Relationships Between Tropical Convection and Cirrus at Darwin

Sally A. McFarlane and Jennifer M. Comstock

Pacific Northwest NATIONAL LABORATORY

Motivation

•Properties of radiatively-important anvil cirrus are only weakly linked to properties of generating convection in climate models

•Relationships between convective and cirrus anvil clouds need to be studied observationally and in process models

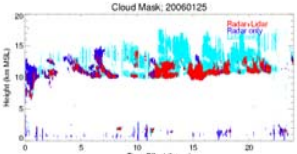
• Combination of the C-Pol (precipitation radar), MMCR/MPL (cloud radar/lidar), and satellite data at Darwin provide a useful dataset for this analysis.

Summary

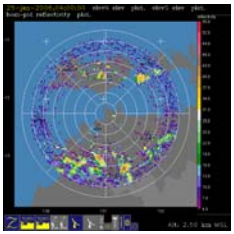
• 3 methods of tracking cirrus/convection lead to different results; study larger number of cases to determine best method and effect on statistics

•Lag regression analysis shows links between convection observed by C-Pol and anvil observed by MMCR

We Explore Three Methods for Tracking Convective Clouds and Associated Anvil:



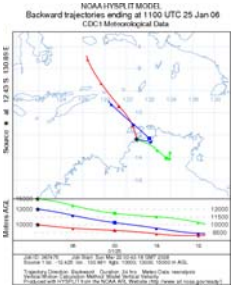
Anvil cloud observed at Darwin ARM site by MMCR/MPL



Convection observed by C-Pol at Gunn Point; 0400 UTC on 1/25/2006

(Image courtesy of J. Cetrone, U. Washington)

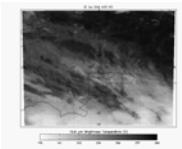
1) Tracking Anvil Backwards w/ Reanalysis Data



1) Track cirrus observed at Darwin backwards with HYSPLIT - calculate backwards trajectory of air parcel using winds from reanalysis data

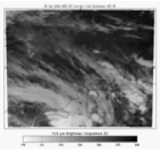
(HYSPLIT runs courtesy NOAA/ARL)

2) Tracking Anvil Backwards w/ Satellite Data



← Cirrus cloud observed over ARM site at 10:33 UTC

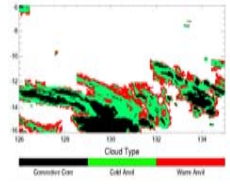
Back trajectory of cirrus → using spatial correlation



2) Find maximum spatial correlation in Tb between reference box over Darwin ARM site and previous satellite image (Soden 1998; Mace et al. 2006)

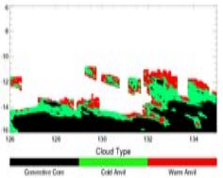
(MTSat data courtesy of P. Minnis, NASA Langley)

3) Tracking Convection Forward w/ Satellite Data



←Convective system at 04:30 UTC

Convective system at 10:33 UTC ↓

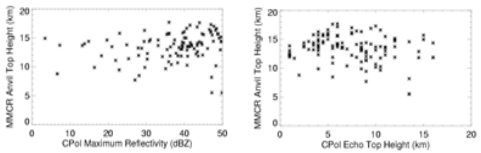


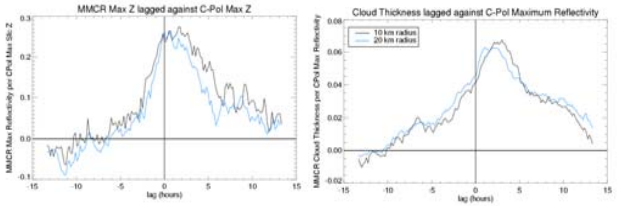
←Forward trajectory calculated using 'center' of convective core

3) Identify convective cores and anvils by Tb thresholds; examine overlap between clouds in successive images (Futyan & DelGenio, 2007)

We Investigate Links Between C-Pol Convection & MMCR Anvil Properties at Darwin:

Instantaneous comparisons between C-Pol at Gunn Point and MMCR at Darwin ARM site show no clear link between maximum reflectivity, echo top height and anvil macrophysical properties





Time lag regression shows that MMCR maximum reflectivity peaks with C-Pol maximum reflectivity; whereas maximum MMCR cloud thickness lags C-Pol maximum reflectivity by 2-3 hours.

References

Soden, B.J., 1998: Tracking upper tropospheric water vapor radiances: A satellite perspective. *J. Geophys. Res.,* 103, 17,069-17,081.

Futyan, J. and A. DelGenio, 2007: Deep convective system evolution over Africa and the Tropical Atlantic. *J. Clim,* 20, 5041-5060.

Mace, G.G. et al., 2006: Assocation of Tropical Cirrus in the 10-15 km Layer with Deep Convective Sources. *J. Atmos. Sci.,* 63, 480-503.

Acknowledgements

We thank Courtney Schumacher and Kaycee Frederick for the C-Pol data, and Brian Mapes for the regression software.

U.S. DEPARTMENT OF ENERGY

Contact: Sally.McFarlane@pnl.gov (509) 375-6402

www.pnl.gov