The Abdus Salam International Centre for Theoretical Physics

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Lake coupled convection permitting simulations over the Lake Victoria basin with RegCM4.7: What is the benefit of permitting convection?

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CORDEX FPS – ELVIC – Climate Extremes in the Lake Victoria Basin

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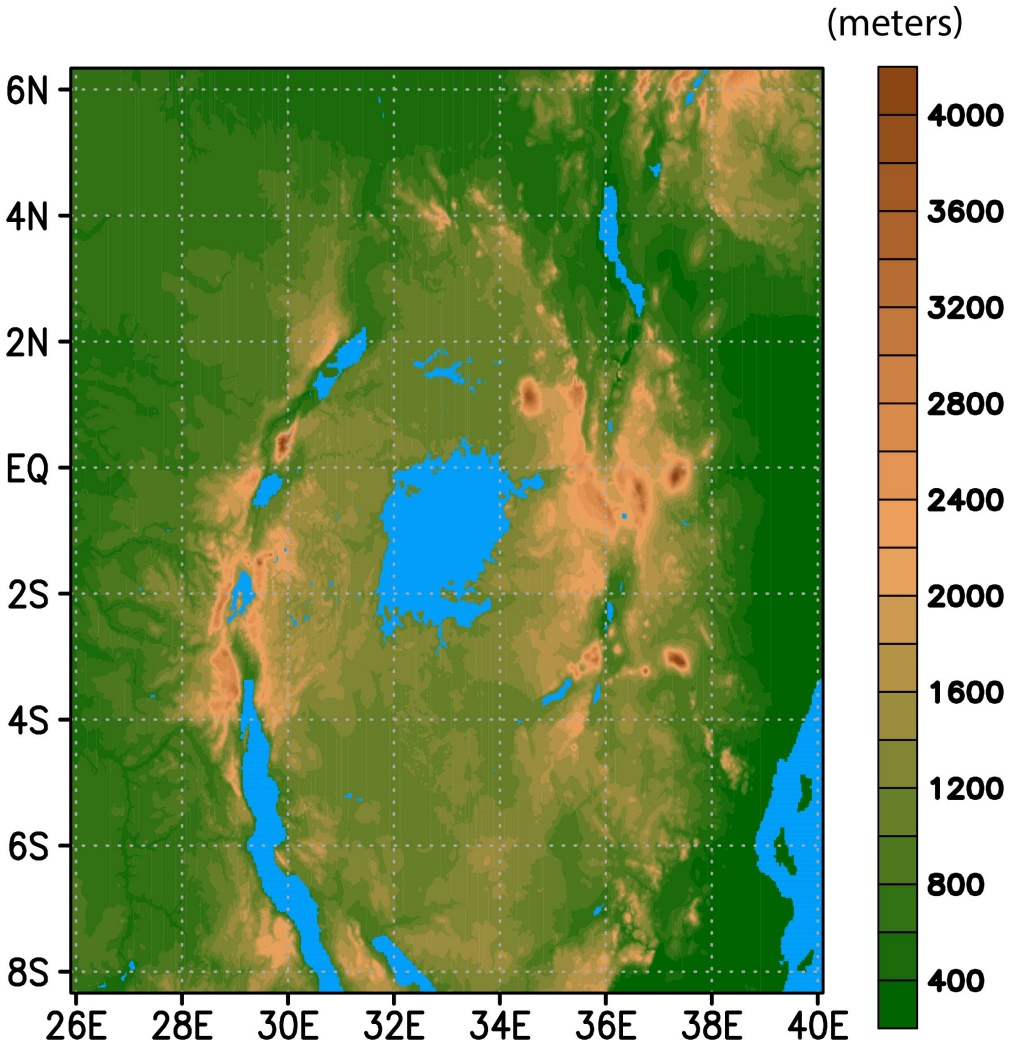
Lake Victoria Region and Hazards

- An Estimated 3,000-5,000 fatalities occur on Lake Victoria per year due to hazardous weather (Red Cross 2014)

Death toll in Lake Victoria boat tragedy rises to 23

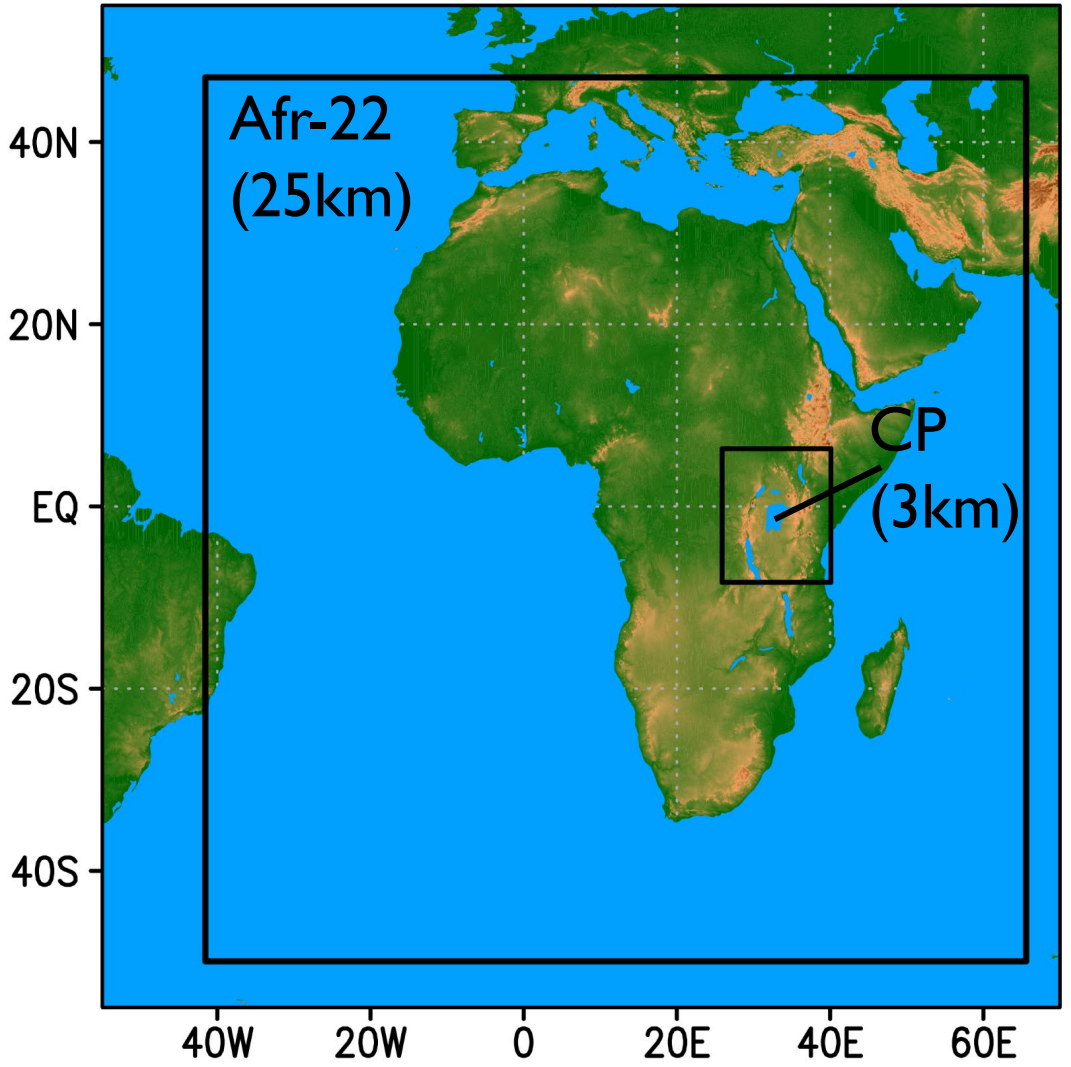
SUNDAY NOVEMBER 25 2018

- Frequent severe nighttime thunderstorm development over the Lake (Thiery et al. 2016; Chamberlain et al. 2014)
- 2nd Largest Lake in the world, Elevation: ~1100m, Mean depth: ~45m

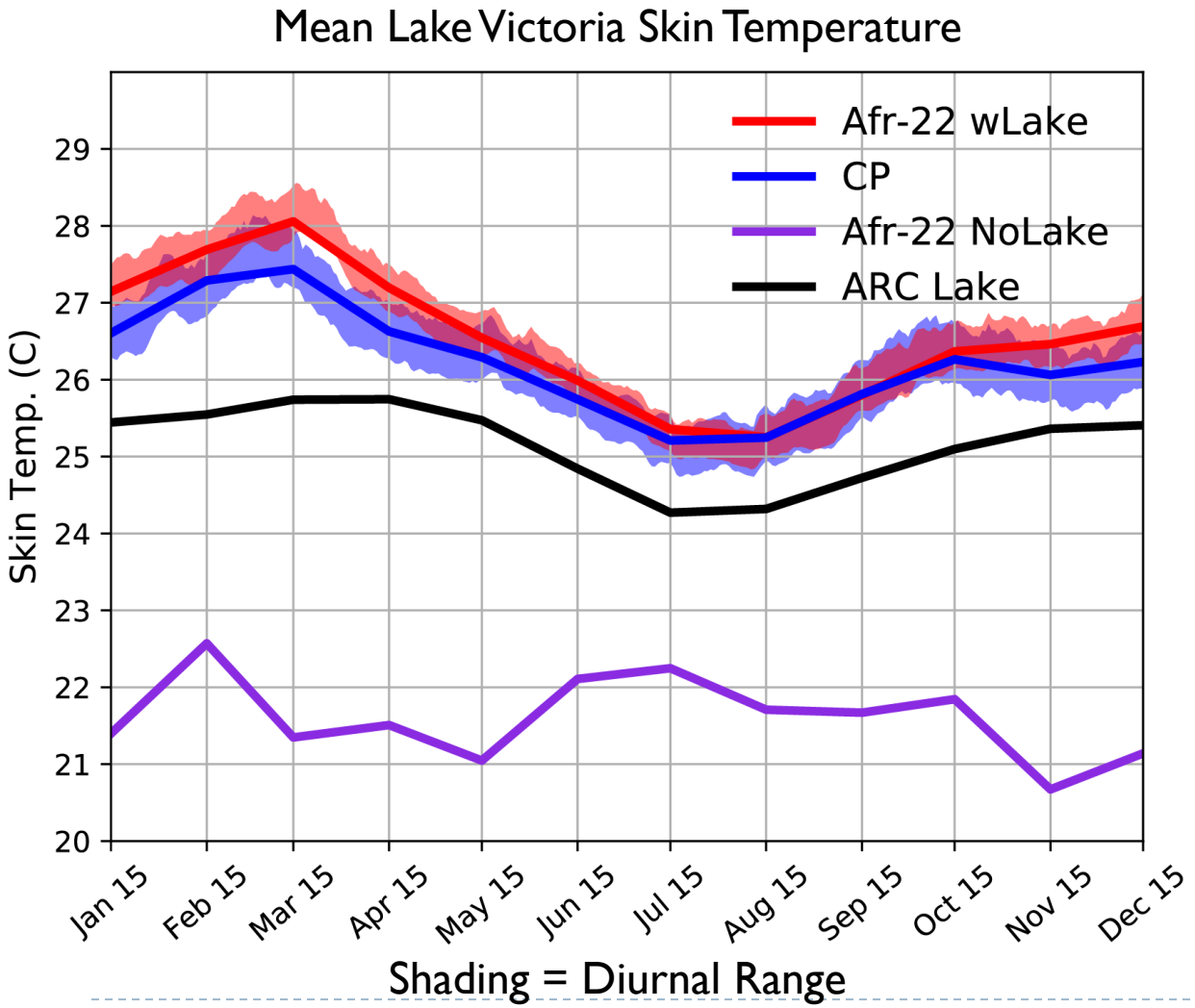


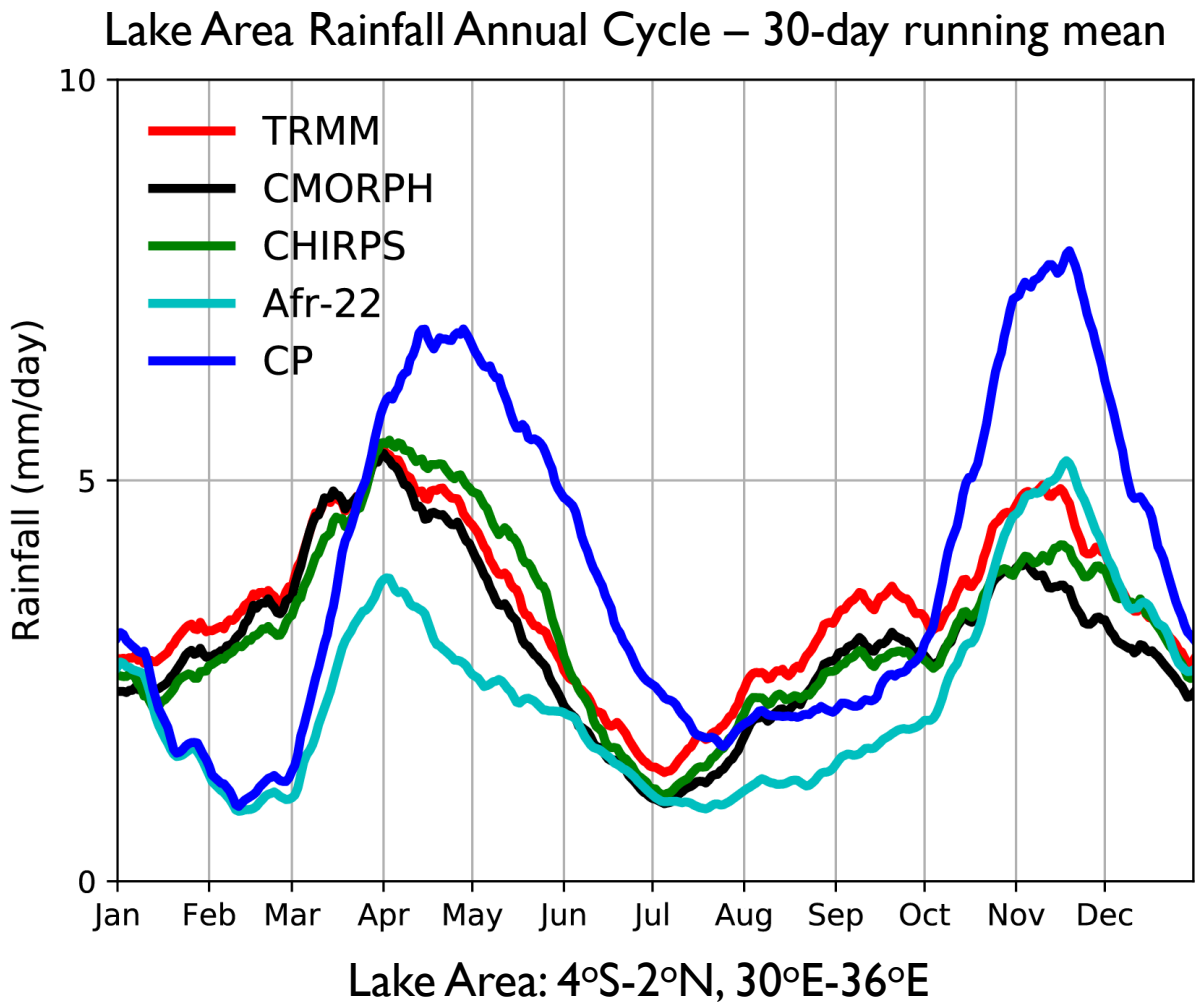
Model Description RegCM v4.7

- RegCM 4.7.0 3km grid-spacing; 41 vertical sigma levels
- Boundary forcing from 25km RegCM 4.7.0 ERA-Int forced Simulation of Pan-Africa CORDEX (Afr-22)
- Time Period: 2005-2015 (2012 ongoing)
- MM5 Non-Hydrostatic core, No large-scale convective scheme – Shallow convection
- Lake Coupling Through: Hostetler et al. (1993) lake model; modifications from Bennington et al. (2014)

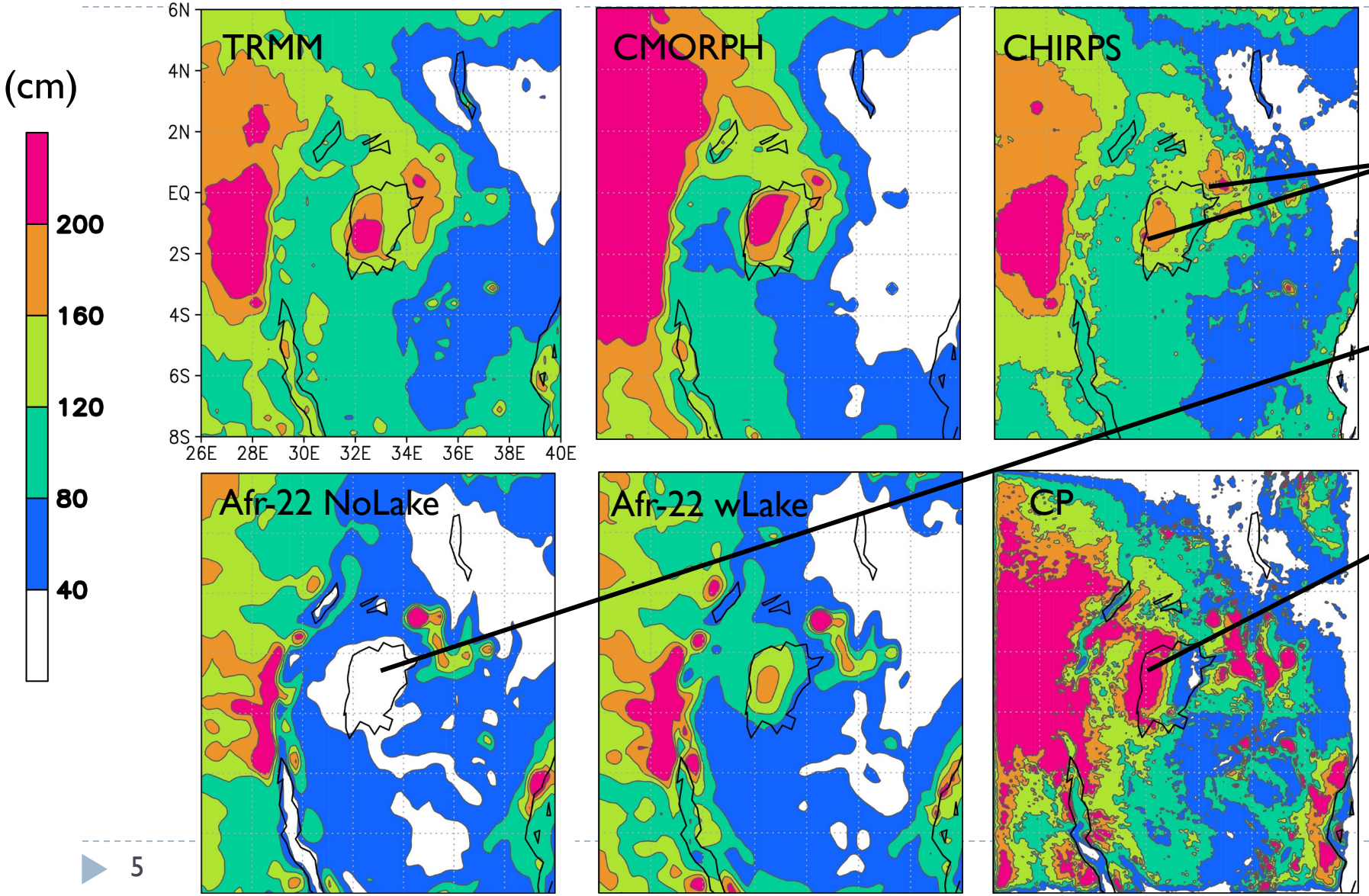


Annual Cycle: Rainfall and Lake Surface Temperature



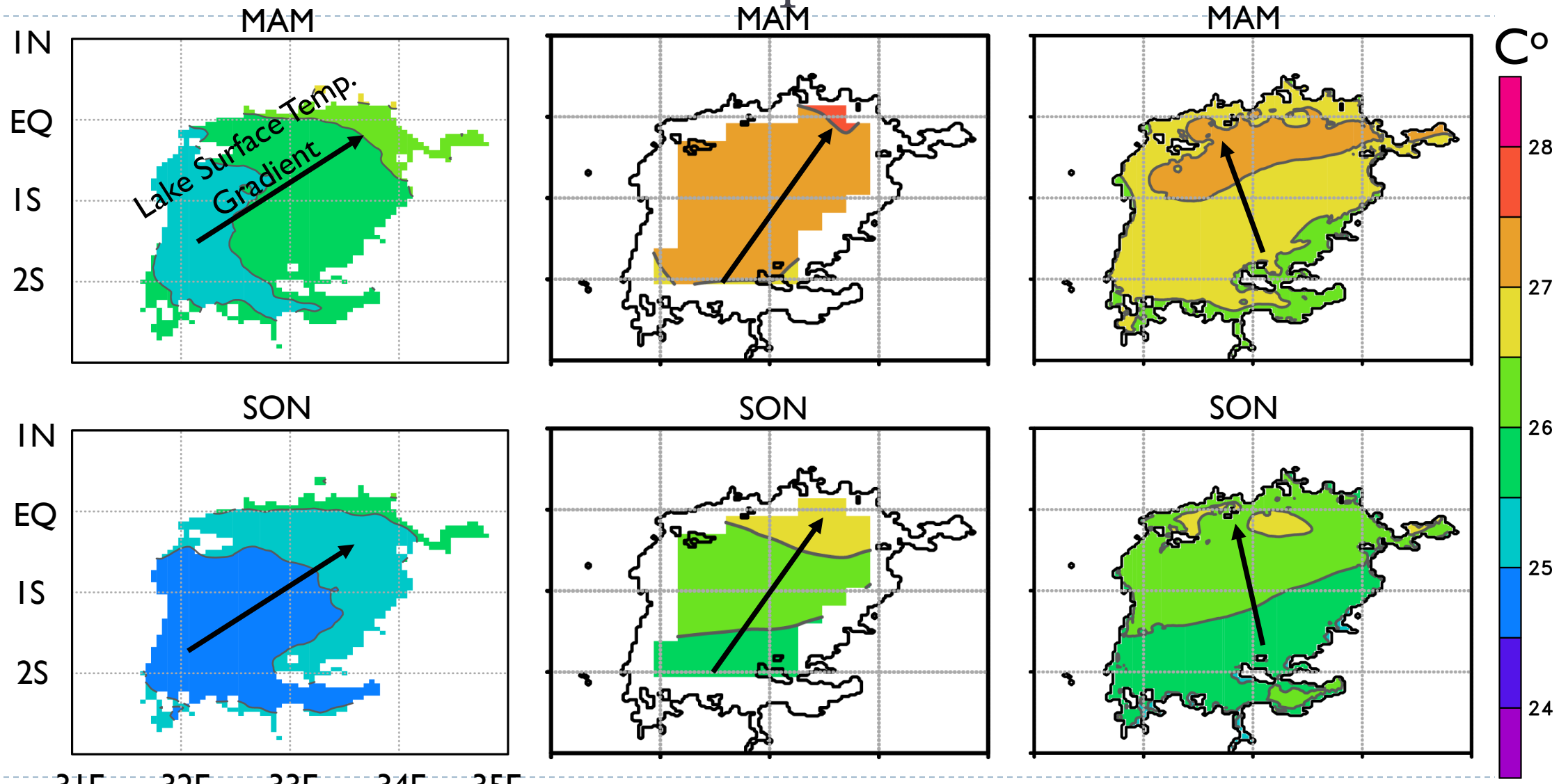


Annual Accumulated Rainfall



- Rainfall maxima SW corner of Lake; NE-E Coast of Lake
- Without Lake model little to no rainfall over Lake
- CP sim. rain maxima along west coast of Lake

Seasonal Lake Surface Temperature

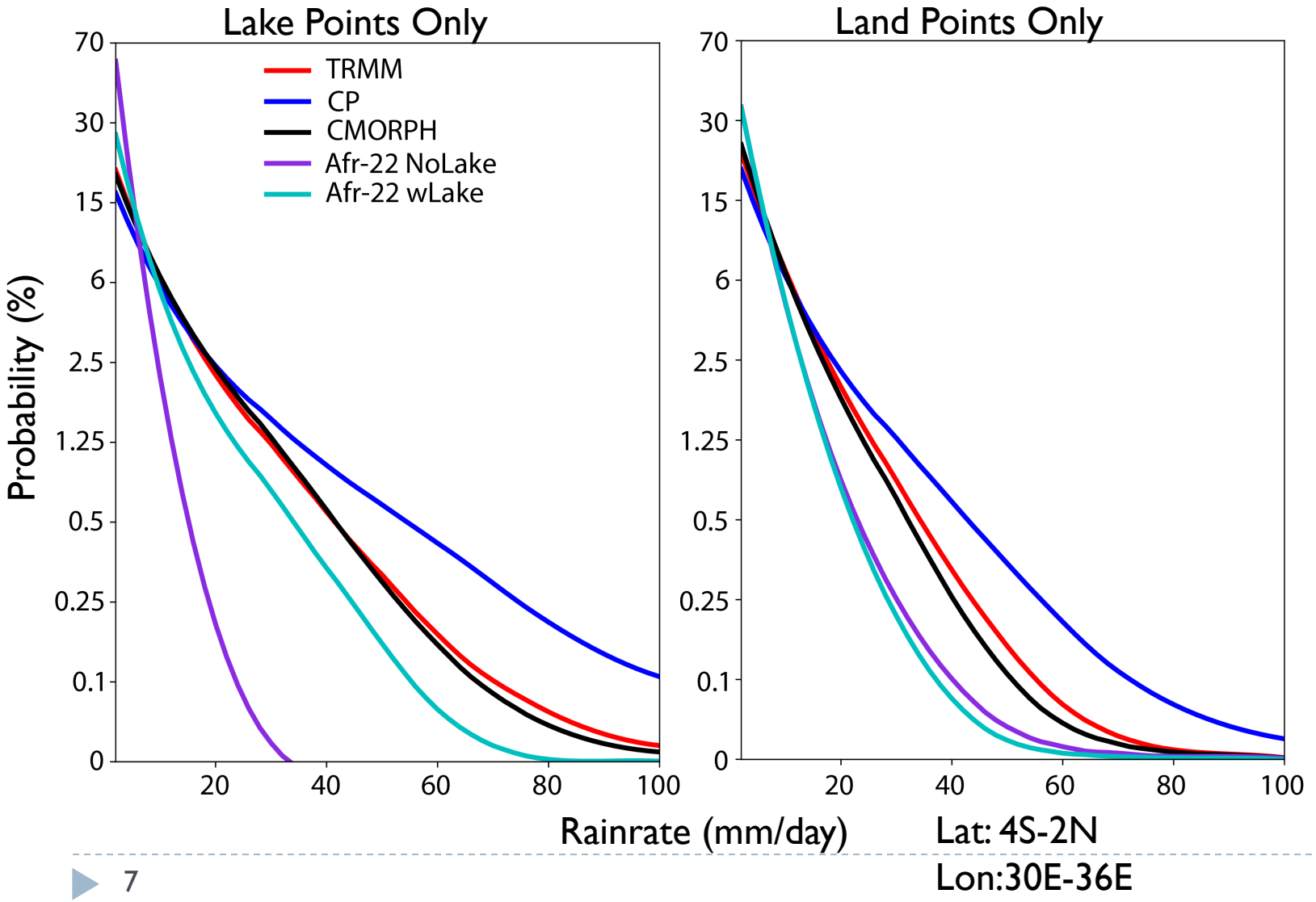


ARC Lake Climatology

Afr-22 wLake

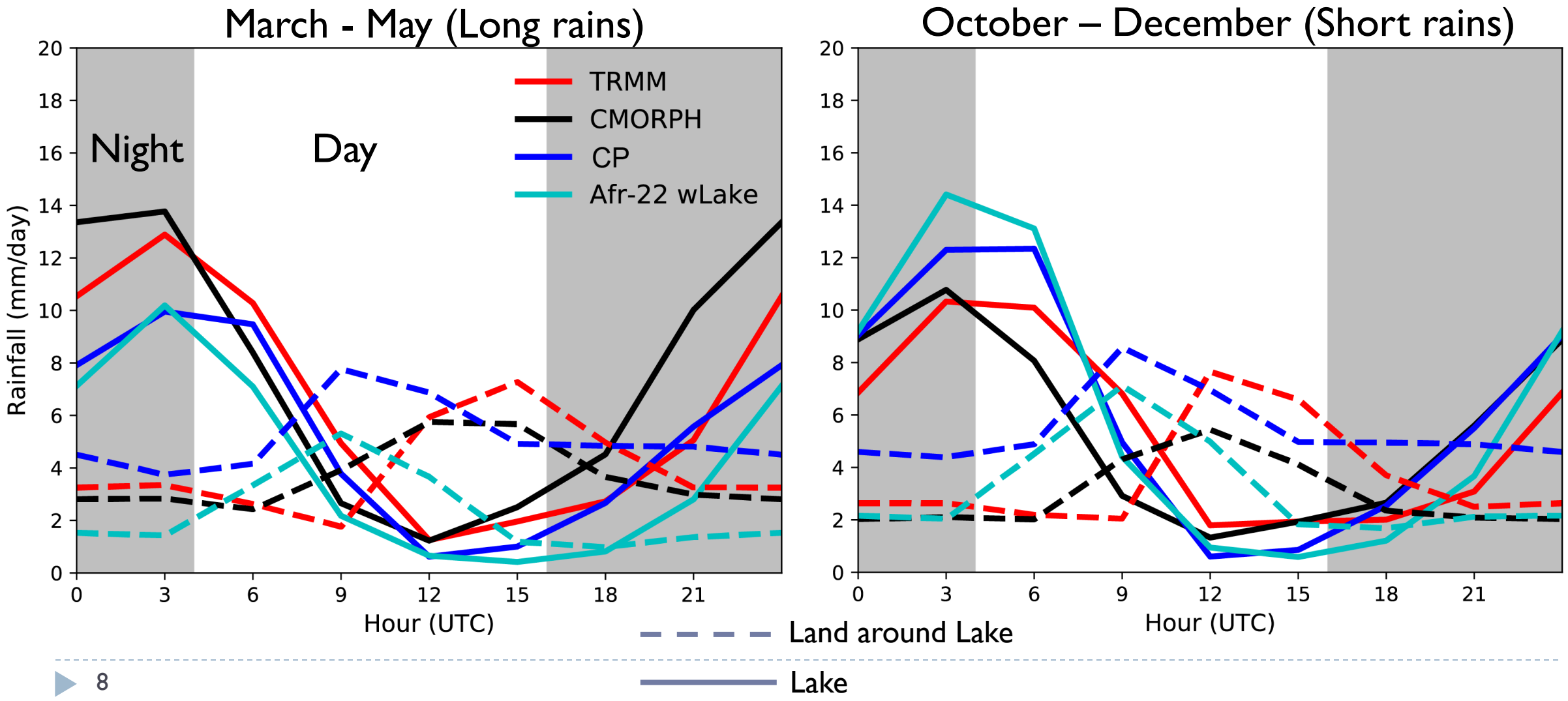
CP

Rainfall Distribution over Land vs. Lake



- Obs. and 3km: more heavy rainfall events over the Lake vs. Land surrounding lake; Coarse simulation lacks heavy rain events over the Lake
- Coarse simulation produces too much light rain

Diurnal Rainfall Cycle over Land vs. Lake



Composited Nocturnal Extreme Rainfall Events

TRMM

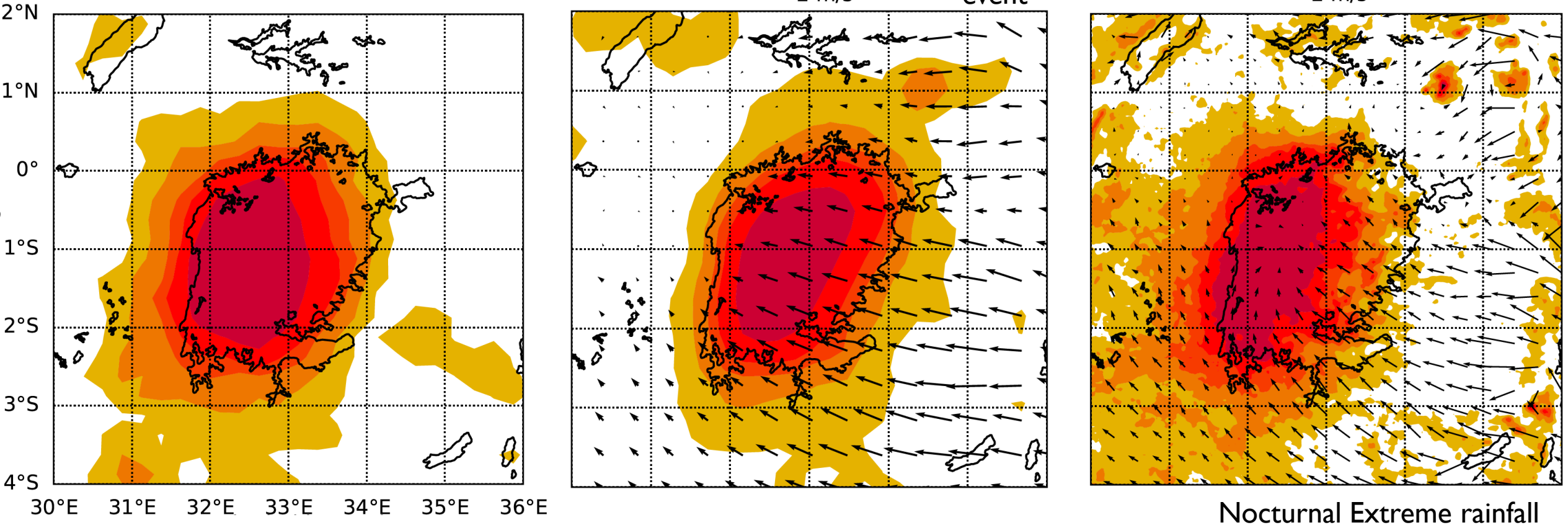
Afr-22 wLake

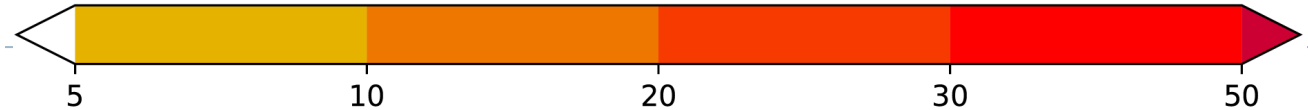
→ 2 m/s

Vectors=850mb winds coincident with extreme event

CP

→ 2 m/s



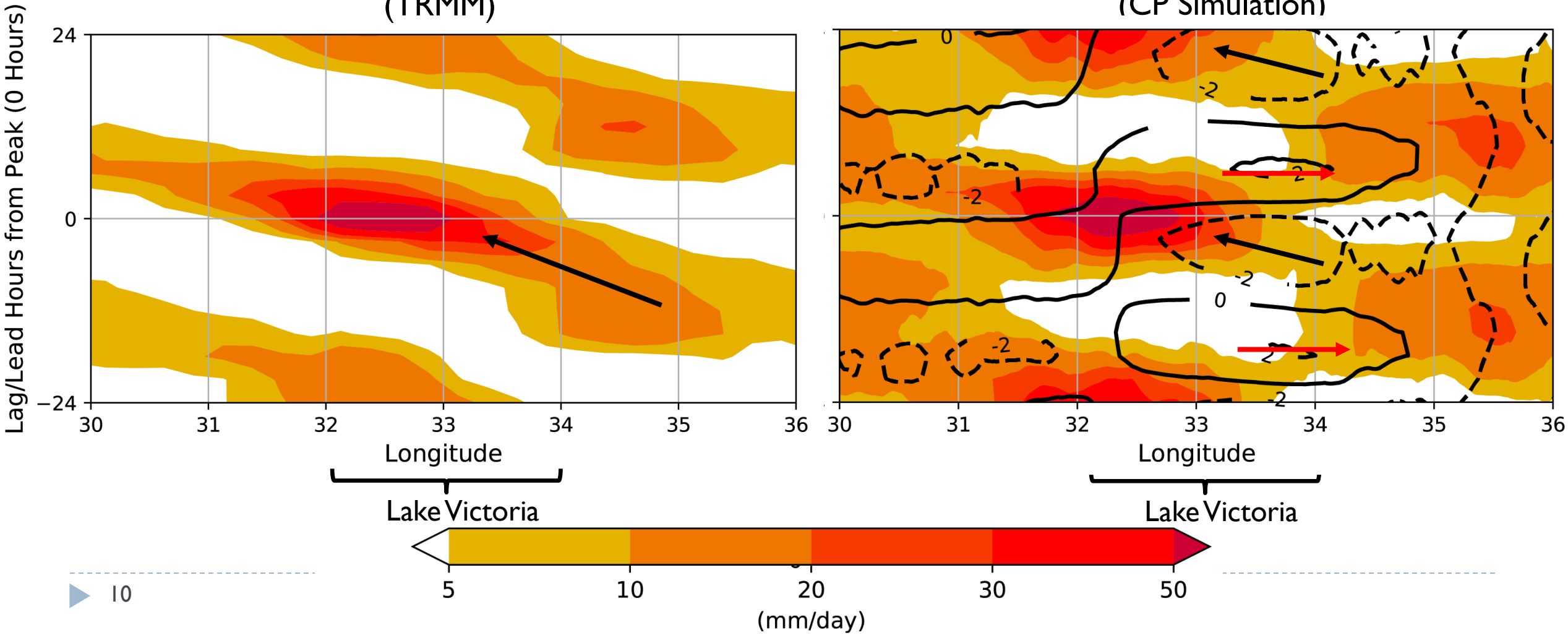


Nocturnal Extreme rainfall event = timeseries of lake rainfall exceeds 2 STDs at night

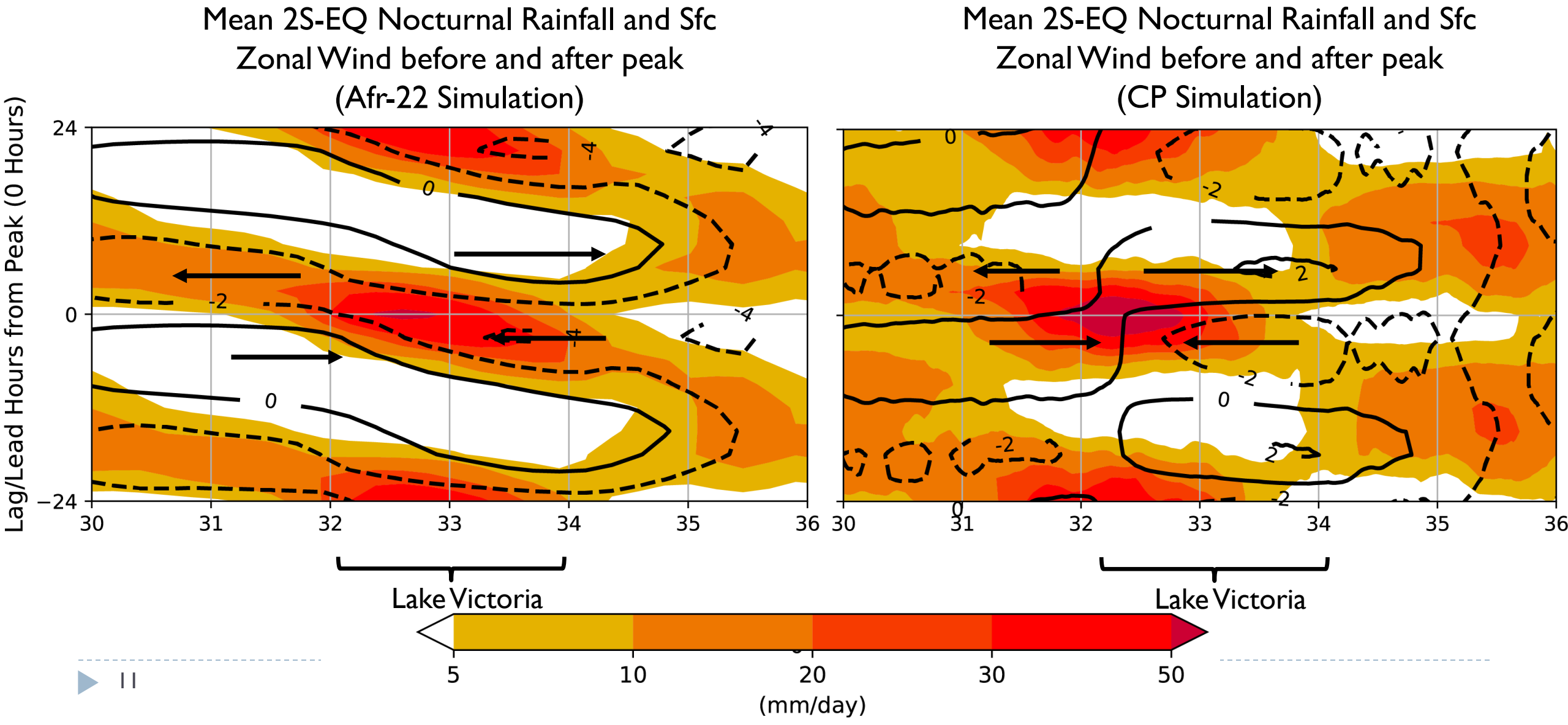
Composite Nocturnal Extreme Rainfall Events Evolution

Mean 2S-EQ Nocturnal Rainfall before and after peak (TRMM)

Mean 2S-EQ Nocturnal Rainfall and Sfc Zonal Wind before and after peak (CP Simulation)



Afr-22 vs. CP


Mean 2S-EQ Nocturnal Rainfall and Sfc Zonal Wind before and after peak (Afr-22 Simulation)
Mean 2S-EQ Nocturnal Rainfall and Sfc Zonal Wind before and after peak (CP Simulation)
Lag/Lead Hours from Peak (0 Hours)
24
0
−24
30
31
32
33
34
35
36
Lake Victoria
Lake Victoria
5
10
20
30
50
(mm/day)

Summary

- CP simulation overestimates, coarser simulation underestimates rainfall during rainy seasons
- Lake-Atmosphere coupling is able to reproduce Lake sfc temperature annual cycle but is generally warmer than ARC Lake
- Timing and intensity of Nocturnal Convective events is well captured however daytime rainfall peaks too early
- Afr-22 resolves Lake well enough to reproduce general features of diurnal cycle, CP provides improved representation of small scale circulations such as those associated with Nocturnal Thunderstorms
- As long as a coupled lake model is present, Afr-22 is able to reproduce Lake climate well enough to compete with CP

References

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- Thiery, W., Davin, E. L., Seneviratne, S. I., Bedka, K., Lhermitte, S., and Lipzig, N. P.M. van (2016), Hazardous thunderstorm intensification over Lake Victoria, *Nat. Commun.*, DOI: 10.1038/ncomms12786, 1-7.