AgMIP

The Agricultural Model Intercomparison and Improvement Project

NORTH AMERICAN REGIONAL WORKSHOP

SEPTEMBER 4-7 2012
AMES, IOWA

USDA

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Agricultural Model Intercomparison and Improvement Project (AgMIP)

North American Regional Workshop

September 4-7 2012
Ames, Iowa

Workshop summary

Attendance: The workshop was attended by 44 individuals from different disciplines over the four-day effort to address the objectives of the workshop. These individuals represented a range of expertise and each contributed significantly to the workshop goals and outcomes.

The workshop summary is presented as outcomes from each of the five different components of the AgMIP effort: crop modelling, economics, climate, information technology, and regional assessment. Each of these groups had separate meetings during the workshop and worked across groups in order to gain insights about the needs and collaborative efforts needed to enhance the progress within each component of the project.

Climate scenarios:
Efforts will focus on the development of baseline data sources for North America to link with crop-climate models, sensitivity evaluations of models to changes in CO_2, temperature, and water (CTW), and development of future scenarios. Development of the baseline analysis will include the identification of historical climate sets using co-located meteorological stations, nearest meteorological stations, and gap-filled meteorological time series. One of the linkages discussed was the use of raw GCM/RCM output as part of the statistical downscaling methods in order to provide future scenarios for the crop simulation models.
As an action item, the climate team will continue to work on all of these aspects to provide comprehensive climate data for the crop models.

Crop models:
The crop model team began their discussions on Tuesday in order to cover the large range of information required for an assessment of the progress and development of future plans. The results of these discussions were as follows;
Goals for CTW (CO_2, temperature, and water) model improvement activities

1. Discuss the need for improving crop model performance based on CTW data.
2. Determine best modelling approaches for predicting response to CO_2, temperature, and water.
3. Identify data available for testing and coordinate data sharing, model testing, and resulting papers.
4. Develop teams, by crop, to share data, test and improve crop models.

The first day (Tuesday, September 4) of the NA Regional AgMIP Workshop was devoted to the CTW activities which were continued at specified breakout times during the rest of the workshop. CTW participants include those identified below in presentations or discussions of data availability as well as discussions of model improvement and teams to proceed with sharing data and testing crop models.

Identifying Data Available and Introducing Experimentalists

1. Sharon Gray - FACE data on maize and soybean
    a. Treatments: CO_2 levels on soybean (2001 to 2008, 2002 and 2004 data were provided by Sharon and Andrew Leakey prior to the Workshop)
    b. Treatments: CO_2 levels on maize (2002 to 2008, need to contact Carl Bernacchi to obtain the data and permission to use it)
    c. Measured Vcmax, leaf CER, canopy ET (residual energy method), phenology, LAI, height, biomass, grain over time). Many other measurements. Soil water measured since 2002.
2. Laj Ahuja – Maize data with RZWQM modeling group
    a. Five irrigation levels on four crops (maize, wheat, bean, sunflower) over 4 years
    b. Measured soil water, Bowen Ratio, phenology, canopy cover, foliage temperature, some biomass). Still in process of collecting 4^{th} year, but anticipate data to be available.
3. Bruce Kimball – Arizona FACE on cotton, wheat, and sorghum, and Hot Serial Cereal on wheat
    a. CO_2 level on cotton in OTC (1983)
    b. CO_2 by water on cotton in OTC (1984 and 1985)
    c. CO_2 by water by N on cotton in OTC (1986 and 1987)
    d. CO_2 level on cotton in FACE (1989) and CO_2 by water on cotton in 1990 and 1991
    e. CO_2 by water on wheat in FACE (2 years starting 1992)
    f. CO_2 by N on wheat in FACE (2 years starting 1995)
    g. CO_2 by water on sorghum in FACE in 1998 and 1999
    h. 2 years of Hot Serial Cereal with 3 sowing dates per year with T-FACE and ambient temperature. About 6 additional sowing dates per year without T-FACE spaced throughout the year.
    i. Measured phenology, leaf CER, ET, foliage temperature, biomass, LAI, NDVI, grain mass over season and end of season. Soil water and many other measurements. Data is available.
4. Jim Kiniry – Maize data, past and present, CERES-Maize
    a. Experimental data on maize and other crops collected by him or by his modelling collaborators are described on his website and can be requested by contacting him.
5. Jerry Hatfield – Corn and soybean data near Ames, IA

   a. Treatments – Multiple seasons on maize and soybean in Meriflux site since 2000
   b. Measured CO_2 and water vapor exchange, foliage temperature, phenology, LAI weekly, reflectance, and for past few years, growth samples at 3 to 4 times per season. Data is available.
6. Rob Malone – N balance and N_2O flux data with ARS group at Ames
   a. N rate and timing experiments on maize
   b. Measured N leaching, water drainage, growth stage, final yields
7. Dennis Timlin – Maize data with MAIZSIM group
   a. Five temperatures by two CO_2 levels on maize in sunlit controlled environment chambers. Other treatments include water by CO_2, and N by P, and temperature during grain filling
   b. Measured transpiration, leaf CER, and canopy CER during season, and sampled four times for biomass, LAI, leaf, grain, etc. Contact Dennis on data.
   c. Field growth data for maize (3 years at 2 sites in Maryland; 3 years at Beltsville), with typical destructive growth analyses during the season. Contact Dennis on data, published with MAIZSIM.
8. Tony Vyn – Maize data at West Lafayette, IN
   a. N fertility and sowing density treatments
   b. Measured leaf stage, biomass, leaf, stem, tissue N conc. Data in process, contact Tony.
9. Teshome Regassa – Nebraska irrigated and rainfed maize trials
   a. Irrigated and rainfed, many varieties, many past years
   b. Only grain yield. Most past data is in old format, not easily accessed, need IT help.
10. Gail Wilkerson – Maize and soybean data in North Carolina
   a. Maize data for irrigated, rainfed, N rates, collected by Heiniger in 2001 and 2002.
   b. Soybean Experiments: 3 cultivars in 1986, 4 cultivars (MG V, VI, and VII) by 8 sowing dates in 1987 and 6 sowing dates in 1988, 15 cultivars in 1993 sown May 12, 12 cultivars in 1993 sown July 22, 31 cultivars in 1994 sown May 25, drought study using rainout shelter in 1997 and 1998 (grain yield and phenology on all of these, but growth analyses only in some years). Data for all but 1993 and 1994 studies were provided to Cheryl Porter at the Workshop and is available. We can provide data for 1993 and 1994 study too. One of the most interesting things that we noted in the 1993 and 1994 study was how much variability in development there was within a given maturity group, and how cultivars switched positions in relationship to each other in some cases in terms of timing of developmental stages when planted on different dates. It appears to us that maturity group gives only a very rough estimate of when a particular genotype will reach important development stages. As genetic information on commercial cultivars is very closely held, cultivars arrive on the market and depart in only a few years, and performing planting date studies on multiple cultivars is labor intensive, this seems to be a problem that we

should consider while moving forward to improve soybean models. How do we deal with the fact that there are now over 370 cultivars for sale in NC, and there will likely be a different 370 available in 5 years? How do we obtain any specificity in simulated results, and continue to have models that reflect the range of responses of current (and future) cultivars to climate variability and possible climate change? It seems that we need some help from the seed companies.

11. Jeff White – Regional and international trial data
    a. Described multi-location environment trials on wheat, dry bean and sorghum collected by international, regional, and state breeders.
    b. Measured final yield, limited phenology. Nearly always lack sufficient management and soil inputs. Data availability varies. Contact Jeff White for advice on strategies for accessing.
12. Ted Wilson – Rice experiments in Texas and weather data collection
    a. Multiple rice inbred and hybrid treatments, over past 5 or more years.
    b. Measuring 28 phenotypic and process traits, including canopy CER and respiration every 5 min over 3 day periods. Ask Ted Wilson about availability of data.
13. Montse Cortasa with Larry Purcell – Soybean data in Arkansas
    a. New experiment started in 2012, evaluating four MG of soybean (MGs 3, 4, 5, and 6) sown on four sowing dates at 8 sites in mid-south (30.6 to 36.4N).
    b. Measuring phenology carefully and final yield components. Goal is to develop a good database and cultivar coefficients for CROPGRO-Soybean and SOYDEB, in order to make management recommendations relative to sowing date and cultivar. Data availability in future after project is completed.
14. Matthew Reynolds – Wheat experiments at CIMMYT
    a. Evaluate many genotypes of wheat at CIMMYT and other sites over past years.
    b. Measure phenology and foliage temperature during the season, and biomass, height, and yield components at maturity. Check with Matthew Reynolds on data availability.
    c. Foliage temperature is a good tool to select for deeper more effective roots.
15. Terry Howell – ET data on various crops
    a. Treatments include sunflower, maize, and soybean
    b. Measure ET, height, width, LAI, total dry matter. Agrees to work with modelers on ET data.
16. Vara Prasad – Temperature effects on wheat, sorghum, rice, and peanut
    a. Treatments: Elevated temperature levels on sorghum, wheat, bean, peanut, and soybean.
    b. Measure phenology and CER on some dates, and biomass, grain yield, grain number, grain size at maturity. More detailed data on pollen viability and flower-set in many of the studies. This data is mostly available, some from University of Florida where peanut and bean studies were done.

17. Senthold Asseng – GCTE wheat data
    a. In the late 1990s, the GCTE conducted wheat and rice crop model intercomparison studies. GCTE had a poor transition and follow up and the data were almost lost, except for recovery of the wheat data by Tony Hunt and now in DSSAT4.5 format. Data are available from Senthold Asseng and Jim Jones.
    b. Measurements are the typical growth analyses used to test crop models.
18. Ken Boote – Soybean, peanut, rice, and bean data and response to CO_2
    a. Soybean experiments on irrigated and rainfed cultivars in 1976, 1978, 1979, 1980, 1984, and 1987 at Gainesville, FL. The data from these studies are publically available in the DSSAT, including data in 1988 and 1990 from Iowa (Shibles) and Ohio (Cooper), and 26 treatments over 3 years with irrigated and rainfed cultivars at Lugo, Spain (F. Sau).
    b. Peanut experiments on irrigated and rainfed cultivars in 1976, 1981, 1986, 1987, 1989, and 1990.
    c. Temperature and CO_2 treatments conducted in sunlit controlled-environment chamber studies on soybean in 1987, 1993, and 1994.
    d. Temperature and CO_2 treatments conducted in sunlit controlled-environment chamber studies on peanut in 2002 (Vara Prasad).
    e. CO_2 and temperature treatments on rice in sunlit controlled-environment chamber studies over 6 years (Jeff Baker).
    f. Measurements in field studies include vegetative and reproductive phenology, LAI, leaf, stem, pod, and grain over time and often leaf and canopy CER. Measurements in SPAR systems are mostly end-of-season on same aspects.
    g. Availability: Field data on above experiments are already part of the files distributed with DSSAT for soybean and maize and are available for the public. Data for SPAR experiments are not in DSSAT system, but will be made available for the soybean and peanut crop pilot studies (only to those participating in that comparison). Similar data from rice experiments have been well published and are available, but will require co-authorship of Jeff Baker.
19. Thijs Tollenaar –Extensive maize data across US
    a. The maize model improvement group (MMIG) has connected with maize phenology data being collected or formerly collected throughout the USA by Monsanto and by MMIG participants in Nebraska, Indiana, Iowa, Maryland, Canada, and Australia.
    b. Measurements on leaf tip appearance, anthesis, and black layer maturity are being used by the maize model improvement group to test various maize phenology models. Most of the sites also have final yield and yield components.
    c. Experimental maize dataset for Monsanto test sites in California drought trials.
20. K R. Reddy – Cotton data and response to CO_2 and temperature
    a. Treatments of temperature and CO2 on cotton in sunlit, controlled-environment chambers.

   b. Measured phenology, vegetative growth, boll growth, and final yield traits. K. R. Reddy was not able to come to, so data availability is not known.
21. J. T. Ritchie – Description of SALUS crop model features
22. Cesar Izauralde – Description of EPIC crop model features

During this meeting, we concluded that we needed to establish policies and standard forms regarding data availability. While our aim is to promote open access to data in the AgMIP data bases, we wish to respect exceptions especially where those who collected the data are still working with it and publishing it. We believe there may be five options relative to data availability and we need data providers to indicate such on a standard form (**AgMIP leadership will create such a form**). (Note: metadata indicates just the description of what the data is, but not actual values). The five options to choose from (complete the italicized portions to fit):

1. I agree to make these data freely available through the AgMIP database. Those who use the data are expected (*or required?)* to cite the data and acknowledge the data owners.

2. I agree to make these data freely available through the AgMIP database, but only after _____*, 2014*. Until then, I agree to make the metadata available.

3. I agree to make the metadata for this set of data freely available on the AgMIP web site. Those who wish to use the data should contact the following: *xxxxxxxxxxx nnnnnnnn*.

4. I agree to make these data available to the following groups in AgMIP. I also agree that AgMIP can store the data, and that it will respect the limitation to distribute only to the following internal AgMIP Group *ggggggggggg*.

5. I agree to make these freely available through the AgMIP database for use in improving agricultural models. All users must cite the data source. Those users who wish to publish part or all of the data before __________ are required to obtain permission from the authors.

Modeling the Processes Important to Account for CTW Effects

Proposed Topics:

1. **Predicting growth and photosynthesis response to CO_2 and temperature:** what approaches are needed? How to test? Enzyme-level? Process-level? Leaf-level? In-season growth? Yield? Dealing with fluctuating CO_2 (FACE versus steady-state)? K. J. Boote to lead this.
2. **General temperature responses for phenology, growth, and reproductive**. GDD? Linear versus non-linear functions? What happens at super-optimum temperatures? Are cardinal temperatures the same during grain-filling? Thijs Tollenaar to lead this – discuss Maize Model Improvement Group and review approaches for modeling phenology response to temperature in maize.
3. **Acute temperature stresses of elevated temperature** on pollen-viability, silking-anthesis interval, spikelet-sterility, and grain-set. How to improve the models for these effects? Accounting for frost damage? Interactions of crop models with statistically downscaled temperatures in climate scenarios? Vara Prasad to lead this.
4. **Modeling transpiration response to CO_2 (soil water uptake and stress effects):** Current crop models have highly different methods for predicting transpiration. Can it be done with daily time-step models? Is instantaneous energy balance needed? Accounting for increased canopy resistance correctly. Kimball, White, Howell, Boote?

1. **Maize Model Improvement Group activities** were led by Thijs Tollenaar.
    a. An expert panel for maize model improvement has been established to discuss up-to-date information on physiological processes underlying maize growth and development and their incorporation in a maize model, sharing ideas about processes that modelers can take back to improve their own models or develop an overall improved model. Connect to MMIG site at http://research.agmip.org/display/mmi/Maize+Model+Improvement+Project
    b. Participants of the panel are: Ken Boote (UF), Jill Cairns (CIMMYT, Zimbabwe), Greg Edmeades (New Zealand), Graeme Hammer (Australia), Jerry Hatfield (Ames), Jim Holland (NCSU), Gerrit Hoogenboom (WSU), Jim Jones (UF), Armen Kermanian (PennState), Kim Soo (WSU), Jim Kiniry (Temple), Saratha Kumudini (Monsanto, RTP), Jon Lizaso (Madrid), Claas Nendel (Germany), Maria Otegui (Argentina), Upendra Singh (IFDC), Claudio Stöckle, WSU), Dennis Timlin (Beltsville), Thijs Tollenaar (Monsanto, RTP), Tony Vyn (Purdue), Mark Westgate (ISU), and Fernando Andrade (Argentina), and Haishun Yang (UNL).
    c. The participants meet electronically via WebEx to discuss and compare maize-model subroutines starting with (i) phenology and followed by (ii) leaf area expansion; (iii) light interception, photosynthesis, and respiration; (iv) dry matter distribution prior to silking; (v) dry matter distribution post

silking; (vi) root growth; (vii) water relations; (viii) nitrogen metabolism.

   d. Whenever possible, data will be shared to compare performance of subroutines outlined in (c), which are utilized by various maize models, and results will be discussed.
   e. Phenology was the first subroutine to be discussed. Different approaches for temperature effects on prediction of rate of leaf tip appearance and reproductive growth stages were discussed. We discussed linear and nonlinear functions and what was in five current maize models. Tollenaar presented evidence that there is a degree of nonlinearity in temperature effect on rate of leaf tip appearance, and that reproductive development after anthesis truly requires a non-linear function that practically did not have a base temperature (progress to maturity occurs at zero C) based on the General Thermal Index developed by Dwyer and Stewart.
   f. Maize development is affected by soil temperature through the 6-8 leaf tip stage, but that requires models with prediction of good soil temperature which we concluded is a deficiency in many models. Development is additionally sensitive to stresses from water deficit, N deficit, and very low light (growth chamber levels), but most models lack these effects. In addition, a relationship that quantifies temperature effects on rate of kernel dry matter accumulation was presented.

2. **Effects of Acute Temperature Stresses** was led by Vara Prasad.
   a. Elevated temperature effects on pollen-viability, flower fertility, and spikelet-sterility derive from high temperature effects during microsporogenesis and subsequent pollen viability and germination. The sensitive phase for a peanut (legume) flower is about 6-8 days prior to flower opening, lasting until after flowering and pollen-shed. Fertilized ovules are fairly heat tolerant. For sorghum the heat-sensitive phase starts 9-10 days prior to anthesis.
   b. Reductions in pollen numbers and pollen viability occur above diurnal Tmax of 32C for rice, and 34C for peanut, with total failure at Tmax of 41-42C for rice and 46-47C for peanut and soybean. Diurnal temperature cycle of 40/30 C (Tmax/Tmin) causes zero grain-set in rice and sorghum, while grain-set and yield of peanut and soybean are about 4-5C more tolerant. There is insufficient data for maize to define these thresholds. Time of flowering may be important.
   c. Heat stress on photosynthesis is less important than heat stress on reproductive processes because heat-stressed plants continue vegetative growth and accumulate carbohydrates in culms and stems (rice and soybean).

3. **Photosynthetic Response to CO_2** led by Ken Boote
   a. Approaches followed by the modelers range all the way from full Farquhar-von Caemmerer rubisco kinetics with Ball-Berry stomatal conductance and energy balance (MAIZSIM and ECOSYS), to modified rubisco kinetics at leaf-level level (CROPGRO and SUCROS-style models), to ratio adjustments of radiation-use-efficiency (many models).
   b. We agreed that models should be tested at multiple levels, from

processes, to intermediate time-series growth variables, to end-of-season variables, with data from all sources (literature, chamber, and FACE, with consideration for limitations of methodology).
   c. The recent paper of Bunce (2012, Photosynthetics) was discussed relative to the lesser response to CO_2 obtained from fluctuating CO_2 levels compared to continuous constant CO_2. This poses the possibility that FACE studies underestimate CO_2 response because of high frequency fluctuating CO_2 (60 sec cycle). This finding may contribute to the proposed discrepancy between FACE and chamber results. It is somewhat predictable from theory of A:Ci response curves, but depends on the time scale of CO_2 fluctuations.
4. **Modeling the CO_2 effect on transpiration of canopies** led by Stockle and Boote
   a. There was agreement that CO_2 effect reduces leaf-level transpiration and conductance, but that translation to canopy transpiration requires full energy balance approaches because the system must balance energy load.
   b. ECOSYS and MAIZSIM models predict instantaneous canopy energy balance, with leaf–level photosynthesis, Ball-Berry approach for stomatal conductance, with iteration on Ci, foliage temperature, and transpiration.
   c. Daily-time step models (and those without hourly energy balance) need improvement in methods to account for this effect on energy balance, rather than present use of scaled reductions in canopy transpiration based on limited literature.
   d. Stockle compared several approaches for this: 1) transpiration use efficiency (TUE) that considers LAI, CO_2, and vapor pressure deficit, with both TUE and RUE affected by CO_2 (attempt to reproduce Tanner and Sinclair approach), 2) CO_2 effect on canopy resistance term in Penman-Monteith equation, where the resistance is a function of CO_2.

Breakouts by Crop to Develop Plans/Suggestions for Testing Crop Models with CTW Data

1. **Soybean Team** (Soybean Crop Model Pilot was initiated, led by Ken Boote)
   a. People: K. J. Boote, D. Fleischer, Dennis Timlin, G. Wilkerson, Sharon Gray, Cesar Izauralde, Vara Prasad, and Saratha Kumudini (all these present). We will invite others on AgMIP website.
   b. Models proposed: EPIC, CROPSYS, CROPGRO, APSIM, GLYCIM, SALUS, STICS, RZWQM, SOYSIM, others?
   c. Plans: The soybean models will be tested against available CO_2 and Temperature response data from SOYFACE (Andrew Leakey, Sharon Gray) and controlled-environment chambers, as well as against ET studies (SOYFACE, Bushland, other), and field growth studies throughout the

world. We will plan for publication on the topic and presentation at ASA meetings in 2013.

   d. **Future activity:** With all the CTW crop modelers, form a CTW-AgMIP community within the A-3 division of the ASA society for the purpose of discussing and presenting results of testing crop models with CTW data. Plan for presentation in 2013, with a 2-day post-meeting on Thursday and Friday after ASA meetings.

2. **Wheat Team** (led Senthold Asseng)
   a. People**:** Senthold Asseng, Cesar Izaurralde, Bruce Kimball, Teshome Regassa, Matthew Reynolds, Joe Ritchie, Vara Prasad, Upendra Singh, Claudio Stockle, Ted Wilson, Jeff White
   b. Discussed opportunities for 2nd phase of AgMIP Wheat Pilot to improve wheat modeling capacity in close collaboration of experimentalists and modelers for predicting climate change impact and develop adaptation strategies**.**
   c. Suggested Plan: Consensus was that temperature response is where the model uncertainties currently are greatest and where good data are available. The wheat models will be tested against available temperature response data from Hot Serial Cereal, Arizona, (Bruce Kimball/Jeff White/ Mike Ottman/Gary Wall) and international CIMMYT experiments (Matthew Reynolds). Plans for model improvement workshop of modelers and experimentalists in May/June 2013 and presentation at ASA 2013 meeting.
   d. Future activity: Explore other experimental data, including FACE data and new model routines to improve wheat models, explore funding opportunities.
3. **Maize Team**
   a. Maize Model Improvement Group is led by Thijs Tollenaar. Team did not meet separately in Ames. For activities of this group see above.
   b. Other Plans: Intercomparisons of maize models against CTW data (MaizeFACE) will be organized by a future group to be determined.

Economics Assessment:
A number of topics were discussed by the Economics team including intercomparison of economic models and impacts assessment for future National Climate Assessment processes. For the model intercomparisons there was a need to identify all of the available economic models and potential collaborators to complete these intercomparisons over the next year. To conduct these studies will require a standardized climate and crop impact scenarios from which there is a need for harmonized management assumptions, baseline crop yields, estimates of productivity growth rates, and quantifying the different levels of uncertainty. In this latter effort, the uncertainty was brokwn into climate uncertainty, crop response uncertainty, and economic response uncertainty.

The integrated assessment for the North American region will require an assessment of the risks and vulnerabilities in the 21st century, development of an integrated assessment methodology, and coupling models to allow for both aggregate and spatially explicit regional scale assessments. To address these needs efforts will be established to identify the data needs for the economic models, development of scenarios for representative agricultural pathways (RAPs), and development of methodologies for model intercomparison, model coupling, and quantification of the uncertainty from various sources.

Information Technology:
The IT group developed a number of tooos capable of providing assistance to the overall project by evaluating different database structures which would allow for the implementation of translation tools. These translation tools would allow for one-time entry of data and the ddata translated into the format necessary as input for different crop simulation models. As part of this effort, the standard list of variables was designed to follow the ICASA list of variables. The IT efforts focused on the application of these tools for climate scenarios, management regimes, crop growth data, irrigation, and incomplete soil data.

North American Regional Assessment:
In preparation for the 2017 National Climate Assessment an effort was developed to construct an action plan for the AgMIP efforts focused on the North American region. The purpose of this effort is to create a strategy for integrating the relevant research community and science toward a continuing assessment process for agriculture. The vision for this effort is to position US agriculture to be able to effectively and economically adapt to climate change using information derived from AgMIP. A number of knowledge gaps were identified including livestock, pests, natural resources, agricultural systems, social sciences, role of diet and health in decision making, near-term climate assessment (5-20 years) and evaluation of innovative adaptation strategies. The AgMIP project is capable of providing a framework for improving agricultural (crop, livestock, and economic) models, integrating climate scenarios into agricultural models, storing, collecting, and retrieving data, and developing a strong scientific community to share ideas to construct effective and useful information. There are some immediate tasks developed from these discussions; first, development of an assessment plan for North America, conduct symposia and workshops, foster a North American community to integrate climate, crop, and economic models into an assessment framework.

AGENDA

The overall goal of the workshop is to develop AgMIP regional project objectives, activities, and outcomes to advance understanding of potential agricultural futures in North America. The workshop will be comprised of a transdisciplinary community of scientists including expertise in agronomy, soil science and hydrology, climate science, agricultural economics, and information technologies.

Objectives:

- Determine the key climate variability and change-related questions for agriculture in North America.
- Evaluate CO_2, temperature, and water interactions using available data and their effect on the performance and improvement of multiple crop models.
- Develop tools for translation of crop model data from AgMIP Crop Experiment database to model-ready files for multiple crop models.
- Create a strategy for integrating the relevant research community and science toward a continuing assessment process for agriculture.

These objectives create the opportunity to demonstrate and build capacity for regional research activities described in the AgMIP Protocols at pilot locations using multiple climate, crop, and economic models to understand important uncertainties of climate impacts on agricultural production and food security.

The focus of the North American Workshop will be to provide a forum for the intercomparison and improvement of crop models, development of climate data and scenarios, and the intercomparison of regional economic models, with the goal of integrating these elements into a strategy for a North America assessment. To facilitate this, the workshop activities will be divided into parallel tracks: Crop Model Improvement for Carbon Dioxide, Temperature, and Water Interactions, Data Translation Tool Development, Climate Data and Scenarios, Regional Economic Model Intercomparison, and North America Assessment Planning. Each of these tracks provides a means for building and facilitating a community for continuing interactions within and among these groups.

The Crop Model Improvement and Data Translation Tool Development Tracks will start on Tuesday morning, September 4. The full Workshop with all the Tracks will start on Wednesday morning, September 5. This organization allows for the maximum amount of impact toward the AgMIP objectives in this short week.

Day 1, Tuesday, September 4, 2012

Objective: Intercomparison and improvement of Crop Models with focus on carbon dioxide, temperature, and water interactions (CTW) and data translation tool development (IT).

8:00 am Welcome and Introductions – Jerry Hatfield, Jim Jones, and Cynthia Rosenzweig

8:30 am Overview of AgMIP Crop Modeling Effort

Improving crop models by considering temperature, water, and CO_2 interactions – Ken Boote

Data translation tool development – Cheryl Porter

9:00 am Breakout Groups – CTW and IT

CTW breakout agenda:

9:00 am Experiment Reports

Each person presents two slides of experimental work on CO_2, T, and/or W

10:00 am Break

10:30 am Crop Model Reports

Each person presents two slides of crop model representation of CO_2, T, and/or W

11:30 am Group Discussion on crop model improvement for CTW

IT breakout agenda

9:00 am Overview of goals, development protocols (C. Porter and C. Villalobos)

10:30 am Work in teams to develop data translation tools

12:30 pm Lunch

13:30 pm Breakout Groups – CTW and IT

CTW -- By crop with experimenters and modelers in each group, testing data in multiple models.

Responses to CO_2 and temperature
Common responses among crops and models
Divergent responses

Implications for modelling and future crop responses under climate change

IT – Tool development for data translators for multiple models

17:45 pm Adjourn

Day 2 Wednesday, September 5, 2012

Objective: Development of AgMIP in North America

8:00 am Welcome, Introductions, and Workshop Goals – Jerry Hatfield, Jim Jones, and Cynthia Rosenzweig

8:30 am Overview of AgMIP
- Climate Team
- Crop Model Team
- Economics Team
- Information Technology Team
- Integrated Regional Assessment

9:30 am Plenary Talk

AgMIP Cross-Cutting Themes: Uncertainty, Aggregation and Scales, and Regional Agricultural Pathways

10:30 am Break

11:00 am Parallel Sessions – Plans for the Workshop

- Crop Model Improvement
- Climate Scenarios
- Regional Economic Model
    - Intercomparisons, regional-national-global model linkages, impact assessments
    - Sub-national case studies – e.g. US Corn Belt or Wheat Belt
- IT Tool Development
- North American Regional Assessment Planning

12:00 pm Lunch

13:00 pm Parallel Sessions – Work Session

Crop Model Improvement: continuation of model evaluations

Economics Team

- Review models and data (short presentations by each)
    - ERS REAP
    - Oregon State TOA-MD
    - regional land use (OSU, ISU?)
    - AgCanada
    - Texas A&M, FASOM
    - Mexico
    - Other
    - Data sources
- Review plan for rest of workshop

15:00 pm Break

15:30 pm Parallel Sessions Continue

18:00 Evening Reception

Day 3, Thursday, September 6, 2012

Objective: Continued Development of AgMIP in North America

8:30 am Joint Session – Goals for the Day

9:00 am Regional Perspectives
- Canadian Perspective
- Mexican Perspective
- United States Perspective

Discussion

10:00 am Break

10:30 Parallel Sessions

- Crop Model Improvement
    - Model evaluations to include CTW interactions
- Climate Scenarios
- Regional Economic Model
    - Methods for linking climate data, crop and statistical yield models to economic impact assessment (discussion leader; presentation?)
    - Intercomparison methods (discussion leader; presentation?)
        - Variables to be basis for comparison, spatial scales, temporal scales
    - Uncertainty analysis (discussion leader; presentation?)
    - Scenario design (discussion leader; presentation?)
        - Adaptation scenarios
        - Socio-econ scenarios: linkages to IPCC, CCAFS, etc
    - Implementation plan
        - Leads for each theme
        - Funding
        - Schedule

IT Tool Development
North American Regional Assessment Planning

12:00 pm Lunch

13:00 pm Parallel Sessions Continue

Crop Model Improvement
Climate Scenarios
Regional Economic Model
IT Tool Development
North Ame17rican Regional Assessment Planning

15:00 pm Break

15:30 pm Parallel Sessions Continue

17:00 pm Joint Session
Report Backs from Parallel Sessions
Discussion

18:00 Adjourn

Day 4, Friday, September 7, 2012

Objective: Building an AgMIP community for North America

8:00 am: Goals for the Day

8:30 am: Reports from Parallel Sessions

Crop Model Improvement
Climate Scenarios
Regional Economic Model
IT Tool Development
North American Regional Assessment Planning

10:00 am Break

10:30 am Discussion, Wrap-up and Next Steps

12:00 pm: Adjourn