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MethaneAIR/SAT

- MethaneAIR is the airborne simulator designed to closely model MethaneSAT, whose purpose is to provide an opportunity to develop science algorithms prior to the launch of MethaneSAT in Q4 of 2022.
- MethaneSAT is a satellite under development by MethaneSAT, LLC, a subsidiary of the Environmental Defense Fund.

- Two spectrometers on board MethaneSAT:
    1. O_2 – 1249 - 1305 nm.
    2. CH_4 – 1605 - 1683 nm
- Two spectrometers on board MethaneAIR:
    1. O_2 – 1236 - 1319 nm.
    2. CH_4 – 1592 - 1697 nm

- MethaneSAT aims to precisely map sources of methane emissions of oil and gas fields across the globe to an accuracy of 2--4 ppb on 2 km^2 scale, with a native spatial resolution of 400 x 130 m at nadir, supporting the goal of reducing methane emissions from the oil and gas sector by 45% by the end of 2025.
- MethaneAIR aims to achieve 2—5 ppb on a 300 x 800 m grid, attainable by averaging native pixels with a spatial resolution of 7 m x 25 m.

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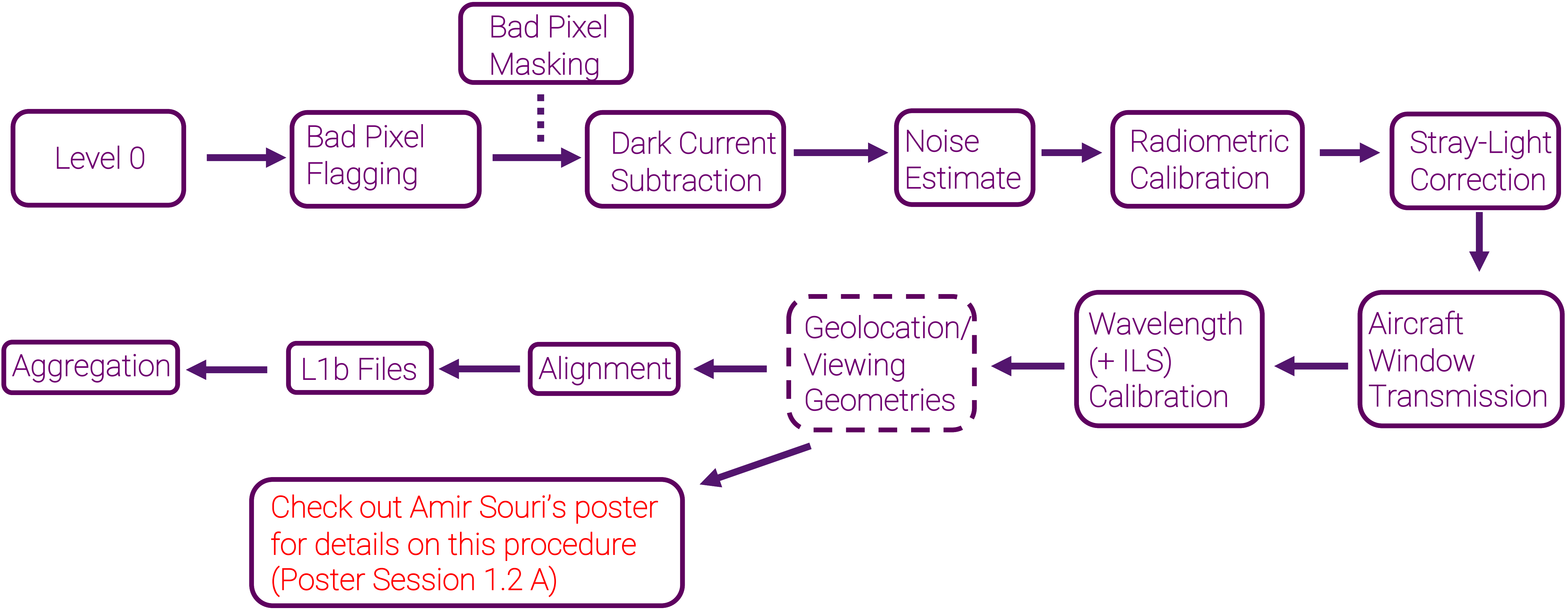
MethaneAIR/SAT L1B Processor Development

- L1B File Requirements:
  - Wavelength calibration, radiometric calibration, noise estimation, pixel quality flagging, geolocation/viewing geometries.

- For early research flights carried out in the Colorado Frontal Range, the data suggested that:

1. Wavelength grid is shifting:
   - During flight.
   - Across the track.
2. Instrument line shape is changing:
   - During flight
   - Across the track.
3. Channels are not aligned.

L0-L1b Processes of MethaneAIR



- The L1B processes for MethaneSAT will be very close to those of MethaneAIR.

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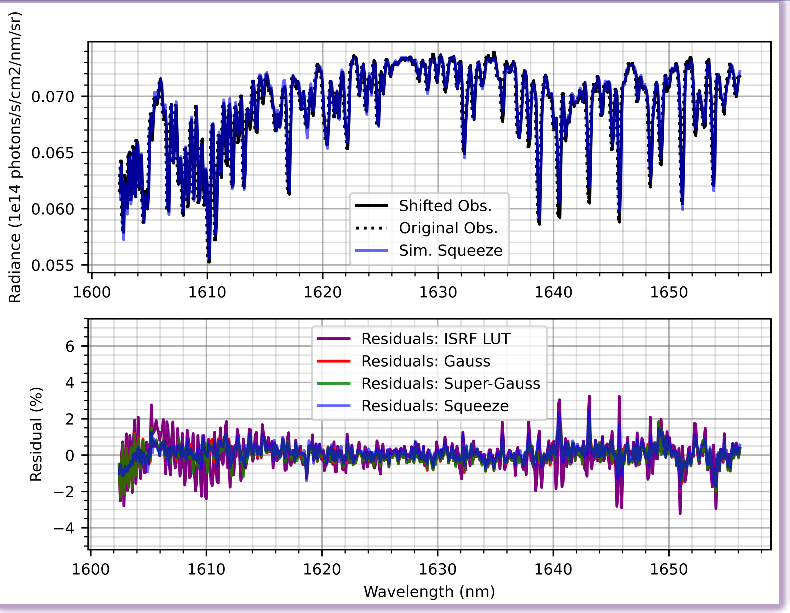
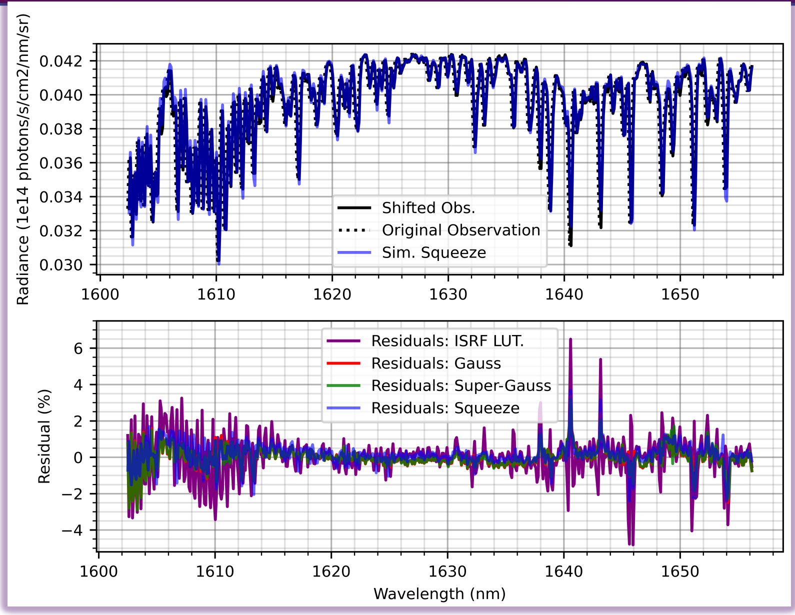
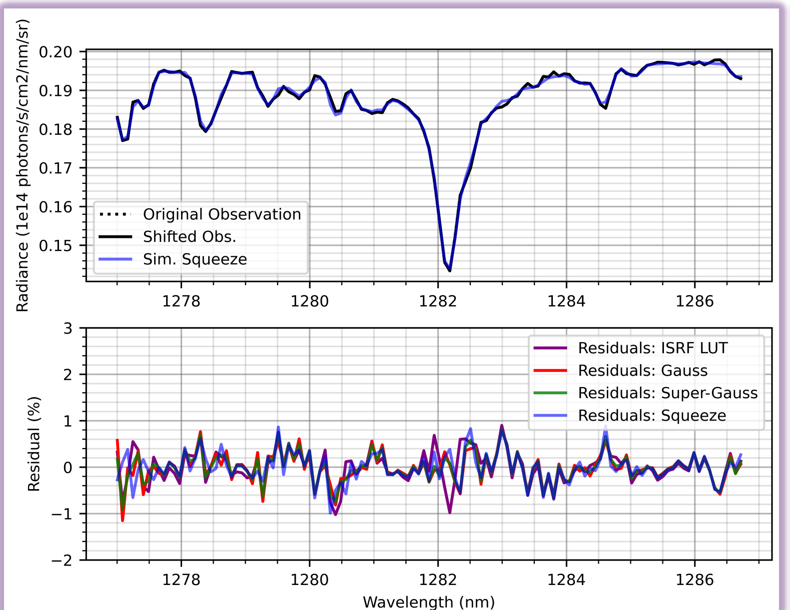
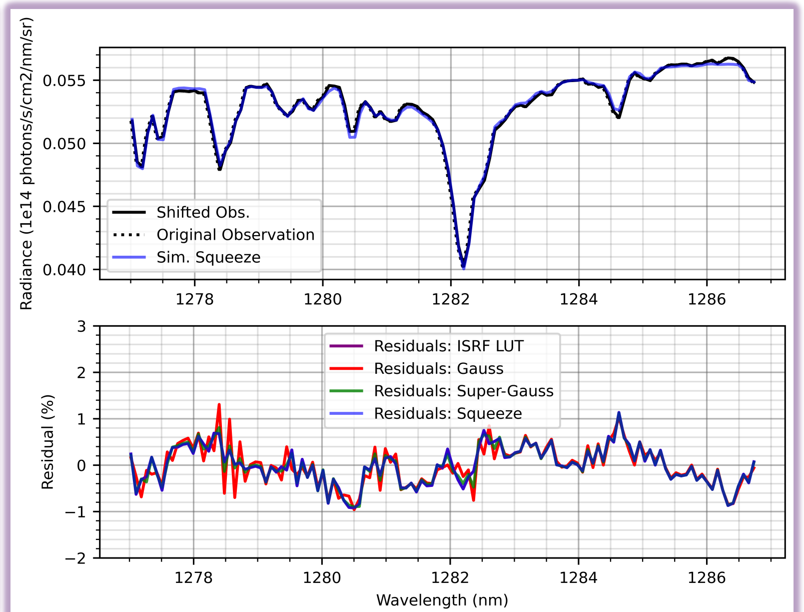
In Flight Wavelength and ISRF Characterization









1. **CH_4**

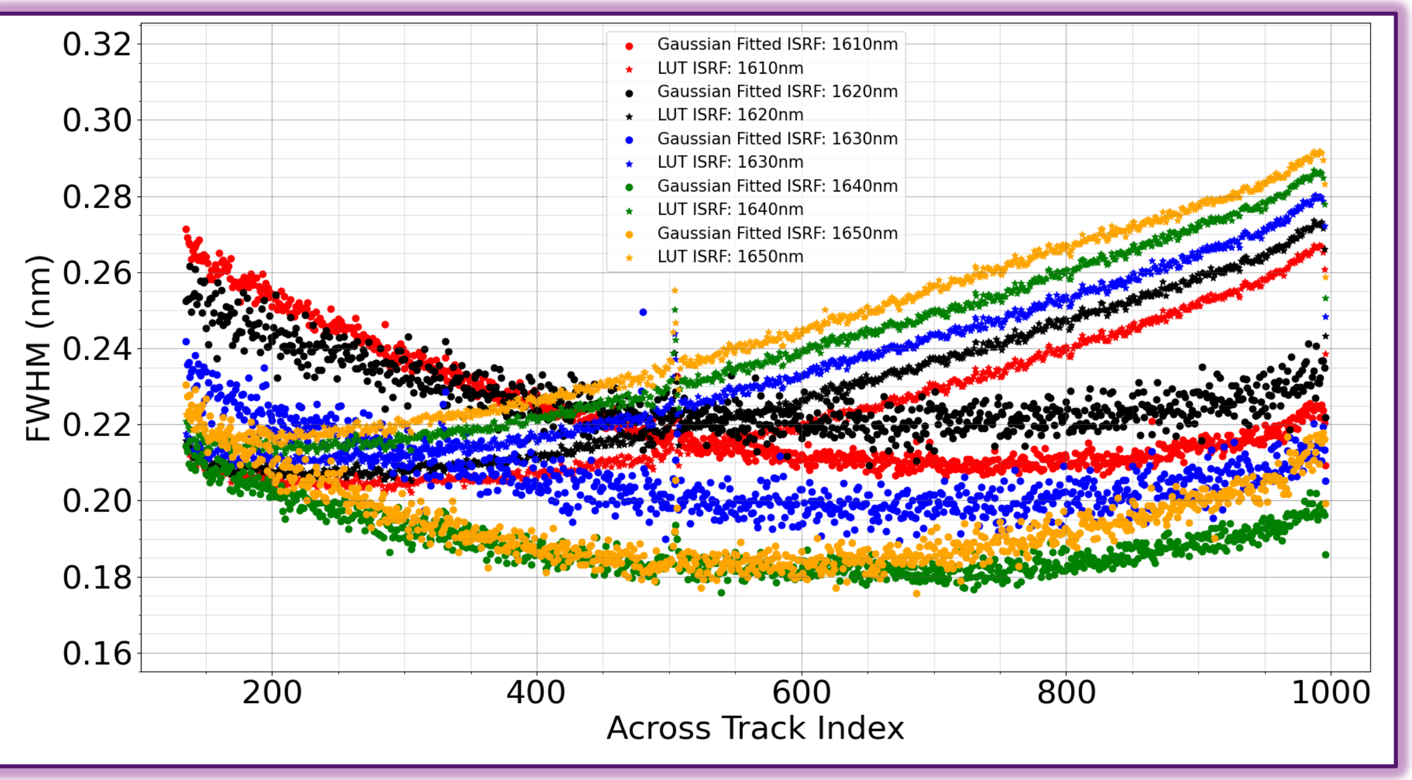
- For RF02, right panels, large temperature variations on board caused large changes to the ILS.
- The wavelength calibration step captures this, together with a 0.13 nm shift.
- The fitting residuals are close to 1-3%.

2. **O_2**

- The O_2 band proved to be very difficult to accurately fit.
- Instead, we fit the solar line at 1282 nm to very high accuracy.
- Residuals are <1%.

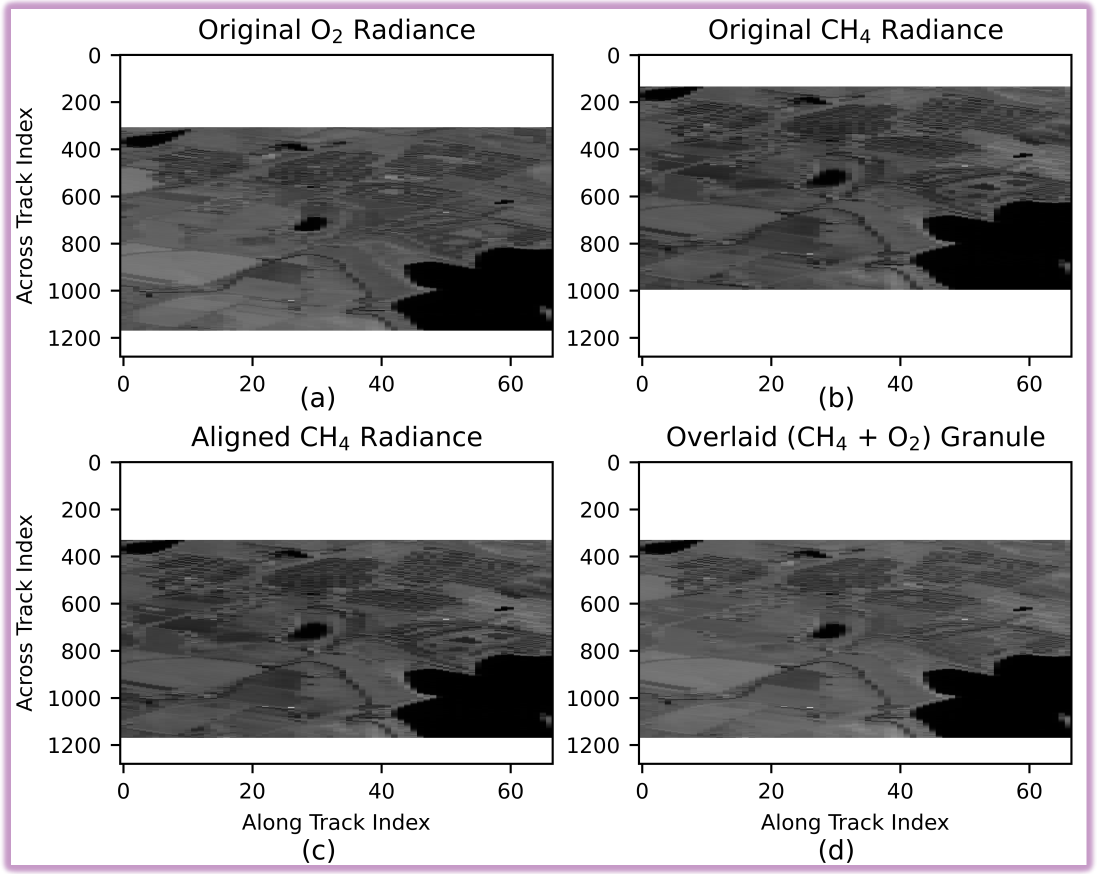
- The latest HITRAN data was used in all shown fits.

ISRF Characterization



- This is an example of the ILS variation for one 30 second observation, aggregated along track.
- The Lab ISRF data were fit to a Gaussian (circles).
- The in-flight Gaussian fitted ILS are asterisks.
- Each ISRF exhibits over 20% change compared to the lab data.
- A similar algorithm will be utilized by MethaneSAT

Channel Alignment



- The O_2 and CH_4 channels are not initially aligned for MethaneAIR, as seen in (a) and (b).
- This represents a problem for the full-physics retrieval algorithm.
- There is almost a 110 pixel offset – not constant.
- We take a sub-image of CH_4 (b) and attempt to find it's location in the frame of O_2(a).
- We obtain an along/across track shift.
- The necessary frames are added/removed for CH_4.
- The frames are then aligned in the across track dimension, to produce (c) and (d).

Check out - https://doi.org/10.5194/amt-14-3737-2021

Thank You!