Calibrating, Validating, and Implementing Process Models for California Agriculture Greenhouse Gas Emissions

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Background

- Large uncertainties in N2O emissions from CA agriculture
- Significant field research in measuring N2O emission from range of agricultural cropping systems (Projects led by Drs. Horwath, Six and Goorahoo)
- Process-based models have been developed to examine the complex interactions of agricultural management practices, soil C dynamics, and N2O emissions.

Project Goal

- The goal is to develop, demonstrate and transfer to ARB a framework for collecting GIS and agricultural management data, link these data in a GIS framework with DNDC process model for agricultural N_2O, CO_2 and CH_4 emission inventories, and develop an explicit uncertainty budget due to both structural (derived from model validation) and scaling (unknowns in model input data for inventory, e.g. soils, agricultural management, crops, etc).

What are Process-based Models? (also known as Mechanistic)

- Modeling approaches: Empirical (range simplistic static EF to multi-parameter) – limited to use to by their development data
- Process-based modeling refers to biochemical and geochemical reactions or processes
  - Process modeling, in this case, does **not** refer to AFO practices or components (e.g. dairy drylots or manure lagoons) per se, but
- **Biogeochemical processes**… like decomposition, hydrolysis, nitrification, denitrification, etc…
- True process-based models **do not rely on constant emission factors**.

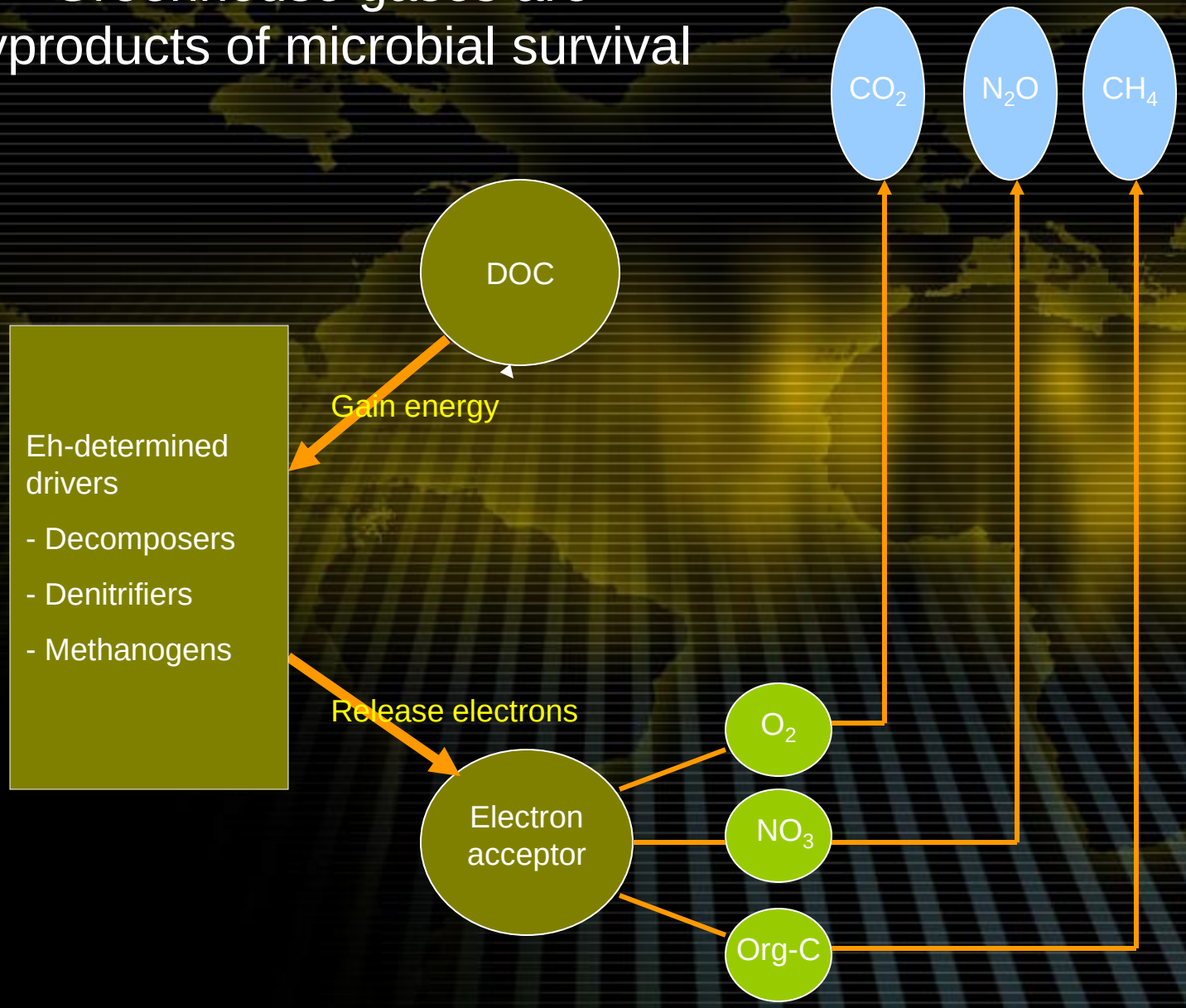
Role of Process-based Models (PBM)

- Interpret – field/lab measurements
- Extrapolate – to new sites and facilities
- Evaluate – test and assess opportunities for mitigation and development of better management practices
- Transform – transform complexity in to information

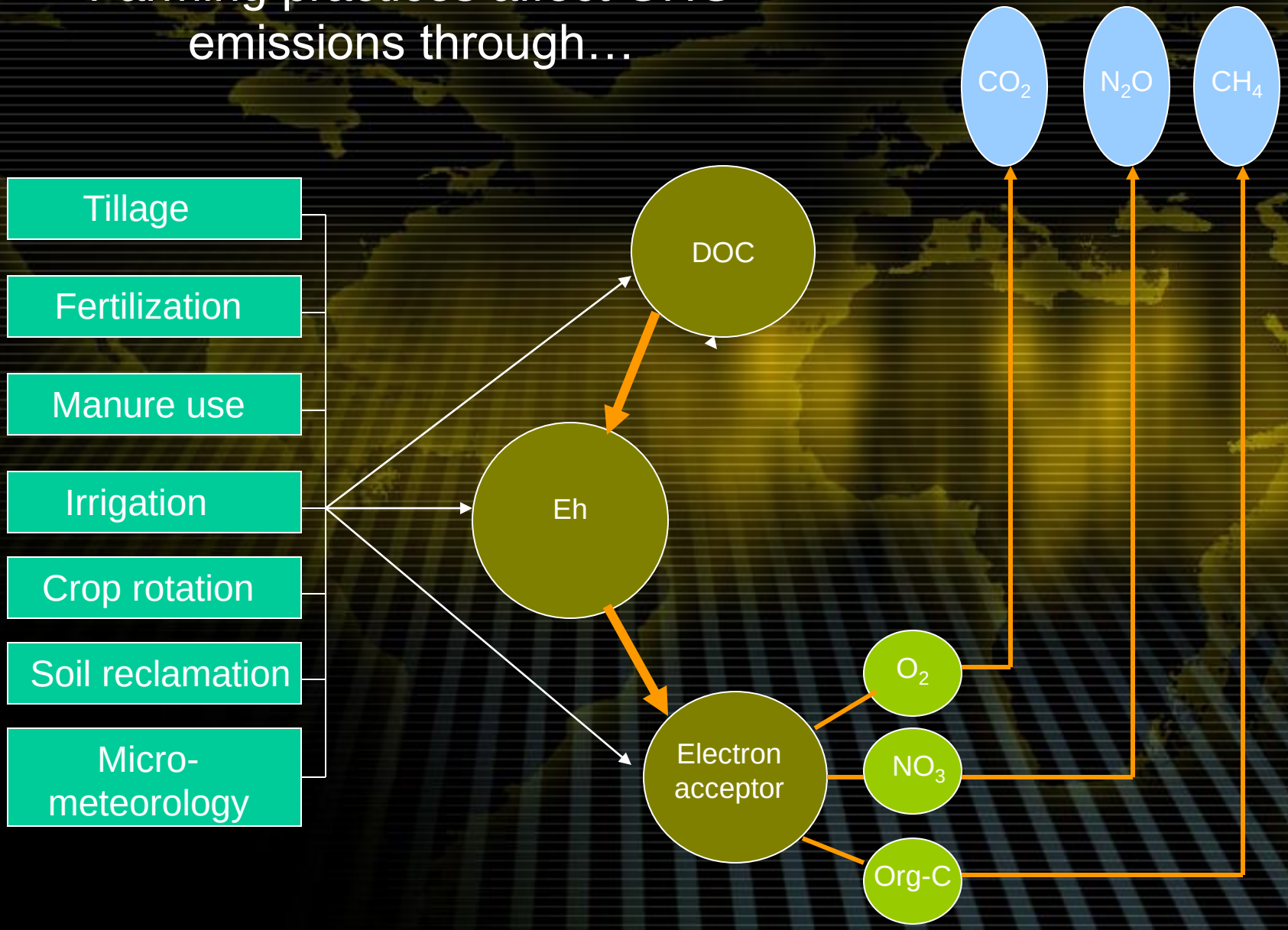
DNDC Modeling Framework

- **Why DNDC?**
  - ✓ Based on first principles of biogeochemistry
  - ✓ Contains algorithms for both anaerobic and aerobic soil and organic matter environments
  - ✓ Unique in its approach for modeling redox potential and microbial activity
  - ✓ Simulates full range of biogeochemical processes: decomposition, hydrolysis, nitrification, denitrification, ammonium adsorption, chemical equilibriums of ammonium/ammonia, and gas diffusion
  - ✓ Well validated across a wide range of agroecosystems and is currently being used for national GHG emission inventories and mitigation studies worldwide.

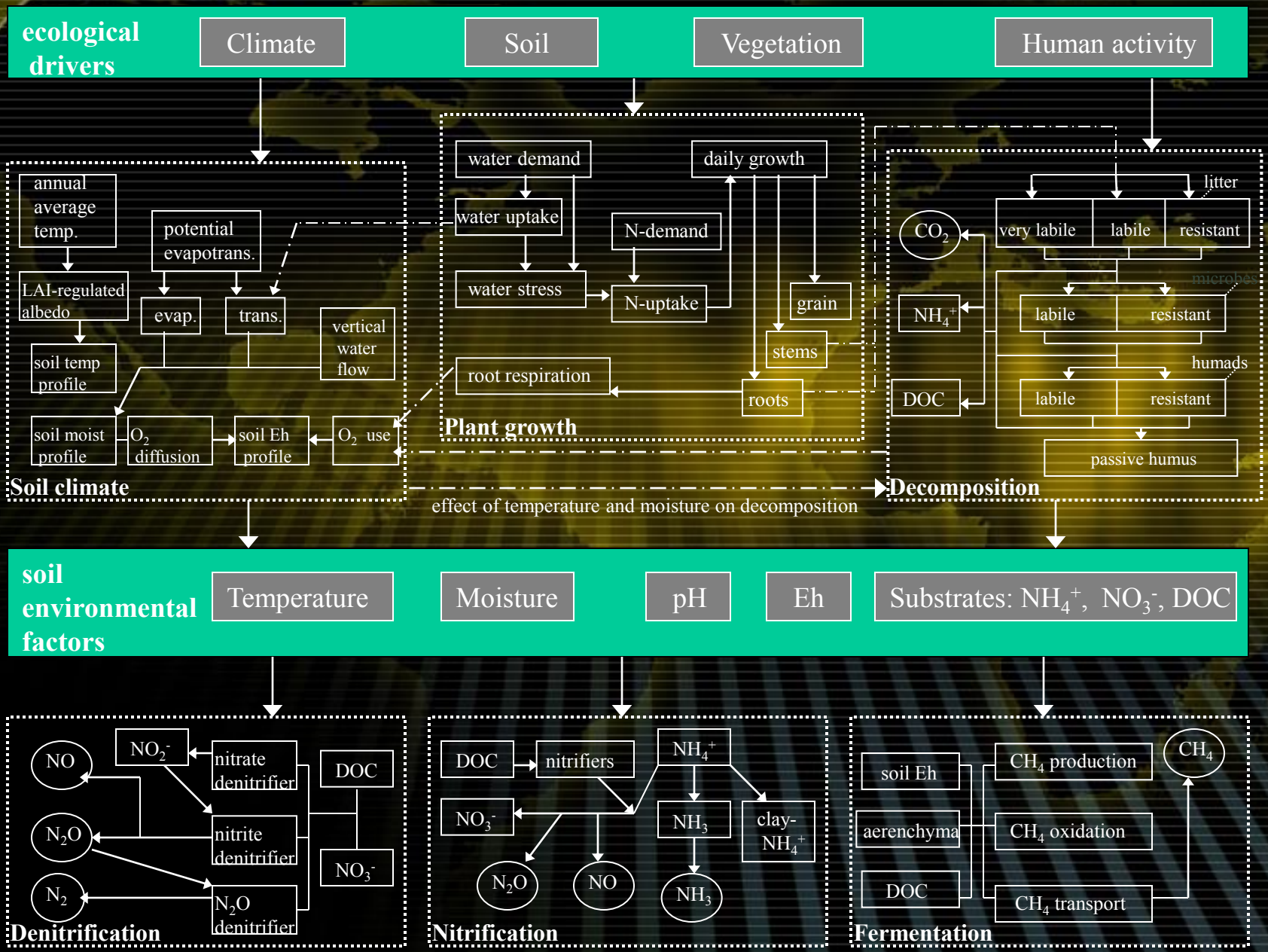
Greenhouse gases are byproducts of microbial survival



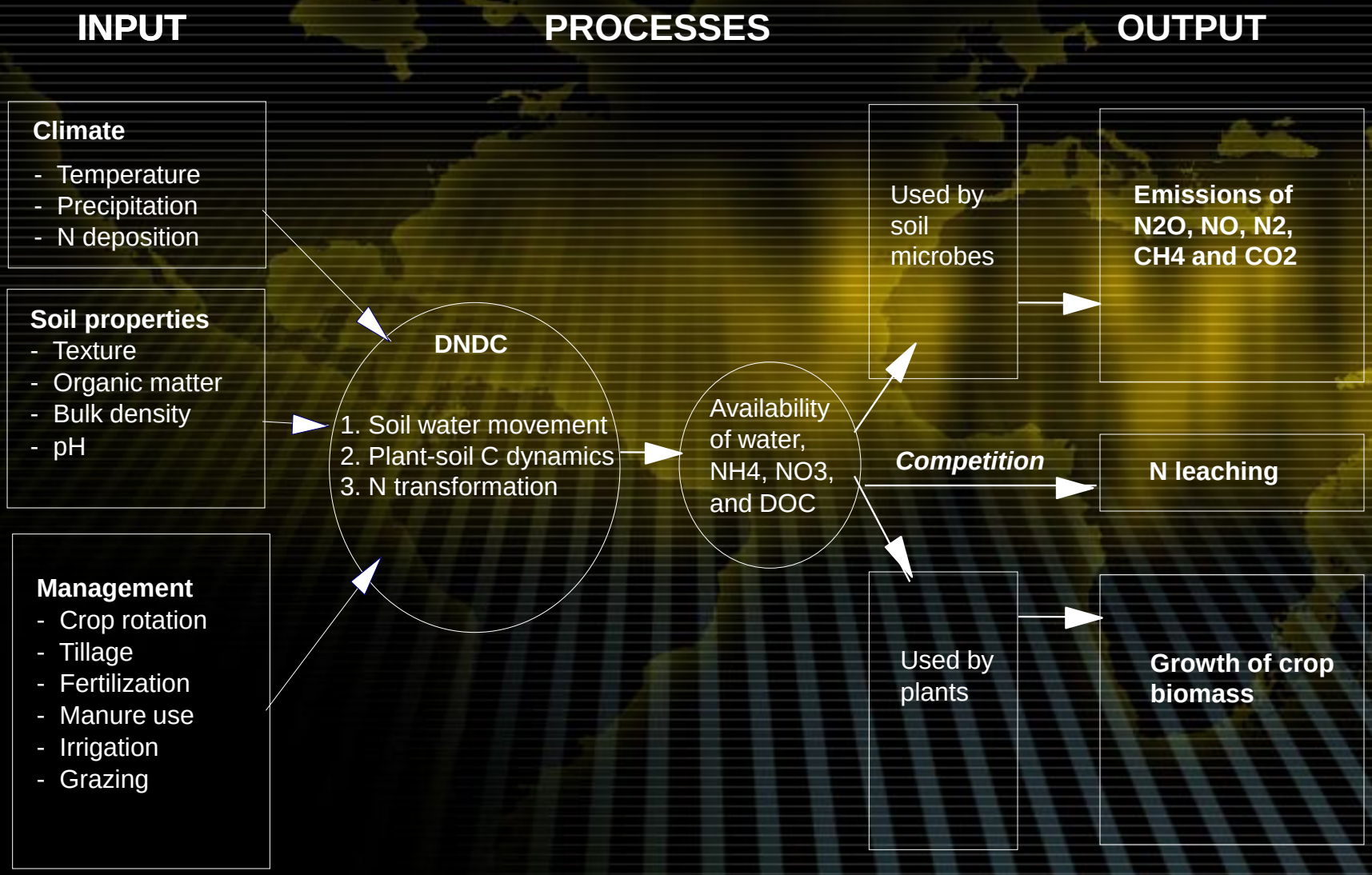
Farming practices affect GHG emissions through…



The DNDC Model



DNDC bridges between ecological drivers and GHG emissions



Model Validation…

- Rigorous model validation is key for acceptance (scientific and market)
- Lack of appropriate field data for process-model validation
- DNDC has been validated extensively for agroecosystems worldwide (over 140 peer review papers)
- Additional validation efforts underway for cropping systems in California

Project Objectives

- Develop GIS databases and agricultural management databases for statewide GHG modeling,
- Compile California field measurement data
- Model calibration and validation with new field data
- Assess model uncertainties (both structural and scaling) through model validation,
- Perform comparison of DNDC and DAYCENT models at select sites,
- Compile GHG emission estimate for California agriculture, and
- Work with ARB staff on use and updates to the modeling system.

Outcomes

- GIS databases of crops, crop rotations, soils and daily CIMIS data for DNDC modeling
- DNDC crop calibration files and current representative management practices
- Calibrated model for extrapolating field measurement and assessing impact of management practices on N2O emissions.
- Tool for quantifying DNDC model structural uncertainty and uncertainties due to input parameters (e.g. using SSURGO soils)
- Model estimates of statewide N2O emissions
- Maps of uncertainty in modeled N2O emissions due to range in soil conditions across conventional, conservation, and no-till systems.

Timeline

- In contracting phase.
- Likely start date: June/July 2011
- Duration: 2 years