Ecological forecasting

There were 16 participants, including researchers from different fields: modelers, plant physiologists, forest ecologists, data and cloud computing experts (Petya has a list of the names).

1. Plant functional types:

Natural ecosystems – community compositional changes and dynamics in functional groups

Are plant functional types, developed for use from AVHRR and MODIS time series, relevant for HyspIRI? They were developed as a step beyond biomes. Is there value in using these PFTs with HyspIRI and should they be the same PFTs (given higher spatial/spectral resolutions)?

If growth form and leaf longevity don't define "functional similarity" what groupings can be used? Can we use spectral similarity (leaf optical types) as a surrogate for functional similarity? Quickly gets to issues of varieties, vertical distributions, phenological changes). Needs more work.

Perhaps promote Hierarchy of PFT classes? Do away with PFTclasses or retrieve parameters directly (not all CLM parameters are accessible (e.g. rooting depth), which is accessed from LUT).

We discussed need to discriminate invasive species, especially where the invasive species forms dominance and/or changes ecosystem functionality. Important indicator of ecosystem changes so we need a strategy for providing this as a capacity (probably "on demand" tools).

This led to a discussion of identifying community successional stages. Community composition and functional groups are important for understanding ecosystem succession. However, they are not necessarily the same MODIS PFTs. Need to consider how to identify these stages in ecosystem evolution. Disturbance brings systems back to earlier stages of succession.

- More study can examine variability with PFT spectral properties and break up class if it is high

In the course of ecological succession there dynamic species function and composition changes (gradual or step changes following disturbance). It is necessary to address these changes to enable forecasting.

2. Agriculture and managed (altered) ecosystems:

To consider global ecological dynamics and the effects of climate change agricultural lands, including managed forests, should be included as managed ecosystems?

- Emerging issue of **food security** makes crop monitoring imperative

Desire to monitor for crop health and yield prediction:

- crop species and functional states (identify new genotypes and varieties (GMOs) that have new traits)
- small field sizes in developing world will make this difficult; also 19 d repeat isn't often enough
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3. HyspIRI data system ("big data" model)

- Support an open data system with user driven products, vs. predetermined set
- Few basic uniform products (e.g., level 2 products: georectified reflectance) delivered to users.
    - Challenge in validating specific functional products and describing their accuracy will be quite serious and needs to be addressed.
    - Open source algorithms can be shared or supported by community development.
      Use prior probabilities
- Considering no computational limitations in the time frame of HyspIRI, produce something like a "data product wiki"?
- Expected ease of data storage and handling will allow delivery of large volumes of diverse data sets to the users to develop custom products as needed (streaming data concept; could be cloud based).
- Modeling and spectral inputs from HyspIRI: The CLM model currently ingests few variables directly (uses PFTs and look up tables). HyspIRI can provide PFT or species, canopy LAI, canopy chemistry: (pigments, water, dry matter (cellulose/lignin), N? …), others ??? The current PFTs in the model can be directly replaced with RS inputs for data parameters.

4. Ecological Forecasting

Seasonal and longer (multiyear, decadal) time steps. Fuse with daily VIIRS/bimonthly Landsat and Sentinel x/. "adaptive reflectance fusion (blending) modeling"(from Arnold Dekker)

- **Phenological stages**
    - **NPP, NEP forecasting**

- **Diurnal time steps** are feasible to be monitored with **data fusion**: Combine HyspIRI data with diurnal GOES data (GOES-R w/1km pixels) combined with targeted, high spatial and spectral resolution ground measurements (using towers, USVs, balloons, buoys).
    - **ET forecasting**

- **Pan Sharpening** capacity for subpixel composition
    - Species composition, biodiversity, change detection
- **Lidar** for canopy structure (3-d canopies),
    - improve chemistry retrieval; new data for CLM models
- **Fluorescence (**photosynthesis, light use efficiency)
    - NPP/NEP forecasting

Disease forecasting is an emerging area of research
Anomaly detection
Facilitate "surprise" changes

5. Need for further research. There is a need for basic functional studies to provide better understanding of the relationship to spectral information.

- The relationship between taxonomic and spectral diversity requires further study.

- Especially, needed is time series data combining spectral and functional information by species and PFTs. Analytical approaches should include data mining and facilitate "surprise". Facilitate detection of temporal anomalies.

- HyspIRI night time observations: The value of HyspIRI observations during night was discussed with applications for study of urban expansion and development. Also carbon emissions (via fires).

- There is interest in using HyspIRI data for assessing **urban energy uses**, however the resolution needed subpixel for HyspIRI.