STABLE WATER ISOTOPE INCORPORATION IN THE JOINT UK LAND ENVIRONMENT SIMULATOR (JULES) MODEL

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INTRODUCTION

In our ongoing recent study, we aim to incorporate stable water isotopes into the Joint UK Land Environment Simulator (JULES) model in order to investigate abrupt climate shifts that occurred in the Earth's past climate system.

THE JULES MODEL

JULES [1,2] is a community land surface model that represents terrestrial processes including surface energy balance, hydrological cycle, carbon cycle, and dynamic vegetation.

The coupled configuration of JULES is the land surface component of the UK Earth System Model (UKESM2), which also consists of an atmosphere model (UM), an ocean model (NEMO), and a sea ice model (SI³). This study is part of a project to add water isotopes to all the physical components of the UKESM2, and details of the ongoing developments on the UM model code can be found in a companion poster by McLaren et al.

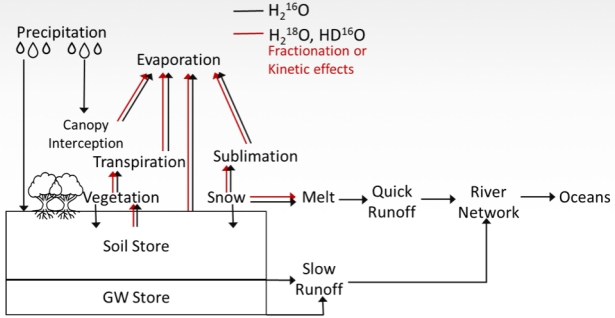


Figure 1: Hydrologic processes modelled within JULES ($H_2{}^{16}O$) and hydrologic processes accompanied by potential isotopic fractionation or kinetic effects ($H_2{}^{18}O$, $HD^{16}O$)

STABLE WATER ISOTOPES IN LAND SURFACE MODELS

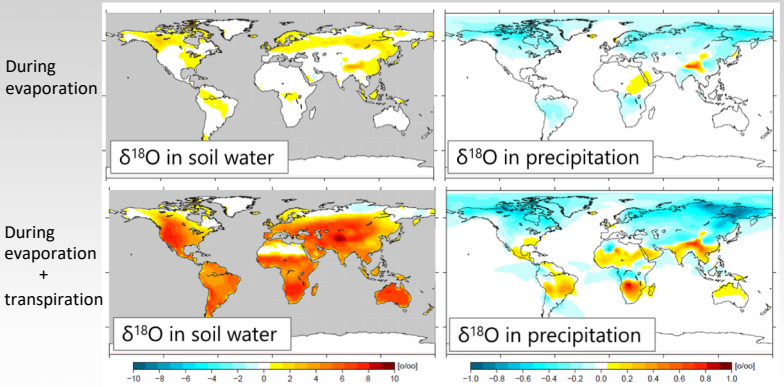
We intend to employ stable isotopes of water ($HD^{16}O$ and $H_2{}^{18}O$) in the model because they provide insight into the links between various pathways of the global hydrological cycle and climate system processes.

As they are powerful tracers of water sources, their ratios and variations can be used to:

a. diagnose the implications or causes of changes in hydrological processes,
b. infer information about the history of water while it passes through the hydrological cycle, and
c. interpret paleoisotope records.

Due to having slightly different physicochemical properties and different latent heat requirements for phase changes, stable water isotopes vary in their relative abundances among hydrological pools.

Figure 2: Impact of fractionation on $\delta^{18}O$ changes modelled by ECHAM5/JSBACH-wiso [3]



STUDY PLAN

In the first stage of model code development, we are adding non-isotopic water tracers to JULES, tracking prognostic water variables throughout the hydrological cycle. In the subsequent stage, we will implement isotopic fractionation processes that occur during soil and water evaporation, condensation, snow sublimation, and evapotranspiration. This implementation will be made and tested in both the standalone and the coupled configurations of JULES.

Our work falls under the large multi-institutional EU Tipping Points in the Earth System (TiPES) project and is expected to be completed by the end of 2022.

REFERENCES

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