Pacific Northwest
NATIONAL LABORATORY

GCAM 5.4 Walkthrough

May 31, 2022

U.S. DEPARTMENT OF ENERGY BATTELLE

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- Installation
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Links & Pre-requisites

Links

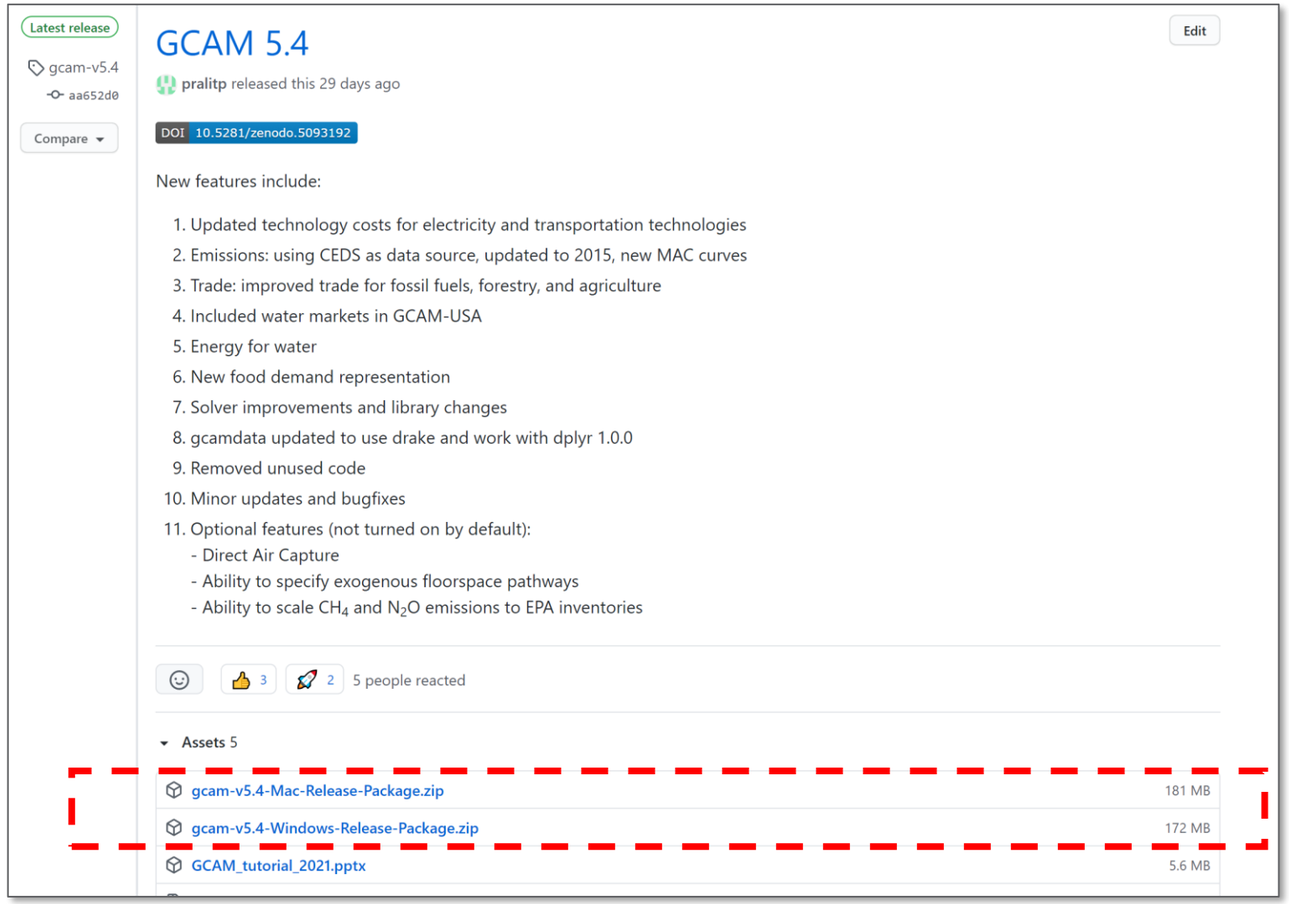
- GCAM Official Documentation: http://jgcri.github.io/gcam-doc/
- GCAM User Guide: http://jgcri.github.io/gcam-doc/user-guide.html
- GCAM github page: https://github.com/JGCRI/gcam-core
- GCAM datasystem R package: https://github.com/JGCRI/gcamdata
- ModelInterface: https://github.com/JGCRI/modelinterface
- Webinar 1 Link: https://register.gotowebinar.com/recording/2893695101765080835

Pre-requisites

- 8 GB RAM
- Install Java 64 https://www.java.com/en/download/windows-64bit.jsp
- Install R https://cran.r-project.org/ and R Studio https://www.rstudio.com
- Install Windows XML Maker http://symbolclick.com/xmlmarker_1_1_setup.exe

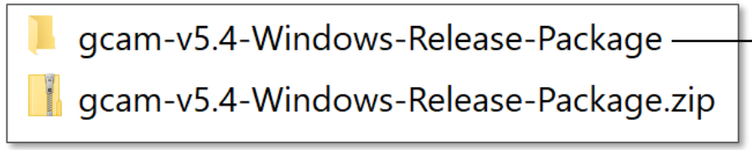
Installation

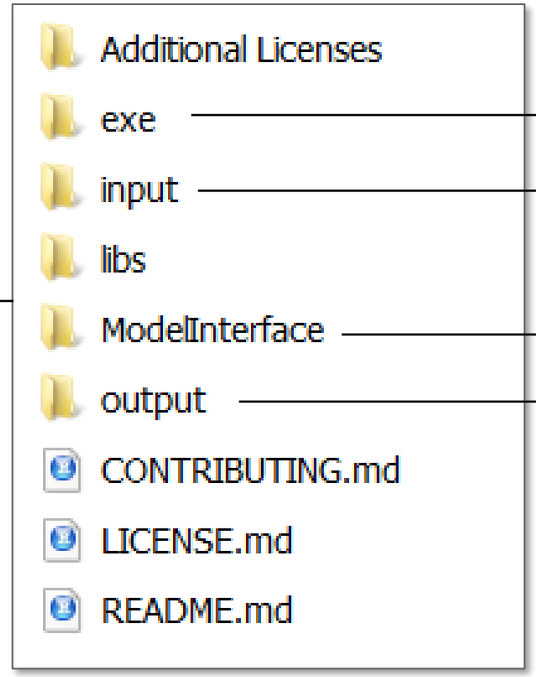
- Unzip compiled version provided OR
- Download release version: https://github.com/JGCRI/gcam-core/releases



Folder Structure

Download and unzip





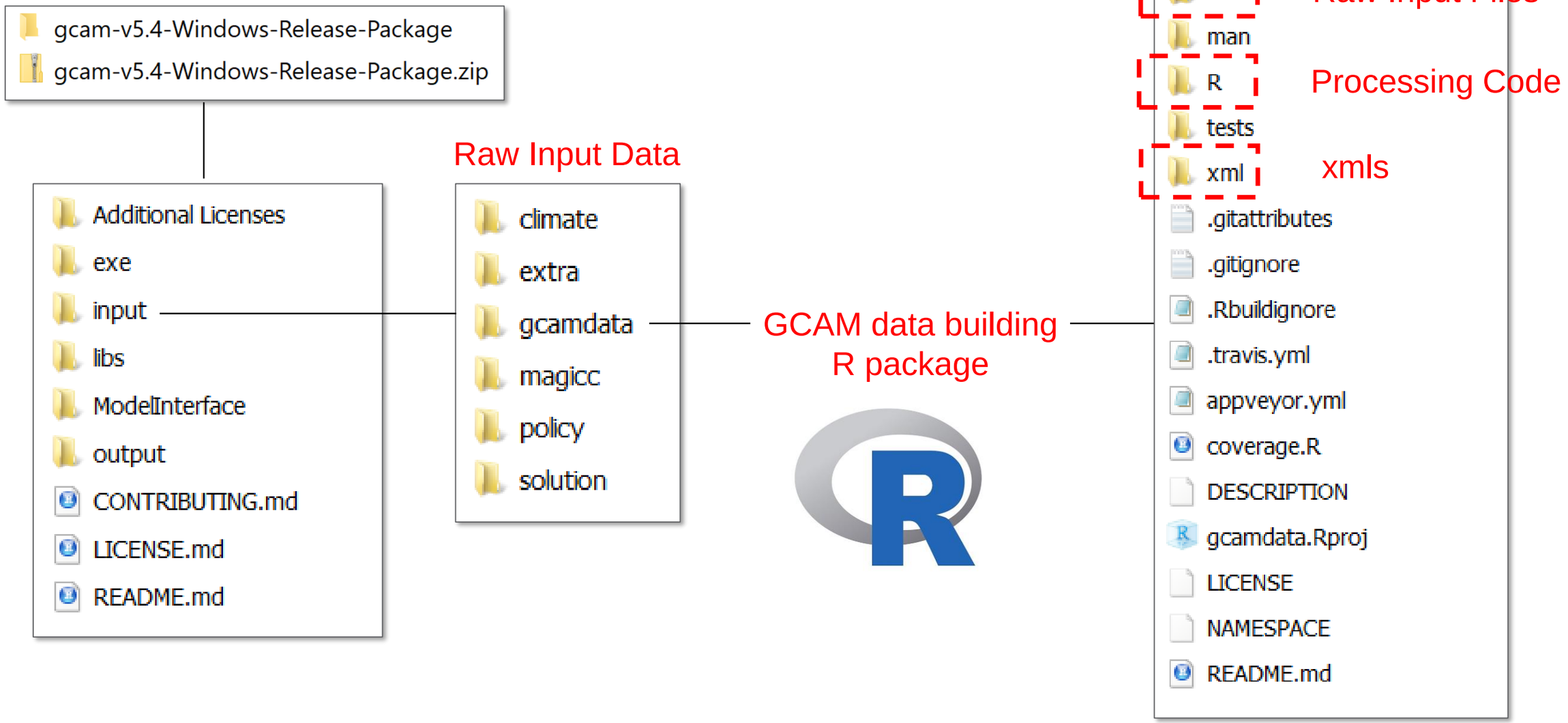
Model executable and code

Model input files

Result viewing software

Output Folder

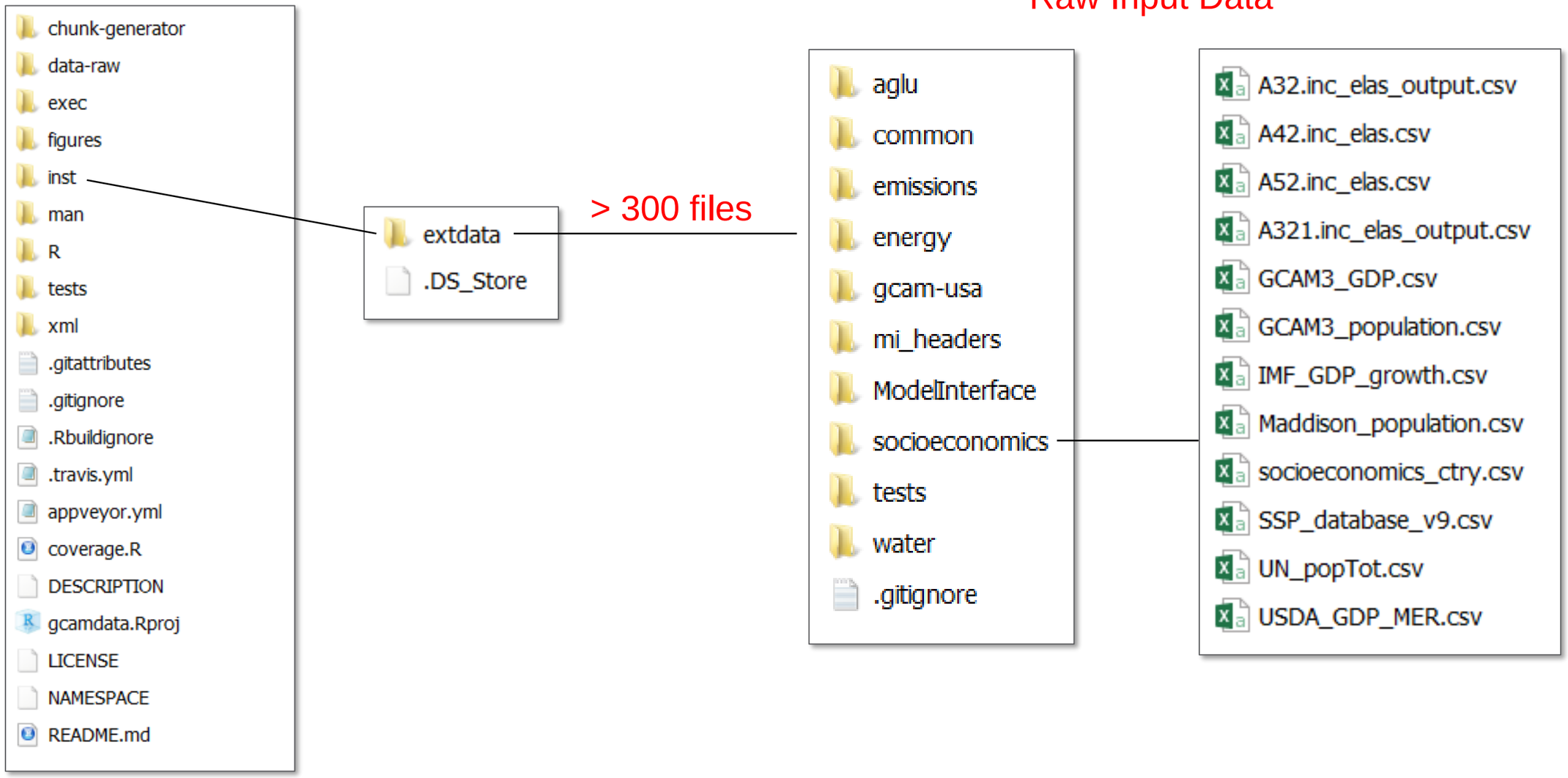
Input Files


gcam-v5.4-Windows-Release-Package
gcam-v5.4-Windows-Release-Package.zip
Additional Licenses
exe
input
libs
ModelInterface
output
CONTRIBUTING.md
LICENSE.md
README.md
Raw Input Data
climate
extra
gcamdata
magicc
policy
solution
GCAM data building
R package
chunk-generator
data-raw
exec
figures
inst
man
R
tests
xml
.gitattributes
.gitignore
.Rbuildignore
.travis.yml
appveyor.yml
coverage.R
DESCRIPTION
gcamdata.Rproj
LICENSE
NAMESPACE
README.md
Raw Input Files
Processing Code
xmls

Input Files
R data system (Raw Input Data)

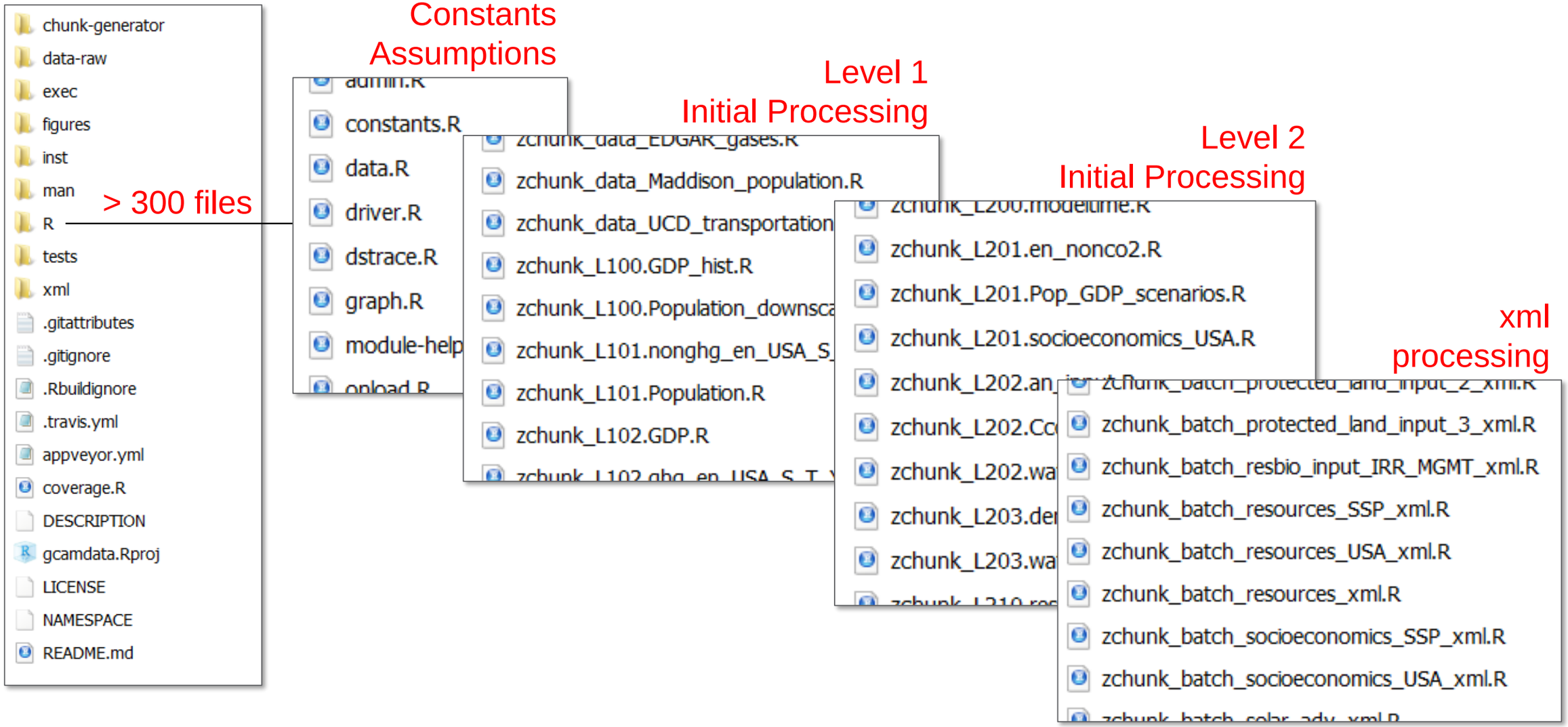
https://github.com/JGCRI/gcamdata

./gcamFolder/input/gcamdata



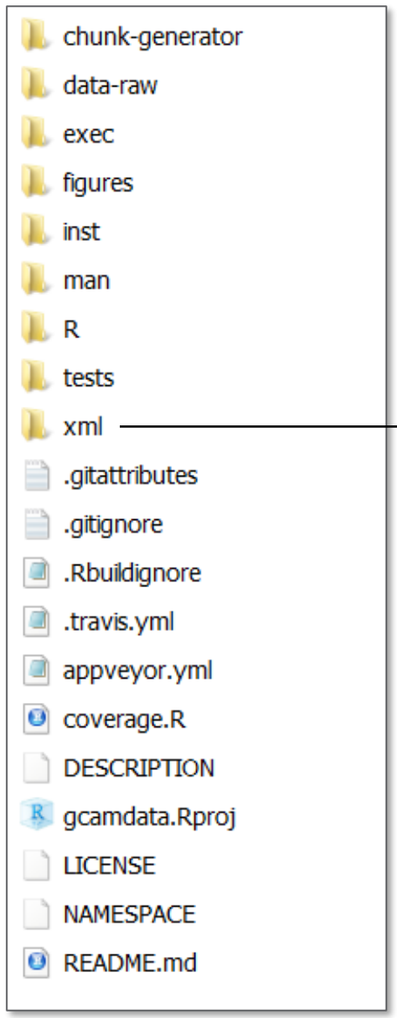
Input Files
R data system (Data processing functions)

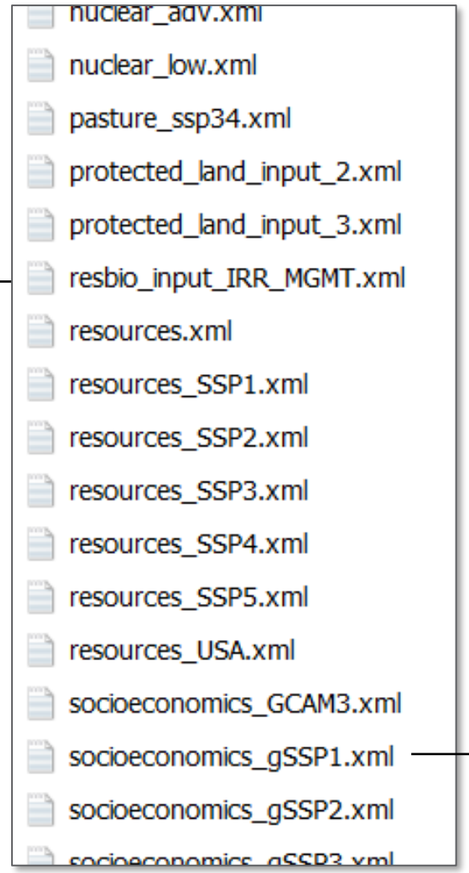
./gcamFolder/input/gcamdata



Input Files
R data system (XMLs)

./gcamFolder/input/gcamdata





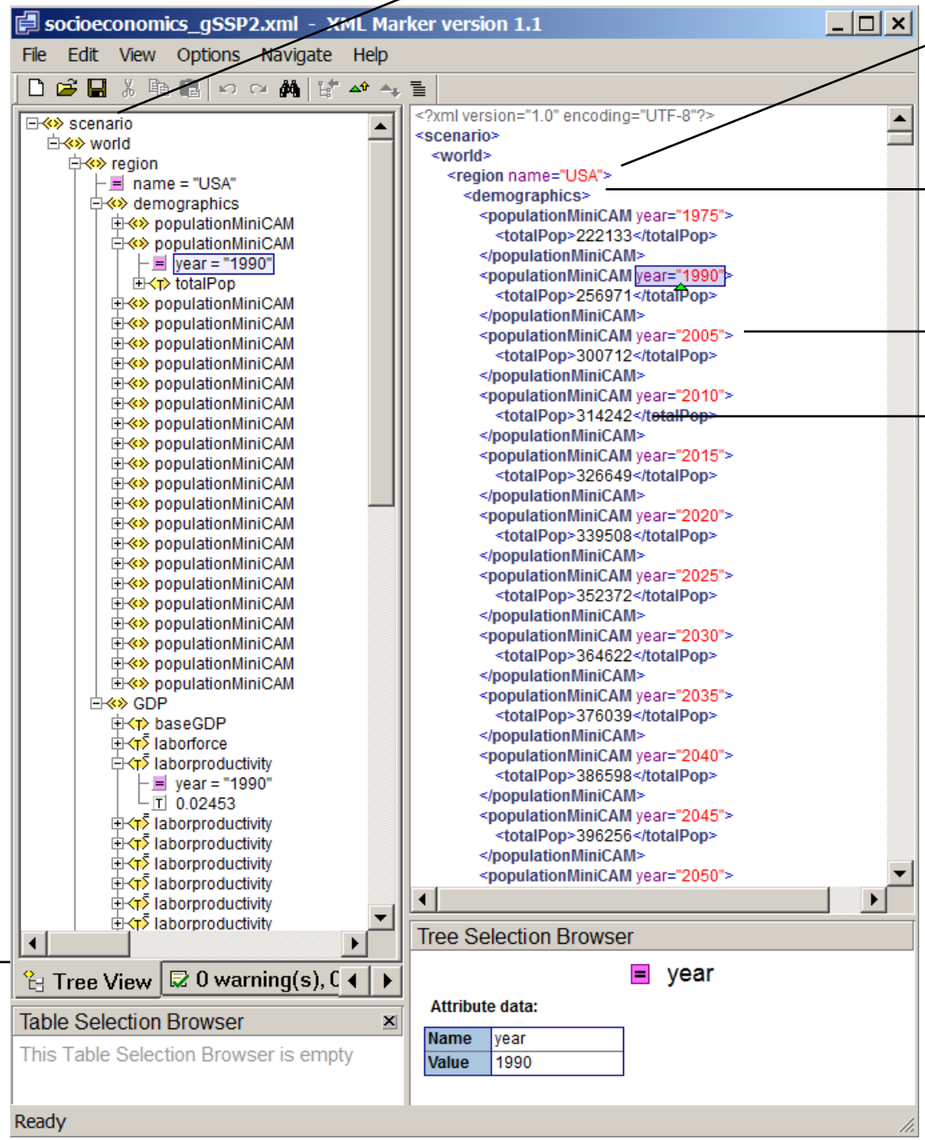
XML nested structure

Region

Parameter

Year

Value



Input Files - Example Raw Data to XML

Raw Input Data

- Maddison_population.csv
- socioeconomics_ctry.csv
- SSP_database_v9.csv
- UN_popTot.csv

File: UN_popTot.csv
Title: UN population 1950-2010 and projected 2010-2100
Units: thousands
Description: UN population data by countryâ€"historical and projected through 2100
Source: http://esa.un.org/unpd/wpp/Excel-Data/population.htm
â€"--
Column types: ccccin

Country	Region	Sex	Scenario	Year	Value
AFG	sas	M+F	EST	1950	8151.455
AFG	sas	M+F	EST	1951	8276.82
AFG	sas	M+F	EST	1952	8407.148
AFG	sas	M+F	EST	1953	8542.906
AFG	sas	M+F	EST	1954	8684.494
AFG	sas	M+F	EST	1955	8832.253
AFG	sas	M+F	EST	1956	8986.449
AFG	sas	M+F	EST	1957	9147.286

R processing

- zchunk_L100.GDP_hist.R
- zchunk_L100.Population_downscale_ctry.R
- zchunk_L101.nonghg_en_USA_S_T_Y.R

```
module_socioeconomics_L100.Population_downscale_ctry <- funct
  if(command == driver.DECLARE_INPUTS) {
    return(c(FILE = "socioeconomics/socioeconomics_ctry",
             "Maddison_population",
             FILE = "socioeconomics/SSP_database_v9",
             FILE = "socioeconomics/UN_popTot"))
  } else if(command == driver.DECLARE_OUTPUTS) {
    return(c("L100.Pop_thous_ctry_Yh",
             "L100.Pop_thous_SSP_ctry_Yfut"))
  } else if(command == driver.MAKE) {
```

- zchunk_batch_resources_xml.R
- zchunk_batch_socioeconomics_SSP_xml.R
- zchunk_batch_socioeconomics_USA_xml.R

```
            "L201.PPPConvert",
            "L201.BaseGDP_GCAM3",
            "L201.LaborProductivity_GCAM3",
            "L201.Pop_GCAM3"))
  } else if(command == driver.DECLARE_OUTPUTS) {
    return(c(XML = "socioeconomics_gSSP1.xml",
             XML = "socioeconomics_gSSP2.xml",
             XML = "socioeconomics_gSSP3.xml",
```

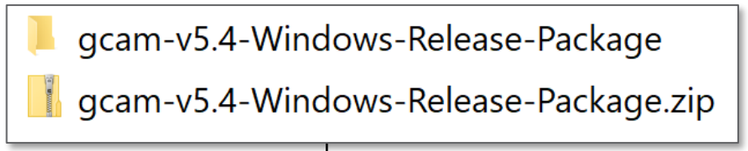
XML Generation

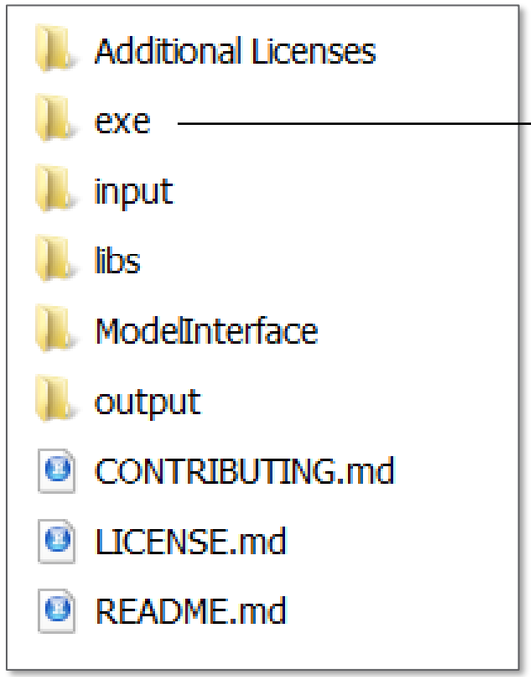
- socioeconomics_gSSP1.xml
- socioeconomics_gSSP2.xml
- socioeconomics_gSSP3.xml

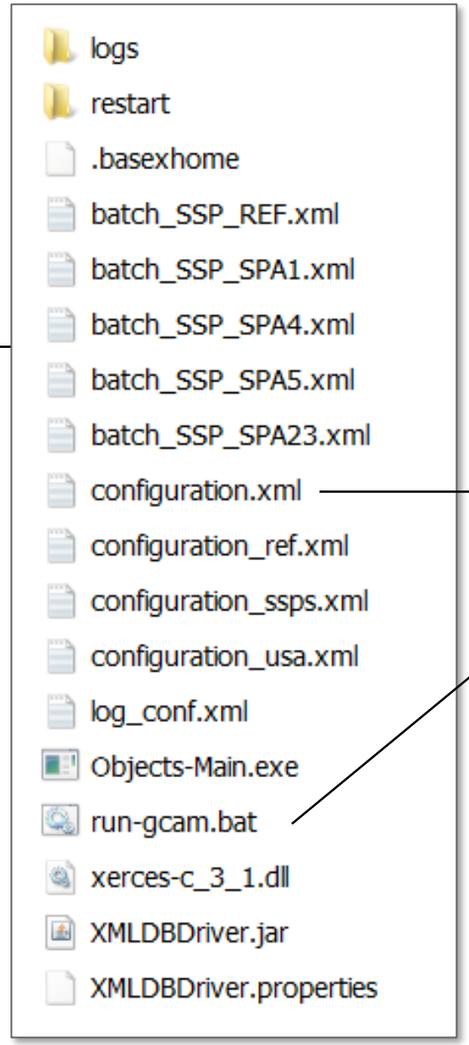
```
<?xml version="1.0" encoding="UTF-8"?>
<scenario>
  <world>
    <region name="USA">
      <demographics>
        <populationMiniCAM year="1975">
          <totalPop>222133</totalPop>
        </populationMiniCAM>
        <populationMiniCAM year="1990">
          <totalPop>256971</totalPop>
```

To GCAM configuration.xml

Model Run – exe folder








```
<?xml version="1.0" encoding="UTF-8"?>
<Configuration>
  <Files>
    <Value name="xmlInputFileName">../input/gcamdata/xml/modeltime.xml</Value>
    <Value name="BatchFileName">batch_ag.xml</Value>
    <Value name="policy-target-file">../input/policy/forcing_target_4p5.xml</Value>
    <Value name="GHGInputFileName">../input/magicc/inputs/input_gases.emk</Value>
    <Value write-output="1" append-scenario-name="0" name="xmldb-location">../output/database_basexdb</Value>
    <Value write-output="1" append-scenario-name="0" name="restart">./restart/restart</Value>
    <Value write-output="1" append-scenario-name="1" name="xmlDebugFileName">debug.xml</Value>
    <Value write-output="1" append-scenario-name="0" name="climatFileName">gas.emk</Value>
    <Value write-output="1" append-scenario-name="1" name="costCurvesOutputFileName">cost_curves.xml</Value>
    <Value write-output="1" append-scenario-name="0" name="batchCSVOutputFile">batch-csv-out.csv</Value>
    <Value write-output="0" append-scenario-name="0" name="supplyDemandOutputFileName">SDCurves.csv</Value>
    <Value write-output="0" append-scenario-name="0" name="flow-graph">gcam-flow-graph.dot</Value>
    <Value write-output="0" append-scenario-name="0" name="dependencyGraphName">DependencyGraph.dot</Value>
    <Value write-output="0" append-scenario-name="0" name="landAllocatorGraphName">LandAllocatorGraph.dot</Value>
  </Files>
  <ScenarioComponents>
    <Value name = "climate">../input/gcamdata/xml/hector.xml</Value>
    <Value name = "interest_rate">../input/gcamdata/xml/interest_rate.xml</Value>
    <Value name = "socioeconomics">../input/gcamdata/xml/socioeconomics_gSSP2.xml</Value>
```

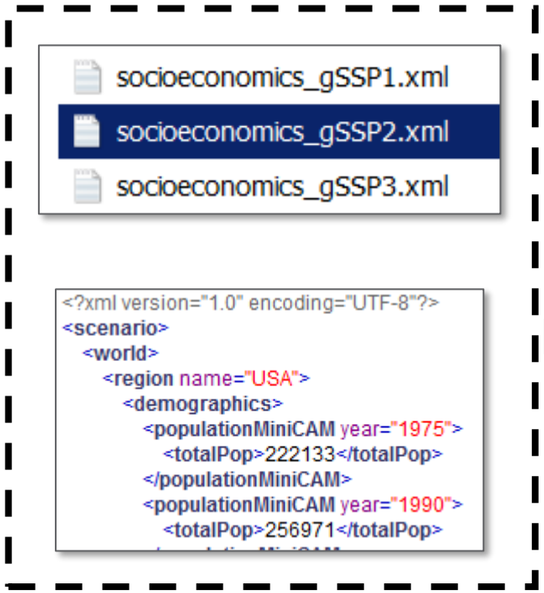
Configuration file

Run GCAM file

```
REM or if it is not 64-bit.  In this case an error mess
IF DEFINED JAVA_HOME (

REM Update the PATH to be able to find the Java dlls
SET PATH=%JAVA_HOME%\bin;%JAVA_HOME%\bin\server

REM Run GCAM
Objects-Main.exe -C configuration.xml

)

pause
```

Model Run – configuration.xml

XML Generation



configuration.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<Configuration>
  <Files>
    <Value name="xmlInputFileName">../input/gcamdata/xml/modeltime.xml</Value>
    <Value name="BatchFileName">batch_ag.xml</Value>
    <Value name="policy-target-file">../input/policy/forcing_target_4p5.xml</Value>
    <Value name="GHGInputFileName">../input/magicc/inputs/input_gases.emk</Value>
    <Value write-output="1" append-scenario-name="0" name="xmldb-location">../output/database_basexdb</Value>
    <Value write-output="1" append-scenario-name="0" name="restart">./restart/restart</Value>
    <Value write-output="1" append-scenario-name="1" name="xmlDebugFileName">debug.xml</Value>
    <Value write-output="1" append-scenario-name="0" name="climatFileName">gas.emk</Value>
    <Value write-output="1" append-scenario-name="1" name="costCurvesOutputFileName">cost_curves.xml</Value>
    <Value write-output="1" append-scenario-name="0" name="batchCSVOutputFile">batch-csv-out.csv</Value>
    <Value write-output="0" append-scenario-name="0" name="supplyDemandOutputFileName">SDCurves.csv</Value>
    <Value write-output="0" append-scenario-name="0" name="flow-graph">gcam-flow-graph.dot</Value>
    <Value write-output="0" append-scenario-name="0" name="dependencyGraphName">DependencyGraph.dot</Value>
    <Value write-output="0" append-scenario-name="0" name="landAllocatorGraphName">LandAllocatorGraph.dot</Value>
  </Files>
  <ScenarioComponents>
    <Value name = "climate">../input/gcamdata/xml/hector.xml</Value>
    <Value name = "interest_rate">../input/gcamdata/xml/interest_rate.xml</Value>
    <Value name = "socioeconomics">../input/gcamdata/xml/socioeconomics_gSSP2.xml</Value>
    <Value name = "resources">../input/gcamdata/xml/resources.xml</Value>
    <Value name = "energy_supply">../input/gcamdata/xml/en_supply.xml</Value>
    <Value name = "energy_transformation">../input/gcamdata/xml/en_transformation.xml</Value>
    <!--Value name = "electricity">../input/gcamdata/xml/electricity.xml</Value-->
    <Value name = "elec_water_base">../input/gcamdata/xml/electricity_water.xml</Value>
    <Value name = "heat">../input/gcamdata/xml/heat.xml</Value>
    <Value name = "hydrogen">../input/gcamdata/xml/hydrogen.xml</Value>
    <Value name = "energy_distribution">../input/gcamdata/xml/en_distribution.xml</Value>
    <Value name = "industry">../input/gcamdata/xml/industry.xml</Value>
    <Value name = "industry_income_elas">../input/gcamdata/xml/industry_incelas_gssp2.xml</Value>
    <Value name = "cement">../input/gcamdata/xml/cement.xml</Value>
    <Value name = "cement_income_elas">../input/gcamdata/xml/cement_incelas_gssp2.xml</Value>
    <Value name = "fertilizer_energy">../input/gcamdata/xml/en_Fert.xml</Value>
    <Value name = "hddcdd">../input/gcamdata/xml/HDDCDD_constdd_no_GCM.xml</Value>
    <Value name = "building">../input/gcamdata/xml/building_det.xml</Value>
    <Value name = "transportation">../input/gcamdata/xml/transportation_UCD_CORE.xml</Value>
    <Value name = "carbon_content">../input/gcamdata/xml/Ccoef.xml</Value>
```

Setup Key Model Inputs & Options

- Output database location
- Output database name
- Input xml list
- Scenario Name
- BatchMode
- Number of Periods

http://jgcri.github.io/gcam-doc/user-guide.html

Model Run - Configuration

Output Database Name and Location

```
<?xml version="1.0" encoding="UTF-8"?>
<Configuration>
  <Files>
    <Value name="xmlInputFileName">../input/gcamdata/xml/modeltime.xml</Value>
    <Value name="BatchFileName">batch_ag.xml</Value>
    <Value name="policy-target-file">../input/policy/forcing_target_4p5.xml</Value>
    <Value name="GHGInputFileName">../input/magicc/inputs/input_gases.emk</Value>
    <Value write-output="1" append-scenario-name="0" name="xmldb-location">../output/database_basexdb</Value>
    <Value write-output="1" append-scenario-name="0" name="restart">./restart/restart</Value>
    <Value write-output="1" append-scenario-name="1" name="xmlDebugFileName">debug.xml</Value>
    <Value write-output="1" append-scenario-name="0" name="climatFileName">gas.emk</Value>
    <Value write-output="1" append-scenario-name="1" name="costCurvesOutputFileName">cost_curves.xml</Value>
    <Value write-output="1" append-scenario-name="0" name="batchCSVOutputFile">batch-csv-out.csv</Value>
    <Value write-output="0" append-scenario-name="0" name="supplyDemandOutputFileName">SDCurves.csv</Value>
    <Value write-output="0" append-scenario-name="0" name="flow-graph">gcam-flow-graph.dot</Value>
    <Value write-output="0" append-scenario-name="0" name="dependencyGraphName">DependencyGraph.dot</Value>
    <Value write-output="0" append-scenario-name="0" name="landAllocatorGraphName">LandAllocatorGraph.dot</Value>
  </Files>
```

Reference case .xml input files

```
<Value name = "resources">../input/gcamdata/xml/resources.xml</Value>
<Value name = "energy_supply">../input/gcamdata/xml/en_supply.xml</Value>
<Value name = "energy_transformation">../input/gcamdata/xml/en_transformation.xml</Value>
<!--Value name = "electricity">../input/gcamdata/xml/electricity.xml</Value-->
<Value name = "elec_water_base">../input/gcamdata/xml/electricity_water.xml</Value>
<Value name = "heat">../input/gcamdata/xml/heat.xml</Value>
<Value name = "hydrogen">../input/gcamdata/xml/hydrogen.xml</Value>
<Value name = "energy_distribution">../input/gcamdata/xml/en_distribution.xml</Value>
<Value name = "industry">../input/gcamdata/xml/industry.xml</Value>
```

Scenario Options

```
</ScenarioComponents>
<Strings>
  <Value name="scenarioName">Reference</Value>
  <Value name="debug-region">USA</Value>
  <Value name="MAGICC-input-dir">../input/magicc/inputs</Value>
  <Value name="MAGICC-output-dir">../output</Value>
</Strings>
<Bools>
  <Value name="CalibrationActive">1</Value>
  <Value name="BatchMode">0</Value>
  <Value name="find-path">0</Value>
  <Value name="createCostCurve">0</Value>
  <Value name="debugChecking">0</Value>
  <Value name="simulActive">1</Value>
  <Value name="PrintValuesOnGraphs">1</Value>
  <Value name="ShowNullPaths">0</Value>
  <Value name="PrintPrices">1</Value>
</Bools>
<Ints>
  <Value name="numMarketsToFindSD">10</Value>
  <Value name="numPointsForSD">21</Value>
  <Value name="numPointsForCO2CostCurve">5</Value>
  <Value name="carbon-output-start-year">1705</Value>
  <Value name="climateOutputInterval">5</Value>
  <Value name="parallel-grain-size">50</Value>
  <Value name="stop-period">-1</Value>
  <Value name="restart-period">-1</Value>
</Ints>
```

Scenario Name

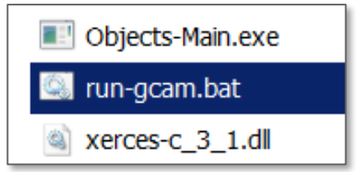
Batch Mode

Periods

-1	All
1	1975
2	1990
3	2005
4	2010
5	2015
6	2020

Model Run - Execution

./gcamFolder/exe/



Similar for mac/linux/unix OS systems

```
C:\Windows\system32\cmd.exe
This computer software was prepared by Battelle Memorial Institute,
hereinafter the Contractor, under Contract No. DE-AC05-76RL0 1830 with
the Department of Energy (DOE). NEITHER THE GOVERNMENT NOR THE
CONTRACTOR MAKES ANY WARRANTY, EXPRESS OR IMPLIED, OR ASSUMES ANY
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prohibited under the Export Laws from receiving the Software.

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For further details, see: http://www.globalchange.umd.edu/models/gcam/

Running GCAM model code base version 5.1 revision gcam-v5.1.3

Configuration file:  configuration.xml
Parsing input files...
Parsing ../input/gcamdata/xml/hector.xml scenario component.
Parsing ../input/gcamdata/xml/interest_rate.xml scenario component.
Parsing ../input/gcamdata/xml/socioeconomics_gSSP2.xml scenario component.
Parsing ../input/gcamdata/xml/resources.xml scenario component.
Parsing ../input/gcamdata/xml/en_supply.xml scenario component.
Parsing ../input/gcamdata/xml/en_transformation.xml scenario component.
Parsing ../input/gcamdata/xml/electricity_water.xml scenario component.
Parsing ../input/gcamdata/xml/heat.xml scenario component.
Parsing ../input/gcamdata/xml/hydrogen.xml scenario component.
Parsing ../input/gcamdata/xml/en_distribution.xml scenario component.
```
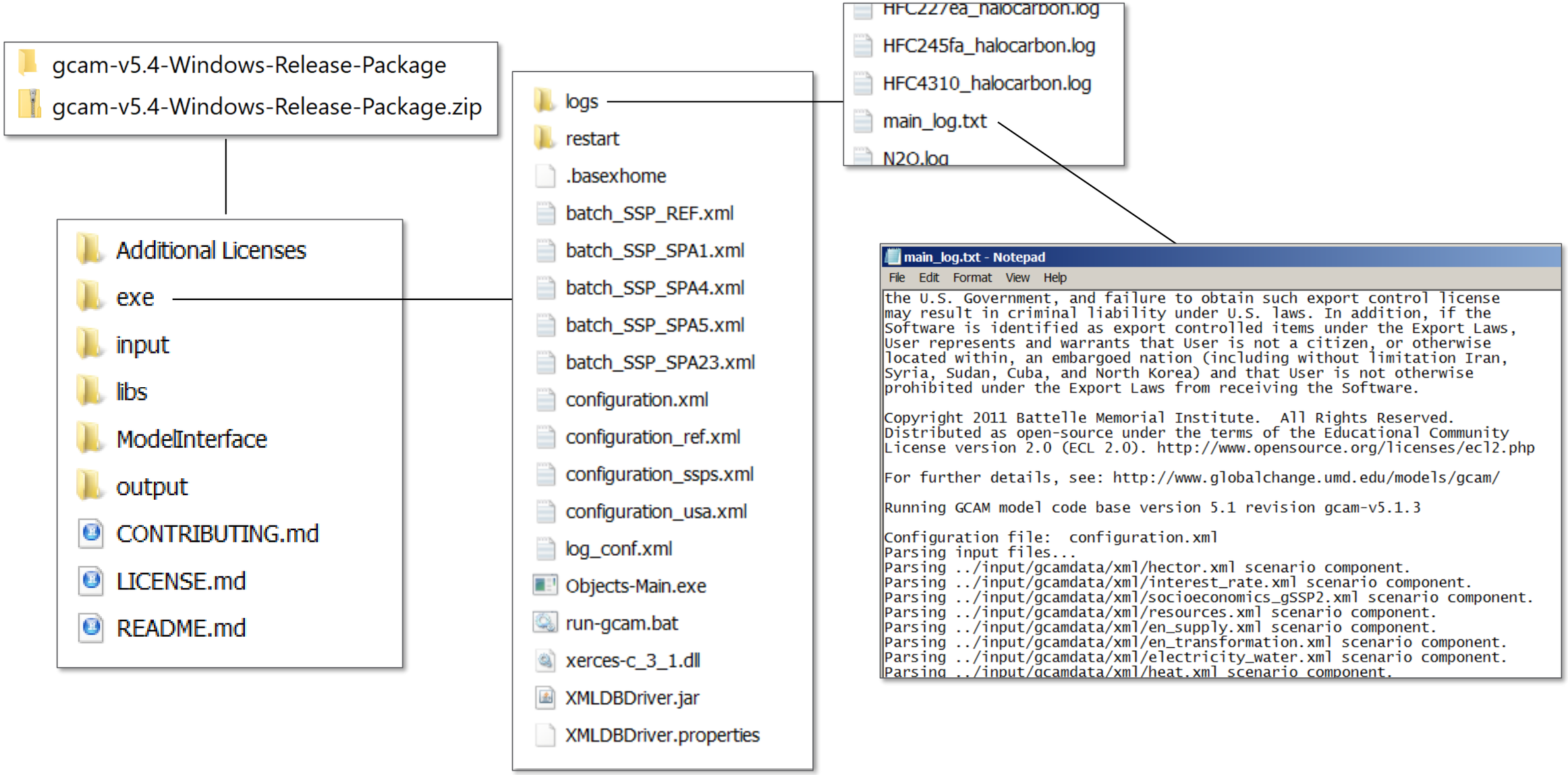
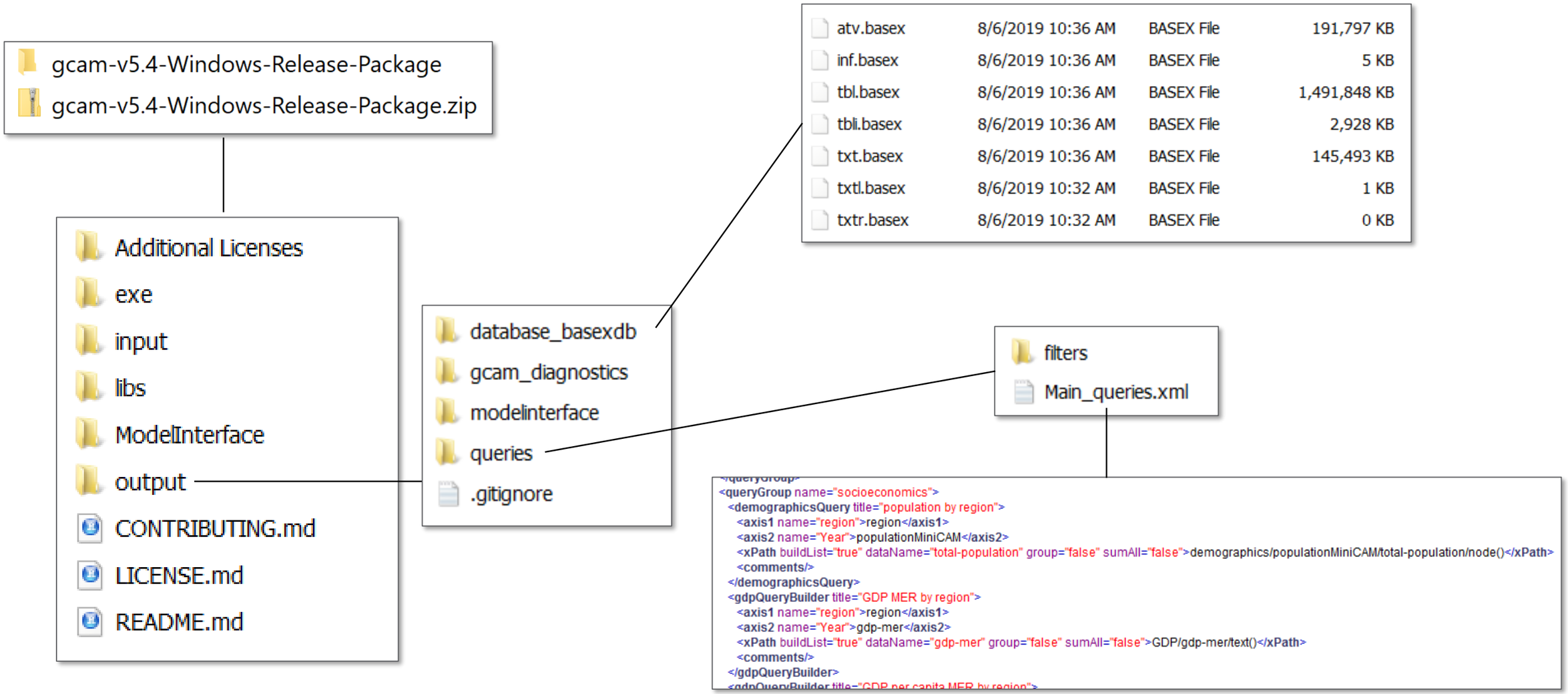

```
C:\Windows\system32\cmd.exe
Starting new scenario: Reference
Tue Aug  6 10:13:36 2019:WARNING:Hector::Logger::printLogHeader: hector version
2.0
Tue Aug  6 10:13:36 2019:WARNING:Hector::Logger::printLogHeader: hector version
2.0
Tue Aug  6 10:13:37 2019:WARNING:Hector::Logger::printLogHeader: hector version
2.0
Caloutput read in but no land read in for technology Middle East Corn_ArabianSea
_RFD_hi
Caloutput read in but no land read in for technology Middle East Corn_ArabianSea
_RFD_lo
Starting a model run. Running all periods.
Model run beginning.
Period 0: 1975
Model solved with last period's prices.

Period 1: 1990
Model solved normally. Iterations period 1: 202. Total iterations: 203

Period 2: 2005
Model solved normally. Iterations period 2: 228. Total iterations: 430

Period 3: 2010
Model solved normally. Iterations period 3: 131. Total iterations: 561

Period 4: 2015
Model solved normally. Iterations period 4: 826. Total iterations: 1387

Period 5: 2020
Model solved normally. Iterat

Period 6: 2025
Model solved normally. Iterat

Period 7: 2030
Model solved normally. Iterat

Period 8: 2035
Model solved normally. Iterat
```

```
Period 20: 2095
Model solved normally. Iterations period 20: 28. Total iterations: 2502

Period 21: 2100
Model solved normally. Iterations period 21: 32. Total iterations: 2534

All model periods solved correctly.
Model run completed.
Printing output
Starting output to XML Database.
C:/Z/GCAMWebinar2/gcam-v5.1.3-Windows-Release-Package/exe/.basex: writing new co
nfiguration file.
Model run completed.
Model exiting successfully.
Press any key to continue . . .
```

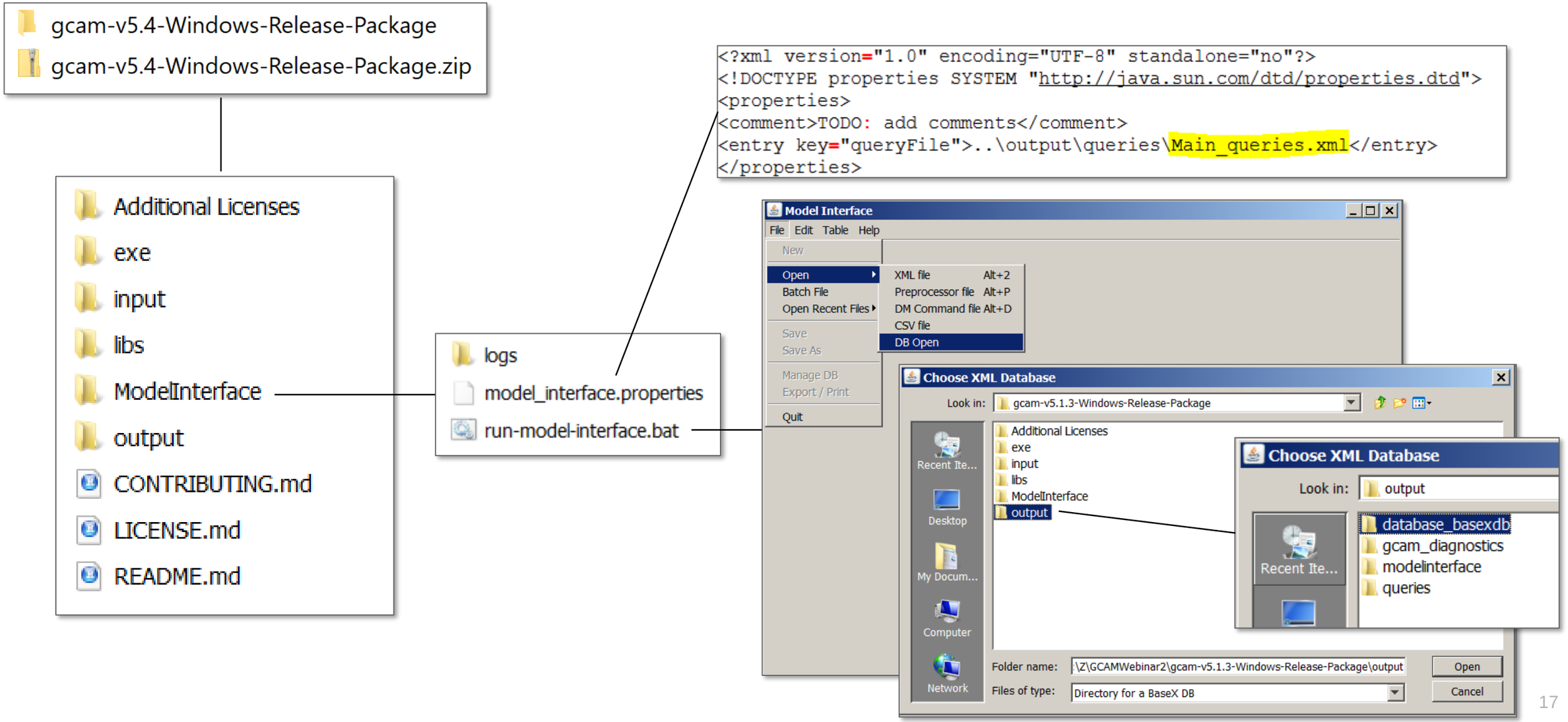
Model Run – Logs



Outputs – Database/Queries



Outputs – Model Interface (View Results)



Outputs – Model Interface (View Results)

Scenario Name

Queries (Main_Queries.xml)

Regions

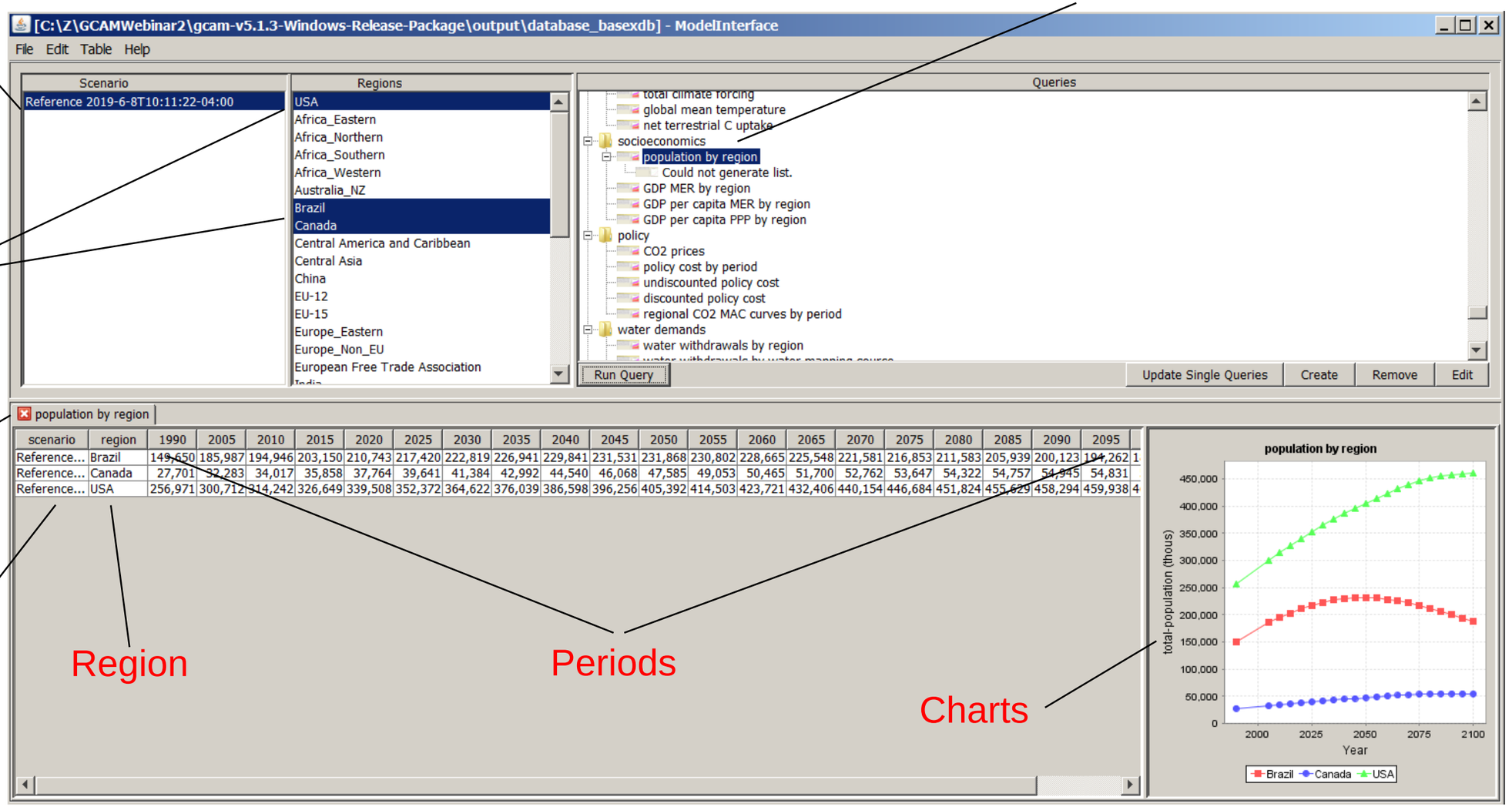
Query

Scenario name

Region

Periods

Charts



Outputs – Model Interface (View Results)

Scenario Name

Queries (Main_Queries.xml)

Regions

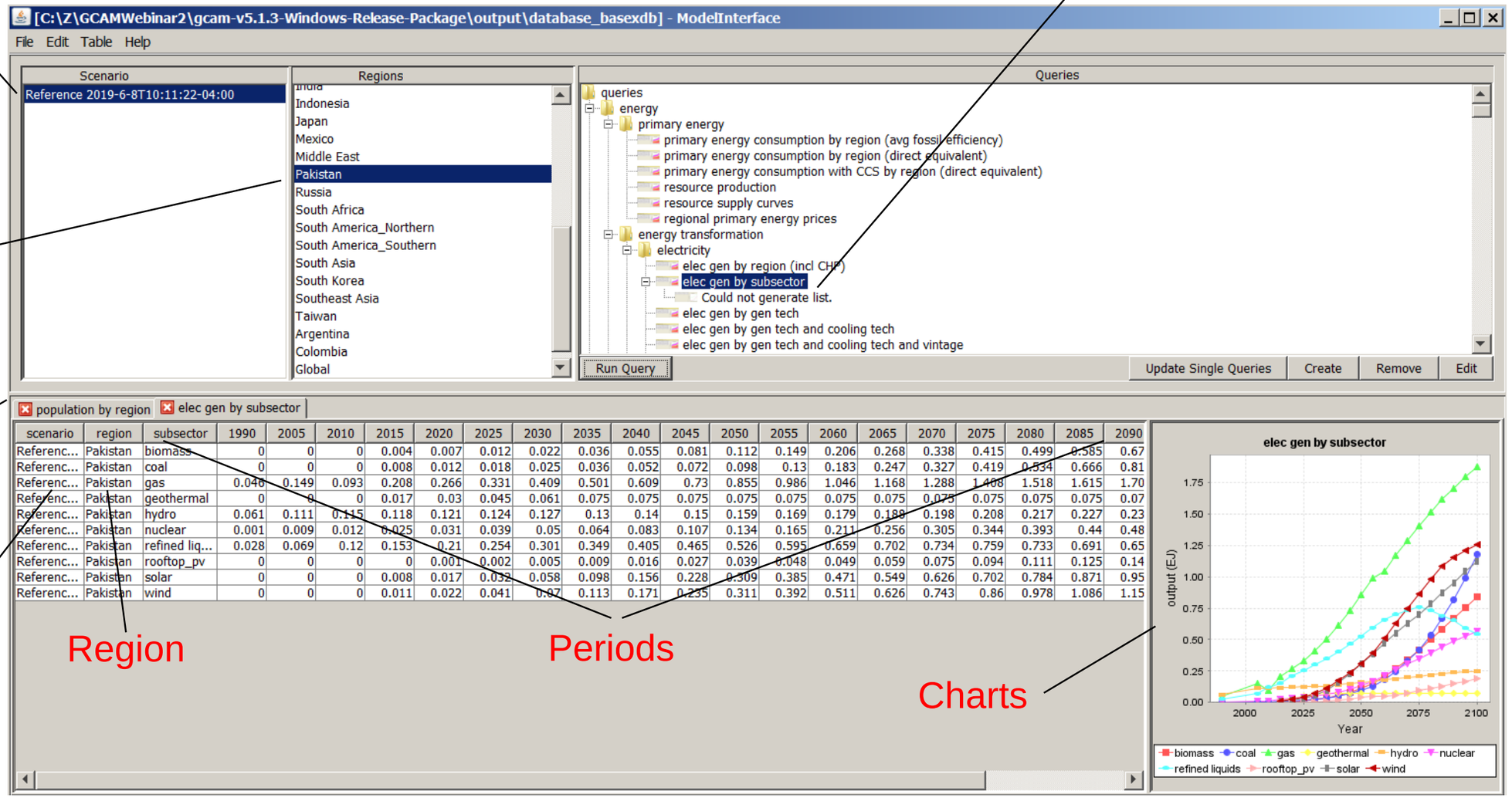
Queries

Scenario name

Region

Periods

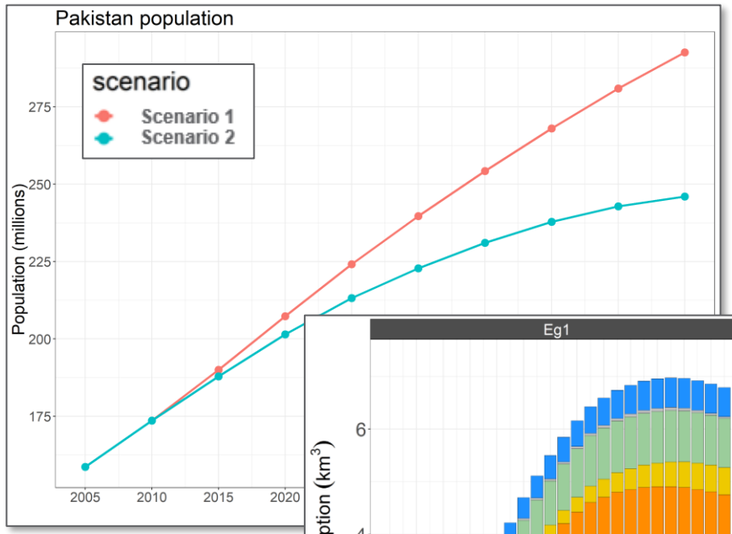
Charts



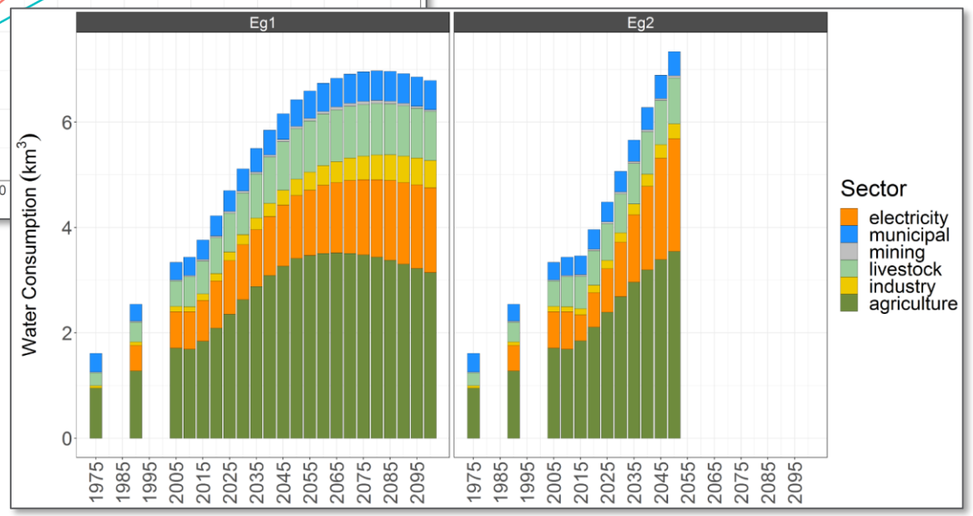
Final Result – Post Processing

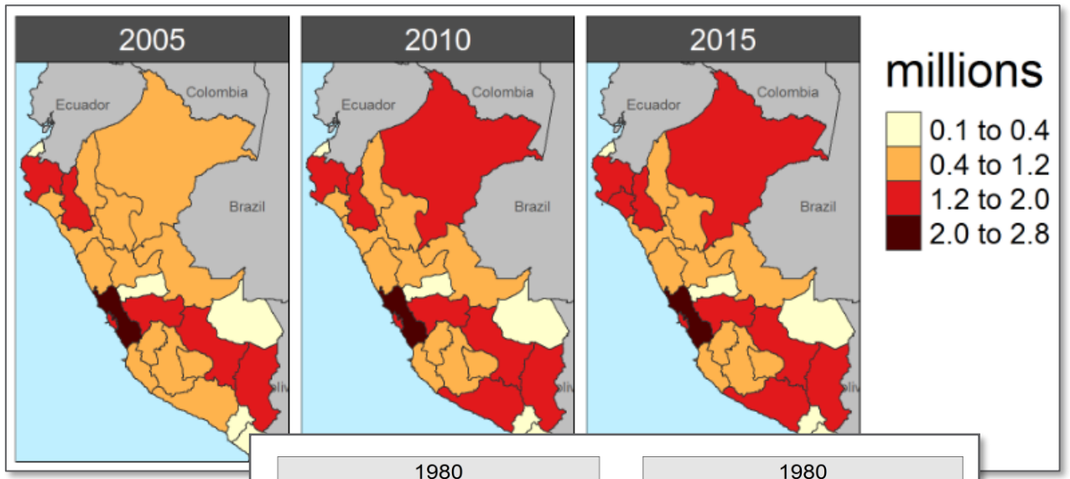
population by region | elec gen by subsector

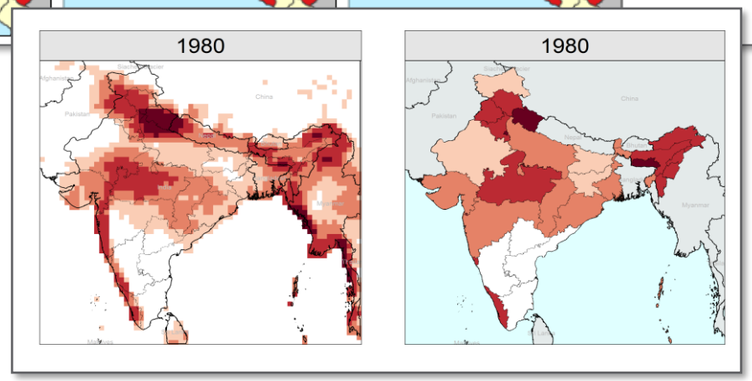
scenario	region	subsector	1990	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075	2080	2085	2090
Referenc...	Pakistan	biomass	0	0	0	0.004	0.007	0.012	0.022	0.036	0.055	0.081	0.112	0.149	0.206	0.268	0.338	0.415	0.499	0.585	0.67
Referenc...	Pakistan	coal	0	0	0	0.008	0.012	0.018	0.025	0.036	0.052	0.072	0.098	0.13	0.183	0.247	0.327	0.419	0.534	0.666	0.81
Referenc...	Pakistan	gas	0.046	0.149	0.093	0.208	0.266	0.331	0.409	0.501	0.609	0.73	0.855	0.986	1.046	1.168	1.288	1.408	1.518	1.615	1.70
Referenc...	Pakistan	geothermal	0	0	0	0.017	0.03	0.045	0.061	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.07
Referenc...	Pakistan	hydro	0.061	0.111	0.115	0.118	0.121	0.124	0.127	0.13	0.14	0.15	0.159	0.169	0.179	0.188	0.198	0.208	0.217	0.227	0.23
Referenc...	Pakistan	nuclear	0.001	0.009	0.012	0.025	0.031	0.039	0.05	0.064	0.083	0.107	0.134	0.165	0.211	0.256	0.305	0.344	0.393	0.44	0.48
Referenc...	Pakistan	refined liq...	0.028	0.069	0.12	0.153	0.21	0.254	0.301	0.349	0.405	0.465	0.526	0.595	0.659	0.702	0.734	0.759	0.733	0.691	0.65
Referenc...	Pakistan	rooftop_pv	0	0	0	0	0.001	0.002	0.005	0.009	0.016	0.027	0.039	0.048	0.049	0.059	0.075	0.094	0.111	0.125	0.14
Referenc...	Pakistan	solar	0	0	0	0.008	0.017	0.032	0.058	0.098	0.156	0.228	0.309	0.385	0.471	0.549	0.626	0.702	0.784	0.871	0.95
Referenc...	Pakistan	wind	0	0	0	0.011	0.022	0.041	0.07	0.113	0.171	0.235	0.311	0.392	0.511	0.626	0.743	0.86	0.978	1.086	1.15



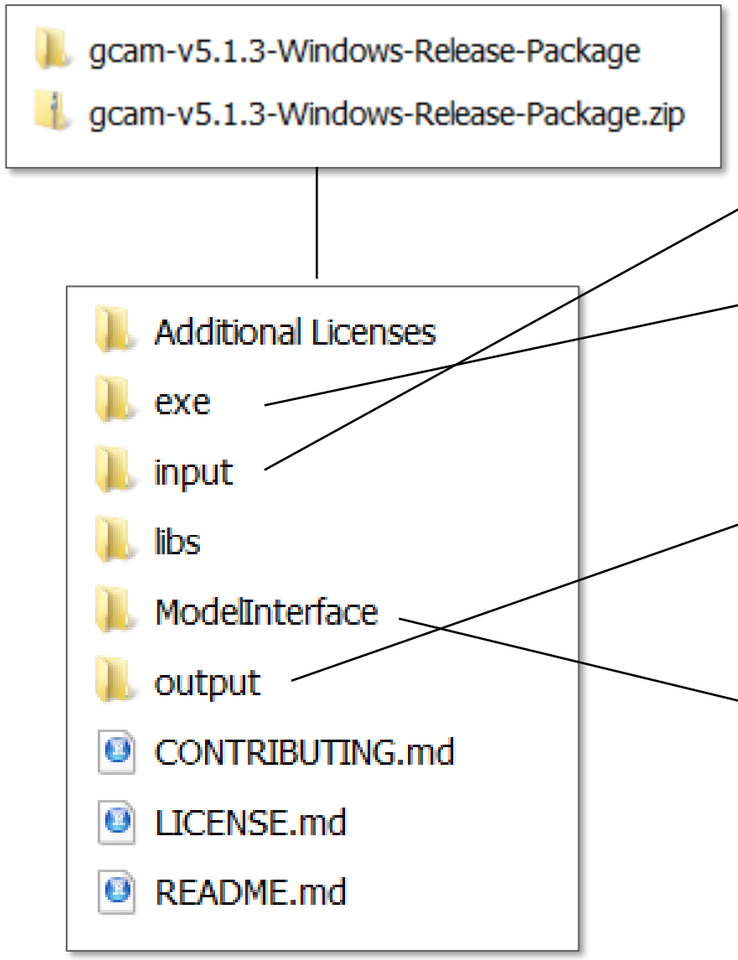
Outputs are post-processed to get final figures







Summary



1. input: Raw Input Files, R datasystem

2. exe: configuration.xml, Model options, model run

3. output: logs and database

4. ModelInterface: view results

Pacific Northwest
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Thank you