Geophysical Research Abstracts
Vol. 19, EGU2017-15497, 2017
EGU General Assembly 2017

Mapping the impacts of thermoelectric power generation: a global, spatially explicit database

Catherine Raptis and Stephan Pfister
Institute of Environmental Engineering, ETH Zurich, Zurich, Switzerland

Thermoelectric power generation is associated with environmental pressures resulting from emissions to air and water, as well as water consumption. The need to achieve global coverage in related studies has become pressing in view of climate change. At the same time, the ability to quantify impacts from power production on a high resolution remains pertinent, given their highly regionalized nature, particularly when it comes to water-related impacts. Efforts towards global coverage have increased in recent years, but most work on the impacts of global electricity production presents a coarse geographical differentiation.
Over the past few years we have begun a concerted effort to create and make available a global georeferenced inventory of thermoelectric power plant operational characteristics and emissions, by modelling the relevant processes on the highest possible level: that of a generating unit. Our work extends and enhances a commercially available global power plant database, and so far includes:
- Georeferencing the generating units and populating the gaps in their steam properties.
- Identifying the cooling system for 92% of the global installed thermoelectric power capacity.
- Using the completed steam property data, along with local environmental temperature data, to systematically solve the Rankine cycle for each generating unit, involving: i) distinguishing between simple, reheat, and cogenerative cycles, and accounting for particularities in nuclear power cycles; ii) accounting for the effect of different cooling systems (once-through, recirculating (wet tower), dry cooling) on the thermodynamic cycle.
One of the direct outcomes of solving the Rankine cycle is the cycle efficiency, an indispensable parameter in any study related to power production, including the quantification of air emissions and water consumption. Another direct output, for those units employing once-through cooling, is the rate of heat rejection to water, which can lead to thermal pollution.
The opportunities afforded by the creation of this comprehensive database are numerous, including its use in integrated studies of electricity production and environmental burden, on local or global scales. The quantification, on the highest possible geographical and technological resolution, of all the different current impacts caused by thermoelectric power generation is crucial in order to conduct a proper assessment of the trade-offs in impacts in future scenario studies including technological changes, and to avoid burden-shifting. Here, we present the progress made in the building of the database so far, as well as the results of its application in a worldwide study of the thermal stress of rivers from the heat rejected by power plants using once-through cooling systems.