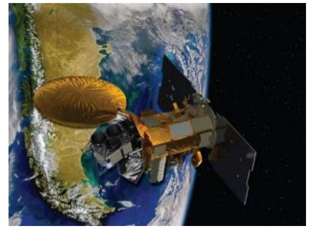


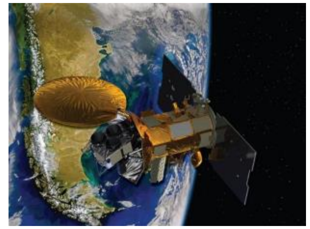
Aquarius surface salinity & Madden-Julian Oscillation: Salinity’s in surface layer density & potential energy

Bin Guan[1,2], Tong Lee[2], Daria J. Halkides[1,2], and Duane E. Waliser[2]

[1]*Joint Institute for Regional Earth System Science and Engineering*
University of California, Los Angeles, California

[2]*Jet Propulsion Laboratory*
California Institute of Technology, Pasadena, California,

Jet Propulsion Laboratory
California Institute of Technology



The Madden-Julian Oscillation (MJO)

- The largest element of tropical intraseasonal variability (~ 30–90 days).
- Involving large-scale coupling between atmospheric circulation & deep convection.
- Propagating eastward from the Indian Ocean to western Pacific.
- Alternating wet (cold) phases with enhanced (suppressed) thunderstorms and precipitation.
- Important to Asian monsoon and El Niño-Southern Oscillation.
- Evidence that ocean-atmos. coupling enhances MJO.

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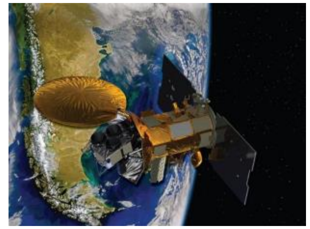

Objectives of this study

- SSS signature of MJO.
- Controlling processes.
- Salinity’s role in surface density: implication to mixed layer depth.
- Salinity’s role in surface potential energy: implication to downward energy propagation.

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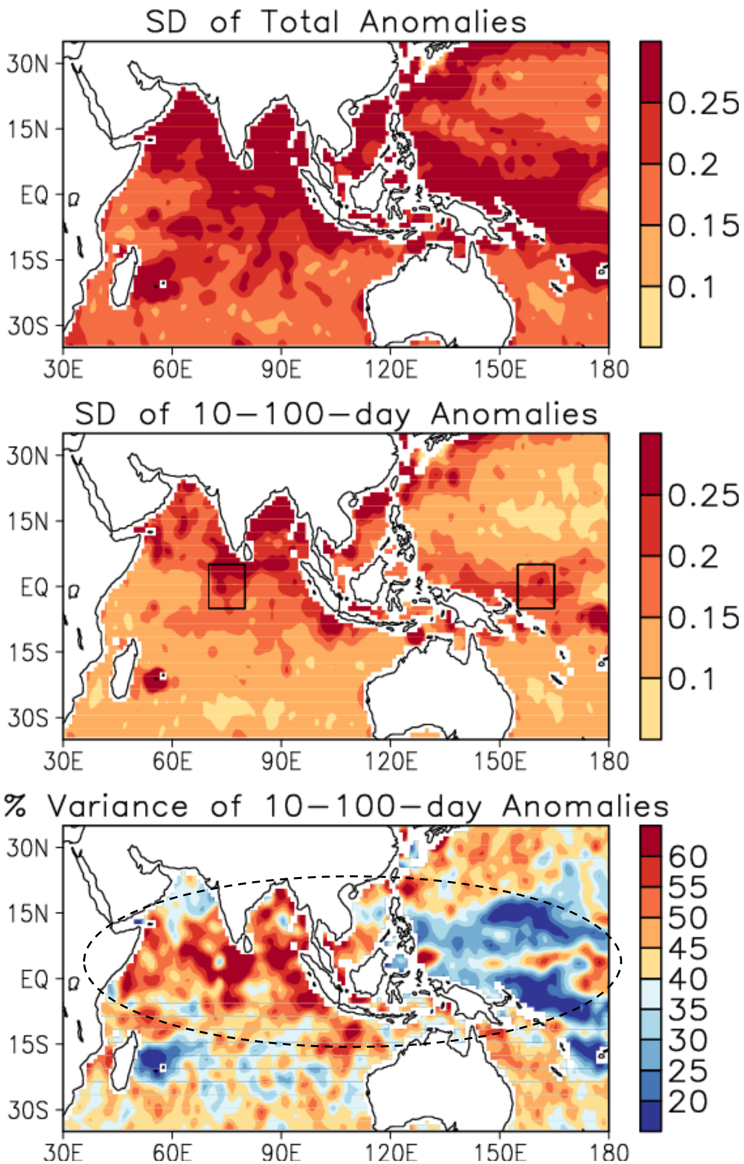
Indo-Pacific SSS variance

Total

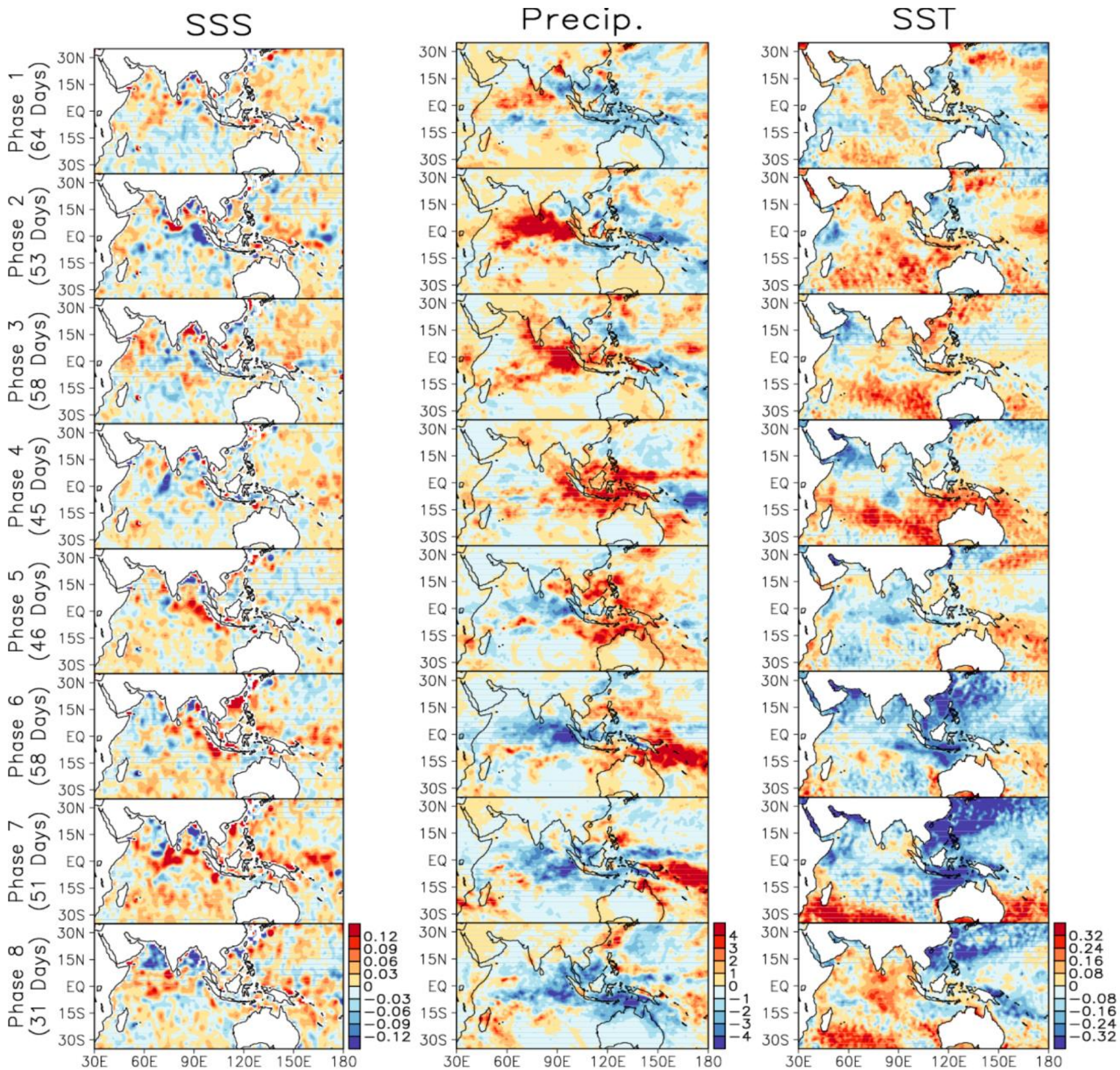
Intraseasonal

Ratio



Composite life cycle of MJO (8 phases)

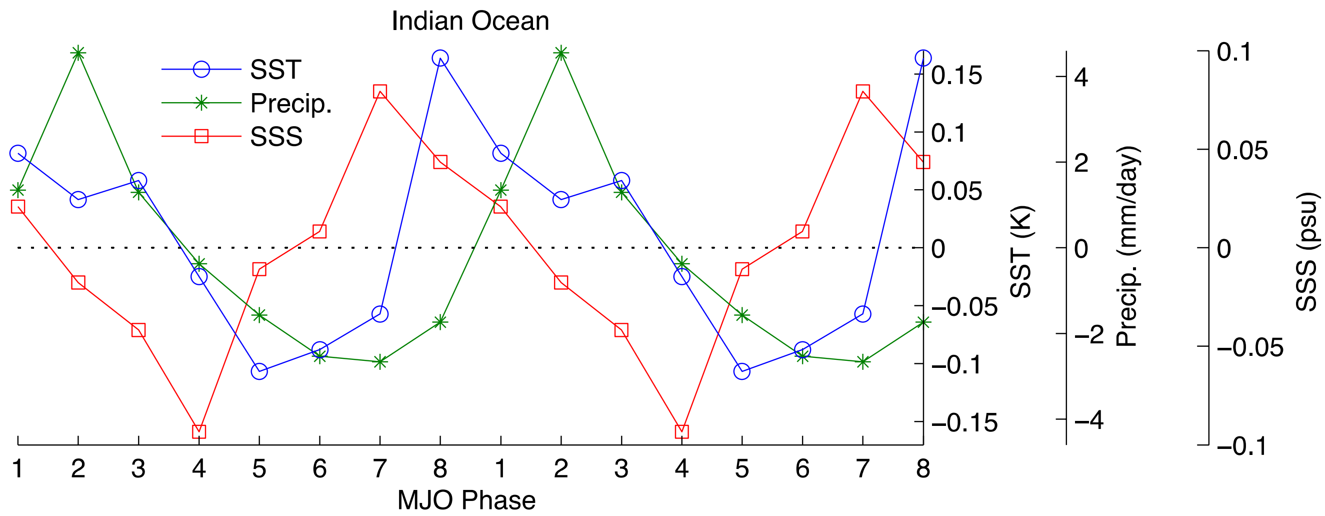
Obtained from combined EOF for the 10-100 day filtered data ("Wheeler-Hendon Index", Wheeler & Hendon 2004)



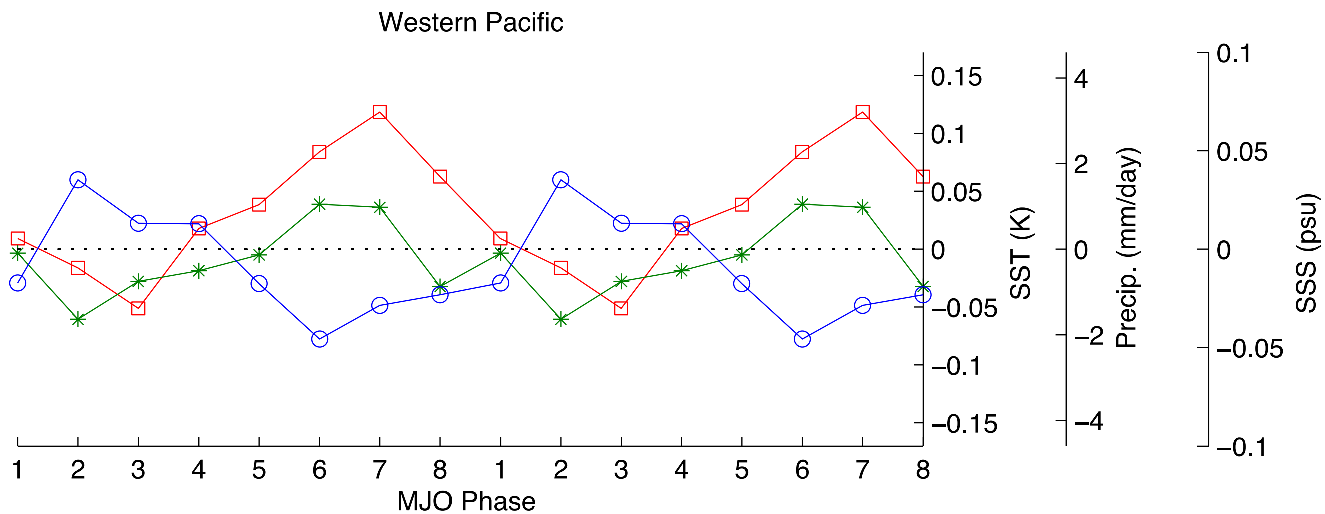
Time series of MJO life cycle averaged over central-equatorial IO & W. Pacific

AQUARIUS/SAC-D

-P explains dS/dt: S lags -P by 2 phases during wet phase (quadrature relation between -P and S)



-P cannot explains dS/dt:
the lack of quadrature relation between -P & S indicates the role of ocean dynamics.



Consistent with Matthew et al. (2010) based on Argo data, different from the interpretation by Grunseich et al. (2013) based on Aquarius.

AQUARIUS/SAC-D

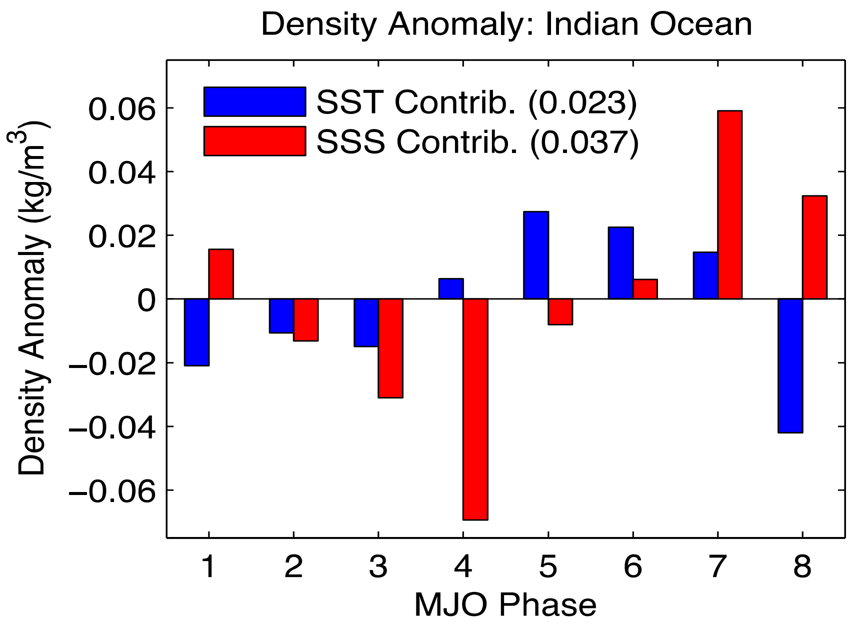
Salinity's role on density during MJO

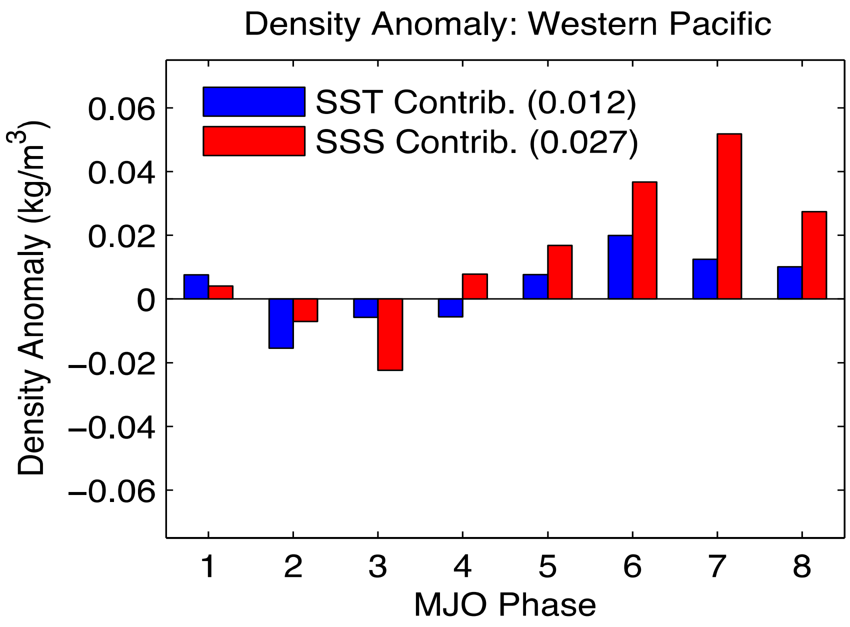
Based on linear equation of state for sea water (surface – zero pressure), surface density anomaly is

$\rho' = (-\alpha T' + \beta S')*\rho_0$

α – thermal expansion coefficient

β – saline contraction coefficient





- Important contribution by S' (overall larger than T' effect); implication to mixed layer depth.
- Offset T' effect on density at times (esp. in the Indian Ocean)
- Pacific Ocean T' & S' effects tend to be more consistent, reflecting the role of ocean dynamics in advecting T' and S'.

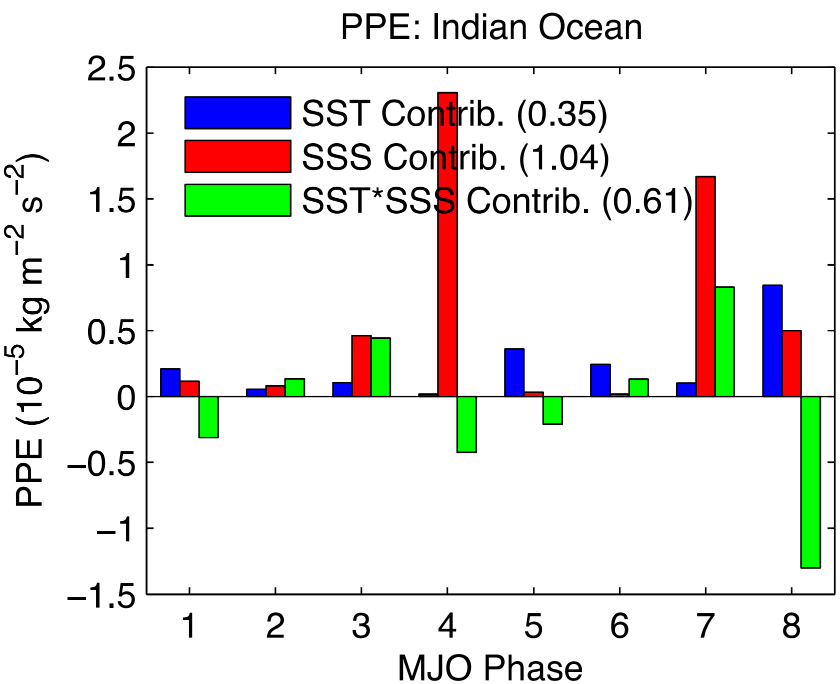
Salinity’s role on Perturbation Potential Energy (PPE)

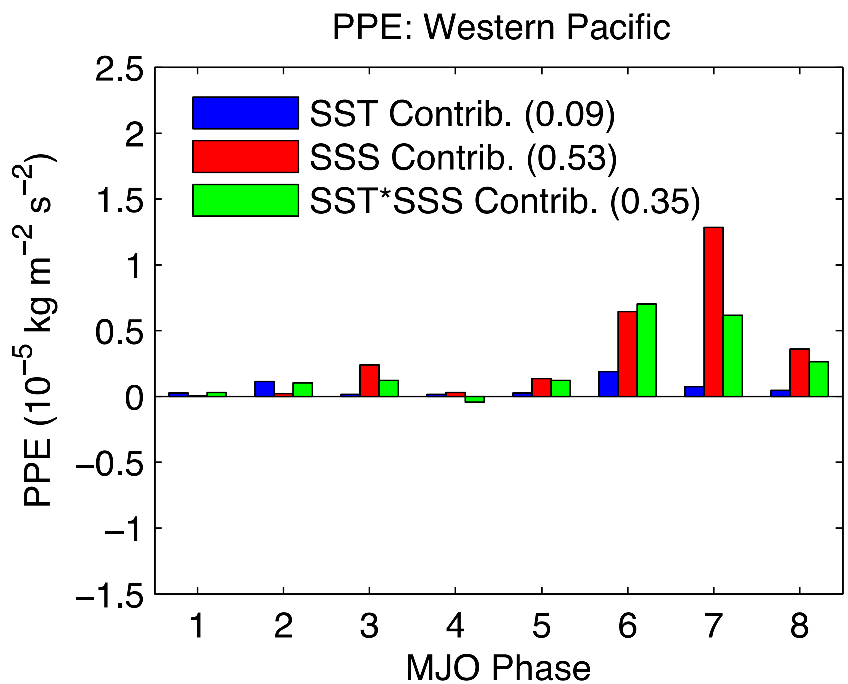
AQUARIUS/SAC-D

$PPE = g\rho'^2/\rho_{0z}$

(ρ' - surface density perturbation, ρ_{0z} – mean ρ gradient across mixed layer)

$\rho'^2 = [(-\alpha T')^2 + (\beta S')^2 - 2\alpha\beta T'S'] * \rho_0^2$

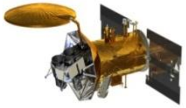




- Dominant role of S’
- Important implication to downward energy propagation

AQUARIUS/SAC-D

Summary



- Aquarius detects MJO signature in SSS (also detected by Matthew et al. 2010 using Argo & Grunseich et al. 2013 using Aquarius).
- Indian Ocean SSS changes are primarily forced by precipitation during wet phase; ocean dynamics plays important role in the western Pacific.
- Salinity has important contribution to surface density (thus mixed layer depth) anomaly.
- Salinity plays a dominant role in surface perturbation potential energy – important to downward energy propagation.

Time series of "MJO" life cycle for weak intraseasonal variability