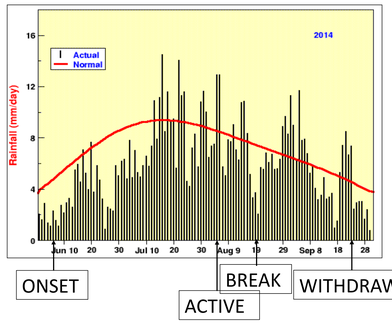
The life cycle of a monsoon season viewed from TRMM, GPM and CLOUDSAT data sets

T. N. Krishnamurti, R. Deepa, Vinay Kumar and Dipak K. Sahu

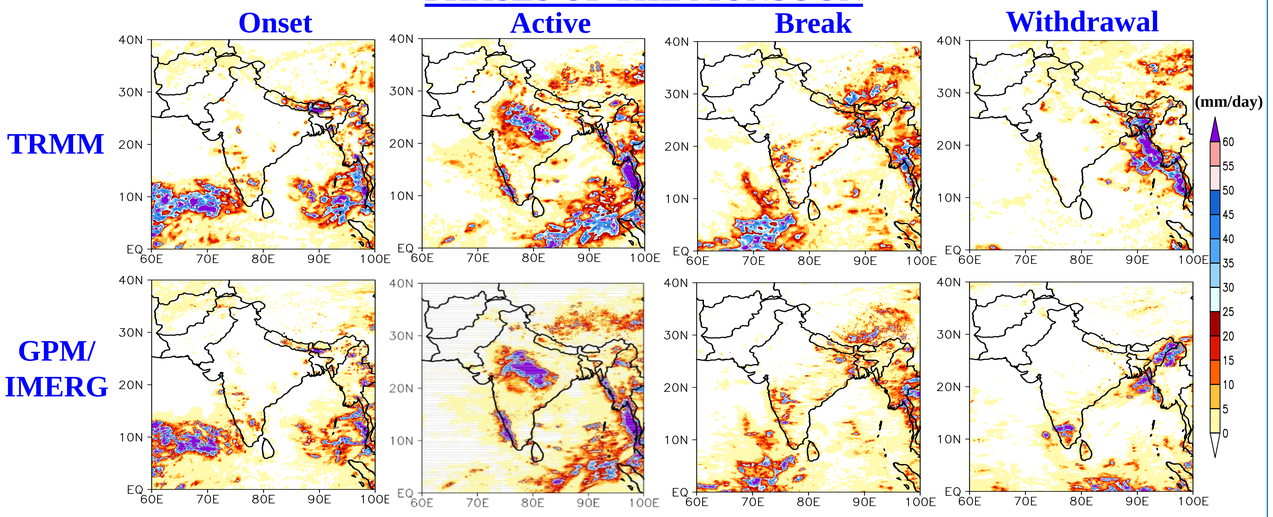
Department of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, FL 32306

MOTIVATION:



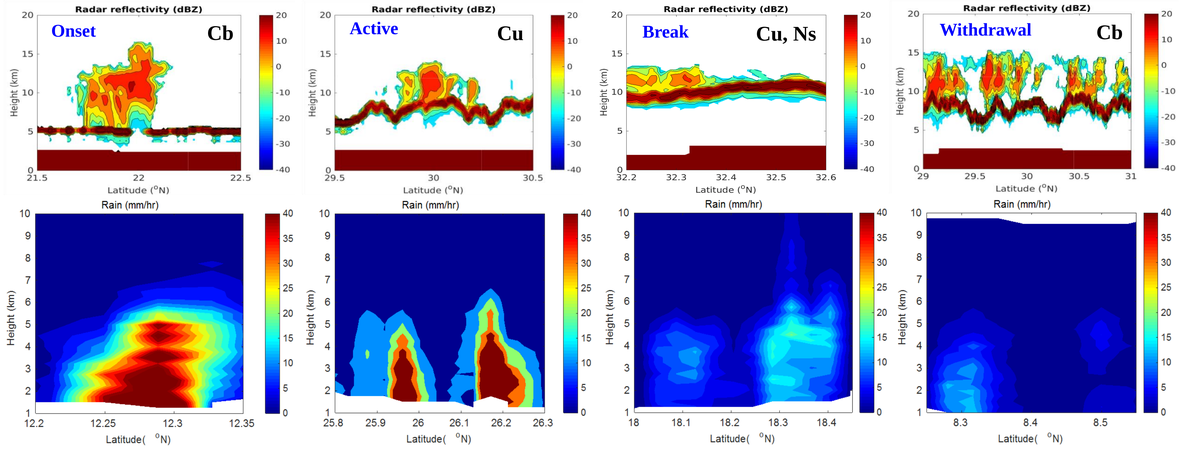
- This study illustrates clouds, precipitation and the surface energy balance during the life cycle of a single monsoon season. The features in a life cycle include onset, active, break, revival and the withdrawal phases of the monsoon. The TRMM, GPM, CLOUDSAT data sets along with results from cloud resolving model examine typical features during these phases.
- The box (20-27.5 ^{o}N and 75-82.5 ^{o}E) over central India is chosen for earth radiation budget analysis.

PHASES OF THE MONSOON



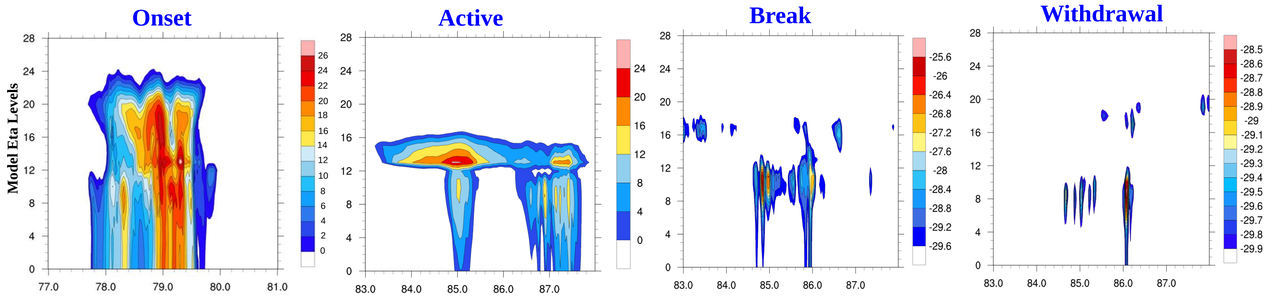
- The TRMM and GPM based rains (mm/day), for individual days, during the monsoon phases for 2014 are quite similar.

CLOUDSAT AND TRMM 2A25 RADAR VIEWS



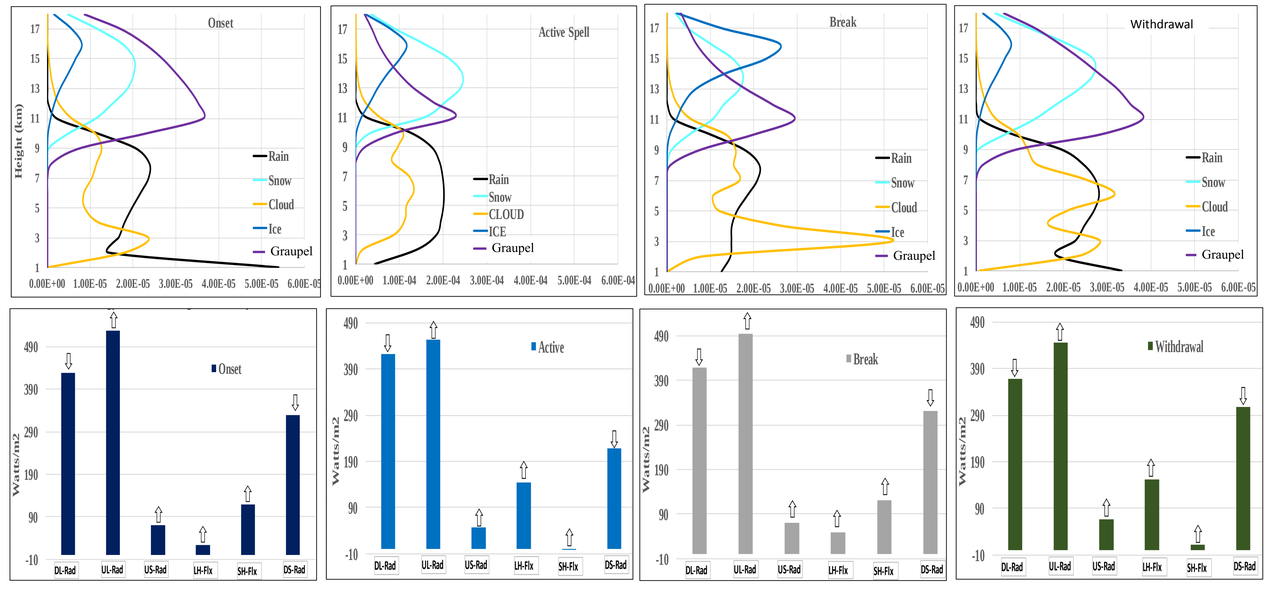
- The CLOUDSAT and TRMM 2A25 radar show deep overshooting cumulonimbus reaching almost 16km (tropopause) during the onset phase. During the active phase the nimbostratus and cumulonimbus are dominant. During the break phase weak nimbostratus clouds are still present. The withdrawal phase with drier air from the north east, lifts the melting layer and still some shallow upper tropospheric convection abounds.

MONSOON PHASES FROM HIGH RESOLUTION CLOUD RESOLVING MODEL



- The radar reflectivity (dBZ) implied by the cloud resolving WRF model output shows deep cumulonimbus clouds during the onset phase when warm ground temperatures and the incursion of moisture from the south leads to very high buoyancy and very deep convection. The active phase is dominated by nimbostratus clouds . The break and the withdrawal phases show spotty convection.

EARTH RADIATION BUDGET OVER CENTRAL INDIA



- The model based surface energy balance during the transitions of the monsoon phases largely reflected the importance of clouds and soil moisture. The surface latent heat fluxes increased to values above 100 watts/m^2 and remained large during the active and even the withdrawal phases, those values were much smaller during the break phase but not as small as in the pre-onset phase. As to be expected the downward short wave radiation was largest during the onset and the break phases.

CONCLUSIONS:

- Through TRMM, GPM, CLOUDSAT observations and modelling with the cloud resolving WRF we found that during Monsoon phase transitions deep cumulonimbus clouds prevail whereas in the active monsoon phase the nimbostratus provides the steady heavy rains.
- The modeling confirms the role of soil moisture and clouds modulating the surface energy balance during this transition.

*Acknowledgements: This work is supported by NASA/PMM grant No. **NNX16AD83G***