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# A climatological view of the vertical stratification of RH, $O_3$ and $CO$ within the PBL and at the interface with free troposphere as seen by IAGOS aircraft and ozonesondes at northern mid-latitudes over 1994–2016

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**S1. Population density around ozonesonde stations and IAGOS airports**

In order to have a first look on how IAGOS and ozonesonde profiles may be influenced by local anthropogenic sources, we investigated the population density around the IAGOS aircraft and the ozonesonde stations using the Gridded Population of the World (GPW) version 4 data (Center for International Earth Science Information Network, 2016; http://sedac.ciesin.columbia.edu/data/collection/gpw-v4) available for 2010 at a resolution of 30 arc-seconds (roughly 1 km at the equator). For each individual location, we calculated the mean population density over the area at ±0.1° in longitude and latitude from the station/airport. On average, the population density is 1,152 inhabitants $km^{-2}$ around ozonesonde stations. It varies from density 5-24 inhabitants $km^{-2}$ at Churchill, Yarmouth, Goose Bay and the Valentia Observatory to 3,200-3,800 inhabitants $km^{-2}$ at Naha (Japan), Barajas (Spain), Ankara (Turkey) and Uccle (Belgium). The mean population density around IAGOS airports is 2,004 inhabitants $km^{-2}$, thus a factor 1.7 higher than at the ozonesonde stations. It strongly varies depending on the agglomeration size and the distance to the airport. The maximum densities are found at the airports of Istanbul (20,405 inhabitants $km^{-2}$), Seoul (10,692), Beirut (9,835) and Delhi (8,657). At the Frankfurt airport, the population density is 1,437 inhabitants $km^{-2}$. The minimum densities are found at some minor Canadian airports like Goose Bay (14 inhabitants $km^{-2}$) or Gander (35). One exception is the Denver airport that is very isolated from the city, as illustrated by its population density of only 69 inhabitants $km^{-2}$ (the airport is surrounded by agricultural lands, a secondary airport and separated from the city by the large Rocky Mountain Arsenal National Wildlife Refuge).

**S2. Supplementary figures**

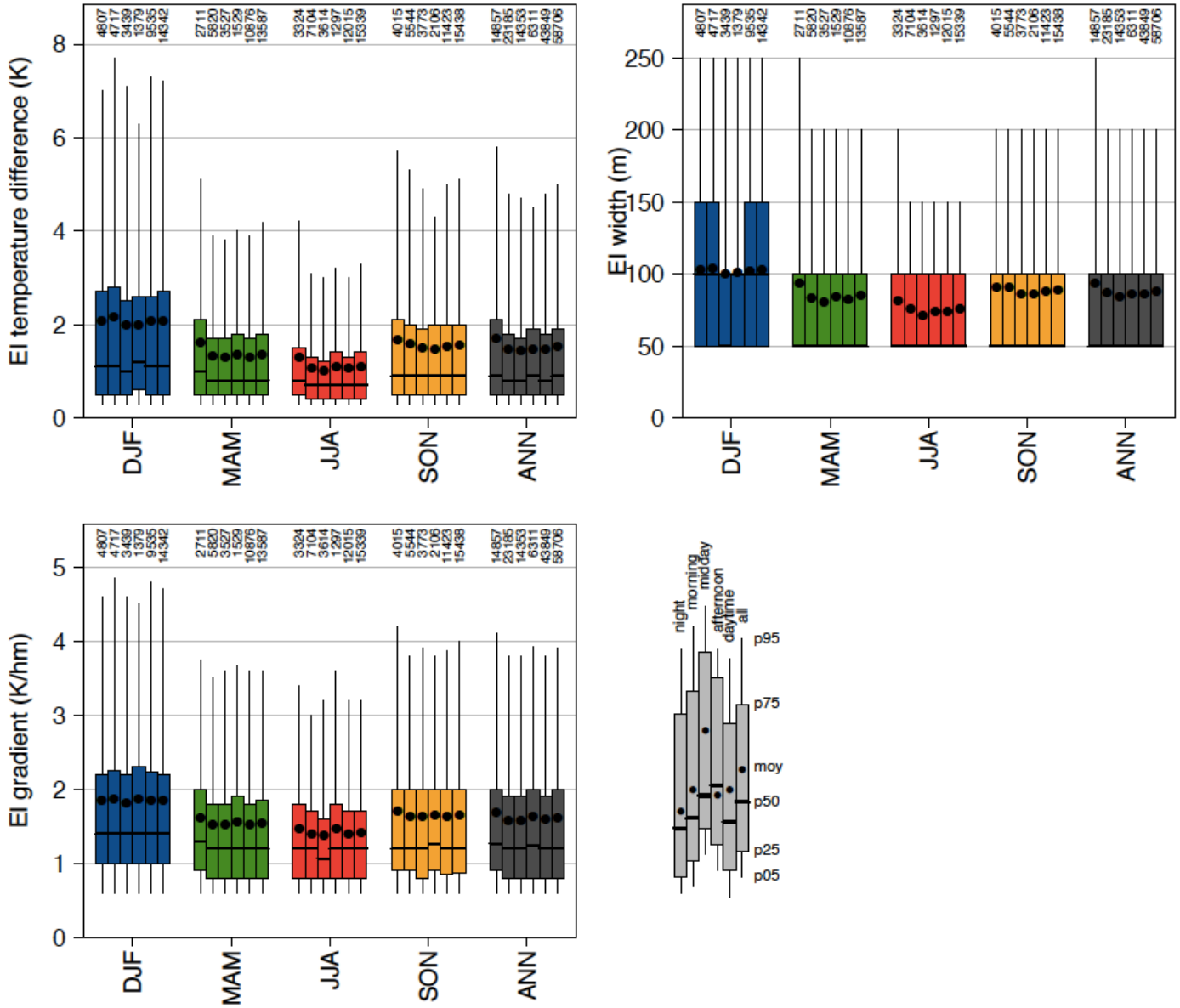


**Figure S1: Diurnal and seasonal variations of the difference of temperature between the EIs' top and base (top left panel), the EI width (top right panel) and the temperature gradient within the EI (bottom left panel). The number of profiles for each bar is indicated on the graph.**

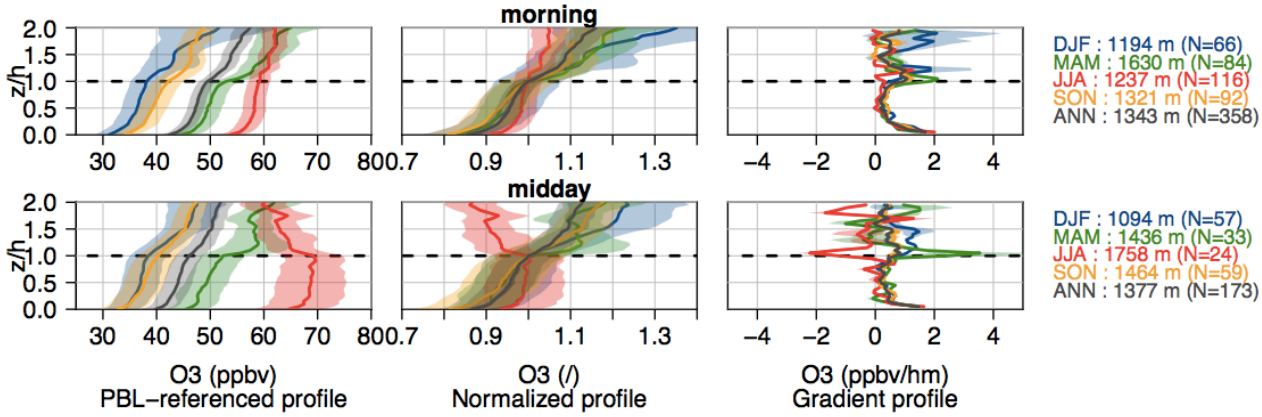


**Figure S2: Vertical profiles of $O_3$ mixing ratios (in ppbv; left panels), same profiles normalized by the $O_3$ mixing ratio at z/h=1 (middle panels), and vertical gradient profiles (in ppbv $hm^{-1}$; right panels), at the Boulder, Colorado, ozonesonde station. Plots are shown only during morning (late morning since most profiles are available after 10:00 LT) and at midday. The shaded area represents the uncertainties (at a 95% confidence level) on the mean. For each season and time slots, we indicate the number of profiles (N) used for calculating the PBL-referenced profile (i.e. profiles without any missing data) and the mean PBL height calculated based on this subset of profiles.**

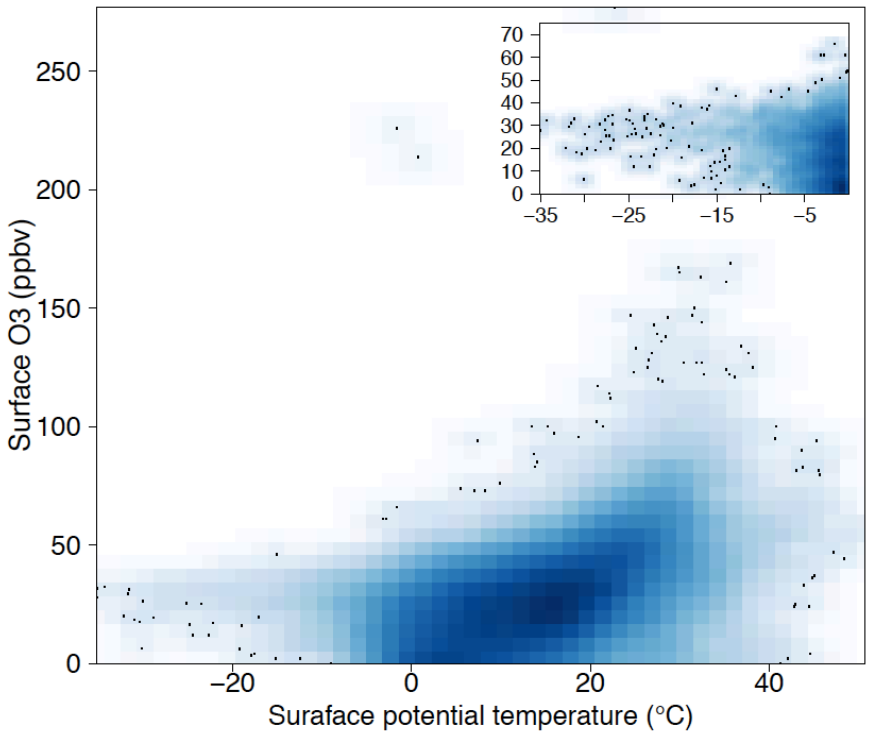


**Figure S3: Density scatter plot of surface $O_3$ mixing ratios against surface potential temperature considering all profiles; a zoom on the negative temperatures is shown in the top-right corner. In each of the two panels, the 100 points corresponding to the lowest densities are shown explicitly.**