Arctic methane tipping points - watching the atmosphere for change

Supervisors

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Project description

In the media, it has become increasingly common to hear the phrase "tipping point" applied to the Arctic. In some cases, these stories can be dismissed as alarmist, underpinned by little observational evidence. However, it is clear that in recent years, the Arctic has changed at a much faster pace than many other parts of the global climate system. Some of these changes may be irreversible and have far-reaching consequences across the planet.

One tipping point that is often discussed is the potential for massive release of methane from thawing permafrost. Such a change would be of great concern because: a) methane is a highly potent greenhouse gas, b) it is estimated that the permafrost holds enormous quantities of organic carbon that could be partly converted to methane, and c) such a change would represent a positive feedback as the warming of the Arctic itself caused further global warming. Similar concerns surround the destabilisation of methane "hydrates", beneath warming Arctic waters.

An observation that global atmospheric methane levels began to surge in 2007 (Rigby et al., 2008) was quickly followed by speculation that this was the first sign of such a tipping point. This hypothesis has largely been ruled out in the subsequent years. However, it has prompted researchers to ask whether we could detect such a change with the current global observing system.

In this project, you will use atmospheric observations to estimate the current methane flux from the Arctic. These estimates will be used to further our understanding of factors such as the freeze-thaw cycle of Arctic wetlands, and the complex biogeochemistry of these intriguing ecosystems. You will also estimate emissions from human activities in this area, particularly related to gas extraction. Such estimates will be produced using the Met Office NAME atmospheric chemical transport model and Bayesian statistical methods in order to "work backwards" from the observations to determine surface fluxes.

Once a "baseline" for current Arctic emissions has been established, you will run plausible permafrost thawing and hydrate destabilisation scenarios for the next 100 years. You will determine whether the current observing system could rapidly detect and attribute such changes. If not, you will design an "early warning system" of atmospheric sensors that could be deployed for such a purpose.

References: Rigby et al. (2008) Renewed growth of atmospheric methane, *Geophys. Res. Lett.*, L22805

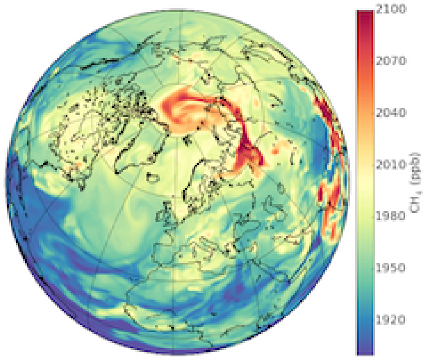

Figure: Simulation of atmospheric methane above the arctic