Status and Progress of All-Sky Hyperspectral IR Radiance Assimilation in GEOS

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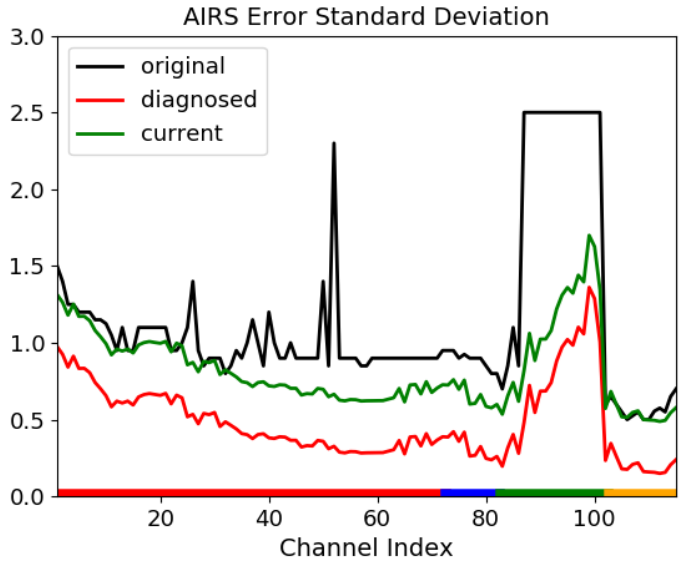
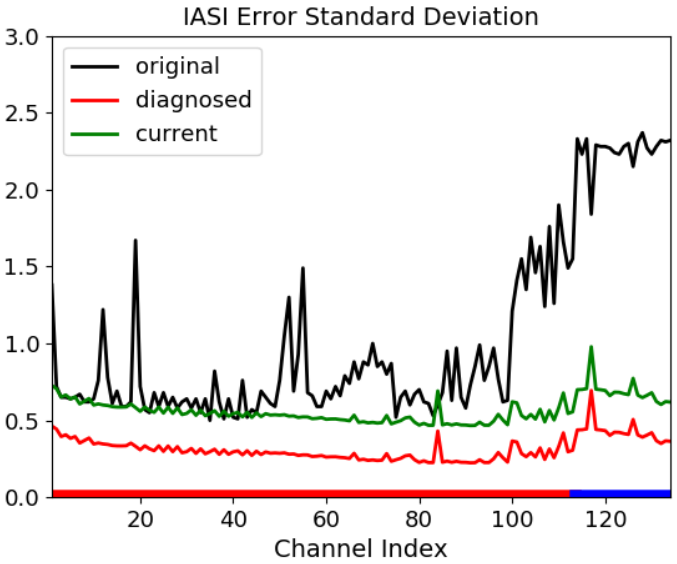
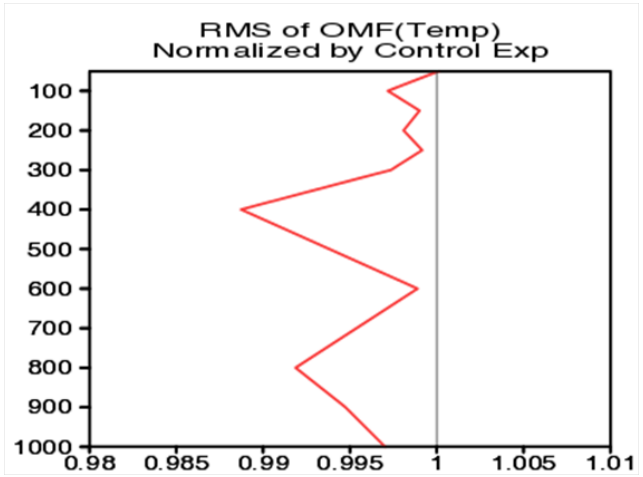
Outlines

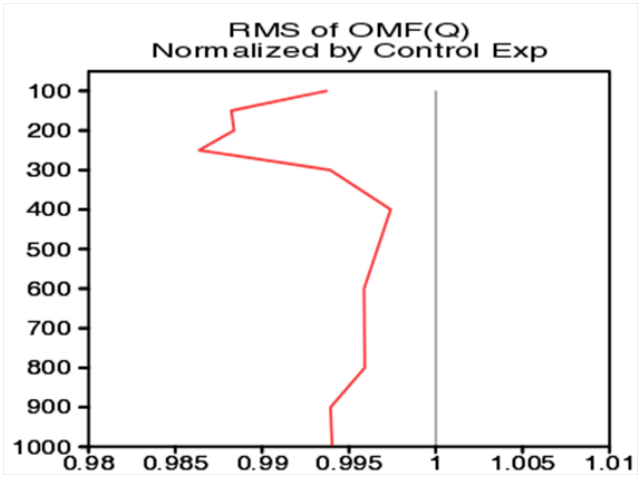
- ❑ Enhancements for clear-sky assimilation of hyperspectral IR observations in GEOS.
- ❑ Development of all-sky assimilation for hyperspectral IR observations in GEOS.
  - Initial focus on observations from CrIS-FSR water-vapor channels.
  - Evaluation of all-sky radiance OmF and sensitivities with respect to hydrometeors.
  - Development of observation error model for cloud-affected observations.
  - Preliminary assimilation testing.

Current Use of Clear-Sky AIRS and IASI Observations in GEOS



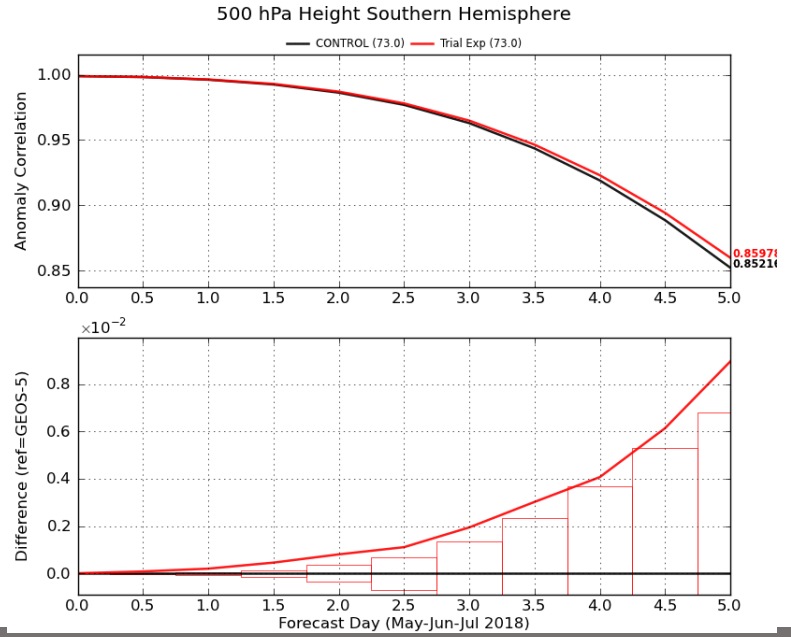






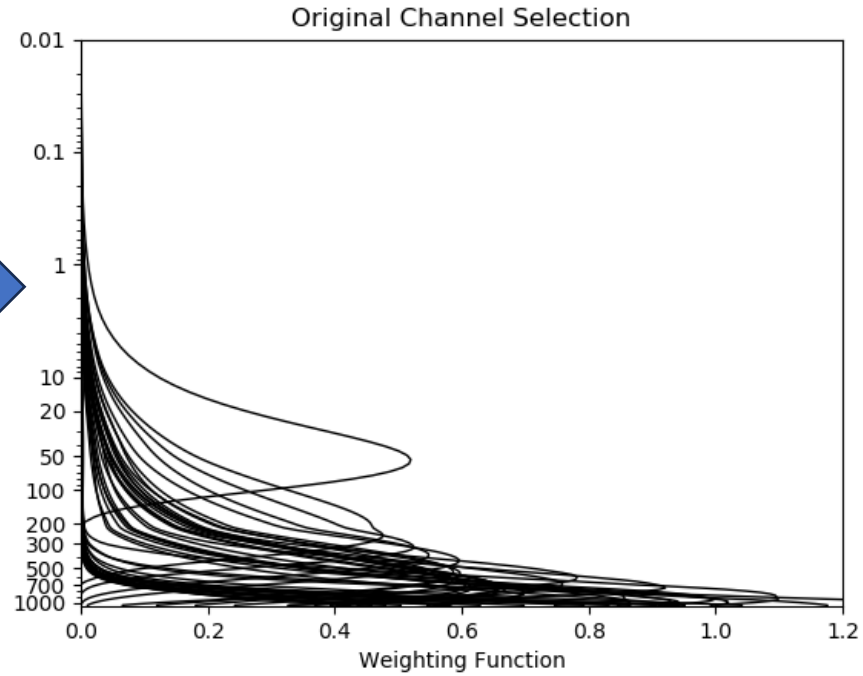
Reduced the RMS of OmFs for rawinsonde T and Q

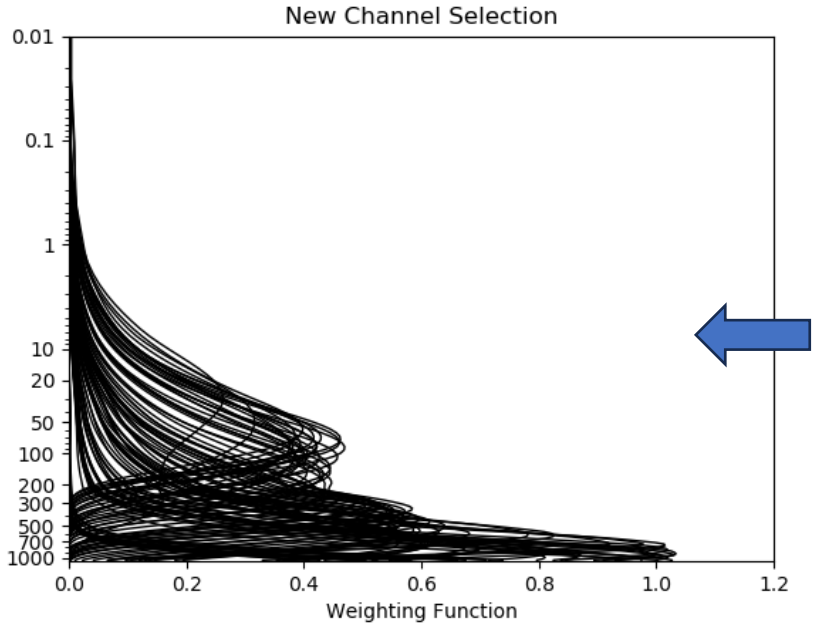
Improved the overall forecast skills of GEOS



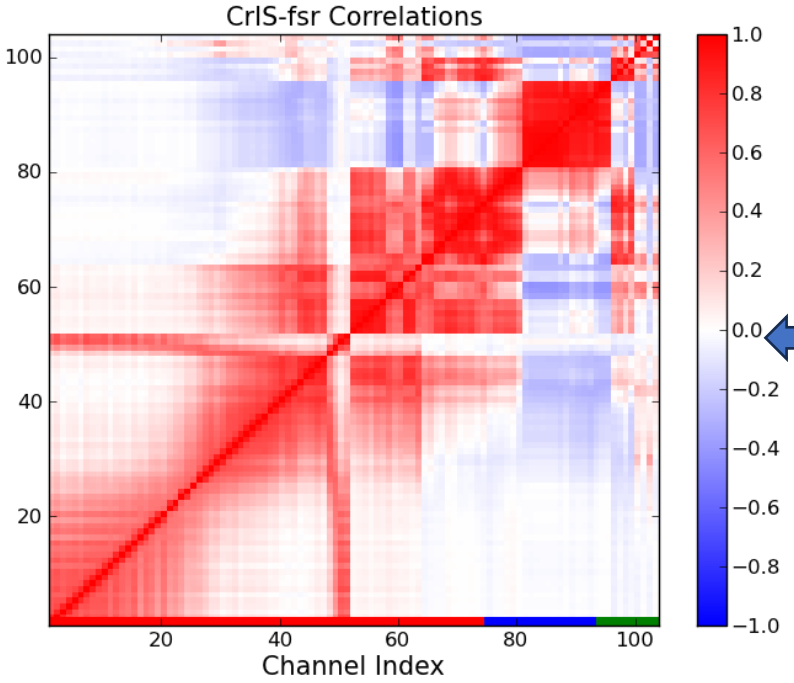
Current Use of Clear-Sky CrIS-FSR Observations in GEOS

CrIS-NSR





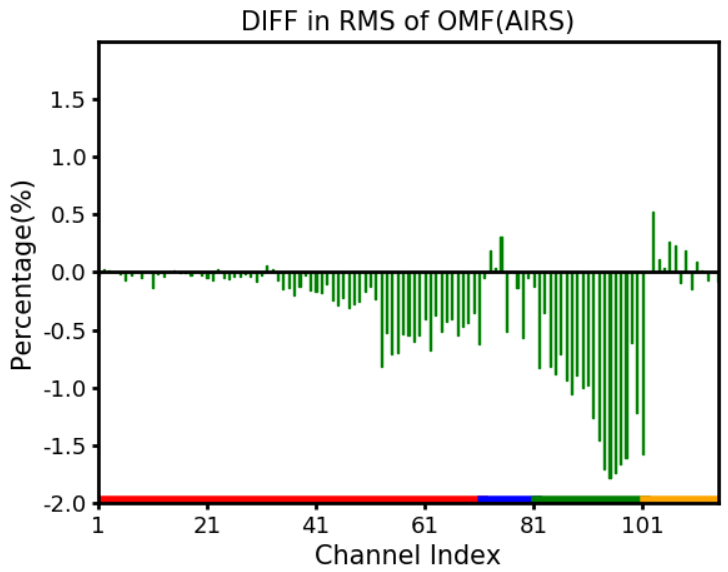
CrIS-FSR

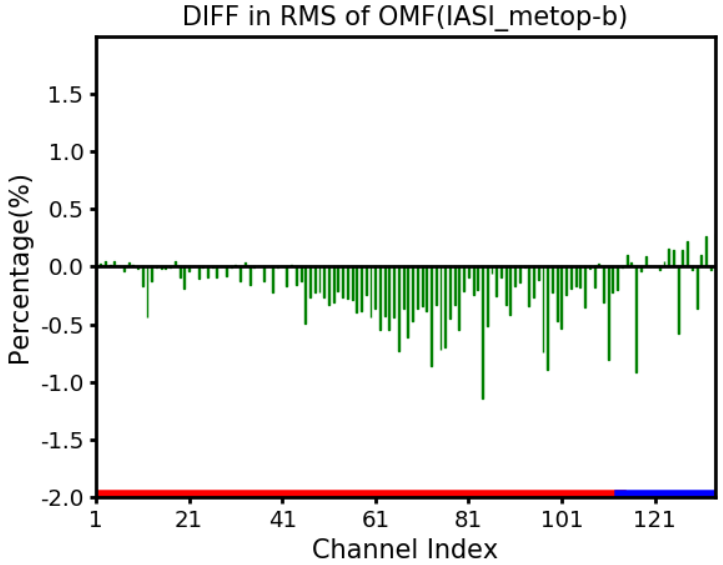


CrIS-FSR

- . Revisited channel selection during the transition from CrIS-NSR to CrIS-FSR.
  - CrIS-NSR: 47 in lw band + 33 wv in mw band.
  - CrIS-FSR: 95 in lw band + 8 wv in mw band.
- Inter-channel Correlations have been taken into account.

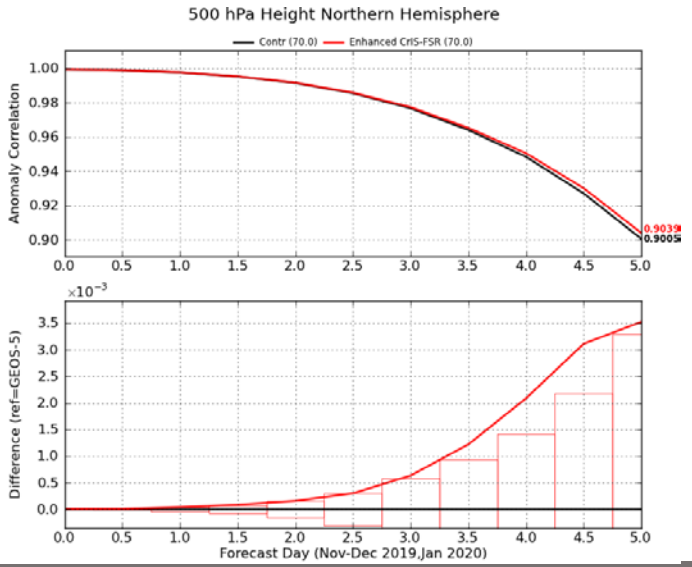
Current Use of Clear-Sky CrIS Observations in GEOS(continued)

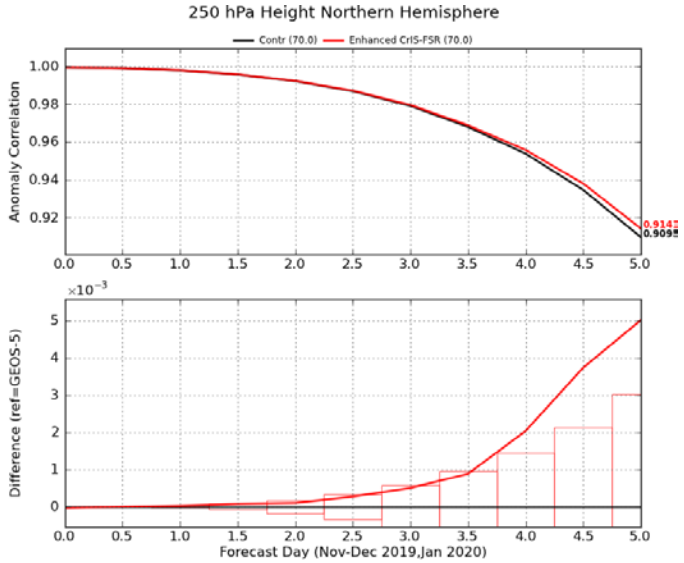




Reduced the RMS of OmFs for other observations, e.g., AIRS, IASI

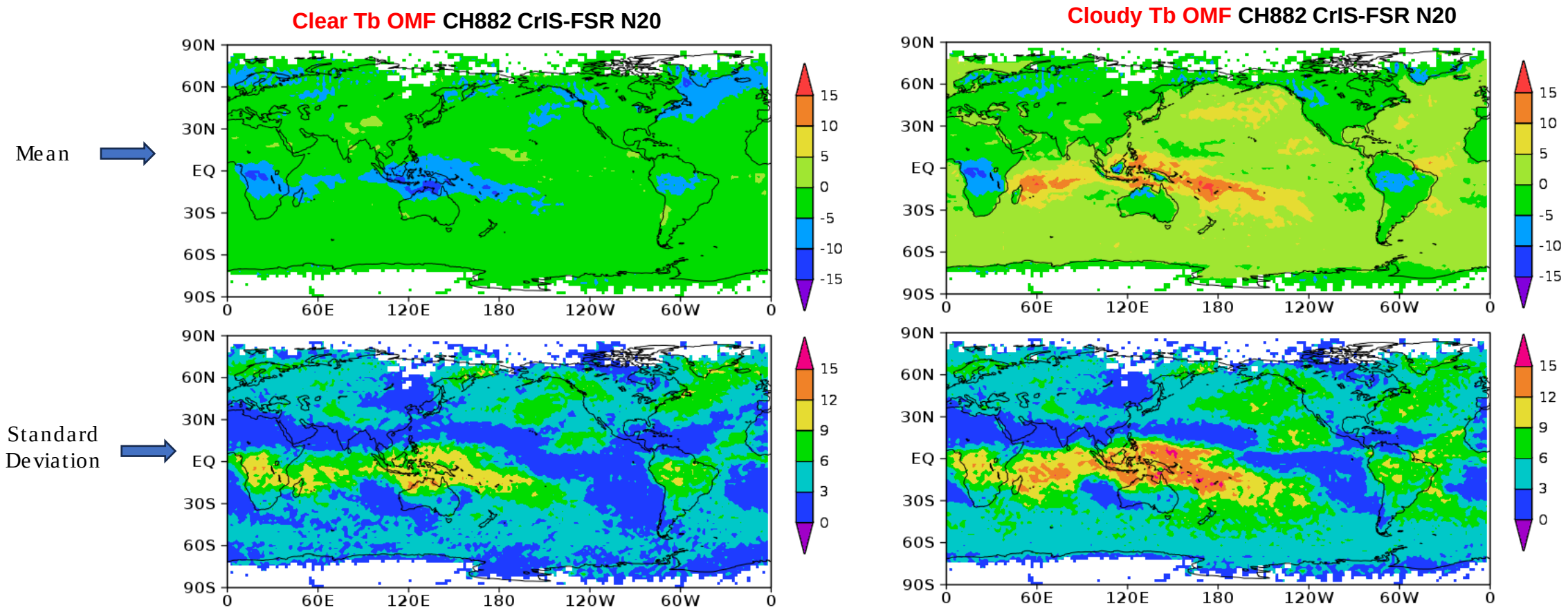
Improved the overall forecast skills of GEOS





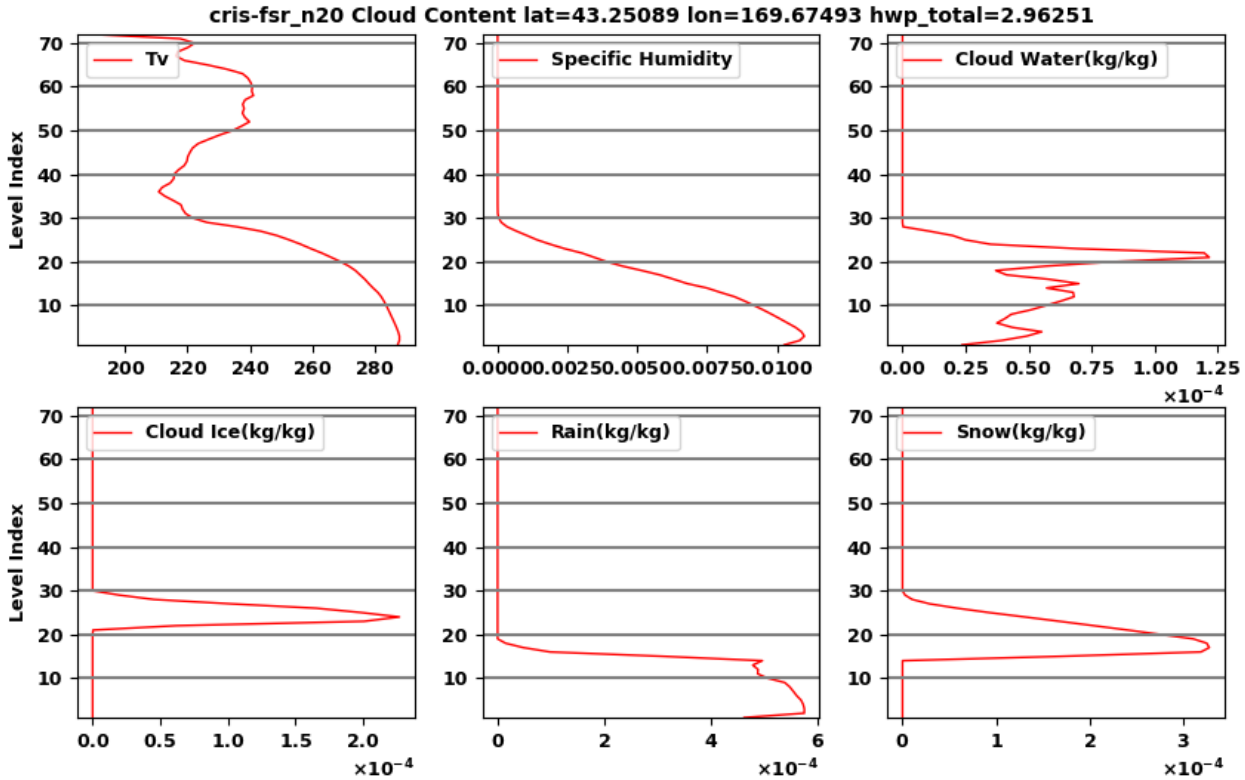
Development of All-Sky Assimilation in GEOS

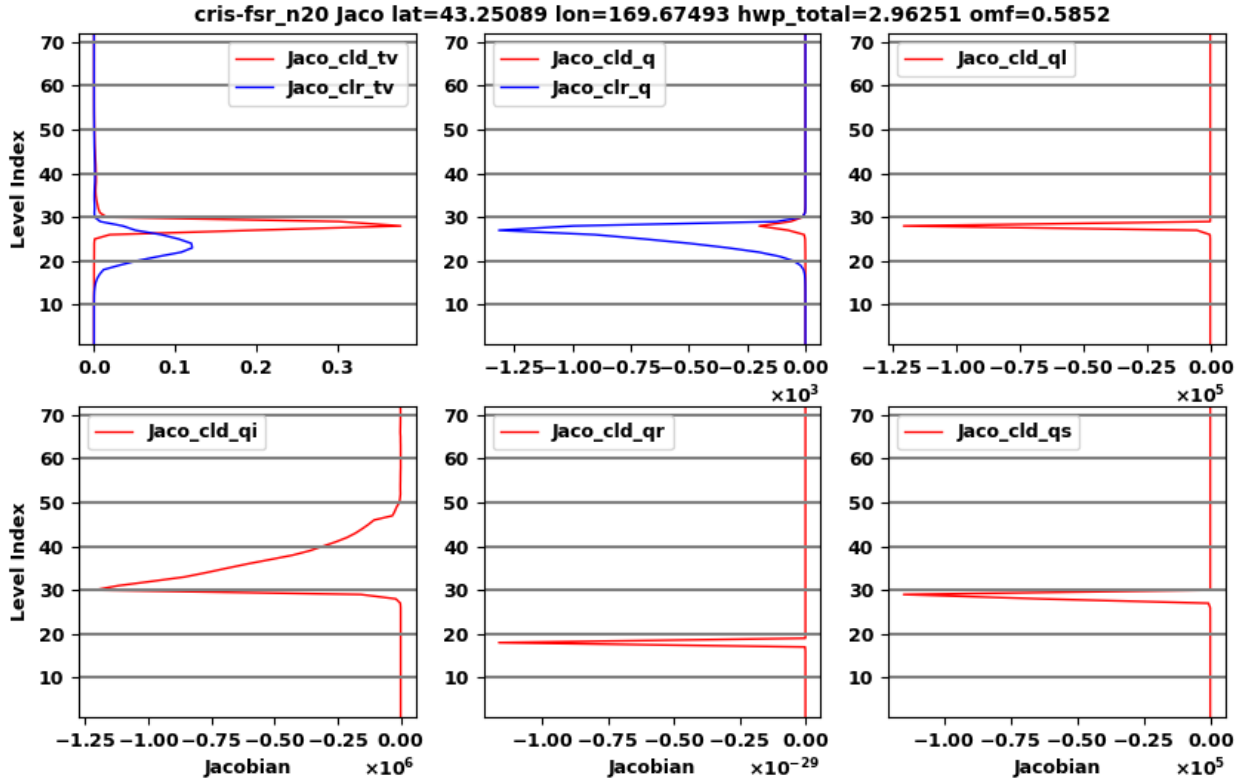
Evaluations of Simulated Cloudy Tb Departures



- ❑ CRTM 2.4.0 with the default cloud coefficient lookup table.
- ❑ Overlap_Id: cloudcover_maximum_overlap().
- ❑ Initial focus is on six water-vapor channels from CrIS-FSR.

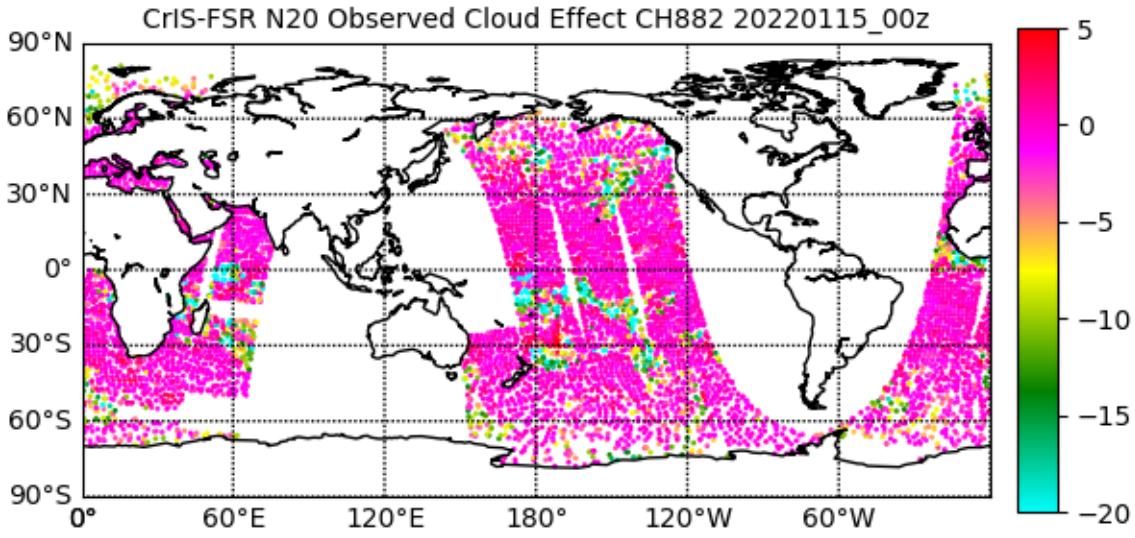
Evaluations of Jacobians with respect to Cloud Hydrometeors



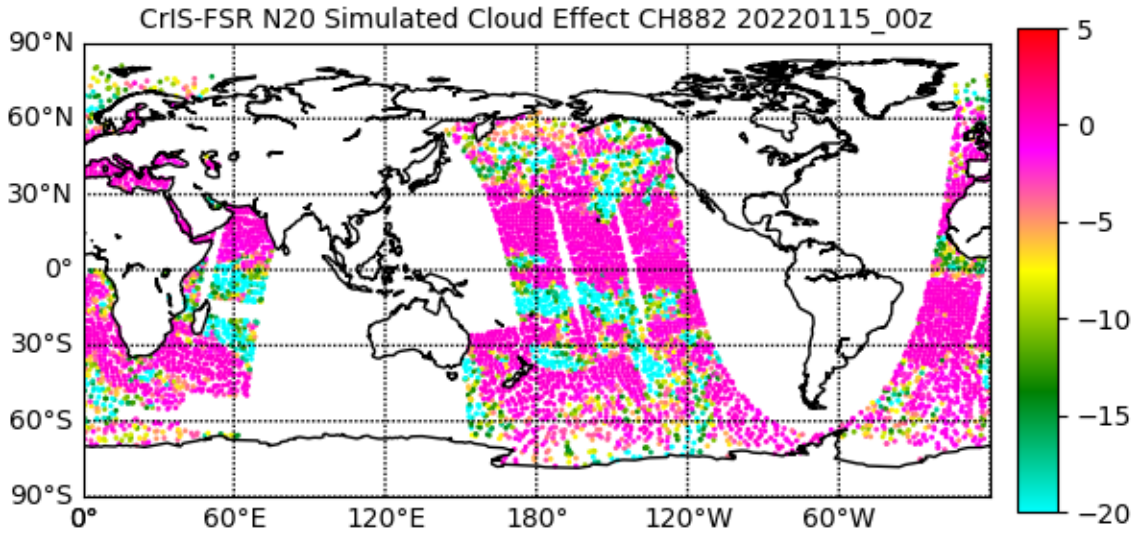


For water-vapor CH 882 CrIs-FSR N20

Observed Cloud Effects ($T_b\_obs - T_b\_clr$)

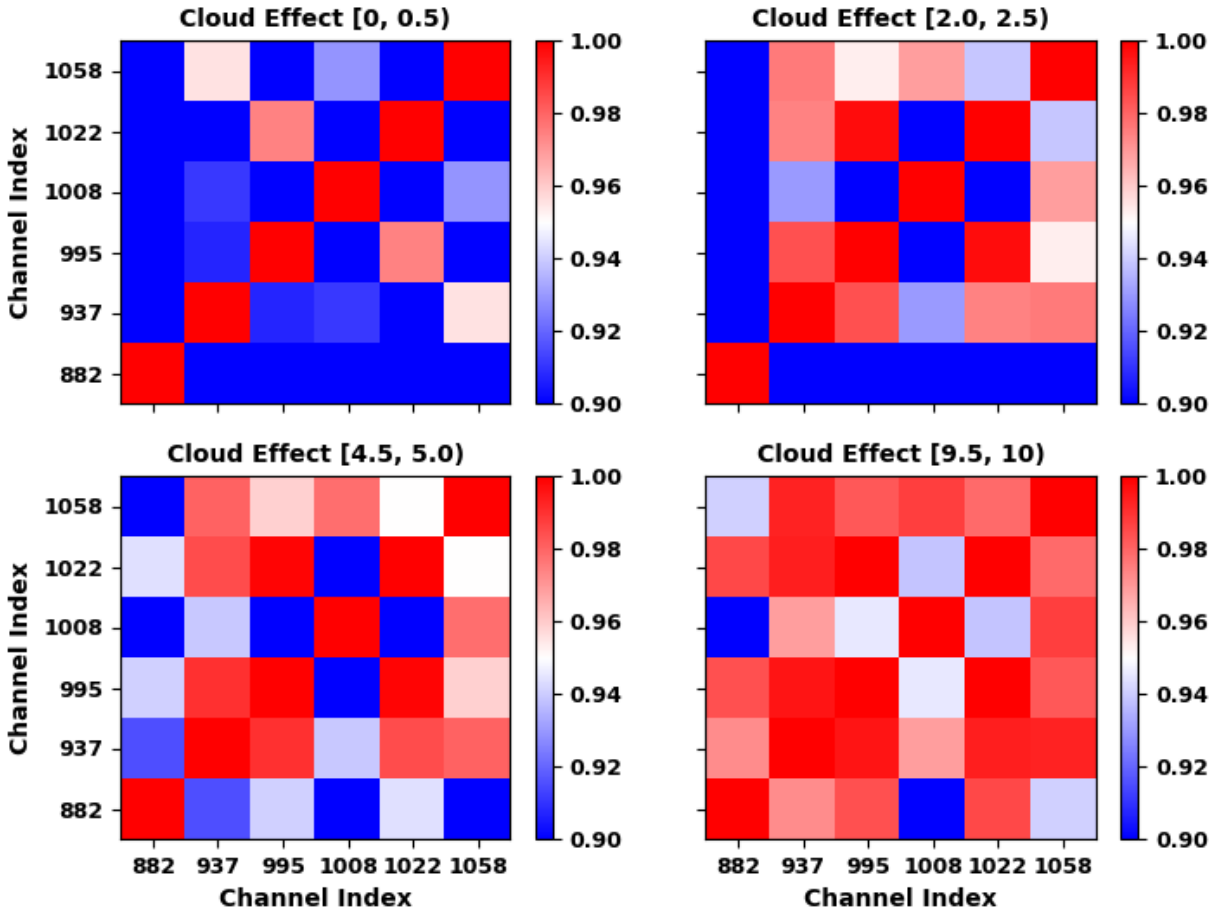


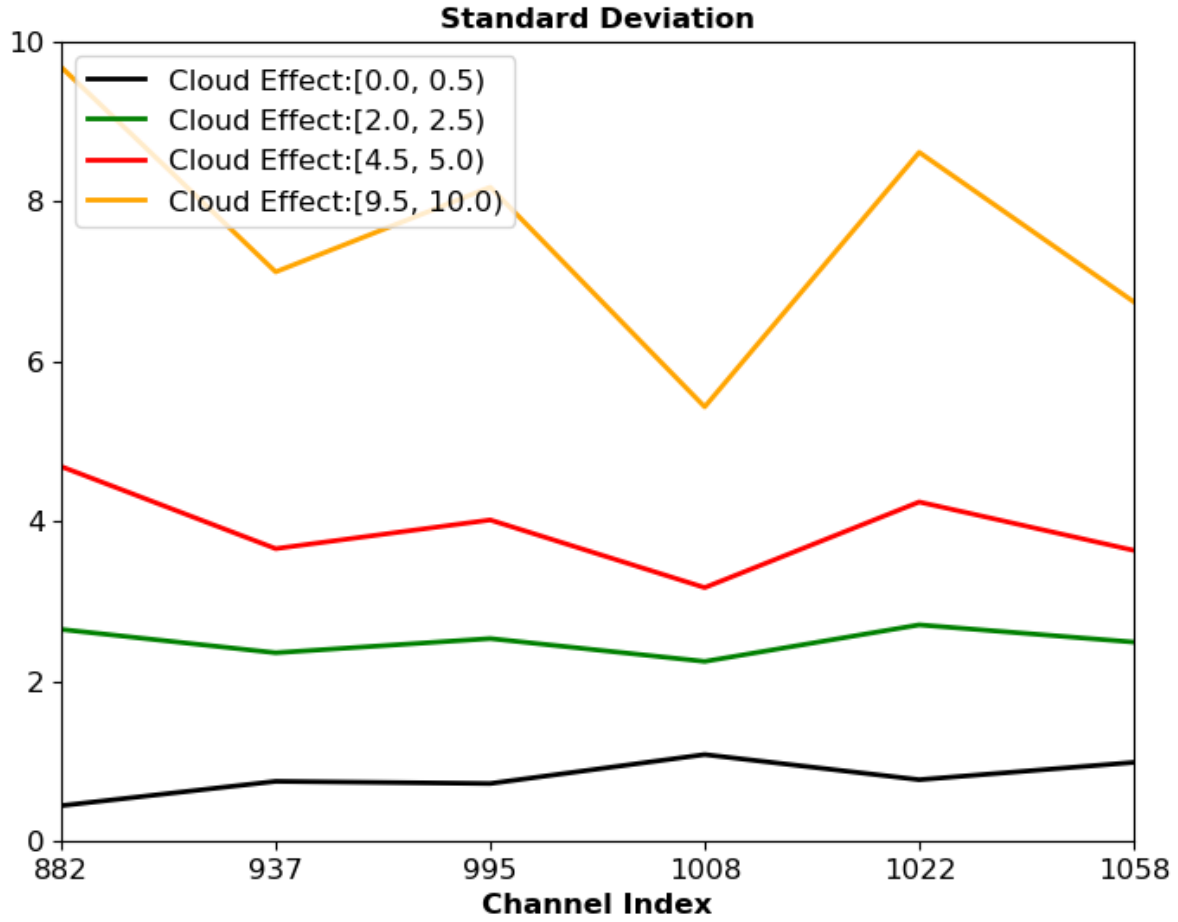
Simulated Cloud Effects ($T_b\_cld - T_b\_clr$)



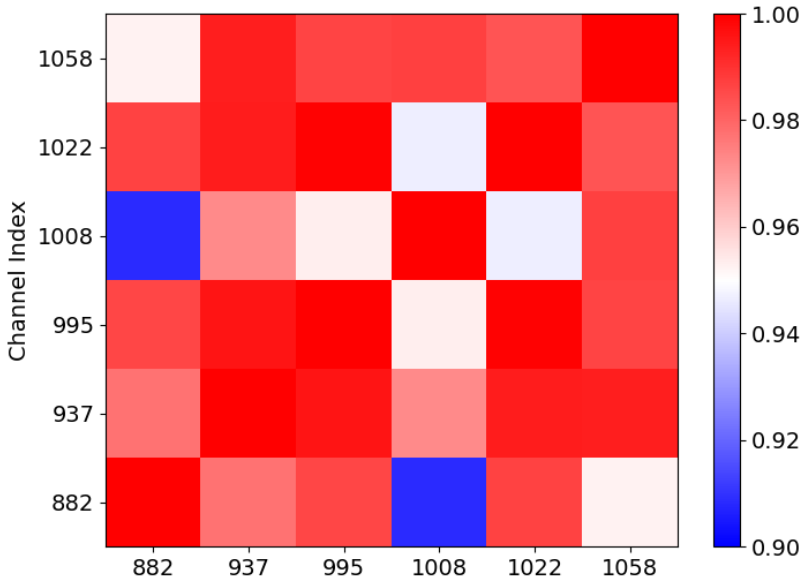
Symmetric Cloud Effects = $\frac{|T_b\_obs - T_b\_clr| + |T_b\_cld - T_b\_clr|}{2}$

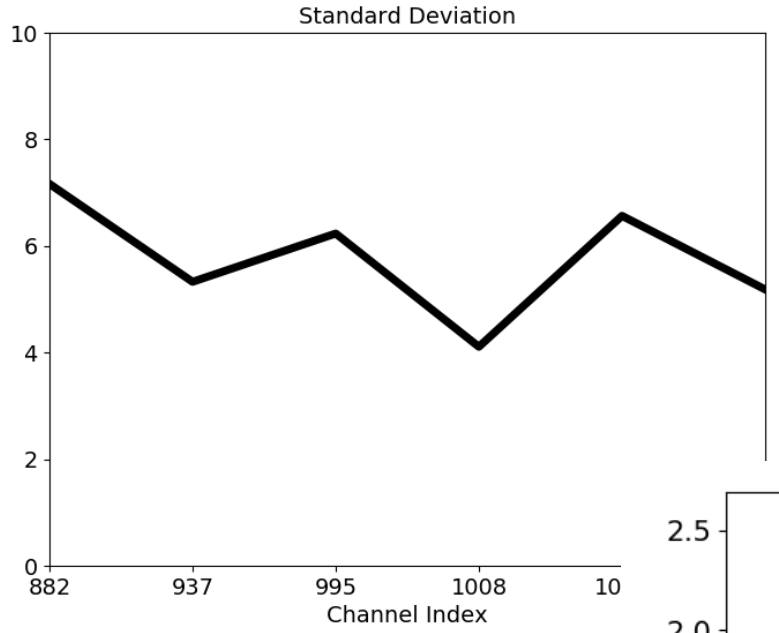
Diagnosed Observational Covariance Matrices as a function of the Symmetric Cloud Effects





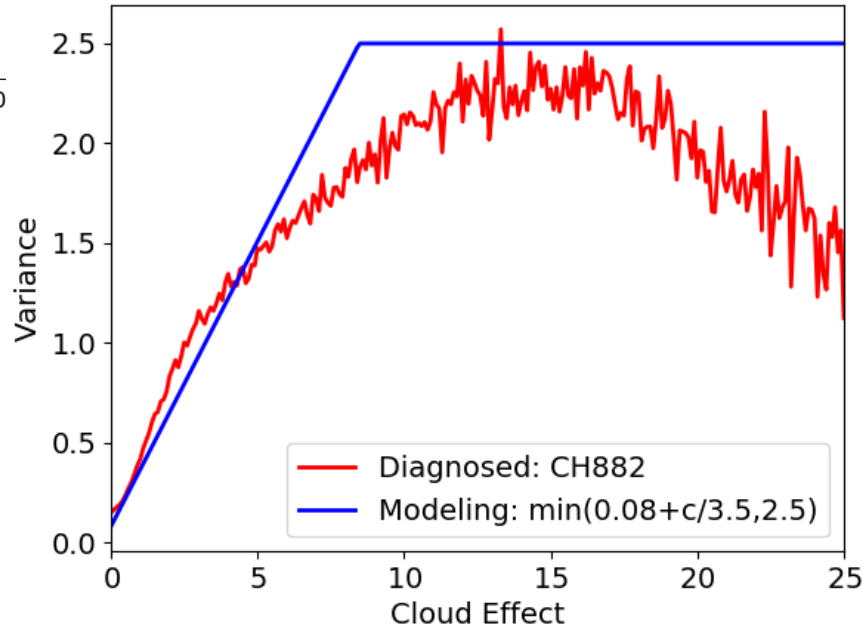
All-Sky Background Departures as a Function of Symmetric Cloud Effects



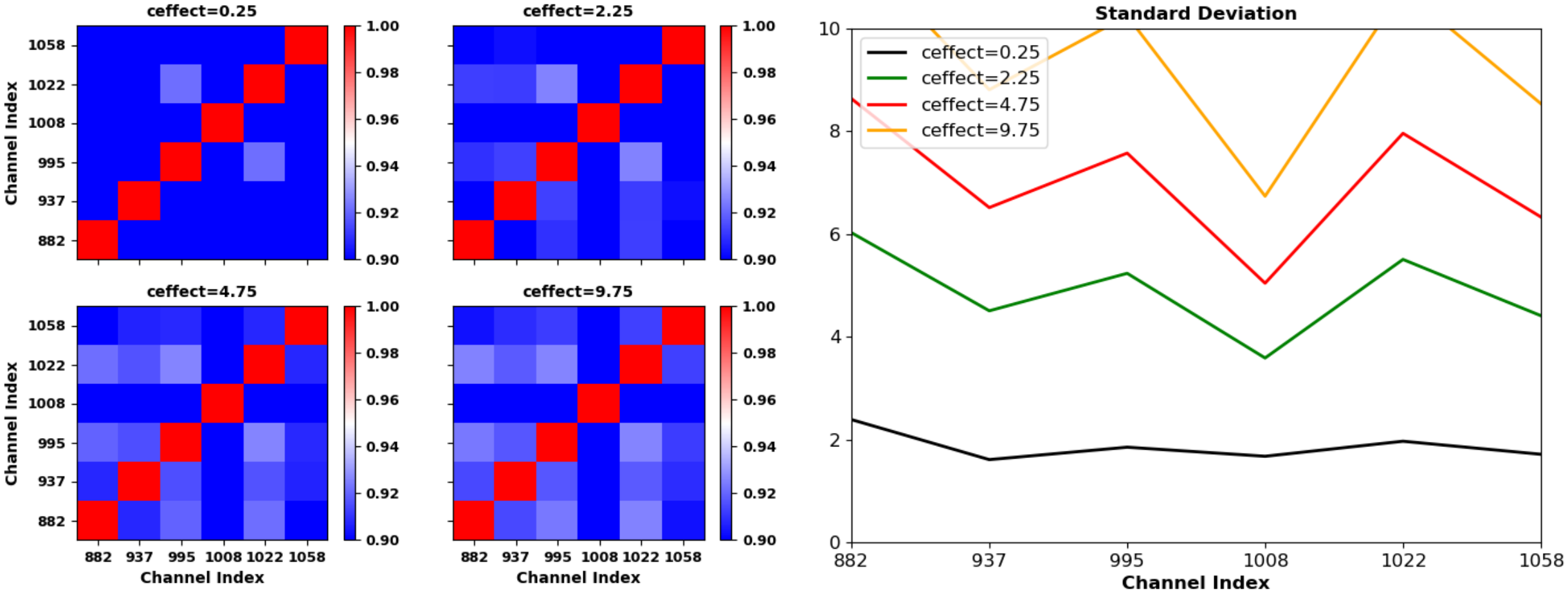


Cloud effect Independent R estimated from all observations

Variances of projected OMF on the space spanned by the inverse of the square root of R as a function of the symmetric cloud effects at channel 882

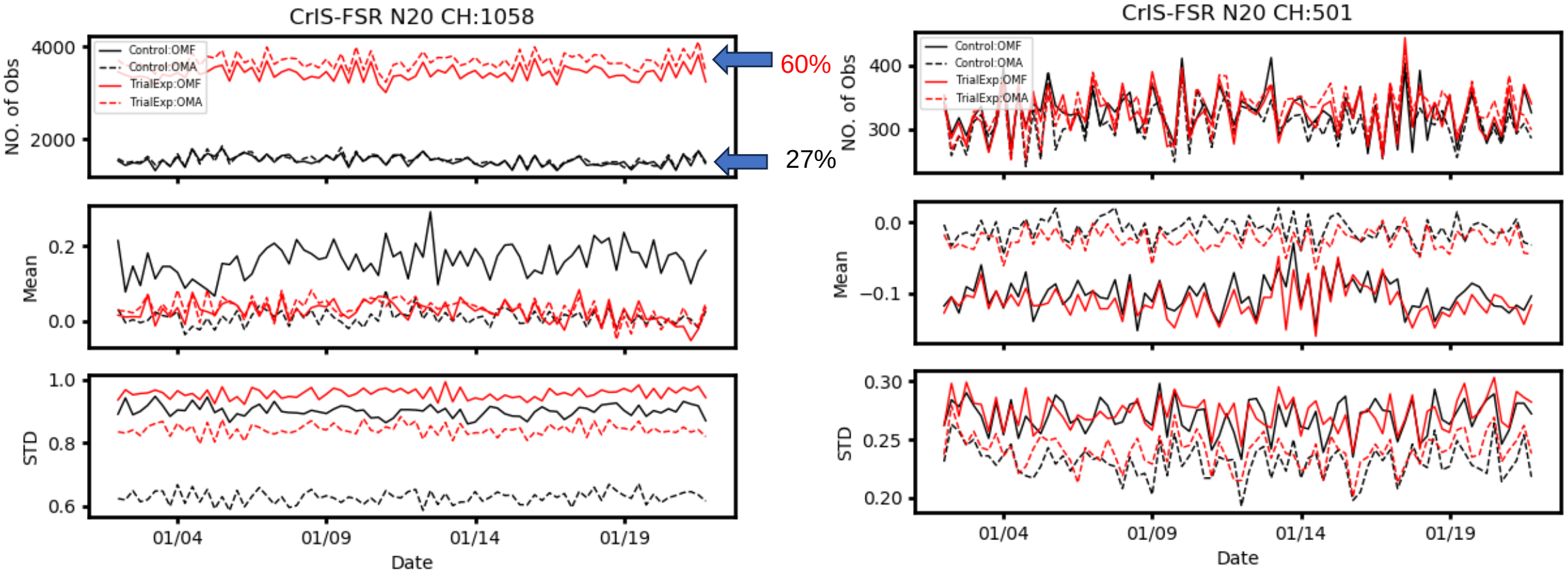


Observation Error Covariance Matrices Modeled



All-sky observation errors modeled are cloud-amount dependent and inter-channel correlated

Preliminary testing All-Sky Framework for Hyperspectral IR Observation Assimilation in GEOS



- **OMF/OMA: CH1058 7.018μm 487hPa**
- **Statistical speaking, all-sky IR assimilation behaves reasonably.**

- **Impacts on the clear-sky assimilation of CrIS-FSR other active channels are statistically neutral.**
- **Impacts on the use of other data types are also statistically neutral in terms of background fittings.**

Summary

- The aim of the current work is to develop the general framework for all-sky assimilation of hyper-spectral IR radiance observations in GEOS.
- The cloudy radiances from CrIS-FSR water-vapor channels have been evaluated. The symmetric cloud effects are used as a cloud proxy for all-sky assimilation of hyperspectral IR observations.
- All-sky observation errors are modeled as cloud-amount dependent and inter-channel correlated.
- Instead of being used as a QC procedure, cloud detection in all-sky assimilation is utilized to determine when all-sky observation errors are applied.
- The preliminary testing of the all-sky framework in GEOS using observations from CrIS-FSR six water-vapor channels that are not strongly sensitive to the surface shows overall neutral impacts on the analyses. This provides a good starting point for further development of all-sky IR radiance assimilation.

Acknowledgements

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