National Oceanography Centre

NCEO CEOI Conference 2020

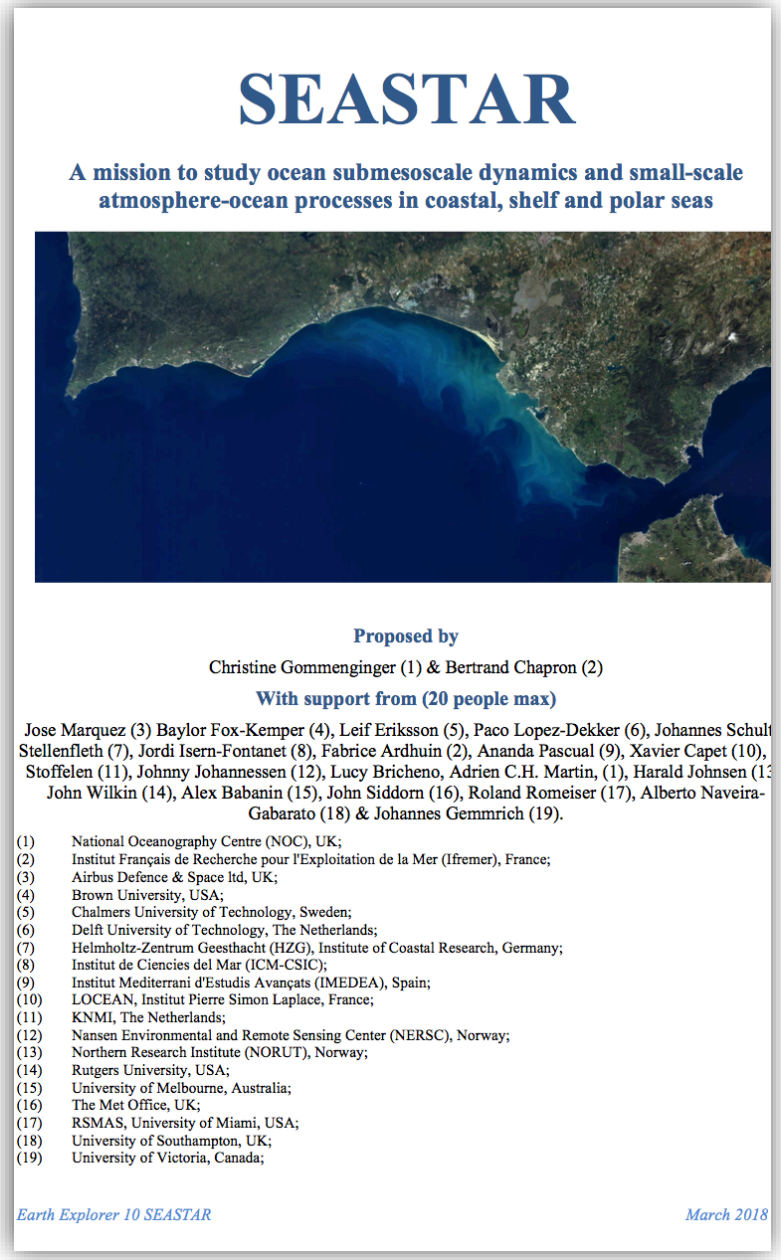
SEASTAR

Christine Gommenginger

National Oceanography Centre

&

the International SEASTAR Science team



SEASTAR

A mission to study ocean submesoscale dynamics and small-scale atmosphere-ocean processes in coastal, shelf and polar seas

Proposed by

Christine Gommenginger (1) & Bertrand Chapron (2)

With support from (20 people max)

Jose Marquez (3) Baylor Fox-Kemper (4), Leif Eriksson (5), Paco Lopez-Dekker (6), Johannes Schult Stellenfleth (7), Jordi Isern-Fontanet (8), Fabrice Ardhuin (2), Ananda Pascual (9), Xavier Capet (10), Stoffelen (11), Johnny Johannessen (12), Lucy Bricheno, Adrien C.H. Martin, (1), Harald Johnsen (13 John Wilkin (14), Alex Babanin (15), John Siddorn (16), Roland Romeiser (17), Alberto Naveira-Gabarato (18) & Johannes Gemmrich (19).

(1) National Oceanography Centre (NOC), UK;
(2) Institut Français de Recherche pour l'Exploitation de la Mer (Ifremer), France;
(3) Airbus Defence & Space ltd, UK;
(4) Brown University, USA;
(5) Chalmers University of Technology, Sweden;
(6) Delft University of Technology, The Netherlands;
(7) Helmholtz-Zentrum Geesthacht (HZG), Institute of Coastal Research, Germany;
(8) Institut de Ciencies del Mar (ICM-CSIC);
(9) Institut Mediterrani d'Estudis Avançats (IMEDEA), Spain;
(10) LOCEAN, Institut Pierre Simon Laplace, France;
(11) KNMI, The Netherlands;
(12) Nansen Environmental and Remote Sensing Center (NERSC), Norway;
(13) Northern Research Institute (NORUT), Norway;
(14) Rutgers University, USA;
(15) University of Melbourne, Australia;
(16) The Met Office, UK;
(17) RSMAS, University of Miami, USA;
(18) University of Southampton, UK;
(19) University of Victoria, Canada;

Content

- SEASTAR: the mission
  - Science objectives & relevance
- Mission concept submitted to EE10
- Boundary conditions for EE10 and EE11
- Implications for SEASTAR ? What else changed ?
- Key issues & way forward

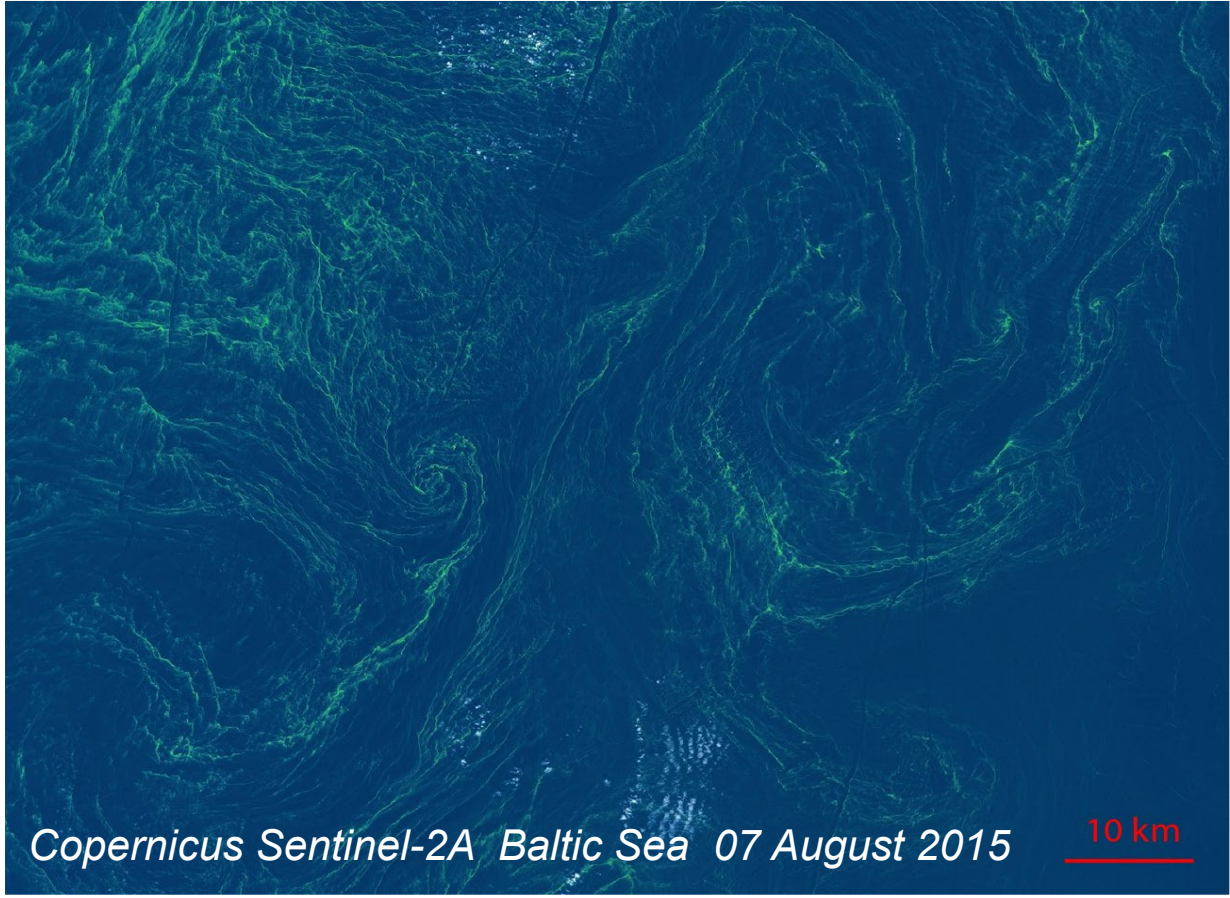
SEASTAR: Science objectives

- Primary science objectives
  - to address the **observational gap** for synoptic measurements of **ocean surface currents and winds** at the **critical 1 km scales** required to understand, model and forecast ocean **submesoscale dynamics**, **air-sea interactions** and **vertical ocean exchanges** in **coastal, shelf and polar seas**

- A major step-forward in ocean observing capability, e.g.
  - **TOTAL** surface currents (incl. ageostrophic)
  - total surface current **VECTORS**
  - **high-accuracy** at **1 km** resolution
  - **synoptic two-dimensional maps** of current vectors, wind vectors and ocean wave spectra

SEASTAR: Relevance

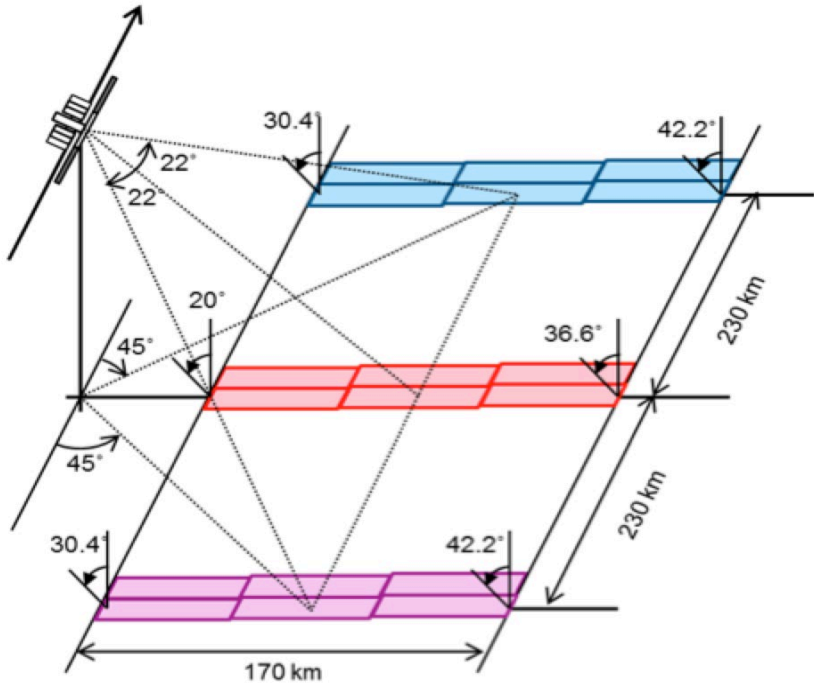
- Ocean is dominated by small features at 1-10km scales
  - frequently seen in high-resolution satellite SST and ocean colour images
  - no available data about dynamics at those scales
    - challenging and expensive to measure by any means, including in situ sensors
  - Satellites are well suited to provide the necessary 2D synoptic imaging

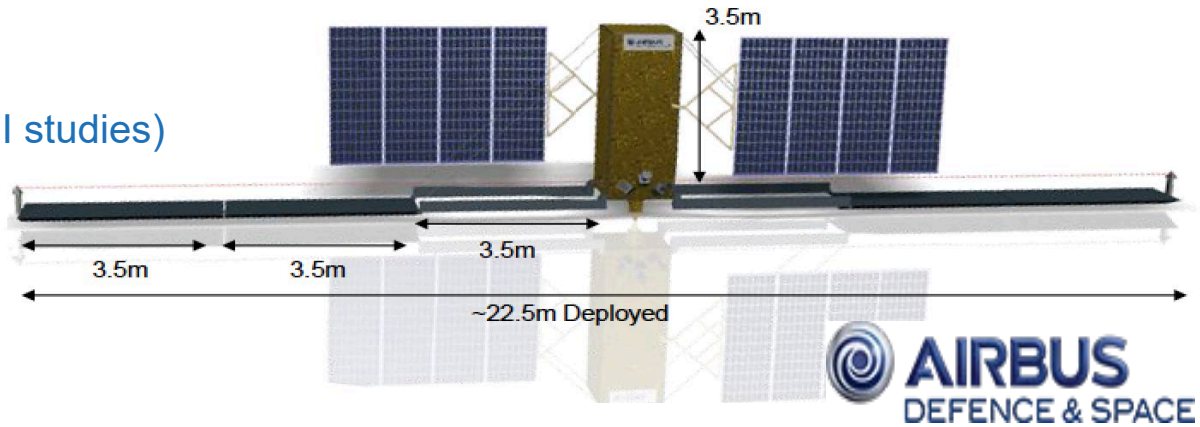


- Ocean small scales have global impact on ocean/atmosphere exchanges and climate
  - modify air-sea exchanges, impact CO2 and heat uptake by the ocean, impact sea ice growth/decay
  - intense ocean vertical transport, linking surface and ocean interior, with impact on marine ecosystems
  - dramatic change in ocean dynamics ~ 1km resolution predicted by high-resolution ocean models
  - But processes are poorly observed & poorly represented in models used for forecasting & climate projections

SEASTAR for EE10: mission concept

- Single payload on single satellite
  - Ku-band SAR along-track interferometer
    - two beams ±45° in azimuth fore and aft + standard beam broadside
- Resolution, Orbit, Sampling, Coverage
  - 1km resolution (L2), 1 x 170km swath, 30-40 deg incidence
  - Sun-synchronous orbit (power), high-inclination (polar)
  - Fast-repeat (1 day) and drifting orbit (global coverage); 5 years
- Technical design & maturity
  - Mass dominated by large antenna and power needs
    - ScanSAR (12 bursts: 3 elevation x 4 azimuth), dual pol (broadside)
  - Total deployed length ~ 22 m
  - High SRL (not shown) & high TRL (several ESA and CEOI studies)
- ROM cost
  - “just about within EE10 budget”





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SEASTAR Mission Proposal to EE10 March 2018

Peer-reviewed paper to OceanObs'2019 with full SEASTAR science team

frontiers in Marine Science | Ocean Observation

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MINI REVIEW ARTICLE

Front. Mar. Sci., 13 August 2019 | https://doi.org/10.3389/fmars.2019.00457

SEASTAR: A Mission to Study Ocean Submesoscale Dynamics and Small-Scale Atmosphere-Ocean Processes in Coastal, Shelf and Polar Seas

Christine Gommenginger[1*], Bertrand Chapron[2], Andy Hogg[3], Christian Buckingham[4], Baylor Fox-Kemper[5], Leif Eriksson[6], Francois Soulat[7], Clément Ubelmann[7], Francisco Ocampo-Torres[8], Bruno Buongiorno Nardelli[9], David Griffin[10], Paco Lopez-Dekker[11], Per Knudsen[12], Ole Andersen[12], Lars Stenseng[13], Neil Stapleton[14], William Perrie[15], Nelson Violante-Carvalho[16], Johannes Schulz-Stellenfleth[17], David Woolf[18], Jordi Isern-Fontanet[19], Fabrice Ardhuin[2], Patrice Klein[2], Alexis Mouche[2], Ananda Pascual[20], Xavier Capet[21], Daniele Hauser[22], Ad Stoffelen[23], Rosemary Morrow[24], Lotfi Aouf[25], Øyvind Breivik[26,27], Lee-Lueng Fu[28], Johnny A. Johannessen[29], Yevgeny Aksenov[1], Lucy Bricheno[30], Joel Hirschi[1], Adrien C. H. Martin[1], Adrian P. Martin[1], George Nurser[1], Jeff Polton[30], Judith Wolf[30], Harald Johnsen[31], Alexander Soloviev[32], Gregg A. Jacobs[33], Fabrice Collard[34], Steve Groom[35], Vladimir Kudryavtsev[36], John Wilkin[37], Victor Navarro[38], Alex Babanin[39], Matthew Martin[40], John Siddorn[40], Andrew Saulter[40], Tom Rippeth[41], Bill Emery[42], Nikolai Maximenko[43], Roland Romeiser[44], Hans Graber[44], Aida Alvera Azcarate[45], Chris W. Hughes[30,46], Doug Vandemark[47], Jose da Silva[48], Peter Jan Van Leeuwen[49,50], Alberto Naveira-Garabato[51], Johannes Gemmrich[52], Amala Mahadevan[53], Jose Marquez[54], Yvonne Munro[54], Sam Doody[54] and Geoff Burbidge[54]

"Although of high scientific merit, the mission is not recommended to be studied in Phase-0 due to programmatic risks" (mission cost will highly likely exceed the cost envelope specified for EE10)

ESA Earth Explorer 10 v ESA Earth Explorer 11

- Deadlines
  - Issued 25 Sept 2017
  - Letter of Intent & team: 15 Dec 2017
  - Proposal deadline: 02 March 2018

- Call for mission ideas: <28 pages
  - Cover (1), Summary (1-2), Science (<10)
  - Technical (<10)

- Proposer team: 20 people max

- SRL 5 (end Phase A), TRL 5 (end Phase B1)

- 400 M€ to ESA (2017 economic conditions)
  - "target of 225 M€ for space segment, excl. launch, operations, ground segment, level 2 processor & ESA internal costs"

- Vega-C launch as baseline
- Launch ~ 2027/28

- Deadlines
  - Issued 25 May 2020
  - Letter of Intent & team: 18 September 2020
  - **Proposer workshop: 5 October 2020**
  - Proposal deadline: 4 December 2020 (noon CET)

- Call for mission ideas: **<30 pages**
  - Cover (1), Summary (1-2), Science (<10)
  - **Technical (<15) inc. mass, power budgets, cost breakdown**

- Proposer team: **12 people max**

- **SRL 4 (end Phase 0)**, SRL5 (end Phase A), TRL 5 (end Phase B1)

- **450 M€** Cost at Completion (CaC) to ESA (2020 economic conditions
  - "strict target of **250 M€**, e.c. 2020 for all industrial development costs for the space segment, including Level 1 Ground Processing Prototype, excluding launch services, operations…"

- Vega or Ariane 6 (if added cost can be offset)
- Launch ~ **2031/32**

What else changed in the meantime?

- EE9 outcome
  - SKIM not selected for EE9
    - will there be a competing SKIM+ concept submitted to EE11 ?
  - But SKIM end-to-end simulator provides useful new capability for SEASTAR
- EE10 outcome
  - EE10 Harmony ?
    - proposes to use squinted ATI to measure ocean currents (?)
    - one of many multi-static experiments, tied to Sentinel-1 acquisition mode
    - cannot deliver necessary systematic mapping

Key issues for EE11 SEASTAR

- No active project since 2018
  - despite positive feedback and recommendations by ACEO at the time
- Science/industry interactions have stopped
  - No further evolution of the concept, no progress on mass or cost reduction
  - International support for the mission continues to grow !
- Developing a competitive proposal for EE11 will need national funding
  - already the case in France and Germany (and probably elsewhere)
  - input on mass, power budget and cost breakdown needed for EE11 need active involvement from industry
  - further iterations are needed between science and engineering to reduce cost but retain scientific excellence
  - in current economic conditions, academia and industry are unlikely to secure internal resources.