

climate change initiative

→ **SEA SURFACE TEMPERATURE**

A 42-year Sea Surface Temperature Climate Data Record from the ESA Climate Change Initiative

Owen Embury, Chris Merchant, Simon Good, Jacob Høyer,
Nick Rayner, Tom Block, Craig Donlon



sst
cci



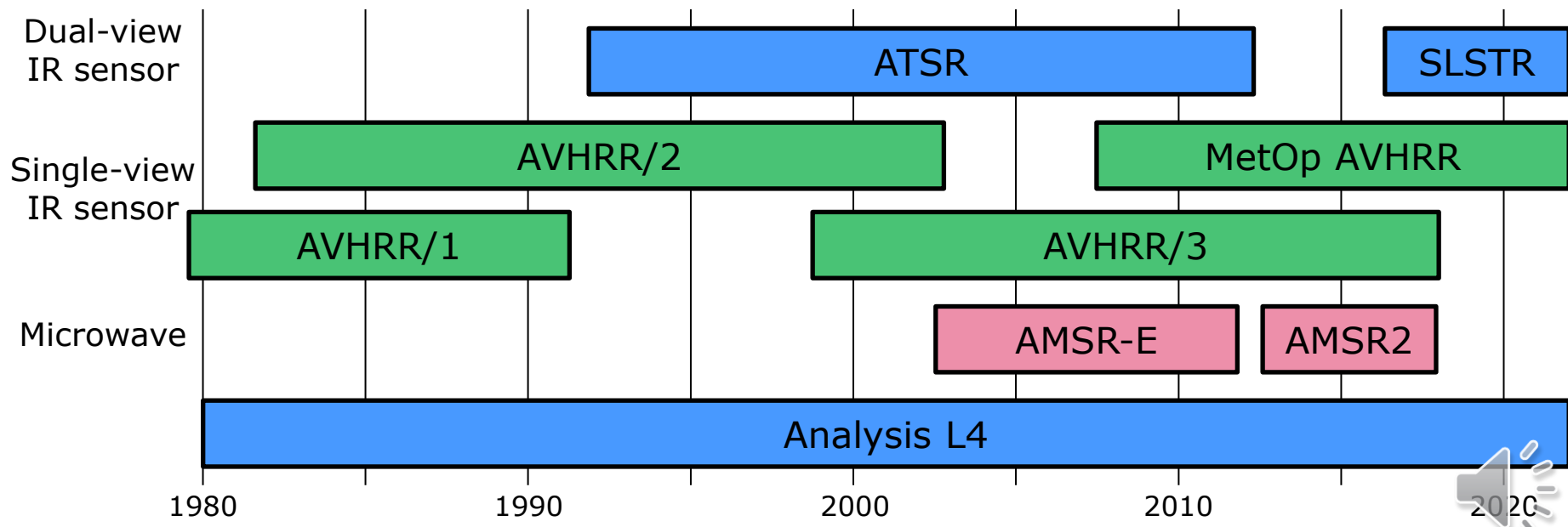


- ESA Climate Change Initiative (CCI) has produced two previous SST Climate Data Records (CDR):
 - Version 1: September 1991 – December 2010 (19 years)
 - Version 2: September 1981 – December 2016 (35 years)
- Currently working towards version 3 to be released this year
 - January 1980 – December 2021 (42 years)
 - Improved AVHRR SST especially 1980s:
 - Addition of AVHRR/1 from NOAA-6, -8, and -10
 - Reduce 1980s data gaps
 - Reduce desert-dust related biases
 - New bias-aware optimal estimation retrieval
 - Switch to full resolution MetOp AVHRR data
 - Addition of SLSTR
 - Addition of Passive Microwave SST from AMSR-E and AMSR2





- Includes products at L2P, L3U, L3C, and L4
- SST_{skin} at satellite overpass; SST_{20cm} at 10:30 local time
- Multi-sensor L4 Analysis generated using Met Office OSTIA system



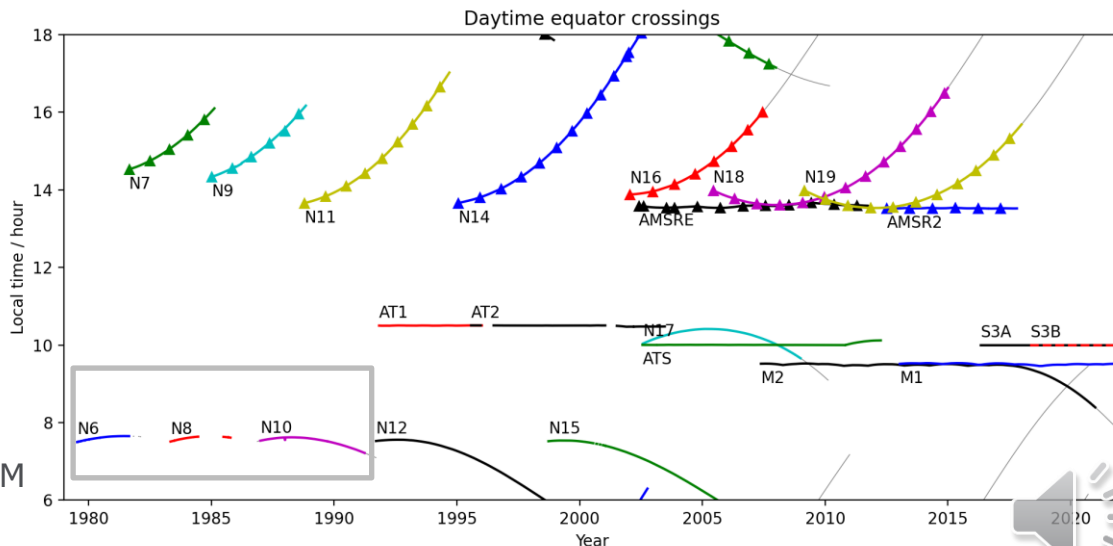


AVHRR/1 instruments



- AVHRR/1 instruments had four channels: 0.6, 0.8, 3.8, 11 μm
 - Solar signal affects SWIR, so two channel retrieval only possible at night
- AVHRR/1 used on NOAA-6, -8, and -10 platforms
 - Only sensor available before August 1981

Right: Satellite equator crossing times
AVHRR/1 instruments were used for the AM orbit until September 1991



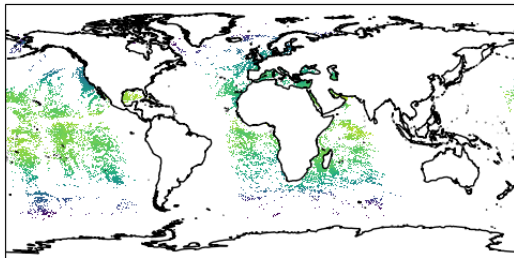


Recovered AVHRR orbits

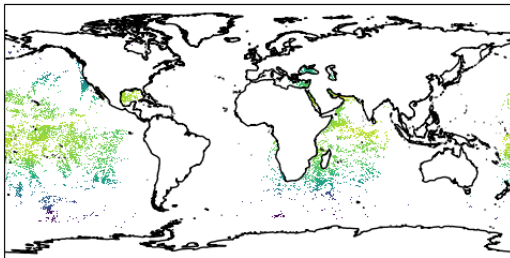


- CDRv2 was affected by AVHRR processing failures in 1980s
 - Due to QC checks falsely flagging data received via Wallops Island
 - Resulted in some intermittent coverage gaps during 1980s

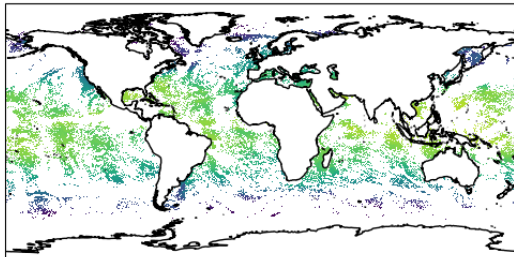
CDR 2.1 Day



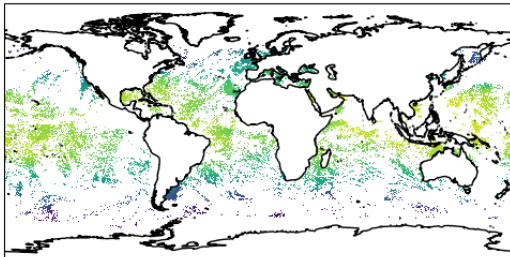
CDR 2.1 Night



CDR 3.0 Day



CDR 3.0 Night



AVHRR11_G from 1989-06-20

Top: CDR v2 orbits from WI are missing

Bottom: CDR v3 all orbits processed



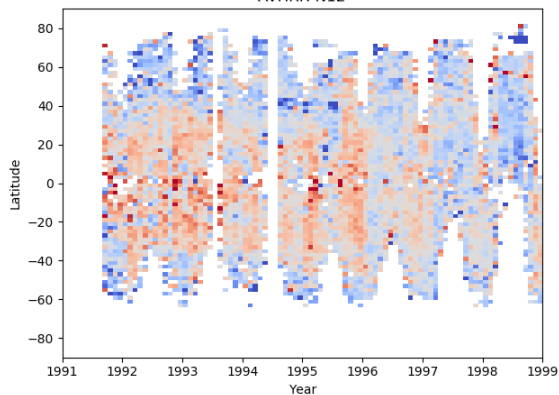


Improved AVHRR-12 coverage



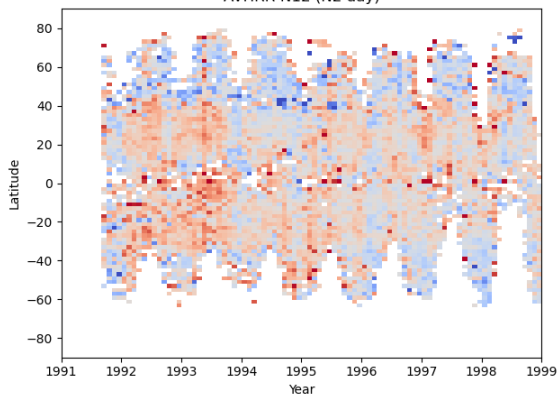
CDR 2.1

AVHRR-N12

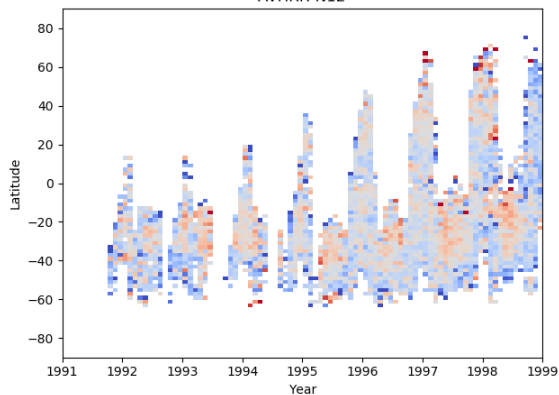


CDR 3.0

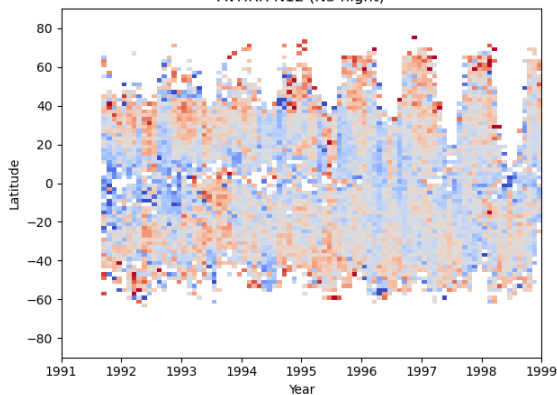
AVHRR-N12 (N2 day)



AVHRR-N12

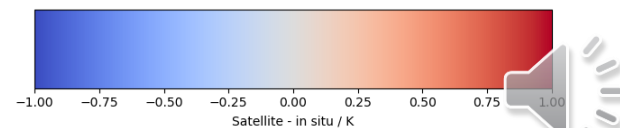


AVHRR-N12 (N3 night)



In CDR v2 limits on the ICT temperature severely limited the amount of NOAA-12 night-time data

CDR v3 improves coverage





Reduced desert-dust biases



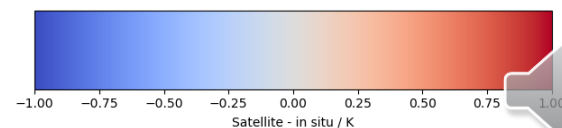
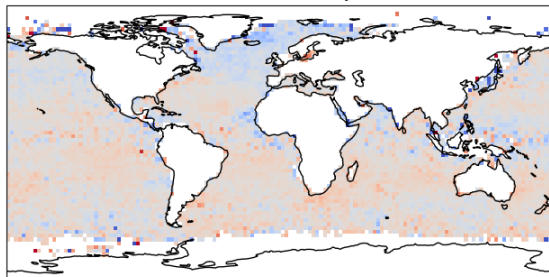
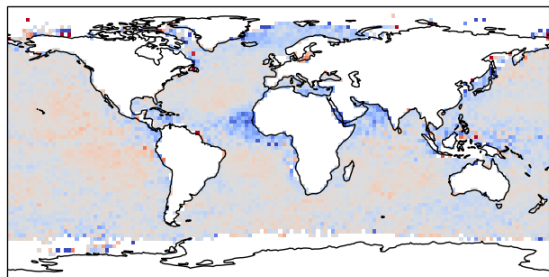
- CDR v2 AVHRR data was affected by cold-biases in due to desert-dust aerosol
 - Strong seasonal cycle with biases in Atlantic Ocean and Arabian Sea
 - Previous retrieval assumed “clear-sky” with no aerosol present
- CDR v3 adds aerosol data from CAMS reanalysis
 - Includes dust component
 - Greatly reduced dust biases in AVHRR SST data

CDR 2.1

CDR 3.0

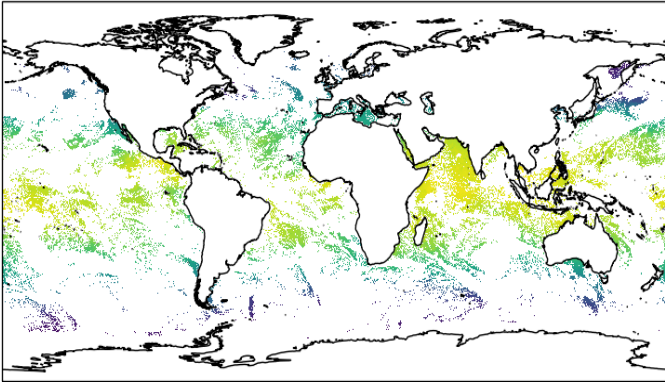
AVHRR-N19

AVHRR-N19 (N2 day)

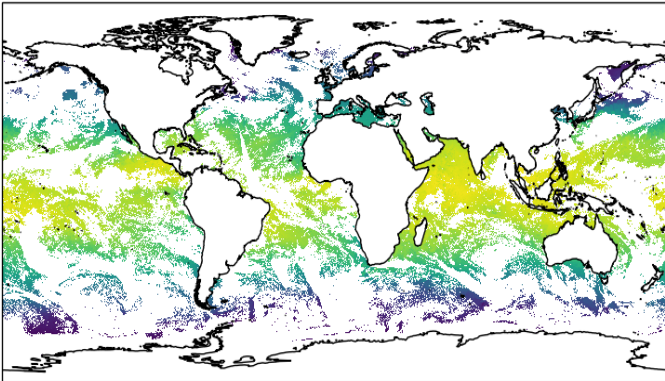




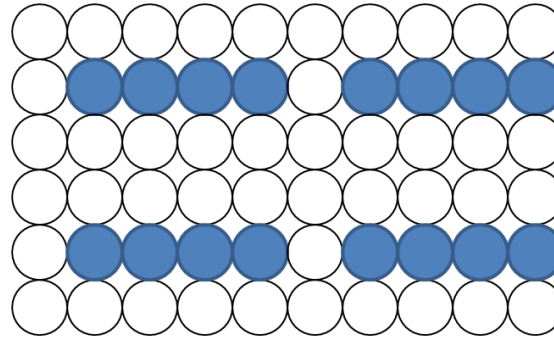
AVHRRMTA_G



AVHRRMTA



- CDRv2 used MetOp AVHRR at GAC resolution
- CDRv3 uses MetOp at full resolution
 - 15x as many pixels at L1/L2



GAC pixels (blue) are average of 4 full resolution pixels. White pixels are unused in GAC data

- Over double number of L3 cells

Left: L3C night-time data for 2019-05-05

Top: GAC resolution

Bottom: Full resolution

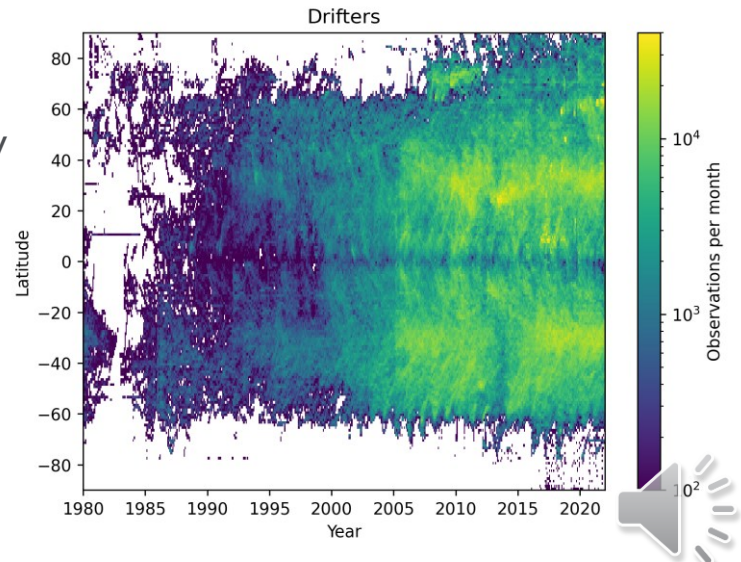




Validation against in situ

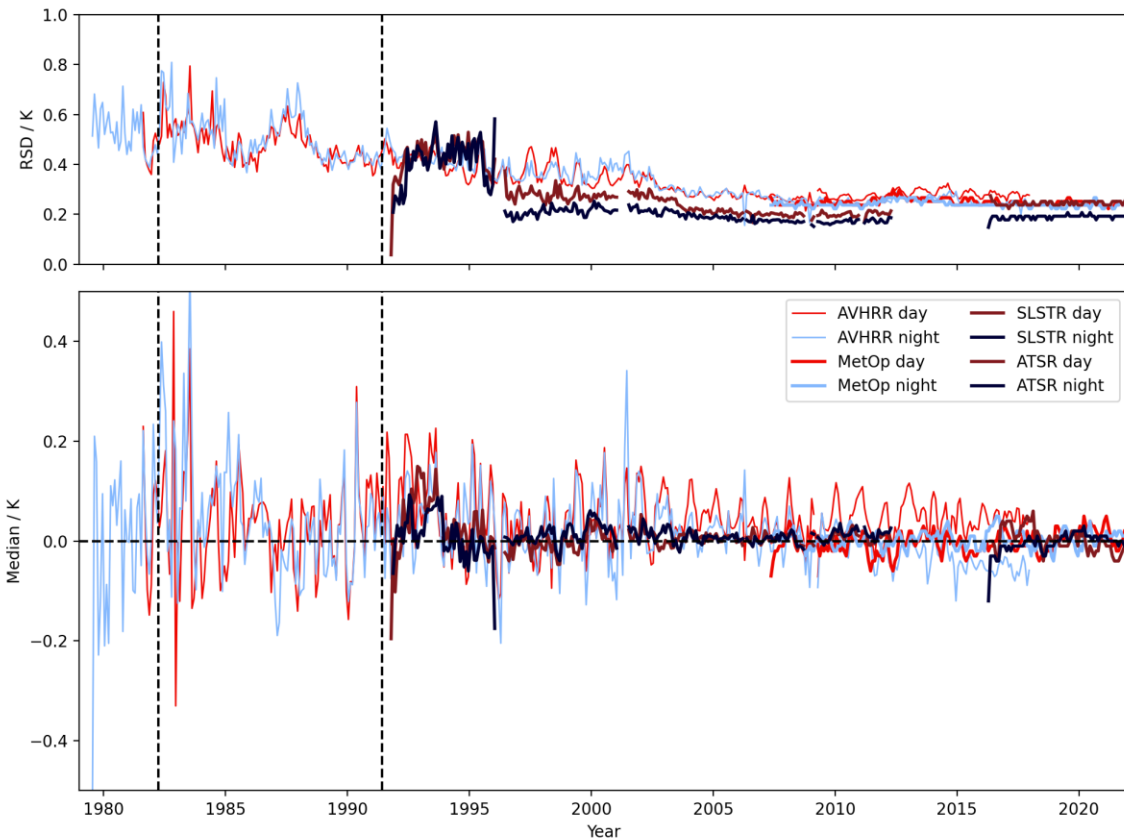


- SST CCI Independent Reference Data Set (SIRDS)
 - Based on Met Office Hadley Centre Integrated Ocean Dataset (HadIOD)
 - <https://www.metoffice.gov.uk/hadobs/hadiod/sirds.html>
 - Includes: drifters, gtmba, moorings, ships, argo, bottle, ctd, mbt, xbt, ...
- Variable coverage over CDR period
- Ships provide best coverage in 1980s, but highest uncertainty – typically larger than satellite uncertainty
- Drifters provide majority of obs. since early 2000s, but very limited spatial coverage in 1980s
- Main validation results use:
 - All non-ship in situ up to 1995
 - Drifters-only from 1995 onwards





Time series of IR validation against in situ



Left: SST_{0.2m}@10:30 to in situ

In situ includes all non-ship data up to NOAA-12; drifters-only used for NOAA-14 onwards.

Vertical dashed lines show time of El Chichón (April 1982) and Mount Pinatubo (June 1991) eruptions.





Summary of IR validation against in situ



	Day		Night	
	Median	RSD	Median	RSD
NOAA-06			+0.02	0.55
NOAA-07	+0.00	0.53	+0.07	0.53
NOAA-08			+0.02	0.57
NOAA-09	+0.02	0.49	+0.02	0.51
NOAA-10			-0.04	0.52
NOAA-11	+0.07	0.43	+0.05	0.41
NOAA-12	+0.02	0.40	-0.00	0.41
NOAA-14	+0.04	0.37	+0.02	0.38
NOAA-15	+0.03	0.32	+0.03	0.34
NOAA-16	+0.05	0.30	-0.03	0.29
NOAA-17	+0.07	0.25	+0.06	0.26
NOAA-18	+0.03	0.28	-0.02	0.27
NOAA-19	+0.05	0.28	-0.03	0.25

Reference in situ includes all non-ship data up to NOAA-12

Drifters-only used for NOAA-14 onwards





Summary of IR validation against in situ



	Day		Night	
	Median	RSD	Median	RSD
MetOp-A	-0.01	0.25	-0.01	0.24
MetOp-B	+0.01	0.25	+0.02	0.24
ATSR-1	+0.04	0.45	+0.01	0.45
ATSR-1 (d3)			+0.00	0.26
ATSR-2	-0.00	0.28	+0.02	0.21
AATSR	+0.01	0.21	+0.01	0.18
SLSTR-A	+0.02	0.25	+0.00	0.19
SLSTR-B	-0.03	0.24	-0.01	0.19





Summary



- 42-year CDR from 1980 to end-2021
 - Adds AVHRR/1, Passive Microwave, full-resolution MetOp, and SLSTR
 - New bias-aware OE retrieval and reduced desert-dust related biases
 - C3S Interim CDR will be updated to version 3 on release of CCI CDR v3
- Data is currently being prepared for release to “trail-blazer” users in June/July
- Users willing to provide feedback and contribute to the Climate Assessment Report can contact Nick Rayner for details at: nick.rayner@metoffice.gov.uk
- Public data release will be late 2022 via the CCI Open Data Portal
 - <https://climate.esa.int/en/odp/>

