



# Tracking ALMA System Temperature Using WVR Data

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## Introduction

1. Traditional method requires discrete Tsys measurement.
2. Candidate data to track Tsys
  - WVR
  - AC & SQLD

WVR <sup>1</sup>	
Advantage	1. The data is continuously calibrated to measure $T_{WVR}^a$ 2. Does not suffer from internal electronic gain drift <sup>b</sup>
Disadvantage	1. Has different frequency coverage as the science target 2. Directly tracks $T_{sky}$ not $T_{sys}$

AC & SQLD <sup>2</sup>	
Advantage	1. Directly proportional to $T_{sys}$ when $\tau_{sky}$ is small 2. Has the same frequency coverage as the science target
Disadvantage	1. The data is not calibrated. 2. Suffers from the electronic gain drift <sup>b</sup> or gain variations 3. For AC, no linearity correction in FDM mode.

a. Hills et al. (2001).

b. Payne et al. (2001).

## AC Data Tracking Tsys

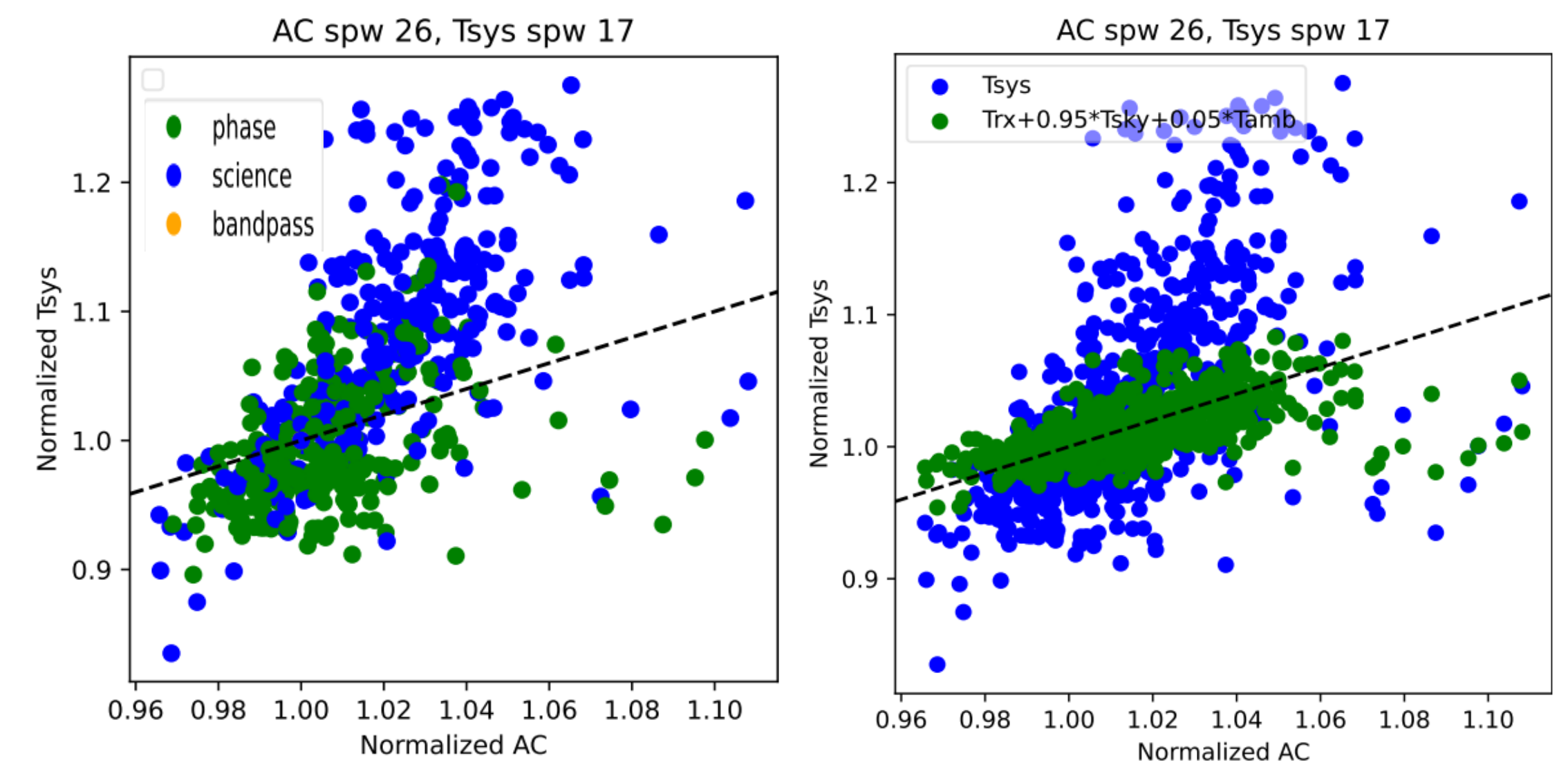


Fig. 1 (Left) The correlation between the normalized Tsys and matched normalized Twvr and normalized AC power for all the antennas. Both WVR and auto-correlation data is averaged over 10 seconds. (right) The correlation between the normalized Tsys (blue) and attenuated Tsys (green) and normalized AC data.

AC data cannot be used to track Tsys

## WVR tracking Tsys

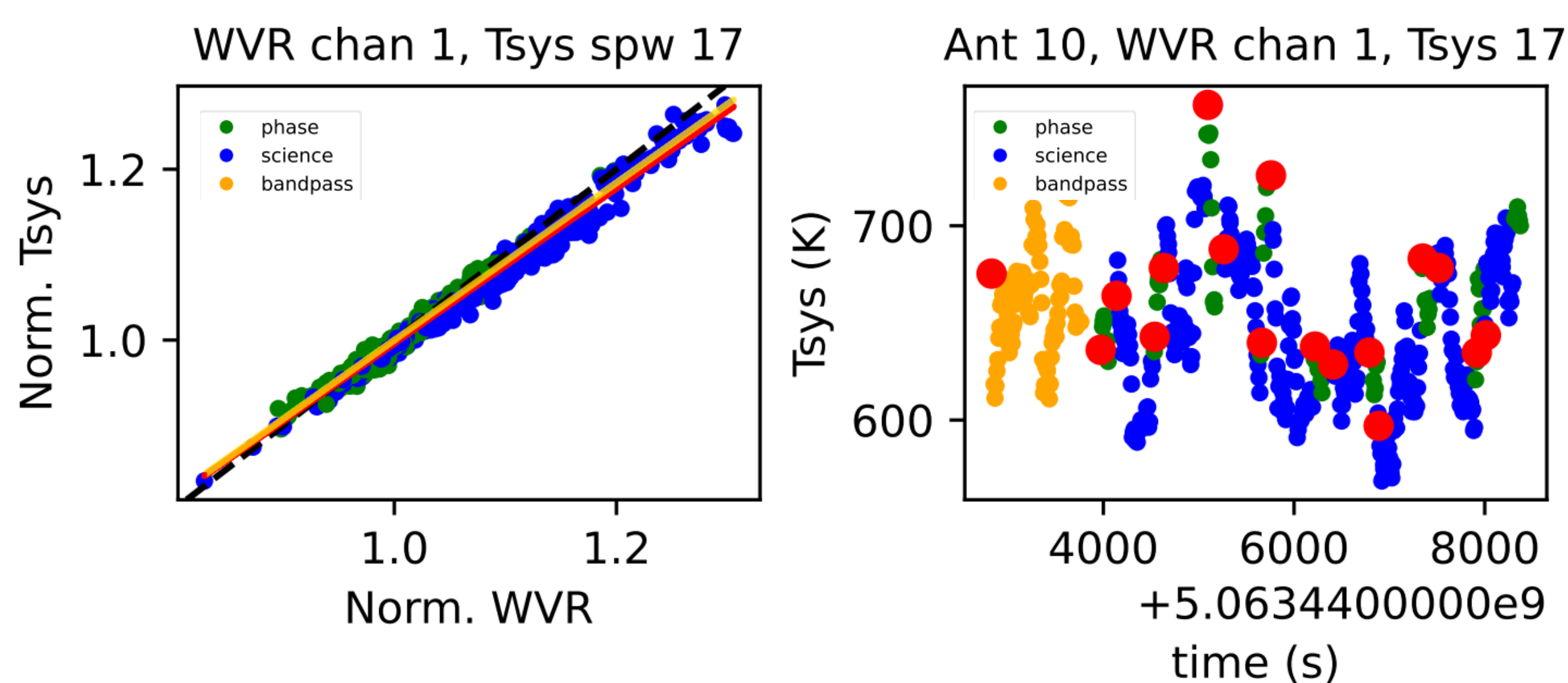


Fig. 2 The linear relation between Tsys and TWVR and comparison between measured and extrapolated Tsys. The left subplot shows the linear correlation between normalized Tsys and TWVR. The blue and green points are from science and phase scan. The dashed line shows the 1-to-1 relation. The red and golden solid line is the fitted linear relation using data from all ATM scans or just 4 ATM scans. The right plot shows the extrapolated Tsys based on the fitting relation using all ATM scans.

WVR data can be used to track Tsys

## Fewer Tsys Extrapolation

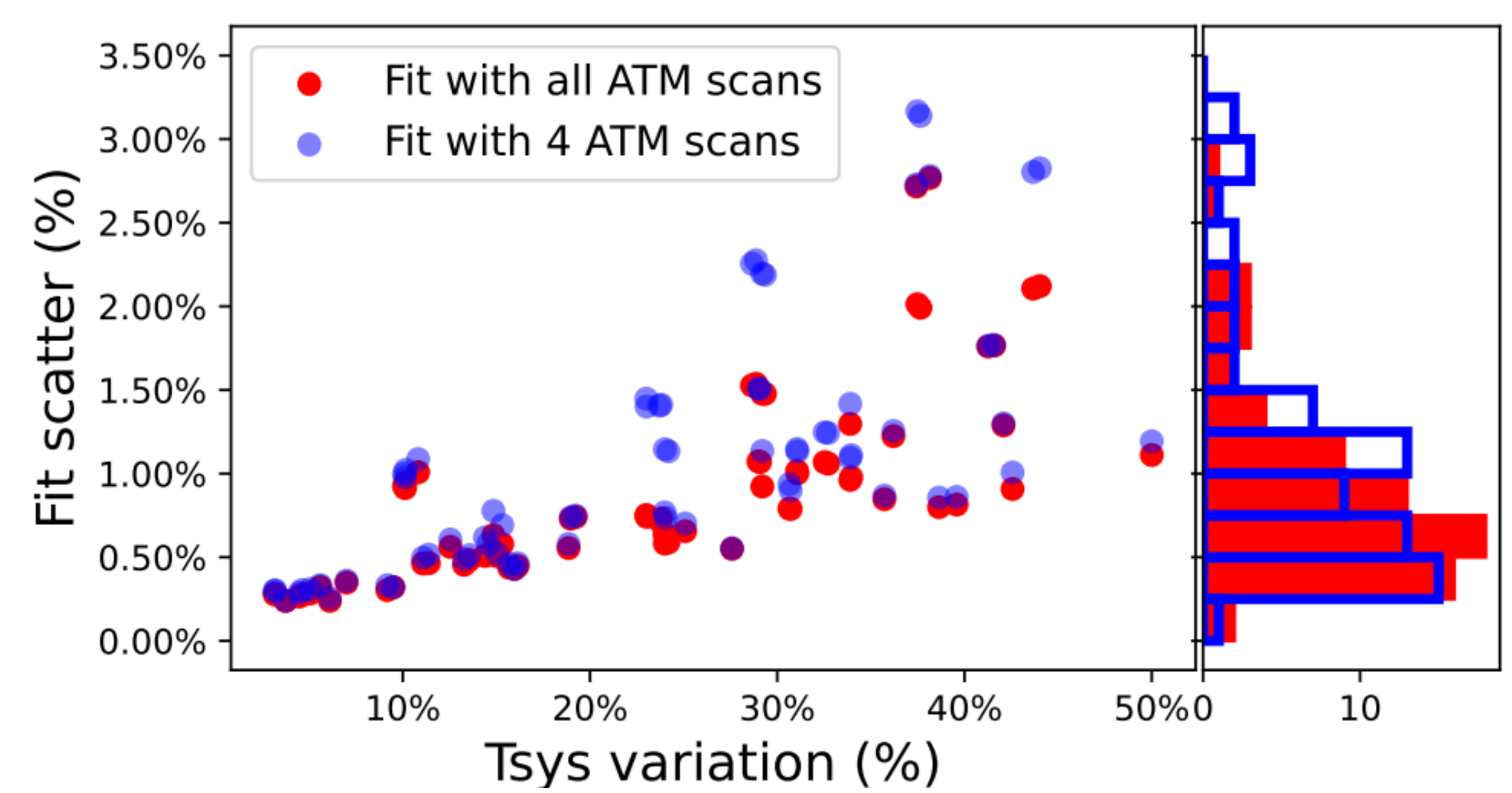


Fig. 3 The scatter of data points around the Tsys vs TWVR fits with all the antennas versus the maximal difference in  $T_{sys}$  values for each Tsys spw of each dataset. The red and blue points are from fitting with all ATM scans or just 4.

We can use at most 4 ATM scans to determine Tsys.

## ATM Modeling

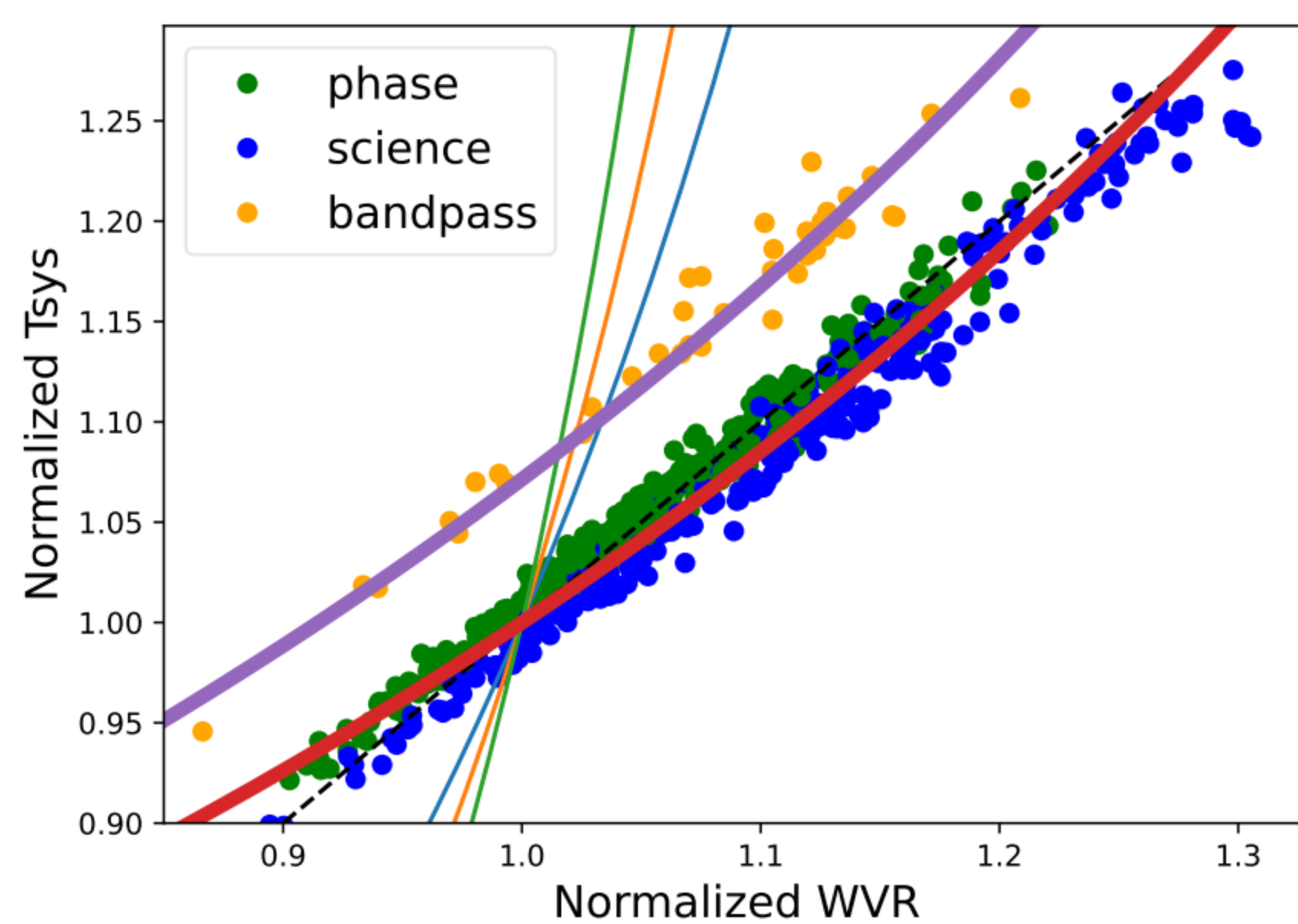


Fig 4. The correlation between normalized Tsys versus Twvr overlaid by ATM modeling curves (blue, orange and green) obtained by varying the elevation (from 40-60 degrees) at a constant PWV. The thick red line is the ATM modeling by changing PWV values from 0.5 to 1.0 mm with a fixed elevation of 53 degrees. The purple thick line is also from ATM modeling by changing PWVs with a fixed elevation of 48 degrees.

- Tsys variation is mainly driven by the PWV variations.
- The offsets between phase/science data and bandpass data is probably due to the different elevations

## Flux Comparison

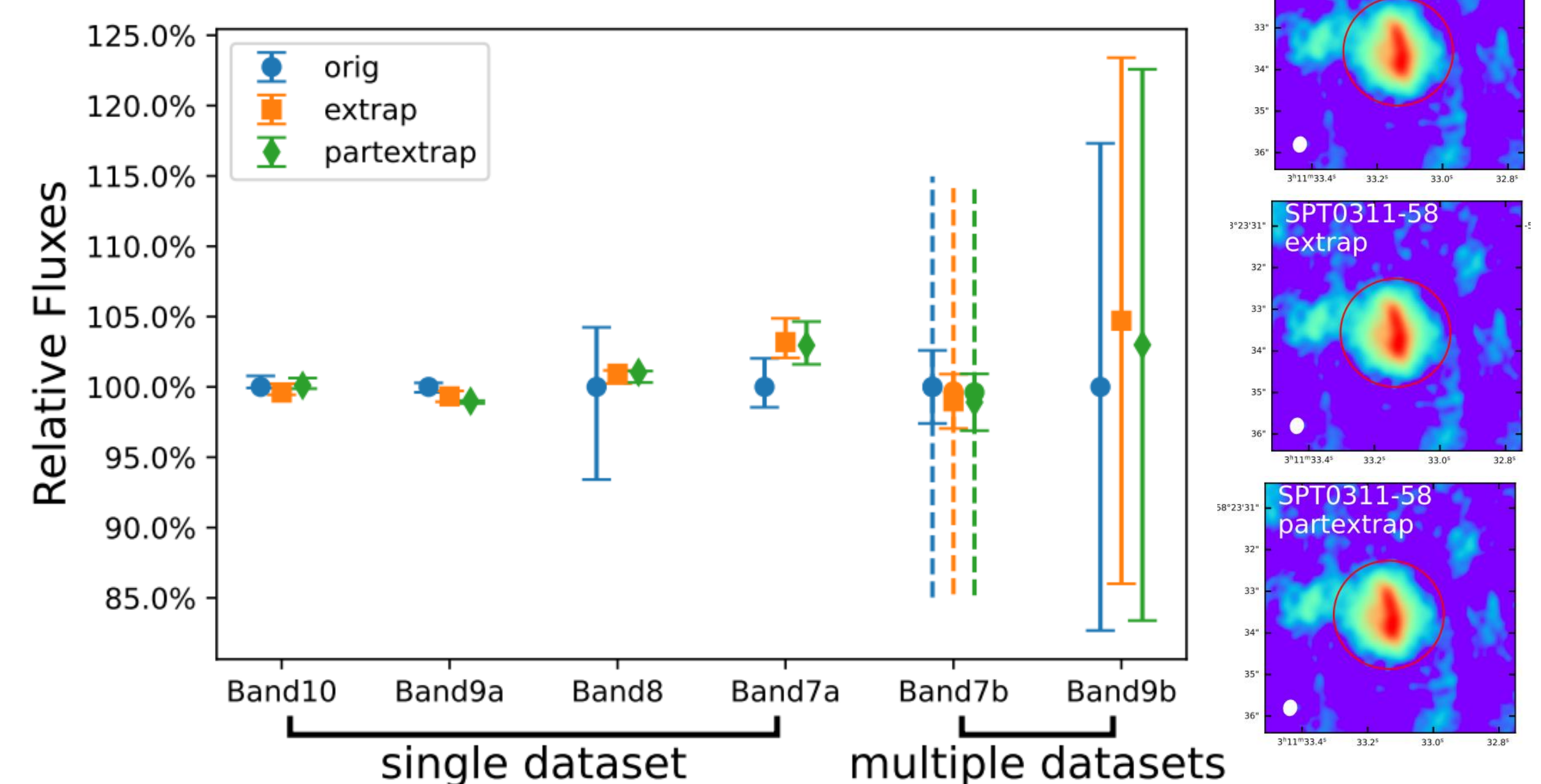


Fig 5. (Left) comparison of fluxes of images made using the original Tsys (orig), continuous Tsys extrapolated from all ATM scans (extrap) and that extrapolated from 4 ATM scans (partextrap). (Right) the dirty images made using originally measured Tsys (orig), extrapolated continuous Tsys with all ATM scans (extrap) and that with just 4 ATM scans (partextrap) for dataset Band8 of SPT0311-58.