

# Joint Reservoir Regulation (RES-J) Model

## 1. Description of Algorithm

<https://vlab.ncep.noaa.gov/documents/207461/1893022/24resj.pdf>

## 2. Model Parameters

RES-J uses the existing NWSRFS operation definition for defining model parameters. The NWSRFS operation definition is enclosed within a single parameter element named "OPERATION\_CONENTS". An example is shown below. For further information see:

<https://vlab.ncep.noaa.gov/documents/207461/1893022/533resj.pdf>

Below is an example of a RES-J parameters input file:

```
RES-J   LTKW3
#
TIMESERIES
  TIMESTEP 6
  INPUT LTKW3  MAP 6 LTKW3_Rain
  INPUT LTKW3INQ SQIN 06 LTKW3_IN  # Rainbow Lake Inflow
  INPUT LTKW3  RQOT 06 LTKW3_obsq # Rainbow Lake Obs Release
  INPUT LTKW3  PELV 06 LTKW3_osp  # Rainbow Lake Obs Pool
  INPUT RRLW3UNR SQIN 6 RRLW3_unr # Unregulated Merrill flow
  OUTPUT LTKW3OUT SQIN 06 LTKW3_REL # Rainbow Lake Release
  OUTPUT LTKW3  SPEL 06 LTKW3_SPEL # Rainbow Lake Sim Pool
ENDTIMESERIES
#
TOPOLOGY
RESERVOIR LTKW3
ENDTOPOLOGY
#
PARAMETERS
UNITS ENGLISH
#
#-----
# Rainbow Lake
#-----
RESERVOIR LTKW3
TSINPUT INFLOW LTKW3_IN
TSOUTPUT RELEASE LTKW3_REL
TSOUTPUT POOL LTKW3_SPEL
TABLE ELEV_STOR
  1572.71  0.00
  1580.00  3115.00
  1581.80  6566.00
  1584.54  10882.00
  1586.86  15588.00
  1589.42  22085.00
  1591.97  30096.00
```

```

1593.84 36846.00
1595.90 45156.00
1597.05 50800.00
ENDTABLE
PREVIOUSPOOL 1592.701115
INITIALPOOL 1592.619751
INITIALINFLOW 258.388459
INITIALRELEASE 571.989618
MINPOOL 1575.05
MINRELEASE 150.0
INITIALWITHDRAW 0.000000
PREVIOUSRELEASE 512.395381
PREVIOUSWITHDRAW 0.000000
PREVIOUSINFLOW 289.665748
ENDRESERVOIR
#
#
ADJUST LTKW3 ltkw3_adj
TSINPUT OBSERVEDPOOL LTKW3_obsp
TSINPUT OBSERVEDRELEASE LTKW3_obsq
ADJSIM OFF
ENDADJUST
#
RAINEVAP LTKW3 LTKW3_re
TSINPUT OBSERVEDPRECIP LTKW3_rain
EVAP
VALUES
01/15 .000 .20 .50 .25 .05
03/15 .000
04/15 .010
05/15 .040
06/15 .120
07/15 .160
08/15 .170
09/15 .140
10/15 .080
11/15 .010
12/15 .000
ENDVALUES
ENDEVAP
ENDRAINEVAP
#
#
SETELEVATION LTKW3 normal
VALUES
01/01_00:00 1588.60
01/09_12:00 1589.00
02/26_12:00 1586.15
03/09_12:00 1582.50
03/31_12:00 1577.50
04/11_12:00 1597.00
11/01_12:00 1595.50
12/31_23:00 1588.61
ENDVALUES
INTERPOLATE
BLENDTS 16 17

```

```

BLENDTBL 16 1
ENDSETELEVATION
#
SETRELEASE LTKW3 minimum
VALUES
ELEV    1575.00 1592.00 1597.05 ENDELEV
01/01_00:00 150.0 150.0 150.0
12/31_23:00 150.0 150.0 150.0
ENDVALUES
ENDSETRELEASE
#
SETRELEASE LTKW3 maximum
VALUES
ELEV    1575.00 1577.00 1587.00 1588.00 1590.00 1592.00 1597.05 ENDELEV
01/01_00:00 150.0 550.0 650.0 750.0 900.0 1200.0 22000.0
12/31_23:00 150.0 550.0 650.0 750.0 900.0 1200.0 22000.0
ENDVALUES
INTERPOLATE BOTH
BLENDTS 12 13
ENDSETRELEASE
#
PASSFLOW LTKW3 pass_inflow
ENDPASSFLOW
#
# MAXINCREASE LTKW3 s_delta_flow
# INCREASE 250.0
# ENDMAXINCREASE
#
#
# MAXINCREASE ILRM5 w_delta_flow
# INCREASE 2.83
# ENDMAXINCREASE
#
LOOKUP3 LTKW3 April
TSINPUT OBSERVEDRELEASE LTKW3_obsq
TSINDEX ROWS RRLW3_unr
ROWVAR INPUT_TS CFS
COLUMNVAR LTKW3.STARTINGPOOL FT
TABLEVAR RELEASE
VALUES
    1580.00 1589.02 1590.68 1591.97 1593.84 1596.06 1597.05
    0 481 590 615 637 672 719 745
    200 427 536 561 583 618 665 691
    400 373 482 507 529 564 611 637
    600 319 428 453 475 510 557 583
    800 265 374 399 421 456 503 529
    1000 211 320 345 367 402 449 475
    1300 130 239 264 286 321 368 394
    1600 49 158 183 205 240 287 313
    1900 0 77 102 124 159 206 232
    2000 0 50 75 97 132 179 205
    2184 0 0 26 47 82 129 155
    2279 0 0 0 21 57 104 130
    2360 0 0 0 0 35 82 108
    2400 0 0 0 0 24 71 97
    2664 0 0 0 0 0 0 71

```

```

2760 0 0 0 0 0 0 0
ENDVALUES
INTERPOLATE ALL
BLENDTS 24
ENDLOOKUP3
LOOKUP3 LTKW3 May
TSINPUT OBSERVEDRELEASE LTKW3_obsq
TSINDEX ROWS RRLW3_unr
ROWVAR INPUT_TS CFS
COLUMNVAR LTKW3.STARTINGPOOL FT
TABLEVAR RELEASE
VALUES
1580.00 1589.02 1590.68 1591.97 1593.84 1596.06 1597.05
0 0 156 206 247 314 404 454
200 0 102 151 193 260 350 400
400 0 48 97 139 206 296 346
600 0 0 43 85 152 242 292
800 0 0 0 31 98 188 238
1000 0 0 0 0 44 134 184
1300 0 0 0 0 0 53 103
1600 0 0 0 0 0 0 22
1900 0 0 0 0 0 0 0
ENDVALUES
INTERPOLATE ALL
BLENDTS 24
ENDLOOKUP3
LOOKUP3 LTKW3 June
TSINPUT OBSERVEDRELEASE LTKW3_obsq
TSINDEX ROWS RRLW3_unr
ROWVAR INPUT_TS CFS
COLUMNVAR LTKW3.STARTINGPOOL FT
TABLEVAR RELEASE
VALUES
1580.00 1589.02 1590.68 1591.97 1593.84 1596.06 1597.05
0 0 161 199 232 285 355 394
200 0 107 145 178 231 201 340
400 0 53 91 124 177 247 286
600 0 0 37 70 123 193 232
800 0 0 0 16 69 139 178
1000 0 0 0 0 15 85 124
1300 0 0 0 0 0 4 43
1600 0 0 0 0 0 0 0
ENDVALUES
INTERPOLATE ALL
BLENDTS 24
ENDLOOKUP3
LOOKUP3 LTKW3 July
TSINPUT OBSERVEDRELEASE LTKW3_obsq
TSINDEX ROWS RRLW3_unr
ROWVAR INPUT_TS CFS
COLUMNVAR LTKW3.STARTINGPOOL FT
TABLEVAR RELEASE
VALUES
1580.00 1589.02 1590.68 1591.97 1593.84 1596.06 1597.05
0 14 177 216 249 301 372 411
200 0 123 162 195 247 318 357

```

400	0	69	108	141	193	264	303
600	0	15	54	87	139	210	249
800	0	0	0	33	85	156	195
1000	0	0	0	0	31	102	141
1300	0	0	0	0	0	21	60
1600	0	0	0	0	0	0	0

ENDVALUES  
INTERPOLATE ALL  
BLENDTS 24  
ENDLOOKUP3  
LOOKUP3 LTKW3 August  
TSINPUT OBSERVEDRELEASE LTKW3\_obsq  
TSINDEX ROWS RRLW3\_unr  
ROWVAR INPUT\_TS CFS  
COLUMNVAR LTKW3.STARTINGPOOL FT  
TABLEVAR RELEASE  
VALUES

1580.00	1589.02	1590.68	1591.97	1593.84	1596.06	1597.05	
0	29	192	230	263	316	386	425
200	0	138	176	209	262	332	371
400	0	84	122	155	208	278	317
600	0	30	68	101	154	224	263
800	0	0	14	47	100	170	209
1000	0	0	0	0	46	116	155
1300	0	0	0	0	0	35	74
1600	0	0	0	0	0	0	0

ENDVALUES  
INTERPOLATE ALL  
BLENDTS 24  
ENDLOOKUP3  
LOOKUP3 LTKW3 September  
TSINPUT OBSERVEDRELEASE LTKW3\_obsq  
TSINDEX ROWS RRLW3\_unr  
ROWVAR INPUT\_TS CFS  
COLUMNVAR LTKW3.STARTINGPOOL FT  
TABLEVAR RELEASE  
VALUES

1580.00	1589.02	1590.68	1591.97	1593.84	1596.06	1597.05	
0	22	221	268	308	373	459	506
200	0	167	214	254	319	405	452
400	0	113	160	200	265	351	398
600	0	59	106	146	211	297	344
800	0	5	52	92	157	243	290
1000	0	0	0	38	103	189	236
1300	0	0	0	0	22	108	155
1600	0	0	0	0	0	27	74
1900	0	0	0	0	0	0	0

ENDVALUES  
INTERPOLATE ALL  
BLENDTS 24  
ENDLOOKUP3  
LOOKUP3 LTKW3 October  
TSINPUT OBSERVEDRELEASE LTKW3\_obsq  
TSINDEX ROWS RRLW3\_unr  
ROWVAR INPUT\_TS CFS  
COLUMNVAR LTKW3.STARTINGPOOL FT

TABLEVAR RELEASE

VALUES

	1580.00	1589.02	1590.68	1591.97	1593.84	1596.06	1597.05
0	113	276	314	347	400	471	509
200	59	222	260	293	346	417	455
400	5	168	206	239	292	363	401
600	0	114	152	185	238	309	347
800	0	60	98	131	184	255	293
1000	0	6	44	77	130	201	239
1300	0	0	0	0	49	120	158
1600	0	0	0	0	0	39	77
1900	0	0	0	0	0	0	0

ENDVALUES

INTERPOLATE ALL

BLENDTS 24

ENDLOOKUP3

#

#

SETMAX LTKW3 normals

SETELEVATION LTKW3 normal

SETRELEASE LTKW3 minimum

ENDSETMAX

#

SETMIN LTKW3 norm

SETMAX LTKW3 normals

SETRELEASE LTKW3 maximum

ENDSETMIN

#

SETMAX LTKW3 April

SETELEVATION LTKW3 normal

SETRELEASE LTKW3 minimum

LOOKUP3 LTKW3 April

ENDSETMAX

#

SETMAX LTKW3 May

SETELEVATION LTKW3 normal

SETRELEASE LTKW3 minimum

LOOKUP3 LTKW3 May

ENDSETMAX

#

SETMAX LTKW3 June

SETELEVATION LTKW3 normal

SETRELEASE LTKW3 minimum

LOOKUP3 LTKW3 June

ENDSETMAX

#

SETMAX LTKW3 July

SETELEVATION LTKW3 normal

SETRELEASE LTKW3 minimum

LOOKUP3 LTKW3 July

ENDSETMAX

#

SETMAX LTKW3 August

SETELEVATION LTKW3 normal

SETRELEASE LTKW3 minimum

LOOKUP3 LTKW3 August

```

ENDSETMAX
#
SETMAX LTKW3 September
  SETELEVATION LTKW3 normal
  SETRELEASE LTKW3 minimum
  LOOKUP3 LTKW3 September
ENDSETMAX
#
SETMAX LTKW3 October
  SETELEVATION LTKW3 normal
  SETRELEASE LTKW3 minimum
  LOOKUP3 LTKW3 October
ENDSETMAX
#
ENDPARAMETERS
#-----
RULES
#-----
#
[TRUE]
::ADJUST LTKW3 ltkw3_adj
# ::PASSFLOW LTKW3 pass_inflow
::SETMIN LTKW3 norm
[(DATE) > 04/01_00:01 && (DATE) < 04/30_23:59]
::SETMAX LTKW3 April
[(DATE) > 05/01_00:01 && (DATE) < 05/31_23:59]
::SETMAX LTKW3 May
[(DATE) > 06/01_00:01 && (DATE) < 06/30_23:59]
::SETMAX LTKW3 June
[(DATE) > 07/01_00:01 && (DATE) < 07/31_23:59]
::SETMAX LTKW3 July
[(DATE) > 08/01_00:01 && (DATE) < 08/31_23:59]
::SETMAX LTKW3 August
[(DATE) > 09/01_00:01 && (DATE) < 09/30_23:59]
::SETMAX LTKW3 September
[(DATE) > 10/01_00:01 && (DATE) < 10/31_23:59]
::SETMAX LTKW3 October
ENDRULES
ENDRES-J

```

### 3. Model States

RESJ model states are defined in a property file format. An example is shown below. The model state property names are:

Property Name	Description
UNIT=METRIC	State Variables units
RESERVOIR_OwnerId_INITIALRELEASE RESERVOIR_OwnerId_INITIALPOOL RESERVOIR_OwnerId_INITIALWITHDRAW	Reservoir Component

RESERVOIR_ OwnerId _INITIALINFLOW RESERVOIR_ OwnerId _PREVIOUSRELEASE RESERVOIR_ OwnerId _PREVIOUSPOOL RESERVOIR_ OwnerId _PREVIOUSWITHDRAW RESERVOIR_ OwnerId _PREVIOUSINFLOW  OwnerId =Reservoir ID	Reservoir states values: initial release, Initial pool, initial inflow, previous pool, Previous withdraw, and previous inflow.
NODE_ <b>Id</b> _DISCHARGE NODE_ <b>Id</b> _PREVIOUSDISCHARGE NODE_ <b>Id</b> _INFLOW – value or set to -888 for future NODE_ <b>Id</b> _PREVIOUSINFLOW– value or set to -888 for future NODE_ <b>Id</b> _DIVERSION– value or set to -888 for future NODE_ <b>Id</b> _PREVIOUSDIVERSION– value or set to -888 for future or -999 for MISSING value  <b>Id</b> = Node component ID	Node Component  state values: Discharge, previous discharge, previous inflow, diversion and previous diversion.
LOOKUP3_ <b>Id</b> _OwnerId _BLENDTS LOOKUP3_ <b>Id</b> _OwnerId _BLENDTBL LOOKUP3_ <b>Id</b> _OwnerId _MAXROW=value or -999 (for "SKIP") LOOKUP3_ <b>Id</b> _OwnerId _MAXCOL = value or -999 (for "SKIP") LOOKUP3_ <b>Id</b> _OwnerId _INITIALTRANSFER=value or -999 (for "MISS")  <b>Id</b> = LOOKUP3 Method ID OwnerId = Reservoir ID	Lookup 3 Method
ADJUST_ <b>Id</b> _OwnerId _BLENDTS=value (MUST BE INTEGER NUMBER)  <b>Id</b> = AJUST method ID OwnerId = reservoir ID	Adjust Method
CALCINFLOW_ <b>Id</b> _Ownerid _REMAININGVOL (assign this variable to 0 when re-parameterizing or set string to 'MISSNGX' CALCINFLOW_ <b>Id</b> _Ownerid _STARTINFLOW=value or -999. for "MISSINGX" CALCINFLOW_ <b>Id</b> _Ownerid _STARTPOOL=value or -999. for	Calculation Inflow Method



<p>"MISSINGX"  CALCINFLOW_<b>Id</b>_Ownerid_STARTRELEASE=value or -999. for "MISSINGX"  CALCINFLOW_<b>Id</b>_Ownerid_STARTWITHDRAW=value or -999. for "MISSINGX"</p> <p><b>Id</b> = Reservoir inflow calculation Method ID  Ownerid = Reservoir ID</p>	
<p>SETRELEASE_<b>Id</b>_Ownerid_BLENDTS – Number of blending time steps  SETRELEASE_<b>Id</b>_Ownerid_BLENDTBL – blending Table</p> <p><b>Id</b> = Set release Method ID  Ownerid = Reservoir ID</p>	Set Release Method
<p>SETELEVATION_<b>Id</b>_Ownerid_BLENDTS – Number of blending time steps  SETELEVATION_<b>Id</b>_Ownerid_BLENDTBL – blending Table</p> <p><b>Id</b> = Set elevation Method ID  Ownerid = Reservoir ID</p>	Set Elevation Method
<p>SETWITHDRAW_<b>Id</b>_Ownerid_BLENDTS  SETWITHDRAW_<b>Id</b>_Ownerid_BLENDTBL  SETWITHDRAW_<b>Id</b>_Ownerid_INITIALTRANSFER</p> <p><b>Id</b> = Set withdraw Method ID  Ownerid = Reservoir ID</p>	Set Withdraw Method
<p><b>Id</b>_Id2_COINFLOW_#0  ...  <b>Id</b>_Id2_COINFLOW_#n  <b>Id</b>_Id2_INITIALOUTFLOW  <b>Id</b>_Id2_INITIALSTORAGE  <b>Id</b>_Id2_INITIALLAGGEDINFLOW  <b>Id</b> = Reach component ID – or Lagk Method ID  Id2 = second ID name</p>	Reach Component and Lagk method
<p>SPILLWAY_<b>Id</b>_Ownerid_INITIALSPILL</p> <p><b>Id</b> = Set elevation Method ID  Ownerid = Reservoir ID</p>	

**Below is an example of a states file:**

```

UNIT=METRIC
RESERVOIR_GILN6RES_INITIALRELEASE=60.03981
RESERVOIR_GILN6RES_INITIALPOOL=343.2596
RESERVOIR_GILN6RES_INITIALWITHDRAW=0.074545
RESERVOIR_GILN6RES_INITIALINFLOW=52.27758

```

RESERVOIR\_GILN6RES\_PREVIOUSRELEASE=55.72908  
 RESERVOIR\_GILN6RES\_PREVIOUSPOOL=343.2231  
 RESERVOIR\_GILN6RES\_PREVIOUSWITHDRAW=0.074545  
 RESERVOIR\_GILN6RES\_PREVIOUSINFLOW=50.37602  
 NODE\_ESO\_CON\_INITIALDISCHARGE=13.29016  
 NODE\_ESO\_CON\_PREVIOUSDISCHARGE=11.52023  
 NODE\_ESO\_CON\_INITIALINFLOW=13.29016  
 NODE\_ESO\_CON\_PREVIOUSINFLOW=11.52023  
 NODE\_ESO\_CON\_INITIALDIVERSION=0.000000  
 NODE\_ESO\_CON\_PREVIOUSDIVERSION=0.000000  
 NODE\_CONF\_INITIALDISCHARGE=73.32997  
 NODE\_CONF\_PREVIOUSDISCHARGE=67.24931  
 NODE\_CONF\_INITIALINFLOW=73.32997  
 NODE\_CONF\_PREVIOUSINFLOW=67.24931  
 NODE\_CONF\_INITIALDIVERSION=0.000000  
 NODE\_CONF\_PREVIOUSDIVERSION=0.000000  
 SETWITHDRAW\_SHANDAKEN\_GILN6RES\_BLENDTS=1  
 SETWITHDRAW\_SHANDAKEN\_GILN6RES\_BLENDTBL=NONE  
 SETWITHDRAW\_SHANDAKEN\_GILN6RES\_INITIALTRANSFER=0.074545  
 SETWITHDRAW\_MIN\_GILN6RES\_BLENDTS=1  
 SETWITHDRAW\_MIN\_GILN6RES\_BLENDTBL=NONE  
 SETWITHDRAW\_MIN\_GILN6RES\_INITIALTRANSFER=0.000000  
 SETWITHDRAW\_MAX\_GILN6RES\_BLENDTS=1  
 SETWITHDRAW\_MAX\_GILN6RES\_BLENDTBL=0  
 SETWITHDRAW\_MAX\_GILN6RES\_INITIALTRANSFER=39.16438  
 SETRELEASE\_RELEASE\_GILN6RES\_BLENDTS=1  
 SETRELEASE\_RELEASE\_GILN6RES\_BLENDTBL=1  
 SPILLWAY\_UNCTRLDSPILL\_GILN6RES\_INITIALSPILL=24.77095  
 ADJUST\_ONGOING\_FIX\_GILN6RES\_BLENDTS=2

#### 4. Model Time Series

Time Series Type	Time Step	Missing Values Allowed	Required [Yes or No]
<b>General Time Series: Input</b>			
Instantaneous inflow (INSTQIN)	any	Yes	No
Mean inflow (MEANQIN)	any	Yes	No
Time series containing observed pool elevation (TS_POOL)	any	Yes	Yes
Time series containing observed reservoir release (TS_RELEASE)	any	Yes	No
Time series containing observed reservoir withdraw (TS_WITHDRAW)	any	Yes	No
Observed Value (OBSERVED_VALUE TS)	any	Yes	No

Reference Time series index either row or column (INDEX_TS)	any	Yes	No
<b>Specific Time Series: Input</b>			
Observed pool elevation (OBSh)	any	Yes	Yes
Observed instantaneous discharge (OBSQO)	any	Yes	Yes
Observed mean discharge (OBSQOM)	any	Yes	Yes

<b>Time Series Type</b>	<b>Time Step</b>	<b>Missing Values Allowed</b>	<b>Required [Yes or No]</b>
<b>General Time Series: Output</b>			
Simulated mean outflow (MEANQOUT)	any	No	Yes
Simulated instantaneous outflow (INSTQOUT)	any	No	No
Simulated pool elevation (POOL)	any	No	No
Simulated storage contents (STORAGE)	any	No	No
<b>Specific Time Series: Output</b>			
Adjusted instantaneous discharge (ADJQO)	any	No	Yes
Adjusted mean discharge (ADJQOM)	any	No	Yes
Adjusted pool elevation (ADJH)	any	No	Yes
Adjusted storage (ADJS)	any	No	Yes

## 5. Notes about configuring Model in FEWS workflow

Examples:

Module Configuration File

[ModuleConfigFiles\RESJ\\_DCBN8\\_DEVIL\\_A\\_Forecast.xml](#)

Module Parameter File

[ModuleParFiles\RESJ\\_DCBN8\\_DEVIL\\_A\\_UpdateStates.xml](#)

## 6. FEWS Adapter Used

The Joint Reservoir Regulation model uses the OHDFewsadapter to communicate. Information about this adapter can be found at [OHDFewsadapter](#).