6 Appendix - Figures and Captions

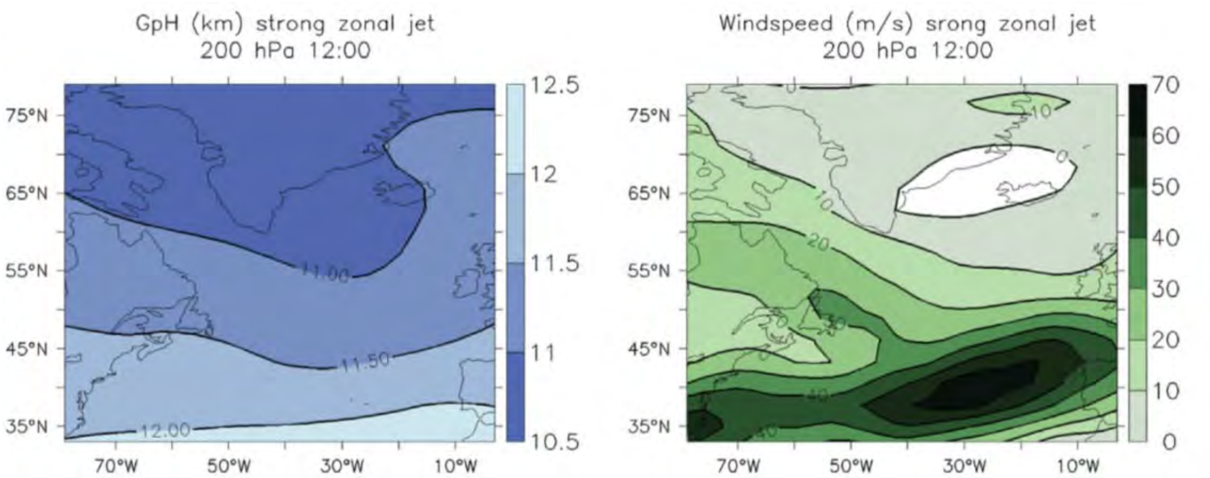

Figure 3.1: Geopotential height [km] (left) and windspeed [m/s] (right) at 200 hPa and 12 UTC for the day for which the air traffic optimisation is performed.

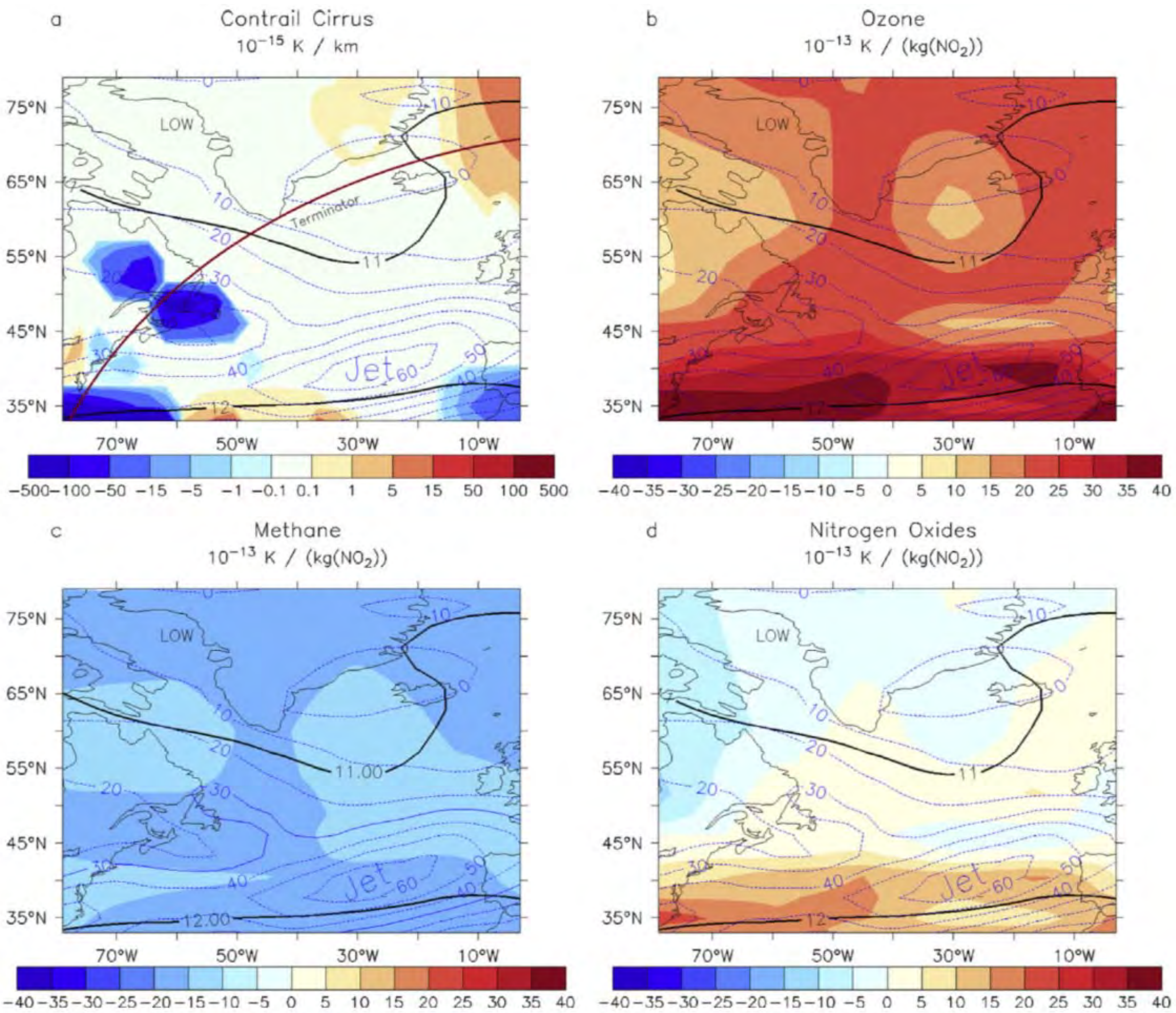

Figure 3.2: Climate cost functions for the metric F-ATR20 at 200 hPa and 12 UTC (as in Fig. 4.1), i.e. 20 year mean near-surface temperature change induced by an aircraft flying. a) Contrails (AiC) in [10^{-15}K/km] b) to d) Ozone, Methane and total NO_x, respectively in [10^{-13}K/kg(NO_2)]. The meteorology from Fig. 4.1 is overlaid, i.e. black isolines show the geopotential height and the blue dashed lines the location of the jet stream. The terminator is indicated by a violet line.

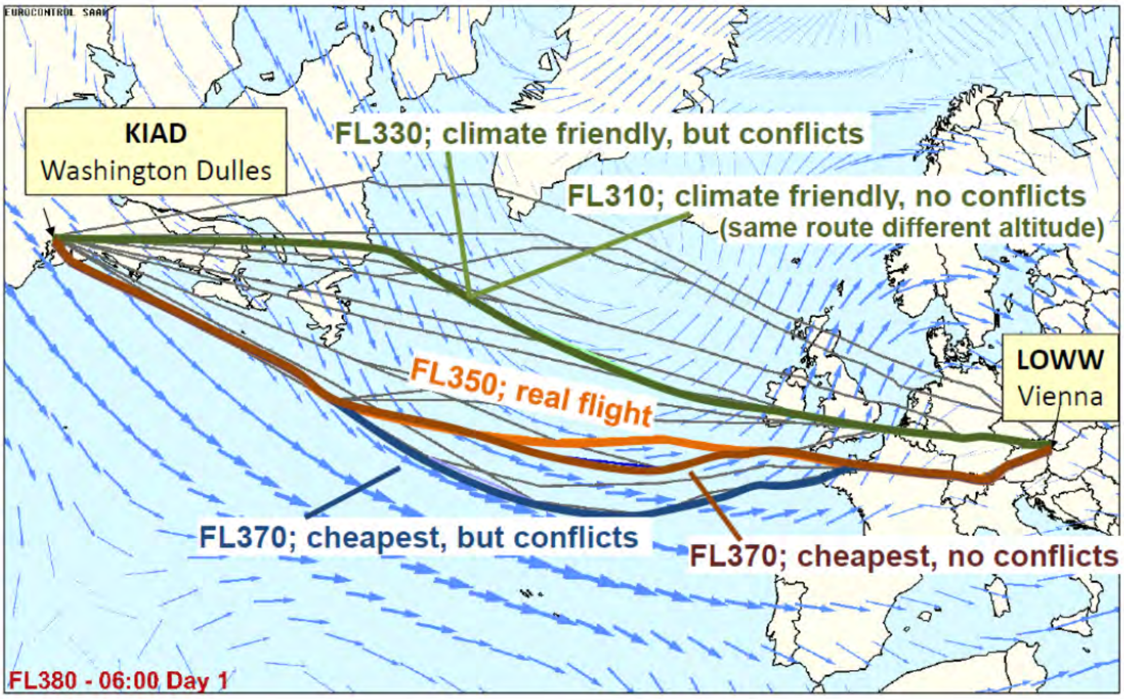

Figure 3.3: Examples of climate-optimised flights. The optimisation was performed for one particular winter weather pattern (Figure 4.1). The selected city pair connection is Washington to Vienna. The real flight at that day is shown in light brown. The economic optimal flights without conflict avoidance are given in blue and the conflict avoidance is given in dark brown. The climate optimal flights are shown in green. In this case the aircraft trajectories with and without conflict avoidance differs only in cruise altitude. Arrows indicate the wind field at flight level 380, i.e. 38 000 ft.

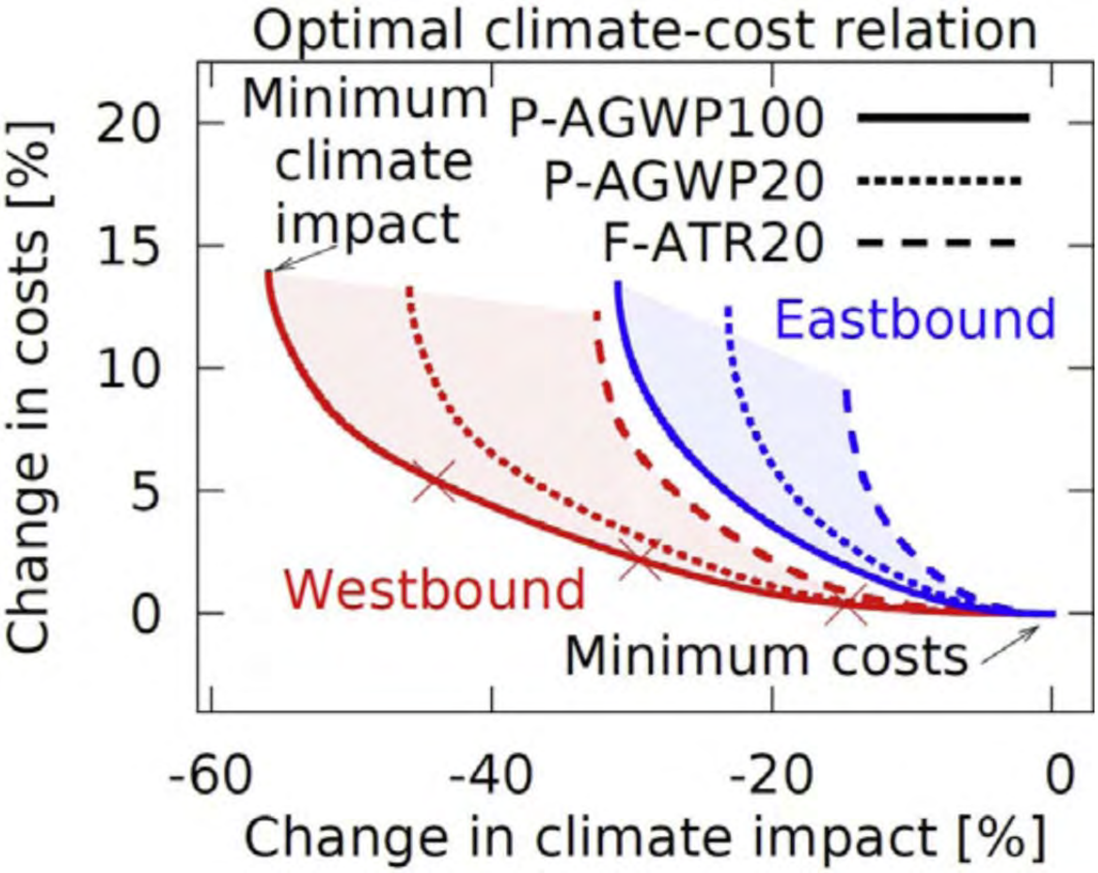

Figure 3.4: Relation of economic cost changes and climate impact changes for an one-day trans-Atlantic air traffic. Relations for westbound and eastbound flights are in red and blue, respectively. Three different climate metrics are used: P-AGWP100 (solid line), P-AGWP20 (dotted line), and F-ATR20 (dashed line).

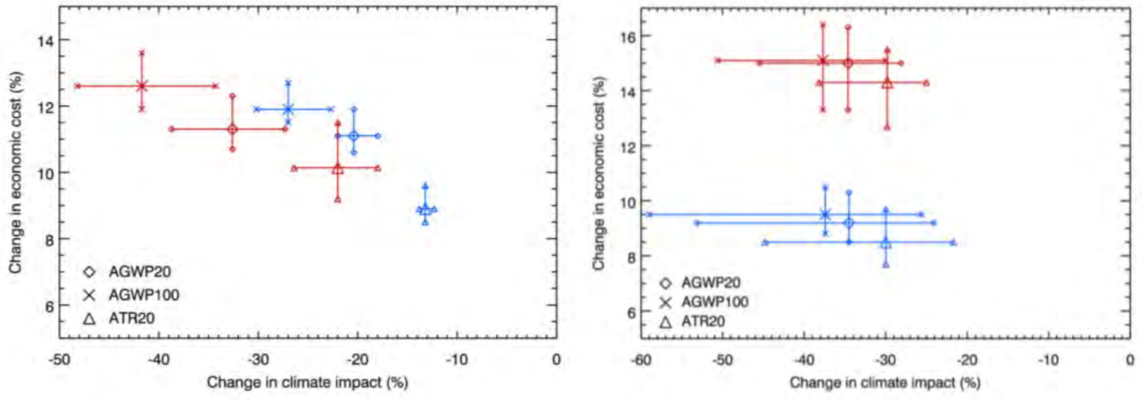

Figure 3.5: For (left) winter and (right) summer, the maximum total mitigation gain for climate-optimal routes (large symbols) and associated economic cost for the AGWP20 (diamonds), AGWP100 (crosses) and ATR20 (triangles) metrics for eastbound (blue) and westbound (red) flights. The range in climate impact and economic cost resulting from the variability in the frequency of the weather patterns (calculated over 1989-2010) is shown by the lines joining the small symbols.

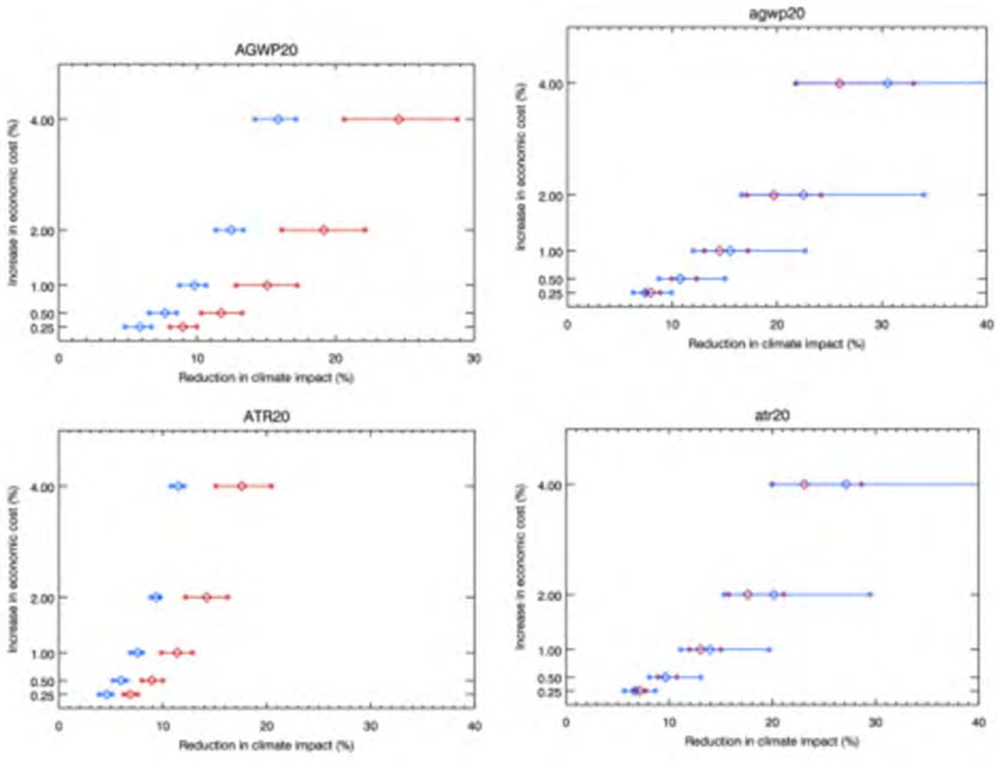

Figure 3.6: Winter (left) and summer (right) mean reductions in climate impact for AGWP20 (top) and ATR20 (bottom) for an increase in economic costs of 0.25, 0.5, 1.0, 2.0, and 4.0% considered as tolerable. Ranges are due to year-to-year variability in the frequency of weather patterns. Westbound (red) and eastbound (blue) flights are shown separately.

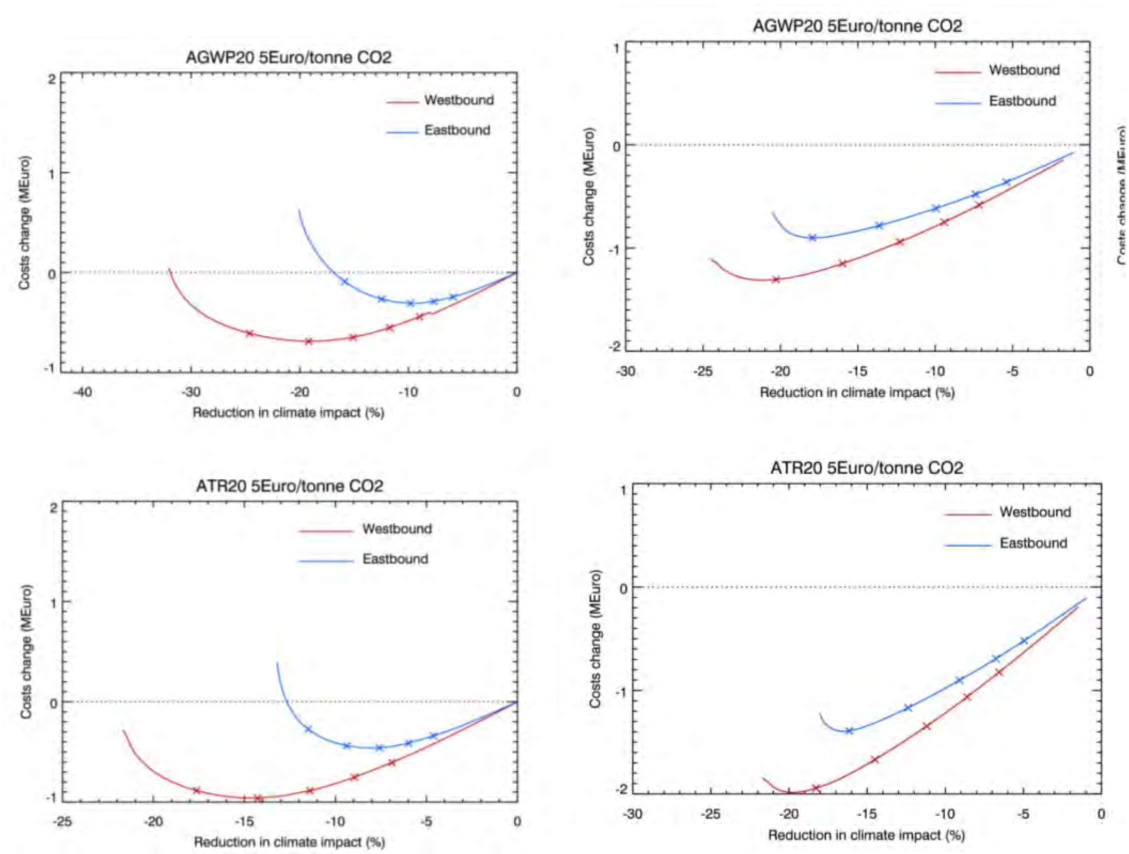

Figure 3.7: Winter (left) and summer (right) changes in economic costs for airlines participating in climate-friendly flight routing when taxes of 5€ per tonne of equivalent CO2 have to be paid. Negative values represent a cost saving, and the minimum of the curves is the optimum for the airlines. It is seen that at such optima quite substantial reductions in climate effect can be achieved if the emission trading system adopts a metric with relatively short time horizon. Westbound (red) and eastbound (blue) flights are shown separately.