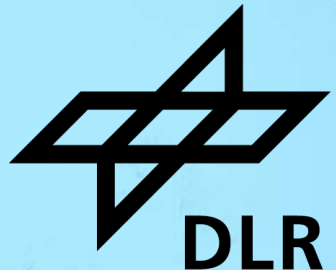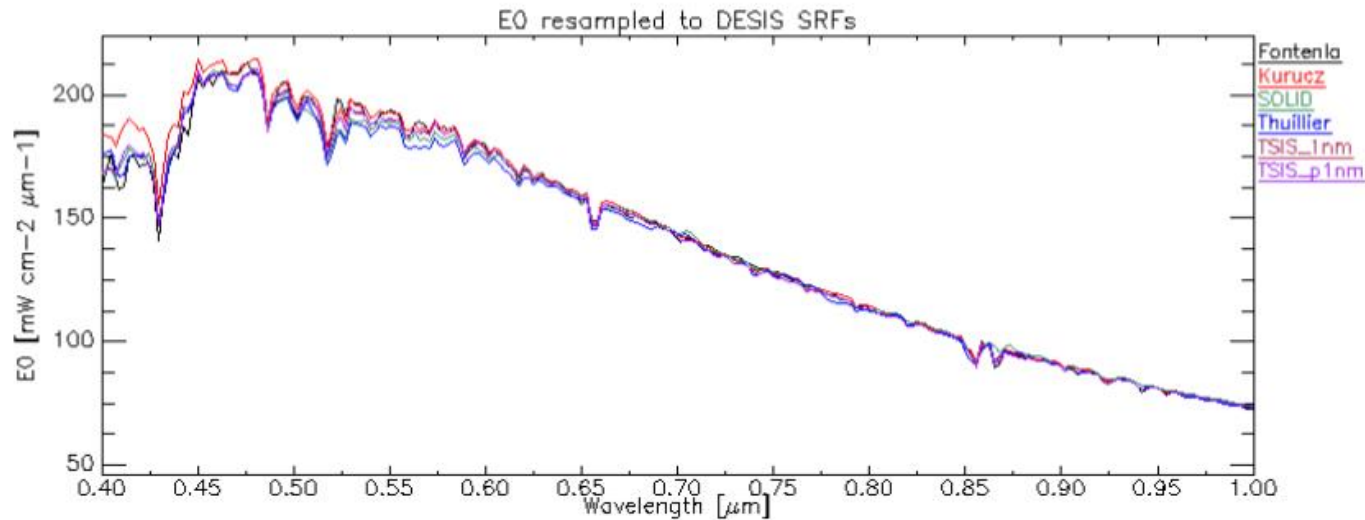# Solar Irradiance Models, some thoughts…

Martin Bachmann, Raquel de los Reyes, Miguel Pato, Emiliano Carmona
German Aerospace Center (DLR), Earth Observation Center, Oberpfaffenhofen

Infrared and Visible Optical Sensors (IVOS) 35
CEOS, Working Group on Calibration and Validation (WGCV)
Oberpfaffenhofen, 27.09.2023

DLR

Various E0 models – example: resampled to DESIS

Figure 1. Solar irradiance spectra resampled to DESIS. "Fontenla" denotes Fontenla 2011, "Kurucz" to Kurucz 2005, "Thuillier" to Thuillier et al., 2003, "SOLID" to the SOLID composite, "TSIS_1nm" to the TSIS HSRS at 1 nm resolution, and "TSIS_p1nm" to the TSIS HSRS at 0.1 nm resolution.

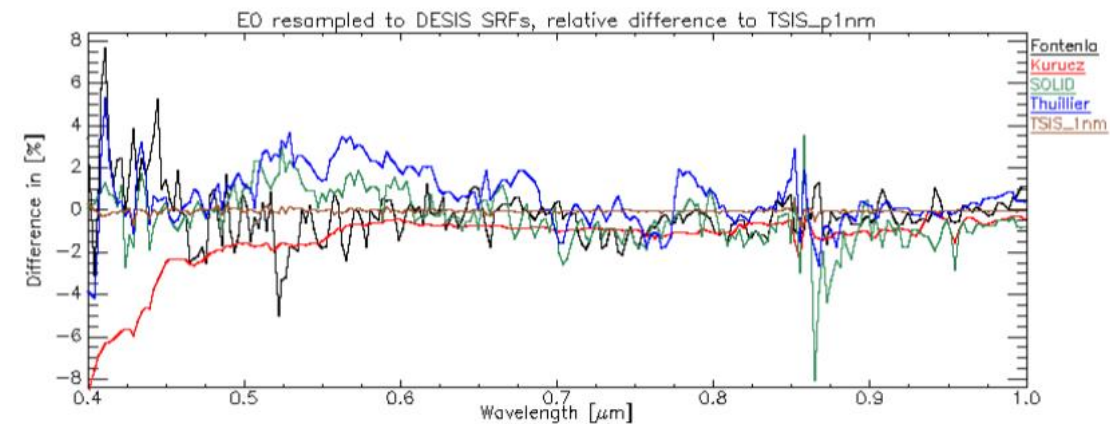**DESIS**
SSD: 2.55 nm
FWHM: ~ 3.5 nm

Figure 5. Relative difference of solar irradiance spectra resampled to DESIS in relation to TSIS_p1nm. "Fontenla" denotes Fontenla 2011, "Kurucz" to Kurucz 2005, "Thuillier" to Thuillier et al., 2003, "SOLID" to the SOLID composite, "TSIS_1nm" to the TSIS HSRS at 1 nm resolution.
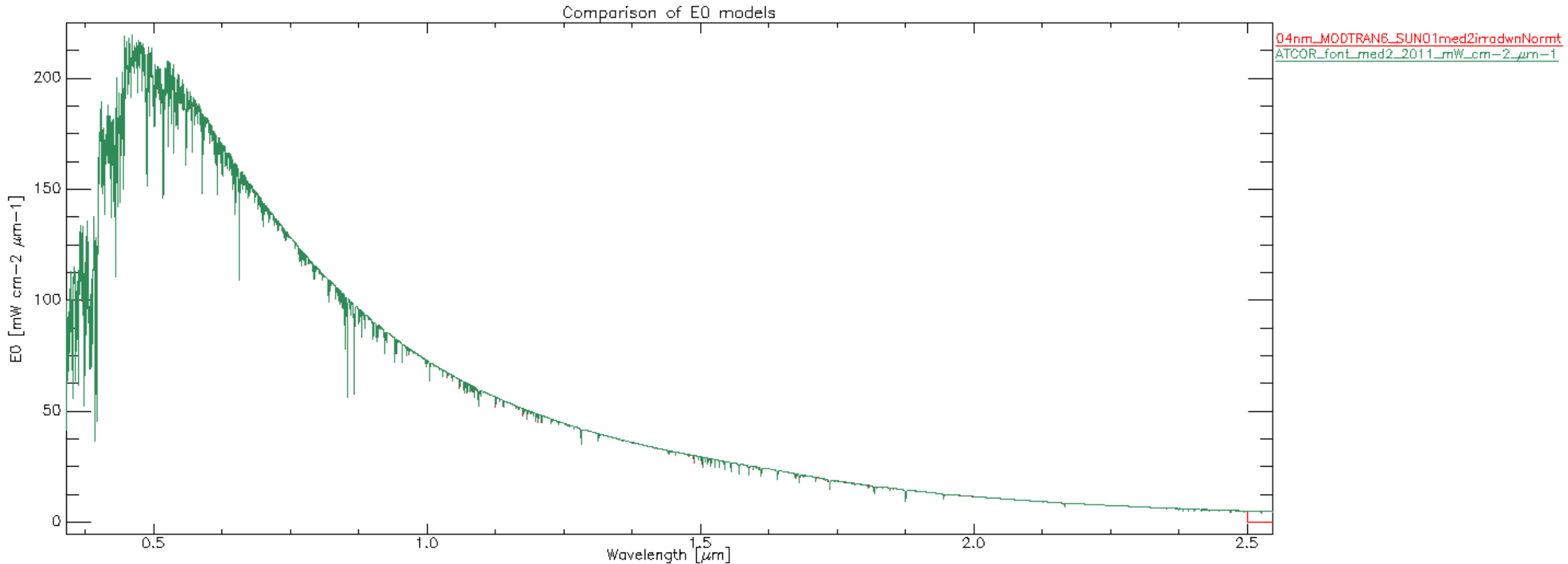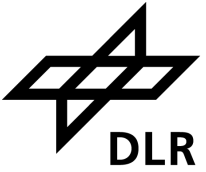
Publication in preparation

- But: what <u>exactly</u> are these models?

- Real-world-example:
  - Question raised by Rayference / ESA to EnMAP Ground Segment
    if two files(!) of FONTENLA E0 models
    (MODTRAN 6 "SUN01med2irradwnNormt.dat")
    are the very same
  - The „original" <u>data</u> of FONTENLA is no longer published (or can't be found
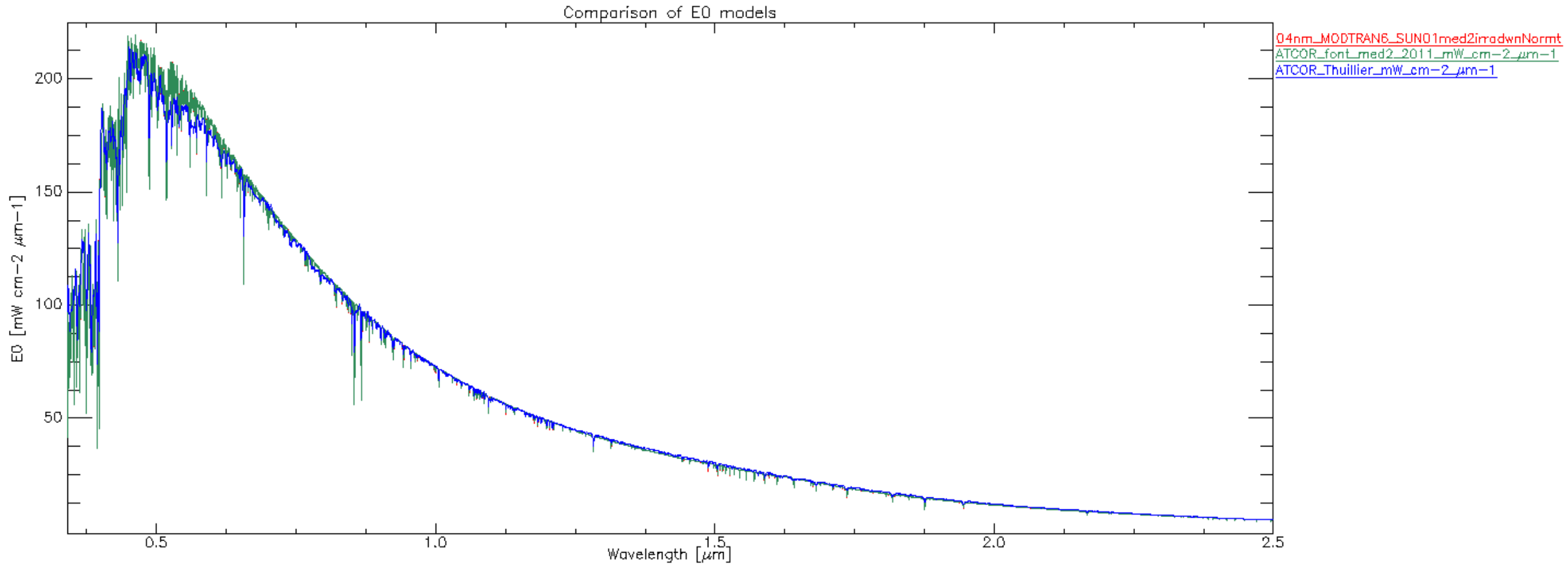   by most people…)

  - Resampling to sensor characteristics will add more questions and (possible)
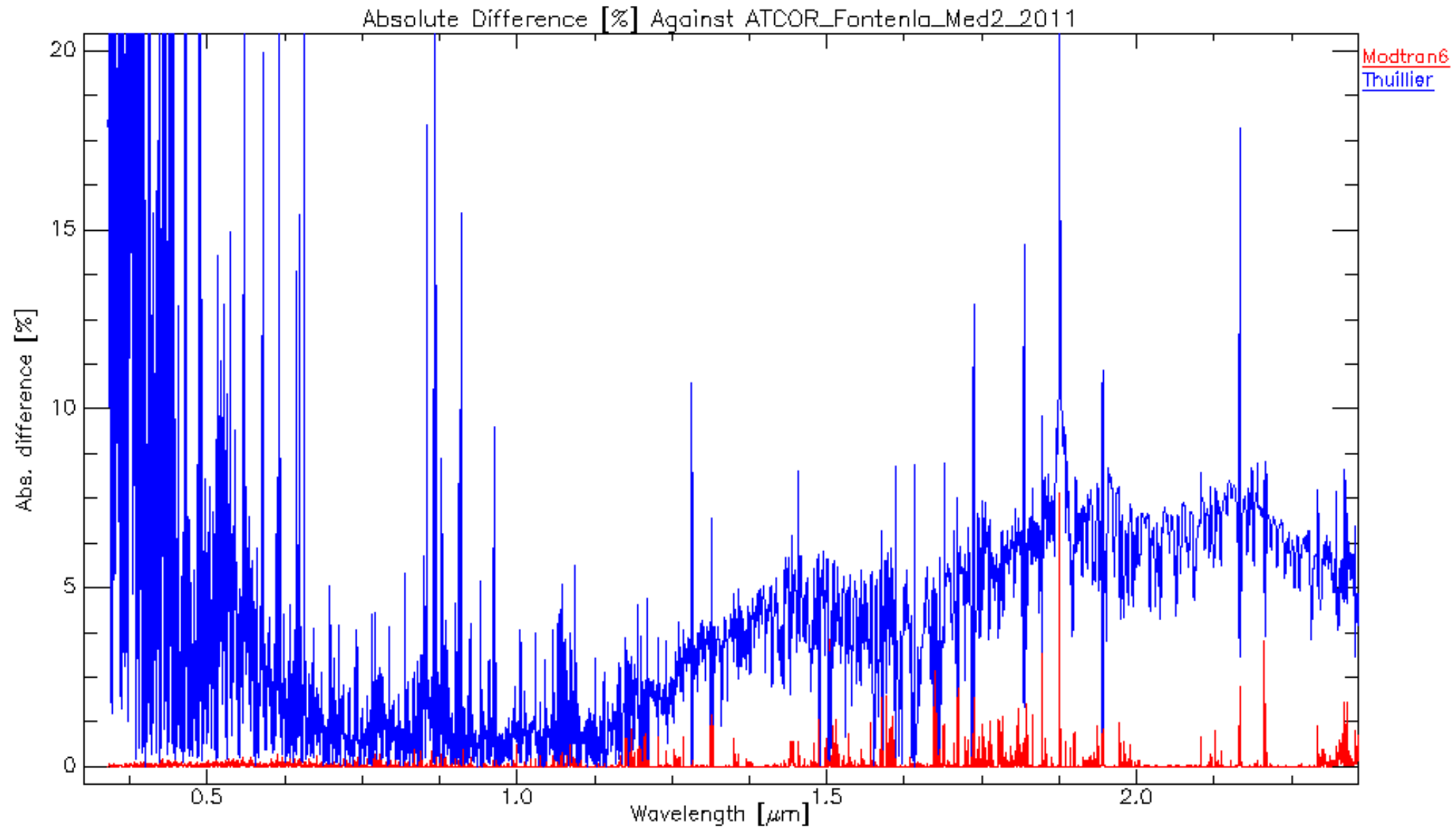   sources of errors…

Full range – 2x Fontenla 2011

Comparison of E0 models

Note: the MODTRAN6 was cut at 2.5 μm in this graph (not in original data)

Comparison of E0 models

Absolute Difference [%] Against ATCOR_Fontenla_Med2_2011

SWIR @ 2.3 μm

Absolute Difference [%] Against ATCOR_Fontenla_Med2_2011

As original data not available:
„Modified" Fontenla model in MODTRAN ?
Copyrights by Spectral Sciences Inc. ?

NOTE: noise starting at ~2.3 μm in both spectra

Absolute Difference [%] Against ATCOR_Fontenla_Med2_2011

100.*abs(s1-
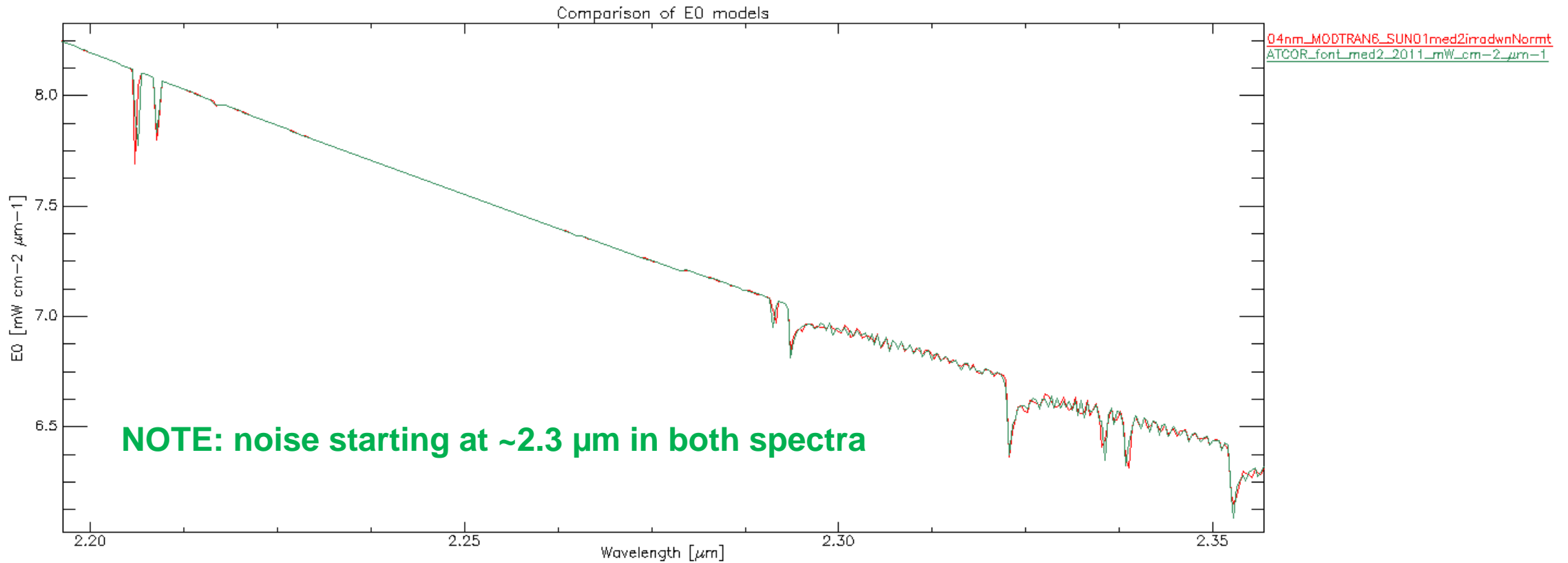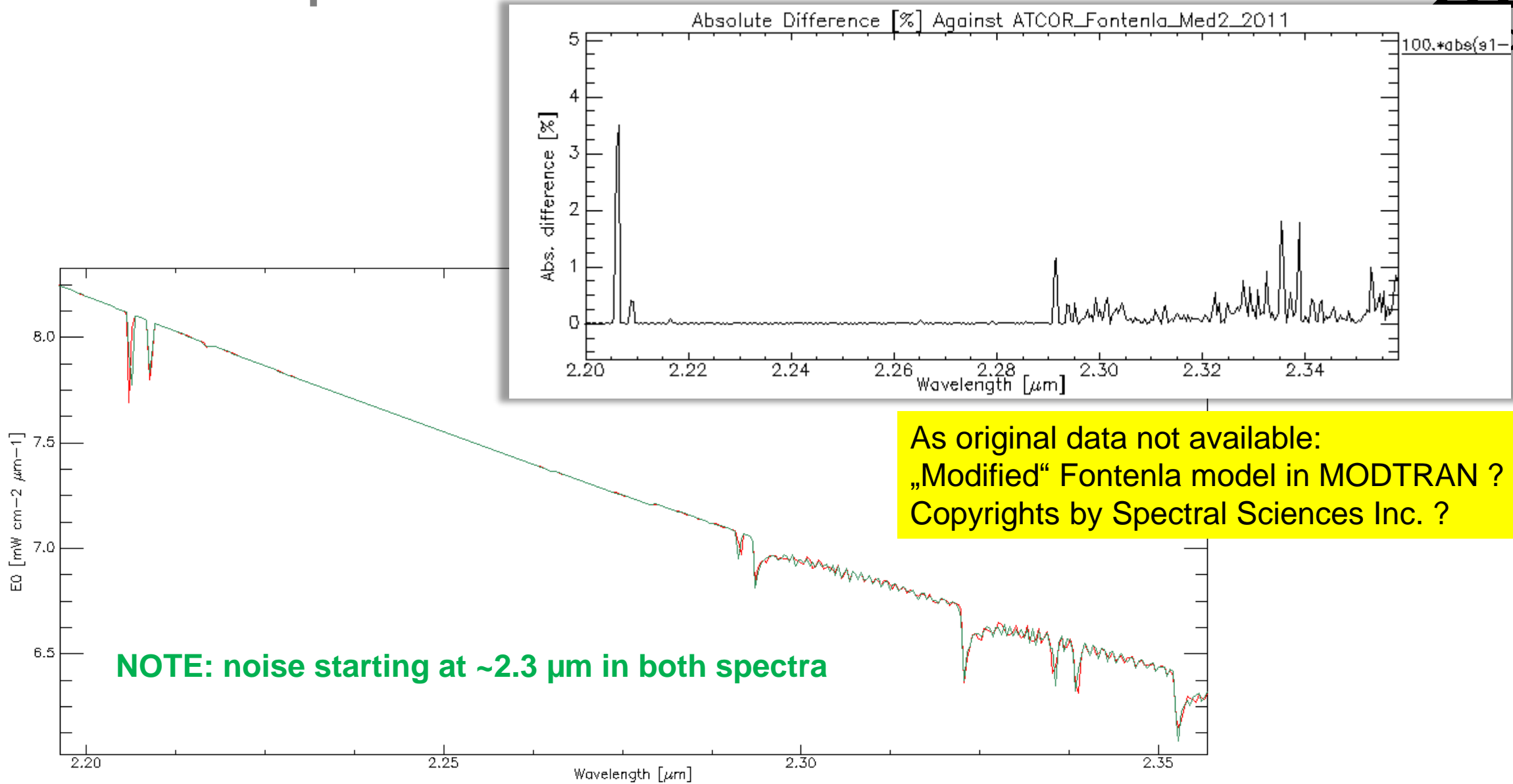
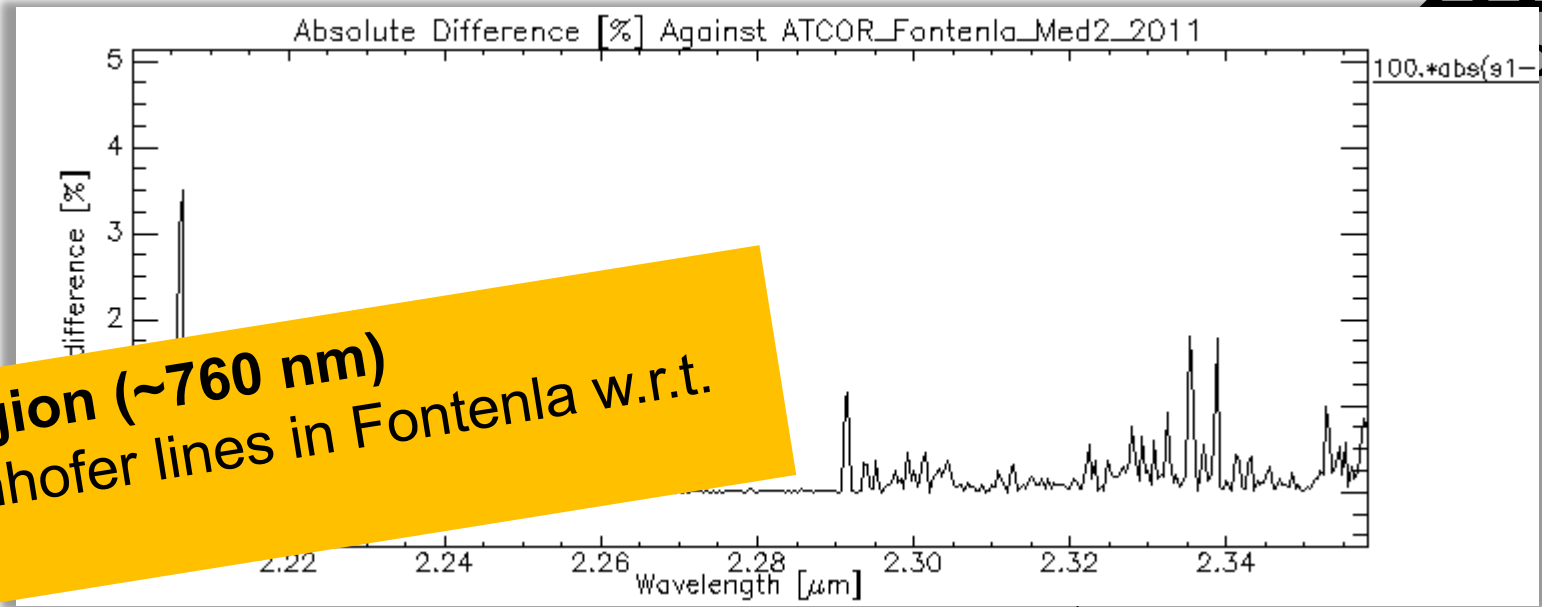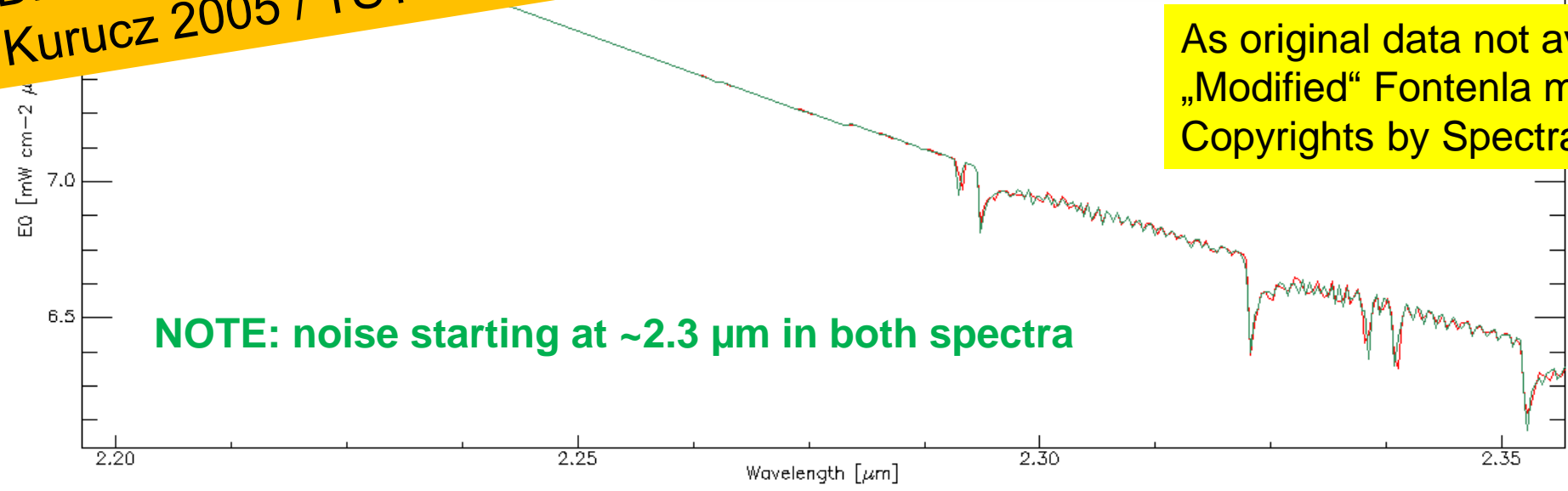**Additionally: in O2A band region (~760 nm)** Differences / missing(?) Fraunhofer lines in Fontenla w.r.t. Kurucz 2005 / TSTS-1

As original data not available: „Modified" Fontenla model in MODTRAN ? Copyrights by Spectral Sciences Inc. ?

NOTE: noise starting at ~2.3 µm in both spectra

„Wishlist" from mission perspective

- „Wishlist"
  - CEOS (or other institution) hosting collection of E0 spectra
  - Full data and documentation provided or linked
  - Intellectual property and other rights clarified (example: E0 included in MODTRAN)

… now moving on to L2A BOA_reflectance

Influence of the Solar Spectra Models on PACO Atmospheric Correction

Raquel De Los Reyes [1,*], Rudolf Richter [1], Martin Bachmann [2], Kevin Alonso [1], Bringfried Pflug [3], Bruno Lafrance [4] and Peter Reinartz [1]

Long story short:

- TOA_ref is „agnostic" to E0 model

- BUT: when using TOA_rad, ensure that consistency in E0 model is included in atm. Correction !

- … no difference when the solar irradiance model is preserved through the full processing chain.

- The differences appear when the solar irradiance model used in the atmospheric correction changes, and this difference is larger between some irradiance models
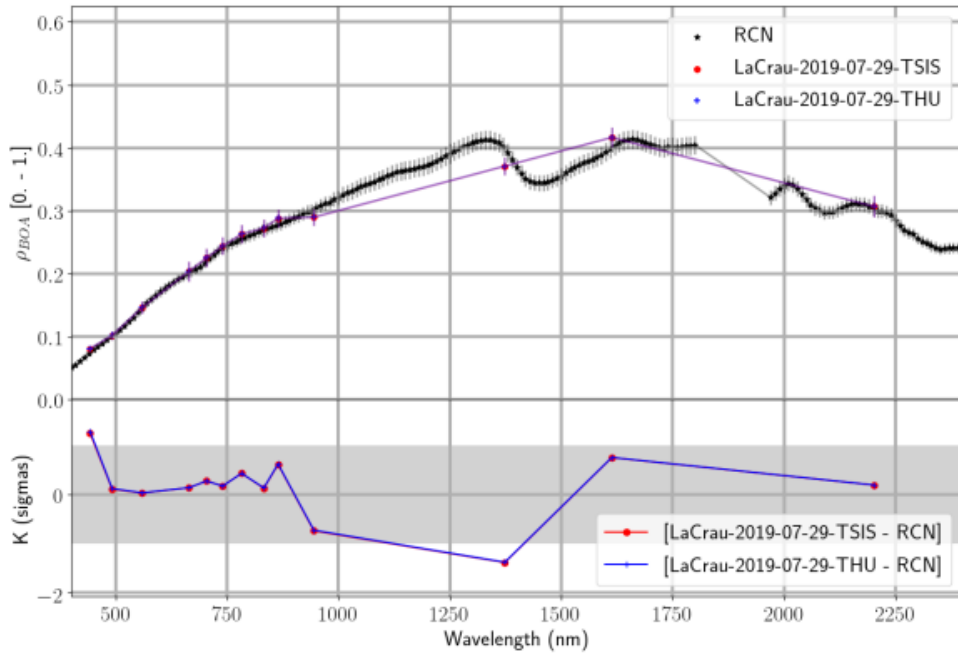
Figure 9. Consistent scenario. **Top**: L2A surface reflectance of RadCalNet (RCN) (black), PACO L2A with Thuillier 2003 (blue, "+") and TSIS (red, "."") solar models. **Bottom**: Uncertainty ratio (K) between each of L2A surface reflectance with the previous solar models with respect to RadCalNet in situ reference values. Grey band limits ± 1 sigma region.
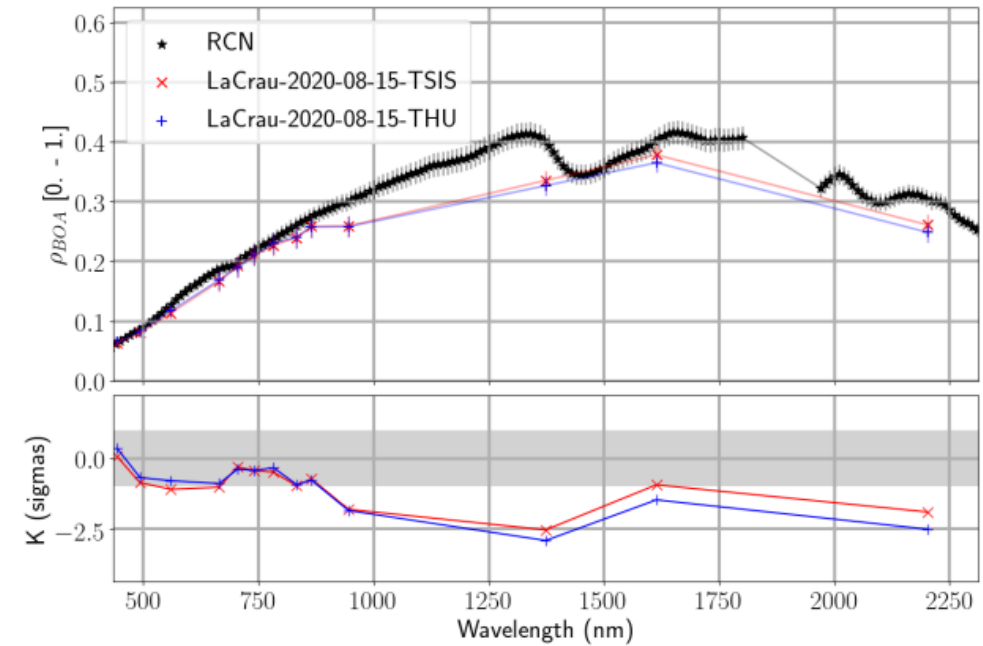
Figure 11. Inconsistent scenario for Sentinel-2. Top: L2A surface reflectance of RCN (black crosses), PACO L2A with Thuillier 2003 (blue, "+") and TSIS (red "×") solar models. Bottom: Uncertainty ratio (K) between each of L2A surface reflectance with the previous solar models with respect to RadCalNet (RCN) in situ reference values. Grey band limits ± 1 sigma region.

Consistent   Vs   Inconsistent