

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Upper troposphere and lower stratosphere (UT/LS) . . . . .	1
1.2	Overview of the thesis . . . . .	7
<b>2</b>	<b>Survey of airborne projects</b>	<b>11</b>
2.1	SPURT, MOZAIC and POLARCAT–GRACE projects . . . . .	12
2.2	Geographical and vertical distribution . . . . .	14
2.3	Measurement systems . . . . .	17
2.3.1	O <sub>3</sub> measuring instruments . . . . .	17
2.3.2	H <sub>2</sub> O measuring instruments . . . . .	18
2.3.3	CO measuring instruments . . . . .	19
<b>3</b>	<b>Statistical analysis of H<sub>2</sub>O and O<sub>3</sub> in the UT/LS</b>	<b>21</b>
3.1	Probability distribution and selection of data . . . . .	22
3.2	Kolmogoroff–Smirnoff test . . . . .	28
3.2.1	Mathematical description . . . . .	28
3.2.2	Test performance . . . . .	29
3.3	Variance analysis . . . . .	31
3.3.1	Test description . . . . .	32
3.3.2	Analysis applied on a joint flight of FISH and MOZAIC sensor . . . . .	32
3.3.3	Analysis on MOZAIC and SPURT flights . . . . .	34
3.3.4	Discussion on variability of SPURT and MOZAIC data . . . . .	36
3.4	Results of this chapter . . . . .	39

<b>4 An observational analysis of the Tropopause Inversion Layer</b>	<b>41</b>
4.1 Static stability and Tropopause Inversion Layer (TIL) . . . . .	42
4.2 High static stability in the extratropical mixing layer . . . . .	48
4.2.1 SPURT case study . . . . .	48
4.2.2 Tropospheric Fresh Mixing (TFM branch) . . . . .	51
4.2.3 A new measure of mixing degree in the extratropical UT/LS . . . . .	53
4.2.4 Static stability and mixing degree in the TIL and TFM branch . . . . .	56
4.2.4.1 Correlation between static stability and mixing degree . . . . .	60
4.2.4.2 Significance and strength of the correlation . . . . .	60
4.3 Time scales of processes within the TIL and TFM branch . . . . .	65
4.3.1 Variance analysis . . . . .	65
4.3.2 CLaMS trajectory calculations . . . . .	66
4.4 Radiative transfer calculations . . . . .	70
4.4.1 Radiative transfer in the UT/LS . . . . .	70
4.4.2 The Reading radiative transfer model . . . . .	71
4.4.3 Impact of trace gas perturbations on the thermal stratification . . . . .	72
4.5 Upper-tropospheric dynamics related to the TIL and TFM branch . . . . .	75
4.5.1 The relative vorticity . . . . .	76
4.5.2 Anticyclones and cyclones related to the TIL- and TFM branch . . . . .	77
4.6 Discussion of possible TIL maintenance processes . . . . .	85
4.7 Results of this chapter . . . . .	86
<b>5 A new diagnostic for the location of the jet cores</b>	<b>89</b>
5.1 The isentropic potential vorticity gradient . . . . .	91
5.1.1 Determination of the jet core and boundaries . . . . .	91
5.1.2 The PV gradient tropopause . . . . .	98
5.1.3 Climatology of PV at the PV gradient tropopause . . . . .	102
5.2 Static stability relative to the jet streams . . . . .	107
5.2.1 Seasonal permeability of the jet streams . . . . .	108
5.3 Results of this chapter . . . . .	113
<b>6 Summary and outlook</b>	<b>115</b>