Comparison of LAI estimates from high resolution satellite observations using different biophysical processors

Filipponi Federico

ISPRA - Italian Institute for Environmental Protection and Research

federico.filipponi@isprambiente.it

Background

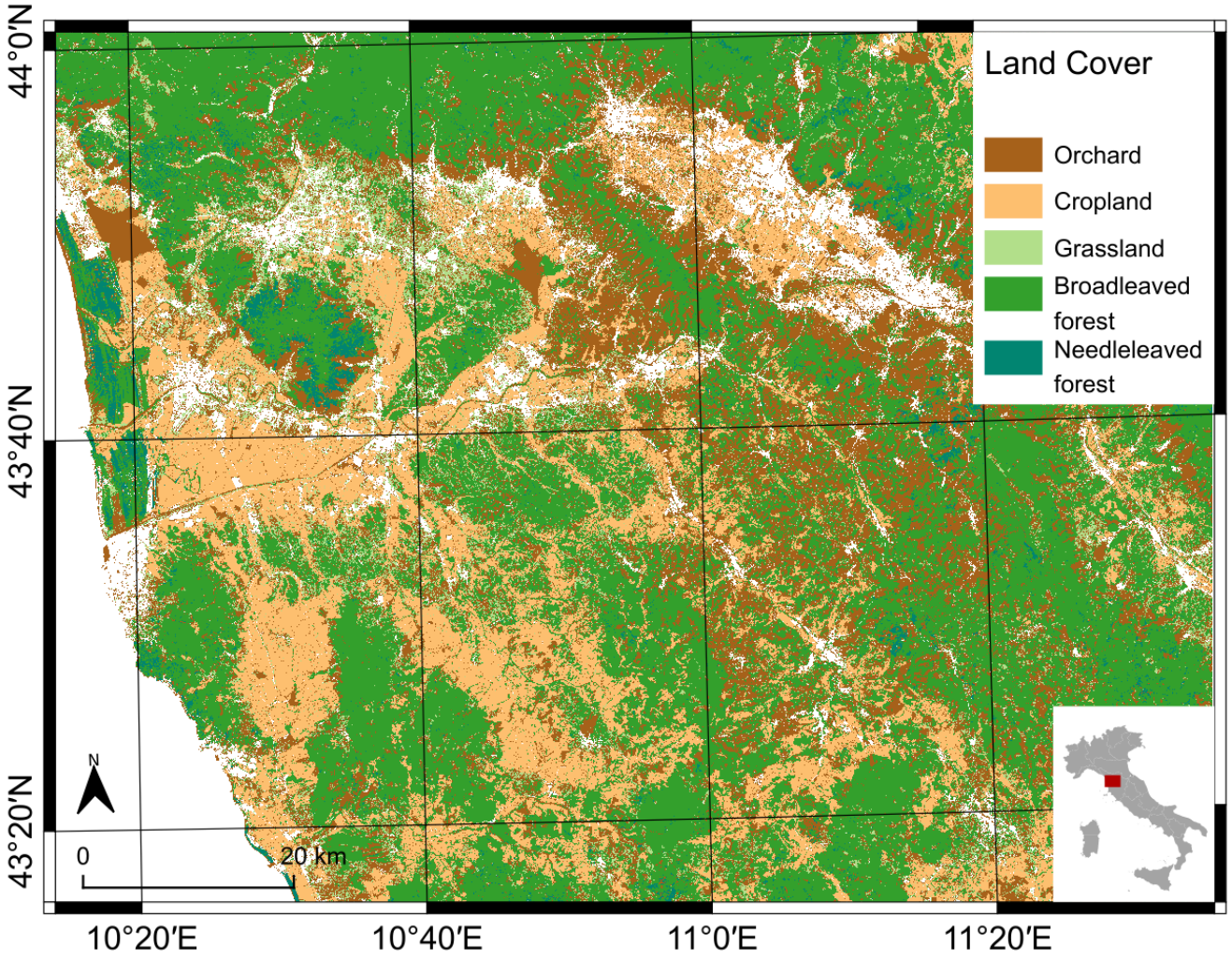
Earth observation provides timely and spatially explicit information on crop phenology and vegetation dynamics that can support decision making and sustainable agricultural land management

Techniques to retrieve biophysical parameters from satellite acquisitions, like the Leaf Area Index (LAI), allowed to assimilate Earth observation time series in numerical modelling for the analysis of several land surface processes related to agroecosystem dynamics

Objectives

Compare LAI estimates from Sentinel-2 MSI and Landsat-8 OLI satellite data over croplands and other vegetation cover types using different biophysical processors

Test area



Test area is located in central Italy and covers an area of about 10,000 km^2.

Test site correspond to Sentinel-2 granule ‘T32TPP’, that overlay with Landsat8 tiles ‘T192030’ and ‘T193029’

Contains modified Copernicus Sentinel data [2021]

Data processing

Sentinel-2 MSI preprocessing

- Spatial resampling at 10 m
- Invalid pixel masking (e.g. cloud, topographic_shadow, snow)

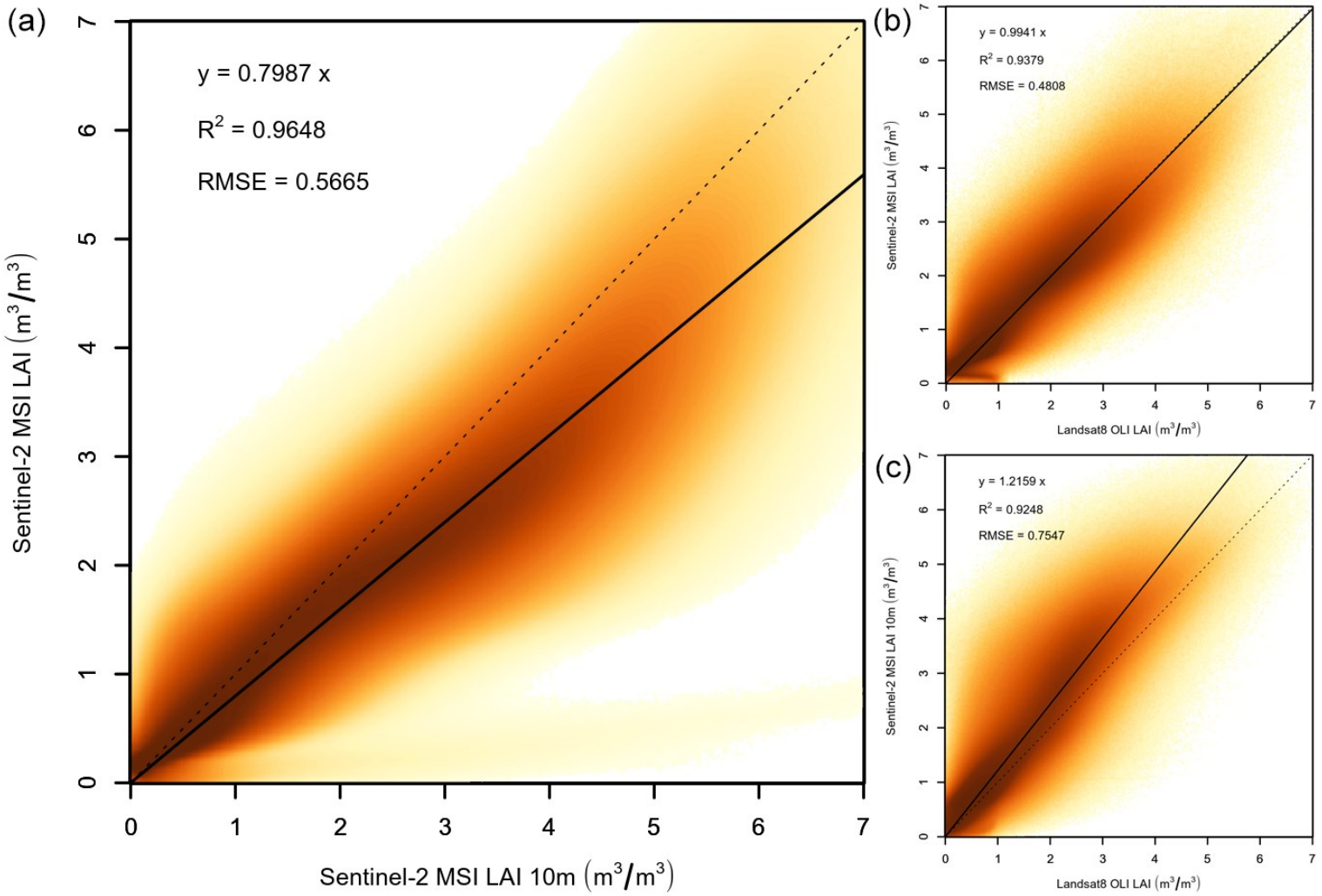
Landsat8 OLI preprocessing

- Reflectance and angle stacking
- Correction for local illumination

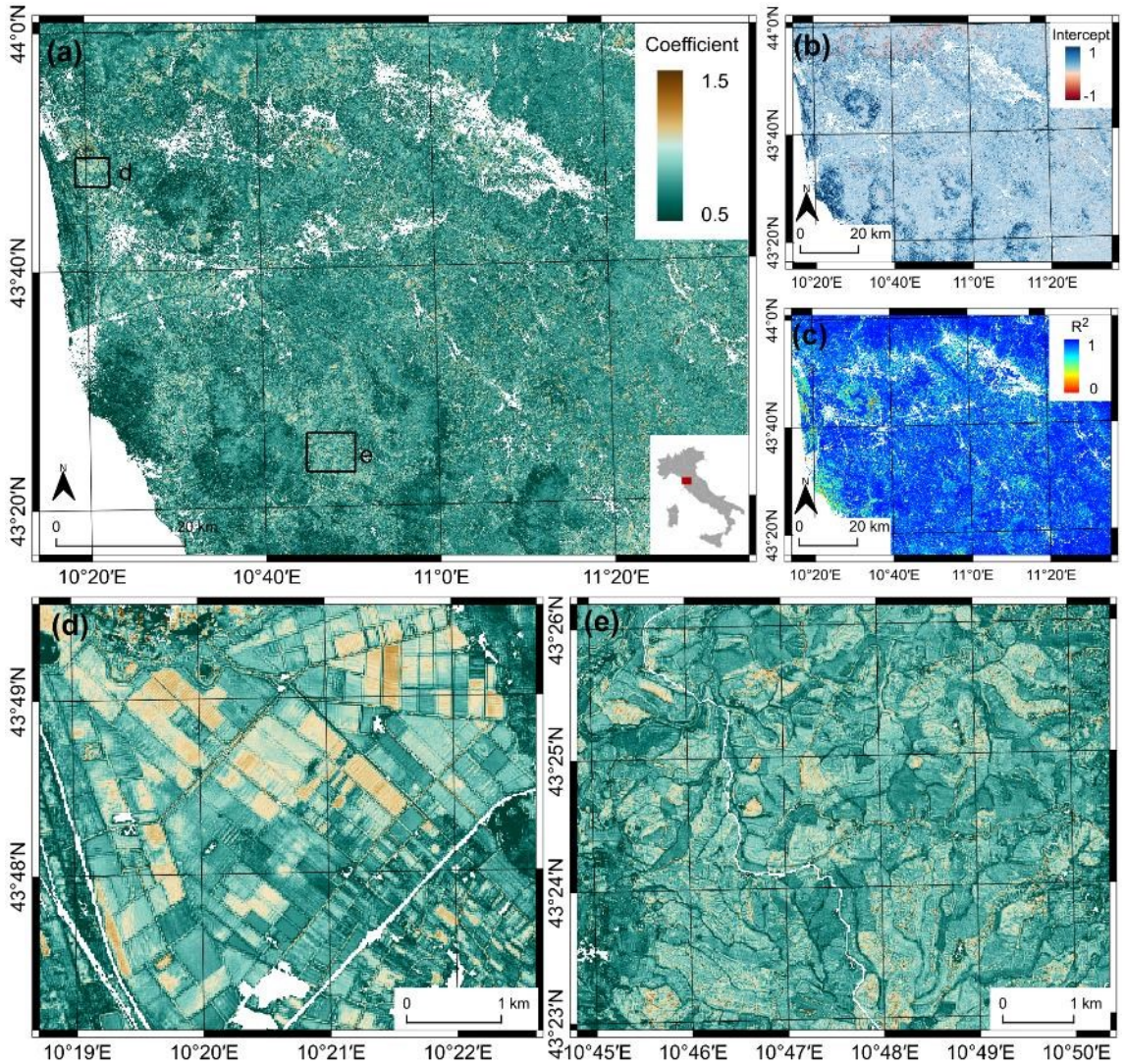
Analysis

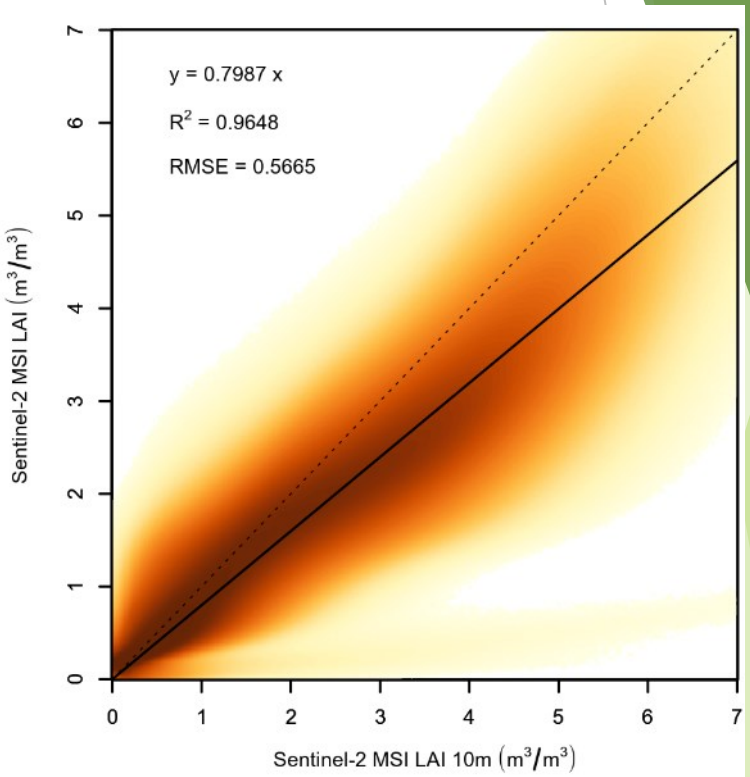
- Estimation of Leaf Area Index (LAI) using SNAP biophysical processor
- Time series stacking and spatial coregistration
- Linear regression

Results


(a)
y = 0.7987 x
R^2 = 0.9648
RMSE = 0.5665
Sentinel-2 MSI LAI (m^3/m^3)
Sentinel-2 MSI LAI 10m (m^3/m^3)
(b)
y = 0.9941 x
R^2 = 0.9379
RMSE = 0.4808
Sentinel-2 MSI LAI (m^3/m^3)
Landsat8 OLI LAI (m^3/m^3)
(c)
y = 1.2159 x
R^2 = 0.9248
RMSE = 0.7547
Sentinel-2 MSI LAI 10m (m^3/m^3)
Landsat8 OLI LAI (m^3/m^3)

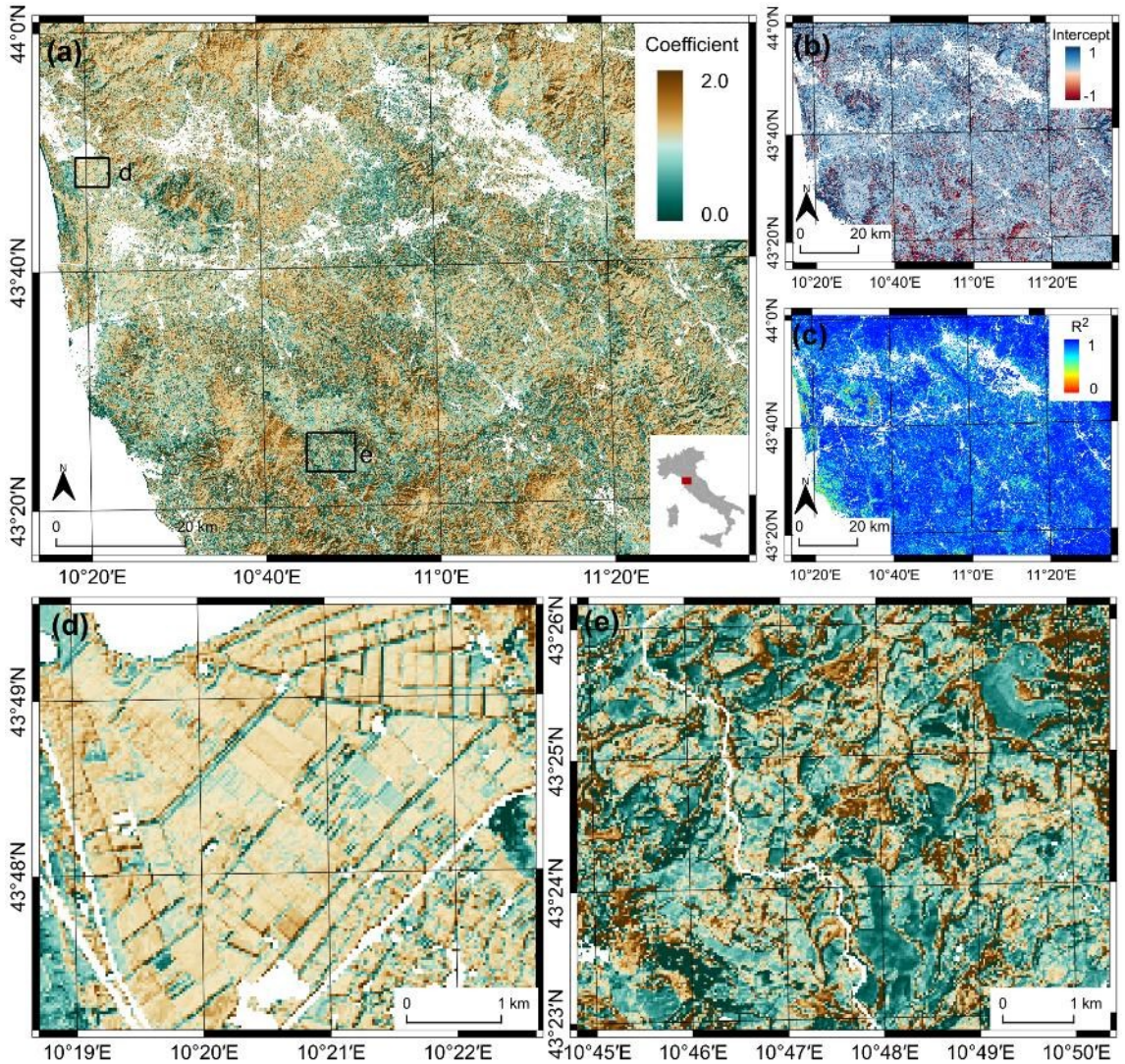
Results

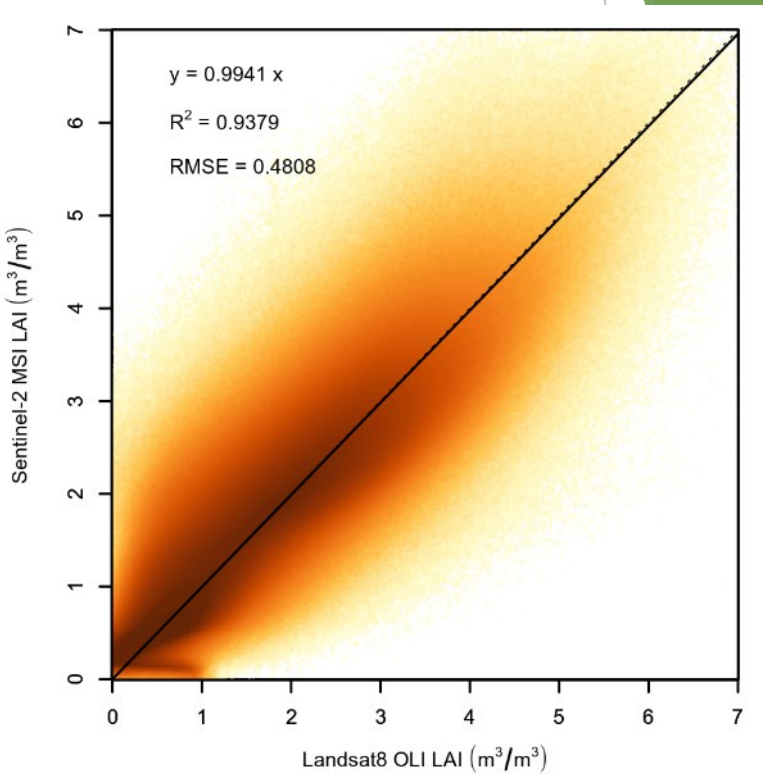




LAI biophysical processor calibrated on S2 spectral bands at 10 m spatial resolution overestimates LAI values, as compared with biophysical processor calibrated on S2 full spectrum

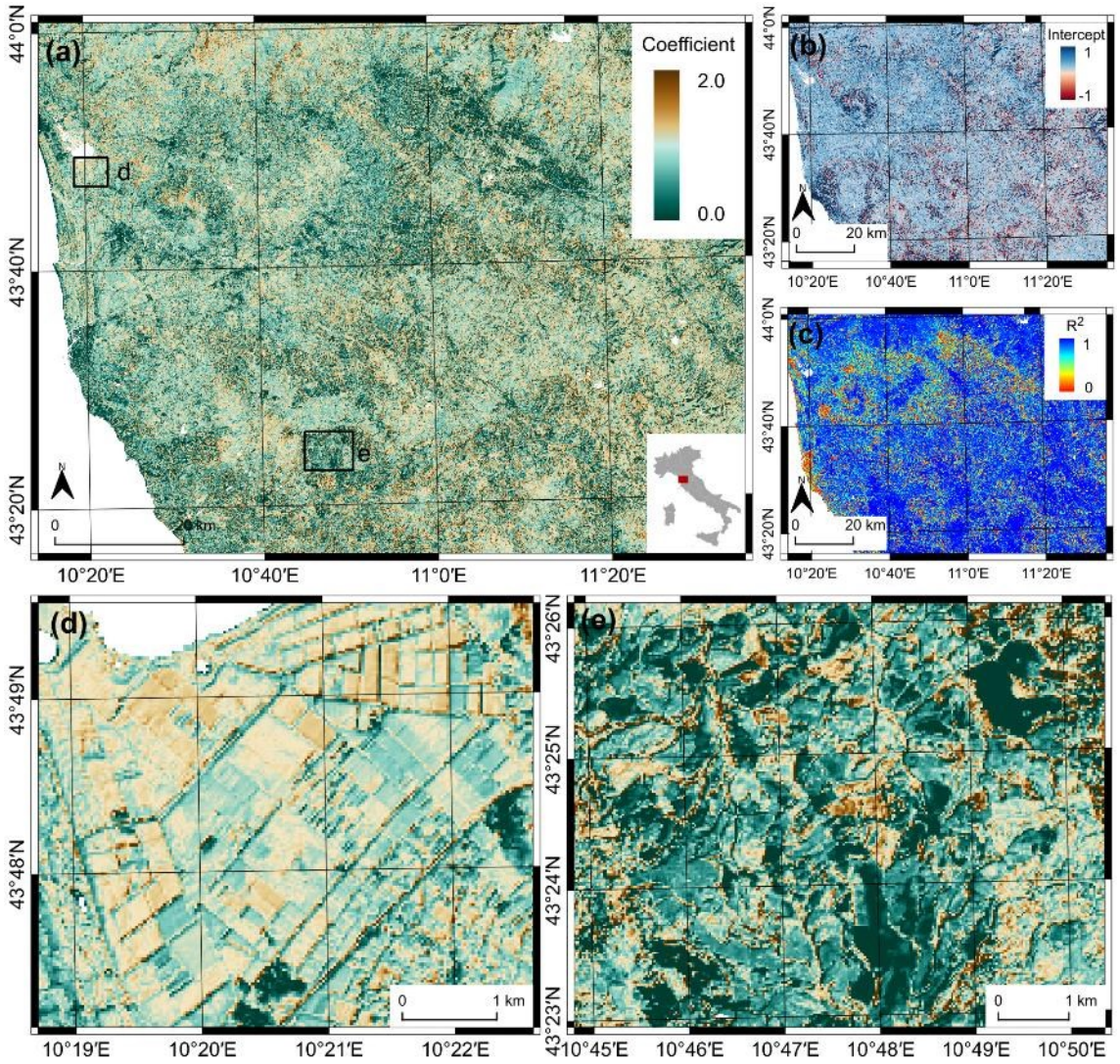
Results

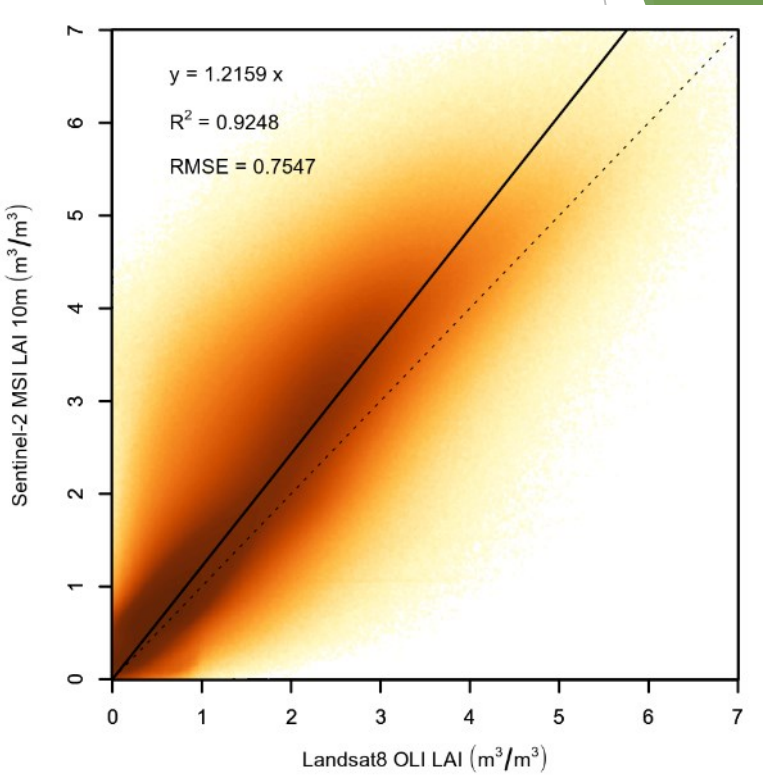




LAI estimates from biophysical processor calibrated on L8 has strong linear relationship with LAI estimates from model calibrated on S2 full spectrum

Results

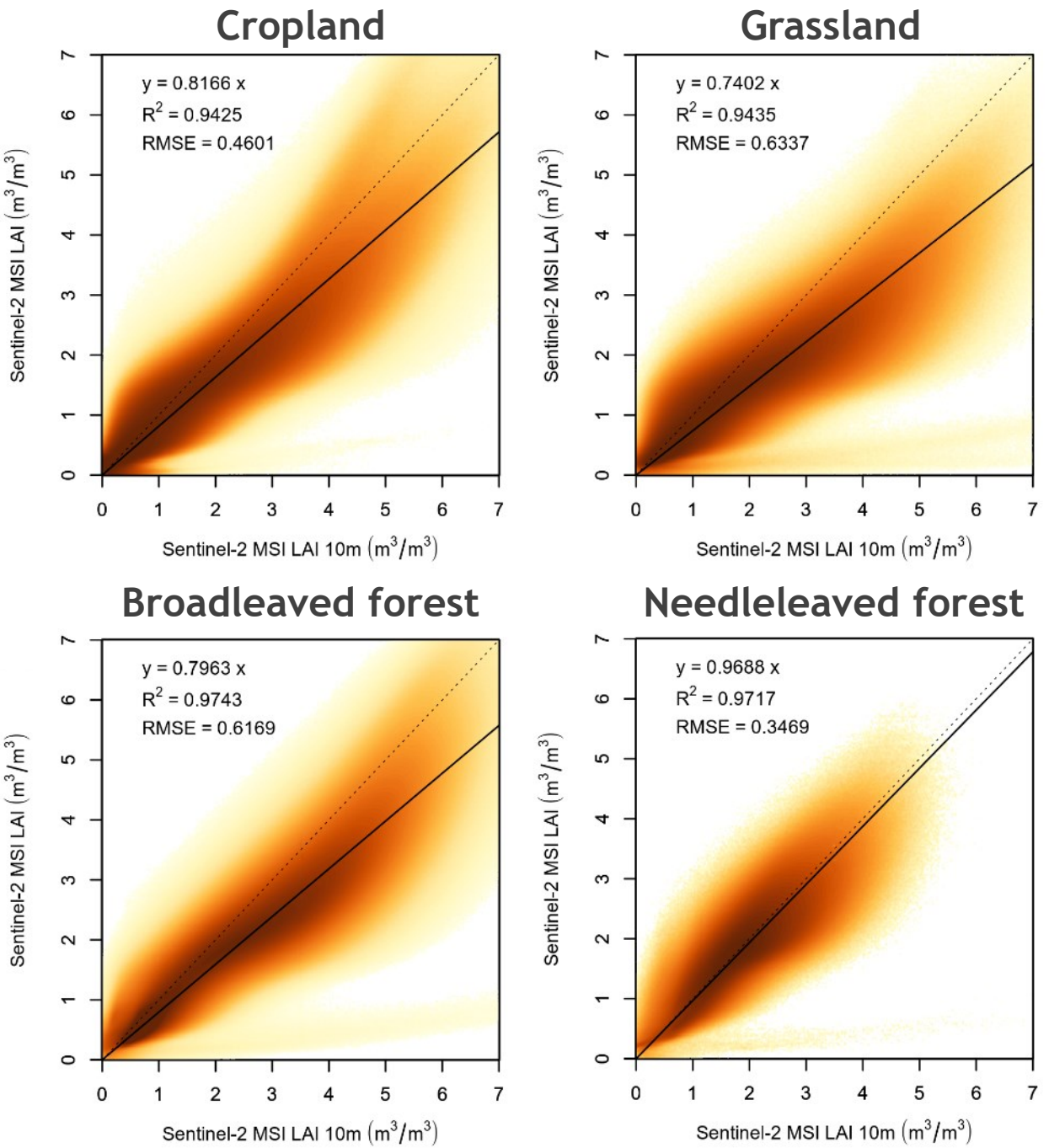




LAI biophysical processor calibrated on L8 spectral bands underestimates LAI values, as compared with biophysical processor calibrated on S2 spectral bands at 10 m spatial resolution

Results

LAI biophysical processor calibrated on S2 spectral bands at 10 m spatial resolution overestimates LAI values for the different plant functional types. overestimation is higher for grasslands and lower for needleleaved forests



Conclusions

Results demonstrate that the tested biophysical processor calibrated on Sentinel-2 MSI full spectrum provides stronger linear relationships with LAI estimated from Landsat8 OLI satellite sensors, as compared to the processor calibrated only on Sentinel-2 MSI 10 m spectral bands

Red-edge and short-wave infrared spectral reflectances provide key information related to vegetation status, that complements plant photosynthetic activity revealed from visible and near-infrared wavelengths

Virtual constellations of satellite sensors allow the generation of denser LAI time series, encouraging the use of estimated biophysical parameters time series to derive important cropland use information over large areas, like vegetation phenology, and consequently enhancing agroecosystems monitoring capacity

Further improvements require in situ measurements to complement the linear relationship analysis with the evaluation of accuracy metrics