

ERA5 Updates on the impact of TAO buoy winds

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ECMWF



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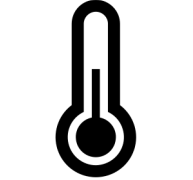
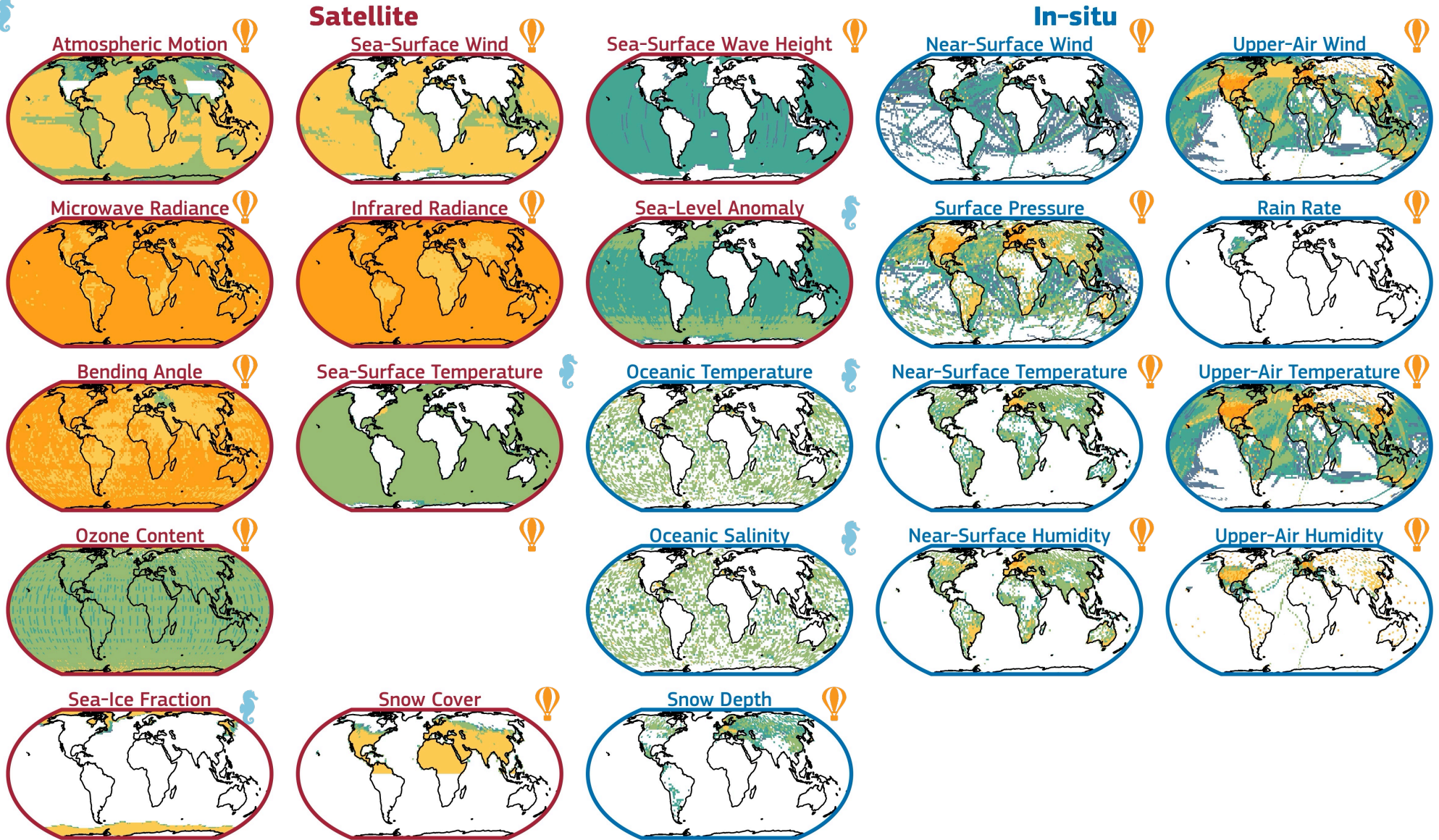
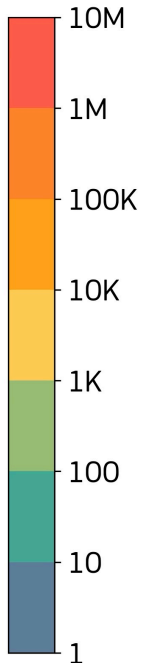


Reanalyses integrate *several* observation types

ERAS, ORAS6
Observations
Assimilated

December
2025

Number of observations assimilated per 2°x2°
normalized to Equator-latitude area



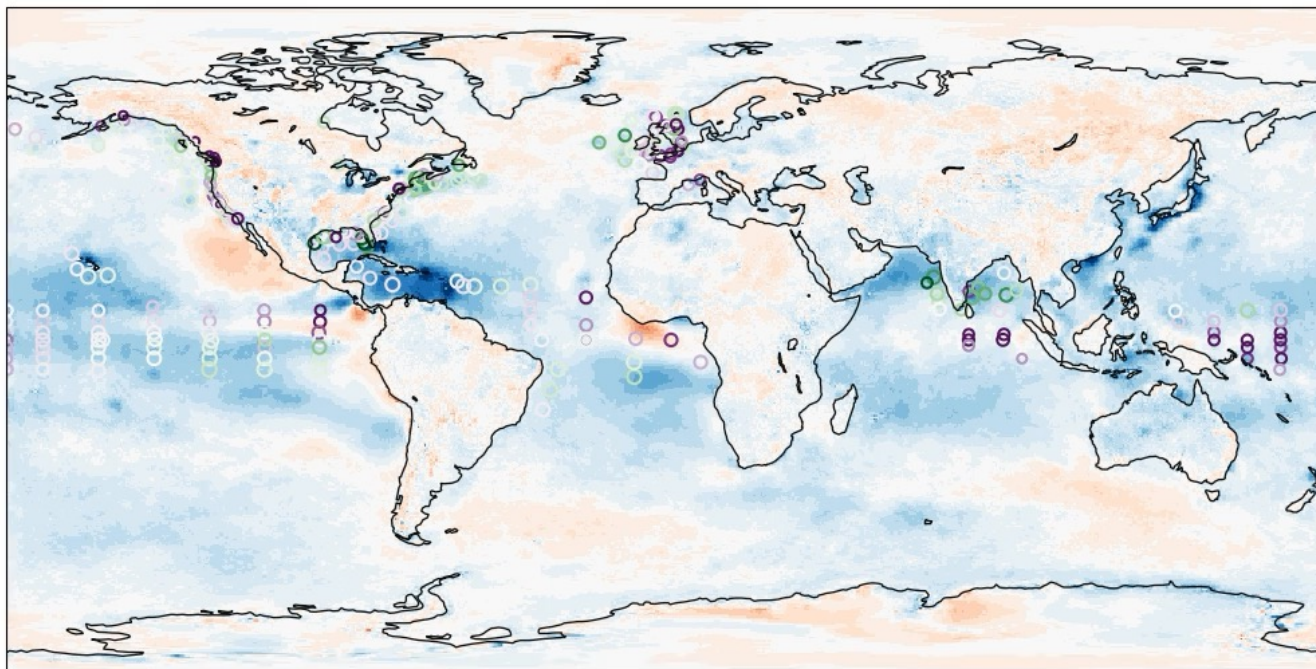
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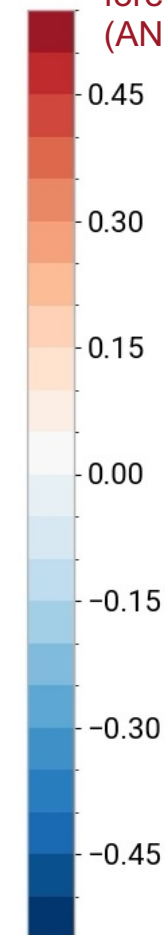
10-m wind speed in ERA5, January 2006 to June 2025

ERA5_OFB 10ff mean analysis increment 200601-200612
(ea-an-oper-???? minus ea-fc6-oper-????)

All quantities: showing 12-month moving average



Red: ERA5 analysis wind speed systematically exceeds ERA5 6-hour forecast wind speed (AN > FG)



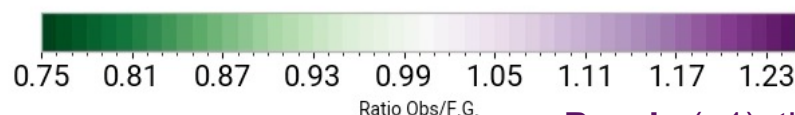
Shaded contours:

Monthly mean ERA5 analysis increment for 10-m wind speed obs., calculated from ERA5 analysis wind speed minus ERA5 wind speed first-guess at step 6, twice daily, at 00 and 12 UTC.

Blue: ERA5 analysis wind speed is systematically lower than the ERA5 6-hour forecast wind speed (AN < FG)

Dots:

Monthly mean ratio of obs. wind speed to ERA5 first-guess wind speed, for moored buoys.
(Obs/FG)



Green (<1): the obs. wind speed systematically underestimate the ERA5 first-guess wind speed (Obs < FG)

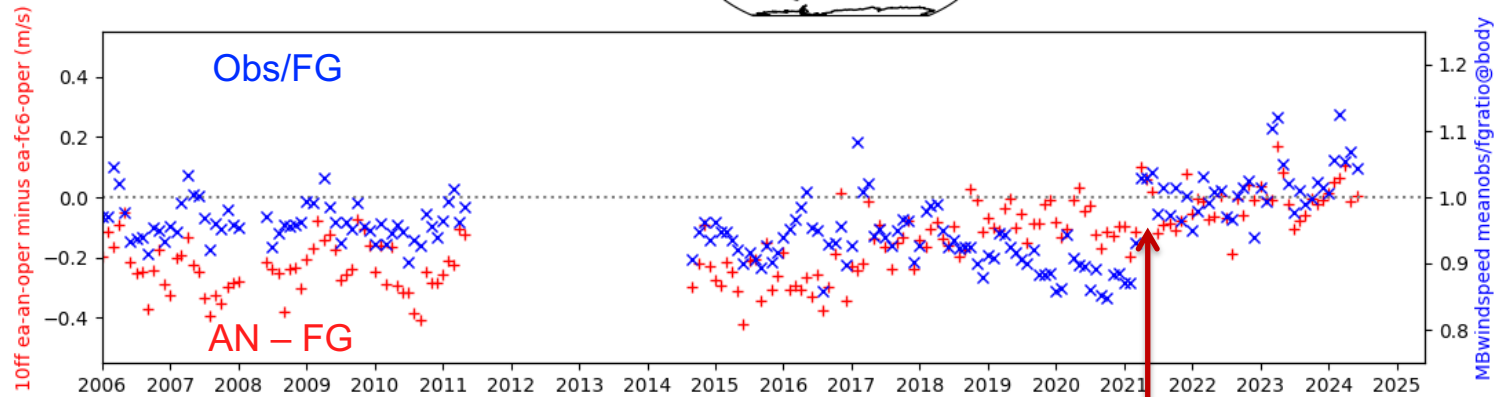
Purple (>1): the obs. wind speed systematically over-estimate the ERA5 first-guess wind speed (Obs > FG)

Example timeseries (monthly data - no moving average)

Snapshot from OceanOPS website

51018 BUFRDATA

Monthly mean ratio of obs. wind speed to ERA5 first-guess wind speed.
(Obs/FG)

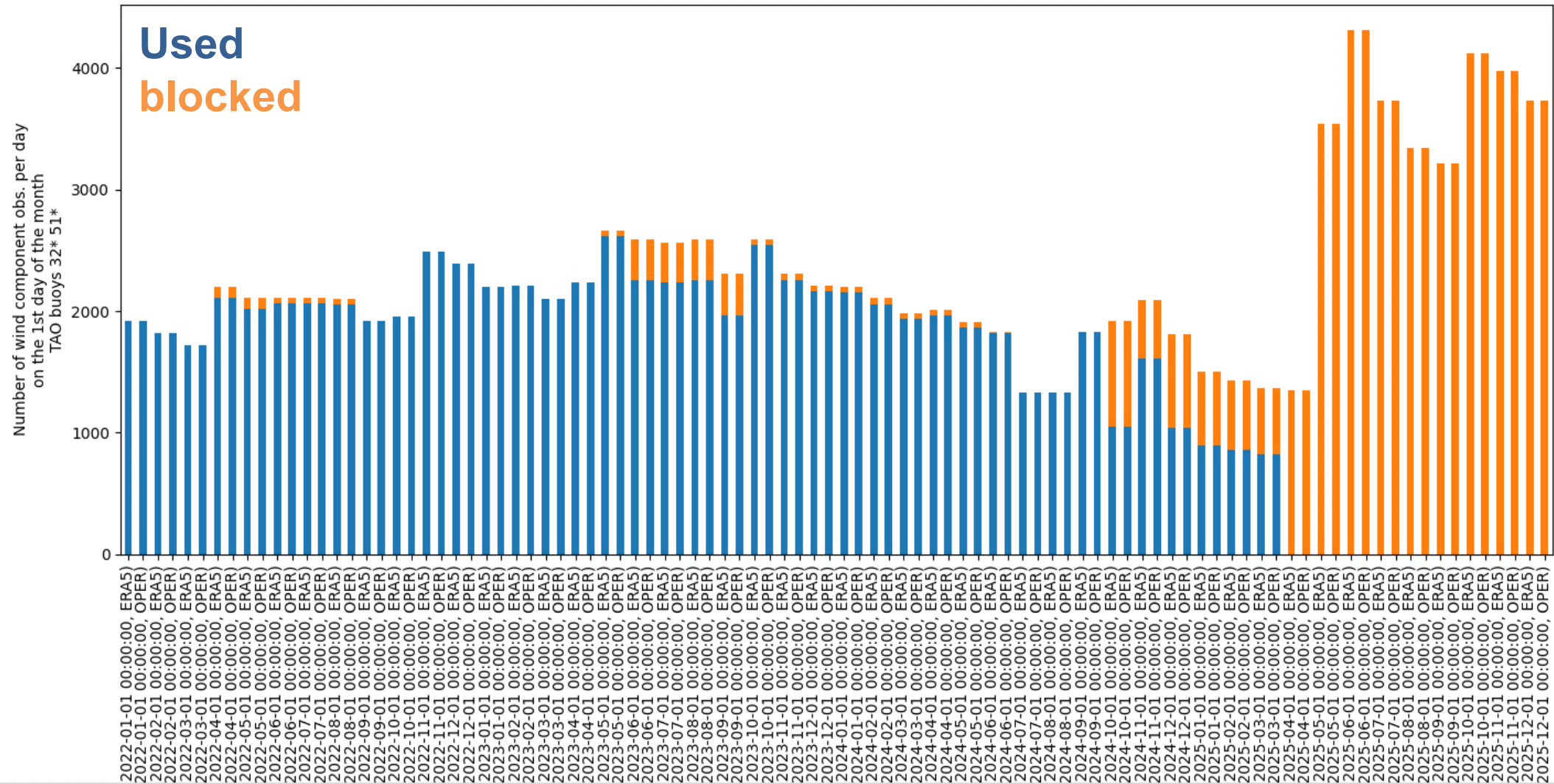


Monthly mean analysis increment (AN - FG) for 10-m wind speed in ERA5, calculated from ERA5 analysis minus ERA5 forecast at step 6, twice daily, at 00 and 12 UTC.

Inspect Site T5S125W

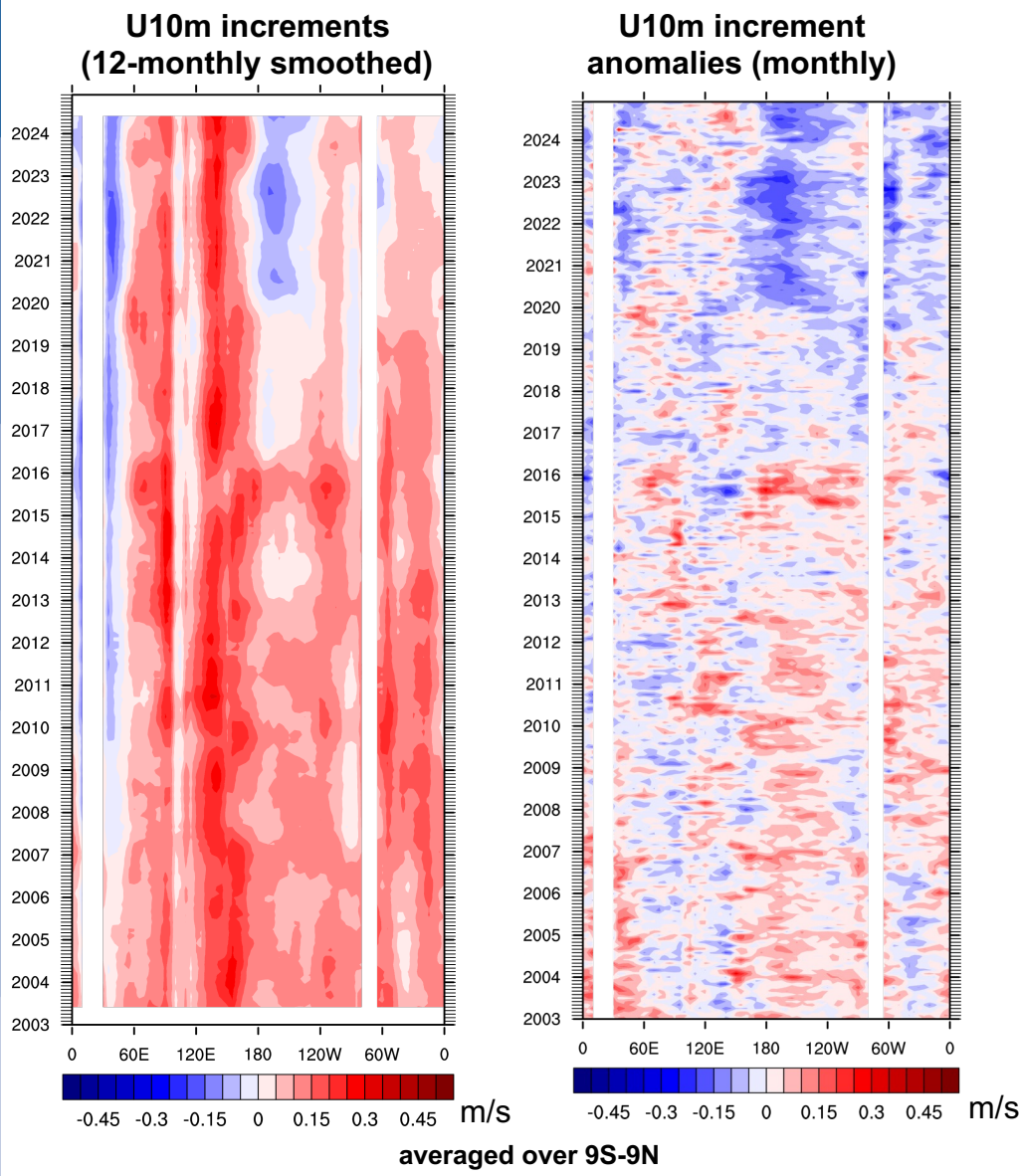
Reference	Deployment date	Retrieval date	Days at sea
5100018	1991-11-02	1992-09-22	324
5100018_001	1992-09-23	1993-10-04	376
5100018_002	1993-10-05	1994-05-01	207
5100018_003	1994-05-01	1995-03-16	318
5100018_004	1995-03-16	1996-06-21	463
5100018_005	1996-06-22	1997-10-10	475
5100018_006	1997-10-11	1998-09-20	344
5100018_007	1998-09-20	1999-02-10	143
5100018_008	1999-02-11	1999-09-29	229
5100018_009	1999-09-29	2000-02-19	143
5100018_010	2000-02-19	2001-02-02	348
5100018_011	2001-02-03	2002-04-23	444
5100018_012	2002-04-24	2003-01-30	281
5100018_013	2003-01-30	2004-05-09	465
5100018_014	2004-05-10	2005-03-13	306
5100018_015	2005-03-13	2006-01-27	319
5100018_016	2006-01-28	2007-05-19	475
5100018_017	2007-05-20	2007-10-13	145
5100018_018	2007-10-13	2008-05-20	219
5100018_019	2008-05-21	2009-09-11	478
5100018_020	2009-09-11	2010-12-04	448
5100018_021	2010-12-05	2011-08-11	249
5100018_022	2011-08-13	2012-04-03	234
5100018_023	2012-04-03	2014-01-31	668
5100018_024	2014-09-08	2015-03-11	183
5100018_025	2015-03-11	2016-03-05	359
5100018_026	2016-03-05	2017-02-04	335
5100018_027	2017-02-05	2018-09-28	600
5100018_028	2018-09-29	2019-10-20	385
5100018_029	2019-10-20	2021-03-25	521
5100018_030	2021-03-25	2022-03-16	356
5100018_031	2022-03-17	2024-10-01	928

Data usage in ERA5 and OPER

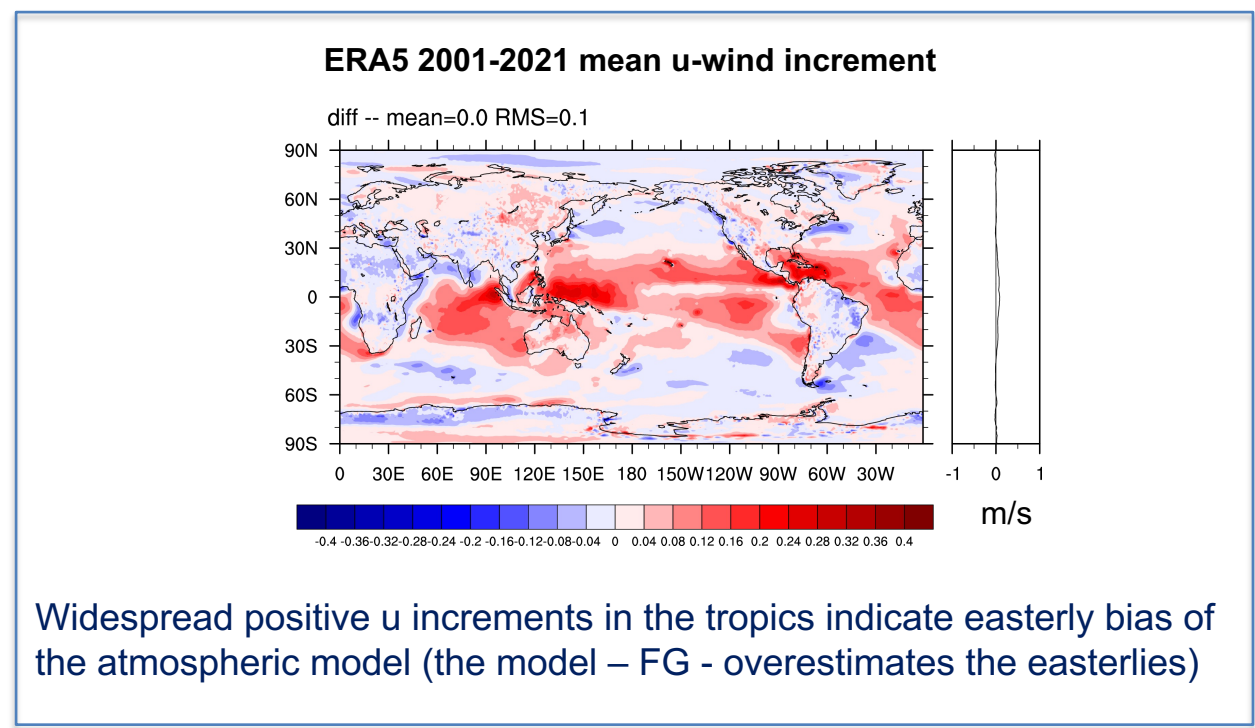


operational systems (OPER+ERA5) have blacklisted winds from several buoys of the TAO array, since Summer 2024 initially, and then with a further set in March 2025.

ERA5 u10 wind increments: changing TAO impact?

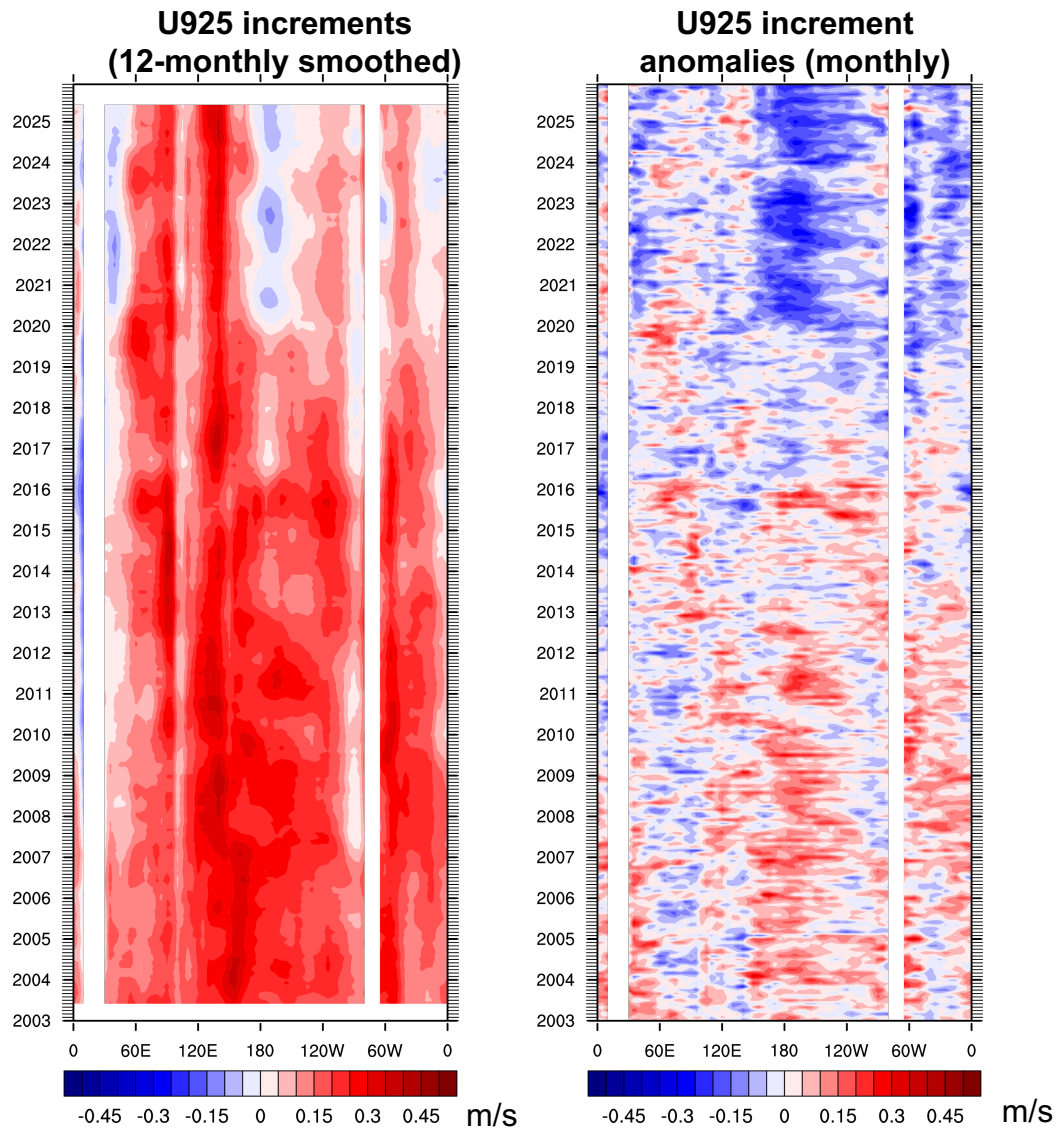


- There is a switch to easterly increments from ~2020 in the central Pacific; this seems perfectly consistent with the changing bias of the TAO moorings according to Ricciardulli et al. (2025; <https://doi.org/10.1175/BAMS-D-24-0072.1> Fig1)
- This would suggest that the changing bias (towards excessive easterlies?) of the TAO data acts to strengthen the easterlies in ERA5 2020 onward
- It would actually mean an enhancement of the atmosphere model easterly bias via the increments!?

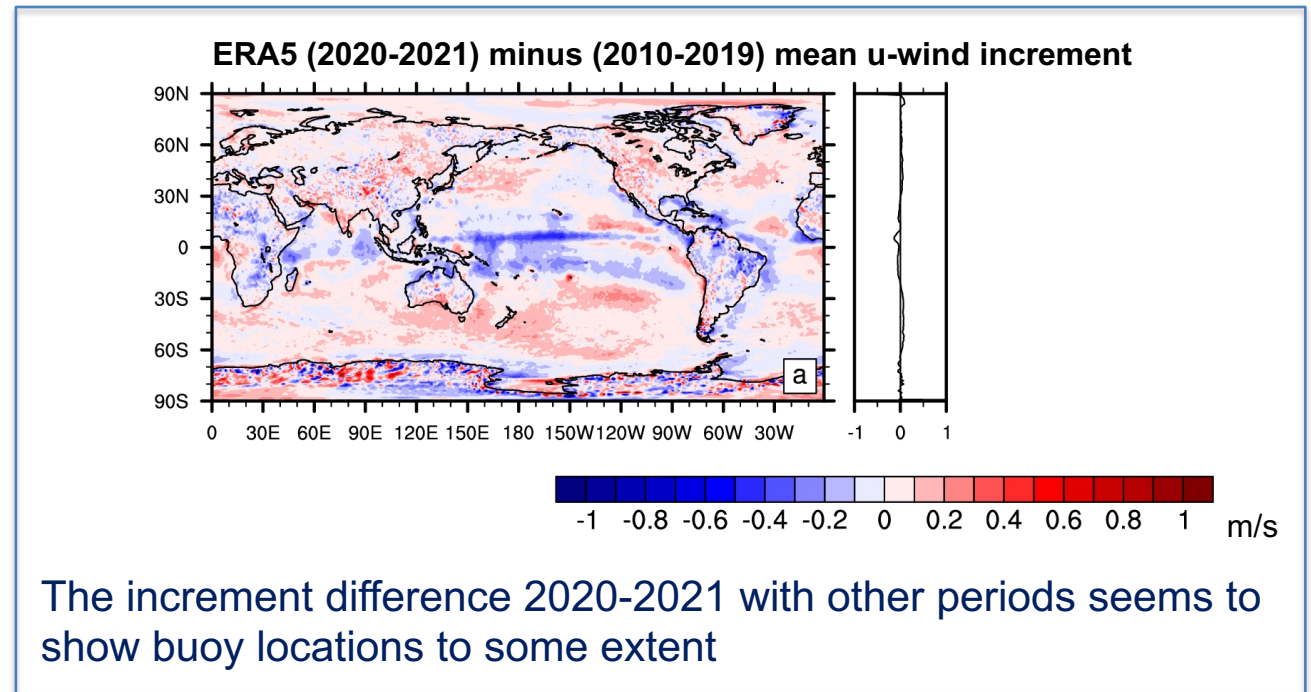


Widespread positive u increments in the tropics indicate easterly bias of the atmospheric model (the model – FG - overestimates the easterlies)

ERA5 wind increments: 925hPa



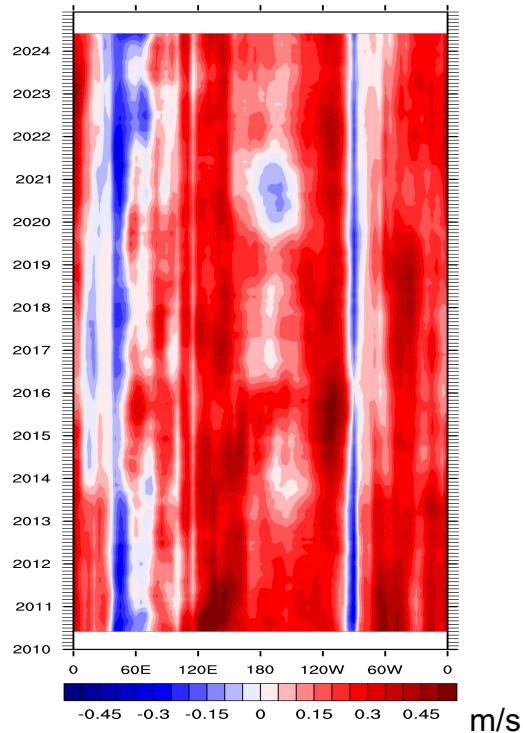
- Similar results at upper levels (also at 850hPa)
- Interestingly, the shift in increments persists until the end of 2025: was there any other change that persisted the wind increments to remain anomalously negative? This is not clearly understood yet!



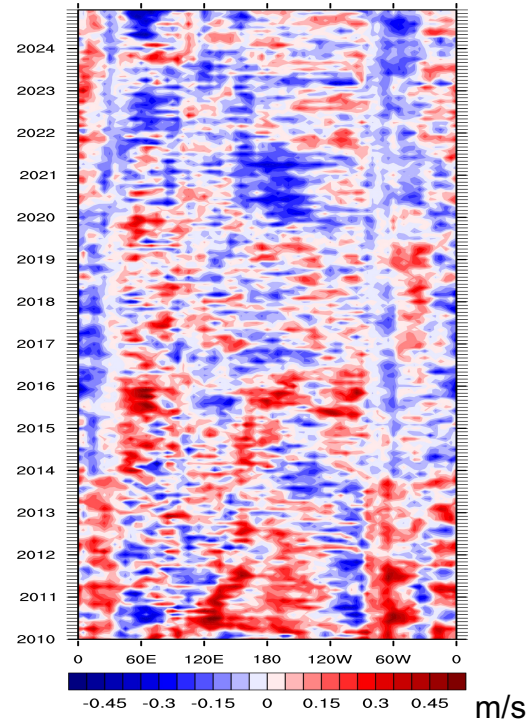
The increment difference 2020-2021 with other periods seems to show buoy locations to some extent

U10m increments in operations

U10m increments
(12-monthly smoothed)



U10m increment
anomalies (monthly)



- Increments estimated as an-fg (step=12) every 12 hours
- There seems a change like in ERA5 around 2020, but it goes away end of 2021 (most likely due to an operational model change)

For climate (and NWP) applications: welcoming information...

1. ...When and where did the 'issues' start?

- The current specification for ERA6 (under production) is a 'blanket blocklisting' of all winds from TAO 95W-165W moored buoys from mid-July 2020 onwards

2. ...Plans for change in NRT data calibration?

- ERA5 (and ECMWF OPS) systems do blocklist such data, too

3. ...Plans for data reprocessing?

- Will make for an important demonstration of the value of raw data curation enabling post-calibration
- Unfortunately, no “second version” for ERA5 – cannot be ‘repaired’ anymore.
- ERA6: it is (in theory) too late to include new observations (2006-2025 period frozen). If a reprocessed dataset arrived timely and with the right format (BUFR) an ‘emergency mode’ may be activated to use the reprocessed data (assuming time is sufficient for testing before production reaches the relevant date)
- ECMWF/C3S could help testing the impact of the TAO issues in data assimilation in NRT (operations) or reprocessing (ERA) mode