

Spatio-temporal Data Models of Biogeophysical Fields for Ecological Forecasting

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Motivation:

**Image time series from remote sensing datastreams
enable monitoring of land surface condition...**

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but we need to be able to define what we *expect to see*,
so that we can recognize and analyze changes.

Monitoring land surface condition

- **Defining expectations**
- **Identifying change**
- **Quantifying change**
- **Assessing change**
- **Attributing change**

One Approach to Spatio-temporal Analysis of Geospatial Fields:

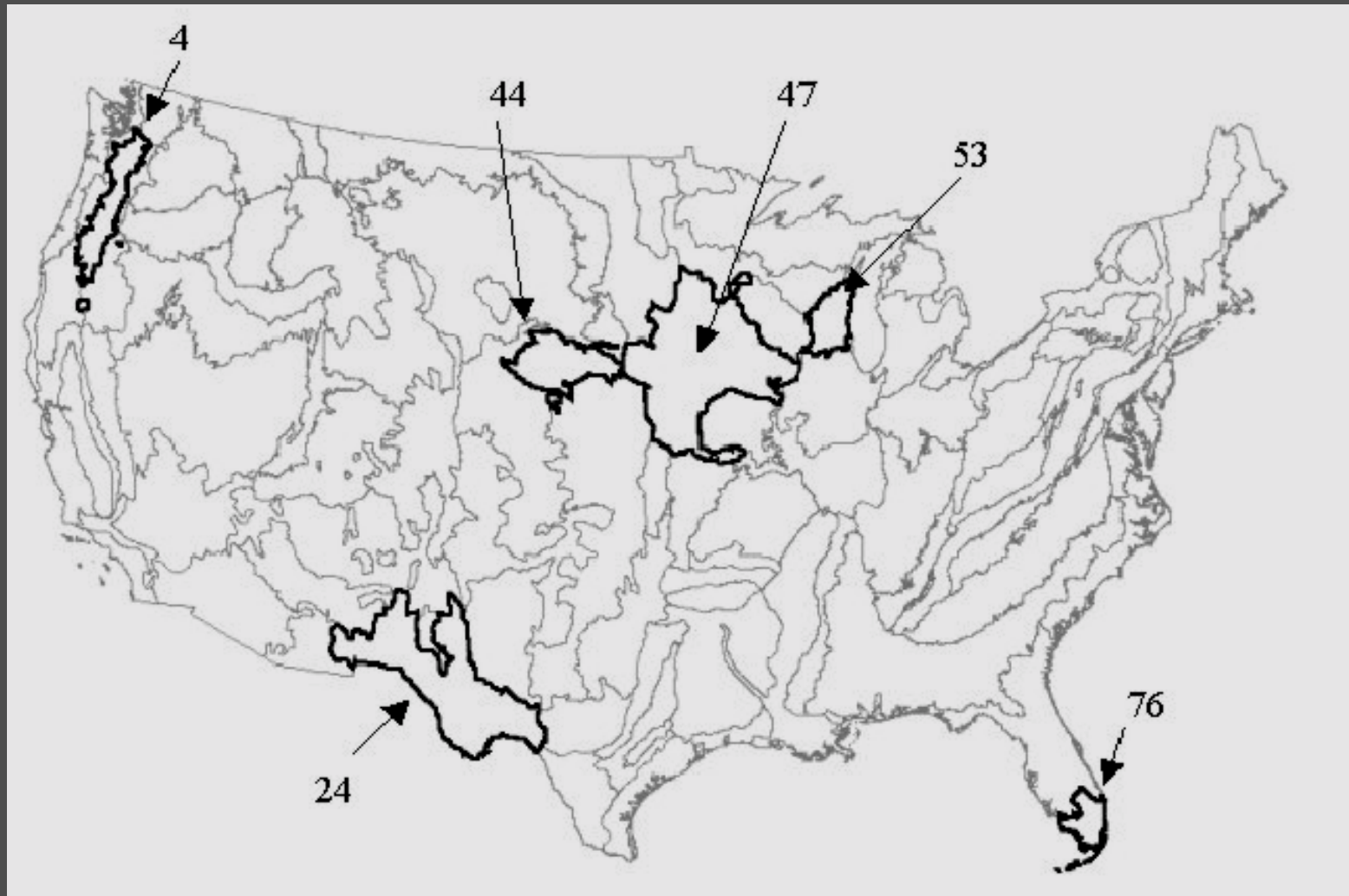
Map image time series into *pattern metric spaces*
to characterize spatio-temporal dynamics,
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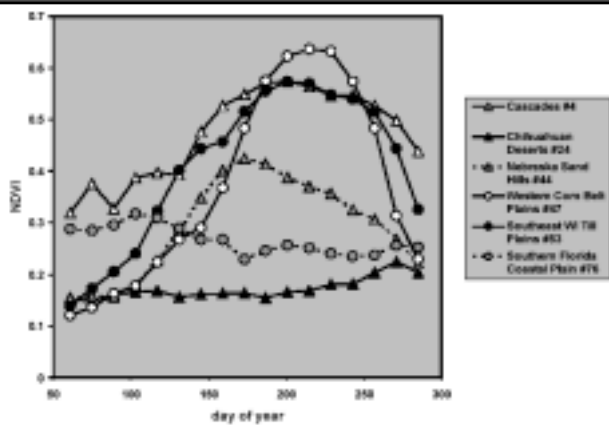
***Objective:* demonstrate derivation of dynamical baselines
(expectations) and detection of the unusual (anomalies)**

Comparative Spatio-temporal Dynamics across six of Omernik's Level III Ecoregions

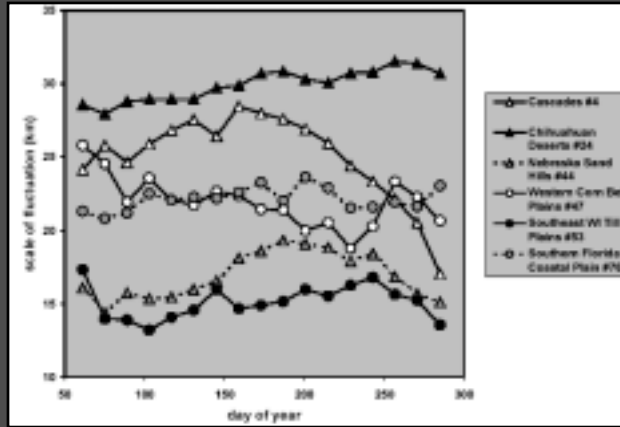


Examples of Expected Ecoregional Trajectories

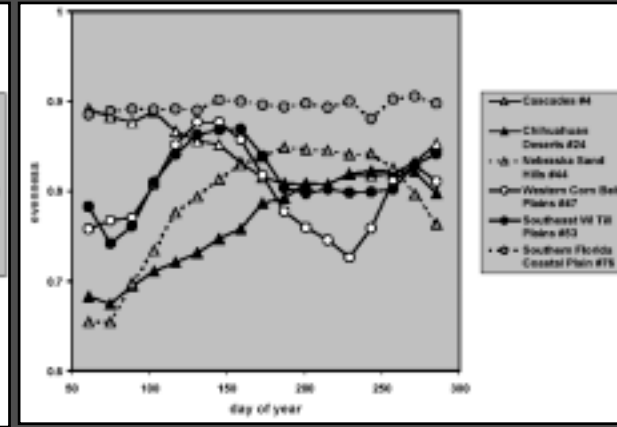
NDVI



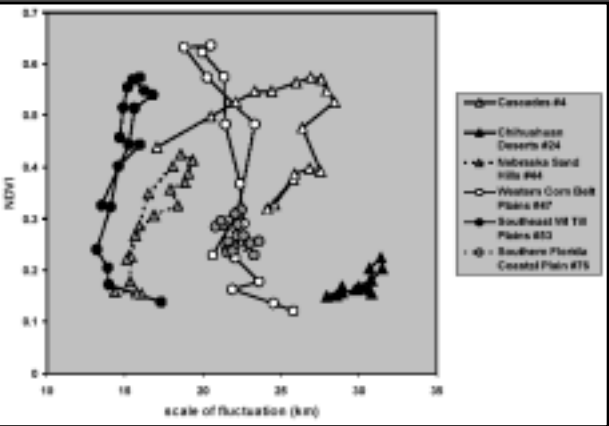
SOF



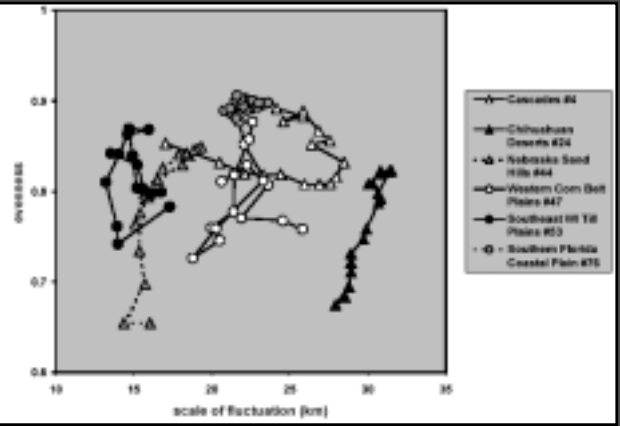
Evenness



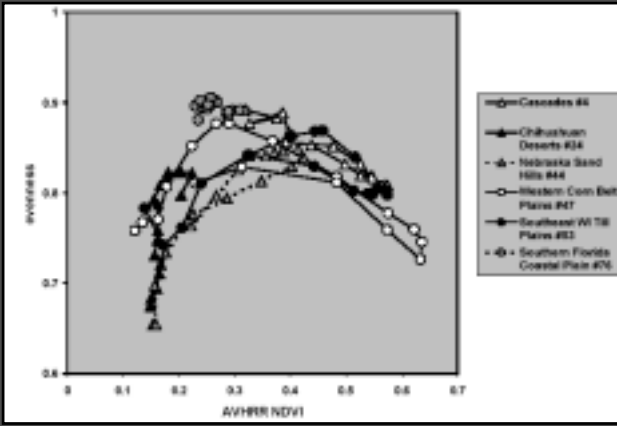
NDVI x SOF



Evenness x SOF



Evenness x NDVI



So there appears to be “ecoregional signatures” ...
but this needs additional study.

Are there deeper structures that may be mined
and used in forecasting?

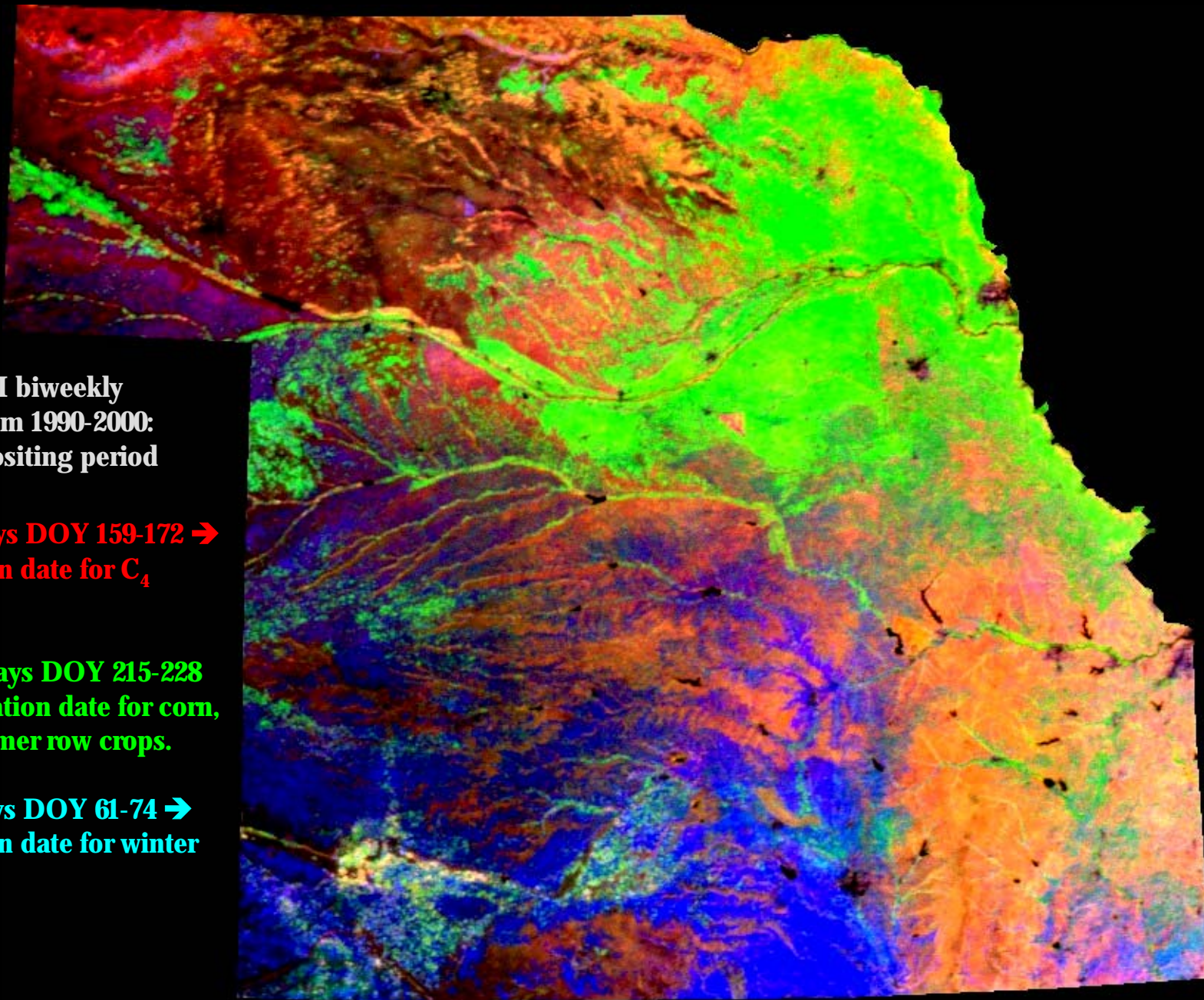
Collecting photons: the power of recurrent observation

AVHRR NDVI biweekly
composites from 1990-2000:
PCA by compositing period

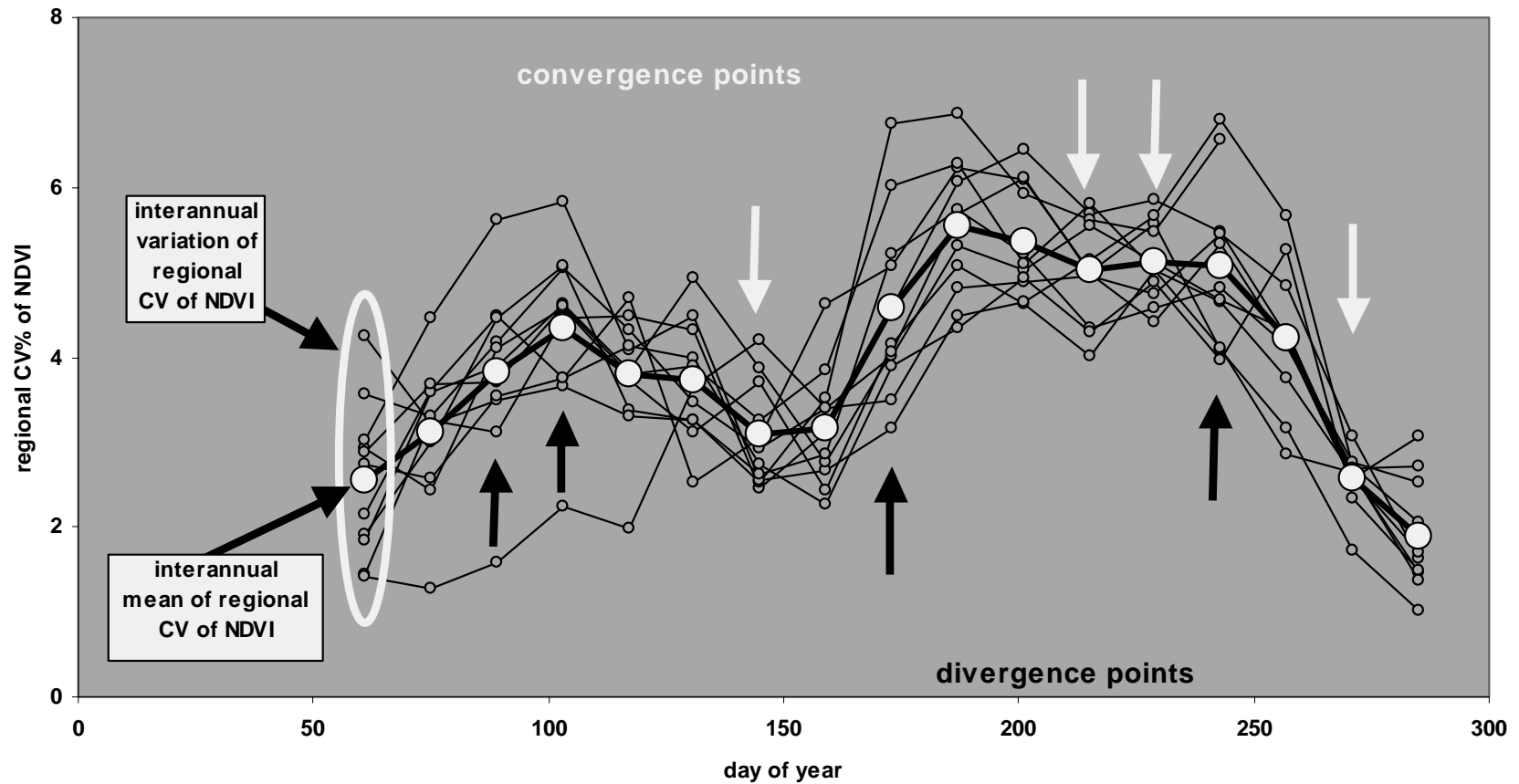
❖ Red displays DOY 159-172 →
peak separation date for C_4
grasses.

❖ Green displays DOY 215-228
→ peak separation date for corn,
soybeans summer row crops.

❖ Blue displays DOY 61-74 →
peak separation date for winter
wheat.



Interannual variation in spatio-temporal pattern: Identifying for dynamical watchpoints for forecasting



**Cross-disciplinary Workshop held 8-10 April 2002
at the San Diego Supercomputer Center**

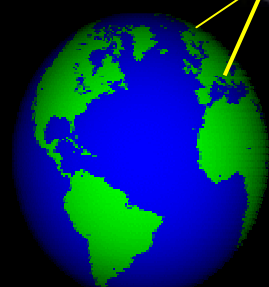
- **Experts in spatio-temporal databases**
- **Experts in spatial & spatio-temporal data mining**
- **Domain experts from ecology, physical geography, remote sensing**

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Five Reasons for the Perceived Gap between Disciplines

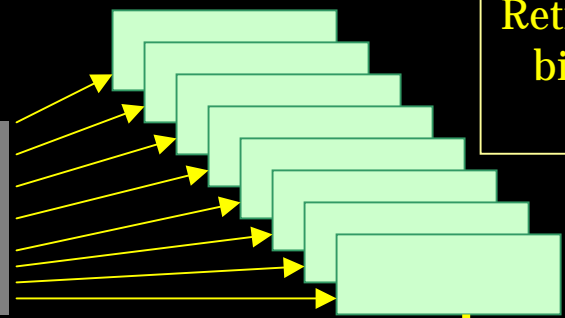
- ***Questions vs. Queries:*** the principal mode of inquiry for domain scientists is analysis and questions often do not (or cannot) have unequivocal answers; in contrast, database scientists seek generalized formulations in order to deliver an unequivocal solution to a query.
- ***Fog of Uncertainty:*** multiple issues on the definition, characterization, and propagation of uncertainty in data and data relationships:
 - * Measurement error (precision & accuracy) * Vagueness/variability of objects
 - * Thematic fuzziness * Missing data * Propagation of uncertainty through models
- ***Multiplicity of Views:*** biogeophysical fields present the opportunity to derive multiple valid views of the data which are context and scale dependent.
- ***Examples of Worthy Targets:*** the lack of exemplary “solved” problems and showcase applications with wide appeal. Need equivalent of Bongard problems to explore characterization of and querying to spatio-temporal pattern.
- ***Institutional Support:*** the general lack of support at universities and sponsoring agencies for regular cross-disciplinary interactions, sustained research collaborations, and technological training for domain scientists, both students and faculty.

Observations



Ground segment
Acquisition, processing,
storage, & archiving

Retrieval of
biogeophysical
variables



Change attribution
Change assessment

**Information for
Ecological
Forecasting**

**Ecological
Questions &
Hypotheses**

Change detection
Change quantification

**Definitions of nominal
trajectories and
estimates of uncertainty**

**Assimilation of current
observational datastreams**

**Spatio-Spectral-
Temporal
analyses**

