Summary of changes in the land model and plan for the land correction

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Summary of changes

Discontinuities

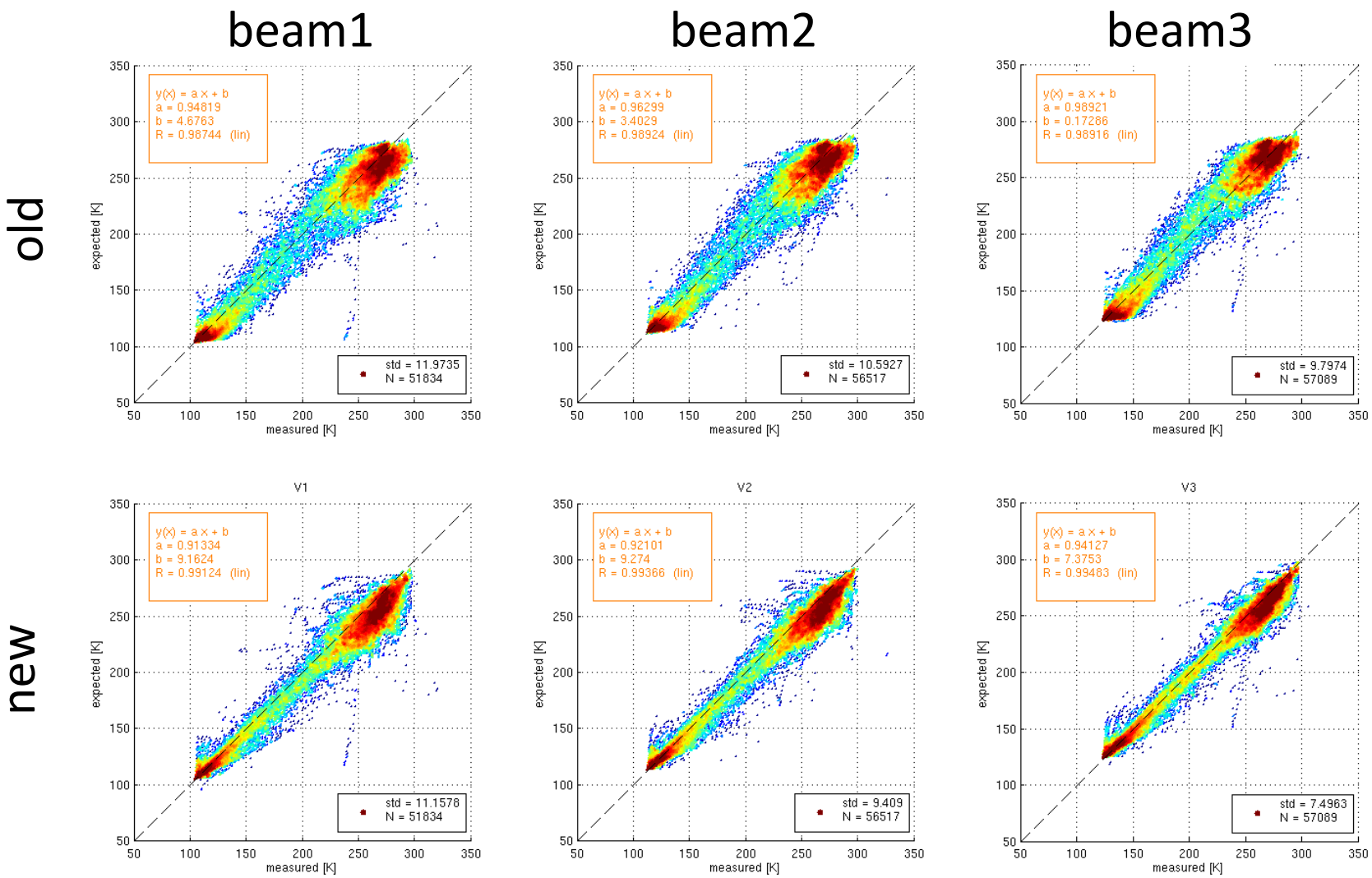
1. Faraday angle (from IGS over land)
2. Ancillary SM near the coasts
3. Difference between frozen and non-frozen soils
4. Land & sea ice fractions (weighted fractions over land)

Consistency with SMAP

5. Land cover classification (ECOCLIMAP to MODIS IGBP)
6. Dielectric mixing model (from Dobson to Mironov)
7. Vegetation opacity
8. Single-scattering albedo (now depends on the land cover)
9. Roughness parameters (now depends on the land cover)
10. Soil attributes (now depend on the land cover)
11. Ancillary LST (from NCEP to GEOS-5)
12. Ancillary SM (from NCEP to GEOS-5)

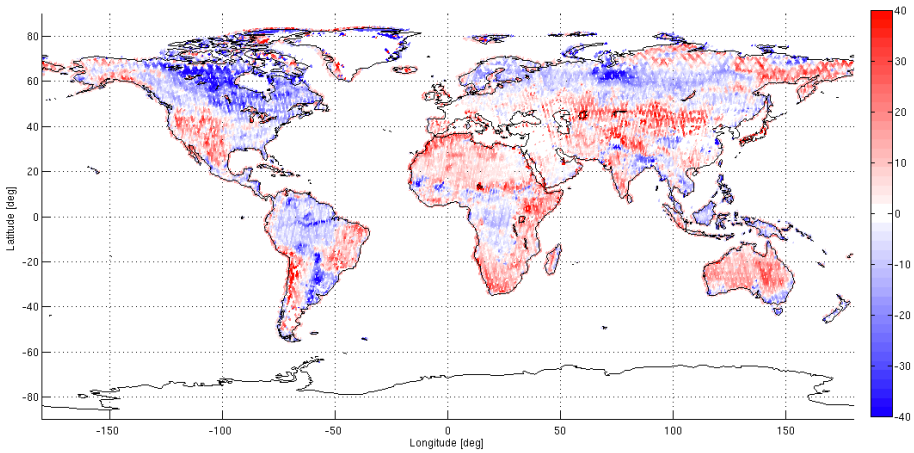
13. Bug fixes

Ta vs Ta_exp (1st week of July 2014)



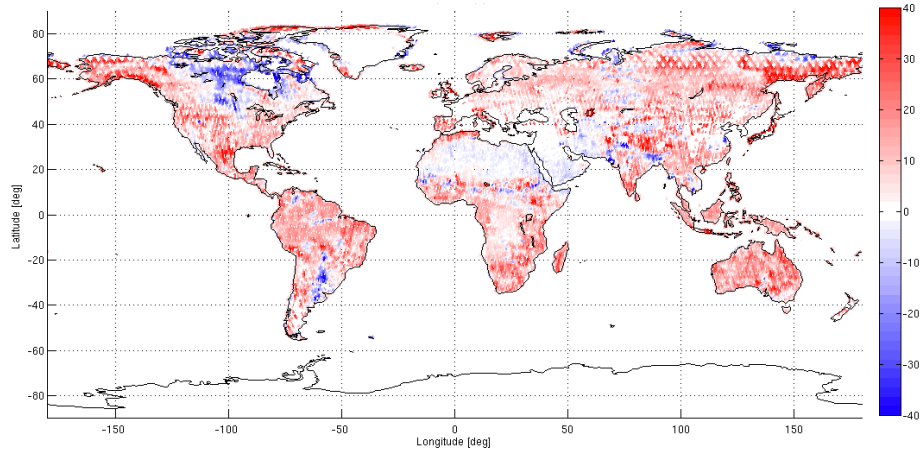
Ta - Ta_exp (1st week of July 2014)

old



RMSE = 16.5 K

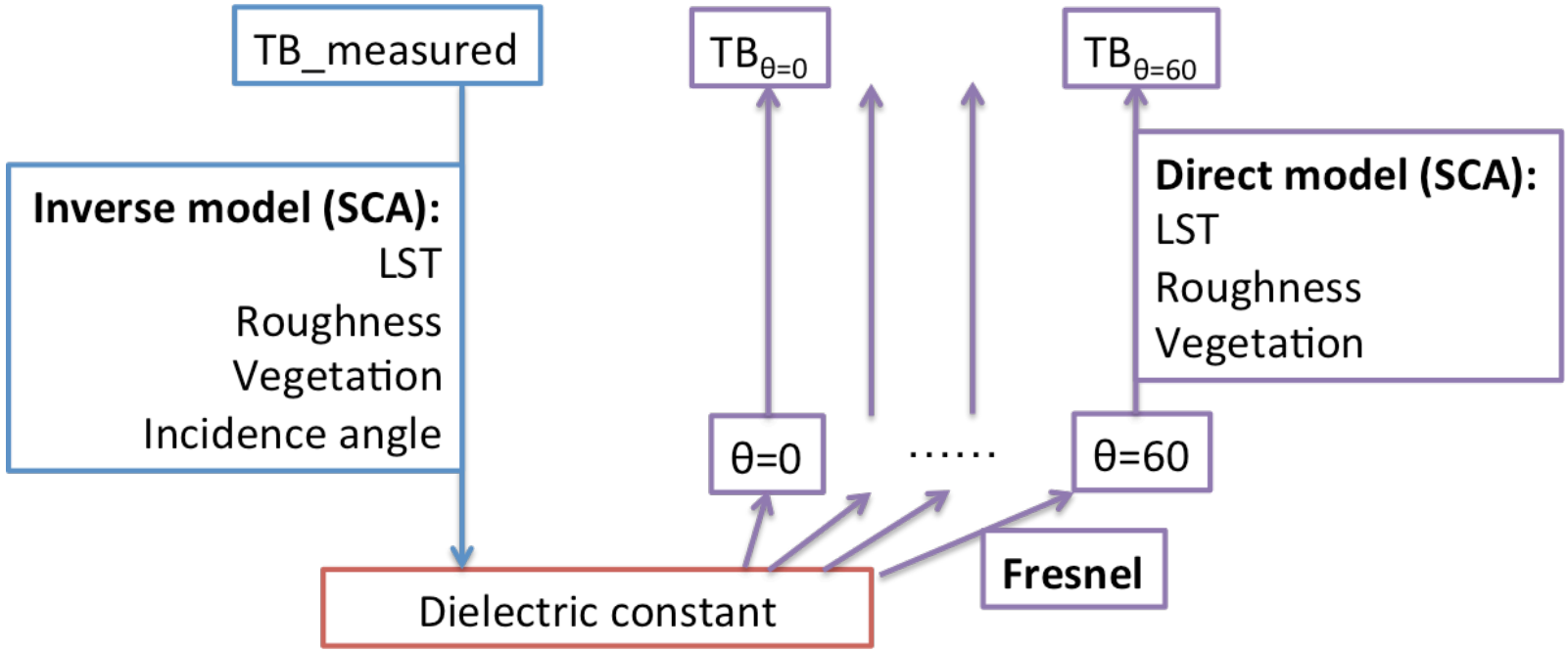
new



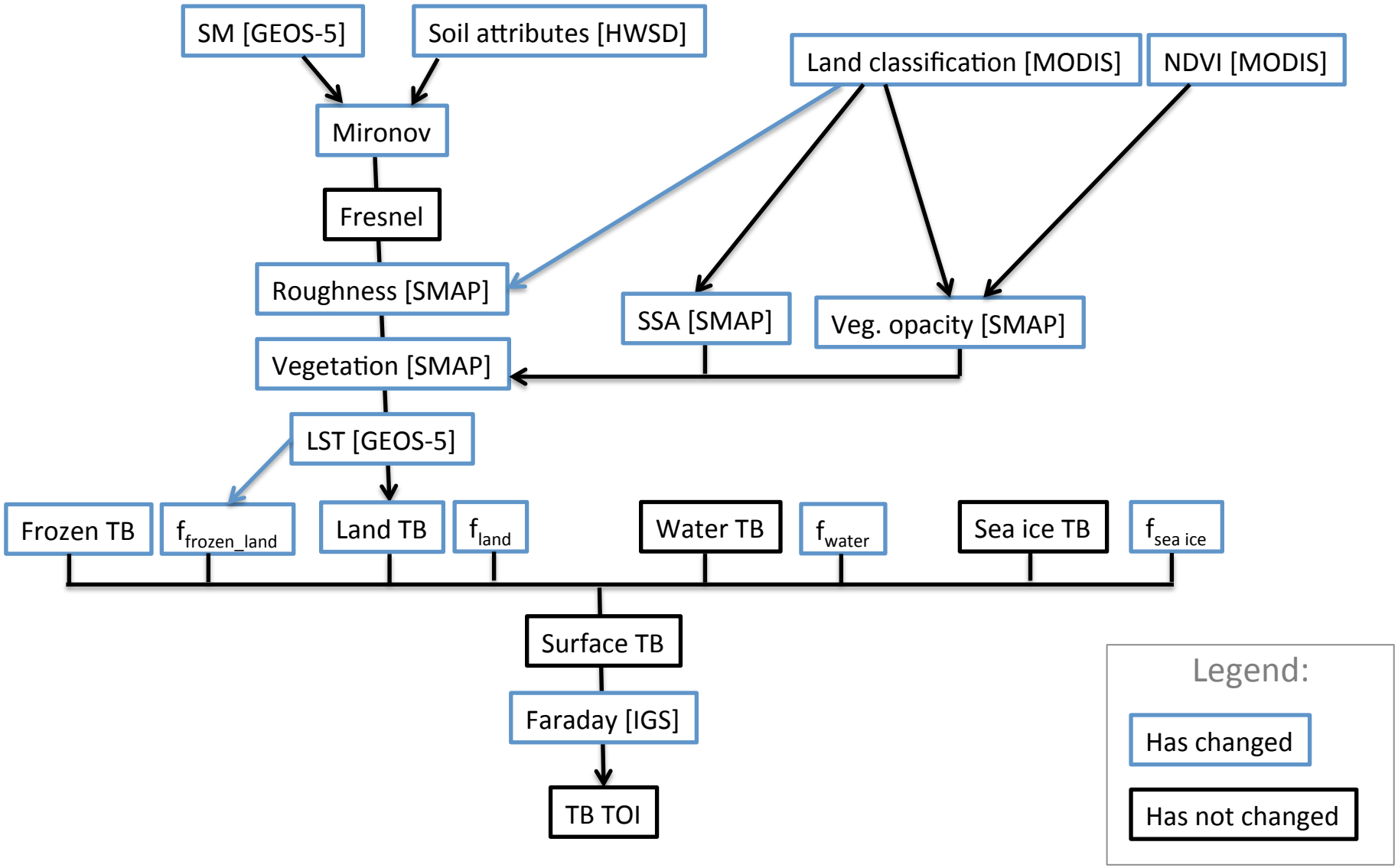
RMSE = 15.3 K

Plan for the land correction

Goal: estimate the land correction from the measured land TB
Approach: for all points on land, retrieve the dielectric constant of the flat surface, then use the Fresnel model to compute the reflectivity at different incidence angles. The same land model would be used twice.



Forward land model



H-pol

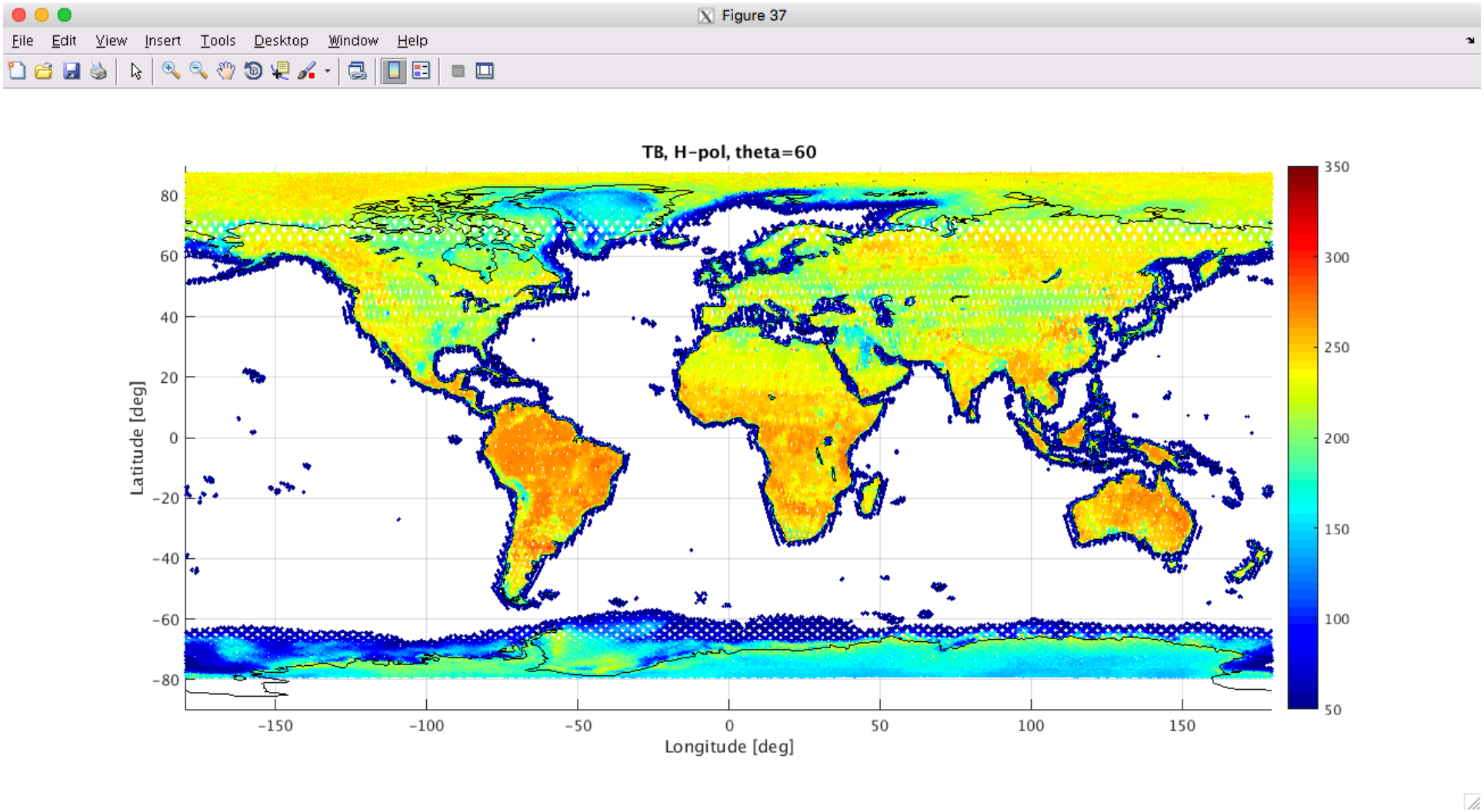


Figure 37
File Edit View Insert Tools Desktop Window Help
TB, H-pol, theta=60
Latitude [deg]
80
60
40
20
0
-20
-40
-60
-80
-150
-100
-50
0
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100
150
Longitude [deg]
350
300
250
200
150
100
50

V-pol

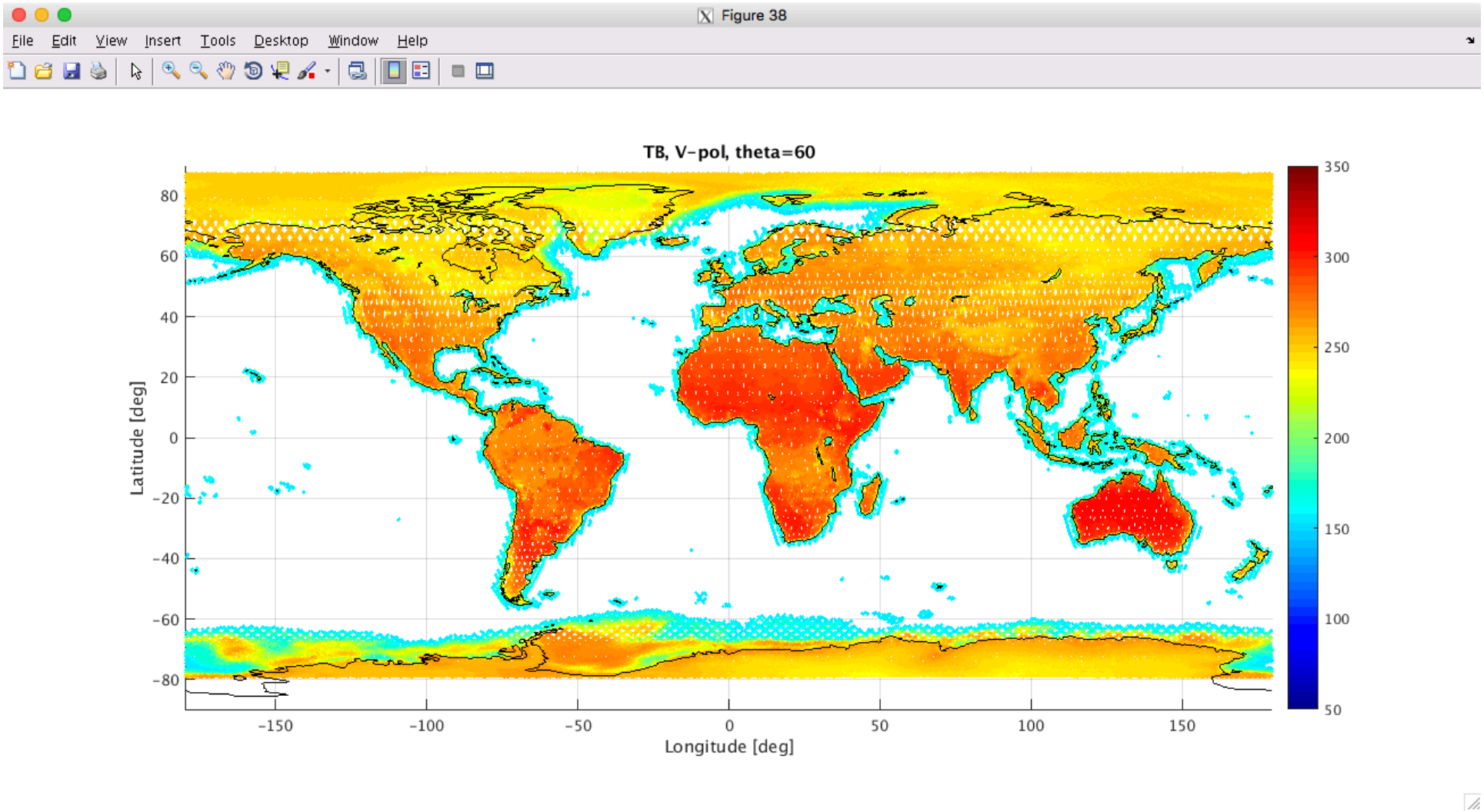
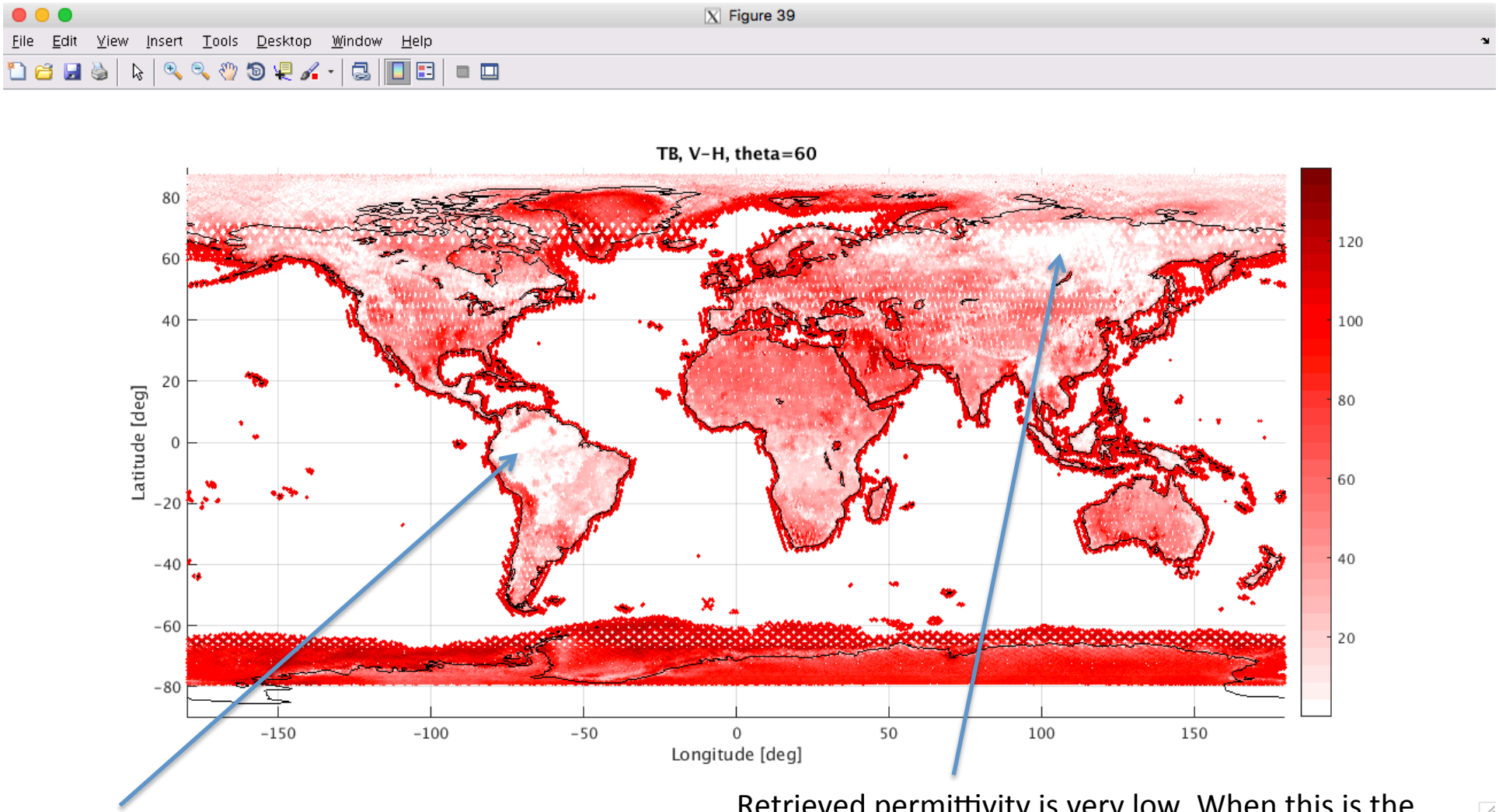


Figure 38
File Edit View Insert Tools Desktop Window Help
TB, V-pol, theta=60
Latitude [deg]
80
60
40
20
0
-20
-40
-60
-80
-150
-100
-50
0
50
100
150
Longitude [deg]
350
300
250
200
150
100
50

V_pol – H_pol

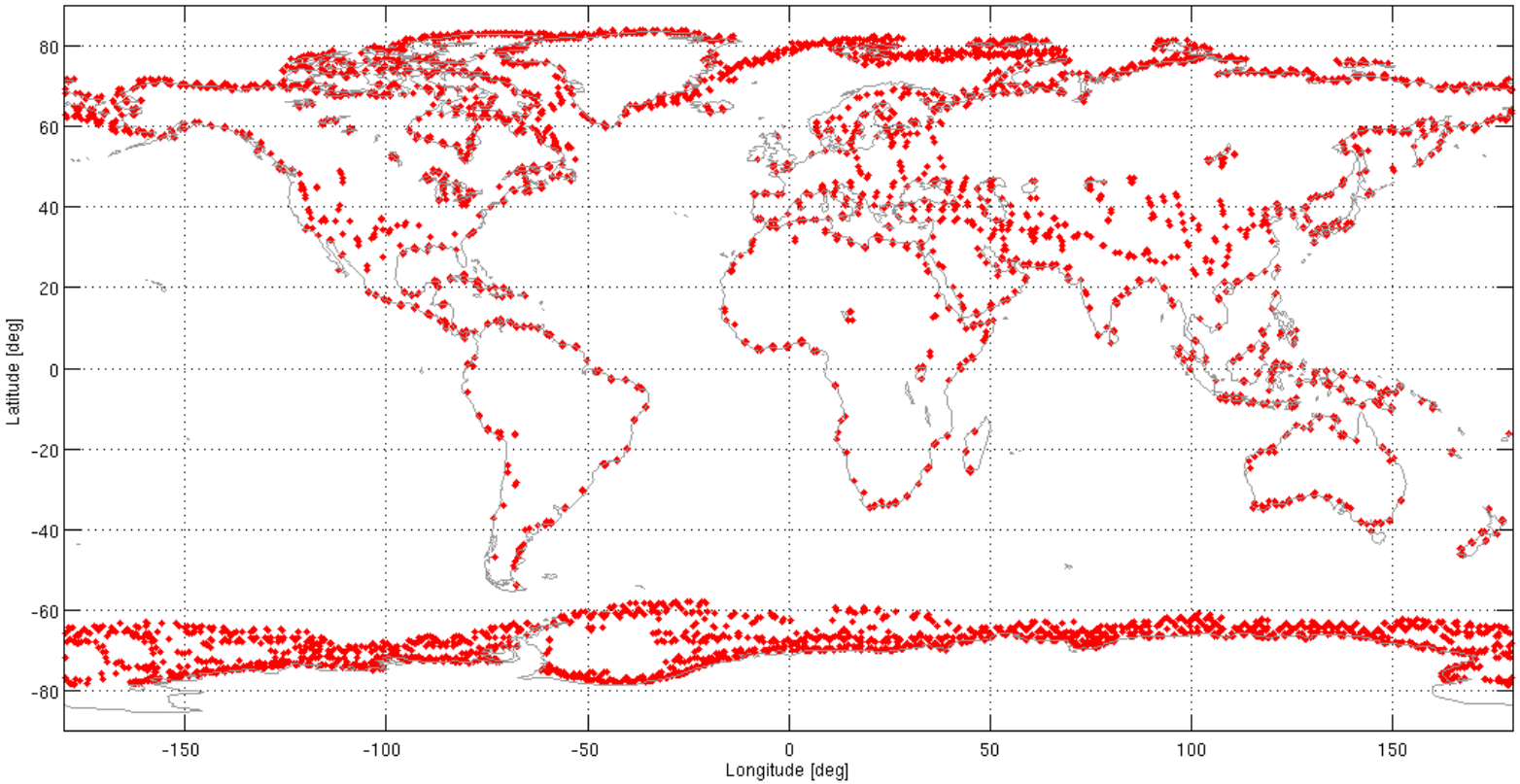


Both the inverse and the direct model are dominated by the vegetation layer.

Retrieved permittivity is very low. When this is the case, there is little difference between V and H reflectivities. E.g. if permittivity = 1, V and H reflectivities are equal.

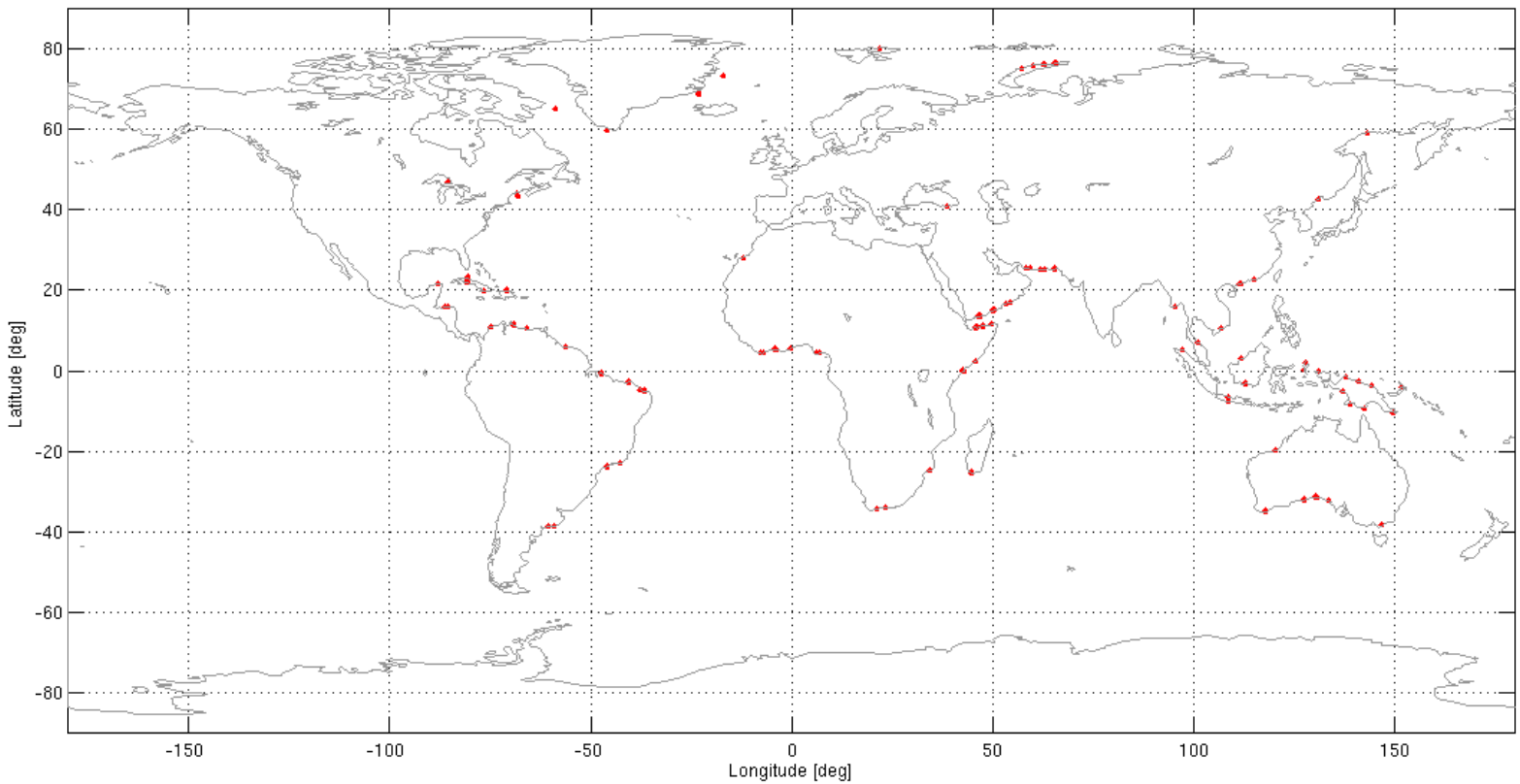
Discontinuities (old)

grad(Ta_expected)>10 K/1.44 s; beam1

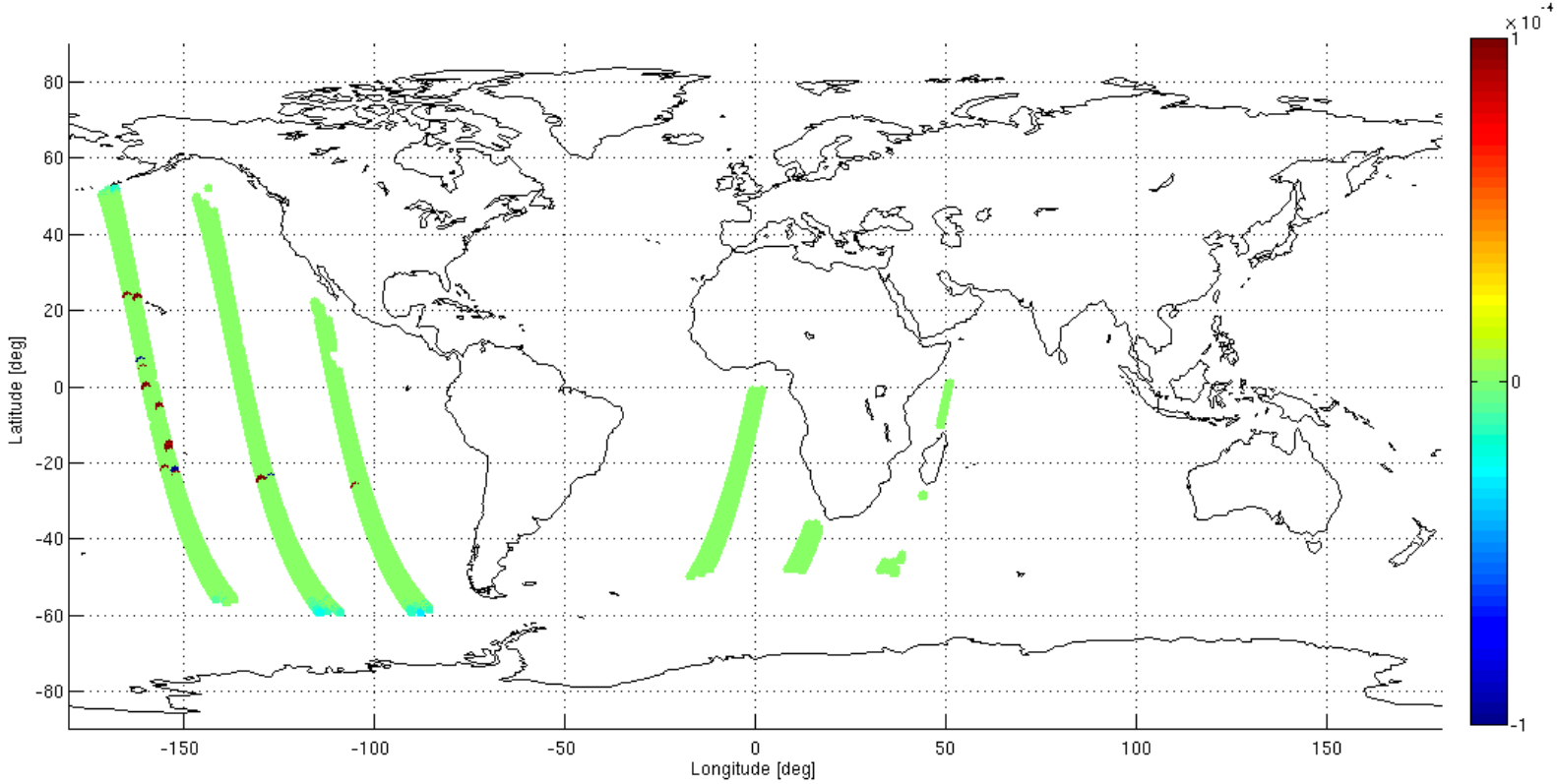


Discontinuities (new)

grad(Ta_expected)>10 K/1.44 s; beam1



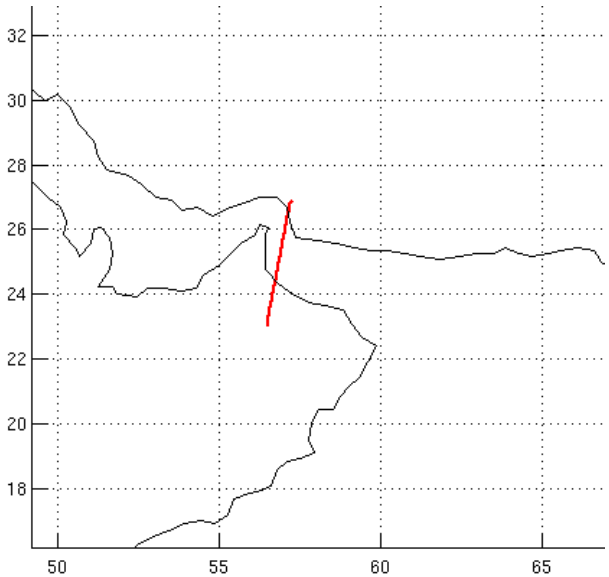
Calibration dataset (not V4.4)
new_Ta_exp – old_Ta_exp [K]

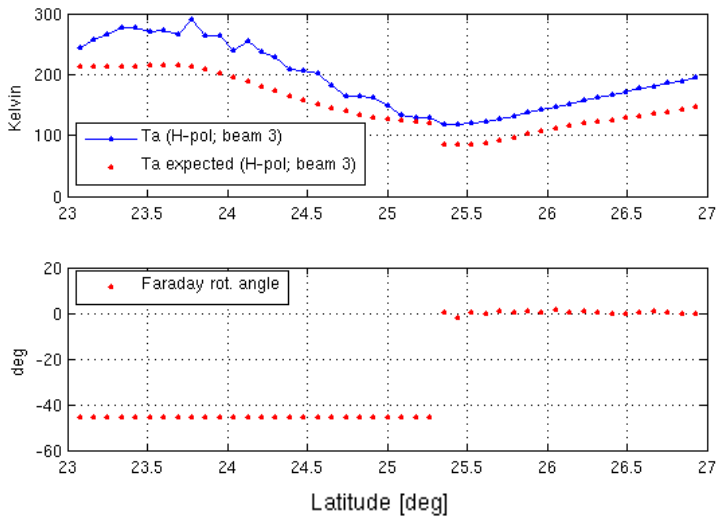


2: Faraday rotation angle

Issue: Ta_expected is computed using the Faraday rotation angle retrieved from the measurements. When the Tf are not valid (e.g. RFI) Faraday rotation angle becomes = -45 deg and this creates discontinuities in the Ta_expected

2*Farad = arctan(T3/(TV-TH))



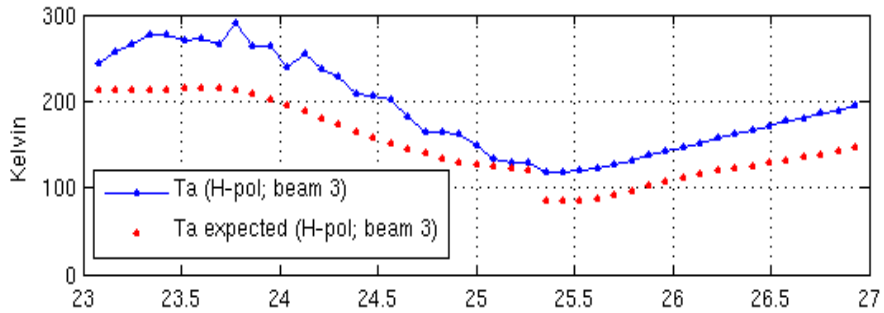


2: Faraday rotation angle

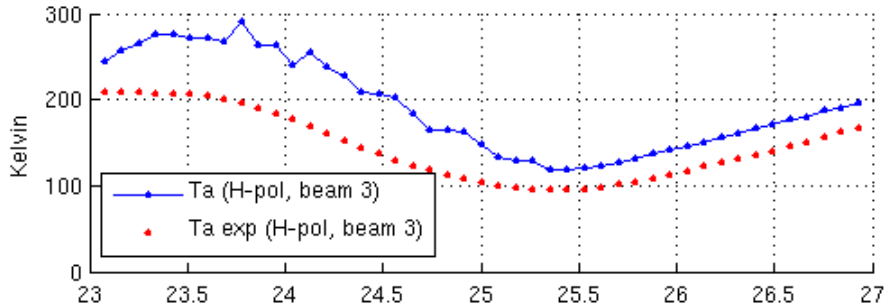
Suggestion: over the open ocean, keep the current procedure. Over land, use theoretical Faraday rotation angle.

The transition occurs when land fraction + sea ice fraction = 0.002 (i.e., ~100 km away from the coast).
This does not affect calibration. The data used for calibration have both land fraction <0.001 and sea ice fraction <0.001.

FRA from measurements

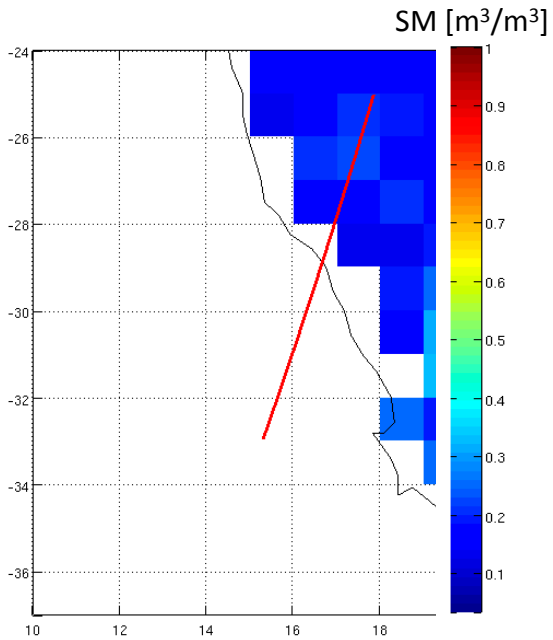


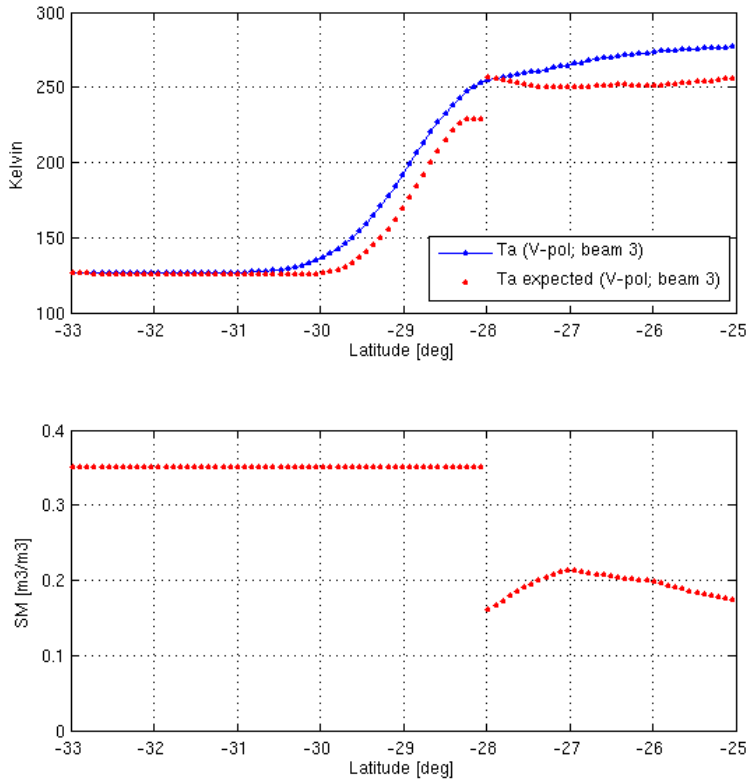
FRA over land from theory



3: Ancillary SM near the coast

Issue: the ancillary SM are not available at coastlines. Missing values are replaced with a default SM (= 0.35 m3/m3). The transition between the ancillary SM and the default SM can create discontinuities in the expected Ta, if they happen when the land fraction is still high.

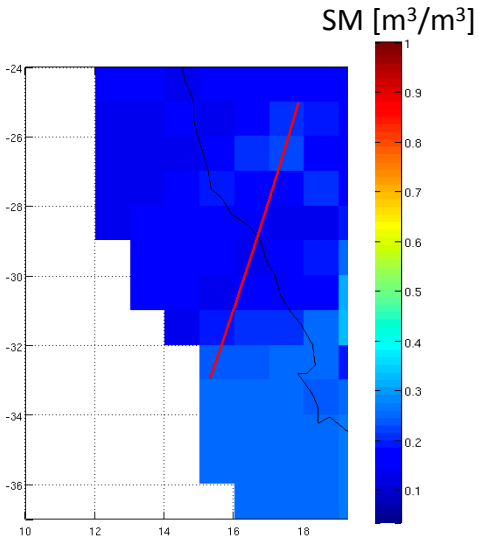


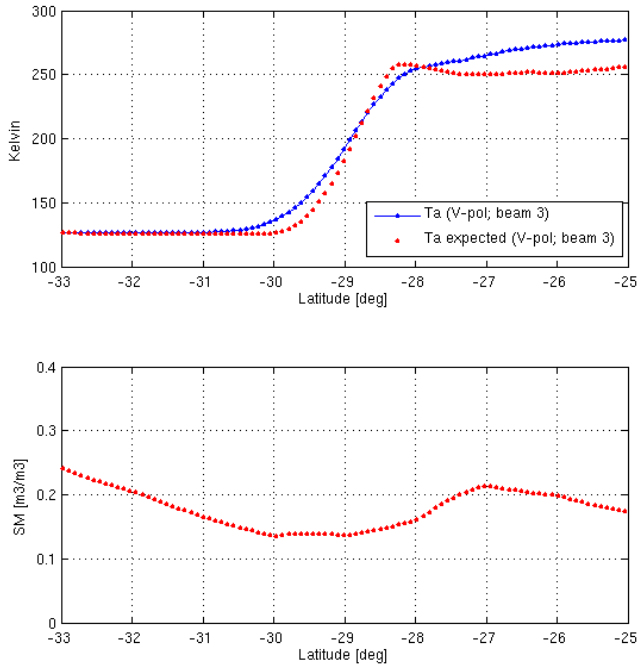


3: Ancillary SM near the coast

Suggestion: smooth the transition between ancillary SM values and missing values by extrapolating the ancillary SM towards the ocean.

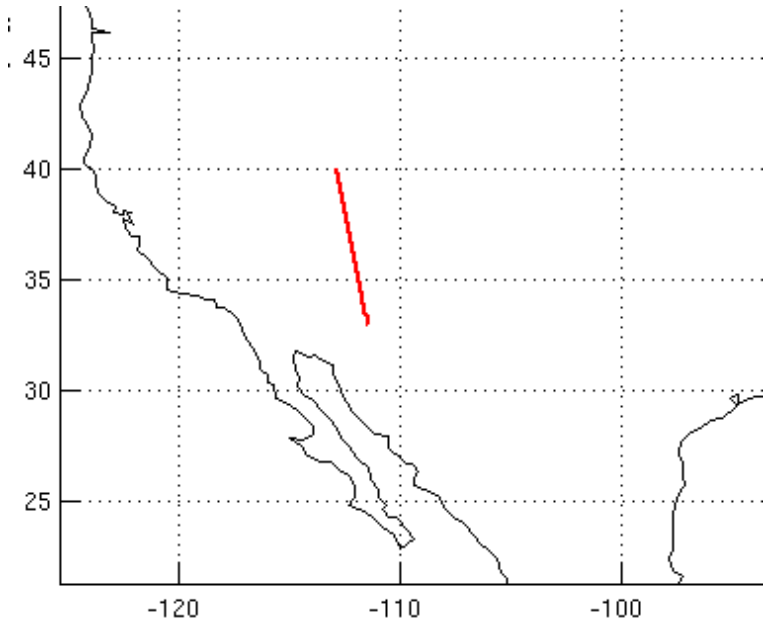
The extrapolation we tested fills the missing values with the average of the neighboring values.

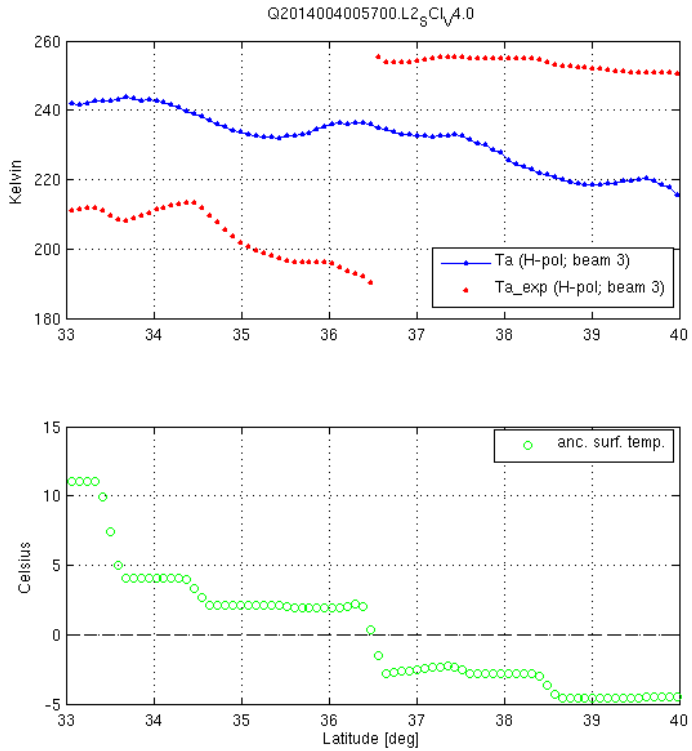




4: Frozen fraction

Issue: Each footprint is either completely frozen or completely non-frozen. Since the dielectric constant of frozen and non-frozen soil are very different, this creates discontinuities.





4: Frozen fraction

Suggestion:

From the ancillary LST define the percent of frozen land

Define the fraction of frozen land as

$$f_{frozen\_land} = f_{land} P_{frozen}$$

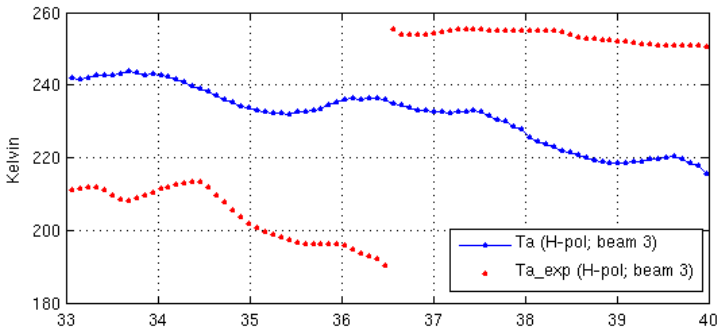
and the fraction of non-frozen land as

$$f_{nonfrozen\_land} = f_{land}(1 - P_{frozen})$$

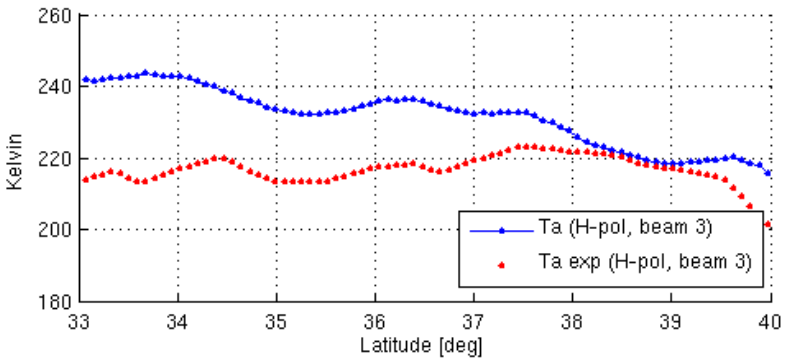
Then use the new fractions in the equation for reflectivity

$$R = f_{water} R_{water} + f_{ice} R_{ice} + f_{frozen\_land} R_{frozen\_land} + f_{nonfrozen\_land} R_{land}$$

without frozen fraction

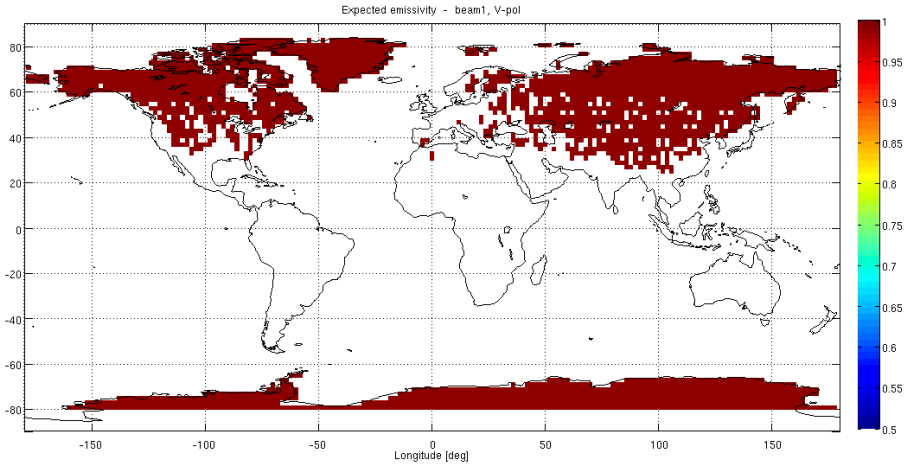


with frozen fraction

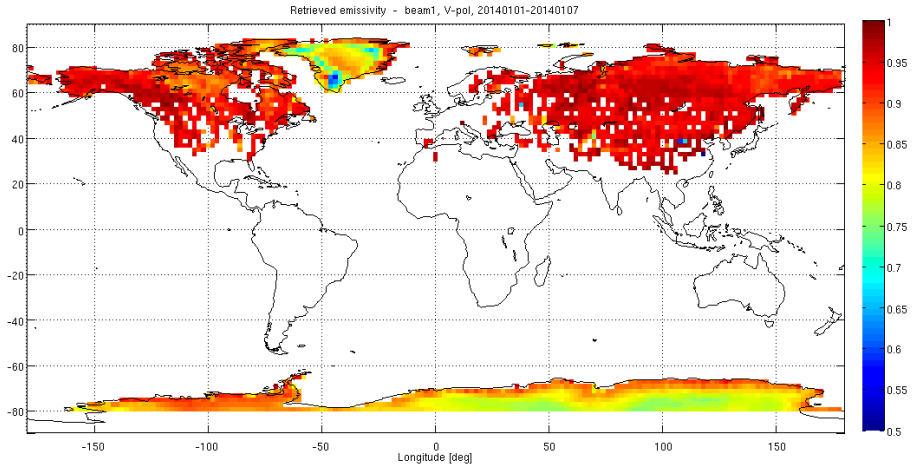


4: Emissivities of frozen regions

Expected emissivities



Retrieved emissivities

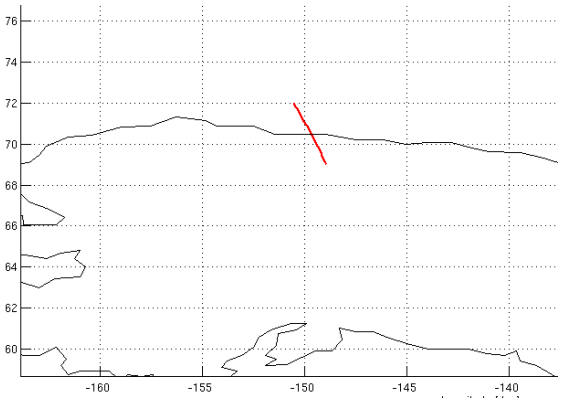


The current model tend to overestimate the emissivity of frozen regions.

Suggested approach: define 1x1 degrees maps of retrieved emissivities of frozen soils, and use them for the emissivities of the frozen fractions.

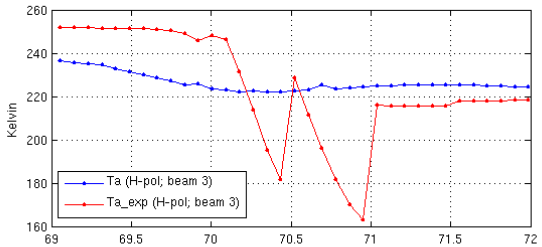
5: Sea ice and land fractions

Issue: the non-weighted fractions of sea ice can create discontinuities

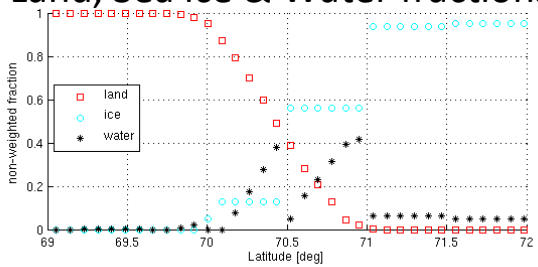


Non-weighted fractions

Ta_meas & Ta_exp

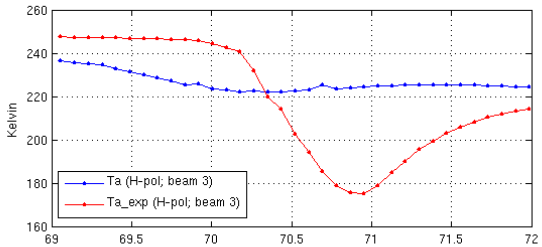


Land, Sea ice & Water fractions

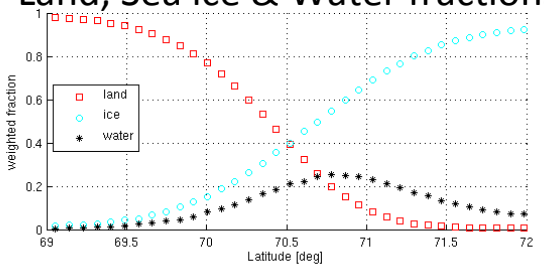


Weighted fractions

Ta_meas & Ta_exp



Land, Sea ice & Water fractions



5: Sea ice and land fractions

From the Cal/Val meeting in Santa Rosa: do not alter the Ta_expected over the ocean where the calibration is done. Therefore keep the non-weighted fractions over the ocean and use the weighted fractions only over land.

Reminder:

Non-weighted fraction = geometrical fractions of land/ice in the footprint

Weighted fraction = geometrical fractions of land/ice weighted by the entire gain pattern of the antenna.

Consistency with SMAP

6. Land cover classification

   Current: from ECOCLIMAP

   Suggested: from MODIS IGBP product (same as SMAP and Aquarius SM)

7. Soil attributes

   Current: fixed values (0.18*clay - 0.11*sand = 0)

   Suggested: use the same maps as SMAP and Aquarius SM.

   These maps are obtained combining regional datasets (CONUS, Canada, Australia) and global datasets (HWSD, FAO)

8. Dielectric mixing model

   Current: Dobson

   Suggested: Mironov

9: Vegetation opacity

$$\tau = b \cdot \mathrm{VWC}$$

Current procedure:

- Land cover from ECOCLIMAP
- VWC from ECOCLIMAP LAI
- “b” fixed (= 0.15)

Suggested procedure (same as SMAP and Aquarius SM):

- Land cover from MODIS IGBP
- NDVI from MODIS climatology
- VWC from NDVI, formulation in Patton and Hornbuckle, 2014
- “b” depends on the vegetation type (see SMAP lookup table)

10: Single-scattering albedo (ω)

Current: fixed (= zero)

Suggested: depending on the vegetation type (look up table from SMAP)

Implementing this requires that the equation for the reflectivity be re-arranged from:

$$\mathrm{R_{obs,P}} = \mathrm{R_{Fresnel,P}} e^{-h} \gamma^2$$

to:

$$\mathrm{R_{Surf,P}} = \mathrm{R_{Fresnel,P}} e^{-h}$$

$$\mathrm{R_{obs,P}} = 1 - (1-\omega)(1-\gamma)\left(1 + \mathrm{R_{Surf,P}}\gamma\right) - (1 - \mathrm{R_{Surf,P}})\gamma$$

where: $\gamma = e^{-\tau \sec(\theta)}$

Consistency with SMAP (cont.)

11. Roughness parameter

    Current: fixed (= 0.3)

    Suggested: depending on the land cover class (look up table from SMAP)

12. Source of ancillary SM

    Current: NCEP

    Suggested: GEOS-5

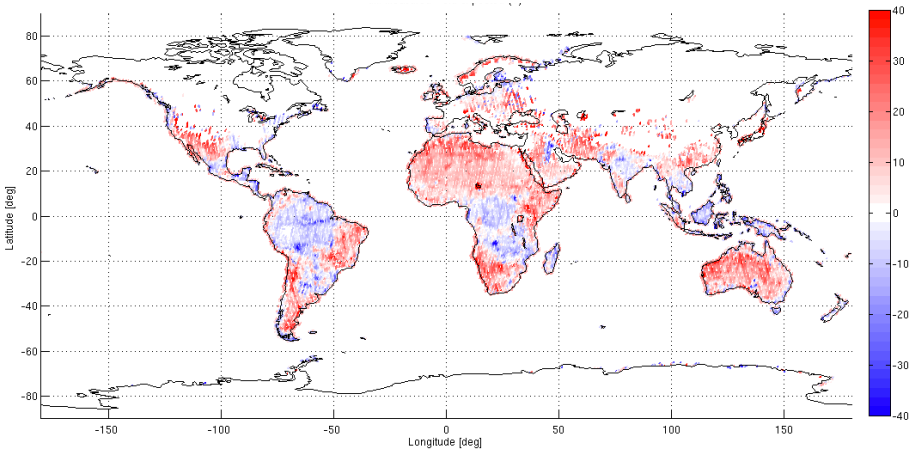
13. Source of ancillary LST

    Current: NCEP

    Suggested: GEOS-5

Ta - Ta_expected

RMSE = 15.5 K



RMSE = 14.8 K