Tropical Oceanic Mesoscale Cold Pools in High-Resolution Global Icosahderal Nonhydrostatic (ICON) Model from DYAMOND

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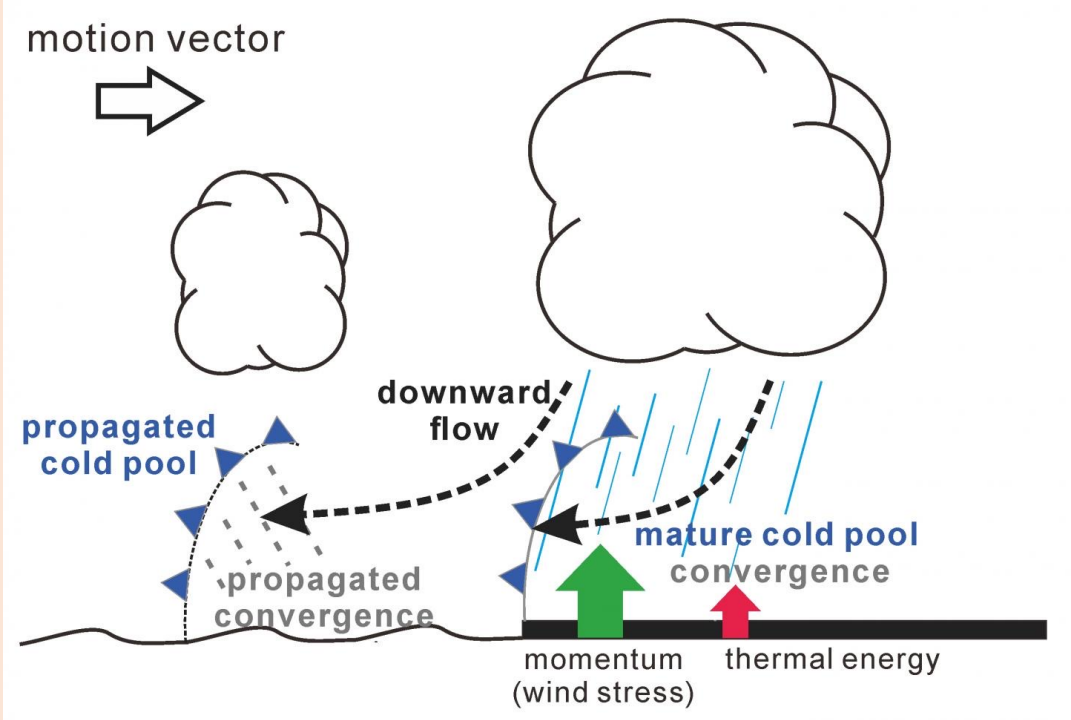
Introduction

- 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).



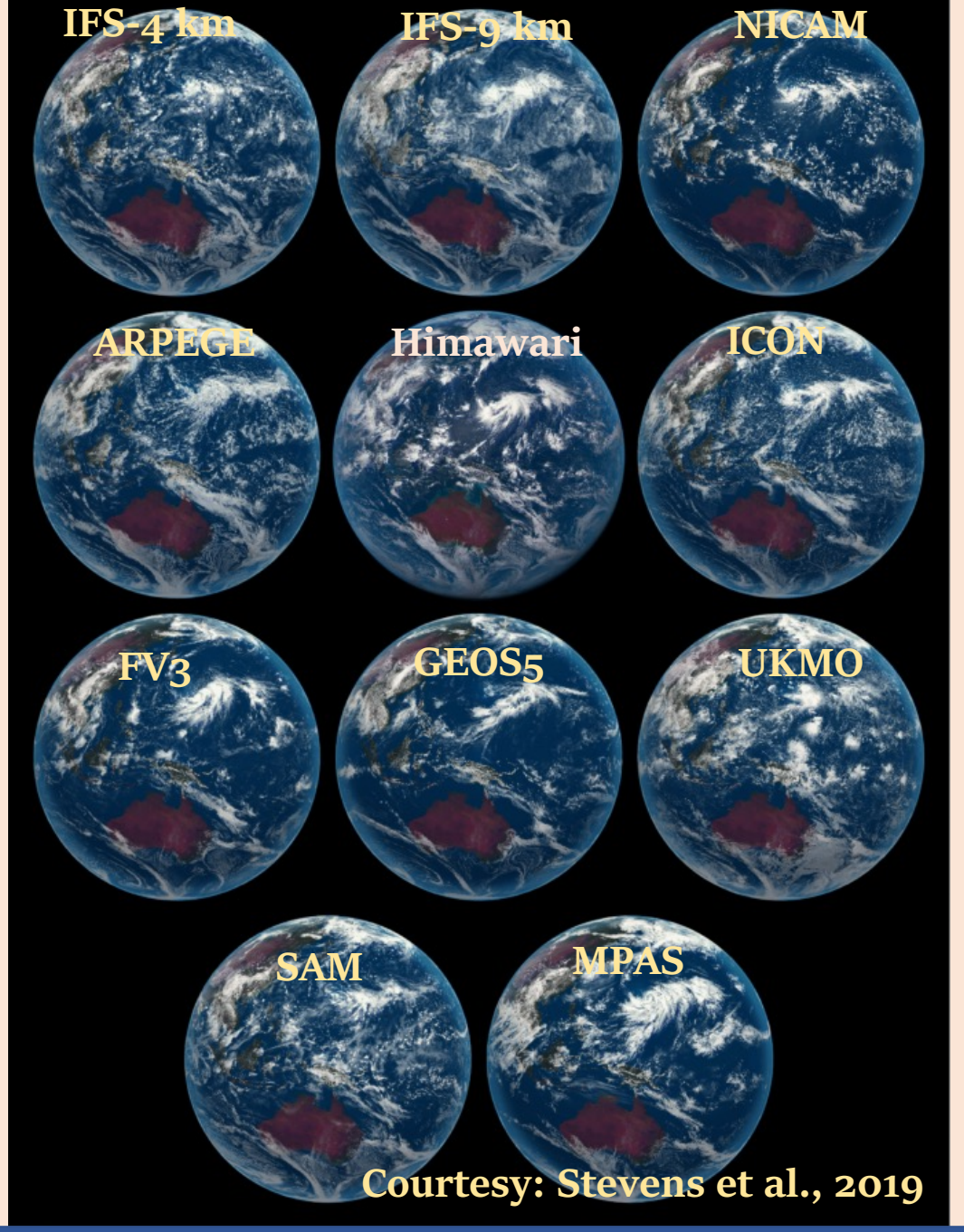
Courtesy: Lee et al. (2019)

Motivation and Aim

- Recent advances in supercomputing have allowed us to run high-resolution cloud-resolving models (CRMs) globally (Satoh et al., 2019).

- These global models are an excellent tool to test and validate hypotheses about how cold pools affect the environment and vice versa.

- In this section, 2.5 km global Icosahedral Nonhydrostatic (ICON) model is used to analyze tropical oceanic mesoscale cold pools.



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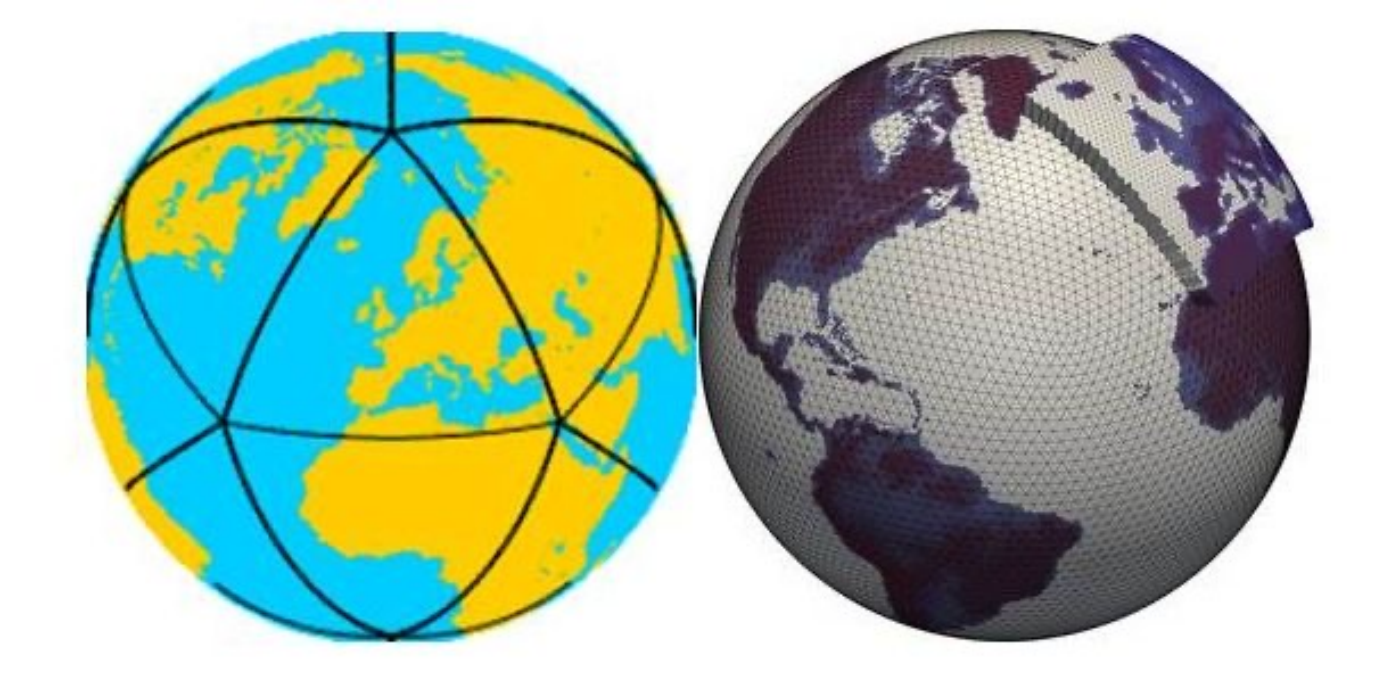
ICOsahedral Nonhydrostatic (ICON) Model
01 August – 11 September 2016

- Part of DYnamics of the Atmospheric general circulation Modeled On Non-hydrostatic Domains (DYAMOND) initiative
- 2.5 km global icosahedral grid
- 90 vertical levels
- T_v anomaly to identify Cold Pools



Courtesy: German Weather Service (DWD)

Science Questions

- How are the cold pool-attributed environmental properties across global tropics?
- What are the diurnal modes of tropical oceanic cold pools in a CRM?
- How can we explain the relationship between environment and cold pool properties in a global CRM?

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Science Question I

How are the cold pool-attributed environmental properties across global tropics?

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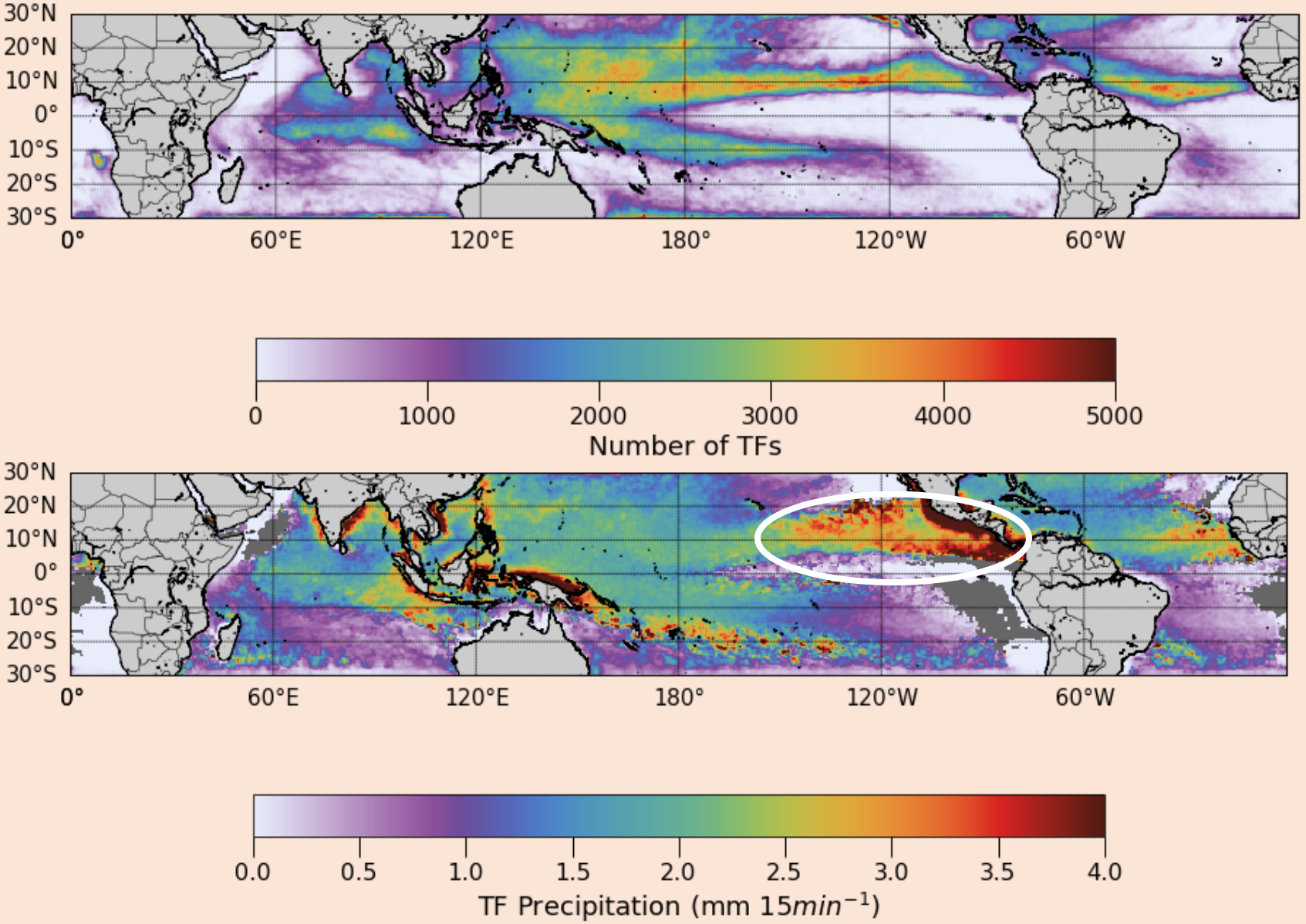

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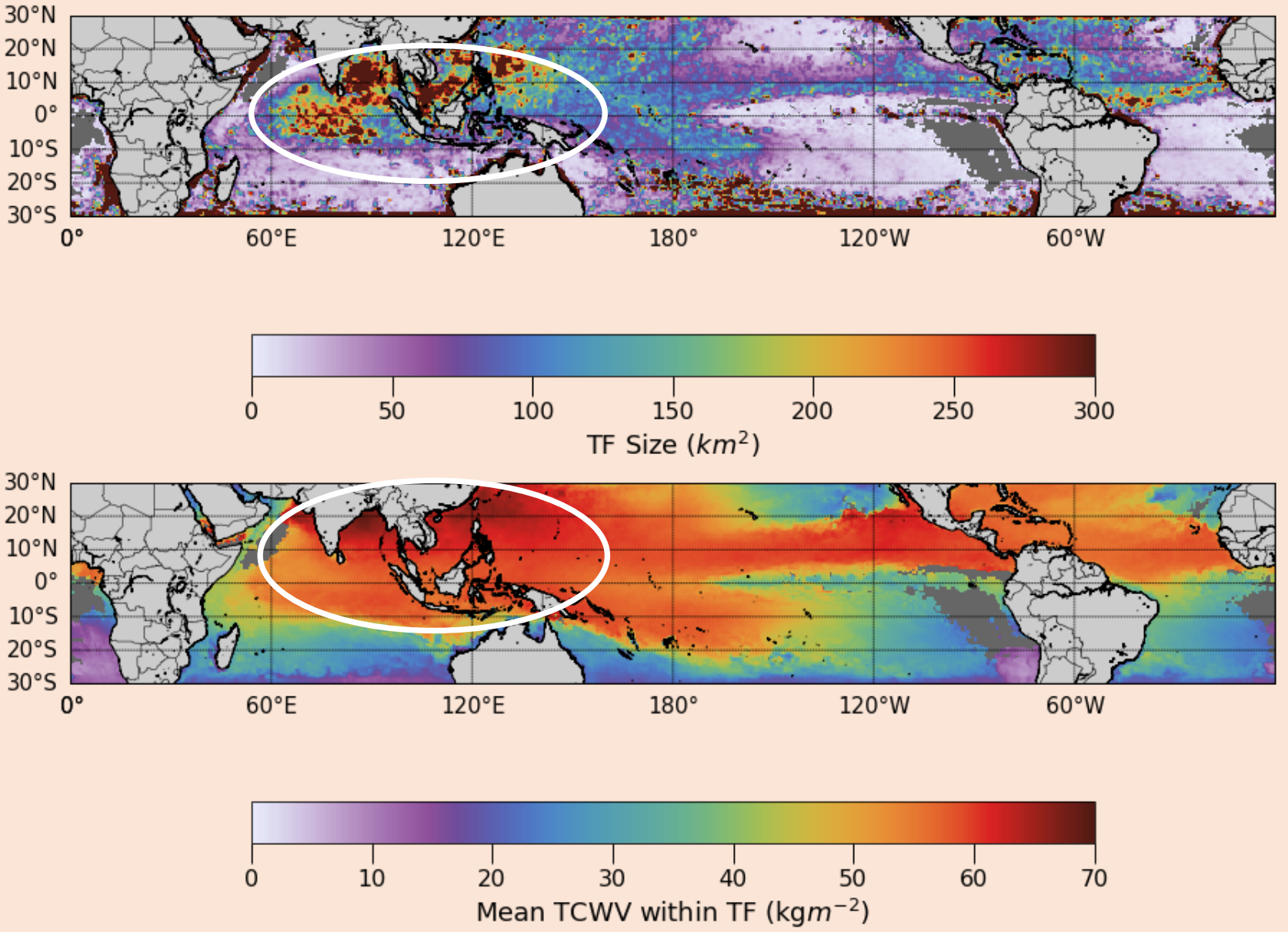

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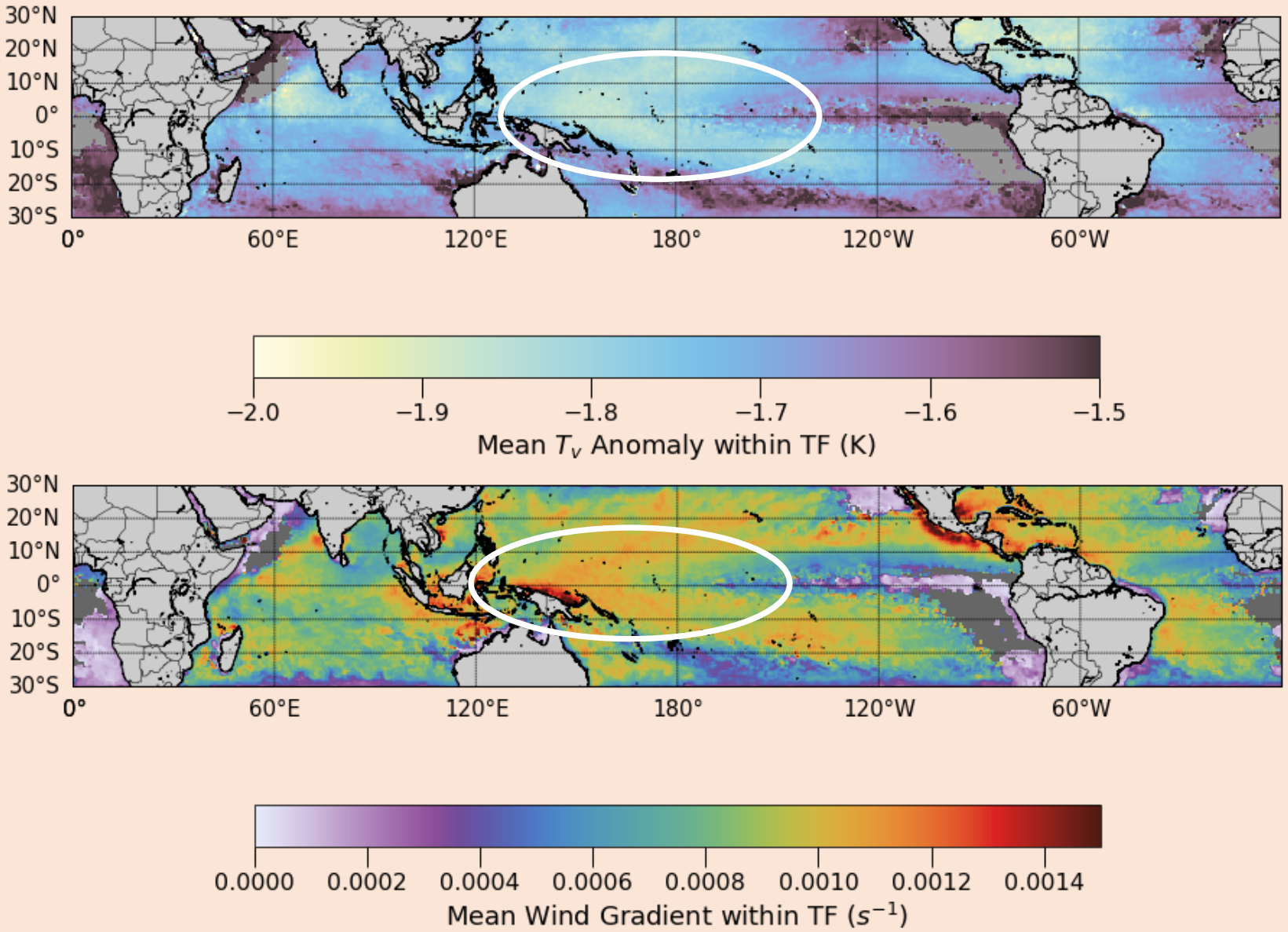

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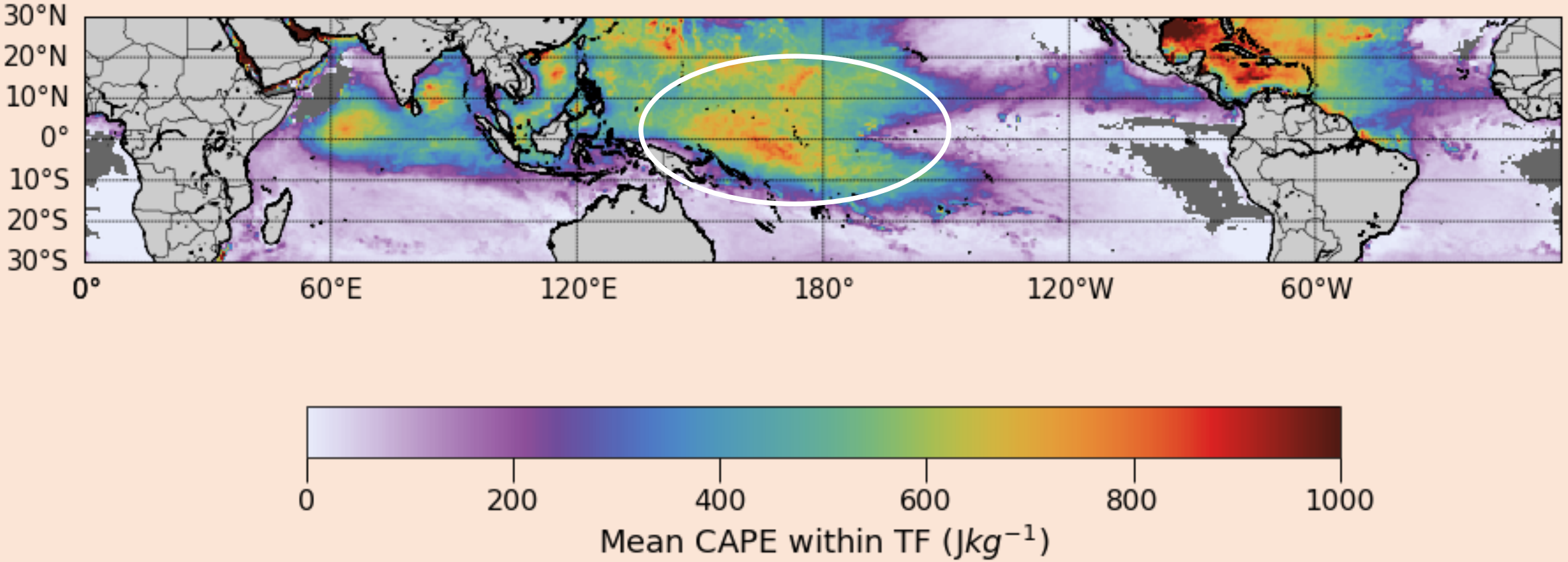

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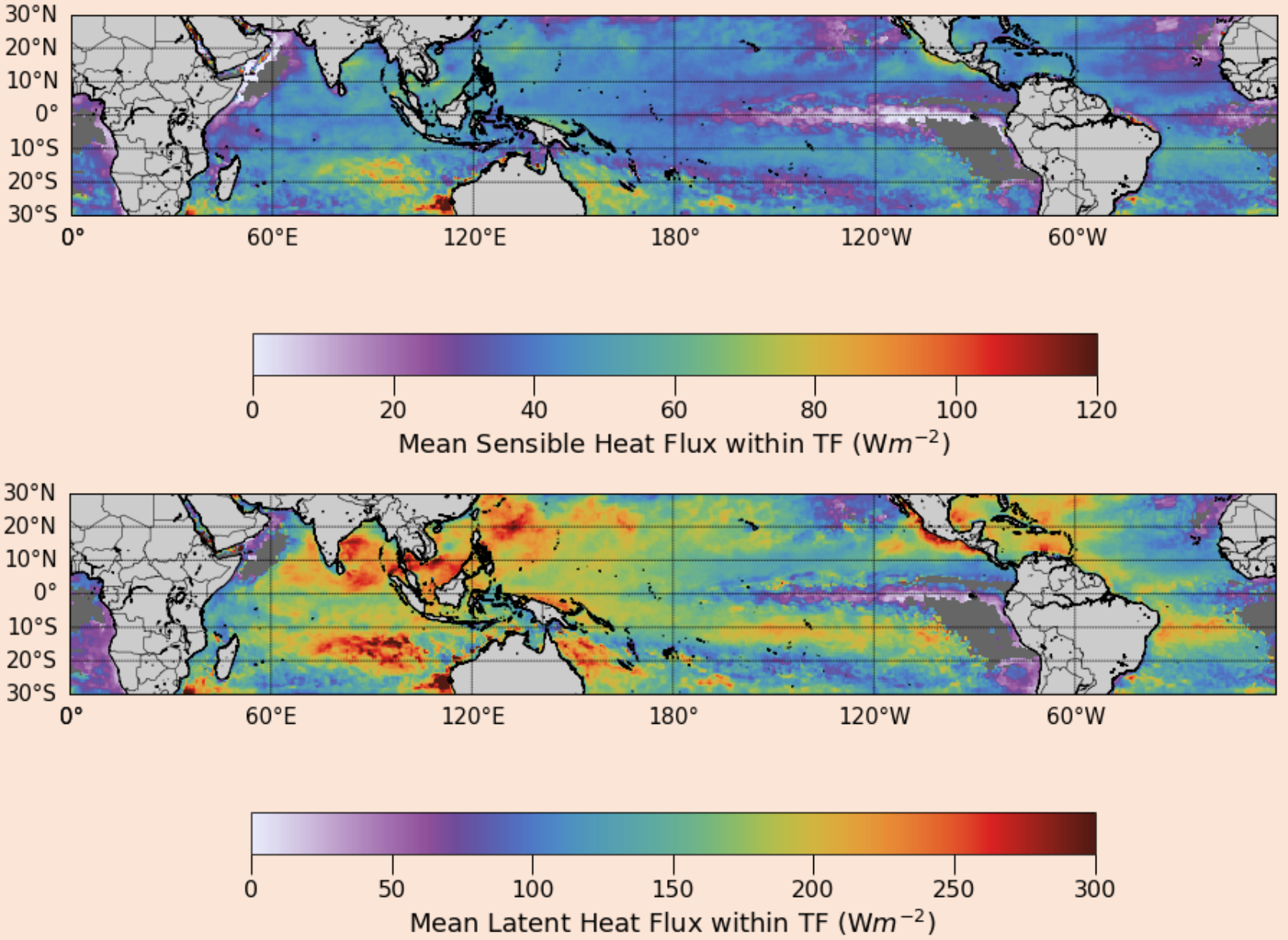

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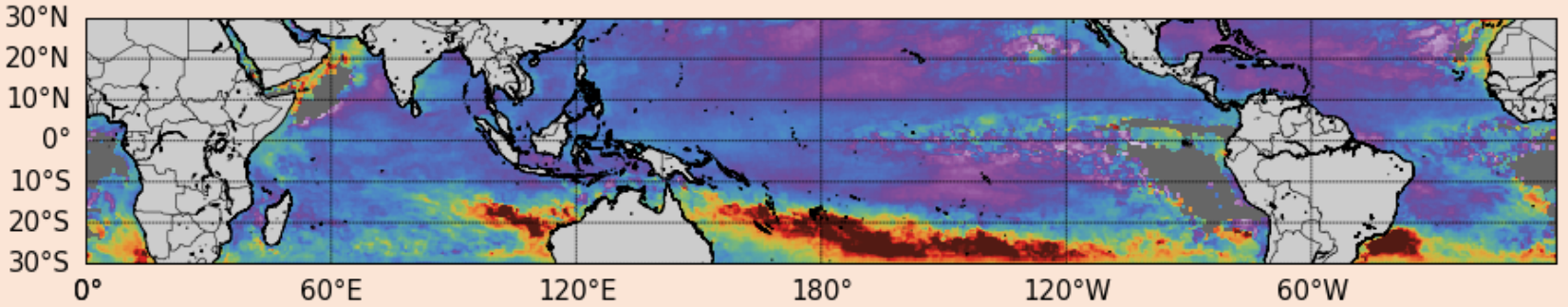

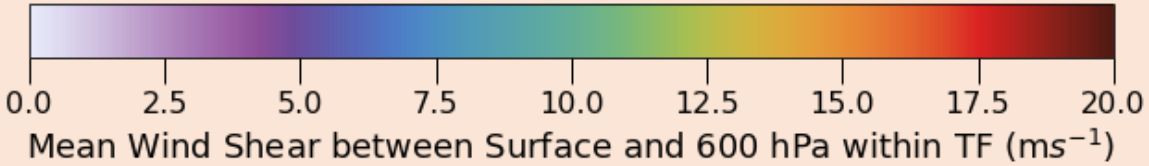

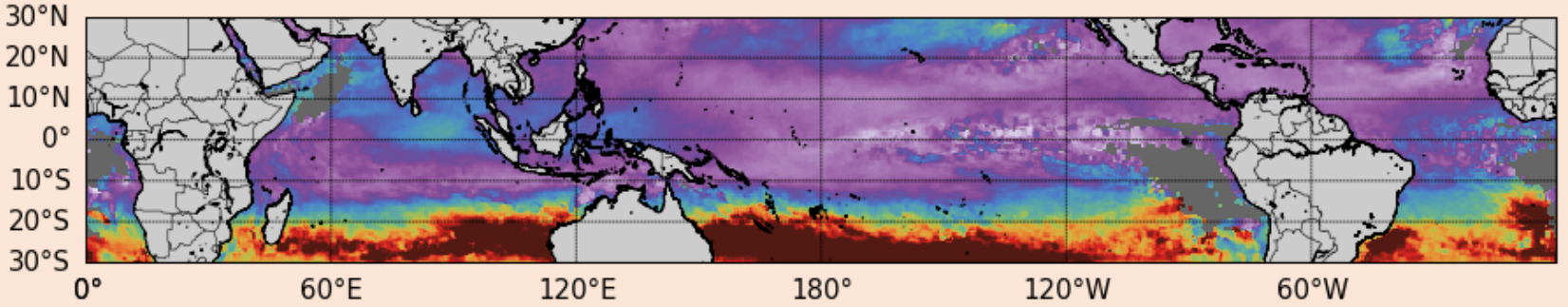

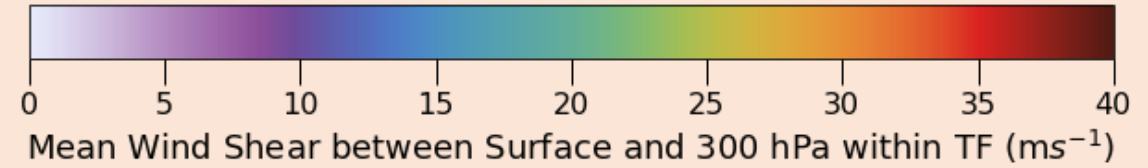

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Science Question II

What are the diurnal modes of tropical oceanic cold pools in a CRM?

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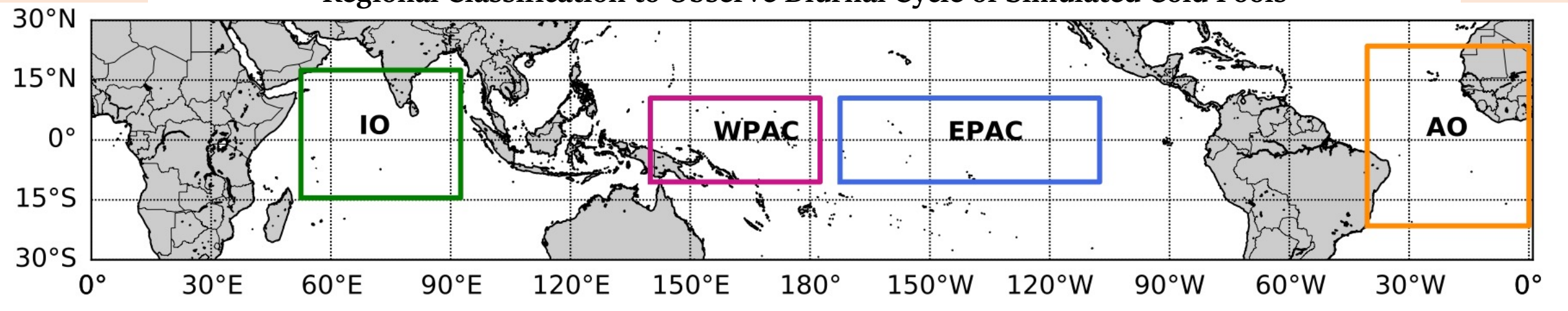
Regional Classification to Observe Diurnal Cycle of Simulated Cold Pools



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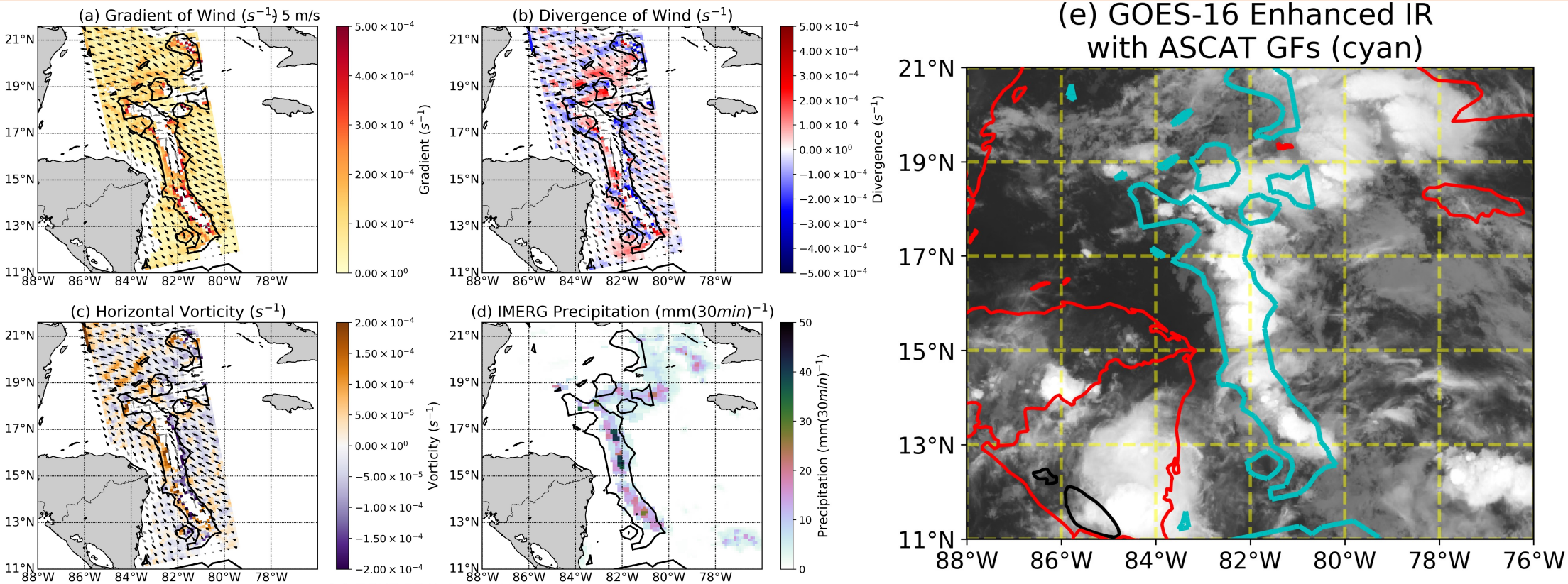
ASCAT-Identified GFs

Garg et al. (2020) JGR-Atmospheres



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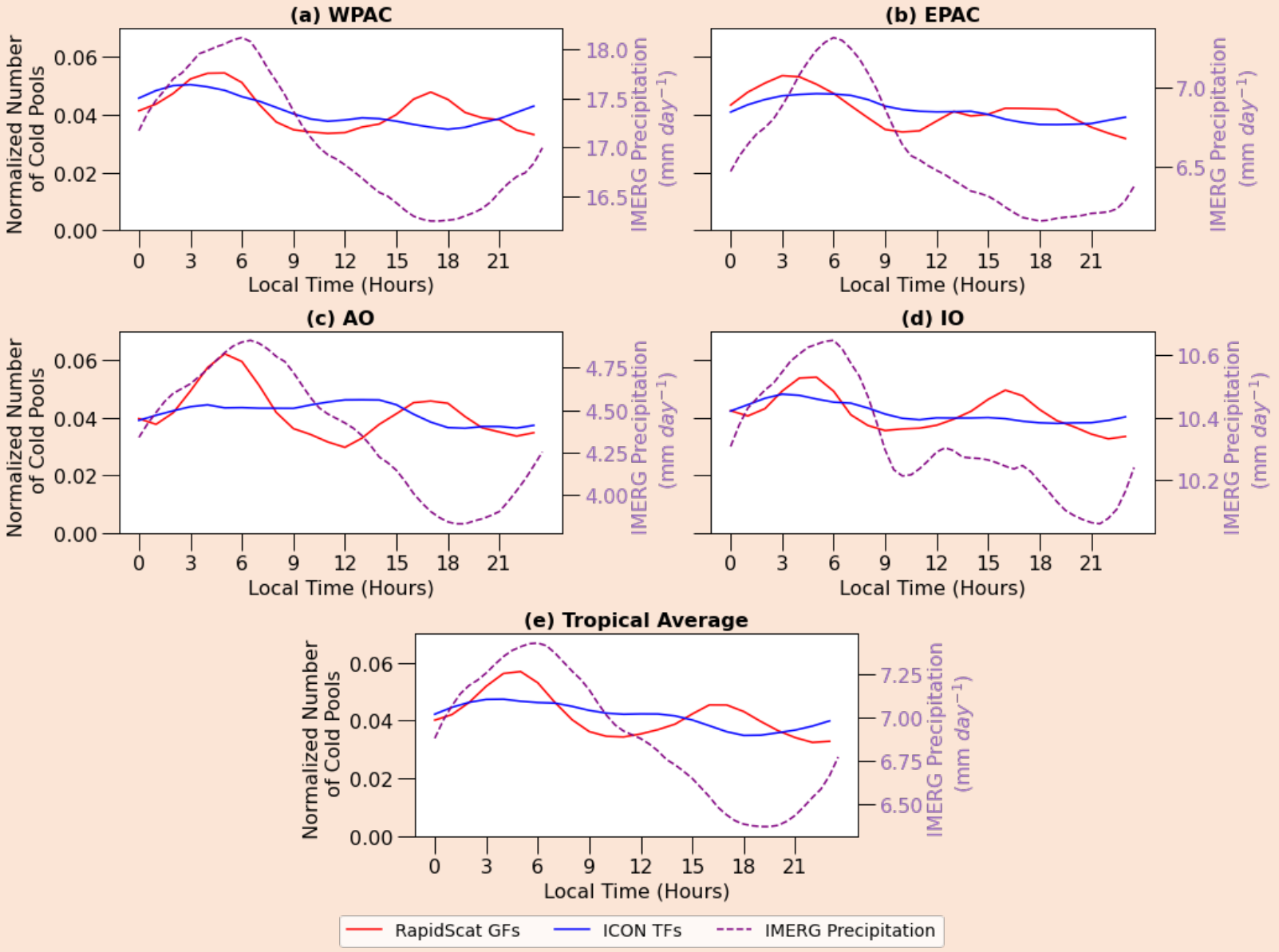

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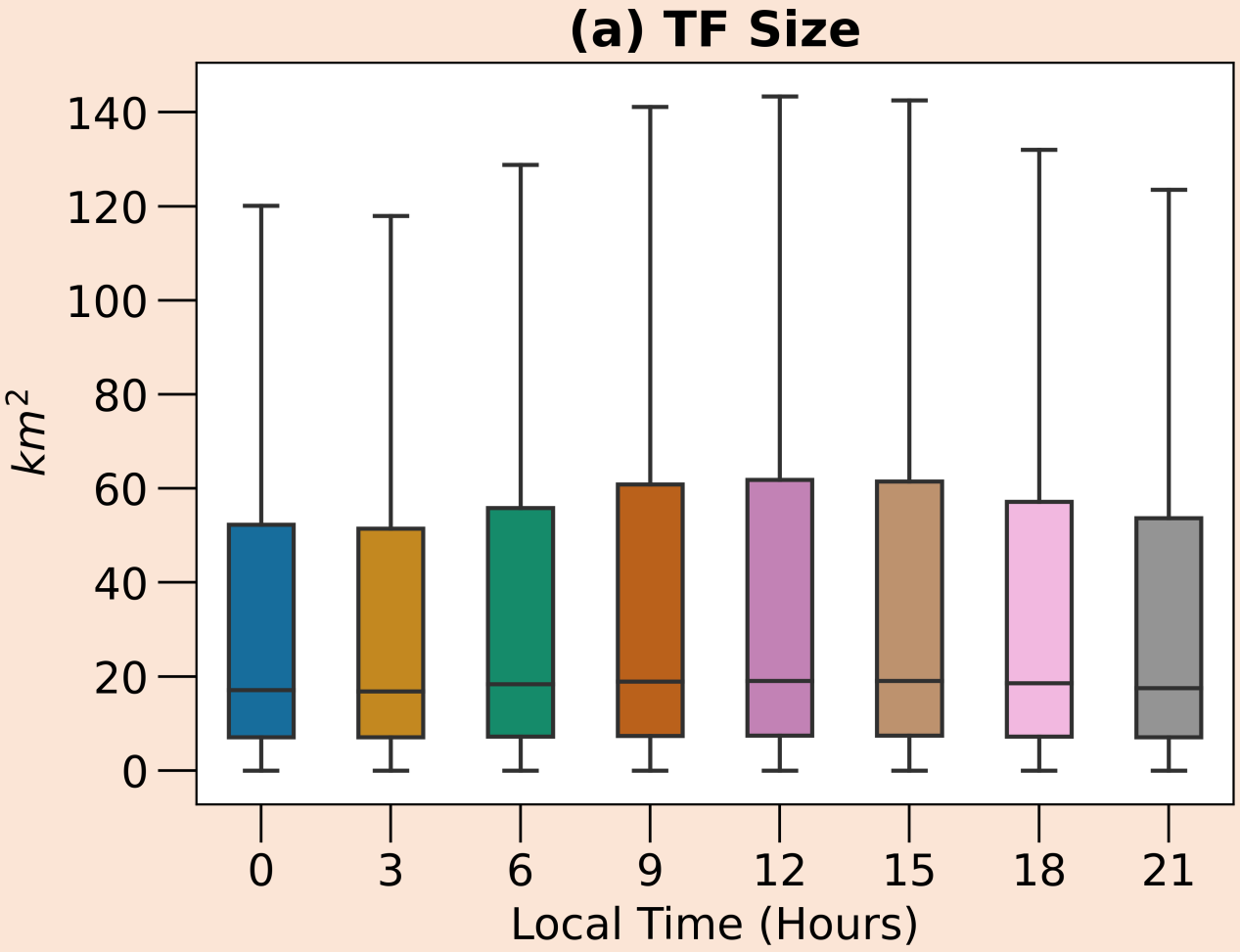

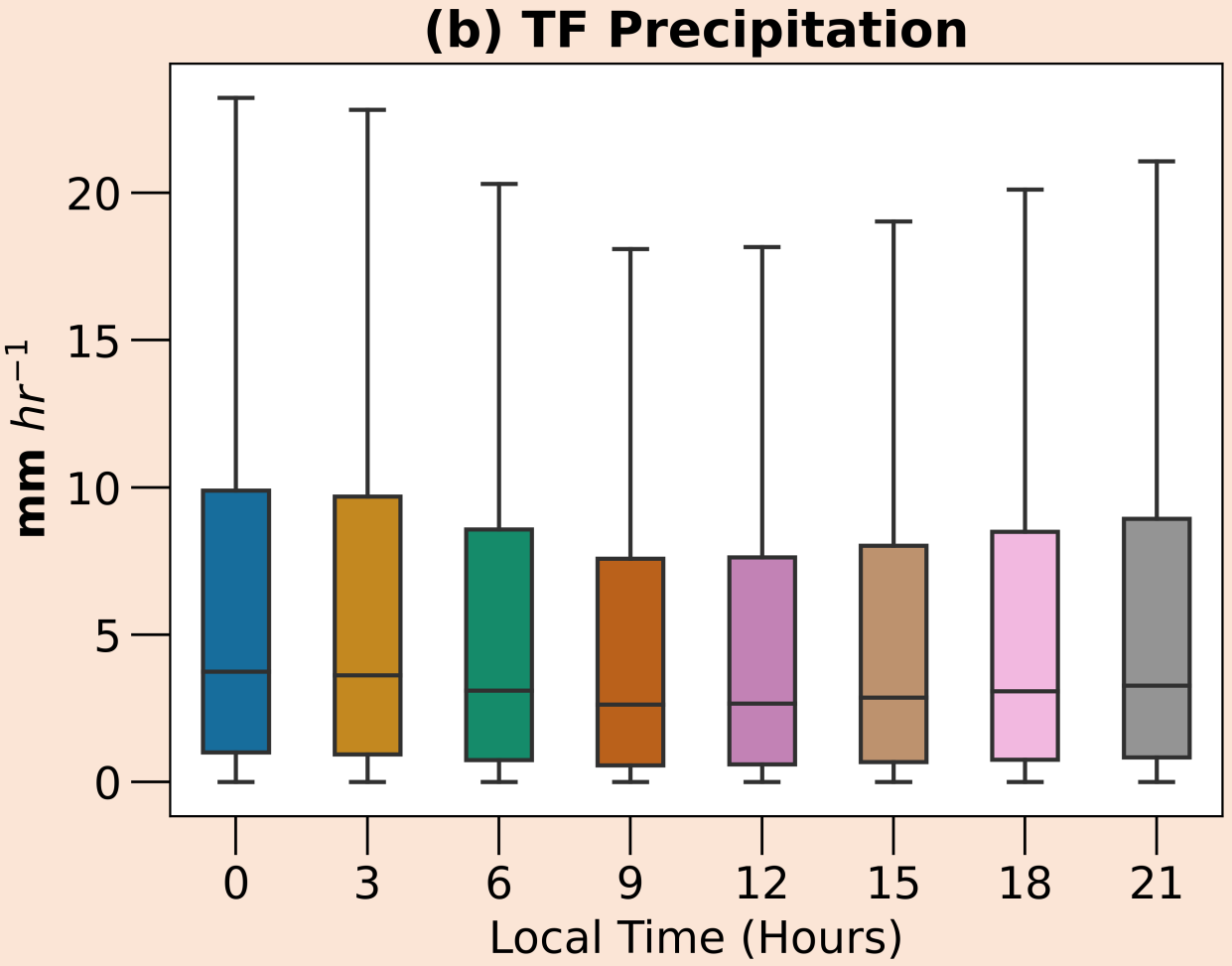

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Science Question III

How can we explain the relationship between environment and cold pool properties in a global CRM?

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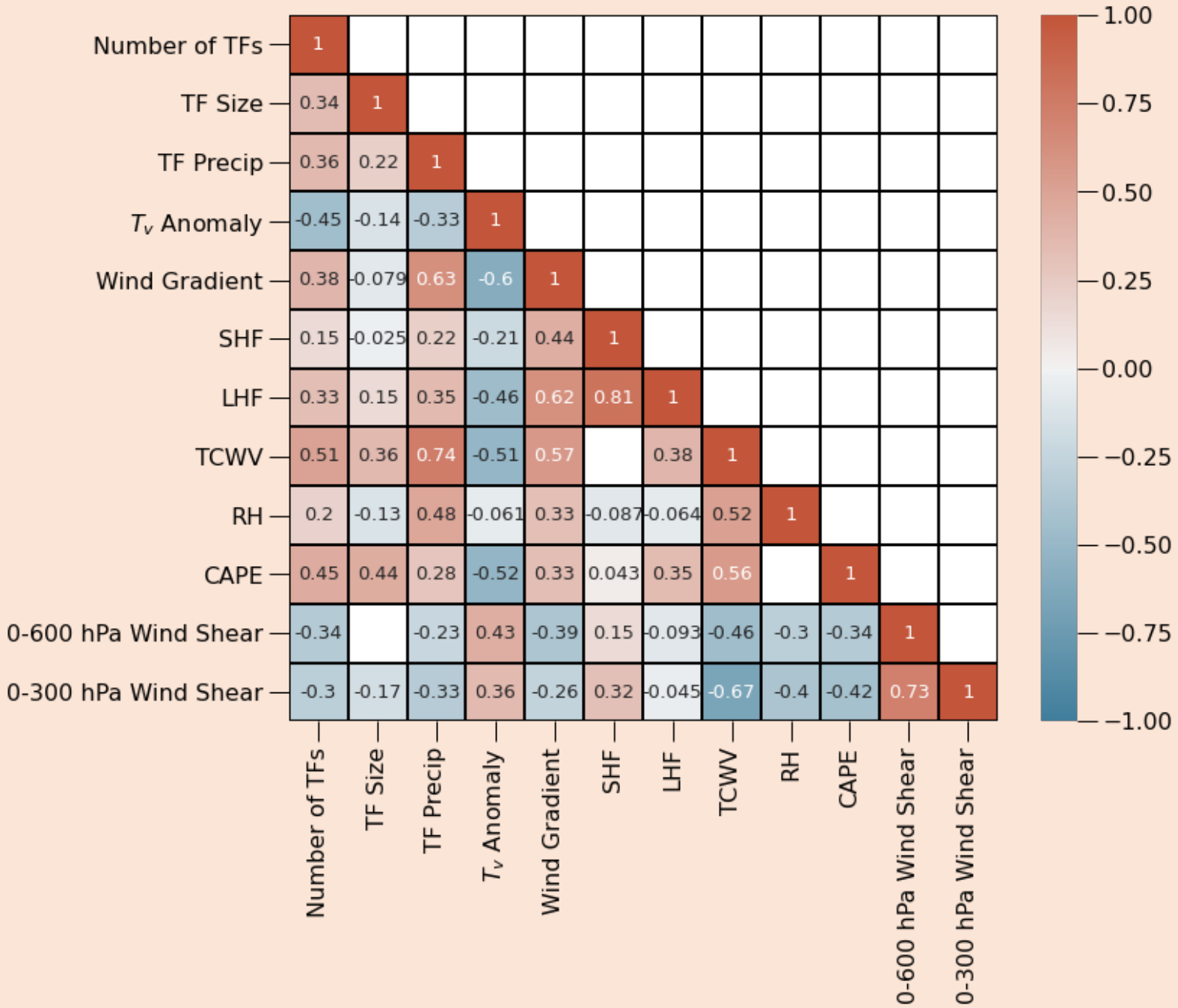
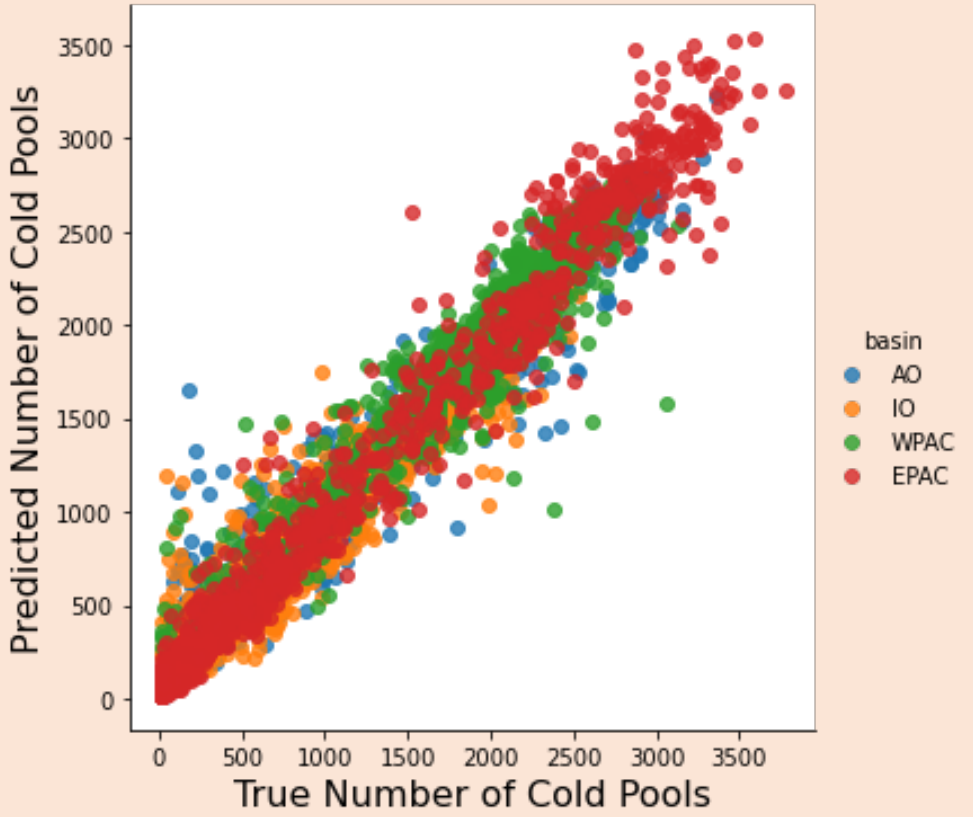

Number of TFs
TF Size
TF Precip
T_v Anomaly
Wind Gradient
SHF
LHF
TCWV
RH
CAPE
0-600 hPa Wind Shear
0-300 hPa Wind Shear
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00

Current Ongoing Work

Identify Relationships between Environmental Properties and Number, Size and Intensity of ICON-Simulated Cold Pools using Machine Learning.

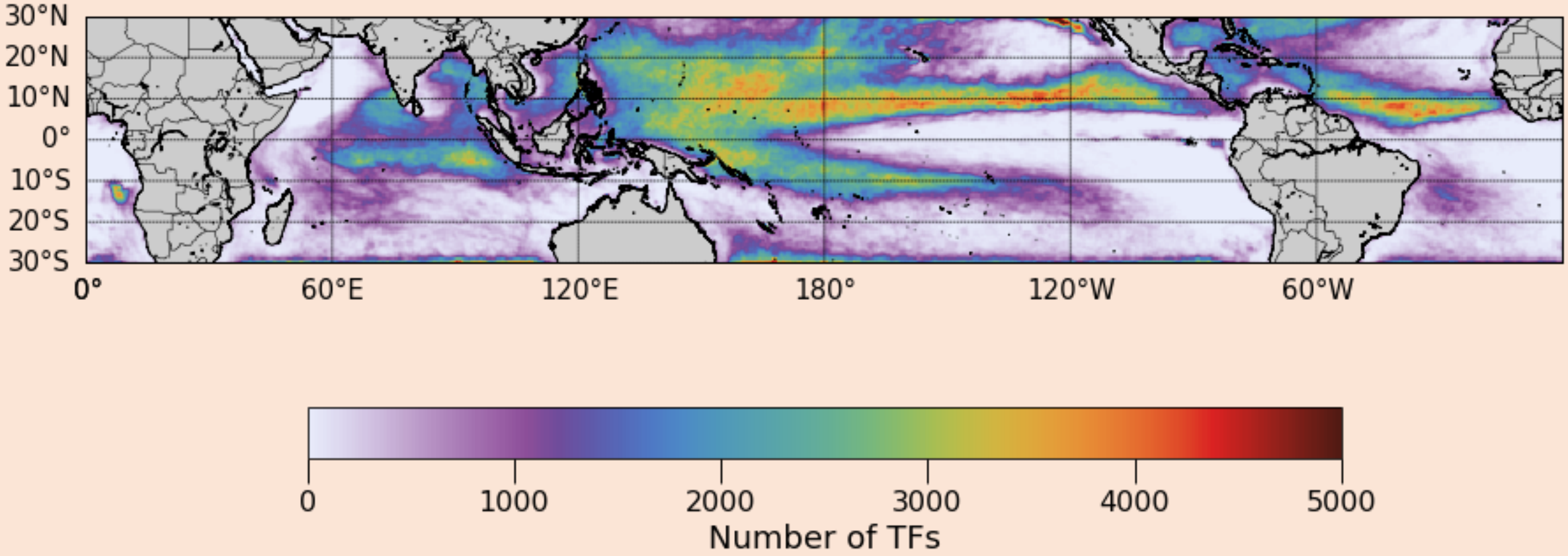
Example shown here is to predict number of cold pools using Random Forest Regression. R^2 Score: 0.94 and RMSE of 0.23



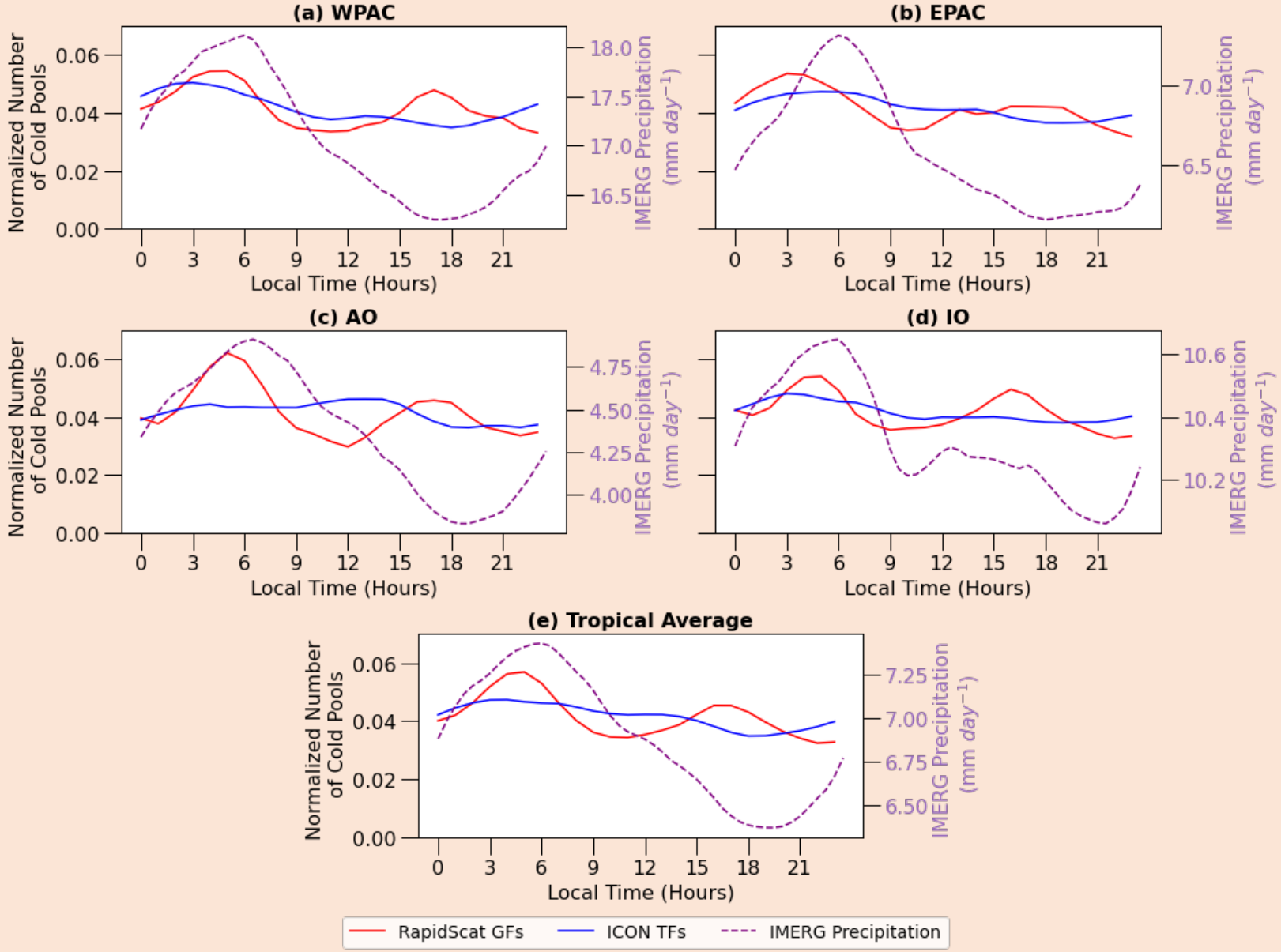
Predictors:
TCWV
CAPE
0-600 hPa Wind Shear
0-300 hPa Wind Shear
RH
Precipitation

Summary

Model Simulated Cold Pool Climatologies are highly insightful in understanding cold pool-environment relationship.



ICON Cold Pool Number Diurnal Cycle Misses the Afternoon Cold Pool Activity Observed from RapidScat GFs



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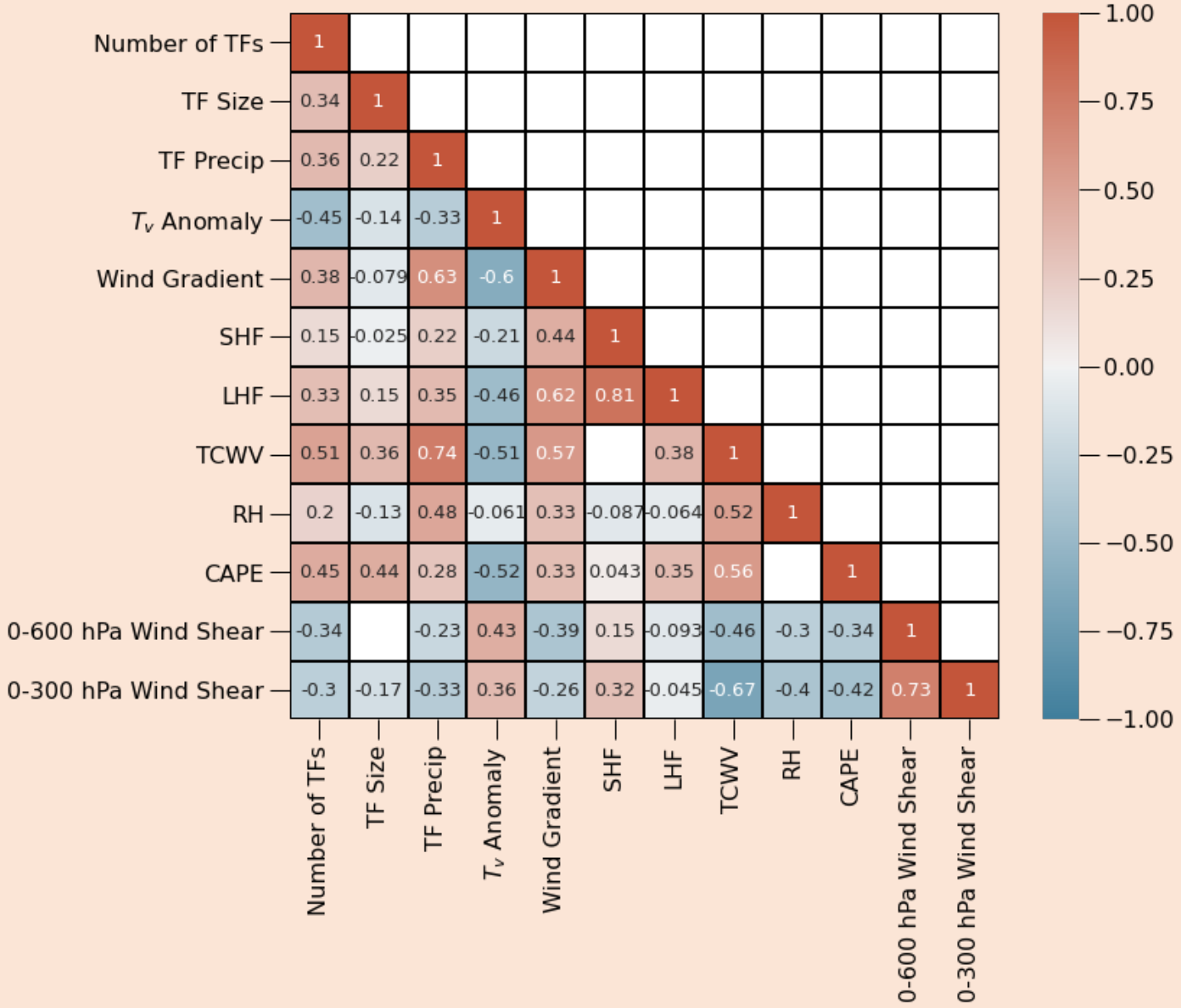
Cold Pool-Environment Relationship differs from basin to basin and needs to be carefully analyzed.



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Thank You!!

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