



Variability of Atmospheric & Land Surface Biophysical Parameters using Space Measurements over India

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REMOTE SENSING APPLICATIONS AREA

SPACE APPLICATIONS CENTRE (ISRO)

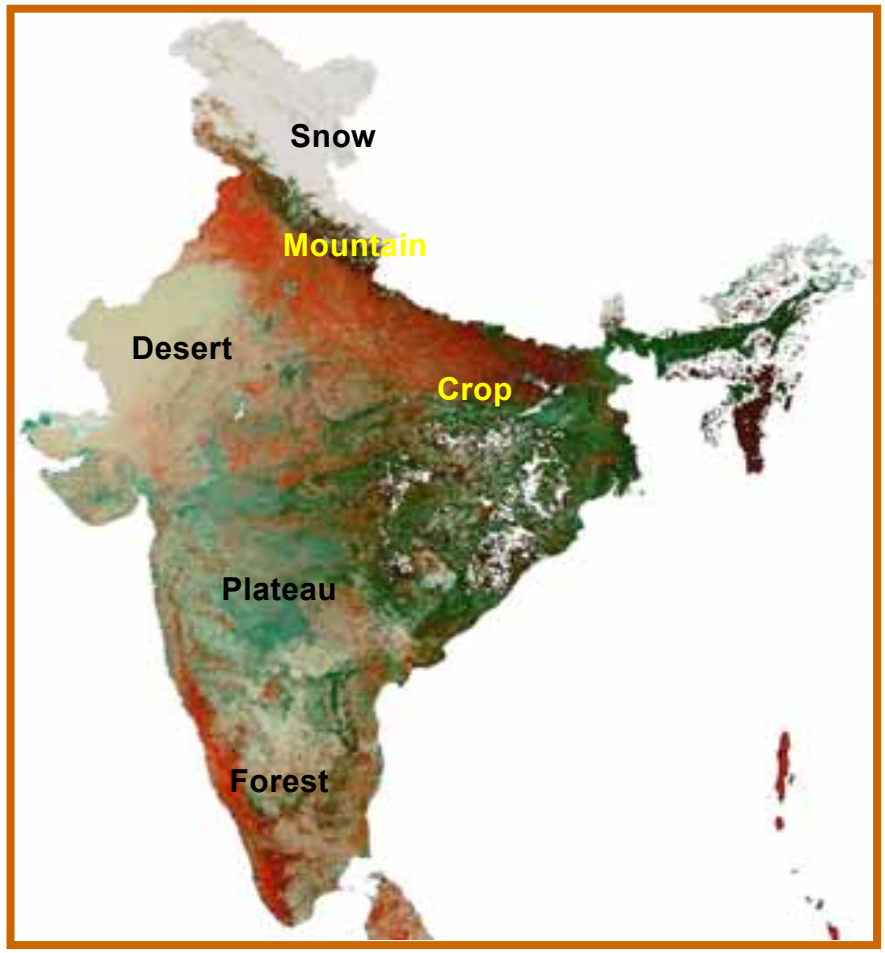
AHMEDABAD-380015

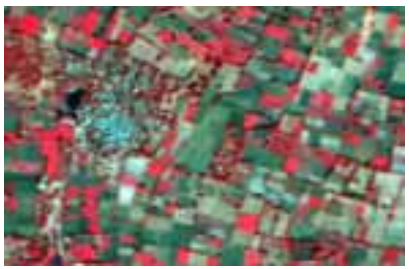
Introduction

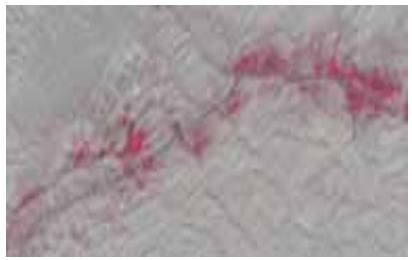
India is endowed with rich natural resources and biodiversity.

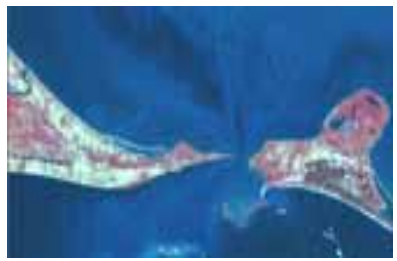
The low productivity, reducing forest cover, increasing atmospheric pollution & climate change are some of the important current challenges.

Space based observations over land, and atmosphere, is important for global environment monitoring and achieving sustainable development.



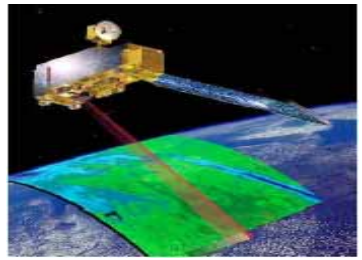






Background

- What is the green house gases concentration over India and how they are varying with time?



- How to infer the land surface characteristics and how they are distributed over India ?

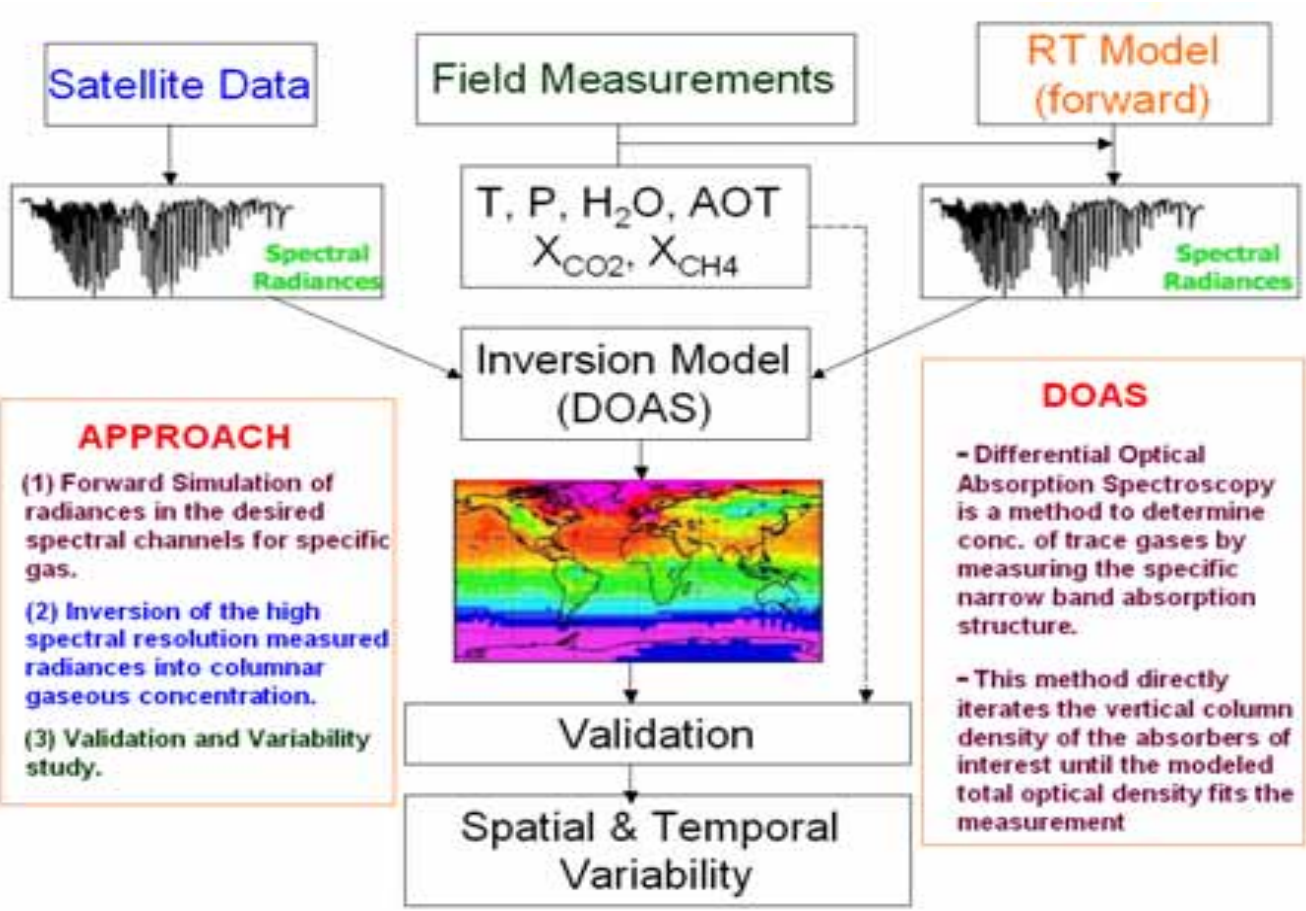
- What are long term vegetation changes occurring over India and how satellites can measure some of these changes ?

Remote Sensing of Trace Gases

•TES: Radiance Spectra
Satellite: EOS-TERRA
Spectral: 3-15 um
FTIR Spectrometer

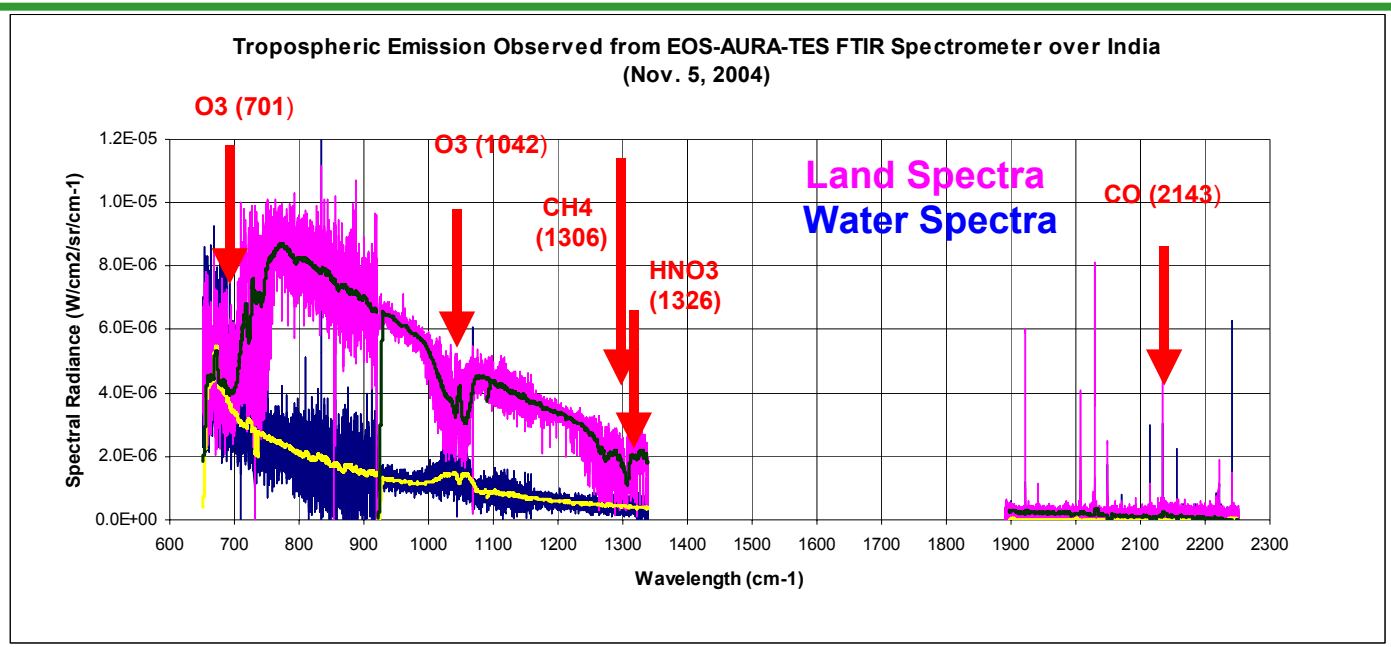
•SCIAMACHY: CO_2, CH_4
Satellite: ENVISAT
Spectral: 0.970-1.772 um
Method: DOAS
Year 2003-2005

•MOPITT: CO
Satellite: EOS-TERRA
Spectral : 4.7 um (CO)
Method: Gas Correlation
Year 2002-2006

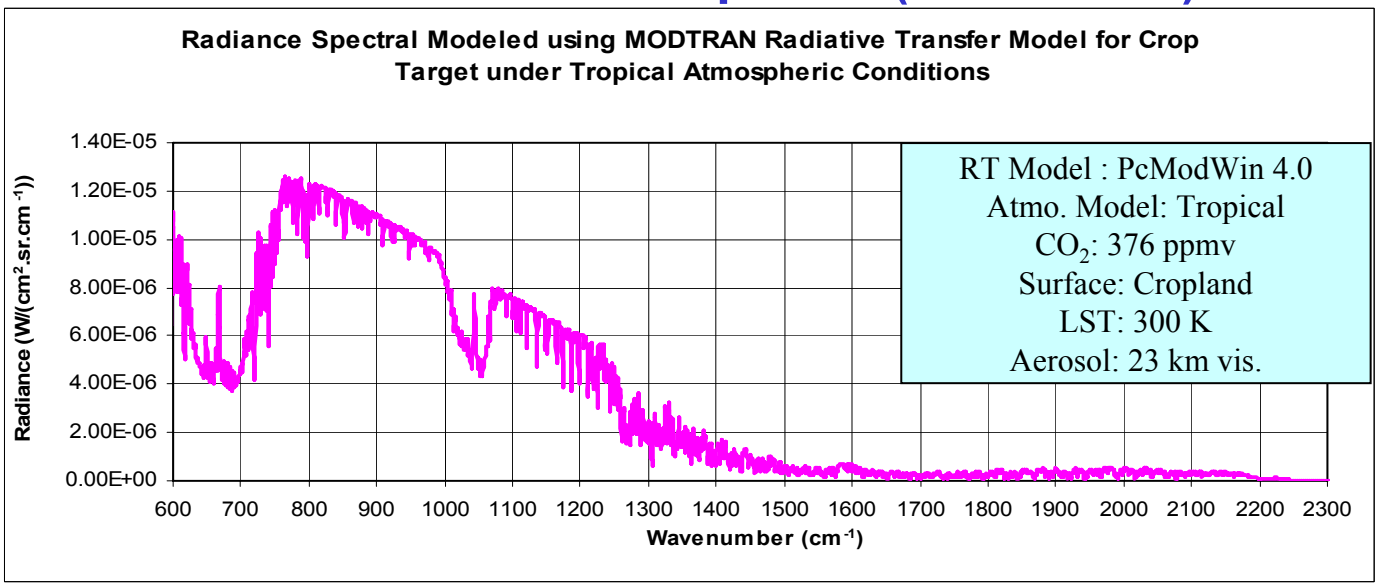


TES: Tropospheric Emission Spectrometer;
SCIAMACHY: Scanning Imaging Absorption SpectroMeter for Atmospheric Chartography
MOPITT: Measurement of Pollution in Troposphere

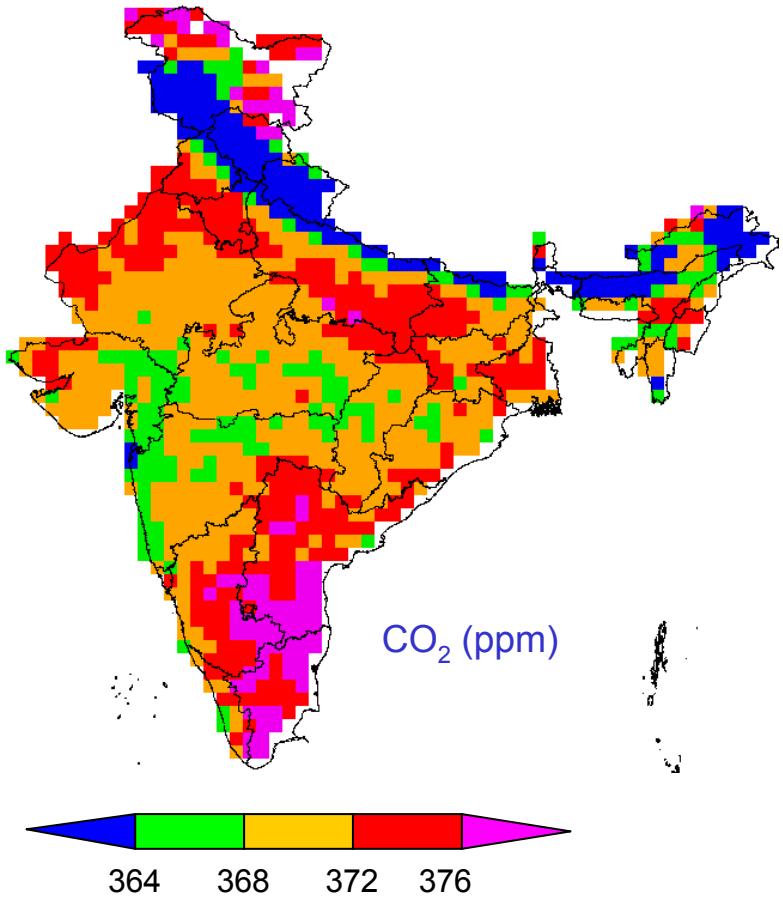
Observed TES Radiance Spectra



Modeled Radiance Spectra (MODTRAN)



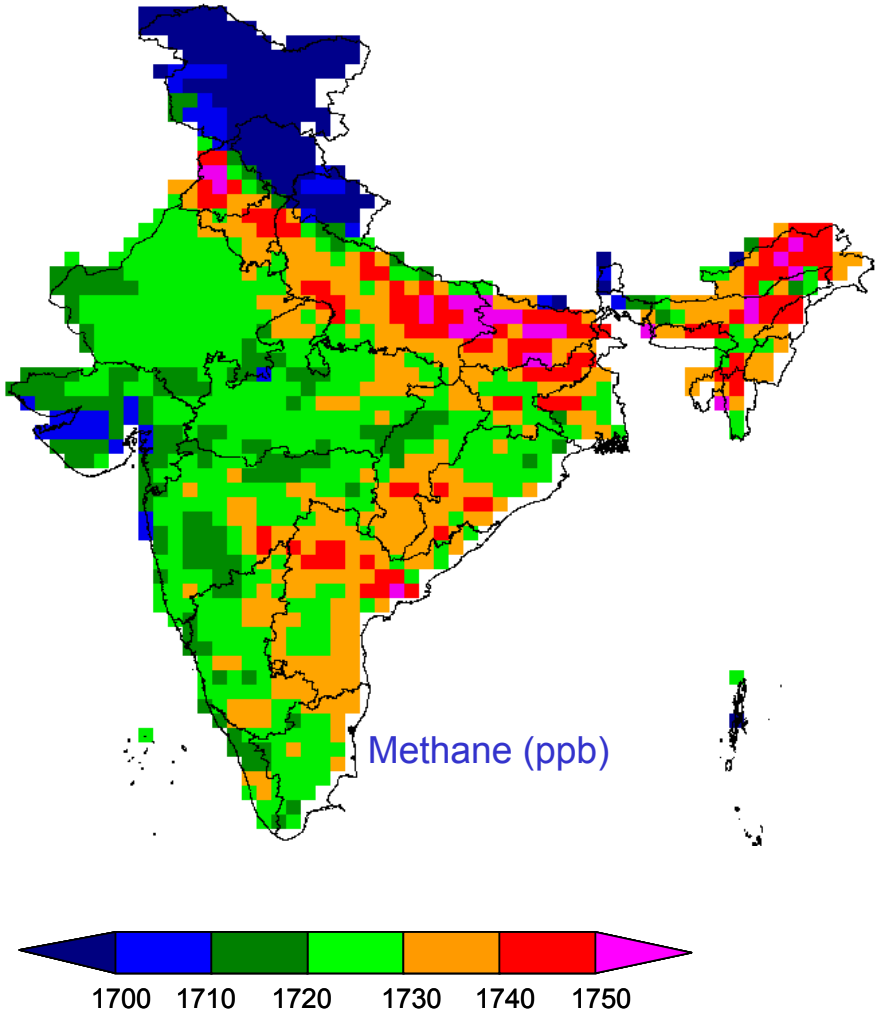
Spatial variability of atmospheric CO_2 over India



SCIAMACHY Data

(2003-05)

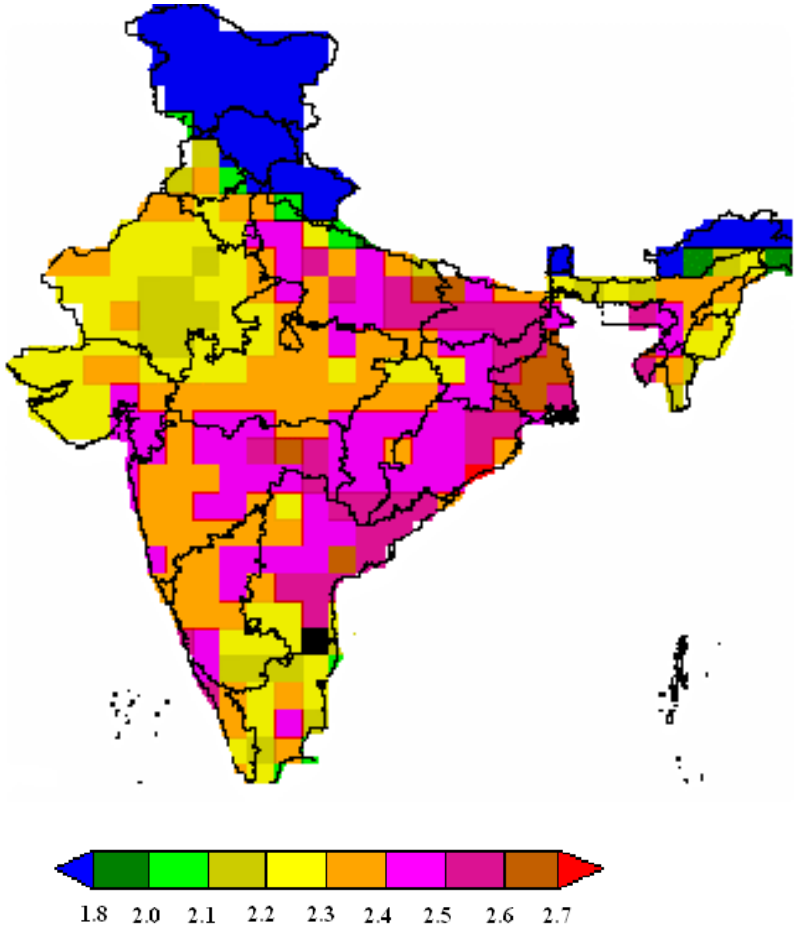
Spatial variability of atmospheric Methane over India



SCIAMACHY Data

(2003-05)

Spatial variability of atmospheric Carbon monoxide over India

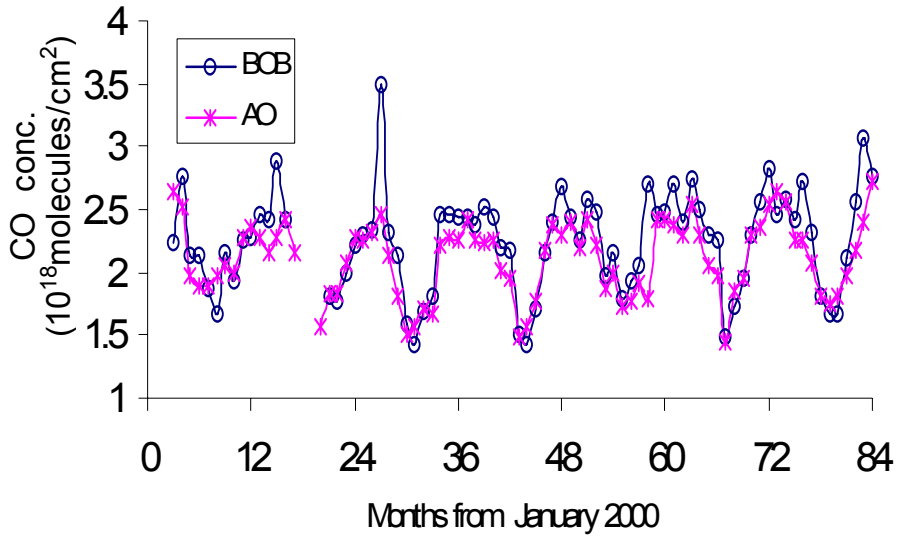


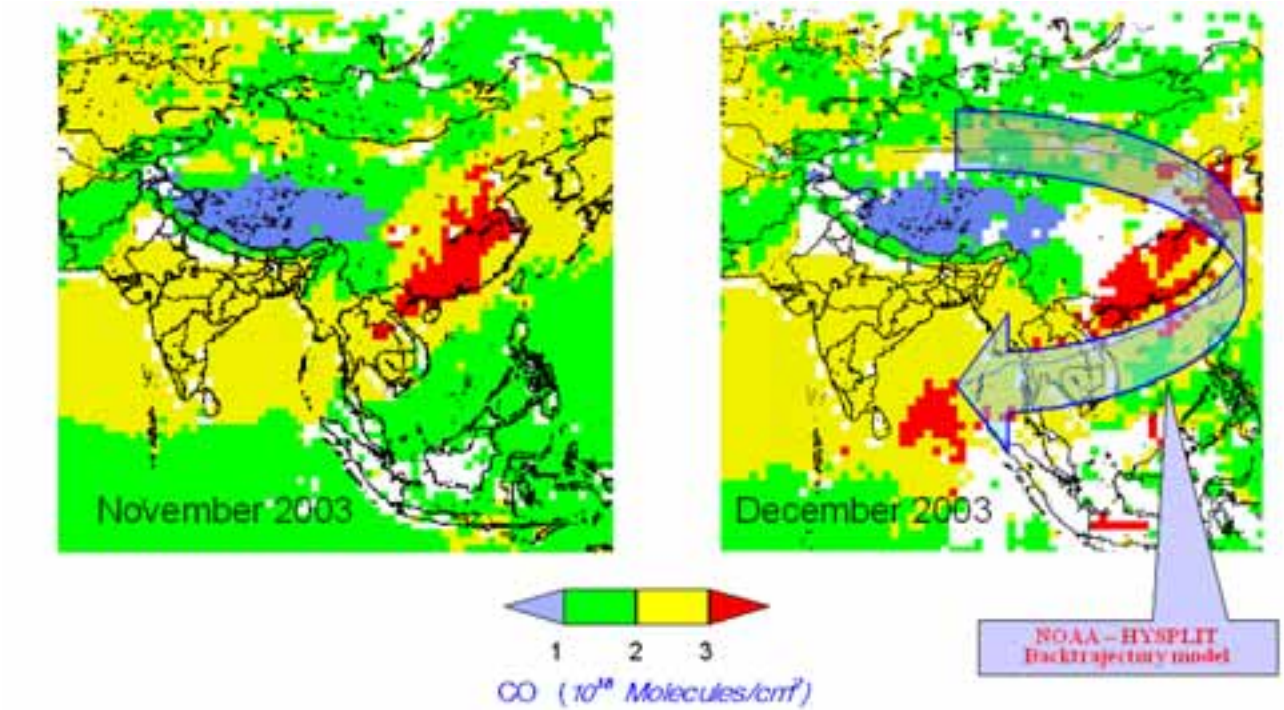
(10^{18} molecules/cm^2)

MOPITT Data

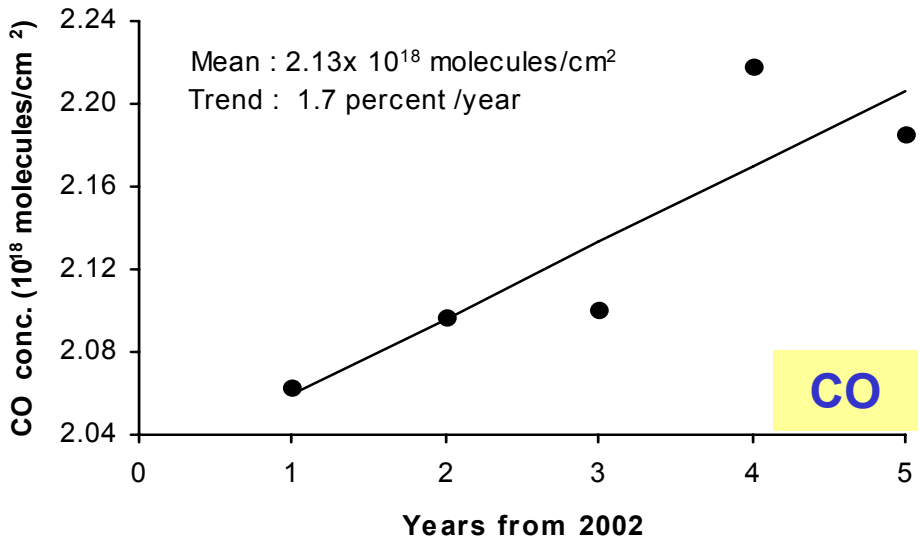
(2002-06)

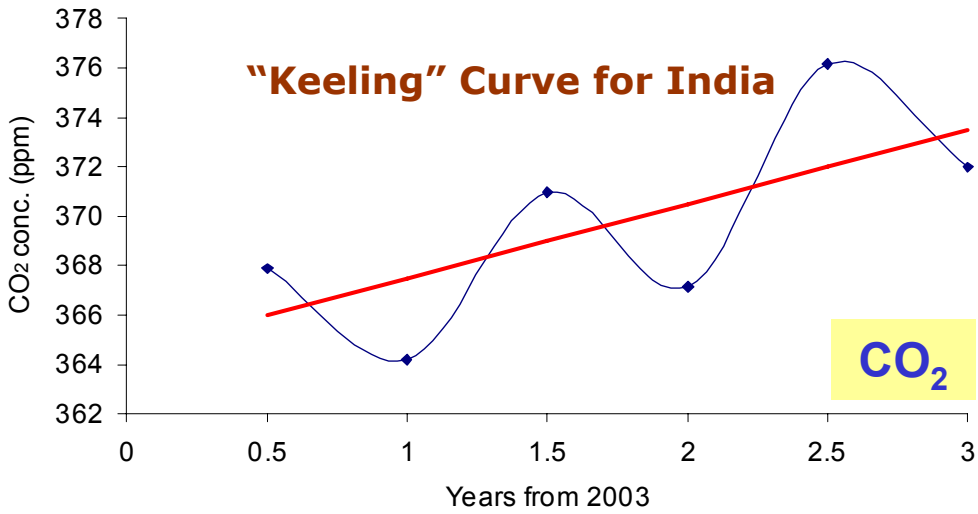
Carbon Monoxide and Transport





Increasing Trends of Trace Gases over India





Biospheric Seasonal Signal of CO_2 of India

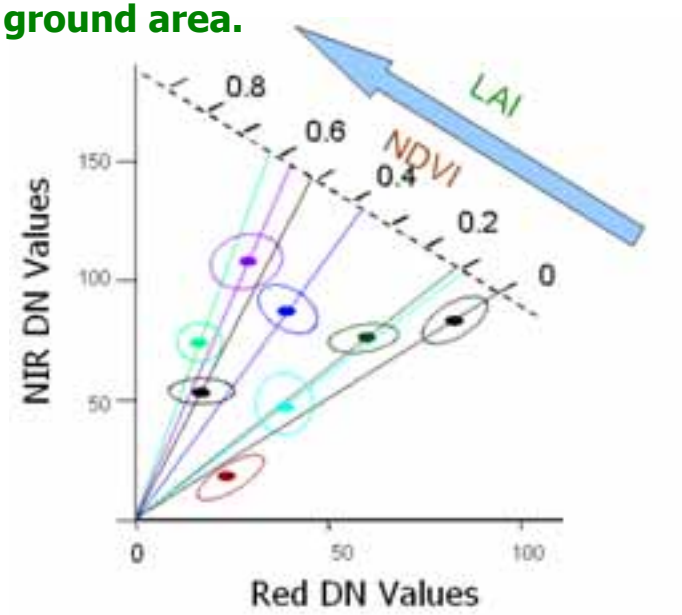
Terrestrial Observations

	Optical	Thermal	Microwave
Imaging System			
Measurements	Reflectance (ρ)	Brightness Temp B(T)	B(T), Backscatter
Physical Basis	Spectral signature $\rho(\lambda) = \frac{\pi . L_{sensor}}{E_0 . \cos\theta_s}$	Planck's law $B(\lambda,T) = \frac{2\pi . h . c^2}{\lambda^5 . (e^{\frac{hc}{\lambda k T}} - 1)}$	Dielectric property $P_r = \frac{P_t . G_t . G_r . \lambda^2 . \sigma}{(4\pi)^3 . R^4}$
Parameters	Land Cover, NDVI LAI/fAPAR, Vegetation Fraction, Albedo	Surface Temperature Soil Moisture Evapotranspiration	Surface Temperature, Soil Moisture, Vegetation Growth

Leaf Area Index Retrieval

Leaf Area Index (LAI) is dimensionless index used to quantify the single-sided vegetation leaf area per unit of ground area.

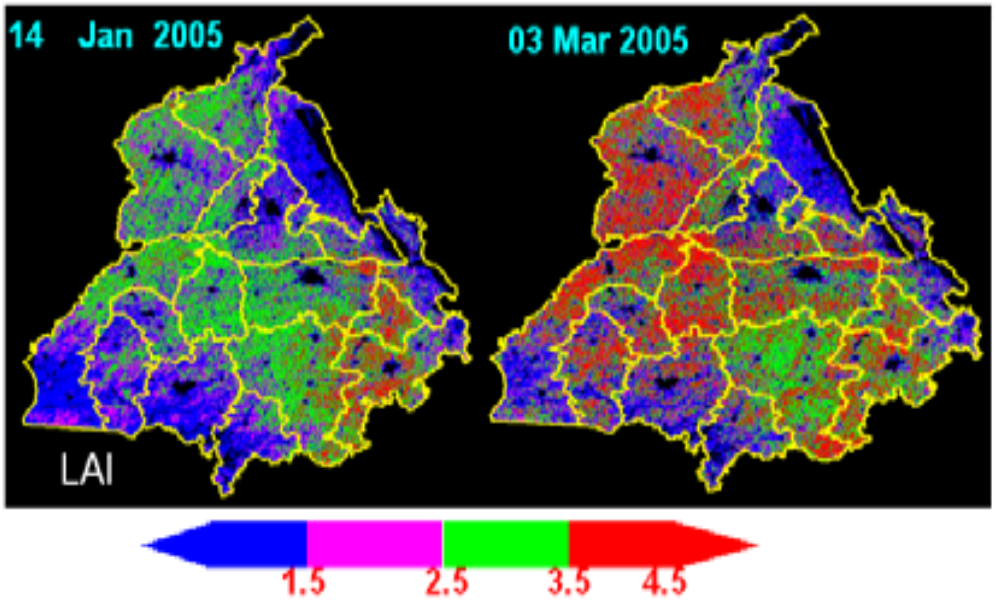
- **Statistical models : LAI-VI empirical relation**
- **Inversion of canopy reflectance (CR) model**

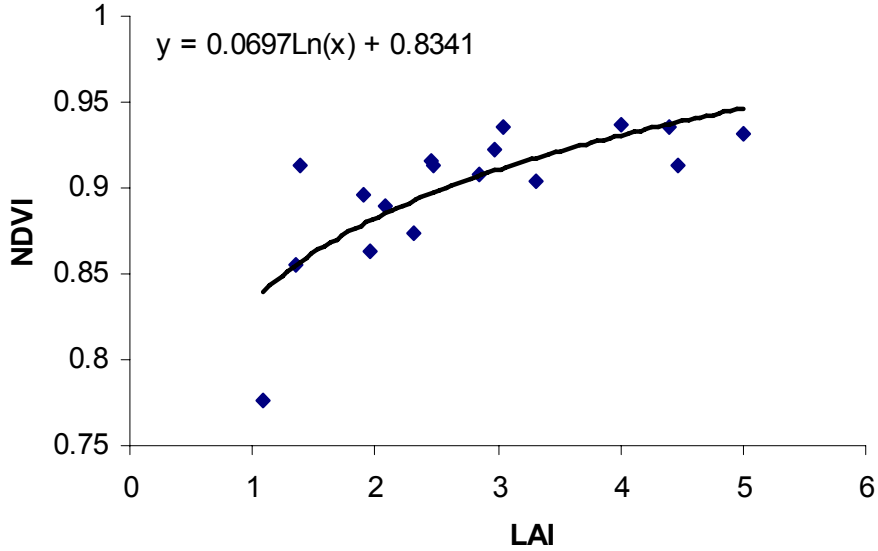


The reflectance slightly above the soil and the canopy

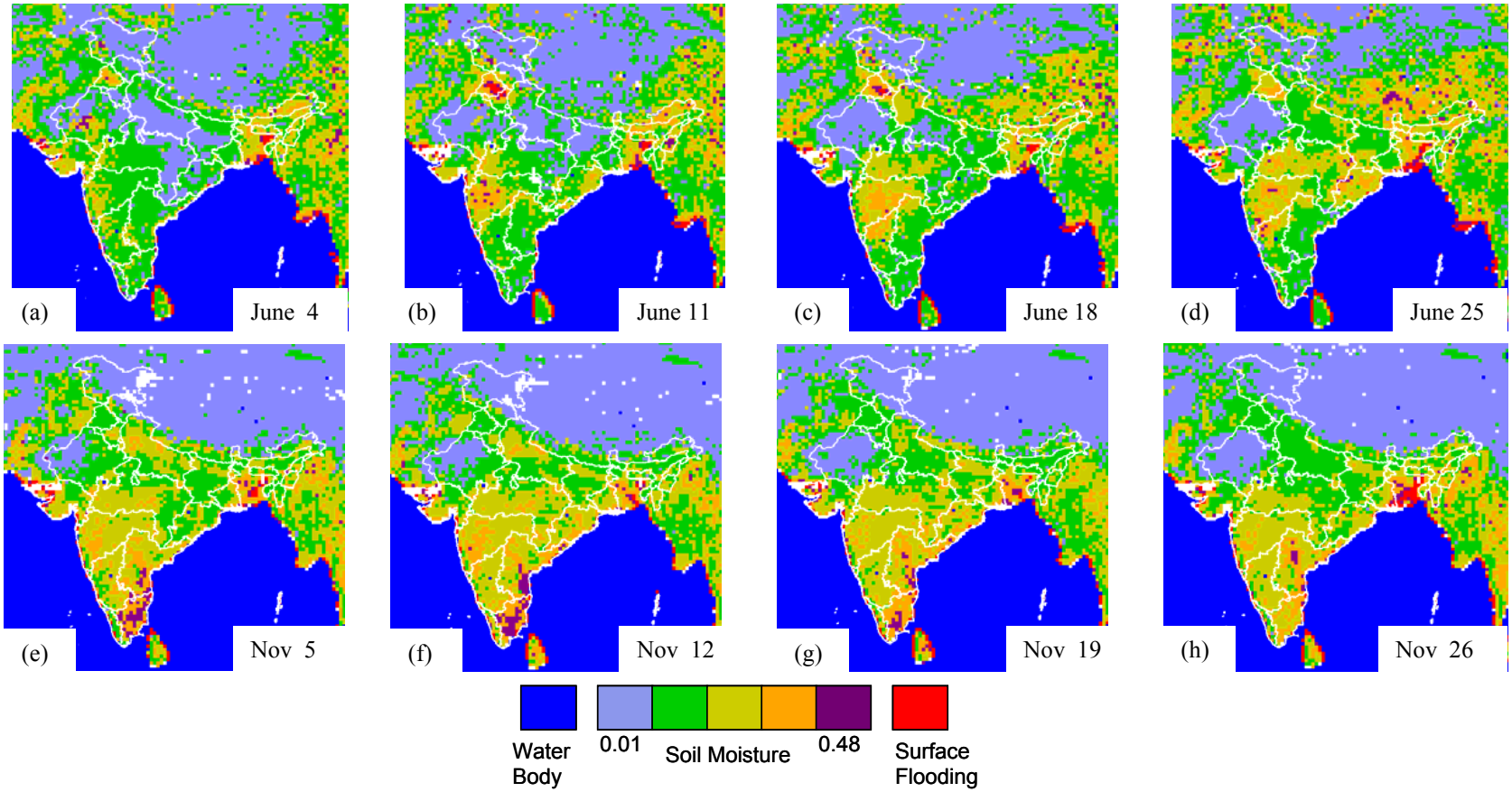
$$R(\lambda) = \left[r_\infty + \frac{D}{r_\infty} \right] \Big/ (1 + D)$$

$$D = \frac{r_s - r_\infty}{(1/r_\infty) - r_s} \cdot e^{-2c \cdot LAI}$$





SOIL MOISTURE



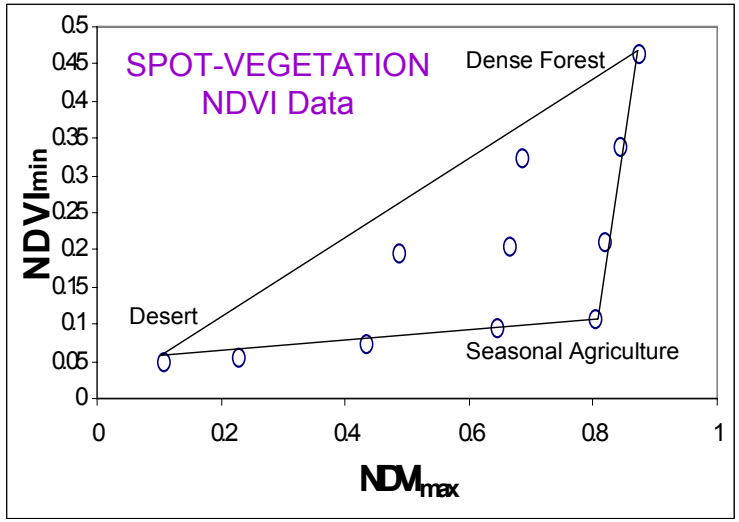
DMSP-SSM/I data

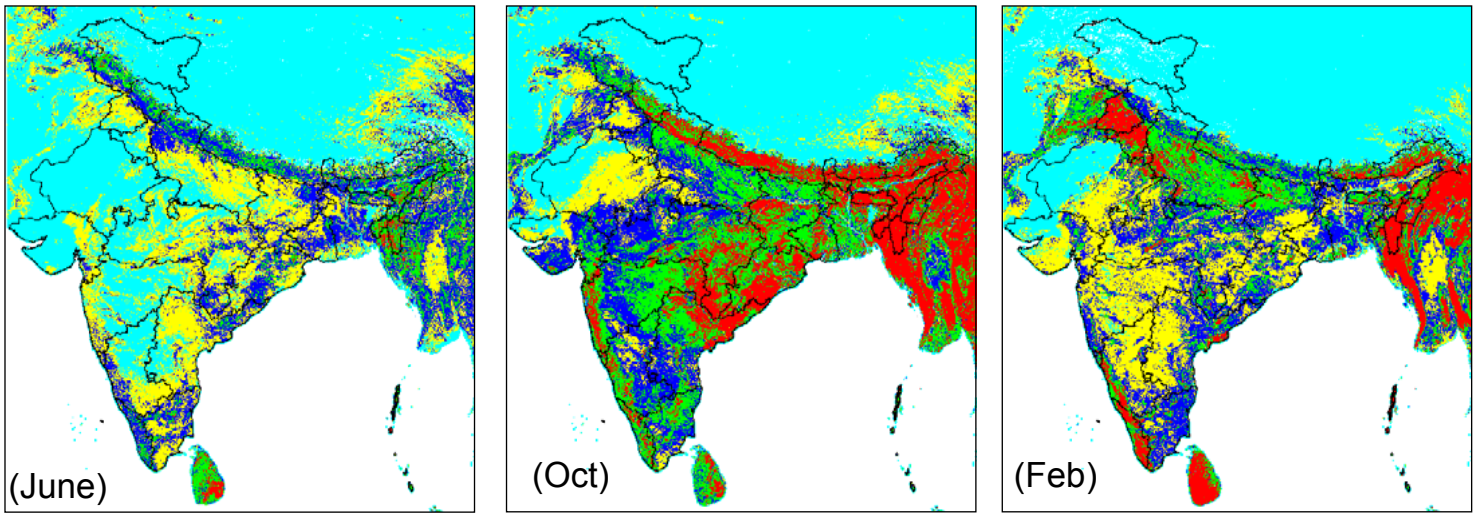
(1998)

VEGETATION FRACTION

Vegetation Fraction represents vegetation amounts in horizontal dimension and used in the climate model to weight the evaporation flux.

$$VF = (NDVI - 0.048)/(0.804 - 0.048)$$



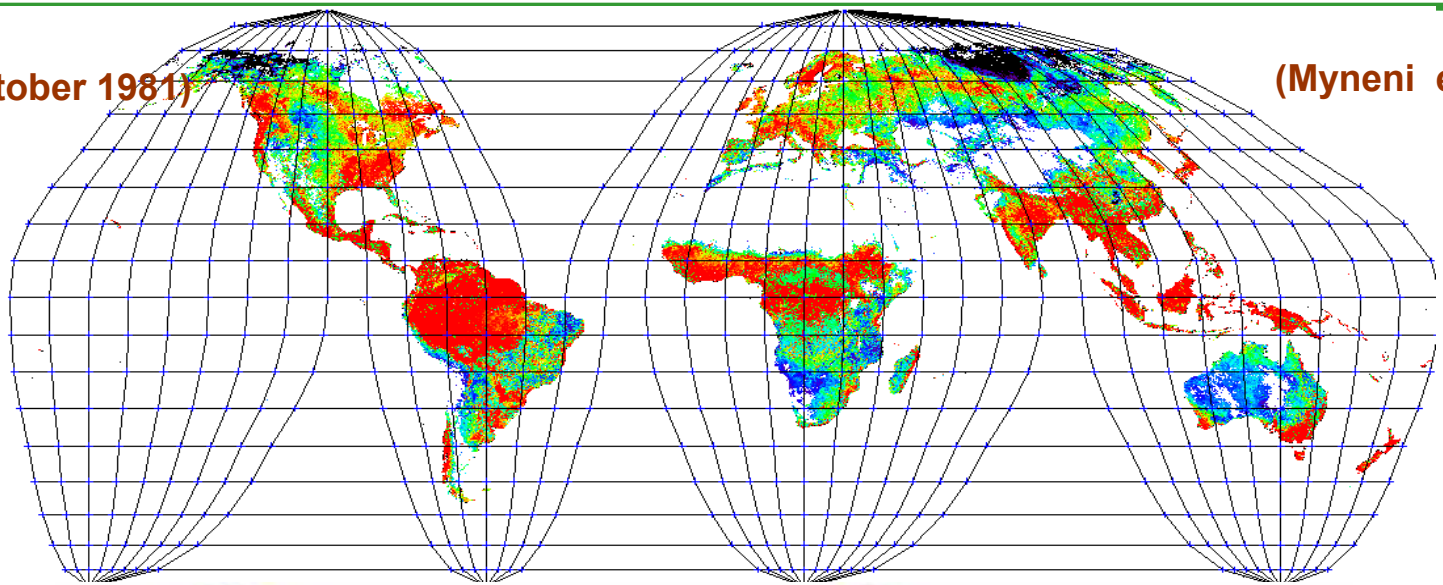


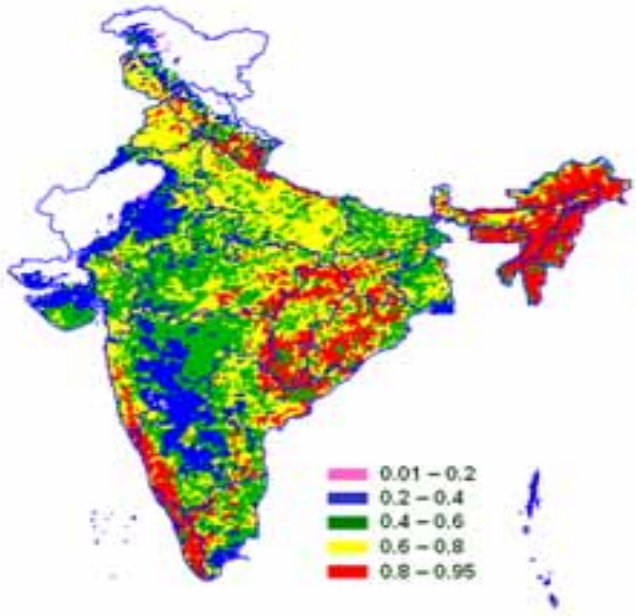
Source: Oza *et al.* 2006

GLOBAL fAPAR PRODUCT

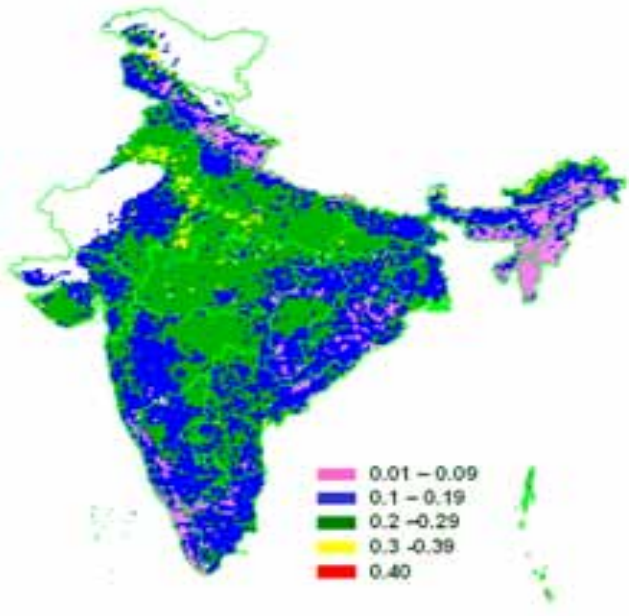
fAPAR (October 1981)

(Myneni et al., 1997)



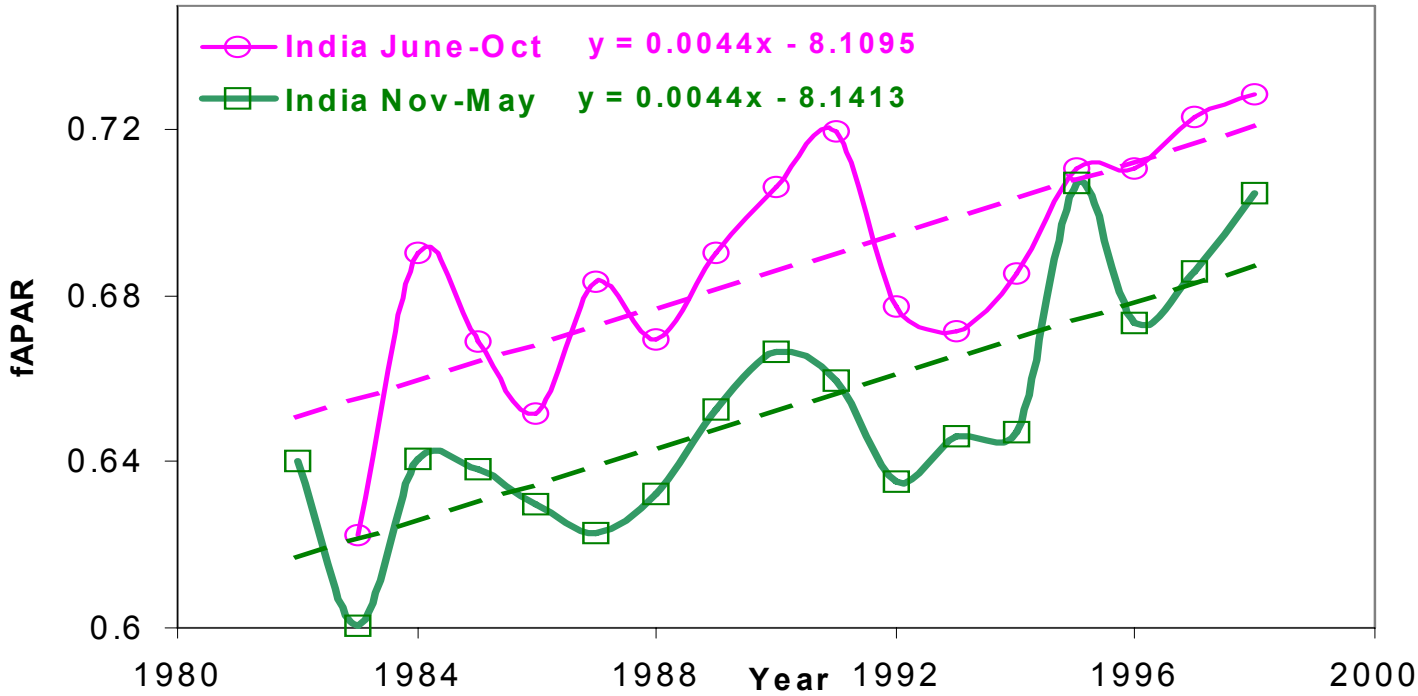


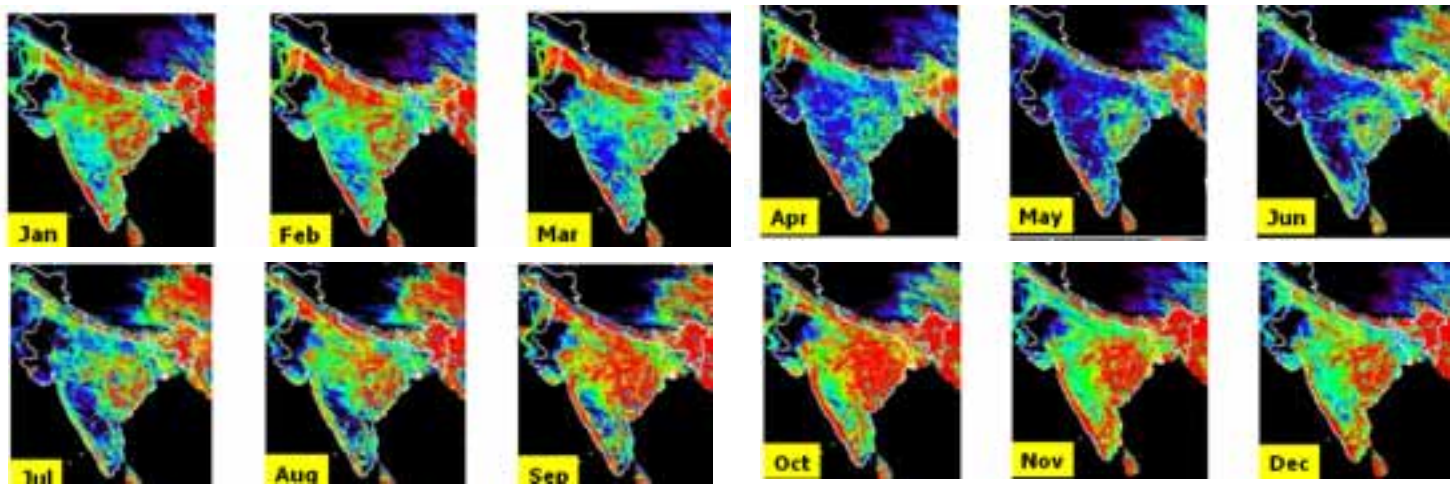
Mean fAPAR (July 1981 – May 2001)



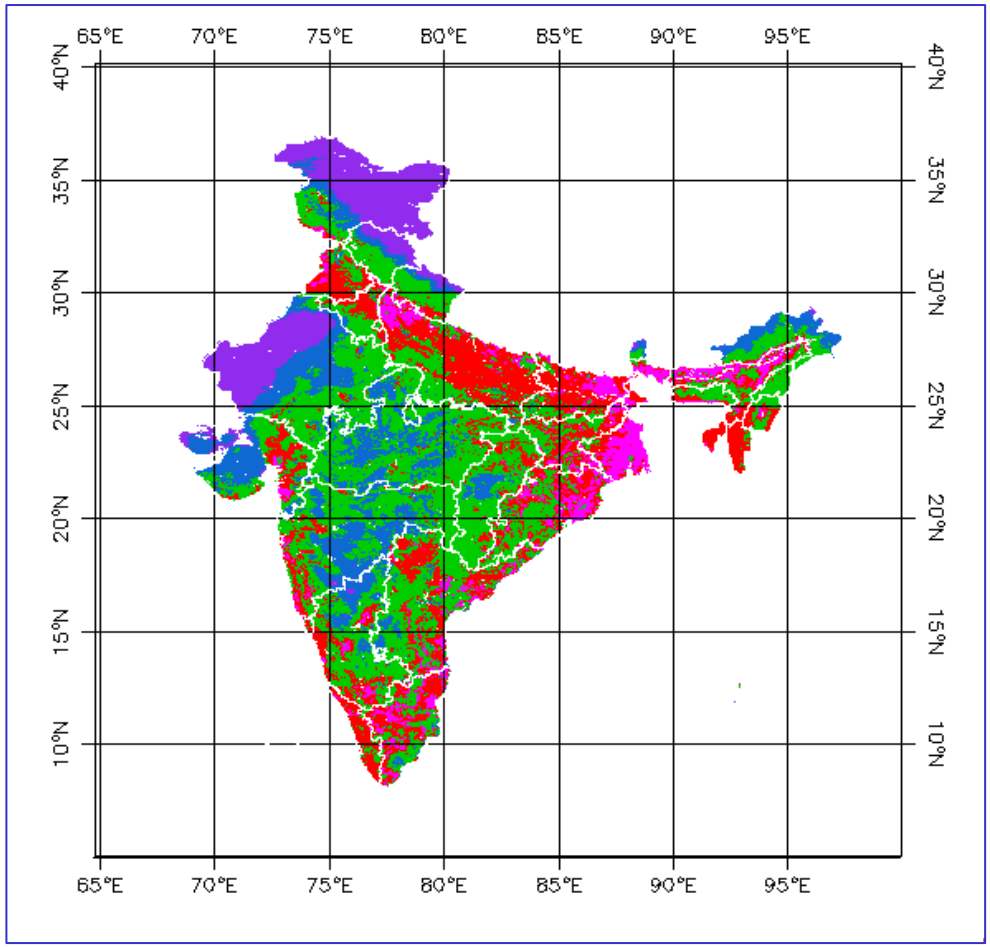
Standard Deviation fAPAR (July 1981 – May 2001)

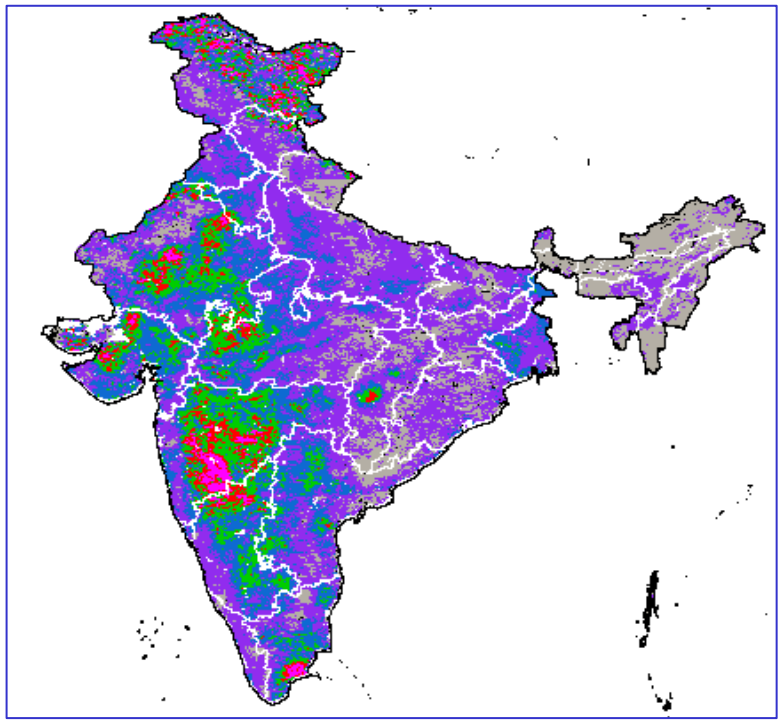
Long term changes in fAPAR using NOAA-AVHRR Data





Decadal Changes in NPP





0 500 1000 1500 >2000

$gCm^{-2}year^{-1}$

Average annual NPP1981-2000

-10 0 10 20 30 >40

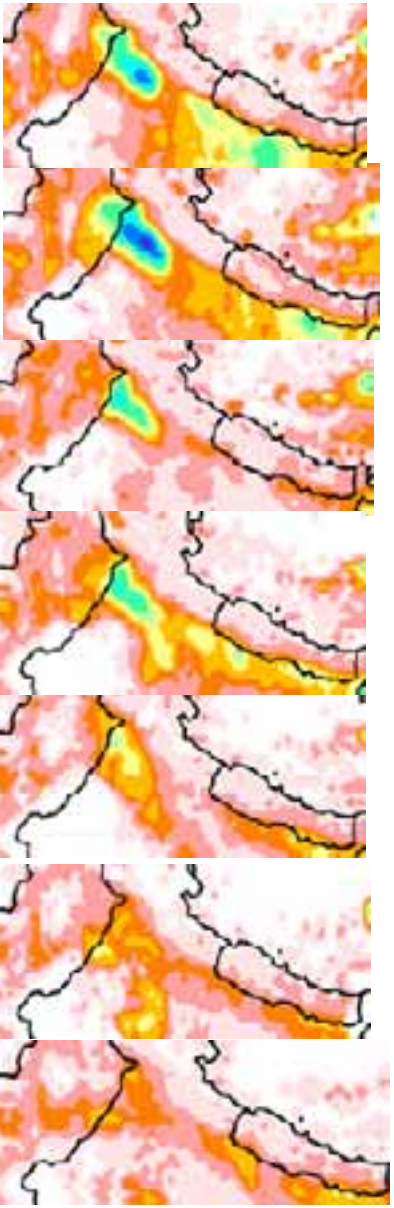
Percentage change in NPP

[Decade (91-00) vs Decade (81-90)]

GloPEM NPP Product

(1981-2000)

Changes in Phenology



June 25-July 01

June 18-24

June 11-17

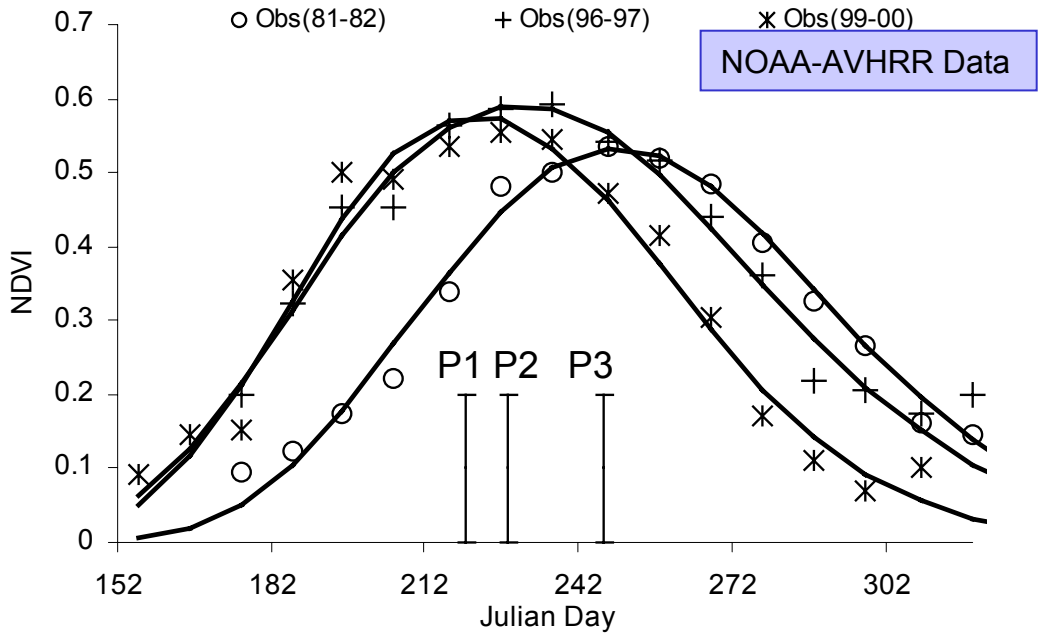
June 4-10

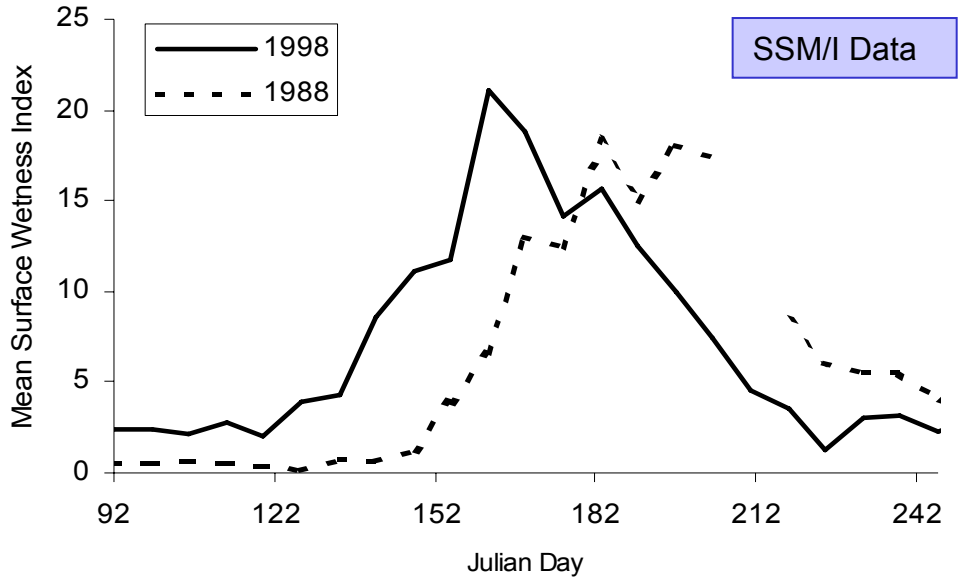
May 28-June 3

May 21-27

May 14-20

Surface Wetness (2001)





THANK YOU