LSA SAF 'Derived LST products' for MSG/SEVIRI

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INSTITUTE OF METEOROLOGY AND CLIMATE RESEARCH (IMK-ASF)
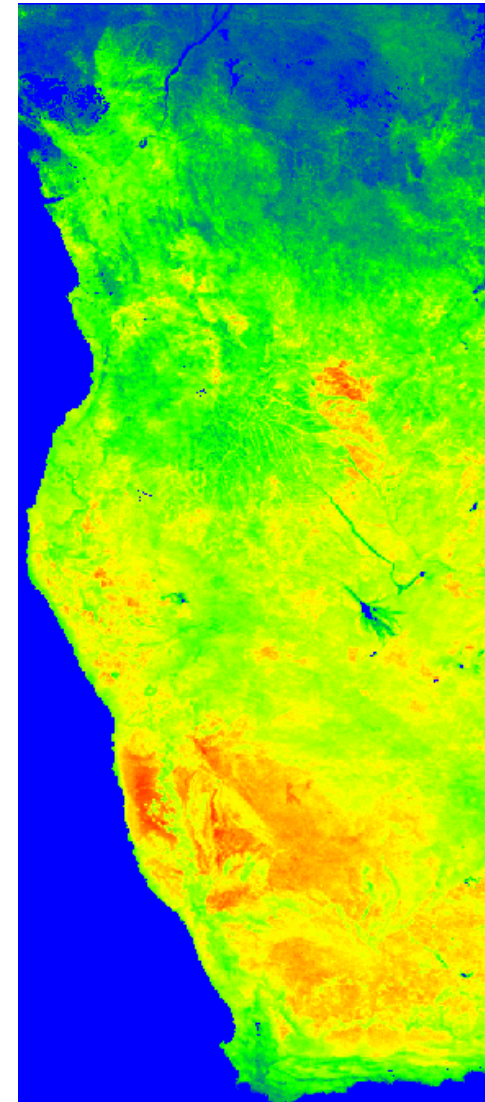
'Derived LST products'

- **LST Composites**
  - Maximum LST composites
  - Median LST composites
  - Analyses of NDVI & LST (literature)

- **Diurnal Temperature Cycle model**
  - Thermal Surface Parameters (TSP)
  - Applications from literature
  - Examples for LSA SAF composites
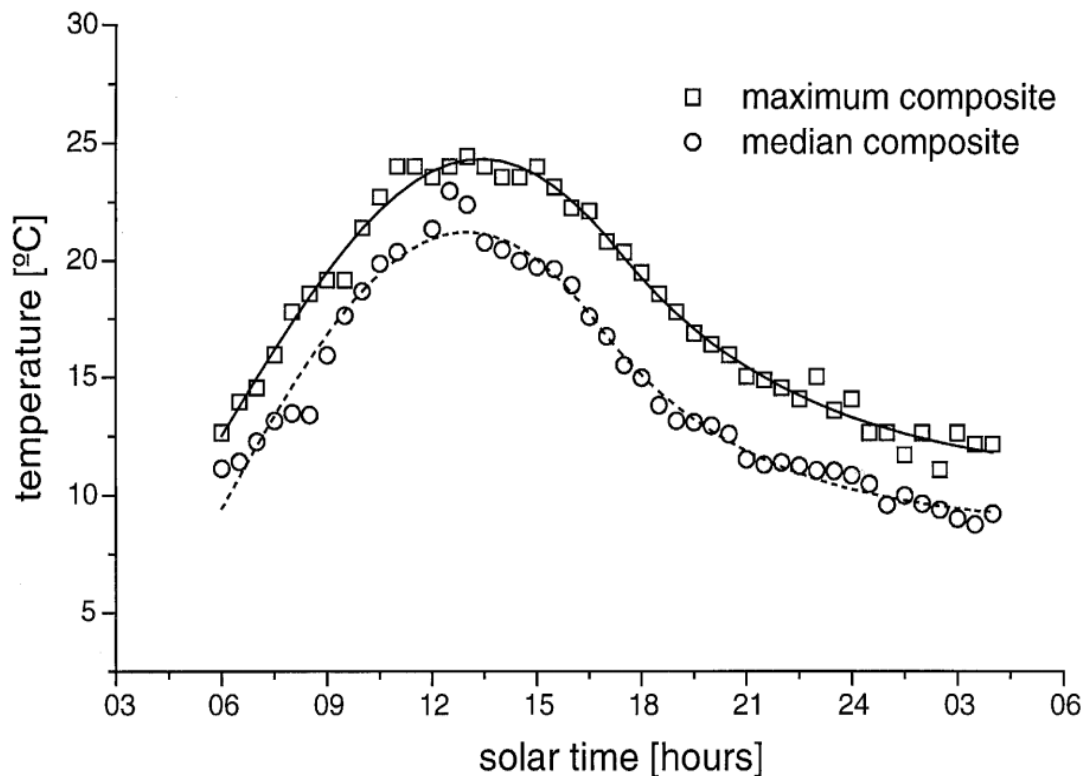
- **Summary and Outlook**

LST Composites - Motivation

- Temporal composites of LST have fewer data gaps (more cont. fields) and may be related to surface characteristics

- Land Use / Land Cover (LULC) changes affect the Diurnal Temperature Cycle (DTC) of the land surface

- LULC changes are slow compared to weather-related changes (clouds, precipitation, advection, …)

- DTCs contain additional information: different LULC may have identical NDVI* but different thermal characteristics

*normalised difference vegetation index
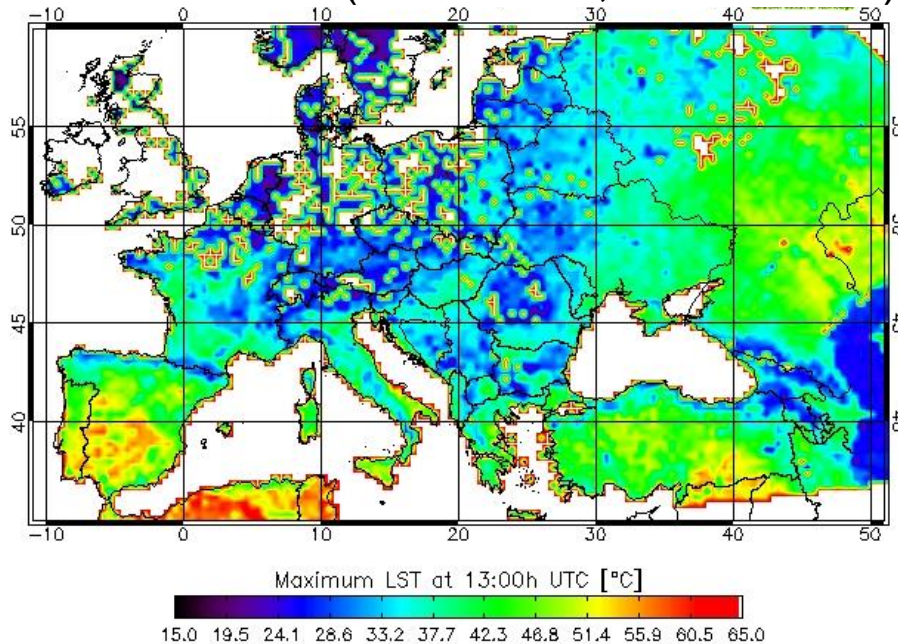
LST composites produced by LSA SAF

- **Maximum**: approximates **hottest** (driest) DTC, straight-forward
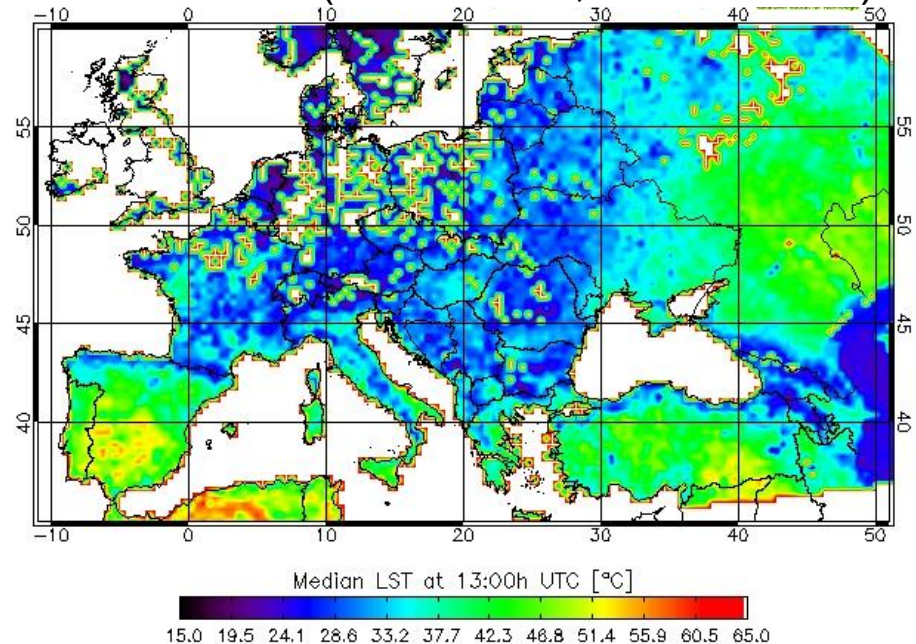- **Median**: approximates **typical** DTC, robust against outliers

METEOSAT BT composites, Karlsruhe, August 1996. Göttsche & Olesen, 2001, RSE, vol. 76(3)

10-day (decadal) LST composites
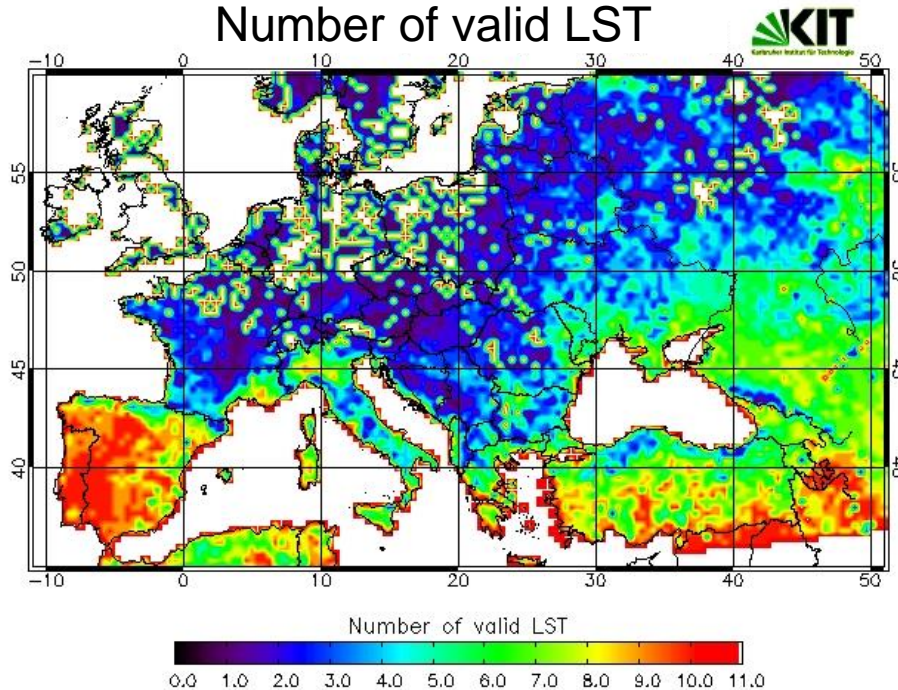

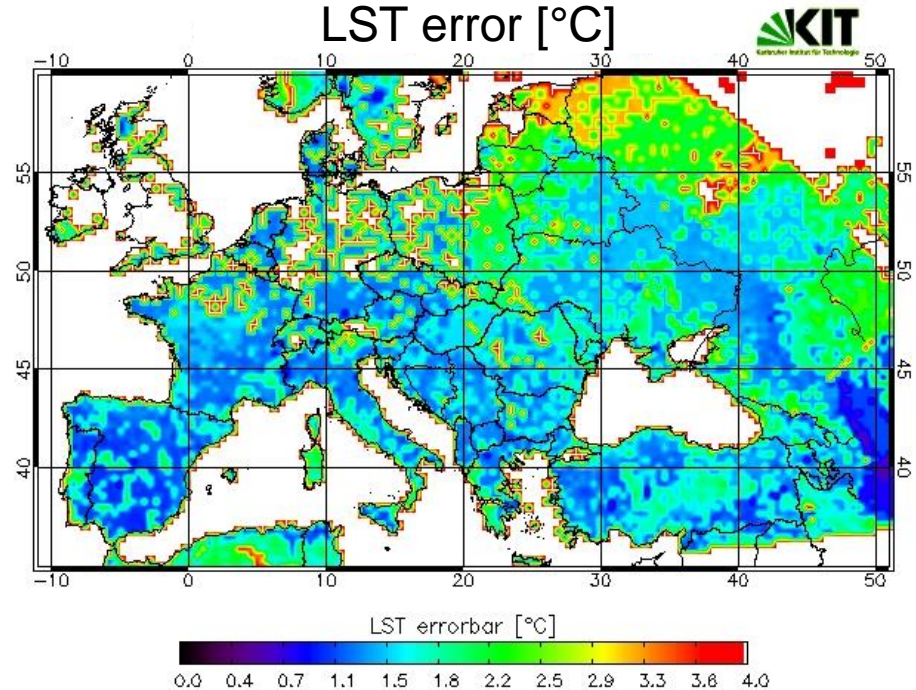Maximum LST (02.08.2010, 13:00h UTC)

Median LST (02.08.2010, 13:00h UTC)

- One composite LST for each of SEVIRI's 96 slots
- Data reduction by a factor of 10
- One 'synthetic DTC' represents the decade

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Additional information from composites
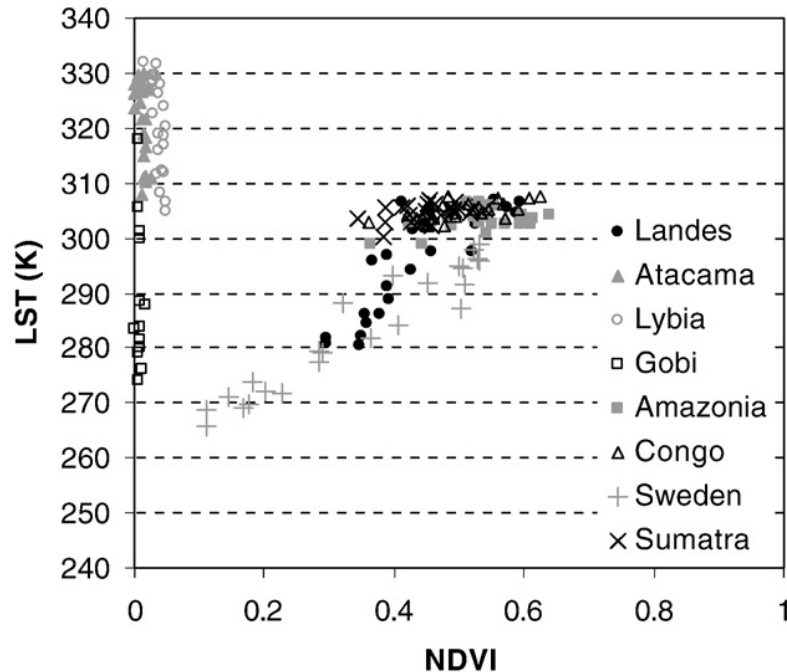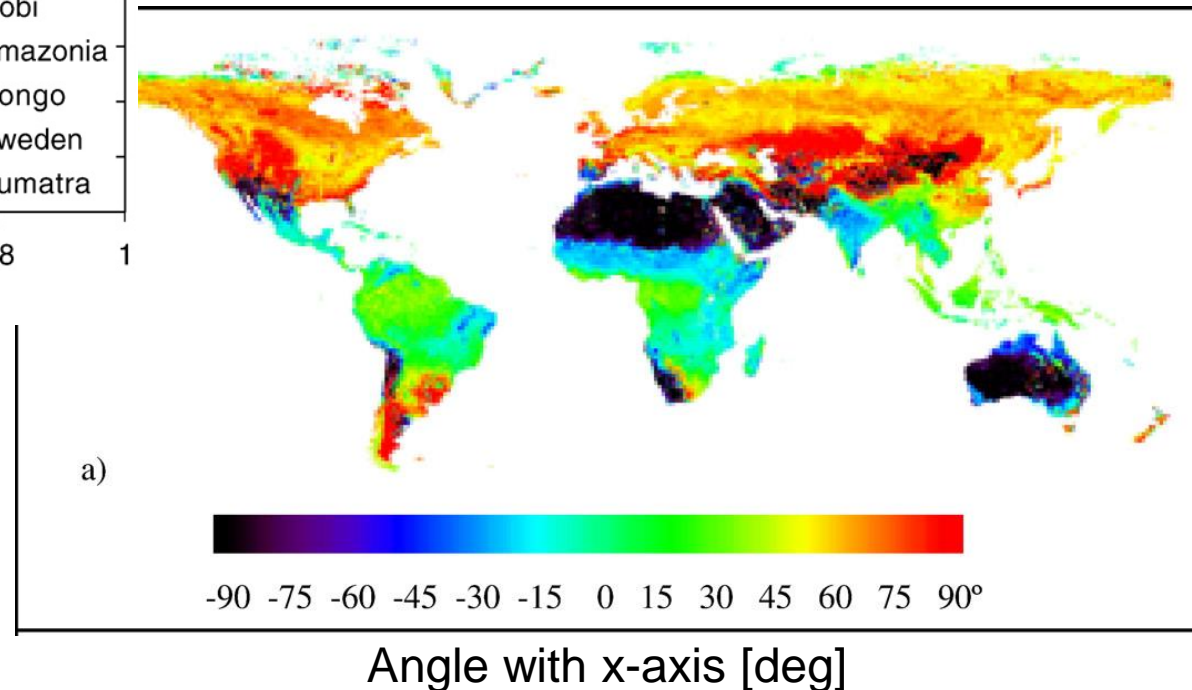

Number of valid LST

LST error [°C]

Additional information in composite files (HDF5):
- Number of valid LST in composite period
- LST error from LSA SAF LST
- Quality flags from LSA SAF LST (for max. composite)

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Application: combined analyses of NDVI & LST

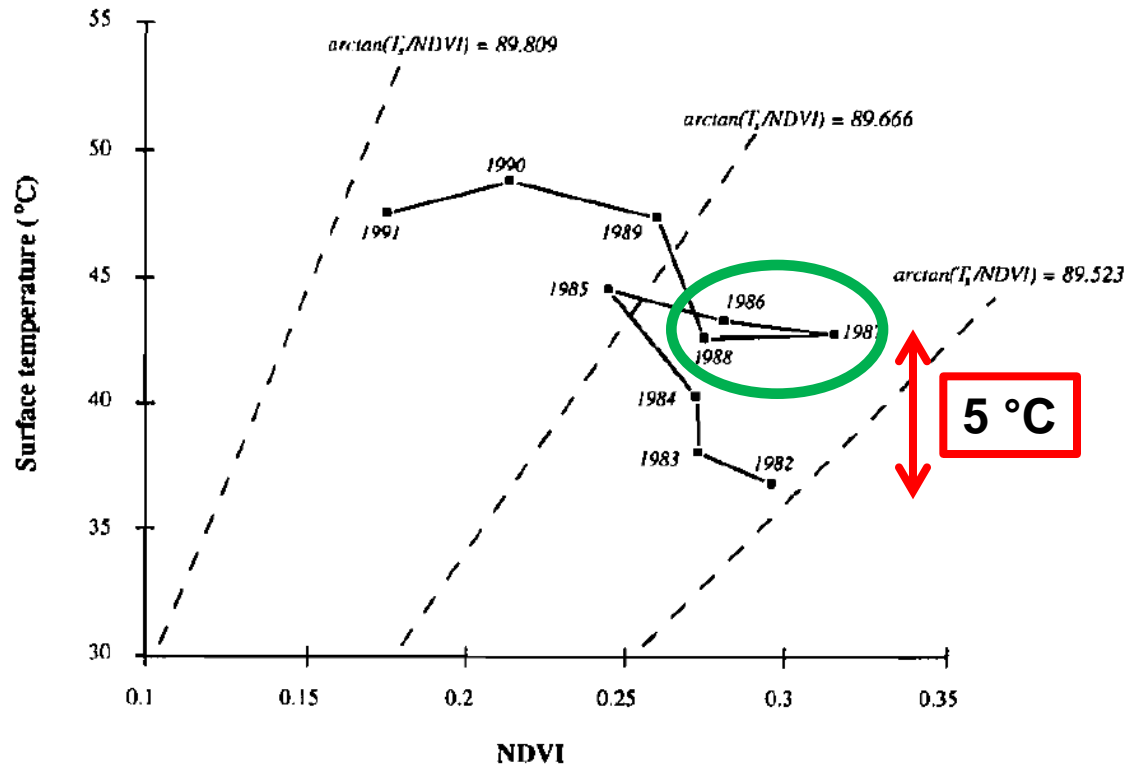**From:** Julien & Sobrino, 2009, RSE, vol. 113.
15-day composites of NDVI from AVHRR,
8km spatial resolution, LST 'co-selected'

a)

Angle with x-axis [deg]

Application: LULC change analysis

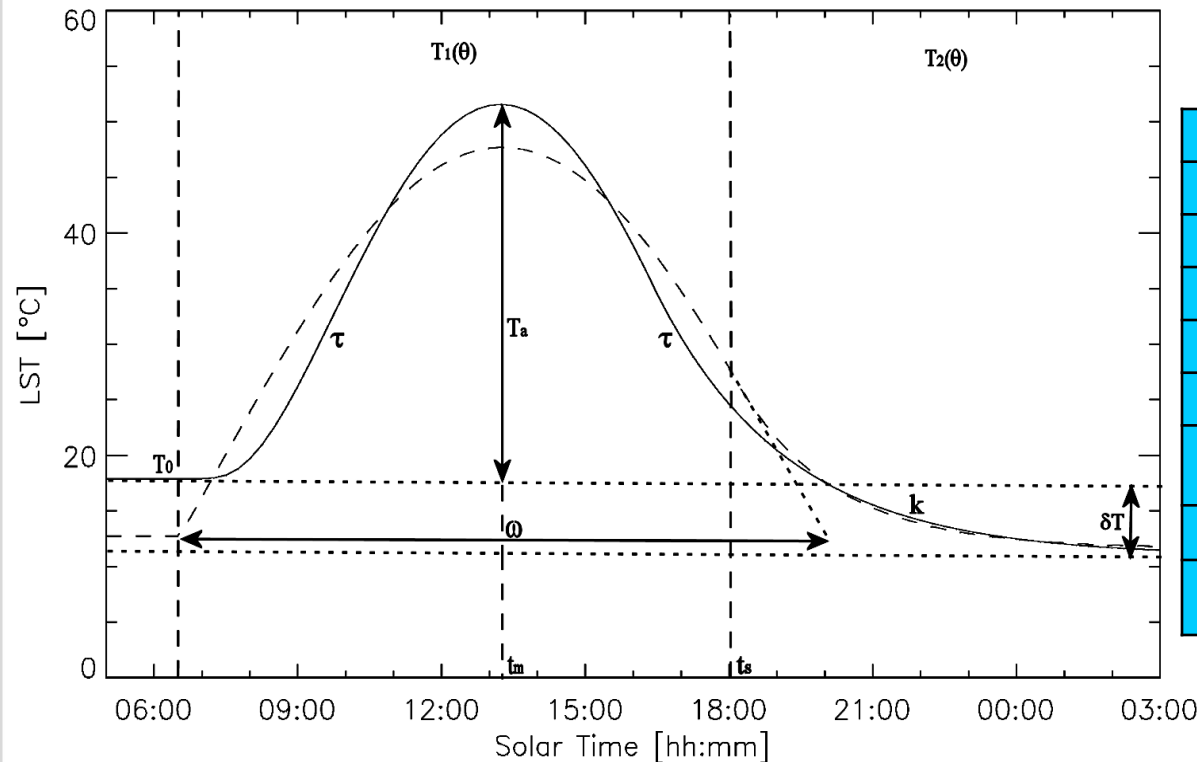**Fuelwood-induced deforestation**

Peri-urban area of Addis Abeba (5x5 GAC pixels)

Inter-annual variability of the average NDVI and LST data over wet season (April – December)

From Lambin & Ehrlich, 1996, IJRS, Vol. 17(3)

Diurnal Temperature Cycle (DTC) model

Thermal Surface Parameters

Parameter		Meaning
T_o	[°C]	residual temperature
T_a	[°C]	temperature amplitude
t_m	[solar time]	time of the maximum
t_s	[solar time]	start of the attenuation function
δT	[°C]	$T_o - T(t \rightarrow \infty)$, where t is time
ω	[hh:mm]	half-period of oscillation of cosine term
k	[hh:mm]	attenuation constant (eq. 20)
τ		total optical thickness (TOT)

"Goe2008" model: solid line
"Goe2001" model: broken line

"Daytime" T1 and "night time" T2
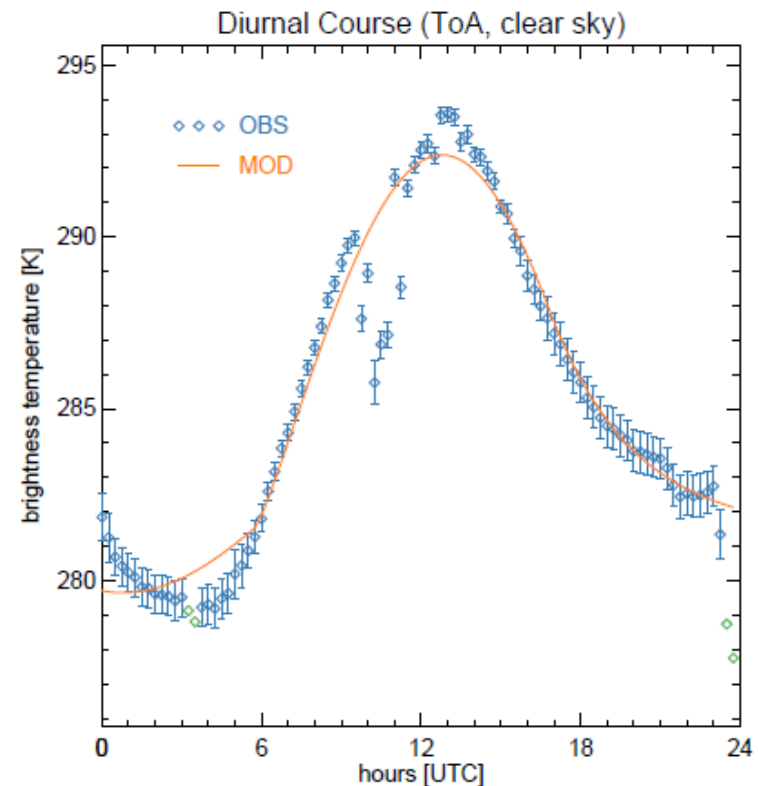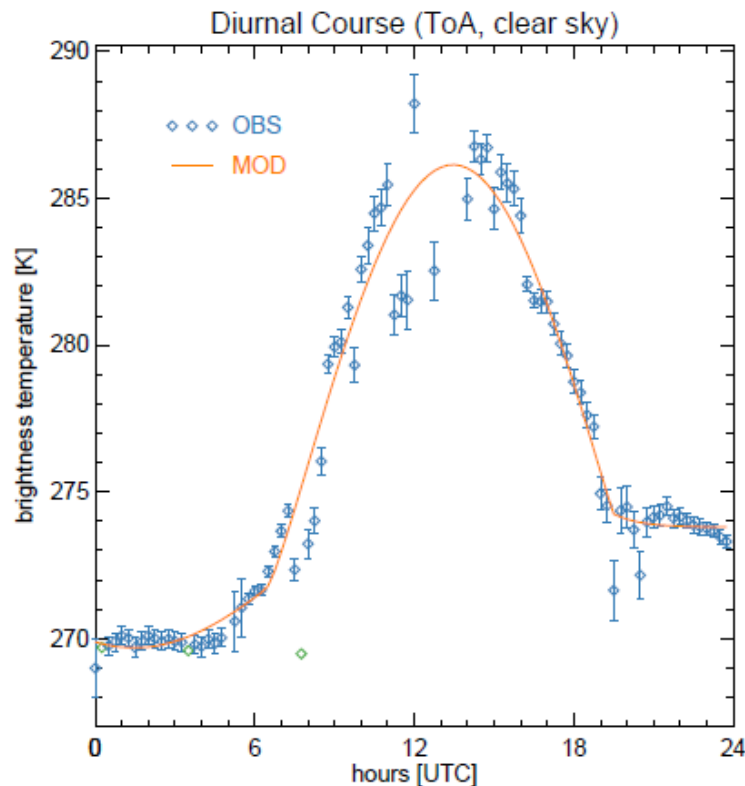are indicated by vertical lines.

Göttsche, F.-M., and Olesen, F.S. (2009).
Modelling the effect of optical thickness on diurnal cycles of land surface temperature.
Remote Sensing of Environment, Vol. 113

Modeling of Diurnal Temperature Cycles (DTC)

- Thermal Surface Parameters (TSP) are
  - meaningful
  - spatially highly continuous
  - representative of cloud-free conditions

- TSP ease combined analyses with vegetation indices

- DTCs are reduced to 6 TSP. Factor for 10-day composites is: 10 [days] * 96 [SEVIRI slots/day] / 6 TSP = **160**

- TSP provide additional information, e.g. the minimum temperature and timing of maximum temperature

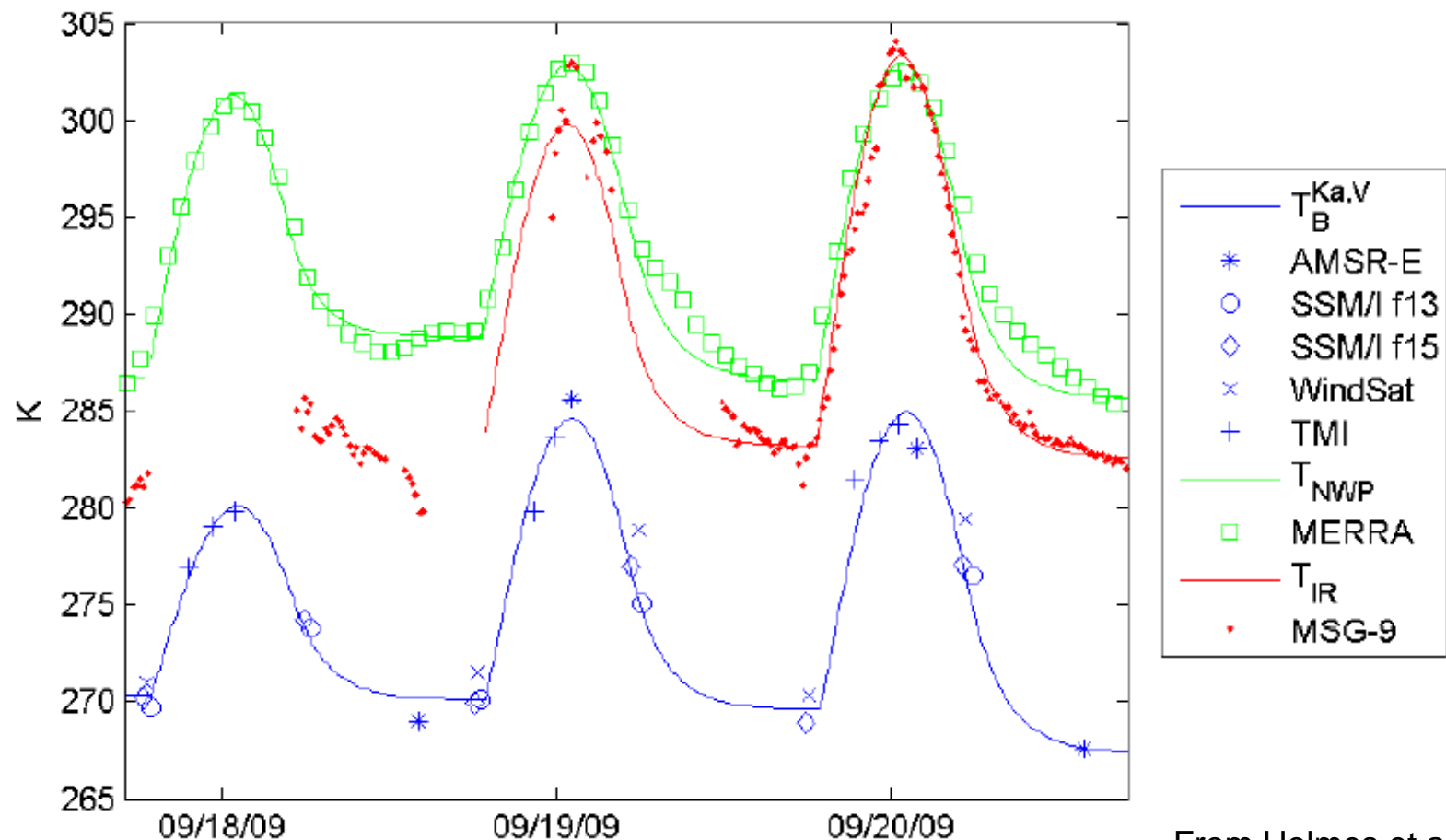# Cloud-clearing: MeteoSwiss 'HelioMont' algorithm

Stöckli, R. (2013). The HelioMont Surface Solar Radiation Processing, *Scientific Report MeteoSwiss*, 93, 122 pp., ISSN: 1422-1381

Meteosat clear sky brightness temperatures (blue) and corresponding fits of the *Göttsche and Olesen 2009* model (orange)to the cloud masked data of the last 10 days (two Alpine locations on 5.8.2008).
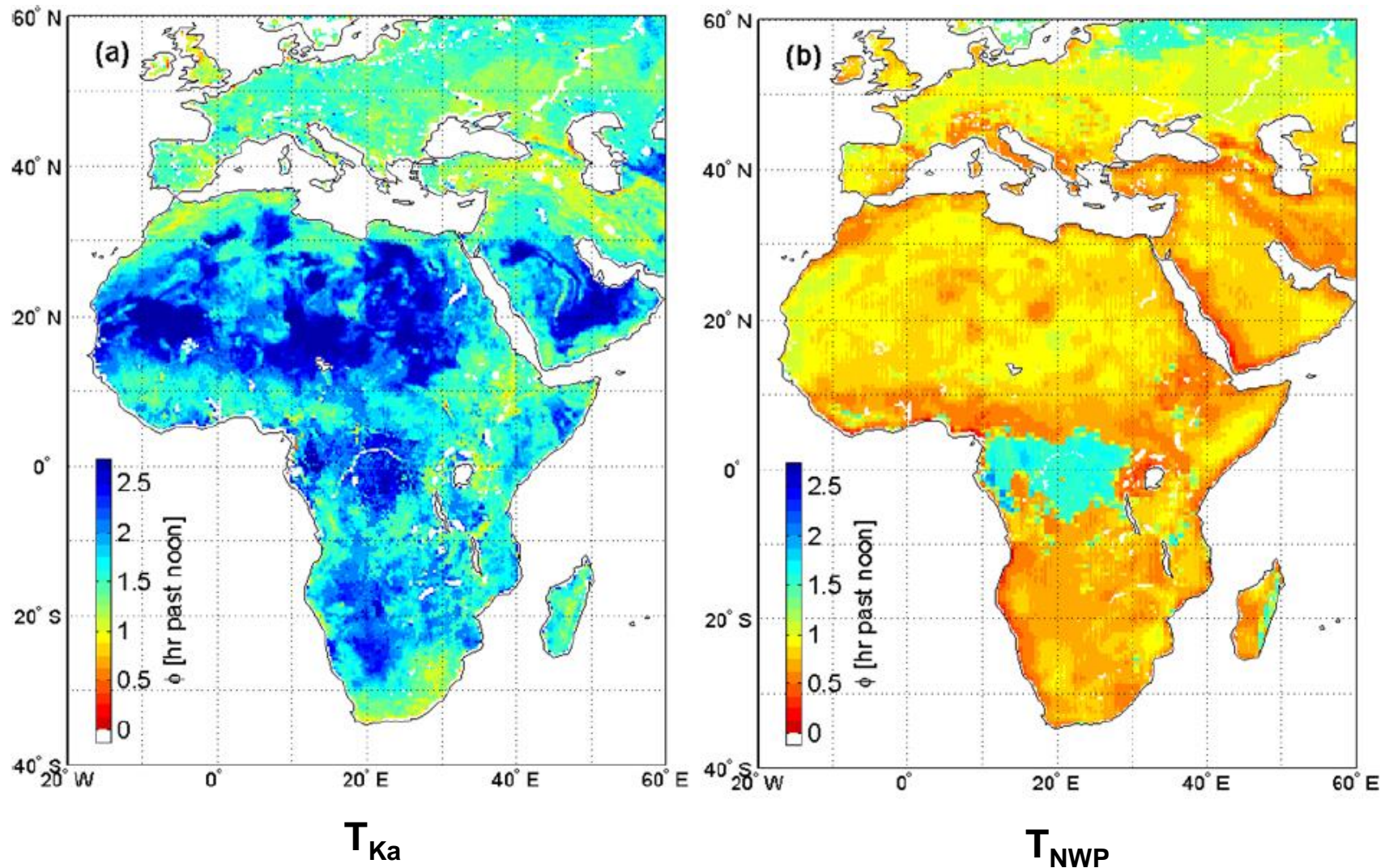
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Accurate determination of the timing of maximum temperature with the DTC model

From Holmes et al. (2013)

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Mean delay of maximum temperature for 2009

T_{Ka}

T_{NWP}

From Holmes et al. (2013)

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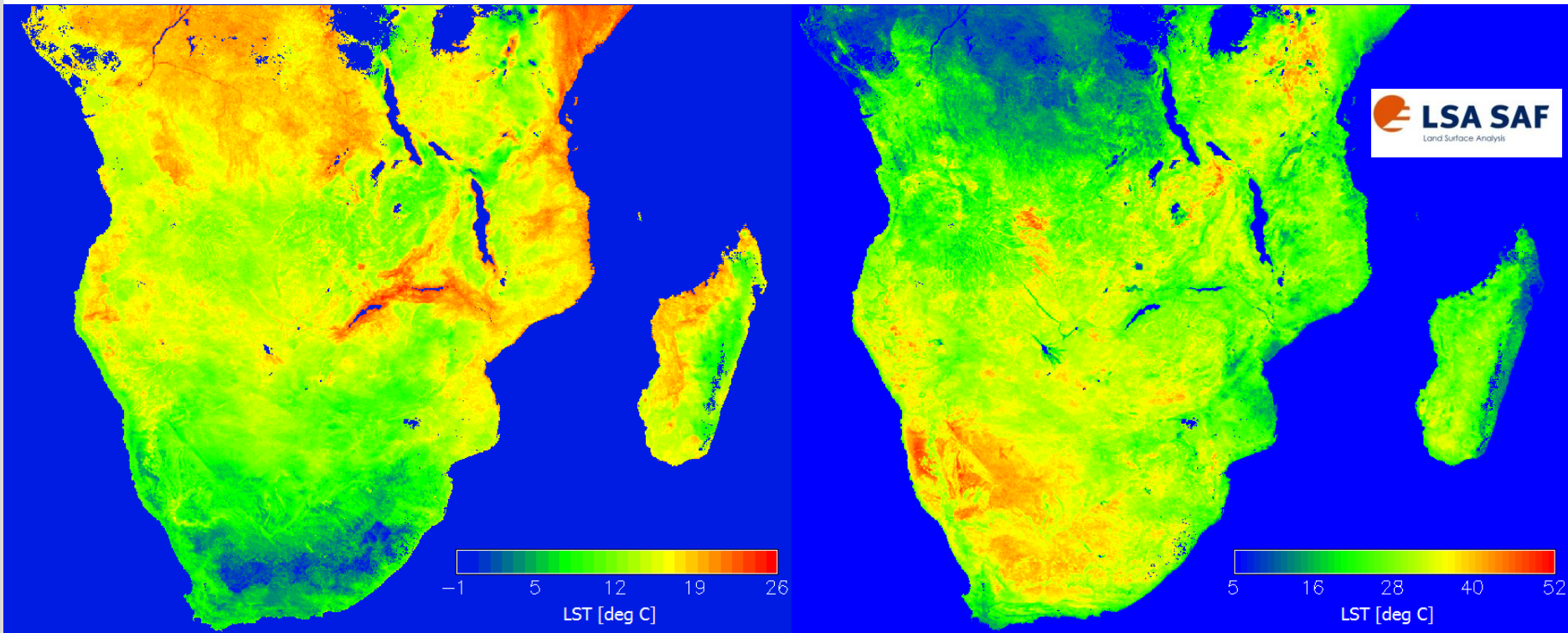
Median LST composite and modeled max. LST

Median LST composite 10:15 UTC
(1st decade Oct 2009)

Modeled maximum temperature
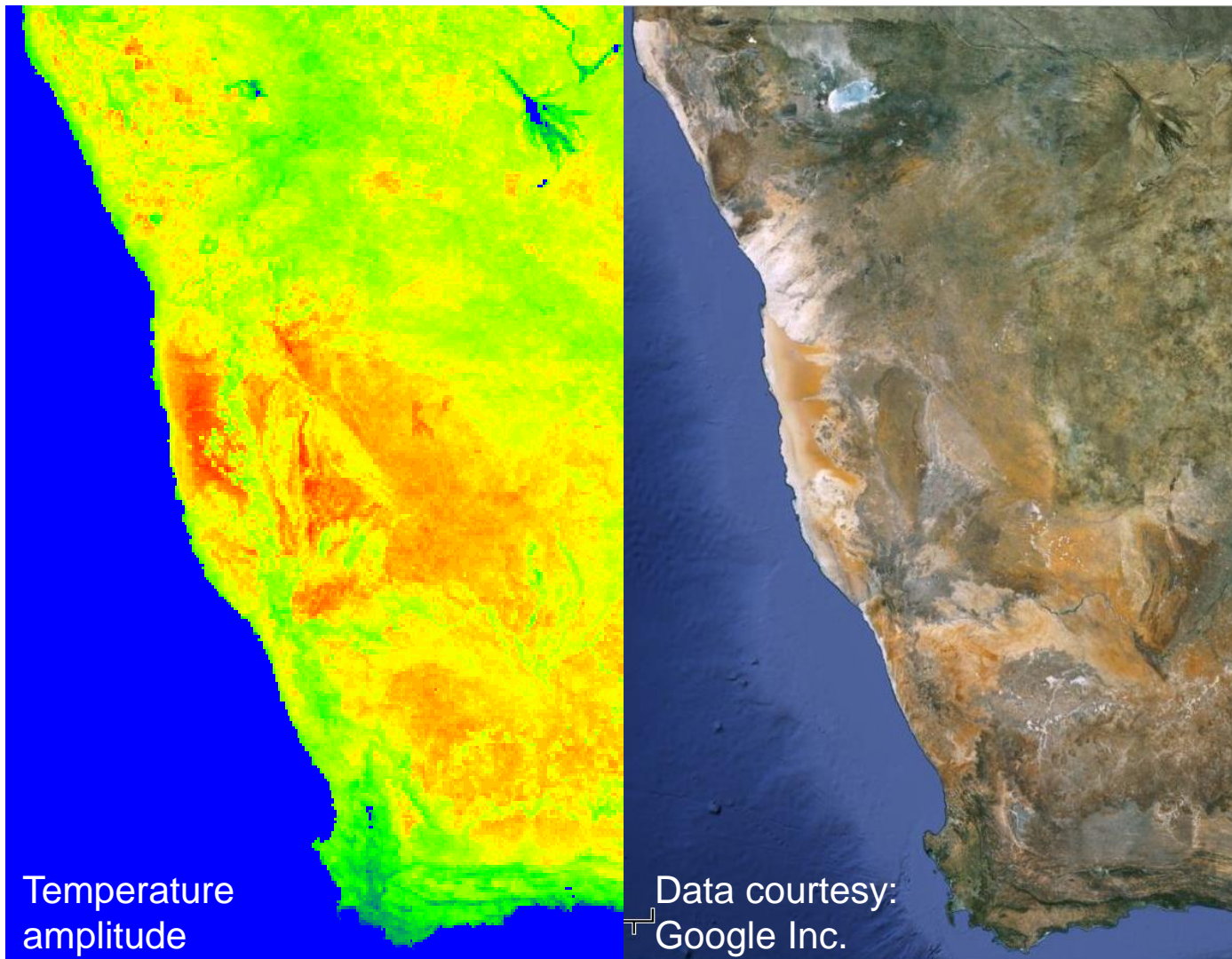(median, 1st decade Oct 2009)

Residual Temperature and Amplitude

Residual temperature T0
(median, 1st decade Oct 2009)

Temperature amplitude Ta
(median, 1st decade Oct 2009)

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Close-up: temperature amplitude and VIS data

Temperature amplitude

Data courtesy: Google Inc.

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Summary and Outlook

- Maximum & median composites are reliable and pre-operational

- DTC model successfully evaluated by other researchers and applied to gap-filling (interpolation), cloud-clearing, spatial analysis of the DTC timing, thermal modeling (mirror of solar telescope), ...: **well tested**

- TSP for max & med composites are stable and pre-operational

- TSP provide accurate estimates of residual temperature (~ sunrise), which are otherwise difficult to obtain from TIR measurements (clouds!)

- TSP also provide accurate and low-noise estimates of temperature amplitude, the key quantity needed to determine thermal inertia

Thank you!

LSA SAF User Workshop 2013, Göttsche & Olesen

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