1. Introduction
The response time of groundwater (GW) discharge to fluctuations in recharge is essential to predict impacts of land-use and climate change on catchment water yield. Aquifers impose a time-lag between changes in recharge and discharge to streams and have a large capacity to buffer surface water variability, depending on the scale of the system and its physical attributes. Over shallow water table (WT) regions, groundwater also influences soil moisture memory and evapotranspiration (Fig. 1).

2. Groundwater representation in land surface models
ORCHIDEE (Kinner et al. 2005) is a land surface model developed in Institut Pierre Simon Laplace that allows the simulation of the terrestrial water and energy balances. In the routing scheme, each successive sub-basin in grid cells includes three linear reservoirs for stream, hillslope and groundwater flow (Fig. 2).

3. Estimation of a physically-based baseflow timescale
We use the long-time solution of the linearised Boussinesq equation (Brutsaert 2005) to estimate r as a function of catchment descriptors (Fig. 3) at global scale (Fig. 4).

4. ORCHIDEE simulated river discharge
ORCHIDEE is run globally in offline mode at 0.5° under a WFDG GPCC forcing (Weedon et al. 2014). Results using r_G (ii) are compared to a reference simulation using the initial almost spatially constant topographic-dependent r (Gleeson et al. 2009) (Fig. 5).

5. Discussion
Preferential flow pathways due to natural heterogeneities in aquifers (Fig. 7) strongly influence groundwater recharge and discharge. Relationships between the groundwater outflow rate and the controlling physical and hydraulic parameters of the basin (Fig. 6) are compared to different formulations (ii), (iii) and (iv).

6. Conclusion and perspectives
The use of a physically-based r in ORCHIDEE deteriorates river discharge simulation due to a strong buffering effect. A more appropriate description of the physical properties of near-surface aquifers (i.e., r_G), is required to provide better agreement with observations. Future research may investigate how to take into account spatial heterogeneity and climate variability in r formulation (i). The implementation of a nonlinear storage groundwater reservoir in ORCHIDEE.