P3.1 WHAT CAN WE LEARN OF SURFACE MESONETS IN FOEHN VALLEYS?

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1. INTRODUCTION

One of the goals of MAP was the gathering of information on the behaviour of meteorological parameters of foehn, Bougeault et al (1998). Some of the phenomena of interest were the evolution of foehn, the foehn related flow-splitting in the area of Sargans and the behaviour of cold-air-pools. To achieve these tasks in the Rhine Valley target area mainly two valleys have been heavily instrumented with surface automated stations. In the western part the main Rhine valley from Masein in the south down to the Lake of Constance in the north and in the eastern part the tributary Brandner Valley from the L¸ nersee, which is situated near the crest of the Rheticon massive, down to Bludenz were under consideration. Hence, surface data with high resolution in time as well as in space are available for a two month period. Our department tried to focus on two concrete questions. On the one hand we studied the possibility of producing realistic analyses of the low level pressure and potential temperature field by using the high resolution surface network. On the other hand a comparison between the development of foehn in the Rhine Valley and its tributary Brandner Valley was carried out.

2. SMALL-SCALE ANALYSES

2.1 *Analysis scheme*

To create small scale analyses of the Rhine Valley the VERA (Vienna Enhanced Resolution Analysis) algorithm was used, Steinacker et al (2000). This is a variational approach, close to a thin-plate-spline. The choice of the minimisation criteria depends on the properties of the parameter, which is analysed. If the pressure at a horizontal level close to the valley ground is treated, the second derivatives are minimized (minimum curvature), if the potential temperature is treated both, the first and the second derivations are taken into account (minimum curvature and minimum gradient), because the temperature field shows less spatial auto-correlation than the pressure field.

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The next step in achieving more realistic analyses results was the introduction of a topographical weight. This is chosen in such a way that the interpolation minimizes the curvature and/or gradient in the valleys much more than across mountain ridges. The used grid space was 2 km horizontally. As an input to the interpolation stations in a height range between 400m and 1200m above msl were used. Due to the mean elevation of all stations pressure was reduced to the 550m msl level. For the field of the potential temperature no reduction was applied.

2.2 *Problems*

Before the analyses could be done a careful data quality control had to be done. It was found out, that some of the data series retrieved from the MAP-Data Centre showed serious inconsistencies producing very noisy fields. Beside some single outliers some systematic errors were detected. Some obvious time shifts had to be corrected. Furthermore some wrong station elevations yielded significant biases, which could be quantified when analysing fields during weak gradient situations.

2.3 *Results*

Looking at the analyses some interesting results could be found. Especially in the curved part of the Rhine valley cross valley pressure gradients are present and along pressure gradients are concentrated in specific segments (Fig.1). This can be used to explain the change of the flow direction in the area of Malans (9,59°E, 46,98°N). Furthermore the pressure perturbation in the area of Sargans (9,45°E, 47,05°N) is indicating the necessary condition for the pronounced flow splitting into the northern part of the Rhine Valley and the east-west oriented Seez Valley. This phenomenon has been thoroughly studied within the FORM (FOehn in the Rhine valley during MAP) - Group also on 3 dimensions by means of a Transportable Wind Lidar (TWL) positioned at Vilters (9,46°E, 47,03°N), Drobinski et al (2001a).
During a day with a foehn event it is common that some isolated areas of cooler air (cold-air-pools) persist for longer time periods. The analyses of foehn periods showed that the penetration of foehn doesnít necessarily have to go steady downvalley like a front, but leaves some isolated cold air lenses at some specific parts of the valley. This seems to be the case, e.g. at Zizers (9,56°E, 46,94°N), where katabatic outflow from a side valley occurs.

Moreover it is frequently observed that cooler air flows into the upper valley from the south of the Alps through mountain passes. This process is termed shallow foehn, which doesnít need any southerly upper level flow.

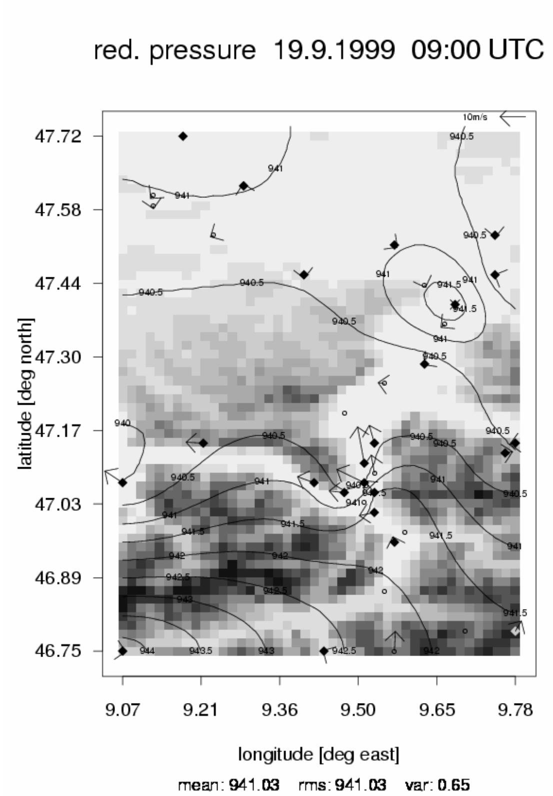

Fig.1: *Interpolation of surface pressure reduced to 550m msl in the area of the Rhine Valley. The interval of the Isobars is 0,5 hPa.*

3. CHARACTERISTIC PATTERN OF SURFACE PRESSURE

During the SOP, which happened to be a period where southerly flow over the Alps dominated, it turned out that both valleys, the large Rhine valley and the small Brander Valley, behaved quite differently during foehn periods. The flow in the Brandner valley was much more unstationary/intermittent and was formed by air masses of significant higher potential temperature than in the Rhine valley, which is a clear indication that air masses in the Brandner valley descend from a higher elevation than in the Rhine valley when southerly flow is observed over the Alps. This means that the foehn in the Brandner Valley corresponds well to the classical thermodynamic foehn theory of Hann (1866). The second remarkable feature of foehn in the Brandner valley is that a very characteristic pattern of pressure may be observed during pronounced foehn cases (Fig.2). A significant area of low pressure is observed in the inner parts of the valley which divides regions of strong and gusty winds upstream of the depression from regions with weak winds downstream. The shape of the observed pattern corresponds nicely to the shape of velocity and pressure fields predicted by the linear theory of Queney (1948). The differences in wind speed along the valley as the consequence of the pressure field is confirmed by the inhabitants of the Brandner valley who noticed for years that foehn occurs mostly and more vigorously in the upper parts of the valley.

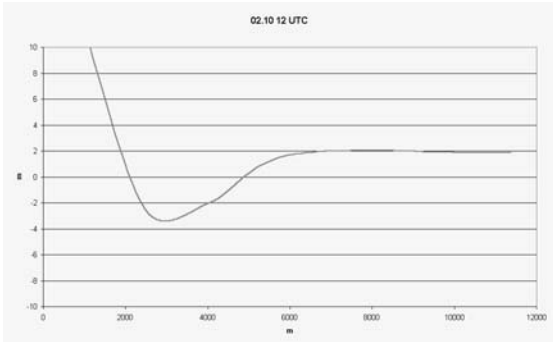

Fig.2: *Relative height of a pressure surface near to the valley floor in gpm (02.10.1999). Low pressure values are observed in the inner parts of the Brandner valley. On the x-coordinate the distance from Lünersee (9,75°E, 47,06°N) is given in m. The northern most point is Bürserberg (9,78°E, 47,13°N)*

Acknowledgements:
Thanks are due to the Austrian “Fonds zur Foerderung wissenschaftlicher Forschung“, Project P12488-TEC, for financial support.

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