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DUST-1.5: General aspects

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The Earth's atmosphere

The term atmosphere has in English as well as in German two meanings: Physically it is the gaseous envelope of a star (planet) - in our case the Earth - in a figurative sense the social conditions of the environment of man. In both cases it is an existential object, since no life is possible without it. Here only the physical meaning has been applied. The Earth's atmosphere is an open system far from equilibrium. It is irradiated by the sun, emits radiation in the infrared and continuously exchanges matter, energy and momentum with the cryosphere, the hydrosphere, the biosphere and the lithosphere. Systems far from equilibrium can spontaneously form spatio - temporal patterns in contrast to closed systems in thermal equilibrium whose macroscopic states are spatially homogeneous and time-independent. By changing external conditions, complex systems may be caused to undergo a whole hierarchy of instabilities. The transitions can change the spatial patterns as well as the temporal behaviour of a system. Chaotic temporal behaviour can already arise by the interaction of few degrees of freedom. By driving a system away from equilibrium usually more and more degrees of freedom are excited, increasing its temporal as well as its spatial irregularity and leading to a turbulent state. We have to distinguish the microscopic, mesoscopic and macroscopic level of description. If we intend to monitor and predict the behaviour of our atmosphere – as far as this is theoretical, technical, and financially possible -, the more and better we need to measure it, using all available useful equipments and technologies. In the last three decades – especially because of the fast progress in microelectronics and in computer engineering - this led not only to tremendous growth rates of the time series data from the Earth's atmosphere, but also to new problems, e.g. in context of their (final) processing and (required fast) interpretation, furthermore to a nearly concealed fact, namely, that it now gets increasingly complicated and expensive to process older data. In many cases it is already impossible. Then we use the term *„technical forgetting"*.

Similar problems can now be observed in many other non geophysical domains. Therefore it seems important to demonstrate the DUST-2 results, especially the new attempts to mitigate the problems. The realization of the DUST-2 is the second, still fairly incomplete, practical step in this direction. It starts from the bottom to the top, i.e. from the problems and needs of the final users. Rather then trying to guide them directly to the sometimes ineffective, uneconomic bureaucratic information systems, (e.g. user-unfriendly and insufficient maintained) mostly designed from the top to the bottom, DUST-2 can serve as a user-friendly interface and begins to reconcile the two different, complementary "documentation" activities. It is envisaged that the future work of the DUST-2 team will substantially enhance this. Because of the special nature of the MPAE research project only atmospheric information was considered here. It became clear that the DUST-2 tools should and can be further developed, adapted, and combined (integrated), according to the special tasks under consideration – especially for other application areas. *The DUST-2 team is ready to support such complex activities.*

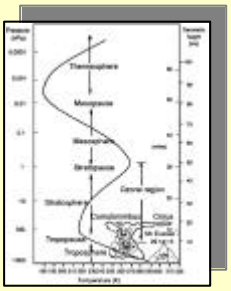
Information growth rate problems

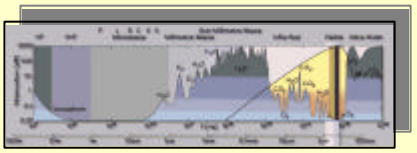
Using **atmospheric research** as an example one can demonstrate the large information growth rates of the last decades, especially the increasing surplus of **primary information** ("raw data") and the increasing lack of direct, fast useable **secondary information** (qualified filtered "raw data"). At the beginning of the decade 1990 there were more than 2,5 x 10^{14} bit of (atmospheric) information available with an annual growth rate of about 10 %. If these 2,5 x 10^{14} bit would have been put - in normal print - on DIN A4 pages, each 1mm thick, the generated (virtual) row of books would have a length of **362 km.** The new generation of "atmospheric satellites" like ENVISAT etc. are not only capable to produce data flows that are more than a magnitude larger than those at the end of the 1980s, but they have been designed to do so. This implies that the mentioned growth rate of 10% per year will be strongly exceeded. It is estimated that per annum about the same amount of data can and/or will be produced that have been stored until now, i.e. at the end of the **year 2001** the row of books has reached at least a length of **nearly 800 km**, i.e. about the distance between Hamburg and Munich.

Another example of an INTERNET information search with conventional search machines (Lycos, search October 1999) is shown in the following table:

Search formulation	Hits
Water	1858896
Water vapour	4707
Water vapor	35206
H_2O	23301
Atmosphere	290324
Water and Troposphere	1695
Stratosphere and water	2652
Water and Atmosphere	65189

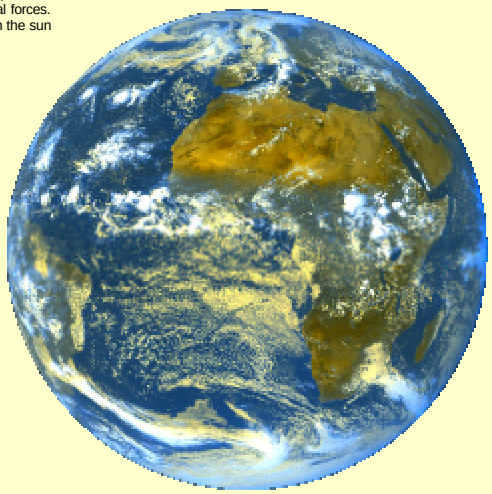
It became clear that not only in the very general INTERNET information system there is insufficient (qualifying) selectivity but also, however to a much smaller degree, in today's special scientific-technical information systems. This is displayed in the poster dealing with O_3 and H_2O retrievals.





Atmospheric transmittance and absorption bands of atmospheric constituents (Courtesy: CNES 1997)

The Earth's atmosphere is subdivided into different regions. The nomenclature of the subdivision is not unique. It differs according to the parameters under consideration. The different regions are called "spheres", the boundaries between them "pauses", the maxima "peaks".The system which is most frequently used is that according to temperature. At lower heights the movement of molecules is controlled by gravitation, thermal movement and collision between the molecules. At greater heights where the mean free path is large, the movements are controlled mainly by the geomagnetic field. This region is called the magnetosphere. The upper boundary of the magnetosphere, and hence of the terrestrial atmosphere, is called magnetopause. Below, the behavior is controlled by terrestrial forces. Outside the magnetopause is the domain of solar wind streaming from the sun through interplanetary space past the Earth.



Images: Courtesy of ESA, CNES, METOSAT, NASA

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