

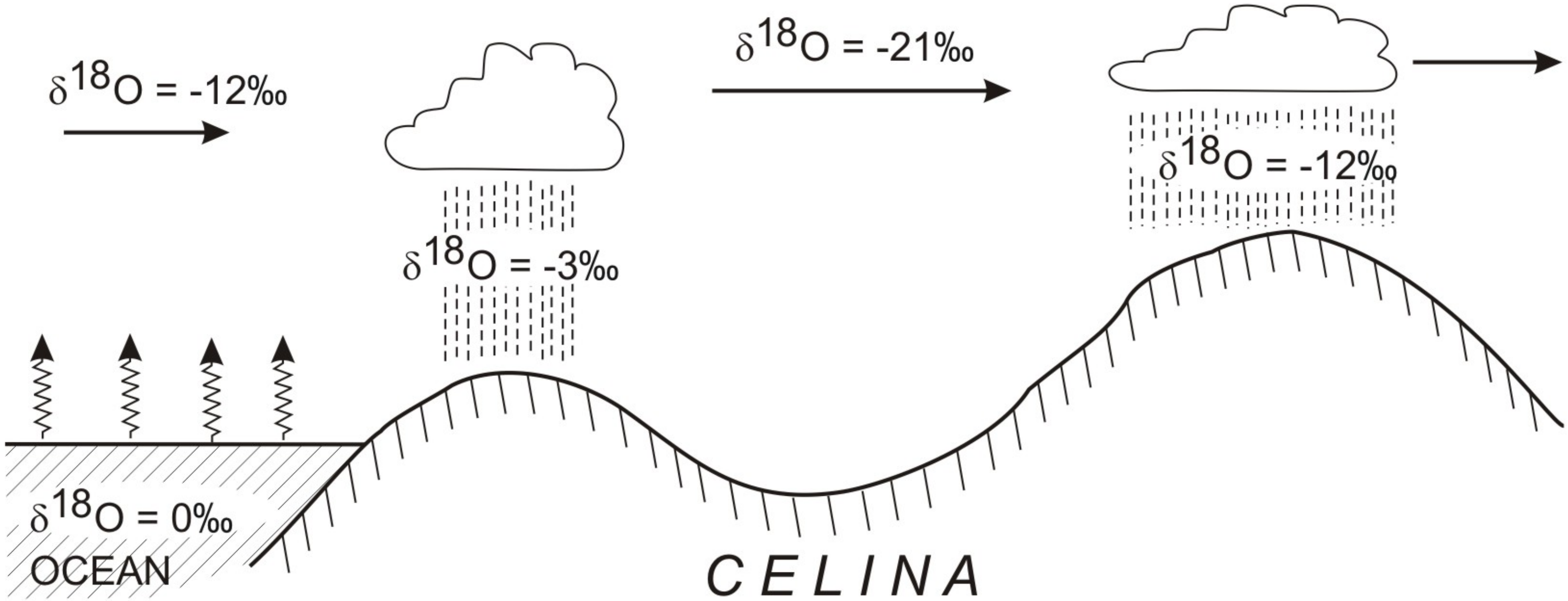
KAKO KROŽI VODA?

Mihael Brenčič
Oddelek za geologijo, NTF, Univerza v Ljubljani &
Geološki zavod Slovenije

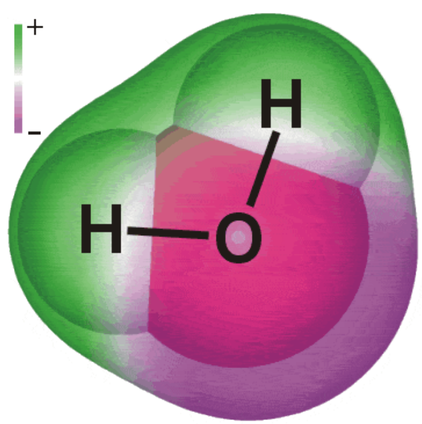




Kroženje vode
zbiranje vode v ledu in snegu
zbiranje vode v atmosferi
kondenzacija
sublimacija
padavine
evapotranspiracija
izhlapevanje
površinski odtok
odtok snežnice v vodotok
rečni tok
izhlapevanje
izvir
infiltracija
sladkovodni zbiralnik
zbiranje vode v oceanih
pretok podzemne vode
zbiralnik podzemnih voda
USGS
U.S. Department of the Interior
U.S. Geological Survey
http://ga.water.usgs.gov/edu/watercycle.html

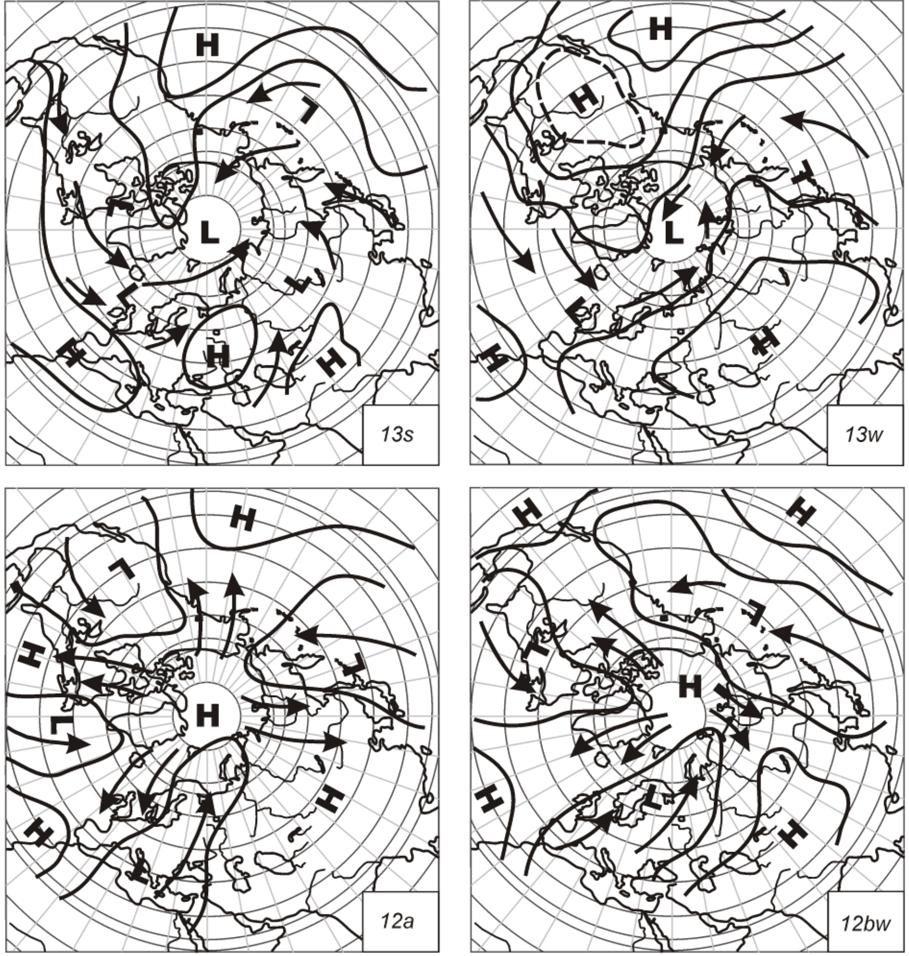


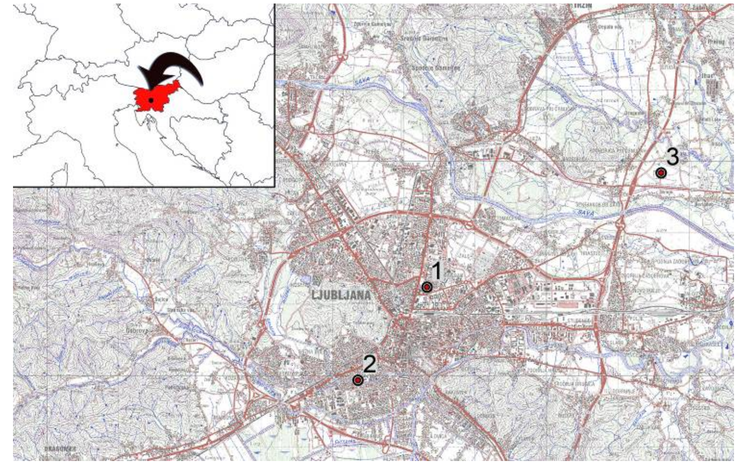
δ18O = -12‰
δ18O = -3‰
δ18O = -21‰
δ18O = -12‰
δ18O = 0‰
OCEAN
CELINA

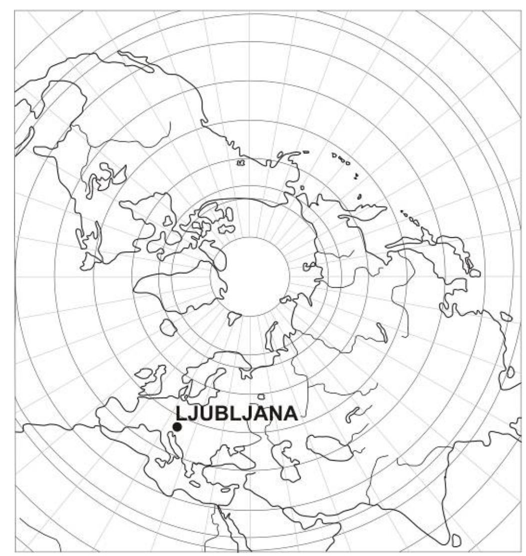


+
-
H
H
O


ARCONT


13s
13w
12a
12bw
11a
10a


LJUBLJANA
1
2
3


LJUBLJANA

Journal of Hydrology 529 (2015) 1422–1432

Contents lists available at ScienceDirect

Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol

Relation between isotopic composition of precipitation and atmospheric circulation patterns

Mihael Brenčič [a,b,*], Nina K. Kononova [c], Polona Vreča [d]

[a] Department of Geology, Faculty of Natural Sciences and Engineering, University of Ljubljana, Aškerčeva cesta 12, SI-1000 Ljubljana, Slovenia
[b] Department of Hydrogeology, Geological Survey of Slovenia, Dimičeva ulica 14, SI-1000 Ljubljana, Slovenia
[c] Institut of Geography, Russian Academy of Sciences, Staromonetny 29, 119017 Moscow, Russia
[d] Department of Environmental Sciences, Jožef Stefan Institute, Jamova cesta 39, SI-1000 Ljubljana, Slovenia

ARTICLE INFO

Article history:
Received 15 July 2014
Received in revised form 12 August 2015
Accepted 18 August 2015
Available online 5 September 2015
This manuscript was handled by Geoff Syme, Editor-in-Chief

Keywords:
Atmospheric circulation pattern
Elementary circulation mechanisms
Precipitation
Hydrogen isotopes
Oxygen isotopes
Deuterium excess

SUMMARY

Precipitation generating processes depend on atmospheric circulation patterns and consequently it is expected that its water stable isotopic composition of hydrogen and oxygen is related to them. Precipitation generated at similar atmospheric circulation patterns should have similar empirical distribution of δ^2H and $\delta^{18}O$ values. Mathematical model based on the linear combination of δ^2H and $\delta^{18}O$ values and on precipitation amount weighted average related to elementary air circulation mechanisms – ECM is proposed. The model enables estimation of average δ^2H and $\delta^{18}O$ values and their standard deviation for the precipitation generated at distinctive atmospheric circulation patterns. Approach in which atmospheric circulation patterns were classified as ECM based on the Dzerdzeevskii classification was applied. Application of the model is illustrated on the long term precipitation record from Ljubljana GNIP station Slovenia. Estimated values of the parameters for empirical distributions of δ^2H and $\delta^{18}O$ of each ECM subtype have shown that calculated estimates are reasonable. Further applications of the proposed model enable new insight into the understanding of isotopes spatial and temporal distribution in precipitation important also for better understanding of climate proxies.

1. Introduction

During studying isotopic composition of the precipitation frequently efforts have been made to elucidate the origin and transport path of water vapour resulting in precipitation at particular location (Liotta et al., 2006; Peng et al., 2005; Vreča et al., 2007) or over certain geographical region (Friedman et al., 2002; Rindsberger et al., 1983; Treble et al., 2005) or globally (Jouzel et al., 2000). It is widely accepted that isotopic composition of precipitation can help to understand the precipitation processes in the atmosphere (Craig and Gordon, 1965; Dansgaard, 1964; Gourcy et al., 2005). Several efforts can be found in the literature to understand also how the origin of the water vapour in the precipitation influences its isotopic composition (Araguas-Araguas et al., 2000; Craig, 1961; Gat, 1996) as well as what is the influence of other meteorological processes and variables on precipitation isotopic characteristics (Rozanski et al., 1993; Liebminger et al., 2007; Siegenthaler and Oeschger, 1980). The interpretation of isotopic composition of precipitation is not straightforward; usually it consists of combination of physical approach based on the understanding of various fractionation processes (Gat, 2005, 2010) and on the interpretation of meteorological conditions resulting in precipitation event (Gedzelman and Arnold, 1994; Lykoudis et al., 2010).

Samples of precipitation for isotope analyses can be collected at various time scales. Most frequent time collection interval is one month. This is the case with International Atomic Energy Agency precipitation sampling program Global Network of Isotopes in Precipitation – GNIP which started in 1961 and resulted in large data base of precipitation isotopic characteristics from the meteorological stations around the globe (Gourcy et al., 2005; Schotter et al., 1996). Monthly samples represent a composite of all the precipitation events for the particular month. Interpretation of the isotopic data on the monthly basis become challenging when sample is a result of several precipitation events and different atmospheric circulation patterns especially at those places where precipitation genesis is a result of water vapour originating from different sources with distinctive isotopic signal. Isotopic composition of

* Corresponding author at: Department of Geology, Faculty of Natural Sciences and Engineering, University of Ljubljana, Aškerčeva cesta 12, SI-1000 Ljubljana, Slovenia. Tel.: +386 1 2445 414.
E-mail addresses: mihael.brencic@ntf.uni-lj.si (M. Brenčič), ninakononova@yandex.ru (N.K. Kononova), polona.vreca@ijs.si (P. Vreča).

http://dx.doi.org/10.1016/j.jhydrol.2015.08.040

Brenčič, M., Kononova, N.K., Vreča, P., 2015: Relation between isotopic composition of precipitation and atmospheric circulation patterns. Journal of Hydology 529, 1422-1432.