Global Urban Parameters for CLM

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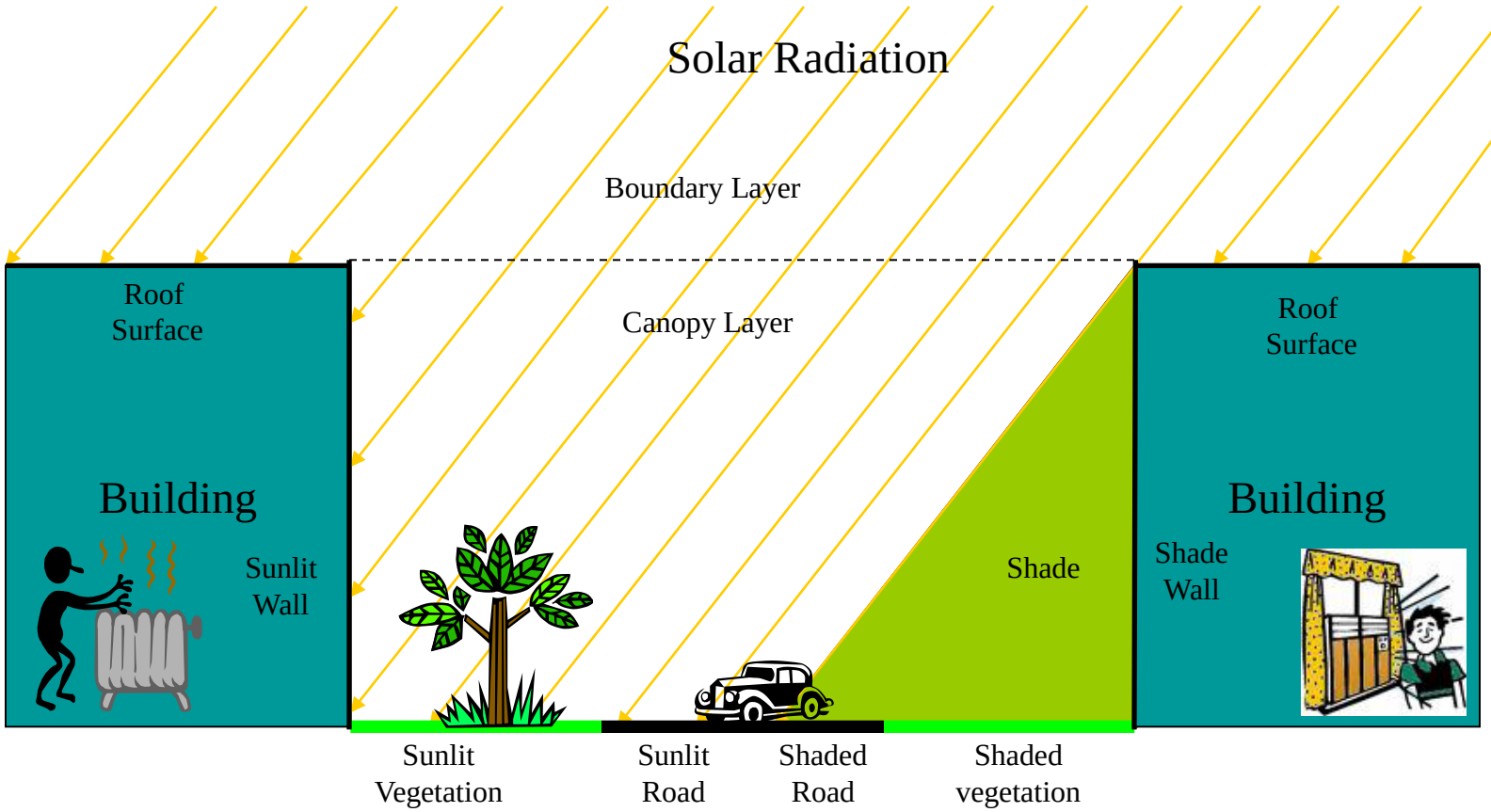
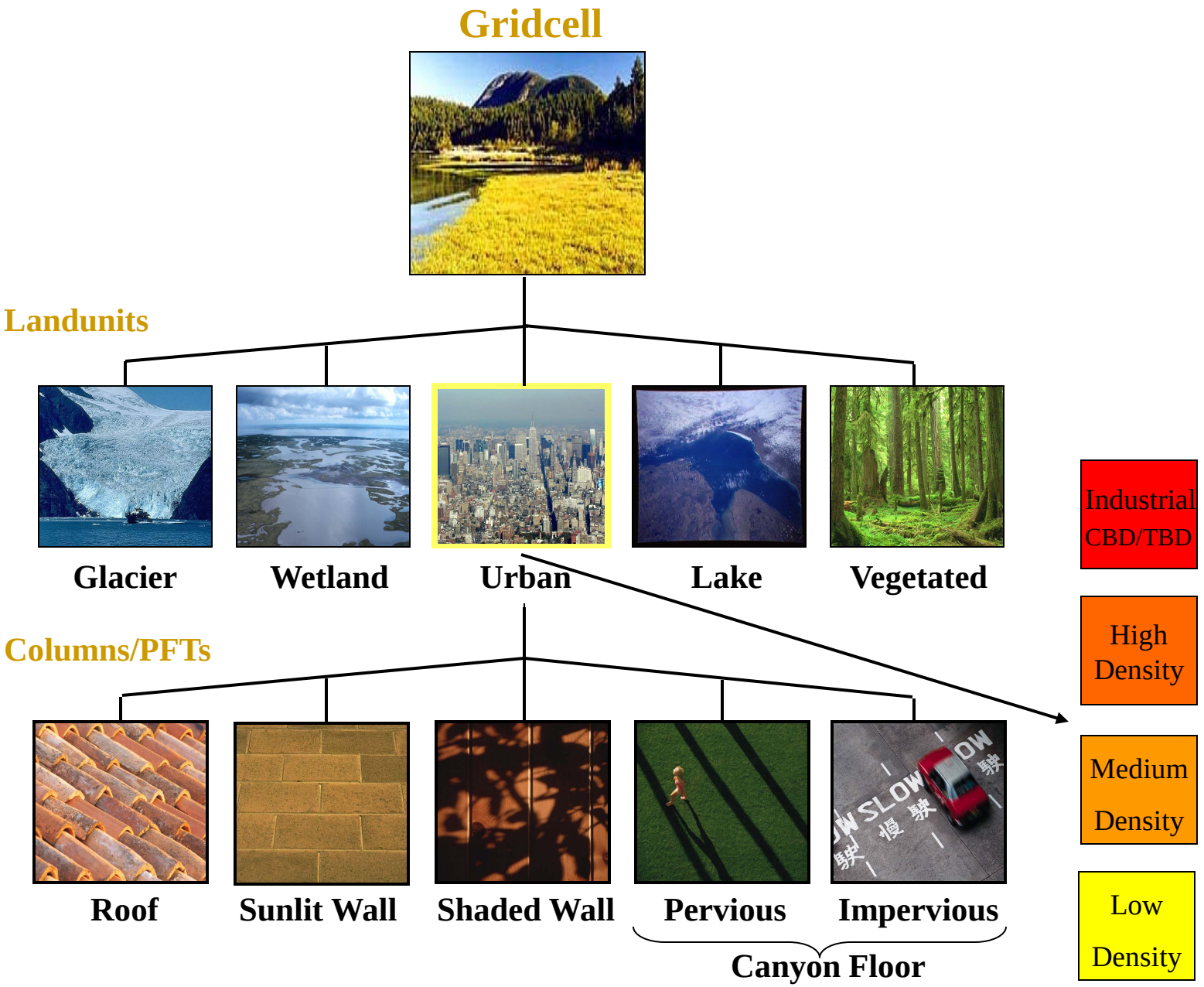
Urban Canyon Model



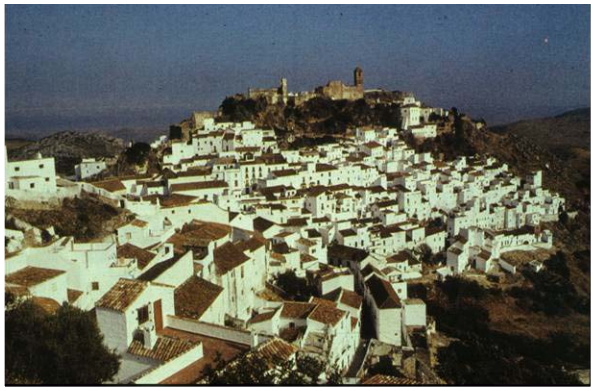
Model Parameter/data needs

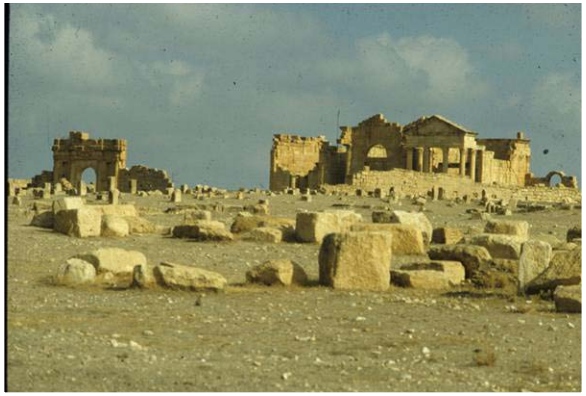
- **Global delineation of urban areas**
- **Geometric and radiative properties of the canyon**
- **Surface and conductive properties of walls, roofs (road properties assumed constant)**
- **Information on human activity and energy consumption levels**

Representing urban areas in CLM/CCSM



What is Urban?





Defining Urban Classes (US)

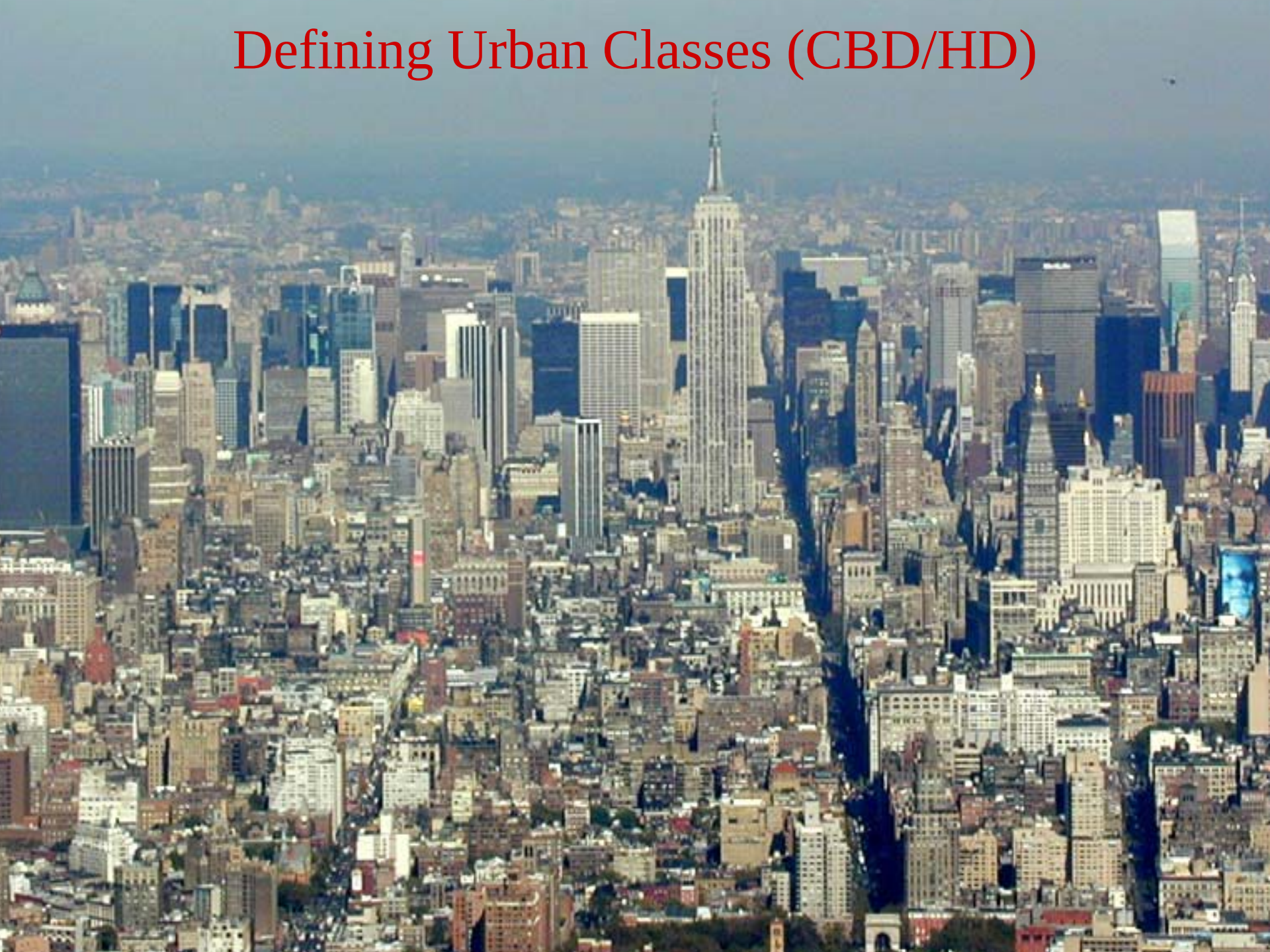
Low Density

Medium Density

High Density

CBD

Defining Urban Classes (CBD/HD)



Urban Characteristics: Nairobi

Urban Characteristics: Nairobi (Kibara Slum)

Defining Urban Classes (LD/HD ??)

Urban Characteristics: Nairobi

Urban Characteristics: Kigali

Urban Characteristics: Northern France (0.5 degree view)

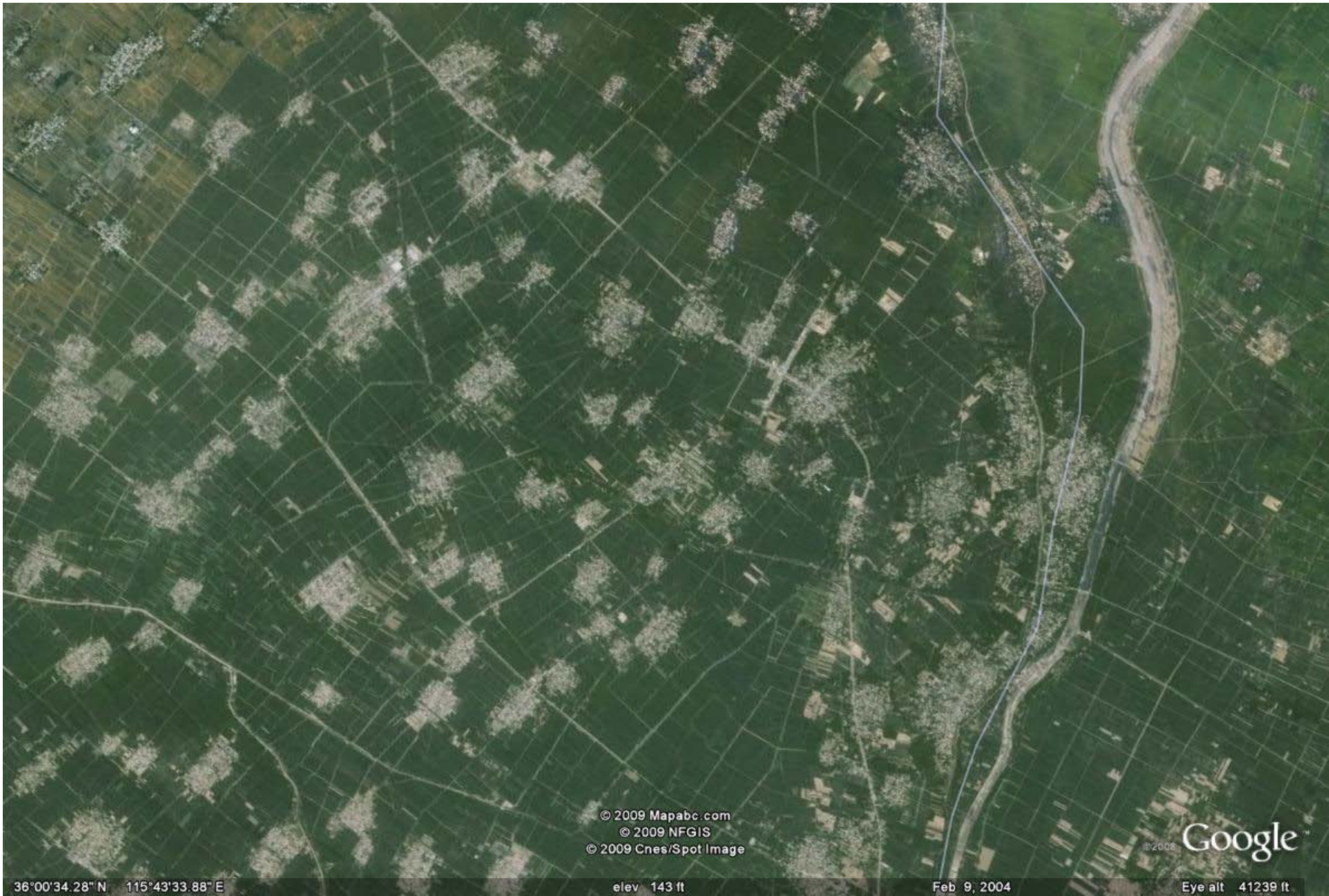
Urban Characteristics: Northern France

Urban Characteristics: Northern France

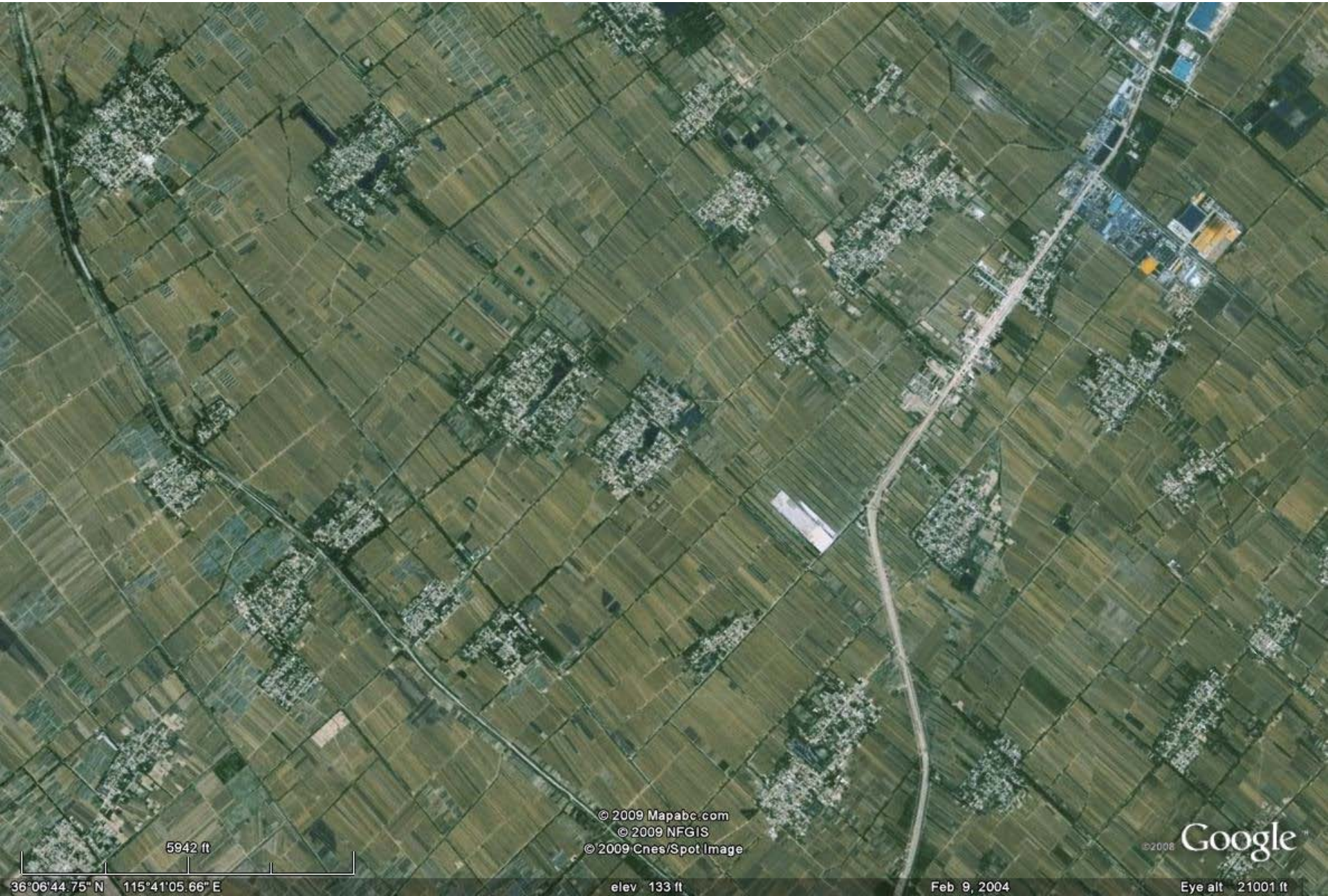
Urban Characteristics: England

Urban Characteristics: China

Urban Characteristics: China

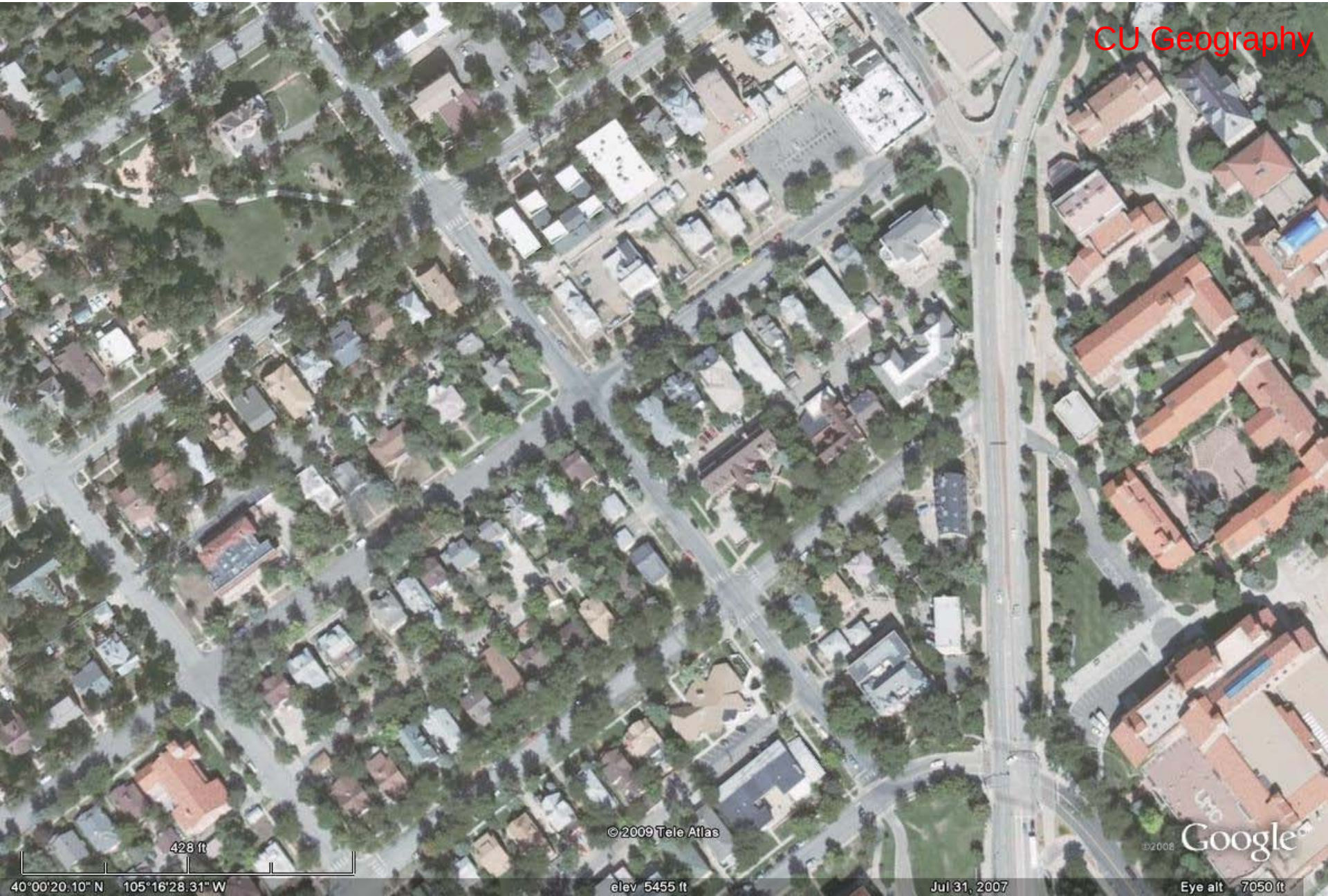


Urban Characteristics: China (0.5 degree view)

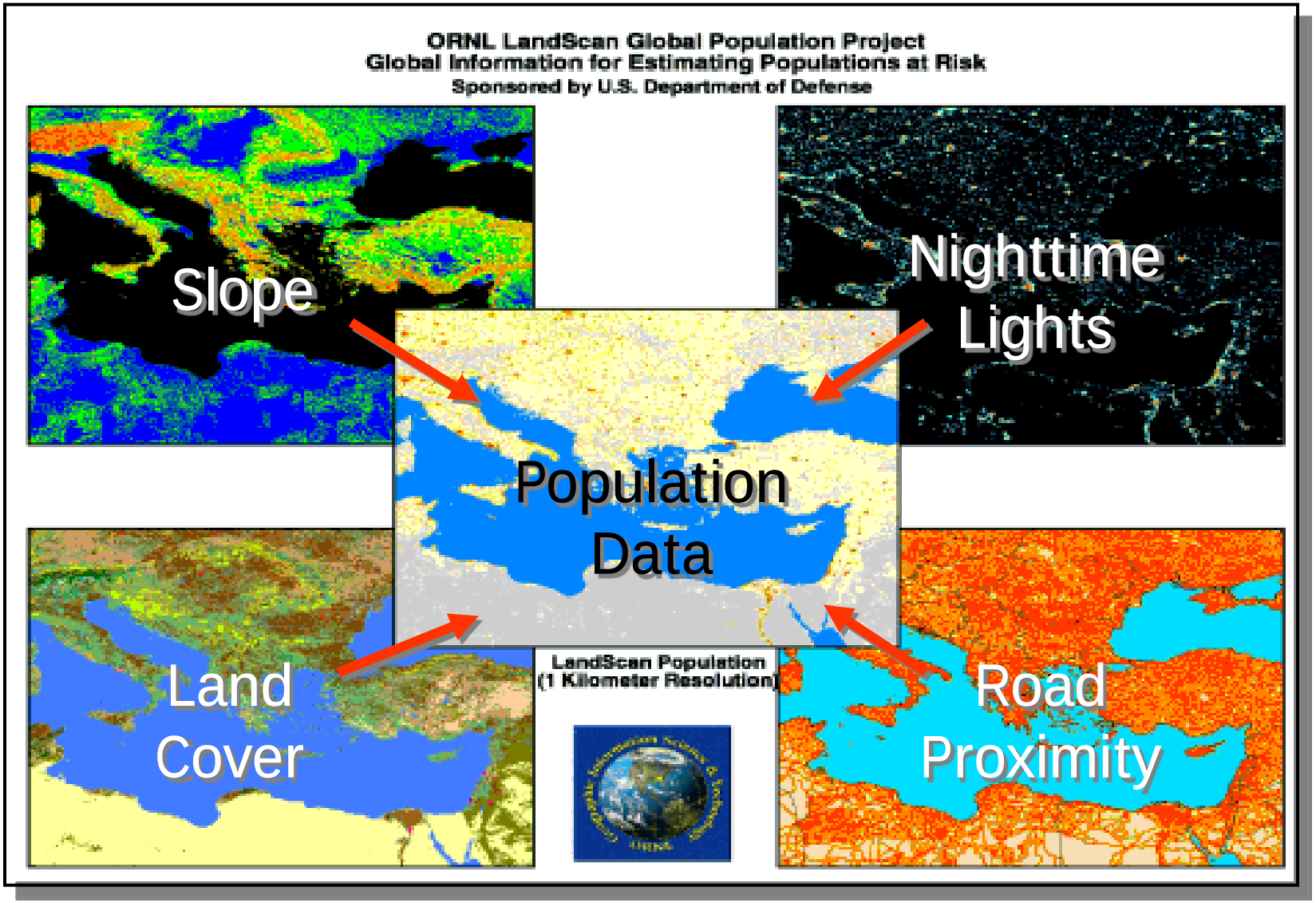


Urban Characteristics: China

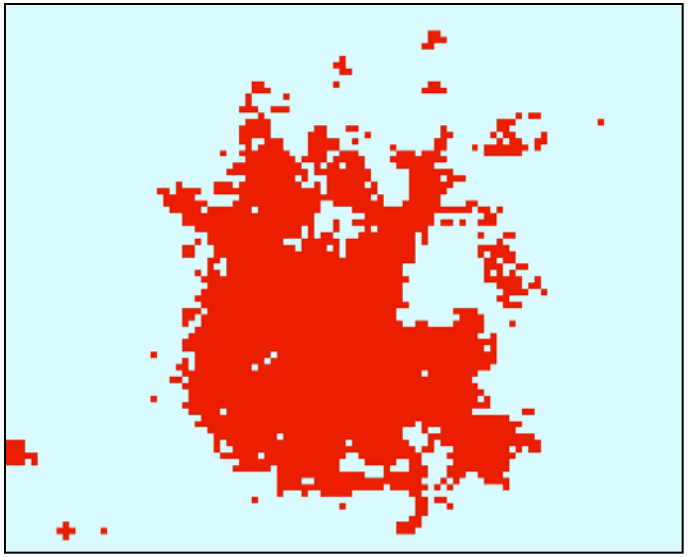
Urban Characteristics: Boulder



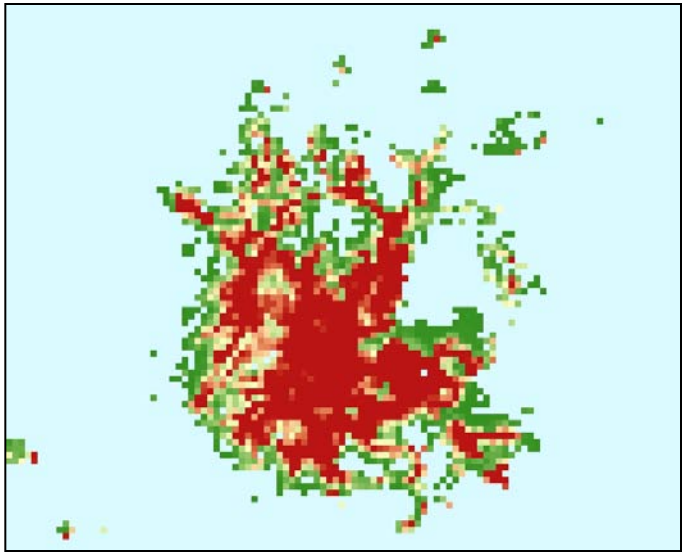
Population Dataset – LandScan



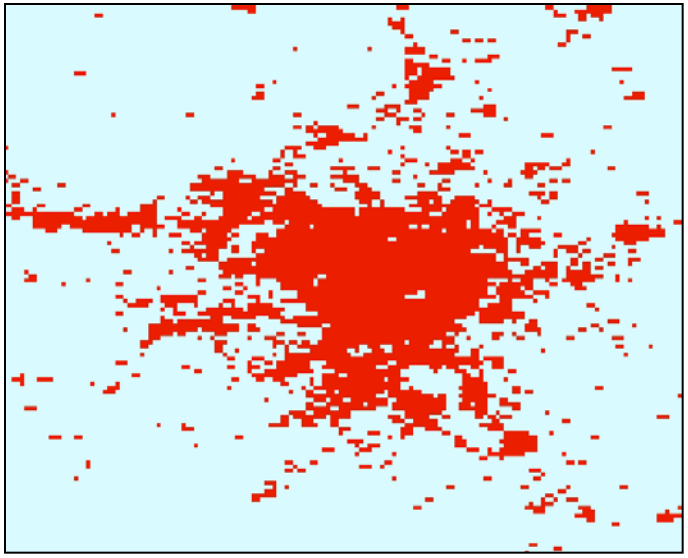
(Dobsen et al, 2000)



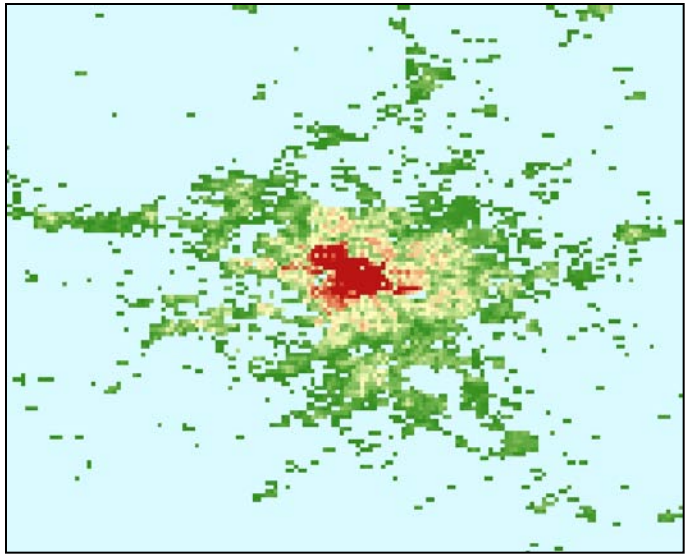
MODIS Mask of Mexico City



Mexico City *(Landscan)*

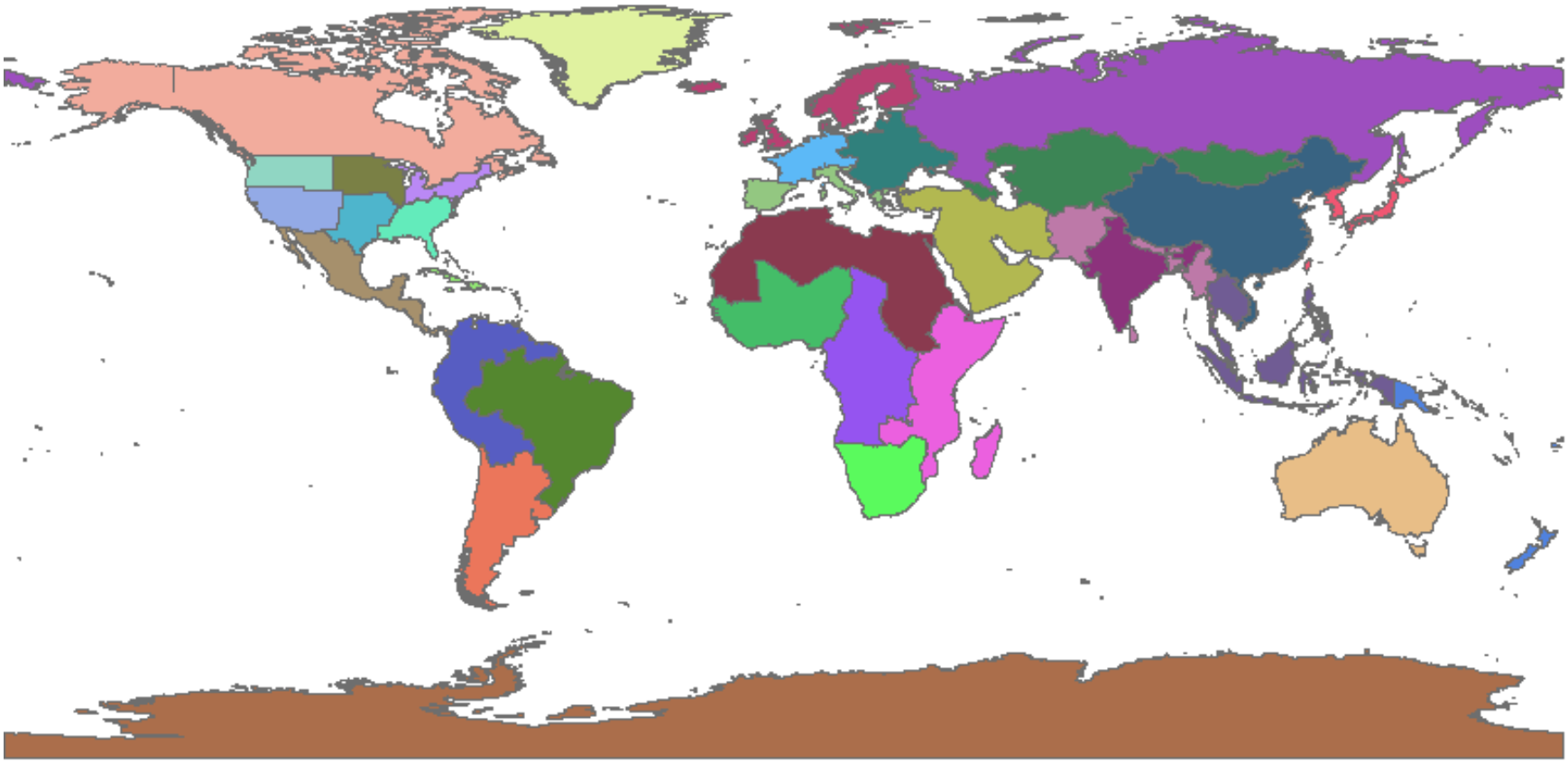


MODIS Mask of Paris



Paris *(Landscan)*

30 Regions With Similar Urban Character



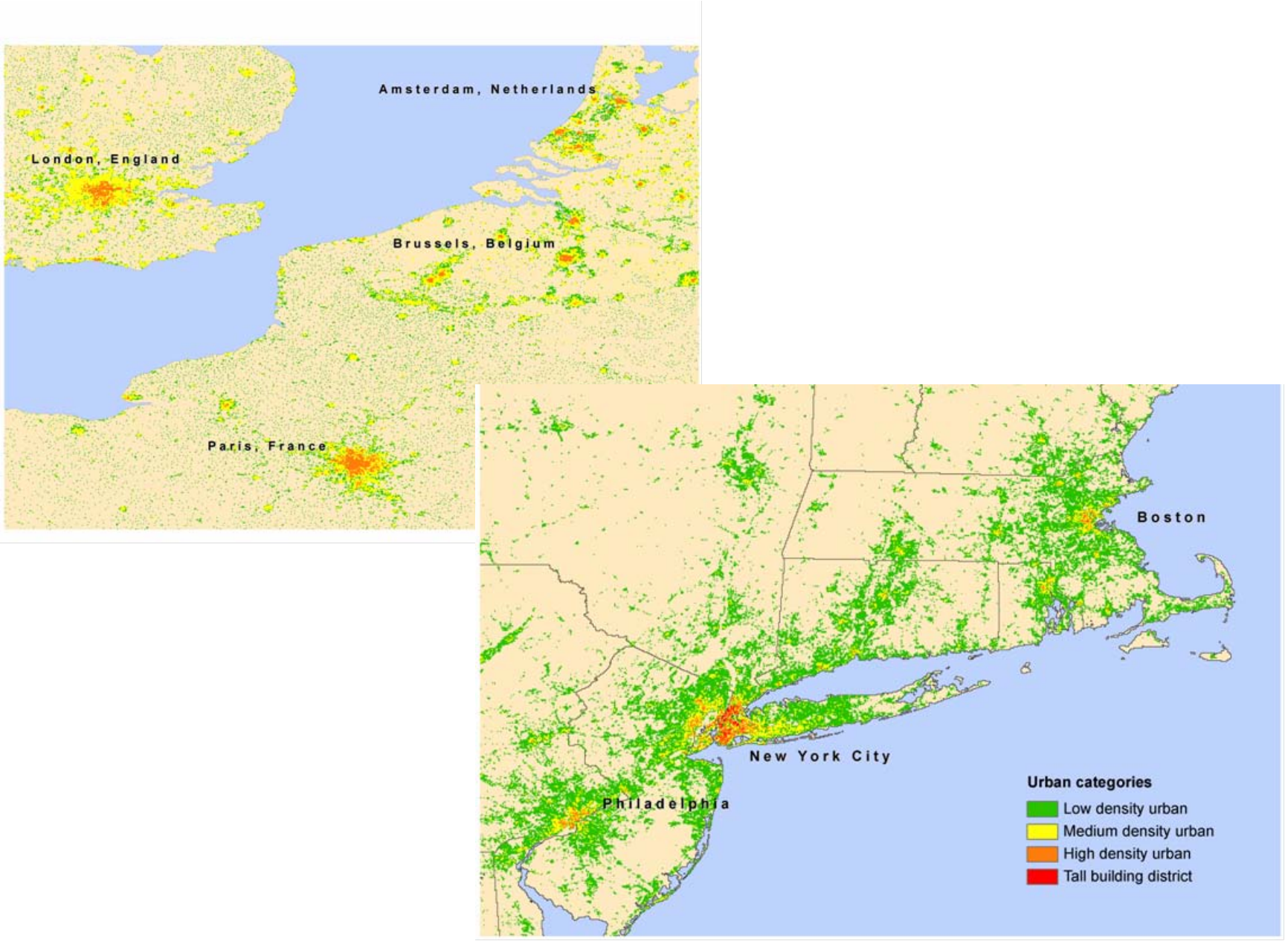
Verification Cities

Alaska	Australia	Brazil	Canada	Carribean	China	C_Africa	C_Asia	E_Asia	E_Africa	E_Europe
Anchorage	Sydney	Sao Paulo	Montreal	Havana	Shanghai	Kinshasa	Almati	Pyongyang	Lagos	Warsaw
Kotzebne	Melbourne	Taboao de	Ottawa	Kingston	Suzhou	Brazzaville	Ulaanbaata	Nampo	Ikorodu	Wroclaw
Fairbanks	Bendings	Jandira/Ita	Saskatoon	Port au Pri	Jiazing	Luanda	Baki/Baku	Songnim	Kano	Poznan
Kodiak	Wagga Wa	Barueri	Calgary	San Juan	Fuzhou	Mbuji-Mayi	Bakixanov	Seoul	Kaduna	Bydgoszcz
Prudhoe Ba	Newcastle	Jundiai	Edmonton	Santiago	Nantong	Bafoussam	Sumqayit	Suwon	Ibadan	Grudziadz
Barrow	Canberra	Atibaia	Vancouver	Santo Dom	Kashi	Bamenda	Tashkent	Gunpo	Benin	Torun
Juneau	Mackay	Rio de Jan	Victoria	Holguin	Lasa	Douala	Angren	Uiwang	Adis Abeba	Gdynia
Sitka	Townsville	Mesquita	Toronto	Santa Clar	Chongqing	Malabo	Baku	Anyang	Antananari	Gdansk
Cordova	Perth	Belem	Sidney	Port of Spa	Xi'an	Uvira	T'Bilisi	Bucheon	Dodoma	Bucharest
Ketchikan	Rockingha	Curitiba	Quebec	Castries	Xianyang	Lubumbasl	Dushanbe	Kimpo	Kampala	Kiev
	Darwin	Jpessoa			Beijing	N'Djamena	Karaganda	Tokyo	Kigali	Minsk
	Bagot	Manaus			Canton		Bishkek	Hiratsuka	Maputo	Prague
		Porto Alegre			Chengdu		Ashgabat	Minamiash	Nairobi	Riga
		Salvador			Haikou		Astana	Odawara	Bujumbura	Sarajevo
		Santos			Tianjin		Yerevan	Sendai	Mogadishu	Herzegovin
					Shenyang			Yamagata	Lusaka	Vilnius
					Hong Kong			Taipei	Djibouti	Tallinn
								Hamamats	Lilongwe	Chisinau
								Nagoya	Nampula	
								Naha	Dar-es-Salaam	
								Osaka		
								Kyoto		
								Sapporo		

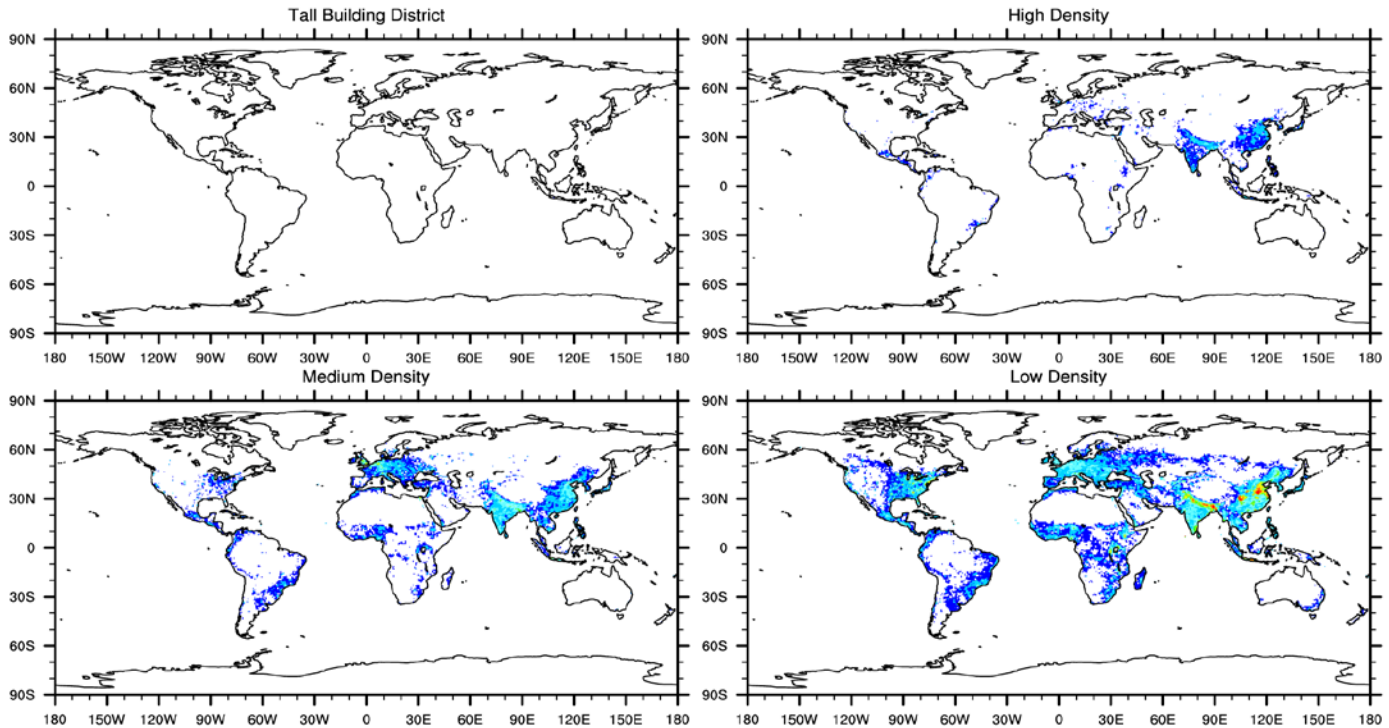
Greenland	India	Mid_Amer	Mid_East	N_Africa	N_Europe	NC_US	NE_US	NW_US	Oceania	Russia
Nuuk	Hyderabad	Mexico Cit	Riyadh	Alexandria	Stockholm	Chicago	New York (	Seattle	Honiara	Moscow
Maniitsoq	Indore	Tlalnepantl	Lefkosia	Algiers	Oslo	Minneapoli	Baltimore	Portland	Port Mores	Vidnoje
Tasiilaq	Mumbai	Ojo de Aqu	Istanbul	Asmara	Copenhage	Pierre	Philadelphi	Tacoma	Taytay	St. Petersb
Ittoqqortoo	Thana	Toluca	Sultanbeyli	Cairo	Bergen	Bismarck	Detroit	Beaverton	Saipan	Murmansk
Sisimint	Navi Mumb	San Jose	Ankara	Casablanc	Helsinki	Madison	Akron	Boise	Koror	Arcangel
Kangerluss	Utan	Panama Ci	Baghdad	Khartoum	Birminghar	Lincoln	Rochester	Cheyenne	Hagatna	Rostov-na-
Illulissat	Ulhasnaga	San Miguel	Tehran	Nouakchot	Cardiff	Champaign	Buffalo	Laramie	Bairiki	Chelyabins
Uummanna	Bhiwandi	La Chorrer	Eslamshah	Tripoli	Dublin	Fargo	Cleveland	Great Falls	Honolulu	Norilsk
Qeqertarsu	Bangalore/	San Salvac	al Basrah	Tunis	London	Rapid City	Boston	Spokane	Papeete	Novosibirsk
Qaqortoq	Bombay	Managua	Hawalli	Tangier	Edinburgh	Milwaukee	Washingto	Opportunity	Apia	Vladivostok
	New Delhi	Guatemala	Abu Dhabi						Pago Pago	Khabarovsl
	Calcutta	Monterrey	Doha							
	Madras	Pachuca	Kuwait City							
	Ahmadaba	Guadalajar	Muscat							
	Gauhati	Belmopan	Sana'a							
	Ernakulam		al Manamah							
	Nagpur		Beirut							

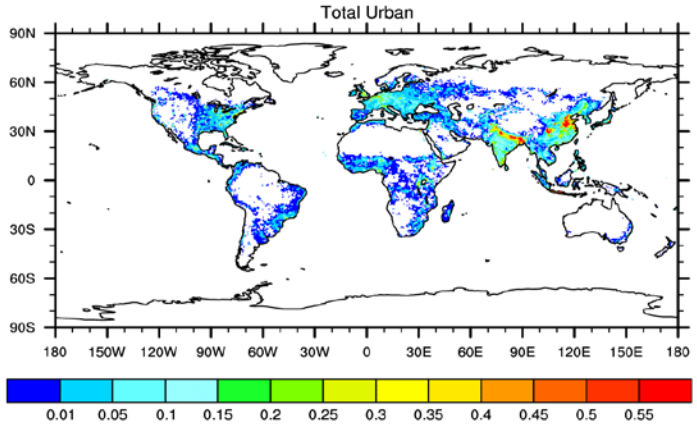
S_Africa	S_Asia	S_Europe	SC_US	SE_Asia	SE_US	SW_US	Temp_SAm	Trop_SAm	W_Africa	W_Eur
Nelspruit	Dhaka	Athens	Austin	Rangoon	Atlanta	Los Angele	Buenos Air	Lima	Lagos, nige	Berlin
Maseru	Tungi	Barcelona	Houston	Singapore	Miami	Malibu	La Plata	Callao	Abidjan	Paris
Cape Towr	Narsingdi	Las Palma	Dallas	Johor Bah	Charlotte	Oxnard	Cordoba	Maracaibo	Ikorodu	Vienna
Pretoria	Khulna	Lisbon	San Antoni	Padang	Pensacola	San Diego	Santiago	Caracas	Lome	Linz
Mbabane	Chatlagam	Madrid	St. Louis	Medan	New Orlea	Phoenix	Asuncion	Medellin	Bouake	Leipzig
Harere	Barisal	Milan	Kansas Cit	Manila	Richmond	Albuquerqu	Mendoza	Itagui	Treichville	Amsterdam
Johannesb	Sandip	Naples	Wichita	Taytay	Memphis	Denver	Bahia Blan	Barranquill	Kumasi	Lichtenstei
Windhoek	Colombo	Thessaloni	Tulsa	Cibu	Louisville	Las Vegas	Montevide	San Cristol	Yamousso	Oelsnitz
Durban	Kathmandu	Rome	Oklahoma	Bangkok	Birminghar	San Franci	La Paz, Uri	Cucuta	Conakry	Marseille
Bloemfonte	Lalitpur	Valletta	El Paso	Ho Chi Min	Orlando	Oakland	Mar del Pla	Quito	Dakar, Sen	Brussels
Gaborone	Thimpu									

Final Classified 1-km resolution product



Example: Urban Input data



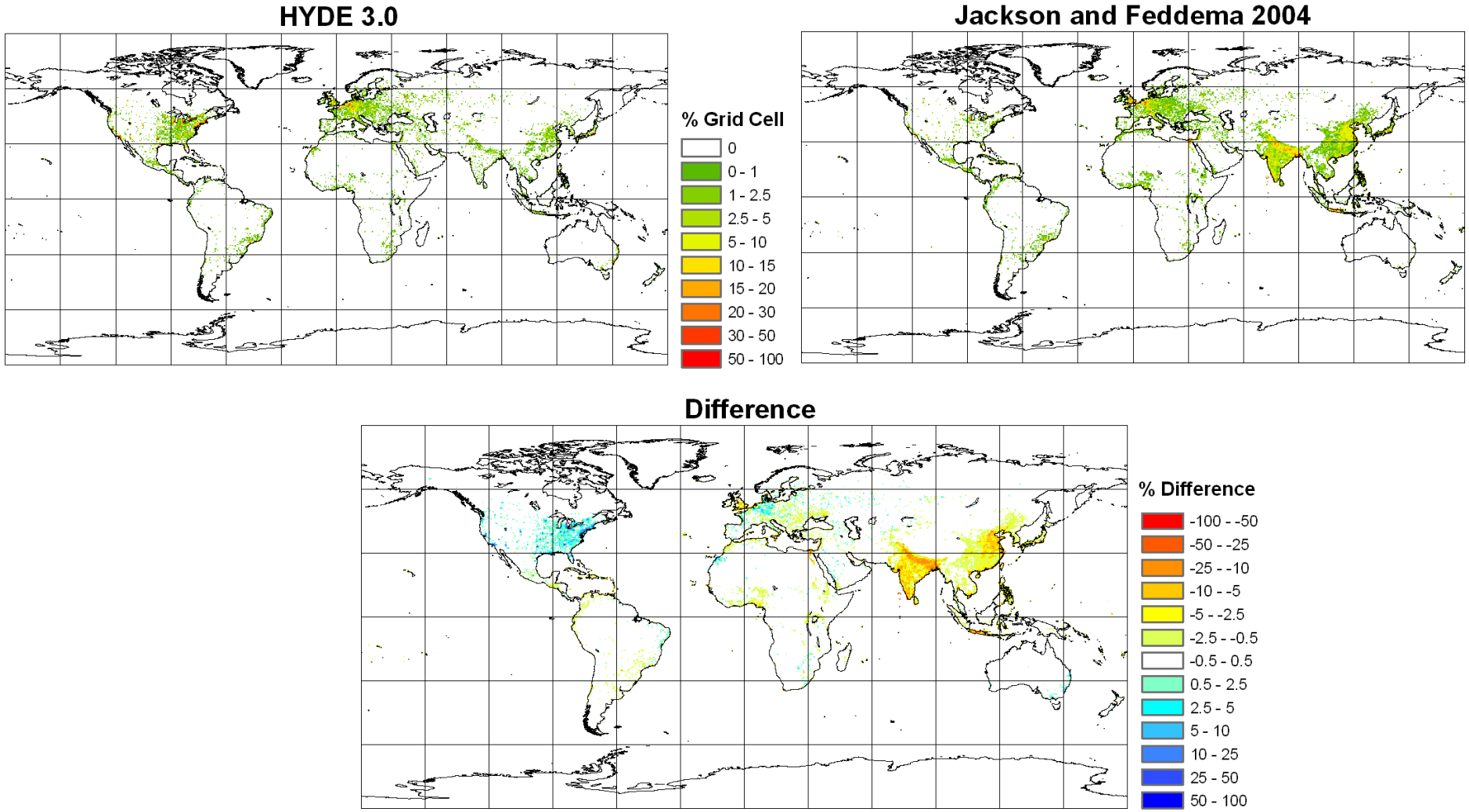


Urban Fraction at 0.5°

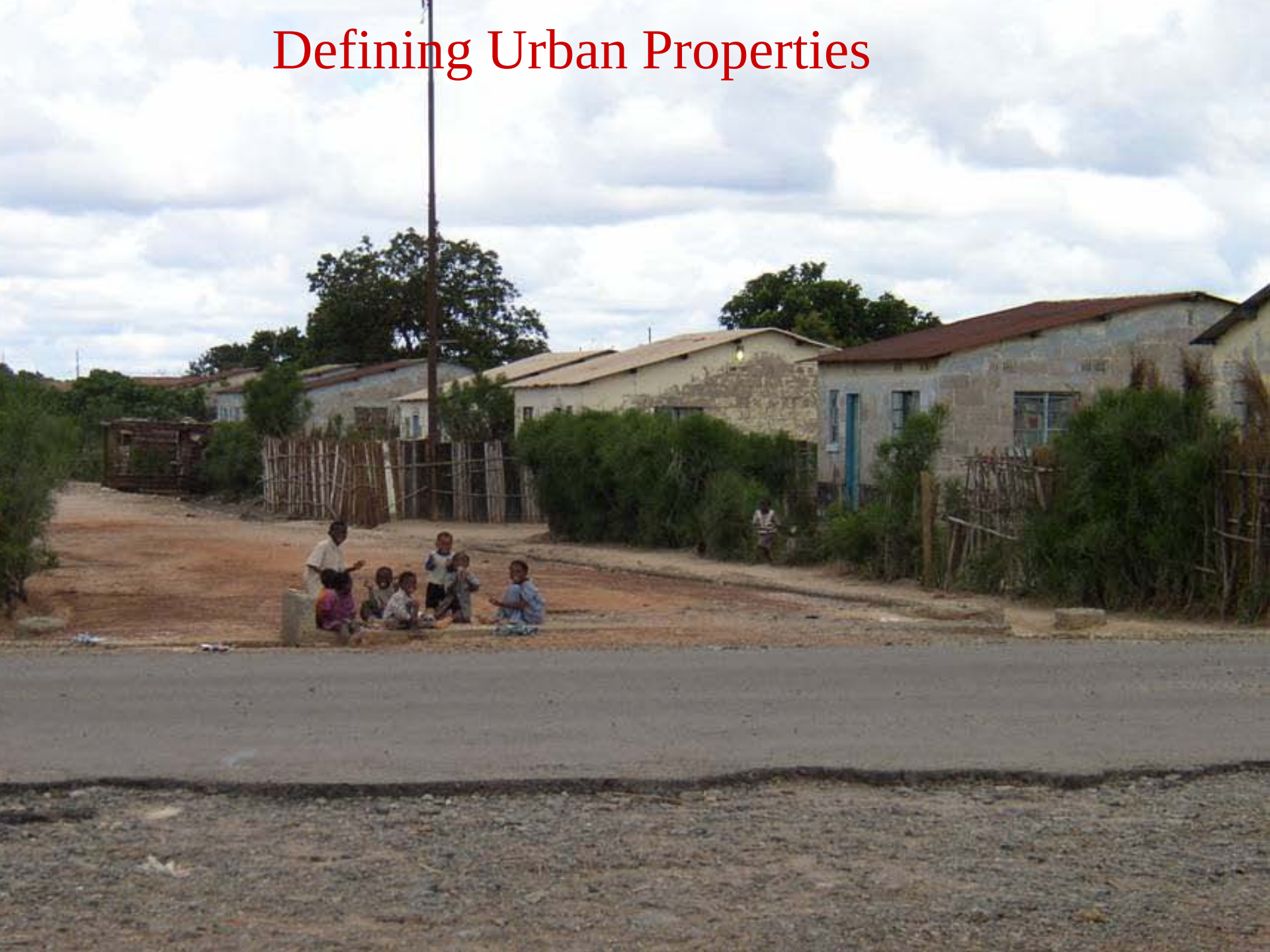
Final product aggregates TBD, HD and MD areas

No LD included

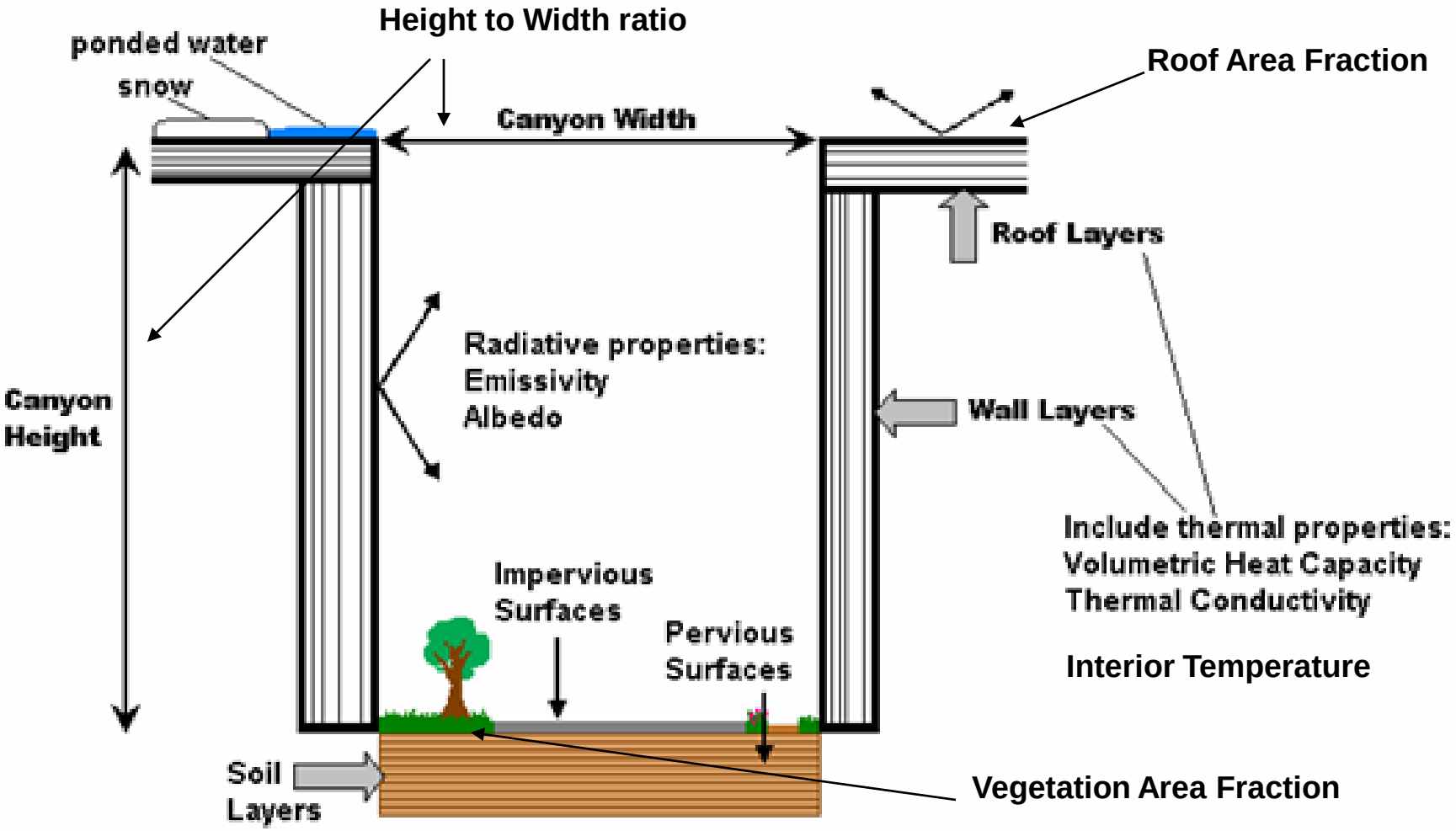
Urban land cover



Defining Urban Properties



Required parameters CLM



Wall Types Descriptions

Wall Type	Description	Source
Conc panels/conc masonry	Pre-cast concrete panels over reinforced concrete masonry insulated with extruded polystyrene (XPS). Interior is finished with drywall.	Mukhopadhyaya *et al.* 2004b
Glass curtain	Glass wall over steel frame construction. Only glass considered because it has greatest surface area.	Vigener and Brown 2007, Schwartz 2001
Brick veneer/conc masonry	Brick masonry façade over reinforced concrete block masonry insulated with XPS. 25 mm drainage cavity between brick and concrete. Interior is finished with drywall.	Mukhopadhyaya *et al.* 2004b
Stone curtain/conc masonry	Stone façade over reinforced concrete block masonry insulated with XPS. 25 mm drainage cavity between brick and concrete. Interior is finished with drywall.	Scheffler 2007, Mukhopadhyaya *et al.* 2004b
Plaster veneer/brick masonry	Plaster façade over reinforced brick masonry with glass fiber insulation. Interior is finished with drywall.	Mukhopadhyaya *et al.* 2004b, PCA 2007
Plaster veneer/conc masonry	Plaster façade over reinforced concrete block masonry with glass fiber insulation. Interior is finished with drywall.	Mukhopadhyaya *et al.* 2004b, PCA 2007
EIFS façade/wood frame	Exterior Insulation and Finish System (EIFS) (a.k.a. synthetic stucco), insulated with expanded polystyrene (EPS) over wood frame. Interior is finished with drywall.	Mukhopadhyaya *et al.* 2003, 2004a
Cement board/wood frame	Cement board, 12mm air cavity, fiberboard, insulated, installed over wood frame. Interior is finished with drywall.	Maref *et al.* 2007, Mukhopadhyaya *et al.* 2004a
Wood frame/hardbrd siding	Painted hardboard siding installed over oriented strand board (OSB), insulation and wood frame. Interior is finished with drywall.	Mukhopadhyaya *et al.* 2003, Sahal and Lacasse 2004
Wood	Painted wood siding over plywood	

Roof Descriptions

Roof Type	Description	Source
BUR/concrete deck	Built-up-roof (BUR) of asphalt-based materials (e.g. felt, bitumen) over insulated cellular concrete deck.	Foamglas 2005, 2006, Knauf 2005a, BUR thickness: Paroli *et al.* 1996.
BUR/wood deck	Built-up-roof (BUR) of asphalt-based materials over insulated wood deck.	Foamglas 2005, 2006, Knauf 2005a, BUR thickness: Paroli *et al.* 1996.
PVC/steel deck	Polyvinyl chloride (PVC) membrane (typically polyester reinforcing fabric between two PVC sheets) over insulated steel deck.	Knauf 2005a, Baskaran *et al.* 2003
EPDM/steel deck	Ethylene Propylene Diene Monomer (EPDM) single-ply membrane over insulation and steel deck.	Knauf 2005a, Baskaran *et al*. 2003, Roofhelp.com 2007
Galv steel/metal bar joists	Galvanized steel, insulated, over metal bar joists.	USACE 1998
Corrugated metal (iron/tin)	Single layer of corrugated iron or tin.	n/a
Shingles/wood deck	Asphalt shingles over wood deck. Considered to be a cold roof, because insulation is on attic floor or is part of ceiling, not as part of roof.	Knauf 2004b, 2005b
Ceramic tiles/wood deck	Ceramic tiles over wood deck - cold roof, but air pockets provide some insulation.	Knauf 2004b, 2005b
Thatch	Thatch roof supported by timber.	Thatch.org 2007
Slate tiles/wood deck	Slate tiles over wood deck - Considered to be a cold roof, because insulation is on attic floor or is part of ceiling, not as part of roof.	Knauf 2004b, 2005b
Metal tiles/wood deck	Metal tiles over wood deck. Considered to be a cold roof, because insulation is on attic floor or is part of ceiling, not as part of roof.	Knauf 2004b, 2005b
Mud	Mud, usually supported by wire mesh.	Binici *et al.* 2005

Exterior Wall Materials and Properties

Material Categories	Therm_Cond_W/m*K (tk)	Dens_kg/m^3	Spec_Ht_J/kg*C	Volumetric Heat_Cap_J/m^3*K (vc)	Emissivity	Albedo	Source of thermal properties	Source of Emissivity value	Source of Albedo value
EXTERIOR/SURFACE MATERIALS									
concrete (cast, dense, reinforced)	1.90	2500	840	2.10E+06	0.88	0.23	Clarke 2001	Oke, Clarke, and Omega	Oke 1987
concrete, blocks (hollow, mediumweight	0.86	930	840	7.81E+05	0.94	0.23	Clarke 2001	Clarke and Omega agree	Oke 1987
painted concrete masonry	n/a	n/a	n/a	n/a	0.93	0.60	n/a	Omega (average of white	Reagan and Acklam 19
concrete, precast panel	1.28	2100	1010	2.12E+06	0.90	0.23	Clarke 2001	Clarke "concrete and plai	Oke 1987
cement board (cement fibreboard)	0.08	350	1300	4.55E+05	0.70	0.25	Clarke 2001	Infrared Services, Inc. 20	Levinson and Hashem 2
brick (reinforced)	1.10	1920	840	1.61E+06	0.91	0.3	Clarke 2001	Oke, Clarke, and Omega	Oke 1987
clay brick (for North America)	0.50	1900	800	1.52E+06	0.91	0.3	Mukhopadhyaya et al. 20	Oke, Clarke, and Omega	Oke 1987
limestone	2.90	2750	840	2.31E+06	0.86	0.28	Clarke 2001	Oke, Clarke, and Omega	Oke 1987
granite	3.49	2880	840	2.42E+06	0.68	0.33	Clarke 2001	Omega and Clarke avera	Weast 1981
sandstone	1.30	2150	840	1.81E+06	0.79	0.35	Clarke 2001	Omega and Clarke avera	Oke, high end of range
stone average	2.56	2593	840	2.18E+06	0.78	0.32	n/a	average of limestone, gra	average of limestone, g
mud or adobe	0.60	1600	880	1.41E+06	0.90	0.35	Straube and Burnett 2005	Omega	average of Omega's "ac
wood, unpainted	0.14	510	2050	1.05E+06	0.86	0.40	Clarke 2001 (average of 7	Clarke and Omega avera	Wechsler and Glaser 19
wood, painted	0.14	510	2050	1.05E+06	0.84	0.38	Clarke 2001 (average of 7	Clarke and Omega avera	average of Oke, Reaga
siding (aluminum or vinyl)	0.70	2700	880	2.38E+06	0.91	0.54	Mukhopadhyaya et al. 20	Clarke (PVC)	Wechsler and Glaser 19
hardboard siding	0.12	917	1880	1.72E+06	0.84	0.49	Mukhopadhyaya et al. 20	Clarke and Omega avera	average of Oke, Reaga
stucco or plaster	0.60	1250	913	1.14E+06	0.91	0.65	Clarke 2001 (average of	Clarke "plaster"	Levinson and Hashem 2
glass (windows)	1.29	2702	810	2.19E+06	0.91	0.08	Clarke 2001 (average of 4	Oke, Clarke, and Omega	Oke 1987
steel	45.00	7800	480	3.74E+06	0.80	0.18	Clarke 2001	Clarke and Omega agree	Akbari and Desjarlais 20
EIFS base and finish coating	0.59	1150	8400	9.66E+06	0.97	0.69	Mukhopadhyaya et al. 20	Fronapfel et al. 2006	Master Wal, Inc. 2006 (
iron	72.00	7900	530	4.19E+06	0.21	0.13	Clarke 2001	Clarke 2001	Oke 1987
tin	65.00	7300	240	1.75E+06	0.05	n/a	Clarke 2001	Omega 2007	not found
corrugated metal (average iron/tin)	68.50	7600	385	2.97E+06	0.13	0.17	n/a	Average of iron/tin (above	Taha et al 1992
bitumen (poured asphalt)	1.20	2100	920	1.93E+06	0.91	0.13	Clarke, J.A. 2001	Oke, Clarke, and LBNL a	Oke, T.R. 1987 ("tar and
bitumen/felt weighted ave	0.95	1815	927.5	1.68E+06	0.91	0.13	Weighted average of 1:3	Oke, Clarke, and LBNL a	Oke, T.R. 1987 ("tar and
tile, ceramic	1.20	2000	850	1.70E+06	0.90	0.23	Clarke 2001	Oke, Clarke, and LBNL a	Oke ("tile"), Reagan and
shingles, asphalt (asphalt roofing)	1.15	2330	840	1.96E+06	0.91	0.14	Clarke 2001	LBNL	Berdahl and Bretz 1997
shingles/felt weighted ave	0.91	1987.5	867.5	1.70E+06	0.91	0.14	Weighted average of 1:3	LBNL	Berdahl and Bretz 1997
EPDM	0.33	1170	2340	2.74E+06	0.87	0.40	Azaar et al 2002	LBNL	Taha et al 1992
slate	1.72	2750	840	2.31E+06	0.83	0.10	Clarke 2001	Clarke and Omega avera	Oke 1987
thatch	0.07	240	180	4.32E+04	0.91	0.18	Clarke 2001	Schmugge et al. 1988 (us	Oke 1987
zinc	113.00	7000	390	2.73E+06	0.04	0.61	Clarke 2001	LBNL (galvanized steel)	LBNL (galvanized steel)
extruded Polystyrene (XPS)	0.03	28.3	1470	4.16E+04	0.91	0.62	Mukhopadhyaya et al. 20	Clarke 2001	Levinson and Hashem 2
expanded Polystyrene (EPS)	0.03	19.7	1470	2.90E+04	0.91	0.62	Mukhopadhyaya et al. 20	Clarke (PVC)	Levinson and Hashem 2

Interior Wall Materials and Properties

Material Categories	Therm_Cond_W/m*K (tk)	Dens_kg/m^3	Spec_Ht_J/kg*C	Volumetric Heat_Cap_J/m^3*K (vc)	Emissivity	Albedo	Source of thermal properties	Source of Emissivity value
INTERIOR MATERIALS								
drywall (coated gypsum board, exterior)	0.16	700	870	6.09E+05	n/a	n/a	Mukhopadhyaya et al. 20(	
drywall (gypsum board, interior)	0.16	700	870	6.09E+05	n/a	n/a	Mukhopadhyaya et al. 20(	
building paper (sheathing membrane)	0.11	870	1880	1.64E+06	n/a	n/a	Mukhopadhyaya et al. 20(	
insulation, wall (glass fiber wool)	0.04	12	840	1.01E+04	n/a	n/a	Mukhopadhyaya et al. 20(	
plywood - roofs	0.15	700	1420	9.94E+05	n/a	n/a	Clarke 2001	
sheathing board (plywood) - walls	0.09	500	1880	9.40E+05	n/a	n/a	Mukhopadhyaya et al. 20(	
roofing felt (felt sheathing)	0.19	960	950	9.12E+05	n/a	n/a	Clarke 2001	
OSB: oriented strand board	0.09	628	1880	1.18E+06	n/a	n/a	Mukhopadhyaya et al. 20(	
timber (softwood)	0.17	550	1880	1.03E+06	n/a	n/a	Mukhopadhyaya et al. 20(	
air, still	0.03	1.2	1005	1.21E+03	n/a	n/a	Straube and Burnett 2005	
insulation slab/rigid fibrous roof insulatio	0.04	115	840	9.66E+04	n/a	n/a	Straube and Burnett 2005	
fiber board (asphalt coated)	0.05	320	1880	6.02E+05	n/a	n/a	Mukhopadhyaya et al. 20(	
cellular concrete (aerated)	0.70	1000	840	8.40E+05	n/a	n/a	Clarke 2001	
rubble	0.80	1900	500	9.50E+05	n/a	n/a	Clarke 2001	

Constructing each Wall Type from 10 Layers of Materials

Wall Type		Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7	Layer 8	Layer 9	Layer 10	Total w (m)	Surface		Window facto	Total Resi	ave layer t
Conc panels/conc masonry		cncrt pnl	cncrt pnl	air	cncrt blk	cncrt blk	cncrt blk	cncrt blk	XPS	XPS	drywall		precast concrete				
	thickness(m)	0.050	0.039	0.025	0.050	0.050	0.050	0.050	0.013	0.012	0.012	0.351	emissivity	0.90	0.20	0.25048	1.401309
	tk	1.28	1.28	0.06	0.86	0.86	0.86	0.86	0.06	0.06	0.16		albedo	0.23			
	cv	2.12E+06	2.12E+06	2.59E+05	7.81E+05	7.81E+05	7.81E+05	7.81E+05	2.90E+05	2.90E+05	6.09E+05						
Glass curtain		glass	glass	air	air	air	air	air	air	glass	glass		glass				
	thickness(m)	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.004	0.003	0.027	emissivity	0.91	1.00	0.016558	1.63061
	tk	1.29	1.29	2.28	2.28	2.28	2.28	2.28	2.28	1.29	1.29		albedo	0.08			
	cv	2.19E+06	2.19E+06	1.88E+05	1.88E+05	1.88E+05	1.88E+05	1.88E+05	1.88E+05	2.19E+06	2.19E+06						
Brick veneer/conc masonry		clay brck	clay brck	air	cncrt blk	cncrt blk	cncrt blk	cncrt blk	XPS	XPS	drywall		brick				
	thickness(m)	0.050	0.039	0.025	0.050	0.050	0.050	0.050	0.013	0.012	0.012	0.351	emissivity	0.91	0.20	0.272174	1.289617
	tk	0.50	0.50	0.06	0.86	0.86	0.86	0.86	0.06	0.06	0.16		albedo	0.30			
	cv	1.52E+06	1.52E+06	2.59E+05	7.81E+05	7.81E+05	7.81E+05	7.81E+05	2.90E+05	2.90E+05	6.09E+05						
Stone curtain/conc masonry		stone	stone	air	cncrt blk	cncrt blk	cncrt blk	cncrt blk	XPS	XPS	drywall		granite, typically				
	thickness(m)	0.015	0.015	0.020	0.050	0.050	0.050	0.050	0.013	0.012	0.012	0.287	emissivity	0.68	0.20	0.221526	1.295557
	tk	2.56	2.56	0.06	0.86	0.86	0.86	0.86	0.05675	0.05675	0.16		albedo	0.33			
	cv	2.18E+06	2.18E+06	2.59E+05	7.81E+05	7.81E+05	7.81E+05	7.81E+05	2.90E+05	2.90E+05	6.09E+05						
Plaster veneer/brick masonry		plaster	clay brck	air	air	bldg ppr	ext drywll	insulation	insulation	drywall	drywall		plaster				
	thickness(m)	0.013	0.089	0.013	0.012	0.001	0.011	0.050	0.039	0.006	0.006	0.240	emissivity	0.91	0.20	0.431304	0.556452
	tk	0.60	0.50	0.06	0.06	0.11	0.16	0.07	0.07	0.16	0.16		albedo	0.65			
	cv	1.14E+06	1.52E+06	2.59E+05	2.59E+05	1.64E+06	6.09E+05	2.66E+05	2.66E+05	6.09E+05	6.09E+05						
Plaster veneer/conc masonry		plaster	cncrt blk	cncrt blk	cncrt blk	cncrt blk	cncrt blk	cncrt blk	XPS	XPS	drywall		plaster				
	thickness(m)	0.013	0.034	0.034	0.033	0.033	0.033	0.033	0.013	0.012	0.012	0.250	emissivity	0.91	0.20	0.153951	1.623897
	tk	0.60	0.86	0.86	0.86	0.86	0.86	0.86	0.06	0.06	0.16		albedo	0.65			
	cv	1.14E+06	7.81E+05	7.81E+05	7.81E+05	7.81E+05	7.81E+05	7.81E+05	2.90E+05	2.90E+05	6.09E+05						
EIFS façade/wood frame		EIFS	EPS	ext drywll	ext drywll	insulation	insulation	insulation	insulation	drywall	drywall		EIFS tan/gray				
	thickness(m)	0.005	0.038	0.010	0.005	0.020	0.020	0.020	0.029	0.006	0.006	0.159	emissivity	0.97	0.20	0.434451	0.365979
	tk	0.59	0.06	0.16	0.16	0.07	0.07	0.07	0.07	0.16	0.16		albedo	0.69			
	cv	9.66E+06	2.80E+05	6.09E+05	6.09E+05	2.66E+05	2.66E+05	2.66E+05	2.66E+05	6.09E+05	6.09E+05						
Cement board/wood frame		cmnt brd	cmnt brd	air	fiberboard	insulation	insulation	insulation	insulation	drywall	drywall		cement board				
	thickness(m)	0.006	0.006	0.012	0.012	0.020	0.020	0.020	0.029	0.006	0.006	0.137	emissivity	0.70	0.20	0.405445	0.3379
	tk	0.08	0.08	0.06	0.05	0.07	0.07	0.07	0.07	0.16	0.16		albedo	0.25			
	cv	4.55E+05	4.55E+05	2.59E+05	6.02E+05	2.66E+05	2.66E+05	2.66E+05	2.66E+05	6.09E+05	6.09E+05						
Wood frame/hardbrd siding		hb siding	air	OSB	insulation	insulation	insulation	insulation	insulation	drywall	drywall		hardboard siding				
	thickness(m)	0.012	0.001	0.011	0.020	0.020	0.020	0.020	0.009	0.006	0.006	0.125	emissivity	0.84	0.20	0.335879	0.372158
	tk	0.12	0.06	0.09	0.07	0.07	0.07	0.07	0.07	0.16	0.16		albedo	0.38			
	cv	1.72E+06	2.59E+05	1.18E+06	2.66E+05	2.66E+05	2.66E+05	2.66E+05	2.66E+05	6.09E+05	6.09E+05						

Constructing each Roof Type from 10 Layers of Materials

ROOF TYPE		Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7	Layer 8	Layer 9	Layer 10	Total w (m)	Surface		wall bridgi	Total Resi	ave layer t
BUR/concrete deck		asphalt	felt	bitumen	ins slab	ins slab	ins slab	ins slab	cllr cncrt	cllr cncrt	cllr cncrt		asphalt				
	thickness(m)	0.007	0.001	0.002	0.040	0.020	0.020	0.020	0.050	0.050	0.050	0.260	emissivity	0.91	1.00	2.727049	0.095341
	tk	1.20	0.19	1.20	0.04	0.04	0.04	0.04	0.70	0.70	0.70		albedo	0.13			
	cv	1.93E+06	9.12E+05	1.93E+06	9.66E+04	9.66E+04	9.66E+04	9.66E+04	8.40E+05	8.40E+05	8.40E+05						
BUR/wood deck		gravel	felt	bitumen	ins slab	ins slab	ins slab	ins slab	tmb/plywd	tmb/plywd	tmb/plywd		gravel/mineral ch				
	thickness(m)	0.007	0.001	0.002	0.030	0.030	0.030	0.030	0.009	0.005	0.005	0.149	emissivity	0.92	1.00	3.138458	0.047476
	tk	1.44	0.19	1.20	0.04	0.04	0.04	0.04	0.15	0.15	0.15		albedo	0.35			
	cv	1.48E+06	9.12E+05	1.93E+06	9.66E+04	9.66E+04	9.66E+04	9.66E+04	9.94E+05	9.94E+05	9.94E+05						
PVC/steel deck		PVC(EPS)	insulation	insulation	insulation	insulation	insulation	air	air	steel deck	steel deck		PVC(EPS)				
	thickness(m)	0.002	0.020	0.020	0.020	0.020	0.020	0.004	0.003	0.004	0.004	0.117	emissivity	0.91	1.00	0.105338	1.11071
	tk	0.03	2.28	2.28	2.28	2.28	2.28	2.28	2.28	45.00	45.00		albedo	0.62			
	cv	2.90E+04	2.79E+05	2.79E+05	2.79E+05	2.79E+05	2.79E+05	1.88E+05	1.88E+05	3.74E+06	3.74E+06						
EPDM/steel deck		EPDM	insulation	insulation	insulation	insulation	insulation	air	air	steel deck	steel deck		EPDM				
	thickness(m)	0.002	0.020	0.020	0.020	0.020	0.020	0.004	0.003	0.004	0.004	0.117	emissivity	0.87	1.00	0.05309	2.203822
	tk	0.33	2.28	2.28	2.28	2.28	2.28	2.28	2.28	45.00	45.00		albedo	0.40			
	cv	2.74E+06	2.79E+05	2.79E+05	2.79E+05	2.79E+05	2.79E+05	1.88E+05	1.88E+05	3.74E+06	3.74E+06						
Galv steel/metal bar joists		galv steel	insulation	insulation	insulation	insulation	insulation	air	air	steel deck	steel deck		zinc coating				
	thickness(m)	0.003	0.020	0.020	0.020	0.020	0.020	0.004	0.003	0.004	0.004	0.118	emissivity	0.04	1.00	0.047096	2.50554
	tk	45.00	2.28	2.28	2.28	2.28	2.28	2.28	2.28	45.00	45.00		albedo	0.61			
	cv	3.74E+06	2.79E+05	2.79E+05	2.79E+05	2.79E+05	2.79E+05	1.88E+05	1.88E+05	3.74E+06	3.74E+06						
Corrugated metal (iron/tin)		metal	metal	metal	metal	metal	metal	metal	metal	metal	metal		iron/tin average				
	thickness(m)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.010	emissivity	0.13	1.00	0.000146	68.5
	tk	68.50	68.50	68.50	68.50	68.50	68.50	68.50	68.50	68.50	68.50		albedo	0.17			
	cv	2.97E+06	2.97E+06	2.97E+06	2.97E+06	2.97E+06	2.97E+06	2.97E+06	2.97E+06	2.97E+06	2.97E+06						
Shingles/wood deck		shingle	felt	plywood	plywood	plywood	plywood	plywood	plywood	plywood	plywood		shingles				
	thickness(m)	0.005	0.001	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.030	emissivity	0.91	1.00	0.169611	0.176875
	tk	1.15	0.19	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15		albedo	0.14			
	cv	1.96E+06	9.12E+05	9.94E+05	9.94E+05	9.94E+05	9.94E+05	9.94E+05	9.94E+05	9.94E+05	9.94E+05						
Ceramic tiles/wood deck		cer tile	cer tile	cer tile	air	plywood	plywood	plywood	plywood	plywood	plywood		ceramic tiles				
	thickness(m)	0.004	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.003	0.003	0.035	emissivity	0.90	1.00	0.207174	0.16894
	tk	1.20	1.20	1.20	0.06	0.15	0.15	0.15	0.15	0.15	0.15		albedo	0.23			
	cv	1.70E+06	1.70E+06	1.70E+06	2.59E+05	9.94E+05	9.94E+05	9.94E+05	9.94E+05	9.94E+05	9.94E+05						
Thatch		thatch	thatch	thatch	thatch	thatch	thatch	thatch	thatch	timber	timber		thatch				
	thickness(m)	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.010	0.010	0.180	emissivity	0.91	1.00	2.403361	0.074895
	tk	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.17	0.17		albedo	0.18			
	cv	4.32E+04	4.32E+04	4.32E+04	4.32E+04	4.32E+04	4.32E+04	4.32E+04	4.32E+04	1.03E+06	1.03E+06						

Road Types and Properties

Road Type		Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7	Layer 8	Layer 9	Layer 10	Total road thickness (m)	Surface	
Concrete road		concrete	concrete	asphalt	aggregate	aggregate	soil	soil	soil	soil	soil		concrete	
	thickness(m)	0.012	0.013	0.005	0.015	0.015	0.060					0.060	emissivity	0.88
	tk	1.90	1.90	1.20	0.36	0.36							albedo	0.23
	cv	2.10E+06	2.10E+06	1.93E+06	1.55E+06	1.55E+06								
Asphalt road w/ stablized sub-base		asphalt	concrete	concrete	aggregate	aggregate	soil	soil	soil	soil	soil		asphalt	
	thickness(m)	0.004	0.008	0.008	0.008	0.008	0.036					0.036	emissivity	0.91
	tk	1.20	1.90	1.90	0.78	0.36							albedo	0.13
	cv	1.93E+06	2.10E+06	2.10E+06	1.73E+06	1.55E+06								
Simple asphalt road		asphalt	asphalt	aggregate	aggregate	aggregate	soil	soil	soil	soil	soil		asphalt	
(aka blacktop, tar and chip)	thickness(m)	0.005	0.005	0.006	0.006	0.006	0.028					0.028	emissivity	0.91
	tk	1.20	1.20	0.36	0.36	0.36							albedo	0.13
	cv	1.93E+06	1.93E+06	1.55E+06	1.55E+06	1.55E+06								
Improved dirt road (added gravel)		aggregate	aggregate	aggregate	aggregate	aggregate	soil	soil	soil	soil	soil		aggregate	
	thickness(m)	0.004	0.004	0.004	0.004	0.004	0.020					0.020	emissivity	soil
	tk	0.36	0.36	0.36	0.36	0.36							albedo	soil
	cv	1.55E+06	1.55E+06	1.55E+06	1.55E+06	1.55E+06								
Unimproved dirt road (native surface)		soil	soil	soil	soil	soil	soil	soil	soil	soil	soil		eroded soil	
	thickness(m)											0.000	emissivity	soil
	tk												albedo	soil
	cv													

Road Type	Code	Description
Concrete road	1	Thick layer of concrete over strong sub-base. Used in dense, high volume traffic areas.
Asphalt road w/stabilized sub-	2	Asphalt over concrete sub-base. Used in HD and suburban settings.
Simple asphalt road	3	Asphalt over aggregate or native surface.
Improved dirt road (added gra	4	Shaped road with added aggregate for stability of road surface.
Unimproved dirt road (native s	5	Native surface with little maintenance/improvements if any.
n/a	0	

			0.005
Averaging across layers			0.003
resistance	0.025	2.86E+04	
thickness	0.016		0.010
tk	0.64	1.79E+06	1.671

Bridging factors applied across various wall types

Assume that insulation has bridging mainly as wood except for steel curtain glass. This sheet shows how the new R and tk and c values are calculated and these values are linked to th

	air	insulation, '	insulation s	fiber board	XPS	EPS	wood	metal
tk	0.03	0.04	0.04	0.05	0.03	0.03	0.14	45
density	1.2	12	115	320	28.3	19.7	550	7800
Sp Heat	1005	840	840	1880	1470	1470	1880	480
cv	1206	10080	96600	601600	41601	28959	1034000	3744000
R	33.33333	25	27.77778	18.69159	34.48276	29.15452	7.142857	0.022222

	air						wood frac
Av tk	0.0575	0.065	0.062	0.075125	0.05675	0.060725	**0.25**
Av cv	259404.5	266060	330950	709700	289700.8	280219.3	
R	17.3913	15.38462	16.12903	13.31115	17.62115	16.46768	

	air/glass curtain	steel joists and roofing systems	Steel Frac
Av tk	2.2785	2.2842	**0.05**
Av cv	188345.7	278970	assume parallel resistances
R	0.438885	0.43779	

	Slate roof	slate/wood roof
Av tk	0.063	**0.3**
Av cv	311044.2	
R	15.87302	

Bridge/Window Factor

0.2	Window/bridging Factor WALL
1	Windows for glass curtain WALL
1	For corrugated Iron (developing countries primarily)
0.5	For mud/adobe, cement blocks and stone/rubble (develop
1.00	Window/bridging Factor ROOF

25% framing - EPA http://www.epa.gov/cppd/climatechoice/Adv%20New%20Home%20Constr%20Adopt%20Plan.pdf

Urban Characteristics by Region

Region	Cat	Ht(m)	H/W	Wall1	Roof1	%	Wall2	Roof2	%	Wall3	Roof3	%	%Pervious	%Roof Area
Alaska	TBD	0	0.0			0			0			0	0	0
	HD	30	1.2	Conc panels/conc m	BUR/concrete deck	70	Brick veneer/conc m	BUR/concrete deck	20	Conc panels/conc m	Galv steel/metal bar	10	15	25
	MD	14	0.7	Conc panels/conc m	BUR/concrete deck	50	Brick veneer/conc m	BUR/concrete deck	40	Stone curtain/conc n	Shingles/wood deck	10	60	25
	LD	8	0.4	Wood frame/vinyl or	Shingles/wood deck	80	Wood frame/hardbrc	Metal tiles	10	Wood frame/stucco	Ceramic tiles/wood c	10	75	15
Australia	TBD	200	8.0	Conc panels/conc m	BUR/concrete deck	60	Stone curtain/conc n	EPDM/steel deck	30	Glass curtain	Galv steel/metal bar	10	5	85
	HD	45	1.8	Brick veneer/conc m	Ceramic tiles/wood c	60	EIFS façade/wood fr	Metal tiles	20	Stone curtain/conc n	PVC/steel deck	20	10	70
	MD	15	0.6	Brick veneer/conc m	Ceramic tiles/wood c	60	Stone curtain/conc n	PVC/steel deck	40				30	55
	LD	8	0.4	Brick masonry, reinf	Ceramic tiles/wood c	40	Stone	Shingles/wood deck	30	Wood frame/vinyl or	Metal tiles	30	55	30
Brazil	TBD	120	4.8	Conc panels/conc m	BUR/concrete deck	70	Glass curtain	PVC/steel deck	20	Conc panels/conc m	EPDM/steel deck	10	5	70
	HD	40	1.6	Conc panels/conc m	BUR/concrete deck	60	Plaster veneer/brick	BUR/concrete deck	30	Brick masonry, reinf	Ceramic tiles/wood c	10	5	80
	MD	15	0.6	Conc panels/conc m	BUR/concrete deck	50	Brick masonry, reinf	Ceramic tiles/wood c	30	Wood frame/stucco	Ceramic tiles/wood c	20	10	80
	LD	8	0.4	Wood frame/stucco	Ceramic tiles/wood c	60	Brick masonry, reinf	Corrugated metal (ir	20	Wood frame/unins w	Corrugated metal (ir	20	15	75
C_Africa	TBD	70	2.8	Conc panels/conc m	Ceramic tiles/wood c	60	Conc panels/conc m	BUR/concrete deck	40				25	65
	HD	20	0.8	Conc panels/conc m	Ceramic tiles/wood c	50	Concrete blocks	Corrugated metal (ir	50				35	65
	MD	8	0.3	Conc panels/conc m	Ceramic tiles/wood c	40	Concrete blocks	Corrugated metal (ir	30	Wood frame/unins w	Corrugated metal (ir	30	50	50
	LD	3	0.3	Concrete blocks	Corrugated metal (ir	50	Concrete blocks	Thatch	40	Wood frame/unins w	Thatch	10	70	30
C_Asia	TBD	60	2.4	Plaster veneer/brick	Galv steel/metal bar	50	Conc panels/conc m	PVC/steel deck	40	Glass curtain	BUR/concrete deck	10	20	55
	HD	30	1.2	Plaster veneer/conc	Galv steel/metal bar	70	Stone curtain/conc n	Ceramic tiles/wood c	30				50	40
	MD	10	0.4	Plaster veneer/conc	Galv steel/metal bar	70	Stone	Ceramic tiles/wood c	30				45	45
	LD	8	0.8	Brick masonry, reinf	Ceramic tiles/wood c	50	Rubble	Corrugated metal (ir	30	Stone	Ceramic tiles/wood c	20	75	20
Canada	TBD	100	4.0	Conc panels/conc m	BUR/concrete deck	60	Glass curtain	Galv steel/metal bar	20	Brick veneer/conc m	Galv steel/metal bar	20	5	60
	HD	40	1.6	Conc panels/conc m	BUR/concrete deck	50	Brick veneer/conc m	Galv steel/metal bar	30	EIFS façade/wood fr	Metal tiles	20	25	50
	MD	15	0.6	Conc panels/conc m	BUR/concrete deck	40	Brick veneer/conc m	Galv steel/metal bar	30	Wood frame/hardbrc	Shingles/wood deck	30	30	55
	LD	8	0.4	Wood frame/hardbrc	Shingles/wood deck	50	Brick masonry, reinf	Metal tiles	30	Wood frame/vinyl or	Shingles/wood deck	20	40	45
Caribbean	TBD	0	0.0			0			0			0	0	0
	HD	35	1.4	Conc panels/conc m	BUR/concrete deck	70	Plaster veneer/brick	Ceramic tiles/wood c	20	Glass curtain	EPDM/steel deck	10	30	60
	MD	13	0.5	Plaster veneer/brick	BUR/wood deck	50	Plaster veneer/conc	Ceramic tiles/wood c	40	Concrete blocks	Ceramic tiles/wood c	10	30	55
	LD	3	0.3	Brick masonry, reinf	Corrugated metal (ir	60	Wood frame/unins w	Ceramic tiles/wood c	30	Mud or adobe	Thatch	10	70	25
China	TBD	180	7.2	Conc panels/conc m	BUR/concrete deck	60	Glass curtain	EPDM/steel deck	20	Conc panels/conc m	Galv steel/metal bar	20	10	50
	HD	45	1.8	Brick veneer/conc m	BUR/wood deck	70	Conc panels/conc m	Ceramic tiles/wood c	30				15	60
	MD	12	0.5	Brick veneer/conc m	BUR/wood deck	50	Conc panels/conc m	Ceramic tiles/wood c	30	Brick masonry, reinf	Ceramic tiles/wood c	20	40	35
	LD	8	0.8	Brick masonry, reinf	Ceramic tiles/wood c	40	Mud or adobe	Corrugated metal (ir	40	Wood frame/wood s	Slate tiles	20	75	20
E_Africa	TBD	60	2.4	Conc panels/conc m	BUR/concrete deck	90	Stone curtain/conc n	Galv steel/metal bar	10				15	40
	HD	20	0.8	Conc panels/conc m	BUR/wood deck	60	Concrete blocks	BUR/wood deck	40				20	60
	MD	10	0.4	Concrete blocks	BUR/wood deck	60	Conc panels/conc m	BUR/wood deck	40				55	35
	LD	3	0.3	Concrete blocks	corrugated metal	50	Wood frame/unins w	Thatch	30	Corrugated metal	Corrugated metal (ir	20	70	25
E_Asia	TBD	180	7.2	Conc panels/conc m	BUR/concrete deck	50	Glass curtain	Galv steel/metal bar	30	Conc panels/conc m	EPDM/steel deck	20	10	55

Urban Characteristics by Region (Continued)

Road_Type	Road	albedo	E	tk1	tk2	tk3	tk4	tk5	cv1	cv2	cv3	cv4	cv5	wall agg	roof agg	Inside_Wall_Min_T	Inside_Wall_Max_T
n/a	0													0	0	-999.99	-999.99
Asphalt road w/stabilize	2	0.13	0.91	1.671	0.558	soil	soil	soil	2060470.6	1712294.7	soil	soil	soil	0	0	292	310
Simple asphalt road	3	0.13	0.91	0.64	0.36	soil	soil	soil	1787100.4	1545600	soil	soil	soil	0	0	290	310
Simple asphalt road	3	0.13	0.91	0.64	0.36	soil	soil	soil	1787100.4	1545600	soil	soil	soil	0	0	290	310
Concrete road	1	0.23	0.88	1.9	0.56	0.36	soil	soil	2100000	1773000	1545600	soil	soil	0	0	292	300
Concrete road	1	0.23	0.88	1.9	0.56	0.36	soil	soil	2100000	1773000	1545600	soil	soil	0	0	290	310
Asphalt road w/stabilize	2	0.13	0.91	1.671	0.558	soil	soil	soil	2060470.6	1712294.7	soil	soil	soil	0	0	290	310
Asphalt road w/stabilize	2	0.13	0.91	1.671	0.558	soil	soil	soil	2060470.6	1712294.7	soil	soil	soil	0	0	290	310
Concrete road	1	0.23	0.88	1.9	0.56	0.36	soil	soil	2100000	1773000	1545600	soil	soil	0	0	290	305
Asphalt road w/stabilize	2	0.13	0.91	1.671	0.558	soil	soil	soil	2060470.6	1712294.7	soil	soil	soil	0	0	285	310
Asphalt road w/stabilize	2	0.13	0.91	1.671	0.558	soil	soil	soil	2060470.6	1712294.7	soil	soil	soil	0	0	285	310
Simple asphalt road	3	0.13	0.91	0.64	0.36	soil	soil	soil	1787100.4	1545600	soil	soil	soil	0	1	278	380
Asphalt road w/stabilize	2	0.13	0.91	1.671	0.558	soil	soil	soil	2060470.6	1712294.7	soil	soil	soil	0	0	290	305
Simple asphalt road	3	0.13	0.91	0.64	0.36	soil	soil	soil	1787100.4	1545600	soil	soil	soil	1	1	278	380
Improved dirt road (adc	4	soil	soil	0.36	0.36	soil	soil	soil	1.55E+06	1.55E+06	soil	soil	soil	1	1	278	380
Unimproved dirt road (r	5	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	1	1	278	380
Asphalt road w/stabilize	2	0.13	0.91	1.671	0.558	soil	soil	soil	2060470.6	1712294.7	soil	soil	soil	0	0	292	305
Improved dirt road (adc	4	soil	soil	0.36	0.36	soil	soil	soil	1.55E+06	1.55E+06	soil	soil	soil	0	0	285	310
Unimproved dirt road (r	5	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	0	0	278	380
Unimproved dirt road (r	5	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	1	1	278	380
Concrete road	1	0.23	0.88	1.9	0.56	0.36	soil	soil	2100000	1773000	1545600	soil	soil	0	0	292	300
Concrete road	1	0.23	0.88	1.9	0.56	0.36	soil	soil	2100000	1773000	1545600	soil	soil	0	0	290	310
Asphalt road w/stabilize	2	0.13	0.91	1.671	0.558	soil	soil	soil	2060470.6	1712294.7	soil	soil	soil	0	0	290	310
Asphalt road w/stabilize	2	0.13	0.91	1.671	0.558	soil	soil	soil	2060470.6	1712294.7	soil	soil	soil	0	0	290	310
n/a	0													0	0	-999.99	-999.99
Simple asphalt road	3	0.13	0.91	0.64	0.36	soil	soil	soil	1787100.4	1545600	soil	soil	soil	0	0	285	380
Simple asphalt road	3	0.13	0.91	0.64	0.36	soil	soil	soil	1787100.4	1545600	soil	soil	soil	1	0	278	380
Improved dirt road (adc	4	soil	soil	0.36	0.36	soil	soil	soil	1.55E+06	1.55E+06	soil	soil	soil	1	1	278	380
Concrete road	1	0.23	0.88	1.9	0.56	0.36	soil	soil	2100000	1773000	1545600	soil	soil	0	0	292	300

Aggregated Properties by Region

Region	Cat	Ht(m)	H/W	%Pervious	%Roof Area	% perv cany	Wall Albedo	Wall P□	Tot Wall Th	Wall layer tl	Wall layer Cv	Roof Albedo	Roof P□	Tot Roof Thickr
Alaska	TBD	0	0.0	0	0	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99
	HD	30	1.2	15	25	0.2	0.24	0.90	0.35	1.38	1012384.13	0.18	0.82	0.25
	MD	14	0.7	60	25	0.8	0.27	0.88	0.34	1.35	961702.99	0.13	0.91	0.24
	LD	8	0.4	75	15	0.88235294	0.54	0.90	0.12	0.37	450240.02	0.20	0.82	0.03
Australia	TBD	200	8.0	5	85	0.33333333	0.25	0.84	0.30	1.39	1000519.23	0.26	0.81	0.20
	HD	45	1.8	10	70	0.33333333	0.38	0.88	0.30	1.11	827066.61	0.38	0.73	0.05
	MD	15	0.6	30	55	0.66666667	0.31	0.82	0.33	1.29	870615.69	0.39	0.90	0.07
	LD	8	0.4	55	30	0.78571429	0.38	0.87	0.23	0.59	902709.38	0.32	0.65	0.03
Brazil	TBD	120	4.8	5	70	0.16666667	0.20	0.90	0.29	1.45	1079394.75	0.26	0.91	0.22
	HD	40	1.6	5	80	0.25	0.36	0.90	0.31	1.07	957632.81	0.14	0.91	0.24
	MD	15	0.6	10	80	0.5	0.34	0.91	0.28	0.97	899827.17	0.18	0.91	0.15
	LD	8	0.4	15	75	0.6	0.53	0.90	0.15	0.52	696327.24	0.21	0.59	0.03
C_Africa	TBD	70	2.8	25	65	0.71428571	0.23	0.90	0.35	1.40	1042862.20	0.19	0.90	0.13
	HD	20	0.8	35	65	1	0.42	0.92	0.28	1.56	912031.10	0.20	0.52	0.02
	MD	8	0.3	50	50	1	0.39	0.90	0.21	1.25	906832.75	0.19	0.44	0.02
	LD	3	0.3	70	30	1	0.58	0.92	0.18	1.61	788189.29	0.18	0.52	0.10
C_Asia	TBD	60	2.4	20	55	0.44444444	0.43	0.91	0.26	1.00	947870.92	0.57	0.48	0.13
	HD	30	1.2	50	40	0.83333333	0.55	0.84	0.26	1.53	772004.37	0.50	0.30	0.09
	MD	10	0.4	45	45	0.81818182	0.55	0.87	0.28	1.39	947060.62	0.50	0.30	0.09
	LD	8	0.8	75	20	0.9375	0.31	0.84	0.46	1.69	1332425.94	0.21	0.67	0.03
Canada	TBD	100	4.0	5	60	0.125	0.21	0.90	0.29	1.42	1048916.69	0.32	0.56	0.20
	HD	40	1.6	25	50	0.5	0.34	0.92	0.31	1.16	913189.86	0.37	0.48	0.17
	MD	15	0.6	30	55	0.66666667	0.30	0.89	0.28	1.06	840097.57	0.28	0.65	0.15
	LD	8	0.4	40	45	0.72727273	0.39	0.88	0.16	0.43	605624.82	0.28	0.65	0.03
Caribbean	TBD	0	0.0	0	0	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99
	HD	35	1.4	30	60	0.75	0.30	0.90	0.30	1.26	1015825.45	0.18	0.90	0.20
	MD	13	0.5	30	55	0.66666667	0.65	0.91	0.24	1.10	783296.38	0.29	0.91	0.09
	LD	3	0.3	70	25	0.93333333	0.34	0.89	0.18	0.65	918196.07	0.19	0.44	0.03
China	TBD	180	7.2	10	50	0.2	0.20	0.90	0.29	1.45	1079394.75	0.28	0.73	0.20
	HD	45	1.8	15	60	0.375	0.28	0.91	0.35	1.32	936188.98	0.31	0.91	0.11
	MD	12	0.5	40	35	0.61538462	0.28	0.91	0.33	1.18	932117.33	0.29	0.91	0.09
	LD	8	0.8	75	20	0.9375	0.34	0.89	0.22	0.79	997857.86	0.18	0.58	0.02
E_Africa	TBD	60	2.4	15	40	0.25	0.24	0.88	0.34	1.39	1022659.12	0.18	0.82	0.25

Aggregated Properties by Region (Continued)

Road Albedo	Road □□	Road 1 tk	Road 2 tk	Road 3 tk	Road 4 tk	Road 5 tk	Road 1 Cv	Road 2 Cv	Road 3 Cv	Road 4 Cv	Road 5 Cv
-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99
0.13	0.91	1.67	0.56	-999.99	-999.99	-999.99	2060470.59	1712294.74	-999.99	-999.99	-999.99
0.13	0.91	0.64	0.36	-999.99	-999.99	-999.99	1787100.38	1545600.00	-999.99	-999.99	-999.99
0.13	0.91	0.64	0.36	-999.99	-999.99	-999.99	1787100.38	1545600.00	-999.99	-999.99	-999.99
0.23	0.88	1.90	0.56	0.36	-999.99	-999.99	2100000.00	1773000.00	1545600.00	-999.99	-999.99
0.23	0.88	1.90	0.56	0.36	-999.99	-999.99	2100000.00	1773000.00	1545600.00	-999.99	-999.99
0.13	0.91	1.67	0.56	-999.99	-999.99	-999.99	2060470.59	1712294.74	-999.99	-999.99	-999.99
0.13	0.91	1.67	0.56	-999.99	-999.99	-999.99	2060470.59	1712294.74	-999.99	-999.99	-999.99
0.23	0.88	1.90	0.56	0.36	-999.99	-999.99	2100000.00	1773000.00	1545600.00	-999.99	-999.99
0.13	0.91	1.67	0.56	-999.99	-999.99	-999.99	2060470.59	1712294.74	-999.99	-999.99	-999.99
0.13	0.91	1.67	0.56	-999.99	-999.99	-999.99	2060470.59	1712294.74	-999.99	-999.99	-999.99
0.13	0.91	0.64	0.36	-999.99	-999.99	-999.99	1787100.38	1545600.00	-999.99	-999.99	-999.99
0.13	0.91	1.67	0.56	-999.99	-999.99	-999.99	2060470.59	1712294.74	-999.99	-999.99	-999.99
0.13	0.91	0.64	0.36	-999.99	-999.99	-999.99	1787100.38	1545600.00	-999.99	-999.99	-999.99
-999.99	-999.99	0.36	0.36	-999.99	-999.99	-999.99	1545603.00	1545603.00	-999.99	-999.99	-999.99
-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99
0.13	0.91	1.67	0.56	-999.99	-999.99	-999.99	2060470.59	1712294.74	-999.99	-999.99	-999.99
-999.99	-999.99	0.36	0.36	-999.99	-999.99	-999.99	1545603.00	1545603.00	-999.99	-999.99	-999.99
-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99
-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99
0.23	0.88	1.90	0.56	0.36	-999.99	-999.99	2100000.00	1773000.00	1545600.00	-999.99	-999.99
0.23	0.88	1.90	0.56	0.36	-999.99	-999.99	2100000.00	1773000.00	1545600.00	-999.99	-999.99
0.13	0.91	1.67	0.56	-999.99	-999.99	-999.99	2060470.59	1712294.74	-999.99	-999.99	-999.99
0.13	0.91	1.67	0.56	-999.99	-999.99	-999.99	2060470.59	1712294.74	-999.99	-999.99	-999.99
-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99
0.13	0.91	0.64	0.36	-999.99	-999.99	-999.99	1787100.38	1545600.00	-999.99	-999.99	-999.99
0.13	0.91	0.64	0.36	-999.99	-999.99	-999.99	1787100.38	1545600.00	-999.99	-999.99	-999.99
-999.99	-999.99	0.36	0.36	-999.99	-999.99	-999.99	1545603.00	1545603.00	-999.99	-999.99	-999.99
0.23	0.88	1.90	0.56	0.36	-999.99	-999.99	2100000.00	1773000.00	1545600.00	-999.99	-999.99
0.13	0.91	1.67	0.56	-999.99	-999.99	-999.99	2060470.59	1712294.74	-999.99	-999.99	-999.99
0.13	0.91	1.67	0.56	-999.99	-999.99	-999.99	2060470.59	1712294.74	-999.99	-999.99	-999.99

Consolidation for CLM

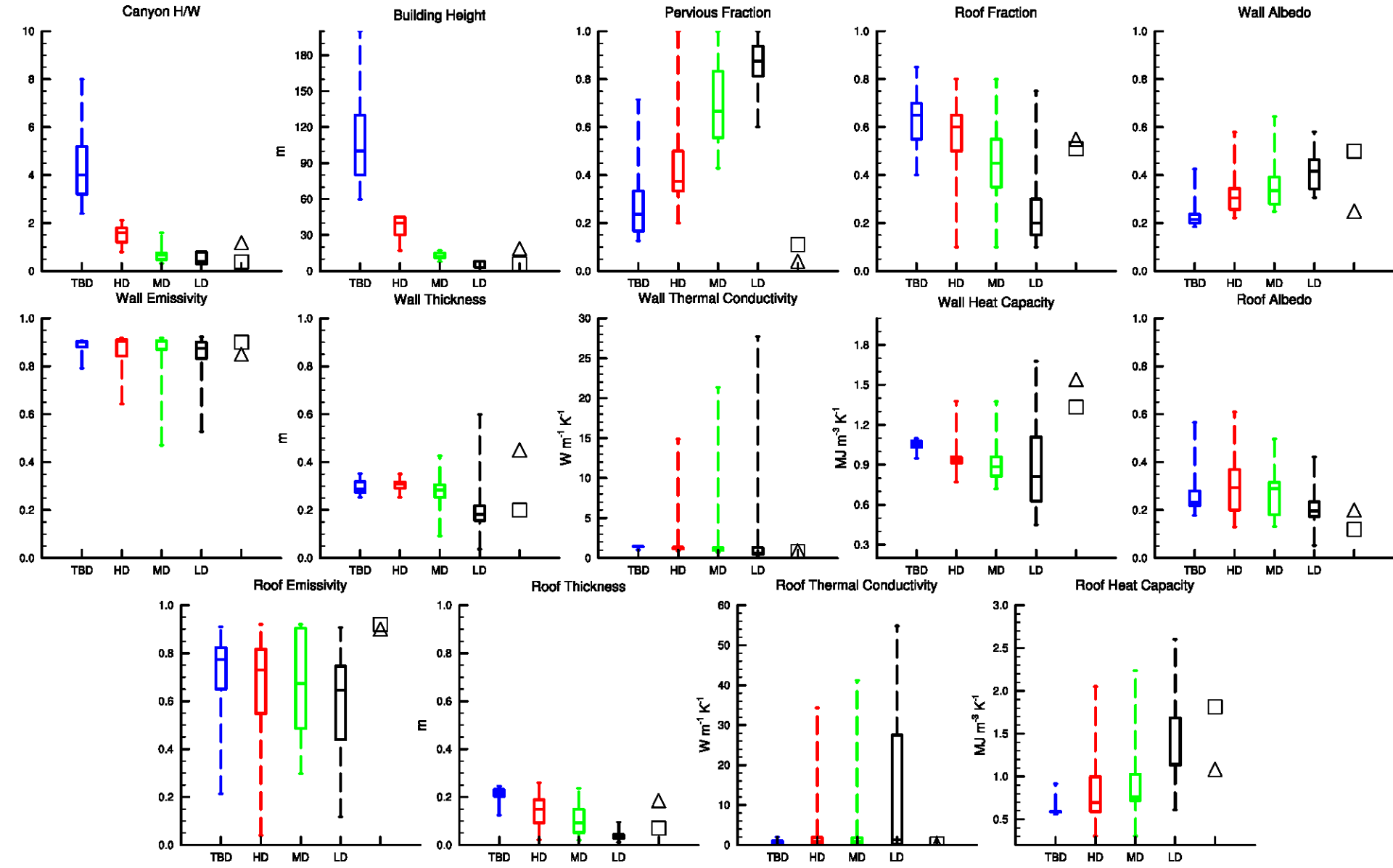
Region_ID	Region	Cat	Ht	H_W	Pervious	Roof_Area	Wall_Albec	Wall_e	Tot_Wall_Thick	Wall_tk	Wall_Cv	Roof_Albe	Roof_e	Tot_Roof_T	Roof_tk	Roof_Cv	Road_Albe	Road_e	Road_1_tk	Road_2_tk	Road_3_tk	Road_1_Cv	Road_2_Cv	Road_3_Cv	Inside_Wal	Inside_Wa	Nlevimproa
1	Alaska	TBD	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99
1	Alaska	HD	30	1.2	0.2	25	0.244	0.902	0.351	1.37897	1012384	0.178	0.823	0.2458	0.336361	592599.7	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	292	310	2
1	Alaska	MD	14	0.7	0.8	25	0.268	0.882	0.3446	1.346057	961703	0.131	0.91	0.237	0.103495	648119.2	0.13	0.91	0.64	0.36	-999.99	1787100.38	1545600.00	-999.99	290	310	2
1	Alaska	LD	8	0.4	0.882353	15	0.535	0.903	0.1209	0.374867	450240	0.196	0.822	0.0301	0.174125	1144376	0.13	0.91	0.64	0.36	-999.99	1787100.38	1545600.00	-999.99	290	310	2
2	Australia	TBD	200	8	0.333333	85	0.245	0.835	0.2994	1.392513	1000519	0.259	0.811	0.2029	0.968905	580704.7	0.23	0.88	1.90	0.56	0.36	2100000.00	1773000.00	1545600.00	292	300	3
2	Australia	HD	45	1.8	0.333333	70	0.384	0.876	0.2998	1.106077	827066.6	0.384	0.73	0.0496	0.354967	1000212	0.23	0.88	1.90	0.56	0.36	2100000.00	1773000.00	1545600.00	290	310	3
2	Australia	MD	15	0.6	0.666667	55	0.312	0.818	0.3254	1.291993	870615.7	0.386	0.904	0.0678	0.545648	882129.2	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	290	310	2
2	Australia	LD	8	0.4	0.785714	30	0.378	0.87	0.2314	0.590346	902709.4	0.317	0.645	0.0308	0.16783	1127624	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	290	310	2
3	Brazil	TBD	120	4.8	0.166667	70	0.2	0.902	0.2862	1.447169	1079395	0.255	0.906	0.2171	0.509263	570998.6	0.23	0.88	1.90	0.56	0.36	2100000.00	1773000.00	1545600.00	290	305	3
3	Brazil	HD	40	1.6	0.25	80	0.363	0.904	0.3064	1.065831	957632.8	0.14	0.909	0.2375	0.102701	646214.1	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	285	310	2
3	Brazil	MD	15	0.6	0.5	80	0.335	0.905	0.2781	0.970157	899827.2	0.18	0.905	0.1475	0.132141	862451.8	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	285	310	2
3	Brazil	LD	8	0.4	0.6	75	0.53	0.9	0.1494	0.520369	696327.2	0.206	0.592	0.025	27.50136	1867451	0.13	0.91	0.64	0.36	-999.99	1787100.38	1545600.00	-999.99	278	380	2
4	C_Africa	TBD	70	2.8	0.714286	65	0.23	0.9	0.351	1.401309	1042862	0.19	0.904	0.125	0.139501	916511.3	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	290	305	2
4	C_Africa	HD	20	0.8	1	65	0.415	0.915	0.2755	1.560654	912031.1	0.2	0.515	0.0225	34.33447	2051127	0.13	0.91	0.64	0.36	-999.99	1787100.38	1545600.00	-999.99	278	380	2
4	C_Africa	MD	8	0.32	1	50	0.392	0.897	0.2127	1.254467	906832.7	0.194	0.438	0.02	41.16758	2234802	-999.99	-999.99	0.36	0.36	-999.99	1545603.00	1545603.00	-999.99	278	380	2
4	C_Africa	LD	3	0.3	1	30	0.58	0.923	0.1841	1.607315	788189.3	0.175	0.52	0.095	34.28745	1561397	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	278	380	0
5	C_Asia	TBD	60	2.4	0.444444	55	0.425	0.906	0.2631	1.00181	947870.9	0.566	0.475	0.1318	1.706588	559997.9	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	292	305	2
5	C_Asia	HD	30	1.2	0.833333	40	0.554	0.841	0.2611	1.525395	772004.4	0.496	0.298	0.0931	1.80456	757448.4	-999.99	-999.99	0.36	0.36	-999.99	1545603.00	1545603.00	-999.99	285	310	2
5	C_Asia	MD	10	0.4	0.818182	45	0.551	0.87	0.2764	1.38586	947060.6	0.496	0.298	0.0931	1.80456	757448.4	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	278	380	0
5	C_Asia	LD	8	0.8	0.9375	20	0.31	0.843333	0.4566	1.690923	1332426	0.212	0.669	0.0275	20.66826	1683776	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	278	380	0
6	Canada	TBD	100	4	0.125	60	0.214	0.904	0.2862	1.424831	1048917	0.322	0.562	0.2032	1.059421	593934.9	0.23	0.88	1.90	0.56	0.36	2100000.00	1773000.00	1545600.00	292	300	3
6	Canada	HD	40	1.6	0.5	50	0.343	0.917	0.3126	1.160735	913189.9	0.37	0.475	0.1706	0.830793	694382	0.23	0.88	1.90	0.56	0.36	2100000.00	1773000.00	1545600.00	290	310	3
6	Canada	MD	15	0.6	0.666667	55	0.296	0.885	0.2832	1.059056	840097.6	0.277	0.649	0.1484	0.842861	761383.5	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	290	310	2
6	Canada	LD	8	0.4	0.727273	45	0.388	0.875	0.1571	0.432925	605624.8	0.281	0.649	0.0288	0.171004	1135245	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	290	310	2
7	Caribbean	TBD	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99
7	Caribbean	HD	35	1.4	0.75	60	0.299	0.903	0.2964	1.255268	1015825	0.177	0.904	0.2007	0.320909	696308.5	0.13	0.91	0.64	0.36	-999.99	1787100.38	1545600.00	-999.99	285	380	2
7	Caribbean	MD	13	0.52	0.666667	55	0.645	0.912	0.24	1.099785	783296.4	0.29	0.91	0.092	0.108208	719404.1	0.13	0.91	0.64	0.36	-999.99	1787100.38	1545600.00	-999.99	278	380	2
7	Caribbean	LD	3	0.3	0.933333	25	0.335	0.894	0.1801	0.646602	918196.1	0.189	0.439	0.0345	41.15817	2136856	-999.99	-999.99	0.36	0.36	-999.99	1545603.00	1545603.00	-999.99	278	380	2
8	China	TBD	180	7.2	0.2	50	0.2	0.902	0.2862	1.447169	1079395	0.28	0.728	0.203	0.999077	585114.8	0.23	0.88	1.90	0.56	0.36	2100000.00	1773000.00	1545600.00	292	300	3
8	China	HD	45	1.8	0.375	60	0.279	0.907	0.351	1.323124	936189	0.314	0.914	0.1148	0.083915	554066.1	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	285	310	2
8	China	MD	12	0.48	0.615385	35	0.279	0.907	0.3284	1.181421	932117.3	0.29	0.91	0.092	0.108208	719404.1	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	285	310	2
8	China	LD	8	0.8	0.9375	20	0.336	0.892	0.2202	0.78734	997857.9	0.18	0.578	0.0244	27.50967	1882170	-999.99	-999.99	0.36	0.36	-999.99	1545603.00	1545603.00	-999.99	278	380	2
9	E_Africa	TBD	60	2.4	0.25	40	0.24	0.878	0.3446	1.390734	1022659	0.178	0.823	0.2458	0.336361	592599.7	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	290	305	2
9	E_Africa	HD	20	0.8	0.5	60	0.378	0.912	0.2906	1.528785	938197.3	0.35	0.92	0.149	0.047476	306059.2	0.13	0.91	0.64	0.36	-999.99	1787100.38	1545600.00	-999.99	285	380	2
9	E_Africa	MD	10	0.4	0.846154	35	0.452	0.918	0.2604	1.592524	885864.9	0.35	0.92	0.149	0.047476	306059.2	-999.99	-999.99	0.36	0.36	-999.99	1545603.00	1545603.00	-999.99	278	380	2
9	E_Africa	LD	3	0.3	0.933333	25	0.454	0.749	0.1143	14.73794	1239829	0.173	0.364	0.061	47.97247	2124640	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	278	380	0
10	E_Asia	TBD	180	7.2	0.222222	55	0.185	0.903	0.2538	1.470099	1097661	0.328	0.641	0.1888	1.240097	585559.8	0.23	0.88	1.90	0.56	0.36	2100000.00	1773000.00	1545600.00	292	300	3
10	E_Asia	HD	45	1.8	0.333333	70	0.304	0.911	0.3318	1.253099	939928.5	0.319	0.554	0.1804	1.070932	655353.9	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	285	310	2
10	E_Asia	MD	17	0.68	0.583333	40	0.377	0.906	0.2925	1.090169	860329.4	0.304	0.646	0.1499	0.84048	755668.1	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	285	310	2
10	E_Asia	LD	8	0.8	0.823529	15	0.456	0.896	0.1826	0.497687	669381.8	0.202	0.872	0.0436	0.277702	1232109	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	278	380	2
11	E_Europe	TBD	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99	-999.99
11	E_Europe	HD	40	1.6	0.25	60	0.222	0.902	0.3186	1.41307	1045889	0.226	0.736	0.2316	0.577381	593044.8	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	285	310	2
11	E_Europe	MD	17	0.68	0.6	50	0.262	0.877333	0.3484	1.264797	1088682	0.306	0.728	0.0516	0.63626	1025520	0.13	0.91	1.67	0.56	-999.99	2060470.59	1712294.74	-999.99	285	310	2
11	E_Europe	LD	8	0.8	0.9375	20	0.45	0.92	0.219	1.150549	825656.8	0.218	0.746	0.03	13.83515	1500100	0.13	0.91	0.64	0.36	-999.99	1787100.38	1545600.00	-999.99	278	380	2

Example results

Roof Albedo

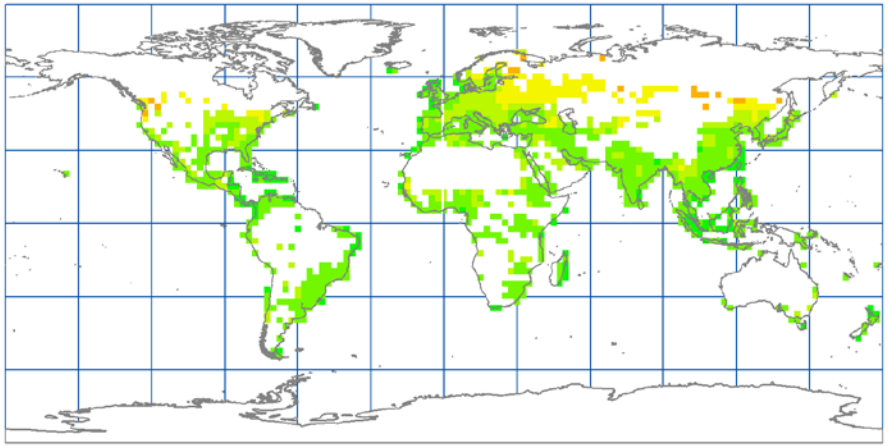
Wall Thermal Conductivity

Global Urban Properties

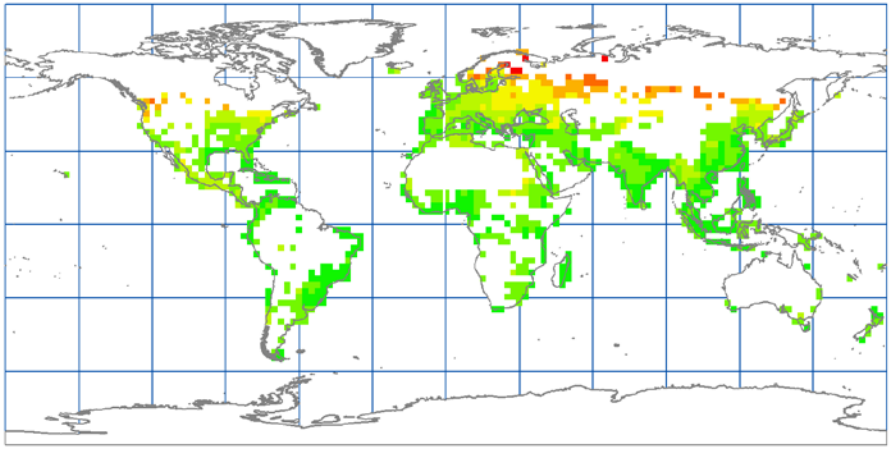


Urban Heat Island Comparison: Parameterization Sensitivity

Vancouver Parameters Applied Globally



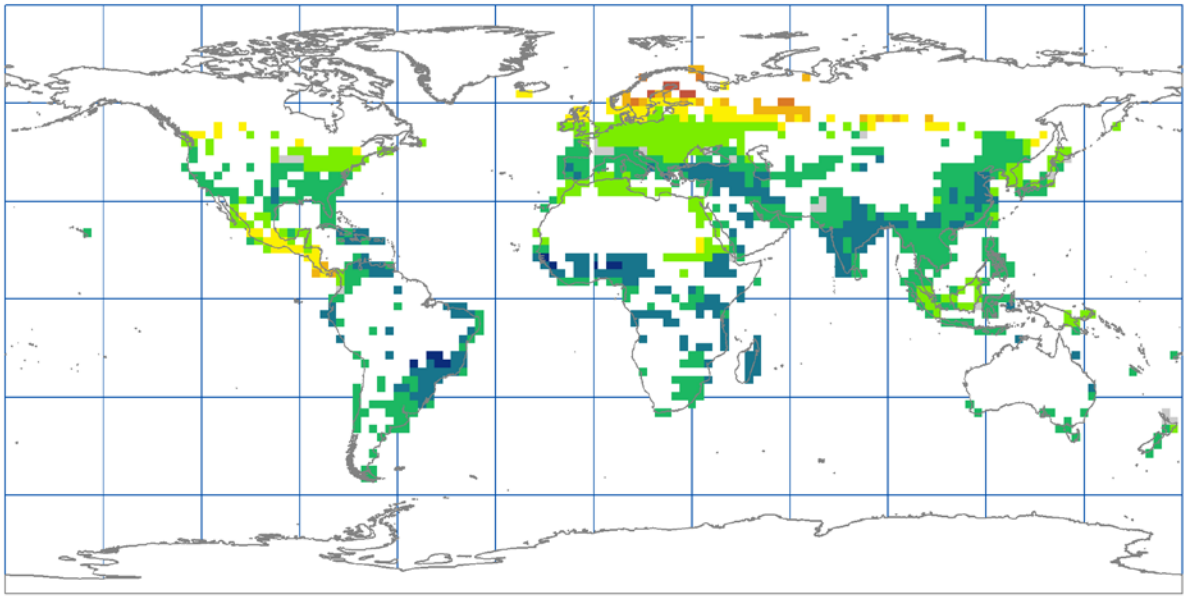
Global Parameter Set



Urban - Rural Temperature Difference (K)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5

Difference: Global - Vancouver



Global - Vancouver UHI Temperature Difference (K)

- -0.75 - -0.50
- -0.50 - -0.25
- -0.25 - -0.01
- -0.01 - 0.01
- 0.01 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25

THE END

Major world population centers 1-20

Rank	Metro area	Country	Population	Area (km²)	Pop (Pop/km²)
1	Tokyo	Japan	32,450,000	8,014	4,049
2	Seoul	South Korea	20,550,000	5,076	4,048
3	Mexico City	Mexico	20,450,000	7,346	2,784
4	New York City	United States	19,750,000	17,884	1,104
5	Mumbai	India	19,200,000	2,350	8,170
6	Jakarta	Indonesia	18,900,000	5,100	3,706
7	São Paulo	Brazil	18,850,000	8,479	2,223
8	Delhi	India	18,600,000	3,182	5,845
9	Osaka-Kobe-Kyoto	Japan	17,375,000	6,930	2,507
10	Shanghai	China	16,650,000	5,177	3,216
11	Metro Manila	Philippines	16,300,000	2,521	6,466
12	Hong Kong-Shenzhen	China	15,800,000	3,051	5,179
13	Los Angeles	United States	15,250,000	10,780	1,415
14	Kolkata	India	15,100,000	1,785	8,459
15	Moscow	Russia	15,000,000	14,925	1,005
16	Cairo	Egypt	14,450,000	1,600	9,031
17	Buenos Aires	Argentina	13,170,000	10,888	1,210
18	London	United Kingdom	12,875,000	11,391	1,130
19	Beijing	China	12,500,000	6,562	1,905
20	Karachi	Pakistan	11,800,000	1,100	10,727

Major world population centers 300-320

300	Raleigh	Raleigh	USA	1,510,000	
301	Gwangju (Kwangju)	Gwangju	South Korea	1,500,000	
302	Peshāwar	Peshawar	Pakistan	1,500,000	
303	Qiqihar	Qiqihar	China	1,500,000	
304	Santa Cruz	Santa Cruz	Bolivia	1,500,000	
305	Kampala	Kampala	Uganda	1, 490,000	
306	Luoyang	Luoyang	China	1,490,000	
307	Makkah	Mecca	Saudi Arabia	1,490,000	
308	Nashville (-Davidson)	Nashville	USA	1,490,000	
309	Marseille	Marseille	France	1,480,000	
310	Rotterdam	Rotterdam	Netherlands	1,480,000	incl. Dordrecht
311	Vārānasi	Benares	India	1,470,000	
312	Kolhāpur	Kolhapur	India	1,460,000	incl. Sangli
313	Lubumbashi	Lubumbashi	Congo (Dem. Rep.)	1,450,000	
314	Tabrīz	Tabriz	Iran	1,450,000	
315	Taizhou (Jiaojiang)	Taizhou	China	1,450,000	
316	Davao	Davao	Philippines	1,440,000	
317	Weifang	Weifang	China	1,440,000	
318	Lyon	Lyon	France	1,430,000	
319	Ciudad Juárez	Ciudad Juárez	Mexico	1,420,000	
320	Khulna	Khulna	Bangladesh	1,420,000	