To Study the Various Factors Affecting the Summer Monsoon Rainfall in Nepal

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Nov 18, 2008

Introduction

- >65% farming
  - Flood: 1993 (540mm in 24 hrs)
    - Lives: 1336
      - Family: 85,451

(MOPE,2004)

Spatial Extreme Variability

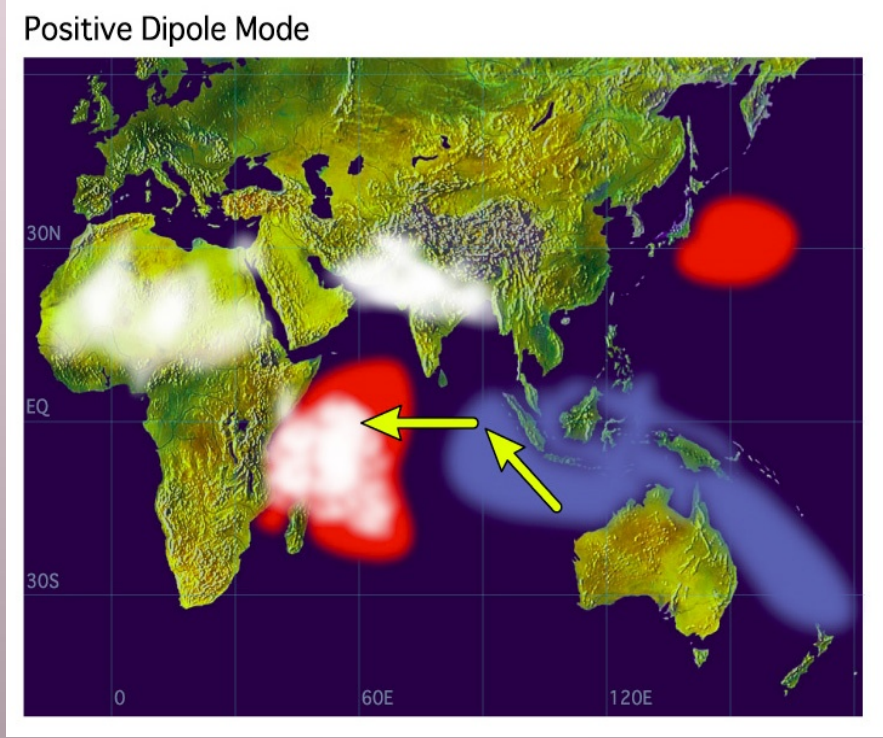
- Flood event: 1994
- Victims: 37 out of 75 districts
- Droughts: 35 out of 75 districts

(MOPE, 2004)

Categorizing Responsible Factors

- Indian Ocean Dipole(IOD)
- Atmospheric Brown Cloud (ABC)
- ENSO (El Nino/ La Nina)

Monsoon Variability(IOD)
(**Prof. Yamagata, Dr. Saji**)



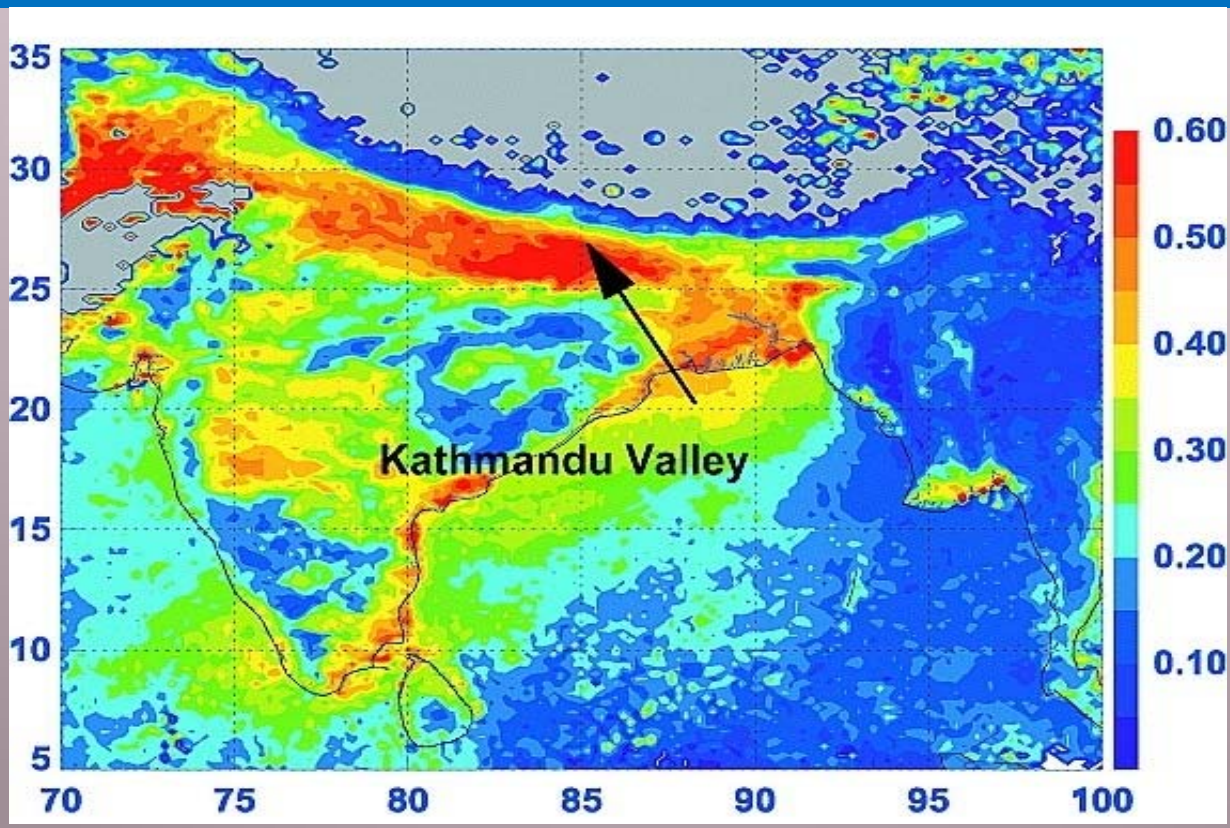
Modeling Output: (IOD)

- IOD coincides with ENSO for 1992 and 1997
- IOD does not coincide with ENSO esp. in the year 1961,1967 and 1994
- Correlation between IOD and ENSO = 0.35 (Saji et.al.1999)

Atmospheric Brown Clouds (ABC)

- Solar Dimming
- Nuclei coagulate more cloud drops
- Reduce solar radiation reaching the surface
- Positive feedback

Aerosol over Nepal
(Source: Ramana et.al.2004)



Differential Heating Over Different Region (ABC)*(Source: Lau et.al. 2006)*

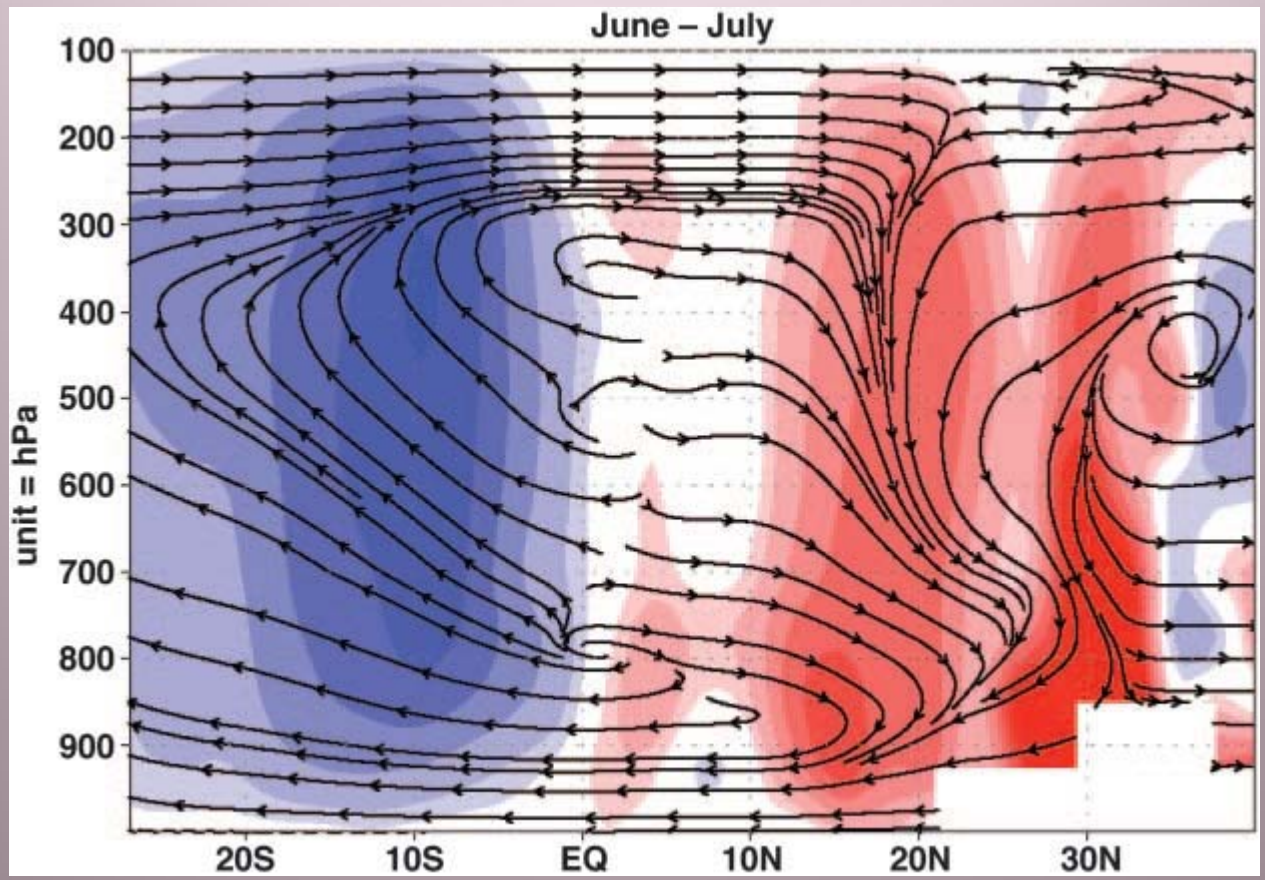
TP(Tibetan Plateau) W/m²						RS(Region South) W/m²				
	SW	LW	SH	LH	NET	SW	LW	SH	LH	NET
TOA	-4.5	2.9			-1.6	-5.5	4.5			-1.0
ATM	16.8	-5.8	-12.4	-0.4	-1.8	14.3	-1.6	-6.7	-3.3	2.7
SFC	-21.3	8.7	12.4	0.4	0.2	-19.8	6.1	6.7	3.3	-3.7

Impact

- Weakens Hadley Cell
- Lesser rainfall over northern Africa (Ramanathan et.al. 2005)
- Long term drought over northern China
- Excessive rainfall over the southern China and India

(Menon et.al.2002)

Contd.. The red shade - increased sinking motions, and the blue shade - increased rising motions (ABC)(Ramanathan et.al.2005)



Recent Modeling Output (ABC)

- Observed rate of dimming for the period(1930-2000) was - 0.42 Wm^{-2}

- Simulated rate of dimming was found to be - 0.37 Wm^{-2}

(Ramanathan et.al. 2005).

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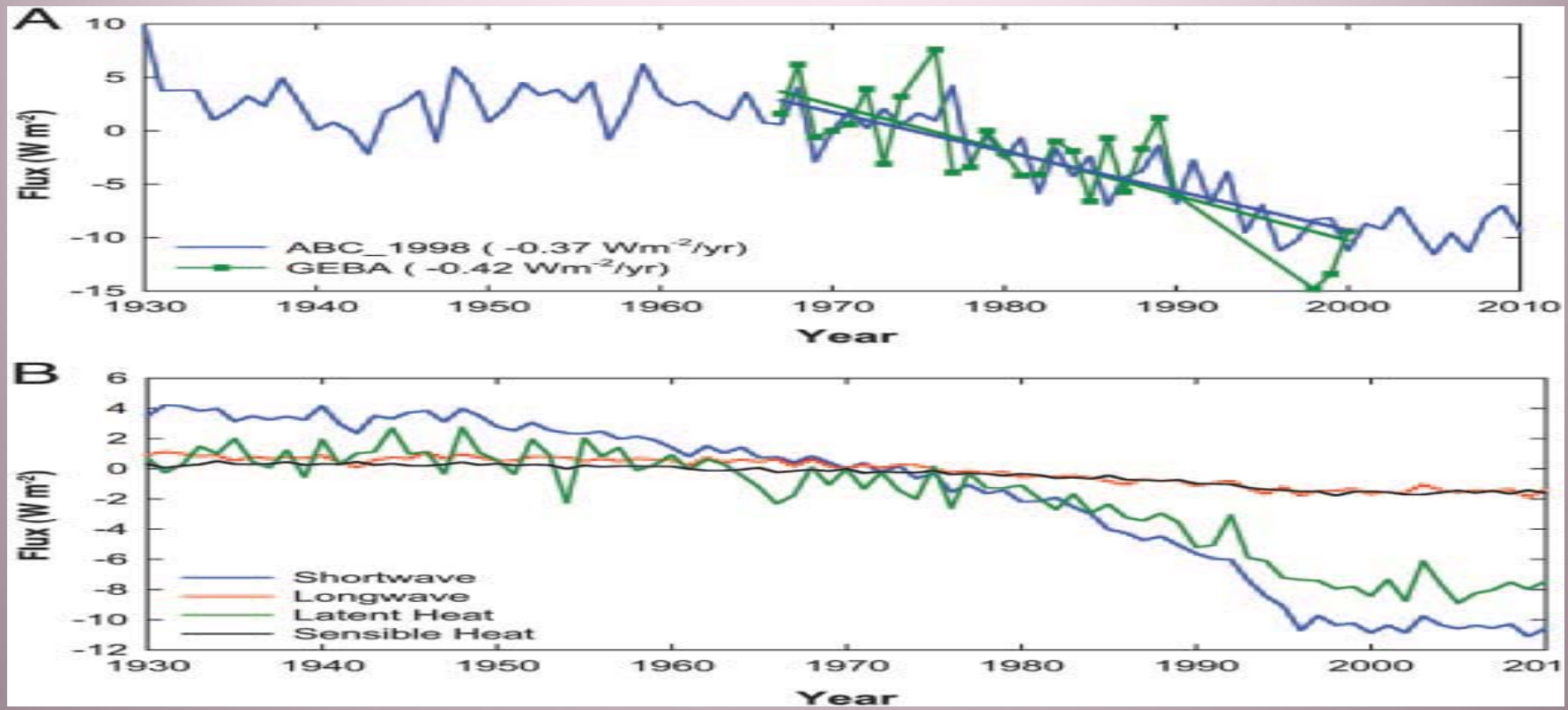


- Simulated (blue) and observed (green)

(Source: Ramanathan et.al.2005)

- About 70% reduction in Incoming solar radiation has been balanced by the reduction in evaporation

For 70 years (1930-2000), Annual Mean surface warming trend:

- GHGs-1998 is 0.8 ^{o}K
- GHG-SO_4-1998 is 0.76 ^{o}K
- ABC-1998 is 0.45 ^{o}K
- The Observed Trend i.e., 0.44 ^{o}K

TRUTH

ABC has strong cooling effect !

ENSO

ISMR

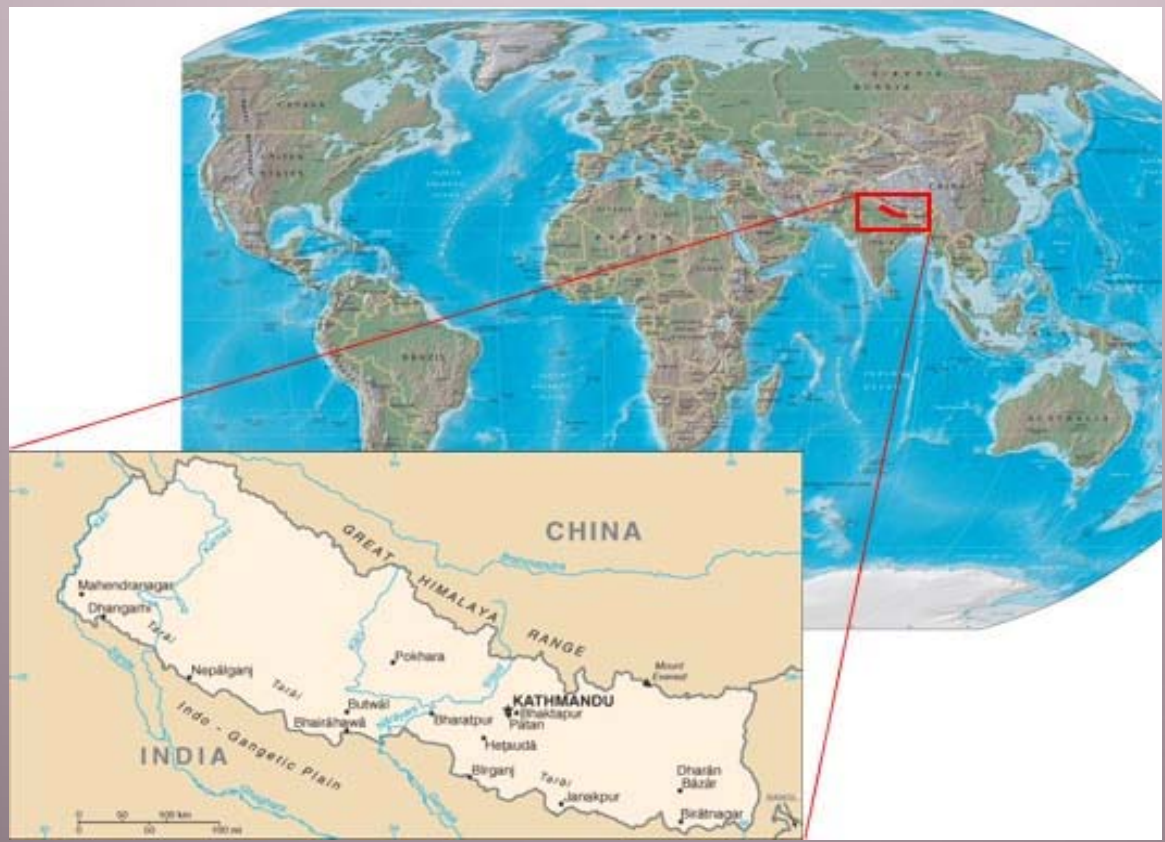
- El Nino - abnormal warming $\rightarrow$ Droughts(ENSO index < -1.0)
- La Nina - abnormal cooling $\rightarrow$ Floods (ENSO index >1.0)
- The drought of 1992 in Nepal has been correlated with the ElNino of 1992-1993 (Shrestha et.al.2000)

How important is ENSO to ISMR ?

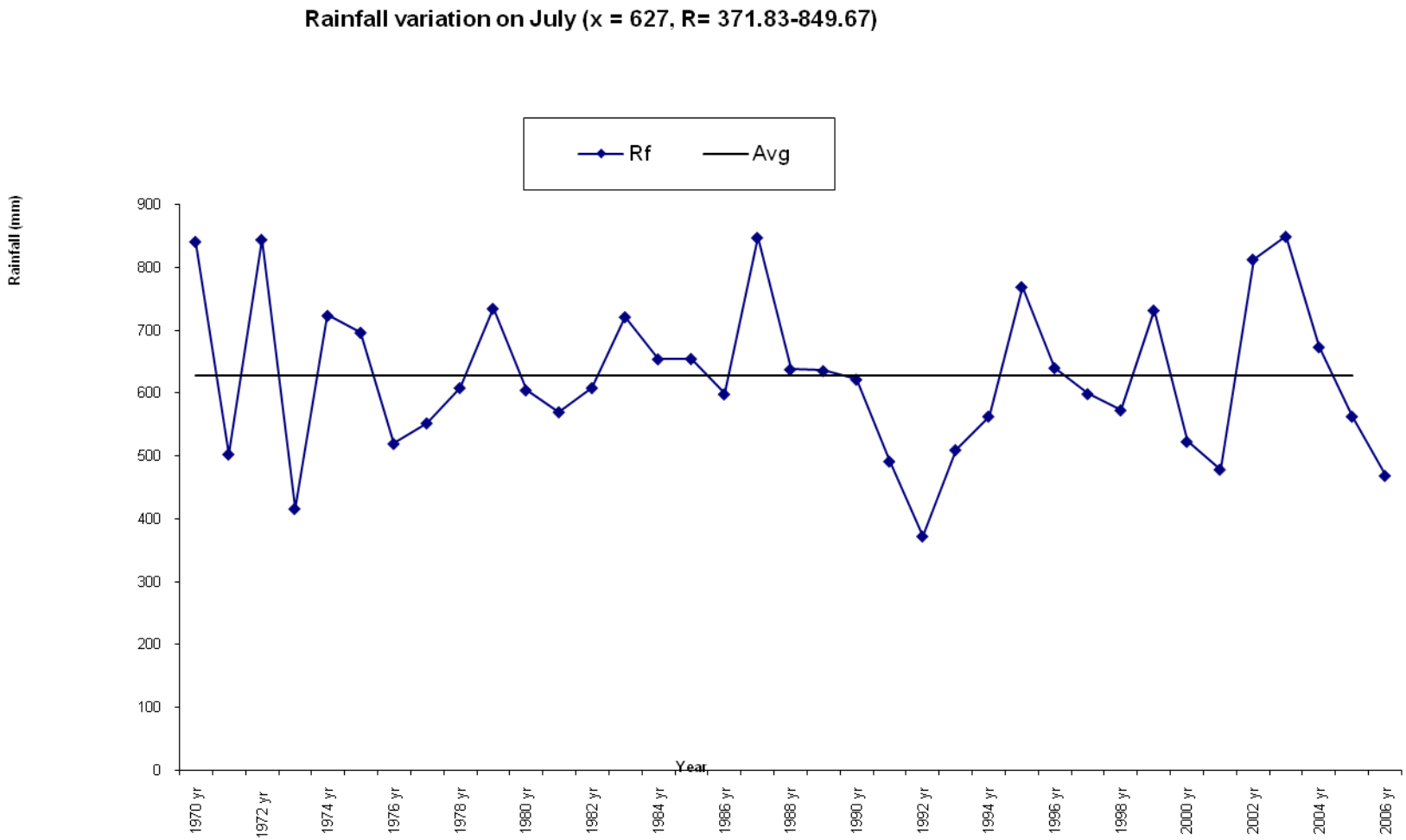
- Ihara et.al 2007 discusses deficit in ISMR despite EL Nino event

- Terray (1995) says, ENSO has no connection with ISMR

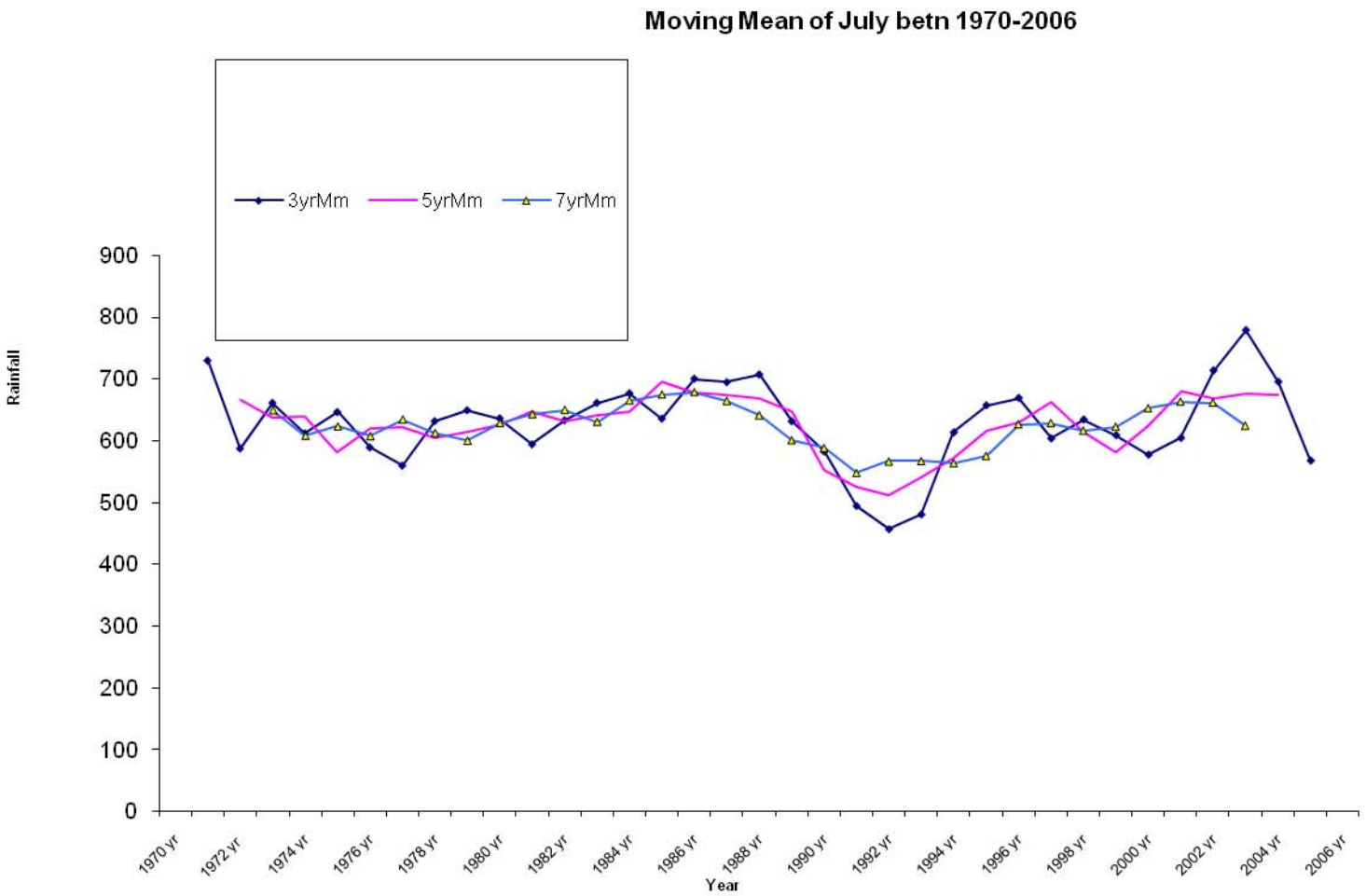
Rainfall Distribution in Nepal:
Eastern >3000mm/Yr
Western < 1000 mm/Yr
Ichiyanagi (2007)

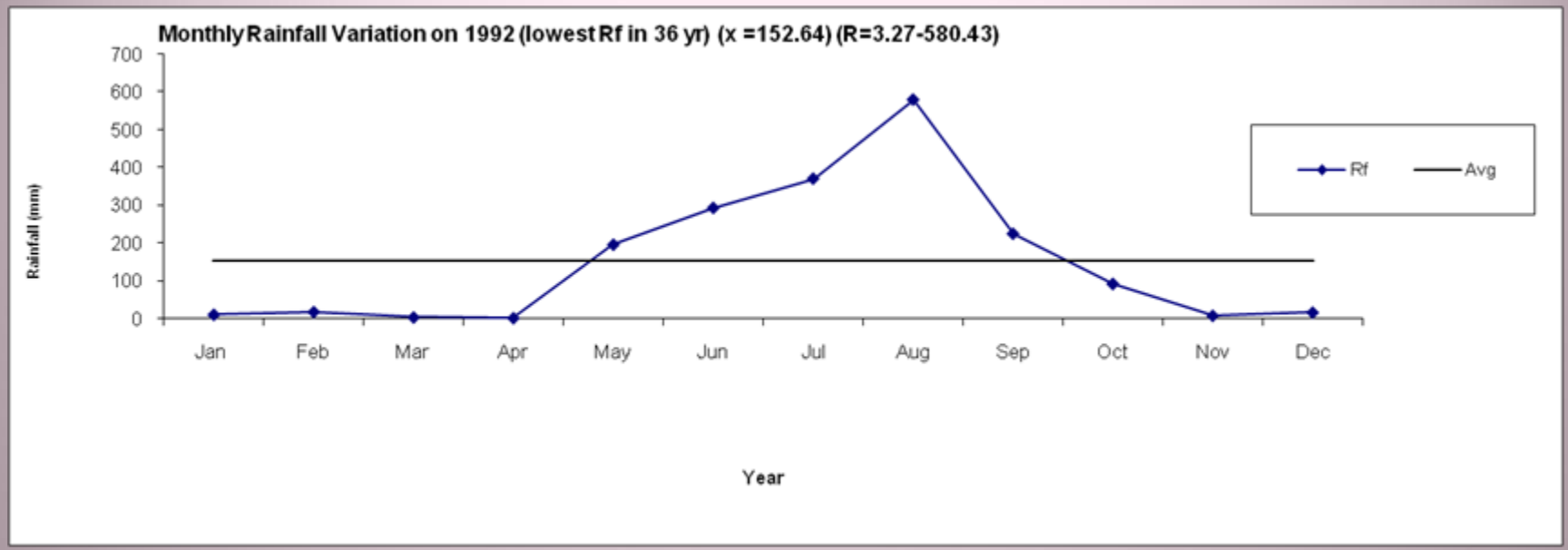


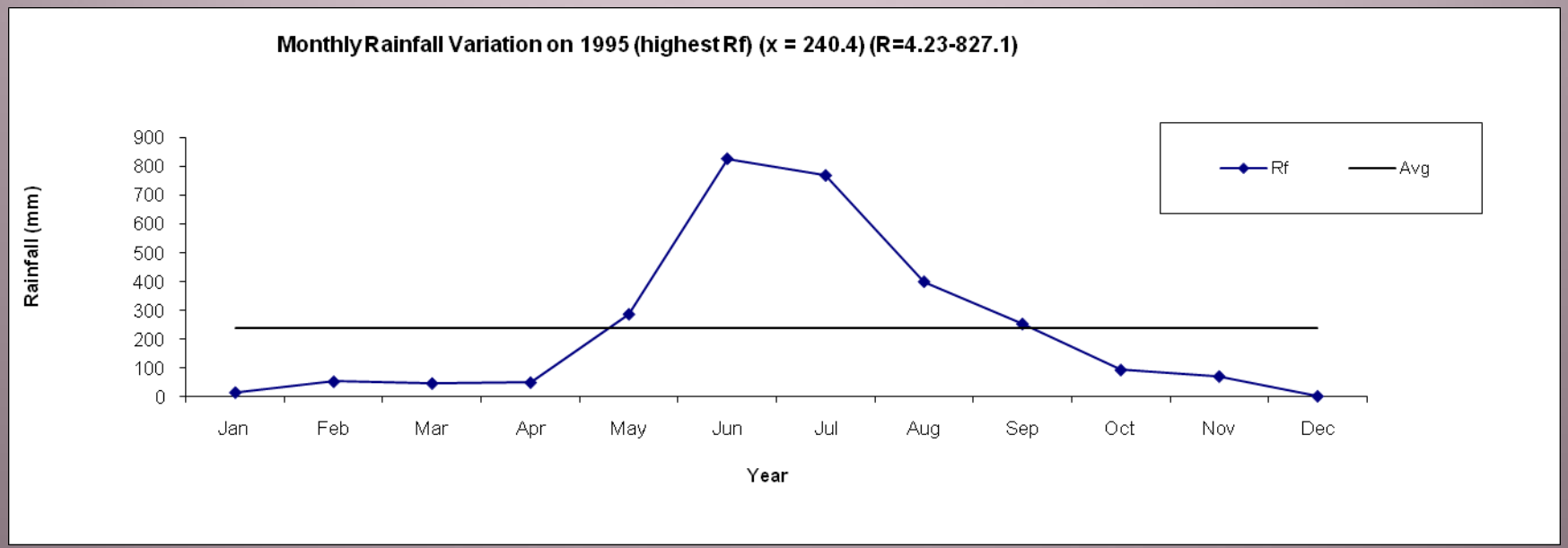
CASE STUDY: Marshyangdi Subcatchment,Central Nepal



…Case Study..


Moving Mean of July betn 1970-2006
3yrMm
5yrMm
7yrMm
Rainfall
900
800
700
600
500
400
300
200
100
0
1970 yr
1972 yr
1974 yr
1976 yr
1978 yr
1980 yr
1982 yr
1984 yr
1986 yr
1988 yr
1990 yr
1992 yr
1994 yr
1996 yr
1998 yr
2000 yr
2002 yr
2004 yr
2006 yr
Year


Monthly Rainfall Variation on 1992 (lowest Rf in 36 yr) (x =152.64) (R=3.27-580.43)
Rainfall (mm)
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Rf
Avg
Year

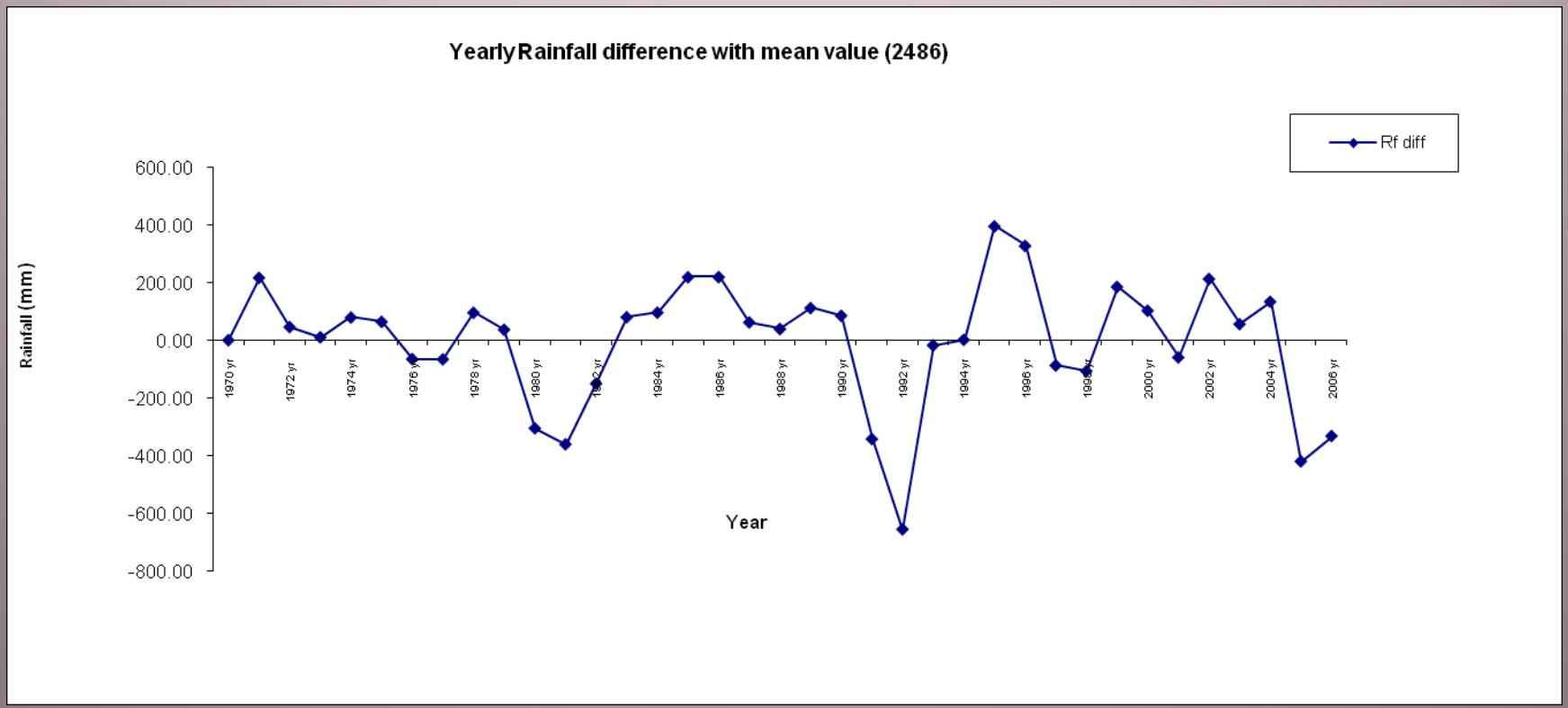

Monthly Rainfall Variation on 1995 (highest Rf) (x = 240.4) (R=4.23-827.1)
Rainfall (mm)
900
800
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Rf
Avg
Year

Total Deficit Years: 13

Deficit (>13%): Year ’91,’92,’05,’06 agree with NOAA El Nino indices

Total Excess Years: 20

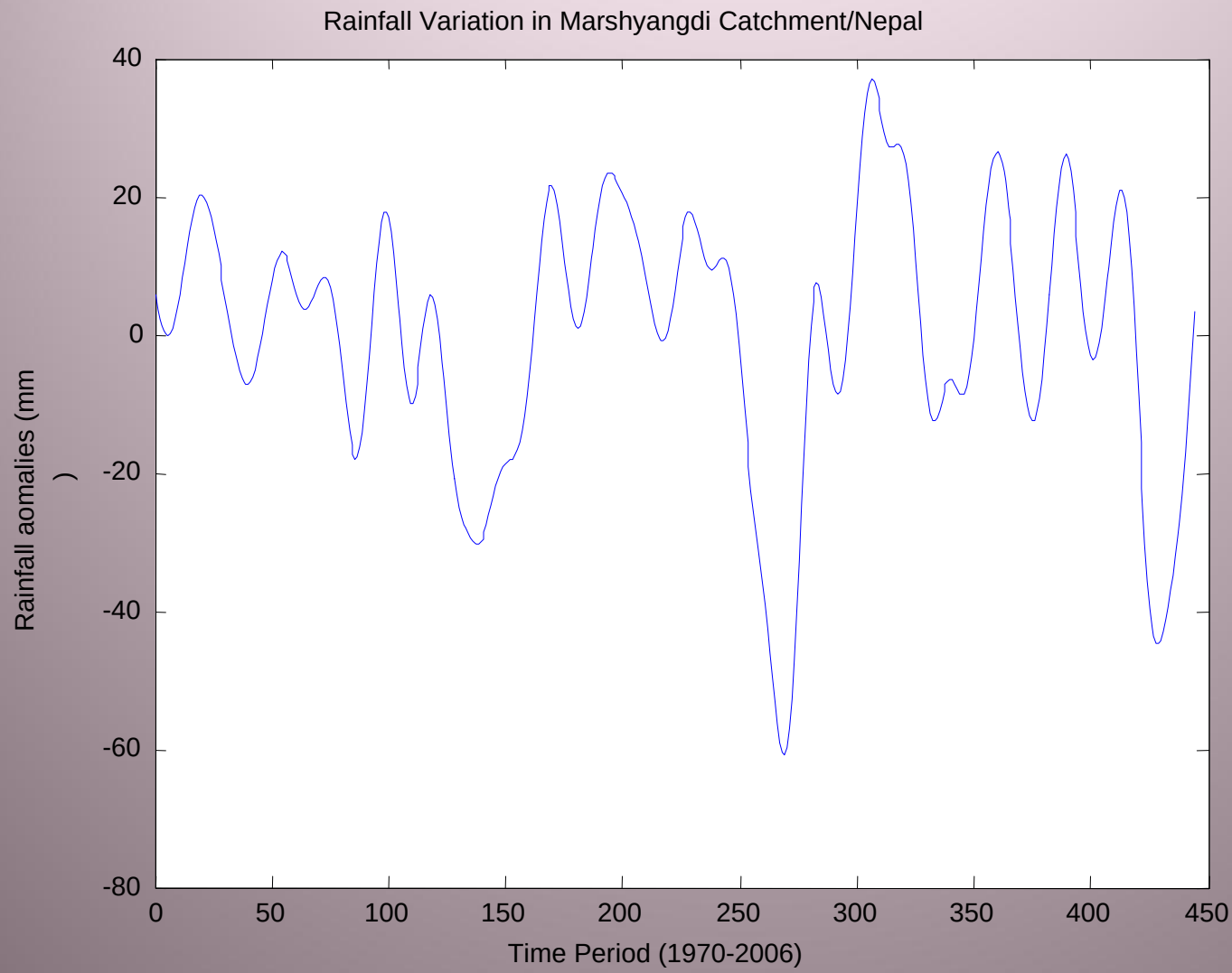
Excess (>13%):Year ’84,’85,’89,’95,’96 agree with NOAA La Nina indices



Analysis

- IOD is independent of ENSO (Saji et.al. 1999)
- Observed trend of rainfall variability matches to a good extent with the trend of ABC-1998 than with the GHG+SO_4(Ramanathan Et.al.2005)
- The simulation record shows that there is reduction of -5%(-3%) between 1930 and 2000 (ABC-1998) in the Indian rainfall amount.

ISMR Lacks any long term trend (Kothyari and Singh,1996),



..Analysis..

- Monsoon Shifting towards the South !
- Impact over Nepal ?
- Overemphasizing GHG over ABC ?

Shortcomings:

- Lack of Ocean Data analysis by Ramanathan,2005
- Impact of Increase of temperature over land upon the Ocean has not been considered
- Overlooking the importance of number of weather stations and spatial variations
- Barros et.al. 2000, in availability of radars or radiosonde networks in these regions

Conclusion:

- Recent simulation shows decrement of 3-5% in ISMR and this fits better with ABC
- ENSO agree with ISMR variability
- Trend: short term 3 years and long term 13 years in Marshyangdi catchment

- FUTURE: COMBINING **IOD AND ENSO**