ITT 1/4729/NL/04/FF
Co-ordinated answer to

Scientific contribution to the SMOS Soil moisture prototype processor development
29/09/2004

PART 1: Overall description of the Proposal

This document is the result of the concatenation of the 4 proposals to the above mentioned ITT. It has to be considered as four distinct proposals which are simply presented here together for both the sake of clarity and to ensure both consistency and lack of loop holes.

1 Rationale and objective

This proposals aims at delivering three main items for the development of the SMOS level 2 processor for soil moisture. These 3 elements are:

- the algorithm theoretical basis document;
- the algorithm validation plan, and;
- the generation and conditioning of auxiliary data.

For this purpose 5 institutes are pooling their expertise so as to ensure an efficient and seamless transfer of knowledge to industry which will be selected independently by ESA.

This proposal is intended to specify to industry what the ESLs contribution could be to the development of the level 2 prototype processor for soil moisture.

It merges the proposal from 5 different laboratories

1 the LI group with CESBIO and IPSL SA
2 the University of Roma
3 the Reading University
4 the INRA EPHYSE in Bordeaux

This team has now gathered a considerable expertise on soil moisture retrievals and associated models, since the 1980s for some of them. The team members have also acquired a reputation for ground data collection and analysis as well as for satellite data analysis. The team has also largely been an active part of the original SMOS proposal team.

The scope of the study will thus be to use existing knowledge and state-of-the-art approaches to modelling at the continental surface so as to derive the most efficient and appropriate inversion algorithms delivering the 2 level products (Soil moisture, vegetation water content, eventually others - see main text). The corresponding deliverable will be an ATBD evolved interactively (first draft, issue 1, issue 2) with industry. The proposed retrieval schemes will be prototyped by industry, in close collaboration with the science team (here after named SM ESL).

The SM ESL will also work actively on the related auxiliary data issues (definition requirements and limitations, fall back options etc…).

Finally the SM ESL will develop a validation plan and perform some validation of the prototype algorithms.

A more detailed description of these tasks is given in part 2. It should be noted however that the proposal given here will have most certainly to be adapted after iterations with both industry and ESA. It has to be considered as a first step of an iterative process.

2. General organisation of the SM ESL

The overall organisation of the SM ESL will be performed by the LI team consisting of CESBIO and IPSL SA (here after referenced as CBSA) as has been done since the beginning of the SMOS project. Another task of CBSA will be to ensure consistency with the Salinity ESL and an active role in calibration issues. CBSA will also have to ensure close feed back with the project and CATDS.

The University of Reading will be in charge of the ATBD and Auxiliary data components while CBSA will be responsible for the validation plan.

The science tasks will be split between the different groups.

Tor Vergata University (Prof Paolo Ferrazzoli) will be in charge of direct (discrete) modelling of forested canopy, of parameterising the models and of course of all related tasks for auxiliary data and algorithm validation

INRA Bordeaux (Jean Pierre Wigneron) will have exactly the same tasks for crops, grass and generally speaking low vegetation. The group will also be in charge of providing the ground data (mainly forest and crop/ bare soil).

CBSA (Y Kerr, P. Waldteufel) will have the responsibility of soils modelling, and topography role assessment. The group will also be in charge of providing the ground data (mainly grass/ bare soil), and satellite data whenever possible. If deemed necessary CBSA will also produce synthetic data sets.

Reading University (R Gurney) will have the responsibility of addressing Urban, snow covered, freezing soils, mixed pixels, sun-glint, atmospheric effects, RFI, etc. The group will also be in charge of providing the ground data they have collected or have access to.

3. Interactions between ESL, Industry and ESA

The SM-ESL will operate with industry as specified in the SoW. The management of this study is quite straightforward as it mainly involves 5 groups which have been working in close collaboration on various projects and in particular around the SMOS mission (since drafting the initial COP 16 proposal for 2 of them), as well as in a number of ESA ITTs. We are thus quite used to exchanging data, information and interacting on practical issues. It is also foreseen to reduce as much as possible the number of contact point by having only Reading University as a contact for ATBD and auxiliary tasks and CBSA for the other tasks.

The SM ESL will continue to co-operate with the project and in particular with the team in charge of the level 1 processor.

Finally, in specific cases the ESL may contact third parties for their improved knowledge and competence in specific fields.

The proposing team might also interact with the SMOS SAG if need be as well as with the Sea Surface Salinity ESLs..

4. Tasks Breadown

Tasks							
1000	1100	1110		CBSA	TV	RU	INRA
1000			Overal coordination	X			
	1010		progress reports	X	x	x	x
	1020		presentations hand outs and presenations	X	x	x	x
2000			ATBD Elaboration				
			ATBD organisation and coordination, literature reviews				
		2010	discsussion of problem areas			X	
			Co-ordination of submodel elaboration: for all				
			DIRECT Sub models for all:				
			algo overview, choice, description, discrete and				
			parametrised				
			validity assessment, error budget				
	2100		validity range requirements on inputs			X	
		2110	bare soil	X			
		2140	forest (broad leaf and conifers)		X		
		2150	croips and grass				X
			problem areas - water bodies, urban, snow-freeze,				
		2160	sun glint, Atmospehre, dew/rain unknowns etc…			X	
	2200		uncertainty sources, specials issues to be tackled				
		2210	RFI	X			
		2220	Mixed pixels and land fractions	X			
		2230	topography	X			
			inversion algorithms probably piecwise				
	2300		replicating 2100 and 2200 structure			X	
			choice of method (iterative NN etc), choice of method,				
			algo description, ,assumptions and validity range				
			input data , error budget				
			quality control and diagnostics				
		2310	exception handling			X	
	2400		overall (i.e. with all the above -2300 merged)			X	
		2410	algorithm description and branching			X	
		2420	input data			X	
		2430	error budget			X	
		2450	quality control and diagnostics			X	
		2460	exception handling			X	
	2500		external calibration	x			
3000			Input data (TGRD-IODD)			X	
	3010		inpouts for TGRD			X	
	3100		Inputs for IODD			X	
	3200		test data generation				
4000			validation plan	X			
	4100		Validation strategy	X			
	4200		Submodels intercomparison and protype validation	X			
		4210	CBSA	X			
		4220	Tor Vergata		X		
		4230	Reading University			X	
		4240	INRA				X
	4300		overall validation	X			

In Red responsible team

in yellow contributing team

PART 2 Proposals

1. CESBIO and Service d'Aéronomie

This part intends to describe in broad lines the proposed work to be performed by both CESBIO and Service d'Aéronomie. The overall distribution of tasks is given in part 3.

1.1 Technical part

1.1.1 direct modelling

a) literature review

Obviously the team is well aware of the state of the art and a literature review might seem superfluous but the proposed algorithm will have to be the real optimum and thus a quick review will be performed just to isolate loose ends.

b) choice of bare soil algorithm

The approach will be as follows. First of all existing state of the art algorithms in conjunction with ground data collected by the team (in the large sense i.e. including INRA, Reading Universtity, Tor Vergata and eventually even other sources such as BARC measurements and Bern University data sets (all already in our possession) we will perform a final tuning of our algorithms for bare soils. Actually we have several models including one recently developed in collaboration with ETH Zurich and USDA Beltsville. The idea is to have a sophisticated model performing as well as possible with the limitation of the inherent complexity. From this point a simpler model will be derived by way of parameterisations. The main points to be addressed at this level are currently being studied at CESBIO (in collaboration with INRA, ETH Zurich and Amsterdam Free University) and concern in particular the items detailed below. One should however note that the issues presented here as a list have to be classified through their temporal and spatial behaviour. Some vary quickly and are commensurate with SM evolution while some evolve slowly (roughness, land use) or not at all (topography). Some evolve continuously while other are step function (rainfall, frost). Similarly spatial scales can be very different, in some cases making by simple "averaging" some issue disappear.
These consideration will have to be accounted for as they may have significant impacts on data processing (auxiliary data needed and flag , exception handling etc…).

Roughness modelling/parameterisation. How can to derive a formulation of roughness which both represents reality (for the whole range of angles and surface conditions) and is tractable. Currently we are considering and validating an approach based on the use of an equivalent temperature, and a simple parameterisation of the surface roughness using 3 parameters . One will be fixed (exponent) and two other the famous h and Q are functions of soil moisture angle and polarisation. We are currently trying to reduce this to simple functions of soil moisture. The results obtained with ground data are globally very satisfactory with the exception of very dry conditions which currently pose problem.

Another point to be addressed is the behaviour of bare soil underneath a canopy. The current approach is to dissociate the two issues (bare soil and vegetation) and this makes sense but we will eventually have to merge approaches so as to ensure both consistency and potential for improvements. Currently the main critical area lies with the role of litter and the way it is accounted for by roughness in some parameterisations., leading to a time varying roughness.

Finally special event will affect the bare soil signal, the most evident being sudden presence of snow, freezing event or heavy rainfall (flooding). Some will be easy to identify, some other will require extra data sets. Apart from such natural events, the level 2 algorithm will also have to cater for human induced signals (mainly RFI) which will have to be detected and flagged, and other effects such as sun glint, possibly Faraday rotation for the afternoon pass etc…
It should be noted that for many of these effects we do not know exactly what will be the effect on the data and hence of the retrieval quality. It is only speculations which will only be resolved once the satellite is flying. The level 2 processor will have to have the necessary flexibility to account for all that. To start addressing this issue we will suggest to produce test data sets and perform simulations on this synthetic data set, fuelled with simulations, existing – higher frequency –satellite data and ground campaigns measurements
These global data sets will also be used in part to address error propagation and error budgets.

c) assumptions

Basic assumptions are here that we have access to level 1 specifications, and that it will be the source for producing level 2; that the processing will be possible "on the fly" that calibration is performed / available together will all the ancillary and that the desired auxiliary data sets will be kept to a minimum.
It is also assumed that we will have full access to all previous and current ESA studies on the subject so as to capitalise as much as possible on existing results.
The basis assumption is also that even though all possible types of retrieval algorithms will be re - considered, we will be a priori in an iterative approach scheme. (See SMRS study)

There are of course a umber of other assumptions which are going to be made related to the physical modelling limitations. These assumptions will be detailed in the ATBD and will be discussed and their impact assessed when ever possible.

d) Special issues

Most of the models are developed for a pure target (i.e., only once ser of surface conditions, for a flat surface etc. These basic assumptions correspond to standard cases. In the reality we will have to deal with mixed targets (as the pixel is large enough to encompass sometimes a large set of surface types and conditions).This can be tackled with the so called tiles where the different constituents of the pixel are itemised and processed separately. However in the retrieval scheme we will have a major challenge at this level as we will require a priori knowledge or estimate of these fractions, as well as their location so that we can take into account eventually the pixel size and shape evolution along the dwell line.
The problem might get more complex and more difficult to tackle (in terms of retrieval accuracy) for pixels including water bodies of changing limits (i.e. tidal areas, variable lakes etc…) This point however and from past experience should not be too critical.

Another significant factor to take into account is topography. Even though topography is fixed and will have to be tackled only once ideally, it will be necessary to assess both where it has a significant effect and possibly where soil moisture can be extracted in spite of topography (and the expected degraded retrieval accuracies).

It is also expected to have to address all the above point sin relation with the measurement scales

e) auxiliary data sets

In most of these modelling activities, so as to infer the surface variables, it will be necessary to use auxiliary data. In an operational flow these data sets will have to be readily available in a timely fashion and with appropriate accuracy. It must be also noted that these data sets might only be "proxies", requiring special care in non standard cases. Our task will thus be to identify the requirements for auxiliary data sets (making a clear distinction between the fixed, slowly evolving and rapidly changing data sets), to identify the sources for these data sets with potential fall back options and assess in all cases the related errors.
Ancillary data will eventually be also assessed together with data available in level 1 products.

1.1.2 Data sets generation

As explained is the various sections (see for instance proposal 4) it will be necessary to use as many data sets as possible to test the retrieval algorithms. Our approach will consist in using all the existing ground data sets, and airborne campaign data sets that currently exist. It must be said that we already have most of them pooled and readily formatted. But we also have access to exixting airborne campaigns (such as Eurostarrs or Monssoon/ SGP /SMEX) or planned ones (CoSMOS) Finally we have all the SMMR and SSM/I data sets and are currently getting access to AMSR data) We have also synthesised data sets either made globally (ESA ITT on SM) or derived locally)

We intend to use these data sets to test the algorithms and eventually benchmark them or validate them.

1.1.3 Bread-boarding

We have already most of the direct algorithm parts in house. The main task will consist in assembling and finalising the models and built both the elements of the ATBD and a sort of test bench to validate the prototypes. These will be run using the datasets of 1.1.2.
Obviously the main task at this level will be the elaboration of the different exception handling and flag setting strategy. The main outcome will be the test algorithm and this wimll be used also for quality control and diagnosis.

1.1.4 Algorithm validation

Algorithm validation will be mainly established globally using the outputs from the different teams. The first step will be to establish with ESA and the Industry the validation strategy to be implemented together with the elaboration of the validation plan.
It is expected that the science teams will propose an approach mainly based upon the inter-comparison of the "science" algorithm and the prototype, using a set of simulated or real data ranging in surface conditions so as to cover most of what exists.
The first step will be a step by step comparison of the sub-models before doing a full fledge validation over some global data sets.
It is scheduled to use not only the usual intercaomprison (i.e. retrieved soil moisture and vegetation characteristics) but also to pay a particular attention to the flags (setting and values).

<table>
<tr><td colspan="2">WORK PACKAGE
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DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : Overall coordination
CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task : management
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT : KO</td><td>PLANNED DATE : T0</td></tr>
<tr><td>END EVENT : Final presentation</td><td>PLANNED DATE : T0+24</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP : Agreed proposal, description of level 1C

TASKS :
➢ A Overall coordination management of the teams
➢ B co-ordination with Industry and ESA (SMOS project)
➢ C delivery of documents , bread-boards and other deliverables
➢ D interaction with industry
➢ Potential interactions with “outside” experts
➢ Report to SAG

Deliverables: hand-outs of meetings, reports</td></tr>
<tr><td colspan="3">OUTPUTS :</td></tr>
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DATE: 30/09/2004</td></tr>
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CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
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Issue No : 1</td></tr>
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<tr><td>END EVENT : final presentation</td><td>PLANNED DATE : T0+24</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP : N/A

TASKS :
➢ A Deliver monthly progress reports

Deliverables: monthly progress reports</td></tr>
<tr><td colspan="3">OUTPUTS : N/A</td></tr>
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DATE: 30/09/2004</td></tr>
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CONTRACTOR : CBSA –University of Reading
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No :</td></tr>
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<tr><td>END EVENT : PM1</td><td>PLANNED DATE : T0+6</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP : access to first results

TASKS :
➢ A elaborate the presentation from different contributors
➢ B assemble the an eventual report if requested
➢ C produce and distribute hand outs
NB ATBD is a different task covered in WPs 2000
Deliverables: draft presentation and related VG</td></tr>
<tr><td colspan="3">OUTPUTS : VG and associated documentation</td></tr>
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WORK PACKAGE DESCRIPTION		**WP number:1022** **DATE: 30/09/2004**
WP. TITLE : Presentations **CONTRACTOR : CBSA –University of Reading** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No :**
START EVENT : PM1	**PLANNED DATE : T0+6**	
END EVENT : PM2	**PLANNED DATE : T0+12**	
WP MANAGER : Yann Kerr		

ITEMS TO START WP : access to first results

TASKS :

- A elaborate the presentation from different contributors
- B assemble the an eventual report if requested
- C produce and distribute hand outs

NB ATBD is a different task covered in WPs 2000

Deliverables: first issue presentation and related VG

OUTPUTS : VG and associated documentation

<table>
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DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : Presentations
CONTRACTOR : CBSA –University of Reading
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No :</td></tr>
<tr><td>START EVENT : PM2</td><td>PLANNED DATE : T0+12</td></tr>
<tr><td>END EVENT : Final presentation</td><td>PLANNED DATE : T0+24</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP : access to first results

TASKS :
➢ A elaborate the presentation from different contributors
➢ B assemble the an eventual report if requested
➢ C produce and distribute hand outs
NB ATBD is a different task covered in WPs 2000
Deliverables final issue presentation and related VG</td></tr>
<tr><td colspan="3">OUTPUTS : VG and associated documentation</td></tr>
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<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number:2111
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : Bare soil modelling
CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT : KO</td><td>PLANNED DATE : T0</td></tr>
<tr><td>END EVENT : SRR</td><td>PLANNED DATE : T0+3</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP :literature review output, accessibility and choice of models

TASKS :
➢ A Algorithm overview, draft description of the ATBD,
➢ B discussion of problem areas
➢ C Discrete approach and firs ideas of the parameterisations

Deliverables: draft version of the ATBD part on soils</td></tr>
<tr><td colspan="3">OUTPUTS : reprt and draft ATBD with list of outstanding issues</td></tr>
</table>

WORK PACKAGE DESCRIPTION		WP number:2112 DATE: 30/09/2004
WP. TITLE : Bare soil modelling **CONTRACTOR : CBSA** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No : 1**
START EVENT : SRR	**PLANNED DATE : T0+3**	
END EVENT : ATBD Issue	**PLANNED DATE : T0+12**	
WP MANAGER : Yann Kerr		

ITEMS TO START WP :Draft ATBD and inputs from other 2100 packages

TASKS :

- A Algorithm overview, ATBD version 1 for bare soil parts,
- B discussion of problem areas, addressing special issues and related flags
- C finalised parameterisation

Deliverables: version 1 of ATBD part on soils

OUTPUTS : report and ATBD issue 1 with list of outstanding issues

WORK PACKAGE DESCRIPTION		WP number:2113 DATE: 30/09/2004
WP. TITLE : Bare soil modelling **CONTRACTOR : CBSA** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No : 1**
START EVENT : ATBD Issue 1	**PLANNED DATE : T0+12**	
END EVENT :ATBD V2	**PLANNED DATE : T0+24**	
WP MANAGER : Yann Kerr		

ITEMS TO START WP : ATBD V1 and inputs from other 2100 packages

TASKS :

- A Algorithm overview, ATBD version 1 for bare soil parts,
- B discussion of problem areas, addressing special issues and related flags
- C finalised parameterisation

Deliverables: final version of the ATBD part on soils

OUTPUTS : report and final ATBD with list of problem areas

<table>
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DESCRIPTION</td><td>WP number:2210
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : RFI analysis
CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT KO</td><td>PLANNED DATE : TO</td></tr>
<tr><td>END EVENT : final presentation</td><td>PLANNED DATE :T0+24</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP: analysis of existing data on ground, Airborne and literature

TASKS :
The tasks will consist in analysisng existing data sets to assess level of RFI pollution and to try to assess a flagging strategy

Deliverables: small report (chapter) and suggestions</td></tr>
<tr><td colspan="3">OUTPUTS : tentative analysis of problems and suggestions for a flagging strategy</td></tr>
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<table>
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CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT KO</td><td>PLANNED DATE : T0</td></tr>
<tr><td>END EVENT : draft ATBD</td><td>PLANNED DATE : T0+3</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP: literature and models

TASKS : address the strategy for including the mixed pixels and land fractions into the retrieval algorithms

Deliverables:</td></tr>
<tr><td colspan="3">OUTPUTS : first concepts</td></tr>
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<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number: 2222
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : Mixed pixels and land fractions
CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT draft ATBD</td><td>PLANNED DATE : T0+3</td></tr>
<tr><td>END EVENT : ATBD issue 1</td><td>PLANNED DATE : T0+12</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP test with existing simulated data with ATBD draft models

TASKS : propose a methodology for including the mixed pixels and land fractions into the retrieval algorithms

Deliverables: scheme for retrieval algorithm</td></tr>
<tr><td colspan="3">inclusion into ATBD V1</td></tr>
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<table>
<tr><td colspan="2">WORK PACKAGE
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DATE: 30/09/2004</td></tr>
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CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT issue 1 of ATBD</td><td>PLANNED DATE : T0+12</td></tr>
<tr><td>END EVENT : ATBD V2</td><td>PLANNED DATE : T0+24</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP: scheme used in V1 and further tests

TASKS : finalise the approach into the ATBD after tests and assessment of potential errors
Deliverables: scheme for retrieval algorithm</td></tr>
<tr><td colspan="3">OUTPUTS : inclusion into ATBD V2</td></tr>
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<table>
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DESCRIPTION</td><td>WP number: 2230
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : Topography
CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT KO</td><td>PLANNED DATE : T0</td></tr>
<tr><td>END EVENT : ATBD V2</td><td>PLANNED DATE : T0+24</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP: DEM and satellite data
TASKS :
➢ Model typical topography and resulting signal
➢ Assess the level of topography required to deteriorate significantly retrieval and set flag
➢ Propose eventually correcting factor for intermediates levels of topography
Deliverables: flag setting approach and potential correcting factor</td></tr>
<tr><td colspan="3">OUTPUTS : scheme to be implemented in ATBD</td></tr>
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<table>
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DESCRIPTION</td><td>WP number: 2500
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<tr><td colspan="2">WP. TITLE : exteranl calibration
CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT KO</td><td>PLANNED DATE : T0</td></tr>
<tr><td>END EVENT : Final report</td><td>PLANNED DATE : T0+24</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP:

TASKS : the task will consist in analysing whether some external calibration targets could be used to improve calibration during level 2 processing

Deliverables:</td></tr>
<tr><td colspan="3">OUTPUTS :</td></tr>
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CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT KO</td><td>PLANNED DATE : T0</td></tr>
<tr><td>END EVENT : Draft TGRD-IODD</td><td>PLANNED DATE : T0+3</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP: first analysis of problem and algorithm
TASKS : provide elements for the draft version of the TGRD-IODD
Deliverables:</td></tr>
<tr><td colspan="3">OUTPUTS : entries for TGRD-IODD</td></tr>
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SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENTdraft TGRD-IODD</td><td>PLANNED DATE : T0+3</td></tr>
<tr><td>END EVENT : TGRD-IODD Issue 1</td><td>PLANNED DATE : T0+12</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP: return and questions from industry, consolidation of ATBD

TASKS : provide inputs as per WP on modelling

Deliverables:</td></tr>
<tr><td colspan="3">OUTPUTS : entries for TGRD-IODD</td></tr>
</table>

WORK PACKAGE DESCRIPTION		WP number:3103 DATE: 30/09/2004
WP. TITLE : auxiliary data for bare soil retrievals **CONTRACTOR : CBSA** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No : 1**
START EVENT TGRD-IODD Issue 1	**PLANNED DATE : T0+12**	
END EVENT : TGRD-IODD Issue 1	**PLANNED DATE : T0+24**	
WP MANAGER : Yann Kerr		
ITEMS TO START WP: return and questions from industry, consolidation of ATBD **TASKS** : provide inputs as per WP on modelling **Deliverables:**		
OUTPUTS : finalised entries for TGRD-IODD		

<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number: 3200
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : TESt data generation
CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT ATBD Draft</td><td>PLANNED DATE : T0+3</td></tr>
<tr><td>END EVENT : final presentation</td><td>PLANNED DATE : T0+24</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP: expression of need from first draft of ATBD

TASKS : identify and prepare data sets for test and validation from a mix of ground airborne satellite and simulated data. The data sets should, as much as possible, cover the necessary ranges of values

Deliverables: test data sets</td></tr>
<tr><td colspan="3">OUTPUTS : test data sets</td></tr>
</table>

<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number: 4000
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : Validation plan co-ordination
CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT Start</td><td>PLANNED DATE :T0+14</td></tr>
<tr><td>END EVENT : final presentation</td><td>PLANNED DATE : T0+24</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP: Inputs from ESA, Industry and teams on the validation strategy

TASKS : coordinate the validation plan activities

Deliverables:</td></tr>
<tr><td colspan="3">OUTPUTS :</td></tr>
</table>

<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number: 4100
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : validation strategy and validation plan
CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT Start of val activities</td><td>PLANNED DATE : TO+14</td></tr>
<tr><td>END EVENT : presentation</td><td>PLANNED DATE : T0+16</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP: availability of data sets et ATBD draft

TASKS : propose a validation strategy for agreement
Deliverables: validation strategy and validation plan</td></tr>
<tr><td colspan="3"></td></tr>
</table>

<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number: 4200
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : corrdinate validation
CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT start of val</td><td>PLANNED DATE : T0+14</td></tr>
<tr><td>END EVENT : Final report</td><td>PLANNED DATE : T0+24</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP: validation elements from all teams

TASKS : co-ordinate and prepare validation

Deliverables: validation report</td></tr>
<tr><td colspan="3">OUTPUTS : validation report</td></tr>
</table>

<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number: 4210
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : bare soil submodel intercomparison and prototype validation
CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :

Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT prototytype available</td><td>PLANNED DATE : T0+14</td></tr>
<tr><td>END EVENT :</td><td>PLANNED DATE : T0+18</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP: availability of strategy, submodel prototype and data

TASKS : inter-compare prototype output with sub model, identify causes of discrepancies and correct

Deliverables:</td></tr>
<tr><td colspan="3">OUTPUTS : validation of prototype</td></tr>
</table>

<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number: 4300
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : ovcerall validation
CONTRACTOR : CBSA
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT end of 4200</td><td>PLANNED DATE : T0+18</td></tr>
<tr><td>END EVENT : final presentation</td><td>PLANNED DATE : T0+24</td></tr>
<tr><td colspan="2">WP MANAGER : Yann Kerr</td></tr>
<tr><td colspan="3">ITEMS TO START WP: all validated sub-models and prototypes from the industry and relevant data sets +strategy

TASKS : validate the overall retrieval model over land for all retrieval outputs, check flags and ranges of validity, accuracies

A

Deliverables:</td></tr>
<tr><td colspan="3">OUTPUTS : validation scheme validity assessment</td></tr>
</table>

1.2 Administrative part

Management and personnel

The contractor will have the responsibility to ensure that tasks defined are performed. They will be executed by Y Kerr, at CESBIO and P. Waldteufel at IPSL/SA. They will be assisted by:

- Patricia de Rosnay CESBIO (55%) (ground data collection and analysis, coherent modelling of soils, equivalent temperature assessment, field experiment in Mali and Benin (cal val),
- Maria José Escorihuela CESBIO (90%) (direct modelling of soils, retrieval algorithms over bare soil and grass covered soil (with INRA), ground measurements
- XX Post doc at CESBIO (90%) (to be recruited as soon as the contract is settled). Will mainly work onnthe breadboard algorithm development
- François Cabot (at CESBIO but CNES) (15%) (insighton the system performances, feed back with the project , validation assessment.)
- Thierry Pellarin (currently at CESBIO) (20%) mainly on synthetic data set elaboration and use of existing satellite data.
- Yann Kerr (CESBIO) will co-ordinate the overall proposal and the algorithm validation part with P. Waldteufel. He will also work on the topography influence, ground data collection and analysis, global test data set development / validation.
- Philippe Waldteufel IPSL/SA Land fractions, sunglint, retrieval approach, coordination with SSS ESLs, external calibration….

Background and experience

Yann H. Kerr

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Phone (+33) 5 61 55 85 22
Fax (+33) 5 61 55 85 00
E-mail yann.kerr@cesbio.cnes.fr

EDUCATION

PhD (Thèse de 3ème Cycle) Astrophysique, Géophysique and Techniques Spatiales, Université Paul Sabatier, Toulouse, 1992
M.Sc. Electronics and Electrical Engineering, Glasgow University, United Kingdom, 1981
ENSAE Radar and Télécommunications, Toulouse, 1977

EMPLOYMENT

CNES employee working at CESBIO

Since 1/1999 research scientist at CESBIO, PI on the SMOS project.
1/1995 -1/99 Assistant Director of CESBIO (created on January 1st 1995 by merging 3 laboratories including LERTS).
2/1994 - 1/95 Deputy Director of Laboratoire d'Etudes et de Recherches en Télédétection Spatiale (LERTS)
12/1988 - 2/94 Research Scientist at LERTS in charge of the research group on water and energy budgets at the land atmosphere interface

5/1987 - 12/88 "Visiting scientist" at the Jet Propulsion Laboratory (Radar Sciences Group)
1/1985 - 5/87 Research scientist at LERTS (created in January 1985). Work on energy and water budgets from remotely sensed data
11/1980 - 1/85 Research Scientist at CNES. Work on thermal infra red data and satellite processing and dissemination (NOAA AVHRR) to users. Development of new approaches for using satellite data.

AWARDS

World Meteorological Organisation : 1st prize (Norbert Gerbier) for the best paper in Agrometeorology, 1991.
Magellan 3 Stars for the Hapex Sahel WEB site,1996.
USDA Secretary's team award for excellence (Salsa Program) 2000

PROFESSIONAL SOCIETIES

American Geophysical Union (AGU)
American Meteorological Society (AMS) Fellow
Institute of Electrical and Electronics Engineers (IEEE) Senior Member
European Geophysical Society (EGS)
Société Française des Thermiciens (SFT)

COMMITTEE ASSIGNMENTS

International

1992 - 2002 Science steering committee, International Satellite Land Surface Climatology Programme
1993 - 2001 Member of IGBP BAHC
1989 - 1996 MIMR Science Advisory group (ESA)
1997 - Present ASCAT Science Advisory Group (EUMETSAT)
1999 - Present Chair of SMOS Science Advisory Group (ESA)
2001 - Present Member of the GEWEX Science Steering Committee

B) SELECTED PUBLICATIONS RELATED TO MICROWAVES

Books

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panel, E. (1995). Scientific achievements of ERS-1. Noordwijk, NL, ESA.

Stewart, J. B., E. T. Engman, et al. (1996). Scaling up in Hydrology using Remote Sensing, John Wiley & Sons.
Birkett, C., K. Blyth, et al. (1997). Satellite data in Hydrology, Experience with ERS. Noordwijk, NL, ESA.
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Kerr, Y. H. and J. P. Wigneron (1995). Vegetation models and observations : A review. Passive Microwave Remote Sensing of Land-Atmosphere Interactions. B. J. Choudhury, Y. H. Kerr, E. G. Njoku and P. Pampaloni, VSP, The Netherlands: 317-344.

Chehbouni, A., H. Ilahiane, et al. (1997). The Desertification Processes. Espace et Environnement. CNES. Ecole d'Eté du CNES, Toulouse, Cepadues Editions: 249-254.
Gastellu-Etchegorry, J. P., F. Adragna, et al. (2000). Observation spatiale des parametres de surface. Actualité Scientifique. R. C. J.-M. Dubois, P. Gagnon. Montreal, Canada, Agence Universitaire de la francophonie: 299-317.
Kerr, Y. H., P. Waldteufel, et al. (2000). The soil moisture and ocean salinity (smos) mission An overview. P. P. S. Paloscia, VSP: 467-475.
Waldteufel, P., E. Anterrieu, et al. (2000). Field of view characteristics of a 2-D interferometric antenna, as illustrated by the MIRAS/SMOS L-band concept. P. P. S. Paloscia, VSP: 477-483.
Kerr, Y. H. (2001). Microondas passivas. Teledeteccion. S. J.A. Valencia (Sp), Servicio de Publicaciones, Universidad de Valencia: 199-239.
Johannessen, J., C. L. Provost, et al. (2002). Observing the Ocean from Space: Emerging capabilities in Europe. Observing the Oceans in the 21st Century. C. J. K. a. N. R. Smith. Melbourne, AUS, GODAE Project Office and Bureau of Meteorology: 198-208.

General publications (since 1995)

Kerr Y. H., Chanzy A., Wigneron J. P., Schmugge T. J. and Laguerre L., 1995, Requirements for assessing soil moisture from space in arid and semi arid areas, Soil Moisture and Ocean Salinity (SMOS) Measurement Requirements and Radiometer Techniques, ESA WPP-87, N. ESA, Pays-Bas, 15-33.
Font J., Kerr Y. and Berger M., 2000, Measuring Ocean Salinity from Space: the European Space Agency's SMOS Mission, Backscatter, 6, 17-19.
Kerr Y. H., Font J., Waldteufel P. and Berger M., 2000, The Soil Moisture and Ocean salinity Mission -:SMOS, Earth Observation Quarterly, 66, 18-26.

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Kerr, Y. H., P. Waldteufel, et al. (2001). "Soil Moisture Retrieval from Space: The Soil Moisture and Ocean Salinity (SMOS) Mission." IEEE Trans. Geosci. Rem. Sens. 39(8): 1729-1735.
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Boulet, G., Y. H. Kerr, et al. (2001). Deriving catchment scale water and energy balance parameters using Kalman filtering. Workshop on Data assimilation in Hydrology, Wageningen (NL).

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Calvet, J.-C., J. Noilhan, et al. (2001). Root-zone Soil Moisture Analysis Using Microwave Radiometry. IGARSS2001, SYDNEY (Australia), IEEE.

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Philippe Waldteufel

Date of birth : 1941

Qualifications : Ecole polytechnique de Paris (1962), Doctorat de l'Unversité de Paris (1970)

Career History :

	Positions & responsibilities
1962-67 :	Scientist at Centre National d'Etudes Des Télécommunications (CNET), within the CNET-CNRS team "ionospheric study through Thomson scattering"
1968-69 :	Team leader "ionospheric study through Thomson scattering"
1970 :	Scientist at the Arecibo Observatory (Cornell University)
1971-75 :	Scientist at CNET, within the CNET-CNRS team "remote sensing atmospheric studies"
1976-81 :	Director of "Institut de physique du globe de Clermont-Ferrand" (Clermont-Ferrand University II)
1982-85 :	Deputy Director of the research department in Météo France
1986-88 :	Head of department "Sciences de l'Univers" in the French research Ministry
1989-90 :	Technical advisor to the Minister for research

1991-93 :	Director for science in the French research Ministry
1994 -96 :	Scientist in the "Observatoire français des conjonctures économiques (OFCE)"
1997-99 :	Scientist at Institut Pierre Simon Laplace (IPSL)
2000 :	Scientist at Center for Earth and Planets' Environnement (CETP) in IPSL
2001 → :	Director of Service d'aéronomie (SA) in IPSL
1975-85 :	Many responsibilities in CNRS & CNES groups and committees

Languages : French (native speaker), English (fluent), German (notions)

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F. Bayle, J.P. Wigneron, Y. Kerr, P. Waldteufel, E. Anterrieu, Jean-C. Orlhac, A. Chanzy, O. Marloie, S. Sobjaerg, J.C. Calvet, J.M. Goutoule, N. Skou		Two-dimensional synthetic aperture images over a land surface scene	IEEE-GE, accepted for publication
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Background and experience of participating team

Patricia de Rosnay received the M.S. degree in Oceanography, Meteorology and Environmental Sciences in 1994 and her Ph.D degree in 1999 from the University Pierre et Marie Curie (Paris 6), in France. She is a research scientist at CNRS\CESBIO, France. Her current research interests are focussed on passive microwave remote sensing of soil moisture and the study of large scale land surface processes. She is involved in several land surface modelling activities such as PILPS, AMMA, and is now working on soil moisture remote sensing on field scale with the SMOSREX field experiment and complimentary scale with the SMOS project.

Maria Jose Escorihuela born in Zaragoza, Spain. Received her engineering degree in Electronics and Comunication from the 'Universitat Politècnica de Catalunya', at Barcelona, Spain. Master in MicroWave and Optical Transmission from the University Paul Sabatier in Toulouse, France, in 2003. Currently at CESBIO preparinga PhD Thesis. She is working on the modelling of the microwave emission.

Thierry Pellarin was born in Versailles, France, in 1972. He received a Ph.D. degree from the University of Grenoble, France, in 2001. In 2001, he joined the Météo-France/CNRM, Toulouse, France, and worked on microwave radiometry, with particular emphasis on the Soil Moisture and Ocean Salinity (SMOS) project. In 2003, he joined the CESBIO, Toulouse, France, and has been interested in existing satellites (AMSR, ERS/SAR) for soil moisture estimation. He is currently a research scientist at LTHE, Grenoble, France. His research interests are in passive and active microwave remote sensing for hydrological applications.

Thierry Pellarin was at CESBIO but is moving to Grenoble, where he will continue in the same line of activities and in realtion with CESBIO, INRA and CNRM.

Presentation of CESBIO and Service d'Aéronomie

CESBIO

Relevent experience of organisation

CESBIO is a joint laboratory of Centre National d'Etudes Spatiales (CNES), Centre National de la Recherche Scientifique (CNRS) and Université Paul Sabatier, Toulouse (UPS). CESBIO was created in january 1995 by merging LERTS (CNES-CNRS), the remote sensing group of CESR (CNRS), and the Laboratoire d'Ecologie Végétale (UPS) in a new entity, within a single building.

CESBIO has three main research activities :

- the study and modelling of water balance and ecosystem function, from local to global scales ;
- the understanding of the signal measured by satellite sensors and of its interaction with the atmosphere and surface targets ;
- the use of remotely sensed data to monitor and study vegetation and water balance at different space-time scales.

CESBIO uses satellite data, together with other data (climatic, ...) and models :

- to classify vegetation, from small agricultural regions to the whole globe ;
- to monitor the evolution of vegetation for periods ranging from weeks to several years, and to relate these evolutions to climate (e.g. drought) or anthropic forcing (e.g. bushfire) ;
- to assess crop yield, natural vegetation production, forest biomass ;
- to develop surface energy budget modeling ;
- to derive surface parameters used by GCM's for input (albedo) or validation (solar radiation) ;
- to derive vegetation net primary productivity on a global scale for global carbon cycle study.

CESBIO has gained considerable experience in the use of long time series of multispectral satellite measurements and other data with physically based method. Most of the work done at CESBIO is dealing with at least continental scale.

- position in organisation

Yann Kerr is a research scientist at CESBIO, haed of the global study teams and PI on the SMOS mission. He works in the field of the use of satellite data (thermal infrared and (mainly) microwaves) for assessing the water cycle and fluxes at the surface atmosphere interface.

IPSL/SA

Service d'Aéronomie has a long record and a vast experience in conceiving and developing projects aimed at remote sensing from space. Outstanding examples in relation with ESA are SWAN on SOHO and GOMOS on ENVISAT.

Dr. P.Waldteufel is the Director of Service d'Aéronomie. Since 1997, he is fully involved in L-band radiometry space projects such as (RAMSES and later SMOS), and has acted informally as the representative of the SMOS Lead Investigator (Y.H. Kerr) in the technical project teams, as well as a technical advisor to the SMOS SAG. He is the former Director for science at the ministry of research and technology, Deputy Director of the French weather service research establishment, Director of the Institut de Physique du Globe du Puy-de-Dôme.

1.3 Financial part

CBSA's joint budget will mainly cover manpower and travel. The expenses linked to field data collection , equipement etc are covered by other budgets.
PSS Forms are sent separately with signatures

2. Tor Vergata

2.1 Technical part

2.1.1 Direct modelling

First of all the relevant literature about microwave forest radiometry and, in particular, emissivity modeling, will be reviewed. For the case of forests, this preliminary work is foreseen to be relatively short. First of all, literature on the subject is still sparse, limited to few papers describing models (Ferrazzoli and Guerriero, 1996; Karam, 1997; Ferrazzoli et al., 2002). and experimental results (Wigneron et al., 1997; Lang et al., 2001; Macelloni et al., 2001; Kauzar et al., 2004a; Kauzar et al., 2004b) and some review papers (Pampaloni, 2004). Morover, it is not planned to implement a totally new modeling software, based on literature. The plan is to use the basic software already available at DISP, to be refined and adapted to specific cases. Several papers describe active models for forests. Also these papers will be reviewed, since some concepts may be common to passive models. In particular, papers describing forest geometry (e.g. Kasischke et al., 1994) are important for this work. Also permittivity models for vegetation elements will be reviewed (e.g. Franchois et al., 1998).

It is foreseen to model forest emission by using a discrete radiative transfer model, able to include multiple scattering effects. The basic structure is described in Ferrazzoli and Guerriero, 1996, Ferrazzoli et al., 2002. Considering multiple scattering effects is important for forests, even at L band, since elements of relatively large dimensions, such as main branches, contribute to scattering processes. Four main steps may be identified in the direct modeling process:

- Subdivision of forest medium into discrete elements. Canonic shapes, i.e. dielectric cylinders and discs, are used to represent trunks, branches, coniferous leaves, deciduous leaves.
- Modeling the permittivity of elements.
- Computation of bistatic scattering cross sections and extinction cross sections.
- Combination of contributions.

Details about the numerical algorithm are given in Ferrazzoli and Guerriero, 1996. It must be considered that the software allows us to work with flexibility. E.g., it is possible to modify the permittivity routines or the distribution of scatterer location by keeping the same basic structure of the software.

In this study, the purpose of the direct model is to relate brightness temperatures measured from space to the soil moisture of the observed pixel. For the case of forests, two major problems must be considered. First of all, the sensitivity to soil moisture is strongly reduced by vegetation attenuation. This effect could prevent us to obtain a reliable retrieval, if the forest is very dense. For younger and/or sparser forests, the retrieval may still be feasible, and the model simulations may allow us to estimate this feasibility. Another problem is related to the large amount of variables influencing the emissivity. For a given soil moisture, the emitted radiation may be appreciably modified by: soil roughness, presence of litter and/or understory, total woody volume and its subdivision into trunk and branch fractions, dimension and orientation of branches, total amount of leafy matter, leaf dimensions. All these effects may be comparable to each other, making the emission process complex. In theory, a reliable model could be able to consider all these variables. However, we must consider that their values are not available, in most cases, and we must produce a manageable algorithm. Therefore, we shall assume some average reasonable values for some variables, based on literature data and auxiliary information about observed forests. Detailed information will be used only for test purposes, over some test areas, such as Les Landes. In order to estimate the errors associated to this simplification process, a suitable parametric study will be carried out.

The output of this basic direct modeling work will consist in look-up tables, relating sets of simulated emissivities (for the SMOS configuration) to SM, by considering some basic forest types, some values of forest age (or biomass) and some realistic scenarios about geometric and structural variables. This will be accompanied by some error figures related to uncertainty about the same geometric and structural variables. Also special issues, such as topography, will be considered. In order to facilitate the retrieval process, and to harmonize the algorithm with parallel works about other kinds of surfaces (e.g. short vegetation, snow, etc.) a parametrization will be done. I.e., a standard rms minimization routine will be used to find the equivalent values of the parameters (optical depth and albedo) to be assigned to a simple first order model, in order to behave mostly similar to the discrete multiple scattering model. This rms minimization will be done by considering, for each forest scenario, several sets of angles, polarizations, and SM values. The output produced after this step will consist on associating a pair of equivalent values of optical depth and albedo to some forest scenarios belonging to an assigned set of forest types, stages, ages, etc.

2.1.2 Data set generation

The outputs produced by the direct model will be used by a retrieval algorithm, which will solve the inverse problem. I.e., given realistic sets of multipolarization, multiangle signatures measured by SMOS radiometer, assuming the forest scenario to be known, the estimated value of SM will be produced. Based on the parametric analysis described in 2.1.1, sources of uncertainty about forest scenario, as well as instrument effects, will be converted into errors in the estimated SM. Due to the complexity of the procedure, the work will be carried out in two steps. First of all, the retrieval will be done under the simplistic assumption of homogeneous pixels. In a second stage, the heterogeneity of pixels will be considered. Of course, this second step needs to be implemented under strict interaction with retrieval works for other kinds of surface.

2.1.3 Bread-boarding

In order to develop a reliable procedure for algorithm validation and dimensioning, preliminary tests over the algorithm itself are requested. Since available measurements of forest emission are scarce, as pointed out in 2.1.1, all efforts must be done aimed at keeping the maximum benefit from them. To this aim, data published in literature, reviewed in 2.1.1, will be considered. However, most of the tests will be done using some data about coniferous Les Landes forest, already available to the team. For some parcels, detailed structural information is available (Kauzar et al., 2004b). Therefore, comparisons between model outputs and experimental emissivities are fully significant. Les Landes site was flown during Eurostarrs campaign, with an L-band radiometer (Kauzar et al., 2004a). Unfortunately, only V polarization measurements are available. Also results of the multitemporal Bray experiment, presently under way, will be important. In the framework of coSMOS campaign, also emissivity data over deciduous forests will be collected.

In order to maximize the reliability of the algorithm, tests will be done at three levels:
- Comparisons between measured brightness temperatures and data simulated by the multiple scattering direct model;
- Comparisons between measured brightness temperatures and data simulated by the first order simplified model produced by parametrization;
- Comparisons between measured SM values and outputs of the retrieval algorithm, using measured brightness temperatures as input.

Moreover, model simulations will allow us to evaluate the extent of forest covers for which the canopy attenuation is so high to prevent us to implement a reliable SM retrieval procedure. Suitable flag setting rules will be developed.

2.1.4 Algorithm validation

Based on the previously described work, the overall algorithm, for forests, will be described in ATBD. A validation strategy will be suggested, considering all the problems found during algorithm implementation and algorithm tests. A suitable validation plan will be elaborated. Of course, this will be done in strict interactions with other parts of the study.

<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number: 2141
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : Direct Submodel for forests (Draft)
CONTRACTOR : Tor Vergata - DISP
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT : KO</td><td>PLANNED DATE : T0</td></tr>
<tr><td>END EVENT : submission of ATBD draft</td><td>PLANNED DATE : January 2005</td></tr>
<tr><td colspan="2">WP MANAGER : Paolo Ferrazzoli</td></tr>
<tr><td colspan="3">ITEMS TO START WP :

TASKS :
➢ A Literature review
➢ B Selection of algorithm, justification of selection, algorithm overview
➢ C Theoretical description of algorithm

Deliverables: Sections of ATBD Draft</td></tr>
<tr><td colspan="3">OUTPUTS : Software for direct forest modeling</td></tr>
</table>

WORK PACKAGE DESCRIPTION		WP number: 2142 DATE: 30/09/2004
WP. TITLE : Direct Submodel for forests (First issue) **CONTRACTOR : Tor Vergata - DISP** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No : 1**
START EVENT : ATBD Draft	**PLANNED DATE : January 2005**	
END EVENT : submission of ATBD first issue	**PLANNED DATE : December 2005**	
WP MANAGER : Paolo Ferrazzoli		
ITEMS TO START WP : generation of ATBD Draft **TASKS** : ➢ A Generation of look-up tables ➢ B Model parametrization ➢ C Testing theoretical model vs. available experimental data ➢ D Testing parametrized model vs. available experimental data ➢ E First model refinements **Deliverables: Sections of ATBD first issue**		
OUTPUTS : Test results, Software for theoretical forest model, software for parametrized model		

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<tr><td colspan="2">WORK PACKAGE
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DATE: 30/09/2004</td></tr>
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CONTRACTOR : Tor Vergata - DISP

SUBSYSTEM :</td><td rowspan="4">Task :

Page : 1

Issue No : 1</td></tr>
<tr><td>START EVENT : ATBD first issue</td><td>PLANNED DATE : December 2005</td></tr>
<tr><td>END EVENT : submission of ATBD second issue</td><td>PLANNED DATE : December 2006</td></tr>
<tr><td colspan="2">WP MANAGER : Paolo Ferrazzoli</td></tr>
<tr><td colspan="3">ITEMS TO START WP : generation of ATBD first issue

TASKS :
➢ A Testing theoretical model vs. new experimental data
➢ B Testing parametrized model vs. new experimental data
➢ C Final refinements

Deliverables: Sections of ATBD second issue</td></tr>
<tr><td colspan="3">OUTPUTS : Test results vs. new data, Final software for theoretical and parametrized direct forest model</td></tr>
</table>

WORK PACKAGE DESCRIPTION		WP number: 4220 DATE: 30/09/2004
WP. TITLE : Validation offorest models **CONTRACTOR : Tor Vergata - DISP** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No : 1**
START EVENT : Validation exercise	**PLANNED DATE : T0+14**	
END EVENT : Validation report	**PLANNED DATE : T0+24**	
WP MANAGER : Paolo Ferrazzoli		
ITEMS TO START WP : validation of forest models **TASKS** : ➢ Direct validation of task 2140 **Deliverables: validation report for forests**		
OUTPUTS :		

2.1 Administrative part

Dipartimento di Informatica, Sistemi e Produzione (DISP) of Tor Vergata University, Roma (Italy) will implement the SM retrieval algorithm for forest covers, and write the relevant parts of ATBD and documents. The work will carried out by Paolo Ferrazzoli, Leila Guerriero and Andrea Della Vecchia.

Background and experience

Paolo Ferrazzoli (DISP)

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Paolo Ferrazzoli graduated from the University "La Sapienza" of Rome in 1972. In 1974 he joined Telespazio s.p.a., where he was mainly active in the fields of antennas, slant-path propagation and advanced satellite telecommunication systems.
In 1984 he joined "Tor Vergata" University of Rome, where he is presently working, teaching Microwaves and Propagation. His research, here, is focused on microwave remote sensing of vegetated terrains, with particular emphasis on electromagnetic modeling. He has been involved in international experimental remote sensing campaigns such as AGRISAR, AGRISCATT, MAESTRO-1, MAC-Europe and SIR-C/X-SAR.
He has participated to the coordinating team of ERA-ORA Project, funded by EEC, establishing an assemblage among several European researchers working in radar applications. He is a member of the Science Advisory Group of ESA SMOS Project.
He is member of IEEE Geoscience and Remote Sensing Society. He is co-author of more than 40 papers published on international journals or books, and more than 110 presentations at conferences. He has been chairman of sessions at international conferences, such as IGARSS, PIERS and ISPRS. He has been reviewer of 30 papers submitted to international journals. In 1998, the IEEE Trans. Geosci. Remote Sensing attributed to him the title of “one of best reviewers”.
He leaded the DISP work in the framework of three ESA Contracts, i.e. Contract 15925/02/NL/SF, “Passive calibration of the backscattering coefficient of the Envisat RA-2”, Contract AO/1-3652/00/NL/DC “Soil moisture retrieval by a future space-borne earth observation mission”, Contract 17011/03/NL/JA, “Development of SAR Inversion Algorithms for Land Applications”.

Leila Guerriero (DISP)

Leila Guerriero received her ”laurea” degree in Physics in 1986, and the Ph.D. degree in Electromagnetism in 1991. Since 1994, she has been a permanent researcher at Tor Vergata University, Rome, where she is now holding a course on Satellite Monitoring. In 1988 she was involved in a cooperation between JPL and Italian National Research Council for investigations on geophysical applications of Imaging Spectrometry in InfraRed and Visible

Remote Sensing. In 1995 she participated in the ESA project concerning radiometric polarimetry of the sea surface. In 1999-2001 she participated at the EEC concerted action ERA-ORA whose objective was to improve radar data analysis and utilization. More recently she has been involved in the ESA project on the Soil Moisture and Ocean Salinity Satellite. Her activities at Tor Vergata University are mainly concerned on modelling microwave backscattering and emissivity from agricultural and forested areas.

Andrea Della Vecchia (DISP)

Andrea Della Vecchia was born in 1979 in Colleferro (Roma). In October 2001, he obtained the First level degree in Telecommunication Engineer at the Tor Vergata University, Rome with 110/110 cum laude. In December 2002 he obtained the higher degree in Telecommunication Engineer at the Tor Vergata University, Rome with 110/110 cum laude. Since November 2003 he is a student of Geoscience PhD at Tor Vergata University, Roma. His research work is on modeling the emission and backscattering of vegetation covered surfaces.

Relevant References

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P. Ferrazzoli, L. Guerriero, S. Paloscia, P. Pampaloni, ``Potential of multifrequency techniques in microwave radiometry of crops'', Microwave Radiometry and Remote Sensing of the Environment, D. Solimini (Ed.), VSP, 1995, pp. 391-400.

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PRESENTATION OF THE INSTITUTE

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Both its teaching and research activities make DISP one of the most active departments of the high-ranked Tor Vergata University in Rome. Its permanent staff presently consists of 23 full and associate professors and 17 researchers. The total number of active people exceeds 100, including technical and administrative personnel, contract researchers, and fellowship or scholarship holders. The Department is essentially interdisciplinary, with groups active in computer science and engineering, control systems, telecommunications, remote sensing, and engineering management. In particular, it is worth mentioning the groups and laboratories of software architectures, artificial intelligence, operating systems, robotics, industrial systems and operations research, satellite navigation, antennas, radar, and microwave earth observation. The remote sensing group, which presently includes a permanent staff of 6 and several contract and scholarship holders, has carried research on active and passive microwave earth observation since almost 20 years and has published over 200 papers on refereed international journals, books and conference proceedings. The group has participated in early international experiments and campaigns (AGRISAR, AGRISCATT, ERS, SIR-C/SAR-X) and is currently involved in the ENVISAT and SMOS missions. The group has been granted several contracts from the Italian and European Space Agencies and from national and international industries. The group has recently coordinated a European project (European Radar-Optical Research Assembly), with the participation of institutions from eight Countries. The main studies that have been carried out and the applications that were developed in microwave remote sensing of the earth surface include: modeling of scattering and emission from terrain covered by vegetation, processing and interpretation of airborne and satellite radar and radiometer data, classification of land surfaces, estimate of agricultural and forest biomass and soil moisture, use of radar interferometry.

Participations in ESA Projects

ESA/ESTEC Contract 11529/95/NL/DS, "G/T assessment study"
ESA/ESTEC Contract 1146/95/NL/NB, "Polarimetry for passive remote sensing"
ESA/ESTEC Contract 15925/02/NL/SF, "Passive calibration of the backscattering coefficient of the Envisat RA-2"
ESA/ESTEC AO/1-3652/00/NL/DC "Soil moisture retrieval by a future space-borne earth observation mission"
ESA ESTEC Contract No. 17011/03/NL/JA, "Development of SAR Inversion Algorithms for Land Applications"

2.3 Financial part

PSS Forms are sent separately with signatures

3. Reading University

3.1 Technical part

3.1.1. Overall ESSC contribution

ESSC will be the lead investigator for dealing with areas such as urban areas or water areas which can cause biases in estimates of the retrieved soil moisture fields, and so must be masked out before retrieval is attempted. It will also have responsibility for defining limits to retrievals in areas of mixed pixels, high topography, freezing soils or snow, atmospheric effects and other possible sources of noise in retrieved soil moisture fields.

ESSC will also coordinate the activities of the science group as required, and will try to ensure wide community acceptance of the algorithms defined. Some of the tasks will require access to ancillary data, both for masking areas, such as urban areas, and for assisting with retrievals, such as surface temperature for freezing soils. As far as possible, data which are on open access for research purposes will be defined. ESSC will assist with obtaining these data sets.

Forward modelling will be used to understand the limitations provided by urban areas, etc., in sensitivity studies. The well-known Tau-Omega model will be adopted for this work initially. Inverse models will be used to understand the effect of retrieval errors. Much of this work will build on existing work in ESSC (Davenport *et al*. 2004; Fernandez Galvez *et al.*, 2004). Simulations of idealised scenes will be used to explore the parameter space and to allow the separation of different sources of errors and bias. The results will be tested against experimental observations collected at Sonning, near Reading, in 2001 and 2002, and also from other published data sets in Europe and the United States.

Particular task descriptions follow.

3.1.2 Establishment of algorithms

A literature review will be carried out to justify the selection of algorithms. These will be described and peer review will be used to ensure that the approach is widely acceptable. The following will be examined:

Effect of extreme topography
Effect of urban areas
Effect of snow cover
Effect of freezing soils and snow cover
Atmospheric effects and sun-glint (if applicable)
RFI
Mixed pixels

All of these tasks also involve the other science teams as appropriate, and so regular email exchanges will be needed.

A Forward and inverse modelling

Forward models will be used both for ideal and actual scenes to understand the possible effects of the areas defined above in Task 1. Inverse modelling will then be carried out on the synthetic brightness temperature fields generated to understand the magnitude of errors and biases, though sensitivity studies, and to define the accuracy of ancillary data required, such as topography, vegetation, snow cover and surface temperature. Many of these fields are freely available from remote sensing or as the products of coupled models, though perhaps not with the required accuracy. This will need determining.

A scientific problem to be addressed is that while there have been many studies of agricultural sites, and certain field experiments have been carried out in agricultural areas, very few studies have been carried out to mask out the effect of the areas defined in Task 1. There are therefore many open issues. This will require peer review both within the science team and more widely. Nevertheless, it is anticipated that the result of the work will be a set of masks and associated look-up tables which give the limits of retrievals and, where possible, corrections that can be applied, that relate simulated brightness temperatures, as estimated by SMOS, to soil moisture, together with associated errors.

B Data set generation and testing

The work will start with synthetic scenes, but will progress to scenes where data are available from aircraft studies, such as from the US SMEX experiments. This will not cover all the cover types given in Task 1, but will allow the general approach to be tested. It is anticipated that for this area considerable ancillary data will be required. A literature review and examination of test data will determine the limits on the accuracy of data such as global land cover data and whether these meet the accuracy requirements of the SMOS retrievals to provide sufficient masks or ancillary data for corrections.

C *Risks*

There is very little work that has been done that examines the limits of retrieval algorithms for soil moisture from brightness temperature in heterogeneous, non-agricultural landscapes. Ancillary data will be required, and it is not known whether these will be of the required accuracy because of the earlier limited scientific work. Only limited observed data sets are available, so there will have to be a reliance on synthetic data sets. These risks will be minimised by peer review within the science team and by wider peer review of algorithms and results.

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Page : 1
Issue No : 1</td></tr>
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<tr><td>END EVENT Final presentation</td><td>PLANNED DATE : T0+24</td></tr>
<tr><td colspan="2">WP MANAGER : Robert Gurney</td></tr>
<tr><td colspan="3">ITEMS TO START WP : AGREED PROPOSAL

TASKS :
➢ Overall coordination of Algorithm Theoretical Baseline Document
➢ Co-ordination of submodel elaboration: for all direct sub models and including:
  ➢ algo overview, choice, description, discrete and parametrisation
  ➢ validity assessment, error budget
  ➢ validity range requirements on inputs

Deliverables: Hand-outs of meetings, reports
OUTPUTS:</td></tr>
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Page : 1
Issue No : 1</td></tr>
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TASKS :
➢ literature review
➢ Discussion of problem areas
Deliverables: report chapter
OUTPUTS:</td></tr>
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Issue No : 1</td></tr>
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TASKS :
➢ Coordinate the contributions from different partners
➢ Assemble the ATBD draft

Deliverables: draft report
OUTPUTS: Draft ATBD</td></tr>
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<tr><td>END EVENT: O5 PMI</td><td>PLANNED DATE : T0+12</td></tr>
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TASKS :
➢ Coordinate the contributions from different partners
➢ Assemble the ATBD Issue 1

Deliverables: Issue 1 ATBD
OUTPUTS: ATBD Issue 1</td></tr>
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WP. TITLE : ATBD Issue 2 CONTRACTOR : University of Reading SUBSYSTEM :		Task : Page : 1 Issue No : 1
START EVENT : PM2	PLANNED DATE : T0+12	
END EVENT: Final presentation	PLANNED DATE : T0+24	
WP MANAGER : Robert Gurney		

ITEMS TO START WP : access to first results for ATBD Issue 2

TASKS :

- Coordinate the contributions from different partners
- Assemble the ATBD Issue 2

Deliverables: ATBD Isue 2

OUTPUTS: ATBD Issue 2

WORK PACKAGE DESCRIPTION		WP number: 2161 DATE: 30/9/04
WP. TITLE : Direct Submodel for Problem Areas **CONTRACTOR : University of Reading** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No : 1**
START EVENT : KO	**PLANNED DATE : T0**	
END EVENT : Submission of ATBD draft	**PLANNED DATE : January 2005**	
WP MANAGER : Robert Gurney		

ITEMS TO START WP :

TASKS :

- A Literature review
- B Selection of algorithm, justification of selection, algorithm overview
- C Theoretical description of algorithm

Deliverables: Sections of ATBD Draft

OUTPUTS: Software for direct modelling of urban areas, etc.

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January 2005</td></tr>
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<tr><td colspan="3">ITEMS TO START WP : generation of ATBD draft

TASKS :
➢ A Generation of look-up tables
➢ B Model parameterisation
➢ C Testing theoretical model vs. available experimental data
➢ D Testing parameterised model vs. available experimental data
➢ E First model refinements

Deliverables: Sections of ATBD Draft
OUTPUTS: Test results, Software for model, software for parameterised model</td></tr>
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<tr><td>END EVENT : submission of ATBD second issue</td><td>PLANNED DATE : December 2006</td></tr>
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ITEMS TO START WP : generation of ATBD first issue

TASKS :

- A Testing theoretical model vs. new experimental data
- B Testing parameterised model vs. new experimental data
- C Final refinements

Deliverables: Sections of ATBD second issue

OUTPUTS: Test results vs. new data, Final software for theoretical and parameterised model

WORK PACKAGE DESCRIPTION		WP number: 2300 DATE: 30/9/04
WP. TITLE : inversion algorithms **CONTRACTOR : University of Reading** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No : 1**
START EVENT : KO	**PLANNED DATE : T0**	
END EVENT: ATBD draft	**PLANNED DATE : T0+3**	
WP MANAGER : Robert Gurney		
ITEMS TO START WP : literature and other studies **TASKS** : ➢ Review possible inversion algorithms and propose one **OUTPUTS: inversion algorithm**		

<table>
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TASKS :
➢ Gather algorithms of all groups as per WP 2000
➢ Produce draft document on algorithms specs (validity range required inputs)
➢ Define flag and flag elaboration
➢ Assess errors

OUTPUTS: inversion algorithm V1 for ATBD</td></tr>
</table>

WORK PACKAGE DESCRIPTION		WP number: 2311 DATE: 30/9/04
WP. TITLE : inversion algorithms **CONTRACTOR : University of Reading** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No : 1**
START EVENT : ATBD V1	**PLANNED DATE : T0+12**	
END EVENT: ATBD V2	**PLANNED DATE : T0+24**	
WP MANAGER : Robert Gurney		

ITEMS TO START WP : inversion algorithms from different teams

TASKS :

- Gather algorithms of all groups as per WP 2000
- Produce draft document on algorithms specs (validity range required inputs)
- Define flag and flag elaboration
- Assess errors

OUTPUTS: inversion algorithm V2 for ATBD

WORK PACKAGE DESCRIPTION		WP number: 2400 DATE: 30/9/04
WP. TITLE : overall inversion algorithms **CONTRACTOR : University of Reading** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No : 1**
START EVENT : ATBD V1	**PLANNED DATE : T0+12**	
END EVENT: ATBD V2	**PLANNED DATE : T0+24**	
WP MANAGER : Robert Gurney		

ITEMS TO START WP : Outputs from WP2300

TASKS :

- Following the evolution of 2300 WP the task is to finalise the overall algorithms specs excluding the pure inversion processt:
- It covers:
- the overall algorithm description and branching , the input data insertion point swith input data characteristics
- the overall error budget
- the quality control elements and diagnostics
- the exception handling

OUTPUTS: Inputs for ATBD final doc

WORK PACKAGE DESCRIPTION		WP number: 3000 DATE: 30/9/04
WP. TITLE : TGRD IODD co-ordination CONTRACTOR : University of Reading SUBSYSTEM :		Task : Page : 1 Issue No : 1
START EVENT : KO	PLANNED DATE : T0	
END EVENT: final presentation	PLANNED DATE : T0+24	
WP MANAGER : Robert Gurney		

ITEMS TO START WP :

TASKS :

- Coordinate partner contributions to TGRD IODD

Deliverables: TGRD -IODD

OUTPUTS: TGRD - IODD

WORK PACKAGE DESCRIPTION		WP number: 3010 DATE: 30/9/04
WP. TITLE : TGRD Draft **CONTRACTOR : University of Reading** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No : 1**
START EVENT : KO	**PLANNED DATE : T0**	
END EVENT: TGRD Draft	**PLANNED DATE : T0+3**	
WP MANAGER : Robert Gurney		

ITEMS TO START WP :

TASKS :

- Coordinate partner contributions to TGRD Draft
- This includes auxiliary; ancillary data and test data generation and covers data source and requirements, fall back options

Deliverables: TGRD Draft

OUTPUTS: TGRD Draft

WORK PACKAGE DESCRIPTION		WP number: 3011 DATE: 30/9/04
WP. TITLE : TGRD –Issue 1 **CONTRACTOR : University of Reading** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No : 1**
START EVENT : TGRD Draft	**PLANNED DATE : T0+3**	
END EVENT: PMI2	**PLANNED DATE : T0+12**	
WP MANAGER : Robert Gurney		

ITEMS TO START WP : Draft ATBD

TASKS :

- Coordinate partner contributions to TGRD Draft
- Generation of look-up table requirements from ATBD
- Discussion of problem areas
- This includes auxiliary; ancillary data and test data generation and covers data source and requirements, fall back options

Deliverables: TGRD Issue 1

OUTPUTS: TGRD Issue 1

WORK PACKAGE DESCRIPTION		**WP number: 3012** **DATE: 30/9/04**
WP. TITLE : TGRD Issue 2 **CONTRACTOR : University of Reading** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No : 1**
START EVENT : PM2	**PLANNED DATE : T0+12**	
END EVENT: Final presentation	**PLANNED DATE : T0+24**	
WP MANAGER : Robert Gurney		

ITEMS TO START WP : ATBD Issue 1

TASKS :

- Coordinate partner contributions to TGRD Draft
- Generation of look-up table requirements from ATBD
- Discussion of problem areas
- This includes auxiliary; ancillary data and test data generation and covers data source and requirements, fall back options

Deliverables: TGRD Issue 2

OUTPUTS: TGRD Issue 2

<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number: 3110
DATE: 30/9/04</td></tr>
<tr><td colspan="2">WP. TITLE : IODD Draft
CONTRACTOR : University of Reading
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT : KO</td><td>PLANNED DATE : T0</td></tr>
<tr><td>END EVENT: Draft TGRD-IODD</td><td>PLANNED DATE : T0+12</td></tr>
<tr><td colspan="2">WP MANAGER : Robert Gurney</td></tr>
<tr><td colspan="3">ITEMS TO START WP : first analysis of problem and algorithm

TASKS :
➢ Coordinate partners in drafting TGRD-IODD

Deliverables:
OUTPUTS: entries for TGRD-IODD Draft</td></tr>
</table>

<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number: 3111
DATE: 30/9/04</td></tr>
<tr><td colspan="2">WP. TITLE : IODD Issue 1
CONTRACTOR : University of Reading
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT : Draft Tgrd-IODD</td><td>PLANNED DATE : T0+3</td></tr>
<tr><td>END EVENT: PM2</td><td>PLANNED DATE : T0+12</td></tr>
<tr><td colspan="2">WP MANAGER : Robert Gurney</td></tr>
<tr><td colspan="3">ITEMS TO START WP : Draft TGRD-IODD

➢ Coordinate partners in drafting TGRD-IODD

Deliverables:

OUTPUTS: Entries for TGRD-IODD Issue 1</td></tr>
</table>

WORK PACKAGE DESCRIPTION		**WP number: 3112** **DATE: 30/9/04**
WP. TITLE : IODD Issue 2 **CONTRACTOR : University of Reading** **SUBSYSTEM :**		**Task :** **Page : 1** **Issue No : 1**
START EVENT : PMD	**PLANNED DATE : T0+12**	
END EVENT: Final presentation	**PLANNED DATE : T0+24**	
WP MANAGER : Robert Gurney		
ITEMS TO START WP : Draft TGRD-IODD ➢ Coordinate partners in drafting TGRD-IODD **Deliverables:** **OUTPUTS: Entries for TGRD-IODD Issue 1**		

<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number: 4230
DATE: 30/9/04</td></tr>
<tr><td colspan="2">WP. TITLE : Submodels validation plan
CONTRACTOR : University of Reading
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT : validation part</td><td>PLANNED DATE : T0+16</td></tr>
<tr><td>END EVENT: Final presentation</td><td>PLANNED DATE : T0+24</td></tr>
<tr><td colspan="2">WP MANAGER : Robert Gurney</td></tr>
<tr><td colspan="3">ITEMS TO START WP : results from WP 2000, validation plan

➢ Manage the validation of submodels corresponding to tasks of University of reading in WP 2000

Deliverables: algorithm validation

OUTPUTS: chapter in validation plan</td></tr>
</table>

3.2 Administrative part

Administrative part – Reading University

Management and personnel

The Environmental Systems Science Centre, University of Reading, will have the responsibility for ensuring that the defined tasks are performed, and will coordinate the ATBD tasks as appropriate. The Director of ESSC, Professor Robert Gurney, will manage these tasks, assisted by Dr. Ian Davenport and Dr. Jesus Fernandez Galvez, research fellows in ESSC. ESSC is a NERC research unit at the University of Reading, and carries out research on all aspects of using novel observations in numerical predictions of environmental processes. It was rated 5* at the last UK Research Assessment Exercise. Professor Gurney has been Director of ESSC since 1990. He was previously Head of the Hydrological Sciences Branch at NASA Goddard Space Flight Centre. He has extensive experience in Earth Observation and hydrology. He was NASA's William Nordberg Lecturer in 2003.

Dr Ian Davenport has been a research fellow in ESSC since 1994. He previously carried out a PhD in Space and Climate Physics at University College London. He has worked on many aspects of land surface processes and remote sensing since in ESSC. (20%)

Dr. Jesus Fernandez Galvez joined ESSC in 2004. He had previously carried out a PhD in Soil Physics in the University of Granada. He won the 2003 José Maria Albareda Prize of the Spanish Society of Soil Science. (100%)

CURRICULUM VITAE: ROBERT GURNEY

Degrees and Posts Held

1995-present	Professor and Director, NERC Environmental Systems Science Centre, University of Reading
1990-1995	Professor and Director, NERC Environmental Systems Science Centre, University of Reading
1984-1990	Head, Hydrological Sciences Branch, NASA Goddard Space Flight Centre and Deputy Project Scientist, Earth Observing System.
1983-1984	Research Fellow, Department of Civil Engineering, University of Maryland
1981-1982	Research Fellow, Hydrological Sciences Branch, NASA Goddard Space Flight Centre
1975-1980	Institute of Hydrology, Wallingford
1976	PhD University of Bristol
1972	BSc University of London, King's College

Member of Professional Societies

1970: Royal Meteorological Society (Council 1992-5; Vice-President 2004-6)
1981: American Geophysical Union
1981: American Meteorological Society (Council 1990-3)
1974: Remote Sensing Society (Council 1991-4)

Honours
2003 William Nordberg Lecturer, NASA
2001 OBE

Current Committees, etc.
Chairman, Earth Observation Programme Board
Member, RCUK eScience Steering Committee
Member. NERC eScience Steering Committee
Member, RCUK Basic Technology Scientific Advisory Committee
Member (ex-Chairman), NERC Earth Observation Expert Group
External examiner, UCL MSc in Remote Sensing
Member, University of Cambridge NIEeS Management Committee
Member, PML Science Advisory Committee

Selected Publications in the Refereed Literature

2004 Davenport, I.J., Fernandez Galvez, J. and Gurney, R.J. "A sensitivity analysis of soil moisture retrieval from the τ−ω microwave emission model. IGARSS2004, (submitted).
2004 Davenport, I..J., Holden, N. and Gurney, R.J. Characterising errors in airborne laser altimetry data to extract soil roughness. IEEE Transactions on Geoscience and Remote Sensing (in press).
2004 Houldcroft, C.J., Campbell, C.L., Gurney, R.J., Davenport, I.J. A Comparison of Maize and Sunflower Canopy Geometry Characteristics using Ground Truth and LiDAR. IEEE Trans. on Geoscience and Remote Sensing (submitted).
2004 Tribbeck, M.J., Gurney, R.J. and Morris, E.M. Simulation of snow assimilation and ablation, snowpack profiles and sub-canopy radiation beneath a fir canopy. J. Hydromet. (submitted).
2004 Tribbeck, M.J., Gurney, R.J., Morris, E.M. and Pearson, D.W.C. A new snow-SVAT to simulate the assimilation and ablation of seasonal snowcover beneath a forest canopy. J. Glaciology. (in press).
2001 Pearson, D., Horritt, M.S., Gurney, R.J. and Mason, D.C. The use of remote sensing to validate hydrological models. In: Model Validation in Hydrological Science (eds. Anderson, M.G. and Bates, P.D.), Wiley, Chichester, **8**, 163-194.
2000 Simmonds, L.P., Burke, E.J., Pearson, D. and Gurney, R.J. Passive microwave remote sensing of soil moisture. Aspects of Applied Biology, **60**, 107-114.
1999 K.A. Browning and R.J. Gurney. Global Energy and Water Cycles, Cambridge University Press, 292pp.
1999 Burke, E.J., Wigneron, J-P. and Gurney, R.J. The comparison of two models that determine the effects of a vegetation canopy on passive microwave emission. Hydrol. & Earth System Sciences, **3**, 3, 439-444.
1999 Pearson, D.W.C., Daamen, C.C., Gurney, R.J. and Simmonds, L.P. Combined modelling of shortwave and longwave radiation for one-dimensional SVATs. Hydrology and Earth System Sciences, **3**, 1, 15-30.
1998 Simmonds, L.P., Burke, E.J. and Gurney, R.J. Estimating near-surface soil water content from passive microwave remote sensing - an application of Micro-SWEAT. Hydrological Sciences Journal, **43**, 4, 521-534.
1998 Burke, E.J., Gurney, R.J., Simmonds, L.P. and O'Neill, P.E. Using a modelling approach to predict soil hydraulic properties from passive microwave measurements. IEEE Geoscience and Remote Sensing, **36**, 454-462.
1997 Burke, E.J., Gurney, R.J., Simmonds, L.P. and Jackson, T.J. Calibrating a soil water and energy budget model with remotely sensed data to obtain quantitative information about the soil. Water Resources Research, **33**,7, 1689-1697.
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ESSC publications 2003-2004

2003 - *Refereed papers*

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Allan, R. P., M. A. Ringer, and A. Slingo, Evaluation of moisture in the Hadley Centre Climate Model using simulations of HIRS water vapour channel radiances, Q.J.R. Meteorol. Soc., **129**, 3371-3389.

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Astin, I. and Di Girolamo, L. (2003). Minimising systematic errors in cloud fraction estimates from cloud radars. J. Atmos. Oceanic Tech., **20**, 707-716.

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Blower, J.D., Keating, J.P., Mader, H.M. and Phillips, J.C. (2003). The evolution of bubble size distributions in volcanic eruptions. J. Volcanology and Geothermal Research, **120**, 1-23.

Brindley, H.E. and Allan, R. P. (2003). Simulations of the effects of inter-annual and decadal variability on the clear-sky outgoing longwave radiation spectrum. Q.J.R. Meteorol. Soc., **129**, 2971-2988.

Burke, E. J. and Simmonds, L. P. (2003). Effects of sub-pixel heterogeneity on the retrieval of soil moisture from passive microwave radiometry. International Journal of Remote Sensing, **24**, (10) 2085-2104.

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Davenport, I.J., Silgram, M., Robinson, J.S., Lamb, A., Settle, J.J. and Willig, A. (2003). The use of earth observation techniques to improve catchment-scale pollution predictions. Physics and Chemistry of the Earth, **28**, 1365-1376.

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Haines, K. (2003). Ocean Data Assimilation. NATO ISI Series, Maratea, Italy, 289-320.

Haines, K, Hipkin, R., Beggan, C., Bingley, R., Hernandez, F., Holt, J., Baker, T. and Bingham, R.J. (2003). Combined use of altimetry and in situ gravity data for coastal dynamics studies. Space Science Reviews, **108**, 205-216. ISSI Workshop Proceedings, Earth Gravity Field from Space Eds. G. Beutler, M. Drinkwater, R. Rummel, and R. von Steiger. Kluwer Academic Publishers.

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Matthiesen, S and Haines, K. (2003). A hydraulic box model study of the Mediterranean response to postglacial sea-level rise. Paleoceanography **18**, 4, 1084 10.1029/2003PA000880.

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2004 - Refereed papers

Allan, R.P., Ringer, M.A., Pamment, J.A. and Slingo, A. (2004). Simulation of the Earth's radiation budget by the European Centre for Medium Range Weather Forecasts 40-year Reanalysis 9ERA40). J. Geophys. Res. (accepted). *PDF version*.

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Bengtsson, L., Hagemann, S. and Hodges, K.I. and (2004). Can Climate Trends be Calculated from Re-Analysis Data? JGR Atmospheres (accepted).

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Davenport, I.J., Fernandez-Galvez, J. and Gurney, R.J. (2004). A sensitivity analysis of soil moisture retrieval from the Tau-Omega microwave emission model. Submitted to IEEE Transactions on Geoscience and Remote Sensing.

Davenport, I.J., Holden, N. and Gurney, R.J. (2004). Extracting High Resolution Information From Laser Altimetry Data by Analysing the Instrumental Error Budget, IEEE Transactions on Geoscience and Remote Sensing (submitted).

Davenport, I.J., Settle, J.J., Silgram, M., Robinson, J.S. Lamb, A. (2004). Derivation of Vegetation and Soil Endmembers, and Vegetation Fraction FromMultispectral Imagery, Remote Sensing of the Environment (submitted).

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Harries, J.E. and 42 authors (include. A. Slingo and R.P. Allan) (2004). The Geostationary Earth Radiation Budget (GERB). Bull. Amer. Meteorol. Soc. (submitted).

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Houldcroft, C..J., Campbell, C.L., Gurney, R.J., Davenport, I.J. (2004). A Comparison of Maize and Sunflower Canopy Geometry Characteristics using Ground Truth and LiDAR. IEEE Trans. On Geoscience and Remote Sensing (submitted).

Johannessen, O.M., Bengtsson, L., Miles, M.W., Kuzmina, S.I., Semenov, V.A., Aleksee, G.V., Nagurnyi, A.P., Zakharov, V.F., Bobylev, L.P., Petterson, L.H., Hasselmann K. and Cattle, H. (2004). Arctic Climate Change - Observed and Modelled Temperature and Sea Ice. *Nansen Environmental and Remote Sensing Center Technical Report*, No. 218. Tellus, Series A (in press).

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Slingo, A., Hodges, K.I. and Robinson, G.J. (2004). Simulation of the diurnal cycle in a climate model and its evaluation using data from Meteosat 7. Q.J.R. Meteorol. Soc. **130**, 1449-1467.

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Williams, K.D., Senior, C.A., Slingo, A. and Mitchell, J.F.B. (2004). Towards evaluating cloud response to climate change using objective identification of cloud regimes. Climate Dynamics (submitted).

4. INRA Bordeaux

4.1 Technical part

4.1.1. Overall INRA contribution

INRA will be the lead investigator for low vegetation covers (grassland, crops, low shrubs, etc.) for all tasks concerned by this aspect and which are summarized in WP 2150.

The reason for subdividing vegetation in two sub-categories, namely forest and low vegetation covers, is that different modelling approaches are best suited for these two categories:

Over forests, a very limited number of experimental data sets are available to date. Therefore, the parameterization of the tau-omega model (or other semi-empirical methods) from experimental observations cannot be done easily over forests. As developed in Ferrazzoli et al. (2002), discrete radiative transfer modelling, such as that developed by the Univ. of Tor Vergata, can be very useful to parameterize simplified modelling and retrievals methods for forests.

Conversely, over low vegetation canopies, several experimental data sets are available as discussed in the following. These data sets have been found to be useful to calibrate tau-omega parameterizations. They also allow a better understanding of specific effects (litter, interception, dew) that cannot be modelled by discrete modelling. Moreover, coherent effects may be significant in dense agricultural crops. It seems that such effects can be modelled using calibrated tau-omega parameterization, while R.T. methods cannot account for phase coherent effects.

The main idea, which will be developed in the following description of INRA contribution, is that retrieval methods over heterogeneous pixels can be evaluated from:

-synthetic data sets. The development of such data sets requires accurate forward model to simulate the emission from the different vegetation types. INRA will contribute to calibrate these forward models over low vegetation canopies based on experimental data sets. Several data sets are (or will be in the near future) available: INRA carried out several experiments over low vegetation covers, is closely associated to the SMOSREX experiment (Météo-France, CESBIO, INRA) over a fallow and will be closely associated to the COSMOS campaign (Toulouse site (Meteo-France, CESBIO, INRA)) over a variety of vegetation covers.

-airborne data sets: possibly from high altitude flights at the Valencia site during COSMOS. Pr. E. Lopez Baeza is the lead investigator on this site in close relation with INRA for data analysis.

4.1.2. FORWARD MODELING (TASK 2100):

a) General approach and objectives of INRA Contribution

The development of new retrieval approaches and the improvement of previous methods (as those defined in the two previous ESA projects: forward model inversion and statistical regression methods) rely on the use of accurate forward model of the vegetation effects:
(i) methods based on forward model inversion, obviously require accurate forward model.
(ii) forward model are also used to develop synthetic data base, accounting for the pixel heterogeneity, which are used to develop and test all possible types of retrieval methods (statistical regression and forward model inversion, Neural Network, look-up table, etc.)

In most cases, retrieval methods are applied over heterogeneous pixels and the implementation of retrieval methods requires an accurate modelling of the different cover types. For instance, four

categories, forest, herbaceous, bare soil, open water were distinguished in the studies of Pellarin et al., 2003a-b-c.
Within the "herbaceous" category, only two sub-categories: crops and grasslands were distinguished in previous ESA studies. However, the microwave signature of the different cover types (natural herbaceous covers, orchards, vineyards, crops, etc) can be very different from one type to the other (Wigneron et al., 2003) and should also be distinguished.

Our work will be based mostly on the use of existing, currently-acquired and near future experimental data sets to improve the tau-omega model parameterization of the vegetation effects. This parameterization should be defined as a function of configuration parameters (incidence angle, etc.) and vegetation characteristics (type, etc.).
Based on the parameterizations developed for a variety of vegetation covers, an improved distinction of different vegetation categories including types with similar microwave signatures will be developed.

The main multiangular data sets we identified are:
-soybean and wheat (PORTOS-91-93), BARC data sets, wheat (EMIRAD'2001)
already investigated in (Wigneron et al., 2003).
-fallow: SMOSREX-experiment, 2002-2005.
-corn: REBEX'2001 (Hornbuckle et al., 2003).
-vineyards, REFLEX'03 (Valencia)
-different types of crops, vineyards, orchards, deciduous forest: to be acquired during ESA-COSMOS'2005 at the Toulouse and Spanish sites.

The new data sets acquired since the study by Wigneron et al. (2003) will be extremely useful to address a number of issues that we identified in the modelling/retrieval over vegetation and are listed in the following section.
Addressing these issues cannot currently be done using physical/numerical models. Discrete radiative transfer models (Wigneron et al., 1993, Ferrazzoli et al., 1992, Karam et al., 1997) neglect coherent phase interactions due to scattering within the vegetation elements. Such interactions may be very significant in dense vegetation layers as shown in several studies (Yueh et al. 1992; Lin and Sarabandi, 1999; Stiles and Sarabandi, 2000). Furthermore, these kinds of models represent all vegetation elements by discs and cylinders and cannot account for scattering by elements with complex geometry, and for specific effects such as interception, modelling of litter, etc.
Conversely, the vegetation parameters of the tau-omega model are generally calibrated from experimental data and implicitly account for these coherent effects. Such an approach has been successful over most of the vegetation canopies to date.

b) Identification of the main scientific issues to be addressed

Preliminary results from ongoing experiments showed that several effects were not correctly taken into account by our current knowledge in modelling and may have significant detrimental effects in the SM retrieval accuracy

- Vegetation structure
The canopy geometry determines the value of the vegetation model parameters and their sensitivity to the configuration parameters (frequency, polarization and incidence angle) (Wigneron et al., 2003, van de Griend et al., 2004).
Several studies showed that neglecting this sensitivity may produce significant uncertainties in the simulations of the microwave emission of crop canopies (e.g., Pardé et al. (2003) over wheat, Hornbuckle et al. (2003), over corn, etc.). Errors in the simulations may often exceed 10 K at V polarization.

The sensitivity of the vegetation model parameters to the configuration parameters (frequency, polarization) should be thus accurately evaluated for most of the main canopy types (crops, prairies, matorral, orchards, vineyards, etc.).
Results have been recently obtained at L-band over many crops in Wigneron et al. (2003). Improvement in this analysis will be obtained by:
-better validating and improving the current parameterization obtained for a variety of crops (corn, soybean, wheat).
-developing new parameterizations for other types of vegetation: perennial covers with strong row effects such as orchards and vineyards, and crops: sunflower, etc.
-developing parameterizations to account for specific effects which are still unknown; such as the effect of litter over natural covers which is very significant and cannot be correctly taken into account by the current tau-omega modelling (Kauzar et al., 2004).

Based on these different parameterizations, our main goal is to contribute to a more accurate definition of vegetation categories, gathering vegetation types with similar microwave radiometric behaviour.

-interception of rainfall/irrigation by the aerial vegetation. Sudden increase in vegetation attenuation (and emission) may appear very quickly after rainfalls. This increased attenuation may disappear very quickly (if sun appears) or persist for several days.
Wigneron et al. (1994) based on radiometric measurements after rainfalls, noted that attenuation effects by intercepted water were similar to those due to internal water included in the vegetation material. Confirmation of this important result obtained for a senescent wheat crop should be confirmed by studies over other vegetation types.
Possible methods of detection of these disruptive effects are not known yet.

-dew effect: similar effects and remarks as those given above.

-litter: this layer is present over natural and agricultural vegetation covers which are rarely or never ploughed (fallow, prairies, shrubs, forests, etc.). It is thus very common over a very large percentage of the global vegetation coverage.
Its thickness is very variable: from a few millimetres for prairies, to several centimetres for forests.
Its water retention capability is also very variable (about 0.5 - 1 kg/m^2 for fallow (Kauzar et al., 2004) to several kg for forests (Bray experiment at INRA Bordeaux).
This layer may stay very wet during time periods of several months during wet seasons (water content ≈ 70 -80 %) and almost dry (water content ≈ 30 %) during dry seasons. Water retention by the dead vegetation material at the soil surface may probably lead to strong attenuation effects of soil emission and increase of vegetation emissivity. Such effects may probably explain why very high values of the b-factor (b~0.5 instead of ~0.15 for crops) have been retrieved in previous studies (Jackson et al., 1991, Wigneron et al., 2003).

Modeling and possible methods of detection of these disruptive effects are not known yet.

-effect of vegetation elements with specific geometry.

The effect of vegetation elements with specific geometry: fruits (cobs, pods, ...), bent leaves (such as those of corn), etc., should be studied. These elements may be the dominant vegetation elements in the vegetation (for instance, fruits within senescent crop canopies).
The ability of the tau-omega model to account for the specific scattering/absorption patterns of such elements is not known.

4.1.3. Inversion algorithms (task: 2310, 2350, 2370)

As a straightforward continuation of item 2150, INRA will be the main investigator in interaction with the other institutes in all tasks related to inversion algorithms over low vegetation covers.

a) Retrievals: Main scientific issues and proposed contribution

The issues listed in the previous sections concerning forward modelling strongly impacts the retrieval accuracy as mentioned above.

Some other questions are more specific to the retrieval problems and are discussed below:
Within methods based on forward model inversion (Wigneron et al., 2000, 2003), using the N-parameter approach, Pardé et al. (2004) propose the simultaneous retrieval of several land surface parameters:
-surface soil moisture w_s (m3/m3)
-vegetation optical depth (τ)
-surface temperature (T_S)
-and also possibly, vegetation parameters accounting for the vegetation structure: single scattering albedo ω, Cpol (for vegetation covers with a vertical structure, etc.)
The main problem to implement this type of approach is to propose an initialization and a constraint on the different parameters (τ, T_S, ω, etc.). For instance no constraint is used for soil moisture w_S that can generally be considered as a free parameter in the inversion process. Conversely, a rather strong constraint on T_S was found to be preferable in the general case by Pardé et al. (2004).

Our contribution will investigate possible approaches to obtain improved initializations and constraints on the different parameters which are retrieved in the N-parameter method. Such a definition will be evaluated for different vegetation categories. The study will evaluate/validate this aspect based on experimental data sets (over homogeneous and heterogeneous pixels in the framework of the COSMOS experiment) and based on synthetic data sets.

a1) Optical depth (τ):
Optical depth can be estimated from the vegetation type and the vegetation water content VWC (kg/m2). This latter is closely related to the vegetation biomass and to Leaf Area Index (LAI).
Information on both the vegetation type and the vegetation dynamics (through vegetation indices such as the NDVI for instance) can be obtained from remote sensing observations in the optical domain. Such observations may thus probably provide useful information for better estimating the initialization and constraint on the τ parameter in the retrieval process.
Such a possibility will be investigated based on experimental data acquired
-at the SMOSREX site over fallow, where observations are acquired in the microwave, thermal infrared (TIR) and optical domains.
-during COSMOS at the Toulouse site, where both airborne microwave and spaceborne optical observations will be available over a variety of vegetation types.
Relationships between optical depth (τ), LAI, vegetation indices obtained from optical observations will be investigated over the different vegetation types and for a variety of surface conditions (in terms of soil moisture, climate, phenology, etc.). Possibilities to use the optical observations to constrain the inversion process will be investigated in a second step.
Intercepted water (or dew) on the vegetation elements may affect strongly the value of τ, but to a much lower extent vegetation indices obtained from optical observations. The combined use of remote sensing observations in several frequency domains could thus be useful to detect specific events such as intercepted water, dew, etc.

a2) Surface temperature:

As mentioned above, a rather strong constraint on T_S was found to be preferable in the general case by Pardé et al. (2004) in the implementation of the N-parameter methods.
Such a result obtained over homogeneous fields will be investigated at larger scale over heterogeneous pixels, using (i) synthetic data sets and possibly (ii) using the airborne observations acquired at high altitude over the Spanish sites (Valencia, Salamanca) during ESA-COSMOS'2005.

a3) Effect of the vegetation structure:
Pardé et al. (2004) found that a priori use of information on the vegetation structure may strongly impact the retrieval accuracy.
This information determines the value of the vegetation model parameters (τ and ω mainly) and also the sensitivity of these parameters on the measurement configuration (θ, polarization, frequency).
For instance the CPOL parameter, that accounts for the dependence of τ on (θ, polarization) for canopies with a vertical structure, was found to be an important parameter that should be introduced in the retrieval process over many crops (Pardé et al., 2004).
In a first step, vegetation types with similar sensitivity of the vegetation parameters on the measurement configuration (incidence angle, polarization) will be gathered in vegetation categories. Parameterizations accounting for this sensitivity (such as the Cpol formulation) can be proposed in a second step. In a third step, for the different vegetation categories that have been identified, possibilities to introduce these parameterizations in the retrieval process will be investigated over heterogeneous pixels based on both experimental and synthetic data sets.

b) Specific issues affecting the retrieval algorithm accuracy.

The main issues that have been identified in the previous section on "modelling" may strongly impact the retrievals. The main aspects that were identified were:

-Effect of litter over grassland and natural vegetation areas:
Several questions should be addressed to improve the retrievals over canopies including a litter layer at the top of the soil surface.
(i) how can we model attenuation effect of the litter depending on its water content?
(ii) can we detect/estimate the moisture status of litter from the microwave radiometric observations or from ancillary remote sensing observations?
(iv) can we develop methods to initialize and constrain the optical depth of the litter in the N-P methods?

-Water interception by the canopy layer (including dew effects):
Should the same retrieval approach be used in case of wet conditions (there is intercepted water in the canopy) or dry conditions (no intercepted water)?
Several specific questions should be investigated to address this issue:
(i) does intercepted water on the vegetation elements has similar effects as the water included in the vegetation material.
If the answer in no:
(ii) can we develop methods to detect "interception" events?
(iii) can we develop parameterization to model the effect of intercepted water?
(iv) can we develop methods to initialize and constrain optical depth in the N-P methods in case of "dry" or "wet" conditions?

c) Summary of INRA contribution

Based on the detailed analysis of the different aspects listed above for low vegetation covers, INRA will contribute directly to
-the choice of the retrieval method (task 2310)
-the definition of the required algorithm inputs (task 2350)

-the estimation of the error in the soil moisture algorithm (task 2370) as a function of uncertainties in the model inputs

4.1.4 AUXILIARY DATA (TASK 3100)

The implementation of the retrievals over vegetation-covered soils, requires auxiliary data (soil texture, vegetation types, etc.) as discussed and documented in previous ESA studies. the availability of new data sets will be reviewed.
A new aspect which has rarely been investigated to date is the possible use of auxiliary remote sensing observations to initialize and constrain the input parameters of the tau-omega model in forward model inversion (e.g. optical depth from vegetation indices obtained from optical data, etc.). This aspect was discussed above and it will be investigated in this study based on experimental data.

4.1.5. VALIDATION PLAN (TASK 4240, 4320).

INRA will contribute to the validation plan in two main aspects:

-validation of sub-models/ retrieval methods specific to low vegetation covers
-overall validation from collected data sets.

Experimental data acquired (from ground-based or airborne radiometric systems) will be used to validate sub-models/ retrieval methods specific to low vegetation covers at the field scale.
The overall validation from collected data sets will be based mostly from airborne measurements made at high altitude over heterogeneous pixels.
Experimental data sets acquired during large scale US campaigns (such as the Southern Great Plains Hydrology experiment) are maybe available for this task. However, these data sets do not include multi-angular observations.
Our main efforts will be devoted to the analysis of the high altitude airborne measurements planned over a 10 x 10 km pixel at the Valencia site during COSMOS. Intensive airborne bi-angular radiometric measurements (about height flight lines covering the site) should be acquired during a 3 month spring period over a well-equipped site in 2005.
The long measurement period will allow to test/validate algorithms for a variety of surface conditions in terms of soil moisture, surface temperature, phenology and biomass.
Bi-angular measurements should be acquired allowing to test the key concept of all retrieval methods: the use of multi-angular observations to decouple between the effects of vegetation (main parameter = optical depth) and soil (main parameter= soil moisture).

<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number:2151
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : vegetation modelling (low covers)- DRAFT

CONTRACTOR : INRA EPHYSE BORDEAUX
SUBSYSTEM :</td><td rowspan="4">Task :

Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT : KO</td><td>PLANNED DATE : T0</td></tr>
<tr><td>END EVENT : Submission of ATBD draft</td><td>PLANNED DATE : TO+3</td></tr>
<tr><td colspan="2">WP MANAGER : Jean-Pierre Wigneron</td></tr>
<tr><td colspan="3">ITEMS TO START WP :
TASKS :
➢ Literature Review
➢ Synthesis of literature review, preliminary discussion on the choice of models and justification
➢ Draft description of the models
➢ Draft on validity assessment, error budget, requirements on inputs
➢ Discussion of problem areas (Draft)

Deliverables: : draft version of the ATBD part on low vegetation covers</td></tr>
<tr><td colspan="3">OUTPUTS: report and draft ATBD with list of outstanding issues</td></tr>
</table>

WORK PACKAGE DESCRIPTION		WP number:2152 DATE: 30/09/2004
WP. TITLE : vegetation modelling (low covers)- Version 1 CONTRACTOR : INRA EPHYSE BORDEAUX SUBSYSTEM :		Task : Page : 1 Issue No : 1
START EVENT : ATBD draft	PLANNED DATE : T0 +3	
END EVENT : ATBD Issue 1	PLANNED DATE : TO+12	
WP MANAGER : Jean-Pierre Wigneron		
ITEMS TO START WP : Draft ATBD and inputs from other 2100 packages TASKS : ➢ Algorithm Overview (ATBD version 1) ➢ Modelling refinement using available experimental data (considering the effects of vegetation structure, litter, interception) ➢ Test, validation of proposed refinements ➢ Discussion on the choice of models and justification, Description of the models (ATBD v. 1) ➢ Validity assessment, error budget, requirements on inputs (ATBD version 1) ➢ Discussion of problem areas (ATBD version 1) Deliverables: : version 1 of ATBD part on low vegetation covers		
OUTPUTS: report and ATBD issue 1 with list of outstanding issues		

<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number:2153
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : vegetation modelling (low covers)- Version 2

CONTRACTOR : INRA EPHYSE BORDEAUX
SUBSYSTEM :</td><td rowspan="4">Task :

Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT: ATBD Issue 1</td><td>PLANNED DATE : T0 +12</td></tr>
<tr><td>END EVENT : ATBD Issue 2</td><td>PLANNED DATE : TO+24</td></tr>
<tr><td colspan="2">WP MANAGER : Jean-Pierre Wigneron</td></tr>
<tr><td colspan="3">ITEMS TO START WP : ATBD V1 and inputs from other 2100 packages

TASKS :
➢ Algorithm Overview (ATBD version 2) including a discussion of issues revealed by the analysis made in WP 2152
➢ Modelling refinement using new experimental data (considering the effects of vegetation structure, litter, interception and other issues found in WP2152)
➢ Test, validation of proposed refinements
➢ Discussion on the choice of models and justification, Description of the models (ATBD v. 2)
➢ Validity assessment, error budget, requirements on inputs (ATBD version 2)
➢ Discussion of problem areas (ATBD version 2)

Deliverables: : version 2 of ATBD part on low vegetation covers</td></tr>
<tr><td colspan="3">OUTPUTS: report and ATBD issue 2 with list of outstanding issues</td></tr>
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<table>
<tr><td colspan="2">WORK PACKAGE
DESCRIPTION</td><td>WP number:4240
DATE: 30/09/2004</td></tr>
<tr><td colspan="2">WP. TITLE : vegetation submodel validation (low covers)
CONTRACTOR : INRA EPHYSE BORDEAUX
SUBSYSTEM :</td><td rowspan="4">Task :
Page : 1
Issue No : 1</td></tr>
<tr><td>START EVENT: validation plan</td><td>PLANNED DATE : T0 +16</td></tr>
<tr><td>END EVENT : final validation document</td><td>PLANNED DATE : TO+24</td></tr>
<tr><td colspan="2">WP MANAGER : Jean-Pierre Wigneron</td></tr>
<tr><td colspan="3">ITEMS TO START WP : vegetaion submodels and validation plan

TASKS :
➢ From sub-models in inversion algorithm, and test data validate the prototype
Deliverables: : validation of prototype</td></tr>
<tr><td colspan="3">OUTPUTS: report of validation exercise and list of outstanding issues</td></tr>
</table>

4.2 Administrative part

INRA EPHYSE

Management and personnel

The main contractor at INRA is Jean-Pierre Wigneron, INRA Research Scientist. He will be assisted by PhD students during their stay at Bordeaux and by engineers and technicians for the experimental campains.

• Kauzar Saleh (EPHYSE, Univ. Valencia, 50%) (modelling , retrieval studies and experiment work over fallow at the SMOSREX site and over several vegetation types during BRAY, COSMOS, etc.)
• Phd students (50%): several students will also carry out modelling, retrieval studies and experimental work during their stay at Bordeaux : Jennifer Grant (Univ. Amsterdam, several months at EPHYSE) in relation with Pr. A. van de Griend, Antonio Dufau (Univ. Valencia, several months at EPHYSE) in relation with Pr. Lopez Baeza.
• Engineers and Technicians of EPHYSE staff through their implications in several microwave experiments (current or near future): Alain Kruszewski (50%), J-M Bonnefond (20%), S. Debesa (20%), etc.
• Jean-Pierre Wigneron (EPHYSE) will coordinate the modelling and retrieval aspects of the study for vegetation canopies excluding forests. He will also coordinate exchange of experimental data sets acquired by INRA to the other teams involved in the study.

Recent activities in support of space or space related projects
Numerous contracts with PNTS (National French Remote Sensing Program) and CNES (Centre National dEtudes Spatiales) in the visible, thermal infrared and microwave domains. Recently, leader in accepted PNTS projects on SMOS in 1999, 2000-2001, 2002-2003, 2004-2005.
Recent contracts with ESA for studies in Support to the Soil Moisture and Ocean Salinity (SMOS) mission (second Earth Explorer Opportunity ESA Mission):
-ESA/ESTEC AO/1-3652/00/NL/DC "Soil moisture retrieval by a future space-borne earth observation mission"
-ESA (RFQ/3-10166/01/NL/SF), 2002, 'Technical assistance for deployment of ground instruments by INRA during EUROSTARRS-2001".

A. Curriculum Vitae

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E-mail: wigneron@bordeaux.inra.fr

Education:

2004 HDR "Accreditation to Supervise Research", Univ. Paul Sabatier, Toulouse
1993 Ph.D. University P. Sabatier, Toulouse, France
1987 Engineer Degree, SupAéro, ENSAE Toulouse, France

Employment:

2004 Head of the Remote Sensing Group, EPHYSE, INRA Bordeaux
2001-2004 Research Scientist (CR1), INRA Bordeaux, France
2000-2001 Visiting Scientist, CNES/CESBIO Toulouse
1995-2000 Research Scientist (CR1), INRA Avignon, France

1993-95 Research Scientist (CR2), INRA Avignon, France
1992-93 Visiting Scientist, CNES/LERTS, Toulouse
1990-91 Visiting Scientist, CNES/LERTS, Toulouse
1990 Contractual Scientist of INRA (ASC), Avignon, France

Awards:

1998 International Price of OMM (Organisation Mondiale de Météorologie) 'Norbert Gerbier Mumm' 2000 for the paper by J-C Calvet et al. in Agricultural and Forest Meteorology, 1998.

Professional Activities:

More than 60 papers in international Journals and books
Senior Member of IEEE, 2003
Session President at PIERS, IGARSS, SMOS, RAQRS,... meetings
PI or co-PI of international experiments (PORTOS, EMIRAD'2000, ESA-EUROSTARRS'2001, BRAY-Tower'2004, etc)
Supervised PhD students: M. Pardé (2003),
Co-supervised PhD students: K. Saleh Univ. Valencia, J. Grant, Univ. Amsterdam & A. Della Vecchia, Univ. Roma (currently)
Research contracts obtained with PNTS (Programme National de Télédétection Spatiale, France), in 1999, 2000, 2001, 2003 and with ESA in 2001 and 2002.

Current Research:

Modeling (active and passive) microwave signature of land surfaces,

SMOS retrieval algorithms and assimilation methods (Wigneron et al., 1993- 2004; Wigneron et al., JGR 2002);

Supervision of ground-based campaigns over forests and crops with EMIRAD

Models:

Mathematical remote sensing models (Wigneron et al., 1993a-b, 1995)
LMEB (L-band Microwave Emission of the Biosphere) (Wigneron et al., 2004)

B. Collaborators (recent and current)

P. Ferrazzoli (Univ. Roma), N. Skou and S. Schmidl (TUD Univ., Copenhagen), T. Schmugge (USDA Beltsville), J-C Calvet (Météo-France), Y. Kerr & P. de Rosnay (CESBIO Toulouse), P. Waldteufel (CETP Paris), A. Chanzy (INRA Avignon), C. Prigent (Obs. Meudon), E. Lopez Baeza (Univ. Valencia), A. van de Griend (Univ. Amsterdam), C. Mätzler (Univ. Bern)

C. Selected Publications Related to Passive Microwaves since 2000

[1] Wigneron J-P, T. Pellarin, J-C Calvet, P. de Rosnay and Y. Kerr, 'L-MEB: A simple model at L-band for the continental areas - Application to the simulation of a half-degree resolution and global scale data set', *Radiative Transfer Models for Microwave Radiometry*, Ed. C. Mätzler, Institution of Electrical Engineers, StevenAge, UK, 2005., *in prep.*

[2] Wigneron Jean-Pierre and Jiancheng Shi, 'Modeling soil emission', *Radiative Transfer Models for Microwave Radiometry*, Ed. C. Mätzler, Institution of Electrical Engineers, StevenAge, UK, *in prep.*

[3] Wigneron Jean-Pierre and Brian K. Hornbuckle, 'Modeling the effect of the vegetation structure: Evaluating the sensitivity of the vegetation model parameters to the canopy geometry and to the

configuration parameters (frequency, polarization and incidence angle)', *Radiative Transfer Models for Microwave Radiometry*, Ed. C. Mätzler, Institution of Electrical Engineers, StevenAge, UK, *in prep.*

[4] K. Saleh, A. Porté, D. Guyon, P. Ferrazzoli, D. Bert, J-P Wigneron, A geometric characterisation of a Maritime pine forest suitable for discrete microwave models, IEEE Trans. Geosc. Remote Sens., to be submitted, 2004.

[5] Van de Griend, A.A. and Wigneron, J.-P. (2004). 'Canopy extinction and single scattering albedo in the microwave region as a function of frequency, polarization, incidence angle and canopy type. IEEE Transactions on Geoscience and Remote Sensing', 2004, *in press.*

[6] Wigneron J.-P., J.-C. Calvet, P. de Rosnay, Y. Kerr, K. Saleh, M. J. Escorihuela, A. Krusevski, 'Soil Moisture Retrievals from Bi-Angular L-band Passive Microwave Observations', IEEE Trans. Geosc. Remote Sens., in press.

[7] Saleh, K., Wigneron, J.P., Calvet, J.C., Lopez-Baeza, E., Berger, M., Wursteisen, P., Simmonds, L., Miller, J., The EuroSTARRS airborne campaign in support of the SMOS mission: First results over land surfaces, Int. J. Remote Sens., vol. 25, no. 1, 177-194, 2004.

[8] Wigneron, J.-P., M. Pardé, P. Waldteufel, A. Chanzy, Y. Kerr, S. Schmidl, N. Skou, Characterizing the dependence of vegetation parameters on crop type, view angle and polarization at L-Band, IEEE Trans. Geosc. Remote Sens., vol. 42, no 2., p. 416-425, 2004.

[9] Van de Griend A. A. and J.-P. Wigneron, 'The b-Factor as a Function of Frequency and Canopy Type at H polarization', IEEE Trans. Geosc. Remote Sens., vol. 42, no. 4, p. 786-794, 2004.

[10] Pardé M, Wigneron J-P, Chanzy A., Kerr Y., Calvet, J.C., Waldteufel P., Schmidl S., Skou N., 'N-Parameter retrievals from L-band microwave measurements over a variety of agricultural crops', IEEE Trans. Geosc. Remote Sens., vol. 42, No. 6, p. 1168-1178, 2004.

[11] (S) Wigneron, J.-P., J.-C. Calvet, T. Pellarin, A. Van de Griend, M. Berger, P. Ferrazzoli, Retrieving near surface soil moisture from microwave radiometric observations: current status and future plans., Remote Sens. Environ., vol 85., pp. 489-506, 2003.

[12] (S) Berger Michael, Yann Kerr, Jordi Font, Jean-Pierre Wigneron, Jean-Christophe Calvet,Kauzar Saleh, Ernesto Lopez-Baeza, Lester Simmonds, Paolo Ferrazzoli, Bart van den Hurk, Philippe Waldteufel, Francois Petitcolin, Adriaan van de Griend, Evert Attema & Michael Rast, 'Measuring the moisture in the Earth's soil- Advancing the Science with ESA's SMOS Mission', ESA Directorate of Earth Observation, ESTEC, Noordwijk, The Netherlands, Esa Bulletin 115, p. 40-45, August 2003.

[13] Van de Griend A. A., J.-P. Wigneron, and P. Waldteufel, "Consequences of Surface Heterogeneity for Parameter Retrieval from 1.4 GHz Multi-Angle SMOS Observations", IEEE Trans. Geosc. Remote Sens., vol. 41, No. 4, 803-811, 2003.

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Computers: PC computer for each member connected to INRA Internal UNIX system
Special laboratories:
-Laboratory for equipment dedicated to flux measurements (radiative, H_2O, CO_2...)
-Remote Sensing laboratory equipped with computers and software for image and GIS processing
Test sites: 3 Forest sites for remote sensing and flux experiments (Bray, Bilos and Nezer) included in several international programs

The BRAY site includes a 40-m high tower equipped with measurements of classic meteorological data and of fluxes (CO_2, H_2O, etc.) at several levels. This site, as the BILOS site, is included in the International Networks of FLUXNET and CARBOEUROPE aiming at monitoring CO_2 and water fluxes at global/regional scale

The NEZER *site* of *Les Landes* forest is a site that consists of well-defined uniform stands of pine trees (*Pinus pinaster*) with a large range of ages (from seedlings to 50 years) and biomass (dry biomass varies from 0 to 160 Tons/ha). Homogeneous stands are approximately 500 m x 500 m over a nearly flat surface. *The Nezer site* has been used for some of the first studies assessing the potential of (1) Synthetic Aperture Radar (SAR) for forest mapping during MAESTRO-1989 (Le Toan et al. 1992; Dobson et al., 1992). (2) passive microwave observations (CNES experiment with PORTOS in 1994 (Wigneron et al., 1997). Since then, NEZER has been used as a reference site for several airborne international campaigns (MAC-EUROPE, PYLA-2001, ESA-EUROSTARRS 2001 (Saleh et al, 2004)), and for studies based on spaceborne observations.

4.3 Financial part

PSS Forms

- **INRA EPHYSE Bordeaux (Ecologie fonctionnelle et Physique de l'Environnement)**

The EPHYSE Unit is a research laboratory of INRA (Institut National de la Recherche Agronomique), a public institute of research related to agriculture and environment (2nd largest Research Institute in France).
It is included in the INRA Bordeaux Research Centre of INRA.

STAFF AND QUALIFICATIONS
The staff of EPHYSE (permanent staff = 35 persons) includes 15 Research scientists and 6 Engineers.

MAIN FIELD OF RESEARCH

EPHYSE (Functional Ecology and Environmental Physics) investigate the physical processes determining the exchanges at the biosphere-atmosphere interface with application to the functioning of landscapes composed of both cultivated and natural areas.
The studies are based on
(i) Modeling: mathematical formulation of the physical and biological processes of the mass and energy transfers.
(i) Experimental approaches: long-term data sets that include measurements of the fluxes and remote sensing data in the whole spectrum (optical, thermal infrared and microwaves (passive and active)) are acquired over well-equipped sites (Nezer, Bray, Bilos, etc.).

The Unit is involved in several national (ACI, PNTS, (Programme National de Télédétection Spatiale), etc. and international programs (CARBOEUROPE, EUROFLUX, FLUXNET, SMOS...)).

Recent activities in support of space or space related projects
Numerous contracts with PNTS (National French Remote Sensing Program) and CNES (Centre National d'Etudes Spatiales) in the visible, thermal infrared and microwave domains.
Several contract with ESA for studies in Support to the Soil Moisture and Ocean Salinity (SMOS) mission (second Earth Explorer Opportunity ESA Mission)

STRUCTURE:

EPHYSE includes three teams according to the three main expertise fields in the Unit:
-**"Remote Sensing" team,** Leader: J-P Wigneron, 3 (+1) Research Scientists, 1 Engineer, 1 Technician, 2-4 PhD students.
This team includes research scientists with expertises in the whole range of wavelengths: visible, thermal infrared, microwaves (passive and active technique). The work are based on modelling and experimental activities on several test sites (including the NEZER and Bray sites)
-**"Biological Processes" team**, Leader: R. Dewar, 5 Research Scientists, 3 Engineers, 4 Technician, 1 PhD student.
Investigating the biological and ecophysiological processes related to the functioning and growth of vegetation canopies (mainly forests)
-**"Physical Processes" team**, Leader: J-P Lagouarde, 6 Research Scientists, 2 Engineers, 3 Technician, 1 PhD student.

FACILITIES:

Part 3 Summary part

1 Financial recap

The overall cost is given in the table below. It corresponds to 350 k€ for two years to be split over 5 institutes (counting CBSA for 2).

Item/ESL Team	Tor Vergata	Reading U.	CBSA	INRA
Personnel	50	75	81	35
Travel	10	10	18	6
Equipment misc	-	-	0	16
overheads	-	46% (35)	11% (11)	5% (3)
Total	60	120	110	60

2 Overall schedule and deliverables

the dates below are given assuming a Kick off around December 01 2004.

- ATBD_draft — Algorithm Theoretical baseline — March 2005 -
- ATBD_iss1 — Algorithm Theoretical baseline — December 2005
- ATBD_iss2 — Algorithm Theoretical baseline — December 2006

Contribution to the elaboration of the following for Industry

- TGRD_draft — Table Generation Requirement Document — March 2005
- DPM/PDL_draft — Data Processing models — April 2005
- IODD_draft — Input Output data definition — April 2005
- DPM/PDL_iss1 — Data Processing models — October 2005
- IODD_iss1 — Input Output data definition — October 2005
- TGRD_iss1 — Table Generation Requirement Doc. — December 20005
- AlgoValP_iss1 — Algorithm validation Plan — February 2006
- AlgoValTPR-iss1 — Algo. valid. Test Proc. and Report — September 2006
- TGRD_iss2 — Table Generation Requirement Doc. — October 2006
- DPM/PDL_iss2 — Data Processing models — December 2006
- IODD_iss2 — Input Output data definition — December 2006
- AlgoValTPR-iss2 — Algo. valid. Test Proc. and Report — December 2006
- AlgoValP_iss2 — Algorithm validation Plan — December 2006

3.Work package summary

		overall		YK	PF	RG	JPW
	Deliv. date	WP		WP	WP	WP	WP
Progress Reports	Monthly	1000	YK				
Presentations hands out	Before Meeting	1000	ALL				
ATBD_draft – Algorithm Theoretical baseline	mars-05	2000	RG				
ATBD_iss1 – Algorithm Theoretical baseline	Dec 2005	2000	RG				
ATBD_iss2 – Algorithm Theoretical baseline	Dec 2006	2000	RG				
DPM/PDL_draft– Data Processing models	Apr 2005	2000	RG				
DPM/PDL_iss1 – Data Processing models	déc-05	2000	RG				
DPM/PDL_iss2 – Data Processing models	Dec 2006	2000	RG				
TGRD_draft – Table Generation Requirement Document	mars-05	3000	RG				
TGRD_iss1 – Table Generation Requirement Doc.	Dec 2005	3000	RG				
TGRD_iss2 – Table Generation Requirement Doc.	oct-06	3000	RG				
IODD_draft – Input Output data definition	Apr 2005	3000	RG				
IODD_iss1 – Input Output data definition	déc-05	3000	RG				
IODD_iss2 – Input Output data definition	Dec 2006	3000	RG				
AlgoValP_iss1 – Algorithm validation Plan	Feb 2006	4000	YK				
AlgoValP_iss2 – Algorithm validation Plan	Dec 2006	4000	YK				
AlgoValTPR-iss1 – Algo. valid. Test Proc. and Report	sept-06	4000	YK				
AlgoValTPR-iss2 – Algo. valid. Test Proc. and Report	Dec 2006	4000	YK				

4 Identification of areas of the project identified as a potential risk factor

There is very little work that has been done that examines the limits of retrieval algorithms for soil moisture from brightness temperature in heterogeneous, non-agricultural landscapes. Ancillary data will be required, and it is not known whether these will be of the required accuracy because of the earlier limited scientific work. Only limited observed data sets are available, so there will have to be a reliance on synthetic data sets. These risks will be minimised by peer review within the science team and by wider peer review of algorithms and results.

Nevertheless, we have to be fully aware that most models used here were developed at local scale and the up-scaling of these at SMOS scales might pose some challenges. Conversely, some issues at local scale might become negligible at larger scales. Airborne data and analysis of other data sets obtained at higher frequencies, might give a first rough cut estimate of the extent of the challenges mentioned in this part

-Coherent phase effects

The only model currently available, and which has been extensively validated at L-band is the so-called tau-omega model (Wigneron et al., 1995). To our knowledge, no other approach has similar favourable characteristics in terms of accuracy and simplicity.

However, as mentioned before radiative transfer models neglect coherent phase interactions due to scattering within the vegetation elements. Such interactions may be very significant in dense vegetation layers as shown in several studies.

To date, it seems that even though coherent effects are neglected in the very simple R.T. equations of the tau-omega model, this latter model performed well over most of canopy types.

The reason is probably that the values of the vegetation parameters (τ, ω, Cpol, etc) which are calibrated based on experimental data sets, are able to implicitly account for the coherent phase effects.

We do not know if such a result will also be valid for most of the other vegetation types which have not been studied yet (fallow, prairies, orchards, matorral and other natural vegetation covers, etc.) and over which several experiments are currently implemented or will be in the near future in the framework of COSMOS.

-Litter:

Preliminary results showed that the effects of litter may strongly impact the retrieval accuracy (Saleh et al., 2004) over a fallow. The moisture content of litter may change very quickly depending on the climatic conditions. It is very difficult to provide estimates of this moisture content from space observations (no flagging, detection methods are available). Moreover, no modelling approaches are currently available to account for these effects. In the framework of this project, we hope it will be possible to improve our knowledge and quantify retrieval errors due to these effects. Studies will be mostly based on the SMOSREX experimental data set. The possibility to develop methods correcting for the effects of litter is a potential risk factor in the implementation of retrieval algorithms over experimental data sets.

-Availability of experimental data.

The overall validation plan based on experimental data mainly relies on the use of the observations to be acquired in Spring'2005 during COSMOS, at high altitude over Spanish sites. These observations are not yet available and this may be also considered a potential risk factor.

- **Forested areas:**

A basic problem with forest radiometry is the scarce amount of previous studies on the subject. Modelling efforts have been scarce until now, so we have no chances to compare the behaviour of our software with similar works carried out elsewhere. Similarly, there is a scarce availability of previously collected experimental data. Therefore, the direct model may be tested only over limited data sets. Moreover, the reliability of simulated data does not depend only of the electromagnetic model in the strict sense, but also on the accuracy of information about structural properties of forests. Finally, the sensitivity to SM is limited by canopy attenuation, and it could result to be not sufficient over an appreciable fraction of world forest cover.

- **Assessing land fractions**

This part, linked in a way with the mixed pixels issue (water mainly) will probably be the most challenging part as expressed above in the main text.

-**Extremely dry land**

Even though soil moisture might be not as useful over very dry land, it is expected that classical approaches will fail over very dry land since the physics involved become quite different and the behaviour of the surface will be altered in a non linear way. Such areas might thus exhibit "strange behaviours" which will have to be detected, and eventually flagged. For similar reasons surface roughness assessment will have to be carefully considered in such conditions.

- **Urban areas, RFI** detection are yet to be fully assessed.

- **Detection of brutal events** (such as freezing or flooding) will have also to be effectively detected and flagged or processed accordingly. This part is yet to be ascertained.

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