Realizing the Full Cycle of Research and Development: From Bench to the Community

Climate and human health: translational research for social security

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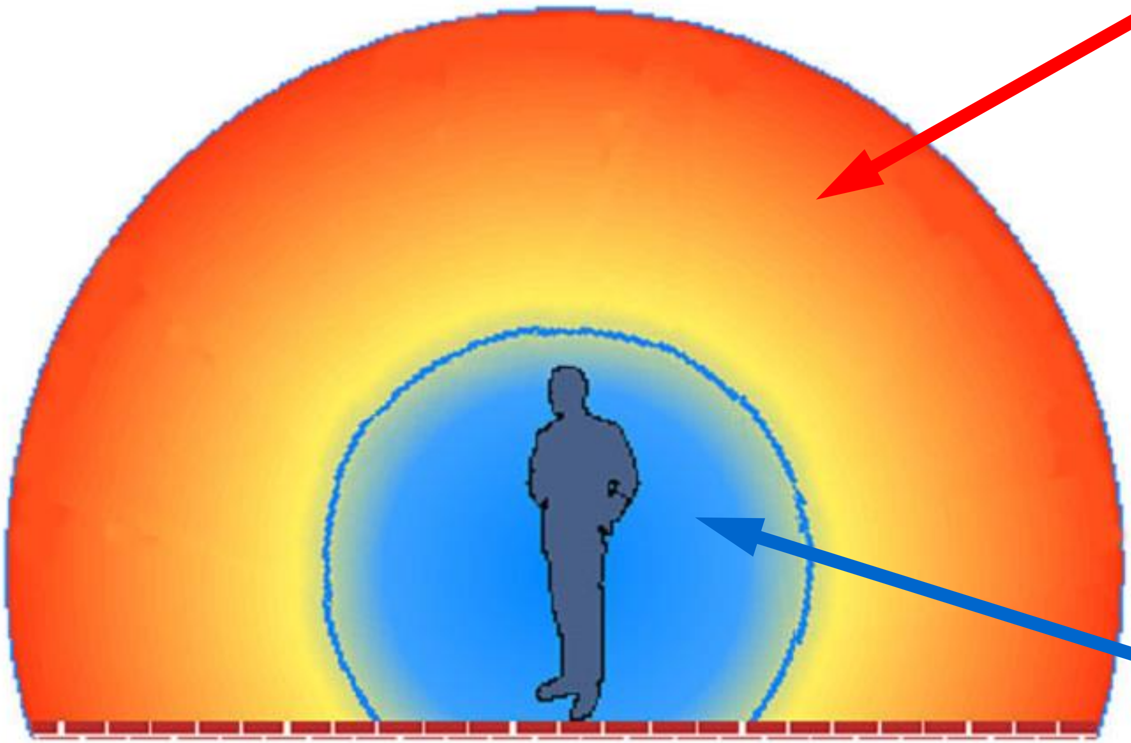
Body-atmosphere energy exchange



"Standard" man, defined as a healthy male, about 25 years of age

Thermal environment

- Air temperature
- Humidity
- Wind speed
- Solar radiation
- Longwave radiation

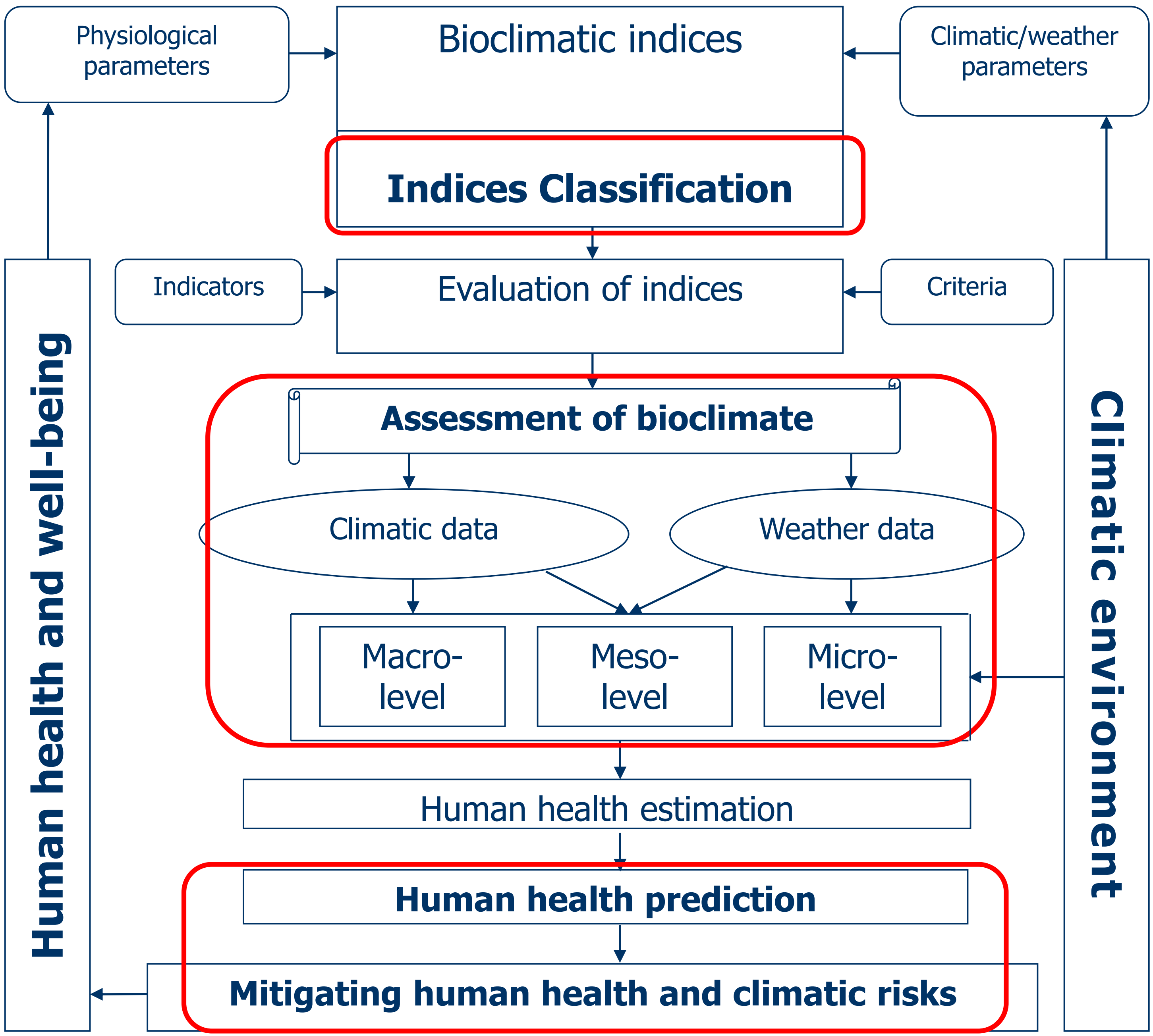
The person

- Internal heat production (activity level)
- Clothing insulation
- Sweat evaporation
- Respiratory heat exchange

Spatial-temporal spectrum for multilevel research of environment

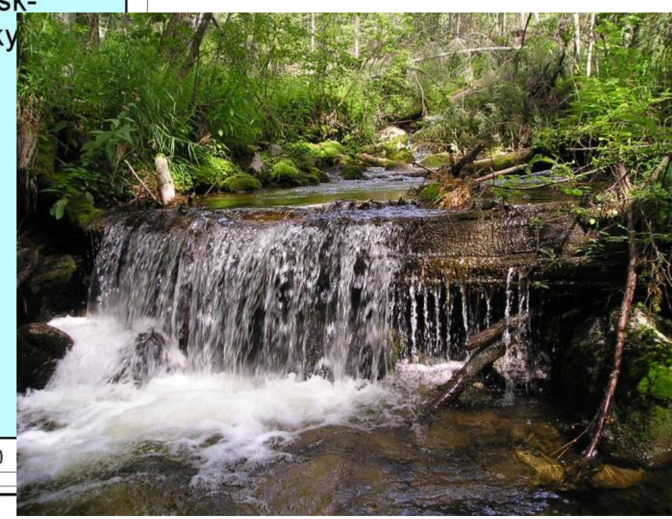
(Turner, 1990; Levin, 1992; Yattaw, 1999; Sarma, 2005; Yoshino, 2005)

Hierarchical level	Scale	
	horizontal, m	temporal, hour
Micro-	$10^2 – 10^4$	$10^1 – 10^4$
Meso-	$10^3 – 10^6$	$10^4 – 10^5$
Macro-	$10^5 – 10^7$	$10^5 – 10^6$



System "Weather/Climate – Human health and well-being"

Russian Far East



Data

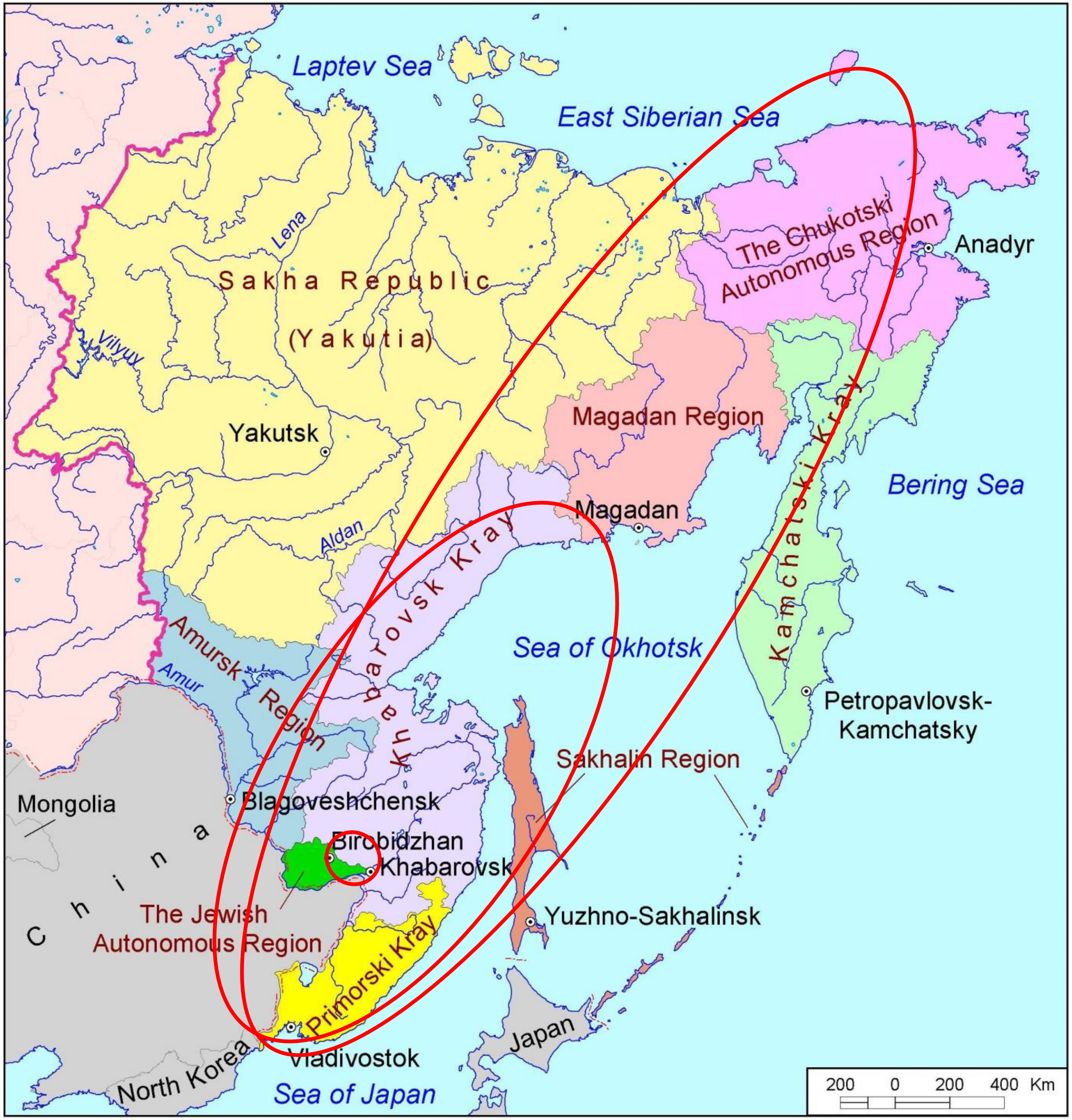
Climatic: Scientific Handbooks on Climate

Weather: http://meteo.ru/

Main Stages and Regions

	Stage	Data	Region	Bioclimatic index*
1.	Macro-level	Climatic	Russian Far East (RFE)	H, Tn, НЭЭТ, AT, ЭЭТ, CLODEX
2.	Meso-level	Climatic, weather	Southern part of the RFE	SSC, PET, T
3.	Micro-level	Weather	Khabarovsk, Birobidzhan	SSC, PET

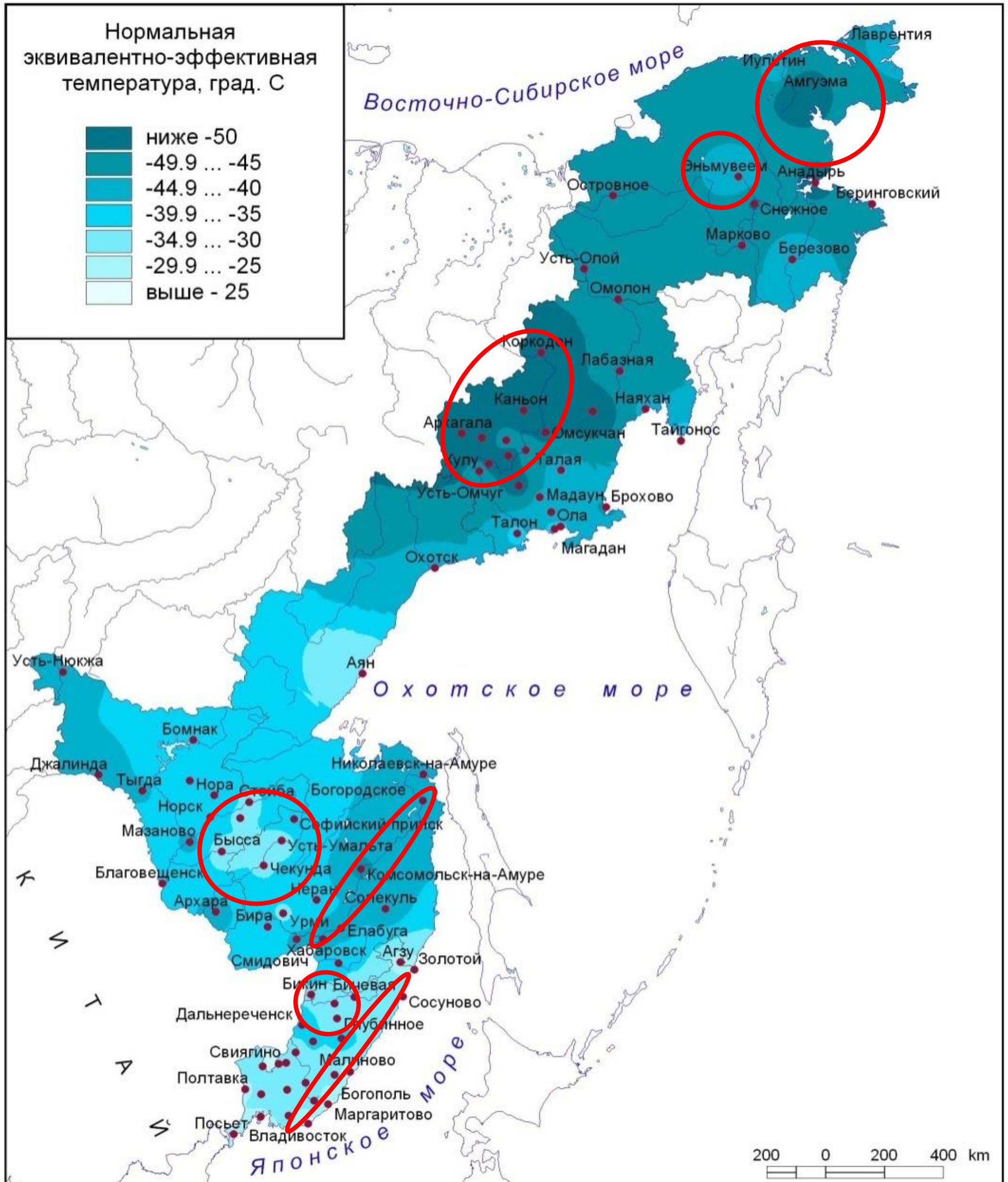
*H – Wet Kata Cooling Power by Hill (Hill et al., 1928)
Tn – Natural Wet Bulb Temperature (Maloney, Forbes, 2011)
AT – Apparent temperature (Steadman, 1984)
NEET – Effective Temperature (or Resultant Temperature) (Missenard , 1948)
EET – Equivalent Effective Temperature (Aizenshtat, Aizenshtat, 1974)
CLODEX – Index of Clothing Required for Comfort (de Freitas, 1979)
SSC – Spatial Synoptic Classification(Kalkstein et al., 1986)
PET – Physiological Equivalent Temperature (Mayer, Höppe, 1987; Höppe, 1999)
T – Air temperature



Russian Far East

Algebraic or statistical model

Effective (or Resultant) Temperature (NEET)



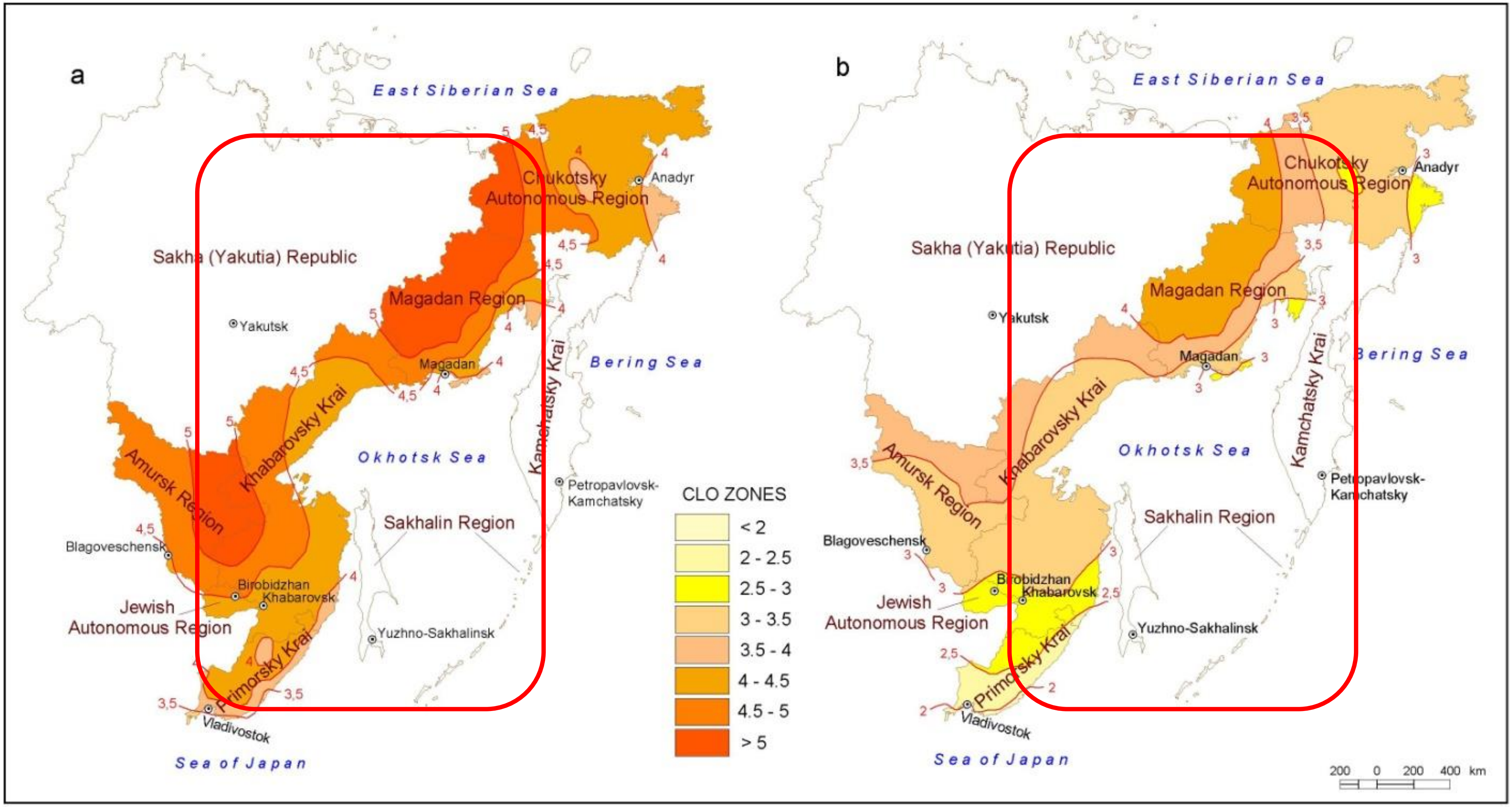
NEET = 37 – (37 – T) / [0,68 – 0,0014 f + 1/ (1,76 + 1,4 $V^{0,75}$)] – 0,29 T (1 – f/100)

$$NEET = 37 - (37 - T) / [0{,}68 - 0{,}0014 f + 1/(1{,}76 + 1{,}4 V^{0{,}75})] - 0{,}29 T (1 - f/100)$$

T – air temperature, °C
f – relative humidity, %
V – wind speed, m s^{-1}

Spacial dynamic of the Effective (or Resultant) Temperature (NEET), continental part of the Russian Far East, winter

Index of Clothing Required for Comfort (CLODEX)



Mean maximum (a) and minimum (b) for winter (January) clo requirements at a metabolic rate of 116 W m^{-2}, Russian Far East

(1 clo = 0,155 °C m^2 W^{-1})

The "Air Mass-Based" Approach: Spatial Synoptic Classification (SSC)

- Each day is assigned a particular air mass type.
- Air mass determination is based on 24 distinct variables (6 variables 4 times per day).
- The air masses are spatially cohesive.
- They lend themselves well to health-based applied studies since "offensive" air masses are statistically linked to negative health outcomes.
- They are primary input for heat-health warning systems.

Spatial Synoptic Classification (SSC), Nomenclature

SSC Air Mass Types	
DP	Dry Polar
DM	Dry Moderate
DT	**Dry Tropical**
MP	Moist Polar
MM	Moist Moderate
MT	Moist Tropical
MT+, MT++	**Moist Tropical Plus**
TR	Transition between air masses

Sheridan S.C. (2002) The redevelopment of a weather-type classification scheme for North America. Int. J. Climatology **22**:51-68

Kalkstein L. S., Greene S., Mills D. M., & Samenow J. (2011) An evaluation of the progress in reducing heat-related human mortality in major US cities. Natural Hazards **56**(1):113-129

Spatial Synoptic Classification (SSC)

http://sheridan.geog.kent.edu/ssc.html

SPATIAL SYNOPTIC CLASSIFICATION

HOMEPAGE

Individual Station Data:

Day-by-day calendar (text)

for station code SUBMIT

Homepage
List of available stations and codes
Maps of available stations
Climatological maps
SSC climate zones
How to interpret SSC data files
Real-time SSC

Daily SSC maps
(Jim Detwiler, Penn State)

This website was created and is maintained by
Scott Sheridan
Department of Geography
Kent State University

Data are free to use for any research purposes with appropriate credit given.

SSC News

2016 data are now added.

There were some issues with the Dayton SSC calendar that have now been rectified.

Synoptic weather-typing and the SSC

Synoptic weather-typing - the classification of ambient weather conditions into categories - is a useful tool for numerous climate impact applications. On this website, the classifications produced by one such scheme, the Spatial Synoptic Classification (SSC), are presented.

The SSC is a hybrid classification scheme, based on both manual and automated processes. Initially, weather type (see right) identification was made manually for each of the weather types, based on climatological knowledge. As the character associated with these weather types changes from season to season, typical days in each type- "seed days"- were picked for each station for different times of the year. Algorithms then develop hypothetical seed days for each of the 365 days of the year.

Once this process is complete, actual conditions on each day were compared to the seed days, and the day ends up being classified as the one it most closely resembles. Hence, when the process is complete, a weather type 'calendar' is available, whereby each day in a station's period of record is classified into one of the weather types.

In order to increase spatial cohesion, seed days were transferred to geographically neighboring stations, thus creating a true spatial grid of weather types.

Development of the SSC

Larry Kalkstein and Scott Greene are two principal developers of the original SSC, created in the mid-1990s for all stations east of the Rockies within the US. Calendars were originally available for only winter and summer. Kalkstein et al. (1996) contains a detailed discussion of this original system.

The SSC was then later redeveloped to be able to classify days year-round; an expansion was also done geographically to include more than 300 stations across the US and Canada. The "SSC2" - which is what is featured on this site - is written up in significant detail in Sheridan (2002). As this version is now the only available version of the SSC, it is usually just written as "SSC" and not "SSC2".

Later expansions of the SSC have taken the SSC global. Donna Bower, as part of her dissertation, worked with Glenn McGregor and Scott Sheridan to expand the SSC to Western Europe. Whereas the US and Canada classifications all began from one origin, the European classifications began from multiple origins in station 'clusters'. More detail on this methodology can be found in Bower al. (2007). Other extensions of the SSC include stations in South Korea, Brazil, and Russia.

What the SSC is

The SSC is based **solely** on surface based observations at an individual station. Four-times daily observations of temperature, dew point, wind, pressure, and cloud cover are incorporated into the

Weather types

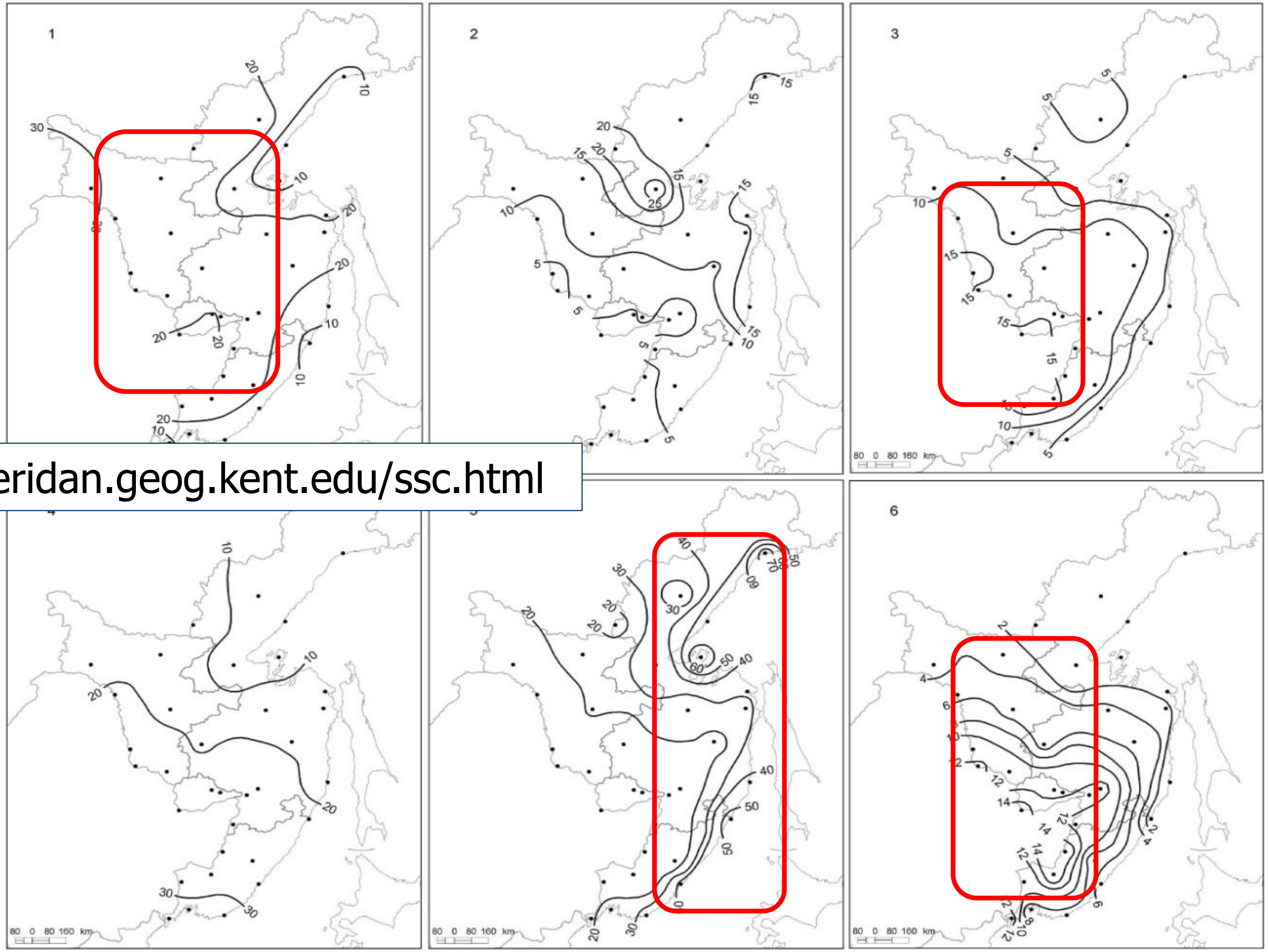
DP (dry polar) is synonymous with the traditional cP air mass classification. This air mass is generally advected from polar regions around a cold-core anticyclone, and is usually associated with the lowest temperatures observed in a region for a particular time of year, as well as clear, dry conditions.

DM (dry moderate) air is mild and dry. It has no traditional analog, but is often found with zonal flow in the middle latitudes, especially in the lee of mountain ranges. It also arises when a traditional air mass such as cP or mT has been advected far from its source region and has thus modified considerably.

The **DT (dry tropical)** weather type is similar to the cT air mass; it represents the hottest and driest conditions found at any location. There are two primary sources of DT: either it is advected from the desert regions, such as the Sonoran or Sahara Desert, or it is produced by rapidly descending air, whether via orography (such as the chinook) or strong subsidence.

MP (moist polar) air is a large subset of the mP air mass; weather

Spatial Synoptic Classification (SSC)



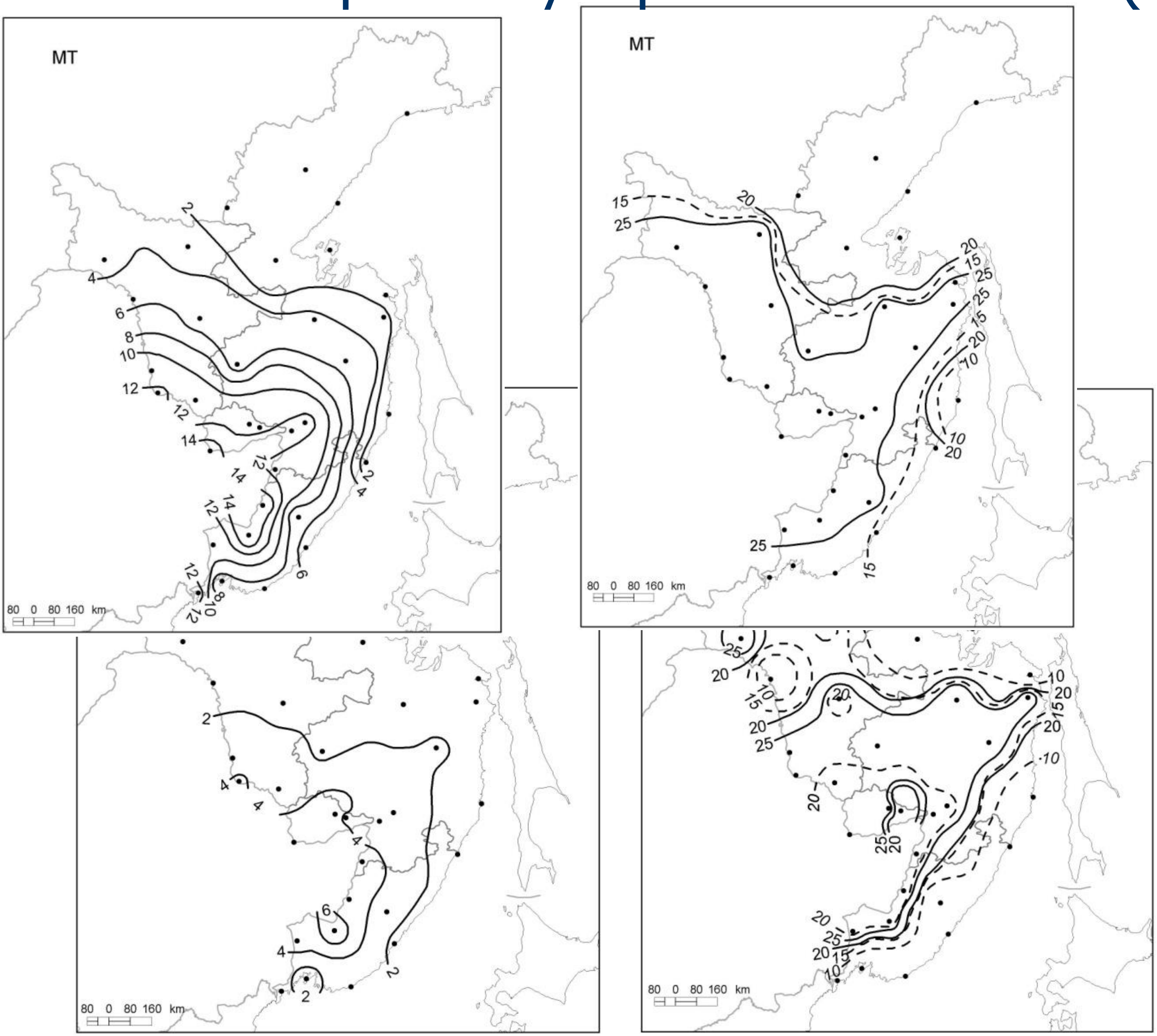
http://sheridan.geog.kent.edu/ssc.html

SSC Air Mass Types, Russian Far East, %: 1. Dry Moderate; 2. Dry Polar; 3. Dry Tropical; 4. Moist Moderate; 5. Moist Polar; 6. Moist Tropical

Meso-level

Proxy thermal stress index

Spatial Synoptic Classification (SSC)



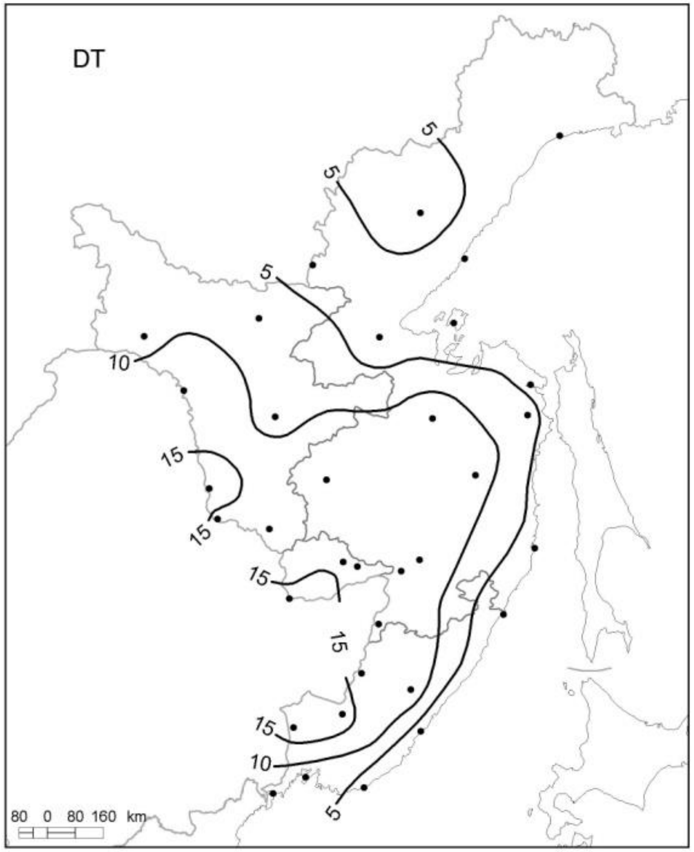
Frequencies

Ta,Td

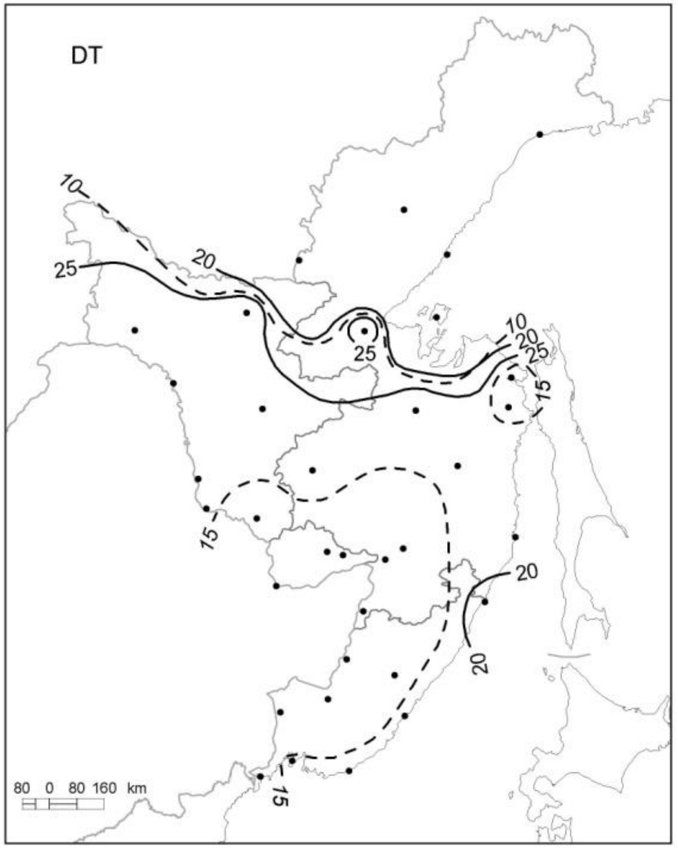
Moist Tropical air masses

MT+ and MT++

Spatial Synoptic Classification (SSC)



Frequencies



Ta, Td

Dry Tropical air mass

Munich Energy-Balance Model for Individuals MEMI

PET derived from RayMan model

Model RayMan 1.2: Meteorological Institute, University of Freiburg, Germany

www.urbanclimate.net/rayman/

RayMan

http://www.mif.uni-freiburg.de/rayman/

Introduction
Forum
Description
Bibliography
Examples
Help

***RayMan* is free for use**

RayMan Pro for academic purposes available

Description:

- RayMan stands for "radiation on the human body"
- Official latest version is *RayMan 1.2*
- Development in english and german
- Continous update and development
- If you want to be informed about new developments please fill out the form below
- For further questions please mail to: Prof. Matzarakis

Application:

- Applied meteorology and climatology
- Landscape and ecological planning
- Forest and agricultural metorology
- Urban meteorology and climatology
- health, recreation and tourism

News:

- RayMan article 2010 in IJB
- RayMan article 2007 in IJB available
- RayMan Pro will be available end of 2006
- Improved input of meta and meteo data
- Implementation of full human energy balance as output
- Improved input possibilities for geometrical properties and free drawing
- High time resolution for shadow and sunshine in complex environments
- Free for academic research
- RayMan obstacle files can be calculated from Shapefiles using the "Shp to Obs" plugin for Quantum GIS.

Uses:

- Education and teaching
- Academic research
- Govermental and administrative use

Modifcations and differences between Rayman 1.2 and 1.1 /1.0
If you have installed *RayMan 1.0* you need the new location list

***RayMan*:**
After sending this form, you will receive an email at the given email address containing the URL where you can download your version of Rayman 1.1. Please allow one day to process your request. Please come back to leave your comment about Rayman.

Name:

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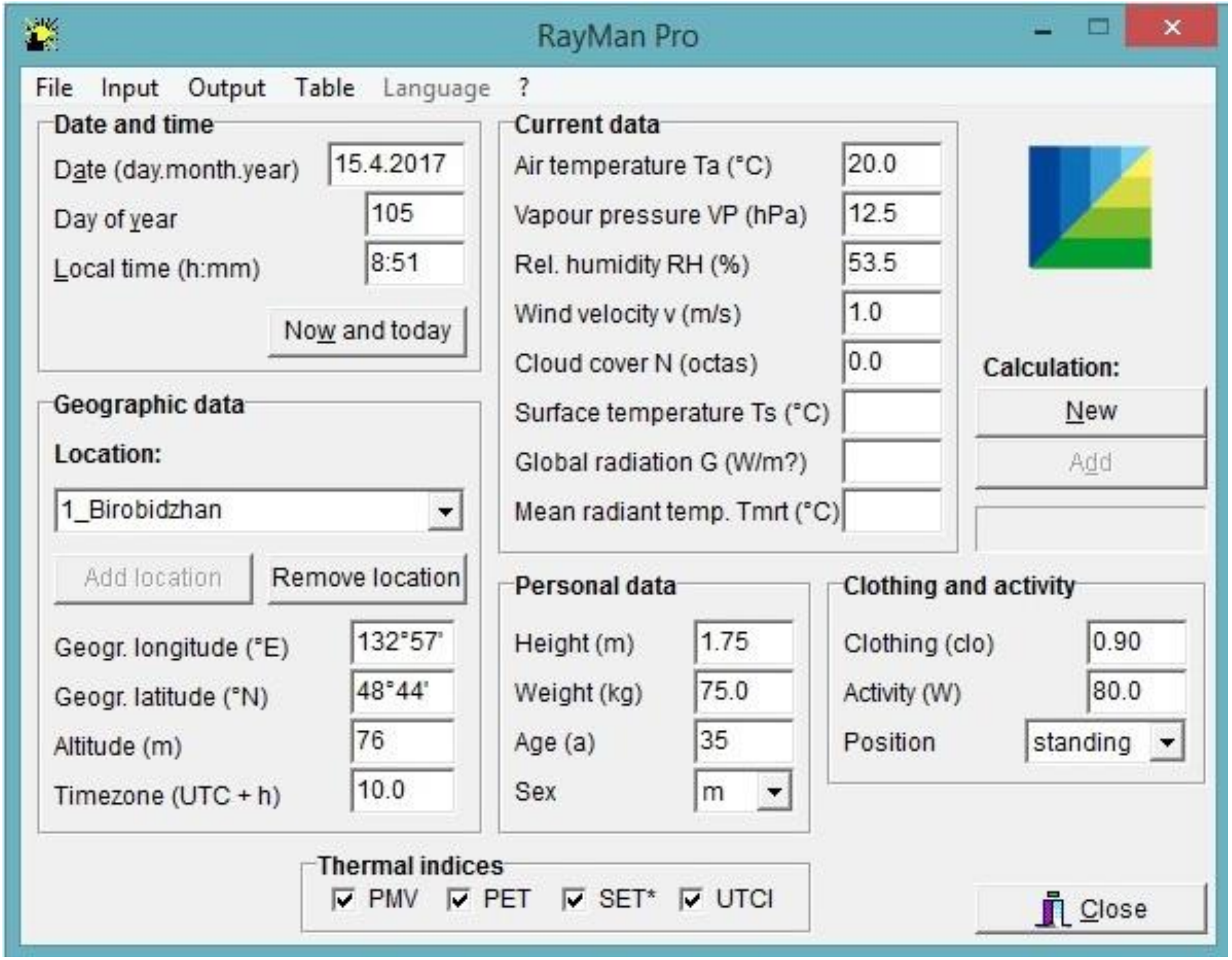
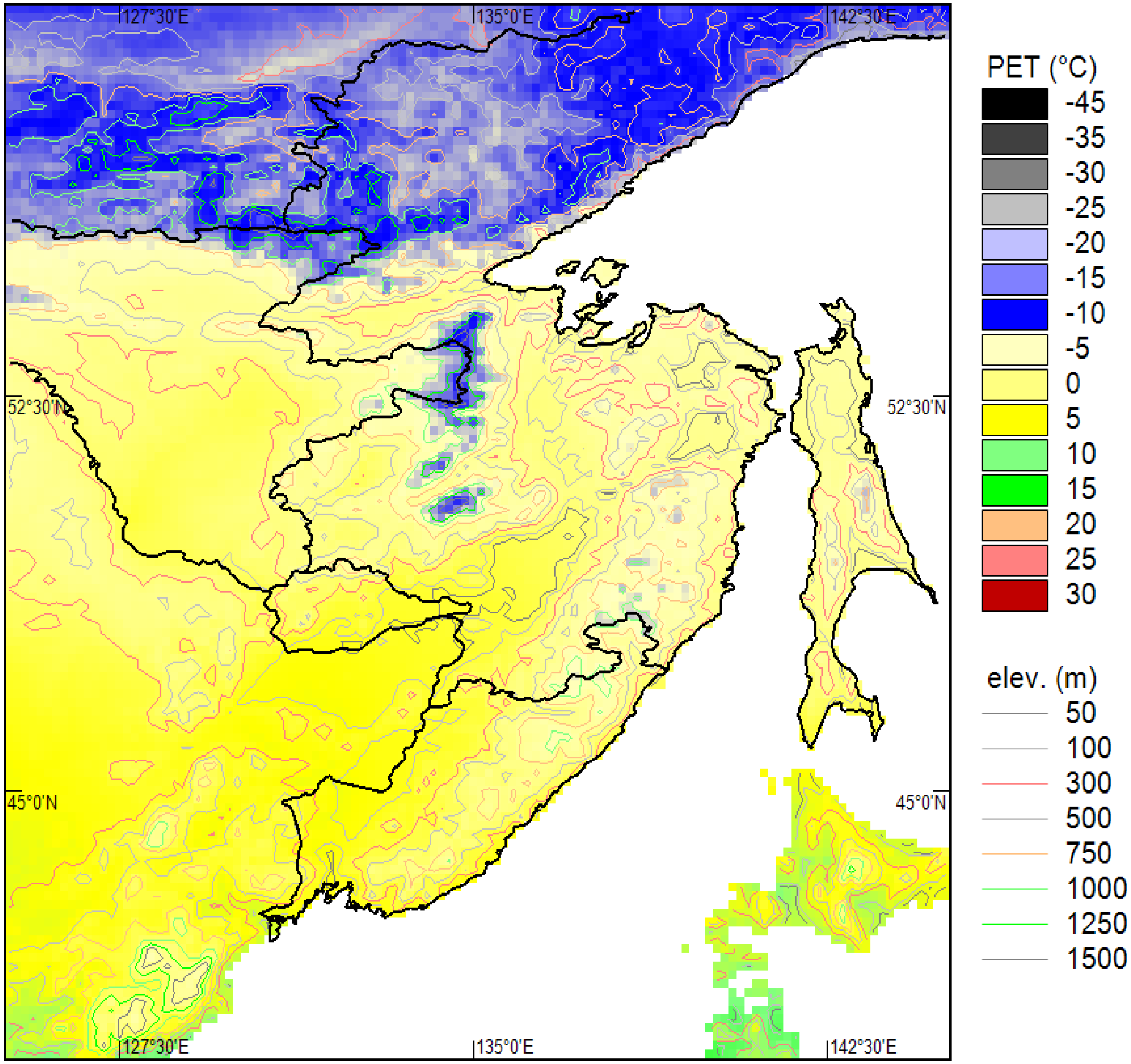
Physiological Equivalent Temperature(PET)

http://www.mif.uni-freiburg.de/rayman



Starting window in RayMan 1.2

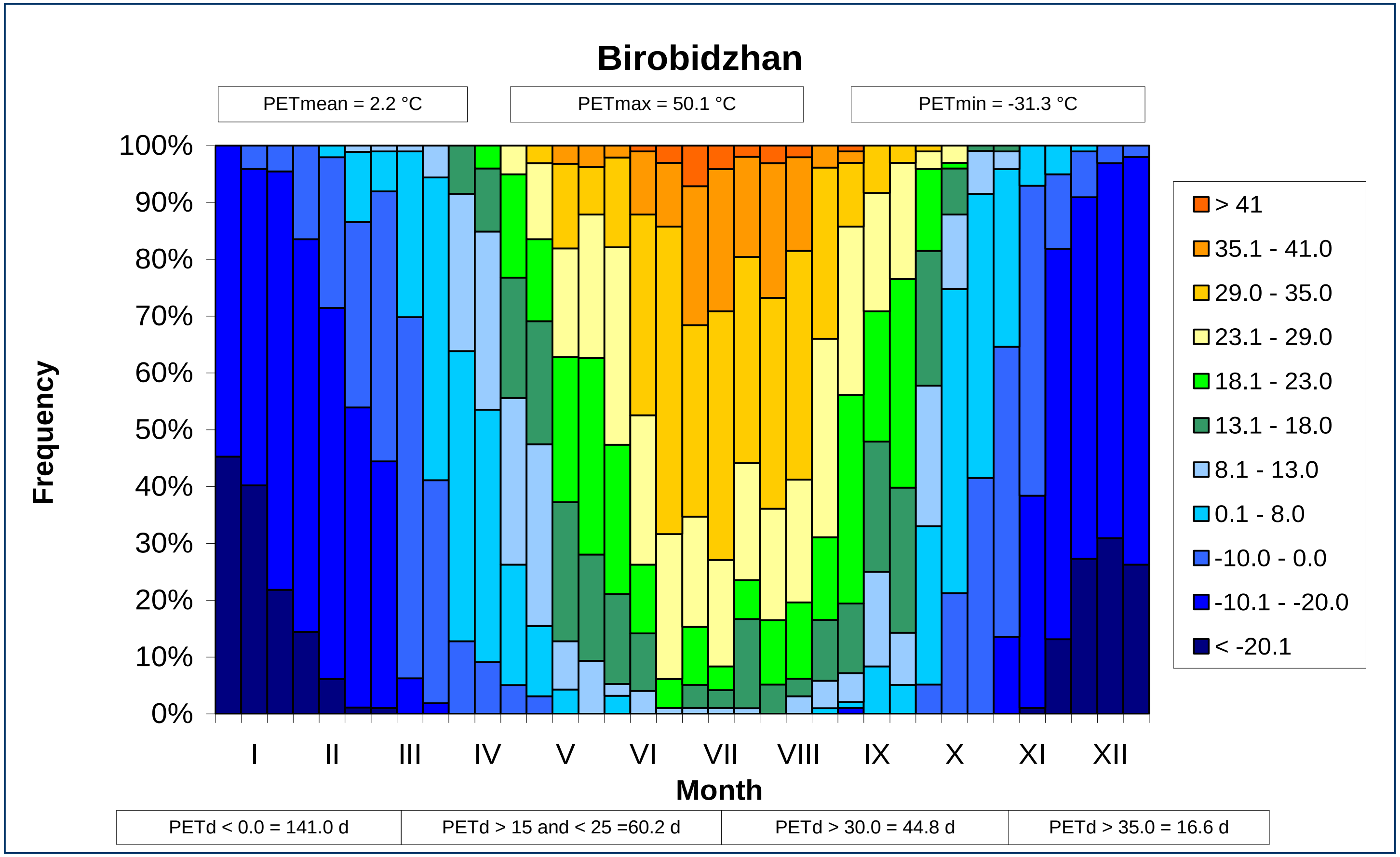
Physiological Equivalent Temperature (PET)



Grigorieva, Matzarakis (2011)

Physiological Equivalent Temperature(PET), mean year values, southern part of the Russian Far East

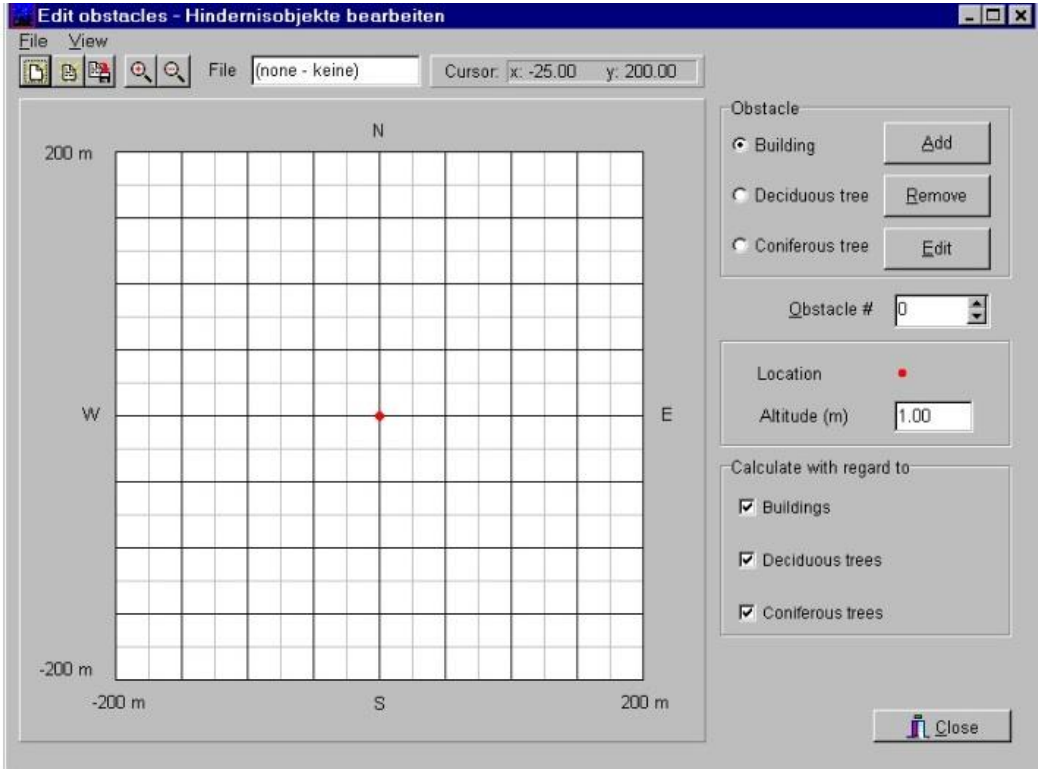
Physiological Equivalent Temperature (PET)



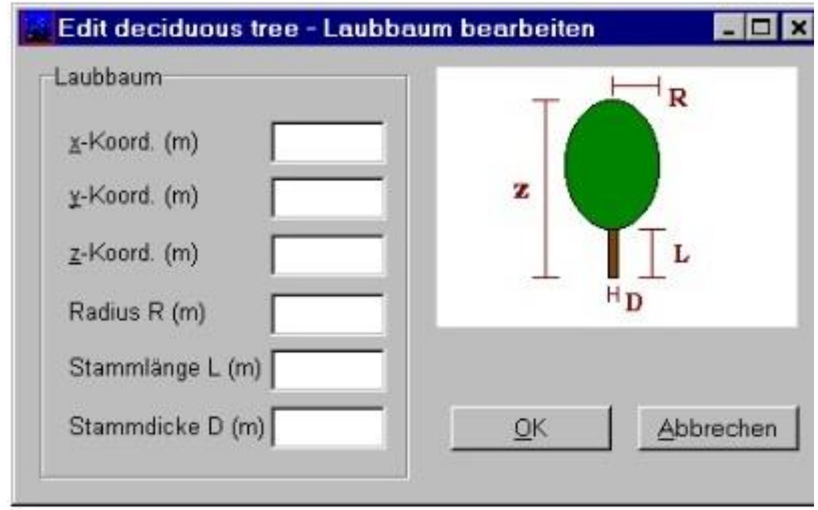
Physiological Equivalent Temperature (PET), Birobidzhan, 15.00 (1997-2006)

Grigorieva, Matzarakis (2011)

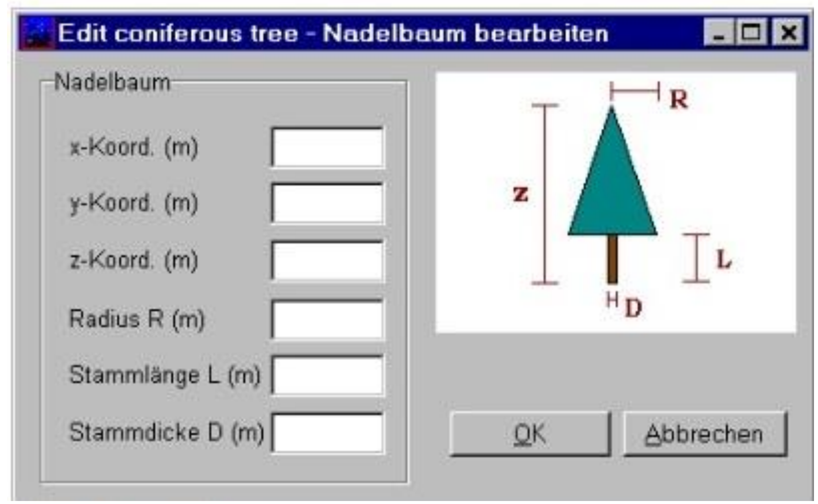
Input windows for buildings and trees

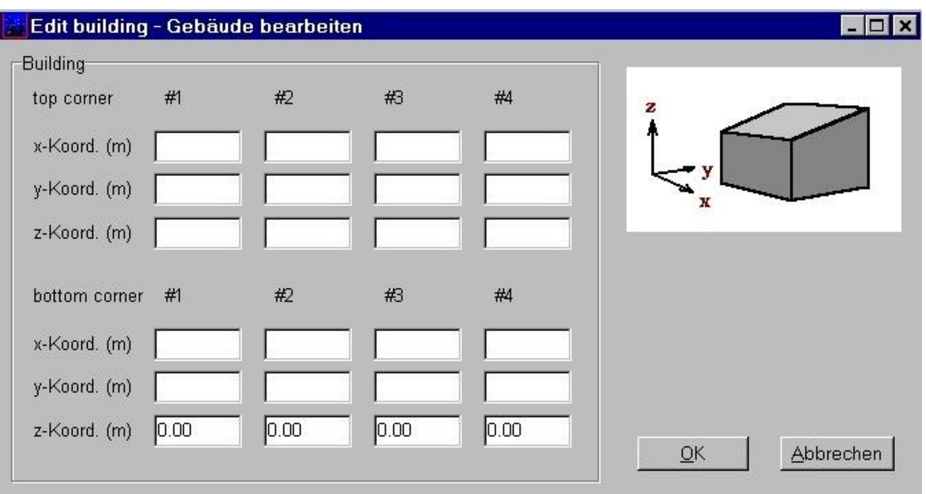


Input window for deciduous trees



Input window for coniferous trees

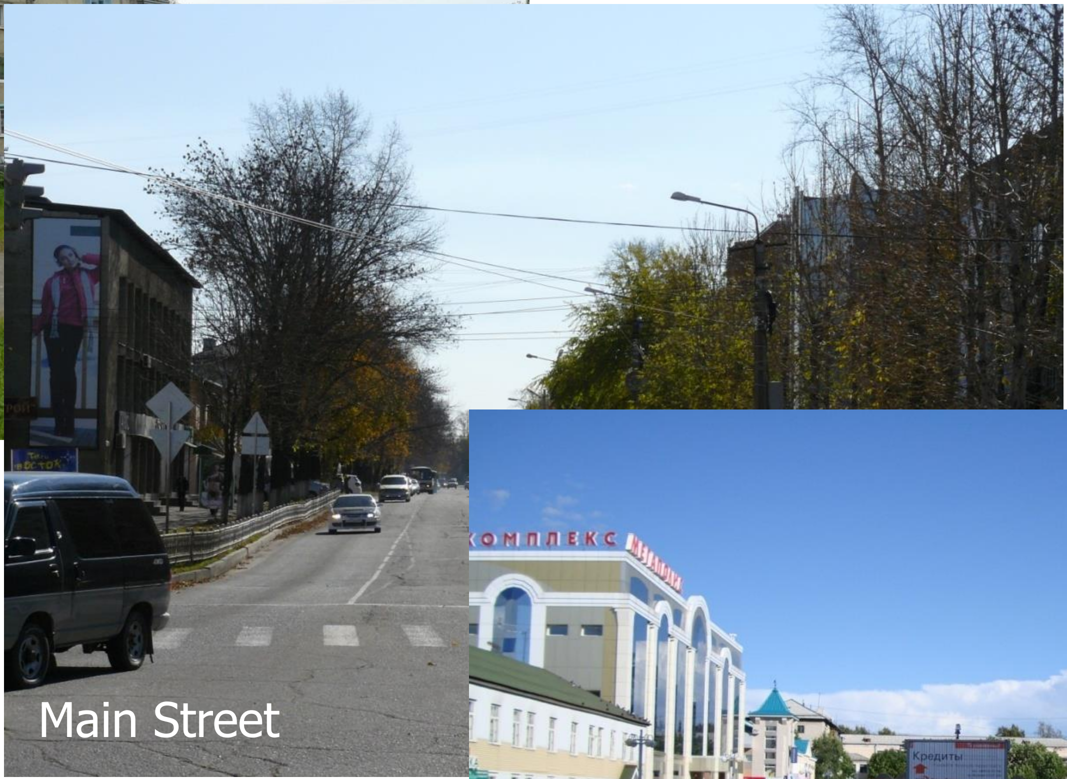




Input of buildings

Birobidzhan
Jewish Autonomous Region

Residential area



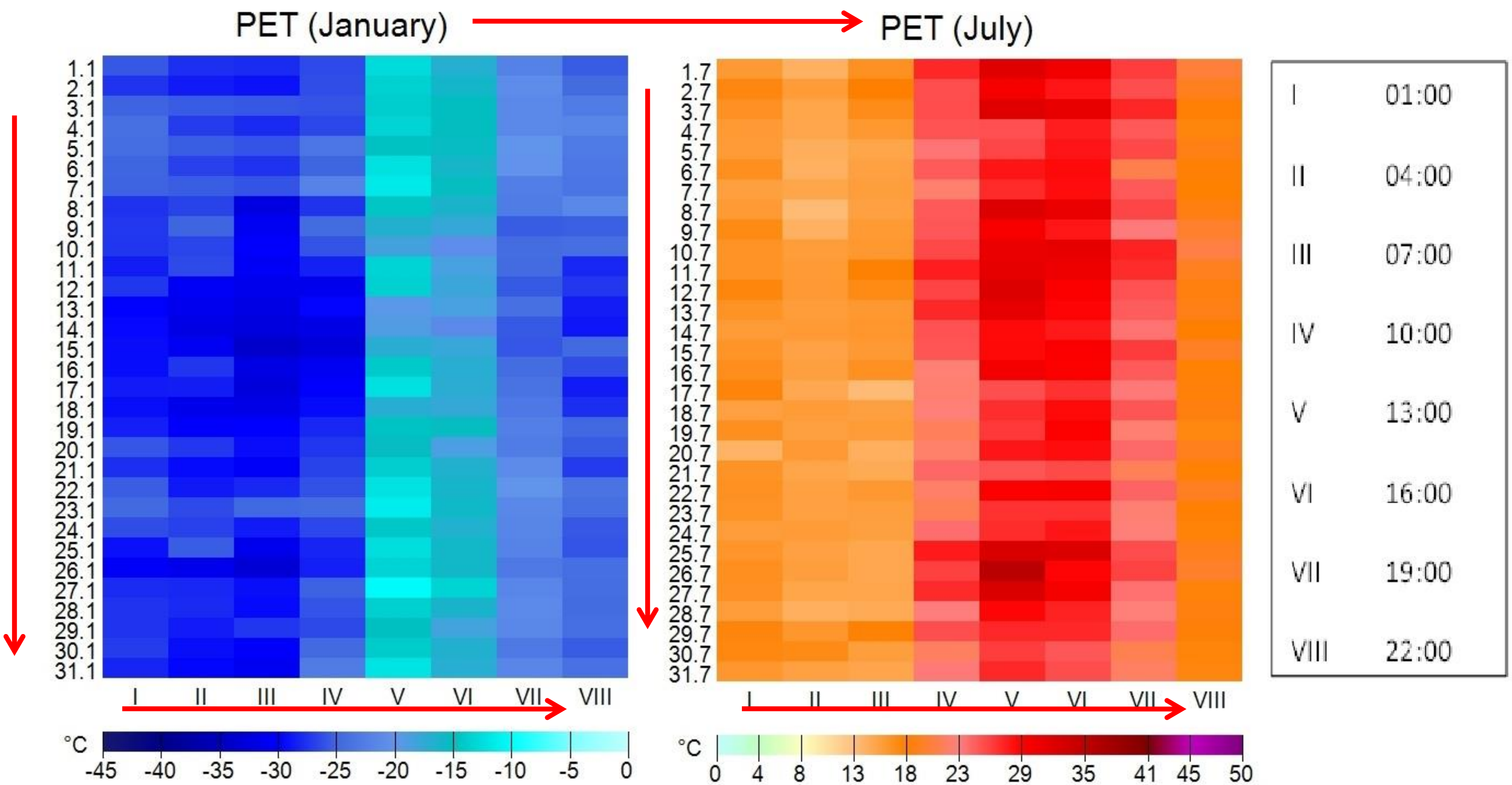
Main Street

Square

Bauche, Grigorieva, Matzarakis (2013)

Energy balance stress index

Physiological Equivalent Temperature (PET)



(a) (b)

Monthly (along y-axis) and daily (along x-axis) dynamics of thermal comfort in winter, January (a), and summer, July (b), calculated with Physiological Equivalent Temperature (PET) for Birobidzhan, residential zone

Bauche, Grigorieva, Matzarakis (2013)

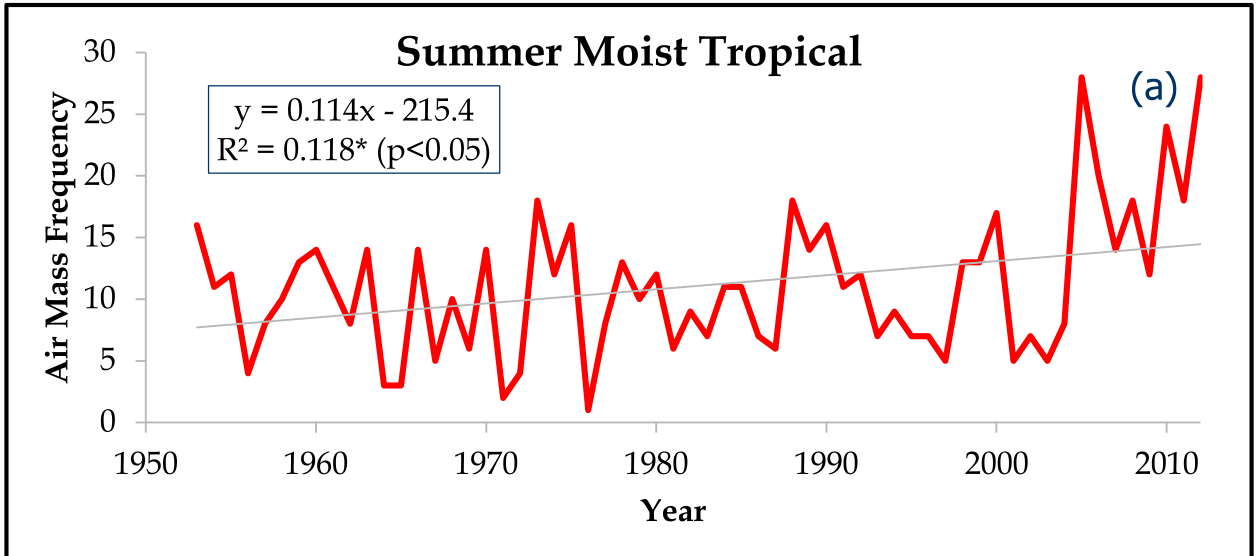
Physiological Equivalent Temperature (PET)
Birobidzhan, 2000–2010

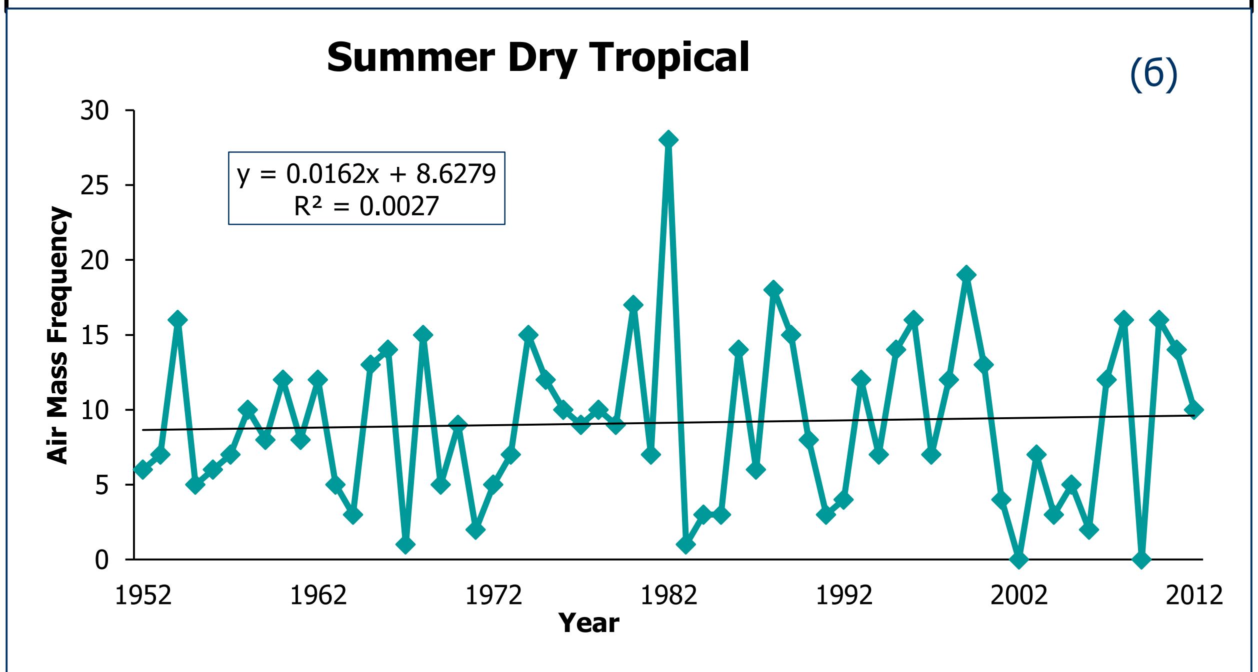
PET (°C)	Weather station	Residential area	Street	Square
< −30	21,0	12,1	14,9	12,9
< −20	68,3	59,4	63,0	60,5
< −10	117,2	113,0	114,6	113,5
< 0	170,1	167,6	168,4	167,7
(15 – 30)	65,4	72,3	70,1	72,2
(18 – 27)	37,0	42,6	40,5	42,6
> 29	19,5	9,9	13,9	10,7
> 35	6,0	2,2	3,4	2,4
> 41	1,0	0,3	0,6	0,4

Bauche, Grigorieva, Matzarakis (2013)

Proxy thermal stress index

Spatial Synoptic Classification (SSC)





SSC in Khabarovsk, summer, 1952–2012:
(a) Moist Tropical;
(b) Dry Tropical

MT = 6.8 more days now than in the early 1950's

SSC, daily temperature and mortality in summer, Khabarovsk, 2000-2012

SSC	T (°C)	T at 3pm (°C)	SSC Frequency (%)	Mortality (M)	$(M - M_{mean})/M_{mean}$ (%)	65+ $(M - M_{mean})/M_{mean}$ (%)
MT+, MT++	25.2	29.3	3.8 ± 2.77	24.2 ± 5.64	12	25
MT	21.8	26.7	15.7 ± 8.08	22.7 ± 5.20	6	8
MP	14.6	16.3	7.5 ± 3.84	20.1 ± 4.78	-8	-8
MM	18.9	21.3	26.8 ± 8.27	21.0 ± 4.72	-4	-2
DT	19.3	27.4	7.8 ± 5.94	23.9 ± 5.16	11	15
DP	13.3	18.5	2.6 ± 2.18	21.2 ± 4.61	-1	-7
DM	18.0	23.9	21.5 ± 5.79	21.6 ± 4.81	-1	-2
mean	20.1	23.4		21.9 ± 5.00		

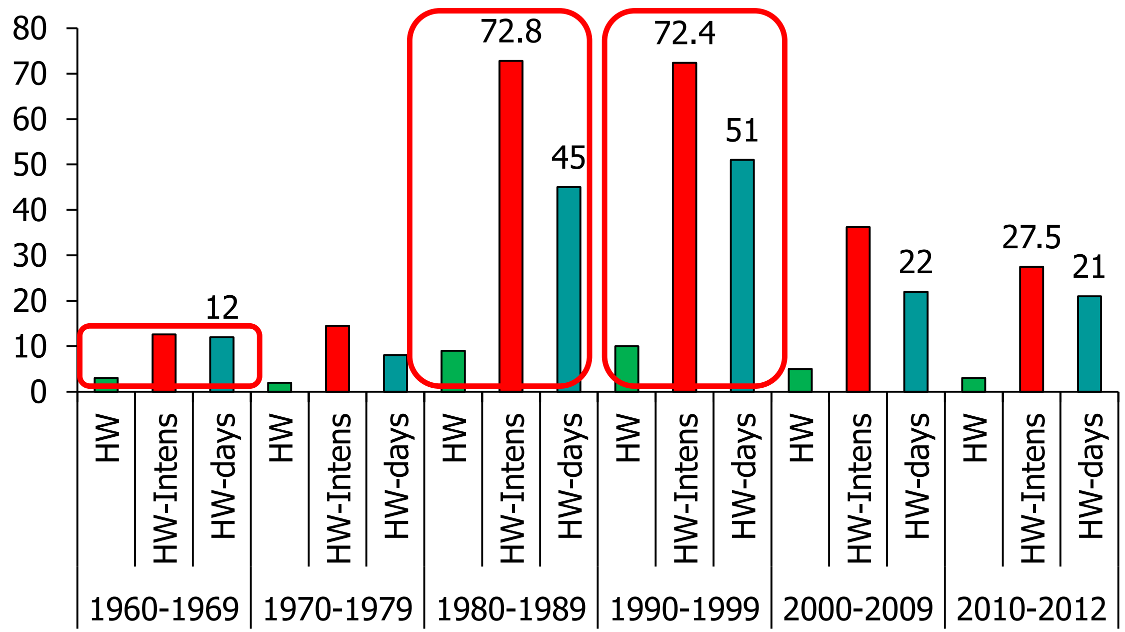
During summer, a 12% higher rate of all-cause mortality (22 % for 65+) is associated with most offensive Moist Tropical plus (MT+, MT++) air mass, and a 10% (14% for 65+) higher rate – with Dry Tropical (DT)

Mortality Algorithm for Khabarovsk

$$\text{Mortality} = 18.836 - 0.007\ \text{TOS} - 0.13\ T_{mean} + 0.384\ \text{DTR} + 0.321\ \text{AT}$$

- For either MT+ or DT
- TOS = time of season (May 1st = 1, May 2nd = 2…)
- T_{min}, T_{mean}, T_{max} = air temperature, °C
- DTR = diurnal temperature range = $T_{max} - T_{min}$, °C
- AT = 3 pm Apparent temperature, °C

Number, intensity (°C) and duration (days) of heat waves per decade for Khabarovsk (1960 – 2012)



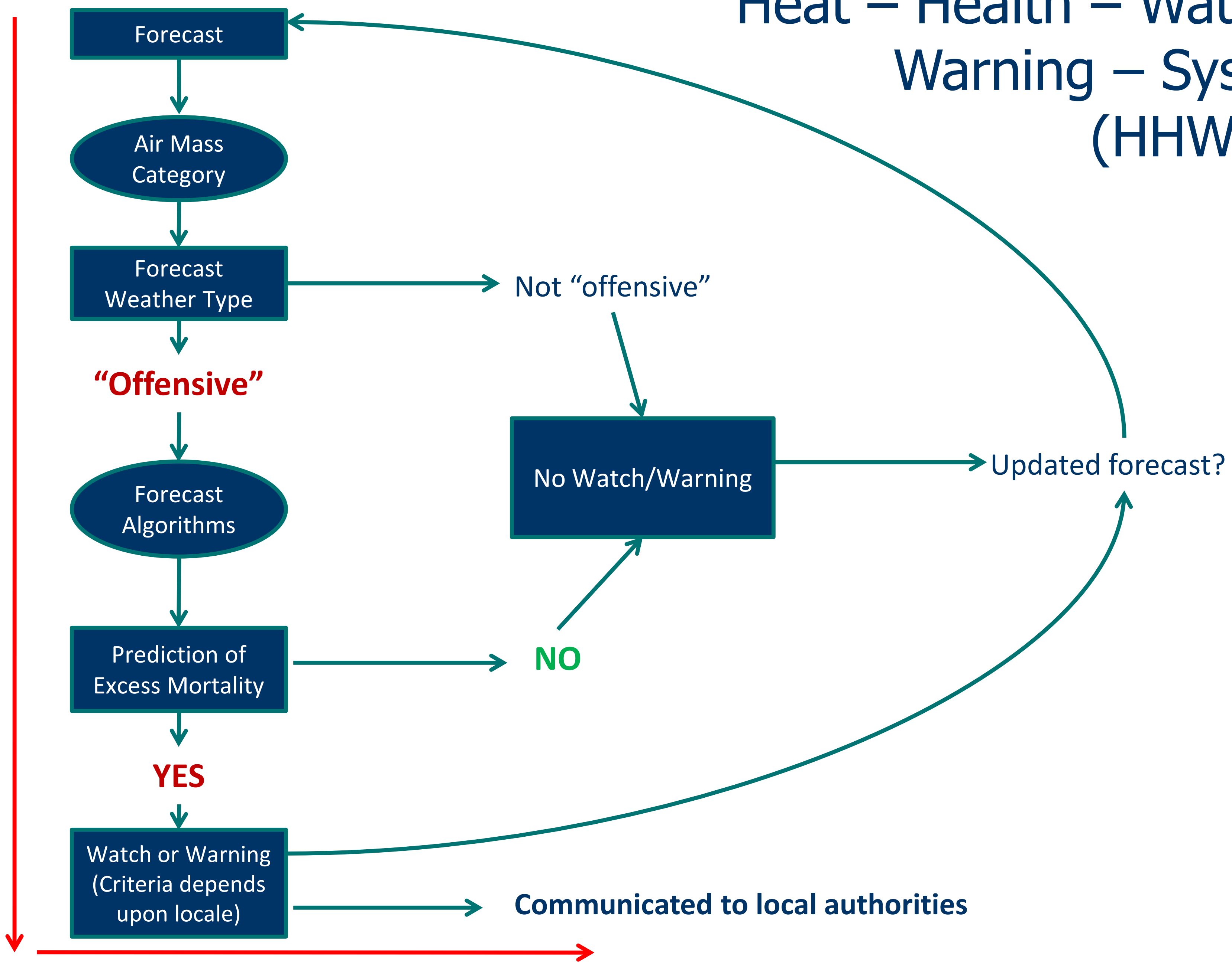
Definitions

Heat wave: 3 and more days when T_{mean} exceeds the 95% percentile for the summer months.

Heat wave intensity: cumulative mean temperature excess.

The fewest heat waves occurred in 1960-1969.
Number of heat waves is highest in the decades 1980-1989 and 1990-1999.
In all cases, the longest heat waves are the most intense.

Heat – Health – Watch – Warning – System (HHWWS)



Conclusions

- The approach applied helps to outline the regions and periods during the year that are thermally most uncomfortable and hazardous for human health and well-being.
- Mapping a particular day’s weather types, and spatial distribution of heat and cold waves helps to contour areas most vulnerable for population health. A more critical use of the methodology used has been the identification of excessive heat- and cold-stress conditions.
- The construction of the operational Weather Health Warning Systems can save human lives during extreme weather, that can be accessed by forecast meteorologists and health-safety authorities to warn the citizens of impending dangerous weather.
- The findings will be valuable for warning stakeholders and the decision makers, and are expected to be translated into action for the development of proper intervention procedures in health control, to minimize population loss and to guarantee social security.

This work is dedicated to Chris de Freitas

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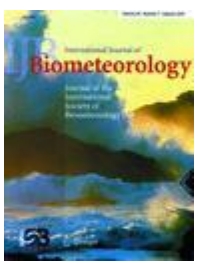
https://www4.uwm.edu/isb/index.cfm

21st International Congress of Biometeorology
September 3–6, 2017, Durham, UK

http://community.dur.ac.uk/icb.2017/



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Living organisms extend from single cell organisms, to plants and animals, including humans. The atmospheric environment includes climate and weather, electromagnetic radiation, and chemical and biological pollutants. The journal embraces basic and applied research and practical aspects such as living conditions, agriculture, forestry, and health.

http://link.springer.com/journal/484