Cloud Cameras at the Pierre Auger Observatory

BY

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Contents

Abstract **v**

Declaration of originality **vii**

Acknowledgements **ix**

1 Cosmic rays **1**
1.1 History . . . 1
1.2 Anisotropy . . . 4
1.3 Energy spectrum . . . 7
1.4 Mass composition . . . 11
1.5 Acceleration mechanisms . . . 14
1.6 Extensive air showers . . . 19
1.6.1 Hadronic component . . . 20
1.6.2 Electromagnetic component . . . 22
1.6.3 Muonic component . . . 28

2 The Pierre Auger Observatory **31**
2.1 Surface detectors . . . 31
2.1.1 Operation . . . 32
2.1.2 Geometry . . . 35
2.1.3 Energy measurement . . . 38
2.1.4 Mass composition . . . 40
2.2 Fluorescence detectors . . . 45
2.2.1 Operation . . . 46
2.2.2 Geometry . . . 49
2.2.3 Energy measurement . . . 51
2.2.4 Mass composition . . . 55

3 Recording cloud conditions **57**
3.1 Light from extensive air showers and clouds . . . 57

3.1.1 Nitrogen fluorescence . . . 58
3.1.2 Cherenkov light . . . 59
3.2 Night sky radiation . . . 61
3.2.1 Clear night sky . . . 61
3.2.2 Cloud . . . 63
3.2.3 Zenith angle dependence . . . 65
3.3 Raytheon 2000B infrared camera . . . 68
3.3.1 Technical details . . . 68
3.3.2 Camera setup . . . 73
3.4 Camera signal and the night sky . . . 75
3.4.1 Clear night sky signal . . . 79
3.4.2 Cloudy sky signal . . . 82
3.4.3 Estimating scene temperature . . . 85
3.5 Camera image artifacts . . . 87
3.5.1 Aural effect . . . 88
3.5.2 Streaking . . . 89
3.5.3 Barrel distortion . . . 92

4 Image processing and cloud detection 95
4.1 Edge detection . . . 95
4.1.1 The Canny edge filter . . . 96
4.1.2 Application of Canny's edge filter . . . 100
4.2 Image segmentation . . . 105
4.2.1 Otsu's thresholding algorithm . . . 106
4.2.2 K-means cluster analysis . . . 110
4.2.3 Atmospheric parameter based thresholding . . . 113
4.3 Cloud detection algorithm evaluation . . . 124
4.3.1 Segmentation: Weather dependent threshold . . . 124
4.3.2 Segmentation: Otsu's algorithm . . . 126
4.3.3 Segmentation: K-means cluster analysis . . . 133
4.3.4 Segmentation: Edge based . . . 137
4.3.5 Summary . . . 141
4.4 Pierre Auger Cloud Manager (PACMan) . . . 143
4.4.1 The .irp file format . . . 143
4.4.2 Usage . . . 146
4.5 Cloud camera database . . . 149
4.5.1 Format . . . 149
4.5.2 Compression . . . 150

5 Accuracy of cloud camera data **153**
5.1 Rate of image capture 153
5.2 Comparison between cloud cameras 161
5.3 Comparison with LIDAR data 167
5.4 Comparison with CLF data 170

6 Applying cloud camera data to events **175**
6.1 Extensive air showers and the position of cloud 175
6.2 Availability of cloud camera data 178
6.2.1 Availability of cloud height information 180
6.3 Cloudy event removal by quality cuts 184
6.4 Cloud induced X_{max} measurement bias 186
6.5 Pixel level veto 189
6.5.1 Methodology 189
6.5.2 Shift in reconstructed parameters 191
6.5.3 Effectiveness 195
6.6 Summary 203

7 Conclusion **205**

8 Appendices **209**

Bibliography **211**

Abstract

This thesis presents the results of measurements made by infrared cloud cameras installed at the Pierre Auger Observatory in Argentina. These cameras were used to record cloud conditions during operation of the observatory's fluorescence detectors. As cloud may affect the measurement of fluorescence from cosmic ray extensive air showers, the cloud cameras provide a record of which measurements have been interfered with by cloud.

Several image processing algorithms were developed, along with a methodology for the detection of cloud within infrared images taken by the cloud cameras. A graphical user interface (GUI) was developed to expediate this, as a large number of images need to be checked for cloud.

A cross-check between images recorded by three of the observatory's cloud cameras is presented, along with a comparison with independent cloud measurements made by LIDAR. Despite the cloud cameras and LIDAR observing different areas of the sky, a good agreement is observed in the measured cloud fraction between the two instruments, particularly on very clear and overcast nights.

Cloud information recorded by the cloud cameras, with cloud height information measured by the LIDAR, was used to identify those extensive air showers that were obscured by cloud. These events were used to study the effectiveness of standard quality cuts at removing cloud afflicted events. Of all of the standard quality cuts studied in this thesis, the LIDAR cloud fraction cut was the most effective at preferentially removing cloud obscured events.

A 'cloudy pixel' veto is also presented, whereby cloud obscured measurements are excluded during the standard hybrid analysis, and new extensive air shower reconstructed parameters determined. The application of such a veto would provide a slight increase to the number of events available for higher level analysis.

Declaration of originality

This work contains no material which had been accepted for the award of any other degree of diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Acknowledgements

So many things I would have done
But clouds got in my way
I've looked at clouds from both sides now
From up and down, and still somehow
It's cloud illusions I recall
I really don't know clouds at all

"Both Sides, Now", by Joni Mitchell

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