Sources for Essays on Mathematics and Climate Change

1. "A climate modelling primer" by Ann Henderson-Sellars and Kendal McGuffie, which is in the main library (several copies).

2. "Global warming : understanding the forecast", by David Archer. I don't know this book but it has been strongly recommended to me. It is available in the Main Library, at QC 981.8.G56 A73. Apparently it does a good job of explaining the greenhouse effect in some depth. The issue with the greenhouse effect is figuring out how to calculate its strength. The basic physics is simple: CO2 and other gases like methane absorb light at the wavelength at which it is emitted by the earth (infra red) but allow visible light to pass unobstructed. So (most of) the energy from the sun is allowed in, but (a large part of) the energy going out from the earth is absorbed and thus retained. So increasing atmospheric CO2 or methane means the earth heats up. But how much? This is complicated. As the atmosphere absorbs IR radiation, it heats up and emits more radiation itself. Some goes up and some goes down. Some of what goes down reaches the earth and heats it up more. Some of the radiation emitted by the atmosphere is absorbed at other points in the atmosphere. And so on. Calculating the final increase in temperature is very complicated. The standard undergraduate text on Climate Change, by Dessler, makes a pigs ear out of this, and draws incorrect conclusions. It does demonstrate one very striking fact, though. Because of the high reflectivity of its cloud-rich atmosphere, Venus absorbs a significantly smaller proportion of the sun's light reaching it than does the earth. This more than compensates for the fact that Venus is closer to the sun. The fact that the surface of Venus is at a terrifyingly high temperature (about 800 degrees C) is due entirely to the greenhouse effect. Though of course the fact that this whole process got started on Venus, and not (yet) on earth may very well be due to the fact that Venus receives more sunlight, due to its greater proximity to the sun.

3. The (Berkeley) Mathematical Sciences Research Institute document at

   http://library.msri.org/msri/MathClimate.pdf

   gives a survey of areas of mathematics likely to be important in climate modelling. Worth reading to the end, though it is old (2007) and written for a mathematically sophisticated audience. At the end it lists participants in the meeting which this document reports on, and the titles of their contributions. These may be useful, though are probably written at a rather high level.

4. A thoughtful piece by Richard Barwell aimed at secondary school teachers, beginning with a press report disputing climate change on the basis of a cold winter in Ottawa, and going on to consider how best to draw conclusions from graphs with a lot of spiky up and down fluctuation.
   https://cms.math.ca/Events/CMEF2014/vignettes/14V%20-%20Richard%20Barwell.pdf
   I think this could give some ideas. Education is crucial for spreading understanding of climate change and gaining public understanding and support for the changes to our economies and technologies which may be needed to combat climate change.

5. Another essay by Barwell. Discusses mathematics, public understanding of climate change, and "post-normal science". Seems very interesting, though more philosophical and sociological than mathematical.

http://www.esri.mmu.ac.uk/mect/papers_11/Barwell.pdf

6. Game theory and climate change. There are many papers on this. It is in some sense one of the most crucial topics. Even when we all may agree on the danger of climate change, this does not mean we can easily agree on how we can share out our efforts at mitigation, as the history of climate negotiations shows. I like the slogan "It's not just rocket science", to describe where the real difficulty in dealing with climate change may lie. There's a very interesting short paper on negotiation mechanism by David McKay (brother of Robert, who's a prof in the Warwick Maths Institute) together with two economists. It's available on the reading list of IL006 at

   http://www2.warwick.ac.uk/fac/cross_fac/iatl/activities/modules/ugmodules/climatechange/reading_list/

   It's concerned with the rules by which climate negotiations take place. It's not very mathematical in the sense of using complicated equations, but it is mathematical in the sense that involves rigorous thought. If it appeals to you, it would be possible to incorporate it into an essay on mathematical Game Theory and climate change.

7. The mathematics of uncertainty and risk assessment. Clearly this is crucial to policy makers dealing with climate change. But in general they have a poor grasp of probability, as evidenced by a test the Royal Statistical Society carried out. They asked 97 British MPs what the probability of getting two heads if you toss a fair coin twice. The result was: 38 of the 97 replied correctly, although 72 said they felt confident when dealing with numbers.

   See work by David Spiegelhalter, Professor of the Public Understanding of Risk at Cambridge. But looking at his blog, I saw only passing references to climate change.