Identifying and Characterizing Tropical Oceanic Mesoscale Convective Cold Pools

Piyush Garg[1], Stephen W. Nesbitt[1], Timothy J. Lang[2], George Priftis[3]

[1]University of Illinois Urbana-Champaign, IL

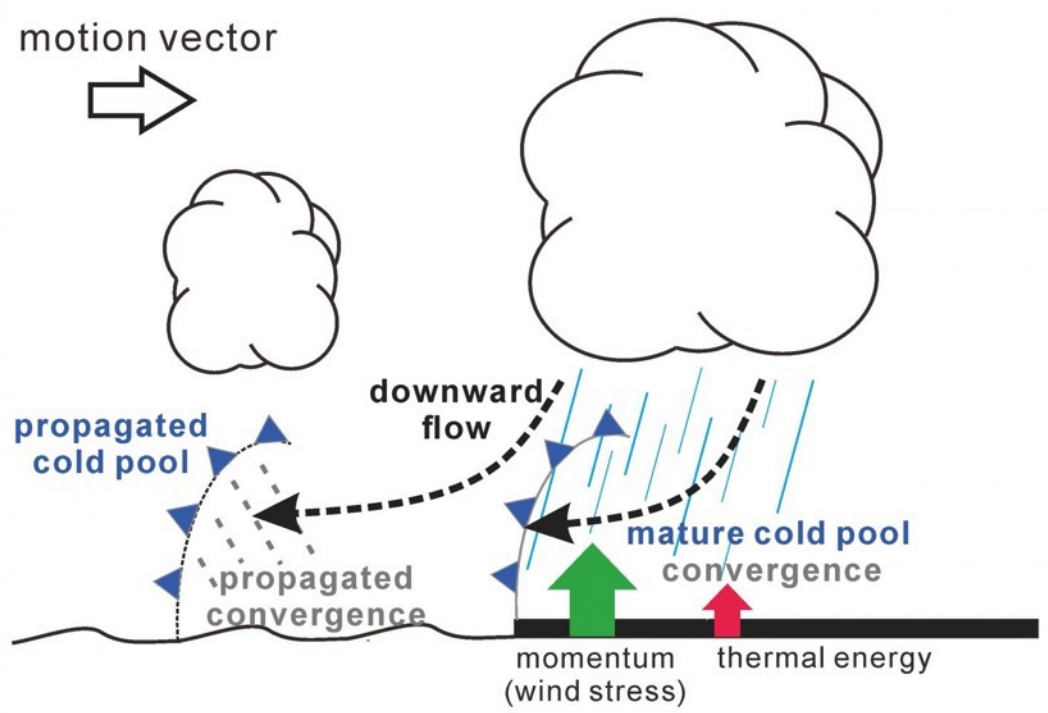
[2]NASA Marshall Space Flight Center, AL

[3]University of Alabama-Huntsville, AL

May 10th 2021 | 34th AMS Conference on Hurricanes and Tropical Meteorology pgarg7@illinois.edu

Introduction

- Cold pools are evaporatively cooled air within falling precipitation that flows outward from the base of thunderstorms (Thorpe et al., 1982).
- Cold pools alter the fluxes of heat from the ocean surface to the atmosphere (Feng et al., 2015).
- Secondary convective initiation is possible at the cold pool boundaries (Emanuel et al., 1994).
- Although cold pools are frequent over tropical oceans, they are relatively unobserved phenomenon (Feng et al., 2015).
- Accurate representation of cold pools plays a major role in correcting erroneous diurnal cycle of convection in the models (Schlemmer and Hohenegger, 2014).

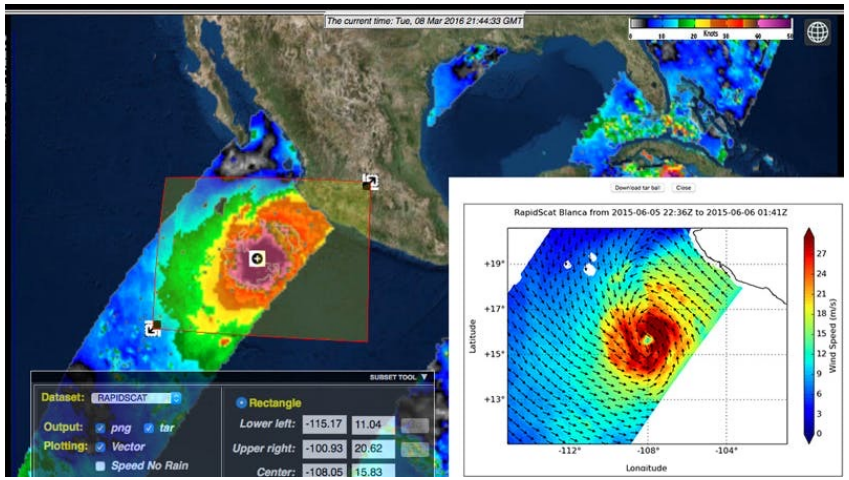


Courtesy: Lee et al. (2019)

RapidScat and ASCAT Satellite

- ASCAT (C-band 5.2 GHZ) being in a sun-synchronous orbit does not provide a diurnal range
- RapidScat was a Ku band (13.4 GHz) scatterometer onboard International Space Station (ISS) from 2014-2016
- Non-sun-synchronous orbit and hence diurnal range of observations
- 12.5 km FOV
- Observation Swath of 900 km





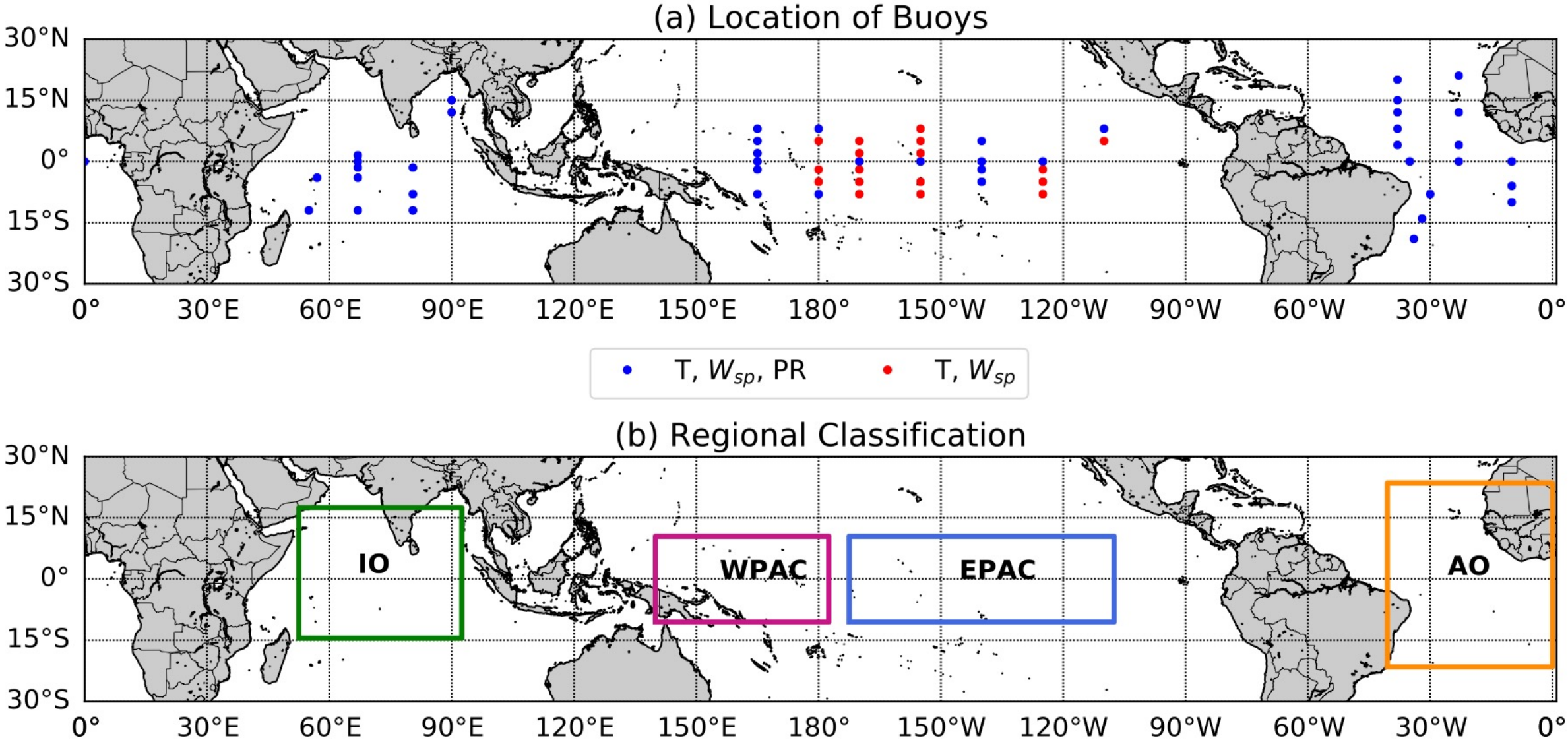
Datasets

Cold Pool Observations

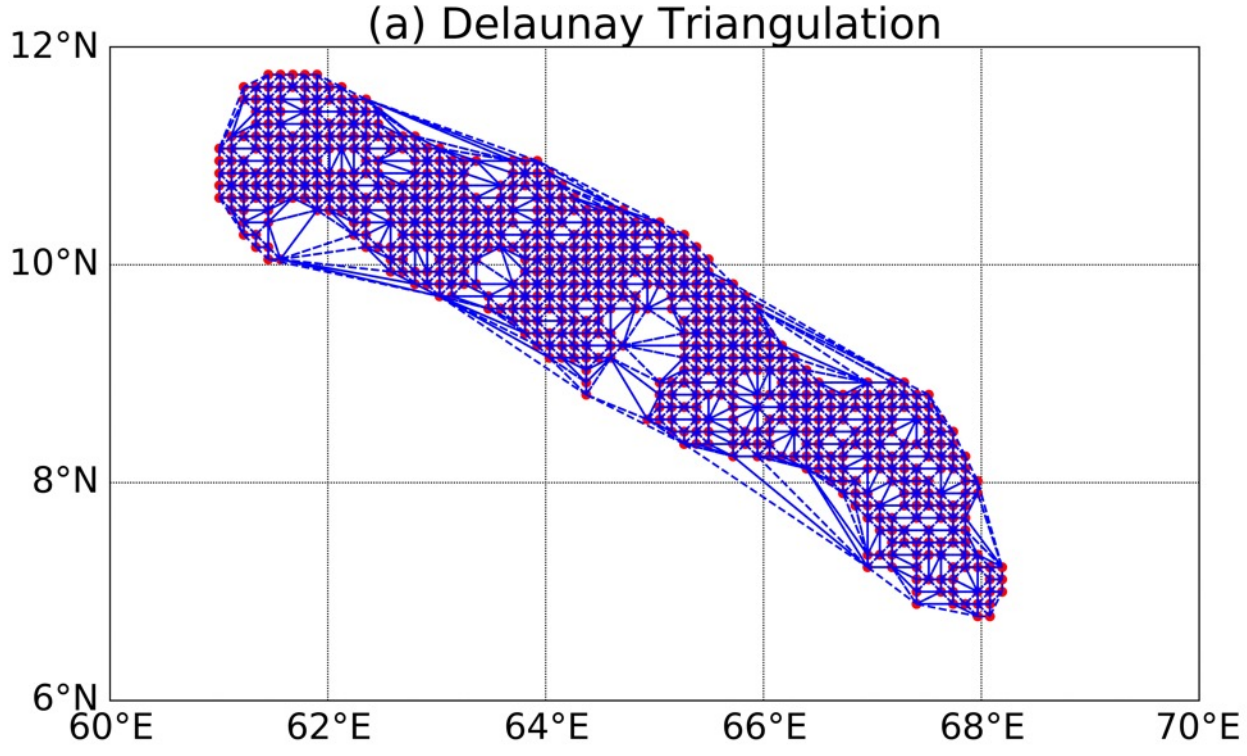
- 12.5 km Field of View (FOV) RapidScat and ASCAT vector winds from 2014-2016
- 0.25°, 3-hourly Tropical Rainfall Measurement Mission (TRMM) 3B42 precipitation
- TAO/TRITON, PIRATA and RAMA Buoy Network air temperature, precipitation and wind speed from 2000-2019

Inferential Datasets

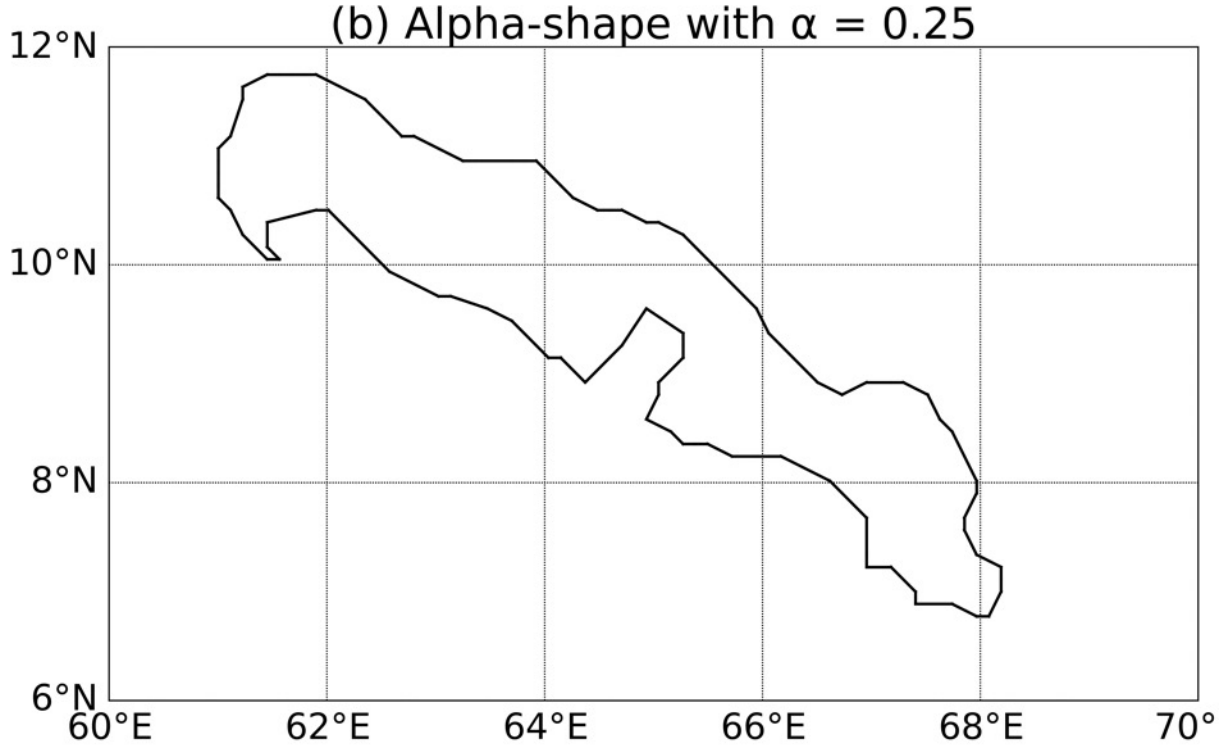
- 0.3° ECMWF Reanalysis version 5 (ERA5) hourly Total Column Water Vapor (TCWV)
- Globally-merged Infrared Brightness temperature at half-hourly, 4-km resolution.

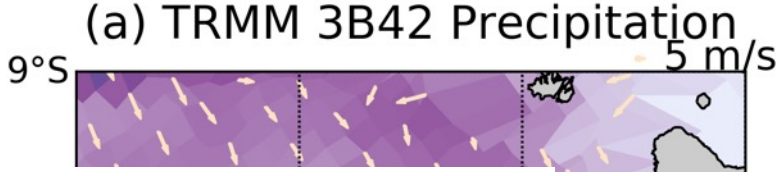

(a) Location of Buoys
30°N
15°N
0°
15°S
30°S
0°
30°E
60°E
90°E
120°E
150°E
180°
150°W
120°W
90°W
60°W
30°W
0°
T, W_{sp}, PR
T, W_{sp}
(b) Regional Classification
IO
WPAC
EPAC
AO

Gradient Feature (GF) Algorithm





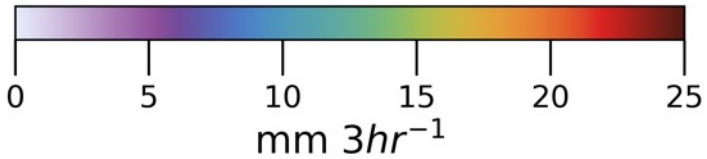




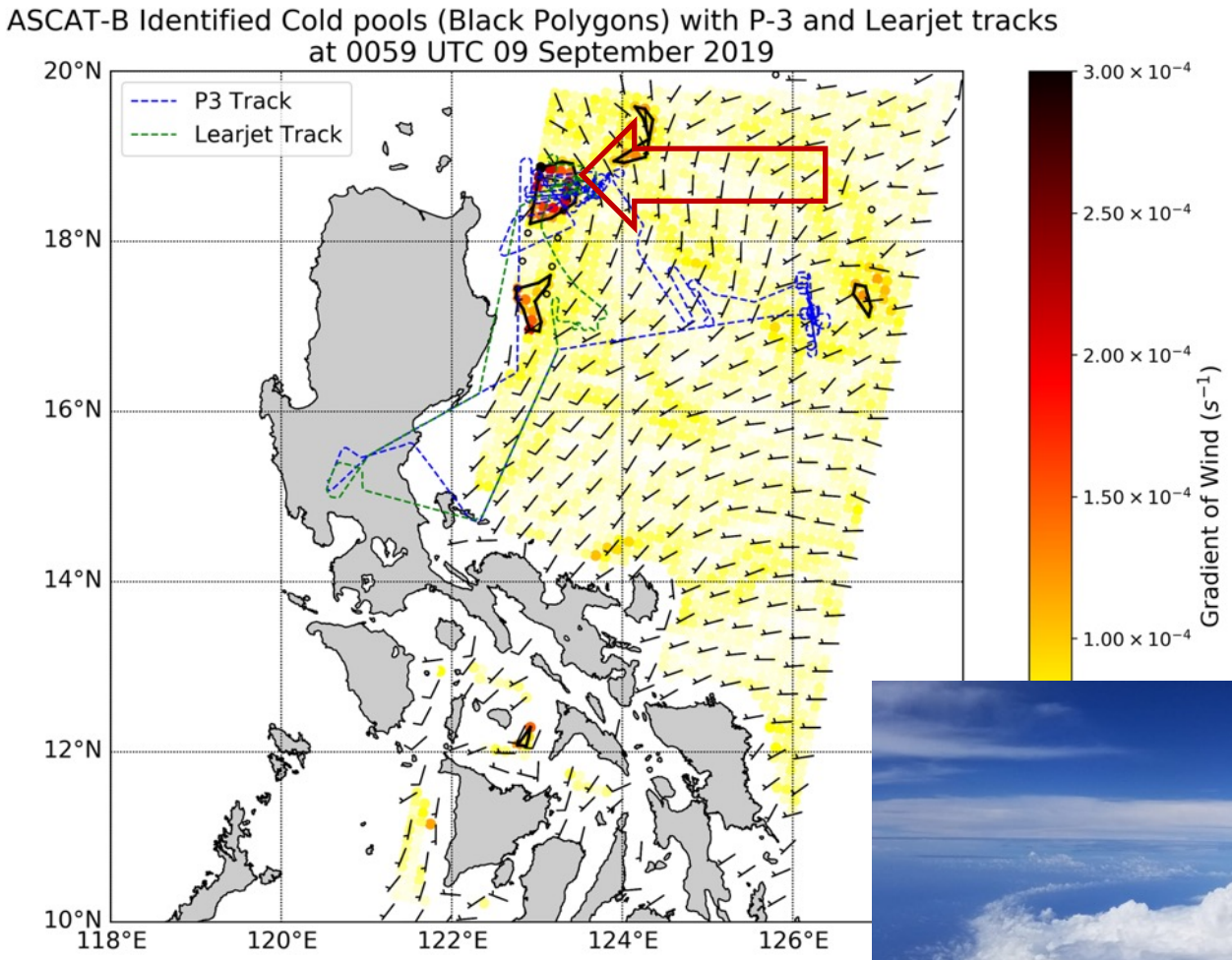


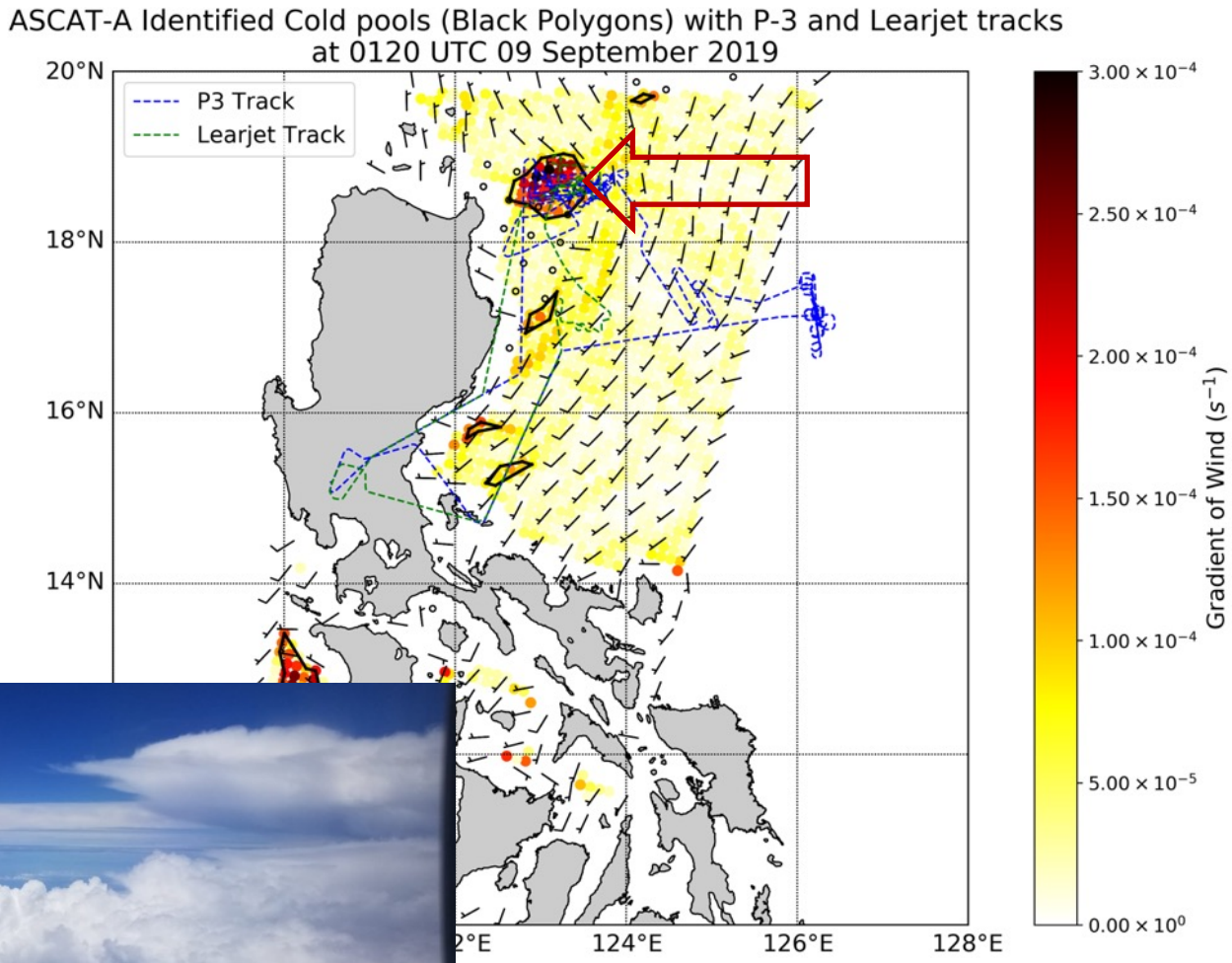


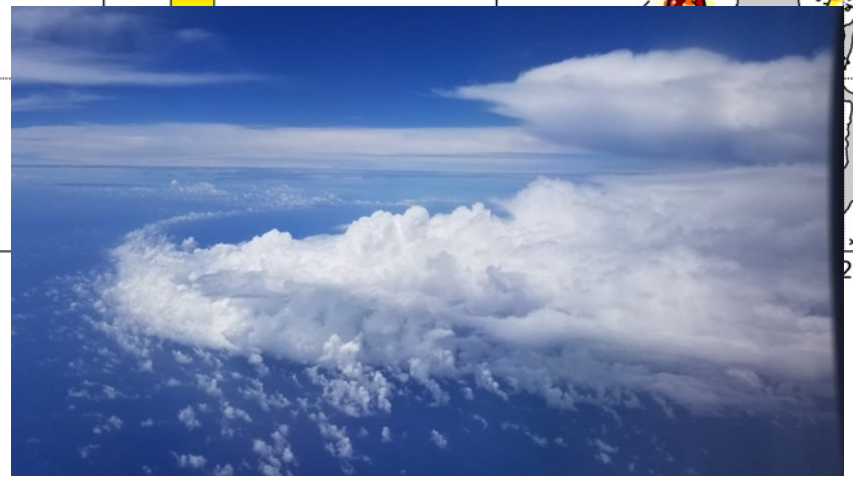
Scan it for the GF Algorithm paper!



GF Algorithm applied to ASCAT-A and B successfully identified cold pools







Picture Courtesy: Sarah Woods (SPEC)

Science Questions

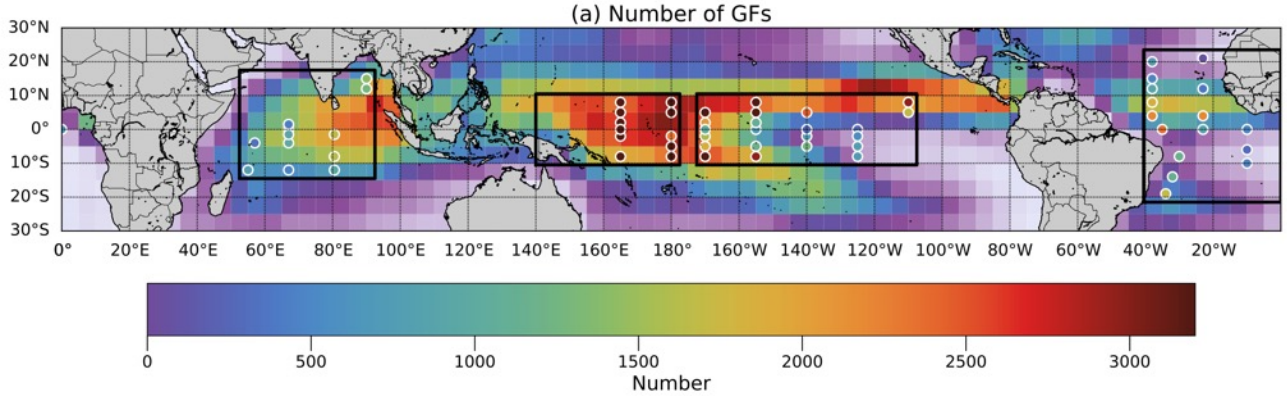
- Are there any regional differences between ASCAT and RapidScat observed Cold Pools?
- What are the diurnal modes of tropical oceanic cold pools?
- How can we formulate a conceptual model to explain the diurnal modes of tropical oceanic mesoscale cold pools?

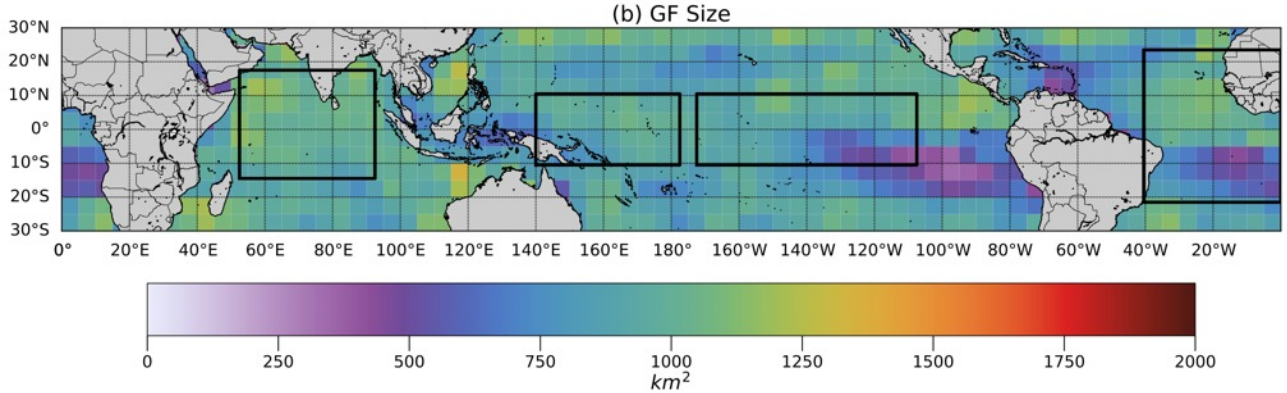
Science Question I

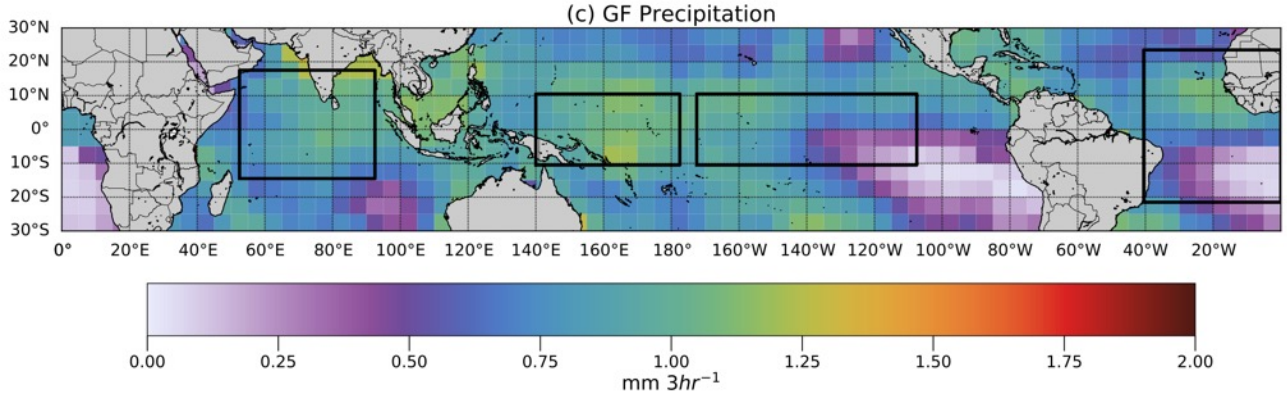
Are there any regional differences between ASCAT and RapidScat observed Cold Pools?

Are there any regional differences between ASCAT and RapidScat observed Cold Pools?

RapidScat-Observed GF Climatology

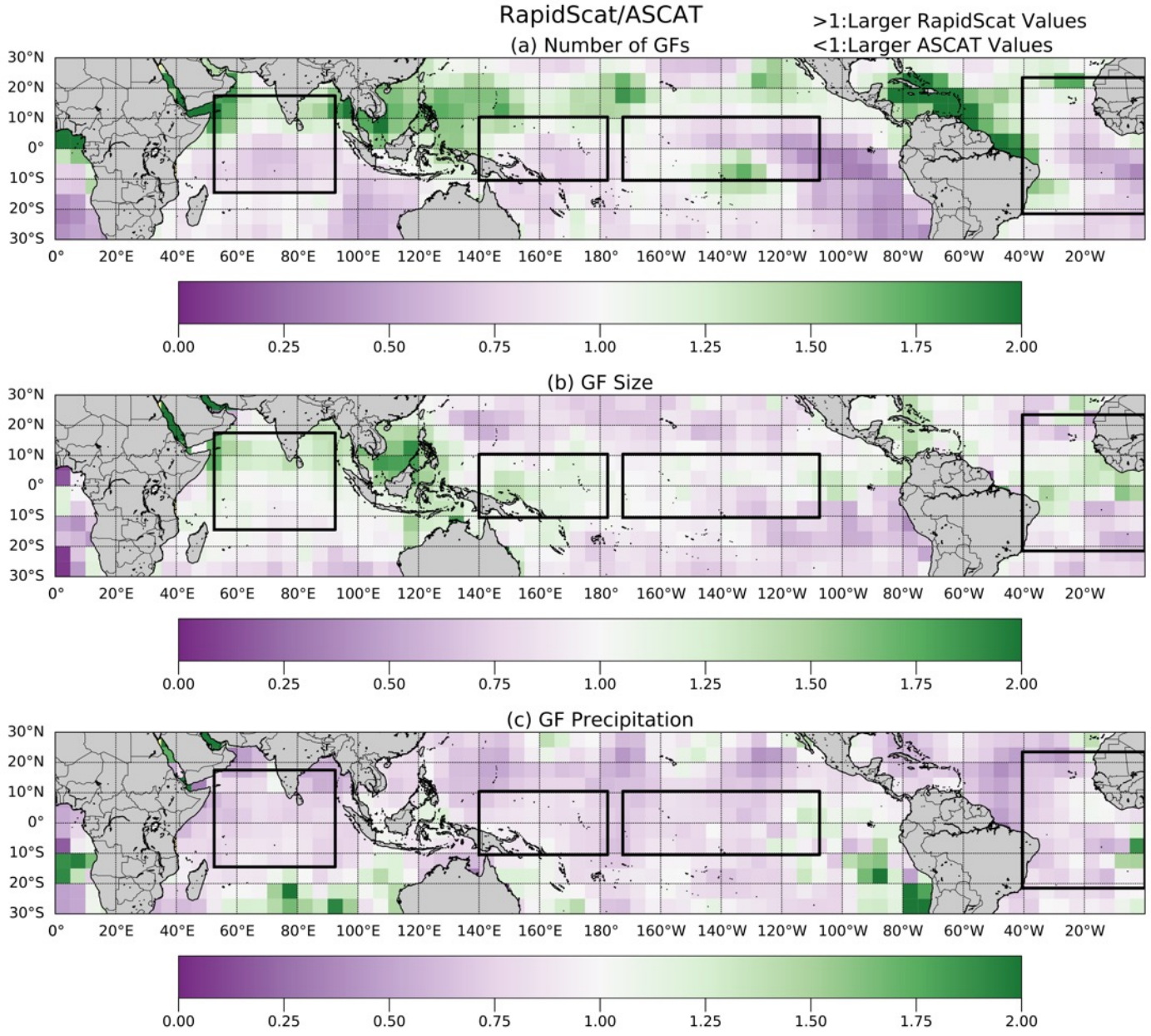






Are there any regional differences between ASCAT and RapidScat observed Cold Pools?

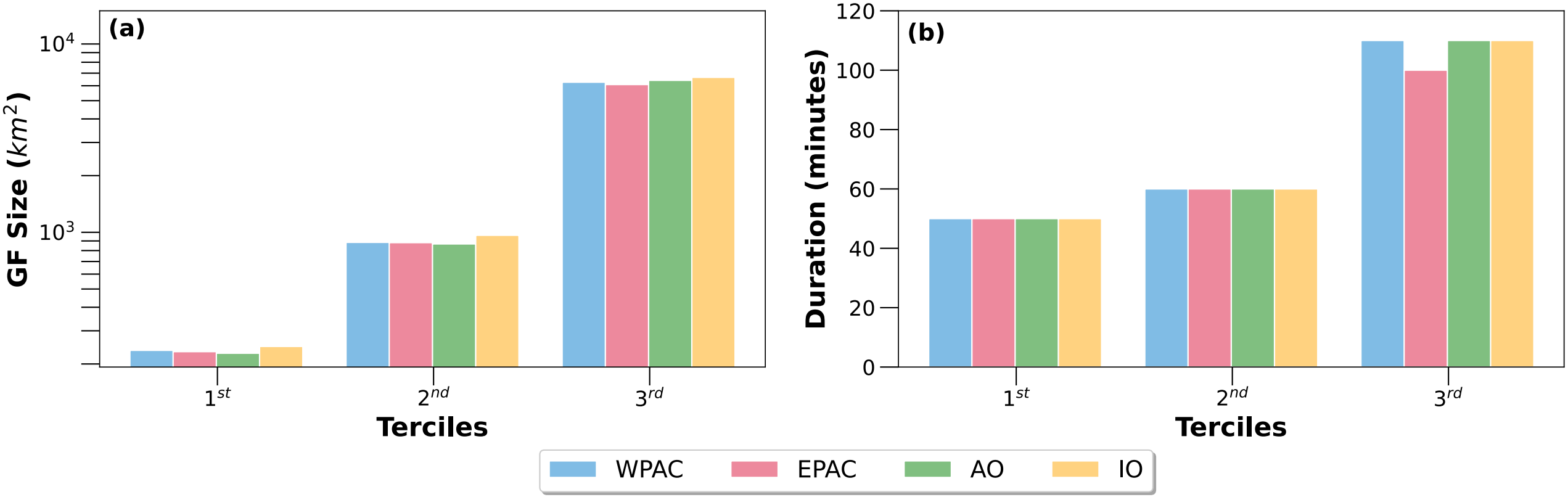
Difference between ASCAT and RapidScat- Observed GF Climatology



Science Question II

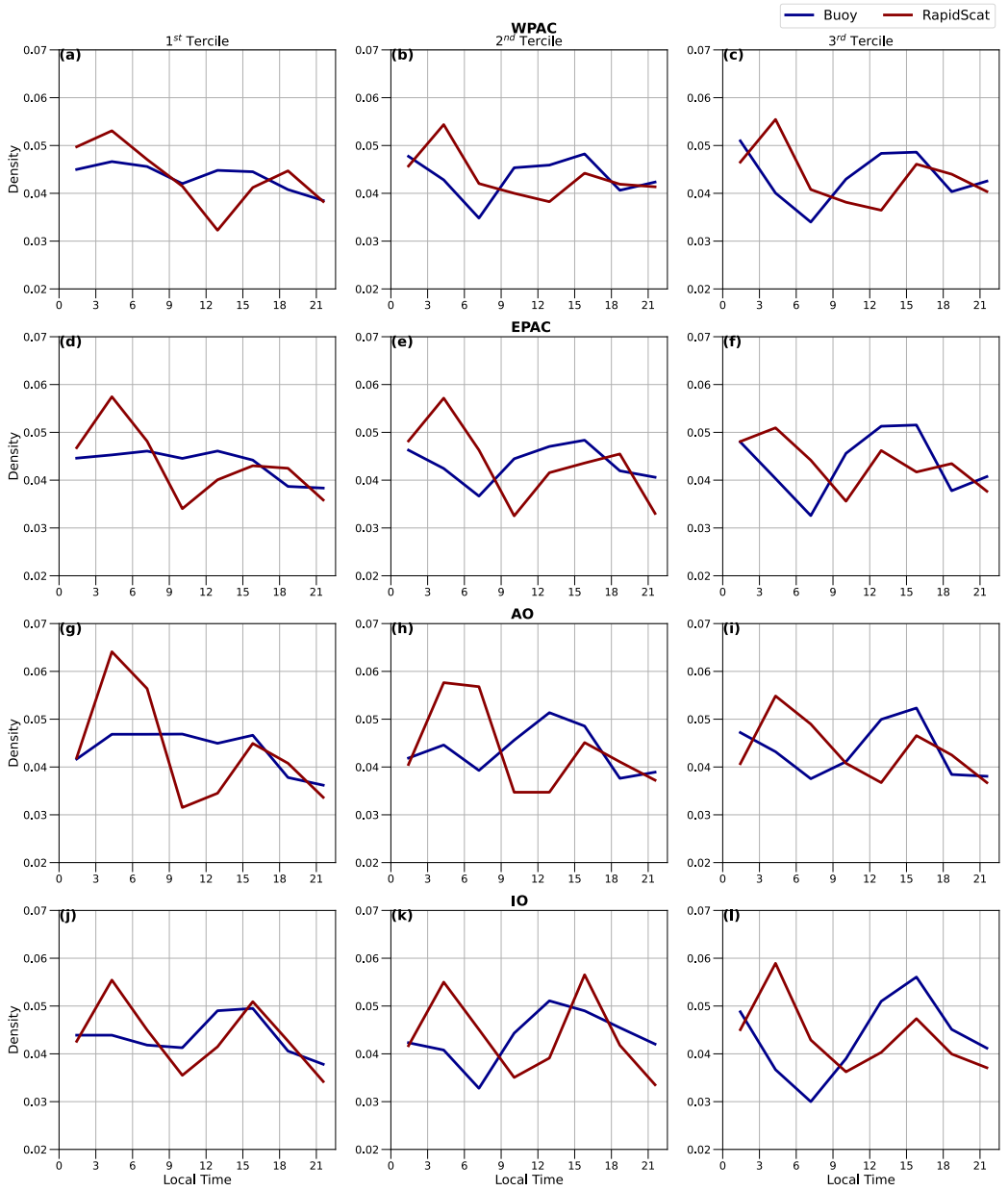
What are the diurnal modes of tropical oceanic cold pools?

Regional Classification of GF and Buoy-Observed Cold Pools



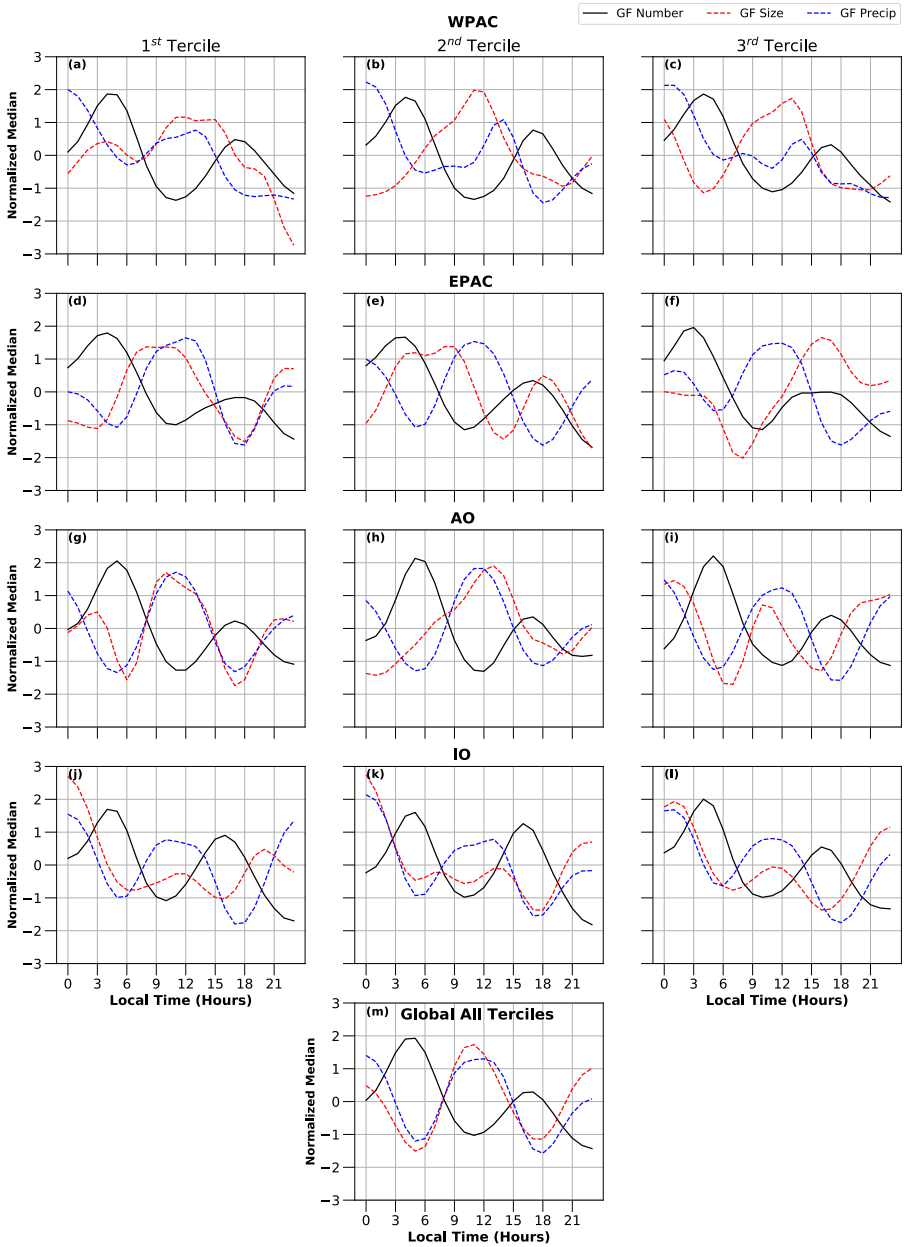
What are the diurnal modes of tropical oceanic cold pools?

Comparison of RapidScat GF v/s Buoy-Observed Cold Pool Diurnal Modes



What are the diurnal modes of tropical oceanic cold pools?

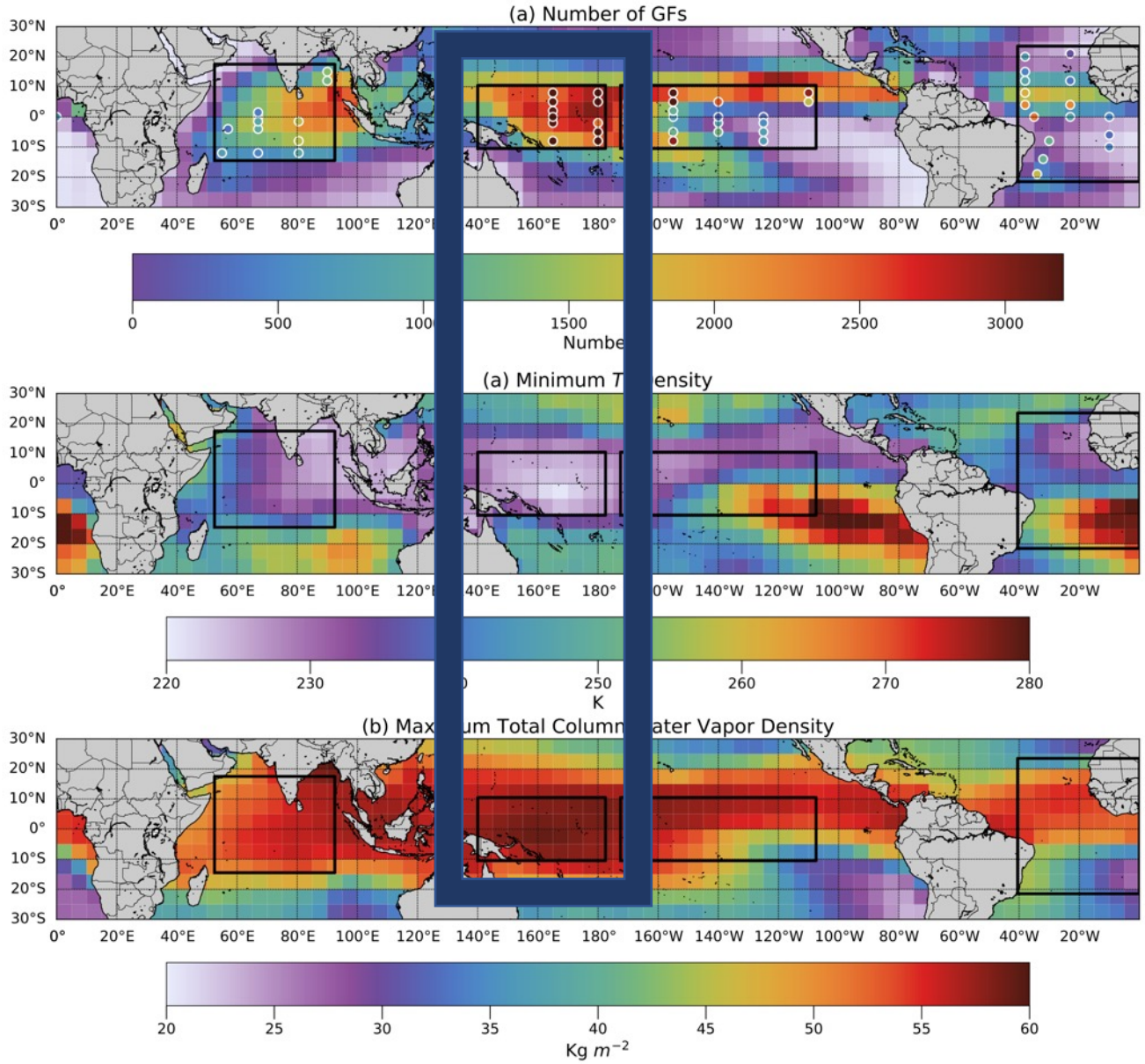
Causality between Precipitation, Cold Pool Number and Size



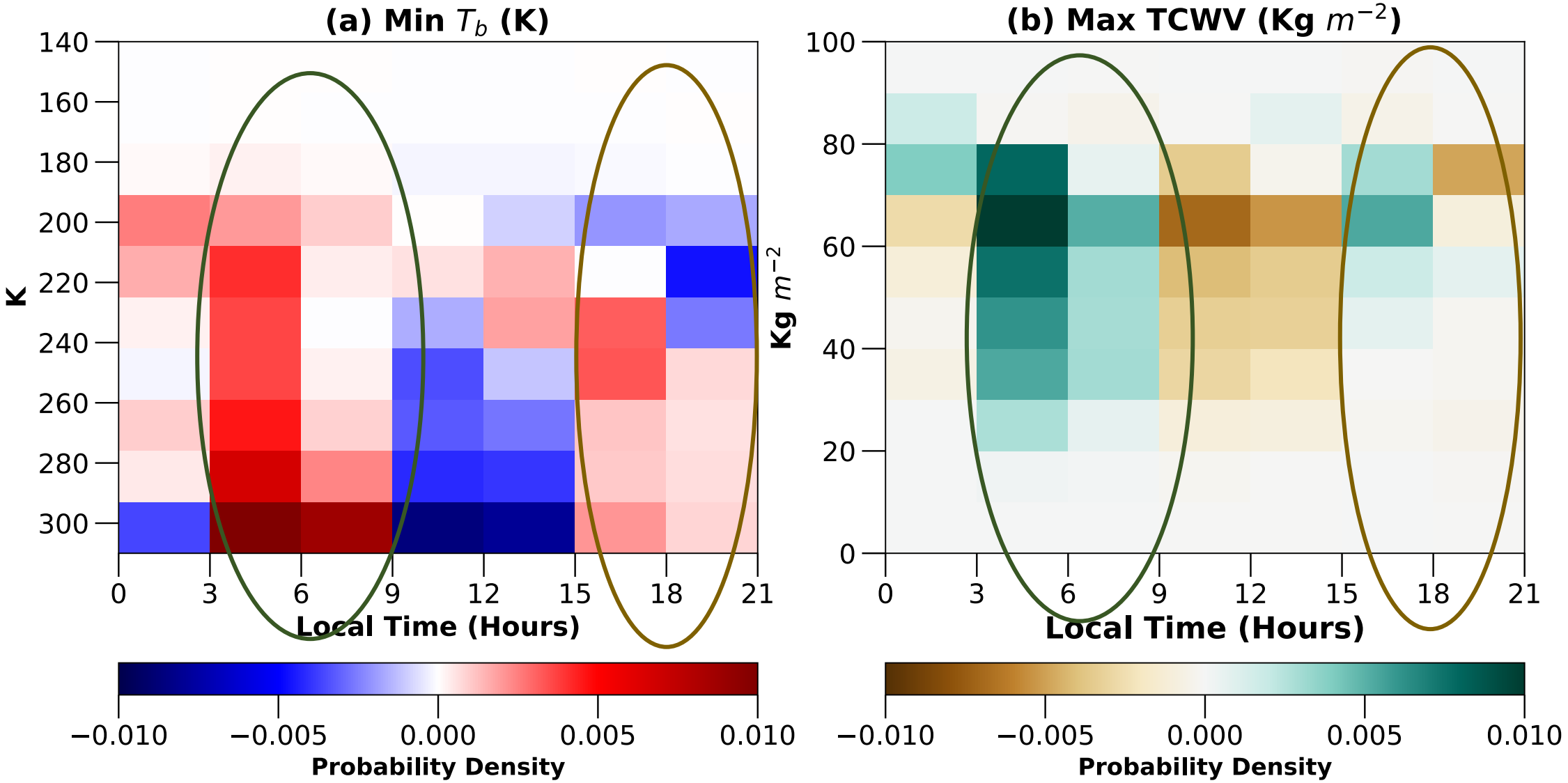
Science Question III

How can we formulate a conceptual model to explain the diurnal modes of tropical oceanic mesoscale cold pools?

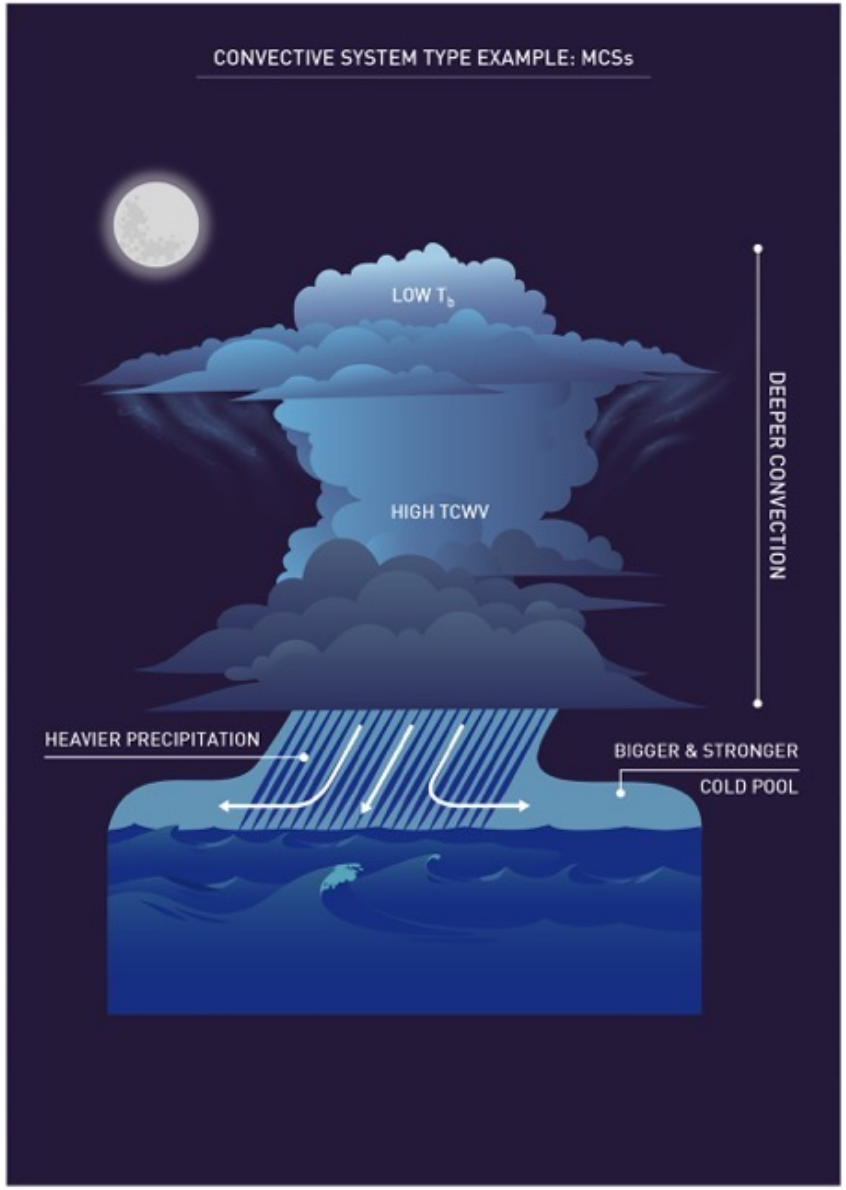
How can we formulate a conceptual model to explain the diurnal modes of tropical oceanic mesoscale cold pools?

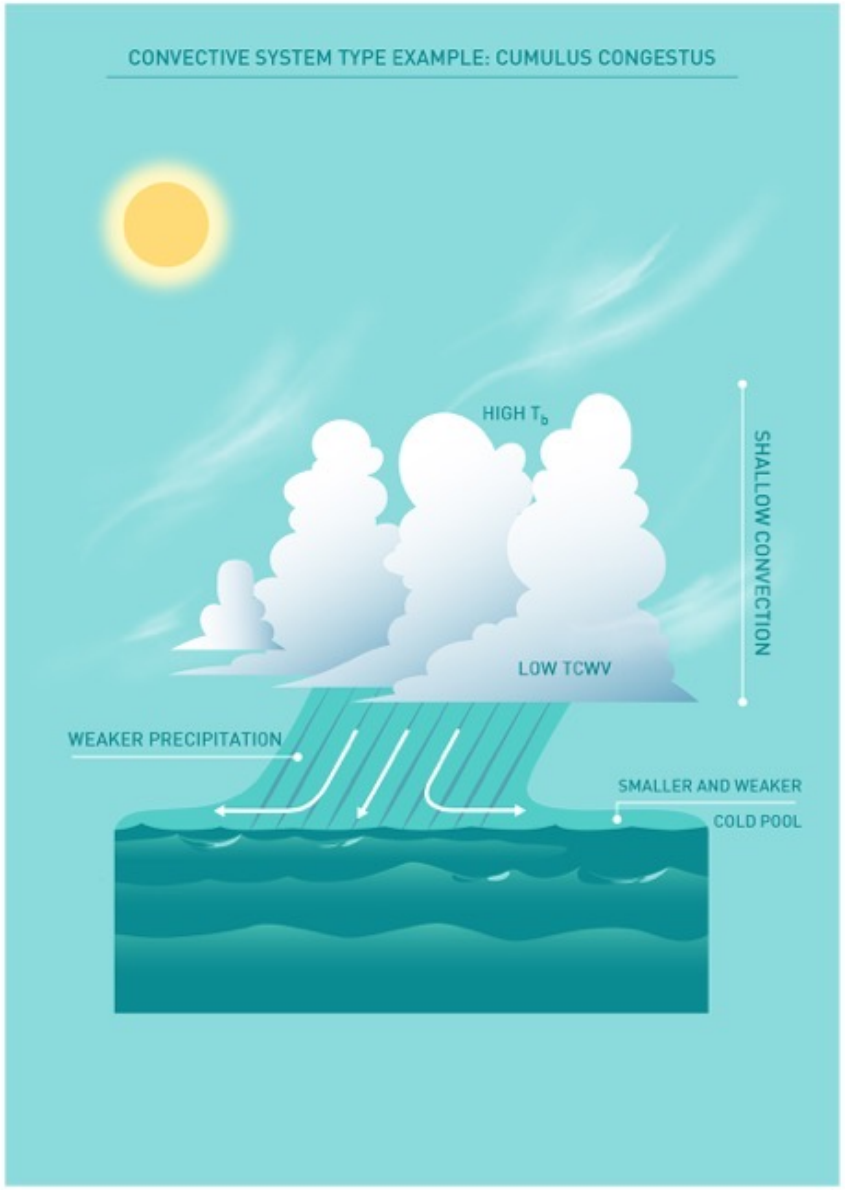


How can we formulate a conceptual model to explain the diurnal modes of tropical oceanic mesoscale cold pools?

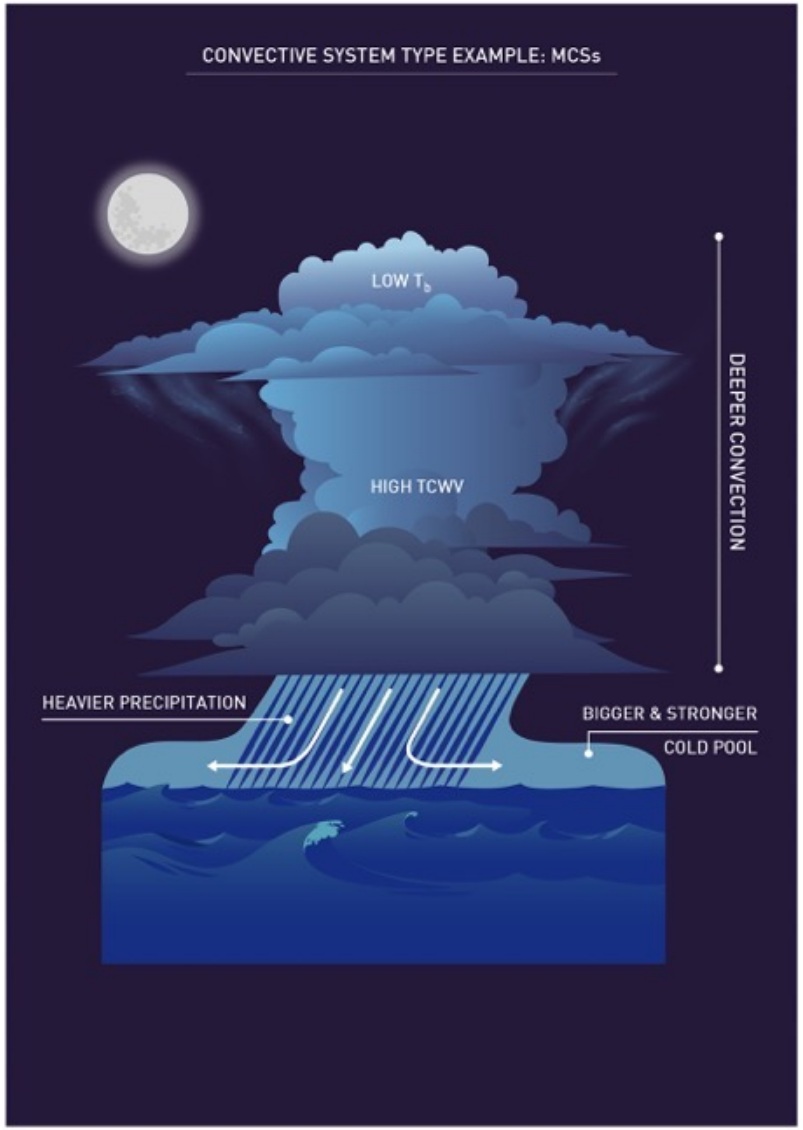


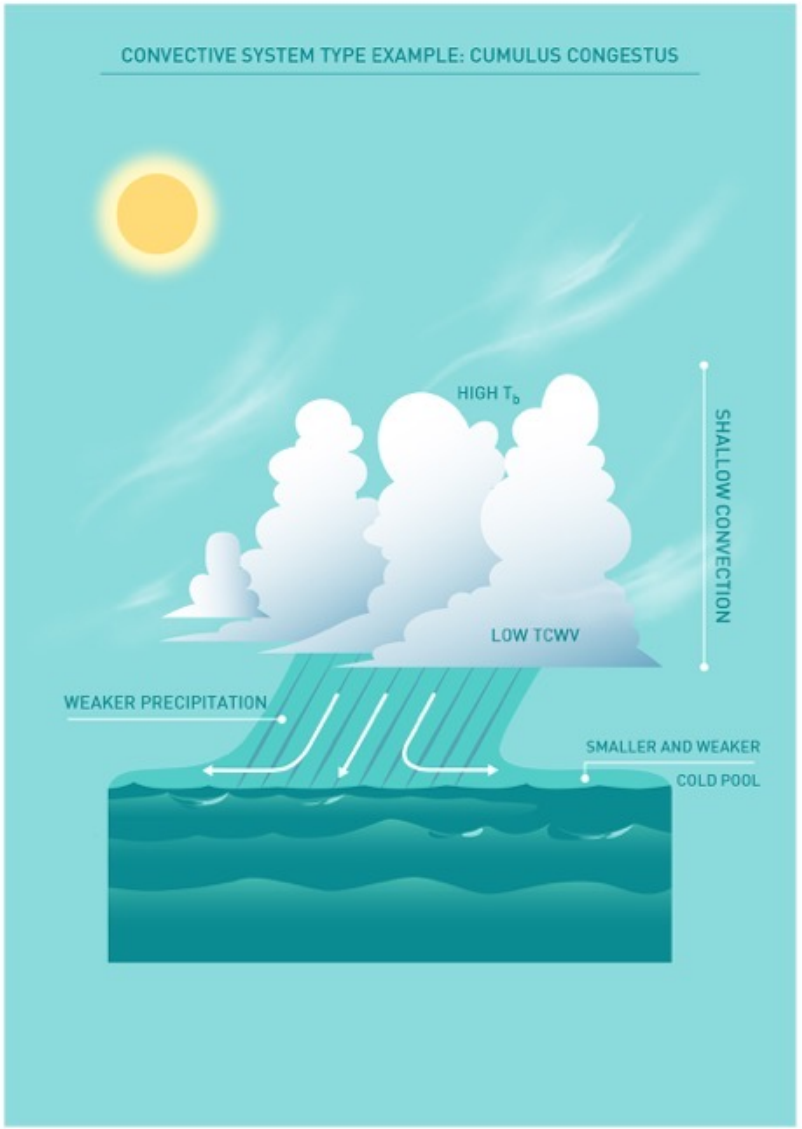
How can we formulate a conceptual model to explain the diurnal modes of tropical oceanic mesoscale cold pools?





Summary and Conclusions





Thank You!
For any questions:
pgarg7@illinois.edu
Twitter DM: @tropmetpie

Scan it for the GF Algorithm paper available in JGR Atmospheres!

Acknowledgements

Thanks to NASA Ocean Vector Winds Science Team for funding this work through NNH17ZDA001N-OVWST.

Note

Diurnal results shown here are a part of manuscript conditionally accepted in the AMS *Journal of Climate* and should be available soon to the interested audience.