

DIURNAL VARIABILITY OF SUMMER MONSOON RAINFALL IN THE UKMO-UNIFIED MODEL

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The Energy and Resources Institute

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Year	Expected Outcome	Deliverables
Year - 1	<ol style="list-style-type: none"> 1) Development of high resolution hourly gridded rainfall data sets. 2) Analysis of observed diurnal variation using rainfall observations and MERRA data. 3) Evaluation of model simulation of diurnal cycle of monsoon rainfall over the Asian monsoon region. UM and GFS models will be considered. 	<ol style="list-style-type: none"> 1) Development of gridded rainfall products. 2) Improved knowledge of observed diurnal variation of convection and rainfall 3) Evaluation of model simulations.
Year - 2	<p>Sensitivity of model simulation of diurnal cycle to physical parameterizations using UKMO UM. This will be done in collaboration with NCMRWF along with other sensitivity experiments.</p>	<p>Understanding of deficiencies in the model simulations.</p>
Year - 3	<p>Improving physical parameterization schemes in the UKMO.</p>	<p>Improved model in simulation of diurnal cycle of monsoon convection and rainfall.</p>

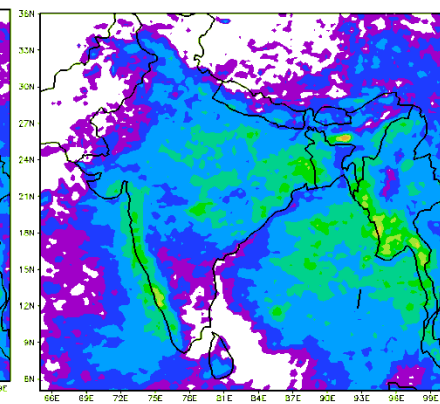
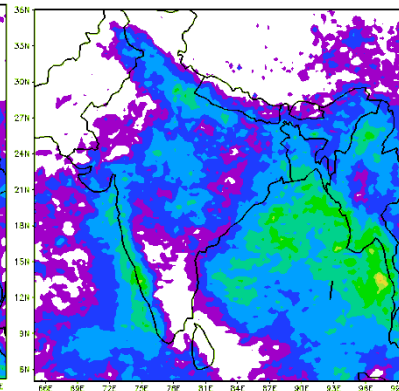
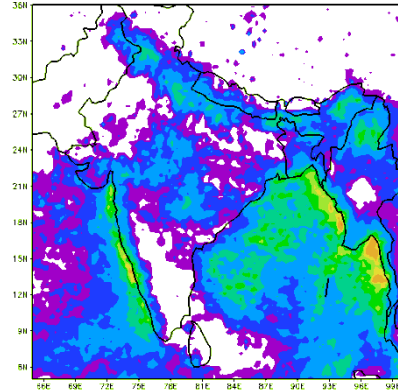
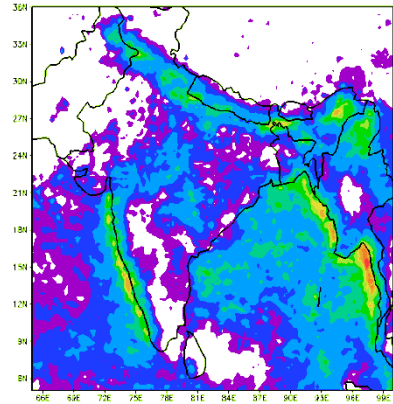
TRMM3B42 - 3 hourly JJAS mean rainfall of 2013 (3hr)

0230-0530 IST

0530-0830 IST

0830-1130 IST

1130-1430 IST

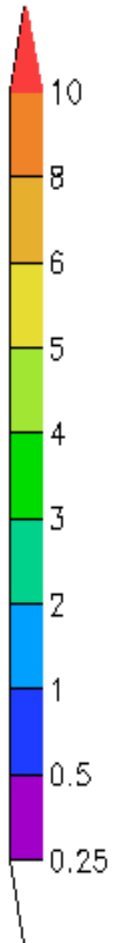
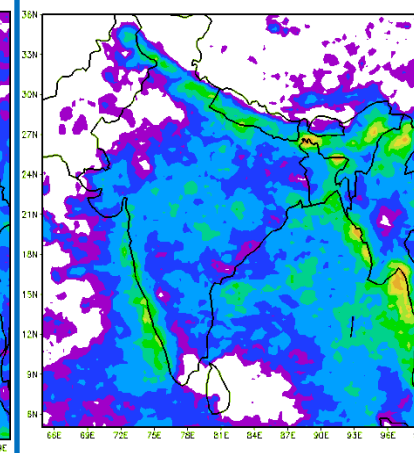
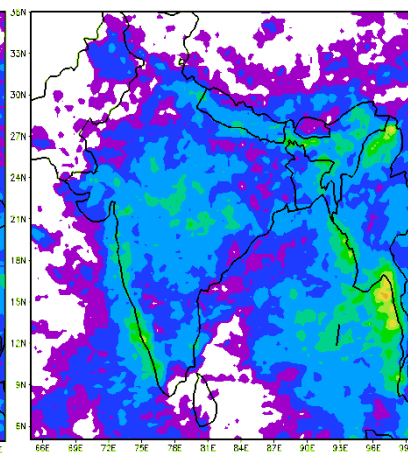
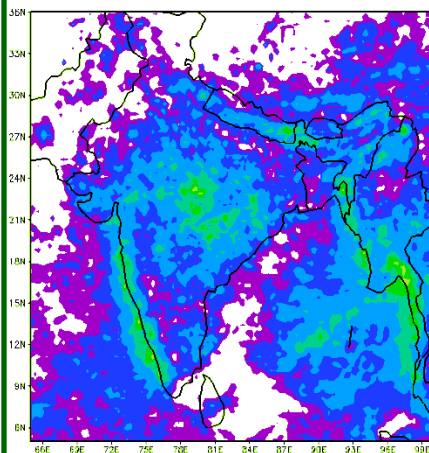
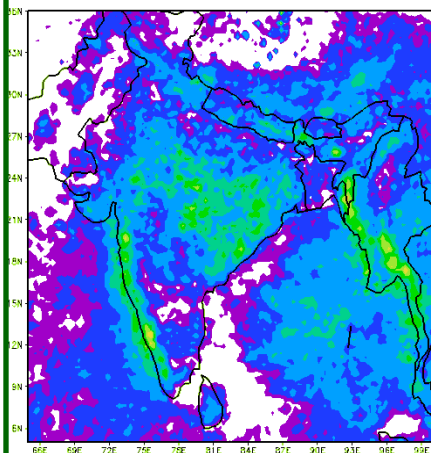


1430-1730 IST

1730-2030 IST

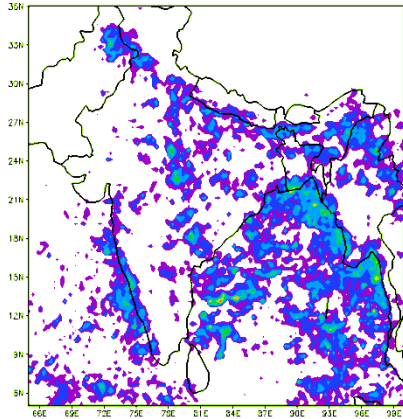
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2330-0230 IST

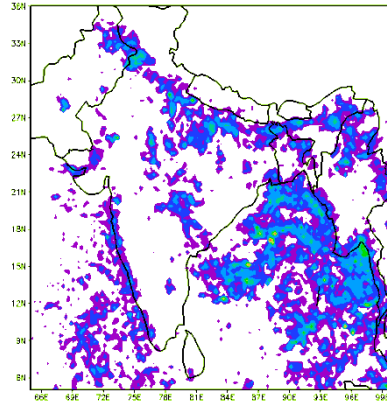


TRMM3G68 - 3 hourly JJAS mean rainfall of 2013

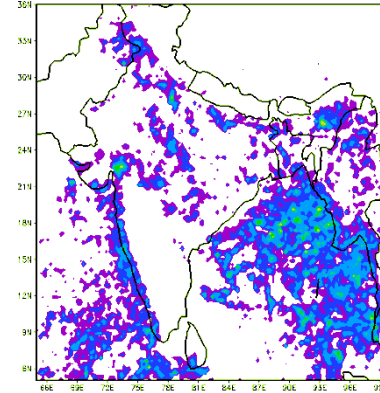
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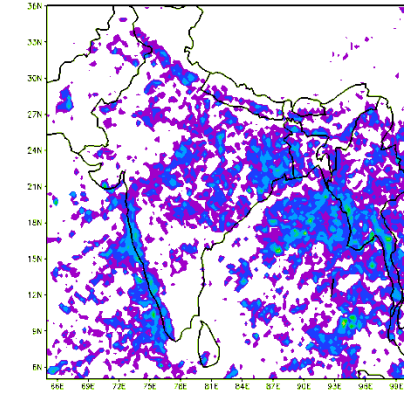
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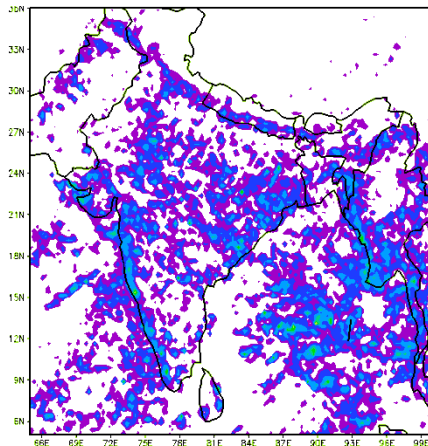
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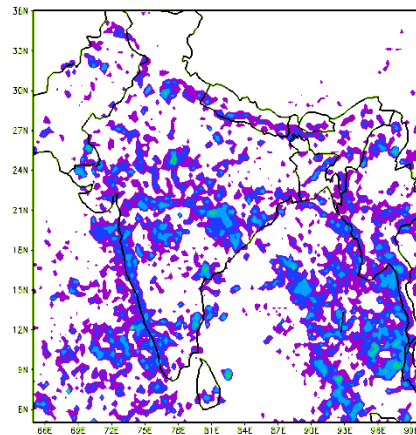
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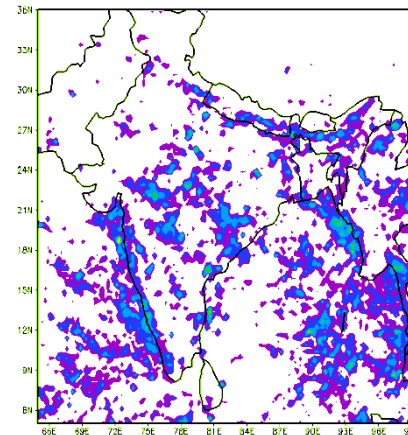
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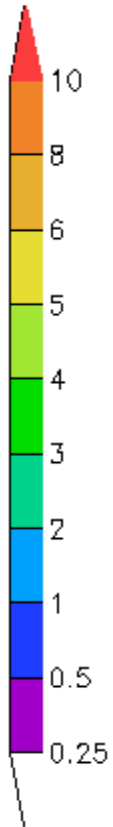
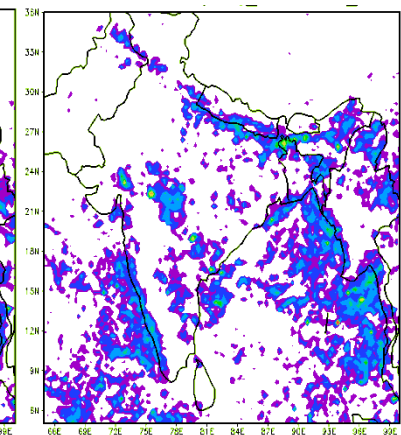
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2030-2330 IST

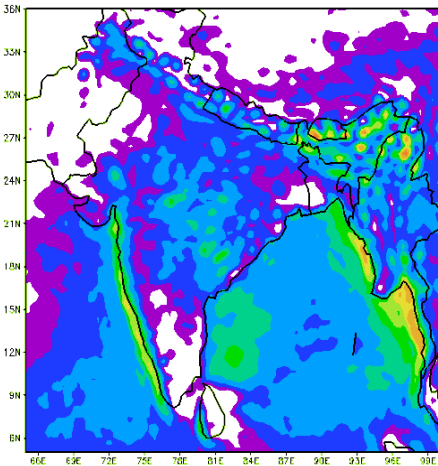


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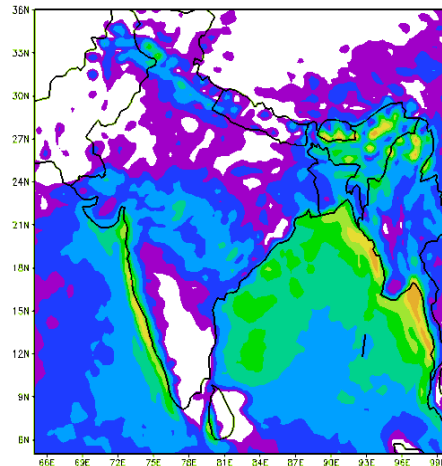


GFS DAY1- Forecast 3 hourly JJAS mean rainfall of 2013

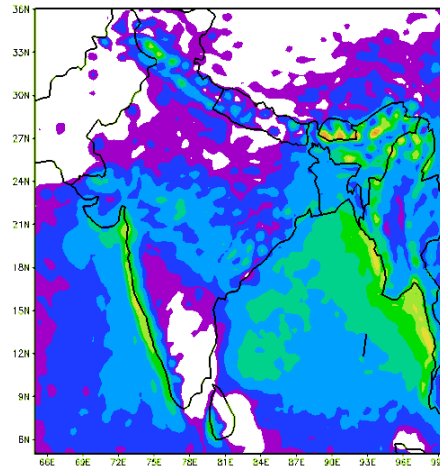
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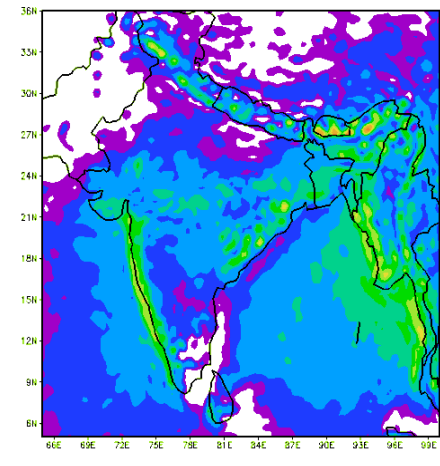
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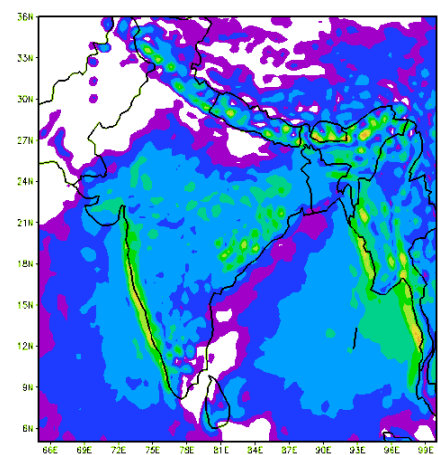
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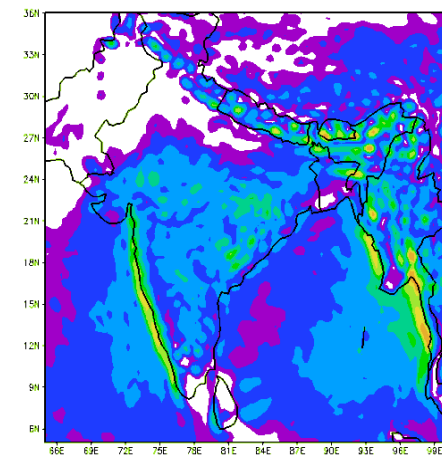
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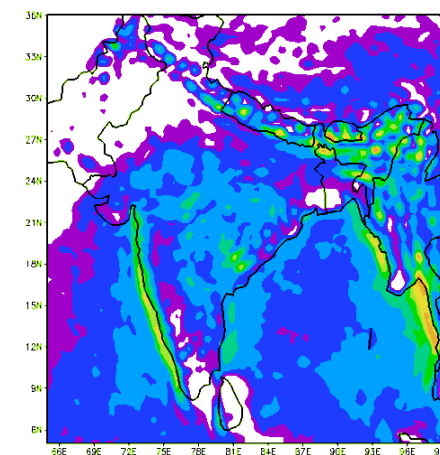
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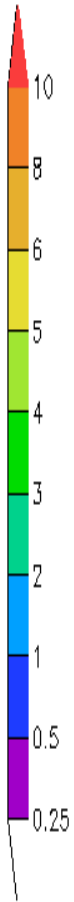
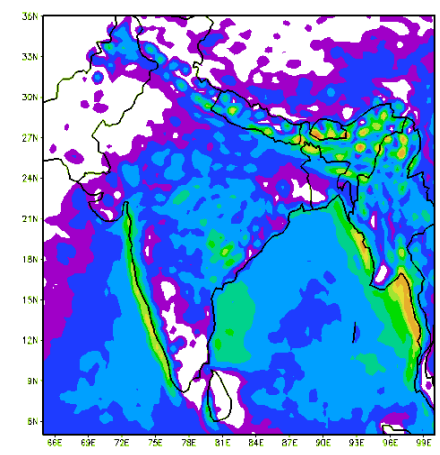
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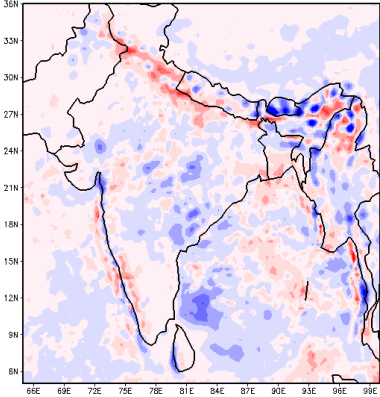


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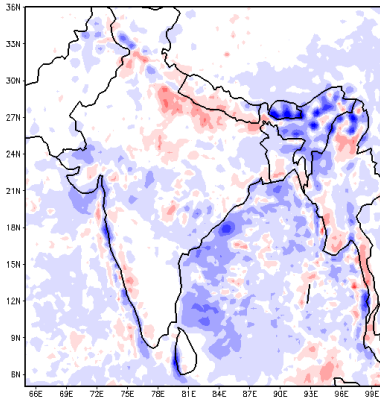


Bias (GFS-TRMM 3B42) DAY1- Forecast 3 hourly JJAS mean rainfall of 2013

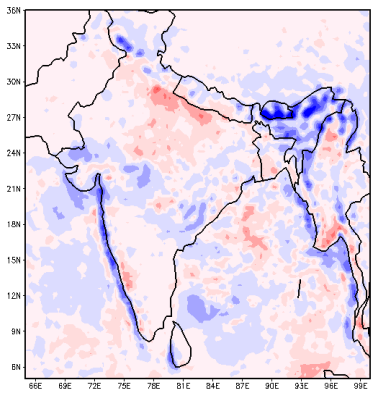
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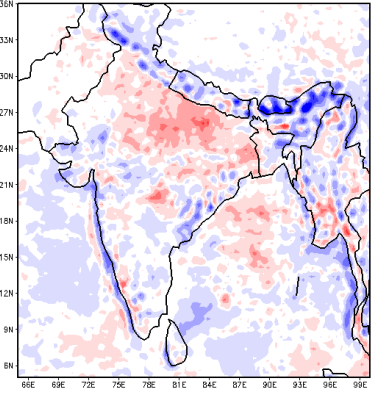
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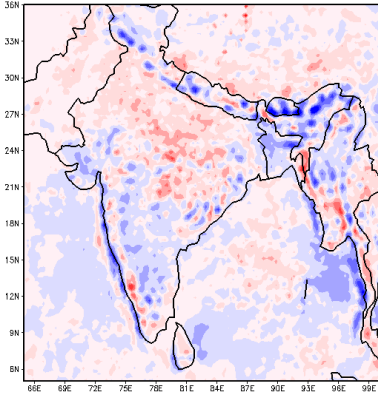
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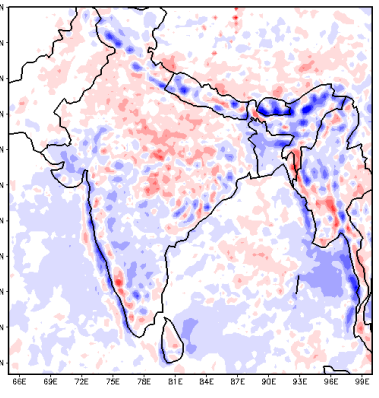
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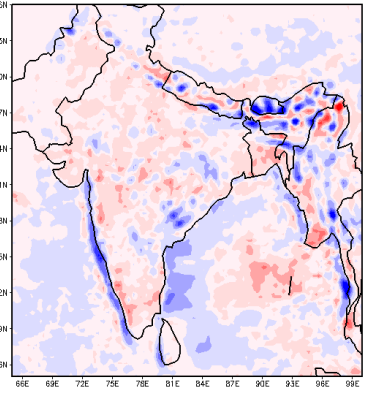
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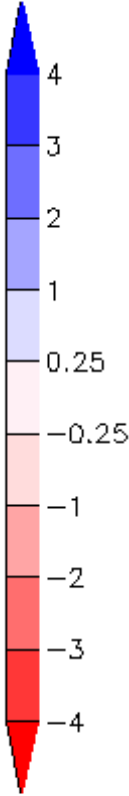
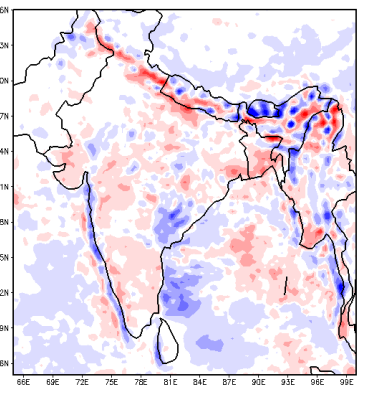
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2030-2330 IST

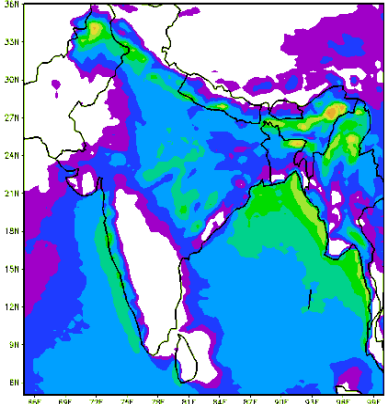


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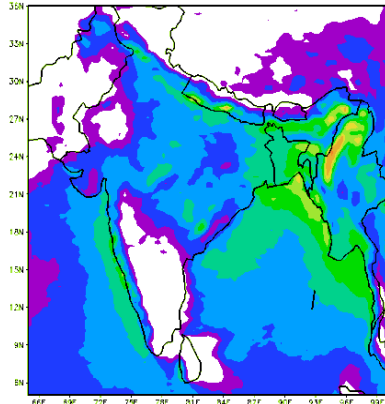


UM DAY1- Forecast 3 hourly JJAS mean rainfall of 2013

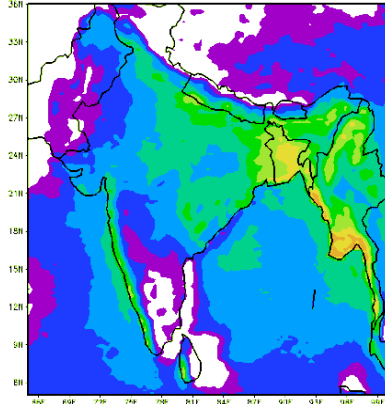
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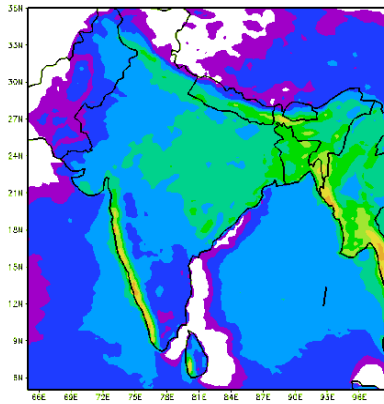
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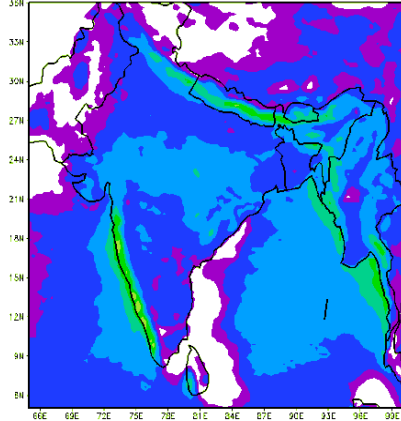
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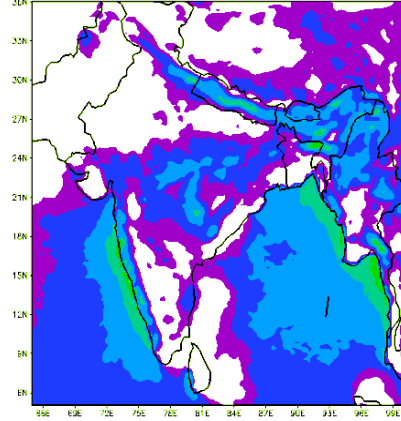
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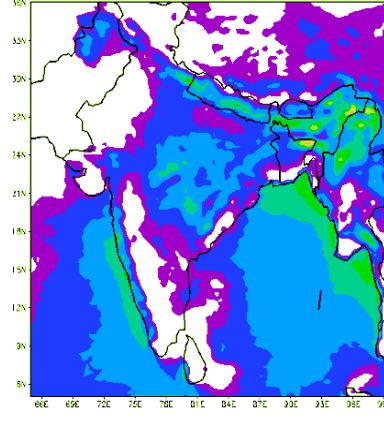
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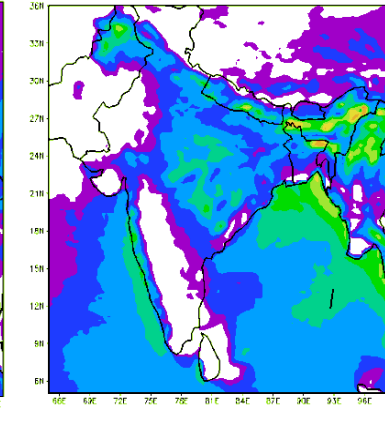
1730-2030 IST



2030-2330 IST

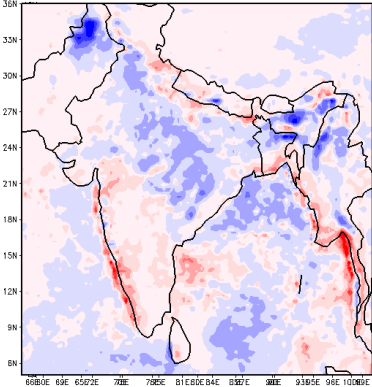


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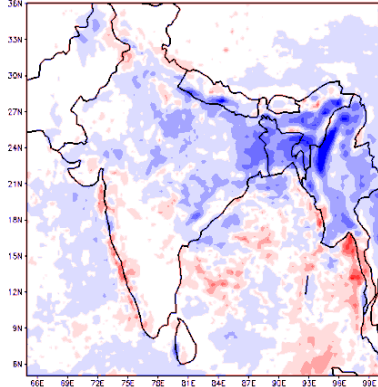


Bias (UM -TRMM 3B42) DAY1- Forecast 3 hourly JJAS mean rainfall of 2013

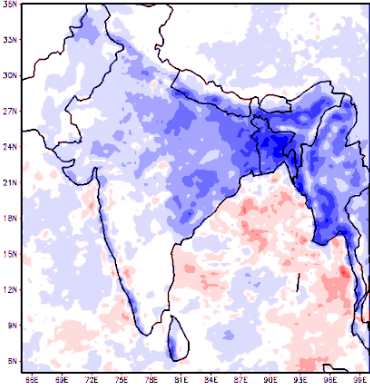
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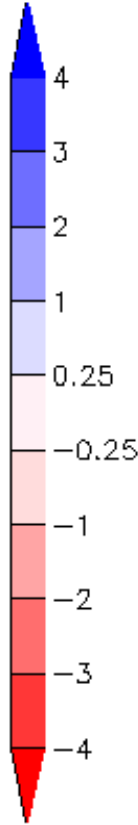
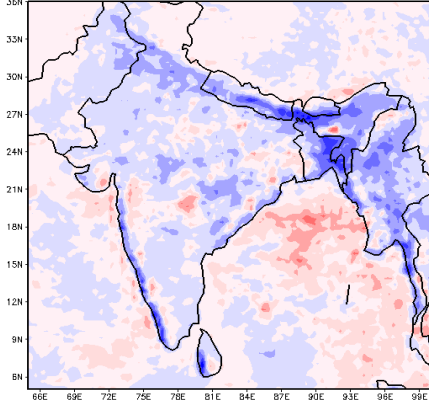
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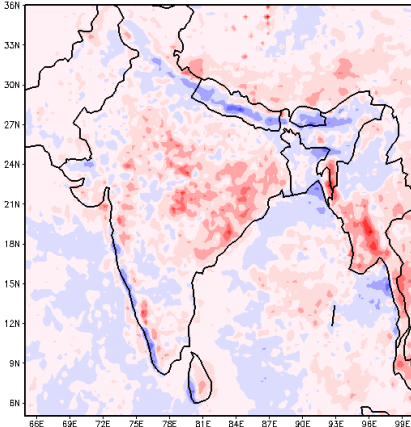
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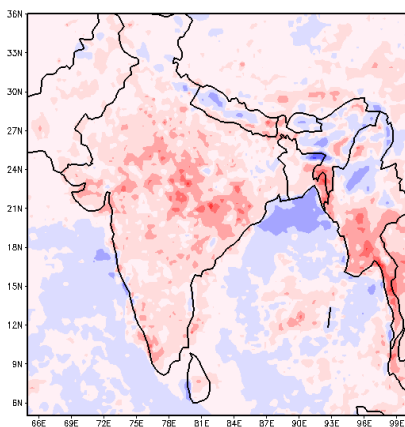
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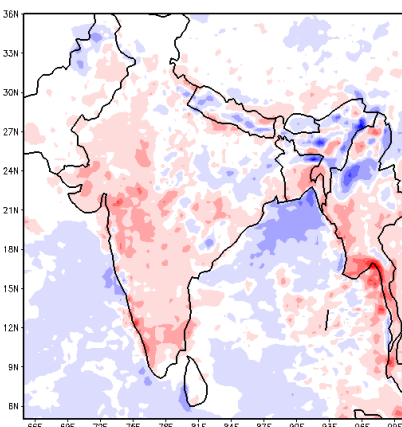
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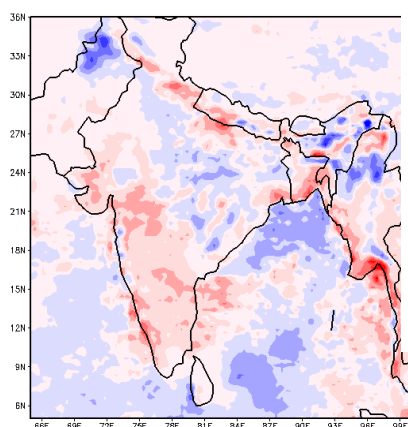
1730-2030 IST



2030-2330 IST

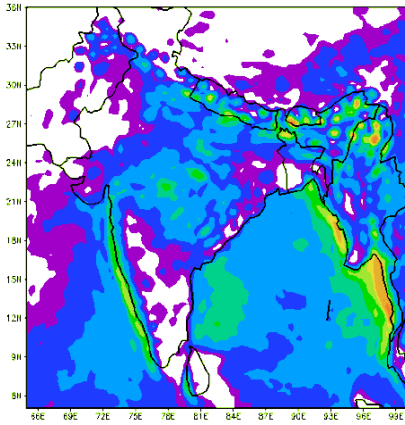


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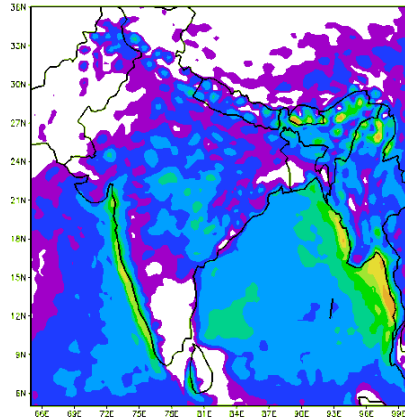


GFS DAY2- Forecast 3 hourly JJAS mean rainfall of 2013

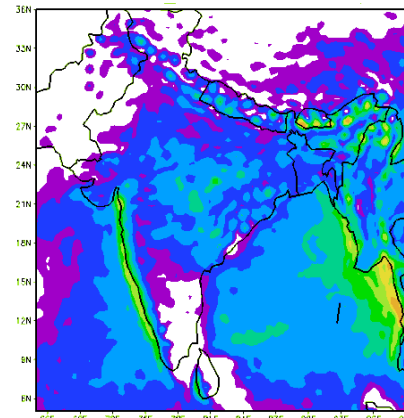
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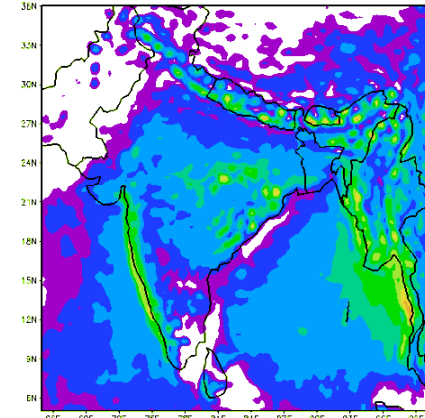
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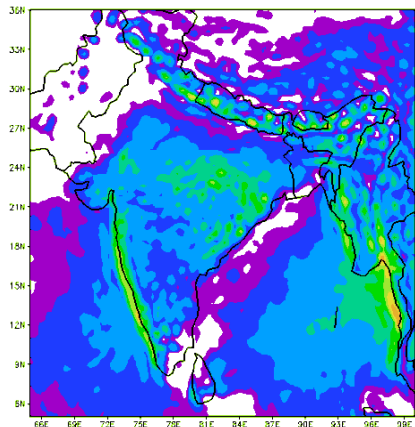
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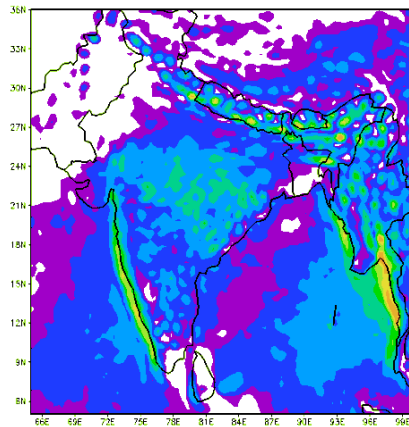
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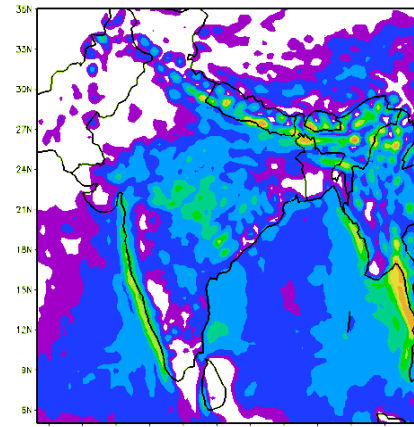
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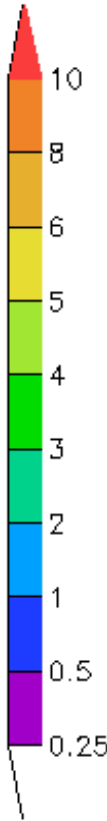
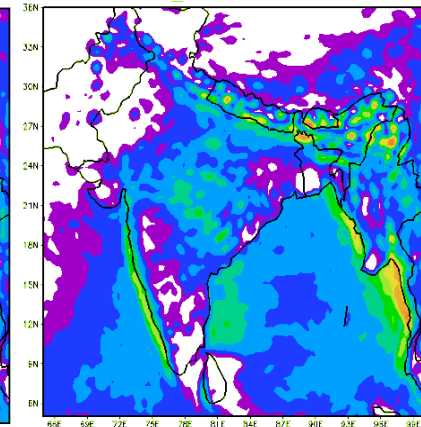
1730-2030 IST



2030-2330 IST

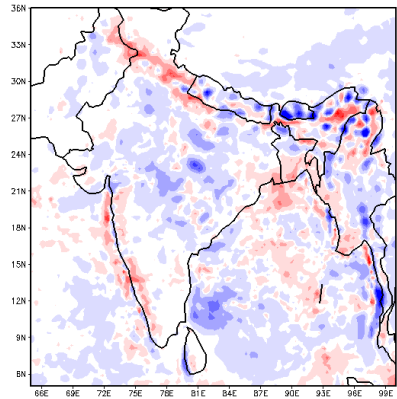


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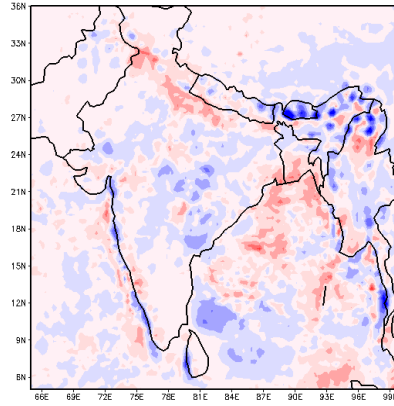


Bias (GFS-TRMM 3B42) DAY3- Forecast 3 hourly JJAS mean rainfall of 2013

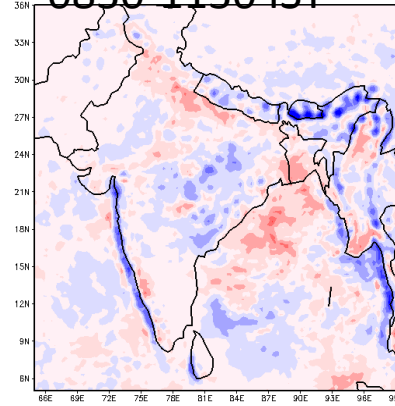
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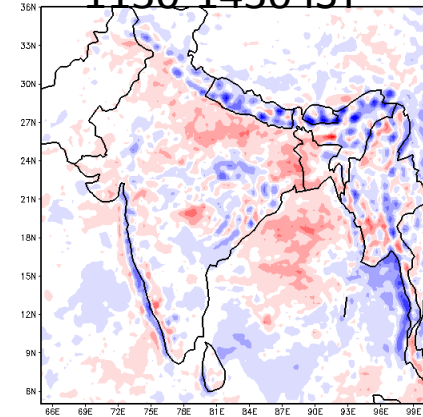
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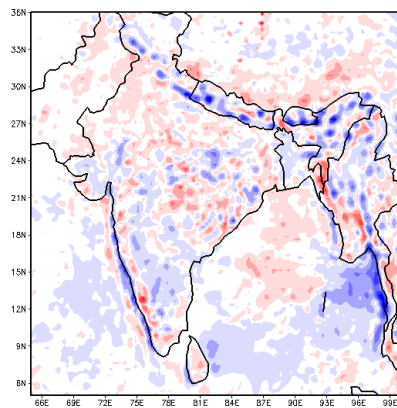
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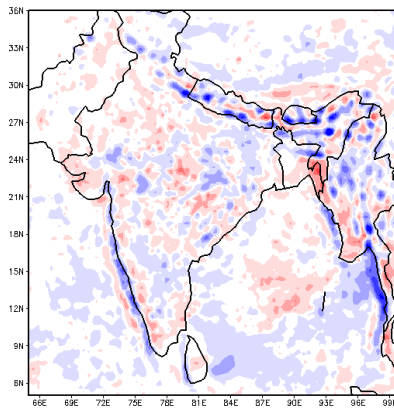
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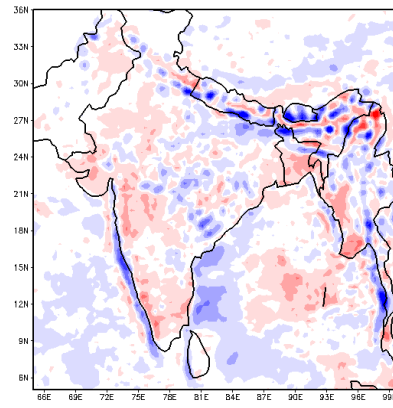
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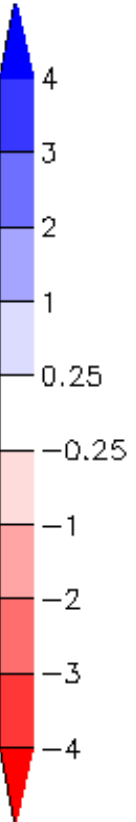
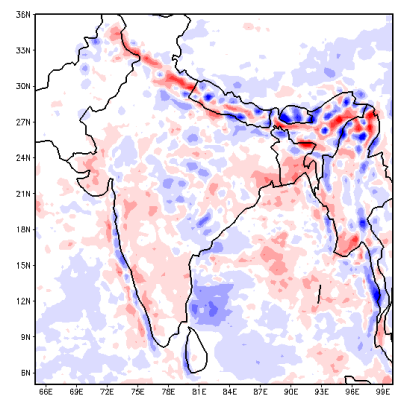
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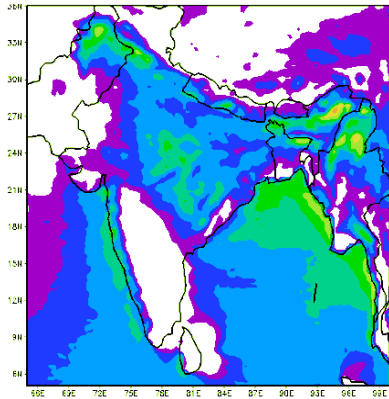


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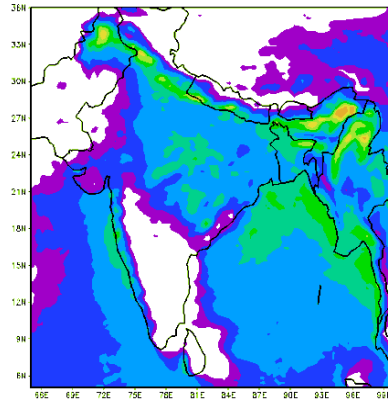


UM DAY2- Forecast 3 hourly JJAS mean rainfall of 2013

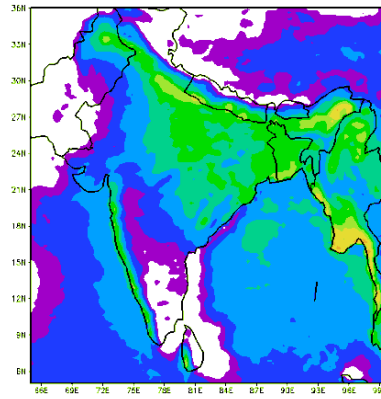
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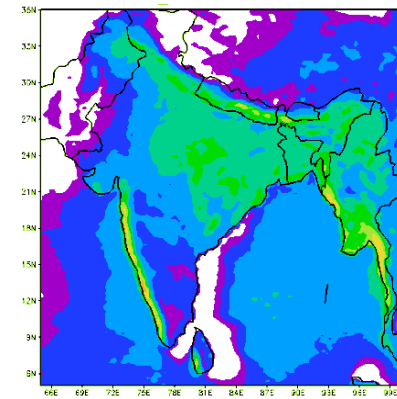
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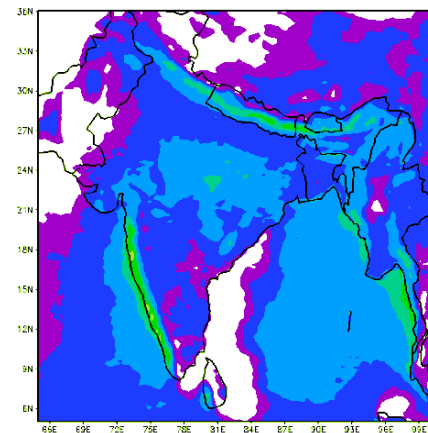
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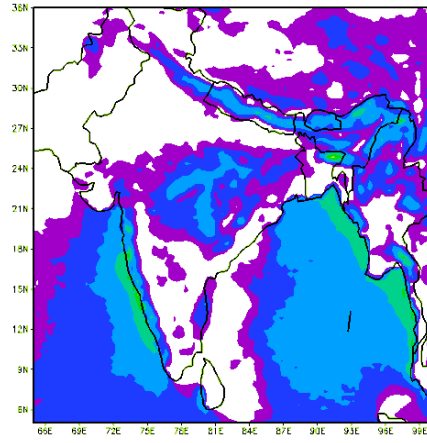
1130-1430 IST



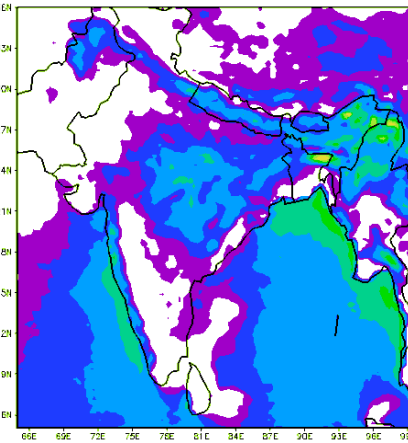
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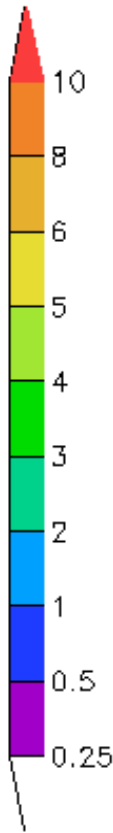
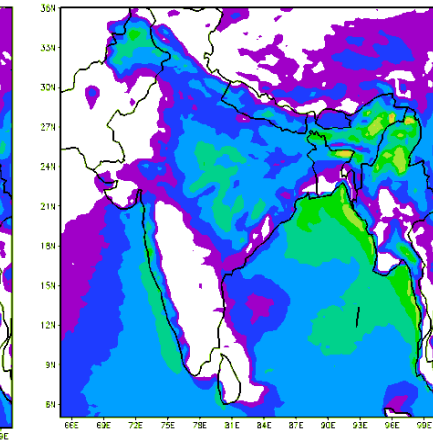
1730-2030 IST



2030-2330 IST



2330-0230 IST



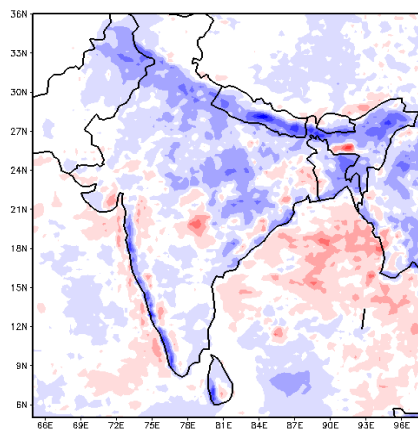
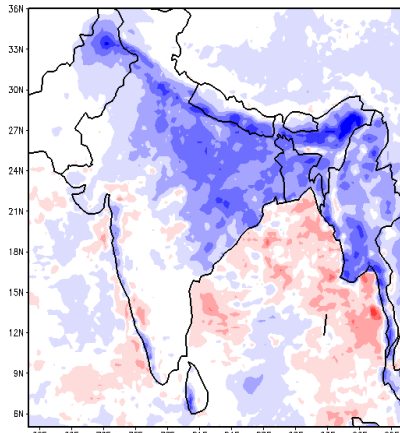
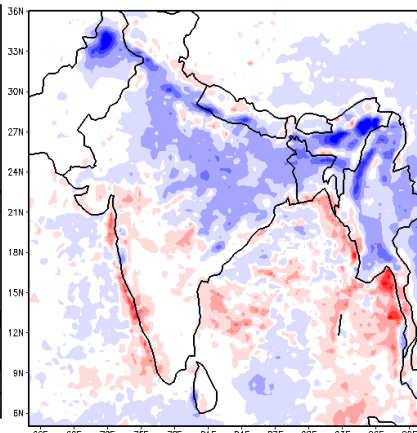
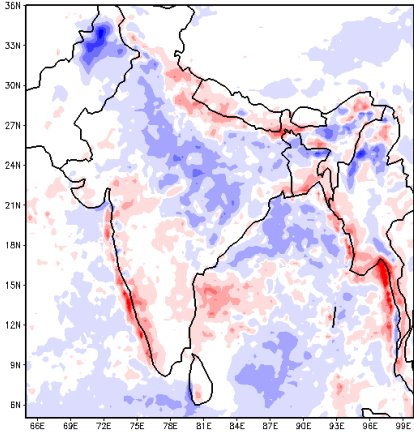
Bias (UM - TRMM 3B42) DAY2- Forecast 3 hourly JJAS mean rainfall of 2013

0230-0530 IST

0530-0830 IST

0830-1130 IST

1130-1430 IST

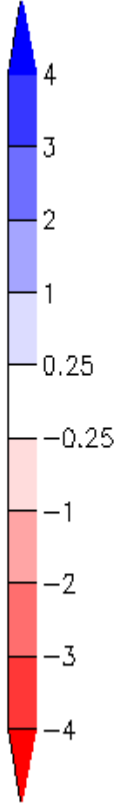
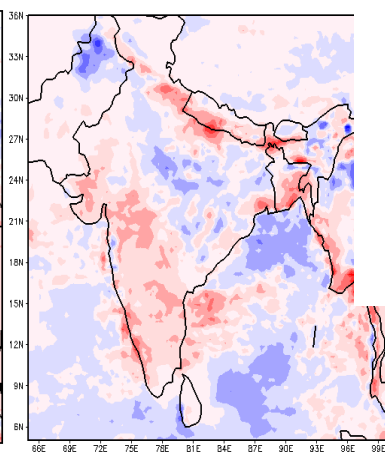
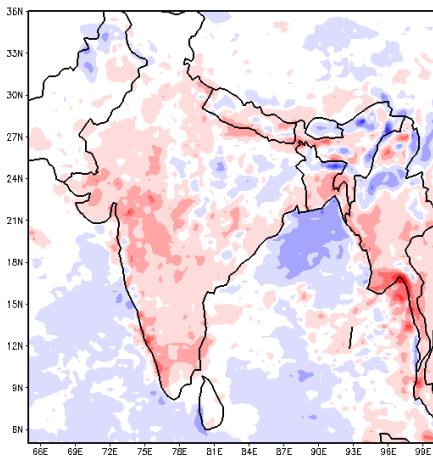
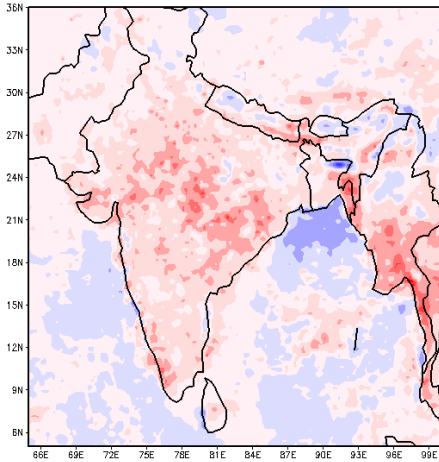
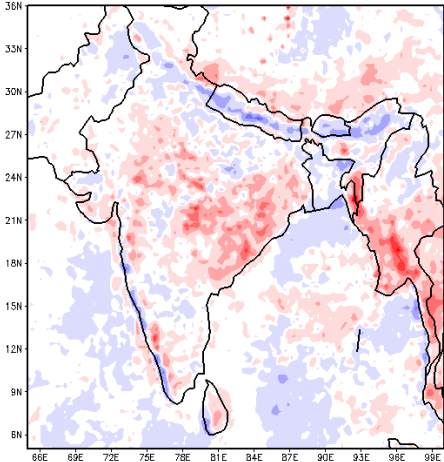


1430-1730 IST

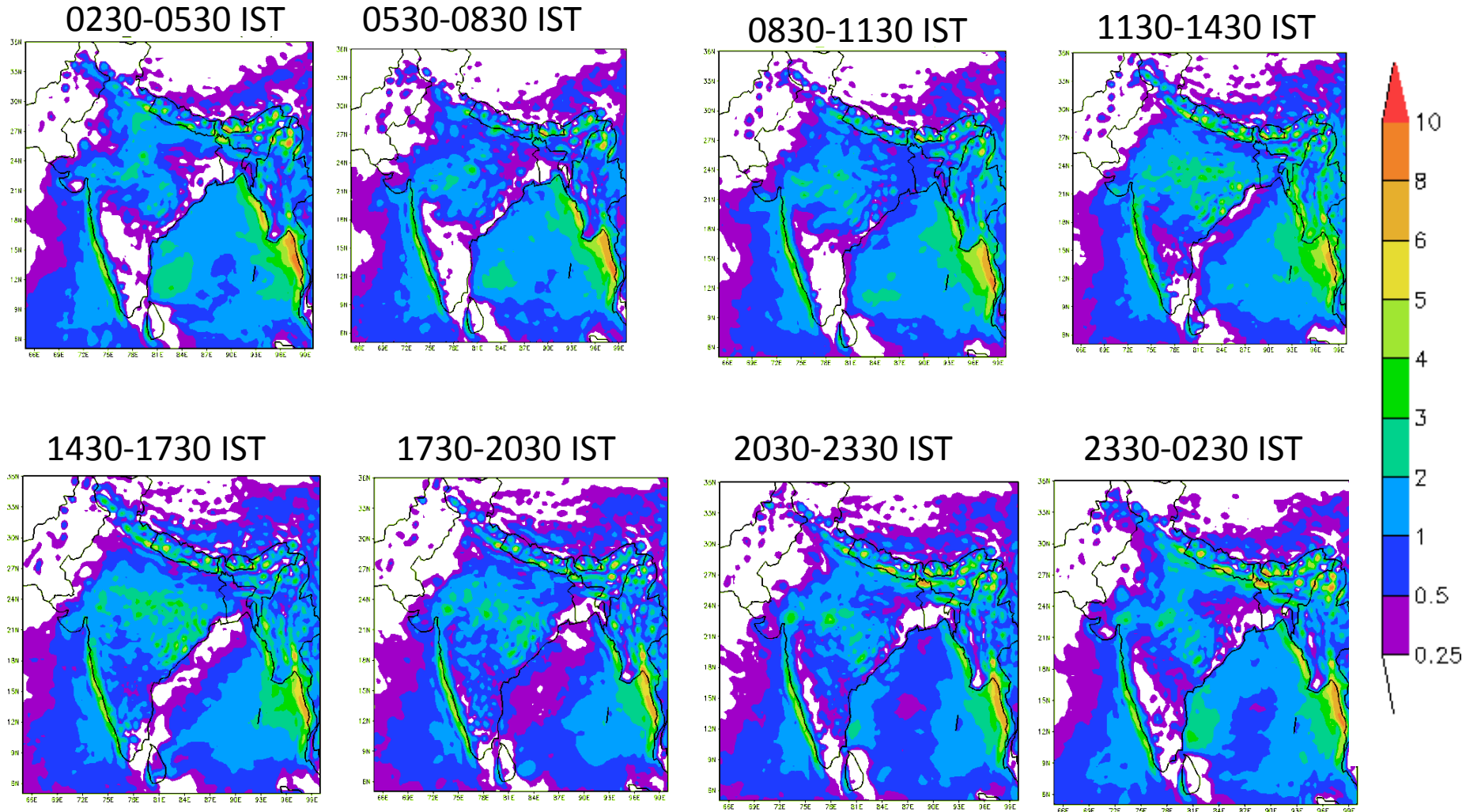
1730-2030 IST

2030-2330 IST

2330-0230 IST

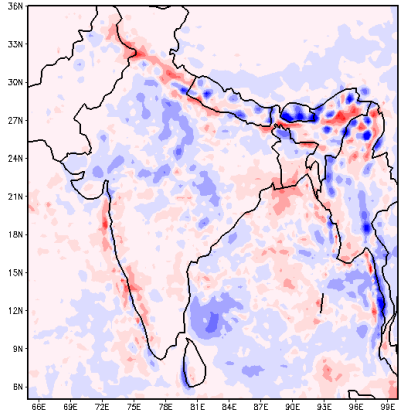


GFS DAY3- Forecast 3 hourly JJAS mean rainfall of 2013 (mm/3hour)

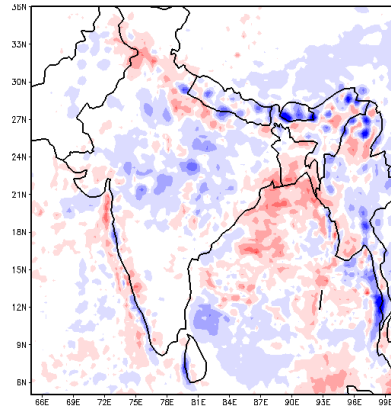


Bias (GFS-TRMM 3B42) DAY3- Forecast 3 hourly JJAS mean rainfall of 2013

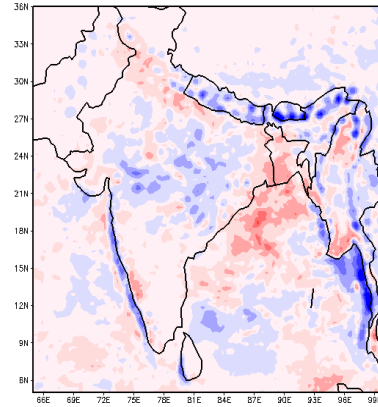
0230-0530 IST



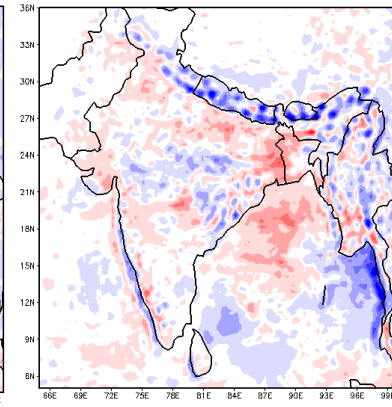
0530-0830 IST



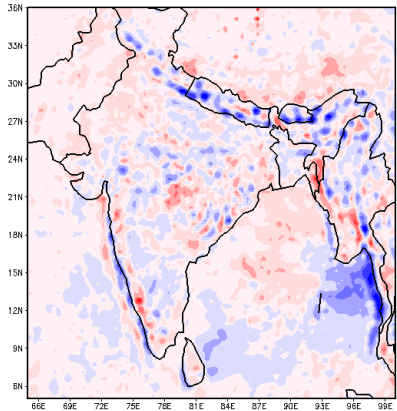
0830-1130 IST



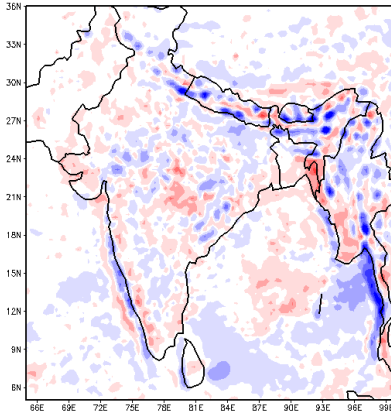
1130-1430 IST



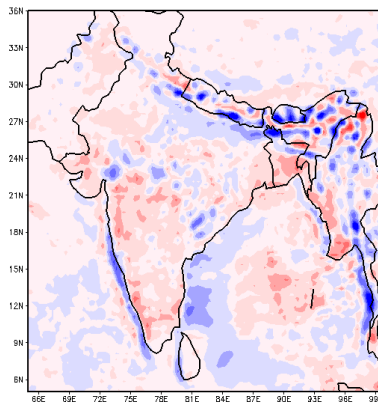
1430-1730 IST



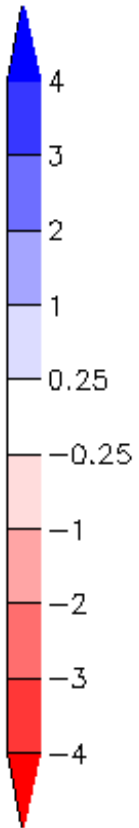
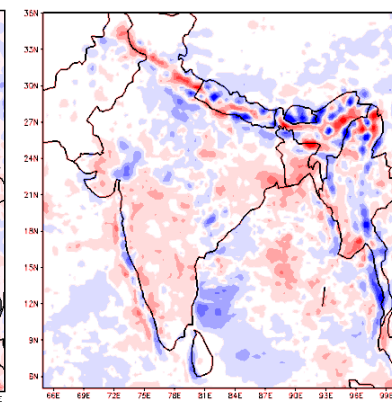
1730-2030 IST



2030-2330 IST

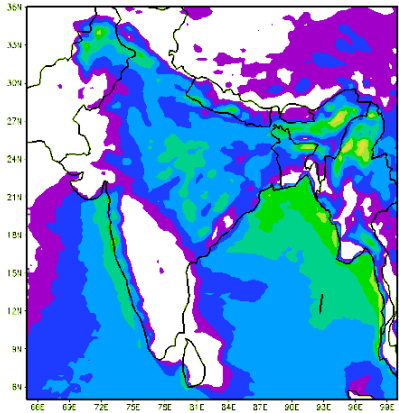


2330-0230 IST

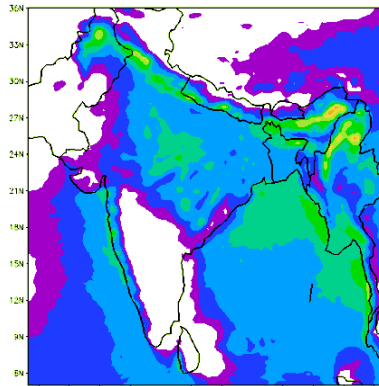


UM DAY3- Forecast 3 hourly JJAS mean rainfall of 2013

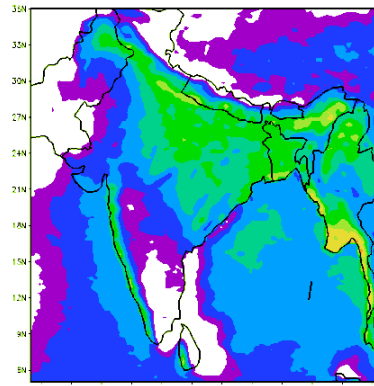
0230-0530 IST



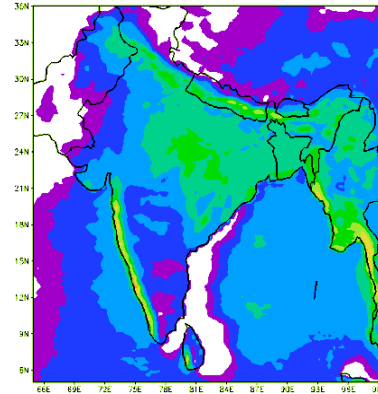
0530-0830 IST



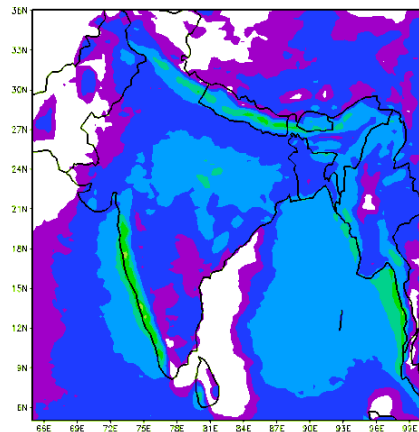
0830-1130 IST



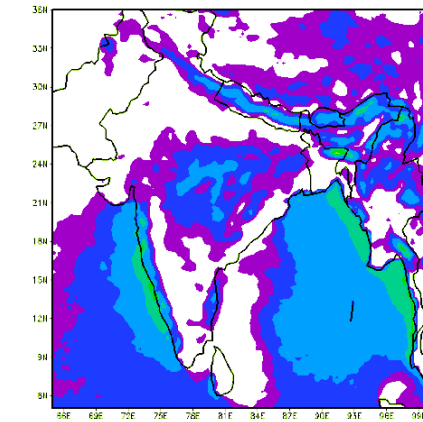
1130-1430 IST



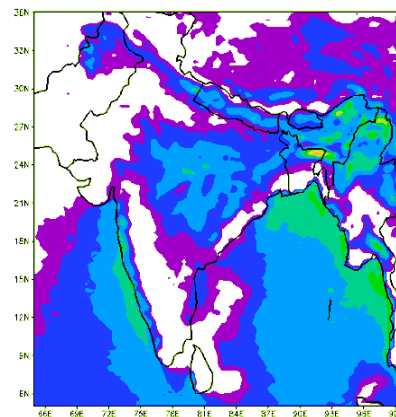
1430-1730 IST



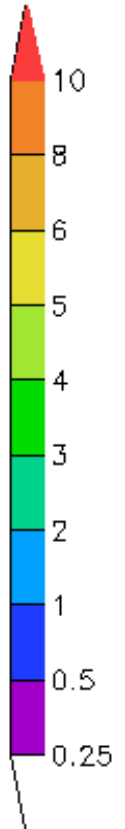
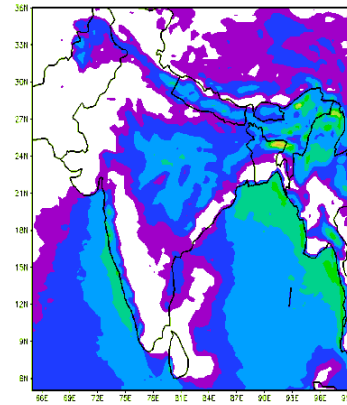
1730-2030 IST



2030-2330 IST

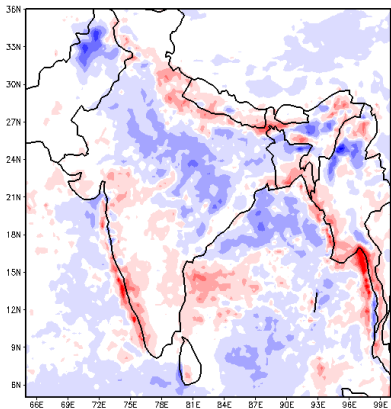


2330-0230 IST

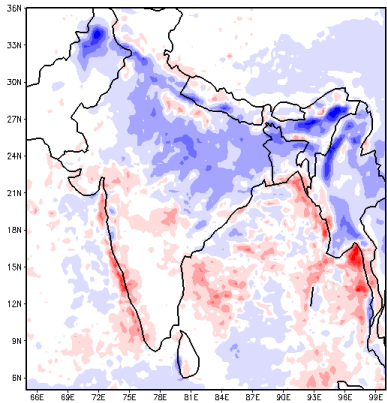


Bias (UM - TRMM 3B42) DAY3- Forecast 3 hourly JJAS mean rainfall of 2013

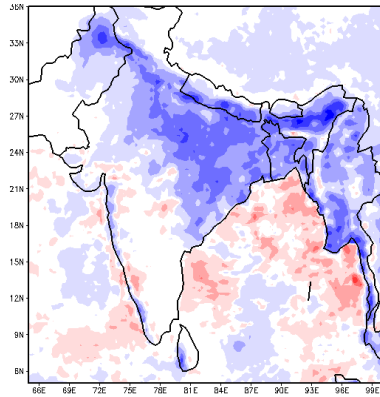
0230-0530 IST



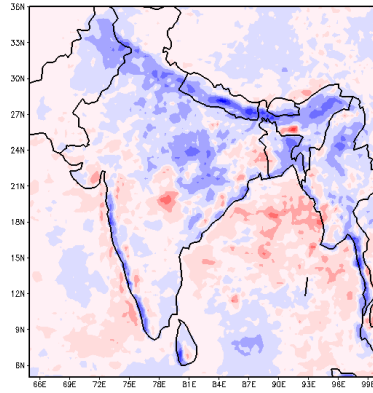
0530-0830 IST



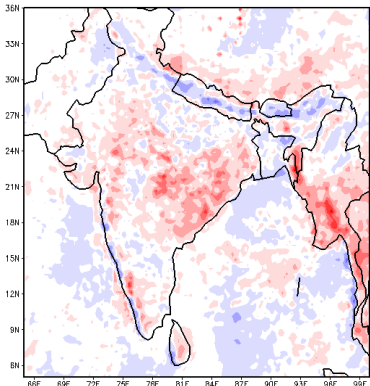
0830-1130 IST



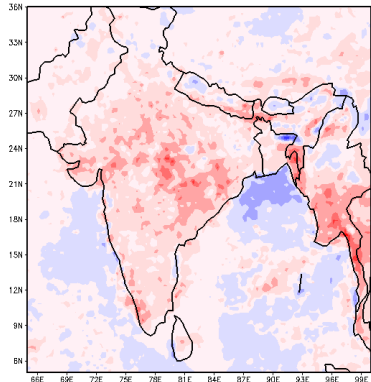
1130-1430 IST



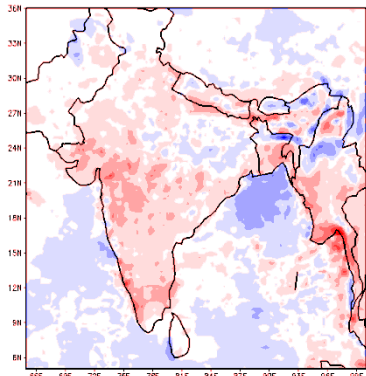
1430-1730 IST



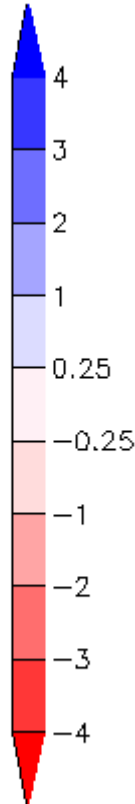
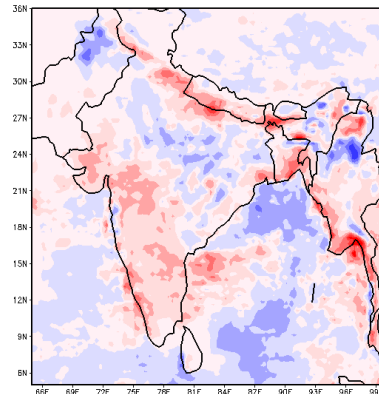
1730-2030 IST



2030-2330 IST

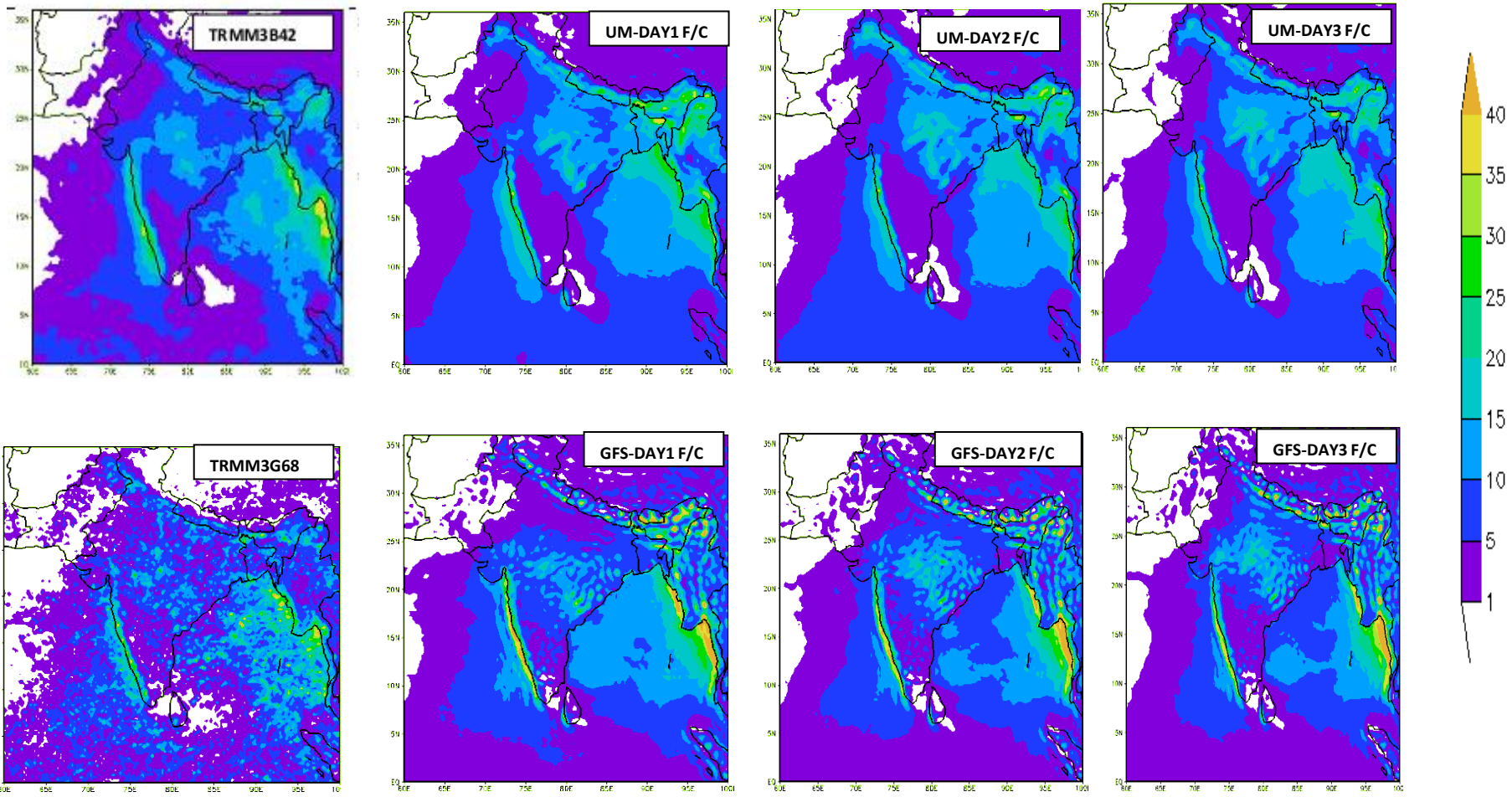


2330-0230 IST



2013 year JJAS mean rainfall (mm/day)

Comparison Model data with observation



Phase of rainfall (first harmonic - mm/day)

Observed

Day1

Day2

Day3

TRMM3B42

GFS

GFS

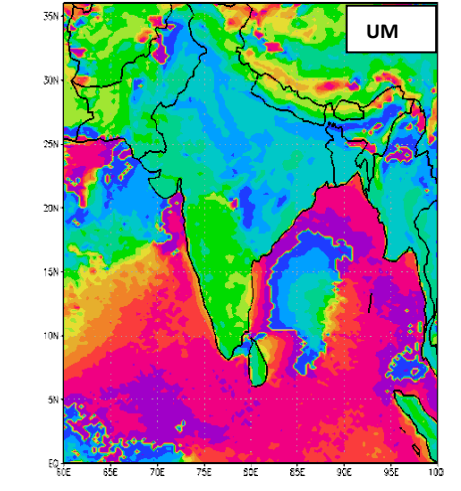
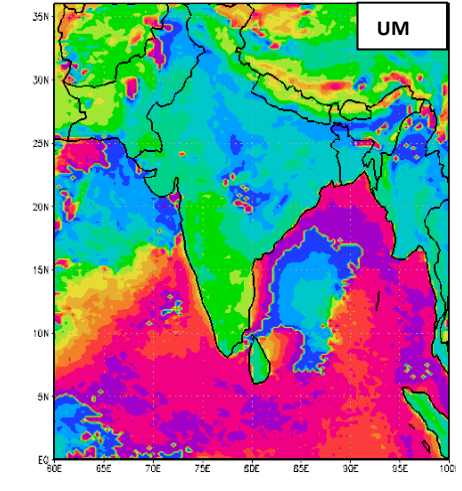
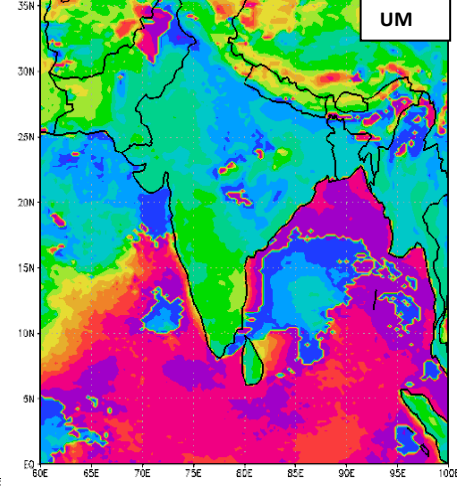
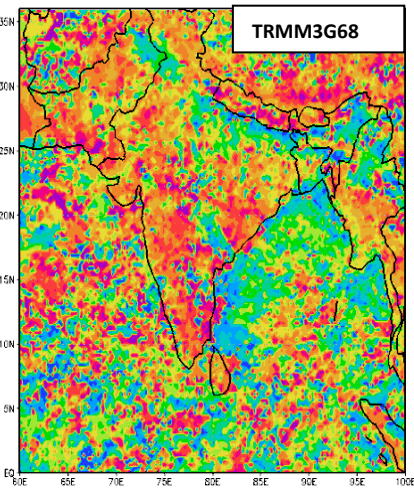
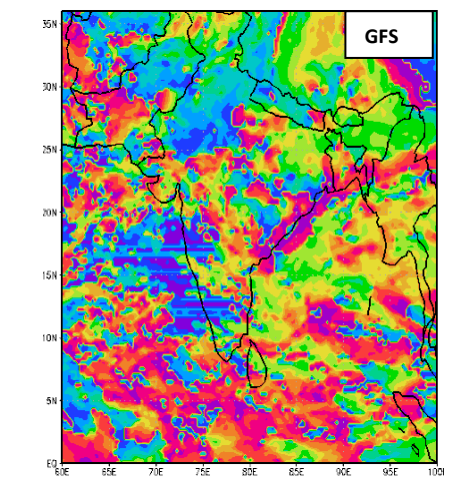
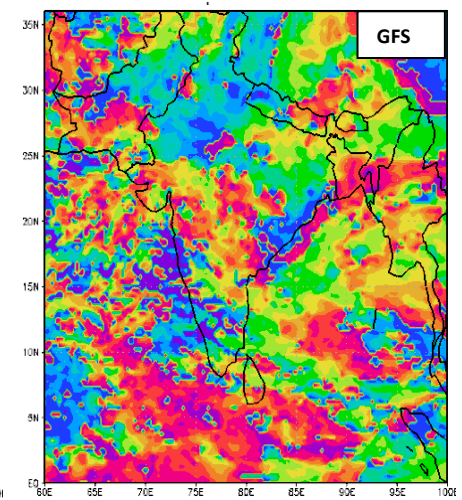
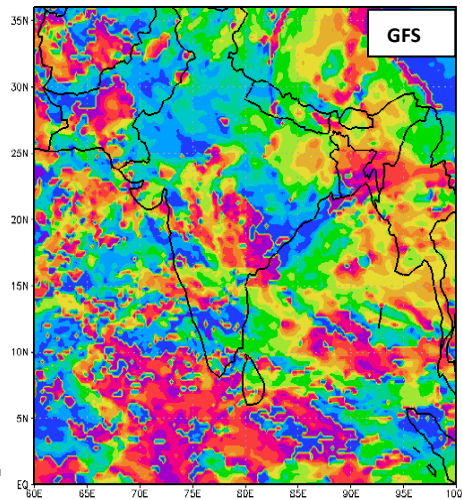
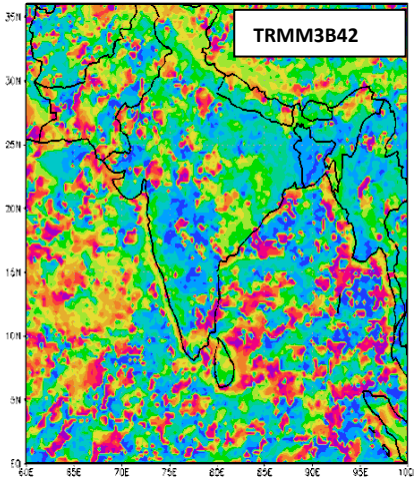
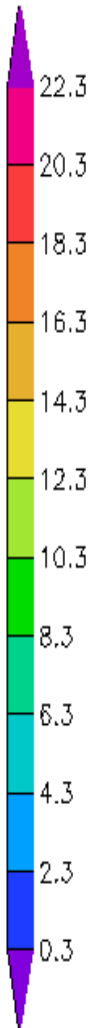
GFS

TRMM3G68

UM

UM

UM



Amplitude of rainfall (first harmonic – mm/day)

Observed

Day1

Day2

Day3

TRMM3B42

GFS-DAY1 F/C

GFS-DAY2 F/C

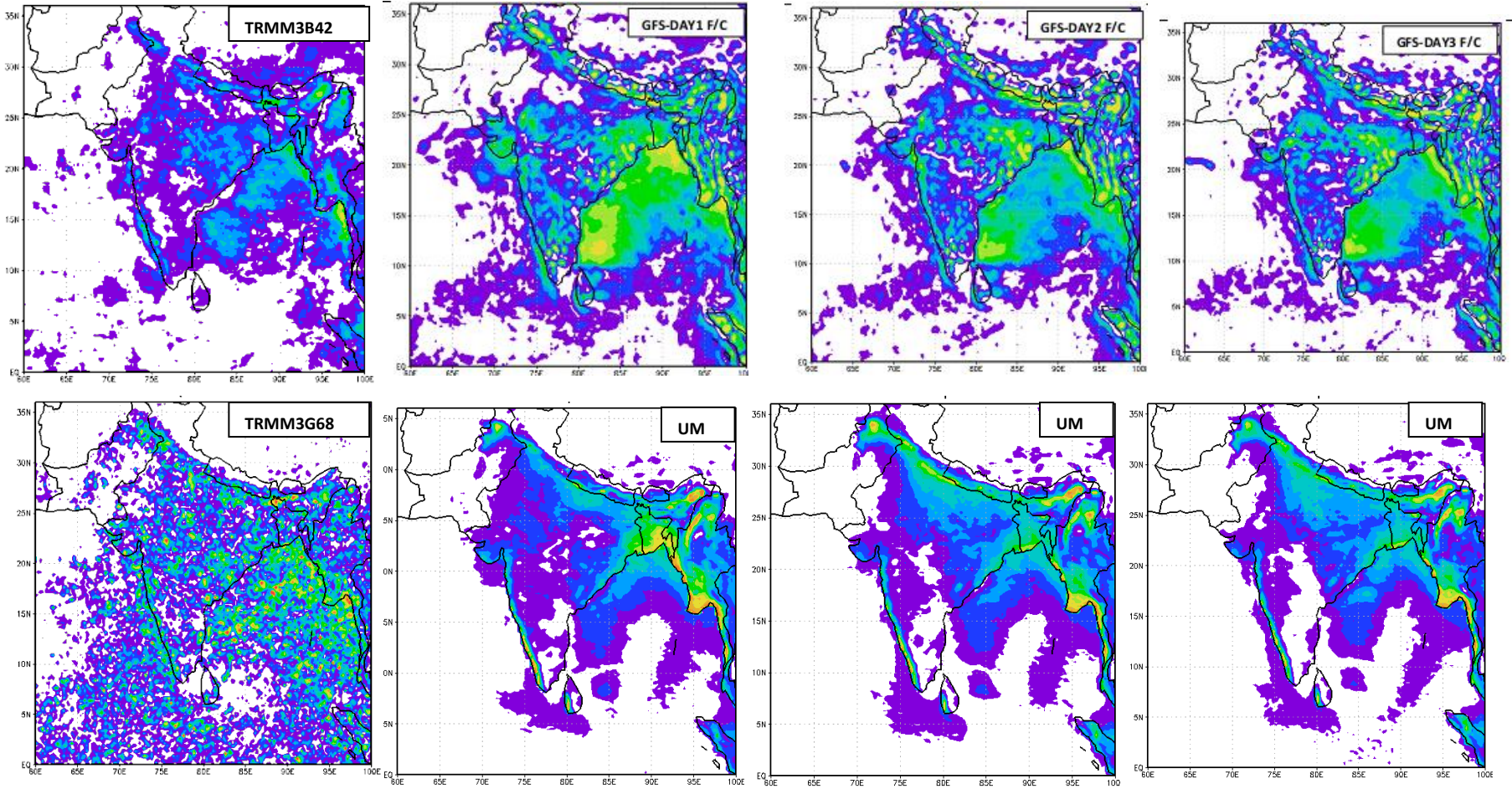
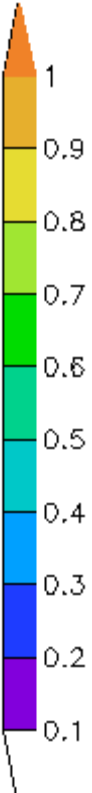
GFS-DAY3 F/C

TRMM3G68

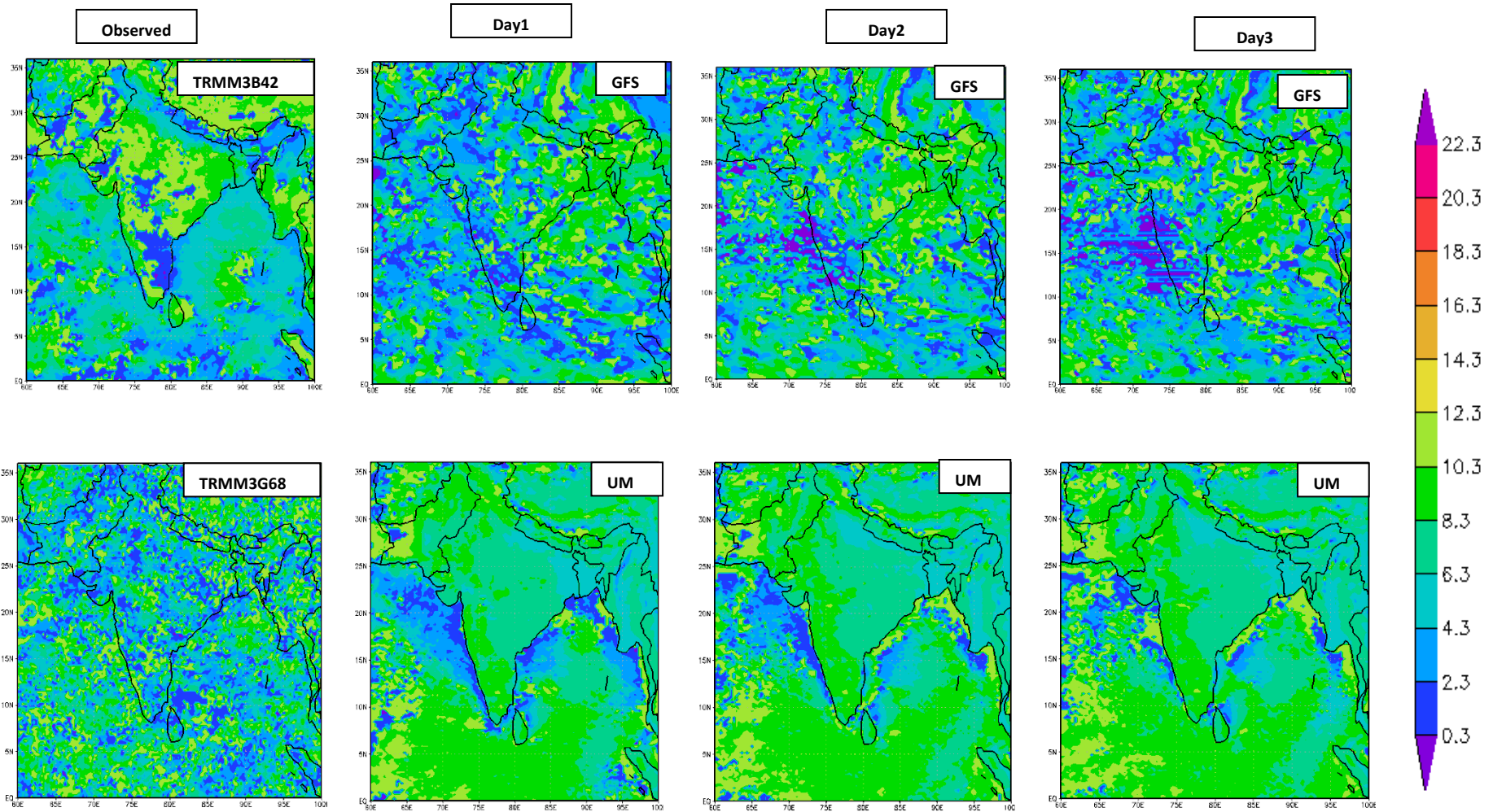
UM

UM

UM

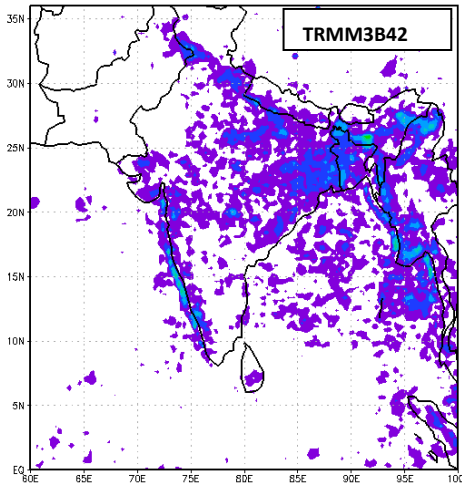


Phase of rainfall (Second harmonic – mm/day)

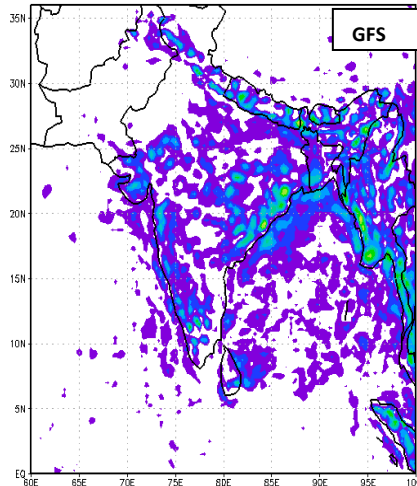


Amplitude of rainfall (Second harmonic -mm/day)

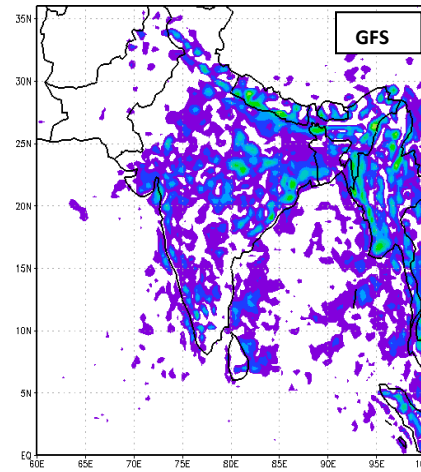
Observed



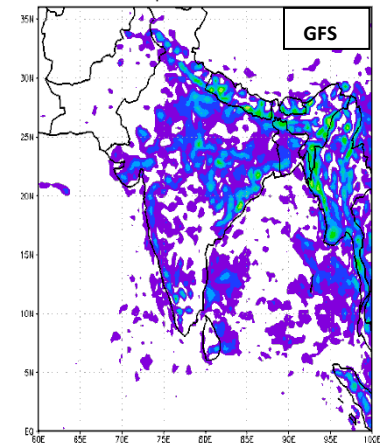
Day1



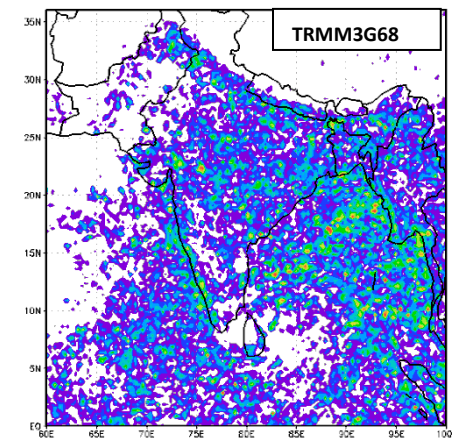
Day2



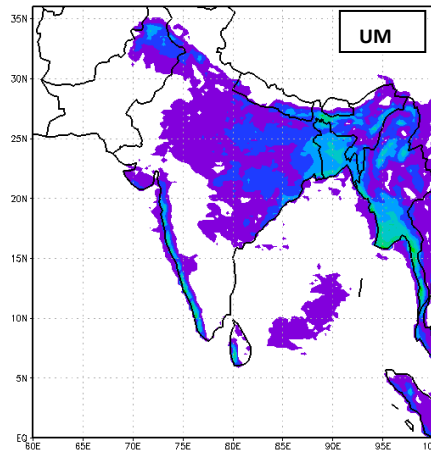
Day3



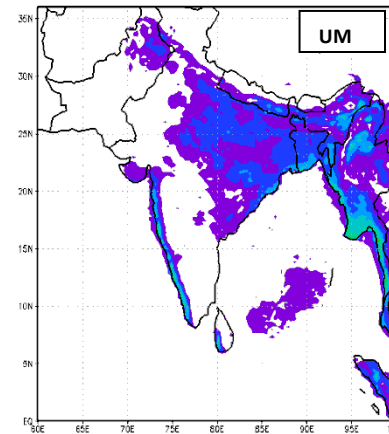
TRMM3G68



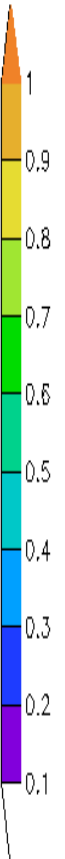
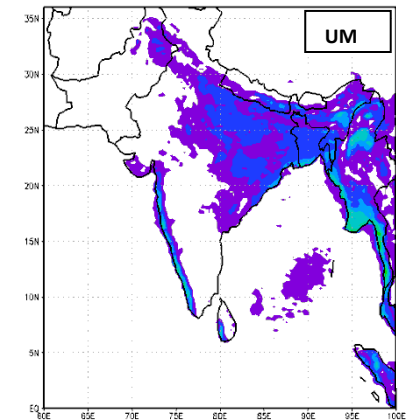
UM



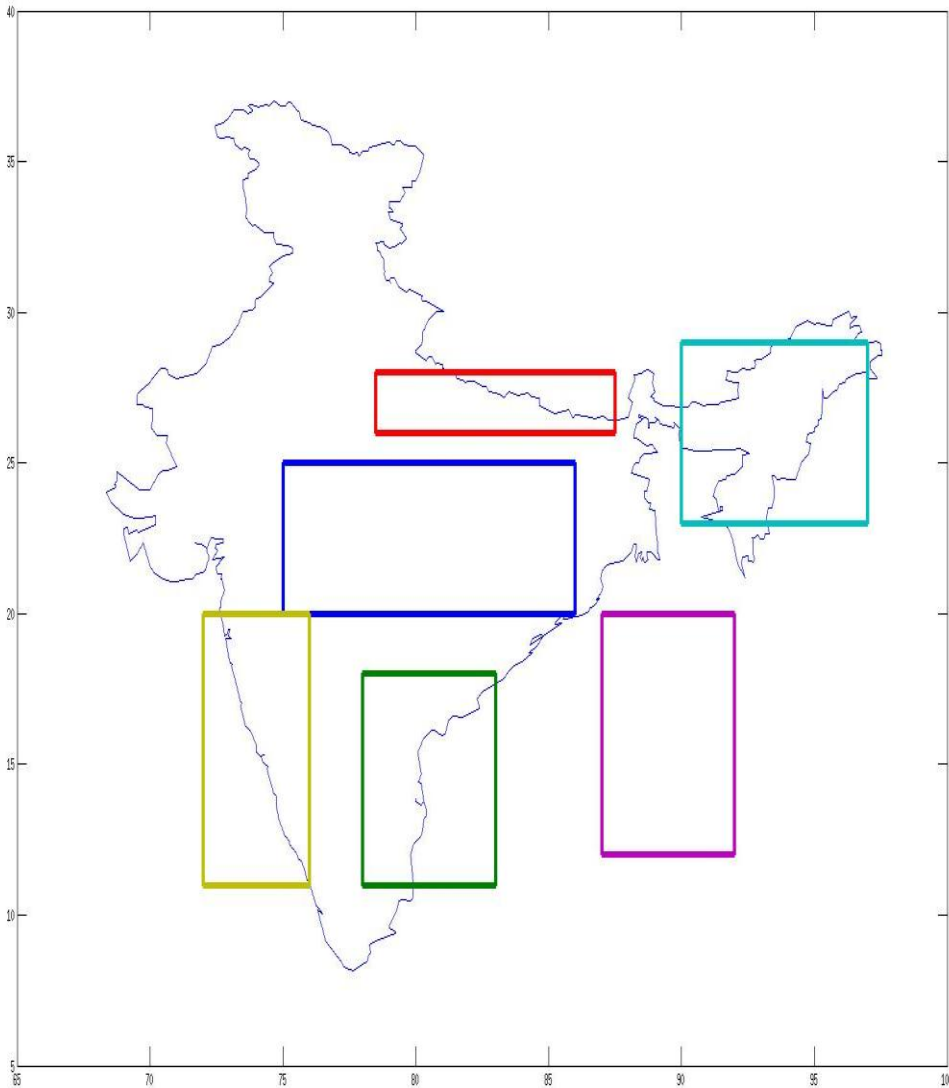
UM



UM



Homogeneous regions considered for the analysis



Central India 75-86 E , 20-25N

Southern Peninsula 78-83E, 11-18N

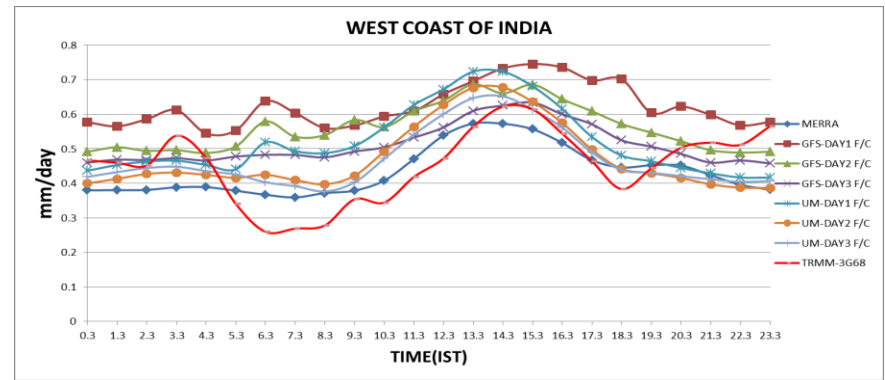
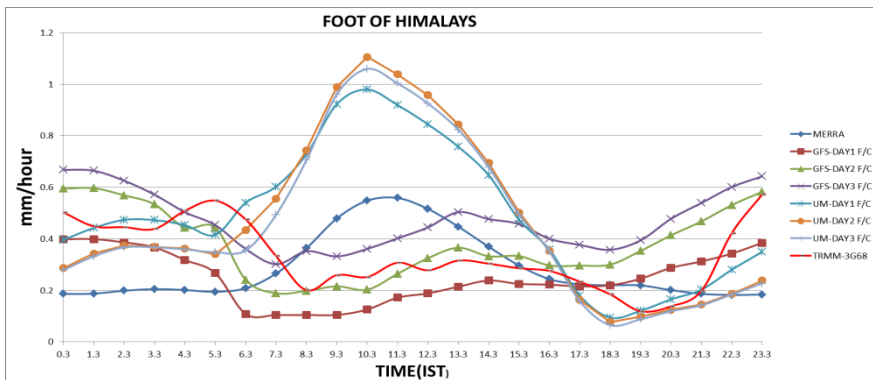
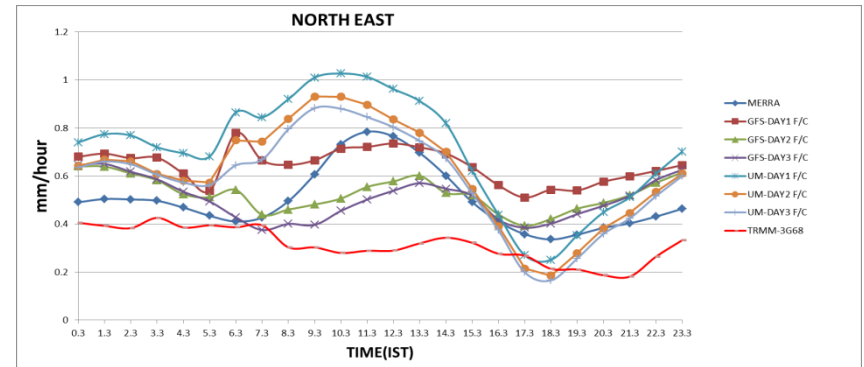
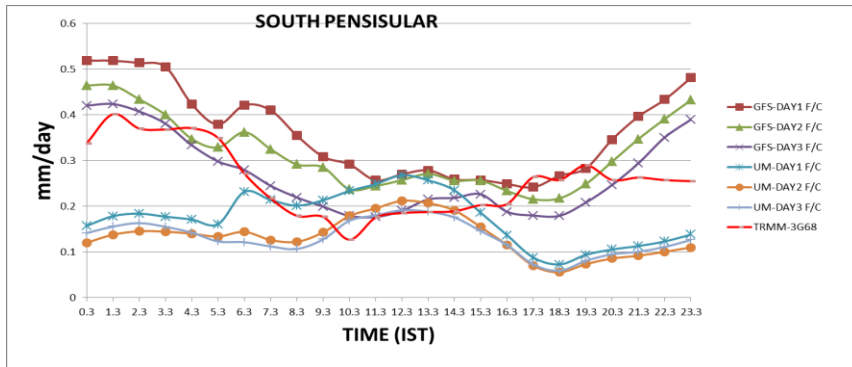
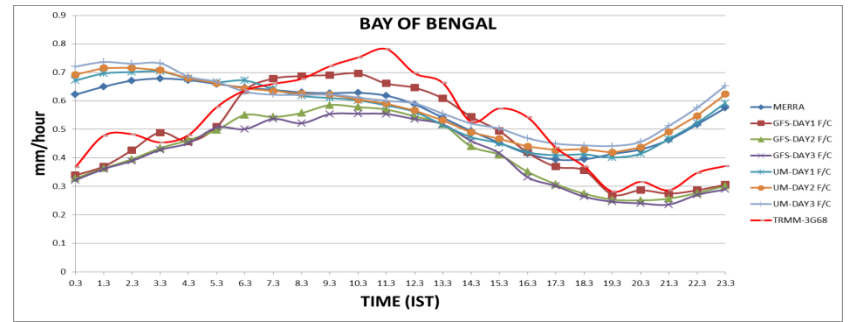
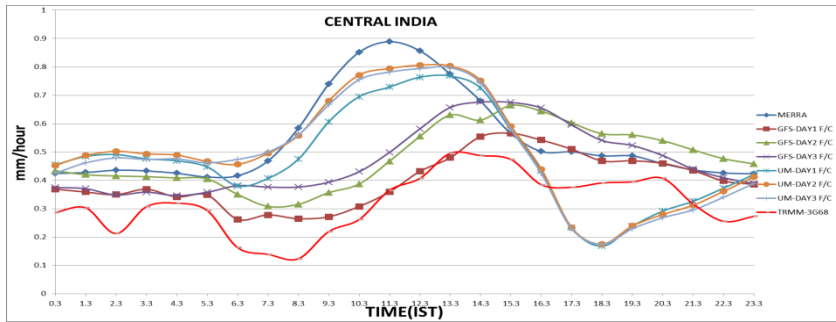
Foot of Himalayas 78.5-87.5E, 26-28N

North East 90-97E, 23-29N

Bay of Bengal 87-92E, 12-20N

West Coast 72-76E, 11-20N

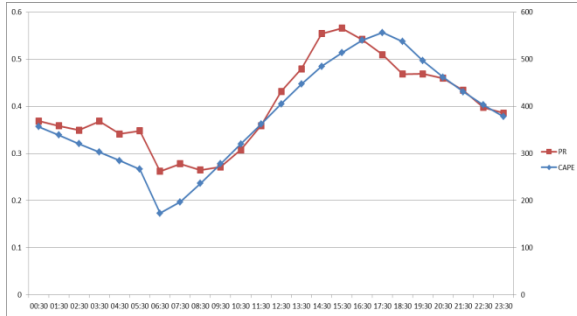
Hourly JJAS mean rainfall over different homogenous regions



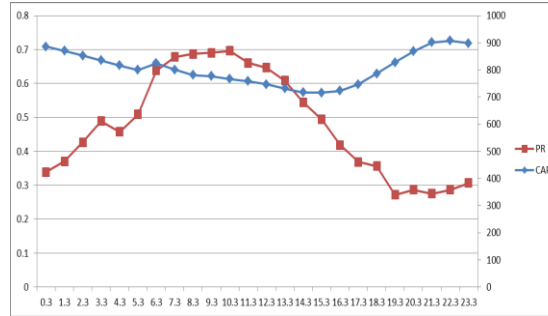
Analysis of CAPE and Rainfall (GFS)

DAY1

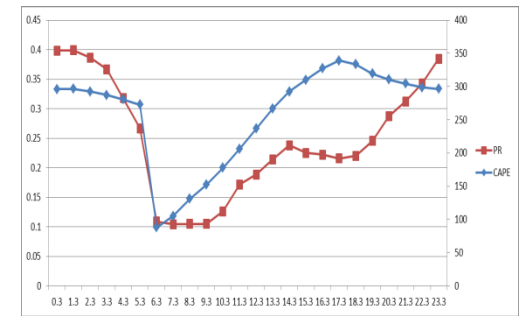
Central India



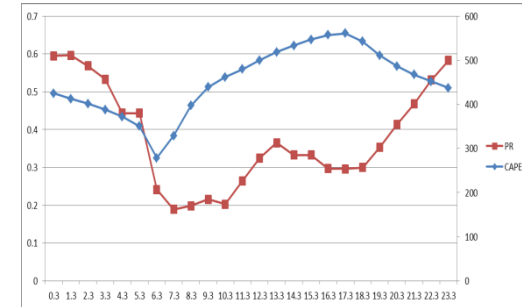
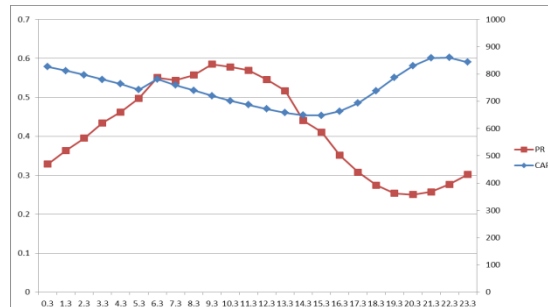
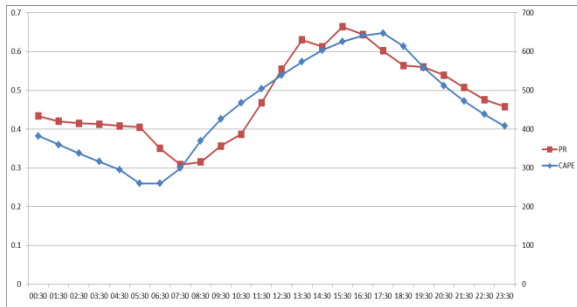
Bay of Bengal



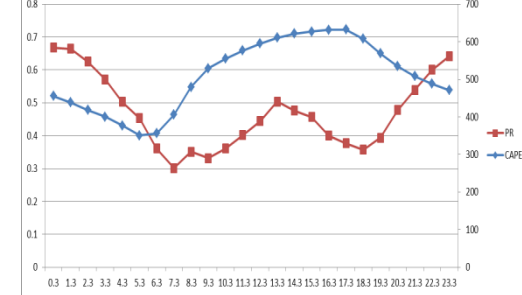
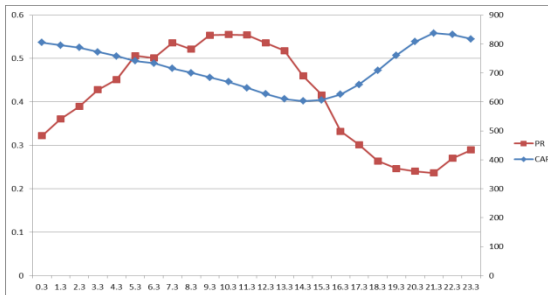
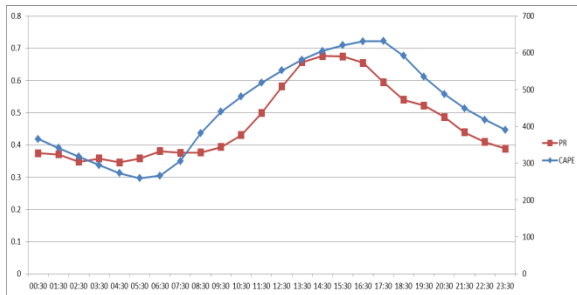
Himalayan Foothills

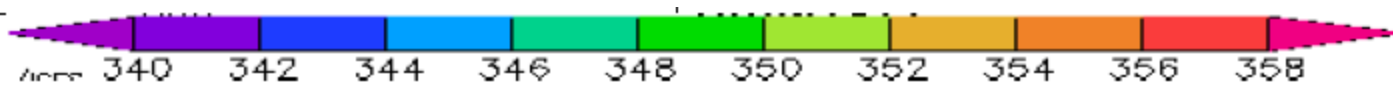
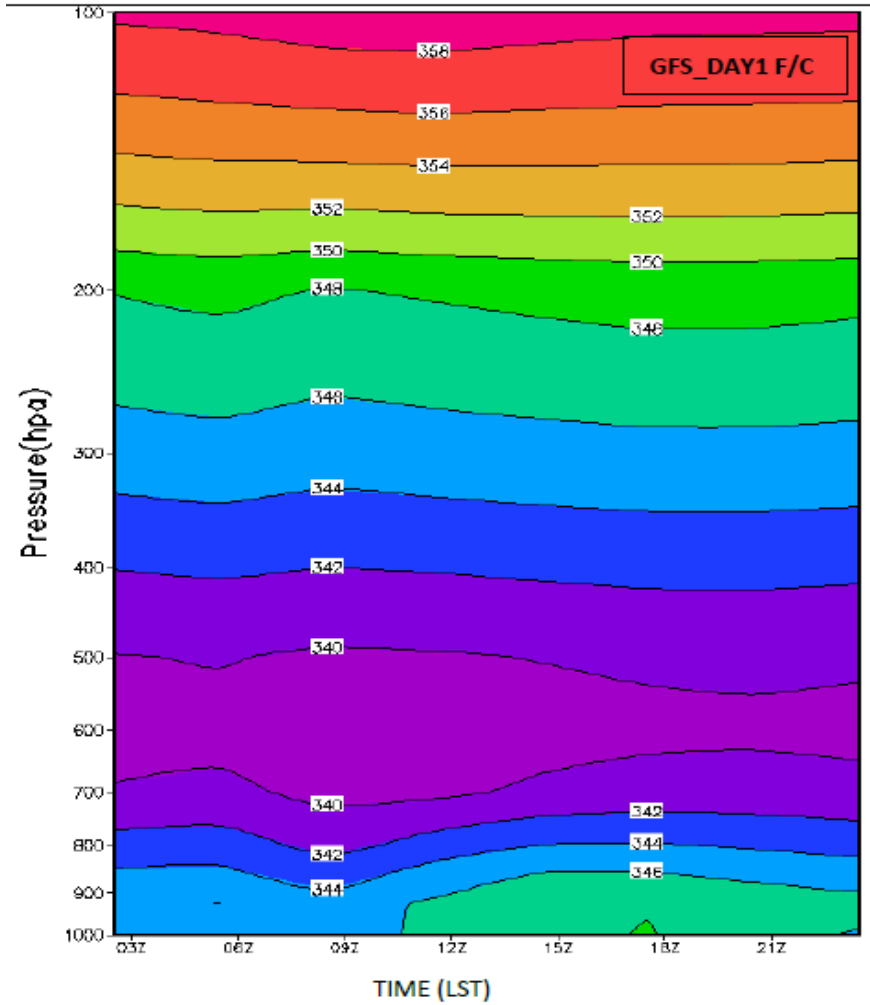
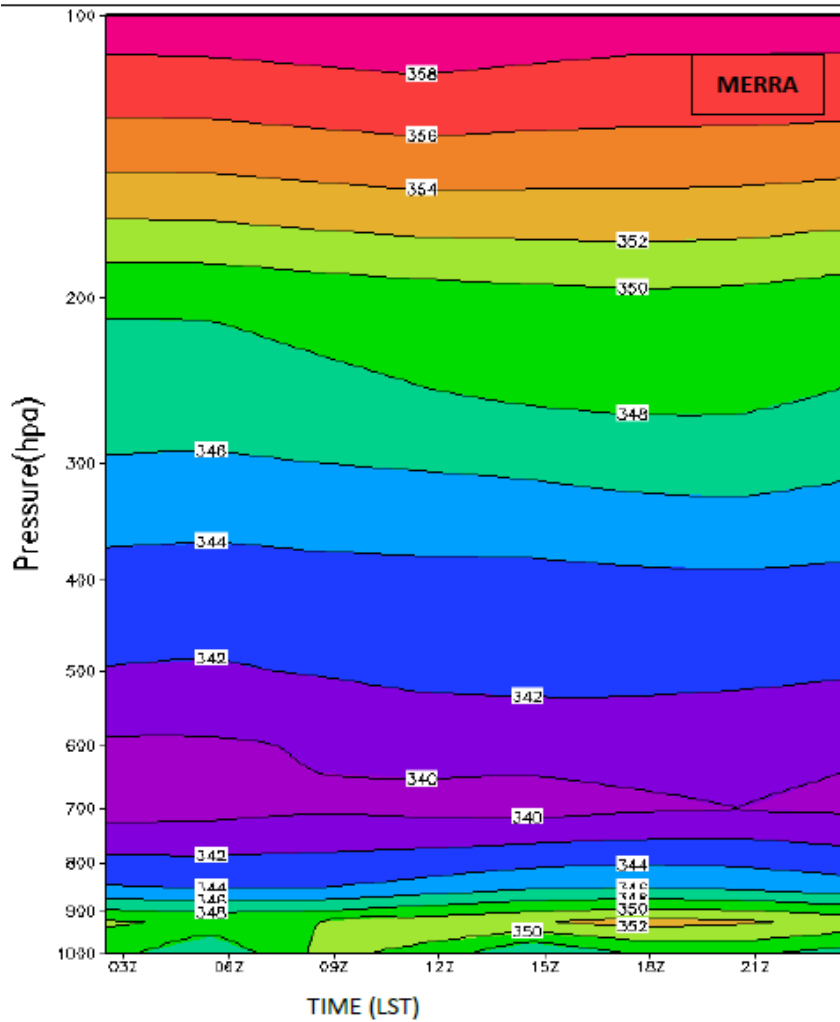


DAY2



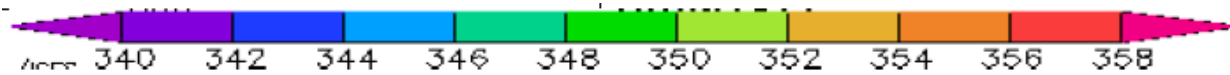
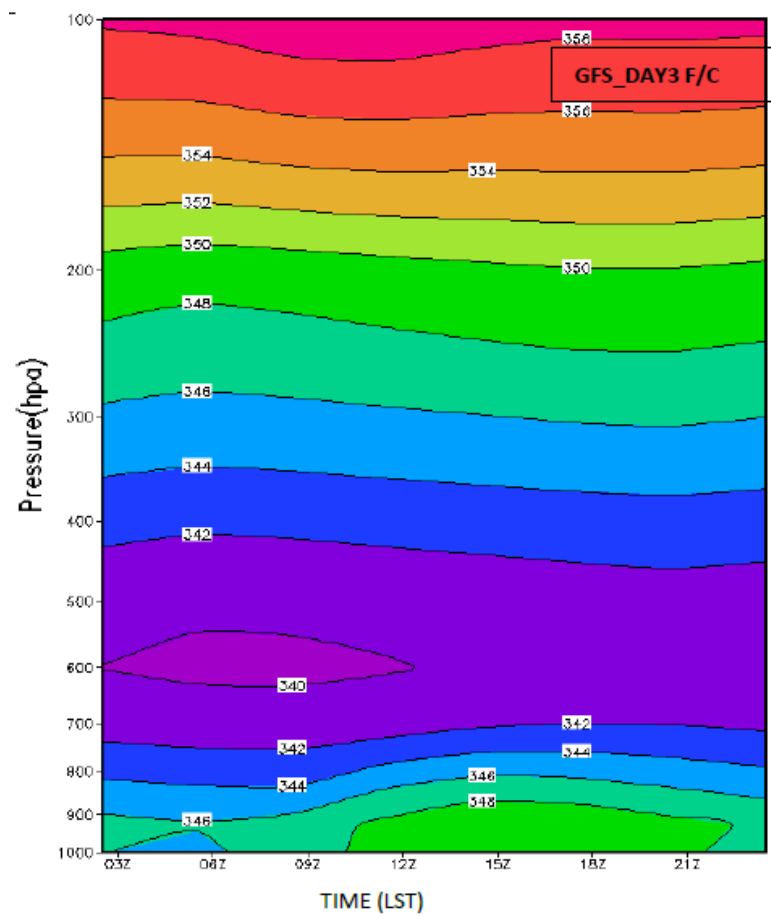
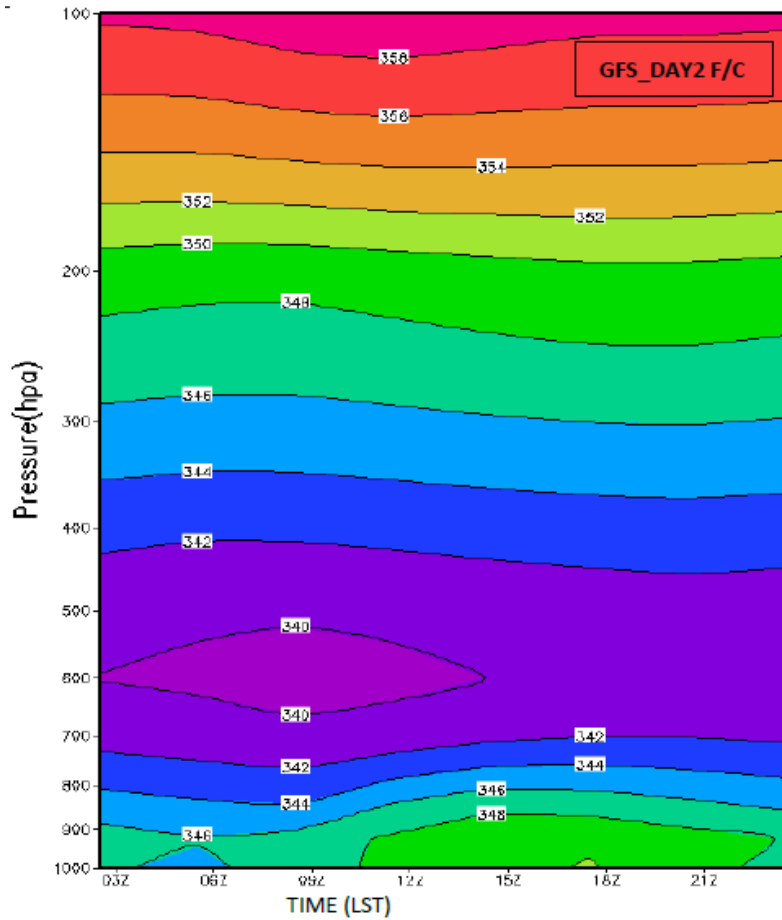
DAY3





Moist Static energy (kJ/kg) - Central India (75-86E,20-25N) for Season (JJAS) mean of 2013

Moist Static energy



Conclusions and Way forward

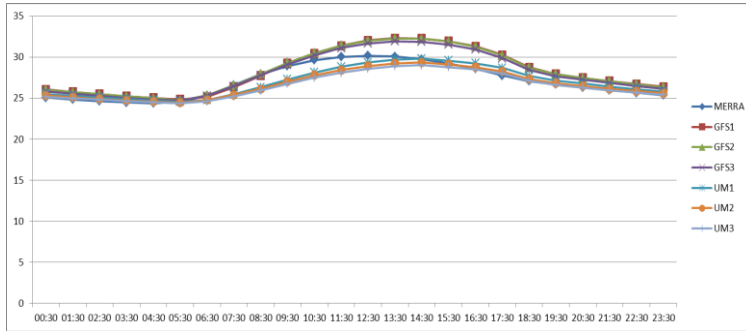
- ❑ **The phase of diurnal rainfall peaks in GFS is closer to observations (TRMM) than UM.**
- ❑ **GFS over estimates rainfall.**
- ❑ **UM rainfall intensity matches with observations, but there is a phase shift (precipitate early).**

- **Analysis of moist static energy and CAPE – for UM (data to be obtained from NCMRWF)**
- **Obtaining UM & GFS data for 2014 from NCMRWF & IMD.**
- **Similar analyses for 2014 monsoon.**
- **UM - Sensitivity runs – to be discussed with NCMRWF**

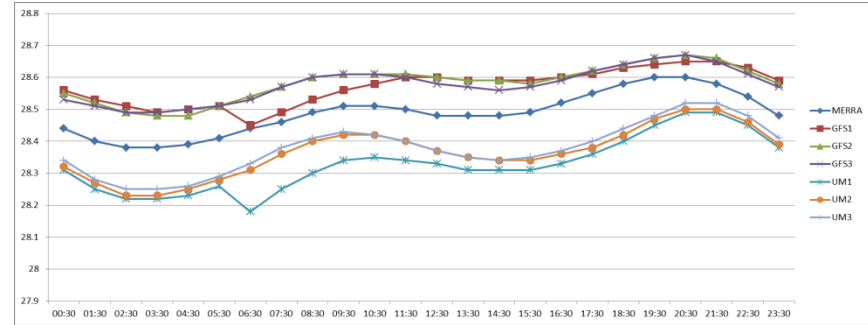
thank you...

Temperature (C) at 2 meter of homogenies regions

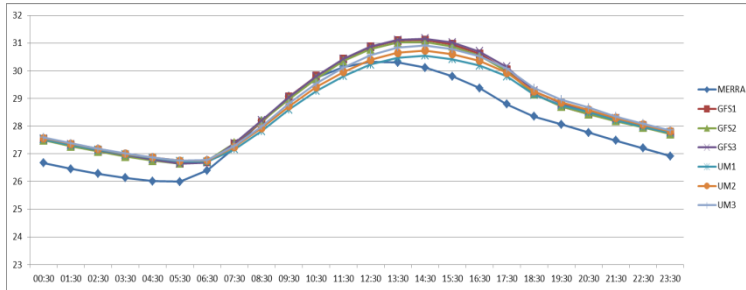
Central India



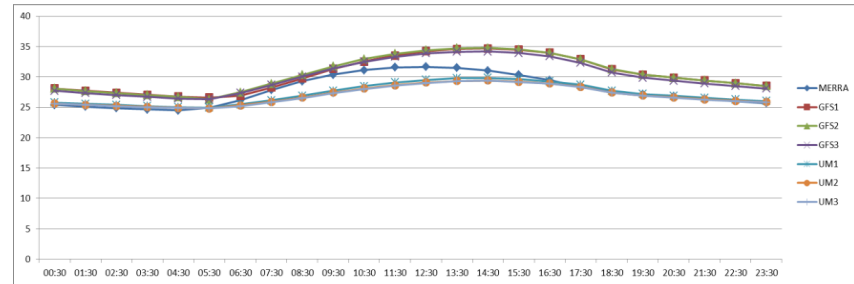
Bay of Bengal



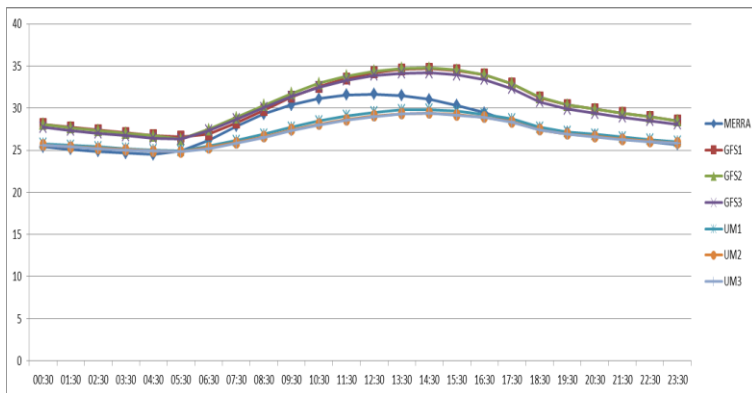
South peninsular



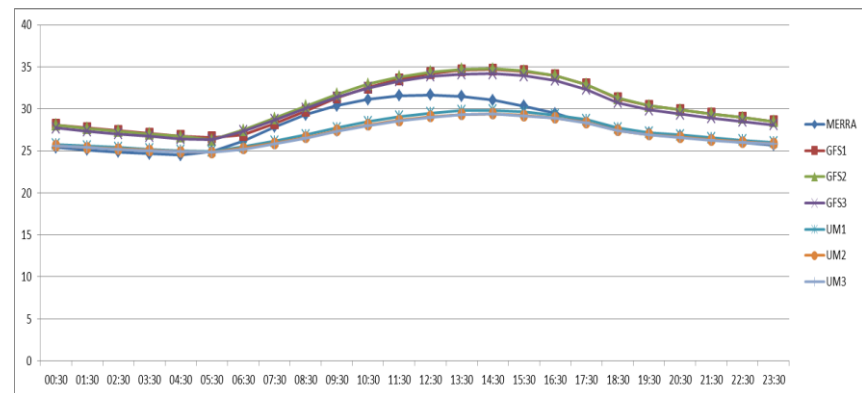
North East



Foot Hills of Himalayas

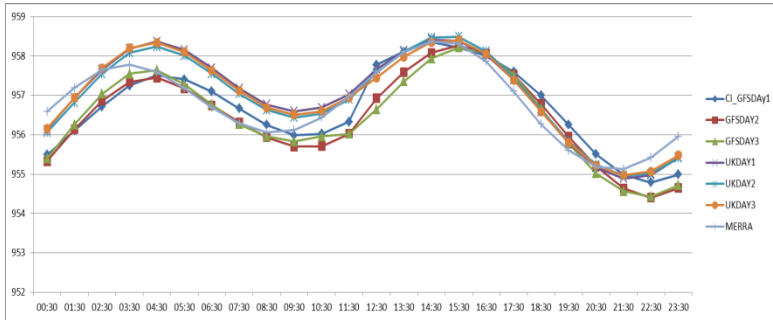


West Coast

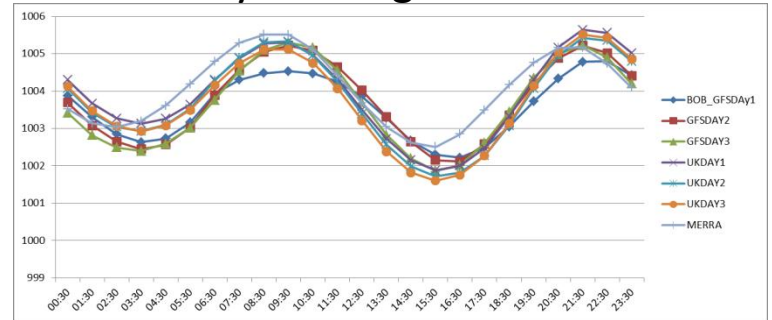


Surface pressure (hPa)

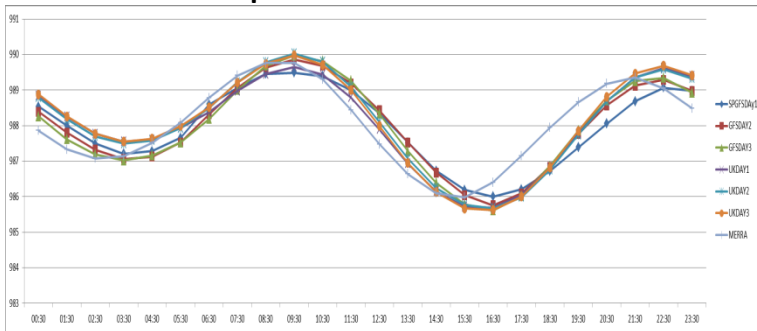
Central India



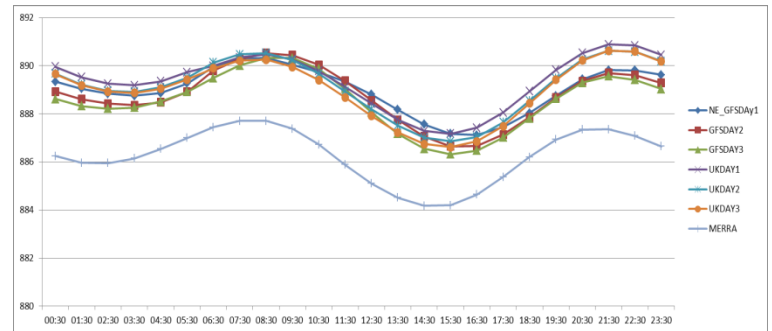
Bay of Bengal



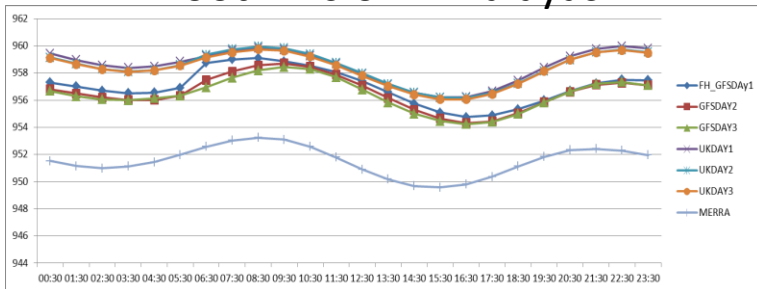
South peninsular



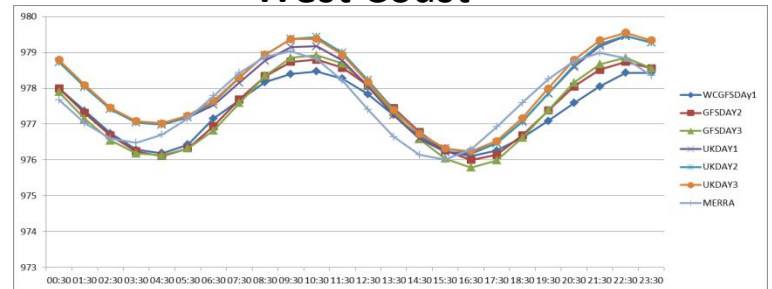
North East



Foot Hills of Himalayas



West Coast



$$S = C_p \cdot T + g \cdot z + L_v \cdot q$$