The GCOM-W1 AMSR2 snow depth and snow water equivalent product: *update*

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- Remember: estimate snow depth using AMSR2 and any static ancillary data
  a purely space-based approach

- Essential variable #1 *snow detection*
- Essential variable #2 *snow depth estimation*

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Essential Variable #1: *snow detection*

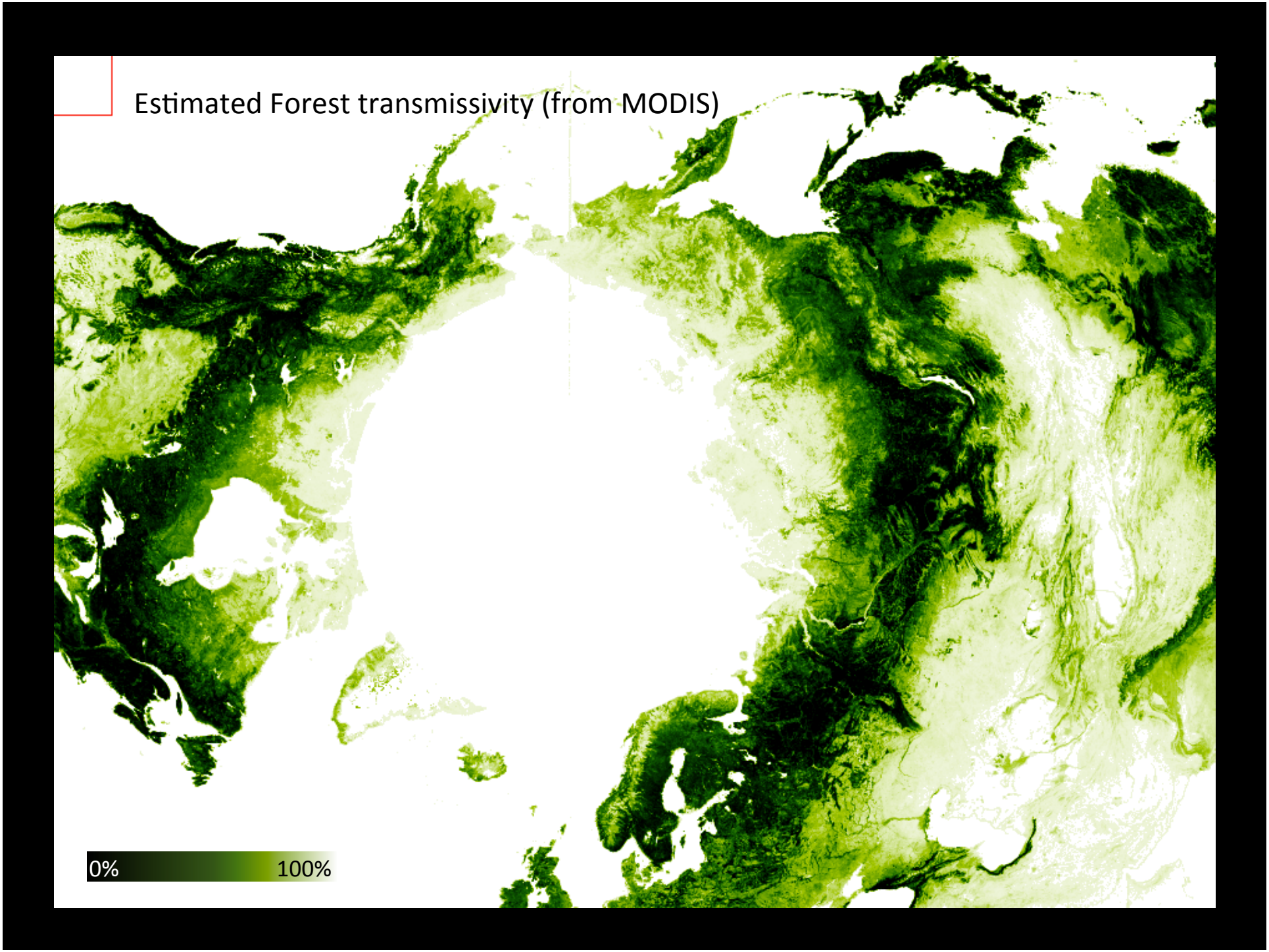
Required to obtain snow onset/renewal date

- Geophysical estimates, correction factors, screening
  - T-surf estimation (empirical) – *for detection and retrievals*
  - Forest correction: transmissivity – *for detection and retrievals*
  - Water fraction (>40%) (Un)Frozen – *for detection and retrievals*
  - TP correction (Tsustui approach adopted) – *for detection and retrievals*
  - Desert/non-snow scatterers – *for detection only*
  - Moderate | Shallow | Wet snow – *for detection and retrievals*

  Not discussed here
  - *Atmospheric correction (36V GHz) – for retrievals (not detection)*

Forest transmissivity

- Methodology developed in Finland (Metsämäki et *al.* 2005)
- Based on Landsat TM analysis applied to MODIS
- Transmissivity is a function of canopy structure (models often use stem volume – globally not available)
- Not the same as forest fraction or NDVI: it's a function of the canopy structure = what we need for microwave corrections.
- With knowledge of emissivity and physical temperature it is possible to derive forest correction equations.


Estimated Forest transmissivity (from MODIS)
0%
100%

Forest correction factors

Band(GHz.)	V-pol	H-pol
6.9	$y = -5.61\,x + 4.89$	$y = -22.42\,x + 20.93$
10.65	$y = -6.79\,x + 5.58$	$y = -24.62x + 22.41$
18.7	$y = -8.76x + 7.42$	$y = -27.84\,x + 25.22$
23.8	$y = -9.85x + 8.47$	$y = -27.99\,x + 25.40$
36.5	$y = -13.47\,x + 12.41$	$y = -30.85\,x + 28.79$
89.0	$y = -33.05x + 32.58$	$y = -45.20\,x + 43.73$

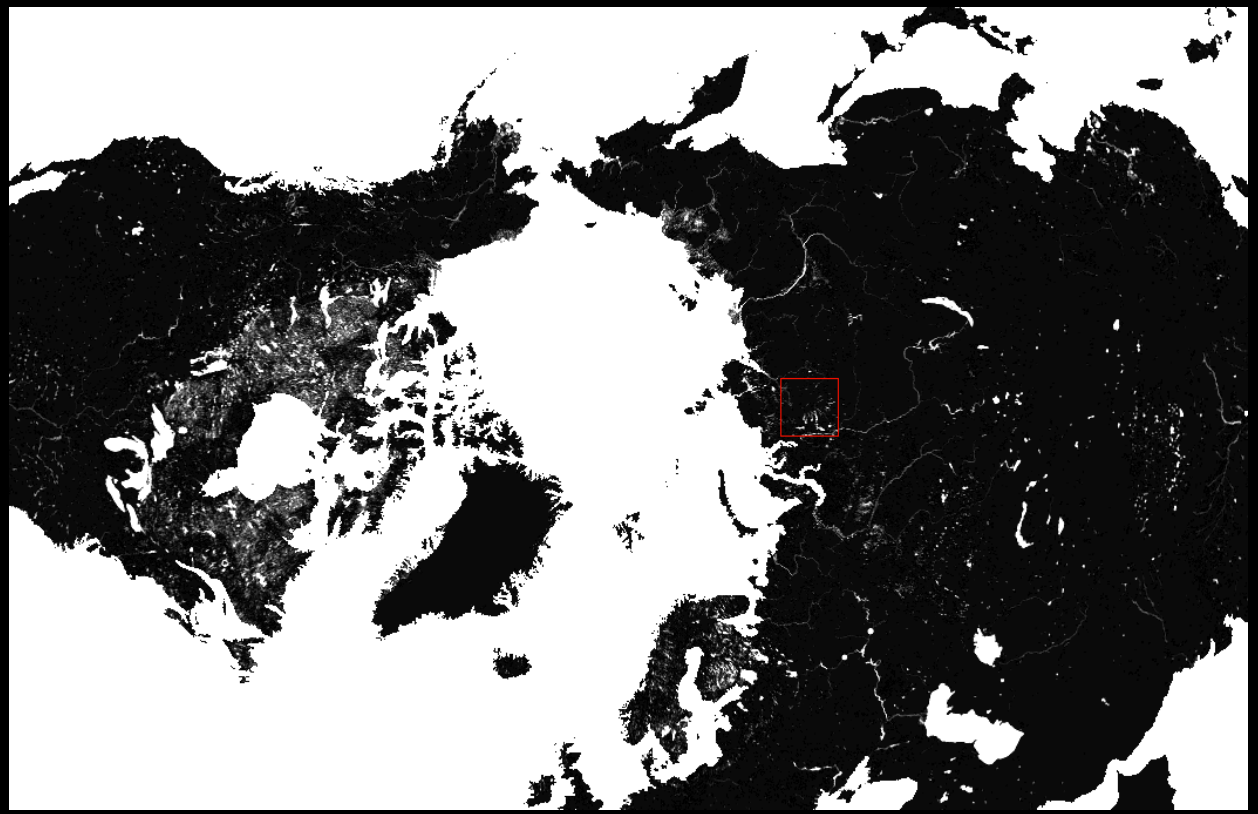
Applied when forest transmissivity < 0.5

y = Tb correction applied to each satellite Tb

y = Forest transmissivity

Improved water fraction

- Based on a WWF GIS data set



Tibetan Plateau correction

- Courtesy of Tsutsui (JAXA) after Tsutsui and Koike (2012)
- Geographical constraint:

  70°E ≦ Longitude ＜ 105°E and

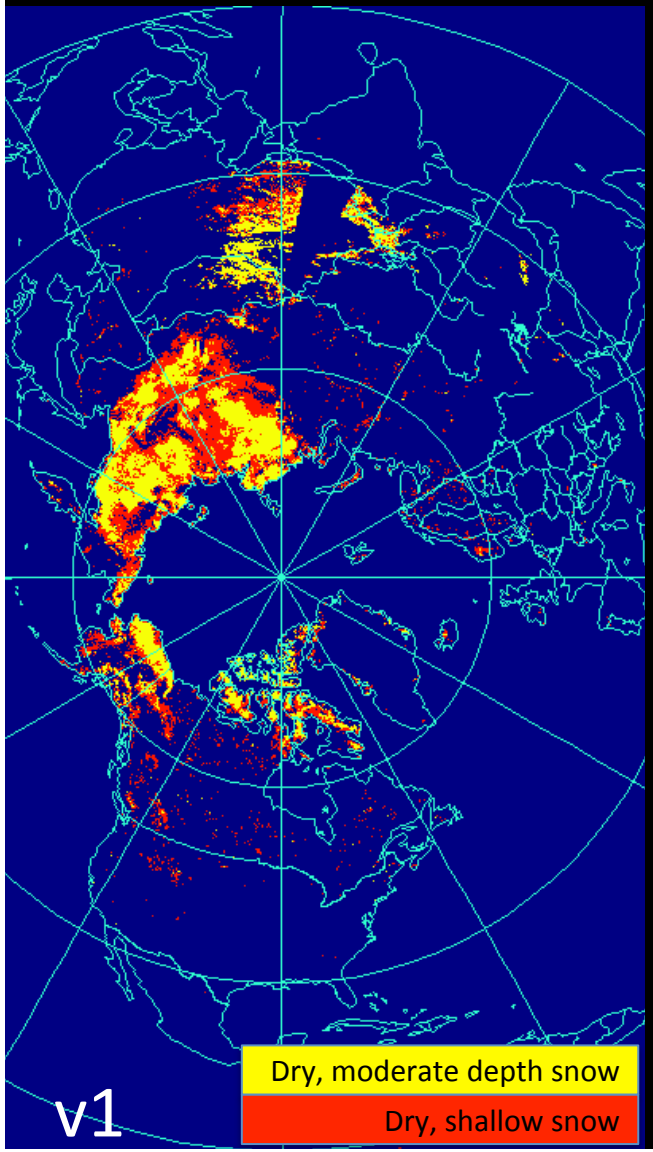
  27°N ≦ Latitude ＜ 40°N
- Elevation constraint:

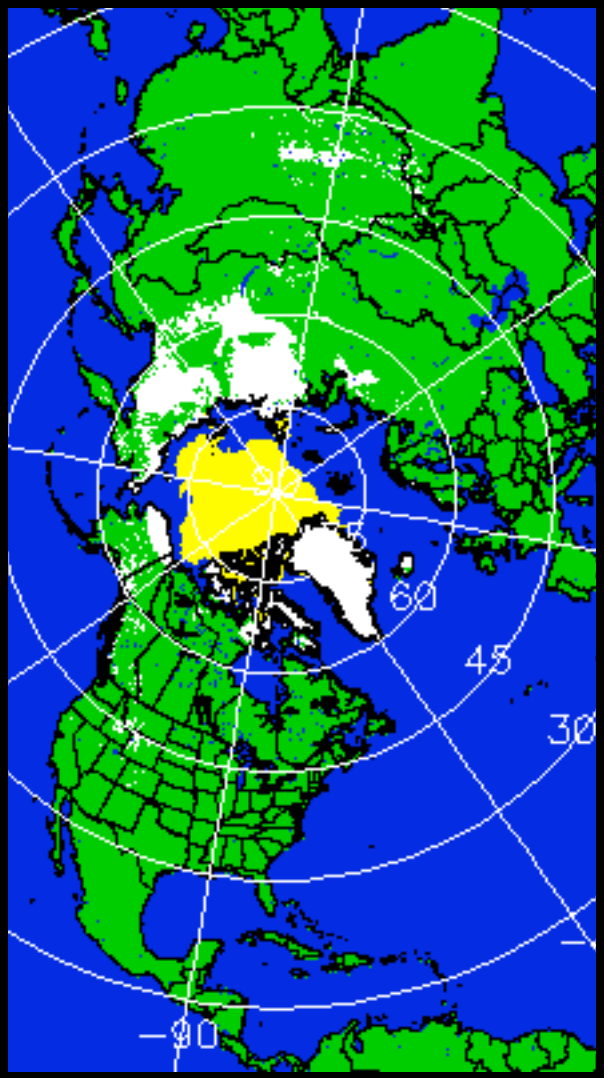
  Elevation >= 2500 m.a.s.l.
- Ratioing of Tb18V, Tb36V, Tb89V:

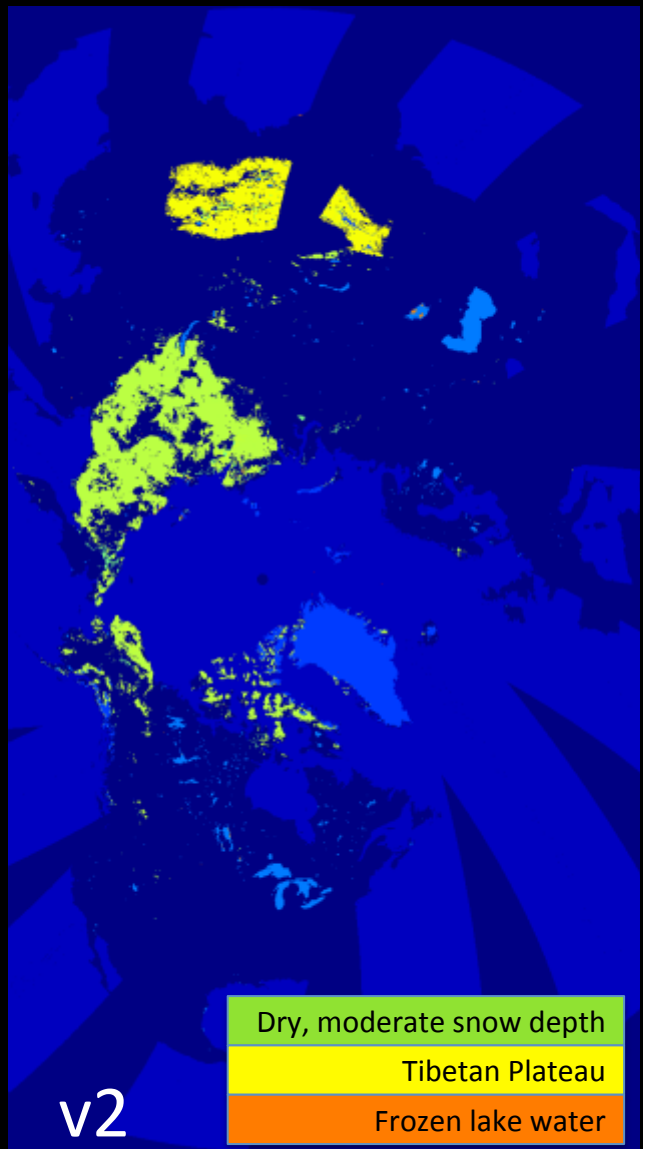
  If (Tb36V/Tb89V) / (Tb18V/Tb37V) < 1.03 :: *no-snow*

V1 vs V2

1 Oct, 2013

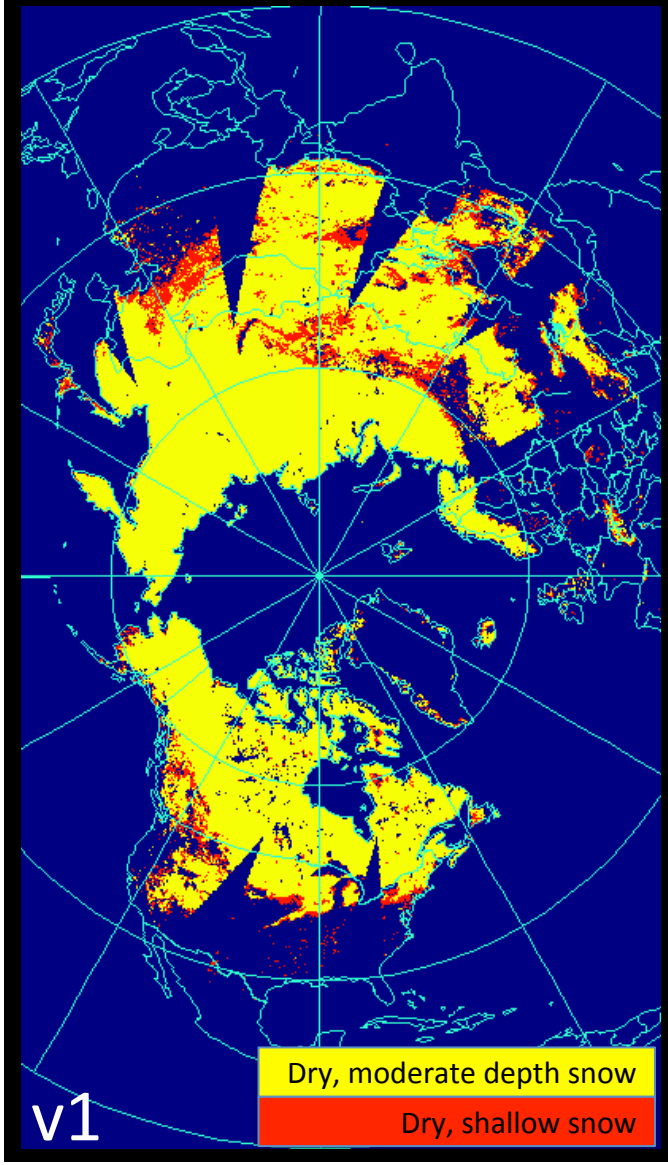


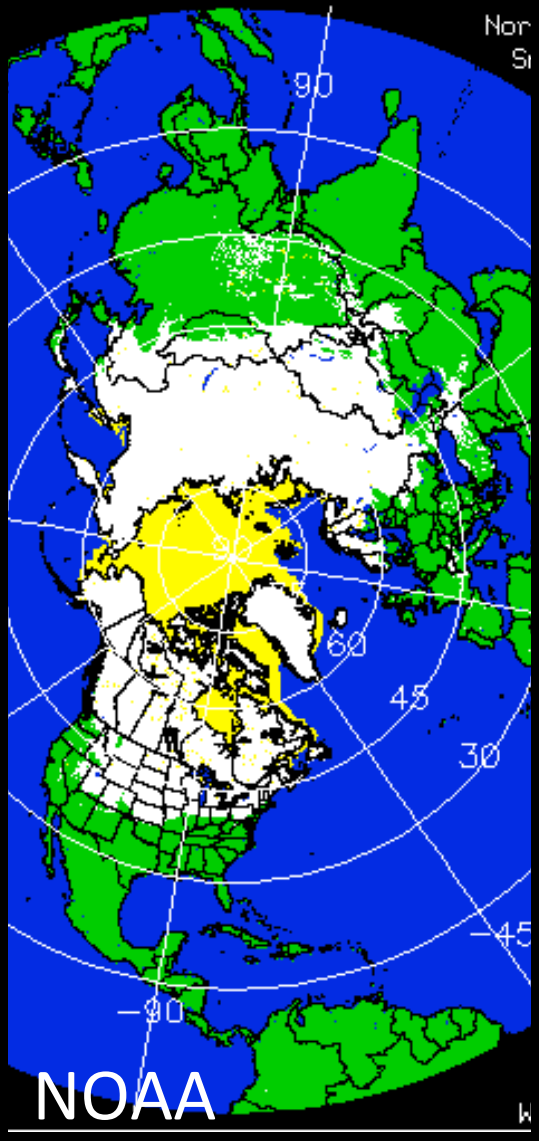


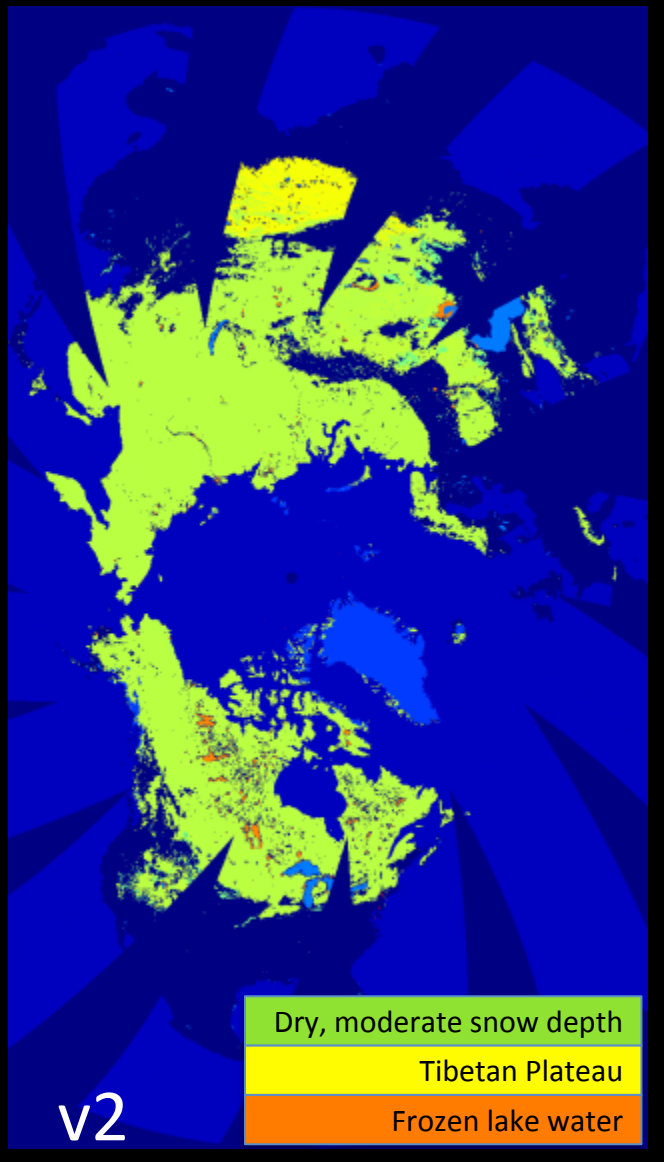


V1 vs V2

1 Jan, 2014

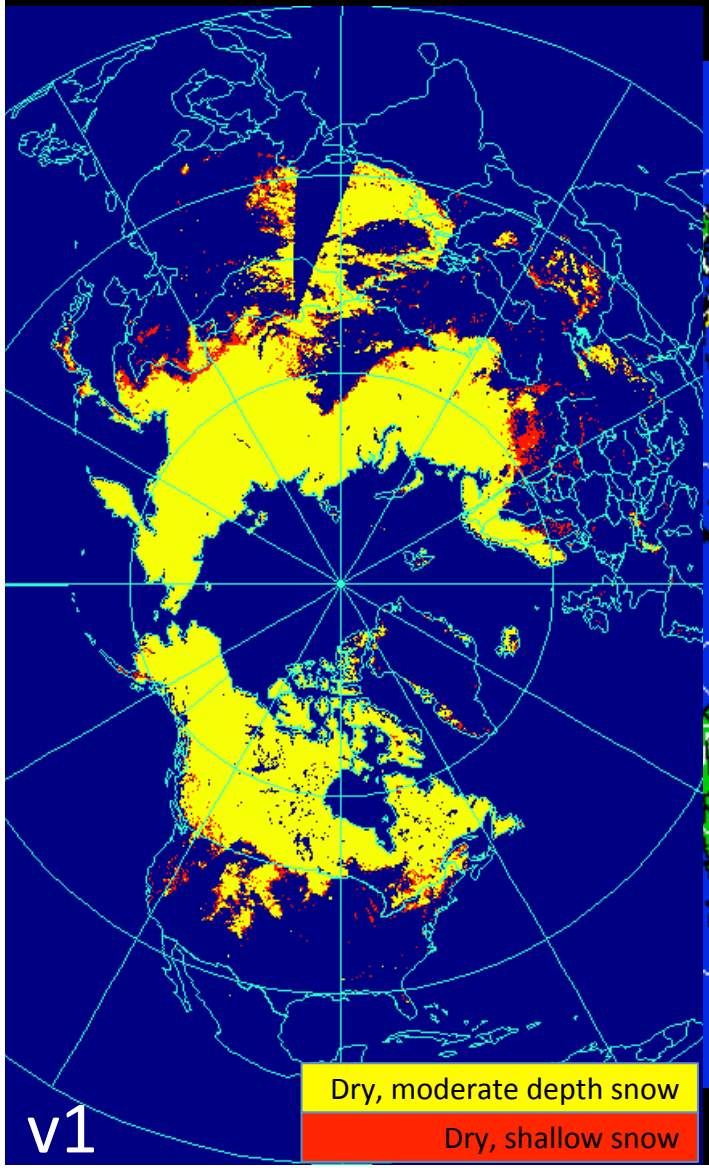


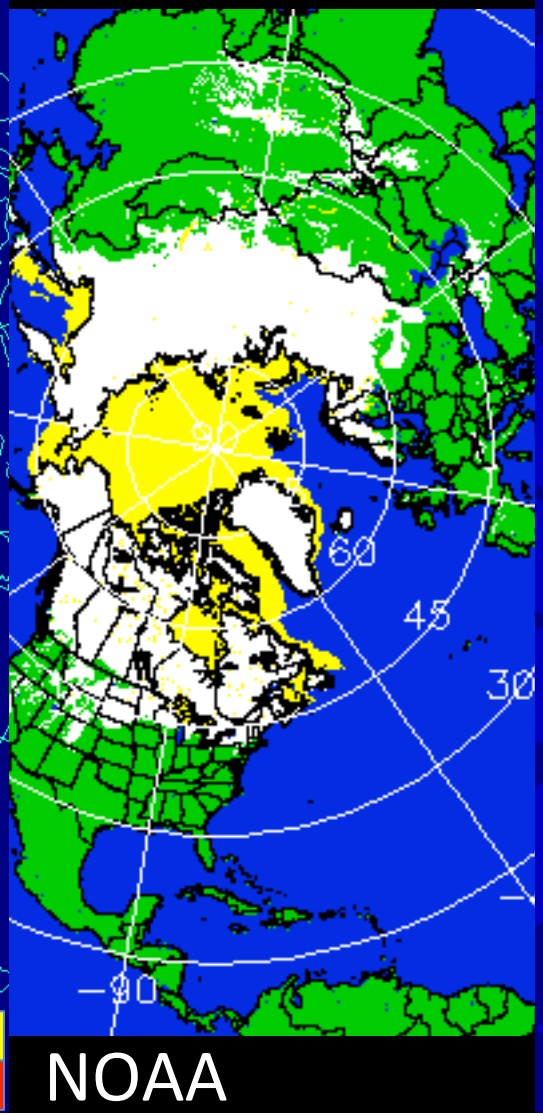


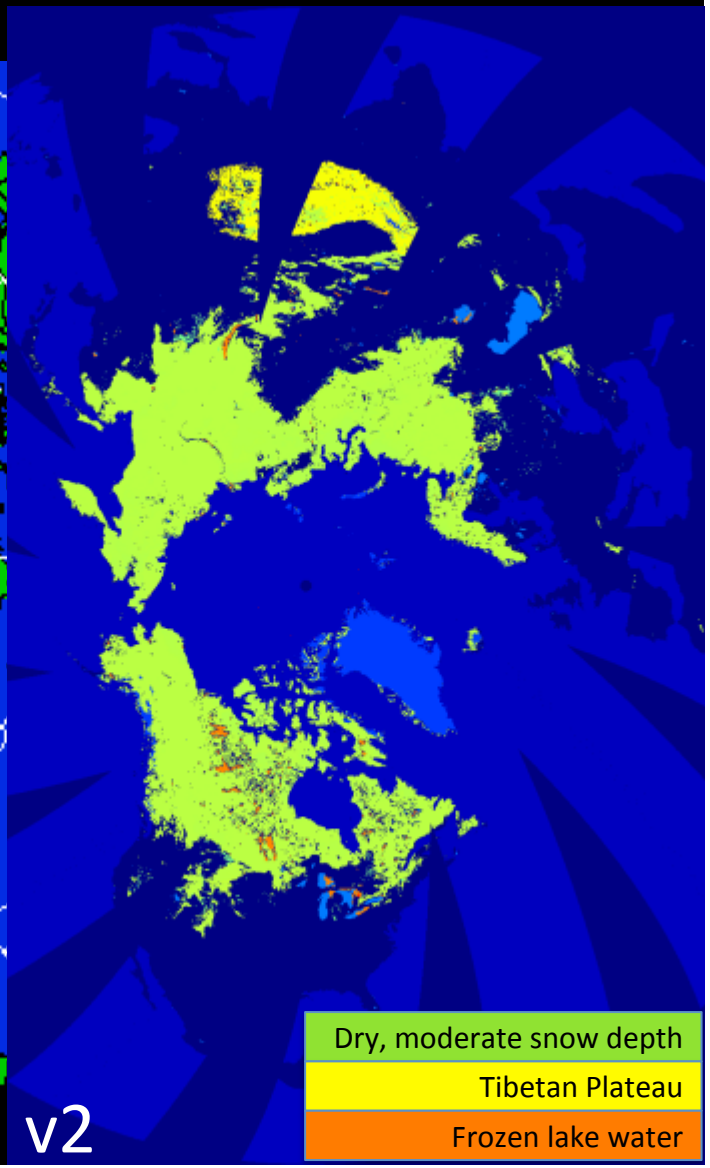


V1 vs V2

1 Apr. 2014







- Essential variable #1 *snow detection*
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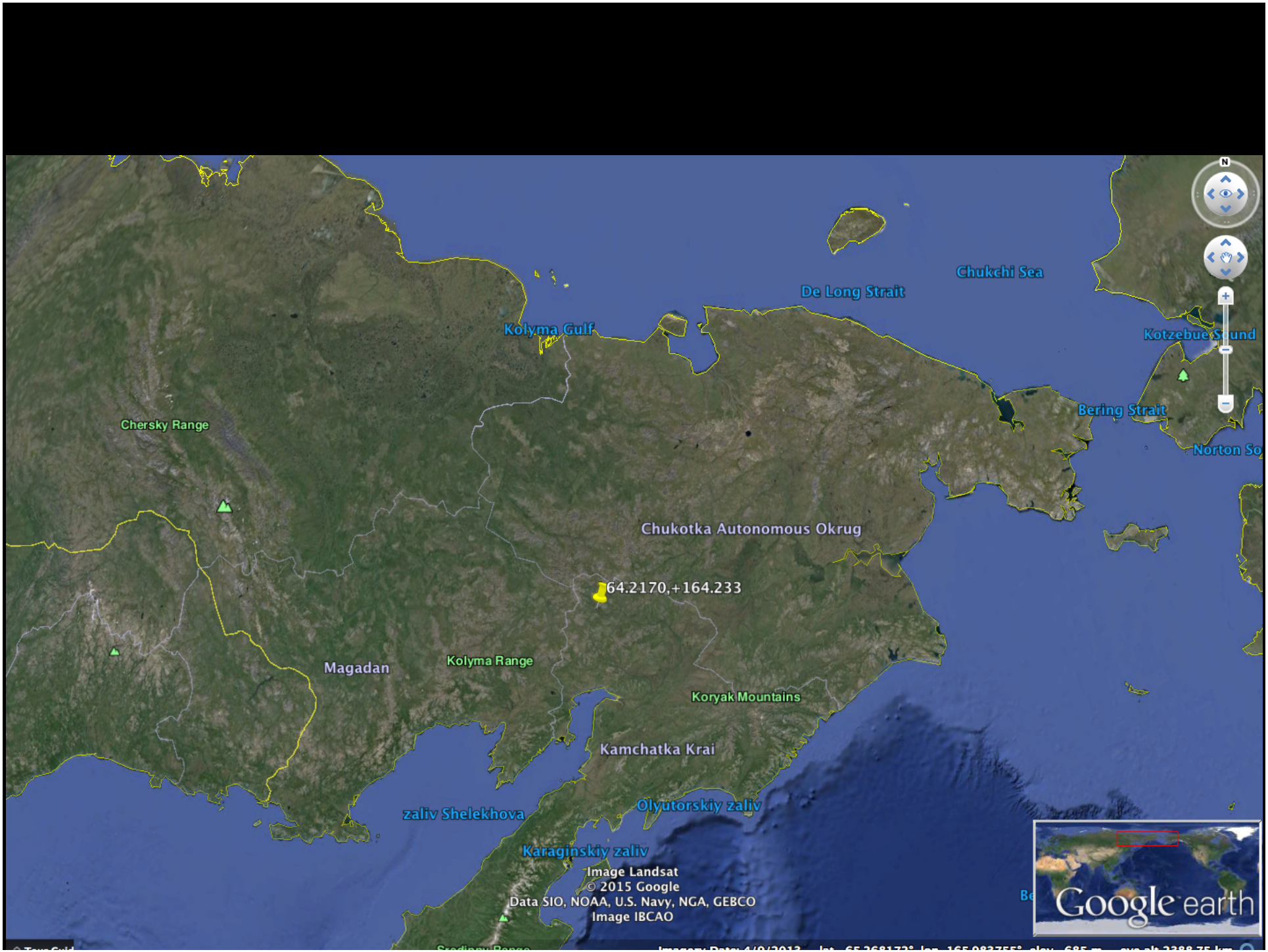
Essential Variable #2: *SWE / snow depth*

Once identified where the snow is, we can perform the retrieval

- DMRT-ML (Picard et al, 2013) Inverted: *Estimate snow depth*
  - Snow temperature (Kelly et al. 2003,*updated*)
  - Grain size (Kelly et al. 2003)
  - Snow density (Kelly et al. 2003)
  - AMSR2 Tb36V GHz

- We have to track (internally):
  - (t-5) history
    - Temperature (from T_{est})
    - Snow presence/absence (from detection)
  - (t-1) history
    - Evolution of the snowfield (no. days)
    - Grain growth regime: (kinetic, EQT, fresh) – from T_{est}
    - Growth Phase
    - Facet Evolution (Kinetic)
    - Grain radius
    - Snow depth
- Specified grain size range 0.2 – 1 mm (D_{max})


Chukchi Sea
De Long Strait
Kolyma Gulf
Kotzebue Sound
Bering Strait
Norton So
Chersky Range
Chukotka Autonomous Okrug
64.2170,+164.233
Magadan
Kolyma Range
Koryak Mountains
Kamchatka Krai
zaliv Shelekhova
Olyutorskiy zaliv
Karaginskiy zaliv
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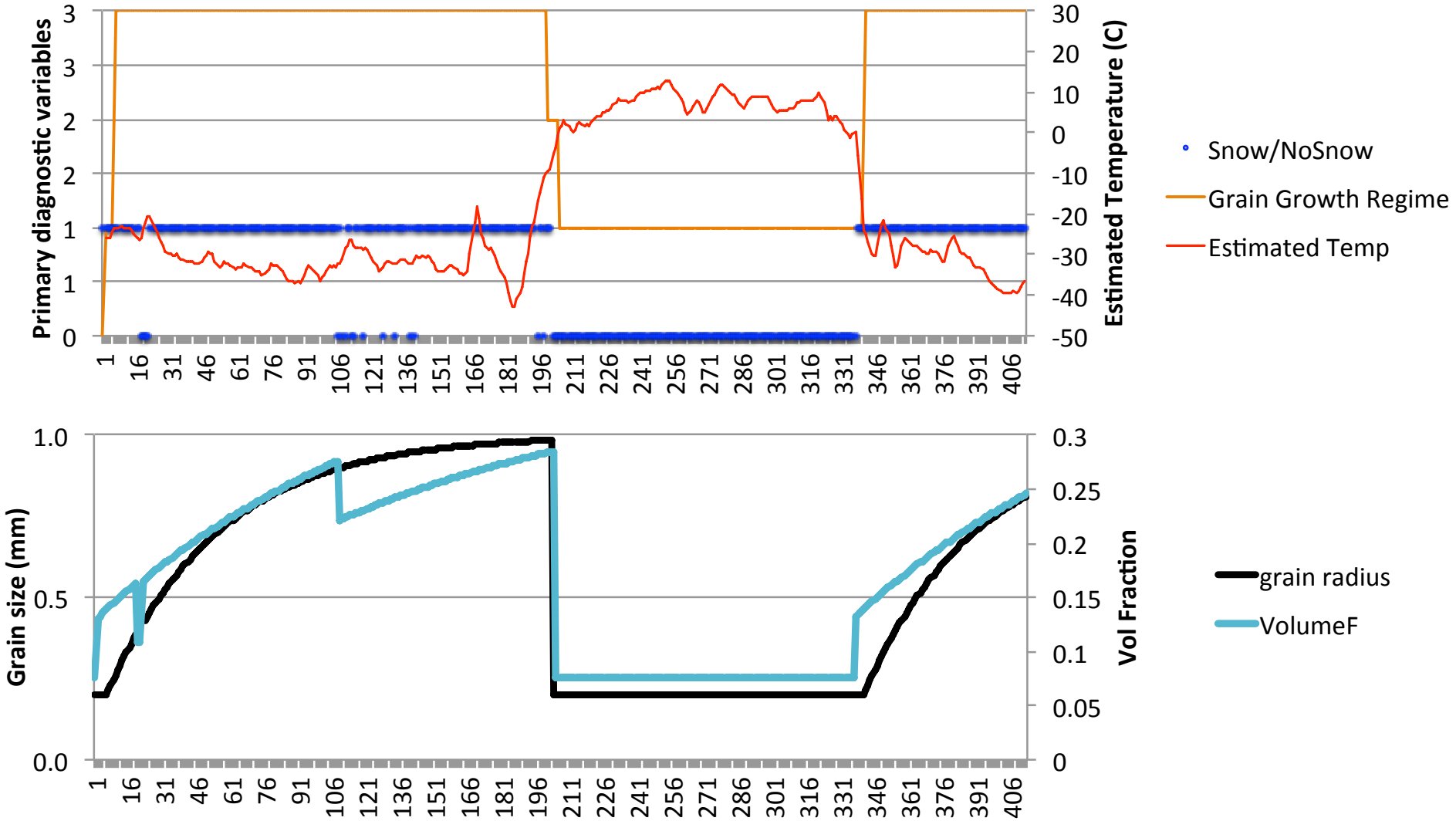

(r) Specified grain size range 0.2 (r_0) – 1.0 (r_∞) mm.
α = 0.02 (dimensionless). t = one day.

$$\frac{dr}{dt} = \alpha\left(r_\infty - r_0\right)\exp\left(\alpha t\right)$$

Able to set up the inversion (see last year's presentation):

- Either…2003 we used a polynomial inversion of DMRT
  - $SD = a(Tb18V-Tb36V)^2 + b(Tb18V-Tb36V)$ [cm]
  - A & B specified by grain size and density
- Or…DMRT-ML minimization with cost function and constraints

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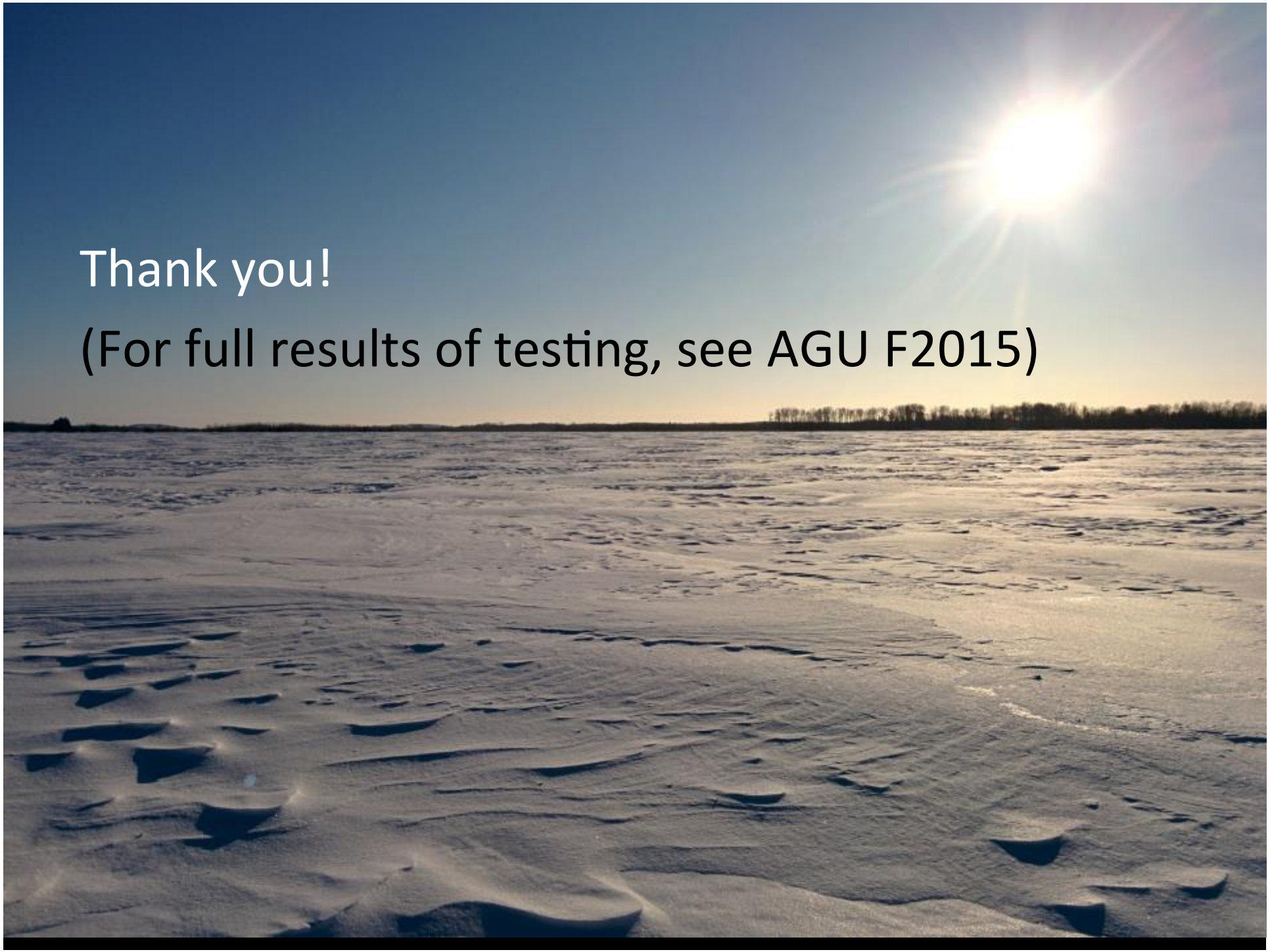
Retrieval – current working

- 1 layer DMRT model
- Infinite background (difficult to parameterize soil background for DMRT at this time)
- Stickiness (τ) is set to 0.3
- Minimize difference between $Tb36V_{est}$ and $Tb36V_{obs}$ AMSR2 (simple cost function)

Summary

- Snow cover detection is done (for now!)
- Snow depth retrieval is being assembled….
  - *Grain size* ✓
  - *Density / volume fraction* ✓
  - *Estimated physical temperature* ✓
  - *DMRT-ML implementation* ✓
- Coding is in C language.
  - Retrievals on the granule basis, BUT, need to track 6 variables in NH +SH EASE grid projection space for continuity of grain size/density estimation.
- Output is granule level SD and SWE(lat/lon).
- Granules are gridded to lat/lon and polar stereographic grid.
- Product delivery ready for JAXA early fall 2015.


Thank you!
(For full results of testing, see AGU F2015)