V3.4 GMF Update

Mitigation of SST Dependent Biases

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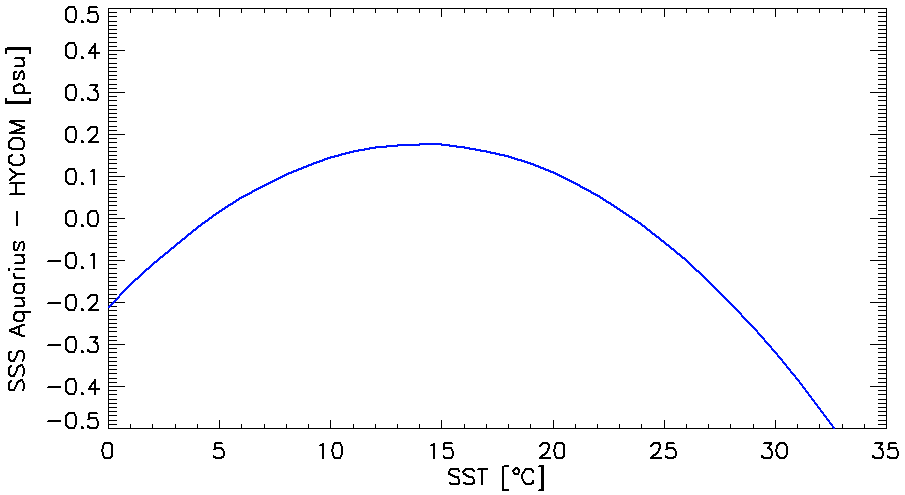
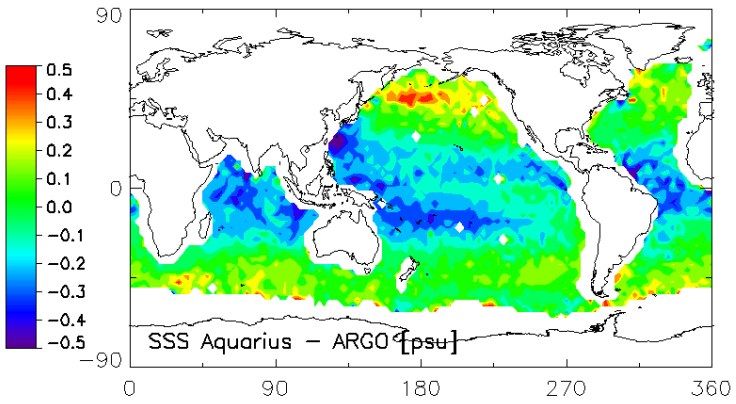
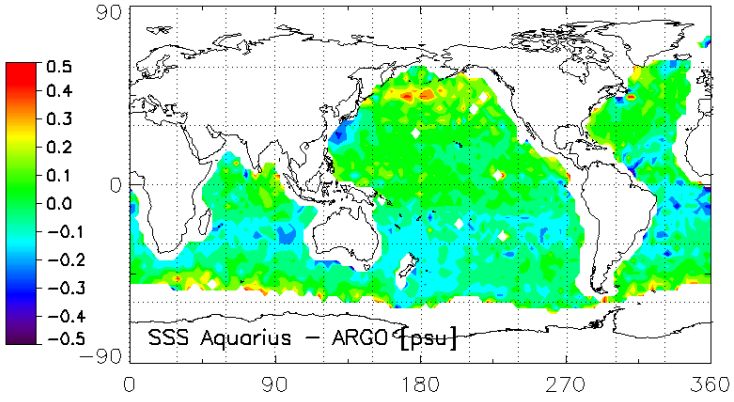
V3.0/V3.3 Post-hoc SST Bias Adjustment



- Done on SSS level.
  Not integrated into GMF.
- Simple 3rd order polynomial fit.
- Same for all 3 horns.





Ultimate Goal of Algorithm Update for V4.0

1. Find physical cause for SST dependent biases.
2. Develop change for geophysical model function, which takes that into account.
3. Implemented at TB level.
4. Implemented in calibration loop.
5. **End up with one single SSS product.**

Possible Physical Causes of Large Scale SST Dependent Biases in V3.0/V3.3

1. **Dielectric constant model ε.**
   - **Specular emissivity E_0.**
2. **Atmospheric oxygen absorption model A_{O2}.**
3. **Wind induced emissivity model ΔE_W (W, T_S) (surface roughness correction).**
4. Biases in the auxiliary SST field (Reynolds) .
5. Galaxy.
6. Undetected RFI
7. …

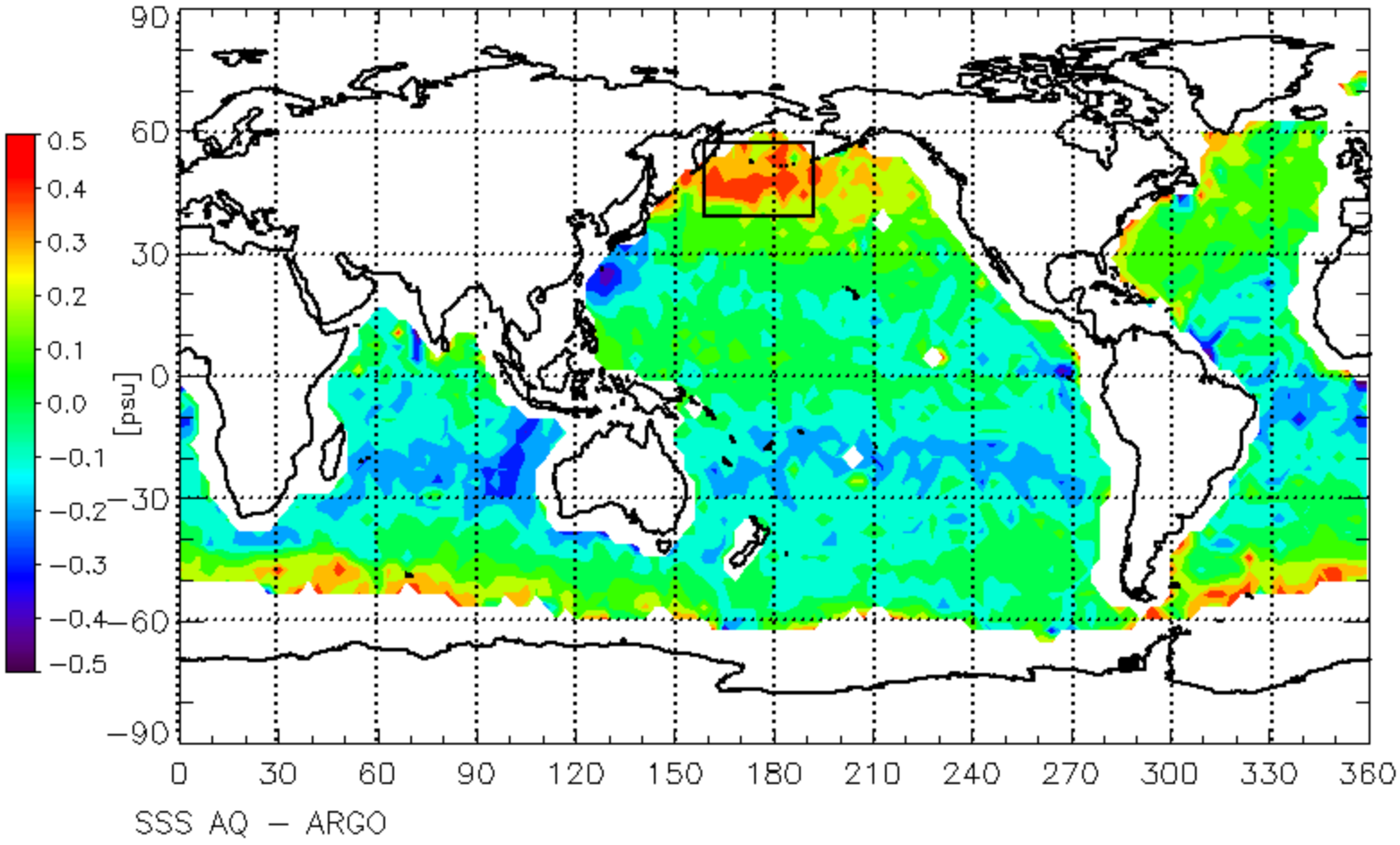
Items 1 – 3 are addressed in proposed GMF update.

Reynolds SST field has no SST dependent biases (see J. Scott).

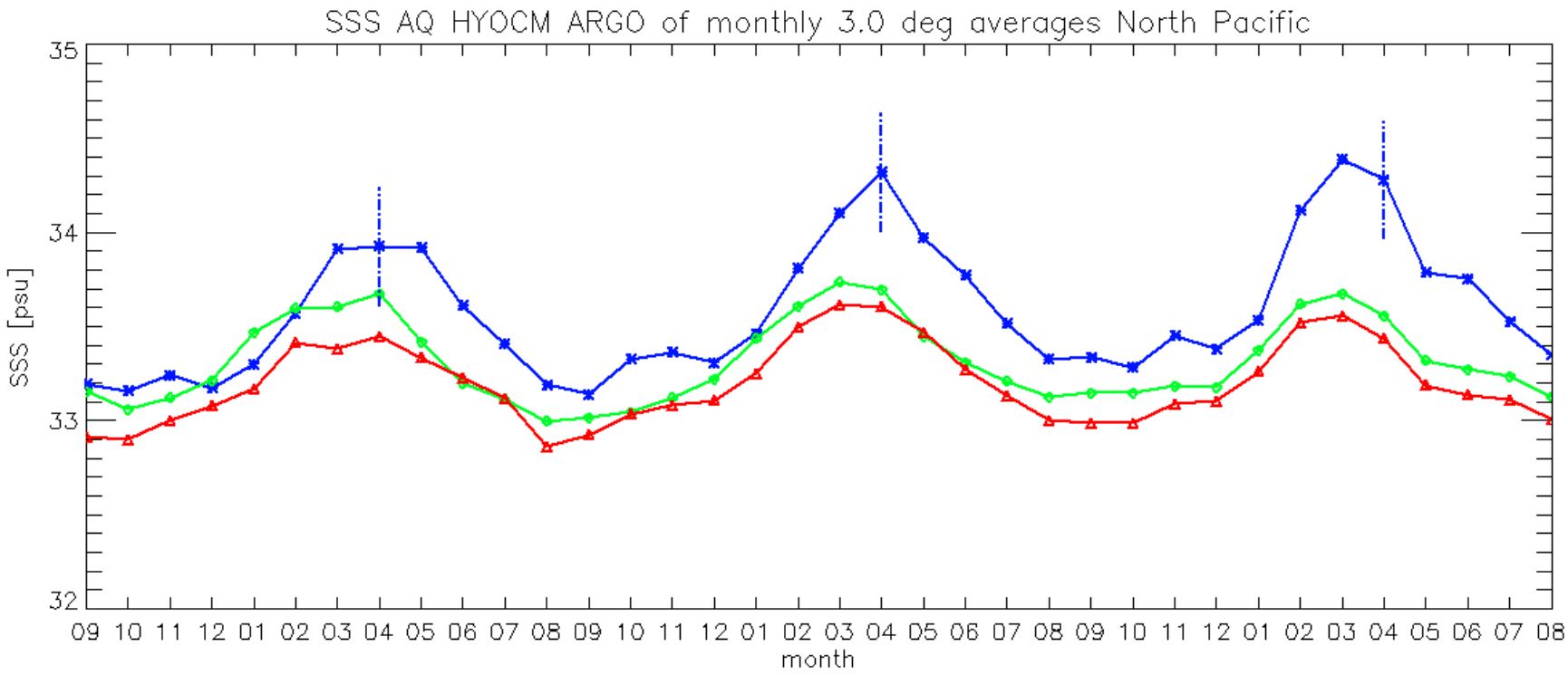
Philosophy: Physical Level 2 Retrieval Algorithm

- GMF/RTM: Computes radiation received by Aquarius sensor from microwave emission of ocean surface and propagation to receiver
- Contains:
  - Flat surface emission (SST) and rough surface emission (wind speed, wind direction, SST).
  - Atmospheric absorption (temperature, cloud).
  - Faraday rotation in ionosphere.
  - Intrusion from galaxy, sun, moon, land, sea ice, RFI, …
  - Antenna effects.
- Does NOT contain:
  - different handling of zonal or meridianal SST gradients.
- GMF/RTM updates are tied to physics of microwave propagation.
- V3.4 GMF Update: Temperature and wind dependence of surface emission and atmospheric absorption.
- Remaining biases: Possible but likely caused to something else.
- Not a *cherry picking* algorithm. Keep predictive power.
- Physical algorithm needs assessment of uncertainty.

Salty Bias in NW Pacific



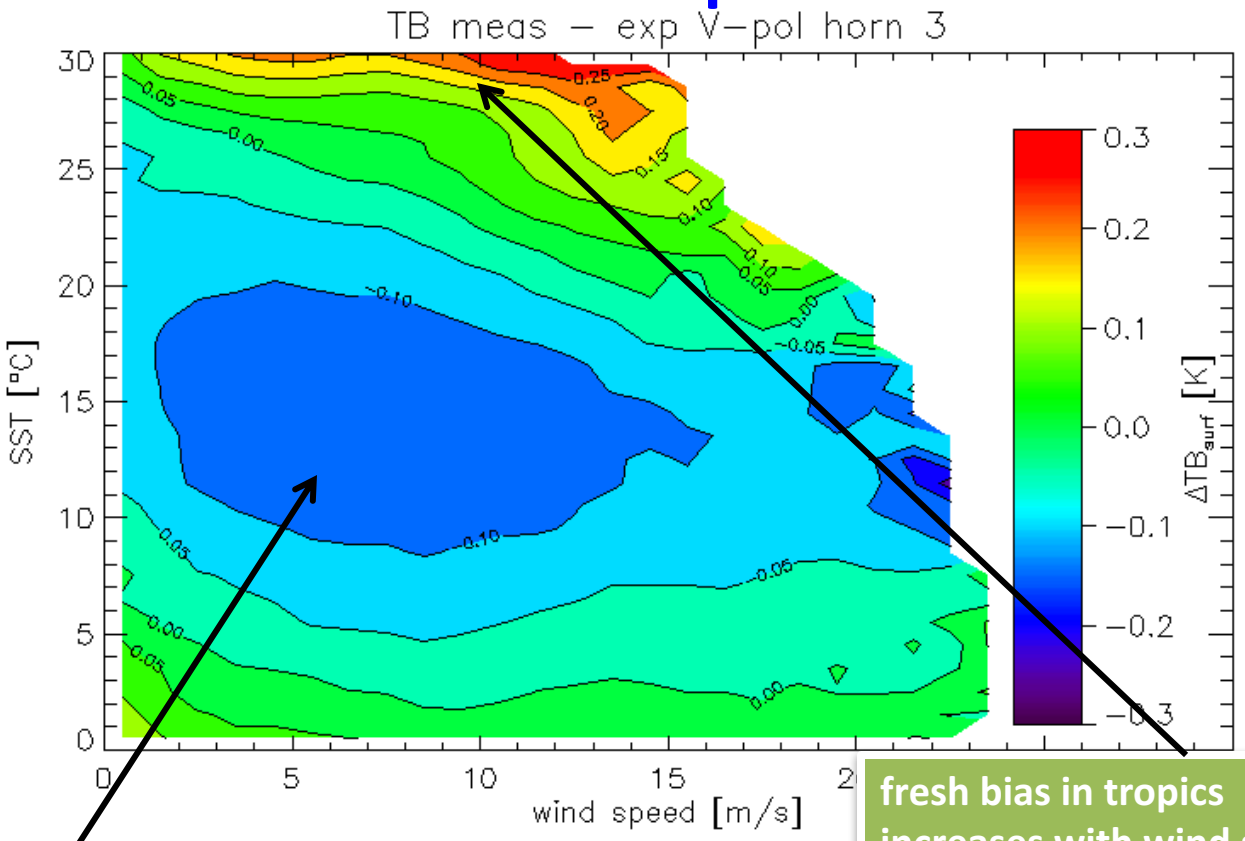
Salty Bias in N Pacific: Time Series



Aquarius V3.4 + error bars
ARGO (ADPRC)
HYCOM

Annual variation: salty peak in early spring.
Aquarius amplitude is twice as big as ARGO/HYCOM.
Difficult to explain from physical model.

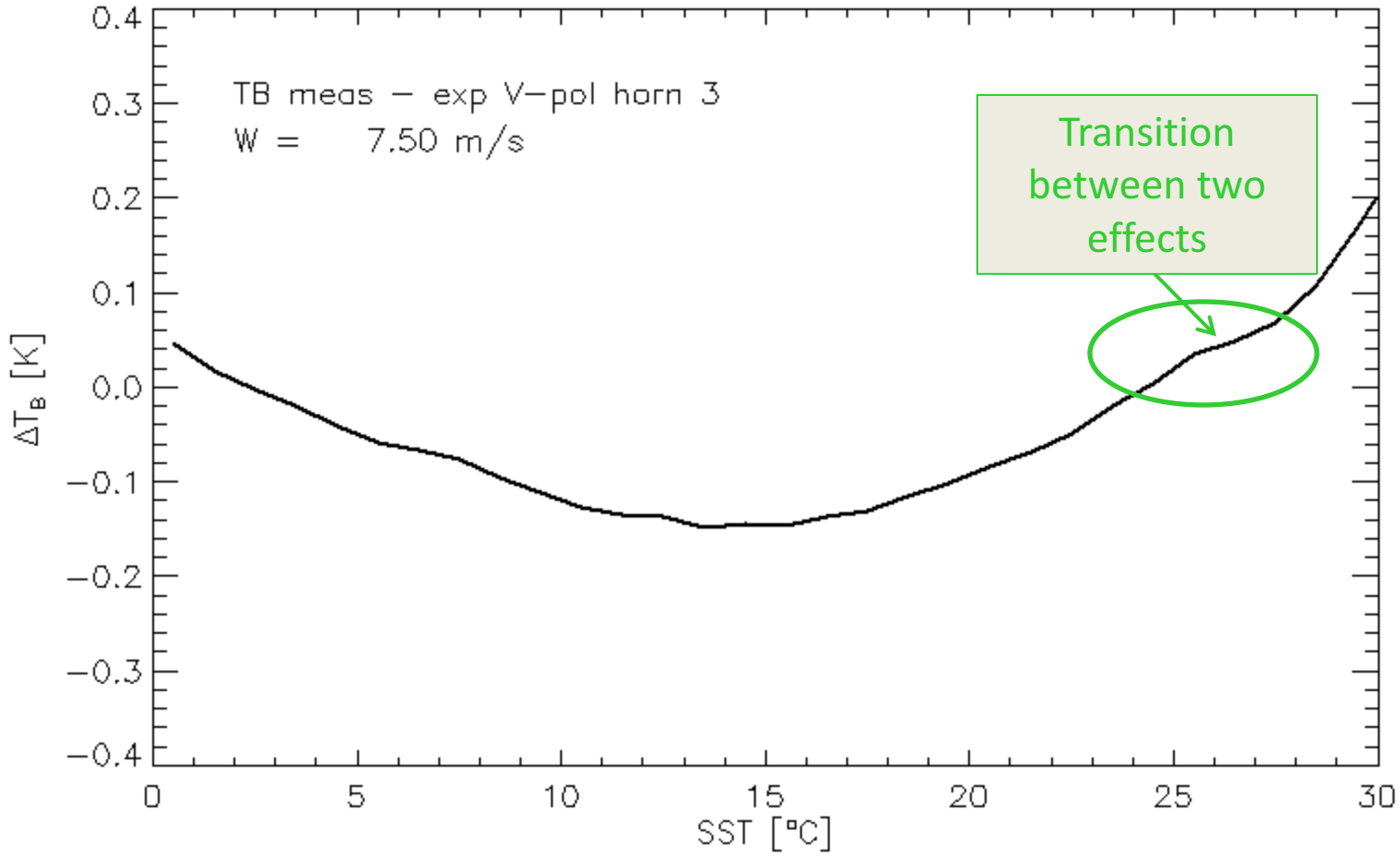
TB measured – expected Stratified as Function of SST and Wind Speed



Salty biases at mid – high latitudes
Dielectric, O2
no/little stratification with wind speed

fresh bias in tropics
increases with wind speed
NOT dielectric or O but most likely roughness correction:
ΔE_W (W, SST) proportional to E_0(SST)

1-Dimensional Cut: WSPD = 7.5 m/s



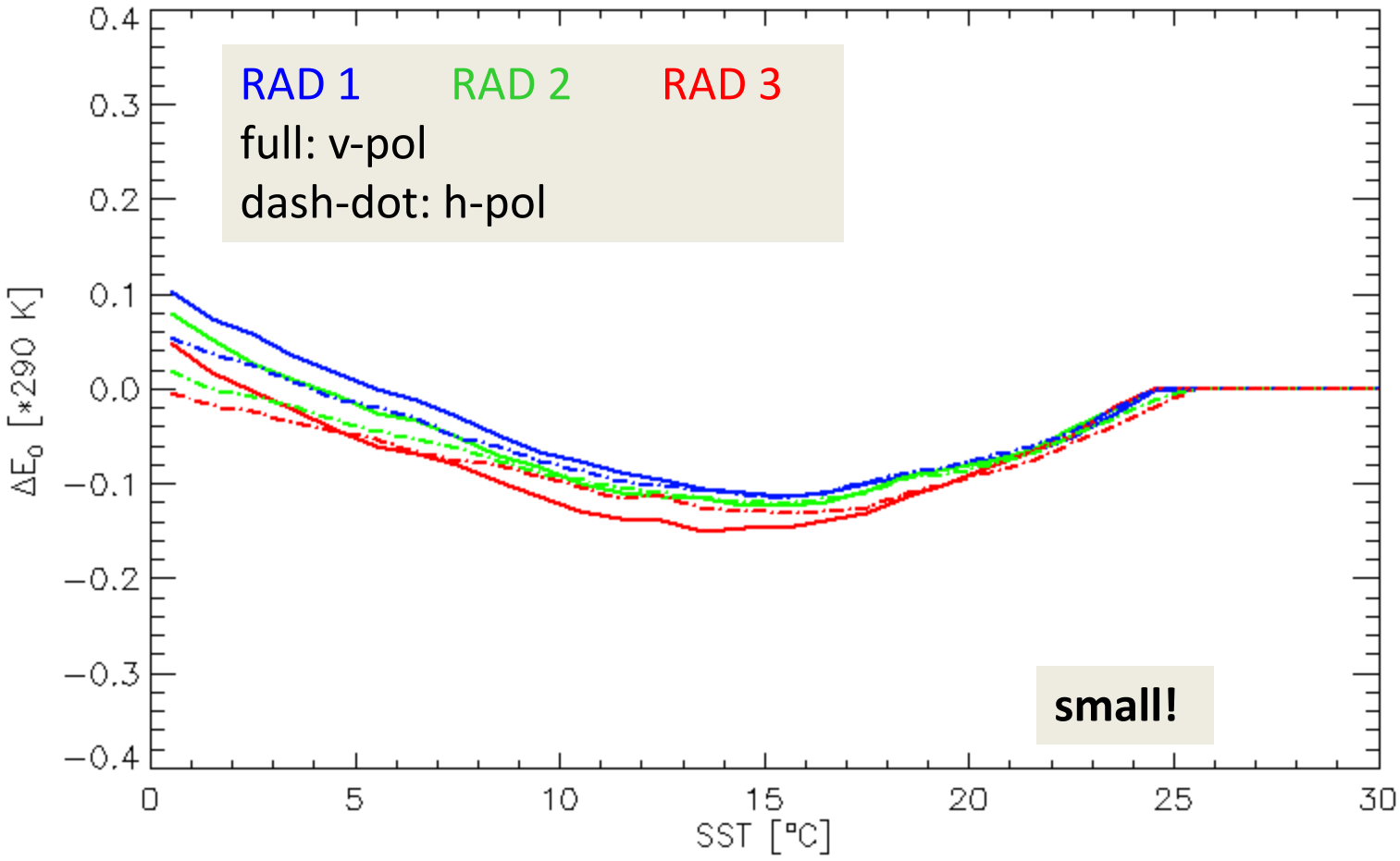
Updated GMF

1. Adjust $E_0(T_S)$ for $T_S < T_{tran}$
   - Small change in ε or A_{O2}
   - I do not disentangle them: Small, inconclusive at that level
2. Adjust the temperature dependence $\delta(T_S)$ of the wind induced emissivity for $T_S > T_{tran}$ which assumes that ΔE_W is proportional to the specular emissivity

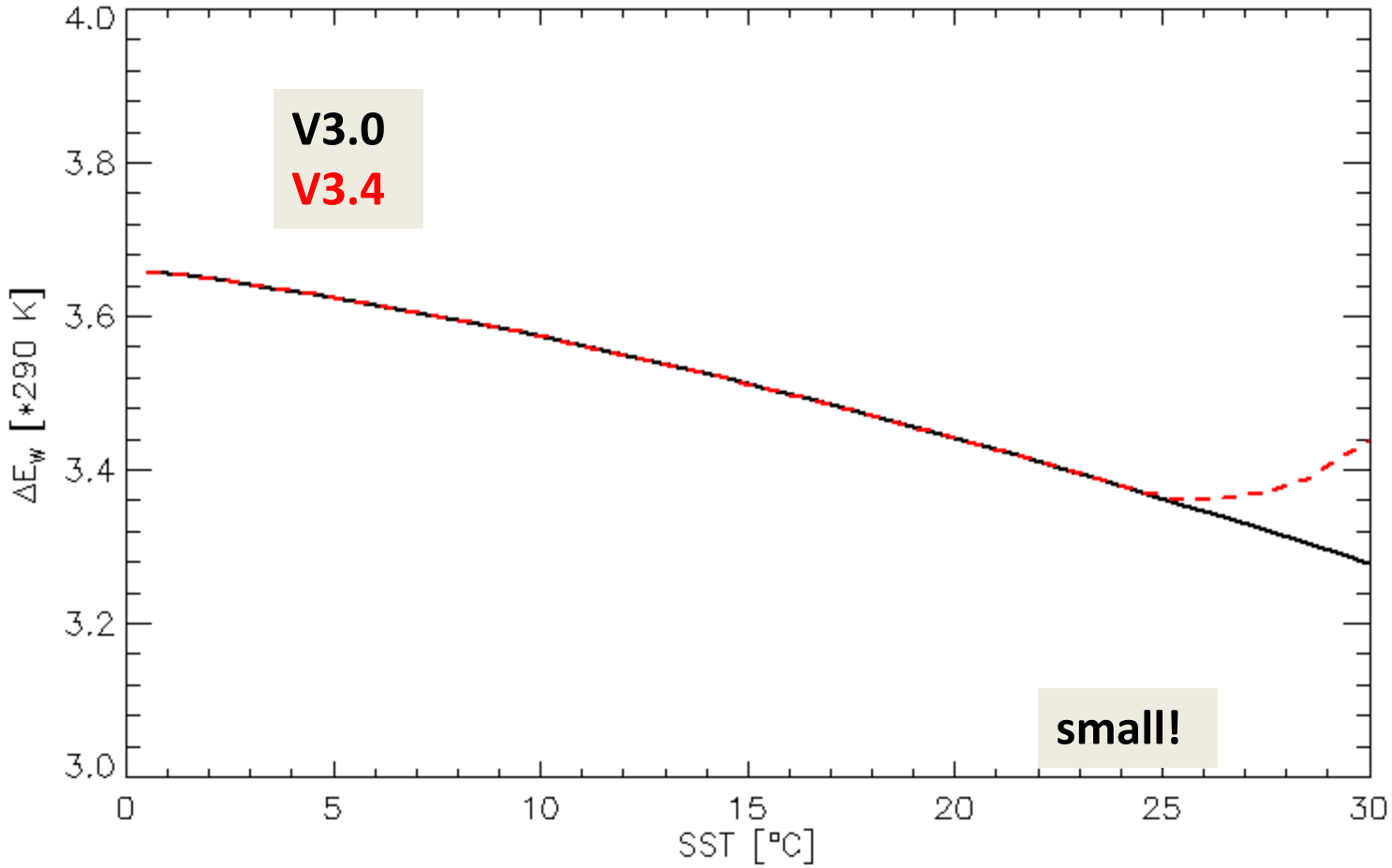
$$\Delta E_W(W, T_S) = \delta(T_S) \cdot \alpha(W) \qquad \delta(T_S) = \frac{E_0(T_S)}{E_0(T_{ref})}$$

3. "Stitch together" at $T_{tran} \approx 25^oC$.
4. Avoid simple polynomial fits.
   - Spline fit.
5. Done separately for each horn and polarization.

$\Delta E_0 (T_S)$

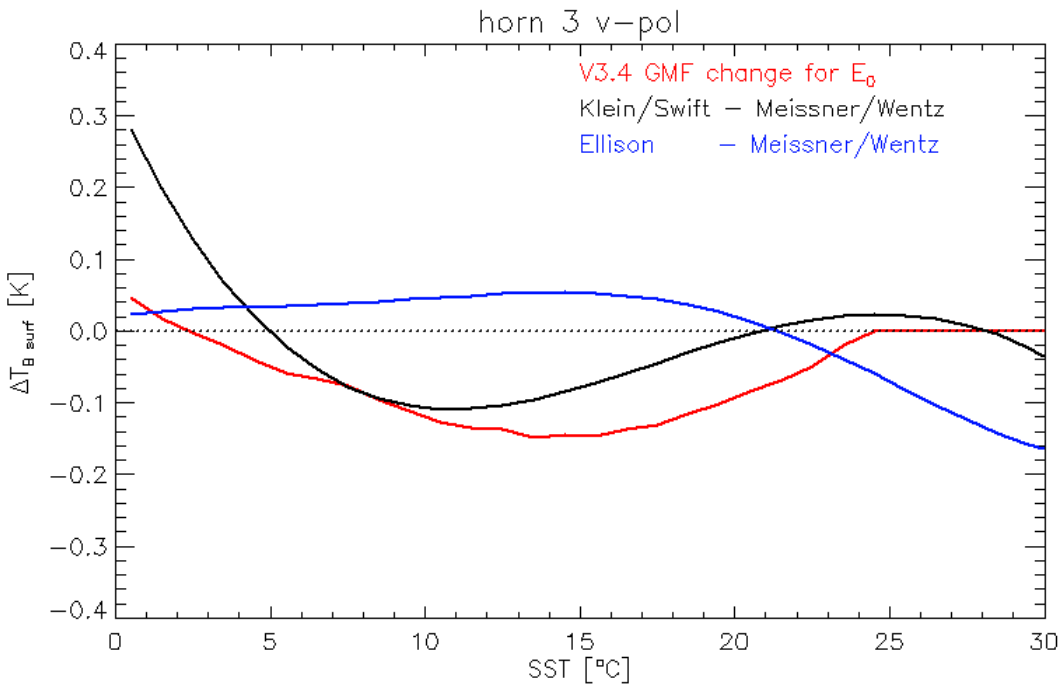

RAD 1
RAD 2
RAD 3
full: v-pol
dash-dot: h-pol
small!
ΔE0 [*290 K]
SST [°C]
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.4
0
5
10
15
20
25
30

$\Delta E_W (W,T_S)$



W = 7.5 m/s

V3.4 Update $\Delta E_0(T_S)$ GMF vs Dielectric Model Uncertainty



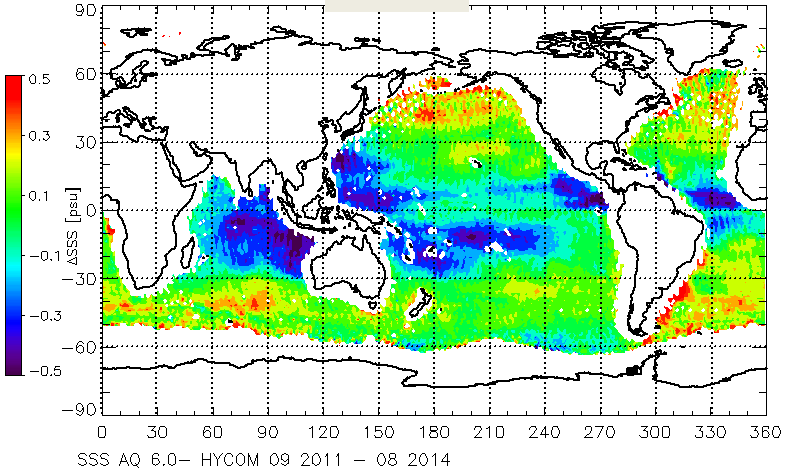
versus Meissner - Wentz

	BIAS	SDEV
Klein - Swift	-0.12	0.10
GWU	0.45	0.14
Stogryn	0.48	0.22
Ellison	0.96	0.11

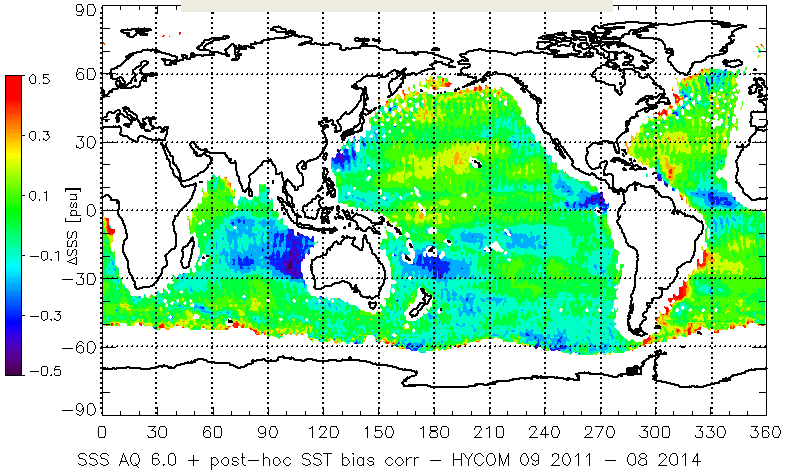
V3.4 GMF adjustment is within uncertainty of dielectric model.
Similar magnitude of uncertainties for O_2 absorption and wind induced emissivity.

Large Scale Biases: Aquarius - HYCOM

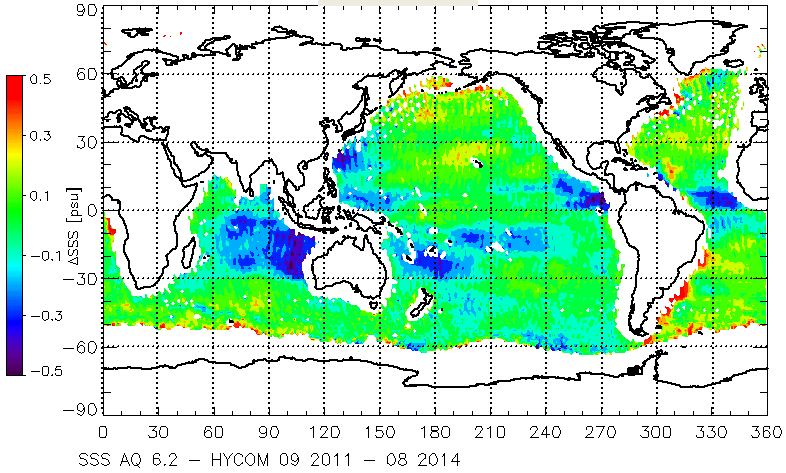
V3.3



V3.3 bias adjusted

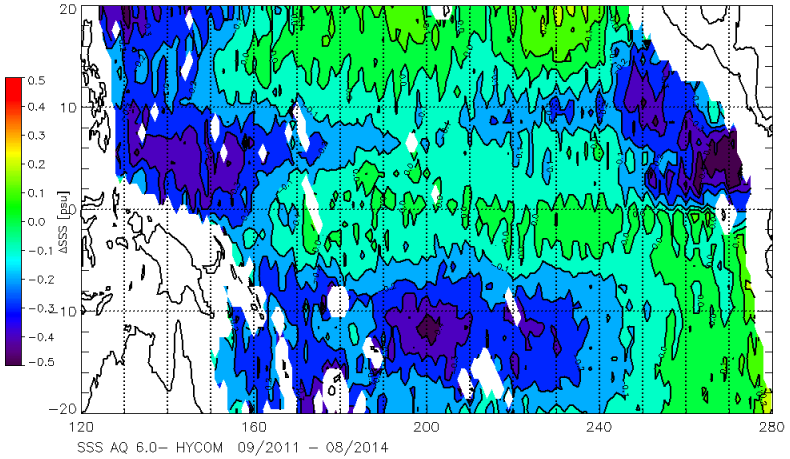


V3.4

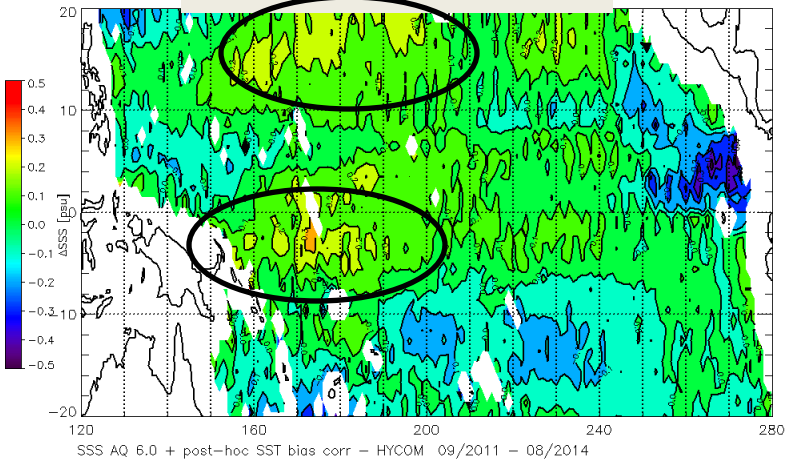


Tropical Pacific: Aq – HYCOM (Maps)

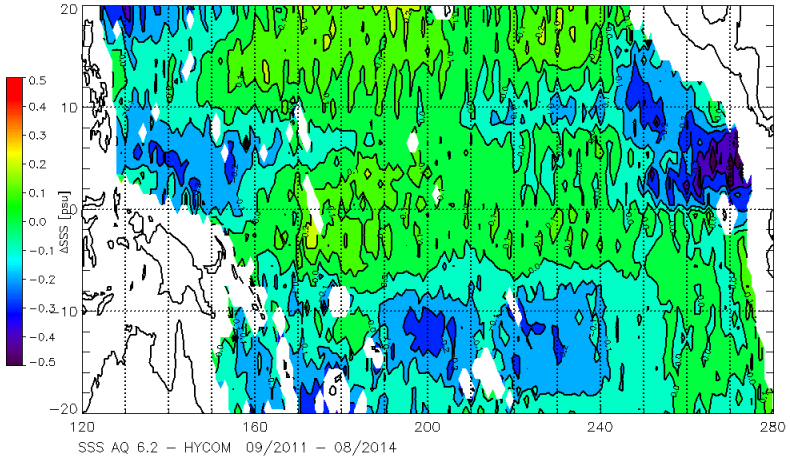
V3.3



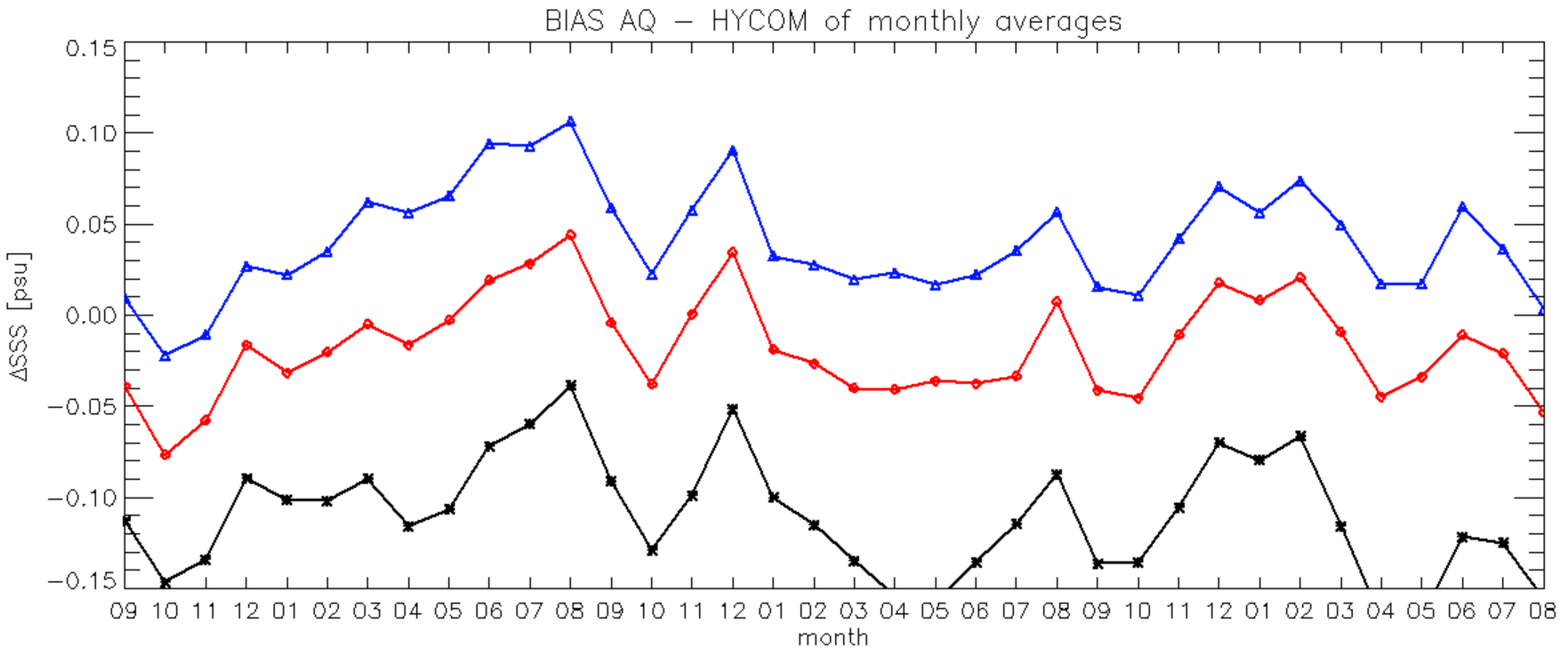
V3.3 bias adjusted



V3.4



Tropical Pacific: Aq – HYCOM (Time Series)

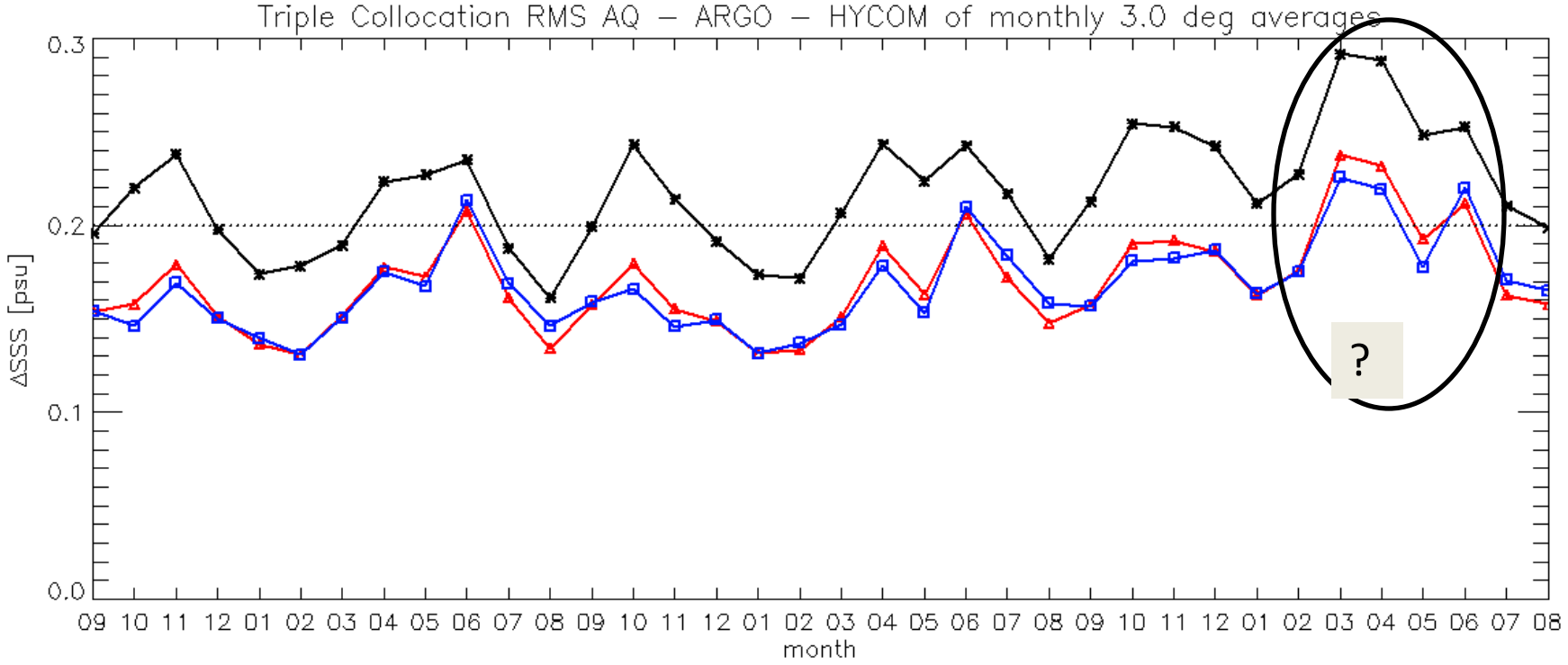


V3.2 V3.0 bias adjusted V3.4

- Compared with the post-hoc V3.0 bias correction, the proposed GMF adjustment is a little softer

Triple Point Analysis: Time Series of Maps

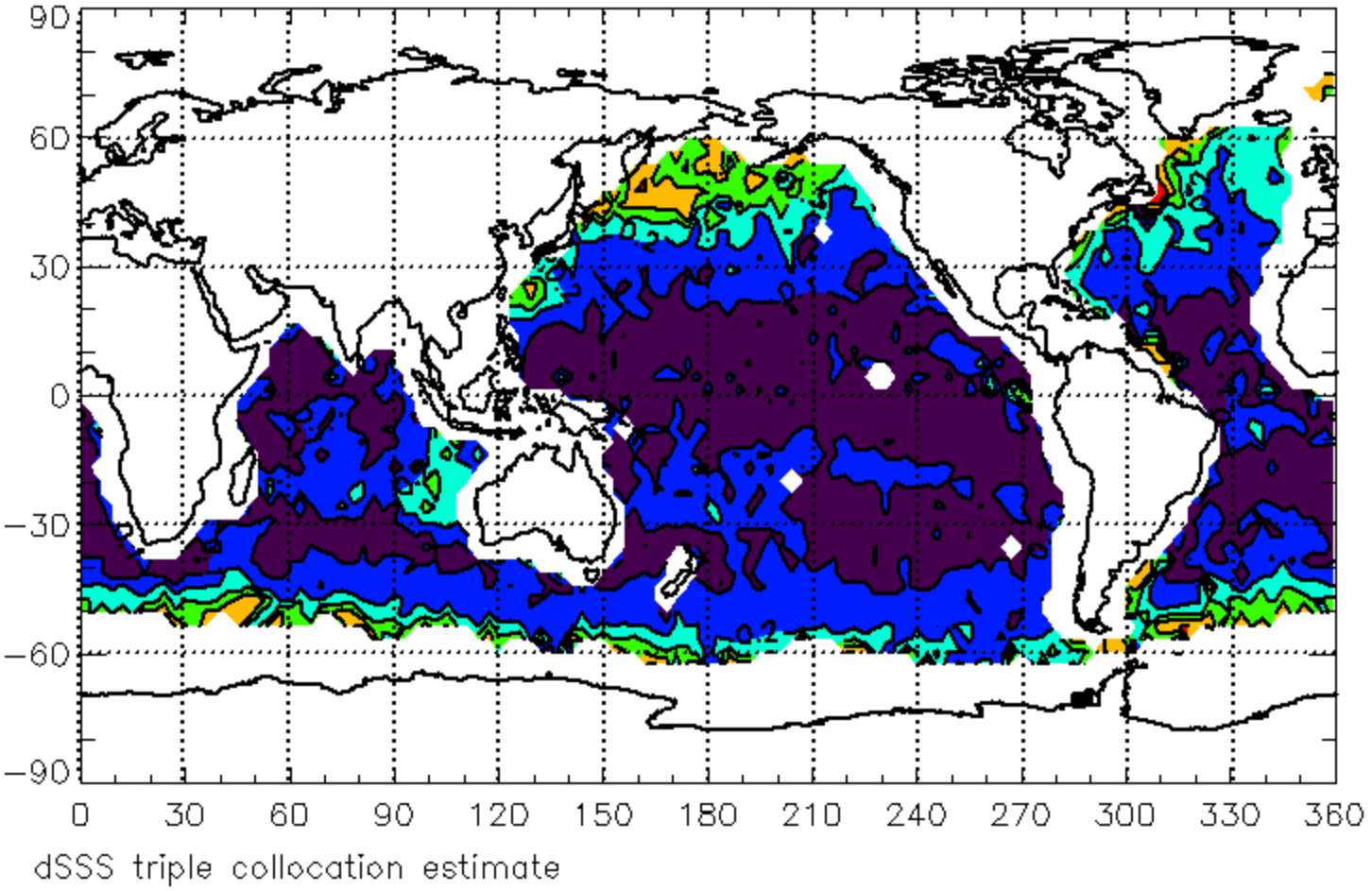
RMS: Aquarius – HYCOM ARGO (ADPRC monthly 3 deg)



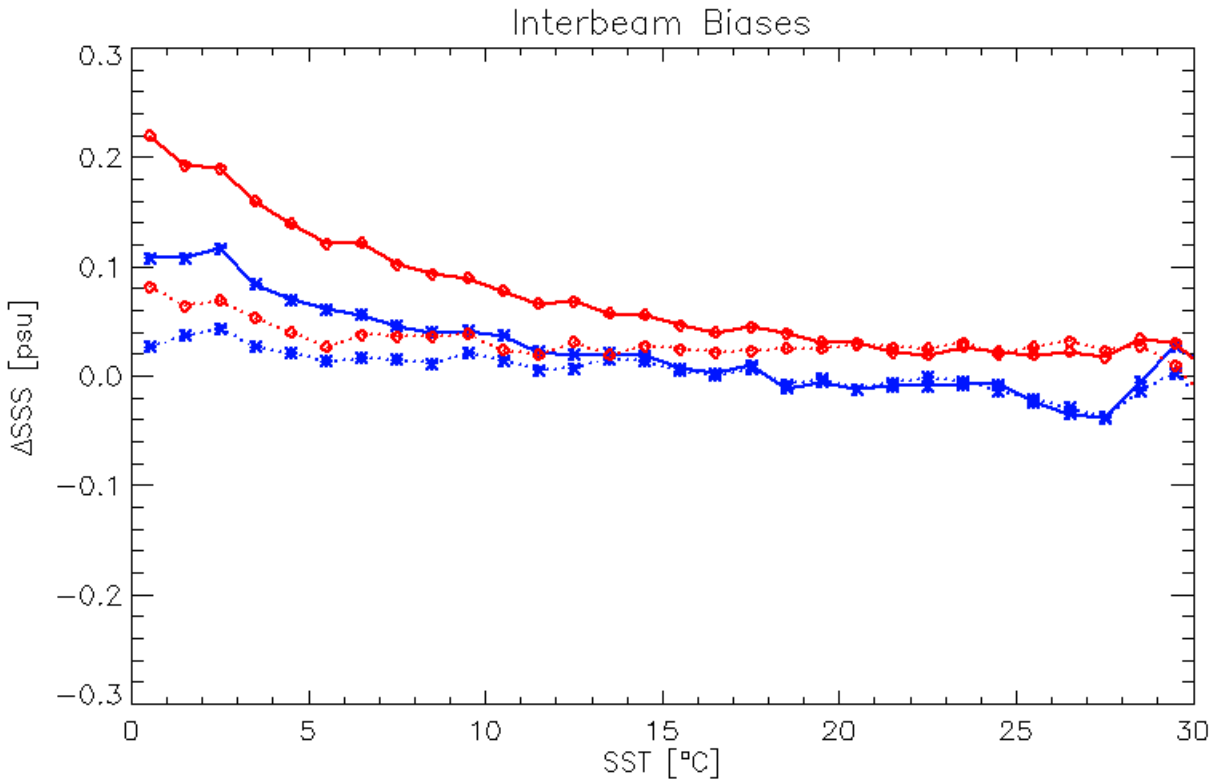
	V3.3	V3.3 bias adjusted	V3.4
RMS	0.220	0.170	0.172

Triple Point Analysis: Map of Time Series

RMS: Aquarius – HYCOM ARGO (ADPRC monthly 3 deg)



Interbeam Biases



Beam 2 – Beam 1 Beam 3 – Beam 1

full lines: V3.3 with or without SST bias adjustment

dotted lines: V3.4

Zonal interbeam biases get reduced

Summary

- V3.4 GMF Update: Temperature and wind dependence of surface emission and atmospheric absorption.
- Implement as "Delta" in emissivity.
- Same purpose as SST bias adjustment in V3.0/V3.3.
- Very similar in performance.
  - Little "softer".
  - Reduces zonal inter-beam biases.
- Discard SST bias adjusted field.