C3S Sea Surface Salinity

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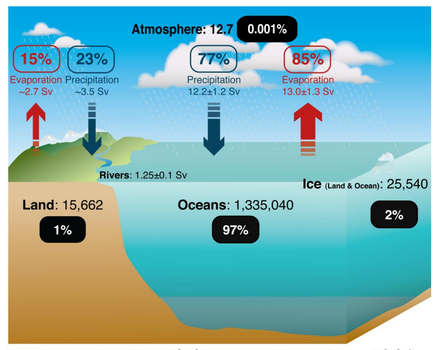
Sea Surface Salinity (SSS) is an Essential Climate Variable (ECV) that plays a key role in the global thermohaline circulation, the hydrological cycle as well as the upper-ocean carbonate system and air-sea exchanges. Owing to its global coverage, satellite-based remote sensing of SSS is a key tool for monitoring this ECV. Since 2010, several missions have been successfully operated, starting with the Soil Moisture and Ocean Salinity (SMOS) mission launched by ESA, followed by Aquarius and Soil Moisture Active Passive (SMAP) missions developed by NASA. Thus, using these satellite measurements, this project aims to produce an **SSS Climate Data Record (CDR) over the 2010-2024 period** and a near-real-time **Interim CDR (ICDR) from 2025 onward**. Building on algorithms developed in the ESA Climate Change Initiative Salinity Project (CCI+SSS), **monthly** L4 SSS products at **50 km resolution** will be provided twice a month on a 0,25° spatial grid through the Copernicus Climate Change Service (C3S). By being compliant with ECMWF and C3S technical standards, and aligned with GCOS requirements, these products are designed for climate monitoring, reanalysis and modelling applications.

Schematic representation of the global water cycle (supportive material from Durack *et al.* (2012))



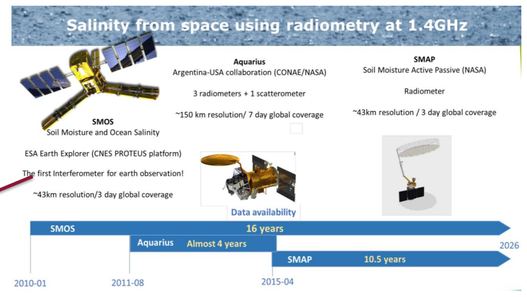
ALGORITHMS

① Preprocessing

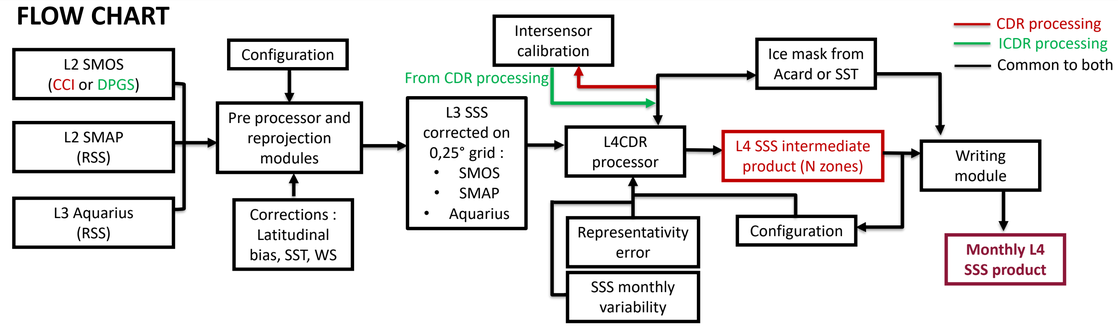
- 3 datasets of SSS satellite measurements :
  - Level-2 SMOS (CDR : CCI or ICDR : DPGS)
  - Level-2 SMAP (RSS)
  - Level-3 Aquarius (RSS)
- Application of corrections :

Corrections	CDR	ICDR
Diurnal SST correction	Yes	No
RFI correction	Yes	No
Sun correction	Yes	Yes
Ice-edge correction near Antarctica	Yes	Yes
Rainfall correction	Yes	Yes
Latitudinal bias correction	Yes	Yes
SST-dependent correction	Yes	Yes
Neutral wind-dependent correction	Yes	Yes

- Projection of all datasets on common regular 0,25° grid



FLOW CHART



② Processing

- Merging of the different corrected satellite SSS datasets using a **temporal optimal interpolation** (OI)
- Estimation of inter-calibration bias which depends on the geometry of acquisition

Algorithms	CDR	ICDR
Same OI algorithm	Applied over the whole 2010-2024 period	Applied over 1 month
Inter-sensor bias correction	Estimated simultaneously with SSS retrievals	Based on the CDR processing

③ Final products

- **Monthly Level-4 multi-mission SSS fields**, which includes :
  - flags provided in the product : ice contamination flag, land sea flag & global quality flag
  - uncertainty estimates of retrieved SSS fields
- Planning of the release of first versions of both products

CDR over 2010-2024 ➔ **CCI+SSS v6** — **November 2026**

ICDR from 2025 onward — **January 2027**

VALIDATION

Objective : Implementation of a **robust** and **continuous** validation system to ensure accuracy and stability of CDR and ICDR products

Reference datasets :

- **Argo floats** : primary reference with near-surface salinity profiles (upper 10 m), global ocean coverage
- **Ship-based TSG** : continuous underway thermosalinograph measurements along shipping routes
- **Moored buoys** : tropical arrays (TAO/TRITON, PIRATA, RAMA) for fixed-point time series

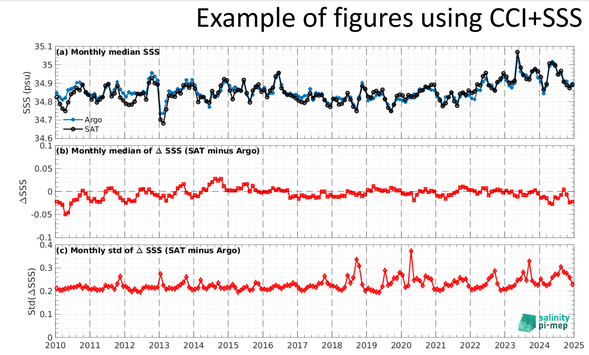
Matchup methodology :

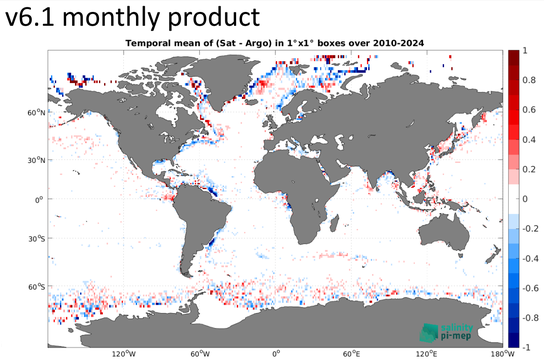
- Colocation within **50 km** and **±15 days**
- Monthly and annual statistics computed globally and by oceanic basin

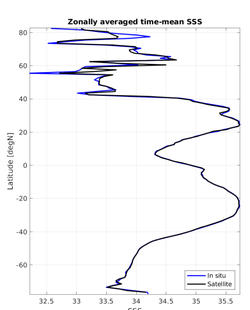
Validation metrics :

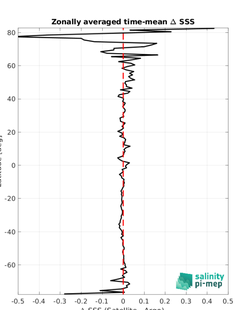
- **Mean bias** and **RMSD** against Argo near-surface salinity
- **Temporal stability** : monitoring of bias and RMSD trends over the CDR period (2010-2024)
- **Regional analysis** : latitudinal and basin-scale assessment of retrieval quality

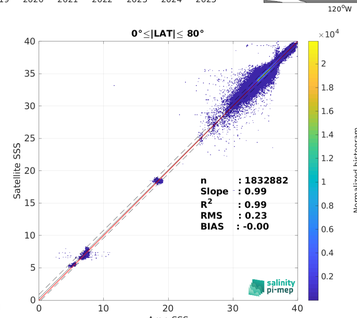
Example of figures using CCI+SSS v6.1 monthly product

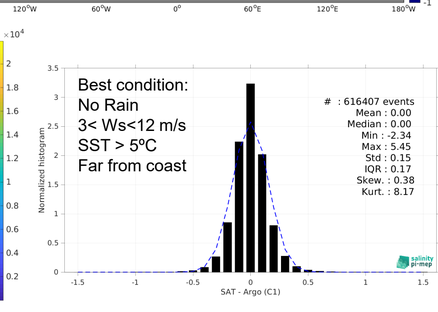








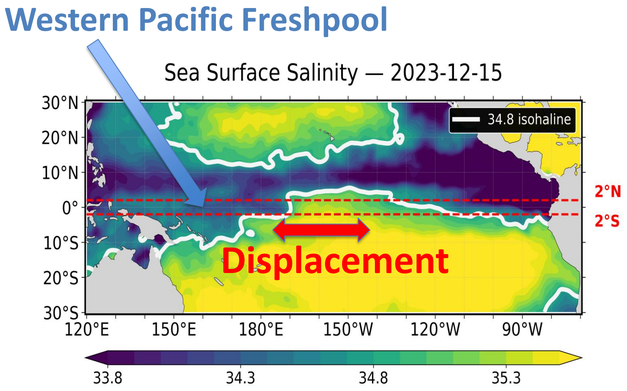




CLIMATE INTELLIGENCE — A prototype : tracking ENSO through the Pacific fresh pool

From SSS fields to a fresh-pool displacement index

Western Pacific Freshpool

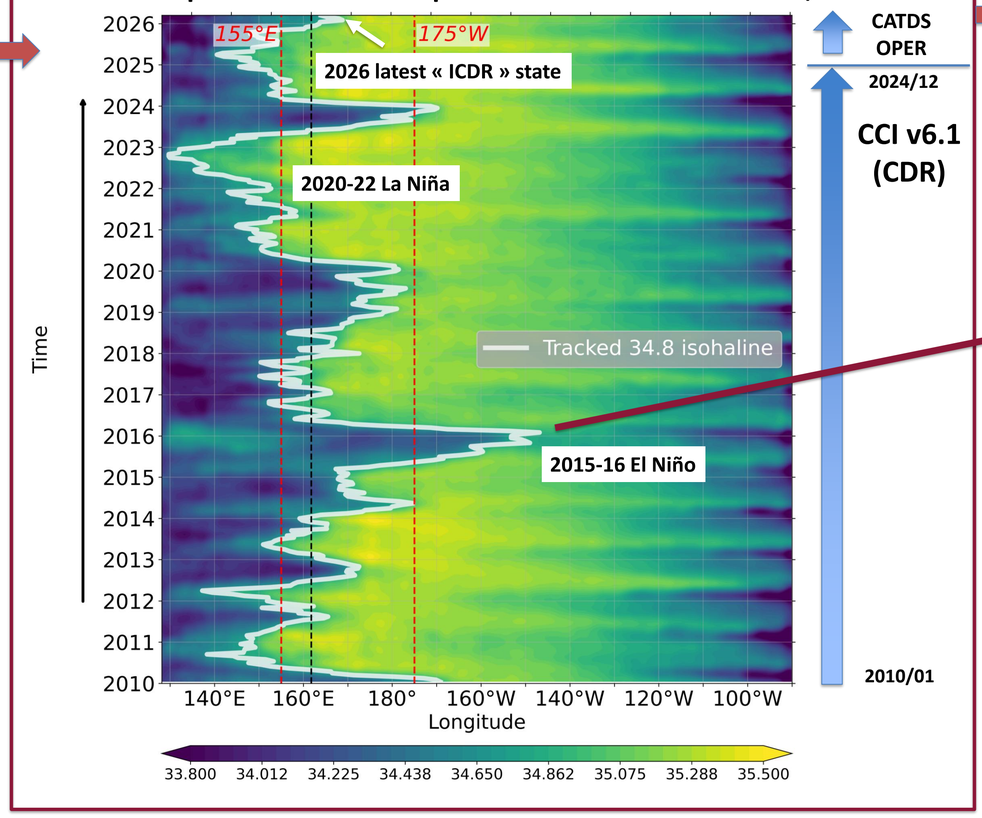


S34.8 index definition

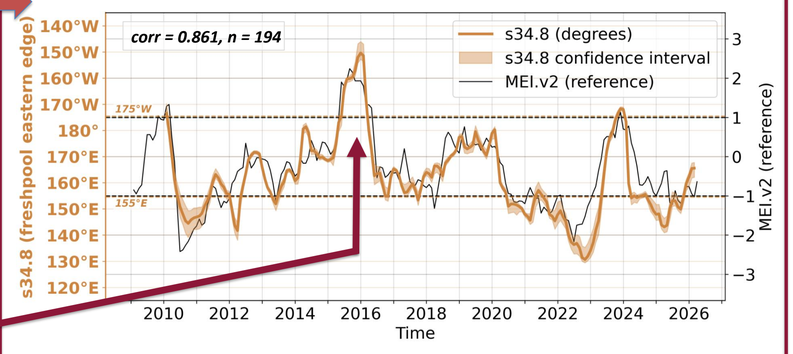
1. Average SSS over 2°S–2°N
2. Track the 34.8 isohaline closest to the eastern fresh-pool edge
3. Convert longitude into displacement from the mean tracked position.
4. The resulting displacement index is compared with MEI.v2 / Niño3.4 to assess ENSO consistency.

- Eastward displacement → fresh-pool extension / El Niño-like conditions
- Westward displacement → fresh-pool retreat / La Niña-like conditions

Observed displacement of the equatorial Pacific 34.8 isohaline, 2010–2026



S34.8: A salinity-based ENSO indicator



S34.8 tracks the equatorial Pacific fresh-pool edge, revealing a freshwater-cycle dimension of ENSO that is not captured directly by conventional thermal or multivariate indices

Conclusion: Satellite SSS provides a freshwater-cycle perspective on ENSO by monitoring the zonal displacement of the western Pacific fresh pool. The S34.8 prototype index tracks the 34.8 isohaline closest to the eastern fresh-pool edge in monthly 2°S–2°N mean SSS fields. Its comparison with MEI.v2 supports its relevance as a candidate C3S climate-intelligence indicator, complementary to conventional ENSO monitoring.

Data and references

S34.8 index: adapted from the Pacific fresh-pool tracking approach of Tangdong Qu and Jin-Yi Yu, J Oceanogr (2014) 70:367–375.
ENSO reference: MEI.v2 multivariate ENSO index, NOAA PSL; Wolter and Timlin (2011).
Not yet C3S CDR/ICDR products: prototype based on experimental CCI+SSS v6.1 fields and NRT CATDS L4 SSS as temporary ICDR proxy.

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