Spatio-temporal Data Models of Biogeophysical Fields for Ecological Forecasting

Geoff Henebry, UNL
Tony Fountain, SDSC
Jan Chomicki, SUNY Buffalo
Jon Ranson, NASA-GSFC

dg.o 2002
20 May, Los Angeles, CA

www.calmit.unl.edu/BDEI

Motivation:

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

Motivation:

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

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,

including baselines and unusual behavior.

One Approach to Spatio-temporal Analysis of Geospatial Fields:

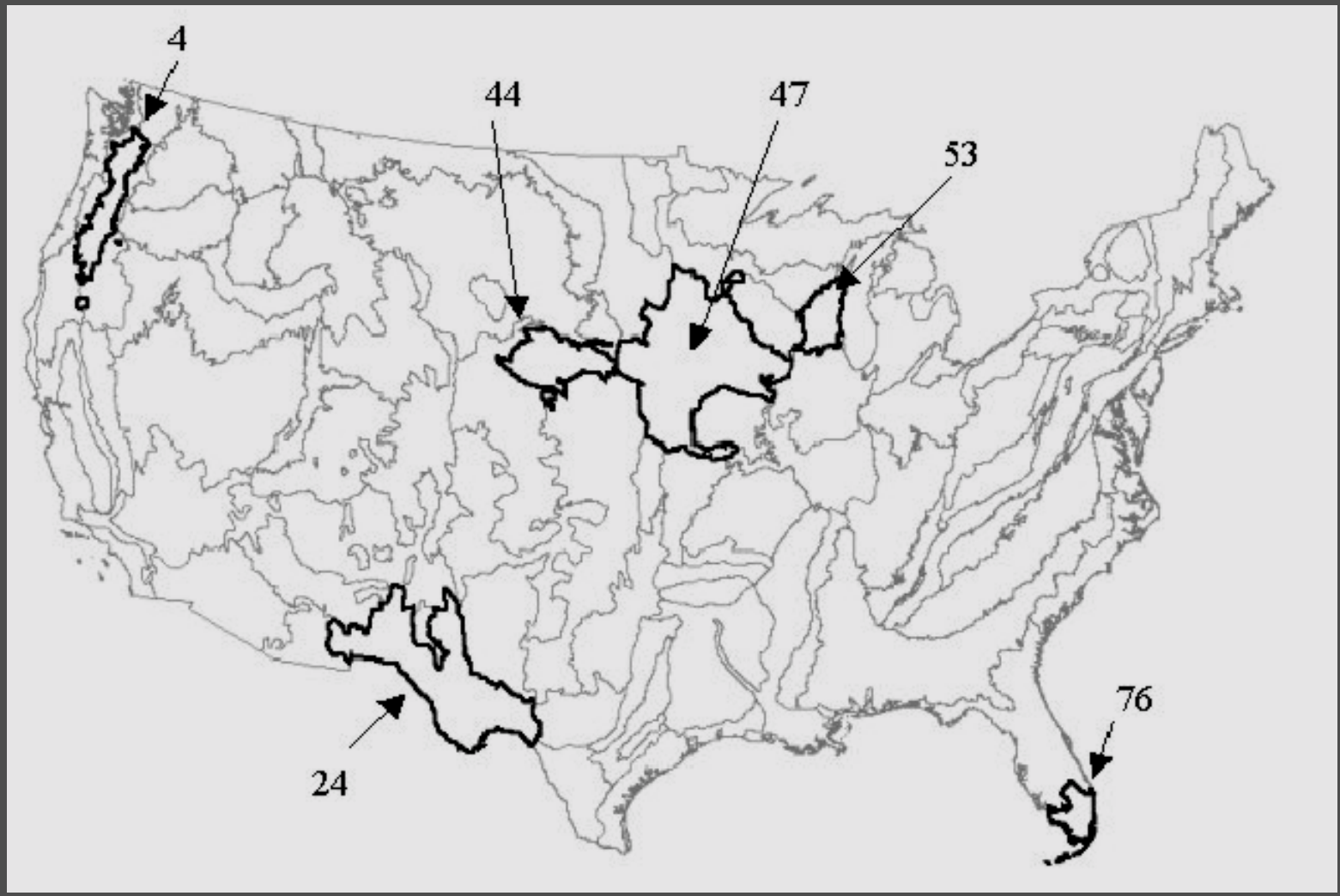
Map image time series into *pattern metric spaces*

to characterize spatio-temporal dynamics,

including baselines and unusual behavior.

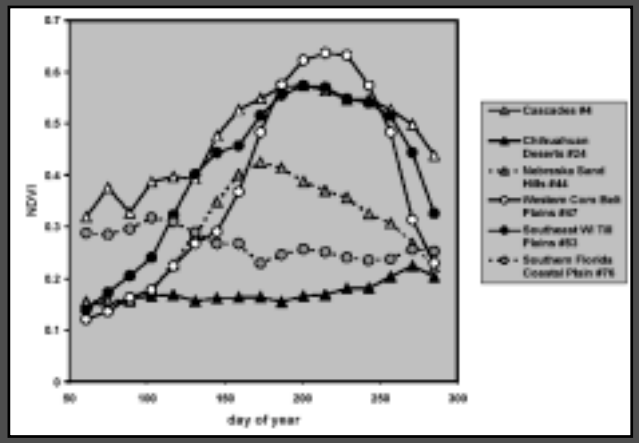
Objective: **demonstrate derivation of dynamical baselines (expectations) and detection of the unusual (anomalies)**

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

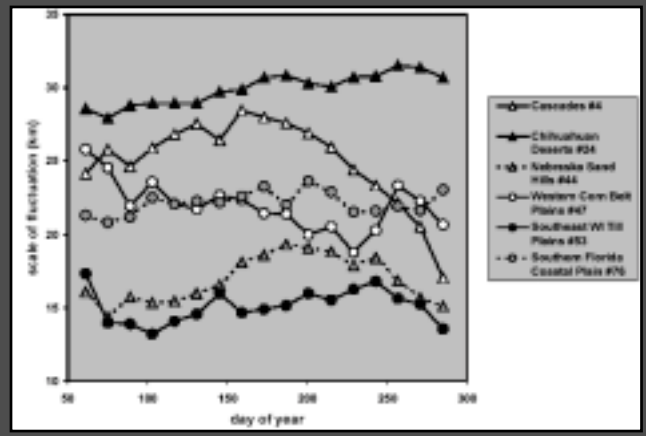


Examples of Expected Ecoregional Trajectories

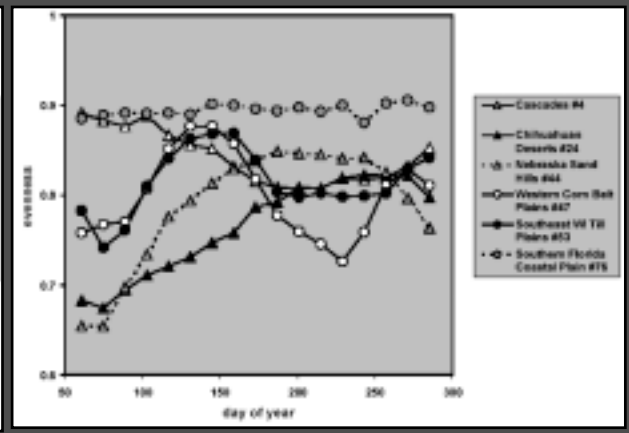
NDVI



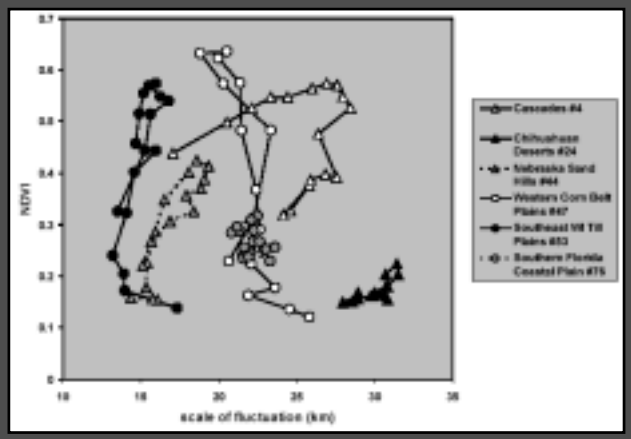
SOF



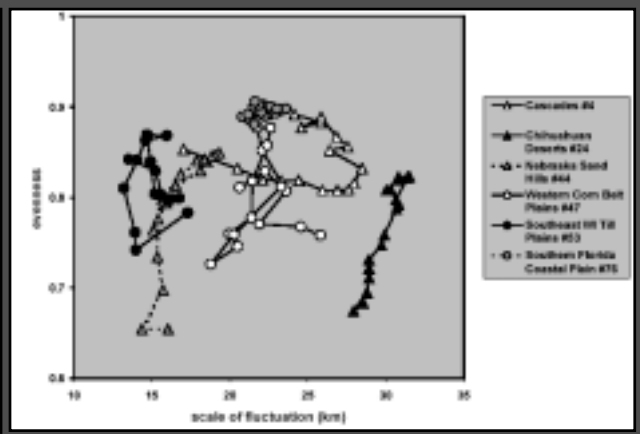
Evenness



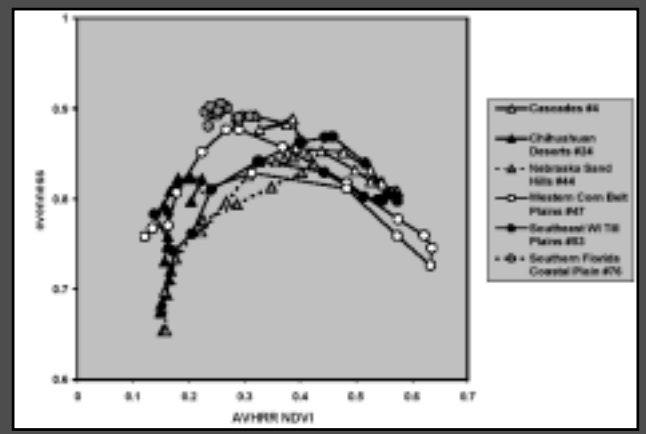
NDVI x SOF



Evenness x SOF



Evenness x NDVI



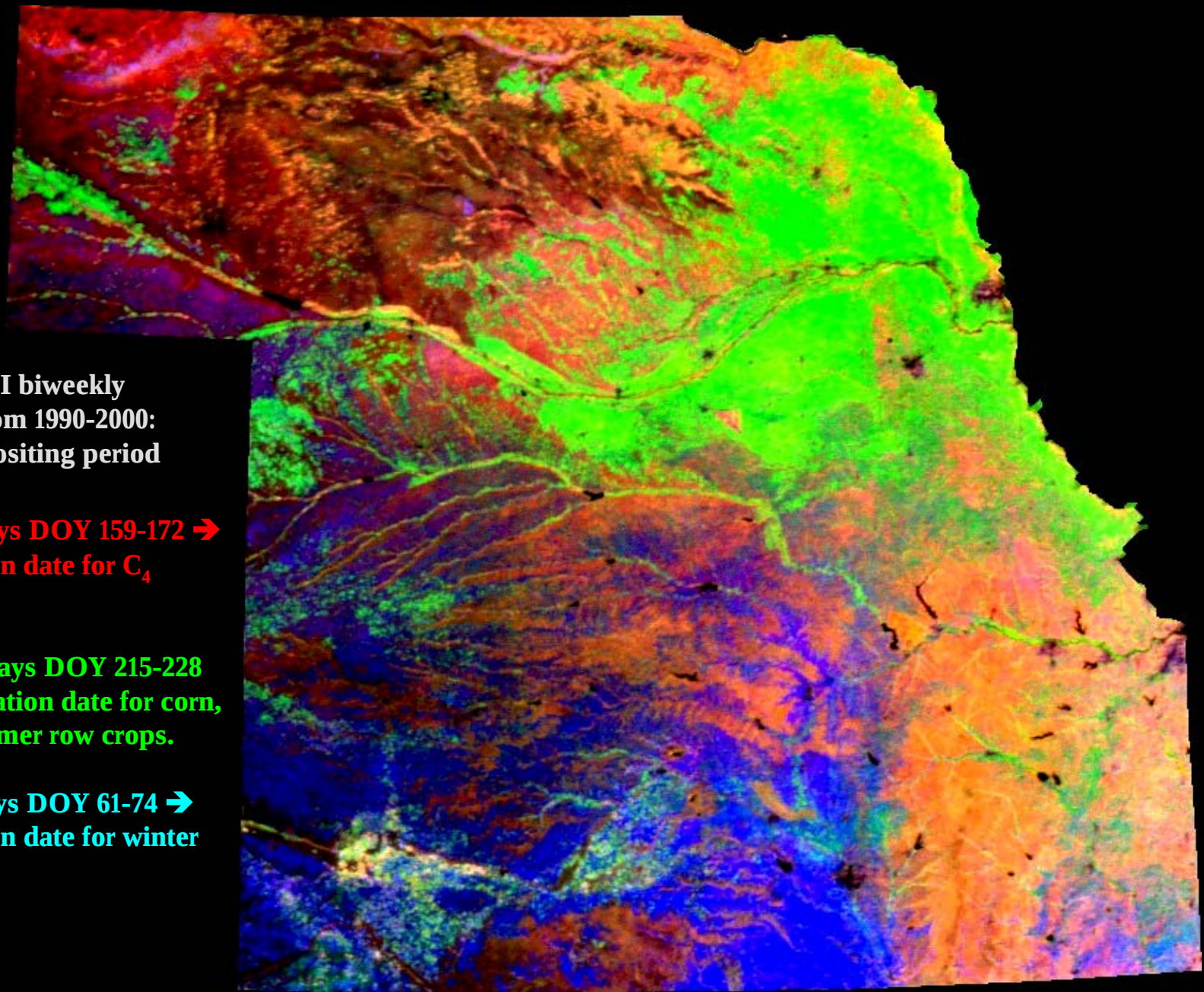
So there appears to be “ecoregional signatures” …

but this needs additional study.

Are there deeper structures that may be mined

and used in forecasting?

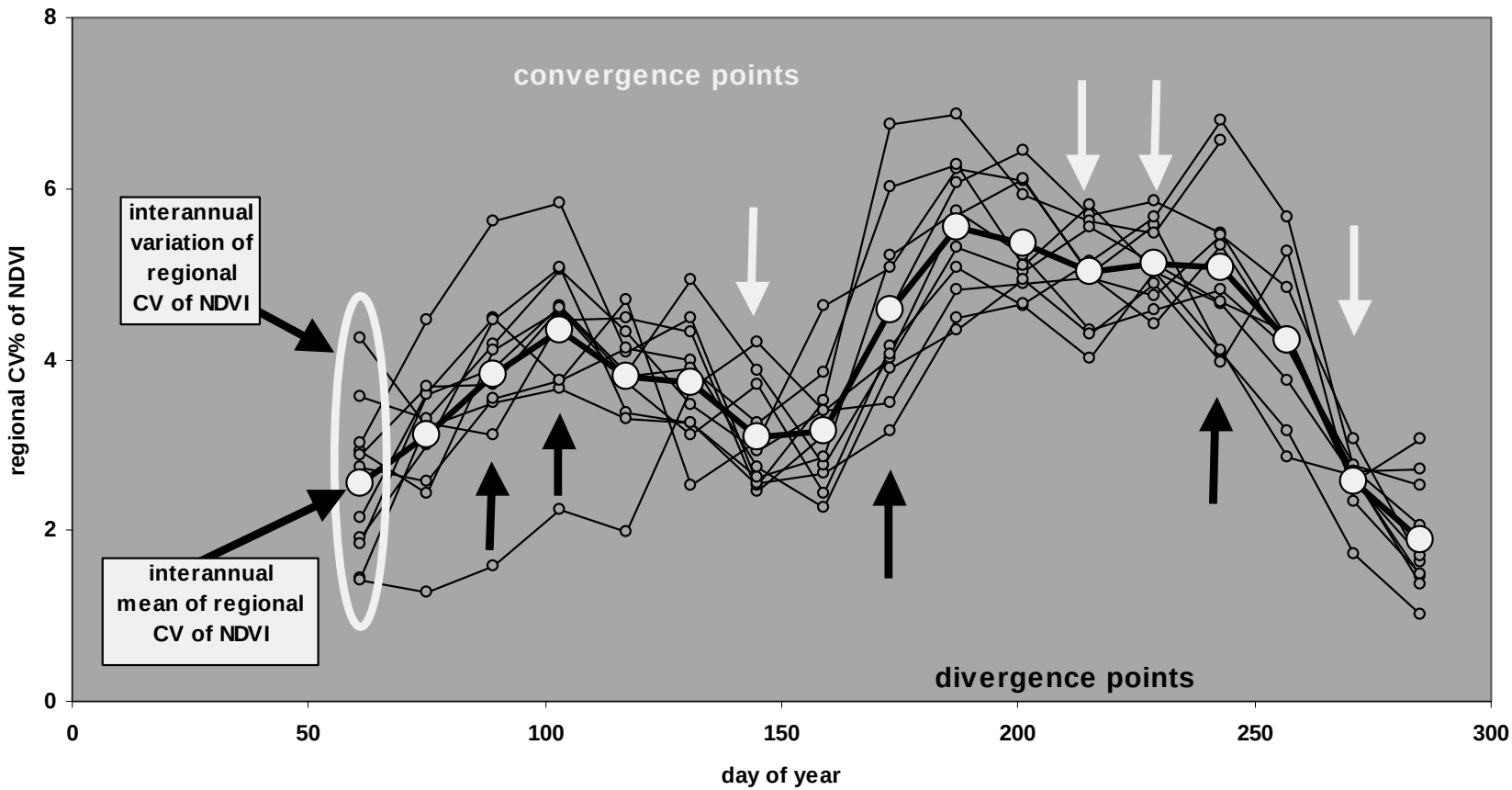
Collecting photons: the power of recurrent observation



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

www.calmit.unl.edu/BDEI/

CALMIT
University of Nebraska - Lincoln
Center for Advanced Land Management Information Technologies

Five Reasons for the Perceived Gap between Disciplines

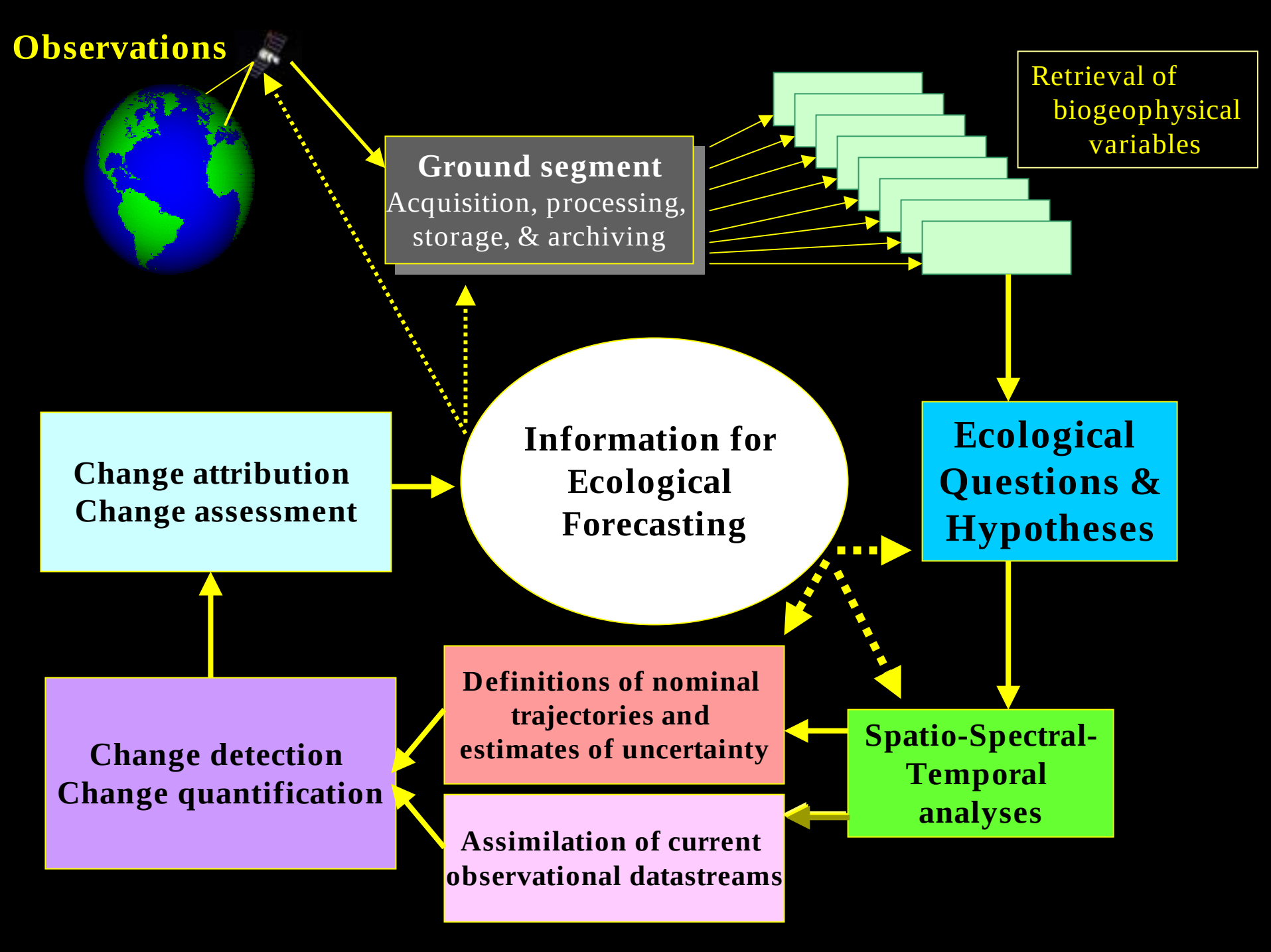
- ***Questions vs. Queries***: the principal mode of inquiry for domain scientists is analysis and questions often do not (or cannot) have unequivocal answers; in contrast, database scientists seek generalized formulations in order to deliver an unequivocal solution to a query.

- ***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
Information for Ecological Forecasting
Ecological Questions & Hypotheses
Change attribution
Change assessment
Change detection
Change quantification
Definitions of nominal trajectories and estimates of uncertainty
Assimilation of current observational datastreams
Spatio-Spectral-Temporal analyses