Land surface temperature retrieval from the synergy of passive microwave, optical and thermal observations

Yoann Malbeteau, J. Dijkstra, P. Guillevic, J. Schellekens, R. De Jeu

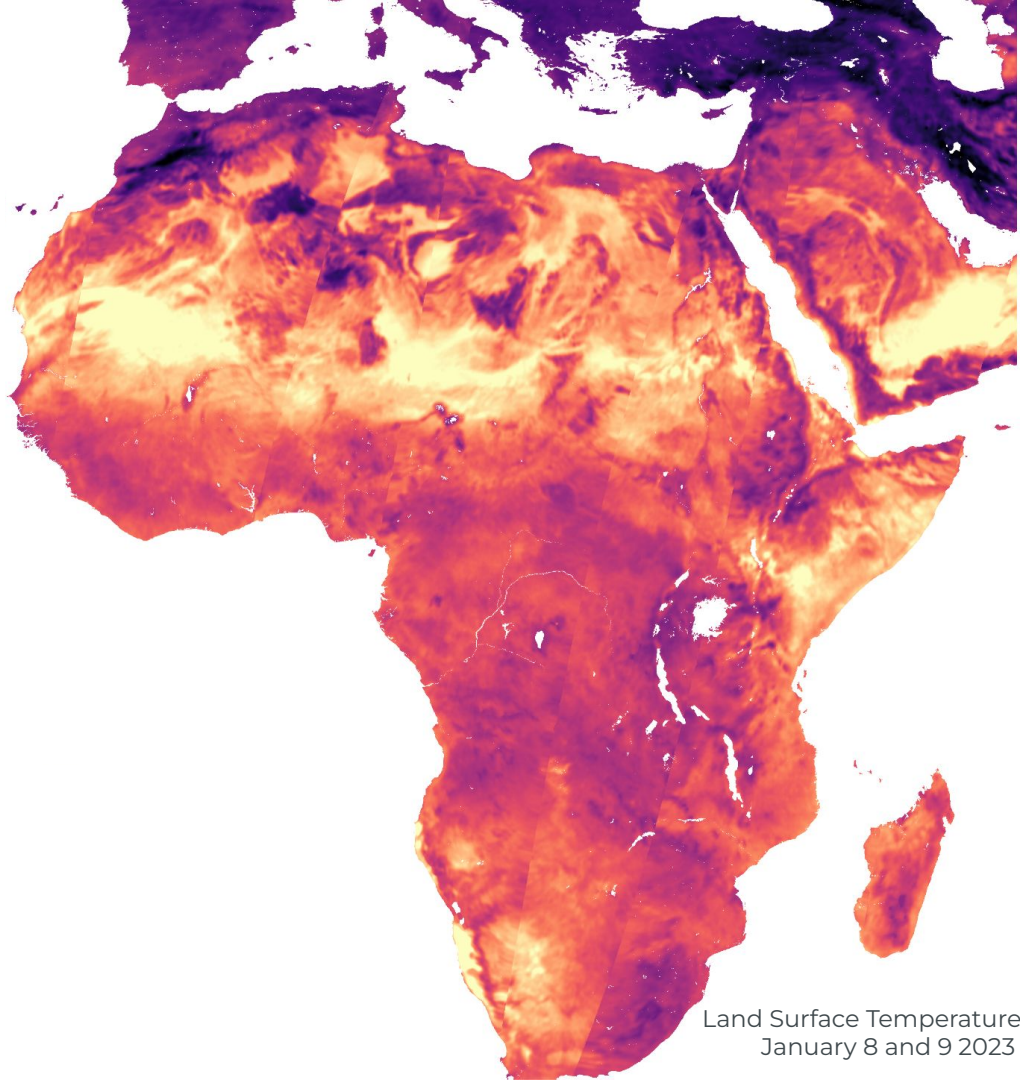**LAND SURFACE TEMPERATURE** · Ogallala, Nebraska, USA · July 27, 2017

Our use-cases focus

Soil Water Content

Yield forecast

Land Surface Temperature
January 8 and 9 2023

Our use-cases focus

Soil Water Content

Yield forecast

Evaporation

Crop health monitoring

Heat & Cold monitoring

Urban heat island

Land Surface Temperature
January 8 and 9 2023

Land Surface Temperature at Planet

Two resolution options for different use-cases and solutions
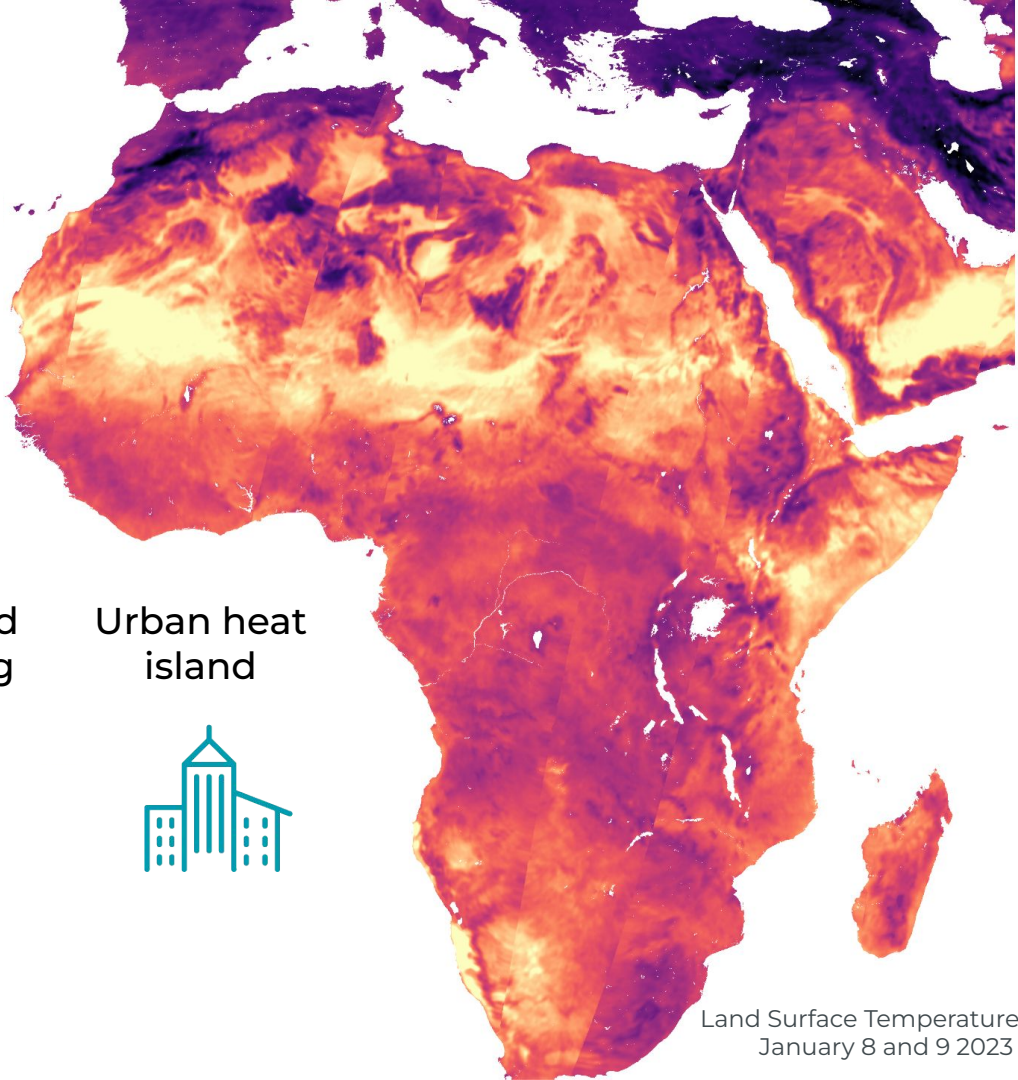
1 km
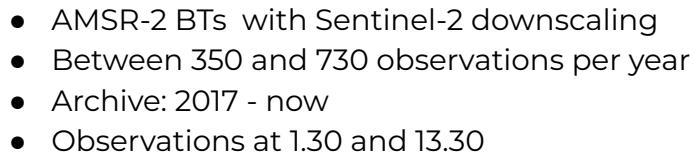- AMSR-E & AMSR-2 Brightness Temperatures
- Between 350 and 730 observations per year
- Archive: 2002 - now (1 year gap in 2011-2012)
- Observations at 1.30 and 13.30

100 m
- AMSR-2 BTs with Sentinel-2 downscaling
- Between 350 and 730 observations per year
- Archive: 2017 - now
- Observations at 1.30 and 13.30

Europe, April 30th 2023 at 13.30

Flevoland, The Netherlands, April 30th 2023 at 13.30

Land Surface Temperature at Planet

Microwave technology gives our products several important features
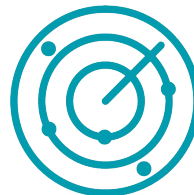

CLOUD AND DARKNESS PROOF

GLOBAL

NEAR REAL-TIME

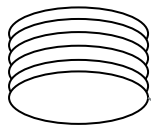**BASED ON MULTIPLE SENSORS**

LONG TIME SERIES

COMPARED WITH GROUND SENSORS

Land Surface Temperature at Planet – Method

Retrieval based on **passive microwave** satellite observations, in combination with Sentinel2 **NIR and SWIR** bands into a **proprietary method*** to get a high resolution image from large overlapping footprints.

Microwave L1b
footprint observations

DIFSAT*

Downscaling
+
atmospheric
corrections

Retrieval
model

Brightness
Temp. to LST
+
Quality Flags

Daily
Land Surface
Temperature

Sentinel-2
NIR and SWIR
(100m only)

Flevoland, The Netherlands,
April 30th 2023 at 13.30

*US Patent #US10643098B2 & EU Patent # 17 728 899.0
De Jeu et al. Method and system for improving the resolution of sensor data

Temporal Quality - in situ networks

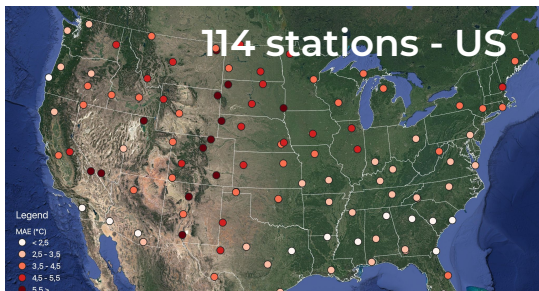## Complementary information from each network

7 stations - US

Footprint size 70mx70m

114 stations - US

Footprint size 1mx1m

The statistics are based on 10 years of data (2013-2022) and averaged over all 7 stations

	SURFRAD at 1:30		SURFRAD at 13:30	
vs	**Planet**	**MODIS***	**Planet**	**MODIS***
# observations	2,216		7,407	
Pearson *r*	0.95	0.98	0.95	0.96
MAE (℃)	3.26	1.73	4.05	2.81
ubRMSE (℃)	3.69	2.31	3.83	3.42

*MOD11 from GEE
Results will be soon published

Temporal Quality - in situ networks

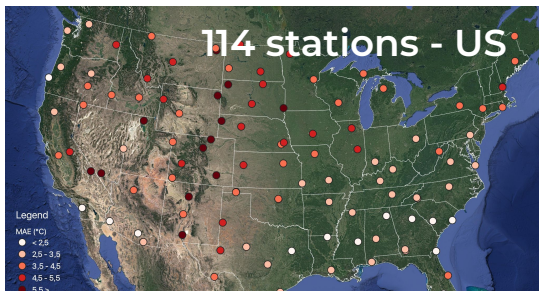## Complementary information from each network

7 stations - US

Footprint size 70mx70m

114 stations - US

Footprint size 1mx1m

The statistics are based on 10 years of data (2013-2022) and averaged over all 114 stations

vs	USCRN at 1:30		USCRN at 13:30	
	Planet	**MODIS***	**Planet**	**MODIS***
# observations	53,809		149,421	
Pearson *r*	0.95	0.93	0.93	0.93
MAE (℃)	2.73	2.36	4.42	5.33
ubRMSE (℃)	2.51	2.61	4.37	4.44

*MOD11 from GEE
Results will be soon published

Temporal Quality - Anywhere

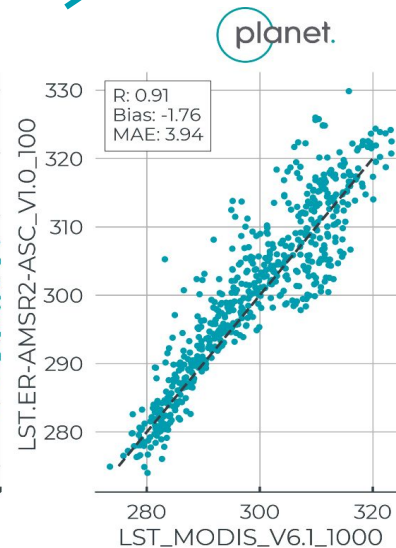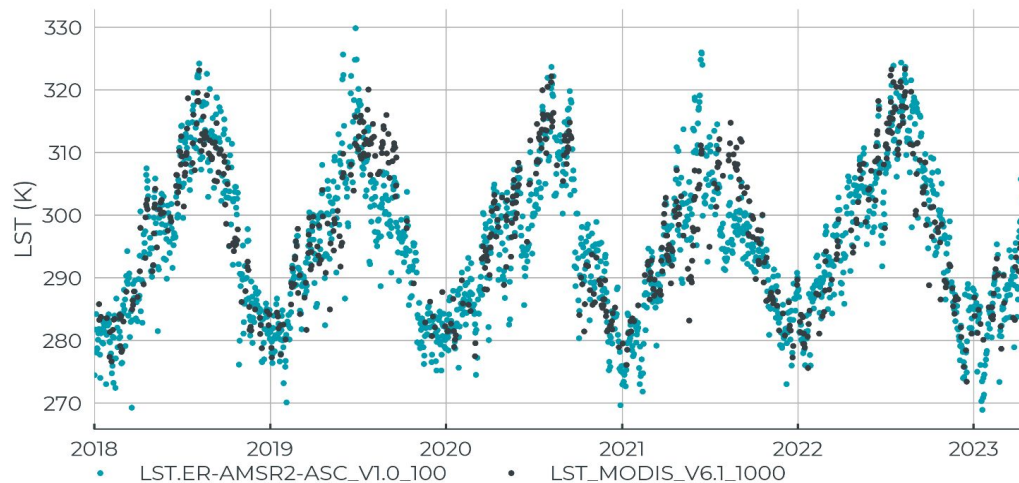We can compare our data temporally against **TIR-based MODIS**

> *1931 days between 2018-01-01 and 2023-04-16*
>
> **1707** (88%) valid observations for LST Planet 13:30 100m
>
> **686** (35%) valid observations for LST MODIS V6.1 13:30 1000m
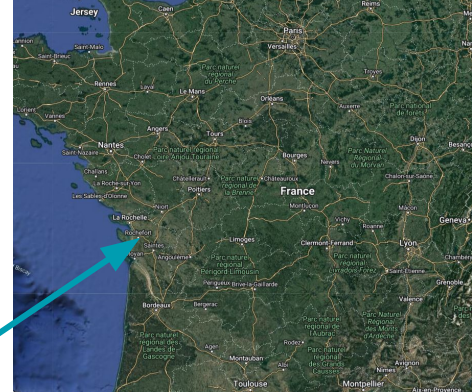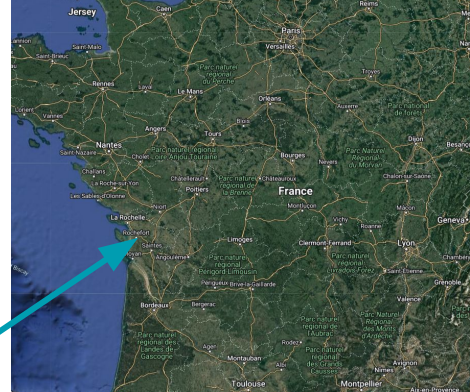
timeserie comparison at lon: -0.5545 lat: 45.9693

R: 0.91
Bias: -1.76
MAE: 3.94

Temporal Quality - Anywhere

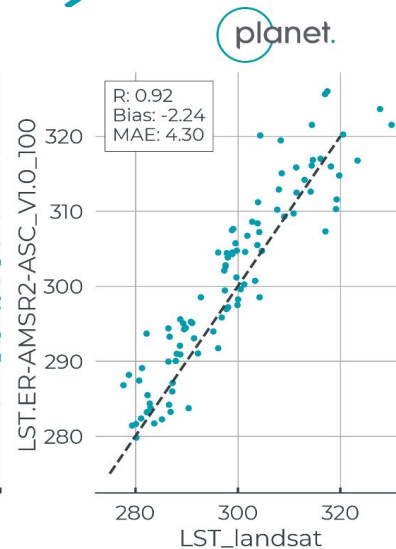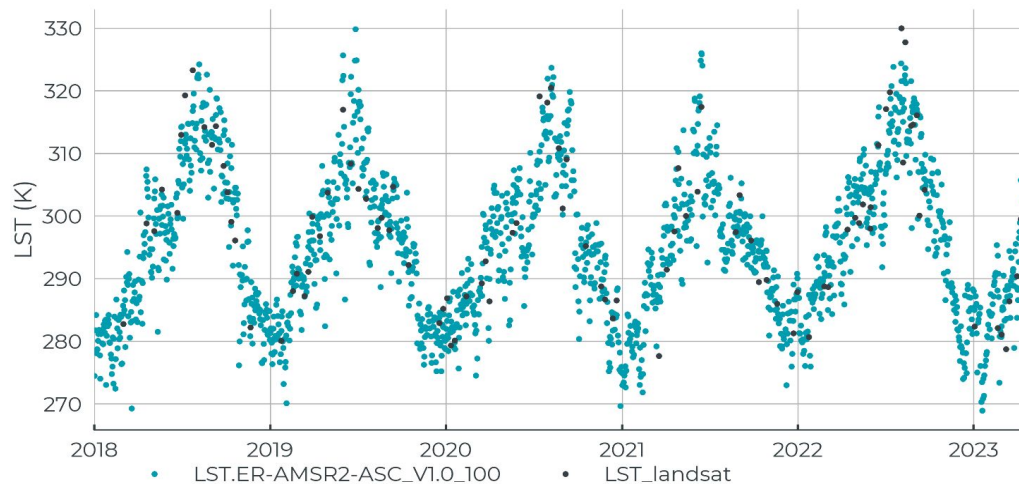We can compare our data temporally against **TIR-based Landsat**

1931 days between 2018-01-01 and 2023-04-16

1707 (88%) valid observations for LST Planet 13:30 100m
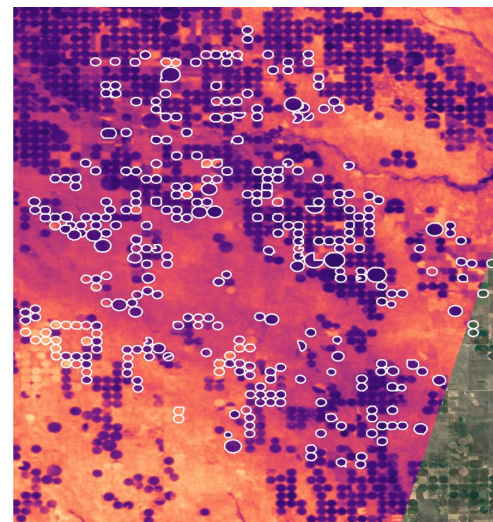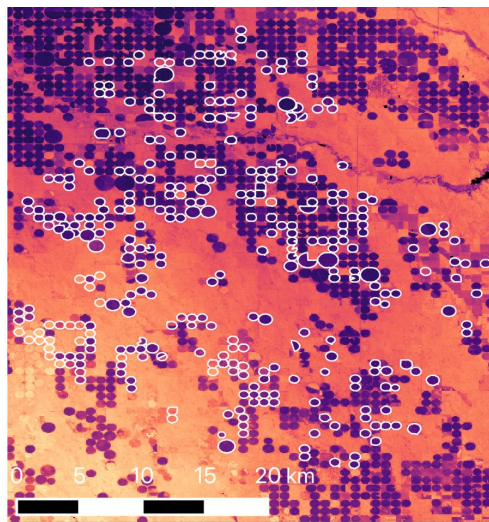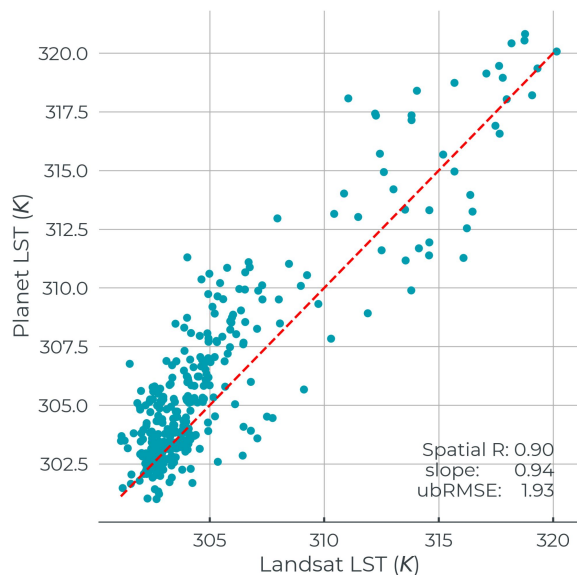
97 (5%) valid observations for LST Landsat 10:30 100m

timeserie comparison at lon: -0.5545 lat: 45.9693

R: 0.92
Bias: -2.24
MAE: 4.30

Spatial assessment against Landsat (TIR)

Comparison over **irrigated** agriculture -
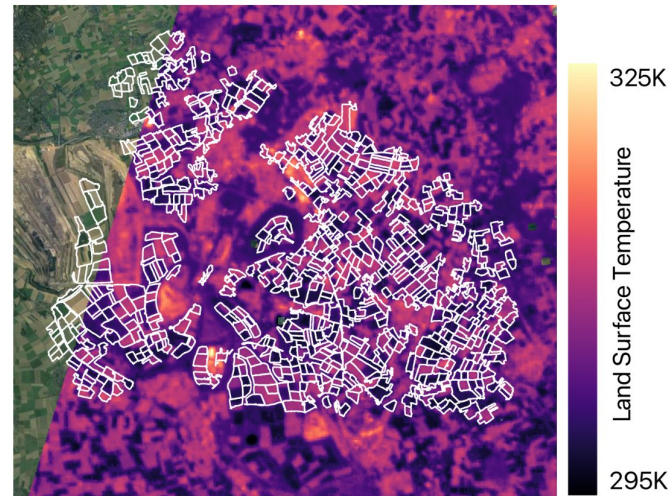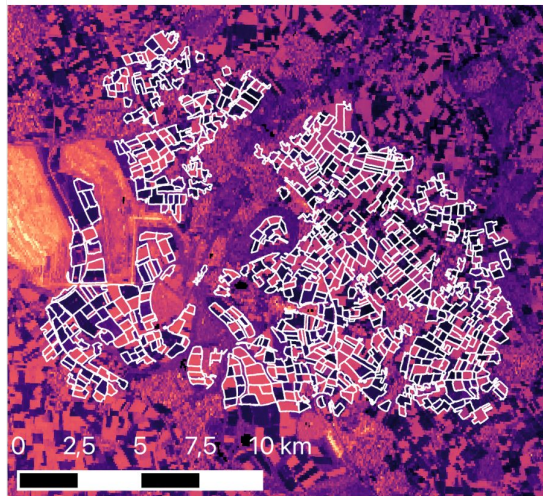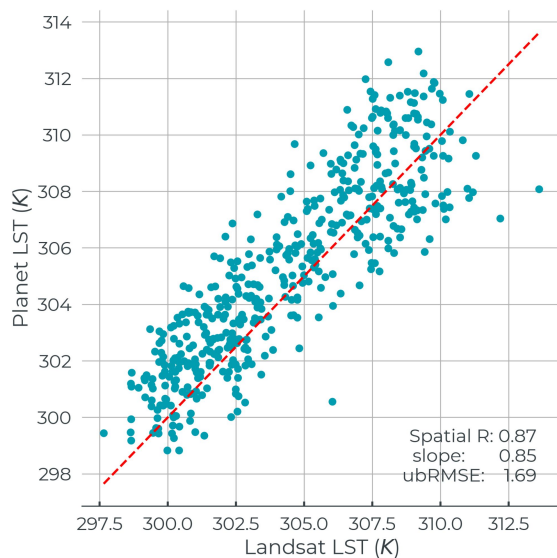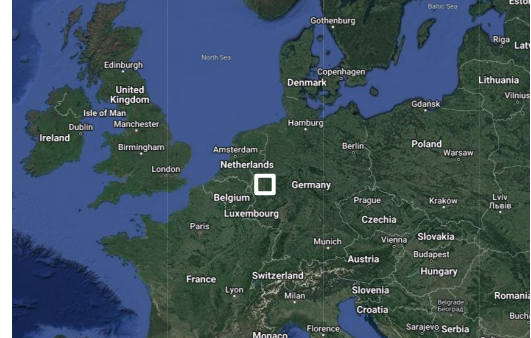at field scale +300 randomly selected pivots

United States, Nebraska - August 29, 2017
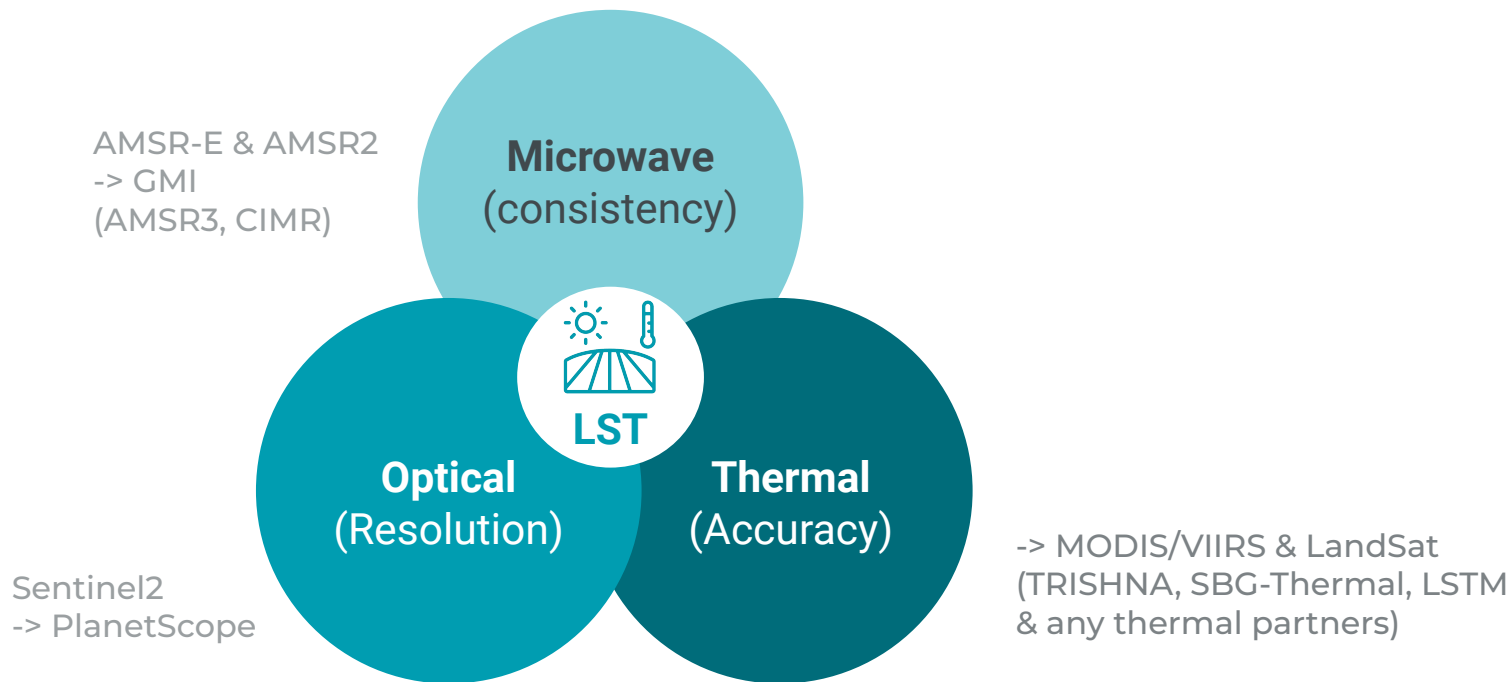
Spatial assessment against Landsat (TIR)

Comparison over **rainfed** agriculture - at field scale
+400 randomly selected fields

Spatial R: 0.87
slope: 0.85
ubRMSE: 1.69

Planet LST (*K*) vs Landsat LST (*K*)

Germany, Nordrhein Westfalen - June 2, 2021

Land Surface Temperature: 325K – 295K

LST retrieval from the synergy of passive microwave, optical & thermal observations

AMSR-E & AMSR2
-> GMI
(AMSR3, CIMR)

Microwave (consistency)

LST

Optical (Resolution)

Thermal (Accuracy)

Sentinel2
-> PlanetScope

-> MODIS/VIIRS & LandSat
(TRISHNA, SBG-Thermal, LSTM
& any thermal partners)

LST retrieval from the synergy of passive microwave, optical & thermal observations

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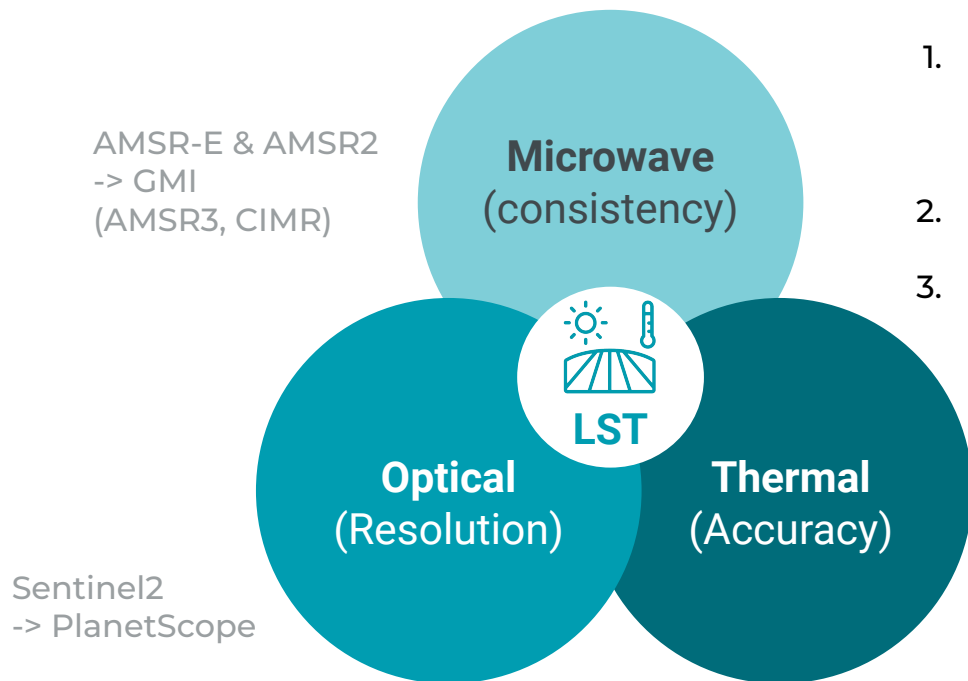
1. Quality layers: uncertainty estimates
   a. LST Analytic Ready Data
2. Improved the accuracy (with Thermal inclusion)
3. Higher spatial resolution (with PlanetScope)

Questions?

yoann.malbeteau@planet.com

Global Land Surface Temperature - April 1 & 2, 2023