CENTRE NATIONAL D'ÉTUDES SPATIALES

CNES Research Announcement of Opportunity on CFOSAT mission

Date of issue: June 4th 2018

Deadline for response: September 14th, 2018

1. Introduction

CNES, the French Space Agency (France), announce this opportunity to carry out scientific research towards the use of the CFOSAT (China France Oceanography SATellite) data. Investigators selected through this call will be part of the CFO-ST (CFOSAT- Scientific Team).

CFOSAT is innovative mission, which will carry two Ku-Band active instruments, SWIM dedicated to the measurement of directional of ocean surface waves, and SCAT dedicated to the measurement of ocean surface wind vectors. Radar cross-sections in Ku-Band will also be will be provided over all surfaces under a large range of incidence (0-50°) and azimuth angles (0-360°). CFOSAT will be launched by the end of 2018.

By providing wind and wave vectors at the same time and at a global scale, CFOSAT will bring major information for various fields of research, especially on the atmosphere/ocean exchanges which are a main challenge for understanding the climate. CFOSAT will also bring useful data for atmospheric, wave or oceanic modeling and forecast and for climate monitoring of wind and wave fields. Thanks to the new types of observations that it will provide (directional wave spectra), it will also be a key element to prepare future oceanographic satellite missions such as those devoted to surface current measurements.

CFOSAT is developed and will be exploited under a Chinese-French cooperation as agreed through the Chinese-French Memorendum of Understanding (MOU).

In addition, a strong partnership with the international scientific community is wished to maximize the scientific return. The present call aims at encouraging scientists in the international scientific community to propose projects that will use CFOSAT data with at least one of the following objectives:

- develop or assess methods, or carry out analyses useful for the geophysical CAL/VAL (calibration/validation) activity: by using the CFOSAT products by *se*, or through comparisons with in situ data, models, or other satellite observations. Coordinated field experiments dedicated to CFOSAT CAL/VAL may be proposed;
- develop improved algorithms for the processing of CFOSAT measurement;
- develop methodologies for combined products between SWIM and SCAT and/or alternative new products;
- develop the synergetic use of CFOSAT products with data from various missions and sensors (in particular the HY-2 series, the Jason series, and the Sentinel-1 Sentinel-2 and Sentinel 3) or in-situ measurements;
- carry out scientific studies based on the products proposed by the mission centers; this could concern in particular: the ocean wind and waves (wave generation and evolution, wind-wave, wave-wave or wave-current interactions, impact of waves and currents on the atmospheric or oceanic boundary layers, waves in sea ice, waves forcing coastal processes, wind and waves in extreme conditions, ocean forcing, wave climatology with emphasis on spectral information), sea ice characterization, continental ice shelf; bare soil or vegetation; for all these studies, the combined use of data from different sources is also encouraged;

- to define and develop tools with potential operational application: data assimilation in numerical models, operational model validation, tools for sea users (marine and offshore industry, ship routine, oil spill mitigation, …)
- to propose technological and scientific basis for future missions that could follow on and inherit from CFOSAT.

Scientists selected on the basis of their proposal will be part of the CFO-ST, which role is:

- to provide the scientific knowledge for the production of the best possible satellite-derived products from CFOSAT: ocean surface wind and waves as first priority but also sea-ice and products characterizing the continental surfaces (land, cryosphere);
- to contribute to the geophysical calibration and validation of the products during the verification phase and all along the mission duration;
- to conduct research and development activities on Earth science and applications based on analyses and use of the CFOSAT data (alone or combined with other satellite measurements, surface-based observations, or numerical models); it includes research in physical oceanography, meteorology, ice study, and related fields. It may also include studies devoted to the land surfaces.
- to increase the visibility of CFOSAT data through scientific publication and communications.
- To prepare definition of future missions that could follow CFOSAT and would inherit from CFOSAT experience and heritage.

Members of the CFO-ST will have priority access to the CFOSAT data products produced by the French mission center and will get expertise from CNES on the performances and data quality.

The CFO-ST will function as an international group of experts to provide advices on:

- CAL/VAL activities,
- choice of operating modes,
- priorities of observations in case of partial failure,
- evolution of the processing chains,
- reprocessing activities,
- links to be developed with other satellite missions or programs.

The results of this activity will be regularly presented in workshops, reports and publications.

2. Who can submit a proposal?

Proposals may by submitted by individuals or a group of scientists, academicians and research scholars belonging to recognized institutions belonging to government or non-government organizations.

Each proposal must be led by a principal investigator (PI) with eventually one or more Co-investigators (CoI) with a cover letter of the PI institution.

3. Information about CFOSAT

CFOSAT (the China France Oceanography Satellite) is a joint mission from the Chinese and French Space Agencies (CNSA, NSOAS, CNES), devoted to the observation of ocean surface wind and waves and related science and applications. Although designed for ocean surface studies, it will also provide observations over continental surfaces.

CFOSAT will embark two-instruments, both of them being innovative instruments in terms of geometry and design:

- SWIM (Surface Wave Investigation and Monitoring) a near-nadir (0 to 10° incidence) real-aperture Ku-Band azimuthally scanning radar designed for measuring the directional spectra of ocean waves;
- SCAT a wind scatterometer SCAT to measure the wind vector, radar in Ku-Band aiming at moderate incidence angles (26° to 46°) with a rotating fan-beam antenna.

With respect to existing satellite missions, the originality of CFOSAT is that it will provide in a continuous way over the oceans, co-located wind vector fields and directional spectra of ocean waves for wavelengths larger than about 70 m. It will also provide normalized radar cross-section in multi-incidence and multi-azimuth geometry which can be used on one hand to improve the inversion algorithms for estimating wind speed and significant wave height and on the other hand to characterize the small scale roughness of all types of surfaces.

CFOSAT will contribute to the global wind field observations in complement to existing scatterometer missions (e.g. ASCAT on METOP, SCAT on HY-2A), and to provisioning of wind speed and significant wave height in complement to other altimeter missions (like Jason or HY-2 series, Sentinel-3). Furthermore, it will provide new information on wave properties with respect to SAR missions (like Sentinel-1), by giving access to directional spectra of ocean waves not only for the long swells but also for wind waves and mixed sea conditions whatever is the direction of these waves.

The system consists of a LEO polar sun-synchronous orbit system with local time ascending pass at the equator at 7:00 am. The orbit parameters are: altitude of about 519 km at the equator, inclination of 97.454°, repetition cycle of 13 days. With these parameters and accounting for the instrument geometry the system will provide a global coverage within 3 days for wind fields (SCAT) and almost global for waves (SWIM) over the 13 day- cycle.

Data will be transmitted to Mission Centers using several receiving stations. Thanks to a set of two polar stations, the system will have the capability to achieve near-real time transmission (i.e. less than 3 hours after the acquisition) of the global set of observations in order to feed operational atmospheric or wave prediction systems for assimilation and forecast processes.

The Chinese Ground Segment is composed of a “Satellite Control Center” located in Xi’an (China), several telemetries, tracking and command ground stations, 3 X-band receiving stations located in China, and a Mission Center for data processing, distribution and archiving.

The French CFOSAT Ground Segment is composed of two X-band Stations, located in Kiruna (Sweden) and Inuvik (Canada), and two mission centers:

- CWWIC operated by CNES in Toulouse (France) for near-real time processing, distribution of data, and data archiving up to the Level2 products. This Centre will also distribute its products within 3 hours after acquisition to agreed meteorological centers through the meteorological network system.

- IWWOC operated by Ifremer in Brest (France) for differed-time data processing, distribution and archiving (alternative L2 products-called L2S, L3 and L4).

For more details on the mission, the reader can refer to [1, 2, 3]. Details on the SWIM instrument are available in [4, 5, 6]. Details on SCAT instrument are in [7].

4. Products available in the frame of the Call for opportunity

4.1 Data product

Details on the SWIM and SCAT products may be found in the references [4-7]. Here below is a summary on the main types of variables for each data processing level from the French mission centers (real time performed at CWWIC and differed time at IWWOC). Appendix 1 gives additional information on the product types. Each product groups the data acquired per ground-station acquisition, i.e there will be approximately one product of each type per orbit.

	CWWIC	***IWWOC***
SWIM	***SWIM nadir measurements***: - L1: altimeter waveform, normalized radar cross-section sigma0 - L2: significant wave height Hs, wind speed. ***SWIM off-nadir measurements:*** - L1, all scenes: sigma0 values following the original sampling and geometry of the instrument, geolocalized on the surface; - L1, only for ocean scenes and observations from incidence beams of 6,8,10°: signal modulations within each scene, and associated density spectrum; - L2 all scenes: mean profiles of sigma0 versus incidence and azimuth, representative of areas of 70 km x 90 km on each side of the nadir track. - L2 for ocean scenes and observations from incidence beams of 6,8,10° only:	***SWIM off-nadir measurements processed in differed time:*** - L2S: 2D wave spectra with associated partitioning (alternative method including a priori information), - L3: statistical products on waves (issued on a 3 months basis) - L4: Swell fields combined with ancillary data (satellites or model) on a global grid

	▪ directional spectra of ocean waves representative of areas of 70 km x 90 km on each side of the nadir track, and associated wave partitions, ▪ main parameters of the total spectra and their partition (significant wave height Hs, dominant direction, dominant wavelength), ECMWF wind and wave parameters from the forecast model gridded at the scale of the L2 product	
SCAT	-L1B product: geocoded sigma0 along the swath, - L2 product: wind vectors over gridded resolution cell	- L3Ice: Backscattering coefficient map over sea ice with mask and ice categories, - L2S: improved wind fields combined with SWIM data, - L3: daily gridded wind fields, -L4: daily wind fields (with kriging).

4.2 Data provisioning

Further to the CFOSAT launch, a commissioning phase is planned for one month, it will be followed by a 6 months CAL/VAL verification phase.

Three months after the launch, a preliminary verification workshop will take place to check the good health and first performances of the satellite instruments, and products. After this preliminary verification workshop, and assuming the preliminary assessment is successful, the products mentioned here above will be made available on a best effort basis:

- with high priority (i.e. about 3 months after launch) to PIs of proposals aiming at contributing to the validation of the geophysical products,
- in a second time (i.e. about 4 or 5 months after launch) to other PIs.

The distribution modalities are:

- from the CWWIC Centre: on an ftp server within a maximum of 3 days after acquisition.

- from the IWWOC Centre: on an ftp server in differed time (delay depending on the kinds of products)

At the end of the verification phase, a verification workshop will be held, to give a status on the product quality and act the official product dissemination.

Before the data are made available, products generated using an end-to- end SWIM simulator and the CWWIC processing chain can be used . The can already be downloaded

from the ftp server (https://www.aviso.altimetry.fr/en/missions/future-missions/cfosat/access-to-simulated-data.html).

5. Functioning of the Science Team

Each team selected will conduct its research project and will interact with mission management teams from CFOSAT space Agencies. These interactions will take place in particular during CFO-ST meetings that will gather representatives of the various teams. These meetings may gather also the scientific team selected by CNSA.

During these meetings the status of the mission will be presented, scientific investigators will be invited to present poster or oral contributions and to discuss about results of their research and topics to be addressed to provide advisory to the CFOSAT project teams.

6. Proposal requirements

Interested scientific teams must propose projects in relation with the objectives detailed in section 1. They must detail the experience and qualification of the Principal and Co Investigators in their related field. The description of work should cover a period of up to four-years.

The main expected outcomes of the proposed work should be described (algorithm and/or product assessment, new product definition, scientific publications, use of data for science and applications, ...)

Each proposal should follow the guidelines indicated in appendix 2.

Each proposal must be forwarded through the Head of the Institution, with appropriate assurance for providing necessary facilities for carrying out the proposed work.

Final selection to join the CFO-ST will require that an adequate support be obtained by these teams

7. Proposal selection

For European proposals, evaluation will be organized by CNES: an ad'hoc scientific committee will conduct the evaluation and make the proposals selection. Coordination between France and Chinese partners will be setup for the selection of non-European proposals.
The PIs will be selected for an anticipated period of four years. A new announcement of opportunity may be organized before or at the end of this period to extend the work of this first selected team.

CNES seek to maximize the scientific output of the CFOSAT-ST through a strong partnership with international investigators and agencies. CNES also encourages proposals that are coordinated with other related and ongoing international programs. For non-French and non-Chinese proposals, proposers will have to seek and to secure appropriate sources of funding

from appropriate national, European or international authorities. It is essential for proposers to document the funding sources required to enable their proposed CFOSAT-ST investigations.

8. Proposal Submission and Selection Schedule

Scientist may submit their proposal through mail sent to oceano@cnes.fr mailbox.

All proposals must be written in English. The proposal must not exceed 10 pages (single space) including figures, tables and references in accordance with the guidance provided in Appendix 2 and cover letters provided in Appendix 3. Additional information such as curriculum vitae and other relevant information may be attached as an appendix.

A proposal schedule is given below:
* Release of Research Announcement: June 4th, 2018
* Proposals due: September 14th, 2018
* Joint announcement of final selection: November 12th , 2018

9. References

[1] "CFOSAT mission requirements document ", Hauser D., Liu Jianqiang and C. Tison; CNES document CF-SYMI-SP-20-CNES
[2] Hauser D., Dong Xiaolong, L. Aouf , C. Tison, P. Castillan, Overview if the CFOSAT mission, proceedings of IGARSS 2016
[3] Hauser D. , C. Tison , T. Amiot , L. Delaye , A. Mouche , G. Guitton , L. Aouf , P. Castillan, "CFOSAT: A new Chinese-French satellite for joint observations of ocean wind vector and directional spectra of ocean waves," Proc. SPIE 9878, Remote Sensing of the Oceans and Inland Waters: Techniques, Applications, and Challenges, 98780T (May 7, 2016); doi:10.1117/12.2225619,http://dx.doi.org/10.1117/12.2225619
[4] "Description of the SWIM instrument for the CFOSAT CDR", C. Tison and T. Amiot, CNES document CF-SCPLSW-NT-2441-CNES
[5] SWIM Products Users Guide, CNES document CF-GSFR-MU-2530-CNES
[6] Hauser D., C. Tison, T. Amiot, L. Delaye, N. Corcoral et al, SWIM: the first spaceborne wave scatterometer, IEEE Trans. on Geoscience and Remote Sensing, 10.1109/TGRS.2017.2658672 , VOL 55, 5, May 2017
[7] RFSCAT Products Users Guide

Appendix 1
CFOSAT products

1-A CWWIC-SWIM products

File Name	File Type	File content (main parameters)	Update frequency
SWI_L1A___	L1a product	Calibrated and geocoded waveform (s0 in the radar geometry)	15 files per day
SWI_L1B___	L1b product	- Signal modulation (surface geometry), - Fluctuation spectrum, - Estimation of speckle and impulse response, - Modulation spectrum due to waves (fluctuation spectrum corrected from speckle and impulse response)	15 files per day
SWI_L2____	L2 product (contains L2a, L2b and L2c variables)	For boxes of about 70 x 90 km on each side of the track: - 2D σ_0 profiles (versus azimuth and incidence), - 2D wave spectra (wave number, direction), - associated partitions and wave parameters. - significant wave height and wind speed from the nadir observations.	15 files per day

SWI_AUX_METEO	ECMWF Meteorological products gridded on SWIM data	Some model variables from the atmospheric or wave model of ECMWF gridded on the location of SWIM L1b products.	15 files per day
SCAT_L1B	L1B product	Time-Ordered, Earth-Located Sigma0s, with a ground resolution about 8 km	15 files per day
SCAT_L2A	L2A_prduct	Surface Flagged Sigma0 and Attenuations in 25 km Swath Grid (50 km TBC)	15 files per day
SCAT_L2B	L2B_product	Sea surface wind vector fields in 25 km Swath Grid (50 km TBC)	15 files per day

2-IWWOC-products

Levels		Variable name	Product content	Geometry and frequency	Main parameters
Level 2	**2S**	pSWH (TBC)	Partition significant wave height	1 set of partitions per orbit and per incidence angle	Geographical parameters, incidence angle, time
		pWL (TBC)	Partition peak wavelength		
		Pdir (TBC)	Partition peak direction		
		wave_height_spectrum	Ribbon 2D ocean wave spectrum	1 spectrum (ribbon) per orbit and per incidence angle	Geographical parameters, incidence angle, time
Level 3	3	count	Number of L2S partitions with respect to latitude, longitude grid , partitions parameters and available incidence angle.	2 by 2 degrees regular grid (TBC). Frequency to be determined.	Geographical parameters, incidence angle, time

Level 4	4	pSWH (TBC)	Partition significant wave height	N/A	Geographical parameters, incidence angle, time
		pWL (TBC)	Partition peak wavelength		
		pDir (TBC)	Partition peak direction		
		TBD	Storm center location	N/A	

Appendix 2
Guidelines for responding to the CFOSAT announcement

Each proposal should be written in English,
Each proposal should be composed of

- the main document which must not exceed 10 pages (single space) including figures, tables,
- appendices with at least the PI curriculum and publication list
- one or several cover letters provided in Appendix 3.

The main document must contain the following sections

Principal Investigator

Surname, First name
Title
Affiliation (laboratory, institution, ...):
Adress
E-mail, telephone

Title of the project

State of the art in the context of the proposal: within the proposing team, at the national and international level

Work plan and project Schedule

Type of CFOSAT data requested for the proposal

Main expected outcomes of the project

Choose one or several in the following list.

- algorithm and/or product assessment,
- new product definition,
- scientific publications,
- other (precise).

Ressources

- ressources brought by the team and its institution
  - personal (CoIs, Other personal)
  - functioning budget
  - existing data, models, …
- ressources requested in the context of this project (specify the frame considered to cover the need)

Considered collaborations

References

Appendices

- PI curriculum vitae including a list of representative publications

- CoIs curriculum vitae including a list of representative publications
- Any other information if necessary for the reviewing process

Appendix 3
Model of cover letter

We have carefully read the terms and conditions of the CFOSAT announcement and agree to abide with them.

We certify that if our proposal is accepted and supported by ……., the facilities and support identified in our proposal and available at our institution will be extended to the Principal Investigator and Co_I of the proposal.

We certify that the data products provided on the basis of our selected proposal will be used only in the context of this proposal.

Signature of PI with name and designation

Signature of Institution Head with Name and signature

Date