CMS External Communications Working Group

Members:

Kevin Bowman, Peter Griffith, Kevin Gurney, Elizabeth Nelson, Ariane Verdy
[*added since 09/13*:] Molly Brown, Sabrina Delgado Arias, Riley Duren, Vanessa Escobar
Interns: Maya Hutchins, Adam Norris

Charge:

Develop pathways to share information with CMS users. Our first task is to redesign the CMS website (http://carbon.nasa.gov).

Methods:

- Brainstorming sessions about the structure of the website were held by telecon. The discussions are guided by inputs from Peter Griffith, who has experience designing the CMS and NACP websites.
- Ideas are implemented by Beth Nelson, who executes the graphic design and web design.
- To create content for the website, two summer interns were hired; they interviewed CMS science team members about their vision of CMS and about their specific projects.
- CMS science team members were asked to contribute content in the form of project-related images.

Progress/results:

- A new website structure has been put together. Navigation is done primarily via a tabs menu located at the top of each page. A clickable graphic links to articles describing the different themes of CMS projects. The new website is not "live" yet.
- Articles have been written that explain carbon biomass and fluxes to a general audience.
- A mission statement is being put together. The first draft was based on a compilation of the responses obtained during interviews. It is currently being revised to include the *applications* aspect that is emphasized in many CMS-2013 projects.
- 5 science team members have submitted images for the website.
- A twitter account has been created for CMS.

Next steps:

1. Mission statement: make a final draft, get feedback from science team, revise as needed.
2. Gather / create content for the empty pages.
3. Coordinate with Users Responsiveness working group.
4. Set-up strategy for keeping "CMS news" up to date and for generating new content highlighting recent activities.
5. Go live.

CMS Responsiveness Working Group

Members: Sean Healey (US Forest Service); Tris West (Pacific Northwest National Laboratory); Holger Brix (UCLA); Daniel Jacob (Harvard)

In consolidating and providing scientifically defensible information about the earth's carbon cycle, CMS will ultimately respond to the needs of regulators, planners, and managers at levels ranging from the local to the international, from terrestrial to atmospheric and oceanic applications. Through a series of conference calls, this working group has adopted two goals: cataloging the user needs CMS may one day serve; and facilitating discussion about possible collaboration between NASA's ABoVE (Arctic-Boreal Vulnerability Experiment) campaign and the US UNFCCC reporting mechanism.

Work toward the first goal built upon potential CMS applications outlined in a report written by a group led by Riley Duren (NASA JPL) during what has been called "CMS pre-phase A." Additional potential applications, along with contextual information, have been summarized in a google document:
(https://docs.google.com/spreadsheet/ccc?key=0AmWcL1qNWd50dEVsYmdfSWFfQkJEMkRWN2l3SGdiUEE&usp=sharing#gid=0). Input was sought and received from the larger CMS community, and the resulting summary (compiled by Tris West) emphasizes needs of groups working at national, continental, and global scales. There have also been encouraging cooperative efforts with state partners.

The Forest Service is responsible for the forest sector of this country's UNFCCC reporting, and has received UN guidance to improve monitoring of carbon in the Alaska's interior, an area not covered by the national forest inventory. Canada's Forest Service likewise has articulated priorities relating to increased monitoring in the region. Given NASA's upcoming ABoVE campaign and the expense of working on the ground in the region, there is much to be gained through cooperation. An example of this type of cooperation is a newly selected CMS project (Project Lead: Ross Nelson, NASA GSFC; Forest Service counterpart: Hans-Erik Andersen), in which the Forest Service is surveying a limited number of ground plots to be used in a LiDAR-assisted inventory. The Working Group has put together an ever-growing list of researchers and governmental representatives interested in carbon monitoring in the region, and has organized several calls. Peter Griffith led a discussion in September, summarizing work his group has done to identify and serve disparate sources of monitoring data in the region. The Responsiveness Working Group will continue to work toward meeting US carbon reporting responsibilities in Alaska and elsewhere through ties to ongoing NASA research and field campaigns.

CMS Uncertainty Working Group

Summary, October 2013

Goal: Develop a structure to define how uncertainty is conceived and implemented across Phase II (2012) NASA CMS projects.

Approach: We encouraged all CMS projects to self-report project goals and to describe how uncertainty was being treated within those goals. As a group, we developed a conceptual structure of uncertainty, and then grouped all projects based on those self-reported descriptions of uncertainty.

Outcomes:

NASA CMS project self-reporting spreadsheet.

Dimitris Menemenlis developed and posted on Google-docs a survey-type spreadsheet for project PIs to summarize their projects. With the help of other CMS Working Groups, the scope of this spreadsheet has grown to include topics relevant to NASA CMS more generally. Table 1 summarizes names, goals, and domain (land, air, water), and Table 2 summarizes how uncertainty would be treated in the projects. The full table can be retrieved online: https://docs.google.com/spreadsheet/ccc?key=0AsSSZURmMDWwdEl2eWY0WmpkYVlMdmhLV2ZGc25CX2c#gid=0

NASA CMS structure for conceptualizing uncertainty

Conceptually, an interpolation method is used to modeling data at locations in space or time for which we do not have observations. To describe our uncertainty in those modeled predictions, we must somehow propagate error from: data, model, and interpolation method. Our group found five broad approaches used in CMS by which this is achieved: 1. Deterministic, 2. Stochastic/Ensemble, 3. Model-data comparison, 4. Model-model comparison, 5. Data-data comparison. Detailed descriptions are shown in Appendix 1. We sorted projects by domain of study and approach to modeling uncertainty (Figure 1).

Uncertainty group conference call participants

(April 16, June 26, September 26)

Participants: Chris Badurek, David Baker, Nicolas Bousserez, Jim Collatz, Sangram Ganguly, Dimitris Menemenlis, John Miller, Steve Pawson

Compiler of this summary/ Group organizer: Robert Kennedy.

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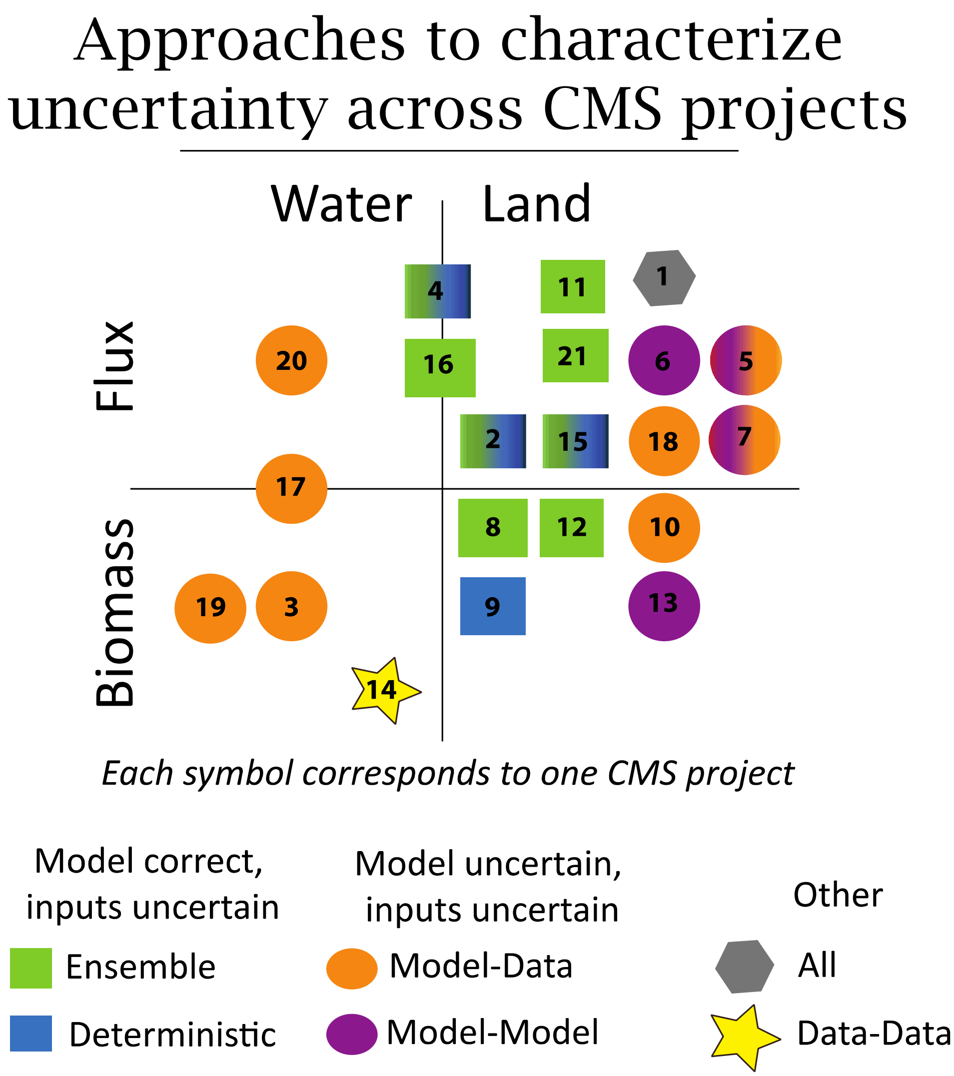

Figure 1. Approaches to characterize uncertainty in NASA CMS Phase II (2012) projects. Numbers correspond to project numbers in Table 2 of the NASA CMS Uncertainty Working Group document.

Uncertainty WG continued

Table 1. Self-reported NASA CMS project information

PI Last Name	*CMS project name*	*Objective*	*Domain of primary products*	*Spatial Domain*
Andrews	North American Regional-Scale Flux Estimation and Observing System Design for the NASA Carbon Monitoring System	Use in situ observations and remote sensing data (ACOS GOSAT + TCCON) together in a regional inverse modeling framework for North America. Comapre with CMS flux estimates.	land-air flux	North America
Baker	GEOS-CARB: A Framework for Monitoring Carbon Concentrations and Fluxes	Enhance existing variational data assimilation system for estimating time-varying net CO2 fluxes at the surface. Investigating the use of a weak dynamical constraint and estimating satellite bias parameters as part of the flux inversion. Assess the accuracy of the low-rank covariance produced by the variational method by comparing it to that given by a stochastic simulation technique (an "OSSE").	land-air flux	Global
Behrenfeld	Characterizing the Phytoplankton Component of Oceanic Particle Assemblages	Develop method(s) for measuring phytoplankton carbon biomass in the open ocean on a routine basis	ocean biomass	global
Bousserez, Henze	Continuation of the Carbon Monitoring System Flux Pilot Project	4D-Var inversion uncertainty quantification	atmosphere transport, air-sea flux, land-air flux	Global
Dubayah	High Resolution Carbon Monitoring and Modeling: A CMS Phase 2 Study	Continued development of a framework for estimating local-scale, high-resolution carbon stocks and future carbon sequestration potential using remote sensing and ecosystem modeling.	land biomass	Local
Fisher	Reduction in Bottom-Up Land Surface CO2 Flux Uncertainty in NASA's Carbon ; Monitoring System Flux Project through Systematic Multi-Model Evaluation and Infrastructure Development	Objective (1): Provide improved land-surface input products to the CMS-Flux system using the multi- model ensemble from MsTMIP: Objective (2): Develop the technical infrastructure of CMS to handle an integrated multi-LSM system for operational use.Objective (3): Evaluate the consistency of MsTMIP model estimates with atmospheric CO2 observations, providing an additional benchmark of land-surface model performance.	land-air flux	Global
French	Development of Regional Fire Emissions Products for NASA's Carbon Monitoring System using the Wildland Fire Emissions Information System	Provide estimates of fire emissions with assessment of uncertianty. Documatation of the model and some imporvements to include mre dynamic input data	land-air flux	CONUS
Ganguly	Prototyping MRV Systems Based on Systematic and Spatial Estimates of Carbon Stock and Stock Changes of Forestlands	The objectives of this proposal respond to the CMS solicitation call to extend, enhance, or evolve the current pilot products (i.e., biomass and flux products) using either the current methodological approach(es) or an alternative approach(es) to producing the product(s)Ó. We propose to evolve the CMS-BPI into a spatial approach for quantifying GHG emissions and removals (or sources and sinks) by focusing on the following three main objectives:1) Spatially represent all carbon pools (AGB, BGB, CWD, forest floor, soil) in forestlands of the United States by integrating remote sensing and GIS techniques with the US forest inventory data, 2) Develop a systematic and spatially refined estimate of net forest carbon stock changes (i.e., fluxes) between 2000 and 2010 that can be compared to net fluxes derived using the extensive network of FIA plots, 3) Develop and prototype an MRV system that tracks emissions and removals of carbon separately to be used for international policy applications with the capability of providing national or sub-national scale baselines of gross and net carbon fluxes and uncertainty, and test its applicability to the State of Alaska, where a GHG inventory is sorely lacking	land biomass	CONUS + Alaska
Healey	A Global Forest Biomass Inventory Based upon GLAS Lidar Data	Develop global country-level estimates for mean aboveground forest biomass per hectare in support of the 2015 UN Food and Agriculture Association Forest Resources Assessment.	land biomass	global
Houghton	Spatially explicity sources and sinks of carbon from deforestation, reforestation, growth and degradation in the tropics: Development of a method and a 10-year data set 2000-2010	Determine the distribution of sources and sinks of carbon from deforestation, reforestation, growth and degradation in the tropics for the period 2000-2010.	land biomass	Tropical forests

Uncertainty WG continued

Jacob	Use of GOSAT, TES, and suborbital observations to constrain North American methane emissions in the Carbon Monitoring System	We contribute to the CMS with a four-dimensional variational (4D-var) inverse modeling capability for methane emissions in North America integrating satellite (GOSAT, TES), aircraft (CalNex, HIPPO, NOAA/CCGG), and surface-based (TCCON, NOAA/CCGG) observations.	land-air flux	North America
Kasischke	The Forest Disturbance Carbon Tracking System A CMS Phase 2 Study	Develop a database that provides estimates of changes to carbon stocks from fires in the boreal forest region of Alaska for 2001-2010	land biomass	Interior Alaska
Kennedy	Integrating and Expanding a Regional Carbon Monitoring System into the NASA CMS	1. Aid CMS evaluation of biomass products using our own Landsat/lidar/FIA plot-based forest carbon monitoring system. 2. Test our system (developed in western forests) in eastern forests	land biomass	US: Pacific coast states & selected sies in eastern foreststs
Key	Towards a 4D-Var Approach for Estimation of Air-Sea Carbon Dioxide Fluxes	Compile a calibrated dataset of in situ ocean observations, such as required to constrain a global 4D-Var biogeochemical model	ocean biomass	Global ocean
Liu	Continuation of the Carbon Monitoring System Flux Pilot Project	Atmospheric top-down flux inversion.	land-air flux	Global
Lohrenz	Development of observational tools and coupled models of land-ocean-atmospheric fluxes and exchanges in the Mississippi River watershed and Gulf of Mexico in support of carbon monitoring	Terrestrial-ocean interface domain. Proposed research will employ a combination of models and remotely-sensed and in situ observations to develop georeferenced products and associated uncertainties for land-ocean exchange of carbon, air-sea exchanges of carbon dioxide, and coastal to open ocean exchanges of carbon.	land-ocean flux	Mississippi River watershed, Gulf of Mexico, South Atlantic Bight
Menemenlis	Continuation of the Carbon Monitoring System Flux Pilot Project	Provide estimates of ocean surface carbon dioxide flluxes.	air-sea flux, ocean biomass	global
Miller	In situ CO2-based evaluation of the Carbon Monitoring System flux product	Use independent (in situ) CO2 observations, mainly from the NOAA network, to evaluate the CMS flux product.	land-air flux	Global
Shuchman	Development of New Regional Carbon Monitoring Products for the Great Lakes Using Satellite Remote Sensing Data	Develop new Grate Lakes satellite derived primary production model to produce monthly and annual carbon fixation products.	lake biomass	Great Lakes Region
Verdy	Towards a 4D-Var Approach for Estimation of Air-Sea Carbon Dioxide Fluxes	Develop the methodology for 4D-Var data assimilation in a coupled physical-biogeochemical ocean model, to improve the estimation of air-sea co2 fluxes	air-sea flux	California coastal ocean
West	Estimating Global Inventory-Based Net Carbon Exchange from Agricultural Lands for Use in the NASA Flux Pilot Study	Develop a global gridded dataset for cropland carbon fluxes, based on global- and country-level inventory data on crop yields	land-air flux	Global ocean

Uncertainty WG continued

Table 2. Plans for representing uncertainty in NASA CMS projects (2012)

PI Last Name	***WG #***	***Plans for uncertainty estimates if any***	***Uncertainty categories: 1. ensemble, e.g., stochastic; 2. deterministic; 3. model-data comparison; 4. model-model comparison; 5. data-data comparison***
Andrews	1	1) case study with two separate transport models (STILT-WRF vs HYSPLIT-HRRR), 2) bayesian versus geostatistical inverse modeling, 3) tests of alternative data-weighting and inclusion/exclusion of certain datasets	All of the above
Baker	2	The 4DVar inversion method produces a low-rank covariance estimate. This will be compared to a better estimate of the covariance produced by a GOSAT OSSE study to assess the scales for which it may be useful.	Both deterministic and ensemble
Behrenfeld	3	preliminary evaluation of uncertainty can be made with point-source data but full evaluation of global phytoplankton carbon retrieval uncertainties is beyond the scope of current study and must await additional funding.	model-data comparison
Bousserez, Henze	4	Two approaches:1)stochastic: Monte-Carlo (Junjie Liu), gradient-based randomization, 2)deterministic: using the BFGS inverse Hessian approximation	deterministic and ensemble
Dubayah	5	1) pixel-level uncertainty estimates for local scale biomass map. 2) Bayesian based model flexibilty and uncertainty analysis 3) Improved metholdogy for estimating FIA biomass estimates in 'non-forest' lands and plot-pixel level comparisons with lidar biomass maps	model-data comparison, model-model comparison
Fisher	6	The primary objective is to provide structural uncertainty from the multi-model ensemble for the GEOS-Chem atmospheric inversion model.	model-model comparison
French	7	Developing a full uncertianty estimation plan under this grant with some aspects completed. Some part of the model will be difficult to asses, so staregies to complete a full error anaysis will be developed for implementation in future versions of the model.	model-data and model-model comparisons
Ganguly	8	Produce error propagation and uncertainty analysis for all carbon stock and stock change calculations. The bootstrapping approach to uncertainty assessment will be used. Estimate statistical uncertainty bounds associated with the final forest carbon stock and change estimates using a randomized, Monte Carlo-style sampling technique. The bootstrapping will be performed on each individual model component used in generating the gridded forest carbon estimates. The major individual model components for which we will conduct this procedure include: (a) the allometry models relating forest structure to biomass (USFS-FIA); (b) the model relating FIA estimated above-ground biomass to the remotely sensed observations; (c) the relationship between above and below-ground biomass (USFS-FIA); (d) the spatial modeling for extrapolating litter, CWD, and SOC; and (e) the model for estimating forest loss/recovery from remote sensing observations.	ensemble
Healey	9	We have a straightforward variance estimator, based on sample theory, that will provide credible confidence intervals for our country- and global-level estimates.	deterministic
Houghton	10	Errors associated with modeled net and gross fluxes of carbon will be analyzed.	model-data comparison

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Jacob	11	Formal uncertainty analysis from ensemble 4-D Var approach, evaluating with suborbital data sets	ensemble
Kasischke	12	Monte Carlo simulation	ensemble
Kennedy	13	To characterize uncertainty in our core imputation steps, we will use the cross-validation results. That measure of uncertainty is aspatial, however. For spatially-explicit estimates of uncertainty, we will produce multiple runs of the entire prediction system for all pixels, and use the variability as an estimate of uncertainty. The multiple runs will vary in three categories: 1. different strategies for time-series analysis of Landsat imagery; 2. different approaches to drawing plot data in imputation space; 3. different allometric equations to convert plot-level tree data to plot-wide biomass estimates.	model-model comparison
Key	14	measurement accuracy is generally determined by simultaneous analysis of primary or secondary standards of known concentration	data-data comparison
Liu	15	The following is how we categorize the uncertainty in the flux estimation from atmospheric top-down flux inversion. Currently, we use both Monte Carlo approach and formal numerical uncertainty quantification extracted from numerical minimization algorithm (Nicolas Bousserez). In the Monte Carlo approach, we sample the uncertainty of both the a priori flux and observations, and then the standard deviation of the Monte Carlo flux estimations gives the uncertainty estimation. The uncertainty of the a priori flux is from the model-model comparison (e.g., different biospheric models), and the observation uncertainty is from the product. In addition, we also investigate the sensitivity of the flux estimation for one category of flux (e.g., biosphere flux) to the uncertainty of the prescribed flux (e.g., Fossil fuel).	deterministic and ensemble
Lohrenz	16	We will focus on quantifying the estimation errors and uncertainties induced by modeling algorithms, model parameters, input data and the coupling between land and ocean models. Formal assessment of uncertainty in coupled land surface-ocean models includes several steps: (1) identification of the output(s) of interests, (2) identification of a limited set of input parameters to which outputs are most sensitive, and that may vary depending on the output of interest, (3) development of the distributions for inputs and their correlation structure, (4) design and evaluation of a Monte Carlo experiment. The input parameters exhibiting the highest model sensitivity will be identified and studied in more detail.	ensemble
Menemenlis	17	model-data comparison	model-data comparison
Miller	18	distributions and summary stats of differences between observed and modeled CO2	model-data comparison
Shuchman	19	Preliminary evaluation of uncertainty will be made with in situ data for the upper three lakes. Full intra-annual and lower lake uncertainty analysis will be discussed under this program, however full implementation may require additional funding	model-data comparison
Verdy	20	We will quantify the consistency of the model with available observations	model-data comparison
West	21	A range of values have been collected in a meta-analysis for each parameter used in estimating crop growth and associated carbon content. These values will be used to generate PDFs which will constitute the monte carlo analysis.	ensemble

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Appendix 1: Definitions of uncertainty classes.

The types of uncertainty used in CMS can be grouped into five categories:
1. Deterministic
2. Stochastic/Ensemble
3. Model-data comparison
4. Model-model comparison
5. Data-data comparison

Definitions:

The first two types require some background on estimation theory.

In optimal estimation theory, a linear error analysis may be performed to quantify the constraint provided by a set of measurements on some variables to be estimated (the "state" of the system). In its simplest form, the dynamics are assumed to be known perfectly, and the only errors in the system are assumed to be unbiased gaussian random errors in the measurements and initial guess of the state. A covariance matrix describing the errors in the state after the estimation process ("a posteriori") may be derived analytically in terms of the initial ("a priori") errors in the state, the errors in the measurements, and the details of the dynamical and measurement models. This a posteriori covariance matrix may be used to place "error bars" on the estimate, to examine correlations between the elements of the state, or to design a measurement system to meet performance requirements for the system.

#1 Deterministic: For smaller problems, this approach can be used to estimate uncertainties directly, with a full-rank state error covariance matrix being produced as a by-product of the inversion. Traditional sensitivity analyses (where parameters are varied and outputs evaluated) can be considered in this category.

#2 Stochastic/Ensemble methods: For larger problems, the full set of linear equations is too large to store or invert directly: more-efficient inversion techniques must be used to approximate the state covariance with a low-rank substitute. In variational methods, this covariance is built up from iteration to iteration of the descent method; in ensemble filters, each ensemble member provides a column in the square root of the covariance. These low-rank covariances do not give reliable estimates of the state uncertainty at the finer scales estimated.

Therefore, stochastic methods are use preferentially. Stochastic methods make use of the probabilistic nature of the Bayesian inversion problem to approximate the covariance matrix of analysis errors. A set of perturbed inversions is generated by adding random errors to the input parameters (prior state and observations) according to their assumed error statistics. The distribution of the posterior states is then used to infer a low-rank approximation of the covariance matrix of posterior error.

Operationally, a "true" state is chosen and the model run to produce a "true" set of measurements. A random draw of errors consistent with the assumed measurement covariance is added to these. The perturbed measurements are then used to estimate the a posteriori state using the inversion method, which generally constrains the estimate to remain close to a Bayesian prior. The difference between the true and a priori state is also chosen stochastically to be consistent with the assumed a priori flux error covariance. The a posteriori state estimate is compared directly to the known true state, and

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statistics on the difference are accumulated across an ensemble of multiple error realizations to give an approximation to the full rank state error covariance.

Both #1 and #2 assume we have a perfect model, and that we are feeding it imperfect data. In contrast, types #3 and #4 assume that there is error in both the model and the data.

#3. Model-Data: Run the model in locations where actual data *do* exist, but were not used in building the model. Compare predictions to actual observations. The term “model” can be use broadly to include statistical models, e.g. generalized linear models, geostatistical approaches, etc.

#4. Model-Model: Run different models and characterize uncertainty using some measure of variance among models (stdv, RMSE, etc.). This assumes that each model is equally defensible, and that there is no way a priori to determine the best model of reality.

The last method family focuses entirely on the errors in measurement of data themselves.
#5. Data-data: Compare observations from one source to higher-quality and more stable standards. Sometimes done as a complement to estimation of the interpolation errors at points.

CMS Algorithm Assessment/Intercomparison Working Group

Progress Report, 2013

Coordinator: Scott Powell, MSU
Members: David Baker, Molly Brown, Jim Collatz, Vanessa Escobar, Nancy French, Sangram Ganguly, Daven Henze, Chris Hill, George Hurtt, Christine Kang, Eric Kasischke, Robert Kennedy, Junjie Liu, Steven Pawson
Email List: cms_wg_algorithms@gs618-ccesrvl4.gsfc.nasa.gov

Charge

- Document the range of intercomparison activities within each of the primary domains (biomass, flux, oceans).
- Identify key gaps where further intercomparison efforts are warranted.
- Document effective strategies for intercomparison activities.

Approach

- Solicit CMS team input to survey question about intercomparison efforts.
- Coordinate with Working Group members to document "best-practices" for intercomparison activities.

Results

- Documentation of current and anticipated intercomparison efforts by primary domain (Biomass, Flux, Oceans) (Table 1).
- Documentation of discussion about effective strategies for biomass map comparisons.
    - Key issues to consider: Differences among maps due to data, methods, and scale.

Next Steps:

- Incorporate new Phase II projects into documentation.
- Continue to seek project- and domain-level input to finalize table.
- Continue domain-level discussions on effective strategies for intercomparison activities, especially Flux and Oceans.

Table 1. Documentation of current and anticipated intercomparison activities by primary domain (2012 Phase II studies only).

PI/CMS Study	**Intercomparison Activities**
BIOMASS	
Cook: Improving forest biomass mapping accuracy with optical-LIDAR data and hierarchical Bayesian spatial models	• (awaiting feedback)
Dubayah: High Resolution Carbon Monitoring and Modeling: A CMS Phase 2 Study	• Comparison to national scale maps (NBCD, FIA, CMS P1) • Comparisons between lidar and FIA biomass maps and ED modeled biomass at local scale
Healey: A global forest biomass inventory based upon GLAS lidar data	• Estimates can be compared with field-based estimates in countries with an established national forest inventory

Houghton: Spatially explicit sources and sinks of carbon from deforestation, reforestation, growth and degradation in the tropics: Development of a method and a 10-year data set 2000-2010	• Previous estimates of tropical emissions from land use and land-cover change
Kasischke: The Forest Disturbance Carbon Tracking System A CMS Phase 2 Study	• Intercomparison of carbon consumed during fires will be carried out between different modeling approaches and fire emissions database
Kennedy: Integrating and Expanding a Regional Carbon Monitoring System into the NASA CMS	• Comparison to national scale maps (NBCD, FIA, CMS P1) • Comparison at select sites to lidar-based estimates
Saatchi: Prototyping MRV Systems Based on Systematic and Spatial Estimates of Carbon Stock and Stock Changes of Forestlands	• Comparison to national scale maps (NBCD, FIA)
FLUX	
Andrews: North American Regional-Scale Flux Estimation and Observing System Design for the NASA Carbon Monitoring System	• Comparison of best estimate CO2 profiles with ACOS GOSAT data, • Evaluation of posterior fluxes using surface and aircraft data, • Comparison of best estimate fluxes with CMS-FPP and NOAA CarbonTracker fluxes
Bowman: Continuation of the carbon monitoring system flux pilot project	• Surface and aircraft sampling network, TCCON
French: Development of Regional Fire Emissions Products for NASA's Carbon Monitoring System using the Wildland Fire Emissions Information System	• Site (landscape-scale) comparisons with other fire emissions methods including GFED (French et al 2011)
Huntzinger: Reduction in Bottom-Up Land Surface CO2 Flux Uncertainty in NASA's Carbon Monitoring System Flux Project through Systematic Multi-Model Evaluation and Infrastructure Development	• Evaluate the consistency of MsTMIP model estimates with atmospheric CO2 observations, providing an additional benchmark of land-surface model performance. Multiple benchmark datasets.
Jacob: Use of GOSAT, TES, and suborbital observations to constrain North American methane emissions in the Carbon Monitoring System	• Surface and aircraft sampling networks, TCCON; SCIAMACHY

Lohrenz: Development of observational tools and coupled models of land-ocean-atmospheric fluxes and exchanges in the Mississippi River watershed and Gulf of Mexico in support of carbon monitoring	• USGS monitoring data, ship-based observations, NOAA Ocean Acidification monitoring program
Miller: In situ CO2-based evaluation of the Carbon Monitoring System flux product	• Comparison between observed CO2 and a posteriori modeled CO2 from the CMS flux product
Pawson: GEOS-CARB: A Framework for Monitoring Carbon Concentrations and Fluxes	• Sander Houweling is conducting an intercomparison of satellite-based CO2 inversions under the aegis of the Transcom project. • in situ CO2 measurements at surface and from aircraft, land-based column CO2 measurements from TCCON, etc.
Verdy: Towards a 4D-Var Approach for Estimation of Air-Sea Carbon Dioxide Fluxes	• Adjoint model evaluation of the cost function (misfit between observations and model); GLODAPv1, CARINA, PACIFICA
West: Estimating Global Inventory-Based Net Carbon Exchange from Agricultural Lands for Use in the NASA Flux Pilot Study	• Inherent intercomparison with inventory and MODIS data
OCEANS	
Balch: Coccolithophores of the Beaufort and Chukchi Seas: Harbingers of a polar biogeochemical province in transition?	• (awaiting feedback)
Behrenfeld: Characterizing the phytoplankton component of oceanic particle assemblages	• Site specific comparison to local optical measurements
Shuchman: Development of new regional carbon monitoring products for the Great Lakes using satellite remote sensing data	• Comparison to Lake Michigan and Lake Superior in situ measurements. Need comparisons to in situ measurements in Lake Erie and Lake Ontario. NOAA GLERL in situ monitoring data.

CMS Capability Risk Working Group

Coordinator: Joshua B. Fisher, JPL
Members: Bob Key, Princeton; George Hurtt, UMD
Email List: cms_wg_risk@cce.nasa.gov

Charge
Create a report of current and planned remote sensing capabilities used across the CMS, and their expected lifespans; then, identify missing parts or expected gaps to help with planning.

Approach
Gather existing tables of relevant missions, instruments, and lifespans; update tables through user input from CMS.

Results

- Tables for land, ocean, and atmosphere have been compiled and formatted.
- A section for putting your name next to each mission/instrument if you use it, and space for a quick statement on how you use it are included.
- There is a section for relevant missions/instruments that are not included.
- Exclude in situ and airborne capabilities for now.
- Tables have been imported into Google Docs.
- Link/tables have been sent to JPL team (land, atmosphere, ocean), to George Hurtt, and to Diane Wickland for initial review.

Next Steps

- Iterate with George Hurtt on changes/edits.
- Send to larger CMS team.
- Review edits/responses from CMS team.
- Write report.

Link to Table (editable only if Fisher provides permission):
https://docs.google.com/spreadsheet/ccc?key=0AtupLt5e_5rydHZ2U1dFZV9oNjZuY2NyOVZyLXc5d2c&usp=sharing#gid=0