Assimilation of Reconstructed Radiances from IASI and CrIS Principal Component Scores into the GEOS-ADAS

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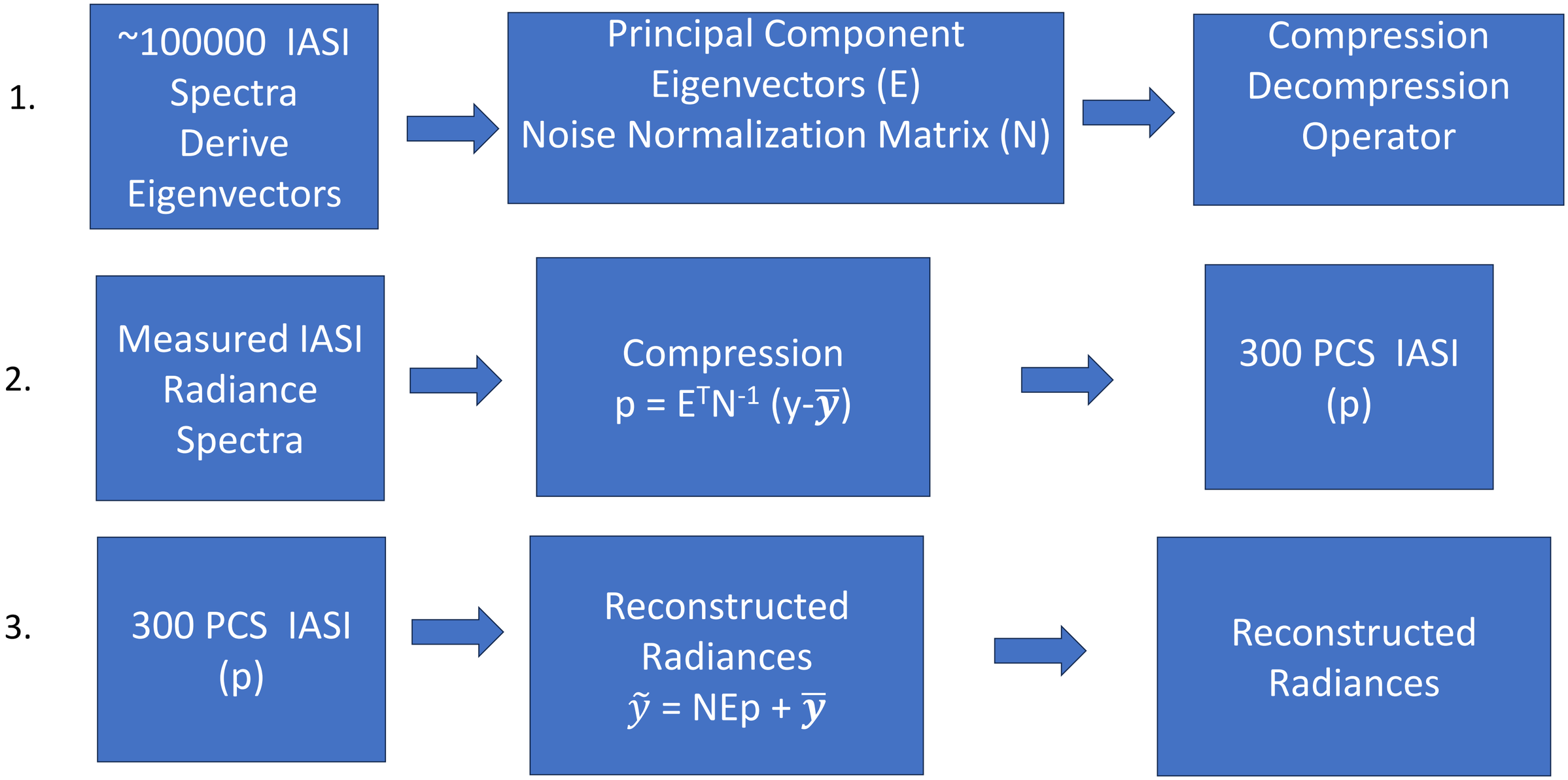
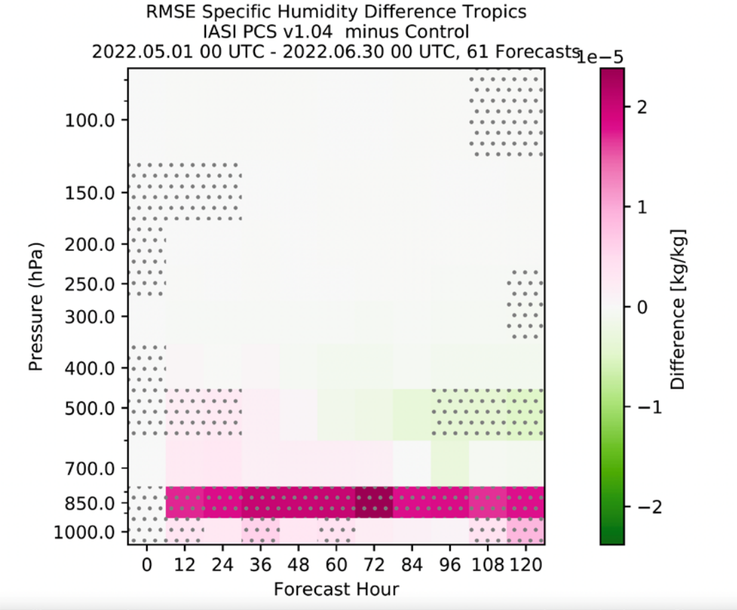
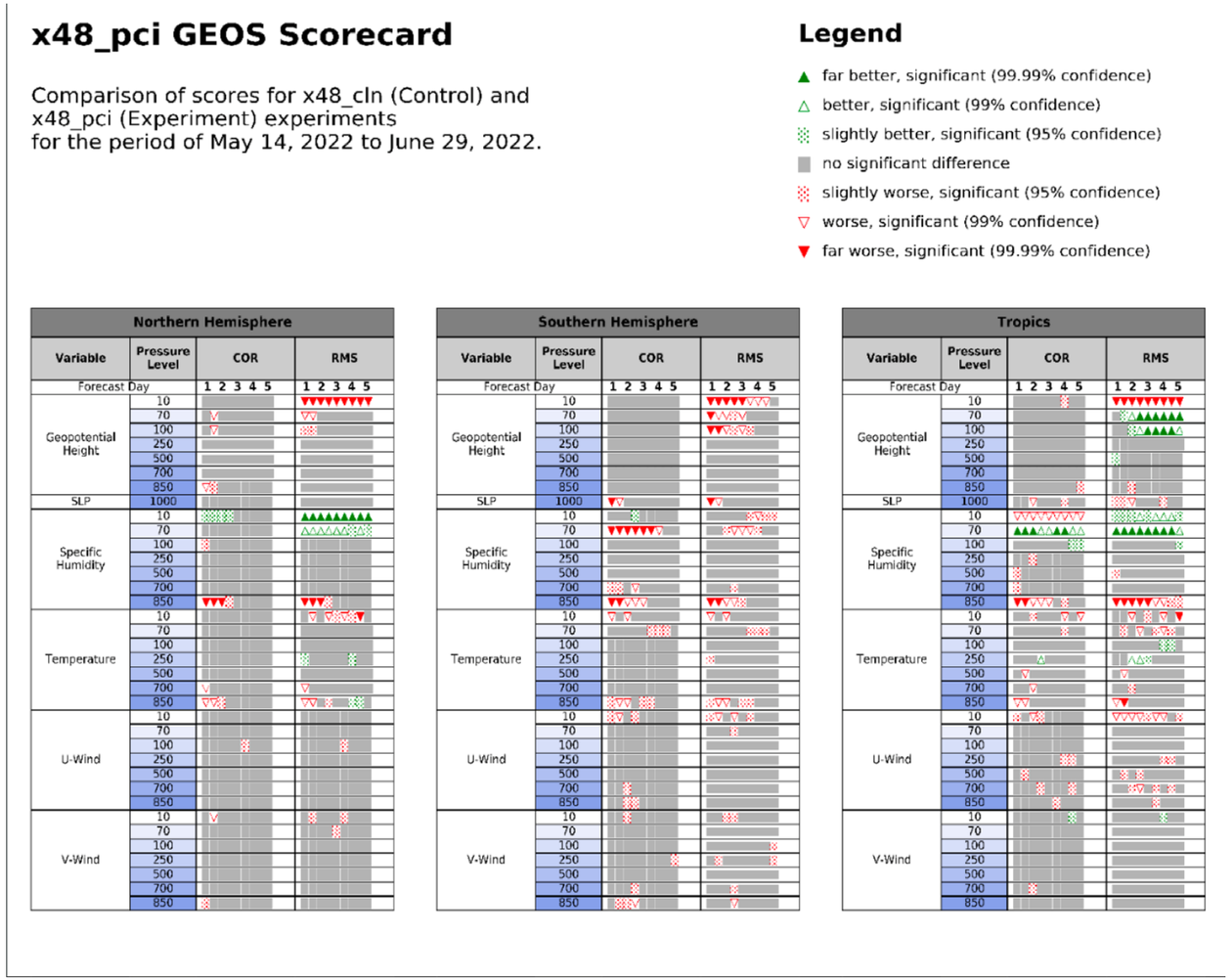

1.
~100000 IASI Spectra Derive Eigenvectors
Principal Component Eigenvectors (E) Noise Normalization Matrix (N)
Compression Decompression Operator
2.
Measured IASI Radiance Spectra
Compression
$p = E^T N^{-1} (y-\bar{y})$
300 PCS IASI (p)
3.
300 PCS IASI (p)
Reconstructed Radiances
$\tilde{y} = NEp + \bar{y}$
Reconstructed Radiances

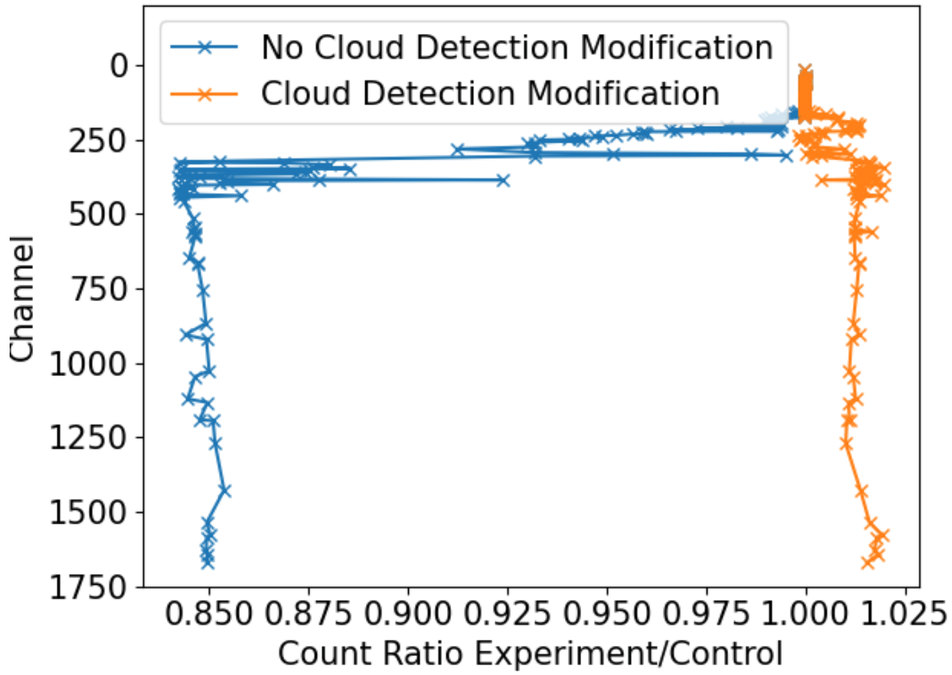
- Work by Cristina Lupu at ECMWF showed they saw no ill effects when the switched to using
- One key piece of their investigation which is not fully optimized → how to estimate correlated Error from a system which only has reconstructed radiances available
- When replacing the operational diagnosed observation error with that derived from reconstructed radiances, degraded performance was the result
- What seemed to work best was adding back the error variance which is removed in the PC scores
- This error variance can be derived using data from the data provider (not diagnosing with DA/original radiances)

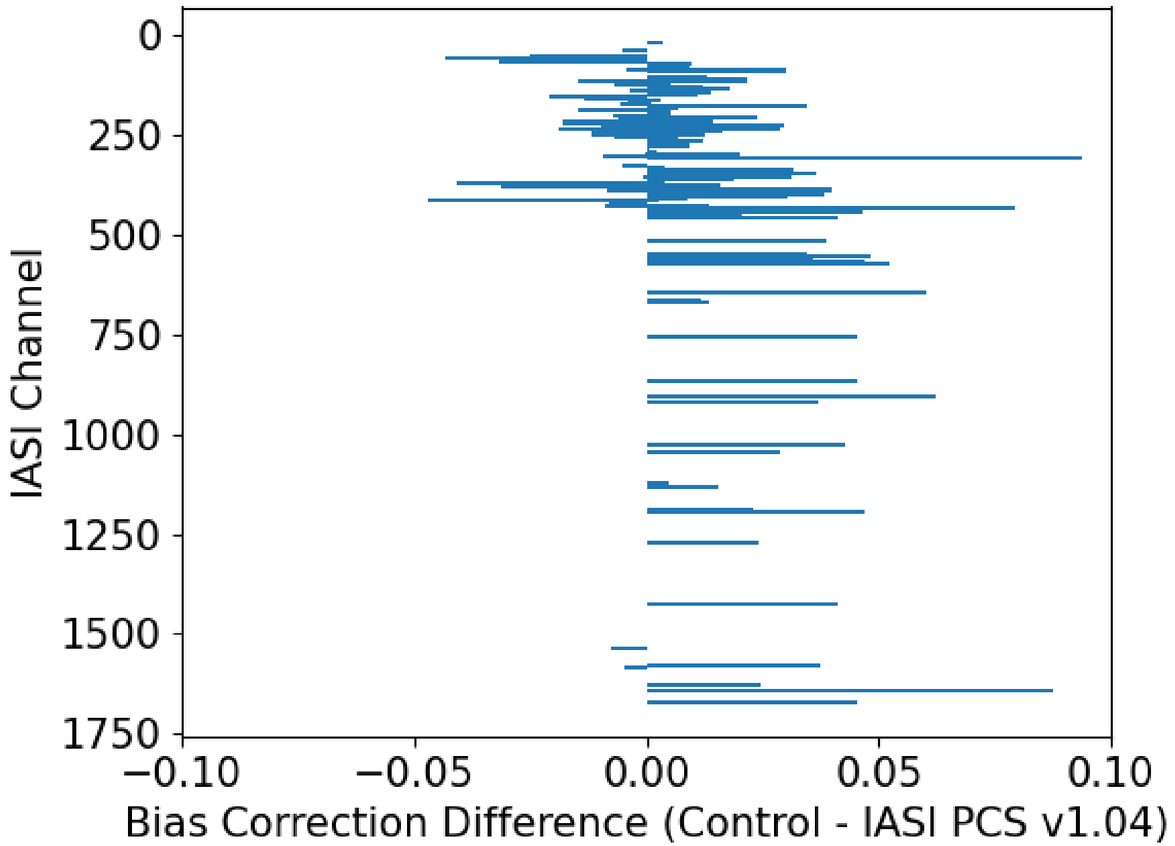
- Make no modifications to the DAS, only difference is replacing the data source to use reconstructed radiances
- Generally Neutral Impact except for 850 hPa
- Why?
  - Bias correction?
  - Cloud Detection?
  - Combination of both.



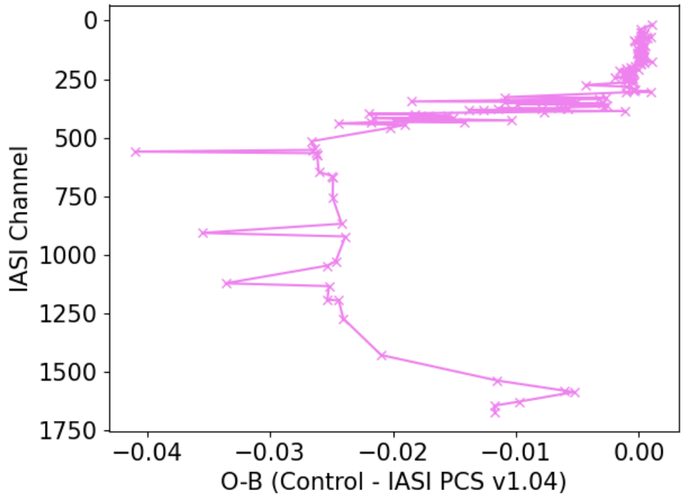


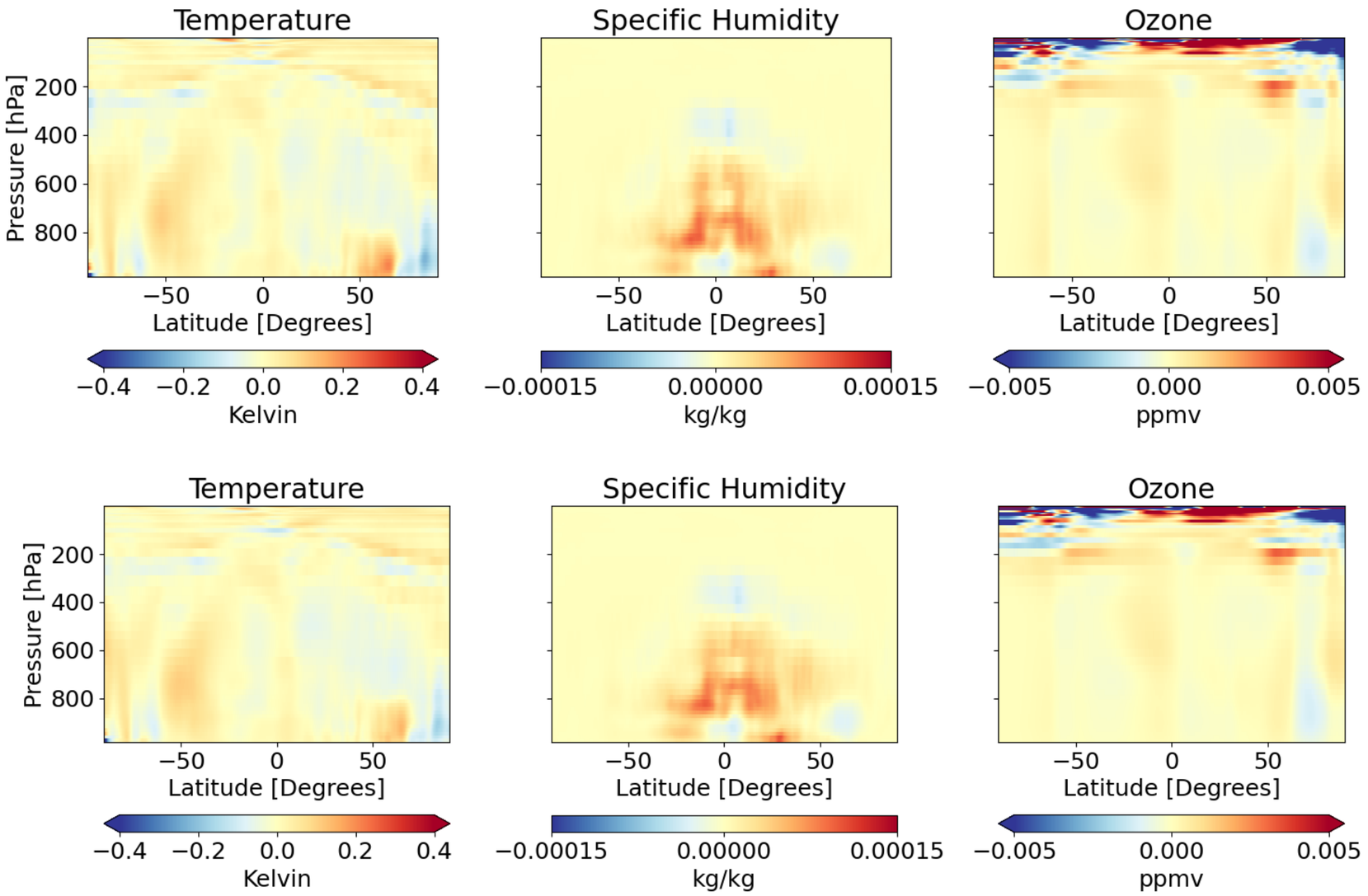
- GSI minimum residual method relies on normalization of by the expected “noise”
- PC compression effectively “drops” noise making it less noisy
- Using the original noise estimate results in cutting off cold end of distribution on surface channels, causing the bias to shift positive, results in a feedback
- Similar phenomenon occurred with CrIS → surface channel drift





- The over enthusiastic cloud detection causes the bias correction to shift the distributions positive for more surface sensitive channels
- Possibly what is causing the undesirable features at 850 hPa forecast error (indirectly)
- Also average OMB difference for surface sensitive channels




Temperature
Specific Humidity
Ozone
Pressure [hPa]
200
400
600
800
−50
0
50
Latitude [Degrees]
−0.4
−0.2
0.0
0.2
0.4
Kelvin
−0.00015
0.00000
0.00015
kg/kg
−0.005
0.000
0.005
ppmv
Temperature
Specific Humidity
Ozone
Pressure [hPa]
200
400
600
800
−50
0
50
Latitude [Degrees]
−0.4
−0.2
0.0
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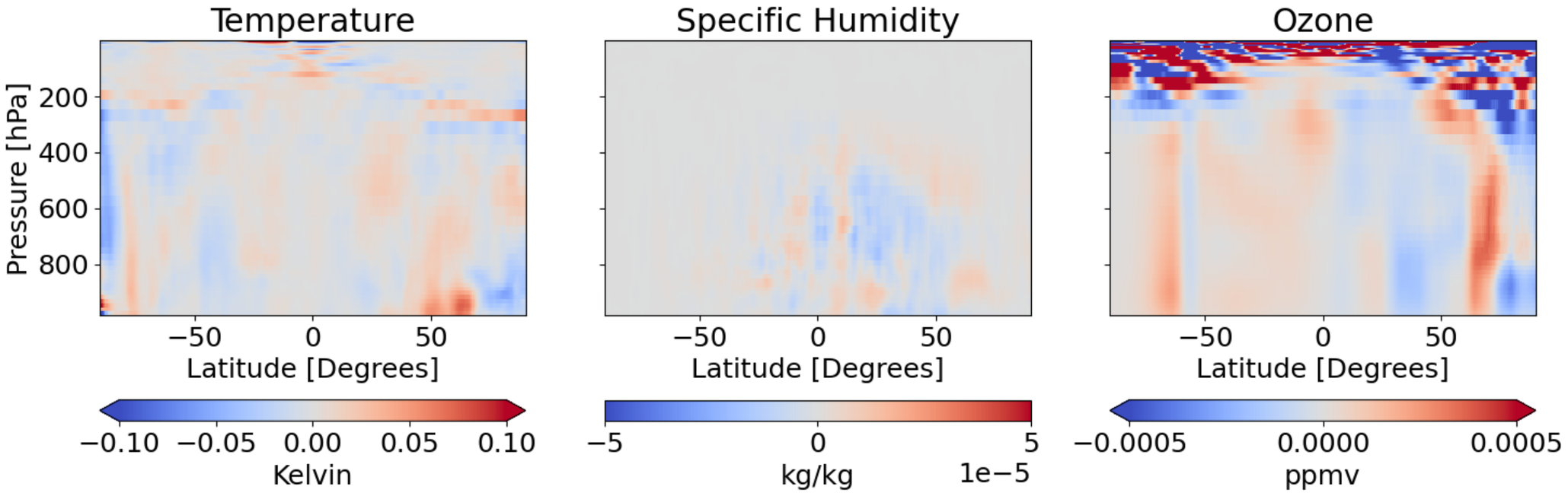
0.4
Kelvin
−0.00015
0.00000
0.00015
kg/kg
−0.005
0.000
0.005
ppmv


Temperature
Specific Humidity
Ozone
Pressure [hPa]
200
400
600
800
−50
0
50
Latitude [Degrees]
−0.10
−0.05
0.00
0.05
0.10
Kelvin
−5
0
5
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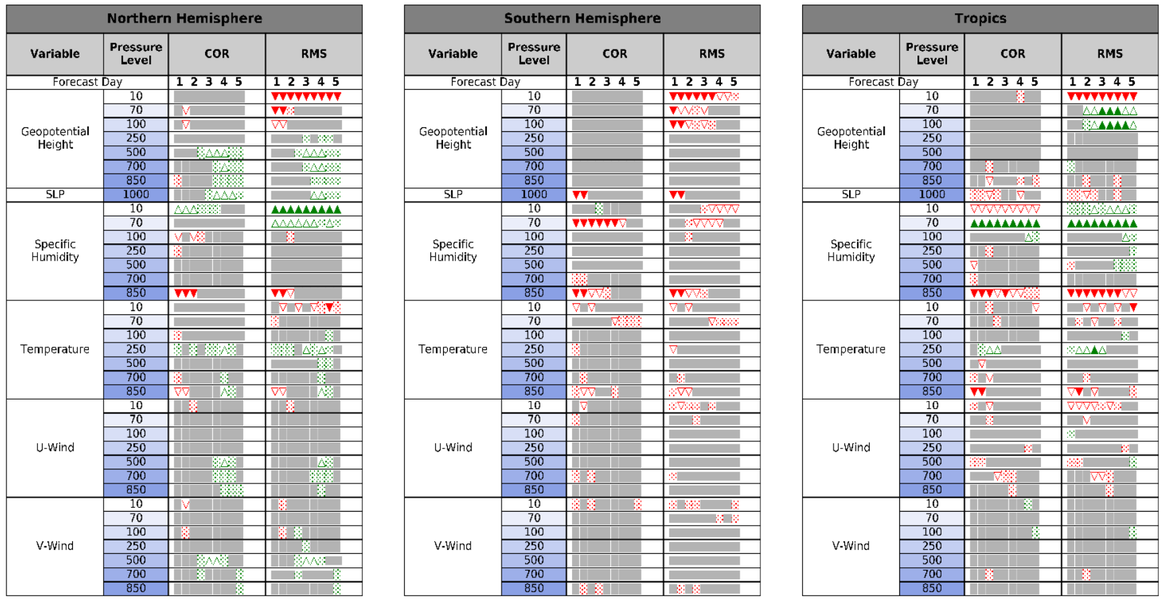
kg/kg
−0.0005
0.0000
0.0005
ppmv

x48_pci GEOS Scorecard

Comparison of scores for x48_cIn (Control) and
x48_pci (Experiment) experiments
for the period of May 1, 2022 to June 30, 2022.

Legend

- ▲ far better, significant (99.99% confidence)
- △ better, significant (99% confidence)
- ⁘ slightly better, significant (95% confidence)
- ▩ no significant difference
- ⁘ slightly worse, significant (95% confidence)
- ▽ worse, significant (99% confidence)
- ▼ far worse, significant (99.99% confidence)

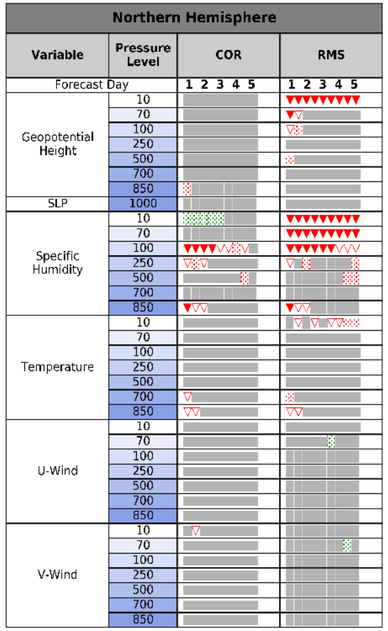


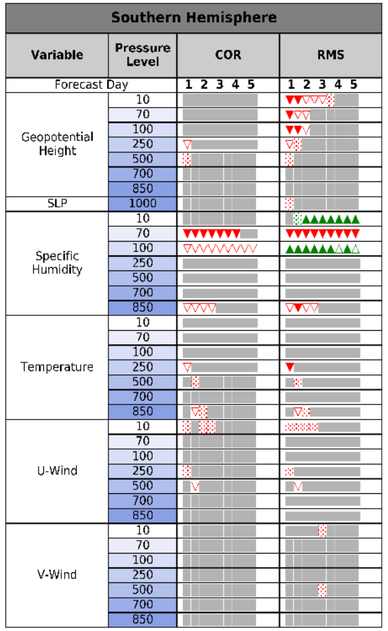
x48_pci2 GEOS Scorecard

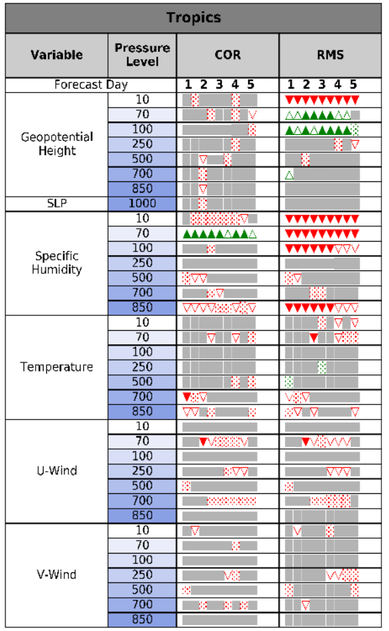
Comparison of scores for x48_cIn (Control) and
x48_pci2 (Experiment) experiments
for the period of May 1, 2022 to June 30, 2022.

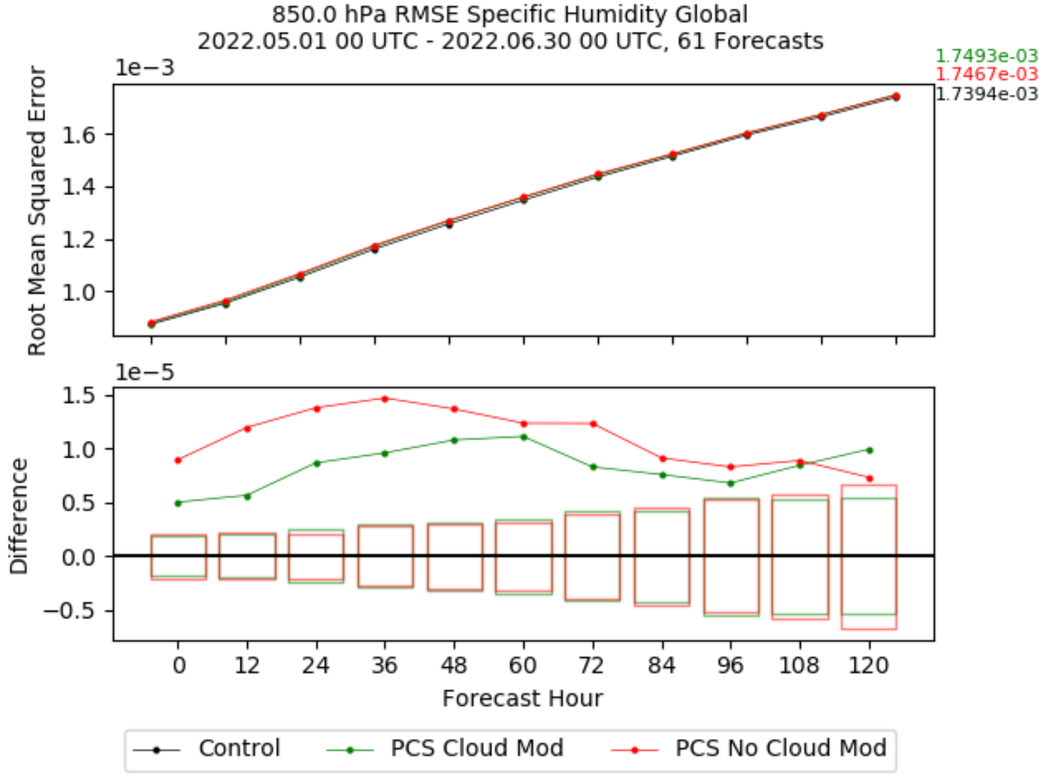
Legend

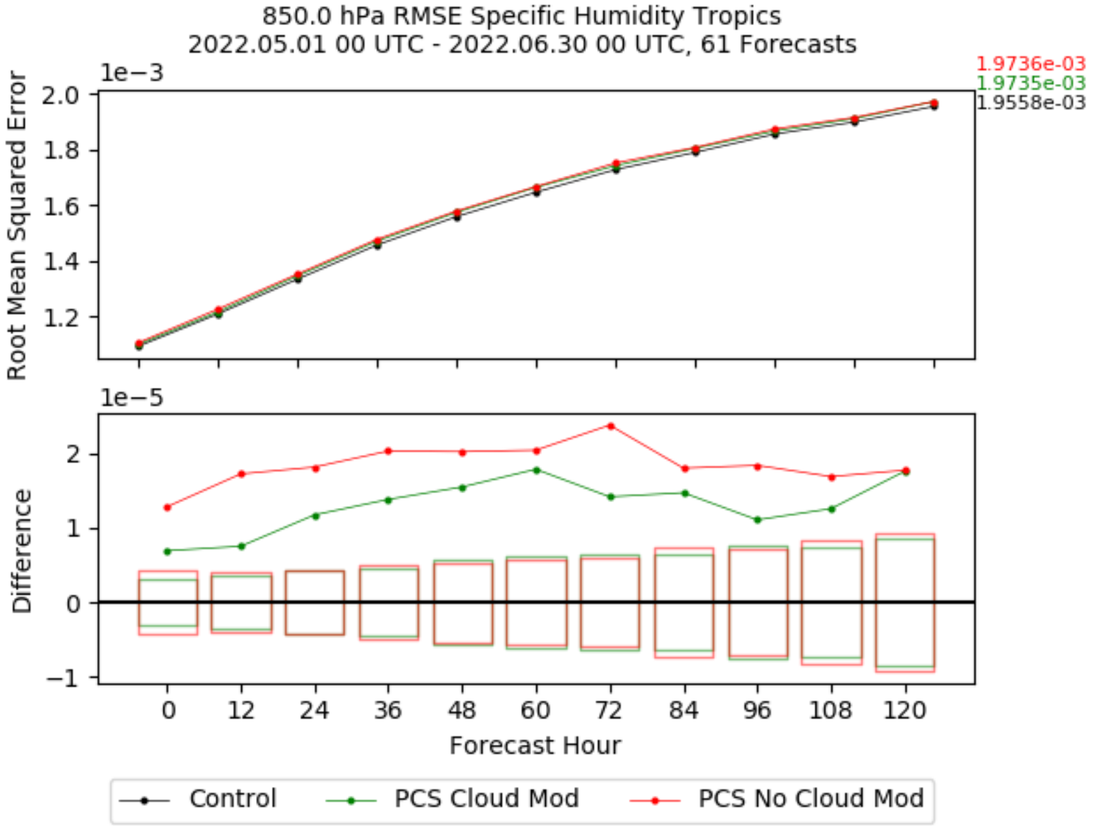
- ▲ far better, significant (99.99% confidence)
- △ better, significant (99% confidence)
- ⁘ slightly better, significant (95% confidence)
- ▩ no significant difference
- ⁘ slightly worse, significant (95% confidence)
- ▽ worse, significant (99% confidence)
- ▼ far worse, significant (99.99% confidence)











- Not spectacular, but some progress reducing 850 hPa Q RMSE
- Possibly creating small problems at 750 hPa T
- **There is a known problem with this version of the DAS related to all-sky assimilation bias correction**

- In preparing for MTG-IRS, it will have a spectral resolution of 0.625 cm^{-1} same as CrIS
- University of Wisconsin SSEC have released a CrIS PC Rapid Event Detection PC score product
- Similar story, but making progress with reducing 850 hPa Q error hasn't been as effective
- Able to get counts back up with modifying QC, but 850 hPa Q remains about the same

x48_cred GEOS Scorecard

Comparison of scores for x48_cIn (Control) and x48_cred (Experiment) experiments
for the period of May 1, 2022 to June 30, 2022.

Legend

- ▲ far better, significant (99.99% confidence)
- △ better, significant (99% confidence)
- ⁘ slightly better, significant (95% confidence)
- ■ no significant difference
- ⁘ slightly worse, significant (95% confidence)
- ▽ worse, significant (99% confidence)
- ▼ far worse, significant (99.99% confidence)

Northern Hemisphere

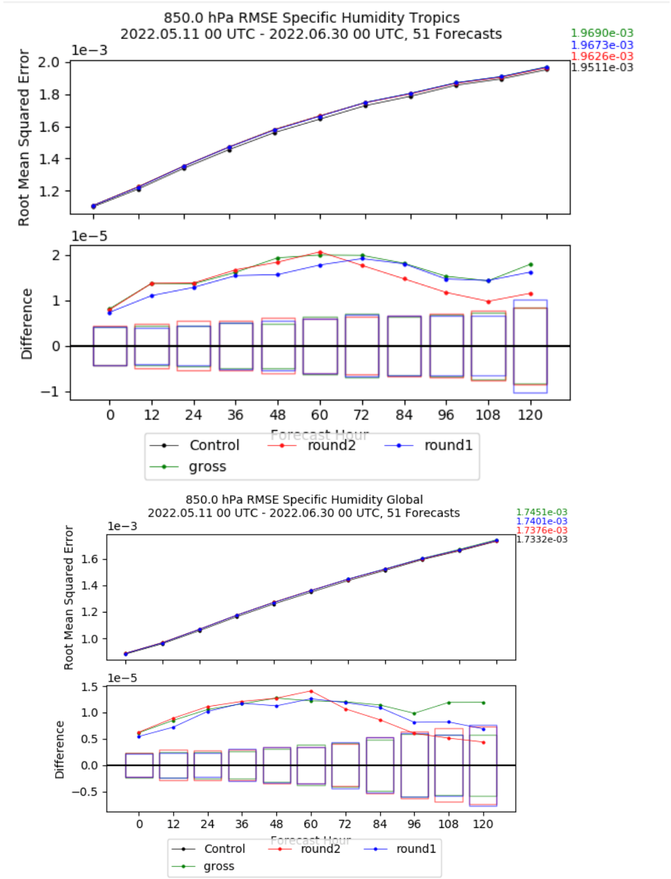
Variable	Pressure Level	COR	RMS
Forecast Day		1 2 3 4 5	1 2 3 4 5
Geopotential Height	10		▼▼▼▼▼▼▼
	70		▽▼
	100		▽
	250		
	500		
	700		
	850		
SLP	1000	⁘	
Specific Humidity	10		▼▼▼▼▼▽▽
	70	⁘△△△△△△	▼▼▼▼▼▼▼
	100	⁘⁘	▽▽⁘⁘
	250		
	500		
	700		
	850	▼▼▽⁘	▼▽▽⁘
Temperature	10		▽▽
	70		
	100		
	250	⁘	△⁘
	500		
	700		
	850	⁘	▽⁘
U-Wind	10		
	70		
	100		
	250		
	500		
	700		
	850		
V-Wind	10	▽⁘	▽
	70		
	100		
	250		⁘
	500		
	700		
	850		

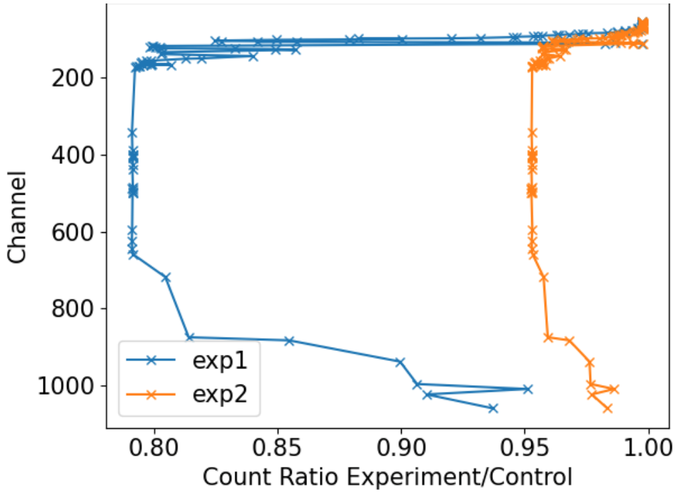
Southern Hemisphere

Variable	Pressure Level	COR	RMS
Forecast Day		1 2 3 4 5	1 2 3 4 5
Geopotential Height	10		▽▽▽▽▽⁘
	70		▼▼▼
	100		▼▼▽
	250	▽	▼⁘
	500		⁘
	700		
	850		
SLP	1000	⁘	⁘
Specific Humidity	10	⁘	△△△△△△
	70		△△△△△△
	100		▲▲▲▲▲▲▲
	250		
	500		
	700		
	850	▼▼⁘	▼▼▽⁘
Temperature	10		▽▽
	70	⁘	▽
	100		
	250		
	500		
	700		
	850	⁘▽	⁘▽
U-Wind	10		
	70		
	100		
	250		
	500	⁘	⁘
	700		
	850		
V-Wind	10		
	70		
	100		
	250	▽	▽
	500		
	700		
	850		

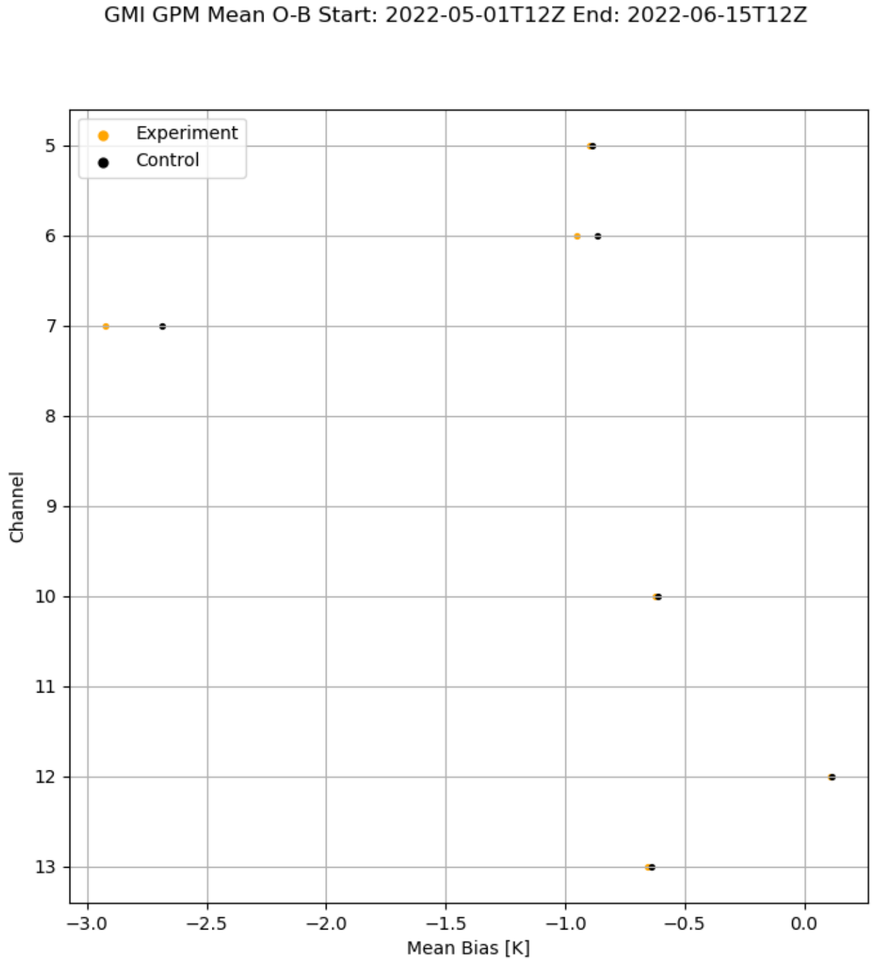
Tropics

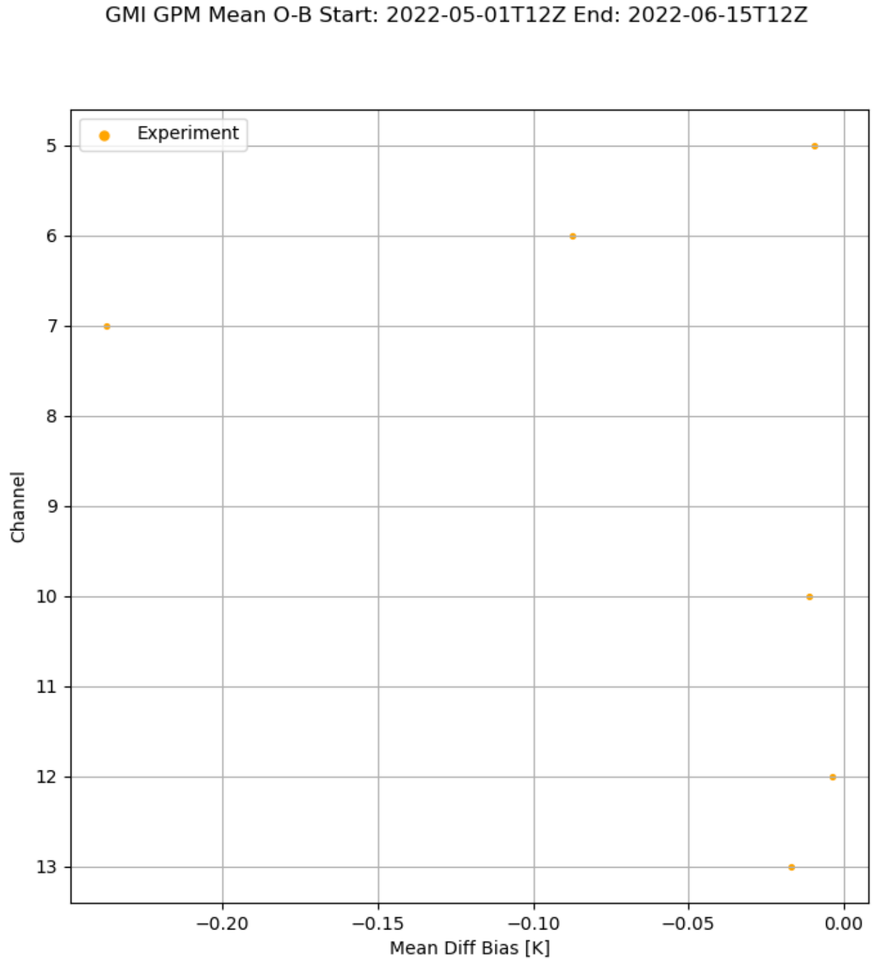
Variable	Pressure Level	COR	RMS
Forecast Day		1 2 3 4 5	1 2 3 4 5
Geopotential Height	10	⁘	▼▼▼▼▼▼▼
	70		△△▲▲▲▲▲
	100		△△▲▲▲▲▲
	250		
	500		
	700		
	850		
SLP	1000	⁘	⁘
Specific Humidity	10		▼▼▼▼▼▼▼
	70		▼▼▼▼▼▽▽
	100		▼▽▽▽▽
	250		
	500	⁘	⁘⁘
	700	⁘	
	850	▽▽▽▽▽▽▽	▼▼▼▼▼▼▼
Temperature	10		▽▽▽⁘
	70		⁘
	100		
	250		△⁘
	500	⁘	⁘△
	700		▼▽
	850	▼	▼▽⁘⁘
U-Wind	10	⁘	▽▽▽▽
	70		
	100		
	250	⁘	
	500	⁘	⁘
	700		
	850		
V-Wind	10		
	70		
	100		
	250		
	500	⁘	▽
	700		
	850		





- A hint there might be something afoot comparing the Bias Correction applied to GMI
- Experiments up to this point have been conducted with a system that we know has an issue with bias correction of all-sky instruments





- A hint there might be something afoot comparing the Bias Correction applied to GMI
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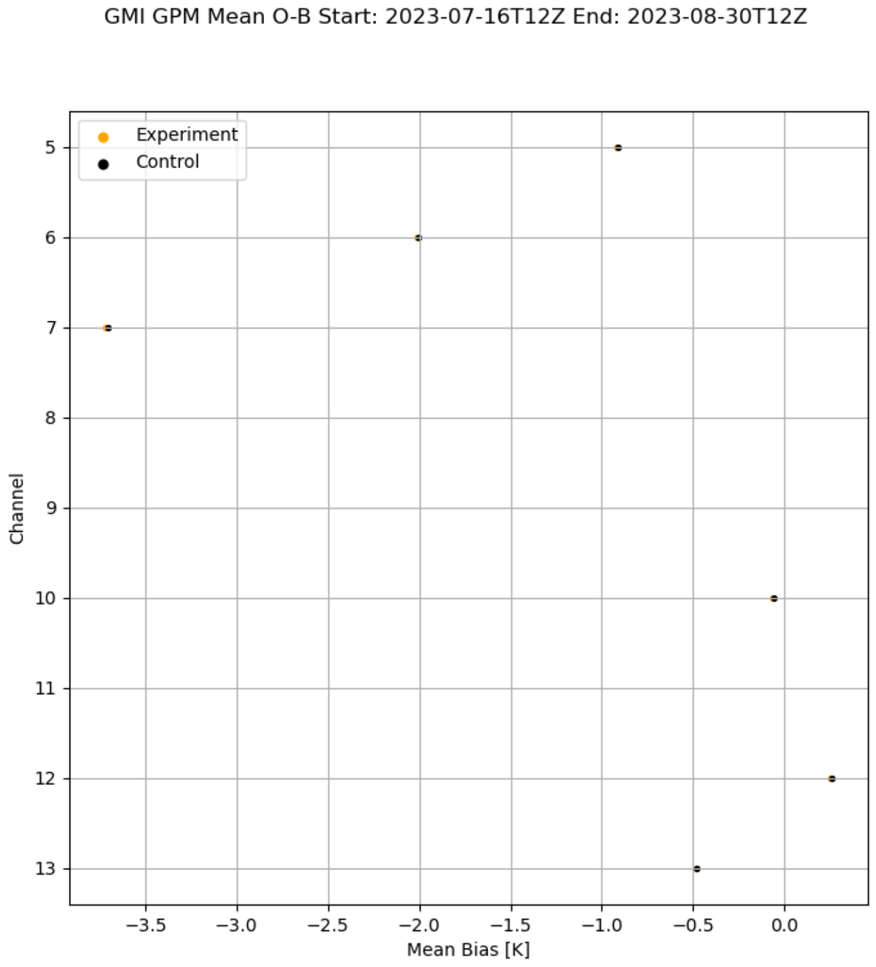
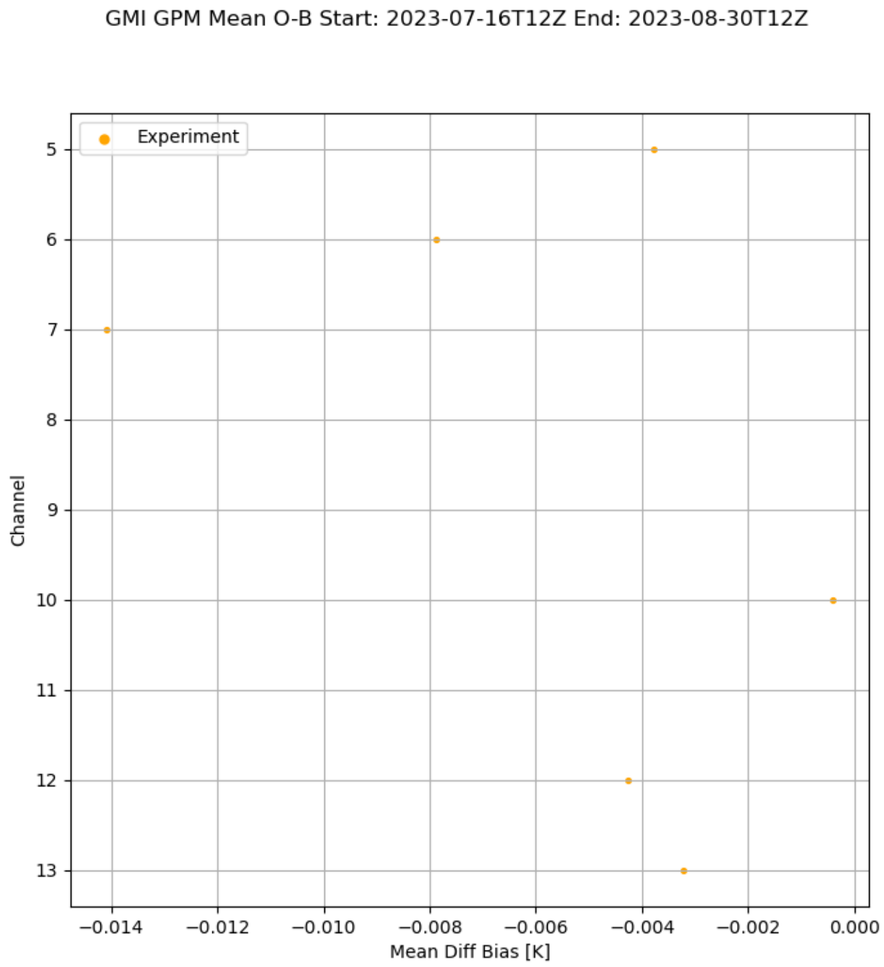
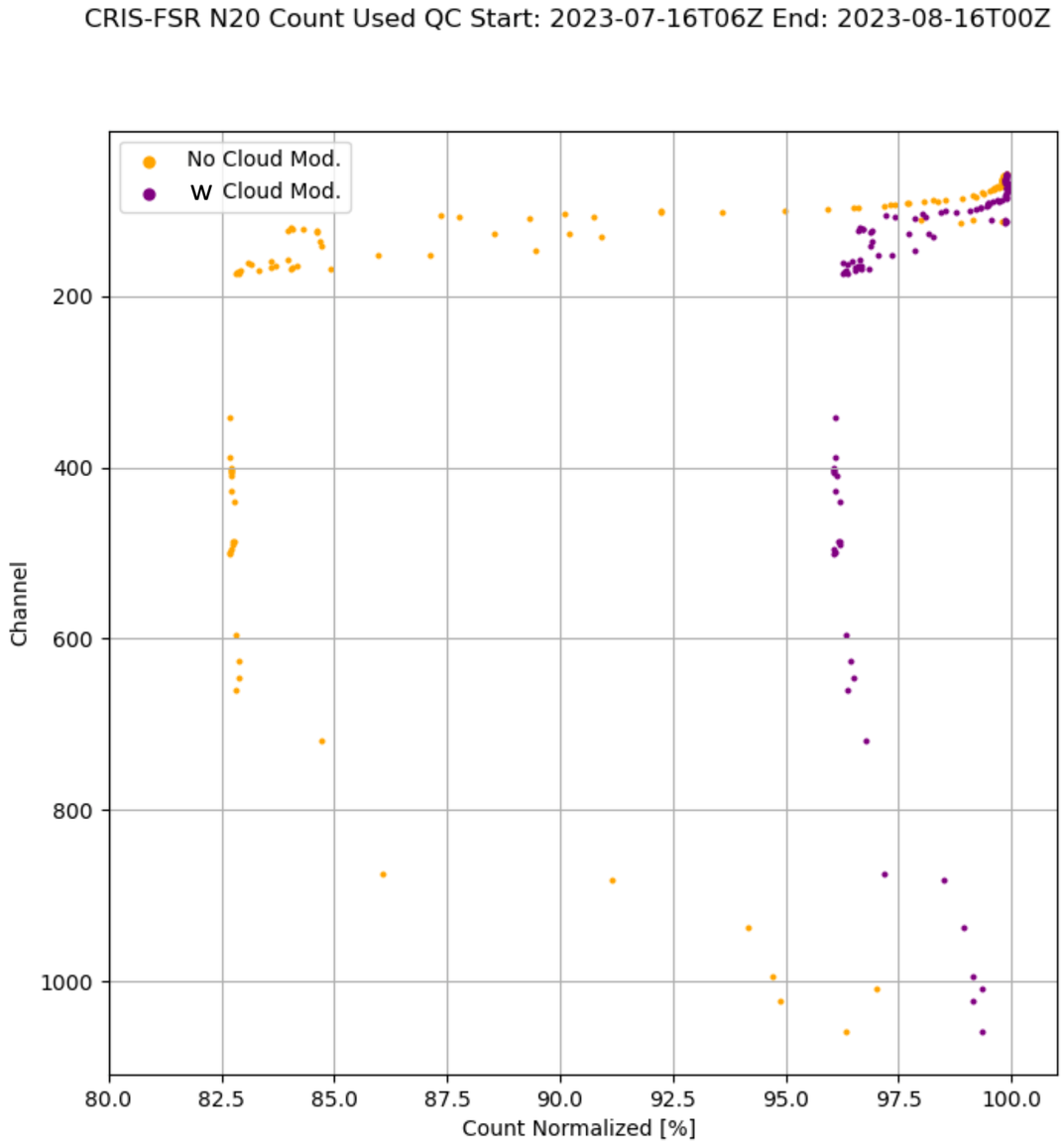




- Previous system had known issues with all-sky microwave bias correction
- Updated system also includes a model update which improved near surface water vapor forecasts
- Experiments shown here are still running, only have ~1month of results to show, but appear promising/less problematic than with previous system
- As with previous experiments, modifying the cloud detection is necessary to bring up surface sensitive channel count



- Scorecards using latest experiments

x50_cred GEOS Scorecard

Comparison of scores for x50bkctl (Control) and
x50_cred (Experiment) experiments
for the period of July 17, 2023 to August 29, 2023.

Legend

- ▲ far better, significant (99.99% confidence)
- △ better, significant (99% confidence)
- ⁘ slightly better, significant (95% confidence)
- ■ no significant difference
- ⁘ slightly worse, significant (95% confidence)
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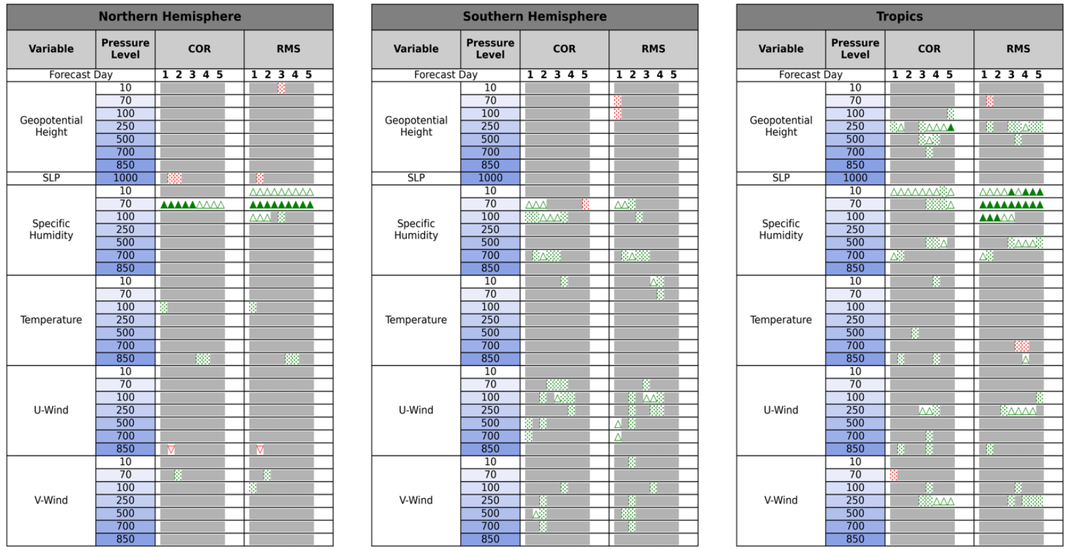
- ▼ far worse, significant (99.99% confidence)

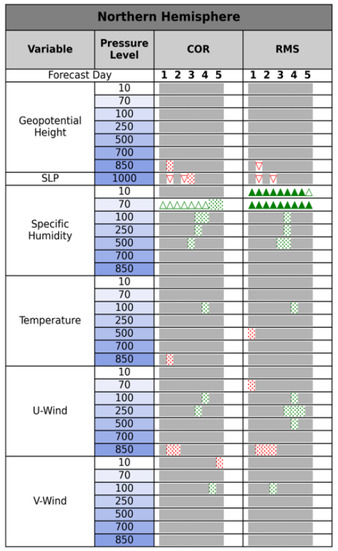


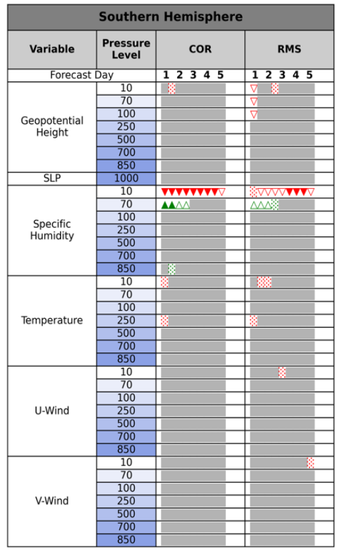
x50_cred2 GEOS Scorecard

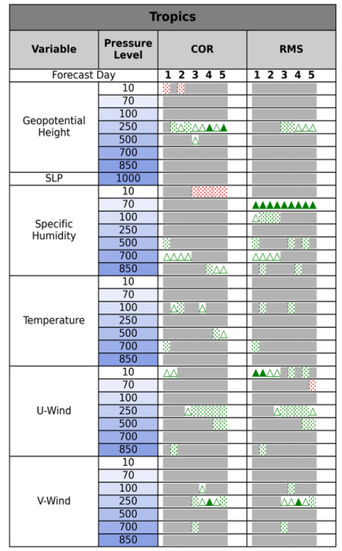
Comparison of scores for x50bkctl (Control) and
x50_cred2 (Experiment) experiments
for the period of July 17, 2023 to August 20, 2023.

Legend

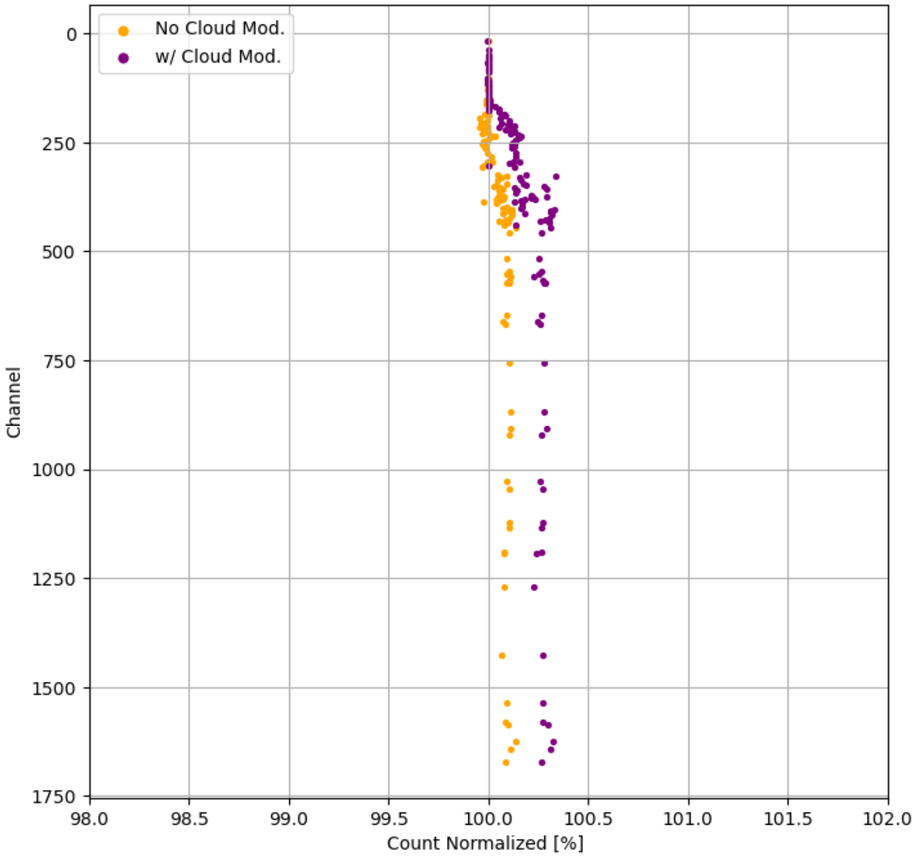
- ▲ far better, significant (99.99% confidence)
- △ better, significant (99% confidence)
- ⁘ slightly better, significant (95% confidence)
- ■ no significant difference
- ⁘ slightly worse, significant (95% confidence)
- ▽ worse, significant (99% confidence)
- ▼ far worse, significant (99.99% confidence)



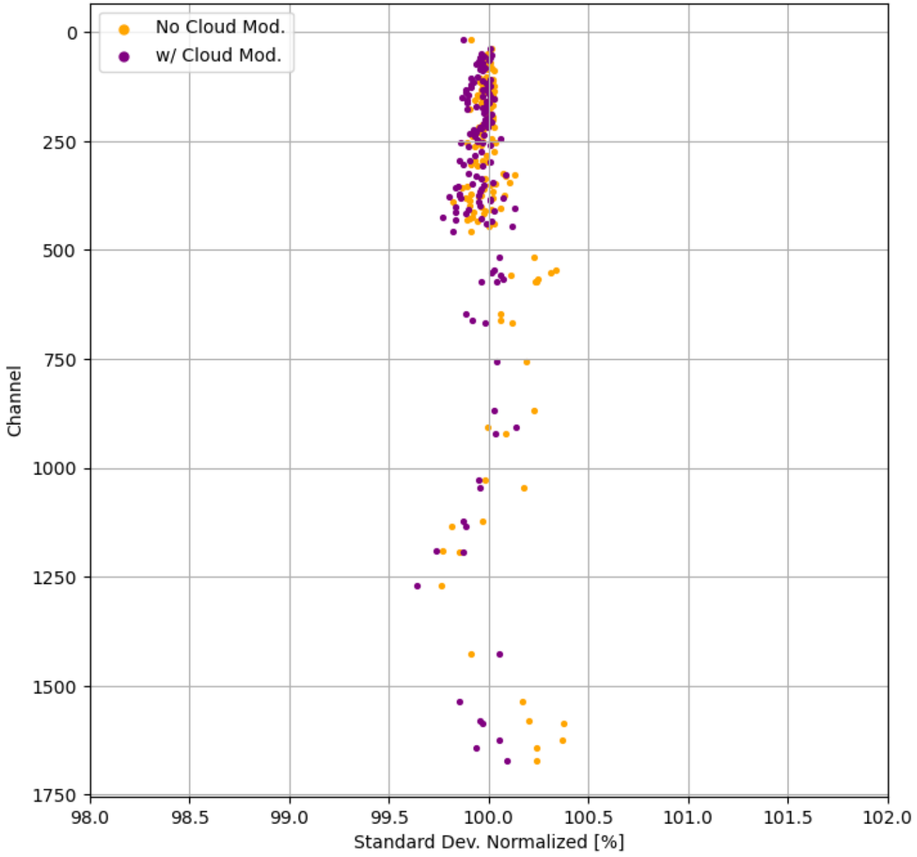


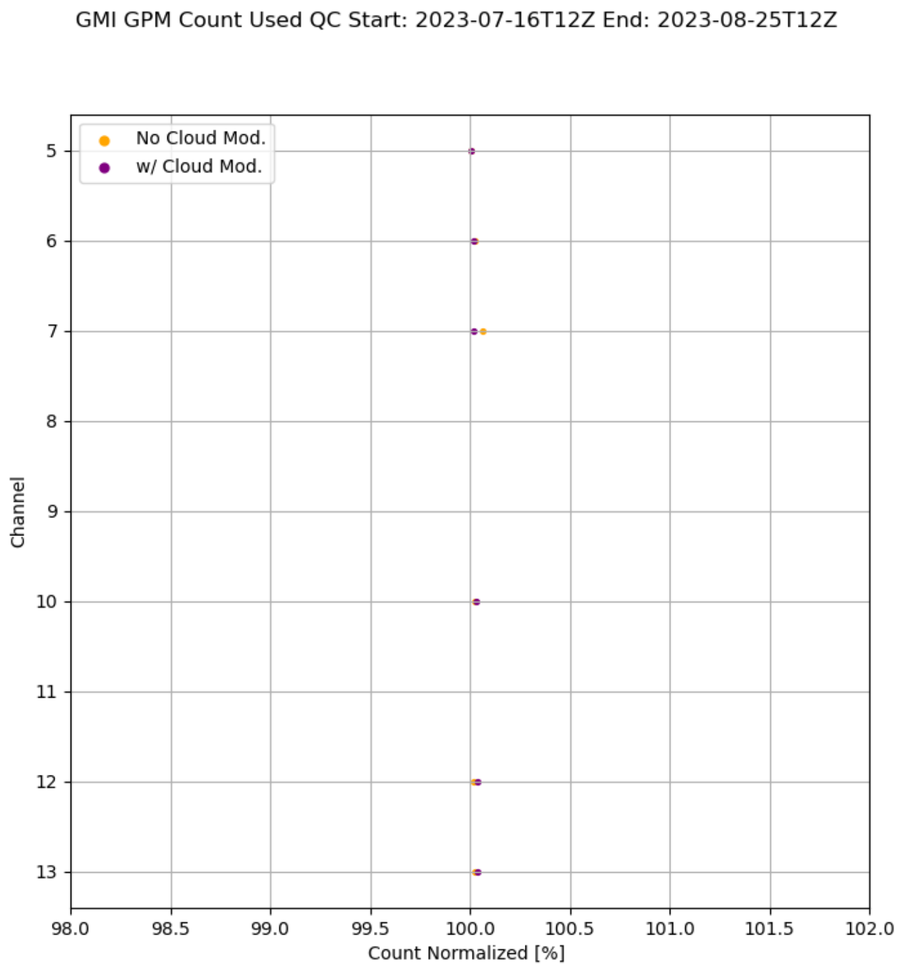


IASI METOP-C Count Used QC Start: 2023-07-16T12Z End: 2023-08-25T12Z



IASI METOP-C Standard Deviation O-B Start: 2023-07-16T12Z End: 2023-08-25T12Z




GMI GPM Count Used QC Start: 2023-07-16T12Z End: 2023-08-25T12Z
No Cloud Mod.
w/ Cloud Mod.
Channel
5
6
7
8
9
10
11
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99.0
99.5
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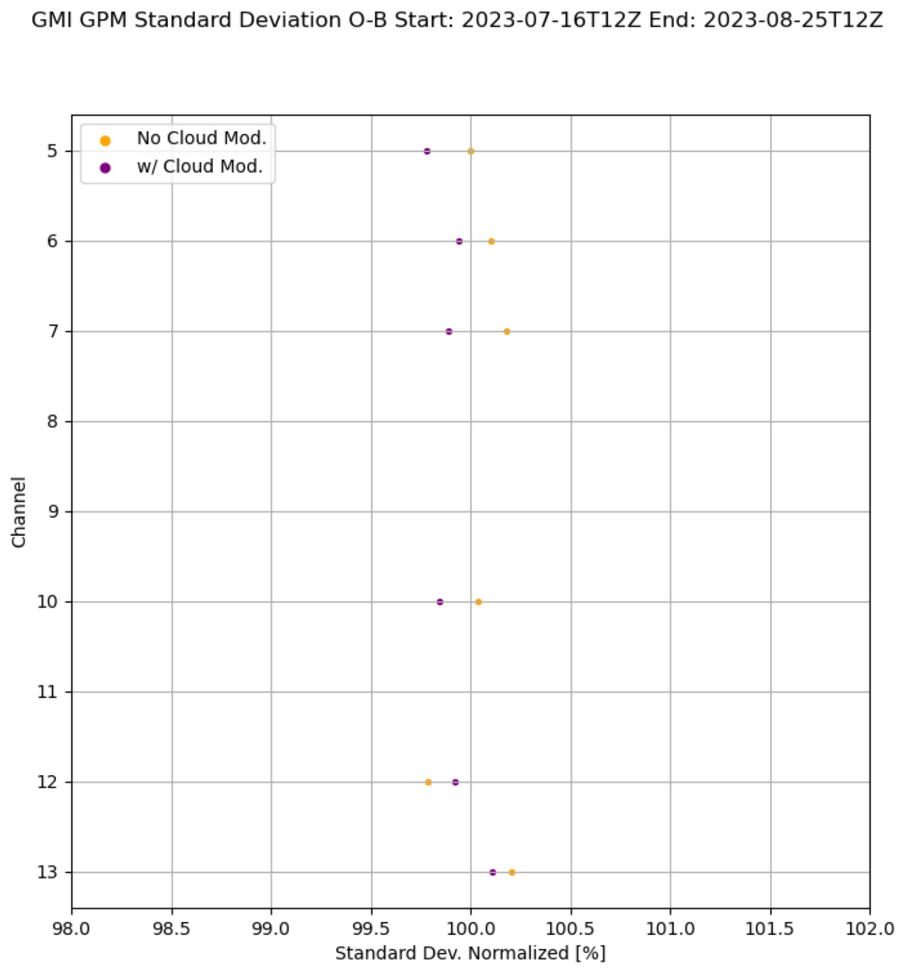
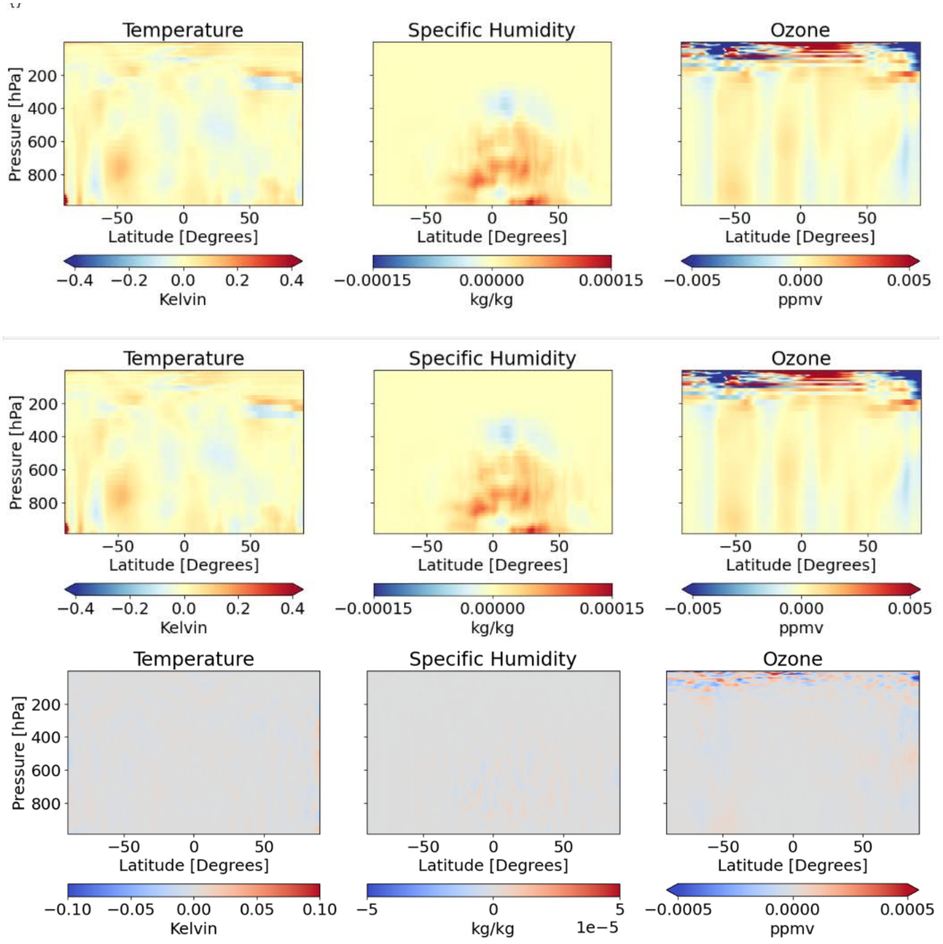
100.5
101.0
101.5
102.0
Count Normalized [%]


GMI GPM Standard Deviation O-B Start: 2023-07-16T12Z End: 2023-08-25T12Z
No Cloud Mod.
w/ Cloud Mod.
Channel
5
6
7
8
9
10
11
12
13
98.0
98.5
99.0
99.5
100.0
100.5
101.0
101.5
102.0
Standard Dev. Normalized [%]


Temperature
Specific Humidity
Ozone
Pressure [hPa]
200
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Latitude [Degrees]
−0.4
−0.2
0.0
0.2
0.4
Kelvin
−0.00015
0.00000
0.00015
kg/kg
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Temperature
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Temperature
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Latitude [Degrees]
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kg/kg
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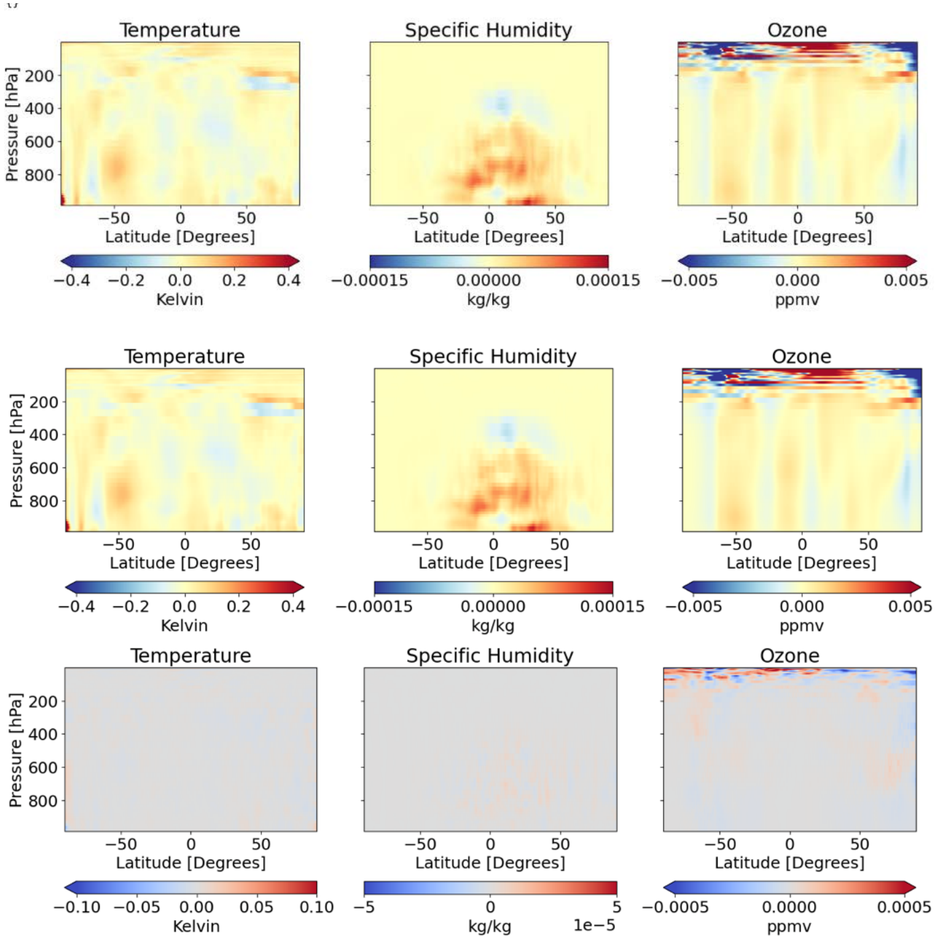
0.0005
ppmv


Temperature
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Ozone
Pressure [hPa]
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0
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Latitude [Degrees]
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0.0
0.2
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Kelvin
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Latitude [Degrees]
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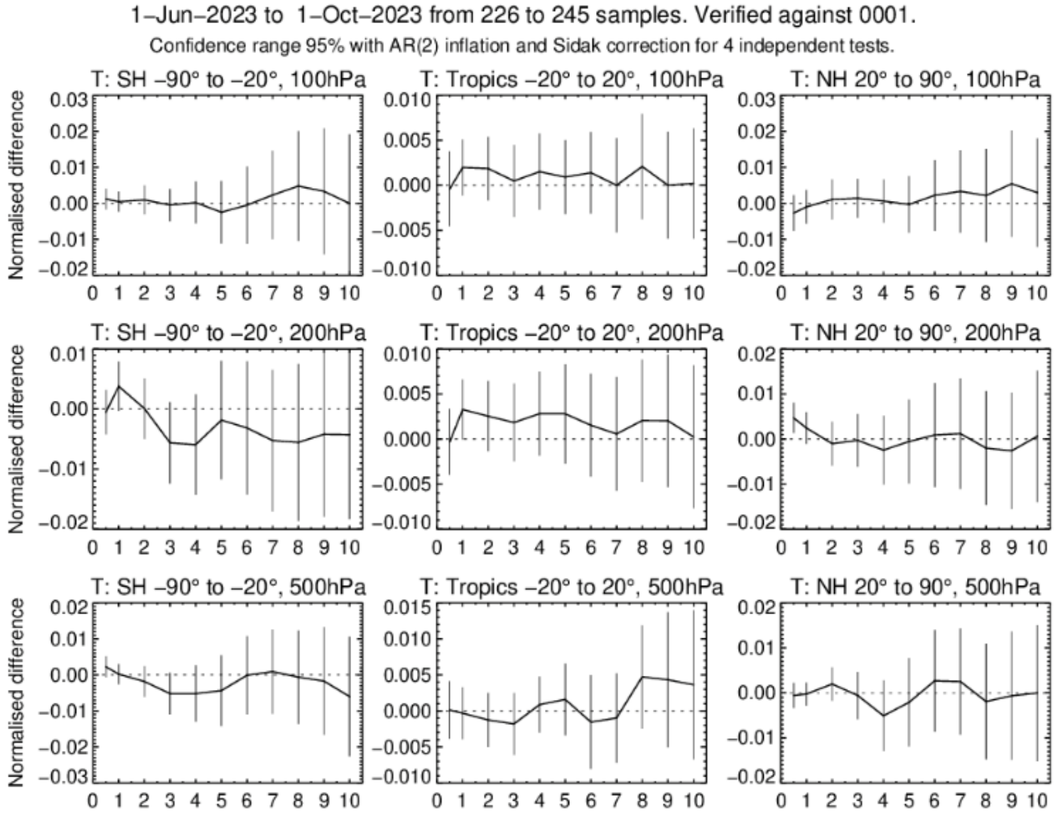
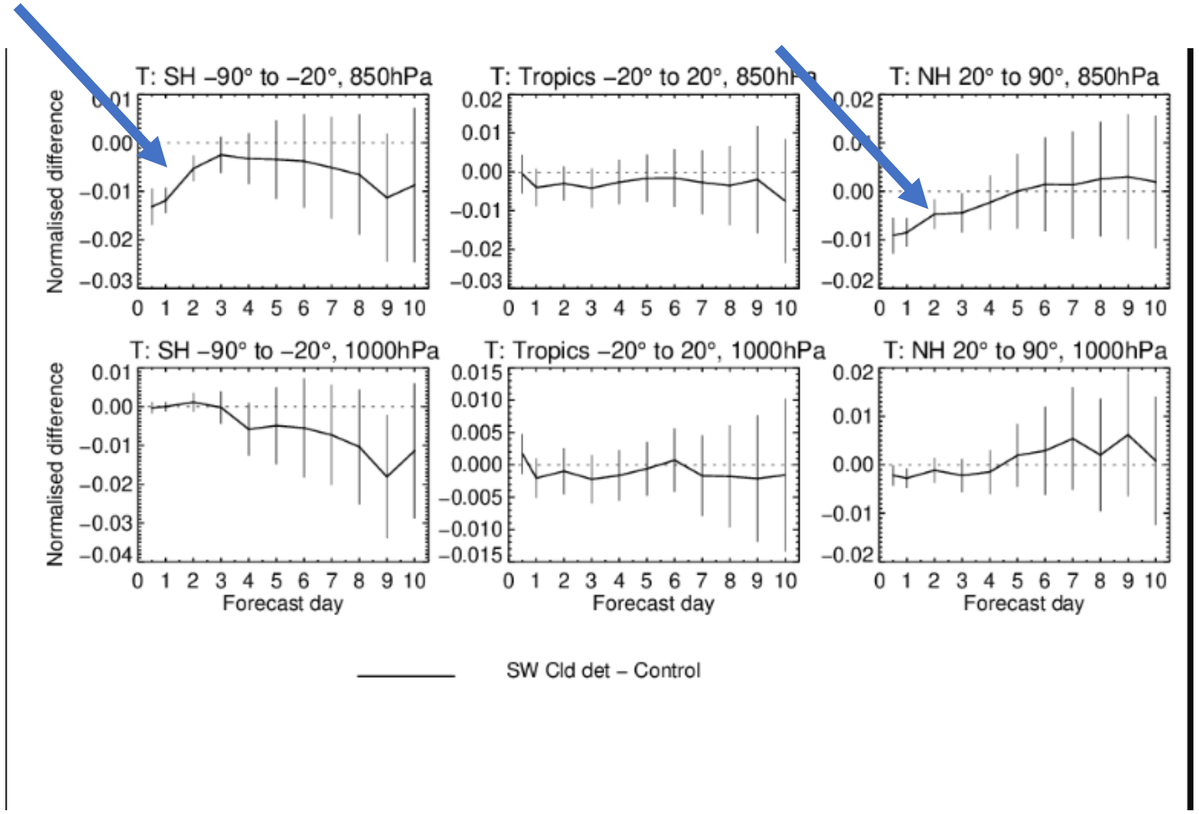
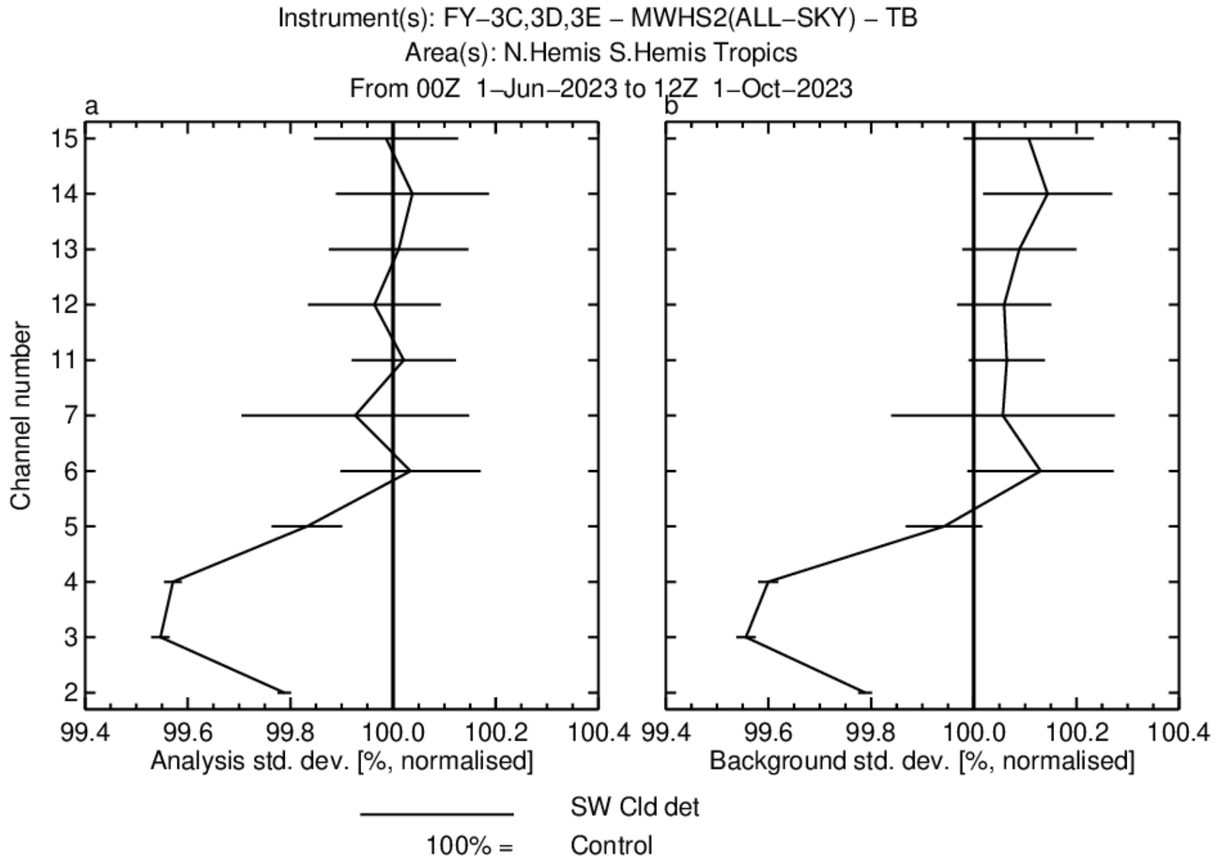
−0.05
0.00
0.05
0.10
Kelvin
−5
0
5
kg/kg
1e−5
−0.0005
0.0000
0.0005
ppmv

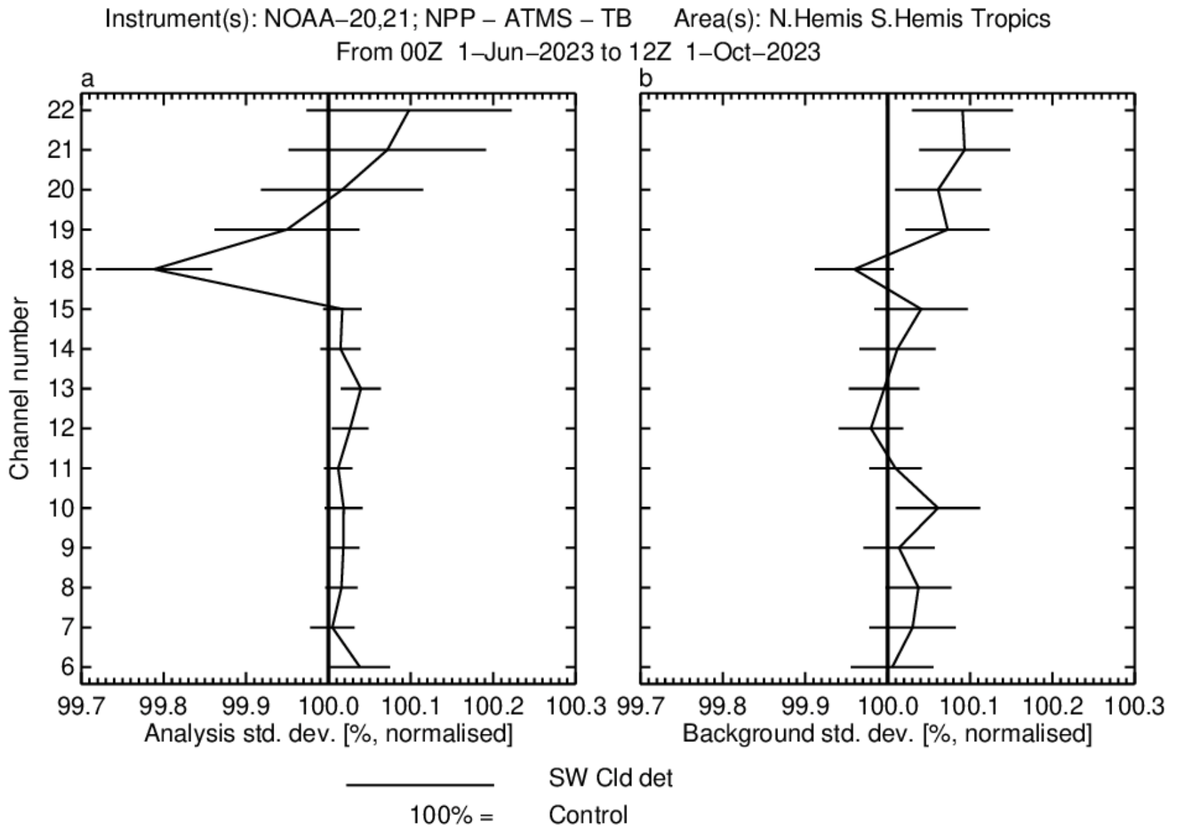
- Run experiment with using inflated Desroziers estimate based upon reconstructed radiances → pretend we're assimilating a "new instrument"
- Prepare for assimilation of MTG-IRS → use sample data set to establish plumbing
- PCA reconstructed radiances should be readily assimilated with some modifications to cloud detection
- Using CADS (Eumetsat/NWPSAF cloud detection) which ECMWF uses has been added to EMC GSI, and coming to JEDI → potential benefits to reducing bias correction/cloud detection feedback

- Update from last time Erin Jones gave a presentation on CADS work with Chris Burrows at ECMWF
- Modified previous configuration to be a single “band” including MW and SW channels
- Saw neutral impact with some indications of statistically significant positive impact









Observation fits a bit hit or miss. MWHS2 shows some improvement, ATMS some degradation