Development of NUCAPS for CSPP Real-Time Processing of Early Morning Orbit Hyperspectral Sounding Suites

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Overview

- **Objective: Enhance NUCAPS hyperspectral sounding profile capability, supplementing infrequent radiosondes with wide swaths of model-independent soundings over the whole globe with much improved spatial and temporal coverage.**
- S-NPP/NOAA-20 and the future JPSS satellites flying in early afternoon orbits (1:30pm), METOP satellite series flying in mid-morning orbits (9:30am), and the FY-3E in the early morning orbit (5:40am) provide continuous monitoring of the atmospheric state throughout the day.
- The FY-3E satellite carries the Hyperspectral Infrared Atmospheric Sounder (HIRAS-2) and Micro-Wave Temperature/Humidity Sounder-3 (MWTS-3 and MWHS-3), which are similar to CrIS/ATMS and IASI/AMSU class of advanced satellite sounding suites.
- NOAA NWS field offices currently are provided with two-orbit coverage (9:30 and 13:25) of NUCAPS sounding profiles that are used routinely to assist forecasters in monitoring and forecasting short life cycle convective storms.
- **The lack of early morning sounding information directly handicaps forecaster's ability to monitor and forecast convective storms.**
- FY-3E sounding retrieval capability to NUCAPS will routinely provide low latency and unified state-of-the-art soundings.
- FY-3E soundings will mitigate the significant gaps that limit the forecasters' ability to monitor and near-cast the short-lived convective storms.

Future Work

- Increase number of focus days in regression coefficient training. Summer currently missing.
- Modify microwave forward model to handle MWTS and MWHS.
- Derive bias tuning and error estimates for HIRAS. Currently assumed they are the same as NOAA-20 CrIS.
- System optimization.
- Extract HIRAS full information content. Currently only using CrIS channels.
- Nowcasting case studies.

Impact of microwave channels sensitive to liquid water and surface emissivity to retrieval
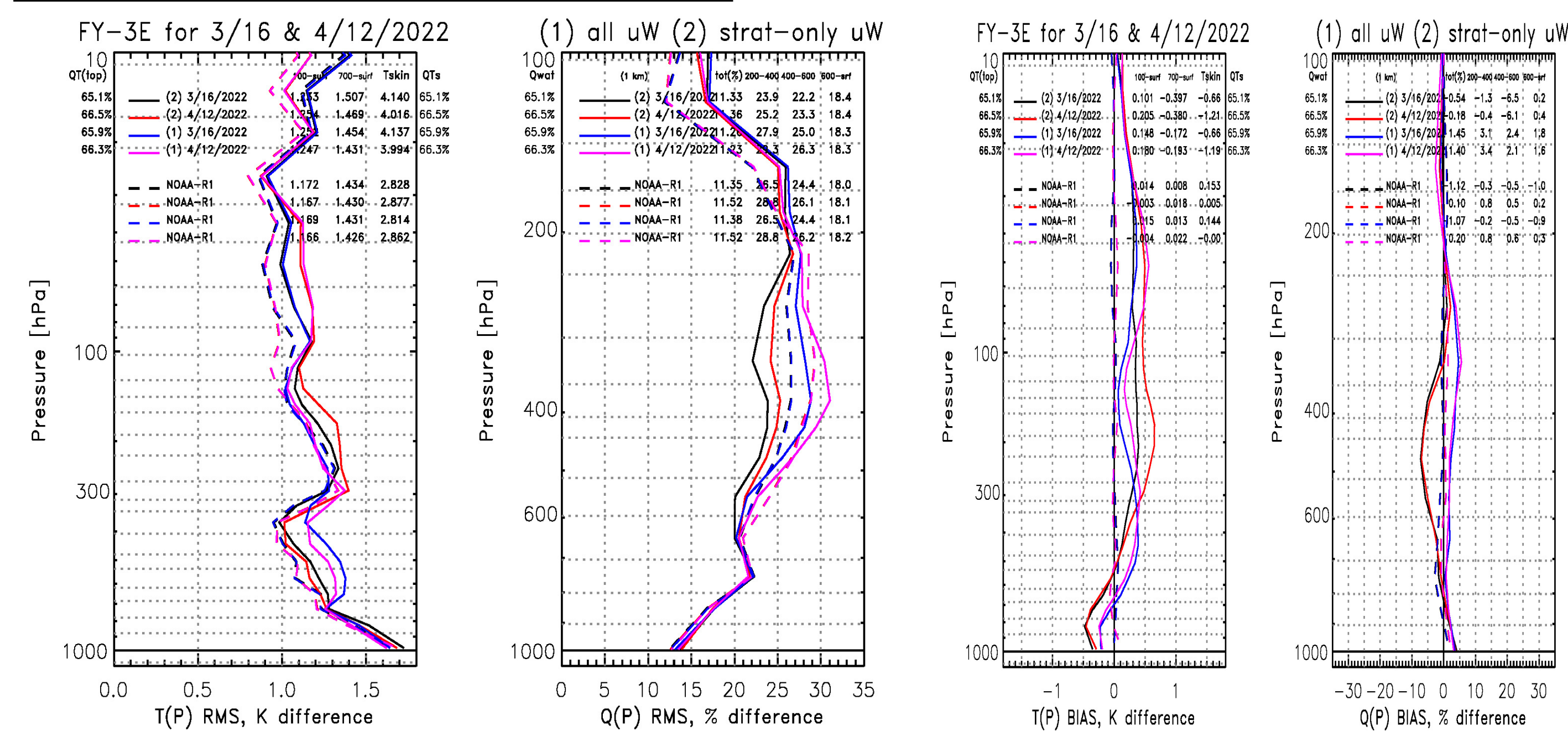

Figure 1   Temperature and moisture RMSE (left) and bias (right). Subsets of 3/16 and 4/12 used for training. Cloudy regression (dashed lines) and physical retrieval (solid lines) **Blue** and **magenta** use all microwave channels in T/q retrievals except MWTS channel 1 and 2. **Black** and **red** have microwave channels sensitive to liquid water and surface emissivity removed.

FY-3E HIRAS-2/MWTS-3/MWHS-3 comparison with CrIS/ATMS

Table 1   FY-3E instruments specifications in comparison to CrIS/ATMS.

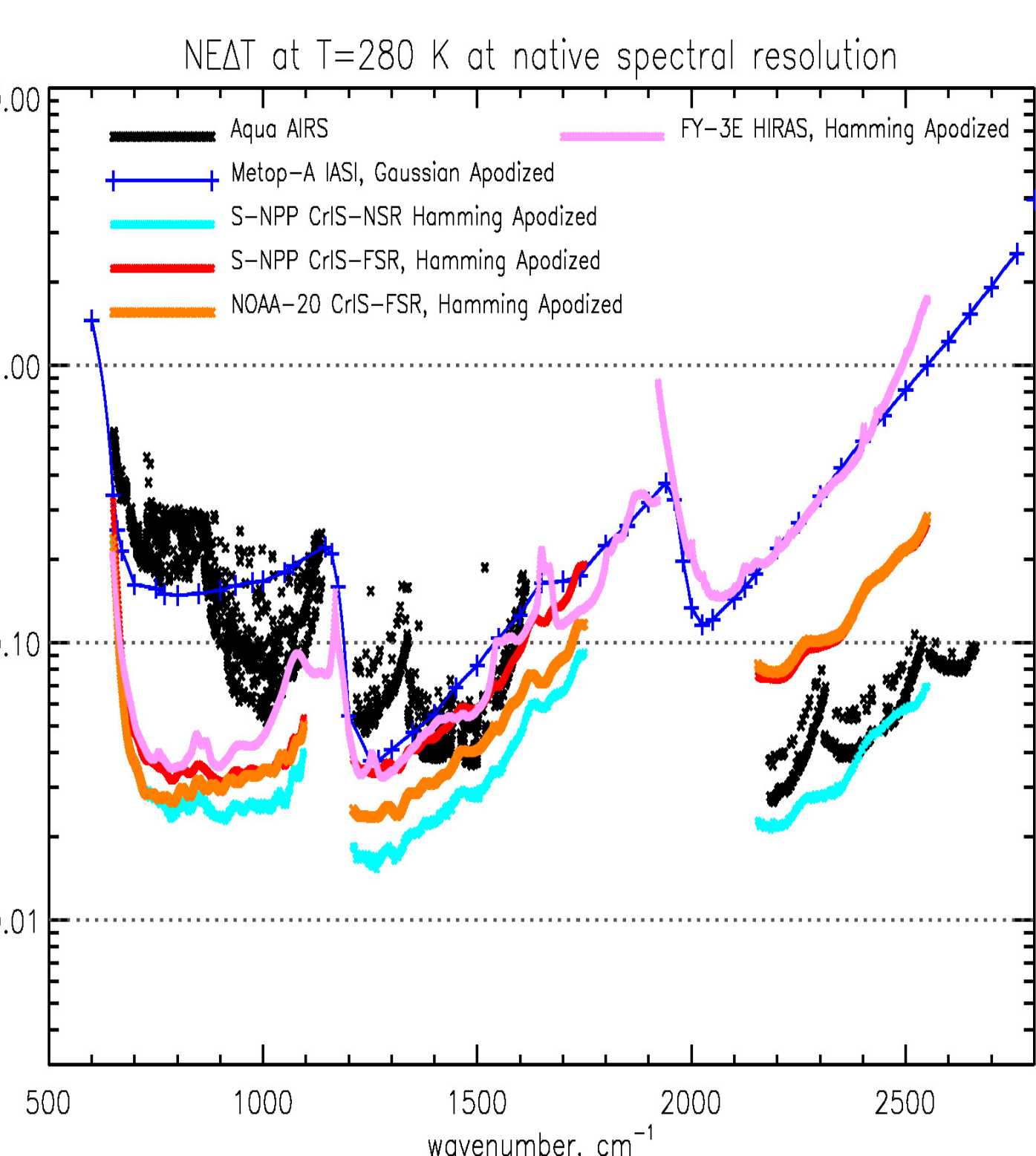|	HIRAS-2	CrIS	MWTS-3	MWHS-3	ATMS
No. of channels	3,041	2,211	17	15	22
Spatial Resolution in km	14	14	16	16	16
FOVs	3 x 3	3 x 3	98	98	96
FORs	28	32			
Notes	Full band coverage		118 GHz band		

Figure A   Comparison of FY-3E HIRAS-2 NeDT with other hyperspectral infrared sounders
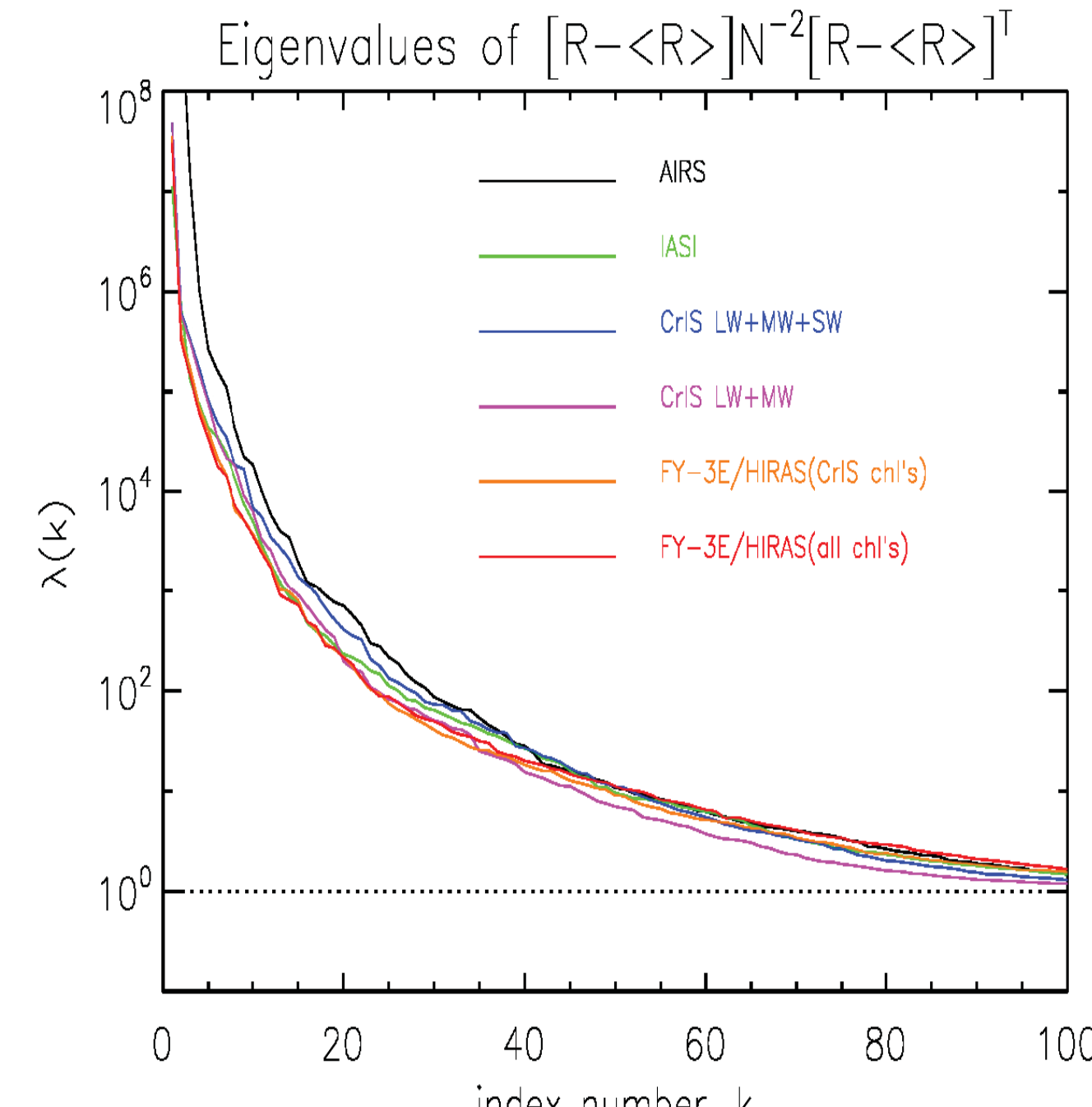
Figure B   Information content estimate of HIRAS-2 in comparison to other hyperspectral infrared sounders.

FY-3E 30 Oct 2022 independent day retrieval

2022 FY-3E
2022 N20
2017 S-NPP

Physical
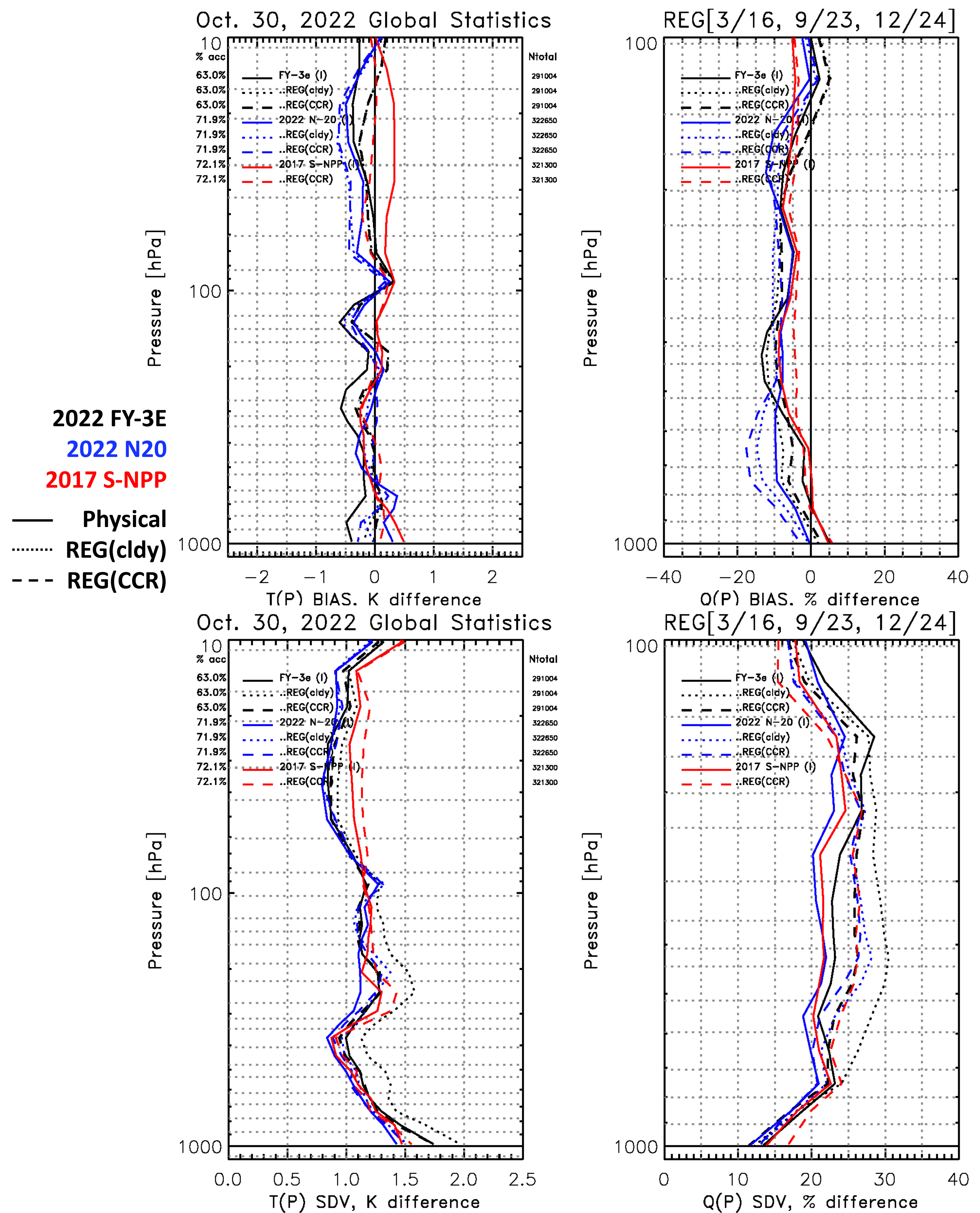**REG(cldy)**
REG(CCR)

Figure 2   Temperature and moisture bias (top) and standard deviation (bottom). Coupled physical retrieval is plotted in solid line. Regression trained on cloudy radiances [REG(cldy)] is plotted as dotted line. Regression trained on cloud clear radiances [REG(CCR)] Is plotted as dashed line. NOAA-20 statistics in blue on 30 Oct 2022 was included for comparison. Microwave channels sensitive to liquid water or surface emissivity not used during retrieval.

Figure 3   (Top) Day vs night. (Center) Polar, mid latitude and tropics. (Bottom) Land, ocean and coast. Temperature and moisture bias (left) and standard deviation (right). Coupled physical retrieval is plotted in solid line. Regression trained on cloudy radiances [REG(cldy)] is plotted as dotted line. Regression trained on cloud clear radiances [REG(CCR)] Is plotted as dashed line. NOAA-20 statistics on 30 Oct 2022 was included for comparison. Microwave channels sensitive to liquid wate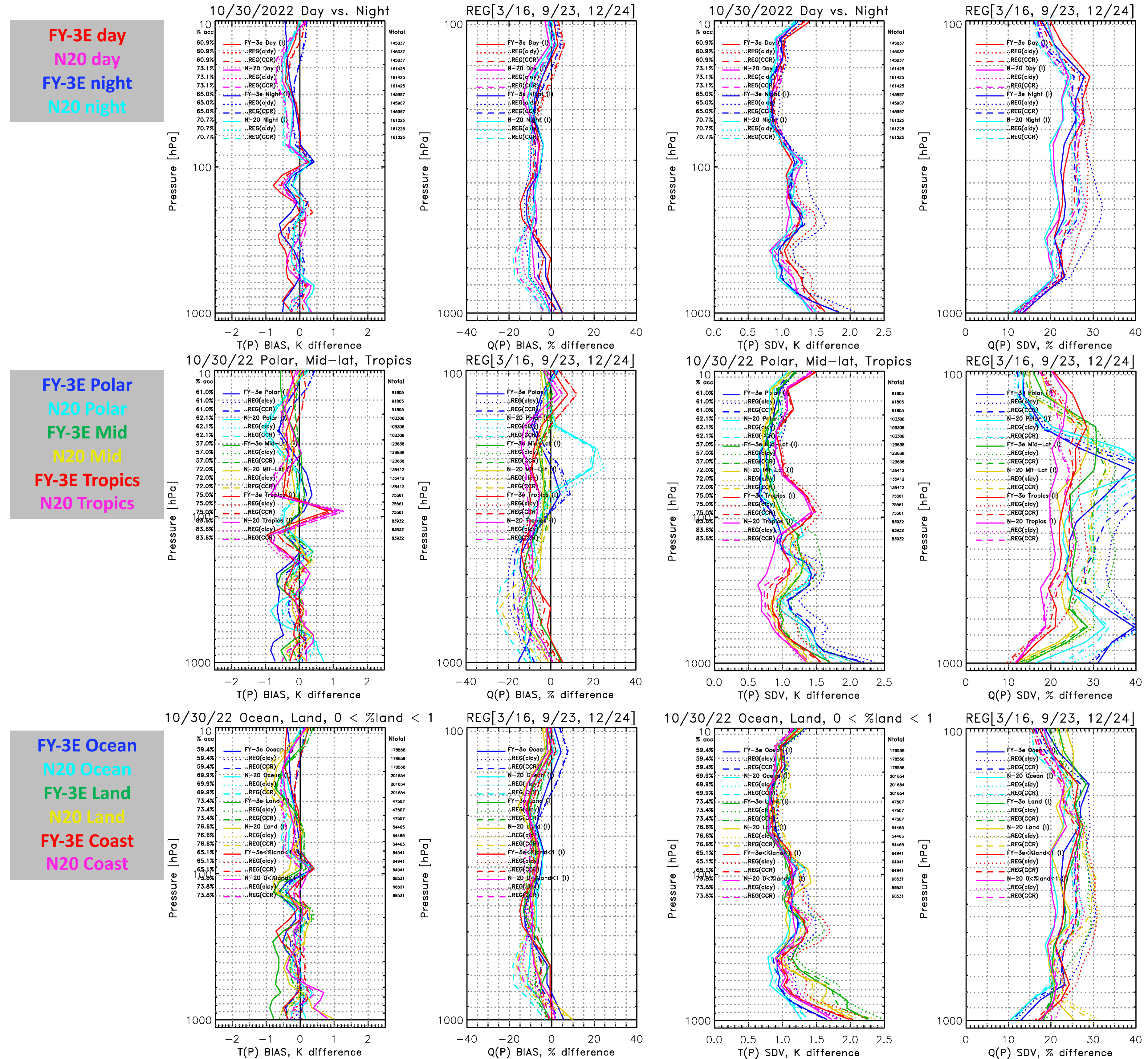r or surface emissivity not used during retrieval.