Update on dielectric constant model for retrieving salinity from L-band radiometer measurements

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(1) (2) (3) (4) (5) (6) (7)

Background (1)

- **Salinity dependency of L-band (1.4GHz) radiometer meas. ⇔ dielectric constant:**

For a flat sea: $Tb_{sea} = e\,(SSS, SST).SST$

$$e_v = 1 - \left| \frac{\varepsilon_r \cos\theta - \sqrt{\varepsilon_r - \sin^2\theta}}{\varepsilon_r \cos\theta + \sqrt{\varepsilon_r - \sin^2\theta}} \right|^2 \qquad e_h = 1 - \left| \frac{\cos\theta - \sqrt{\varepsilon_r - \sin^2\theta}}{\cos\theta + \sqrt{\varepsilon_r - \sin^2\theta}} \right|^2$$

- $|\partial Tb/\partial SSS|$ small (1 to 0.2 K/pss)
  => **need very precise ε_r** to retrieve SSS with ~0.1-0.2pss uncertainty
- **Various dielectric constant models used for processing satellite data today:**
  - SMOS ESA : **Klein & Swift (1977) (KS)**: model fitted to laboratory measurements until L2OS v662;
    Boutin et al. (2020) (BV): model fitted to SMOS Acard measurements : SMOS L2OS v700 (to be released end of this month) and CCI v3
  - Aquarius/SMAP RSS: **Meissner and Wentz (2004, 2012) (MW):** model fitted to satellite meas. (multiple frequencies)
  - Aquarius/SMAP CAP JPL: intermediate between KS and MW

New SMOS v7 reprocessing: Descending orbits: May 2018 influence of dielectric constant model change

SST ECMWF

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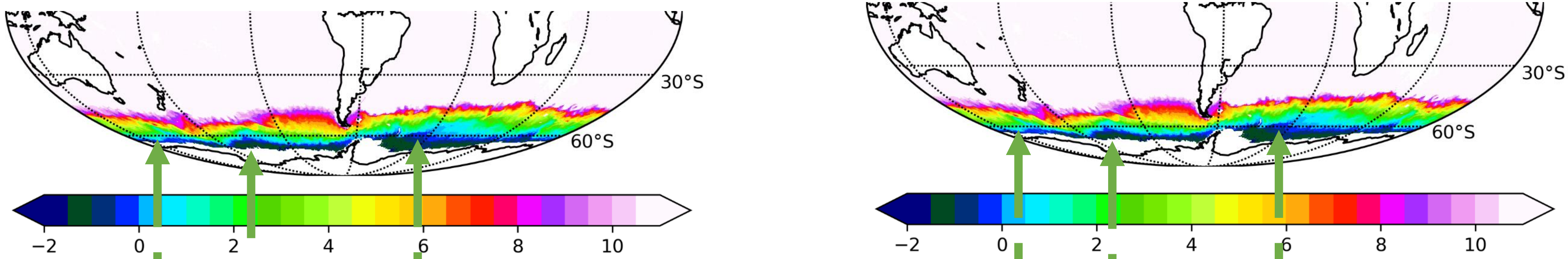
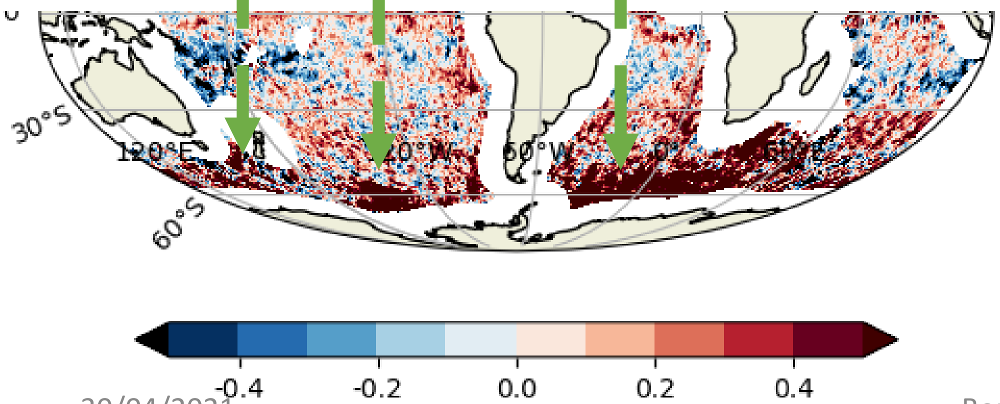
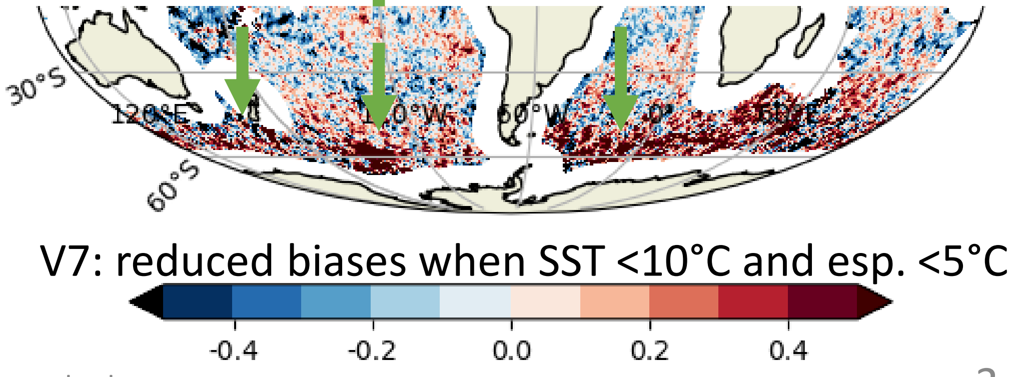


ESA V6 **SMOS SSS – ISAS SSS** **ESA V7***



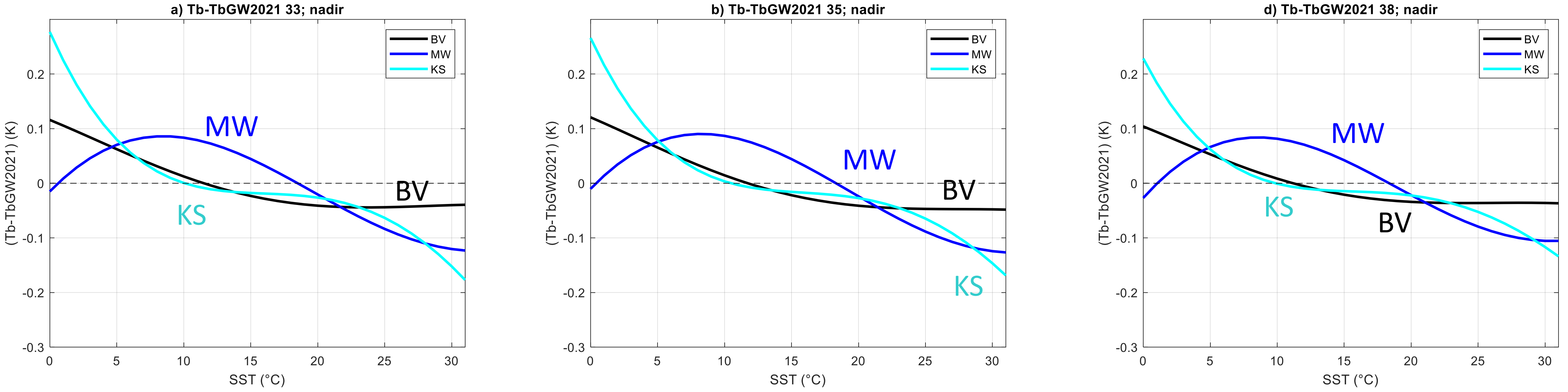


V7: reduced biases when SST <10°C and esp. <5°C

* SMOS-ESA V7 will become operational end of May 2021

Comparison to new GW 2020 parametrization

GW2020 parametrization derived from new laboratory measurements (Zhou et al. 2021)



MW, BV, GW2020 Tb lower than KS Tb at low SST

MW, BV, GW2020 Tb higher than KS Tb for SST >25°C

Overall, BV Tb closer to GW2020 than to MW or KS Tb

Differences normalized with the mean difference over all (SSS,SST) pairs

Comparison with GW2020 relationship over commonly observed oceanic conditions

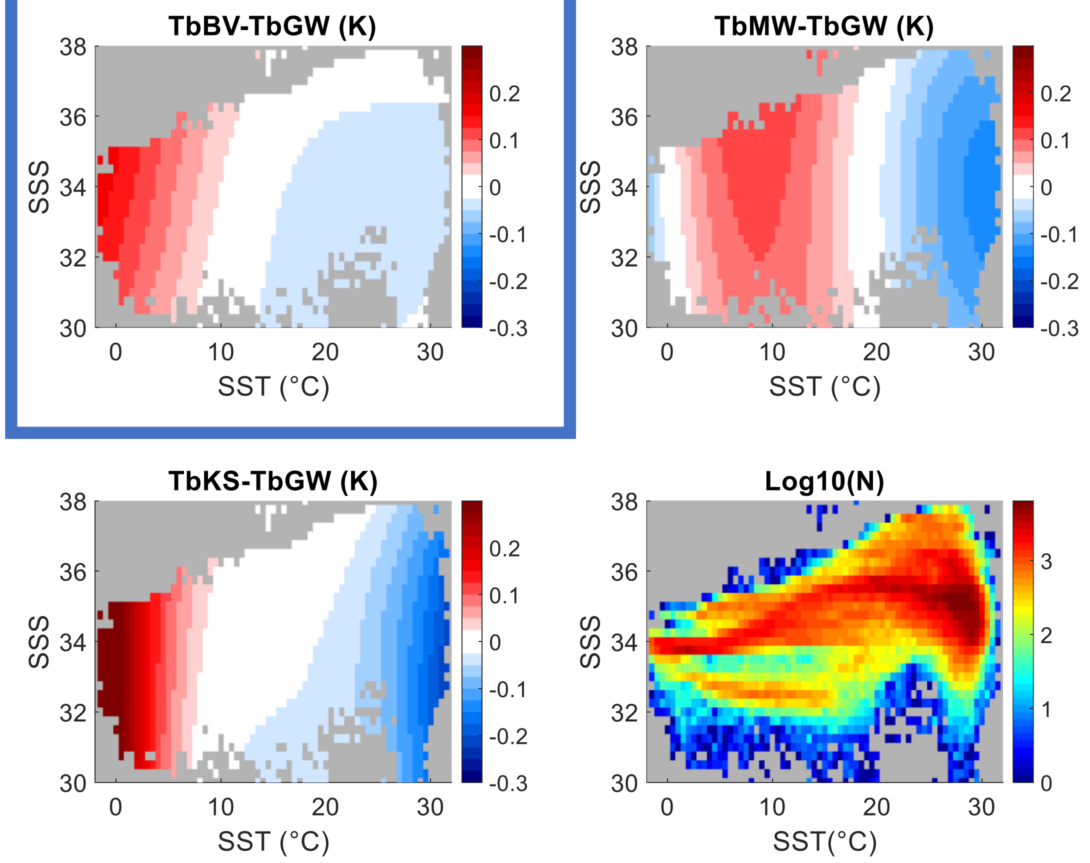


Figure: Differences in Tb (V-pol, 40°incidence angle) and number of points (bottom right), in the SSS, SST plane for SSS and SST pairs most often observed in the open ocean (70°N-70°S). The mean over all (SSS,SST) pairs (see TABLE below) has been subtracted.

	Mean (K)	Std (K)
TbBV-TbGW	0.1009	0.0592
TbBV-TbMW	-0.0802	0.0737
TbMW-TbGW	0.1928	0.0842
TbKS-TbGW	0.0753	0.1092

Mean and std difference of Tb for all SSS,SST pairs most commonly observed over the open ocean (see figure)

BV Tb closer to GW than to KS and MW Tb
Positive difference (TbBV-TbGW) at low SST (<0.15pss) (also seen in SMOS SSS comparisons)

Conclusions and perspectives

- Still some uncertainty in ε_r model at very low SST (<5°C):
  - SMOS reprocessed SSS and GW2020 Tb suggests that BV Tb could still be slightly (<0.15K) too high . But:
    - Aquarius SSS reprocessed with BV compared to Argo suggests an overestimate only for SST< 2°C
    - Aquarius SSS reprocessed with GW2020 compared to Argo scattered at low SST (Zhou et al. 2021)
  - Analysis based on satellite data only difficult: low Tb sensitivity to SSS and potential ice contamination
- Further analysis of GW results from the point of view of SMOS SSS ongoing