Use of Land Surface Temperature to assess the realism of Global high resolution models

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Motivation

Land surface temperature (LST) temporal and spatial variability carries a blueprint of the surface energy budget. The temporal variability of LST is mostly dominated by the diurnal cycle of available energy, modulated by cloud presence, and synoptic variability. Averaged over a few weeks, LST filters the cloud and synoptic variability, remaining the diurnal cycle. On these time scales, the daily maximum of LST spatial variability will be mostly dominated by the land surface conditions (e.g. elevation, land cover, vegetation state, soil moisture state, etc.). Therefore, the LST spatial variability of the daily maximum should reflect the different sources of land surface variability, making it an optimal candidate for evaluating the realism of storm-resolving models in representing such surface heterogeneities.

Methods

In this study we use a newly reprocessed **GEO-Ring Land Surface Temperature (LST)** dataset, spanning the period from 2018-2013, hourly and with 5 km spatial resolution. This product (**SAT**) is employed to investigate the **realism of the NextGEMS storm-resolving** models from a land surface perspective. NextGEMS cycle 3: 5 years simulations IFS-FESOM 4.4 km (**ifs4**), IFS-NEMO 9 km (**ifs9**) and ICON 5 km (**icon**).

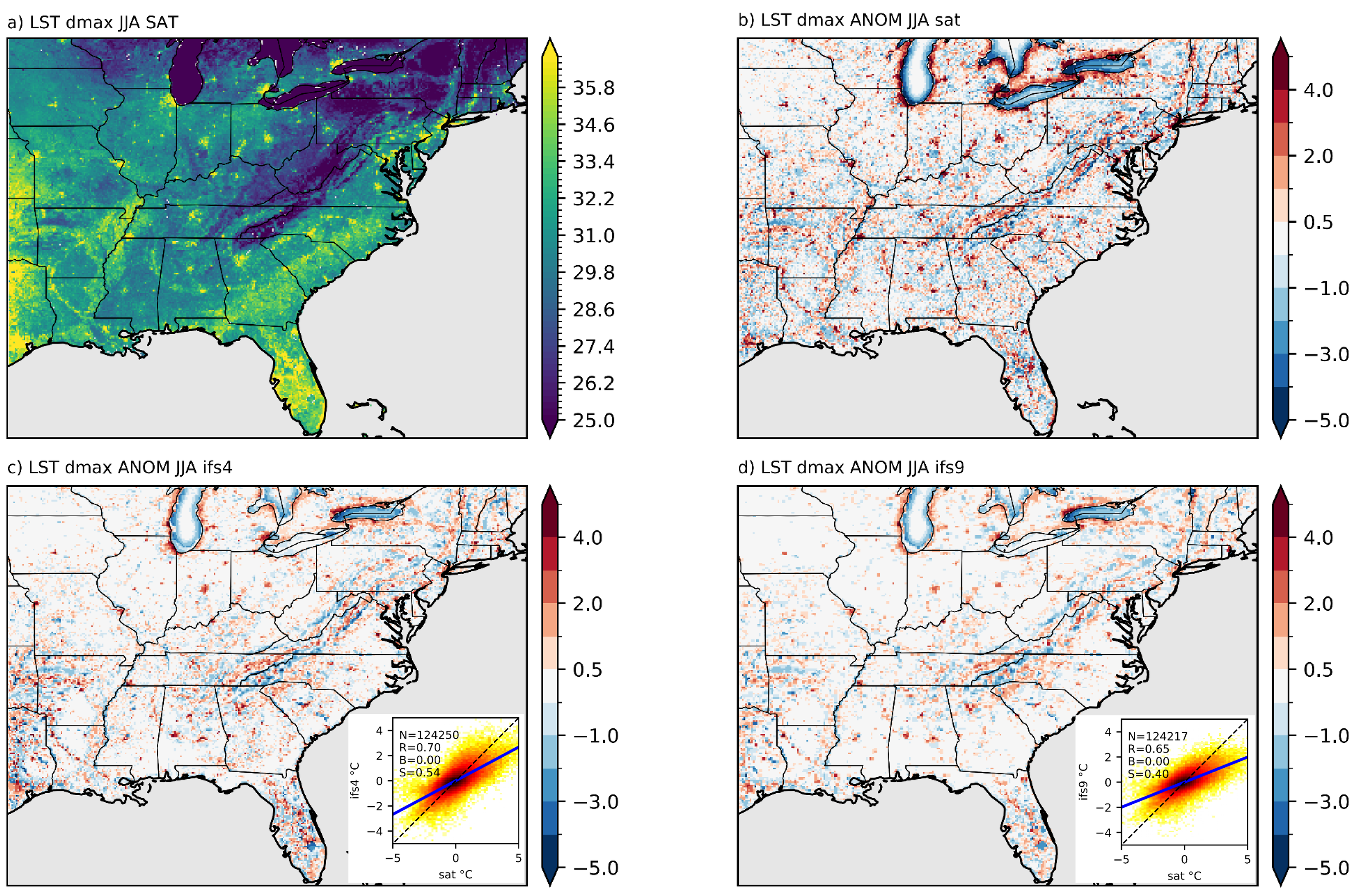

Fig. 1. LST daily max JJA over North US. Top SAT field (left) and spatial anomaly (right), bottom ifs4 (left) and ifs9 (right). Spatial anomalies in respect to a gaussian filter with a 25 km radius.

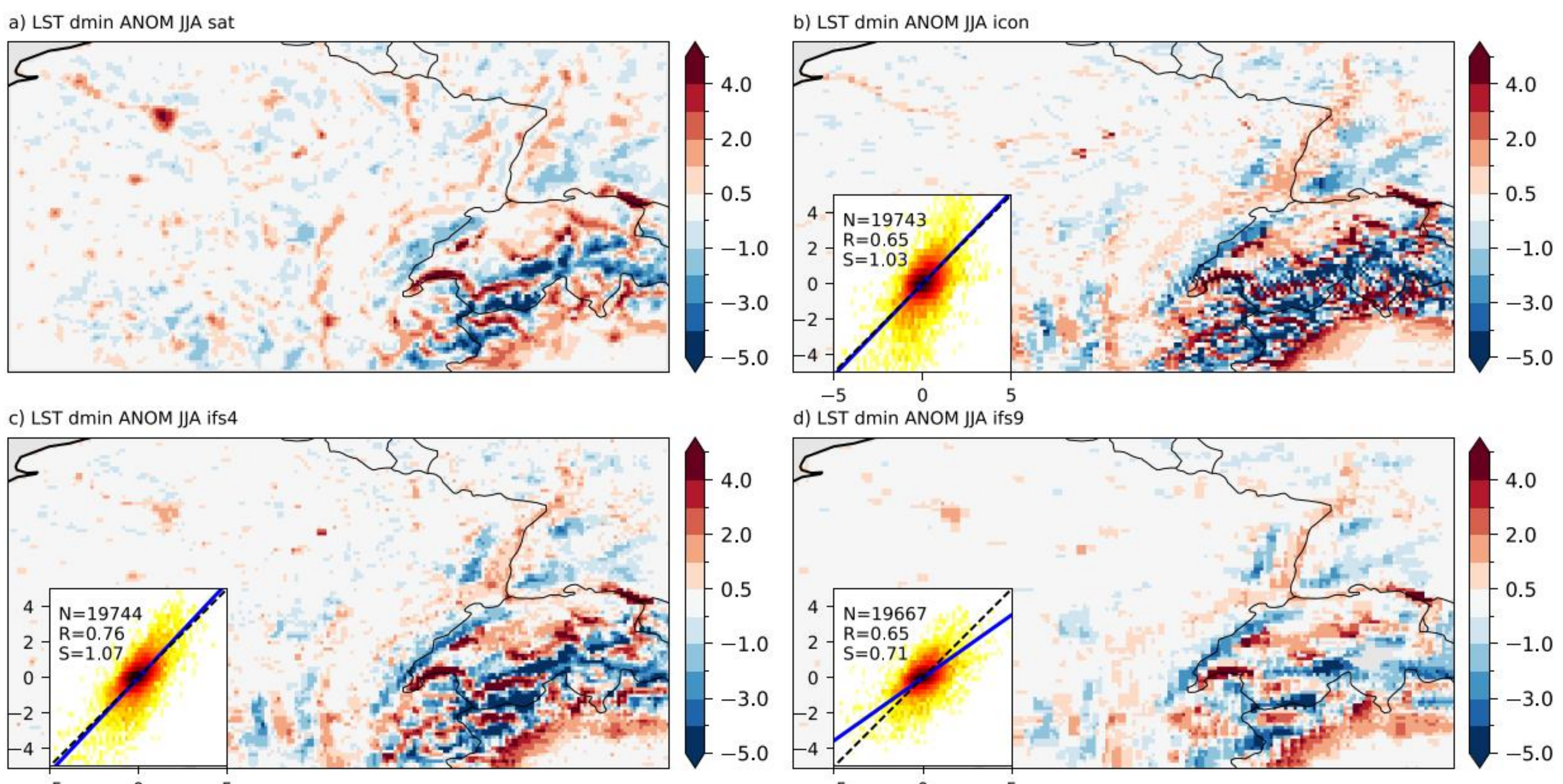

Fig. 2. LST daily min JJA spatial anomalies of SAT (a), icon (b), ifs4 (c) and ifs9 (d)

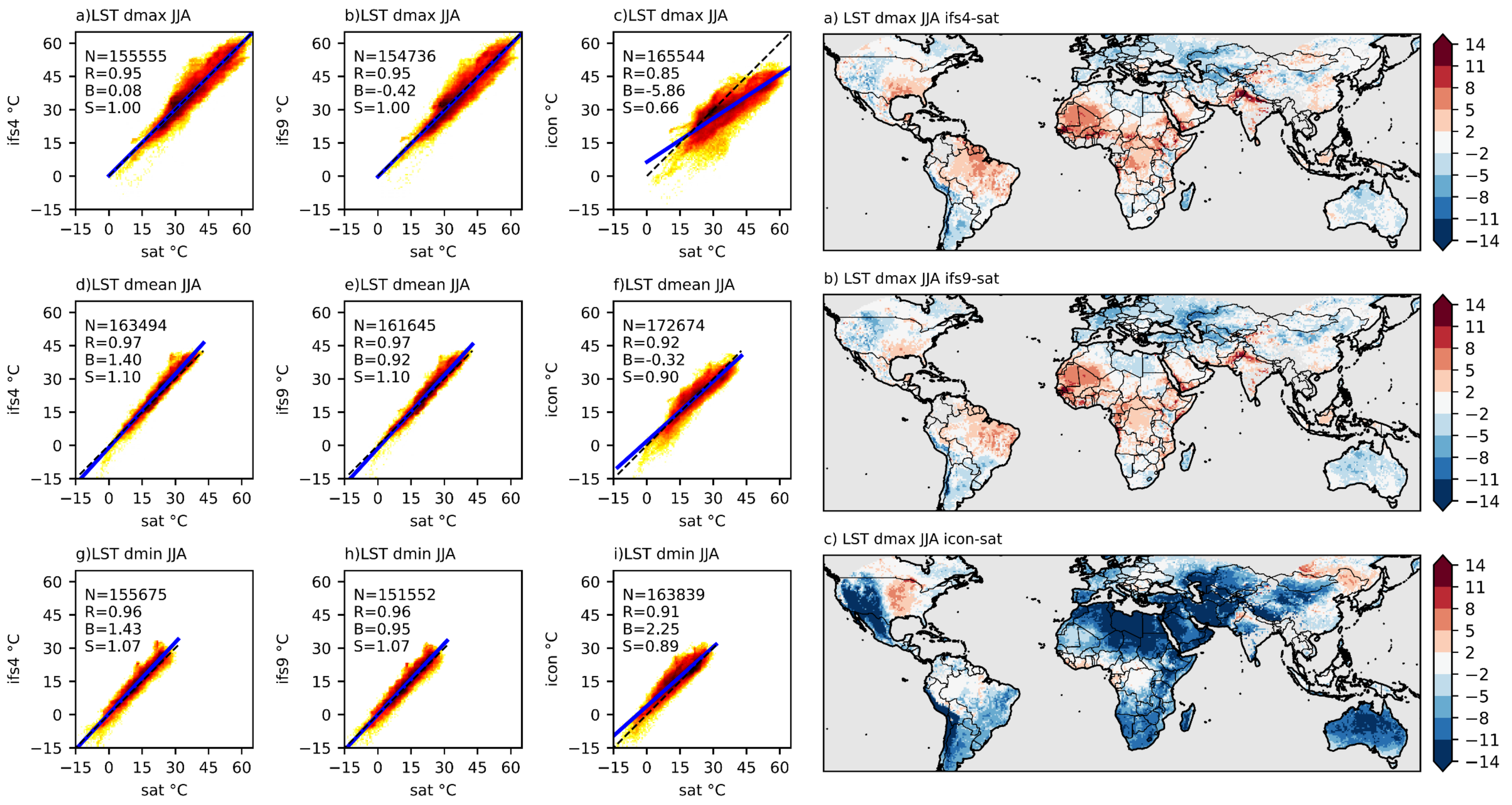

Fig. 3. Global comparison of LST SAT vs model simulations in JJA. Maps for LST daily max.

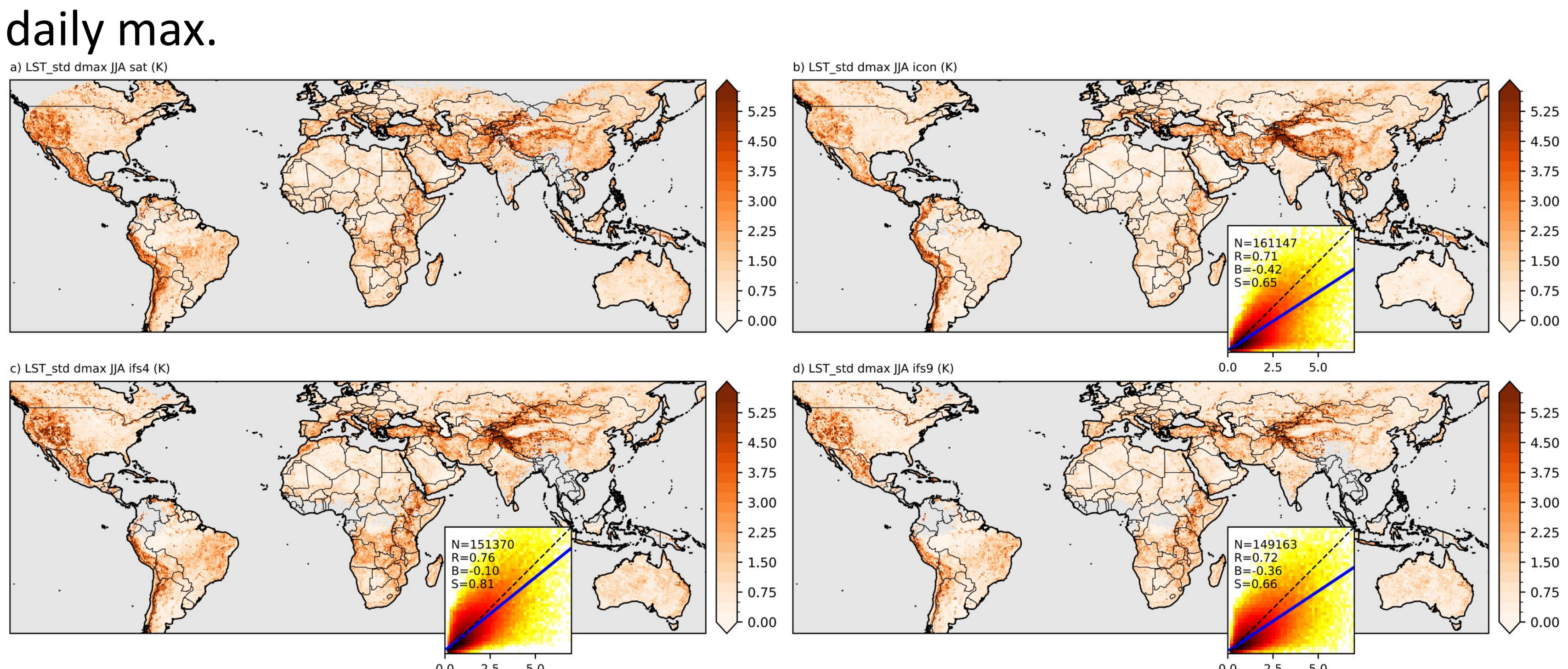

Fig. 4. LST daily max JJA sub-grid scale variability (a) SAT, (b) icon, (c) ifs4, (d) ifs9).

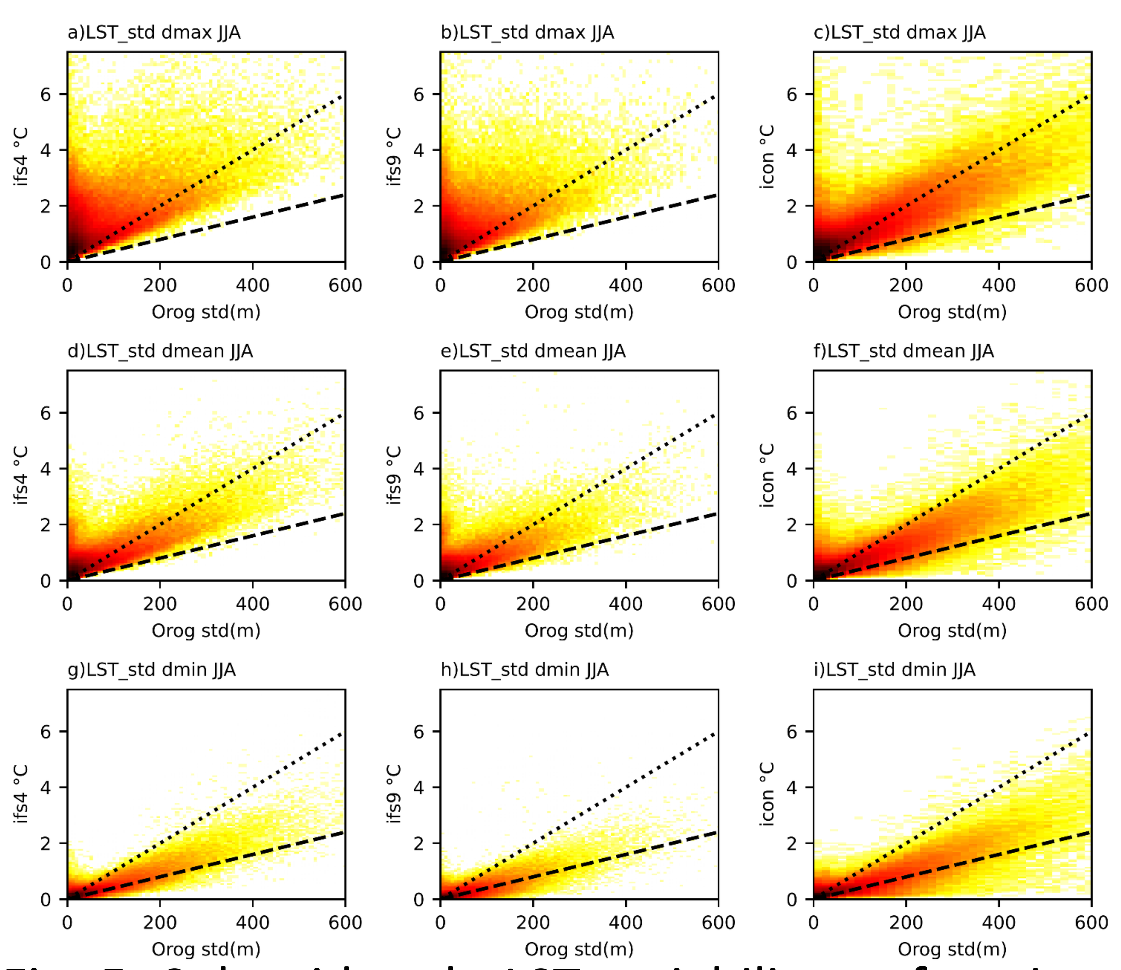

Fig. 5. Sub-grid scale LST variability as function of orography variability. Dotted line dry adiabatic lapse rate.

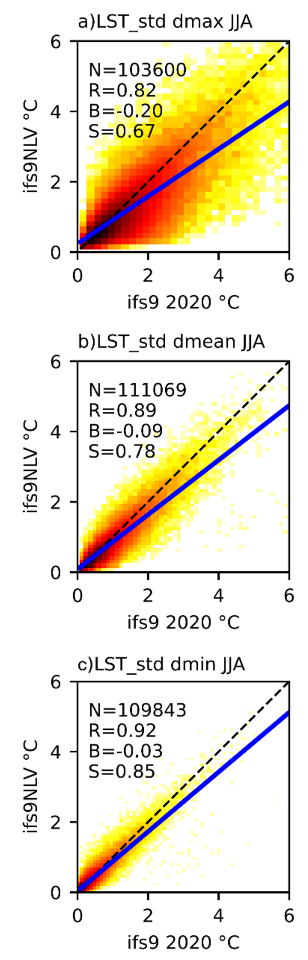

Fig. 6. Sub-grid scale LST variability in ifs9 versus ifs9 with **No Land Variability**.

Final Remarks

- Assessing the **realism** of high resolution global models is essential and satellite **LST is a unique product.**
- **nextGEMS** models show a good agreement with the **LST** in terms of **sub-grid spatial variability**, but **large biases** remain.
- Orography is the main driver of LST sub-grid variability.
- Idealized ifs9 experiment with coarse land/veg. cover: **Land cover and vegetation spatial variability** explain part of the LST daily maximum sub-grid variability.
- **LST products and models are not perfect: important to bring these communities together.**

References:

Rackow et al (2024) https://doi.org/10.5194/gmd-18-33-2025

Segura et al. (in review) https://doi.org/10.5194/egusphere-2025-509

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