

## Operational Satellite Missions

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*with contributions from the plenary paper co-authors*

# Outline

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1. What do we mean by an “Operational Satellite Missions” or by “Transition into an Operational Missions” ?
2. Where are we? How are we doing with respect to the standard oceanographical products? Sea Surface Temperatures? Ocean Surface Topography? Ocean Vector Winds? ...
3. What are the challenges?
4. Summary and Recommendations.

# Differences Operational versus Research Mission

	Operational Mission	Research Mission
Key Driver	User/Service Requirements	Technological/Scientific challenge
Budget	Operational Agencies (NOAA, EUMETSAT,...)	R & D agencies (NASA, ESA,CNES,...)
Users	Operational forecaster	Scientists
Availability	Guaranteed, Monitored	Best Effort
Dissemination	Operational Networks	FTP, by and to science consortia
Support	Pro-active 24/7	Ad Hoc
Sustainment	Continuous	Incremental

**We know, there is not always a so strong distinction,  
but rather a mixing from both categories.**

# Example

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## Is altimetry now operational ?

YES if we consider the routine availability of timely, accurate, and validated individual and multi-mission products from the current flying missions.

NO if we look at “fragility” of the system and the time it takes to decide any new mission, or the lack of use and maybe even lack of awareness of the key products in substantial number of countries.

# Operational Transition

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- When research missions have clearly demonstrated operational usefulness, this usefulness must become the strongest driver behind follow-on missions.
- Programmatically this follow-on mission or rather a sequence of missions have to make a transition to become a component in a wider operational structure and planning.

This represents new challenges and constraints on the mission itself, the programmatic procurements and the mission operations.



# Transition: From the R&D phase to operations

## 1. Transition Scenario's

OceanObs 1999  
St. Raphael France:

***"... Missions may well fall between two stools, if development and operational agencies do not balance their respective investments, or if they compete for the same resources or fail to agree on appropriate transition scenarios."***

[Ratier,1999]

# Transition: From the R&D phase to operations

## 2. International cooperation

OceanObs 1999  
St. Raphael France:

***"Planning will also continue to require international co-operation and co-ordination, e.g. in the framework of the Integrated Global Observing Strategy promoted by CEOS"***

[Ratier,1999]



# Transition: From the R&D phase to operations

## 3. User pull

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**GODAE Final Symposium 2008  
Nice France:**

***We need Timely Data Access!***

[Wilson et al, 2008]



# OCEAN OBS 2009



## OceanObs 1999: Development and Demonstration



OceanObs 2009: **How far are we to transition into operational satellite oceanography?**

# OceanObs 2009 Community White papers:

## 1. Several on Operational Applications

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- **Summarizing Demonstrated Usefulness**
- **Forwarding Operational Needs and Requirements**

Operational Application	Community White Paper	Status
Operational Oceanography	Le Traon et al. 2009	Emerging, maturing
Climate Ocean State estimation and climate monitoring	Lee et al 2009 Fairall et al. 2009 Nerem et al. 2009	emerging, critical
Numerical Weather Prediction, Seasonal and Decadal Forecasts	Eyre et al. 2009 Balmaseda et al. 2009	Expanding, enhancing

# OceanObs 2009 Community White Papers:

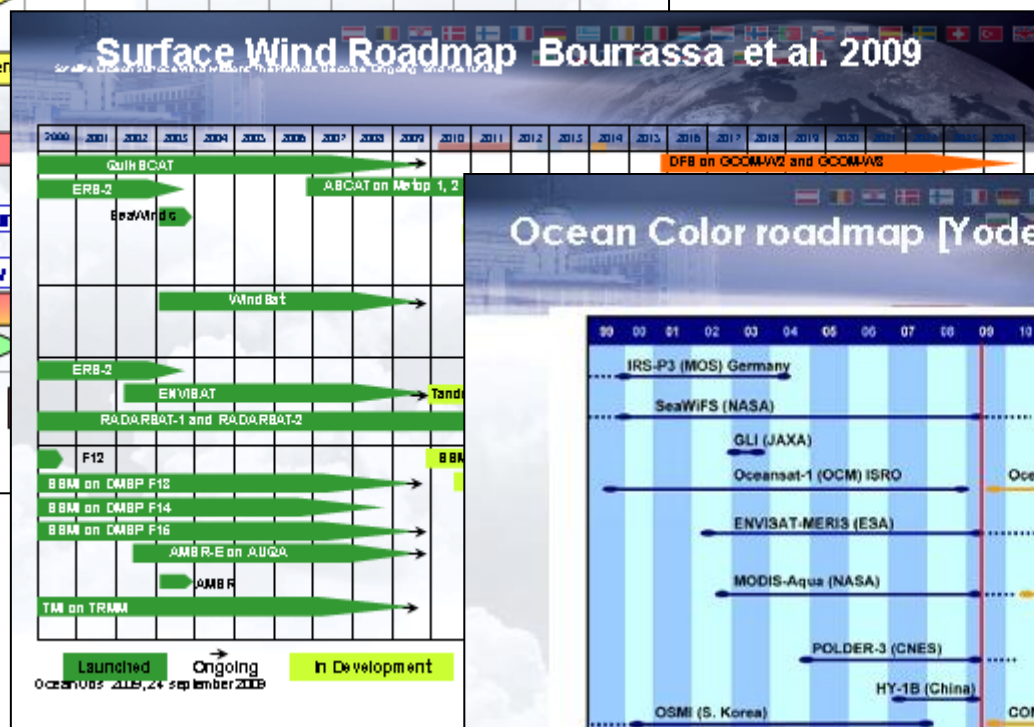
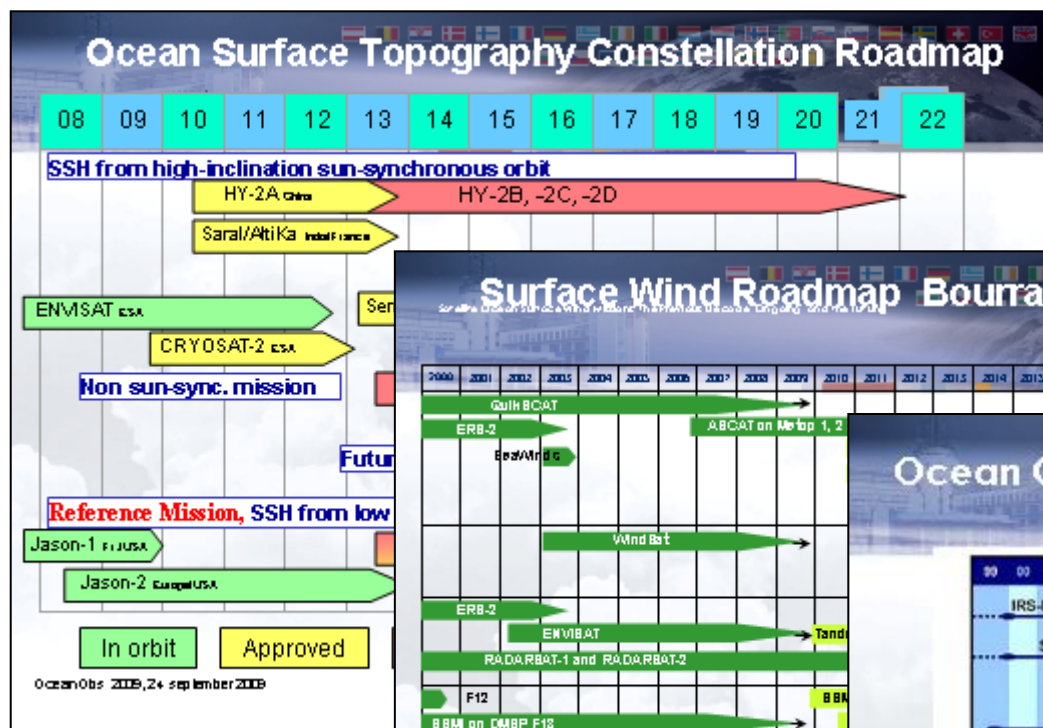
## 2. Several on the standard products

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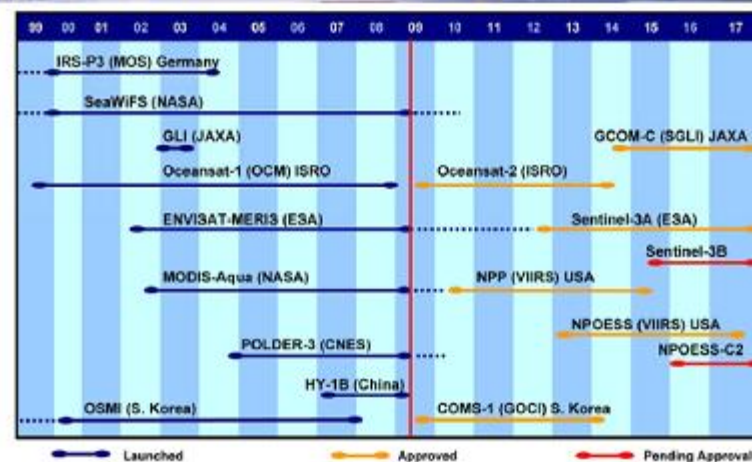
- **Summarizing Demonstrated Usefulness**
- **Forwarding Operational Needs and Requirements**

Oceanographic Variable	Community White Paper
Sea Surface Temperature	Donlon et al. 2009
Ocean Vector Winds	Bourassa et al. 2009
Ocean Surface Topography	Wilson et al. 2009
Sea Ice	Breivik et al. 2009
Ocean Color	Yoder et al. 2009
Ocean Salinity	Lagerloef et al. 2009

# No time to discuss the mission schedules in detail !



## Ocean Color roadmap [Yoder et al. 2009]

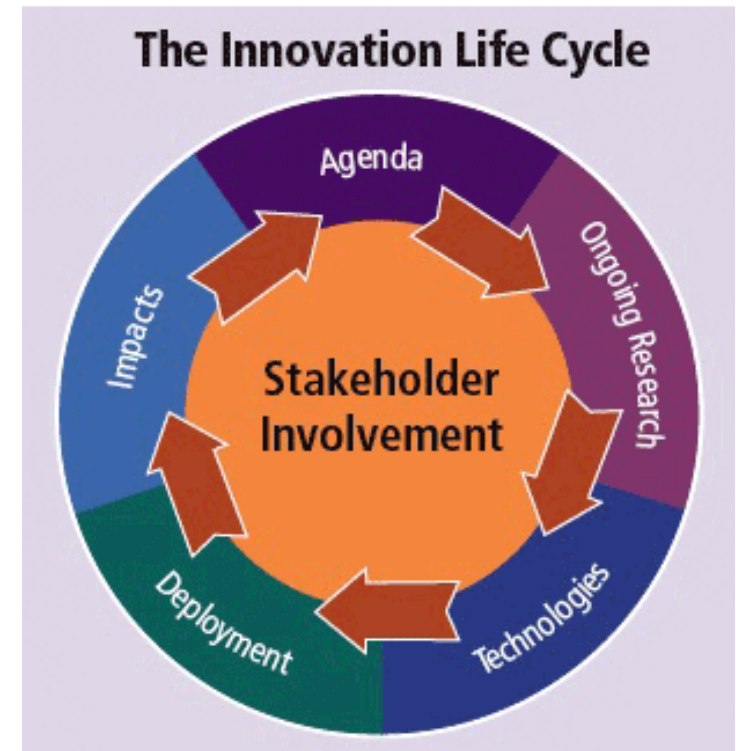




# Three Phases of Innovation

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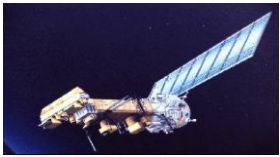
1. Development and Initial Demonstration
2. Sustainment and Continuation
3. Demonstration of New Capabilities



Source: FHWA

# Ocean Missions: Sea Surface Temperature

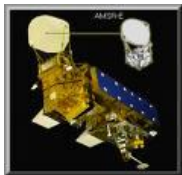
## Development and Demonstration



AVHRR on TIROS-N, AHRR/2 on NOAA-7



ATSR (ERS), AATSR (ENVISAT)



AMSR-E on Aqua

## Sustainment and Continuation



AVHRR/3 on METOP and NOAA series (IJPS) and follow-on's as part of JPS



SLTSR (Sentinel 3A, 3B, 3C, 3D ..)



AMSR-2 on GCOM-W 1, 2 and 3.

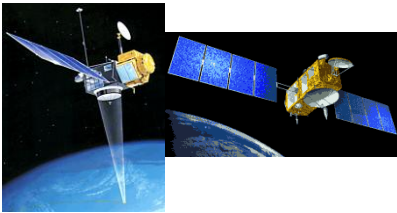
## New capabilities

MicroWat concept

**We don't cover the geostationary missions in this overview**

# Ocean Missions: Ocean Surface Topography

## Development and Demonstration



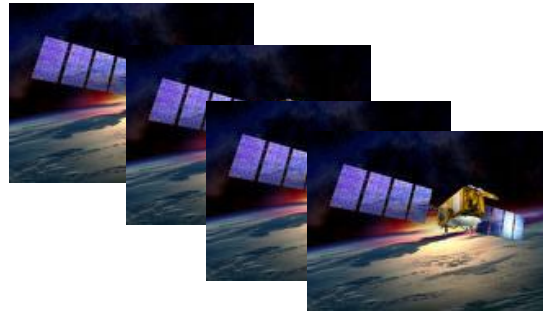
Topex/Poseidon, Jason1

RA (ERS), RA2 (Envisat)  
SARAL

GEOSAT

HY-2A

## Sustainment and Continuation



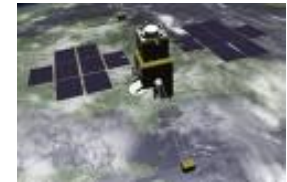
Jason2, Jason3, Jason-CS

SRAL (Sentinel 3A, 3B, 3C, 3D .. )

GFO, GFO2

HY-2B, HY-2C, HY-2D

## New Capabilities



SWOT

CFOSAT

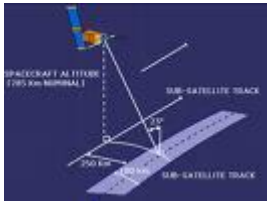
IRAC

# Ocean Missions: Ocean Surface Vector Winds

## Development and Demonstration



QuikSCAT, ADEOS I,II

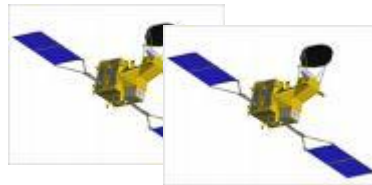


AMI (ERS1, ERS2)

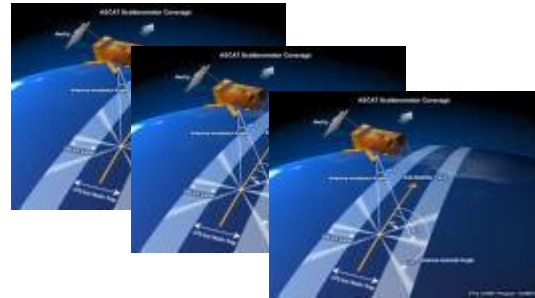
SCAT on HY-2A

SCAT on OceanSat 2

## Sustainment and Continuation



DFS on GCOM W1,W2



ASCAT (METOP,1,2,3), SCA on Post EPS

SCAT on HY-2B, HY-2C, HY-2D

SCAT on OceanSat 3

## New Capabilities

XOVWM

CFOSAT

**We don't cover Sea State  
Applications of SAR  
Missions in this overview**



# Ocean Missions: Ocean Colour

## Development and Demonstration



SeaWifs, MODIS,  
VIIRS on NPP

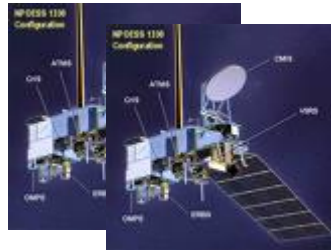


MERIS (envisat)



OCM on IRS-P4

## Sustainment and Continuation



VIIRS on NPOESS-C1



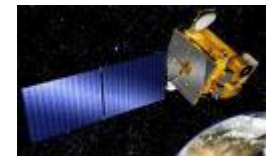
OLCI (Sentinel 3A, 3B, ... )



OCM on OceanSat 2,3

## New Capabilities

Geo-cape, Geo-Oculus



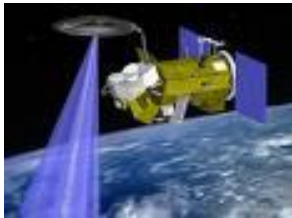
GOCI (geostationary!)

# Ocean Missions: Ocean Surface Salinity

## Development and Demonstration



**SMOS**



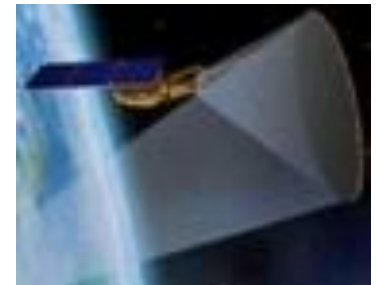
**AQUARIUS**

...

## Sustainment and Continuation

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## New Capabilities



**SMAP**

# International Coordination and Cooperation

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	CEOS Constellation	International Science Team	Operational cooperation
Sea Surface Temperature	<b>under discussion in GHRST community</b>	<b>GHRST</b>	<b>(GHRST) Mature</b>
Ocean Surface Topography	<b>OST VC</b>	<b>OST ST</b>	<b>Mature</b>
Ocean Vector Winds	<b>OVW VC</b>	<b>IOVWST Under discussion</b>	<b>Under development</b>
Ocean Colour	<b>OCR VC (IOCCG)</b>	<b>IOCCG</b>	<b>Under development</b>
Ocean Salinity	<b>?</b>	<b>?</b>	<b>?</b>

# Data product suites and dissemination.

	Level 2	Multi mission product	Timely Open access	Dissemination
Sea Surface Temperature	<b>Harmonized</b>	<b>Mature</b> <b>(GHRST)</b>	<b>+++</b>	<b>GTS</b> <b>GEONETCAST</b> <b>FTP</b>
Ocean Surface Topography	<b>Harmonized</b>	<b>Mature</b> <b>(DUACS)</b>	<b>+++</b>	<b>GTS</b> <b>GEONETCAST</b> <b>FTP</b>
Ocean Vector Winds	<b>Harmonization in development</b>	<b>In Development</b> <b>(e.g MyOcean)</b>	<b>+++</b>	<b>GTS</b> <b>FTP</b> <b>GEONETCAST</b>
Ocean Colour	<b>In development</b>	<b>In development</b>	<b>+</b>	<b>FTP, Internet</b>
Ocean Salinity	<b>In development</b>	<b>-</b>		<b>-</b>



# Summary

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We can restate the GODAE final symposium conclusion of Wilson et al [2008] that

**Impressive progress made over the last decade!**

Sea Surface Temperature	Fine	
Ocean Surface Topography	Fine	
Ocean Vector Winds	Fine	enhancing international scientific cooperation and coordination
Ocean Colour	On the right track	
Ocean Salinity	Emerging	
...		

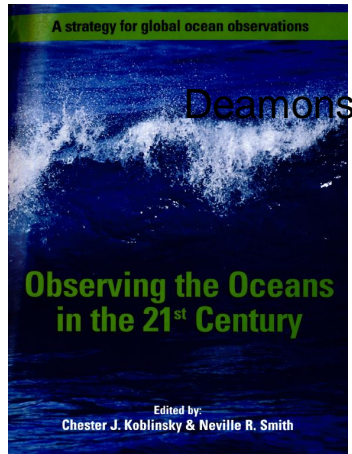
•Based on a qualitative assessment of e.g. the OceanObs2009 Community White Paper's one could argue that indeed operational maturity is most advanced in those chains where the international cooperation and coordination is the most intense.

# Recommendations for the Future

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- **Keep on making work of timely data access to really establish the user pull. Develop integrated, easy-to-use products, each available from a single point of access in a common format and in a timely manner**
- **Keep up and enhance international cooperation to ensure that all data are freely available to all in a timely manner; to share experience in how to calibrate the sensors, use the data, harmonize orbits for optimal coverage**
- **Foster the interplay between science teams and operational teams and program officers. Initiate/strengthen/maintain partnerships between research and operational users**
- **Ensure an adequate programmatic answer to the observations sustainment challenge widely expressed here**

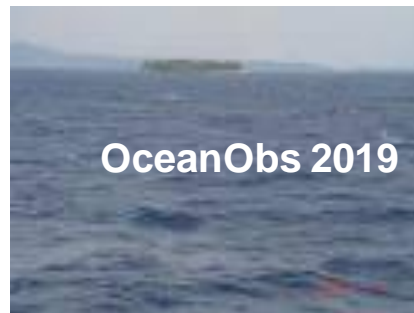
# OCEAN OBS 2009



OceanObs 1999,  
Previous Decade:  
Development and Demonstration!



OceanObs 2009,  
This decade:  
**Sustainment and Continuation!**



OceanObs 2019,  
The decade thereafter:  
New capabilities!

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END