Land Surface Temperature CCI

Darren Ghent

University of Leicester

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Objectives

Consistency in algorithms, cloud masking, uncertainties

Building the first 20+ year climate datasets for LST

Resolving the global diurnal cycle for LST by merging multiple polar orbiting and geostationary data

An objective to be the best source of LST data for the user community:

- LST is an essential parameter for diagnosing Earth System behaviour and evaluating Earth System Models
- Crucial constraint on surface energy budgets, particularly in moisture-limited states
- A metric of surface state when combined with vegetation parameters and soil moisture
- As an independent temperature data set for quantifying climate change complementary to the near-surface air temperature ECV based on in situ measurements and reanalyses

User requirements

	Threshold	Breakthrough	Objective
Dataset length	10 years	30 years	> 30 years
Spatial resolution	1 km	< 1 km	< 1 km
Temporal resolution	6 hours	1 hour	< 1 hour
Accuracy	1 K	0.5 K	0.3 K
Precision	1 K	0.5 K	0.3 K
Stability	0.3 K / decade	0.2 K / decade	0.1 K / decade

← LST CCI User Requirements

High quality data more important than spatially complete fields

High temporal resolution more important for global studies

High spatial resolution more important for local studies

Dataset length is more important for global studies, whilst high data resolution is more important for local studies

GCOS LST Requirements ↓

Item	Type	Value
Horizontal resolution	Threshold	0.05°
Temporal resolution	Threshold	Day-night
	Target	≤ 3-hourly
Accuracy	Threshold	<1 K
Precision	Threshold	<1 K
Stability	Threshold	<0.3 K per decade
	Target	<0.1 K per decade
Length of record	Threshold	20 years
	Target	>30 years

Latest Developments

The Version 2.0 release of the LST_cci products is complete with all products publically available on the JASMIN facility (http://gws-access.ceda.ac.uk/public/esacci_lst/)

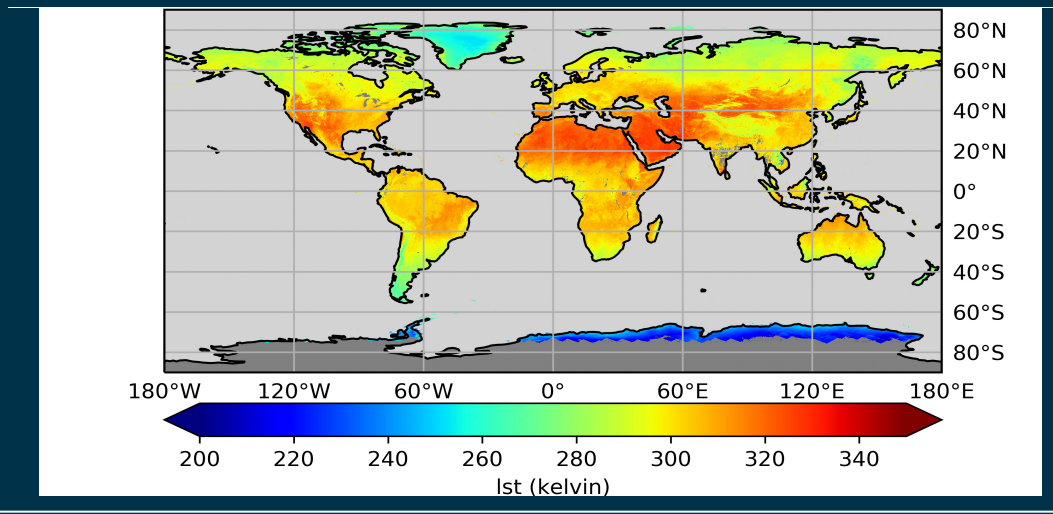
This includes global and regional cloud free data from thermal infrared sensors, global all sky data from microwave sensors, and global cloud free data over the full diurnal cycle from merging data of geostationary and polar-orbiting thermal infrared sensors

An important advance on the Version 1.0 products is the implementation of consistency across the product suite

This means products are using common algorithms, cloud detection methods, uncertainty models and calibration databases to deliver the best possible climate data records for LST

The final Phase-1 Version 3.0 release of the LST_cci products is progressing with all products being delivered to the Open Data Portal shortly

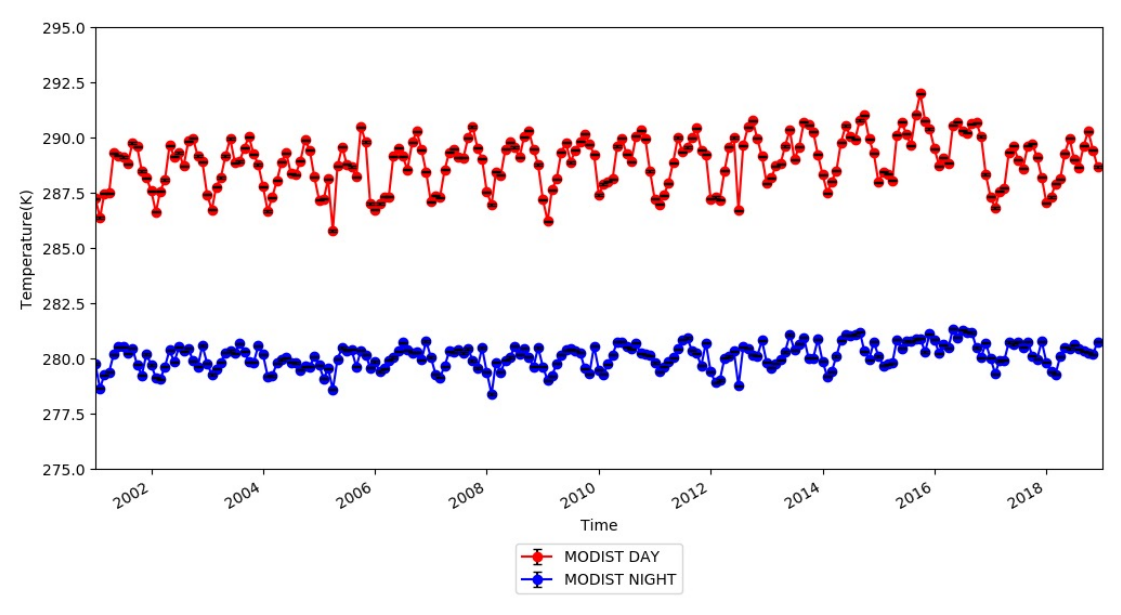
Select CDRs being prepared for Obs4MIPs submission



LST ECV products

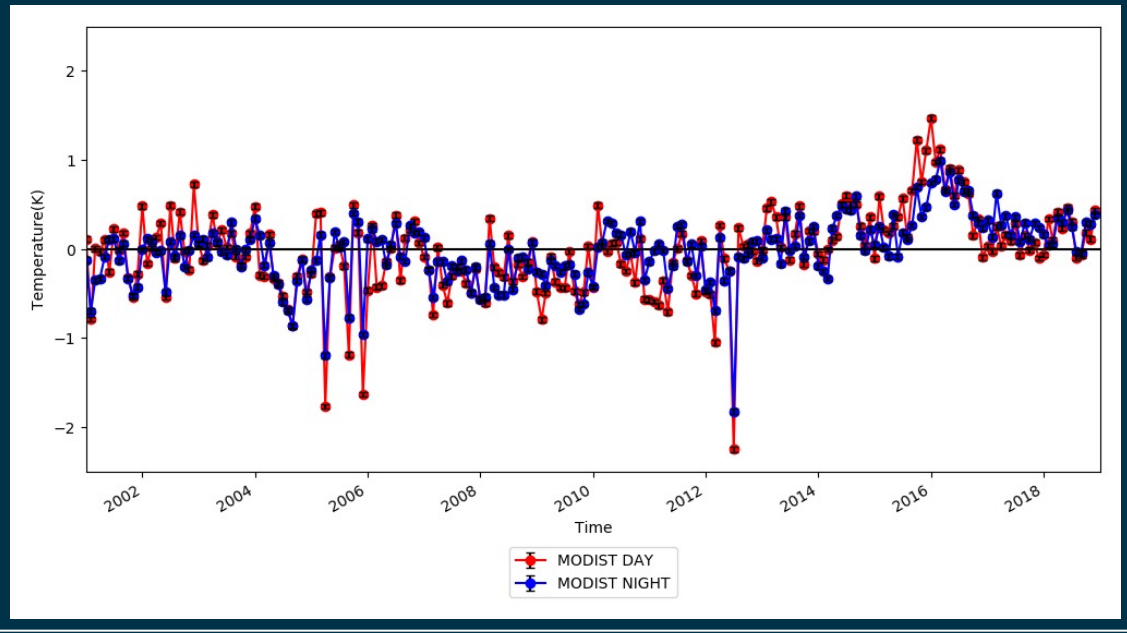
Instrument	Satellite(s)	Year 1	Year 3	Products	Comments
ATSR-2	ERS-2	1995-2003	1995-2003	1 km L2P 0.01° Daily L3C	
AATSR	Envisat	2002-2012	2002-2012		
AVHRR/3	NOAA-19		2009-2020		GAC (4km)
	Metop-A-C		2007-2020		FRAC (1km)
MODIS	Terra	1999-2018	1999-2018		
	Aqua	2002-2018	2002-2018		
SLSTR	Sentinel-3A	2016-2018	2016-2020		
	Sentinel-3B		2018-2020		
SEVIRI	MSG-1-4	2008-2010	2004-2020	0.05° Hourly L3U	MVIRI being done by CM SAF
Imager	GOES 12-16		2004-2020		
JAMI	MTSAT-2		2009-2015		
SSM/I	DMSP F-13,17	1998-2018	1995-2020	0.25° Daily L3C	
ATSR-MODIS-SLSTR CDR	ATSR, MODIS, SLSTR	1995-2012	1995-2020	0.05° Daily + Monthly L3S	ATSR-2 through to SLSTR
Merged IR CDR	LEO+GEO IR above		2009-2020	0.05° 3-hourly L3S	3-hourly Merged GEO+LEO

18-year Time Series



Terra MODIS LST

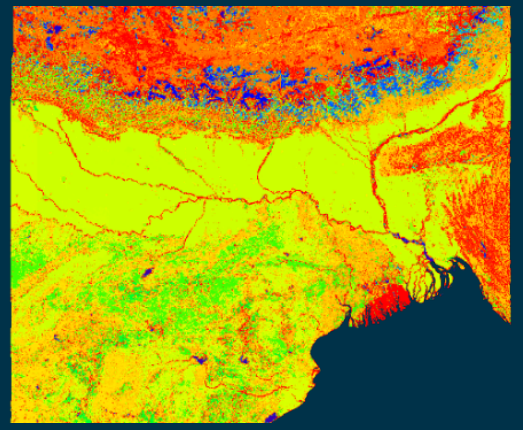
Terra MODIS Monthly LST Anomalies



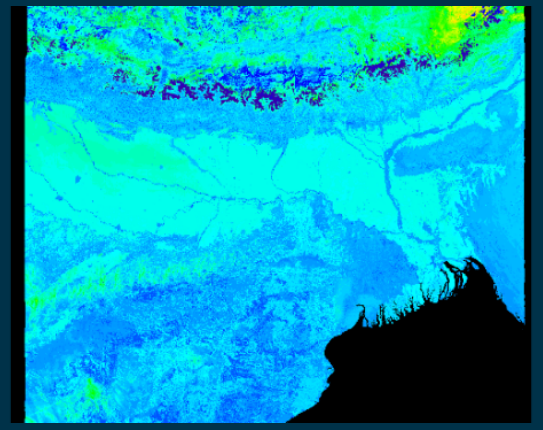
Consistent Uncertainty Characterisation

SLSTR-A Level-2 uncertainty components

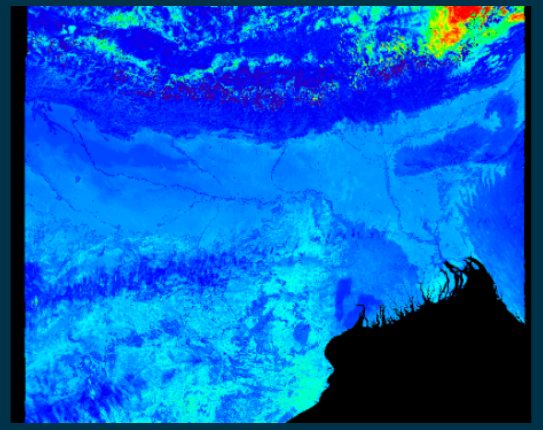
Total uncertainty



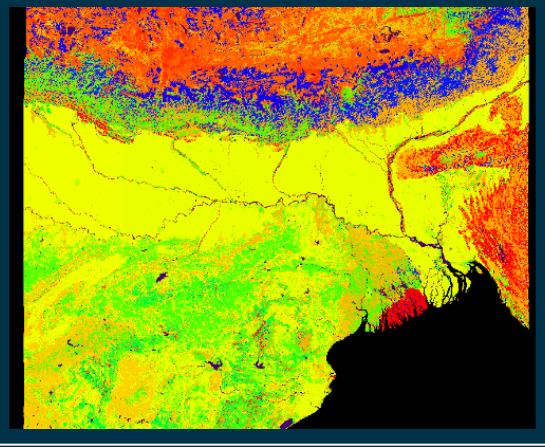
Random



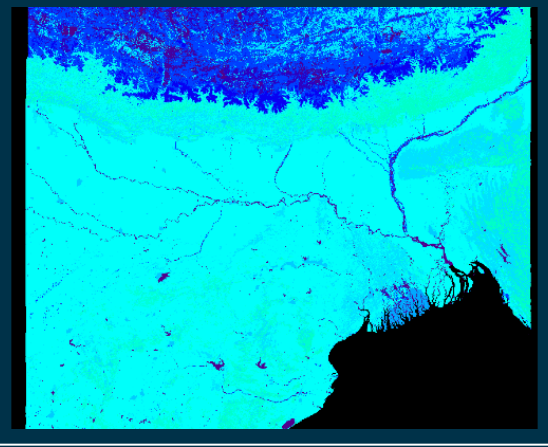
Calibration



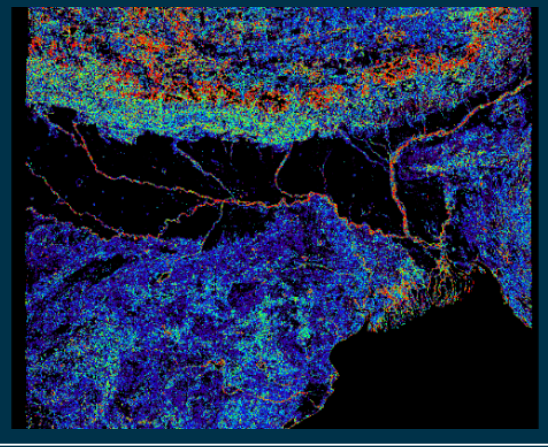
Atmosphere



Surface

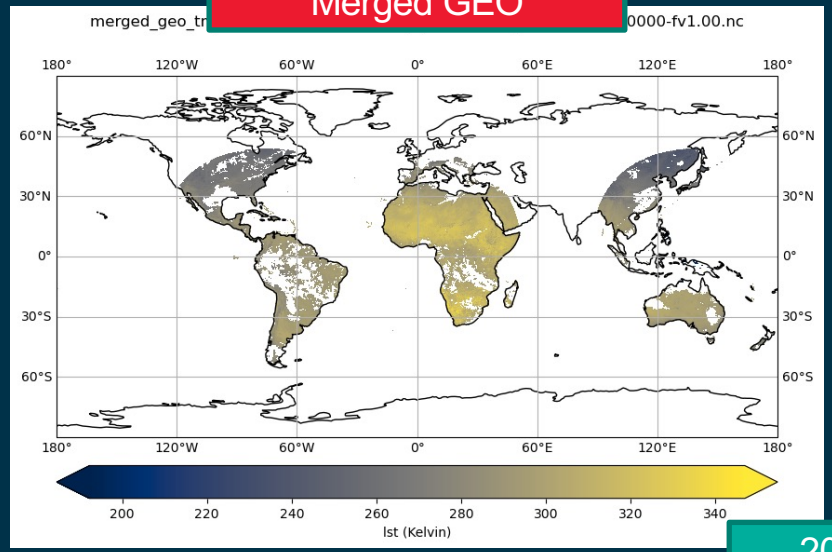


Geolocation

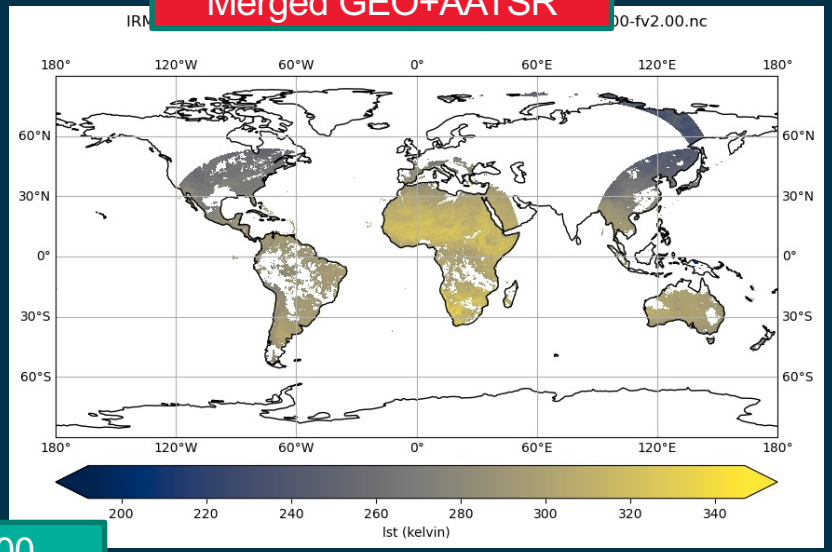


Resolving the Global Diurnal Cycle for LST

Merged GEO

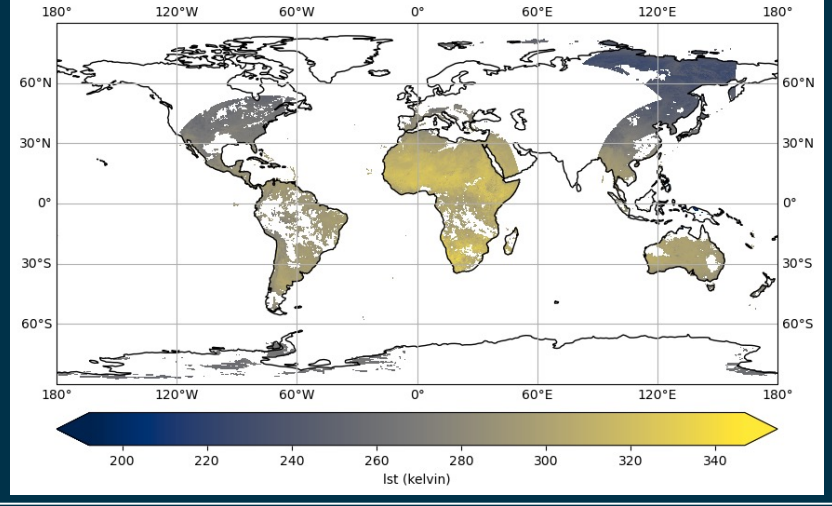


Merged GEO+AATSR

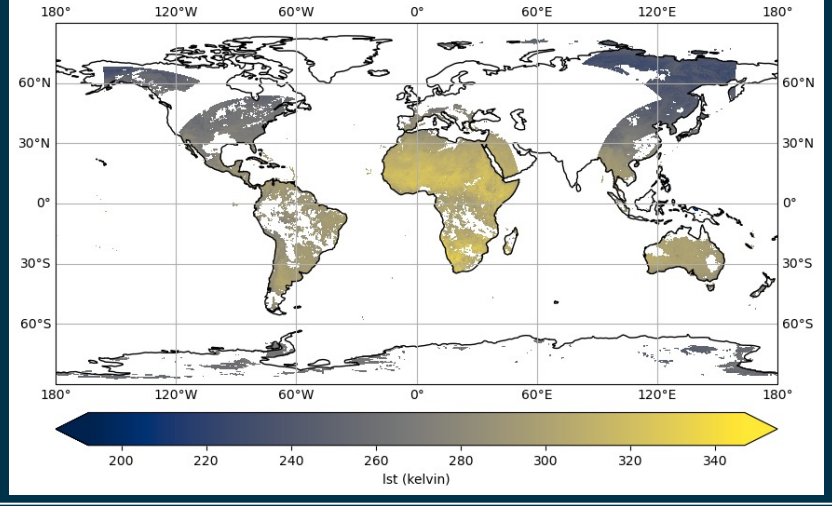


2010/01/15 12:00

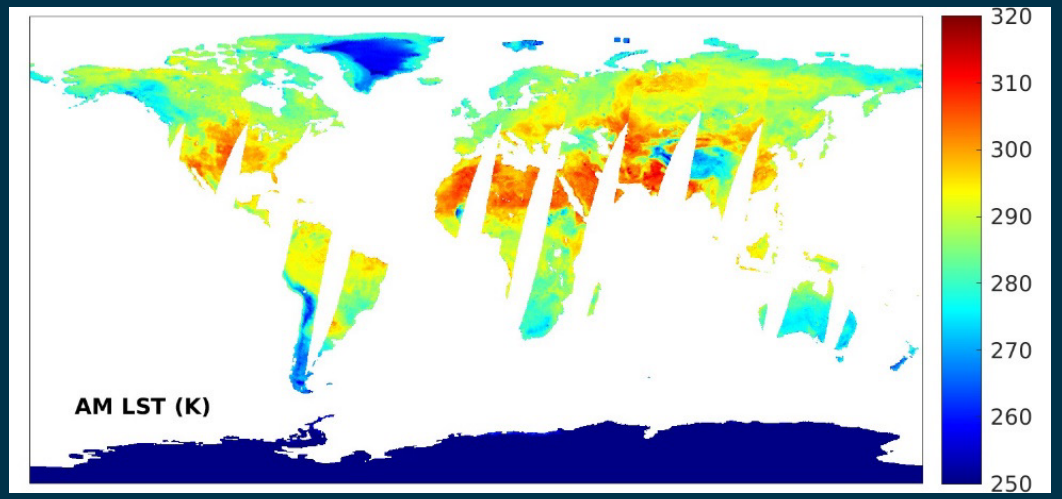
Merged GEO+AATSR+MODIST

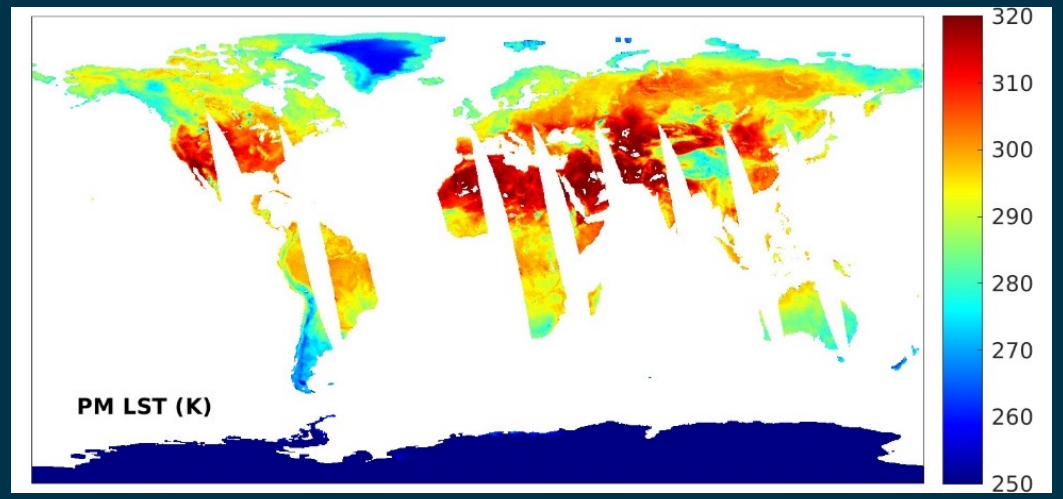


Merged GEO+AATSR+MODIST+MODISA

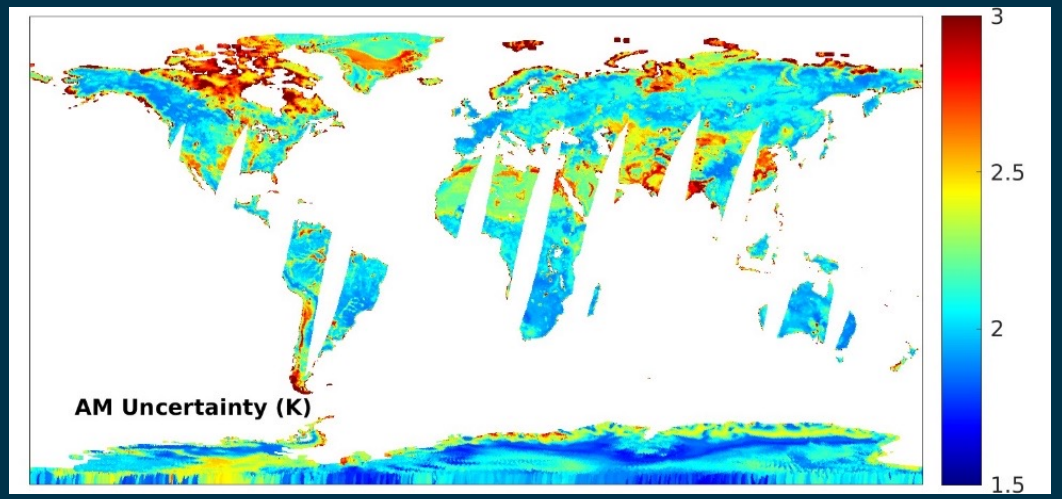


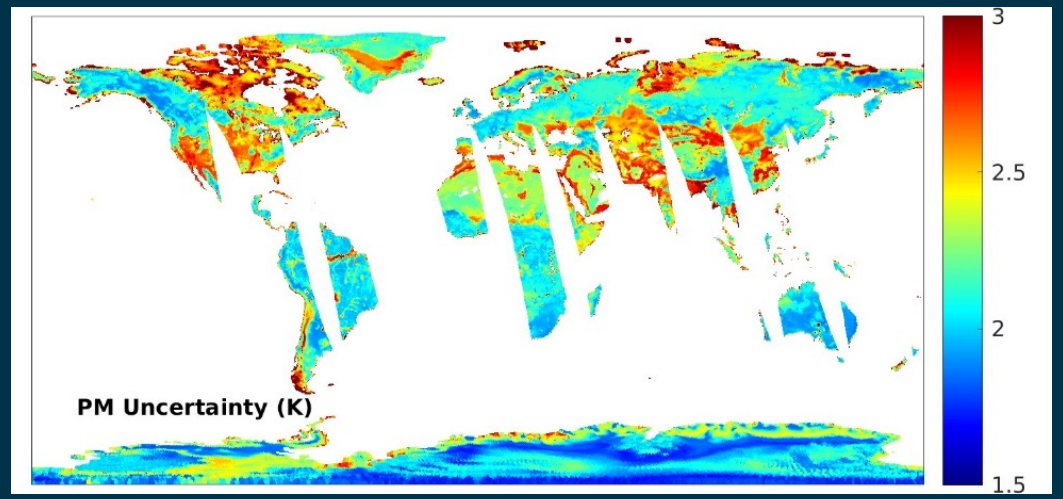
Microwave Product





Single Sensor SSM/I on F-13, SSMIS on F-17/18; example 2012/07/02





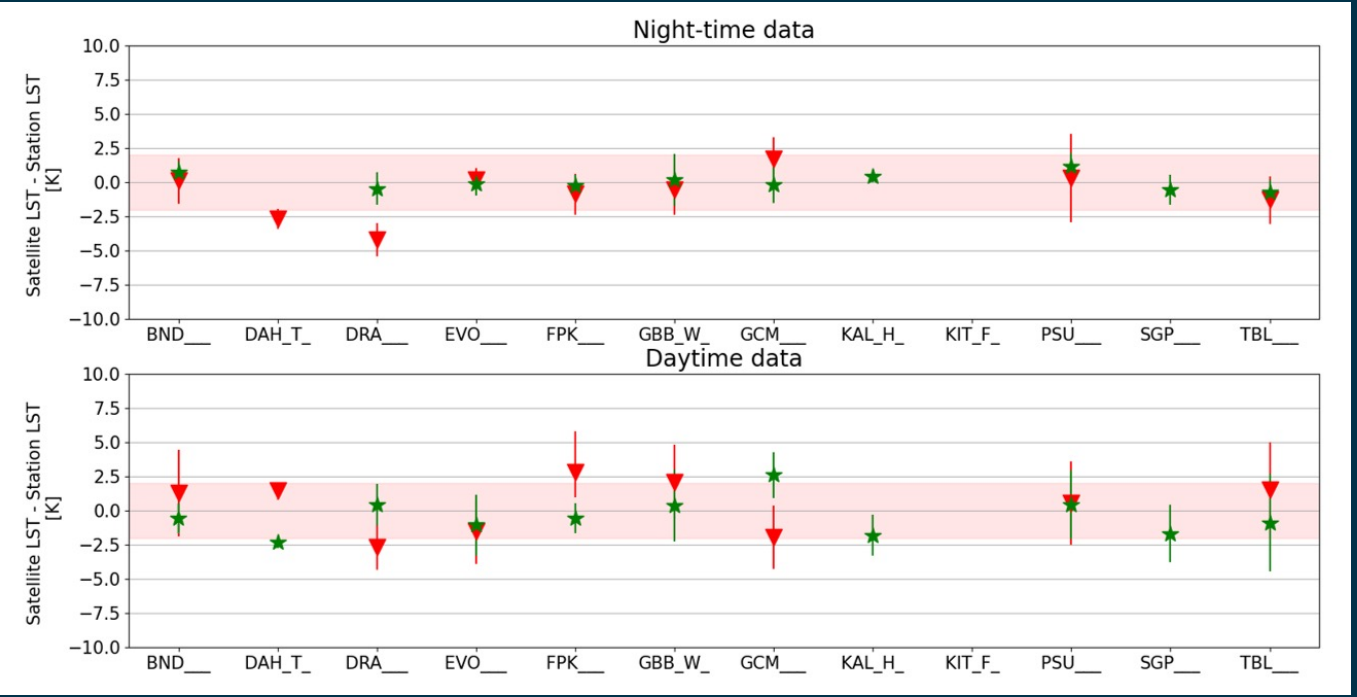
In Situ Validation

Median bias (satellite LST – in situ LST)

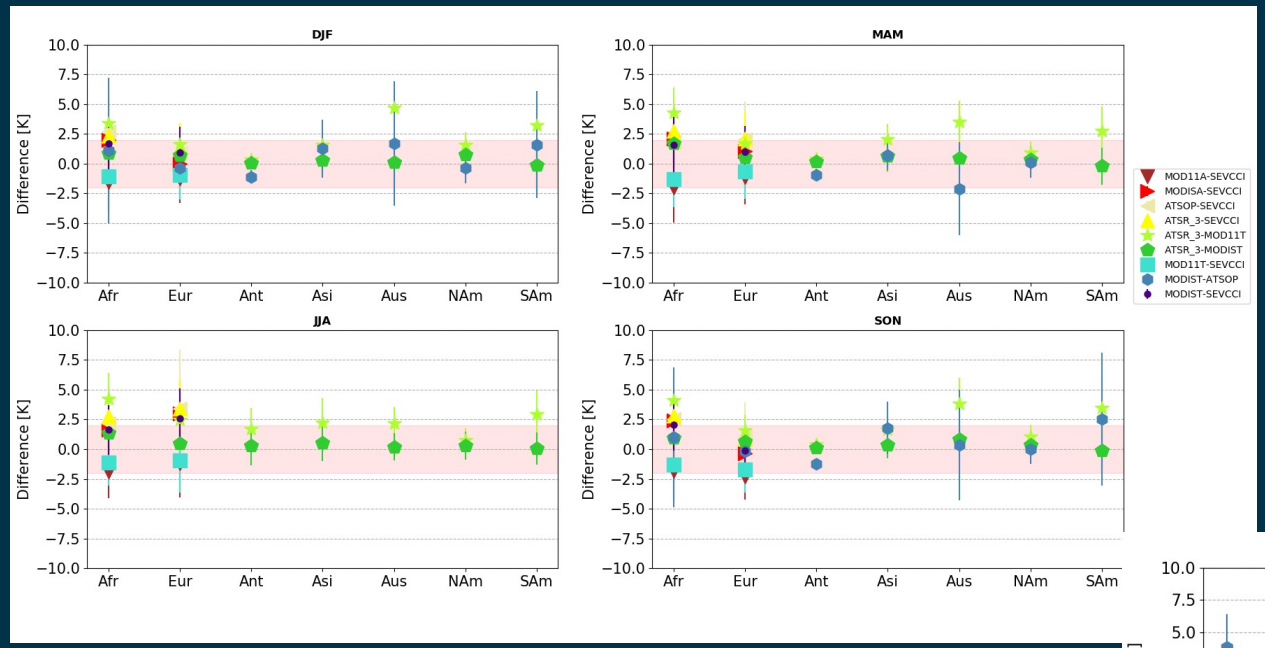
Few well characterised global stations for ground-based validation of LST

Progress towards the GCOS requirements – improvements in accuracy and better cloud masking

Comparison between V1.0 LST from SLSTR-A (red triangles) and V3.0 LST from SLSTR-A (green stars)



Intercomparisons to check consistency

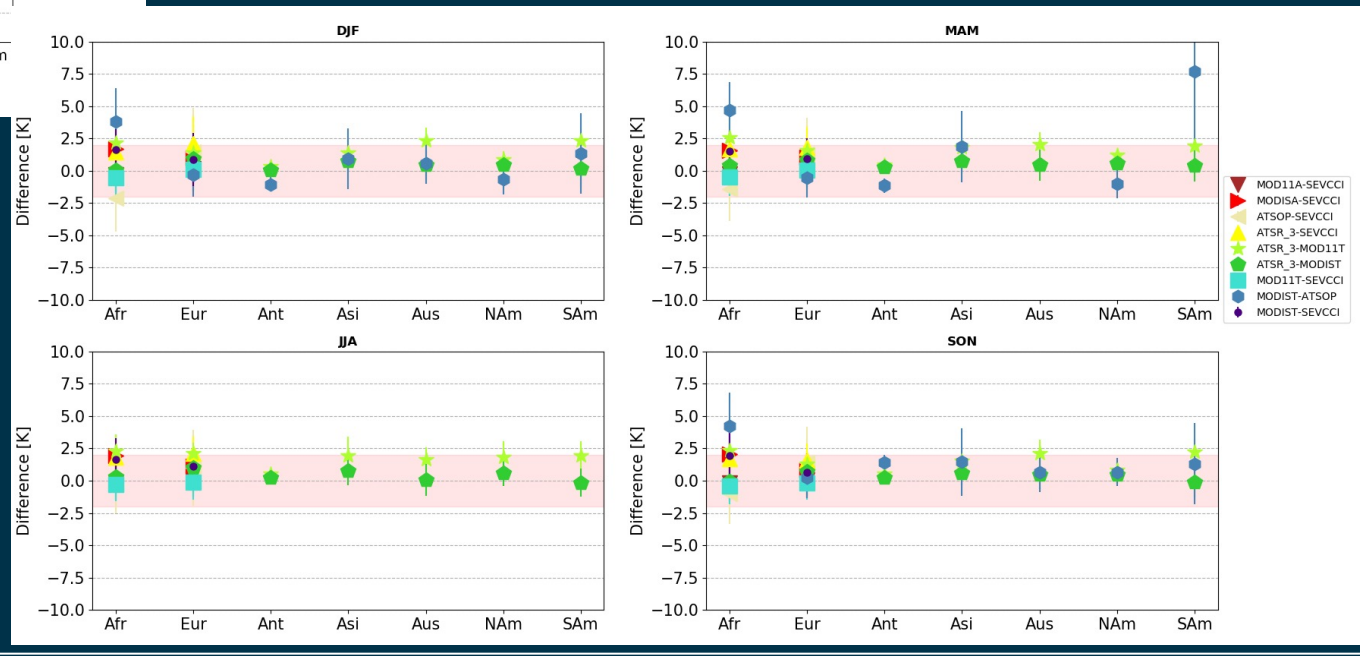


Very good agreement between CCI datasets

Larger differences between CCI datasets and operational datasets

Daytime

Night-time



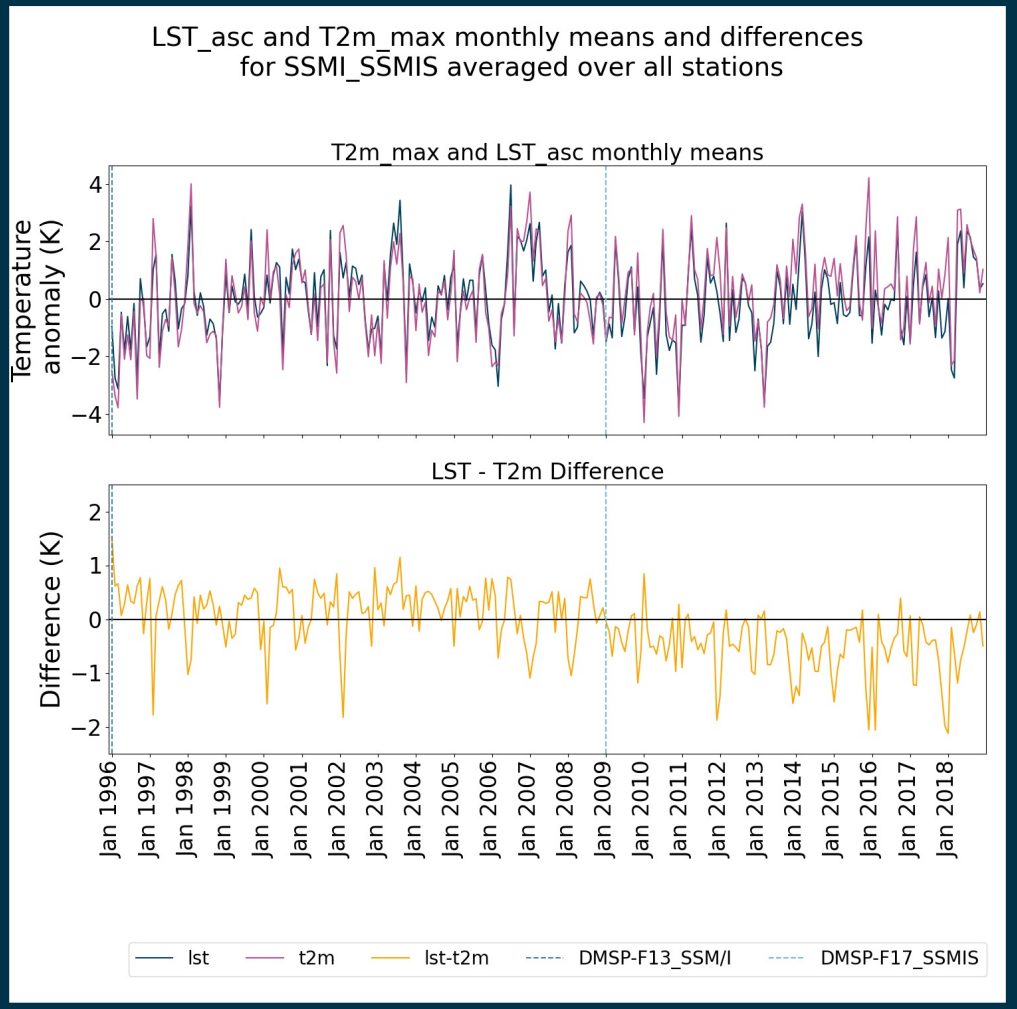
User Case Study Feedback

Key messages which emerged from the Climate Research Group on the assessment of the LST_cci products are:

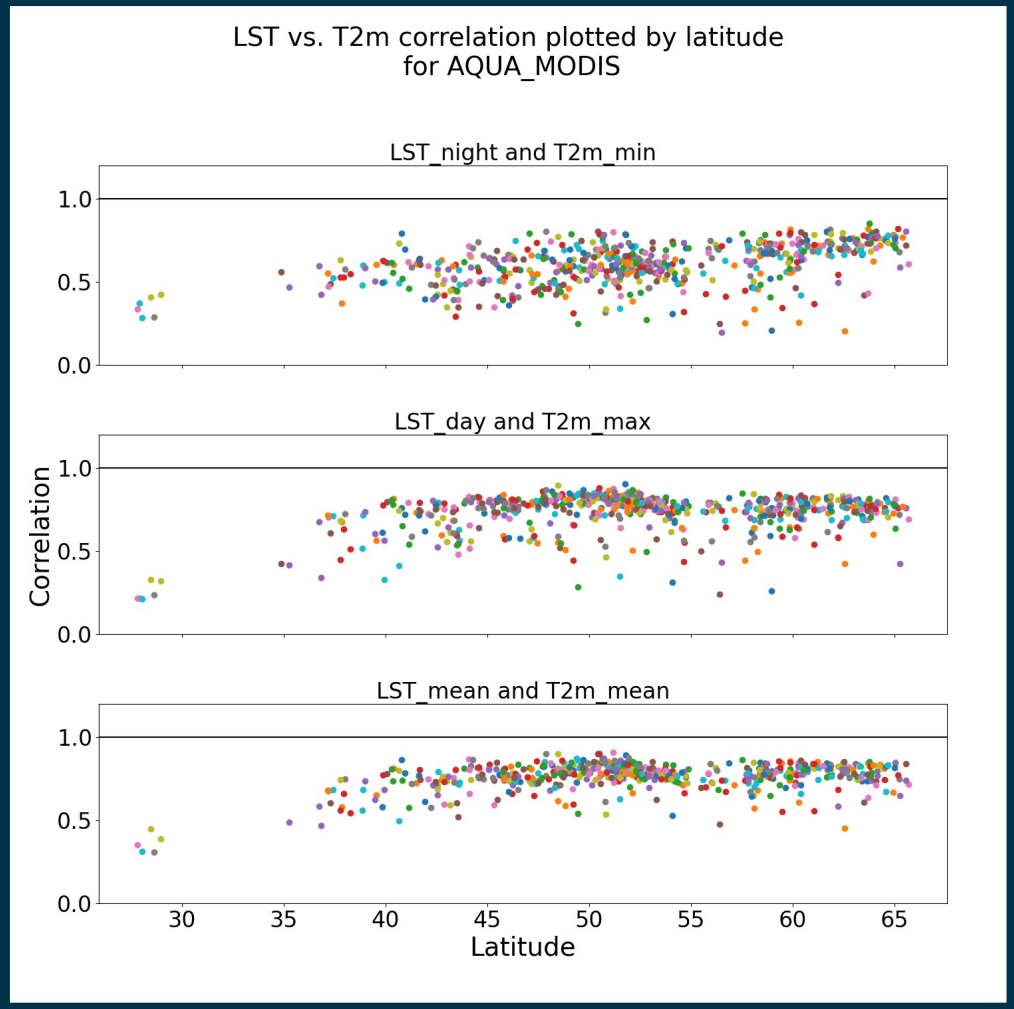
- The products are easy to use and are well described in netCDF format. Users comment that the common format for LST products from different sensors is very valuable
- Users appreciate the provision of additional fields in the files, such as viewing and solar geometry, and land cover class
- Use of higher resolution gridded products at 0.01° has been core to the success of these studies
- The gridded LST products are generally well correlated with collocated 2-m air temperatures (T2m) for both 'actual' and 'anomaly' temperatures
- The Surface Urban Heat Island Intensity (SUHII) estimates and hysteretic cycles calculated from the 0.01° LST_cci products agree with those reported in the published literature using other products

Comparing global/regional trends with T2m trends

MW product stability is MUCH improved, with some challenges remaining.



LST vs T2m correlations are MUCH improved in v2.0 IR products.



Publications

First paper published:

Perry et al., 2020, “Multi-sensor thermal infrared and microwave land surface temperature algorithm intercomparison”, *Remote Sensing*

Papers submitted and in review:

“The Seasonality of Surface Urban Heat Islands Across Climates” (RUB)

“MODIS-based climatology of the Surface Urban Heat Island at country scale” (MeteoRomania)

Several papers in advance drafts ready for submission over next couple of months:

“An analysis of the stability and trends in the LST_cci land surface temperature data sets” (UKMO)

“Improved estimates of Greenland ice sheet mass budget with assimilation of observed skin temperatures” (DMI)

“The role of land surface temperature in the statistical modelling of land-atmosphere fluxes: importance and systematic biases” (MPI)

“An Assessment of ESA CCI+ and NASA MODIS LST in ecological transects of Australia” (LIST)

“Towards a Consistent Global SUHI Dataset” (RUB)

“Heat Hazard Risk at Country-Scale using MODIS LST-cci dataset” (MeteoRomania)

MW LST paper, describing the product and the analysis presented (Estellus)

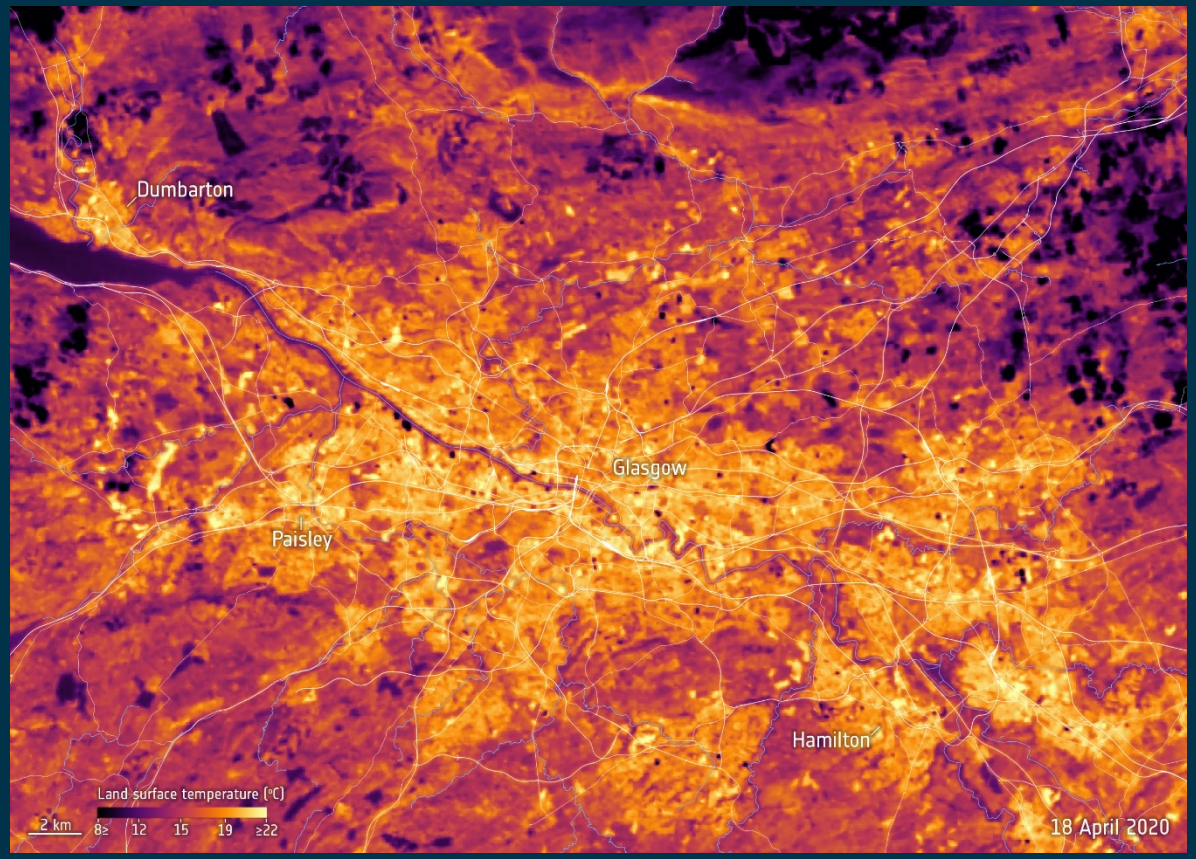
Multi-sensor LST intercomparison (KIT)

Long-term LST time series from ATSRs through to SLSTRs (ULeic)

Exploitation

Exploitation of LST CCI in downstream applications (eg urban heat islands, food security, …):

- LST CCI algorithms and methods applied to high resolution data
- Huge interest from stakeholders for locally focussed LST CCI data



Data from LST_cci
Credit ESA for visualisation