UNIVERSITY OF OXFORD

Department of Physics
Atmospheric, Oceanic and Planetary Physics
Parks Road
Oxford OX1 3PU
UK

Raymond T. Pierrehumbert, FRS
Halley Professor of Physics

Raymond.Pierrehumbert@physics.ox.ac.uk

January 4, 2021

CNRS Selection Committee

To the Committee;

I am pleased to support the application of **Martin Turbet** thesis for a permanent CNRS position. I was on the thesis defense committee for Martin, and have corresponded with him over several years on his work, as well as having met him at several professional meetings. This was one of the most remarkable and productive theses on planetary atmospheres I have ever seen. He treats a breathtaking array of subject, and does them all well. Among other things, he managed to model the role of carbon dioxide condensation in limiting deglaciation of Snowball Earth – something I proposed as an issue many years ago, but never managed to model properly. Besides that, his thesis does an amazingly comprehensive job at modeling a suite of possible atmospheres for Proxima Centauri b, and also makes some very intelligent progress on atmospheric behavior of the Trappist 1 planets. I have long-standing research collaborations on planetary climate with CNRS chercheurs in France (and especially LMD, having spent two sabbatical years there in addition to numerous shorter visits) and have written many letters of recommendation for candidates for CNRS positions (most of whom were successful in winning positions). I don't think I have seen such an impressive application since I wrote a letter for Francois Forget himself some decades ago.

Turbet's GCM modeling work alone would be impressive enough to qualify Martin for a CNRS position, but the depth of physical insight on novel physical processes is also impressive. For example, Martin came up with a completely original and novel understanding of the carbon dioxide cycle on Snowball Earths, based on the fact that carbon dioxide ice sinks when put on top of water ice. He also used idealised glaciological modeling concepts to address issues of possible cold-trapping of water or carbon dioxide on the night-sides of tide-locked planet.

Even more astonishing is that Martin successfully made a foray into laboratory spectroscopy, making important contributions towards checking a theoretical prediction on the H2-CO2 collisional opacity made by my former postdoc Robin Wordsworth (now on the faculty of Harvard University). This is not a minor issue, but in fact the key to the climate of Early Mars, and has broad implications for H2-supported habitability on exoplanets as well. Martin also incorporated the results of his laboratory work into a model of Early Mars, which also was innovative in taking into account true polar wander in relating the model predictions to geological features observable on Mars today. Since his thesis, Martin has continued and extended the laboratory work on collision-induced absorption, and it has culminated in a recent paper he led, co-authored by Boulet and Karman.

During his time in his current position at Geneva, Martin has deepened his ability to connect theoretical insights on exoplanets with astronomical observations. This is a very important step forward, as productive work in this area requires a constant interplay between theory and observation. He published a paper with some useful insights on the effect of runaway steam atmospheres on mass-radius relationships, but more importantly has worked as part of a team developing the strategy for the use of the RISTRETTO instrument and its variants for characterization of exoplanet atmospheres. This work lays the ground for the breakthroughs anticipated from the ELT telescope coming online. His theoretical and modeling work has also continued, with a useful review article on possible atmospheres of the Trappist 1 planets, which shows the breadth of his grasp of the subject, and ability to synthesize and critically evaluate published observational results.

It is already clear to me that Martin is poised to become a major leader in the subject of exoplanet atmospheres. One example of the esteem in which I hold his work is that I invited him to present the keynote lecture on modeling terrestrial targets the Exoclimes V conference held in Oxford a little while back – the premier meeting on exoplanet atmospheres. He did an outstanding job at that. Martin's calibre, established in his thesis and subsequent work, is such that I would be happy to have him join our faculty at Oxford in a permanent position immediately, were such an opportunity to present itself. We do not currently have a position available in exoplanet modeling, unfortunately, so we are not in the running this year.

Martin richly deserves to be awarded a CNRS position, and LMD would be one of the very best places in the world in order to carry out his programme of research. I am sure he would flourish there, and that he would be a great asset in assuring that LMD continues to maintain its world-leading position in modeling of planetary atmospheres.

Sincerely,

R. T. Pierrehumbert

Raymond T. Pierrehumbert