LSA SAF

Towards a Harmonized LST Product – the problem of angular anisotropy of LST

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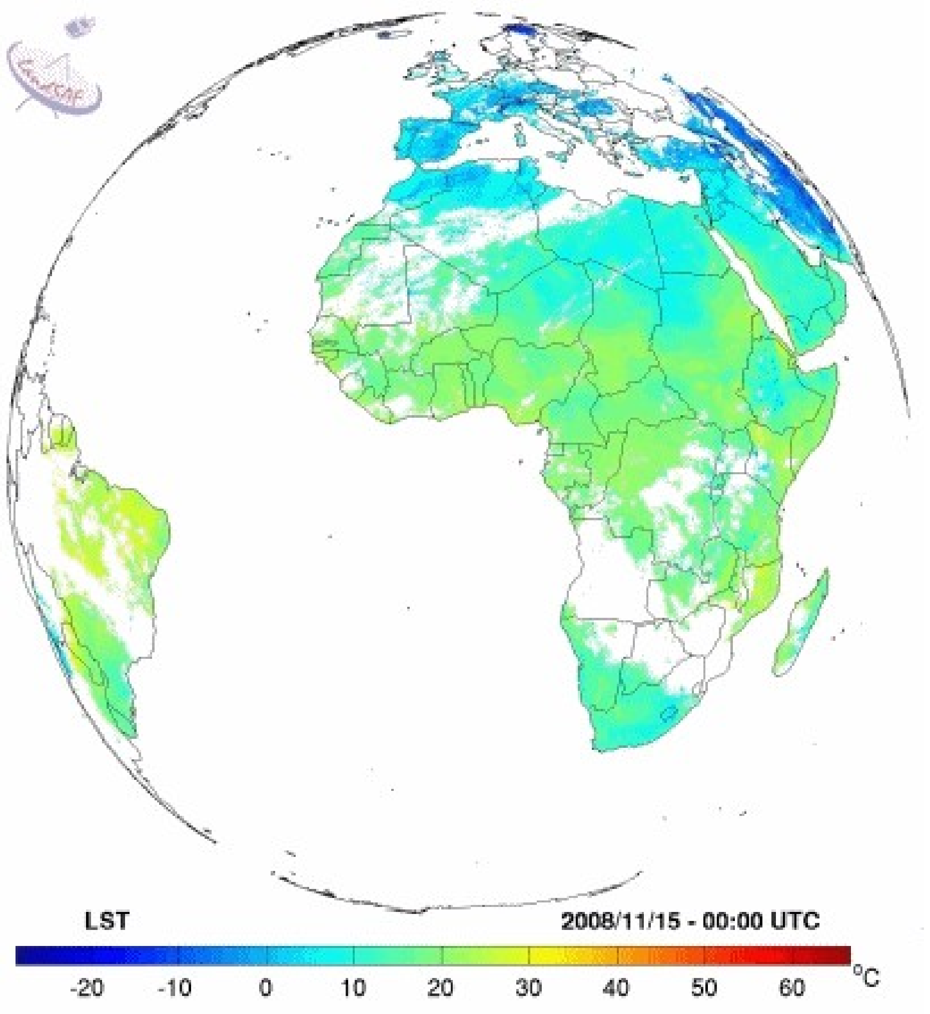
6th LSA SAF Workshop

LSA SAF LST product

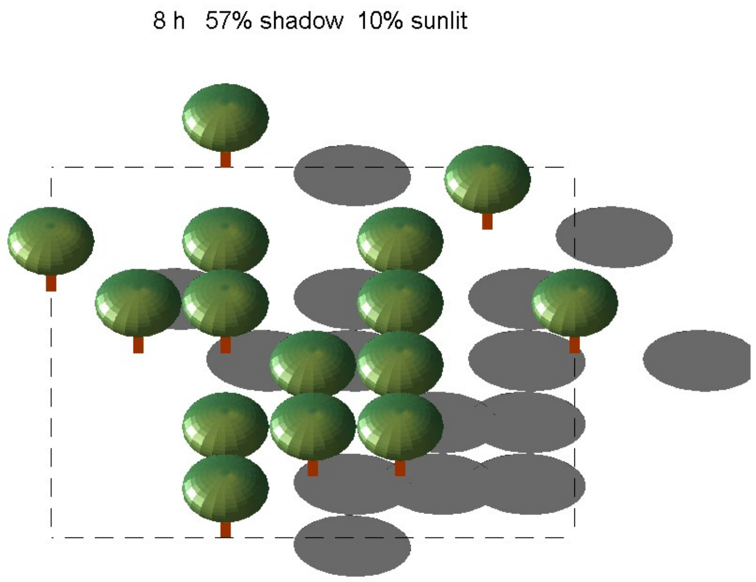
landsaf.ipma.pt

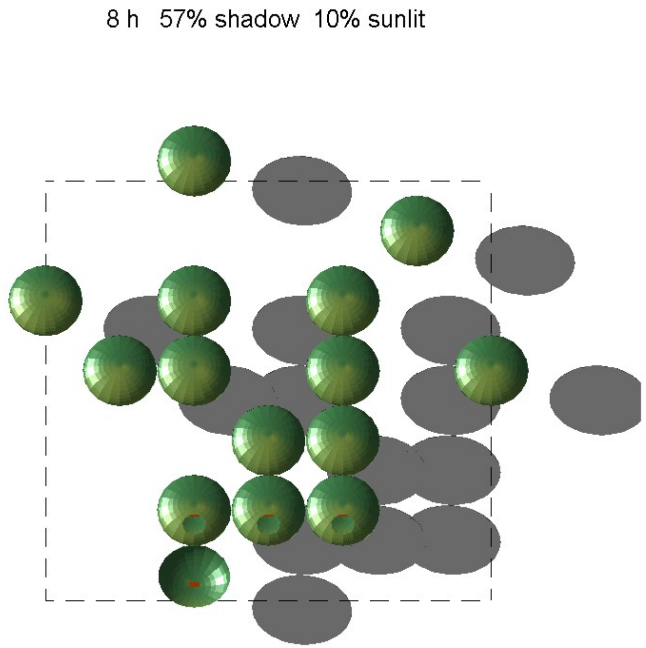
Land Surface Temperature

- SEVIRI instrument on board Meteosat
- Thermal infra-red
- Split-windows algorithm
- Clear sky
- 15 min temporal resolution
- ~3 km spatial resolution (nadir)



LST directionallity





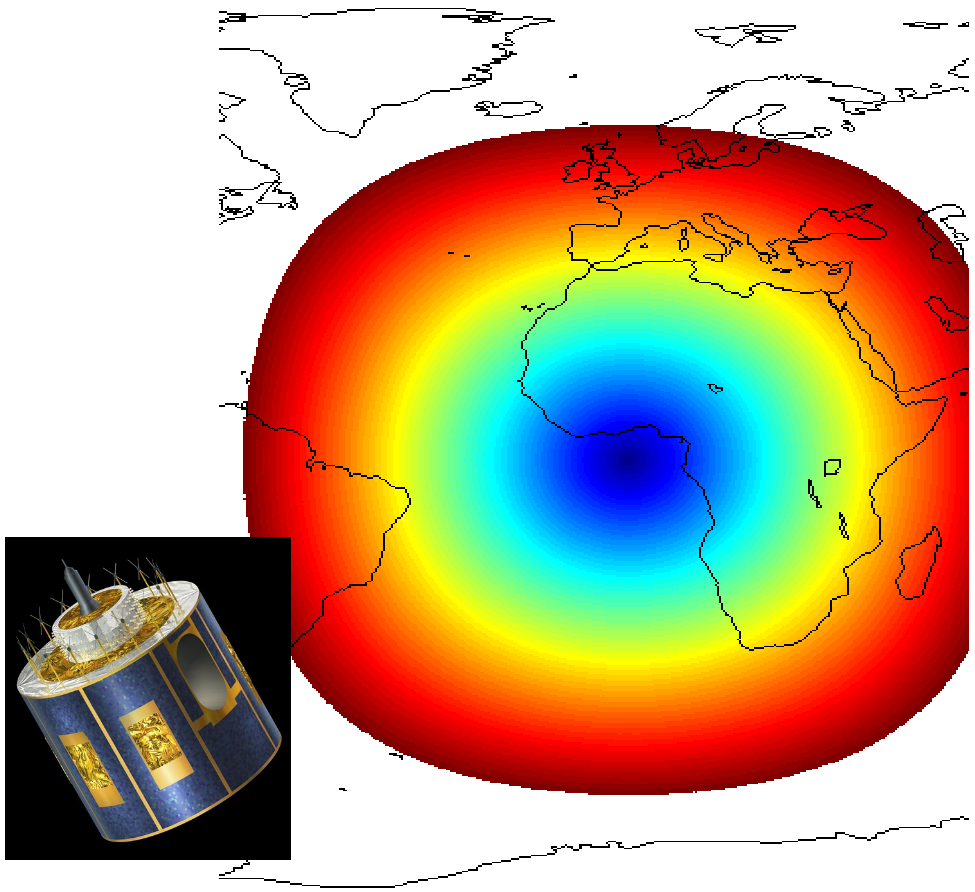
45º view

nadir view

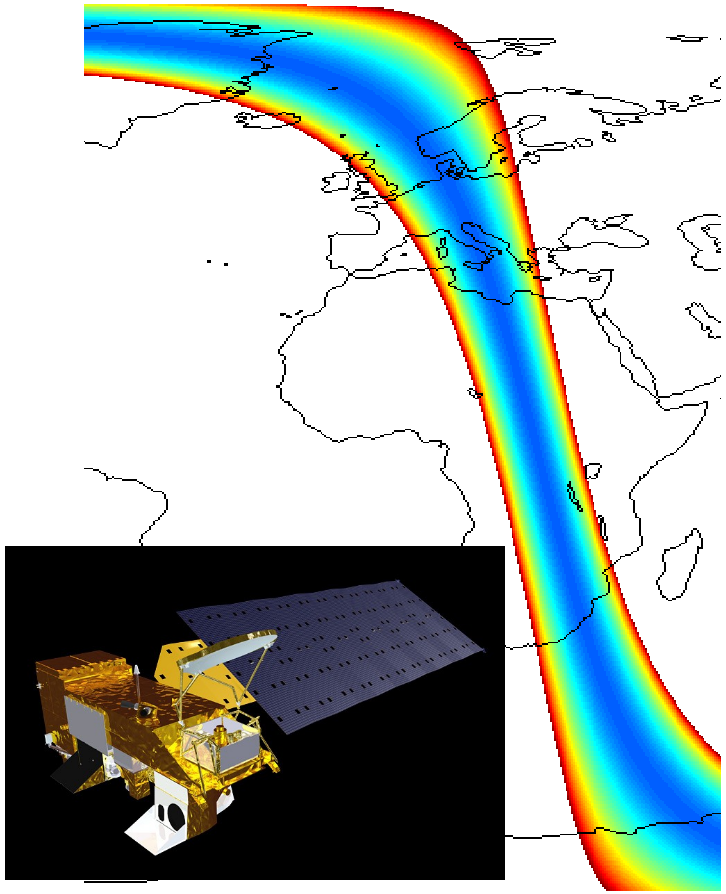
LST directionality

VZA
(degrees)

MSG/SEVIRI



AQUA/MODIS



Method

Kernel model of directional effects

↓

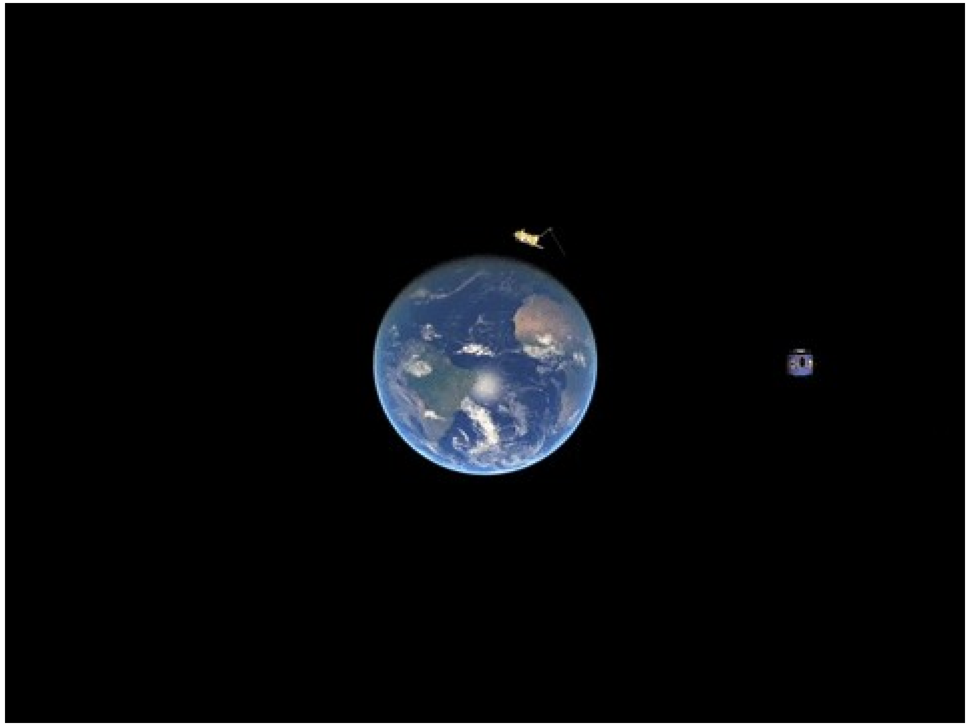
Geostationary orbit
(fixed view)

+

Polar orbit
(variable view)

↓

Correction of LST to **any view**



Meteosat (geostationary) vs Metop (polar) orbits

Source: *Two orbits, one Earth* by EUMETSAT

Remote Sensing data

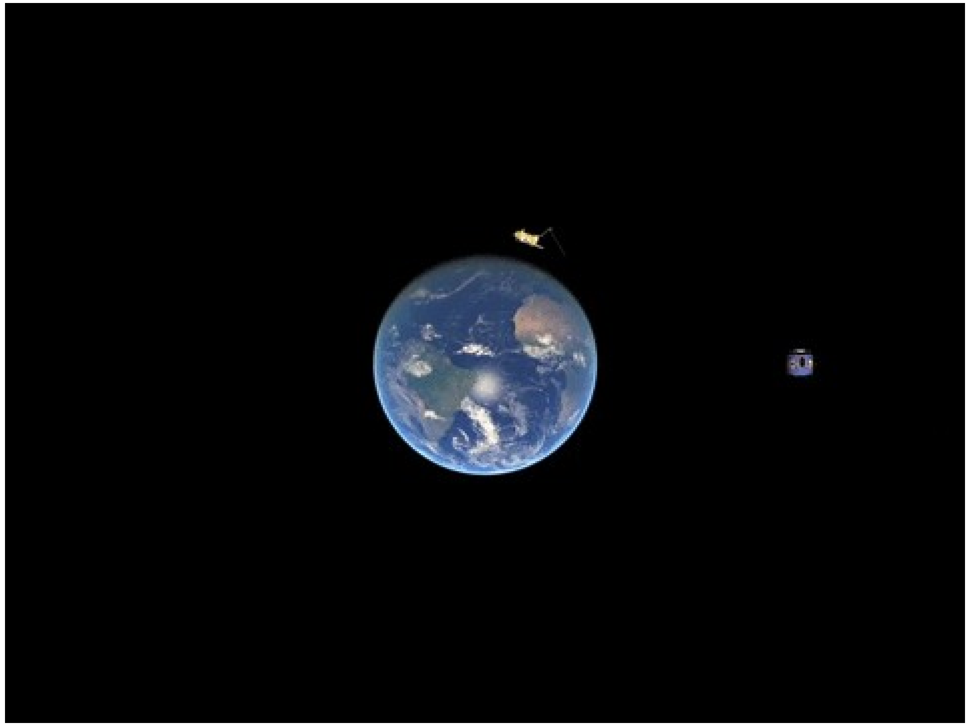
SEVIRI MSG

MODIS TERRA/AQUA

- Polar orbit
- Temporal resolution: ~12h
- Spatial resolution: 1 km

AATSR ENVISAT

- Polar orbit
- Temporal resolution: 1-2 days
- Spatial resolution: 1 km

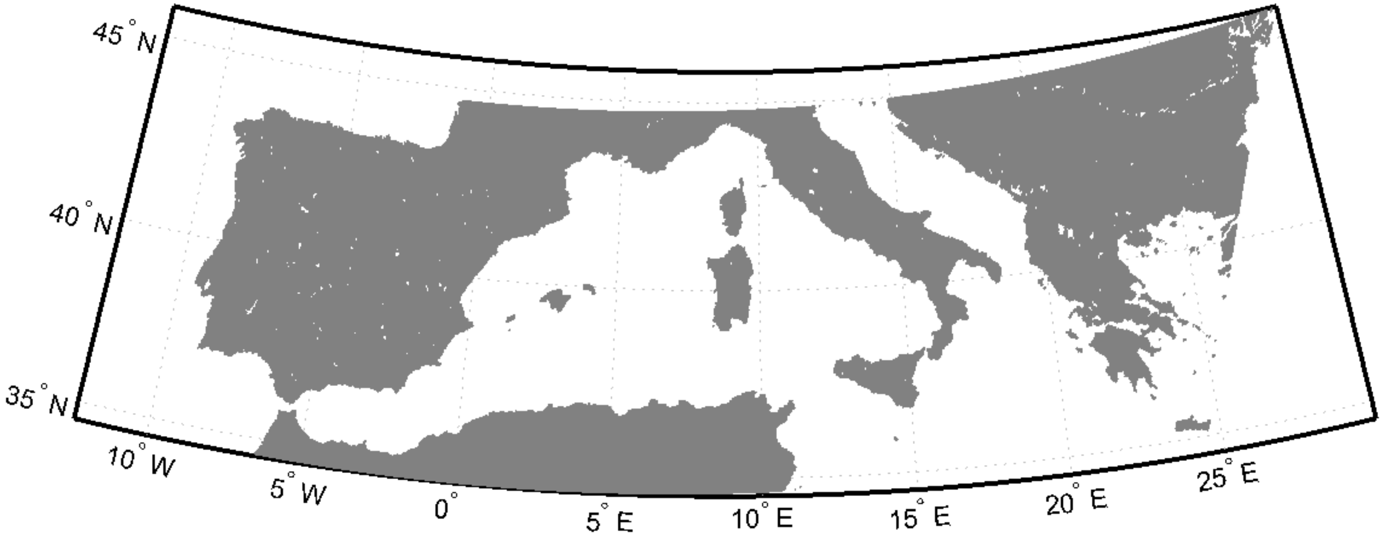


Meteosat (geostationary) vs Metop (polar) orbits

Source: *Two orbits, one Earth* by EUMETSAT

Study area

- MODIS + SEVIRI
  - Jan 2013 to Oct 2014
  - Jan to Dec 2011
- AATSR + SEVIRI
  - Jan to Dec 2011



MODIS (1km) → Average → SEVIRI (~5km)

SEVIRI (15min) → Linear interpolation → MODIS (~12h)

The kernel model

Model description

Vinnikov et al. (2012)

Vinnikov et al. (2012)

$$\frac{T(\theta_v,\theta_i,\Delta\phi)}{T_0} = 1 + A\Phi(\theta_v) + D\Psi(\theta_v,\theta_i,\Delta\phi)$$

Emissivity kernel:

Emissivity kernel:

$$\Phi(\theta_v) = 1 - \cos(\theta_v)$$

Solar kernel:

Solar kernel:

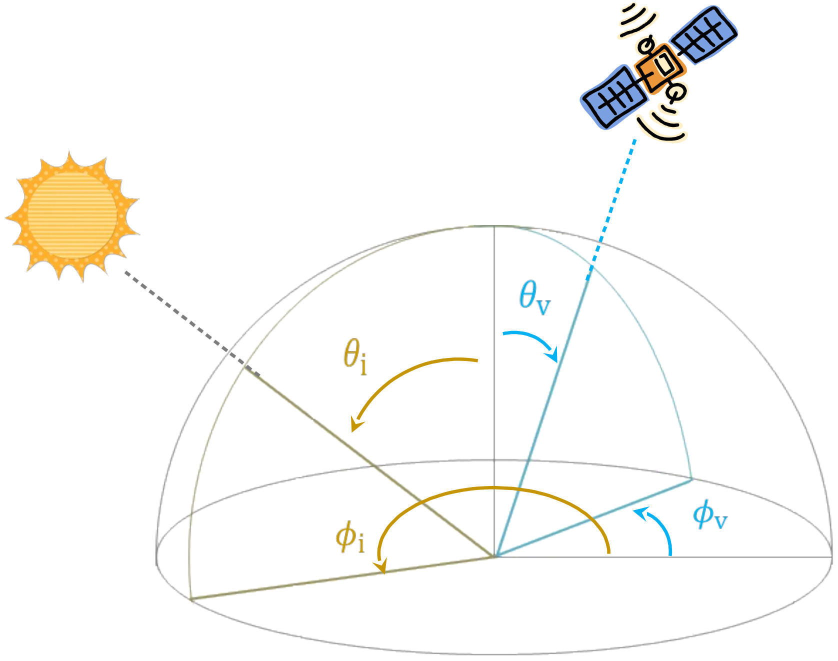
$\Psi(\theta_v = 0) = 0$

Shadowing

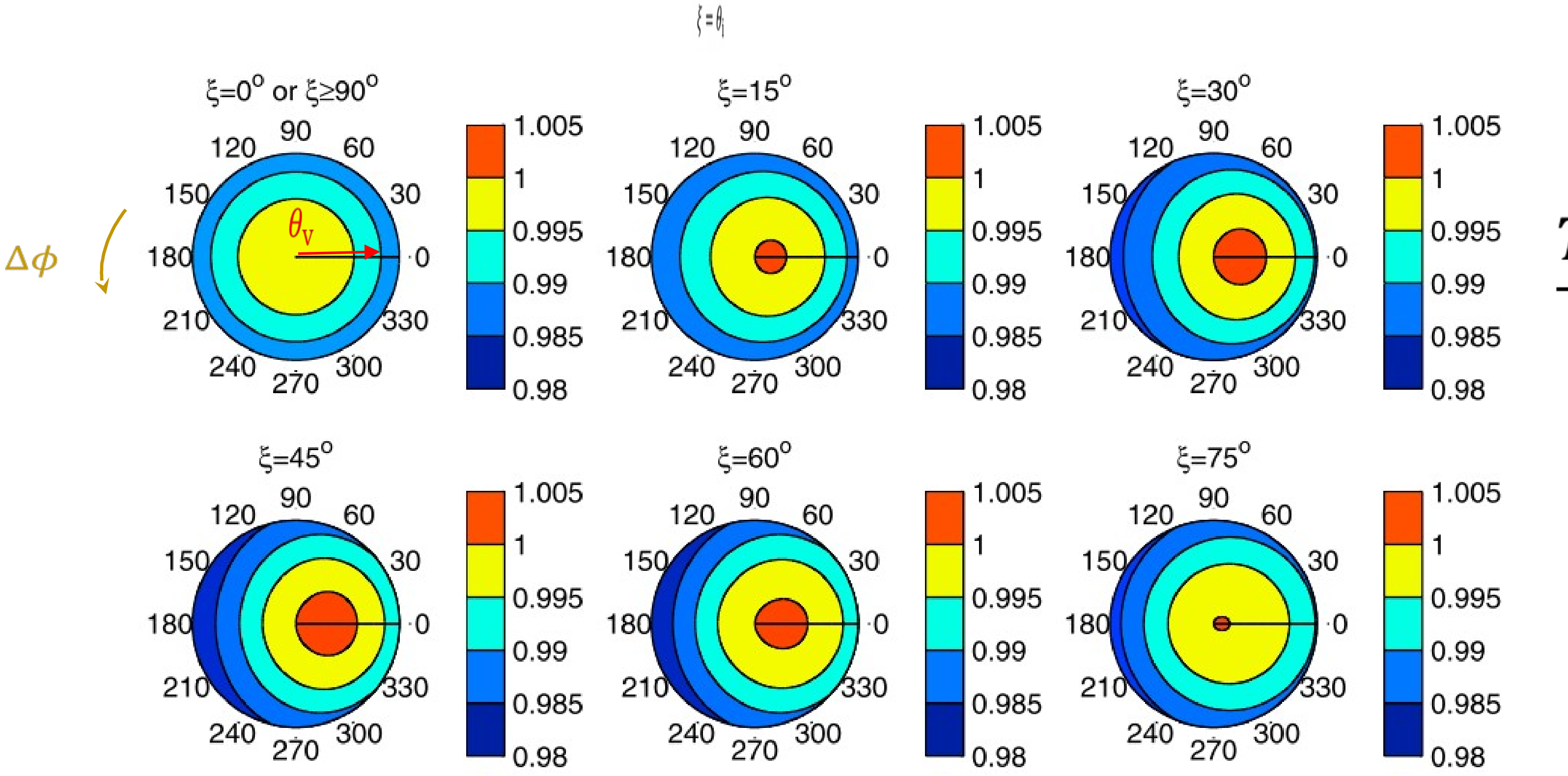
$$\Psi(\theta_v,\theta_i,\Delta\phi) = \sin(\theta_v)\cos(\theta_i)\sin(\theta_i)\cos(\Delta\phi)\cos(\theta_i - \theta_v)$$

Incoming radiation

Hot spot effect



Model description



$$\frac{T(\theta_v, \theta_i, \Delta\phi)}{T_0}$$

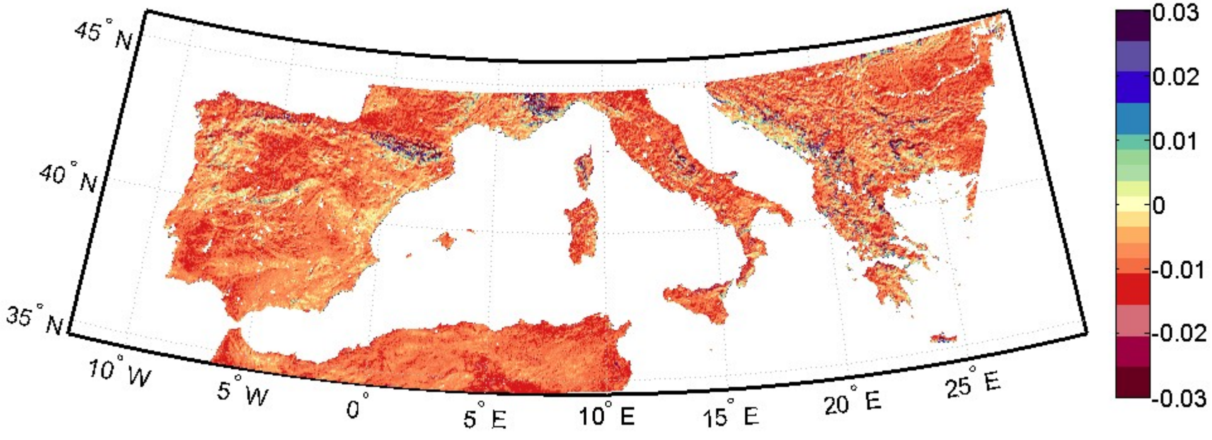
Vinnikov et al. (2012)

Results

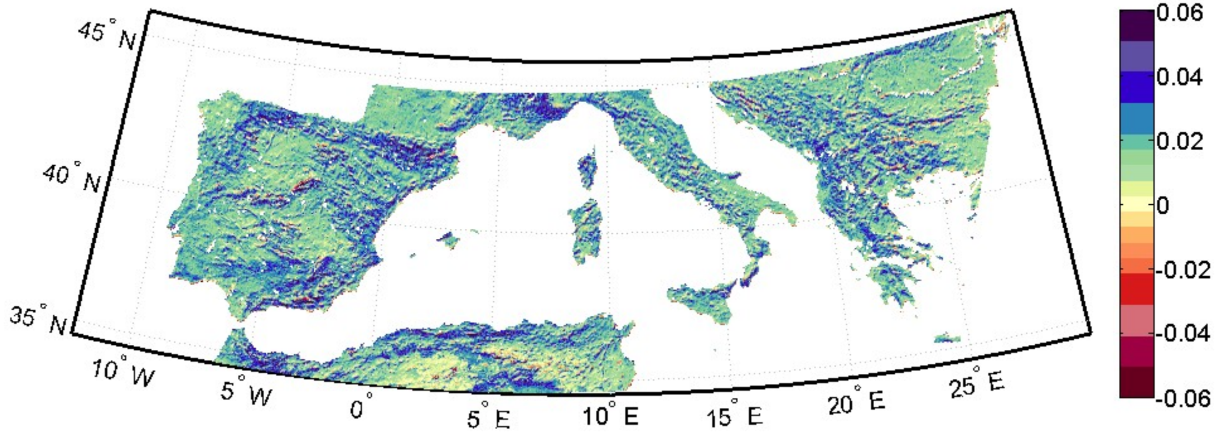
Model parameters

$$\frac{T(\theta_v, \theta_i, \Delta\phi)}{T_0} = 1 + \boldsymbol{A}\Phi(\theta_v) + \boldsymbol{D}\Psi(\theta_v, \theta_i, \Delta\phi)$$

Emissivity Kernel (A)



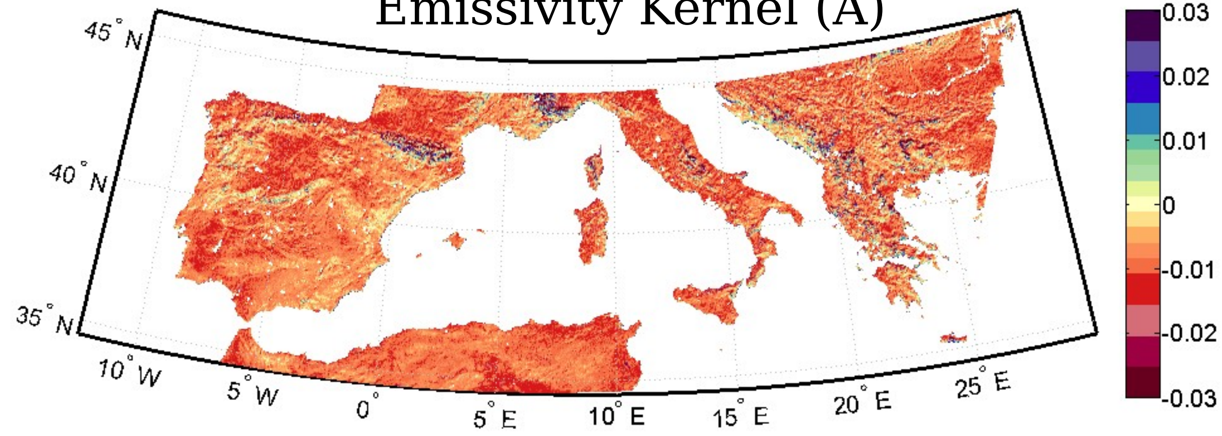
Solar Kernel (D)



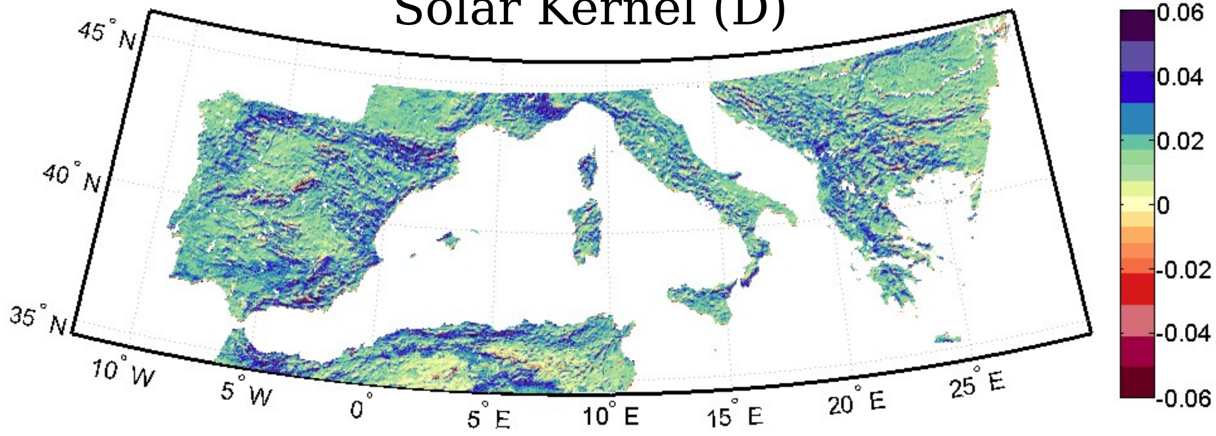
Model calibrated with MODIS+SEVIRI 2013+2014

Model parameters

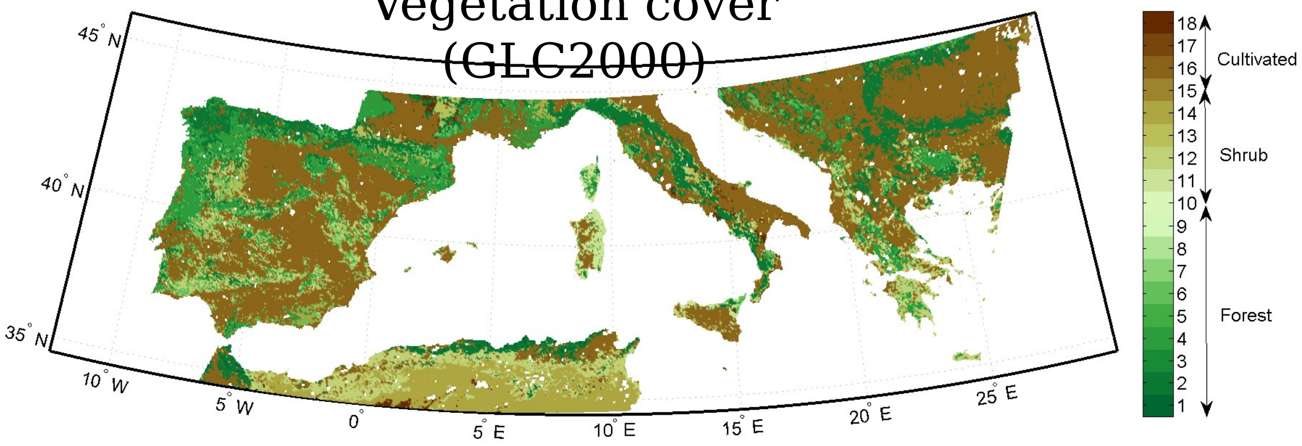
Emissivity Kernel (A)



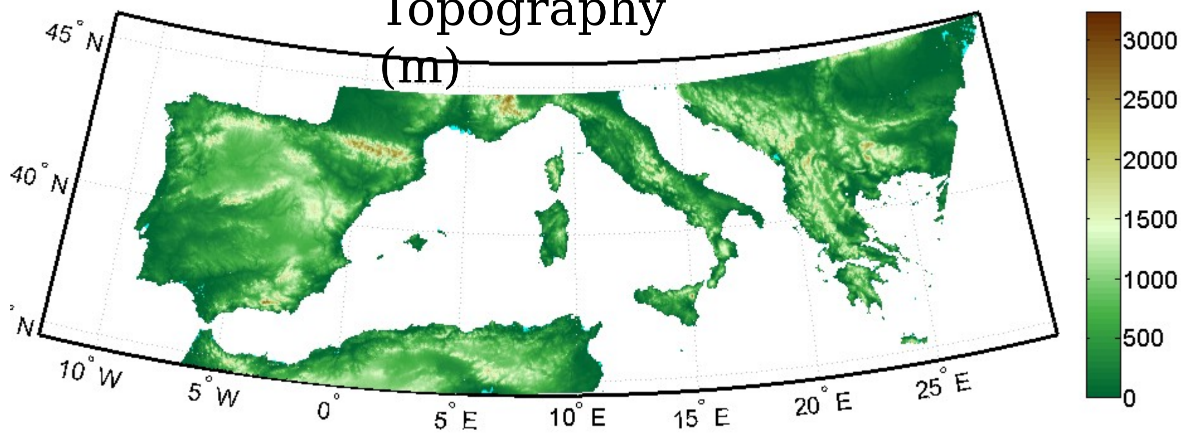
Solar Kernel (D)



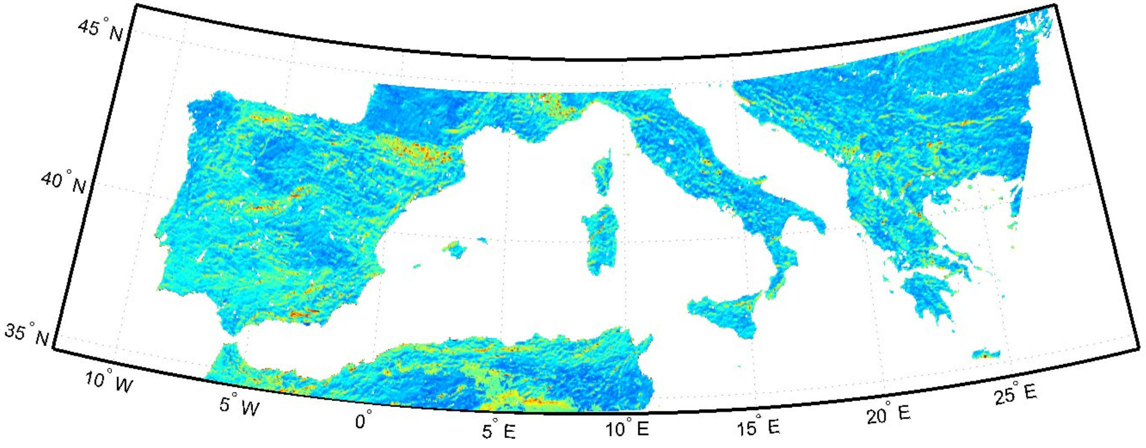
Vegetation cover (GLC2000)



Topography (m)

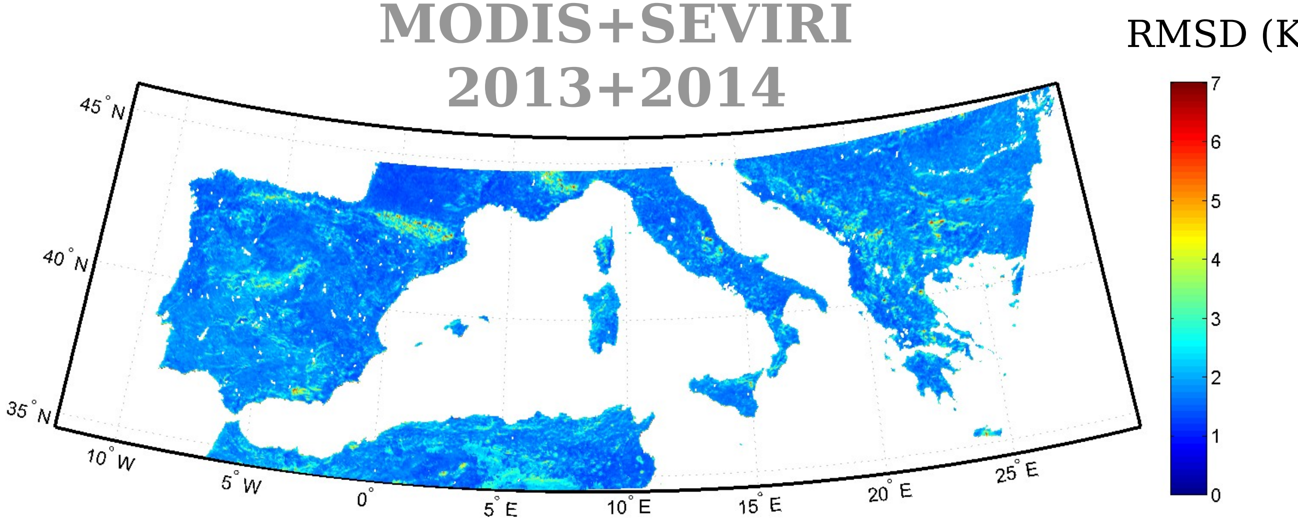


MODIS vs SEVIRI



Root Mean Square Differences (RMSD) between SEVIRI LST and MODIS LST for 2013+2014 data

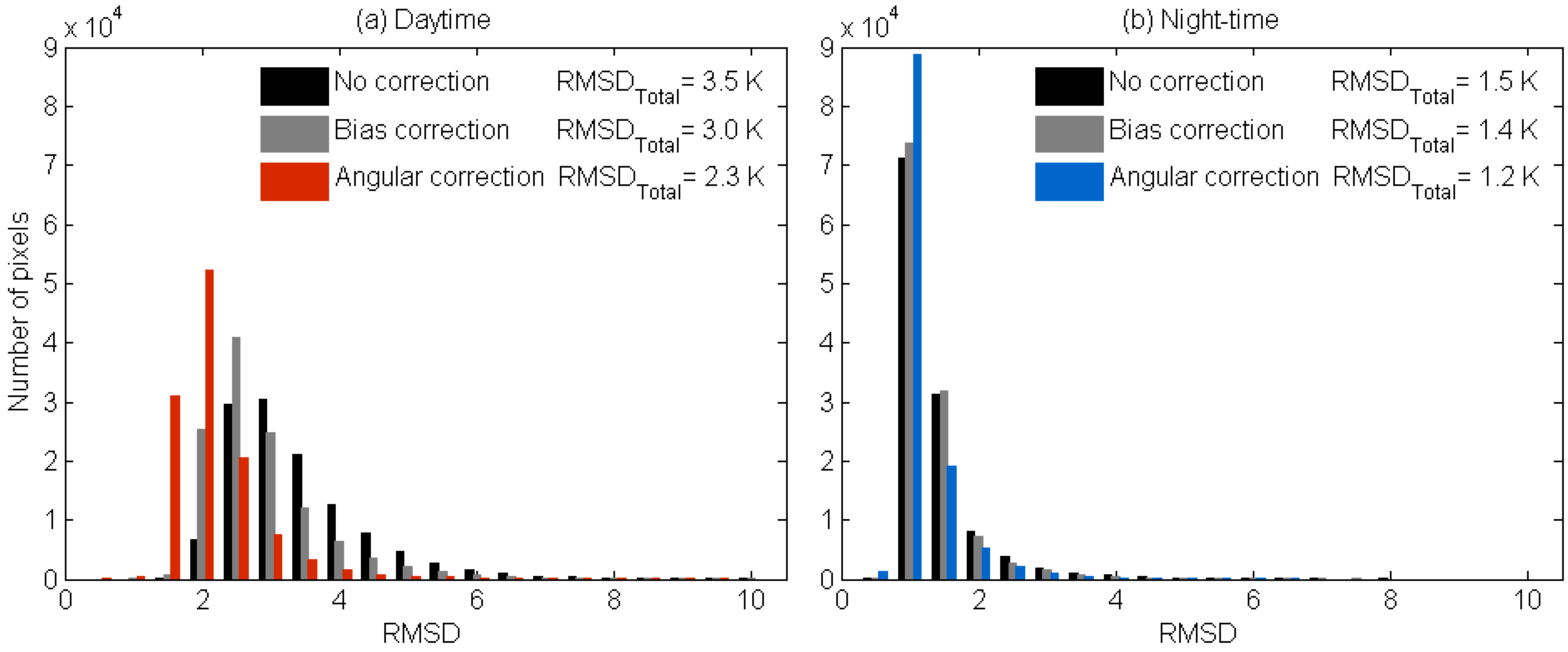
Model calibrated with MODIS+SEVIRI 2013+2014



Root Mean Square Differences (RMSD) between SEVIRI LST and MODIS LST for 2013+2014 data **after correction with kernel model**

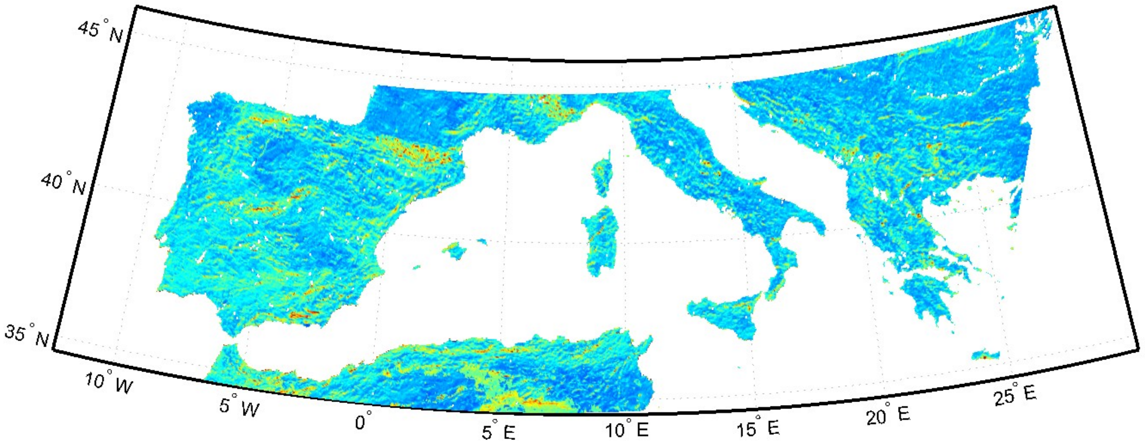
MODIS vs SEVIRI

Model calibrated with MODIS+SEVIRI 2013+2014

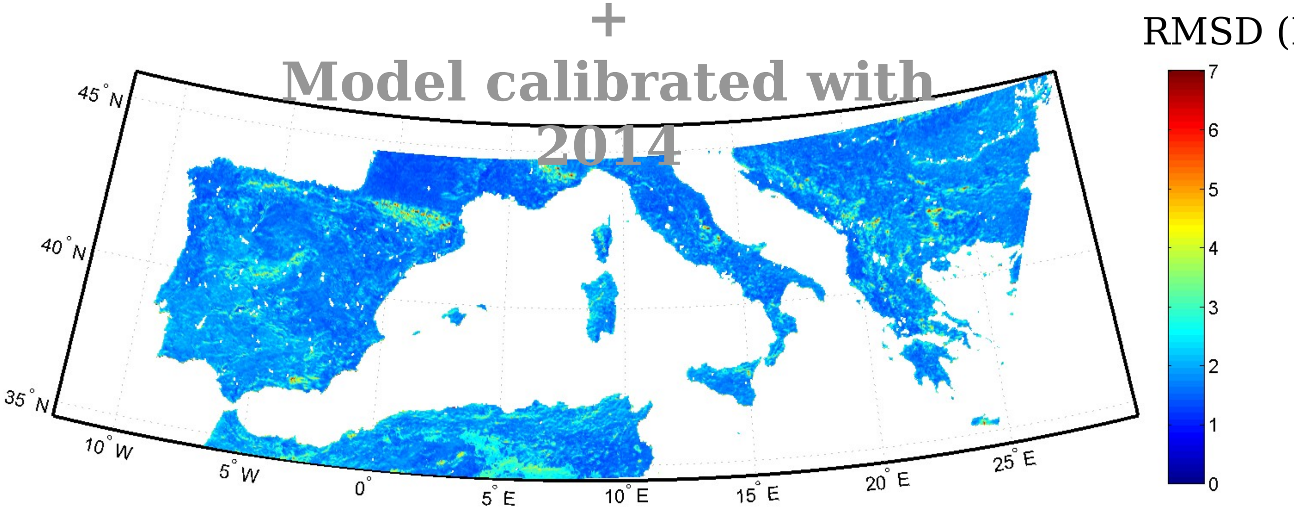


MODIS vs SEVIRI – cross validation

Model calibrated with 2013
+
Model calibrated with 2014



RMSD between SEVIRI LST and MODIS LST
for 2013+2014 data



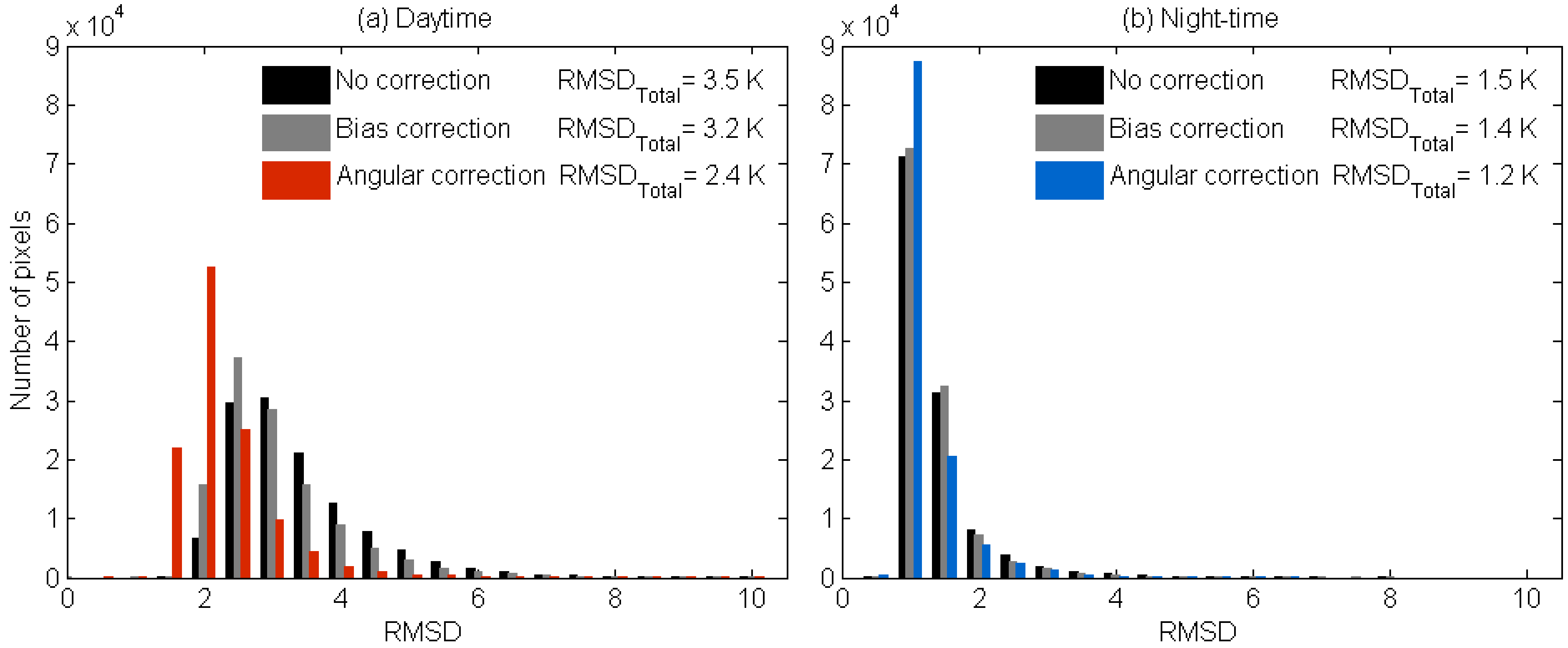
RMSD between SEVIRI LST and MODIS LST
for the cross validation
after correction with kernel model

MODIS vs SEVIRI – cross validation

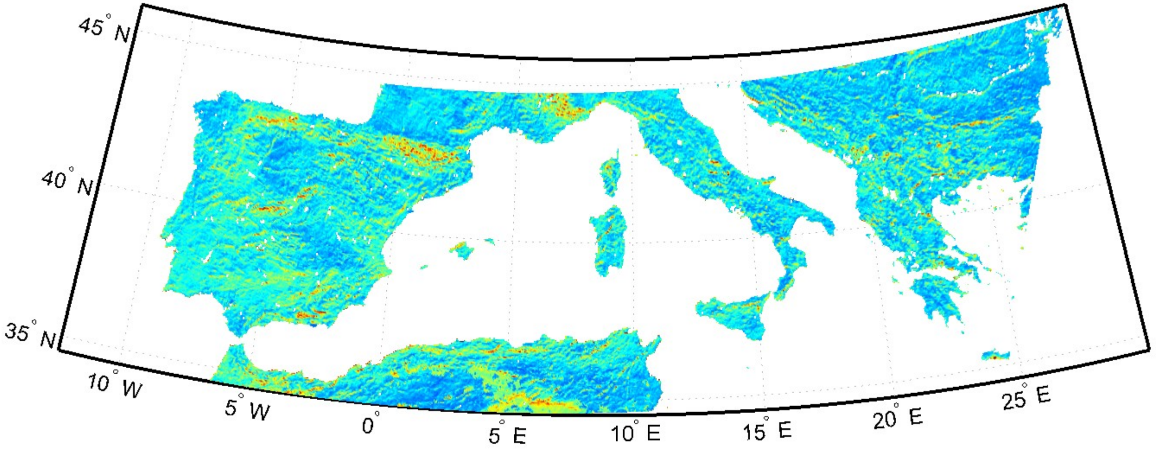
Model calibrated with 2013

+

with

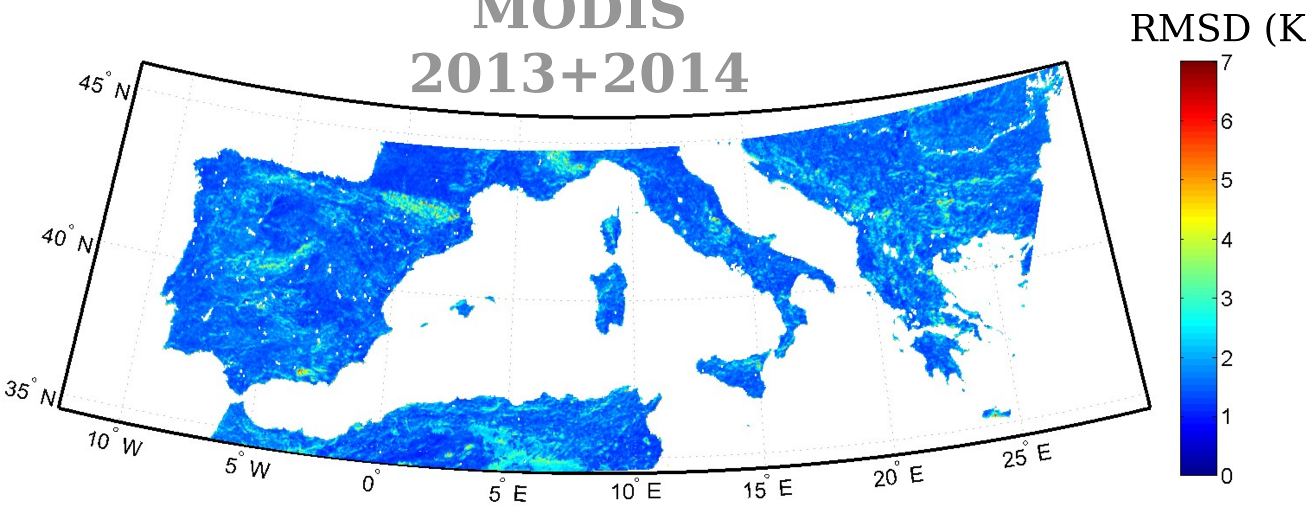


MODIS vs SEVIRI – independent data



Root Mean Square Differences (RMSD) between SEVIRI LST and MODIS LST for **2011** data

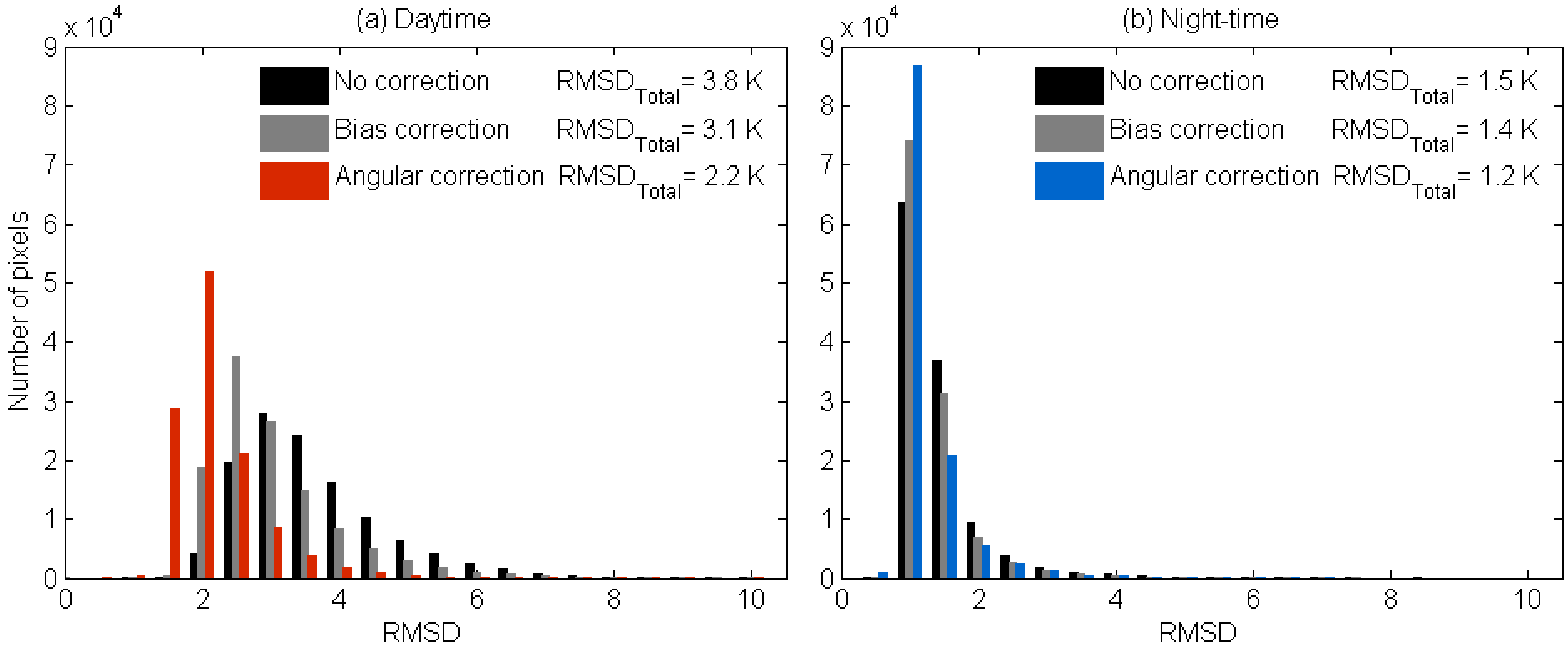
Model calibrated with MODIS 2013+2014



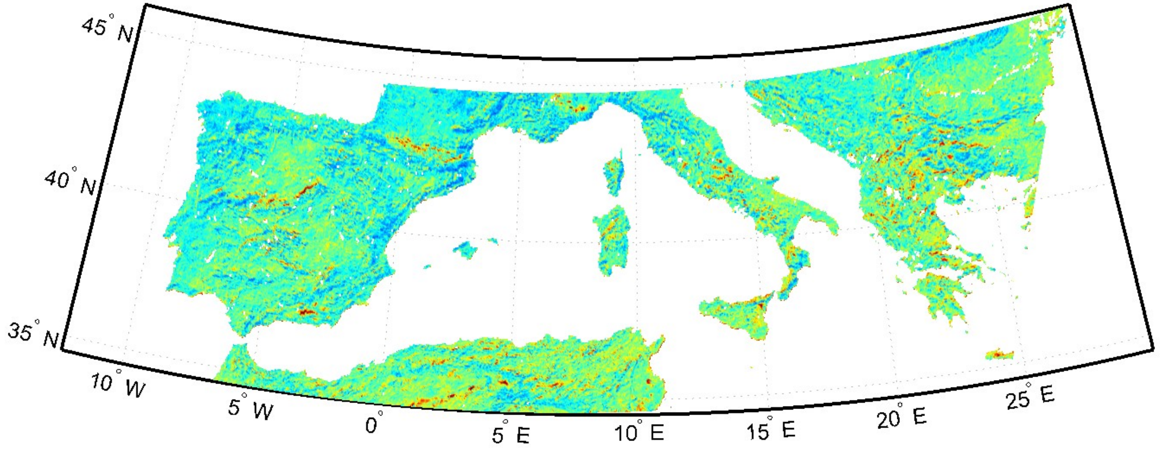
Root Mean Square Differences (RMSD) between SEVIRI LST and MODIS LST for **2011** data **after correction with kernel model**

MODIS vs SEVIRI – independent data

Model calibrated with MODIS 2013+2014

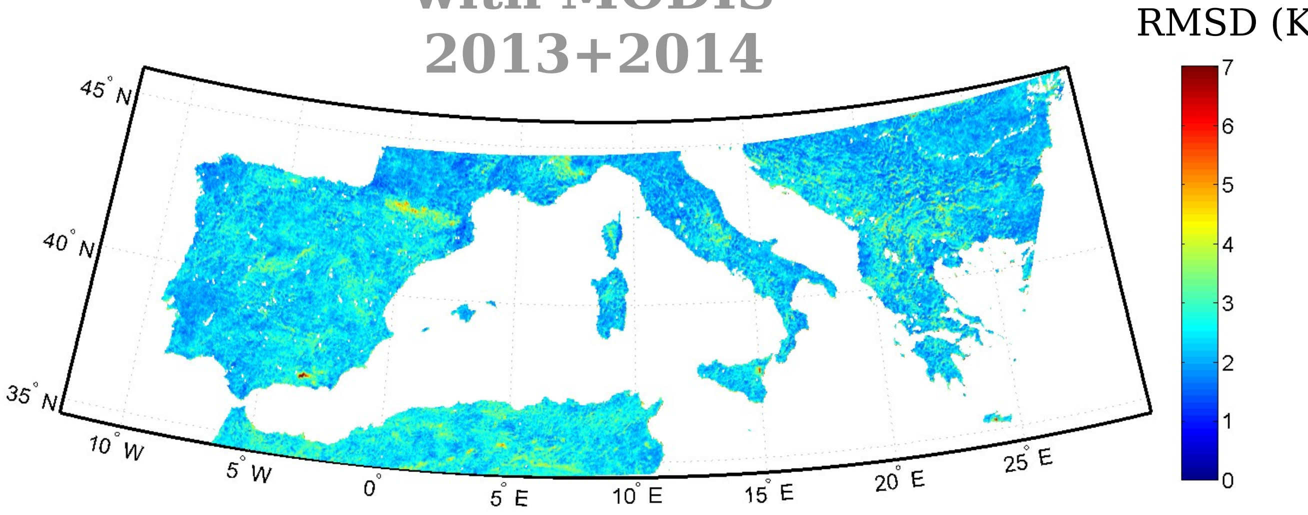


AATSR vs SEVIRI



RMSE between SEVIRI LST and **AATSR** LST for **2011** data

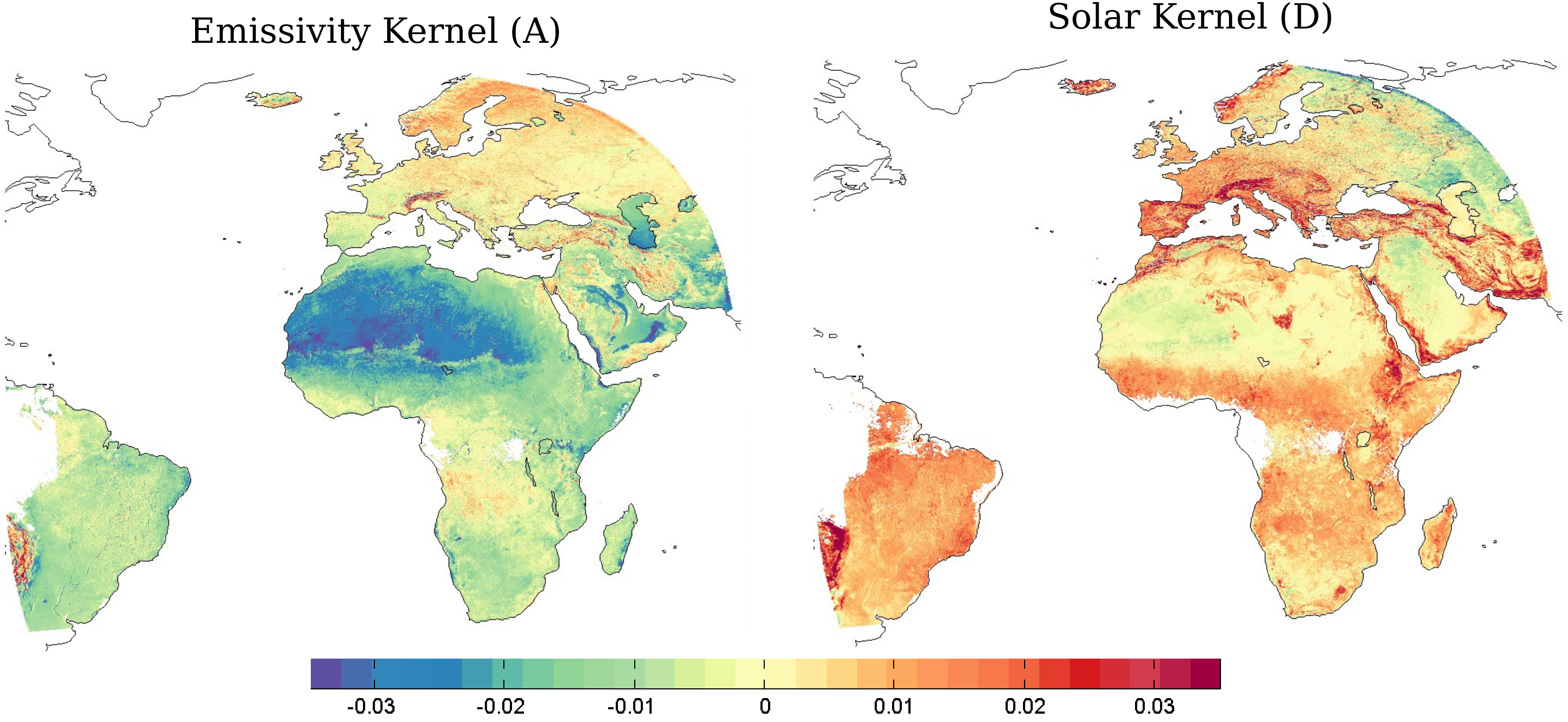
Model calibrated with MODIS 2013+2014



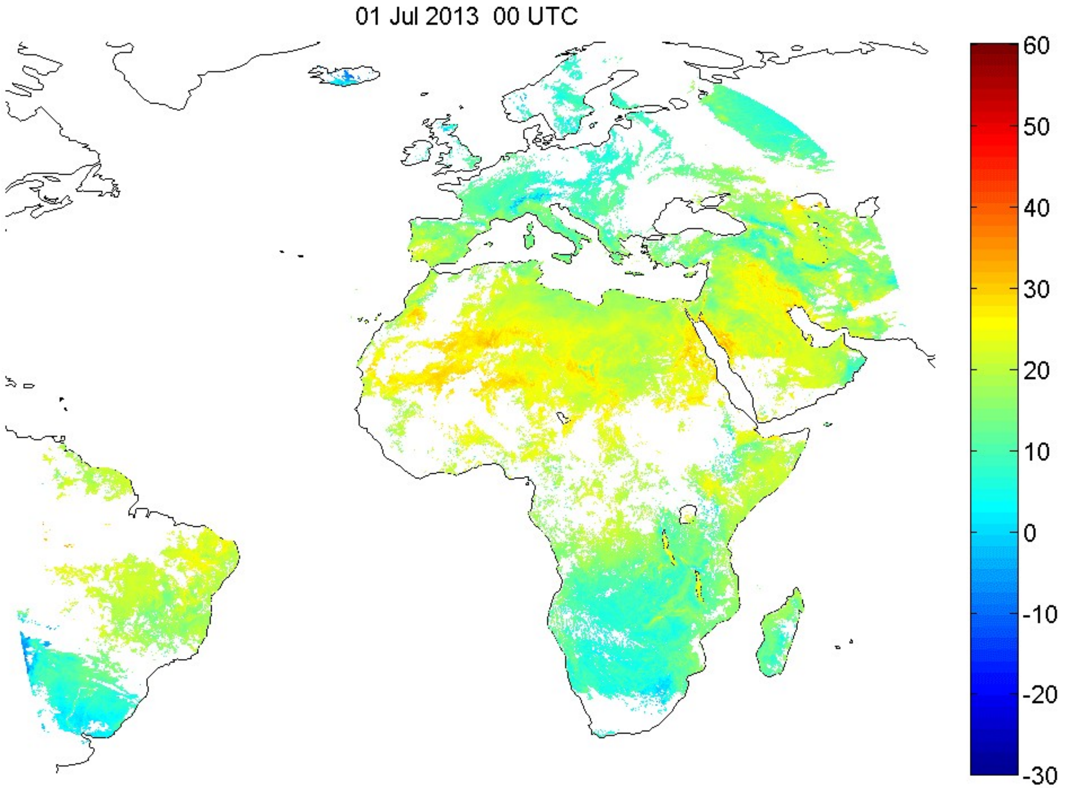
RMSE between SEVIRI LST and **AATSR** LST for **2011** data
after correction with kernel model

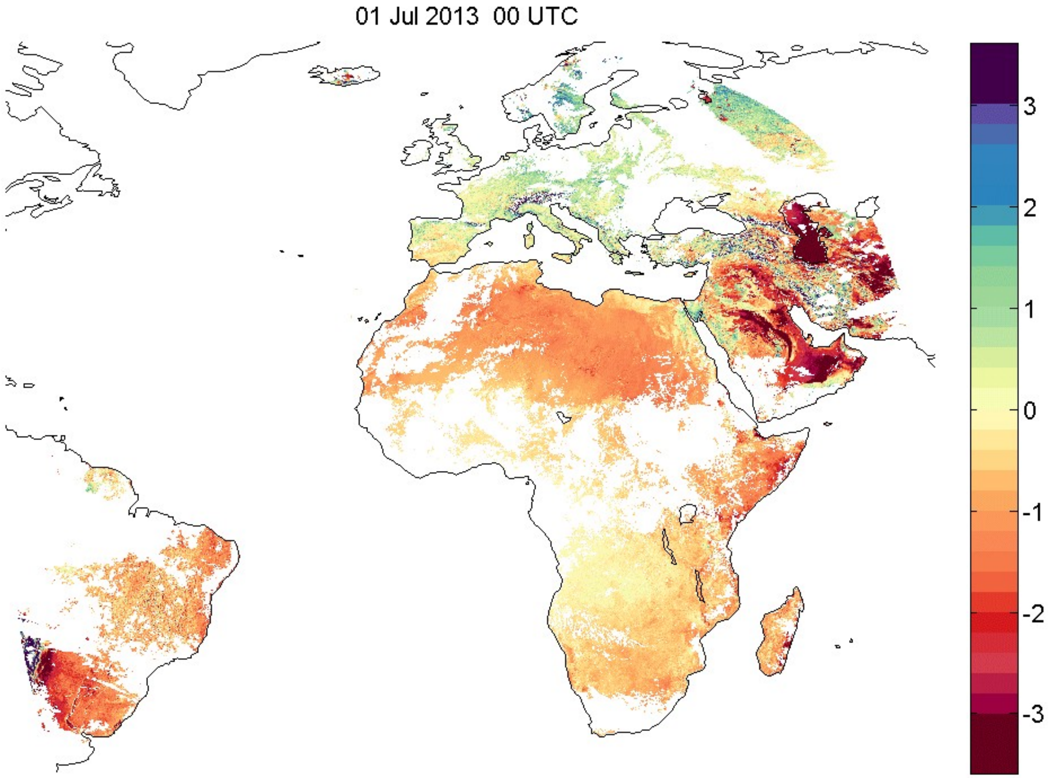
Applications

SEVIRI full disk



Applying to LST…





LST (ºC)

LST – T_0 (ºC)

Concluding remarks

- The Kernel model is an effective tool in correcting angular effects in satellite retrieved LST
- The model presents good performance and robustness
- The model's parameters seem to have a relation with vegetation and ground relief

- The angular information provided by the kernel model is planned to be incorporated in the LSA-SAF LST product

Thank you