Minutes of the 9th K&C Meeting, Tokyo, Japan

January 21-24, 2008

Rapporteur (and incredible typist!):
Richard Lucas

Future meetings and outlines of work
K&C#10: June 23-26, 2008 (updated 20080410)

January, 2009 (3 years after ALOS launch)

- Expiration of K&C agreements
- Final Science Team meeting (K&C 11)
- Product delivery and project report

January – March, 2009

- Project evaluation by JAXA

TBC (April, 2009)

- Extension phase (2-3 years) for successful projects

Travel support
Reiterated that active support in project issues needed (including progress reports, wiki sites etc.).

PALSAR acquisition strategy
Details can be found at http://www.eorc.jaxa.jp/ALOS.

PALSAR status up-date
M. Shimada provided an overview of the current status of the ALOS PALSAR. Key issues included:

- 170 people (70 from overseas) attended the ALOS PI meeting in Kyoto and a CD of presentations and papers (downloadable from the web) will be provided.
- The satellite bus subsystems and three mission instruments are in good condition. This august, the inclination angle will be changed slightly so it goes back to the original state. A 0.86 degree change is needed.
- Power generation, surface condition and transmission power are showing minimal variation.
- Since April, have lost a transmitter from DRTS but this has been replaced. A test transmission to the US is to be trialled during this year (to White Sands) using TDRS.
- The calibration is retained at 83.0.

Strip data processing at EORC
K Isono explained strip data processing at the EORC and the schedule. Good success in acquisition based on requests has been achieved, ranging from 73 % to 88 %. The loss of data occurring can be attributed to a conflict of observation requests or issues in satellite operation.

Processing of slant-range and ground-range products (FBS and FBD) commenced in August 2007 and processing is stable. Currently processing cycles 12, 13 and 14. The ScanSAR (path browse; low resolution primarily for IBAMA) data commenced in September, 2007. SLP and GRP products from ScanSAR commenced in January, 2008. The sigma-SAR needs to be upgraded for all orthorectified products and so these are not currently being processed.

The amount processed for each cycle has varied with cycles 12 and 14 being largely processed. Requested data can now be processed on schedule from March onwards. SLP and GRP products will be processed as new acquisition data, cycle 12, 14 and 14, and then cycle 8 and 9 in order of priority. Cycles, 12, 13 and 14 will be completed by the end of March. Path browse ScanSAR processing is on schedule. Other products are progressively being processed. *For more information or if need data to be processed earlier, email* ALOS-KC@jaxa.jp. It is also worth checking the AUIG to see if there are strips missing but by March, these will be available in the K&C directory. You should also propose a new path/cycle where acquired and then request this to be processed as a replacement. Note that this task is manual and so need to be considerate in the requests.

K&C data dissemination and user interface

A. Mukaida outlined the status of dissemination and also the AGAP system. Processed products are provided by FTP and ASPERA and the 1st SDLT has been shipped and the second is in preparation. Several issues including that the time stamp was one year behind but this has been fixed. Furthermore, the data list cannot be sorted by time stamp although this is being investigated. The directory structure also needs to be divided depending upon observation (e.g., descending/ascending) modes.

The AGAP system works well and the interface has been improved. The system will be replaced in 2008 (October or November) and this will give greater capability for processing and storage.

A demo is being prepared and this can be found at www.eorc.jaxa.jp/ALOS/opn. Here, you can scroll the path map and there is a better colour indicator on the path map. There is also some disagreement between the requested and processed path. Personal account setting is still ongoing which allows individual logging in. Within this account, only a closed map image for each member is shown. If the whole pathmap can be imaged as pdf, then have the same information as on the site. Capability in generating a google earth (kml) map is also being introduced and is based initially on a browse mosaic product; this approach is almost complete. Any comments to akira@restec.or.jp. Need to check the spreadsheets sent by Ake which provide a quick way to locate the RSP number.

Mosaic theme

B. Chapman provided an overview of the mosaic theme, which has the objectives of developing products to facilitate science product generation and to provide public presentation of the data, thereby promoting the project. He reported that NASA funding was now provided for global wetlands mapping. The mosaics will be generated using SRTM and SRTM-like tiles will be generated and a number of software packages are available for geocoding and mosaicking.

From Level 1.5 data, simple stitching is required but Level 1.5 is not a standard product for K&C.

Mapready software from the ALASKA SAR facility runs on linux and windows (http://www.asf.alaska.edu/softwaretools/mapready) but only works with the AUIG frame images but not the strip data (although there is interest in supporting). The software is free and open source.

ROI-PAC software is from http://roipac.org which also does not work on the K&C data and is largely for interferometry.

JPL multimosaic software suite is hard to get outside of JPL and only works on unix platforms. Geocoding of the data is not possible and so major updates are required.

The EORC mosaicking software uses a tie point initially.

Gamma remote sensing. InSAR method which starts with orbit data then generates a simulated SAR image (or other geocoded image) to automatically rgistered. K&C script is already developed although some geolocation areas.

SARscape (http://www.sarmap.ch) is bundled with IDL/ENVI and is largely for interferometry but can geocode using the GCP method. The K&C script is already developed and working.

Key questions are that image strips should be in the mosaics and which image strips should be 'on top' in the overlap region.

The summer 2007 acquisition of dual pol data will form the main initial mosaics of north and south America. The ScanSAR data is to be used for establishing the seasonal variation. The dual polarisation will be 90 m and this will be equivalent to the SRTM although *there was a strong request for data to be generated at 45-50 m*.

There was a need to consider the use of other registered datasets for orthorectification in flat areas and particularly where flat and mountainous areas occur within the same frame or strip.

M. Shimada gave an status report on the mosaic generation. JAXA is generating browse mosaics for all data and regional mosaics (fine resolution) for SE Asia, Australia and Japan. JAXA also needs to maintain the SAR processor and in particular the STRIP mode SAR correlator and the SPECAN processor for SCANSAR and browse products. Data will then be distributed to the users.

Examples were presented for two cycles over South America (browse mosaics) and also for Antarctica (cycles 8, 13 and 14). Two mosaicing methods are used; slant-range mosaic and orthorectified mosaic. The orthomosaic maintains better geometric accuracy and so this is being used. The software is also been debugged which occur because of changes in SWST and PRF. SCANSAR far range defocusing also needs to be analysed as causing a major problem with the data. The mosaicking software is also been updated to correct for banding. Memory allocation errors have also been fixed; path interferometry is awaiting evaluation. The antenna pattern for 343HV is to be updated. Coregistration of the SCANSAR image seems erroneous when contains PRF changes. Report any defocusing to M. Shimada, particularly in the far range where blurring of the images occurs. These data will then be reprocessed. This can be done by cutting different sections of the image although a permanent solution is being sought. The suggestion was made (by A. Rosenqvist) that cutting ot strips might be routine for the Amazon but this depends on a visual evaluation which is needed for everypass. *Recommendations to JAXA are required.*

The method of mosaicking involves:

- SRTM simulated SLC SAR image is generated.
- Offsets (azimuth and range) are generated between SLC SAR and SLC simulated using 400 GCPs (half pixel change leads to a time shift). A very good match is obtained but the delay between the transmitter and the receiver is included in the second process and this allows the SLC SAR image to be regenerated.
- Using the SLC SAR simulated image, the image is georeferenced to Mercator SAR image where the resampling from the SLC SAR images will be used.
- This image is then pasted onto the campus (no co-registration is needed but there is tuning in intensity across and along the path for continuity.
- Geometric error is measured using the Landsat image.

Current products include Japan, Samatra and Kalimantan (HH). An equal latitutde longitude coordinate system is being used. The accuracy is < 50 m in latitude but is slightly greater in longitude (up to 100 m). The average is 32.39 and 41.72 for latitude and longitude respectively at 50 m pixel spacing.

There is some slight banding between passes which is due to antenna pattern. The off-nadir (incidence) angle changes along the track and so there is variation across the mosaics (e.g. in Australia). These errors are being corrected. Across the Amazon, there is considerable variation in incidence angle (SCANSAR). Suggested that the far range be used ‘on top’.

In summary, the first version of the southeast Asia mosaic will be released by the end of February. Australia and Japan will be released next (although date to be decided0. The antenna elevation pattern (FBD 343HV) will also be corrected for.

The tiling of mosaics needs to be considered as NASA are tiling to the SRTM mosaics but other options are available.

A. Rosenqvist outlined the generation of mosaics for Africa, Siberia, Europe and French Guyana. Africa and FG mosaics will be generated using Geographical coordinates. Sibera and Europe will be projected to Albers conical. 50 m SCANSAR mosaics will also be generated for the Congo River Basin, the Okavango Delva and the Ob River basin. Mosaics for Africa and French Guyana will be generated during the early spring of 2008, whilst those for Siberia and Europe will be generated during the summer and autumn of 2008.

Geocoding is achieved using the solution of a range-Doppler equation. SRTM and GTOPO data are also been used in conjunction with JAXA orbital data. Radiometric revision is undertaken to consider the effective scattering area and radiometric loss. Concern about radiometric calibration. The geometric accuracy was less than 1 pixel. Noted that the HH, HV and HH-HV (DN values) gives a good display when stretched. *Recommended that such mosaics be generated where data are available globally.*

General discussion on data issues

Main issues that have been raised include:

- <u>SLT strip product artefacts</u>; in long strips provided by JAXA, the longer the strip, the more the image disappeared out of the frame in the form of dark edges. JAXA has a list of strips where these occurred and have been reprocessed. *Such strips need to be reported back to JAXA. Requested that K&C members have the list of affected images and that these are then replaced when appropriate but the originals are retained.* Data from August to mid September, 2007 might have this problem.
- <u>Near range radiometry</u>; in some passes, and in the near range, blurring and a slight darkening effect occurs because of range ambiguity and no correction is possible in these strips. In SCANSAR, there is a similar problem.
- <u>Changes in azimuth spacing</u>; There is a change in the azimuth spacing along the track and as a function of PRF. In this case, the values based on the first PRF are used. Suggested that there is a possible change in the azimuth spacing along the K&C strips. 1500 km corresponds to one PRF so over South America, may have two PRFs and the join may be over a specific target site. Gamma noted a change in azimuth spacing, particularly within longer strips; the solution is to base the simulated data based on time.
- <u>Consistency in mosaic generation</u>; The mosaics generated by JAXA, JRC and NASA needs to be consistent in terms of resolution etc. Consideration should also be given to areas where the terrain is level and there are no features for matching using the SRTM.
- <u>Strip coverage</u>; Some strips started at a different location compared to what was originally requested (L. Hess). *Recommended to report errors to RESTEC and also to look at the browse images.*
- <u>FACTOR-M Definition</u>; The FACTOR-M documentation needs to be put onto a website including a key to the file. A Japanese format document is available but a fuller description is needed to establish which information is occurring. There are 1800 fields for which information is needed. *Solution is to translate and to put onto a website if time is available.*
- <u>Discussion board</u>; A number of questions are repeatedly asked and so these should be placed on the K&C wiki site.
- <u>Ground range data</u>; Non-overlap of adjacent strips occurs within the ground range data. The shift is primarily in the east-west direction. *The best approach is to use a higher order* polynomial equation and also consider the geofactors, information on which is a subset of the FACTOR-M file. Note that the coordinates of the four corners are correct but those in between are not and so adjustments need to be made.

ALOS K&C Wiki site

R. Lucas presented on the wiki site. Initially, this was set up using Microsoft Sharepoint but there will be a transfer of material to a wiki-type site based at the Institute of Geography and Earth Sciences, Aberystwyth University. An overview of capability (updating wiki pages and word documents) was given by B. Chapman and R. Lucas to demonstrate the ease of use. The new site will be up and running by the end of February and the site will be supported by Rachel Bott (Aberystwyth University). Key documents that need to be updated and kept current on the wiki site are the Science Plan and also individual project reports. Requests for processing information were made and input from JAXA was desirable.

K&C Project Overviews

Deserts Theme

Water prospecting in arid Africa.

Using optical data, only the surface layer is observed in desert areas. However, L-band microwaves penetrate through the surficial deposits and provide an overview of palaeo-hydrology. Several sites were acquired during cycles 12 and 13. Further data from cycles 20 and 21 will also be used and 80 % of the area has been covered. By February/March 2008, a radar mosaic of the Sahara and Arabia will be generated based on HH data. A ratio mosaic (HV/HH) will also be generated by May 2008 and a one year change map will then be produced in December, 2008. The mapping will be extended to other arid regions, including the Gobi (part of A7), South Africa (E6 & E7) and Australia (part of C3).

Currently, more than 100 strips have been processed (at HH). Some strips are missing. Reported that the data quality was very good and comparable to SIR-C SAR data. Compared to JERS-1 SAR (penetration of up to 1 m), there is greater penetration (20 cm to 2 m) of the surficial material and also better resolving because of the low noise level and the greater spatial resolution. Significant geological features can be observed and potential for oil and water exploration. An interpretation of the mapping is still required. Some of these features can be seen from high resolution (1 m) optical data and others are obscured from the SAR by larger sand dunes.

For the analysis, access to optical coverage is needed (as provided by Google Earth). A web map server was set up within the laboratories allowing data to be displayed on Google Earth. Suggested that the data products are provided to JAXA.

A number of issues were raised regarding the data including missing strips (cycles 12 and 13; 47 strips are needed). The problem with geometrical accuracy has been solved (Shimada was thanked for his assistance with this). Large areas without any holds are essential, particularly when dealing with hydrology. Presented a specifc example of a paleo-lake in Sudan. Here, some Wadis were observed but no real information on the past environment was provided. The PALSAR provided good information on flows and watersheds, but missing strips lead to uncertainties in the hydrology. A strong correlation between ‘radar’ rivers and SRTM topography was observed but not in all cases and so some further interpretations are needed.

Land degradation

This project seeks to assess land degradation in parts of Africa. The project uses high resolution SAR and optical data as well as lower medium resoluton optical data as input to a neural network to produce a map of cultivation extent. The group is using a combination of Landsat, SPOT and C/L-band SAR as well as MODIS data, for example. The test areas are in south west Africa (Zimbabwe, Malawi) and west Africa (Senegal). PALSAR data provde a very clear overview of land cover patterns. By integrating these data, crop acreage maps are produced which indicate cultivated area. For the project, ALOS PALSAR increase the tempoeral resolution and also complement C-band data, particularly in detecting initial vegetation growth. Long-term L-band coherence (in image and SCANSAR mode provides significant inforation on land degradation.

Wetlands Theme

Global inundation mapping

The MEASUREs project is dedicated to Making Earth System data records for use in Research Environments and the objective it to produce a global inundated wetlands Earth System Data Record with an ALOS-based high resolution comonent and a long-term coarse resolution component derived from multiple satellite data sources (e.g., SSM/I and ERS Scatterometer). Work during 2008-2009 will focus on the existing KC prototypes.

Data used include FBD SLT WB SLT and FBD and WB (SCANSAR). Many of the passes have been processed. Some additional acquisitions have been provided for southeast US. Some issues; with the fine beam data, there are missing sections at the start and/or ends. The reasons for this is tha the acquisition might have stopped before the north coast of South America or could be the cutting algorithm. These passes will be checked to establish the reasons for the omissions. A similar issue was observed in Siberia where a gap between cut strips occurs. Some geolocational errors (by about 5 pixels is evident in some passes. As scattering occurs from rough water surfaces, the near range portion is not useable for mapping and so not all of the data are usable. This effect is attributable to the different incidence angle compared to the JERS-1 SAR. The main problem with this is that there is difficulty in distinguishing a rough surface from macrophytes.

The ALOS does provide better definition of wetlands in savanna areas compared to the JERS. However, with the better noise floor and dual polariation, there is better definition of the ponds, including where sedges occur. There is good discrimination at the lower range of the return. There is also potential to differentiate flooded forest from flooded palm by integrating the HV channel. Some confusion still remaining between palms and regrowth (e.g., dominated by Cecropia).

Presented a dynamic map of flooding across the Amazon region across a one year cycle, as observed from SCANSAR data (8 images included). The sequence provides a very comprehensive overview of flooding in large rivers but is less discernible in the smaller streams. The information can be used to support anti-pollution measures and also optimising fishing and flood protection/warning. As a minimum, 5-6 scenes per year are needed and in each transition, new information is obtained. The peak flooding is also better captured by increasing the temporal coverage. Highlights the requirement for frequent temporal coverage of wetland areas to understand dynamics. From these data, masks of flooding can be generated representing the dynamics of the vegetation occurring within the varzea areas.

The case of the Napo River and the implications of developing transport systems was also presented. Within flooded areas, information on the distribution of macrophtypes and other vegetation is important for assessments of biodiversity.

Brazil are currently planning on launching an L-band SAR for 2012 which can complement the data from ALOS and extend the time-series.

The K&C provides an opportunity to develop systems for mapping wetlands based on the available ALOS data and also algorithms. Such developments can be undertaken using the existing datasets (without having to wait for the mosaics) and could lead to new ways to defining wetlands.

Supporting the International Water Management Institute
L. Rebelo noted the work of the IWMI which focuses particularly on water management and the environment and there is also a strong drive to develop a global wetland map and inventory. This latter project was set up to support regional to global mapping and monitoring and planning. Baseline datasets are often incomplete and inconsistent and mapping often does not include inventory. As part of this, an open partnership for global wetlands and inventory in support of Ramsar and other biodiversity conventions/initiatives has been launched. The K&C should logically fit in with the partnership project.

Within the K&C, focus is on the Zambezi and upper Nile with a view to producing seasonal inundation maps. The Nile contains extensive wetlands and floodplains, supporting fisheries and agriculture. Dams are planned along the rivers so this will impact downstream. The work will quantify the dynamics of the flooding. The Sudd Wetland is being studied in more detail as little is known about the state of the ecosystem. Impacts include the continuation and rebuilding of the Jonglei canal which could reduce flows by as much as 20 %. ALOS provides an option for quantifying wetland dynamics in a quicker time-frame than conventional methods.

The projects will look at the impacts of reducing water flows on the ecosystems downstream with a focus on better management of resources. In the Sudd wetlands of Sudan, the focus is on improving livelihoods and ecosystem services. Within the Zambesi, efforts will focus on monitoring flooding and providing more information on seasonal wetland extent and inundation patterns. Current and future scenarios of damming will also be considered as will varying patterns of flooding and inundation.

Further work is focusing on the use of wetlands for agriculture in southern Africa. Prioity wetland sites have been selected across southern Africa with many threatened by population pressures and exploitation of resources. Examples were presented of the Lake Chilwa wetlands in Malawi and Gorongosa National Park in Mozambique (Lake Urema). The projects will therefore provide new information on inundation mapping.

Irrigated Rice mapping

B. Salas presented on irrigated rice mapping. The products to be developed include improved maps of the extent and location of rice production systems and the frequency of production. The start and duration of flooding and approximate planting and harvesting dates. The main tool will be the multi-temporal SCANSAR data as frequent revisits are provided. Examples were presented of ALOS PALSAR data in Java where fish ponds, different rice production systems and the distribution of rice are evident. To estimate trace gas emissions, the DNDC model will be used and natural woodlands will be considered.

The multi-temporal SAR data will be used to provide input to the models and climate and soils data will also be used to produce estimates of greenhouse gas emissions and water yield. Key aim is to quantify the Redux dynamics which relates to methane dynamics and emissions. The analysis is to be extended to natural wetlands to estimate methane production and seasonality.

Data issues relate largely to the provision of the K&C products as not all data have been delieverd. A large amount of ground truth data have been collected to support the analysis. Prototype areas include the Qintang River Watershed, Zhejiang Province in China and also Java and Central Thailand. Several approachs to rice mapping were considered. Within the Fuyang City Administrative area, maps of rive and other land cover types were classified and accuracies were generally greater than 90 % for rice (users). Misclassifications were largely associated with drylands and orchards and this might also be attributed to registration issues. Studies using multi-temporal data suggest that there is considerable change which can be exploited to assist classification with the ALOS PALSAR data. In Haining city in China, biophysical measurements were taken over the period of the data acquisitions and to support simulation of the SAR return. Several funding bids have been successful or are in the course of assessment. A further research objective is to consider the links between migratory birds and domestic poultry and the spread of avian flu. Other proposals have been submitted to look at the regional estimation of trace gas emissions from natural and anthropogenic wetlands.

T. Le Toan noted that there was some overlap with the project and there is opportunities for collaboration within the K&C.

Assessment of flood extent, inundation pattern and duration mapping, Mekong River Basin and Alligator Rivers Region of northern Australia.

T. Milne described how ALOS PALSAR data are to be used for mapping of wetlands in the lower Mekong River. 30 Billiom dollars of infrastructure development is scheduled for this region and so there is a need to make assessments of wetlands and their status and condition. From a technology point of view, aim is to establish a method that is consistent.

Research is focusing on a number of sites including the Tram Chim Reserve in the Plain of Reeds in Vietman. Attention has focused on time-series datasets for examining change. PALSAR data have been considered and colour composites of images show changes in the dynamics of the wetland areas. A second study area is Tonle Sap where a wide range of airborne (e.g., AIRSAR) and spaceborne (e.g., ASTER, JERS-1) data are available. Temporal changes in inundation can be observed using time-series of ALOS PALSAR datasets and reflect the changes in water flows (e.g., those associated with rice production). Higher level of detail available within the ALOS PALSAR data and clear patterns of water distributions are observed. Changes within the natural vegetation are also detected. Able to detect fish farms and floating villages and these are more discernible compared to previous images. ScanSAR data provides a wider and more comprehensive overview of land cover types. SRTM data have been used to model the water flows and distributions within the river system.

Mangrove monitoring in the tropical regions.

R. Lucas presented an overview of research on mangrove mapping in the tropics and subtropics. The main objective is to obtain maps of mangrove extent and potentially structure, biomass and species composition and also to identify areas of change (largely through comparison of JERS-1 SAR and ALOS PALSAR data). The main study areas are in northern Australia, French Guyana, Belize and the mouth of the Amazon and strip data have been obtained for these areas. Work has focused primarily on pre-processing the available datasets and establishing within the framework of a GIS. Research was presented on the mapping of mangrove type based on a combination of SRTM, Landsat-derived Foliage Projected Cover (FPC) and ALOS PALSAR HH and HV data. Higher biomass forests were retrieved as these supported a low L-band SAR backscatter but were > approximately 10 m. Four biomass classes were defined for an area near Hinchenbrook Island in the Wet Tropics of Australia. The maps presented are typical of those to be produced for the study areas.

Wetland mapping in the Pantanal

M. Costa explained how she was developing a classification of lakes in the Pantanal and will be based on a backscattering library for different lake types. The database of lakes is being organised in Google Earth and includes detailed ground truth and descriptions of lakes, including geochemistry.

Some issues were raised including those relating to orthorectification. Field work is to be conducted in June/July 2008. The geometry problem has now been solved and so it is possible to consider change across the area. Data are time-separated by at least 10 years and the ALOS PALSAR data provide a very good overview of the lake systems and particularly the definition of the boundary. A combination of ALOS, RADARSAT and JERS-1 SAR is also being used to establish the types of lakes occurring in the area. Differences between lakes with hard and brackish water can be observed which is largely a function of the vegetation.

The strip data are to be used for providing a map of flooding within the Pantanal and to consider change. Different lake types will also be classified. Problems include the issues associated with the ground range strip data.

Global lake census

K. Telmer is attempting to create a single seasonal snapshot of Canada's lakes using PALSAR data and generate a lake size distribution for the region. From this, carbon fluxes can be parameterised for each of the lakes. Preliminary results show the considerable improvement obtained by using ALOS PALSAR data, particularly in terms of estimating the extent of smaller lakes (which store the most carbon). A national map of lakes for Canada was used to assess the accuracy of lake classification (size and extent). Established a similarity between these existing maps and the ALOS PALSAR data. For the larger lakes, both datasets match well although for the very small lakes, the PALSAR is under-estimating although the base map may also be incorrect. Suggested a 2.5 % difference in lake area with most errors being for those that are small in area. The accuracy of large lake detection is much higher. In the north west territories, the densities of lakes are very high and so this area will be the focus of future ground truth work. This area is also vulnerable to climate change. Problems are associated largely with the geometry as data was provided in ground range. Further problems result from the relatively coarse spatial resolution of the ALOS.

Monitoring artisanal gold mining
K. Telmer is using ALOS data in Indonesia to detect mining areas. For the study area, interferometry of two PALSAR scenes was undertaken to locate areas that had been mined for gold (both in the past and currently). The focus is on small gold mines around the world.

Mapping peat swamp forests
M. Quinones explained the mapping approach using a polarimetric classification based on Marcov Random Fields. The approach is not affected by speckle and also multi-dimensional data can be combined. Multi-temporal data can also be combined. In this approach, all the data are read and where there is a minor change, then a new class is produced. However, need to be careful in the classifications so the exercise was to test how robust this approach would be with ALOS PALSAR data.

The classification generates a series of models (defined by the user) and statistically separates the classes. The changes can be attributed to biomass, structure or biomass burning for example. Showed an example from central Kalimantan which is an area of peat swamp forest and where the mega-rice project is located. Many NGOs are working in the area and need classifications to assist with management of the area. The area is very complex and so classify first the forest area and then the non-forest, producing 15 classes per piece, giving a total of 30. The legend therefore had to consider the various types of information and present this so it is usable. A Bayesian information Criterion defines which of the models have the most information.

For classification, the 50 m pixel resolution data are being used as input to an unsupervised classification. From this, initial vegetation types are identified and a legend produced that conforms to international criteria. The classification is based on the LCCS so that the legend is consistent. This approach is recommended for many forest type classifications. Based on this analysis, a final legend is produced. The dry crop class was considered useful for the user but ws difficult to classify, even with information from the field.

A mosaic was generated for the area and a considerable amount of information was provided. Areas of clearing and also the forest and peat swamp areas were evident. The composite images is based itself on composites of other data and of the 60 or so classes, the average accuracy was > 80 %. Large differences in the forest structure were observed and burnt areas were easy to observe. Mangroves were confused with peat swamp forests. Hot spot maps were also produced to demonstrate monitoring of fires. Maps of IPCC land covers which can be associated with carbon values can be used to support REDD monitoring. The project aims to produce such maps for parts of south east Asia, including Sumatra.

Probems included separating flooded forest from burnt areas and also mangroves. This could be solved by including more data and also HV data. A combination of datasets can be used to map land covers more accurately. Maps of available data have been generated. About half of the passes have been received. Very clear observations of Riau using ALOS PALSAR data and plantations are evident. Mangroves are also particularly evident within the north of Irian Jaya and key areas include Riau/Jambi and the Kampar peninsula. Mangrove extent and properties will be retrieved and also maps of tropical peat samp forest extent and vegetation and hydrological characteristics will be generated. Mapping of vegetation types will also be undertaken in new Guinea and there will also be maps of tropical forest and land cover.

The land cover map is of high accuracy and is being used by local and regional governments in central Kalimantan. SARVision give priority to areas where users are active and enthusiastic. Systemmatic processing is being undertaken in conjunction with the national and regional governments. Additional projects are also based in the Guiana Shield. Products will be provided at variable (medium, high) spatial resolution. Also aiming to produce ecosystem maps based on various types of data.

The classification algorithm has reached maturity and is ready for quantifying lare areas. Field data collection is being undertaken and has increased understanding of ecosystem dynamics and land cover change. All products are developed in co-operation with local users.

Earth Science Data Record Assembly

K. McDonald presented information on MEASUREs, the objective of which is to develop a dataset to facilitate global and regional studies of the role of inundated wetlands in studies of climate, biogeochemistry, hydrology and biodiversity. Another activity will focus on land surface freeze/thaw status particularly in areas where the influence of vegetation productivity is significant.

MEASUREs is a cooperative agreement and Diane Wickland has been assigned as the NASA project scientist. There are two components. First, regional inundated wetland datasets will be generated from SAR. Retrospective mapping will occur using JERS-1 SAR data and datasets generated will include wetland vegetation type (non-vegetated, herbaceous, shrub, woodland and forests) and inundation state as well as annual inundation duration. A global monthly inundation dataset will also be generated. Attention will focus first on the Americas. The algorithms will be run globally and will be evaluated based on other projects within the K&C (e.g., for the Pantanal). Noted that there will be links with other K&C members.

The global algorithm to be produced will be made available such that any one can reproduce the results with the correct input data. The project focuses on the use of existing algorithms which has been proposed to NASA. One of the requests was to make the backscatter data generally available but there was a need to refer to the JAXA data policy.

The algorithm was developed for a number of sites. The algorithm uses regional training datsets through a decision tree and segmentation approach. In the tropics, an enhanced algorithm was generated. The decision tree is based on the random forest approach and is statistically based. The algorithm generates a series of decisions and allows the correct decision to be made; it also considers the timing of the mosaic set and generates accuracies approaching 90 %.

For the global monthly inundation data, the Legacy Algorithm is used and considers SSMI/I, ERS and AVRHRR data and produces a map of fractional inundation. The objective is to upgrade the satellite input using AMSR-E and MODIS as well as topographic information. A key component will be to harmonise with high resolution datasets. Examples were presented globally and for Eurasia and the resolution will be 25 km.

The assembly of data for freeze/thaw state is a further project. The SSM/I can provide information on the Pan-Arctic growing season and these data will be included as well as SAR data (JERS-1 and ALOS PALSAR). The analysis will cover a range of sites of varying complexity. Studies will focus on sites in Alaska and Canada and will build on existing studies. The data will be distributed through the University of Montana web portal where a suite of productivity information are already provided routinely.

Some issues were raised. In particular, there is some re-scoping under consideration and options are cutting back on the JERS-1 and also the regions proposed for the PALSAR. Activities will be moved out to the later regions. Data distribution requires the need for a long term data archive and the Alaska SAR facility is one option. ESIP Federation membership was suggested in the original proposal but not seen as critical by NASA. There is also the need to form a review board of independent scientists who can assess the quality of the data products for scientific applications. An option would be to ask NASA to work within assisting on these panels.

Using Google Earth within the mosaic theme

B. Chapman explained how the ALOS mosaics might be displayed within Google Earth. Kml files can also be directly overlain in Google maps and software on a webserver can also be combined (i.e., put kml files on the webserver). If a full resolution image taken into Google Earth, you need to make a pyramid of imagery.

Mosaics used to be static but possible to now make these so different representations can be provided. Mosaics are also useful as they simplify area calculations and science product generation. A problem with mosaics though is that overlap regions can be lost but out of season or replacement data can be included. The MEASUREs project aims to enable user-customised mosaics.

When mosaicking, it is useful to have flexibility in regards to which images to use (e.g., on top). The idea is to go to a website, load up the kml files, chose the images on top and then stitch images together and download as an ftp file. The option to produce mosaics in different projections is also desirable. The science products can also be linked.

Practically, you create a placemark (in Google Earth) which links to the webpage. A form on this webpage executes a program (perl based) on the webserver which indicates how you want the images to appear. Another script resolves any conflicts and then another script stitches these together into the mosaic. A component of this is to change the resolution so maintain detail as zooming in. The placemarks (pins) are interactively selected and take you to the form where you have options to select the images used for the eastern, northern, southern or western sides. Mandatory and preferred options are allowed. A text file is then created and this is then used in the mosaic generation.

A related application was demonstrated for UAV SAR as it shows that three – dimensional information might be included. Such an approach might be useful for looking at inundation.

Displaying ALOS PALSAR data in Google Earth
A. Mukaida gave a presentation of Google Earth and how ALOS PALSAR data might be integrated. For generating kml files, the RAW file (BSQ) is used. The projection is equal area latitude and longitude. Radiometric correction and stretching is needed and stretching for display. The data are 8 bit and the image size and the coordinates of the four corners are also used for location.

Four layers of imagery are produced in a pyramid structure. Only the top image layer needs to be downloaded as a kml file. Google Earth then needs to be started and the mosaic will appear. The kml file (top layer) is held in a directory which contains information on the type of mosaic (e.g., 500 m), the cycle, the continent (e.g., South America), the mode (e.g., FBS) and the polarisation (e.g., HH). A 200 m mosaic will also be generated for each year of observation.

Future plans include the addition of annotations and links, the implementation of a stretch algorithm for better radiometery, the production of a colour composite polarisation image (the RGB image is too heavy) and facilitating changes in map projection for higher latitude mosaics. The website can be accessed as follows:

http://www.eorc.jaxa.jp/ALOS/ge/demo080121/PALSAR_DEM/html. For ID and password, contact Akira Mukaida.

You need to download the kml file and Google Earth will automatically be generated. The resolution is replaced so the detail is increased. The annotation showing which paths are available can also be included. If zoom into more than 100 % of the resolution, then the image can no longer be displayed or the image has to be interpolated. Dark areas indicate missing strips but some interpolation is provided as a temporary infill. The transparency of the image can be changed so can see the standard Google Earth imagery below. Options are available also for displaying RGB images.

Viewing ALOS PALSAR data in Google Earth
S. Lopez presented the use of a WMS web map service which is the standard defined by the OGC Open GIS Consortium. Most tools have WMS support. Three kinds of requests are supported including XML file uery, returning available information of objects and requesting image and map files. The advantages are that radar data

import in Google Earth is provided. All data are centralised on one server and the number of formats for each image is reduced (e.g.k only jpg and jgw for GIS software). There are a wide range of supported data formats including Gdal library. Data sharing is each (as a map file) and security is provided. Mapserver is open source and works on both linux and windows. Once server is configured, Google Earth requests are possible and there are then options for displaying images (e.g., path, version, projection, size, transparency, formats, boundary boxes etc.). The map file is the access point to the server and a simplified overview of the content and layout of this file was presented (on powerpoint presentation). For generating mapfiles on demand, a web interface was created with PHP/Mysql. To process strips, a shell script runs twice per day which checks and downloads new strips from the JAXA ftp server. C programs are then used to extract Sigma0, correct geometry, enhance the imagery and create jpgs and jpw format files. More than 200 strips have been processed for the Sahara region. A video demonstration was also provided. Tools are available at:
\WMS webserver: mapserv er.gis.umn.edu.
Open GIS Consortium: www.opengis.org
Project: \\remotesensing.org
Gdal: http:\\ www.gdal.org
Google Earth: http:\\earth.google.com

Forest structural mapping in northern Australia.
R. Lucas provided an overview of the datasets being used to support the mapping of forest structural formations (including regrowth) in Queensland, Australia. The Injune Landscape Collaborative Project has a generated a substantial dataset of LiDAR, hyperspectral and RADAR data. From these data, tree level maps of stem density, component biomass and species distribution have been generated and methods have been established for linking these data to produce maps of forest community composition. For the full range of forest types across Queensland, LiDAR and other data (ground data, drive by views, interpretations of aerial photography) are available. Statewide coverage of Landsat-derived Foliage Projected Cover (FPC) are available to support the registration of the data and also the retrieval of forest attributes and structural types. Full aerial photography interpretation of the State has been conducted by the Queensland Herbarium and these data provide a comprehensive dataset on which to base the interpretation of the ALOS PALSAR and associated datasets. JERS-1 SAR datasets are also available for the region and provide an opportunity for time-series comparisons.

Using a combination of ALOS PALSAR and Landsat-derived FPC, areas of regrowth but also regrowth stage are able to be mapped, simply because many areas of regrowth have a high FPC but a low L-band HH return. Where L-band returns are greater, this reflects the structural development of the forests. Areas of dead standing timber associated with stem injection/poisoning of trees and also those affected by drought can also be detected as these exhibit a low FPC and a high L-band return because of direct interaction with the woody material. The presentation also highlighted that P-band data does not necessarily interact with all of the woody biomass and that the integration of these data with that obtained at L-band can potentially lead to better estimation of the total. An alternative approach to biomass was presented that considered this differential interaction of microwaves and an estimation algorithm. The use of different datasets (e.g., Landsat and ALOS) for discriminating and mapping forest structural types using eCognition was also demonstrated and the possibilities for regional mapping using a rule-based approach were highlighted. The use of multi-temporal JERS-1 SAR and ALOS PALSAR data for detecting forest degradation and thickening was also highlighted and airborne datasets are to be acquired again over Injune to support the intepretation.

The project is utilising Gamma software for processing the datasets and in particular has focused on the use of Statewide Landsat FPC and panchromatic coverages for orthorectification, particularly in areas of limited topographic relief. The procedures for processing of the data are now established. Multiple passes of ALOS PALSAR data at different incidence angles and frequencies over Injune are also been used to establish the capacity for retrieving forest structure, biomass and community composition and accurate registration of these data has been essential to allow the Injune datasets to be effectively utilised. A key finding has been that the retrieval of biomass is dependent upon the incidence angle, which has implications for the mode of operation in future sensors.

INPE's Amazon Program

D. Valeriano outlined the PRODES, DETER and DETEX (Detection and Monitoring of Selective Logging Activities) programs. The PRODES provides a yearly inventory of deforestation rates and uses high resolution optical data (Landsat, CBERS, DMC and SPOT). Cloud cover is a problem and is persistent. Multiple sensors are used to reduce uncertainty associated with cloud cover but despite this, an average 15 % of the area is cloudy.

PRODES runs every year and maps cumulative deforestation but does not consider regeneration. PRODES supports deforestation control policies and assessments of these and also increases public awareness. Now, is being used to support carbon emission reports for the Kyoto Protocol and REDD and estimation of biodiversity loss.

DETER (Fast Detection of Deforestation Events; acronym means to halt) provides, for IBAMA, the location of new deforestation. Uses MODIS and AVNIR-5 data and the raw data (rather than mosaics) are used and so cloud is a particular problem. 2-3 surveys are conducted per month. Applications include law enforcement, early warning for policy makers and public awareness. Deforestation rates have been reduced by about half as a consequence.

ALOS PALSAR data are needed because the deforestation is starting to move into the rainy season. This may be a climatic effect but is a new phenomenon. The greater deforestation was in Mato Grosso but also Roraima and hence there is a need to use ALOS PALSAR data to overcome the cloud cover.

The products proposed from the ALOS data include the generation of deforestation estimates for areas of persistent cloud cover. There are also significant areas of regeneration and so the ALOS provides an opportunity to establish how much regeneration is occurring and also what the errors might be in the deforestation assessment. ALOS PALSAR data are also to be used within DETER, at least during the rainy season.

The ALOS PALSAR was particularly useful for detecting regrowth and several examples of this were provided. The mapping of regeneration is therefore fundamental for regrowth detection. The shift of deforestation to the wet season is in part attributed to avoidance of detection and so ALOS PALSAR will contribute to the prevention. Fines have also been increased from approximately 1000 dollars to 3000 dollars which is a greater deterent as the subsequent sale of the land does not compensate.

ALOS is also now starting to create a RADAR culture in Brazil and particular effort needs to be made to achieve this. There is also a need to prepare the grounds for the MAPSAR mission which is planned to provide L-band coverage across the region (L-band HH/HV as a minimum). Demonstration products are also needed to convince funding agencies of the need for ALOS PALSAR.

Satellite monitoring and the use of SCANSAR data as a complementary dataset for fast detection of deforestation.

H. de Mesquita provided an overview of IBAMA (Brazilian Institute for Environment and Renewable Resources). The ALOS PALSAR SCANSAR data are particularly useful because of the high temporal frequency of observation. IBAMA works with INPE (satellite provision of deforestation) and SIPAM (airbone sensors and systems for environmental protection in the Amazon). With this information, IBAMA produces law enforcement data which are easy to understand. IBAMA works together with DETER, PRODES and DETEX and has a well-planned system of where to focus. IBAMA uses a high quantity of high resolution images and these are used for checking information (e.g., from MODIS). Errors are corrected for. Information is also contained within the database on the licenses issued for land exploration and information on the owner and the types of land use is included.

The main reason for linking with K&C is that there is the need for enhance the DETER system and in particular to expand the monitoring area per time. This will improve the data provided to the law enforcement agencies and will intensify IBAMA's capacity to clarify the time-series datasets (in terms of old deforestation, regrowth etc.). The ALOS PALSAR can provide the capability also for cloud free observations. The level of cloud cover varies seasonally and there are only small windows.

IBAMA is required to receive and process images rapidly, to have a good knowledge of image interpretation and to store and manipulate a substantial dataset. JAXA is providing browse SCANSAR images by internet to assist with this process. From August, 2008 until December, 2008 data were provided within eight days of acquisition, with a range of 2-20 days. The frequency of provision is increasing. In the Amazon region, 8 strips covering 49 % of the Amazon were provided in Cycle 13 but in Cycle 15, the entire region was imaged. In the Atlantic Forest region, coverage was lower but still significant. The image meta_data was also provided which allowed registration of the images and greater familiarity with the data is increasing processing speeds. The four corners of the image are used to convert the entire image to the correct projection but there were a few geometrical problems although these have been largely resolved.

The use of ALOS data was demonstrated for an area in Para, Brazil (200 x 200 km) where significant areas of deforestation occur. Here, the data are been used to establish methods for real-time monitoring and also for assessing the capability of SCANSAR data for discriminating recently deforested areas. A number of problems have arisen including the detection of forest associated with the time when deforested as regrowth etc. can cause confusion. Deforestation polygons age from 15 days to > 1 year. At the start of the dry seaon, most of the polygons are older becaue of a long period without clear images. The ALOS PALSAR can provide a more up-to-date assessment of when deforestation occurred. In many cases, an area is observed as deforested although sometimes it is difficult to establish how old the cleared areas are. The ALOS can address this issue.

Practically, the SCANSAR strip data are georectified and subset (2^{nd} order). DN values are converted to the normalised radar cross section (dB). Areas detected previously by PRODES are masked to eliminate very old (> 1 year) areas of deforestation. Data extraction occurs for all sets of DETER deforestation detections within 2007 and also for the rainforest. The analysis indicated that the older polygons, the signal was low but was greater for those that were more recently deforested. Noted that very old deforestation has a low signal but there is a very high backscatter from recently deforestation because of the presence of dead trunks and other material on the floor. The stage of deforestation can therefore be assessed.

A lee sigma speckle reduction filter is applied to the SCANSAR data and then a simple classification is undertaken based on thresholds of data. An illuminated topographic image based on the position of the SAR sensor is also used to exclude area where steep slopes lead to an exaggeration of the SAR signal. The analysis revealed areas where new and old deforestation occurred (mean for recent deforestation was -5.31 dB and for old deforestation was about -7 dB). Some areas of older deforestation seemed to be evident outside of the areas. Also, some deforestated areas supported regeneration. In subsequent seasons, the interpretation can be checked. Some areas that were deforested but occurred in areas of high relief were omitted and so this presents the greatest issue. The work established that ALOS PALSAR can greatly assist with the monitoring of deforestation and is a significant and important contribution to the existing programs. The conclusions were that the use of thresholds was sufficient for operational detection of deforestation and that the data complemented that provided by optical sensors. Some areas may not be detectd because of the backscattering ambiguity between the medium age deforestation areas and the native preserved forest. Where some polygons are intermediate in backscatter between the newly felled areas and the old deforestation and these appear similar to the primary forest areas.

IBAMA is also assessing the use of ALOS data for mangrove monitoring and changes in the Pantanal area. These areas are associated with flooded forest and so the backscatter values are going to differ. There is therefore a need to look more closely at deforestation on the floodplain. The areas affected are quite small (in terms of individual clearings) and also they are flooded and so there are issues in detection. A better approach to the mapping of such areas and also other more specific types of land use types.

For the mountainous areas, it was suggested that time-series datasets might be useful. It was also noted that deforestation rates are very high and that the quick response is essential. The results from this analysis are to be published in ISPRS.

Temperate forest mapping and characterisation

S. Quegan provided an overview of temperate forest mapping, with focus on the UK. The objective of the project is to map managed forest at a national scale and assess the level of clear cutting. A component is to estimate the age-class structure and also the biomass and to use this information to better quantify carbon pools and fluxes. The study focuses on the UK and also managed forests in France. 7 % of forests in the UK (of the 14 %) is owned by the Forestry Commission but information on private forests is lacking. These forests are managed in different ways and this has implications for the regional carbon budgets and how these themselves are managed. Management also varies between Scotland, Wales and England. Research has focused on analysis of these datasets although attention has also shifted to supporting REDD. The uncertainties in the global carbon budget were highlighted.

Biomass retrieval

T. Le Toan is considering the various algorithms for above ground biomass retrieval and for regional mapping of forest and forest biomass classes within prototype areas. The intended use of these data is to assess carbon budgets (carbon sources and sinks) in relation to post-disturbance forests. An approach being considered is to develop a biomass mapping algorithm using multi-temporal PALSAR FBD data and to assess regional mapping using PALSAR WB1. The prototype areas include central Sibera (WB1), France and Northern Spain and also Vietnam (FBD). A large number of strips have been delivered and these data are now being collated. The anticipated deliverables are an assessment of forest and biomass class mapping in Central Sibera (June, 2008) and the development of algorithms for forest and biomass classes using multi-temporal PALSAR FBD data. Collaboration will be needed with other members of the K&C. Maps of forest and biomass classes will be generated for France, N. Spain and Vietnam.

The main problem to date is that the SCANSAR data are not available yet for France and Spain. Work has instead been focusing on differentiating forest and trees from a combination of the HH and HV data. Noted that with one polarisation (HV) forests are confused with urban areas so the dual polarisation assists discrimination. Noted that there was an incidence angle effect on the biomass retrieval. Showed a general map of biomass classes which visually was sensible; these were generated using existing algorithms. The ALOS was also detecting smaller clusters of trees along the roads and in fields were included. These trees contribute significantly to the amount of biomass contained within an area and these areas are often omitted.

Biomass is estimated using an invesion based on an Bayesian approach. A prior distribution of the biomass is given locally and then the probability of having a biomass within this range is given. If the PDF is large, then enter as input or can have hard boundaries. The approach takes multi-temporal images which are filtered. L-band HV data are then used and inverted to produce a biomass map and the put in the pdf and using Bayes Theorem, establishes the uncertainty. Each region has a biomass distribution that might be used for biomass inversion as the PDF is considered.

The second thread attempted to establish whether it was possible to map forests and biomass using SCANSAR data. L-HH was affected by surface conditions which proved problematic. The Siberia datasets are used to support the analysis and in particular forest cover and type data are available. The chain of image preparation was undertaken with assistance from Gamma and normaliseation was undertaken for a local incidence angle and for an angular decrease correction. So, a geocoded normalised image (GNI) was used as the base for biomass estimation. Suggestions to JAXA were made that much of the ALOS data be prepared in this format. Analysis of the SCANSAR data indicated that there was a high level of variation between dates which was attributable to snow cover and rainfall and also the state of the snow (in terms of melt). The values of backscatter from the forest therefore varied. Noted a general increase in backscatter was observed with volume and the angular correction did improve the correction.

Other problems were associated with differences between the near and far range and some of this was attributed to spatial variation in rainfall within a strip. R2 values ranged from 0.55 to 0.76. Values for forest ranged from about -8 dB to -5 dB although there was considerable scatter in the relationships. In other forests, the overall range decreased. So, there is considerable variation as a function of weather. The analysis indicated however that the volume of forests < 50 cubic metres could be retrieved. An associatd biomass map was produced. When extrapolated across larger areas, then the biomass estimates were influenced by the radiometric quality.

Other observations on image quality were made. Errors up to 10 pixels in near range were observed whilst geocoding the SCANSAR strips. The lower radiometry of the near range is not desirable and some reprocessing is needed particularly if biomass mapping is to be undertaken. There is also a large amount of temporal variation and consideration of winter and summer imagery might address this. Radiometric distorations as a function of slope might be reduced by using SRTM although the coverage is lacking above 60 degrees. Other sources of errors are associated with cor-registration within the GIS and the information contained within the databases and also in radiometry. There is an increase in L-HH with biomass and classes can be mapped. Multi-temporal data will improve pixel inversion, particularly as the weather is an important influence. Recommended that a method for retrieval using HV be established and then provided to JAXA so can run through and generate for a wider area, with focus particularly on Siberia. SCANSAR is more problematic.

Forest mapping in Siberia

M. Santoro presented the mapping to be undertaken n Siberia focusing on forest cover but also disturbances. The areas is important as it was the area associated with the greatest temperature anomaly in 2007 by up to 4 degrees. Data have been requested for the winder and also summer and both FBS and FBD are being used. The problems with the data delivered is that some have not arrived as yet whilst the north-south extent of some is not as expected.

The processing steps used encompass the following:

a) generation of geocoded backscatter images from strip and full resolution data
b) generation of geocoded coherence images from InSAR winter pairs

The full resoluation data are processed and used within the GSE Forest Monitoring Project and K&C data strips are periodically geocded to low resolution to check the data coverage. The K&C products are generated at 50 m and will be commenced (either from Jena or Gamma). Future projects which can contribute to the funding of the work include FRA-SAR 2010 (DLR), Permafrost and GSE-FM.
Differences in the data between the winter and summer were shown, with a higher backscatter in the summer and also a greater contrast in HV. The geocoding of images is about 0.3 pixels in accuracy and this is typical where there is topography. Clear cuts are particularly evident within the images and deforestation is extensive as are water bodies, fire scars and agricultural areas. Mosaics for cycle 13 were generated; more information was available within the HV and there were gaps in the coverage. Gaps were also occurring between strips along the same track as if these had been cut too low. This was the same as with the Amazon datasets. These gaps are limiting the analysis of the data and hence the development of products. Smaller gaps were also evident between consecutive strips but this is because of a missing RSP pass.

The strips have been placed into Google Earth Geolocational errors are evient. Geocoding needs refining as the orbital data do not seem to be sufficient. Geocoding reinement is normally achieved using a DEM or another dataset 9e.g., Landsat). Geocoding refinment can be problematic from > 60 degrees N and where available optical data does not present features that are similar to the PALSAR data. As a result, mismatches may occur between neighbouring tracks. Refinement can be done with Landsat. The level of mismatch depends on the reference image used for the refinement. Refinement is necessary as there is an offset of 2-10 pixels.

For forest and non-forest discrimination, considered a range of datasets. Observed contrast between forest and non-forest in the FBS data and clearly discriminated. The discrimination was better with the 41 compared to the 34. The clear cuts are evident within the fully polarimetric data. Winter coherence is useful for detection in the boreal forest areas and clear cuts are very distinct and clearly separable from the intact forest. The summer intensity seems better than winter, but there is poor separability based on the polarimetric intensity. Different decomposition of the polarisation signatures suggested that HV, Alpha or PV or the kd2 distance provide the best discrimination. The intensity data are also useful. The combination of PALSAR and ASAR data adds value and capacity for discrimination.

Forest mapping in Sweden
The objective of the project was to evaluate the potential for large scale mapping and monitoring of change and particularly detecting clear cuts in boreal forest in Sweden. If successful for the prototype areas, the goal is to use the method operationally for the country. The current system utilises optical data and cloud cover leads to incomplete coverage. The two study areas are in the south and north central part of Sweden. The local study areas are at Remingstorp and Brattaker, the former of which was used for establishing the corner reflectors.

Studies have been undertaken previously using JERS-1 data and the team have been involved in the calibration and validation activities. Field work has also been undertaken to support the analysis of the data. Strip data have been received. A range of forest treatments (e.g., artificial wind throw, clear felling) have been implemented.

The analysis indicated that the backscatter (averagd per compartment) was lower for the artificially wind thrown forest in the winter, although partial separation was achieved in the autumn. Images acquired in descending and ascending mode, a shadowing effect is evident between a forest stand and an open area. Lakes appear as black areas and confuse with shadows.

A component of the work is focusing on biomass retrieval and the stands at Remingstorp were considered for this analysis. Unbiased estimates of biomass and other forest attributes were generated for selected areas. The model for estimating stand volume considered the backscatter as a function of the ground and vegetation contributions (see papers published in Bari and IGARSS). The best estimates of retrieval were obtained using FBS HH data (77 %), which was attributable in part to the spatial resolution. The weather conditions at the time of acquisition were also important. The stem volume estimation accuracy for the best FBS image was 30 % (corresponding to 97 m^3 ha^{-1}).

InSAR forest height retrieval

P. Sequeira reported on the use of InSAR for forest height retrieval and particularly the use of the normalised interferometric correlation. This correlation contains phase and amplitude information that is sensitive to the presence of volume scattering as well as thermal noise and temporal decorrelation. By rmoving these effects through normalization, what is left should give sensitivity to vegetation signatures.

Interferometry allows the estimation of terrain height and also the height of vegetation. Within forest, the return comes from different heights within the volume. By sampling at different baselines, can reconstruct the vertical profile of forests.

An important component is the need for calibration. Within the correlation observed have the volumetric correlation but also surface noise, and geometric correlation and and temporal correlation. The temporal decorrelation is one of the larger error sources. The study area is Harvard Forest which is run by Harvard University. There is also a considerable amount of full waveform LiDAR (LVIS) acquired over the area. The vegetation in the area is mixed conifer and hardwood and the entire area is secondary. UAV SAR acquisitions are also proposed.

ALOS data have been acquired over the Harvard Forest and 10 scenes are acquired. So, there is plenty of opportunity for performing interferometry. A range of baselines are available. Each overpoass offers and opportunity to measure the target backscatter and polarimetric characteristics. Each pair offers opportunity for interferometry. Baseline diversity is advantageous for retrieval. Gamma softwar was used for geolocation, baseline estimation etc. Within the analysed data, fringes are evident within the data and correlation is variable. This may be attributable to weather and temporal decorrelation in general.

A sensitivity of backscatter to height (derived from LiDAR) was investigated but limited link between target correlation and vegetation height. Greatest sensitivity is to temporal decorrelation. Within the ALOS imagery, there was little contrast between cut areas and the forest itself. Very little change in the overall backscatter was observed over time which contrasts to other studies. The phase gives information on the differential penetration into the canopy but this is inconsistent although more so in other image areas.

A more detailed analysis is being undertaken including taking into account ground slope effects on radar backsatter and thermal noise. Relationships between backscatter and biomass are very poor and not much variation was observed. However, using GeoSAR, it is possible to get height from interferometry and so the capacity has been demonstrated. Future activities will focus on the inclusion of polarimetric scnes and PolInSAR techniques and automation of the process. Temporal decorrelation will also be investigated. Recommended that better orbital control would assist with this.

Forest height and structural retrieval in Japan.
M. Watanabe reviewed the previous relationships established between above ground biomass and Sigm0 using PiSAR (L-band) data. The dispersion was attributable to the tree number density. A further issue might be the changes in the permittivity of trees which changes as a function of the time of year and also between species. The freeze-thaw state is also an important influence. The difference in incidence angle is also significant in contributing to the dispersion.

As it is difficult to examine changes in the dielectric constant from the SAR data, polarimetric ground based SAR (GB-SAR) was investigated. The system transmits and receives radar pulses and is portable, powered by generators. Using these systems, three measurements of trees were undertaken with one occurring during PALSAR observations.

The first experiment illuminated three trees with buildings. The signal from the building was evident and also from the lap pole. The trees are less evident but were observed although some trees missing in some polarisations. A second experimet was conducted on riverside trees in Sendai. The crown area was evident from HV data and the trunks were also evident within the HH. The third experiment involved day and night time observations; several trees were wrapped within tin foil. The trees were enhanced from trees with the foil. Within the HV, two returns were associated with the horizontal and angular (downwards) transmission. The GB SAR can therefore be used to establish dominant scattering processes but also the diurnal changes in the permittivity of trees. In the future, the aim is to link the GB SAR data with PALSAR data to try and establish the reasons for the variation in the relationship between SAR backscatter and biomass.

Development of carbon accounting methods for FCMS
Y. Yamagata providing a background to the FCMS. He noted that the Australian Government had developed a global initiative to meet the needs of REDD monitoring. Japan is now hosting the G8 meeting and it is hoped that there will be some agreement reached regarding REDD. Highlighted the importance of ALOS PALSAR in REDD.

In the FCMS, ALOS will be used to monitor deforestation and degradation as input to an area-based carbon accounting system, primarily to look at carbon stock decrease. A key component of this approach is that an ecosystem model will be integrated to allow process-based accounting. The FCMS will also look at ecosystem services such as biodiversity, hydrology and food/fibre. The system would have to be developed initially and linked to government.

Gary Richards presented the new Department of Climate Change which sits within the PM Department. Australia has announced it will have a domestic emissions trading scheme. The National Carbon Accounting System (NCAS) has also been established (over a ten year period). The move towards an emissions trading scheme requires a system that people will have confidence in.

Australia has 16 national coverages of Landsat data and there is an annual update. This work is linked to a carbon system. Australia has shown that this system can work operationally and that measurements in agriculture and forestry can now be included and is capable of reporting markets. The system has to be wall-to-wall and needs the robustness. Australia has funded an international initiative relating forests and carbon. Australia has also announced work towards a global carbon monitoring system and this was agreed with Japan that there would be cooperation with this and partnership is particularly important.

In tropical countries, Landsat data are limited because of cloud cover. The ALOS data are therefore considered to be key to taking the models into countries where cloud cover is problematic. Work is already ongoing in Indonesia and China and significant quantities of funding are being put into Indonesia to design and implement a forest monitoring schemes. Indonesia intends to be ready within 1-2 years and so as a research community, there is a need to move quickly. Similar issues will also be considered in Papua New Guinea.

There are other propositions from the United States and there are five in total. Australia does not want to compete but would rather collaborate. The work from the US will focus in Africa for example. There is not a global solution and so there needs to be a country by country consideration so that the market for trading can occur. The Clinton Foundation has been clear that it wants demonstration within 12-18 months; not that a project can be done but that the roll out of a global system should be achieved within 3 years.

Noted that the Clean Development Mechanism was not that effective and difficult to engage in. However, there is likely to be an expansion of voluntary markets. The UN process might be slower and supporting voluntary markets through robust provision of methods is important.

REDD Monitoring by WWF Indonesia.

Y. Yryu noted that 20 % of global emissions are caused by deforestation and 50 % are associated with Indonesia and Brazil. Indonesia's emissions from deforestation, degradation and peat decomposition and burning have made the country the third largest emitter of CO_2. Over half of emissions are from defroestation and degradation.

Riau in Indonesia is the primary hotspot of deforestation and is 11 % per year and is higher compared to the Brazilian Amazon. Riau has over 14.6 Gt of Carbon and all is threatened by deforestation. WWF aims to stop deforestation by getting Riau Prvice chosen as an official pilot REDD area, providing baseline data needed for the process and improving the current “Eyes on fhe Forest deforestation monitoring system”. For monitoring, there has been reliance on Landsat data for the period 1982 – 2007 and there is the intention to continue monitoring to at least 2015.

Since 1982, 4.1 million ha have been lost which is approximately a 65 % loss. Rates are accelerating for peat swamp forest but most of the lowland forest remaining is protected or is in the mountainous areas. Average deforestation rates vary as a function of industry drivers and government investigations. The pulp paper industry is a particular driver of the deforestation. There has been no further loss of forests since formal investigations into processes. Similar patterns were observed in other regions.

For the region, maps of land use following deforestation and showed that 24 % and 29 % were used for Acacia and oil palm respectively. 17 % of the cleared area was not used subsequently. Degradation is also occurring and much of the deforestation is occurring wthin closed intact forest.

Emissions associated with the clearing are estimated to be 3.21 Gt C. 1.17 Gt C is from deforestation, 0.32 from degradation, 0.73 from peat decomposition and 1.39 from fires within the peat. The sink associated with Acacia and oil palm is -0.39. This emission is compared to other regions. The annual CO_2 emissions from Riau was 0.19 which is 50 % of Australia but is also offsetting much of the sinks/savings established through the Kyoto Protocol. Significant declines in biodiversity but particularly elephants and tigers were also noted so only 210 individual elephants remaining in the province.

For the future, two scenarios were presented. The first scenario was based on 11 % deforestation per year and the second was following the full implementation of a recently proposed draft land use plan which is still under debate. With the land use plan, a reduction in the rate occurs although deforestation still continues. Approximately 6 % of the forest is reserved and it is likely that this might be all that remains. This loss of forest cover based on these scenarios was illustrated and it was estimated that 1 million ha would be lost under the land use planning but this would be 1.9 million ha under business as usual. Most of the deforestation will be on peatlands and so the carbon emissions from clearing will be substantial. Most of the forest would be lost to Acacia plantations (74 %) and to a lesser extent oil palm (23 %). Based on these scenarios, 0.94 and 0.49 Gt CO_2 will be released based on business as usual and the draft land use plan.

Recent news is that the WWF Riau CO_2 study was related and experts called this the most comprehensive pre-REDD study available for Indoensia. The Riau Government issued a press release calling for a halt to deforestation. No logging has occurred since 2007 because of a major police crackdown on all natural forest logging and clearance. There is a need to follow up these events by:

Using ALOS PALSAR images as a REDD monitoring tool. This should be evaluated as soon as possible to establish potential. The existing CO_2 data may be a good control dataset to measure ALOS data performance. The ability to penetrate cloud is a key feature of ALOS and could assist support of enforcement operations by authorities. Ideally, need to update maps far more regularly.

The role of ALOS in REDD

J. Kellndorfer gave an overview of the potential of ALOS PALSAR in relation to REDD. Key acheievements from COP were that a new negotiation process was launched which was designed to tackle climate change with the aim of completion by 2009 and lauch of an adapation process. REDD was also considered.

REDD started in 2005 following a COP in Montreal. The first workshop was in Rome which focused on scientific and technical issues. A 2nd workshop in Cairns focused on monitoring and policy issues. In Bonn, a draft decision text was made. Basi text encoursaged and insgtructs pilot activities. Bali supported REDD.

Key dates are important. In 2008, there will be the third SBSTA workshop in June. COP 14 is in Poland in Dcembe and there will be tri-monthly meetings of the post-2012 Ad Hoc Working Group that will include REDD. In 2009, these meetings will continue and there will be additional REDD workshops. In December, the framework for the Kyoto Protocol will be established in Copenhagen.

At Bali, the USA focused on past activities and avoided any discussion of financing developing countries to take action. The EU was championing REDD and was promoting capacity building. Brazil is supportive of REDD and is opposed to a market-based approach. The Coalation of Rain Forest nations is driving the REDD process pushing for credit action and is for a market-based approach.

The African countries are strongly in favour of REDD but degradation was pushed into the agreement as this is the main driver for forest loss. India supportive but seeks to do net accounting crediting for reforestation and regrowth, China neither strongly supports or oppose but generally agrees. Mexico and other Latin American countries are in support of a project based approach but there are interest in the way this shifts deforestation. Japan and Canada were generally supportive of REDD.

The REDD position was that deforestation is a significant contributor, degradation leads to emissions and early action is needed for some countries. The problem is complex because of different national issues and there is an urgent need for meaningful action. Stable and predictable availability of resources is essential. There was also a need to address the requirements of local and indigenous communties.

The Bali text included degradation was to be included. Consideration should be given to conservation, sustainable management of forests and enhancement of forest carbon stocks in developing coutries (India). There was a need to strengthen and support ongoing effortsto reduce emissions from deforestation and degradation on a voluntrary basis Brazil). A range of actions, options and efforts (including demonstration activities) should be undertaken to address the drivers of deforestation relevatnt to national circumstances. A good guidance practice should be put in place.

There was also the need to support capacity building, provide technical assitance, facilitate the transfer of technology to improve, inter alia, data collection, estimation of emissions from deforestation and forest degradation, monitoring and reporting. The World Bank Forest Carbon Partnership facility (165 million dollars) is a readiness fund to prepare nations to participate in REDD tradings and contributions have come from Australia, Europe etc. There was concern that indigenous groups were not included but there is a lot of sensitivyt within the World Bank to this. Radar was also mentioned as a new tool.

GOFC-GOLD is also producing a REDD Sourcebook which is meant to provide the technical guidelines of how to undertake monitoring. The approach is sample based and there is wording to open the door for other activities. However, there needs to be a closer dialogue regarding other options. It is meant to be a concensus document and it is important to make sure that this is the chase. Chapte 3 deals with the role of remote sensing, Chapter 4 deals with estimating carbon stocks and Chapter 5 and 6 look at estimating and reporting carbon emissions. There is, however, only one paragraph that considers radar is provided but states that radar is not widely used operationally for tropical deforestation monitoring. There is a need to convince on radar and less than a five year schedule is essential.

At Bali, there was good demonstration of the use of ALOS PALSAR for deforestation monitoring. For the Xingu Basin, a mosaic of PALSAR data was generated within 20 hours. A classification was undertaken using support vector machines which allows the inclusion of backscatter, texture, slope, aspect and incidence angle. The algorithm was trained with ground reference data. The classification accuracies for forest and non forest were generally around 90 %. The changes over 11 years were also considered and there was a desire to reprocess. For Africa, data were shown for Gabon where few optical data are available and areas of forest and deforestation were quite discernible. In Uganda, the ALOS data was able to identify some of the degradation versus deforestation. Also, areas of forest are encroaching into the savanna areas. In some areas, degraded forest were not detected so other approaches might be useful here. The imagery from Bali was also generated and areas of degradation on the volcanic slopes evident. ALOS was also mentioned in the Wall Street journal and material was also provided (http://whrc.org/bali).

In conclusion, the ALOS PALSAR emerged as a key remote sensing tool to support REDD. Scientifically, need to establish what can be delivered in relation to deforestation and degraation and also biomass. There also needs to be consideration given to the need for processing time-series datasets and integration with optical data is also essential. All analysis should be compatible with the IPCC definitions and guidelines. Recommended that links with the JERS-1 SAR data are needed and that reprocessing is desirable. There was also the need to establish gaps in the image coverage so that global reporting can be achieved. There is also the need to assess cost and accessibility options. Long-term availability during the commitment period is also essential and continuity is very important. For these data to be part of the process, there needs to be a clear message on continuity. For the next period, there needs to be a rvision or optimisation of the strategies to meet the REDD needs. Can there also be some coordination in relation to the L-band observation strategy. SCANSAR observations were also considered to be important. It was emphasised that JAXA ought to acknowledge the enormous potential of ALOS beyond research and highest priority ought to be given to this. Safeguarding of the facility is also essential.

Japan's methods of FCMS for Kyoto Reporting and the development of a monitoring system

H. Sawada presenting on Japan's approach to monitorin and initially provided an overview of the physical environment of Japan and the vegetation. Noted that 69 % of forests are privately owned and 31 % are nationally owned. There are two independent monitoring systems, with one undertaken by the forest planning system based on the forest law. The second is a forest resources monitoring survey. The former provides very detailed enumeration.

The Kyoto target for Japan is a 6 % reduction from the base year but there is a 7.4 % increase by 2004. Forests have the potential to act as a sink for carbon. Accounting of carbon is based on forest registers and planning maps and verification is based on independent stand and geographical information. The GIS information includes satellite images (e.g., SPOT images of 2.5 m spatial resolution). The estimation is based on carbon stock changes between two time-separated periods and carbon stocks is calculation from volume, density, biomass expansion fraction, root and stem proportions and the carbon fraction. Landsat TM data were found not to detect ARD effectively because of differences between the types of changes and land use and difficulty in separating harvested from deforested areas The FM ratio is used which links the area of FM lands with that of managed forests. This can be estimated by FM monitoring and considers age and species. Carbon flux models are also considered (e.g., for dead wood, soil carbon). The National Forest Resources Database is used to support the system in terms of accounting and reporting, forest planning, statistics and evaluation of multi-function. A comprehensive forest resource base is therefore provided. From this analysis, the carbon sink under the Kyoto Protocol was 9.7 Mt C year in 2005 but the carbon sink expected is 13 Mt C year and so the additional carbon needs to be sequestered through changes in forest management.

Problem resolving

a) IBAMA raised the question of distortion of the georeferenced image. This is being checked.
b) CESBIO noted that the SCANSAR is brighter in the far range than the near range in sigma 0. The products were generated in June 2006 (using the oldest version of Sigma0). This problem has been overcome using the current

version. Noted that the reliabily and consistency of gamma 0 (HH) is very stable for the FBS but less so for the SCANSAR. Correction for the incidence angle generally works but some residual errors. Suggested that all data on the ASPERA site were processed from the spring but then processing has been reduced. The previous SCANSAR data should be deleted and replaced with the new version.

c) Incidence angle information. The factor_m() file only contains information on the incidence angle as a function of the scan line. This information is defined at the beginning of ths scan and updating of this information will be considered. The processor takes 9216 samples and analyses this segment. The incidence angle is expressed differently in each segment (there are 10 +) and initially, the Factor_m file had only one value for the first segment. However, the update will include this value for each segment.
d) RSP number and mode. CESBIO could not acquire data over the test sites and this is because K&C requests are not the first priority. Need to know the RSP number and the PALSAR mode; these are necessary for the data to be processed.
e) There are gaps in the FBD and FBS data along the strips. The request was divided into two because there were two zones. From the operational point of view, the requests were processed based on the latitude specified but the cutting does not achieve the desired result. The solution is to add or substract a half degree but this was considered not to be a problem. There is a need to check the imagery in more detail.
f) A location shift (of up to 10 pixels) occurs between the actual and simulated SAR. This has to be evaluated. Contributory factors include the accuracy of the orbit, reading the fdfdd file (contains coefficients of Doppler polynomial) and in particular Doppler frequency, its rate, the 2nd order data, the azimuth times. Possible not to include these data. This is largely a problem with SCANSAR. Errors may occur because the area is very flat and so the transformation is not refined correctly. The fdffdd file was not provided to Gamma and hence the errors occurred.

Overview of Projects within the Forest Theme

Region	Institution	Product	R	D	REDD	Biomass	Mode

						& structure	
Australia Queensland/NT	Aberystwyth University QDNRW, QHerb	Forest structural types focusing on regrowth	√	√		√	FBD
Brazil Amazon	INPE	Forest regrowth and infill of deforestation in cloudy areas; detection of deforestation in rainy season; age of deforested areas	√	√	√		FBD
Brazil Amazon	IBAMA	Fast detection of deforested area		√			SCANSAR
UK	Sheffield	Forest age class distribution and biomass	√	√		√	FBD
France, N. Spain and Vietnam	CESBIO	Forest biomass				√	
Siberia	Gamma, Jena	Forest extent and disturbance mapping		√		√	FBD
Sweden	Swedish University of Agricultural Sciences	Commerical forest clear cut area and forest disturbance type.		√		√	FBD
US (Harvard Forest)	Massachusetts	Forest height and biomass retrieval from interferometry.				√	All modes
Europe	DLR	Forest height				√	All modes
Japan	Tohoku University	Forest biomass and structural retreival				√	GB SAR & modes

Proposed topics for special issues
Deforestation mapping
Regrowth mapping
Biomass retrieval
Forest structural mapping
Forest height retrieval
Ground-based descriptions

Suggested journals
Forest Ecology and Management (to inform on forest-specific issues)
Remote Sensing of Environment (to inform of remote sensing algorithms).

Coordination
Suggest use of arcgis layers or Google Earth to indicate processing sequences, particularly in areas where there is overlap in studies (e.g., Siberia).