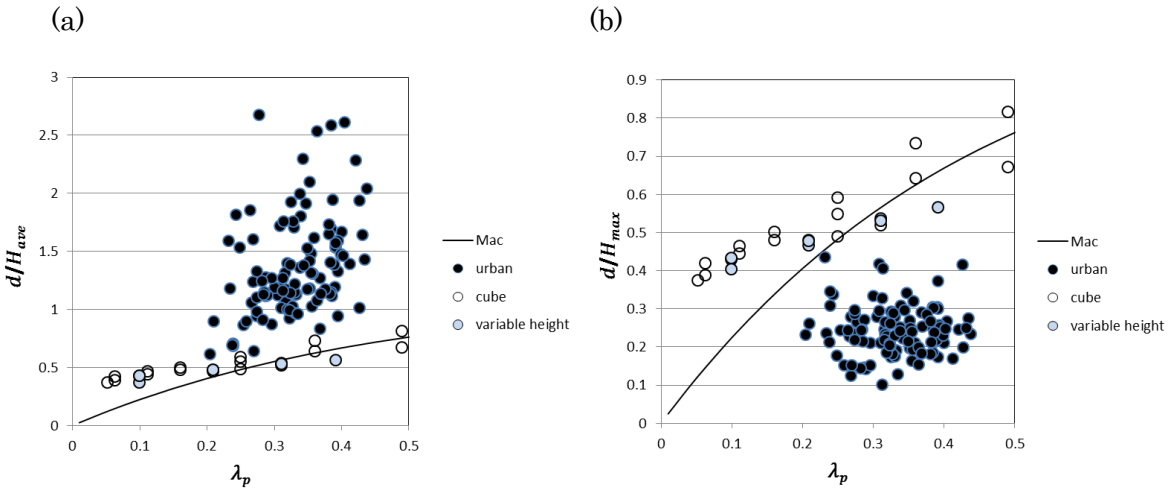
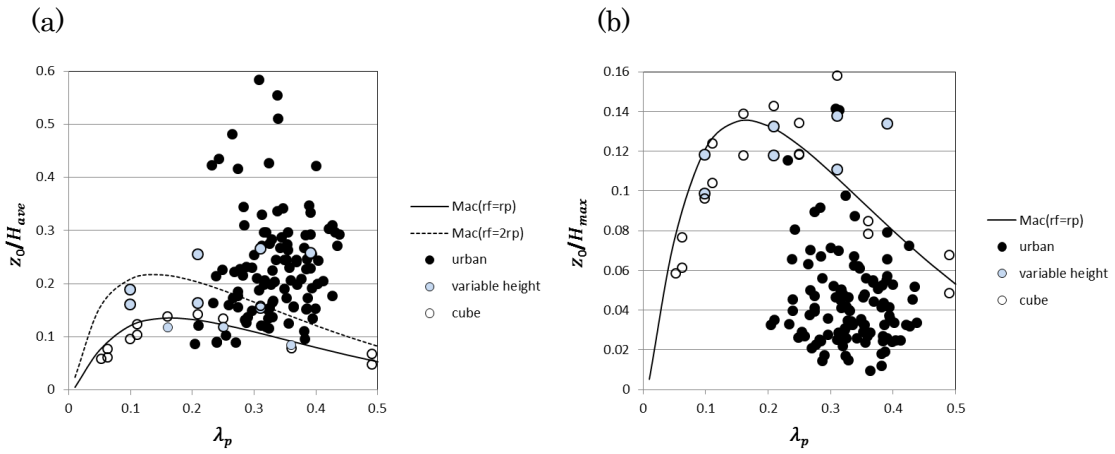
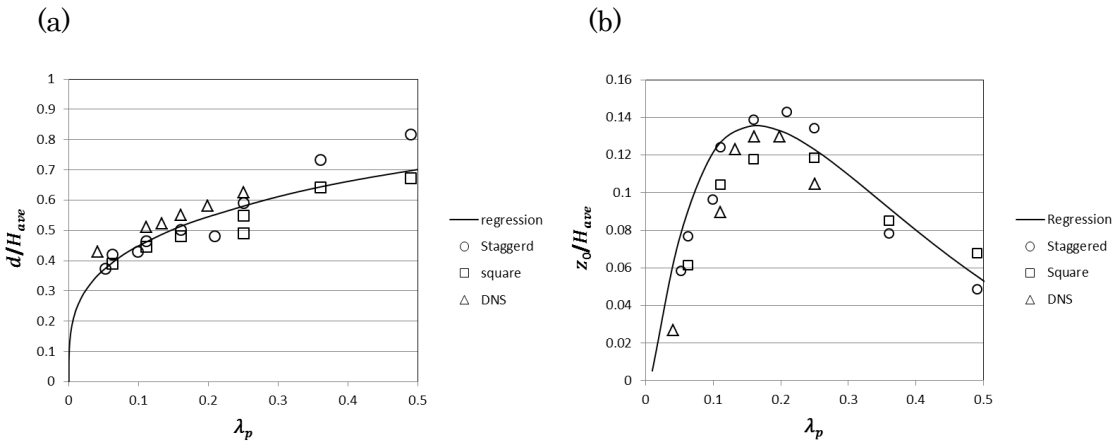


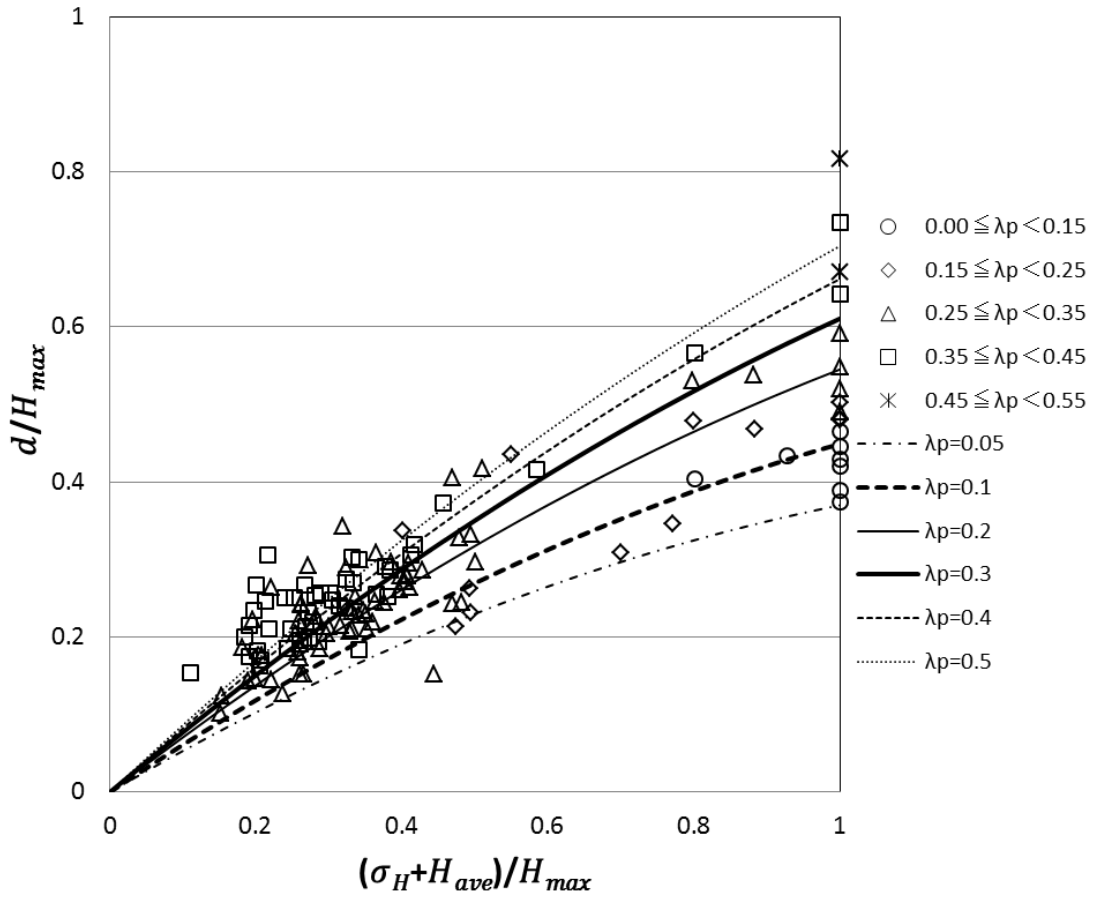
RESULTS for METHOD2 Figure 8 (a) d/H_{ave} versus λ_p with Macdonald equation (Eq. (8)), and (b) same as Fig.8a but replacing H_{ave} with H_{max}, i.e., d/H_{max} versus λ_p. Filled circles: real urban surfaces from LES-Urban, grey circles: simple arrays with variable building height from LES-Urban, open circles: simple array of cubes from LES-Urban, and triangles: simple arrays with variable building height from the experiments by Hagishima et al. (2009). The solid line shows the Macdonald equation (8).



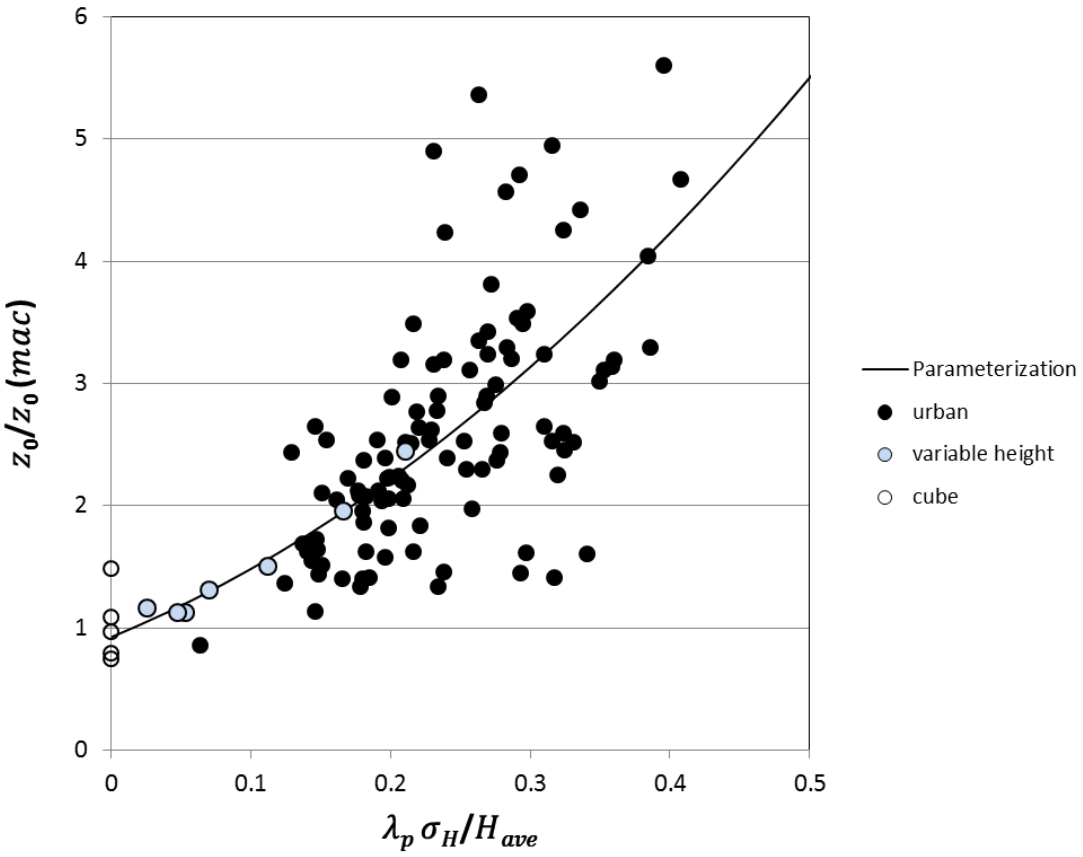
RESULTS for METHOD2 Figure 9 (a) z_0/H_{ave} versus λ_p, with Macdonald equation (9), and (b) same as Fig.9a but replacing H_{ave} with H_{max}, i.e., z_0/H_{max} versus λ_p. Filled circles: real urban surfaces from LES-Urban, grey circles: simple arrays with variable building height from LES-Urban, open circles: simple array of cubes from LES-Urban, and triangles: simple arrays of buildings with variable height from the experiments by Hagishima et al. (2009). The solid line shows Macdonald equation (9) for $\lambda_f = \lambda_p$. The dotted line shows Macdonald equation (9) for $\lambda_f = 2\lambda_p$.



RESULTS for METHOD2 Figure 10 Applicability of new aerodynamic parametrizations in the case of $\sigma_H = 0$ (homogeneous buildings) by Method 1. (a) d/H_{max}versus λ_p, with the new parametrization Eq. (11) as the lower limit of $X = 1$ in Eq. (10). The solid line shows Eq. (11). The "staggered" (open circles) and "square" (open squares) points are from LES-Urban, "DNS" (open triangles) is from Leonardi and Castro (2010), "EXP(Hagishima)" is from Hagishima et al. (2009), and "EXP(Cheng)" is from Cheng et al. (2007). (b) z_0/H_{ave} versus λ_p with the new parametrization (13) as the lower limit of $Y = 0$ in Eq. (12). The solid line shows Eq. (13). The symbols are all the same as in (a).

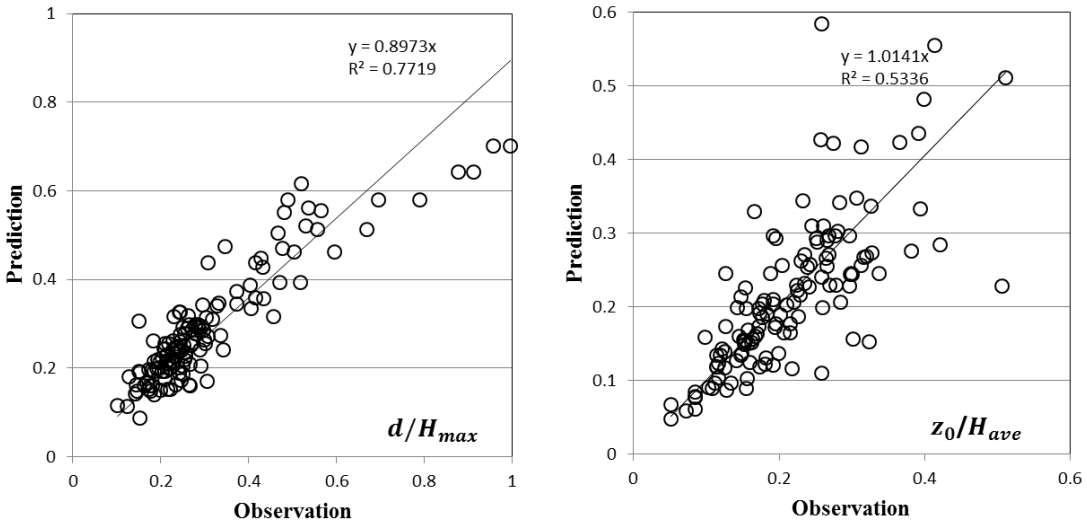


RESULTS for METHOD2 Figure 11 d/H_{max} versus $(\sigma_H + H_{ave})/H_{max}$ with the new parametrization by Method 1. The lines show Eq. (10), while open symbols are from LES-Urban, shaded symbols are from Hagishima et al. (2009), and filled symbols are from Zaki et al. (2011). The plots at X = 1 are consistent with Fig.10a.



RESULTS for METHOD2 Figure 12 $z_0/z_0(mac)$ versus $\lambda_p\sigma_H/H_{ave}$ with the new parametrization by Method 1. Solid line: Eq. (12), filled circles: realistic geometry of LES-Urban, grey circles: variable height of LES-Urban, open circles: cubes of LES-urban, open triangles: Hagishima et al. (2009), and grey triangles: Zaki et al. (2011). The plots at Y = 0 are consistent with Fig.10b.

(a) (b)



RESULT for METHID2 Figure 13 Performance of new aerodynamic parametrizations by Method 2. (a) Displacement height normalized by maximum building height (d/H_{max}) from LES-Urban (x-axis: observation) versus that from new parametrization (y-axis: prediction by Eq. (10)). (b) Roughness length normalized by average building height (z_0/H_{ave}) from LES-Urban (x-axis: observation) versus that from new parametrization (y-axis: prediction by Eq. (12)).