Deep Learning-Based Image Segmentation Model for Detection of Atmospheric Rivers in the Arctic

Sinéad Mcgetrick*[1,2], Hua Lu[2], Matt Osman[1], Oscar Martínez-Alvarado[3], and Grzegorz Muszynski[4]

[1]University of Cambridge [UK] – United Kingdom
[2]British Antarctic Survey – United Kingdom
[3]National Centre for Atmospheric Science [Leeds] – United Kingdom
[4]The University of Edinburgh – United Kingdom

Abstract

The Arctic is experiencing accelerated warming, with atmospheric rivers (ARs) amplifying critical changes such as rapid ice melt, extreme precipitation events, and abrupt temperature shifts. Despite their importance, detecting Arctic ARs remains challenging due to their complex structure, transient nature, and distinct polar characteristics. Existing AR detection models, primarily developed for mid-latitude regions, perform poorly in the Arctic because of unique atmospheric dynamics and sparse observational data. This study aims to develop a regional deep learning-based image segmentation model specifically tailored for Arctic AR detection using large-ensemble climate model simulations. The research involves preprocessing Integrated Vapor Transport (IVT), Total Column Water Vapour (TCWV), and 850 hPa Wind Speed fields from the 40 ensemble historical simulations, as recently generated by the **C**limate change in the **A**rctic and **N**orth **A**tlantic **R**egion and **I**mpacts (CANARI) extreme weather prediction project. Existing rule-based AR detection algorithms are being assessed for their suitability of detecting Arctic ARs, in order to create a new set of training ARs using CANARI large-ensemble output. This CANARI-based AR training dataset will then be used to develop a novel segmentation approach for Arctic AR detection. Finally, the robustness of the new model, and its ability to generalise under Arctic-specific conditions, will be validated using both CANARI simulations and observational ARs detected previously based on ERA5.

*Speaker