Atmospheric classification at Darwin, Australia

Stuart Evans, Roger Marchand, Thomas Ackerman
Department of Atmospheric Science, University of Washington
Joint Institute for the Study of the Atmosphere and Ocean

Introduction

• General Circulation Models (GCMs) have difficulty representing clouds, and determining the source of the errors is challenging.

• Because GCMs do not predict specific weather events, model output cannot be directly compared to observations. Rather, long term averages of model and observational data are usually compared. This obscures the source of any errors that may exist.

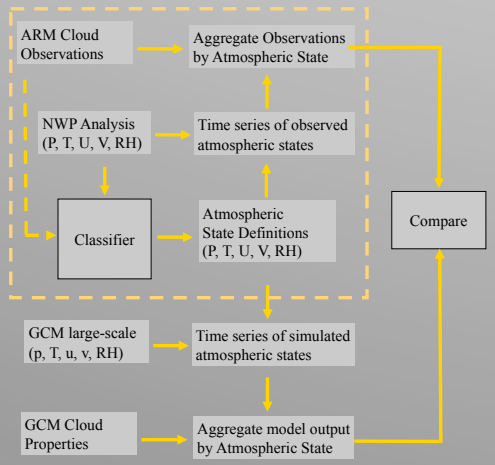
• Compositing model and observational data by atmospheric state is an alternative method of making comparisons. In this case, when errors are found, the physical conditions which caused the errors are better known.

Methods

• Two years of ECMWF reanalysis fields (T, U, V, SLP, RH) comprise our input data. We use a competitive neural network to define an initial set of states

• An issue common to many clustering studies is the proper selection of the number of clusters. We use an iterative technique[1,2] to determine the optimal number of states and ARM data to validate the statistical significance of the states.

Algorithm flow chart



Acknowledgements

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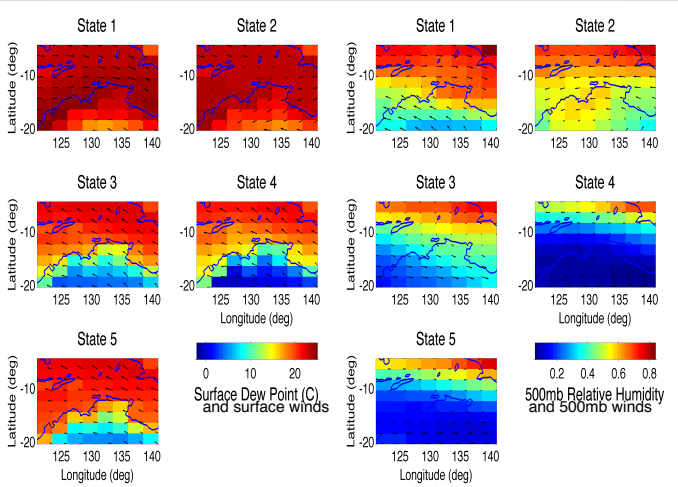
Results

• We find 5 distinct atmospheric states for the region surrounding Darwin. The first two of these states occur during the monsoon season, while the latter three occur during the dry season.

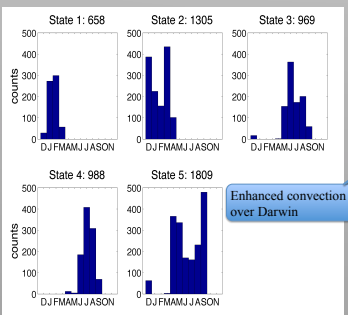
• The five states have distinctive meteorological characteristics, including cloud occurrence profiles and liquid water path.

Meteorology of the five atmospheric states

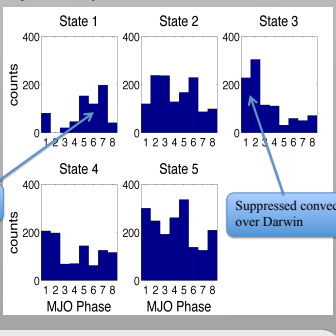


Timing of the states

by month



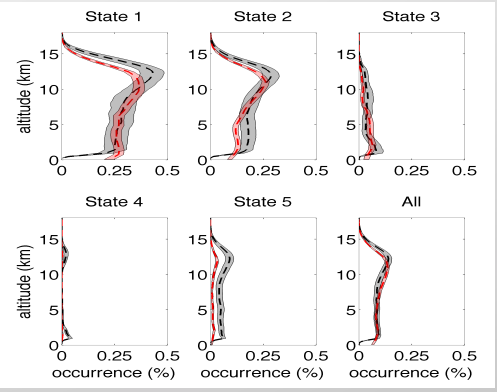
by MJO phase



• States 1 & 2 occur during the monsoon season.
• States 3, 4, & 5 occur during the dry season.
• States 2 & 5 peak during the transitions between monsoon and dry seasons.

Phases of the MJO[3] indicate different regions of enhanced convection:
• Phases 1 & 8: western hemisphere & Africa
• Phases 2 & 3: Indian Ocean
• Phases 4 & 5: maritime continent
• Phases 6 & 7: western Pacific Ocean

Cloud Profiles

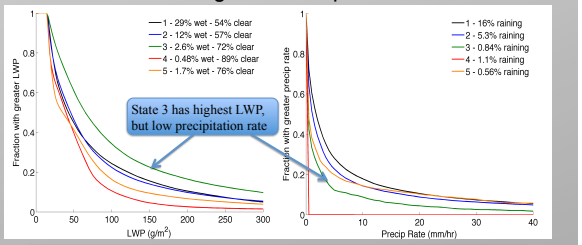


• The probability of measuring a reflectivity greater than -30dBz. Data from the millimeter radar at the ARM site in Darwin are shown in red. Data from Cloudsat are shown in black. Shading shows 95% confidence limits.

Cloud Properties

LWP when not raining

Precipitation rate



• Data from the microwave radiometer at the ARM site in Darwin.

• Excluded are data from when the instrument was wet or when there were no clouds in the sky.

• Data from the rain gauge at the ARM site in Darwin.

• Only data from times there was precipitation are included.

Citations

[1] Marchand, R., N. Beagley, S.E. Thompson, T. Ackerman and D. Schultz, 2006: A Bootstrap Technique for Testing the Relationship between Local-Scale Radar Observations of Cloud Occurrence and Large-Scale Atmospheric Fields. *J. Atmos. Sci.*, **63**, 2183-2830

[2] Marchand, R., N. Beagley, T. Ackerman, 2009: Evaluation of Hydrometeor Occurrence Profiles in the Multiscale Modeling Framework Climate Model using Atmospheric Classification. *J. Climate*, **22**, 4557-4573

[3] Wheeler, M., and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction. *Monthly Weather Review*, **132**, 1917-1932