The CLIMCAPS-SNPP and CLIMCAPS-JPSS1 results in v02_28_02

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Special thanks to:

Nadia Smith and Chris Barnet (STC)

Jet Propulsion Laboratory
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Oct 8, 2020

NASA Sounder Science Team Virtual Meeting FALL 2020

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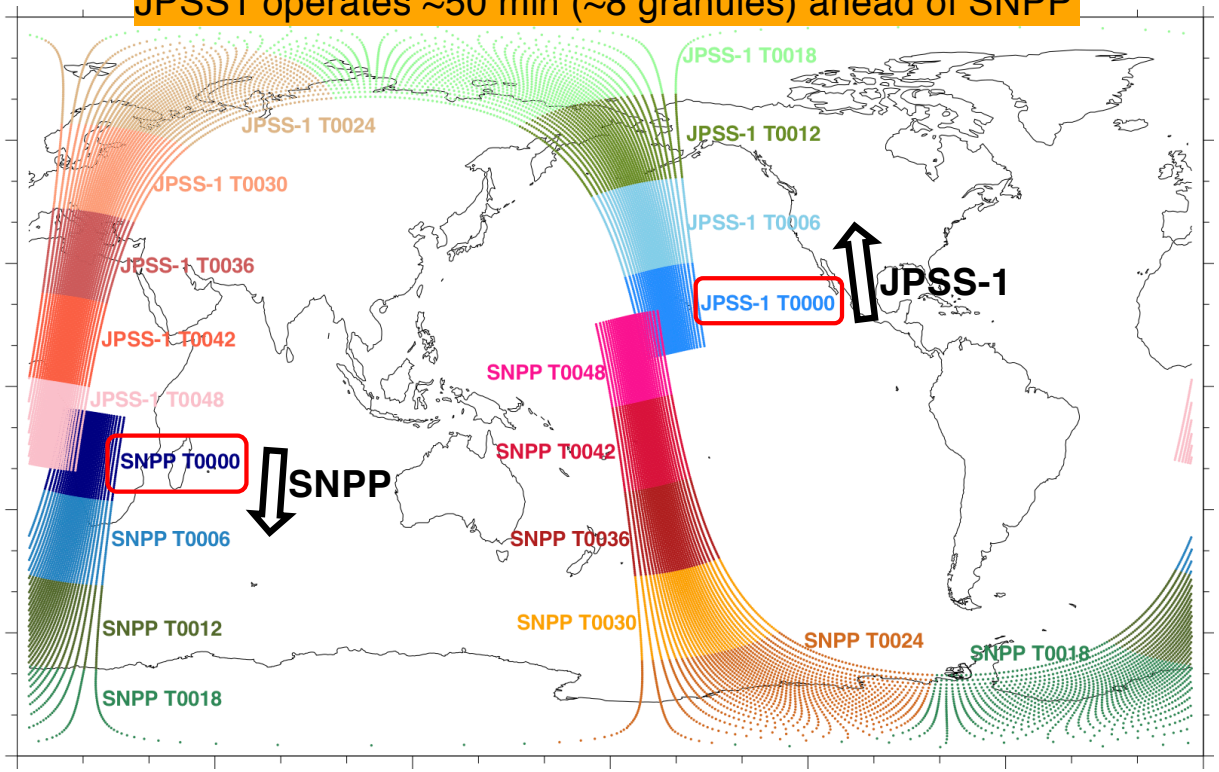
CLIMCAPS: Community Long-term Infrared Microwave Coupled Atmospheric Product System

CrIMSS instrument suite: CrIS (Cross-track Infrared Sounder) **+ ATMS** (Advanced Technology Microwave Sounder)

onboard the **SNPP** since October 2011

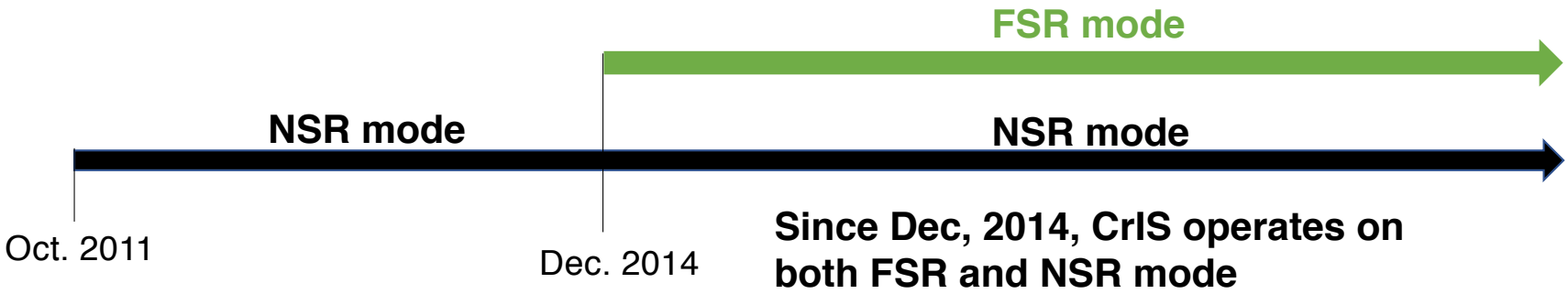
onboard the **JPSS-1** (now known as **NOAA-20**) since November 2017

JPSS1 operates ~50 min (~8 granules) ahead of SNPP



First 9 granules (T0000–T0048) of CrIMSS footprints onboard the SNPP and the JPSS-1 during **January 1st, 2019**

- **A note for CrIS onboard the SNPP**



Band	Spec. Rng. (cm^{-1})	# of Chan.	Spec. Res. (cm^{-1})
LWIR	**650-1095** 650-1095	**713** 713	**0.625** 0.625
MWIR	**1210-1750** 1210-1750	**433** 865	**1.25** 0.625
SWIR	**2155-2550** 2155-2550	**159** 633	**2.50** 0.625

NSR → FSR

- **most changes in MW and SW**
- **Increased Spectral Resolution (SR)**
- **Increased # chan.: 1304 → 2211**

All data are available in GES-DISC:

CLIMCAPS-**SNPP FSR**: https://disc.gsfc.nasa.gov/datasets/SNDRSNIML2CCPRET_2/summary?keywords=climcaps%20snpp%20L2

CLIMCAPS-**SNPP NSR**: https://disc.gsfc.nasa.gov/datasets/SNDRSNIML2CCPRETN_2/summary?keywords=climcaps%20snpp%20L2

CLIMCAPS-**JPSS1 FSR**: https://disc.gsfc.nasa.gov/datasets/SNDRJ1IML2CCPRET_2/summary?keywords=climcaps%20snpp%20L2

Objective:

Retrieval System:

CLIMCAPS **version v02_28_02** (algorithm version **v02.00.02**)
First guess: **MERRA2**

Evaluate CLIMCAPS-SNPP **FSR & NSR** vs.
CLIMCAPS–JPSS1 **FSR**

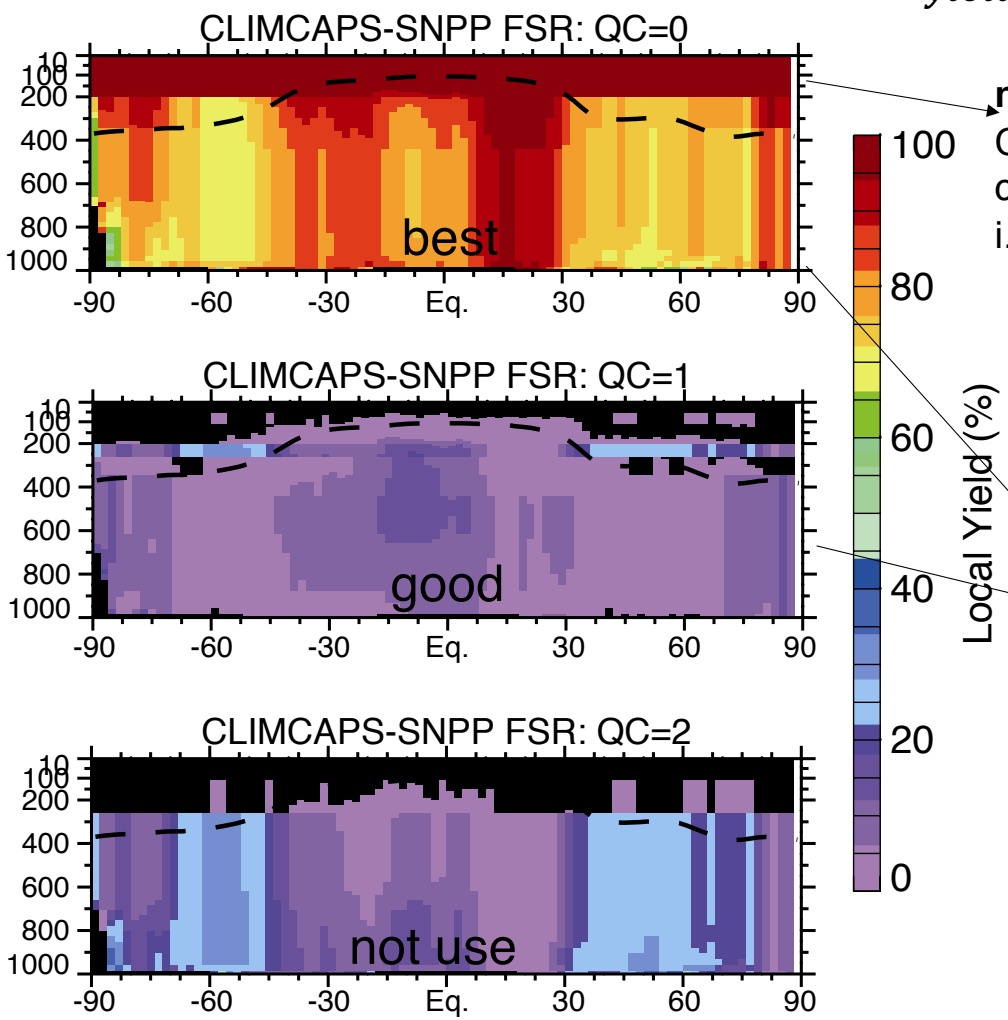
1. **General attributes:** 3 days Jan 10-12, 2019
   retrieval yields, retrieve ability (deviation from first guess)

2. **Retrieval quality of T/H_2O:** January, 2019
   comparing to IGRA radiosondes, v2

All results are QC controlled (QC=0 or 1 for scientific use)

1. General attributes: retrieval yields

$$yield = \frac{retrieval\ \#\ (QC'ed)}{total\ \#\ of\ obs.} \times 100\%$$

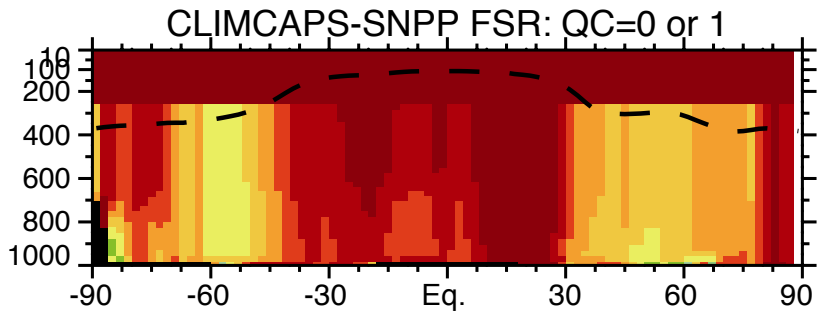


near ~100% data yield when P < 200 hPa

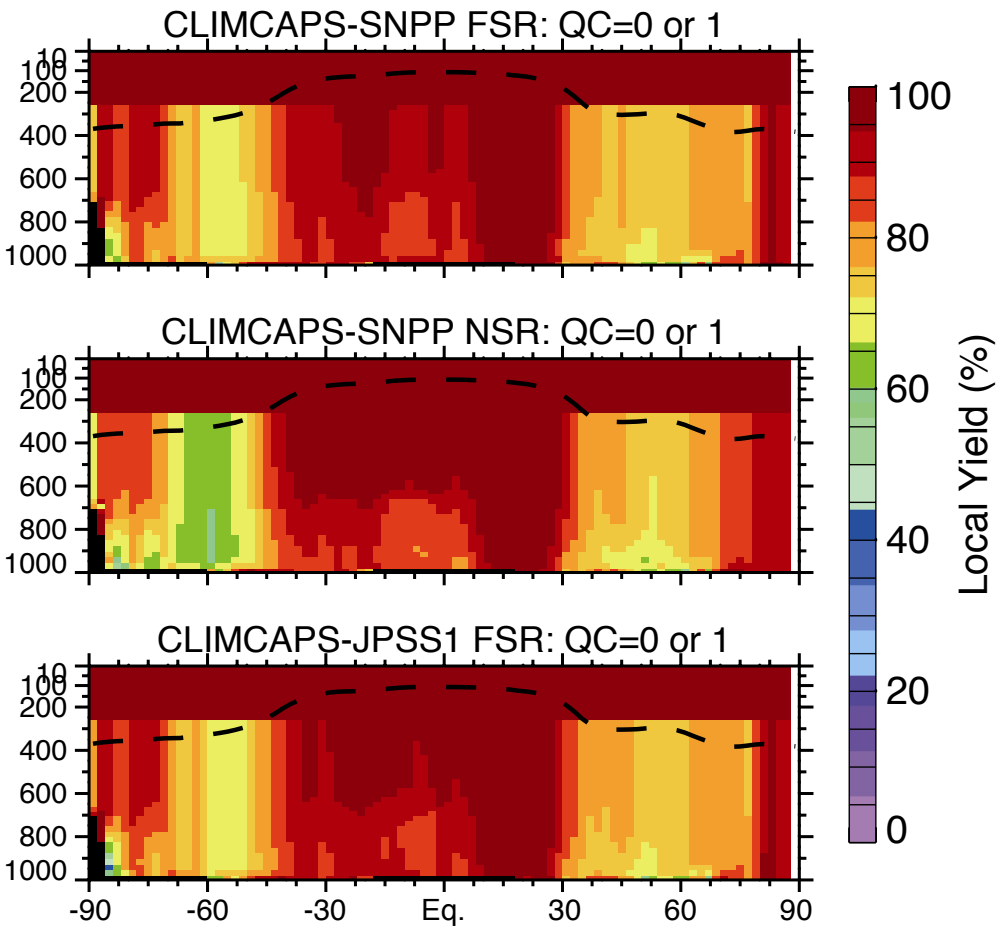
CLIMCAPS assumes excellent cloud contrast so cloud clearing should be working reasonably well,

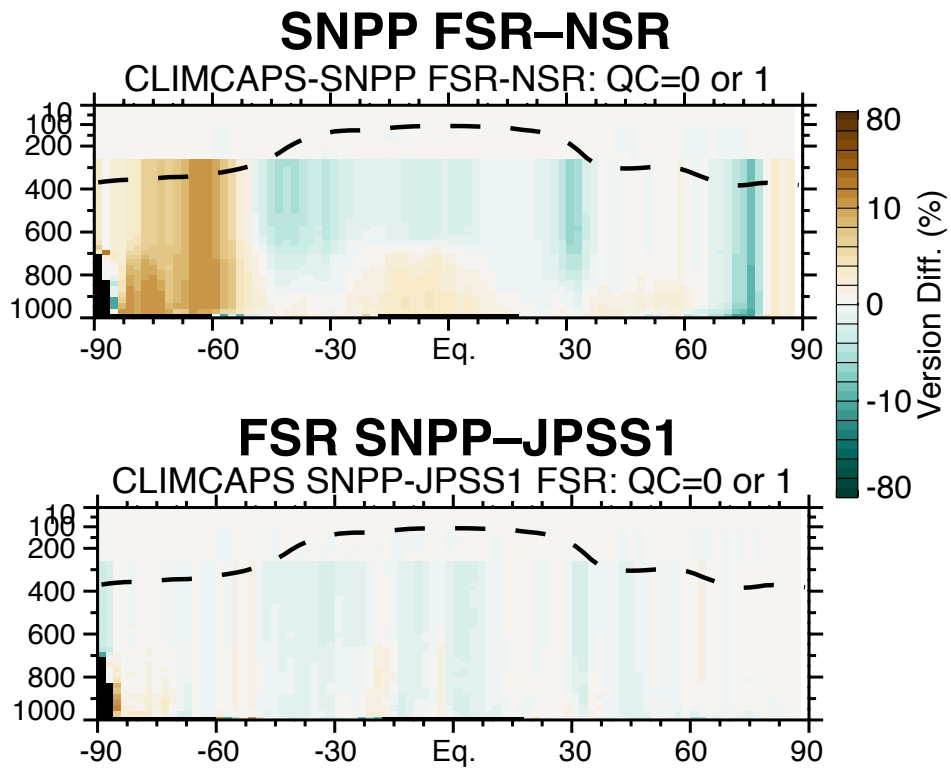
i.e., **all measurements are considered useful**

For scientific use



1. General attributes: retrieval yields



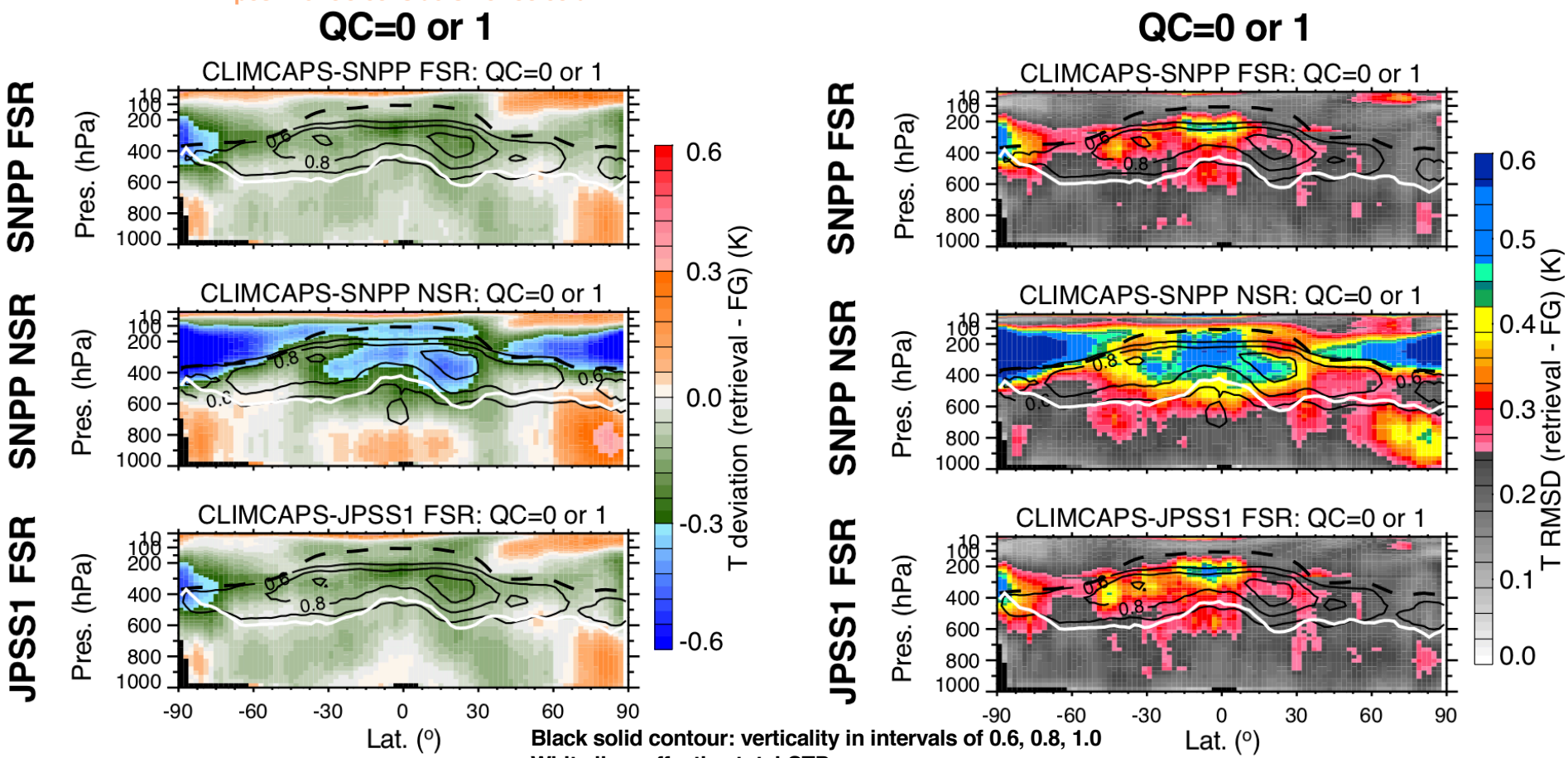


1. General attributes: retrieval deviation from first guess (MERRA2)

$$T_{deviation} = mean(T_{retrieval} - T_{first\ guess})$$

negative: CC considers FG too warm
positive: CC considers FG too cold

$$T_{RMSdeviation} = \sqrt{mean((T_{retrieval} - T_{first\ guess})^2)}$$



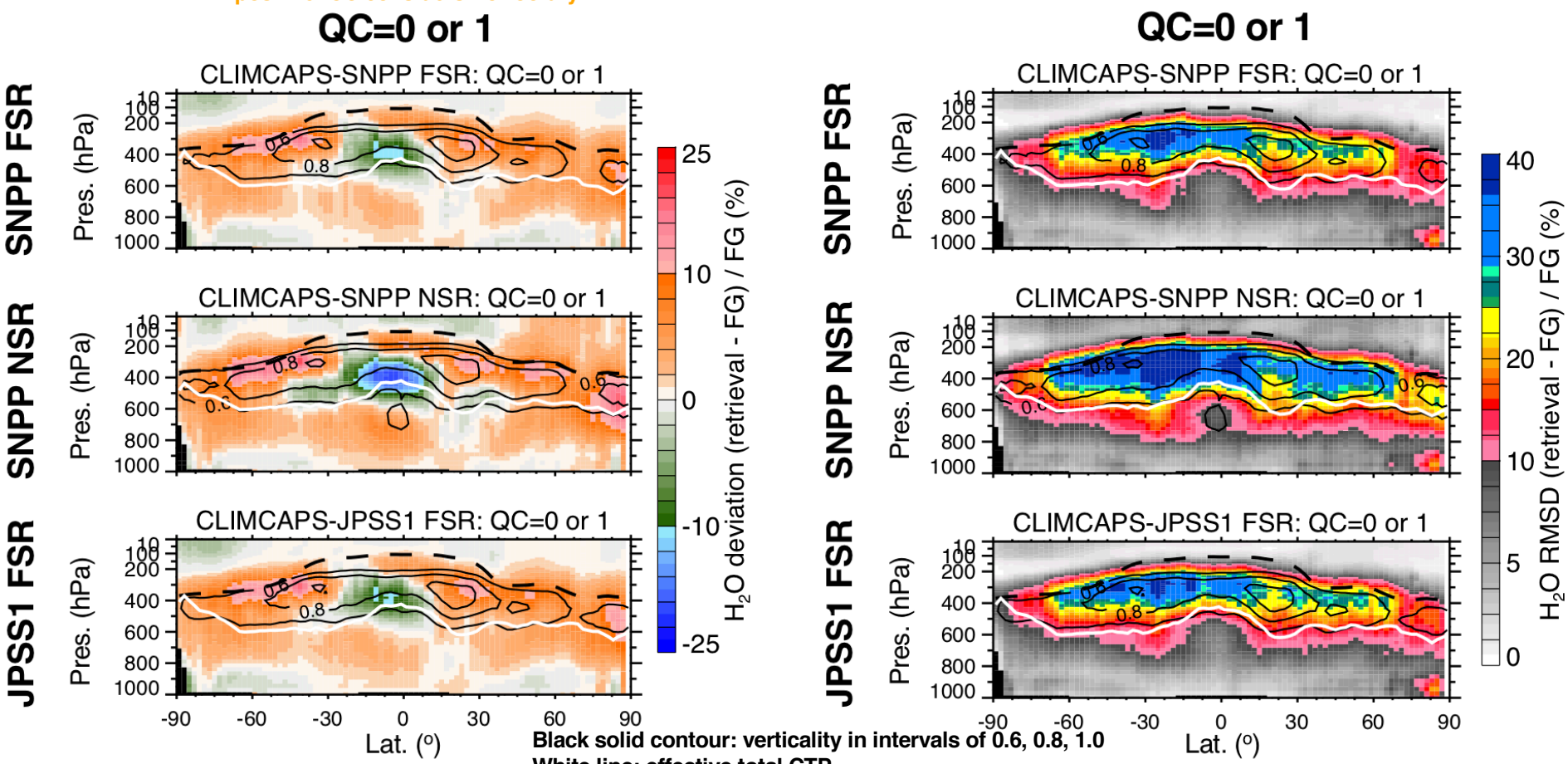
Black solid contour: verticality in intervals of 0.6, 0.8, 1.0
White line: effective total CTP

1. General attributes: retrieval deviation from first guess (MERRA2)

$$H_2O_{deviation} = \frac{mean(H_2O_{retrieval} - H_2O_{first\ guess})}{mean(H_2O_{first\ guess})} \times 100$$

negative: CC considers FG too wet
positive: CC considers FG too dry

$$H_2O_{RMSE} = \frac{\sqrt{mean((H_2O_{retrieval} - H_2O_{first\ guess})^2)}}{mean(H_2O_{first\ guess})} \times 100$$

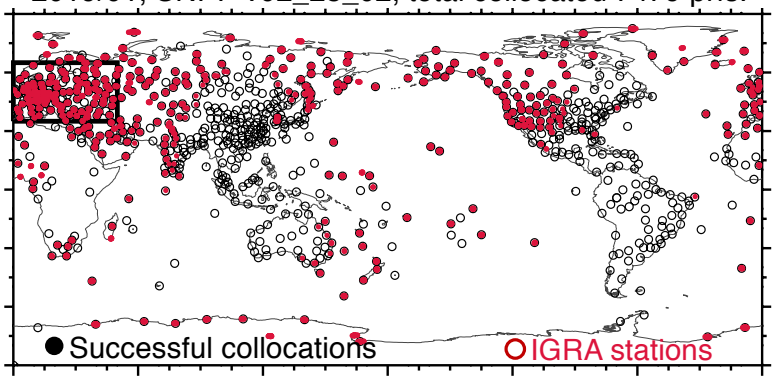


Black solid contour: verticality in intervals of 0.6, 0.8, 1.0
White line: effective total CTP

2. T/H_2O retrieval quality comparing to IGRA radiosondes

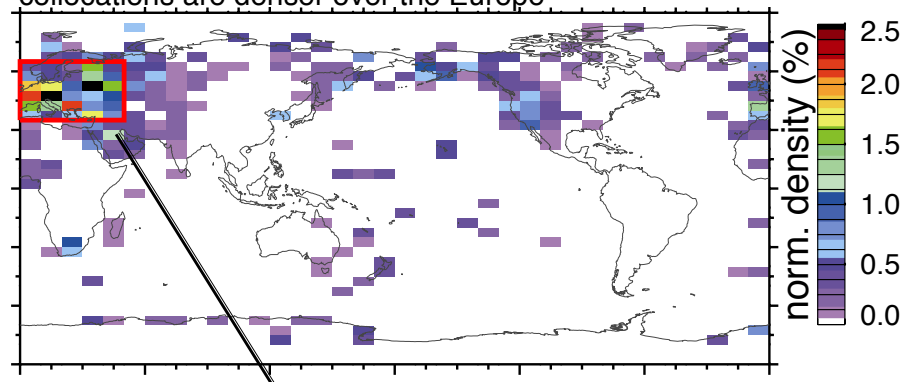
Collocated to IGRA within 3 hours, 50 km radius

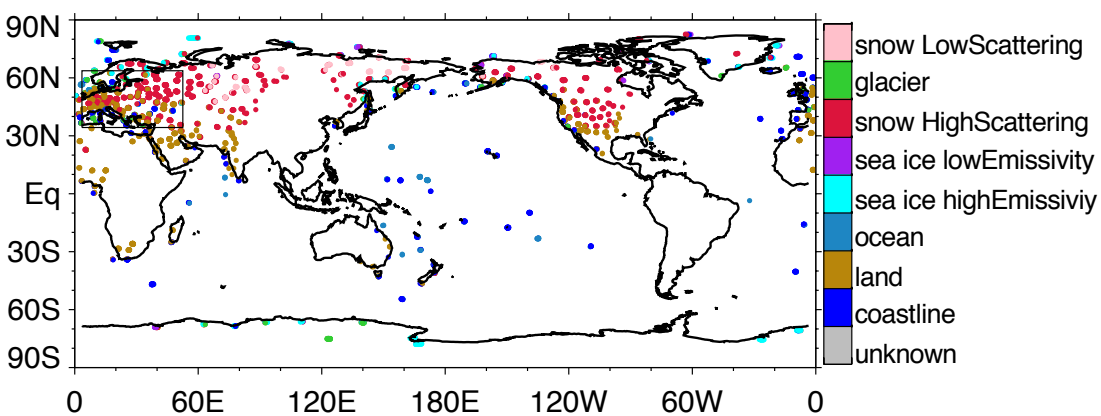
2019/01, SNPP v02_28_02, total collocated 7479 prfs.

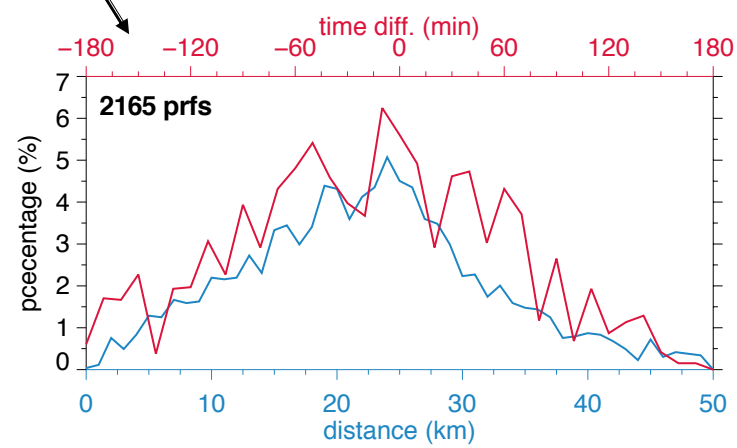


Normalized density of collocated profiles

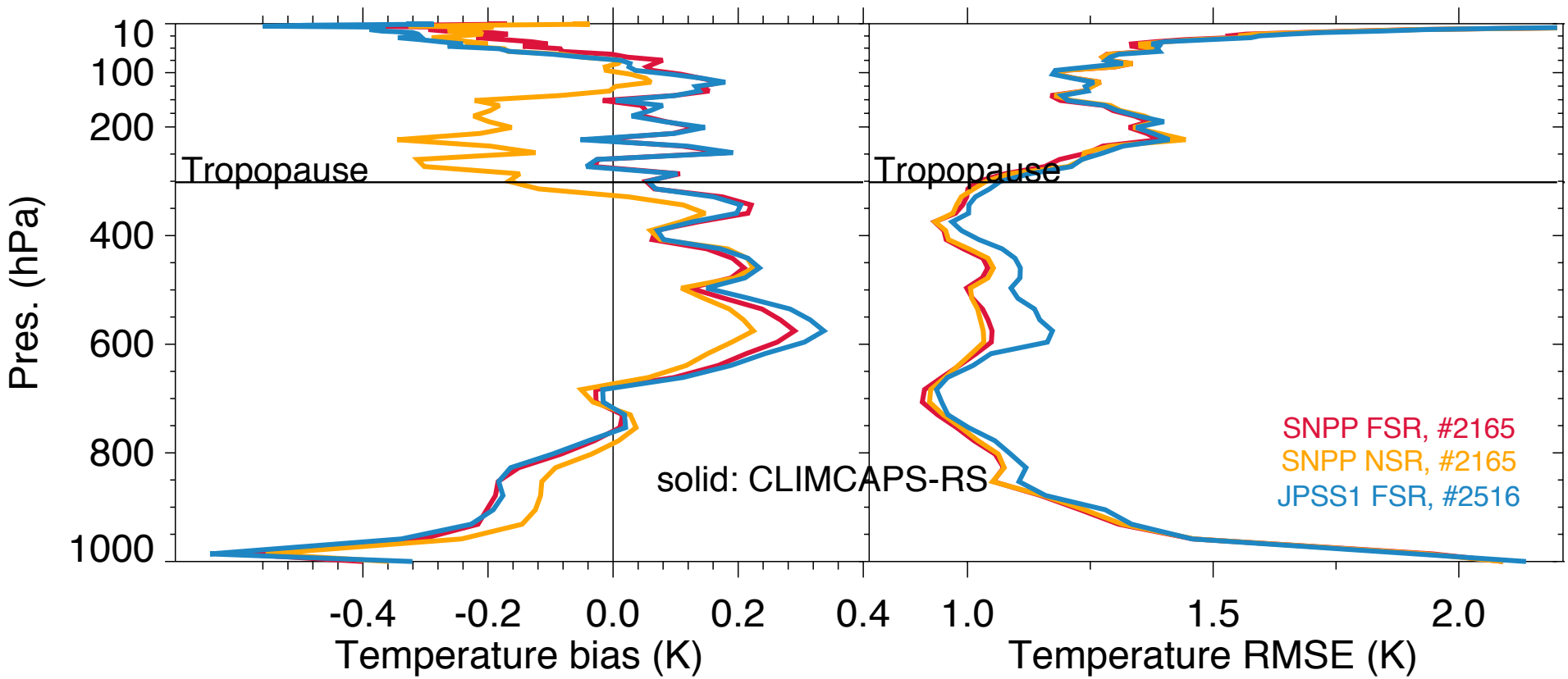
collocations are denser over the Europe



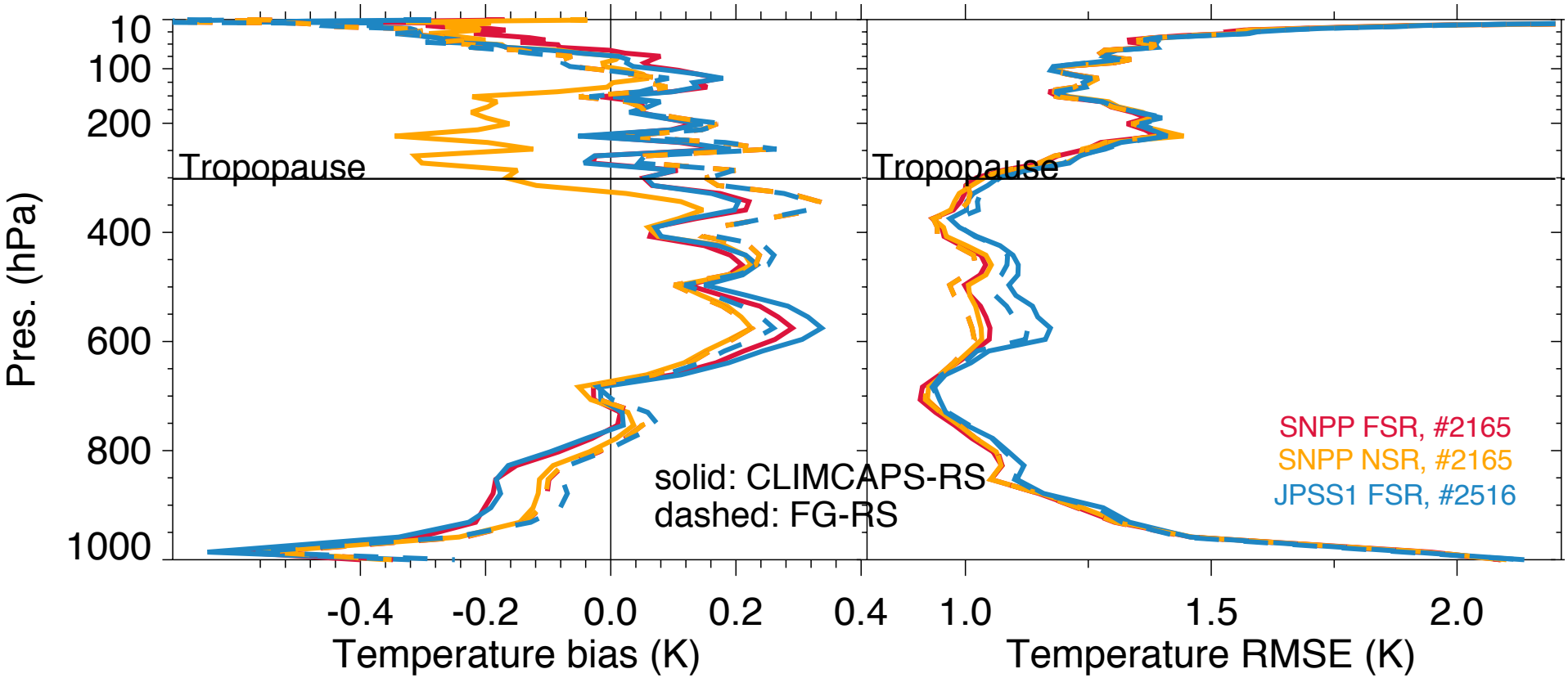




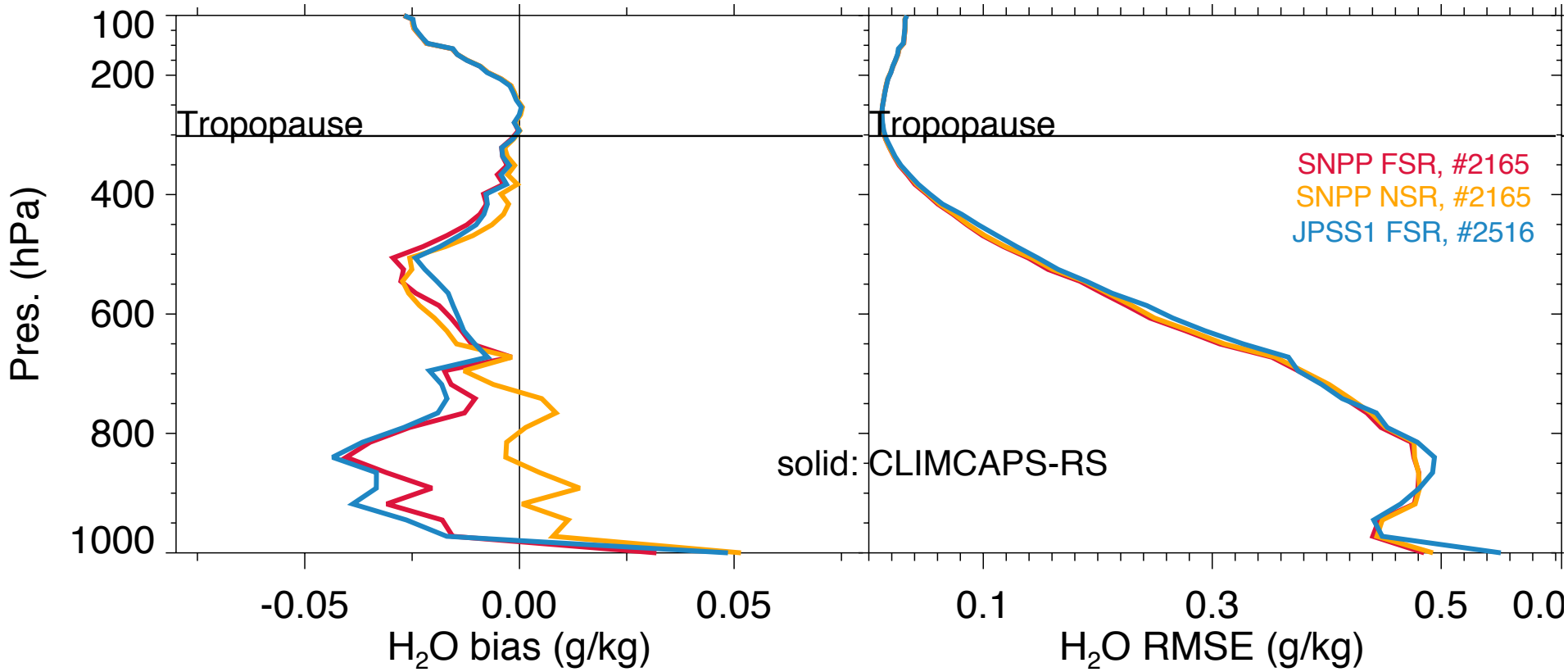
Temperature bias & RMSE in Europe



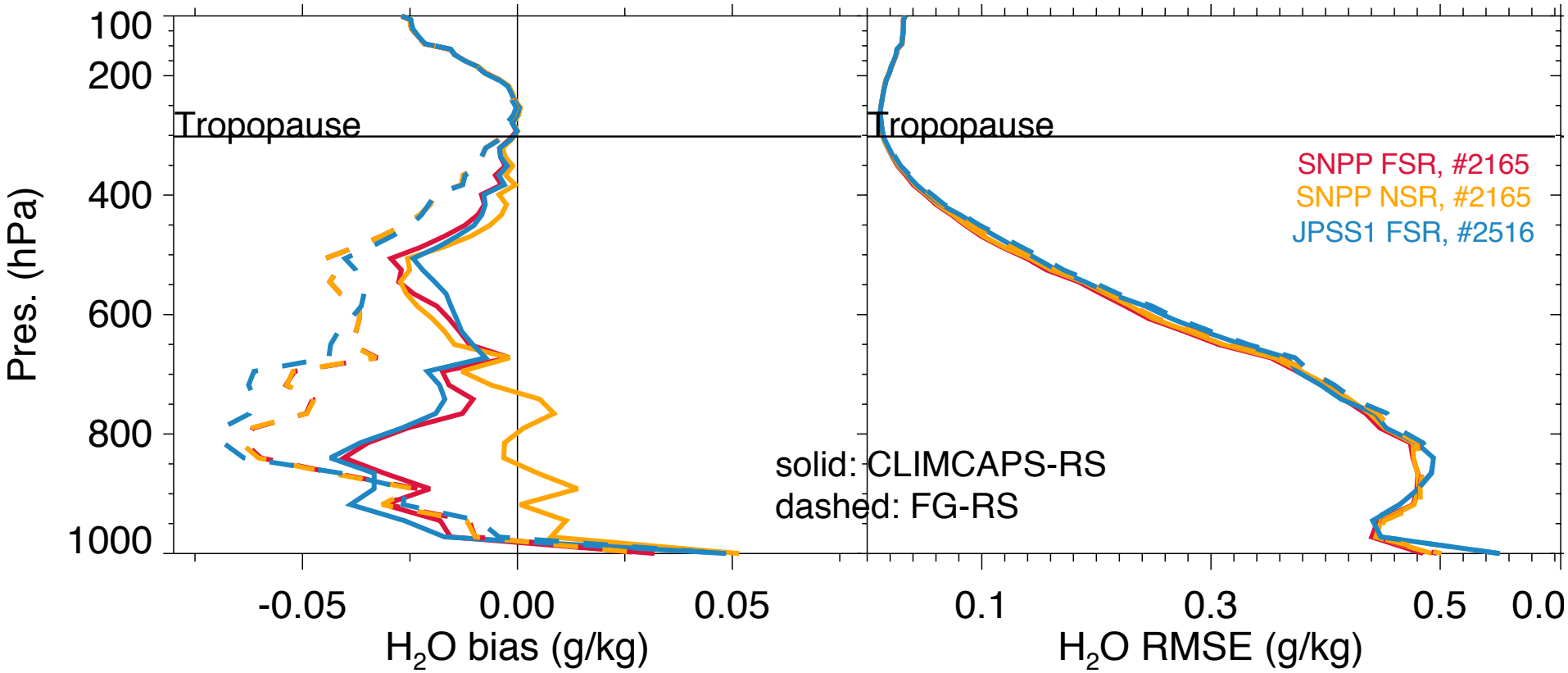
Temperature bias & RMSE in Europe



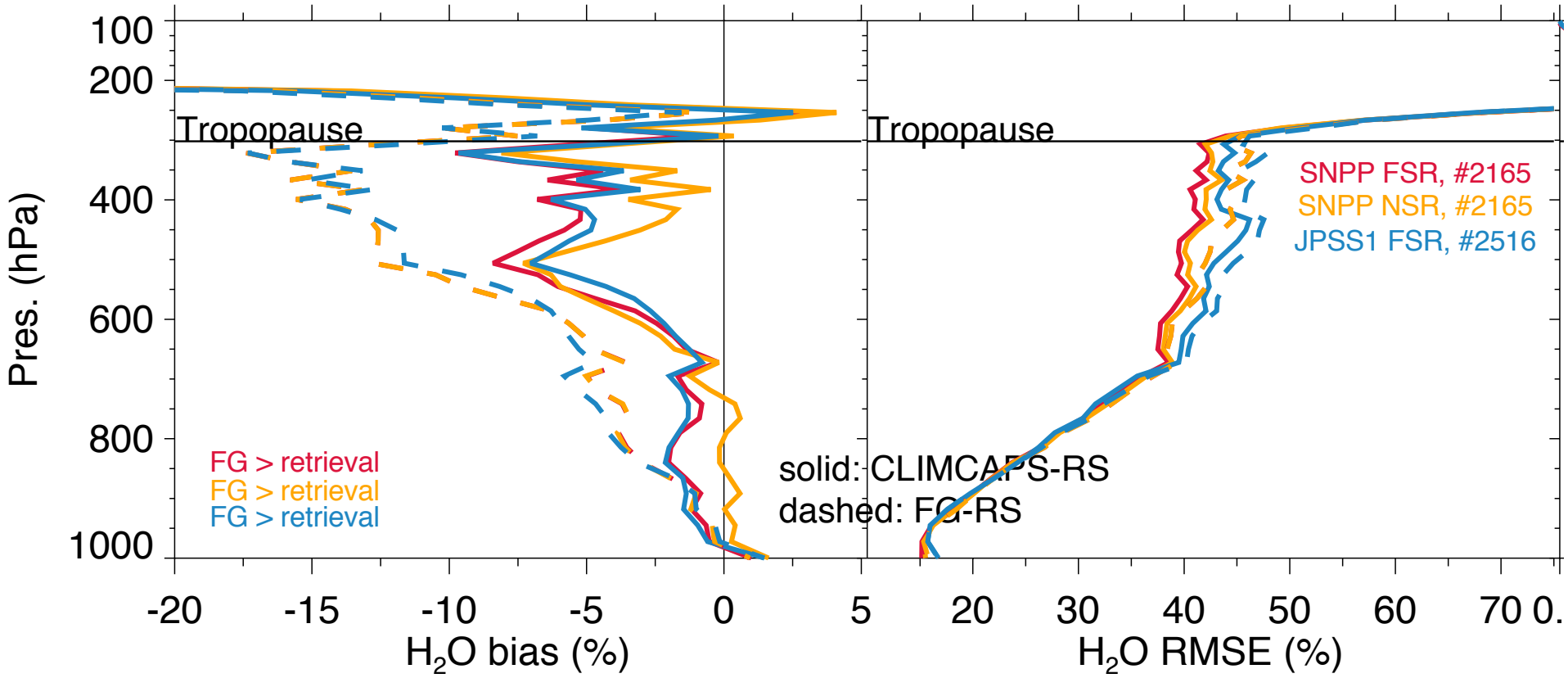
H_2O bias & RMSE in Europe



H_2O bias & RMSE in Europe

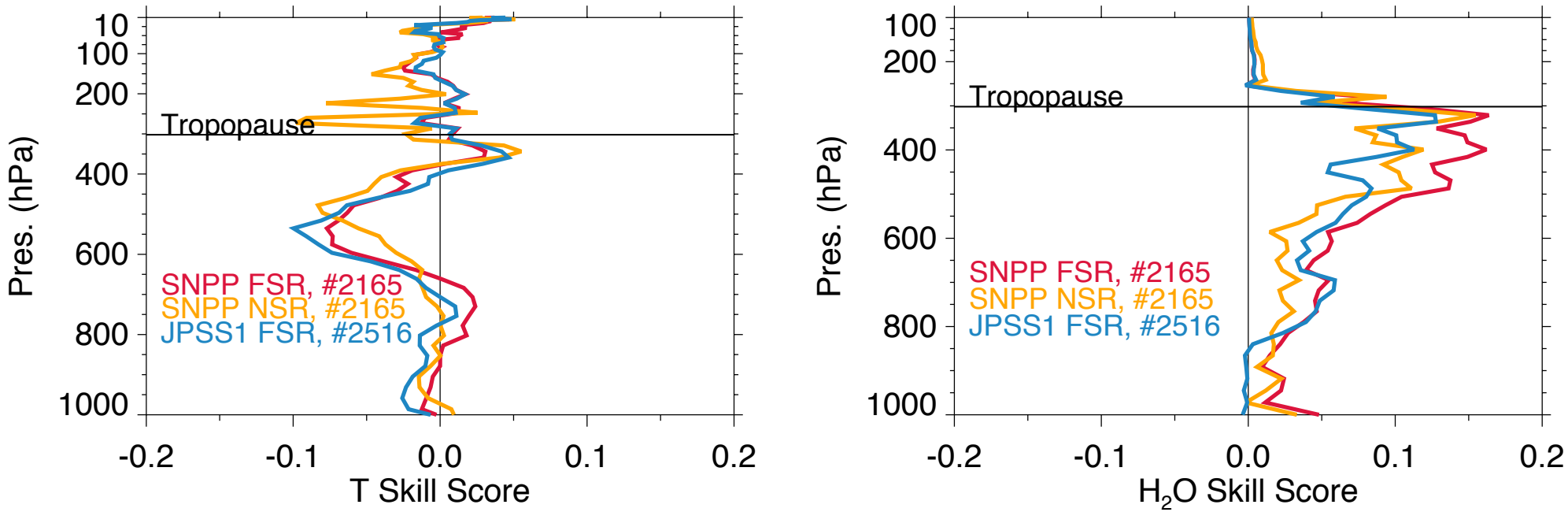


H_2O bias & RMSE (%) in Europe



mean squared error $$Skill\ Score = 1 - \frac{MSE_{retrieval}}{MSE_{First\ Guess}} = 1 - \frac{mean((T_{retrieval} - T_{IGRA})^2)}{mean((T_{First\ Guess} - T_{IGRA})^2)}$$

Score < 0: first guess is more skillful
Score > 0: retrieval is more skillful

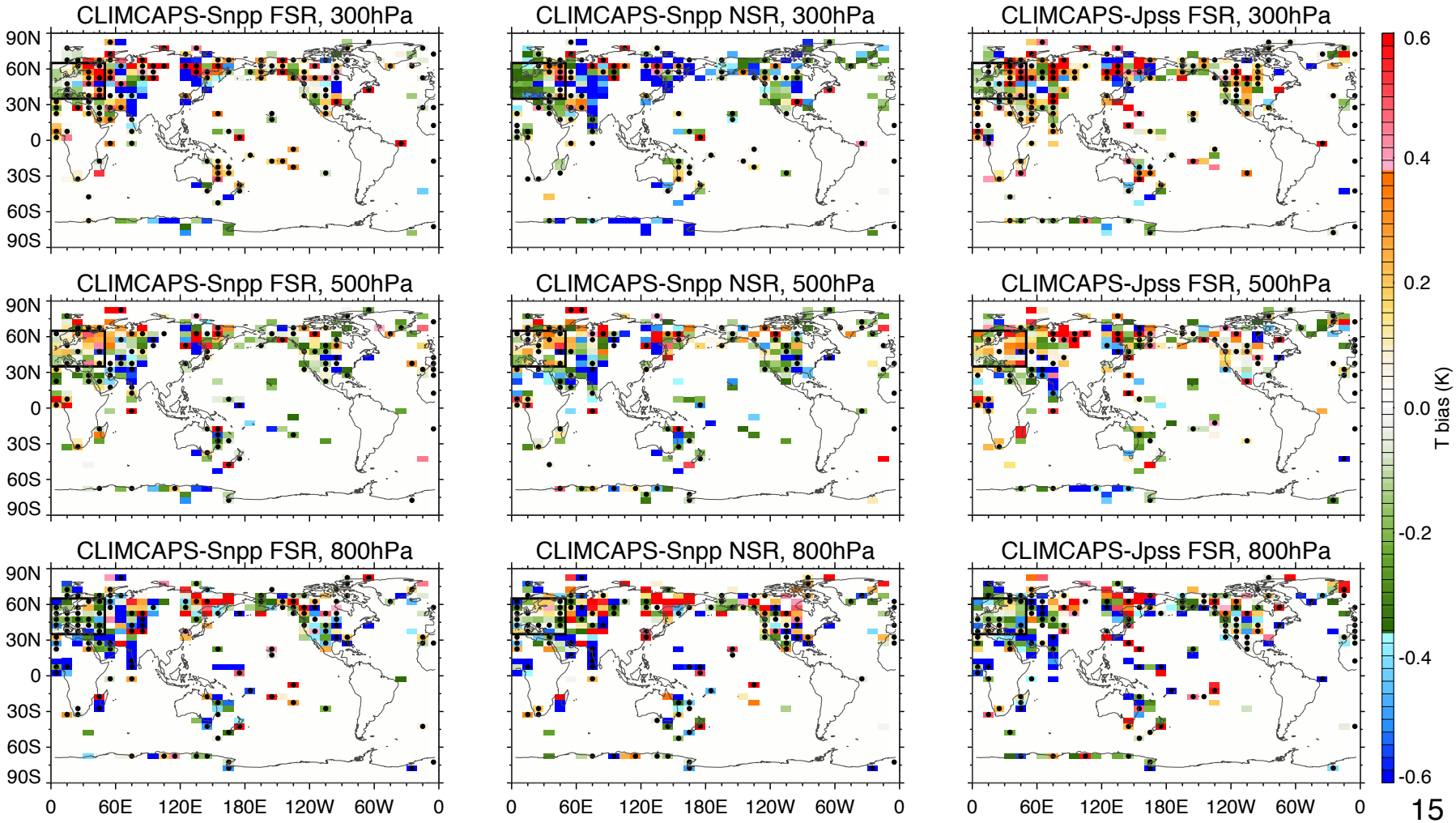


FG is MERRA2 !

Temperature bias for all collocated data

- **When retrieval is more skillful than FG**

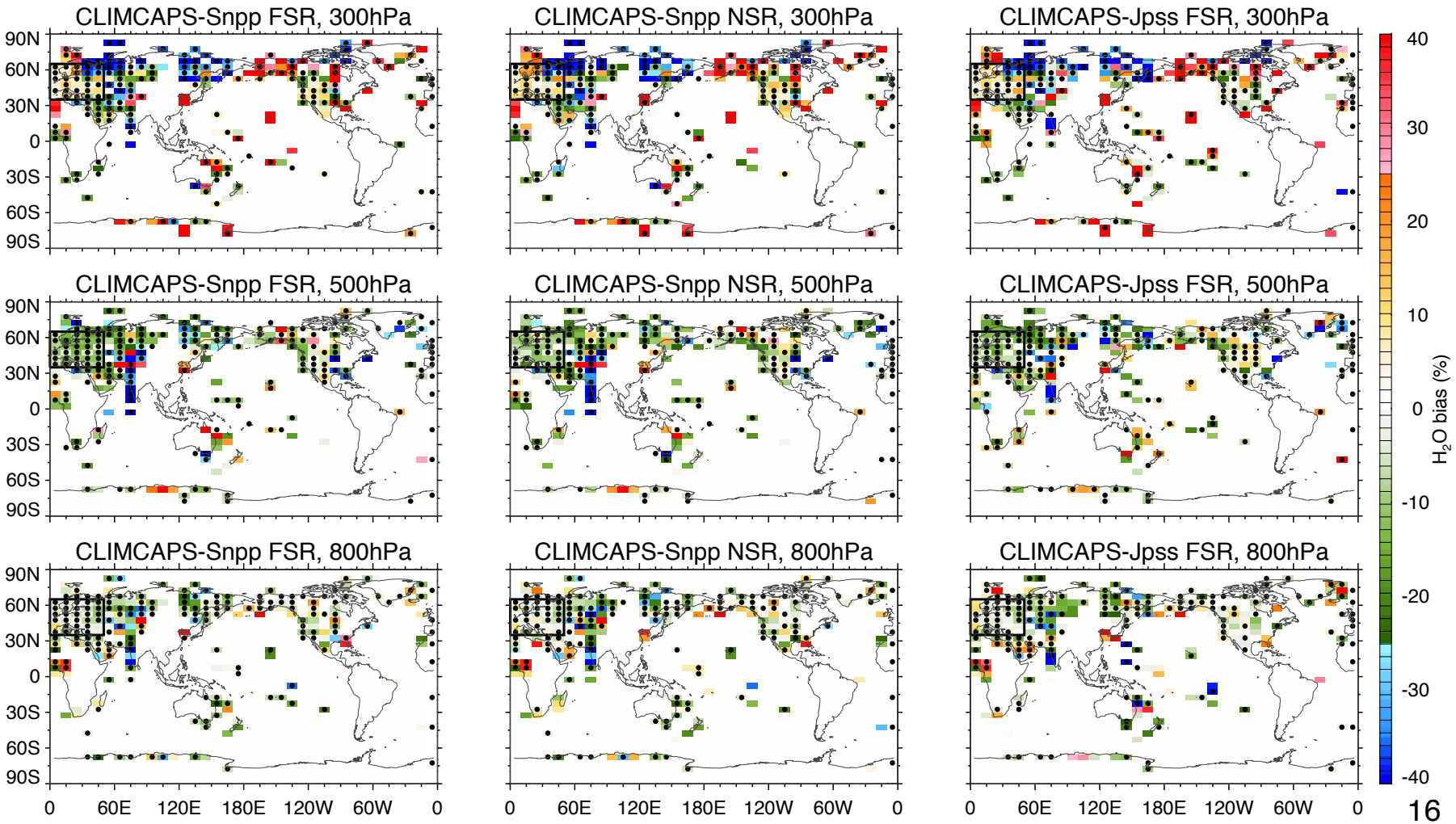
- T is biased small in Europe
- In non-Europe region, CC retrieval is more skillful than FG



H_2O bias for all collocated data

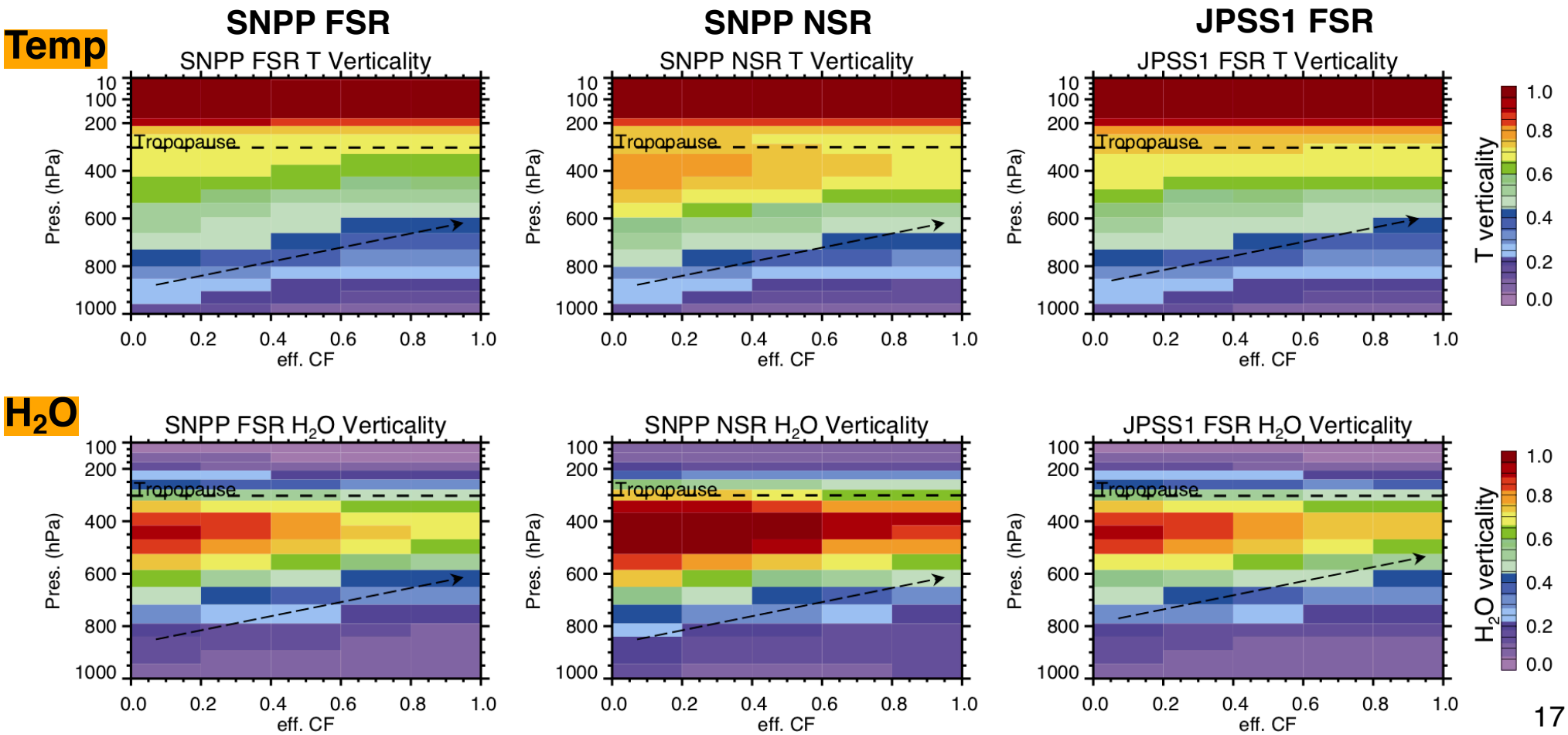
- **When retrieval is more skillful than FG**

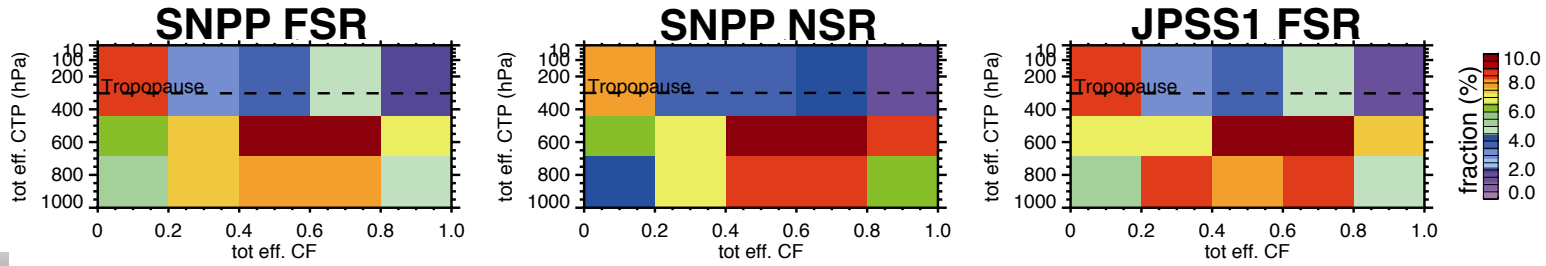
- H_2O is biased small in Europe
- CC retrieval is more skillful than FG



3. Retrieval affected by clouds

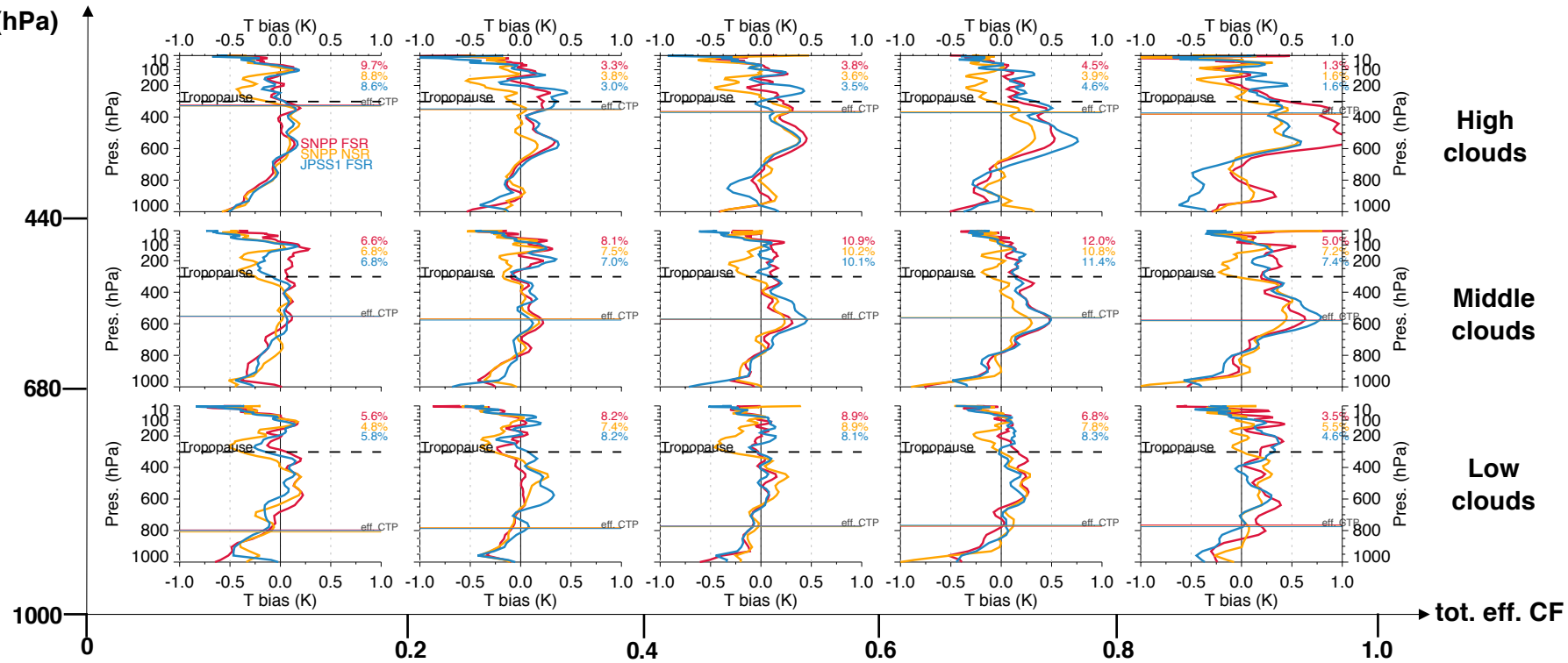
Verticality in functions of total effective cloud fraction

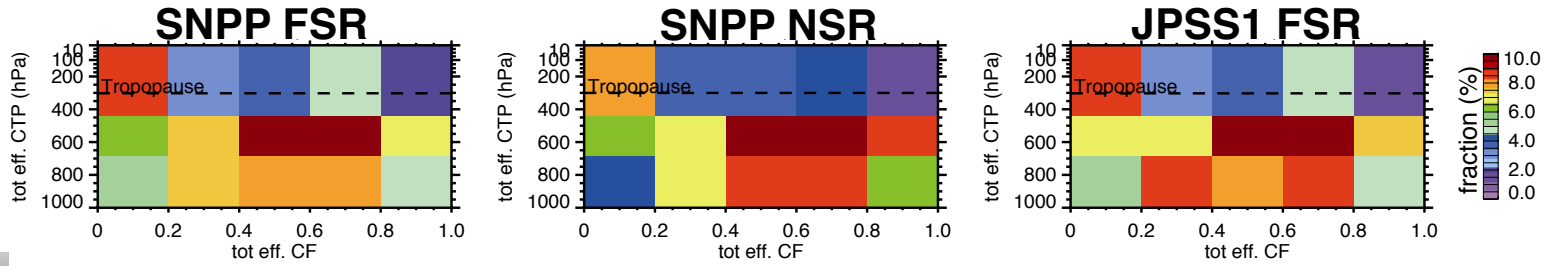




For T

Solid lines (lower x-axis): CLIMCAPS – RS
Thin, horizontal lines: effective CTP

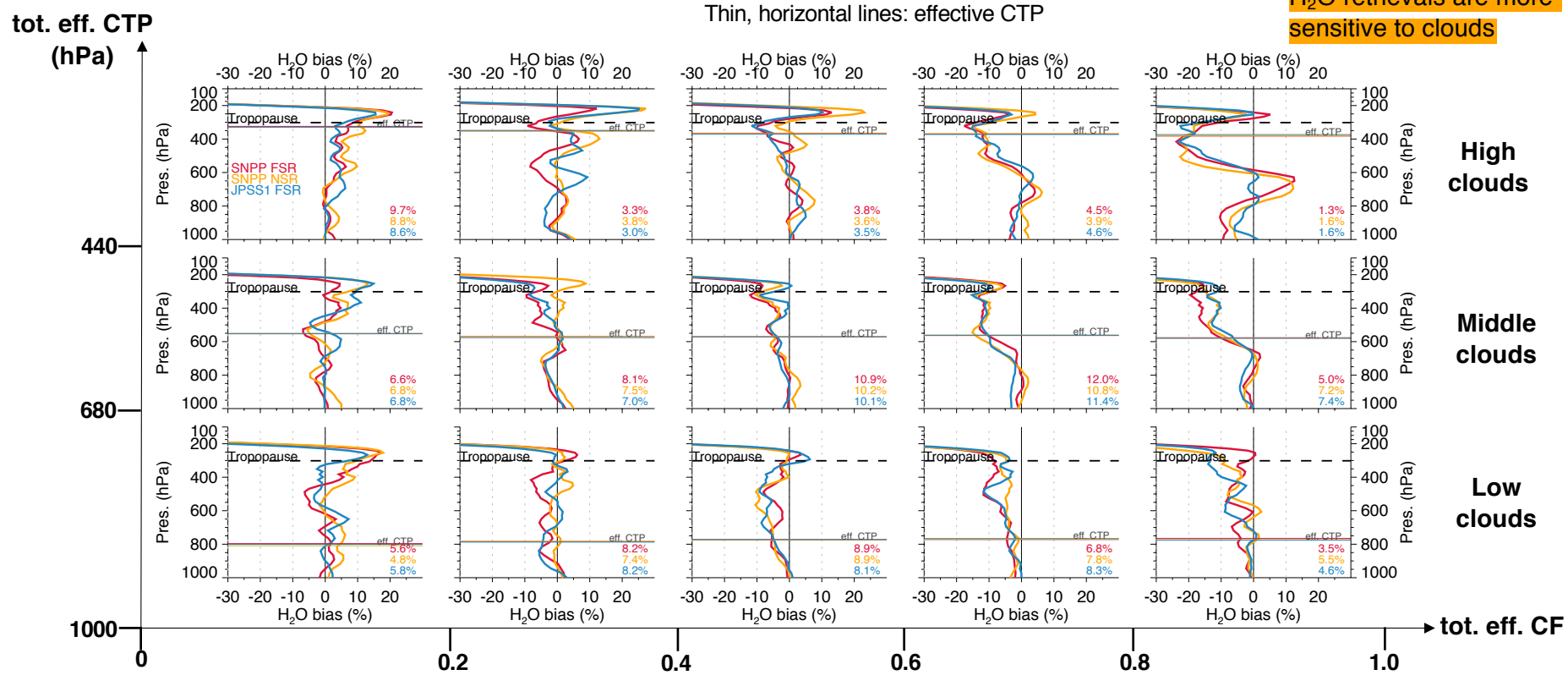




For H_2O

Solid lines (lower x-axis): CLIMCAPS – RS
Thin, horizontal lines: effective CTP

H_2O retrievals are more sensitive to clouds



Summary:

1. CLIMCAPS has pretty restrict quality control: its data yields are smaller than the previous retrieval system.

2. In FSR mode, CLIMCAPS generates very similar results between SNPP and JPSS1, indicating that the two suites of CrIMSS instruments onboard operate smoothly well so far.

3. Armed with MERRA2 as first guess, CLIMCAPS T retrieval is more skillful in non-Europe regions where less temperature observations were assimilated into MERRA2.

4. CLIMCAPS H_2O retrieval powerfully and skillfully corrects the first guess.

5. High, thick clouds affects the retrieval the most;

6. **In Europe: T** is **cold**-biased (**−** 0.1-0.5K) **below ~700hPa**

   warm-biased (**+** 0.1-0.2K) ~**700-100hPa**

   H_2O is **dry**-biased (**−** 2%) **below ~700hPa**

   dry-biased (**−** 5-10%) ~**700hPa to tropopause**

SNPP NSR generates the smallest biases below the tropopause for both T/H_2O;
above the tropopause, NSR has quite different T comparing to FSR