Figure S1. Example of the submodel ACCF calculations. The instantaneous distributions of aCCFs at FL350 (∼240 hPa, 10.7 km) on December 1, 2015 at 12:00:00 UTC: (a) $aCCF_{O_3}$, (b) $aCCF_{CH_4}$, (c) $aCCF_{H_2O}$, and (d) $aCCF_{contrail}$. $aCCF_{CO_2}$ is given in Eq. (A4) in the Appendix.
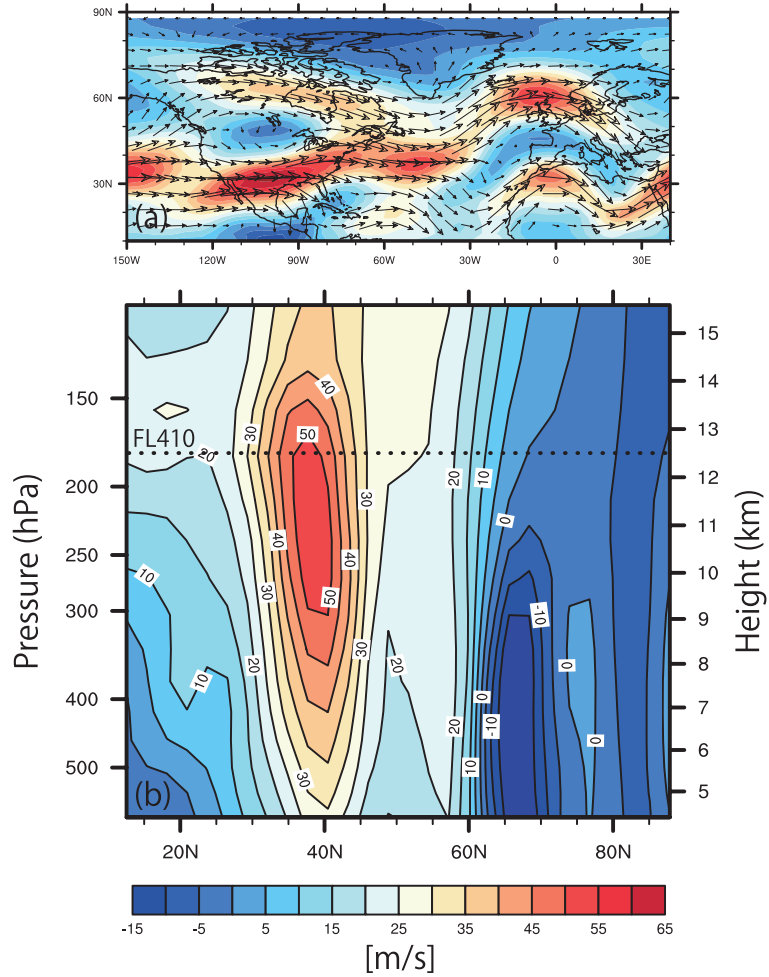
Figure S2. Averaged wind fields on December 1, 2015: (a) the contours show the u component of wind at FL410 ($\sim$180 hPa, 12.5 km) and arrows show the wind vector (u, v); (b) similarly, the u component of wind on the cross section at 45°W. The dotted line indicates FL410, corresponding to the altitude of (a).
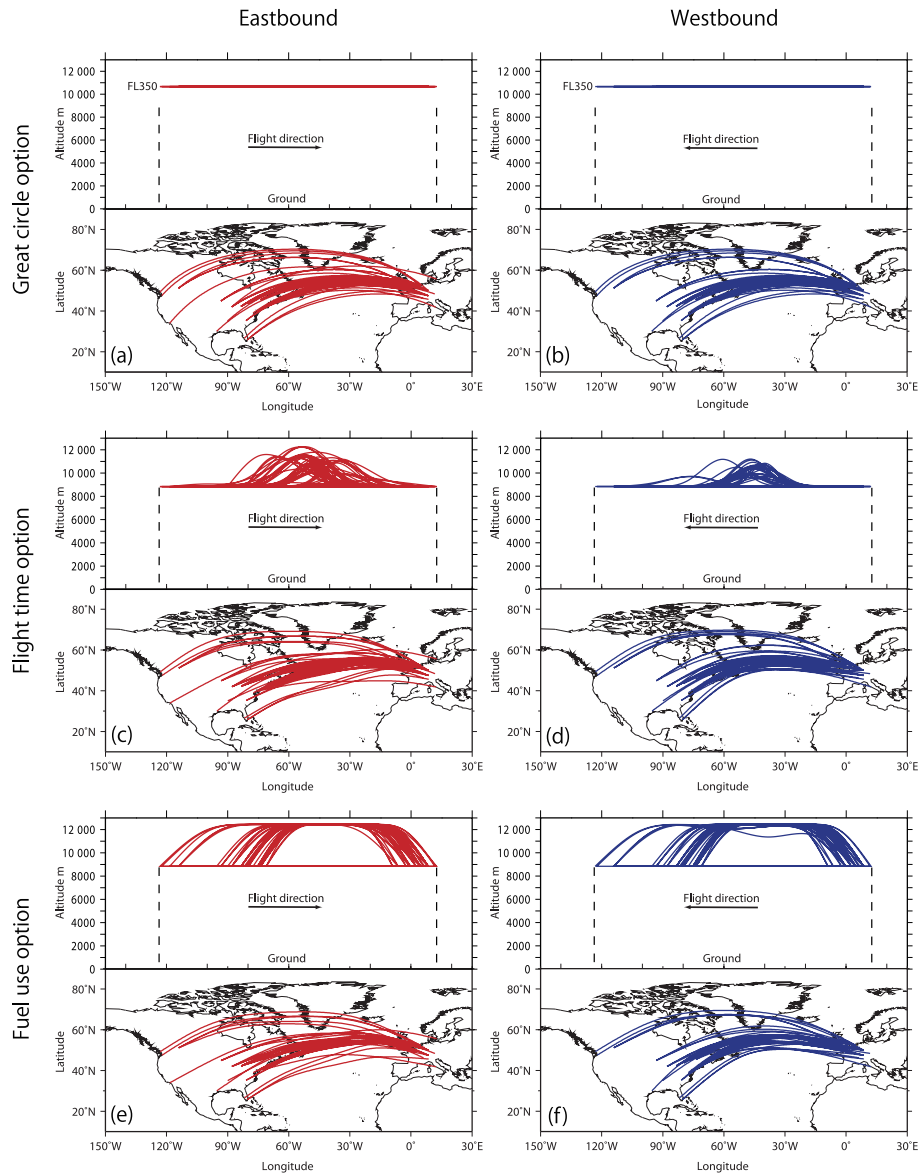
Figure S3. Optimized flight trajectories from a one-day AirTraf simulation (52 eastbound and 51 westbound flights) for the following aircraft routing options: the great circle (at FL350; a, b), the flight time (c, d), the fuel use (e, f), the NO_x emission (g, h), the H_2O emission (i, j), and the SOC (k, l) options. For each figure, the trajectories are shown in the vertical cross-section (top) and projected on the ground (bottom). In brief, the time option shows similar optimum trajectories as those of the COC option (see Figs. 2c and 2d) with respect to geographic locations, whereas most of the flights choose different flight altitudes. This option aims to benefit from tailwinds and to avoid headwinds only for time minimization. On the other hand, the fuel, the NO_x, the H_2O and the SOC options show similar optimum trajectories as those of the COC option (see Figs. 2c and 2d) with respect to geographic locations and in the vertical direction, because their objective functions depend on time and on fuel. The difference among these routing options is discussed in the text.
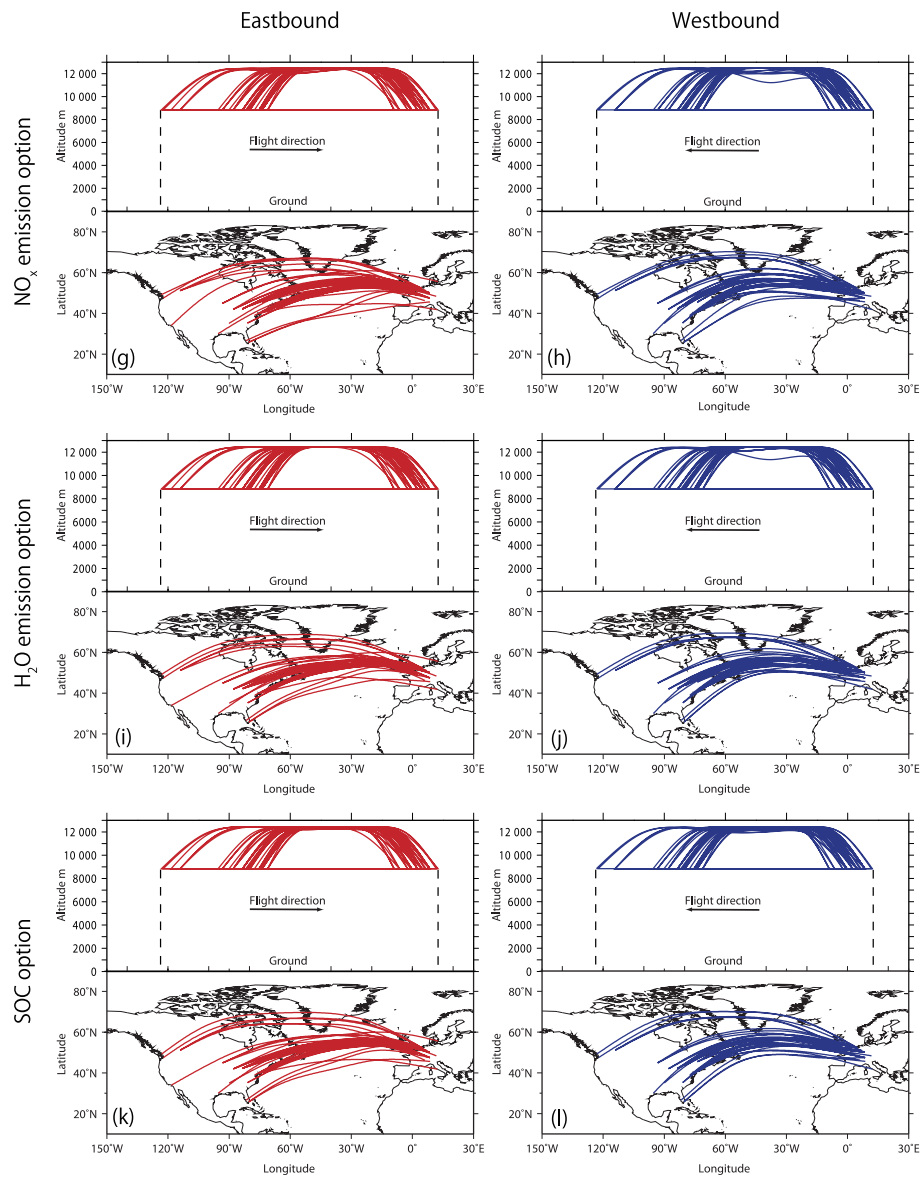
Figure S3. (continued.)
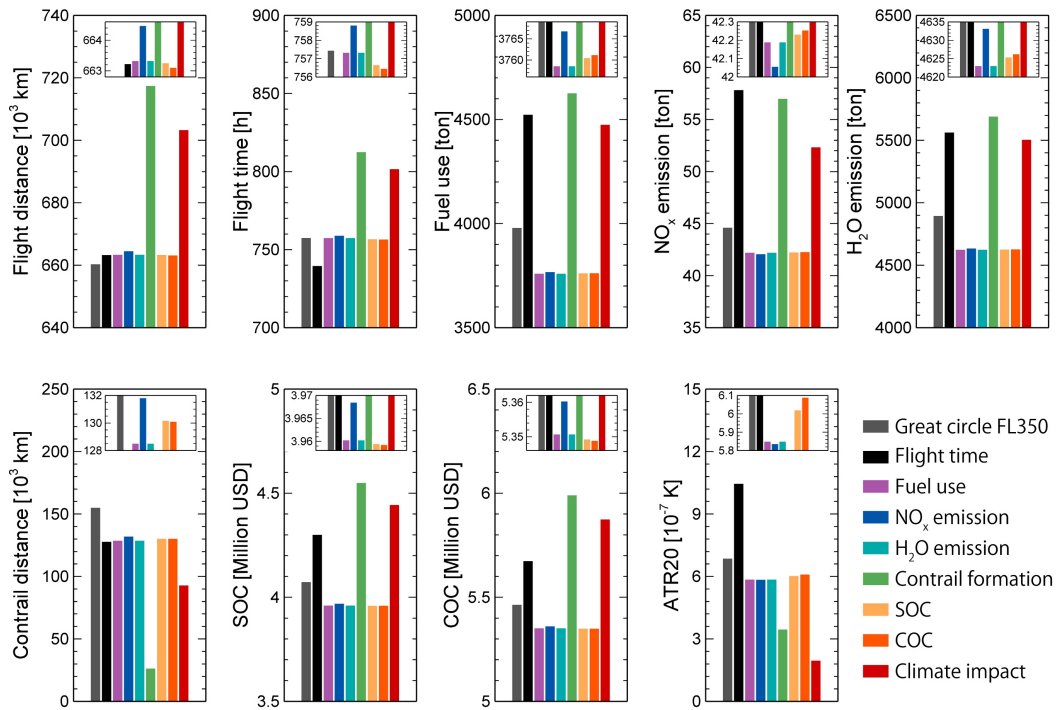
Figure S4. Bar charts of the nine performance measures obtained from one-day AirTraf simulations with different aircraft routing options (the bars indicate the sum of 103 flights), including the enlarged drawings around the values of the COC option. The summary data are listed in Table 4 in the text.