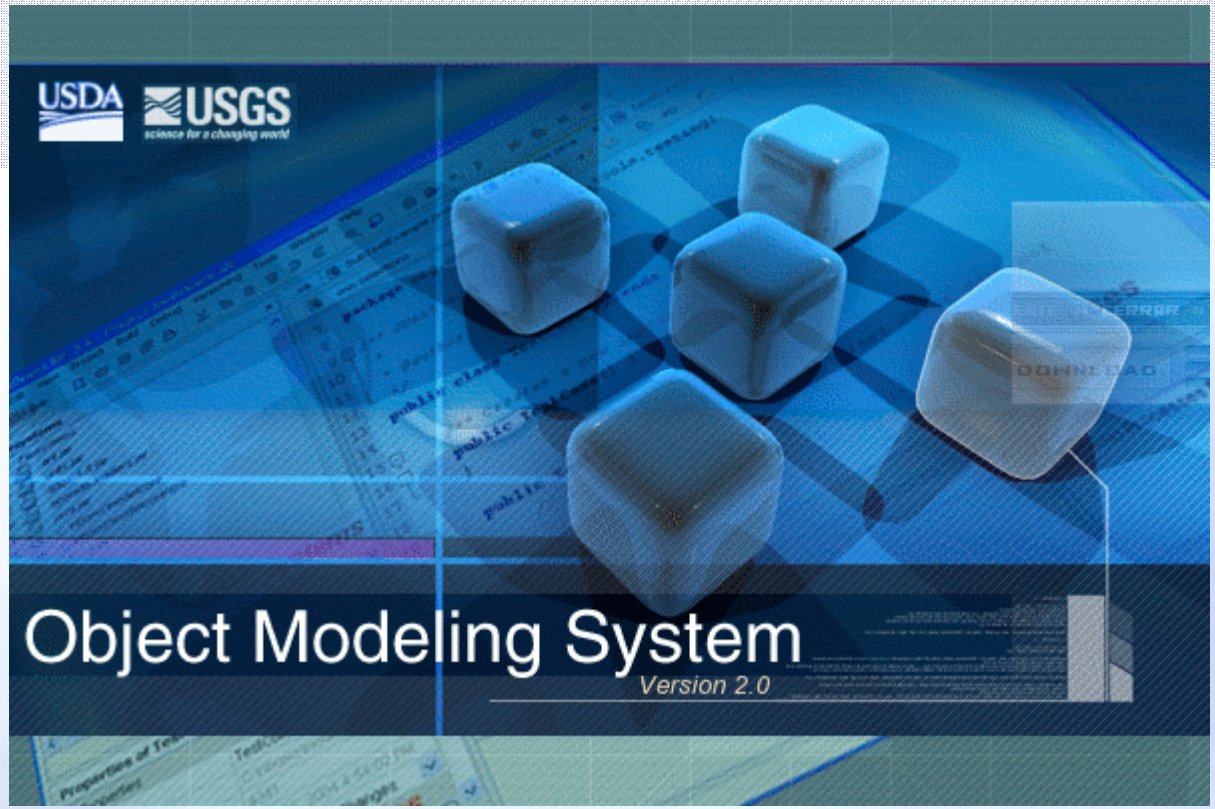

ARS Model Development using the Object Modeling System

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James C. Ascough[2], Dennis C. Flanagan[4],
Frank W. Geter[3], Ken W. Rojas[3], Allan Andales[3]

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[3]USDA NRCS, Information Technology Center
Fort Collins, Colorado

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West Lafayette, Indiana

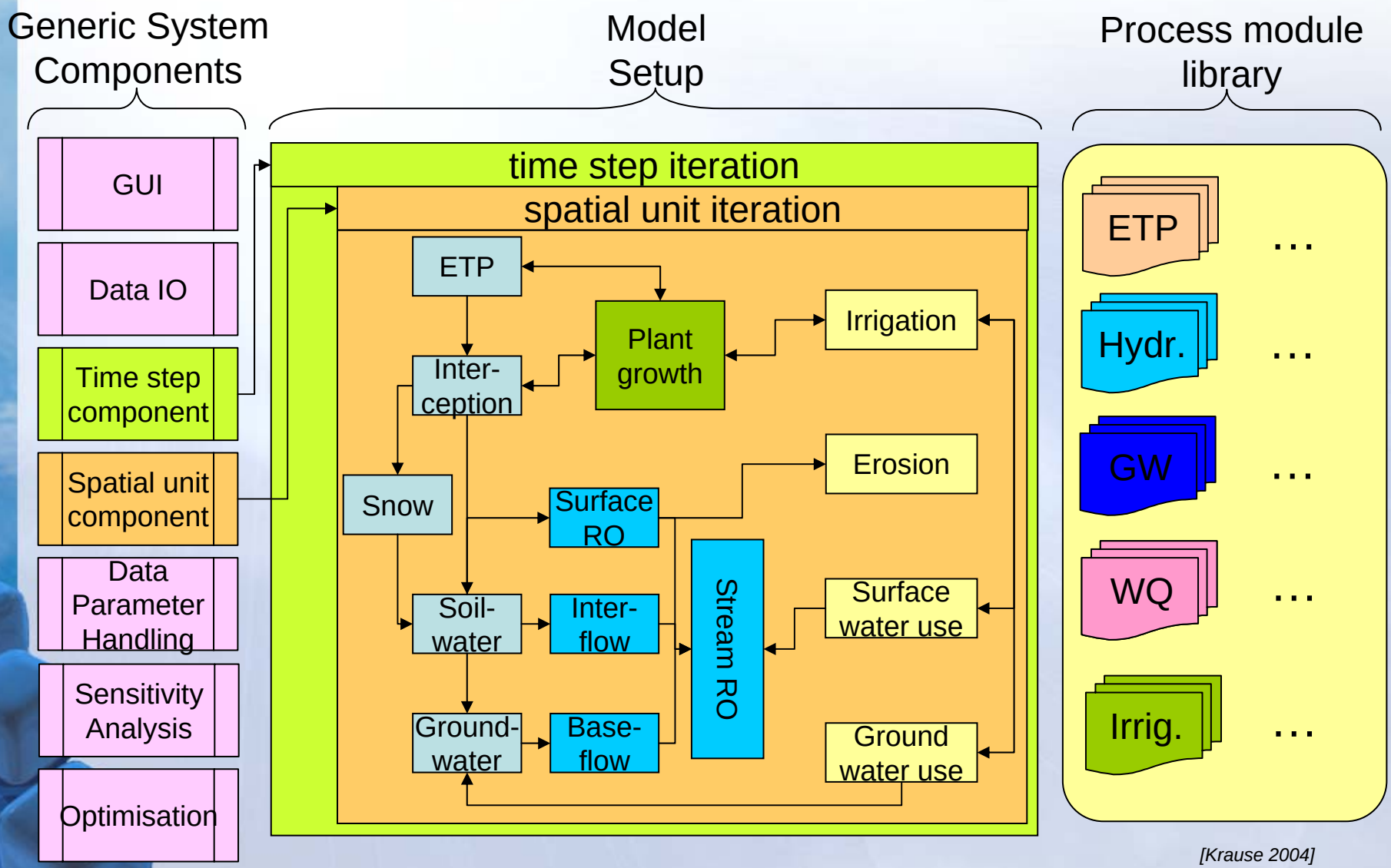
Outline

- OMS Introduction
- System Development Update
- Application Update
  - Implementing an ARS Unified Water and Wind Erosion Model based on WEPP / WEPPS
  - Create a physical based simulation model supporting the iFarm effort (Integrated Farm Management) at ASRU, Livestock/Rangeland
- Model development under Colab and Version Control

Why OMS Modeling Framework for CEAP ?

- Establish standardized method for model development
- Plan for medium-long term maintainability
- Enable model adaptation (regional model variants)
- Implement a model development process that can be managed, tracked, and verified.
- Allow for flexible Data I/O management that is model independent

Modelling System

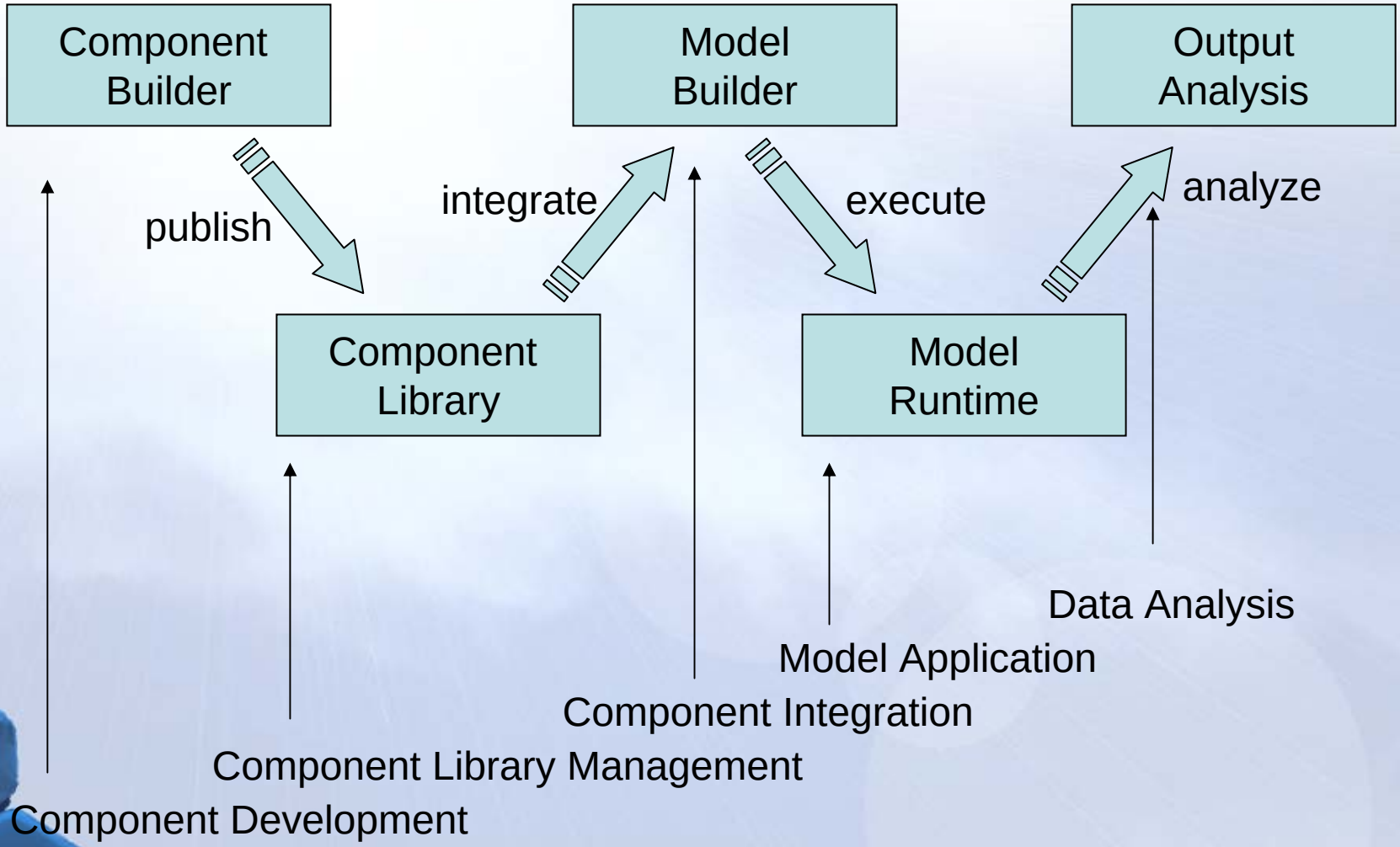


[Krause 2004]

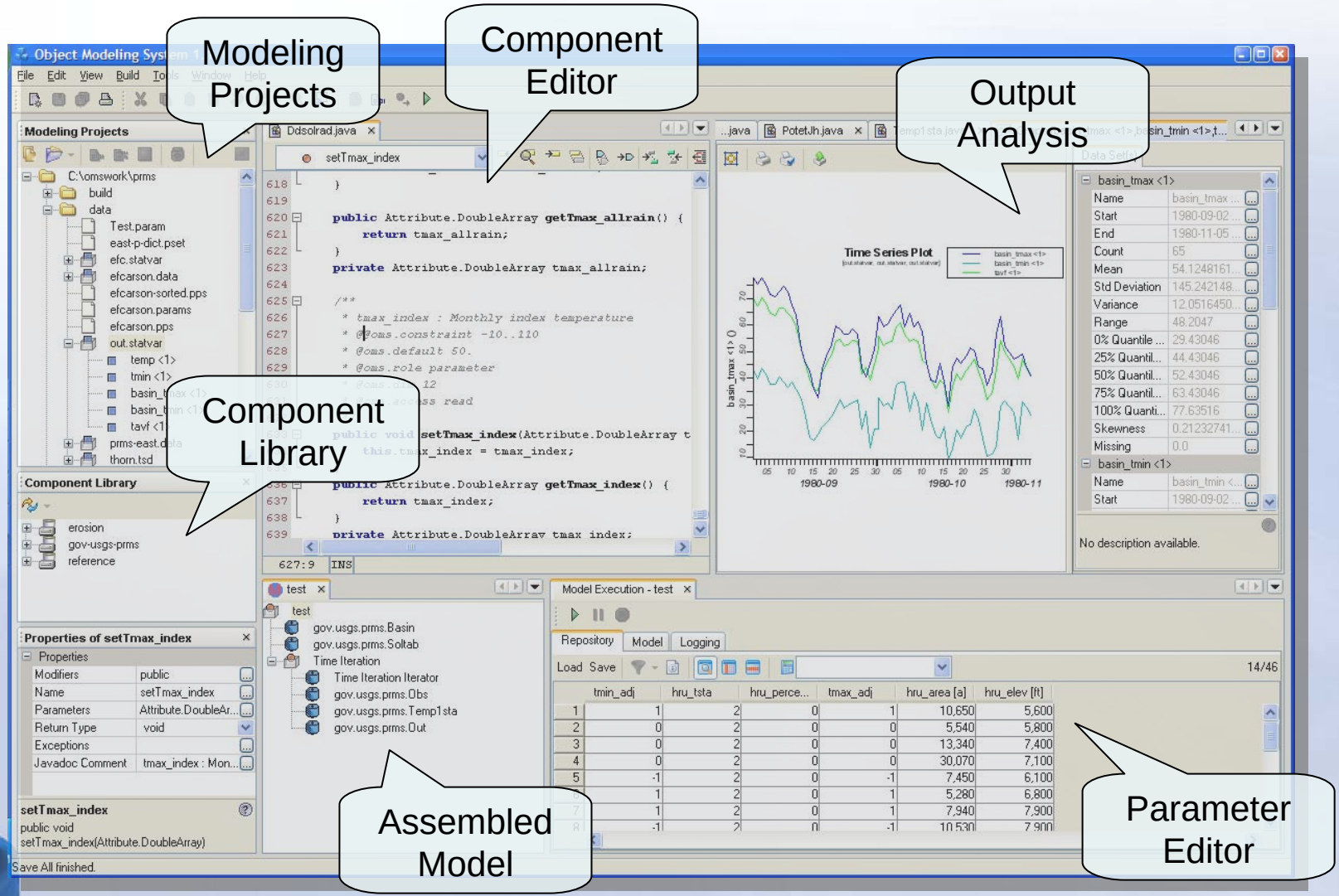
Benefits

- Supports building of new models and decision support tools from reusable/standardized components from a library.
- Leads to “Customized Modeling” – fitting the model to the problem and customer need.
- Enhances deployment of new tools to action agencies (NRCS) and leverages established databases.
- Eliminating duplication of work by modelers. The library of components will serve as a reference and a coordination mechanism for future improvements.
- Significantly reduce the problem for users of different models giving different results by utilizing a library of evaluated, documented and standardized modules
- The common interface for model usage will result in lower training costs and reduced startup time for future modelers and scientific users.

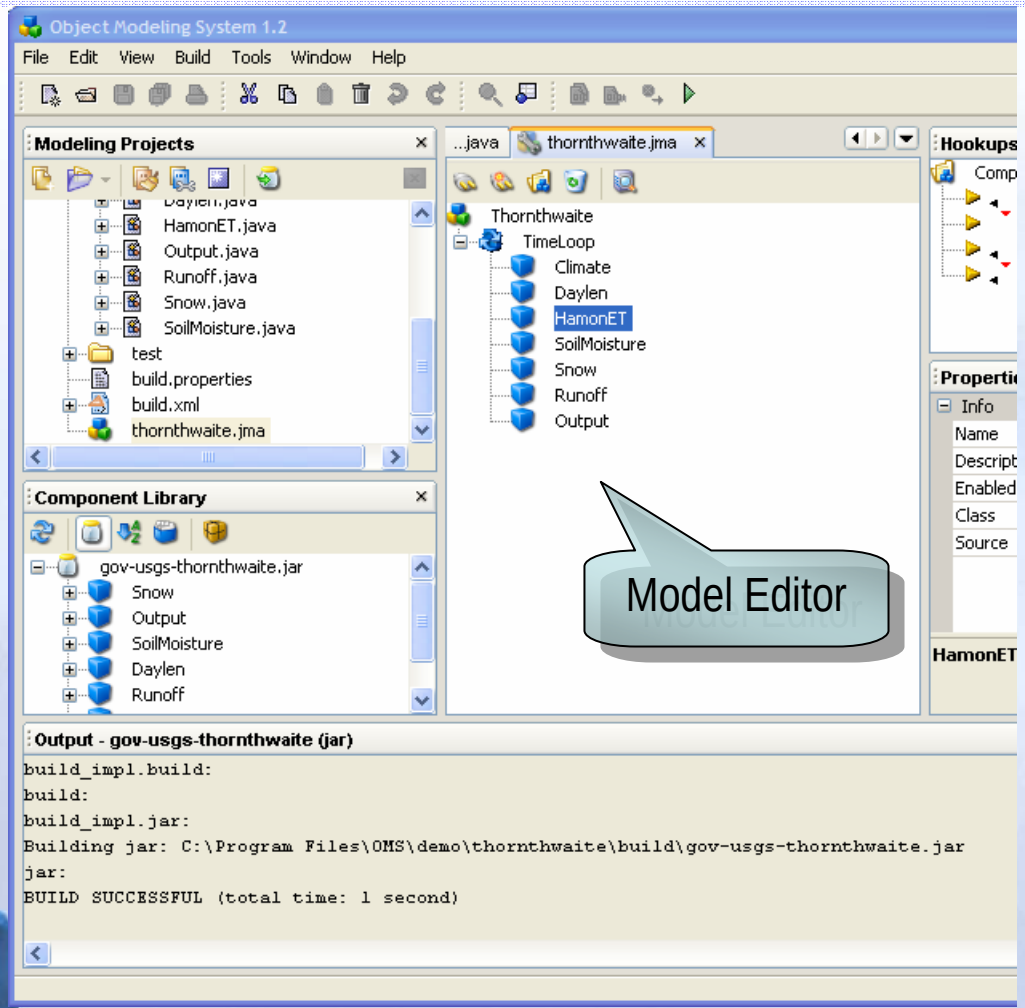
OMS Features/Workflow



OMS as a Modeling Environment



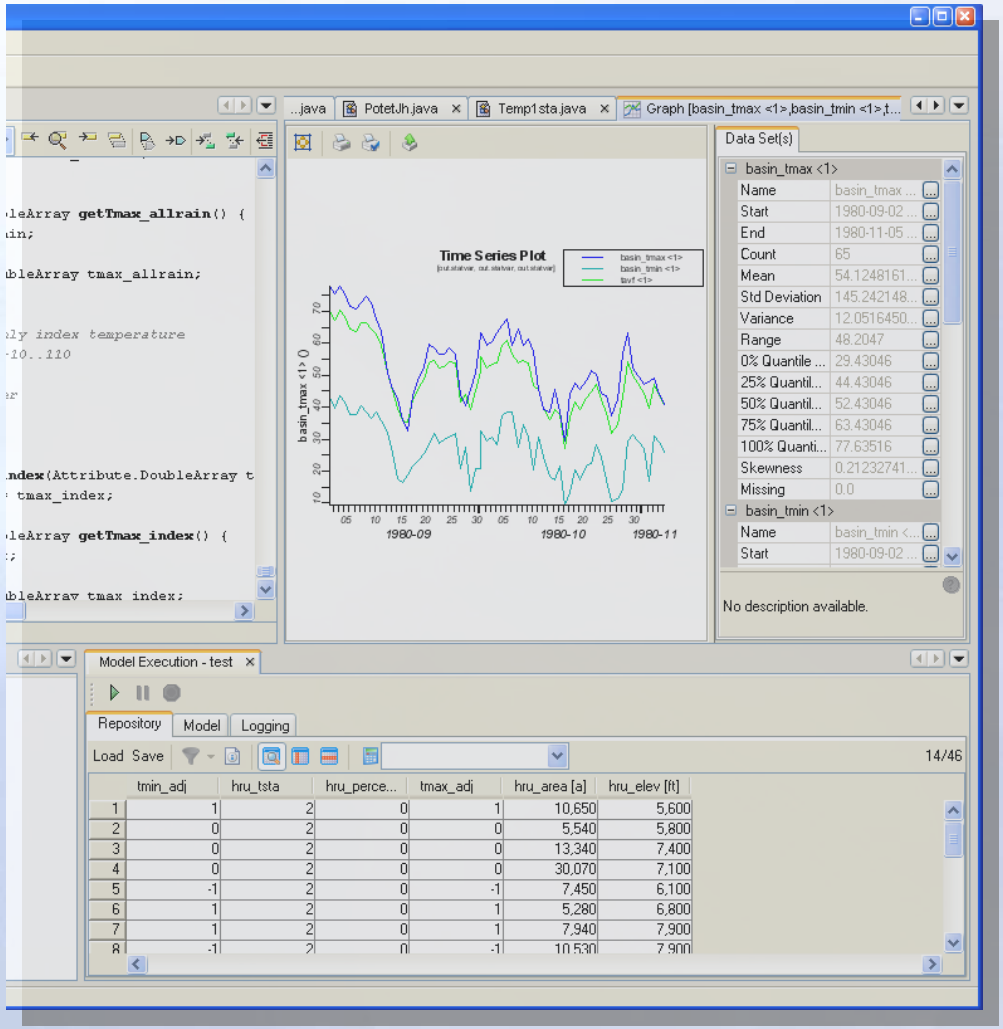
ModelBuilder



- Build a hierarchical model based on dictionary components
- Visual Assembly of components to a model
- Dependency check
  - Access
  - Scale

Model Application

- Model Parameterization
- Automated GUI Element generation
- Parameterization
- Visualization of results
- Visualization GUI is adaptable

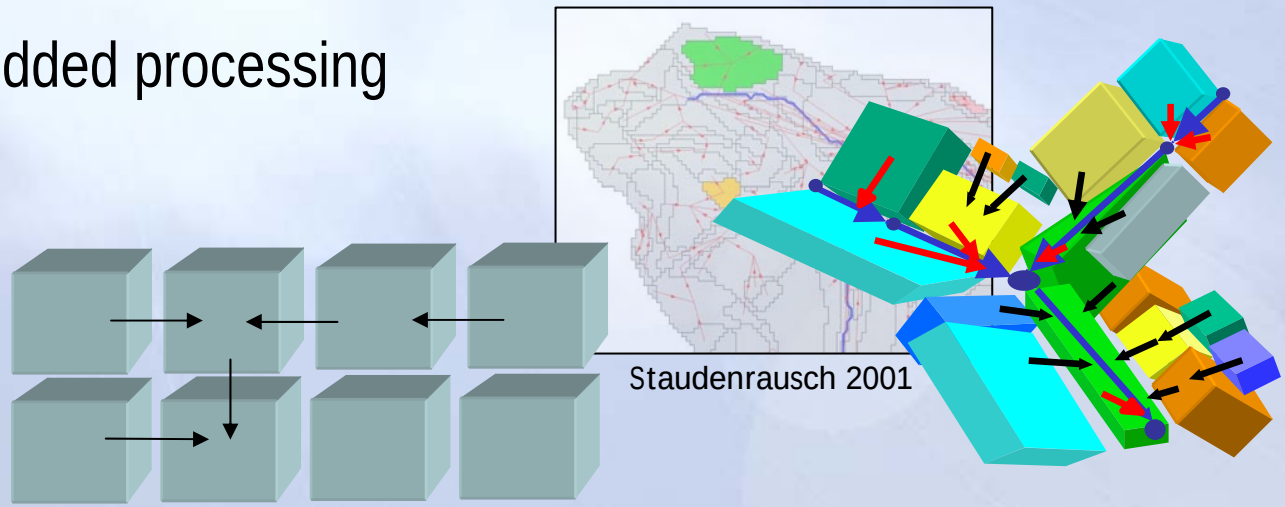


Recent System Accomplishments in Development

- Release OMS 2.0
  - Comprehensive Fortran 95 support
  - Netbeans 5.0 platform porting
  - Extended the OMS tools set
  - Updated Manual / Training material
- Adopt a CMM level 2 for OMS development
  - shared ARS NRCS project management in Colab
- Model Building extended for the development of spatial models

Work in Progress

- Uncertainty and Sensitivity Analysis and Parameter Estimation
- Analysis tool set
- Spatial/Temporal pattern
  - Network traversal
  - Gridded processing



(1) Common Wind and Water Erosion Model

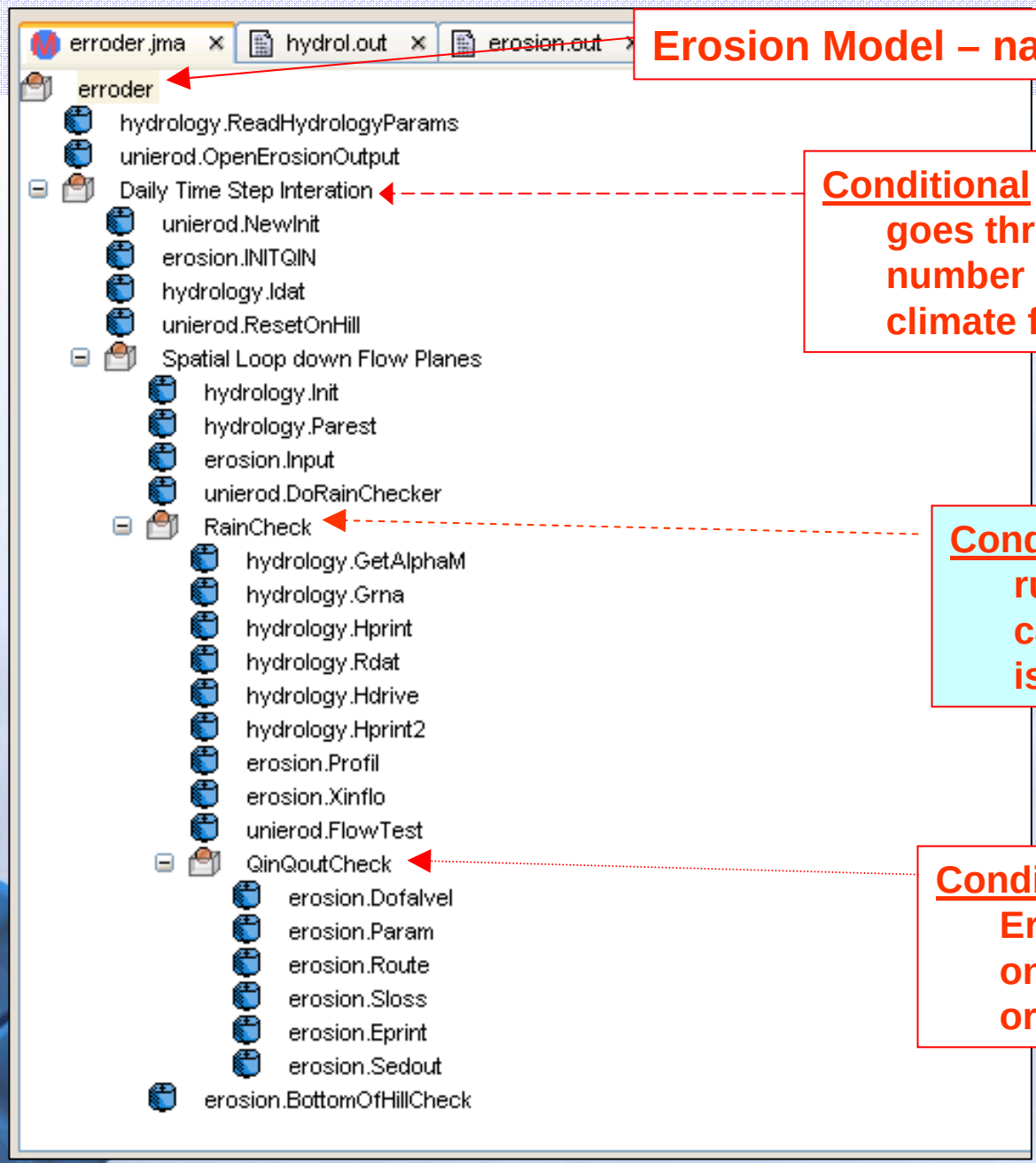
- The Natural Resources Conservation Service (NRCS) re-evaluated its need for erosion prediction technology from ARS
- A high priority long-term need of NRCS was development of a common wind and water erosion process model, to work with a single interface and database and give consistent results for plant growth, water balance, crop yield, etc.

ARS Erosion Prediction Tools

- Erosion Prediction Tools developed by ARS:
  - Universal Soil Loss Equation (USLE)
  - Revised USLE (RUSLE)
  - Water Erosion Prediction Project (WEPP)
  - WEPP-SPUR (Simulation, Production & Utilization of Rangeland)
  - Wind Erosion eQuation (WEQ)
  - Revised WEQ (RWEQ)
  - Wind Erosion Prediction System (WEPS)
- Model Interface & Database Systems:
  - Individual RUSLE, WEPP, RWEQ, WEPS interfaces
  - Trend of moving from standalone Windows applications to Web-based interfaces (at least for WEPP & WEPP-SPUR-RHEM)

Hillslope Erosion Module for WWEM

- Initially
  - Convert hillslope erosion component from WEPP into a standalone Fortran program.
  - Test and verify standalone program against original WEPP v2004.7 model
  - Incorporate standalone program into OMS, test and verify.
- Continuing
  - Add more components – surface hydrology, daily water balance, plant growth, wind detachment, etc.
  - Contribute to development of CEAP regional water and air quality models (CEAP objective 5).



Erosion Model – named "erroder" here

Conditional – Daily Time step – goes through loop for number of days read in from climate file.

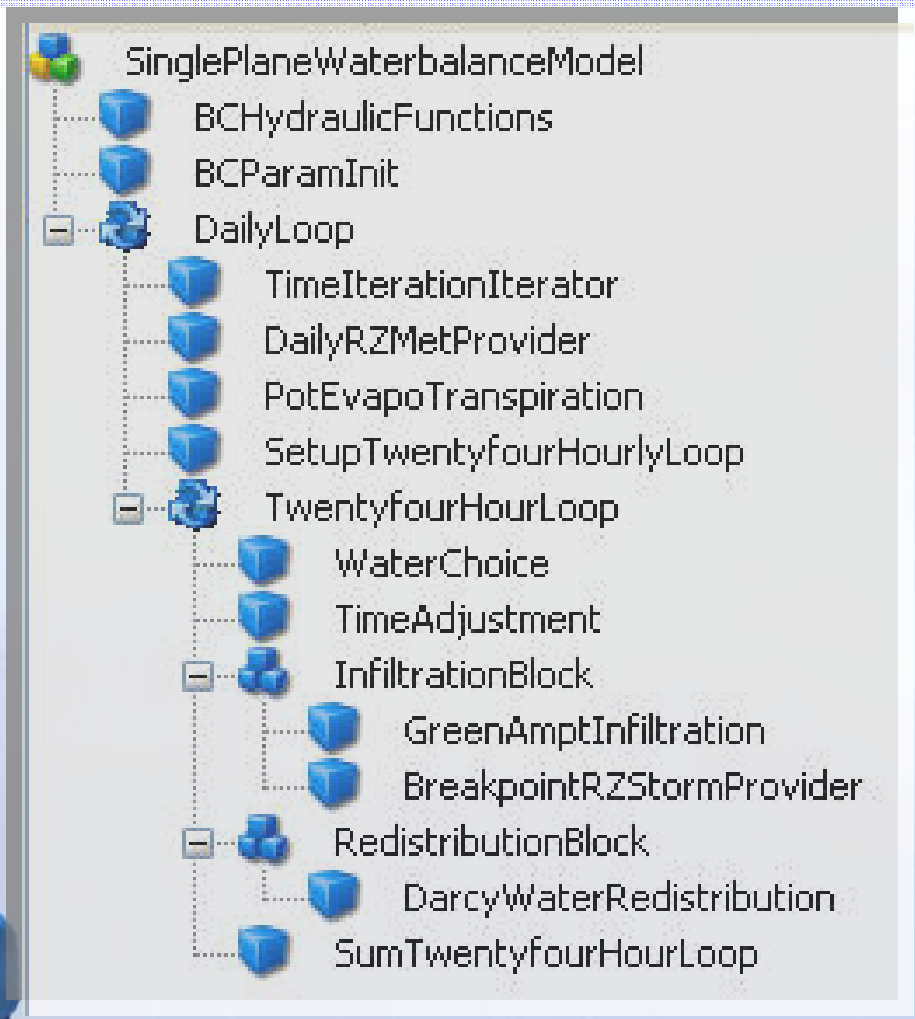
Conditional – to do infiltration, runoff and erosion calculations, only if there is rainfall on the day

Conditional – to do Erosion Calculations only if there is outflow or inflow to plane.

Water Balance Routines for WWEM

- Provide basic water balance functionality to support erosion code development
  - Use existing code if possible – don't reinvent the wheel
- Easily switched out for newer / robust routines to be developed by ARS, therefore clean interface
- Developed and executed in OMS

Model Structure

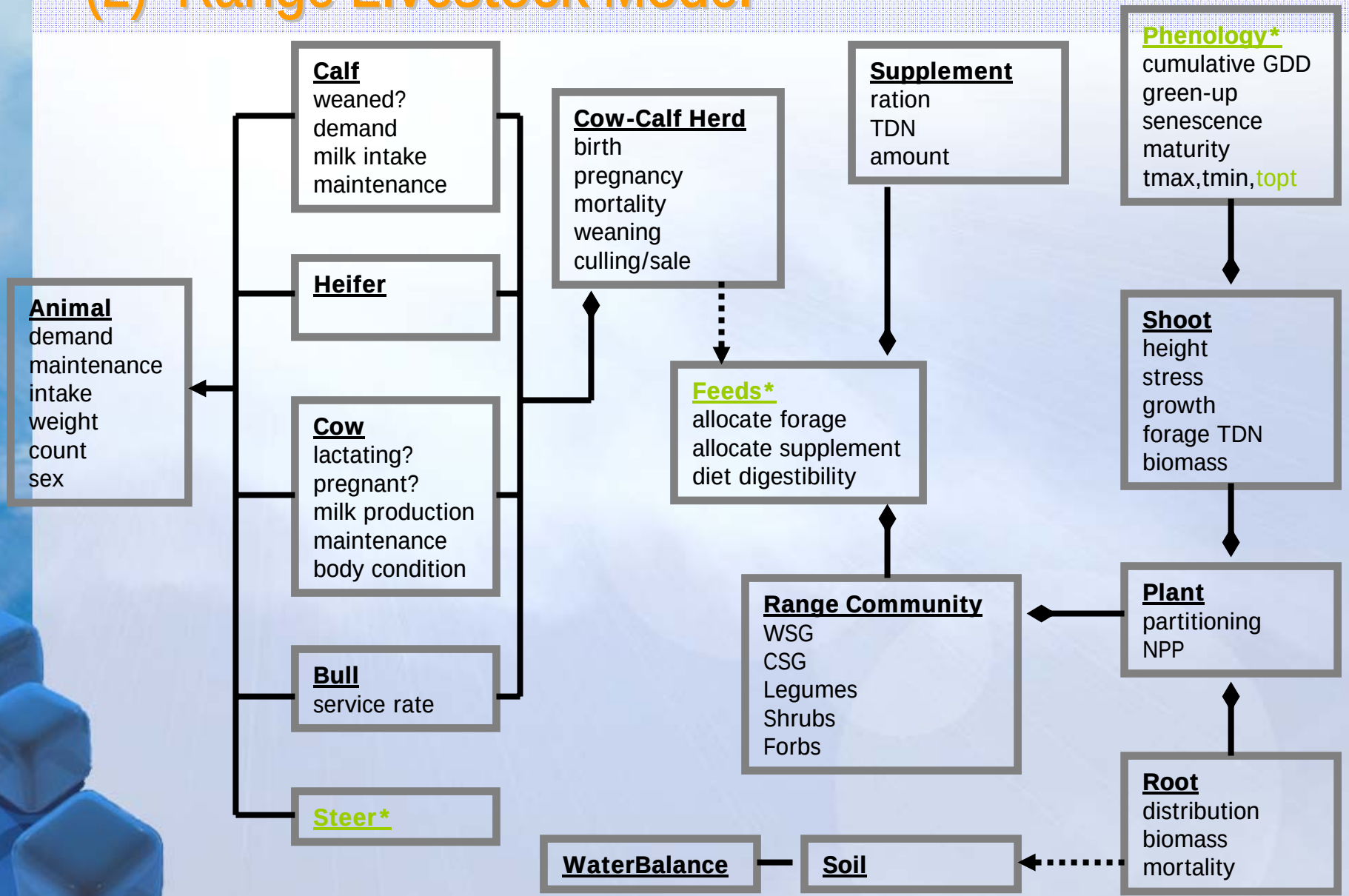


- Soil profile initialization
- Daily meteorology
- Potential evapotranspiration
- Time adjustment
- Green-Ampt Infiltration
- Breakpoint rainfall
- Darcy water redistribution

Needed

- Wind Erosion

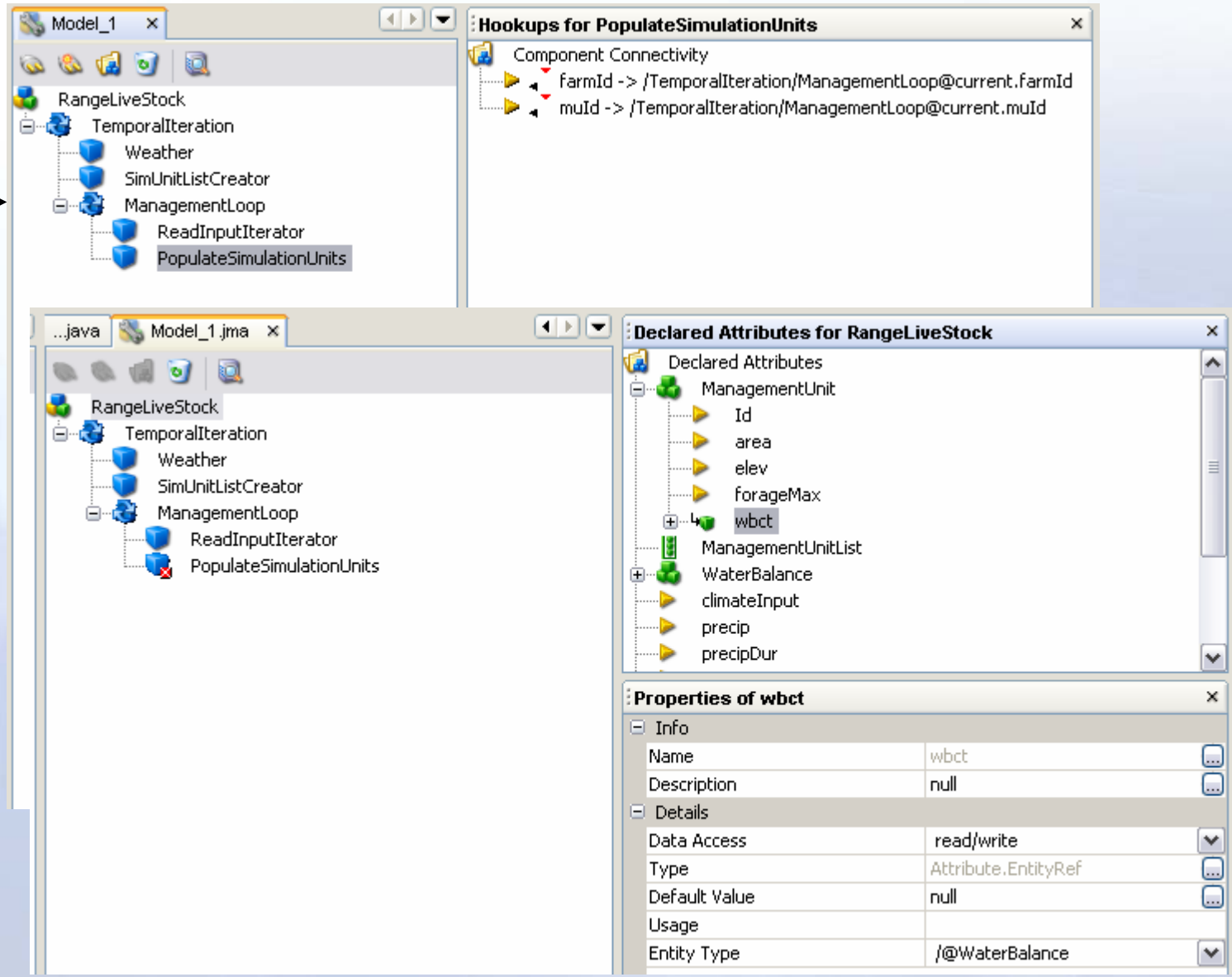
(2) Range Livestock Model



Spatial /Temporal Interaction in this model

Time →

Space →



Progress in Component Extraction/Module Creation

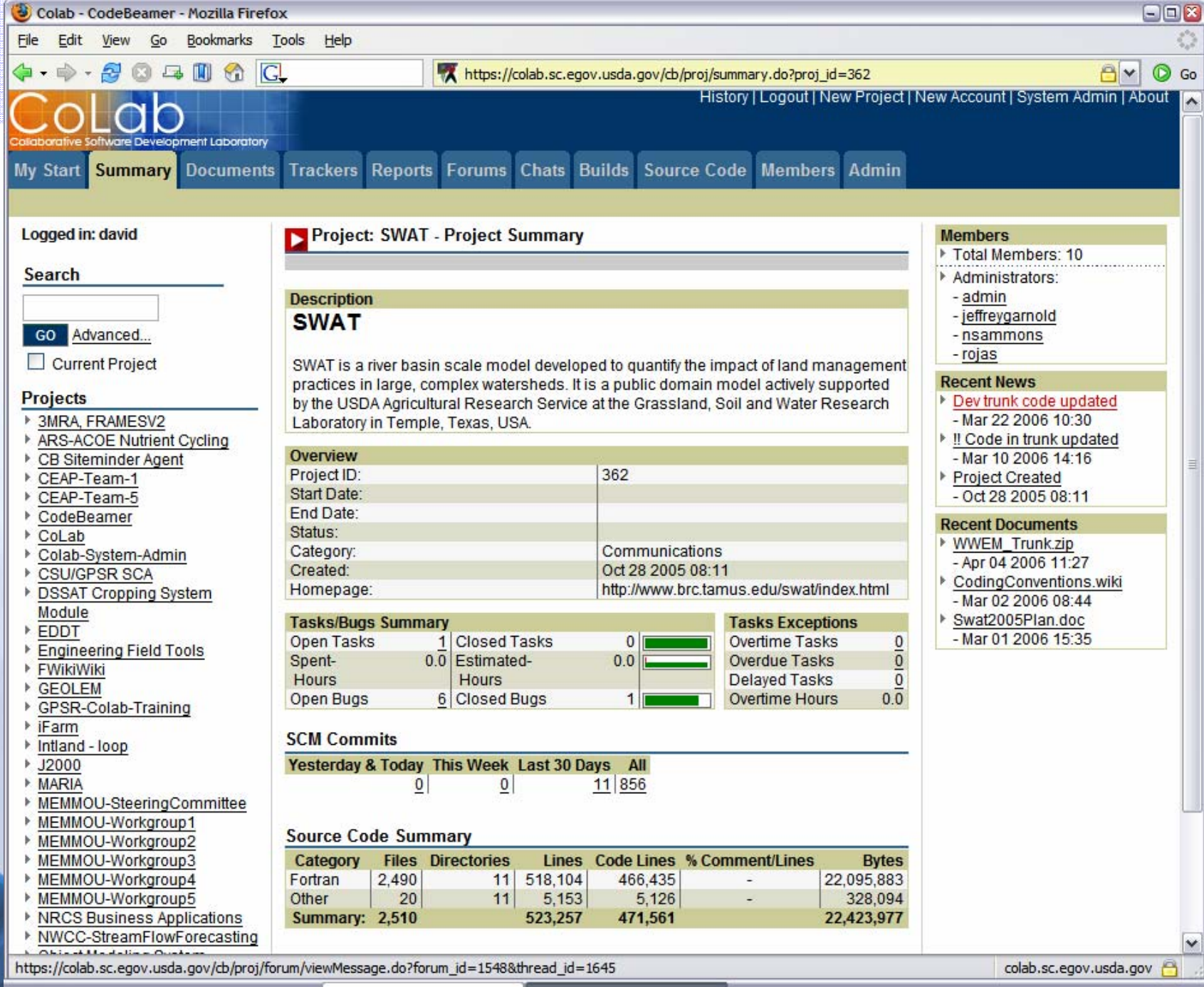
- Water Balance – Runoff, Infiltration, ET, Deep Seepage (GPFARM)
- Soil Parameter Estimation (RZWQM)
- Management Practices (RZWQM)
- Green-Ampt Infiltration (RZWQM)
- Snowmelt (PRMS)
- Overflow Flow Routing (Kineros)
- Soil Erosion (WEPP)
- Object-Oriented Nutrient Model – NOURISH (RZWQM)
- “Simple” Crop Model (WEPS)
- “Complex” Crop Model (DSSAT 4.0 CSM – Cropping System Model)
- Range Forage Growth Component (GPFARM)

OMS & Colab

- Supporting the co-located development of simulation models using an Software project management infrastructure - USDA Colaborative Development Laboratory (Colab)
- Host Object Modeling System (OMS) modeling projects and related modeling efforts in Colab.
- Host major ARS modeling projects for CEAP and other activities in Colab

USDA Colab Overview

- Acronym
  - Collaborative Software Development Laboratory
- Purpose
  - Facilitate collaborative software/model development in a location independent environment.
- History
  - Identified in 2004 .. Prototype in 2004/2005 .. Production in April 2005
  - Founding members USDA, EPA, CSU, USGS


Colab - CodeBeamer - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
https://colab.sc.egov.usda.gov/cb/proj/summary.do?proj_id=362
Go
CoLab
Collaborative Software Development Laboratory
History | Logout | New Project | New Account | System Admin | About
My Start Summary Documents Trackers Reports Forums Chats Builds Source Code Members Admin
Logged in: david
Search
GO Advanced...
Current Project
Projects
3MRA, FRAMESV2
ARS-ACOE Nutrient Cycling
CB Siteminder Agent
CEAP-Team-1
CEAP-Team-5
CodeBeamer
CoLab
Colab-System-Admin
CSU/GPSR SCA
DSSAT Cropping System Module
EDDT
Engineering Field Tools
FWikiWiki
GEOLEM
GPSR-Colab-Training
iFarm
Intland - loop
J2000
MARIA
MEMMOU-SteeringCommittee
MEMMOU-Workgroup1
MEMMOU-Workgroup2
MEMMOU-Workgroup3
MEMMOU-Workgroup4
MEMMOU-Workgroup5
NRCS Business Applications
NWCC-StreamFlowForecasting
Project: SWAT - Project Summary
Description
SWAT
SWAT is a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds. It is a public domain model actively supported by the USDA Agricultural Research Service at the Grassland, Soil and Water Research Laboratory in Temple, Texas, USA.
Overview
Project ID: 362
Start Date:
End Date:
Status:
Category: Communications
Created: Oct 28 2005 08:11
Homepage: http://www.brc.tamus.edu/swat/index.html
Tasks/Bugs Summary
Open Tasks 1 Closed Tasks 0
Spent-Hours 0.0 Estimated-Hours 0.0
Open Bugs 6 Closed Bugs 1
Tasks Exceptions
Overtime Tasks 0
Overdue Tasks 0
Delayed Tasks 0
Overtime Hours 0.0
SCM Commits
Yesterday & Today This Week Last 30 Days All
0 0 11 856
Source Code Summary
Category Files Directories Lines Code Lines % Comment/Lines Bytes
Fortran 2,490 11 518,104 466,435 - 22,095,883
Other 20 11 5,153 5,126 - 328,094
Summary: 2,510 523,257 471,561 22,423,977
Members
Total Members: 10
Administrators:
- admin
- jeffreygarnold
- nsammons
- rojas
Recent News
Dev trunk code updated
- Mar 22 2006 10:30
!! Code in trunk updated
- Mar 10 2006 14:16
Project Created
- Oct 28 2005 08:11
Recent Documents
WWEM_Trunk.zip
- Apr 04 2006 11:27
CodingConventions.wiki
- Mar 02 2006 08:44
Swat2005Plan.doc
- Mar 01 2006 15:35
https://colab.sc.egov.usda.gov/cb/proj/forum/viewMessage.do?forum_id=1548&thread_id=1645
colab.sc.egov.usda.gov

Benefits for Model Development

- Manage issues ranging from requirements to bugs
- Workflow (Approval), Peer Review
- Real time visibility on tasks, bugs, resources and projects
- “Live” Document Management (WIKI)
- Seamless SCM integration for Subversion
- Source Code Comprehension & Coding violations, QA and Audits with trends
- Build Automation using schedulers for builds, releases and tests
- Development Interaction: Discussion Forums, Chats
- CMM Level-2 and Level-3 software measurement reports

Colab Status

- ~220 Projects, ~520 registered Users, ~60-70 active User/Day
- Code repository ~20 GB, Documents ~4GB
- Users from ~15 different institutions.
- Example Modeling Projects
  - AGNPS (NRCS), FRAMES/3MRA (EPA), OMS Unified Wind and Water Erosion (ARS), PRMS (USGS), SWAT (ARS; 2005), RZWQM (ARS), DSSAT Components (OMS), Range/Lifestock (ASRU), J2000 (FSU Jena), COSU (MOU on MIMS), and many others …
- Training classes on (i) Version Control Workflow using Subversion (ii) Codebeamer Project Management and (iii) OMS

Structured Model Development Process

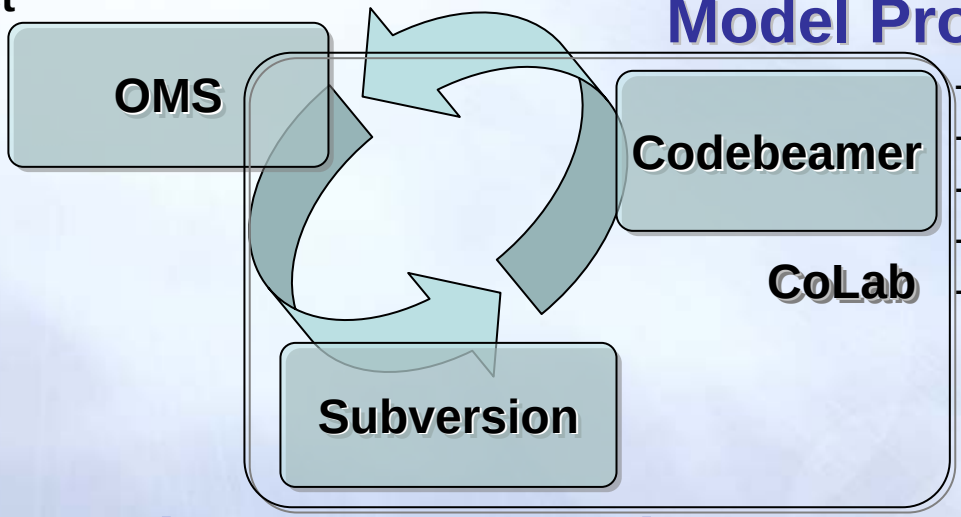
1. **Integrate Source into Colab**
2. **Adopt the use of a (i) version control system and (ii) software project management as provided in Colab**
3. **Modeling Source; Refactoring using peer review**
4. **Modularize and use a modeling framework (OMS), eliminate redundancies**
5. **Implement automated model tests against selected data sets within Colab**
6. **Use Colab progress tracking methods on model development (software project management)**
7. **Involve external collaborator and scientific community for contribution and enhancements.**

- Progress Levels for different models
  - SWAT: 1..2
  - WWEM: 4
  - Plant Growth: 5
  - AGNPS: 2
  - OMS ASRU Components: 5

USDA Modeling and Collaboration Infrastructure

Model Development

- Construct
- Run
- Analyze
- Test
- Verify



Model Project Management

- Tracker
- Forums
- Documents
- CMM Reports
- Access Control

Model Resources Change Management

- Version Control
- Change Management
- Repository
- Concurrent Access