LSTM Mission Performance Consolidation Study

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INTERNATIONAL WORKSHOP ON HIGH-RESOLUTION THERMAL EO
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Project Rationale

- This study has the primary aim of supporting the development of LSTM from a scientific basis through the use of advanced simulation of the various instrument effects on the performance of the LSTM mission.

- Providing updates and analysis of the MRD requirements, whilst providing a review of the methodologies and practises of the OPSI activities relating to the scientific performance

Project Overview

- Create a database of tools in a software environment to enable the analysis of the various instrument effects on the performance of the LSTM mission
- Conduct the review and refinement of several reference scenes to be used in testing
- To provide updates and analysis of the MRD requirements
- To provide a review of the methodologies and practises of both the OPSI and Level-2 approaches relating to the scientific performance
- To support and develop upgrades for the End-To-End processor using selected reference scenes

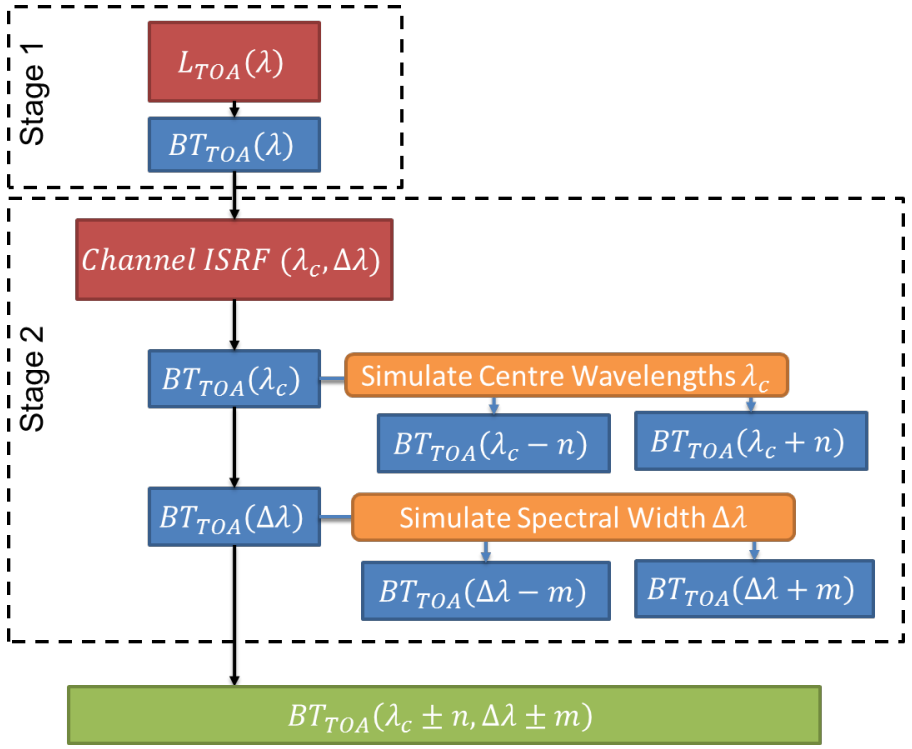
Performance Simulation: Overview

A software environment is being developed in Python in a robust version controlled manner with the capability to incorporate into the simulations all the features identified as key variables for testing:

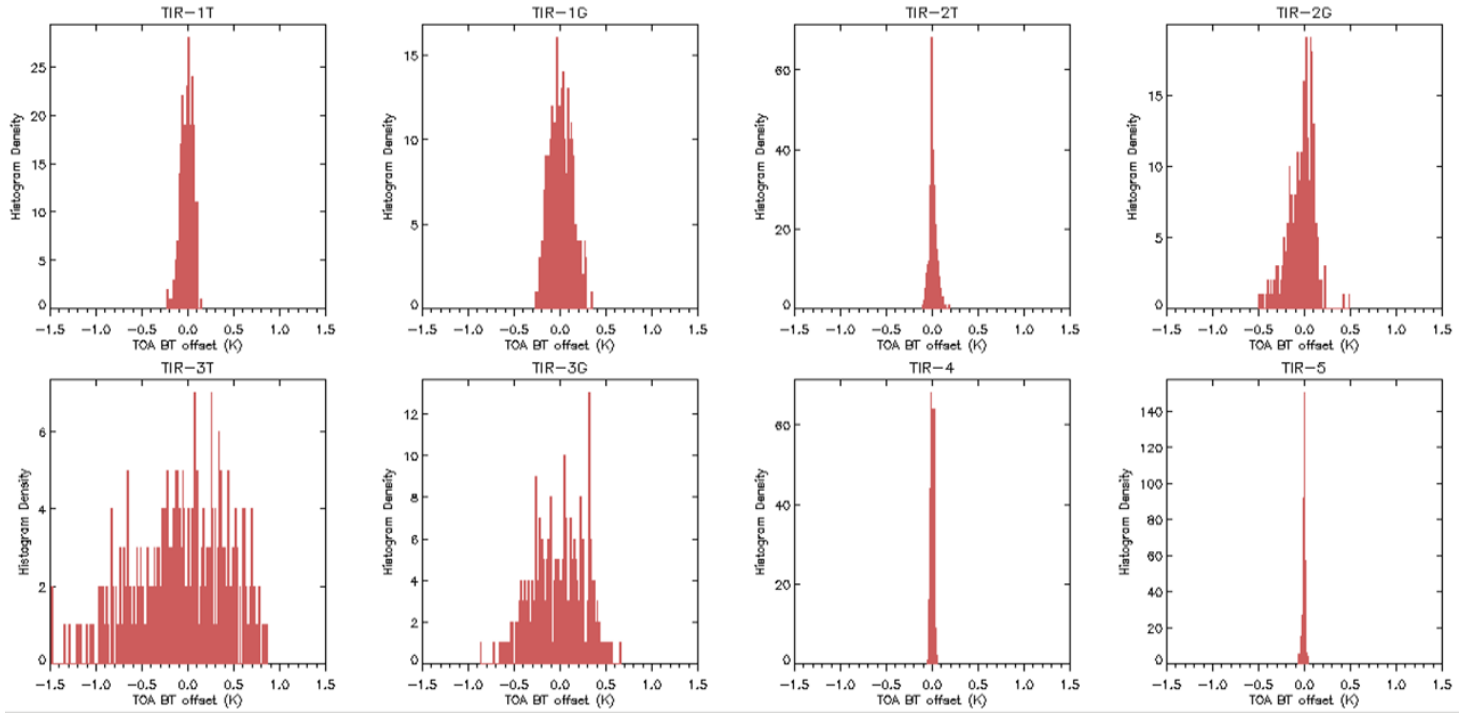
- ARA
- NEdT
- Pixel cross-talk
- Pseudo-noise
- Stray light
- Band position and characteristics (Knowledge and tolerance)
- Observation characteristics: observation time, revisit time
- Pointing performance
- Inter-band co-registration
- SSD pixel stability
- Resampling impacts on L1c
- Full uncertainty budget (including estimates for ancillary data)

Performance Simulation: Spectral Responce

- Analysis the impact of the channel centre wavelengths and FWHM



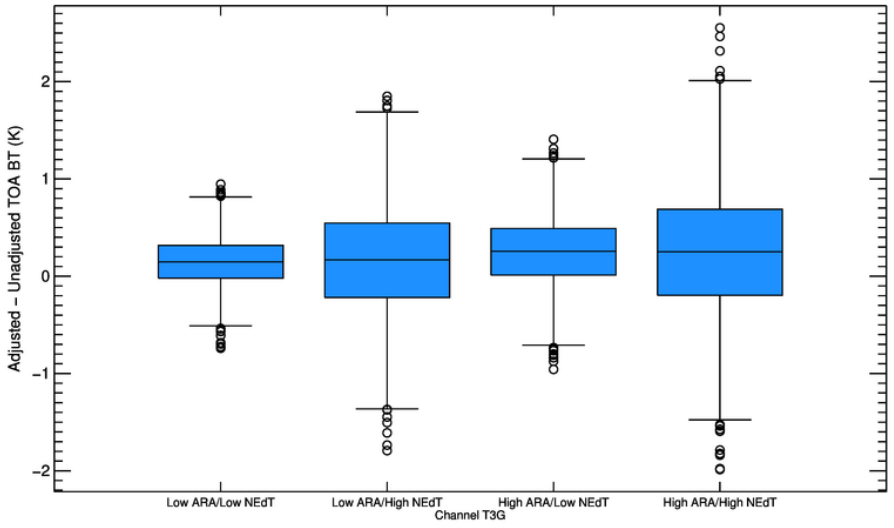
Example from Phase A/B1

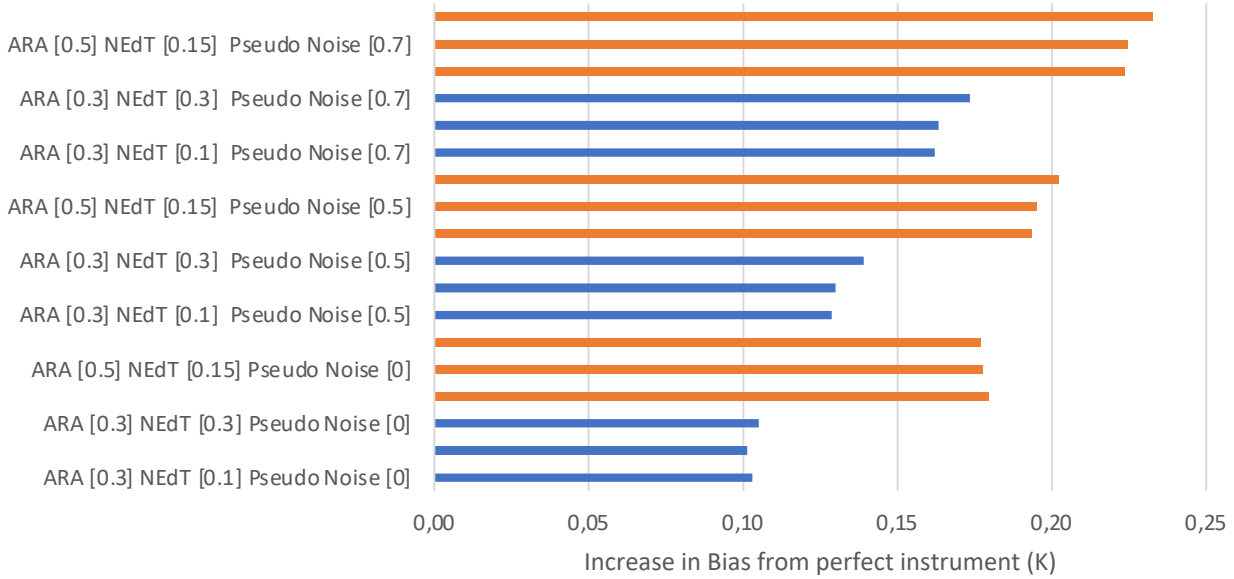


Performance Simulation: Radiometric Parameters

- The sensitivity to radiometric requirements
- The TOA BT impacts can be propagated through to the resulting bias in the LST and the associated uncertainty.

Example from Phase A/B1





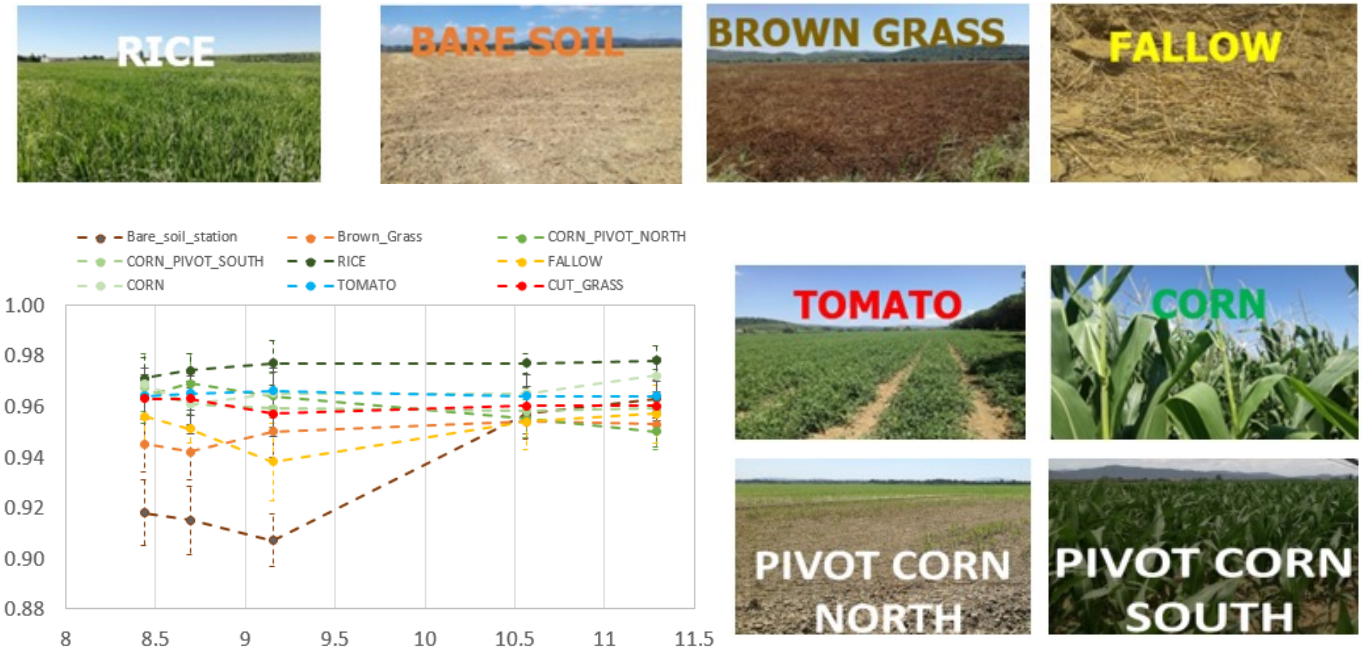
Campaign Data: Scene Assessment

- A review of the Campaign database
- Assessment of both quantative performance and the suitability to address key issues
- Example:

- The area has a circular shape with one km diameter and is irrigated by a rotating pivot-irrigation system, which is normally operated 24 h a day in the period June-August. A full irrigation cycle is completed within four days.
- The area was cultivated with a grass mixture from January to May 2018 and then entirely planted with corn at the end of May. This crop was grown during the period June-September under full irrigation and fertilization. It reached full canopy cover at mid/end July and a maximum height of 2.8/3.0 m in mid August

Campaign Data: Scene Assessment

- In situ measurements from U. Valencia team
- Spectral characterization of surfaces has been performed with CIMEL radiometer and LSE has been estimated applying TES algorithm



MULTI BAND RADIOMETER

DIFFUSE REFLECTANCE PLATE

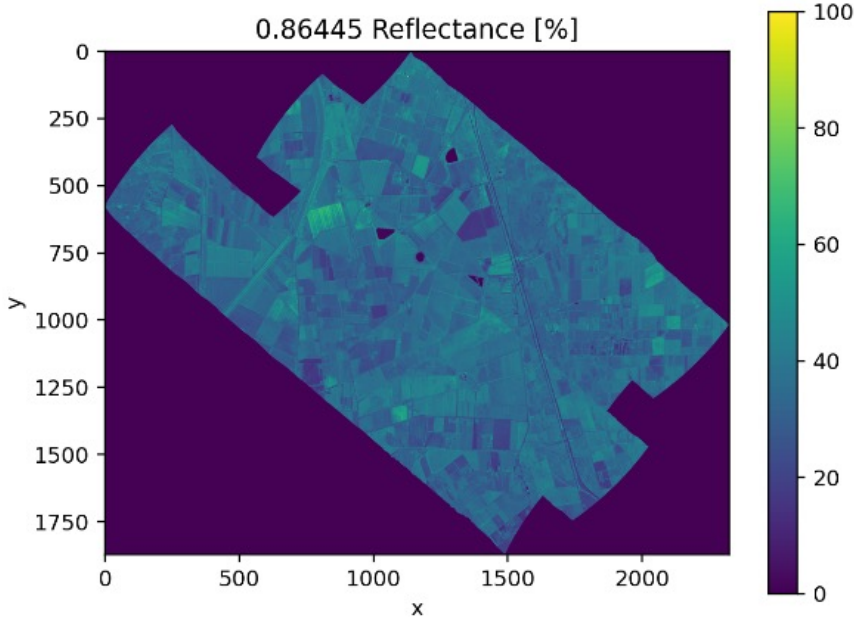
Infragold Labsphere

Campaign Data: Processing - TOA Radiances

- Three scenes of interest from a campaign in Grosseto, Italy in 2018
- TOA radiances generated using the retrieved LST and LSE from the airborne campaign propagated by a Line-By-Line Radiative transfer model to TOA
- Uses variable atmospheric profiles, so the data can be tested under conditions more extreme than seen for the actual conditions during the campaign

Campaign Data: Processing - TOA Radiances

- Adding capability to propogate VNIR wavelengths in as well as TIR
- Mosaics of Top of Canopy reflectance spanning 0.37 - 2.50 µm
- Requirement to propagate to TOA radiance

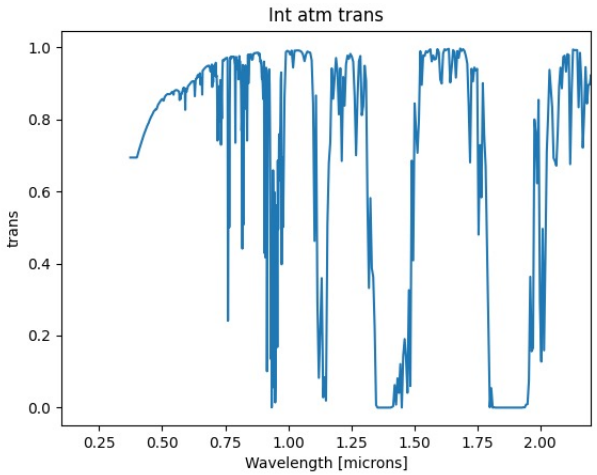


TOC reflectance at 0.86 µm (VNIR2 band)
20180718-S3IT-1310-1325-3050-MOSAIC

Campaign Data: Processing - TOA Radiances

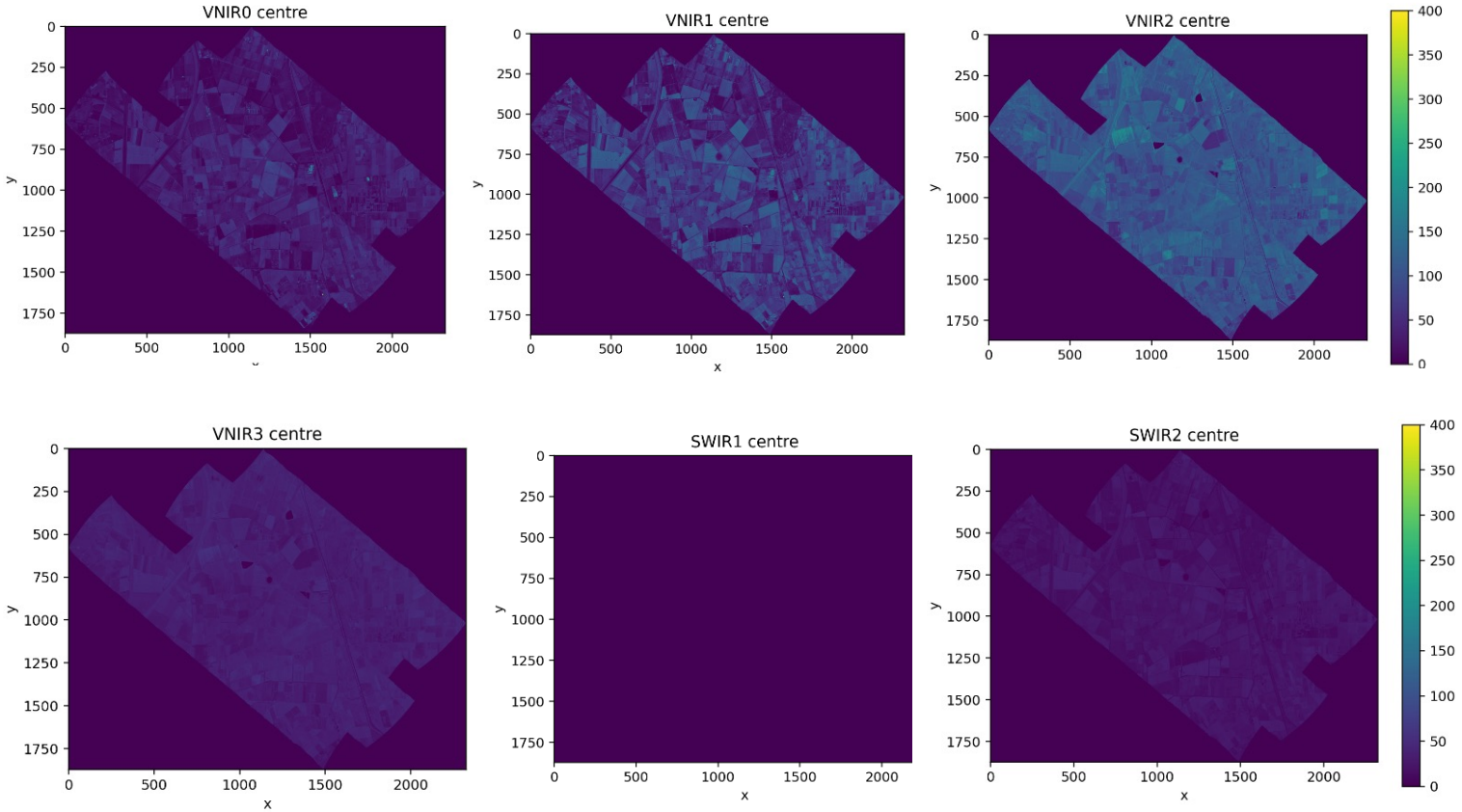
- Propagated TOC mosaics to TOA radiances
  - Initial Simulation over band widths of VNIR/SWIR LSTM channels
  - Used atmospheric transmission of a mid latitude summer atm.
  - View angles of 0 (nadir) and 27.5 (swath edge)
- Next step is to set up RT model and generate any atmospheric conditions, geometries etc. Integrate within the simulation framework.

LSTM Band	Centre wavelength [micron]	Band Spectral width
VNIR0	0.490	0.065
VNIR1	0.665	0.030
VNIR2	0.865	0.020
VNIR3A/3B	0.945	0.020
SWIR1	1.380	0.030
SWIR2	1.610	0.090



Nadir transmission of a mid-latitude summer atmosphere, generated using MODTRAN

Campaign Data: Processing - TOA Radiances



[$mWm^{-2}sr^{-1}nm^{-1}$]

Nadir TOA radiances for mosaic 20180718-S3IT-1310-1325

Campaign Data: Processing - LSE extrapolation

- The campaign LSE data extends to 11.5 to 12 microns (instrument dependant), for LSTM assessment up-to 13 microns is required
- Spectral extrapolation using spectral libraries is required to extend the usable range
- Fortunately the gap is in a less variable spectral region so the impact of extrapolation errors will be less significant than in the 8-9 micron region

Ongoing Activities

- Constructing a simulation framework for evaluating different instrument specifications
- Processing the data from multiple campaigns
- Providing scientific support to the LSTM MAG
- E2E upgrades, such as propagation of VNIR/SWIR within the Scene Generator Model