Water and Temperature SVD Estimates to Improve OCO-2 XCO$_2$ Errors

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Day 1: 10:00 – 11:00 JST
Day 2: 10:00 – 11:00 JST

Motivation: OCO-2 currently includes a single scalar water vapor and temperature state vector element in the XCO$_2$ retrieval. However, 2-3 pieces of water vapor and temperature information are actually in the measured radiances and simulations show that this mismatch can results in XCO$_2$ errors!

Methodology: Here, we derive the most common patterns of temperature and water vapor profile error using Singular Value Decomposition (SVD) (Fig. 3) and then including them in the retrieval state vector. We also implement a genetic algorithm (DOGO) to generate optimized quality filters for our results.

Results: We find that the residuals are reduced in the strong CO2 band (Fig. 4) and that the scatter against TCCON can be slightly reduced using DOGO (Fig. 5)
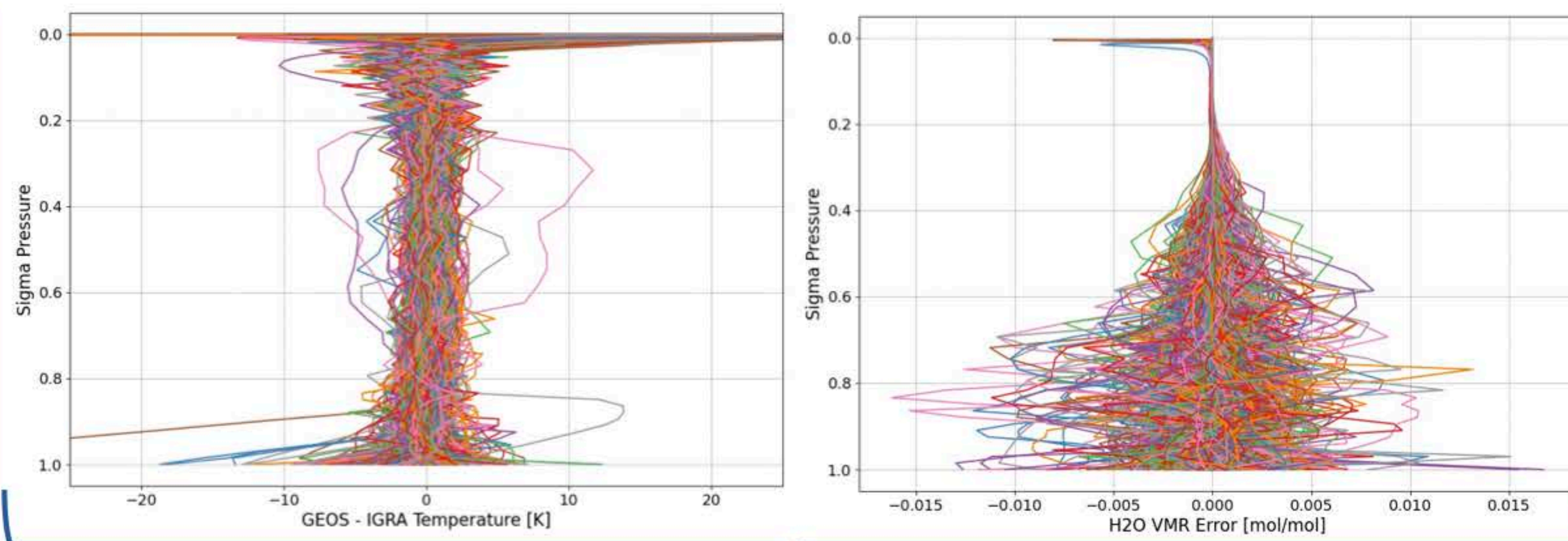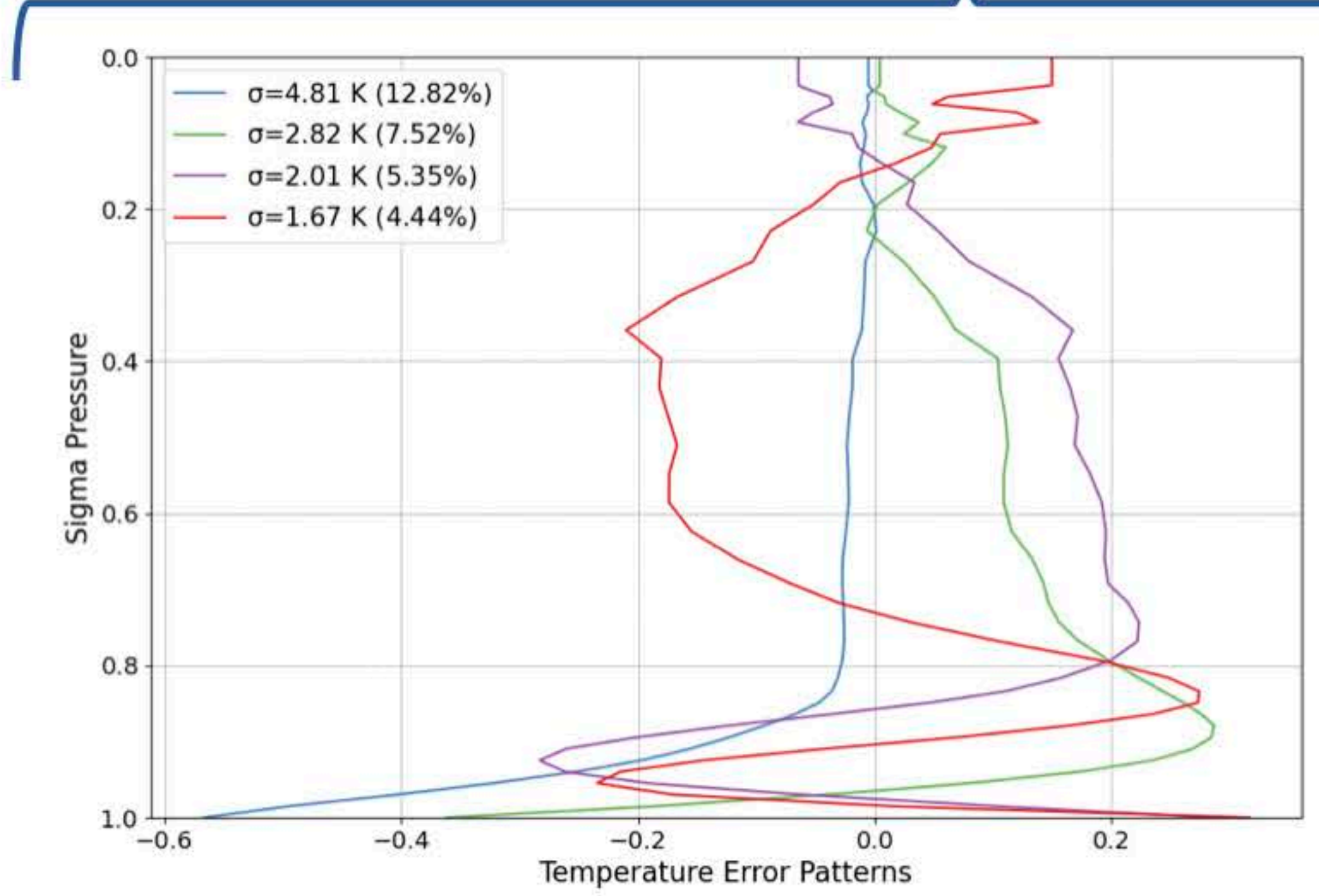

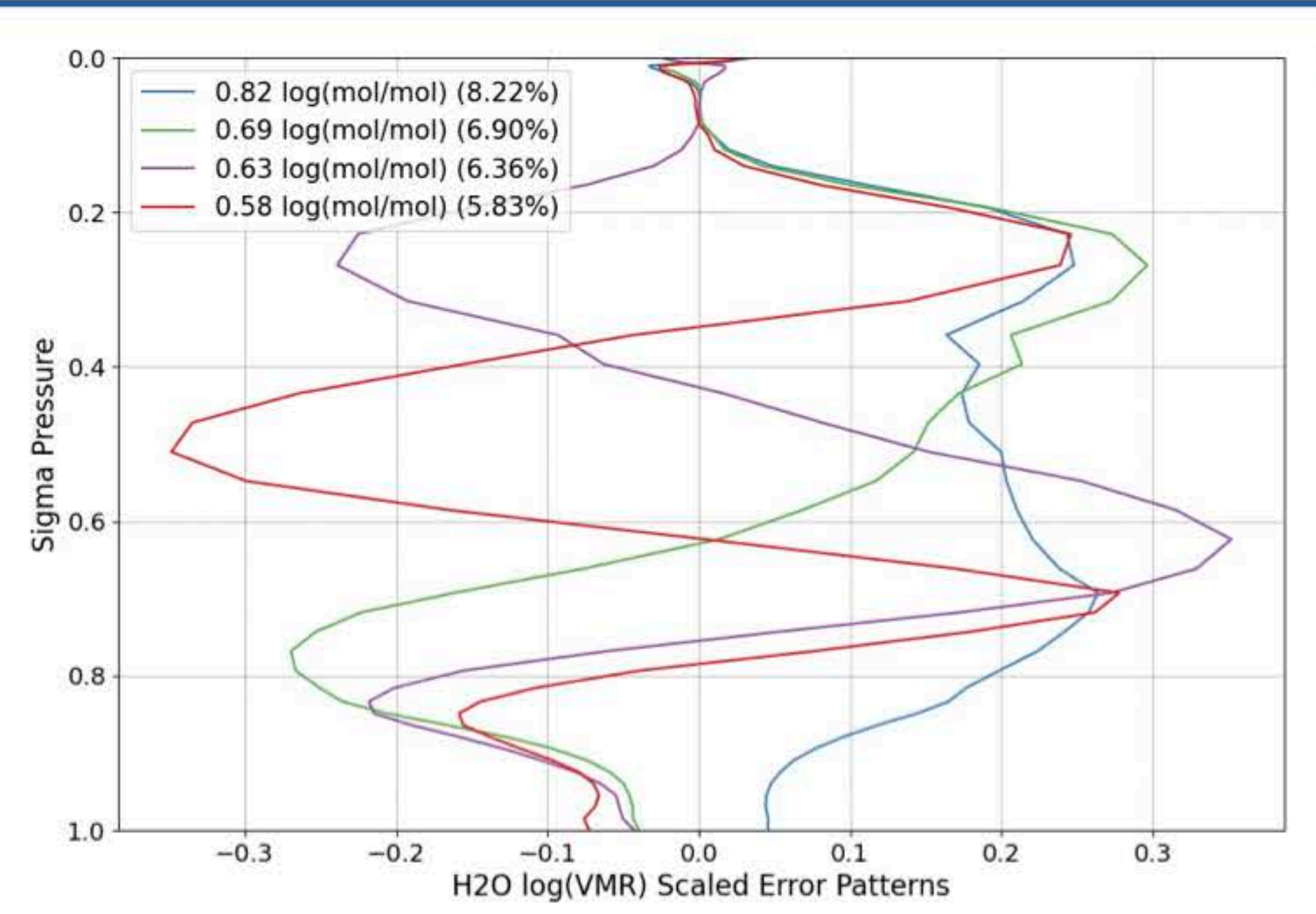Figure 2: example profile errors (GEOS-5 minus radiosondes) of temperature (left) and water vapor (right)

SVD: $A = USV^T$

A = some matrix [m x n]
U = left singular vector / EOFs [m x m]
S = singular values / Eigenvalues [m x n]
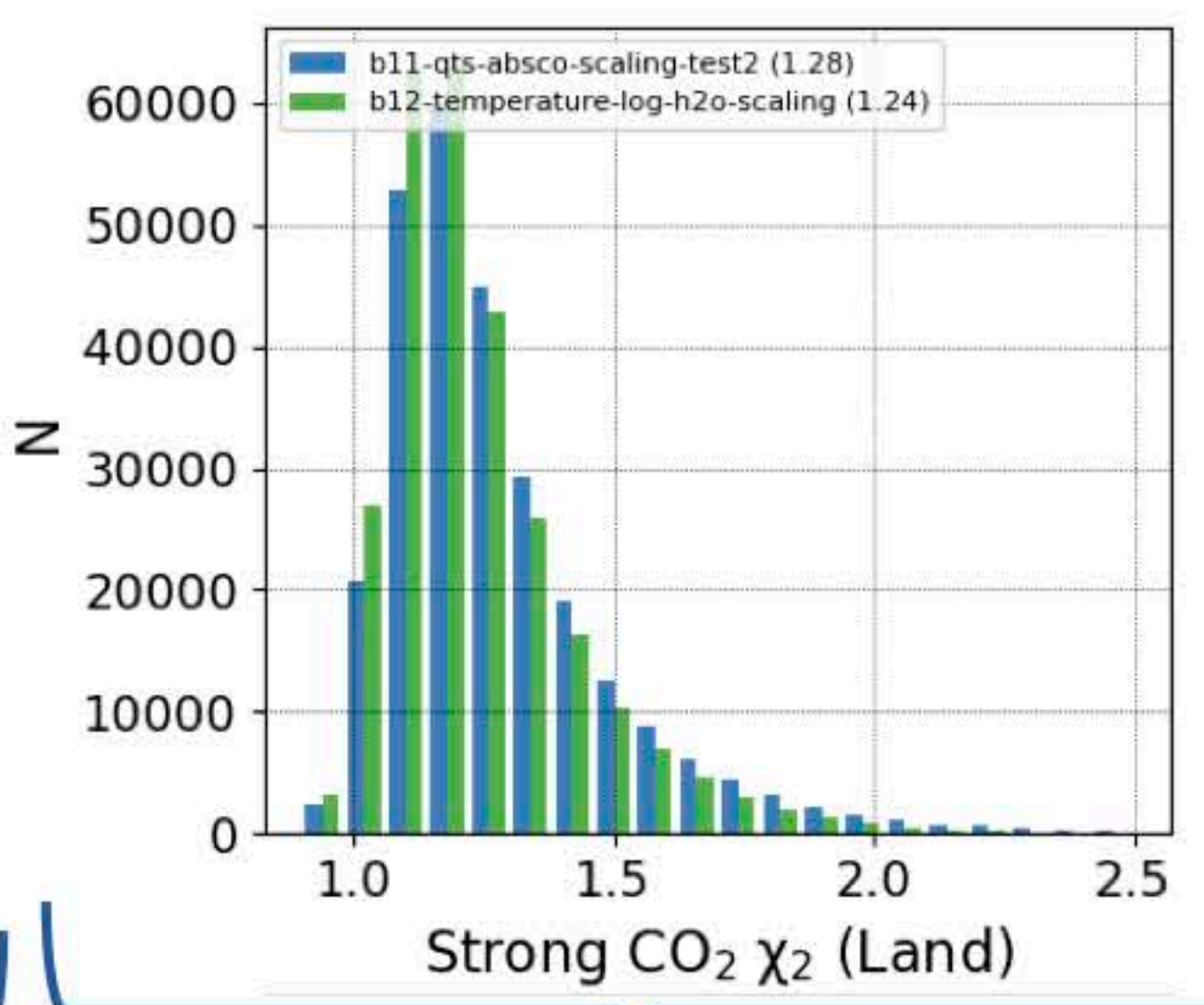V = right singular vector / Principle Components [n x n]

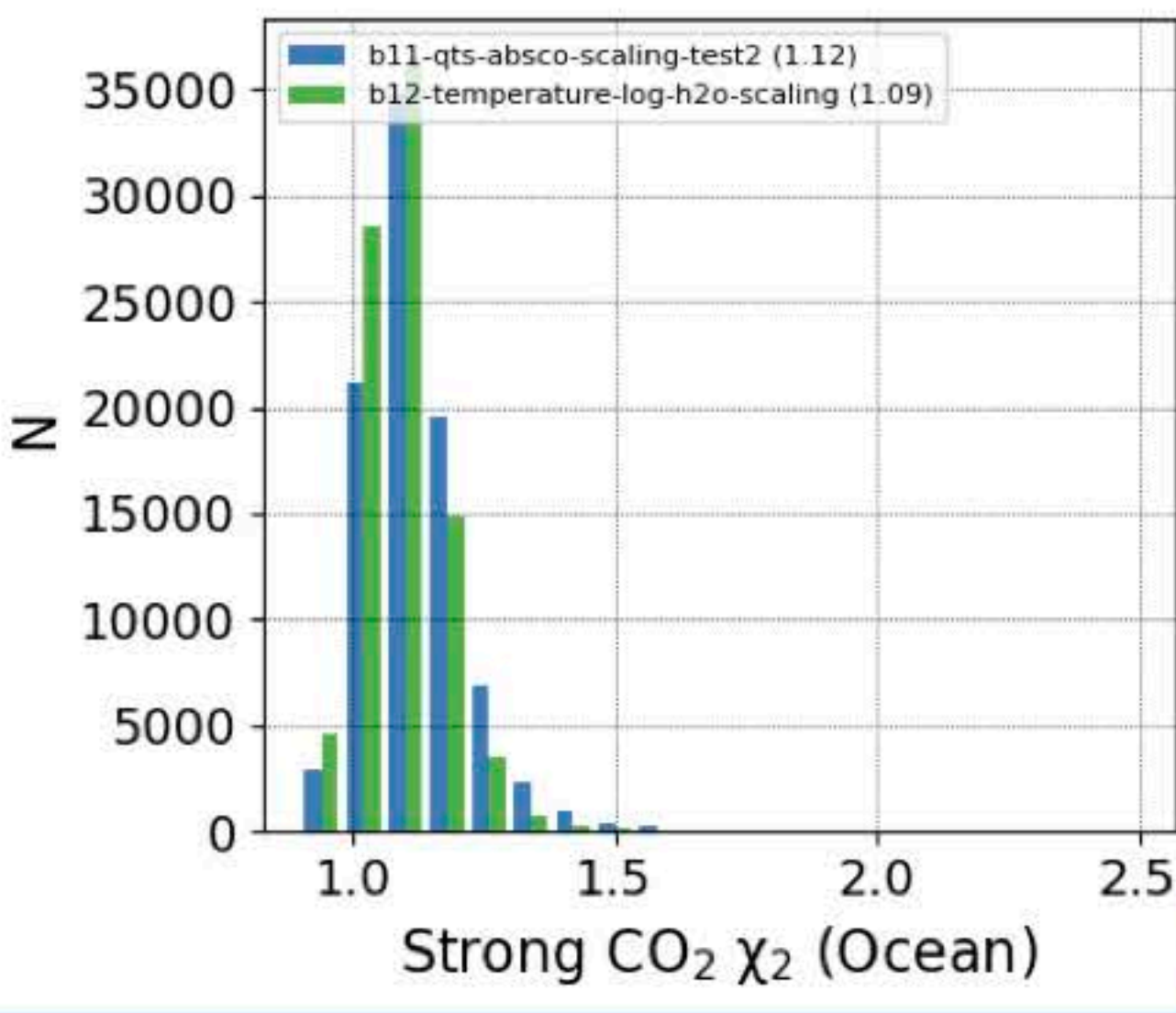Figure 4: radiance residuals are slightly reduced in the strong CO$_2$ band

Figure 5: scatter of error vs. TCCON slightly reduced using the Data Ordering Genetic Optimization (DOGO)

Figure 3: SVD tells us what vertical "shapes" explain the most variance in our prior temperature (left) and water vapor (right) profile errors!
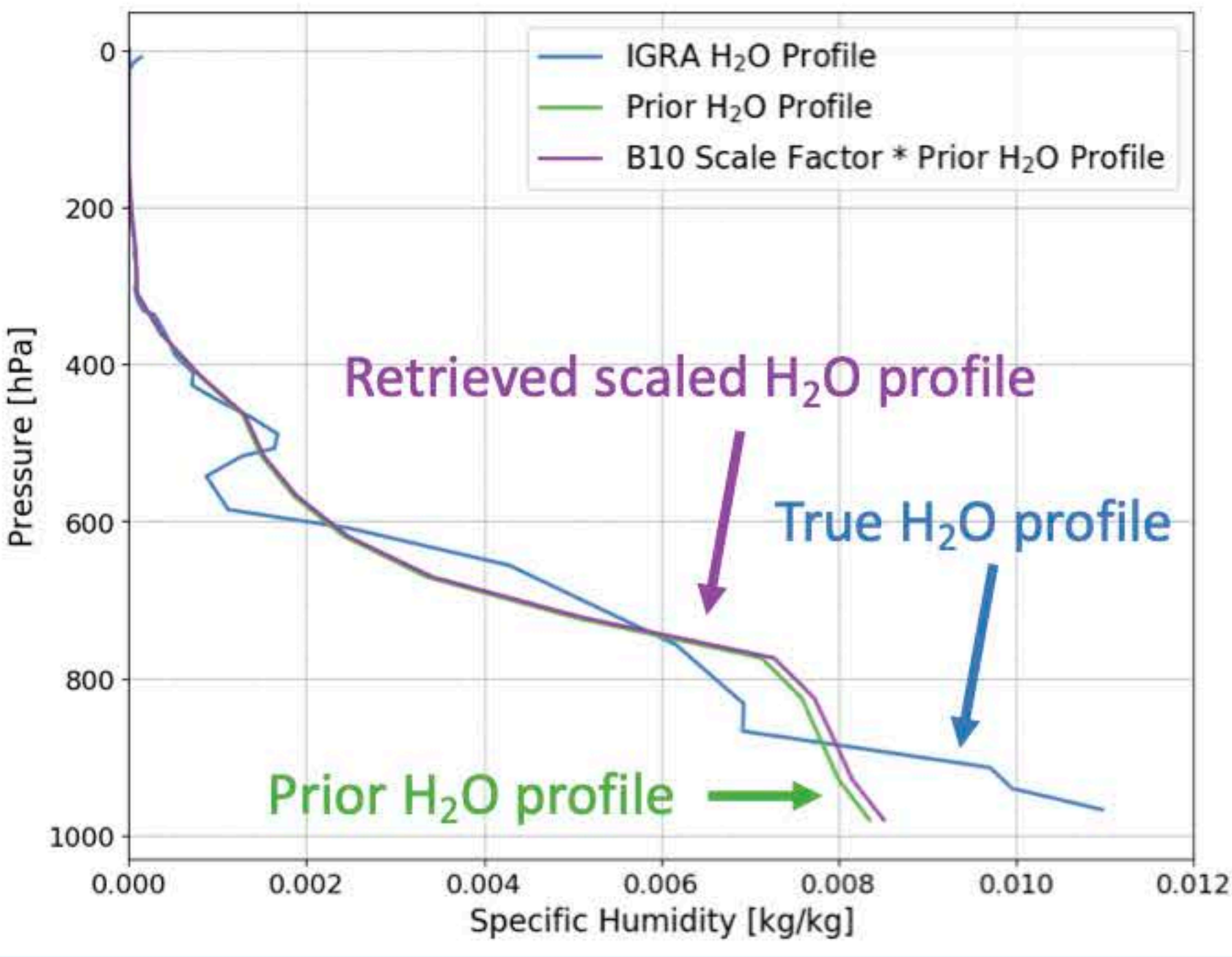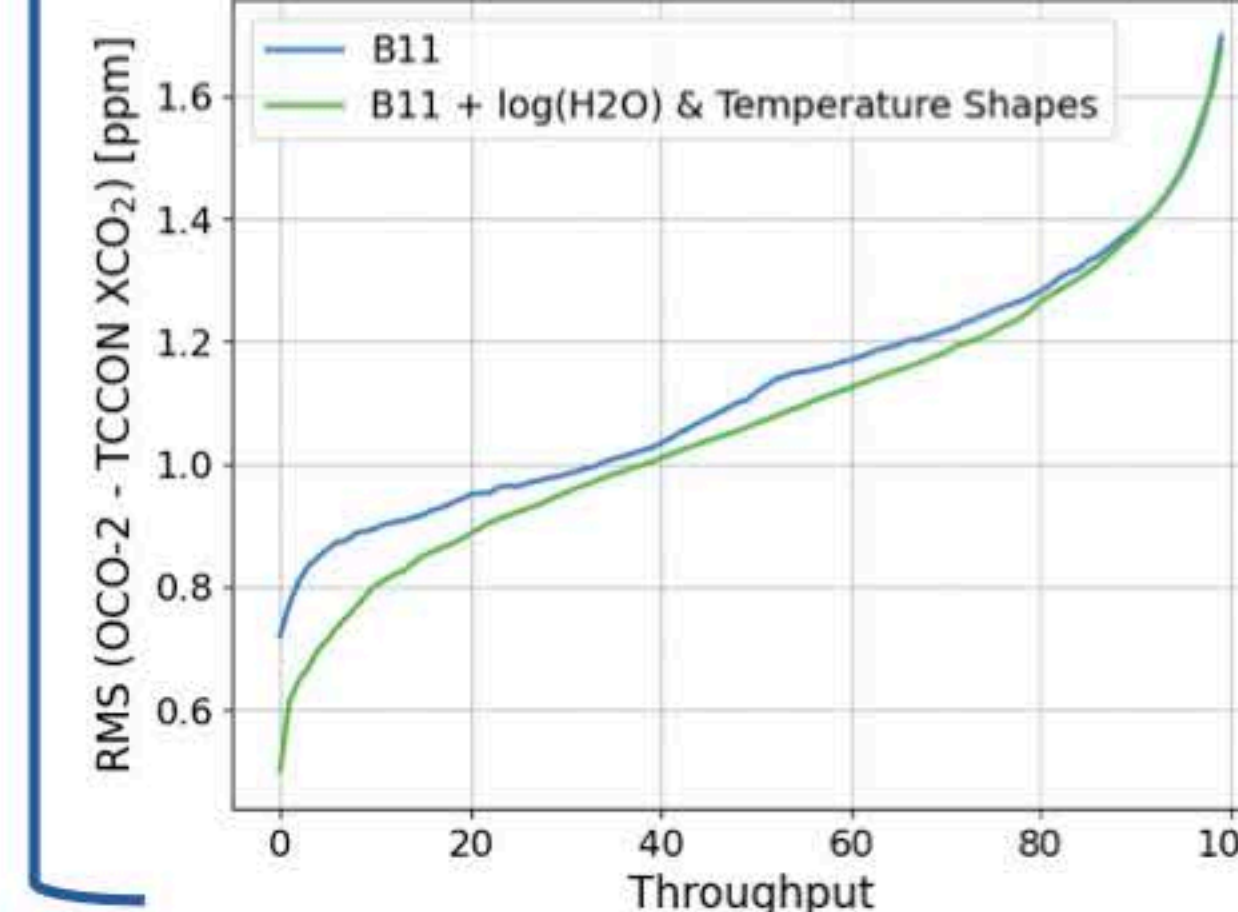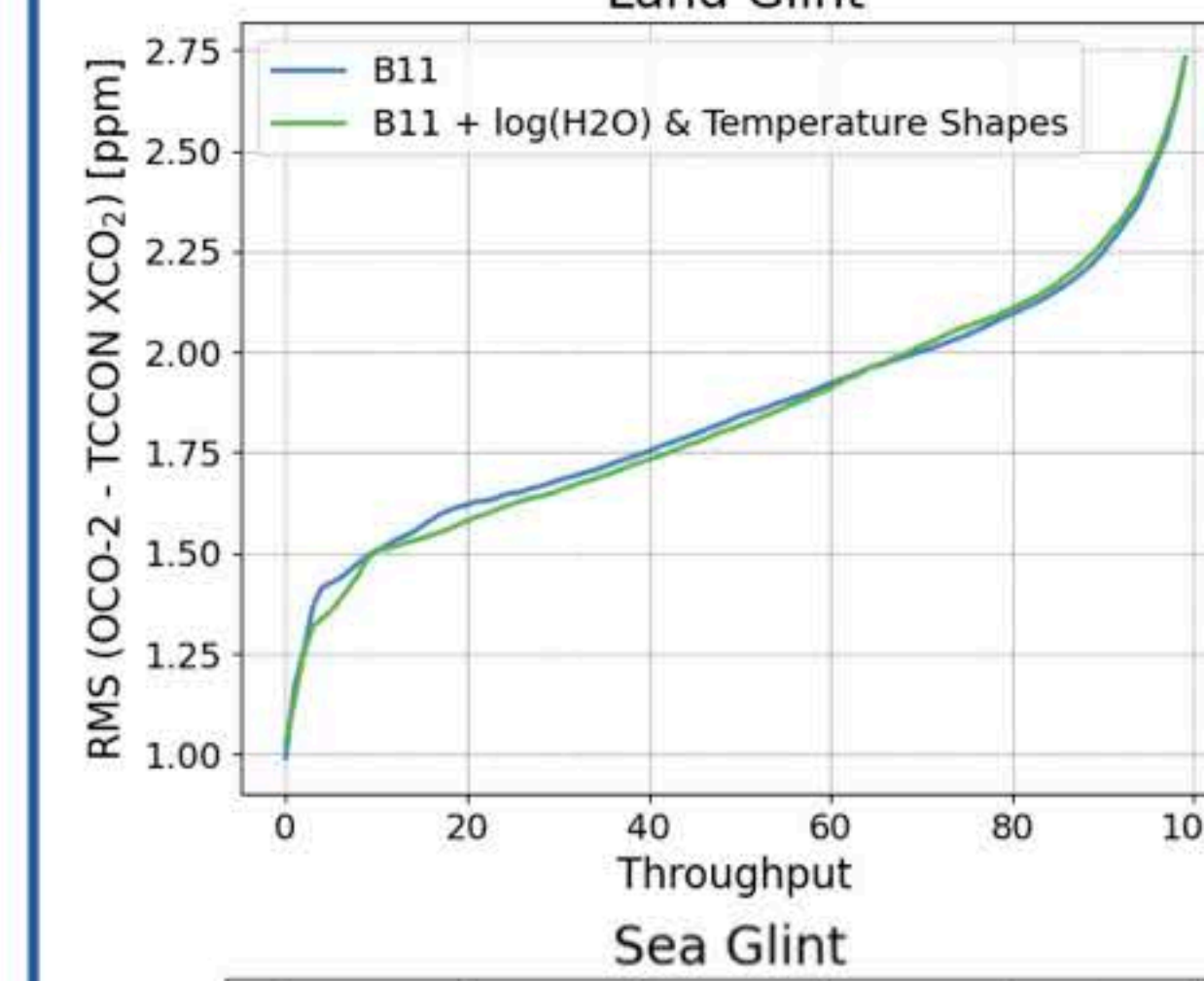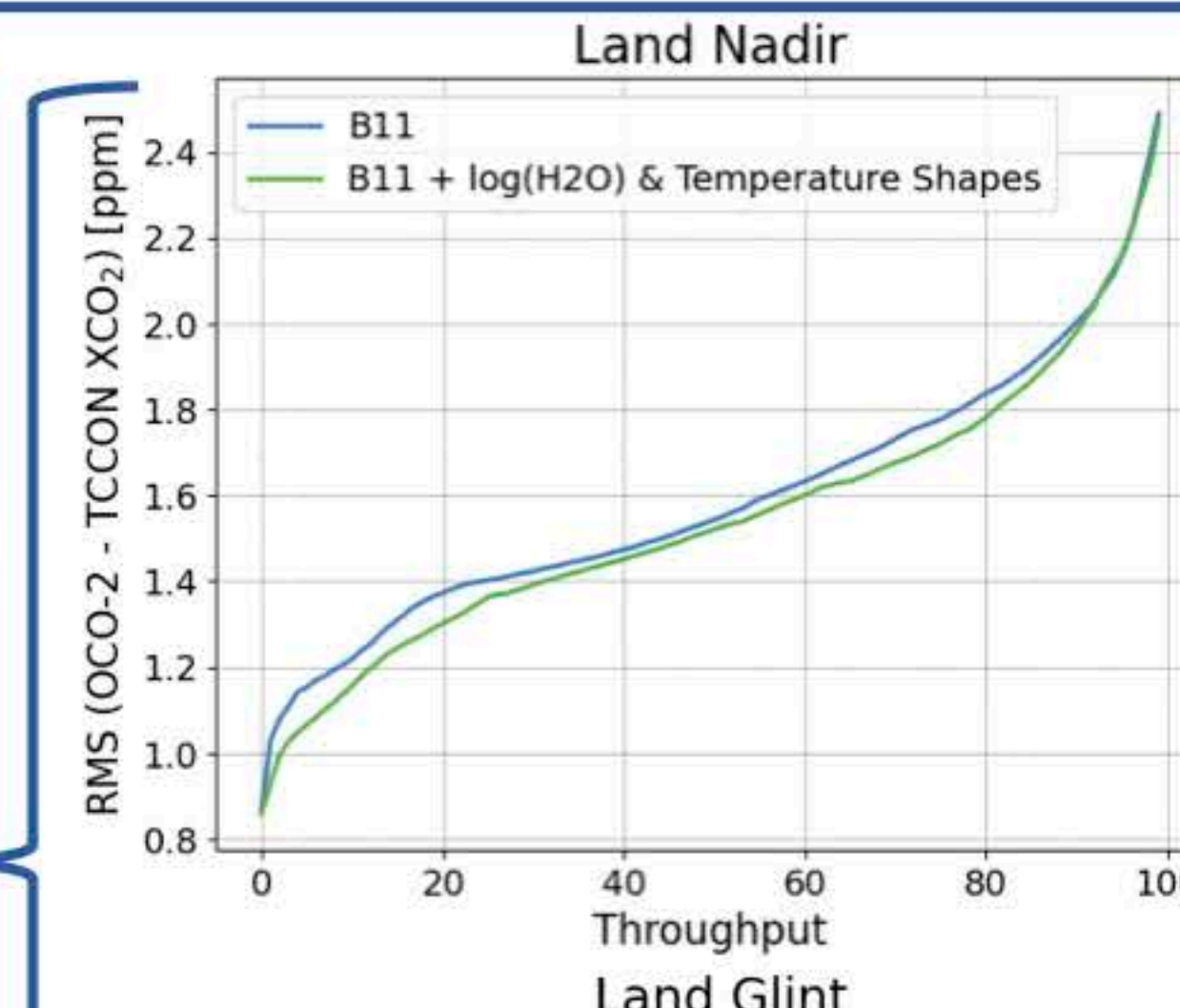

Figure 1: example retrieval demonstrating current lack of ability to fit the true H$_2$O vertical profile

Temperature profile error patterns

log(H$_2$O) profile error patterns