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Innovation

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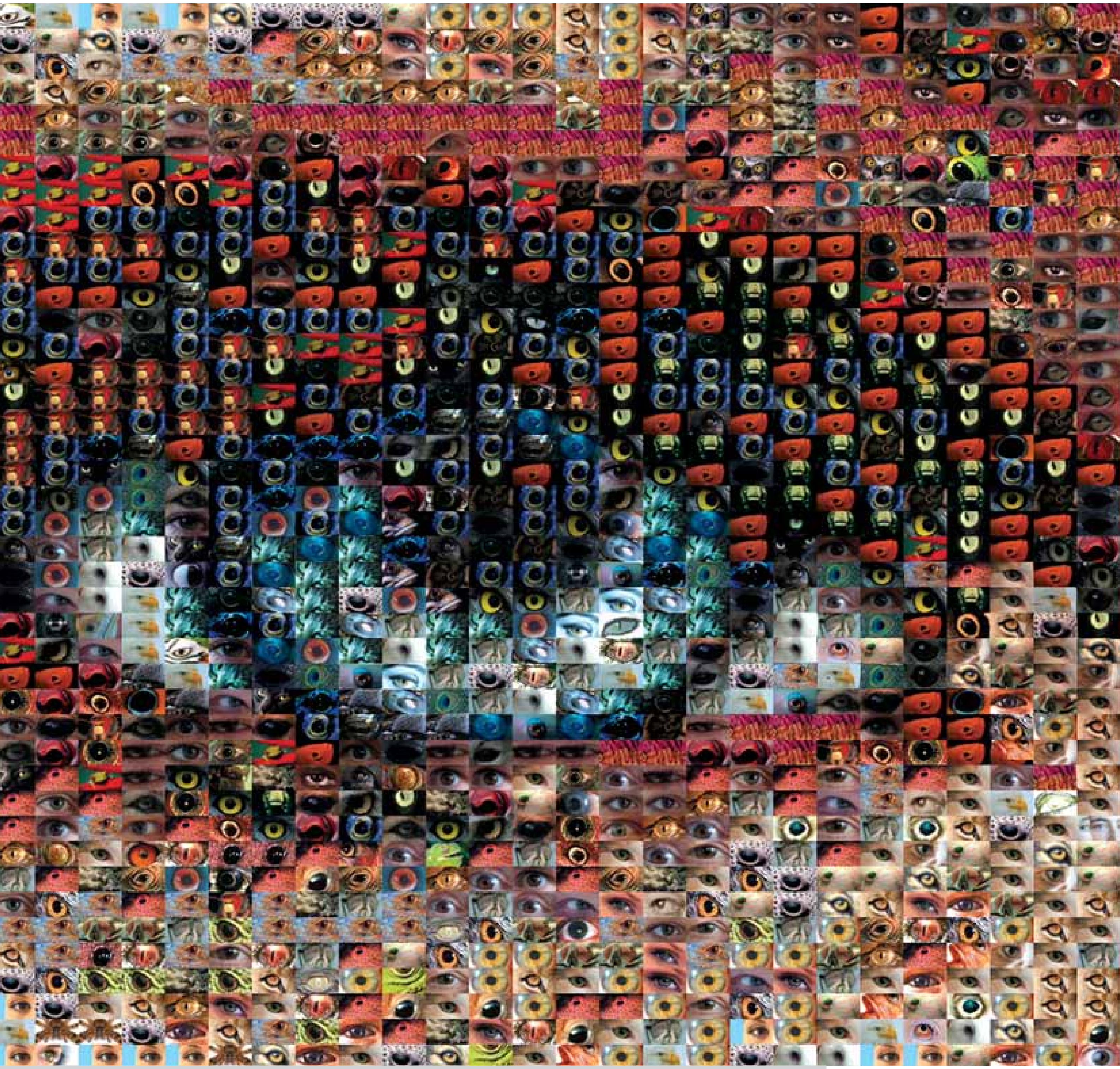
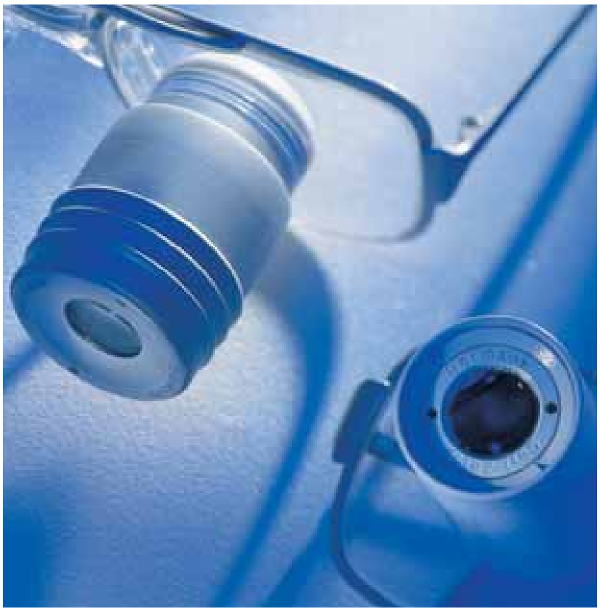


- Visual Perception
- The Fascination of the Eye
- Diagnosis – Therapy – Follow-up Care

Telescopic Eyeglasses and Model Airplanes

One of the focal points of research at the Meteorological Institute of the University of Munich in Germany is unusual wind systems. In recent years *Joseph Egger*, Head of the Theoretical Meteorology workgroup, has been investigating valley and plateau winds. To achieve this goal, pressure, temperature and humidity have to be measured at altitudes of approximately 1500 m above the ground.

An electrically driven model plane is the ideal measuring platform for this purpose because it can be used flexibly and repeatedly in terrain that is otherwise difficult to access. The flying measuring platform was used in 2001 during the Lhormar II expedition in order to examine the valley wind in the Nepalese Kali Gandaki valley and in 2003 to conduct research into the plateau wind on the Bolivian Altiplano.



The Kali 1 flying measuring platform

The "Kali 1" model was designed by the model plane pilot *Wolfgang Schäper* in 2001 for the Lhomar II expedition and built by the firm Modelbau Müller in a total of ten models. *Stephan Lämmlein* and *Philip Kolb* from the German Aero Club were also available as pilots. During the entire measuring campaign, ten of these models, equipped with miniature systems, were used. The model airplane with a wingspan of 2.1 meters and a battery-driven electro-drive, weighed 3.1 kilos and reached a height of 2200 meters above ground. During the flight time of approximately 25 minutes, the temperature and humidity profiles were measured at a high measuring rate. Stationary, ground-based measuring stations and pilot balloon ascents supplemented the spectrum of measuring methods used.

After the start, the pilot takes control of the plane with a range-optimized remote control device. He is supported by a colleague who constantly observes the plane with a pair of binoculars. The pilot himself is equipped with a special visual device, a pair of telescopic eyeglasses from Carl Zeiss to enable him to also control the plane safely and precisely at high altitudes.

The telescopic eyeglasses were specially produced for the pilots. They consist of a system with a Kepler design and feature 3x magnification. The telescope was integrated into a pair of glasses to ensure that the pilots' hands were free to control the model plane and observe at the same time. For the pilots, handling the telescopic glasses was a major challenge, as the magnification used clearly changes the visual impressions conveyed. The model planes observed are imaged with a greater size on the retina and the visual system therefore perceives them as being closer. Movements inside the field of view are also greater due to the magnification factor. This is why microsurgeons, for example, cannot operate with magnifying visual devices until after a considerable training period.

Left: Helping the Kali 1 measuring platform get off the ground.

Center: Kepler-type telescopic eyeglasses.

Right: The entire team of the Kali Gandaki expedition: scientists, pilots, bearers and kitchen staff in the border area between Nepal and Tibet.

details

Valley of the Kali Gandaki

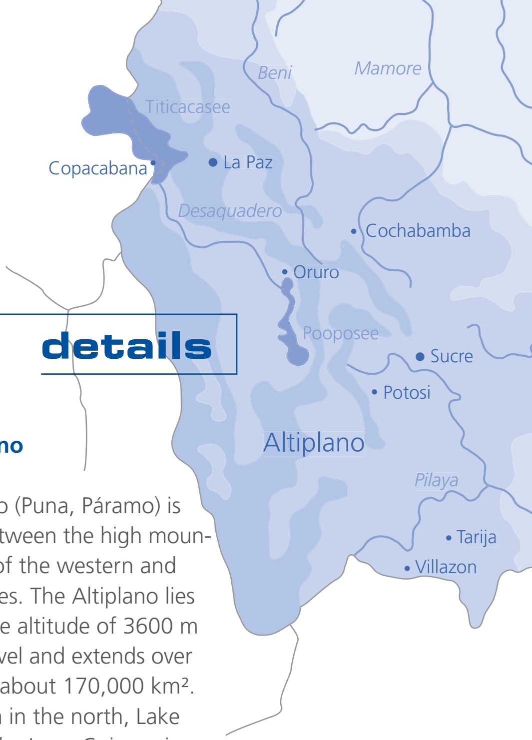
The valley of the Kali Gandaki features two superlatives: between Kalopani and Larjung one finds oneself standing at the bottom (approx. 2540 meters) of the world's deepest valley. Its winds display the most extreme diurnal cycle known to scientists. The 8167-meter Dhaulagiri in the west and the 8091-meter Annapurna in the east are only about 35 kilometers apart at this point. This means one is around 5500 meters under the mountain peaks.
At the breakthrough, the distance between the river bed and the peaks is more than 5000 meters. The Kali Gandaki is one of the four large rivers in Nepal. It rises in Mustang on the border with Tibet and flows into the Ganges.
At Ghasa, the river rushes downward by a thousand meters in a steep canyon and finally approaches Nepal's lowlands.

The Kali Gandaki wind system

Joseph Egger and his team had set themselves the goal of investigating the unusual wind system in the world's deepest valley together with the model plane pilots *Wolfgang Schäper, Stephan Lämmlein* and *Philip Kolbe*. While a wind with storm force blows into the valley during the day, the wind leaving the valley at night is weak.

Therefore, this wind system is totally different from the wind systems observed in large Alpine valleys. The question to be asked was how this unusual wind system can develop in the first place.

By means of very successful measurements and computer simulations, a conclusive explanation was finally found for the development mechanism of the Kali Gandaki winds. A wall separates the Mustang basin from the world in the south. A narrow passage through the wall represents the valley section from Ghasa to Marpha. If the sun shines from above, the air in the basin heats up strongly, and that in the foreland to a lesser degree as there is much greater mass to be heated there. In the gateway, a valley wind then emerges, the speed of which then increases. This wind extends into the posterior part of the basin. In the narrow connecting area, the winds accelerate and reach the basin in the form of strong gusts.



The Altiplano wind system

The Altiplano in the Andes is the largest high plateau in the southern hemisphere. Extensive tablelands in the tropics and subtropics display an independent diurnal air circulation. Due to the strong solar irradiation, the earth's surface is strongly heated during the daytime. The hot ground acts like a hot plate under the atmosphere above it. The air above the Altiplano is heated to a considerably greater extent than the surrounding air at the same level above the lowland. This results in pressure gradients with an area of low pressure above the plateau and an area of high pressure above the lowland. From these gradients of temperature and pressure, an extreme wind is produced from the lowland to the Altiplano.

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The Altiplano

The Altiplano (Puna, Páramo) is a plateau between the high mountain ranges of the western and eastern Andes. The Altiplano lies at an average altitude of 3600 m above sea level and extends over a surface of about 170,000 km². Lake Titicaca in the north, Lake Poopó and the Lago Coipasa in the middle as well as the Salar de Uyuni salt lake in the south are the most important stretches of water on the Altiplano. The climate of the Altiplano is cold and semi-arid to arid, and the average annual temperatures fluctuate between 3 degrees in the western region and 12 degrees at Lake Titicaca.

Top: The deep Kali Gandaki valley channels the winds from Nepal toward the Tibetan plateau.

Center: Philip Kolb navigates with the Zeiss telescopic eyeglasses while Wolfgang Schäper follows the model with a pair of binoculars for added safety.

Right: Initial preparations against the backdrop of the 5916 m-high Licancaburs on the Altiplano.

Other research projects

There were also assignments for the "Kali" and its team in Germany. In August 2005 the Munich meteorologists moved close to Neuschwanstein Castle to investigate a wind phenomenon never experienced before. Flights were also undertaken on the Zugspitze mountain in order to study the emergence and dynamics of banner clouds.

Andreas Bürkert from the University of Kassel approached *Wolfgang Schäper* with a totally different task: in Oman's Hajar mountains, aerial photos were to be taken of remote mountain oases. The subject of scientific interest here was the mapping of field cultures that were thousands of years old and were primarily created in the form of terraces. From the meteo-plane „Kali", *Schäper* developed the photo-plane "Horus" for the installation of a high resolution digital camera. About 20 flights were conducted during two expeditions in the spring and fall of 2005.

"Horus" the photo-plane

The analysis of changes in the conditions and processes of agricultural production in Oman's oasis settlements is part of an interdisciplinary, humanistic and scientific project of the workgroup "Ecological Crop Farming and Research into Agricultural Ecosystems in the Tropics and Subtropics" of University of Kasel in Germany. In 2005 a specially equipped model plane was used during two Oman expeditions. *Schäper's* task was to use the "Horus" photo-plane to map the ecosystems using high resolution aerial photos: for the scientific analysis of the systems on the one hand and to record the status quo on the other. The flights, most lasting a half an hour, took place between 1000 and 1400 meters above the ground. With about four flights a day, several thousand pictures were obtained in all. Schäper used the special telescopic eyeglasses from Carl Zeiss to control the plane safely and precisely at the high altitudes.

Wolfgang Schäper, ModellFlugGruppe Markdorf
www. mfg-markdorf.de
www.wiz.uni-kassel.de/ink/
www.meteo.physik.uni-muenchen.de
www.zeiss.de

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Oasis settlements in Oman

The Sultanate of Oman lies on the southern coast of the Arabian peninsula. For centuries, highly advanced agriculture and coastal fishing were the livelihood of the population of Oman. The country's agricultural structure started to change with the beginning of commercial oil production and the political opening in the early 1970s.

Top: Aerial photo of the Massirat mountain oasis in Oman.

Center: Wolfgang Schäper with the "Horus" photoplane in Oman's Hajar mountains.

Right: On the dune of Al Hawiyah.

The Perfect Lens Material

In June 2006, the physicists Prof. Dr. *Martin Wegener* and Prof. Dr. *Kurt Busch* were honored with the Carl Zeiss Research Award, worth EUR 25,000. At the award ceremony, Dr. *Michael Kaschke*, the Member of the Carl Zeiss AG Executive Board responsible for research, emphasized the importance of basic research in the field of optics: "Optical technologies are now an integral part of our everyday lives and they lay the foundation for future technologies. They also make a considerable contribution to innovations in medical technology and the life sciences."

Refraction in normal water

Refraction in "metamaterial water"

www.zeiss.de
www.aph.uni-karlsruhe.de/ag/wegener/index.de.html
http://photonics.tfp.uni-karlsruhe.de/

Both scientists work at the University of Karlsruhe, and with their work they have added decisive momentum to the fields of three-dimensional photonic crystals and optical metamaterials. Unlike common optical materials or "normal" crystals, optical metamaterials display exceptional properties, such as a negative refractive index. This has far-reaching consequences for the use of these materials: "perfect" lenses can be produced in which diffraction does not limit resolution. This can lead to new lithography techniques for the fabrication of computer chips. Artificial materials functioning on the basis of light and produced with the aid of nanotechnology play a key role in information technology: their discovery often leads to huge advances in technology within a short time.

The contributions made to the theory of light propagation in structured materials by *Kurt Busch's* research team and the experimental approaches adopted by Prof. Dr. *Martin Wegener's* research group have considerably enhanced the possibilities for the production of three-dimensional photonic crystals. The physical properties of these artificially produced materials are unique: the intention is that one day they will enable researchers to build compact chips that function on the basis of light and can be used on the Internet, for example. "Light as an information carrier has two attractive properties: first, photons are almost always much faster than electrons, and second, two light beams can penetrate each other without mutual disruption", explained Prof. Dr. *Martin Wegener*. "This is not possible with an electrical current, since the charge carriers influence each other and produce short circuits."

Kurt Busch

Martin Wegener

Masthead

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