

# HYDROGNOMON: A HYDROLOGICAL DATA MANAGEMENT AND PROCESSING SOFTWARE TOOL

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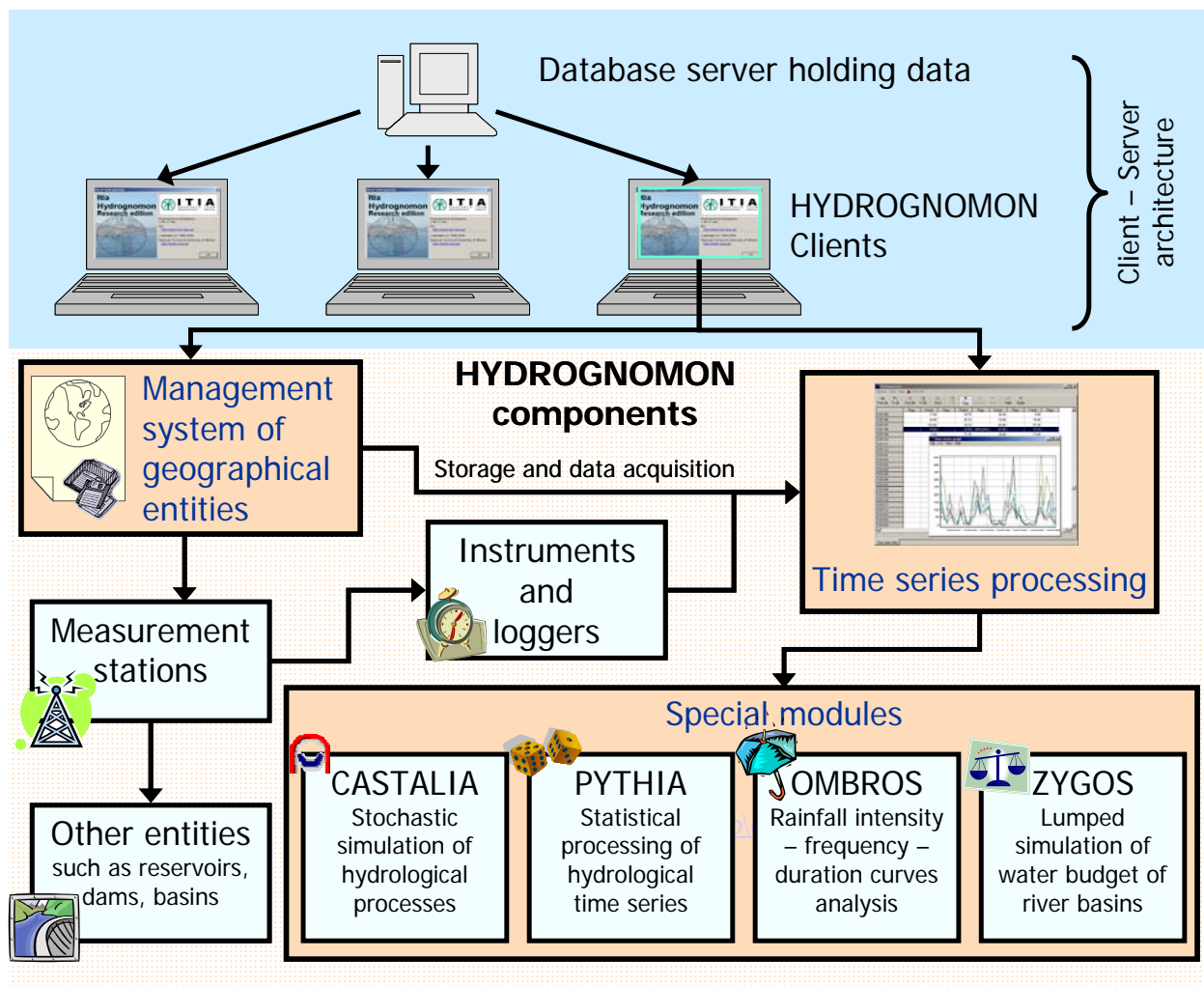
Session HS29: *Hydrological modelling software demonstration*

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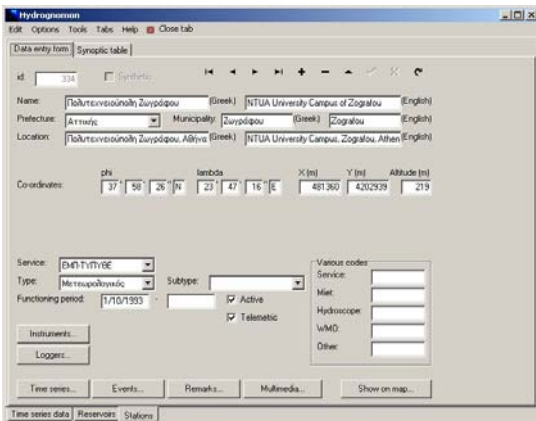
## 1. Introduction

HYDROGNOMON is a software tool for the management and analysis of hydrological data. It is built on a standard Windows platform based on client-server architecture; a database server is holding hydrological data whereas several workstations are executing HYDROGNOMON, sharing common data. Data retrieval, processing and visualisation are supported by a multilingual Graphical User Interface.

## 2. Program structure



### 3. Geographical entities

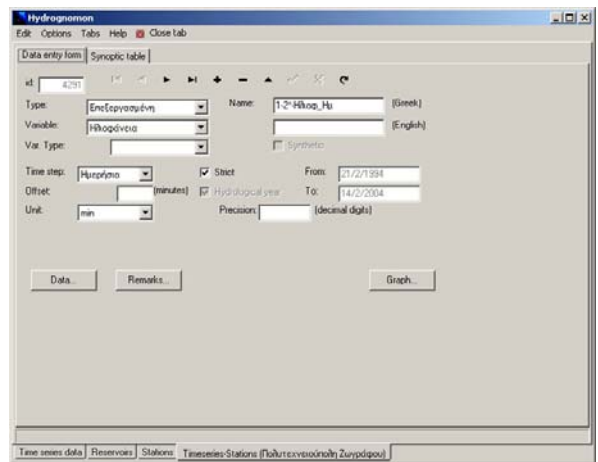


User interface based on single window application. Several entities (e.g., basins, reservoirs, aqueducts, monitoring stations) are organised in Tabs. Special properties are stored and displayed for each entity, such as station type for measurement stations.

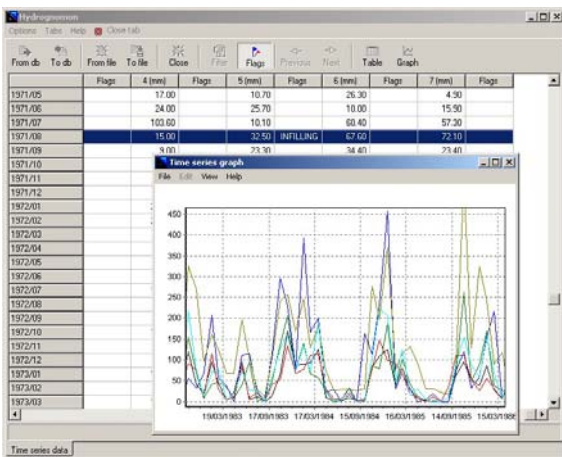
Entities system helps the organisation of time series.

Several attributes are assigned to time series such as time-step, variable type, measurement unit, etc.

Synoptic tables are included to browse into entities or time series records.



### 4. Time series data



Time series records are displayed on data grids as sets of timestamps, values and flags, or on graphical views.

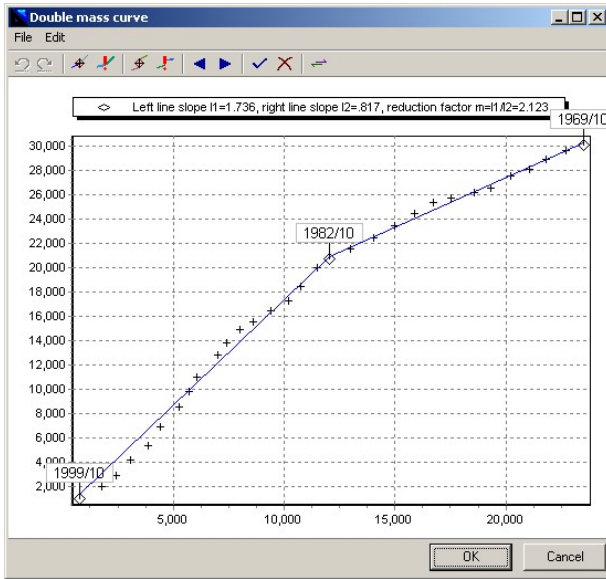
Time series grids help operation with multiple time series and data exchange between HYDROGNOMON and other applications, such as spreadsheets.

Data representation is extended with tabularisation, data filtering and highlighting capabilities.

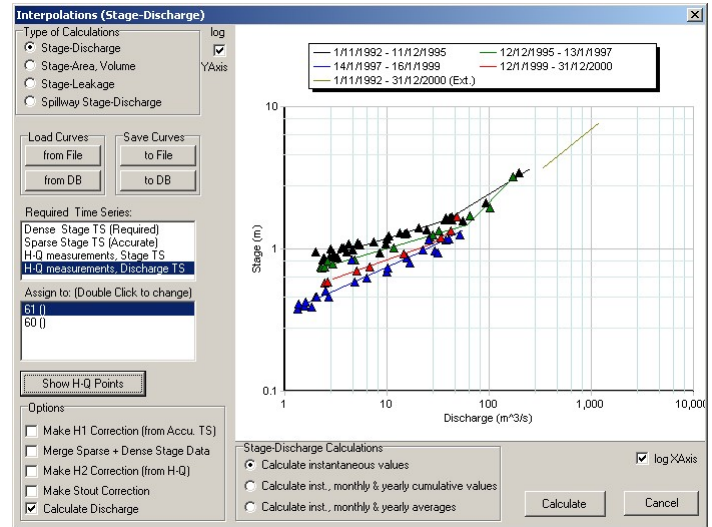
Time series processing system may work independently of the database system by using ASCII files for storage.

From db	To db	10	11	12	1	2	3	4	5	6	7	8	9	Mean	Stdev	Var coef	N	Miss	Max
1993-04	14.00	66.00	168.60	86.80	89.70	92.10	125.20	10.00	0.50	6.00	32.40	1.90	57.77	55.48	0.96	12	0	168.60	
1984-05	0.80	87.70	108.20	125.30	37.60	80.30	29.60	8.60	1.10	1.40	0.00	10.70	43.43	46.11	1.14	12	0	125.30	
1985-06	62.50	94.50	53.20	38.60	86.20	26.90	6.30	61.70	10.40	0.20	0.00	0.30	36.73	34.47	0.94	12	0	94.50	
1986-07	110.90	15.30	62.80	54.60	58.40	89.70	89.90	5.30	10.80	5.80	15.90	0.00	43.28	39.25	0.91	12	0	110.90	
1987-08	86.30	70.10	55.70	64.40	58.40	65.60	21.80	11.70	12.60	0.00	0.00	9.20	37.92	31.37	0.83	12	0	86.30	
1988-09	59.90	157.10	130.70	5.00	26.30	69.10	11.00	26.90	3.90	12.50	0.00	5.30	41.31	52.85	1.27	12	0	157.10	
1989-10	70.60	37.90	63.20	5.90	23.00	28.60	26.40	16.90	8.90	3.30	73.70	8.00	35.47	25.84	0.84	12	0	73.70	
1990-11	38.40	96.00	135.50	137.40	65.90	97.80	99.70	53.90	0.10	3.70	64.80	0.40	66.10	49.01	0.74	12	0	137.40	
1991-12	61.40	69.50	127.70	32.10	64.00	48.90	17.90	45.60	23.40	3.40	6.20	0.80	42.57	35.98	0.85	12	0	127.70	
1992-01	46.60	30.90	7.00	44.00	66.90	23.60	16.60	111.70	0.40	0.60	0.40	0.90	29.13	34.00	1.17	12	0	111.70	
1993-02	0.00	195.70	19.40	165.30	204.50	37.80	33.30	49.80	0.90	36.20	1.50	0.00	62.00	78.64	1.27	12	0	204.50	
1994-03	146.30	83.60	83.90	117.90	5.00	88.20	33.40	3.40	2.30	0.00	0.00	30.70	50.09	51.43	1.03	12	0	146.30	
1995-04	31.90	83.90	102.40	84.80	106.20	62.60	21.30	69.40	0.00	2.50	22.90	49.60	53.09	37.29	0.70	12	0	106.20	
1996-05	44.00	23.40	50.90	130.90	46.70	102.80	57.40	8.00	5.90	2.20	7.40	0.60	48.05	41.81	1.04	12	0	130.90	
1997-06	50.50	44.10	142.40	22.70	20.40	141.30	14.70	61.20	10.10	2.20	6.60	32.20	45.70	48.29	1.06	12	0	142.40	
1998-07	44.80	103.40	86.60	45.50	64.10	165.30	26.90	15.70	5.90	0.00	7.50	41.80	50.62	48.29	0.96	12	0	165.30	
1999-08	63.70	108.90	43.70	33.40	95.10	36.30	11.80	4.00	0.00	0.00	0.00	2.80	32.97	37.64	1.14	12	0	108.90	
2000-09	45.60	109.00	41.80	93.10	37.60	27.10	43.90	13.90	5.90	12.60	43.03	33.86	0.79	10	2	109.00			
Mean	72.19	88.06	106.27	94.88	79.05	70.51	40.52	33.94	21.05	6.61	12.51	29.00							
Standard deviation	59.99	52.98	58.59	53.23	46.18	43.76	33.10	29.16	26.63	9.98	26.92	35.00							
Variance coefficient	0.83	0.60	0.55	0.56	0.58	0.62	0.82	0.86	1.22	1.51	2.07	1.17							
Number of values	93	94	94	94	94	94	94	94	94	94	94	94	93						
Missing values	1	0	0	0	0	0	0	0	0	0	0	1							

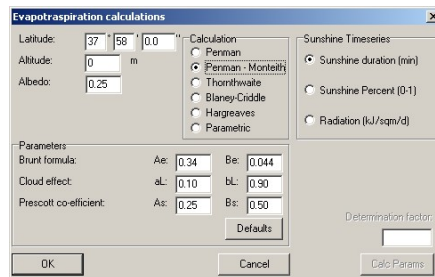
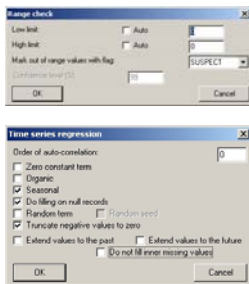
## 5. Hydrological data analysis



Homogeneity analysis by the double mass curve method

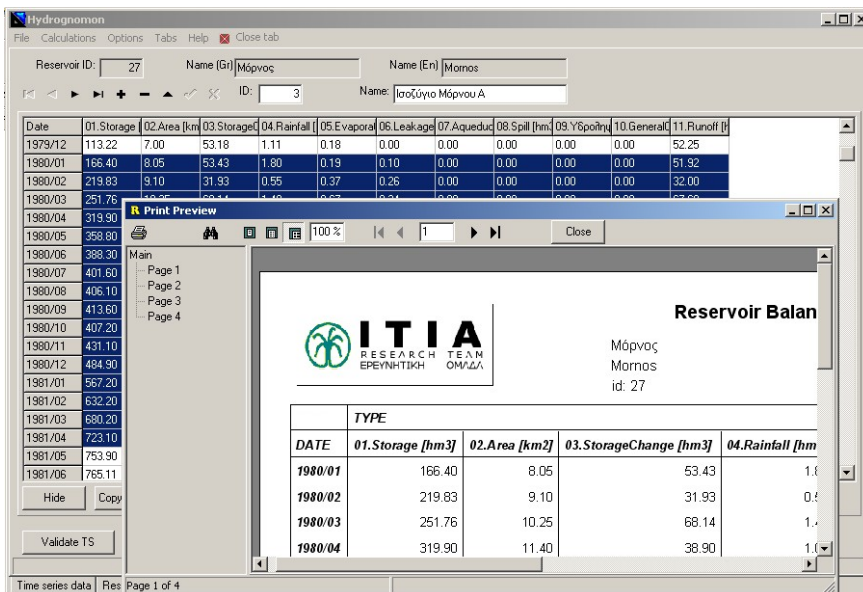


Stage-discharge curves



Hydrological data analysis includes the majority of typical hydrological manipulations, such as:

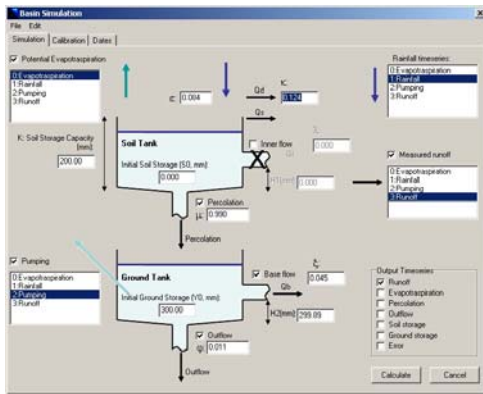
- Range and time consistency tests
- Homogeneity test
- Time step regularisation
- Time series integration and aggregation
- Stage-discharge calculations and other interpolations
- Evapotranspiration modelling
- Time series regression and infilling of missing values
- Time series combinations
- Hydrological balance



Hydrological balance of reservoirs, with reporting capabilities



## 6. ZYGOS: Lumped water balance model



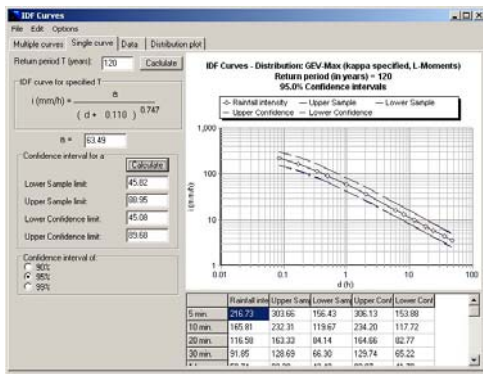
ZYGOS models the main hydrological processes of a watershed, using a lumped approach. It implements a conceptual soil moisture accounting scheme, based on a generalisation of the standard Thornthwaite model, extended with a groundwater tank.

A visual representation of modelling components helps the implementation of different configurations.



A global optimisation procedure, implementing the evolutionary annealing-simplex algorithm, is included for the automatic estimation of model parameters.

The user interface allows to determine the parameter bounds. Also, it provides graphical tools for monitoring the progress made during optimisation and assessing the model fitting.



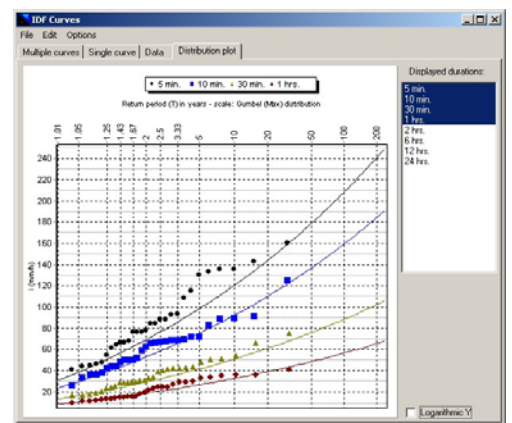
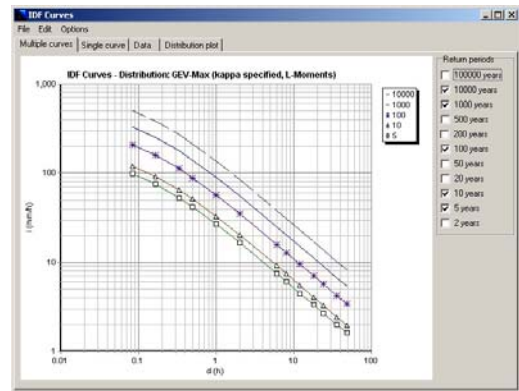
## 7. OMBROS: Intensity – duration – frequency analysis

The construction of rainfall intensity – duration – frequency curves is achieved through an original methodology, which allows a unified expression of rainfall intensity using a single equation, in terms of time scale (duration) and return period.

A set of probability distribution functions is offered to describe the intensity values including Exponential, Gamma, Log-Pearson III, Gumbel-Max, GEV-Max and Pareto distributions. A Monte-Carlo simulation procedure allows the estimation of confidence intervals for the curves.

The results are displayed in graphical format (IDF curves, distribution functions), as well as in tabular format, with data exchange capabilities with other software.

The input to the models, i.e. annual time series of extreme rainfalls, either may imported into HYDROGNOMON manually or calculated directly from time series of fine time-step.

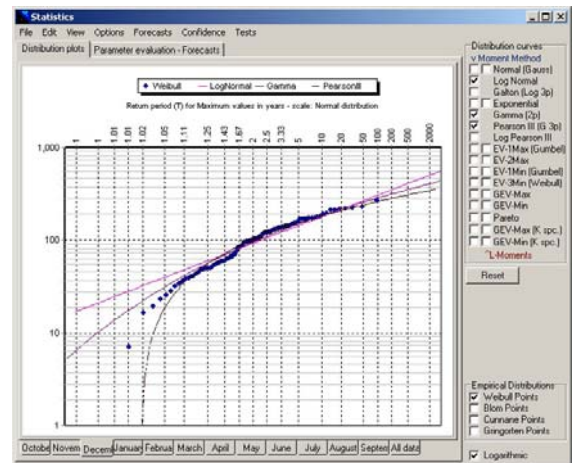


## 8. PYTHIA: Statistical analysis of hydrological time series

PYTHIA is an advanced statistical analysis tool for time series. Some characteristic features are:

- Calculation of sample statistics
- Parameter estimation of 16 distribution functions, including Normal, Gamma and EV families, using the moment or the L-moment methods
- Visualisation of results and export to spreadsheets and word processors
- Statistical prediction
- Estimation of confidence intervals though Monte Carlo simulation
- Hypothesis testing

	October	November	December	January	February	March	April
LogNormal sp	72	56	52	52	54	57	71
Gamma sp	4.82	5.33	5.08	4.95	5.06	5	4.32
Gamma c	42	25	16	34	28	28	42
Gamma o	-63.00	-124.46	-256.69	-55.16	-84.14	-83.47	-34.05
Exponential c	12.2	35.07	47.69	41.65	33.67	26.74	7.43
Exponential Lambda	02	02	02	02	02	02	03
Gamma Lambda	1.45	2.76	3.29	3.18	2.89	2.6	1.5
Gamma Kappa	02	03	03	03	04	04	04
Pearson III Kappa	1.99	6.06	10.76	3.25	5.32	5.22	1.99
Pearson III Lambda	02	05	07	03	05	05	04
Pearson III c	-12.44	50.75	-133.62	-1.11	-26.66	-23.45	-6.13
Log Pearson III Kappa	1.81	1.86	4.81	2.04	1.96	6.01	12.7
Log Pearson III Lambda	1.20	1.74	3.25	2.03	1.86	3.32	3.91
Log Pearson III c	2.49	3.18	3	3.35	3.11	1.99	1.2
EV I (Gumbel) Max Lambda	46.8	41.33	45.7	41.52	36.02	34.14	25.82
EV I (Gumbel) Max Pi	57	1.55	1.75	1.71	1.64	1.49	99
EV 2 Max Kappa	37	21	3	3	3	32	36
EV 2 Max Lambda	18.69	20.95	24.37	21.91	18.65	16.88	10.45
EV I (Gumbel) Min Lambda	46.8	41.33	45.7	41.52	36.02	34.14	25.82
EV I (Gumbel) Min Pi	2.12	2.71	2.9	2.86	2.73	2.64	2.15
EV 3 (Weibull) Min Kappa	83	59	53	54	56	61	81
EV 3 (Weibull) Min Lambda	63.68	57.76	63.62	57.86	50.28	47.73	35.24
GEV Max Kappa	04	-07	-14	00	-05	05	04
GEV Max Lambda	44.11	44.99	52.95	41.29	38.29	36.21	24.33
GEV Max Pi	1.02	1.45	1.55	1.72	1.56	1.42	1.04



## 9. CASTALIA: Stochastic simulation of hydrological processes

CASTALIA provides advanced stochastic analysis tools, for the generation of synthetic hydrological time series. Some specific features are:

- Multivariate analysis, for many processes and locations
- Multiple time scales, in a disaggregation framework
- Generalised generating scheme for any covariance structure
- Preservation of essential marginal statistics up to third order (skewness) and joint second order statistics (auto- and cross-correlations)
- Reproduction of long-term persistence (Hurst phenomenon) and periodicity
- Operation in either steady-state simulation or forecast mode

