

Supplementary

To obtain spectral features for each sample point, we selected Ground Range Detected (GRD) and Level 2A (L2A) products for Sentinel-1 (S1) and Sentinel-2 (S2), respectively, which are the mainstream data sources for 10-meter land cover mapping. We also adopted AW3D30 Version 3.2 for terrain features considering its relatively high accuracy and complete coverage at high latitude areas. These remote sensing data were retrieved on GEE with time constrained from 2020-01-01 to 2020-12-31. Thus, we could ensure the temporal consistency between the estimated accuracy by GLC-TCCA and the reported accuracy of WorldCover 2020. Only the first observation per day was kept in case of redundancy in remote sensing data.

The features used in this experiment are summarised in Table S1. Inspired by the image preprocessing in the production of WorldCover 2020, we first applied a filter on the scene classification layer (SCL) of the L2A product to remove clouds, cloud shadows, cirrus and saturated pixels and calculated eight vegetable indices (VIs) for each time series step of S2 data, as listed in Table S1. As for S1 data, a thermal noise correction followed by a radiometric terrain correction was applied. After preprocessing, monthly median composites were calculated based on the bands' time series of S1 and S2 data. Consequently, based on the monthly time series, the 10th, 50th and 90th percentiles and the interquartile range (IQR) were computed for each band and VIs. Furthermore, terrain features, including each sample point's slope and absolute elevation, were extracted from AW3D30. Overall, we obtained 98 features, of which 80 are from S2, 16 are from S1, and 2 are from AW3D30.

Table S1. Summary of the features used in this experiment

Data source	Band name	Description	Remarks
S1 GRD	VV	Single co-polarisation, vertical transmit/vertical receive	10 th , 50 th and 90 th
	VH	Dual-band cross-polarisation, vertical transmit/horizontal receive	percentiles and IQR of the
	<u>VVVH ratio</u>	VVVH cross-polarised ratio	monthly median
	<u>angel</u>	Approximate incidence angle from ellipsoid	composite time series
S2 L2A	B1-B8, B8A, B9, B11, B12	Spectral bands of S2 L2A	
	<u>NDVI</u>	Normalised Difference Vegetation Index	
	<u>EVI</u>	Enhanced Vegetation Index	10 th , 50 th and 90 th
	<u>NDWI</u>	Normalised Difference Water Index	percentiles and IQR of the
	<u>AVI</u>	Advanced vegetation index	monthly median
	<u>ARVI</u>	Atmospherically Resistant Vegetation Index	composite time series
	<u>SAVI</u>	Soil Adjusted Vegetation Index	
	<u>GNDVI</u>	Green Normalised Difference Vegetation Index	
	<u>BSI</u>	Bare Soil Index	
AW3D30	<u>Slope</u>	-	-
	<u>Elevation</u>	-	-

Note: Names of customised bands are underlined