Regional variability of vegetation impact on maximum temperature (T_{smax}) in Kanto Area on summer

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Motivation

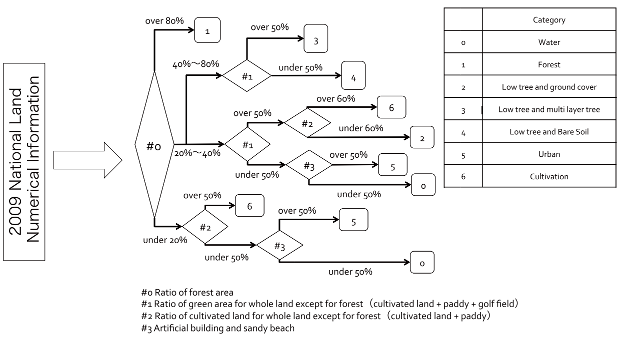
To determine the urban planning and create policies to mitigate high temperature of urban area, impacts of afforestation and land use change should be estimated.
Several urban plannings were proposed. (Yamagata et al. 2011).
This study investigated the impacts of land use change and afforestation for these urban plannings through the experiment using a meteorological model.

Implement surface parameters into JMANHM

Surface parameters to express the land use :
Evapotranspiration coef. (β), Albedo (A), Heat Capacity (C_h)
These value were based on Kondo (2000) and MOriwaki et al. (2002)

Categorization of each grids:
Category of each grids was created from the "2009 National Land Numerical Informatio" and Population of 2010 and 2050 (Ariga and Matsuhashi 2009)

Land use (Category)	Albedo(A)	Heat Capacity (C_h)	Evapotranspiration Coefficient(β)
Forest	0.175	1.3	0.26
Low tree and ground cover	0.17	1.54	0.259
Low tree and multi-year ground cover	0.185	1.3	0.316
Low tree and bear soil	0.157	1.62	0.184
Urban	0.13	2.1	0.07
Cultivation	0.2	1.3	0.4
Water	0.06	4.18	1.0

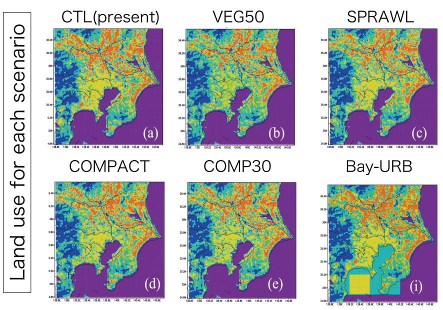


Experimental setup and Scenario experiments

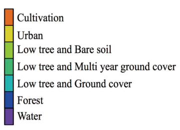
Model and experimental setup
Model : JMANHM(Saito et al. 2006)
Grid resolution: 1km (horiontal), 40m~1120m (vertical)
Microphysics: 1-moment bulk (Yamada 2003)
Turbulence : Nakanishi and Niino (2006)
Surface flux: Land (Louis 1975), Sea(Kondo 1975)
Radiation: Kitagawa(2000)

Initial and Boundary condition : JMA-MANAL (u, v, θ, q_v), NCEP2(SST)
Calculation time : 10 days (20070810 00UTC ~ 20070817 00UTC)

Scenario experiment

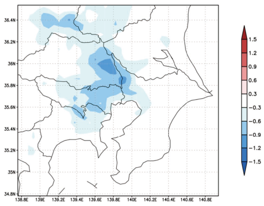


Scenario	Name
Present	CTL
Afforestation for 50% of urban	VEG50
Dispersed city (Yamagata et al. (2011)	SPRAWL
Compact city (Yamagata et al. (2011)	COMPACT
Compact city + Afforestation for 30% of urban	COMP30
Put urban area over Sagami bay	Bay-URB



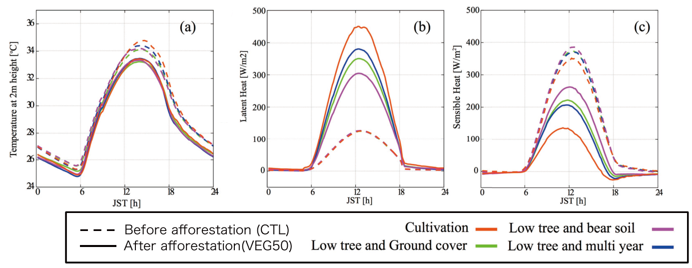
Impacts of afforestation

Difference of T_{smas} ($\Delta T = T_{smax,CTL} - T_{smax,VEG50}$)



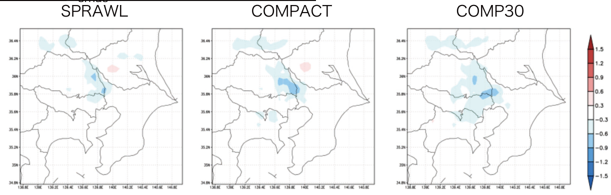
- Land use change from "Urban" to "vegetation" resulted in the reduction of T_{smax}
- The reduction of T_{smax} was derived from conversion in main surface heat flux from latent heat flux to sensible heat flux

Daily variation of T_s, Latent heat and Sensible heat



Impacts of urban planning on T_{smax}

Difference of T_{smas} (ΔT) for each scenario



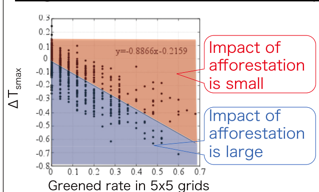
Greened area (Area of Urban → Vegetation) [km²]

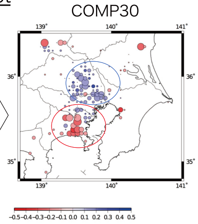
1165	1444	1785

- Compact city was more effective for reducing T_{smax} than dispersed city.
- The afforestation futher reduced T_{smax}
- This came from the difference of greened (vegetated) area

Regional variability in the impact of afforestation

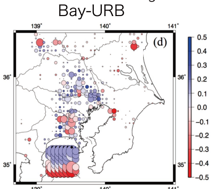
Magnitude of the afforestation impact





Inland area→Large

Coastal area→Small



Coastal area→upwind region:
Only the afforestation of its own area contributed to reduce T_{smax}
Inland area→donwind region:
Afforestation of its own area and afforestation of upwind region both contributed to reduce T_{smax}

Summary

- Surface parameters were implemented into JMANHM
- Compact city and Afforestation was effective for reducing T_{smax}
- Afforestation of coastal region which is upwind region for general wind contributed to not only reducing T_{smax} in its own area but also that of inland (downwind region) region.

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