Item 4 - EOV & ECV requirement setting

Belén Martín Míguez, OOPC officer

OOPC 25, 21 October, EUMETSAT HQ, Darmstadt, Germany

Item 4 - EOV & ECV requirement setting

1. EOV and ECVs framework revisited
2. New EOVs/ECVs (before/after lunch)
3. WMO Rolling Review of Requirements (after lunch)

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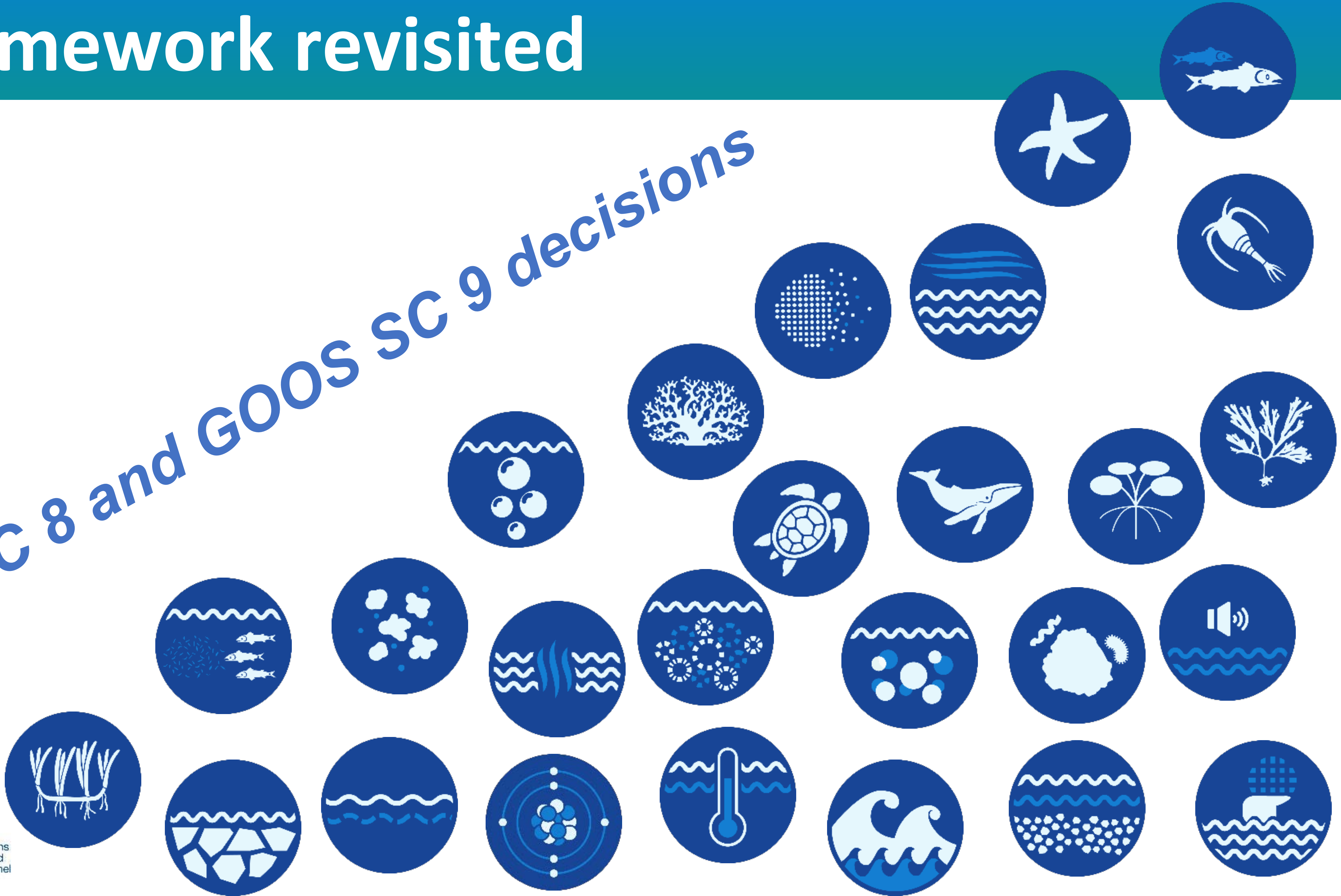
GCOS KEEPING WATCH OVER OUR CLIMATE

GOOS The Global Ocean Observing System

WCRP World Climate Research Programme

EOV framework revisited

GOOS SC 8 and GOOS SC 9 decisions



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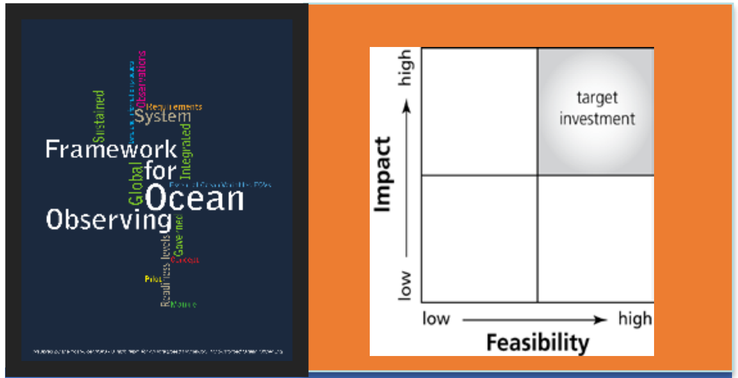
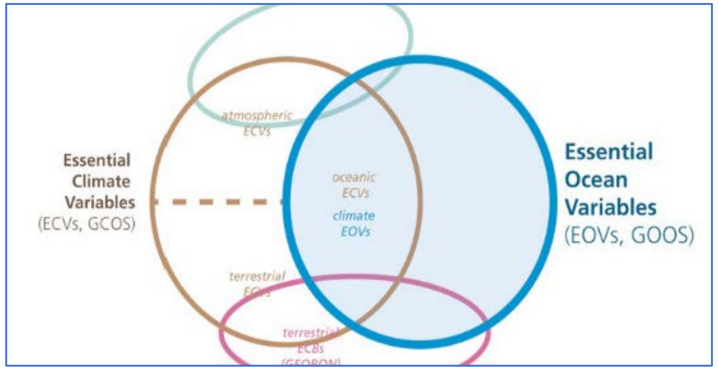
10 year of EOV framework: successful but…



The process is not transparent

- Criteria are clear, but the assessment process isn't



The relationship with other EV frameworks needs to be clarified

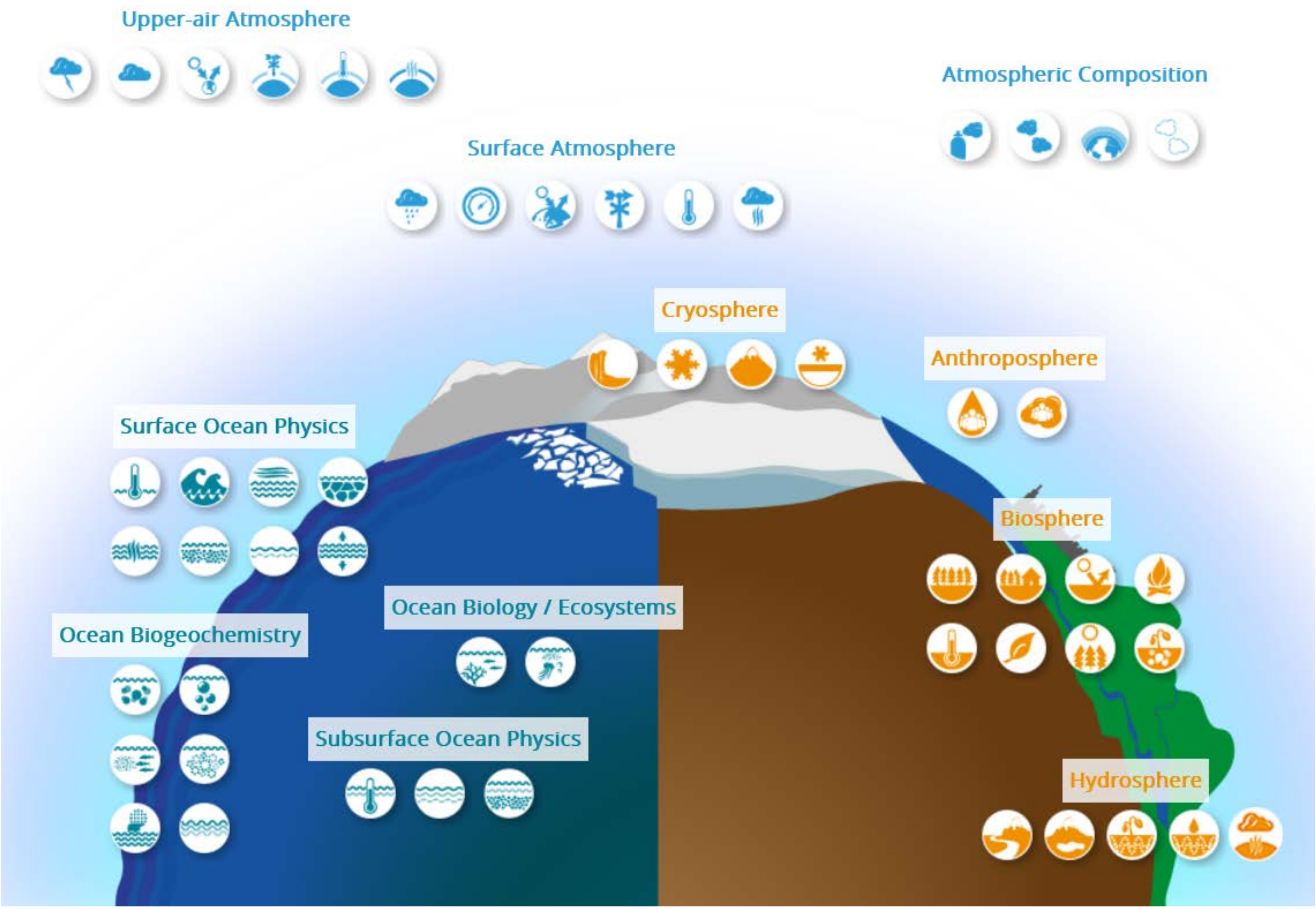
- E.g. overlap and duplication with GCOS ECV framework

Ocean communities inside and outside GOOS are proposing new variables – OO19

- Can GOOS EOV framework incorporate them all?

ECV framework revisited

GCOS SC 29



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15 year of ECV framework: successful but…

There are too many variables

- Do we need different ECVs for different domains?

DOMAIN	ECV	ECV PRODUCT
Atmosphere	Surface Radiation Budget	Upward Long-Wave Irradiance at Earth Surface
Atmosphere	Surface Radiation Budget	Downward Long-Wave Irradiance at Earth Surface
Atmosphere	Surface Radiation Budget	Downward Short-Wave Irradiance at Earth Surface
Ocean	Ocean Surface Heat Flux	Latent Heat Flux
Ocean	Ocean Surface Heat Flux	Sensible Heat Flux
Ocean	Ocean Surface Heat Flux	Radiative Heat Flux
Terrestrial	Evaporation from Land	Latent Heat Flux
Terrestrial	Evaporation from Land	Sensible Heat Flux
Terrestrial	Evaporation from Land	Bare Soil Evaporation
Terrestrial	Evaporation from Land	Interception Loss
Terrestrial	Evaporation from Land	Transpiration

Lack of coherence:

- what is a product?
- accuracy vs. stability
- Specific domain terms

Requirements	
Value	**Notes**
0.1	The length scales required to detect spatially heterogeneous responses, particularly if agricultural applications are intended (Fisher et al., 2017; Martens et al., 2018).
1	Scales needed to achieve a realistic partitioning of evaporation into different components considering land cover heterogeneity (Talsma et al., 2019; Miralles et al., 2016).
25	Current spatial resolution of global datasets (McCabe et al. 2016; Miralles et al., 2016), which has so far been deemed sufficient for climatological applications (Fisher et al., 2017).

“Climate applications” is too broad, and greater granularity is needed…

What’s wrong?

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Are we missing something? Extra variables

- Are we “too shallow”? → presentations from DOOS
- Are we “too global”? Regions need other set of variables. We are not considering coastal processes
- Should some products become ECVs/EOVs→ presentations from Sea Ice
- Do all ocean ECVs need to be EOVs and vicecersa?

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Rationalization and Homogeneization

- **Does it make sense to talk about currents and temperature at different depths and consider them different variables?**
- **Should we work towards more harmonization with the other panels?** Similar vocabulary, units…

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New specification sheets - EOVs

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Ocean Surface Heat Flux

Surface heat flux is the rate of exchange of heat, per unit area, crossing the sea surface from ocean to atmosphere. The net heat flux is the sum of turbulent (latent and sensible) fluxes and the radiative (short wave and long wave) components. Oceanographic convention is that a positive flux implies heating of the ocean. Latent heat flux is associated with the phase change of water during evaporation or condensation and proportional to evaporation. Sensible heat flux is the rate at which heat is transferred from the ocean to the atmosphere by conduction and convection. In the tropics, latent heat flux is typically an order of magnitude greater than sensible heat flux, but in polar regions they are similar in magnitude. Downward shortwave at the surface is predominantly visible light. Upward shortwave flux is reflected sunlight, often determined by parameterization of surface albedo. While sensible, latent, and longwave heat fluxes occur at the sea surface, the shortwave radiation penetrates seawater and is absorbed with depth. These fluxes are major contributors to energy and moisture budgets, and are largely responsible for thermodynamic coupling of the ocean and atmosphere on all scales. Variability of these fluxes is in part related to largescale variability in weather (climate) patterns. For most regions, the two major components are the net shortwave gain by the ocean and the latent heat flux loss by the ocean.

Sensible and latent heat fluxes have traditionally been estimated through bulk formulae with the aid of the observations of SST, near surface air temperature and humidity, surface winds, waves, and surface air pressure. These estimate have regional and seasonal biases because of assumptions and missing wave data. We now measure or infer the above bulk variables from satellite observations, therefore it is clear that these fluxes can be globally estimated from satellite; however, this is currently hampered by limited ground truth. At a very limited number of locations, direct measurements of the sensible and latent heat flux are being made on buoys and ships using fast-response, three-dimensional wind sensors together with fast-response air temperature and humidity sensors. These sensors, together with the observations needed to correct for platform motion, allow direct computation sensible and latent heat flux through covariance flux methods. There have been efforts to estimate radiative fluxes from visual cloud estimates, but even monthly averages are very noisy. Radiative fluxes can be measured directly from buoys, ships, and other ocean platforms using sensors to measure downward shortwave and longwave. Buoys that measure surface meteorology as well as downward shortwave and longwave can thus approximate all four components of ocean surface heat flux.

Air-sea exchanges (fluxes) are sensitive indicators of changes in the climate system, with links to floods and droughts[1], and East Coast storm intensity and storm tracks[2] and tropical storm intensity. On longer temporal scales, several well-known climate variations (e.g., El Niño/Southern Oscillation; North Atlantic Oscillation, Pacific Decadal Oscillation) are associated with variability in these fluxes and hypothetically impact of changes of these fluxes on regional economies, populations and infrastructure. For example, the contribution to the water cycle alone is often extremely important. Improved predictions of ENSO phase and associated impact on regional weather patterns could be extremely useful to the agricultural community. These fluxes also contribution to cool wakes behind tropical cyclones, which influence the intensity of tropical cyclones later (up to a month) in the season. These fluxes will be critical for successful coupling of ocean and atmospheric models (as well as ice models) for the purpose of climate forecasts.

Version 5.2 Updated January 2017 by OOPC.

AutoSave On — 4-Ocean Heat Fluxes Requirements_2020 • Last Modified: 3h ago — Belén Martín Míguez BM

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Timeliness is the delay between the observation and the data being available. This only applies to current observations, not to rescue

B	C	D	E	F	G	H	I	J	K	L	M
eat Flux	ocean and atmosphere associated with the phase change from liquid to gas of seawater during evaporation or from gas to liquid during condensation.			100km		Daily		10Wm^-2	2Wm^-2	Mixed Layer, Extreme Events, Stratification, Storage (Freshwater), Sea Ice extent, Sea Level, Heat Storage, Water masses, Circulation.	Climate
				25 km		3-Hourly		10 Wm^-2	2Wm^-2		
				10km		Hourly		10Wm^-2	2Wm^-2		
Heat Flux	The heat exchanged between the atmosphere and ocean when a warmer ocean warms the air above or when a cooler ocean cools the air above.			100km		Daily		10Wm^-2	2Wm^-2	Mixed Layer, Extreme Events, Stratification, Storage (Freshwater), Sea Ice extent, Sea Level, Heat Storage, Water masses, Circulation.	Climate
				25km		3-Hourly		10Wm^-2	2Wm^-2		
				10km		Hourly		10Wm^-2	2Wm^-2		
Heat Flux	The heat exchanged between the ocean and atmosphere resulting from the balance between radiation leaving the sea surface (reflected and emitted) and radiation passing through the sea surface into the ocean; often divided into an infrared or longwave and a visible			100km		Daily		10Wm^-2	2Wm^-2	Mixed Layer, Extreme Events, Stratification, Storage (Freshwater), Sea Ice extent, Sea Level, Heat Storage, Water masses, Circulation.	Climate
				25km		3-Hourly		10Wm^-2	2Wm^-2		
				10km		Hourly		10Wm^-2	2Wm^-2		
eat Flux	The heat exchanged between the ocean and atmosphere associated with the phase change from liquid to gas of seawater during evaporation or from gas to liquid during condensation.			100km		Daily	24 hours	10Wm^-2	2Wm^-2	Mixed Layer, Extreme Events, Stratification, Storage (Freshwater), Sea Ice extent, Sea Level, Heat Storage, Water masses, Circulation.	Operational Services
				25km		3-Hourly		10Wm^-2	2Wm^-2		
				10km		Hourly	6 hours	10Wm^-2	2Wm^-2		
Heat Flux	The heat exchanged between the atmosphere and ocean when a warmer ocean warms the air above or when a cooler ocean cools the air above.			100km		Daily	24 hours	10Wm^-2	2Wm^-2	Mixed Layer, Extreme Events, Stratification, Storage (Freshwater), Sea Ice extent, Sea Level, Heat Storage, Water masses, Circulation.	Operational Services
				25km		3-Hourly		10Wm^-2			
				10km		Hourly	6 hours	10Wm^-2	2Wm^-2		
Heat Flux	The heat exchanged between the ocean and atmosphere resulting from the balance between radiation leaving the sea surface (reflected and emitted) and radiation passing			100km		Daily	24 hours	10Wm^-2	2Wm^-2	Mixed Layer, Extreme Events, Stratification, Storage (Freshwater), Sea Ice extent, Sea Level, Heat Storage, Water masses, Circulation.	Operational Services
				25km		3-Hourly					
				10km		Hourly	6 hours	10Wm^-2	2Wm^-2		

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New specification sheets - ECVs

Year 2016

*Download shortened print version of ECV factsheet (pdf) **here**.*

Data Sources

Ocean Surface Heat Flux

ECV Products and Requirements for Ocean Surface Heat Flux

*These products and requirements reflect the Implementation Plan 2016 (**GCOS-200**). GCOS is reviewing and will update the requirements until 2022. More information on: **gcos.wmo.int**.*

PRODUCT	DEFINITION	FREQ.	RES.	REQUIRED MEASUREMENT UNCERTAINTY	STABILITY	STANDARDS/ REFERENCES
LATENT HEAT FLUX	The heat exchanged between the ocean and atmosphere associated with the phase change from liquid to gas of seawater during evaporation or from gas to liquid during condensation.	Hourly to monthly	1-25km	10-15Wm^{-2}	1-2Wm^{-2}	See EOV Specification at www.goosocean.org/eov
SENSIBLE HEAT FLUX	The heat exchanged between the atmosphere and ocean when a warmer ocean warms the air above or when a cooler ocean cools the air above.	Hourly to monthly	1-25km	10-15Wm^{-2}	1-2Wm^{-2}	www.goosocean.org/eov
RADIATIVE HEAT FLUX	The heat exchanged between the ocean and atmosphere resulting from the balance between radiation leaving the sea surface (reflected and emitted) and radiation passing through the sea surface into the ocean; often divided into an infrared or longwave and a visible or shortwave components.	Hourly to Monthly	1-25km	10-15Wm^{-2}	1-2Wm^{-2}	www.goosocean.org/eov

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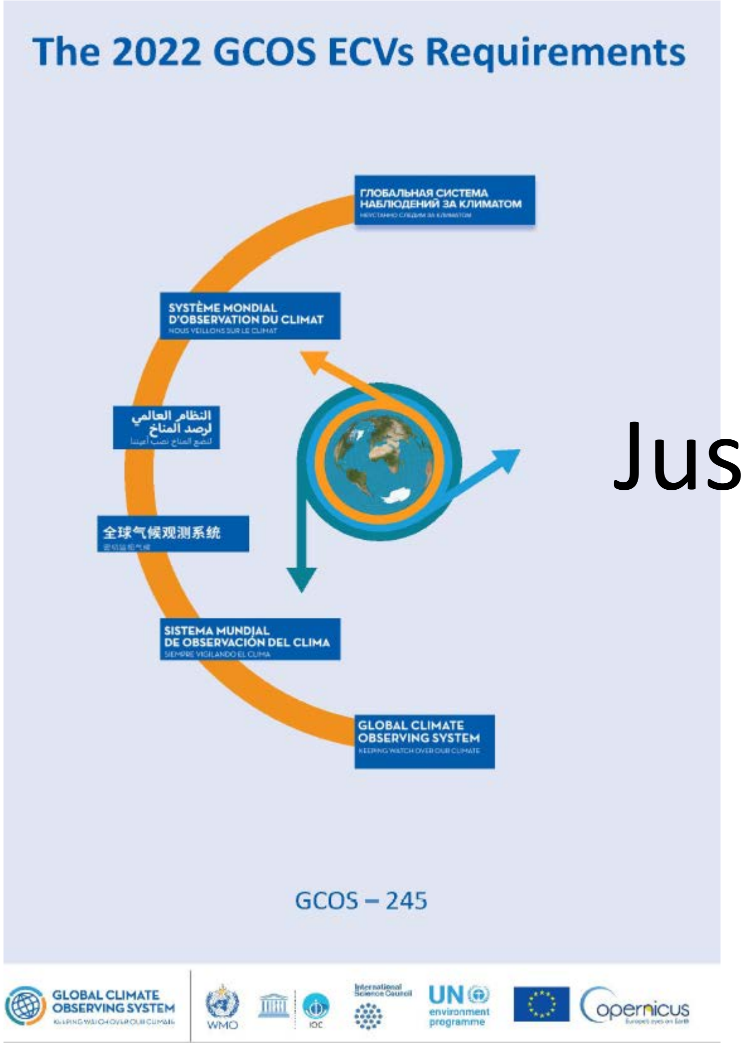
New specification sheets -



Just released

4.10 ECV: Ocean Surface Heat Flux

4.10.1 ECV Product: Radiative Heat Flux

Name	**Radiative Heat Flux**
Definition	The net difference between radiation leaving the sea surface (reflected and emitted) and downward radiation impinging on the sea surface; commonly divided into an infrared or longwave and a visible or shortwave component ($Q_{LW,net} + Q_{SW,net}$): $Q_{LW,net} = LW\uparrow - LW\downarrow = \epsilon\,\sigma_{SB}T_s^4 + (1-\epsilon)\,LW\downarrow - LW\downarrow = \epsilon\,(\sigma_{SB}T_s^4 - LW\downarrow)$ and $Q_{SW,net} = Q_{SW}\uparrow - Q_{SW}\downarrow = Q_{SW}\downarrow(\alpha - 1)$ where ϵ is the IR surface emissivity ($\epsilon = 1$ for black-body emission), σ_{SB} is Stefan-Boltzmann constant, and T_s is the sea surface (skin) temperature that is emitting the IR-radiation, in degrees Kelvin. Upward shortwave flux is reflected sunlight, often determined by parameterization of surface albedo (α).
Unit	$W\ m^{-2}$
Note	Surface heat flux is the rate of exchange of heat, per unit area, crossing the sea surface from ocean to atmosphere. Sign conventions vary; heat fluxes are sometimes reported with positive values for heat into the ocean. The net heat flux is the sum of turbulent (latent and sensible) fluxes and the radiative (short wave and long wave) components. Downward shortwave at the surface is predominantly visible light. While sensible, latent, and longwave heat fluxes occur at the sea surface, the shortwave radiation penetrates seawater, with red light absorbed close to the surface and blue light absorbed at deeper depths. These turbulent and radiative surface fluxes are major contributors to energy and moisture budgets, and are largely responsible for thermodynamic coupling of the ocean and atmosphere on all scales. Variability of these fluxes is in part related to largescale variability in weather (climate) patterns. For most regions, the two major components are the net shortwave gain by the ocean and the latent heat flux loss by the ocean.

Requirements					
Item needed	**Unit**	**Metric**	[1]	**Value**	**Notes**
Horizontal Resolution	km		G	10	
			B	25	
			T	100	
Vertical Resolution			G	-	N/A
			B	-	
			T	-	
Temporal Resolution	h		G	1	
			B	3	
			T	24	
Timeliness			G	7	
			B	30	
			T	365	
Required Measurement Uncertainty (2-sigma)	$W\ m^{-2}$		G	10	.
			B	15	
			T	20	
Stability	$W\ m^{-2}$/ decade		G	1	
			B	2	
			T	3	
Standards and References	Meghan F. Cronin et al. (2019). Air-Sea Fluxes with a Focus on Heat and Momentum, Frontiers in Marine Science, 6, article 430, p1-30. https://www.frontiersin.org/articles/10.3389/fmars.2019.00430/full Meyssignac, Benoit, et al. Measuring global ocean heat content to estimate the Earth energy imbalance" Frontiers in Marine Science 6 (2019): 432.				

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New specification sheets – allowing for reporting EOV and ECV

Ocean Surface Heat Flux

Global Ocean Observing System (2023). Essential Ocean Variable Specification Sheet: Ocean Surface Heat Flux. GOOS Reference No; DOI: [to be assigned, e.g. by depositing on the Zenodo repository]

EOV Specification Sheet curated by: OOPC

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EOV Information

Name of EOV		Ocean Surface Heat Flux
EOV sub-variables		• Radiative Heat [1] • Sensitive Heat [2] • Latent Heat [3]
		[Space for optional comment/reference]
Corresponding other Essential Variables	ECV	Ocean Surface Heat Flux
	EBV	N/A
	Other	N/A
Relevant global indicators	SDG	[SDG #: Title]
	CBD	[insert text]
	Climate	[insert text]
	other (e.g. regional such as MSFD)	[insert text]

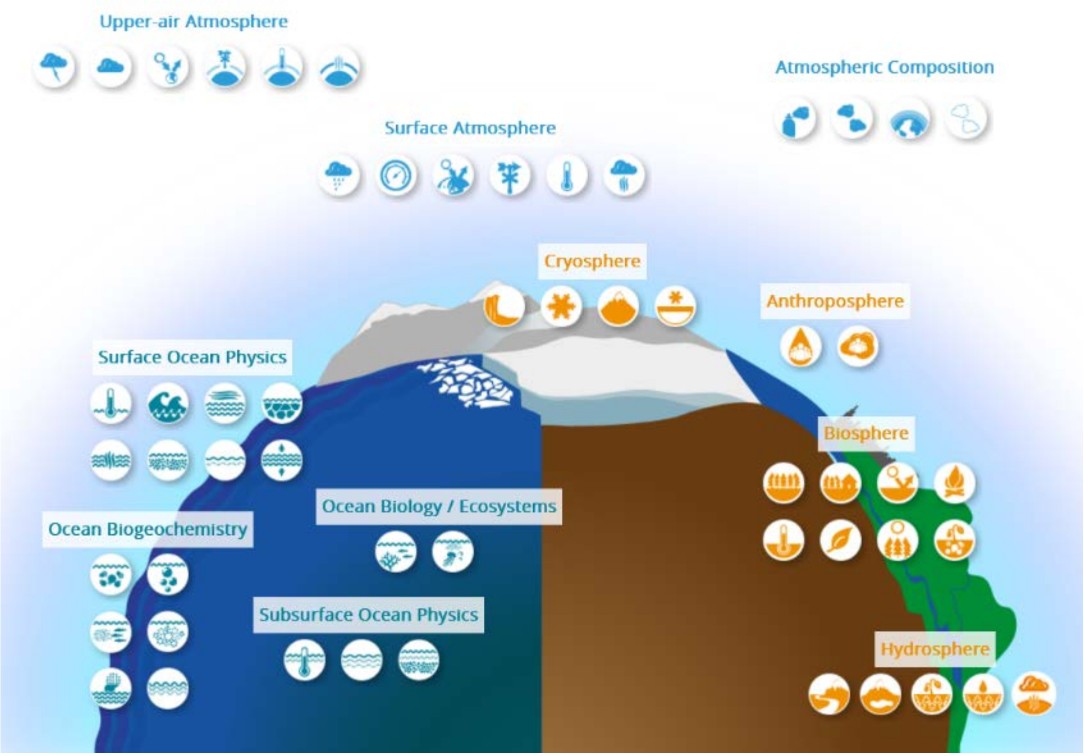
Requirements setting: Phenomena

GOOS Applications / Societal Drivers / Pressures / Scientific Question		[insert text]		
Readiness level		[insert text]		
Phenomena to capture		Mixed Layer	Phenomenon #2	Phenomenon #N
Coverage	horizontal	Global	[Refer to list of options]	[Refer to list of options]
	depth	surface	[Refer to list of options]	[Refer to list of options]
Spatial scale/resolution [order of magnitude]	horizontal	10 km	[insert text]	[insert text]
	vertical	N/A	[insert text]	[insert text]
Temporal scale/resolution		hourly	[insert text]	[insert text]
Signal to capture		*range: -1500 - 1000Wm^-2*	[insert text]	[insert text]
EOV subvariables required		Sensible Heat Flux, Latent Heat Flux, Solar and IR Radiative Heat Flux	[insert text, comma-separated]	[insert text, comma-separated]
Relevant global indicators		[insert text, comma-separated, hyperlinked]	[insert text, comma-separated, hyperlinked]	[insert text, comma-separated, hyperlinked]

New specification sheets - ECVs

Physics	Biochemistry	Biology and Ecosystems
• Sea state • Ocean surface stress • Sea ice • Sea surface height • Sea surface temperature • Subsurface temperature • Surface currents • Subsurface currents • Sea surface salinity • Subsurface salinity • Ocean surface heat flux	• Oxygen • Nutrients • Inorganic carbon • Transient tracers • Particulate matter • Nitrus oxide • Stable carbon isotopes • Dissolved organic carbon	• Phytoplankton biomass and diversity • Zooplankton biomass and diversity • Fish abundance and distribution • Marine turtles, birds, mammals abundance and distribution • Hard coral cover and composition • Seagrass cover and composition • Macroalgal canopy cover and composition • Mangrove cover and composition • Microbe biomass and diversity (*emerging) • Invertebrate abundance and distribution (*emerging)
Cross-disciplinary (including human impact)		
	• Ocean colour • Marine debris (*emerging)	• Ocean sound

EOVs GOOS	OOPC	BGC	BioEco	cross
31 ECVs	11	8	10	3
~ 20 subvariables	20	20	20	



ECVs GCOS	AOPC	OOPC	TOPC
55 ECVs	16	19 (11, 6, 2)	20
174 ECV products	75	44 (20, 15, 8)	55