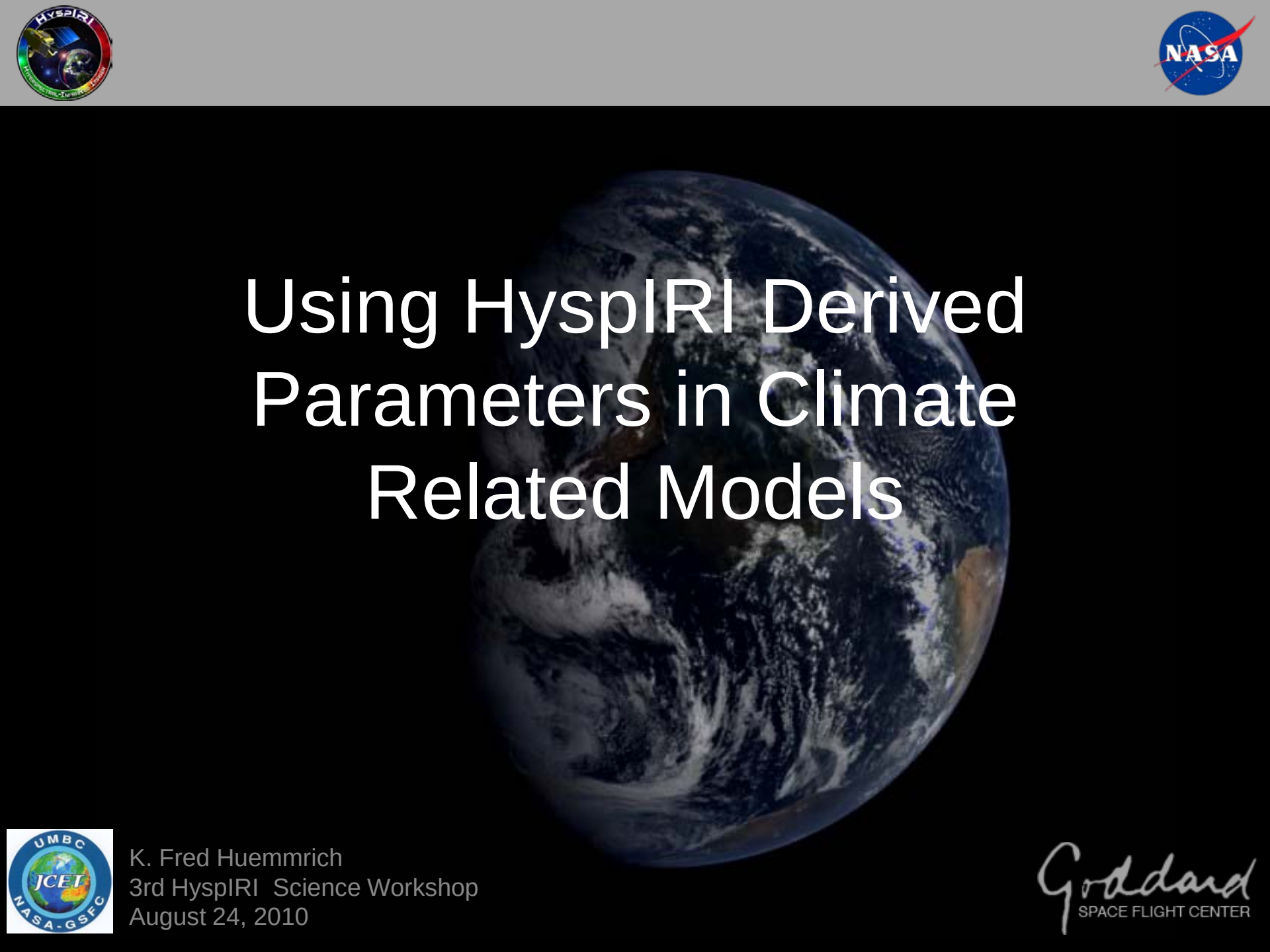
Using HyspIRI Derived Parameters in Climate Related Models



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Climate – Ecosystem Feedbacks

- May be very large
- Represent a significant unknown
  - both in strength and even sign
- Need to understand
  - Ecosystem responses to climate change
  - Climate forcing from ecosystem change

Land-Atmosphere Interactions

- Include feedbacks between surface radiation, the vegetation-soil system, and the atmosphere
- These interactions produce complex exchanges of energy and water that influence climate
- There are wide disparities among current climate models in characterizing land-atmosphere interactions
- Further understanding and improving representation of the processes governing land-atmosphere interactions are important for climate predictions and projections

Climate – Ecosystem Feedbacks

Climate Change

- Temperature
- Precipitation
- Humidity
- Wind

Ecosystem Response

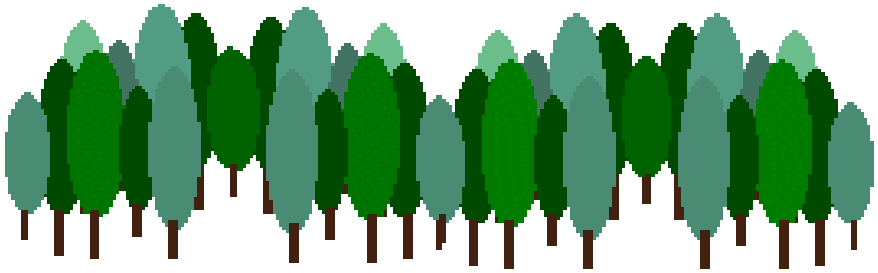
- Reproduction, Recruitment, Mortality
- Species Interactions
- Species Distribution & Composition
- Photosynthesis, Respiration, Biomass

Biophysical & Biogeochemical Changes

- Carbon Storage
- Canopy Roughness & Phenology
- Surface Albedo
- Evapotranspiration
- Trace Gas Fluxes

Change in Climate Forcing

- Concentrations of Greenhouse Gases & Aerosols
- Energy Balance (e.g. latent and sensible heat fluxes, albedo)



Adapted from Kuppers et al., 2007

Ecosystem Responses

- Productivity
  - CO_2 Fertilization effects
- Leaf area
- Phenology
- Canopy roughness
- Rooting depth
- Respiration
- Soil water holding capacity
- Changes in disturbance regimes
  - e.g. fire frequency, insect outbreaks
- Nutrient cycling
- Species composition

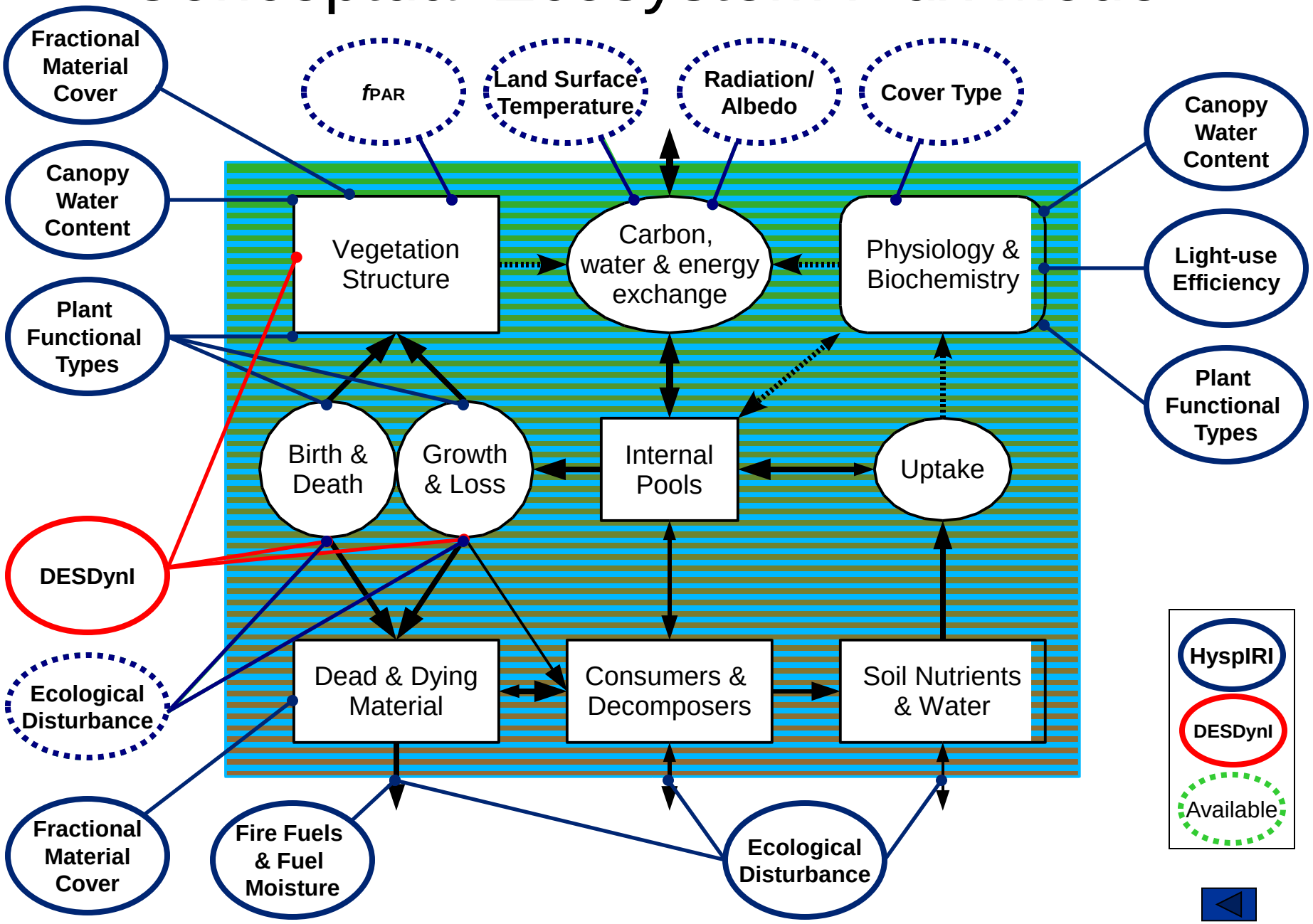
Climate – Ecosystem Feedbacks

- Feedbacks act through
  - Biophysical pathways that alter energy and water exchange
    - Alters albedo, evapotranspiration rates, vegetation structure, and phenology
    - Directly altering temperature, humidity, precip, convection, and wind
  - Biogeochemical pathways that alter carbon and nutrient cycles affecting uptake and release of greenhouse gasses and aerosols
    - CO_2
    - CH_4
    - N_2O
    - Black carbon
    - Aerosols
    - Volatile Organic Compounds

Climate – Ecosystem Feedbacks

- Some unknowns
  - Geographic shifts in species and plant functional types (PFT)
    - May create non-analog communities,
    - with potentially unique functional consequences
  - CO_2 fertilization
    - Effects water and energy balance
    - Constrained by N and P
  - non-CO_2 greenhouse gas release
    - CH_4
    - N_2O

Conceptual Ecosystem Flux Model



Modeling Approaches

- Diagnostic models
  - Describes fluxes, e.g. Light Use Efficiency models
  - Inputs from HyspIRI include
    - PRI
    - Chlorophyll concentrations
    - Canopy water content
    - *f*PAR
    - Albedo
    - Radiometric surface temperature

Diagnostic Models

- Diagnostic models and HyspIRI
  - HyspIRI will provide an unprecedented seasonally varying global description of vegetation type and status
    - Large-scale data use in synthesis studies
  - Output at spatial scale appropriate for land management
    - Model output will be important for applications such as carbon monitoring
  - VSWIR will not provide a dense time series
    - Merge with temporally frequent broadband data to improve temporal resolution

Diagnostic Models

- Mission too short to directly observe climate change effects
  - Provides validation data sets for prognostic models
  - Use to develop and test algorithms that can feed into prognostic models
    - e.g. examining effect of foliage N content on photosynthetic stress responses in different plant functional types

Modeling Approaches

- Prognostic models
  - Can be utilized to provide predictions and projections
  - Can be extrapolated to describe different conditions
- HyspIRI produced input data fields
  - New types of data for inputs, e.g. better descriptions of Plant Functional Types
  - Provide seasonally changing input values
  - Higher spatial resolution and improved classification provide better understanding of mixtures and disturbance

HyspIRI Model Inputs

- Leaf nitrogen
  - photosynthetic rates
- Disturbances
  - Thinning and diffuse disturbances
  - May have important effects on carbon balance
- Species distributions (functional biodiversity)
- Biomass in low stature ecosystems (grasslands, shrublands, etc.)
  - Cover types with the largest areas
  - May be significant biomass changes with increased shrubs

Plant Functional Types

- In models PFT are often defined based on landcover classification
  - HyspIRI will produce improved landcover classifications
  - Improved descriptions of complex mosaic of anthropogenic landscapes
- Different ways of grouping species into PFT for climate studies
  - By response to climate change (functional response group)
  - By role in climate forcing (functional effects group)
  - May need to detect differences in populations in terms of responses

Plant Functional Types

- PFT often used to define values for a number of variables in models
- PFT can be defined by direct measurement of a suite of variables or continuous fields of these variables could be determined from HyspIRI
- Variables such as:
  - Green/nongreen fractions, green leaf area
  - Maximum photosynthetic rate, Photosynthetic efficiency
  - Specific leaf area
  - Foliage Nitrogen, Pigment concentrations
  - Leaf water content
  - Albedo
  - Sensitivity to climate change (e.g., inferring rooting depth from stress responses)
  - Canopy roughness
  - Seasonality

Conclusions/Issues

- Model improvements occur through
  - Improved algorithms
  - Utilization of new types of information
  - Improved accuracy of input data fields
  - More and better data for validation

Conclusions/Issues

- How do we facilitate using HyspIRI data to improve models?
  - Development of ways to organize and manage the huge data volumes from HyspIRI
    - Ability to extract level 2+ data for study sites
    - Standardized gridding of global products
      - Cloud-free composites
    - Tools to make it easy to link HyspIRI data with other data products in synthesis studies