ChEAS 2012 workshop
June 27, 2012
Erica Smithwick notes

5 minute talks

Ken Davis

Where ChEAS fits into US Carbon Cycle Science Plan 2011

Q1: process, carbon management, impact

Diagnose (past/current, spatial) and Predict (temporal and spatial problem)

Prediction: long time scales to test/develop prognostic skill (better for mgt than climate change?)

Diagnosis: 100x denser sampling than available at global scale; great place to test upscaling (key)

Worry: QC, database management

Relative simple uncertainty estimates; few comparisons esp at high resolution; innovative RS, "write the book" for the global science community

Ankur Desai

Worry: >250 raw data points a day; single flight = Tb = lots of data!

Funding it, processing, assimilating, inferences, publishing

Beat goes on: WLEF, willow creek, Sylvania, lost creek NEE
Data ingest and processing – real time
Data harmonization – netcdf files conversion
Methane flux
Pecanproject.org – ED
Lakeflux – C sink in lakes; Buffam et al. 2011 GCB
Restart old-growth site
Biome-bgc at willow creek (Tom Gower)
Worry: funding! Working with tribal colleges

Johnathan Thom

- data mgt in Antartica, Ankur
- upgraded computer systems, real-time, remote desk-top, updated half-hourly
- good point of contact if want to conduct experiment at flux tower sites to make sure it's in data stream

Erika Marin-Spiotta

Soil organic matter in successional forests; working with Claire, Ankur, Rob Scheller
Physical fractionation; stable and radiocarbon isotopes to look at turnover; plant vs. microbial sources of organic C
Worry: scaling from mechanisms to landscapes → utility for modelers

Claire Phillips

With Karis McFarlane at LLNL DOE

Impacts of large thinning → increased decomp, decrease (less C inputs); what is balance of physical and biological drivers
14C profile gradients (2600 yrs old) – where is carbon coming from – shallow (young) vs. deep
how quickly did bomb spike move through fractions; how quickly decomposing vs . snapshot approach – measurements of soil air within profile (bulk CO2) at soil surface and in soil profile; plus radiocarbon + willow creek and WLEF radiocarbon from towers; can we detect soil bomb carbon in the towers, esp after disturbance
results: soil co2 appears to be modern throughout profile; little decomp from old carbon; even in winter dormancy; soil fluxes were large relative to tower, but fluxes may be too modern to distinguish from atmosphere
take home; 14C in models is another constraint

Peter Curtis
150 is the new 80: continuing carbon storage in ageing great lakes forests; is it true? At what scale? Mechanisms? Management?

UMBS – knute nadelhoffer, chris gough, gil bohrer;
Many forests are at an ecological transition point between young early successional into mature older forests; signal since 1999, permanent plots,
Gough et al. 2008 bioscience; increase in carbon storage still increasing >200 yrs; most hardwood data only goes to 100 years, so we don't really know what happens after that – may not be the same as western conifers; so how generalizable is this pattern??
-more structure → higher wood production; rugosity (measure of complexity) and NPP increase with stand age; quantifying canopy complexity using lidar; relationships with LUE and NUE (total canopy N/NPP)
-resilience higher with greater biodiversity (Gough et al. 210 FEM)
-counter theory to Odum: carbon storage will increase with forest age as ecosystem complexity increases → forest accelerated succession experiment (girdling aspen); Nave et al. 2011 JGR Biogeosciences) – hypothetical NEP → N availability

→ generality of sustained C storage in older great lakes forest
→ reinstrumentation of Sylvania, other old-growth UP sites (Eukes EF, Huron Mt. Club)
→ Mechanisms of canopy-level response to changing structural and biotic complexity
→ forest ecosystem resistance/resilience to disturbance
→ getting mechanisms into ecosystem models

Dong Hua
Impacts of forest harvesting and prescribed fire on carbon storage and exchange in northern temperate forests; based on CENTURY model with new modules; Willow Creek
-results show effects of fire interval on SOM (similar to our GYE results); assuming 50% loss of roots (check)

Seyed Kia
Temporal and spatial variability of spectral indicators of CO_2 fluxes around a UK flux tower (Wytham woods, oxford) – univ of Southampton
→ determination of the sensitivity of a number of vegetation indices (NDVI, MSAVI, PRI) in definition in flux footprint
→ bridging the EC measurements and satellite indicators of CO_2 flux using airborne LiDAR and hyperspectral data
--airborne imagining spectrometer for application (AISA) Eagle (252 narrow bands)
→ role of landscape level heterogeneity/canopy patches through growing season
→ what causes flux footprint to be uncertain

Mike Dietze
PEcAn project; Predictive Ecosystem Analyzer (scientific workflow system to manage flow of data ecoinformatics; how to get data at different spatial temporal scales to talk to each other; automate
→ variance decomposition analysis, normalized as CV%, and model elasticity to partial variance of ensemble run; what's causing the model to be uncertain; fine root allocation is #2!
→ targeted analysis – go from uncertain to constrained
machine learning – can always build on existing data with new data; partitioning uncertainty
→ built framework in biofuels; now testing in messy landscape, data
PalEON, gap macrosystems, Starch-Xsite, Woody biofuels in Rhinelander

Shawn Serbin
From multiple datasets to ecological prediction – the PecAn + ChEAS project
Ecological statistical mechanics; canopy structure using lidar/radar hyperspectral by PFT
AVIRIS – ER2, JPL, 224 spectral bands – geology and soils; Green et al. 1998 RSE; 12km swatch
NASA AVIRIS/MASTER & ecosystem studies
AVIRIS 2008, 2009, 2010, 2011 – map of flight paths
Using AVIRIS data in data assimilation in hindcasts – determine what is missing

Aditya Singh
Townsend lab;
How do PFTs vary across gradients of environmental change and disturbance; implications for ecosystem function (nutrient retention and C assimilation); effects on water quality
-measurement of functional traits using spectroscopy at leaf level
spatial scaling using AVIRIS and thermal (MASTER);
Plant functional traits: leaf N, LMA, fiber/lignin/cellulose, leaf d15N, Vcmax and Jmax
Also disturbance: defoliation, impacts, C and N flux
75-80% accuracy in defoliation

→ developing scaling approaches leaf to canopy; validation of retrieval of metabolic parameters is a challenge; need to link to canopy data (cheas)

Bruce Cook
--more soil science
--lidar data 2005/06
--instrument fusion; one instrument but can control simultaneously
-lidar radiative transfer
-upscaling of biological processes and co2/ch4 exchange
G-LiHT; Goddard's Lidar, hyperspectral and Thermal airborne imagine system; 3 instruments in same package, 1m resolution, band-widths (1-2nm)

- off the shelf instruments, surface temp, downwelling irradiance, profiling and scanning LiDAR, $1000/hr for flying (buck a hectare)

ICESat
Passive optical lidar-thermal synergy
+VCT (stand age) + biomass → yield curve, rate of biomass change
june 2012 G-LiHT acquisition; WLEF landscape (growth, disturbance); Willow Creek landscape (pre-harvest0
→ canopy height, calibrated reflection (~LS 5 band – coniferous vs. open vs. deciduous), Chris Neigh Lands ecology submitted 2012, northern Wisconsin – disturbance maps (but lacked temporal sensitivity); decreasing NDVI trend over this period/region – why?

Linda Parker, forest ecologist and research coordinator
--building a framework for climate change mitigation and adaptation; "model forest for climate change'
-science-mgt partnership; climate change response framework: vulnerability, mitigation, adaptation, partnership, applications
Ecosystem Vulnerability Assessment and Synthesis (EVAS):
www.nrs.fs.fed.us/pubs/
-TreeAtlas + Landis II; most species show large declines in habitat suitability
Forest Carbon Sequestration and Mitigation (Rich Birdsey et al.); mitigation options
→ forest management: changing rotation age, harvest strategies, forest density, harvest intensity → *does it really matter at landscape scales for C mgt;*
→ Minimizing impacts of natural disturbances
→ role of harvest in acting as C sink
Phase 2 of mitigation assessment; scenario analyses; add scenario: biome-bgc, Landis-ii, PNet-CN
Land model (LM3V) from GFDL ESM
--life cycle analysis – broad bounds of analysis
--Adaptation: Forest Adaptation Resources (FAR): workbook for adaptation
climateframework.org

Bjorn Brooks
Biosphere – atmosphere inversion modeling
RACCOON, CarbonTracker

Biogeography: geology and ecology, CCSM-CLM RTM; data mining
PalEON: millennial scale ED modeling; long-term model performance with paleo proxies

MINI-WORKSHOPS

Robert Kennedy – Workshop I
Remote sensing: Needs – gaps – issues
Remote sensing: pros/cons - -may NOT be consistent over time-space
It's a zero-sum game: Tradeoffs – spatial/temporal/spectral domains
What role will remote sensing play in C cycle studies?
State and dynamic variables (initializing and process)
Separating real from false change: only a small portion of change is interesting
False positives: clouds and shadows, phonological variability
False negatives: spectral variability, quick spectral recovery, multiple successive disturbances
Key RS contributions; timing and magnitude of disturbance; attribution (human/natural)

State change, cyclical change, condition change (drought/stress)– change occurs all the time; critical events occur when direction changes; how do you capture all this across a landscape, where its all happening all the time

LandTrendr
--Looks for TRENDS and EVENTS in the same algorithm
--Segmentation
Timing, magnitude of disturbance, ChEAS: pixel
Find all the places where it bounced up; look at the delta (measure of magnitude)
Uncertainty in detection; disturbance signal varies by spectral index: NBR, Band 5
Eventually a voting/scoring approach may be useful
Both are defensible algorithms that represent a standard methodology; Multiple spectral indices to use at once? Multi-proxy; do all the indices show the same thing…does that increase our "certainty"
--Colors – different years
--Longer-term processes: disease (cause of declining NDVI) – white spruce; everywhere there is long-term change that is what you are looking for

Riley Creek/South Fork: combination of slow and abrupt change + longer-term processes critical!!! Very dynamic landscape!
Incremental change from successional may not be detectable from background noise

Bringing in "recovery"
Willow creek tornado;
Very low

400gC/m2/yr – willow creek most productive flux tower in the region; can see drainage ways – in this case, successional development can be seen

--Disease then salvage (white spruce, dying, then harvest event signal) – yearly C accounting? Constraining models?

→ how to incorporate this into the scaffolding approach that Mike is building

→ how to represent; just telling a story about long-term vs. instantaneous change (can cherry pick the data query)

Expanding spectral scope: roughness, greenness, wetness → change happens at same time; can use each component to tell more about what was happening before, during change: spectral signature is different for different areas of change: before, during , after

Attribution: natural vs. anthropogenic: capturing the story of landscapes

Pixel to patch world

Have to have people in the loop! Assigning labels: characterizing disturbance

Use algorithms (Random Forests) to find things (change);

Humans then check the label and check the dataspace (iterative)

Sources of truth

-ancillary databases

-air photos

-satellite imagery itself

Challenge: Validation or corroboration when maps/info is over large areas and across many change types: Database offers richness but also errors; need corroboration

Reference databases tell us where to look – may be anticipating events that haven't happened; so database needs to be cleaned up first before accuracy assessment

Feeding the machine!+ other relevant data

Finding places in data space where training data not good enough to elucidate change: use random forests

Challenge: Technical: clouds, data processing

Representational: *Condensing time-series data into digestible form*: characterizing uncertainty in detection and attribution

Integrational: *how to bring long and slow processes into models*? How to represent in accounting? – good ways to constrain model output/management!

Bruce: G-Liht data designed to validate products; also a question of what we can detect with Lidar; useful to formulate a method for validation! How do you quantify these disturbance events: repeat lidar. Use lidar flight pre and post-harvest for validation.
Look for correlations of what is driving it:
Processes or change of things we missed (analyze with residuals)

Let process/remote sensing guide the sampling

Clustering analysis? Systems for trying to identify anomalous behavior
Can you cluster to lump NEP curves; family of change; waveform for particular type of change: wavelet analysis for multiduration, multifrequency (data mining approach)

MODIS?

Assessment of representativeness: happening fairly commonly but we don't have data on; *where are the biggest holes*?!

Private vs. public processes represented? Characterize towers by dominant process: ask how representative the towers are of the landscape!!!

What would landscape modelers/managers use now? Events, abrupt changes (time of disturbance, type of disturbance)

How to get a soils angle on this? Take a set of disturbances, response related to soil variables? Hydrologic regime of soil responsible for change;

Band 5 problem – too much water on landscape (too many forested wetlands; more water absorption in that band?)

To do:
Put on .kmz file
Compare to TWI
Landtype associations: soils, veg. nutrients, hydrology – these are mapped across the forest; drives past + current disturbance; also use to look at representativity of the towers spatially!
Need GIS overlay analysis in CheAS region; get all data in same format;

Mike Dietz – Workshop II
Barriers to Modeling
--accessibility (too complicated/training)
--relevance (my system, how help me in the field)
--flow of information (too much, one-way field to model)** the real barrier!
[-use of mental models!]

PEcAn 2.0: Ecoinformatics
Workflows allow transparency, repeatability, provenance tracking
Connection between data and model
Pecan.ncsa.illinois.edu
Web interface

Trait database: betydb.org: biofuel ecosphysiological trait/yield database: metadata, priors, model-runs,

Will be adding calibration datasets (MODIS), Fluxnet to compare against model output

Ask non-trivial hypotheses: working hypotheses, ensembles as significance test, Var Decomp to identify drivers, design experiments

-my favorite process/most recent finding should be incorporated in global change models → better to find way to have those people confront models with data (esp when using Bayesian approaches which would be used make the model smarter)

--do you miss the anomalies through this approach? Uncertainty in models not appreciated (accurate but low precision); by constraining uncertainty → should identify gaps; faster feedbacks = more time for science

Model-Data Challenges
-explosion in data volume and diversity
-Clark dietze, ecol application – inventory/bayes
JGR 2011 Dietze → characteristic temporal scales of variability; ensemble mean

Data assimilation more than just a cost fcn;

Models to field: focused field efforts, compare apples to apples, power analysis

Use PEcAn to parameterize the tundra; field campaign; data assimilation; forecasts with error propagation; using model to design field campaign!

Linda Parker – Workshop III
Timber harvest volume (top 3 timber producing forests; despite decreases in value and volume; Nicolet overharvested for awhile, but value increased; peak in value in 90s
Threshold for timber harvest not being exceeded; limited by budget from fed

1.3 to 1.5% per year in ground disturbing activities
85% undisturbed over a decade
average size of clearcuts – 20ac (max = 40ac)
<1200 ac of clearcuts per year

acres of regenerating aspen forest 1950-2010, declining since 1990 (maybe because focus is not there)
Northern hardwoods; most common type, un-even aged silviculture; post-cutover origin; Willow creek tower most productive; middle aged; willow creek in 2B, interior forest restoration focus –trying to get bigger trees, more patches, more complexity
-used to be more diverse; now just dominated by a few species

red pine almost all exclusively CCC planted (post 1930s); very little being planted, usually on sandy soils, even-aged silviculture; will thin by rows, then thin individual trees; rotation age = 120, leave few trees for seed, but clearcut
; not establishing new red pine plantations because not using herbicides and hard to get it established because of aspen competition

HW mostly middle-aged, none old;

Winter logging required in some areas (more and more difficult because of warmer winters)

Increasing woody biomass harvesting; tipwood remains from harvest; near park falls paper mill; recent change (5 yrs) ; BMPs – leave just a little bit on site; fuel for mill

Oak Wilt, Spruce decline (budworm), prescribed fire (outwash plains); wildfire (1200 ac; average size = 4ac); beaver colonies decline (trapping), warm trout stream + orchids in cedar swamp;

Marcus Sadak CNNF GIS coordinator mlsadak@

FACTS: veg activities: timber harvests, planting, site prep, ETC
FSVEG: veg composition: stands, type, age, density, soils, LTAs
Landtype Associations: national hierarchy of ecological units: dnr.wisconsin
Fsgeodata.fs.fed.us/ fsgeodata clearinghouse
Nrcs.fsf.fed.us/gla :; great lakes ecological assessmet
Research natural areas: nrs.fs.fed.us/rna - more than any other forest in the country

Kusum – Workshop IV
Characterizing observational and model uncertainty
Quantification of regional/global C fluxes and associated uncertainty
Diagnosis of uncertainty (input data, model structure, model framework, spatial representation of flux towers)
Benchmarking standards for model-intercomparisons focused on uncertainty
Visualization C fluxes and associated uncertainty

Uncertainty declines with increasing temporal coverage of flux tower data record

Uncertainty increases with increasing spatial coverage of flux data record
[[is there a threshold of increasing uncertainty as landscape extent increases; use Turner et al. 1993 as model for graphing uncertainty in space/time]]
Need to find sweet spot that equilibrates spatial/temporal uncertainty [[put equilibrium space on that figure =compromising one or other]]
Xiao et al. 2011 JGR – wetland representation →NEE flux variability
Independent vs. common vs. hierarchical risk
What parts of the process are defensible; many methods have no a priori information, so hard to know;
-how to start with dealing with all this uncertainty, e.g., resolution of landcover maps; plus additional uncertainty in datasets – but its not propagated into data stream; use probabilities of class membership + cross-validation; go to second level of MODIS products; MODIS LAI is ensemble + SD

As a community: what is useful to report?

Choice of model introduces uncertainty: representation of processes; residuals and MIPS (model intercomparison process) existing MIPs not telling us much because we still don't know WHY the model is performing the way it is (don't have uncertainty with each model)

Better communication of modeling outputs in terms of visualization of mean and uncertainty

Synthesis papers on assessment and/or visualization of uncertainties in C flux upscaling; upscaling methodology; comparisons of products