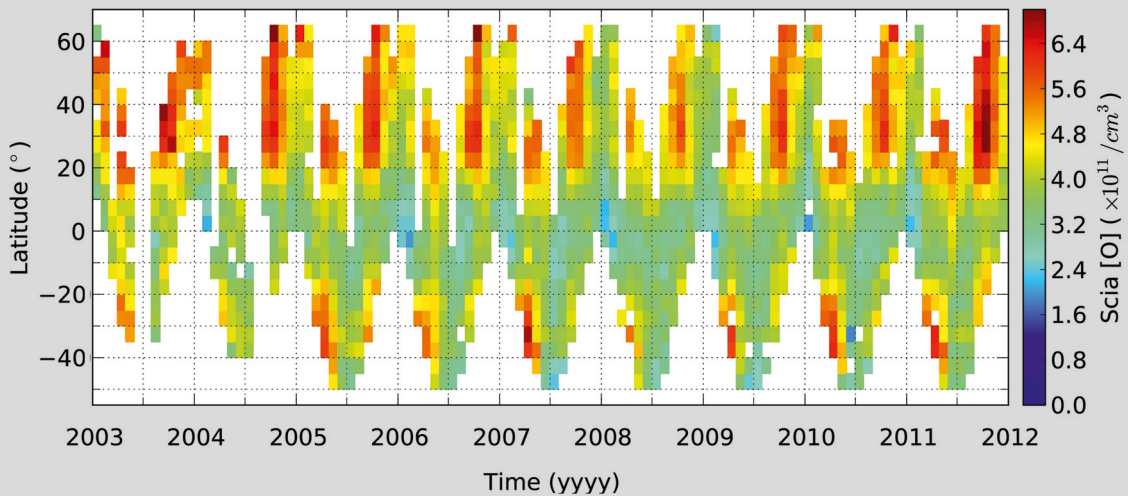


Atomic oxygen derived from SCIAMACHY O(¹S) and OH airglow measurements in the Mesopause region

Yajun Zhu



Forschungszentrum Jülich GmbH
Institute of Energy and Climate Research
Stratosphere (IEK-7)

Atomic oxygen derived from SCIAMACHY O(¹S) and OH airglow measurements in the Mesopause region

Yajun Zhu

Schriften des Forschungszentrums Jülich
Reihe Energie & Umwelt / Energy & Environment

Band / Volume 340

ISSN 1866-1793

ISBN 978-3-95806-178-1

Contents

1	Introduction	1
1.1	Atmospheric structure	1
1.2	The Upper Mesosphere and Lower Thermosphere (UMLT) region	4
1.3	Atomic oxygen in the UMLT region	8
1.4	The SCIAMACHY instrument aboard the Envisat	14
2	Nighttime O(¹S) green line emission measurements and modeling	19
2.1	O(¹ S) green line emission measurements	19
2.2	O(¹ S) photochemistry	21
2.3	Green line photochemical models	27
2.4	Quantitative analysis of different O(¹ S) models	31
3	Nighttime OH airglow emission measurements and modeling	41
3.1	Hydroxyl emission measurements	42
3.2	Hydroxyl nightglow modeling	45
3.3	Methodology to derive atomic oxygen abundances from OH airglow measurements	54
3.4	Quantitative analysis of OH(9-6) band simulations	56
4	Retrieval approach	59
4.1	Inverse issue	60
4.2	Diagnostics	63

5	Atomic oxygen retrieved from SCIAMACHY $O(^1S)$ green line measurements	69
5.1	Monthly zonal mean green line limb measurements . . .	70
5.2	Atomic oxygen retrieval	76
5.3	Analysis of retrieval results	86
5.4	Temporal variations of atomic oxygen abundances	92
6	Atomic oxygen retrieved from SCIAMACHY OH airglow measurements	107
6.1	Atomic oxygen retrieval from OH(9–6) band measurements	108
6.2	Latitudinal and temporal variations	120
7	Intercomparison of various atomic oxygen datasets	125
7.1	Intercomparison of atomic oxygen datasets based on $O(^1S)$ and OH nightglow observations from the same instrument	131
7.2	Intercomparison of atomic oxygen abundances derived from SABER and SCIAMACHY measurements	135
7.3	Intercomparison of atomic oxygen abundances derived from WINDII and SCIAMACHY measurements	139
8	Conclusions	143
8.1	Outlook	145
A	Appendix	148
A.1	Rate constants of $O(^1S)$ forward model	148
A.2	OH nascent production rates	152
A.3	OH Einstein coefficients	154
A.4	OH relaxation models	158
A.5	Tikhonov regularization	163
A.6	Temporal variations of green line volume emission rate and atomic oxygen abundance	165
A.7	Effect on atomic oxygen abundances due to the usage of different OH Einstein coefficients.	170

A.8	Latitudinal and temporal variations of atomic oxygen abundances and volume emission rates derived from SCIAMACHY $OH(9-6)$ band measurements	172
A.9	SABER atomic oxygen abundances	179