



## Deciphering Hydroclimatic Complexity with Information Physics and Quantum Technologies

**Rui A. P. Perdigão** and Julia Hall

Meteoceanics Institute for Complex System Science, International ([perdigao@meteoceanics.eu](mailto:perdigao@meteoceanics.eu))

Discerning the dynamics of complex systems in a mathematically rigorous and physically consistent manner is as fascinating as intimidating of a challenge, stirring deeply and intrinsically with the most fundamental Physics, while at the same time percolating through the deepest meanders of everyday life.

The socio-natural coevolution in hydroclimate dynamics is an example of that, exhibiting a striking articulation between governing principles and free will, in a stochastic-dynamic resonance that goes way beyond a reductionist dichotomy between deterministic and probabilistic approaches and between physical principles and information technologies.

Subjacent to the conceptual and operational interdisciplinarity of that challenge, lies the simple formal elegance of a “lingua franca” for communication with Nature. This emerges from the innermost mathematical core of Information Physics articulating the wealth of insights and flavours from frontier natural, social and technical sciences in a coherent, integrated manner.

Communicating thus with Nature, we equip ourselves by developing formal innovative methodologies and technologies to better appreciate and discern complexity in articulation with expert knowledge. Thereby opening new pathways to assess and predict elusive non-recurrent phenomena such as irreversible geophysical transformations and extreme hydro-meteorological events in a coevolutionary climate.

Our novel advances will be shared across the formal, structural and functional theory of the Information Physics of Coevolutionary Complex Systems, along with the analysis, modelling and decision support in crucial matters afflicting our environment and society, with special emphasis onto hydroclimatic problems.

In an optic of operational empowerment, some of our flagship initiatives will be addressed such as Earth System Dynamic Intelligence and Quantum Information Technologies in the Earth Sciences (QITES) on a synergy among our information physical and quantum technological developments.

The articulation between these flagships leverages our proprietary synergistic quantum gravitational and electrodynamic QITES constellation from deep undersea to outer space to take the pulse of our planet, ranging from high resolution 4D sensing and computation to unveiling early warning signs of critical transitions and extreme events.

