QUANTIFICATION OF COHERENT ATMOSPHERIC STRUCTURES USING A BEAM STEERING METHOD.

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Abstract: Atmospheric pressure signals contain a huge amount of information across a broad range of frequencies. Pressure signals are ideal for the quantification of the velocity, phase propagation and direction of motion of a coherent atmospheric structures. Coherent structures such as cold pools and gravity waves produce pressure and temperature perturbations which can be identified in pressure time-series. By method of signal feature extraction and subsequent cross correlation of the time lags of these events over three or more stations is known as beam steering. (Hauf et al, 1996). The ground based automatic weather stations deployed at Terrain Induced Rotor Experiment (T-REX) and the Convective Storm Initiation Project (CSIP) by the University of Leeds provides a large data set to analyse with this beam steering method. The AWS data contains signals from coherent structures such as cold pools and gravity waves which passed over the network during the CSIP and TREX Special Observation Periods (SOPs).

Keywords: CSIP, TREX, beam-steering,, mesonet, cold-pools.

1. INTRODUCTION

The University of Leeds automatic weather station (AWS) mesonet used at both the above mentioned projects, measured atmospheric pressure, temperature, relative humidity and 2D winds, at a frequency of 0.33 Hz. The deployment of a mesonet of 16 weather stations during these intensive field campaigns meant that signals can be detected over a larger area, and maximise the chances of capturing a large number of these events in the data. Coherent structures such as cold pools and gravity waves produce pressure and temperature perturbations which can be identified in pressure time-series. By using an array of three or more barometers, a pressure anomaly can be tracked using the time shifts between the different sensors, simply put this is beam-steering. (Hauf, *et al*. 1996) Identification and extraction of the signal is by application of a wavelet analysis.

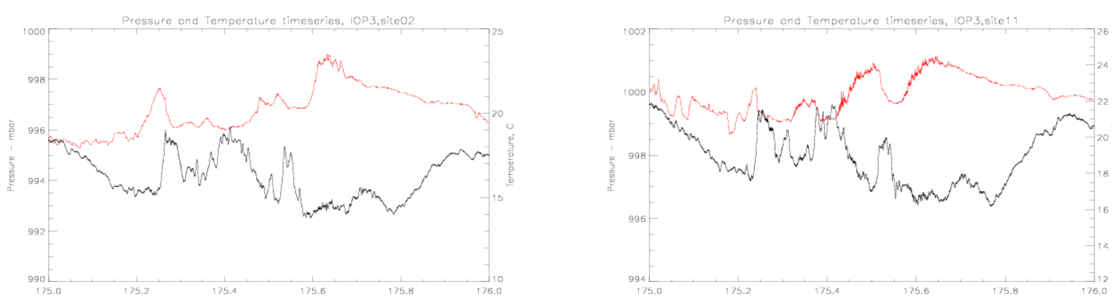
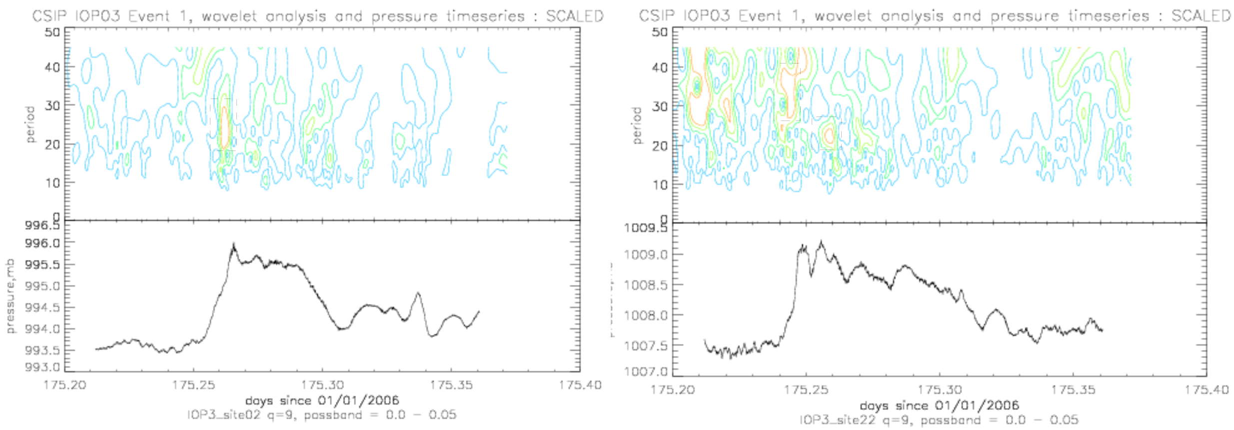


Figure 1a and 1b – Show time series of pressure and temperature from CSIP IOP03. At these sites pressure increases are seen to be coupled with temperature decreases, possibly showing that a cold pool passed the stations. Identification of the times at which these events occurred at different locations will allow the quantification of the speed and direction of the cold pool motion. It may even be possible to calculate the approximate origin of the cold pool due to the radial nature of these disturbances.

Using a Morelet wavelet transform these time series can be transformed to a wavelet analysis diagram (Figure 2a and 2b). This technique gives information about the frequencies which are in the time series without loosing the temporal information which can be lost with other analysis methods such as Fourier transforms.

2. RESULTS

During CSIP there were 16 intensive observation periods (IOPs), of these three have been identified as ideal cases for cold pool activity in the CSIP target area. Application of this beam steering technique to these well established case forms the methodology to allow the analysis of other cases which do not have such well defined events which are visible by eye. Detection of other atmospheric disturbances, such as gravity waves may also be possible.



Figures 2a and 2b: Wavelet analysis of a small section of CSIP IOP03 also shown in Figure 1a and b. Top panel shows a wavelet transform of the pressure time series seen in the lower panel. The dashed box in the top panel outlines the event maximum which can be used to identify the time and frequency of the event.

Once a disturbance is detected in three on more time series the speed and direction of this event can be calculated by a method of cross correlation. If the disturbance is detected in more than three stations a more accurate estimation of these parameters can be given. Generally coherent structures in the atmosphere are not plane structures, many, especially those produced or influenced by mesoscale storm systems are radial. By using different combinations of stations the changes in speed and direction over the mesonet area can also be investigated.

3. CONCLUSIONS

Disturbances passing over ground stations can be detected and quantified to estimate the velocity and direction of the feature. If enough stations 'see' the disturbance then these estimates can be refined, or variations in the velocity and direction can be shown.

4. FUTURE WORK

Application of this method to more cases from CSIP and TREX, which will facilitate the tuning of the methodology allow the distinction between cold, pools, convective rolls, gravity waves. The latest results will be represented on the poster.

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5. REFERENCES

Hauf, T., U., Fink, J., Neisser, G., Bull, and J.-G Stangenberg, 1996. A Ground-Based Network for Atmospheric Pressure Fluctuations. *Journal of Atmospheric and Oceanic Technology.* **13**, 1001-1023.