# SMOS Pilot-Mission Exploitation Platform (Pi-MEP) – Project overview

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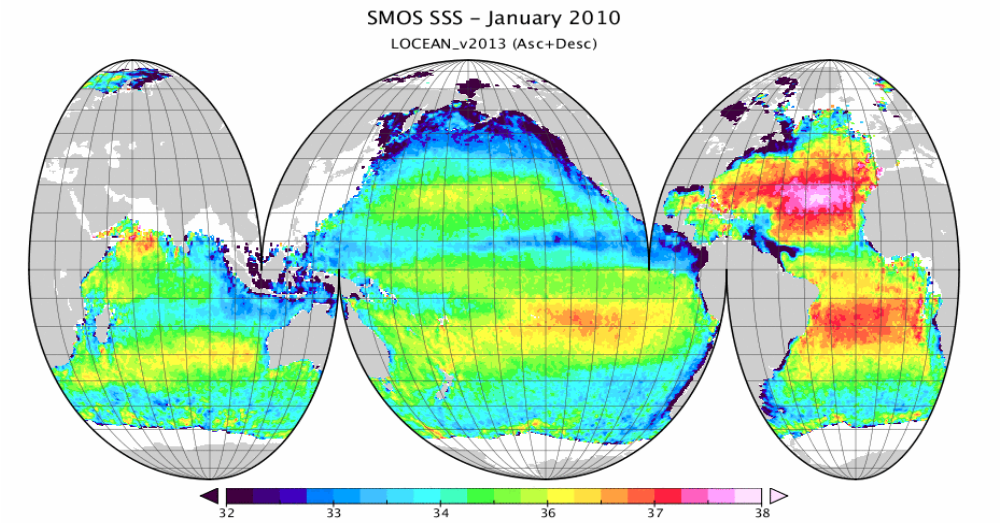
**Global Ocean Salinity and the Water Cycle Workshop**
**Woods Hole Oceanographic Institution,**
**Woods Hole, Mass., USA**
**May 25, 2017**

# Outline

- Recommendations by ESAC panel from mission extension review in 2014
- SMOS Level 2 Ocean Salinity v662 release
- SMOS Pilot-Mission Exploitation Platform (Pi-MEP)
  - Rationale and objectives
  - Features and implementation
- SMOS Pi-MEP SAG: membership and involvements

  **[Switch to S. Guimbard presentation]**
- SAG Consultation Meeting #1 (May 3rd, 2017) feedback



# ESAC recommendations from 2014 extension

| ESAC recommendations triggered Actions | Actions undertaken L2 OS |
|---|---|
| Improve SSS data quality (#6) | Selection of a reference roughness model (SSS1) |
| Improve SSS data quality (#6) | Land-Sea-Contamination correction |
| Improve SSS data validation (#3,#6) | Revised ESL validation protocol (since July 2015) |
| Improve SSS data validation (#3,#6) | **Pi-MEP** Salinity: enhanced validation platform (from January 2017) |
| Synergy with additional data (#4) | **Pi-MEP** for process studies over ocean; In general, synergy ever increasing (SST, WS, rain rates, currents, Ocean colour, SLA, etc) |

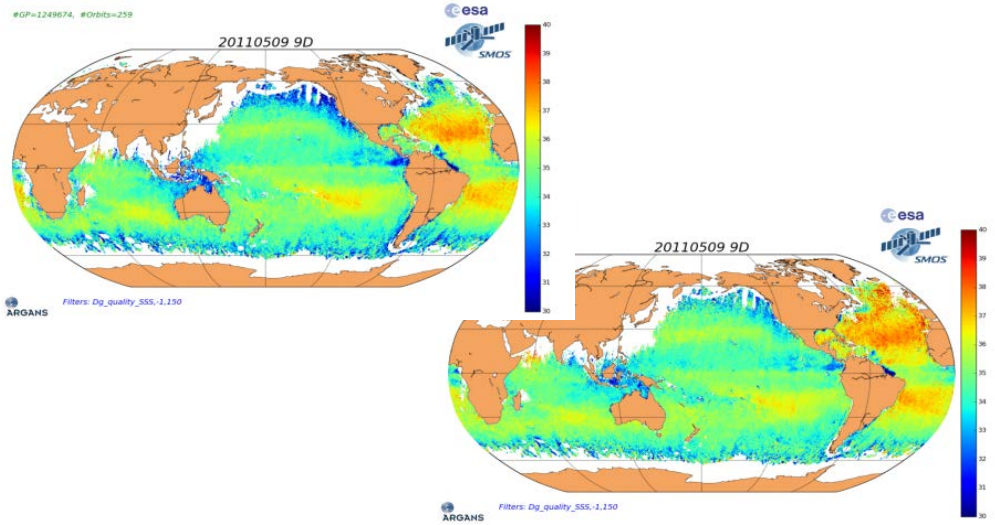
# SMOS L2OS v662 propaganda

## Land-Sea Contamination sources (L1)

- Residual calibration errors
- Floor errors (aliasing)
- Uncertainties in antenna patterns

## Level 2 OS empirical correction

- Empirical method developed by ESL L2OS (J. Tenerelli, OceanDataLab) - LSC bias estimation as a function of polarization, overpass direction, geographic position and across-track distance.



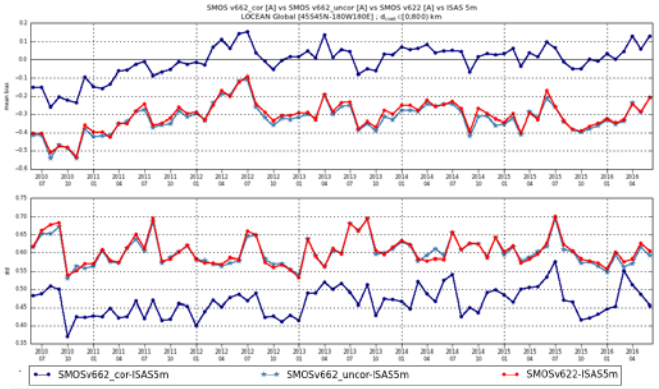

Land-Sea contamination effect, before and after correction. Credits: Argans

## L2 OS v662 (delivered October 2016) features

- LSC-correction implemented
- Single roughness model selected (SSS1)
- SSS anomaly (currently wrt WOA-09)
- Improved data filtering (RFI and Sun)

- Dedicated L2OS v662 reprocessing just completed
- Dissemination to community May 15, 2017

L2SSS validation statistics for global oceans near the coast (<800 km). Credits: LOCEAN




| L3 pixel stats, 45S-45N, Dcoast<800km, Asc | | | |
|---|---|---|---|
| | N | bias | std |
| V662(corr)-ISAS | 3795642 | -0.01 | 0.44 |
| V622-ISAS | 3795642 | -0.31 | 0.61 |

# Pi-MEP Salinity – Semantic, Foci and Objectives

**Pilot** [Exploratory, precursory, trial]

**Mission** [ESA SMOS mission]

**Exploitation** [Increased, synergetic uptake of SMOS data in a variety of oceanographic domains]

**Platform** [web-based, user-friendly, data-intensive IT environment]

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**Focus #1 –** To serve as enhanced **validation platform** [matchup in-situ, filtering/QC, spatial/temporal scales, -> ESL validation testbed and "plug-in"]

**Focus #2 –** To offer a testbed to enable and monitor **oceanographic process studies** [data synergy, statistical and computational IT tools, on-demand processing etc.]

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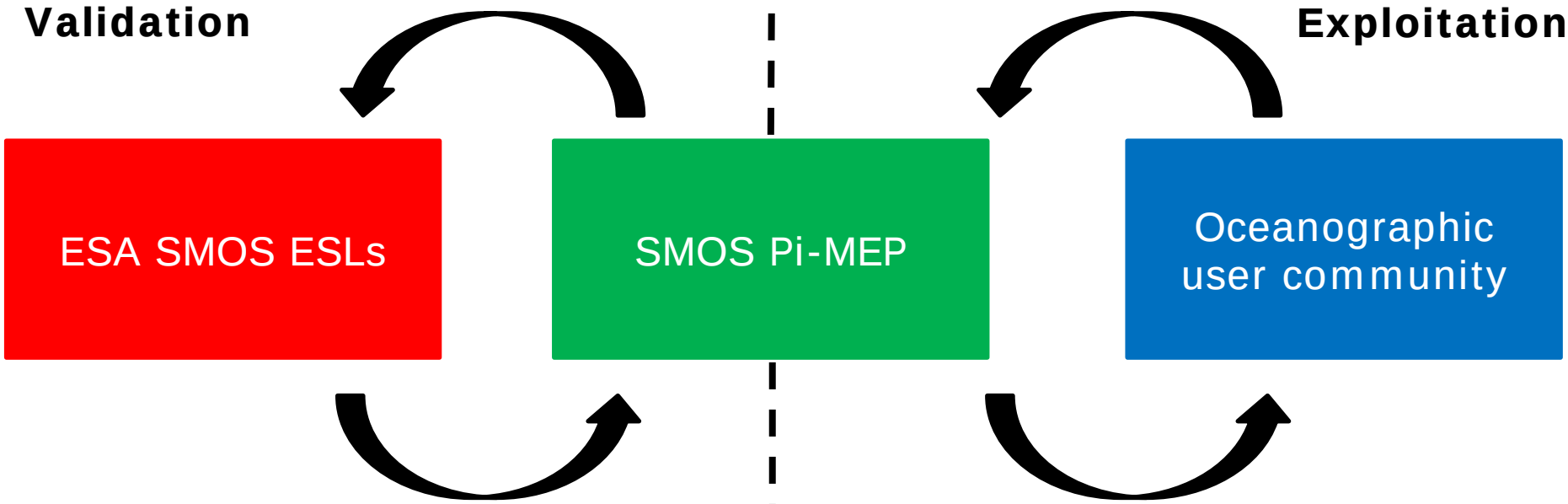
- **One-stop-shop** for scientific validation, monitoring, assessment and exploitation of the SMOS salinity data

- **Stakeholders**: SMOS Expert Support Laboratories (ESL), CATDS, CP34, remote sensing experts, hydrographers, modelers, oceanographers - either using SMOS SSS as research core or as auxiliary data

# Twofold scope of Pi-MEP Salinity




**SMOS ESA ESLs**

- Inputs to Pi-MEP: current validation protocol, advisory (SAG)
- Outputs from Pi-MEP: enhanced validation protocol, assessment, monitoring
- (SMOS salinity)-centric

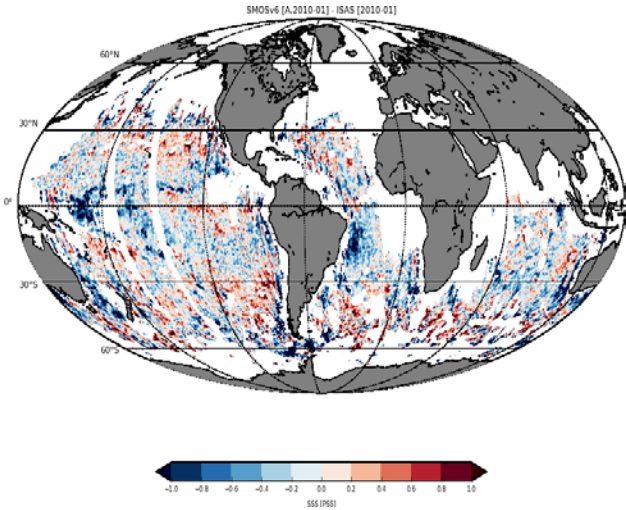
**Oceanographic user community**

- Inputs to Pi-MEP: literature scientific studies, datasets (tbc), user coding (tbc), advisory (SAG)
- Outputs from Pi-MEP: visualization, statistical and computational tools, selected case studies monitoring
- (SMOS salinity)-synergistic

# Pi-MEP Salinity – Focus #1

**SMOS L2 ESL standard Validation protocol**

- SMOS reference: L2 **SSS1**, spatio (100km)-temporally (1 month) averaged using a weighting function; filtered for quality flags.
- *In-situ* reference: **Argo** float (4-10m) and optimally-interpolated fields of SSS (5m) generated using the In-Situ Analysis System (**ISAS**, Gaillard, 2009).
- Colocalization SMOS/In situ: spatial radius of 50km, temporal range of +/-15 days around Argo measurements.



Monthly difference between SMOS (v6) and ISAS SSS – credits: LOCEAN

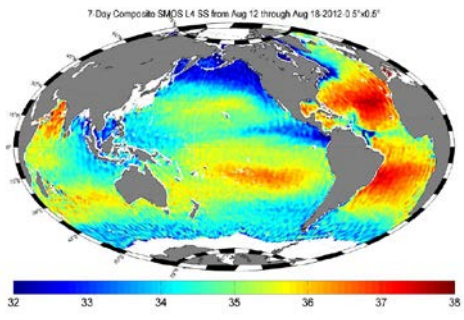
| | | | | |
|---|---|---|---|---|
| Satellite dataset | $SSS_{L3\_1}$ | $SSS_{L3\_2}$ | $SSS_{L3\_3}$ | … |
| In-situ ground-truth | Argo/ISAS | TSG | Drifters, mooring | … |
| s/t scales | 100 km/1m | 100 km/10dd | 50 km/1m | … |
| Processing Level | L3 | L2 | L1 | … |
| Processing criteria | Filtering and collocation criteria | Other filtering and collocation criteria | Other filtering and collocation criteria | … |
| Satellite mission | SMOS | Aquarius | SMAP | … |
| Performance indicators | Statistics (mean, std, RMS) | Other Statistics (median, mode, correlation) | Other Statistics (skewness, kurtosis) | … |

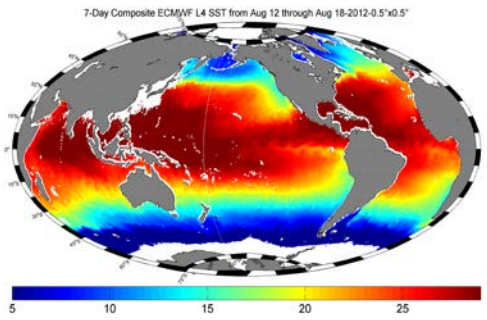
SMOS ESL Validation protocol will be revised and enlarged -> enhanced validation platform (Focus #1)

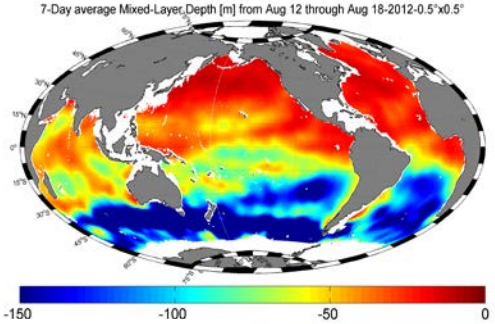
**Conceptually, the ESL validation protocol is only a "vector" of the Pi-MEP "matrix" (enhanced validation platform)**

# Pi-MEP Salinity – Focus #2

SSS | SST | rain | currents | E-P fluxes | wind stress | MLD



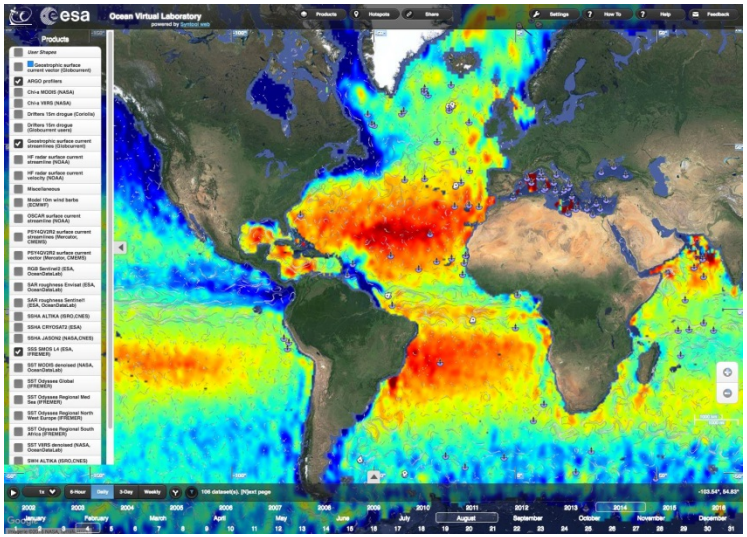




ML Salinity budget, (encompassing various oceanographic satellite datasets)

$$\frac{\partial S}{\partial t} = \frac{(E - P - R)S}{h} - \boldsymbol{u} \cdot \boldsymbol{\nabla S} - \Gamma(w_e)\frac{w_e(S - S_d)}{h} + \kappa \nabla^2 S$$

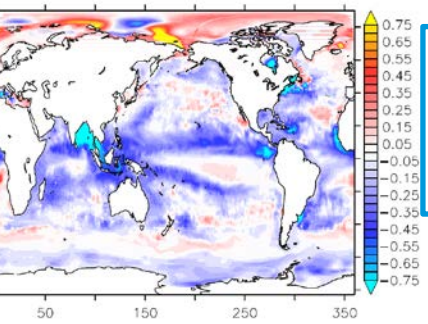
Credits:
N. Reul, IFREMER




Sample view of *Syntool Web*, providing integrated access and multidimensional inter-comparison of EO, in-situ and model data. In the background, a L4 SSS map and Argo profilers (credits: ODL, IFREMER).

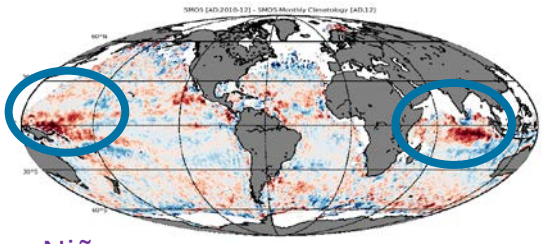
# SMOS oceanographic applications

**Samples of the wide range of applications stemming in the last few years from the use of SMOS SSS and TB**



Ocean Circulation Modeling

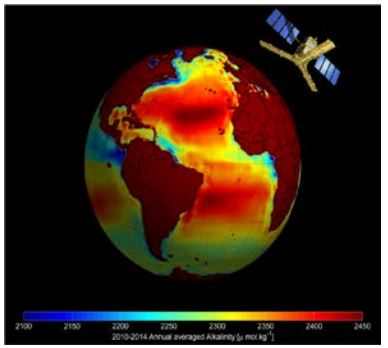
SSS Data Assimilation (Köhl et al.)



La Niña detection (Boutin et al.)

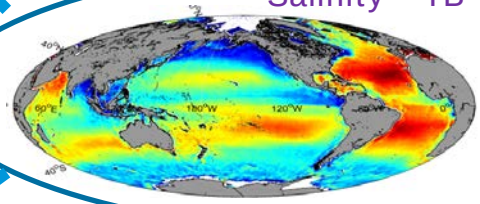
Climate indexes

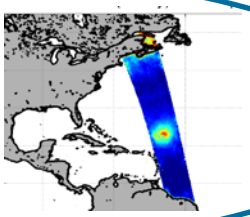
Total Alkalinity (Land et al.)

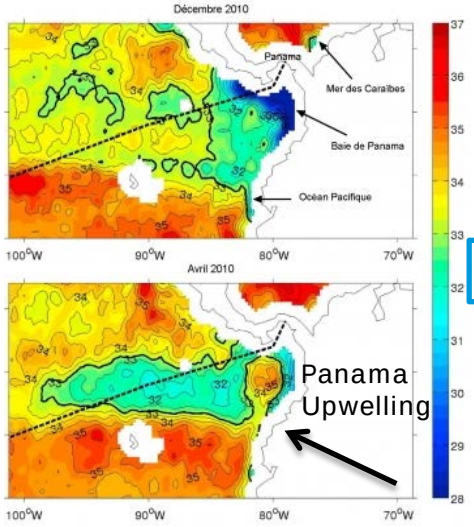


Marine Biology & Biogeochemistry

Salinity TB



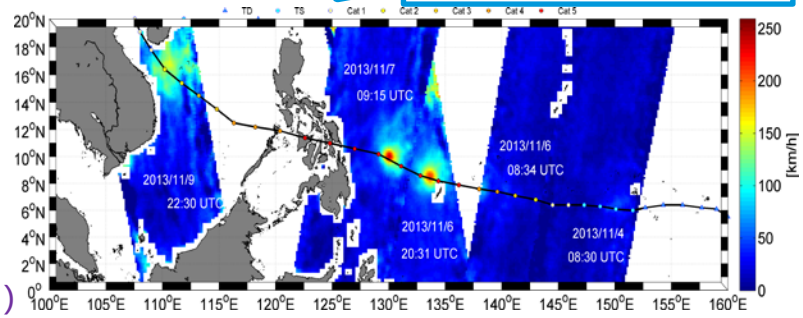





Air-Sea interactions

Upwelling detection (Alory et al.)

Weather Predictions




Hurricane tracking (Reul et al.)

# Pi-MEP Salinity – Implementation

## Tasks

Task 1: Definition of the requirements baseline for the Pi-MEP

Task 2: Definition of the overall technical design for the Pi-MEP

Task 3: Implementation of the Pi-MEP Salinity

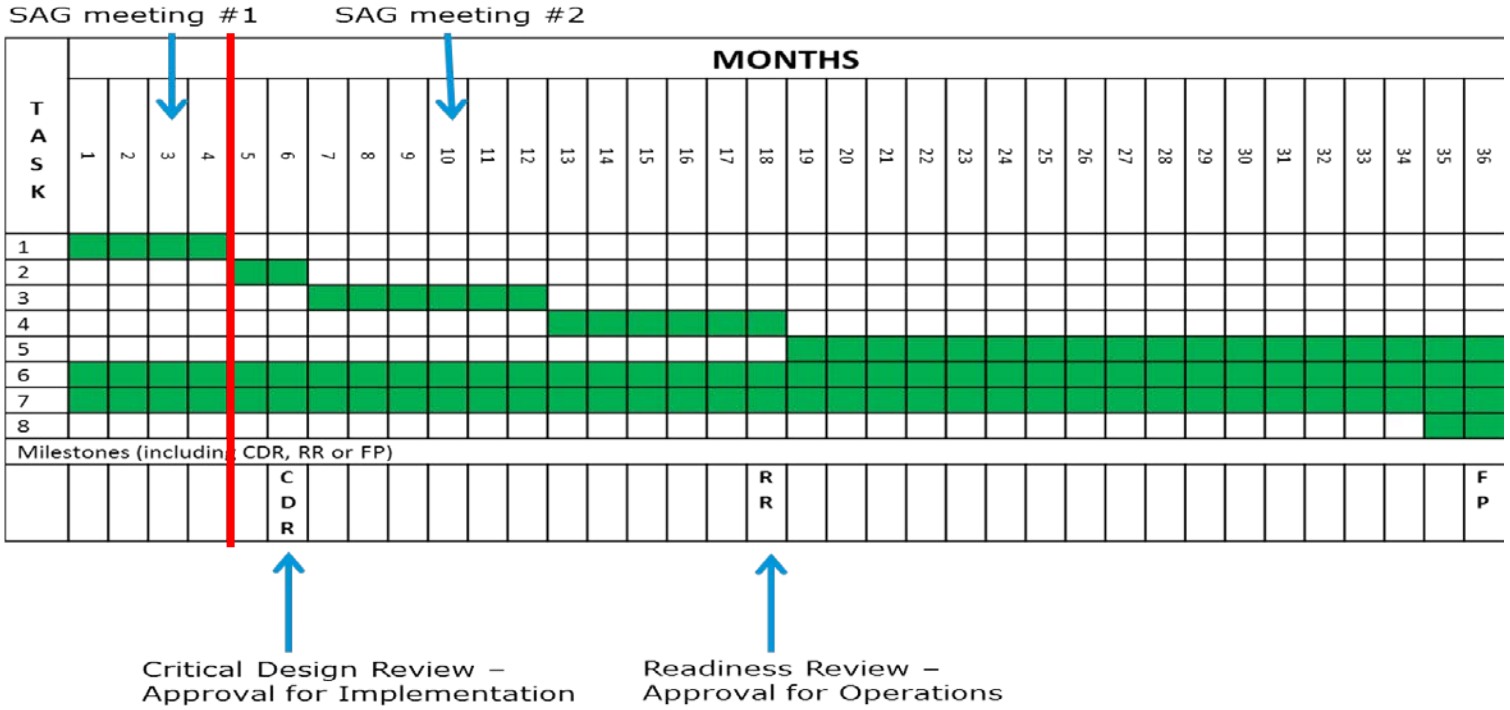
Task 4: Pre-operational phase of the Pi-MEP Salinity

Task 5: Operational phase and maintenance of the Pi-MEP Salinity

Task 6/8: Project management, Community animation, Outreach and Promotion, Evolution roadmap

Phase 1 (Tasks 1/4): 0-18 m
Phase 2 (Task 5): 18-36 m

- Funded by ESA
- IFREMER prime
- N. Reul - Science lead
- S. Guimbard – ops eng.
- ODL – IT/System




KO: Jan-2017

SAG - Scientific Advisory Group (25-people , scientific advisory and pre-ops Platform testing)

SAG meeting #1: May 3rd, 2017, ESA-ESTEC

# SAG panel – invitation and TOR

Ifremer
oceandatalab

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Laboratory of Physical and Spatial Oceanography
Institut Français de Recherche et d'Exploitation de la MER (IFREMER)
Phone: +33 (0)4 94 30 44 86
E-mail: nreul@ifremer.fr

**Subject: Invitation to join the Scientific Advisory Group for the SMOS Pilot Mission Exploitation Platform**

Dear Sir/Madam,

I am writing to you regarding the SMOS Pilot Mission Exploitation Platform (Pi-MEP) for Salinity, which is a recent initiative to support and widen the uptake of SMOS data over ocean. We would like to invite you to become a member of the Scientific Advisory Group for this initiative.

The Pi-MEP salinity will:

i) serve as an **enhanced validation platform**, complementing and expanding the efforts of the SMOS Expert Support Laboratories (ESLs) through, for example, exploring satellite performances at different spatial/temporal scales, applying different filtering criteria, or verifying SMOS outputs against various ground-truth data;

ii) offer a testbed to enable **oceanographic process studies**, capitalizing on SMOS salinity data in synergy with additional satellite products (e.g., SST, WS, currents, rain estimates). The platform will offer a series of statistical and computational tools in a user-oriented scientific environment to foster an increased uptake of SMOS salinity data in combination with other relevant oceanographic parameters.

The project started in January 2017. The first task will be to consolidate the user requirements baseline, before proceeding to the technical design of the platform. In the subsequent period, the implementation and pre-operation phase will give way to the platform operations in mid-2018.

Instrumental to the activities of the SMOS Pi-MEP Salinity is a dedicated Scientific Advisory Group (SAG), which will provide valuable inputs to the scientific/industrial team in charge (led by IFREMER and OceanDataLab). The SAG inputs will allow to set up this platform by helping to define the requirements of the user community and by providing scientific expertise and advice. The SAG will also serve as super-user of the platform functionalities before the opening to the wider oceanographic community.

A SAG one-day workshop is currently foreseen for **May 3rd, 2017** at **ESA-ESTEC** premises in **Noordwijk, the Netherlands**. ESA will support the costs incurred for your efforts as a member of the SAG. A second SAG meeting is foreseen at the beginning of 2018 to follow-up Pi-MEP activities.

As a member of the Pi-MEP SAG you will support the definition of:

- Satellite/in-situ datasets to be included in the Pi-MEP catalogue
- The scientific analyses foreseen in the requirements baseline definition phase
- Additional tests/criteria to be assessed in the enhanced SMOS validation protocol
- The technical design of the platform
- A list of oceanographic process studies to be supported by Pi-MEP
- The metrics for the performance assessment of the platform in the pre-operational phase

In the subsequent evaluation phase, you will provide feedback on the implementation of the platform.

Thank you for considering your participation in this initiative. Please let us know your availability by **March, 27th, 2017**.

Your sincerely

SAG - Scientific Advisory Group
(~25-people, scientific advisory and pre-ops Platform testing)

SAG meeting #1: **May 3rd, 2017**, ESA-ESTEC

Agenda and presentations to support the discussion distributed on **April 26th, 2017,** following the Pi-MEP PM1

## Terms of Reference

Pi-MEP SAG members will support the definition of:

- **Satellite / in-situ datasets** to be included in the Pi-MEP catalogue
- The **scientific analyses** foreseen in the requirements baseline definition phase
- Additional tests/criteria to be assessed in the **enhanced SMOS validation protocol**
- The **technical design** of the platform
- A list of **oceanographic process studies** to be supported by Pi-MEP
- The **metrics** for the performance assessment of the platform in the pre-operational phase

In the subsequent evaluation phase, Pi-MEP SAG members will:

- provide **feedback** on the implementation of the platform

# SAG panel– membership and involvement

| | | |
|---|---|---|
| Antonio | TURIEL | ICM |
| Jacqueline | BOUTIN | LOCEAN |
| Manuel | ARIAS | ARGANS |
| Jean-Luc | VERGELY | ACRI-ST |
| Stéphane | TAROT | Ifremer |
| Justino | MARTÍNEZ | ICM |
| Tong | LEE | JPL |
| Thomas | MEISSNER | RSS |
| Gilles | REVERDIN | LOCEAN |
| Nicolas | KOLODZIEJCZYK | Univ. Brest |
| Benoît | TRANCHANT | CLS |
| Lisan | YU | WHOI |
| Julian J. | SCHANZE | ESR |
| Johnny | JOHANNESSEN | NERSC |
| Adrien | MARTIN | NOCS |
| Chris | BANKS | NOCS |
| Marie-Hélène | RIO | CLS |
| Christophe | MAES | IRD |
| Lars | KALESCHKE | Univ. Hamburg |
| Jamie D. | SHUTLER | Univ. of Exeter |
| Sébastien | CLERC | ACRI-ST |

- Provide guidance as per the points described in the SAG Invitation Letter
- Inspect slides sent before the SAG CM1 workshop (those not attending) and provide feedback on the Table with seed questions
- Participate in the discussion at the SAG CM1 workshop (those attending) driven by the Table with seed questions

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- Participate in the discussion/wrap-up at the WHOI salinity and water cycle workshop – late May (those attending)
- Revise outcome/feedback document to be produced and shared as output of this meeting
- Gather for the SAG CM2 – Jan 2018 (tentative), once the design of the Platform is complete and its implementation is ongoing

# SAG seed Questions – feedback (i)

## Datasets

| | |
|---|---|
| 1. Would you favour the inclusion of SMOS L1 (**TB**) data in the Platform and, if so, in which frame (antenna/earth), at which level (TOA/BOA) and with which correction included (eg. Atm/Gal/Ionosphere)?<br><br>--<br><br>24. Any insight to avoid overlapping with future **CCI SSS** activities, considering that merging spaceborne SSS datasets is already beyond scope of this Platform? | TB merging or inter-comparison with other satellites TBs are beyond primary scope and left to the "Inter-comparison WG" and "CCI SSS".<br>"**Inter-comparison WG**" and "**CCI SSS**" domains:<br>• L1 comparison/homogenization **fwd models**<br>• Re-calibration or update of **retrieval algorithms**<br>• Standardization of **aux SST, WS and dielectric constant** algo parameters<br>Potentially, in the Platform could be considered:<br>• L3TB from CATDS<br>• List of L1c products (orbits list) used per each specific pixel of the match-up db. |
| 2. SMOS L2 SSS will only refer to **SSS1** (roughness model #1). Do you consider adequate to retain only the last two reprocessed dataset (currently **v622** and **v662**)? | Agreed to maintain the current ops (v662) and the last repro (v622). In 662 both "uncorr" and "corr" products (**LSC-correction**). |
| 4. Could you spot any **missing** crucial **dataset**? | • EN4<br>• CATDS Release RE05.<br>• Canadian Meteorology Centre (CMC) SST<br>• The subsurface T at the ML base<br>• Wek - Ekman upwelling velocity<br>• OAFlux-HR<br>• GPCP or CMORPH |

# SAG seed Questions – feedback (ii)

## Processing criteria

| | |
|---|---|
| 9. Match-up criteria: suggested **collocation radii**? | • **Rossby deformation radius** of (when relevant).<br>• **Radius of correlation** for interpolated fields.<br>• **Customizable** temporal radius (defining only lower and upper bounds) |

| | |
|---|---|
| 11. Any clear limitation with the current **official SMOS validation protocol**? | • Ocean dynamics is smoothened and mesoscale variability can be hidden.<br>• Agreed to be assessed at different s/t scales and also beneficial to have spectral analysis. |

# SAG seed Questions – feedback (iv)

## Scientific assessment

| | |
|---|---|
| 14. The Platform intends to "stratify" data according to selected **geophysical regimes** to favour an enhanced validation (Eg. wrt SST, or WS/SWH, or WS/MLD). Any suggestion for additional regimes to be considered? | • High-variability regions vs low-variability regions.<br>• High-latitude oceans vs. tropical/subtropical oceans.<br>• Strong currents versus weak currents regimes.<br>• Instantaneous precipitation.<br>• Longhurst or biogeochemical provinces.<br>• Density Compensated regimes. |

| | |
|---|---|
| 15. The platform aims at a full **characterization/error budget** of the actual SMOS performances; any suggested metric to characterize and discount errors due to h/v variability and representativeness? | • Inherit all the inputs from "**SISS WG**" and the community-based related BAMS paper<br>• Assess h/v variability and representativeness error<br>• Agreed to decompose the satellite uncertainty from the geophysical signals and h/v variability. |

# SAG seed Questions – feedback (iii)

## On-demand processing

| | |
|---|---|
| 7. Any suggested mechanism for transferring/including **campaigns data** (eg. SPURS-2) directly into the Platform?<br>--<br><br>19. The platform intends to allow some capability of ingesting **user datasets** (yet limited in size and format) – Any suggested constraint to the user? | • Capability to ingest datasets if fulfilling specific format standard (NetCDF, csv etc.) and size quota.<br>• Capability to ingest campaign data (eg. SPURS-2).<br>• Database not necessarily ending up in the Platform, yet allowing users to perform studies.<br>• **Decisions case-by-case**; raise conditions/IPRs/disclaimer whenever needed |

| | |
|---|---|
| 18. The platform intends to allow some capability of ingesting **user code**s (yet limited in complexity) – Any suggested constraint to the user? | • Capability to ingest codes according to the language and operability burden.<br>• **Decisions case-by-case**; raise conditions/IPRs/disclaimer whenever needed |

# SAG seed Questions – feedback (v)

## Process studies

| | |
|---|---|
| 21. Could you **rank** your most valuable 3 case studies among those selected? | • Case studies still being ranked.<br>• Currently, highly ranked are: "**Mesoscale**", "**River plumes**" and "**High-latitude**"<br>• Climate Indexes and "Biogeochemistry" most likely monitored in dedicated ESA studies. |

# Summary

- Overview of the Pi-MEP project objectives
- Focus 1- Enhanced validation and products assessment
- Focus 2- Oceanographic exploitation and case-studies monitoring
- Description of the Platform datasets and tools
- List of the selected process studies
- Pi-MEP SAG role
- Selected feedback on the seed Questions

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