Educational programme of the road weather principles subject which is lectured in the Czech University of Life Sciences Prague

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ABSTRACT

The educational programme of the road weather meteorology subject which is lectured in the Czech University of Life Sciences in Prague involves essential knowledge about the Earth's atmosphere and physical processes that determine its properties and behaviour; atmospheric composition and energy, water in the atmosphere and air circulation besides the transport meteorology topics. Within the field of the road weather meteorology we inform the students mainly about the SIRWEC organization, RWIS methods and technologies, and transport climatography of the World. For the practical purpose we organize tutorials focused on the basic meteorological phenomena as well as on the particular topics as the roadway icing estimation, depth of the road-body freezing etc. In the future we would like to concentrate our efforts on closer cooperation with the Czech RWIS organization, namely in the field of data processing and practical verification of physical theories through the field measurements, as well as within the scope of diplomas and PhD study programme.

Key words: SIRWEC, RWIS, roadway icing, depth of freezing

1. INTRODUCTION

The Faculty of Engineering offers its prospective students three year Bachelor degree courses and two year Master degree courses within the scope of two-stage study plans. The Master degree course graduates are offered three year postgraduate courses in the following fields:

1. Agricultural machinery
2. <u>Road transportation and city traffic.</u>
3. Waste disposal technology and techniques.
4. Technological equipment of constructions.
5. Trade and Business Dealing with Machinery
6. Information and Control Technology in an Agri-food Complex

Within the subject of road transportation and city traffic we provide essential knowledge about the Earth's atmosphere and physical processes which determine its properties and behaviour; atmospheric composition and energy, water in the atmosphere and air circulation (global, synoptic and local scales). The Course continues in the description of the climate in the World. Special emphasis is put on the problems of transport meteorology, a guide to the road weather systems and SIRWEC suggestions [7].

2. MATERIALS AND METHODS

The individual topics of our programme of lectures and seminars concerning meteorology are outlined in the Tables 1 and 2.

1. Meteorology and Climatology, history, present, World Meteorological Organization.
2. The Earth's atmosphere, air composition, vertical and horizontal structure, ICAO atmosphere.
3. Pollutants in the atmosphere, sources, emission, standards, ecotoxicology.
4. Barometric pressure, relations to the synoptic, altitude.
5. Radiation of the Earth and atmosphere, heat balance. Greenhouse effect.
6. Air, water, soil and roadway surface temperature - diurnal and annual course.
7. Water in the atmosphere, evaporation, condensation. Air moisture. Cloudiness and fog.
8. Hydrometeors and shipping, air and overland transport.
9. General circulation. Ocean circulation. ITCS. Trade winds, monsoons, westerlies.
10. Cyclone and anticyclone. Air masses and fronts. Regional winds - breezes, foehn, heat island, tornado.
11. World Weather Watch. Synoptic meteorology, weather information - charts, radiolocators, satelites.
12. Meteorology and transport. Weather forecast.
13. Road meteorology. SIRWEC Standing International Road Weather Commission. SERWEC (European).
14. Transport climatography of the World.

Table 1. Lecture topics schedule.

Practicals / Seminars

1. Introduction, literature. Services - Czech Hydrometeorological Institute, World Meteorological Organization.
2. Time - UTC, LMT, GMT, IAT. Sunrise, sunset, twilights. Phases of Moon.
3. Atmospheric pressure. Instruments, barometric hypsometry, reduction of pressure.
4. Radiation, sunshine, illumination. Instruments, standards.
5. Air, water, soil and road surface temperature. Instruments, characteristics. Completion of the missing temperature`s data.
6. Air moisture. Instruments, characteristics, computational procedure. Condensation effects.
7. Cloudiness, wind, refrigeration. Instruments, characteristics. Standards.
8. Fog. Technical and meteorological visibility. Estimation of the freezing depth of pavement.
9. RWIS system of data processing and collection. Characteristics, computational procedure.
10. Synoptic charts, information of meteorological satelites and radiolocators, meteorological films.
11. Classification of synoptic situation, fronts, air masses, meteorological elements and their symbols and codes.
12. Climate evaluation of selected sites in Czech Republic, climatological standards, methodology.
13. Climagram Griffith- Taylor, Walter-Lieth, Köppen classification.
14. Credit.

Table 2. Seminar topics schedule.

We will focus on the transport meteorology topics only, or on the subjects which have some relation with this item.

Regarding ICAO ISA we use a Standard Atmosphere Table, which provides the basic information on the relationships between the altitude, pressure, temperature and relative air density (Table 3.).

Standard Atmosphere

Altitude (Feet)	Pressure (mb)	Temperature (˚C)	Density Ratio**
0	1013.25	15.000	1
100	1009.50	14.802	0.997
500	995.07	14.009	0.985
1,000	977.16	13.019	0.971
2,000	942.13	11.038	0.943
4,000	875.13	7.077	0.888
6,000	812.04	3.116	0.836
8,000	752.71	-.844	0.786
10,000	696.94	-4.803	0.738
12,000	644.58	-8.761	0.693
14,000	595.46	-12.718	0.650
16,000	549.42	-16.675	0.609
18,000	506.32	-20.631	0.570
20,000	466.00	-24.586	0.533
22,000	428.33	-28.541	0.498
24,000	393.17	-32.494	0.464
26,000	360.40	-36.447	0.433
28,000	329.87	-40.399	0.403
30,000	301.48	-44.351	0.374
32,000	275.11	-48.301	0.347
34,000	250.64	-52.251	0.322
36,000	227.97	-56.200	0.298
*36,200	225.79	-56.500	0.296
38,000	207.14	-56.500	0.271
40,000	188.23	-56.500	0.246
42,000	171.04	-56.500	0.224
44,000	155.42	-56.500	0.203
46,000	141.24	-56.500	0.185
48,000	128.35	-56.500	0.168
50,000	116.64	-56.500	0.152
52,000	106.00	-56.500	0.138
54,000	96.332	-56.500	0.126
56,000	87.547	-56.500	0.114
58,000	79.565	-56.500	0.104
60,000	72.312	-56.500	0.094
62,000	65.721	-56.500	0.086
64,000	59.732	-56.500	0.078

* Tropopause
**The ratio of density at the given altitude to that at mean sea level

Appendix B-2

Aviation Weather

Table 3. Standard atmosphere characteristics, taken from [4].

As a basic diagram we apply the figure which gives schematic information about the profile and cross section of the atmosphere – Figure 1.

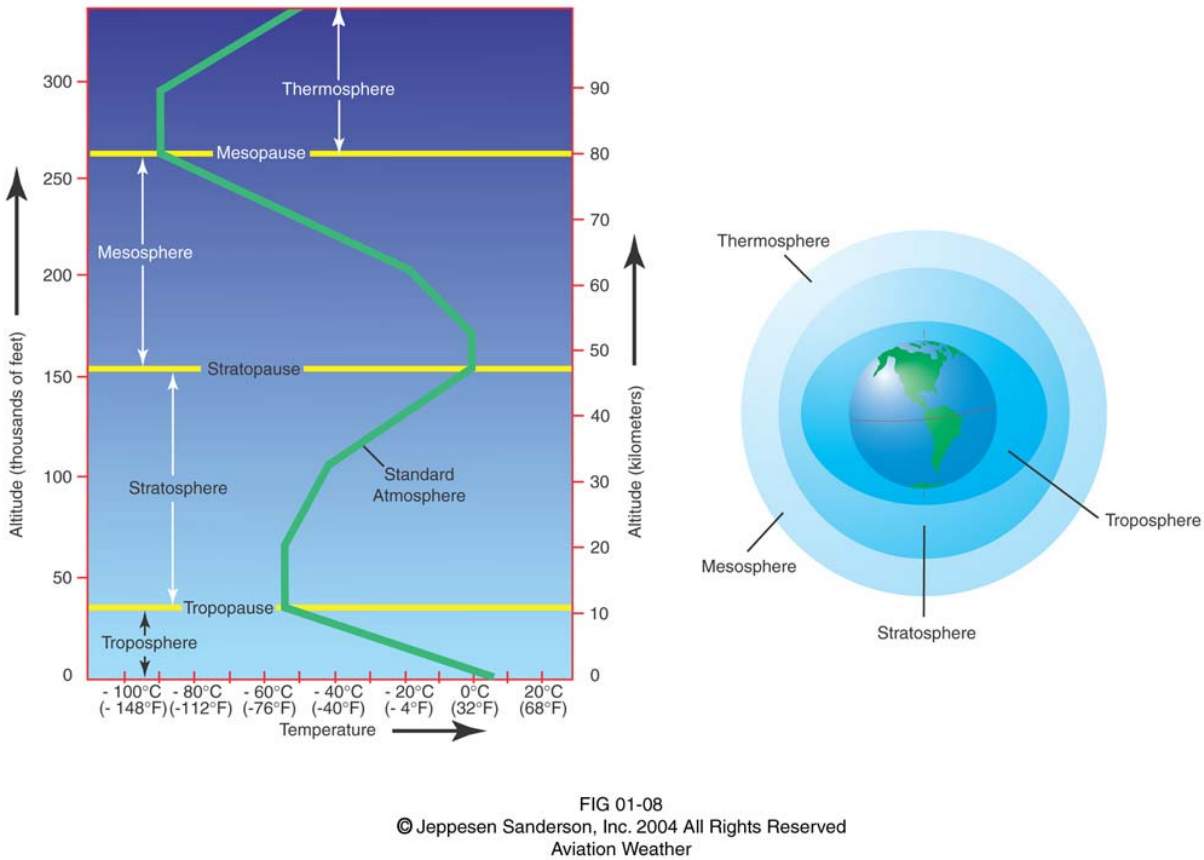

Figure 1. Standard atmosphere profile and cross section, taken from [4].

In respect of barometric pressure we point out the relationship between the altimeter

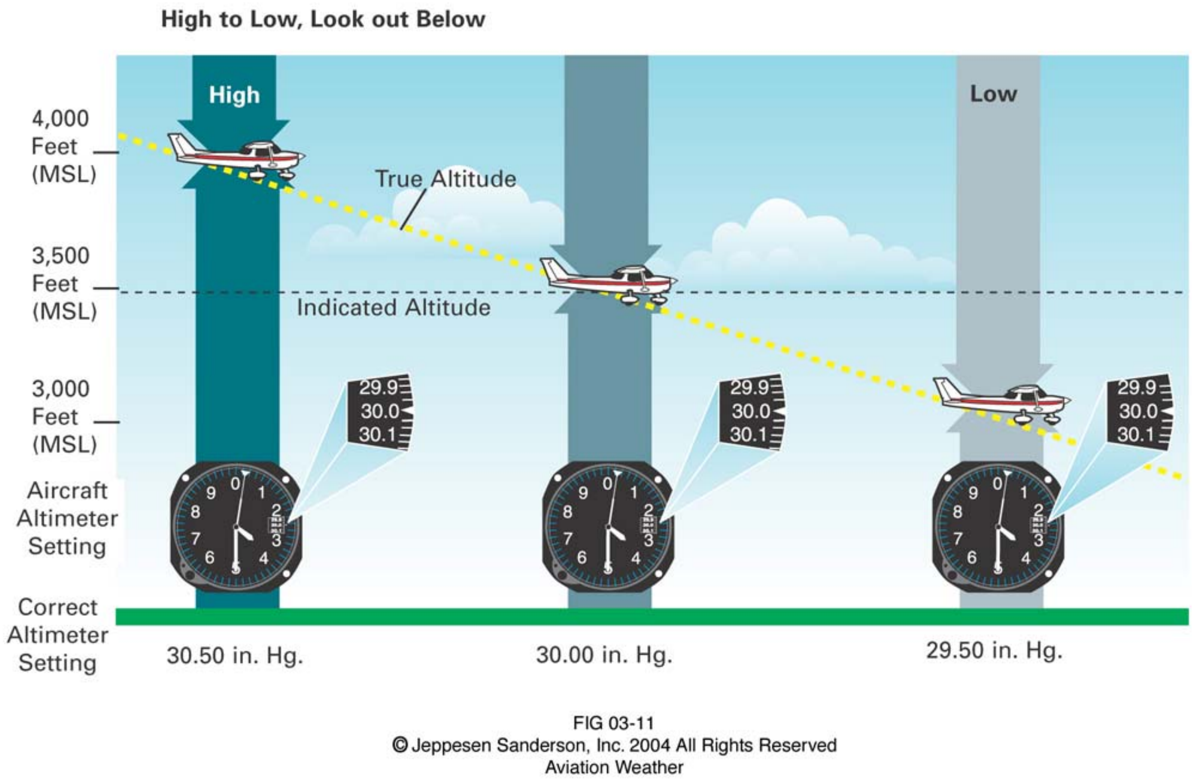

Figure 2. Situation within different pressure areas transition, taken from [4].

indications and the actual height above the ground (QFE) and its difference from the flight level (QNH). As a graphics we use Figure 2.
The conditions for absolute instability, conditional instability and absolute stability are demonstrated by diagrams which show these variants – Figure 3.

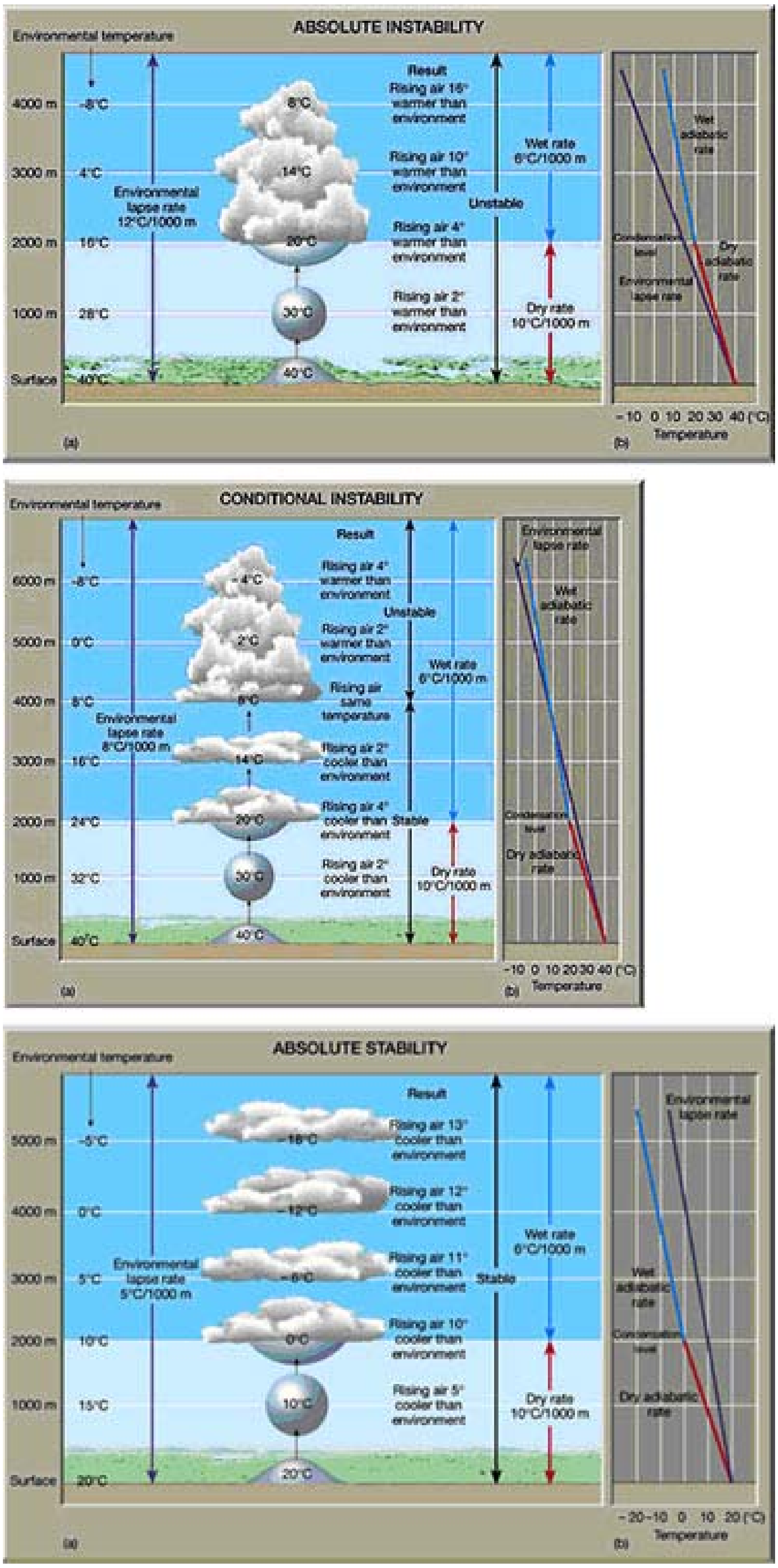

Figure 3. Situation within different stability variants, taken from [6].

The air humidity characteristics we demonstrate by the diagram in Figure 4.

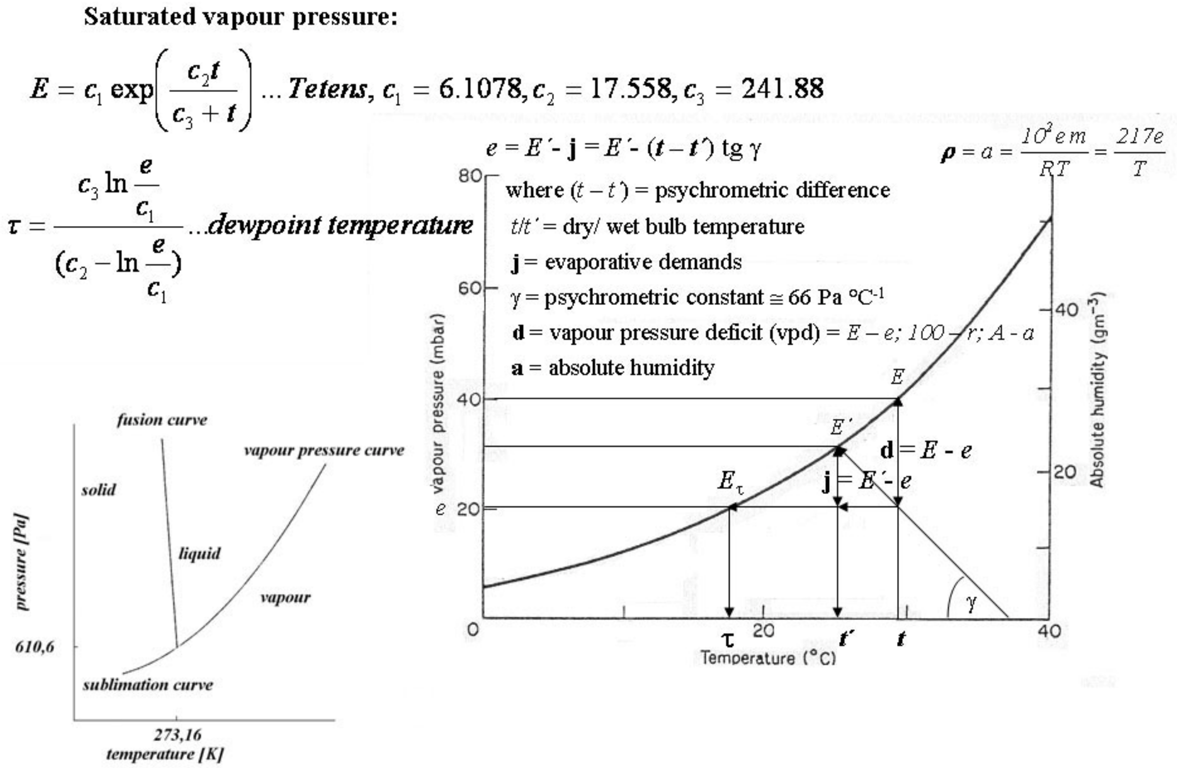

Figure 4. The air humidity characteristics.

Acquiring these characteristics is fundamental for the understanding of the dew and ice formation on the road and other surfaces, and for comprehension of the black ice creation conditions. In the scope of these issues we practice the estimation of suitable conditions from the actual temperature and humidity measurements by automatic weather station within the campus of the university, which is one of a few data source for our demands [2]. The example of that estimation we can see in the Figure 5.

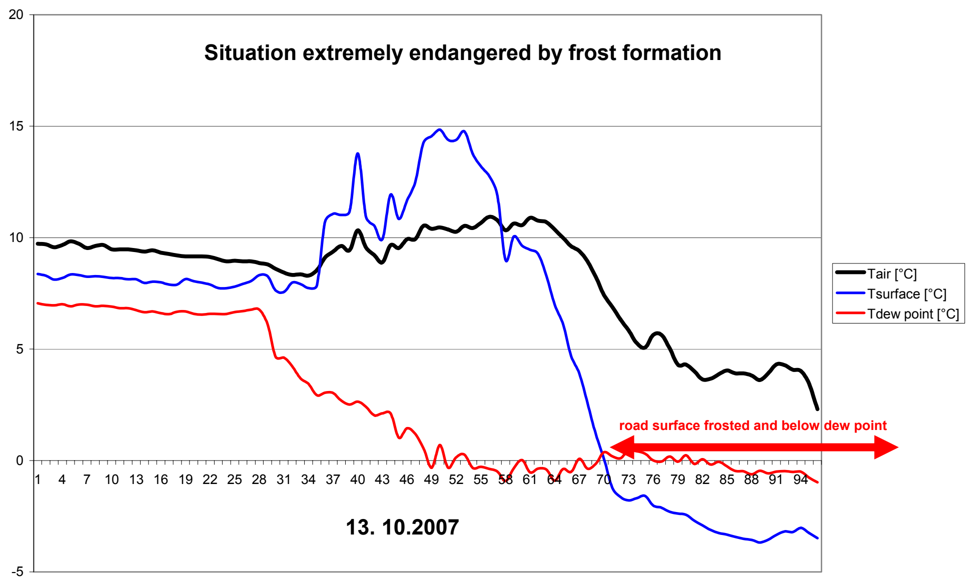

Figure 5. Estimation of icing danger during the actual measured period.

Of the Internet sources we use the websites of the Standing International Weather Commission SIRWEC, Federal High Way Administration FHWA U.S. Department of transportation and a number of links to other road weather sites, including the Czech websites of The Road and Motorway Directorate of the Czech Republic. As the first of many examples we mention the table of the weather impacts on roads, traffic and operational decisions - Table 4.

Road Weather Variables	Roadway Impacts	Traffic Flow Impacts	Operational Impacts
Air temperature and humidity	N/A	N/A	• Road treatment strategy (e.g., snow and ice control)
Wind speed	• Visibility distance (due to blowing snow, dust) • Lane obstruction (due to wind-blown snow, debris)	• Traffic speed • Travel time delay • Accident risk	• Vehicle performance (e.g., stability) • Access control (e.g., restrict vehicle type, close road) • Evacuation decision support
Precipitation (type, rate, start/end times)	• Visibility distance • Pavement friction • Lane obstruction	• Roadway capacity • Traffic speed • Travel time delay • Accident risk	• Vehicle performance (e.g., traction) • Driver capabilities/behaviour • Road treatment strategy • Traffic signal timing • Speed limit control • Evacuation decision support • Institutional coordination
Fog	• Visibility distance	• Traffic speed • Speed variance • Travel time delay • Accident risk	• Driver capabilities/behavior • Road treatment strategy • Access control • Speed limit control
Pavement temperature	• Infrastructure damage	N/A	• Road treatment strategy
Pavement condition	• Pavement friction • Infrastructure damage	• Roadway capacity • Traffic speed • Travel time delay • Accident risk	• Vehicle performance • Driver capabilities/behavior (e.g., route choice) • Road treatment strategy • Traffic signal timing • Speed limit control
Water level	• Lane submersion	• Traffic speed • Travel time delay • Accident risk	• Access control • Evacuation decision support • Institutional coordination

Table 4. Weather impacts on roads, traffic and operational decisions by FHWA Road Weather Management Program, U.S. Department of transportation, taken from [3].

The second example is the surface condition management by Boschung organization, illustrated by Figure 6.

Figure 6. Surface condition management by Boschung organization, taken from [1].

The third one is the scheme of atmospheric sensors, used by a road weather meteorological station within the RWI system - Figure 7.

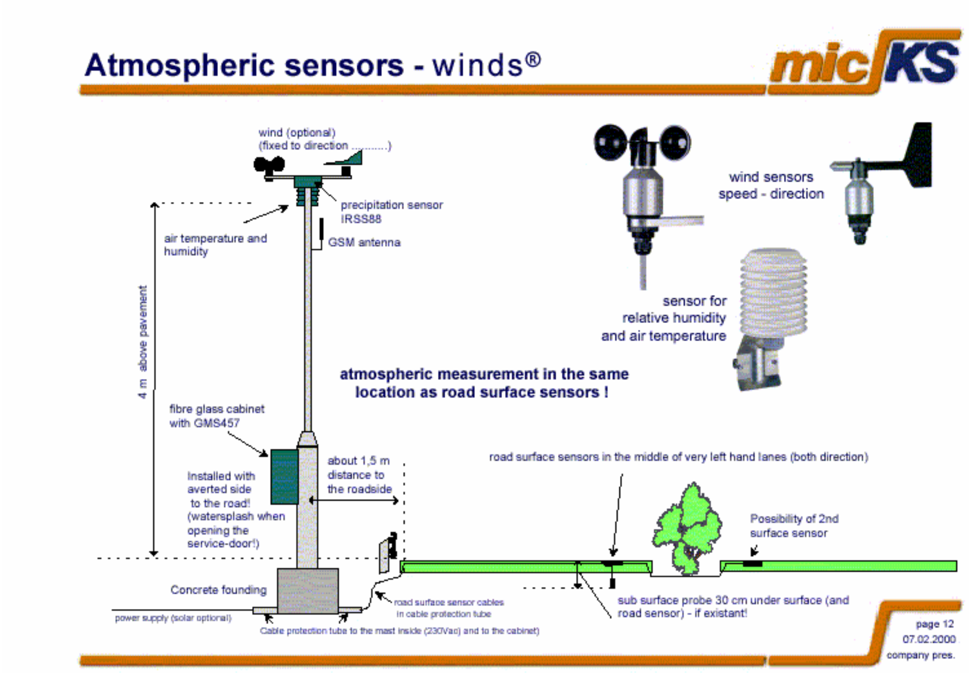

Figure 7. Road weather meteorological station scheme, taken from [5].

3. CONCLUSIONS

This short submission gives a brief review and examples of the educational programme relating to the road weather principles subject which is lectured in the Czech University of Life Sciences Prague within the Master degree course in The Faculty of Engineering. This programme involves the basic principles of relationships between individual meteorological phenomena as well as the special topics, such as icing conditions estimation, depth of the road-body freezing etc. In the future we would like to concentrate our efforts on closer cooperation with the Czech RWIS organization, namely in the field of the data processing and practical verification of physical theories through the field measurements as well as within the scope of diplomas and PhD study programme.

4. REFERENCES

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ACKNOWLEGEMENT

Special thanks to the vice-president of SIRWEC organization Dr. Miroslav Skuthan, who accepted this contribution to the SIRWEC international road weather conference Prague, May 2008.