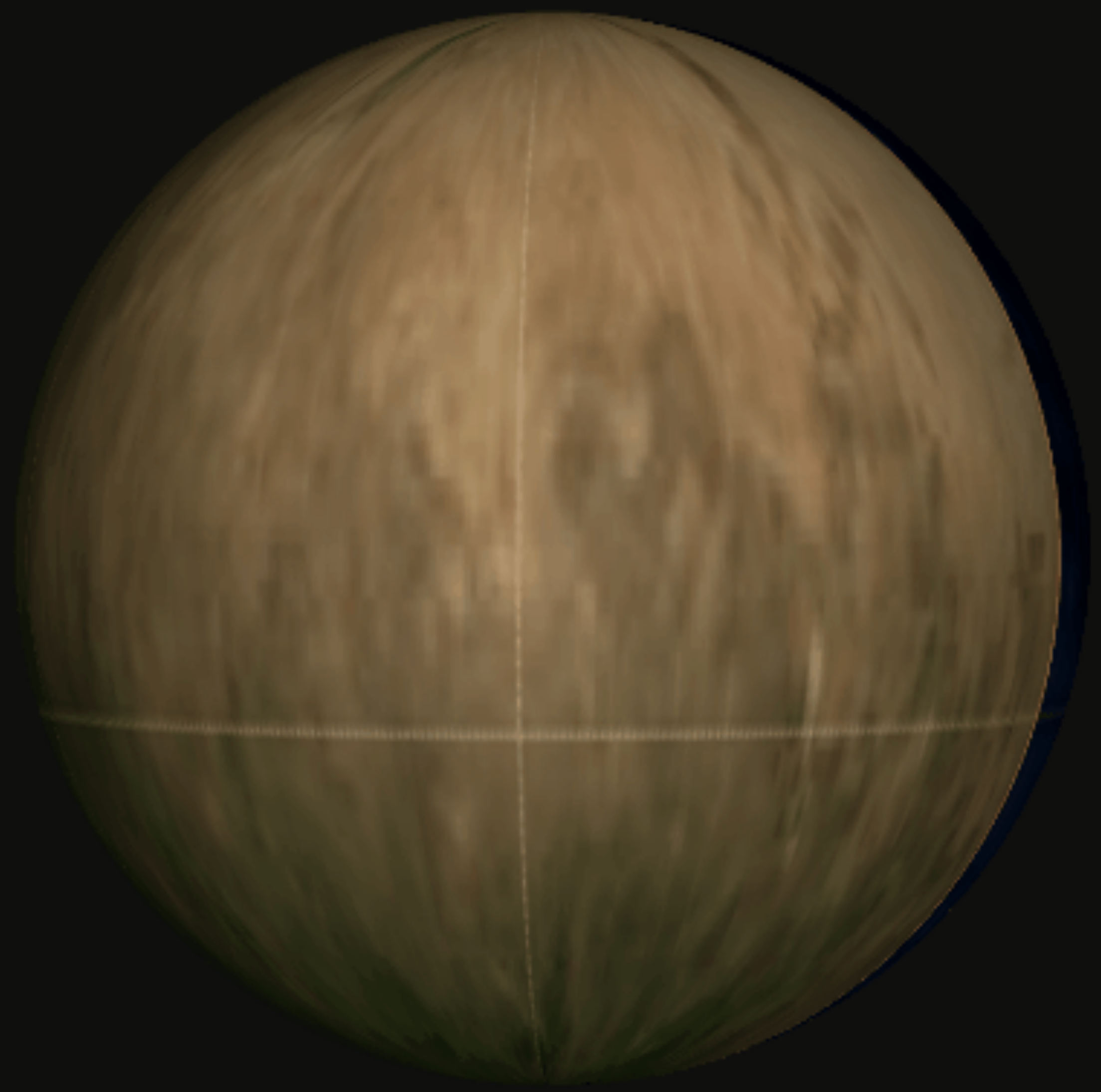


LAND-OCEAN TRANSITIONS IN THE TROPICS: WHAT MAKES MCSs PERSIST?

IRENE LIVIA KRUSE & JAN O. HAERTER @

EGU General Assembly 2022

MESOSCALE CONVECTIVE SYSTEMS (MCSs) IN THE TROPICS

From above

Satellite view of cumulonimbus cloud over Africa. Source: NASA

From below

MCSs:

- Clusters of thunderstorms spanning more than **100 km** horizontally, persisting often for multiple hours.
- The **dominant source of rainfall in the tropics**
- The longest-lived are largely responsible for tropical **extreme precipitation**[1].

1. Rémy Roca and Thomas Fiolleau. 2020. Extreme precipitation in the tropics is closely associated with long-lived convective systems. Communications Earth Environment 1 (1): 1–6.

MESOSCALE CONVECTIVE SYSTEMS (MCSs) IN THE TROPICS

- The most extreme storms tend to be located over land.
- The **most intense storms over oceans tend to be adjacent to land**, where motion is favored from land to ocean[2].
- **Hurricanes** in the Western Atlantic **can often be traced back to MCSs** originating off the African coast.

From 'A Year of Weather - 2019' https://youtu.be/8w3o6_cn-O8

2. E. J. Zipser, Daniel J. Cecil, Chuntao Liu, Stephen W. Nesbitt, and David P. Yorty. 2006. WHERE ARE THE MOST INTENSE THUNDERSTORMS ON EARTH? Bulletin of the American Meteorological Society 87, (8): 1057–1072.

THE DATASETS WE USE TO OBSERVE MCSs

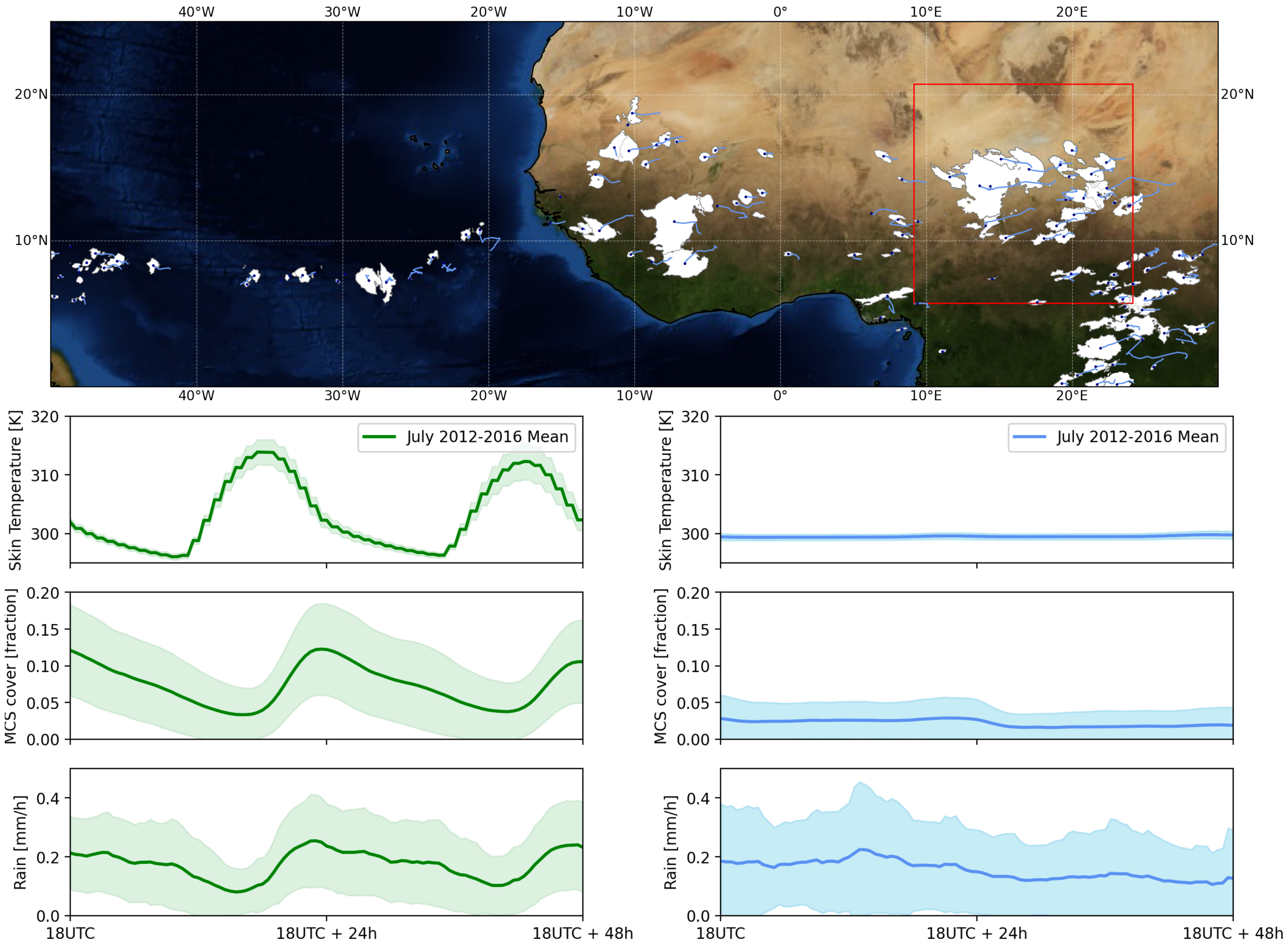
- **TOOCAN**[3]: Database of **5 years of tracked MCSs from geostationary infrared satellite** observations. We use this to obtain statistics about MCSs, and to guide the study of environmental variables around the MCSs.
- **ERA5**: Reanalysis data used to extract domain-averaged values of meteorological variables (e.g. surface temperature, wind profiles), to understand better the environment that the MCSs are embedded within.
- **IMERG**: Precipitation-estimate data mainly from microwave satellite observations, to retrieve domain-averaged precipitation.

- Location of study:
  Tropical Africa and the adjacent **Atlantic Ocean**.

- Period of study:
  2012-2016. based on the availability of data.
  July-September. Maximum convective activity in the region and hurricane season.

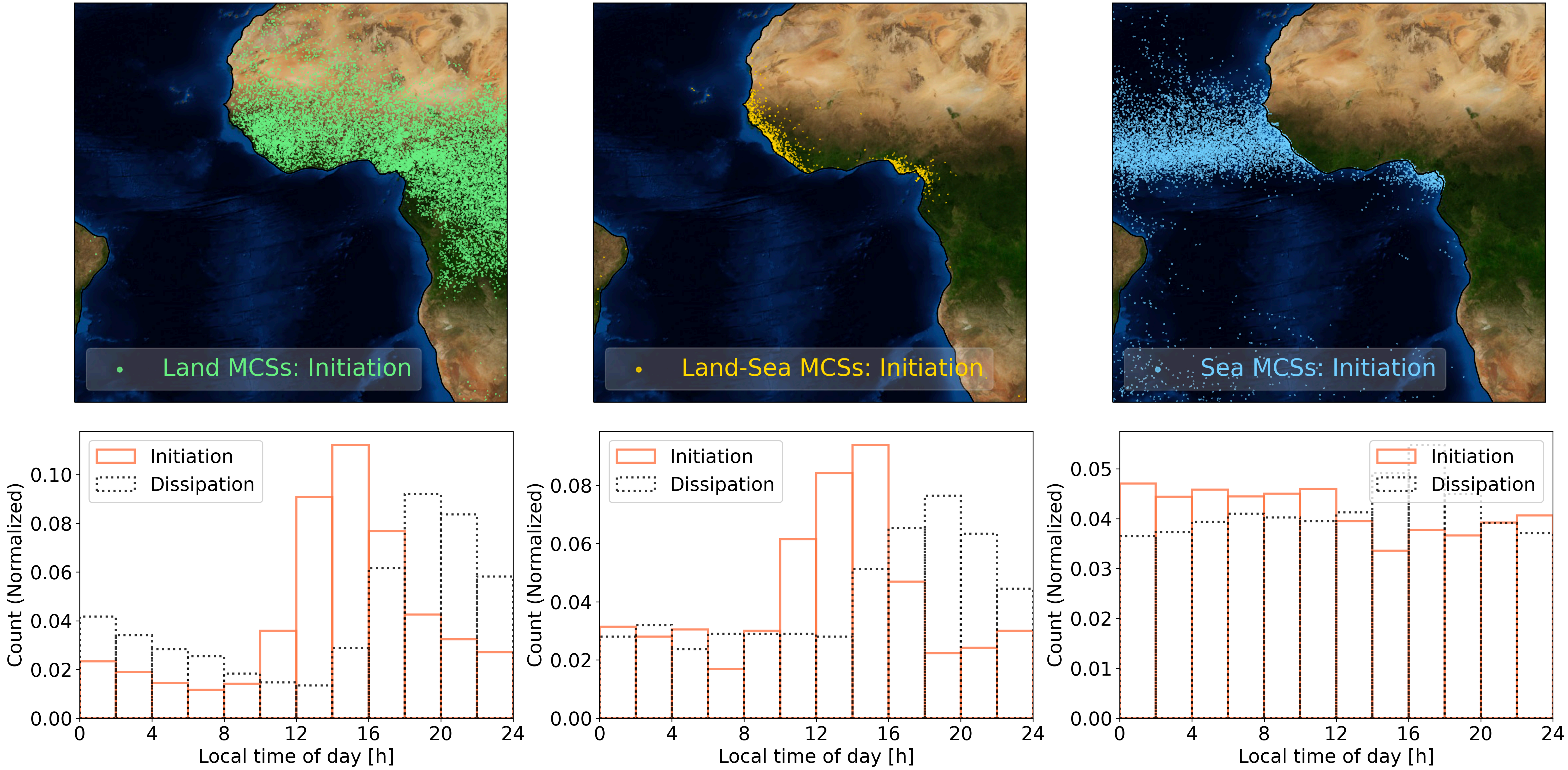
3. Thomas Fiolleau and Rémy Roca. 2013. An Algorithm for the Detection and Tracking of Tropical Mesoscale Convective Systems Using Infrared Images From Geostationary Satellite, IEEE Trans. Geosci. Remote Sens. 51 (7): 4302–4315.

ENVIRONMENTAL PROPERTIES OVER LAND AND SEA



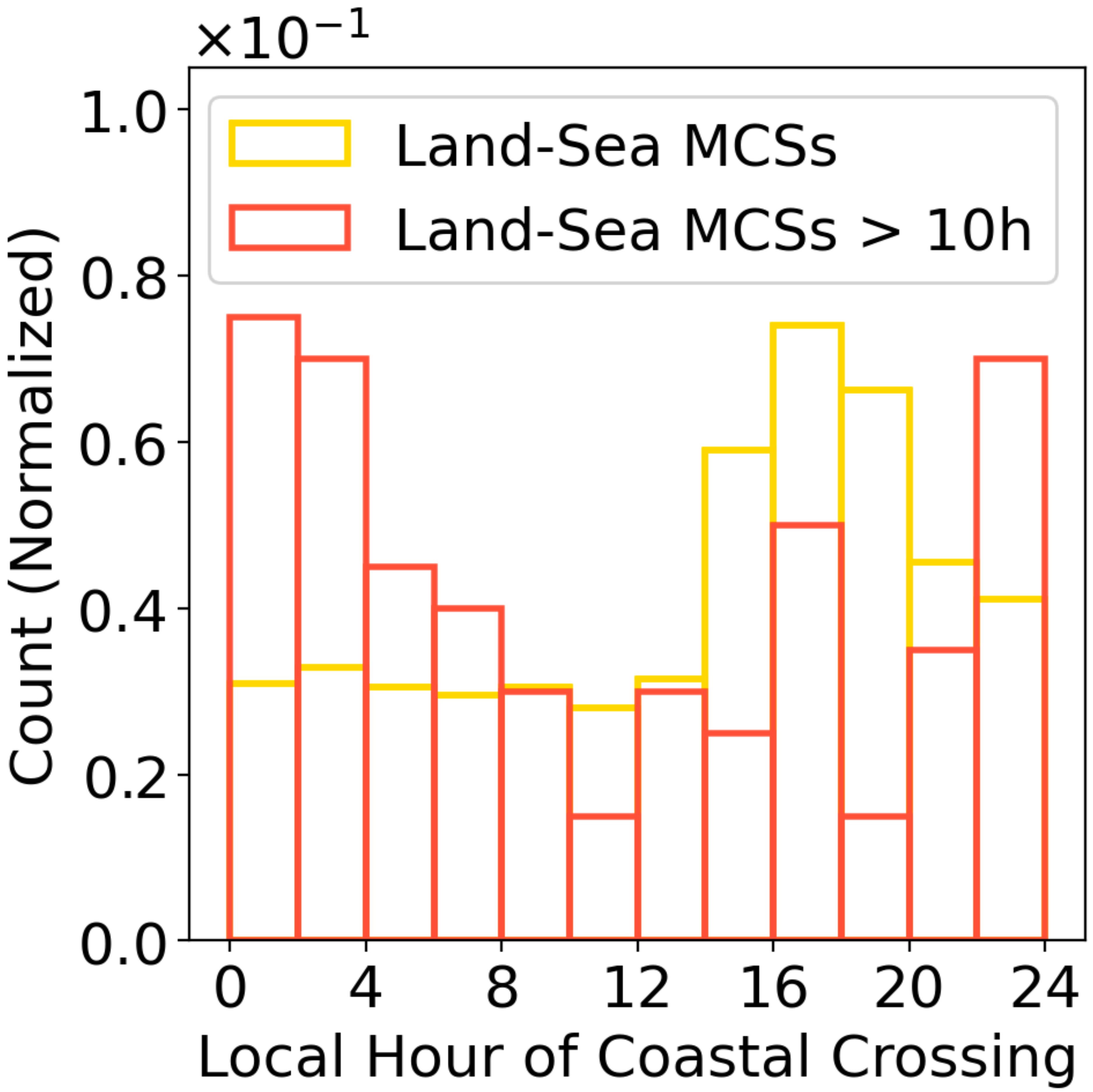
Domain averaged skin temperature (from ERA5 reanalysis), MCS cover (from TOOCAN), and rain (from IMERG), calculated within a 15deg x 15deg Lagrangian frame that follows tracked MCSs across tropical African land and onto the adjacent Atlantic Ocean, in July 2012-2016.

MCS STATISTICS OVER LAND AND SEA



Lifecycle of MCSs: Initiation and Dissipation times for Land MCSs, Land-Sea MCSs and Sea MCSs.
MCSs shown here from the period Jul-Sep 2016.

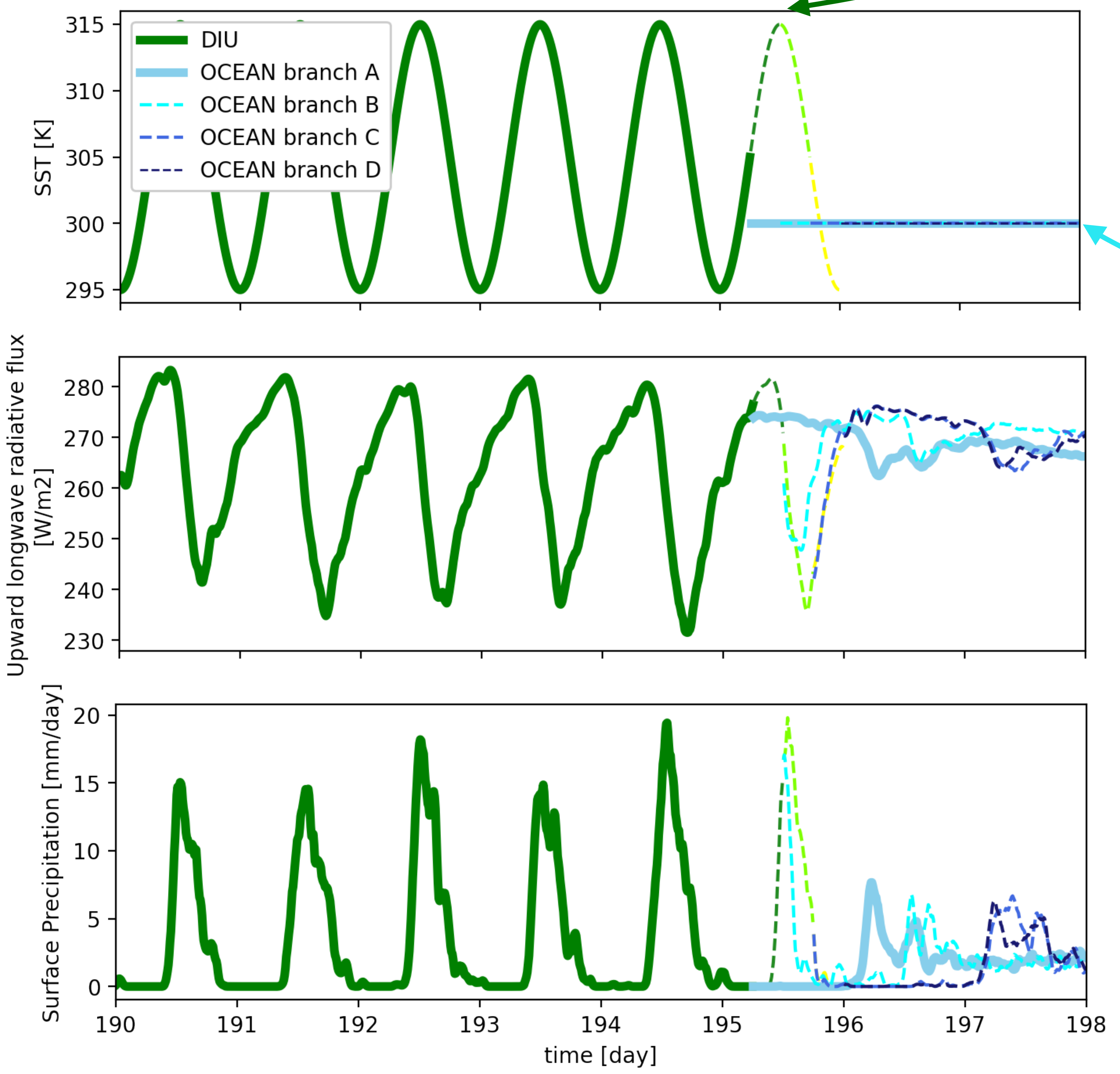
COULD LONGER-LIVED LAND-SEA MCSs BE CROSSING AT NIGHT?



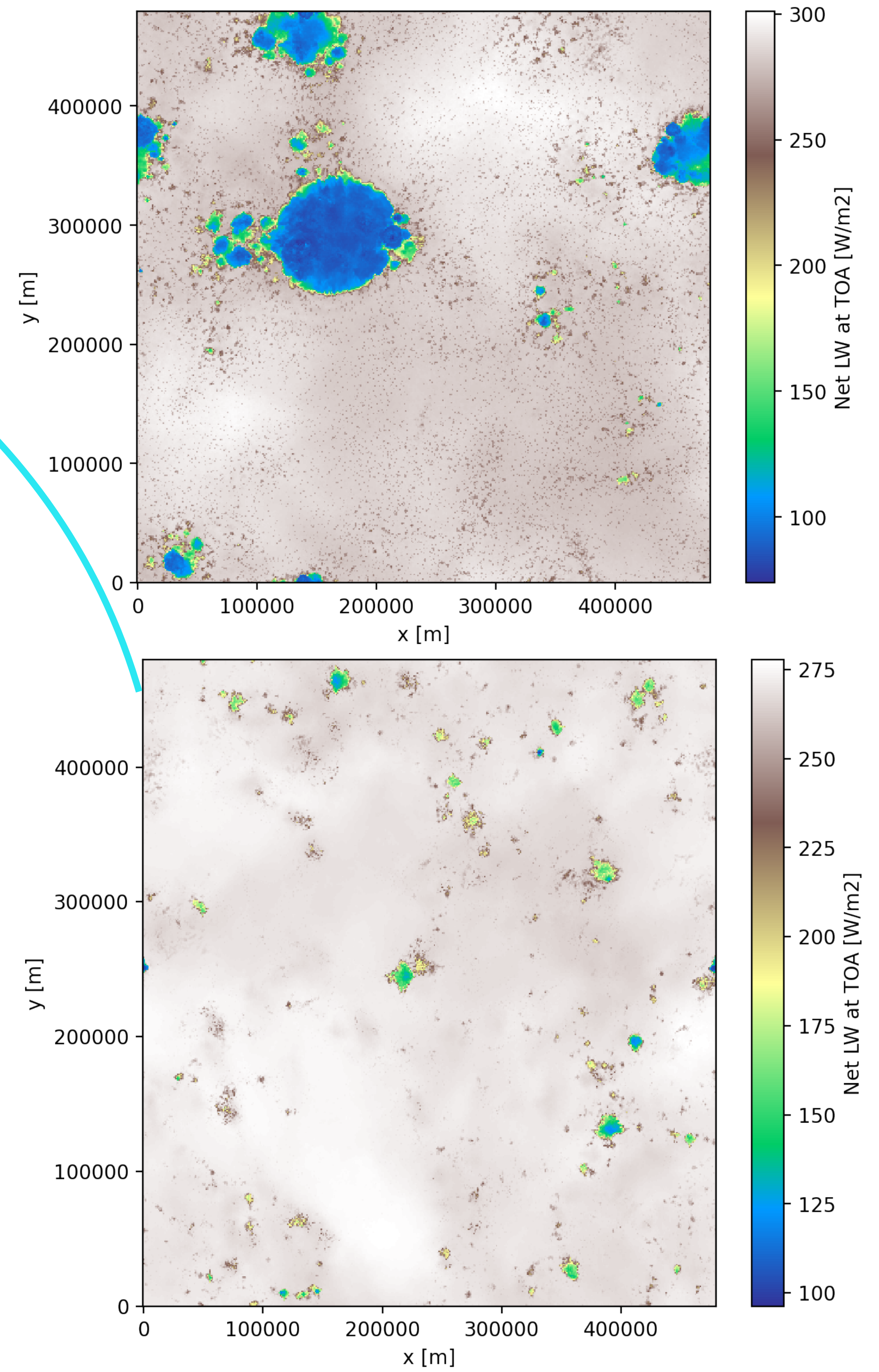
Coastal Crossing times for the 90th percentile longest-lived (after-crossing) Land-Sea MCSs compared to all Land-Sea MCSs, from July-Sep 2016.

SIMULATING THE LAND-SEA TRANSITION WITH SAM[4]

TO INVESTIGATE THE EFFECT OF THE TIME-OF-CROSSING



Output from preliminary runs of Land-Sea simulation, with main simulation over a simplified land surface with an imposed diurnally oscillating surface temperature, and 4 branches onto a constant SST sea surface at different times of day (6am, noon, 6pm, midnight).



Snapshot of simulation output: outgoing long wave radiation from TOA (Top of Atmosphere) at noon, before a branching onto sea occurs, and after 2.5 days over sea.

Time step	10s
Horizontal res	1km
Domain size	480km x 480km
Vertical res	64 levels
Boundary	Double periodic
Incoming rad	Constant (July 1 at 10N)

STAY TUNED!

4. Khairoutdinov, Marat F., and David A. Randall. 2003. “Cloud Resolving Modeling of the ARM Summer 1997 IOP: Model Formulation, Results, Uncertainties, and Sensitivities.” *Journal of the Atmospheric Sciences* 60 (4): 607–25.

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IN FOUR POINTS:

1. We focus on MCSs transitioning from land to sea.

2. Over land they feel the diurnal cycle, over sea they do not.

3. The MCSs crossing the coast at night might be longer lived over sea.

4. We are simulating the land-sea transition in a CRM with a diurnally oscillating SST, going to constant SST at different times of day.

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