



Water stable isotopes in daily precipitation in Reykjavík during 2016-2021: Link to climate parameters and the isotope-enabled ECHAM 5 and ECHAM 6 climate models

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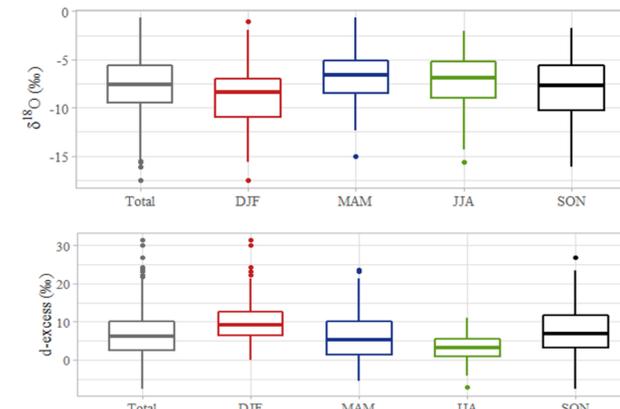


A dataset covering almost continuous samples from rainy days for the last 5 years is now available from Reykjavik. This data consist of 584 samples from the period from 30 June 2016 until 20 September 2021. A large range is found in the daily isotopic values, where $\delta^{18}\text{O}$ was found to range from -22.44 to $+0.53\text{‰}$, δD from -173.4 to $+8.9\text{‰}$ and the deuterium excess from -10.0 to $+31.4\text{‰}$. Deuterium excess shows significant anti-correlation with both temperature and specific humidity. A weaker positive correlation was observed between $\delta^{18}\text{O}$ (and δD) and the weather parameters.

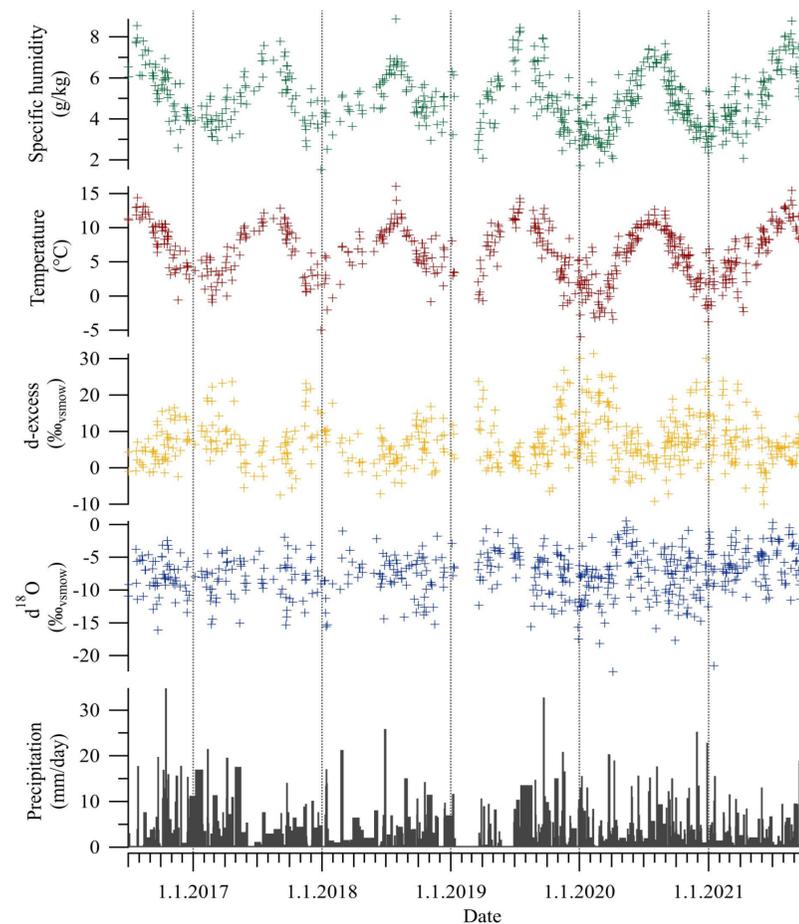
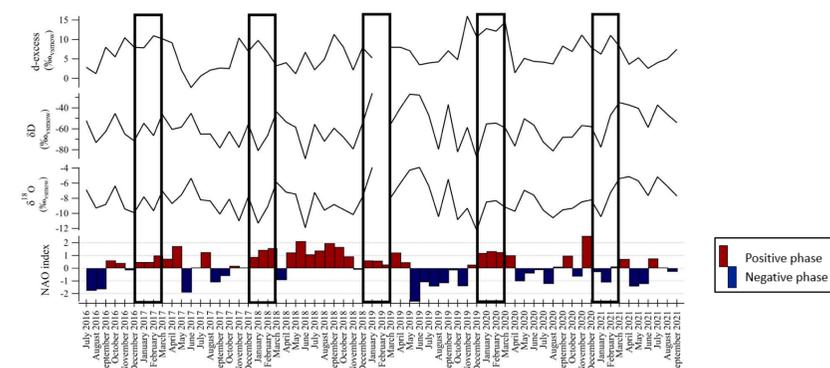
Linear regression results (slope and correlation coefficients $-r$) for observed IES isotope data (from July 2016 until February 2020).

Slope IES / IMO data	Total data*	P- value
$\delta^{18}\text{O}$ vs. temperature	-9.17 ± 0.31	$p < .001$
$\delta^{18}\text{O}$ vs. specific humidity	-10.39 ± 0.63	$p < .001$
$\delta^{18}\text{O}$ vs. precipitation	-7.36 ± 0.22	$p < .001$
d -excess vs. temperature	13.72 ± 0.04	$p < .001$
d -excess vs. specific humidity	20.69 ± 1.13	$p < .001$
d -excess vs. precipitation	7.0 ± 0.47	$p = .626$
Specific humidity vs. temperature	3.05 ± 0.07	$p < .001$

Boxplot of $\delta^{18}\text{O}$ and d -excess, displayed by seasons: Winter (DJF), Spring (MAM), Summer (JJA) and Fall (SON).

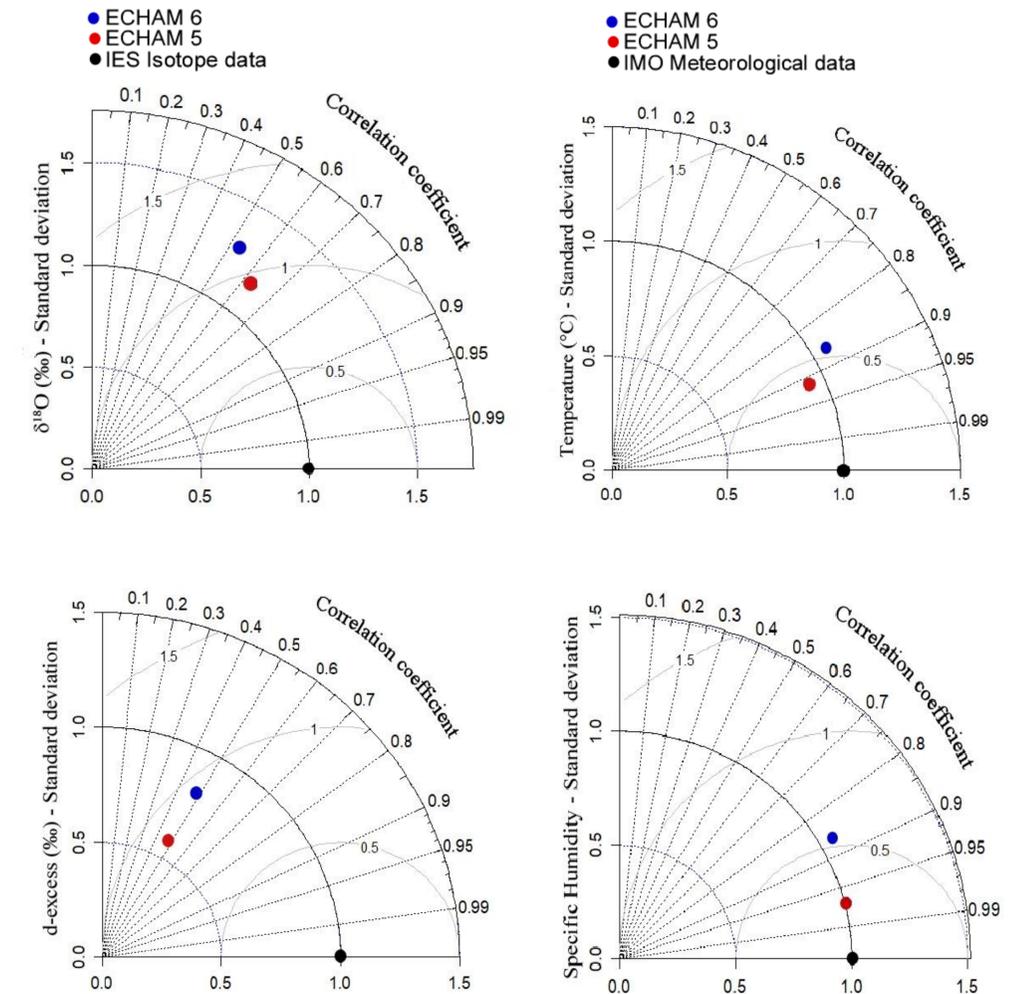


Relationship between the isotopic precipitation data and the North Atlantic Oscillation (NAO) suggests a weak anti-correlation between $\delta^{18}\text{O}$ (and δD) and the NAO index, especially during winter months, outlined here with black boxes, though statistically non-significant. Further observational and modelling studies are necessary to better understand the complex relationship between the atmospheric circulation presented in the NAO index and the isotopic records from Iceland.



The results from the measurements of the IES isotope data, $\delta^{18}\text{O}$, δD and calculated d -excess, are here plotted on a timeline together with the climatic data obtained from the Icelandic Meteorological Office (IMO), precipitation amount, temperature and calculated specific humidity. The IES isotope data exhibits some seasonality. The values for d -excess are higher in winter and lower in the summer, while the $\delta^{18}\text{O}$ and δD data, show the opposite trend, i.e., lower values during winter and higher values in the summer.

Parameterization of water isotopes in the hydrological cycle is implemented in isotope-enabled climate models such as the ECHAM 5 and ECHAM 6 general circulation models. To investigate how well the two models capture observed isotopic variations, the isotopic values, $\delta^{18}\text{O}$ (‰) and δD (‰) and calculated d -excess (‰), temperature (°C) and specific humidity (g/kg) from the models were used to compare to the Reykjavik observations. The results are plotted below in Taylor Diagrams showing the normalized standard deviation and the correlation coefficient for ECHAM 5 (red dot) and ECHAM 6 (blue dot) with the observed IES Isotope and IMO climate data (black dot).



Moderate correlation was found between the observed isotope data and the isotope-enabled ECHAM 5 (red dot) climate model for the period from 2016-2018. Similar correlation was found between the observed data and the ECHAM 6 (blue dot) model for the period from 2016-2020.

