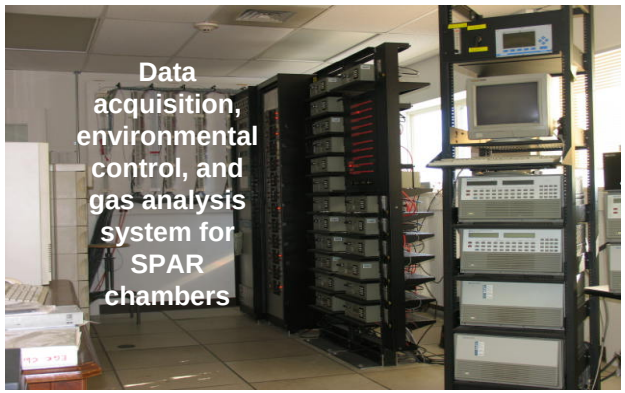
Crop Systems and Global Change Laboratory SPAR Facility

At the heart of mechanistic, process-level, crop simulation models are rate equations that describe the physiological responses of crop plants to environmental variables. In order to develop these rate equations, experiments are conducted under carefully controlled environmental conditions. Outdoor, naturally sunlit, plant growth chambers referred to as SPAR (**S**oil **P**lant **A**tmosphere **R**esearch) units provide precise control of the major environmental variables influencing crop growth including temperature, humidity, and atmospheric carbon dioxide concentration. The SPAR units are fully automated to measure crop canopy gas exchange including photosynthesis, respiration, transpiration and water use efficiency. Outdoor facilities include 6 daylit and 12 soilbin chambers. There are also 6 indoor lamplit chambers.

SPAR Chambers

- Use natural sunlight and soil volume
- Control and monitor aerial and soil environments
- Monitor whole canopy gas exchange (Photosynthesis, Respiration, Transpiration)
- Measure gas leakage rates with a N_2O system to maintain accuracy
- Facilitate study of
  - Entire crop growth season
  - Root and canopy growth and development
  - Source-sink relationships
  - Assimilate partitioning
  - Physiological responses to various environmental variables



Daylit and Soilbin Chambers

Control features:

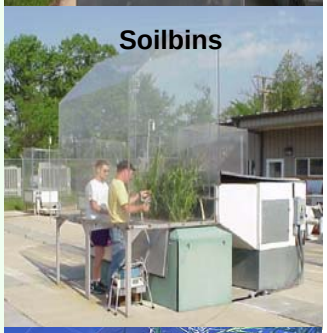
- Air temperature between 10 – 45 ° C
- Atmospheric CO_2 concentration between 350 – 1500 µmol mol^{-1}
- Humidity
- Irrigation / Fertigation

Monitoring features:

- Air, canopy, and soil temperature
- Atmospheric CO_2 concentration
- Relative humidity
- Solar radiation
- Photosynthesis
- Evapotranspiration
- Respiration
- Soil moisture

Other features:

- Canopy shade-cloth
- Root imaging and tracing



Lamplit Chambers

Control features:

- Air temperature
- Light intensity
- Photoperiod
- Irrigation

Monitoring features:

- Air and soil temperature
- Relative humidity
- Light intensity

Data Acquisition and Control

Data are automatically collected and catalogued via a computer controlled system. Control and data measurement cycles are conducted every 30 seconds. Data is averaged and recorded on 5 minute intervals and web-based access is available.

Results

Results have been used to develop crop models that answer research questions involving global climate change, precision agriculture, soil properties and plant physiology.

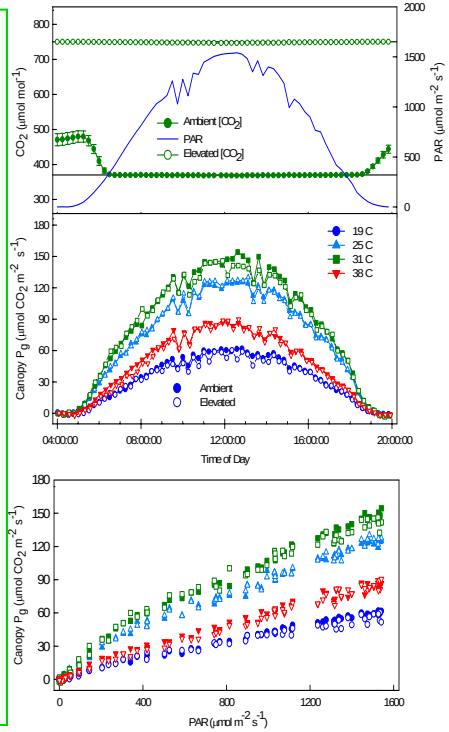
Daily SPAR data for a corn experiment grown at ambient or elevated CO_2 at different temperatures.

Top: Diurnal patterns for light intensity (PAR) and CO_2 versus time of day.

Middle: Gross photosynthesis (Pg) versus time of day.

Bottom: Gross photosynthesis versus PAR.

Experiments with soybean, wheat, potato, cotton, and rice have also been conducted.



Additional Equipment

- Portable photosynthesis meters
- Leaf area meters
- Time-domain reflectometry (TDR) probes
- Seedcounter
- Minirhizotron video camera system
- Steadystate porometer
- Water potential data acquisition system
- ET gage
- Ozone meter
- Electronic mass balances and forced air drying ovens

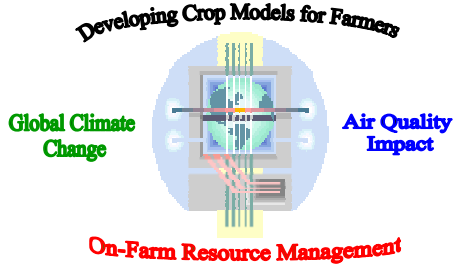
Why Use SPAR Chambers?

Agricultural production managers, natural resource managers, and strategic decision makers require accurate, timely, and cost-effective information to provide high quality food and fiber for the nation and the world. The Crop Systems and Global Change Laboratory (CSGCL) develops crop simulation models to predict growth, development and yield of agricultural crops. These mechanistic, process level crop models are used in decision support systems, resource management, policy planning, and global climate change studies.

Sunlit controlled environment chambers, known as SPAR chambers, have been built to evaluate plant responses to key environmental variables. SPAR units precisely control and monitor major environmental variables including atmospheric carbon dioxide concentration, temperature, humidity, and soil moisture while allowing plants to grow under natural sunlight. SPAR units are fully automated to collect important physiological and physical data like canopy closure, water use, soil moisture content, photosynthesis, evapotranspiration, and respiration.

Crop Systems and Global Change

The Crop Systems and Global Change Lab (CSGCL) carries out basic and applied research to discover and improve methods for planting and farming. Research includes application of systems theory to complex agricultural problems, development of models and expert systems, and studies to improve the growth, yield and quality of horticultural and agronomic crops.



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Applying Systems Theory To Complex Agricultural Problems

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Beltsville Agricultural Research Center

USDA Agricultural Research Service
U.S. Dept. of Agriculture

Soil Plant Atmosphere Research (SPAR) Facility

Crop Systems and Global Change Laboratory (CSGCL)

SPAR chambers allow

- Study of crop growth and development under natural sunlit conditions
- Precise control of plant aerial and root environments
- Automated measurements of crop photosynthesis, respiration, and transpiration

SPAR research includes

- Crop simulation modeling
- Crop physiology
- Crop responses to environmental stresses and global climate change