

Contents

1	Introduction	1
1.1	Atmospheric structure	1
1.2	The dynamics in the mesosphere and lower thermosphere (MLT)	3
1.2.1	Atmospheric tides	4
1.2.2	Planetary waves	5
1.2.3	Atmospheric gravity waves (GWs)	6
1.3	Observations of GWs in the atmosphere	7
1.4	Chapter summary	10
2	Temperature measurements from O₂ A-band airglow obser-	
	vations	13
2.1	O ₂ A-band airglow emission	14
2.1.1	Production and loss mechanisms	14
2.1.2	Photolysis rates	18
2.1.3	Volume emission rate	20
2.1.4	Rotational structure of the O ₂ A-band emission .	22
2.1.5	Airglow perturbations induced by GWs	25
2.2	Radiative transfer	29
2.3	Ray tracing of line-of-sight (LOS)	34
2.4	Observational spectra modelling	37
2.5	Retrieval algorithm	37
2.5.1	Inverse problem	38
2.5.2	Regularization	41

2.5.3	Diagnostics	43
2.6	Chapter summary	46
3	'Target mode' 2-D tomographic reconstruction of small-scale GWs	47
3.1	1-D GW retrieval	48
3.2	2-D GW retrieval	52
3.2.1	Horizontal wavelength derivation from phase analysis	53
3.2.2	Horizontal wavelength derivation from 2-D tomography	56
3.3	'Target mode' observation	65
3.3.1	Observational geometry of 'target mode'	65
3.3.2	Numerical simulations	71
3.3.3	Horizontal wavelength analysis	80
3.4	Chapter summary	81
4	'Sweep mode' 3-D tomographic reconstruction of GW parameters	83
4.1	'Sweep mode A' observation strategy	84
4.1.1	Observation geometry of 'sweep mode A'	85
4.1.2	Case study of a GW retrieval	87
4.2	'Sweep mode B' observation strategy	91
4.2.1	Observation geometry of 'sweep mode B'	92
4.2.2	Case study of a GW retrieval	95
4.2.3	Horizontal wavelength analysis	103
4.3	Chapter summary	111
5	Summary and outlook	113
A	Appendix	117
A.1	Line parameters of O ₂ A-band	117
A.2	Rate constants of O ₂ A-band volume emission	122
	Acknowledgements	124