



PhD Position

Towards a 150-year hydrometeorological reanalysis over France through data assimilation in probabilistic reconstructions

Abstract

Extended global atmospheric reanalyses covering the 1871-2014 period and recently made available to the research community provide unprecedented information on drivers of historical hydrological events. Such large-scale meteorological information have been downscaled over France during the on-going PhD thesis of Laurie Caillouet at Irstea (2013-2016) thanks to the statistical downscaling method SANDHY (Stepwise ANalogue Downscaling method for Hydrology) (Caillouet *et al.*, 2015). This approach allows reconstructing probabilistic and spatialized meteorological pseudo-observations that serve as forcings to hydrological models to reconstruct historical streamflows. The uncertainty associated to those pseudo-observations is however very large and propagated through the hydrological model.

This PhD work aims at reducing and quantifying this uncertainty by introducing independent historical meteorological observations through data assimilation methods. Data assimilation methods are commonly used in different contexts like weather or oceanic forecasting, but their application in hydrometeorological reconstruction is particularly innovative. The work will build on recent developments in the context of paleoclimatic reconstructions where global climate model simulations are constrained by scarce and sparse proxys (e.g. Matsikaris *et al.*, 2015) through *offline* data assimilation methods, i.e. methods that do not require the climate model itself but only already existing simulations.

The first objective is to develop a meteorological reanalysis that would be optimal with respect to downscaled reconstructions and available historical observations over the whole of France. This first part aims at implementing appropriate data assimilation methods for estimating the state of meteorological variables over a large temporal window while taking account of their spatialized nature, by combining local meteorological reconstructions (precipitation and temperature spatial fields), station-based historical observations (sparse and discontinuous), and their associated errors. Several offline methods will be tested mainly based on the particle filter and ensemble Kalman filter approaches.

The second objective corresponding to the second part of the PhD work aims at building a continuous hydrological reconstruction since 1871 over the whole French reference network of hydrometric stations, by using the above meteorological reanalysis as forcings to a hydrological model. Comparing such reconstructions to raw existing reconstructions—without data assimilation—as well as to historical streamflow observations will allow estimating the added value of the meteorological data assimilation process through its impact on streamflow hydrology. This hydrometeorological reanalysis will provide future opportunities for studying the hydrological impact of the climate variability and anthropogenic climate change, and for defining historical reference events for informing adaptation strategies to future climate evolutions.

Caillouet, L., Vidal, J.-P., Sauquet, E. & Graff, B. (2015) Probabilistic precipitation and temperature downscaling of the Twentieth Century Reanalysis over France. *Climate of the Past Discussions*, 11, 4425-4482. doi : 10.5194/cpd-11-4425-2015

Matsikaris, A., Widmann, M. & Jungclaus, J. (2015) On-line and off-line data assimilation in palaeoclimatology: a case study. *Climate of the Past*, 11, 81-93. doi : 10.5194/cp-11-81-2015

Required skills

- MSc in Applied Mathematics or equivalent, or MSc in Earth Sciences/ Environment with skills in applied mathematics
- Skills in one or several following domains: data assimilation, optimization, statistics, meteorology/climatology, hydrology
- Experience in hydrological modelling and interpreted programming (R, Matlab, etc.)
- Interest for interdisciplinary work (applied mathematics, climatology, hydrology)
- High communication level in English (spoken and written)
- Environmentally aware

Supervision

- Jean-Philippe Vidal¹ (jean-philippe.vidal@irstea.fr), Irstea, Hydrology-Hydraulics Research Unit², thesis director
- Claire Lauvernet (claire.lauvernet@irstea.fr), Irstea, Freshwater Systems, Ecology and Pollution Research Unit³, co-supervisor

Scientific environment

- The PhD candidate will be based at Irstea Lyon-Villeurbanne, in the Hydrology-Hydraulics Research Unit, in the team “Catchment hydrology”
- He/she will be registered with the doctoral school “Terre Univers Environnement⁴” of the Grenoble-Alpes University
- Scientific partnership and cofunding by the Compagnie Nationale du Rhône (CNR⁵), Lyon (Benjamin Graff)
- Close collaboration foreseen with Météo-France (Direction of Climatology and Climate Services) and other research labs (LGGE⁶, LJK⁷, etc.)

Employment contract

3-year fixed-term contract starting in October, November or December 2016, gross monthly salary: 1 852 €

How to apply?

Applications should be made online (letter of motivation and CV as a first step, then a full application file) on the following website from the 10th of February 2016 and as soon as possible afterwards:

<https://pasi.irstea.fr/fr/>

How to get more information?

A 10-page document detailing the PhD project is available on request by e-mail from J.-P. Vidal or C. Lauvernet.

¹ www.irstea.fr/en/vidal

² www.irstea.fr/en/research/research-units/hhly/hydrology-catchment-areas

³ www.irstea.fr/pollutions-agricoles-diffuses

⁴ www.obs.ujf-grenoble.fr/ecole_doctorale/

⁵ www.cnr.tm.fr

⁶ lgge.osug.fr

⁷ www-ljk.imag.fr