CH4 update

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Analysis at Thule.

- ❑ Linelist (HIT08 vs HIT20 vs ATM20)
- ❑ WACCM v6 vs V7
- ❑ Sa (OE & Tik)

Retrieval code: sfit4 v1.0.18
Years (Thule): 2017-2019

Overview

Version	Description	Some Retrieval parameters
HIT08	HIT08	mw1: 2613.70 - 2615.40 cm^{-1} mw2: 2650.60 - 2651.30 cm^{-1} mw3: 2835.50 - 2835.80 cm^{-1} mw4: 2903.60 - 2904.03 cm^{-1} mw5: 2921.00 - 2921.60 cm^{-1} OPD:257 cm FLT: 3 OE Sa: 7% weighted as (Sa/sqrt(thickness)
HIT20	All HIT20	
ATM20	All ATM20	
WACCM V6	WACCM V6	
WACCM V7	WACCM V7	

- Start from current NDACC retrieval strategy.
- Change retrieval method one aspect at a time.
- Analyze effect on RMS, DOFS, total column and profile
- Validation against other instruments is missing.

Summary

- ATM20 shows significant better RMS/DOF (~40%), an improvement, and columns do not change a lot. ATM20 is about 0.25% larger than HIT08. Is this the same for other sites?

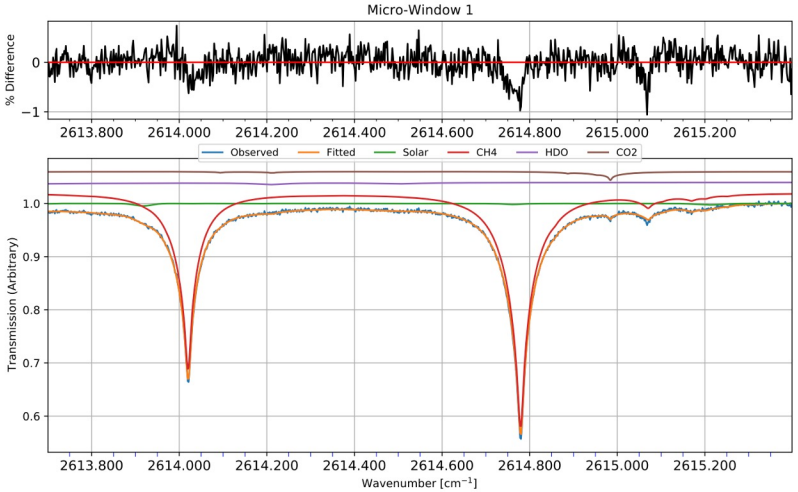
- WACCM v7 should be ok with slightly better RMS/DOF and the magnitude takes into account the increase in CH4. Note that an optimization of regularization may be needed, depending on the site(s)

- Either Tik or OE would be ok.

From Gordon et al. (2022) concerning CH_4.: *"A major global revision of the methane line shape parameters is currently underway for Voigt and speed dependent Voigt parametrizations, as well as the inclusion of linemixing parameters. At present, this work is still ongoing and will not form part of the current update for methane. The improvements for HITRAN2020 concern updating line-shapes of individual transitions where major issues have been identified".* Furthermore, lines were improved but it does not seem like the mw we use here.

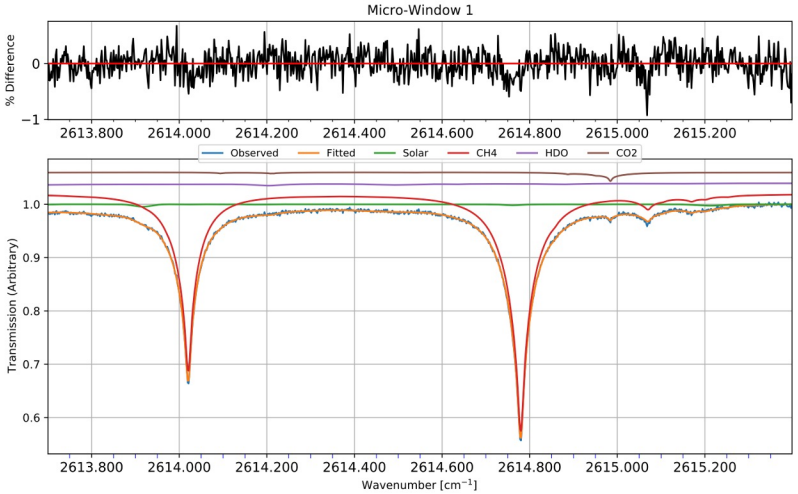
Fits (HIT08 VS ATM20)

HIT08 (OE & WACCM V6)



RMS: 0.3882

ATM20 (OE & WACCM V6)

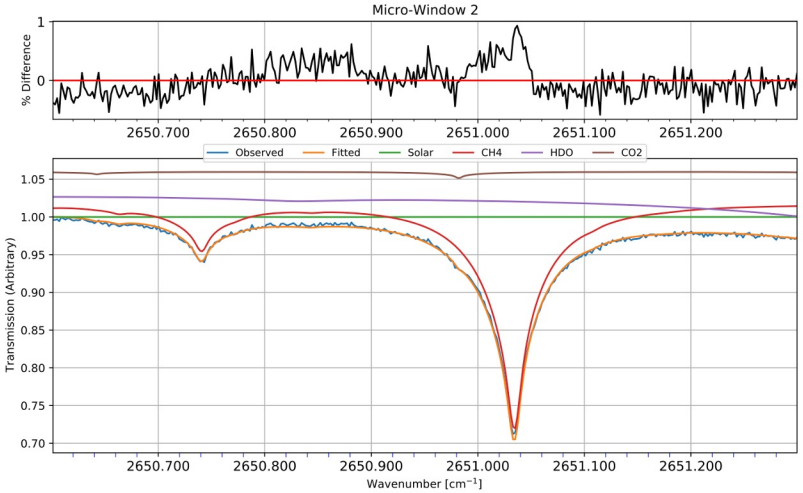


RMS: 0.2321

Example: 20170819.201333

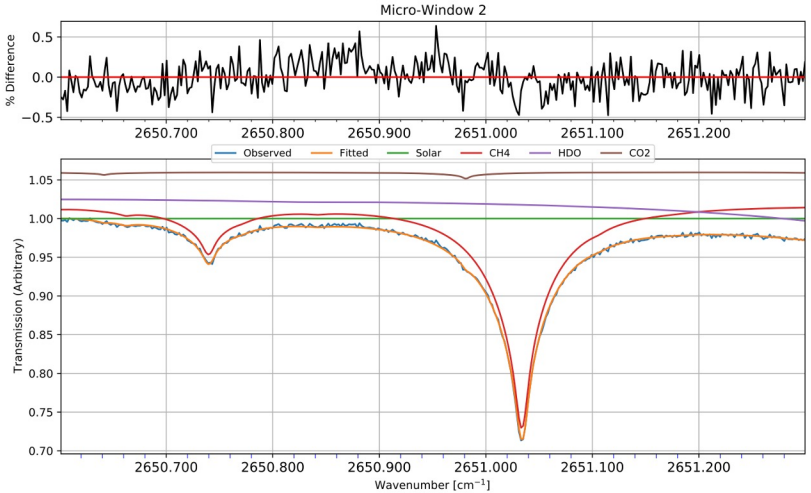
Fits (HIT08 VS ATM20)

HIT08 (OE & WACCM V6)



RMS: 0.3882

ATM20 (OE & WACCM V6)



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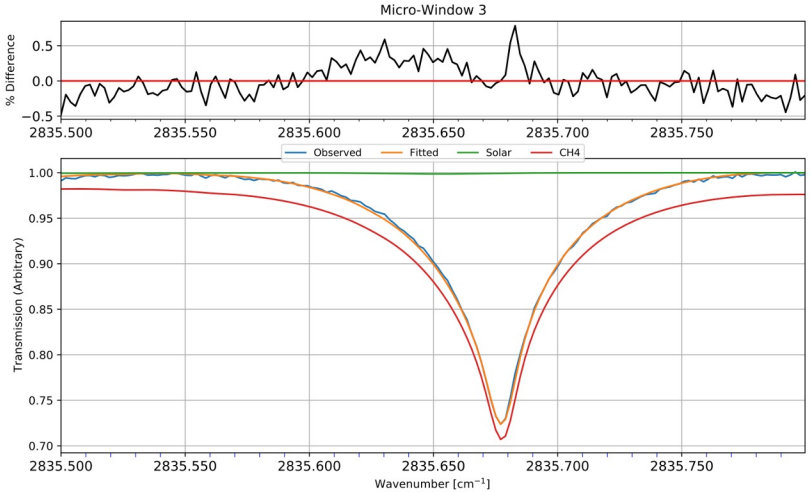
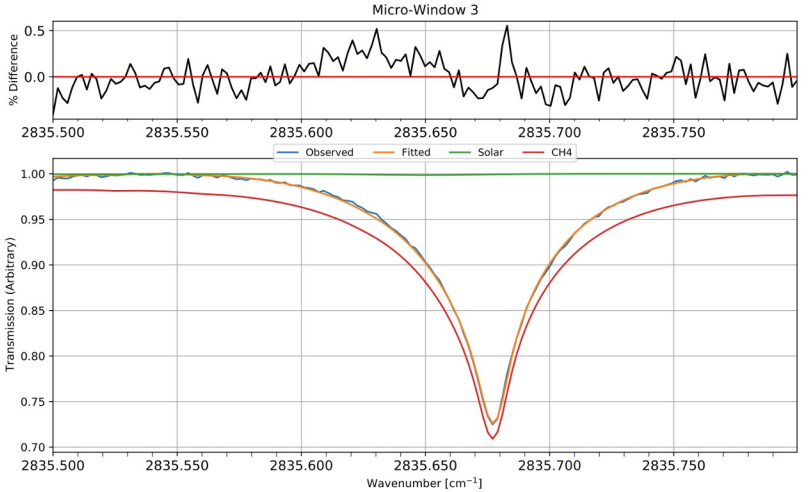
Fits (HIT08 VS ATM20)

HIT08 (OE & WACCM V6)



RMS: 0.3882

ATM20 (OE & WACCM V6)

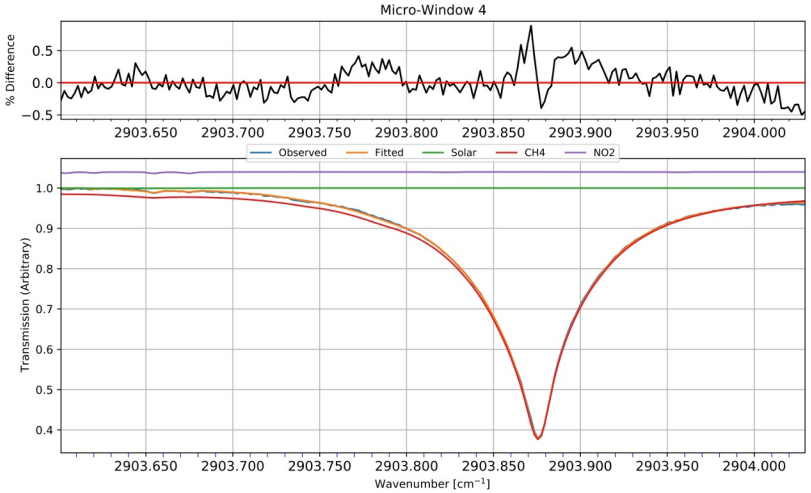


RMS: 0.2321

Example: 20170819.201333

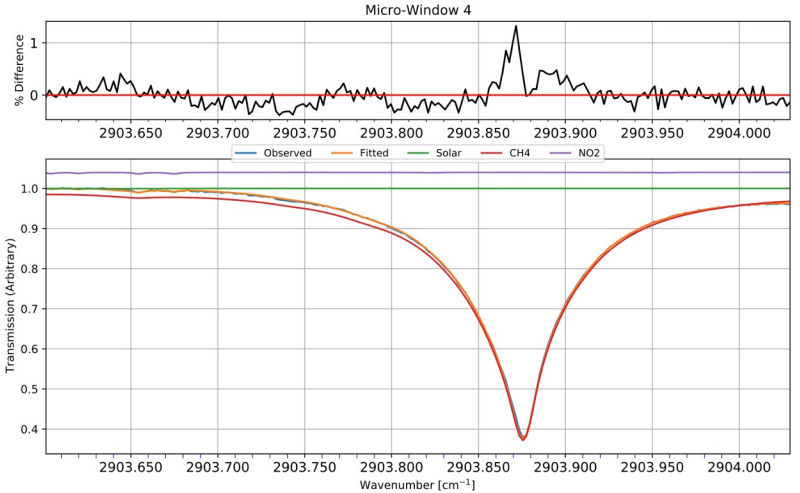
Fits (HIT08 VS ATM20)

HIT08 (OE & WACCM V6)



RMS: 0.3882

ATM20 (OE & WACCM V6)



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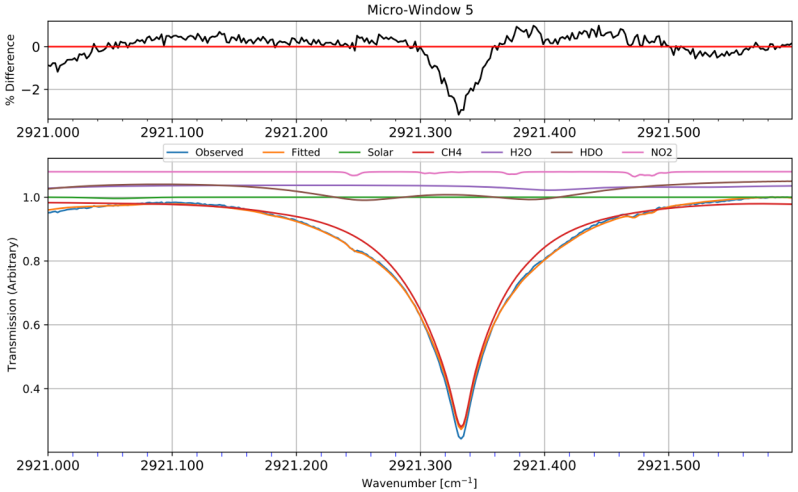
Example: 20170819.201333

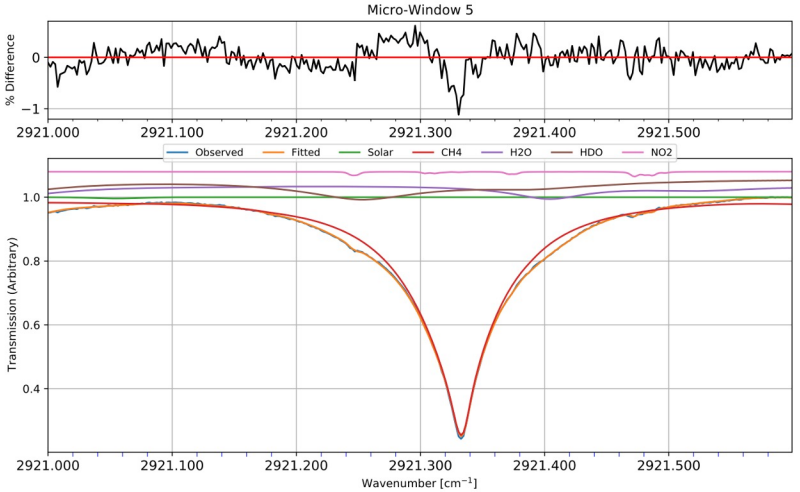
Fits (HIT08 VS ATM20)

HIT08 (OE & WACCM V6)



RMS: 0.3882

ATM20 (OE & WACCM V6)

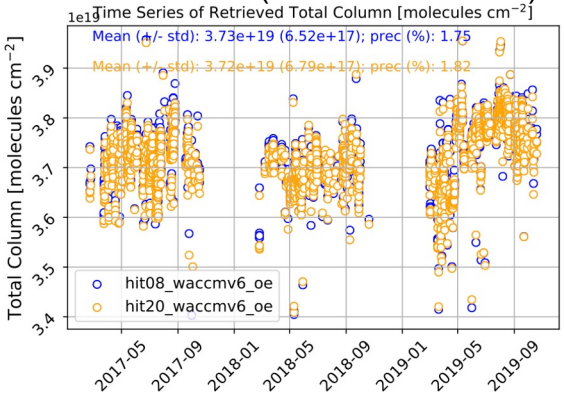


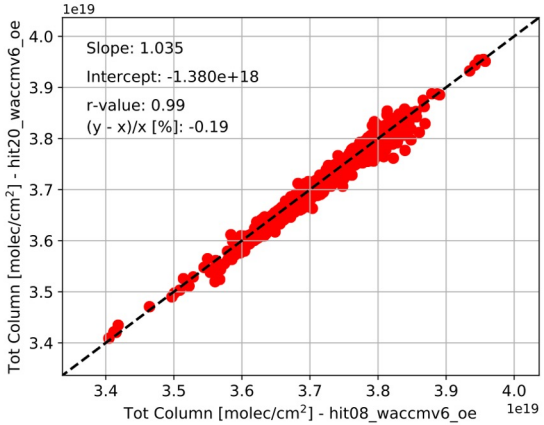
RMS: 0.2321

Example: 20170819.201333

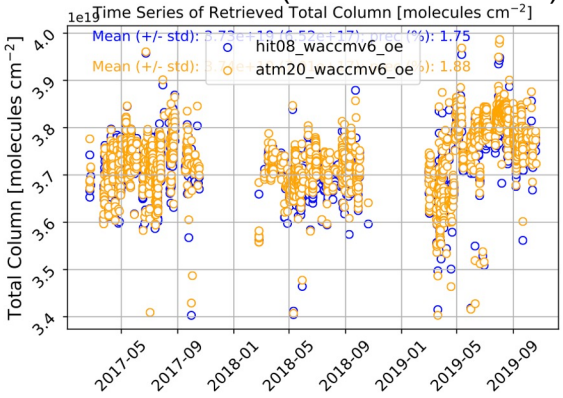
Time Series: total Columns

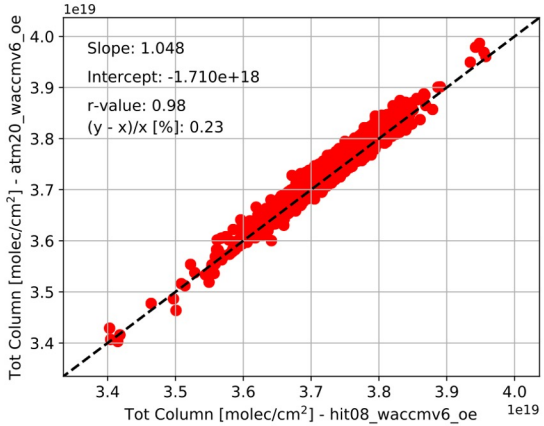
HIT08 vs HIT 20 (OE & WACCM V6)



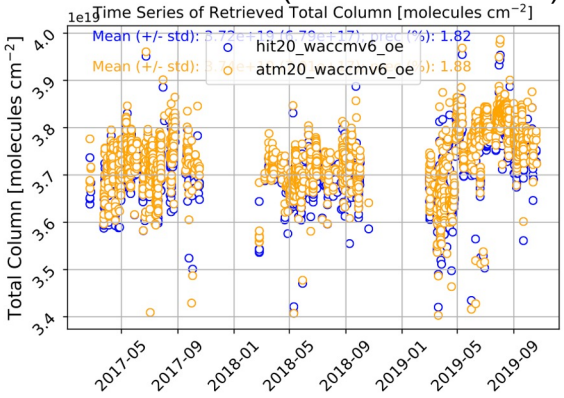


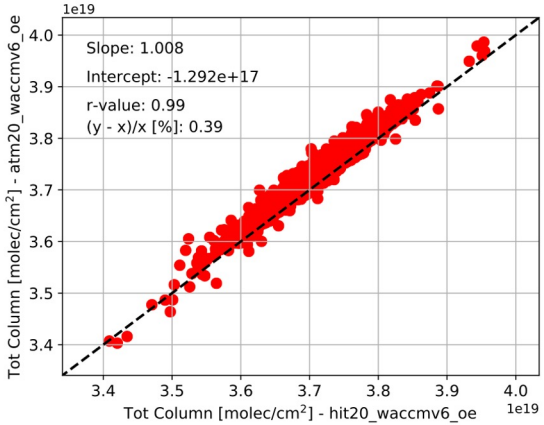
HIT08 vs ATM20 (OE & WACCM V6)





HIT20 vs ATM20 (OE & WACCM V6)





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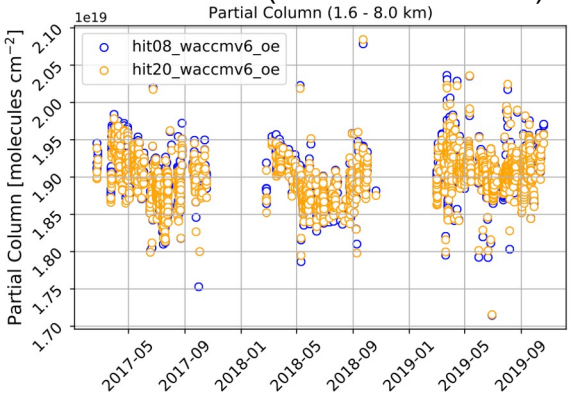
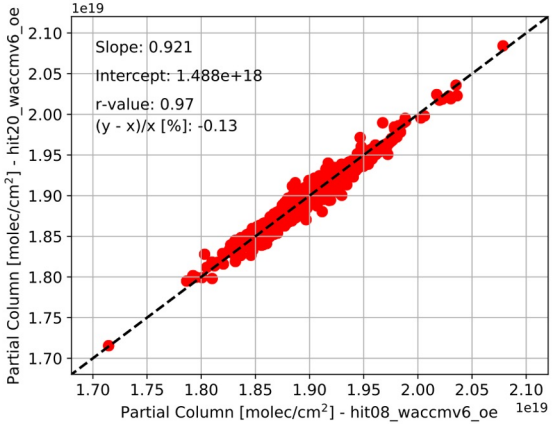
Differences in total columns range from -0.19% (HIT20) to +0.2% (ATM20)

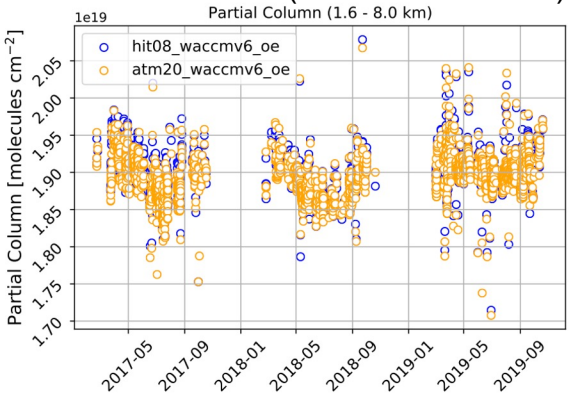
Time Series: Tropospheric Columns

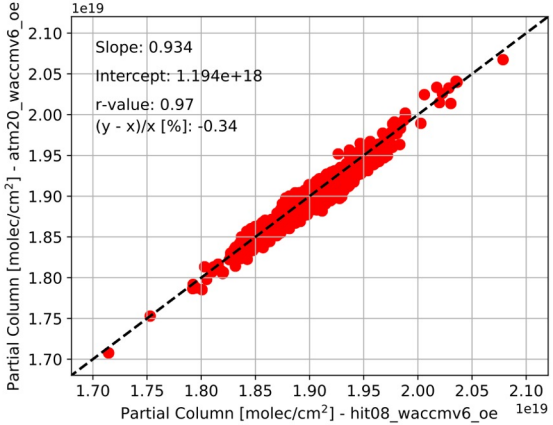
HIT08 vs HIT 20 (OE & WACCM V6)



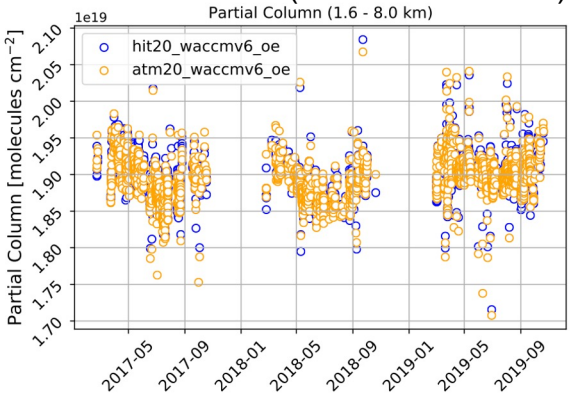


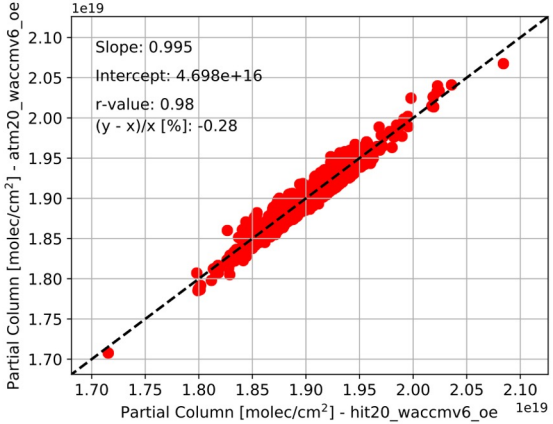
HIT08 vs ATM20 (OE & WACCM V6)





HIT20 vs ATM20 (OE & WACCM V6)





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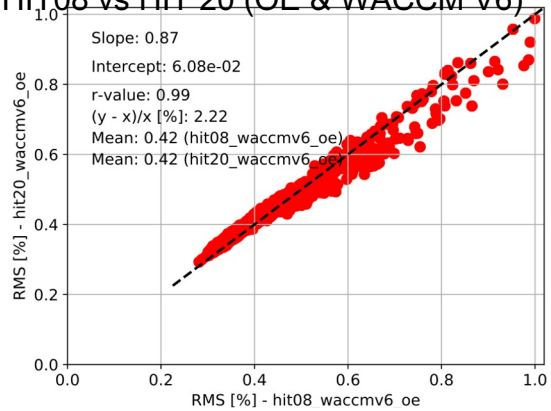
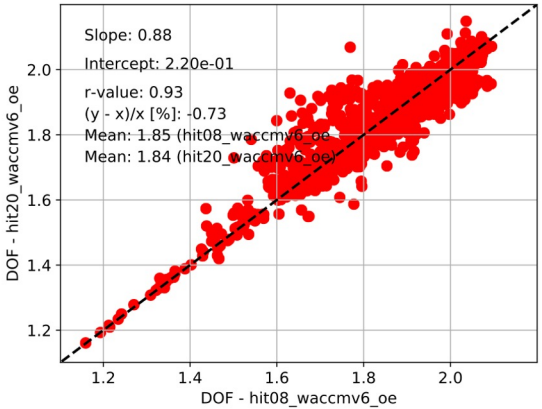
Differences in total columns range from -0.13% (HIT20) to -0.34% (ATM20)

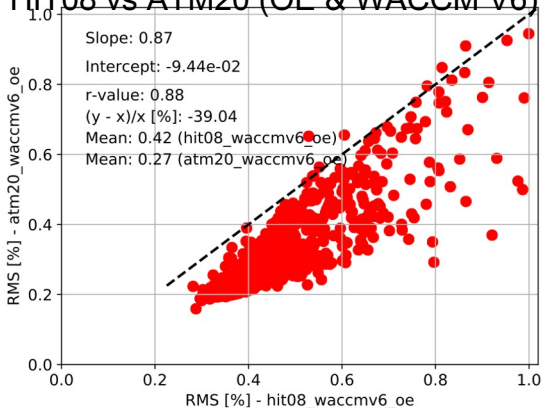
RMS and DOF

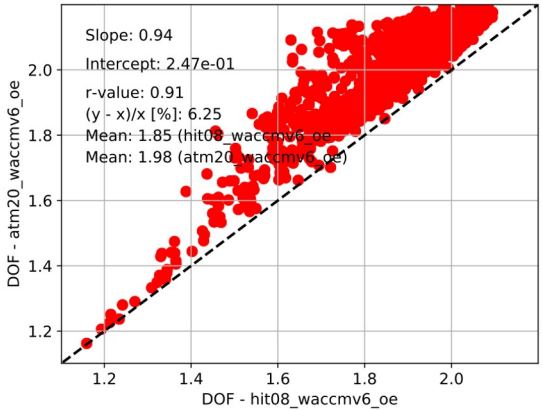
HIT08 vs HIT 20 (OE & WACCM V6)



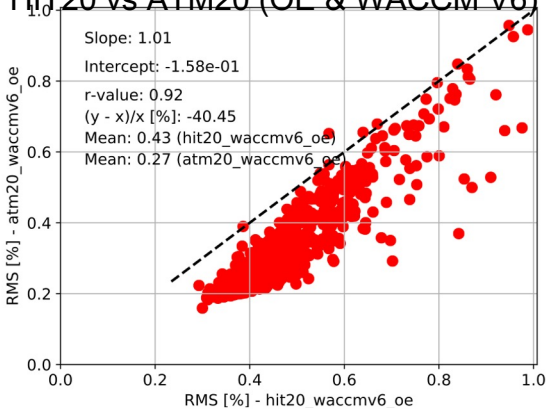


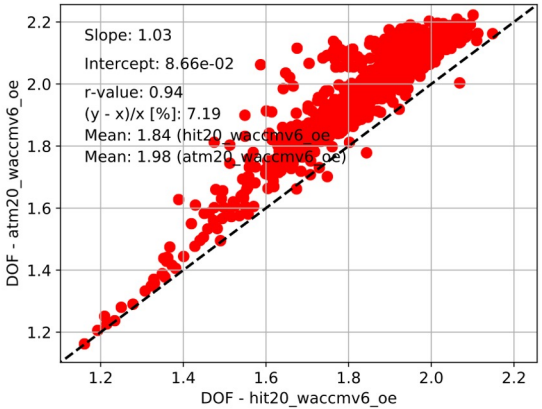
HIT08 vs ATM20 (OE & WACCM V6)





HIT20 vs ATM20 (OE & WACCM V6)





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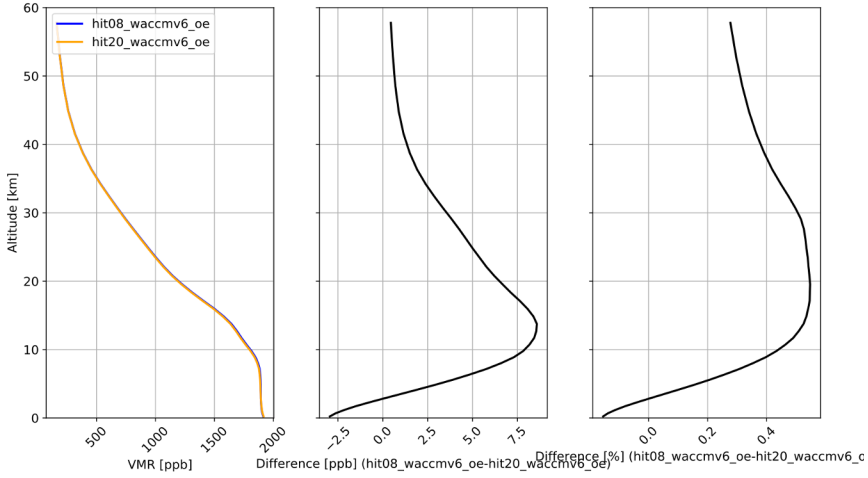
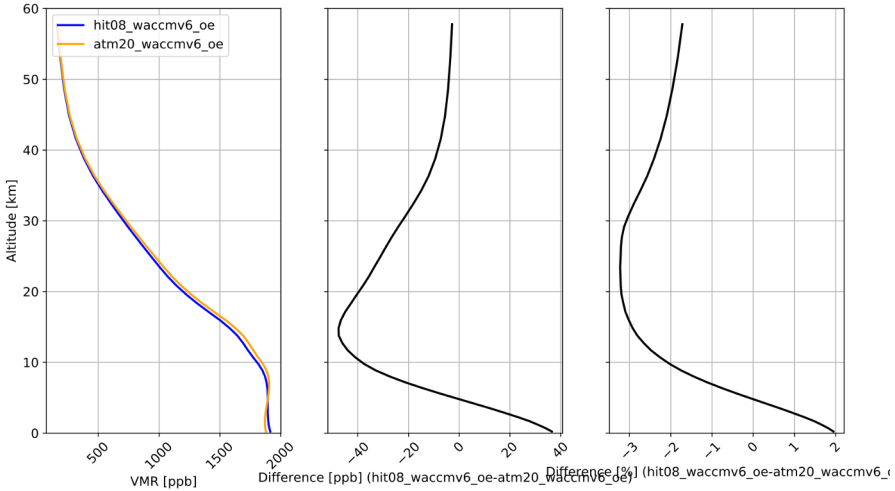
ATM20 shows significantly better RMS (40%) and DOF (6%)

Profiles

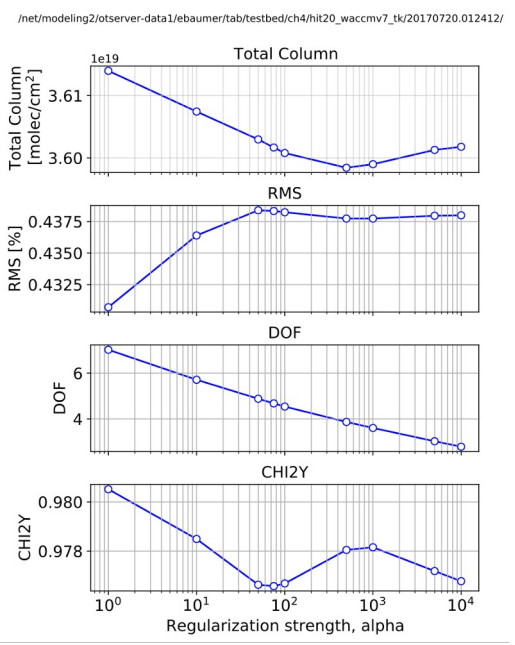
HIT08 vs HIT 20 (OE & WACCM V6)

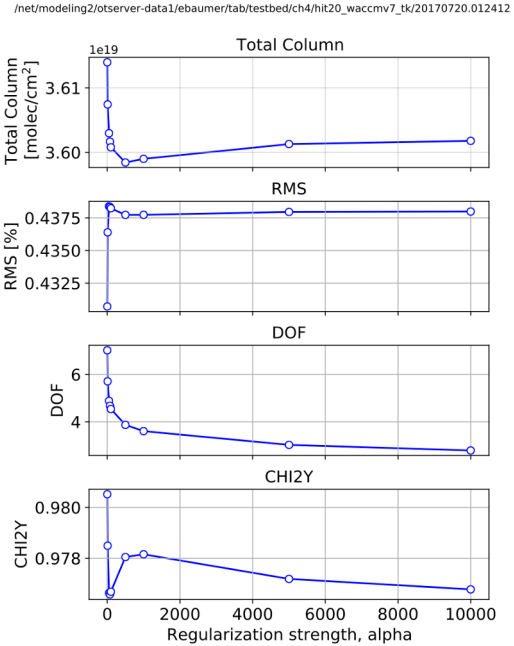


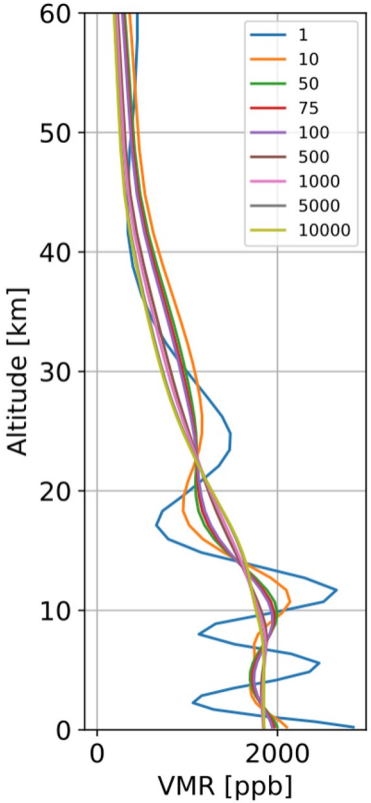
HIT08 vs ATM20 (OE & WACCM V6)



Tik Optimization





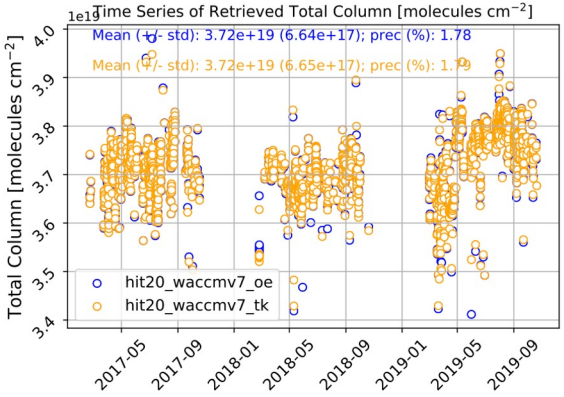


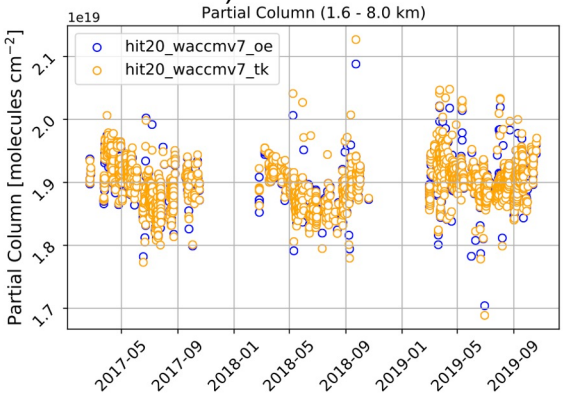
OE
RMS: 0.4377
DOF: 1.978
CI_2_Y: 0.977
TC:3.6006E19

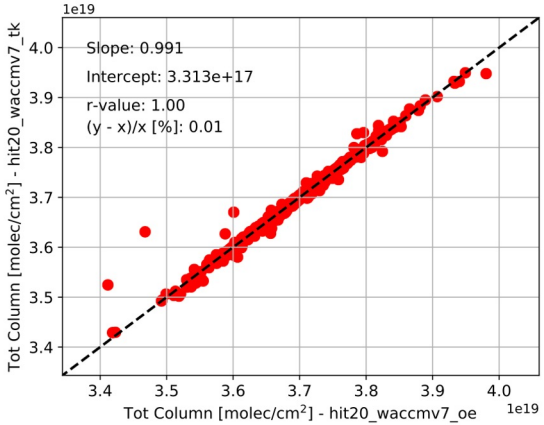
With an alpha of 50000 we get about 2.2 DOF for the same retrieval test case.

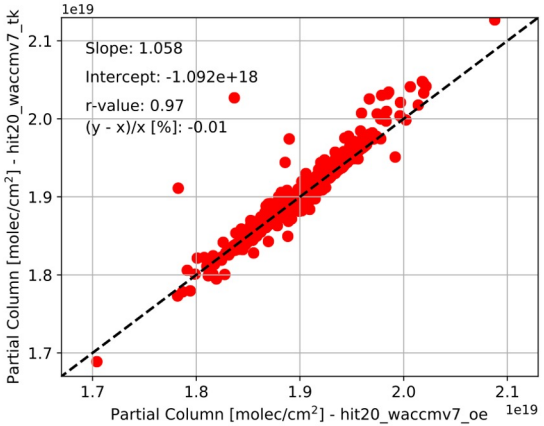
Time Series: total/partial Columns

OE vs TK (HIT20 WACCM V7)



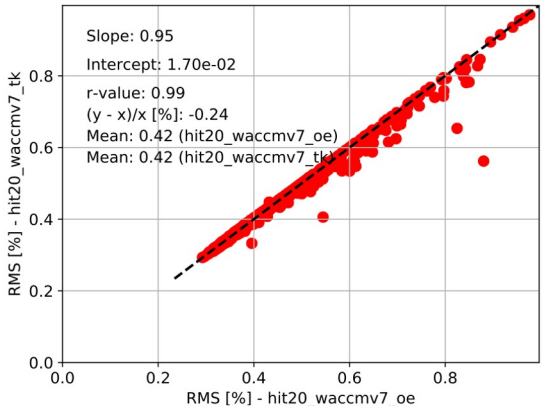


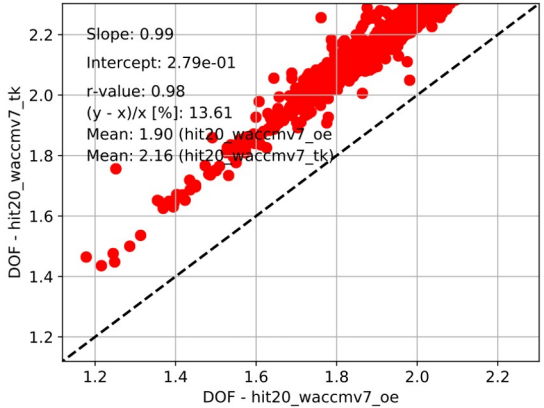




Not significant differences in total/partial columns (0.01%)

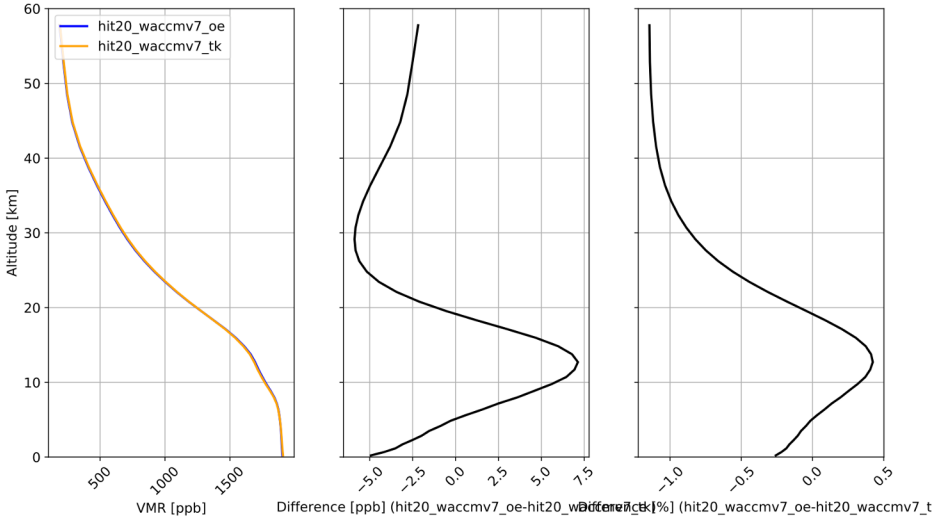
RMS/DOF and profiles





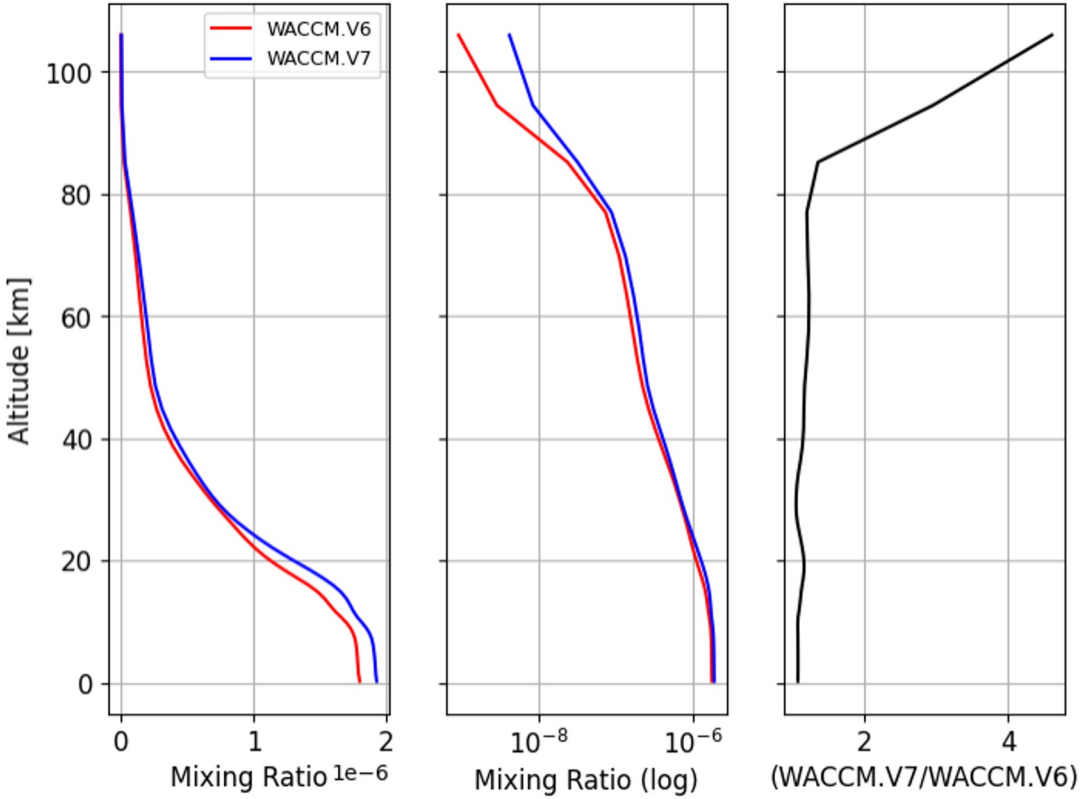
Slightly better RMS with Tik. Due to reg strength Tik shows better DOF

Similar profiles



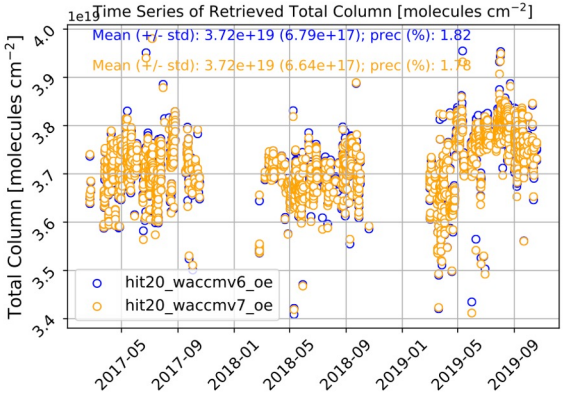
Tik and OE show similar results

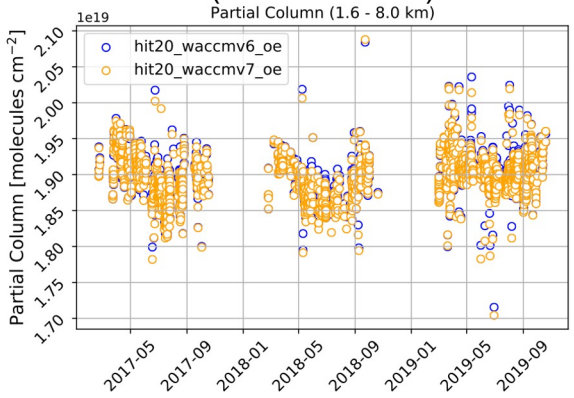
Apriori Profiles

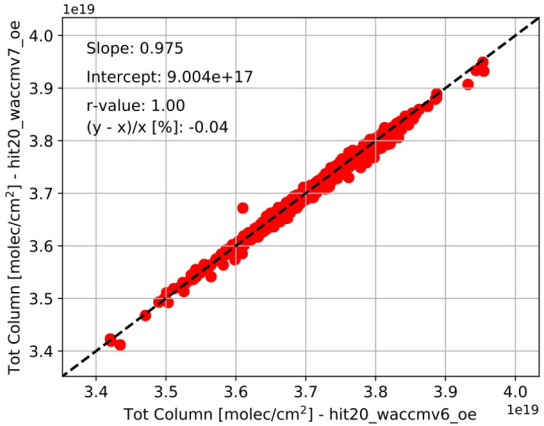


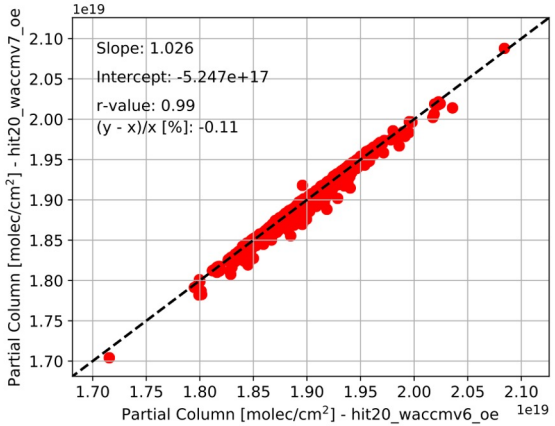
Time Series: total/partial Columns

WACCM v6 vs WACCM v 7 (HIT20 and OE)



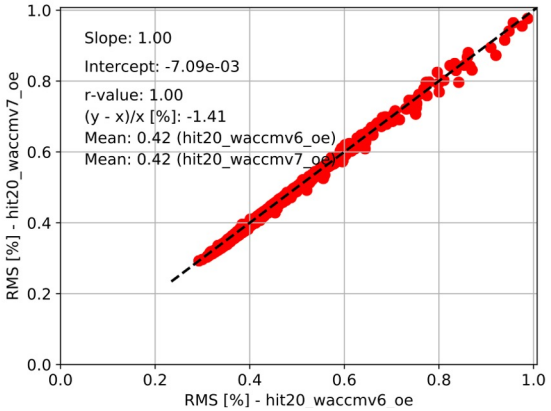


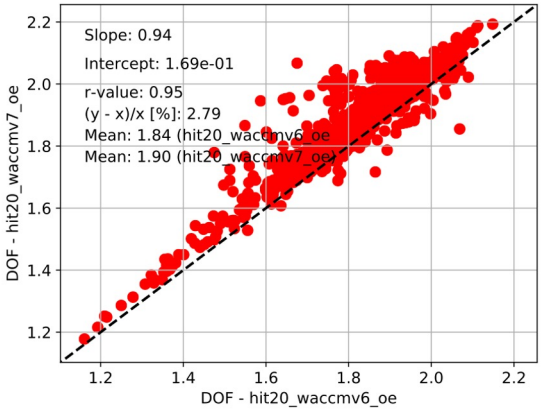




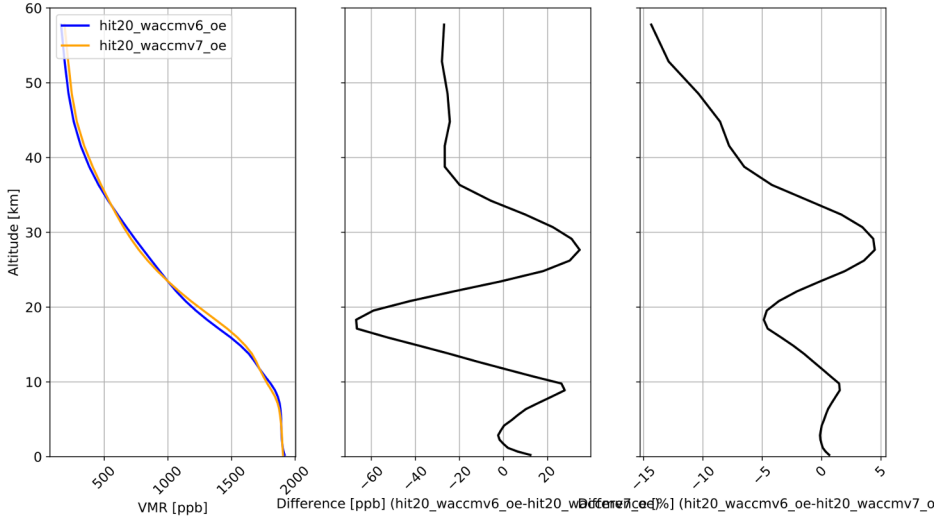
Differences in total columns of -0.04% and -0.11% partial columns

RMS/DOF and profiles





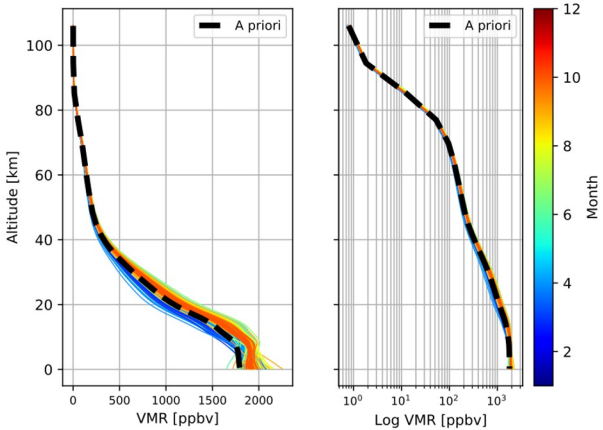
Slightly better RMS/DOF with WACCM V7.



Profiles

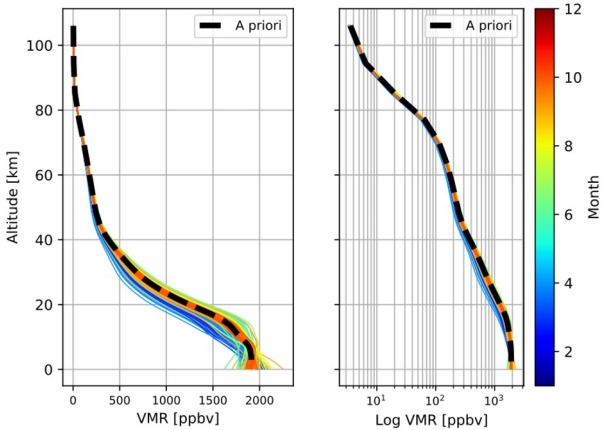
HIT20_WACCMv6_OE

CH4



HIT20_WACCMv7_OE

CH4



HIT20_WACCMv7_TK

CH4