Abstract:

CERN is a successful international organisation which, in 2012, did what no national science lab could do on its own: discover the elementary particle which gives mass to other elementary particles.

I believe a comparable type of international organisation is needed to understand and predict what our emissions of greenhouse gases are doing to the climate of our planet. This may seem a surprising statement, as we surely know that these emissions are warming and moistening the atmosphere - enhancing the likelihood of flooding where it is already rainy, and enhancing the likelihood of drought where it is already dry.

However, these consequences merely reflect one aspect of climate change - the so-called "thermodynamic" aspect. This is simple to understand, and current climate models capture it well. However, there is a second aspect of climate change which is not well understood at all – the "dynamical" aspect – associated with the way our carbon emissions are affecting the winds in the atmosphere and the currents in the world's oceans. Unlike the thermodynamic aspect, the dynamic aspect is highly nonlinear, highly chaotic and extremely complex, involving interaction between different scales of motion. Current global climate models only capture the dynamic side partially, and with considerable systematic shortcomings.

An example concerns the Indian Monsoon. There is hardly a more important question for the Indian economy than knowing how the monsoon will be affected by climate change. We know that, year on year, the monsoon is affected by the El Niño event, a dynamical ocean-atmosphere phenomenon in the tropical Pacific region. However, we do not know how the El Niño phenomenon will be affected by climate change; current generation models have too many shortcomings in simulating El Niño. It is not inconceivable that under climate change, a tipping point may switch El Niño into a new mode of variability, with profound long-term effects on the Indian Monsoon.

In this talk I will argue that it is better the scientific community works together to solve the complex problem of modelling the dynamical aspect of climate change. If there were an international CERN for Climate Change, with dedicated exascale computing to develop and run a new generation of global climate model (including, where appropriate, techniques from AI), the sooner we will be able to answer these crucially important questions, and the sooner we'll be able to adapt wisely to the coming climate. Without such a capability, we are doing little more than guessing.