Upper tropospheric humidity and climate change

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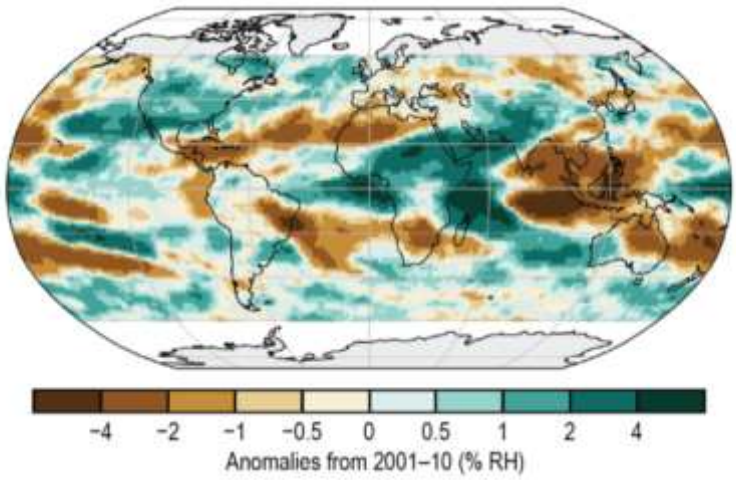
The tiny quantities of water vapour in the air many kilometres above our heads is of central importance to the Earth's greenhouse effect and ongoing climate change. It regulates the planet's natural cooling system through absorption of outgoing infrared radiation and where the humidity exceeds saturation point determines the distribution and thickness of high altitude clouds. Upper tropospheric humidity is an essential climate variable because it controls key atmospheric processes, including water vapour and cloud feedbacks that can amplify the climate system's response to increases in other greenhouse gases such as carbon dioxide. It is therefore vital to understand past variability and change in upper tropospheric humidity and evaluate these key processes in complex climate prediction models.

This project will exploit state of the art global satellite measurements and novel diagnostic tools to evaluate dataset quality, quantify the variability of atmospheric humidity in space and time and use this information to advance understanding of important atmospheric processes as well interrogate and improve detailed weather and climate prediction models that are of great benefit to society. The research will provide a valuable interface between Earth Observation and climate modelling, as well elucidating feedbacks processes fundamental to climate change and therefore of great relevance to policymakers. The supervision team provides a broad expertise across climate science and Earth Observation and there will be the opportunity to work with scientists from the UK Met Office involved in the development of weather and climate models and with scientists stationed in EUMETSAT who are directly involved in producing and extending key satellite observing systems.



Microwave-based upper tropospheric humidity 2019 annual average anomalies (in % relative humidity) compared to 2001-2010 climatology (John et al. 2019, in State of the Climate in 2019, J. Blunden; D. S. Arndt doi.org/10.1175/2020BAMSStateoftheClimate.1)

The project will tackle some important questions including:

- How much does upper tropospheric humidity amplify climate change?
- Can state of the art climate models capture the processes determining variability and change in upper tropospheric humidity?
- Will signatures from upper tropospheric humidity provide new insight into high altitude cloud feedbacks?
- How does upper tropospheric humidity control Earth's radiative energy balance and is there a tropical super greenhouse effect?

Training opportunities:

There will be opportunities to liaise and learn from EUMETSAT partners involved in developing Upper Tropospheric Humidity datasets, the ESA Water Vapour Climate Change Initiative and the Met Office partners on using and evaluating climate model simulations. This will provide comprehensive training in cross-disciplinary data analysis skills applied to models and Earth observations.

Student profile:
The candidate will have a background in physical science with good numerical skills including use of python. An interest in observing the Earth and monitoring ongoing climate change as well as an interest in meteorology and climate science will be an advantage as will knowledge of programming and experience in developing numerical models: all of these aspects are desirable but not essential.

Funding particulars:
Met Office CASE award confirmed.
Additional funding to support a trip to the EUMETSAT partners in Darmstaad, Germany is likely although this is not currently confirmed.

References:

Lang, T., Buehler, S.A., Burgdorf, M. et al. (2020). A new climate data record of upper-tropospheric humidity from microwave observations. *Sci Data* 7, 218 https://doi.org/10.1038/s41597-020-0560-1
Sherwood, S. C. et al. (2020). An assessment of Earth's climate sensitivity using multiple lines of evidence. *Reviews of Geophysics*, 58, e2019RG000678. https://doi.org/10.1029/2019RG000678
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https://research.reading.ac.uk/scenario/