Two-day waves and the extended lifecycle of convection during AMIE/DYNAMO: Observations and high resolution simulation

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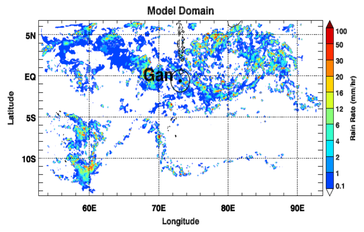
Motivation and Objectives

- Precipitation events observed during AMIE/DYNAMO show a lifecycle typical of MCSs (deep convection followed by broad stratiform regions) but over extended time.
- High-resolution regional model simulations, radar and sounding data are used to examine the processes responsible for this extension of lifecycle of convection.

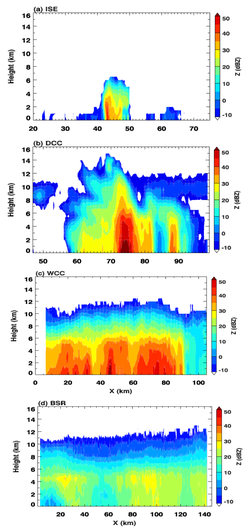
Model and Experiments

- WRF V3.4 at 3km resolution, in 48hr hindcast mode. ERA-I reanalysis for lateral, initial, and surface boundary conditions.
- The RRTM, YSU and Morrison schemes are used to parameterize radiation, PBL and microphysics respectively. No cumulus parameterization.



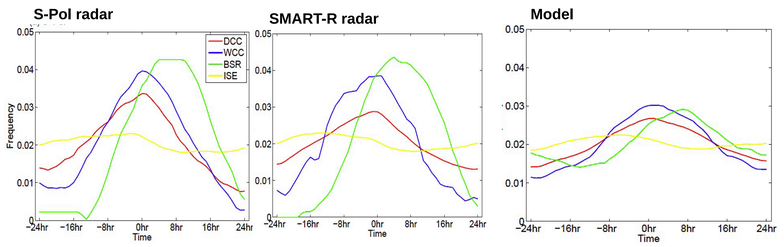
Definition of radar echo types

- Isolated Shallow Echo (ISE): 10 dBZ echo top height < 8 km, no echo > 16 dBZ in 10 km distance
- Deep Convective Core (DCC): 30 dBZ echo top height > 8 km
- Wide Convective Core (WCC): convective area with 30 dBZ in the column > 800 km^2
- Broad Stratiform Rain (BSR): stratiform rain area > 30,000 km^2



Evolution of frequency of echo-types

Frequency of occurrence of each echo type composited with respect to maximum precipitation.

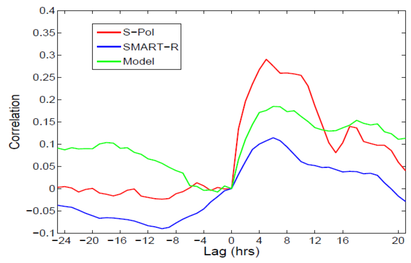


- Five to eight hour difference between precipitation and peak broad stratiform area (BSR) frequency.
- Isolated shallow echoes (ISE) maximum are between 16 to 8 hours before peak precipitation.

What causes the extended lifecycle?

$$BSR(t) = \alpha DCC(t) + S_p(t)$$

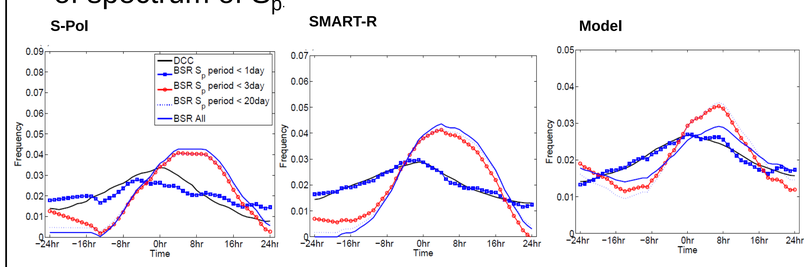
- S_p (t) is "*stratiform productivity*" of the deep convective cores, the part of BSR time-series that is related to the extension.



Lag-correlation between S_p (t) and DCC(t).

Spectral Analysis

- BSR is reconstructed by only including a certain range of spectrum of S_p.



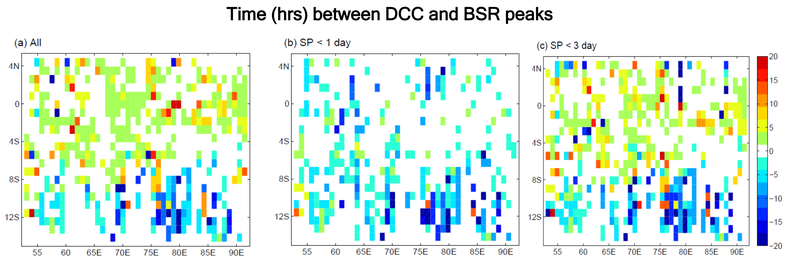
- The modulation of "*stratiform productivity*" by 1 - 3 day modes explains the extended lifecycle of convection.

Summary

- **The extended lifetime of convection observed during AMIE/DYNAMO is due to modulation of stratiform production by westward propagating baroclinic 1-3 day waves, whose temperature and humidity anomalies are out of phase.**

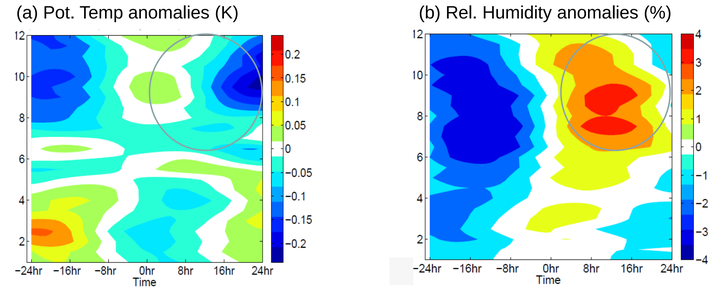
Model grid-points as virtual radar sites

- The spectral analysis is repeated for every 150km by 150km area in the model domain.



- Again, the lag is reproduced by only retaining 1 - 3 day signals.

Mechanism



Composites of (a) potential temp (K) and (b) relative humidity (%) anomalies associated with the 1 - 3 day variability from AMIE soundings at Gan.

- In the 1-3 day modes, temperature and humidity are out of phase.
- The cold anomalies behind the deep convection favor larger-relative humidity and the extended BSR.