EGU General Assembly 2020

Evaluation of altimeter undersampling in estimating global wind and wave climate using virtual observation

Haoyu Jiang (Haoyujiang@cug.edu.cn)

College of Marine Science and Technology,
China University of Geosciences, Wuhan, China

More information can be found:
Haoyu Jiang, Evaluation of altimeter undersampling in estimating global wind and wave climate using virtual observation, Remote Sensing of Environment, 2020.

Wind & wave climate from altimeters

PROS:

- High accuracy (especially significant wave height)
- Nearly global coverage
- More than 30 years' consistent data available for computing long-term trends (e.g., Ribal and Young 2019, Dodet et al. 2020).

CONS:

- Sparse sampling

  Typical across-track distance 300~500 km / revisit period > 10 days
  but U10 and SWH can greatly vary within short time

Q: Is the undersampling error an issue for analyzing wave climate and its variability?

A: Use the altimeter tracks to "observe" a model hindcast.

Data and Method

DATA

- Track information from 13 altimeters (1985-2018)

  (GEOSAT, ERS-1/2, TOPEX, GFO, JASON-1/2/3, ENVISAT, CRYOSAT-2, HY-2, SARAL, SENTINEL-3A)

- Model hindcast (ERA5 & IOWAGA)

  Parameters: wind speed & SWH

  Resolution: smoothed into 1h $\times$ 2° $\times$ 2° resolution.

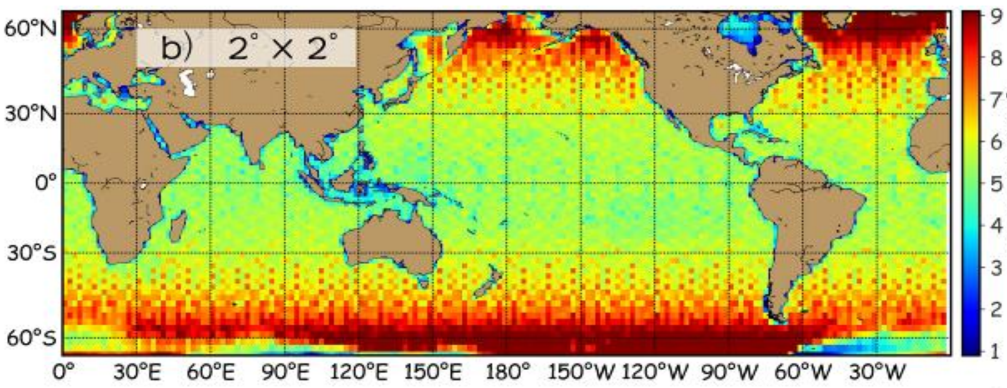
METHOD

- Interpolate the model data into an "along-track" model hindcast (Virtual Observation (VO)).

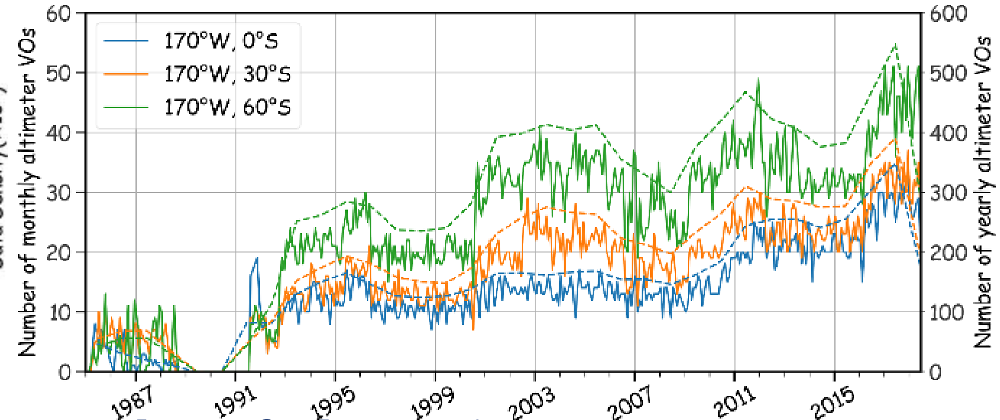
- Compare the statistics from the re-gridded "along-track" and the original hindcast data.

Altimeter sampling data density

- Not many (Less than 10,000) hourly (independent) measurements in each grid point.
- The number of observation increase with time.
- In low/high latitudes, the number of observations are often less than 20/30. Is it enough for estimating mean and 90th/99th percentiles?



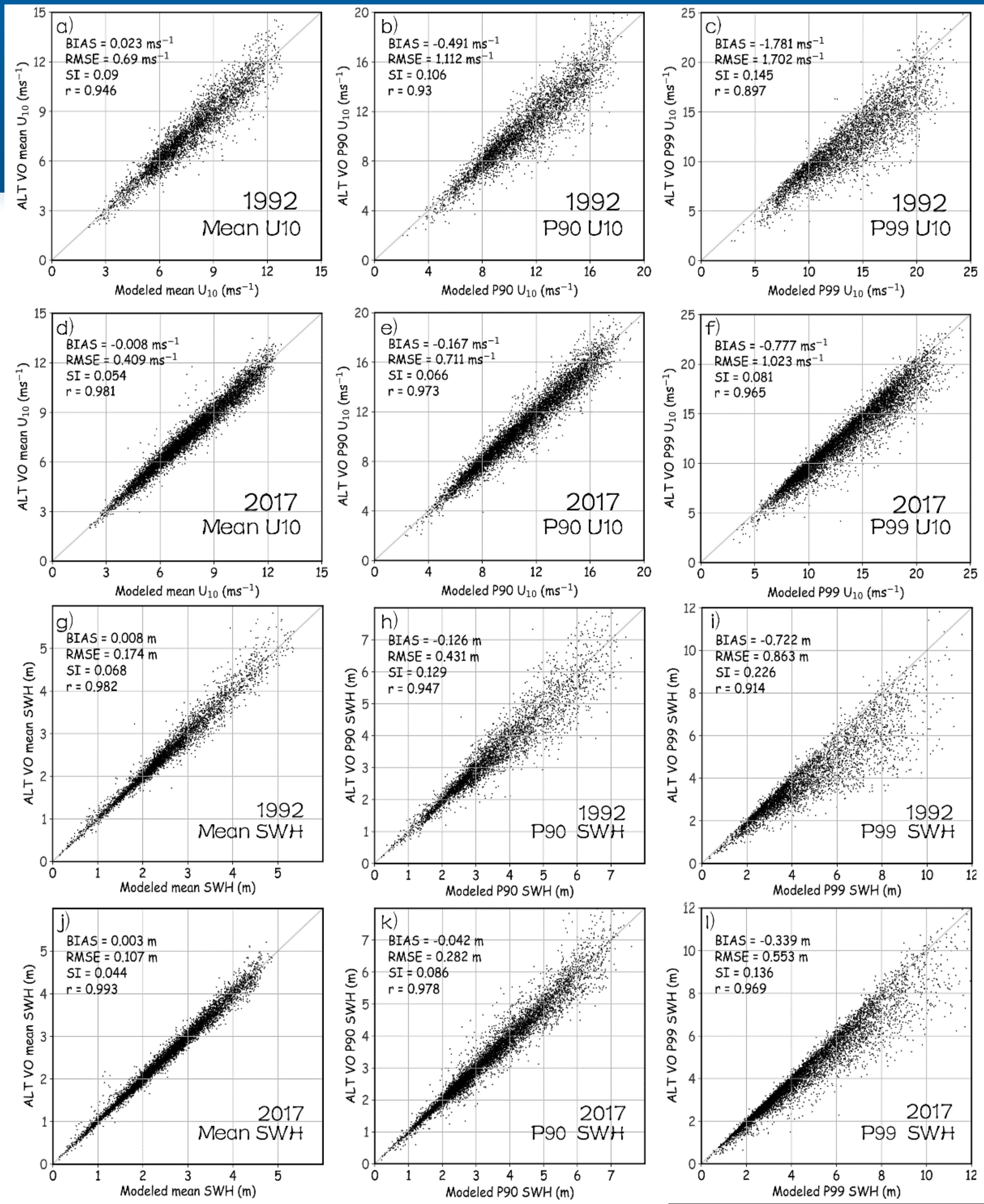
Global distributions of the numbers of hourly altimeter observations in 2by2 deg grid for the period 1985-2018.



Number of observations per month (solid lines) and per year (dash lines) at different locations

Monthly Statistics

- Monthly mean VO is OK
- 90th/99th percentiles of both wind and wave VO are significantly underestimated.
- More underestimated in 1992 (less data) than in 2017 (more data).



Comparison between monthly U10 (a-f) and SWH (g-l) statistics from ERA5 and VO in a 2° ×2° grid for Jan 1992 (a-c and g-i) and Jan 2017 (d-f and j-l). The left, middle, and right columns correspond to the comparisons of means, 90th percentiles, and 99th percentiles, respectively.

Long-term trends

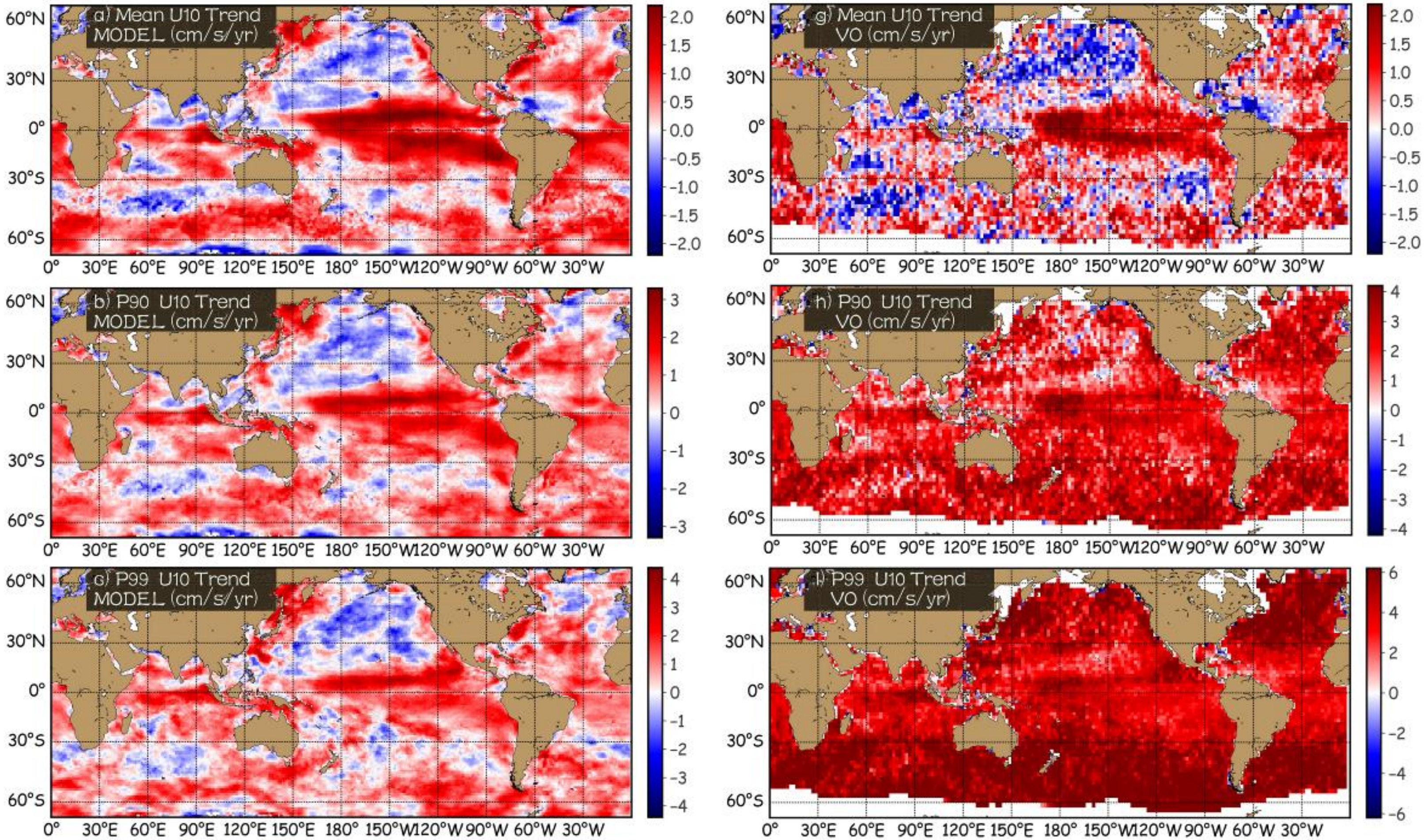
Left:
ERA5 33 year trends of U10 from monthly statistics

Right:
corresponding VO trends

1st row:
mean U10

2nd row:
90th U10

3rd row:
99th U10



REFERENCE

VO results

Long-term trends

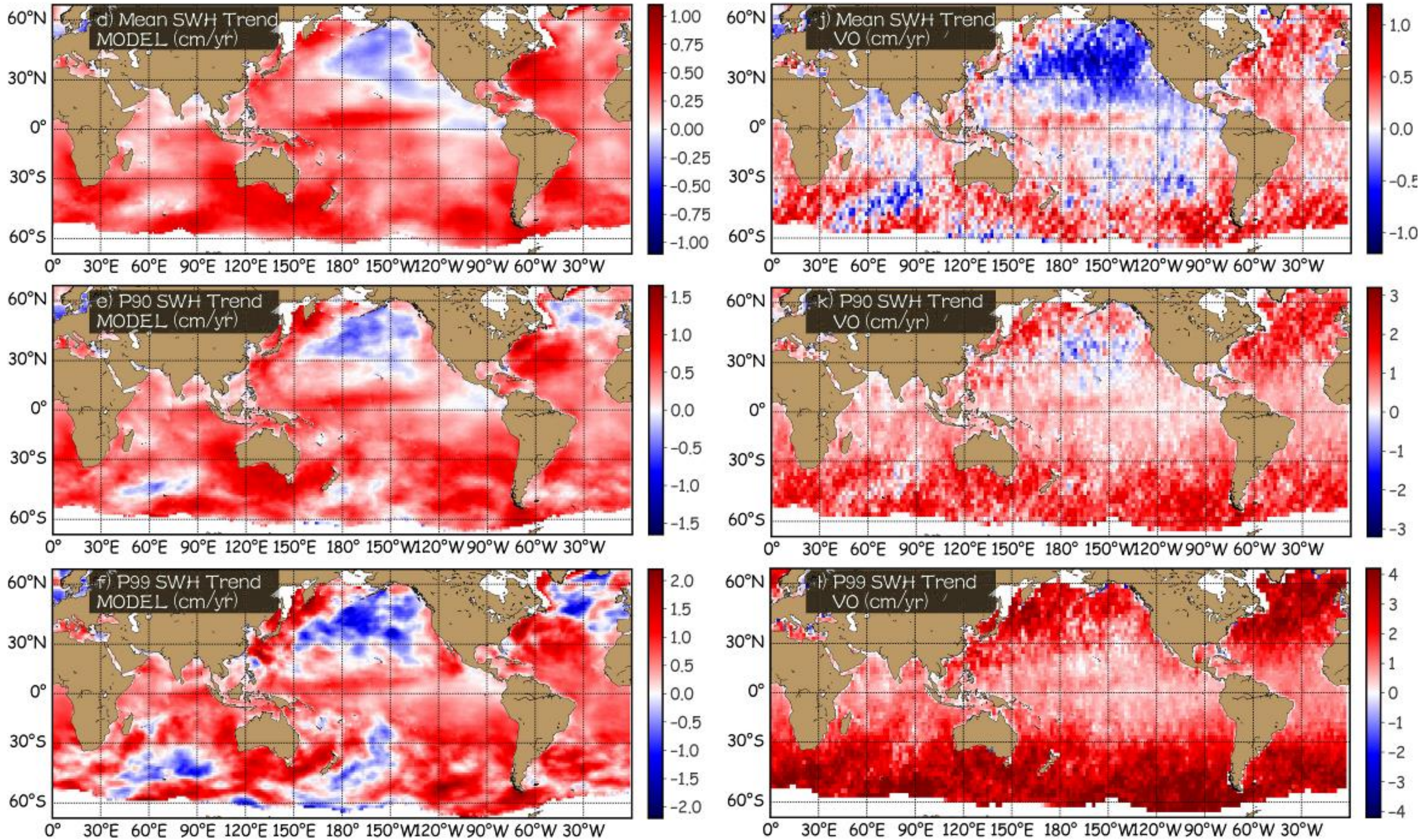
Left:
ERA5 33 year trends of SWH from monthly statistics

Right:
corresponding VO trends

1st row:
mean SWH

2nd row:
90th SWH

3rd row:
99th SWH

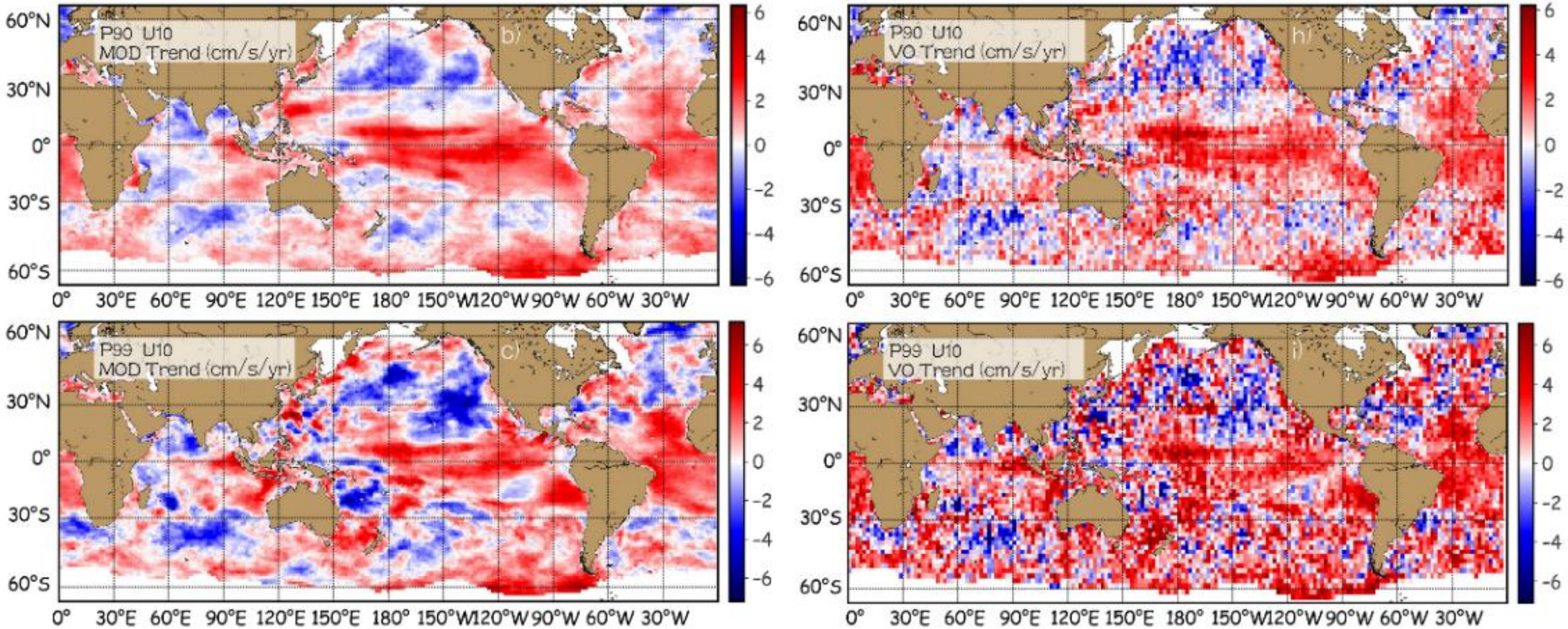


REFERENCE

VO results

Long-term trends

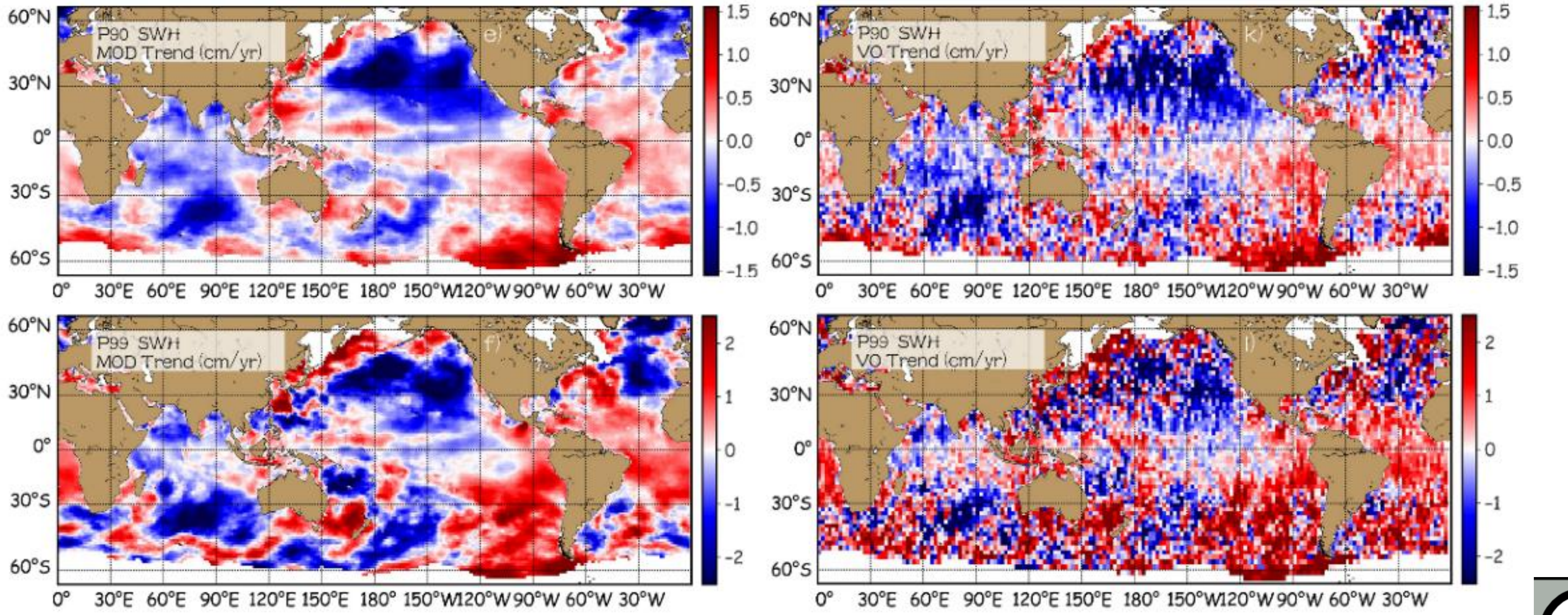
- Trends of monthly 90th/99th percentiles from altimeters might be unreliable! As the underestimation is reduced with increase of satellite.
- Those from annual 90th/99th percentiles are better
- But trend overestimation still exists



REFERENCE VO results

Long-term trends

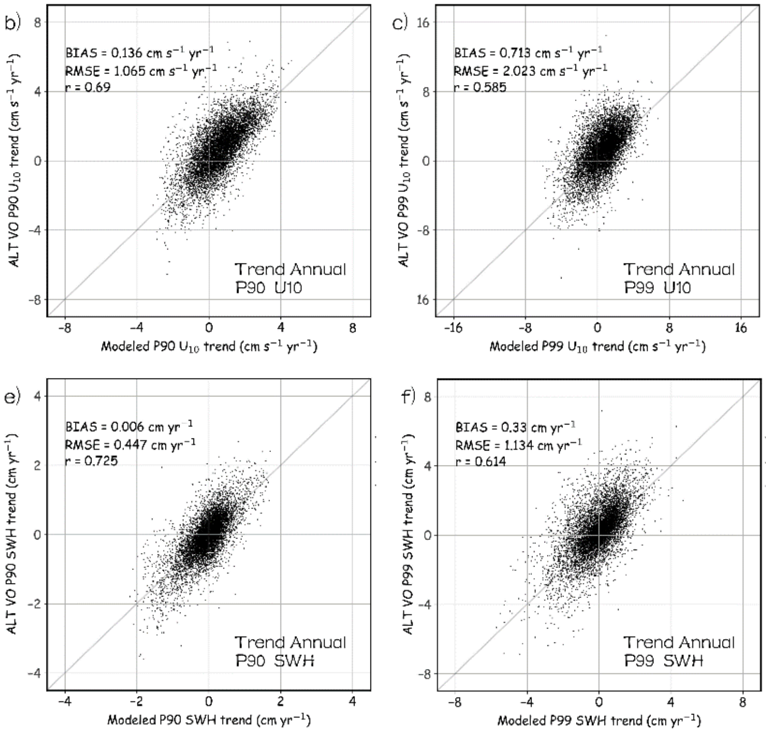
- Trends of monthly 90th/99th percentiles from altimeters might be unreliable! As the underestimation is reduced with increase of satellite.
- Those from annual 90th/99th percentiles are better
- But trend overestimation still exists

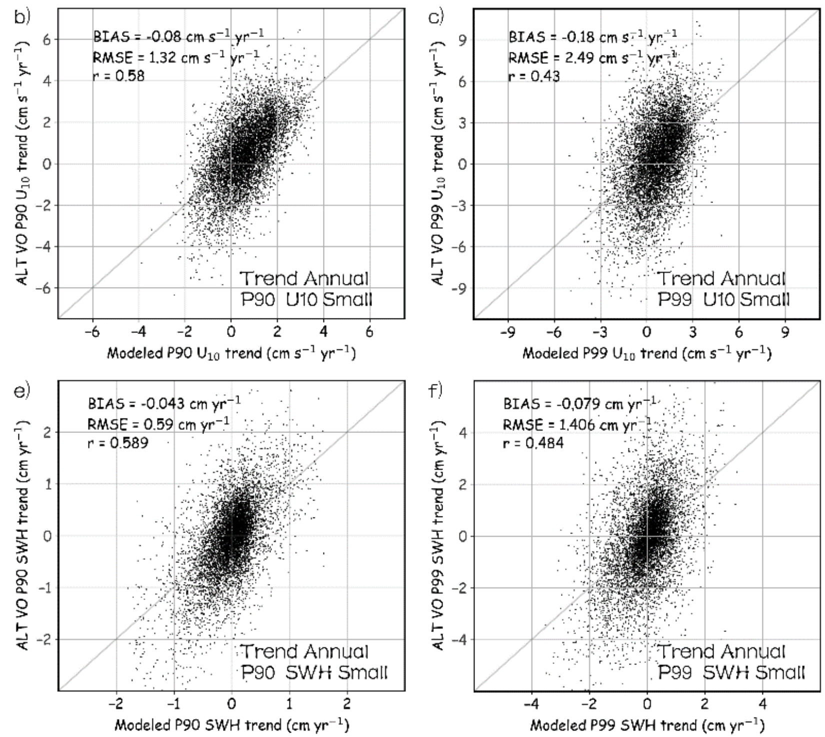


REFERENCE VO results

How to solve?

- Reducing the sample size: Randomly remove some data to make the sample size stable with time.

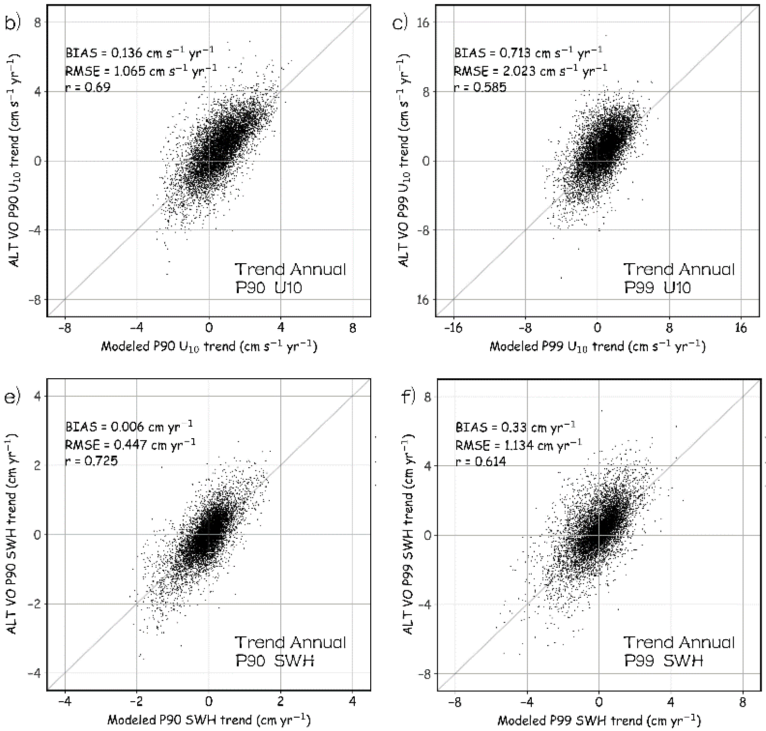


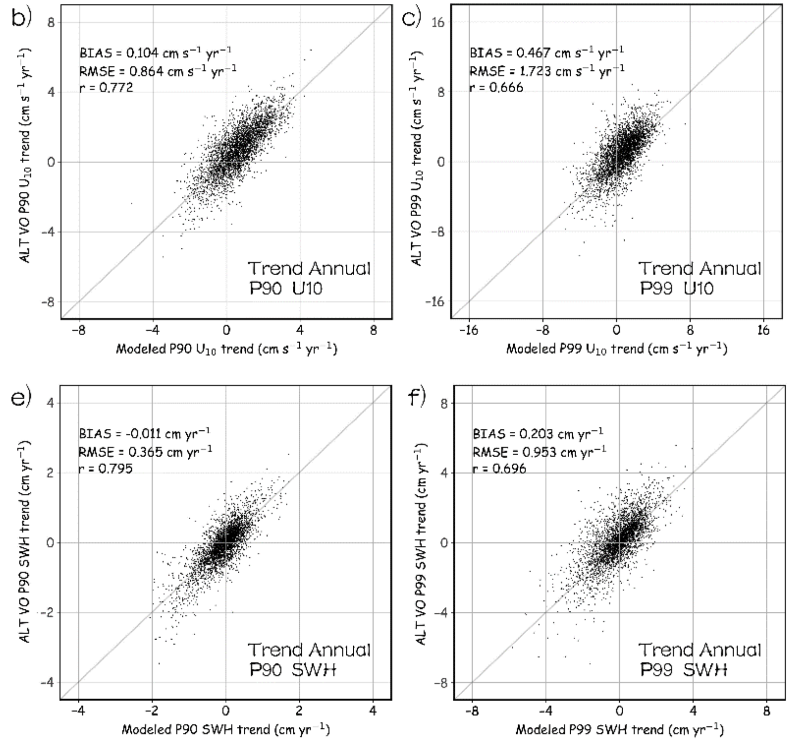


- Not very effective

How to solve?

➢ Reducing the spatial resolution: Use 3deg by 3deg grid so that the number of observations in each grid point increases.





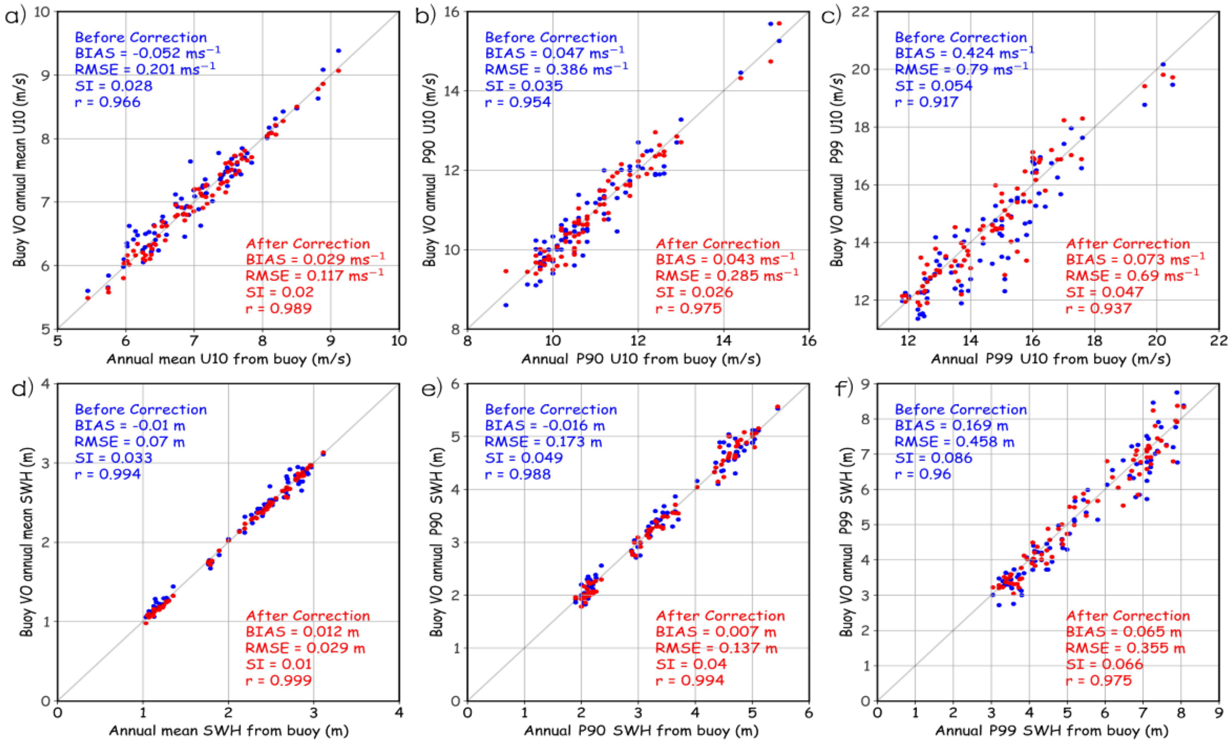
➢ Small improvement, but hard to say if the result is better.

How to solve?

- Use the difference between hindcast and its VO to compensate real observation.

$$A_{real} - A_{obs} \approx A_{mod} - A_{VO}$$

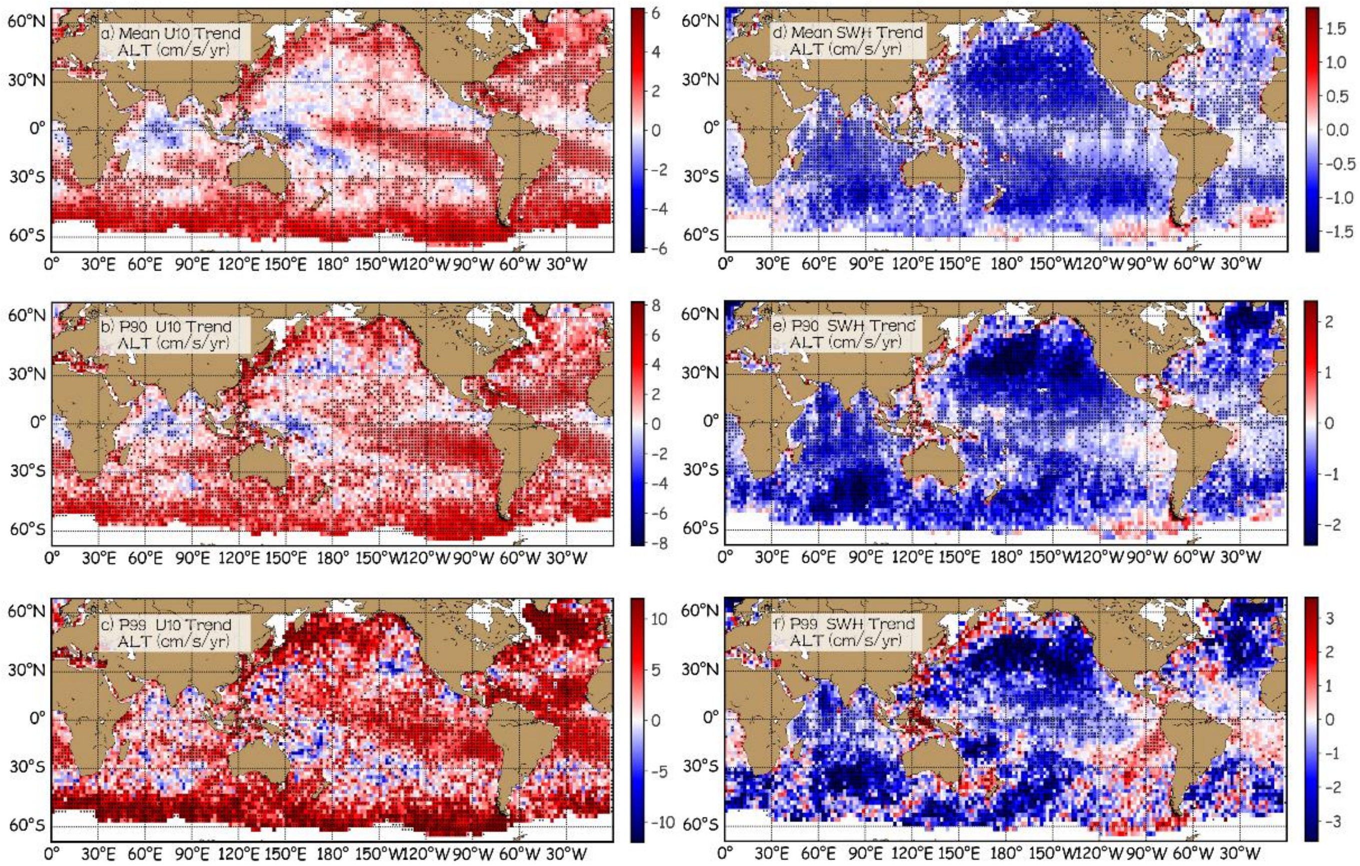
- A_{real}: "Real" annual statistics
- A_{obs}, A_{mod}, A_{VO} : Annual statistics from altimeter observations, models, and altimeter VO.



- Buoy results indicate that this method seems to be effective

Long-term trends from altimeters

- After model-based correction, altimeters show global wind speed and wave height trends (1992-2017) to be opposite.
- Uncertainty still exists in the results and the reason for this discrepancy is unknown at this stage.



Global trends of U10 (left) and SWH (right) statistics from altimeter observations after model-based correction over the period 1992-2017.