GOFC-GOLD GLOBAL OBSERVATION OF FOREST AND LAND COVER DYNAMICS

Report on the 2nd Meeting of the GOFC-GOLD Land Cover Implementation Team

Jena, Germany

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Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) is a coordinated international effort to ensure a continuous program of space-based and in situ forest and other land cover observations to better understand global change, to support international assessments and environmental treaties and to contribute to natural resources management.

GOFC-GOLD encourages countries to increase their ability to measure and track forest and land cover dynamics by promoting and supporting participation on implementation teams and in regional networks. Through these forums, data users and providers share information to improve understanding of user requirements and product quality.

Summary and Main Outcomes

The concerted plan from the previous GOFC-GOLD Land Cover Implementation Team (LC-IT) meeting in Toulouse 2002 (Toulouse Plan – GOFC-GOLD Report no. 15) outlined the activities to prototype operational forest and land cover monitoring systems using both satellite and in situ observations. Based on this report, the workshop at Jena was used to review and evaluate the previous implementation activities. The following LC-IT objectives were clarified and extended during the workshop:

1. Global land cover observations for mapping and modeling carbon dynamics are crucial and should be the priority of the LC-IT. This extends the previous activities that were more focused on mapping forest cover and other specific land cover types, as well as, ecosystem assessment.
2. The LC-IT has to strengthen the consideration of earth observation requirements posed by international conventions. In particular, the adequacy and advocacy of current and future earth observation efforts in supporting these requirements should be a central component in the implementation strategy.
3. The LC-IT will take immediate implementation action in specific areas:
    a. The harmonization of global and regional land cover products in close cooperation with the FAO to find a translation and "common language" between and among the different maps.
    b. The validation of global earth observation products. In cooperation with the CEOS Cal/Val group, efforts will immediately focus on existing global land cover maps, and in the near future on continuous field products. The regional networks will play an important role in specific validation tasks.
    c. The analysis of land cover change requires coordinated international activities that will be initiated and guided through the LC-IT framework. One example is the proposed joint US – European assessment of tropical forest change" discussed during the workshop. Other actions have to consider the objectives of the new IGOL (IGOS-P) initiative that also emphasizes other aspects of land dynamics (e.g. human dimension of change, urbanization etc.)
4. The internal structure of the GOFC-GOLD organization will be modified and updated along with the appointment of Michael Brady as executive director and the establishment of the new ESA GOFC-GOLD LC-IT project office (LC-IT PO). They relate to the organizational issues (e.g. appointments of new LC-IT members) and standardization of GOFC-GOLD products and documents.

These issues were discussed and outlined during the workshop and will form the basis for the future activities of the LC-IT.

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1. Introduction and Objectives

The second meeting of the LC-IT was held on 2-4 March 2004 at the Friedrich Schiller University Jena, Germany. The new LC-IT PO hosted this meeting. GOFC-GOLD and the ESA initiated the new office. Christiane Schmullius who is a co-chair of the LC-IT is responsible for this office. The main purposes of this new LC-IT PO are to strengthen the GOFC-GOLD framework, to coordinate and promote and fulfill the GOFC-GOLD land cover implementation plan, and to support the European Space Agency and related projects and services. The meeting was organized as a "kick off" for the new office and focused on several general objectives:

1. Introduce and inaugurate the LC-IT PO.
2. Review and evaluate previous accomplishments and implementation objectives of the LC-IT.
3. Discuss current and planned efforts in global earth observations of land dynamics.
4. Develop action plans and coordinate future LC-IT activities.

The meeting was supported by several sponsors that are kindly acknowledged: GOFC-GOLD, ESA, NASA-START, Jena-Optronik, HUGIN GmbH, Ernst-Abbe Stiftung, and the Friedrich Schiller University, Jena.

2. Participants

The meeting was attended by LC-IT members; representatives from several national and international organizations; and space agencies (e.g. from ESA, DLR, CEOS, GTOS, FAO, AFRICOVER); and members of the scientific community and companies. Other participants represented other GOFC-GOLD Implementation Teams, Regional Networks and other major contributors to GOFC-GOLD related initiatives. The complete participation list is shown in Appendix A.

3. Agenda and Summary of Presentations

Appendix B consists of the meeting program. During the first two days the workshop was dedicated to reviewing the Implementation Team and Regional Networks activities, discussed ongoing and contributory projects and initiatives, and elaborated on the scientific perspective and the role of global land cover observations, in particular, land cover mapping and monitoring, and carbon modeling and accounting. Special attention was given to European contributions. The third day of the workshop was focused on breakout group discussions. The aim was to develop objectives and action items essential for the future work of the LC-IT. A summary of the presentations of day one and two follows in the next section. The results of the breakout groups will be presented in section 5.

GOFC-GOLD Activities

Michael Brady from the Canadian Forest Service is the new executive director of the GOFC-GOLD project office in Edmonton, Canada. During his introduction he emphasized the role of GOFC-GOLD as a catalyst that brings together the various institutions and interest groups involved in the global earth observation process. The presentations by D. Skole and J. Townshend outlined the previous GOFC-GOLD achievements. GOFC-GOLD had a rapid initial start and important progress in the late 1990s, e.g. establishment of regional networks,

the global Landsat ETM dataset, and the contributions to IGOS-P land theme. In recent years the focus has been on getting stable and extending the infrastructure, which has resulted in the appointment of the new executive director and the establishment of the new LC-IT PO

Christiane Schmullius acknowledged ESA and their representatives (S. Briggs and O. Arino) and J. Townshend for their support and thrust in establishing the LC-IT PO at the Friedrich Schiller University Jena, Germany. The office will be funded for an initial three years by ESA. With a prospect of continued operations since the implementation objectives certainly go beyond this time frame. C. Schmullius, the co-chair of the LC-IT, will lead the LC-IT PO, supported by the office coordinator Martin Herold. For the time being, Kathleen Neumann will be the office coordinator until July 2004 when M. Herold will take over the position.

With these new resources, GOFC-GOLD is ready to take the challenges we are facing in global and regional earth observations (EO). The LC-IT has a key role to play in providing sustainable advocacy for EO capabilities: to move from research to operational functions based on firm scientific underpinnings. EO needs operational data and product suites that are well defined and openly available. The implementation process requires international efforts in coordination and multi-mission EO approaches. There is need for integration of satellite and in situ data, and "end to end" information and integration systems for applications. For example, the establishment of the new GOFC-GOLD Data Information Services and Systems (DISS) ensures that an adequate data service capability exists to meet the current suite of land cover information challenges and the long term monitoring needs of GOFC-GOLD. Crucial for the success of LC-IT are the regional networks and the close cooperation with key international programs and initiatives such as IGOS-P or IGOL, CEOS, GTOS, IGBP, TCO, FAO and GLCN. The long-term framework to guide GOFC-GOLD activities will soon be outlined in a strategic document developed by the Science and Technical Board (STB). For short-term activities the LC-IT needs to revise and refine the implementation strategies and activities outlined in the previous LC-IT meeting in Toulouse 2002. The "Toulouse Plan" outlined six objectives of the LC IT:

1. Improve access to remote sensing data
2. Improved pre-processing of remotely sensed data
3. Evaluation and validation of global land cover products.
4. Improved global land cover products
5. Land cover change monitoring
6. Coupled remote sensing - in situ systems

All of these objectives were discussed during this workshop. Significant progress and revisions were made relating to objectives three, four, five and six. They are described in the next sections.

Another important issue emphasized several times during the workshop is the need for increased funding. Additional resources are needed for regional networks, for future implementation workshops, and other activities (e.g. outreach and documentations, data access facilities and related GOFC-GOLD projects).

Improved Global Land Cover Products and Harmonization

There were presentations by several participants on ongoing efforts related to objective four of the Toulouse Plan: towards improved global land cover products. J. Latham introduced the GLC2000 dataset representing a global baseline land cover inventory for the year 2000 derived from uniform data input (SPOT VEGETATION). The product is based on a hierarchical land cover classification scheme and implemented through international partnerships. The GLC2000 will be updated in 2005 within joint ESA-IGBP GLOBCOVER initiative based on ENVISAT/MERIS data. The experiences with the GLC2000 project have shown that global land cover mapping is a reality. However, the myth that up-to-date, accurate global land cover maps are easy to produce and are always available still persists. Processes to guarantee this availability are just beginning and must be further developed with the support of the LC-IT. Similarly, the AFRICOVER is aiming at developing a consistent, flexible and reliable land cover database for Africa. The USGS/EDC land cover mapping efforts continue to provide important products on both the regional and the global scale, e.g. there were more than 1200 registered users of the global IGBP DISCover dataset as of November 2002. H. Balzter presented the UK Land Cover Map 2000. The European CORINE Land Cover (CLC) map of 1990 is currently in process of being updated for the year 2000 using Landsat ETM data. The project is led by the European Environmental Agency (EEA) and provides a consistent map update and assessment of land cover and land use changes in Europe between 1990 and 2000. GEOLAND is an integrated European project with 56 partners focused on land dynamics. The project is closely related to GMES and aims at investigating land cover change, environmental stress and vegetation monitoring on regional and global scales.

All these efforts certainly improve the mapping products and our understanding of regional and global scale land dynamics. However, most of these efforts use their own thematic definition of land surface categories. The comparison between and analysis among them is only possible to a very limited extent. This workshop emphasizes that regardless of how databases are generated, the thematic class legends have to adhere to international standards. In this process of harmonization GOFC-GOLD has to take responsibility to lead the discussions and work towards an international agreement on how to approach this problem. In that context A. Di Gregorio introduced the FAO Land Cover Classification System (LCCS) that will soon be released in its second updated version. LCCS is a comprehensive methodology for description, characterization, classification and comparison of land cover features identified anywhere in the world, at any scale or level of detail. In its generic base LCCS purely focused on land cover and not on a mix of land cover and land use as other classification systems such as the Anderson and the CLC legends. Land use can be defined within LCCS as additional “overlay” to land cover. Furthermore, LCCS is applicable to both field observations and remote sensing data interpretations without emphasizing the unique characteristics of a subjective field of interest, e.g. the UNESCO system uses a mixture of structural floristic vegetation parameters in class definitions that are hard to map if you are not a vegetation ecologist. Based on the related discussion during the workshop one of the breakout groups focused specifically on the issue of harmonization, and developed specific action plan for future LC-IT activities (section 5).

Programs, Users and GOFC-GOLD Related Initiatives

A. Belward reported on the relevance of GOFC-GOLD in supporting the Terrestrial Observation Panel for Climate (TOPC). The 2nd GCOS adequacy report of global observations systems for climate in support of the UNFCCC was recently published and endorsed by COP9 and the 2003 WMO congress. The report urges the free and unrestricted exchange of data for essential climate variables, the need for integrated global climate products to meet user requirements, the efforts in capacity building and system improvements in developing countries, the development of observing standards (harmonization and validation), and proposes a full implementation of integrated global observing systems for climate for both satellite and in situ data. For land cover information, the implementation requires a partnership between space agencies for providing and processing EO data, international panels such as GOFC-GOLD and FAO to ensure legend relevance and standards, and the research community for optimizing data analysis approaches. The mechanism for establishing and funding such partnerships are emerging (e.g. GEO, GMES) but not yet guaranteed on a sustainable basis. It is central task of GOFC-GOLD to strengthen these partnerships and ensure their continued operation.

The European Global Monitoring of Environment and Security (GMES) program and GEO initiative for sustainable development enforces the role of EO in the implementation process. EO data have to be combined with in situ measurements and models to provide reliable, continuous and inter-comparable results on information about understanding the earth system. The objectives posed by GMES/GEO emphasize the continuity and renewal of space infrastructure and EO services (esp. after 2008). The aggregation of competence within the fragmented European scientific and user communities is on the way. GOFC-GOLD has a central role for consolidating these efforts at the international level. GOFC-GOLD can help design and develop a new internationally coordinated EO strategy to improve jointly space resolution and revisit frequency for better observing and characterizing earth surface parameters and land dynamics changes at local to global scales. In this context, a new issue is raised in the relationship and synergy between environment and health.

The presentation of S. Plummer and O. Arino showed the new orientation within ESA. Traditionally ESA was an EO data provider but is now establishing a working process with users. The LC-IT PO is one of these ESA efforts to strengthen the user perspective in the EO process and establish a long-term dialogue and partnership with users. The suite of global EO data users is quite diverse and includes international scientific programs, environmental conventions, intergovernmental organizations, non-governmental organizations and national governmental ministries and agencies. GOFC-GOLD has a key role in communication and support of users and policy makers. The LC-IT has to pay attention and engage in initiatives like GEO that reflect the political level and is essential for the future of EO. Another example is the new IGOL (IGOS-P) theme. IGOL is a policy-setting framework and also critical for future EO. GOFC-GOLD has to influence and drive forward IGOL objectives and implementation, e.g. with strategic partnerships and networking between key drivers and users of EO. In this context, GOFC-GOLD activities need to follow guiding principles posed by international conventions. As a technical panel of GTOS, the profile of GOFC-GOLD has to be raised and it should drive the contact with respective international organizations like GLCN, IGOL, GEO and GMES. As a first step, GOFC-GOLD's role in adequacy and advocacy of global EO was discussed in more detail in one of the breakout groups (section 5).

David Skole proposed that GOFC-GOLD should have a specific international initiative in collaboration with US-European assessment of tropical forest changes. Regional estimates of tropical forest changes have been improved through the use of remote sensing but global estimates have been more problematic. Despite some recent advances, the access to uniform datasets along with a consensus-oriented approach can lead to a more comprehensive approach, e.g. using Landsat 1990/2000 global dataset, the SPOT products suites and TERRA products. The emerging GOFC-GOLD capabilities can help to deliver these datasets and products through information systems support. The objective is to utilize the framework of the US-French bilateral agreement between NASA and CNES and expand the focus to be a US-European initiative including support to GMES and related initiatives. GOFC-GOLD working groups and regional networks should be engaged with their key specialists. Once successful this initiative could be a good prototype to be extended to other areas in addition to tropical forests, for example temperate environments.

Validation

The issue of validation directly addressed objectives three and four of the Toulouse Plan. The need for evaluation and validation of global datasets is unquestioned since a good understanding of accuracy and uncertainty of a mapping product is essential for its appropriate use. International environmental protocols and agreements imply that the EO mapping products may be independently evaluated and possibly challenged. Explicit statements about uncertainty foster an informed user community and improve applications use of the data. Also the inter-use of similar global mapping products produced by CEOS members will require characterization of each product's uncertainty. Since nearly all global EO mapping products lack an appropriate validation, the goal of the CEOS Cal./Val. group is to ensure long-term confidence in the accuracy and quality of EO data and products. A document describing the "best practice" in validation will be released soon based on the recent CEOS Cal./Val. meeting in Boston in Feb. 2004. As C. Woodcock pointed out, during the Boston meeting important issues were raised that GOFC-GOLD needs to consider support of validation efforts. There is a need to develop methods to validate continuous fields products (e.g. LAI and biophysical parameters) and land change maps. Furthermore, the validation efforts require a better understanding of users needs for accuracy data and the way the users use the reported accuracy/uncertainty information.

The validation of global land cover maps at coarse resolution pose unique challenges for accuracy assessment. These include the high frequency of mixed pixels, difficulty in precise geo-location of map products and reference materials. The validation of nominal scale land cover data has to be based on a robust reference data sample scheme. Although there are core validation sites they are not easily utilized for land cover validation, e.g. DEMMIN site (presentation by R. Ressl), since they don't result from a robust spatial sampling scheme. The establishment of appropriate global land cover validation sites poses logistical difficulties associated with field data collection. Hence, a global land cover validation requires substantial efforts and it has been proven difficult to obtain the appropriate funding. Another problem is the missing standardization of mapping units and classification legends that again raises the issue of harmonization. GOFC-GOLD certainly provides the framework to pursue these important issues. The role of GOFC-GOLD is to build on the known scientific practice, to advise on actual validations and work towards coordinated international efforts for accuracy

assessment of global EO datasets. One of the breakout groups dealt with this issue of validation and outlined future GOFC-GOLD activities (section 5).

Land Cover Monitoring and Modeling

Land cover monitoring is reflected in objective five of Toulouse Plan. During the workshop this issue was discussed in several presentations. The update of the CORINE/CLC1990 dataset will result in detailed land cover/use change maps for Europe for 1990-2000. IGBP related projects have analyzed recent land cover changes on a global scale (presentation of H. Geist). Despite previous progress, there are still many unmeasured land-cover changes at the global scale related to sub/tropical dry forests, forest cover changes caused by selective logging, alteration of wetlands, soil degradation in croplands, dryland degradation or desertification, and urbanization. The importance is to approach these change processes from an integrated perspective. Causes, drivers, factors, actors, and feedbacks together with the initial conditions make up pathways of land change. The understanding of these pathways and the human dimension of land dynamics are essential in land change modeling for assessing possible impacts and elaborate on future development scenarios. This integrated perspective is emphasized in several GOFC-GOLD related programs and initiative such us TOPC, GLCN, IGBP, and IGOL.

From an EO perspective, it is important to enhance the collection and use of the data by moving from supply to demand-driven observing systems. The terrestrial observational requirements have to be defined jointly with the user community. So far the global land cover datasets have been mainly mono-temporal and the science community has used the few "simple" change datasets as much as possible. Improved land change analysis can be expected with continued observations and efforts in harmonization and validation. Areas of rapid land change or "hot spots" should be the priority in the analysis of annual 250m – 1km resolution.

Carbon Observations and Accounting

In the Toulouse Plan the LC-IT defined an initial focus on three areas: carbon observatory, ecosystem assessment observatory and forest inventory and management observatories. This workshop has emphasized that global carbon observations are crucial and should be the priority of the LC-IT. The joint ESA-IGBP initiative presented by S. Plummer highlighted the importance in assessing the global carbon cycle with EO mapping products such as land cover, vegetation parameters, fire monitoring etc. J. Latham pointed out that there is a lot of affinity between TCO and GOFC-GOLD and additional interaction and communication is needed between both groups. The TCO objectives are an estimate of annual net land-atmosphere fluxes at a sub-continental scale with a 30% accuracy globally and spatial resolution (10^6 km^2 regionally) by 2005, by 2008 improve accuracy (20%) and spatial resolution (10^6 km^2 globally), and produce sink/source maps with the highest spatial resolution enabled by the available satellite-derived and other input products (~1 km^2 or less).

From a scientific perspective, M. Heimann reported on the CarboEurope and TCOS Siberia projects. The aim of these projects is to understand, quantify and predict the terrestrial carbon balances and associated uncertainties at local, regional and continental scale. EO plays an essential role in bridging the gap between in situ field measurements (e.g. flux measurements) and the atmospheric carbon concentrations and coarse scale modeling results. There are also new methods of integrating EO products in carbon/ecosystem modeling efforts. The presentation by W. Knorr showed preliminary results of data assimilation of FAPAR and

plant functional type/land cover information within a modeling framework that represents the impacts of land cover change on carbon balance. The SIBERIA II project is a prominent example for deriving multiple parameters influencing the carbon cycle from regional and global scale EO. The LC-IT has to consider these science-driven efforts of integrating EO and carbon balance modeling and use it in their ongoing discussion with space agencies and the user community.

Sensors and Data Access

Improved access to data relevant to EO (remote sensing and in situ data) is one of the main objectives of the LC-IT mentioned in the Toulouse Plan. Key objectives are to make observation systems operational, data and products more available, and ensure the extension and continuity of EO sensors. Sophisticated observatories and related data assimilation infrastructure already exists for oceans and atmosphere; the terrestrial domain requires further improvements. J. Townshend informed the participants of the Global Land Cover Facility (GLCF) at the University of Maryland. The goal of this facility is to provide free access to an integrated collection of critical land cover and earth science data. This availability of data encourages the use of remotely sensed imagery, derived products and fosters a wider range of applications. GLCF is a good example for future GOFC-GOLD efforts to make optimum use of scattered data sets and archives for both remote sensing and in situ data, i.e. for validation purposes. Scanex represented by O. Gershenzon holds several satellite data acquisition stations and a large data archive of main EO systems, IRS, and Meteor/Resurs data for Russia and Asia.

In terms of EO sensors, the issue of continued LANDSAT observations came up several times during the workshop. So far, there is no explicit plan for a LANDSAT 8, at least within the next 24 months. The current situation interrupts the longest and most valuable temporal land observation dataset and the science community strongly urges LANDSAT continuity. Furthermore, the SPOT satellite program will not be continued after SPOT 5 as well. The presentation by H. Jeanjean further points out the gap in spatial-temporal scales that current EO systems serve. He proposed the idea of a Super-LANDSAT program with 10-20 m spatial resolution, 8-12 spectral bands and 2 days revisit cycle. In any case, GOFC-GOLD has to work towards a continuation of LANDSAT-like observations since they are essential for global land observations, i.e. to study hot spots of change or for validation purposes. GOFC-GOLD will provide contributions and suggestions to future missions and urges international cooperation between space agencies (e.g. ESA and NASA) in development and operation of long-term future EO systems.

Although discussed during the workshop, the participants did not come up with a common support for the planned SPECTRA mission. SPECTRA is the only proposed terrestrial satellite of ESA. However, it is a test site-oriented hyperspectral mission that would not directly support the EO strategy proposed by GOFC-GOLD, at least not as much as continued LANDSAT observations. A. Rosenquist presented to the participants the latest EO objectives of JAXA. The next sensor to be launched is ALOS in December 2004. This sensor aims to support the " three C's ": carbon, conventions, and conservation. All data will be available in public domain and accompanied by international research efforts. This sensor emphasizes the importance of continued Radar observations along the JERS tradition with its unique information about specific surfaces types like forests and wetlands. In particular a global map

of wetlands is still missing and can be considered one of the most important products from the ALOS mission.

Regional Networks

The importance of the regional networks as one of the main implementation instruments within the GOFC-GOLD organization was stressed. Especially the future efforts in validating global EO dataset require a strong regional network infrastructure. M. Mahmud reported on the South East Asia Regional Research and Information Network (SERRIN). SERRIN is a very active GOFC-GOLD regional network that consists of scientists in the SE Asia region, dedicated to the scientific understanding of human-environment interactions influenced by global changes. The research organization consists of 7 nations that include Thailand, Indonesia, Malaysia, Philippines, Vietnam, Laos, and Cambodia. The network is currently working on variety of projects of land cover change and burnt area mapping. To maintain and sustain long-term continuity and expansion of network membership (such as China, Taiwan, Australia) the network needs support from GOFC-GOLD and other sponsors and funding agencies.

Olga Krankina informed the participants that the Northern Eurasia Regional Information Network (NERIN) developed from GOFC-GOLD workshops held in 2000 and 2001. The most recent initiative of this network is the Northern Eurasia Earth Science Partnership Initiative (NEESPI). The goal is to establish a large-scale, international, interdisciplinary program aimed at developing a better understanding of interactions between ecosystem, atmosphere, and human dynamics in Northern Eurasia. A major factor in the success is the development of a network of scientists and institutions capable of meeting the needs of NEESPI research agenda. The first major activity is the exchange of EO related datasets. The recent NEESPI meeting in St. Petersburg was a landmark event and has revealed that data sharing is facing substantial problems within Russia. The related action plan is more short term and preliminary but will focus on making NEESPI GOFC-GOLD communities aware of available data resources, help to identify critical gaps and restrictions, and provide points of contact for the data users. Further funding of activities is essential for the continuation of NERIN.

4. Breakout Group Discussions and Action Items

Three breakout discussion groups were formed on the third day of the workshop. The task of the discussion groups was to review prominent issues raised during the workshop, identify the role of GOFC-GOLD towards resolving and responding to these issues, and define LC-IT actions and implementation steps for immediate steps and visionary goals that should be brought up in future meetings.

Classification/Harmonization Breakout Group

Contributors: Woodcock, Mahmud, Ressl, Schmidt, Herold, Di Gregorio, Latham, Haeusler, Bartalev, Schmullius

I. Is it possible to agree on classification on a fairly limited number of classification systems?

Conclusion - This is the wrong question! The requirement is to have projects contribute to the understanding of land cover dynamics therefore they should follow the recommendations and be applicable to a larger process.

2. Do we need a common language to ensure we are referring to the same class in different parts of the world? Yes

3. What are alternative classification systems?

UNESCO classification system,- mixture of groups structural to floristic - difficult to map with - if you are not a vegetation ecologist, mixes LC, environ. parameters/LU

Anderson et al 1976 - LC and LU.

CORINE - more detailed on anthropogenic surfaces than vegetation

LCCS - has advantages, parametric, scale independent etc.

Conclusions: Existing systems mix issues - we need a system that is applicable to RS and Ground conditions, therefore we should not focus only on floristic as a basis for classification systems. Also we need to find a classification system that defines only Land cover. Land use can be added as additional layer. The advocated classification approach should not be scale or sensor dependent.

II. Can LCCS be used as a translation device?

It would seem so! There are analogies in other thematic disciplines to similar environments, e.g. FAO soil classification. The result was also to use translation.

LCCS breaks into parameters - which are consistent - do other classification systems/legends have such parametric systems - can they be broken down in the same way?

LCCS classes can be seen on the ground and on imagery - it has advantages.

There is a translation device in LCCS.

Recommendation: that we start our products form descriptors are based on life form and cover, leaf type etc. which are - we must have consistency to a certain level minimum is life form.

It was recognized that some major mapping activities at global already use LCCS - e.g. GLC 2000, don't need translation, translation efforts also exist for IGBP and CLC, hence others need to be translated.

To take a harmonization approach often means a least common denominator approach - this has trade offs.

Problem for existing products and translation into LCCS or using LCCS from the beginning

Some classes translate well others don't, e.g. translation not only classes but also the cartographic standard - e.g. MMU/mixed unit.

It is recognized that the help file and glossary of LCCS is a helpful tool in order to avoid re-discussing what are/is a tree/ shrub etc -and thresholds - a good starting point.

III. Action Plan:

We need to establish a suite of key users. This will take time but process needs to start. Who can we use as primary entities? EEA, USGS, UN – FAO, UNEP, IGBP – LUCC, UMD, etc

Facilitating mechanisms and Recommendations:

Action item 1. Request assistance from CEOS W/G on Land Cover Validation - can we adopt LCCS as a method for translation and will it support new programs based recommended GOFC-GOLD standards - Timeframe ASAP – Action: C. Woodcock

Action item 2. The new LCCS web page, to be established under GLCN, could be a mechanism for providing translation. Of GOFC-/GOLD legends.- Timeframe - 3 months, Action: A. Di Gregorio/FAO

Action item 3. FAO offers to undertake translation of existing thematic legends into LCCS as requested- this requires commitment from developer to provide detail on their legend and interact. As above

Action item 4. Produce a document of recommendations of standards for translation to be testbeds. - Timeframe next 4months, Action:LC-IT PO in cooperation with FAO.

Action item 5. Establish test beds in different areas, e.g. NEESPI, Siberia II and tropical regions - for translation experiences. Timeframe …, Action O Krankina, LC-IT PO.

Action item 6. We need a GOFC-GOLD workshop on scaling -(global to local) and also translation. Invite broad. List and have LCCS circulated and tested before meeting. Timeframe within 6months, Action – LC-IT PO and Chair IT.

Action item 7. Raise awareness and distribute LCCS-2 broadly prior to workshop for evaluation.

Adequacy and Advocacy Breakout Group

Contributors: Townshend, Brady, Larsen, Plummer, Rosenquist, Balzter, Skole, Neumann

Two issues were discussed: 1) Inputs to Improve TOPC Adequacy Report re: Land and 2) Revision of GOFC-GOLD design and strategy document re: EO.

1. Inputs to Improve TOPC Adequacy Report re. Land

Biggest input to report is high resolution data needs. Medium to coarse resolution is OK

Needs for finer resolution EO:

- 30-50 data needs (wall-to-wall globally every 5 years, other periods based on sampling)
- Data availability-should be open and freely available
- Science strategy that drives observations-what key science impact could be made with modifications/improvements to EOS? e.g. tower-based vs stock-based measurements (what is needed to improve the science?).

There are, however, some EO needs which will require some form of research and development (RD) while others, have advanced beyond the RD and need to move towards routine operations. For example, EO of biomass still needs RD:

- Several approaches including microwave (SAR, interf) and lidar

- Opportunity for increased detection at high biomass
- Clear opportunity for regeneration vegetation

There are also some science needs which are ready and do not need EO RD. Key science issues include:

- Carbon cycle: C modeling community needs better EO data (resolution, reliability, consistency, continuity); resolution of differences in flux measurements vs stocks; and EO community can use better data to question model outputs.
- Confusion in directions of rates of global/tropical deforestation: EOS can help resolve this.
- Relative role of regrowth vs deforestation in tropics (e.g., rates and areas of forest regeneration)
- Changes in forest density and other attributes due to climate change: Need to track changing density (recruitment-mortality rates) and extent (woody encroachment C3-C4 (NPP changes), forest response to CC and to land use practices (e.g. agricultural land abandonment)
- EO community to distinguish between land use changes in regions to present to modelers (e.g., differing LU dynamics between South tropics vs North tropics-synchrony of changes in pools over time possibly leading to episodic periods of sink conditions-there are no measurements yet to capture these dynamics)
- Changes forest/land cover extent – special case of woody encroachment
- Changes in non carbon biogeochemistry, e.g. nitrogen cycling
- Adaptation and mitigation (finer resolution EO required for adaptation and mitigation strategies; community consensus on land surface change (beyond C, climate models))

Action: A. Rosenquist/C. Schmullius (AR/CS) -prepare a state of evidence report or statement. Given the importance of biomass estimates and changes, need to compile evidence of success and failures of EO for biomass estimation (include SAR).

2. Revision of GOFC-GOLD design and strategy document re. EO

Issue discussed: should GOFC-GOLD also focus on specific sustainable development concerns, e.g., EO for global mangrove loss?

- Requires high frequency, high resolution EO of focused areas. May not have resources to do this in all locations.
- Need to move away from concerns on one-off events e.g., C from fires in Boreal, to longer-term systematic analysis of so-what questions (inside or outside global-historical variability)
- Risks need to be addressed in investing long-term continuous records, e.g., fire-Siberian fire issue looked at overall long-term to determine statistical patterns.
- There should be more emphasis on data acquisition strategies to support science questions of long-term-large scale dynamics (continuity is a key concern)

Issue discussed: There is a lot of data collected, but not systematically organized, e.g., fire data (Fire IT is now trying to do this). Data are not all equal in quality.

But continuity can only be evaluated after reviewing existing data-difficult to evaluate at start.

Need for continuity must be justified for science use (few examples of big science done with continuous data)

Issue discussed: C models require long-term continuous records (in-situ records)

Need for assimilation between ground and space based measurements, e.g., rainfall in US

If proposing continuous EO, must match with continuous ground-based monitoring (link between monitoring agencies). Ensure EO are valid. And in some cases EO have limitations (e.g., heterotrophic respiration).

Action: Generate separate adequacy document/revise GOFC-GOLD design and strategy reports (Executive Committee)

Validation Breakout Group

Contributors: Woodcock, Skole, Schmullius, Herold, Latham, Krankina, Brady, Larsen, Mahmut, di Gregorio, Balzter, Bartalev, Schmidt

Validation issues and status:

I. Validation best practices: land cover mapping (categorical maps) (in process, report from CEOS Cal/Val group in summer)

No action items at this point in time.

II. Validation best practices: biophysical parameters (continuous maps) (needs work) proportional coverage vs biophysical variables and change maps. Very little has been done on validation of change maps. Some progress on continuous fields – push on CEOS LPV to move forward.

Action Item: Forward a recommendation to the CEOS LPV to move forward with the development of a "best practices" document for validation of biophysical and continuous fields data (ie continuously measured parameters) (IT Chairs)

Action Item: Forward a recommendation to the CEOS LPV to move forward with development of a "best practices" document for validation of land cover change products. (IT Chairs)

III. Funding (Space Agencies need to realize that validation of multiuser products is essential)

Action Item: Forward recommendation from GOFC-GOLD to CEOS on the importance of funding validation. (IT Chairs)

Key points:

Accuracy datasets can benefit a multitude of users (evidence is the extensive use of the Global Landsat datasets).

In-kind contributions (such as imagery) can be very helpful (for example, SPOT high resolution imagery).

One idea discussed was to forward a proposal to GTOS from the IT for validation of global land cover products. It was noted that Strahler and Woodcock (and others) had submitted a proposal to NASA on this topic, but it was in response to a NASA NRA and not well suited to the topical needs. The IT planned to resubmit a modified version of that proposal for an international effort that better integrated the regional networks and can be used for multiple scales (ie global and Siberia).

Action item: Prepare proposal for submission for validation of global and regional land cover products via an international effort (Woodcock and IT Chairs).

IV. How do we establish accuracy requirements and standards?

Review existing documents for statements on requirements

What are the needs of various user communities for accuracy data, and are we producing the right accuracy metrics (ie the effects of aggregation, thematic resolution, etc). Very little time for discussion of this topic, so it should be carried over for future meetings.

Action Item: Review existing international conventions and documents for stated requirements for accuracy (and thematic resolution and map scale, ie minimum mapping unit) and compile a report (LC-IT PO)

V. User Requirements from the Validation process.

Who are the end users: climate/atmospheric modelers, for example, how do they deal with reported accuracy measures? Should be focus in future meetings.

Action Item: Once the immediate action items have been fulfilled there is need for another workshop involving the regional networks where validation could be the main objective.

5. Appendices

Appendix A : Participation List

Name	Institution	E-mail
Balzter, Heiko	Centre for Ecology and Hydrology (CEH)	hbal@ceh.ac.uk
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Appendix A. continued

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Woodcock, Curtis	Boston University	curtis@crsa.bu.edu

Appendix B : Agenda

2-4.03.2004: GOFC-GOLD Land Cover Implementation Plan & Project Office Inauguration Meeting

Tuesday, March 2 Location: Scala Restaurant, Intershop-Tower, Neue Mitte Jena

12.00-14.00 Ice-Breaker: Bird´s Eye View on Jena, Lunch and Workshop in Scala Restaurant (Sponsor: START)

14.00	Start of Workshop / Organisational Issues	Schmullius
14.15	Welcome and Logistical Information	Schmullius
14.25	GOFC-GOLD Introduction	Brady
14.40	Friedrich-Schiller-University Jena: Geoinformatics and Remote Sensing	Flügel
14.55	Meeting Objectives	Schmullius

SESSION 1: Implementation Team Priorities and Implementation Plan Status (15 min presentation, 5-10 min discussion

15.10	GOFC Implementation	Skole
15.30	MODIS Land Cover: Status and validation	Woodcock
15.50-16.20	Coffee	

SESSION 2: Programme Requirements and Global Initiatives (15 min presentation, 5 min discussion)

16.20	Global Terrestrial Observing System - Summary and Status Report	Latham
17.00	GMES Issues	Jeanjean
17.30	LUCC Land Use and Cover Change – International Project Office	Geist
17.50	Joint US-European Assessment of Tropical Forest Change	Skole
18.10-18.30	Conclusion	Schmullius
19.00-21.00	Inauguration Event (Zeiss Optical Museum, Sponsors: Abbe-Stiftung and JenaOptronik GmbH)	

Appendix B. continued

Wednesday, March 3 Location: Friedrich Schiller University Main Building, Senate Hall		
SESSION 3: Carbon and Biodiversity (15 min presentation, 10 min discussion)		
8.15	Organisational Issues, Logistical Information	Schmullius
8.30	Regional Carbon Balance Studies: CarboEurope-IP (2004-2008) - Terrestrial Carbon Observing System - Siberia (TCOS-Siberia, 2002-2004)	Heimann
8.50	Simultaneous Constraints on Land Cover and Carbon Fluxes through Assimilation of FAPAR into Ecosystem Models	Knorr
SESSION 4: Global Land Cover Products and Classification Strategies (max. 15 minutes presentation, 5 min discussion)		
9.10	ESA applications related to GOFC	Plummer (Arino)
9.30	The IGBP-ESA Networks Initiative	Plummer
9.50	Terrestrial Observation Panel for Climate	Belward
10.10	Global Land Cover 2000 project	Belward
10.30	JAXA regional scale monitoring initiatives	Rosenqvist
10.50-11.00	Coffee	
11.00	Overview on LCCS 2 - Basic concept and operational contest	Di Gregorio
11.20	Land Cover Mapping at EDC	Giri
11.40	Updating the CORINE Land Cover Database in Germany	Schmidt
12.00	Conclusions/Task List	Schmullius, Skole
12.15-14.30	Lunch in Cospeda (Restaurant 'Grüner Baum zur Nachtigall', Sponsor: START) and short walk to Napoleonstein (…beautiful view and fresh air…)	

Appendix B. continued

SESSION 5: Validation, Large Scale projects, Regional Networks, (15 min presentation, 5 min discussion)		
14.30	Global Land Cover Facility	Townshend
14.50	Some challenges for the GOFC-GOLD Land Cover Implementation Team	Townshend
15.10	DEMMIN – Testsite for environmental monitoring and validation	Ressl
15.30	Geoland	Belward
15.40-16.00	Coffee (Sponsor: Hugin GmbH)	
SESSION 6: Large Scale projects and Regional Networks, (10-15 min presentation, max. 5 min discussion)		
16.20	Centre for Ecology and Hydrology	Balzter
16.40	GMES Service Element (GSE) for Forest Monitoring	Haeusler
17.00	Siberia-II Objective	Schmullius
17.15	NERIN – North European Regional Information Network	Krankina
17.35	Inventory of Remote Sensing data for Russia and CIS in NEESPI	Gershenzon
17.55	Space Research Institute of Russian Academy of Sciences: GOFC-GOLD related projects over Northern Eurasia	Bartalev
18.10	Refreshments (Sponsor: ESA)	
18.30	Overview on the Africover products and applications	Di Gregorio
18.50	Overview Of The Global Land Cover Network Initiative (GLCN) - Strategies for Land Cover Mapping and Monitoring	Latham
19.10	Land Use and Land Cover Change in Southeast Asia – the SEARRIN GOFC-GOLD	Mahmud

Regional Network

Appendix B. continued

19.30	Wrap-up, Status-Quo, Keywords for Implementation Plan Phase 2 and Tasks for Working Groups	Townshend, Skole, Schmullius
20.00	Dinner in historical City Hall (Sponsor: START)	
Thursday, March 4	Location: Institute of Geography	
SESSION 7:	Working Groups on Land Cover Implementation Plan	
8.30	Introduction to Working Group Tasks	Brady, Townshend, Skole, Schmullius
09.00-10.30	Classification and harmonization	Working Group I
	Adequacy and advocacy	Working Group II
	Validation	Working Group I+II
10.30-11.00	Coffee (Sponsor: ESA)	
SESSION 8:	Synthesis	
11.00-12.00	Working Group presentation	Brady, Townshend, Skole, Schmullius
12.00-12.30	Synthesis, Wrap-up, Future Plans	All
12.30	End of meeting. Possible snack lunch: typical Thuringian Bratwurst	
15.00	Land Cover Implementation Planning, Future Plans	Brady, Larsen, Skole, Woodcock, Schmullius/Herold/Neumann