RAPPORT D'ACTIVITE
DU COMITE NATIONAL BELGE DE GEODESIE ET DE GEOPHYSIQUE
EN 2007

Au cours de l'année 2007 le Comité National de Géodésie et de Géophysique (CNBGG) a tenu une assemblée générale (25.01.2007) et quatre séances ordinaires (22.03.07, 24.04.07, 10.05.07 et 13.12.07).
Sa présidente, Mme. Véronique Dehant a assumé la charge de déléguée nationale à la XXIV^{ème} Assemblée Générale de l'UGGI à Perugia (I). Le Comité a délégué un représentant national auprès de la plupart des Associations.
Les conférences suivantes ont été données à la tribune du Comité:

25.01 Mr. Laurent White, du "Centre for Systems Engineering and Applied Mechanics" (CESAME) et du "G. Lemaître Institute of Astronomy and Geophysics" (ASTR) de l'UCL, qui présente en anglais un exposé intitulé :

"A revolution in numerical model design: towards the second generation of geophysical fluid flow models"

Un bref résumé est donné ci dessous :
The last decade has been witnessing an increased interest into the development of ocean models using unstructured meshes. The latter offer many attractive features such as the ability to conform to complex coastlines and bathymetry but they also allow for the mesh resolution to vary in space and time. Numerical ocean models based on these techniques have the potential to simultaneously resolve both small and large scale processes. While much effort has been devoted towards ocean modeling, numerical methods based on such unstructured meshes are believed to be very promising for all kinds of geophysical and environmental fluid flows. Hence, the range of capabilities of such models is admittedly huge. Unfortunately, a step-by-step conversion from existing structured-mesh models to unstructured-mesh models is extremely unlikely to occur due to intrinsic algorithmic differences. Therefore, the second-generation models must be built starting from zero. In spite of this original approach in the field of geophysical fluid dynamics, the point of no return has probably been reached in terms of models development. Yet, many challenges still lie ahead and should be addressed within the next decade. A few examples of these concepts have been shown and include the propagation of slow Rossby waves in the Gulf of Mexico, barotropic and baroclinic instabilities, barotropic tidal flow, flow in the Great Barrier Reef and a few idealized test cases in spherical geometry.

22.03 Le Dr. Vladimir Pletser, « Senior Physicist-Engineer at the European Space Research and Technology Center of ESA at Noordwijk, NL », qui présente en anglais un exposé intitulé :

"The ESA Programmes of Earth Observation: an introduction"

Un bref résumé est donné ci dessous :
Earth Observation encompasses several geophysical disciplines: remote sensing, meteorology, geodesy, atmospheric studies, cryosphere studies, etc.. The past, present and future satellites of Earth Observation of the European Space Agency (ESA) cover all these fields.
Building on the experience gained with the French series of SPOT satellites, the Agency has launched several remote sensing satellites (ERS-1, ERS-2 and Envisat) carrying different kinds of instruments, among which the Synthetic Aperture Radar (SAR) is mostly used yielding spectacular insights of the planetary surface and subsurface features.
ESA Meteorological satellites encompass three series of satellites, Meteosat-1 to -7 (from 1977 to 1997), MSG-1 and -2 (2002 and 2005), and Metop-1 (launched in. 2006), yielding information on

weather evolution and patterns. Future developments include the new MTG (Meteosat Third Generation) series.
In the frame of the Earth Exploration programme, ESA is preparing six missions to study Earth's atmosphere, biosphere, hydrosphere, cryosphere and interior, with the overall emphasis on learning more about the interactions between these components and the impact that human activity is having on the Earth's natural processes. The first of these missions GOCE (Gravity Field and Steady-State Ocean Circulation Explorer) will be launch at the end of 2007. It will be followed in 2009 by ADM-Aeolus (Atmospheric Dynamics Mission) which will observe global vertical wind profiles, Earth's gravity field and the geoid. After the launch failure of the first Cryosat in 2005, Cryosat-2 will be launched in 2009 with a radar-altimeter to measure thickness variations of Earth's continental ice sheets and marine ice cover. The mission SMOS (Soil Moisture and Ocean Salinity) foreseen for 2008 will study ocean salinity, the water cycle and soil moisture, all vital indicators for weather forecasting, climate monitoring and prediction of extreme events on Earth. The SWARM mission is a four-year mission foreseen to be launched in 2010, designed to investigate Earth's magnetic field. EarthCARE (Earth Clouds, Aerosols and Radiation Explorer), due for launch in 2012, is a cooperative mission with Japan, addressing the interactions between clouds, radiative and aerosol processes.
Finally, the joint GMES (Global Monitoring for Environment and Security) initiative between the European Union and ESA will collect and manage environmental and civil security data and information. Several series of satellites, known as Sentinels, are under study and the first Sentinels will be launched in 2011.
The conference reviewed these missions and presented some main characteristics of some of them.

24.04 Mme. Rosalyn Pertzborn « Office of Space Education of the University of Wisconsin-Madison » et Mr. Sanjay S. Limagne « Senior Scientist at the Space Science and Engineering Center of NASA », qui présentent en anglais un exposé intitulé :

"Back to Venus and in the future to Jupiter with Juno"

Un bref résumé est donné ci dessous :
In April 2006, the Venus Express Spacecraft was inserted into orbit around Venus and has been returning data that is helping scientists make new discoveries. Venus has been explored in the past by many missions from the US and the Soviet Union, and soon even Japan will launch a mission to Venus. These missions have ranged from flyby spacecraft, orbiters, instrumented probes descending down to the surface, and even balloons.
Juno, NASA's second New Frontiers mission is currently being developed to explore Jupiter with an orbiting spacecraft, with the main purpose to investigate Jupiter's interior structure, its deep atmosphere, its intense magnetosphere and aurora. Juno follows the fly-by survey missions of Pioneer 10, Pioneer 11, Voyager 1, and Voyager 2, and a deeper exploration by Galileo Orbiter over a period of several years.
These missions have been and will be carried out to help us understand how the planets evolved, and understand the differences between the planets.

10.05 le Dr. Jim Ray du « National Geodetic Survey (NOAA) » à Washington, qui présente en anglais un exposé intitulé :

"Anomalous Harmonics in the Spectra of GPS Position Estimates"

Un bref résumé est donné ci dessous :
Prior studies of the power spectra of GPS position time series have found pervasive seasonal signals against a power-law background of flicker noise plus white noise. Dong et al. (2002) estimated that less than half the observed GPS seasonal power can be explained by redistributions of geophysical fluid mass loads. Much of the residual variation is probably caused by unidentified GPS technique errors and analysis artefacts. Among possible mechanisms, Penna and Stewart (2003) have shown how unmodelled analysis errors at tidal frequencies (near 12- and 24-hour periods) can be aliased to longer periods very efficiently. Signals near fortnightly, semi-annual, and annual periods are expected to be most seriously affected.

We have examined spectra for the 167 sites of the International GNSS (Global Navigation Satellite Systems) Service (IGS) network having more than 200 weekly measurements during 1996.0-2006.0. The non-linear residuals of the weekly IGS solutions that were included in ITRF2005, the latest version of the International Terrestrial Reference Frame (ITRF), have been used. To improve the detection of common-mode signals, the normalized spectra of all sites have been stacked, then smoothed with a boxcar filter (full width of 0.05 cycle per year, cpy), for each local north (N), east (E), and height (H) component. The stacked, smoothed spectra are very similar for all three components. Peaks are evident at harmonics of about 1 cpy up to at least 6 cpy, but the peaks are not all at strictly 1.0 cpy intervals. Based on the 6th harmonic of the N spectrum, which is among the sharpest and largest, and assuming a linear overtone model, then a common fundamental of 1.040 ± 0.008 cpy can explain all peaks well, together with the expected annual and semi-annual signals.
A flicker noise power-law continuum describes the background spectrum down to periods of a few months, after which the residuals become whiter.
Similar sub-seasonal tones are not apparent in the residuals of available satellite laser ranging (SLR) and very long baseline interferometry
(VLBI) sites, which are both an order of magnitude less numerous and dominated by white noise. There is weak evidence for a few isolated peaks near 1 cpy harmonics in the spectra of geophysical loadings, but these are much noisier than for GPS positions. Alternative explanations related to the GPS technique are suggested by the close coincidence of the period of the 1.040 cpy frequency, about 351.2 days, to the "GPS year"; i.e., the interval required for the constellation to repeat its inertial orientation with respect to the sun. This could indicate that the harmonics are a type of systematic error related to the satellite orbits. Mechanisms could involve orbit modelling defects or aliasing of site-dependent positioning biases modulated by the varying satellite geometry.

13.12 Le Dr. Gerald Ernst, «Universiteit Gent», qui présente un exposé intitulé:

"Understanding how volcanoes and eruptions work: Insights from observations and analogue modeling; what, how and what for?"

Un bref résumé est donné ci dessous :

Many aspects of how volcanoes and eruptions work remain incompletely understood to the extent that in most cases the character of eruptions cannot yet be anticipated. Hundreds of active volcanoes in the developing world are yet to be documented and monitored. Only 200-300 of the 1500 potentially active volcanoes have been studied and are continuously monitored with state-of-the-art monitoring techniques. Volcanology is a young and exciting science only just starting to find its marks. New insights into the mechanics of eruptions and volcanoes can come from documenting unstudied volcanoes and volcanic phenomena in the field, in the lab or by taking advantage of advances in integrated remote sensing techniques, as well as from new applications of first principles of geological fluid mechanics or cloud physics to volcanic phenomena. In the lab, the simplest possible scaled-down geological fluid dynamics experiments focus on one aspect of the phenomenon at a time that can be carried out and modelled theoretically, with predictions subsequently compared to natural observations. Such simple experiments and comparative work typically provide the most insights.

The analogue modelling approach is illustrated to show how it enables to advance understanding of the dynamics of particulate dispersal from turbulent jets, plumes or associated gravity currents in a still ambient or in a crossflow. Geological examples of such flows include deep-sea black smokers and turbidity currents, powder snow avalanches and desert dust storms, as well as flows produced by explosive volcanic eruptions. During a plinian eruption for example, a 1000°C hot multiphase flow mixture exits the vent vertically at 100s m/s, entrains air and heats it up and can produce a turbulent jet developing into a buoyant plume and finally a radially-spreading gravity current intruding the cold upper troposphere or lower stratosphere, at ca.10-50km elevation before interacting with crosswinds. Eruption column gravitational instability can produce collapsing fountains and hot, ground-hugging density currents that can move kilometres to tens of kilometres before lofting and producing giant stratospheric ash clouds.

Material can be dispersed far and wide from such flows and can devastate entire regions as well as threaten international air traffic and have a short-term influence on the atmosphere-climate system *(eg. Pinatubo in 1991). A simple analytical model is developed for fallout from turbulent jets and plumes and compared to analogue lab experiments to show that particle recycling is a key control on such flows and on deposition from them. Another model is developed to show that dispersal from associated gravity currents is characterised by dynamic regimes with high, intermediate and low Reynolds number settling and that this has important implications for eruption reconstruction from deposits which is the basis for hazard assessment at volcanoes. Simple flow visualization experiments show how the dynamics of interaction between explosive eruption clouds and crosswinds depends on the plume-to-crossflow characteristic velocity ratio. Strong plumes in weaker crosswinds are dominated by wind-advected gravity currents at their final rise level whereas relatively weaker plumes are dominated by a counter-rotating vortex pair and bifurcate, dispersing tracers in two directions. The relationship between deposits and advected volcanic clouds as seen from satellites can also be studied experimentally and exploited to infer key eruption parameters from deposits.*

In water-rich eruptions, an eruption column accounting for water and ash particle interactions (cloud microphysics) is developed from the ATHAM numerical model. Developed through joint efforts with the Max Planck Institute for Meteorology (Hamburg), it is the first eruption column model accounting for cloud microphysics and meteorology. Volcanic cloud particle aggregation is another key poorly understood process. In water-rich clouds, pea-size dense ash aggregates form (accretionary lapilli), which we also studied through observations and measurements. A number of their features can only be accounted for if they form in a way analogous to hailstones from severe thunderstorms and a simple conceptual model for their formation is illustrated. There are analogies between the turbulent columns of water-rich eruptions and severe thunderstorms: both are rich in supercooled water and ice, are dominated by particle-particle interactions, fallout and recycling, contain hailstone-like particles growing by riming, have similar scales and emplace particles during discrete and repeated fallout events, the number of which depends on storm intensity, together with maximum hailstone size.

A focus in volcanology has been to relate deposit features to dynamic processes. We are extending this approach in a systematic way to relate the shape, size and vent distributions of entire volcanoes to explore what understanding of processes can be inverted. This effort takes advantage of near-global topographic and other remote sensing datasets which now enable to systematically quantify the morphometry of volcanoes, document and compare sizes of volcanoes or their vent distributions for the first time. This then leads us back to the lab where new analogue experiments are starting at UGhent to provide insights into controls on the geometry of particular volcano types (notably volcanic cones and cone-forming eruptions to start with), on magma ascent and on the outbreak locations of future eruptions. New insights are then applied to unstudied volcanic regions, notably across central Africa, where we survey the regions by remote sensing, carry out novel field and physical volcanology work and first explore the development of low cost hazard analyses or monitoring that can be derived with existing means in the developing world. Recent applications enabled to carry out the first assessment of hazards from lava flows at Mt. Cameroon (one of the biggest undocumented on-land lava-dominated volcano; and the most active volcano in W Africa), to document the transitional phase associated with the major change in eruptive activity from effusive to explosive and from carbonate to silicate magmas at Oldoynio Lengai (N Tanzania) and to develop semi-automated daily thermal RS monitoring of its crater, as well as discover major catastrophic events which occurred in the last thousands of years at Lengai and in the Rungwe Volcanic Province (RVP, SW Tanzania). These include major volcano collapse events at Lengai and the RVP, and Pinatubo-scale plinian eruptions in the RVP. These central Africa unstudied volcanic regions are now a major new focus of study in the new UGhent volcanology group. Objectives are to simultaneously advance scientific understanding of eruptions and volcanoes and to apply our work to anticipate hazards and contribute to poverty alleviation in the developing world.