Met Office

A cross-spectral approach to assessing the performance of hydrological models: observed v modelled daily discharge of the River Thames, UK

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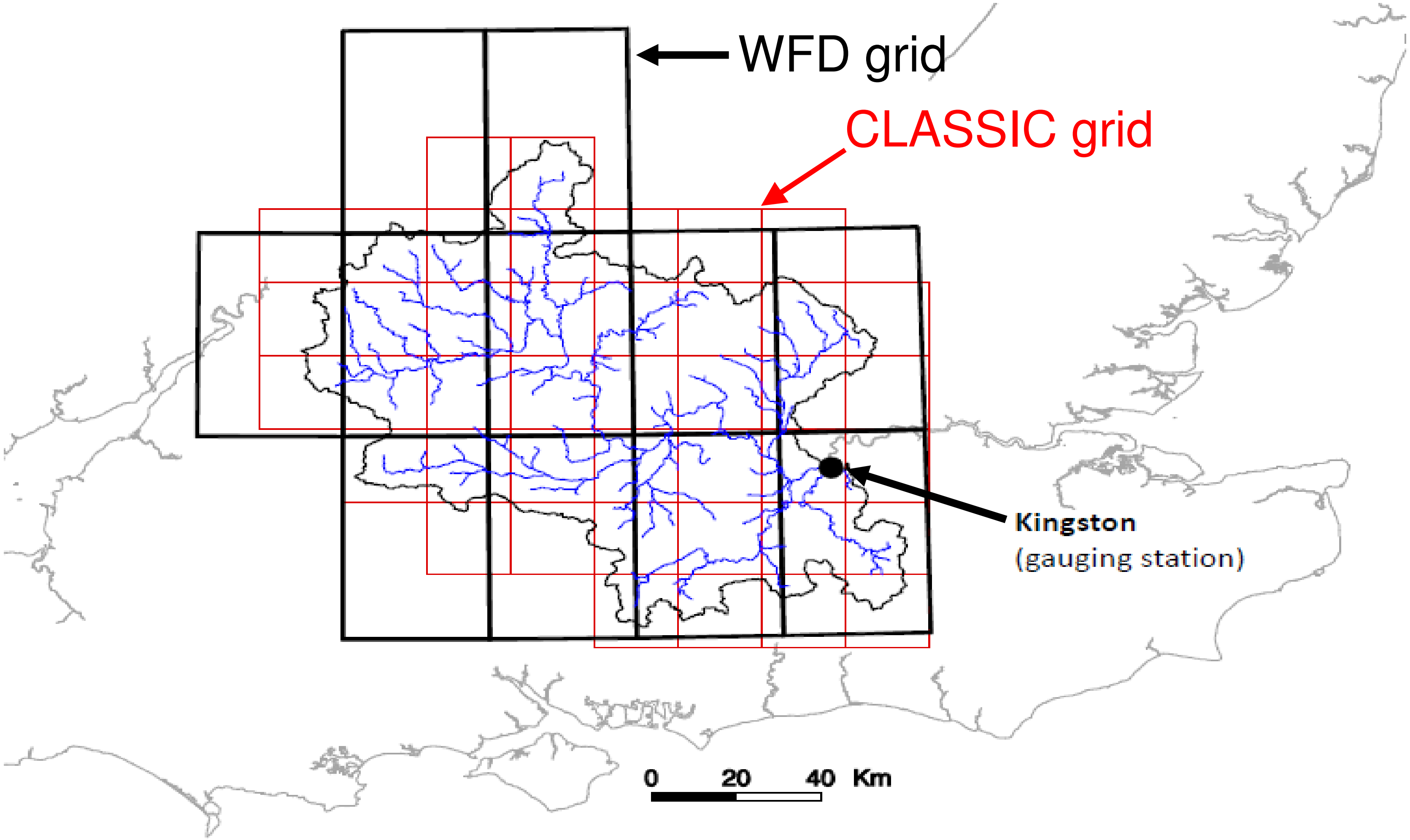
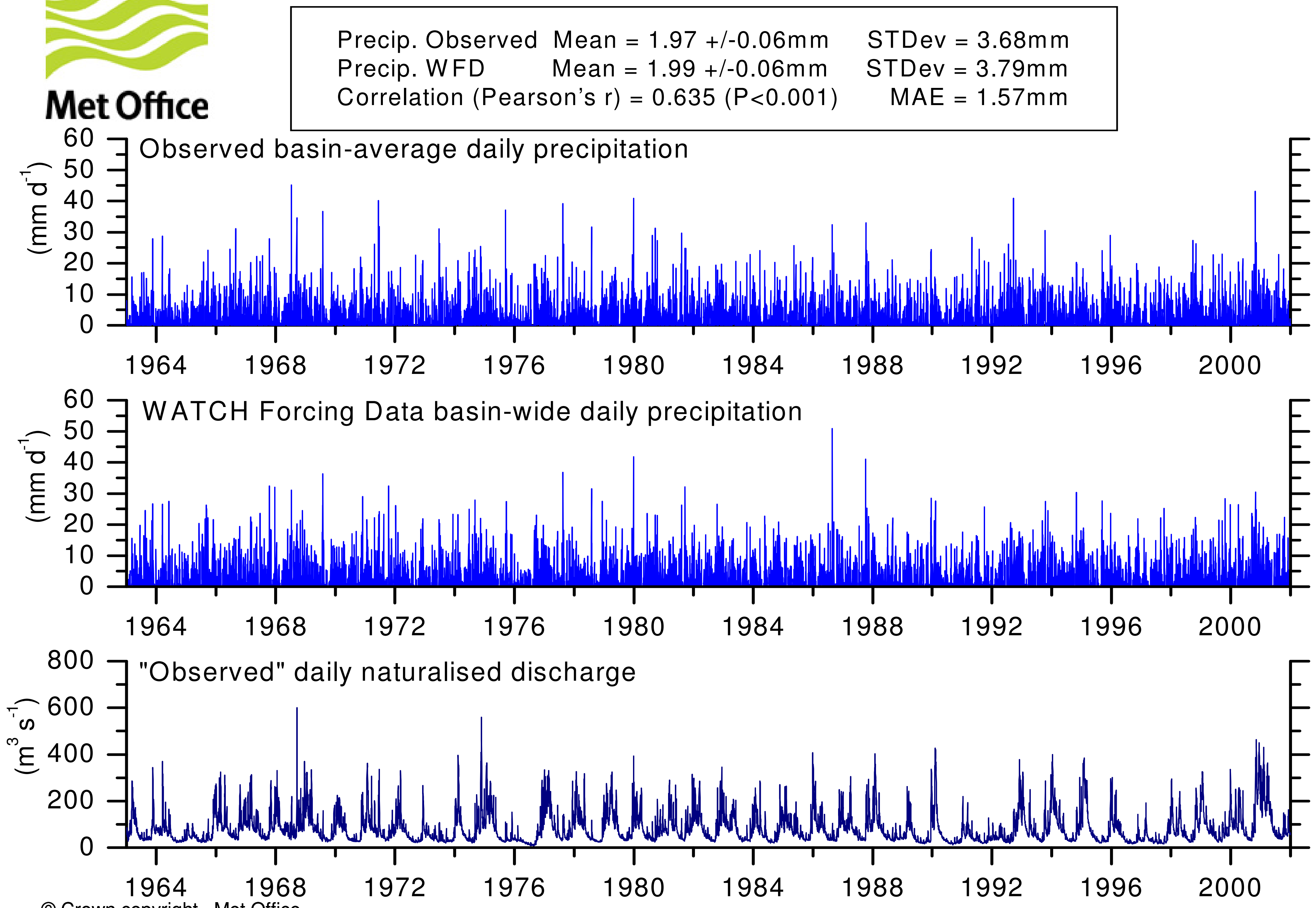
Modelling the Thames Basin

Model type	Models	(* = Calibrated)
RBM =	CLASSIC*	
GHM =	WaterGAP*, MPI-HM, LPJml, GWAVA	
LSM =	MATSIRO, JULES, H08, Orchidee	

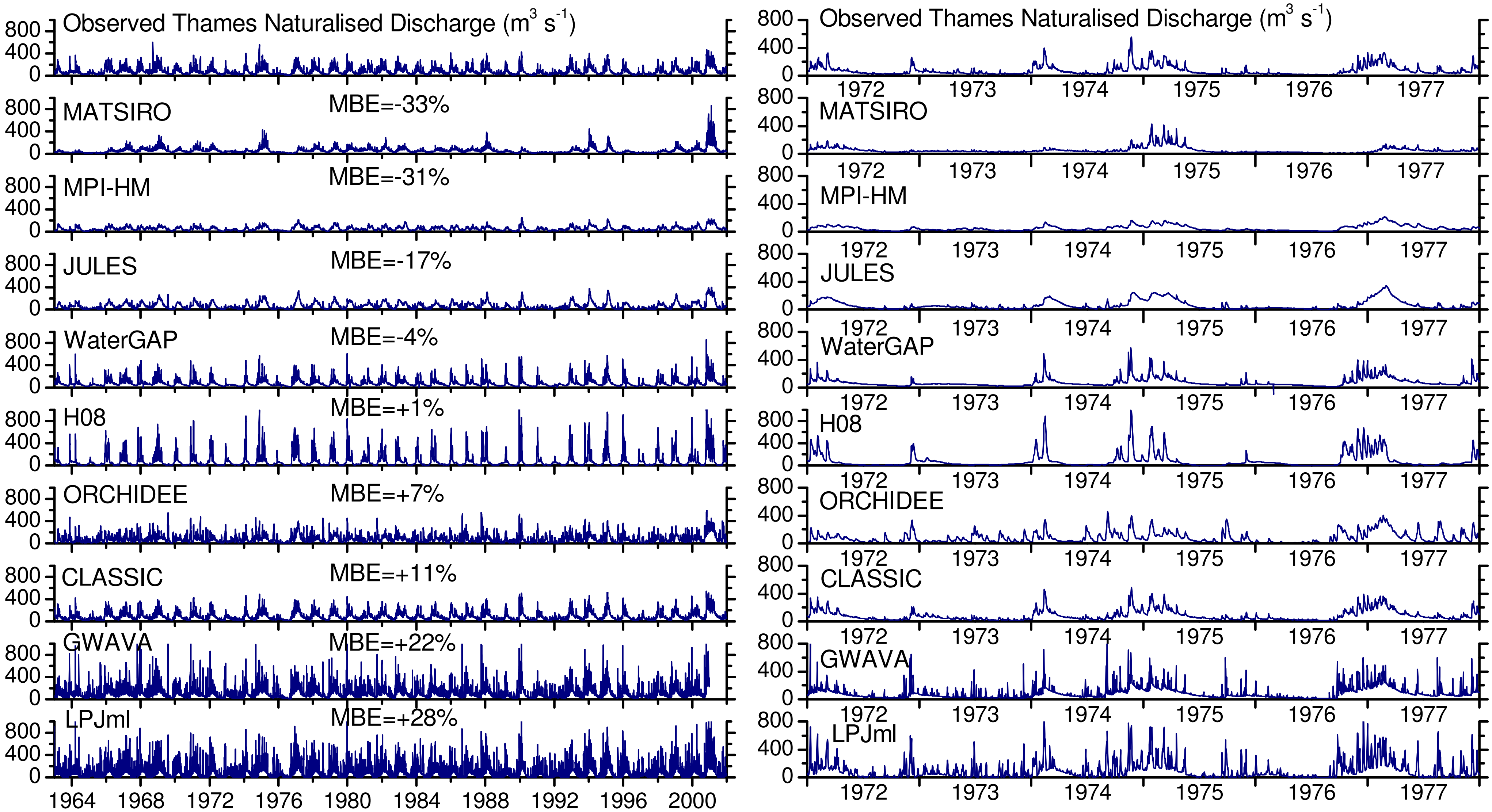


WATCH Forcing Data (WFD): Weedon et al. 2011 ***JHM*** 12, 823-848



Precip. Observed Mean = 1.97 +/-0.06mm STDev = 3.68mm
Precip. WFD Mean = 1.99 +/-0.06mm STDev = 3.79mm
Correlation (Pearson's r) = 0.635 (P<0.001) MAE = 1.57mm
Observed basin-average daily precipitation
(mm d-1)
WATCH Forcing Data basin-wide daily precipitation
(mm d-1)
"Observed" daily naturalised discharge
(m3 s-1)
1964 1968 1972 1976 1980 1984 1988 1992 1996 2000

Observed and modelled time series of daily discharge

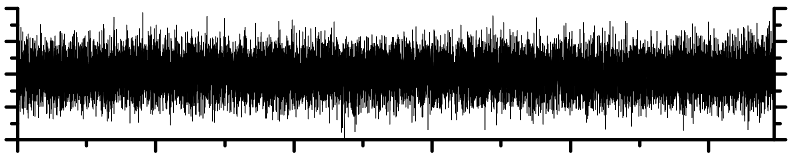


Standard Noise Models

Time series

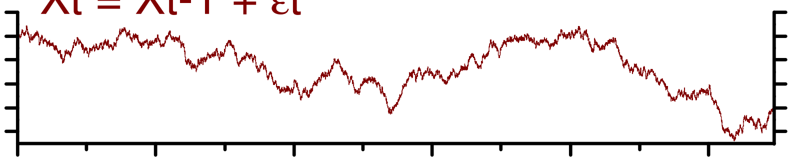
Random numbers or **White Noise**

$Xt = \varepsilon t$



Random walk or **Brown Noise**

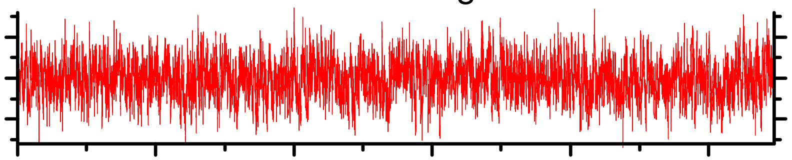
$Xt = Xt\text{-}1 + \varepsilon t$



Autoregression, AR1 Noise or **Red Noise**

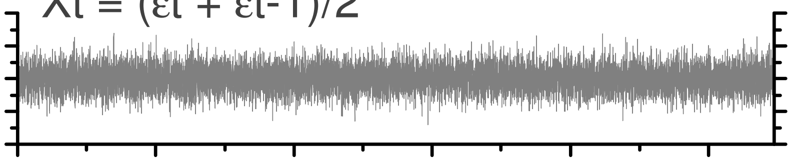
$Xt = \rho_1 Xt\text{-}1 + \varepsilon t \quad (0.0 >= \rho_1 >= 1.0)$

Lag-1 auto-correlation



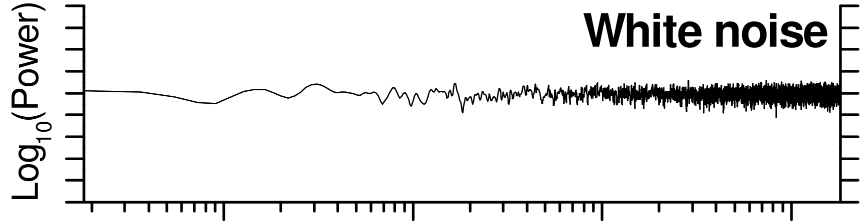
Moving average Noise

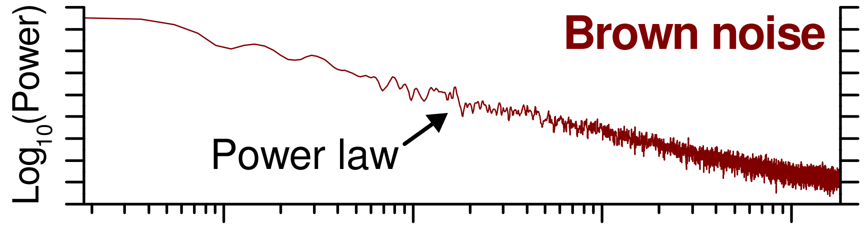
$Xt = (\varepsilon t + \varepsilon t\text{-}1)/2$

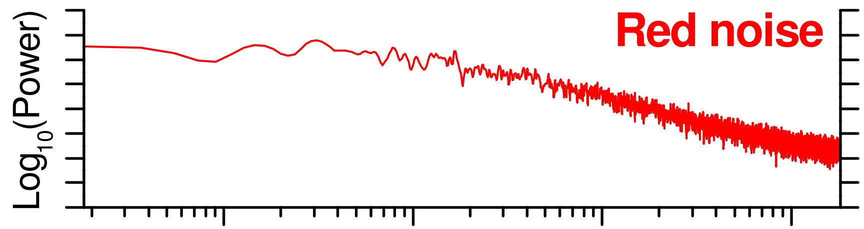


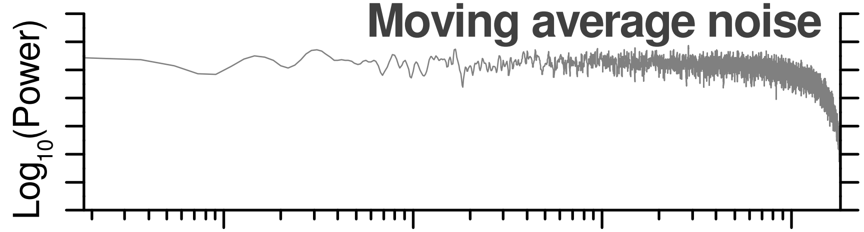
Time

Power spectra



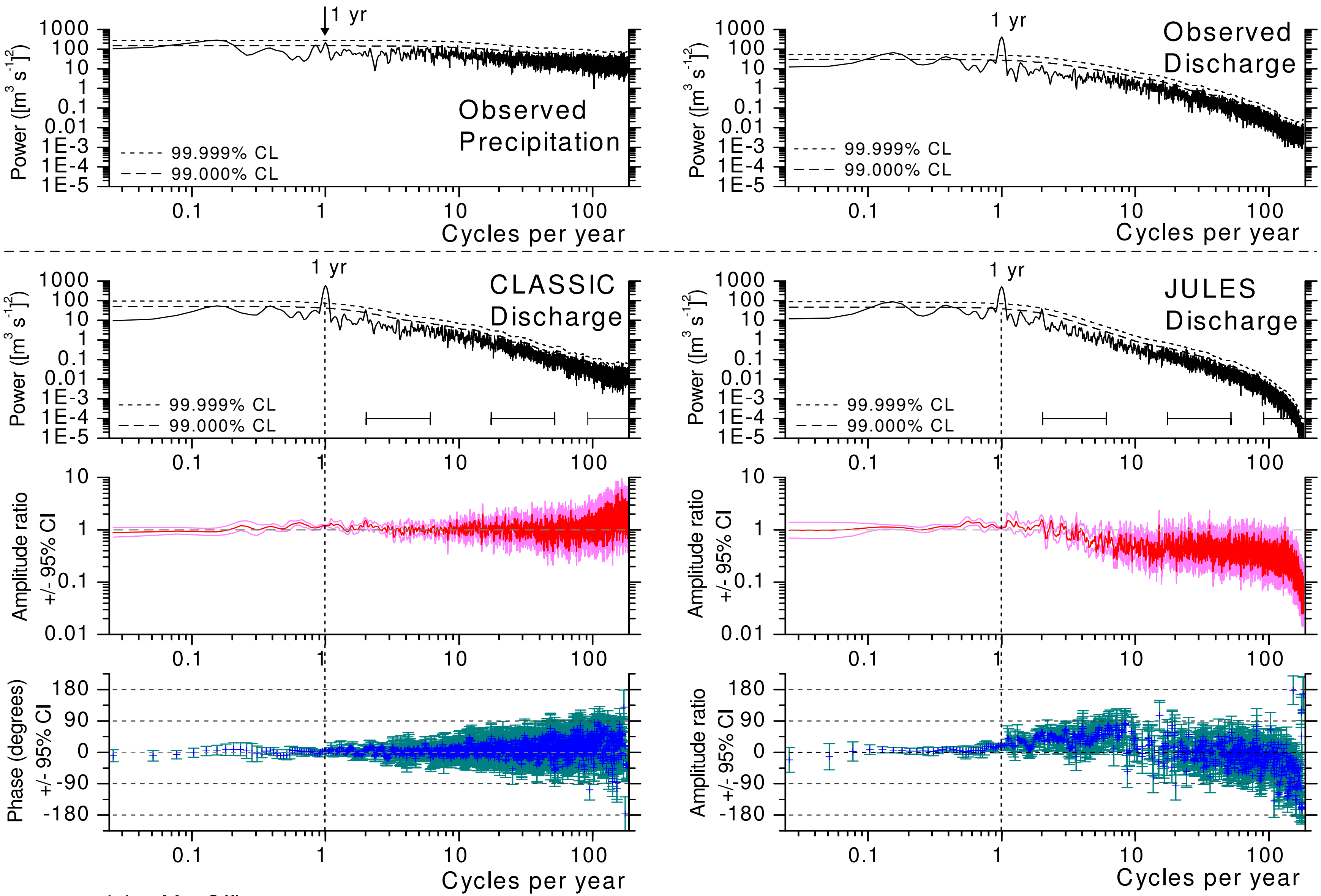




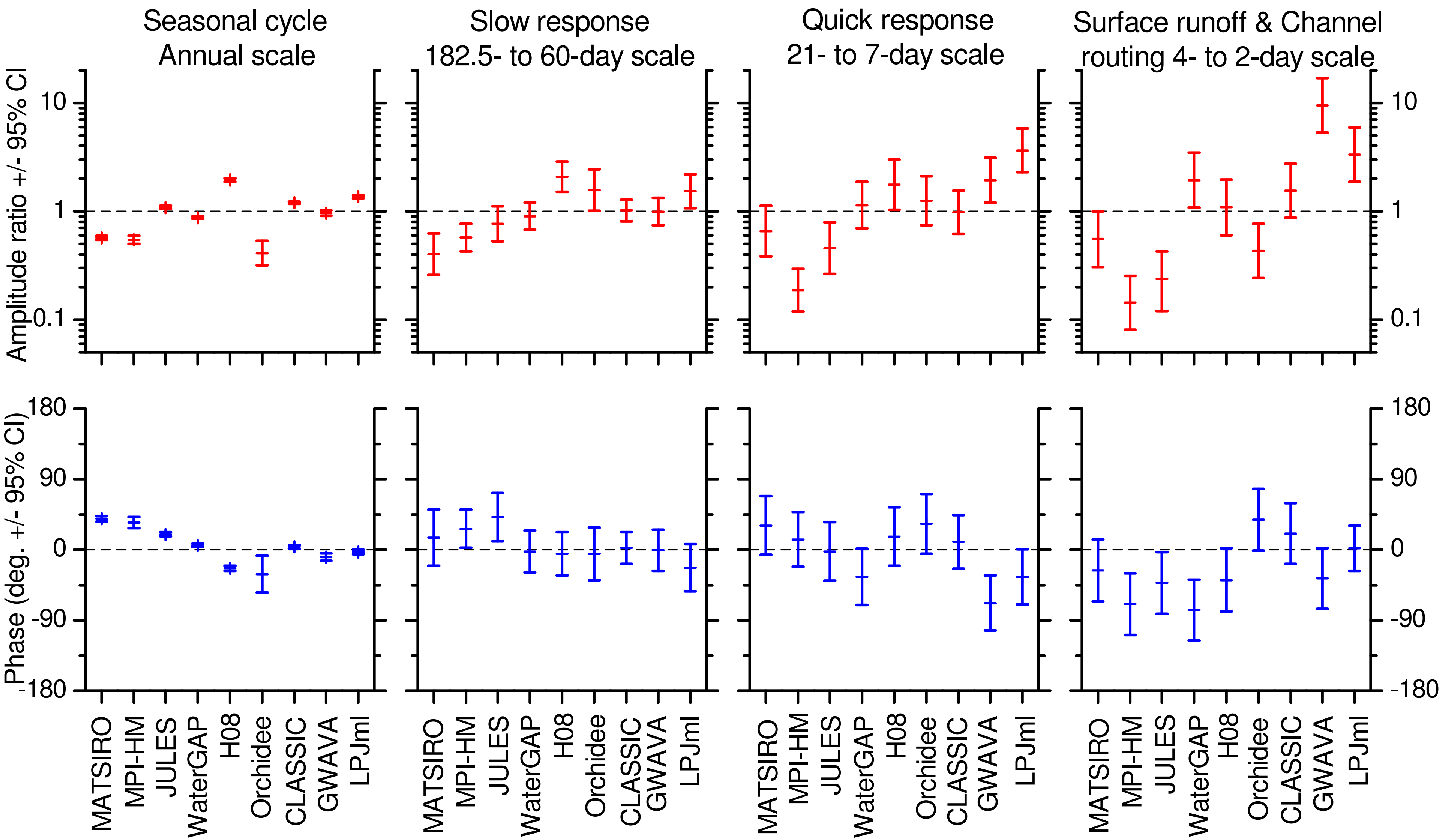


Frequency

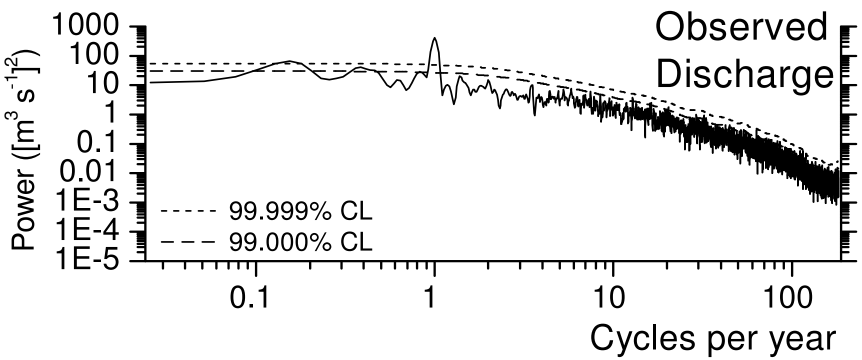
Thames Basin Discharge Spectra

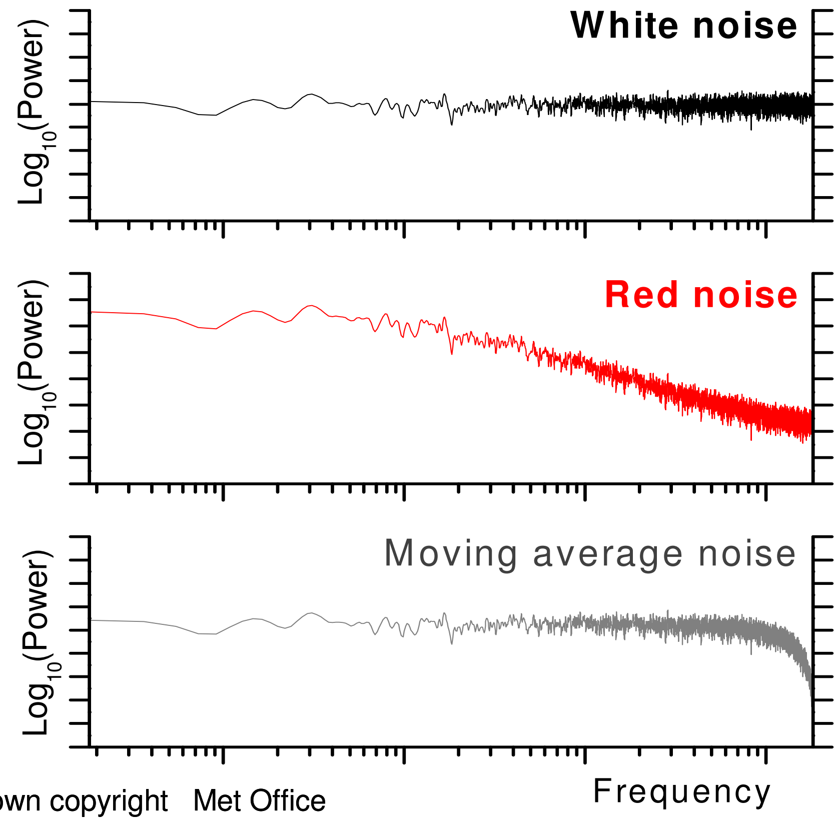


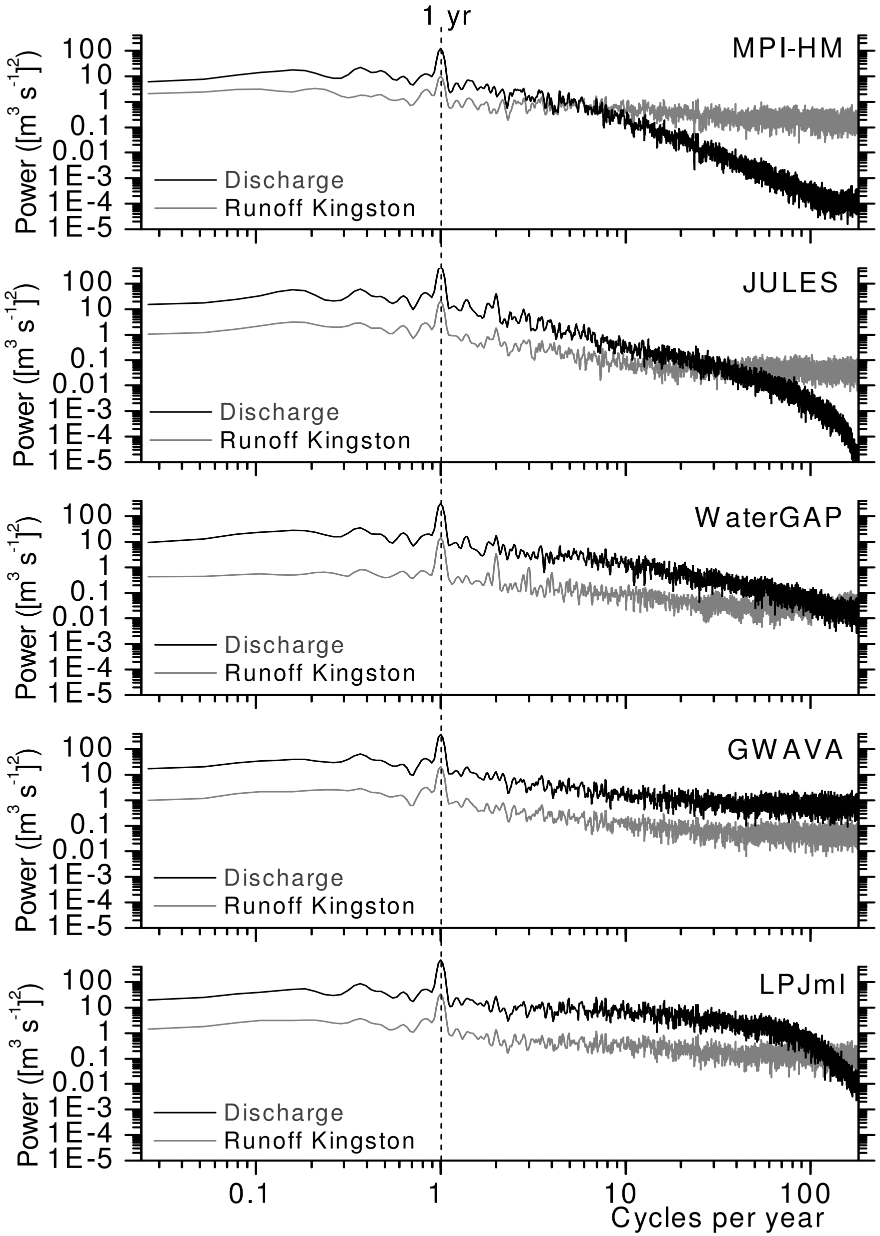
Modelled v Observed Discharge



Power Spectra of Modelled Runoff & Discharge







Conclusions

Met Office

- Cross-spectral analysis is a valuable technique to help understand model performance
- Can study model's response at different ranges of frequencies related to physical processes
- Observations indicate that the physical processes in the Thames Basin convert rainfall variability to river discharge variability by adding "short term" memory
- Within distributed hydrological models this memory is introduced at the river routing stage rather than during runoff generation
- Some routing schemes introduce smoothing at high frequencies due to a moving average
- Numerical coupling within models can lead to un-physical responses – e.g. short term output variations leading inputs
- Weedon et al., submitted to *J. Hydrometeorol.*