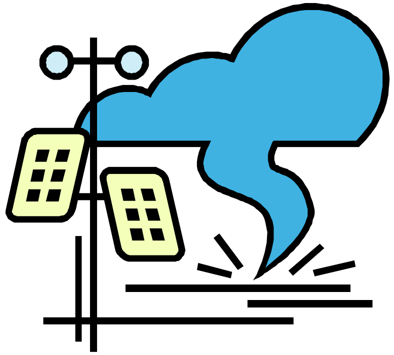


Agrometeorology

Concept, subject and tasks of agrometeorology;

meteorological phenomena

- Agricultural production, especially crop production is highly dependent on the weather conditons.

- The meteorological factors affect:
  - jobs related to crop production (e.g. tilling, sowing, etc.);
  - agronomic methods (fertilization, pest control, etc.);
  - biological processes of plants (their life processes, development, crop formation, etc.);

The beginnings of climate research:

- First observations on the climate were performed in the era of the ancient river cultures of East (Egypt, Mesopotamia, India and China) in the 3rd-1st millennia BC. The **observations** were of great importance in terms of **agricultural production** (river floods, monsoons).

- In the 5th century BC **Herodotus** enters the historical, geographic and climatic description of areas known by Greeks people. **Hippocrates** studied the effects of the climate and meteorological phenomena on human health.

- The word ”climate” comes from the Greek word clinein (= bend). It was first used by **Aristotle** in the 4th century BC. He recognized that the energy source of climatic phenomena is the Sun; namely, inclination of irradiance is of basic importance to climate differences.

- The word „meteorology" comes from ther Greek philosopher, Aristotle (384-322 BC).
- Experiences, observations.
- Mauritius Knauer abbot (1612-1664): Calendar of One Hundred Years (7 years of observations, conclusions).
- „If it does not match until the last raindrop, the goods will be as described; otherwise I cannot define either the aims or the devices of almighty."
- Since 1700ies instrumental measurements have been started (thermometer, measurement of air pressure, wind speed, wind direction, etc.).
- Morse (1837): discovery of the telegraph.
- **Daily News (London):,1848: weather reports via telegraph.**
- International Meteorological Congress (1837, Vienna): International Meteorological Organization, since 1951 Worold Meteorological Organization (WMO).

- Meteorological Institute (1870, Budapest): organization of station network, processing of climate data.
- **The first mapped daily weather forecast: 1891.**
- **The first radio sad forecasts: 1936.**
- Hungarian Meteorological Service (HMS); http://www.met.hu
- HMS: 30 main meteorological stations, nearly 70 climate stations, more than 600 rain gauge stations, 3 meteorological radar stations (Budapest, Szentgotthárd-Farkasfa, Nyíregyháza-Napkor).
- 1999: Hungary joined EUMETSAT as an associate member, so we can take METEOSAT satellite broadcasts every 30 minutes.

- Meteorology (sscience of weather phenomena, science of weather, science of the atmosphere): science dealing with processes that take place in the atmosphere.

- Agrometeorology: purpose: transforming knowledge on climate to useful information for agriculture.

- Smith (1970): agrometeorology: short form of the word ***agricultural meteorology***. The science of meteorology serves agriculture in order to make a conscious land use and to increase yield without exploiting natural resources.

Solar radiation

- Energy of the solar radiation reaching the Earth's surface depends on:
  - solar constant;
  - angle of incidence of the solar radiation;
  - length of the day;
- **Solar constant:** It characterizes the intensityx of the electromagnetic radiation of the Sun. This is the amount of radiation energy, which in the case of medium Sun-Earth distance at the outer boundary of the atmosphere traverse at unit cross-section perpendicular to radiation, during unit time (1368 $W \cdot m^{-2}$).
- Absolute value of the radiation intensity in perihelion is around 7% higher at the Earth's surface than in aphelion.
- The surface gets only **40%** (i.e. 136.8 $W \cdot m^{-2}$) of the solar radiation that reaches the upper boundary of the atmsophere, namely 342 $W \cdot m^{-2}$.

- Solar radiation reaches the Earth's surface as almost completely beam. The spherical Earth shares an energy from the parallel beam, proportional to the area of its cross-section ($I_0 \cdot R^2 \cdot \pi$) (*R:* radius of the Earth). This energy is distributed on the whole Earth (spherical surface) ($T = 4 \cdot R^2 \cdot \pi$).

  ⇒ the calculated mean radiation:

$$I = \frac{I_0 \cdot R^2 \cdot \pi}{4 \cdot R^2 \cdot \pi} = \frac{I_0}{4} = \frac{1368}{4} = 342 \quad \left[W \cdot m^{-2}\right]$$

- Only a fraction of the energy of the solar radiation is captured by the Earth and the other planets; its most part removes from the solar system;

  ⇒ radiation from other stars can get to Earth;

  ⇒ **the resulting energy corresponds to a black-body radiation temperature of ≈3 K;**

  this energy is energetically negligible, but understanding of the universe is essential;

1965: **Arno Penzias** and **Robert Wilson** carried out radio astronomy experiments with a small, highly sensitive antenna; they observed a steady, low-frequency noise, filming the antenna in any direction ←→ their instrument was flawless;

This noise is the remains of the cosmic microwave background radiation → it was created when, following the **Big Bang**, the temperature of the universe reduced enough to allow the material to become transparent. Then the temperature of the universe was ≈ 3000 °C (today -270 °C). This radiation is actually light that is induced by low-temperature blacbody radiation ⇒ it can be observed in μm wavelength range;

⇒ final proof → time of the **Big Bang**;
⇒ **1978: Nobel Prize in Physics;**

once the material of the **universe** was condensed in an infinitely smal point; **Big Bang** ⇒ gaalxies were formed from this material; The age of the universe ≈ **13,7 billion years;** black-body radiation reveals data on an early phase of its existence;

The discovery of **Penzias** and **Wilson** is an evidence in support of felfedezése bizonyíték **Lemaître's theory** and **Hubble's observation** supporting it;

Georges-Henri Lemaître (1894 – 1966);

Belgian catholic priest, honorary prelate, physicist, astronomer;

1927; 1931: **Nature:** „ancient atomic theory”; he theroetically proved that:

- ✓ **Einstein’s** general theory of relativity (static universe) is faulty;
- ✓ The universe can be written with a better model, if it is based on the theory of the expanding universe;

Edwin Hubble (1889-1953);

American astronomer;

1929: on ther basis of astronomical observations he found evidence that other galaxies are moving away from our;

⇒ **Lemaître:** the universe occurred by exploding of some original atoms (**Big Bang**);

❑ Additional results confirming the Big Bang

John C. Mather and **George F. Smoot** US researchers:
⇒ discovery of anisotropy of black-body radiation and cosmic microwave background radiation;

(Anisotropy is defined as the phenomenon where some of the properties of the material are different in different directions.)

Their research results have shown that the the universe really owes its birth to the **Big Bang;**

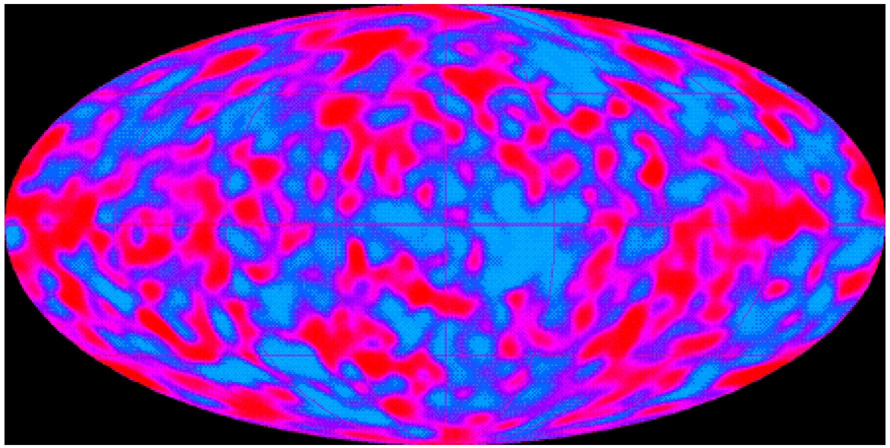
⇒ **2006: Nobel Prize in Physics**;

- ✓ **Mather** and **Smoot** measured low-temperature black-body radiation of the universe with a self-developed instrument allocated into the space for measuring cosmic microwave background radiation.

- ✓ Their discovery is a proof that after the **Big Bang** there was not exactly the same temperature in the universe everywhere.

  The existence of the imprint of density and temperature fluctuations at that time is currently shown only in the cosmic microwave background anisotropy.

Temperature fluctuations of the background radiation



- **Ha feltételezzük, hogy a Föld-légkör rendszer sugárzása feketetest-sugárzás, akkor mennyi annak egyensúlyi hőmérséklete?**

  - ✓ A Föld éves átlagos albedója: 30 %;
  - ✓ A jellemző visszavert napsugárzás: $0{,}3 \cdot 342\ W \cdot m^{-2} = 103\ W \cdot m^{-2}$;
  - ✓ A rendszerben maradó napsugárzási energia: $239\ W \cdot m^{-2}$;

Az egyensúly követelménye miatt a rendszerben maradó napsugárzási energiának valami módon távoznia kell:

- A légkörből könnyű molekulák állandóan távoznak ⇒ energiavesztés (elhanyagolható);
- Hőmérsékleti sugárzás (meghatározó);

E = 239 W·m^{-2};

T = ?

According to the **Stefan–Boltzman law**:

$$E = \int_{\lambda=0}^{\infty} f(\lambda, T) = \sigma \cdot T^4 \quad \left[J \cdot m^{-2} \cdot s^{-1}\right]$$

$$\sigma = 5,67 \cdot 10^{-8} \quad \left[J \cdot m^{-2} \cdot s^{-1} \cdot K^{-4}\right]$$

Expressing the temperature from the above equation:

$$T = \sqrt[4]{\frac{E}{\sigma}} = \sqrt[4]{\frac{239}{5,67 \cdot 10^{-8}}} = 255K$$

- Namely T = 255 K = -18ºC;
  - ⇒ E = 239 W·m^{-2} radiation energy is lost at -18ºC temperature by the Earth;
  - ⇒ looking at the Earth from the space, its temperature is -18ºC;

- **Satellite measurements:** annual average of the emission, 1979– : ≈ 235 W·m^{-2};
  - ⇒ there is no energy balance: the global energy balance in the study period: +4; +5 W·m^{-2};

Possible causes:

✓ Sloar constant measurements: absolute error (0,3%);

✓ albedo measurements: systematic error;

✓ Emission measurements: systematic error (more %);

- **The atmospheric greenhouse effect**

  The Earth is in radaiation balanace when its surface temperature:

  T = -18ºC;

  But the Earth's actual average surface temperature: T = +15ºC;

  ⇒ **this is 33ºC warmer than the equilibrium temperature;**

  ✓ The difference between the surface temperature and the equilibrium temperature comes from the atmospheric greenhose effect.

  What plays a role in the 33ºC increase of the equilibrium temperature of the Earth's atmosphere?

  ✓ The solar radiation intensity and spectral composition;

  ✓ The characteristics of the atmosphere;

  ✓ The climate-modifying effect of the surface;

  ✓ **Greenhouse gases (H_2O, CO_2, CH_4, CFC, NO_x, etc.)**

- **Correctly:** we can talk about the greenhouse effect of the Earth-atmosphere system ($a_{F\text{-}l}$ = 30%) ⇒ equilibrium temperature:

  $T_{F\text{-}l}$ = +15ºC;
- If we disregard the Earth's atmosphere (a_F = 10%)

  ⇒ equilibrium temperature: T_F = 0ºC ;

- **The absorbed solar radiation in the atmosphere and the Earth's surface**

The Earth-atmosphere system reflects a certain amount of the incident solar radiation:

- ✓ 30% is reflected into the space (a_{F-l} = 30%);
- ✓ 70% is absorbed by the atmosphere and the Earth's surface;

Although all the absorbed solar radiation energy leaves the Earth-atmosphere system, but considering the evolution of the processes in the system it is important, how the incoming energy is distributed within the system;

Absorption of the solar radiation in the atmosphere and on the Earth's surface

légköri állapotok	sugárzáselnyelés, %	
	légkör	felszín
a légkör tiszta, a felhők desztillált víz cseppjeiből állnak	20	50
a légköri aeroszolt is figyelembe véve	25	45
valódi légkör esetén	30	40

• The solar radiation and energy needs of mankind

- ✓ The solar radiation is the energy source of the inanimate and living nature (food, energy-carriers nuclear fusion);
- ✓ A portion of the solar radiation energy is absorbed by the vegetation → during this process they extract carbon dioxide from the atmosphere;
- ✓ Since more plants are found on the Northern Hemisphere compared to the Southern ⇒
  - in the summer of the Northern Hemisphere the Earth's carbon inventory decreases around 2%;
  - in the summer of the Northern Hemisphere it increases around 3 %;

From the last 150 years the accumulation of carbon dioxide could be prevented if every year we burn as much carbon energy, as is stored annually through the vegetation, oceans and oceanic limestone formation.

How much energy does this mean every year for humanity?

- Every square meter of the Earth's surface absorbs around 40% of the solar radiation energy arriving to the upper boundary of the atmosphere:

  $E = 0.4 \cdot 342\ \mathrm{W \cdot m^{-2}} = 136.8\ \mathrm{W \cdot m^{-2}}$;

- If this value is mutiplied by the Earth's surface ($5.1 \cdot 10^{14}\ \mathrm{m^2}$)

  $\Rightarrow$ the solar radiation absorbed by the whole surface of the Earth:

  $E = 136.8\ \mathrm{W \cdot m^{-2}} \cdot 5.1 \cdot 10^{14}\ \mathrm{m^2} = 697.68 \cdot 10^{14}\ \mathrm{W}$;

- Only one-fifth of the surface is covered by vegetation $\Rightarrow$ the above performance should be multiplied by 0.2:

  $E = 0.2 \cdot 697.68 \cdot 10^{14}\ \mathrm{W} = 139.536 \cdot 10^{14}\ \mathrm{W}$;

- Suppose that the plants absorb 1% of the solar radiation:

  $E = 0.01 \cdot 139.536 \cdot 10^{14}\ \mathrm{W} = 1.39536 \cdot 10^{14}\ \mathrm{W}$;

- Solar radiation energy absorbed by the vegetation is utilized by 5% efficiency:

  $E = 0.05 \cdot 1.39536 \cdot 10^{14}\ \mathrm{W} = 6.9768 \cdot 10^{12}\ \mathrm{W} \approx 7 \cdot 10^{12}\ \mathrm{W}$;

- Mean annual energy consumption in technologically developed countries : ≈10 kW / unit;

- If the above high level energy consumption is supposed

$$\frac{7 \cdot 10^{12}\ \text{W}}{10\ \text{kW} \cdot \text{fő}^{-1}} = \frac{7 \cdot 10^{12}\ \text{W}}{10^{4}\ \text{W} \cdot \text{fő}^{-1}} = 7 \cdot 10^{8}\ \text{fő} = 700\ \text{millió fő}$$

⇒ approx. 700 million people could live on Earth that their energy demand woild increase the atmospheric carbon dioxide concentration;

- The population of the Earth is currently approx. 7.2 billion people, and will stabilize when it reaches around 10 billion people.

- **ALL HUMAN ACTIVITIES LEADS TO THE GLOBAL WARMING.**

Polluted air over the Po River Plain, Italy

- **THE GROWING ENERGY PROBLEM OF THE PROLIFERATING MANKIND IS A MAJOR SOURCE OF ENVIRONMENTAL CONCERNS.**

- **SOLUTIONS (?)**

The object and functions of agrometeorology

Weather, climate and agricultural production

Introduction

- Recently, the development of agricuture has significantly accelerated;
- A sharp increase in crop yields was induced by:
  - new, more profuctive hybrids;
  - large quantities of fertilizers;
  - modern agornomic methods;
- It is known that currently almost every process in industrial production is under the direction and control of man.
- Agricultural production: meteorolgical effects;

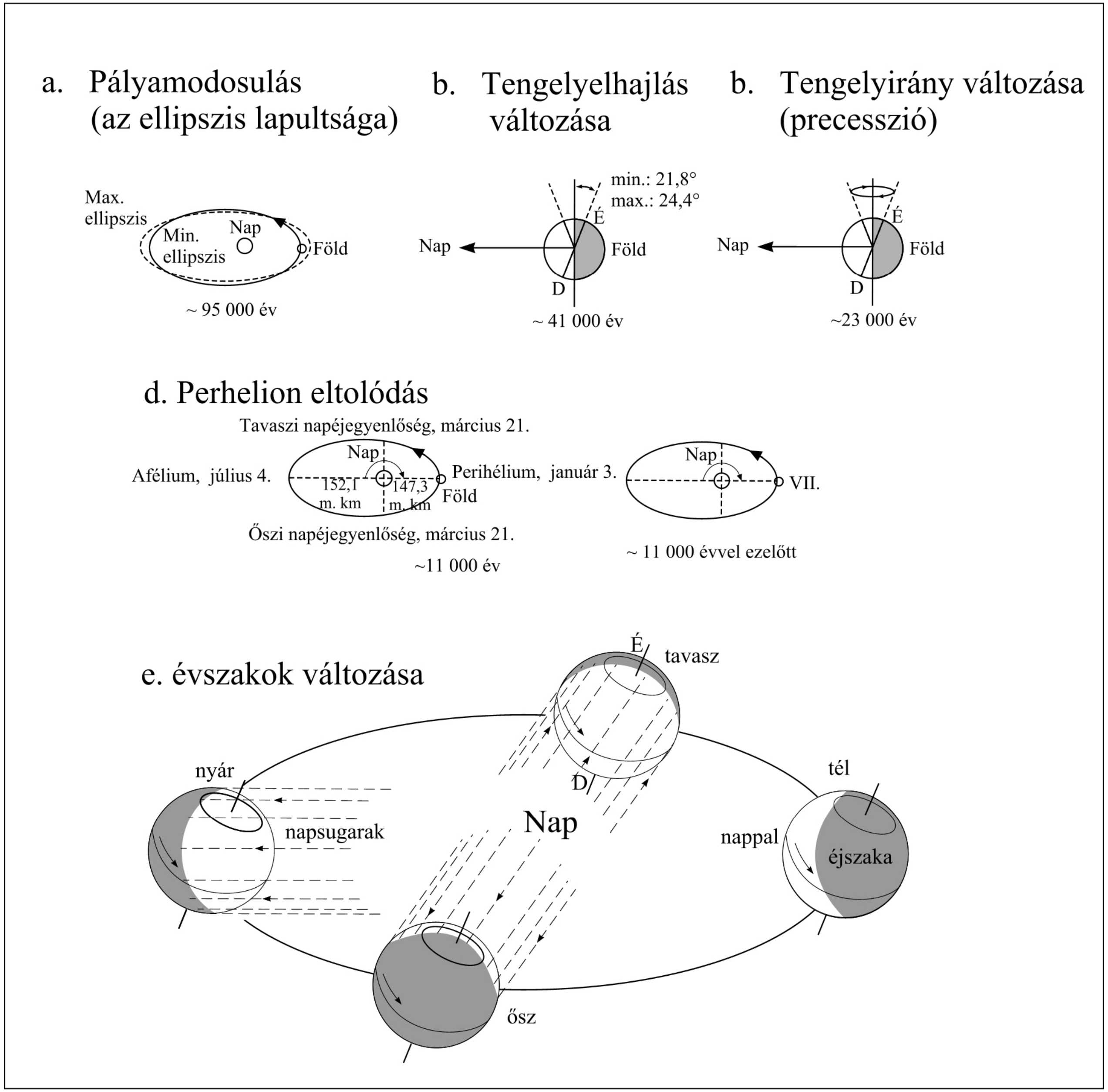
The concept of time, weather and climate

- *Time* is the system of physical properties and processes of the atmosphere being in constant interaction with the environment and each other at a given place and **given moment**.

- *Weather* is the system of physical properties and processes of the atmosphere being in constant interaction with the environment and each other at a given place and **over a shorter period (a few days, 1-2 weeks)**.

- *Climate* is the system of physical properties and processes of the atmosphere being in constant interaction with the environment and each other at a given place and **during a longer period (usually a few decades)**.

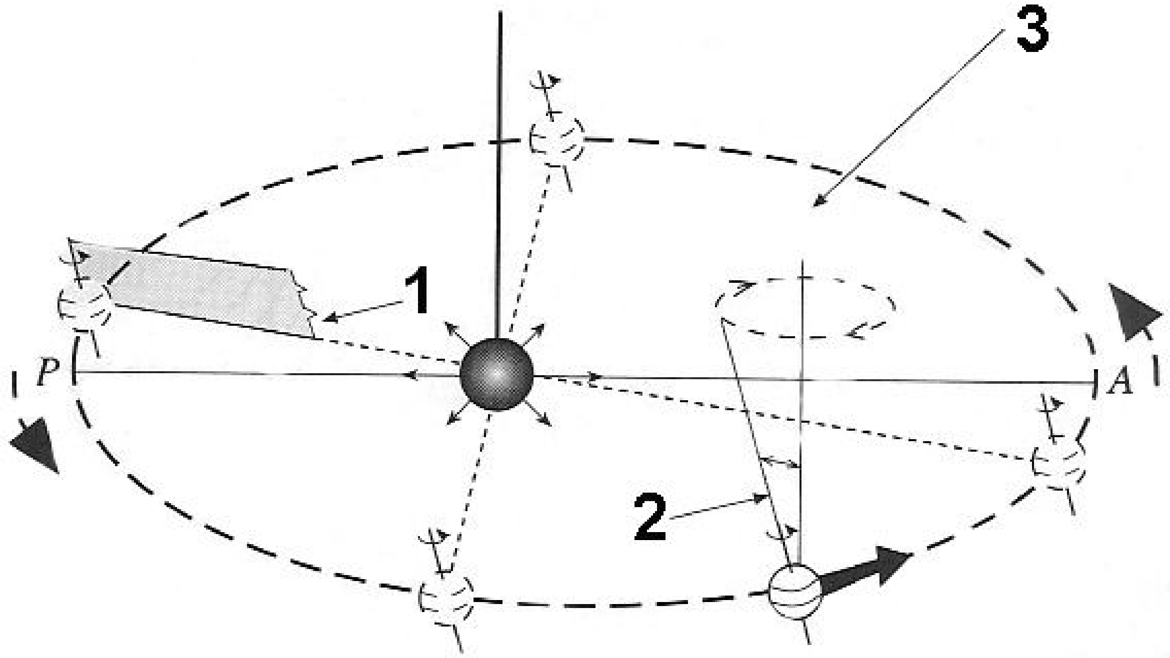
Astronomical factors modifying solar radiation



Orbit elements of the Earth

A: Aphelion point
P: Periohelion point

1: Plain of the inclination of the Earth's axis
2: Rotation axis of the Earth
3: Plain of the Earth's orbit



Increase in greenhouse gas emissions;

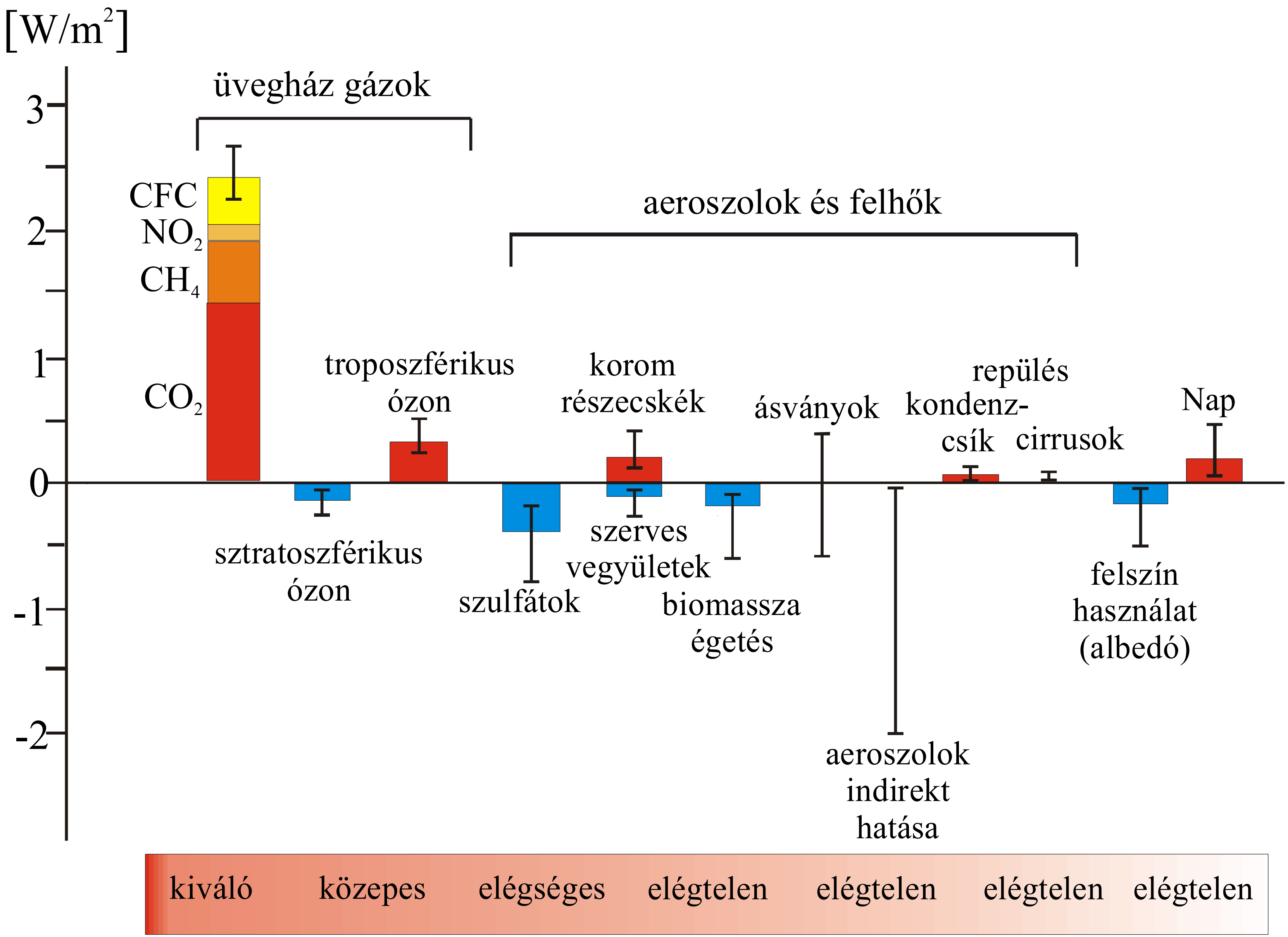
- Increase in SO_2 and NO_x emissions
  (acid rain, increase in aerosol concentrations);

- Biomass burning (increase of aerosol concentrations);

- Increase in concentrations of halogenated hydrocarbons
  (O_3-decompsition in the stratopsphere);

- Change of the surface (e.g. forest burning, soil erosion, etc.);

Impacts on the radiation balance, since the 1700s



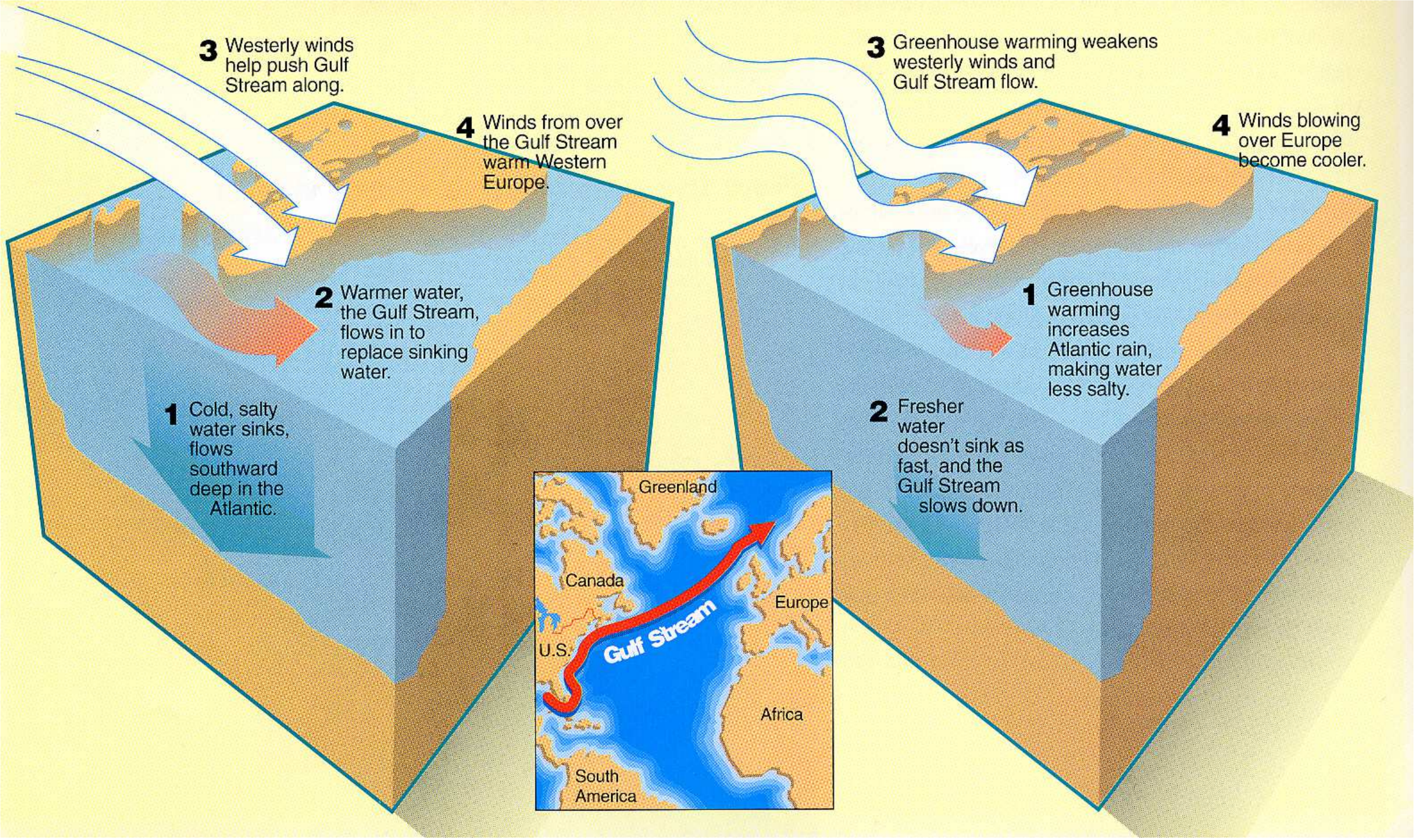
Positive feedback:

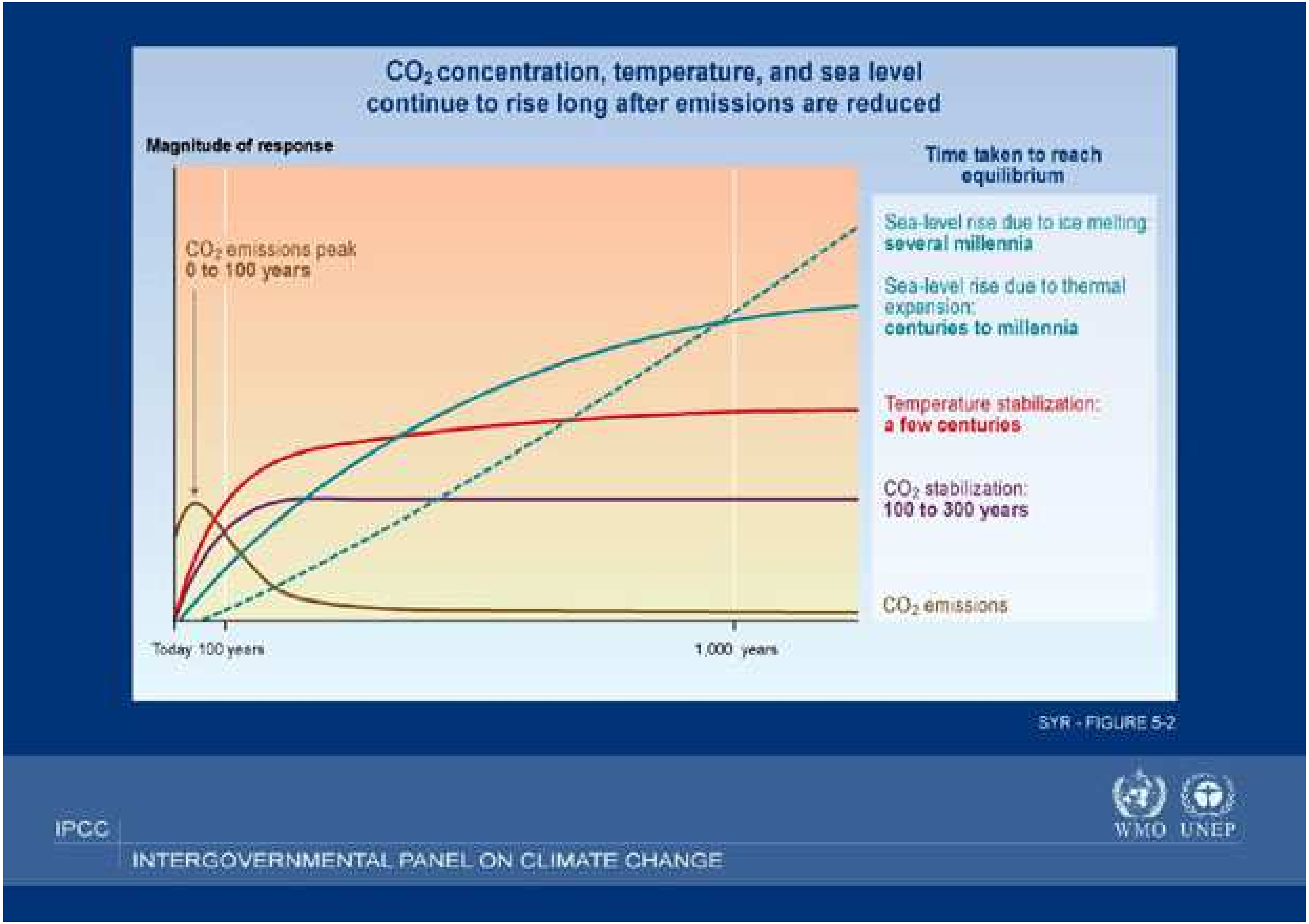
a) between atmospheric CO_2 content and temperature;
b) between the size of the ice cover and temperature;

Negaitive feedback:

a) between the surface temeprature and cloud formation;

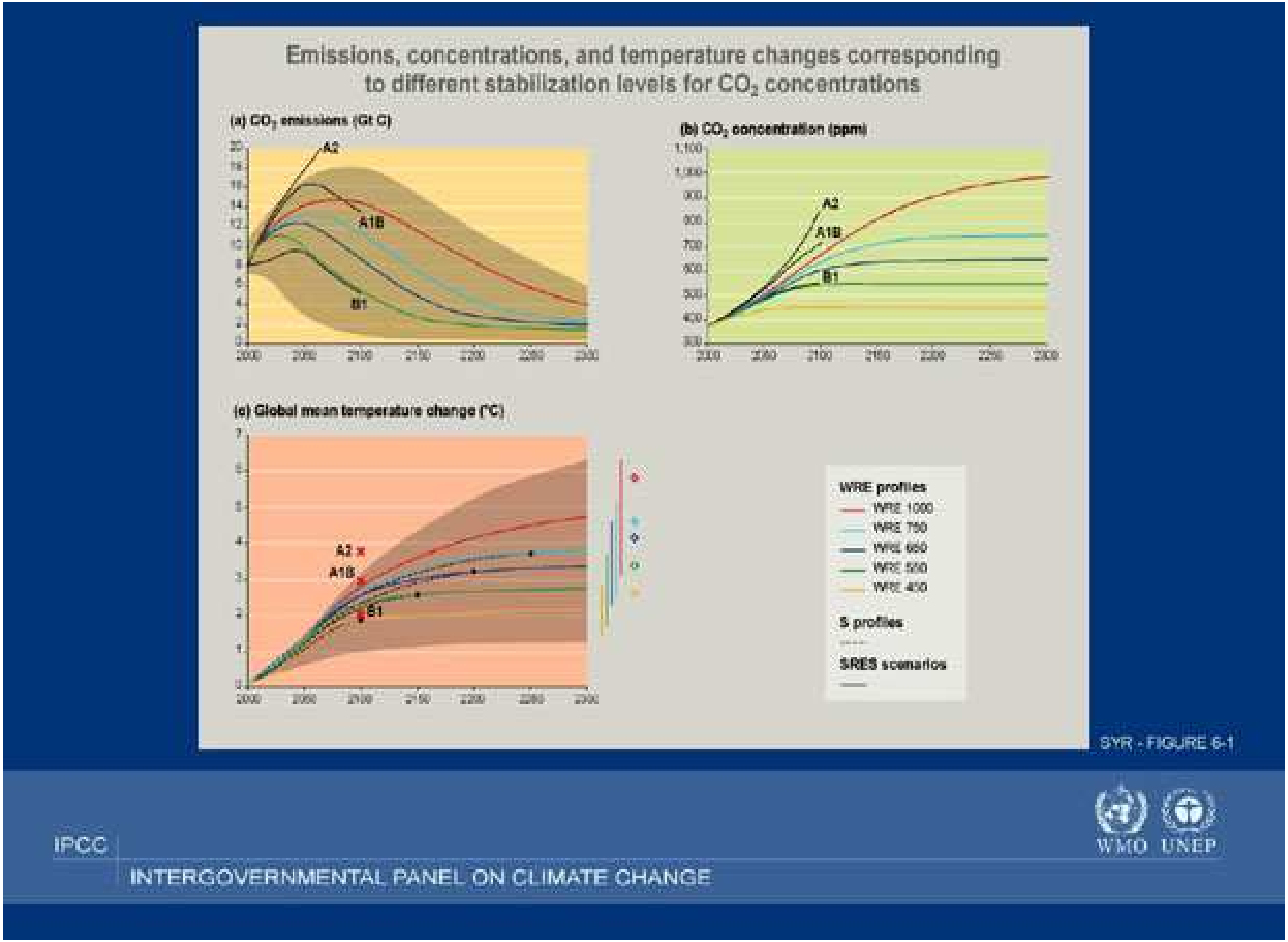
Surface ocean currents on the Earth


3 Westerly winds help push Gulf Stream along.
4 Winds from over the Gulf Stream warm Western Europe.
2 Warmer water, the Gulf Stream, flows in to replace sinking water.
1 Cold, salty water sinks, flows southward deep in the Atlantic.
3 Greenhouse warming weakens westerly winds and Gulf Stream flow.
4 Winds blowing over Europe become cooler.
1 Greenhouse warming increases Atlantic rain, making water less salty.
2 Fresher water doesn't sink as fast, and the Gulf Stream slows down.
Greenland
Canada
Europe
U.S.
Gulf Stream
Africa
South America

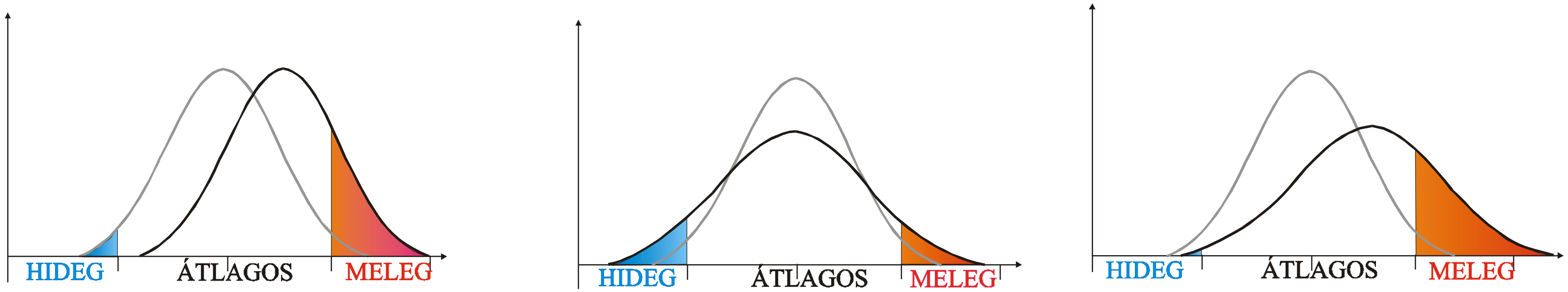


CO2 concentration, temperature, and sea level
continue to rise long after emissions are reduced
Magnitude of response
Time taken to reach equilibrium
Sea-level rise due to ice melting:
several millennia
Sea-level rise due to thermal expansion:
centuries to millennia
Temperature stabilization:
a few centuries
CO2 stabilization:
100 to 300 years
CO2 emissions
CO2 emissions peak
0 to 100 years
Today
100 years
1,000 years
SYR - FIGURE 5-2
IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WMO
UNEP

Forecast of the global mean temperature



Possible realizations of climate change and their interpretation



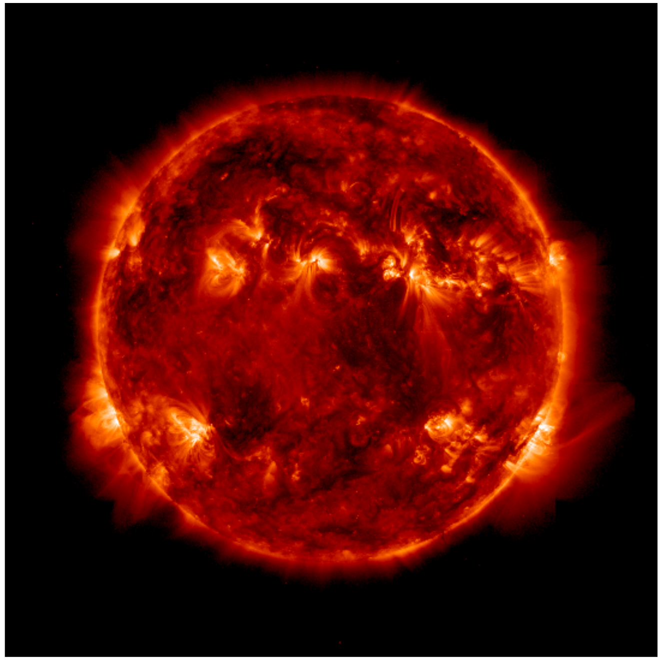
Factors forming weather and climate

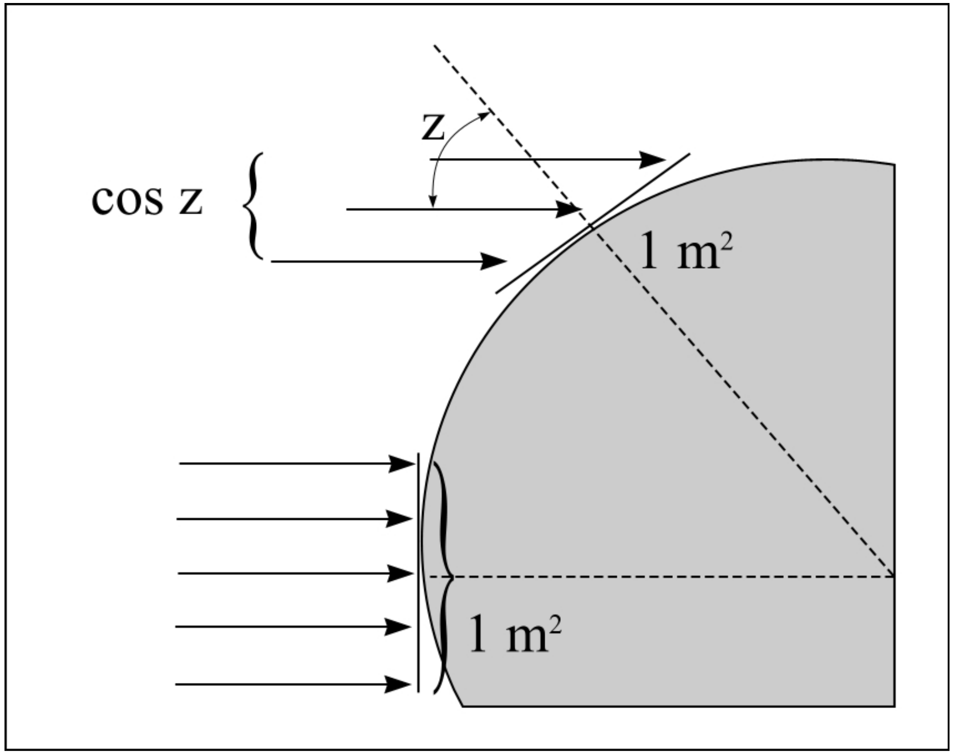
- Weather and climate are such system of conditons characterizing the properties of the atmosphere, which is affected by the external environment and the internal interactions are also important.

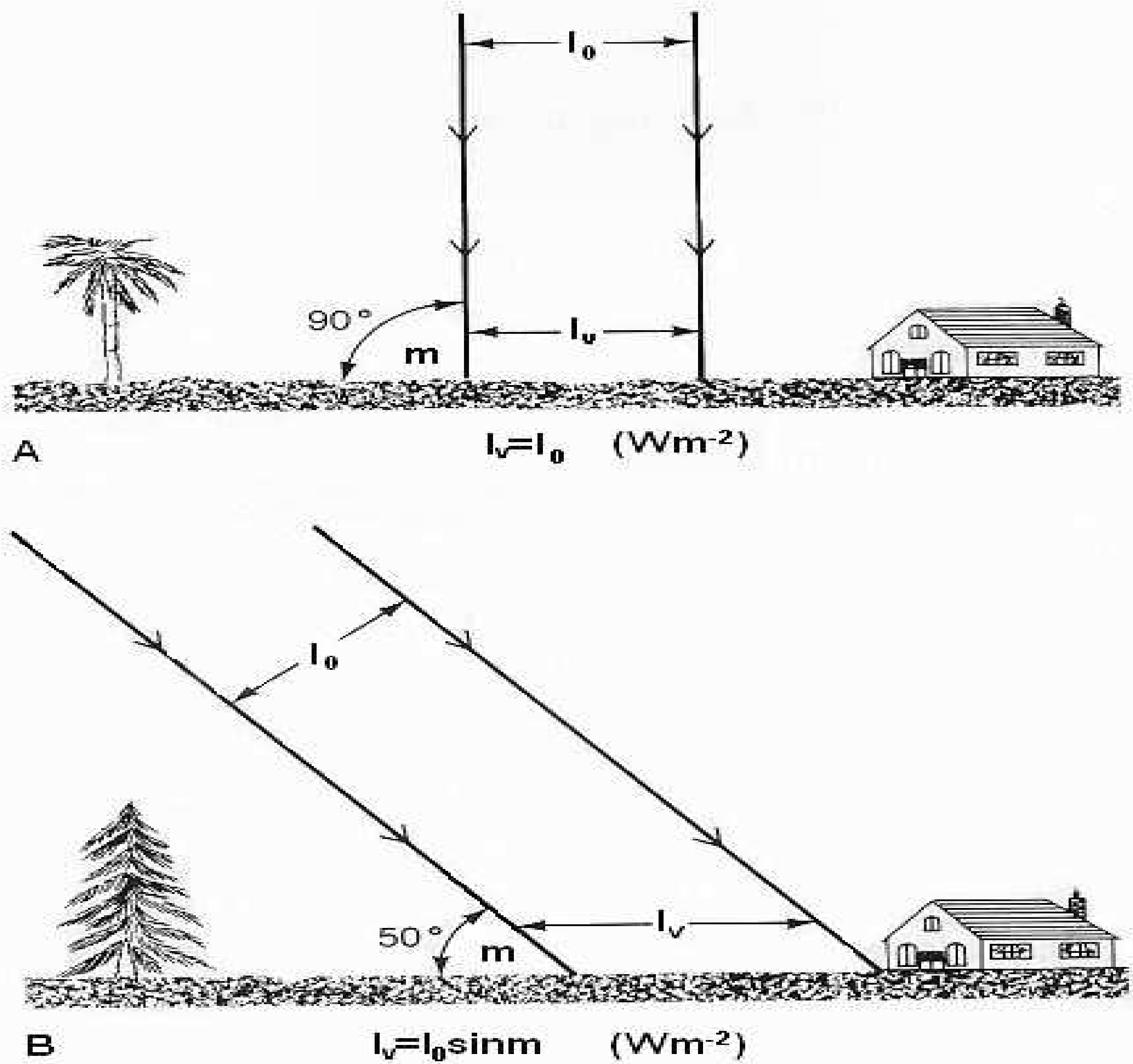
- Cimate-forming factors:
  1. **solar radiation;**
  2. heat supply;
  3. air currents, sea currents;
  4. water supply;
  5. formal and material properties of the surface;

1. Solar radiation

- Solar radiation has the greatest importance, which delivers energy to the atmospheric processes.
- When developing long-term agrometeorological forecasting methods, the relationship between solar radiation and some meteorological phenomena are also taken into account.







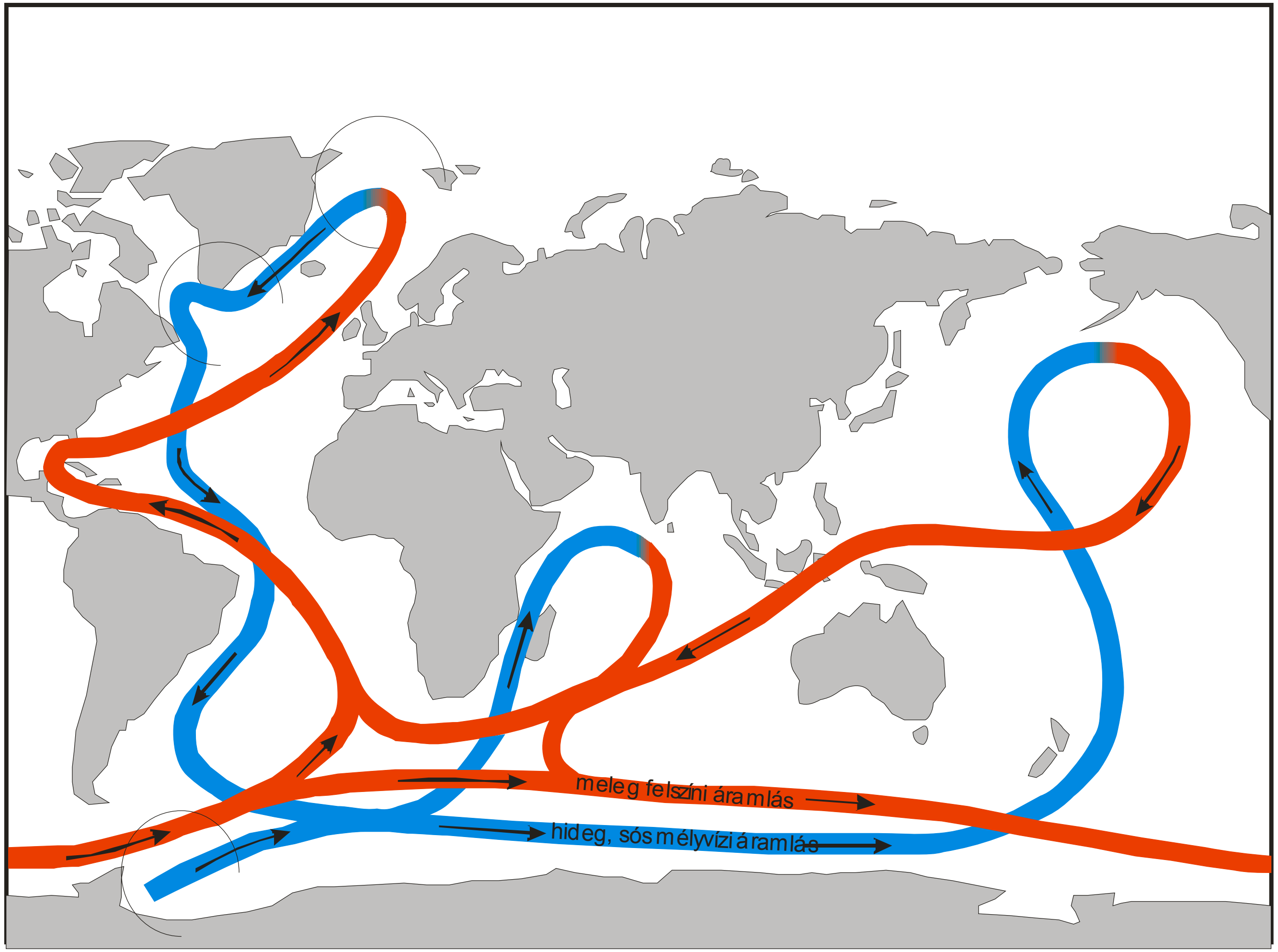
The amount of solar energy as a function of the angle of incidence of the solar radiation
A: in the tropics; B: in the temperate belt;

3. Air currents

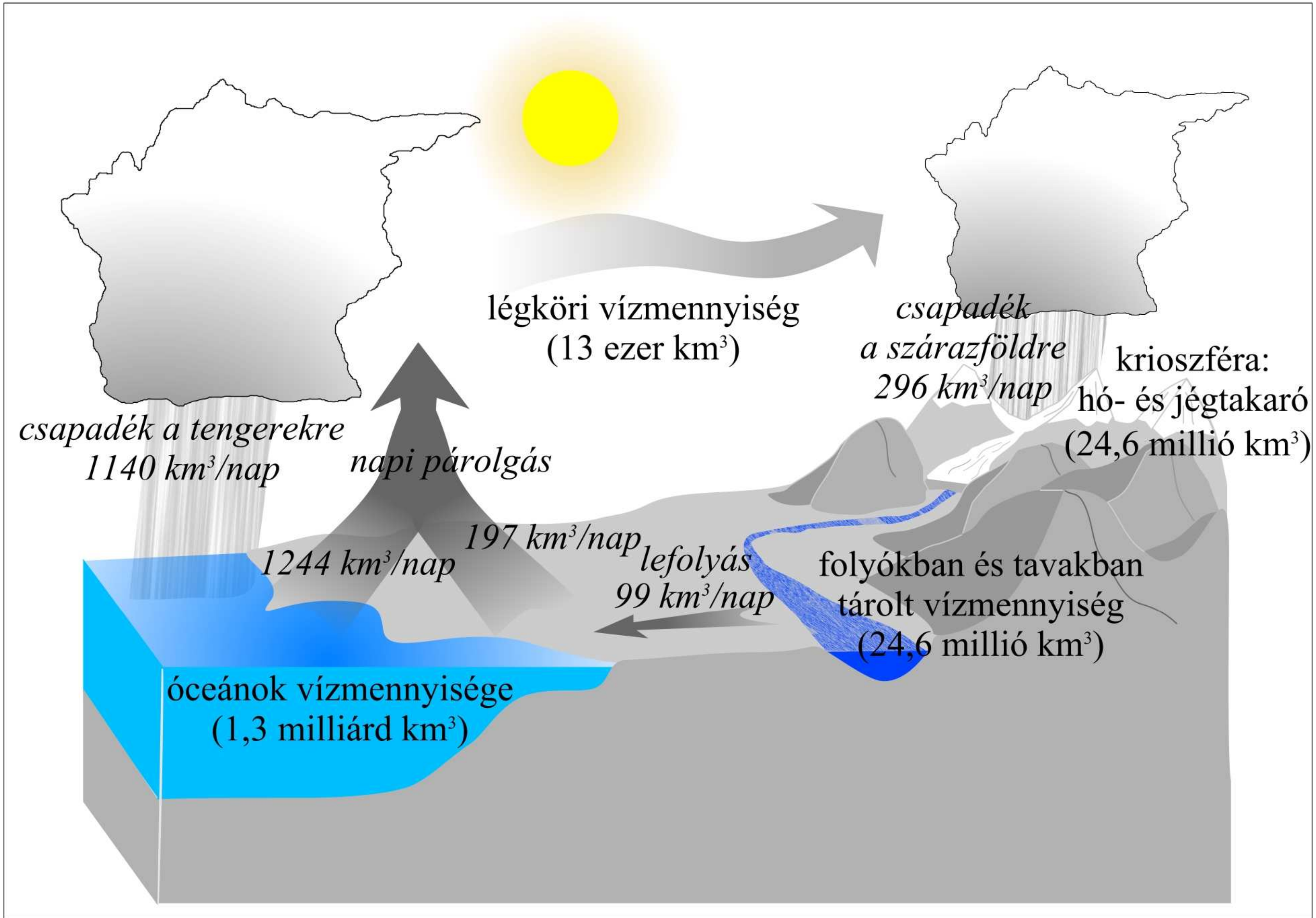
- They develop their effect within the atmosphere;
- consequences:
  - air masses of particular characteristics formed over some active surfaces pass away from their place of origin;
  - over a new location different weather conditios occur;

Other factors affecting climate

Sea currents. Broeker's oceanic conveyor;



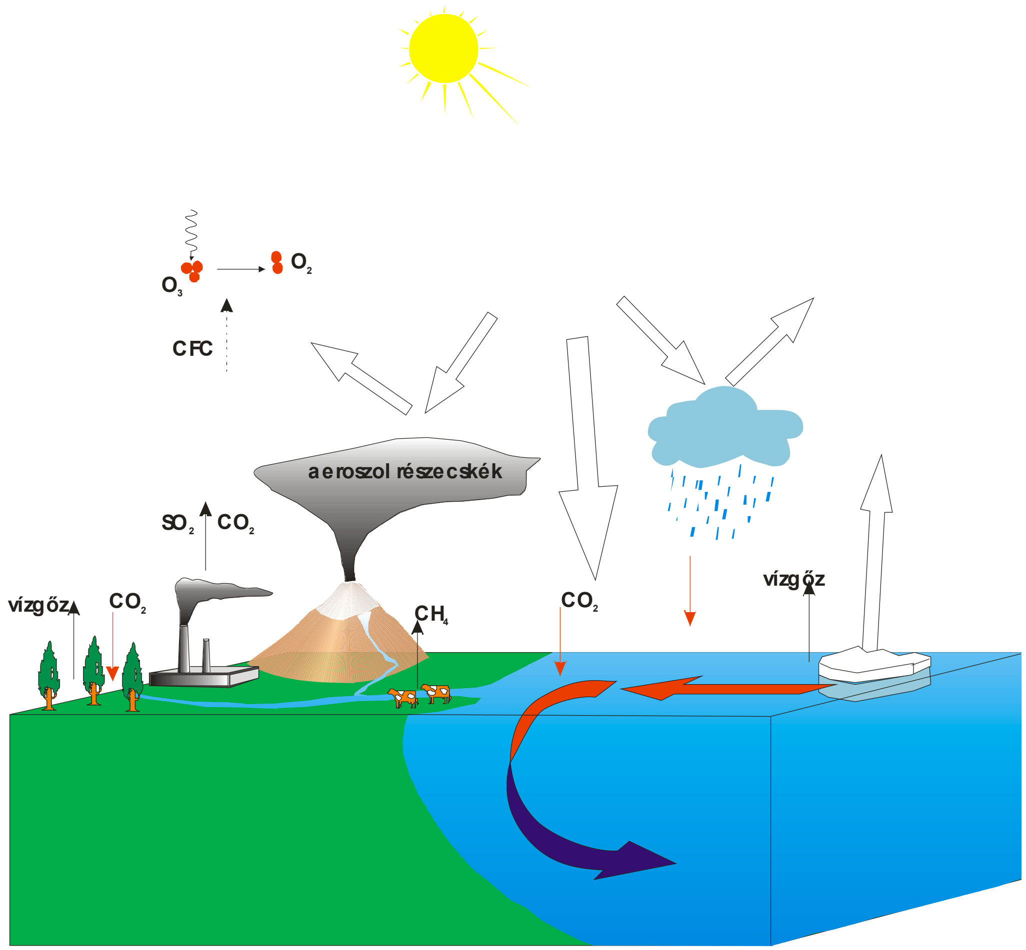
Water supply



2. Active surface

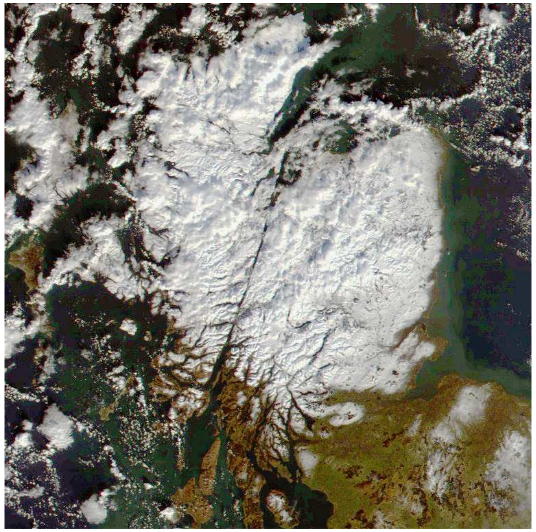
Solar radiation passes through the air, and in the air, or below the air layers, on the surface of a material that is usually much thicker than the air

- a portion is reflected back;
- the other part is absorbed;



Dependence of albedo on material quality

type of surface	albedo
fresh snow	0.81 – 0.85
old snow	0.42 – 0.70
sand	0.10 – 0.25
deciduous forest	0.10 – 0.15
coniferous forest	0.15 – 0.20
water	0.08 – 0.10



Weather and the climate elements

Meterological elements:

physical properties characterizing weather and climate:

e.g. air pressure, air temperature, precipitation, etc.

- they are regularly measured or observed at the individual meteorological stations;
- they can be used for characterizing:
  - weather;
  - climate;

Tasks of agrometeorology

Agrometeorology:

a science dealing with meteorological conditions that affect objects and processes of agricultural production;

Object of agrometeorology:

the relationship between meteorological conditions and agricultural production;

- Meteorological conditions:
  - weather;
  - climate;

- Agricultural production:
  - field and garden crops;
  - forestry;
  - livestock breeding;

Task of agrometeorology:

Detecting the effects of meteorological conditions on

- plants,
- processes of plant production and
- activities associated with plant production;

To this end, research must specify:

- *The thresholds*:
  - between upper and lower values of which the production is possible and economic, or
  - below or upper of them the plants are damaged or completely destroyed;
- *The territorial extremes*:
  - between which life phenomena of the individual plants occur in a particular area;
- *Probability values* of the meteorological conditions in a given production area that characterize
  - economic growing of the individual plants,
  - conditions of the performance of the agricultural work, and
  - favourable conditions of the effective implementation of agricultural procedures;

- probability of occurrence of *adverse or harmful meteorological effects* for plant production;

- *agroclimatological analogies*:
  - i.e. those production areas, where the meteorological conditions of growing the individual economic plants can be expected with the same probability;

- those *prognostic methods*:
  - which allow providing appropriate information for the managers of the agricultural production on the expected mteorological conditions;

Organization of agrometeorology

The three basic components of agrometeorology are as follows:

- data collection;
- reserach;
- information services;

Data collection

- The base of information services:
  - data collection based on the principle of parallel observation (data collection based on the whole of air-soil-plant system);

- Data processing:

  (control, correction, organization);

- After proper processing data can be used for:
  - research;
  - information purposes;

Resarch

- Agrometeorological researches can be classified into three groups:

    1. Agroclimatological researches;

    2. Filed trials;

    3. Methodological researches;

1. Agroclimatological reseraches

Its aim is to collect data for a longer period, and based on them to discover laws of:

- weather-plant relationship and
- the process of weather – agricultural production;

- These analysis can be significant for:
  - agroclimatological evaluation of the growing area;
  - cultivation works;
  - answering questions left open by agroclimatological researches;

2. Field trials

Task:

1. to get more detailed data compared to network monitoring;

2. answering questions left open by agroclimatological researches;

3. Methodological research

Purpose:

- to provide objective methods for agrometeorological routine service;
- and allow response for specific meteorological problems arising from agricultural production;

Verification

Comparison of calculated or predicted data to actual data, in order to:

- confirm the research results;
- check and correct our information service;
- explore the causes of mistakes;

Information service

- The organization of agrometeorology was founded to provide meteorological information for agricultural production.

- It has two main elements:
  1. analysis;
  2. information;

Analysis:

study and evaluation of agrometeorological data using agrometeorological theory and objective methods;

Purpose:

to produce data into the form requested by the farms;

Information:

the process when, as a result of the analysis, meteorological responses to the actual issues of the agricultural production are composed;

These may refer to the following time related meteorological effects:

- past
- ongoing and
- future developments;

Agrometeorological data collection and -processing

Data collection methods

- The method of parallel meteorological and phenological observations;
- The method of simultaneous sowing in different climate regions;
- The method of intermittent drilling;

1. The method of parallel meteorological and phenological observations

- Its essence:

  simultaneous observation of meteorological elements and phenology;

- Principles of agrometeorology;

2. The method of simultaneous sowing in different climate regions

- Its essence:

  the seeds of one and the same plant is sown at the same time in different climate regions;

- A sufficient number of monitoring stations;

3. The method of intermittent drilling

- Its essence:

  at the same place, the seeds of one and the same plant is sown at consecutive dates (e.g. every 7th day);

- during their different phenophases they conduct their life processes under different meterological conditions (1 year);

The agrometeorological observation network

Agrometeorological stations are listed into three gropus by the World Meteorological Organization:

1. Main agrometeorological station
    - they perform detailed and simultaneous meteorological and phenological observations;
    - they conduct agrometeorological researches (observatories);
2. General agrometeorological station
    - they are mostly related to a given synoptic or climate station performing specifically tasks associated also with agricultural production. In Hungary: Keszthely, Debrecen, Martonvásár;
3. Additional agrometeorological station
    - agricultural observations are only intermittently;

Phenological observations

- In Hungary there is an agrometeorology related station type non-classified by WMO: **phenological station**. They are used to tracking life phenomena of the individuals of the natural ecosystem, as well as to record phenological phases of the grown economic plants. It is not associated with observations of a meteorological station.

  - Phenological observations cover the following plant related activities and main works:
    1. agricultural works, e.g. sowing, harvesting;
    2. development phases of crop plants, e.g. emergence, bud burst;
    3. condition of the crops, e.g. weedness, the general condition;
    4. harmful phenomena affecting crop plants, e.g. plant diseases;
    5. the quantiy and quality of crops growing;
    6. other phenomena related to cultivated crops, e.g. hay, mowing;
    7. life phenomena of wild plants, e.g. development phases of trees, shrubs and herbaceous plants;

Forms of the phenological monitoring network

- Central phenological monitoring network
  - operates within the meteorological services of each country;
  - its work is based on centrally issued guidance;
- Rapid phenological network
  - reports are fowarded by telegram or telephone;
- Special phenological monitoring network
  - a system of monitoring stations working with a more detailed programme;

Meteorological observations and measurements

The most important factors concerning crop production:

- solar radiation;
- air temperature;
- soil temperature;
  - in the upper layers of the soil (2, 5, 10, 20 cm), 3 times a day;
  - in depths of 50, 100, 150 és 200 cm, once a day;
- precipitation (once a day, in the morning);

Special-purpose meteorological stations I.

AGR-100 automatic agrometeorological station (with AmarMet/AgroMet programme)

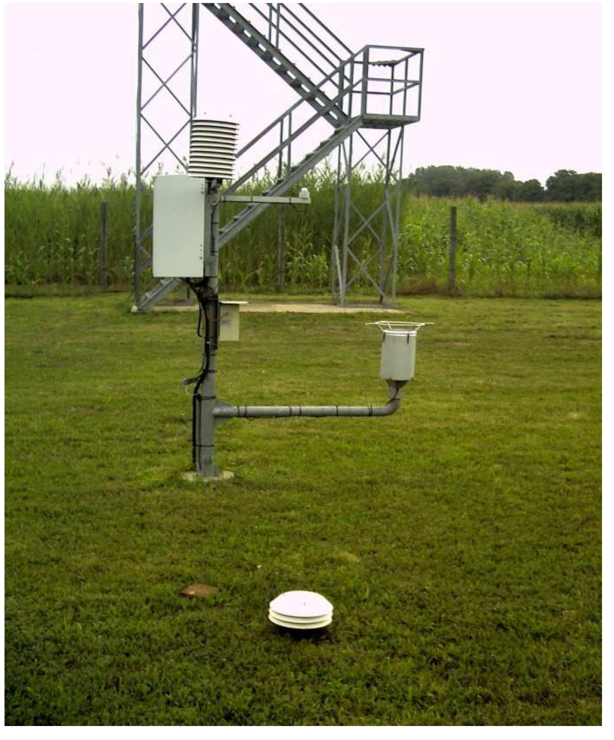
http://www.gammatech.hu/php/showproduct.php?lang=hun&group=Custom&product=agr

Agrometeorological station of the Boreas company

The PicoMet miniature station measures air temperature, air humidity, precipitation, leaf covergae, sunshine duration and photosynthetically active radiation (FAR).

old.agrarunio.hu/index.php?page=news_more&id=390

Agrometeorological Research Station, Keszthely



In the foreground: automatic monitoring station (QLC-50-climate station), in the background: the object of the observations, i.e. vegetnale plots;

Special stations

This is the fourth group according to the WMO standard (next to the synoptic-, climate- and agrometeorological stations). They do not belong to the basic montioring system but they are a member of the so called group of special-purpose stations. Diversity is emphasized here both in space and time!

Aerological (radiosonde) stations (in Budapest and Szeged) they get up to the height of 25-30 km and measure the vertical characteristics of the atmosphere:

- wind measurements (speed and direction);

- measurement of solar radiation;

- measuring precipitation pattrens, radioactivity, etc.

Weather radar stations in Budapest – Liszt Ferenc Airport, Szentgotthárd-Farkasfa, Pécs, Pogányvár and Nyíregyháza (Napkor); geographically they cover the whole country. By following weather processes they perform areal precipitation measurements, as well as thunderstorm detection.

Besides *radar stations*, **sodar** and **windprofiler stations** also occur.

Satellite station (Budapest) – a station for receiving satellite information.

Stations measuring solar radiation – measuring also radioactivity (28 stations in Hungary).

Stations measuring gamma radiation in Hungary

Special-purpose meteorological stations II. Representativity of the measurements. Synoptical principle. Tasks of the observer

Background pollution measuring station: its profile may comprise measurement of atmospheric carbon dioxide content, the composition or rainwater, and deposited dust and PM_{10}.

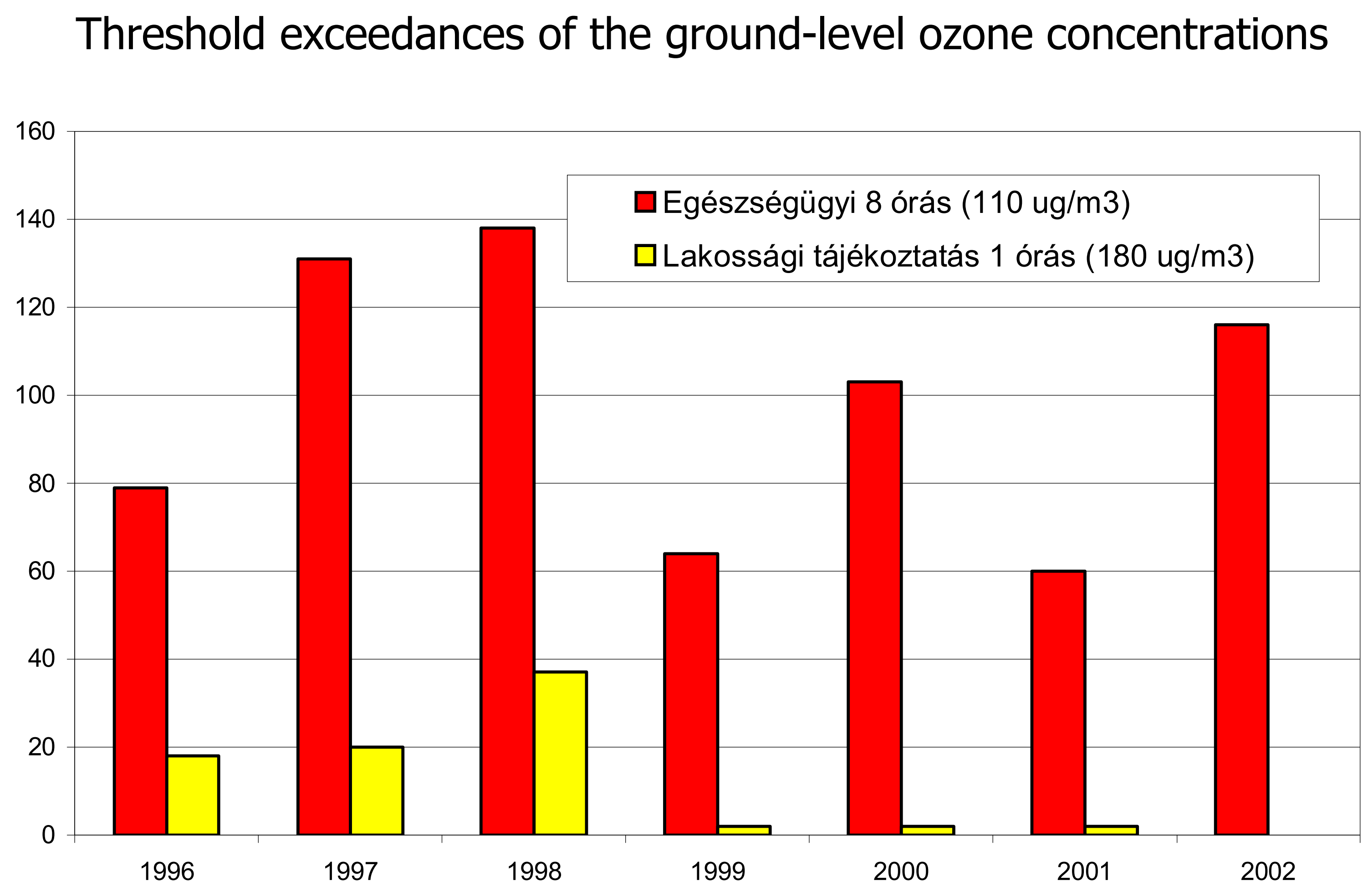
- tropospheric ozone concentration is measured in Hungary by 6 background and 15 urban stations.

Conclusions based on the measurements of the 2002-2003 year:

1. The level of ozone concentration is higher on average at the background stations compared to urban stations; however, extremely high values are characteristic at local stations.
2. Ozone concentrations measured at background stations more frequently exceed the health threshold as the measured ozone concentrations in urban centres.
3. The highest ozone concentrations are measured at local stations.

During the two years alarm threshold was measured at local stations: altogether at 3 stations.

Number of days exceeding the threshold value (ground-level ozone)



- Data of background pollution monitoring are particularly suitable for detecting large-scale processes. These stations are set up in remote areas of human activity, in order to filter out the effect of nearby anthropogenic air pollution. They have a great role in the detection of global and regional processes.
- Currently **4 background pollution monitoring stations are operating in Hungary:**

  - K-Puszta (near Kecskemét);
  - Kunmadaras;
  - Nyírjes;
  - Szentgotthárd-Farkasfa;

An information table indicating air pollution

http://www.gammatech.hu/php/showproduct.php?lang=hun&group=Custom&product=hw6

Representativity of the measurements – scaling of atmospheric processes

- Microscale measurements: < 100 m agrometeorological observations (evapotranspiration);
- Lovcal measurements : 100 m - 3 km: air pollution processes;
- Mezo-scale: 3 km - 100 km: large-scale thunderstorms;
- Macro-scale: 100 km - 3000 km: weather fronts, cyclones;
- Planetary scale: < 3000 km: waves of the upper troposphere, jet stream;

Time of the observations

- According to the principe of synoptics, simultaneity for meteorological observations is of particular importance, for which matching of times is essential.
- **Time concepts:**

❑ **Standard Time (Greenwich Mean Time; GMT):** median time of the zero-degree meridian;

❑ **Local Time:** median time of the meridian of the given geographival area (Local Mean Time; LMT);

❑ **Zonal Time:** median time of the meridians located in 15° intervals from the center meridian. Central European Zonal Time is one hour less than GMT.

Observations occur in main and additional time.

Main terms:

00,00; 06,00; 12,00; and 18,00 GMT

Additional terms:

03,00; 09,00; 15,00; and 21,00 GMT.

In Hungary, these terms in local time are as follows:

06,45; 12,45; 18,45 and 00,45.

Night values – after midnight – are mostly provided from station records.

The measurement of precipitation occurs daily, at 6,45, and relates to the previous day.

Tasks of the observer

- ✓ Workers of the meteorological stations are called observer.
- ✓ For peforming the work technician certification is necessary. The training is coordinated by the meteorological service, providing curriculum and opportunities for consultation.
- ✓ Those who work not at main stations, are expected to make their own tasks professionally.

The tasks for observers working at meteorological stations:

- They collect information on the weather in predefined terms.
- They fix extraordinary events between two terms.
- They make measurements and observations according to the regulations.
- They should be familiar with the station facilities. They shuld be able to pass easier errors.
- The data should be transmitted to the centre in complience with the deadline.
- They should insure an assistant who, in exceptional cases, is able to subscribe to the new job instead.

A part of the quality assurance is the regular control of the observers by the centre.

Why agrometeorology?

- Climate is a natural condition;

  - scope and time of plants that can be grown;

- System of factors affecting agricultural production;

  - water, CO_2, solar radiation…

  are the reasons of annual crop fluctuations;

- Risk factors;

  weather risk factors = yield risk factors;

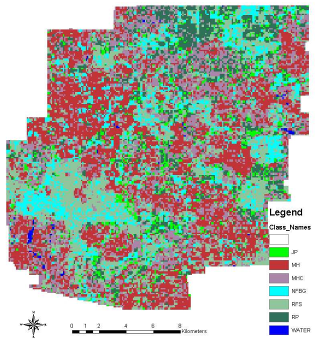
Classification of agrometeorology

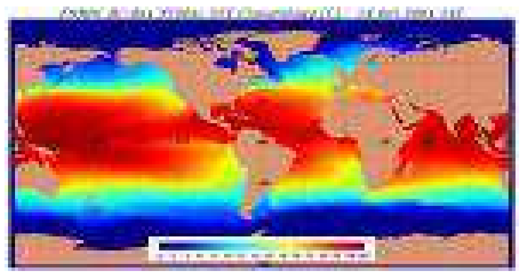
- Agricultural micrometeorology
  (or micrometeorology)

- Mezoclimatology:

www.images.google.com

- Macroclimatology: valid for several
  hundreds of km^2;





Prediction – forecast and the preparing process

- **Preparatory phase**
- Designation of the object;
- Selection of the methodology: time is determinant;
- Design of the database;
- Process management (data flow, operations, …verification);
- Toolkit;

▪ Operative phase

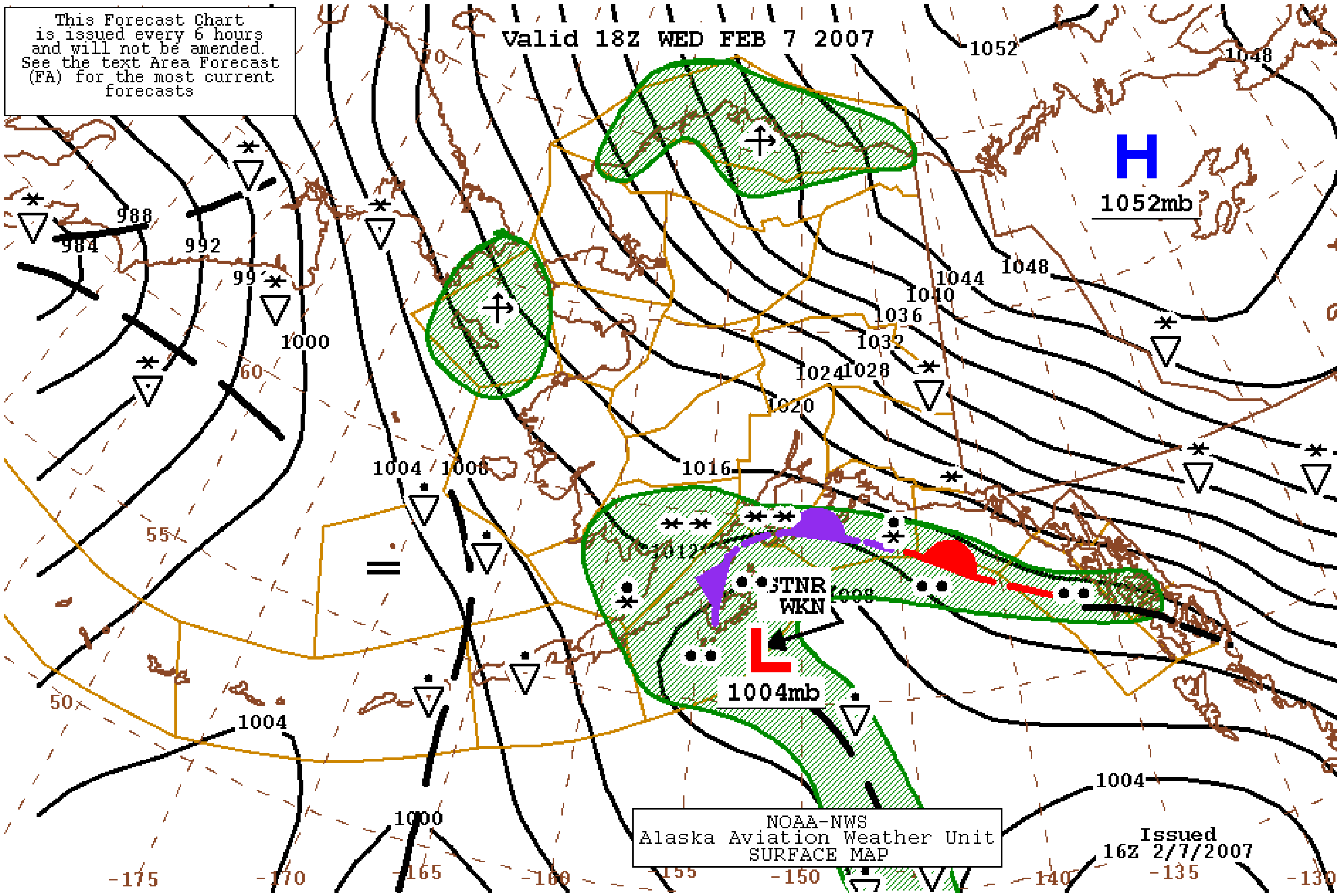
- Data management, coding, verification, data restoration;

Creating maps

- Analysis – contours, fronts;

Principle of ANALOGY!!!

- Interpretation – weather content, explanatory text;



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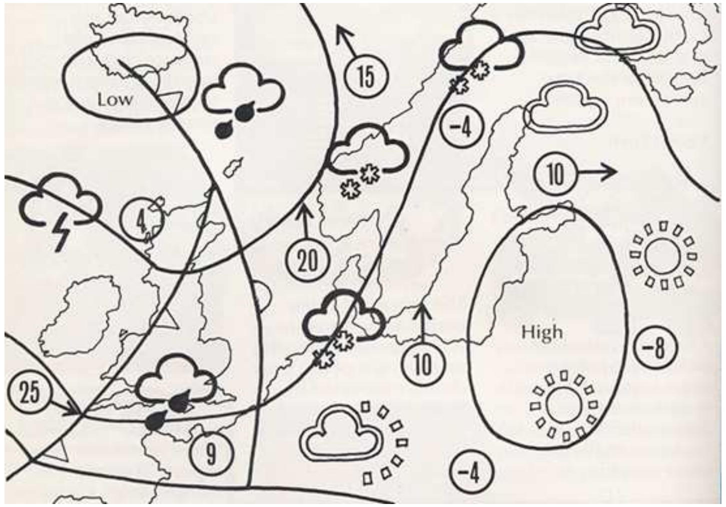
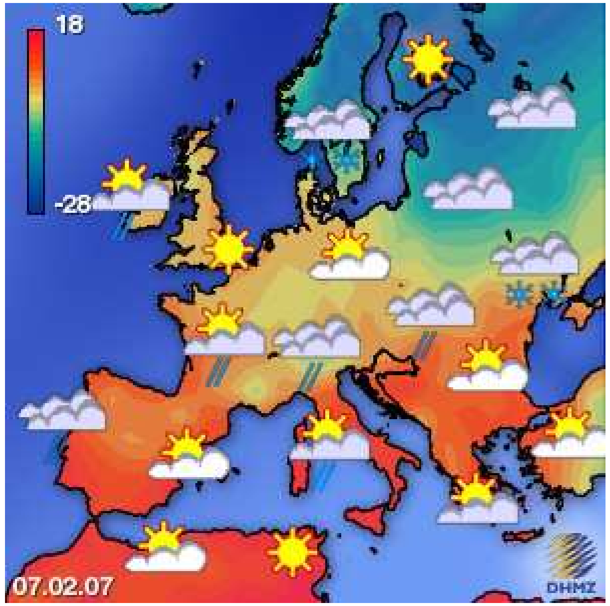
- **Service text + pictogram**





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- **Verification, %, – control phase**

made subsequently;

Types of predictions

1. Ultra short term: ‹12-hour;
2. Short-term: 24-48-hour;
3. Medium-term: 5-10-day;
4. Long-term: 10-30-day;
5. Climate: >30-day;
6. Speciific predictions – diversity;

Rescues, agriculture, water management, etc.

Special test methods

- Parallel observations;
- Field observations;
- Phytotron;

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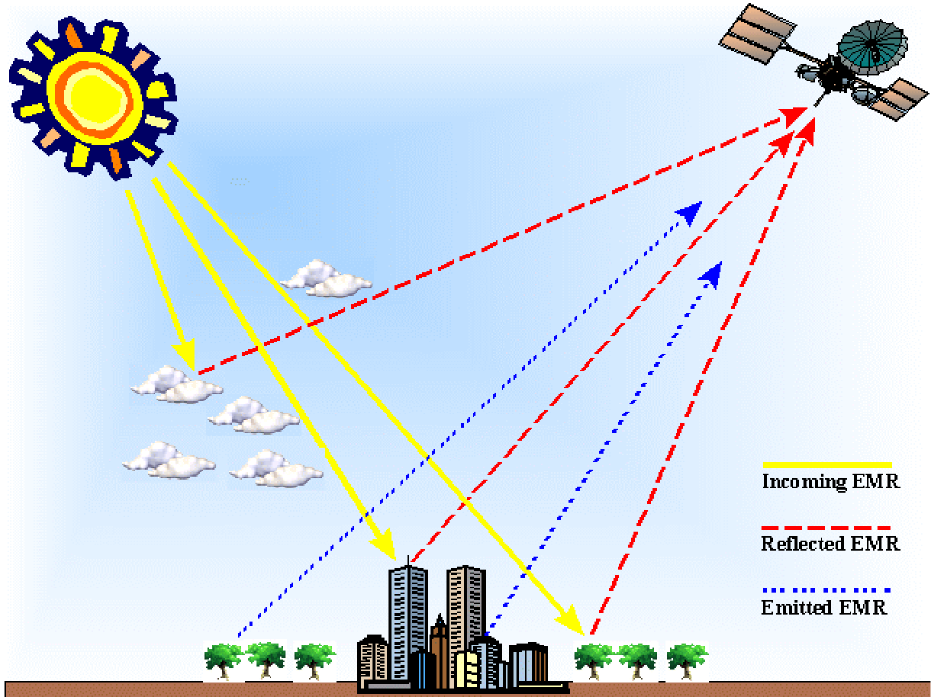
Remote sensing



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Getting information;

- any distance;
- without touching;

Fields of application:

- Crop estimation (NDVI), crop characteristics;
- Soil condition estimate;
- Conventional meteorological estimation, etc. (confounding factors);

NDVI – Normalised Vegetation Index

✓ Based on the measurements of reflected solar radiation

NDVI = (NIR — VIS)/(NIR + VIS)

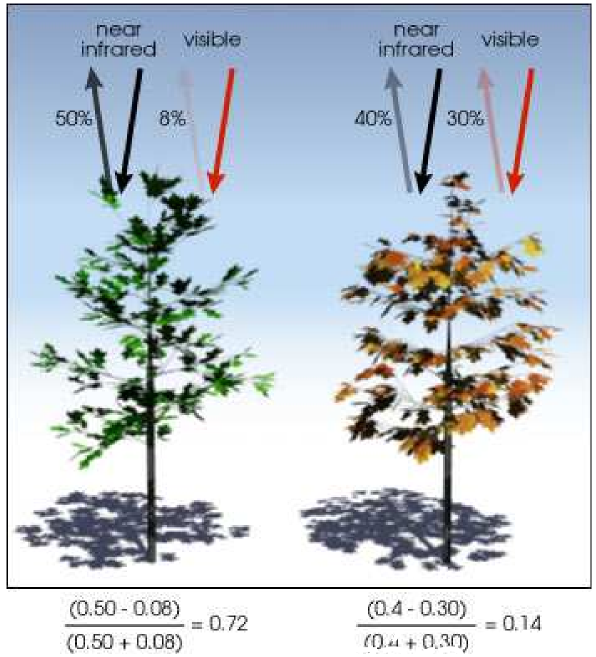
Wherein the visible light: VIS

Infrared range: IR

Value: [-1; 1]

O: no plant

1: thick, green vegetation (normal, healthy);



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Always look on the bright side of things!

We finished for today, goodbye!

ямарваа нэг зүйлийн гэгээлэг талыг нь үргэлж олж харцгаая

өнөөдөртөө ингээд дуусгацгаая, баяртай

让我们总是从光明的一面来看待事物吧！

今天的课程到此结束，谢谢！

دعونا ننظر دائما إلى الجانب المشرق من الأشياء!

انتهينا لهذا اليوم، وداعا!