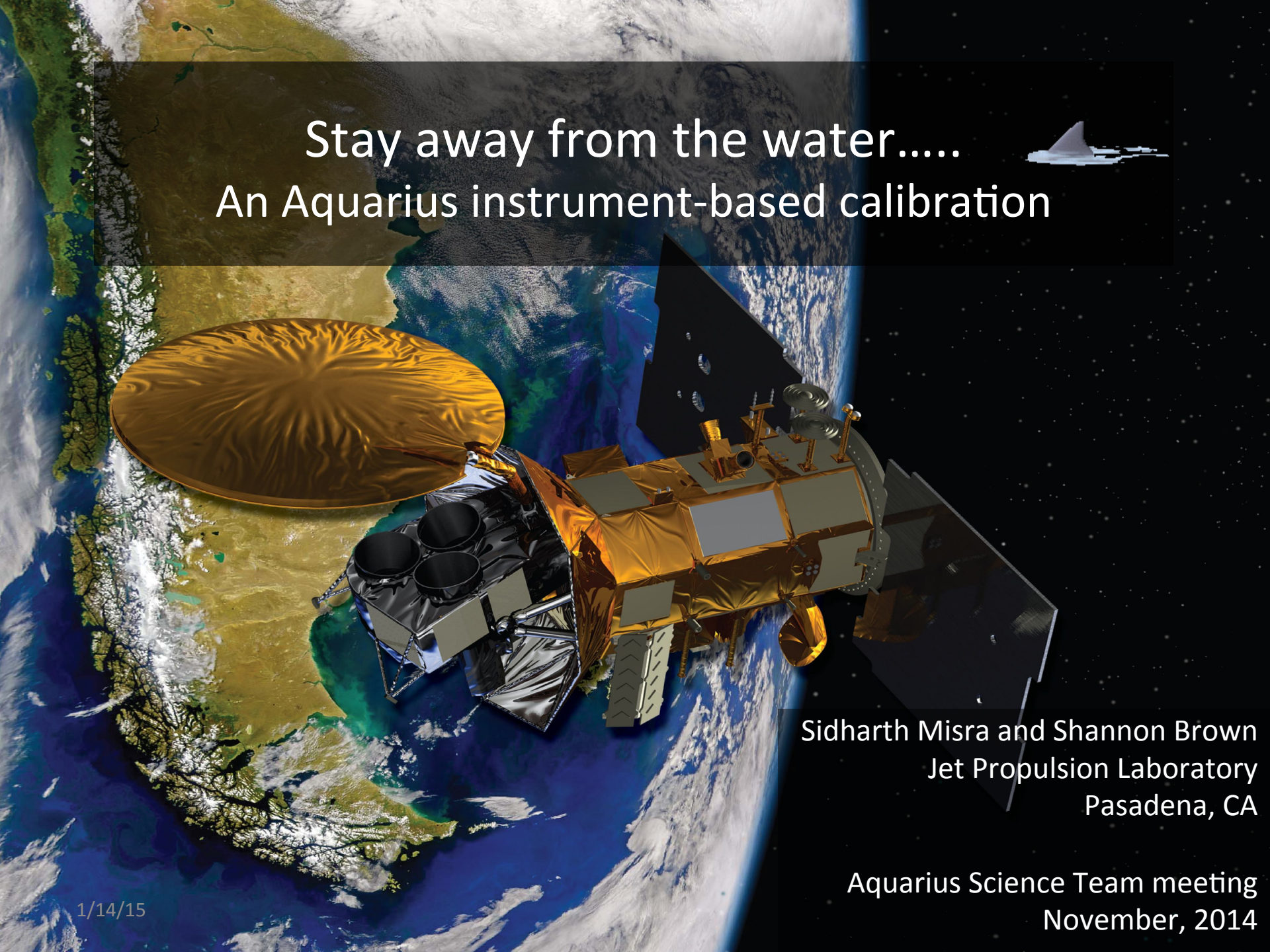
# Stay away from the water…..

## An Aquarius instrument-based calibration



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Aquarius Science Team meeting
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# Aquarius and HYCOM

Aquarius salinity measurements are anchored to global HYCOM measurements on time scales longer than 7-days to compensate for instrument calibration anomalies

For Aquarius to provide independent information on long term salinity trends it is necessary to establish an alternate calibration reference

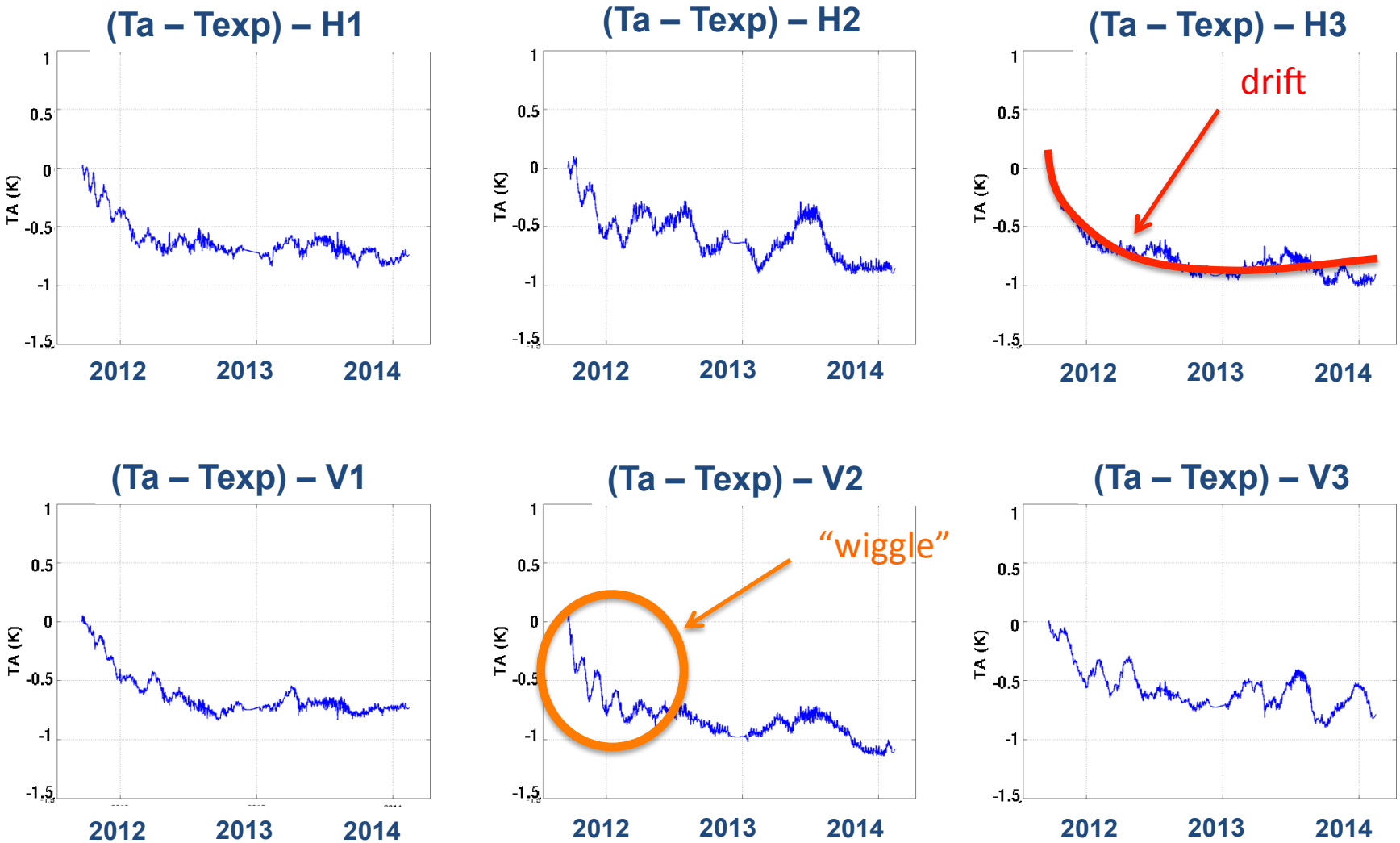
# Independent calibration reference

In order to achieve eliminate dependency on HYCOM we apply an instrument-only correction

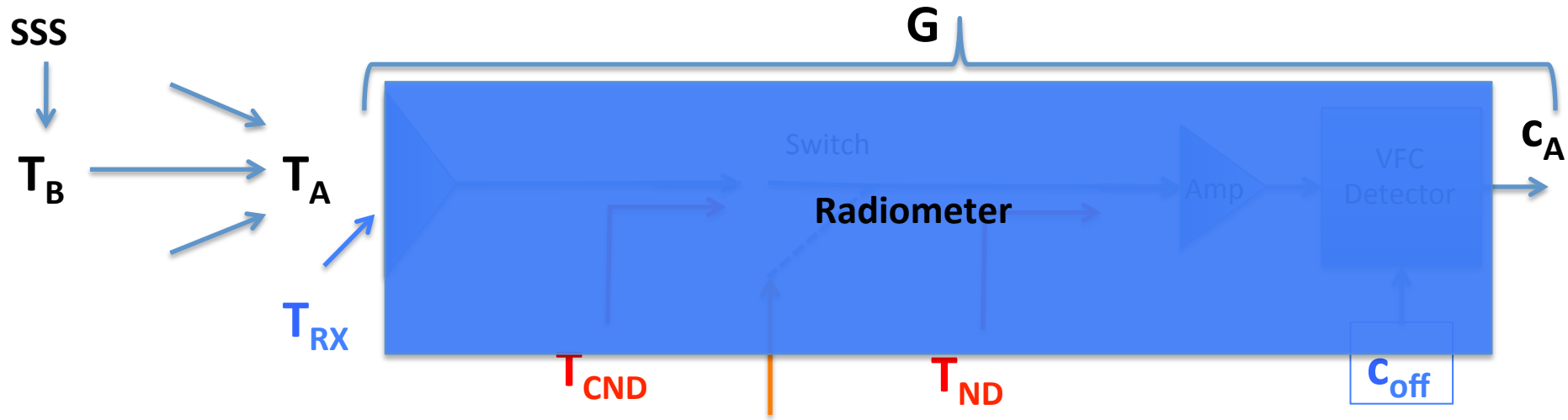
The correction relies on discovery and knowledge of the root cause of the calibration anomalies, and the use of alternate instrument parameters for internal correction

# Calibration anomalies
# Uncorrected TAs

Measurement comparison over the ocean
TA – TA_exp (global ocean mean)



# Instrument Forward Model




$$C_A = G\left(T_A + T_{RX}\right) + C_{off}$$

$$C_R = G\left(T_R + T_{RX}\right) + C_{off}$$

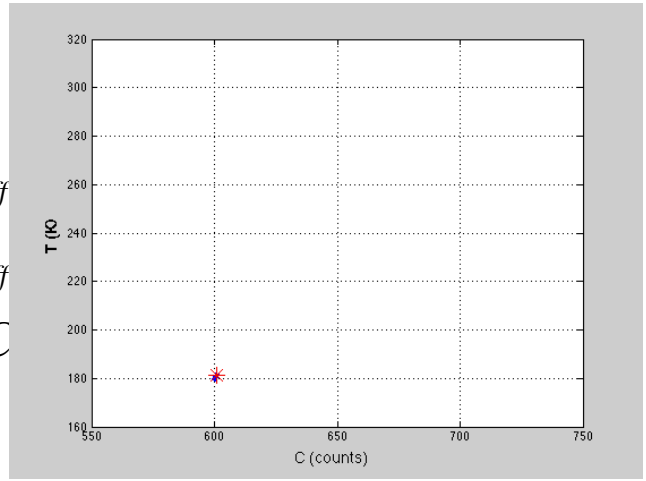
$$C_{RND} = G\left(T_R + T_{ND} + T_{RX}\right) + C_{off}$$

$$C_{AND} = G\left(T_A + T_{ND} + T_{RX}\right) + C_{off}$$

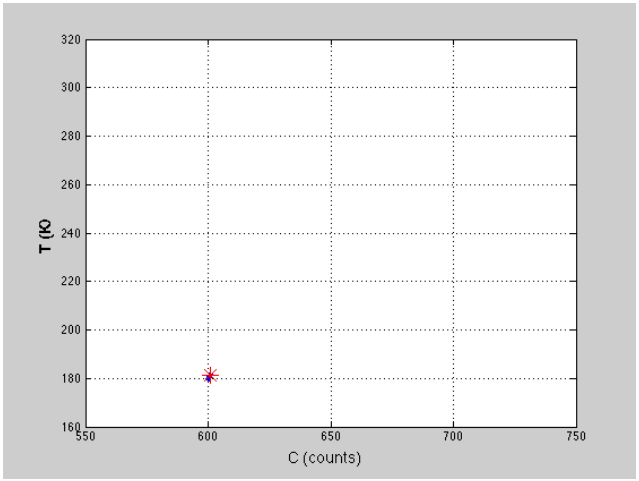
$$C_{ACND} = G\left(T_A + T_{CND} + T_{RX}\right) + C$$

$$T_A = \left(\frac{C_A - C_R}{C_{RND} - C_R}\right) T_{ND} + T_R$$

Good !

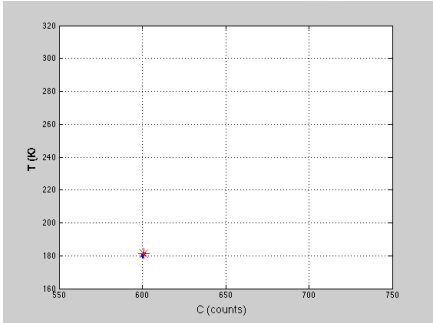



Not so good …



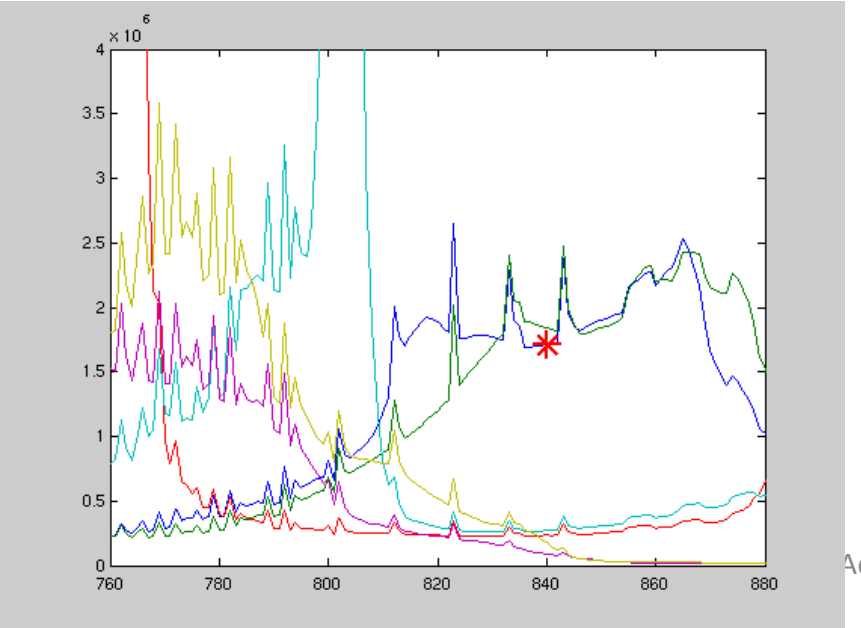
# Calibration anomaly "Wiggle"

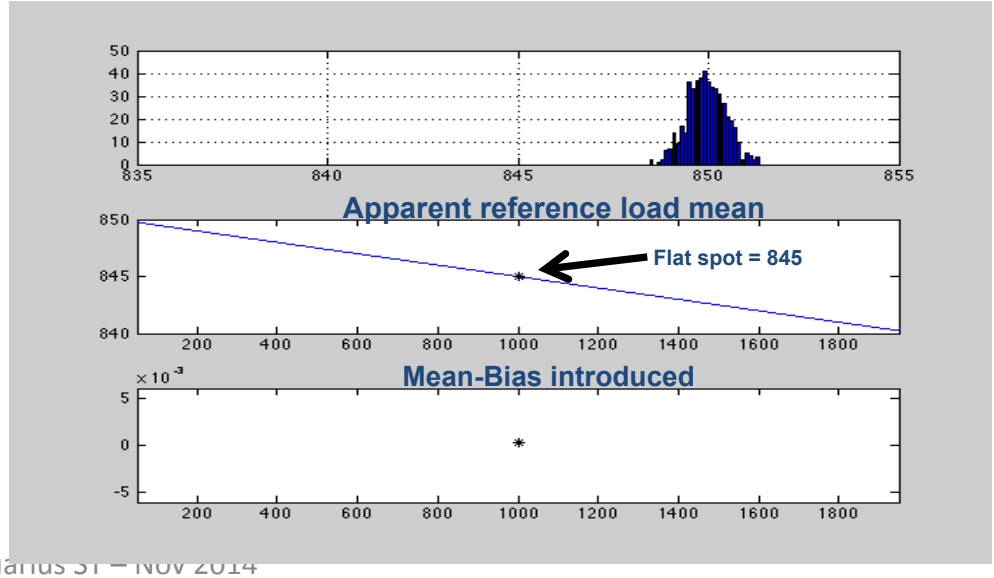
$$TA = \left( \frac{C_A - C_R}{C_{RND} - C_R} \right) T_{ND} + T_R$$




1. Counts get "locked" at certain values
2. Reference load counts slowly drift over time going in and out of these "locked" values
3. The noisy distribution of counts at any particular time is biased one way or another by a "locked" count
4. This results in a mean bias of reference counts
5. This results in wiggle

Histogram of counts



# “Wiggle” correction

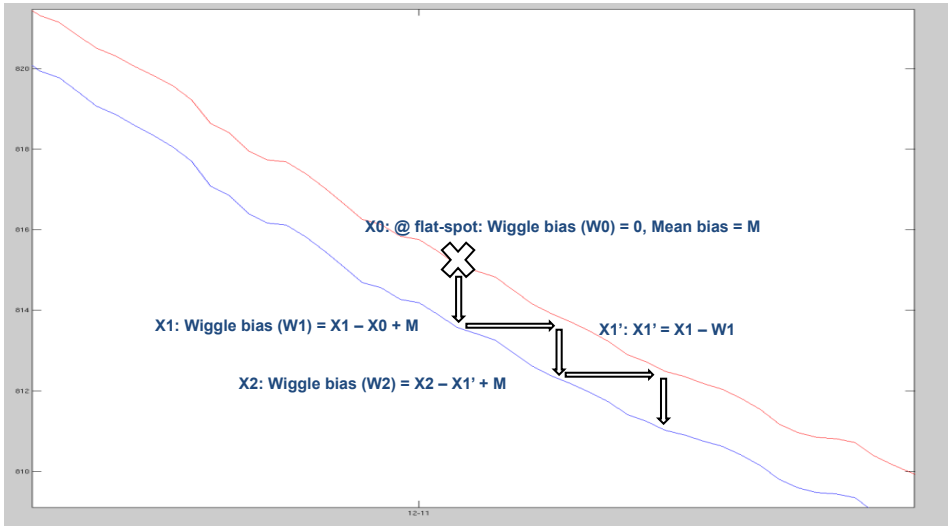
- “Wiggle Correction”
  - **A problem to fix a problem!**
  - **Good Problem**: A bias exists between consecutive reference load counts
  - **Solution**: The consecutive reference loads go in and out of locked counts at different times. The difference of the two loads behaves like a differential that can be solved for using initial conditions
  - If there is locking

$$\boxed{\begin{aligned} c_{R1} &= c_R + v(c_R) \\ c_{R2} &= c_R + M + v(c_R + M) \end{aligned}}$$

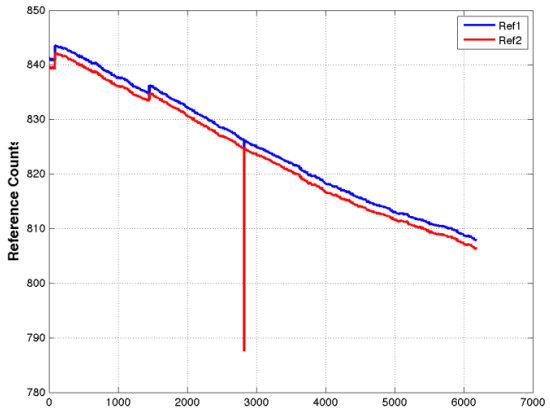
  - Solve differential equation:

$$\boxed{\begin{aligned} \frac{dv}{dc_R} &= \frac{c_{R2} - c_{R1}}{M} = f\left(c_R\right) \\ v(c_{R0}) &= 0 \end{aligned}}$$

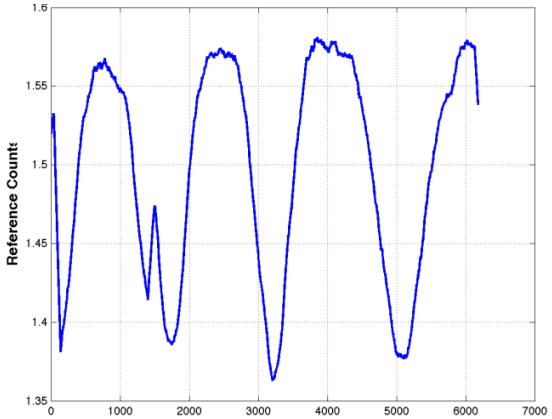
  - Need initial condition. Know *v(c)* at one locking location and go from there
  - Creates “wiggle” correction look up table based on reference load counts



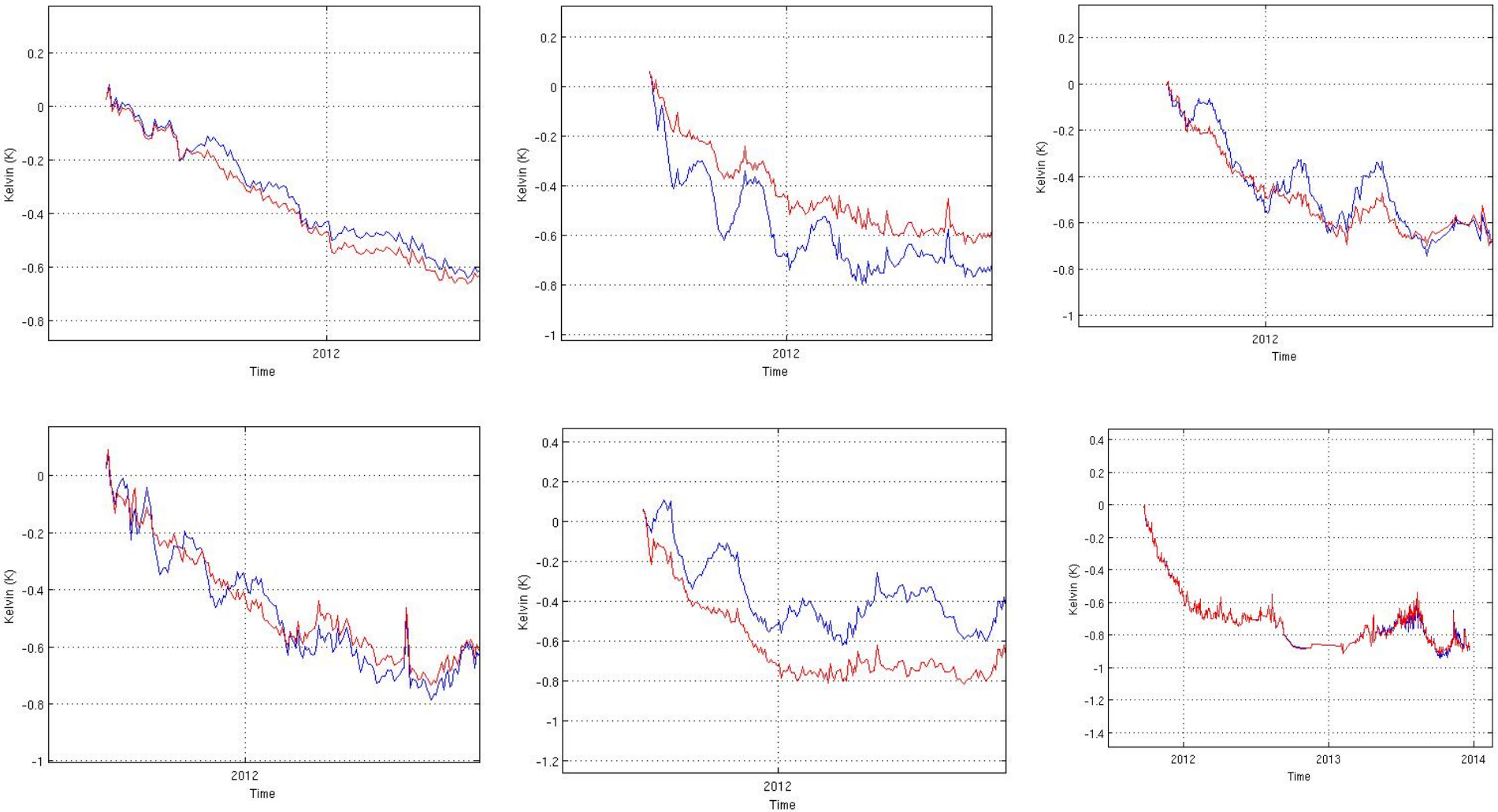

## Reference load counts




## Reference load count diff



# “Wiggle” correction
# Correction comparison over the ocean



# Calibration anomaly Drift

$$TA = \left( \frac{C_A - C_R}{C_{RND} - C_R} \right) T_{ND} + T_R$$

$$C_A = G(T_A + T_{RX}) + C_{off}$$
$$C_R = G(T_R + T_{RX}) + C_{off}$$
$$C_{RND} = G(T_R + T_{ND} + T_{RX}) + C_{off}$$
$$C_{AND} = G(T_A + T_{ND} + T_{RX}) + C_{off}$$
$$C_{ACND} = G(T_A + T_{CND} + T_{RX}) + C_{off}$$

6 unknowns

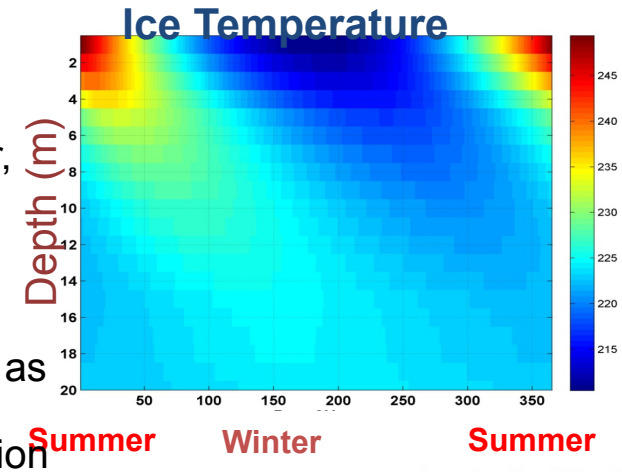
5 equations

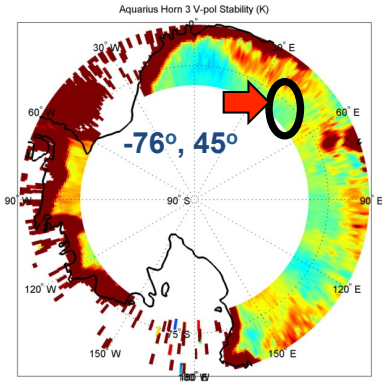
- Impossible to calibrate the calibrator using instrument only parameters
- Need an external constraining source
- CAN NOT use Ta ocean model
- Antarctic model used for relative calibration

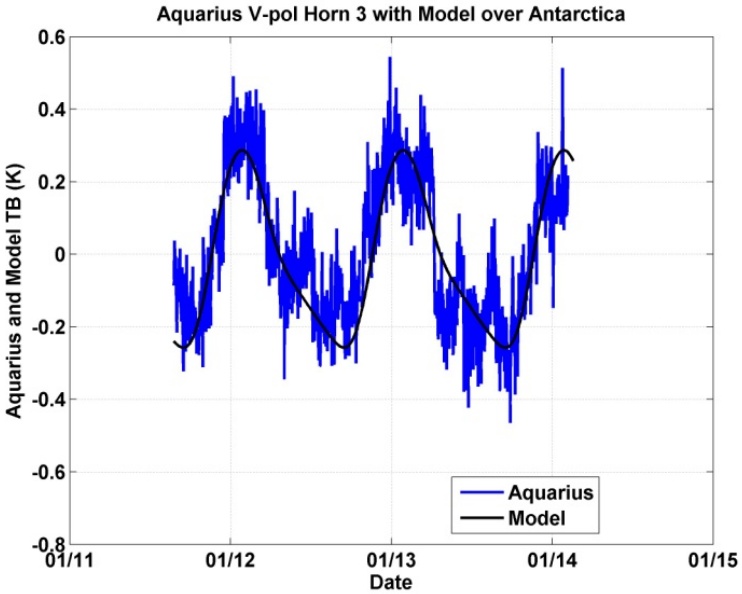
# Drift correction
# Correction using ice model

- Coupled thermodynamic/radiative transfer model
  - MEMLS model (Wiesmann and Matzler, 1999) used to compute upwelling TB
  - Heat transport equation solved for ice T(z,t) profile
  - Surface temperature values obtained from near by AWS station (JASE) used as top boundary condition
  - Thermal diffusivity increases as a function of density (Paterson, 2000)

- Tuned using multi-frequency AMSR-E TBs and in situ surface temperature data
  - Generated random snow layer structures to find a realization that gave best fit 6-37 GHz V&H-pol TBs
  - Ice dielectric model from Tiuri et al., (1984) gave best fit AMSR-E data



# Drift correction
# Vicarious correction

$T_{A,v3\_ice}$ $T_{Amodel,v3\_ice}$

↓

Solve for $\alpha_{v3}$
Remove slope
$T_{A,v3\_ice} - T_{Amodel,v3\_ice}$

↓

Apply $\alpha_{v3}$
To ocean Tas
$T_{A,v3\_ocn,new}$

↓

$bias_{A,v3\_ocn} = T_{A,v3\_ocn,old} - T_{A,v3\_ocn,new}$

↓

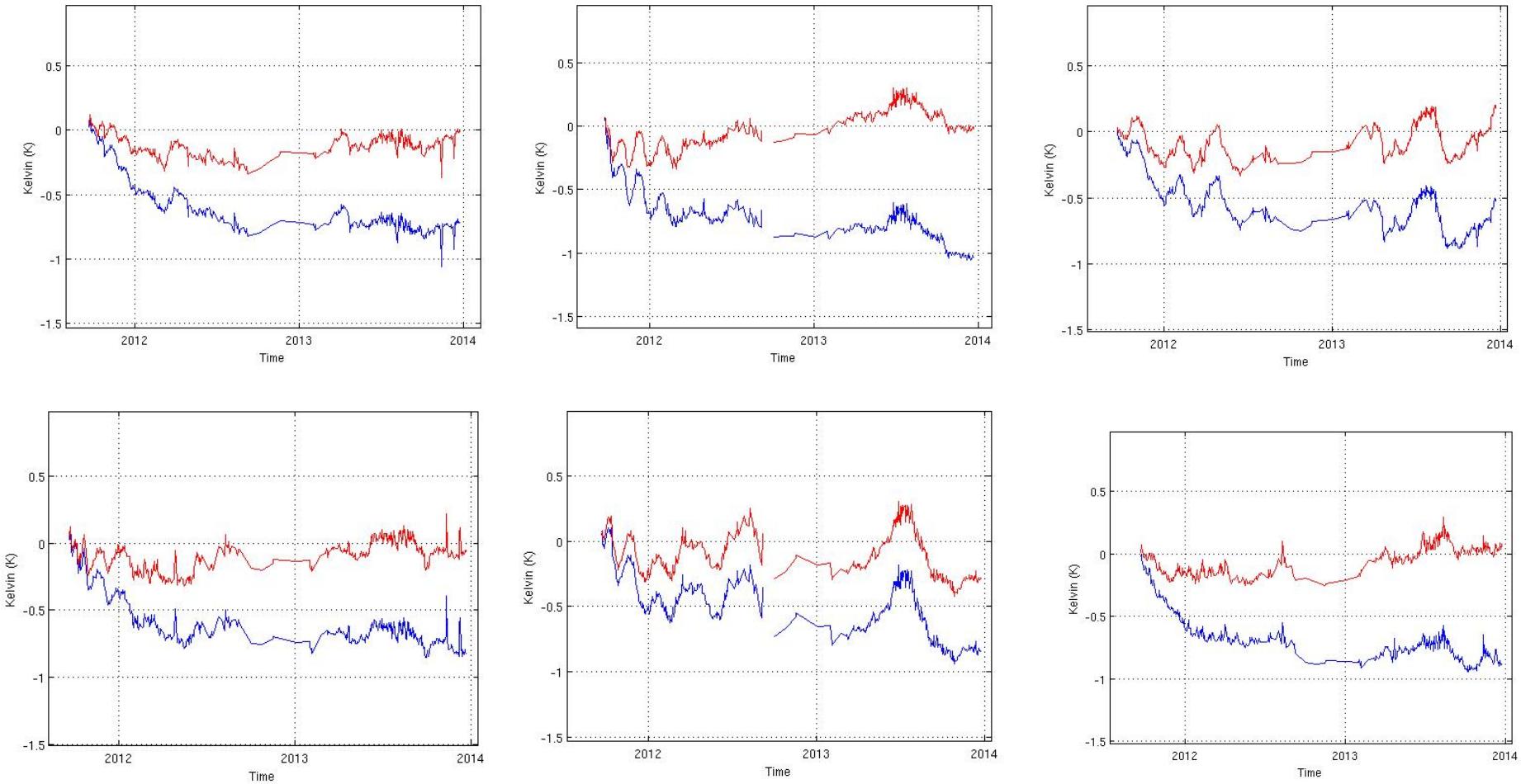
$bias_{A,pb\_ocn} = [T_{Amodel,v3\_ocn} - T_{amodel,pb\_ocn}] - [T_{A,v3\_ocn,old} - bias_{A,v3\_ocn} - T_{A,pb\_ocn,old}]$

↓

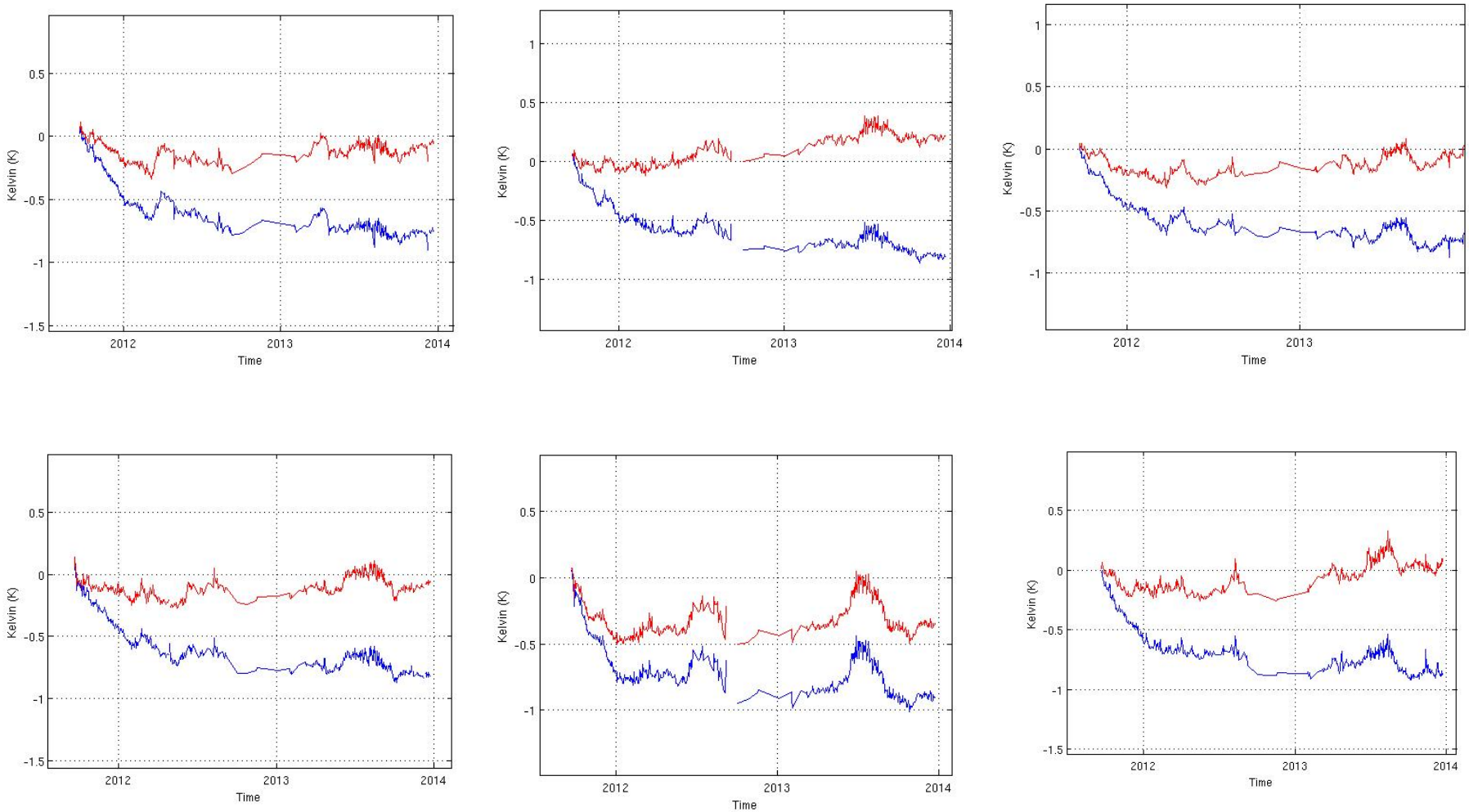
Solve for $\alpha_{bp}$
Using $bias_{A,pb\_ocn}$

$$TA = \left(\frac{C_A - C_R}{G}\right)(1 + \alpha G) + T_R$$

# Drift correction
# Correction comparison over the ocean



# Drift and "wiggle" correction
# Correction comparison over the ocean



# Where do we stand?

An independent calibration has been developed that can get us away from the ocean model

Still residual differences exist relative to HYCOM

HYCOM or instrument?

The method needs to be validated and tweaked

ARGO comparisons

Cold-sky comparison points