1 Introduction
After the doctoral degree in meteorology at Innsbruck University in 1906, the scientific interests of Albert Defant (Trento, 1884 – Innsbruck, 1976), best known as a modern oceanography pioneer, focused on the dynamics of alpine and valley winds. In particular, he studied the periodic seiches of Lake Garda and the winds developing in the valleys of South Tyrol, thereby distinguishing between the Po Plain and the inner Alps (Mountain and valley winds in South Tyrol; Defant, 1909). In the latter work particular attention is paid to the Ora del Garda wind, a coupled lake-valley wind which blows over the northern edge of Lake Garda. In recent years this wind has been the subject of a number of studies, based on both surface and airborne data (Lalli et al., 2013a, b; 2014; Giovannini et al., 2015), as well as on NWP model simulations (oral O4.3).

Defant also proposed a first explanation of the differential heating mechanisms associated with mountain and valley winds including slope winds as a factor, determining the diurnal cycles of temperature and pressure gradients observed along the valleys. This explanation has been further developed, thanks to results from dediucational field experiments (Rotach and Zardari, 2007) and numerical simulations (Rampanelli et al., 2004; Serafini and Zardari, 2010a, b). Here we revisit Defant’s seminal work of 1909 in the light of the more recent investigations and results on the subject.

3 Adige Valley pressure gradients
The observed pressure oscillation amplitude is larger at Bolzano than over the Po Plain. Accordingly, positive pressure gradients occur during the night and early morning hours (down-valley wind phase), while negative gradients characterize the afternoon, in association with up-valley winds. The maximum positive gradient is always slightly smaller than the maximum counter-gradient (especially in spring and fall); indeed, observed down-valley winds are not as intense as up-valley winds. The largest gradients are found in summer (>2 times the winter values; Fig. 2). In summer the average pressure gradient at 4 pm is around 1 Hg mm over 150 km (0.009 hPa km⁻¹). The time of the gradient (wind direction) reversals (11 a.m. and 9 p.m.) and peaks (5 a.m. and 3:4 p.m.) slightly change with the season (see Fig. 2).

In the recent study presented by poster P1.25 the pressure gradients along the Adige Valley are analyzed using 2014 data from 10 stations, for selected summer days of up-valley wind. An average pressure gradient of 0.022 hPa km⁻¹ is found at 4 pm. The diurnal positive gradient is always larger than the nocturnal negative gradient, and the two correlate well with the corresponding up-valley wind speed. The reversal times are in good accord with Defant (1909), although later onset times are observed in the lower Adige Valley, probably due to local urban effects.

5 The Adige and Sarca valley wind systems
The wind direction frequencies observed at the 6 stations in the Adige and Sarca valleys reflected well the seasonal patterns of the daily cycles of the pressure gradients (Tab. 2). However, winds from this sector were not collected at 2 pm (i.e. around the peak of the diurnal winds) revealed an anomaly: while at all stations up-valley winds dominated, at Trento northern winds were frequently observed. This fact has been explained only later, as an effect of the Ora del Garda overflying into the Adige Valley at 2.30 p.m., channeling in both northward and southward direction and displacing the local up-valley wind (see Fig. 5; Schaller, 1938; Lalli et al., 2013b, 2014; Giovannini et al., 2015).

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6 Explanation of the along-valley pressure gradients
Defant compared the observed along-valley pressure gradients with corresponding estimates based on observed temperature daily cycles only. He concluded that the different heating of the air columns over the plain and over the mountain slopes does not provide a sufficient explanation. Instead, he ascribed the amplitude at the afternoon pressure minimum to a greater expansion of the air column at the valley center (with respect to the air columns above the valley slopes), causing air flow to develop. Hence, an average up-valley wind prevail over the valley center towards the valley sides (Fig. 6). The recent developments of the theory of valley winds are based on the clarification of the real structure and their role in the cross-valley circulations. In building up the pressure gradients driving the valley winds, in particular, Rampanelli et al. (2004) and Serafini and Zardari (2010a, b) highlight the role of the subsidence associated with up-valley winds in the daytime heating of the valley atmosphere core and in determining the valley boundary layer structure (Figs. 7-8).

7 Conclusions and outlook
- Defant (1909) first analyzed the daily cycles of the average pressure gradients observed between Bolzano and the Po Plain and the associated winds developing in the Adige and Sarca valleys. He focused in particular on the Ora del Garda wind, thanks to lymnograms taken at the Lake Garda northern shore.
- Recent studies have tackled in more detail the subject and found substantially good accord with Defant’s results. They provided explanations for specific aspects and small scale phenomena that were not solved or even approached by Defant (Lalli et al., 2013b, 2014; Giovannini et al., 2015).
- Defant (1909) first included cross-valley circulations in the explanation of the along-valley pressure gradients driving the valley winds. However, his hypothesis was not very accurate. Only very recently, investigations based on modern approaches (e.g. high-resolution airborne datasets, NWP model simulations, etc.) clarified the role of the cross-valley circulations in building up the above-cited temperature and pressure gradients (Rampanelli et al., 2004; Serafini and Zardari, 2010a, b).
- Investigations based on both surface observations and high-resolution NWP model simulations (LES) are being carried out at present, to perform a conclusive characterization of the valley wind systems developing in the study area, among the investigated aspects are: synoptic flow influence, urban effects, interactions between different valley circulations, small-scale features (like lake breeze front structures) (see oral O4.3 and poster P.1.25 at this conference).