TWP Cloud Behavior Analyses – Approaches for Model Validation with ACRF Observations

Andrew M Vogelmann[1], Ed Luke[1], Courtney Schumacher[2], Mike Jensen[1], Erwin Boer[3], Pavlos Kollias[4], Minghua Zhang[5]

[1] Brookhaven National Laboratory, [2] Texas A&M University, [3] LUEBEC, [4] McGill University, [5] State University of New York at Stony Brook

SUMMARY

Preliminary tests provided of an artificial neural network, trained on C-Pol data, that uses infrared satellite data to determine precipitation regimes.

- **Encouraging results show skill in most classes, including the difficult stratiform-anvil discrimination.**
- **Differences arise between comparable neural net trainings that will be the addressed in further research.**

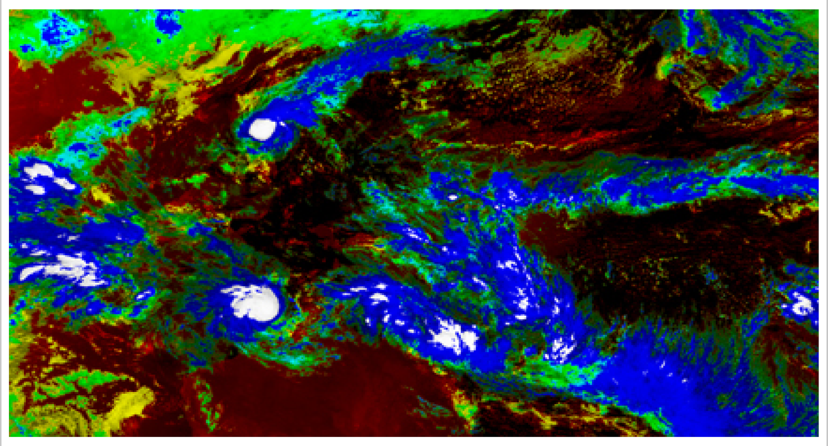
OBJECTIVE

Help improve model parameterizations of clouds and convection by extending the local cloud ACRF TWP observations to the broader TWP region. Approaches determine cloud dependences on: Cloud life cycle stage, Cloud regime, and Convective regime.

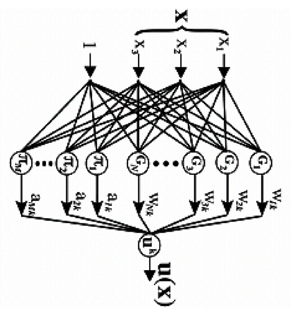
We report on determining precipitation regimes from satellite data.

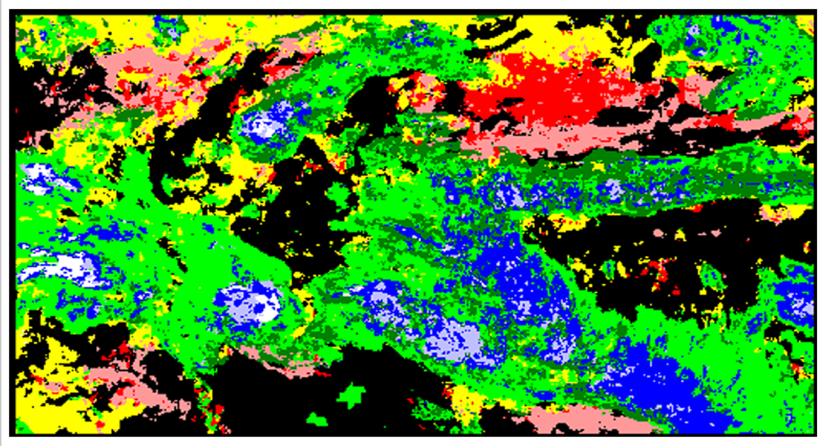
Cloud Types & Regimes

An artificial neural network identifies cloud types using infrared data, enabling full diurnal coverage.



False color image for the TWP region using visible **and** infrared data.





Neural net result using only infrared data, color coded by cloud type: **Cumulus**, **Low cloud**, **Low or mid-level**, **Mixed (Thin & thick cirrus, or Mixed hi/lo)**, **Thin cirrus**, **Thick cirrus**, **Boiler plate**, Deep convective, **Clear.**

Cloud Regimes

With the success of identifying cloud types, modifications are underway to identify cloud regimes (Jakob and Tselioudis, 2003; Rossow et al., 2005) with full diurnal coverage.

Convective Regimes

Combinations of these cloud types identify the convective regimes encountered during the TWP-ICE Period: active monsoon, dry monsoon, and break period.

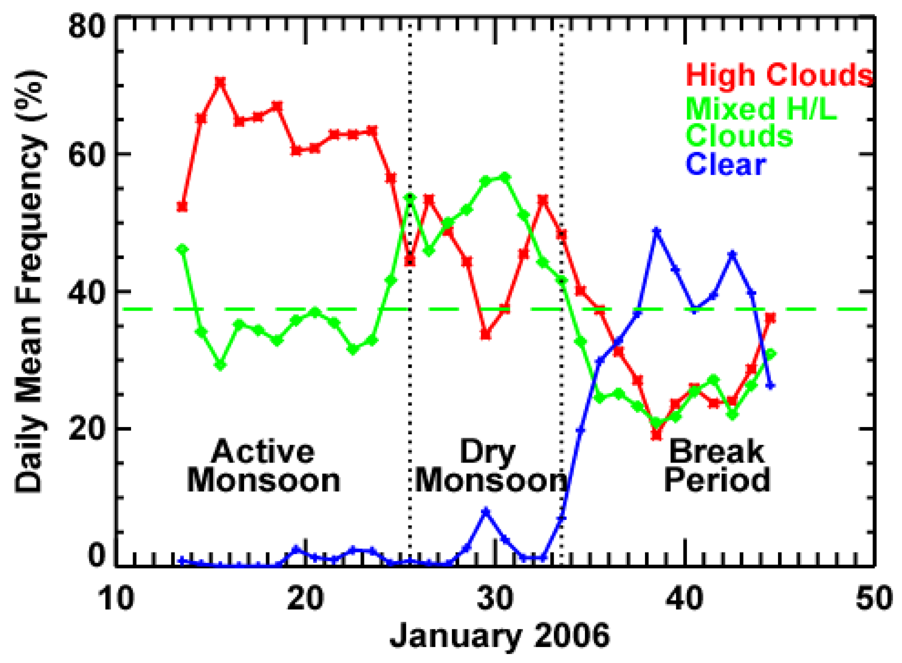
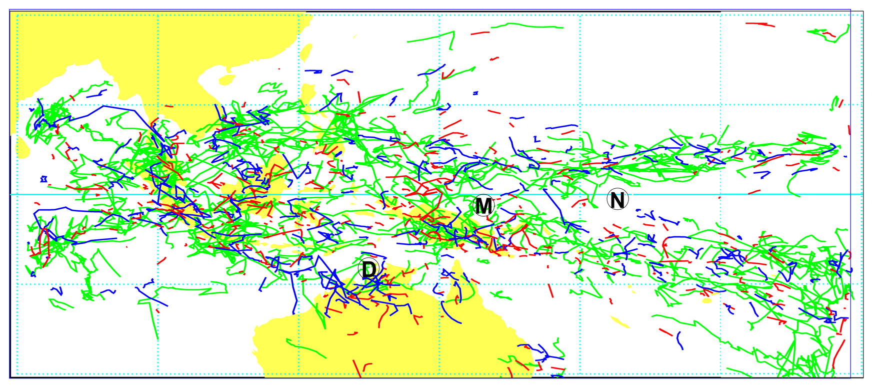


Figure for the Australian Monsoon Region (2.5-15ºS, 110-150ºE)

Cloud Life Cycle Stage

Cloud life cycle stage is determined using a satellite cloud identification & tracking algorithm (Boer and Ramanathan, 1997).



Mesoscale Convective System paths determined by our cloud tracking algorithm and their duration: t 6 hrs, 6 < t 12 hrs, t > 12 hrs. TWP ACRF sites indicated.

Precipitation Regimes

Precipitation regimes include (e.g., Jakob & Schumacher, 2008):

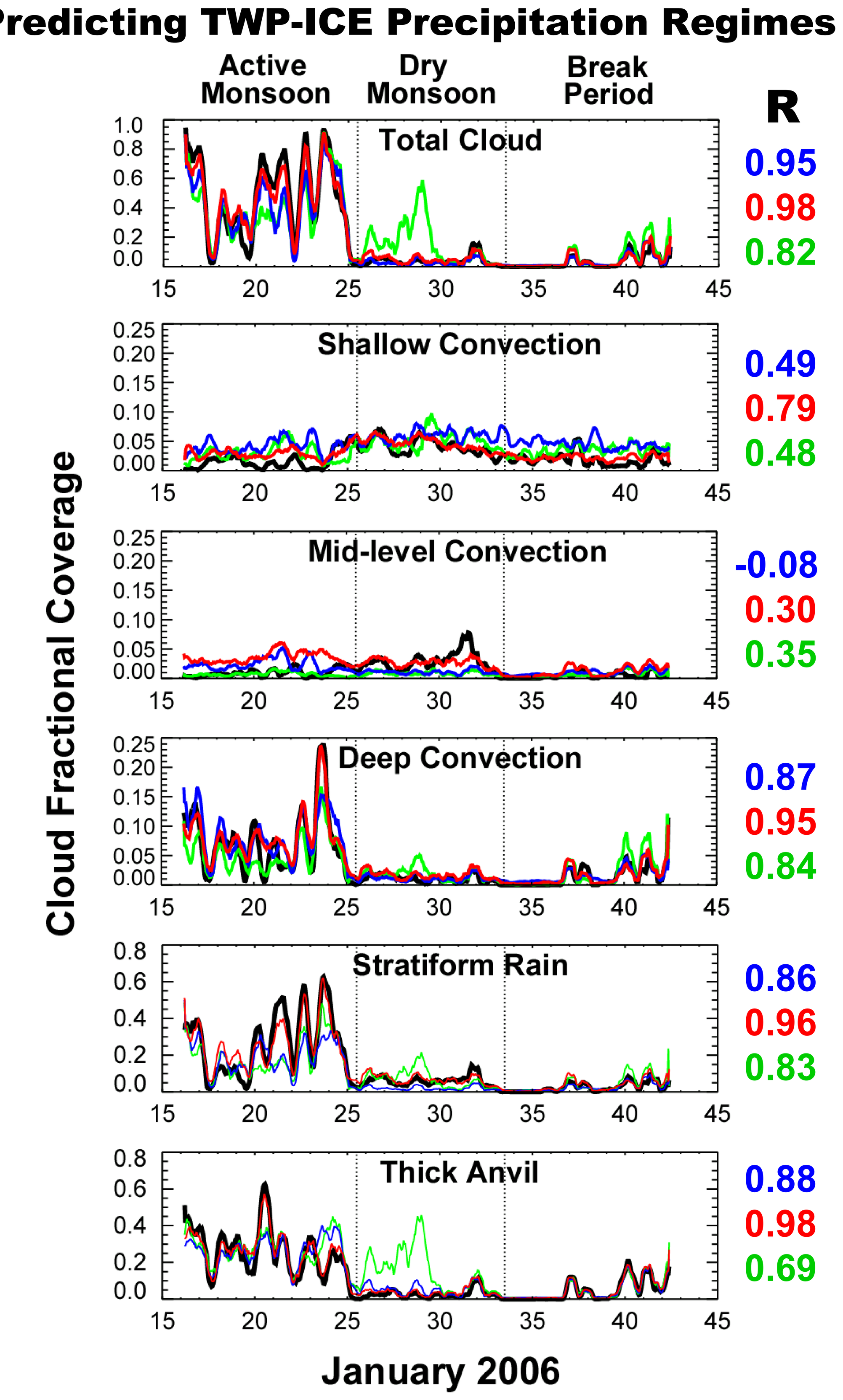
- Shallow convection (tops < 4 km)
- Mid-level convection (tops 4-8 km)
- Deep convection (tops > 8 km)
- Stratiform rain
- Non-precipitating thick anvils (no rain at 2.5 km, tops > 6 km)

- We test an artificial neural network, trained on C-Pol data, that uses infrared satellite data to determine precipitation regimes.
- Result will enable a trans-TWP picture of precipitation regimes

BMRC C-Pol Radar

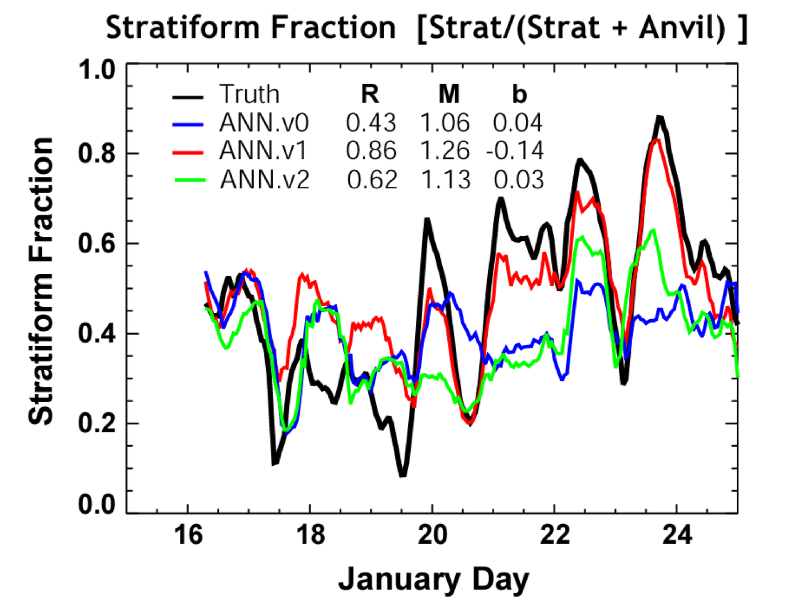
- Located 25 km NE of the Darwin
- Full volume scan every 10 min

Predicting TWP-ICE Precipitation Regimes



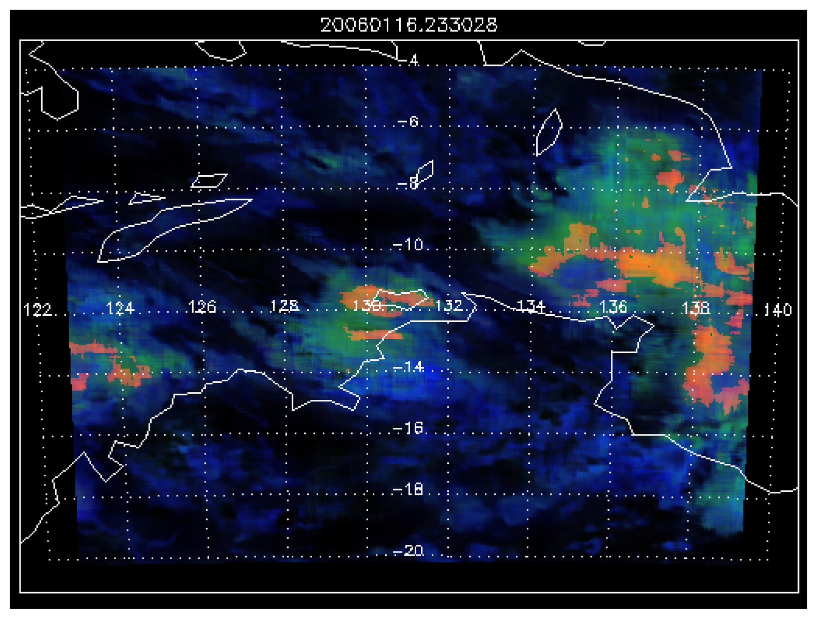
Three artificial neural network (ANN) trainings given by colored lines, and truth by black. Linear-correlation coefficients (R) given at right.

Distinguish Stratiform from Anvil?



Linear-correlation coefficients (R) and linear regression terms (M,b) provided for the TWP-ICE "Wet Monsoon" period for the 3 ANN versions.

Regional Fidelity of Classification



Predicted precipitation classes (ANN.v0) over Northern Australia. BLUE=Anvil, GREEN=Stratiform rain, and RED=Deep convection.

Future Work

Complete artificial neural networks for identifying cloud and precipitation regimes.

Create "simulators" that enable 1:1 matching between observations and simulations by regional & climate models for validation.

Contact author

Andy Vogelmann
vogelmann@bnl.gov
631-474-4424

References

Boer, E.R. and V. Ramanathan, 1997: Lagrangian Approach for Deriving Cloud Characteristics from Satellite Observations and Its Implications to Cloud Parameterization. *J. Geophys. Res.*, 102 (D17): 21383-21399.

Jakob, C., and C. Schumacher, 2008: Precipitation and latent heating characteristics of the major Tropical Western Pacific cloud regimes. *J. Climate*, accepted.

Jakob, C., and G. Tselioudis (2003), Objective identification of cloud regimes in the Tropical Western Pacific, *Geophys. Res. Lett.*, 30(21), 2082, doi:10.1029/2003GL018367.

Rossow, W.B., G. Tselioudis, A. Polak, and C. Jakob, 2005: Tropical climate described as a distribution of weather states indicated by distinct mesoscale cloud property mixtures. *Geophys. Res. Lett.*, 32, L21812, doi:10.1029/2005GL024584.