INTERNATIONAL CONFERENCE ON DATA ASSIMILATION
Centre for Atmospheric & Oceanic Sciences (CAOS), Indian Institute of Science.

IMPACT OF DATA ASSIMILATION ON THE PREDICTION OF MONSOON RAINFALL

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Research Guide

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- **Indian Summer Monsoon (ISM) exhibits wide spectrum of variability from daily to decadal time scales.**

- **The ISMR fluctuates within the season between periods of enhanced rainfall activity over the central India and north Bay of Bengal referred as Active spell and a suppressed rainfall period as Break spell (ISOs).**

- **These intraseasonal oscillations (ISOs) of the Indian monsoon plays a major role in influencing seasonal (June–September) mean monsoon characteristics and their interannual variability (Goswami and Ajayamohan, 2001).**

- **Prediction of the dry and wet spells (break or active phases) of the ISM two to three weeks in advance is of great importance for food production and water management of the country, but is currently a challenge for the modellers.**

- **So far, many models have performed poorly in the simulation of monsoon intraseasonal variability (Gills Bellon et al., 2008).**

- **Researchers are making constant efforts to predict the Indian summer monsoon rainfall (ISMR) using statistical (Goswami and Xavier 2003; Chattopadhyay et al., 2008) and dynamical models (Liess et al., 2005).**

- **Using a high resolution regional WRF model, Taraphdar et al., (2010) showed that the predictability limit for the active and break phases are around 4 and 10 days respectively over the Indian Region.**

- **Rajeevan (2001) suggested that eventhough the chaotic internal dynamics may limit the predictability of Indian summer monsoon, but prediction is sensitive to the initial conditions**

- **Gadgil et al., (2010) suggesting that the accuracy of prediction of rainfall, few days in advance is high when satellite data have been assimilated to specify initial conditions accurately.**

- **Rakesh et al., (2010) showed that, the assimilation of temperature and humidity profiles from remote sensing data (AIRS and MODIS) significantly improved the model predicted rainfall during monsoon period (2006).**

MODEL DETAILS :

Model type	Primitive equation, Non – hydrostatic model (WRF-ARW-V3.2.1)
Domain of integration	40^o E – 120^o E 25^o S – 40^o N → D1,
Vertical resolution	38 sigma levels
horizontal resolution	45 km
Convection scheme	Betts-Miller-Janjic
Explicit moisture scheme	Simple Ice (Dudhia)
PBL scheme	Yonsei University Scheme
Microphysics	Lin scheme
Radiation scheme	Dudhia scheme for shortwave radiation. Rapid Radioactive Transfer Model for long wave radiation
Surface scheme	NOAH Land – Surface Model
Sea Surface Temperature	RGT SST

Initial and boundary conditions

NCEP/NCAR FNL data available at 1° x 1°

Data Assimilation used in the study

- **Four-Dimensional Data Assimilation (FDDA), is a continuous data assimilation technique which is to run a full-physics model while incorporating observations. Thus the model equations assure a dynamical consistency while the observations keep the model close to the true conditions and make up for errors and gaps in the initial analysis and deficiencies in model physics (Stauffer and Seaman, 1994)**
- **The model state is relaxed toward the observed state by augmenting some of the prognostic equations with forcing terms based on the difference between the observed state and the model state.**

$$\frac{\partial \alpha}{\partial t} = F + G_\alpha W(x, y, \sigma, t)\cdot(\alpha_0 - \alpha),$$

Where F = All model's Physical Processes

G_α = Positive relaxation term which determines relative weight the relaxation term

W = Four dimensional weighing Function

α_0 = Gridded field of α obtained from objective Analysis of Observations

where 'α' is a prognostic variable (u, v, t, q), F denotes the normal tendency terms due to physics, advection, etc. The estimate of the observation analyzed to the grid and interpolated linearly in time to t is 'α_o'. 'G' is nudging factor and 'W' specifies the horizontal, vertical, and time weighting applied to the analysis. G controls the magnitude of nudging.

INITIAL RESULTS WITH ASSIMILATION:

- Experiment has done for 1-10 July, 2010.

OBSERVATIONS USED IN PRELIMINARY EXPERIMENT

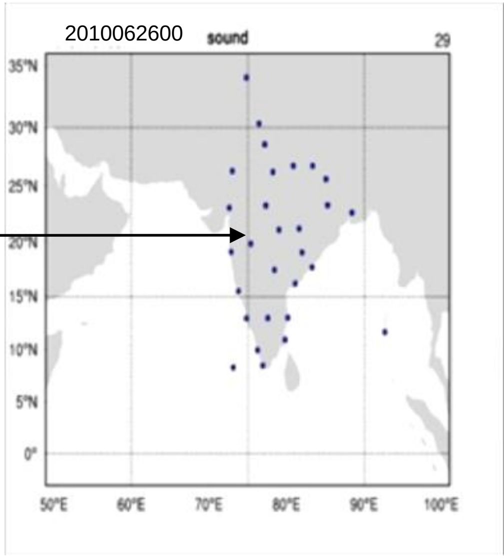
UPPER AIR OBSERVATIONS

Satellite Observations

Aircraft Observations

Radiosonde (31)

Pilot balloon (64)



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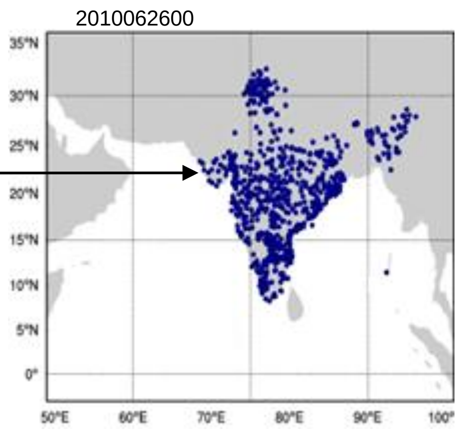
SURFACE OBSERVATIONS

SYNOPTIC OBS (200)

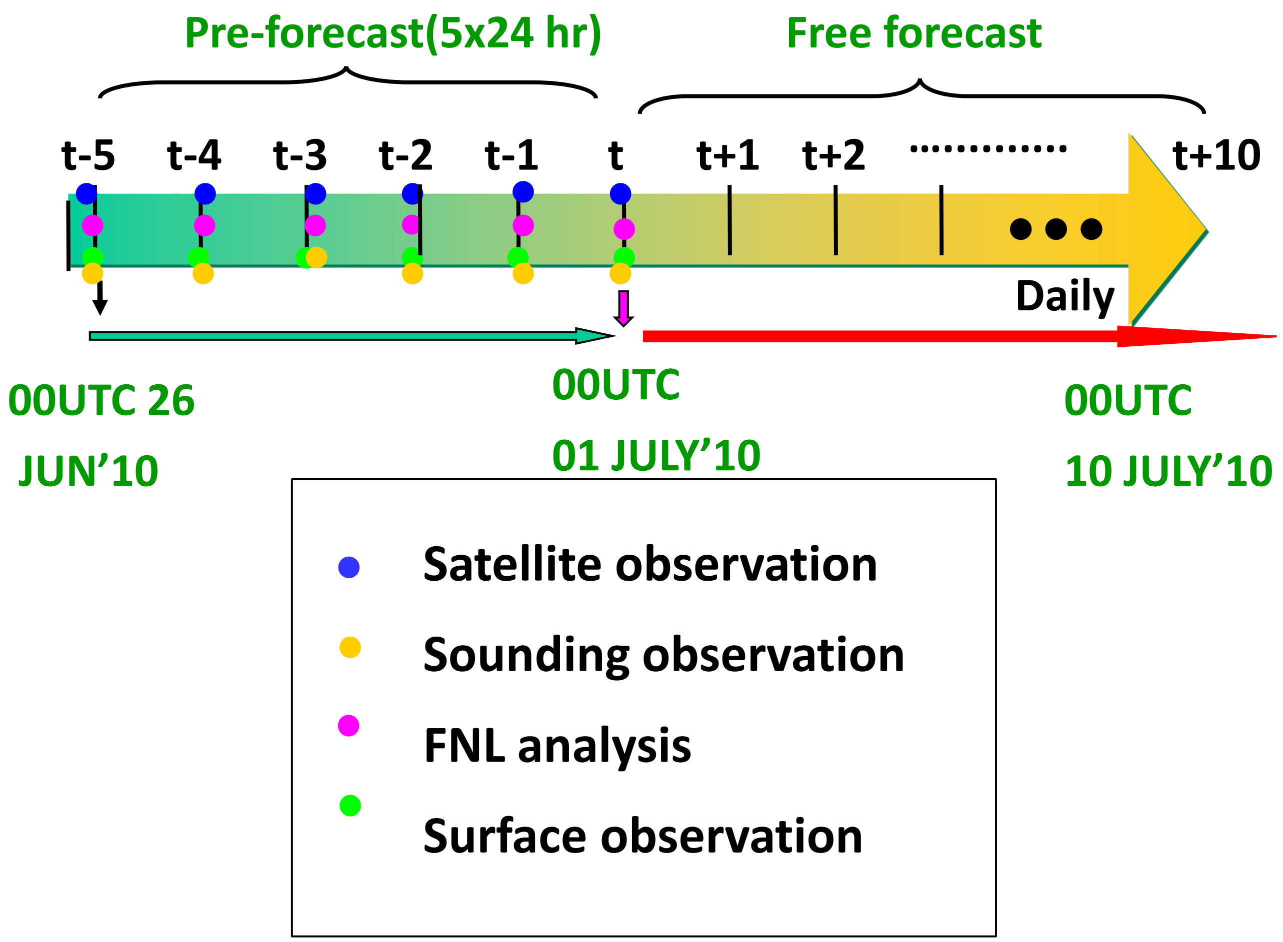
IMD AWS (504)

SHIP

BUOY(12)

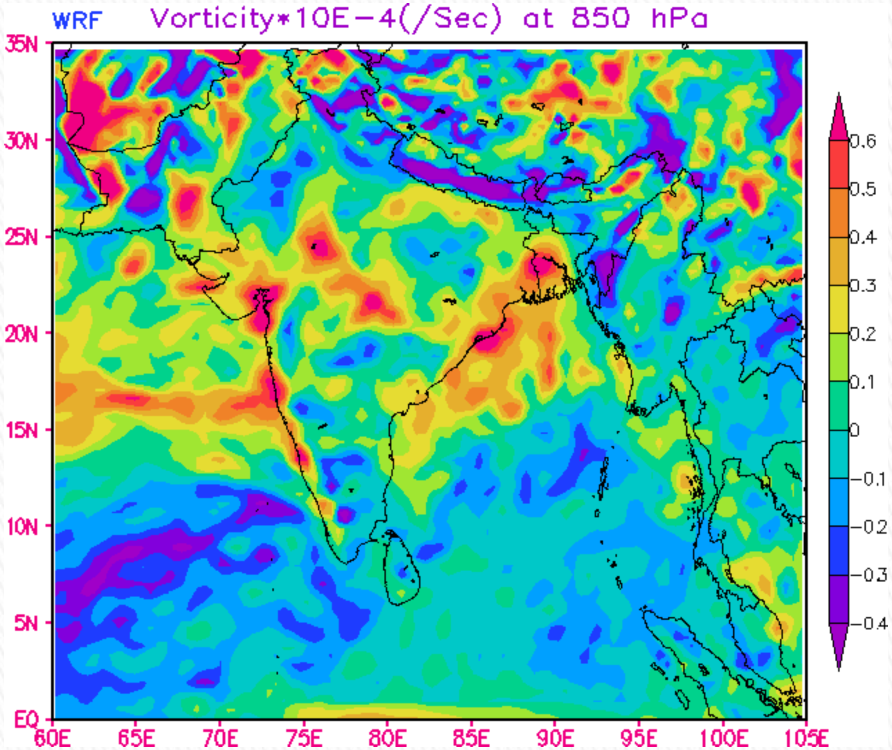


Four Dimensional Data Assimilation flow in Study

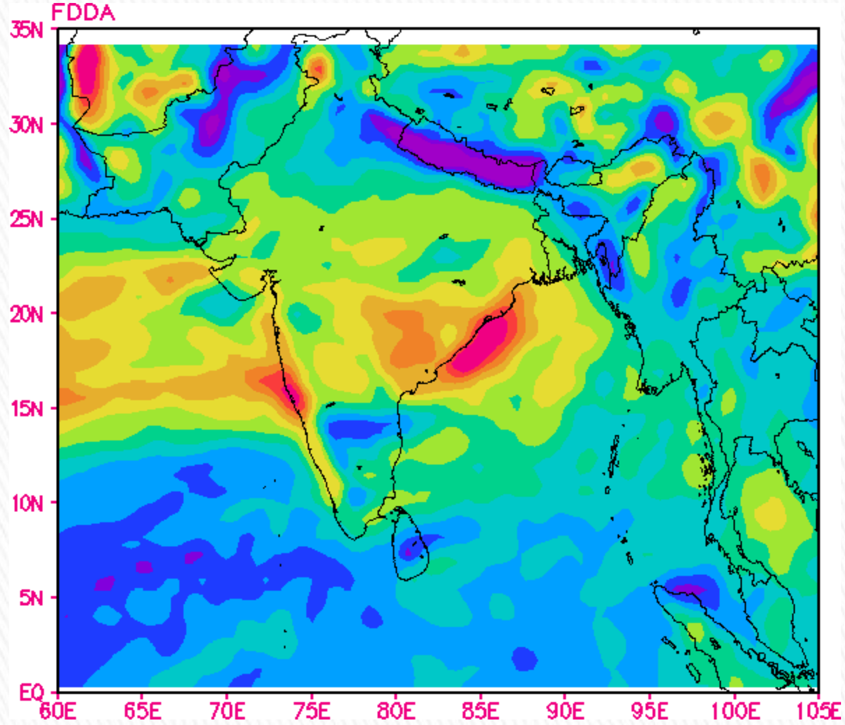


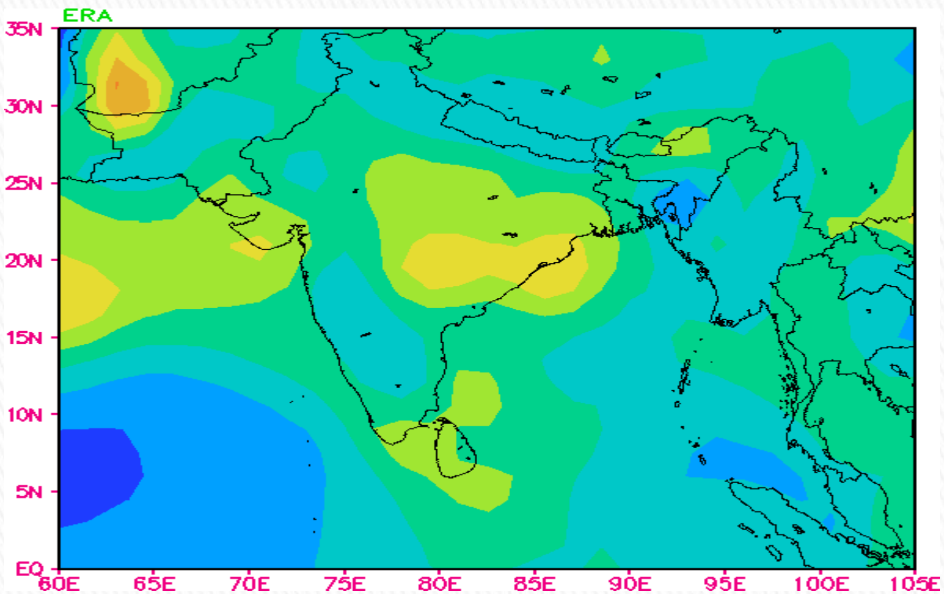
➢ use WRF analysis as background, assimilate all available data, include surface, sounding, and satellite data.

WRF CTRL



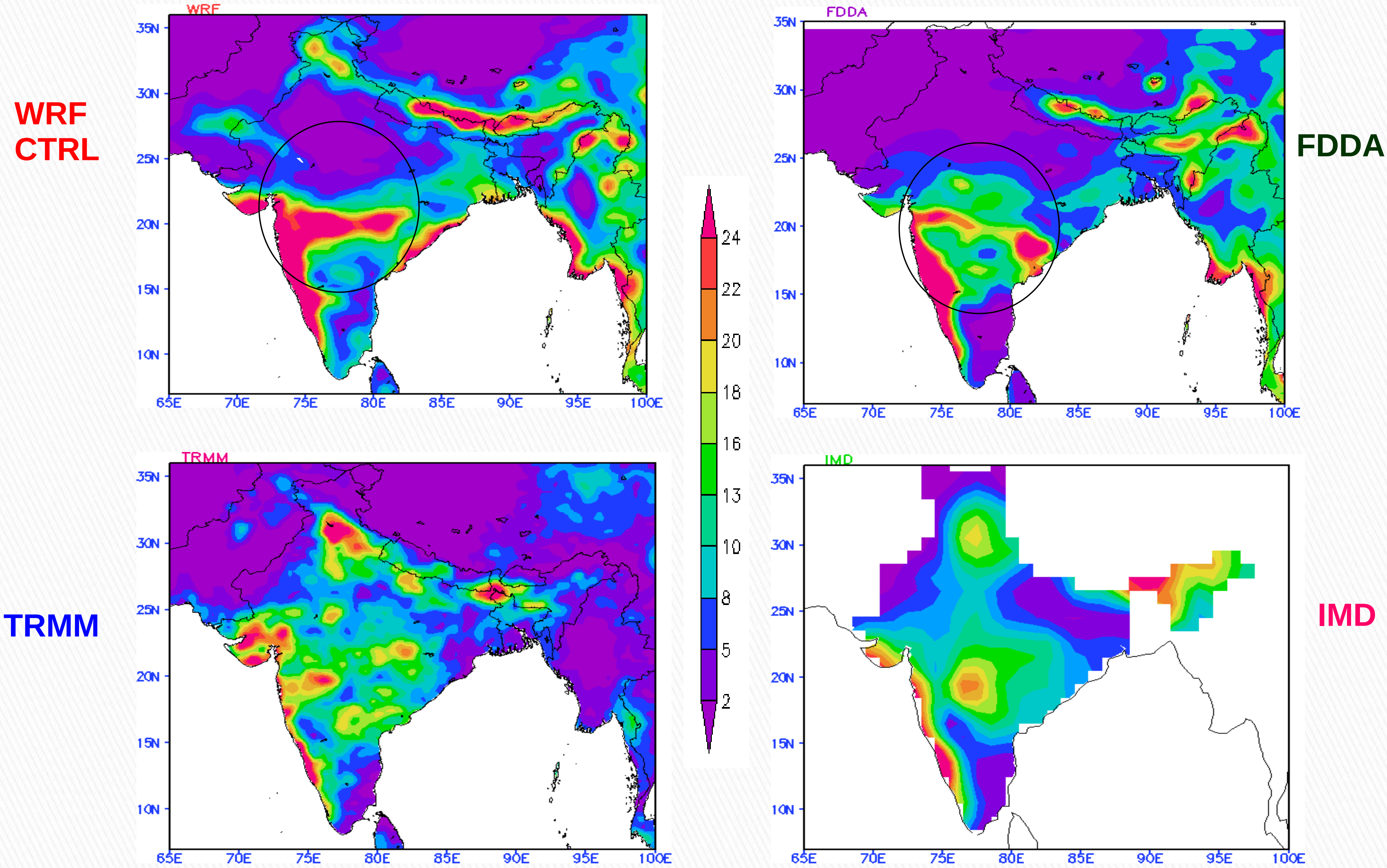
FDDA

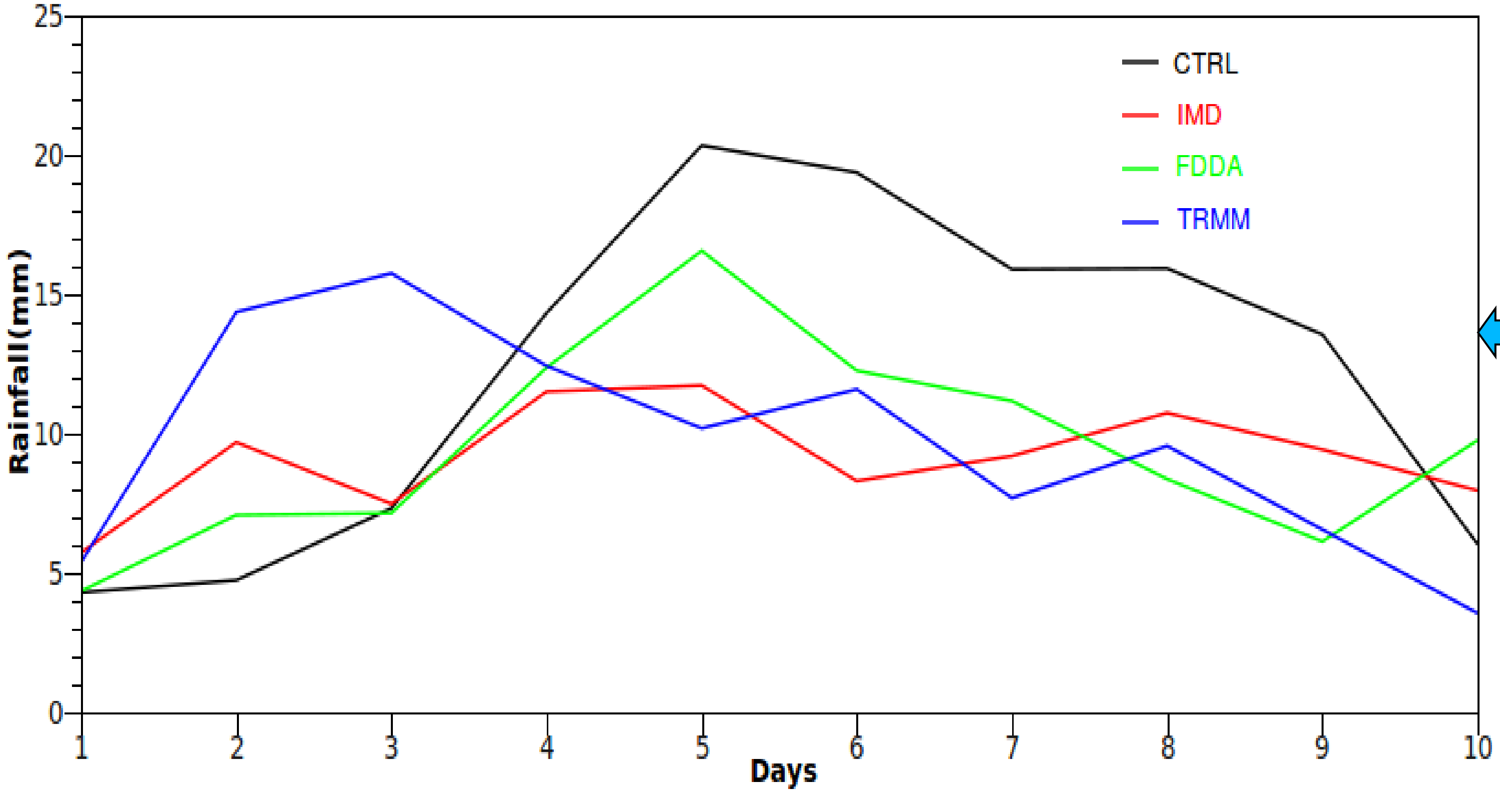




ERA

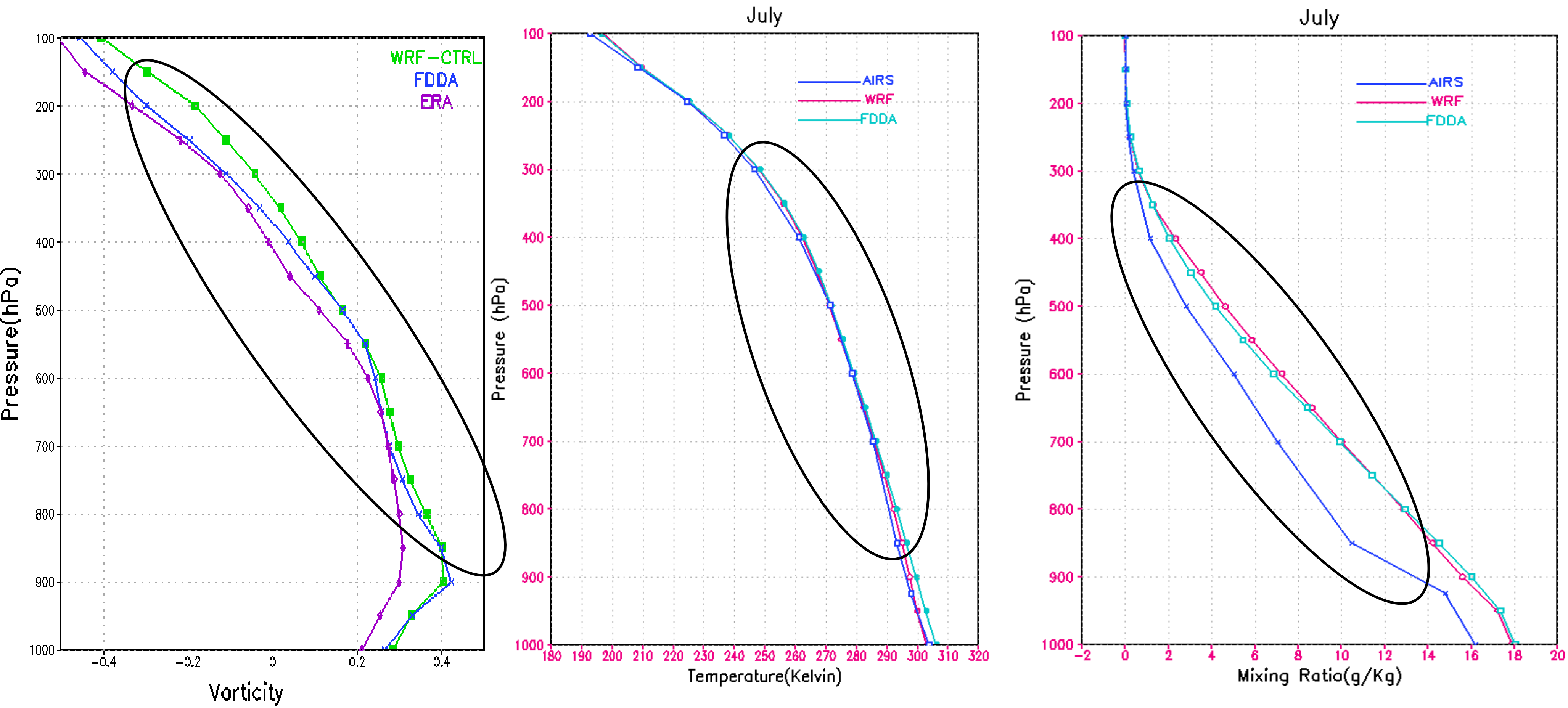
Averaged Rainfall (1-10 July)





Rainfall over Central (69º E – 88º E & 18º N – 28º N) Indian region

	IMD	WRF+CTRL	WRF + FDDA
Mean	9.312	12.865	9.123
Std. Dev	1.93	6.01	2.51
RMSE	5.96 (IMD – Model)		3.62(IMD-WRF With Assimilation)



- **Vertical profiles of Vorticity(1e-4),Temperature(K),WVMR(g/Kg) over central Indian region**

THANK YOU