

Ville à haute intensité écologique : la place du végétal

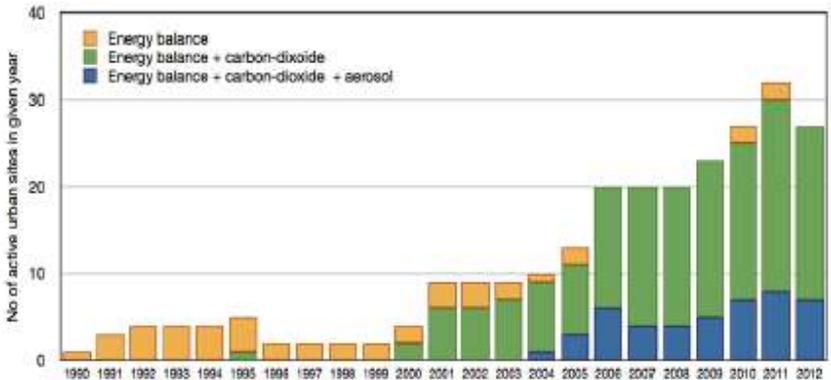
► Mercredi 30 septembre 2015



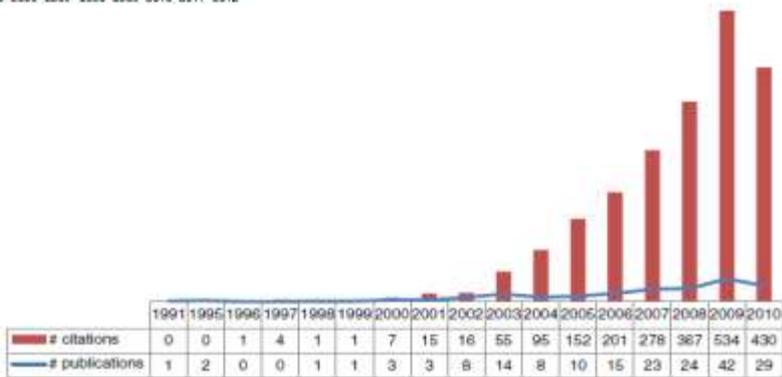
Microclimats urbains : déterminants, caractéristiques, modélisation

Yves Brunet, INRA, UMR 1391 ISPA, Villenave d'Ornon

Un domaine de recherche très actif



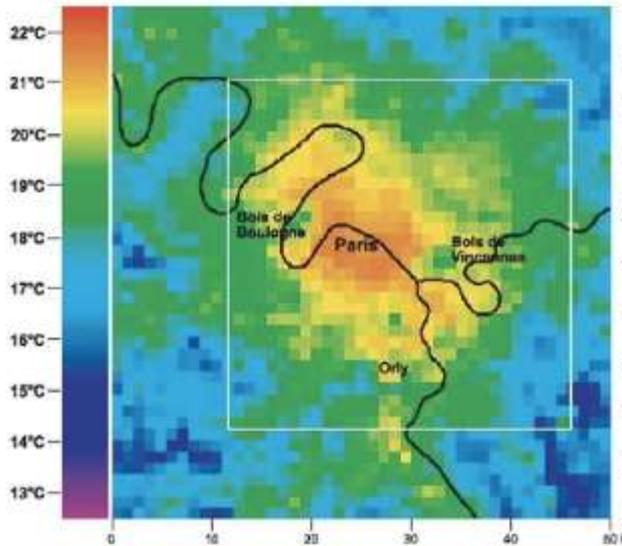
Grimmond et Christen (2012)



Weng (2012)

L'îlot de chaleur urbain

- Un aspect emblématique du microclimat urbain



AVHRR , 9/8/2003, Paris (Dousset, 2007)

Le cœur de Paris sous un « dôme de chaleur »

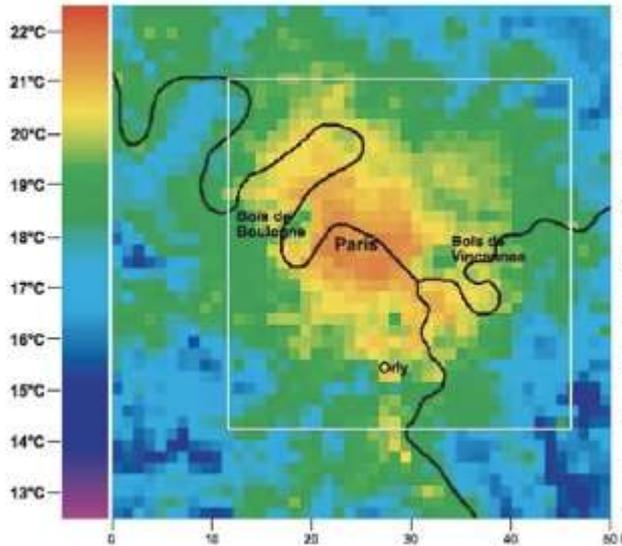
COUPE TRANSVERSALE DE L'ÎLOT DE CHALEUR URBAIN D'OUEST EN EST



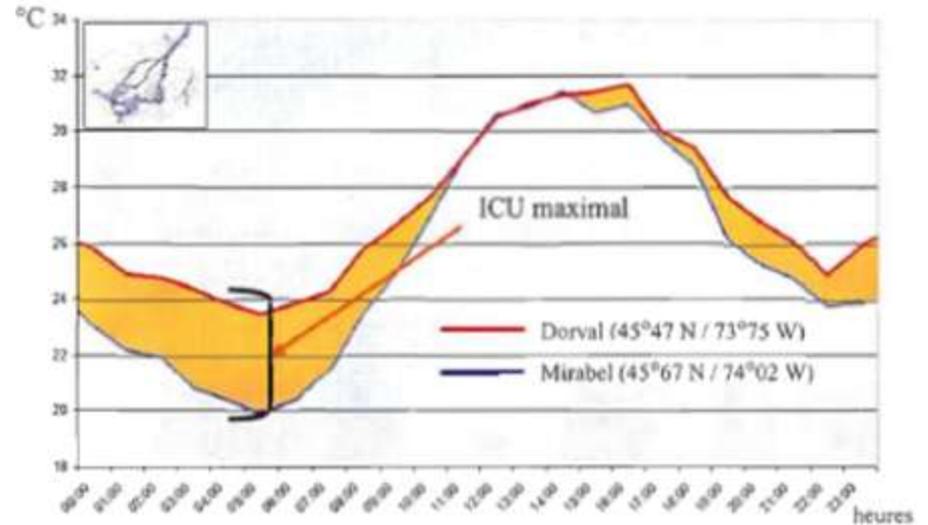
SOURCES : MÉTÉO FRANCE ; CSTB ; MAIRIE DE PARIS

L'îlot de chaleur urbain

- Un aspect emblématique du microclimat urbain



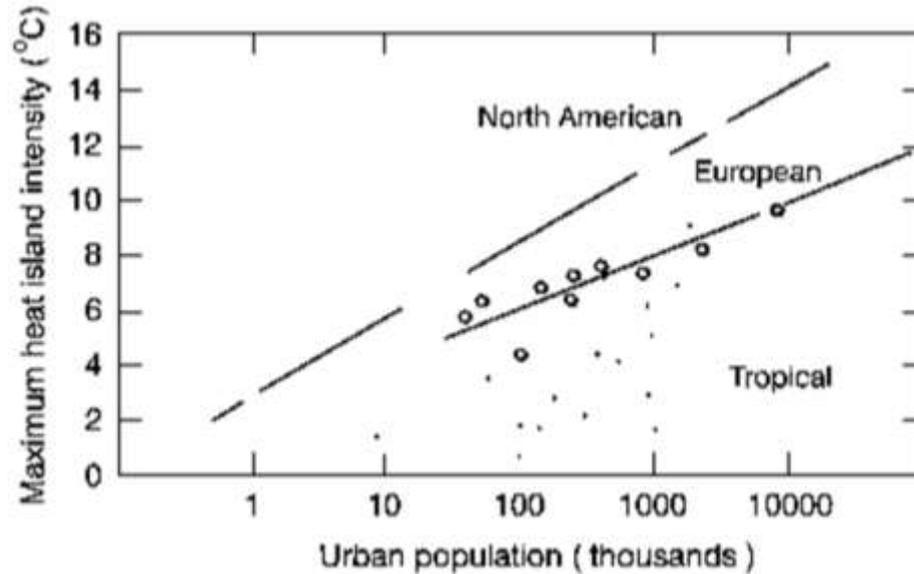
AVHRR , 9/8/2003, Paris (Dousset, 2007)



QUEBEC (Martin, 2008)

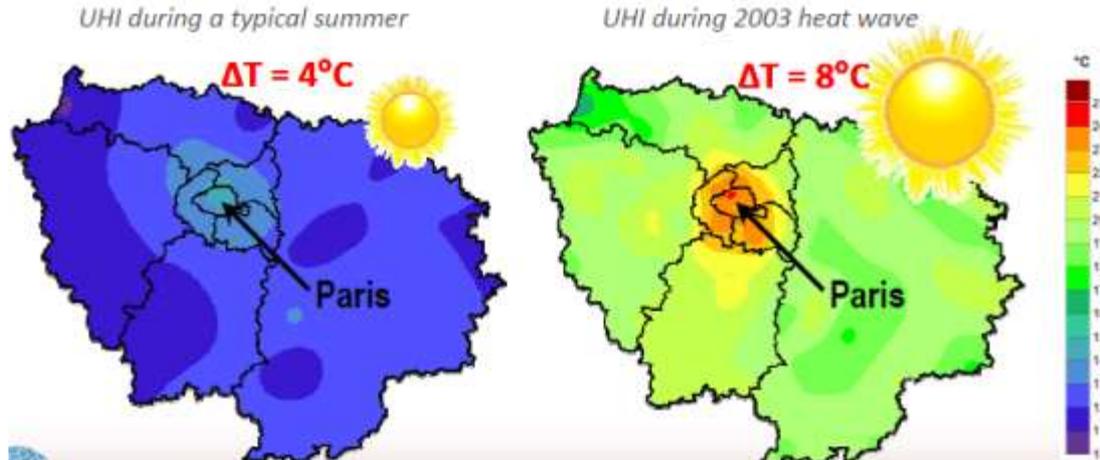
L'îlot de chaleur urbain

- Un aspect emblématique du microclimat urbain

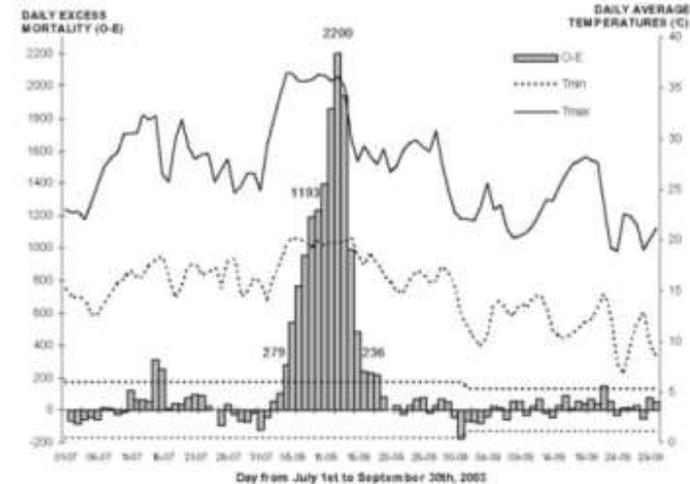


L'îlot de chaleur urbain

- Un aspect emblématique du microclimat urbain



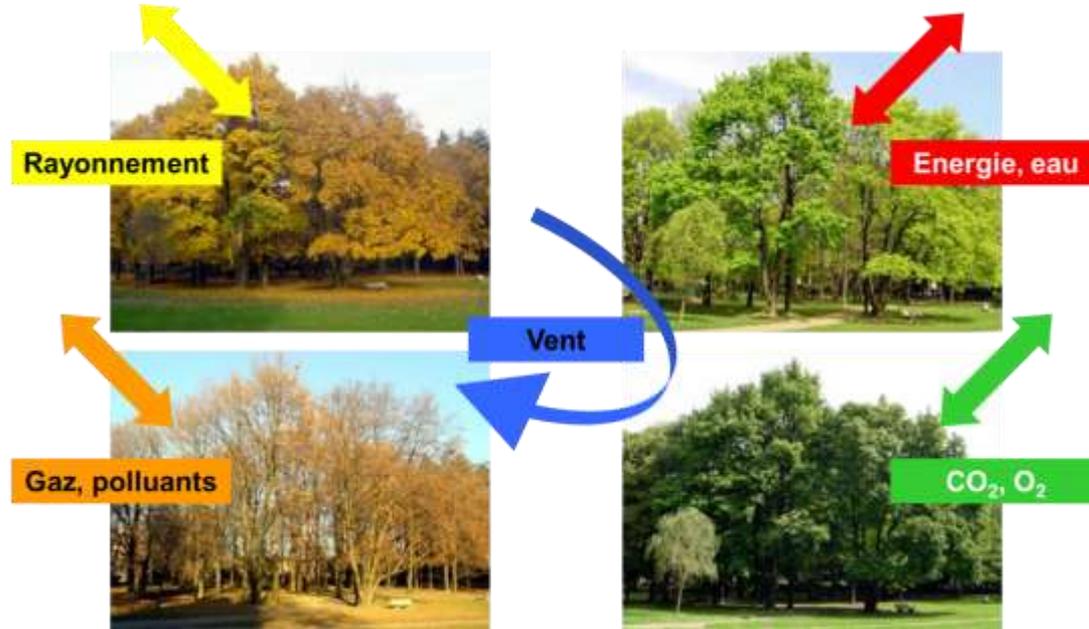
Lemonsu et al. (2015)



Int Arch Occup Environ Health (2006)

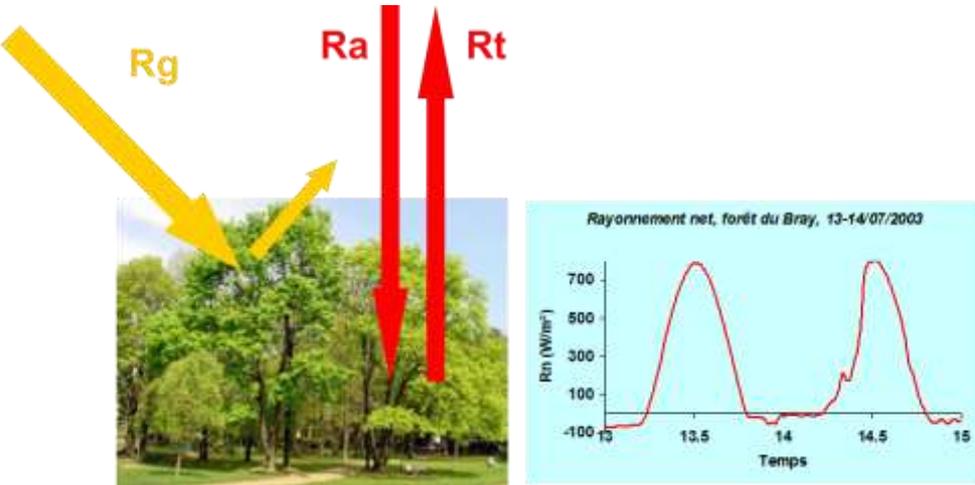
Une clé : le bilan d'énergie

- Les échanges surface – atmosphère

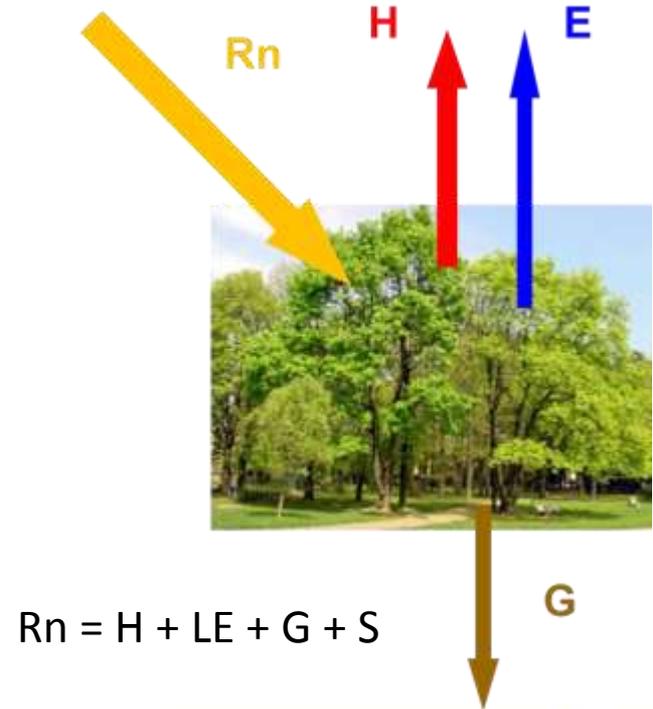


Une clé : le bilan d'énergie

- Bilan radiatif, bilan d'énergie



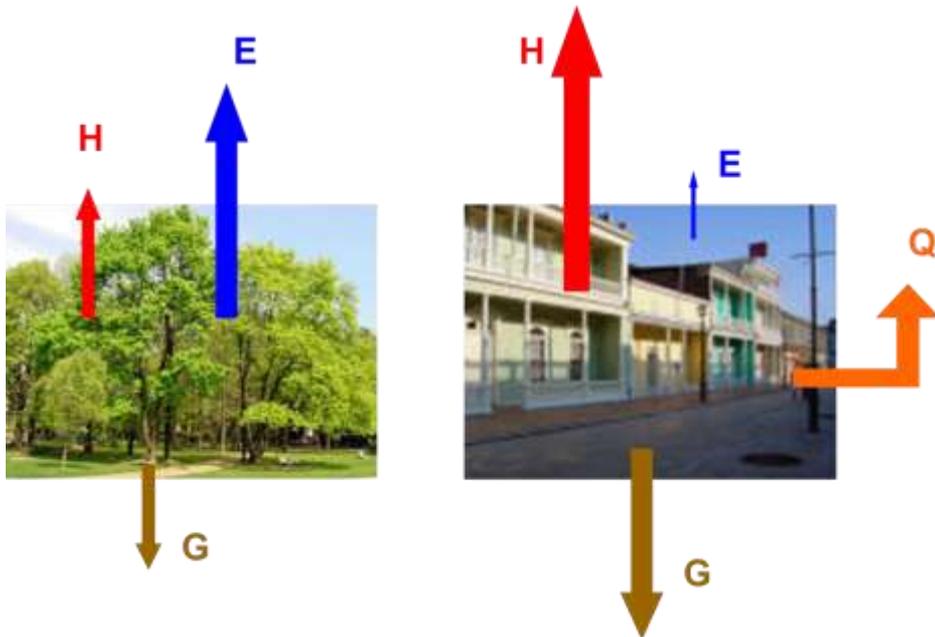
$$R_n = R_g (1-a) + R_a - R_t$$



$$R_n = H + LE + G + S$$

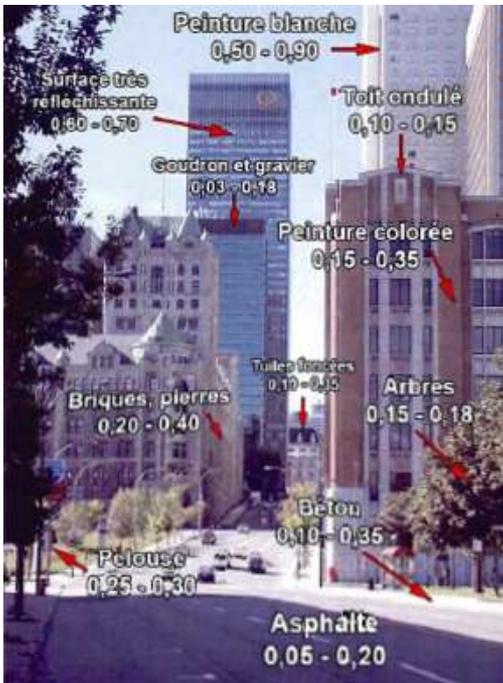
Une clé : le bilan d'énergie

- Végétation et bâti : les différences

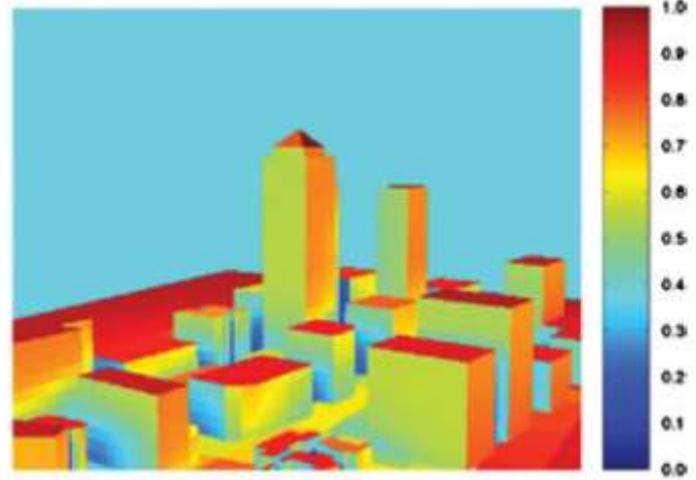
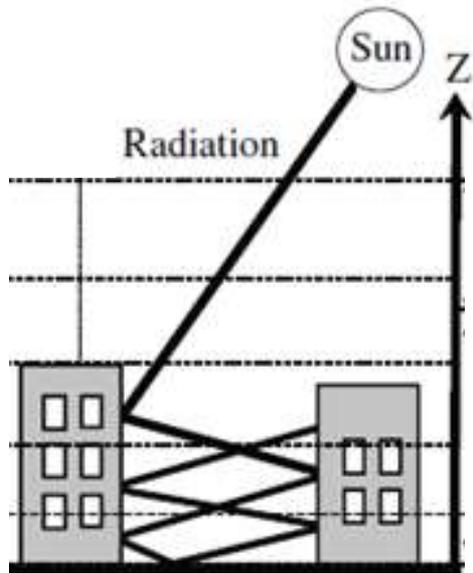


- Faible évaporation (plus fort échauffement)
- Sources internes de chaleur (chauffage, clim, industrie, automobiles...)
- Meilleur stockage de chaleur (piège radiatif + propriétés thermiques)
- Plus faible vitesse moyenne du vent (échanges plus limités)

Rayonnement : le piège radiatif

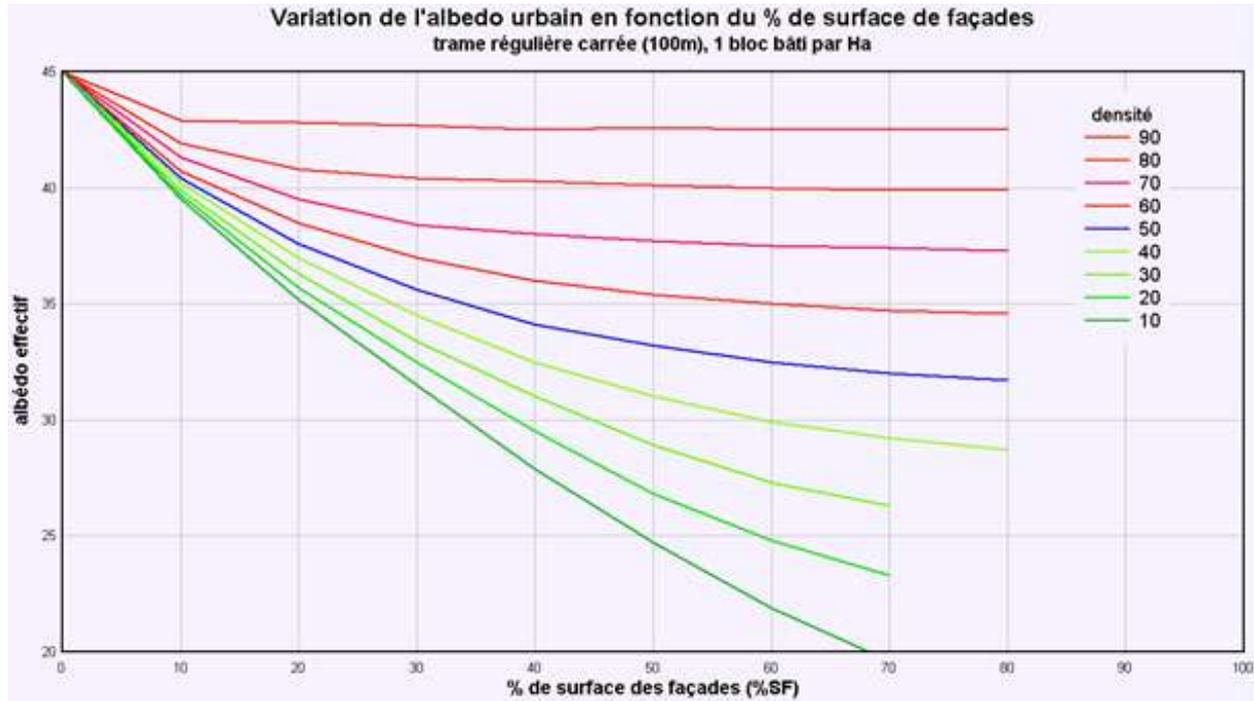


Martin (2008)



Rayonnement solaire annuel (MWh) simulé sur le Canary Wharf à Londres (Rasheed et al., 2011)

Rayonnement : le piège radiatif



Modèle SOLENE (Groleau, 2008)

La végétation : un îlot de fraîcheur

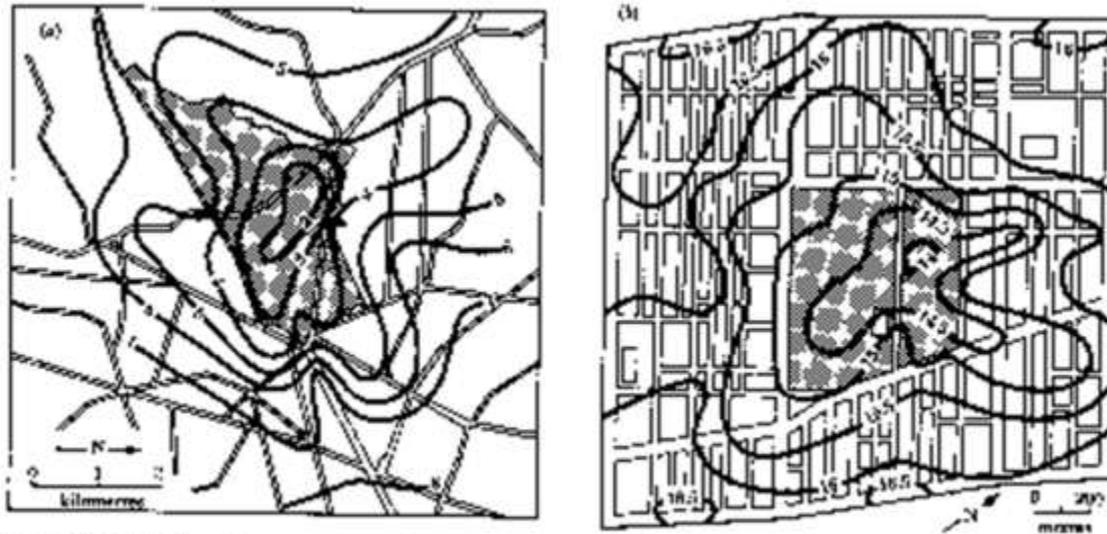
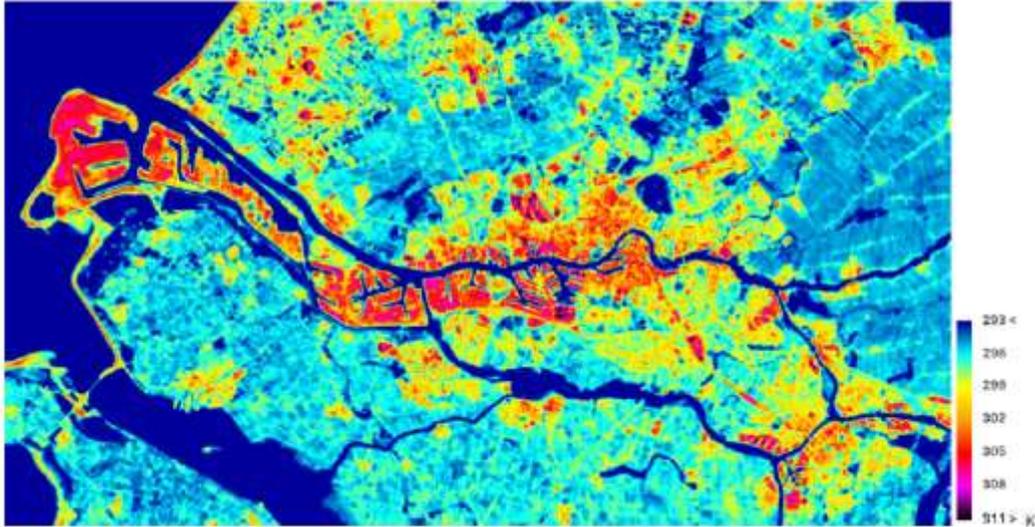
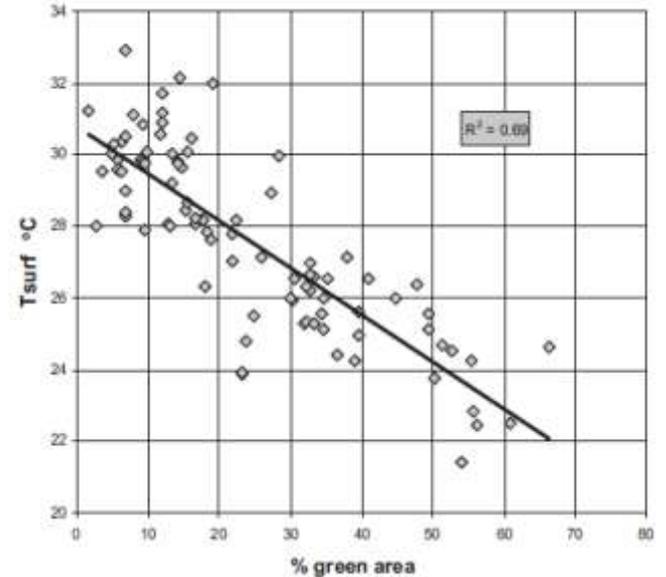


FIGURE 3. Distribution of near-surface air temperature (in degrees Celsius) in the vicinity of urban parks: (a) Chapultepec Park, Mexico City (500 ha) with calm cloudless conditions at 06:28–06:48 on 3 December 1970 (after Jauregui 1973). (b) Parc LaFontaine, Montreal (38 ha) with cloudless skies and winds of 3 m s^{-1} from the southwest at 20:15–21:15 on 28 May 1970 (Park area shaded).

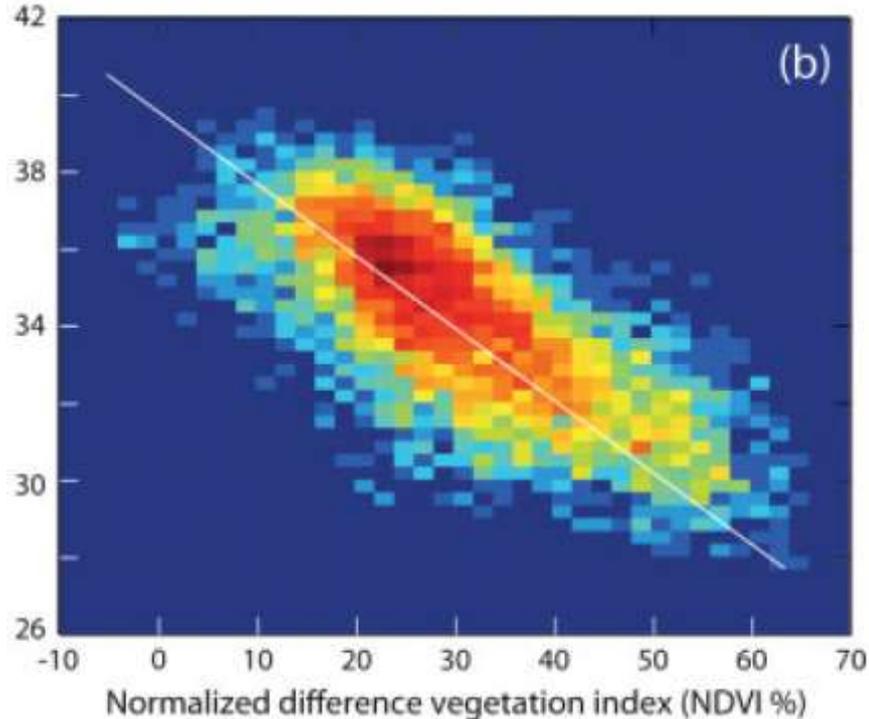
La végétation : un îlot de fraîcheur



ROTTERDAM (Klok et al., 2012)

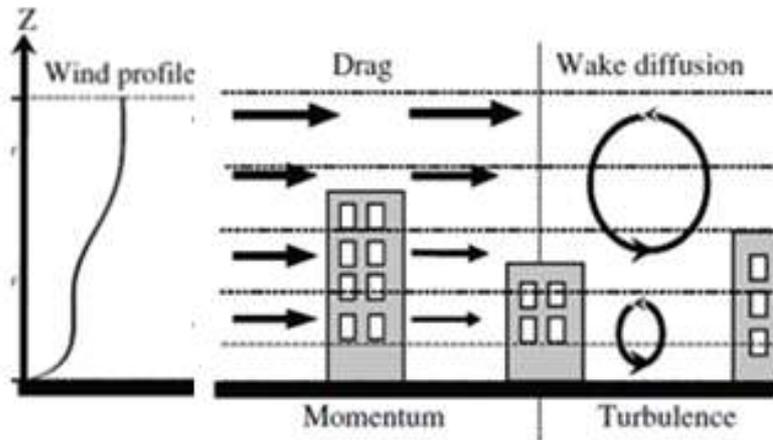


La végétation : un îlot de fraîcheur

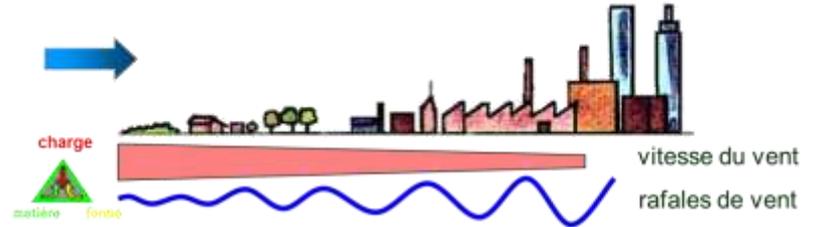
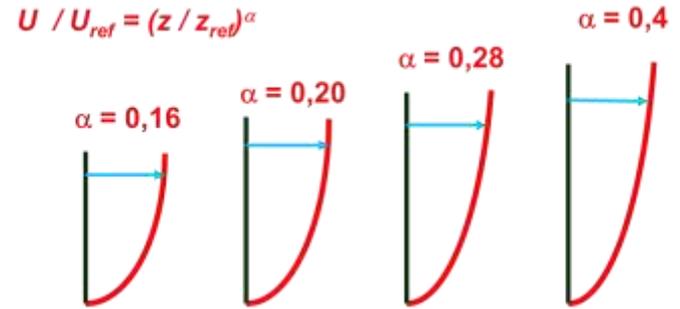


PARIS, août 2003
(Dousset et al., 2011)

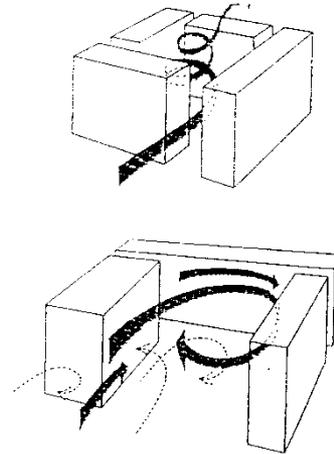
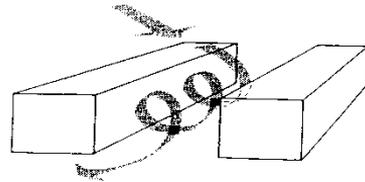
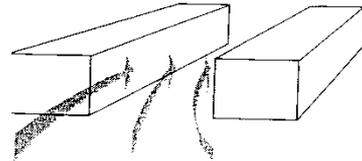
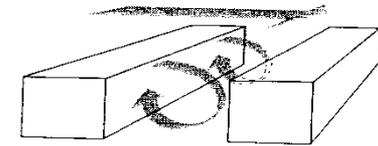
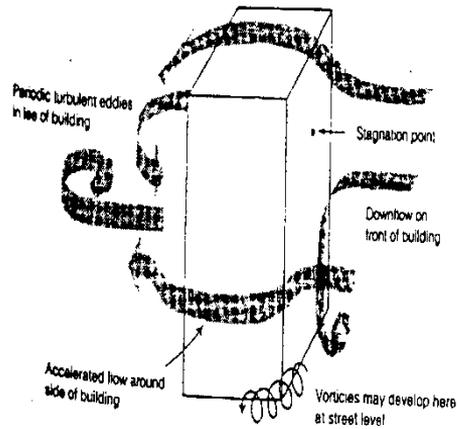
Vent moyen, turbulence, effets locaux



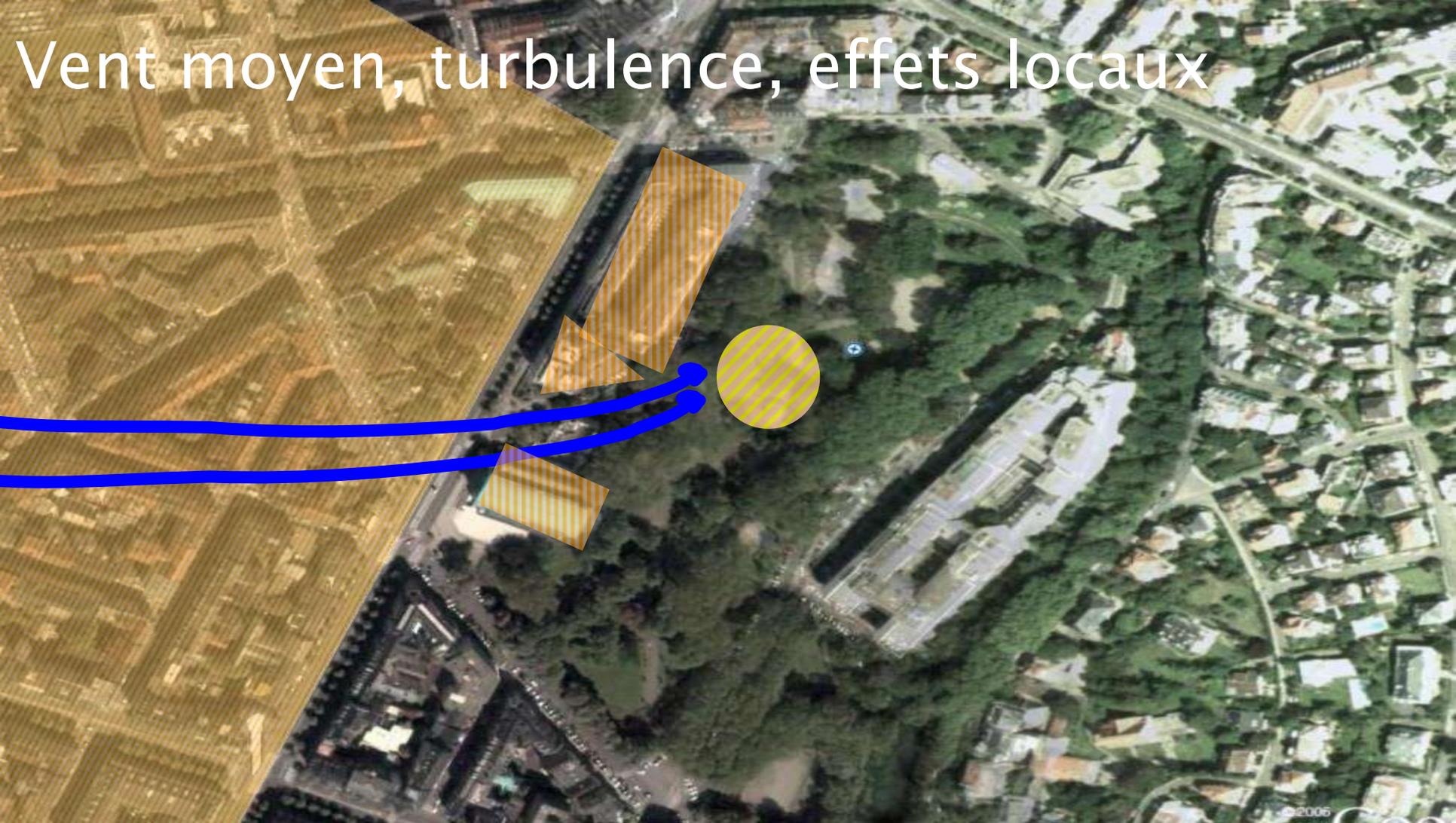
- Baisse de la vitesse moyenne
- Génération de turbulence
- Circulations locales



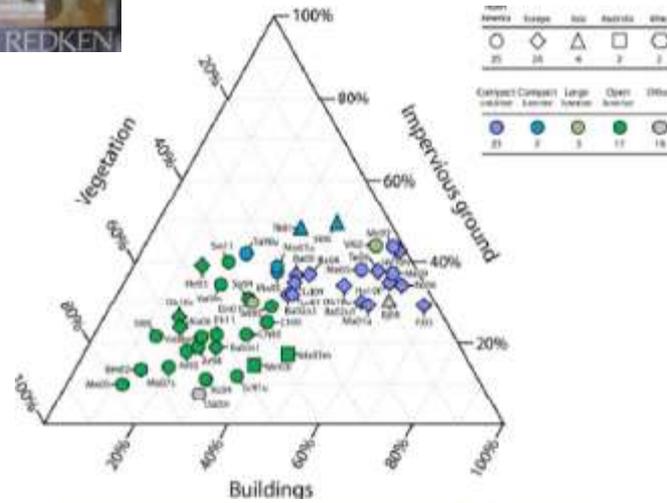
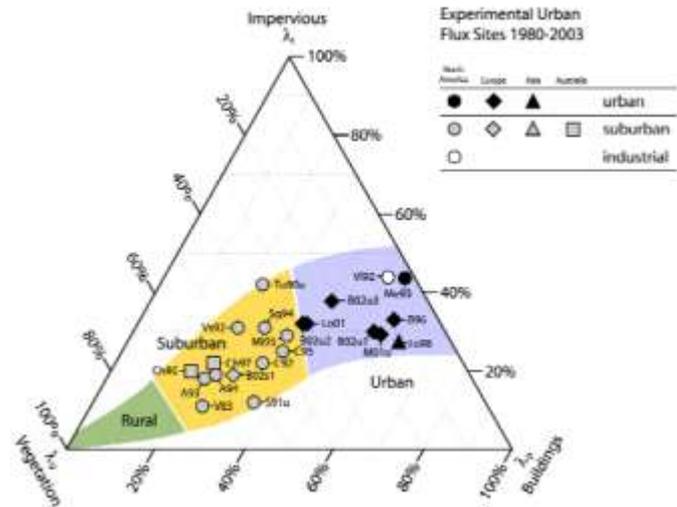
Vent moyen, turbulence, effets locaux



Vent moyen, turbulence, effets locaux



Sites d'observation et d'expérimentation



Grimmond et Christen (2012)

Sites d'observation

- France : Marseille (Escompte, 2001–02), Toulouse (Capitoul, 2004–06), Nantes (FluxSAP 2010–12)



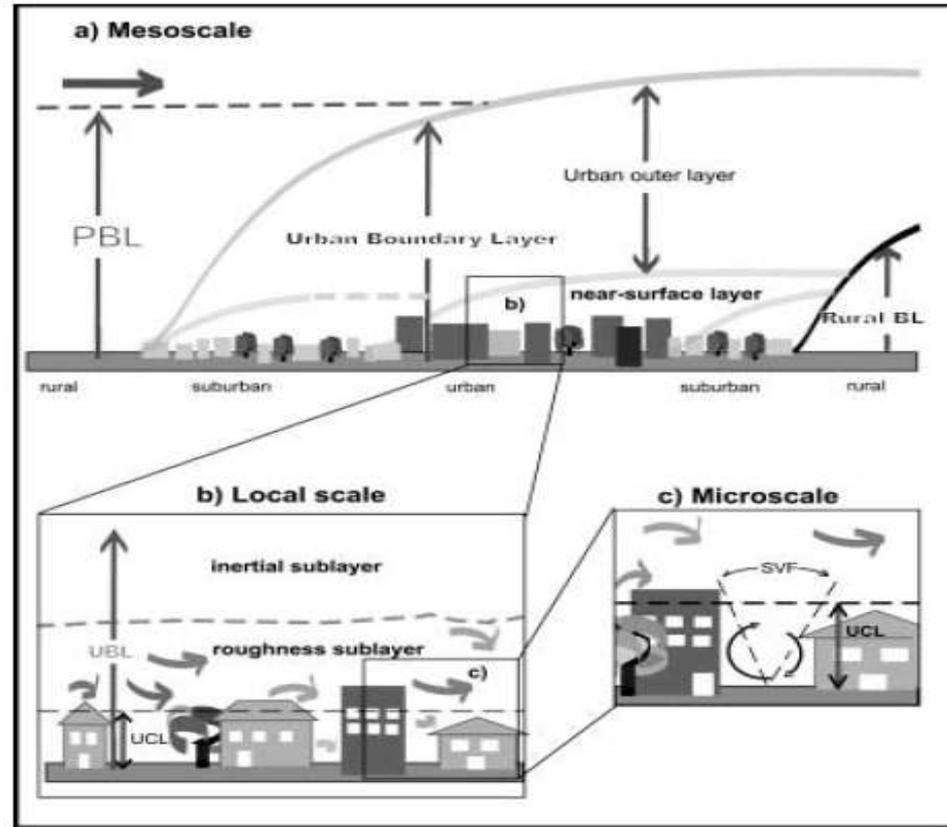
Mestayer et al. (2011)



Rodrigues (2015)

Modélisation

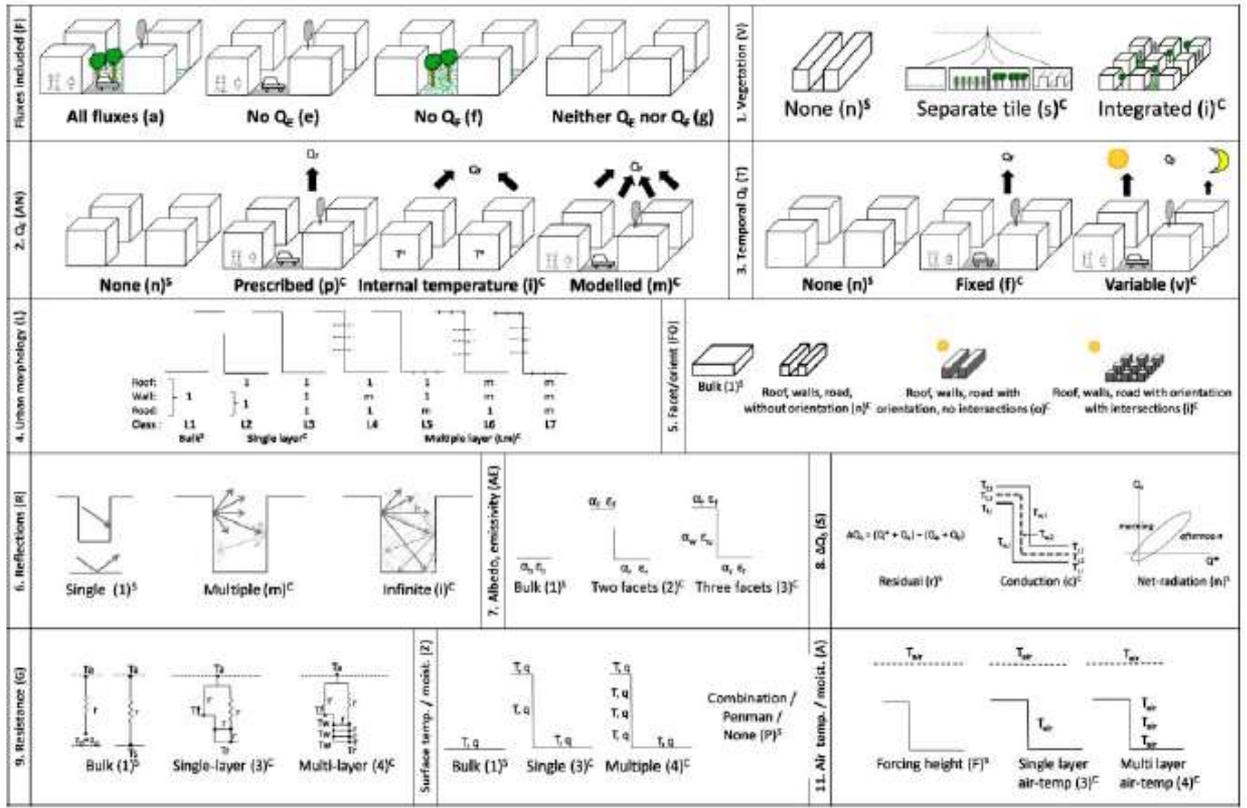
- Différentes échelles d'approche :
 - la ville surface
 - la ville poreuse
 - la ville explicite



Rotach et al. (2004), modifié après Oke (1987)

Modélisation

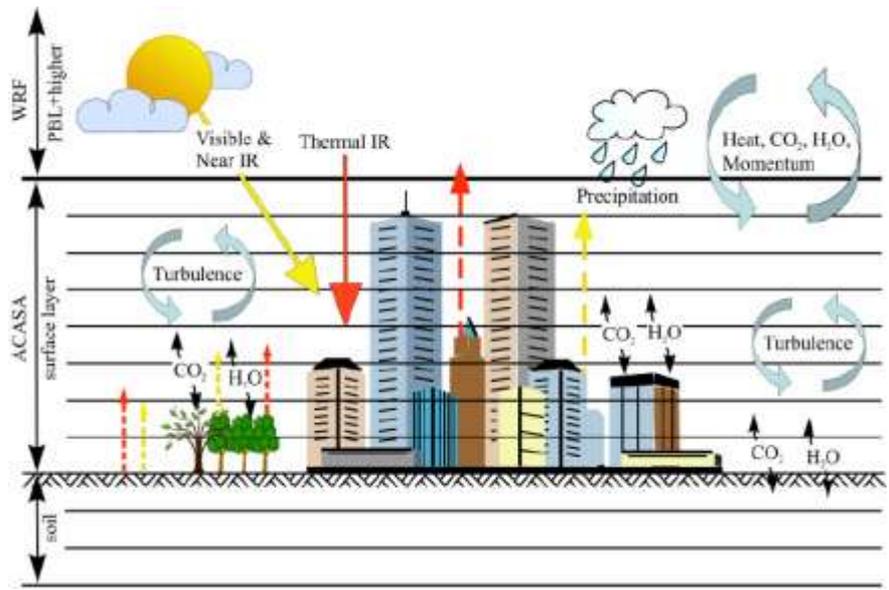
Code	Model name	References
BEP02 BEP_BEM08	Building effect parameterization BEP coupled with building energy model	Martilli <i>et al.</i> (2002) Martilli <i>et al.</i> (2002); Salamanca <i>et al.</i> (2009, 2010); Salamanca and Martilli (2010)
CLMU IISUCM	Community land model – urban Institute of industrial science urban canopy model	Olesen <i>et al.</i> (2008a, 2008b) Kawamoto and Ooka (2006, 2009a, 2009b)
JULES	Joint UK land environment simulator	Essery <i>et al.</i> (2003); Best (2005); Best <i>et al.</i> (2006)
LUMPS	Local-scale urban meteorological parameterization scheme	Grimmond and Oke (2002); Offerle <i>et al.</i> (2003); Loridan <i>et al.</i> (2010b)
NKUA MORUSES	University of Athens model Met Office reading urban surface exchange scheme	Dandou <i>et al.</i> (2005) Harman <i>et al.</i> (2004a, 2004b); Porson <i>et al.</i> (2010)
MUCM	Multi-layer urban canopy model	Kondo and Liu (1998); Kondo <i>et al.</i> (2005)
NJU-UCM-S	Nanjing University urban canopy model-single layer	Masson (2000); Kusaka <i>et al.</i> (2001)
NJUC-UM-M	Nanjing University urban canopy model-multiple layer	Kondo <i>et al.</i> (2005); Kanda (2005a, 2005b)
NSLUCM/ NSLUCMK/ NSLUCM- WRF	Noah land surface model/single-layer urban canopy model	Kusaka <i>et al.</i> (2001); Chen <i>et al.</i> (2004); Loridan <i>et al.</i> (2010a)
SM2U	Soil Model for submesoscales (urbanized)	Dupont and Mestayer (2006); Dupont <i>et al.</i> (2006)
SNUUCM	Seoul National University urban canopy model	Ryu <i>et al.</i> (2009)
SRUM2/ SRUM4	Single column reading urban model tile version	Harman and Belcher (2006)
SUEB	Slab urban energy balance model	Fortuniak (2003); Fortuniak <i>et al.</i> (2004, 2005)
SUMM	Simple urban energy balance model for mesoscale simulation	Kanda <i>et al.</i> (2005a, 2005b); Kawai <i>et al.</i> (2007, 2009)
TEB	Town energy balance multi-layer option	Masson (2000); Masson <i>et al.</i> (2002); Lemonsu <i>et al.</i> (2004); Pigeon <i>et al.</i> (2008)
TEB-ml	Town energy balance with multi-layer option	Hamdi and Masson (2008); Masson and Seity (2009)
TUF2D	Temperatures of urban facets 2D	Krayenhoff and Voigt (2007)
TUF3D	Temperatures of urban facets 3D	Krayenhoff and Voigt (2007)
UVCUM	Vegetated urban canopy model	Lee and Park (2008)



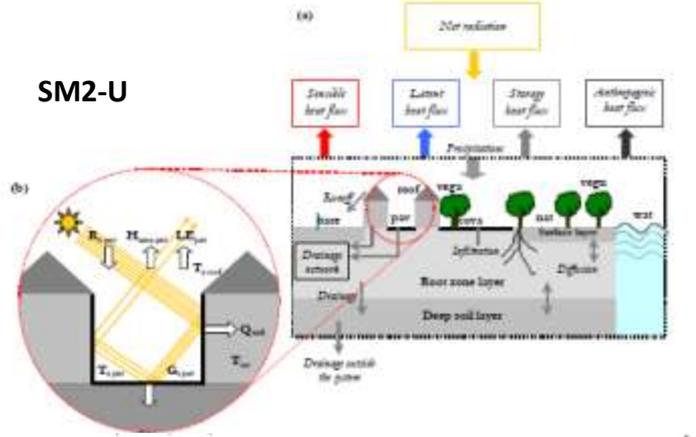
Grimmond et al. (2011)



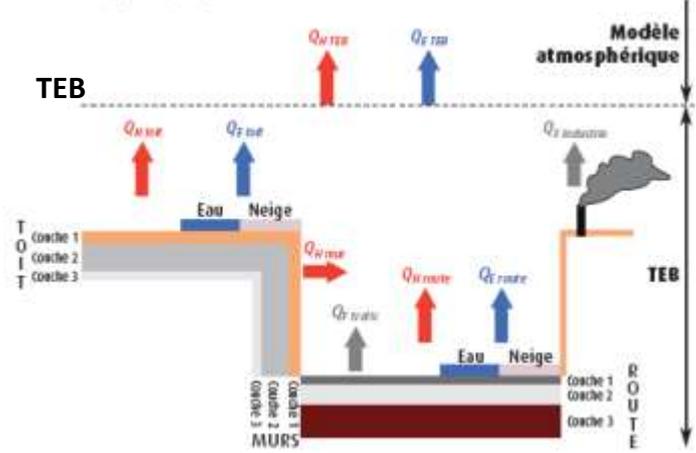
Modélisation



WRF-Urban

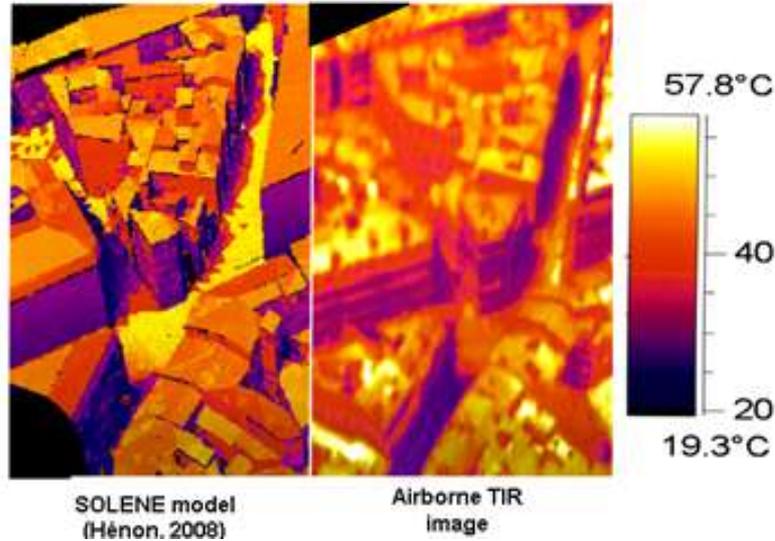


TEB



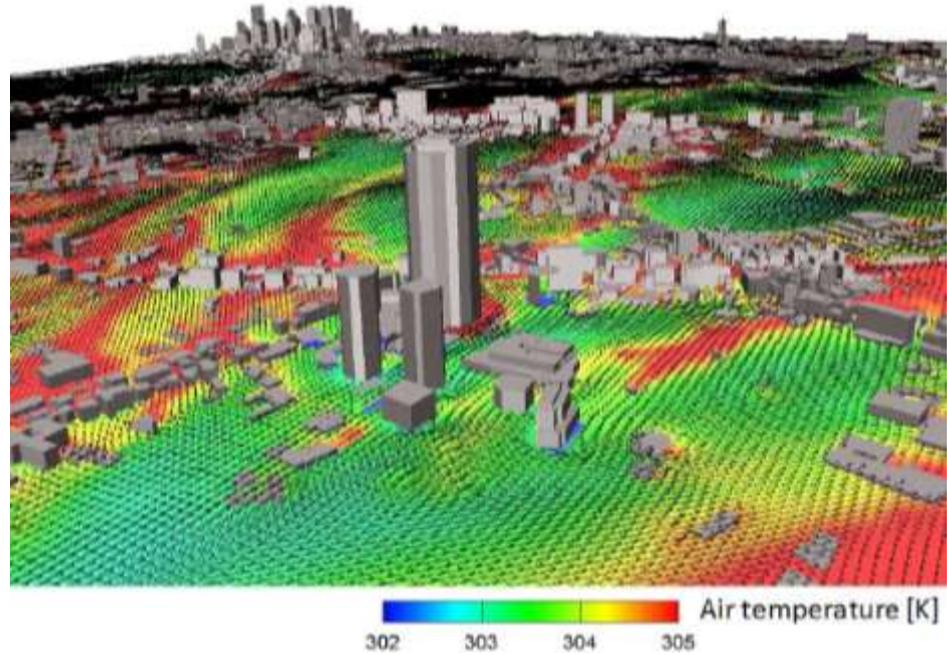
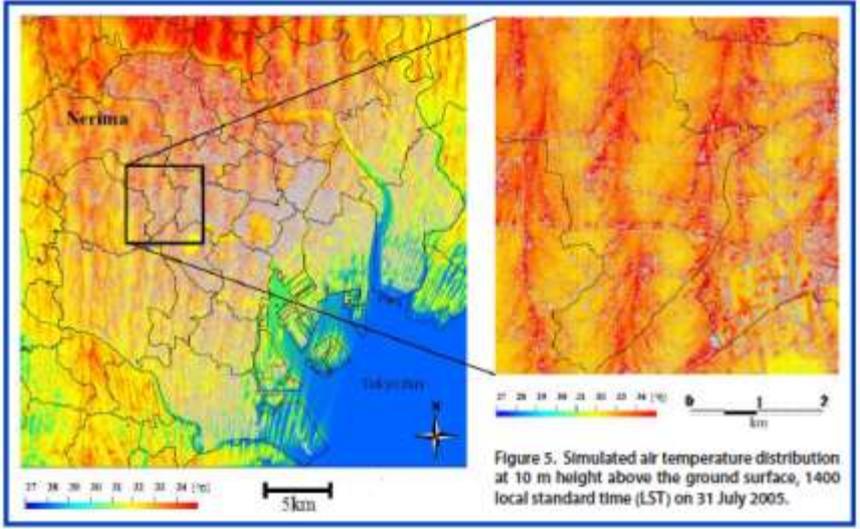
Modélisation

Toulouse / CAPITOUL project



Comparison between TIR airborne image and SOLENE modelled Ts (*Hénon, 2008*)

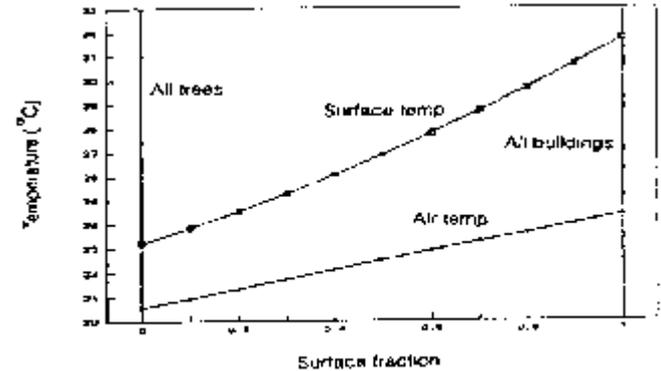
Modélisation



TOKYO (Ashie, 2011)

Modélisation

- Analyses de sensibilité à la présence de végétation
- Impact des pelouses, parcs, arbres, façades et toits...
- Impact sur la consommation énergétique des bâtiments
- Scénarios de végétalisation
- Effet de la configuration spatiale



Proc. 1994 National Greening Australia Conference

Impact de la végétation

- Projet ANR VegDUD 2010–2013
« Une ville verte – Les rôles du végétal en ville » (Ed. QUAE, 2014)

