THE SR-1 HYDROLOGIC RESPONSE DATA SET

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Summary
The SR-1 data is a detailed set of synthetically-generated hydrologic response for a rangeland catchment. It was developed using the comprehensive, physics-based Integrated Hydrology Model (InHM) (VanderKwaak, 1999). The SR-1 dataset builds on the previously reported hypothetical reality of hydrologic response (Mirus et al., 2009) based upon the Tarrawarra catchment (Western and Grayson, 1998). The emphasis in developing the SR-1 dataset was on generating a set of internally-valid hydrologic-response observations with higher spatial and temporal resolution than could presently be obtained in the field. The dataset spans eleven years of continuous forcing (precipitation and potential evapotranspiration) and hydrologic response (integrated response, distributed fluxes and state variable dynamics). The SR-1 dataset is provided here for use by the community. It should be useful for a wide range of problems including model testing, parameter estimation, network design, and concept development.

Basic Information
The data is provided in data file formats (i.e., with the file extension .DAT). These can be accessed with a variety of software platforms (we used tecplot and notepad) and can be converted to tab-delimited text files by adding the extension ".TXT" to the end of a given file.

All values are given in Standard SI units of meters [L], seconds [T], and kilograms [M].

The dataset spans January 1, 1996, 00:00:00 – December 31, 2006, 24:00:00 and is given as:
1. Continuous forcing data
2. Surface and subsurface hydrologic response, divided into:

***WARNING*:** The entire dataset takes up ~116 GB * and download times will vary depending on connection speed, etc. We strongly urge perusal of this user manual in its entirety before downloading. By employing this readme file, users can download only the desired portions of the data, thereby avoiding overloading their system or filling up hard drive space unnecessarily.

The following sections describe the characteristics of the files for each type of data.

* A zipped version of the entire dataset can be made available by some alternative arrangements with the authors.

1. Continuous Forcing Data
The continuous forcing data includes time-series of spatially-uniform precipitation and potential evapotranspiration that drive the synthetically-generated hydrologic response. These are given as times series for each calendar year with three variables (i) time-on, (ii) time-off, and (iii) flux intensity during the specified time interval. File names are given in the format "PPT.*year*.dat" and "PET.*year*.dat" for precipitation and potential evapotranspiration, respectively. The files containing the precipitation and potential evapotranspiration time-series for the calendar year 1996 are PPT.1996.DAT and PET.1996.DAT, respectively.

2. Subsurface and Surface Hydrologic Response

Files for the integrated hydrologic response are given in the hydrograph files, indicated by the extension HYD.DAT. Variables in the hydrograph files are summarized in Table R1. Files for the distributed hydrologic response for the subsurface porous media and surface are distinguished by file extensions of E.PM.DAT and E.S.DAT, respectively. The hydrologic fluxes and state variables included in the porous media and surface files are summarized in Table R2 and R3, respectively.

The surface and subsurface hydrologic response is provided as:

2.1 Continuous records includes discharge at the catchment outlet and hydrologic fluxes and state variables at eleven vertical profiles throughout the catchment [*]

2.2 Higher temporal resolution response for twelve selected storms, with half-hourly snapshots of hydrologic fluxes and state variables over the entire catchment

[*] Continuous records also include daily snapshots of subsurface and surface hydrologic response throughout the catchment. Although these files are not posted here due to space constraints, they can be made available by some alternative arrangements with the authors.

Table R1. Hydrograph file variables included in Files with extension .HYD.DAT

Variable name	Units	Description
Time	s	Time from beginning of calendar year
Q	L/s	Discharge across the catchment outlet
Qporousmedia	L/s	Subsurface discharge across the catchment boundary
Qsurface	L/s	Surface discharge across the catchment outlet
Area	m^2	Catchment area
SatArea	m^2	Saturated area
SatArea/Area	m^2	Fraction of the catchment that is saturated
PondArea	m^2	Ponded area
PondArea/Area	m^2	Fraction of the catchment that is ponded
Q/Area	$L/s/m^2$	Discharge over the catchment area
Q/SatArea	$L/s/m^2$	Discharge over the saturated area
Q/PondArea	$L/s/m^2$	Discharge over the ponded area

Note: each HYD.DAT file is generally less around 1,000 KB for the continuous simulations (section 2.1) and less than 100 KB for the individual storms (section 2.2).

Table R2. Subsurface flux and state variables included in files with extension .PM.DAT.

Variable name	Units	Description
X	m	Horizontal coordinate in the x-direction
Y	m	Horizontal coordinate in the y-direction
Z	m	Vertical coordinate, elevation above sea-level
Node	-	Finite element mesh node number
Zone	-	Porous media zones used in assigning parameter values
Kxx	m^2	Permeability in the x-direction
Kyy	m^2	Permeability in the y-direction
Kzz	m^2	Permeability in the z-direction
Porosity	m^3/m^3	Porosity, aka void space
P	m	Pressure head
H	m	Total head = pressure head + elevation head
S	-	Saturation = volumetric water content / porosity
Krw	-	Relative permeability
V_x	m/s	Velocity in the x-direction
V_y	m/s	Velocity in the x-direction
V_z	m/s	Velocity in the x-direction
V_mag	m/s	Magnitude of velocity vector
Qw_p_-_s	-	Normalized exchange flux, porous media to surface
Specified boundary flux	m/s	Applied subsurface flux

Note: each .PM.DAT file is 31,475 KB

Table R3. Surface flux and state variables included in files with extension .S.DAT.

Variable name	Units	Description
X	m	Horizontal coordinate in the x-direction
Y	m	Horizontal coordinate in the y-direction
Z	m	Vertical coordinate, elevation above sea-level
Node	-	Finite element mesh node number
Zone	-	Porous media zones used in assigning parameter values
Nxx	-	Manning’s n in the x-direction
Nyy	-	Manning’s n in the y-direction
D	m	Surface water depth
D (log_1_0)	m	Log_10 of surface water depth
H	m	Elevation of water surface
S	-	Saturation = Surface water depth / mobile water depth
Krw	-	Relative permeability
V_x	m/s	Velocity in the x-direction
V_y	m/s	Velocity in the x-direction
V_z	m/s	Velocity in the x-direction
V_m_a_g	m/s	Magnitude of velocity vector
Qw_s_-_p	-	Normalized exchange flux, surface to porous media
Specified boundary flux	m/s	Applied surface flux (i.e., rainfall intensity)

Note: each .S.DAT file is 477 KB

2.1 Continuous, Long-Term Hydrologic Response

To allow manageable file sizes, each calendar year is divided into four seasonal quarters (a-d), using the following file prefix nomenclature and characteristics:

tw.*year*.a.
- Spans the first 90 days of each year (Julian Days 1 through 90)
- Initial conditions are taken from final output time of previous calendar year *

tw.*year*.b.
- Julian Days 91 through 184 (i.e., the next 94 days of the year)
- Initial conditions from final output time of (a) of same calendar year

tw.*year*.c.
- Julian Days 185 through 278 (i.e., the next 94 days of the year)
- Initial conditions from final output time of (b)

tw.*year*.d.
- Julian days 279 through 365 or 366 (i.e., the final 87 or 88 days of the year depending on whether leap-year or not)
- Initial conditions from final output time of (c)

* Initial conditions for 1996 (i.e., the first year) taken from the hypothetical reality of Mirus et al. (2009)

The *year* refers to the calendar year, such that the hydrograph files for the first and third quarter of the year 1996 would be, respectively:

tw.1996.b.HYD.DAT and tw.1996.c.HYD.DAT.

The long-term hydrologic response also includes continuous observations for vertical profiles at 11 locations in (x,y), each with 5 depths (z). Observation node locations are shown in Figure 1 of Mirus et al. (2011) and (x,y,z) coordinates are given Table R4. Observation node files give the continuous time-series of hydrologic flux and state variables listed in Table R5 for a single point in space. Observation node filenames for porous media are given in the form:

tw.*year*.*letter*.OBS.#.PM.DAT

where the *letter* indicates the quarter of the calendar year (letters a-d, see above) and # indicates the observation node number. Observation node numbers 1-11 are the surface nodes at the (x,y) locations in Figure 1 of Mirus et al. (2011). Note that these 11 nodes are at the interface between the surface and porous media, so in addition to the porous media observation nodes there are co-located surface observation nodes, with filenames of the form:

tw.*year*.*letter*.OBS.#.S.DAT

For example, observation location 10 will have two files associated with the hydrologic response during the first 90 days of 1996 for the porous media (tw.1996.a.OBS.10.PM.DAT) and surface (tw.1996.a.10.S.DAT). It should be noted that for the surface files the saturation variable, *S*, is the surface water depth as a fraction of the mobile water depth, whereas in the porous media files *S* is the fraction of the porosity filled with water right below the surface (see Tables R2 and R3 above).

The numbering scheme for observation nodes are summarized in Table R6. For example, the file for observation location 10 at 0.1 m depth for the first quarter of 1996 will be called:

tw.1996.a.OBS.32.PM.DAT

It should be noted that the exact coordinates in (x,y,z) and Finite Element Mesh (FEM) node numbers are given within each file as the *X*, *Y*, *Z*, and *node* variables (see Tables R1 and R2).

Table R4. Location of observation nodes at the surface for the SR-1 dataset.

X-coordinate (m)	Y-coordinate (m)	Land surface elevation (m)	Surface observation file name
926.634	820.035	82.205	tw.*year*.*letter*.OBS.1.S.DAT
904.950	881.175	84.889	tw.*year*.*letter*.OBS.2.S.DAT
1000.182	867.833	85.594	tw.*year*.*letter*.OBS.3.S.DAT
873.965	931.321	88.066	tw.*year*.*letter*.OBS.4.S.DAT
1085.775	907.467	89.487	tw.*year*.*letter*.OBS.5.S.DAT
909.692	1045.178	99.468	tw.*year*.*letter*.OBS.6.S.DAT
1097.931	1015.506	102.288	tw.*year*.*letter*.OBS.7.S.DAT
1176.591	1015.401	103.251	tw.*year*.*letter*.OBS.8.S.DAT
1187.206	835.784	100.853	tw.*year*.*letter*.OBS.9.S.DAT
1195.679	925.998	94.077	tw.*year*.*letter*.OBS.10.S.DAT
1290.048	985.217	105.497	tw.*year*.*letter*.OBS.11.S.DAT

Table R5. Variables in the observation node files included in the SR-1 dataset.

Variable name	Units	Description
Time	s	Time from beginning of calendar year
Total head	m	Total hydraulic head
Pressure head	m	Pressure head
Saturation	-	Saturation = volumetric water content / porosity
Relative permeability	-	K(pressure head)/Ksat
Q_s_u_m	m/s	Discharge vector
Permeability (x) [1]	m^2	Permeability in the x-direction
Permeability (y) [1]	m^2	Permeability in the y-direction
Permeability (z) [1]	m^2	Permeability in the z-direction
Porosity [1]	-	Porosity
Gradient [1]	m/m	Hydraulic gradient

[1] Only present in porous media observation files (i.e., OBS.#.PM.DAT)

Note: observation files are generally between 300 and 1,000 KB

Table R6. Observation location and corresponding OBS.#.PM.DAT file numbers.

Location [1]	Depth from surface (m)				
	0	0.02	0.1	0.5	1.0
1	1	12	23	34	45
2	2	13	24	35	46
3	3	14	25	36	47
4	4	15	26	37	48
5	5	16	27	38	49
6	6	17	28	39	50
7	7	18	29	40	51
8	8	19	30	41	52
9	9	20	31	42	53
10	10	21	32	43	54
11	11	22	33	44	55

[1] See Figure 1 (Mirus et al., 2011) and Table R4, above.

2.2. High Resolution Snapshots for Selected Storms

Twelve storms are described in Table 2 of Mirus et al. (2011), which were selected to span a range of both long and short, and high and low intensity rainfall events. Hydrologic fluxes and state variables are given throughout the catchment at half-hour intervals (1800 seconds) for the duration of each storm. No observation nodes are provided for these storms, since these are already provided in the continuous, long-term hydrologic response portion of the dataset. For the storms of duration longer than three days, the simulations were divided into three day blocks, much as the long-term simulations for each calendar year were divided into quarters. Simulation blocks are indicated by the following file prefix nomenclature:

TW.Ev.dd.mm.yy.*Roman_numeral*.*output_type*.#.DAT

- dd/mm/yy is the storm start date
- *Roman_numeral* (I, II, III, IV …) indicates the subdivisions of simulation periods longer than three days, events shorter than three days are not subdivided
- *Output_type* refers to the file type: either surface (E.S) or porous media faces (E.PM)
- Output time 1 is associated with the onset of precipitation for the given storm
- The output number # refers to the sequence within that storm, but exact output time in seconds for each storm can be gleaned from the title within the observation file

It should be noted that the duration of the hydrologic response in these files includes some time before the storm related to the initial conditions, and after the storm to allow adequate representation of drainage. In some cases the period before the precipitation begins is quite long, due to the sparse output times at the beginning and end of the calendar years when little runoff occurs. The start and stop times and the file names for the selected storms are given in Table R7. For example, the porous media file for the storm starting on August 27, 1999, one hour after rainfall begins is:

TW.Ev.8.27.1999.2.E.PM.DAT.

Further details related to the development of the SR-1 dataset are given in Mirus et al., (2011).

Table R7. Filename prefixes and start/stop times for the 12 selected storms in the SR-1 dataset.

Start date	Filename prefix	Time (s)			
		Simulation		Precipitation	
		Start	Stop	Start	Stop
4/11/1996	TW.Ev.4.11.1996.	8121600	9939600	8127000	9723600
6/23/1996	TW.Ev.6.23.1996.	14947200	15206400	14949000	15120000
8/14/1996	TW.Ev.8.14.1996.	19440000	19767600	19510200	19728000
9/3/1996	TW.Ev.9.3.1996.	21081600	21636000	21202200	21589200
6/25/1998	TW.Ev.6.25.1998.	14774400	15321600	14805000	15159600
7/29/1998	TW.Ev.7.29.1998.	17971200	18514800	17998200	18482400
2/28/1999	TW.Ev.2.28.1999.	0	5320800	5063400	5286600
8/27/1999	TW.Ev.8.27.1999.	20390400	20930400	20413800	20782800
7/26/2003	TW.Ev.7.26.2003.	17366400	18439200	17460000	18320400
11/13/2004	TW.Ev.11.13.2003.	24019200	27496800	27264600	27495000
9/12/2005	TW.Ev.9.12.2005.	21772800	22582800	21915000	22579200
9/29/2005	TW.Ev.9.29.2005.	23328000	23634000	23380200	23565600

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