Assessing Drift Correction over Antarctica and Amazon

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Aquarius Calibration Meeting
1/29/2013

Objective

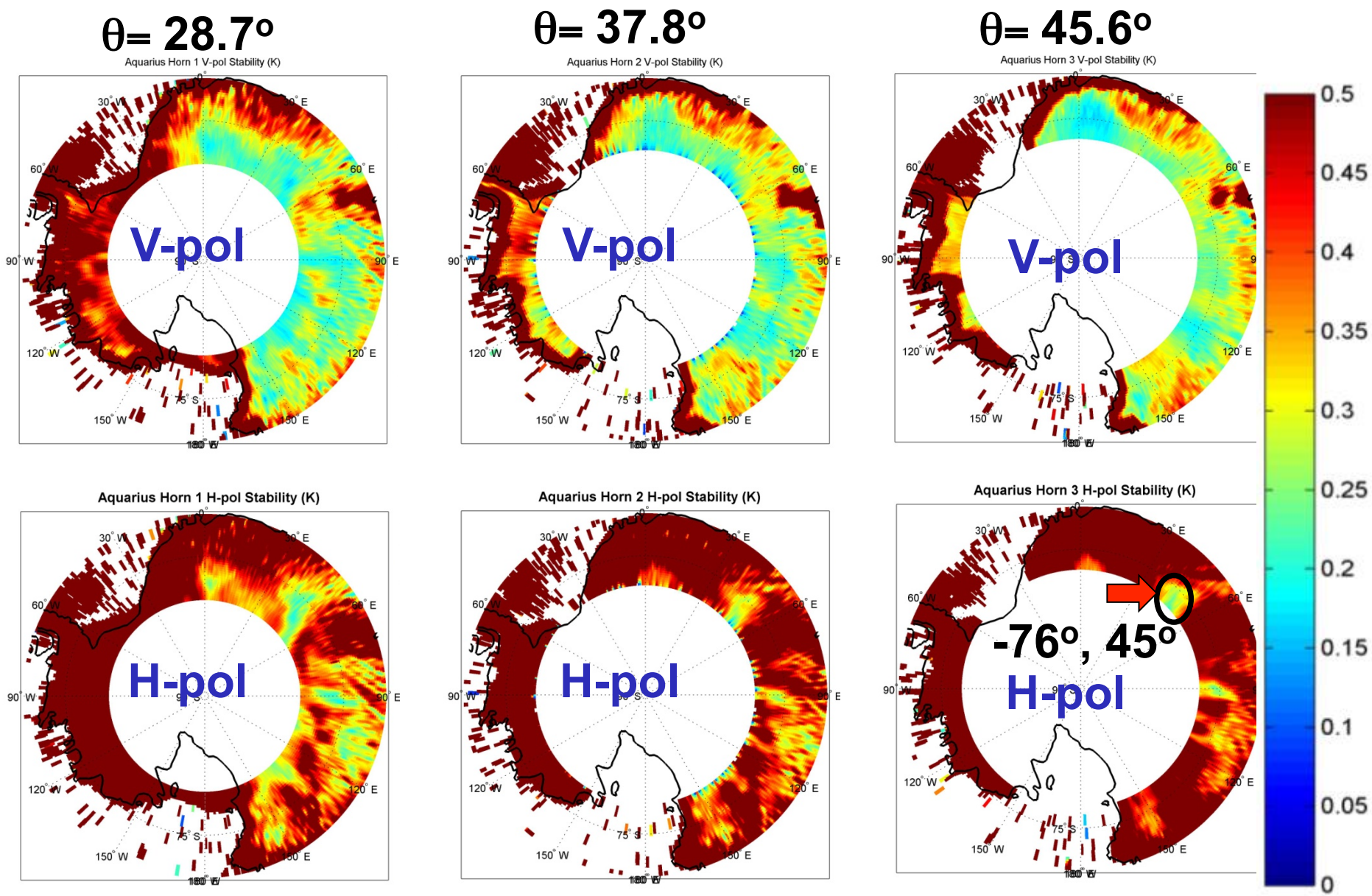
- Antarctica reference model serves as a means to assess the radiometer TA calibration stability independent of the ocean model
- Does the exponential gain drift correction remove the observed drift over Antarctica?
- Is there evidence for "calibration wiggles" observed over ocean in Aquarius - Antarctica model differences (or Aquarius - Amazon depolarized model differences)?
  - If yes: then they are due to instrument variability (identify magnitude over ice, warm end -> gain vs offset correction)
  - If no: then they are likely due to residual model errors
  - Not easy (e.g. 0.1K gain "wiggle" would be 0.05K over ice, lesser over Amazon)

Summary

- **Exponential drift correction successfully removes observed drift over Antarctica**
  - **Confirms gain (e.g. noise diode) drift as source**
- **Calibration wiggles <u>are</u> observed in Antarctic model differences and have the same magnitude as those observed over the ocean**
- **Calibration wiggles <u>are</u> observed over warm rainforest regions in inter-channel differences and have a similar magnitude as those observed over the ocean**
  - **Suggests quasi-monthly variability observed in TA-TAexp over ocean is due to TA calibration drift**
  - **Suggests that correction should be implemented as an offset correction**

Antarctic Modeling
(Drift)

Aquarius L-band Temporal Stability (Sep'11-July'12)

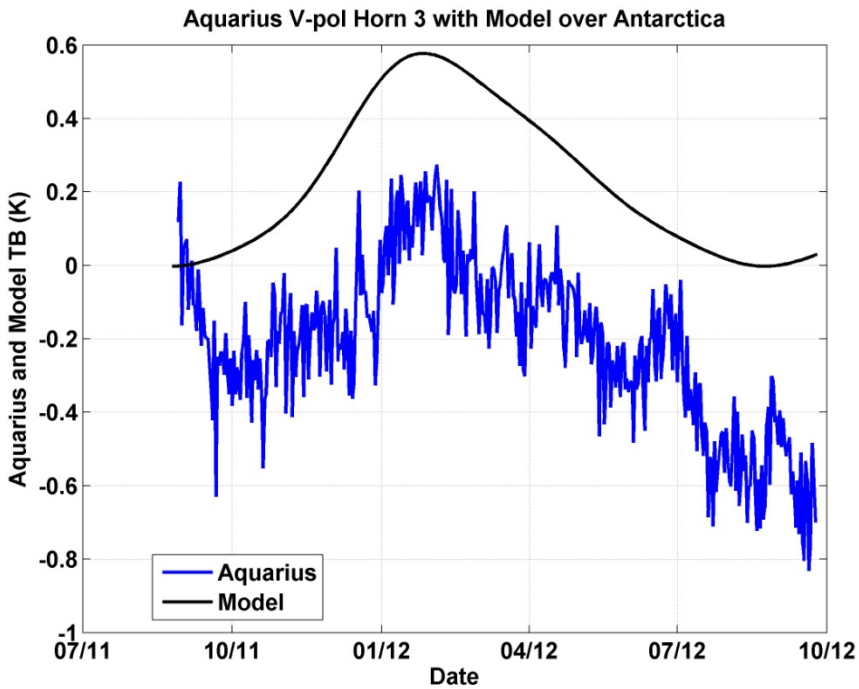


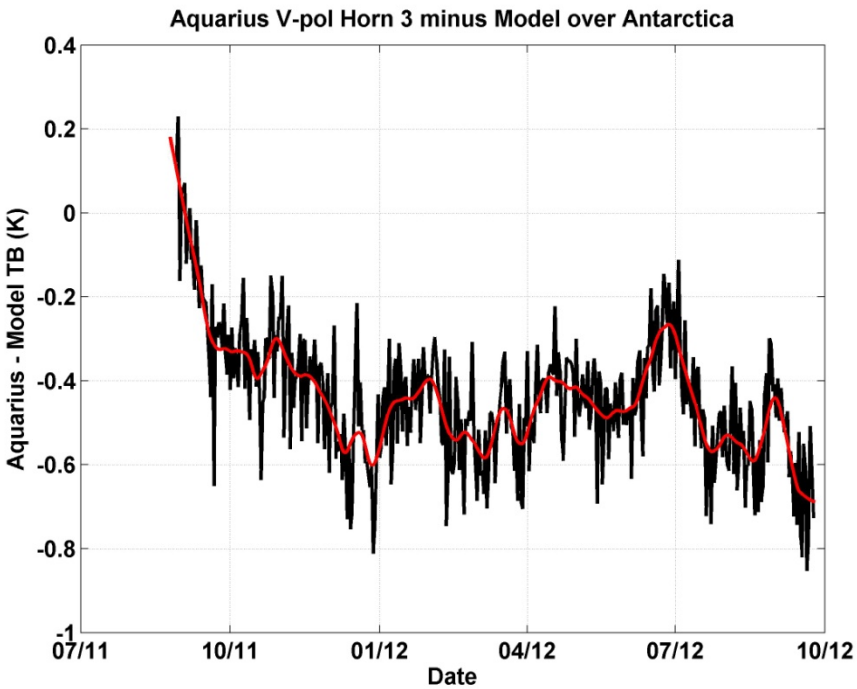
Antarctica Ice Model

- **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
- **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
- **Currently does not account for short time scale near surface firn variability**
  - Limits ability for H-pol, particularly at higher incidence angle
  - Initial results using higher frequency 6-37 GHz observations (e.g. WindSat, AMSR-2) to constrain dynamic snow variability shows promise

V1.3.5 rad_TbV0

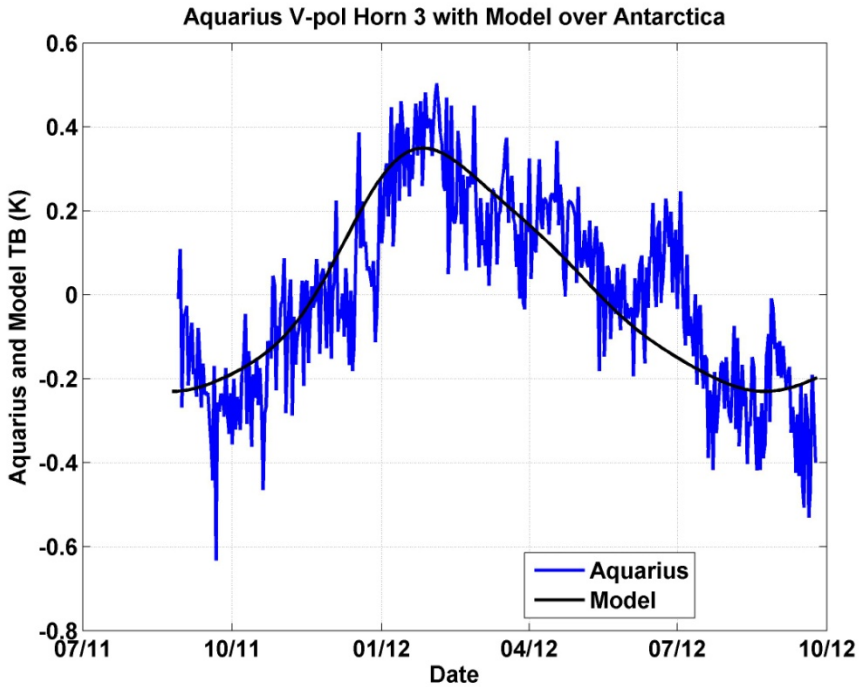
- **Horn 3 V-pol shown here as an example to assess exponential drift correction since ice model performs best near Brewster angle (minimizes sensitivity to surface variability, wind crusts)**

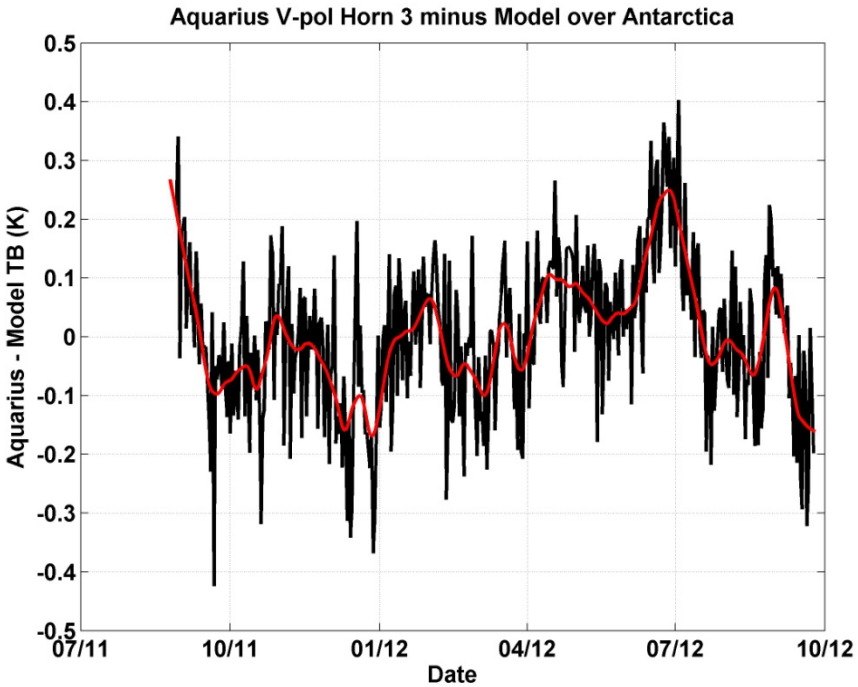


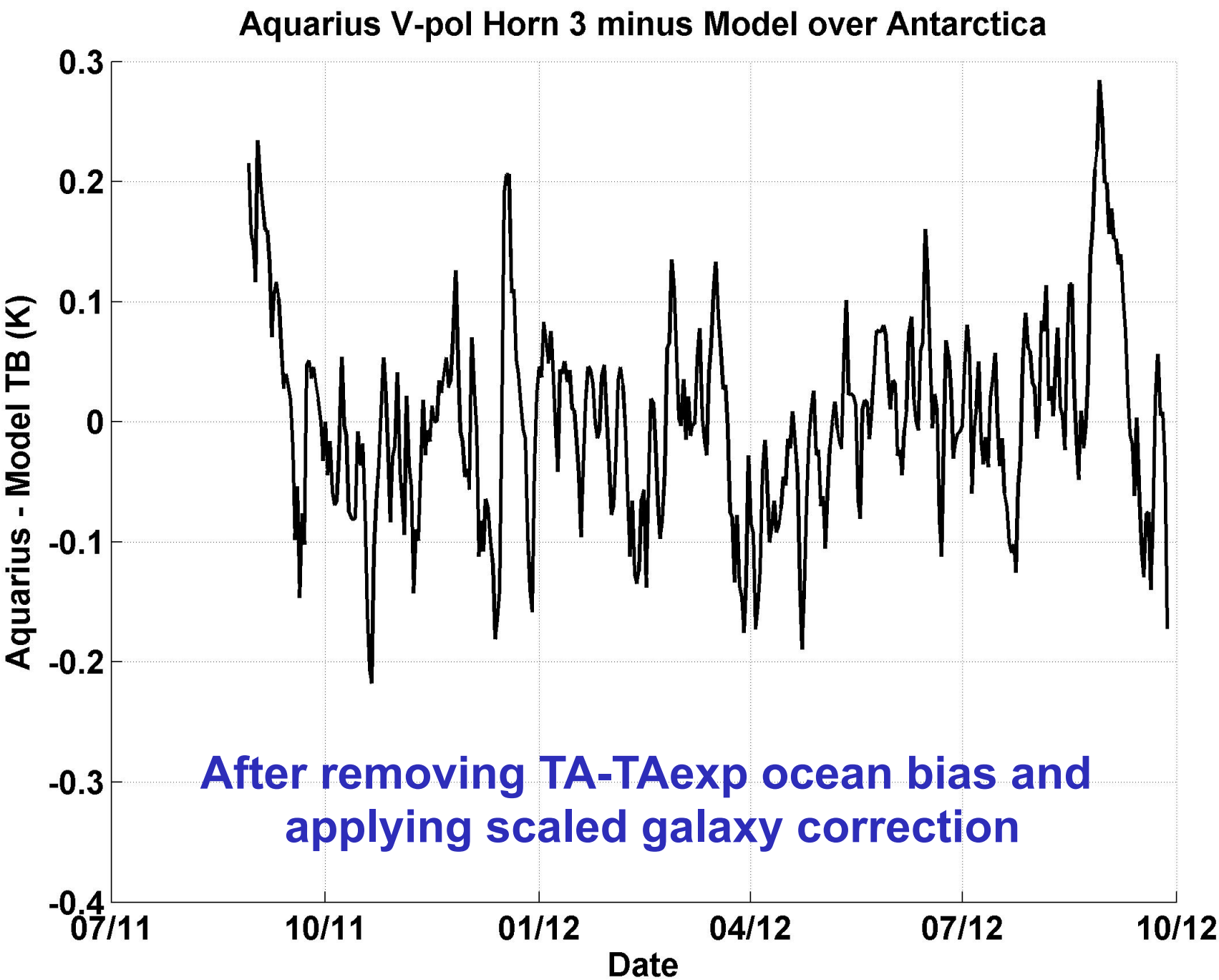


V1.3.5 rad_TbV

- **Exponential TND correction removes long term drift over Antarctica**
  - **Note, if offset correction was applied instead of a gain correction, a ~ +0.5K drift would have been introduced over Antarctica**

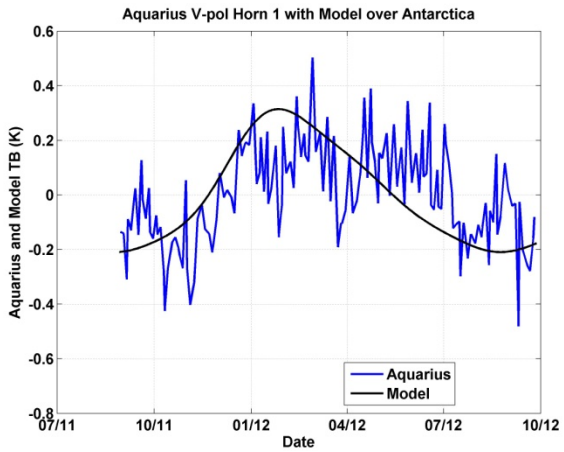


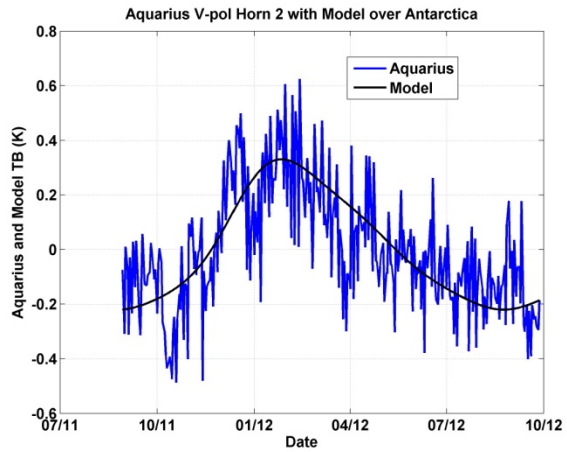


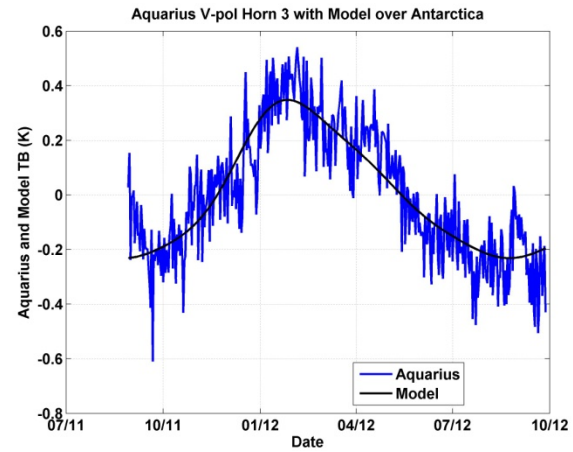

Aquarius V-pol Horn 3 minus Model over Antarctica
Aquarius - Model TB (K)
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
07/11
10/11
01/12
04/12
07/12
10/12
Date
After removing TA-TAexp ocean bias and applying scaled galaxy correction

V-pol Drift Corrected v1.3.5 TB with Model

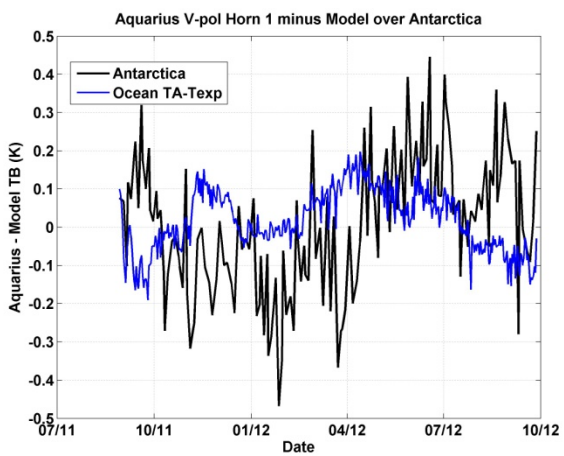
- **All channels in good agreement with model after applying gain drift correction based on ocean TA drift estimates**

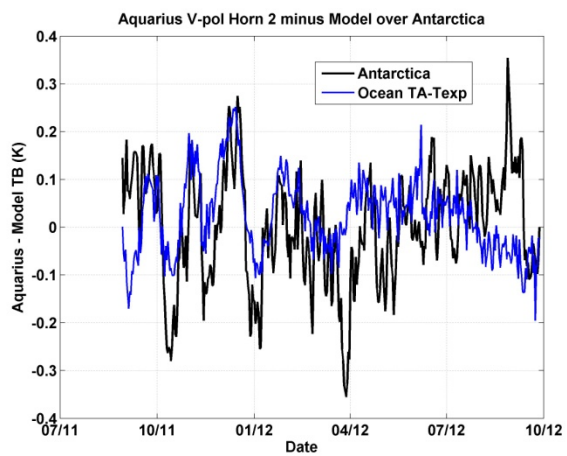


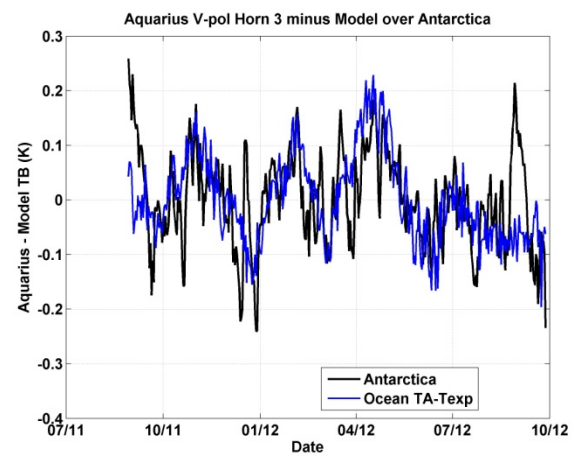




Aquarius- Model

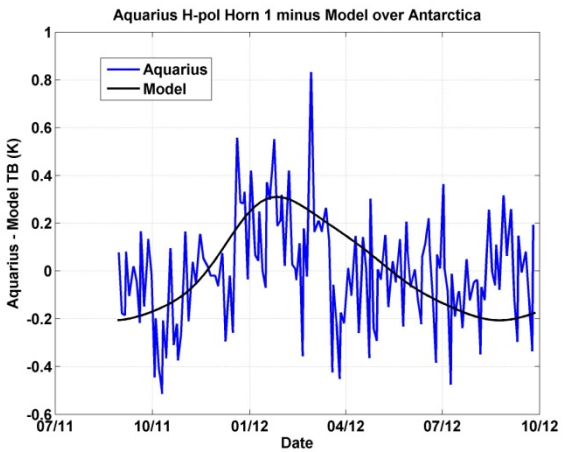


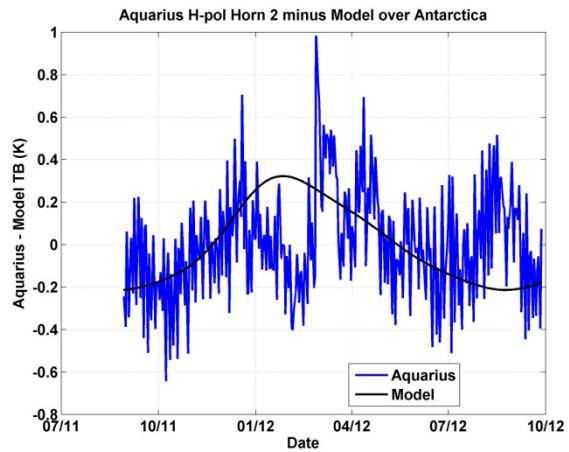


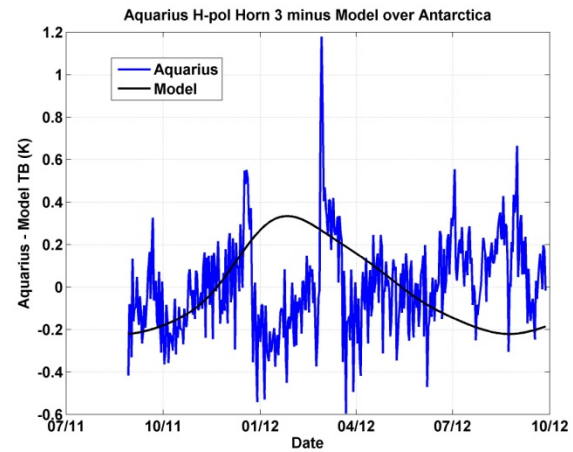


H-pol Drift Corrected v1.3.5 TB with Model

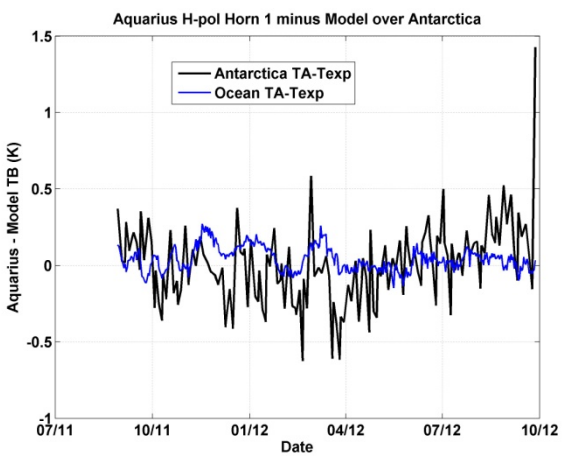
- **H-pol comparisons nosier due to ice surface variations currently not accounted for in model, but no evidence of residual drift**

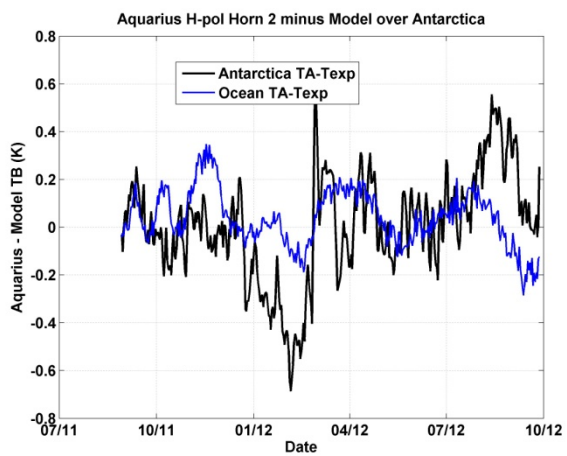


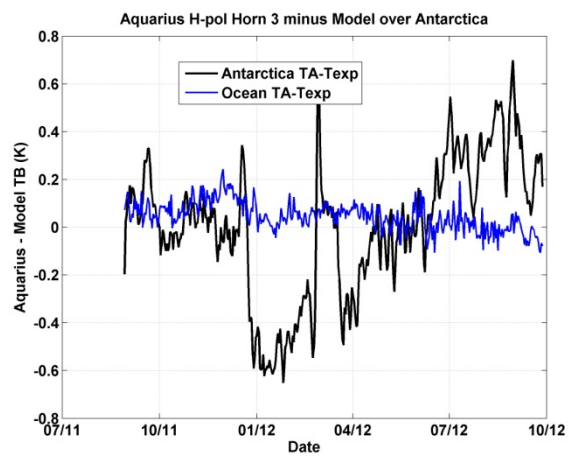




Aquarius- Model





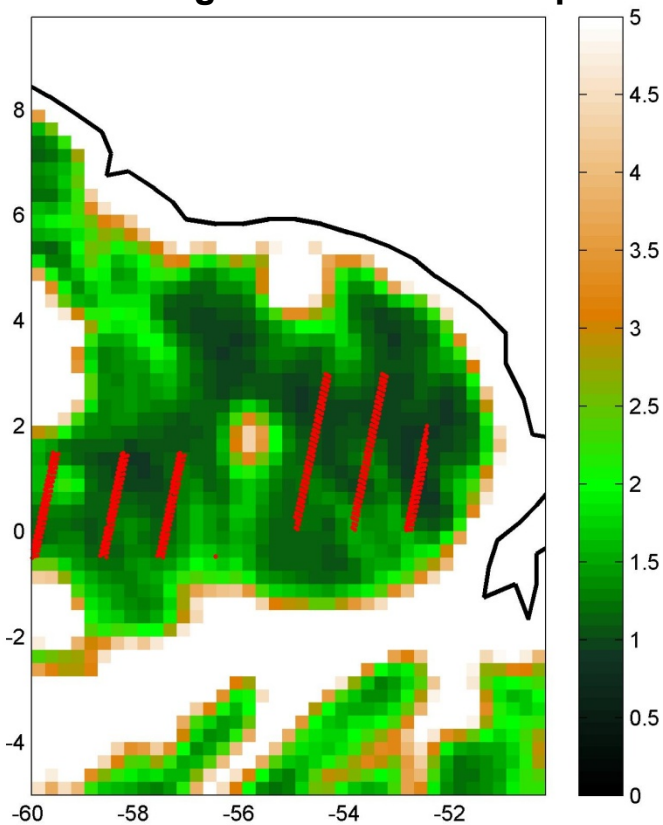


Amazon Modeling
(Wiggles)

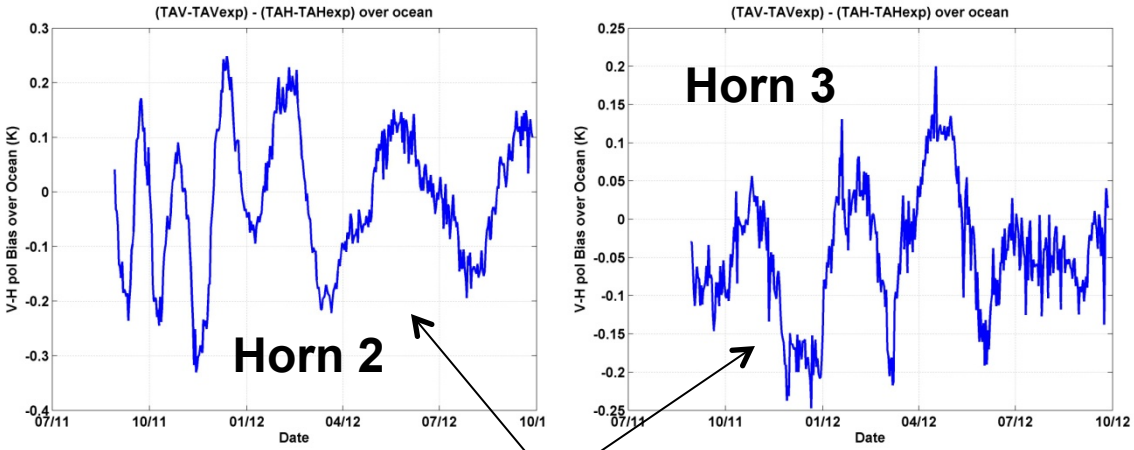
Warm Rainforest Regions

- **Offset error should be apparent in rainforest comparions**
- **Currently, uncertainty in TA over rainforest regions at > 0.1K level on time scales < 30 days mainly due to uncertainty in T_{canopy}, but…**

Amazon Region TMI 10 GHz De-polarization



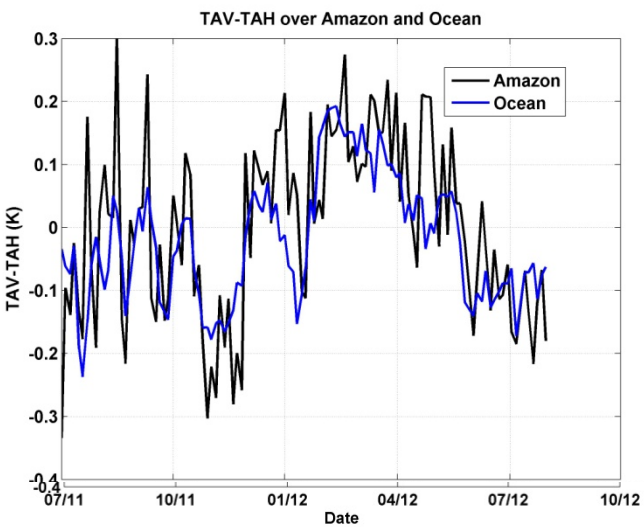
these uncertainties largely cancel if looking at inter-channel differences

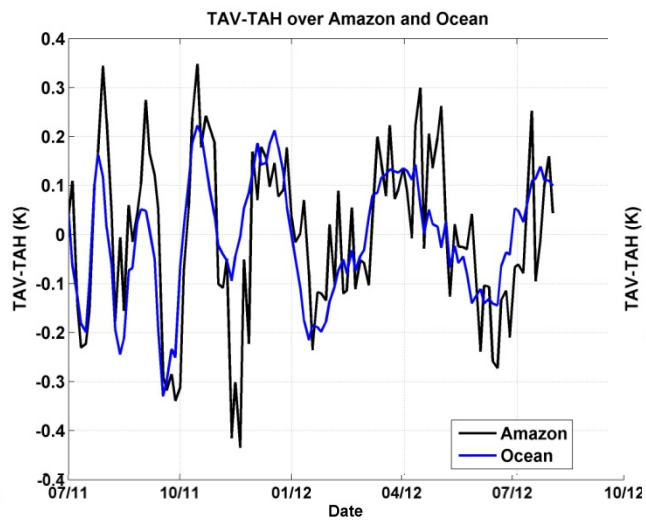


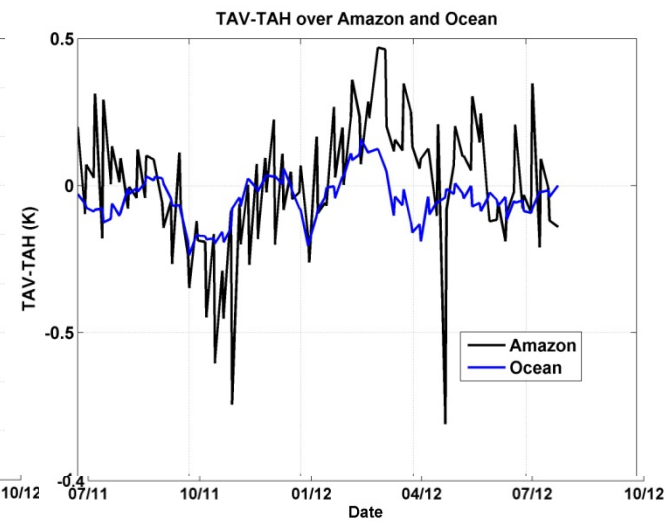
$$\left(T_V - T_{V\_Expected}\right) - \left(T_H - T_{H\_Expected}\right)$$

Inter-Channel Differences over Rainforest

- Uncertainty in T_{canopy} largely cancels in V-pol – H-pol difference over the rainforest regions
- Assuming that surface emissivity is stable (and depolarized), then these inter-channel differences allow us to assess relative offsets compared to ocean

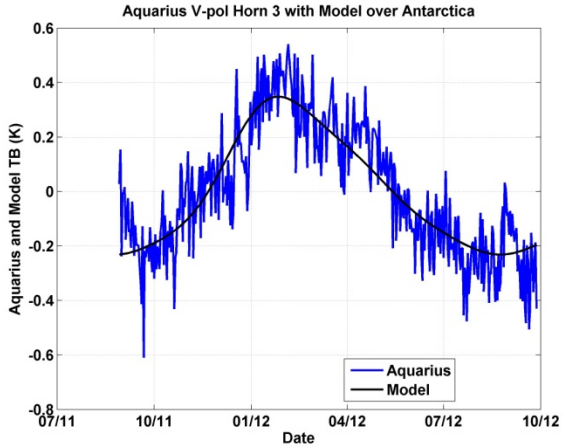


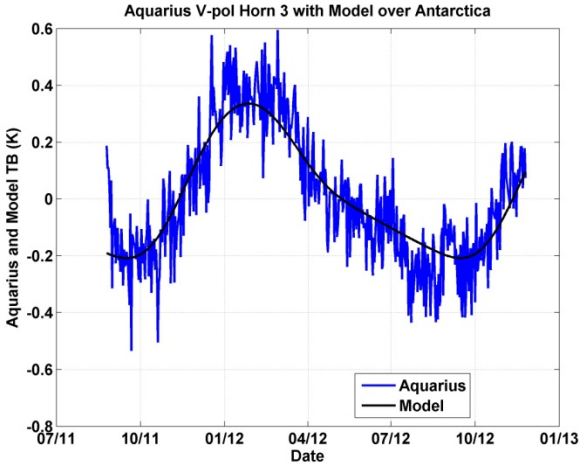




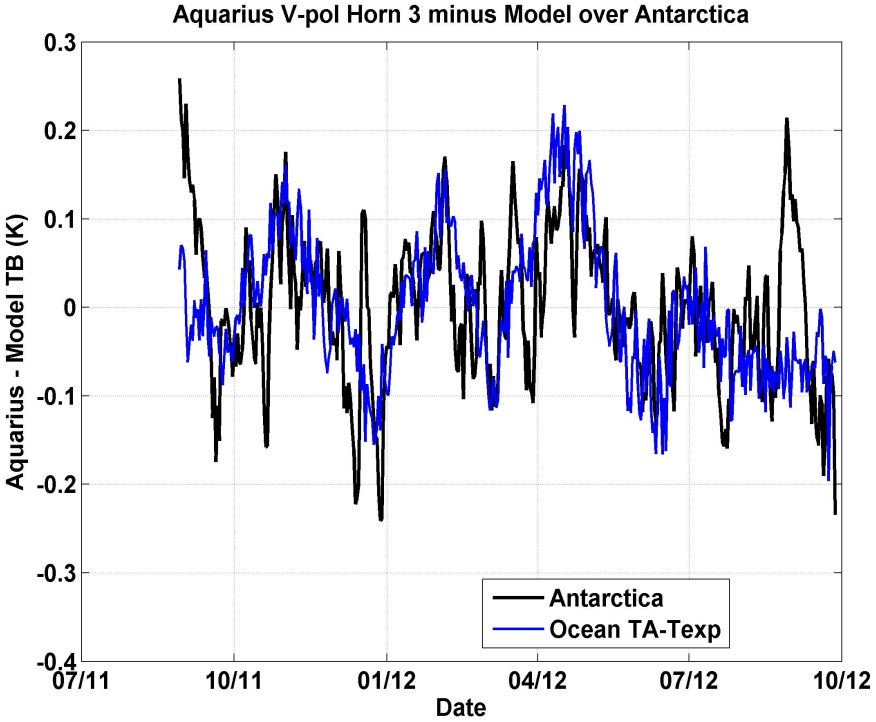
Quick Look – Current Wiggle Correction

Horn 3 V-pol Antarctica

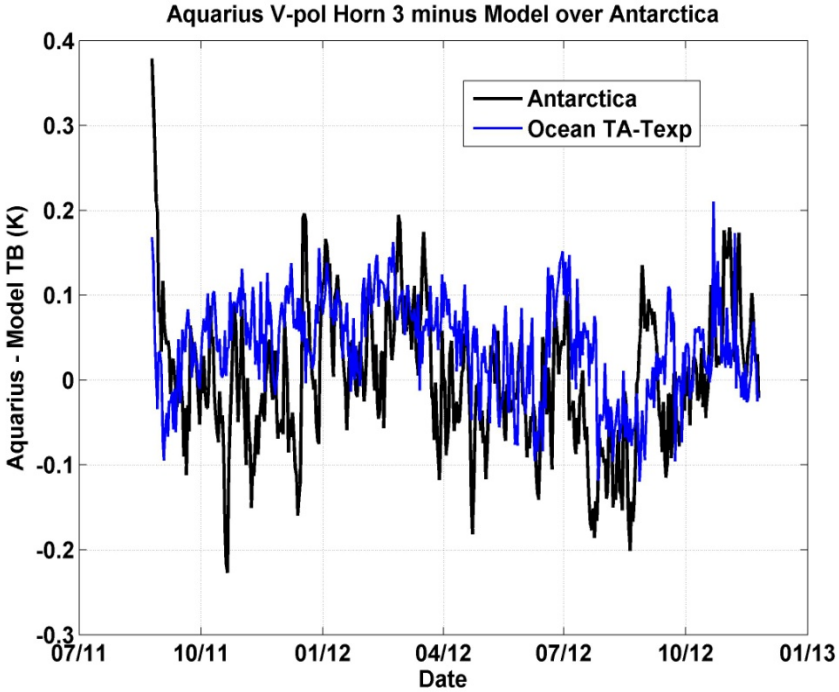


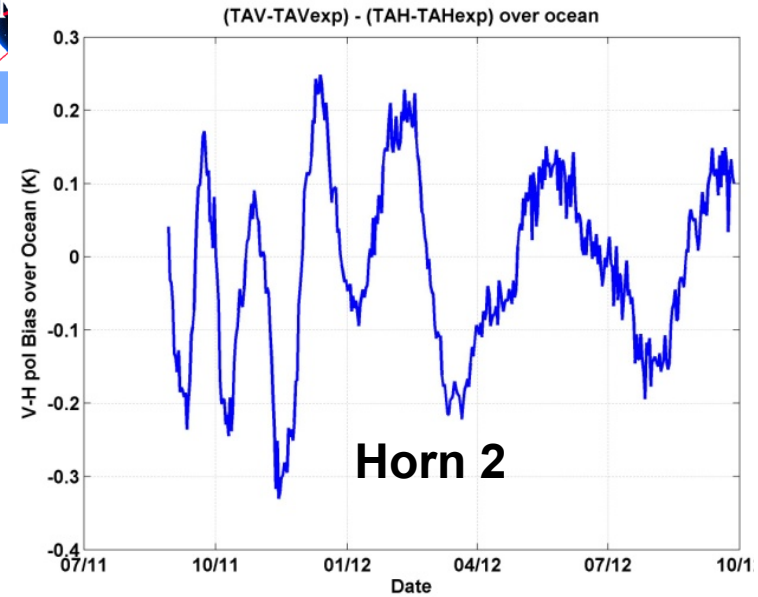


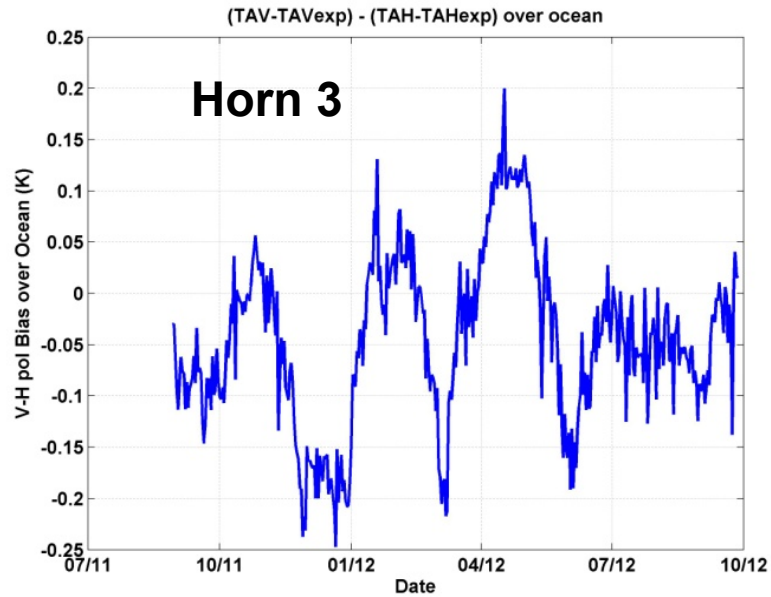
V1.3.5 with exponential drift correction



V1.3.7 with exponential drift correction + wiggle offset correction



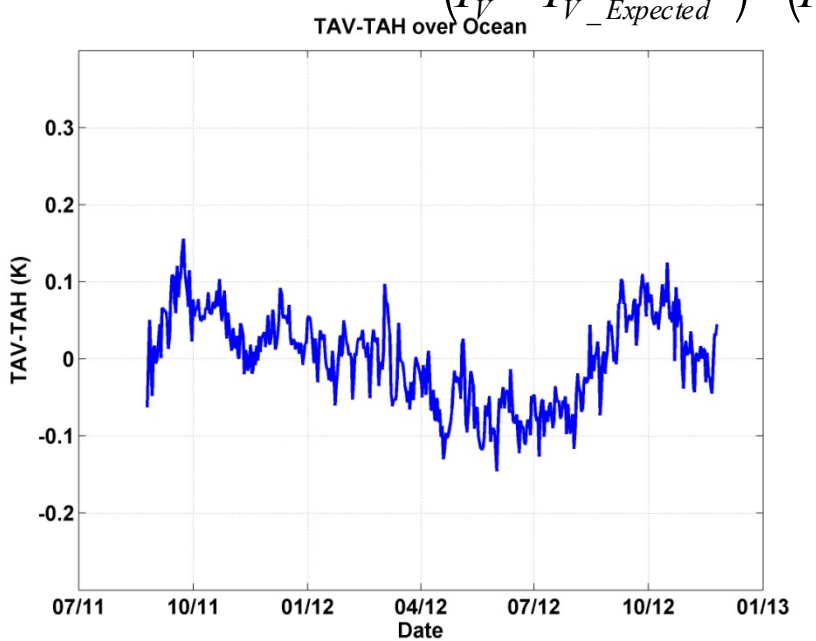


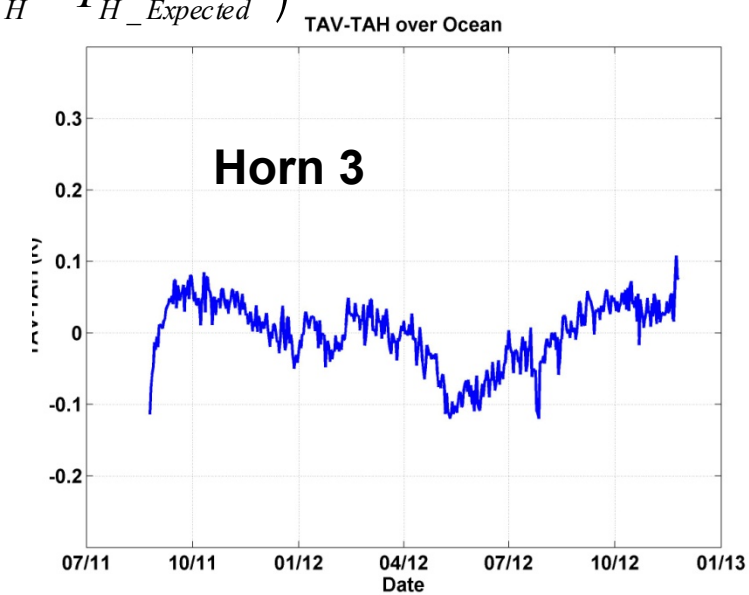


V1.3.5

$$\left(T_V - T_{V\_Expected}\right) - \left(T_H - T_{H\_Expected}\right)$$

Ocean





V1.3.7

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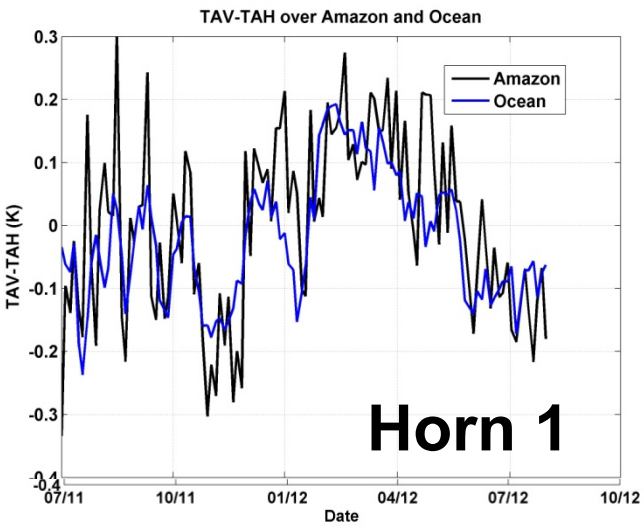
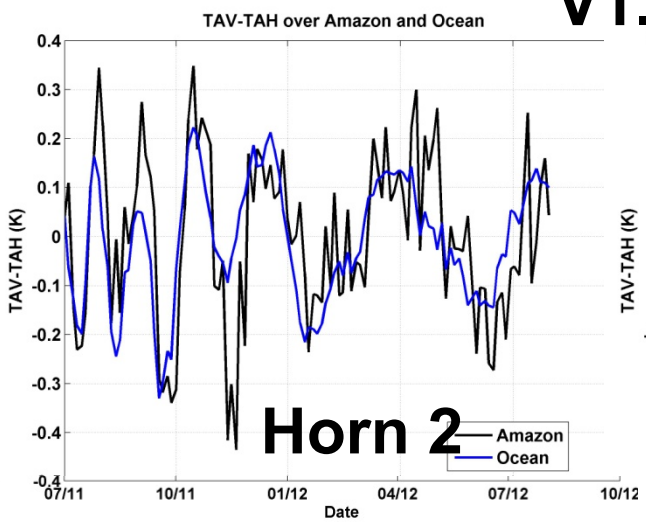
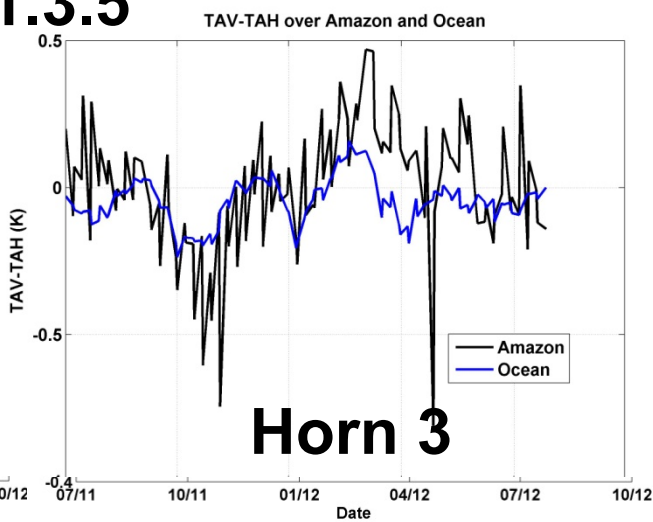
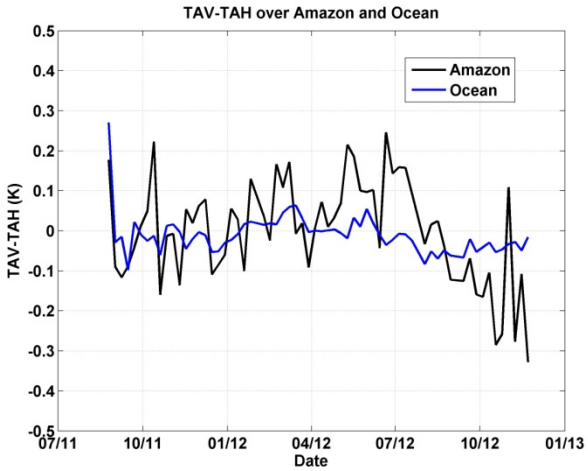
V1.3.5

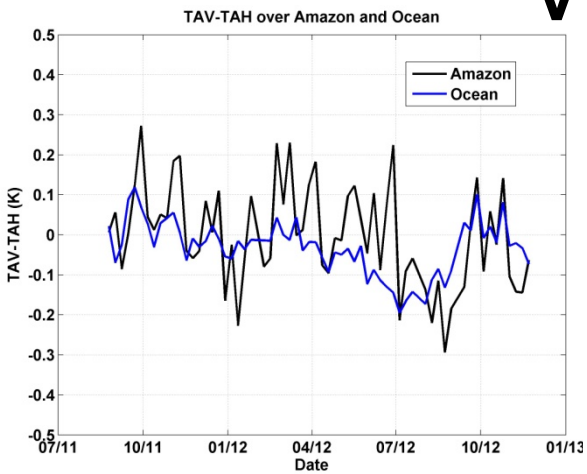


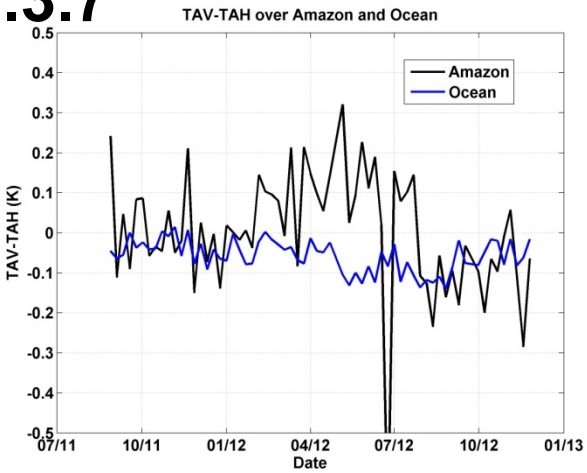




V1.3.7







Summary

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  - **Confirms gain (e.g. noise diode) drift as source**
- **Calibration wiggles <u>are</u> observed in Antarctic model differences and have the same magnitude as those observed over the ocean**
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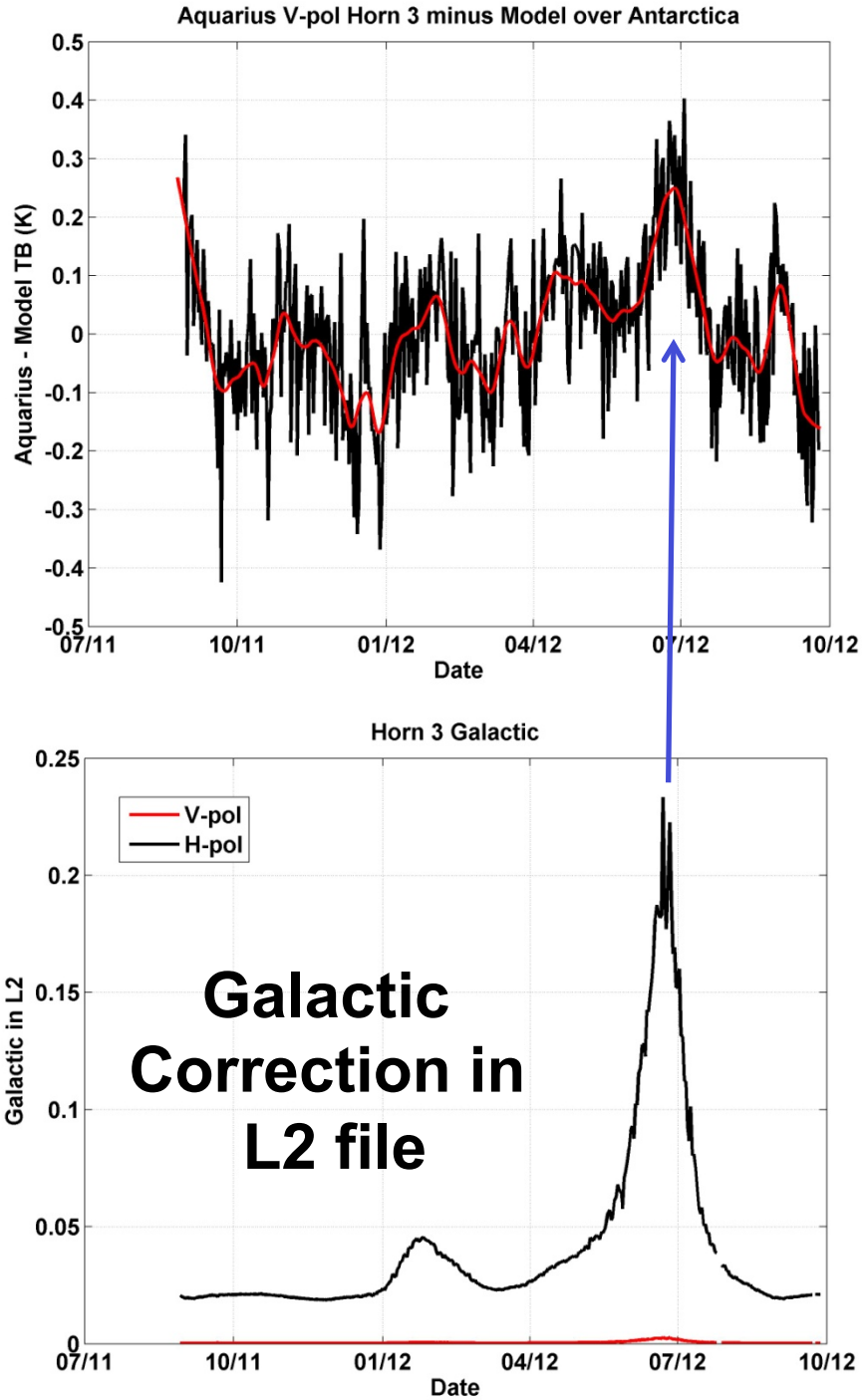
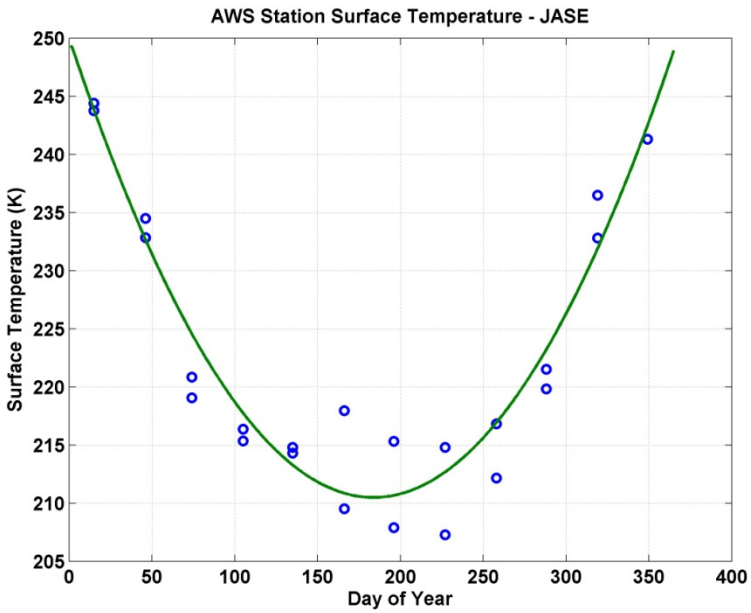
  - **Suggests quasi-monthly variability observed in TA-TAexp over ocean is due to TA calibration drift**
  - **Suggests that correction should be implemented as an offset correction**

Backup Slides

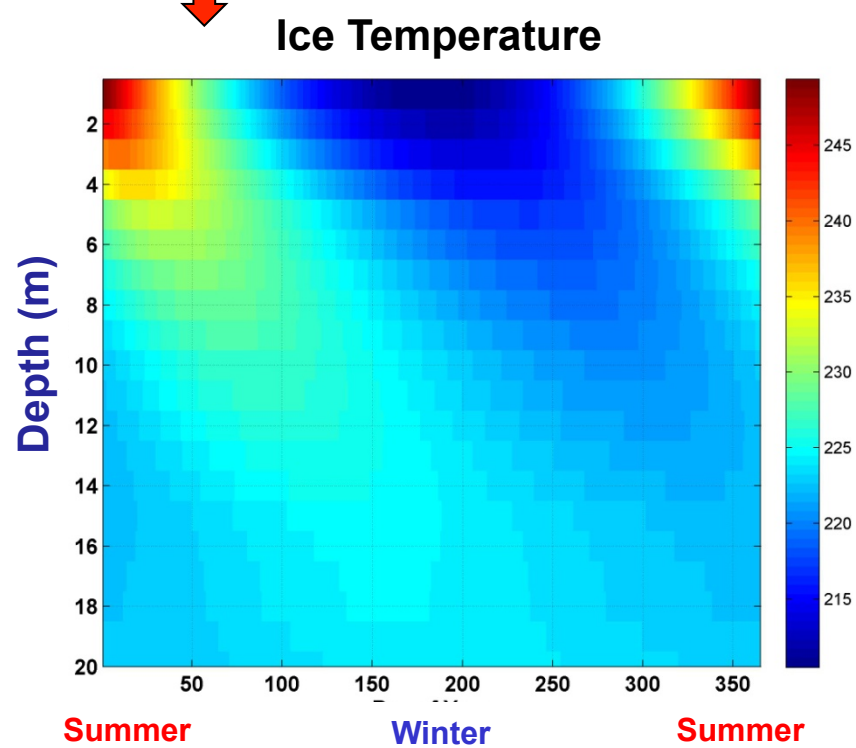
- **Deviation from model in July 2012 appears to be from reflected galaxy**
  - **Need to scale galactic contribution in L2 file to remove**



Thermal Profile



$$\frac{\partial T}{\partial t} = \alpha_T(\rho)\frac{\partial^2 T}{\partial z^2}$$

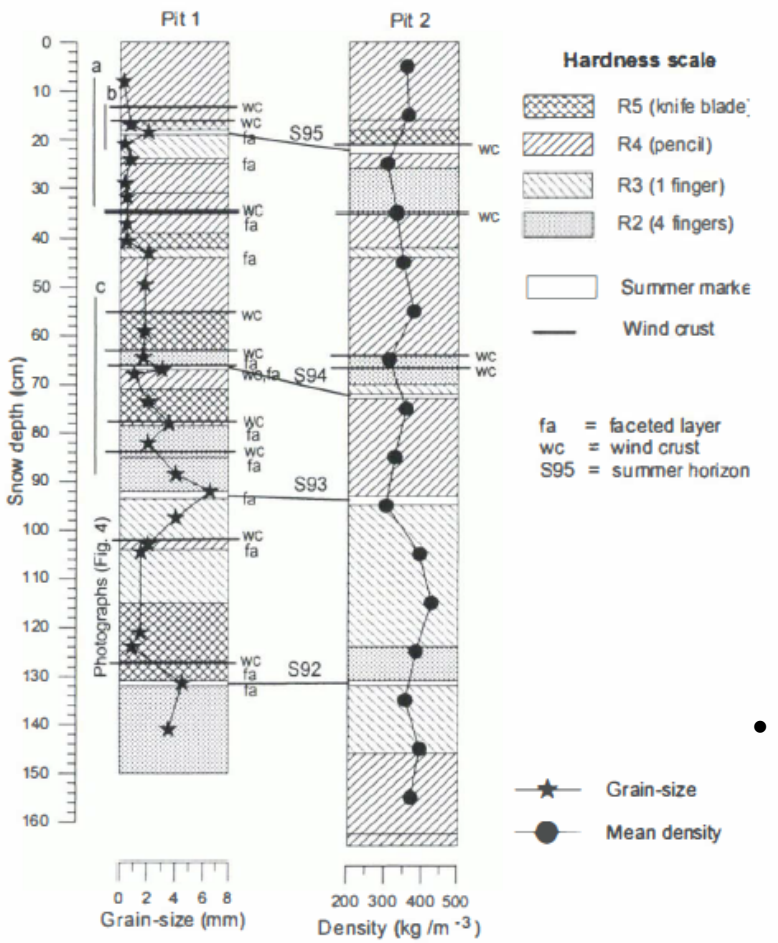


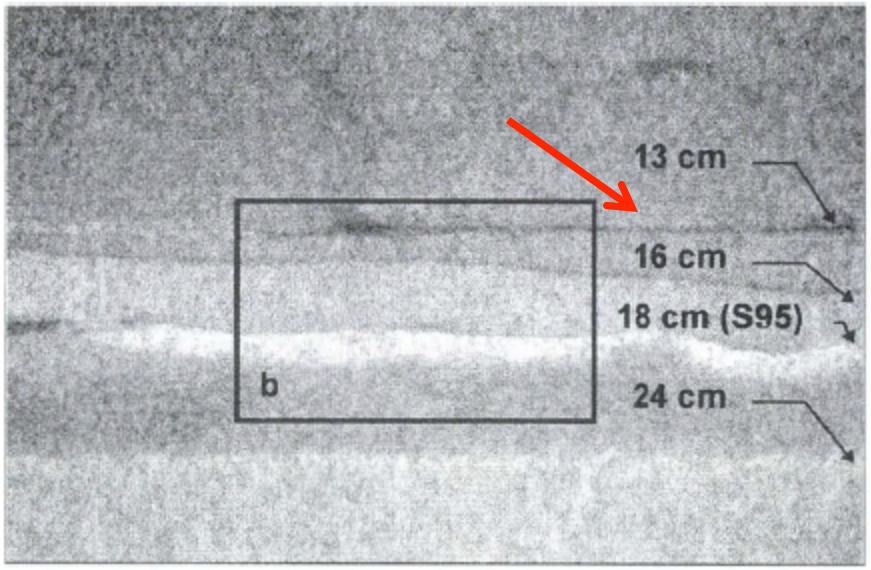
Surface temperature values obtained from near by AWS station (JASE) used as top boundary condition

Solved heat equation numerically to determine T(z,t) assuming only vertical heat transport

Thermal diffusivity increases as a function of density (Paterson, 2000)

Snow Structure



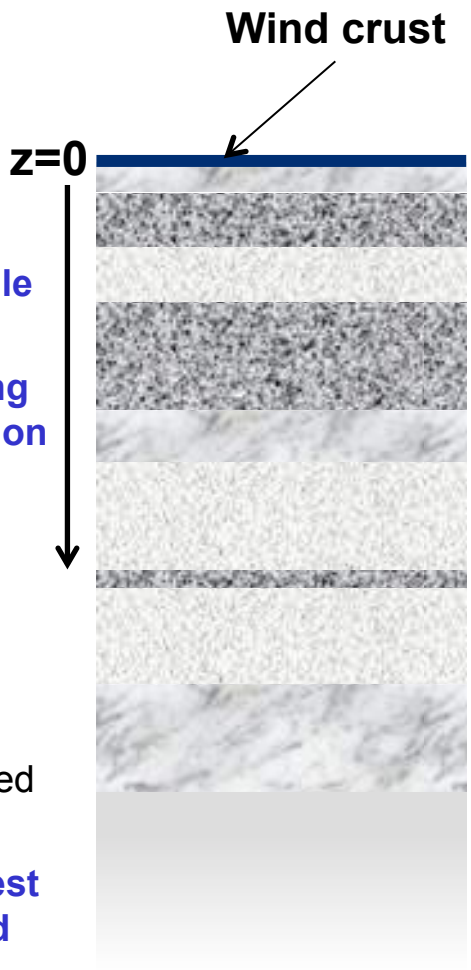


Steffen et al., 1999

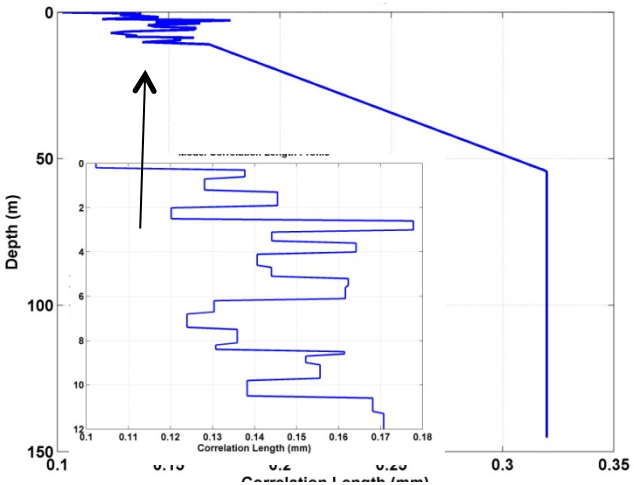
- **Snow structure near top surface contains layers with variable thickness, density and grain size (e.g. Steffen et al., 1999; Macelloni et al., 2006)**
- **Wind crusts (thin, high density) can be present**

TB Model

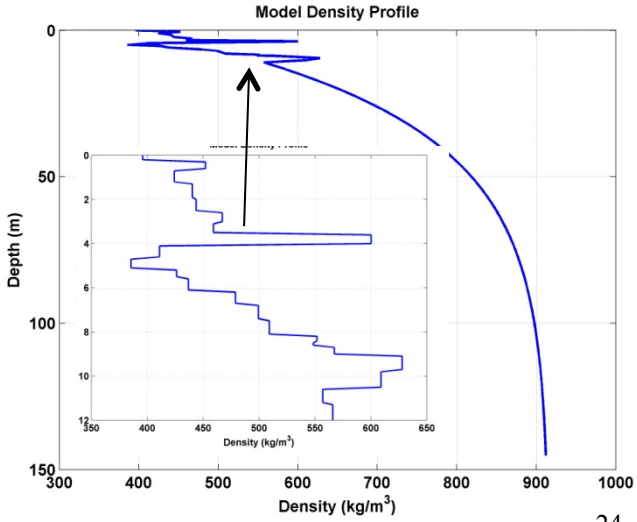
- **MEMLS model (Wiesmann and Matzler, 1999) used to compute upwelling TB**
  - **Started with exponentially increasing density profile and increasing correlation length profile**
  - **Generated multiple realizations of snow structure by randomly adding layers of varying density, correlation length and thickness to first 20 m**
    - Density variations based on measurements found in literature (e.g. Steffen et al., 1999; Paterson, 2000; Macelloni et al., 2007)
    - Correlation length profile based on Matzler (2002)
  - **Chose realization that provided best fit to AMSR-E 6.9 – 36.5 GHz V-and H-pol TBs**
  - **Ice dielectric model from Tiuri et al., (1984) gave best fit AMSR-E data**

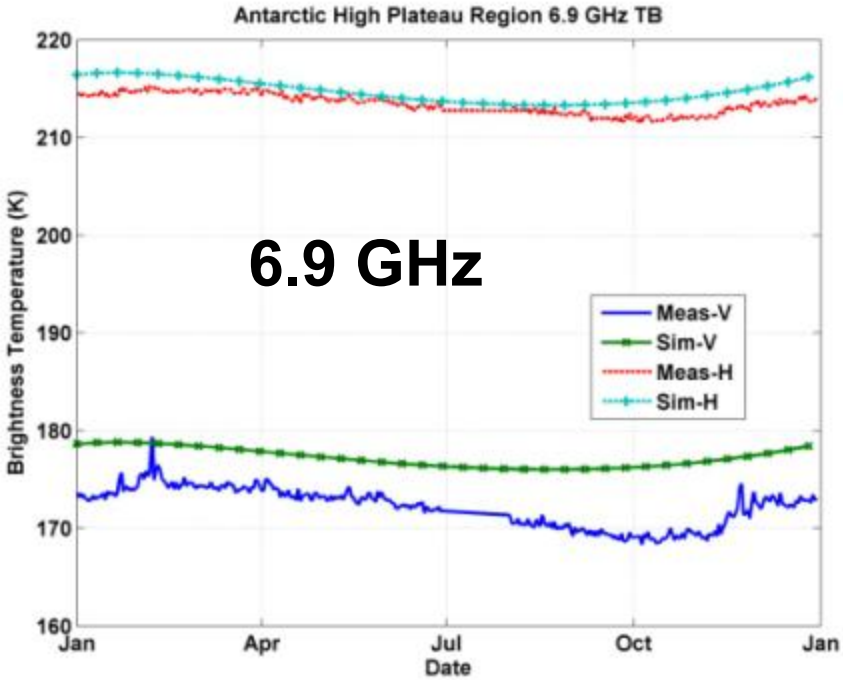


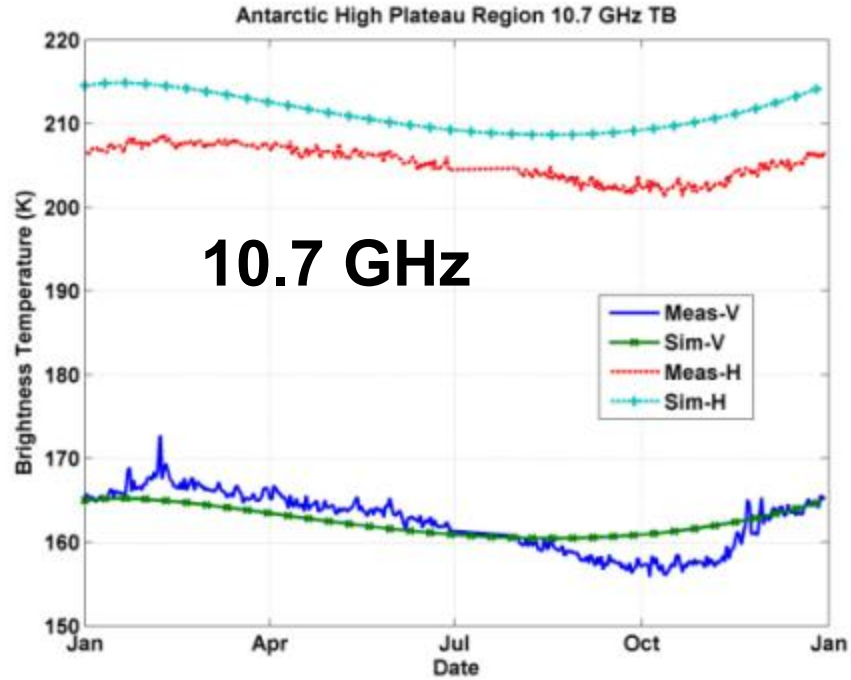
Correlation Length Profile

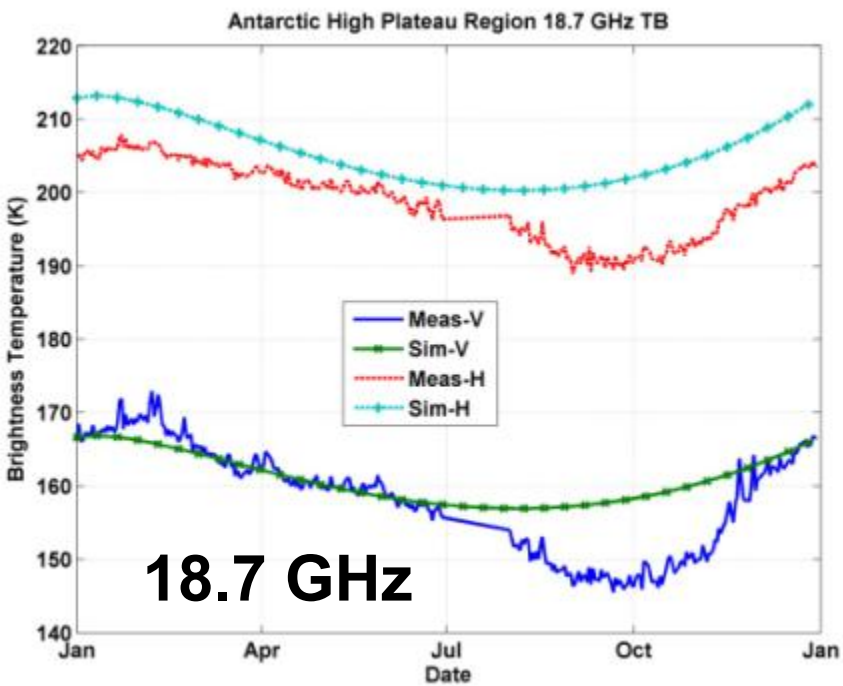


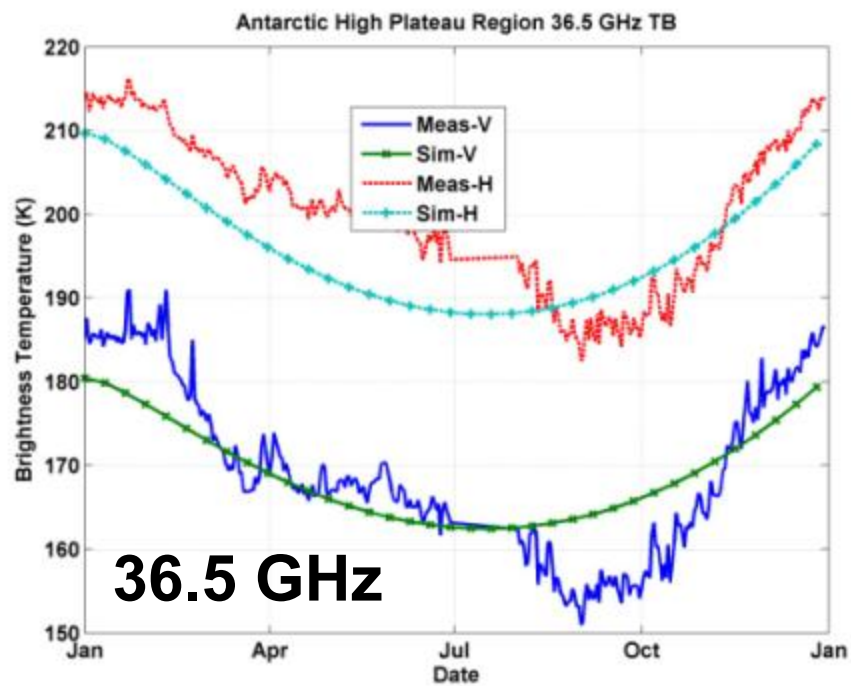
Density Profile




Antarctic High Plateau Region 6.9 GHz TB
6.9 GHz
Meas-V
Sim-V
Meas-H
Sim-H
Brightness Temperature (K)
Date
Jan
Apr
Jul
Oct
Jan
160
170
180
190
200
210
220


Antarctic High Plateau Region 10.7 GHz TB
10.7 GHz
Meas-V
Sim-V
Meas-H
Sim-H
Brightness Temperature (K)
Date
Jan
Apr
Jul
Oct
Jan
150
160
170
180
190
200
210
220


Antarctic High Plateau Region 18.7 GHz TB
18.7 GHz
Meas-V
Sim-V
Meas-H
Sim-H
Brightness Temperature (K)
Date
Jan
Apr
Jul
Oct
Jan
140
150
160
170
180
190
200
210
220


Antarctic High Plateau Region 36.5 GHz TB
36.5 GHz
Meas-V
Sim-V
Meas-H
Sim-H
Brightness Temperature (K)
Date
Jan
Apr
Jul
Oct
Jan
150
160
170
180
190
200
210
220