

***SFP*² : Evaluation of Allsky Single Footprint retrievals using Artificial Intelligence methods and Optimal Estimation methods**

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Outline and Motivation

- Compare boundary layer parameters from single footprint (SFP) retrievals versus L2 cloud cleared retrievals
- We are focusing primarily on boundary layer height
- SFP^{AI} Eric has developed a very fast Artificial Intelligence Single Footprint Retrieval (last 3 years or so)
- SFP^{OEM} Sergio has been upgrading his Optimal Estimation Single Footprint Retrieval
- Ruben estimates boundary layer height (PBLH) based on using wavelets to study transitions of profiles ($T(z)$, $WV(z)$, $lidar\ backscatter(z)$) near the surface

SFP^{AI} : AI retrievals

- Trained using GFS
- Can do ATMS only, CrIS only, Combined ATMS/CrIS
- Retrieves and output thermodynamic info (SKT, $T(z)$, $WV(z)$) and cloud parameters (ice/water cloud height, optical depth)

SFP^{OEM} : Physical Retrieval

- Initialized using NWP thermodynamics and “best cloud swap”
- **Can now read in Eric’s retrieved parameters; hence SFP^2**
- Have developed SARTA-Cloudy Analytic Jacobian recently
- Typically use all 97 layers or so for retrievals
- Takes less than about 1.5seconds per retrieval (faster if initialized by Eric’s clouds)
- Retrieves and output thermodynamic info (SKT, $T(z)$, $WV(z)$) and cloud parameters (ice/water cloud height, optical depth)
- Plan to do error analysis characterization (AI vs OEM)
- Same code is used for AIRS, CrIS, IASI (channel information, NeDT etc is updated)

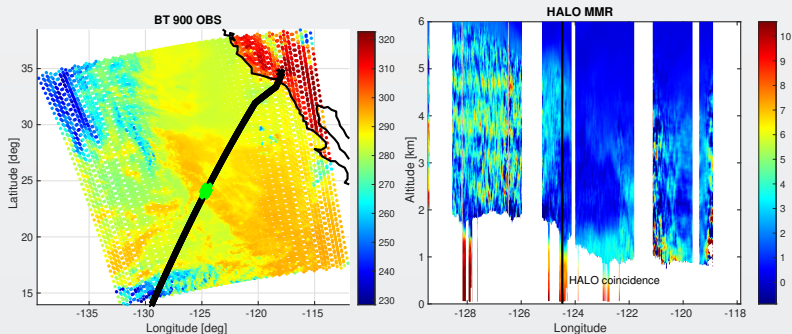
Some results of *SFP*²

Have run off a granule for 2019/04/15 and 2022/09/03; have the following datasets for JPSS CrIS

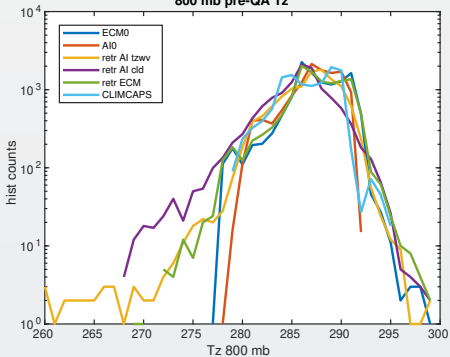
- ECM initialization
 - retrieval from ECM first guess (with cloud swap)
- AI CrIS only retrieval
 - retrieval from ECM cloud swap, AI thermodynamics
 - retrieval from AI cloud (no cloud swap), ECMWF thermodynamics
- CLIMCAPS

QA filter : profile discarded if ST,T(800 mb) or WV(800 mb) is more than 2σ away from mean/stddev ST,T(800 mb),WV(800 mb) of ECMWF
NASA Langley High Altitude Lidar Observatory (HALO)

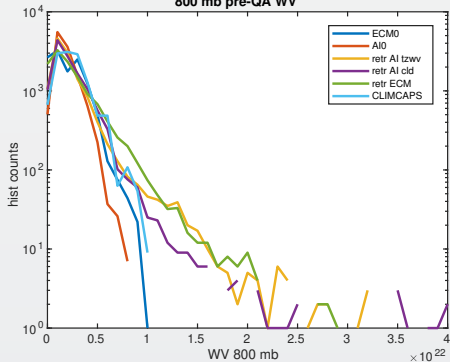
Worked with d/dz (and d/dp !!!) RH, WVgg, Tvirtual, T
Code finds max (or min) derivative closes to ground
Black is HALO track, green is JPSS/HALO coincidence



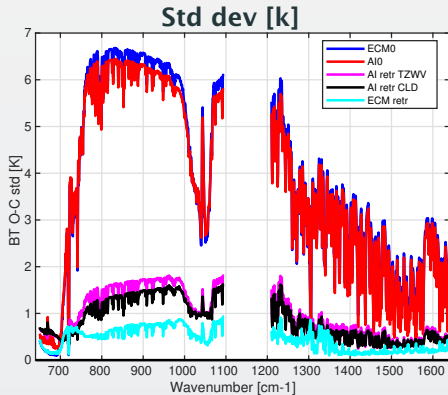
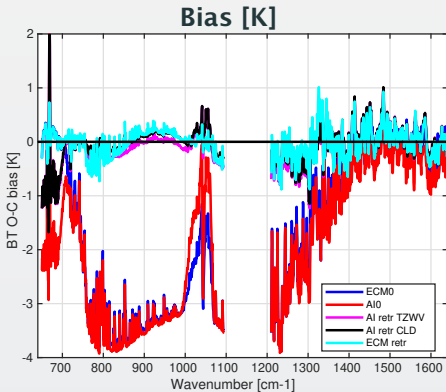
T(800 mb) 800 mb pre-QA Tz



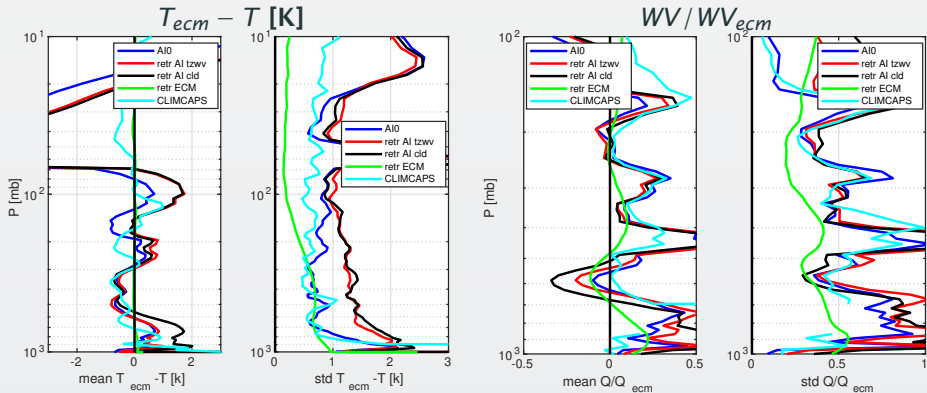
WV(800 mb) 800 mb pre-QA WV



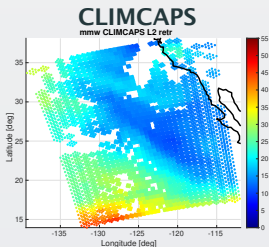
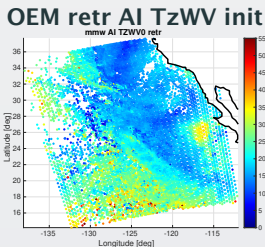
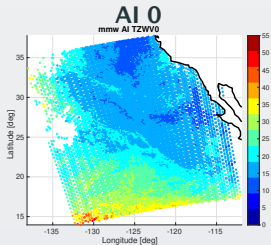
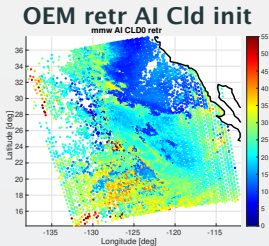
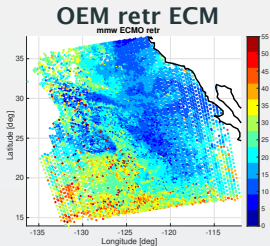
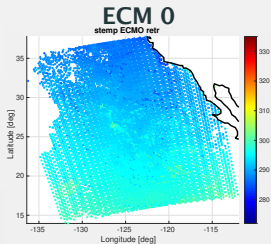
QC : 2019/04/25 BT bias and std dev



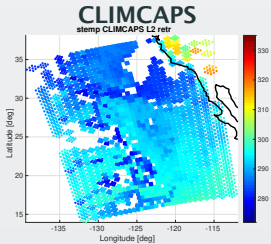
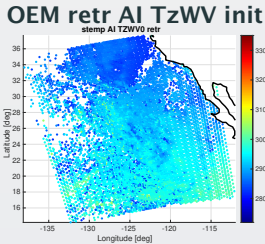
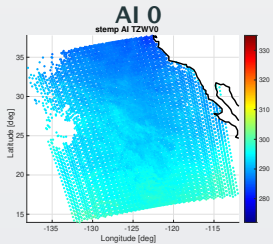
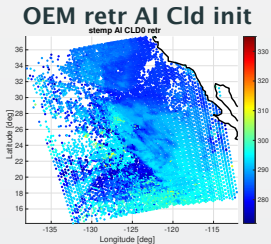
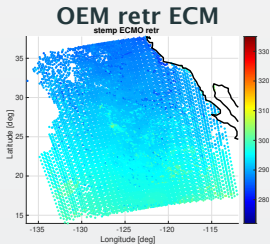
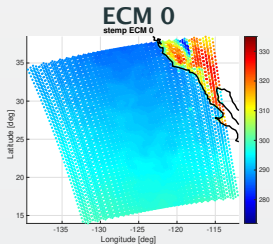
QC : 2019/04/25 T(z) and WV(z)



2019/04/25 g214 : Column Water(mm)



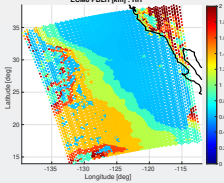
2019/04/25 g214 : Surf Temp [K]



2019/04/25 g214 : Comparing PBLH [km] for ECM and AI

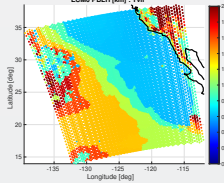
d/dz RH

ECM0 PBLH [km] : RH



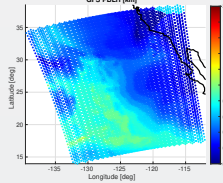
d/dz Tpotential

ECM0 PBLH [km] : Tvir

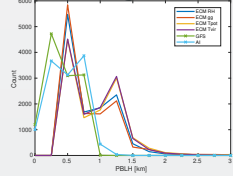


GFS

GFS PBLH [km]

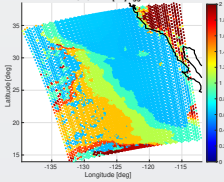


Histogram



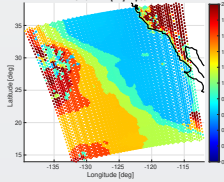
d/dz g/g

ECM0 PBLH [km] : g/g



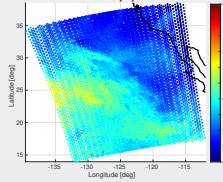
d/dz Tvirtual

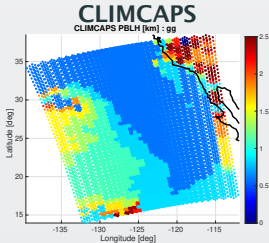
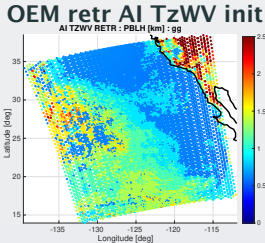
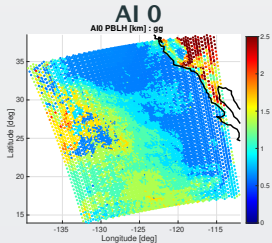
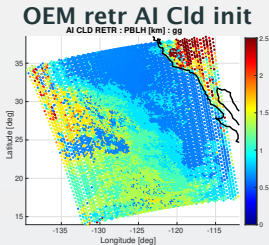
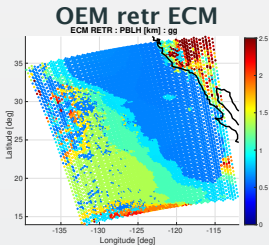
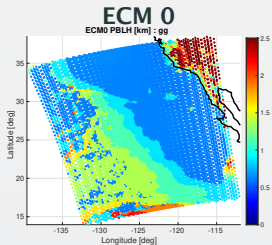
ECM0 PBLH [km] : Tpot



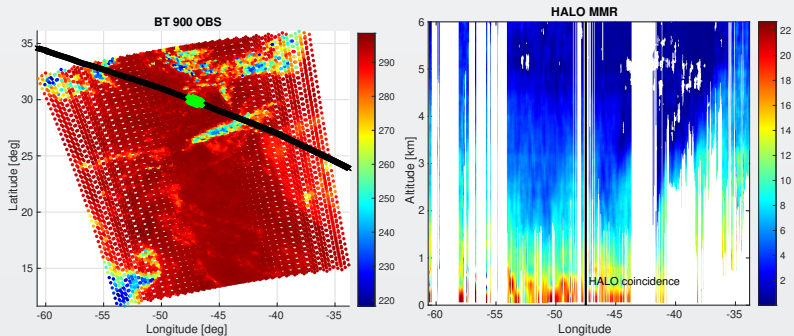
AI 0

AI PBLH [km]



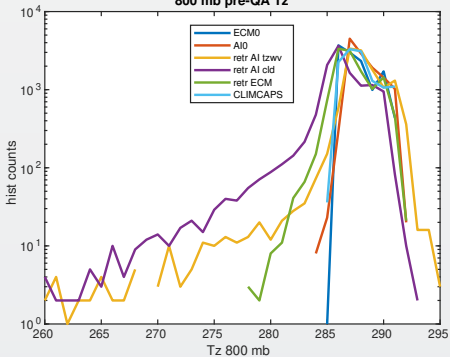


Worked with d/dz (and d/dp !!!) RH, WVgg, Tvirtual, T
Code finds max (or min) derivative closes to ground
Black is HALO track, green is JPSS/HALO coincidence



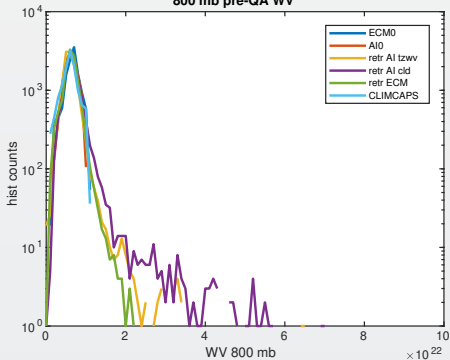
T(800 mb)

800 mb pre-QA Tz

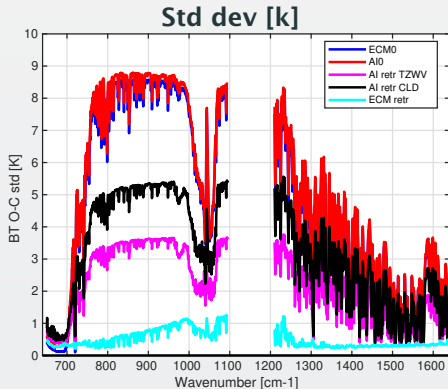
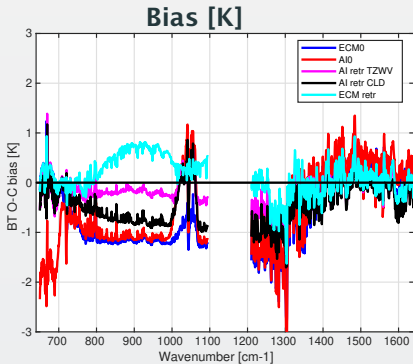


WV(800 mb)

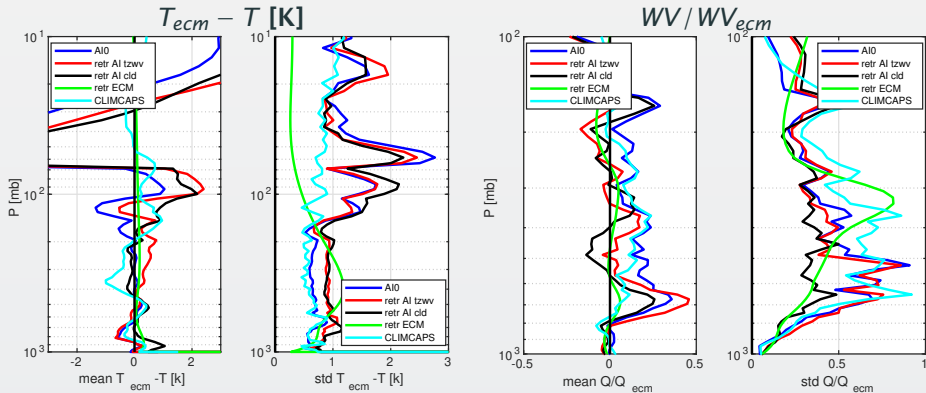
800 mb pre-QA WV



QC : 2022/09/03 BT bias and std dev



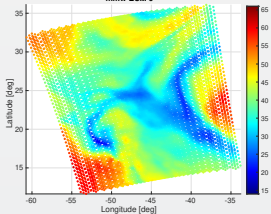
QC : 2022/09/03 T(z) and WV(z)



2022/09/03 g162 : Column Water(mm)

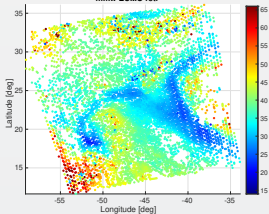
ECM 0

mmw ECM 0



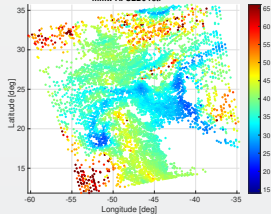
OEM retr ECM

mmw ECMO retr



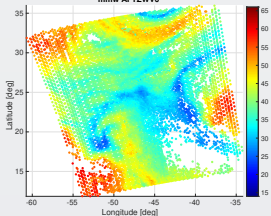
OEM retr AI Cld init

mmw AI CLD0 retr



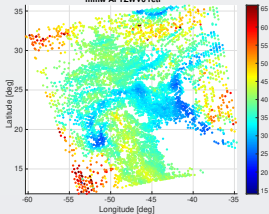
AI 0

mmw AI TZWV0



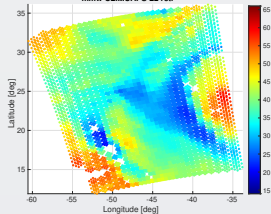
OEM retr AI TzWV init

mmw AI TZWV0 retr



CLIMCAPS

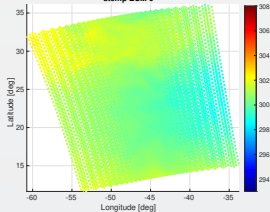
mmw CLIMCAPS L2 retr



2022/09/03 g162 : Surf Temp [K]

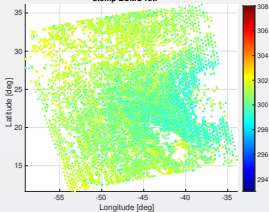
ECM 0

stemp ECM 0



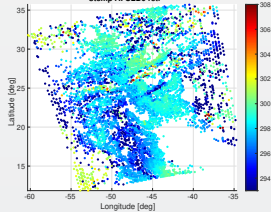
OEM retr ECM

stemp ECM0 retr



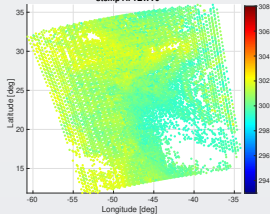
OEM retr AI Cld init

stemp AI CLD0 retr



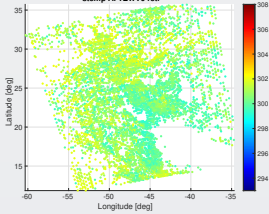
AI 0

stemp AI TZW0



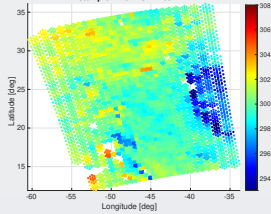
OEM retr AI TzWV init

stemp AI TZW0 retr

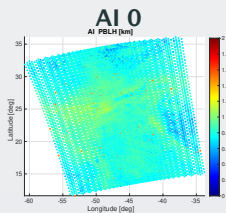
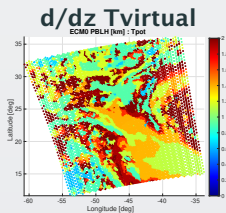
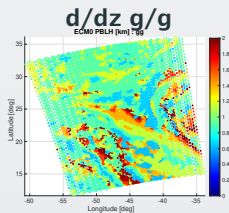
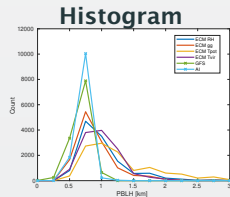
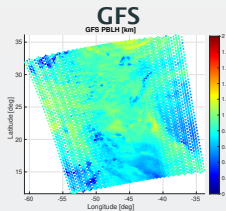
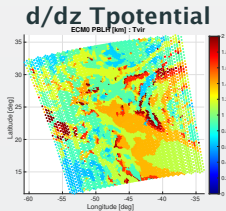
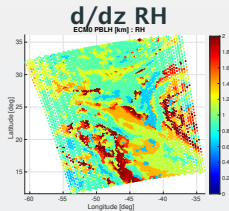


CLIMCAPS

stemp CLIMCAPS L2 retr

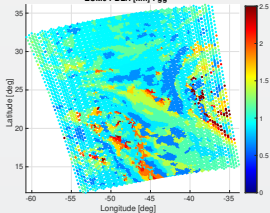


2022/09/03 g162 : Comparing PBLH [km] for ECM and AI



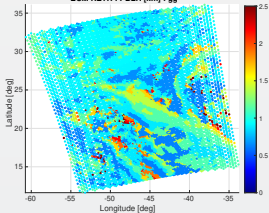
ECM 0

ECM0 PBLH [km] : gg



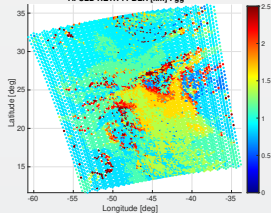
OEM retr ECM

OEM RETR : PBLH [km] : gg



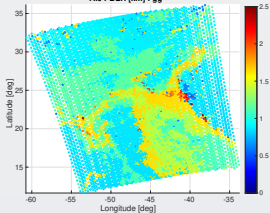
OEM retr AI ClD init

AI CLD RETR : PBLH [km] : gg



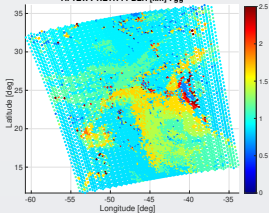
AI 0

AI0 PBLH [km] : gg



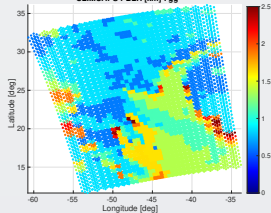
OEM retr AI TzWV init

AI TZWV RETR : PBLH [km] : gg



CLIMCAPS

CLIMCAPS PBLH [km] : gg



Conclusions

- AI based CrIS or ATMS or CrIS/ATMS code is working
 - Looked at CrIS only result, over ocean
 - Eric will work on improving cloud retrievals
 - *Also provides PBLH*
- Can ingest the profiles into UMBC-OEM
 - Can parse out what to read (clouds or thermodynamic profiles, or both)
- Use SARTA 100 layer allsky analytic jacobians : sequential or simultaneous granule retrieval in 3-5 hours (1-2 seconds per FOV)
- OEM code *also provides PBLH* after tweaking dY/dz code
- Will work on more testing of the code (covariance matrices etc)
- And on validations ...

Thanks to NASA-Langley HALO scientists!