Weather-associated index service

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Outline

1、 Brief introduction of the weather-associated index

2、 Approach of the probabilistic weather forecast products used for weather-associated index

Weather index information

Air quality

Morning exercise

Clothes drying

Comfort

Climbing mountain

Flower blooming

Fishing

Negative ions

Beer

Ice cream

Boating

Skiing

Wind chill

Cloth heat isolation

UV index

Mildew

8月16日

Spring	Summer	Autumn	Winter
春季	夏季	秋季	冬季
空气污染条件	空气污染条件	空气污染条件	空气污染条件
晨练指数	霉变指数	红叶观赏	晨练指数
晒衣指数	晒衣指数	穿衣指数	滑冰指数
舒适度指数	舒适度指数	舒适度指数	风寒指数
晒太阳指数	紫外线指数	紫外线指数	晒太阳指数
穿衣指数	啤酒与冷饮	啤酒与冷饮	穿衣指数
登山指数	登山指数	登山指数	登山指数
医疗气象	中暑指数	花期预报	医疗气象
钓鱼指数	钓鱼指数	钓鱼指数	冬泳指数
花期预报	游泳指数	游泳指数	商场客流量
划船指数	划船指数	划船指数	划船指数
洗车指数	洗车指数	洗车指数	洗车指数
负离子指数	负离子指数	负离子指数	负离子指数
啤酒与冷饮	空调开启	高空作业	水泥冻害

北京气象指数信息源

the weather-associated daily life index in Shanghai

- Thermal index(comfortable index/ Perceived Temperature)
- UV index
- Common cold index
- Fire hazard index
- Skin moisture index
- Beer index
- Ice cream index
- Morning exercise index
- Heat stroke index
- Pollen index
- Cloth insulation index

- ......

Met. Parameters used for weather-associated index

- Cloud cover：（0：sunny、1：cloudy、2：overcast、3：rainy)
- Temperature
- Wind speed/Wind direction
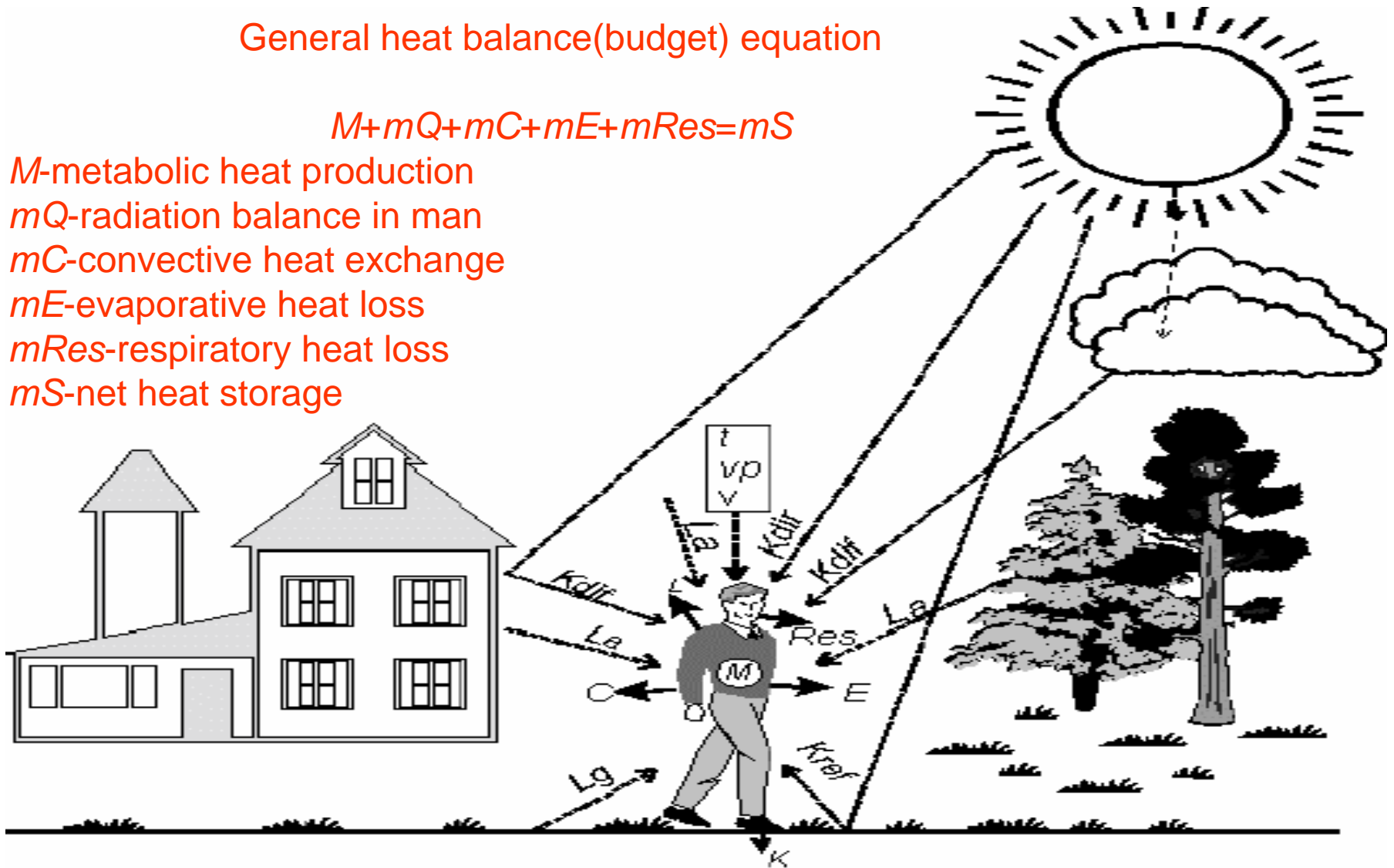- Relative humidity
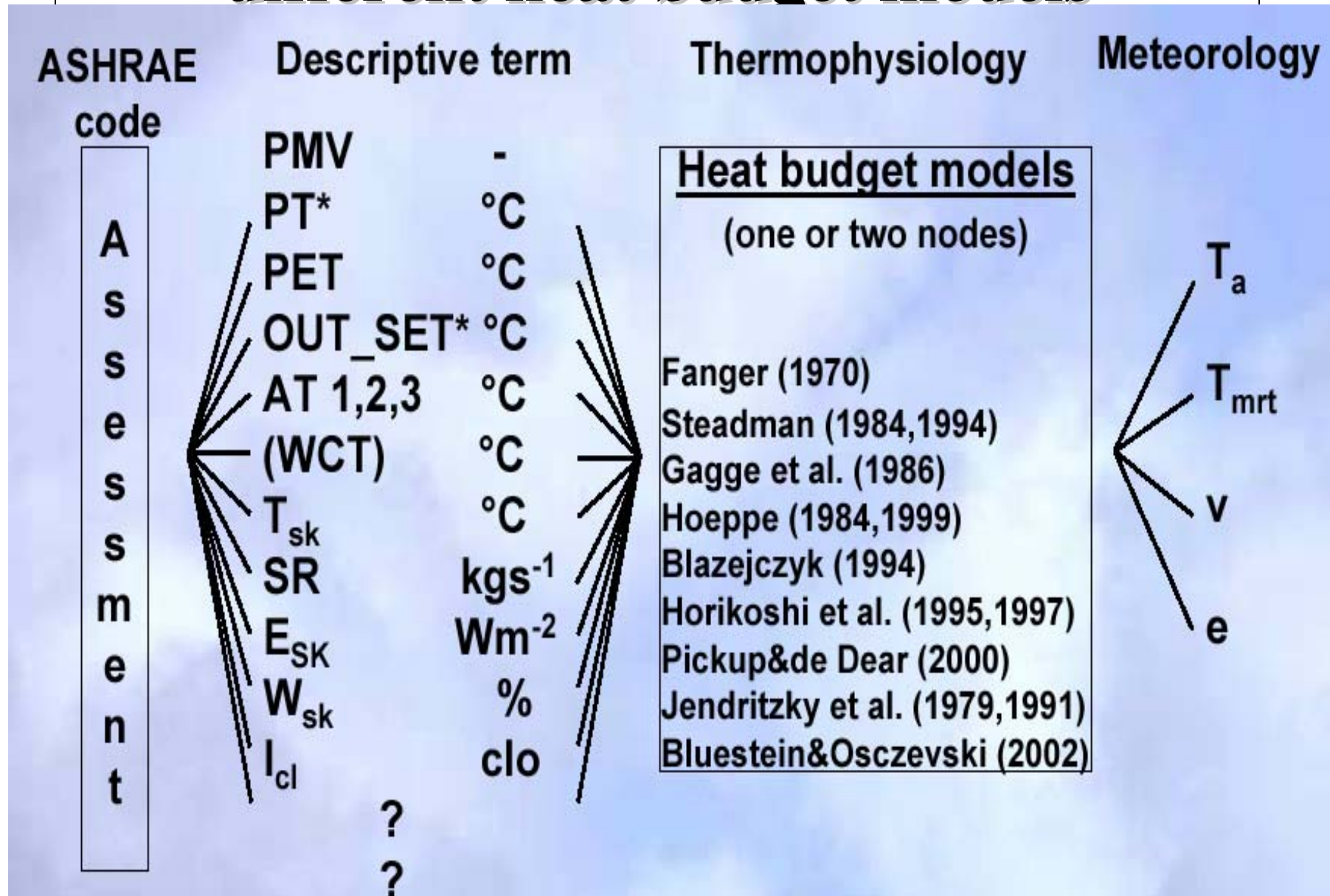- Precipitation probability
- Visibility

General heat balance(budget) equation

$$M+mQ+mC+mE+mRes=mS$$

M-metabolic heat production
mQ-radiation balance in man
mC-convective heat exchange
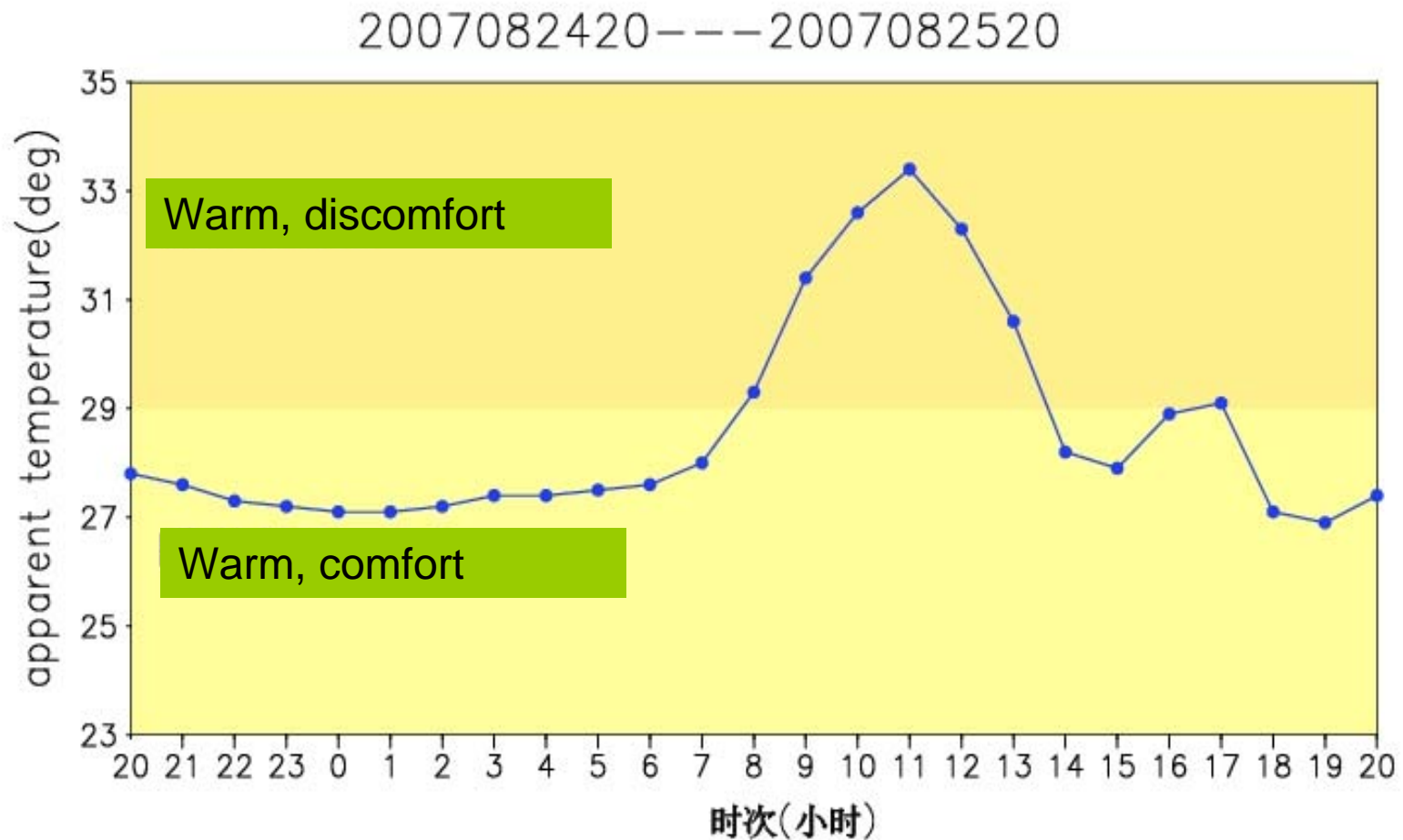mE-evaporative heat loss
$mRes$-respiratory heat loss
mS-net heat storage

Thermal index derived from the different heat budget models

Perceived temperature forecast derived from **Human and environment heat budget model and NWP**

2007082420---2007082520

Warm, discomfort

Warm, comfort

NOAA's National Weather Service Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution Extreme Caution Danger Extreme Danger

$$HI = -42.379 + 2.04901523T + 10.14333127R - 0.22475541TR - 6.83783 \times 10^{-3}T^2$$
$$-5.481717 \times 10^{-2} R^2 + 1.22874 \times 10^{-3} T^2R + 8.5282 \times 10^{-4} TR^2 - 1.99 \times 10^{-6} T^2 R^2$$

where

T = ambient dry bulb temperature degrees Fahrenheit

R = relative humidity

Category	Heat Index	Possible heat disorders for people in high risk groups
Extreme Danger	130° F or higher (54° C or higher)	Heat stroke or sunstroke likely.
Danger	105 - 129° F (41 - 54° C)	Sunstroke, muscle cramps, and/or heat exhaustion likely. Heatstroke possible with prolonged exposure and/or physical activity.
Extreme Caution	90 - 105° F (32 - 41° C)	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Caution	80 - 90° F (27 - 32° C)	Fatigue possible with prolonged exposure and/or physical activity.

Heat stress index

Australia

Apparent temperature (AT) from temperature and relative humidity - after Steadman 1994

Temperature (°C)																														
RH (%)	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
0	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
5	16	17	18	19	20	21	22	23	24	25	26	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	44	45	46	47	48
10	17	18	19	20	21	22	23	24	25	26	27	28	29	31	32	33	34	35	36	37	38	39	41	42	43	44	45	46	48	49	50
15	17	18	19	20	21	22	24	25	26	27	28	29	30	31	33	34	35	36	37	38	40	41	42	43	45	46	47	48	50		
20	17	18	20	21	22	23	24	25	26	28	29	30	31	32	33	35	36	37	38	40	41	42	43	45	46	47	49	50			
25	18	19	20	21	22	24	25	26	27	28	29	31	32	33	34	36	37	38	40	41	42	44	45	46	48	49					
30	18	19	21	22	23	24	25	26	28	29	30	31	33	34	35	37	38	39	41	42	43	45	46	48	49						
35	19	20	21	22	23	25	26	27	28	30	31	32	34	35	36	38	39	40	42	43	45	46	48	49							
40	19	20	21	23	24	25	26	28	29	30	32	33	34	36	37	39	40	41	43	44	46	48	49								
45	19	21	22	23	24	26	27	28	30	31	32	34	35	37	38	40	41	43	44	46	47	49									
50	20	21	22	24	25	26	28	29	30	32	33	35	36	38	39	41	42	44	45	47	49	50									
55	20	22	23	24	25	27	28	30	31	32	34	35	37	38	40	42	43	45	46	48	50										
60	21	22	23	25	26	27	29	30	32	33	35	36	38	39	41	42	44	46	48	49											
65	21	22	24	25	27	28	29	31	32	34	35	37	39	40	42	43	45	47	49												
70	21	23	24	26	27	28	30	31	33	35	36	38	39	41	43	44	46	48	50												
75	22	23	25	26	28	29	31	32	34	35	37	38	40	42	44	45	47	49													
80	22	24	25	27	28	30	31	33	34	36	38	39	41	43	45	46	48	50													
85	23	24	26	27	29	30	32	33	35	37	38	40	42	44	45	47	49														
90	23	25	26	28	29	31	32	34	36	37	39	41	43	45	46	48	50														
95	23	25	26	28	30	31	33	35	36	38	40	42	43	45	47	49															
100	24	25	27	29	30	32	33	35	37	39	41	42	44	46	48	50															

AT above 50°C

Three- to seven-day forecast of mean heat index for Dallas, Texas, USA

Mean heat index	Thursday OCT 03 82 °F	Friday OCT 04 82 °F	Saturday OCT 05 76 °F	Sunday OCT 06 70 °F	Monday OCT 07 69 °F
100 °F	0%	0%	0%	0%	0%
95 °F	0%	0%	0%	0%	0%
90 °F	1%	1%	0%	0%	0%
85 °F	20%	22%	2%	0%	0%
80 °F	69%	68%	21%	0%	0%
75 °F	94%	94%	62%	15%	7%
70 °F	100%	100%	91%	48%	40%

Probability of mean heat index exceeding

WCT(℃) represents the coldness and risk outside door in winter

WCT = 13.12 + 0.6215 t - 11.37 (1.5 v)^0.16 + 0.3965 t (1,5 v)^0.16

WCT (℃)	Description	Health concern
〉 -10	Low	Slight increase in discomfort
-10 ~ -25	Moderate	Uncomfortable exposed skin feels cold, risk of hypothermia without adequate protection
-25 ~ -45	Cold	Risk of frostbite, check face and extremities (e.g. toes, ears) for numbness or whiteness, risk of hypothermia
-45 ~ -60	Very cold	Warning level, exposed skin freeze in minutes, serious risk of hypothermia
<-60	Extreme clod	Danger level, outdoor conditions are hazardous, exposed skin freezes in two minutes

Clothing insulation index(Icl, clo)

$-30°C < t < 25°C$ $Icl = 2.1455 - 0.0618 t$

$t < -30°C$ $Icl = 4.0$

$t > 25°C$ $Icl = 0.6$

GRAPES－UV model output

UV index is largely depended on cloud cover

UVG_mean on 2007_08_25

UVI_max on 2007_08_25
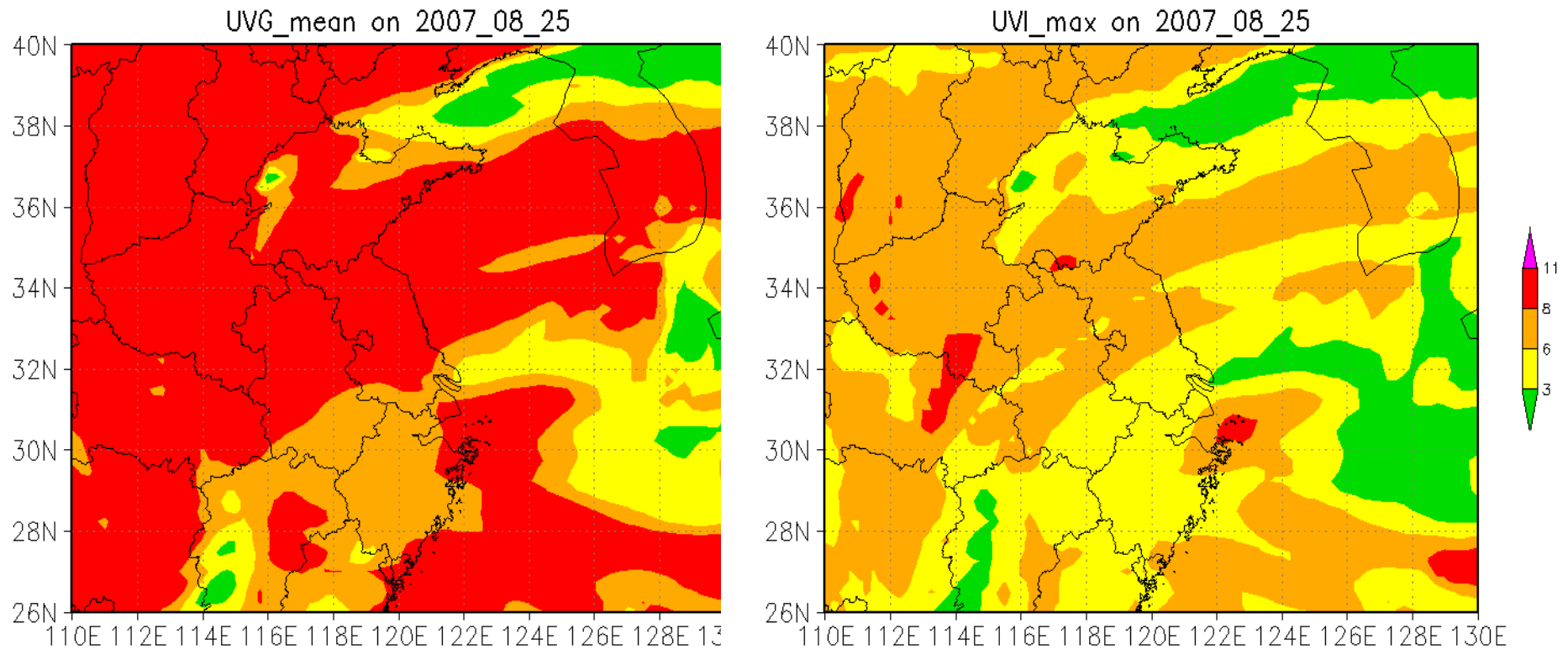
Fire hazard index

- Fire hazard index_ a index represents the occurrence probability of catch fire

score	5	4	3	2	1
Temperature(℃)		≥34 ≤-4	22—34 -4—10	10—22	
Wind(m/s)		≥10	3-9	<3	
RH(%)	≤30	30-50	50-75	75-90	>90
Weather phenomena		Sunny	Cloudy	Overcast	Rain

Level	Score	The probability of catch fire
5	17	>40%
4	13-16	30-40%
3	11-12	15%-30%
2	8-10	8%-15%
1	≤7	>8%

Common cold index

_an index represents the human's probability of catching cold.

it is associated with the variation of temperature(T), wind speed(W), humidity(H) and rain probability(P).

$$\lambda = \alpha * W * H * T$$

Where, when the rain probability(P) ≥80% and next day's probability(P) P<50%时， α =1，otherwise， α =0.5

α	level	probability of catching cold
0	4	safety
(0,1]	3	Low probability
(1,10]	2	Medium probability
>10	1	High probability
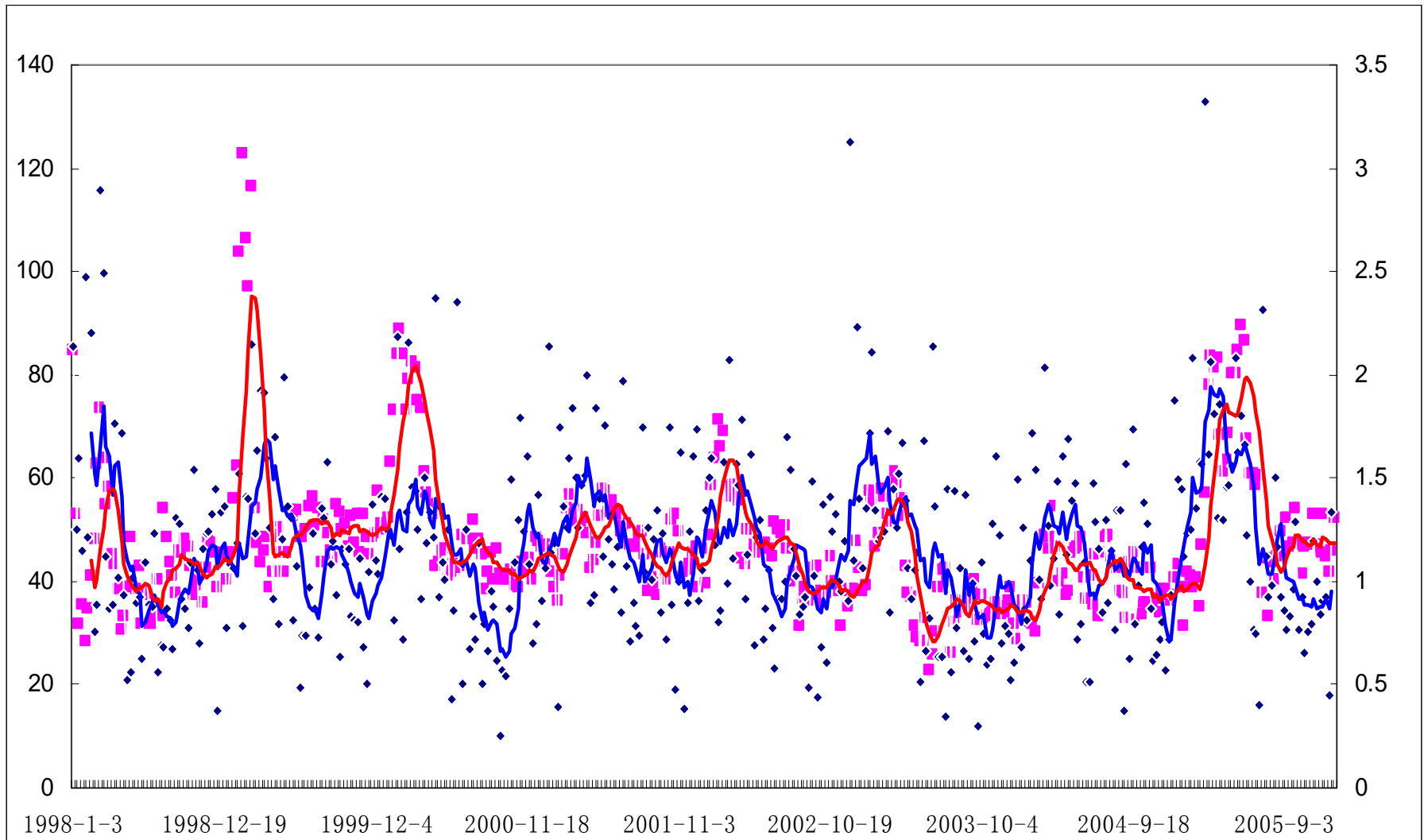
（red line:influenza cases，blue line- temperature variation)

Skin wetness index

_an index represents the wetness of skin surface,
it is associated with the variation of temperature(T), wind speed(W), humidity(H).

$$SWI = (\beta *(T +5)+ \gamma *W)/H*0.8$$

, When T≤0℃, β =2, ɣ =1

0℃<T≤5℃, β =0.5, ɣ =1

. 5℃<T≤10℃, β =0.2, ɣ =0.7

. T>10℃, β =0.2, ɣ =0.1

SWI	level	Skin moisture status
>20	1	Dry
(10,20]	2	Little dry
(5,10]	3	Little wet
<5	4	wet

Pollen index: represents the (high, medium, low) level of pollen counts
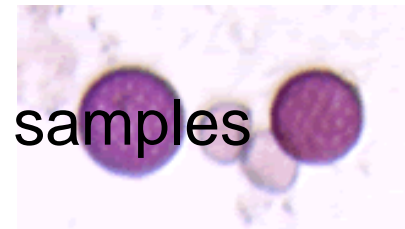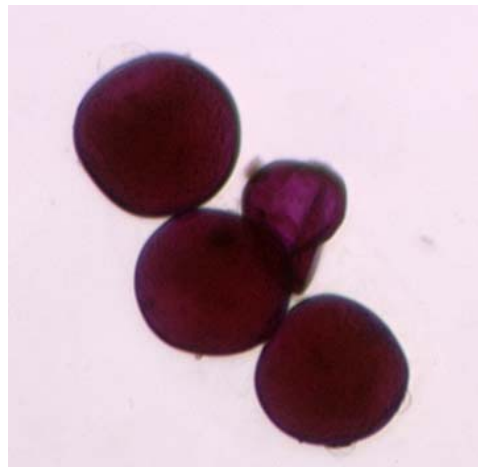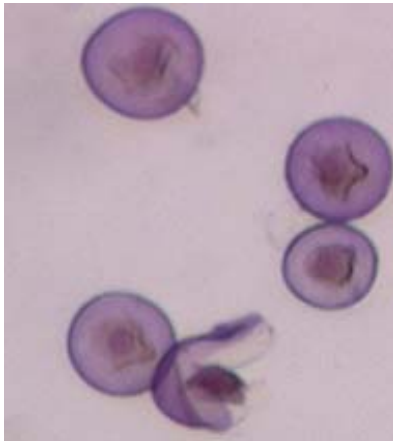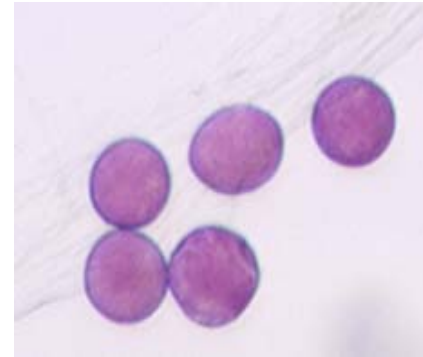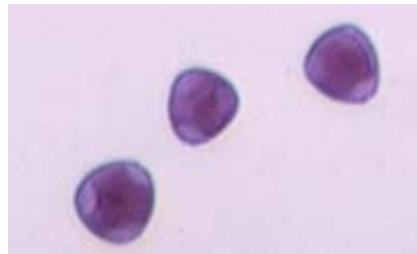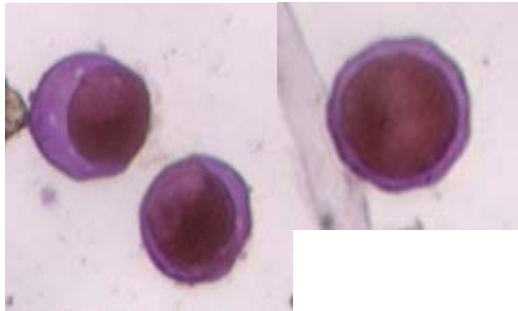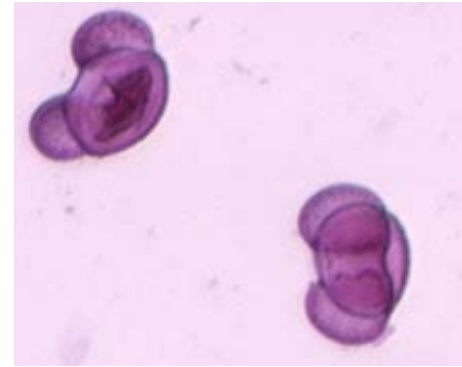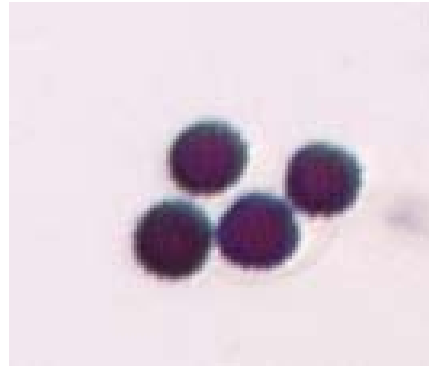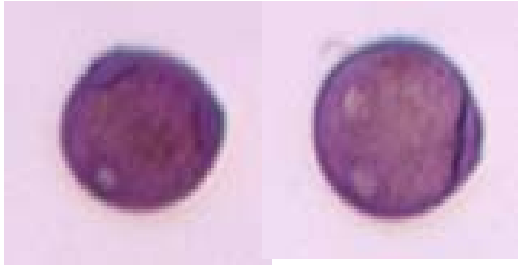
Pollen samples

Approach of the probabilistic weather forecast products used for the weather-associated index.

1、Special application model merged with NWP model

  i.e. UV index: radiation transfer model + NWP model

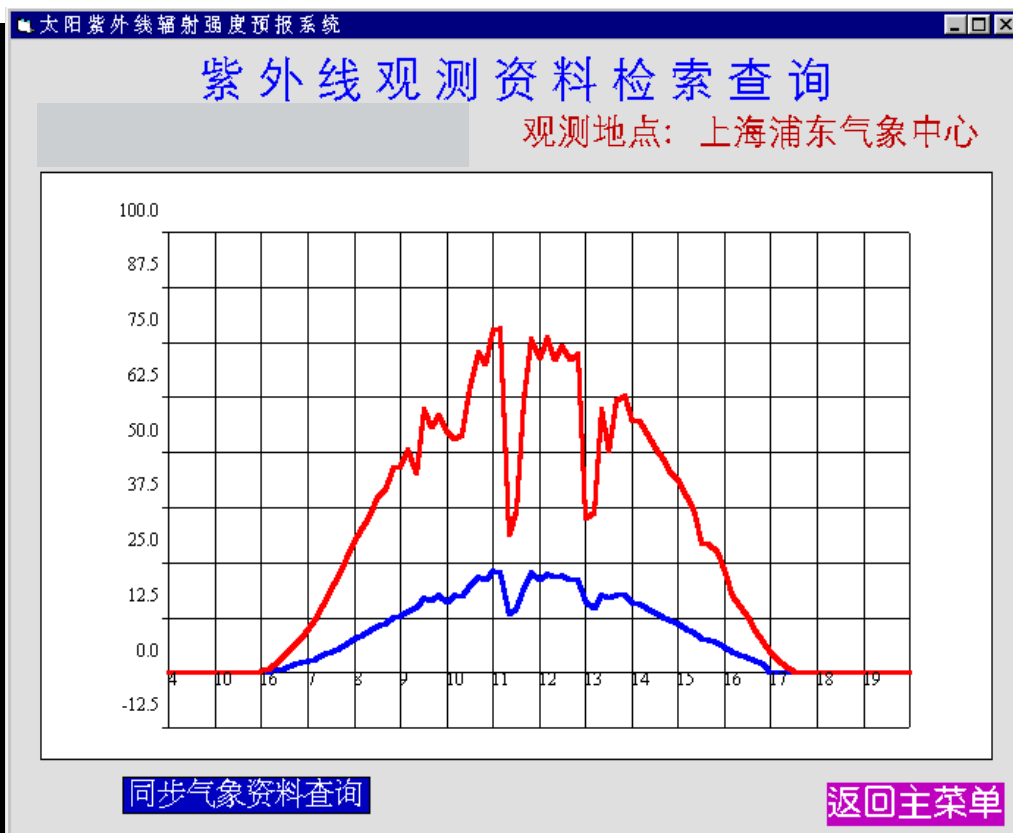   Perceived temperature: Human budget model + NWP model

2、Simple index based on the meteorological parameters
  i.e. umbrella index, morning exercise index

UV measurements

Q: How to verify accuracy of the weather-associated daily life index

1. The outcome can be measured, such as UVR. Pollen count.

2. The outcome can be represented by occurrence probability of the event which can be investigated, such as hospital visit probability.

3. The outcome cannot be verified, such as morning exercise index.

Thank you for your attention!