



Validating LST and inter comparing observations from polar orbit and geostationary satellites by means of a model of illumination and viewing geometries

Sofia L. Ermida⁽¹⁾, Isabel F. Trigo^(1,2), Carlos C. DaCamara⁽¹⁾,
Frank Götsche⁽³⁾, Folke Olesen⁽³⁾

⁽¹⁾Instituto Dom Luiz, Universidade de Lisboa, Lisboa, Portugal

⁽²⁾Instituto Português do Mar e da Atmosfera, Lisboa, Portugal

⁽³⁾Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

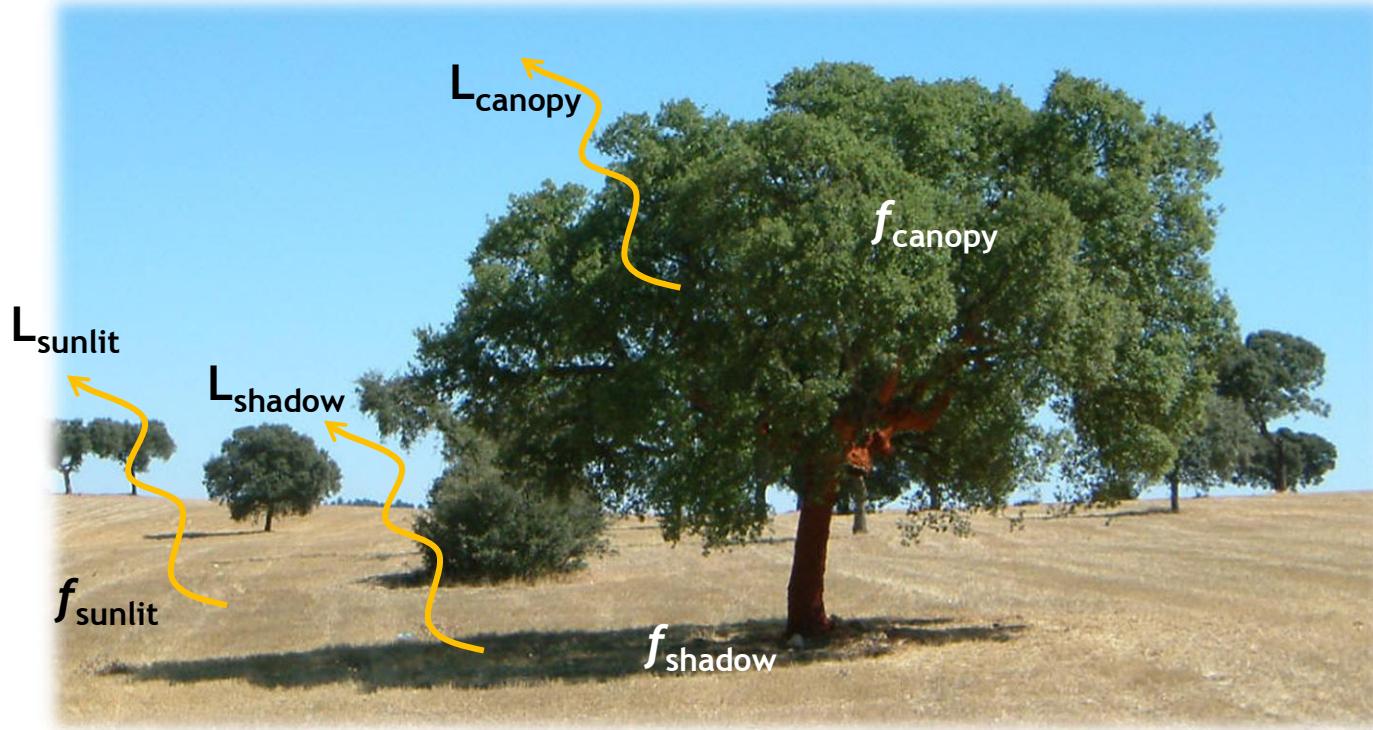
Basic Assumptions

Land covered by 3 main components:

- Sunlit background
- Shaded background
- Canopy

Composite radiance of a MSG pixel:

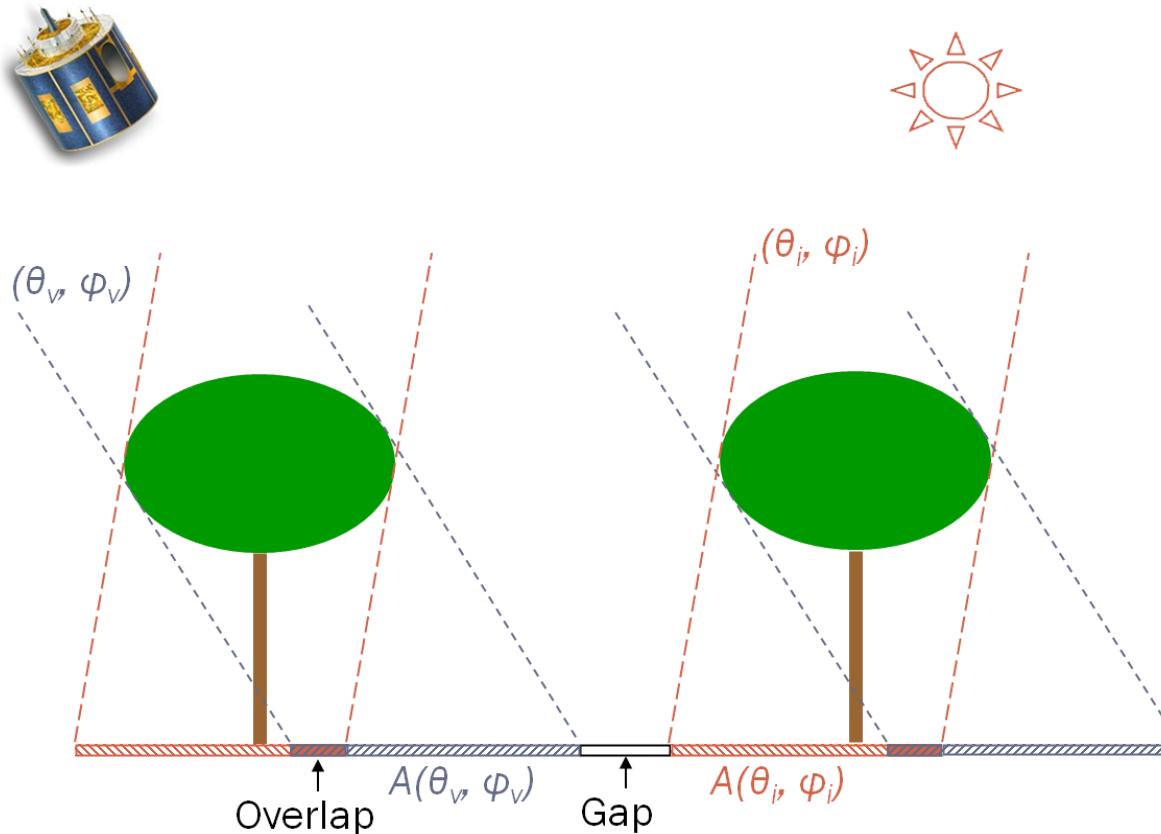
$$L_{avg} = f_{sunlit} * L_{sunlit} + f_{shadow} * L_{shadow} + f_{canopy} * L_{canopy}$$



The Geometric Model

- Based on the **Boolean Scene Model** that shows that the gap probability between objects within a layer is

$$q(\theta, \varphi) = e^{-\lambda \bar{A}(\theta, \varphi)}$$

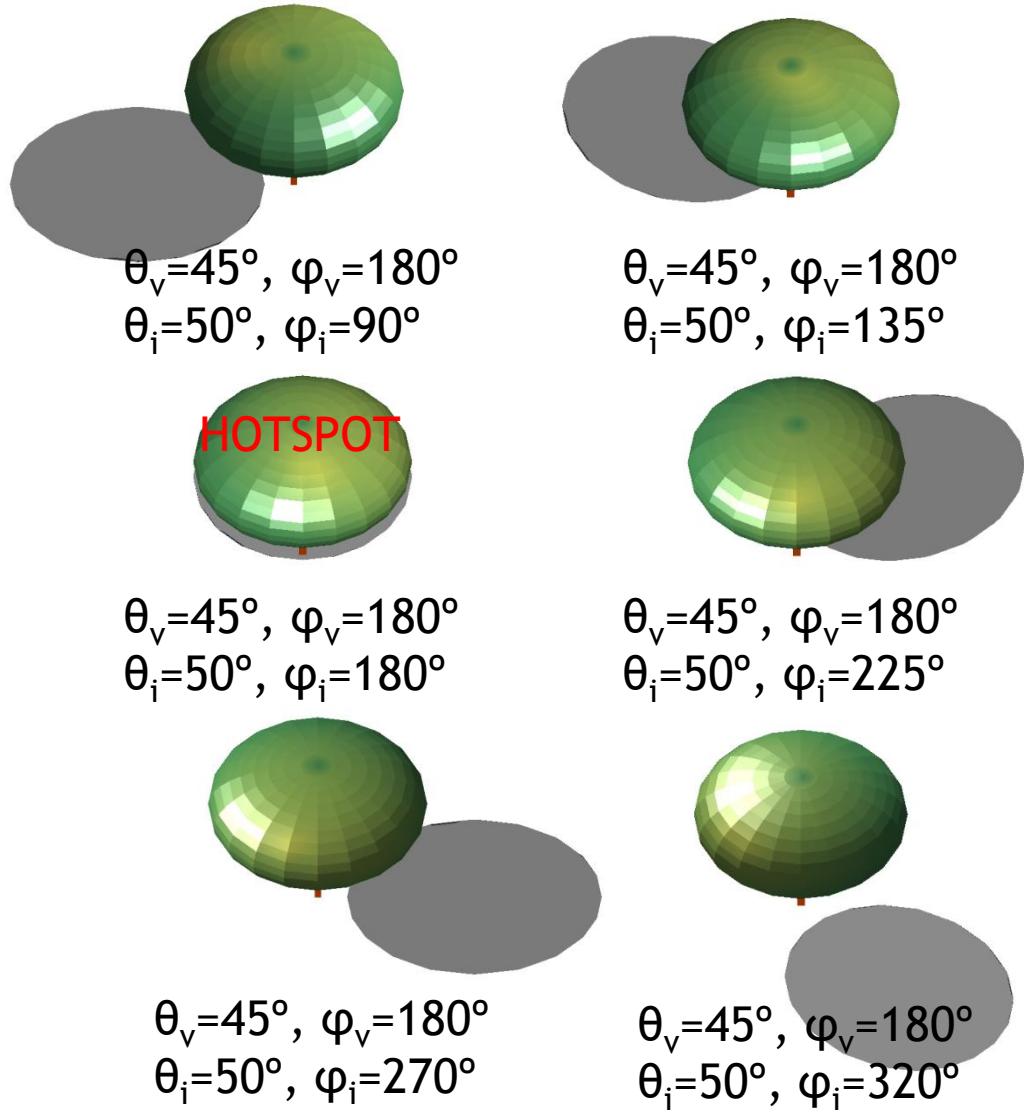
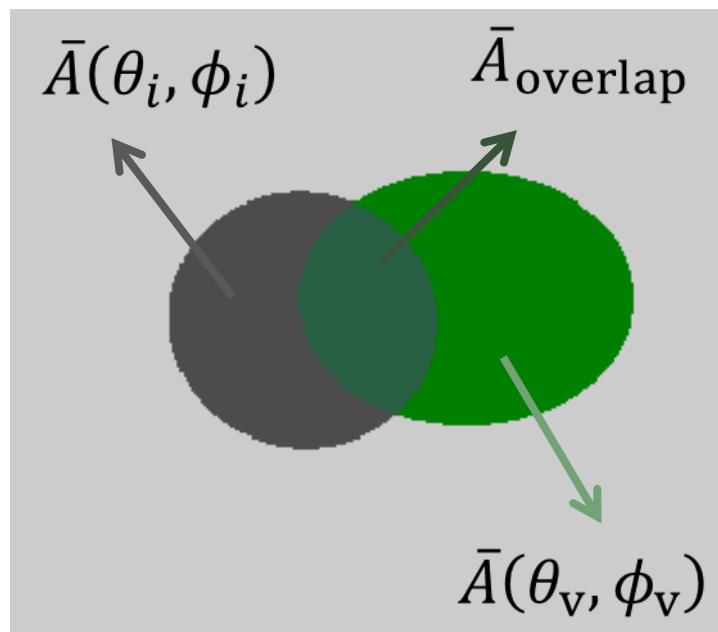


The Geometric Model

$$F_{\text{sunlit}} = \exp\{-\zeta[\bar{A}(\theta_v, \phi_v) + \bar{A}(\theta_i, \phi_i) - \bar{A}_{\text{overlap}}]\}$$

$$F_{\text{shadow}} = \exp\{-\zeta\bar{A}(\theta_v, \phi_v)\} - F_{\text{sunlit}}$$

$$F_{\text{canopy}} = 1 - \exp\{-\zeta\bar{A}(\theta_v, \phi_v)\}$$



Insitu Measurements

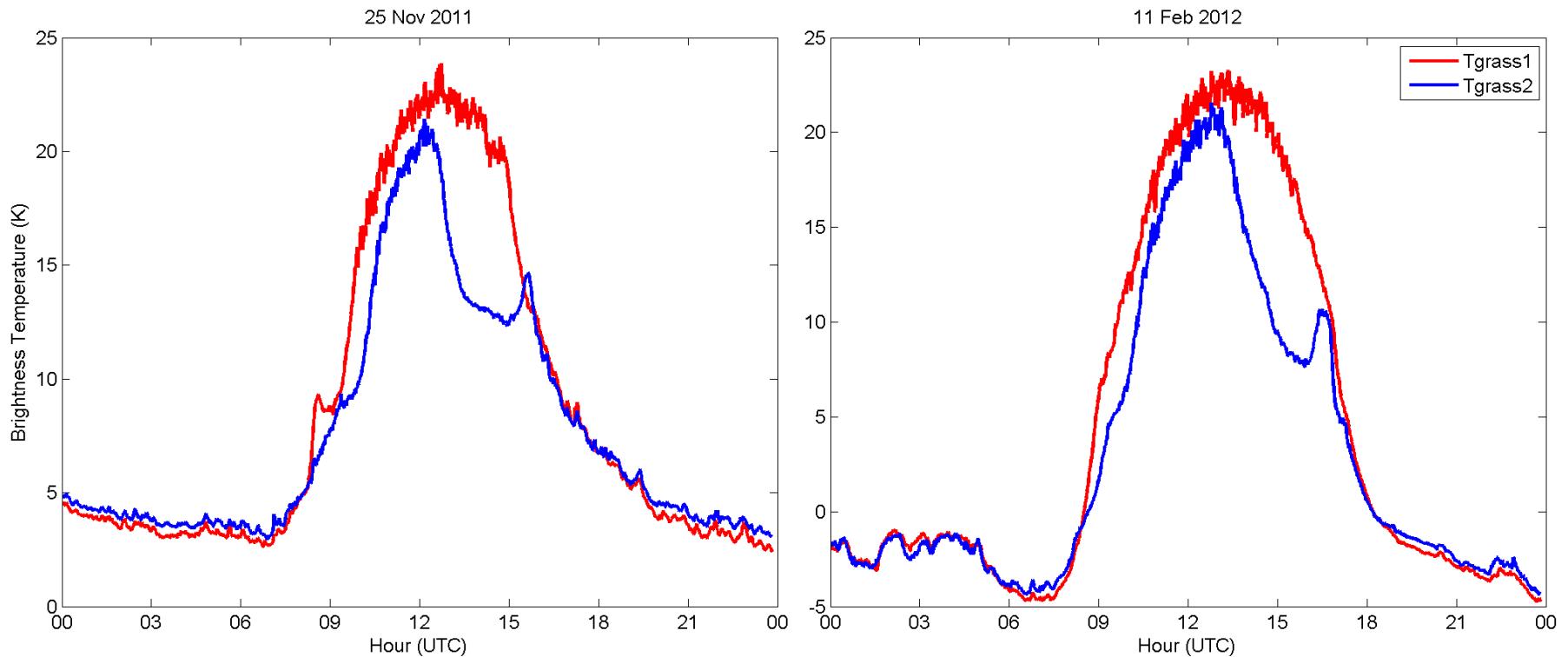
→ Brightness temperature for grass, tree and sky



Source: GoogleMaps

Insitu Measurements

→ Brightness temperature for grass, tree and sky

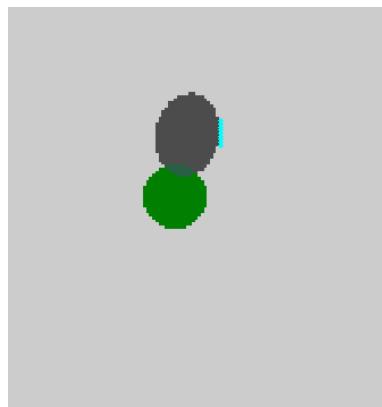


$$T_{\text{grass2}} - T_{\text{grass1}}^{\min} = \alpha(T_{\text{grass1}} - T_{\text{grass1}}^{\min}) + \beta$$

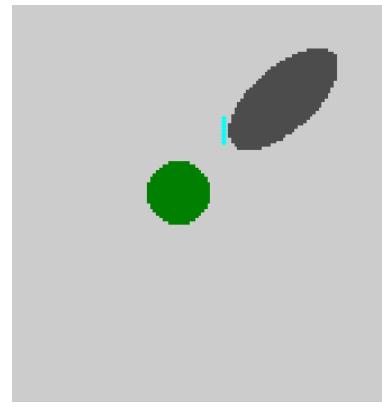
Insitu Measurements

Starting and ending instants of shadow contamination to the radiometer. Blue dots indicate possible locations for the radiometer on that day.

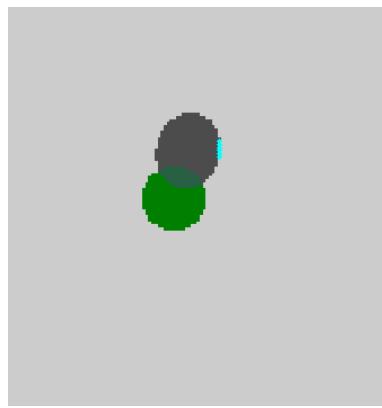
25/11/2011 13:00



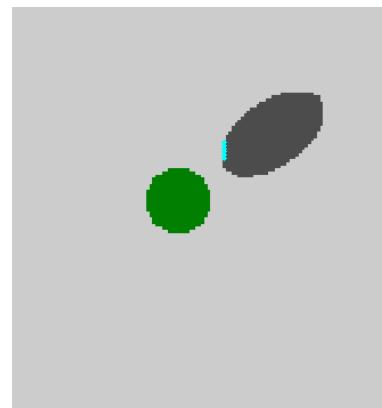
25/11/2011 15:40



11/02/2012 13:40

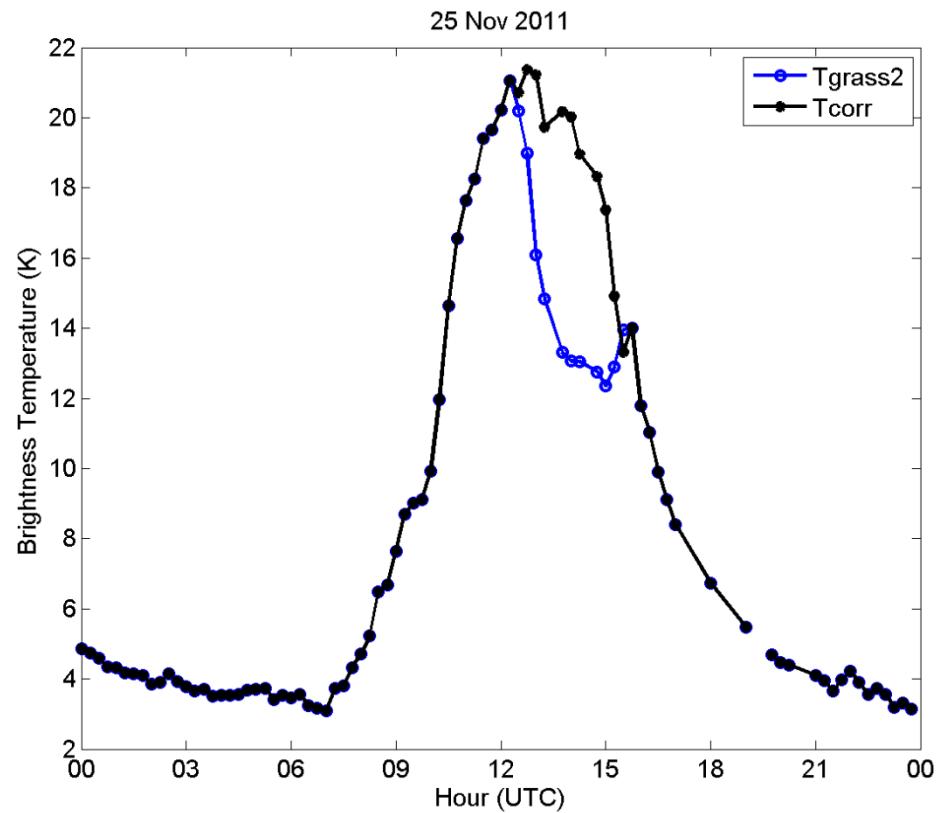
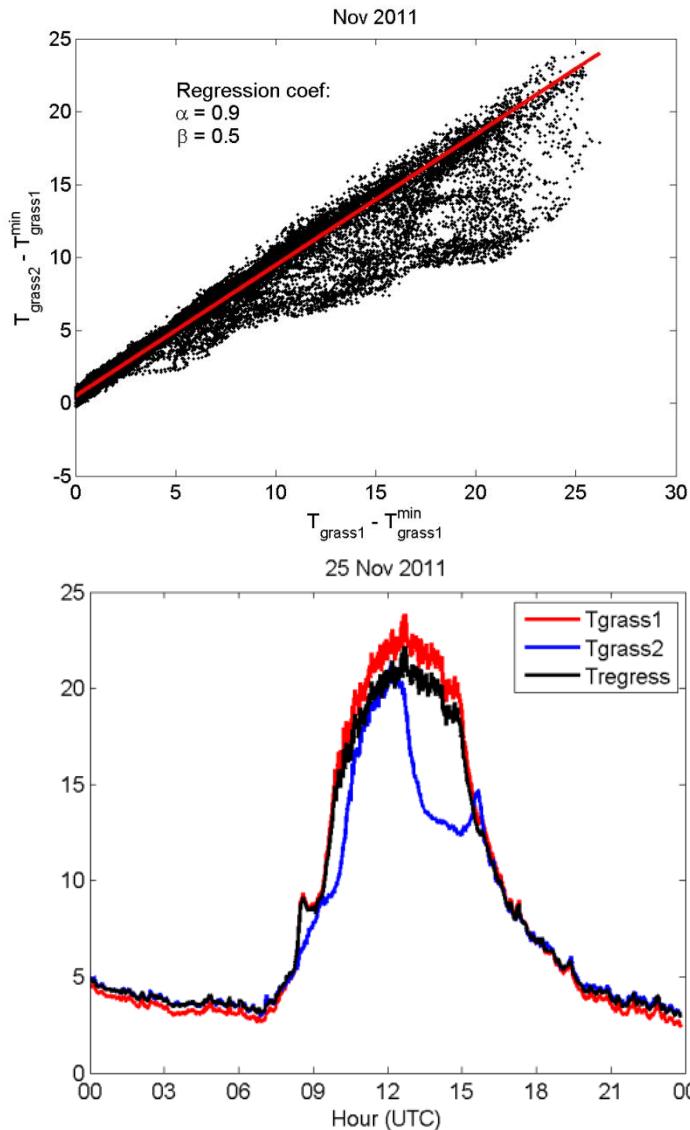


11/02/2012 16:20



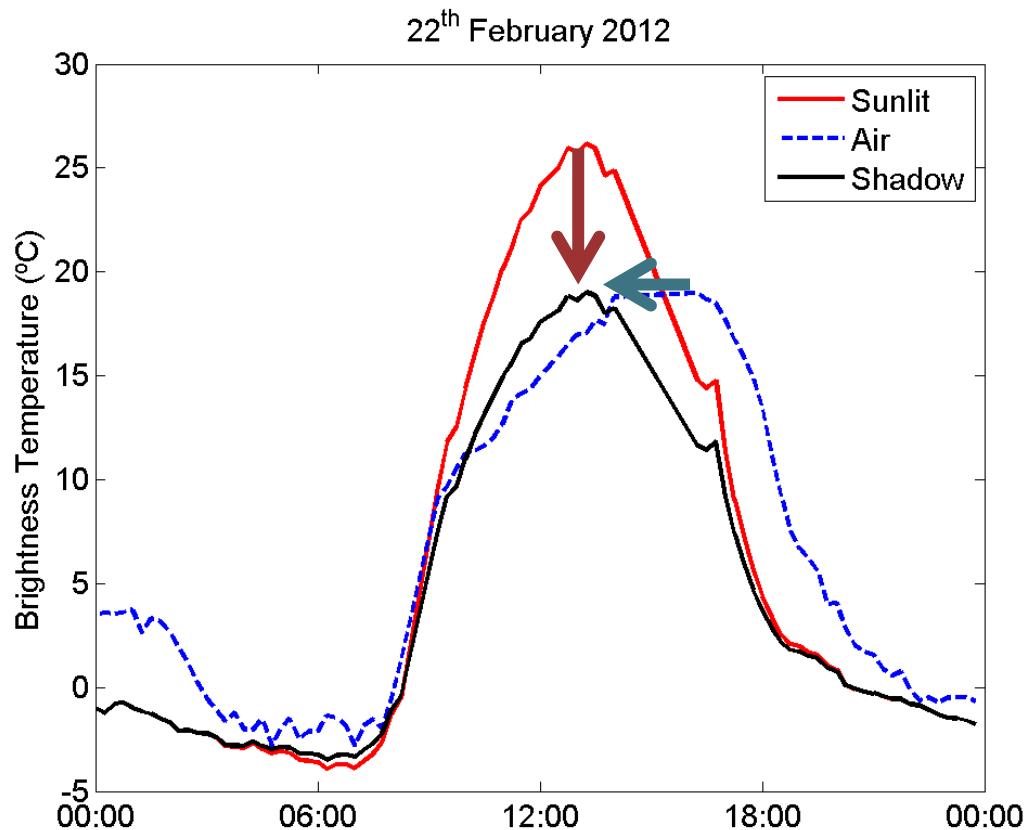
Insitu Measurements

$$T_{\text{grass2}} - T_{\text{grass1}}^{\min} = \alpha(T_{\text{grass1}} - T_{\text{grass1}}^{\min}) + \beta$$

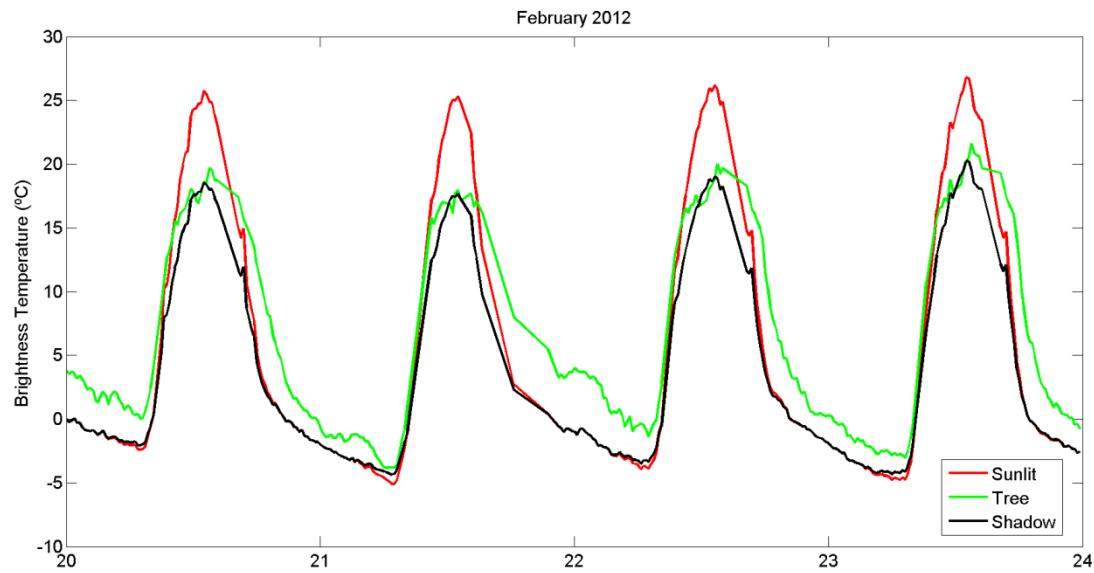


Insitu Measurements

Shadow's temperature?



Insitu Measurements



Planck's law → Radiances
 ↑
 Centered at 10.8 μm
 $L_{\text{sunlit}}, L_{\text{tree}}, L_{\text{shadow}}$

$$L_{\text{avg}} = f_{\text{sunlit}} * L_{\text{sunlit}} + f_{\text{shadow}} * L_{\text{shadow}} + f_{\text{canopy}} * L_{\text{canopy}}$$

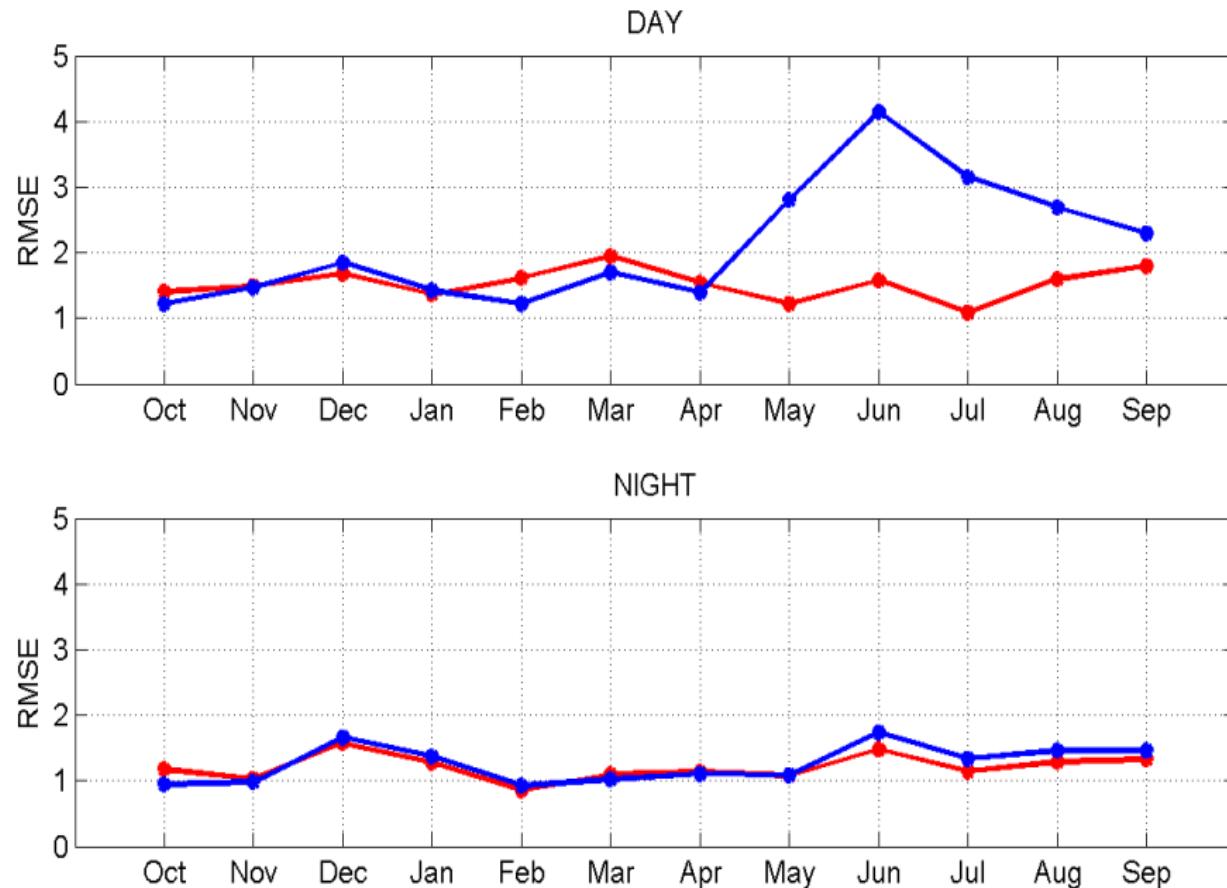
- Correction of downward flux contribution:

$$L_{\text{avg}} = \varepsilon_{\text{eff}} * L_{\text{sfc}} + (1 - \varepsilon_{\text{eff}}) * L_{\text{sky}}$$

→ Planck's law → T_{comp}

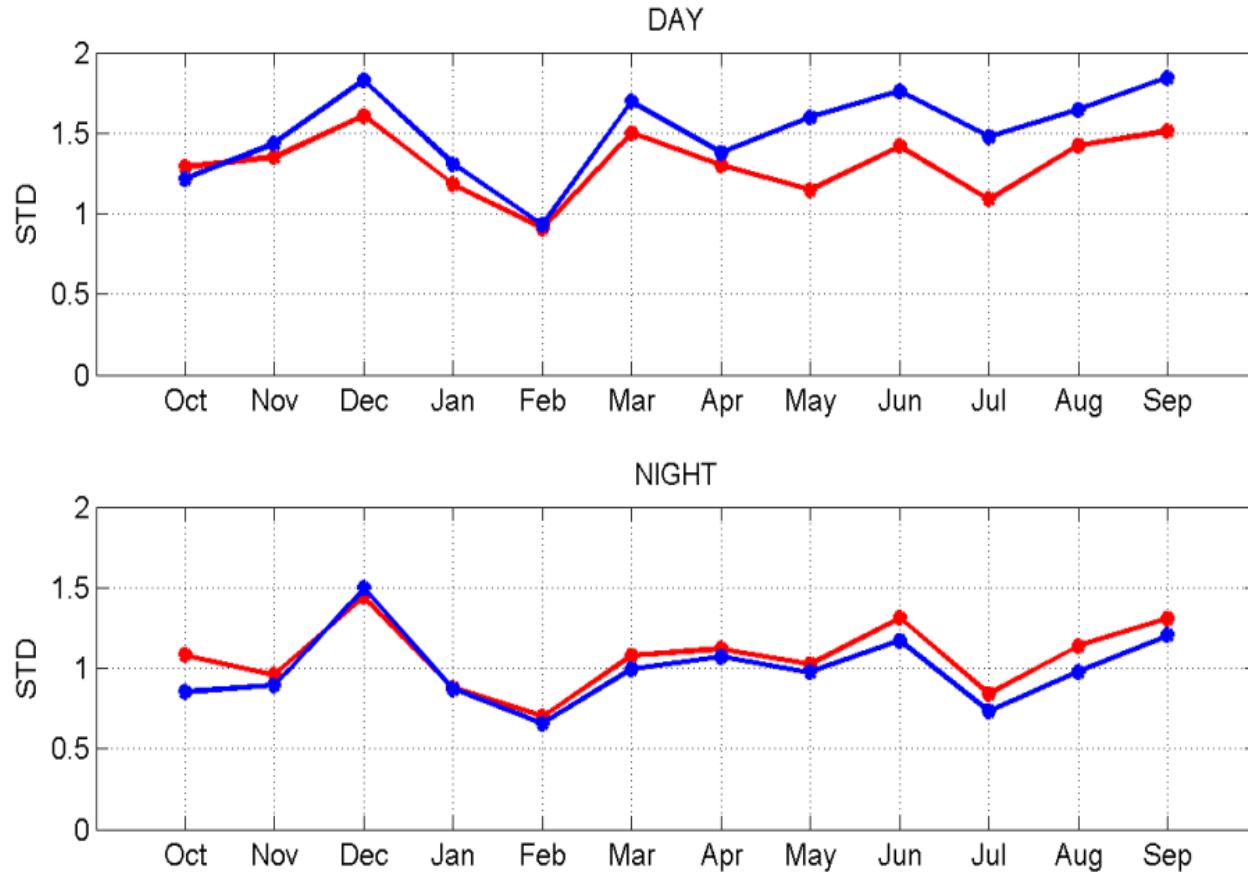
$$\varepsilon_{\text{eff}} = FVC * \varepsilon_{\text{tree}} + (1 - FVC) * \varepsilon_{\text{ground}}$$

Results - comparison against LST



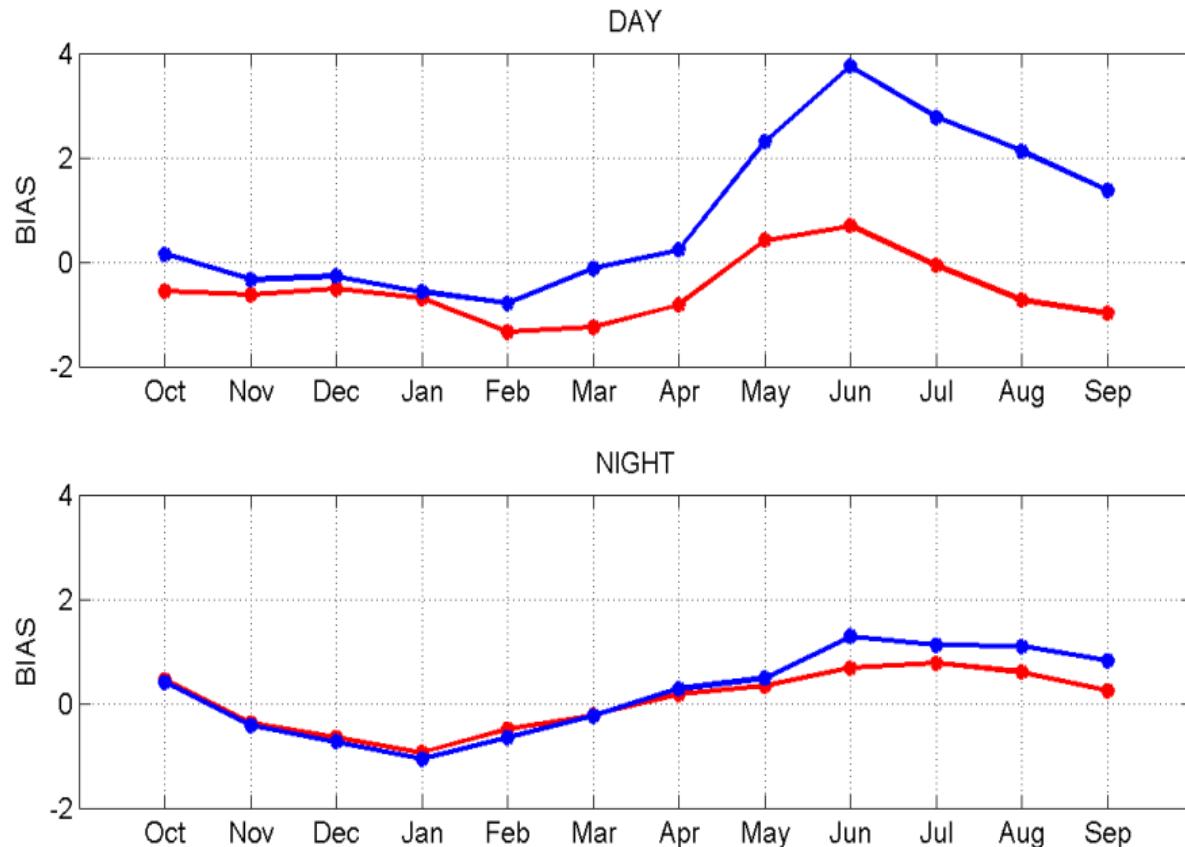
- Without geometrical model
- With geometrical model

Results - comparison against LST



- Without geometrical model
- With geometrical model

Results - comparison against LST

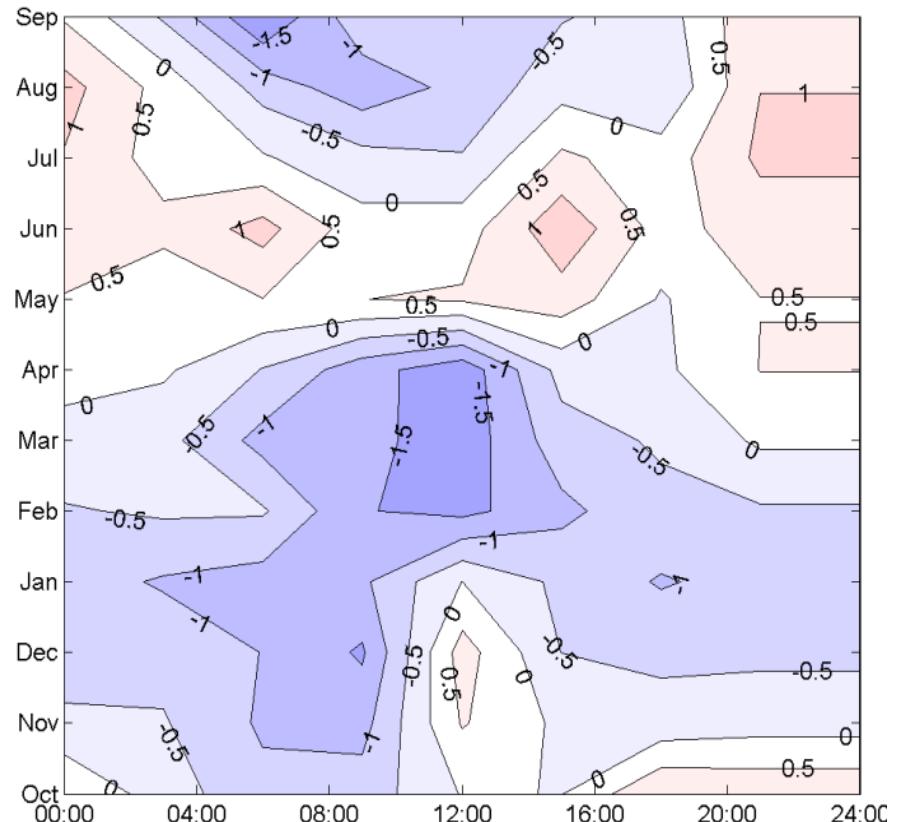


- Without geometrical model
- With geometrical model

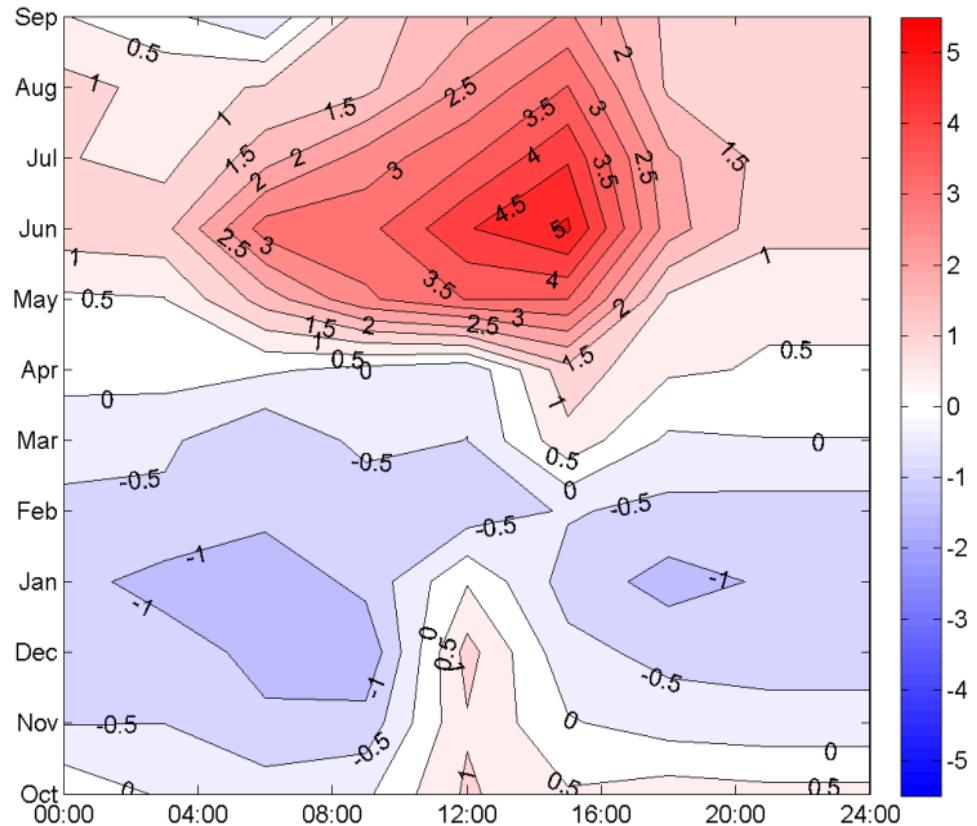
Results - comparison against LST

BIAS

With geometrical model

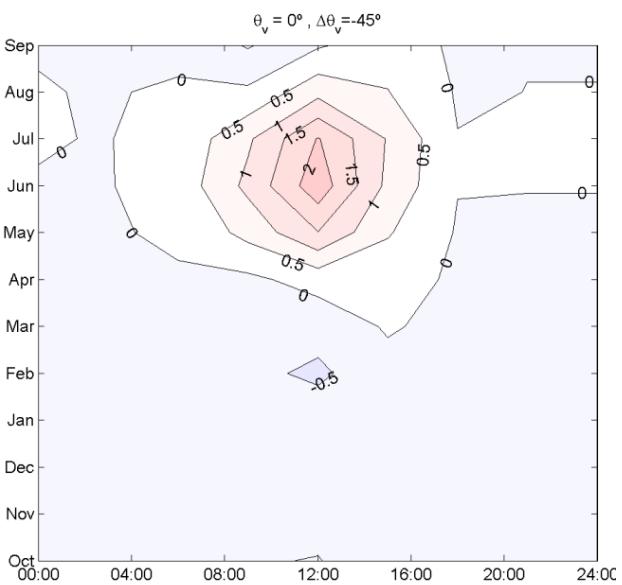
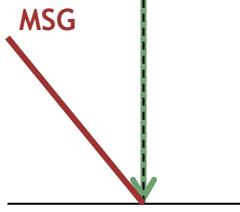


Without geometrical model

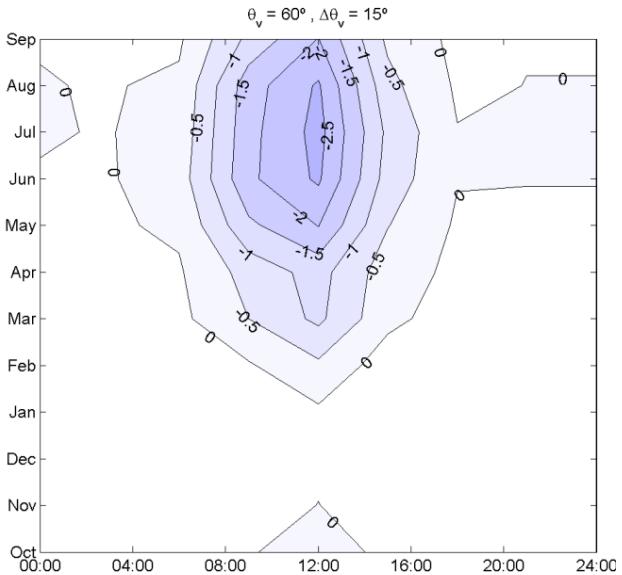
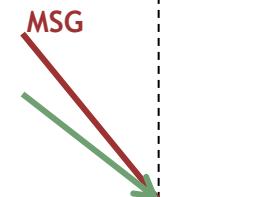


Change in viewing zenith angle

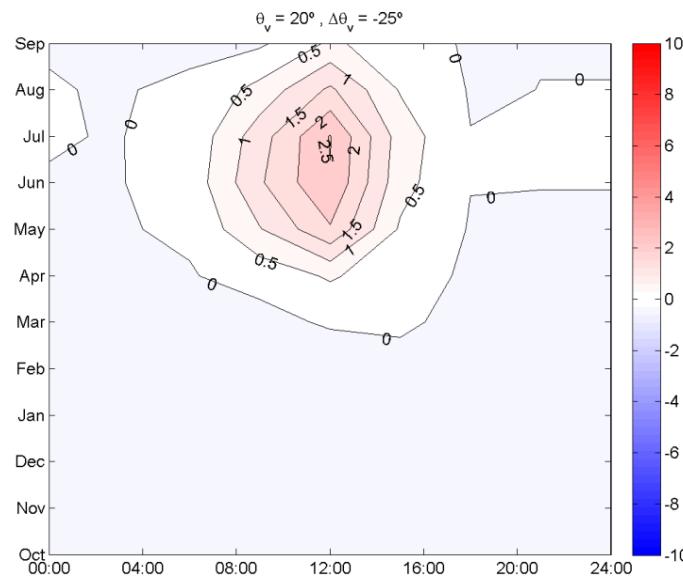
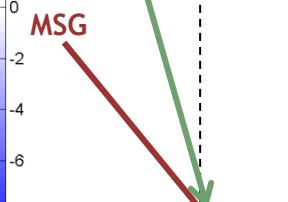
$$\theta_v = 0^\circ \\ \Delta\theta_v = -45^\circ$$



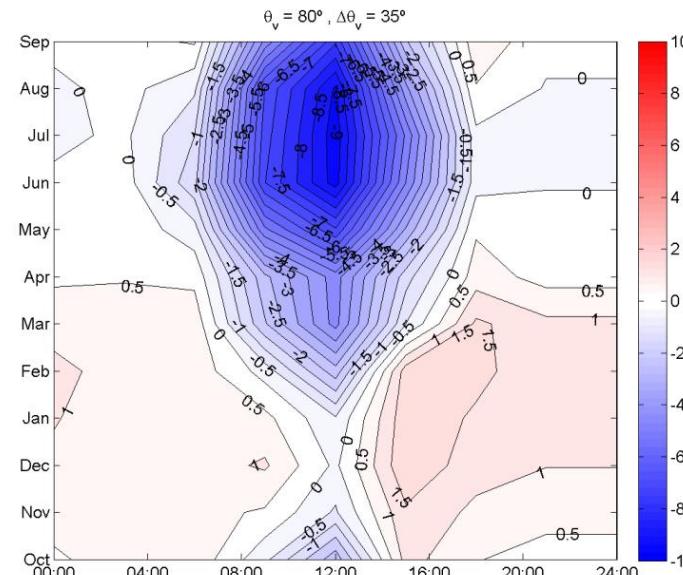
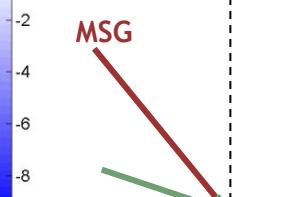
$$\theta_v = 60^\circ \\ \Delta\theta_v = 15^\circ$$



$$\theta_v = 20^\circ \\ \Delta\theta_v = -25^\circ$$

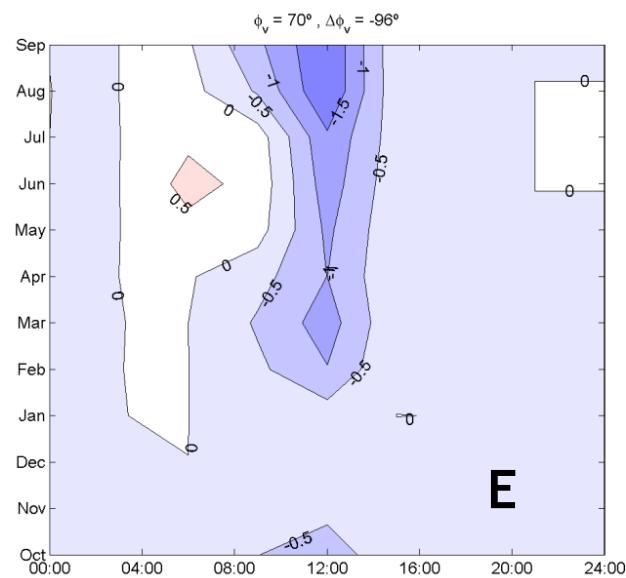


$$\theta_v = 80^\circ \\ \Delta\theta_v = 35^\circ$$

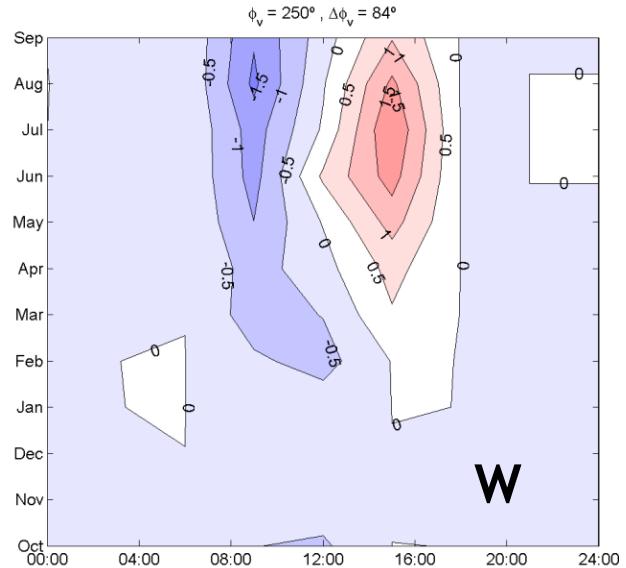


Change in viewing azimuth angle

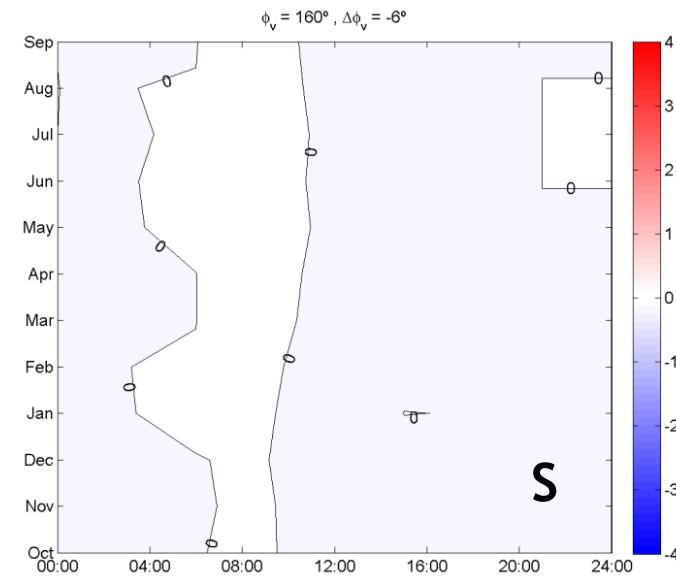
$$\varphi_v = 70^\circ \\ \Delta\varphi_v = -96^\circ$$



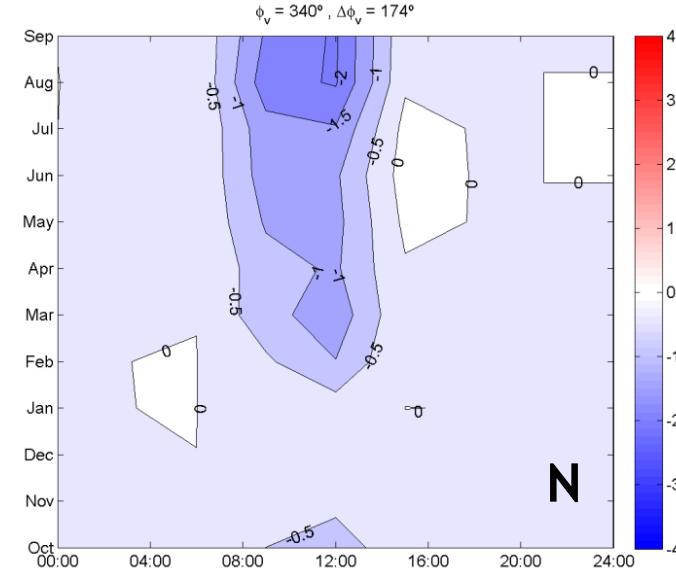
$$\varphi_v = 250^\circ \\ \Delta\varphi_v = 84^\circ$$



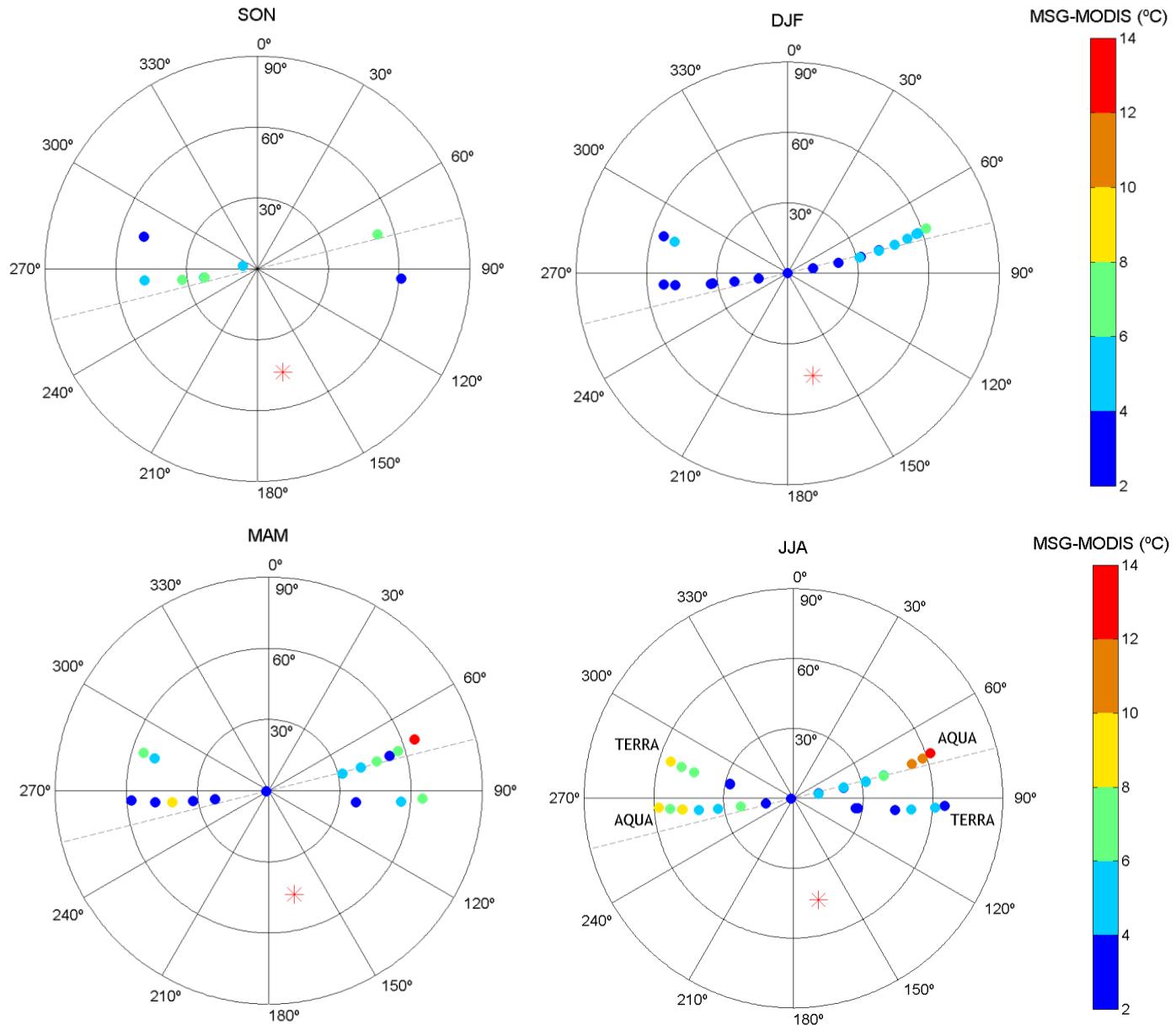
$$\varphi_v = 160^\circ \\ \Delta\varphi_v = -6^\circ$$



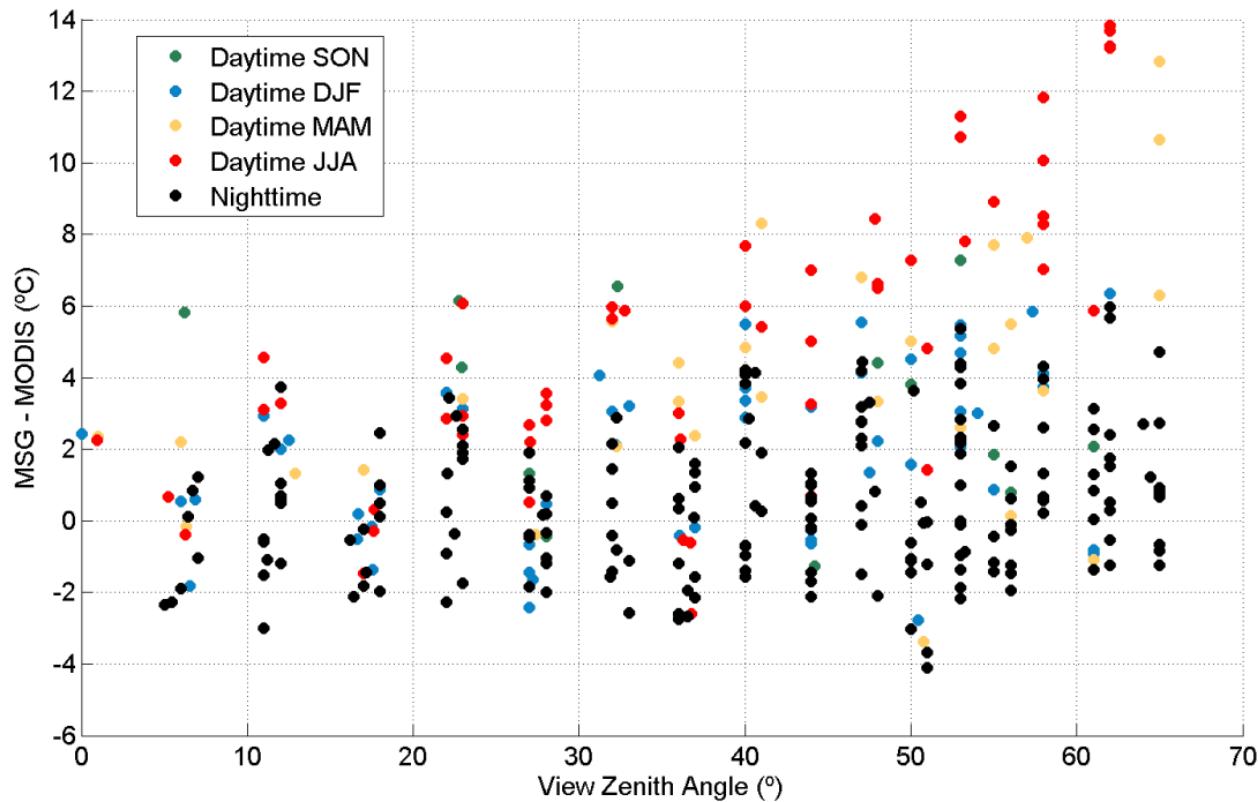
$$\varphi_v = 240^\circ \\ \Delta\varphi_v = 174^\circ$$



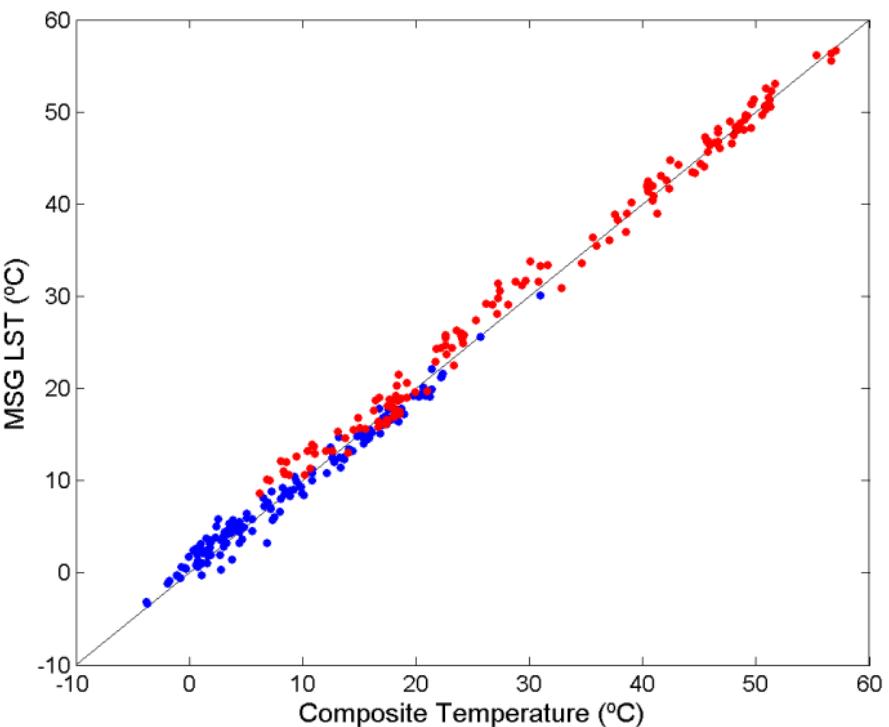
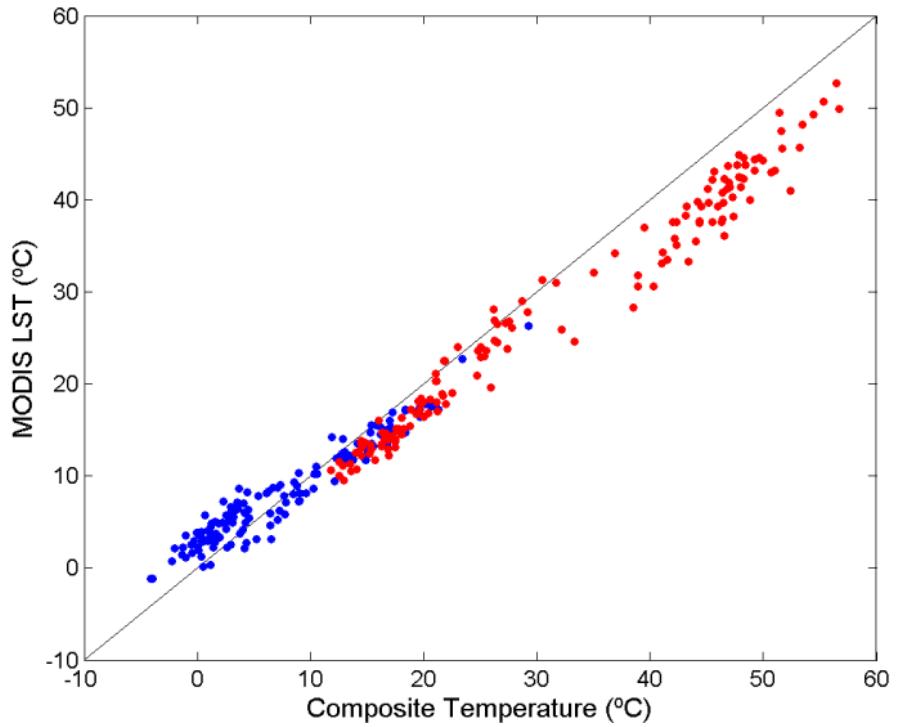
Comparison against MODIS



Comparison against MODIS



Comparison against MODIS

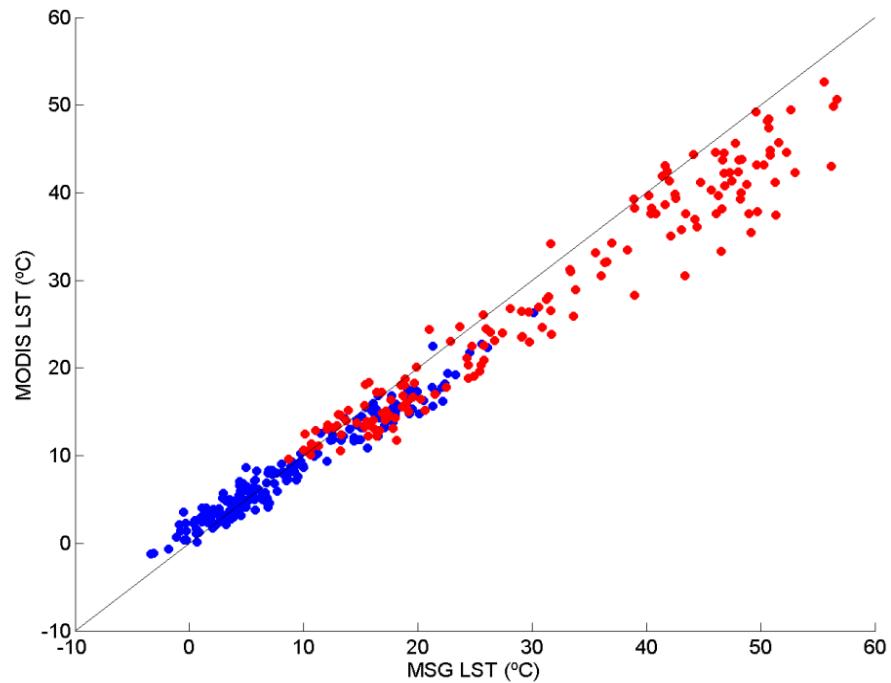


		RMSE	STD	BIAS
MODIS	Daytime	4.70	2.69	-3.86
	Night-time	2.33	2.29	0.47
MSG	Daytime	1.64	1.40	0.86
	Night-time	1.20	1.20	0.03

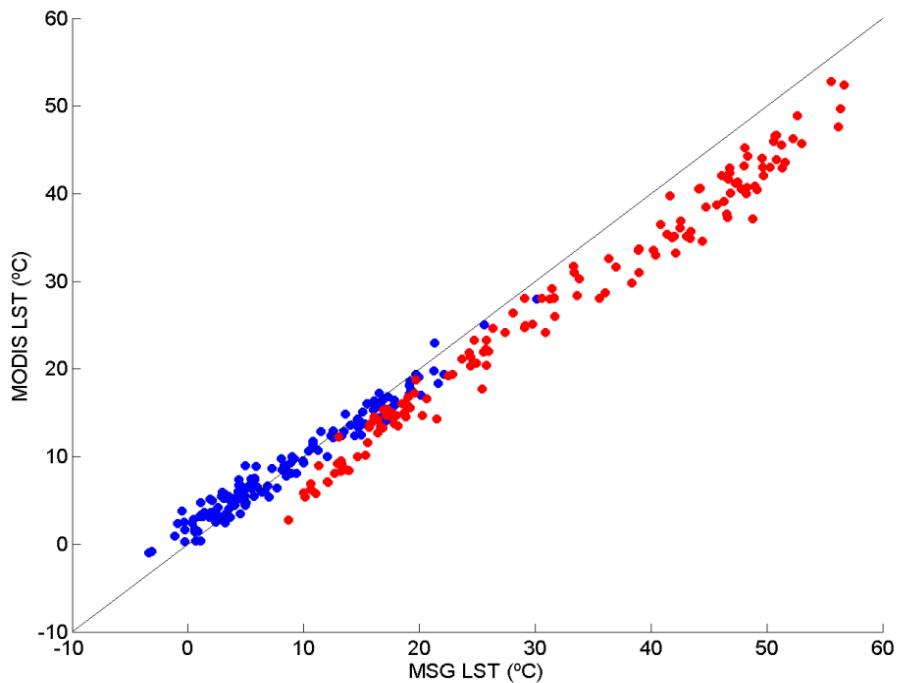
Comparison against MODIS

Correcting angular effects...

BEFORE



AFTER





THANK YOU!

Validating LST and inter comparing
observations from polar orbit and
geostationary satellites by means of a model
of illumination and viewing geometries

Sofia L. Ermida⁽¹⁾, Isabel F. Trigo^(1,2), Carlos C. DaCamara⁽¹⁾, Frank Götsche⁽³⁾, Folke Olesen⁽³⁾

⁽¹⁾Instituto Dom Luiz, Universidade de Lisboa, Lisboa, Portugal

⁽²⁾Instituto Português do Mar e da Atmosfera, Lisboa, Portugal

⁽³⁾Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany