Evaluation of Surface fluxes and SST in the CORe data set

Caihong Wen

Surface winds and turbulent fluxes

Data:

- NCEP Reanalyses

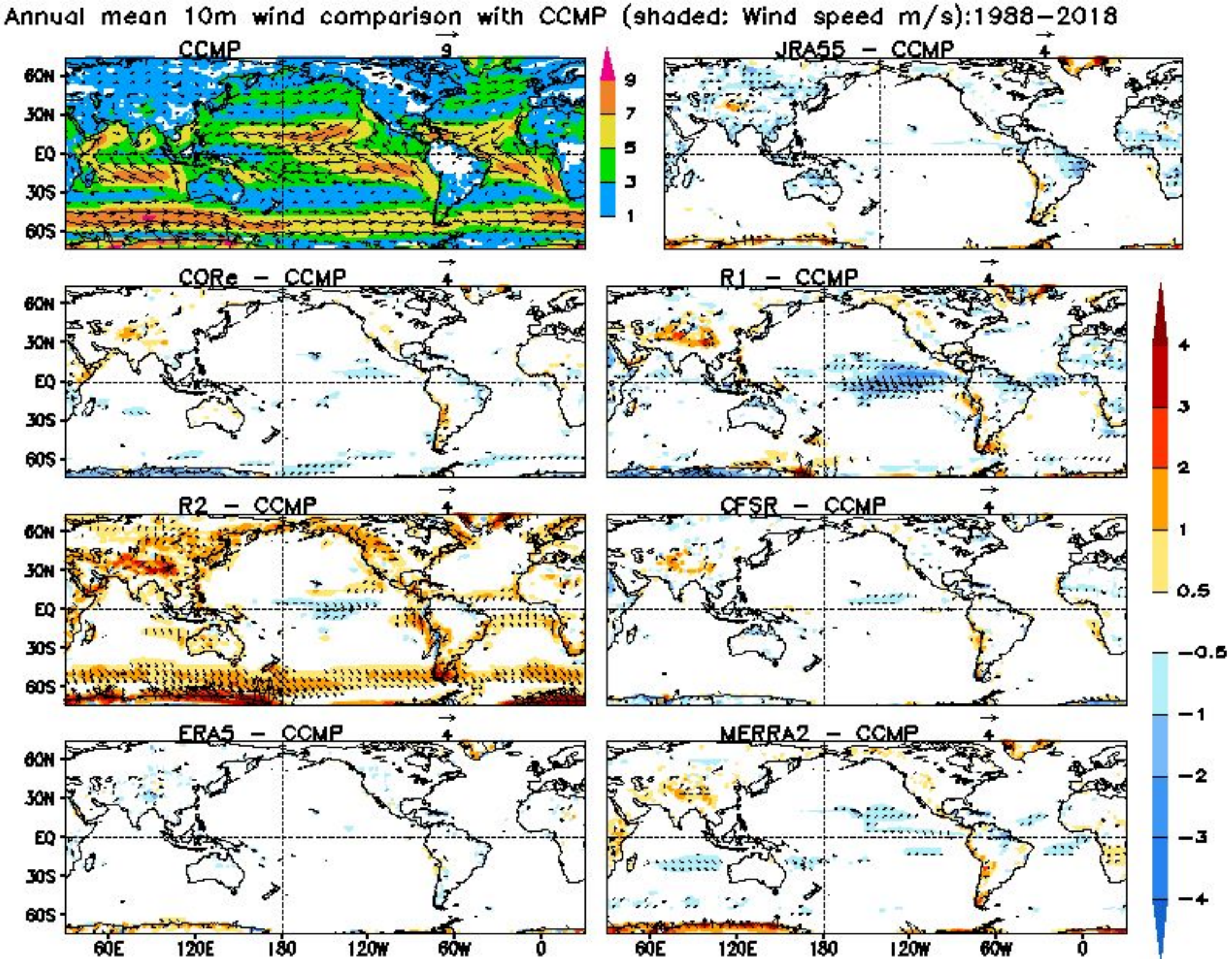
  CORe, R1, R2 and CFSR
- External Reanalyses

  ERA5,MERRA2, JRA55
- **Satellite related observation (Benchmarks)**

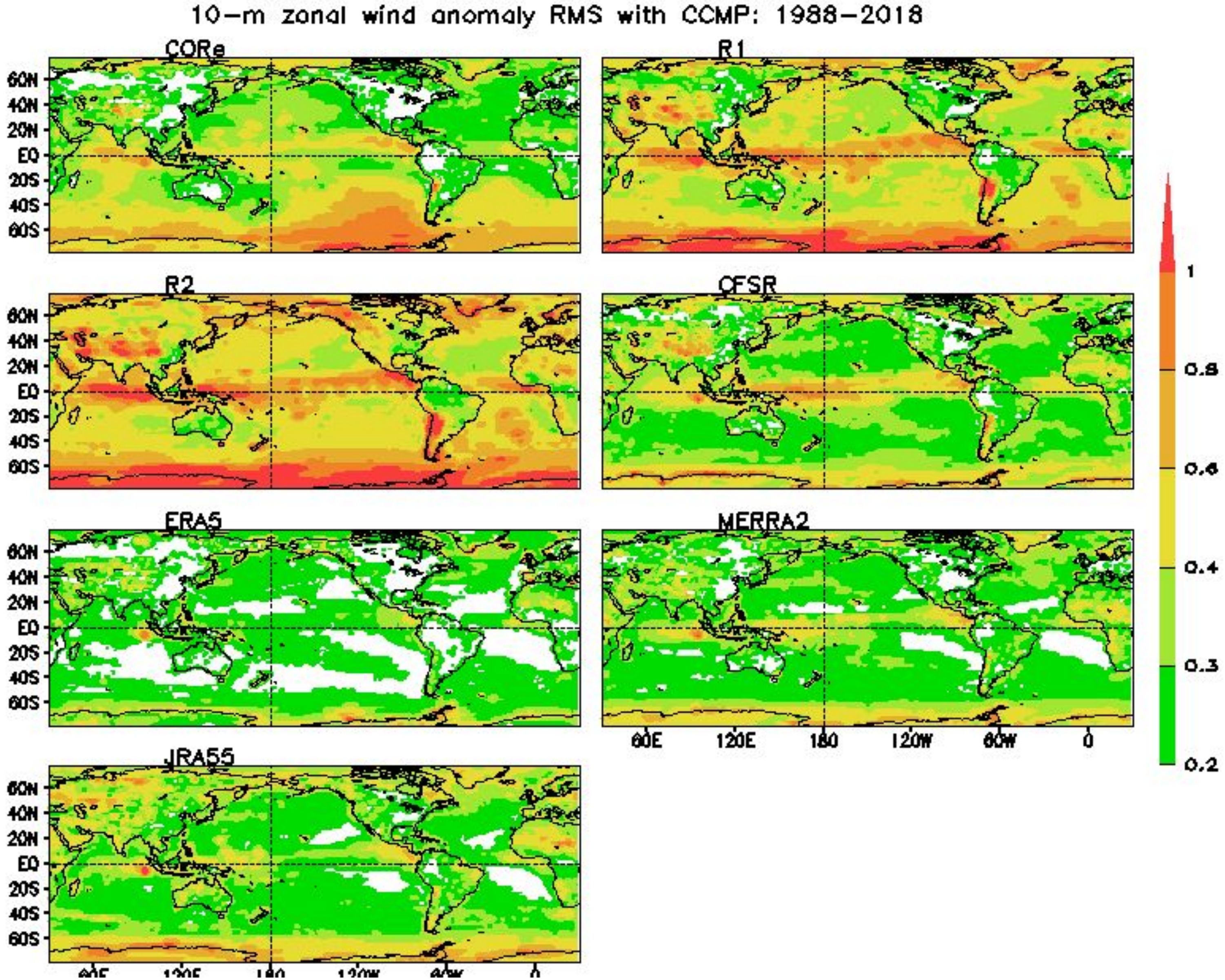
  10m winds: Cross-Calibrated Multi-Platform (CCMP v2.0) gridded surface vector winds from 1988-2018

  Wind stress climatology : Scatterometer climatology of Ocean Winds (SCOW) based on Sep 1999-Oct 2009 of QuikSCAT scatterometer data

For validation, climatology periods of reanalyses are defined as the common period of corresponding observations.



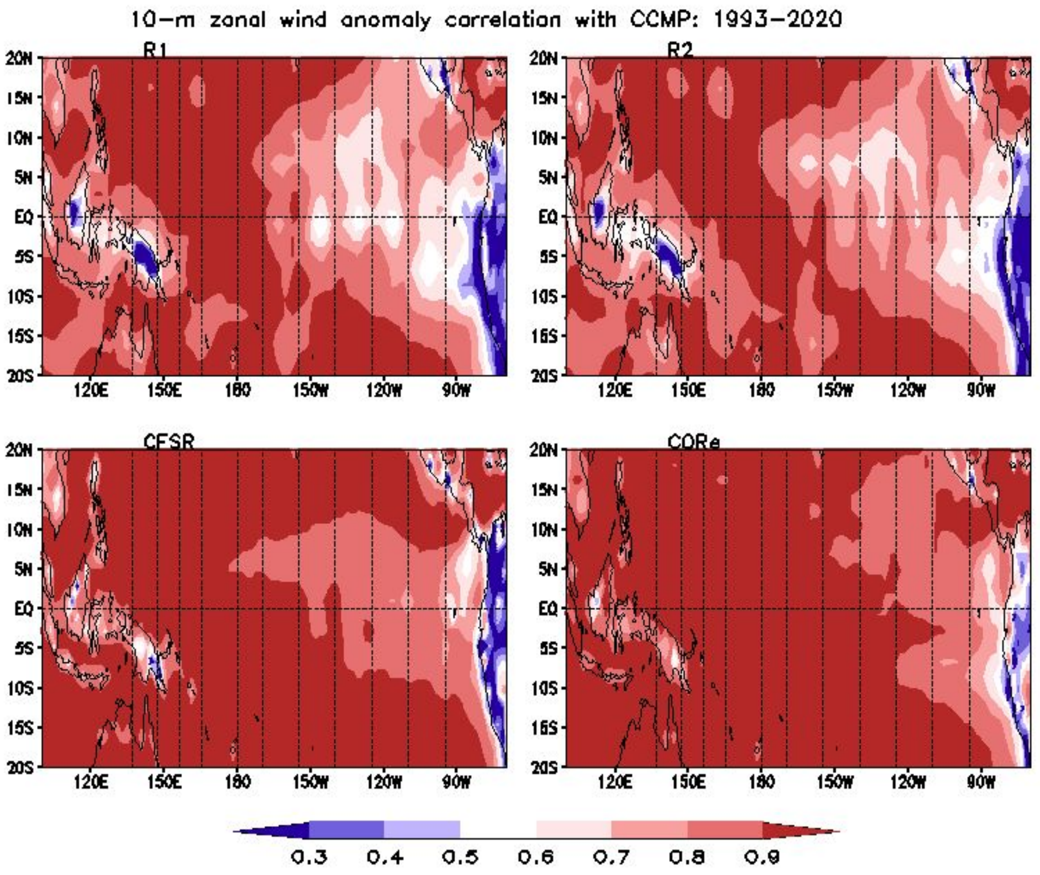
- Easterly trade winds from R1 are much weaker than CCMP over the eastern tropical Pacific.
- R2 winds are slightly underestimated over the eastern equatorial Pacific, while overestimated near Antarctic Circumpolar current and much of Eurasia.
- CORe is significantly improved compared with R1 over the eastern tropical Pacific and Atlantic Oceans.
- ERA5 has smallest bias to CCMP. ERA-Interim model wind fields were used to derive CCMP. This might be one of the contributors.

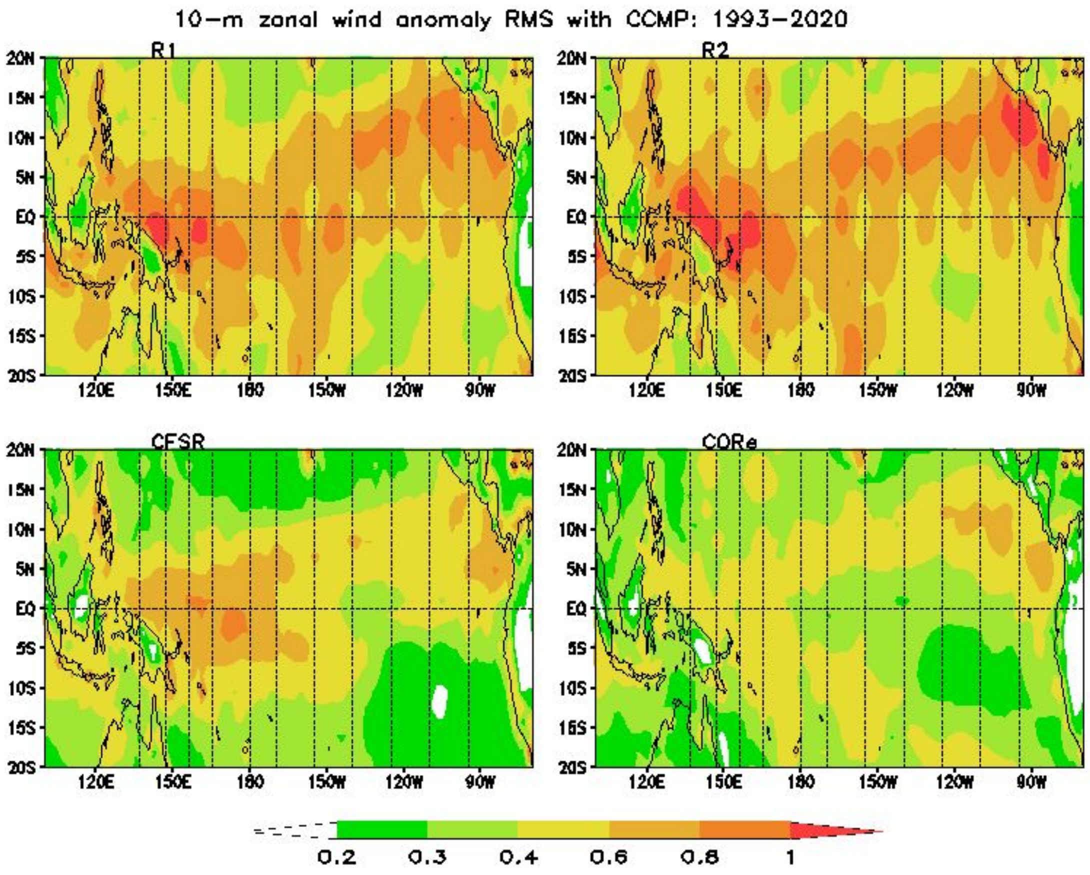


Reanalysis climatology: 1991-2020
CCMP climatology:1991-2018
Analysis period: 1988-2018

- Both R1 and R2 has large RMS near ITCZ region.
- Both R1 and R2 RMS spatial distributions display meso-scale pattern in the tropical Pacific ocean.
- CORe has the smallest RMS in the tropical oceans among NCEP reanalysis products.
- Large RMS of CORe is found in the high-latitude of southern hemisphere.

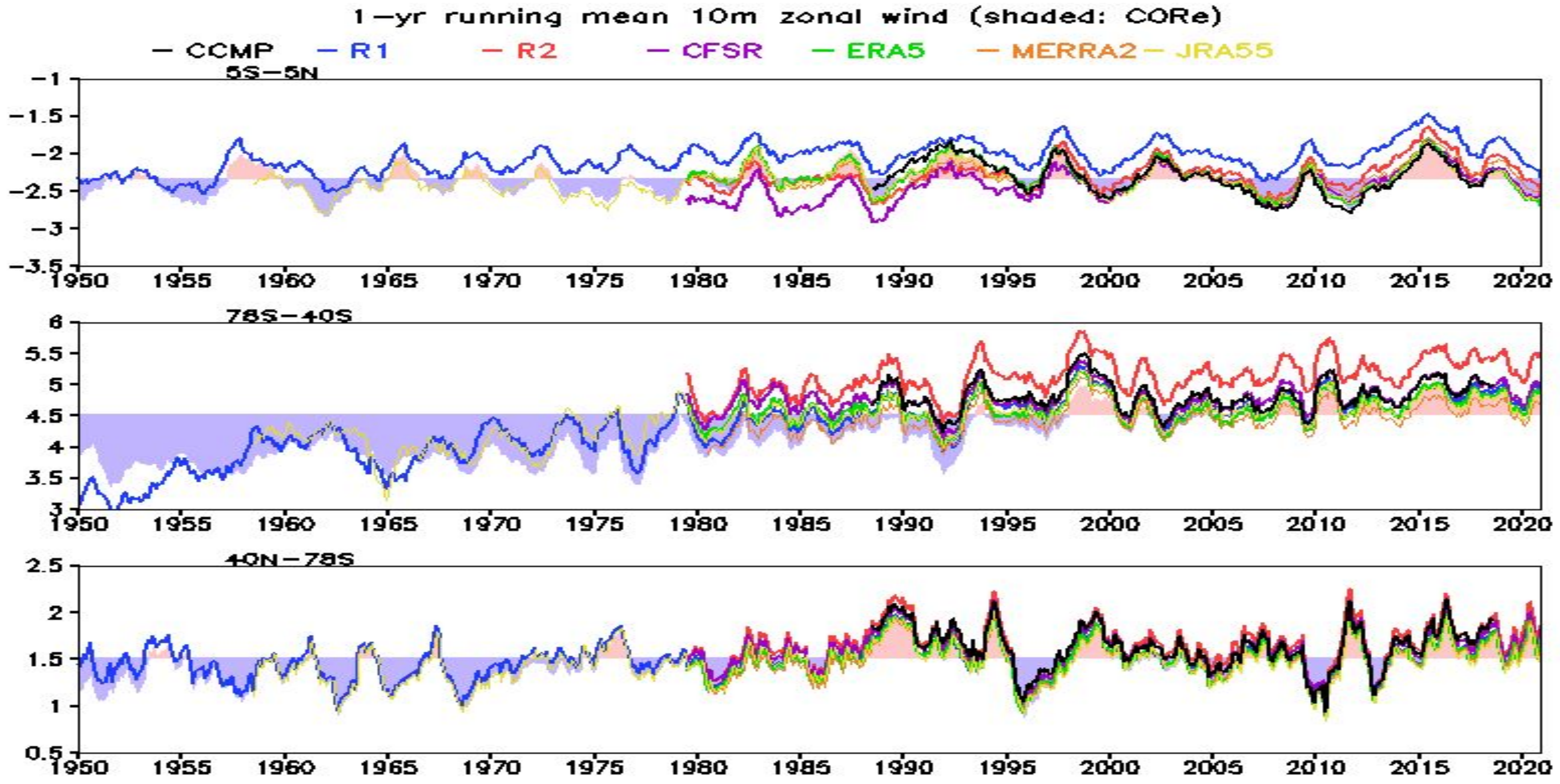
Impact of TAO mooring data on surface winds



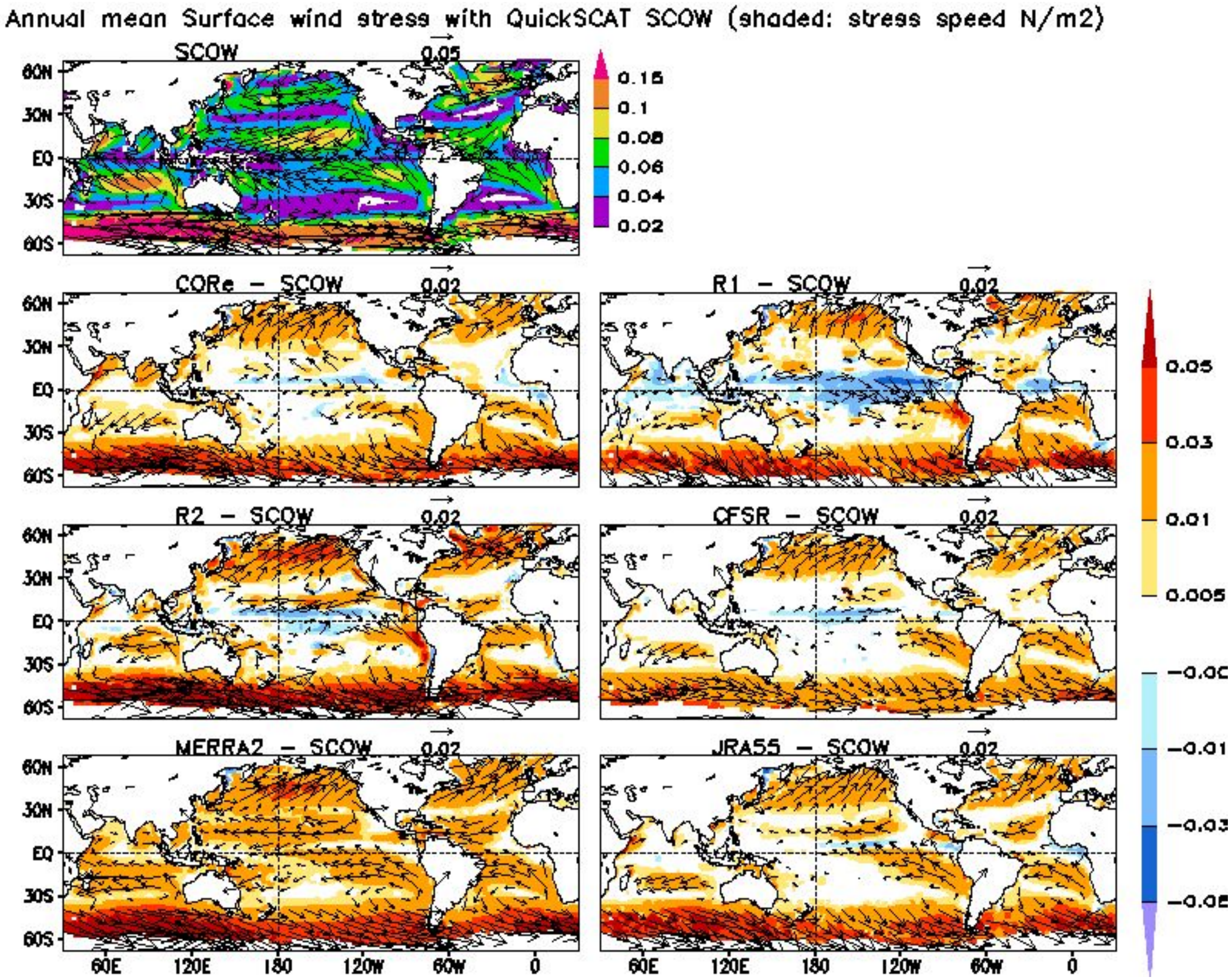


Dash lines : location of TAO mooring sites

- The “bull-eyes” features in R1 and R2 is more clearer during the period when TAO was fully implemented.
- Locations where R1 and R2 has higher correlation/smaller RMS with CCMP coincide with TAO mooring site. It indicates the performance of two reanalyses are strongly dependent on the in situ observation constraint.
- There is no discernible impact of TAO data on CORe. It suggests the model performance or/and data assimilation technique in CORe is much better than R1 and R2.

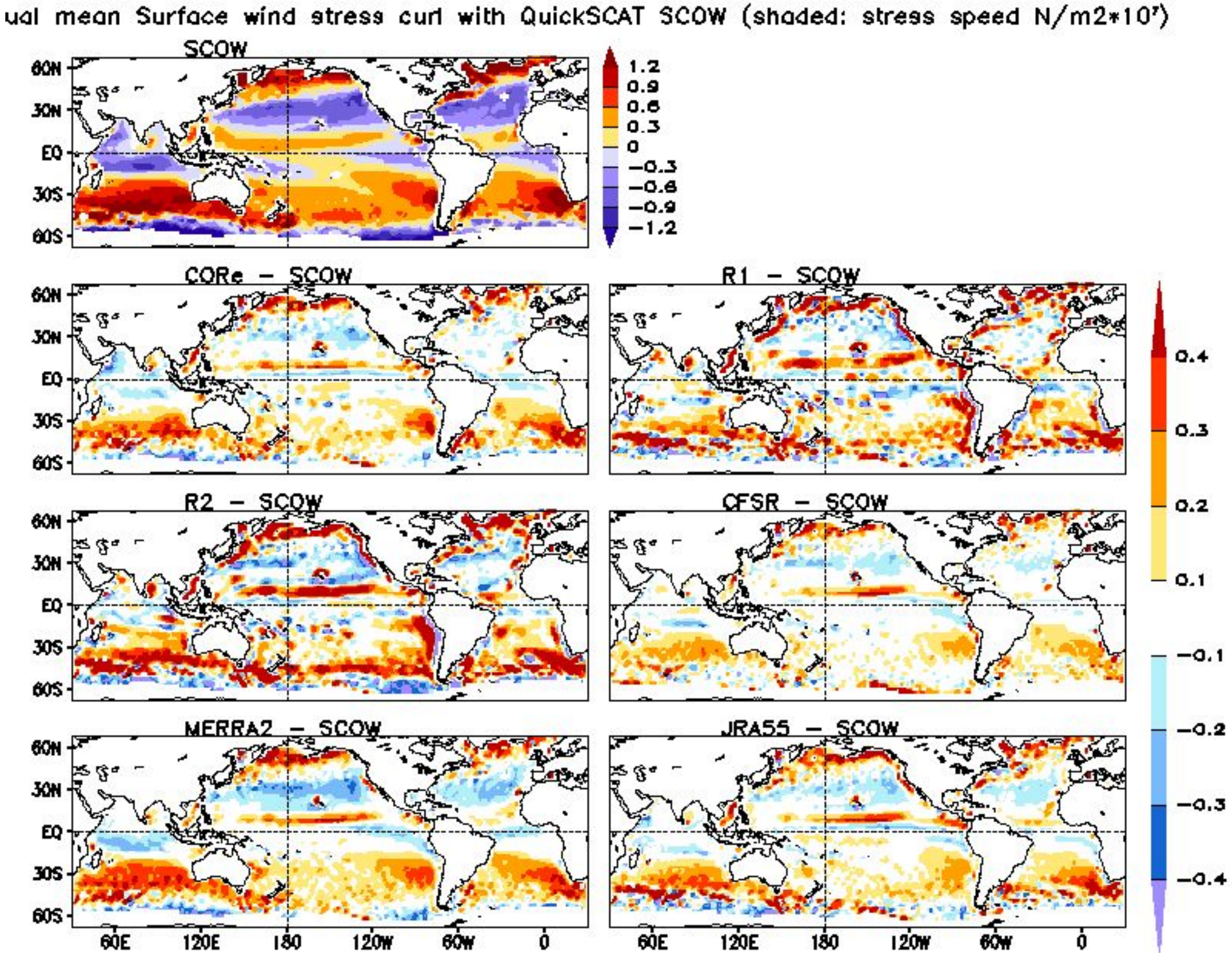


- In the equator band (upper panel), CORe zonal wind average (shaded) agrees well with CCMP during 1988-2018. CFSR was stronger than CCMP and other reanalysis products prior 2000. R1 is weaker than CORe since 1950.
- In the southern hemisphere (middle panel), COre is slightly weaker than CCMP. R1 and COREs are very close with each other.
- Reanalysis products are quite consistent with each other in the northern hemisphere (bottom panel).



- CORe and CFSR has smallest wind stress bias with SCOW over the tropical oceans.

- All reanalyses overestimate westerly winds in the southern hemisphere.



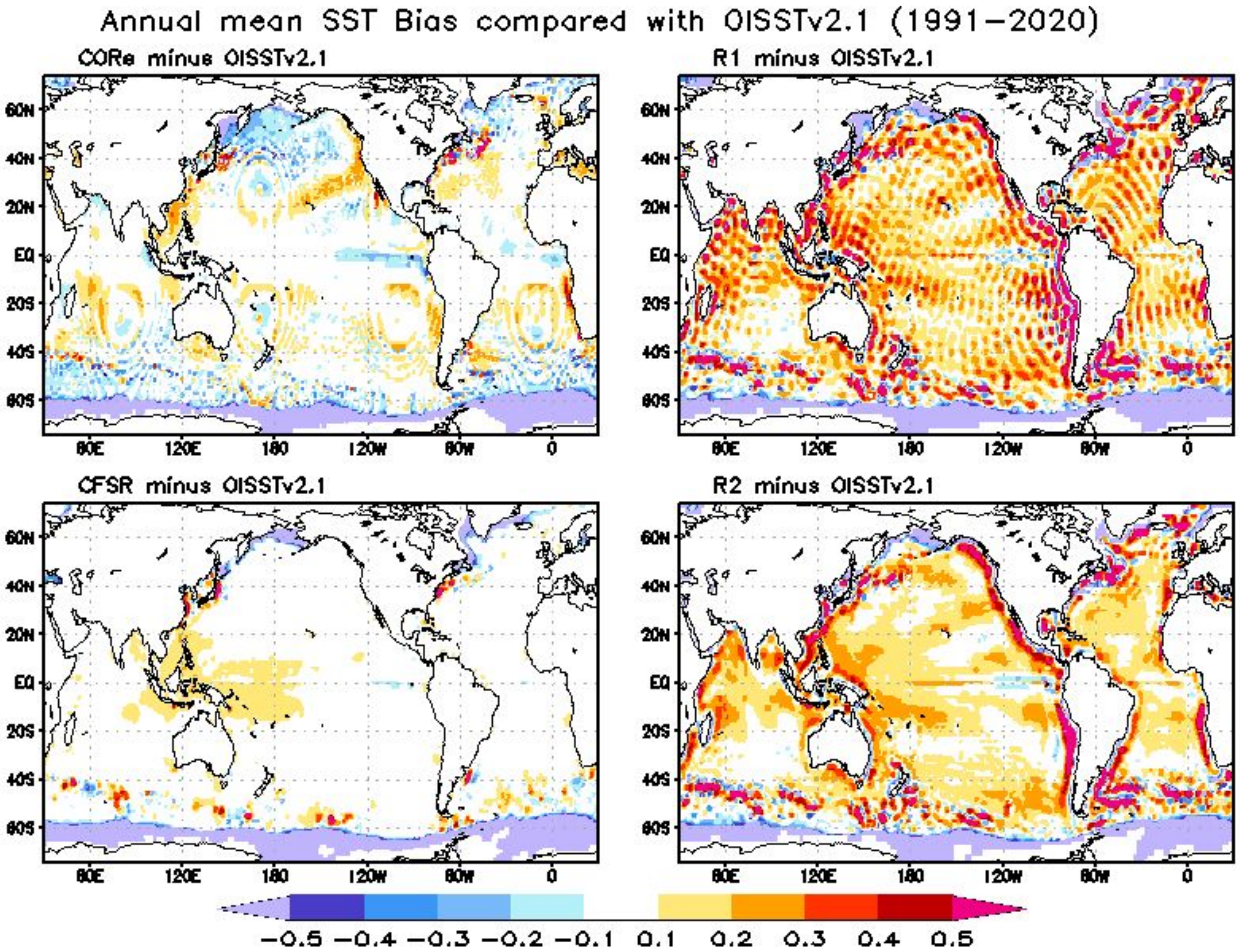
- Surface wind stress curl (or the spin of wind stress) plays a crucial role in determining ocean circulation via Ekman pumping/suction.
- Compared with other reanalyses, CORe and CFSR have the smallest annual mean bias between 45S-45N.

SST Comparison

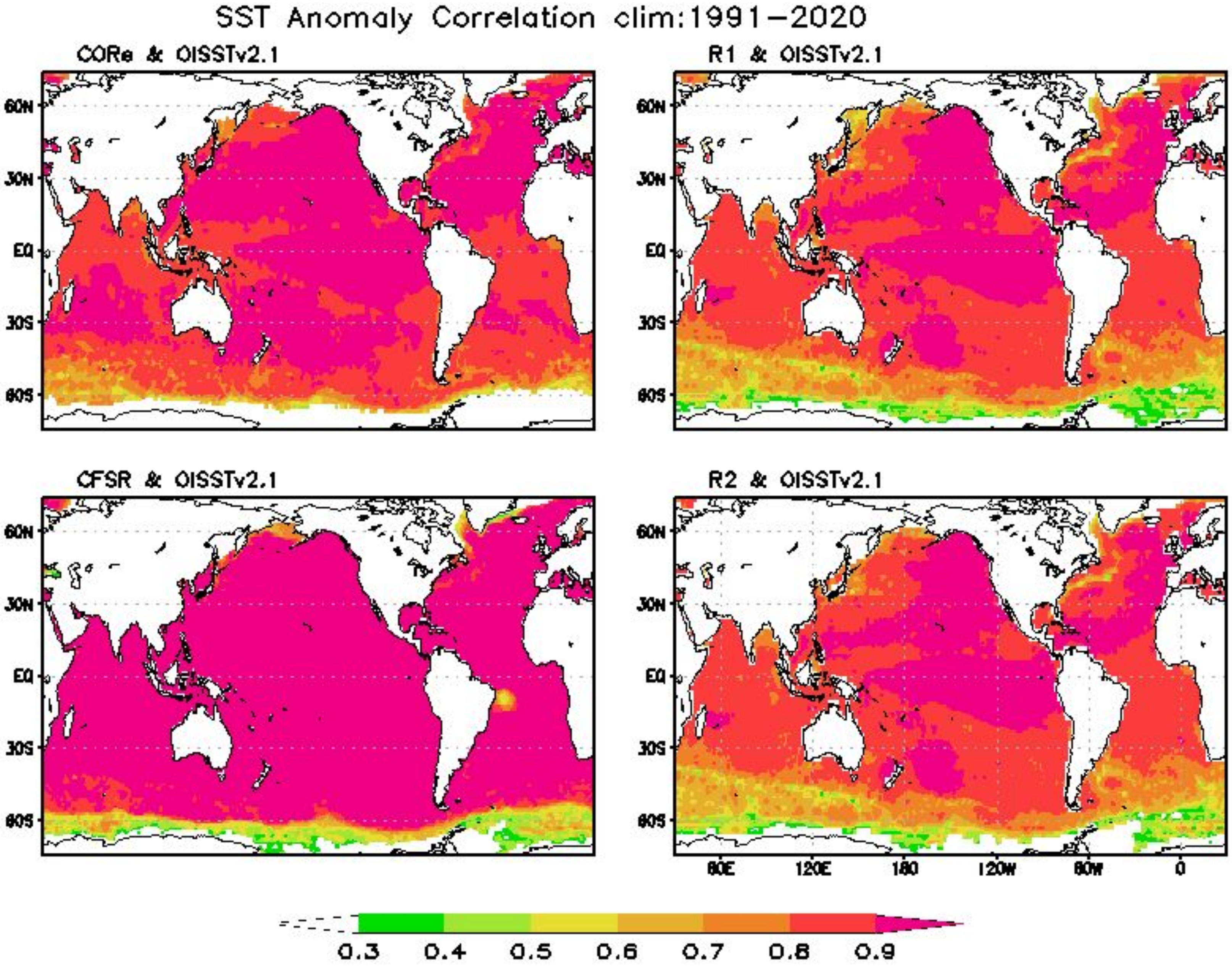
- Data sets
- NCEP reanalyses: CORe, R1, R2, CFSR
- SST analysis products (benchmarks)

  OISSTv2.1 1982-2020

  ERSST :1950-2020

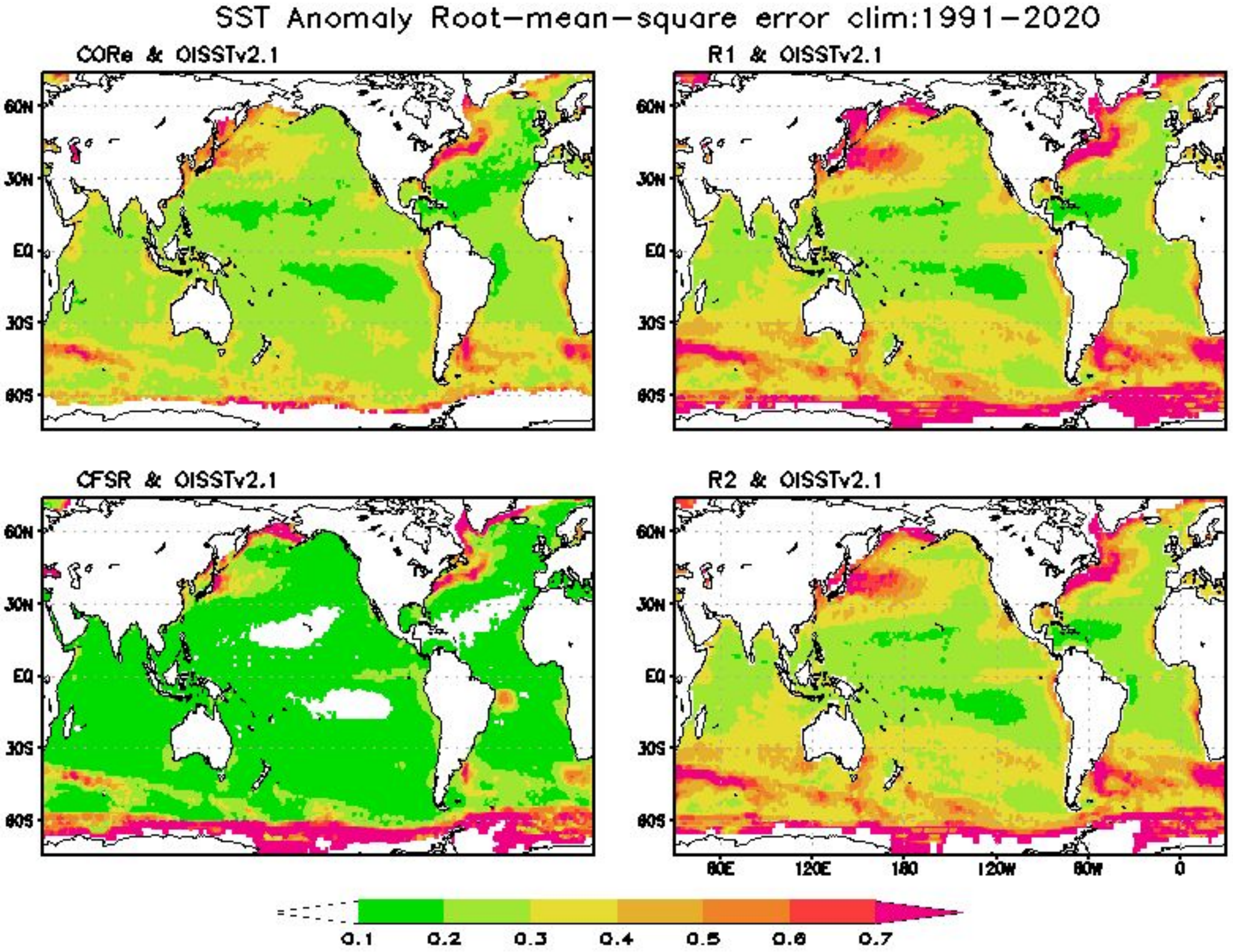


- Both R1 and R2 annual mean SST are warmer than OISSTv2.1 in most of regions.
- R1 Bias spatial distribution displays interesting web-like features, which was not observed in R2.
- Overall, COREs annual mean biases are reduced substantially compared with those in R1 and R2. However, disk-shaped RMS are found in the northern Pacific and southern extratropical oceans.
- CFSR bias is very small in most of areas because CFSR is strongly nudged to OISST v2 prior Feb 2020.



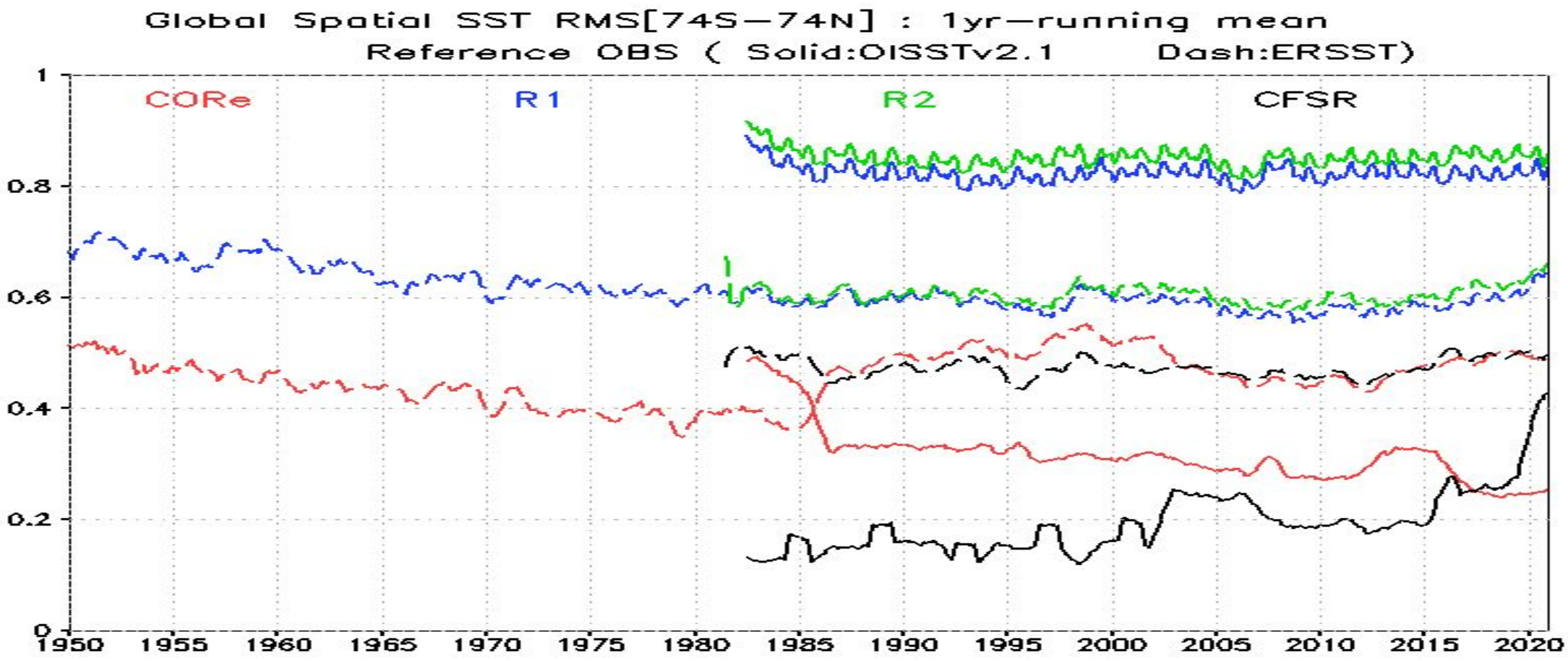
Analysis period: 1982-2020

- CORe has very high correlation with OISSTv2.1 (>0.9) in much of the Pacific Ocean, Northern Atlantic Ocean, and southern tropical Indian ocean.
- CORe has better correlation skill than R1 and R2 near the western boundary currents and mid-to-high latitudes of southern hemisphere.



Analysis period: 1982-2020

CORe has smaller RMS than R1 and R2 near the western boundary currents and mid-to-high latitudes of southern hemisphere.

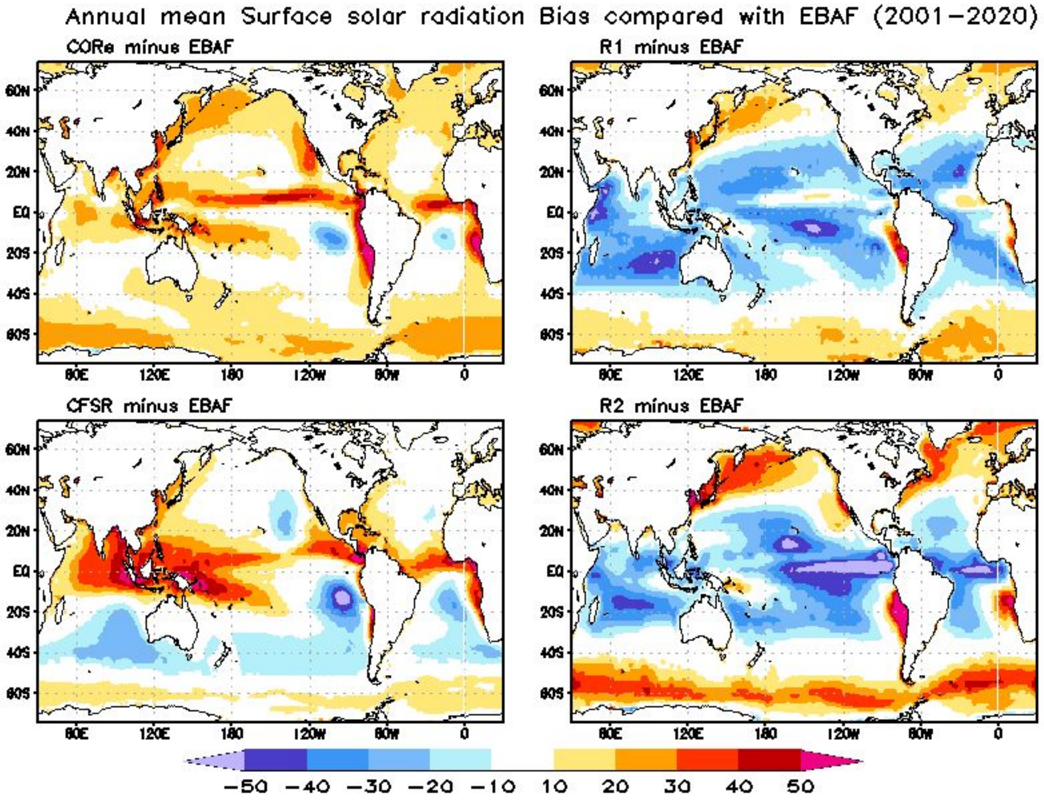


- Compared with OISSTv2.1, global SST RMS of R2(solid green line) and R1 (solid blue) is about 0.9C and are relatively stable during 1982-2020. RMS of CORe (solid red line) is reduced by more than 50% (~0.4C) in after 1985. RMS of CORe is smaller than CFSR in 2020.
- Compared with ERSSTv5, CORe (dash red line) has smaller RMS than R1 (dash green line) in all the years back to 1950.

Surface heat flux validation

Data sets:

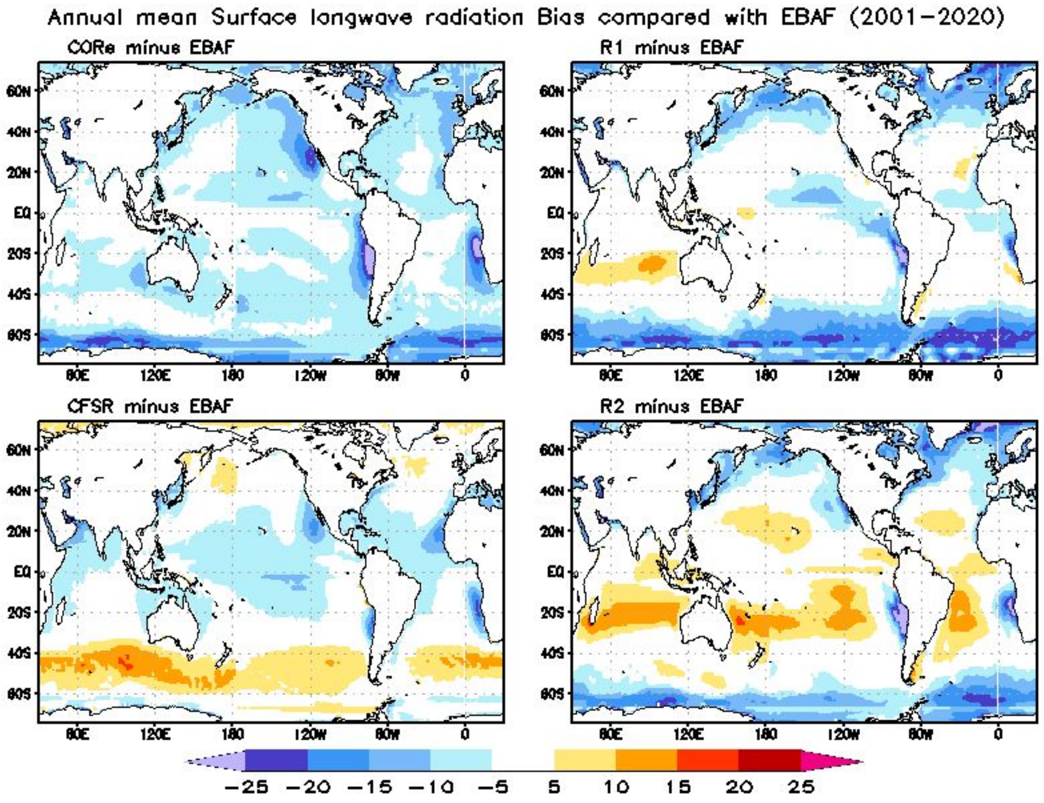
- NCEP reanalyses: CORe, R1, R2, CFSR
- CERES-Energy Balanced and Filled (EBAF): solar radiation and longwave radiation
- Objective and analyzed air-sea fluxes for the global oceans (OAFLUX): Sensible heat flux and latent heat flux



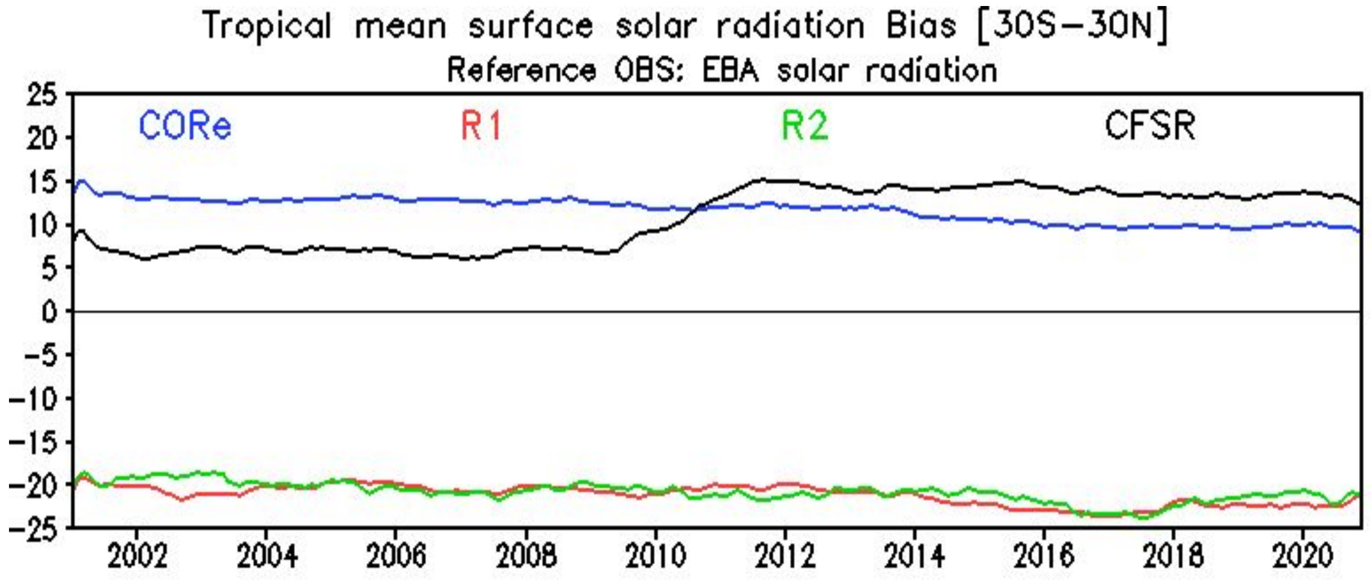
Positive value: incoming flux into the ocean

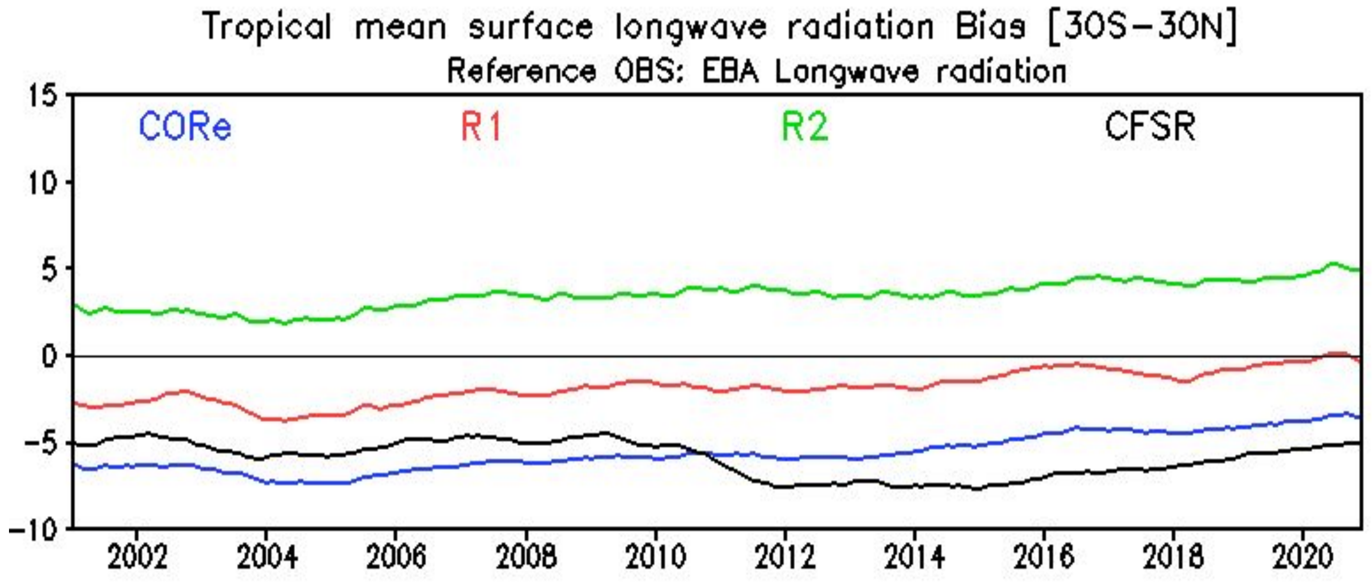
- Both R1 and R2 underestimate solar radiation fluxes input into the ocean in the tropical Oceans.
- CFSR produce excessive solar radiation over much of the tropical oceans except for the southeastern Pacific.
- Compared with CFSR, excessive solar radiation flux in the Indo-Pacific region are improved in CORe.

- Except for R2, CORe, R1 and CFSR overestimate longwave radiation into the atmosphere in the tropical oceans.
- Large longwave radiation bias(>20w/m2) are found near the coasts of north America and southern America and the west coast of southern Africa.

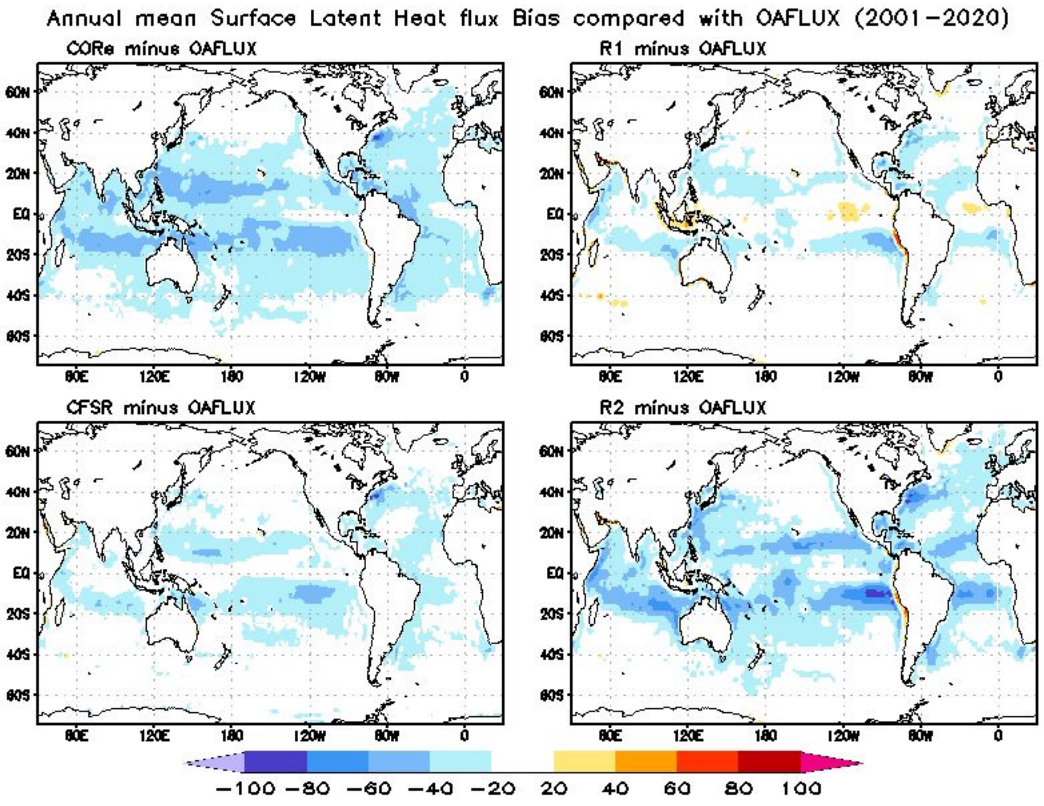


Positive value: incoming flux into the ocean





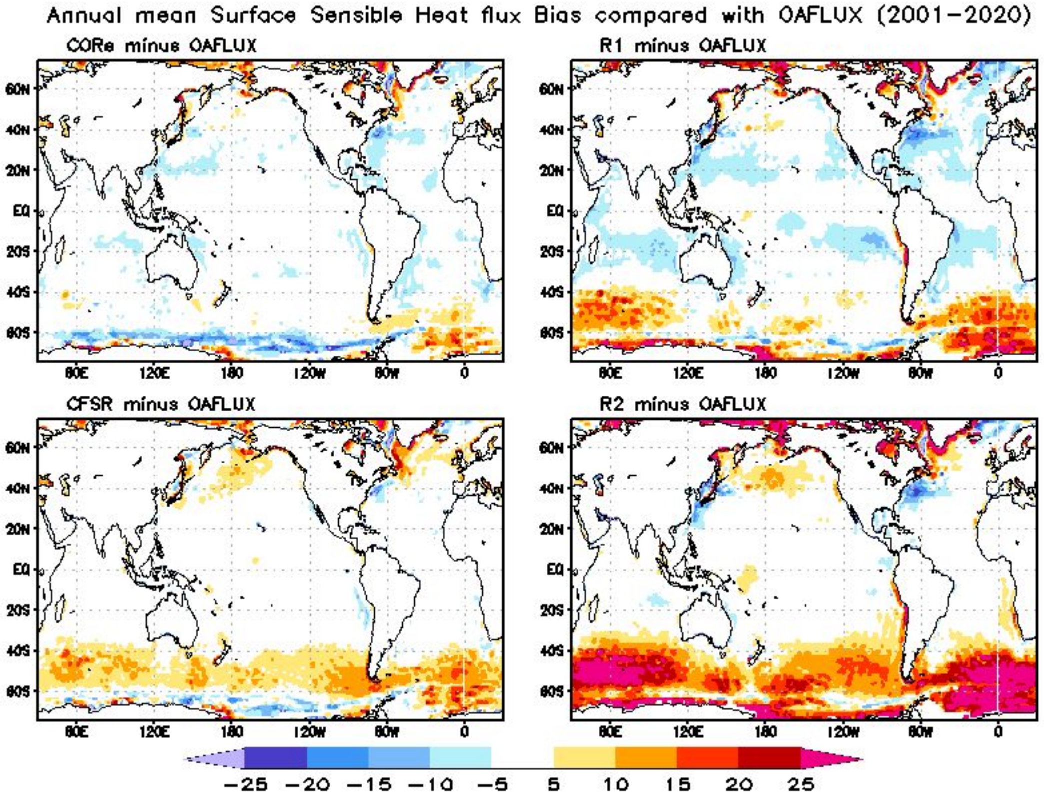
- Both SW and LW flux bias in CORe (blue lines) display decreasing trend during 2001-2020 period.
- Compared to R1, CORe gets improved SW over the tropical oceans, but LW bias is greater than in R1.
- There was systematic shift of SW and LW in CFSR around 2011.



Positive value: incoming flux into the ocean

- R1 and CFSR annual mean latent heat flux are closer to OAFLUX.

- CORe annual mean sensible heat flux resembles OAFLIX in most of areas.



Positive value: incoming flux into the ocean