CCSM3 Scripts Tutorial
How to Build, Run, and Test CCSM3

http://www.ccsm.ucar.edu/models/ccsm3.0/ccsm/

CCSM Software Engineering Group

Climate and Global Dynamics Division

NCAR

Tutorial Outline

- User Support and Post Processing
  Sylvia Murphy
- How to Build and Run CCSM3
  Mariana Vertenstein
- How to Test CCSM3
  Tom Henderson
- Setting up Production Runs
  Lawrence Buja
- Machine Dependent Details
  George R Carr Jr

User Support

- Send user support questions to ccsm@ucar.edu
- User's Guide
  http://www.ccsm.ucar.edu/models/ccsm3.0
- Post Processing:
  - netCDF Operators (NCO)
    - **http://nco.sourceforge.net**
  - NCAR Command Language (NCL)
    - **http://www.ncl.ucar.edu**

How to Build and Run CCSM3

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Building and Running CCSM3

I. What is CCSM?

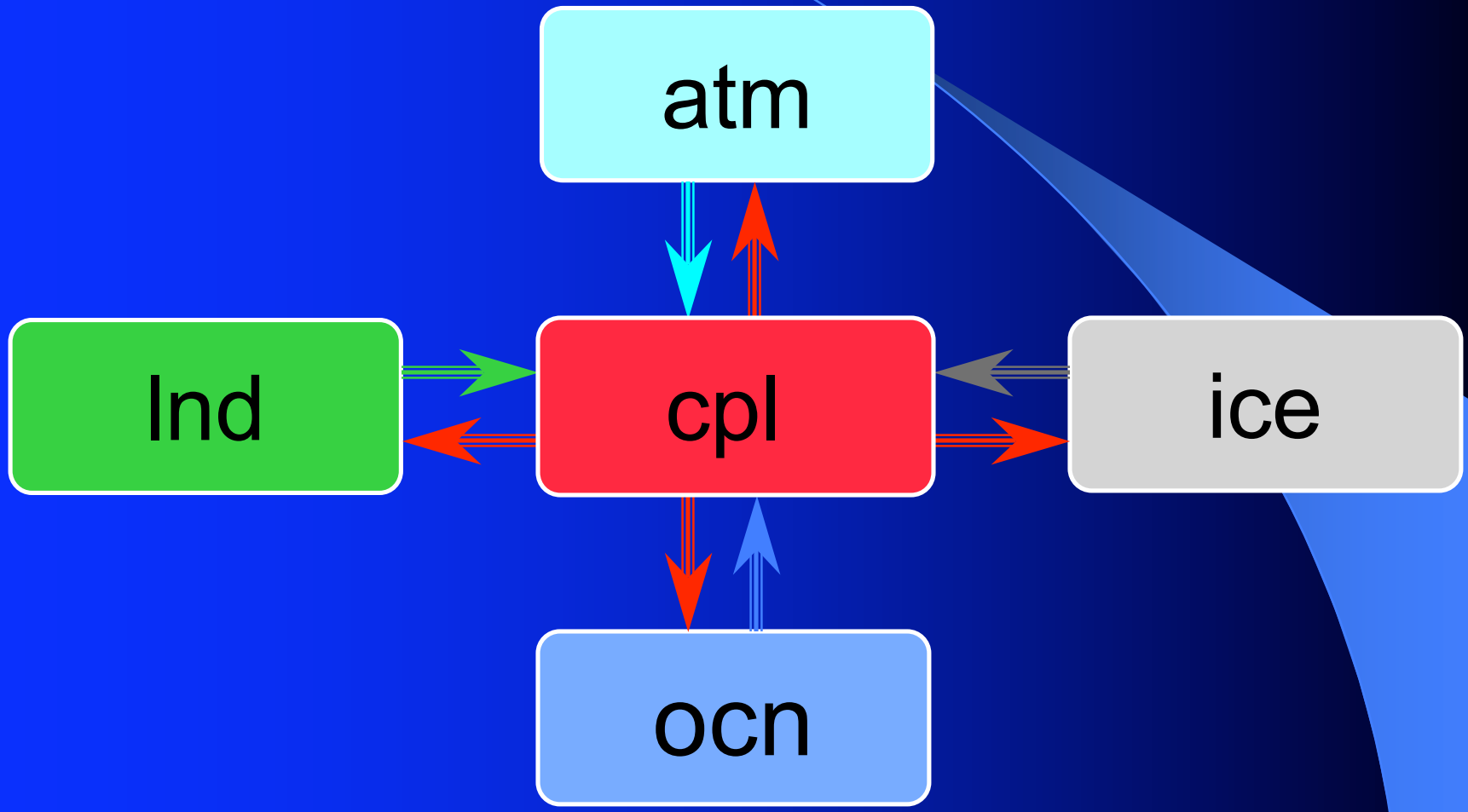
II. How do I get started?

III. CCSM3 Script Features

IV. How do I build and run a case?

V. More details …

CCSM Models



CCSM Components

- each model is represented by components:
  - atm: cam, datm, latm, xatm
  - lnd: clm, dlnd, xlnd
  - ice: csim, dice, xice
  - ocn: pop, docn, xocn
  - cpl: cpl
- active components are cam,clm,csim,pop
- "dead" components (xatm..) are used for software testing

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The CCSM3.0 distribution

Model code and scripts:

ccsm3.0.tar.gz

Input data (e.g. for T42_gx1v3):

ccsm3.0.inputdata.atm_lnd.tar.gz

ccsm3.0.inputdata.T42.tar.gz

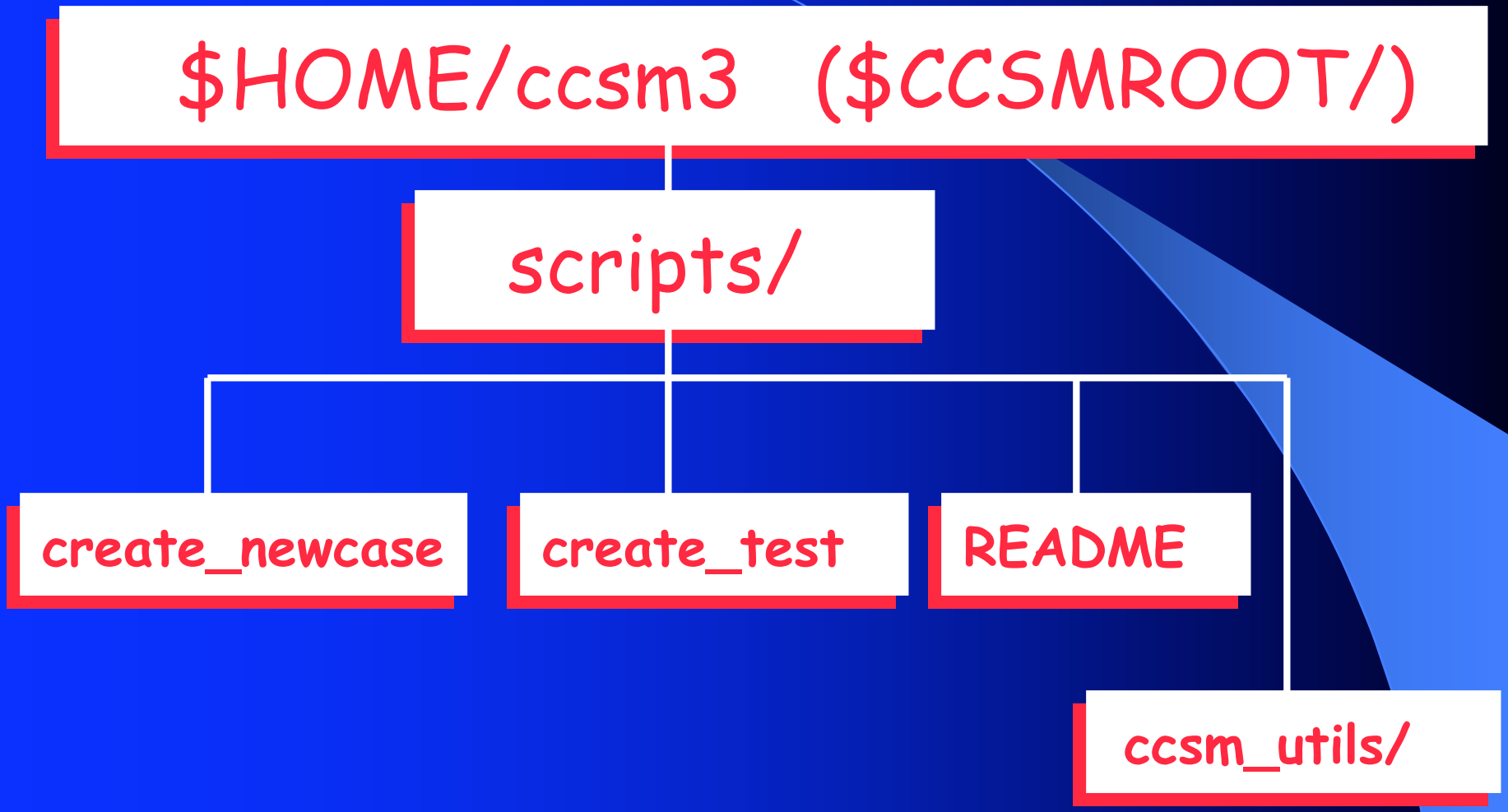
ccsm3.0.inputdata.gx1v3.tar.gz

ccsm3.0.inputdata.cpl.tar.gz

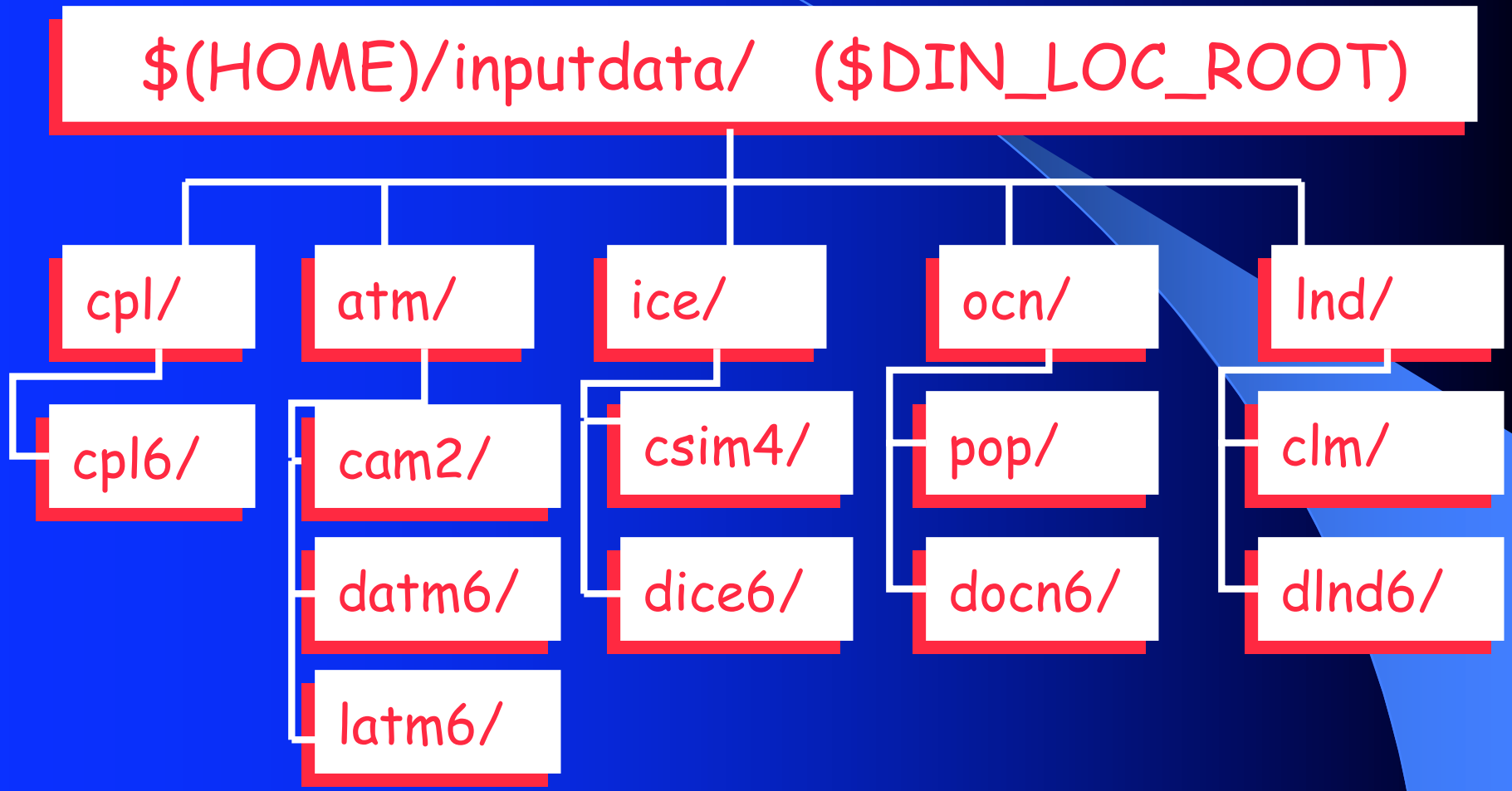
http://www.ccsm.ucar.edu/models/ccsm3.0

CCSM3 Case Directories

CCSM3.0 top level script directory



CCSM3.0 input data directory



Above directories have not kept up with component names

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Key script features (1 of 2)

- modular and extensible – easy to use
- modular - cases are generated using 3 editable environment variable files
  - build time related environment file
  - run time environment file
  - machine dependent environment file
    - (contains both build and run time variables)
- extensible - straightforward to add new machines
- script error checking adds reliability

Key script features (2 of 2)

- Default MPI tasks/ OpenMP threads are provided for each component, resolution and machine
- User can run same case on multiple machines out of one case directory
- Larger set of supported resolutions
- Automated tests are provided
- Performance tools are included

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Naming Conventions

- $CCSMROOT/ – root directory containing CCSM3 source code and scripts
- $CASE - defines both new case name AND case directory name
- $CASEROOT/ – root of new case directory (e.g. $HOME/$CASE)
- $MACH - "supported" machine name
- $EXEROOT/ – root directory containing model executables

Script Basics

- Two commands generate new case scripts
- create_newcase
  - creates a new CCSM3 case directory containing 3 environment variable files
- configure
  - uses the environment variable files to generate build and run scripts

Creating Building and Running a CCSM3 case

Step 1: cd into the scripts directory and create a new case for the target machine

Step 2: cd into the new case directory and configure the new case for the target machine

Step 3: build the model on the target machine

Step 4: run the model on the target machine

Step 5: examine output data

Default case – 6 commands

To generate a T42_gx1v3 1990 control run with fully active components that will run for 5 days on NCAR IBM-SP blackforest

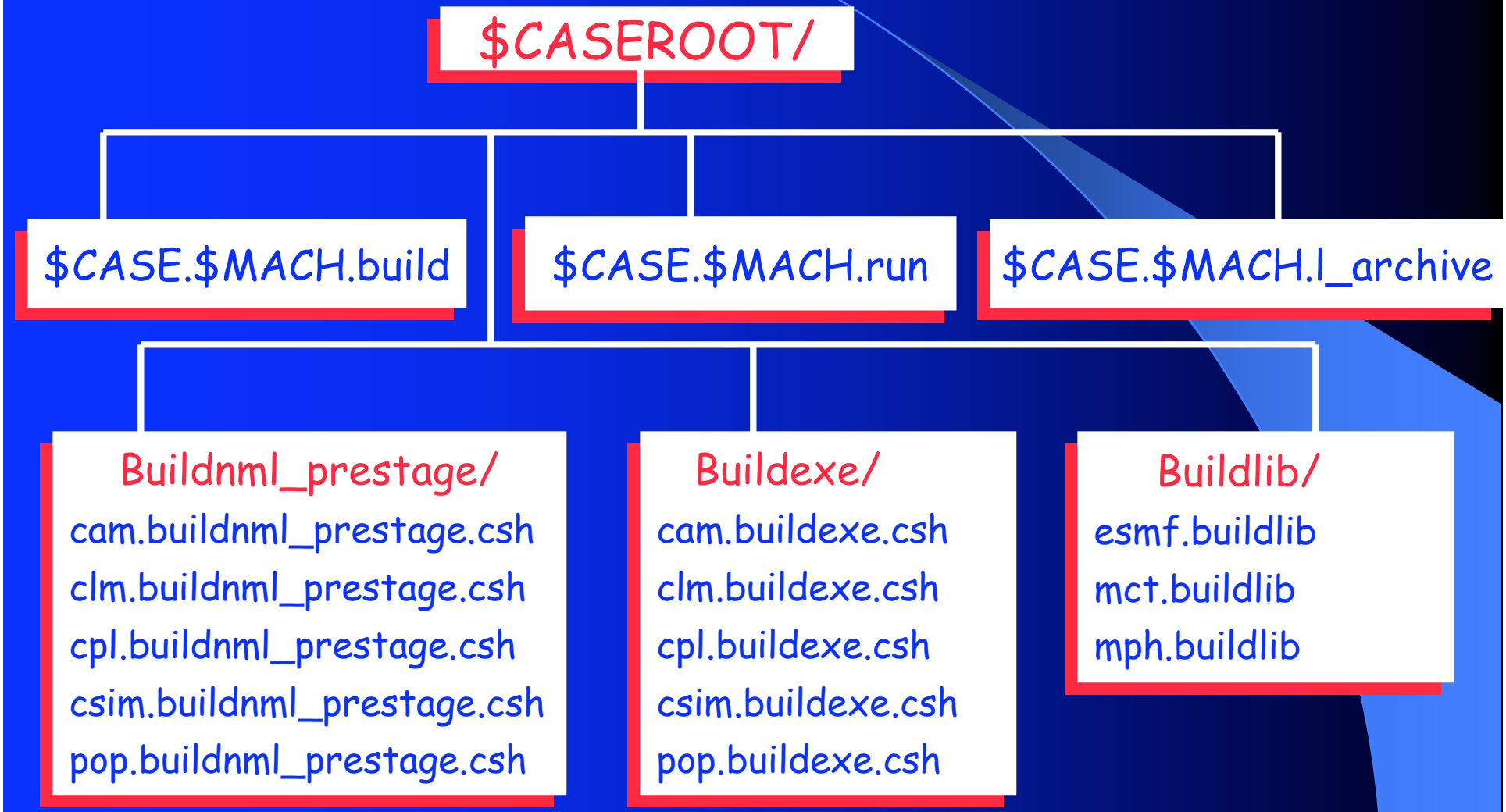
```
> cd $CCSMROOT/scripts
> ./create_newcase  -case /user/Case1 -mach blackforest
> cd /user/Case1
> ./configure -mach blackforest
> ./Case1.blackforest.build
> llsubmit Case1.blackforest.run
```

Step1: create_newcase produces:

- new /user/Case1 directory containing:
  - configure
  - env_conf
  - env_run
  - env_mach.blackforest
  - env.readme
  - SourceMods/

- $CASEROOT is /user/Case1
- $CASE is Case1
- $MACH is blackforest
- SourceMods/ - place holder for user-modified source code

Step2: configure produces



Step3: Build the CCSM3 model

- prestages input data in $EXEROOT/
- creates component namelist in $EXEROOT/
- creates component executables in $EXEROOT/

  $EXEROOT/atm/<atm exec>

  $EXEROOT/lnd/<land exec>

  $EXEROOT/ocn/<ocn exec>

  $EXEROOT/ice/<ice exec>

  $EXEROOT/cpl/cpl

Step 4 - Run the CCSM3 model

- submit $CASE.$MACH.run to batch queue
  - > cd /user/Case1
  - > llsubmit Case1.blackforest.run
- invoke build script and submit run script from $CASEROOT/
- model will be run in $EXEROOT/

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CCSM3 Component Parallelization

- CAM : MPI, OpenMP or MPI/OpenMP
- CLM: MPI, OpenMP or MPI/OpenMP
- CSIM: MPI only
- POP: MPI only
- CPL: MPI, OpenMP or MPI/OpenMP
- Data and Dead Comps: serial (1 proc)

CCSM3 Component Resolutions

- cam/clm: T85, T42, T31, 2x2.5
- datm/dlnd: T42, T31
- latm/dlnd: T62
- pop/csim: *gx1v3, gx3v5*
- docn/dice: *gx1v3, gx3v5*

CCSM3 Model Resolutions

Component resolutions can be combined as follows:

- T85_gx1v3
- T42_gx1v3, T42_gx3v5
- T31_gx3v5
- 2x2.5_gx1v3 (cam finite volume only)
- T62_gx1v3,T62_gx3v5 (latm only)

CCSM3 Component Sets

- A = datm,dlnd,docn,dice,cpl
- B = cam, clm, pop,csim,cpl
- C = datm,dlnd, pop,dice,cpl
- D = datm,dlnd,docn,csim,cpl
- G = latm,dlnd, pop,csim,cpl
- H = cam,dlnd,docn,dice,cpl
- I = datm, clm,docn,dice,cpl
- K = cam, clm,docn,dice,cpl
- L = latm,dlnd, pop,dice,cpl
- M = latm,dlnd,docn,csim (mixed layer ocean),cpl
- O = latm,dlnd,docn,dice,cpl
- X = xatm,xlnd,xocn,xice,cpl

Details of Building and Running a case

Step 1: cd into $CCSMROOT/scripts/ and run
create_newcase

Step 2: cd into $CASEROOT/, optionally edit
env_conf and tasks/threads in **env_mach.$MACH**,
run configure

Step 3: build CCSM3 model interactively by running
$CASE.$MACH.build

Step 4: optionally edit env_run and non-task/thread
part of **env_mach.$MACH**, submit
$CASE.$MACH.run

Step 5: examine output data

Step 1: run create_newcase

> cd $CCSMROOT/scripts/

> create_newcase -case $CASEROOT
-mach $MACH [-compset <comp set>]
[-res <resolution>]

$CCSMROOT and $CASEROOT => env_run

$MACH => env_mach.$MACH

resolution and comp set => env_conf

Step 2: configure command

- configure creates build and run scripts using environment variables in

  env_conf and env_mach.$MACH

- edit before running configure:
  - env_conf
  - MPI tasks/OpenMP threads in env_mach.$MACH
- edit anytime:
  - env_run
  - non tasks/threads in env_mach.$MACH

Step 2: Edit env_conf (1 of 2)

Environment var	Description
$CASE	case name
$CASESTR	case description
$COMP_ATM	atm comp: cam,datm,latm,xatm
$COMP_LND	lnd component: clm,dlnd,xlnd
$COMP_ICE	ice component: csim,dice,xice
$COMP_OCN	ocn component: pop,docn,xocn
$COMP_CPL	cpl component: cpl
$CSIM_MODE	Prognostic, oceanmixed_ice

Step 2: Edit env_conf (2 of 2)

Environment Var	Description
$RUN_TYPE	startup,branch,hybrid
$RUN_STARTDATE	yyyy-mm-dd (startup or hybrid)
$RUN_REFCASE	Ref case name (branch or hybrid)
$RUN_REFDATE	Ref yyyy-mm-dd (branch or hybrid)
$GRID	T42_gx1v3, T85_gx1v3,…
$IPCC_MODE	OFF, 1870_CONTROL, RAMP_CO2_ONLY

Step 2: Edit env_mach.$MACH tasks/threads

Machine specific settings provided for MPI/tasks and OpenMP theads. If default settings are changed, modify:

- setenv NTASKS_ATM $ntasks_atm
- setenv NTHRDS_ATM $nthrds_atm
- setenv NTASKS_LND $ntasks_lnd
- setenv NTHRDS_LND $nthrds_lnd
- setenv NTASKS_OCN $ntasks_ocn
- setenv NTHRDS_OCN $nthrds_ocn
- setenv NTASKS_ICE $ntasks_ice
- setenv NTHRDS_ICE $nthrds_ice

Step 2: Resolved scripts (1 of 2)

- configure command generates "resolved" scripts in Buildnml_prestage/ and Buildexe/ valid for given component set, resolution, CCSM initialization (set by env_conf variables)

- If want to change env_conf after running configure - must use
  - > configure -cleanall
  - > configure -mach $MACH

Step 2: Resolved Scripts (2 of 2)

- configure also uses tasks/threads in env_mach.$MACH to produce batch queue command - on ibm

  # @ task_geometry = {(……)}

- if change tasks/threads in env_mach.$MACH after running configure must use

  > configure –cleanmach $MACH

  > configure –mach $MACH

Step 2: CCSM Initialization

- Initialization set by $RUN_TYPE in env_conf
  - startup: new run from "cold start" input files
  - hybrid : new run from combination of initial (cam,clm) and restart files (pop,csim)
  - branch : new run from restart files
- Each initialization type has a unique set of input data
- Continuation run set by $CONTINUE_RUN in env_run

Step 3: Build the CCSM model

- Build the CCSM3 model interactively
  > ./$CASE.$MACH.build
- Calls Buildlib/*buildlib
- Calls Buildnml_prestage/*.buildnml_prestage.csh
  - Prestages necessary input data
  - Copies data **$DIN_LOC_ROOT** -> $EXEROOT
  - $DIN_LOC_ROOT needs to be accessible from $EXEROOT
- Calls Buildexe/*.buildexe.csh
  - each *.buildexe.csh calls gmake

Step 3: Build Macros and Makefile

- All component executables created using Makefile in $CCSMROOT/models/bld/
- Makefile is machine independent – uses machine specific details in Macros.$OS files (*e.g.*, Macros.AIX)
- User should modify appropriate Macros.$OS file to change machine specific gmake flags

Step 4: Run the CCSM model

- Submit (or run) $CASE.$MACH.run
- $CASE.$MACH.build is invoked from $CASE.$MACH.run
- Input data will be prestaged from $DIN_LOC_ROOT/ during build
- Model will be run in $EXEROOT/
- Component stop time and restart file write times controlled by $STOP_OPTION and $STOP_N

Step 4: Short and Long-term archiving

- Short-term archiving moves model output data to separate area on local disk
  - set by $DOUT_S_ROOT
- Long-term archiving copies model output data from $DOUT_S_ROOT to local mass store
  - set by $DOUT_L_MSROOT
  - done by script $CASE.$MACH.l_archive

Step 4: Edit env_run

Environment Var	Description
$RESUBMIT	Automatic resubmission number
$CONTINUE_RUN	Continuation run flag TRUE or FALSE
$STOP_OPTION	Coupler stop time (ndays, nmonths, newyear…)
$STOP_N	Number of days or months

Step 4: Edit env_mach.$mach

Environment var	description
$EXEROOT	Executable root dir
$DIN_LOC_ROOT	Input data root dir
$DOUT_S	Turns on short-term archiving
$DOUT_S_ROOT	Short-term archiving root
$DOUT_L_MS	Turns on long-term archiving
$DOUT_L_MSROOT	Long-term archiving root

Step 5: Model output data

- only active components output history and restart files (default)
- active components write netCDF monthly averaged history files (default)
- active components write binary restart files at end of run (default)
- CAM and CLM also periodically write netCDF initial files at beginning of each year (default)
- each component writes standard output "log" files

Summary

CCSM is now easier to build and run!

For more details see the CCSM3.0 User's Guide at:

www.ccsm.ucar.edu/models/ccsm3.0

CCSM3 Testing

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Overview

- Built-in test facility
- CCSM3 test cases
- Test creation
- Test execution
- Test evaluation

Built-in Test Facility (1 of 2)

- CCSM includes new built-in tests
- Everyone should use them
- Why should users test?
  - Validate download
    - Source code, data sets, etc.
  - Verify exact restart after all source code changes
- See User's Guide section 7

Built-in Test Facility (2 of 2)

- DO NOT USE BUILT-IN-TEST SCRIPTS TO START PRODUCTION RUNS
- Only use `create_newcase` for production runs

Common CCSM Test Cases (1 of 2)

- Smoke test
  - Run for a few days
  - Pass if run completes
- Exact restart
  - Compare initial and restart runs
  - Pass if results match bit-for-bit

Common CCSM Test Cases (2 of 2)

- Debug
  - Run with compiler trapping
    - Out-of-bounds indexing, floating-point exceptions, etc.
  - Pass if run completes
- Regression
  - Compare with old run
  - Pass if results match bit-for-bit

Test Case Names (1 of 2)

- Exact restart for startup runs
  - ER.01a: 1990 control
  - ER.01b: 1870 control
  - ER.01e: CO2 ramping
- Exact restart for branch runs
  - BR.02a: 1990 control
- Exact restart for hybrid runs
  - HY.02a: 1990 control

Test Case Names (2 of 2)

- Debug (software trapping)
  - DB.01a: 1990 control
  - DB.01b: 1870 control
  - DB.01e: CO2 ramping

Test Creation (1 of 3)

- Choose a test case (like ER.01a), then select:
  - Resolution
    - T31_gx3v5, T42_gx1v3,T85_gx1v3, …
  - Machine
    - bluesky, blackforest, chinook, jazz, …
  - Component set
    - B, A, X, G, …

Test Creation (2 of 3)

- Run `create_test` from CCSM3 scripts directory
  - Uses `create_newcase` and `configure`
- Try the `–help` option…
- Use the `–testroot` option to specify location of generated test scripts
  - Otherwise location is in CCSM3 scripts directory

Test Creation (3 of 3)

- Use the `-inputdataroot` option to specify alternate input data directory
  - Use outside of NCAR

Test Creation Example (1 of 3)

- Exact restart test for 1990 control

```
> create_test -test ER.01a -mach bluesky
  -res T42_gx1v3 -compset B
  -testroot $HOME/tst
...
Successfully created new case root directory
  $HOME/tst/TER.01a.T42_gx1v3.B.bluesky.123456
...
```

Test Creation Example (2 of 3)

- `create_test`…
  - Creates new test directory
  - Runs `create_newcase` and `configure`
    - Creates usual build and run scripts
    - Do not use run script!
  - Builds test script
  - Also builds script `batch.$MACH`
    - Use to run test suite, see Users Guide

Test Creation Example (3 of 3)

```
> cd $HOME/tst/TER.01a.T42_gx1v3.B.bluesky.123456
> ls
TER.01a.T42_gx1v3.bluesky.B.123456.build
TER.01a.T42_gx1v3.bluesky.B.123456.run
TER.01a.T42_gx1v3.bluesky.B.123456.test
configure
restart_compare.pl
env_run
Buildnml_Prestage/
Buildexe/
...
```

Test Execution Example (1 of 2)

- Go to new test case directory

```
> cd $HOME/tst/TER.01a.T42_gx1v3.B.bluesky.123456
```

- Run build script interactively

```
> TER.01a.T42_gx1v3.bluesky.B.123456.build
```

Test Execution Example (2 of 2)

- Edit test script to modify default batch queue (optional)

```
> vi TER.01a.T42_gx1v3.B.bluesky.123456.test
```

- Submit test script to queue

```
> llsubmit TER.01a.T42_gx1v3.B.bluesky.123456.test
```

Test Evaluation

- Test results summarized in two files
  - **`Testcase.out`**
    - Human-readable log file
  - **`Testcase`**
    - Simple state
      - PASS, FAIL, ERROR, …
    - "PASS" means test passed
    - Anything else means look at log file

Test Evaluation Example

```
> more Testcase
PASS

> more Testcase.out
doing a 10 day initial test
…
Doing a 5 day restart test
…
Comparing initial log file with
   restart/branch/hybrid log file…
log files match!
PASS
```

Questions?

- See section 7 in the User's Guide

CCSM3 Production Runs

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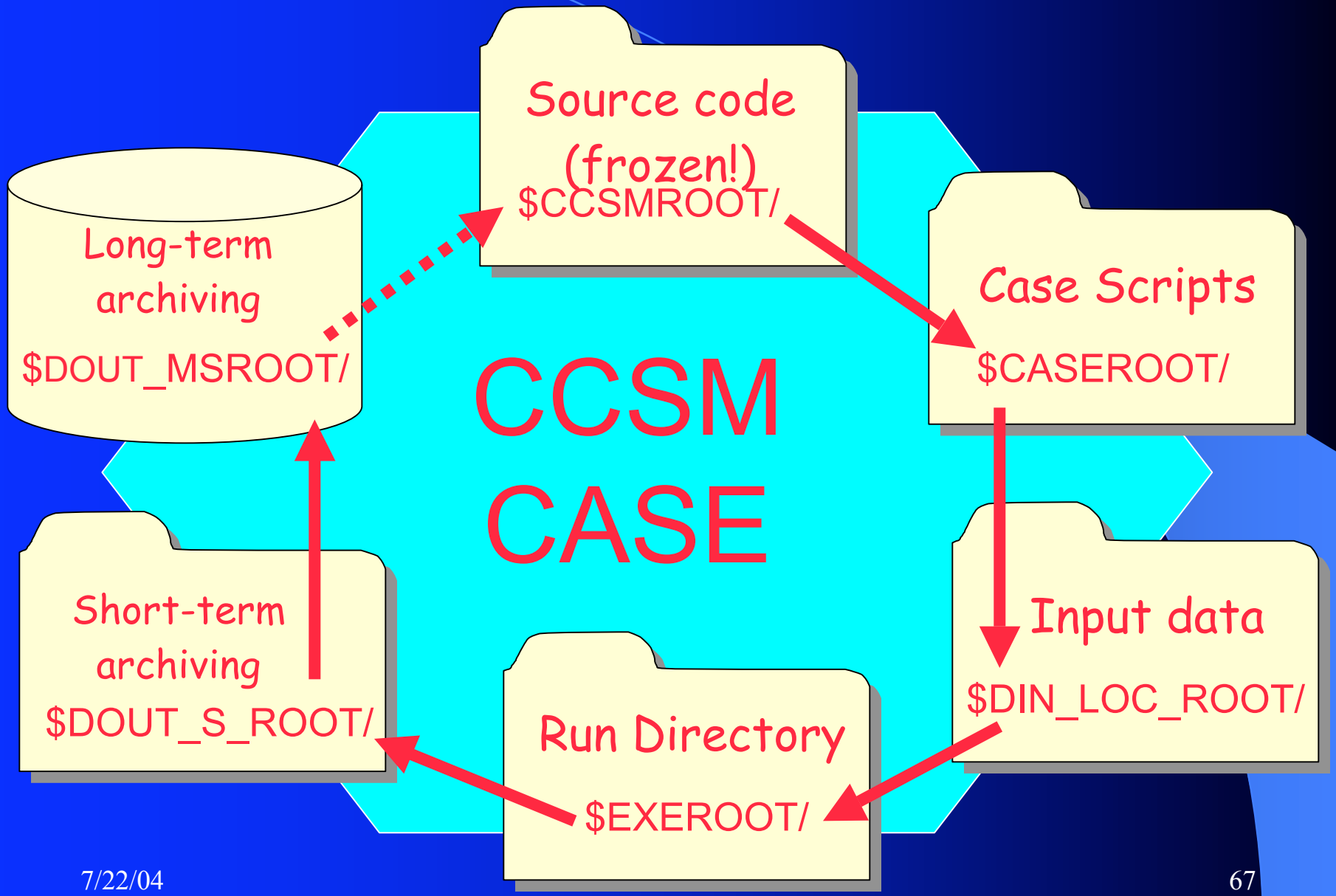
CCSM3 Case Directories



Resources

- Computational Cost (on NCAR Bluesky, 1 GAU = $21):

Resolution	PEs	Myr/day	CPUhrs/Myr	GAUs/Myr
T31_gx3v5	64	24.2	63	16
T42_gx1v3	128	8.5	363	87
T85_gx1v3	128	3.0	1030	244

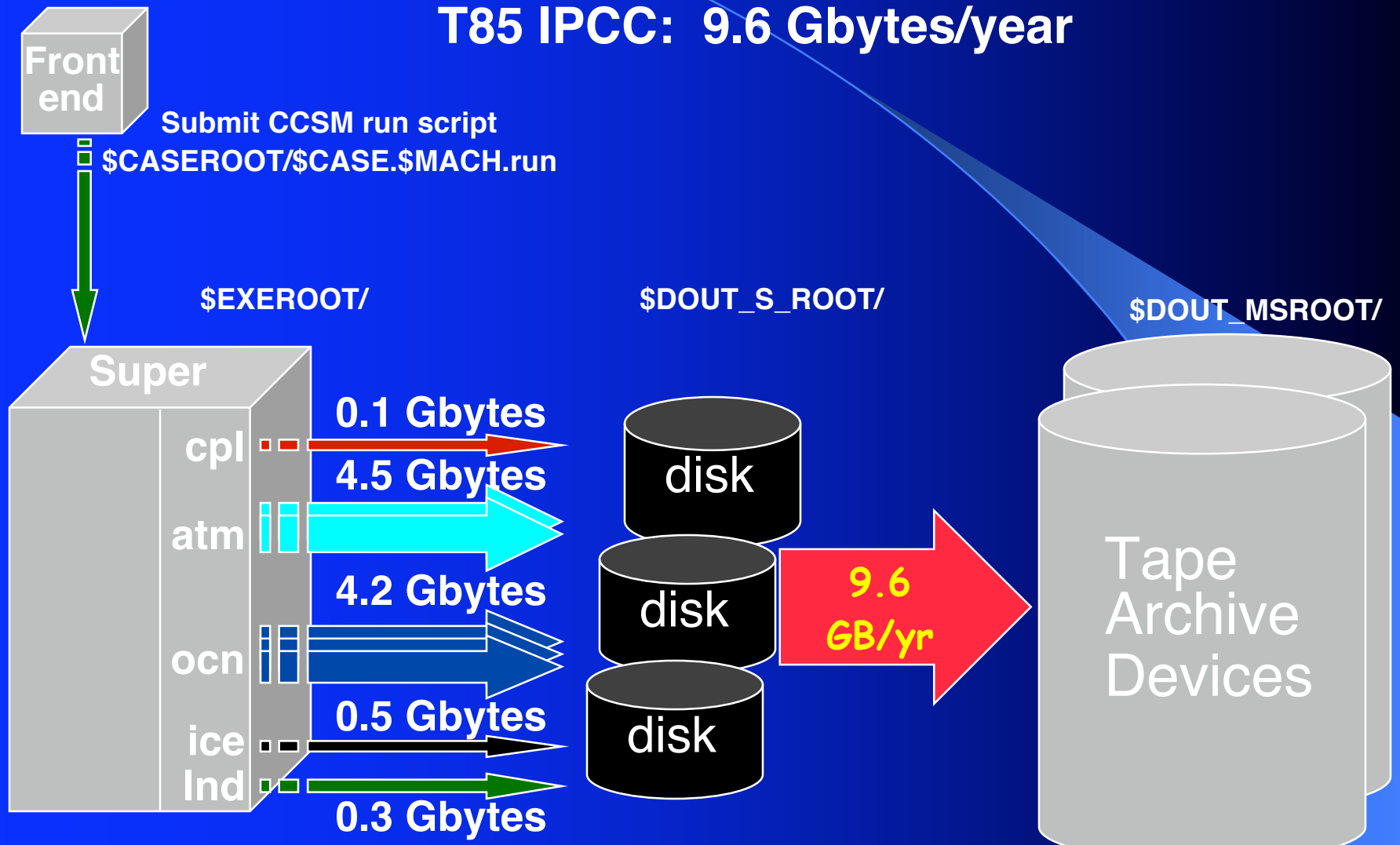
- Data Volume:
  - T42_gx1v3 = 6 GB/Myr
  - T85_gx1v3 = 10 GB/Myr
- Disk space: 100 GB of scratch space per case
- Time to Solution = Y / S + Q + D
  - Y = Years of integration
  - S = Ave Model Execution Rate (Model_Year/Wall_Day)
  - Q = Queue wait time
  - D = Machine downtime

CCSM Data Flow

- INPUT:
  - CCSM run scripts ($CASEROOT/$CASE.$MACH.run)
  - Initial/Restart data (usually previous CCSM run)
  - Boundary Data (Located in $DIN_LOC_ROOT)
- Output Data Archiving ($DOUT_S_ROOT)
  - History data
  - Restart data
  - Initial data
  - Printed Log files

CCSM T85 Data Output

T85 IPCC: 9.6 Gbytes/year



Setting up a run

1. Standard Build + some modification
   - $CCSMROOT/scripts/create_newcase
   - Modify env_conf, env_run, env_mach.$MACH
   - configure
   + Apply modification to scripts or code
2. Prestage initial/restart datasets
3. Build model interactively (run $CASEROOT/$CASE.$MACH.build)
4. Check that modifications happen
   - Look in $EXEROOT/*/*.buildexe.*
5. Check exact restartability

Setting Up a Production Run

1. cd $CCSMROOT/scripts
2. ./create_newcase -case $CASEROOT -mach $MACH
   -res T85_gx1v3 -compset B
3. cd $CASEROOT
4. Modify env_conf, env_run, env_mach.$MACH
5. ./configure -cleanall
6. ./configure -mach $MACH
7. Modify $CASEROOT/Buildnml_Prestage/*.csh
   as necessary
8. Position restart files in $DOUT_S_ROOT/restart
9. Build model interactively: $CASEROOT/$CASE.$MACH.build
10. Submit $CASEROOT/$CASE.$MACH.run

Production env_conf settings

RUN_TYPE	branch
RUN_STARTDATE	2000-01-01
RUN_REFCASE	b30.030a
RUN_REFDATE	2000-01-01
CASESTR	"$GRID $IPCC_MODE from $RUN_REFCASE year $RUN_REFDATE"

Production env_run settings

CASEROOT	$HOME/ccsm_runs/$CASE
CCSMROOT	$HOME/ccsm3
STOP_OPTION	yearly
INFO_DBUG	0
DIAG_N	365

Production env_mach settings

EXEROOT	$SCRATCH/$LOGNAME/$CASE
DIN_LOC_ROOT	$HOME/ccsm/inputdata
DOUT_S	TRUE
DOUT_L_MS	TRUE
DOUT_L_MSNAME	CCSM
DOUT_L_MSPWD	secret

Modifying CCSM

- Changing code
  - Frozen code (Don't modify code in $CCSMROOT!)
  - Modifed code ($CASEROOT/Source/Mods/src.*)
- Changing boundary data
  - Modify $CASEROOT/Buildnml_Prestage/cam.buildnml_prestage.csh
- Validating your change
  - Verify that your change was applied correctly
  - Document your change
  - Do no damage:
    - Check exact restarts
    - Check performance
    - Compare new model climate with control climate

Running a production job

- Run in batch queues

  llsubmit $CASEROOT/$CASE.$MACH.run

- Extend CCSM runs as "continue" runs.
  - A continued run gives exactly the same results as if the run had never stopped.
  - Set CONTINUE_RUN TRUE in $CASEROOT/env_run

- CCSM Restart Data
  - CCSM writes restart files at specified intervals
  - $DOUT_S_ROOT/restart/ & restart.tars/

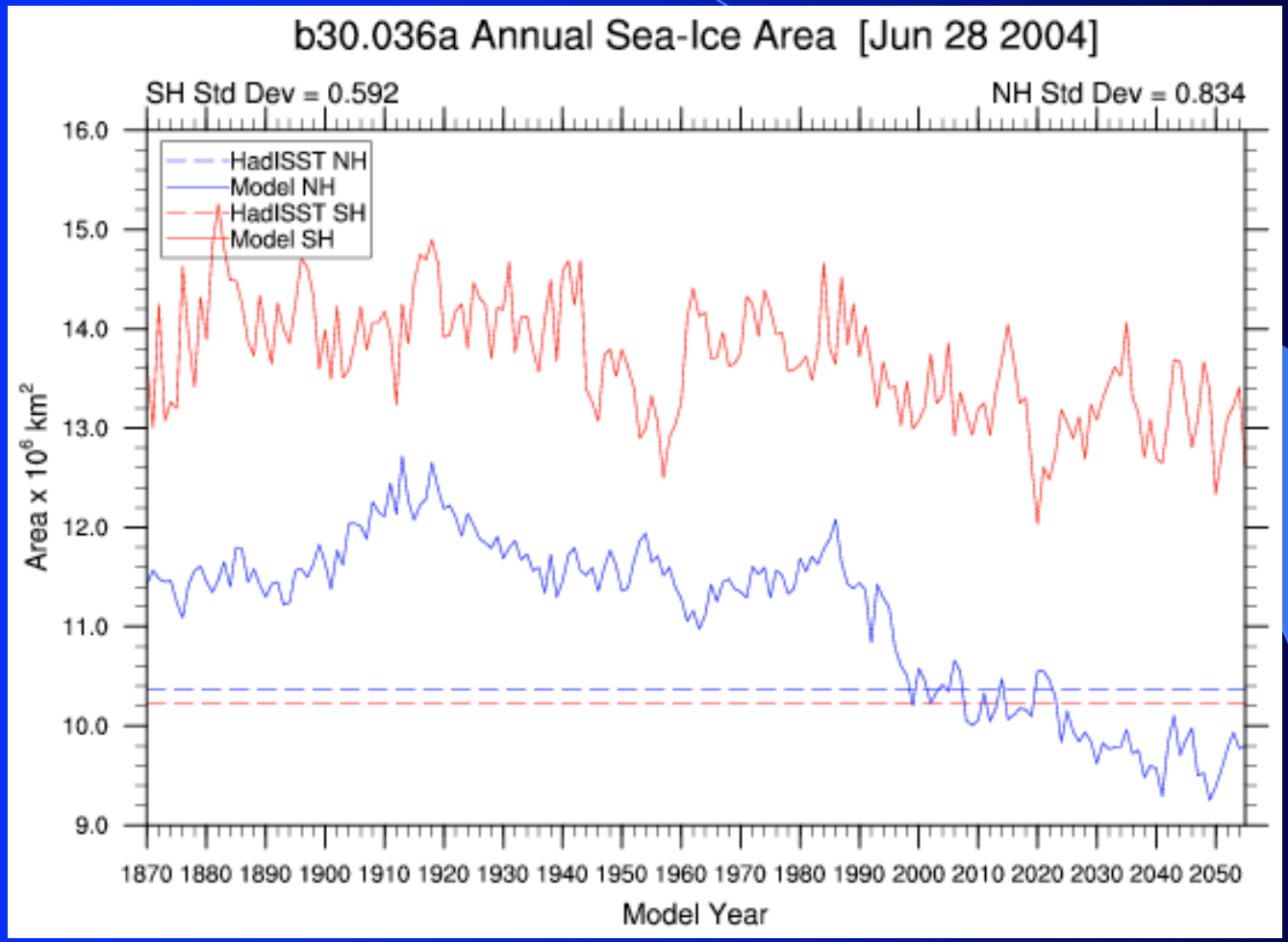
Automatic resubmission

- The CCSM can automatically resubmit itself
- RESUBMIT variable:
  - Automatic resubmit flag that counts down to 0
  - Located in $CASEROOT/env_run
- At end of run, if RESUBMIT is not 0, automatically:
  - Decrement RESUBMIT by 1 ($CASEROOT/env_run)
  - Set CONTINUE_RUN true ($CASEROOT/env_run)
  - Resubmit $CASEROOT/$CASE.$MACH.run

Monitoring a production job

- Is it still running?
  - Check your job(s) in the batch queue:
    llq -u $LOGNAME (IBM SP)
  - Monitor the end of the newest cpl log file
    `tail -30 `ls -t $EXEROOT/cpl/cpl.log.* | head -1``
- Disk space management
  - Verify long-term archiving
  - Monitor quotas: `spquota (bluesky)`
  - Monitor disk usage: `du $EXEDIR/.. | sort -n`
  - Cleanout $LOGDIR

Monitoring a production job



Log Files, Aborts and Errors

- Common Model Errors:
  - Build failure
  - Pointing to wrong restart directories
  - No/incorrect input data
  - POP ocean model non-convergence
  - CAM model stops due to non-convergence
  - CSIM model failures
- Exceed disk quotas or Wall-clock limits
- System problems
- Warnings:
  - CAM Courant limit warning messages

Log Files, Aborts and Errors

Finding your Error can be a challenge!

Look at:

1. $EXEROOT/*/*.log.*
2. $CASEROOT/poe.std*
3. Your mailbox
4. quotas, batch queue limits, disk scrubbing

Some of my favorite shortcuts:

```
alias mev 'source env_run;source env_run;source env_mach.bluesky32'
alias s   'cd $CASEROOT; ls -lrt | tail -20'
alias e   'cd $EXEROOT;  ls -ldrt */* | tail -20'
alias r   'cd $DOUT_S_ROOT/restart;  ls -lrt'
alias tc  'tail -30 `ls -rt */cpl.log.* | tail -1`'
alias mo  'more `ls -rt $CASEROOT/poe.stdout.* | tail -1`
alias me  'more +/" C O N N" `ls -rt $CASEROOT/poe.stderr.* | tail -1`
```

Questions?

- See use cases in the User's Guide

Machine Dependent Details

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Where Do You Start???

- You've got a machine to run on
- You've got users (might be you)
- You've got the tarball's (src and data)
- You've read the User Guide … **right?**
- You want to make building and running CCSM3 on your system …. EASY

The Process

- Look at the list of machines already supported
- You may choose to …
  - Make your machine look like a fully supported machine
  - Create/modify machine specific files based on the existing files for other similar machine(s)
    - You'll need to know some of the basic details of your system (libraries, tools, architecture, …)

Categories of Machine Support (1 of 2)

1 Climate Verified, fully tested
   - bluesky, bluesky32, blackforest, cheetah, seaborg

2 Runs, passes exact restart test, climate not verified
   - chinook, jazz

Machines Supported (2 of 2)

3 Builds, might not run, may not pass exact restart test

- anchorage, bangkok, phoenix, lemieux, moon

4 Unsupported, being looked at or worked on, possible future support

- eagle, ram, calgary, mauve, rime, lodestone, rex, TBD Apple G5, many others

Machine Descriptions

Machine	Description	OS	Compiler	Network type	Queue SW	Status
bluesky	IBM Power4	AIX	IBM XL	IBM	Load Leveler	1
bluesky32	IBM Power4	AIX	IBM XL	IBM	Load Leveler	1
blackforest	IBM Power3	AIX	IBM XL	IBM	Load Leveler	1
cheetah	IBM Power4	AIX	IBM XL	IBM	Load Leveler	1
seaborg	IBM Power3	AIX	IBM XL	IBM	Load Leveler	1
chinook	SGI R12000	IRIX	MIPS	NumaLink	NQS	2
jazz	Intel Xeon	Linux	PGI	Myrinet	PBS	2
anchorage	Intel Xeon	Linux	PGI	Gbit Ethernet	SPBS	3
bangkok	Intel Xeon	Linux	PGI	Gbit Ethernet	SPBS	3
lemieux	Alpha	OSF/1	Compaq	Myrinet	PBS	3
moon	Earth Simulator	NEC	NEC	NEC	PBS	3
phoenix	Cray X1	Unicos	Cray	CrayLink	PBS	4
calgary	Intel Xeon	Linux	PGI	InfiniBand	SPBS	4
rex	AMD Opteron	Linux	PGI	Myrinet	PBS	4
lightning	AMD Opteron	Linux	PGI	Myrinet	Load Sharing Facility	4

What To Expect???

- If your machine matches a supported machine … order hours to build
- If your machine is similar to a supported machine … order days to build
- If your machine is completely different … order days to weeks

Setting Up a New Machine

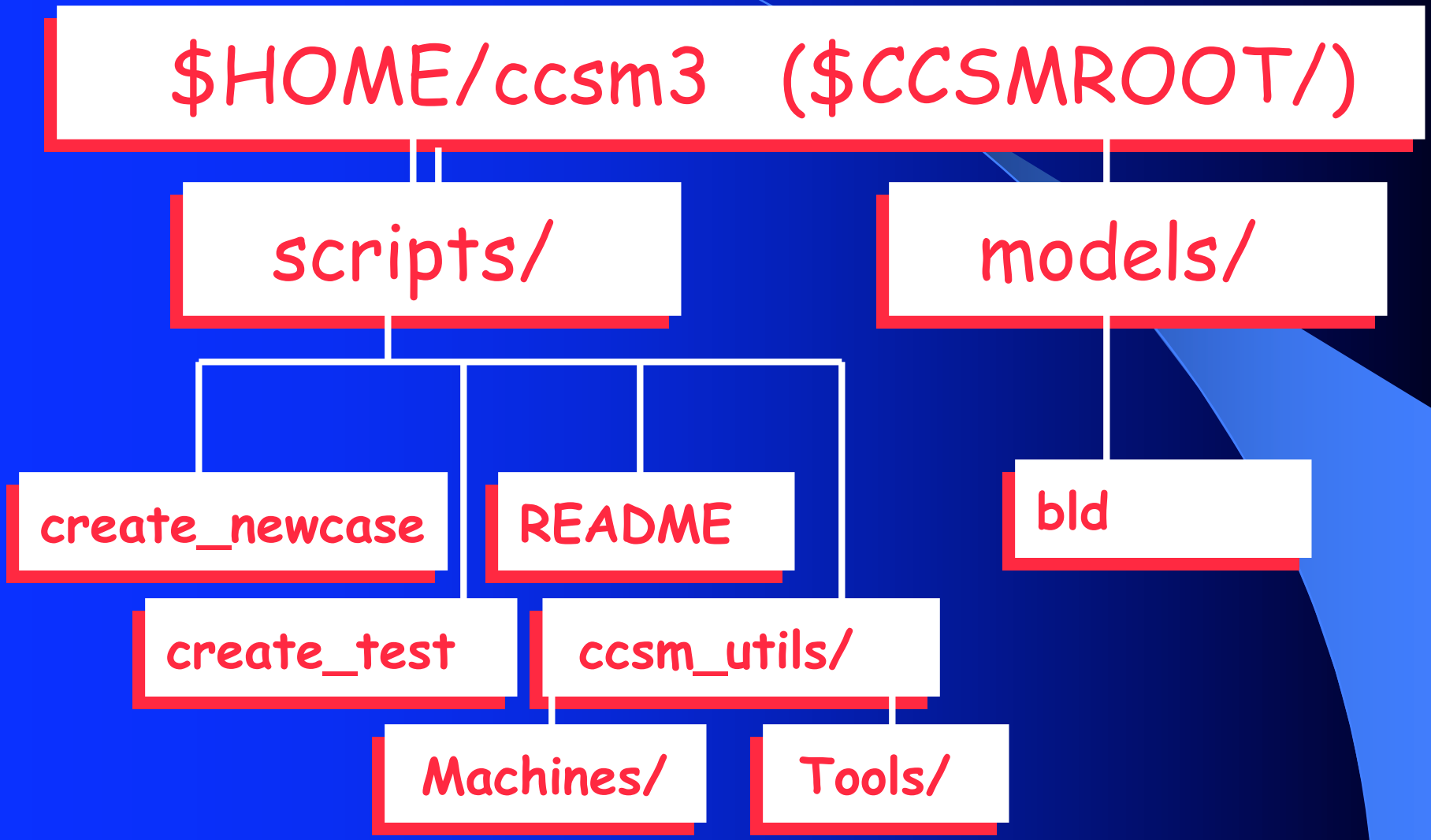
- Look for supported machine(s) with
  - Your CPU
  - Your architecture
  - Your compiler
  - Your interconnect
  - Your batch process
  - Your storage strategy
- May need to combine from more than one "supported" configuration

Files of Interest

Can be found in

- $CCSMROOT/scripts/ccsm_utils/Tools/
- $CCSMROOT/scripts/ccsm_utils/Machines/
- $CCSMROOT/models/bld/

CCSM3.0 top level script directory



Recipe For A New Machine

Assuming new "Linux" machine named "newmach"

- Modify 1 file
  - $CCSMROOT/scripts/ccsm_utils/Tools/check_machine to add "newmach"
- Create 3 files minimum (at most 5 files)
  - $CCSMROOT/scripts/ccsm_utils/Machines/{batch, run, env, l_archive, modules}.linux.newmach
- Look at, maybe modify one more file
  - $CCSMROOT/models/bld/Macros.Linux
- Try it … run some of the test scripts
- Repeat as needed

The File "check_machine"

```
#!/bin/csh -f

#--------------- valid machine list
set resok = (  \
  bluesky      \
  bluesky32    \
  blackforest  \
  cheetah      \
  cheetah32    \
  eagle        \
      .
      .
      .
  rime         \
  generic_ibm  \
  generic_sgi  \
  generic_linux \
  generic_compaq \
  generic_sx  )
#----------------------------------
```

"Machines" Directory Files

- What do the file names look like
  - {batch,env,run,l_archive,modules}.<machine vendor or type>.<machine name>
- Examples
  - batch.linux.bangkok
  - env.linux.lodestone
  - run.linux.jazz
  - l_archive.ibm.bluesky
  - modules.sgi.chinook

"Machines" Directory Files

- batch.* (required) - provides the template for building the batch job submission commands
- env.* (required) - provides the template for basic component configuration and model run options
- run.* (required) - provides the template for building the commands needed to run the model
- l_archive.* (optional) - commands for long term archiving
- modules.* (optional) - specific commands for machines needing run modules

File "env.linux.newmach" (1 of 3)

```
#! /bin/csh -f

# Documentation of following environment varibles is provided in env.readme

# ----------------------------------------------------------------------
# Tasks and Threads: Edit any time prior to invoking the configure command
# ----------------------------------------------------------------------

set COMPONENTS = ($COMP_CPL $COMP_ICE $COMP_LND $COMP_OCN $COMP_ATM)

                          set ntasks_atm =  1; set nthrds_atm = 1
                          set ntasks_lnd =  1; set nthrds_lnd = 1
                          set ntasks_ice =  1; set nthrds_ice = 1
                          set ntasks_ocn =  1; set nthrds_ocn = 1
                          set ntasks_cpl =  2; set nthrds_cpl = 1

if ($COMP_LND == xlnd) then
                          set ntasks_lnd =  2; set nthrds_lnd = 1
endif

if ($COMP_ICE == xice) then
                          set ntasks_ice =  4; set nthrds_ice = 1
endif

      :
```

File "env.linux.newmach" (2 of 3)

```
    :

# ------------------------------------------------------------------------
# General machine specific environment variables  - edit before the initial build
# ------------------------------------------------------------------------

setenv EXEROOT              /ptmp/$LOGNAME/$CASE
setenv RUNROOT              $EXEROOT
setenv GMAKE_J              1

# ------------------------------------------------------------------------
# Environment variables for prestaging input data - edit anytime during run
# ------------------------------------------------------------------------

setenv DIN_LOC_ROOT         /fs/cgd/csm/inputdata
setenv DIN_LOC_ROOT_USER    /fs/cgd/csm/inputdata_user
setenv DIN_LOC_MSROOT       /CCSM/inputdata
setenv DIN_REM_MACH         dataproc.ucar.edu
setenv DIN_REM_MSROOT       /CCSM/inputdata
setenv DIN_REM_ROOT         /fs/cgd/csm/inputdata

    :
```

File "env.linux.newmach" (3 of 3)

```
      :
# ------------------------------------------------------------------------
# Environment variables for short term output storage - edit anytime during run
# ------------------------------------------------------------------------

setenv DOUT_S                TRUE
setenv DOUT_S_ROOT           /ptmp/$LOGNAME/archive/$CASE

# ------------------------------------------------------------------------
# Environment variables for longer term output storage - edit anytime during run
# ------------------------------------------------------------------------

setenv DOUT_L_RCP            FALSE
setenv DOUT_L_RCP_ROOT       mylogin@remotesite.edu:/ptmp/$LOGNAME/archive/$CASE
setenv DOUT_L_MS             FALSE
setenv DOUT_L_MSNAME         `echo $LOGNAME | tr '[a-z]' '[A-Z]'`
setenv DOUT_L_MSROOT         /$DOUT_L_MSNAME/csm/$CASE
setenv DOUT_L_MSPWD          $DOUT_L_MSNAME
setenv DOUT_L_MSRPD          3650
setenv DOUT_L_MSPRJ          00000000

      :
```

"batch.linux.newmach" (1 of 2)

newmach

```
#! /bin/csh -f

set mach = bangkok

source $CASEROOT/env_conf || exit -1
source $CASEROOT/env_run  || exit -1
source $CASEROOT/env_mach.${mach} || exit -1

##Determine the nodes for batch queue
@ cpu_per_node = 2
@ tasks = 0
@ mpp = 0
foreach n (1 2 3 4 5)                  # loop over components
  @ tasks = $tasks + $NTASKS[$n]
  @ mpp = $mpp + $NTASKS[$n] * $NTHRDS[$n]
end
```

"batch.linux.newmach" (2 of 2)

```
      :

cat >! ${CASEROOT}/${CASE}.${mach}.run << EOF1
#! /bin/csh -f
#
#  This is a CCSM batch job script for ${mach}
#
## BATCH INFO
#PBS -q medium
# Maximum number of processes (CHANGE THIS if needed)
#PBS -l nodes=${nodes}:ppn=${cpu_per_node}
# output file base name
#PBS -N testbatch.pbs
# Put standard error and standard out in same file
#PBS -j oe
# Export all Environment variables
#PBS -V
# End of options

      :
```

File "run.linux.newmach" (1 of 4)

```
    :

# ------------------------------------------------------------
# Create processor count input files
# ------------------------------------------------------------

cd $EXEROOT/all
@ PROC = 0                # counts total number of tasks
rm -rf mpirun.pgfile1  # create new pgfile
rm -rf mpirun.pgfile   # create new pgfile
echo "0" >! mpirun.pgfile1;
foreach n (1 2 3 4 5)
   set comp  = $COMPONENTS[$n]
   set model = $MODELS[$n]
   set nthrd = $NTHRDS[$n]
   set ntask = $NTASKS[$n]
   @ M = 0
   while ( $M < $ntask )
      if (($n == 1) && ($M == 0)) then
         echo "skipping first model"
      else
         echo "1 $EXEROOT/all/$comp" >>! mpirun.pgfile1;

    :
```

File "run.linux.newmach" (2 of 4)

```
      ⋮


# ------------------------------------------------------
# Run the model
# ------------------------------------------------------

cd $EXEROOT/all
paste ${PBS_NODEFILE} mpirun.pgfile1 > mpirun.pgfile
echo "`date` -- CSM EXECUTION BEGINS HERE"
mpirun -p4pg mpirun.pgfile ./$COMPONENTS[1]
wait
echo "`date` -- CSM EXECUTION HAS FINISHED"

# ------------------------------------------------------
# Save model output stdout and stderr
# ------------------------------------------------------

cd $EXEROOT/cpl
set CplLogFile = `ls -1t cpl.log* | head -1`


      ⋮
```

File "run.linux.newmach" (3 of 4)

```
      :

# ------------------------------------------------------------------------
# Perform short term archiving of output
# ------------------------------------------------------------------------

if ($DOUT_S == 'TRUE') then
  echo "Archiving ccsm output to $DOUT_S_ROOT"
  echo "In $CASEROOT directory using the short term archiving script ccsm_s_archive.csh"
  cd $CASEROOT; $UTILROOT/Tools/ccsm_s_archive.csh
endif

# ------------------------------------------------------------------------
# Submit longer term archiver if appropriate
# ------------------------------------------------------------------------

if ($DOUT_L_MS == 'TRUE' && $DOUT_S == 'TRUE') then
  echo "Long term archiving ccsm output using the script $CASE.$MACH.l_archive"
  qsub $CASE.$MACH.l_archive
endif

      :
```

File "run.linux.newmach" (4 of 4)

```
      ⋮

# ------------------------------------------------------------------------
# Resubmit another run script
# ------------------------------------------------------------------------

set echo
cd $CASEROOT
source env_run
if ($RESUBMIT > 0) then
    echo RESUBMIT is $RESUBMIT
    @ RESUBMIT = $RESUBMIT - 1
    echo RESUBMIT is $RESUBMIT

    sed '1,/^ *setenv *CONTINUE_RUN .*/s//setenv CONTINUE_RUN TRUE/' \
        env_run > env_run.tmp; mv env_run.tmp env_run
    sed "s/^ *setenv *RESUBMIT .*/setenv RESUBMIT $RESUBMIT/;" \
        env_run > env_run.tmp; mv env_run.tmp env_run

    qsub $CASE.$MACH.run
  endif
endif
```

The Macros file

- Located in $CCSMROOT/models/bld
- Where you place the build specific modifications (do not change the Makefiles)
- Examples
  - Macros.Linux
  - Macros.AIX

File "Macros.Linux" (1 of 2)

```
#===============================================================================
# CVS $Id: Macros.Linux,v 1.11 2003/10/09 14:09:50 tcraig Exp $
# CVS $Source: /fs/cgd/csm/models/CVS.REPOS/shared/bld/Macros.Linux,v $
# CVS $Name: ccsm3_0_rel03 $
#===============================================================================
# Makefile macros for "Linux", supports portland + gnu
#===============================================================================

ifeq ($(MACH),jazz)
   INCLDIR    := -I. -I/soft/apps/packages/netcdf-3.5.0/include -I/usr/include -
I${INCROOT} -I/soft/apps/packages/mpich-gm-1.2.5..9-pre6-gm-1.6.3-pgi-4.0/includ
e
   SLIBS      := -L/soft/apps/packages/netcdf-3.5.0/lib -lnetcdf  -llapack -lbla
s
else
   INCLDIR    := -I. -I$(INC_NETCDF) -I$(INCROOT) -I$(INC_MPI)
   SLIBS      := -L$(LIB_NETCDF) -lnetcdf  -llapack -lblas
endif

        :
        :
        :
```

File "Macros.Linux" (2 of 2)

```
      :
      :
      :
ULIBS       := -L$(LIBROOT) -lesmf -lmct -lmpeu -lmph
CPP         := NONE
CPPFLAGS    := -DLINUX -DPGF90 -DNO_SHR_VMATH
CPPDEFS     := -DLINUX
CC          := mpicc
CFLAGS      := -c
ifeq ($(CC),pgcc)
   CFLAGS   += -fast
else
   CFLAGS   += -DUSE_GCC
endif
FIXEDFLAGS  :=
FREEFLAGS   := -Mfree
FC          := mpif90
FFLAGS      := -c -r8 -i4 -Kieee -Mrecursive -Mdalign -Mextend
      :
      :
      :
```

Performance Tuning

- Default run configuration
  - Basic "will run" configuration
- You might want to change to
  - Optimize machine (cpu) efficiency
  - Optimize run speed
  - Reflect machine limits
  - Reflect usage options or new science

How Does It All Fit Together?

- The new machine files are used
  - When you execute"create_newcase"
    - Creates new case directory with configure, env_run, env_mach.newmach, env_conf
  - "configure" command creates
    - <casename>.newmach.build
    - <casename>.newmach.run

Gotcha's

- Your MPI must support multiple binaries
  - Each component is a different binary
- Your search path needs to be able to find the mpi and compiler files
- A new processor and/or compiler may not generate correct results
- I/O can impact performance

Finalizing The Process

- Get the file additions and changes back to NCAR
  - If the machine is uniquely different and interesting we may be able to get it into a later release
- Provide performance numbers
  - We may be able to serve various performance numbers to the community

Plans For Future

- Simplification/Modularization for reuse
- Range of configuration selections
  - Optimal processor utilization
  - Optimal run speed
- How does one know what is optimal?
  - Somewhat complicated
  - Beginnings of scripts to help
    - ./scripts/ccsm_utils/Tools/timing/getTiming.csh
  - Web based information

Questions

- For more information see Section 6.10 of the User's Guide
- ???