TEMPERATURE AND EMISSIVITY SEPARATION FROM MODIS MULTISPECTRAL TIR DATA

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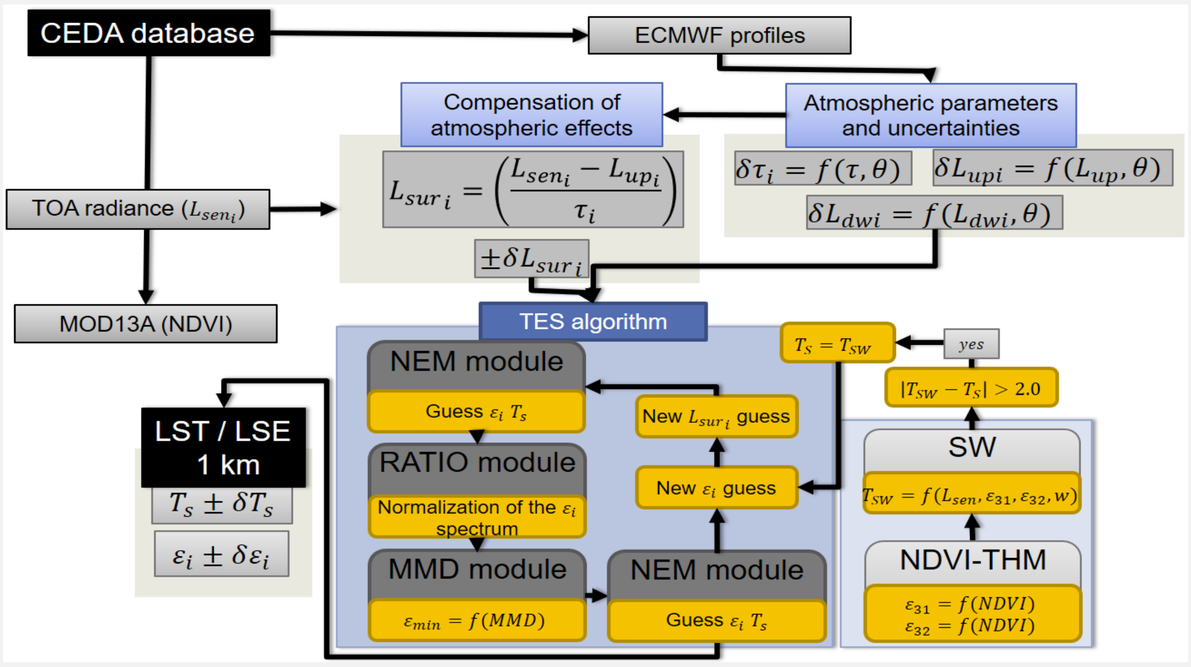
ABSTRACT: Generation of long-term Land Surface Temperature (LST) series from Thermal InfraRed (TIR) sensors on board polar orbiting or geostationary satellites has usually been based on the application of Split-Window (SW) techniques. SW algorithms over land also require as input a correction for the surface emissivity, usually estimated from vegetation indices or classification-based approaches using Visible and Near-Infrared (VNIR) bands. These algorithms have systematically been used because of the dominant spectral configuration of most low-resolution Earth Observation sensors, with only two bands in the 10.5-12 μm spectral region. However, LST retrieval from SW algorithms and surface emissivity estimations from classifications and/or vegetation indices may be problematic in some landscapes because emissivity of land surfaces is heterogeneous and is dependent on many factors such as soil moisture and surface compositional changes which are not characterized by land cover maps. A reduction in LST uncertainty due to improved emissivity knowledge could be beneficial for long time series data if the accuracy of the joint retrieval of temperature and emissivity could be verified. In the framework of ESA LST Climate Change Initiative (CCI) project we propose the application Temperature and Emissivity Separation (TES) method that combine TIR data in different spectral bands, providing both LST and Land Surface Emissivity (LSE) by solving the radiative transfer equation and thus reflecting the real conditions of the surface. To do se, the whole Moderate Resolution Imaging Spectroradiometer (MODIS) database will be processed applying the TES algorithm in order to generate LST and LSE Essential Climate Variable (ECV) products which can be useful for global trends and for local-scale LST climate applications, such as urban areas, agricultural land, or semi-arid areas. An additional benefit of the computed LSE product is the retrieval of global maps which can be used as input in the classic SW algorithms for generation of long-term LST series. The work proposed here uses ECMWF profiles as input atmospheric data and some auxiliary algorithms (SW, NDVI-THM) for better estimate LSE and then LST in the TES algorithm, making this processing chain different to others. These global retrievals will be validated using in situ measurements to assess their feasibility and performance. Other global TES products will be also compared to our retrievals.

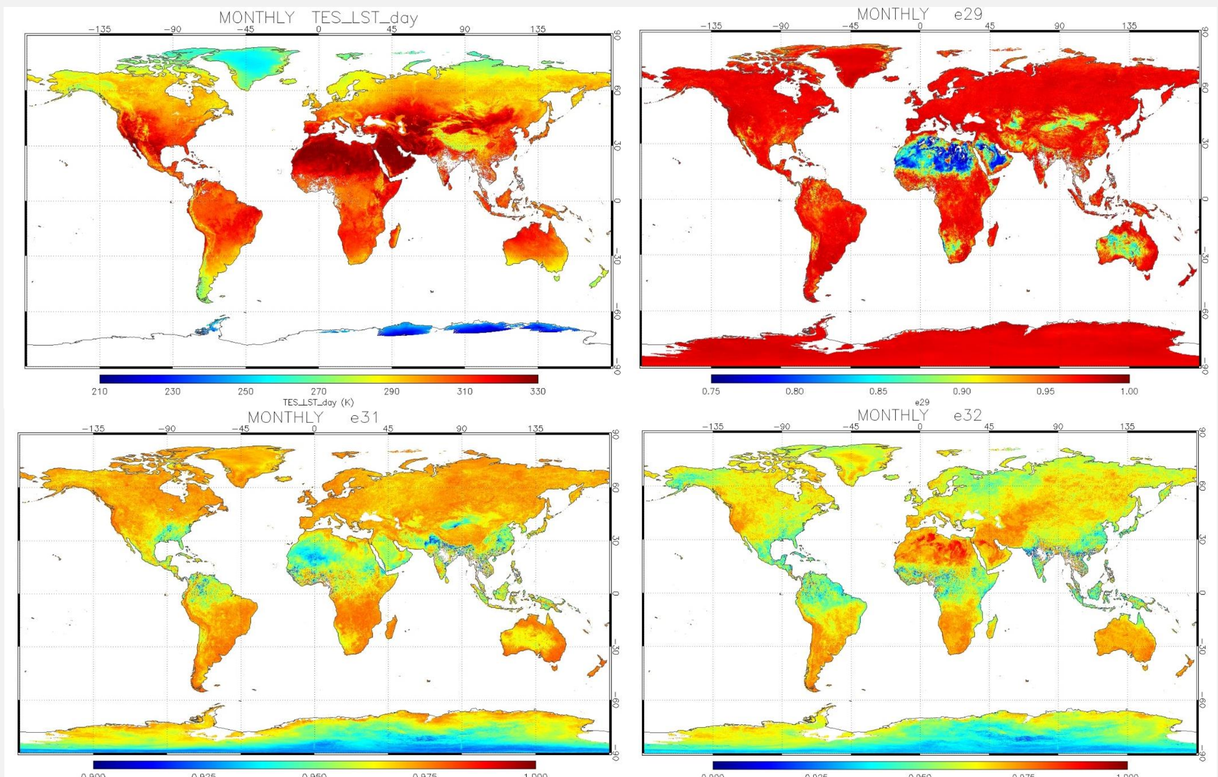
TES PROCESSING CHAIN



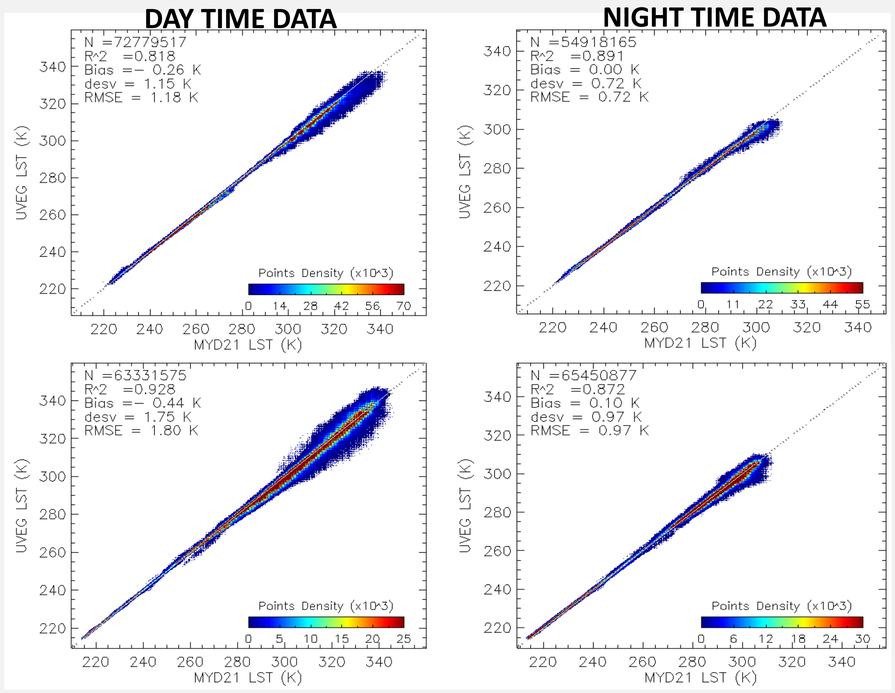
AUXILIAR ALGORITHMS	STRUCTURE
Split Window	$T_{LST} = T_i + a_0 + a_1(T_{ij}) + a_2(T_{ij})^2 + (a_3 + a_4 w)(1 - \varepsilon) + (a_5 + a_6 w)\Delta\varepsilon$
NDVI Thresholds Method	$\varepsilon = \varepsilon_s(1 - FVC) + \varepsilon_v FVC + C \quad (0 < FVC < 1)$ $\varepsilon = 0.99 \quad (FVC = 1)$

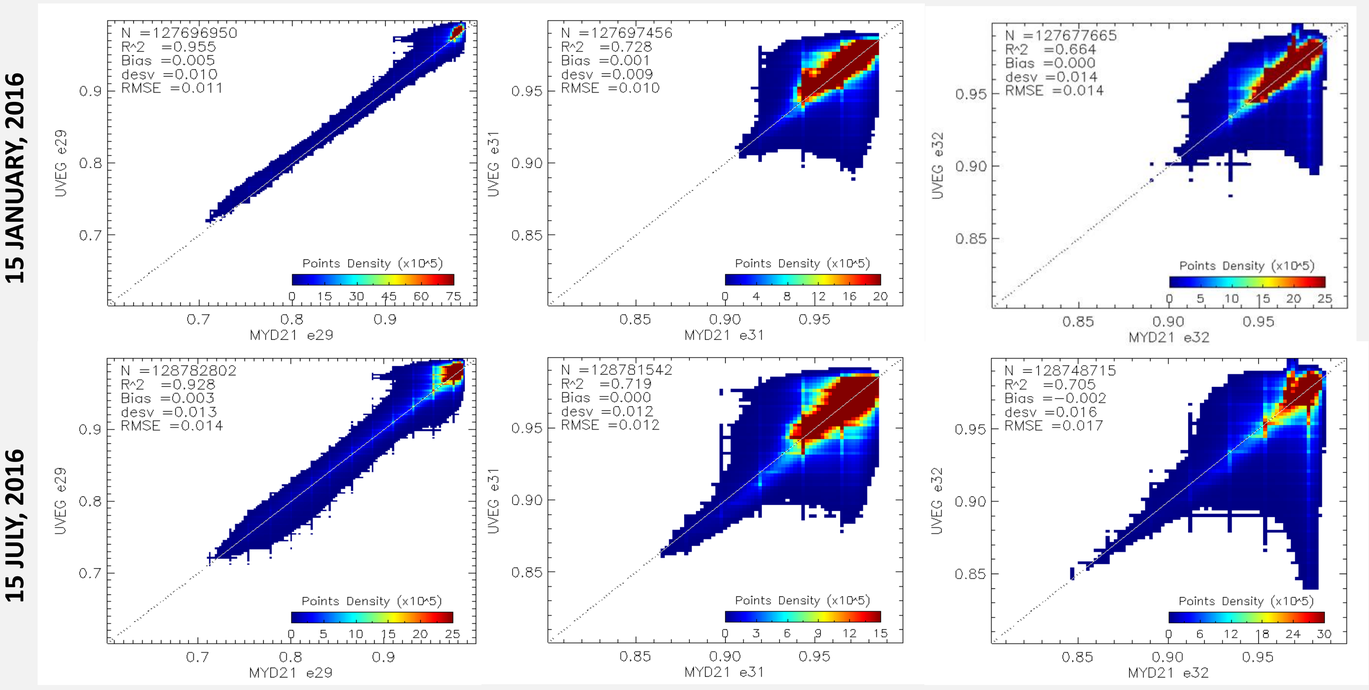
UNCERTAINTIES	ESTIMATION
Land leaving radiance	$\delta L_{sur_i} = \left(\left[\frac{1}{\tau_i} \cdot \delta_{L_{SENi}}\right]^2 + \left[\frac{1}{\tau_i} \cdot \delta_{L_{UPi}}\right]^2 + \left[\frac{L_{sen_i} - L_{up_i}}{\tau_i^2} \cdot \delta_{\tau i}\right]^2\right)^{1/2}$
LST and LSE	Ingestion of $L_{sur_i} + \delta L_{sur_i}$ and $L_{sur_i} - \delta L_{sur_i}$ to TES algorithm

MONTHLY AVERAGED LST AND LSE OUTPUTS



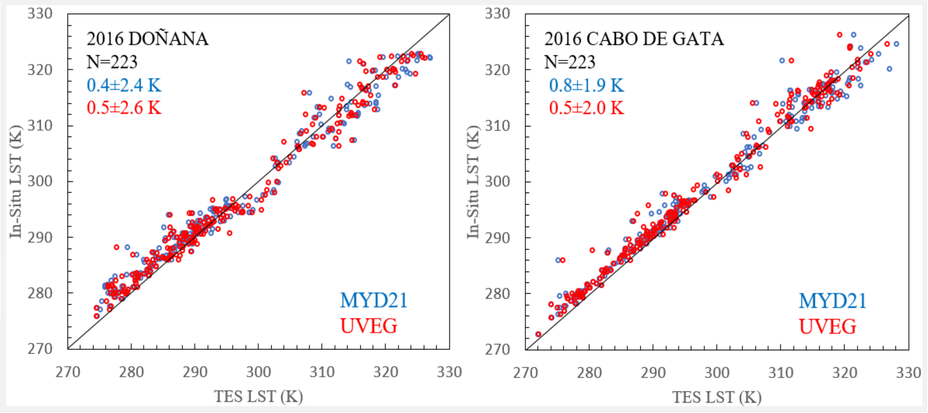
UVEG PROPOSED TES vs MOD21 PRODUCT





IN-SITU ASSESSMENT

LOCATION OF TEST SITES IN SPAIN



CONCLUSION: UVEG TES algorithm can deliver an accurate LST and LSE products as in situ assessment and MOD21 comparison show. Proposed processing chain pretends to be a complementary product to other efforts currently taken by other entities such as NASA.

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