## Topics (reminder)

- Function: including vegetation physiology, biogeochemistry (attendees: ~10, *Room: 1109/1111*)
- Structure: biomass; structural indicators for habitat (~12, *2112*)
- **Disturbance: fire and others (~12, *2117*) -- THIS SESSION**

  **Chairs: Skee Houghton and Mark Chopping**
- Ecosystem services (cf. DS, adaptability/sustainability ~6, *2129*)
- Ecosystem-Climate Interactions (drought, ~15+, *1123*)

Note: d. = "disturbance" throughout

# Questions to Address

1. What are the most important and **compelling research questions / science issues** in this thematic area for NASA's Terrestrial Ecology Program to address next? (and Why?)
2. What are the key **remote sensing data records** (time series products, CDRs, ESDRs) required to address these research questions / science issues? (and Why / How will they be used?)?
3. What **new measurements** (from Decadal Survey missions and other satellite missions) will be used to address these research questions / science issues? (and Why / How will they be used?)
4. **What else** will be needed (e.g., supporting research and technology investments, field studies, model development, cal/val) to achieve the NASA scientific objectives for this theme?
5. What is needed to **support this theme from other themes** in the NASA Terrestrial Ecology Program ? and how should it be done?

# Terrestrial Ecology 05/01/08 Disturbance Breakout

1. What are the most important and compelling **research questions / science issues** in this thematic area for NASA's Terrestrial Ecology Program to address next? (and Why?) --1/5

We need to consider:

- The characteristics of disturbance *frequency*: seasonal timing, patterns in different ecosystems, *severity* effects, and *interactions* (e.g., pests-fire);
- Insects -- climate dependencies (e.g., habitat zones changing);
- Natural and direct human impacts; and
- Effects on processes: biogeochemical (C, N, water) cycling.

# Terrestrial Ecology 05/01/08 Disturbance Breakout

1. What are the most important and compelling **research questions / science issues** in this thematic area for NASA's Terrestrial Ecology Program to address next? (and Why?) --2/5

## Baselines and change from baselines-1/2

- Long-term data records; cumulative/aggregate effects of d. on C/water cycles and albedo -- but when is the *baseline*?
- Timescales (open Landsat record excellent; gives 30-y timeframe).
- baselines should be interpreted relative to ecosystem services.
- D. alters structure and function: d. and processes interlinked, not a series of discrete events (d. and response to d.); we are often looking at the consequences of past disturbance events.
- Therefore we need links with people who work on longer timescales (e.g., dendrochronologists).
- Emphasis on the Decadal Survey missions (DESDynI record too short?).
- Space for time substitutions are useful.

# Terrestrial Ecology 05/01/08 Disturbance Breakout

1. What are the most important and compelling **research questions / science issues** in this thematic area for NASA's Terrestrial Ecology Program to address next? (and Why?) --3/5

## Baselines and change from baselines-2/2

- We don't know d. well (demographic process vs metabolic changes -- DS missions / phenology will help us here but false ecosystem recovery signatures can be a problems; the atmospheric signal is useful; 250 m EOS/MODIS data not yet exploited fully).
- Changes with respect to climate in various regions:
  - bark beetle (invade+adapting; short-term effects)
  - mid-lat concern over pathogens (evolve at a scale we can observe; acclimate; range changes; we need models to test this).
  - D. is a global phenomenon:globally we have different interactions, so this is very challenging from a remote sensing point of view.

# Terrestrial Ecology 05/01/08 Disturbance Breakout

1. What are the most important and compelling **research questions / science issues** in this thematic area for NASA's Terrestrial Ecology Program to address next? (and Why?) --4/5

- We may see short-term LAI (condition/function) changes that are not related to *true* disturbance: do we see a trend?
- Trends across space and time can be confusing: thresholds, step functions, episodic events & cycles…
- Role of humans. E.g., land use change is a form but also a cause of d.
- Drought leads to other disturbances; e.g., invasives can be d. and be a response to d. (and also a cause of drought: d. feedbacks and cyclical patterns).
- Agriculture / land cover conversions comparisons w/natural ecosystems.
- Crossover: what is a climate response?
- D. as mechanism for for successional changes (e.g., boreal forest); linkages between dynamic global vegetation modeling (DGVMs) and disturbance studies.
- Integration w/other non-RS data sources and more highly developed models.

# Terrestrial Ecology 05/01/08 Disturbance Breakout

1. What are the most important and compelling **research questions / science issues** in this thematic area for NASA's Terrestrial Ecology Program to address next? (and Why?) --5/5

- What can we / do we want to measure using remote sensing?
- currently we mostly map disturbed areas -- we need to go beyond and quantify the effects biophysically (e.g, kg C $ha^{-1}$)
- Area is important but so is *severity* (what characteristics are important? We need useful information products; but what is useful to diverse user communities? What metrics are useful? Land cover? This is different for different communities.
- What information can we provide? Interpreted? Live/dead ABG pools?
- People often don't understand the products they are using; problems w/phenology products vs. disturbance signal (=noise?!)
- MODIS/EOS have most applications but have not (YET) delivered the products expected -- don't (YET) capture range of potential
- Both empirical & physical approaches needed.

# Terrestrial Ecology 05/01/08 Disturbance Breakout

## 2. What are the **key remote sensing data records** (time series products, CDRs, ESDRs) required to address these research questions / science issues? (and Why / How will they be used?)? --1/2

- The long-term record has to be interpreted through empirical approaches that reflect the underlying physics: this has enormous value but also limitations.
- Exploratory vs. planned; serendipitous discoveries post-launch.
- R&D vs science vs human/social element -- conflicts here?
- The records we have have not yet been exploited fully, e.g., Landsat: long record on a large scale; international records (Canadian FS); EOS; we need to pull the records together.

# Terrestrial Ecology 05/01/08 Disturbance Breakout

2. What are the **key remote sensing data records** (time series products, CDRs, ESDRs) required to address these research questions / science issues? (and Why / How will they be used?)? --2/2

- SUGGESTED KEY RECORDS:
  - 1 km AVHRR } a lot of synthesis | we still need characterize
  - MODIS } studies are under way | imptt temp/spatial trends:
  - Landsat } (empirical -- but have | d. regimes -- this is
  - radar (wetlands) } value) | fundamental information
- Need to attribute type of d.; e.g., use Monitoring Trends in Burn Severity (MTBS; www.mtbs.gov) when looking at deforestation.
- Should there be an officially sanctioned d. CDR/ESDR or team?
- Consistent reflectance data sets (BRDF corrected AVHRR/MODIS; Landsat).
- MODIS reflectance products are deemed inadequate: compositing/cloud-screening/atmospheric correction create problems for detecting some types of d.
- High frequency of sampling is important: timing is critical to understanding.

3. What **new measurements** (from Decadal Survey missions and other satellite missions) will be used to address these research questions / science issues? (and Why / How will they be used?) --1/8

- Temporal sampling is important and one big constraint on independent use of active sensors; e.g, some applications need daily (or perhaps monthly) measurements
- If d. is based on *phenology* then repeats of 45-180 days are inadequate.
- However, 85% of biomass is in forest, so one look $yr^{-1}$ is good enough, where phenology doesn't matter.
- e.g., early warning on crop failure has different requirements
- Caveat: we must be careful with new missions: they don't always give us what we thought they would.

3. What **new measurements** (from Decadal Survey missions and other satellite missions) will be used to address these research questions / science issues? (and Why / How will they be used?) --2/8

Decadal Survey Missions: Overarching / Other Questions:

- First, we need continuity: we need to keep getting what we have now to do the science (not continuity for continuity's sake).
- It is crucial to overcome implementation obstacles (agencies, institutions are crying out for continuity, as well as scientists)
- Will VIIRS provide continuity for certain types of d. shifts?
- We also need new types of measurements.
- Serendipitous uses (e.g., ACE multiangle imager, cf. MISR)
- Synergies & complementarities with atmospheric instruments…

# Terrestrial Ecology 05/01/08 Disturbance Breakout

3. What **new measurements** (from Decadal Survey missions and other satellite missions) will be used to address these research questions / science issues? (and Why / How will they be used?) --3/8

- OCO useful for attribution, source/sink assessments, and processes. Caveat: there are often spatial/temporal sampling issues; so must use together with other information for d. studies.
- Measure $CO_2$ emissions to atmosphere from fires as measure of severity/"what burned?" questions (OCO can stare)
- Flux towers give useful information for pest/pathogen studies, so OCO will too.
- It's constrained by sampling (large spatial scale) and primary requirements but useful nonetheless.
- Drought/heat event link to anomaly in $CO_2$, traced back to d. (recent paper -- no citation).

3. What **new measurements** (from Decadal Survey missions and other satellite missions) will be used to address these research questions / science issues? (and Why / How will they be used?) --4/8

- HyspIRI(hyperspectral):
  - physiological measures to get at d. we cannot get with current instruments, e.g., climate as a disturbance: pests, pathogens (pre-visual detection).
  - subtle effects (e.g., drought effects, leaf biochemistry; Asner); more sophisticated fire burn severity assessment through differences in ash --> temperature and duration, needlecast; improved species classifications.
  - Importance of TIR band(s) if not on LDCM (water balance, drought, land cover classification).

3. What **new measurements** (from Decadal Survey missions and other satellite missions) will be used to address these research questions / science issues? (and Why / How will they be used?) --5/8

- DESDynI (lidar/radar):
  - Very important for d. studies: a critical data resource for the land community ("an FIA plot everywhere").
  - canopy structural variations from d.; post-d. regrowth: canopy heterogeneity as an indicator of successional stage.
  - useful in discriminating / classifying PFTs.
  - stand demography (e.g., link with modeling, e.g, ED).
  - forest regeneration (post-fire; L-band SAR good for understory).
  - biomass variations (more subtle than e.g., clearing).
  - Synergies with HyspIRI.
  - limited by 5-yr mission length.

3. What **new measurements** (from Decadal Survey missions and other satellite missions) will be used to address these research questions / science issues? (and Why / How will they be used?) --6/8

- ICESat-II
  - ICESat-I (GLAS, 70 m footprint; -II might be 50 m).
  - A sampling instrument (~160 m spacing between shots): high error bands but the trend is right (Lefsky).
  - Repeat tracks (shots over same spot; -II 180 days).
  - DESDynI will have distributed lidar samples?
  - Precision will be important; combination with VIIRS data; use for calibration of relationships / validation / comparative.

3. What **new measurements** (from Decadal Survey missions and other satellite missions) will be used to address these research questions / science issues? (and Why / How will they be used?) --7/8

- LDCM
  - Gives us LT trends (1972 onwards).
  - Consistent measurements.
  - Allows us to use existing methods.
  - Temporal sampling is good.
  - A TIR band is desirable.

3. What **new measurements** (from Decadal Survey missions and other satellite missions) will be used to address these research questions / science issues? (and Why / How will they be used?) --8/8

- SMAP (soil moisture from active/passive $\mu$wave)
  - Low biomass areas.
  - Drought stress.
  - Post-d. regeneration duff moisture (hi-lats, tropics).
  - Sampling frequency low @EQ (~10 days).

4. **What else will be needed** (e.g., supporting research and technology investments, field studies, model development, cal/val) to achieve the NASA scientific objectives for this theme? --1/2

- Field campaigns necessary: there's still a LOT we do not know
- $\mu$-campaigns OK (we need to make more demands; can be used to calibrate multi-annual sequences of measurements especially in hi-lat ecosystems where we see more consistent changes).
- Tundra, taiga, wetlands, shrub invasions, forest expansion, permafrost zones. It's time and opportunities abound; > interactions with Russian/Canadian science teams?
- Focus on zones where pathogens are trending up (e.g., sudden oak death).

4. **What else will be needed** (e.g., supporting research and technology investments, field studies, model development, cal/val) to achieve the NASA scientific objectives for this theme? --2/2

- A systematic approach to characterizing d. needed (wih respect to the circumstances we need to cover).
- Observe: 1. Immediate impacts (quantification: e.g., what burned? area/extent/severity/C lost); 2. Recovery (difficult to do with simple spectral measures).
- Need to be ready to understand how we can make best use of and interpret the DS mission data; aircraft campaigns will help with this -- targeted for specific events. This may require a team: cost is a constraint but this would inform us while we wait for the DS missions to enter science phases).

# Terrestrial Ecology 05/01/08 Disturbance Breakout

## 5. What is needed to support this theme from other themes in the NASA Terrestrial Ecology Program ? and how should it be done? --1

Not covered -- deferred.