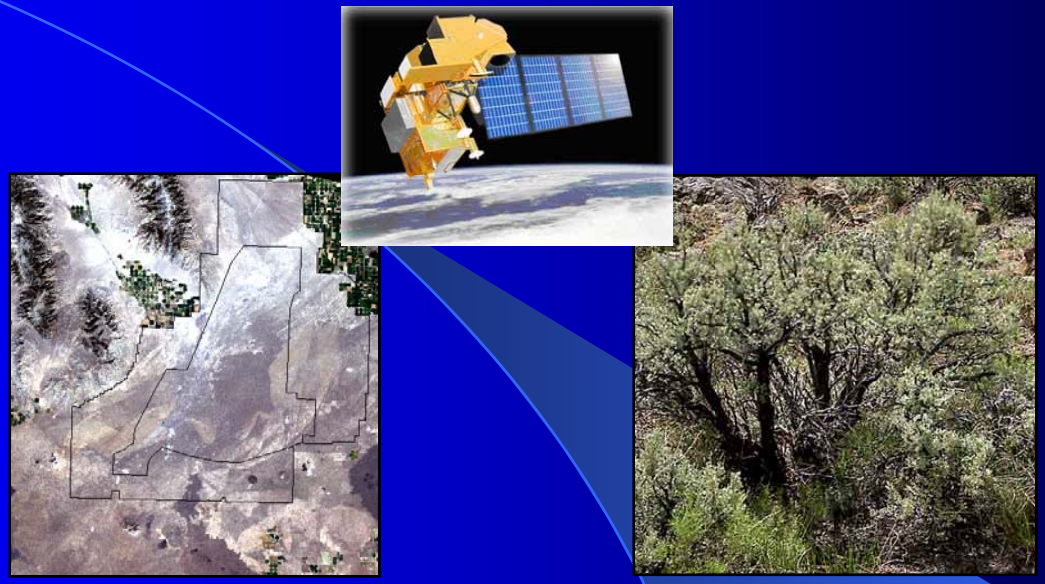
Spatial and temporal variation in remotely sensed vegetation indices on the INEEL from 1984 - 2002



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Importance

- How does vegetation vary among years?
- Need for understanding of ecological processes and mechanisms driving change (Anderson and Inouye, 2001)
- Vegetation types that show least variation during climate anomalies may be most suitable for barrier caps for protecting hazardous waste

Sagebrush-Steppe Rangelands

- Information regarding variation in vegetation exists primarily at small-plot scale
- Anderson and Inouye (2001) state the need for large-scale perspective to better understand vegetation dynamics of sagebrush-steppe
- Little is known about responses to climate variation or disturbance at large-scales

Project Goals

- Examine temporal and spatial variation of vegetation in sagebrush steppe rangelands on the INEEL from 1984 – 2002

- Investigate response to climate variability or disturbances (fire and/or grazing)

Remote Sensing Platforms

- Landsat 5 TM and 7 ETM+
  - Provide regional-level and monthly coverage
  - Measure electromagnetic radiation reflected from Earth's surface
  - 185km swath width
  - 30m pixel resolution
  - continuous, 16-day repeat cycle
  - 7 spectral bands (0.45-12.5µm)

Image Date Selection

- One cloud-free image selected per year from 1984 to 2002 for 30-day window centered over Julian day 183 (~1-July)
  - missing years: 1987, 1992, 1995, 1999
- Multiple images from April – September for 2000 to 2002
- Allows for comparisons of non-phenological differences in vegetation between years

Image Pre-processing

- The following pre-processing was performed on all images using ENVI 3.6 software:

1.) Reflectance conversion

2.) Image-to-image registration

3.) Radiometric normalization

4.) Vegetation index calculation

Image Co-registration

- Geometric correction procedure that aligns corresponding pixels of one image to another
- Allows for the comparison of pixels between multiple images
- Performed using 20 GCPs
- RMS error < 1.0

Radiometric Normalization

- Accounts for radiometric differences due to non-surface factors
- Applied multi-date linear regression method (Jensen 1996)
  - 20 ‘pseudo-invariant’ ground targets
  - targets selected based on acceptance criteria
- Removing non-surface factors allows differences in reflectance values between pixels of multiple images to reflect actual changes in vegetation

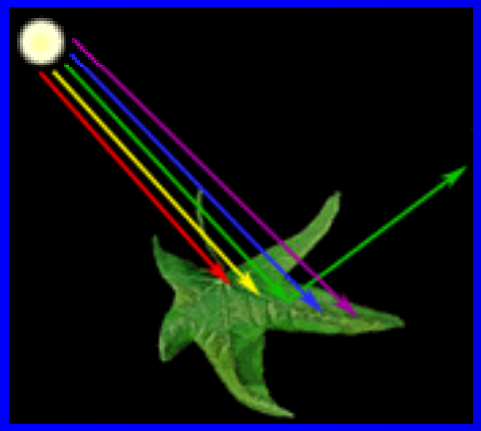
Vegetation Indices

- Dimensionless, radiometric measures that function as indicators of relative abundance and activity of green vegetation

- Rely heavily on the vegetation's ability to reflect highly in the near-infrared (NIR) region of the electromagnetic spectrum

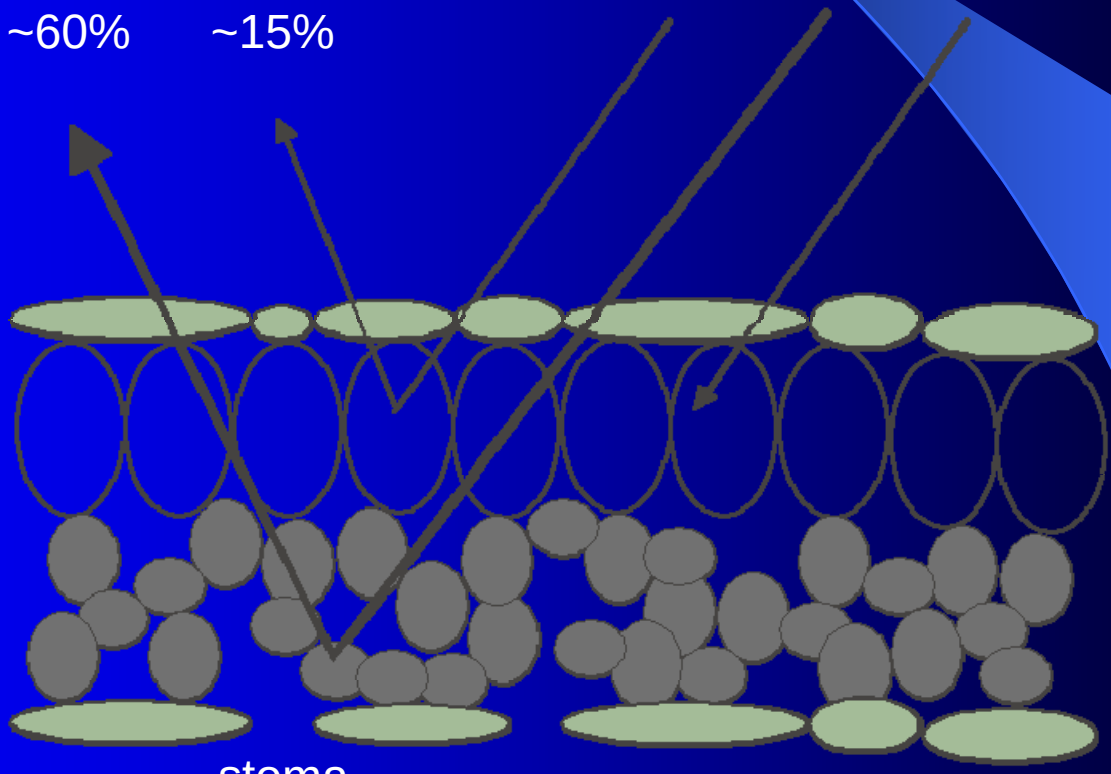
Leaf Cross-section:

absorbs red and blue, reflects some green, reflects mostly near-IR



Green **Near-IR** Blue/Red

~60% ~15%



Upper epidermis

Chloroplasts

Spongy Mesophyll

Lower epidermis

stoma

http://geology.isu.edu/~chadjohn

Soil-Adjusted Vegetation Index (SAVI)

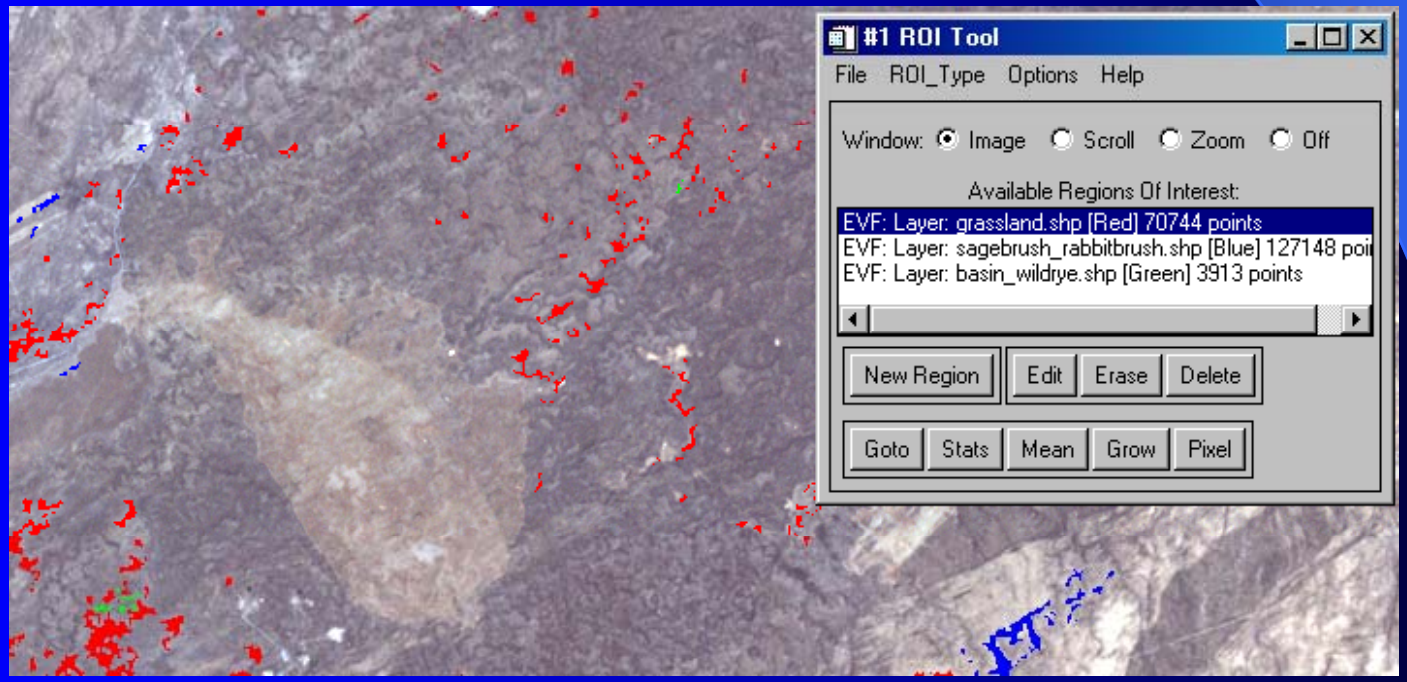
- Introduces a soil calibration factor to minimize soil background influences

$$SAVI = \frac{(1 + L)\,(NIR - red)}{NIR + red + L}$$

- Results range from +1 to –1
- Correlates with number of leaf layers per ground area (LAI)

Methods

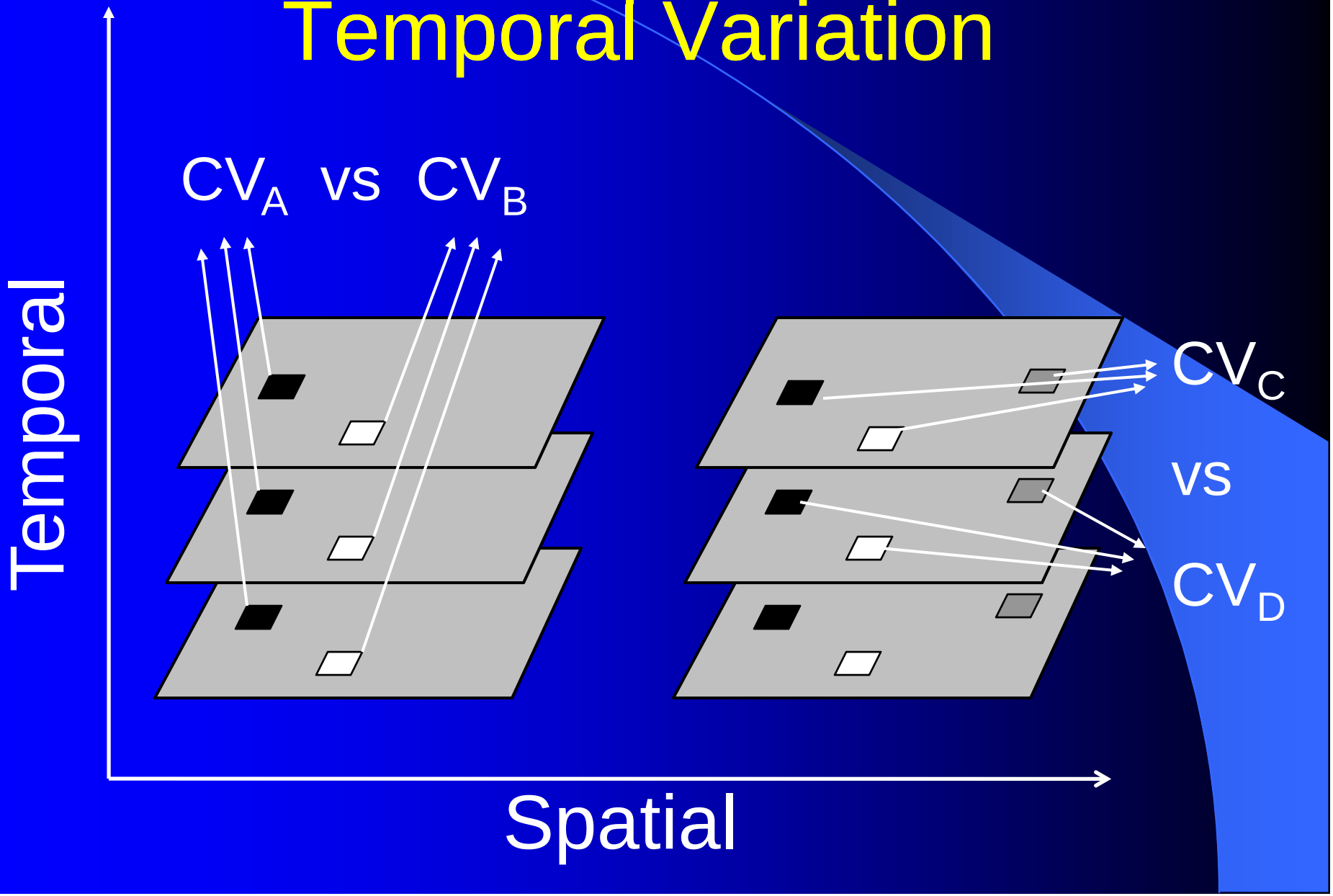
- Used ENVI 3.6 software
- Created regions of interest (ROIs) for vegetation and disturbance types from GIS shapefiles and exported SAVI values to ASCII text



Examining Variation in SAVI

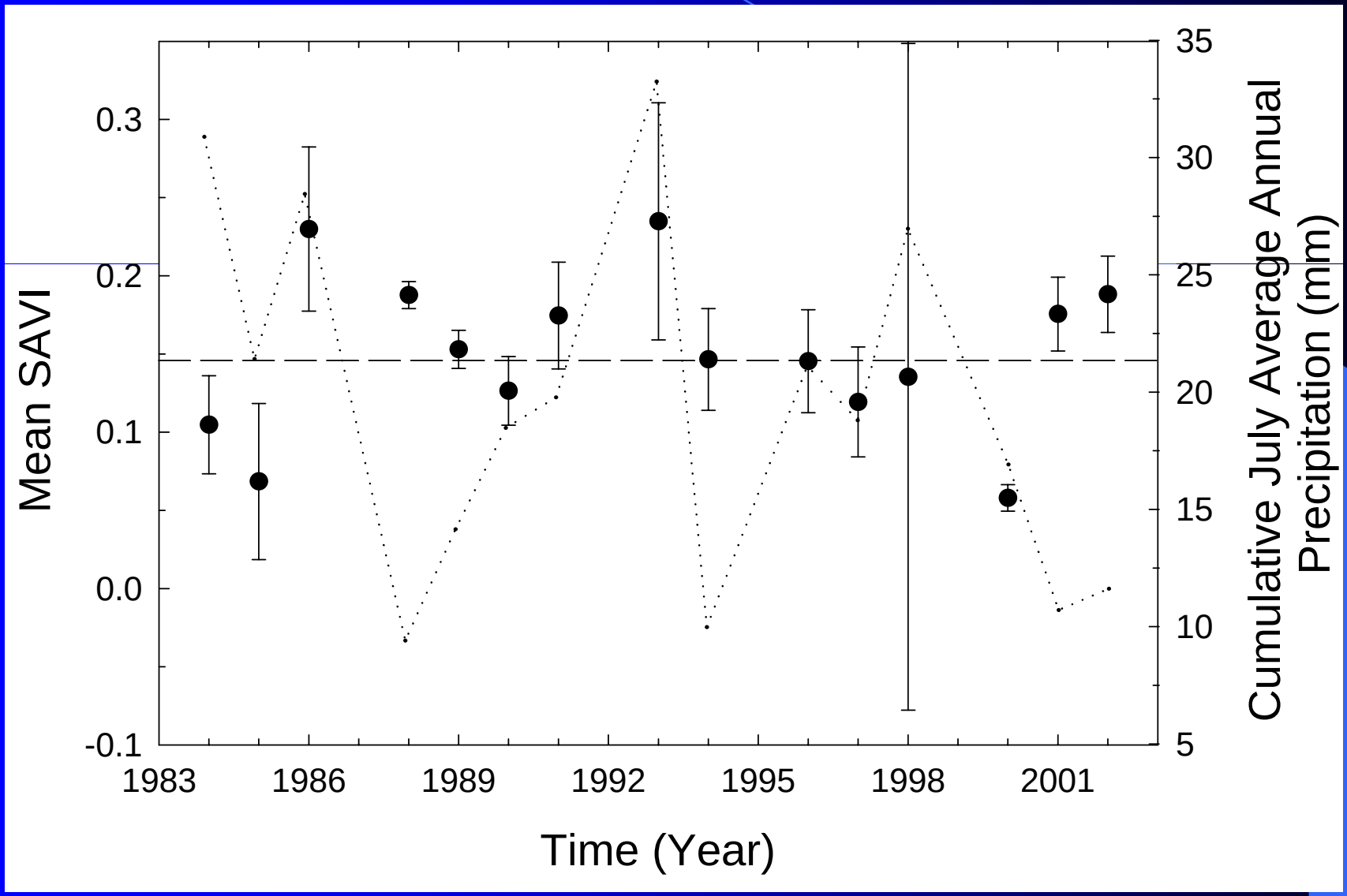
TEMPORAL	SPATIAL
- Inter-annual variation (climate)	- Community type (eg. Sage,grassland)
- Intra-annual variation (weather, phenology)	- Disturbance type (fire, grazing)

Interactions of Spatial and Temporal Variation

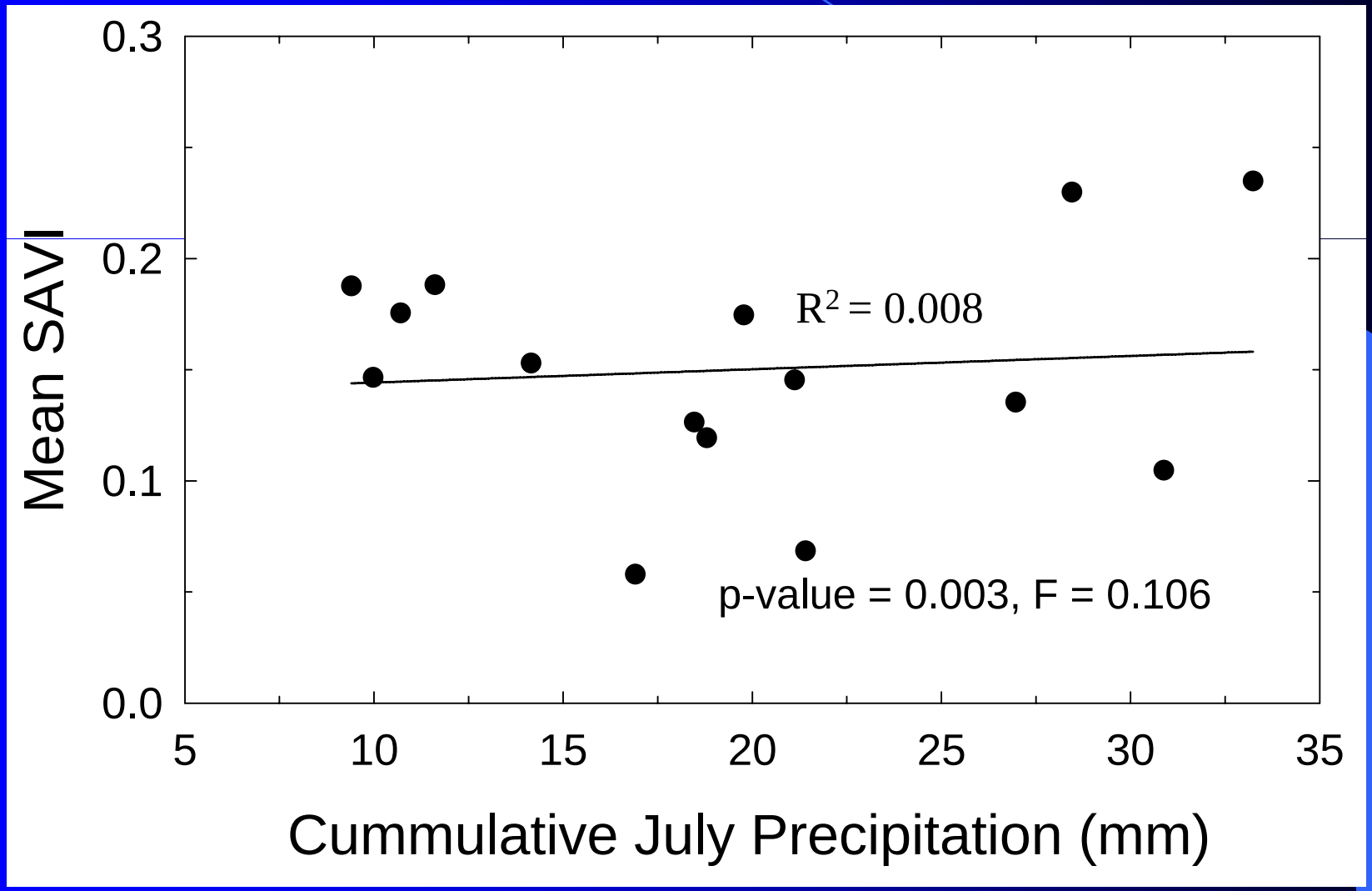


Inter-annual Variation

for entire INEEL (1984 – 2002)

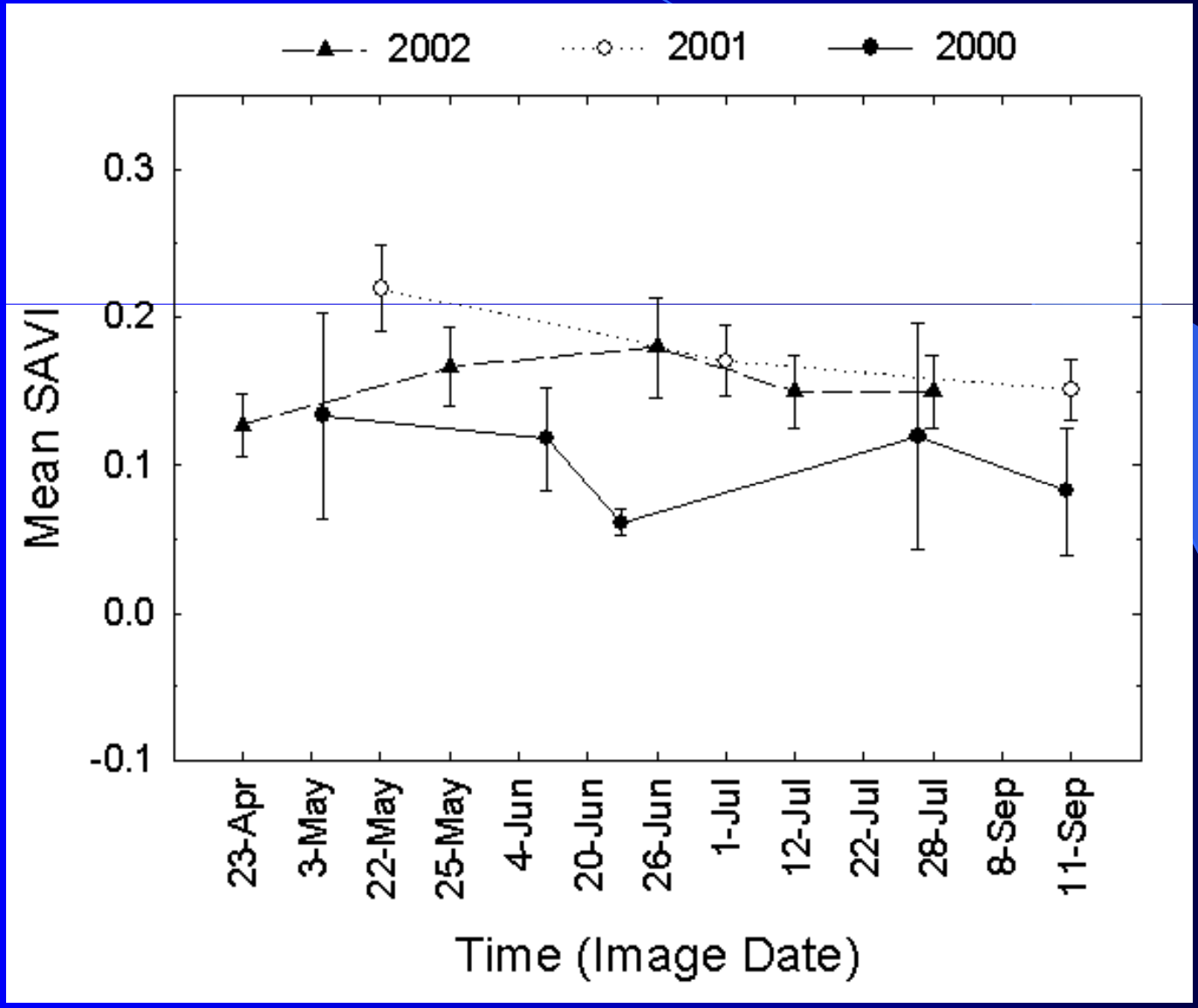


Inter-annual Variation and Precipitation

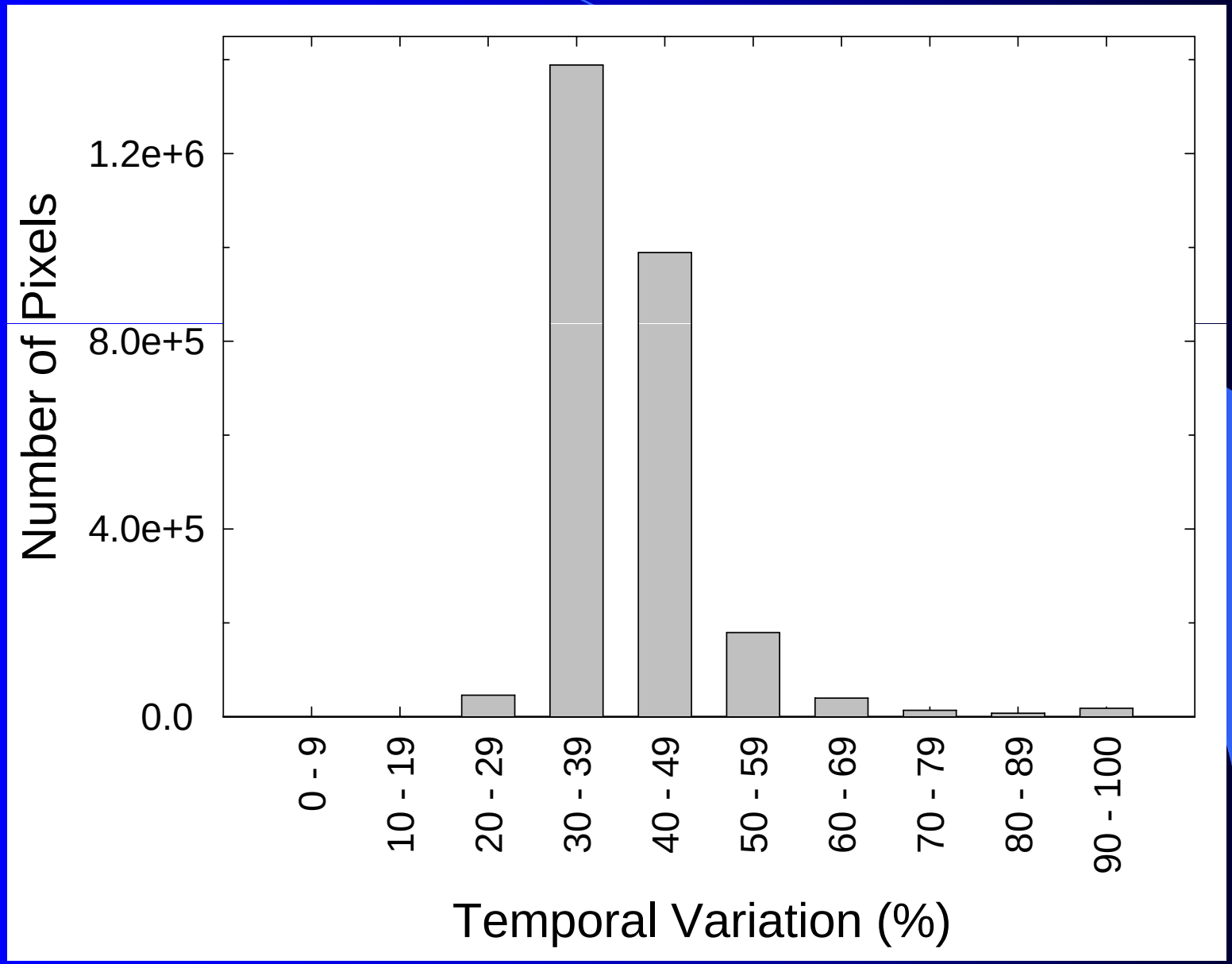


Intra-annual Variation

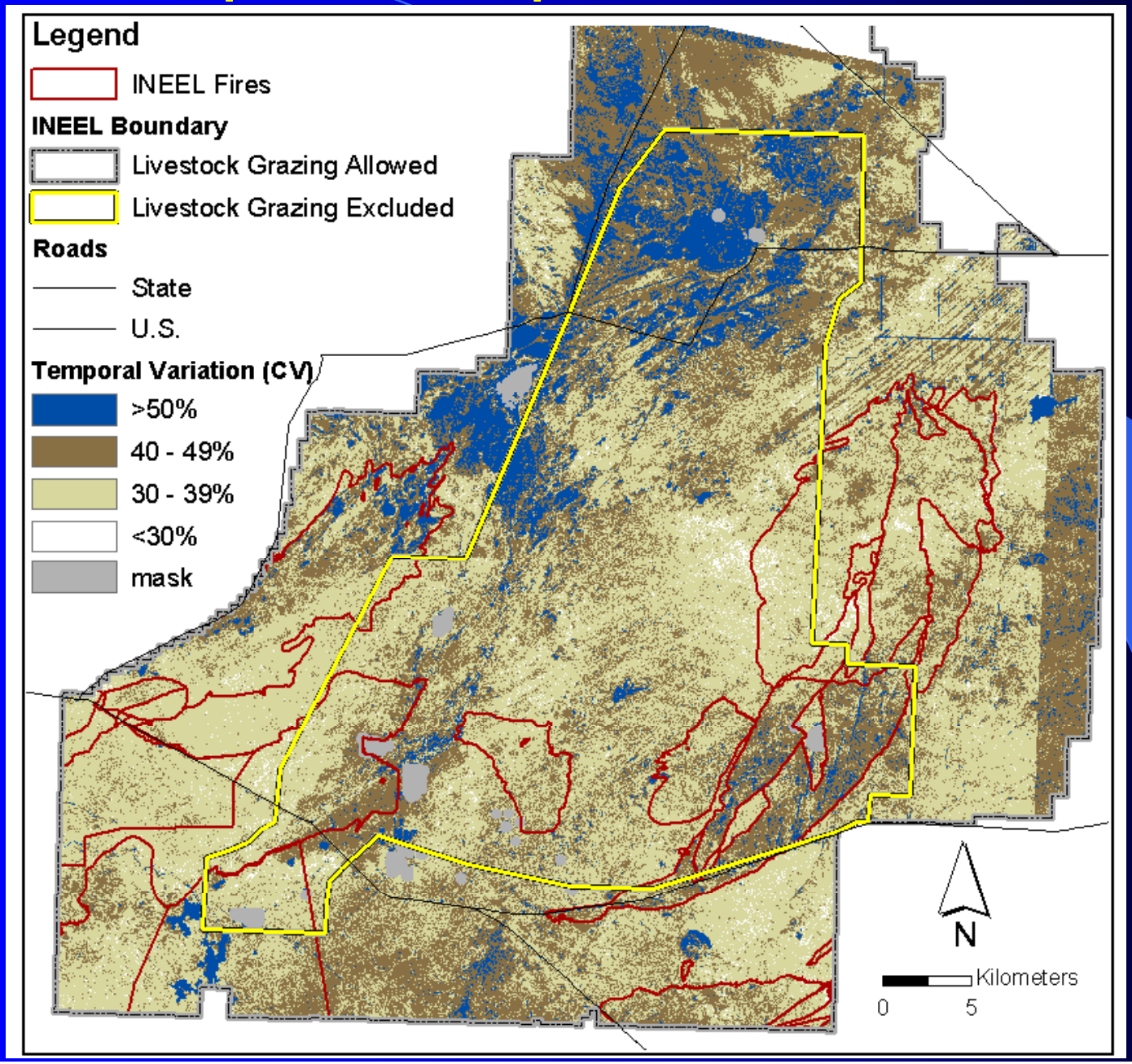
for entire INEEL (2000 – 2002)



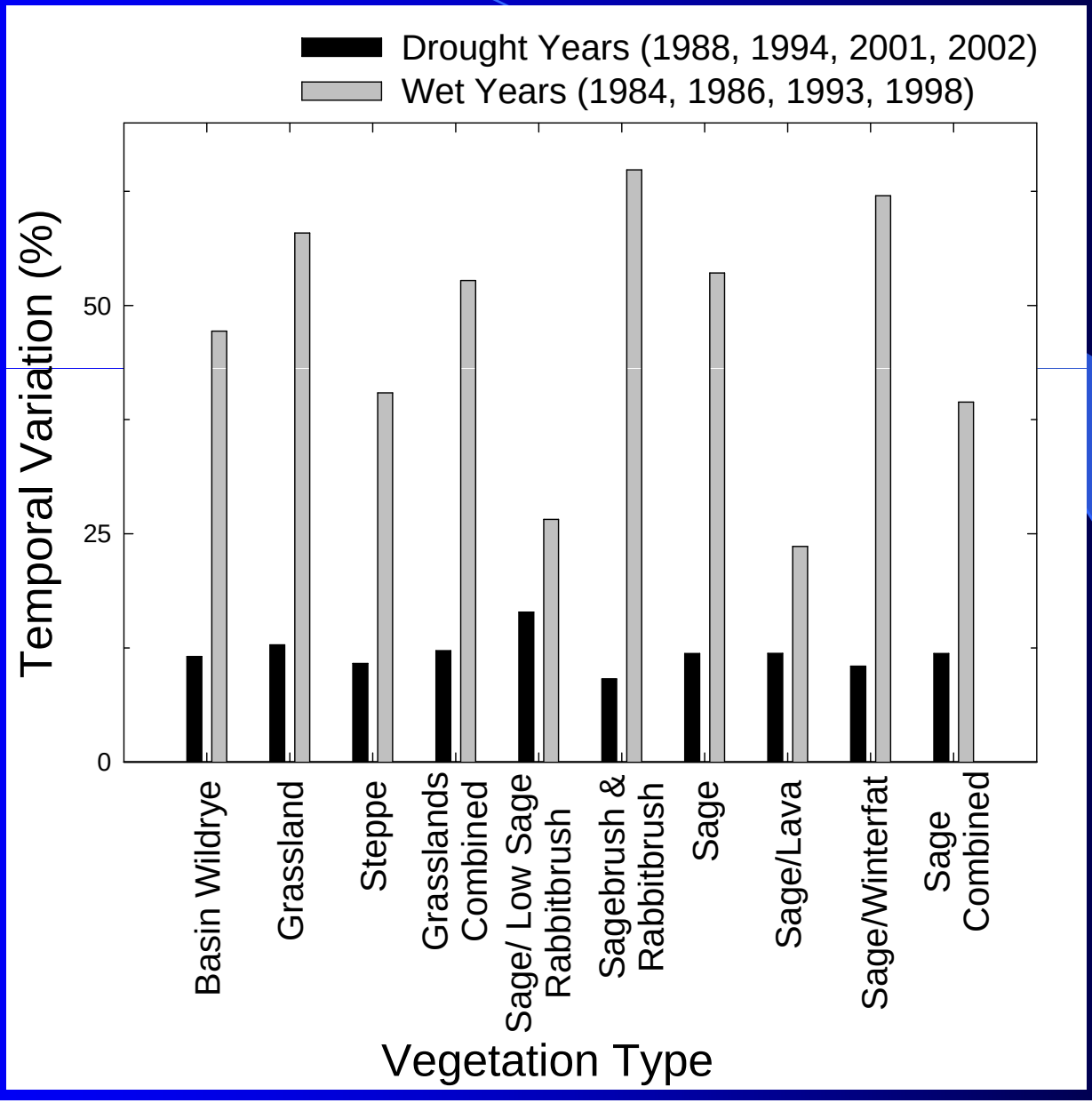
Histogram of Temporal Variation



Map of Temporal Variation

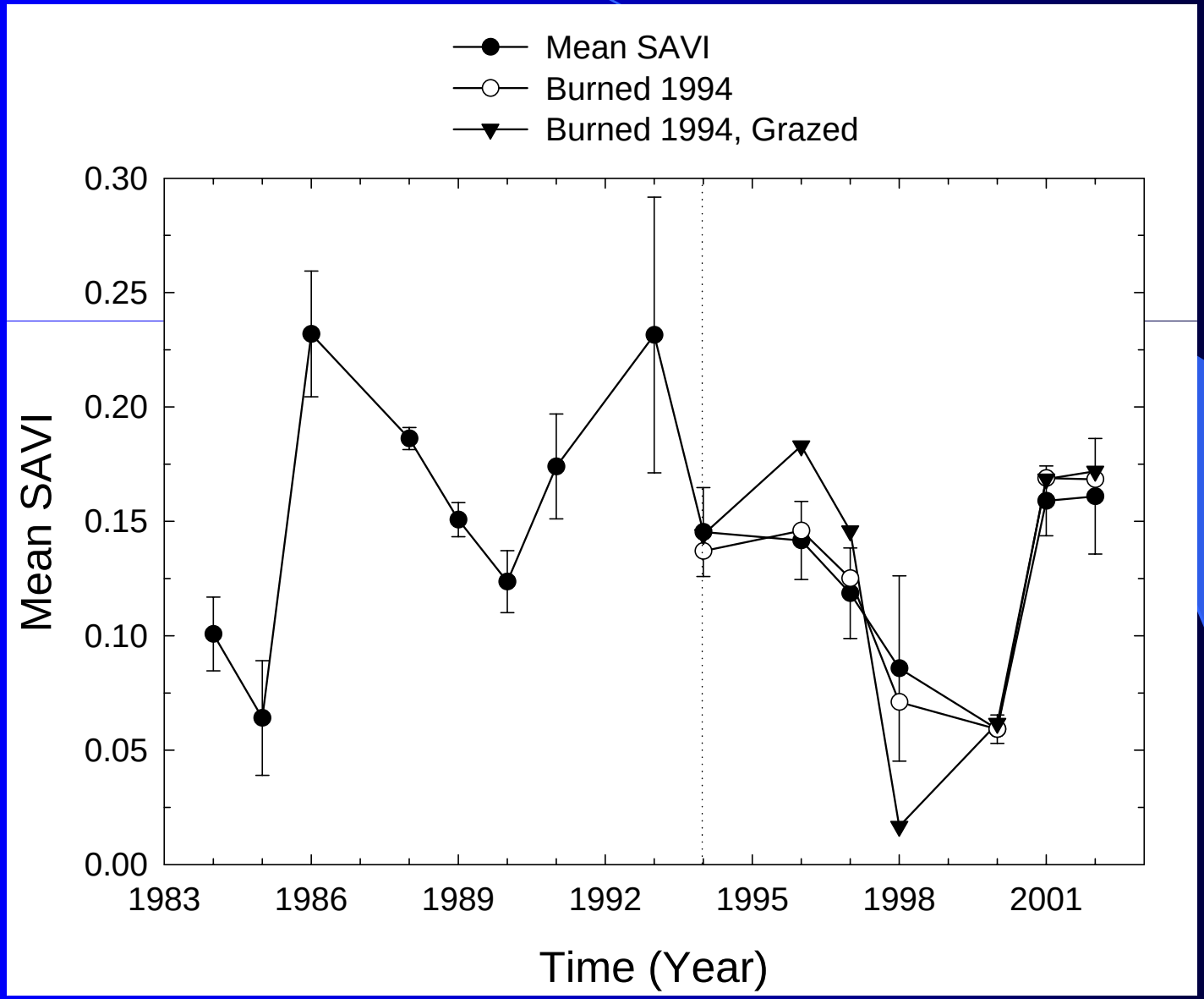


Spatial Determinants of Temporal Variation:
effect of community type



Sagebrush-Steppe

comparison of burned and burned/grazed



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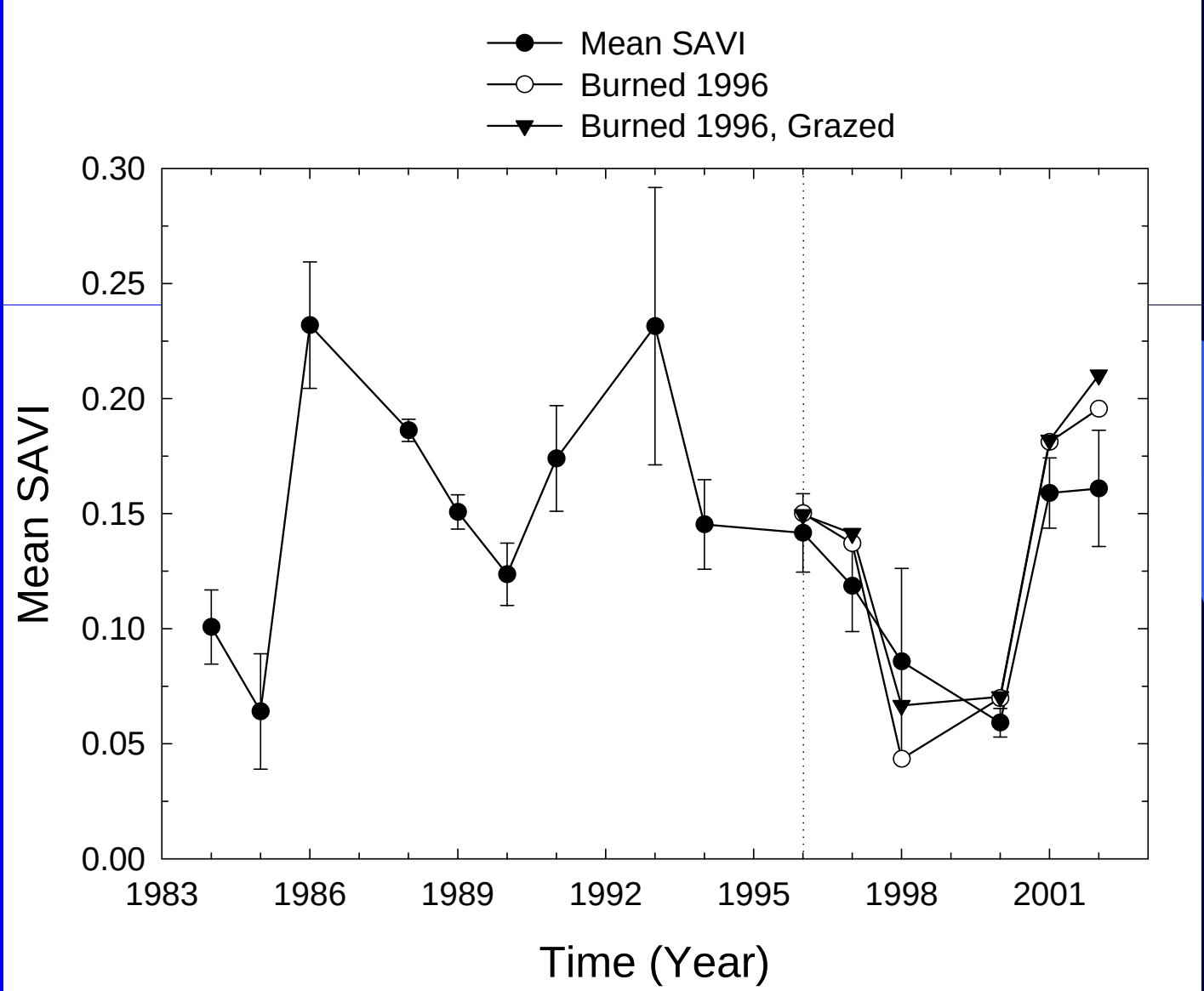

Conclusions

- Range of inter-annual variation higher than intra-annual variation in SAVI for entire INEEL
- Variation among vegetation types four times higher in wet compared to dry years, but no consistent variation between functional groups
- No consistent differences in temporal variation among lands with grazing and/or fire effects

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Questions?