The Global Ocean Water Cycle in Atmospheric Reanalysis, Satellite, and Ocean Salinity

Problem: The ocean-surface freshwater budget estimated from the present satellite and atmospheric reanalyses is known to have large uncertainty. This study explores the potential of using ocean salinity observations (Aquarius, Argo, & WOA) to assess the variability and uncertainty in 12 atmospheric reanalyses and satellite-based evaporation-minus-precipitation (E-P) products.

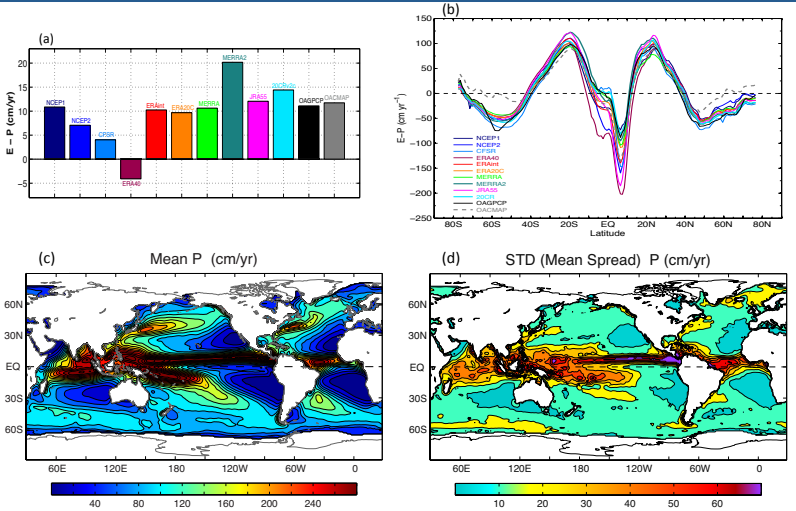

Fig.1 (a) E-P budget over the global ocean. (b) Zonally averaged E-P. (c) Ensemble mean and (d) standard deviation betwen the 12 products.

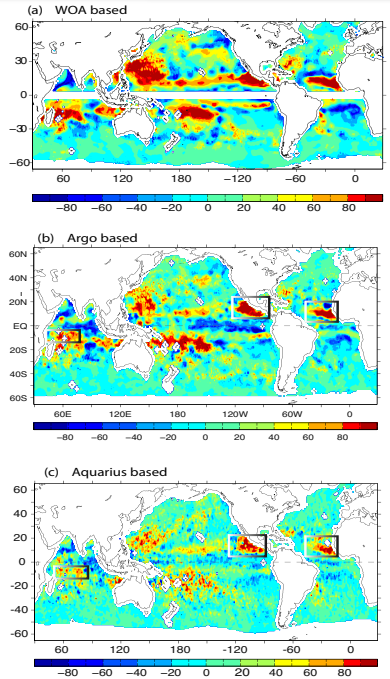

Fig.2 The percentage of seasonal variances of surface salinity that can be explained by E-P from OAFlux-GPCP based on (a) WOA, (b), Argo, and (c) Aquarius SSS. The three boxed areas are used inFig.3.

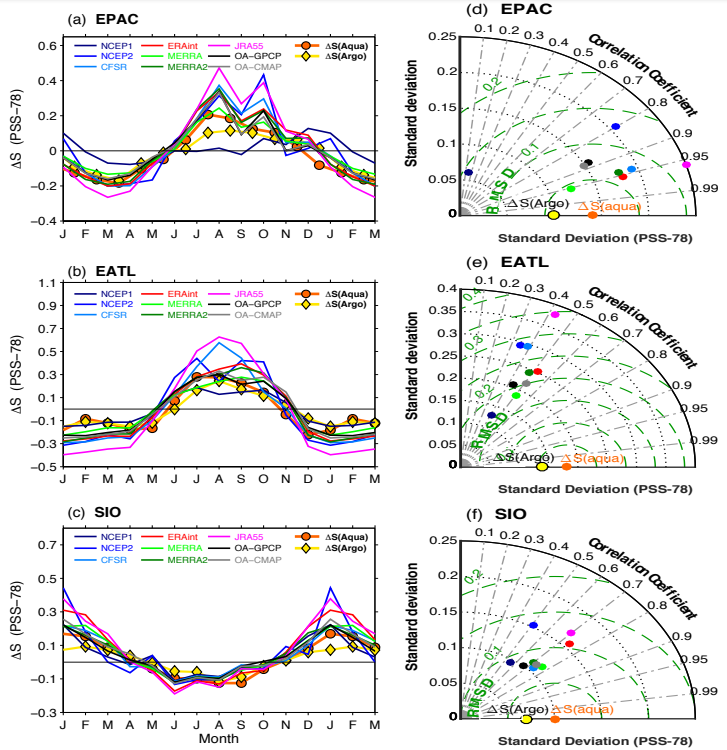

Fig.3 a-c): Salinity-based evaluation of the *E*-*P* forced seasonal SSS variability for the three boxed areas (see Fig.2). The thick orange and yellow curves denote the seasonal SSS variability estimated from Aquarius and Argo. d-f): Taylor diagrams.

Finding: The 12 products agree on the global mean pattern but differ considerably in magnitude. The estimated global E-P budgets are 11±4 (36%) cm yr^{-1}, where the mean and error represent the ensemble mean and one standard deviation of the ensemble spread. The large uncertainty is attributed to P in the tropical wet zone associated with the ITCZ and SPCZ (Fig.1). Satellite salinity appears feasible to evaluate the fidelity of E-P variability in three tropical areas (Fig.2), where the E-P seasonal variances from JRA55 and NCEP2 are largely overestimated while those from NCEP1 are underestimated (Fig.3). The regional diagnosis is consistent with the uncertainty level of the global E-P in these products (Fig.1b), suggesting the global indication of the salinity-based evaluation.

Significance: The uncertainty is attributed primarily to the P estimates in the ITCZ/SPCZ region where the moist physics and the realism of tropical rainfall remain a key challenge for atmospheric reanalysis. The spread among E-P products in terms of implied seasonal salinity tendency exceeds the salinity observation uncertainty (including the difference between Aquarius and Argo), which gives the confidence on the potential use of ocean salinity observations as verification dataset.

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