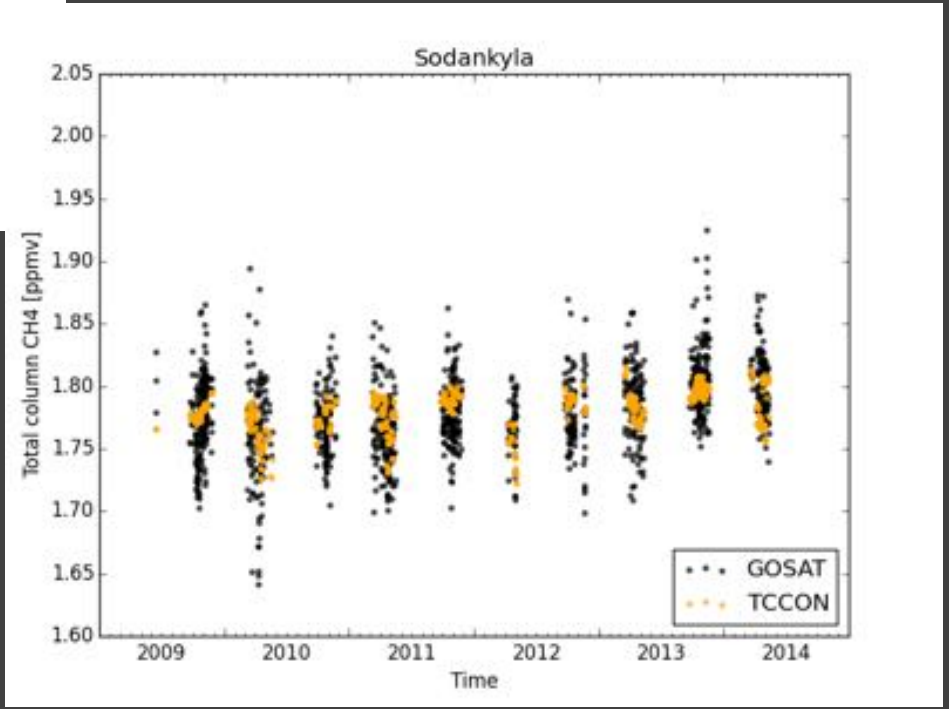
Mean residue

PC1

Total columns, including PC correction



PC correction



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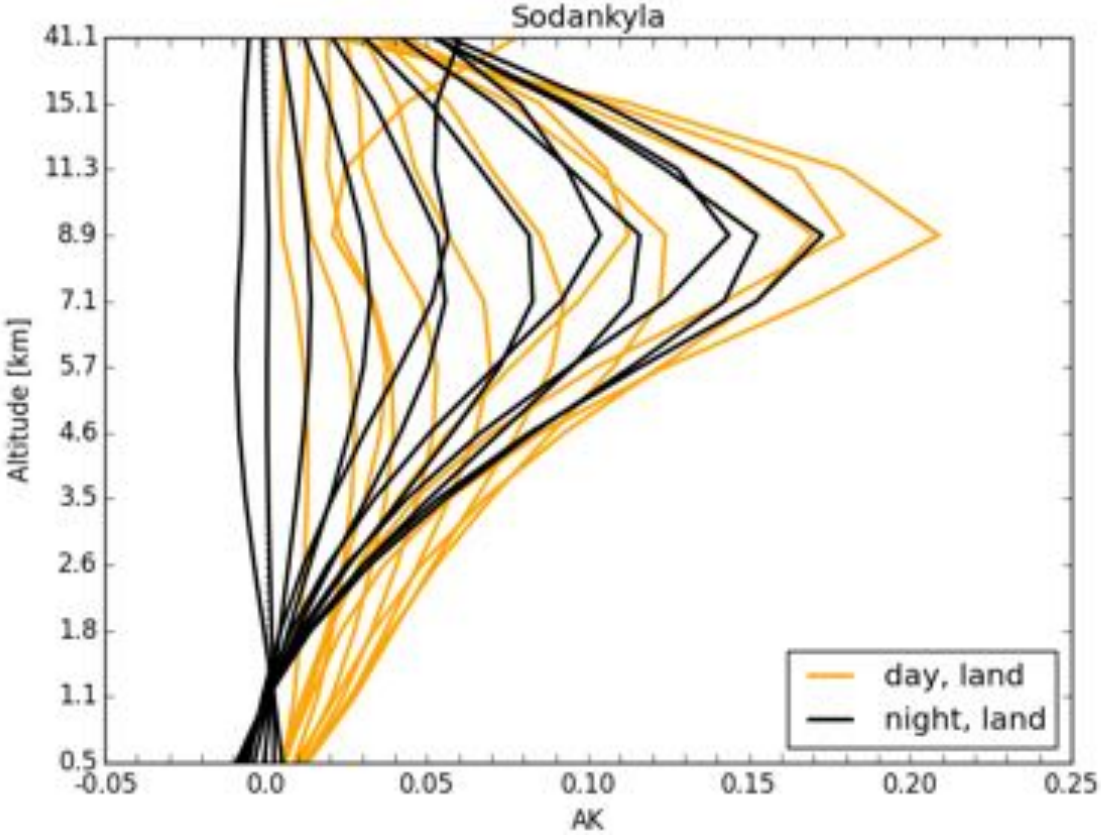
Averaging kernel



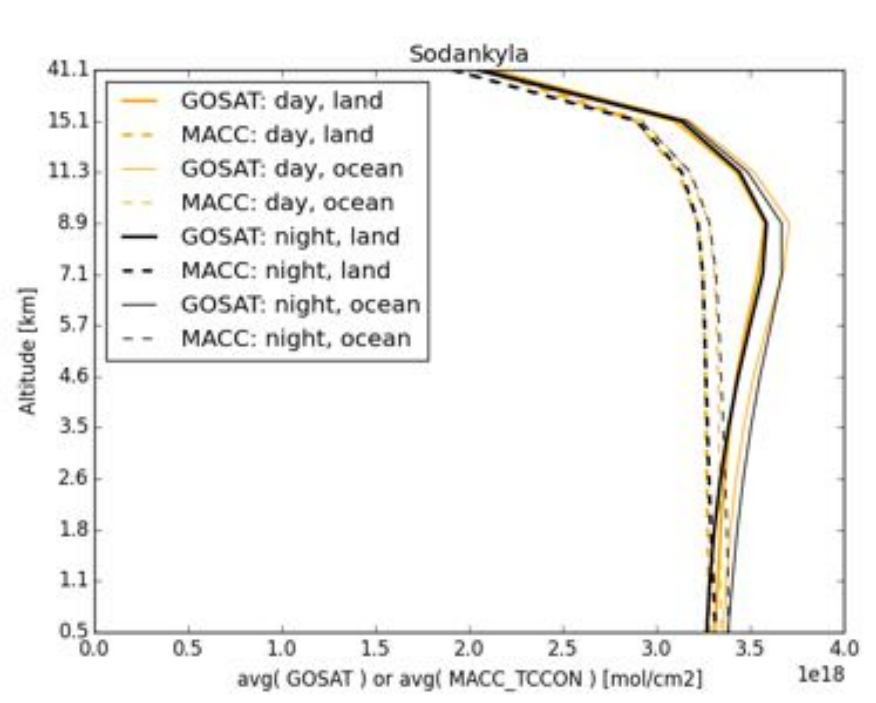
Highest sensitivity between 5 and 15 km

Regularization tuned such that DFS ~ 1

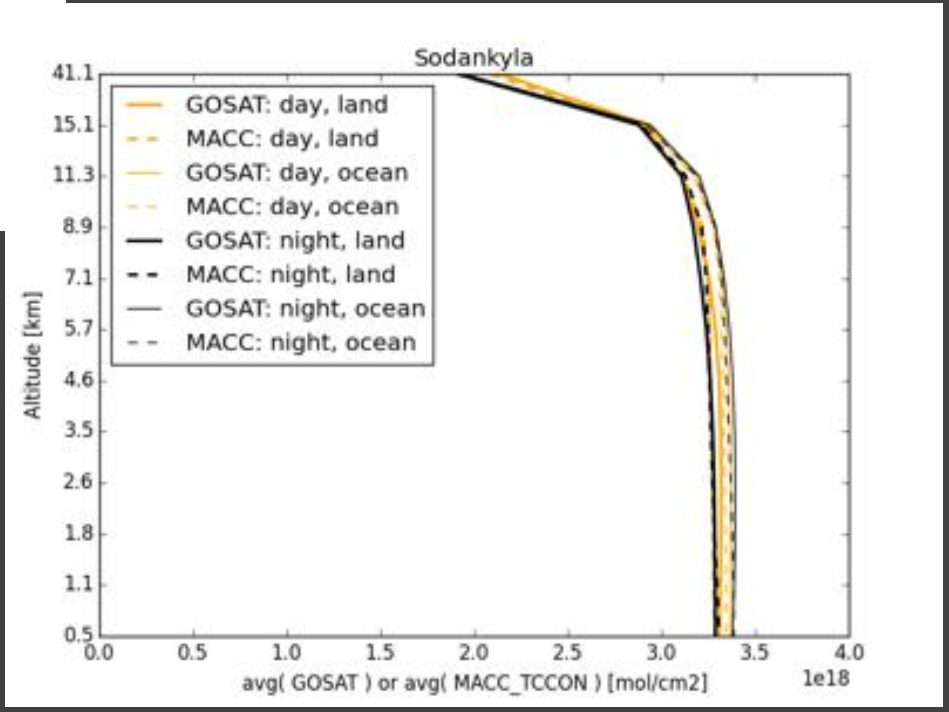
Daytime measurements show higher sensitivity than nighttime

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

Mean CH_4 profile, including PC correction



PC correction



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

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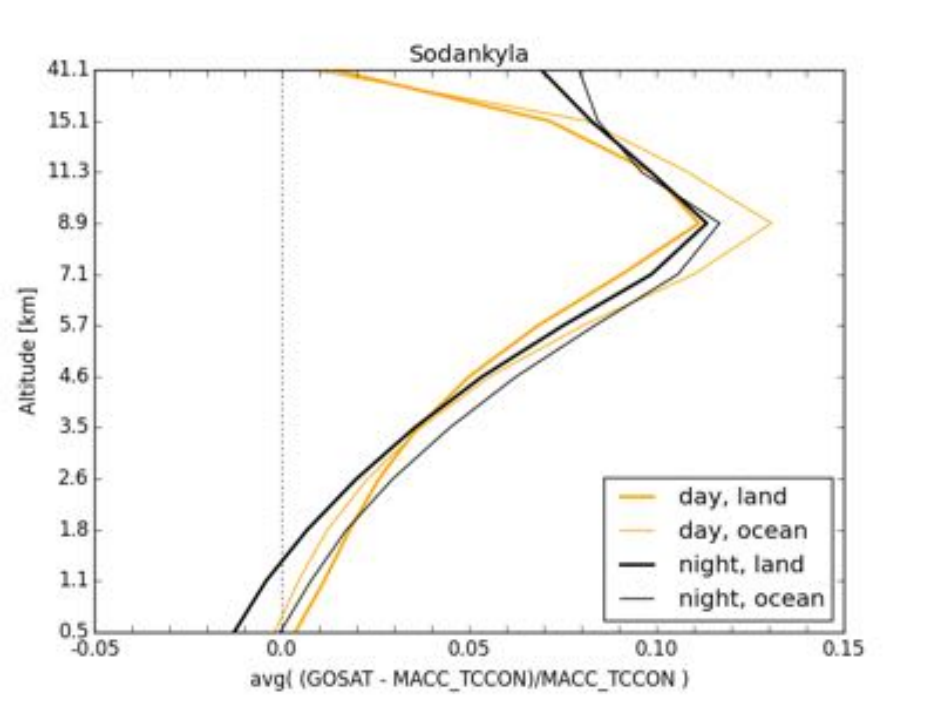
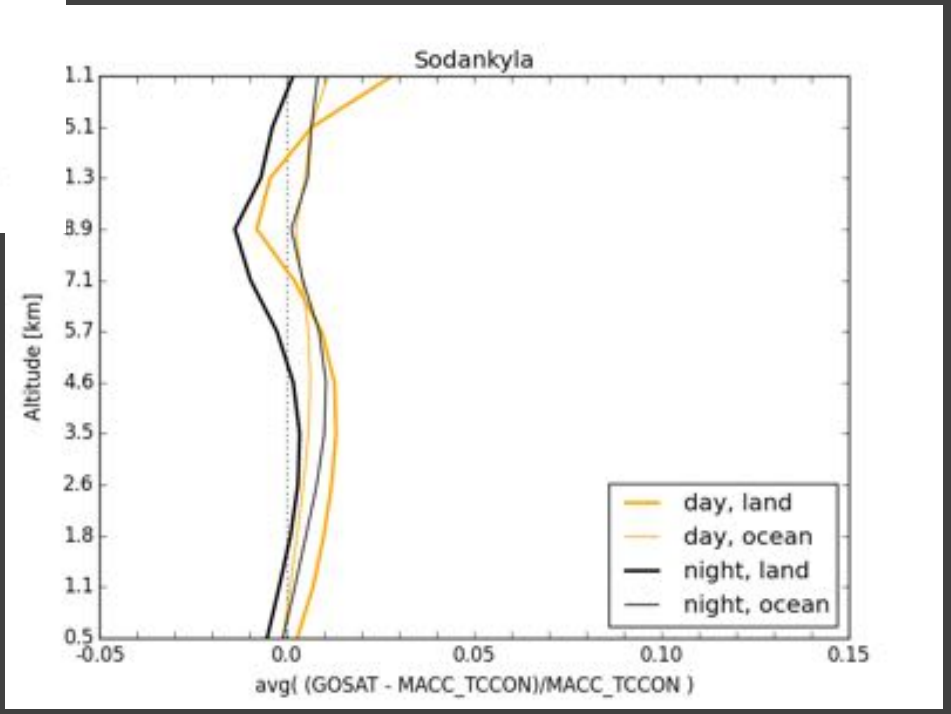
Mean difference, including PC correction



PC correction



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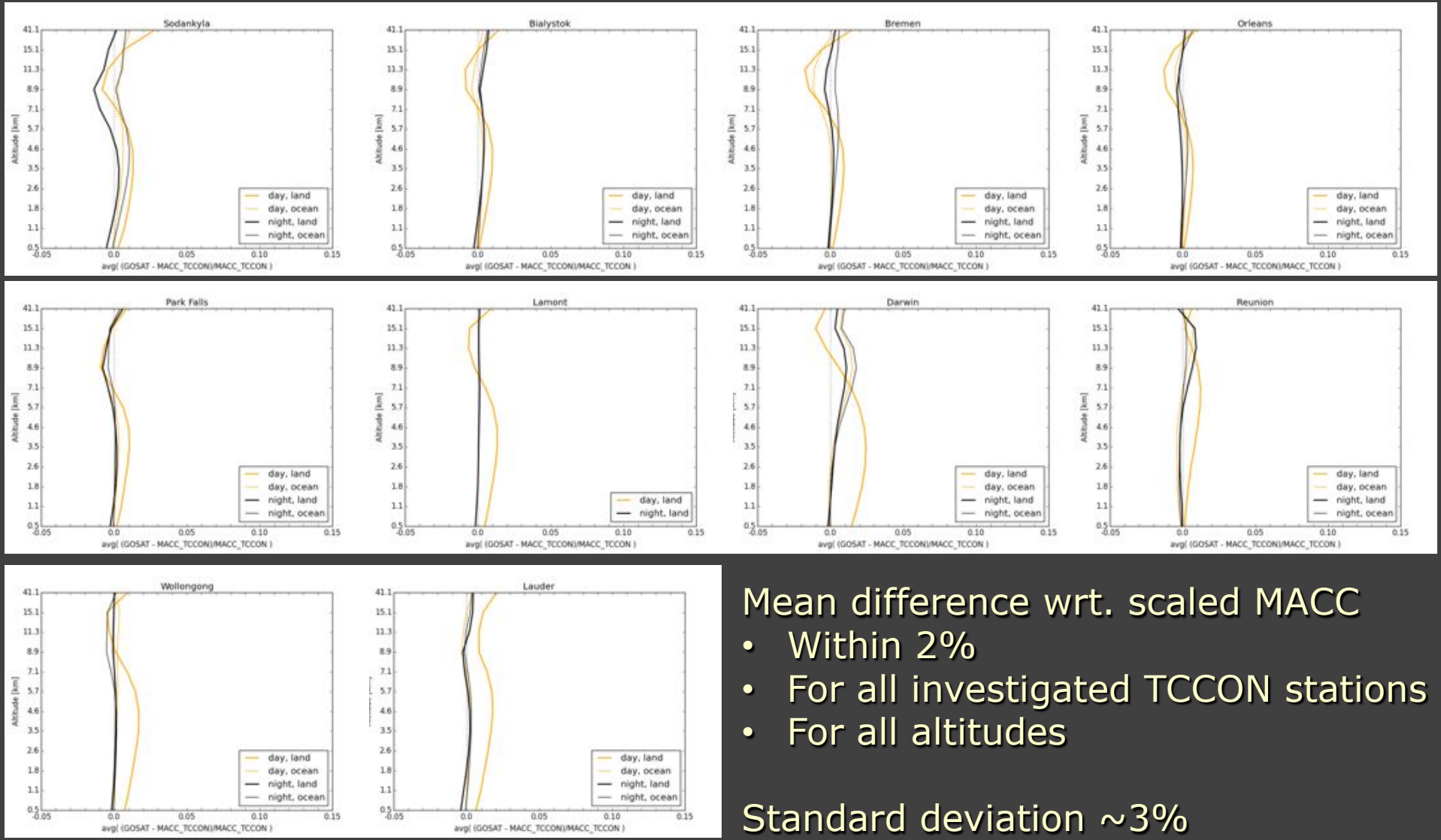
Bias correction NOT a local effect

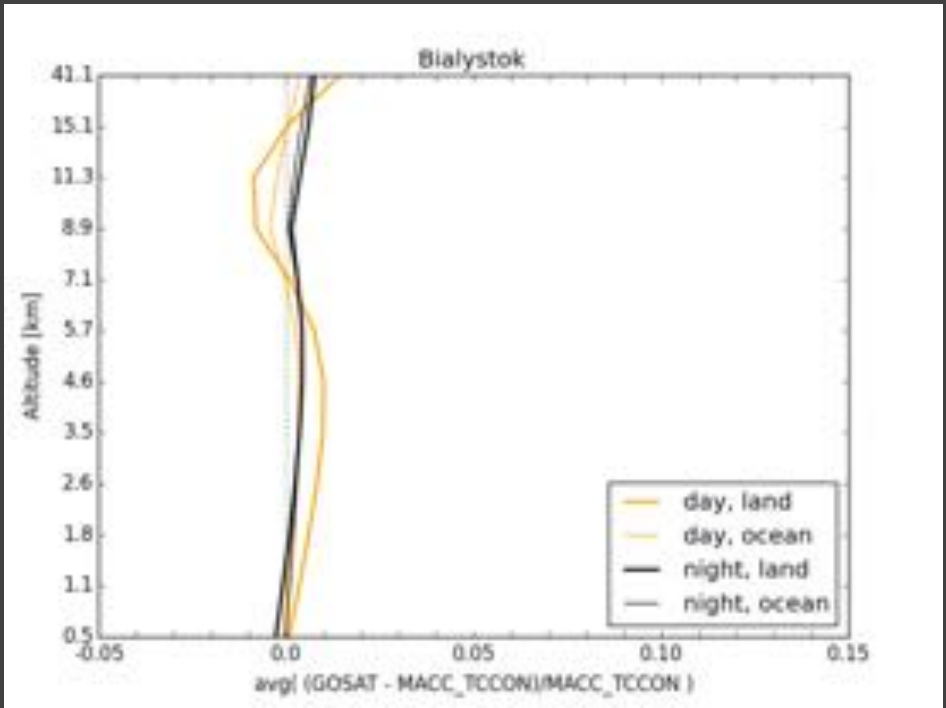


Mean difference wrt. scaled MACC

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

Standard deviation ~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

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Conclusion and outlook

CH_4 TIR retrieval is sensitive to small spectral features

➔ Therefore biases are easily introduced

CH_4 from GOSAT TIR

- Positive bias in retrieved CH_4 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)

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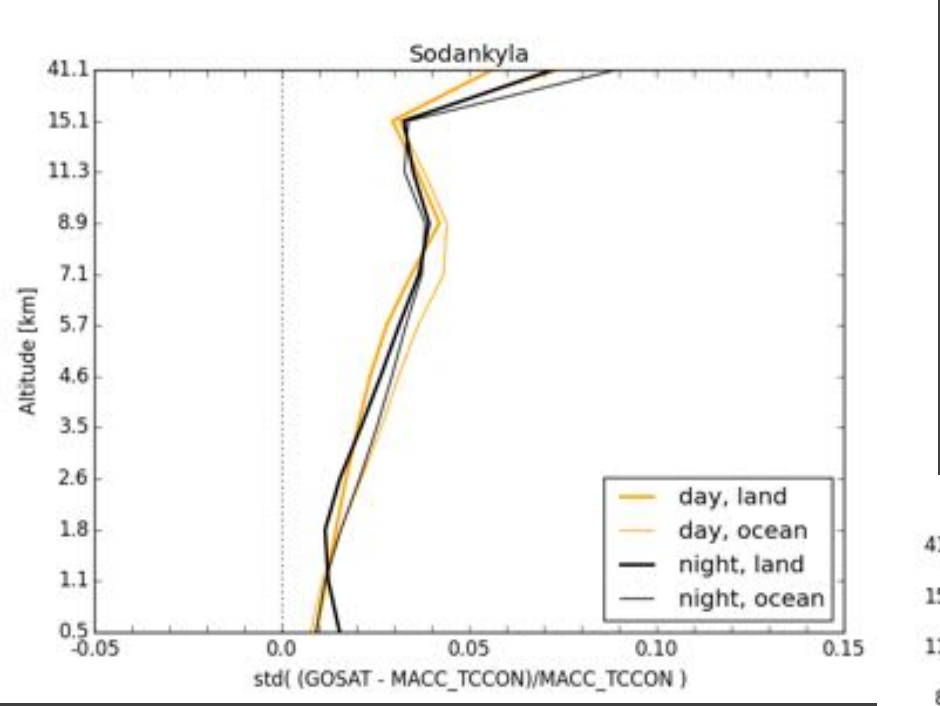
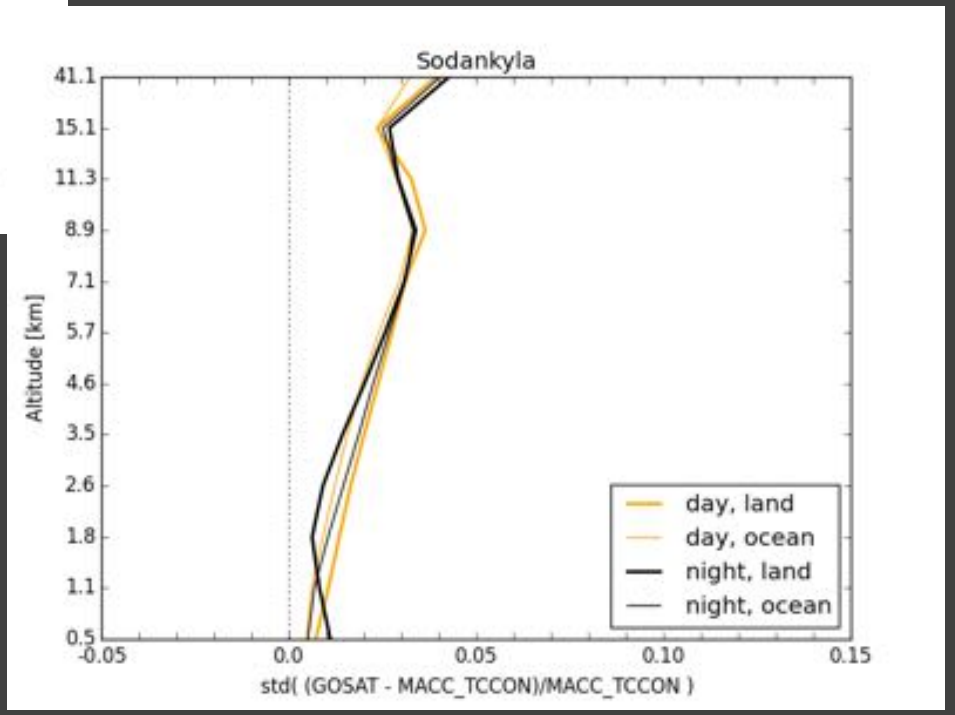
Standard deviation, including PC correction



PC correction



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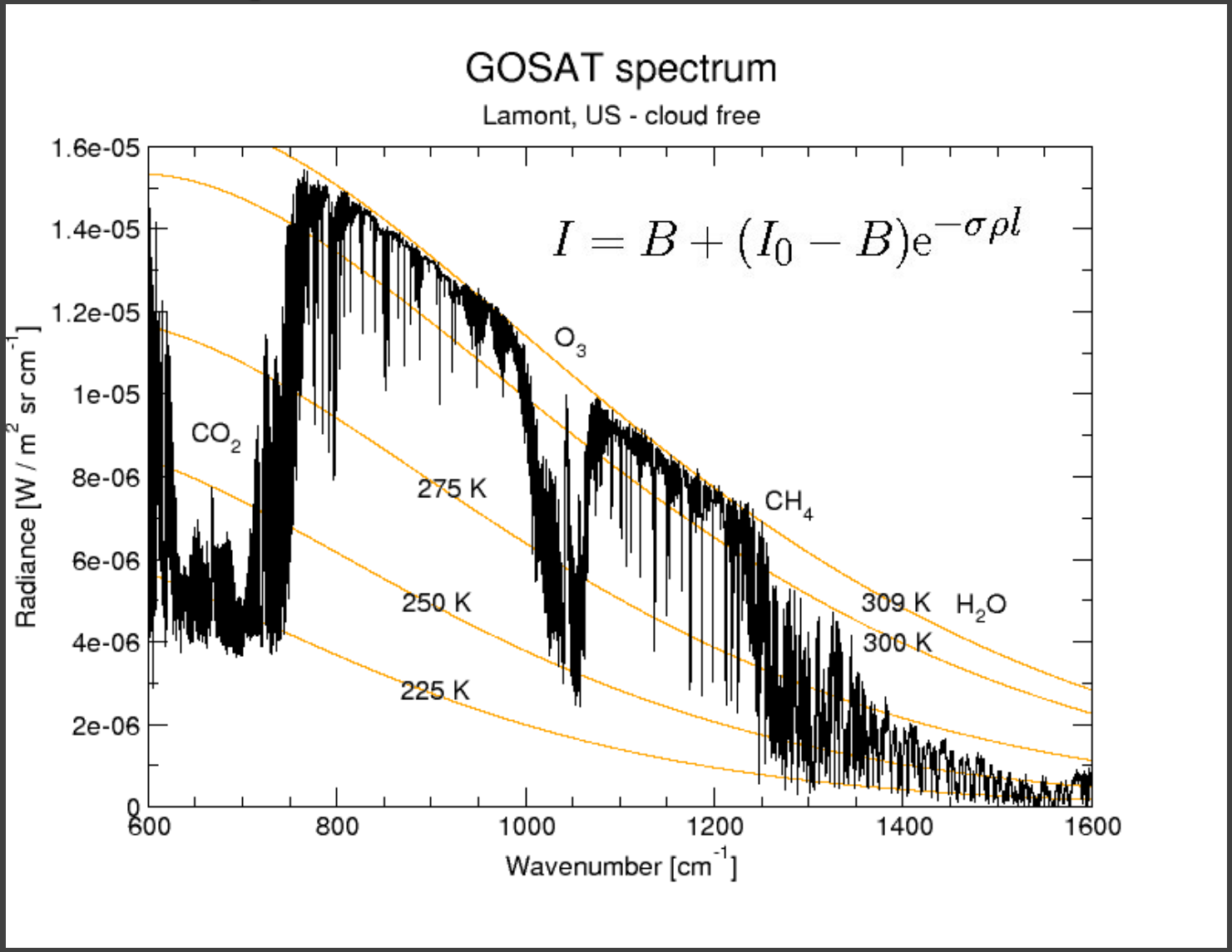
GOSAT TIR spectrum with Planck curves



Interpretation of PC1