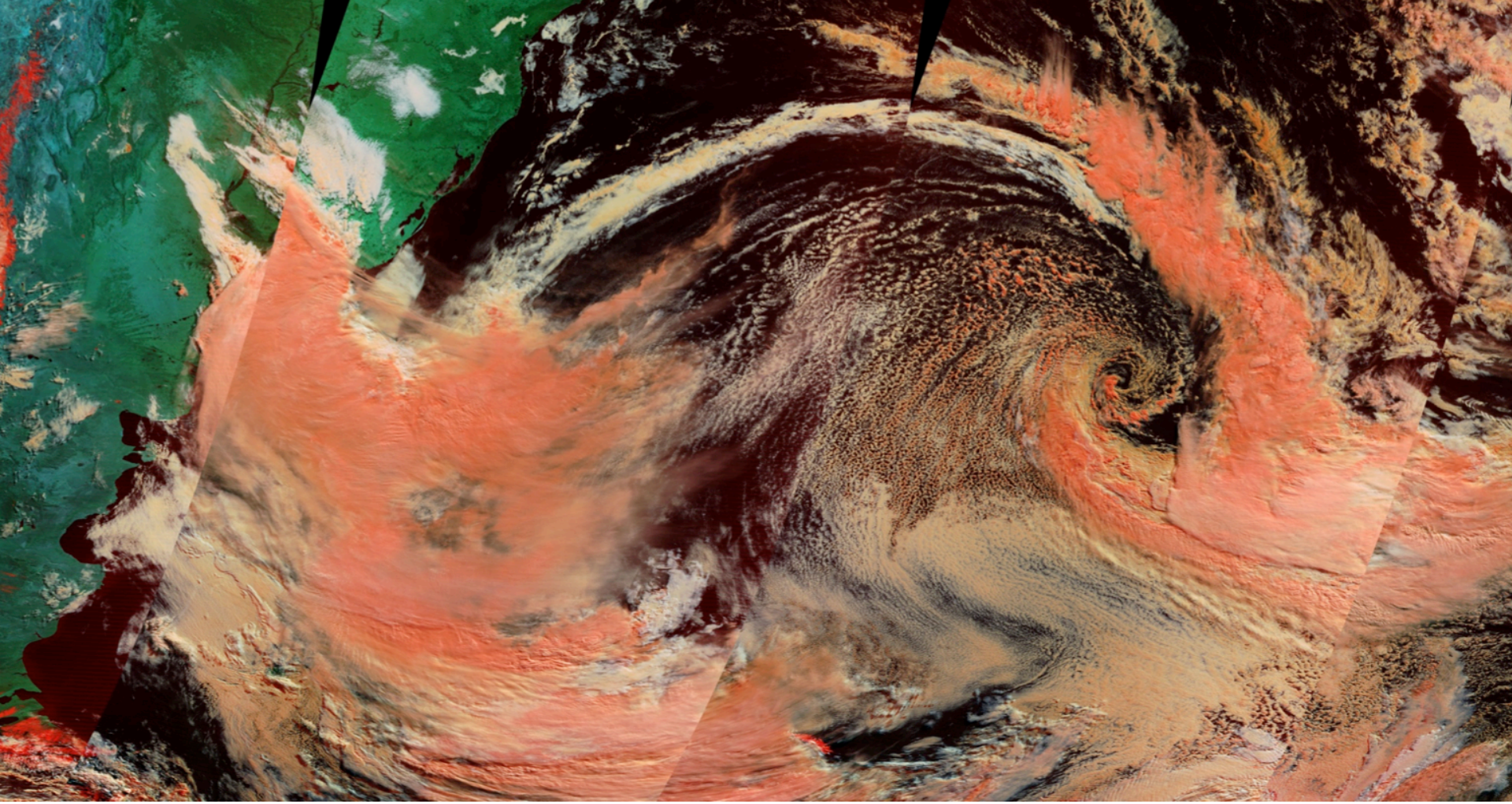


UNDERSTANDING THE RADIATIVE IMPACTS OF OPEN AND CLOSED MESOSCALE CELLULAR CONVECTION

Isabel McCoy, Robert Wood

University of Washington Atmospheric Sciences

CERES Team Meeting, 1-3 September 2015

OUTLINE

Open and Closed Mesoscale Cellular Convection (MCC)

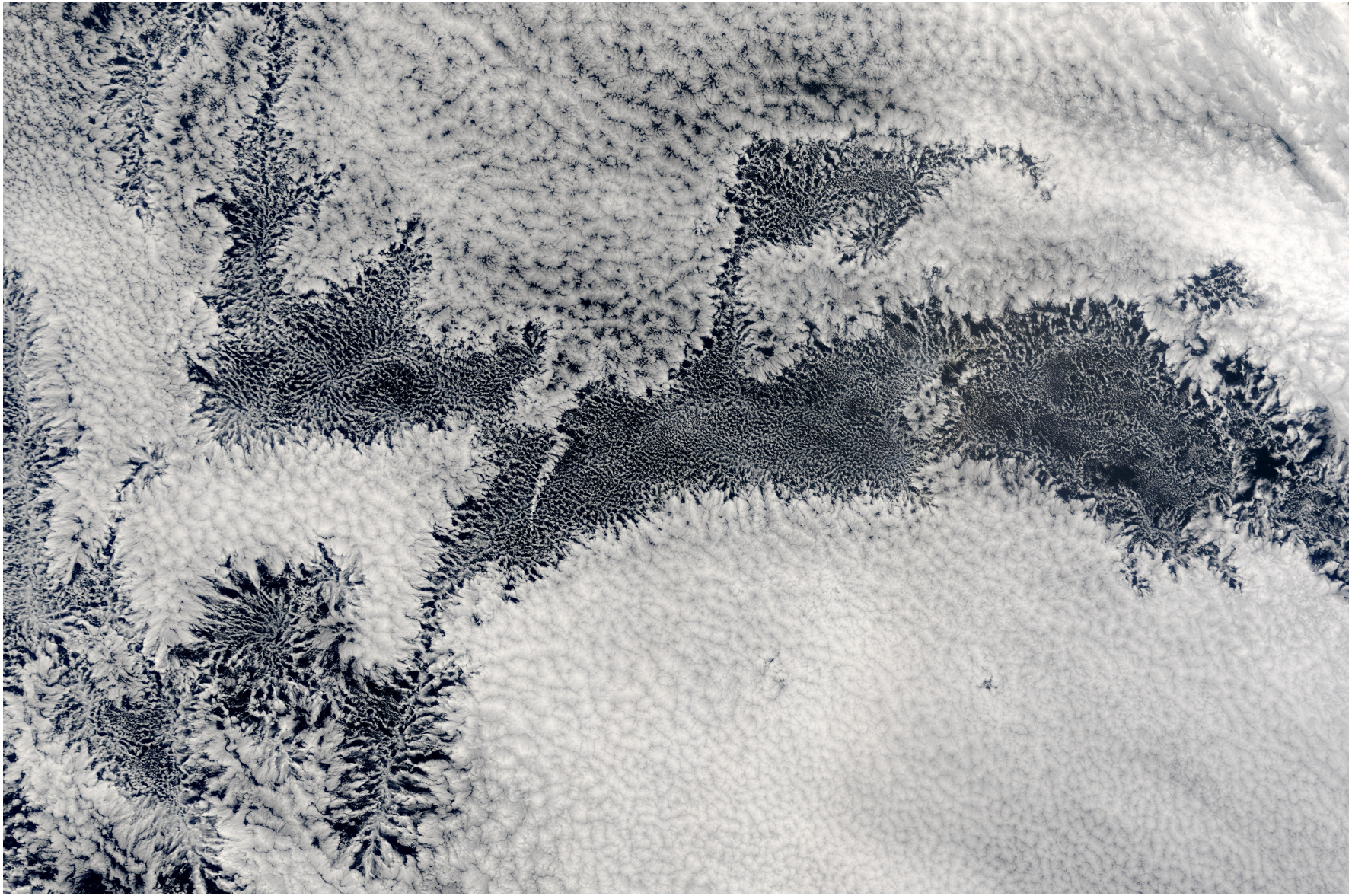
- Cloud structure and formation
- Developing identifications (Wood and Hartmann, 2006)
- Occurrence and Location
- Radiative properties (Muhlbauer, McCoy, and Wood, 2014)

Prediction of Open MCC using Marine Cold Air Outbreaks (MCAO)

- Additional motivation
- Spatial and temporal patterns
- Correlation of seasonal cycle
- Compositing of MCAO Events and Total Surface Heat Flux by Open and Closed MCC

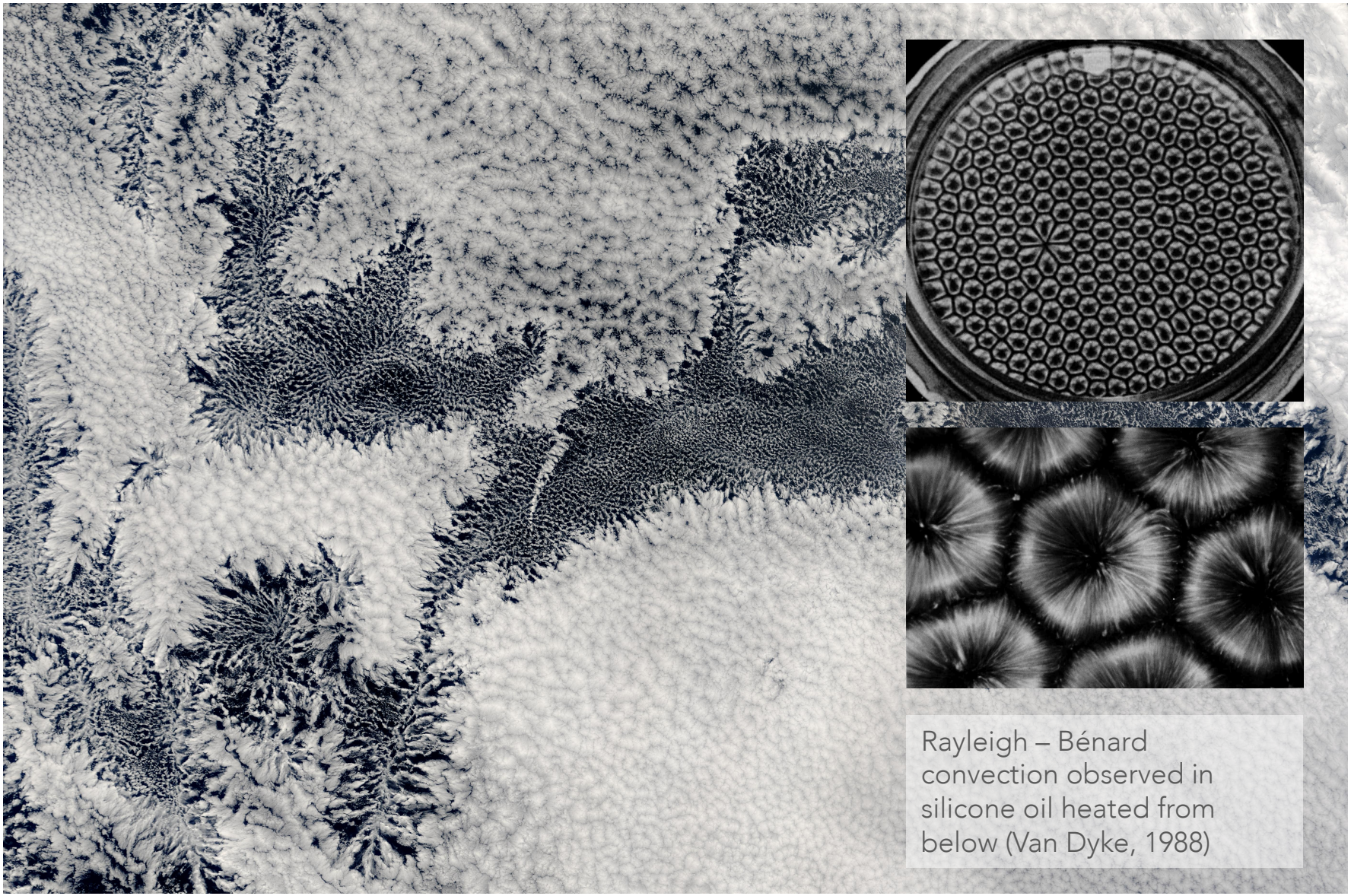
Summary, acknowledgements, and references

OPEN AND CLOSED MCC — STRUCTURE AND FORMATION



Open and closed cells off the coast of Peru, September 4, 2003 (MODIS)

OPEN AND CLOSED MCC — STRUCTURE AND FORMATION

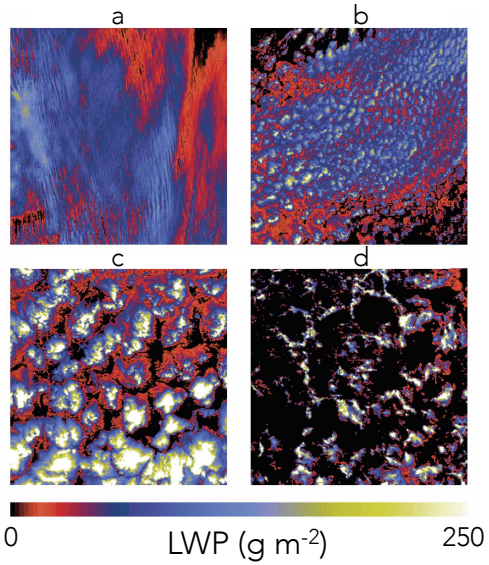


Rayleigh – Bénard convection observed in silicone oil heated from below (Van Dyke, 1988)

Open and closed cells off the coast of Peru, September 4, 2003 (MODIS)

OPEN AND CLOSED MCC — DEVELOPING IDENTIFICATIONS

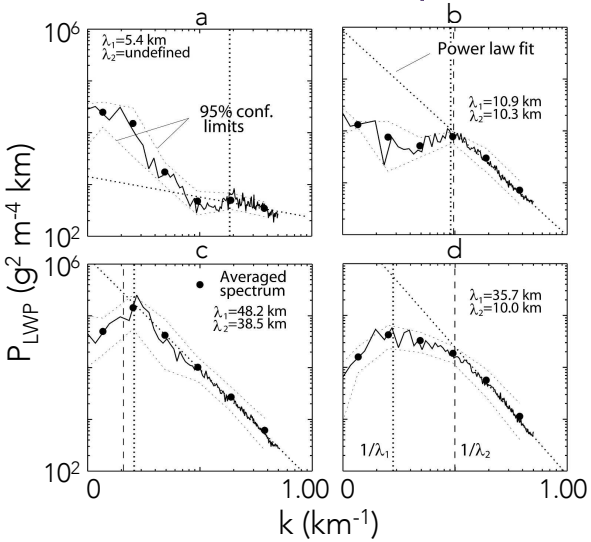
LWP from MODIS



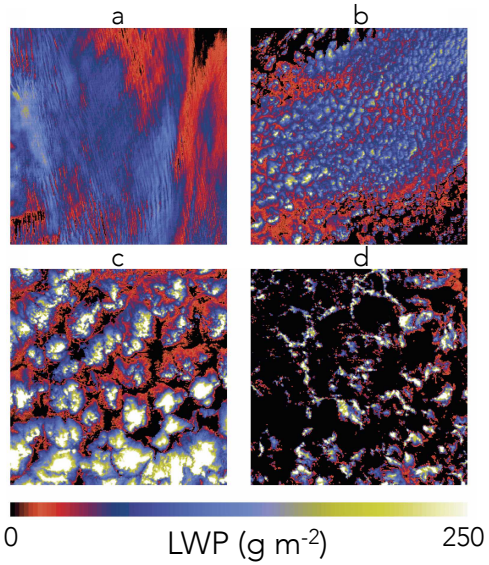
Wood and Hartmann, 2006

OPEN AND CLOSED MCC — DEVELOPING IDENTIFICATIONS

2D FFT Power Spectra



LWP from MODIS



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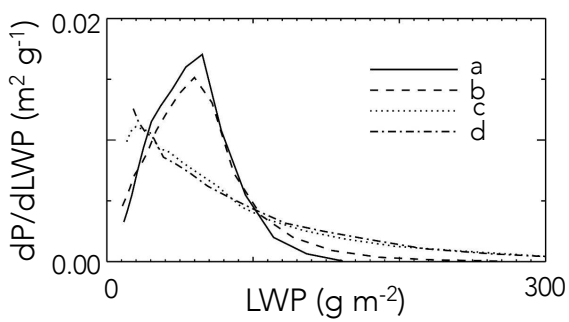
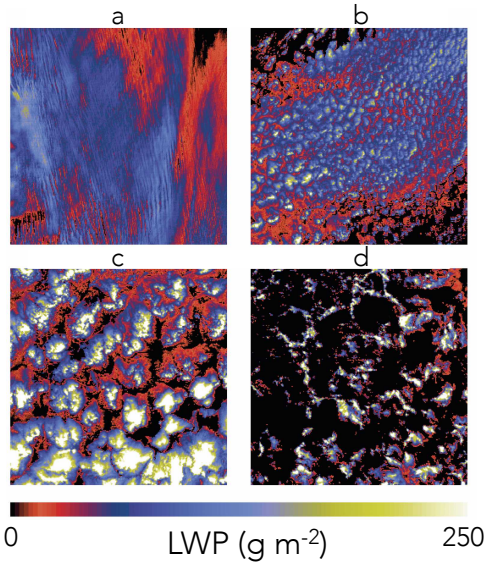


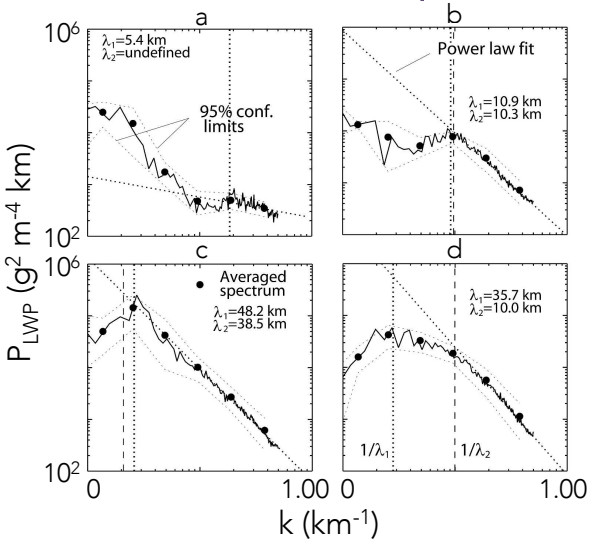
Wood and Hartmann, 2006

OPEN AND CLOSED MCC — DEVELOPING IDENTIFICATIONS

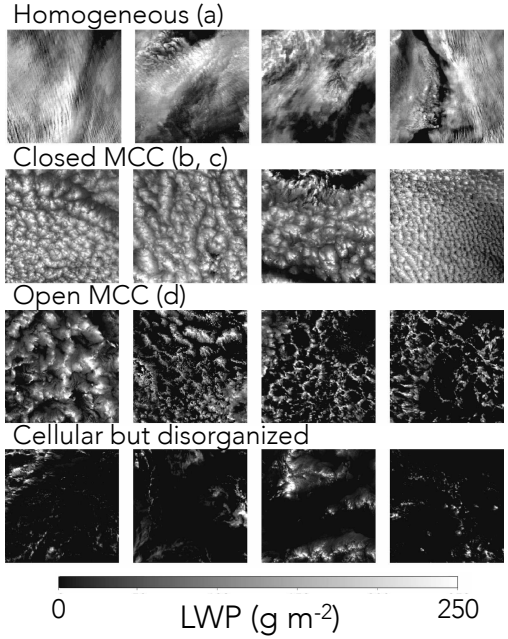
LWP from MODIS



2D FFT Power Spectra



MCC Identifications



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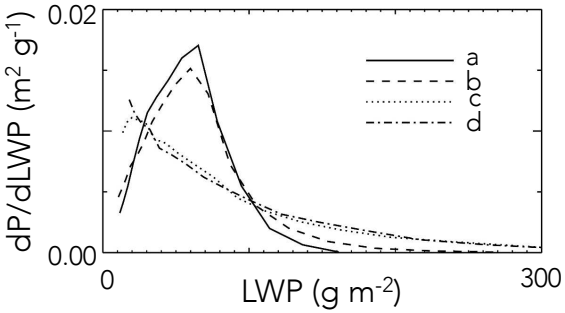

Wood and Hartmann, 2006

OPEN AND CLOSED MCC — DEVELOPING IDENTIFICATIONS

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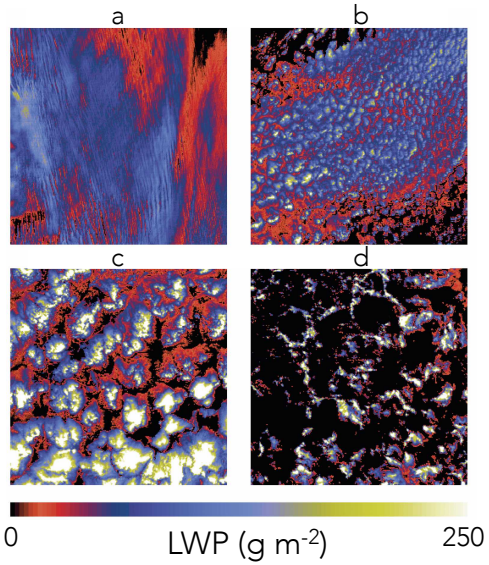

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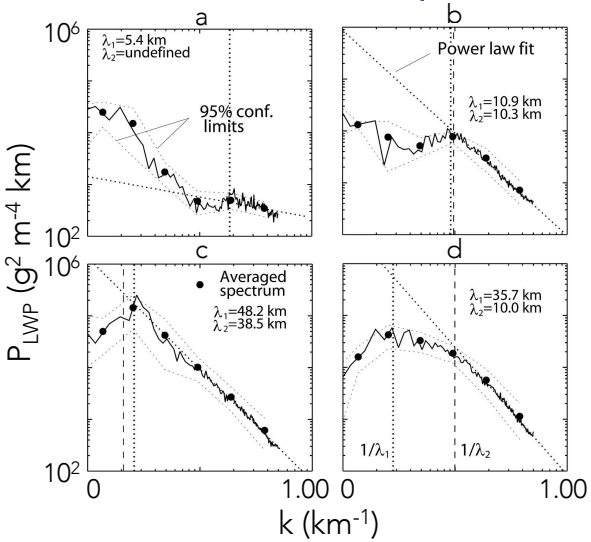
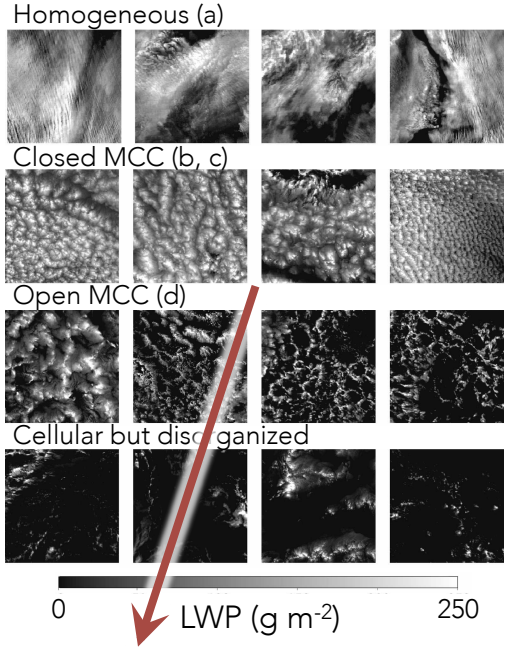


MCC Identifications



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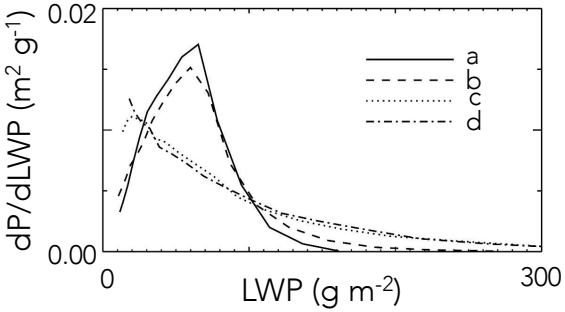
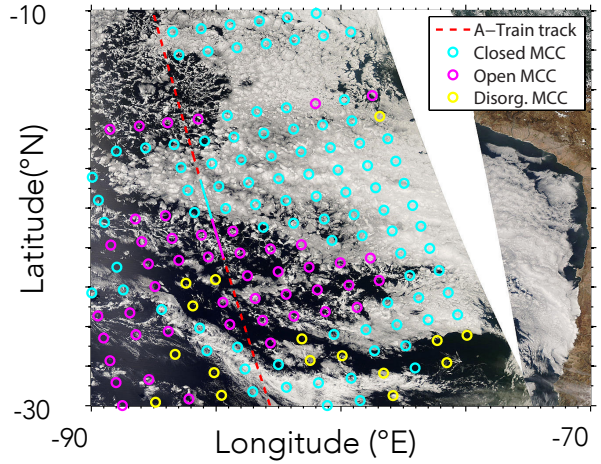
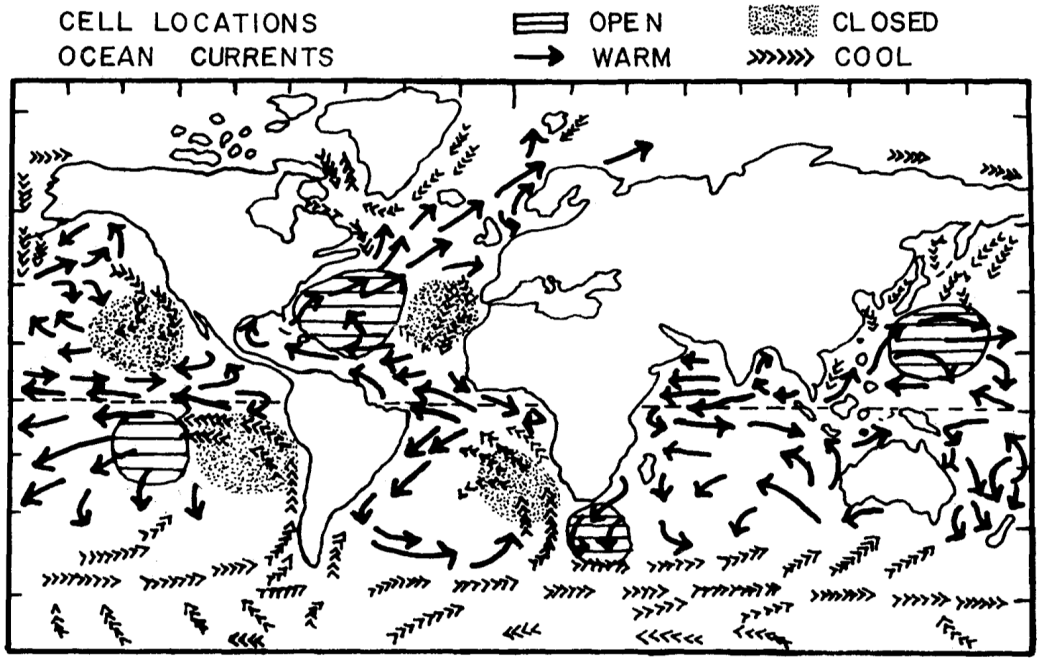


Identifications applied to A-Train

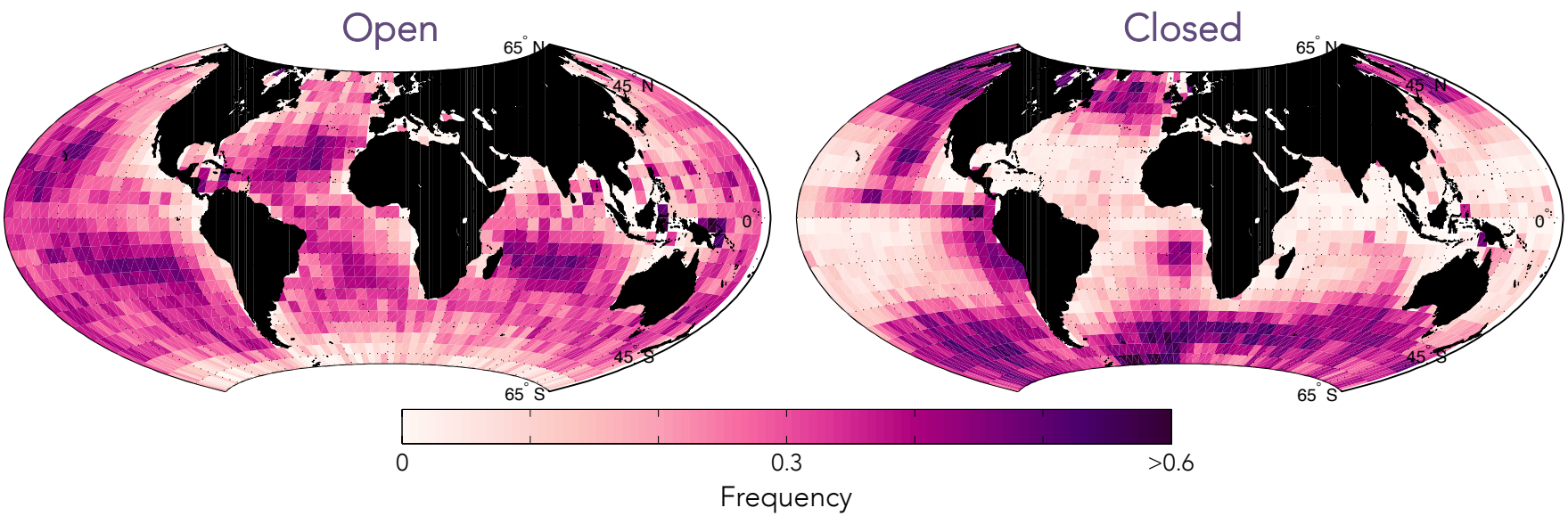


Wood and Hartmann, 2006
Muhlbauer et al. 2014

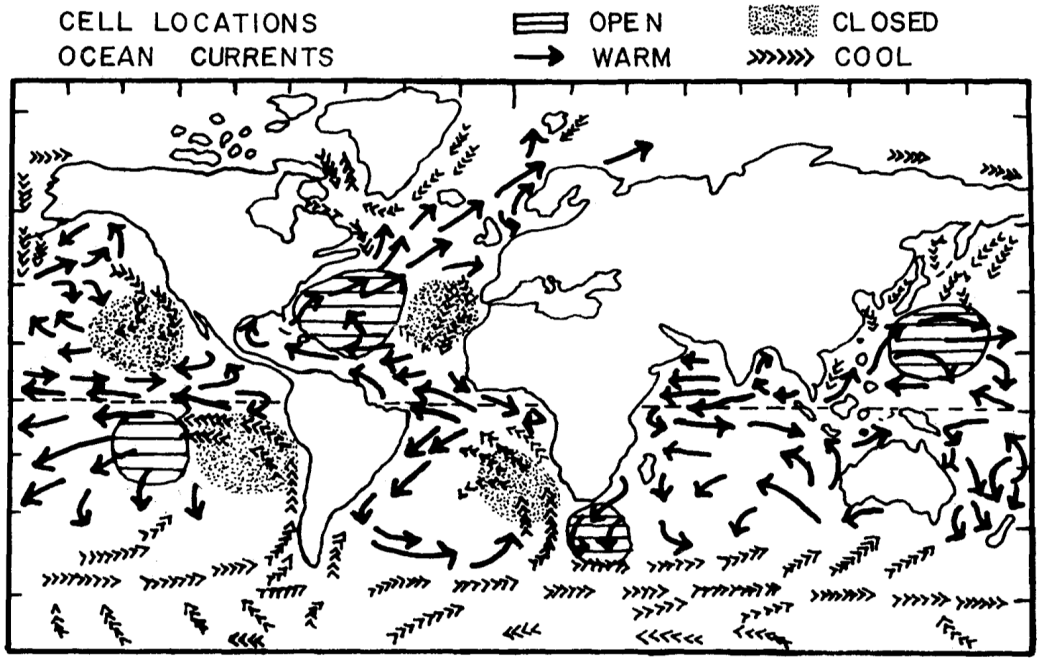
OPEN AND CLOSED MCC — LOCATION AND FREQUENCY



Climatology developed from early satellite measurements (Agee, 1984)



OPEN AND CLOSED MCC — LOCATION AND FREQUENCY



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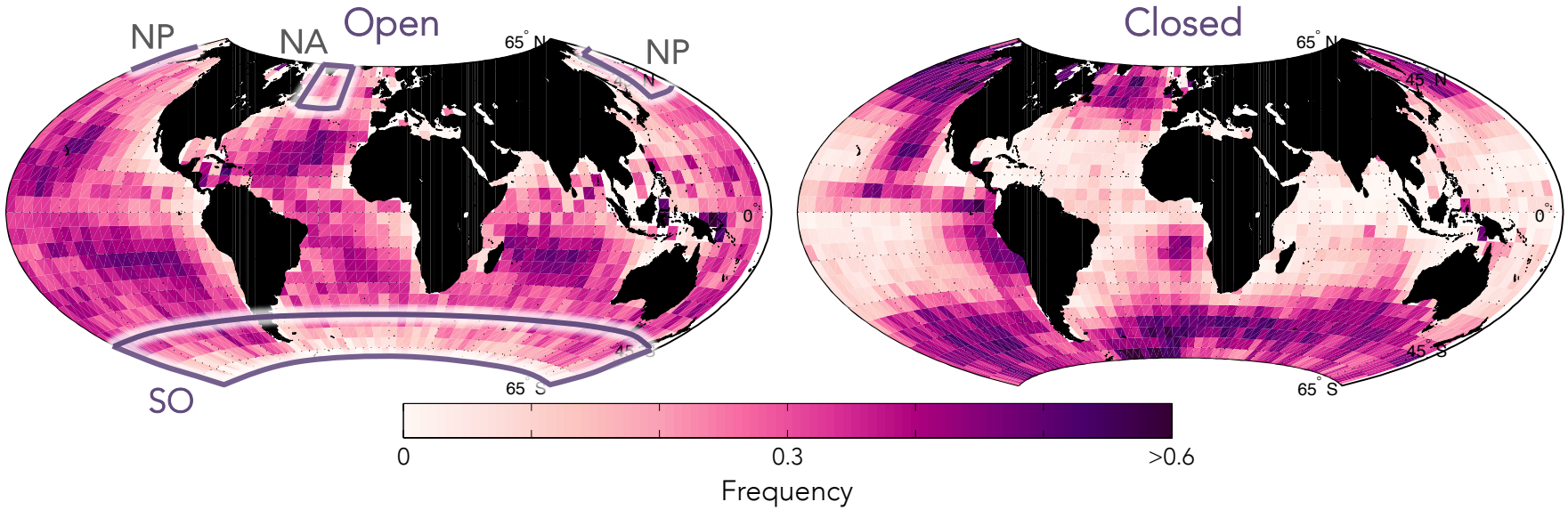
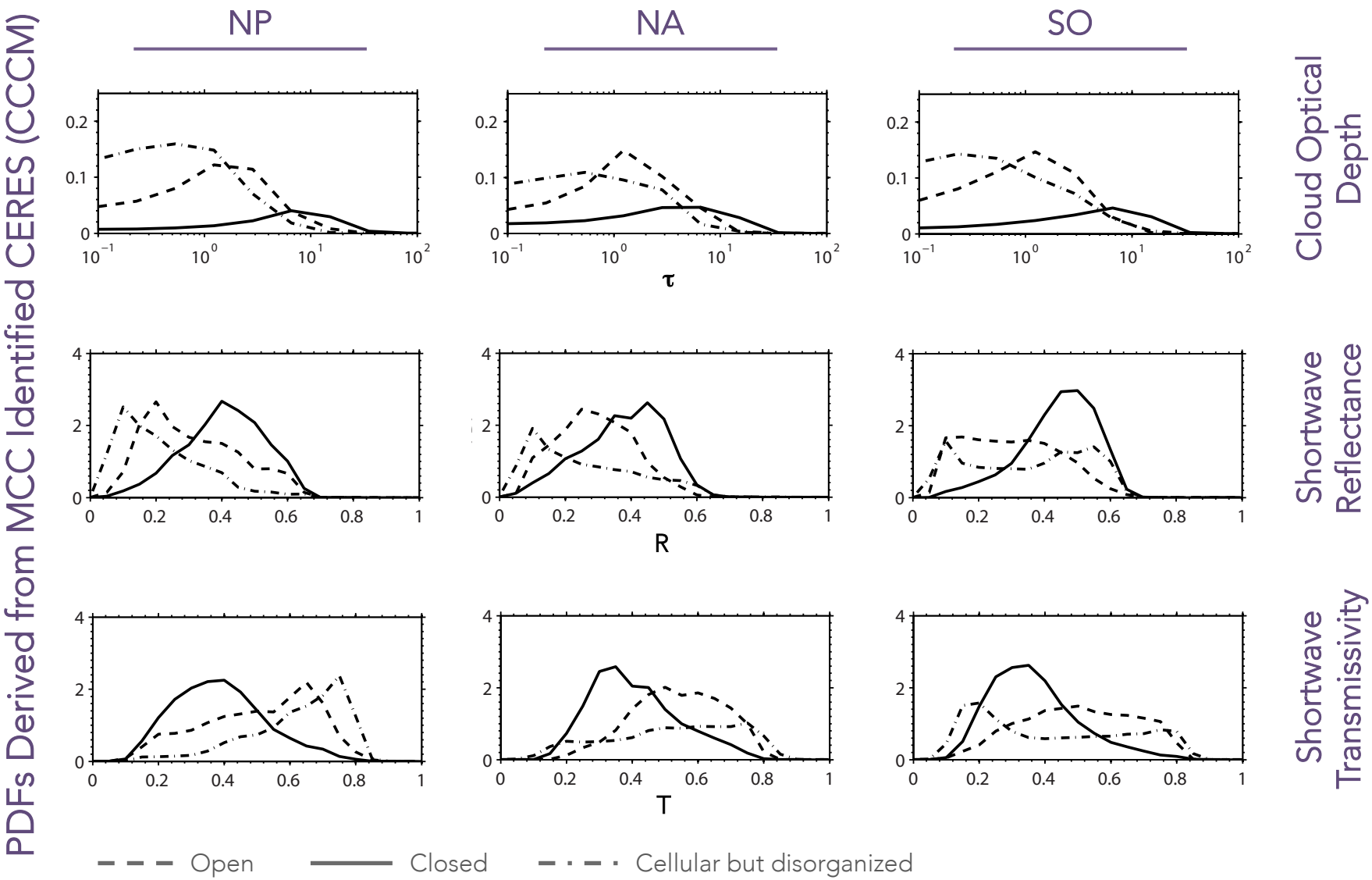
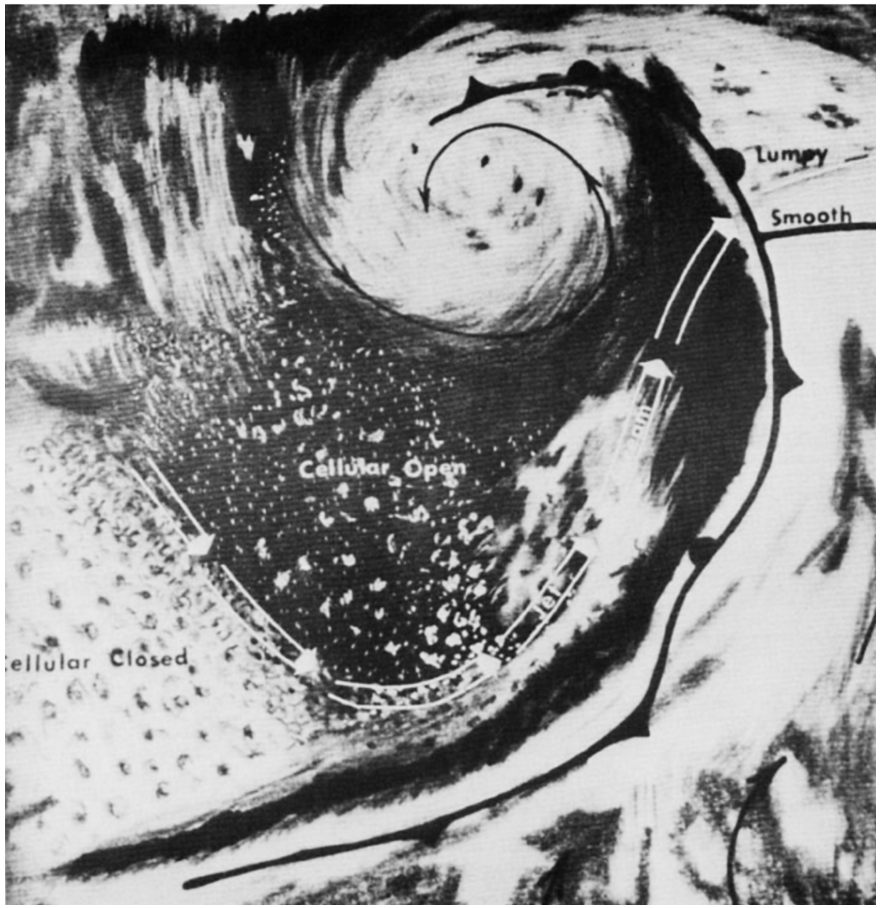


OPEN AND CLOSED MCC — RADIATIVE PROPERTIES

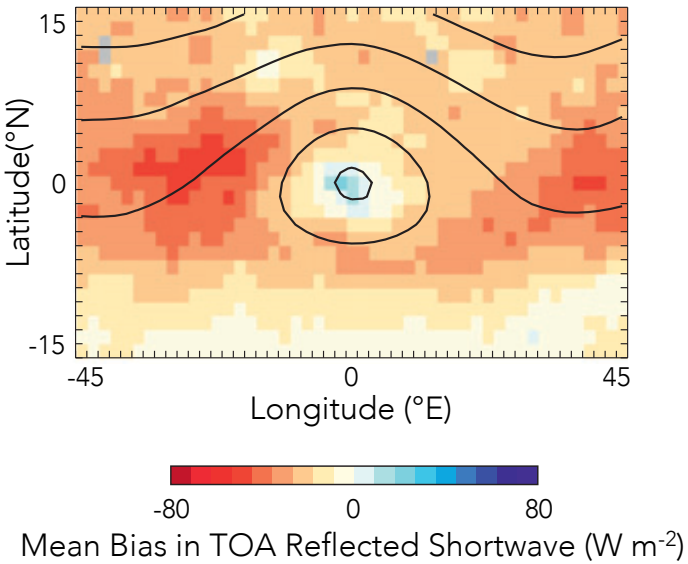


Muhlbauer et al. 2014

PREDICTION USING MCAO — ADDITIONAL MOTIVATION

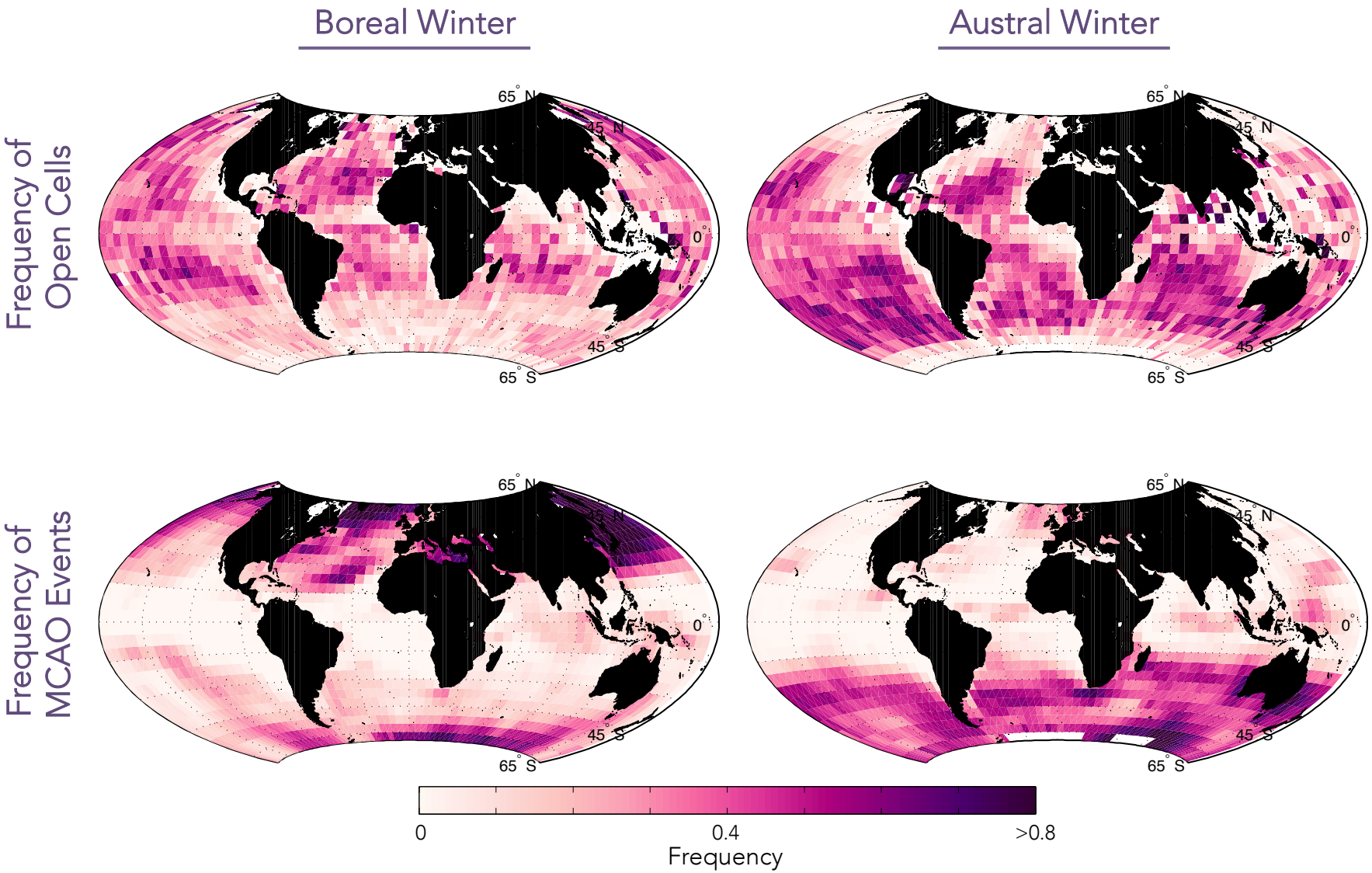


Mid-latitude cyclone identified using Open and Closed MCC occurrences (Agee, 1984)

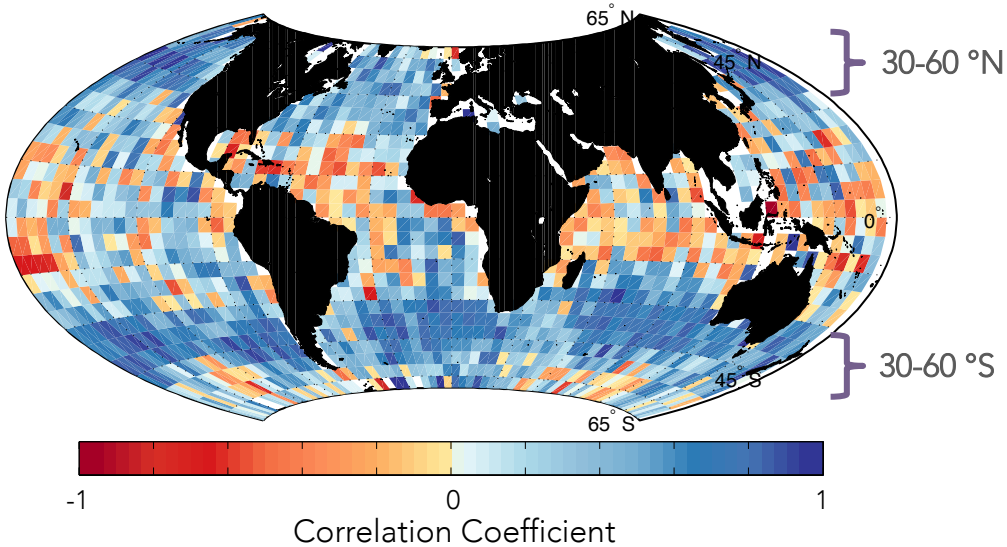


Reflected shortwave bias observed on the cold air side of a composite southern ocean cyclone in boreal winter (Williams et al. 2012).

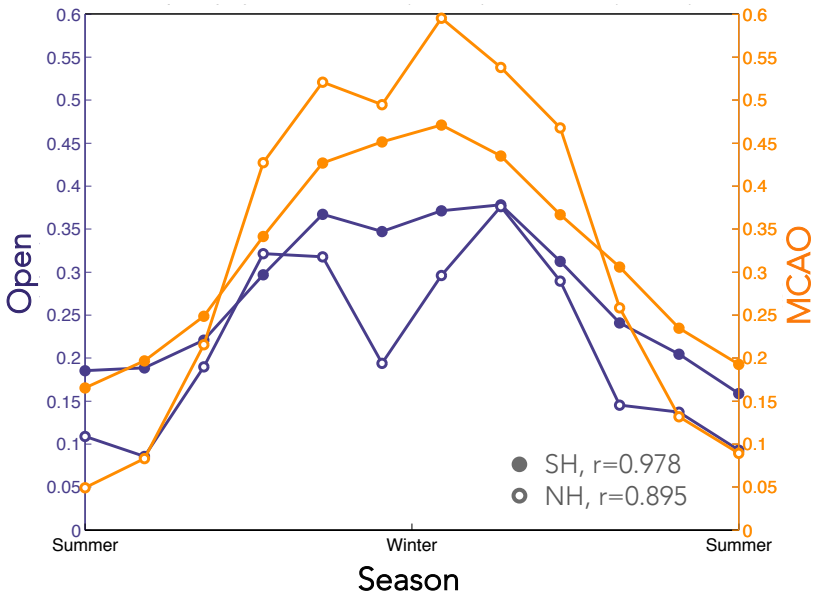
PREDICTION USING MCAO — SPATIAL AND TEMPORAL PATTERNS

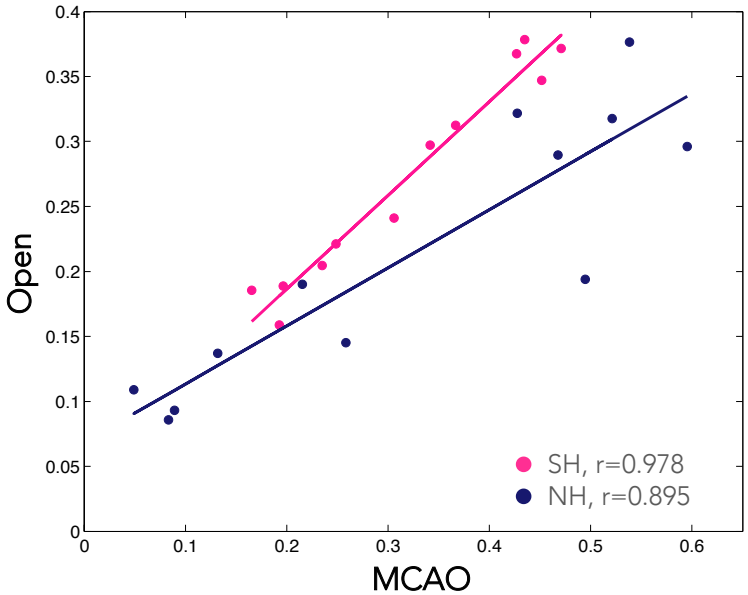


PREDICTION USING MCAO — SEASONAL CYCLE CORRELATION

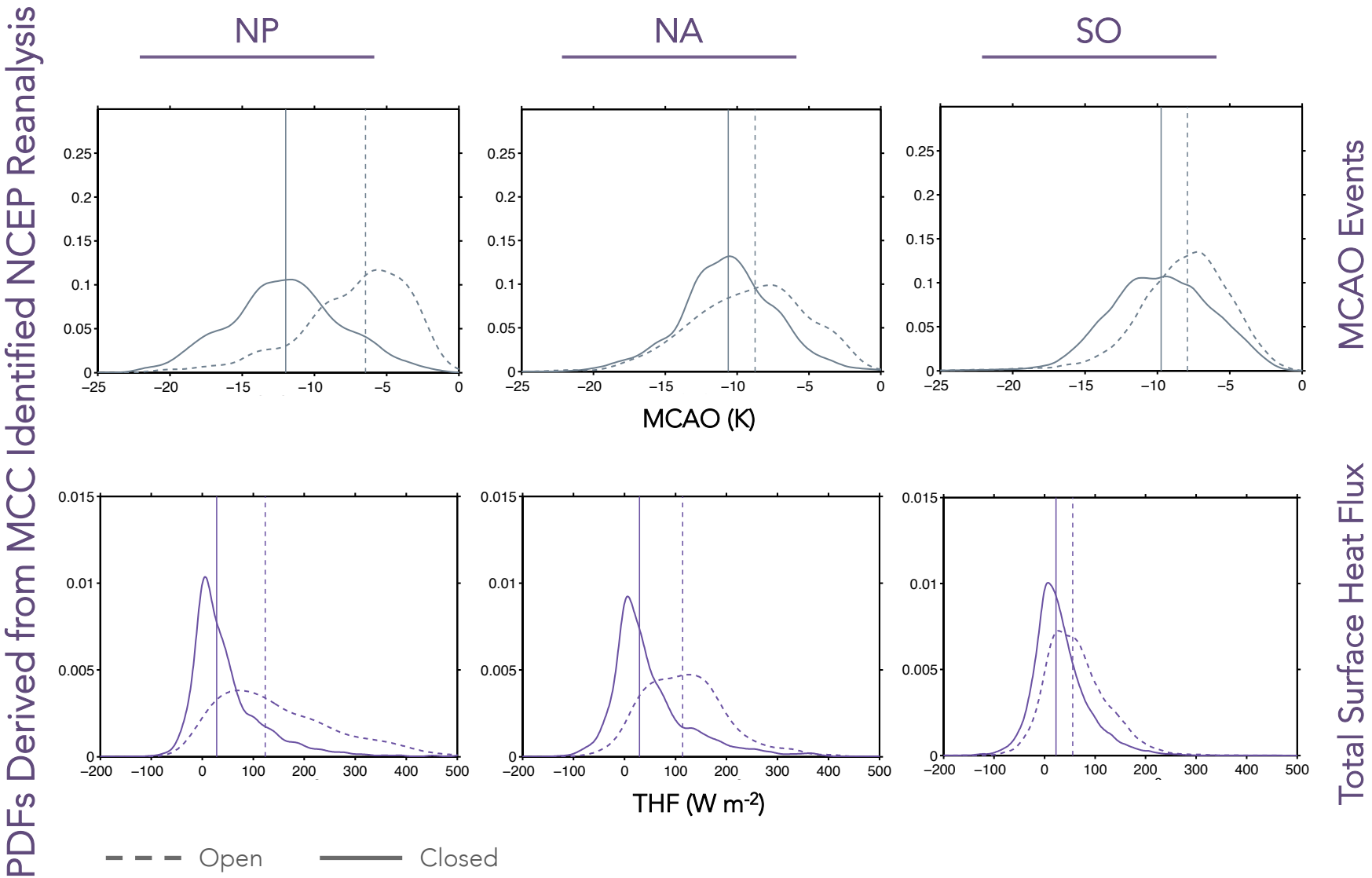


Contrasting Open MCC and MCAO Frequency



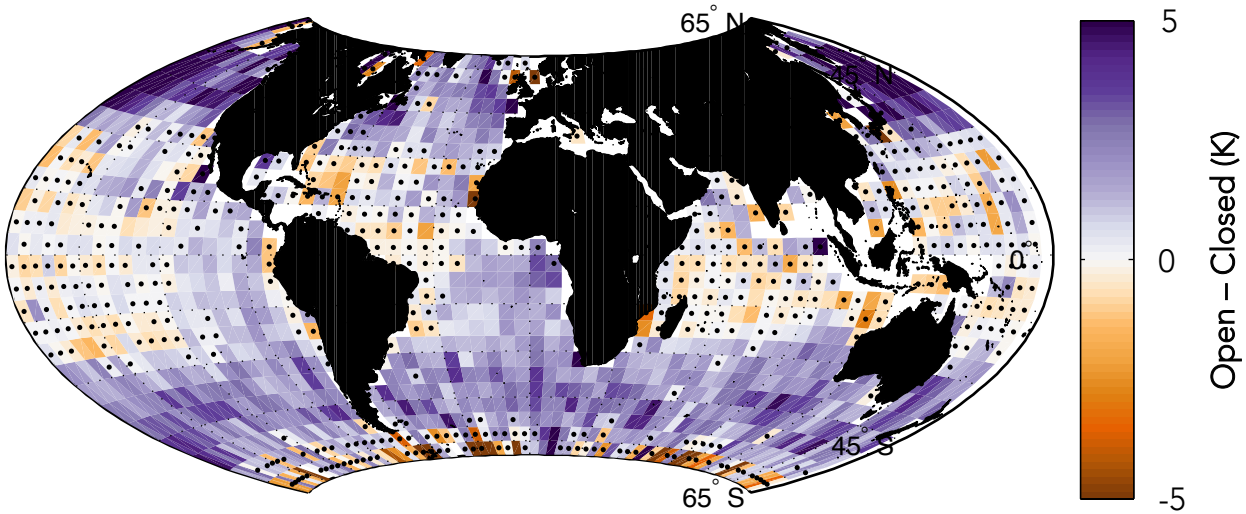


PREDICTION USING MCAO — COMPOSITING BY OPEN AND CLOSED

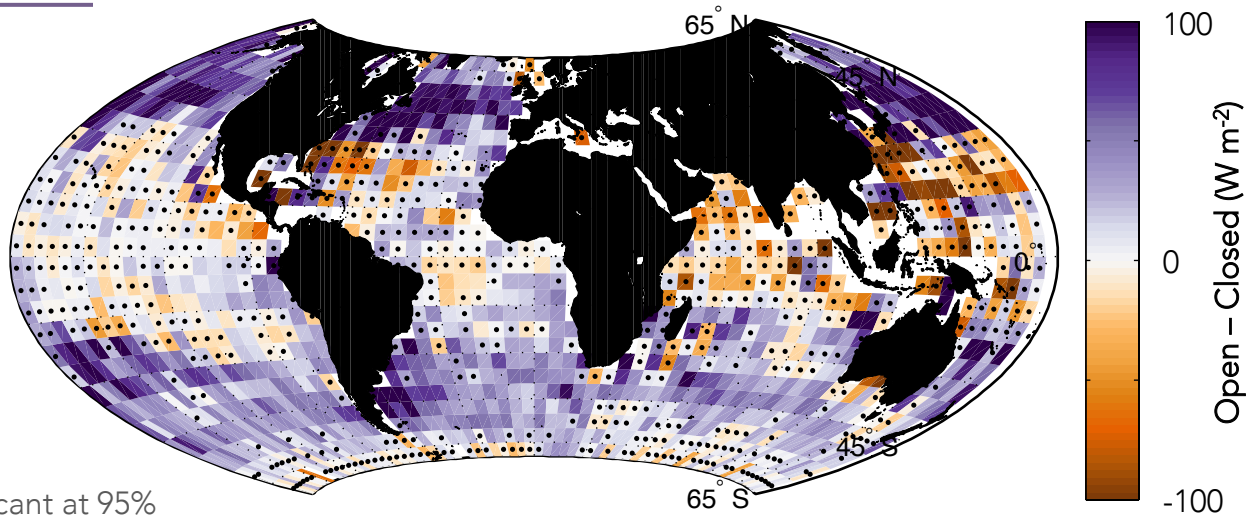


PREDICTION USING MCAO — GLOBAL DIFFERENCES IN MEDIAN

MCAO Events



Total Surface Heat Flux



- Not significant at 95%

SUMMARY, ACKNOWLEDGEMENTS, & REFERENCES

- Significant differences in the radiative properties of Open and Closed Mesoscale Cellular Convection (MCC) motivate developing a predictive scheme for these clouds.
- Temporal and spatial patterns of Open cellular clouds and Marine Cold Air Outbreak (MCAO) events are seen to be similar. In the Northern and Southern 30-60° bands, MCAO is a good predictor of the Open MCC seasonal cycle.
- Yearly composites of MCAO and Total Surface Heat Flux by Open and Closed are contrasted and found to be significantly different, both in key stratocumulus regions and throughout the 30-60°N and S bands.

This research is supported by the National Science Foundation (NSF) Graduate Research Fellowship under Grant (DGE-1256082), the NSF Physical and Dynamic Meteorology Grant (AGS-1102505), and the American Meteorological Society Graduate Fellowship.

1. MODIS image near S. America 31 July 2015 from EOSDIS-Worldview: http://1.usa.gov/1LGDHGL
2. Descloitres, J. *Open-cell and closed-cell clouds off peru, pacific ocean.* MODIS Rapid Response Team, NASA/GSFC. Retrieved 1 June 2015 from: http://visibleearth.nasa.gov/view.php?id=68362
3. M. Van Dyke *An album of fluid motion, 4th ed.* Parabolic Press, CA, (1988)
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5. A. Muhlbauer, I. L. McCoy, and R. Wood, Atmos. Chem. Phys. 14 (13), 6695 (2014)
6. E. M. Agee, Bull. Amer. Meteorol. Soc. 65 (9), 938 (1984)
7. K. D. Williams, A. Bodas-Salcedo, M. Déqué, S. Fermepin, B. Medeiros, M. Watanabe, C. Jakob, S. A. Klein, C. A. Senior, and D. L. Williamson. J. Clim. 26 (10), 3258 (2012)