

# **ICB02 Kansas City 2002**

## **An Update on the Development of a Universal Thermal Climate Index**

### **Progress Report of ISB Commission 6 on UTCI Under the „umbrella“ of WMO**

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# Why UTCI?

- **Assessment of the thermal environment:  
Key issue in human biometeorology**
- **History: >100 simple thermal indices**
- **Last 30 years: heat budget modeling**
- **Integration of new knowledge and concerns**
- **Need: global harmonization → UTCI (ISB Comm.)**

# Key applications

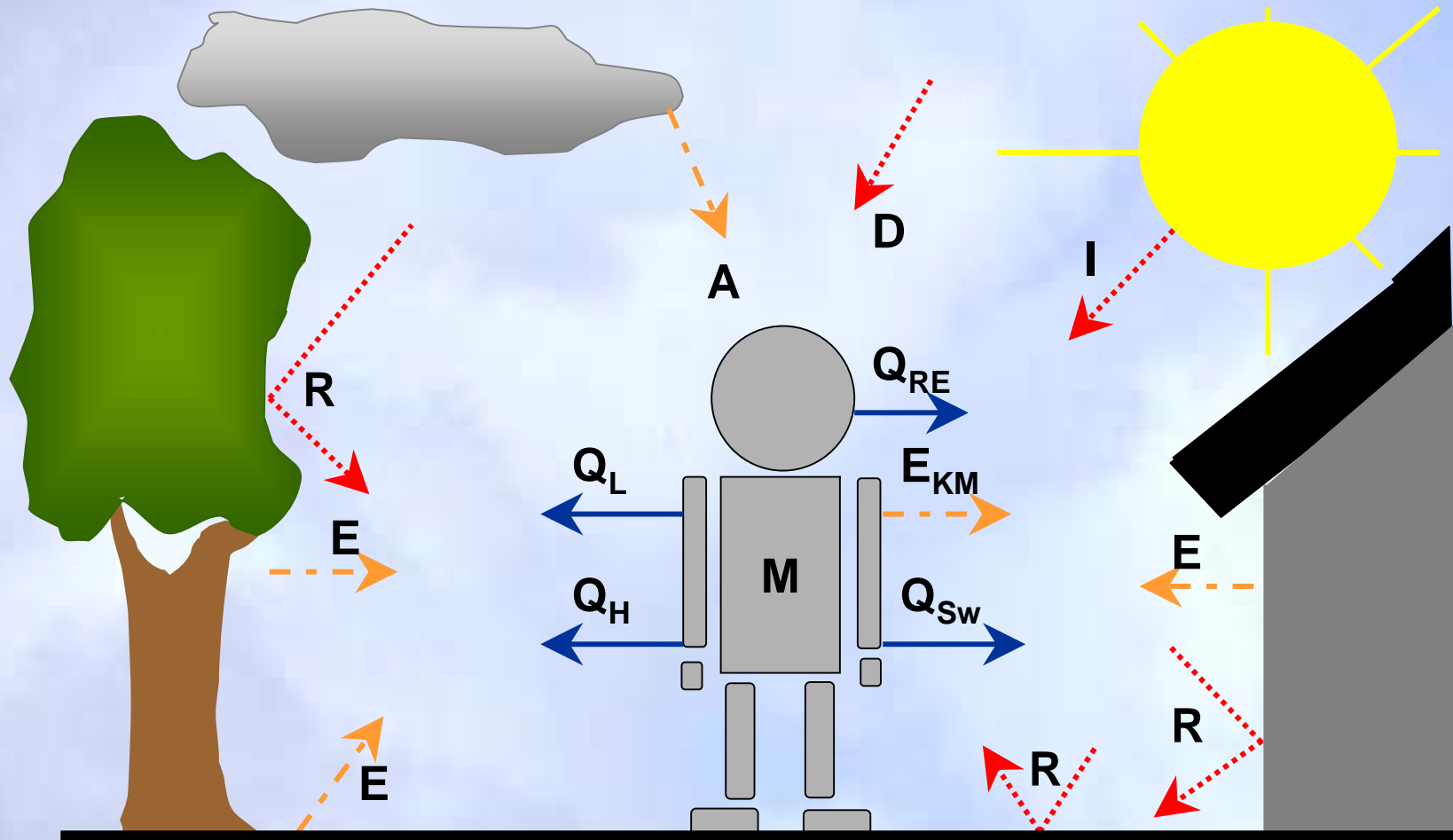
## Daily forecasts

- Public weather service
- Warnings (windchill, heat load)
- Advice (clothing, outdoor activities)

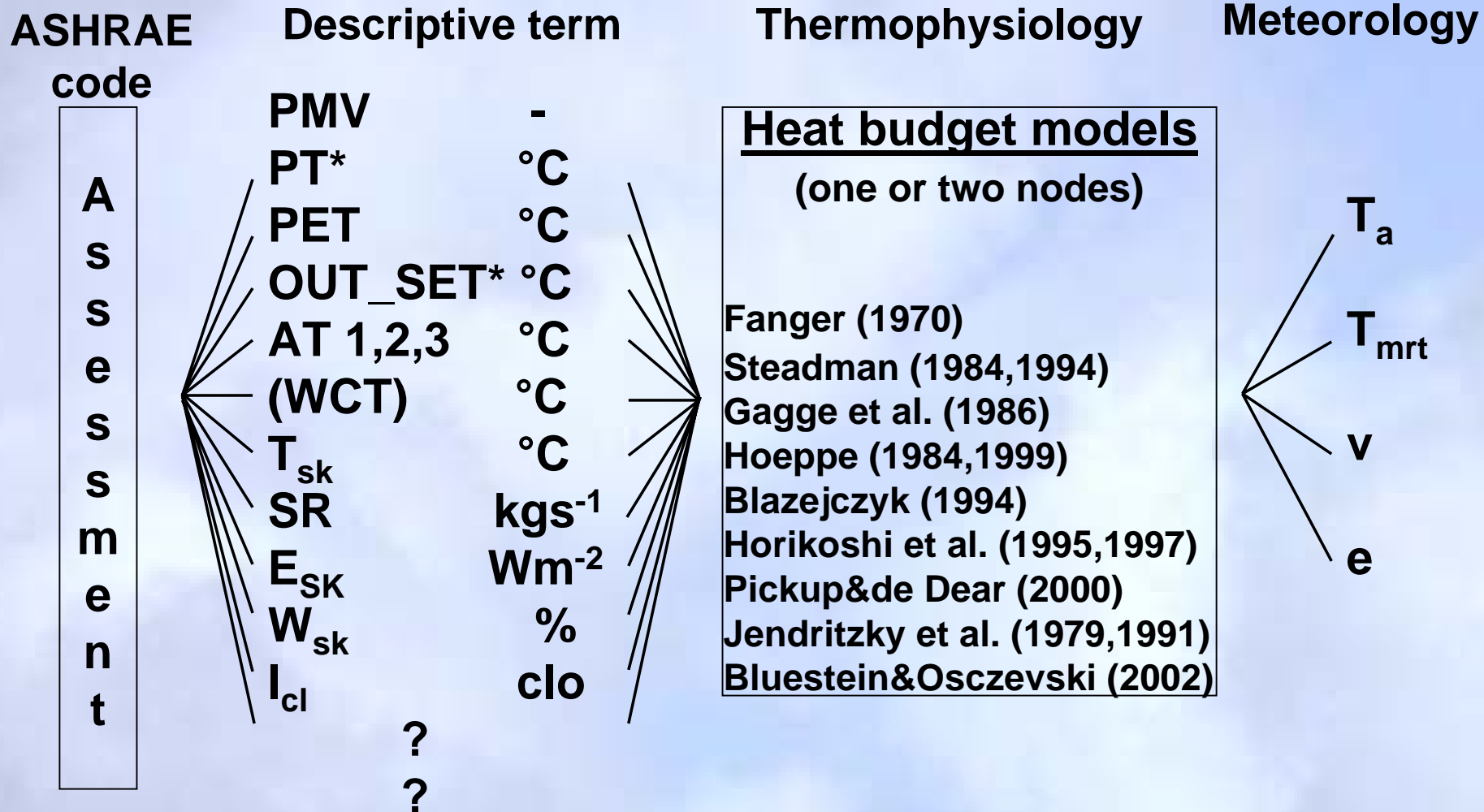
## Climate

- Bioclimatological assessments
- Bioclimate maps in all scales (micro - macro)
- Urban design, engineering of outdoor spaces
- Consultancy for residence
- Outdoor recreation and climatotherapy
- Epidemiology
- Climate impact research

# The Thermal Environment

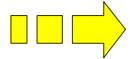


## Thermophysiological Assessment of the Thermal Environment



Fiala et al. 2001

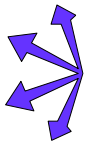
SHORT WAVE RADIATION



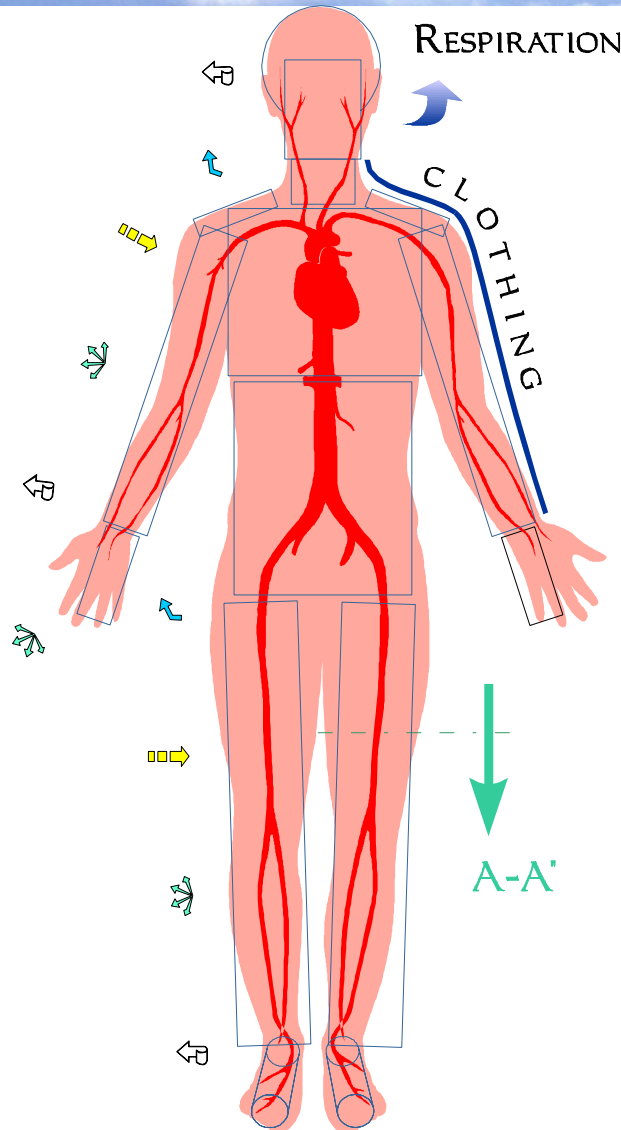
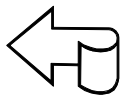
EVAPORATION



LONG WAVE RADIATION



CONVECTION



SECTION A-A' :

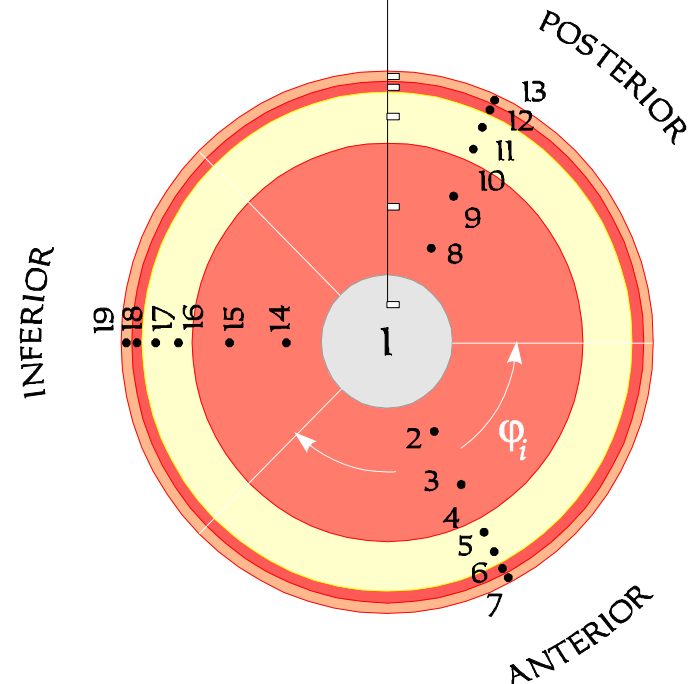
OUTER SKIN

INNER SKIN

FAT

MUSCLE

BONE (CORE)



## **Main research teams**

**for the most advanced multi-node models  
considered as basis for the UTCI development**

- **Fiala D., Lomas K.J., Stohrer M. (2001)**
- **Huizenga C., Zhang H., Arens E. (2001)**
- **Tanabe S.I., Kobayashi K., Nakano J., Ozeki Y., Konishi M. (2002)**

# Variables for multi-node model simulations

## Meteorological input

Δ

Air temperature ( $T_a$ ):  $-40^{\circ}\text{C} < T_a < +45^{\circ}\text{C}$  5K

Mean radiant temperature ( $T_{\text{mrt}}$ ):  $-10\text{K} < T_{\text{mrt}} - T_a < +40\text{K}$  10K

Relative humidity (rh):  $5\% < \text{rh} < 95\%$  15%

Relative wind speed ( $v_r$ ): 1.1, 2.2, 4.4, 8.8, 17.6 m/s (\*2)

→ 3780 combinations (partially unrealistic, but which?)

Intrinsic clothing (Icl): 0.4, 0.6, 0.9, 1.3, 1.8, 2.6 clo

Simulation of all  $T_{\text{mrt}}$ , rh,  $v_r$  combinations within a given Icl dependent range of  $T_a$  (*to reduce number of simulations*)



# Simulated whole body and local thermophysiological variables

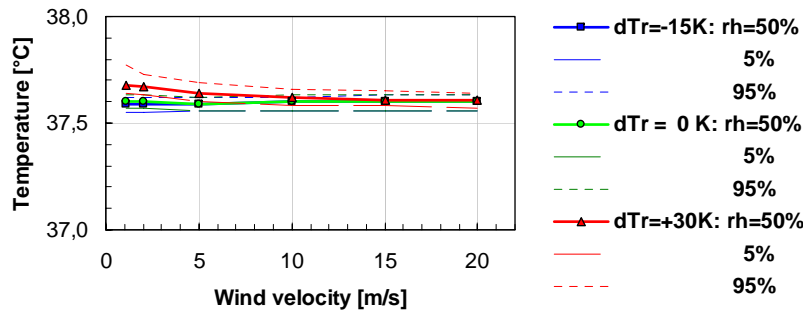
- Mean skin temperature,  $T_{sk,m}$
- Head core temperature (hypothalamus),  $T_{hy}$
- Total evaporative heat loss from the skin,  $E_{sk}$
- Skin wettedness,  $w_{sk}$
- Local skin temperatures of face and hands,  $T_{sk,f,h}$

Exposure time two hours; cooling time for  $T_{sk,f,h} < 0^{\circ}\text{C}$

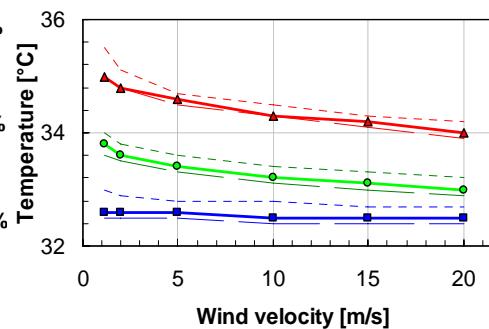
### Simulation multisegmental model of D. Fiala et al., 2001

$T_a = +30^\circ\text{C}$ ,  $I_{cl} = 0.5$  clo, walking 4 km/h = 2.3 MET ( $135 \text{ Wm}^{-2}$ ), exposure  $t = 2$  hrs

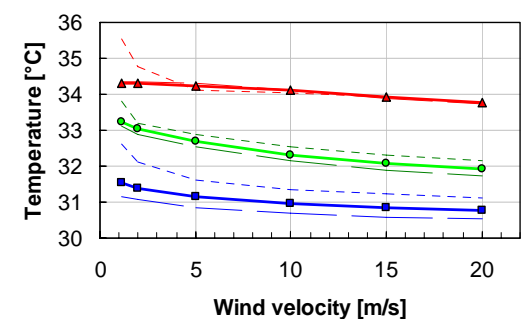
#### Core (head) temperature



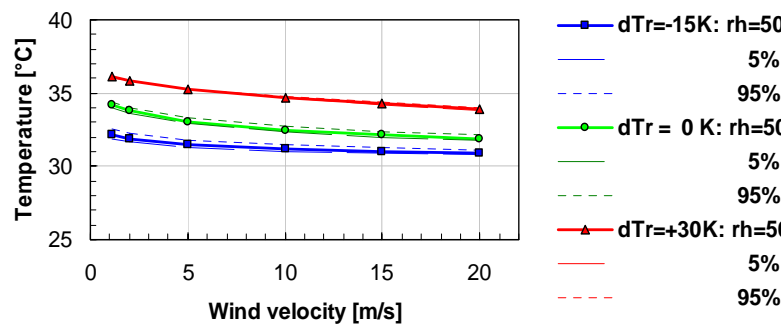
#### Mean skin temperature



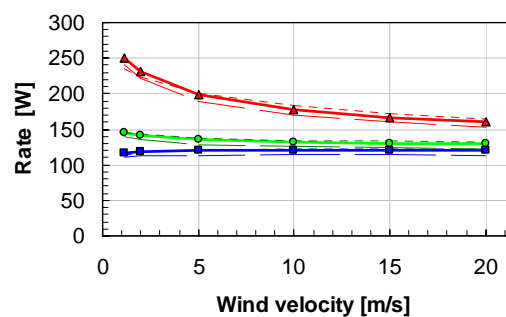
#### Skin temperature face



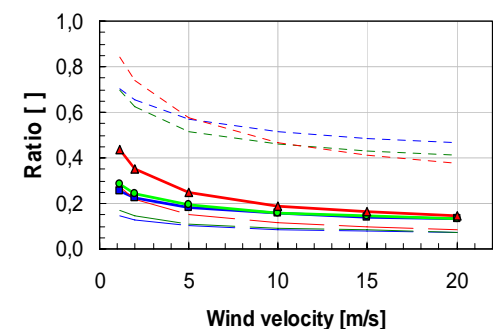
#### Skin temperature hand



#### Skin evaporation



#### Wetted skin surface



# Reference conditions for UTCI temperature\*

- Activity walking 4 km/h = 2.3 MET ( $\sim 135 \text{ Wm}^{-2}$ )
- Calm wind, i.e. only wind induced by walking (1.1 m/s)
- $T_{\text{mrt}} = T_{\text{a}}$
- rh = 50% (still under discussion)
- Icl: fixed or variable (0.4 -2.6 clo) (not yet defined)

**\*Temperature of a reference environment that provides the same heat exchange as under the actual thermal conditions**

# Summary: Basic features of UTCI

- **Thermophysiologicaly significant in the whole range of heat exchange conditions**
- **Valid in all climates, seasons and scales**
- **Useful for key applications in human biometeorology**
- **Steady-state conditions → practically useful results**
- **Independent of individual characteristics**
- **Prediction of whole body and local thermal effects**
- **Based on the most advanced multi-node models**
- **Temperature scale index**