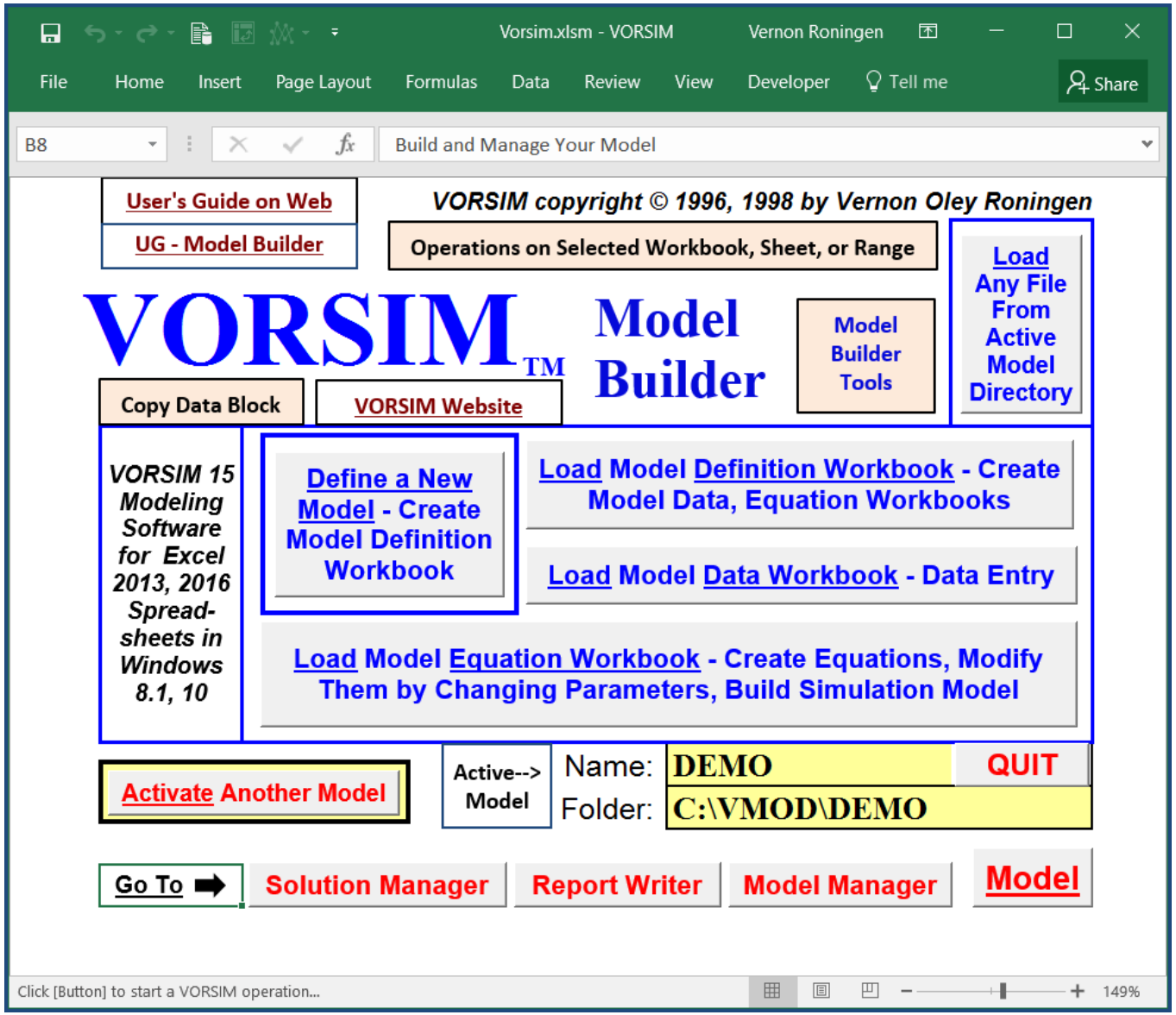
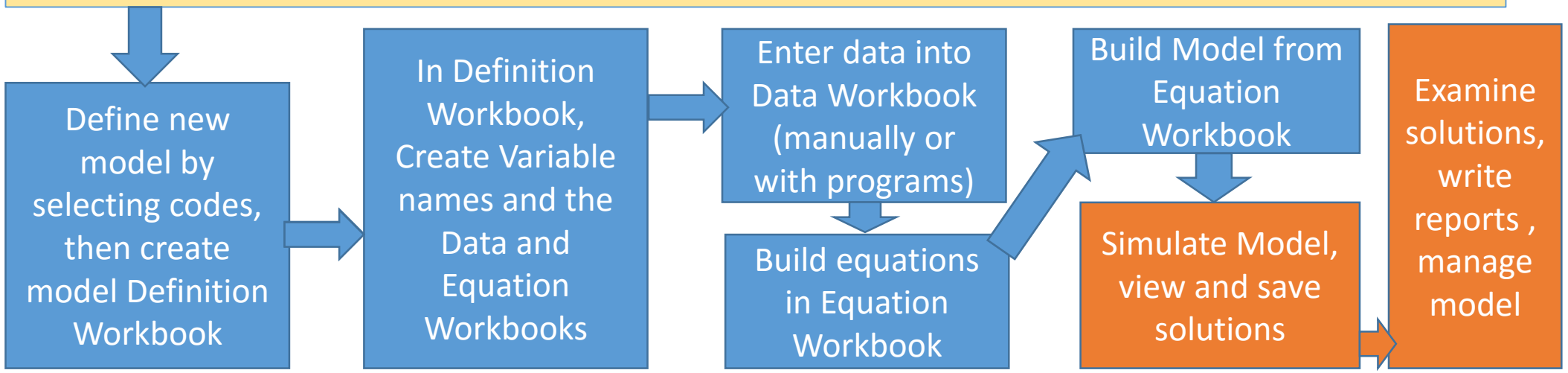
A model is built by VORSIM from this Model Builder control screen that loads when the VORSIM desktop icon is clicked. One starts by defining a new model and creating a model definition workbook. When the latter workbook is complete, then data and equation workbooks are created. Data is entered in the data workbook and equations are created in equation workbook. Then from the first sheet of the equation workbook, the stand-alone model workbook itself is created. When the model workbook is loaded, the model can be configured for solution and solved. Control buttons for various model operations are added as the workbooks are created.



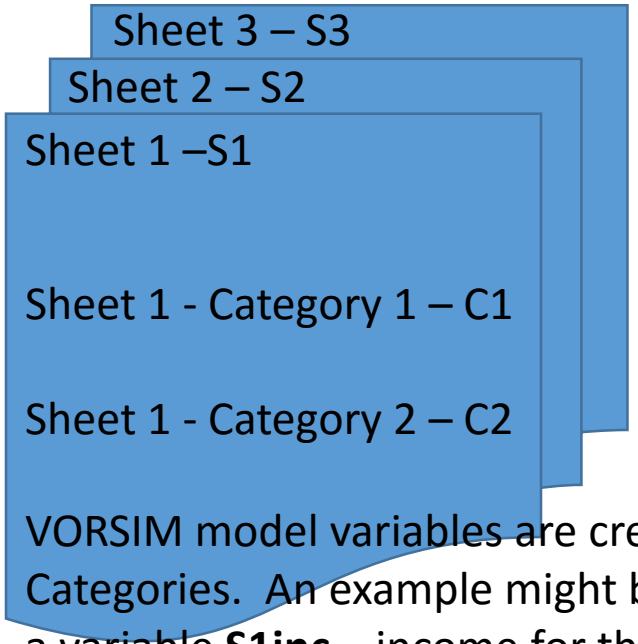
Steps in building a model in Excel With VORSIM 15 using buttons on the Model Builder control screen

Design model by defining problem to be examined, determining data availability, designing model structure, and selecting a closure method. This paper and pencil exercise is the most important part of the model building effort using VORSIM or any other modeling software. Thinking required!



VORSIM 15 requires Office Excel 2013 or later versions

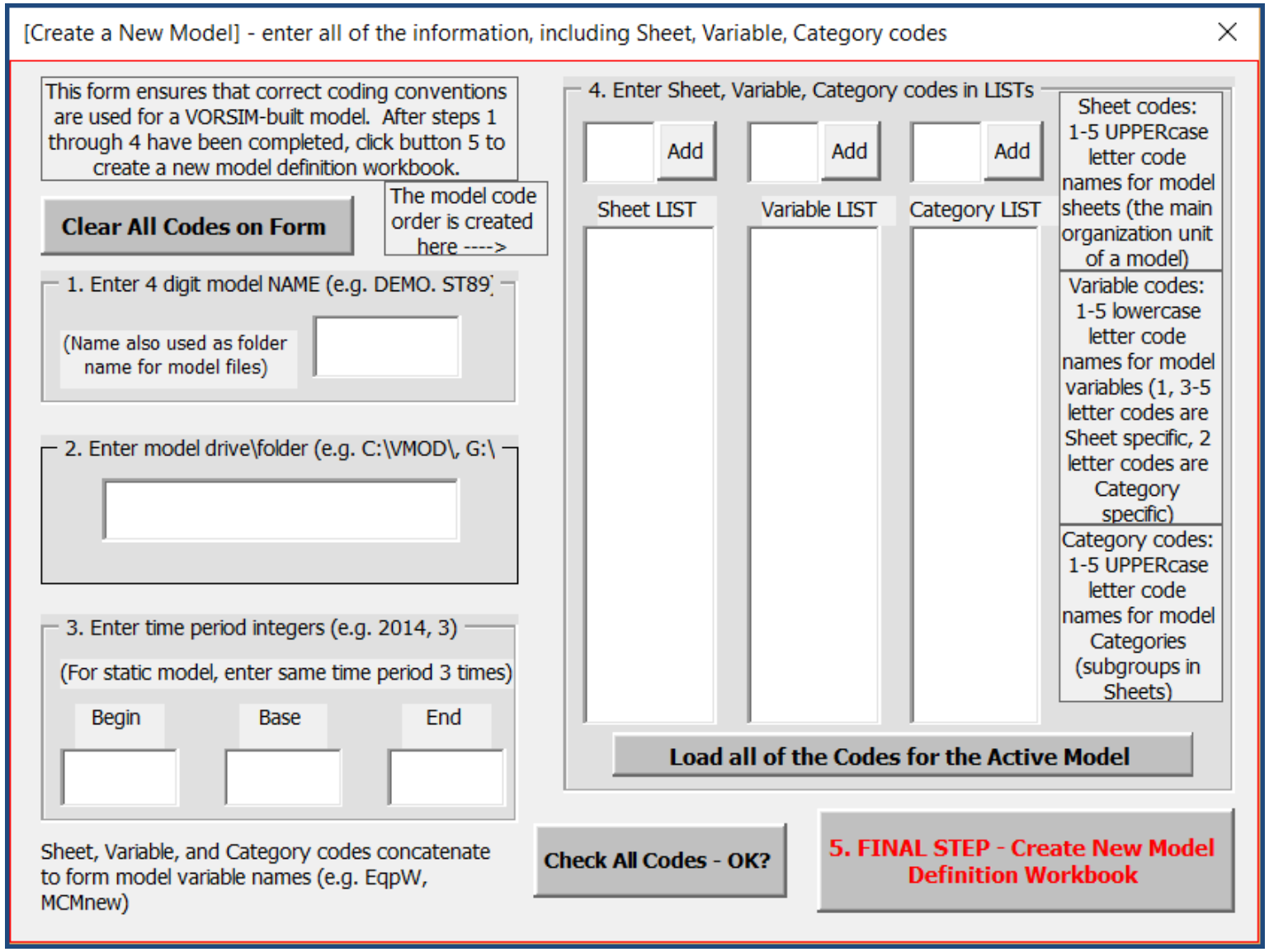
VORSIM uses the structure of the Excel spreadsheet for building a model. Information is kept in Excel Workbooks containing Sheets which in turn, can be subdivided into Categories.



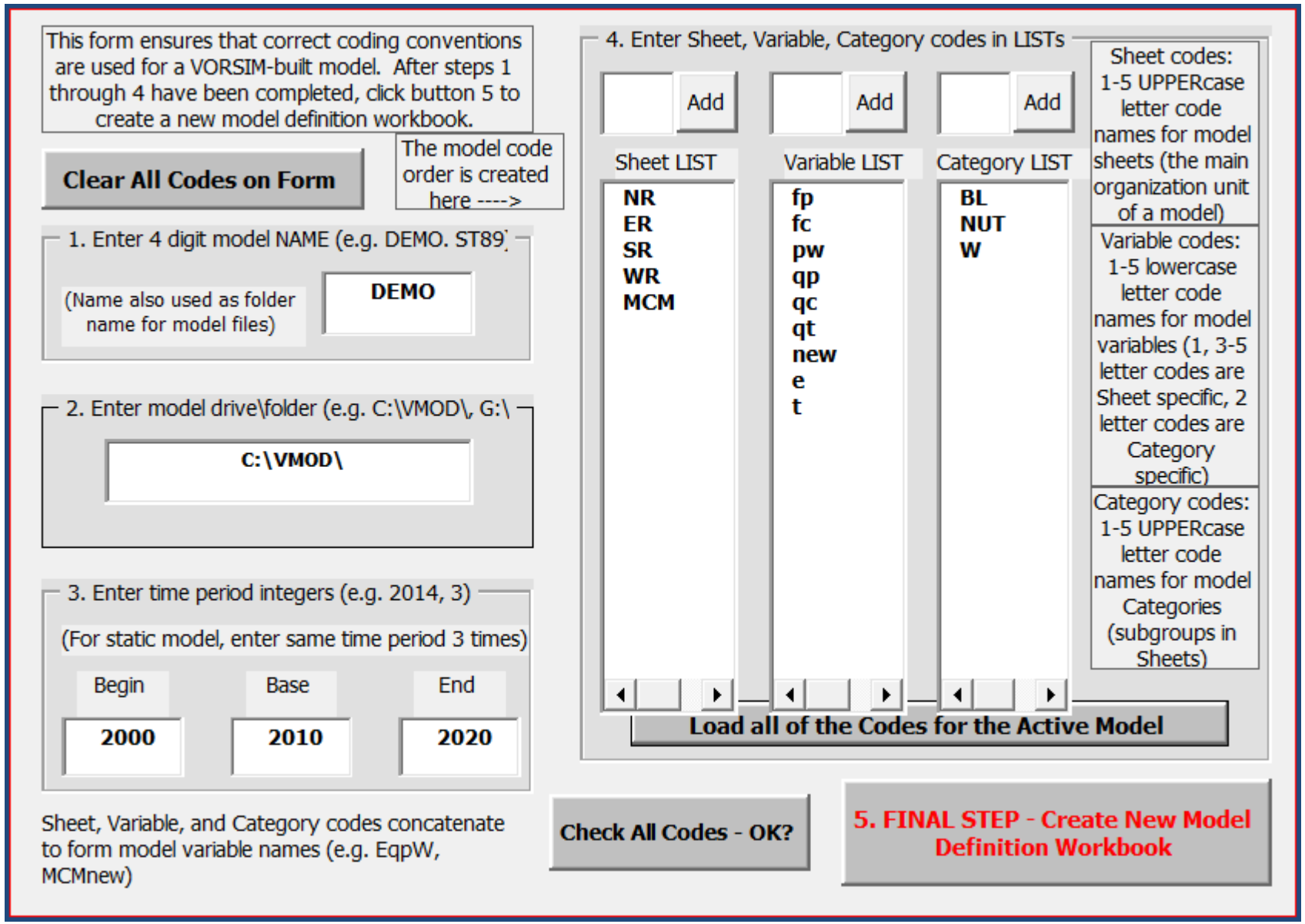
An Excel model consists of equations made of variables using Excel math notation. In Excel, numbers and equation variables are located in Sheet cells referenced by row and column – e.g. B3 or AX241. Because a model with many variables and numbers can be spread out in a workbook, VORSIM provides a way of naming variables consistent with Workbook structure and a way of setting the cell location of each and every variable in a model. With VORSIM, when a model is built so you know where variables and equations are located.

VORSIM model variables are created by concatenating variable codes with codes for Sheets and Categories. An example might be a variable code **inc** for income joined with a Sheet code to form a variable **S1inc** – income for the part of the model residing on Sheet 1. A two digit variable code **qs** for quantity **C1** sold would be used in the variable name **S2qsC1** – the quantity sold in Sheet 2 of the Category 1 product. A simple but flexible set of rules is enforced which creates readable variable names , sets locations for all variables, and maintains a model which follows the structure of an Excel Workbook. Procedures in VORSIM make sure the rules are followed in code entry forms using your designated codes and model structure.

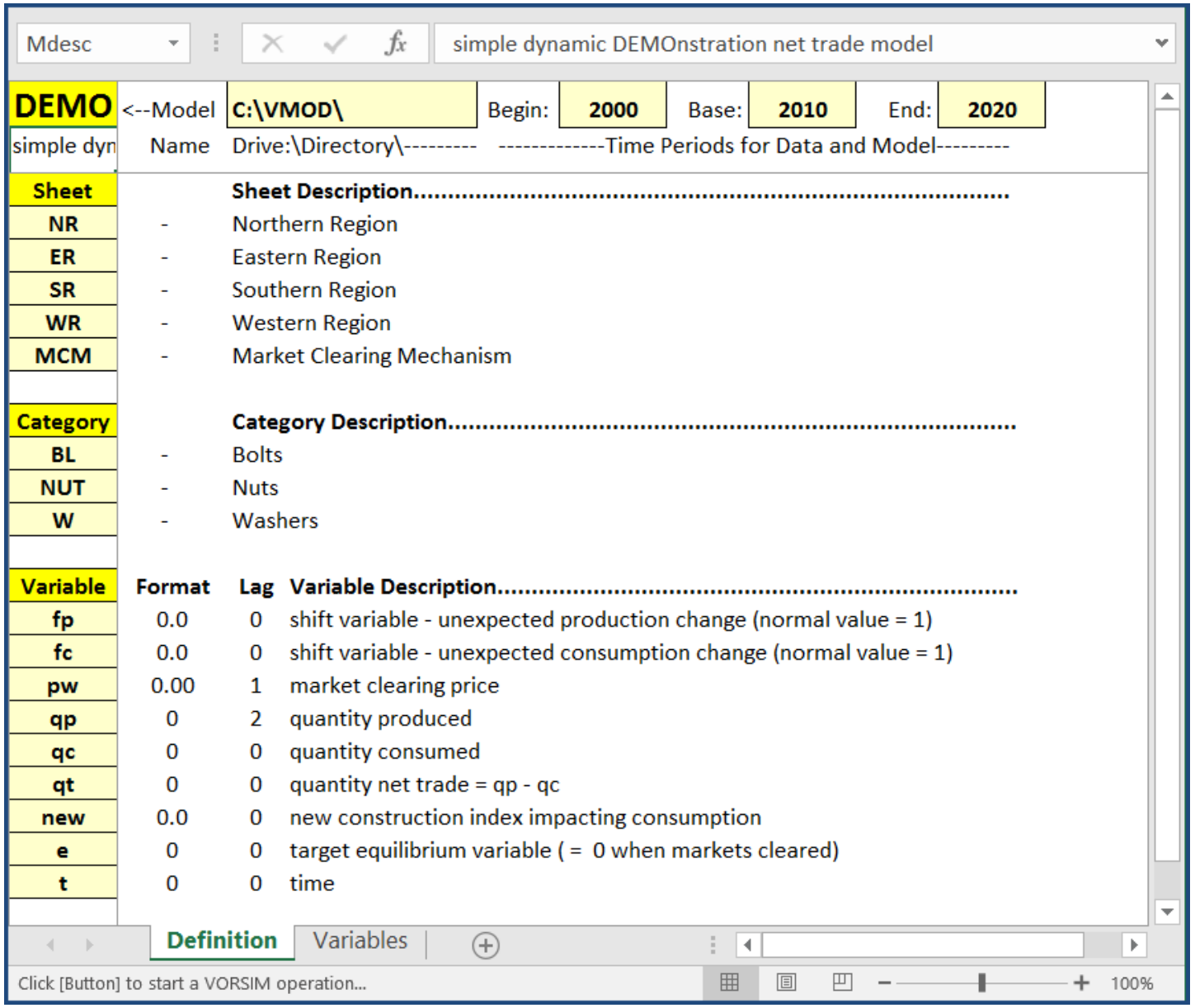
When planning a model, information for this form must be selected. When creating a model, this form must be filled out. As code information for a model is entered on this form, VORSIM rules are enforced so that everything in later model building steps will work. As us true with all VORSIM forms, explanations appear on the forms and numbers often specify the order of tasks on the forms. The final step creates the model definition workbook and closes this form. Documentation of codes and the final selection of model variables takes place in the model definition workbook.

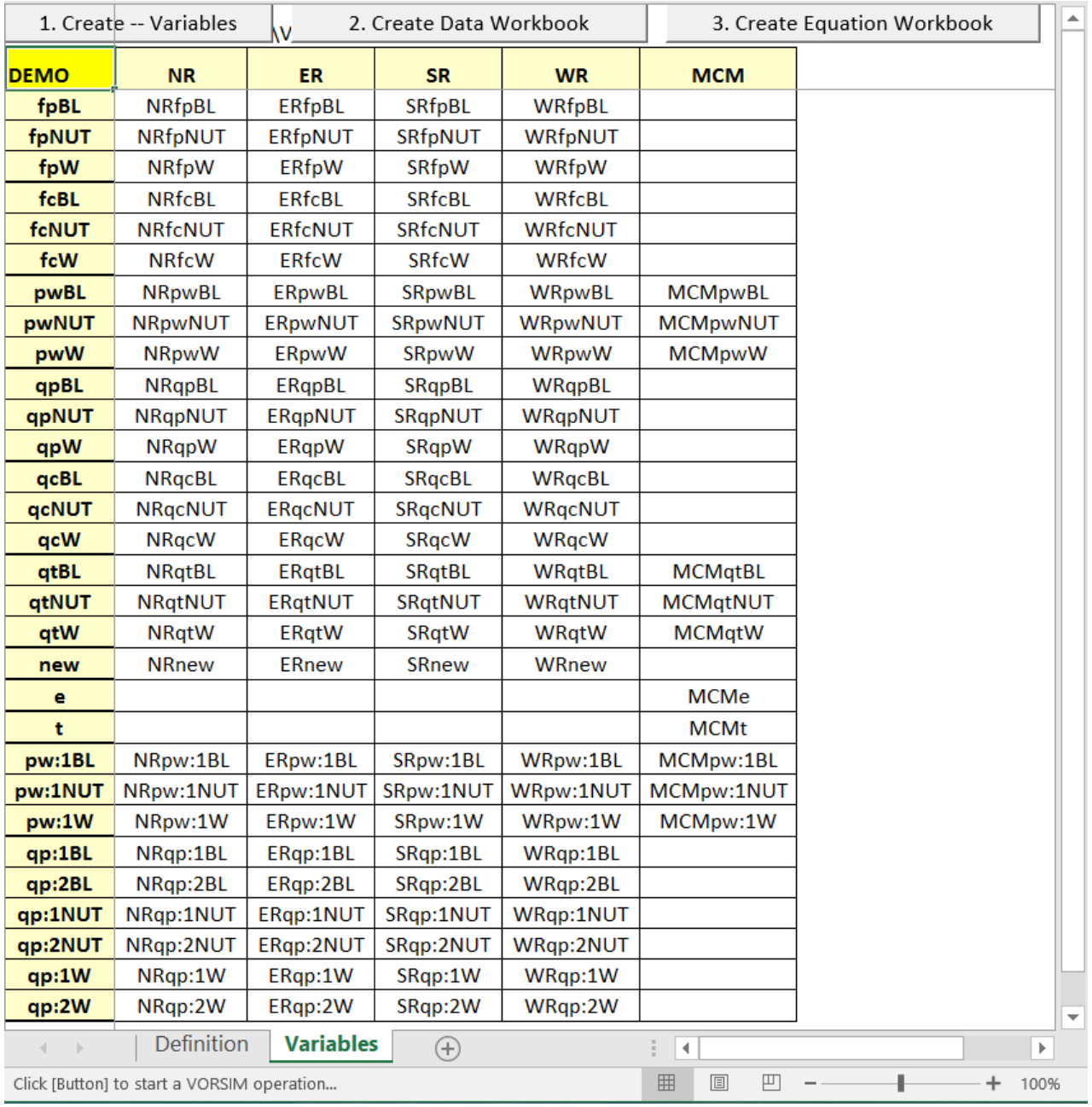


Here, information needed to create the model DEMO has been added to the model creation form. Model workbooks are usually stored in a folder with the model name on the VMOD directory. So, for example, the location of the DEMO files would be C:\VMOD\DEMO in this example. The sheet, variable, and category codes follow the selected structure and type of equations for the model. Two digit variable codes allow similar equations to be written for categories.



Here is the Definition sheet of the model definition workbook that was created. Descriptions have been manually added to the codes. Excel format codes are added to variable codes. For example, any cell with variable using the pw code will appear numerically with 2 places after the decimal point, e.g. 45.00. Also, the maximum number of lags for a variable in equations is set. The documentation shown is minimal but adequate. As long as key model cells (here in column A-C) are not disturbed, documentation can be entered anywhere in workbooks. Workbooks can be backed up as needed so that information is not lost if a workbook is damaged. The second sheet of this workbook contains a "map" of all the model variables.

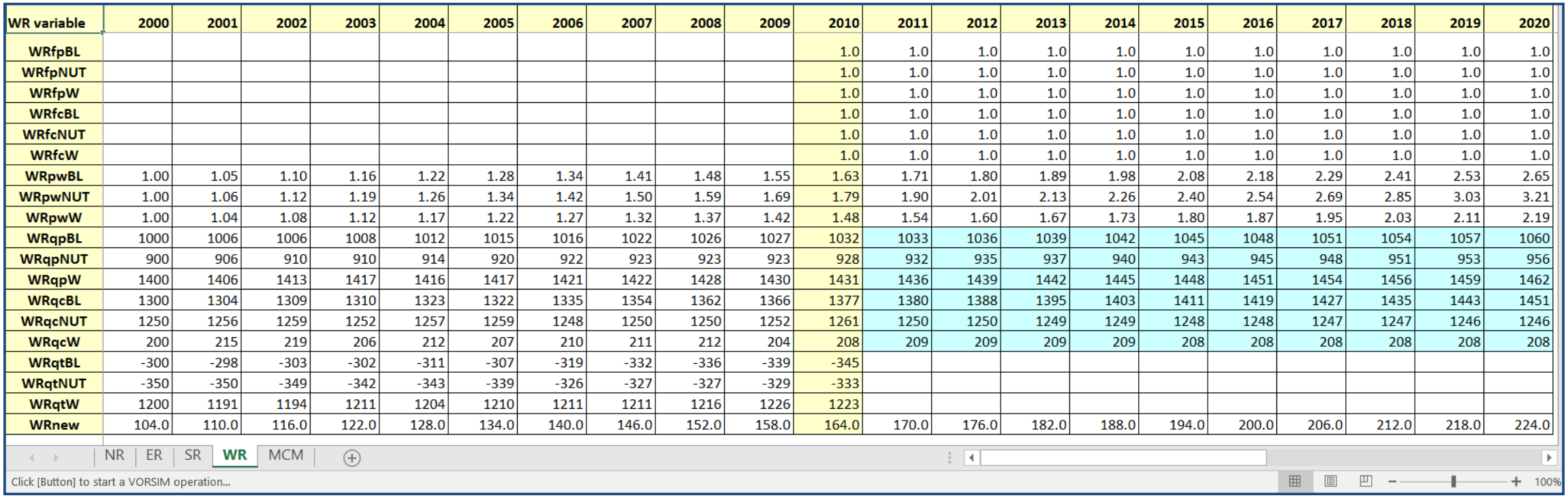




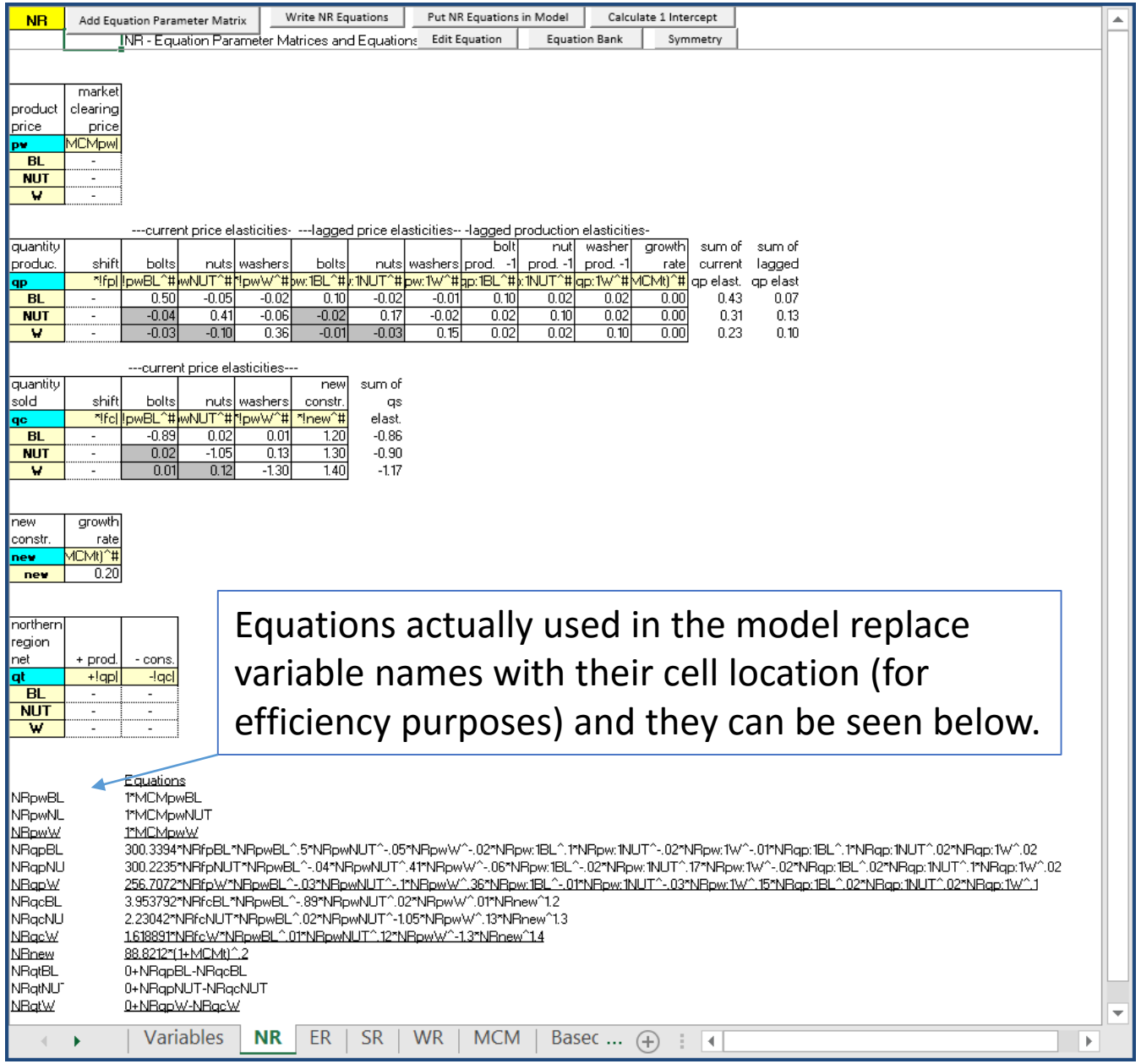
DEMO	NR	ER	SR	WR	MCM
fpBL	NRfpBL	ERfpBL	SRfpBL	WRfpBL	
fpNUT	NRfpNUT	ERfpNUT	SRfpNUT	WRfpNUT	
fpW	NRfpW	ERfpW	SRfpW	WRfpW	
fcBL	NRfcBL	ERfcBL	SRfcBL	WRfcBL	
fcNUT	NRfcNUT	ERfcNUT	SRfcNUT	WRfcNUT	
fcW	NRfcW	ERfcW	SRfcW	WRfcW	
pwBL	NRpwBL	ERpwBL	SRpwBL	WRpwBL	MCMpwBL
pwNUT	NRpwNUT	ERpwNUT	SRpwNUT	WRpwNUT	MCMpwNUT
pwW	NRpwW	ERpwW	SRpwW	WRpwW	MCMpwW
qpBL	NRqpBL	ERqpBL	SRqpBL	WRqpBL	
qpNUT	NRqpNUT	ERqpNUT	SRqpNUT	WRqpNUT	
qpW	NRqpW	ERqpW	SRqpW	WRqpW	
qcBL	NRqcBL	ERqcBL	SRqcBL	WRqcBL	
qcNUT	NRqcNUT	ERqcNUT	SRqcNUT	WRqcNUT	
qcW	NRqcW	ERqcW	SRqcW	WRqcW	
qtBL	NRqtBL	ERqtBL	SRqtBL	WRqtBL	MCMqtBL
qtNUT	NRqtNUT	ERqtNUT	SRqtNUT	WRqtNUT	MCMqtNUT
qtW	NRqtW	ERqtW	SRqtW	WRqtW	MCMqtW
new	NRnew	ERnew	SRnew	WRnew	
e					MCMe
t					MCMt
pw:1BL	NRpw:1BL	ERpw:1BL	SRpw:1BL	WRpw:1BL	MCMpw:1BL
pw:1NUT	NRpw:1NUT	ERpw:1NUT	SRpw:1NUT	WRpw:1NUT	MCMpw:1NUT
pw:1W	NRpw:1W	ERpw:1W	SRpw:1W	WRpw:1W	MCMpw:1W
qp:1BL	NRqp:1BL	ERqp:1BL	SRqp:1BL	WRqp:1BL	
qp:2BL	NRqp:2BL	ERqp:2BL	SRqp:2BL	WRqp:2BL	
qp:1NUT	NRqp:1NUT	ERqp:1NUT	SRqp:1NUT	WRqp:1NUT	
qp:2NUT	NRqp:2NUT	ERqp:2NUT	SRqp:2NUT	WRqp:2NUT	
qp:1W	NRqp:1W	ERqp:1W	SRqp:1W	WRqp:1W	
qp:2W	NRqp:2W	ERqp:2W	SRqp:2W	WRqp:2W	

This is the master variable “map” for the model DEMO. Sheet codes are at the top and a concatenation of variable and category codes are in the left column. The combination yields the variable name in the white cells. Where variables are not needed, cells are left blank. For example, cell B3 contains the variable **NRfpBL**. Two digit variable codes create allow the creation of variables for each category while other variable codes create one variable for each sheet (e.g. **NRnew**). This map sets the location of variables (formulas or data) in the model workbook. Lagged variable names are created where they are needed. Button 1 at the top of the sheet creates the variable names from cells initially containing the number 1 (but not for blank cells). So decisions are made here about which variables to include in the model DEMO. Once variables have been selected, buttons 2and 3 create the model Data and Equation Workbooks.

WR variable	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WRfpBL											1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
WRfpNUT											1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
WRfpW											1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
WRfcBL											1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
WRfcNUT											1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
WRfcW											1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
WRpwBL	1.00	1.05	1.10	1.16	1.22	1.28	1.34	1.41	1.48	1.55	1.63	1.71	1.80	1.89	1.98	2.08	2.18	2.29	2.41	2.53	2.65
WRpwNUT	1.00	1.06	1.12	1.19	1.26	1.34	1.42	1.50	1.59	1.69	1.79	1.90	2.01	2.13	2.26	2.40	2.54	2.69	2.85	3.03	3.21
WRpwW	1.00	1.04	1.08	1.12	1.17	1.22	1.27	1.32	1.37	1.42	1.48	1.54	1.60	1.67	1.73	1.80	1.87	1.95	2.03	2.11	2.19
WRqpBL	1000	1006	1006	1008	1012	1015	1016	1022	1026	1027	1032	1033	1036	1039	1042	1045	1048	1051	1054	1057	1060
WRqpNUT	900	906	910	910	914	920	922	923	923	923	928	932	935	937	940	943	945	948	951	953	956
WRqpW	1400	1406	1413	1417	1416	1417	1421	1422	1428	1430	1431	1436	1439	1442	1445	1448	1451	1454	1456	1459	1462
WRqcBL	1300	1304	1309	1310	1323	1322	1335	1354	1362	1366	1377	1380	1388	1395	1403	1411	1419	1427	1435	1443	1451
WRqcNUT	1250	1256	1259	1252	1257	1259	1248	1250	1250	1252	1261	1250	1250	1249	1249	1248	1248	1247	1247	1246	1246
WRqcW	200	215	219	206	212	207	210	211	212	204	208	209	209	209	209	208	208	208	208	208	208
WRqtBL	-300	-298	-303	-302	-311	-307	-319	-332	-336	-339	-345										
WRqtNUT	-350	-350	-349	-342	-343	-339	-326	-327	-327	-329	-333										
WRqtW	1200	1191	1194	1211	1204	1210	1211	1211	1216	1226	1223										
WRnew	104.0	110.0	116.0	122.0	128.0	134.0	140.0	146.0	152.0	158.0	164.0	170.0	176.0	182.0	188.0	194.0	200.0	206.0	212.0	218.0	224.0



This is the data sheet for WR (western region) in the Data Workbook. There is a workbook sheet for each sheet code. Historical data is on the left, base period (2010) data in the middle yellow cells, and exogenous (white cells) or projected (blue cells) are on the right. DEMO is a time series model starting in the base period 2010 and simulating out to 2020. Data is entered manually or programmatically and the data workbook can be backed up at any time so that data entry efforts do not have to be repeated if the data workbook is corrupted. Data for the base period is used to initialize the model's constant terms making the model reproduce the base period data. Exogenous data from this workbook is used to simulate the model into the future. Note that if the model were static (one time period), the data workbook would only contain one column of base period data per sheet.



Buttons for model operations are placed at the top of each model equation sheet.

Equations are built and stored in matrix form where rows represent variables for categories and columns represent equation terms. Term coefficients in the matrix cells replace the # symbol when the equation is written (using the button at the top). Re-writing the equation when coefficients are changed is a simple matter of using the button at the top again. Equation terms with no numerical coefficients have –'s in the cells if the term is to be included.

The equations written for model variables are shown at the bottom of the sheet. They begin with constant terms calculated so the equation reproduces variable base data. They include model variable names related by Excel math notation. These are the documentation of model equations.

Write Sheets of Equations | 1. Create Model Workbooks | 2. Put ALL Equations in Model | 2 | Create An Alternative Model | 2020 | <-Enter D for double precision constant terms

DEMO	NR	ER	SR	WR	MCM
fpBL	NRfpBL	ERfpBL	SRfpBL	WRfpBL	
fpNUT	NRfpNUT	ERfpNUT	SRfpNUT	WRfpNUT	
fpW	NRfpW	ERfpW	SRfpW	WRfpW	
fcBL	NRfcBL	ERfcBL	SRfcBL	WRfcBL	
fcNUT	NRfcNUT	ERfcNUT	SRfcNUT	WRfcNUT	
fcW	NRfcW	ERfcW	SRfcW	WRfcW	
pwBL	NRpwBL	ERpwBL	SRpwBL	WRpwBL	MCMpwBL
pwNUT	NRpwNUT	ERpwNUT	SRpwNUT	WRpwNUT	MCMpwNUT
pwW	NRpwW	ERpwW	SRpwW	WRpwW	MCMpwW
qpBL	NRqpBL	ERqpBL	SRqpBL	WRqpBL	
qpNUT	NRqpNUT	ERqpNUT	SRqpNUT	WRqpNUT	
qpW	NRqpW	ERqpW	SRqpW	WRqpW	
qcBL	NRqcBL	ERqcBL	SRqcBL	WRqcBL	
qcNUT	NRqcNUT	ERqcNUT	SRqcNUT	WRqcNUT	
qcW	NRqcW	ERqcW	SRqcW	WRqcW	
qtBL	NRqtBL	ERqtBL	SRqtBL	WRqtBL	MCMqtBL
qtNUT	NRqtNUT	ERqtNUT	SRqtNUT	WRqtNUT	MCMqtNUT
qtW	NRqtW	ERqtW	SRqtW	WRqtW	MCMqtW
new	NRnew	ERnew	SRnew	WRnew	
e					MCMe
t					MCMt
pw:1BL	NRpw:1BL	ERpw:1BL	SRpw:1BL	WRpw:1BL	MCMpw:1BL
pw:1NUT	NRpw:1NUT	ERpw:1NUT	SRpw:1NUT	WRpw:1NUT	MCMpw:1NUT
pw:1W	NRpw:1W	ERpw:1W	SRpw:1W	WRpw:1W	MCMpw:1W
qp:1BL	NRqp:1BL	ERqp:1BL	SRqp:1BL	WRqp:1BL	
qp:2BL	NRqp:2BL	ERqp:2BL	SRqp:2BL	WRqp:2BL	
qp:1NUT	NRqp:1NUT	ERqp:1NUT	SRqp:1NUT	WRqp:1NUT	
qp:2NUT	NRqp:2NUT	ERqp:2NUT	SRqp:2NUT	WRqp:2NUT	
qp:1W	NRqp:1W	ERqp:1W	SRqp:1W	WRqp:1W	
qp:2W	NRqp:2W	ERqp:2W	SRqp:2W	WRqp:2W	

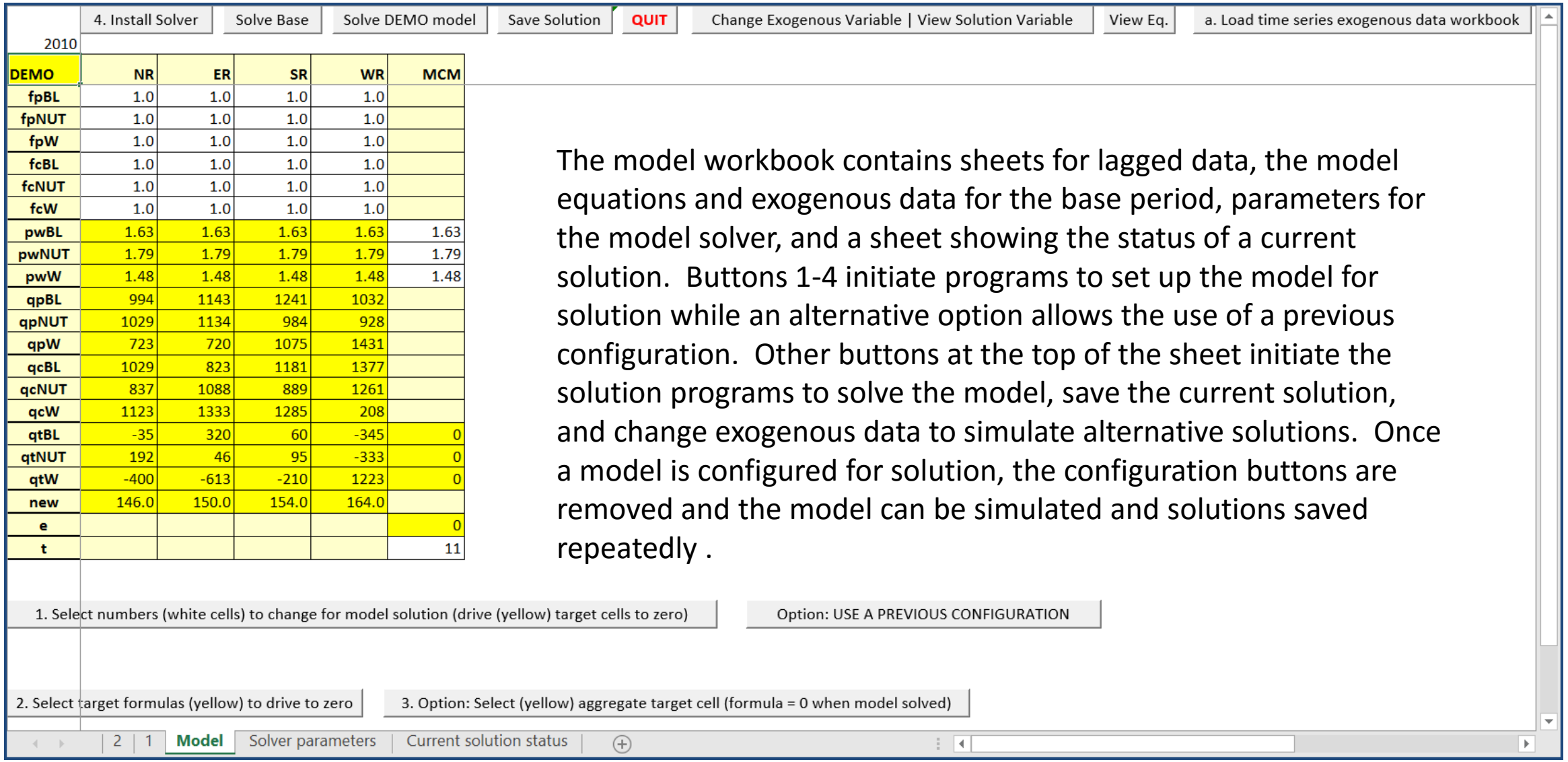
Funcs: ABS AVERAGE MAX MIN SUM EXP LN IF INT AND OR SMALL COUNT ISERROR SUMPRODUCT

Refer to VBA help for the proper use of these functions in an equation.

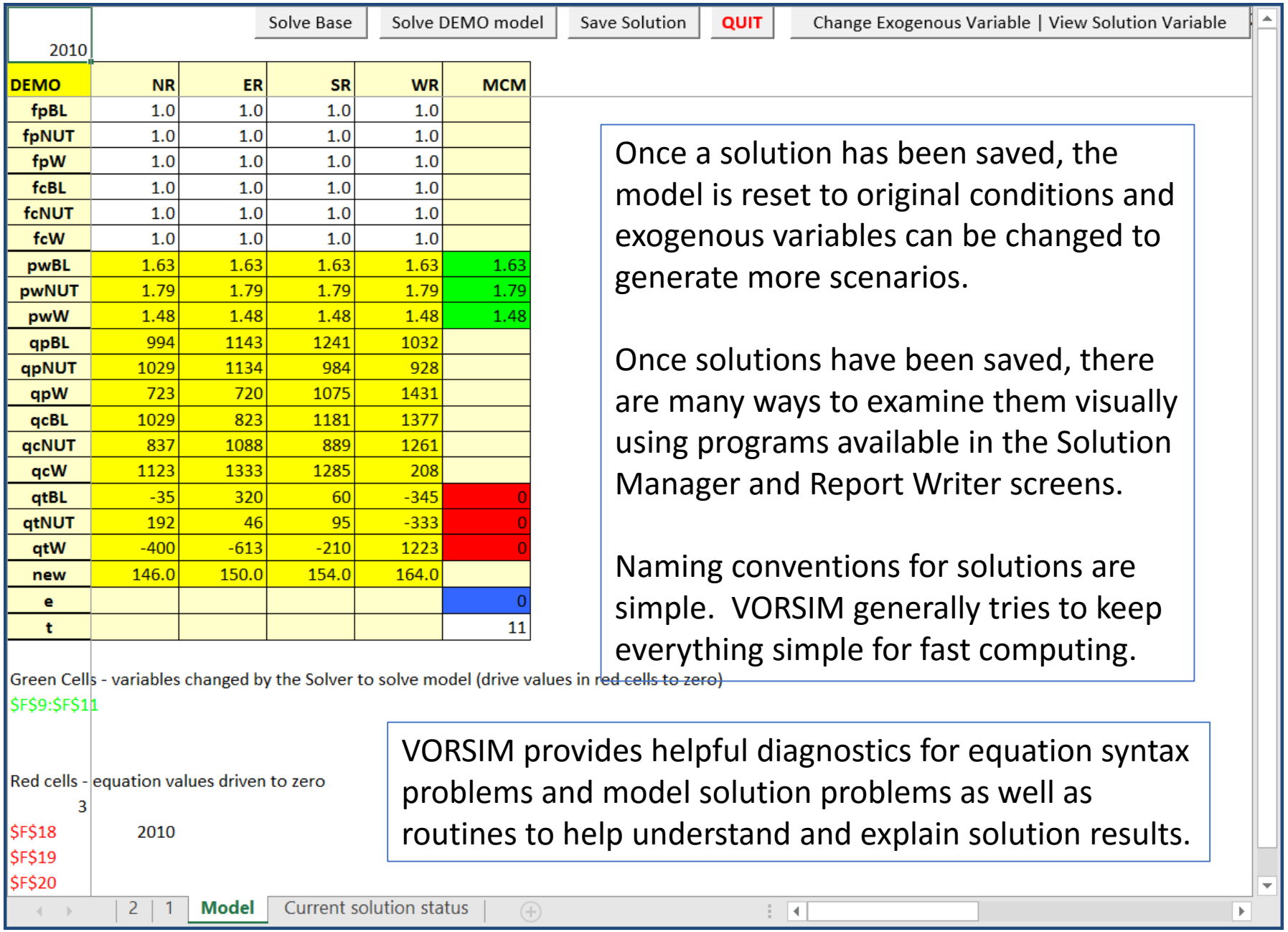
The first sheet of the equation workbook repeats the variable map from the definition workbook. Buttons 1 and 2 at the top are used to create model workbooks (the model workbook, exogenous data workbook) and to put the equations from this workbook into the model. Also, an alternative model can be created, (normally leaving out selected equations). The last sheet in this workbook (Basedata) contains the base data that is needed to initialize equations. The func list at the bottom lists all of the Excel math functions that can be used in VORSIM built Excel equations.

VORSIM is set up so that complex operations can be easily repeated. For example, if equation parameters are changed on sheets in this workbook, equations can be quickly re-written on the equation sheets and the model re-created from this sheet.

Variables | NR | ER | SR | WR | MCM | Basedata



This is the model sheet after the model DEMO has been created. Yellow cells contain equations; white cells data.



This is the model sheet after configuration. The configuration buttons have been removed. The green cells contain the variables changed by the solver to target the red variables and the blue target variable. The cell location of these cells appear below the model cells. At this point, the model can be simulated with the [Solve DEMO model] button at the top. A VORSIM-built model is created as a stand-alone workbook.