Nextdata deliverable D1.1.C: network of fixed deposimeters in the Dolimite region (Task 2).

1. Introduction

The objective of this Task was the creation of a network of fixed deposimeters for monitoring the isotopic composition (δD, $\delta^{18}O$) along an altitudinal transept from the Venetian lagoon to the Dolomitic area. Since June 2015, 8 deposimeters have been installed starting from the sea (Venice-Mestre, 10 m asl) up to 2550 m asl of the Col Margherita. (Tab. 1), following a North-South transect. The network of deposimeters will remain active in the coming years in order to extend the experimental database but, in order to guarantee the sustainability of the experimental program after Nextdata, at some selected sites (Nevegal, Arabba), the sampling strategy will be changed from monthly to "per event".

SITE (province)	CODE	COORDINATES (latitude)	COORDINATES (longitude)	ALTITUDE (m asl)
Venezia-Mestre (VE)	VCE	45.47	12.27	10
Conegliano (TV)	CON	45.86	12.23	80
Belluno aeroporto (BL)	BL	46.16	12.25	370
Nevegal (BL)	NVG	46.08	12.27	960
Col Indes (IND)	IND	46.12	12.44	1190
Falcade (BL)	FAL	46.36	11.88	1140
Arabba (BL)	ARB	46.50	11.88	1620
Col Margherita (BL)	MGA	46.37	11.79	2550

Tab. 1 GPS coordinates and altitude of the 8 fixed deposimeters

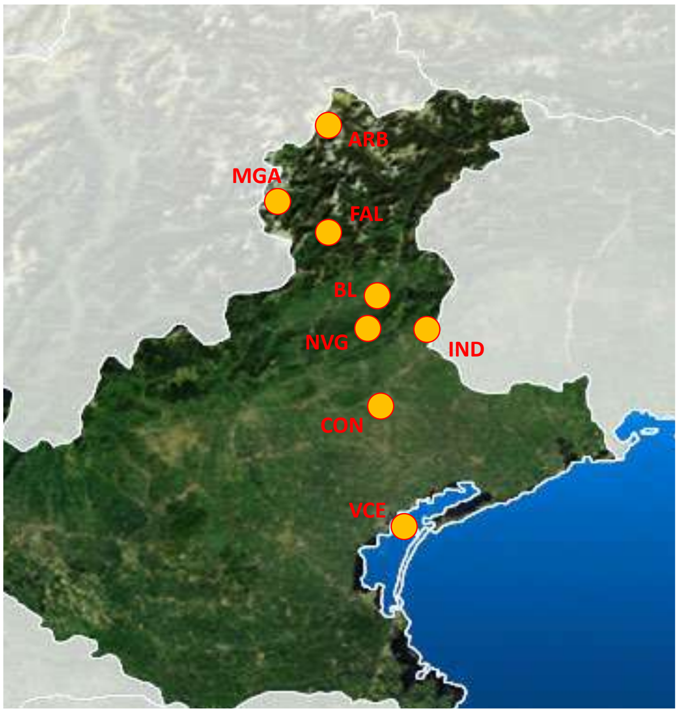

Fig. 1 geographic location of the fixed deposimeters installed along a North-South transept from the Venetian lagoon to the Dolomites of Belluno

2. Stable isotope variability in the precipitation

Compared to ocean waters, rainwater has a reduced content of heavy isotopes. The main reason for the presence of these reduced values in meteoric waters is the Rayleigh distillation effect. This is true if the condensation of the vapor is immediately followed the removal of the condensed phase (Dansgaard, 1964). The isotopic composition values in the precipitations becomes gradually more negative because during the condensation process the heavy isotopes of the water are removed from the air mass and the values of δ become smaller as far as the rain-out process goes on. There are some effects influencing the isotopic composition of precipitation. Most of these depend on temperature variation: the seasonality effect, the latitude effect, the continentality effect, the altitude effect and the quantity effect.

- SEASONALITY EFFECT: it is mainly related to the temperature variation during the formation of precipitation. During the winter the condensation temperature is lower than during the summer. At lower condensation temperature there is a lower content of heavy isotopes and consequently more negative isotope composition values. In areas where temperature variations are not so marked during the transition from winter to summer, the seasonality effect depends mainly on the distribution of precipitation during the year (Rozanski et al, 1993).
- LATITUDE EFFECT: taking into account that the isotopic composition of the precipitation is dependent on the temperature and the "rain-out" processes, at higher latitudes the value of $\delta^{18}O$ and δD is lower than at lower latitudes. From the equator to the polar regions is evident a depletion of heavy isotopes.
- CONTINENTALITY EFFECT: when a mass of water vapour moves away from the coast towards the innermost parts of a continent it is subjected to partial condensations that deplete the vapor and therefore precipitation shows more negative $\delta^{18}O$ and δD values.
- ALTITUDE EFFECT: as the pressure decreases with the altitude, adiabatic expansion will take place, followed by a subsequent cooling of the air-masses. Precipitation resulting from the condensation of water vapor in these air-masses will have lower values of $\delta^{18}O$ and δD than those found at lower altitudes. Typically, the isotopic gradients found in Italy are -0.2 ‰ /100m ($\delta^{18}O$) (Longinelli and Selmo, 2003).
- QUANTITY EFFECT: when heavy precipitations occur, a decrease in the $\delta^{18}O$ and δD values is observed due to the low temperatures.

3. Main results

Since June 2015, more than 190 samples have been collected at monthly frequency by the 8 fixed deposimeters (Tab. 2). In the presence of solid precipitation (snow), in addition to the material present collected by the deposimeters, samples of the snowpack were also collected in situ.

SITE (province)	CODE	Starting sampling	Sampling frequency	Samples (n)
Venezia-Mestre (VE)	VCE	06/2015	Monthly	43
Conegliano (TV)	CON	07/2016	Monthly	27
Belluno aeroporto (BL)	BL	07/2016	Monthly	29
Nevegal (BL)	NVG	07/2016	Monthly	29
Col Indes (IND)	IND	07/2016	Monthly	29
Falcade (BL)	FAL	05/2017	Monthly	17
Arabba (BL)	ARB	07/2017	Monthly	14
Col Margherita (BL)	MGA	07/2017	Monthly	9

Tab. 2 List of fixed deposimeter and sampling details

As reported by Table 3, the sampling area is characterized by a moderate spatial variability of $\delta^{18}O$‰ with averaged pluri-annual weighted values ranging from -6.07‰ (Venezia-Mestre) to -10.66‰ (Col Margherita). These significant differences can be explained with a combination of the continentality and altitude effects. The trends of the isotopic composition of oxygen and hydrogen have been described as a function of temperature and the local precipitation amount, while the vertical isotopic gradient has been calculated for the region of investigation and the Local Meteoric Water Line equation has been determined for Veneto.

SITE (province)	CODE	MIN $\delta^{18}O$‰	MAX $\delta^{18}O$‰	AVERAGE $\delta^{18}O$‰
Venezia-Mestre (VE)	VCE	-15.77	-2.44	-6.07
Conegliano (TV)	CON	-9.56	-3.11	-6.21
Belluno aeroporto (BL)	BL	-11.05	-3.03	-6.63
Nevegal (BL)	NVG	-13.04	-4.11	-7.47
Col Indes (IND)	IND	-12.97	-4.98	-7.75
Falcade (BL)	FAL	-14.01	-5.01	-7.75
Arabba (BL)	ARB	-15.36	-5.27	-8.31
Col Margherita (BL)	MGA	-18.99	-5.44	-9.71

Tab. 3 $\delta^{18}O$‰ values (Min, max and averaged values)

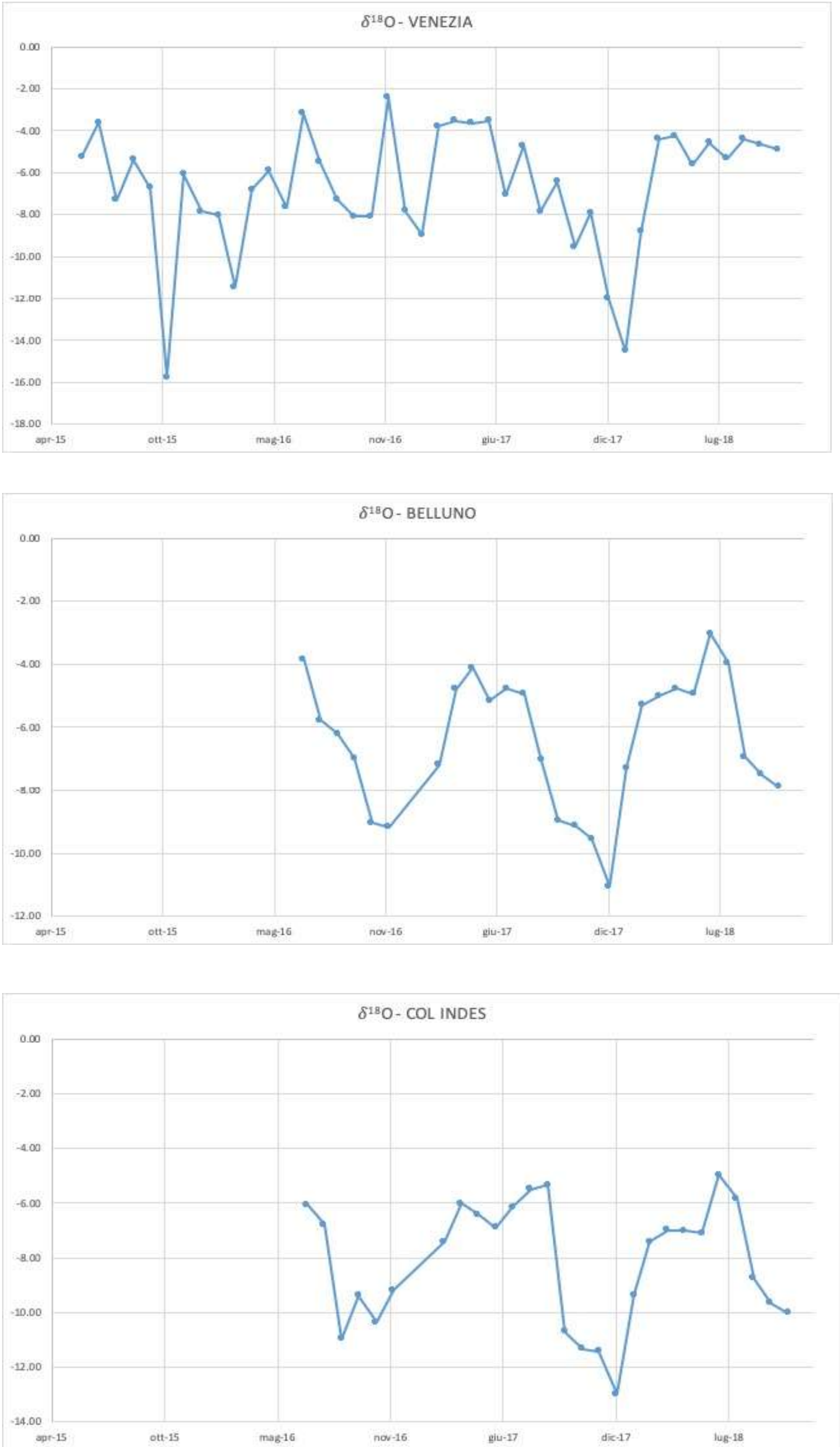

Figure 2 $\delta^{18}O$‰ seasonal variability at 3 selected locations (Venezia-Mestre, Belluno and Col Indes)

As reported by Figure 3, the values of δ^{18}O become more negative as the altitude increases. This therefore respects the altitude effect which leads to a reduction in pressure and a consequent adiabatic cooling of the humid masses which in turn leads to precipitation with values lower than δ^{18}O and δD. We calculated the δ^{18}O - altitude linear regression:

$$\delta^{18}O = -0{,}0018m - 5{,}9922$$

The slope parameter, which corresponds to the vertical isotopic gradient, is equal to -0.18 ‰ / 100m. This result is in good agreement with a previous study on the isotopic composition of Italy (Longinelli and Selmo, 203), which suggested a value of -0.20 ‰ / 100m.

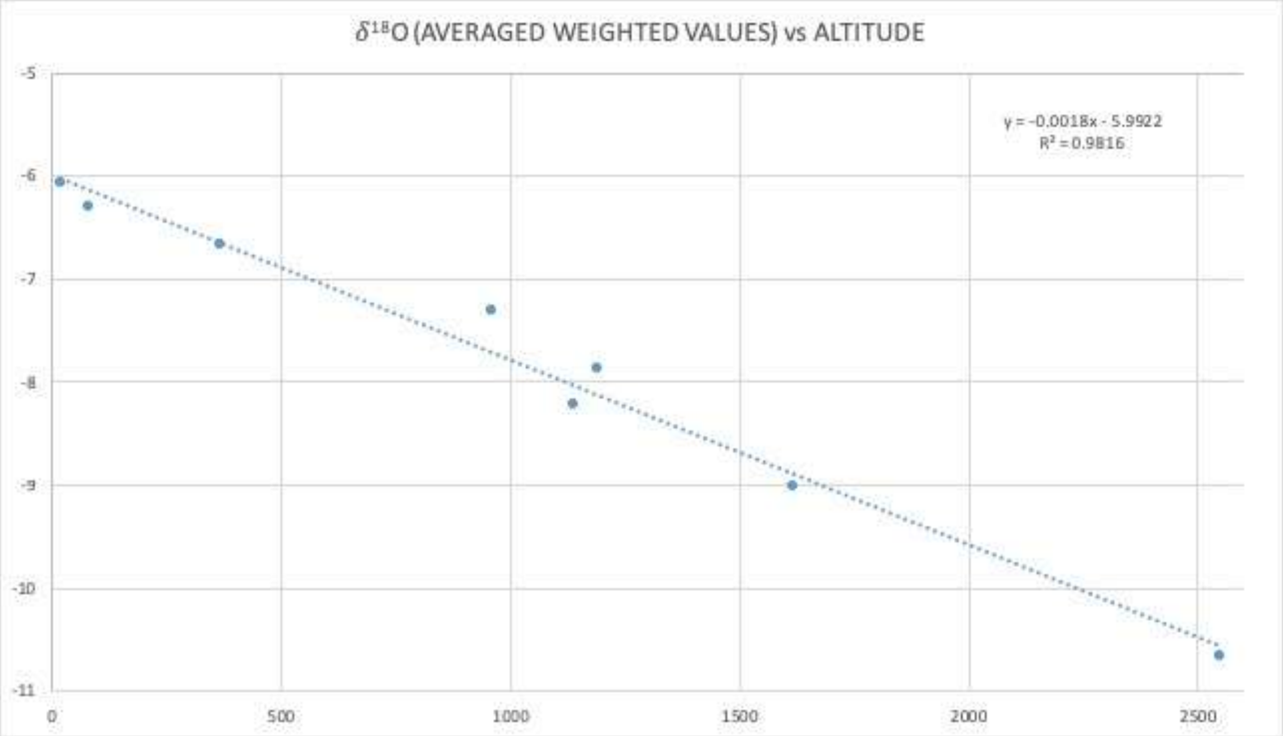

Figure 3 δ^{18}O‰ altitudinal trend

For the sites of Venice, Belluno and Col Indes, a further comparison was made between the monthly average data of δ^{18}O collected for this study and the monthly average data obtained from "*The Online Isotopes in Precipitation Calculator*" (OIPC). The OIPC is a mathematical model that allows to estimate the values of δ^{18}O and δD by provoding the values of latitude, longitude and altitude of a specific site. OIPC is a tool that aims to facilitate the use of stable isotope values in hydrology studies. The estimated value provide by OIPC are calculated from a global data set using an algorithm developed by Bowen and Wilkinson (2002) and updated by Bowen and Revenaugh (2003) and Bowen et al. (2005). For the observations carried out at the coastal area (Venice), no good agreement was found with OPIC: this clearly point out the need of collecting observational local data. The mathematical model, especially for the winter months, underestimates the values of δ^{18}O while for the summer months a slight overestimation is evident. For Belluno and Col Indes, the average monthly data from collected δ^{18}O and those obtained by the OIPC are similar (R^2 equal to 0.78 and 0.81, respectively), with a slight underestimation of measurements by the mathematical model during the period winter. Col Margherita site shows an almost perfect agreement (R^2=0.94).