OPTICAL STUDIES OF THE MESOSPHERIC REGION

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Contents

Abstract vii

Originality declaration ix

Acknowledgements xi

List of Figures xvi

List of Tables xvii

1 Introduction 1

1.1 The earth’s atmosphere . . . . . . . . . . . . . . . . . . . . . . . . . . . 1

1.2 Motivation and thesis overview . . . . . . . . . . . . . . . . . . . . . . 3

2 Background and Theory 7

2.1 Atmospheric airglow . . . . . . . . . . . . . . . . . . . . . . . . . . . . 7

2.2 Origin of the airglow . . . . . . . . . . . . . . . . . . . . . . . . . . . . 8

2.2.1 OH emission . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 9

2.2.2 OI emission . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 11

2.3 Atmospheric gravity waves . . . . . . . . . . . . . . . . . . . . . . . . . 12

2.4 Gravity wave effects on the atmosphere . . . . . . . . . . . . . . . . . . 17
CONTENTS

2.4.1 Airglow intensity ........................................... 17
2.4.2 Background winds ......................................... 18

2.5 Previous studies ................................................. 20
  2.5.1 Historical development .................................. 20
  2.5.2 Recent gravity wave research ............................. 22

3 Equipment ........................................................... 27
  3.1 Buckland Park three field photometer ....................... 27
    3.1.1 Physical description .................................... 27
    3.1.2 Control system .......................................... 30
    3.1.3 Instrument operation ................................... 33
    3.1.4 Operational difficulties ................................. 35
  3.2 Davis three field photometer ................................. 40
    3.2.1 Differences from Buckland Park photometer ............ 40
    3.2.2 Instrument operation ................................... 42
  3.3 Buckland Park MF radar ...................................... 42
    3.3.1 Hardware .................................................. 42
    3.3.2 Software improvements .................................. 46
    3.3.3 Spaced antenna operation ............................... 47
    3.3.4 Doppler beam steering operation ......................... 47
    3.3.5 Operational difficulties ................................. 48
  3.4 Davis MF radar ............................................... 50

4 Data processing and analysis .................................. 51
  4.1 Photometer data ............................................... 51
    4.1.1 Data preprocessor ....................................... 52
    4.1.2 Background filter techniques ........................... 55
      4.1.2.1 Subtraction of an average background .............. 56
      4.1.2.2 Fourier amplitude filter ............................ 57
      4.1.2.3 Fourier phase filter ................................. 62
Abstract

A three-field photometer has been employed at the University of Adelaide’s Buckland Park field site to collect optical observations of the 557.7 nm OI and 730 nm OH airglow emissions. Data have been collected on an almost continuous basis since May 1995 through to May 2000, with observations made whenever the moon was not up.

Techniques and analysis procedures have been developed which allow routine extraction of the parameters of gravity waves observed each night. A cross-spectral analysis was performed on processed data from the photometer to identify short period (≤ 3 hours) wave activity on nights where the impact of clouds on the data was minimal. The resulting wave parameters are analysed for seasonal variability and used to build up a climatology of wave parameters over the 5 years of observation. No consistent seasonal variation was observed, although there was a strong eastward preference to the wave’s propagation direction. Implications of this finding are discussed.

A co-located MF radar has been operating in spaced antenna mode providing wind data concurrent with the optical observations for most of the acquisition period. When available the wind data allowed calculation of the intrinsic parameters for waves identified in the optical data. The seasonal variability of these parameters was investigated. An evaluation of energy and momentum fluxes estimated using the method of Swenson & Liu (1998) was carried out. Approximations made in this method were found to be inappropriate for the waves detected by the photometer, and a refined procedure was
therefore developed. This gave more realistic results, although large number of physically unreasonable momentum flux measurements were reported. Possible reasons for these were explored, and the need for further investigations emphasised.

The five year dataset also allowed investigation of the long-term behaviour of the airglow. Both the intensity and variance were analysed using the Lomb-Scargle method across the complete dataset to identify the dominant periods present. Following similar treatment, the MF spaced antenna winds were compared with the optical results; this utilised a complex spectrum extension to the basic Lomb algorithm. Seasonally related periodicities of two years, one year, one half of a year and one third of a year were observed in the optical data, along with a possible signature of a five and a half year period potentially linked to the eleven year solar cycle. The radar data did not have strong signatures of the one third of a year periodicity although the presence of a five and a half year periodicity could not be ruled out. Gravity wave activity, as measured by the optical intensity variance, reached a maximum during autumn with a secondary maximum occurring in spring. The annual variability of the wave spectrum detected by the photometer was also studied which showed a falloff in the wave energy at short periods (less than thirty minutes) during autumn and spring. This suggested that the enhanced wave activity at these times consisted mainly of waves with periods greater than thirty minutes.
This work contains no material which has been accepted for the award of any other degree or 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.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Signed: ............................. dated: .............................

Jonathan Woithe, B.Sc. (Hons)
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List of Figures

1.1 The earth’s atmosphere .................................................. 2

3.1 Schematic depiction of the Buckland Park three field photometer. ... 28
3.2 Arrangement of filters on the filter wheel ................................. 30
3.3 System block diagram of the three field photometer ...................... 31
3.4 System flowchart for control of the photometer .......................... 34
3.5 Schematic diagram of revised lightning detector .......................... 38
3.6 Davis three field photometer field arrangement .......................... 41
3.7 The Buckland Park MF antenna array .................................... 44

4.1 Data from 2 August 1996 showing a peak of 2 minutes’ duration .... 53
4.2 Typical performance of the average background subtraction .......... 57
4.3 Detail of data and average background signals ............................ 58
4.4 Simulated photometer data used to evaluate filter methods ............ 59
4.5 Typical performance of the Fourier amplitude filter ..................... 60
4.6 Performance of the Fourier amplitude filter on uncontaminated data .. 61
4.7 Typical performance of the Fourier phase filter ........................ 63
4.8 Performance of the Fourier phase filter on uncontaminated data ........ 64
4.9 Schematic representation of the functionality of the wavelet filter. . . . 67
4.10 Typical performance of wavelet based filter . . . . . . . . . . . . . . 69
4.11 Response of the wavelet filter to uncontaminated data . . . . . . . . 70
4.12 Filter performance on contaminated data shown by wavelet transforms 73
4.13 Filter performance on uncontaminated data shown by wavelet transforms 74
4.14 Method of calculating phase velocities given three component velocities 76
4.15 Example of typical Davis photometer data . . . . . . . . . . . . . . . 82
4.16 15 minute averaged 730nm intensity data from 1996 at Davis . . . . 83
4.17 Illustration showing estimation method for average 730nm intensity . . 92
4.18 Difference between the alternative methods of amplitude estimation . . 96
4.19 Arrangement of 2D data array used for long-term analysis . . . . . . 98

5.1 Typical uncontaminated photometer timeseries . . . . . . . . . . . . . . 106
5.2 Effect of cloud on preprocessed photometer time series data . . . . . . 107
5.3 Cloud effects on wavelet-filtered data . . . . . . . . . . . . . . . . . . . 108
5.4 Typical phase velocity plot from photometer data . . . . . . . . . . . . 109
5.5 Wavelet-filtered data for a cloudless night . . . . . . . . . . . . . . . . 110
5.6 Summary of all observed wave parameters . . . . . . . . . . . . . . . . 112
5.7 Summary of historical wave parameters inferred from optical data . . 113
5.8 Composite plot of data shown in figure 5.7 . . . . . . . . . . . . . . . 114
5.9 Occurrence histograms of summer gravity wave parameters . . . . . . 117
5.10 Occurrence histograms of autumn gravity wave parameters . . . . . . 118
5.11 Occurrence histograms of winter gravity wave parameters . . . . . . . 119
5.12 Occurrence histograms of spring gravity wave parameters . . . . . . . 120
5.13 Summary of intrinsic wave parameters from photometer observations . 122
5.14 Histograms of summer gravity wave intrinsic parameters . . . . . . . 123
5.15 Histograms of autumn gravity wave intrinsic parameters . . . . . . . 124
5.16 Histograms of winter gravity wave intrinsic parameters . . . . . . . . 125
5.17 Histograms of spring gravity wave intrinsic parameters . . . . . . . . 126
5.18 Vertical wavelength vs horizontal period for all waves observed . . . . . 129
5.19 Momentum flux estimations for all identified waves . . . . . . . . . . . 131
5.20 Polar plot of energy and momentum flux derived from optical data . . 133
5.21 Revised momentum fluxes of waves from the 730nm emission . . . . . 137
5.22 Revised polar plot of energy and momentum flux from 730nm data . . 138
5.23 Energy and momentum flux greater than 0.1mWm$^{-2}$ and 1m$^{2}$s$^{-2}$ re-
spectively . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 140
5.24 Momentum flux distribution, and average flux within 5km vertical wave-
length bins . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 142
5.25 Seasonal variation of zonal and meridional momentum flux components 144
6.1 Overview of 557.7nm intensity data recorded at Buckland Park . . . . 148
6.2 Overview of 730nm intensity data recorded at Buckland Park . . . . . 149
6.3 Three hour averaged 557.7nm intensity data from Buckland Park . . . 152
6.4 Three hour averaged 730nm intensity data from Buckland Park . . . . 153
6.5 Normalised Lomb periodogram of 557.7nm OI intensity data . . . . . . 156
6.6 Normalised Lomb periodogram of data with moon-induced gaps present 158
6.7 Normalised Lomb periodogram of data without moon-induced gaps . . 159
6.8 Three hour averaged OI data with fitted harmonic timeseries . . . . . . 162
6.9 Comparison between 10.7cm solar flux and 557.7nm intensity . . . . . 165
6.10 Normalised Lomb periodogram of 730nm airglow intensity . . . . . . 166
6.11 Variance of 557.7nm photometer data relative to overall mean . . . . . 167
6.12 Periodogram of 557.7nm variance . . . . . . . . . . . . . . . . . . . . . 169
6.13 557.7nm variance data relative to daily mean intensities . . . . . . . . 170
6.14 730nm variance data relative to daily mean intensities . . . . . . . . . 171
6.15 Lomb periodogram of 557.7nm local variance data . . . . . . . . . . . . 172
6.16 Lomb periodogram of 730nm local variance data . . . . . . . . . . . . 173
6.17 Example half-month averaged photometer spectrum . . . . . . . . . 175
6.18 Normalised averaged photometer spectra from Buckland Park . . . . . . 177
6.19 84–88km wind components ................................. 179
6.20 92–96km wind components ................................. 180
6.21 Lomb periodogram of 84–88km wind components ....... 181
6.22 Lomb periodogram of 92–96km wind components ....... 182
6.23 Eight-day averaged variance of 84–88km wind components 184
6.24 Eight-day averaged variance of 92–96km wind components 185
6.25 Periodogram of MF wind variance between 84km and 88km 187
6.26 Periodogram of MF wind variance between 92km and 96km 188
6.27 Example cross spectrum obtained using the Lomb method 191

A.1 Davis MF radar antenna arrangement .......................... 204
## List of Tables

5.1 Assignment of months to seasons used in seasonal parameter plots . . . 116
5.2 Number of gravity wave events observed per season . . . . . . . . . . 116
5.3 Number of gravity wave events observed per season for which back-
ground wind data (and hence intrinsic parameters) were available. . . . 121

6.1 Cross spectral phases: 557.7nm vs 92km–98km winds . . . . . . . . . 192
6.2 Cross spectral phases: 730nm vs 84km–90km winds . . . . . . . . . . 192
6.3 Cross spectral phases: 557.7nm vs 730nm . . . . . . . . . . . . . . . . . 192