Regional Comparisons of Marine Stratocumulus Precipitation Patterns

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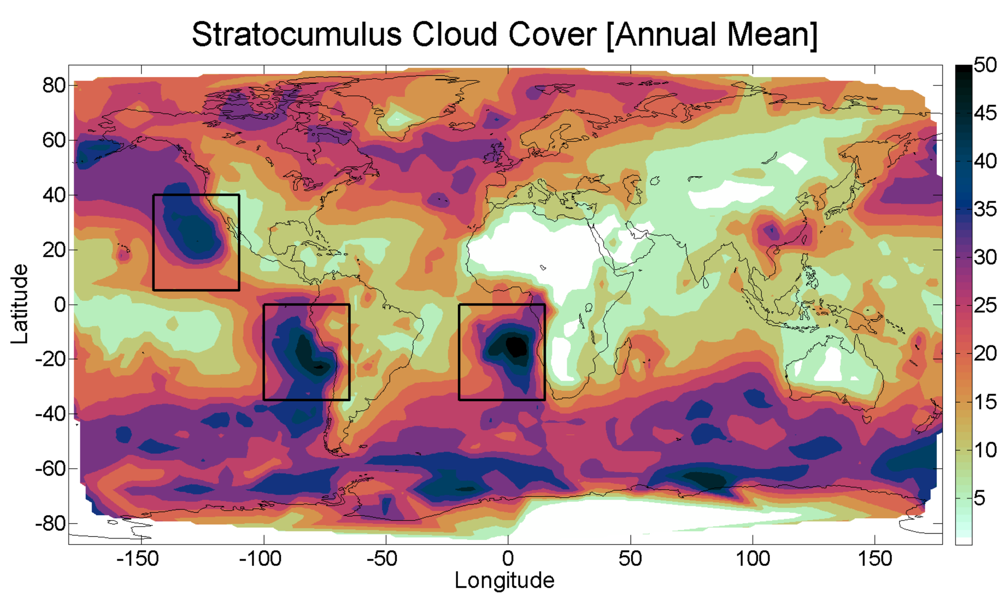
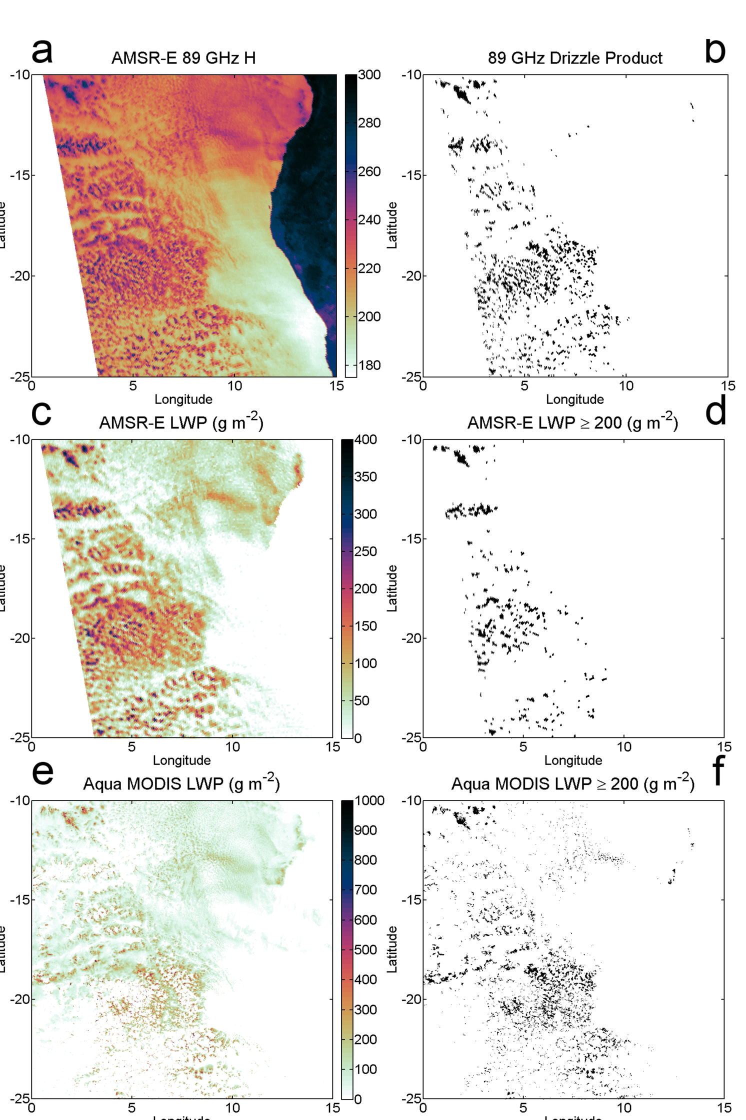


Fig. 1. Annual mean stratocumulus cloud cover with areas of interest outlined in black (Hahn and Warren, 2007).

Fig. 2. MODIS visible images of stratocumulus cloud decks in each area of interest - a) off the coast of California on 24 July 2009 at 21:40 UTC, b) off the coast of Peru on 3 September 2009 at 19:45 UTC and c) off the coast of Namibia on 11 October 2009 at 14:10 UTC.

Introduction

Marine stratocumulus clouds are important sources of net cooling in the global radiation budget and are poorly represented in global climate models. Several field studies have shown that drizzle has a role in modulating low cloud mesoscale structures, cloud fraction and albedo. In this work, we use an 89 GHz passive microwave emission algorithm to document the spatial frequency of drizzle occurrence during the day and at night off the coasts of California, Peru and Namibia for the period 2002-2011 (the entire AMSR-E data set). The resulting climatology is more comprehensive than previous work using the Cloudsat radar and allows us to do regional as well as interannual comparisons.



Data Overview

AMSR V002

- AE_L2A - AMSR-E/Aqua L2A Global Swath Spatially-Resampled Brightness Temperatures
- AE_Ocean - AMSR-E/Aqua L2B Global Swath Ocean Products derived from Wentz Algorithm

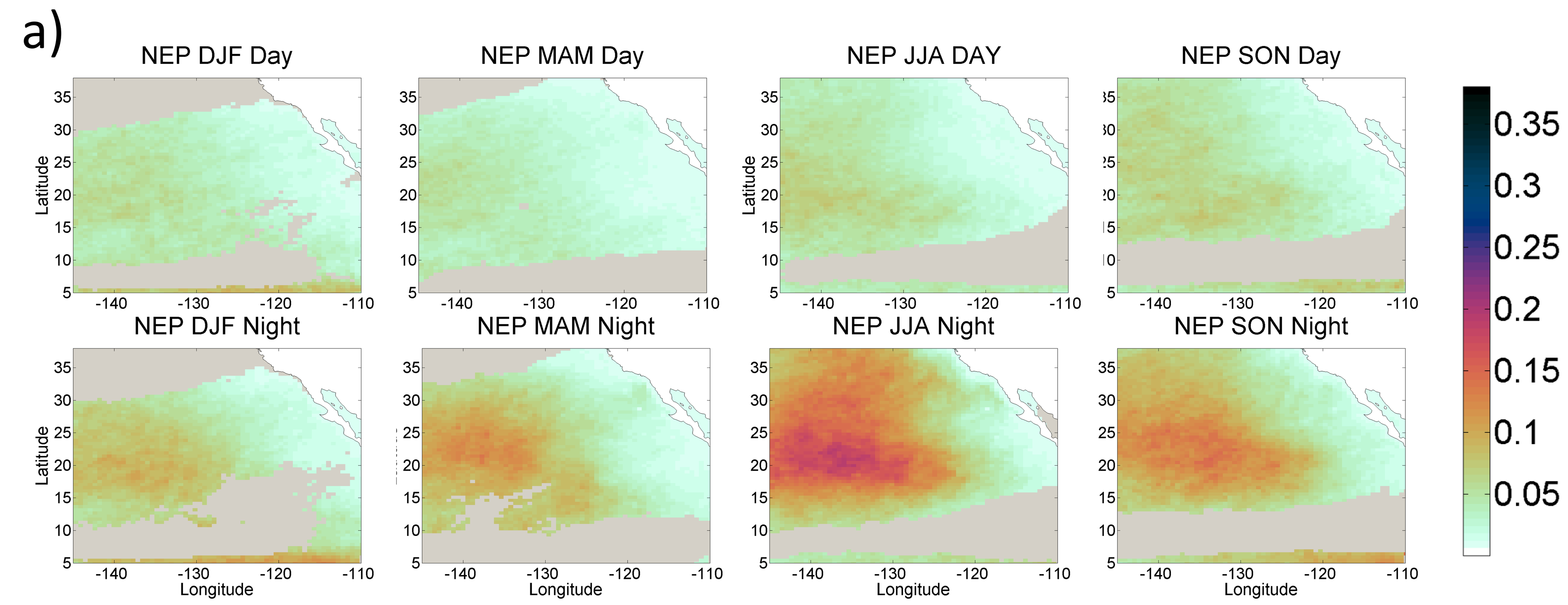
MODIS Series 51

- MYD06_L2 - Aqua MODIS Level 2 Cloud Product

Data Inventory: 2002-2011

Region	Day Scenes	Night Scenes
SEP	8727	8692
Namibia	8744	7842
California	6028	8953

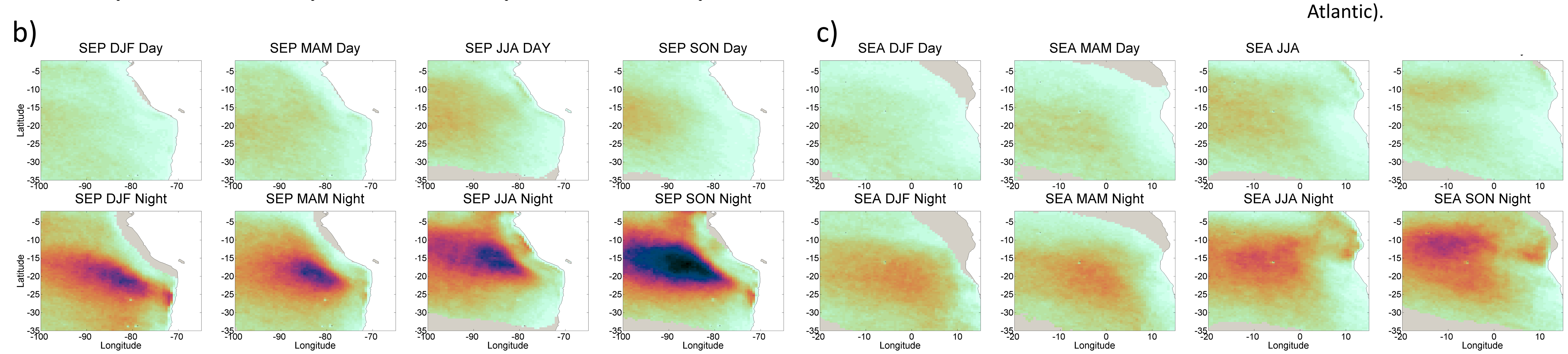
Fig. 3. Comparison among 89 GHz drizzle detection method (top row), AMSR-E LWP > 200g/m2 (middle row) and MODIS LWP (bottom row). Left column shows the indicated product which is simplified to a binary drizzle occurrence map in the right column. Data are from the Namibian region. Scenes from 26 June 2007.



Methodology

We use 89 GHz emission from AMSR-E to detect drizzling clouds with LWP > 200 gm^2 (Miller and Yuter, 2012). The 89 GHz drizzle detection method and the AMSR-E liquid water path are highly correlated in terms of spatial distribution (Fig. 3). The 89 GHz drizzle detection method has the advantage of utilizing finer spatial resolution inputs.

Fig. 4. Normalized frequency of drizzle by region, time, and season over the entire AMSR-E dataset (2002-2011). Bins where ice-phase cloud frequency > 0.33 are shaded in grey and excluded from the analysis. **a)** The Californian region is indicated as NEP (Northeast Pacific), **b)** Peruvian as SEP (Southeast Pacific), and **c)** Namibian as SEA (Southeast Atlantic).



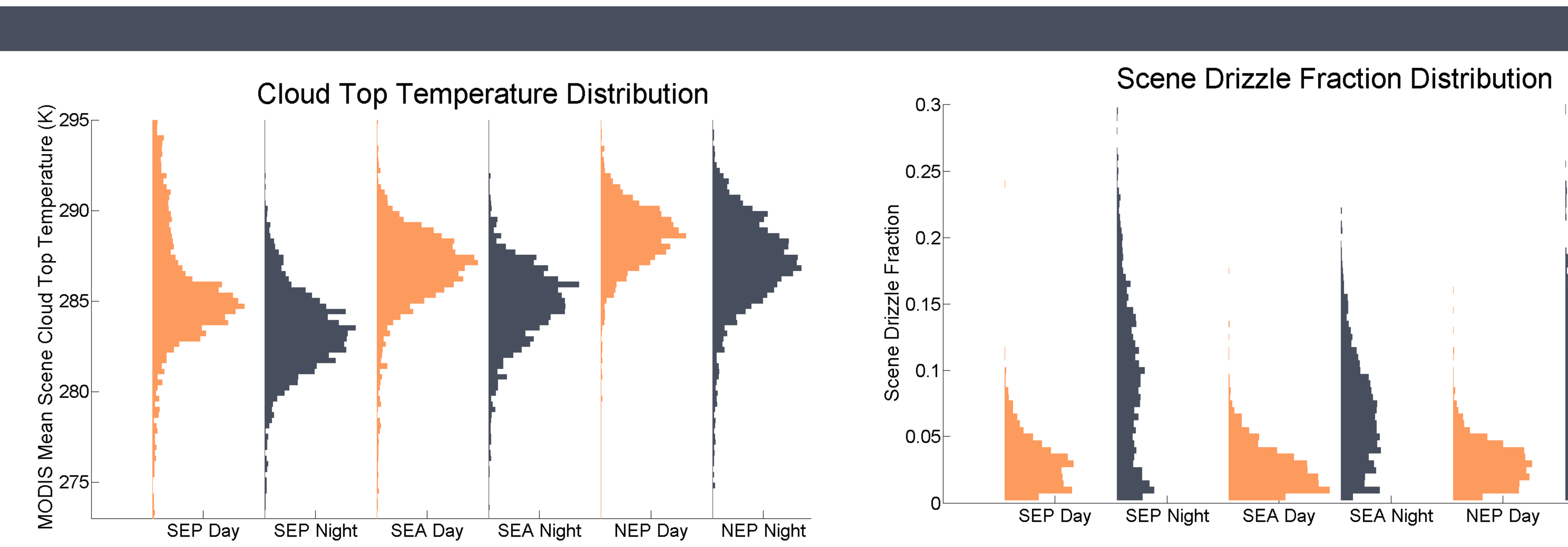


Fig. 5. (Left) Distributions of liquid-phase cloud top temperature and scene drizzle fraction by region and time for the season with the highest drizzle occurrence (SON in SEP and SEA; JJA in NEP).

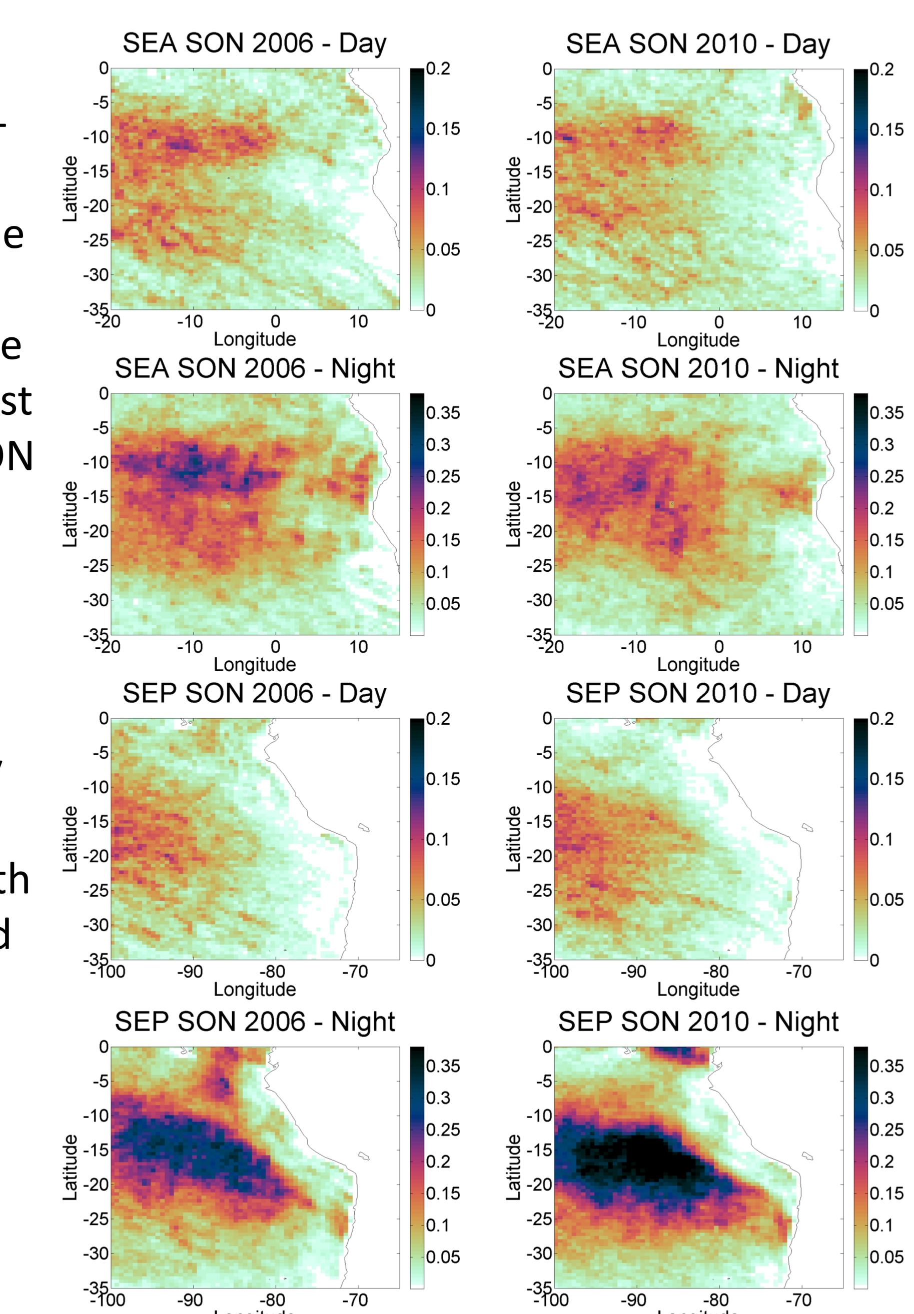


Fig. 6. (Right) Normalized frequency of drizzle by time and region for the year with the highest (2010) and lowest (2006) drizzle occurrence within the peak drizzle season in the Southeast Pacific.

Conclusions

There are distinct differences between the Southeast Pacific, Namibian, and Californian marine stratocumulus regions:

- Overnight drizzle occurs more frequently throughout all seasons within Southeast Pacific marine stratocumulus as compared to the Namibian and Californian regions (Fig. 4).
- The Californian stratocumulus region has a larger liquid-phase cloud top temperature distribution and less boundary layer deepening between day and night scenes.
- The Southeast Pacific region has the most pronounced boundary layer deepening between day and night scenes (Fig. 5).
- There is interannual variability in drizzle occurrence in all regions, there is enhanced variability at night in the Southeast Pacific (Fig. 6).
- Future work will examine the joint variability of drizzle with other variables, specifically albedo, cloud water path, cloud fraction, and cloud effective radius.

References Miller and Yuter, 2012; *Atmos. Measure. Tech., in press.*
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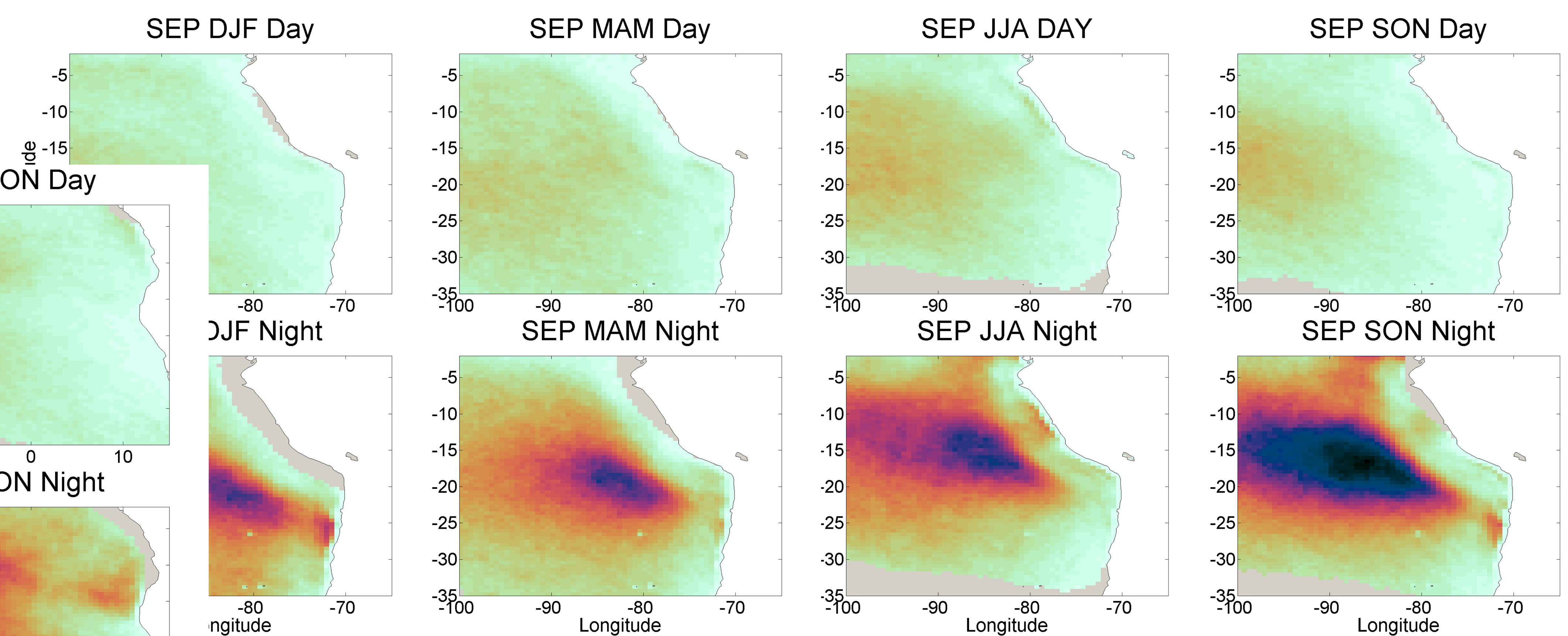
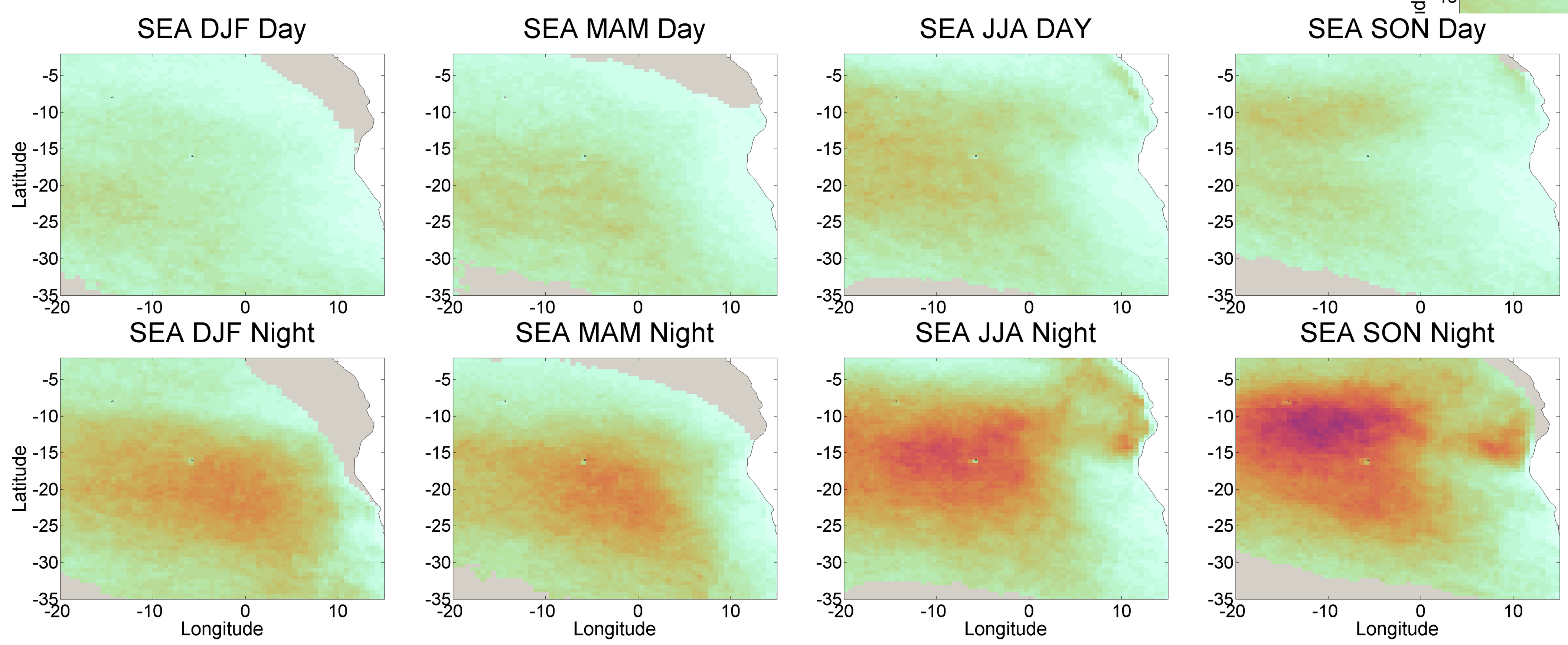

SEP DJF Day
SEP MAM Day
SEP JJA DAY
SEP SON Day
DJF Night
SEP MAM Night
SEP JJA Night
SEP SON Night
Longitude


SEA DJF Day
SEA MAM Day
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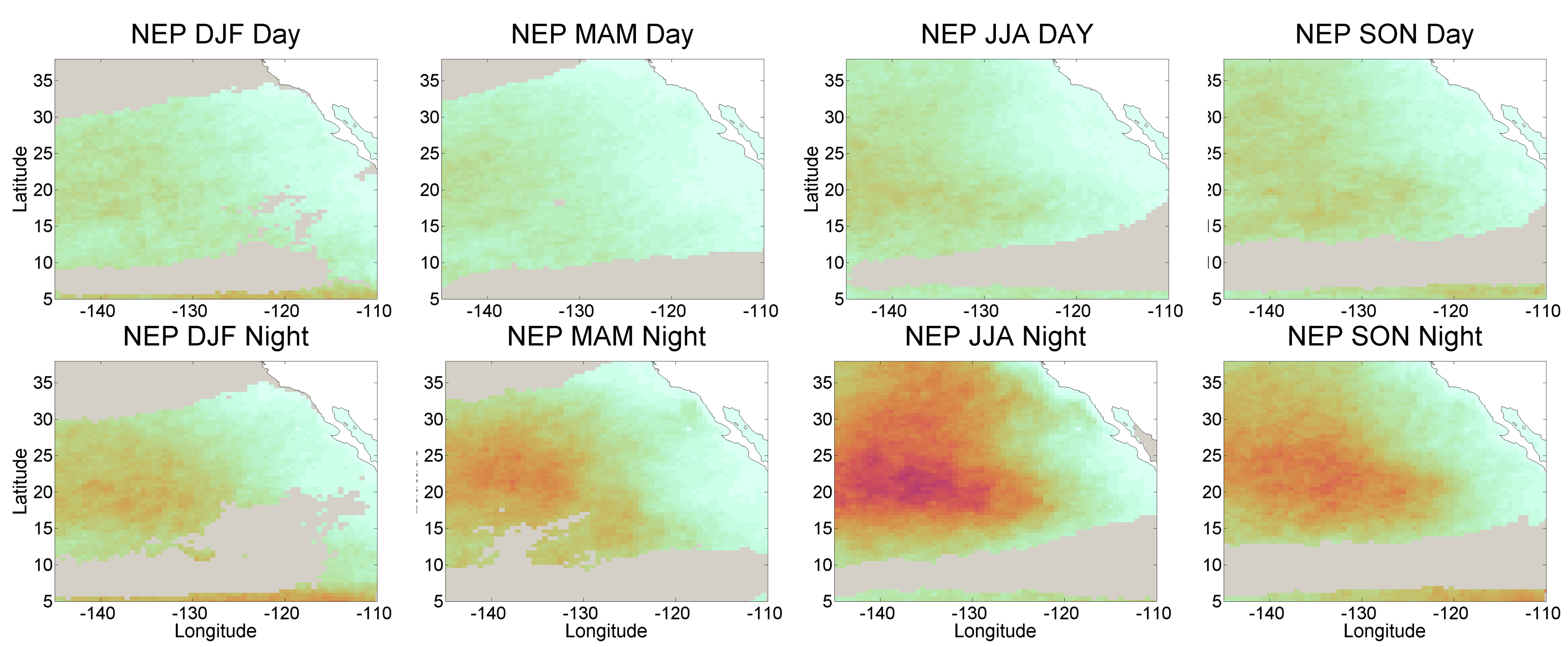
SEA DJF Night
SEA MAM Night
SEA JJA Night
SEA SON Night
Latitude
Longitude


NEP DJF Day
NEP MAM Day
NEP JJA DAY
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NEP DJF Night
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NEP SON Night
Latitude
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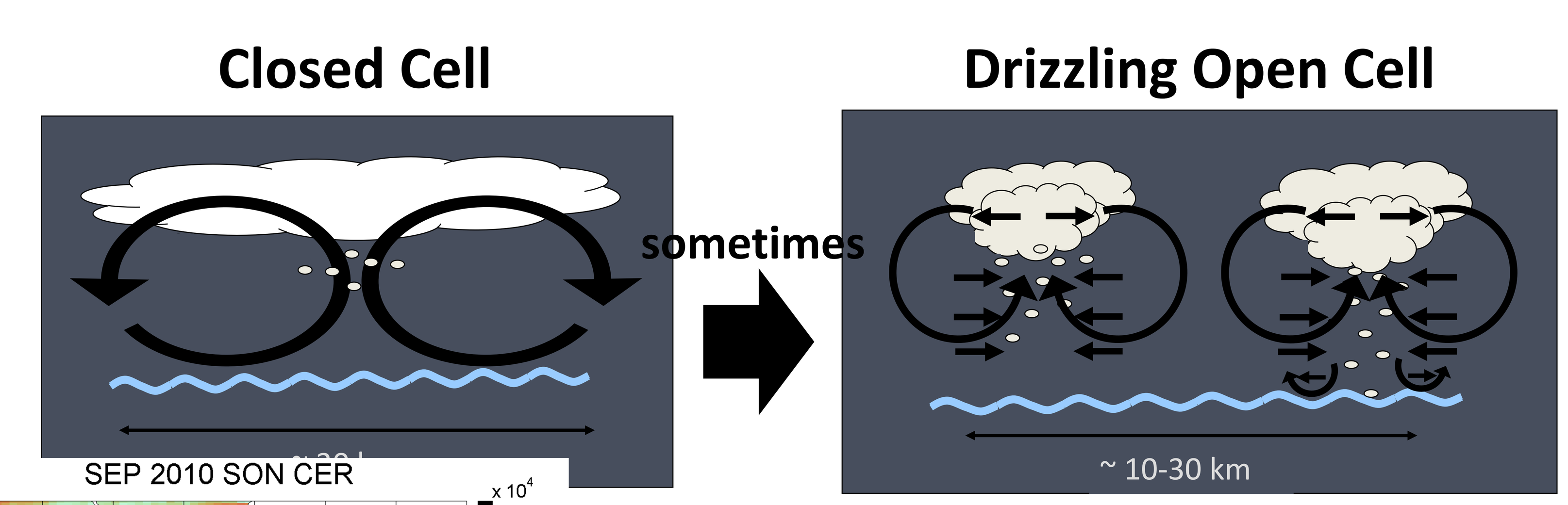
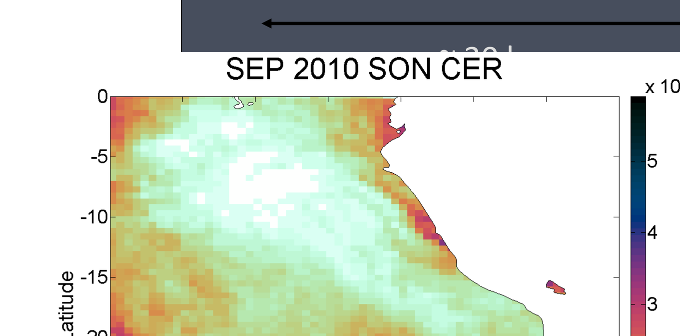
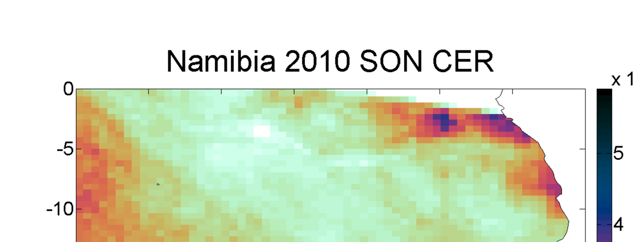

Closed Cell
Drizzling Open Cell
sometimes
~ 10-30 km


SEP 2010 SON CER


Namibia 2010 SON CER