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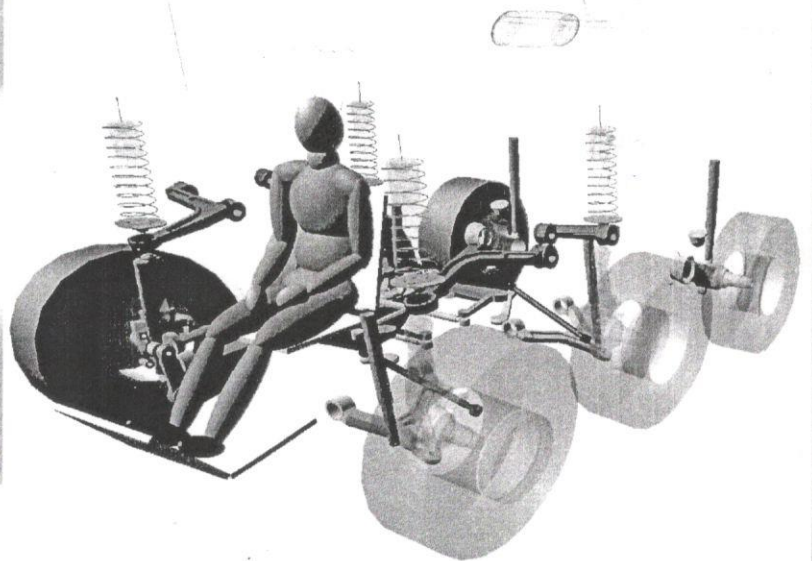
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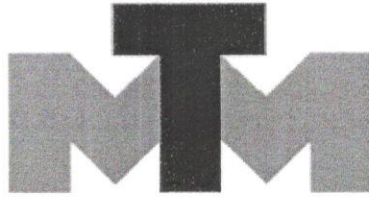
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## CONTENTS

<b>NEW THEORY OF ROTOR DYNAMICS: DYNAMICS OF OUTBOARD ROTOR WITH QUASI-STATIC UNBALANCE AT SUPERCRITICAL VELOCITIES</b> <b>НОВАЯ ТЕОРИЯ ДИНАМИКИ РОТОРА: ДИНАМИКА КОНСОЛЬНОГО РОТОРА С КВАЗИСТАТИЧЕСКОЙ НЕУРАВНОВЕШЕННОСТЬЮ НА СВЕРХКРИТИЧЕСКИХ СКОРОСТЯХ</b> Zhivotov A., Zhivotov Yu. ....	4
<b>ULTRASOUND DIAGNOSTICS OF THE PRESSURE VALVE PVV-25</b> <b>УЛЬТРАЗВУКОВАЯ ДИАГНОСТИКА НАГНЕТАТЕЛЬНОГО КЛАПАНА PVV-25</b> Z. HEJMAL .....	8
<b>DIESEL ENGINES WITH NEW FUEL-AIR MIXTURE FORMATION AND COMBUSTION MECHANISM</b> <b>ДИЗЕЛОВИ ДВИГАТЕЛИ С НОВ МЕХАНИЗЪМ НА ГОРИВО-ВЪЗДУШНО СМЕСООБРАЗУВАНЕ И ГОРЕНЕ</b> Rafiq Mehdiyev, Taner Derbentli, Hikmet Arslan, O. Akin Kutlar .....	11
<b>THE VICE-VERSE MOVEMENT OF THE REVERSE TUMBLE CENTER OF ROTATION IN A PARTICULAR COMBUSTION CHAMBER</b> <b>ПРОТИВОПОСОЧНО ДВИЖЕНИЕ НА ОСТА НА НАПРЕЧНО ВИХРОВО ДВИЖЕНИЕ С ПРОТИВОПОТОК В СПЕЦИАЛНА ГОРИВНА КАМЕРА</b> JOVANOVIĆ Z. S., MASONIĆ Z. M., TOMIĆ M. C. ....	17
<b>THE ANALYSIS OF THE INFLUENCE OF NEW MATERIALS APPLICATION ON CAR BODY CONSTRUCTION</b> <b>АНАЛИЗ ВЛИЯНИЯ ПРИМЕНЕНИЙ НОВЫХ МАТЕРИАЛОВ НА КОНСТРУКЦИЮ КУЗОВ</b> Milovanović M., Vitošević N. ....	21
<b>DECISION SUPPORT SYSTEMS FOR ALLOCATION OF LOGISTICS CENTRES</b> <b>СИСТЕМИ ЗА ВЗЕМАНЕ НА РЕШЕНИЯ ЗА РАЗПРЕДЕЛЯЩИТЕ ЛОГИСТИЧНИ ЦЕНТРОВЕ</b> Denisa Mocková .....	25
<b>HOW TO MAKE RAILWAY FREIGHT TRANSPORT MORE COMPETITIVE</b> <b>КАК СДЕЛАТЬ ЖЕЛЕЗНОДАРОЖНЫЙ ГРУЗАВОЙ ТРАНСПОРТ БОЛЕЕ КОНКУРЕНТОСПОСОБНЫМ</b> Kendra M., Barta D. ....	27
<b>MODELLING OF ENTRANCE FEE TO THE BUS TERMINAL</b> <b>МОДЕЛИРОВАНИЕ ВЪЕЗДНОГО ТАРИФА НА ТЕРРИТОРИЮ АВТОВОКЗАЛА</b> Ing. Lánská M. ....	30
<b>ON LINKAGE OF TRANSPORTATION THEORY AND LOGISTICS</b> <b>РАЗВИТИЕ МОДЕЛИРОВАНИЯ СВЯЗИ ТРАНСПОР - ЛОГИСТИКА</b> Otto Pastor .....	32
<b>TRANSPORT SYSTEM COSTS IN CONTEXT OF COST-BENEFIT ANALYSIS</b> <b>ИЗДЕРЖКИ ТРАНСПОРТНОЙ СИСТЕМЫ В КОНТЕКСТЕ АНАЛИЗА ИЗДЕРЖЕК И ДОХОДОВ</b> Kampf R., Becková H. ....	34
<b>THE ANALYSIS OF DOMINANT FACTORS OF LONGITUDINAL TRUCK VIBRATION WITHIN FREQUENCY RANGE 0-5 Hz</b> <b>АНАЛИЗ НА ДОМИНИРАЩИТЕ ФАКТОРИ ПРИ НАДЛЪЖНИТЕ ТРЕПТЕНИЯ НА ТОВАРЕН АВТМОБИЛ В ЧЕСТОТНИЯ ДИАПАЗОН 0-5 Hz</b> Sakota Z., Diligenski D., Demic M., Casnji F. ....	38
<b>МОНИТОРИНГ НА СЪСТОЯНИЕТО И ПРОГНОЗИРАНЕ НА ОСТАТЪЧНИЯ РЕСУРС НА ЕЛЕМЕНТИ ОТ ГАЗОТУРБИНИ ДВИГАТЕЛИ</b> <b>HEALTH MONITORING AND REMAINING LIFE PROGNOSIS OF GAS TURBINE ENGINE COMPONENTS</b> Андонова М. ....	42
<b>THEORETICAL ACCESSES TO ANALYSIS OF A USER BEHAVIOUR IN TRANSPORT</b> <b>ТЕОРЕТИЧЕСКИЙ ПОДХОД К АНАЛИЗУ ПОЛЬЗОВАТЕЛЬСКОГО ПОВЕДЕНИЯ В ТРАНСПОРТЕ</b> Švadlenka L., Chlaň A. ....	46



<b>THE POSITION OF THE BULGARIAN TRANSPORT COMPANIES ON THE SUPPLY CHAIN MANAGEMENT IN THE EU</b> <b>ПОЗИЦИЯ БОЛГАРСКИХ ТРАНСПОРТНЫХ ФИРМ ПО РУКОВОДСТВО ЦЕПИ ДОСТАВОК В ЭС</b> Dragneva N. ....	49
<b>METEOROLOGICAL SECURITY IN ROAD TRAFFIC THROUGH EXAMPLE OF TRANSPORT ROAD NETWORK IN REPUBLIC OF MACEDONIA</b> Dukoski I., Sretenova Simjanovska V., Bunevska J. ....	51
<b>DETERMINATION OF THE OPTIMAL DELIVERY SUPPLY</b> Petr Průša, Roman Hruška .....	55
<b>NANOSTRUCTURED COMPOSITE COATINGS FOR THE PROTECTION AND RESTORATION OF PRECISION FRICTION PAIR PARTS</b> <b>НАНОСТРУКТУРИРОВАННЫЕ КОМПОЗИТНЫЕ ПОКРЫТИЯ ДЛЯ ЗАЩИТЫ И ВОССТАНОВЛЕНИЯ ДЕТАЛЕЙ ПРЕЦИЗИОННЫХ ПАР ТРЕНИЯ</b> Urbahs A., Savkovs K. Urbaha M. ....	58
<b>UNMANNED AERIAL VEHICLE DESIGN</b> <b>ПРОЕКТИРОВАНИЕ БЕЗПИЛОТНОГО ЛЕТАТЕЛЬНОГО АППАРАТА</b> Urbahs A., Petrovs V., Savkovs K., Jakovlevs A., Bulanovs V. ....	60
<b>INITIALISATION OF OPTICAL CAR TRACKING SYSTEMS USING VIDEO DATA ANALYSIS</b> <b>ИНИЦИАЛИЗИРОВАНИЕ ОПТИЧЕСКИХ СИСТЕМ СЛЕЖЕНИЯ АВТОМОБИЛЕЙ С ИСПОЛЬЗОВАНИЕМ АНАЛИЗЫ ДАННЫХ ВИДЕО</b> Okarma K., Mazurek P. ....	62
<b>APPLICATION OF HUE-SATURATION COLOUR MODEL TO THE REDUCTION OF VEHICLE'S TRACKING ERRORS</b> <b>УПОТРЕБЛЕНИЕ ЦВЕТОВОЙ МОДЕЛИ ТОН-НАСЫЩЕННОСТЬ К УМЕНЬШЕНИЮ ОШИБОК СЛЕЖЕНИЯ АВТОМОБИЛЕЙ</b> Mazurek P., Okarma K. ....	66

# METEOROLOGICAL SECURITY IN ROAD TRAFFIC TROUGH EXAMPLE OF TRANSPORT ROAD NETWORK IN REPUBLIC OF MACEDONIA

Ass. Prof. Dr. Dukoski I.<sup>1</sup>, Ass. grad. mech. eng Sretenova Simjanovska V.<sup>2</sup>, Ass m. sci Bunevska J.<sup>3</sup>  
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**Abstract:** In Europe and Balkan boundaries, R. of Macedonia is important crossroad trough which many important and intense transit routes are passing by from Western and Middle Europe to Near East. R. of Macedonia is in position of mediator of international traffic routes between above mentioned regions. This basic traffic routes, as part of Europe routes have power of economic, social, cultural and other kind of integration of Europe and nations from that part of world. This makes clear why question for road meteorology, which is accented in this paper, is of high importance for road traffic in common, and especially for international transport corridors. The question is how and how much meteorology conditions can increase/decrease road traffic safety, and also how much road meteorology can make gain for more quality, more efficient and more economic work of all instances in charge for road traffic safety.

**KEYWORDS:** ROAD METEOROLOGY, INFORMATION SYSTEM, TRANSPORT CORRIDORS

## 1. Introduction

Meteorological conditions have important influence on safety and capacity of roads. Comparing to air and water vehicles, road vehicles are less affected by meteorological appearing, but they are equal in need for methodological secure because of the number of vehicles involved in road transport and its intensity.

Numerous measures are taken in place to increase safety in road traffic, for example road maintenance. In this context, road meteorology should be seen as service for user oriented information and information about weather, necessary for deciding which measures should be taken by all services for maintain and secure road network. This information contains data from usual special meteorological measuring and observing, refining collected data, forecast of meteorological conditions and information system which will provide user's access to informations. Irregularities of a transport volume and transport engagement makes difficulties to the working rhythm of vehicles in vehicle park. For decreasing negative consequences it is necessary to adjust the working rhythm of vehicles in vehicle park, which means to adjust transport ability to dynamics of change of transport demands. Also it is necessary to adjust level of technical correctness of vehicles in vehicle park to exploitation demands. With this highest level of technical correctness is achieved in the moment when there is highest demand for transport tasks and lowest level in period with lower transport demands.

## 2. Terrain and climate informations for R. of Macedonia

Republic of Macedonia is mountain country. Almost 79% of its territory is mountain, and 19.1% is plain. Other 1.9% is water. Macedonia has different climate characteristics or mixture of continental and Mediterranean climate. Such condition is caused by direct climate influences from north and south, which results with temperature regime typical for both seasons: warm and dry summer and relatively cold winter. Average summer temperature is between 24.3°C and 20.6 °C, and absolute maximal temperature is between 44.5°C and 40.0°C. Average winter temperature varies between 4.9°C and 0.9°C, but absolute minimum reaches to -29.4°C and -13.0°C.

Based on long term measures and observations, basic climate parameters in R. of Macedonia are defined in few relatively homogenous regions:

- Sub-Mediterranean climate region: Gevgelija-Valandovo, on (50-500)m above sea level. This is warmest region in R. of Macedonia, with average air temperature of (12-14)°C and highest temperatures during month July. July/August is driest months during year with average rain showers of 30 mm/m<sup>2</sup>.

- Continental-Sub-Mediterranean climate: Central part along river Vardar, Stip, Veles, Kocani, Strumica and Radovish region. Average above sea level height is up to 600 m. Average air temperature is between (12-13)°C with highest temperature during July. Lowest temperature is in January, between (0-2)°C.
- Warm Continental climate region: Eastern part of R. of Macedonia. Average air temperature is between (10-11)°C.
- Cold Continental climate region: Western part of R. of Macedonia. Average air temperature is about 9°C.
- Sub-Mountain climate region: on about 2250 m above sea level and average air temperature of 5°C.
- Coldest are regions with Mountain climate: Solunska glava, on above sea level height greater than 2250m and average air temperature below 0°C.

This kind of terrain, climate and temperature characteristics of our country territory emphasizes very important need of meteorologically securing road traffic and on time information to its users. Use of it is multiple: state, people involved in traffic, road maintenance services, insurance companies and lots of other instances.

## 3. Meteorological measurements

Meteorology is based on measuring of different atmosphere parameters, among which most important are: temperature, humidity and air pressure, direction and wind strength, visibility, rain occurs (type, intensity and duration of), duration of sunlight, road surface condition and others. Necessary for process of measuring meteorological parameters are continuousness, exactness and validness.

- Continuousness is provided by permanent measuring in certain network and point.
- Exactness is achieved by using appropriate instruments and apparatus.
- Validness is condition which guarantee that measured values is valid for place by which is gathered. Validness of measurements is most hard to obtain, because of fact that meteorological parameters on relatively small distance may significantly vary.

It is true and maybe only way to make measurements which will provide relevant picture of meteorological conditions of the road is automation. For this purpose Automated Meteorological Stations (AMS), are used with great reliability, exactness and automate work, and in the end with great economics because measurements performed do not ask large number of employees.

3.1. Meteorological measurements of critical points in road traffic

Critical points in road traffic are places on which meteorological conditions are significantly different than other in immediate surroundings. It can be dings, curves, bridges and other places where meteorological phenomenon happens with different meteorological conditions than other in immediate surroundings which have negative and surprising influence on road traffic users.

Effects of negative meteorological conditions are more emphasized on out of town traffic networks, but its influence is also great in towns, where traffic jam and delays burdens with extra load, and can even paralyze town living.

Bridges are important objects which are especially exposed and sensitive on metrological conditions. During low temperature, with increase of air humidity visibility is lowered in bridge areas, and ice on roads occurs. Also strong winds along rivers can have great influence on vehicles. Above mentioned metrological conditions hardens and slow down traffic and is cause for lots traffic accidents with great material damage.

For increasing safety in traffic, especially on critical parts and bridges, it is recommended to install automated meteorological stations for measuring metrological parameters which has influence on traffic. Additionally road surface conditions has to be measured and also the degree of ice on road. This measured date should be accessible in real time and can provide quick and on time preventing measures such are: slowing down or redirect traffic, cleaning and sanding the road with anti-ice products etc. Also this meteorological condition data for critical points of roads enable forecast for negative conditions development and it's on time announcement which will help to make decision for appropriate and on time traffic safety measures.

3.2. Treatment of metrological data and meteorological condition forecast

High safety in road traffic has need for long term and short term weather forecasts, climate analysis and very short term weather forecasts. For performing such forecasts very narrow specialty is necessary for analyzing measured meteorological parameters.

- Long term forecasts are unreliable and do not provide necessary data for road services.
- Short term forecasts for one to tree days are used for preparation of road services and eventual technical activity on the road networks.
- Very short term forecasts are used for decision making on road actions, and especially on type and kind of activities.
- Climate analyses provide long term preparation, service organization, for deployment and size of services planning. They are important for designing roads; define the trace of road and securing passive safety measures.

4. Road meteorogly condition in R. of Macedonia

In our country public services responsible for road maintenance and all road transport companies and unions on one way or another have need of use or show metorological data, they usre informations provided by Hydro-Meteorolglcal Work Office (UHMR).

Hydro-Meteorological activity on territory of R. of Macedonia has rich and long tradition. It starts since 1891 when first meteorological measurements and observations are made, but organized network of meteorological stations has since 1923. Until 1947, despite the conditions has temporary interruption in measurement and observations. In that year Hydro-Meteorological Service of People's Republic of Macedonia is founded and new hydro-meteorological network is formed.

In UHMR there are following departments:

- Meteorological department;

- Department for analysis and forecast;
- Hydrological department;
- Department for analysis of nature environment and water
- Department for artificial influence and modifications.

Department of synoptic is in charge for making and defining all forecasts. Computer forecasts are made by data refining gathered by satellite snapshots, and trough model which for all data make analysis and forecast. Computer forecast model, provides data for temperature, wind, rain showers, energy and cloudness.

There are following types of forecasts:

- Three day forecast;
- Numerical forecast for Europe (72 hours)
- Numerical forecast for R. of Macedonia (48 hours)
- Metograms for R. of Macedonia towns

4.1 Meteorological station in R. of Macedonia

Actual weather data are gathered with measurement in sinoptical stations network and further in Metrological department are performed actions which are related to:

- Organization and management the work of performing complete meteorological, climate and agro-meteorological measurements and observations;
- Obrabotka, critical control, archiving, publish and analysis of the results of performed measurements and observations;
- Following of the components of climate system and appliance of its results in science and economy.

Further down meteorological stations on R. of Macedonia territory in relation to transport corridors 8 and 10 will be shown.

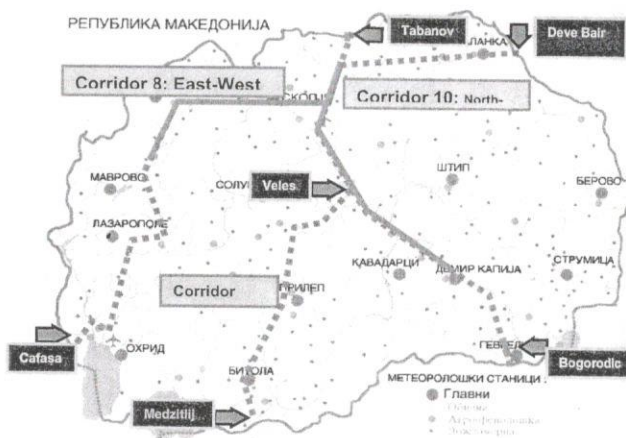


Figure 1. Meteorological stations in R. of Macedonia in relation to transport corridors 8 and 10

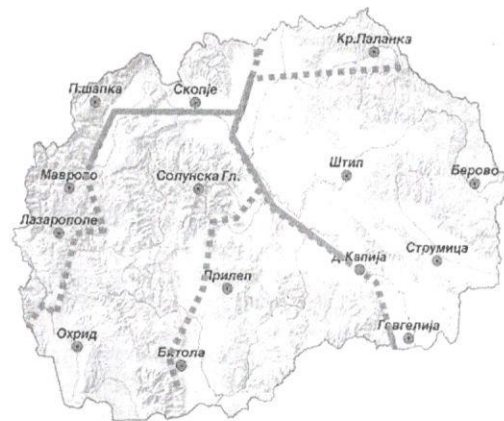


Figure 2. Main station in R. of Macedonia in relation to transport corridors 8 and 10



Figure 3. Climatological stations in R. of Macedonia in relation to transport corridors 8 and 10



Figure 4. Rain measuring stations in R. of Macedonia in relation to transport corridors 8 and 10

As it can be noticed, meteorological stations are positioned far from road and transport corridors. This means that such gathered data are not significant and valid for good view of road conditions. Data for wind, temperature and air humidity and visibility type and intensity of rains, also data for ice on road possibility are practically non-existing.

Monthly forecasts have low probability of achieving and most commonly they are only base for expert analysis and representing.

Forecasts for present and next day have very basic character, because they are made for large number of different users, and the degree of responsibility for it is very low.

Very short term forecast almost is not available, and they not use climatology analysis necessary for tracing roads and building passive measures for road traffic safety.

#### 4.2 Meteorological data from AMSM

Meteorological information which can be obtained from Auto-Mono-Union of Macedonia (AMSM) is mostly in following form:

- Daily information, which can be also called traffic and not meteorological information, because they are related to way of traffic performance;
- Information for road conditions, mostly for road clearance and throughput and;
- Information for border check points, for example time necessary for passing the border.

Such conditions, calls and obligates to make organization and establishing system for meteorological securing the road traffic in R. of Macedonia. This information system for providing real time information to users should achieve increased traffic safety, efficiency and economic in road traffic.

### 5. Information system for metrological securing road traffic in R. of Macedonia

For meteorological securing the road traffic in R. of Macedonia it is necessary to:

- Purchase and install automated meteorological stations for measuring meteorological parameters of roads, and especially critical sections and bridges;
- Provide transmission of metrological information to users, which understand forming metrological information center.

By this way will be achieved:

- Analysis of present conditions;
- Definition of road traffic users needs;
- Development of suggestion system for meteorological securing road traffic

There are different configurations of automated meteorological stations. Most simple configuration provides simple installation and programming.

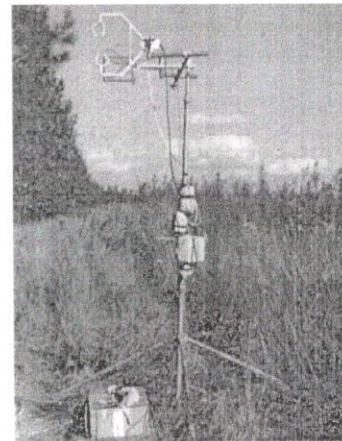


Figure 5. Simple configuration of automated meteorology station

System of this automated meteorology station is contained of:

- Automated station
- Sensors for scanning meteorology parameters: air temperature, humidity, direction and wind speed, quantity of rains, snow depth and direction of sunlight.
- PC software for visualization of data and report creation.

Elements for simplest configuration of automated meteorology station are shown on following figure 6:

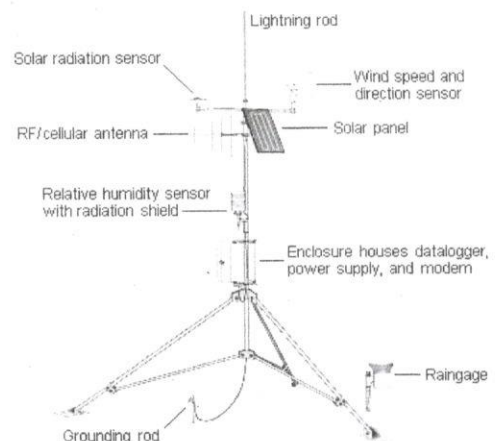


Figure 6. Elements of automated metrological station

More complicated configurations of automated meteorological station, also contains: sensors for level of water on road surface – ultrasonic sensors, sensors for visibility – optical sensors, sensors for height of snow – detectors, cameras, etc.

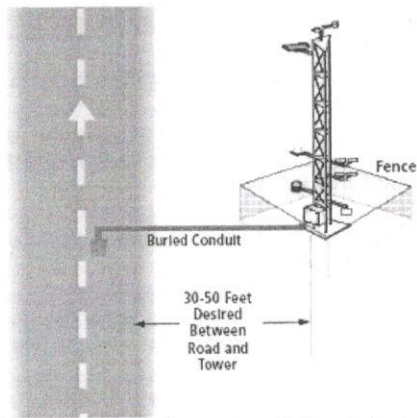


Figure 7. Optimal distance from automated meteorological station to road

For great importance for securing reliable and exact meteorological data is distance of meteorological station from the road. Optimal distance is shown on figure 7:

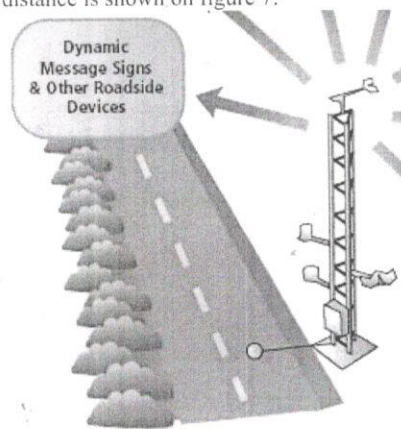


Figure 8. Transmitting the meteorological condition to users

Further, gathered data for meteorological parameters and conditions, trough signs with dynamical messages and other road side objects and portal are transmitted to users, (Figure 8).

### 6. Conclusion

Analysis of metrological securing the road transport network in R. of Macedonia is partial and not enough valid. Metrological information provided to road transport users is old, non-transparent and unsatisfactional. With installing meteorological stations and forming meteorological information center, also with development of national prgramme and strategy for road meteorology, scientifically can be increased road traffic safety an economy and also road maintenance. On other hand, expenses for purchasing and installing the equipment are incomparable lower in relation to gains, lower traffic accidents, human losses and material damages, also in saving in road maintenance services.

### 7. References

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