*Conference: GeoSmart India 2016 (Theme: Climate Change)*

# "Remote Sensing and Modelling approaches for exploring Agriculture-Climate-Human interactions over India"



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# Introduction & Motivation

- Vegetation plays an active role in the climate system through altering the energy and water in the earth systems.
- The projected climate change fueled by increases in greenhouse gases may have pronounced effects on agriculture, forestry, natural ecosystems, and biodiversity [Christensen et al., 2013].

- Currently, substantial gaps exist in our knowledge about the location, magnitude, direction of ecosystem change, and the underlying dominant mechanisms.
- Limited knowledge about the vulnerability of ecosystems to future climate change and its associated impact on biogeochemical cycles [C-N-P].

# Objective

- **This study investigates:**

  *Climatic drivers* (TEMP, PREC, SOLRAD, etc.) of *large-scale Ecosystem change* over the Indian subcontinent.

- Nearly >3 decades of *climate* and *satellite data* were used to investigate the mechanisms and processes associated with changes in ecosystems.

# Data used and Methods

| Name | Years | resolution | Source |
|---|---|---|---|
| **NDVI 3g (GIMMS, AVHRR)** | 1982-2013 | **0.0833 degree/bi-mo** | Tucker et al. (2005) |
| **TEMP, PREC** | 1982-2013 | **0.25 degree/mo** | CRU (2012) |
| **SPEI (drought index)** | 1982-2013 | **0.25 degree/mo** | **Calculated from CRU** |

NDVI and climate fields were *aggregated* (pixel aggregate)/*downscaled* (nearest neighbor) to a common 0.25° spatial grid on which all statistical analyses were performed.

- Mann-Kendall test (Deseason, Pre-Whitening)
- To perform grid point correlations at interannual time scales, trends were removed in the original data.
  - **removal of linear trends** (estimated via least squares linear regression) in the original data

# Results

## NDVI trend during 1982-2013 (32 years: Jan-Dec)

**768 layers**

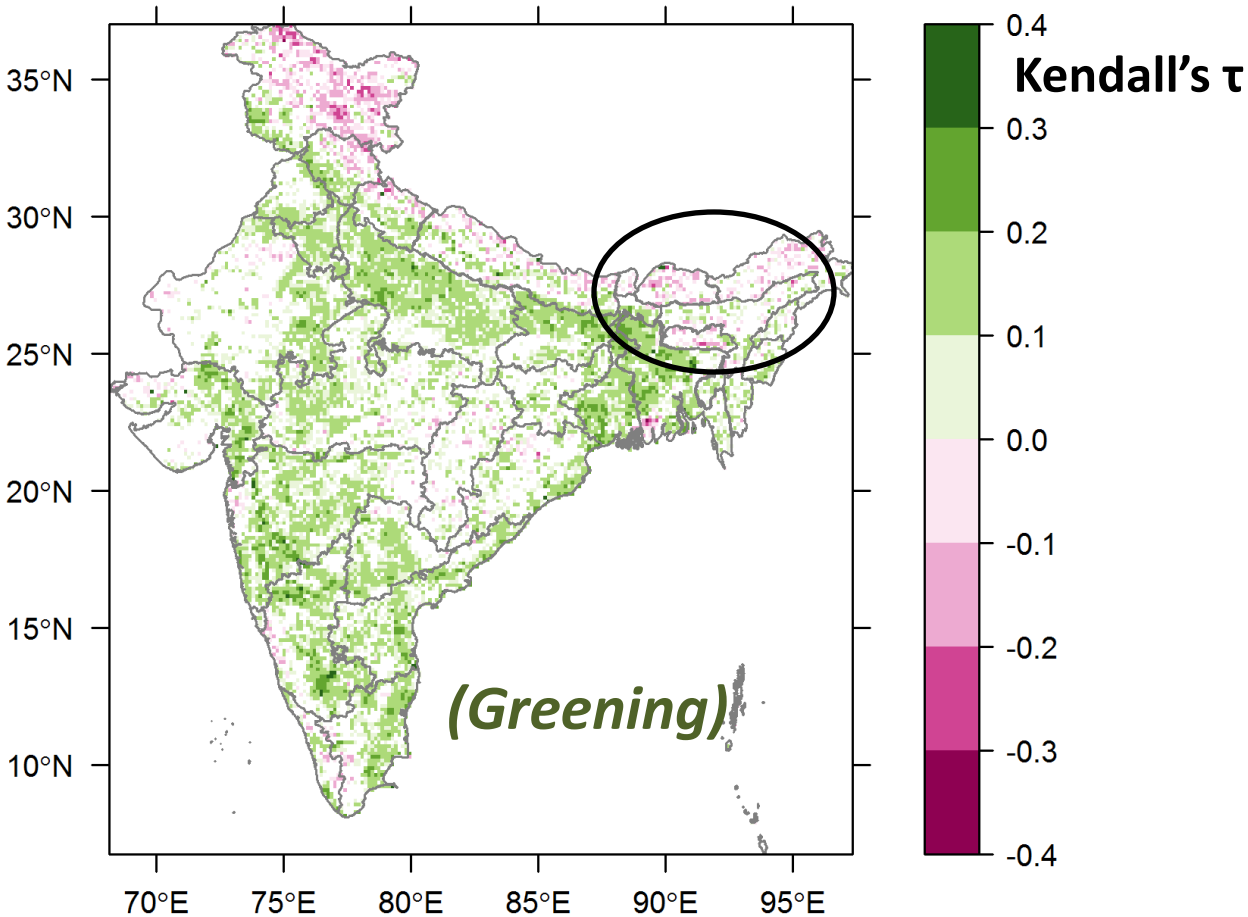



**Figure:** Trends are statistically significant at $p < 0.05$ level. De-seasoning and Pre-whitening were performed prior to Mann-Kendall test.

# NDVI trend during 1982-2000 (L) and 2000-2013 (R)

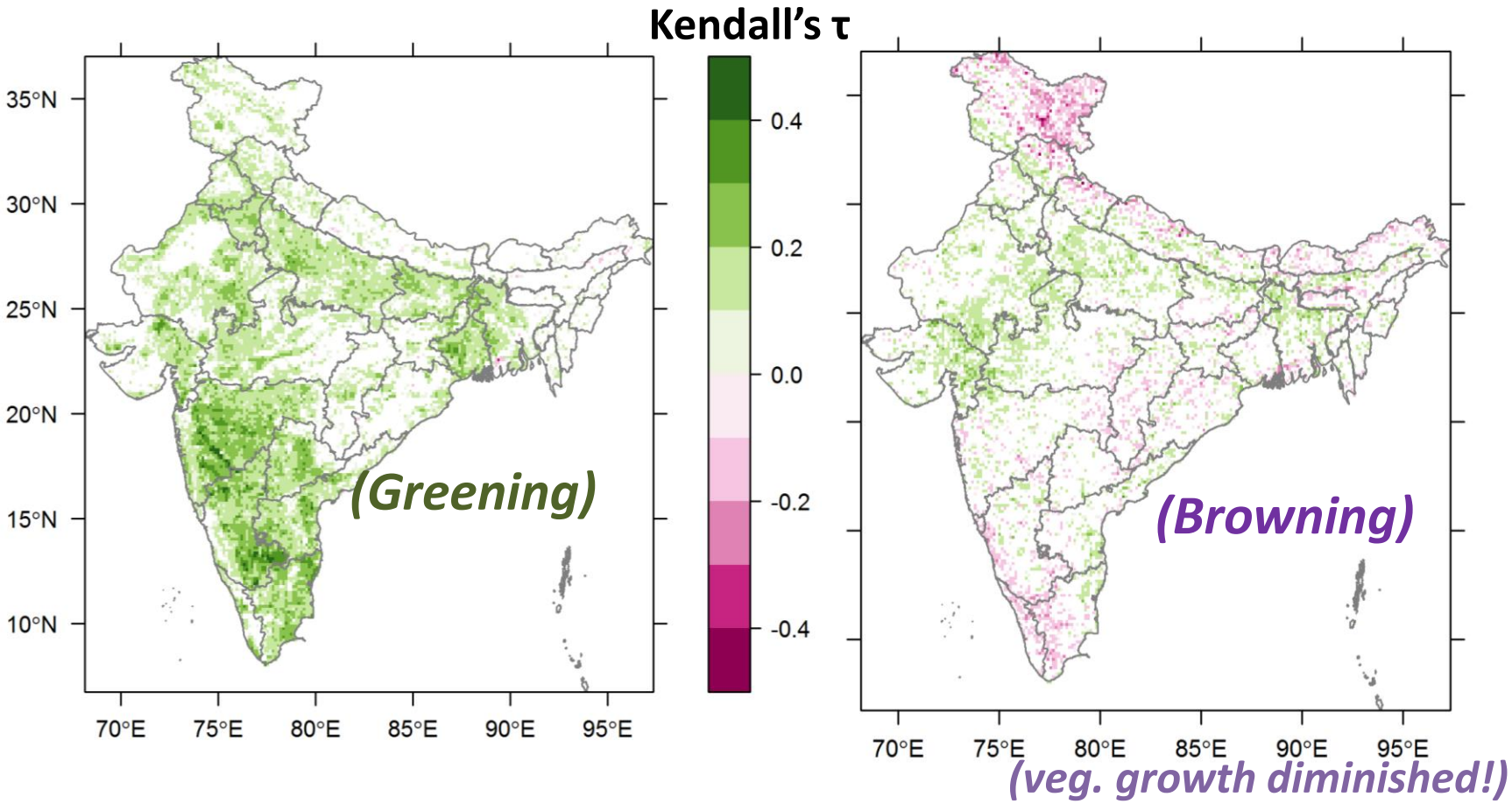



**Figure:** Grid point Mann-Kendall test for NDVI trends for the two focal periods: 1982-00 and 2000-13.

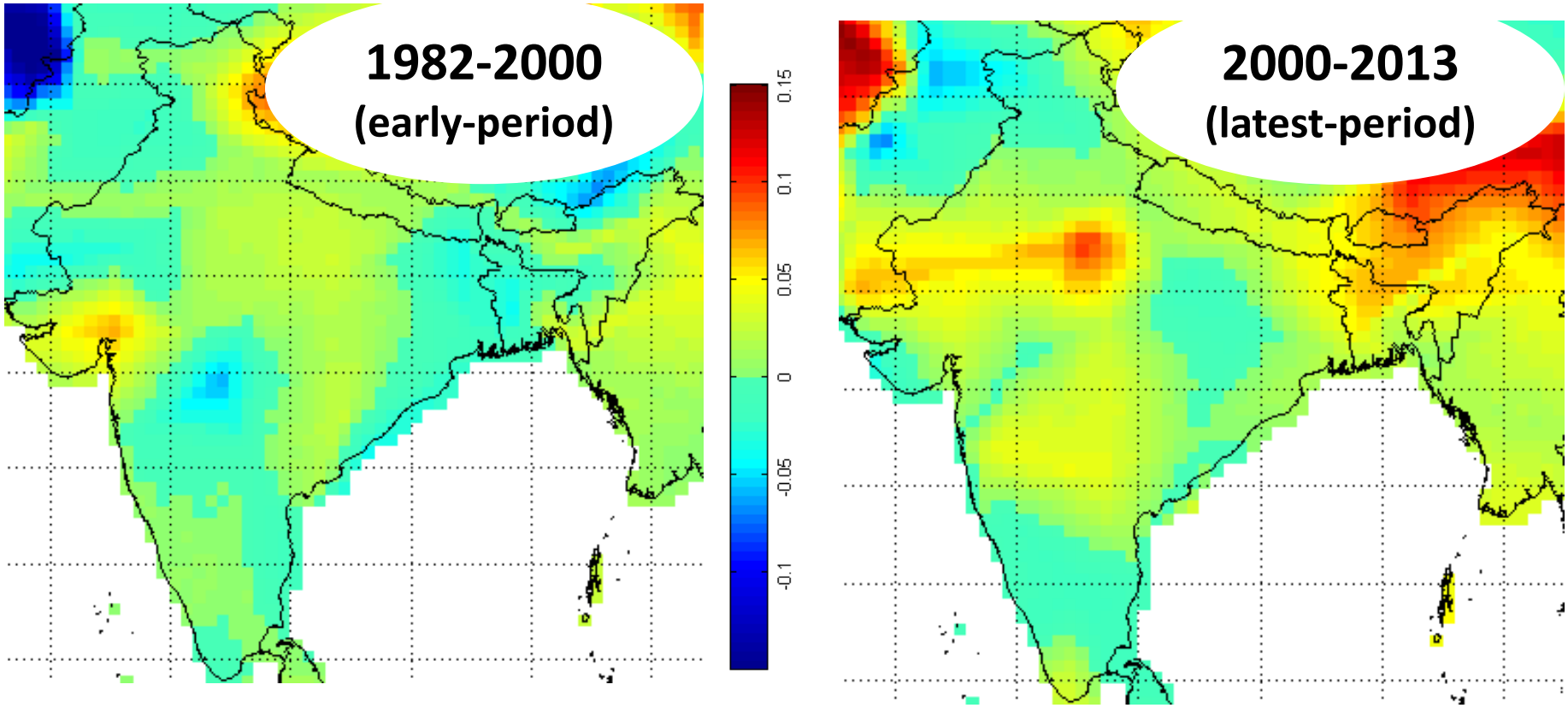
# Shifting from greening to browning

- Human pressure such as Deforestation, Urbanizations, Smart city, Infrastructure development…
- Climate change such as CO2 emissions, Other traces gases, Temperature and Precipitation variations,
- Other drivers such as Solar radiation, Nutrient deficiency, Land degradation, Flood, Drought …..

- Each state will have different reasons
  - **On-going work (under DST funded project)**

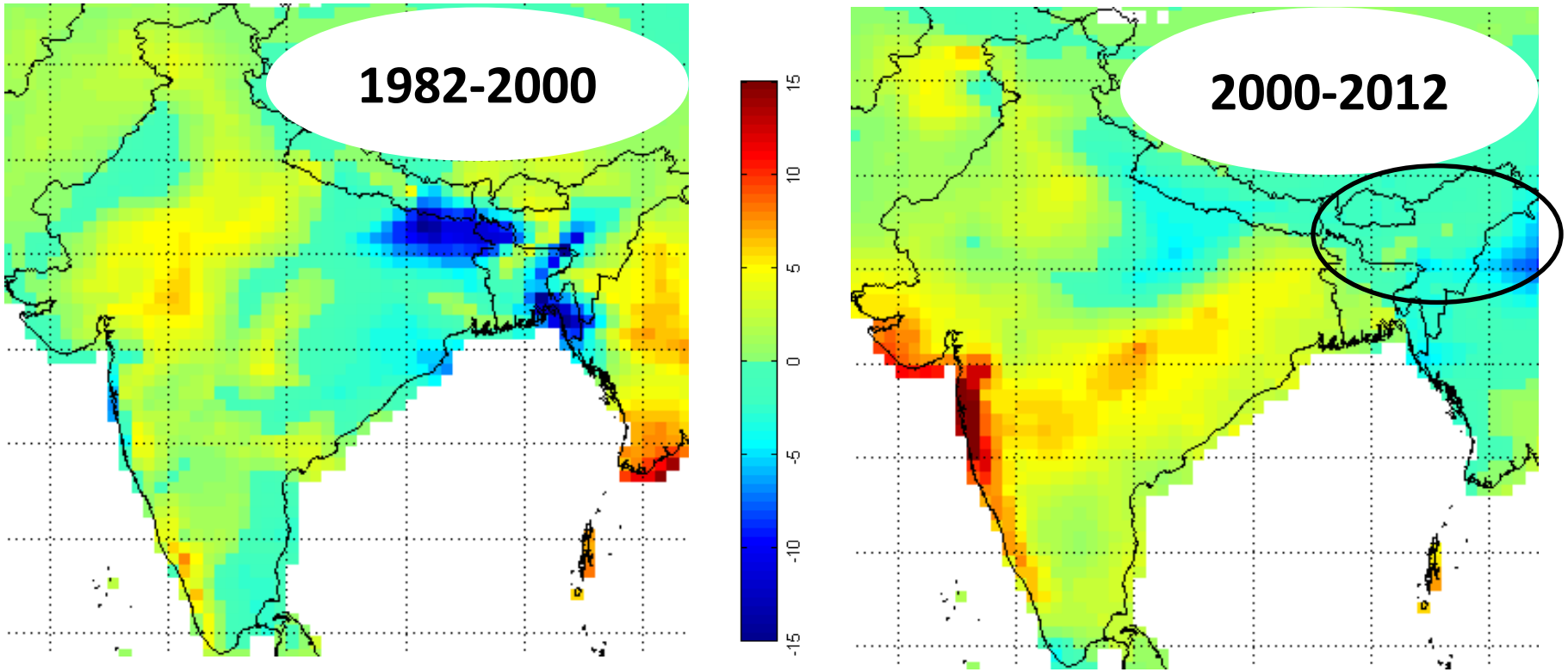
# Preliminary Results-

## Fig. TEMP trend (°C /yr) during June-Sep derived from 1982-2013




(Increases in temp. in all parts except southern Peninsular India)

# Fig. PREC trend (mm/yr) during June-Sep derived from 1982-2012




(Increases in prec. in all parts except central NE and NE India)

# Coupling between NDVI and TEMP

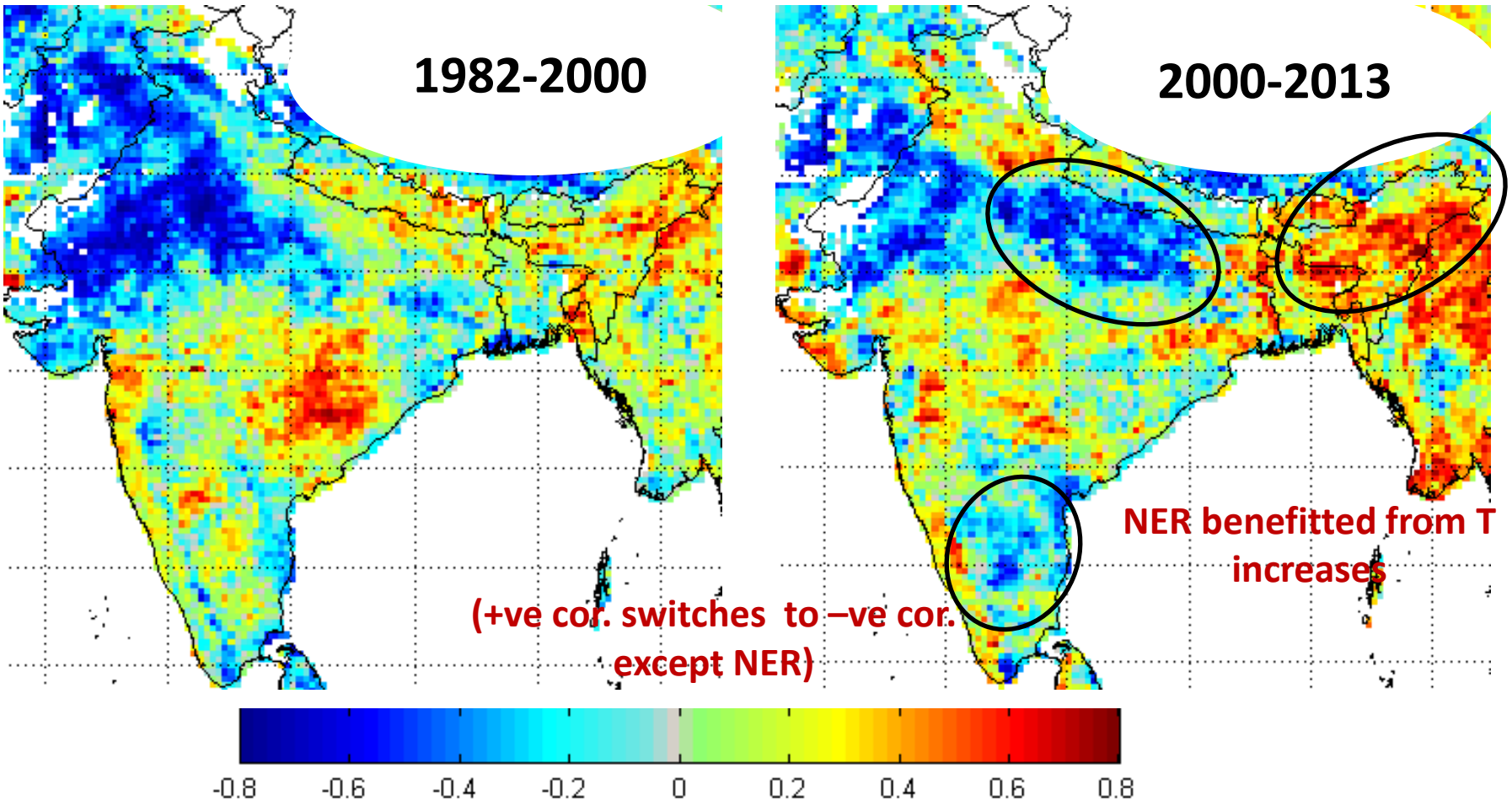



**Fig. Grid point correlations b/w NDVI and TEMP**. Original data have been detrended prior correlations. r values greater or smaller than 0.32, are statistically significant.

# Coupling between NDVI and SPEI6

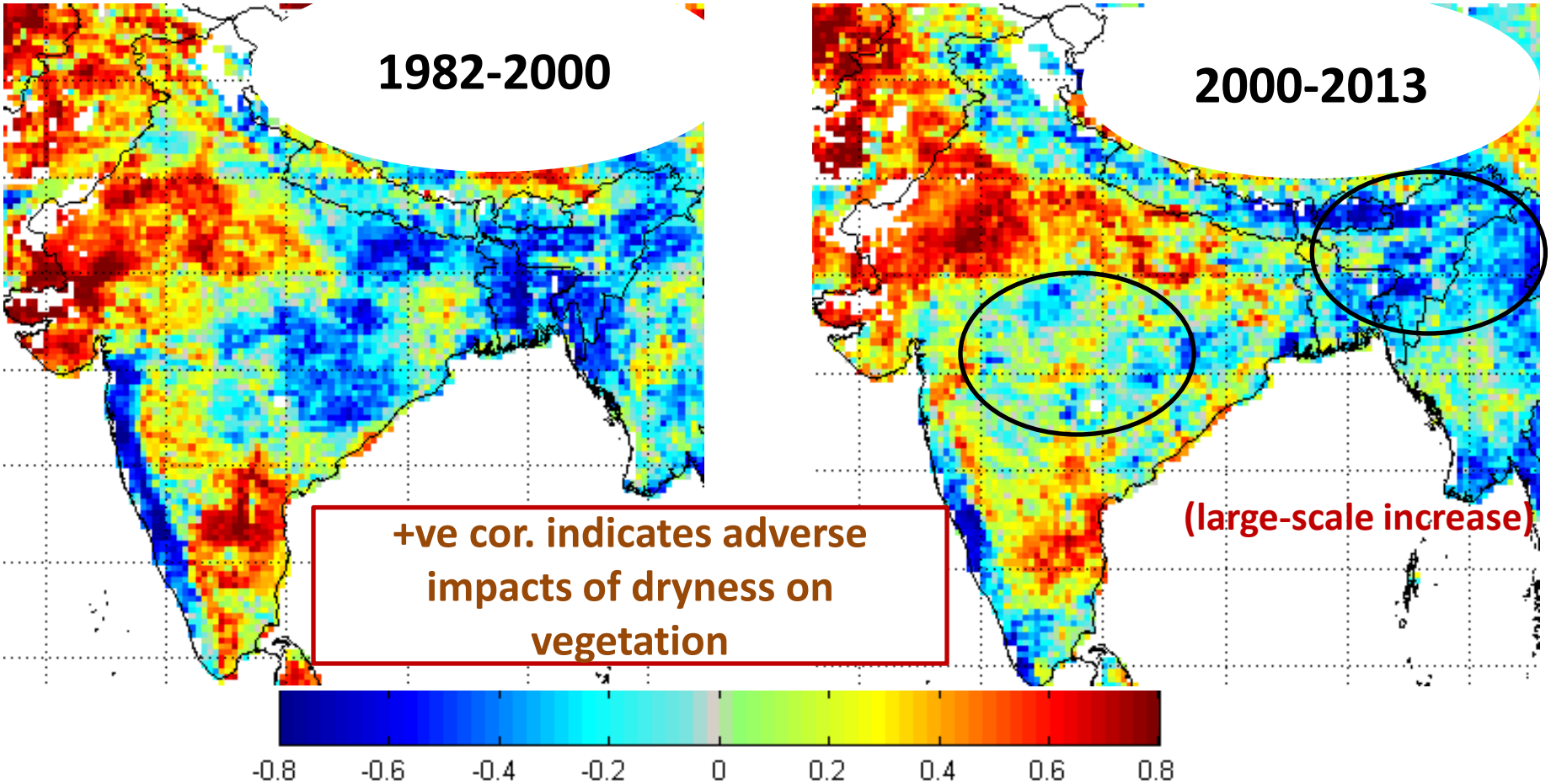
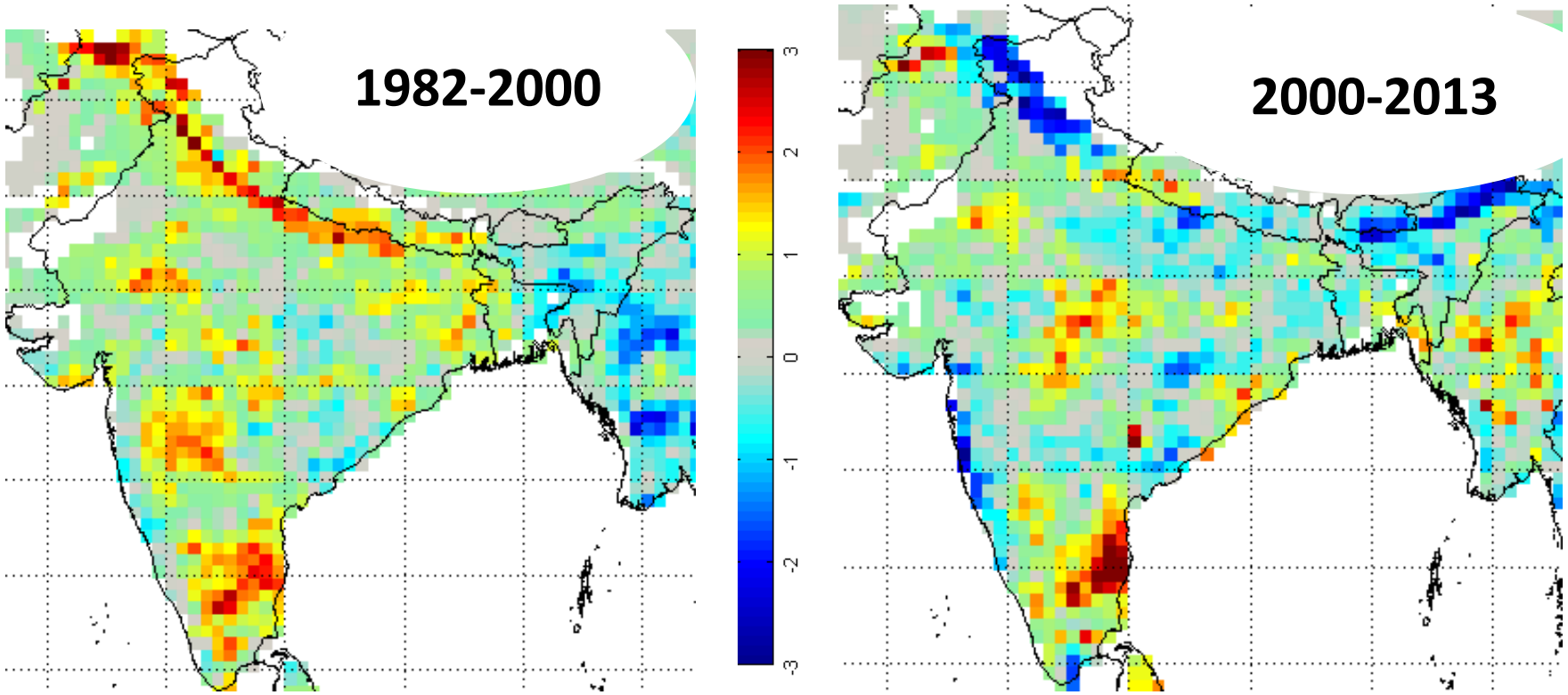



**Fig. Grid point correlations b/w NDVI and SPEI**. Original data have been detrended prior correlations.

**Fig. NPP trend (gC/m2/yr) during kharif season (June-Sep) derived from 1982-2013.**




NPP from CASA-GFED3

# Discussions and Conclusion

- Switching from ***greening to browning trends*** of vegetation in recent decades over most parts of India.
- Important climatic drivers for such change are ***temperature and moisture induced stress*** [***Evident from SPEI6 indicator***].
- Other drivers under investigation are: **Solrad, Soil moisture, Fires, land use and land cover change, CO2 fertilization, Irrigation, Fertilizer,** etc.

- ***Browning of veg.*** will have severe implications for the *forest, agriculture, and natural* ecosystems under future climate projections.

- **Impacts of such changes on Carbon source-sink strength?**

# Ongoing work

- **CASA-GFED3 model and simulations**
  - **Surface Radiation Budget (SRB)**
  - **International Satellite Cloud Climatology Project (ISCCP)**
  - **MODIS burnt area (MCD14ML)**
- **Sensitivity test**
  - **FPAR3g data**

- **Fluxnet tower data integration:**
  - **Upscaled-Fluxnet data [Jung et al. 2011 from MPI-Jena]**
  - **Asiaflux and Indoflux community**

# Acknowledgements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