

UTCI

The Universal Thermal Climate Index

COST TC Sept. 30 - Oct. 1, 2004 in Nice

Gerd Jendritzky
Freiburg, Germany

ISB

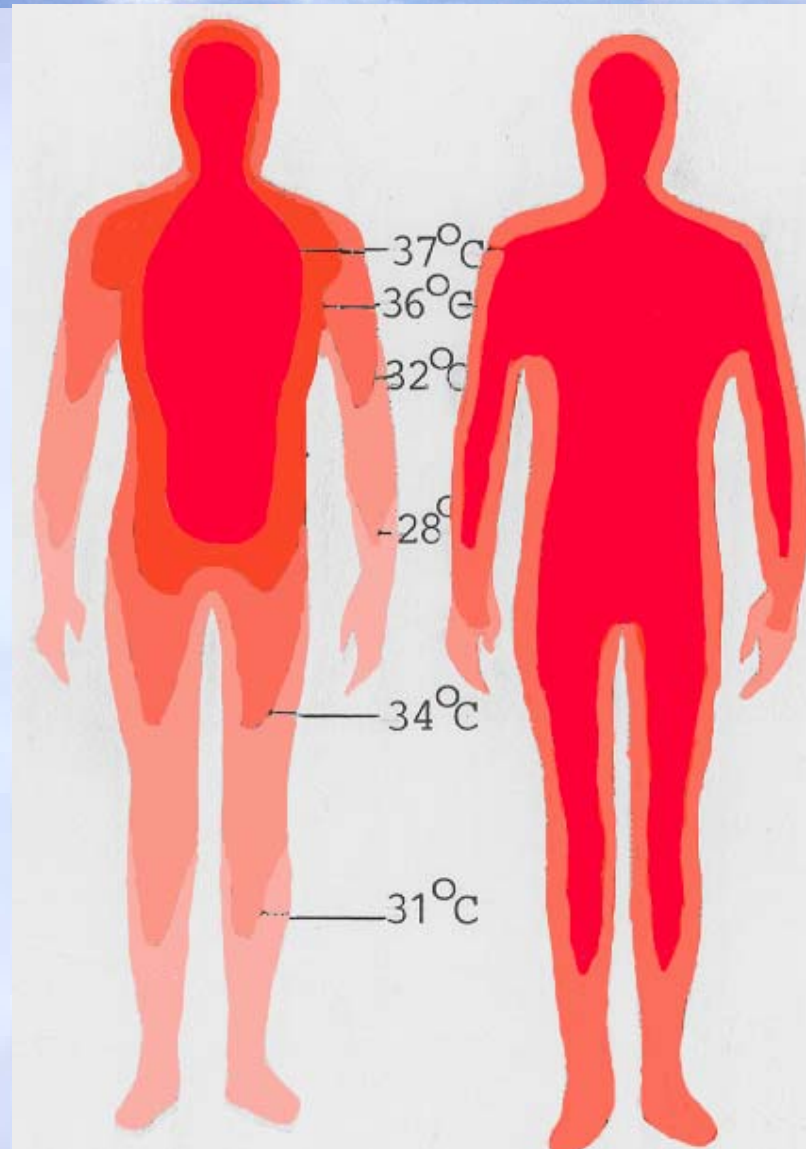
WMO

Deutscher Wetterdienst

Human Biometeorology

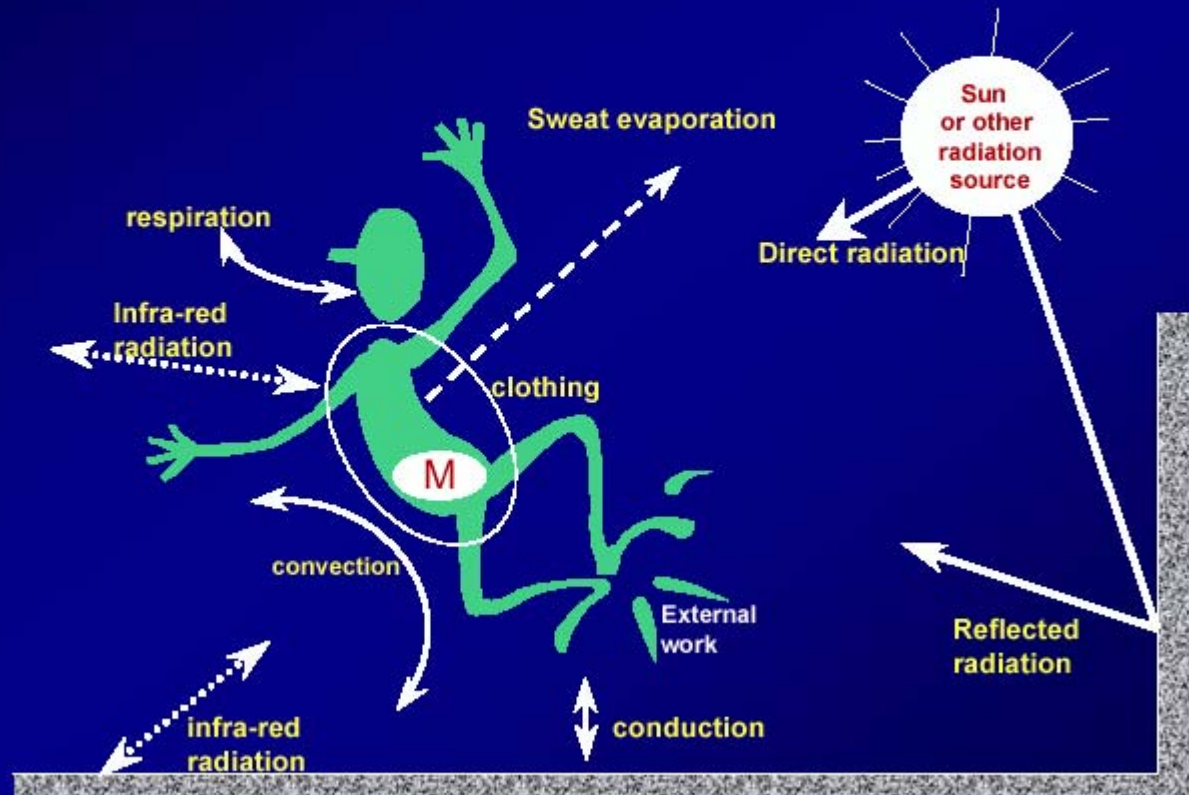


cold



warm

Avenues of Heat Exchange



The human heat budget

$$M + W + Q^* + Q_H + Q_L + Q_{SW} + Q_{Re} = 0$$

M metabolic rate

W mechanical power

Q* radiation budget

Q_H turbulent flux of sensible heat

Q_L turbulent flux of latent heat (diffusion of water vapour)

Q_{SW} turbulent flux of latent heat (sweat evaporation)

Q_{Re} respiratory heat flux (sensible and latent)

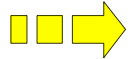
Principle

**Each index value
must result in the same thermophysiological effect
regardless of the combinations the meteorological and
other environmental input values.**

No simple index is able to fulfill this requirement!

Fiala et al. 2001

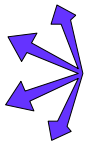
SHORT WAVE RADIATION



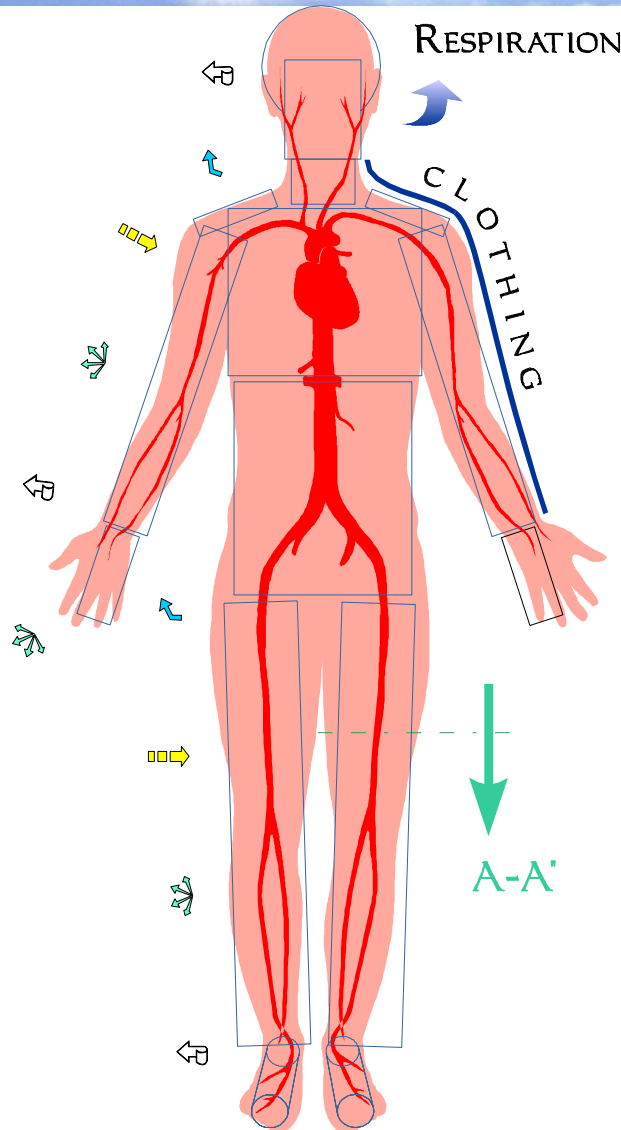
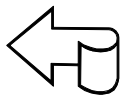
EVAPORATION



LONG WAVE RADIATION



CONVECTION



SECTION A-A' :

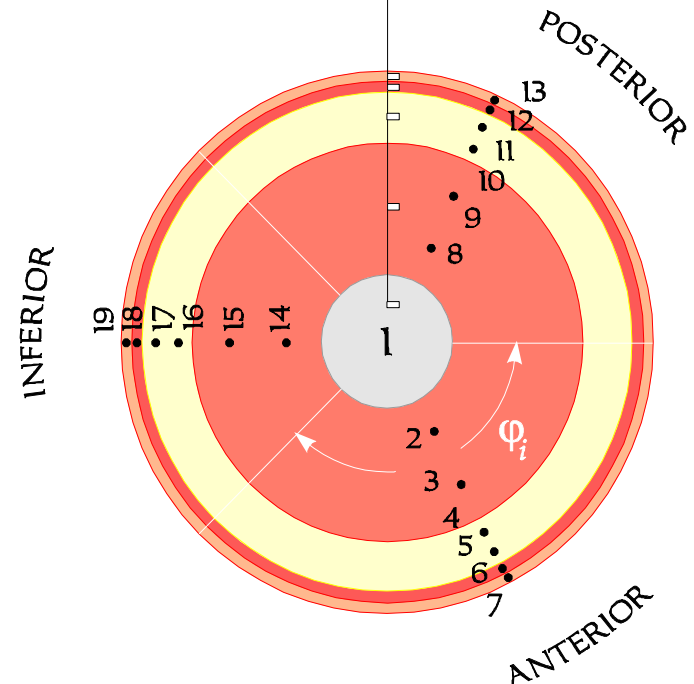
OUTER SKIN

INNER SKIN

FAT

MUSCLE

BONE (CORE)

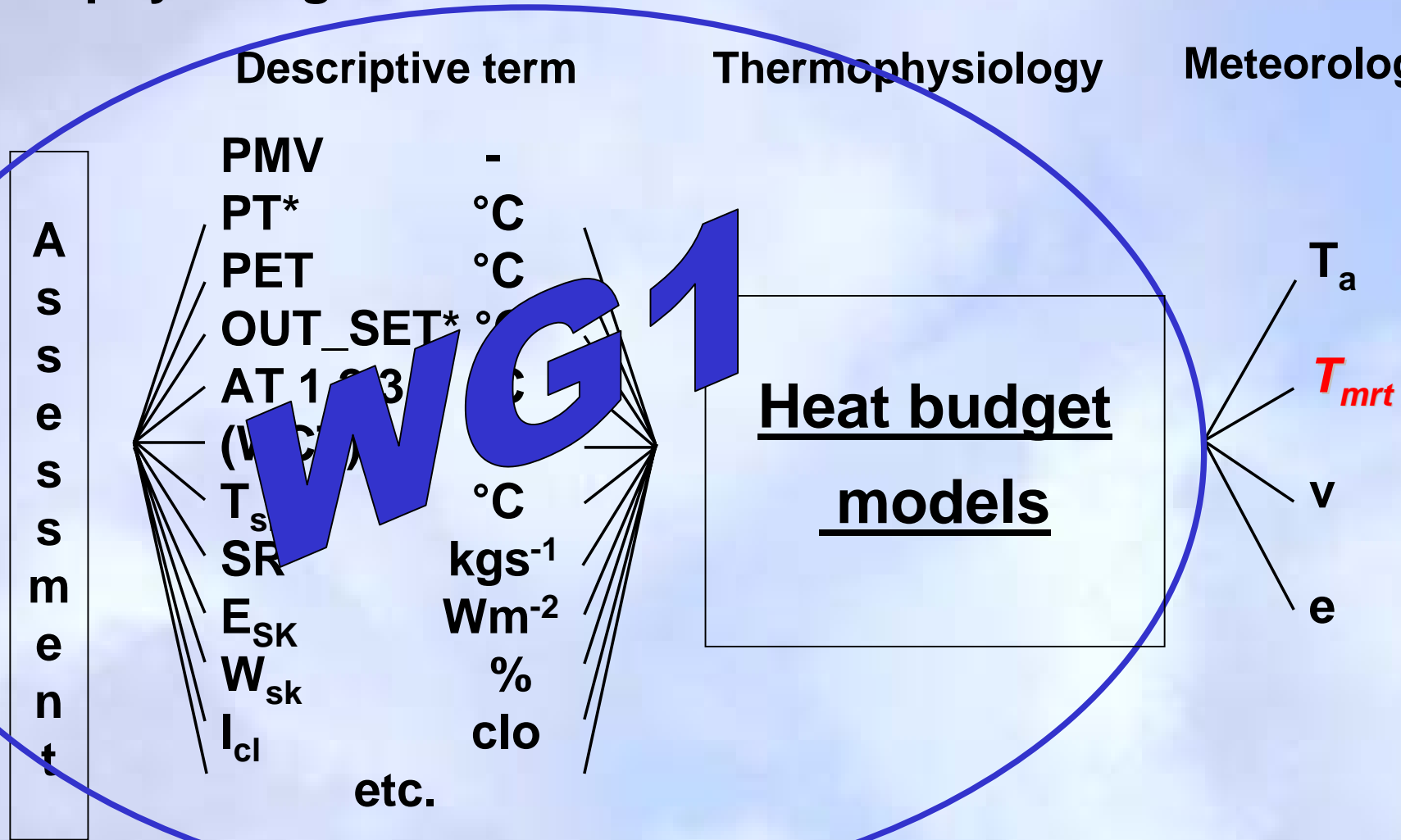


Simulated whole body and local thermophysiological variables

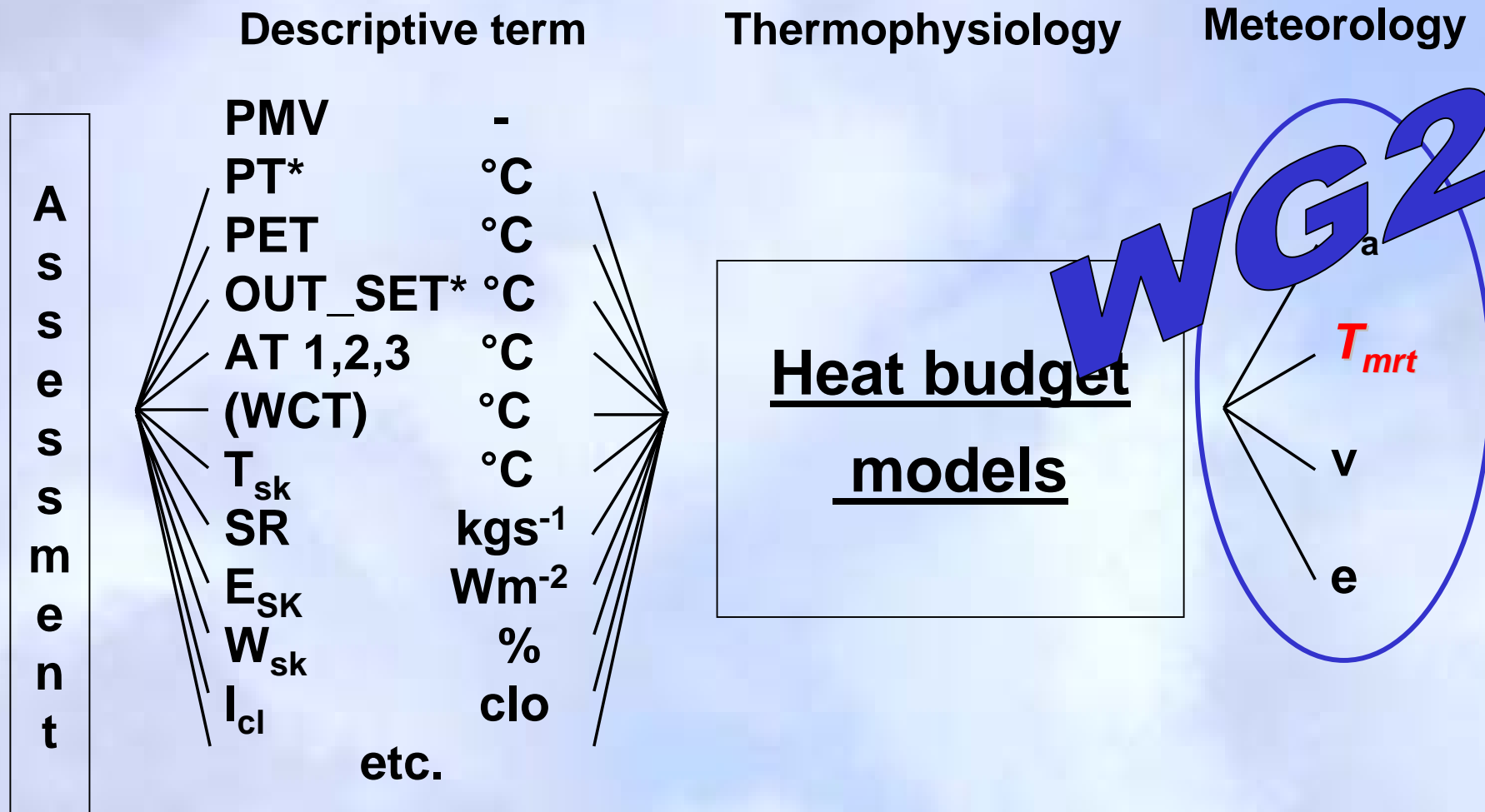
- Mean skin temperature, $T_{sk,m}$
- Head core temperature (hypothalamus), T_{hy}
- Total evaporative heat loss from the skin, E_{sk}
- Skin wettedness, w_{sk}
- Local skin temperatures of face and hands, $T_{sk,f,h}$
- Cooling time for $T_{sk,f,h} < 0^{\circ}\text{C}$

Assessment problem!

Thermophysiological Assessment of the Thermal Environment



Thermophysiological Assessment of the Thermal Environment



T_{mrt}









Uniform temperature of a black body enclosure that results in the same radiant heat exchange as under actual conditions

- **Direct solar radiation**
- **Diffuse solar radiation**
- **Reflected solar radiation**
- **Infrared radiation from the sky**
- **Infrared radiation from the surroundings**

Deutscher Wetterdienst

Human Biometeorology



Azimuth	Elevation			
	0°	30°	63°	90°
0°				
90°				

Key applications

Daily forecasts

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

Climate

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

WG 3 Applications

- **Public weather service**
- **Public health system**
- **Precautionary planning**
- **Climate impact research**

Selected subproplems

- Heat budget modelling WG1
- Assessment of physiological variables WG1
- Acclimatisation WG1
- Meteorological input, in particular radiation → Tmrt WG2
- Definition of areas of validity, requirements WG2
- Applications (Needs of users) WG3

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**