UNIVERSITY OF TWENTE.

Meso-scale Soil Moisture Validation Sites On the Eurasia Continent

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ITC GEO Soil Moisture Soil Temperature Networks

	Twente	Naqu	Maqu	Ngari
Nr. Domains	1	1	1	2
Nr. stations	22	7	20	20

	Twente	Naqu	Maqu	Ngari
Data Download	Per 3 Mons. (1 site automatic)	Per Year	Per 3/6 Mons (summer)	Per Year
Calibration	Gravimetric	Gravimetric	Gravimetric	Gravimetric

Measurement Type	Method	Depths
Soil Moisture	ECH_2O (Capacitance probe) Type: EC-10 & EC-TM	Naqu Station -2.5, -7.5, -15, -30 , -60cm Maqu & Twente Station -5, -10, -20, -40, -80cm Ngari Station -5, -10, -20, -40, -60, -80cm
Soil Temperature		
Micrometeorological	AWS, PBL Tower	1.5, 2, 5, 6.5, 10, 14.0 m

Station description (Maqu)

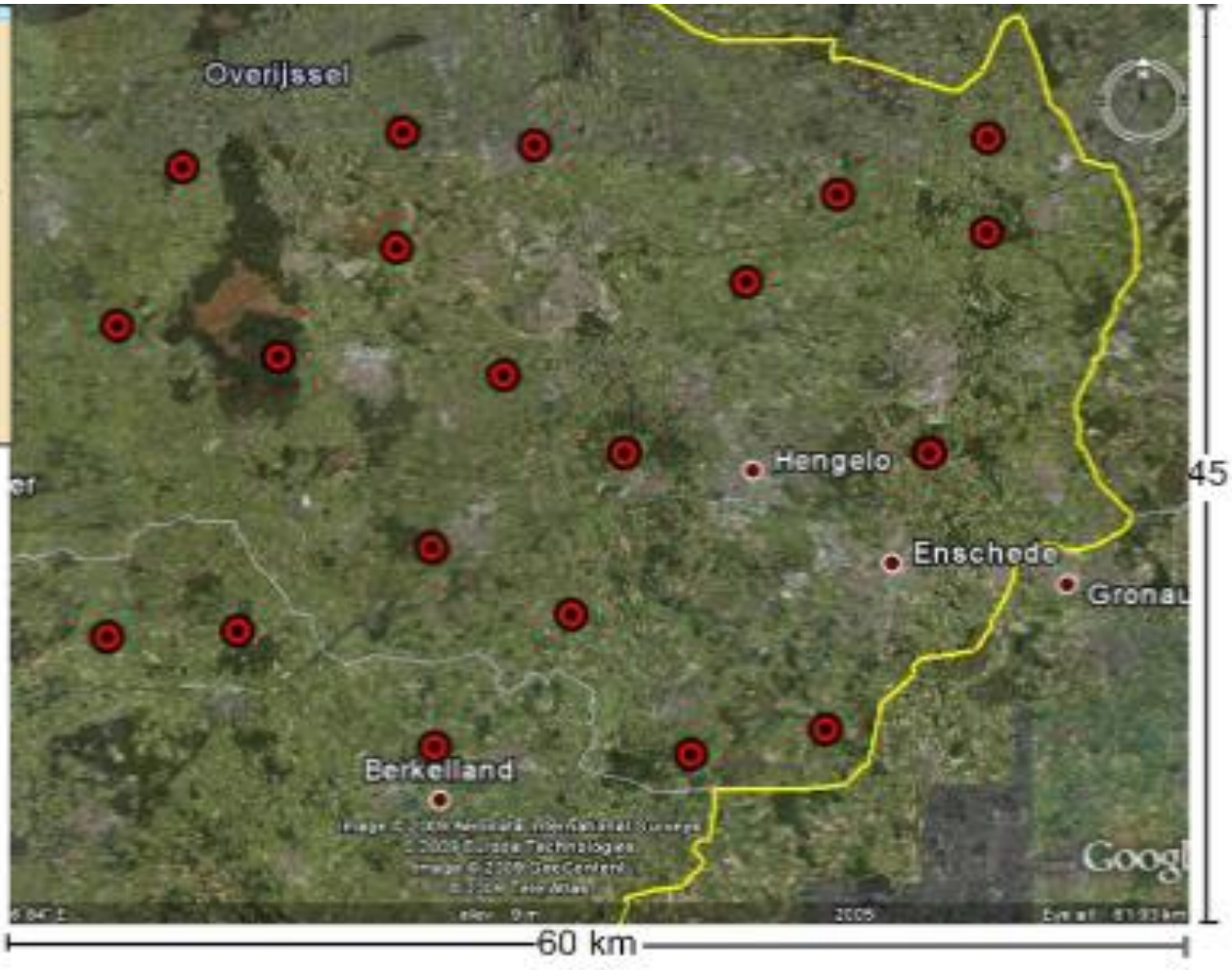
- 2/3 soil moisture & temperature probes
- 5, 10 & 20 cm deep (few profiles deep 80 cm)
- 1 datalogger
- data collected every 15 min
- memory capacity of 1 year
- completely buried
- site revisit to download data:
  - beginning and end of monsoon season in Maqu

Twente SMST Network – technical details

20 sites

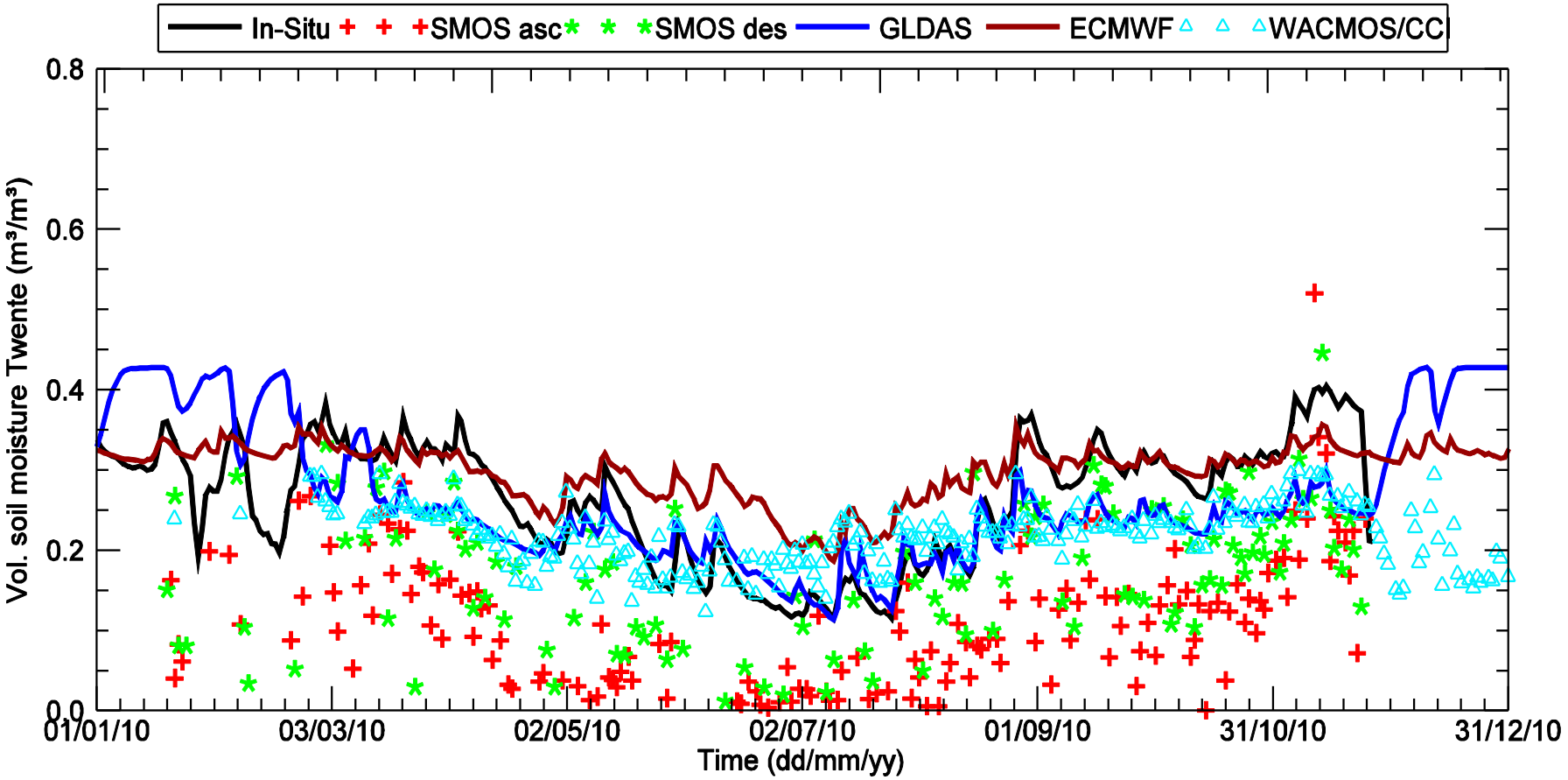
(52° 05'–52° 27'N, 6° 05'–7° 00'E).

EC-TM ECH2O probes (Decagon Devices, Inc., USA)

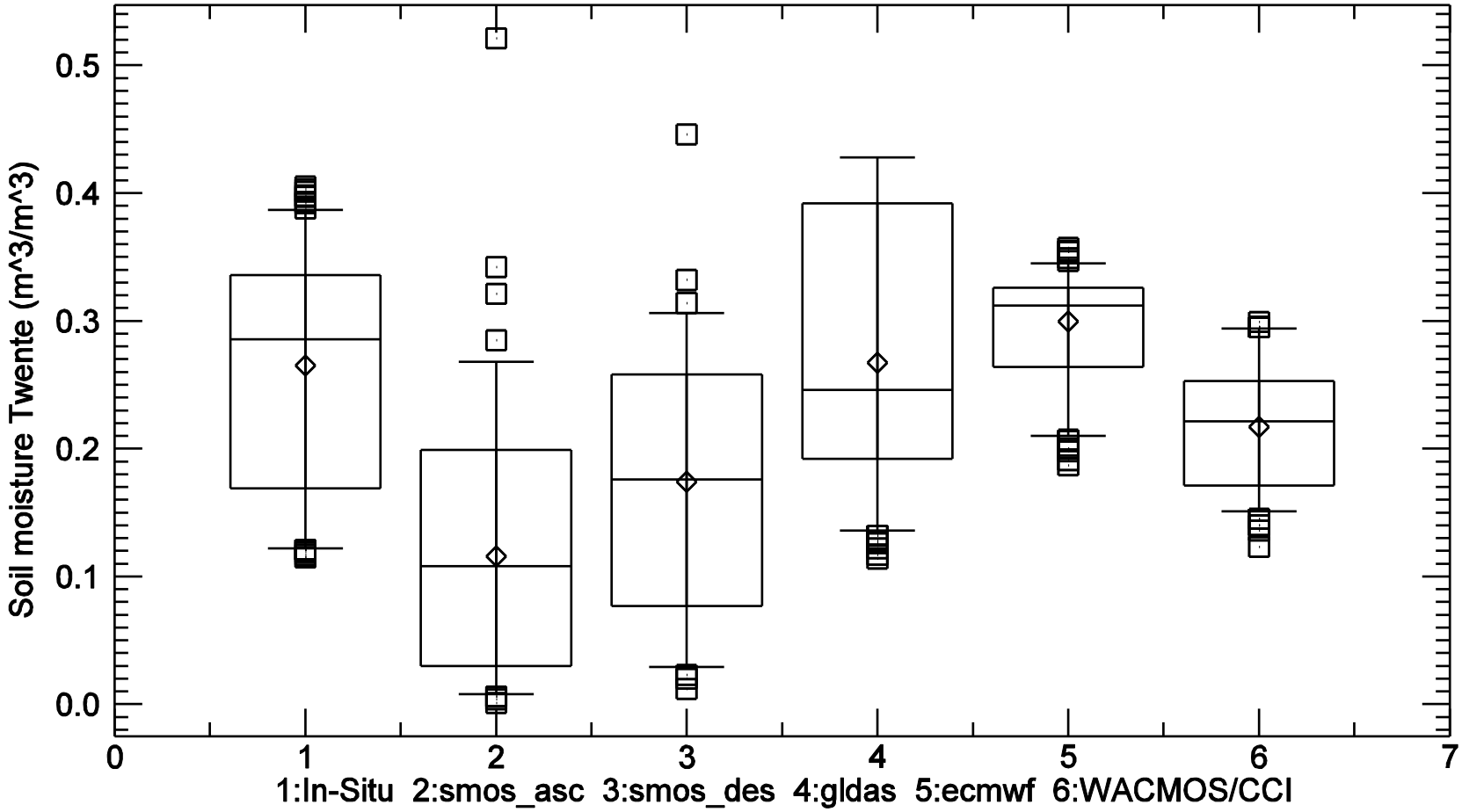


Twente SMST Network – technical details

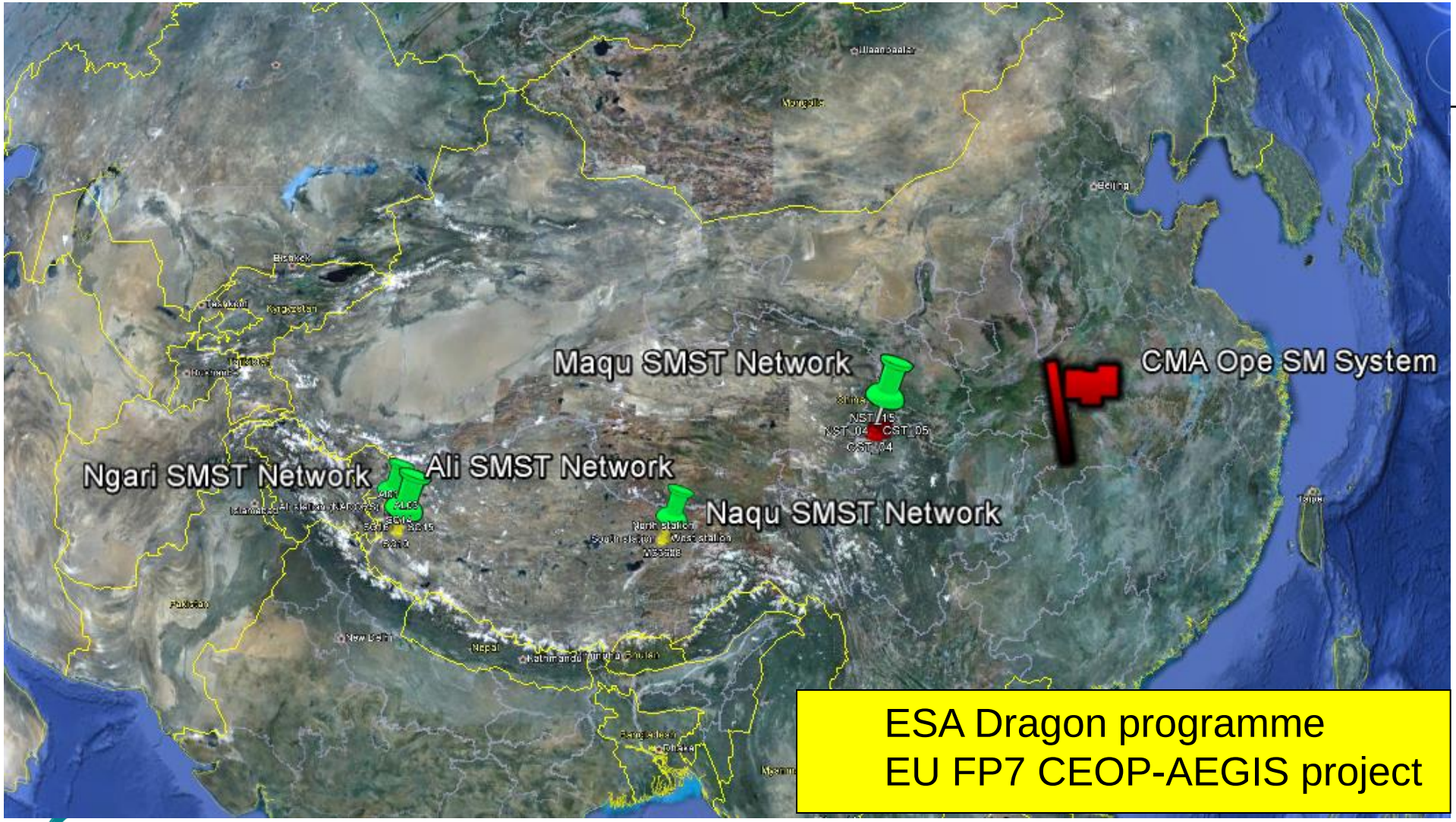
Twente SMST Network – validation results



Twente SMST Network – validation results



Tibetan Plateau observatory of plateau scale soil moisture and soil temperature (Tibet-Obs)



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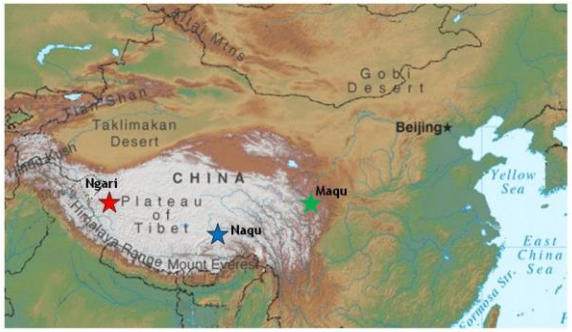
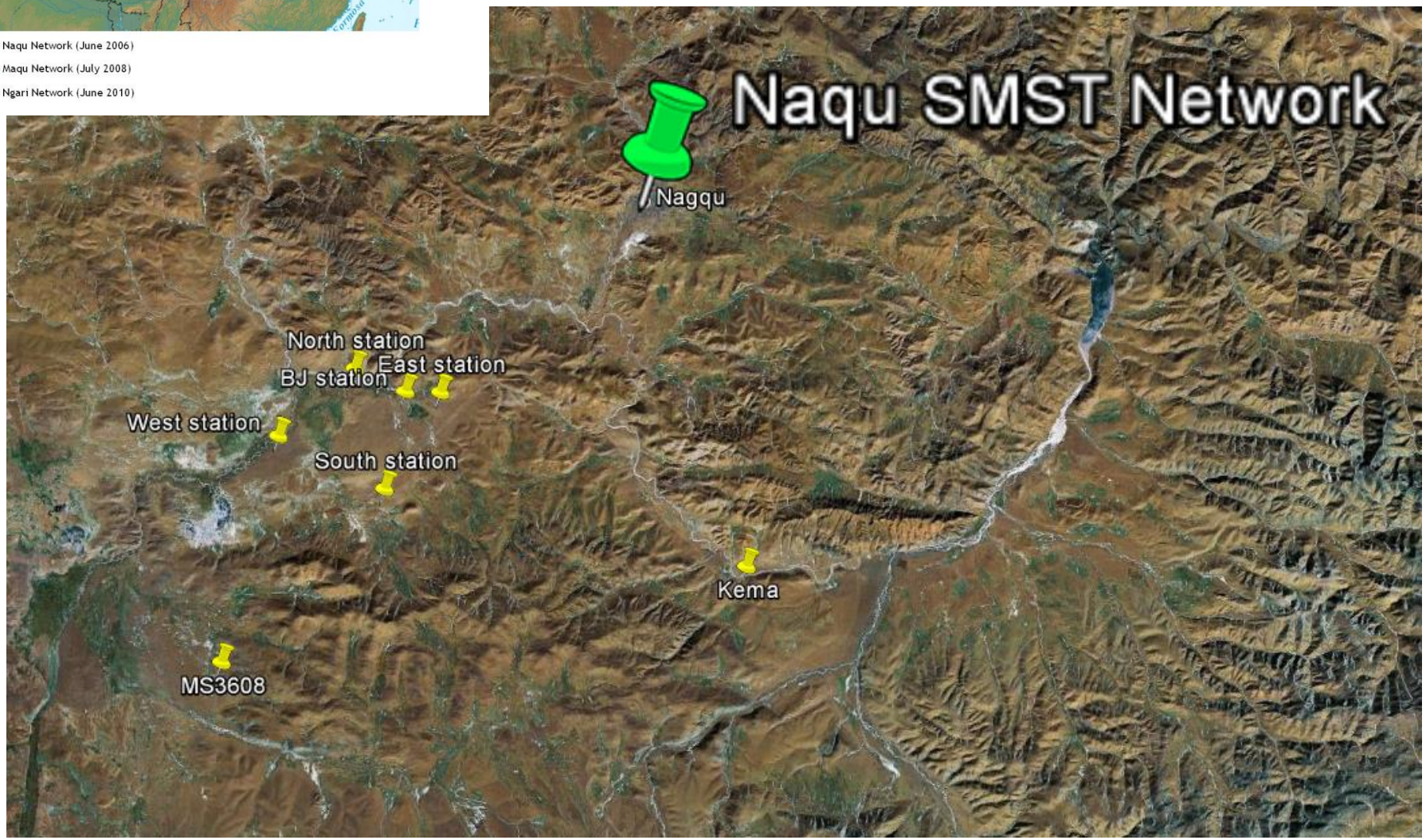
Su, Z., et al. 2011, Hydrol. Earth Syst. Sci., 15, 2303–2316, www.hydrol-earth-syst-sci.net/15/2303/2011/

Tibetan Plateau soil moisture and soil temperature Observatory (Tibet-Obs)



- Naqu Network (June 2006)
- Maqu Network (July 2008)
- Ngari Network (June 2010)



ITC Earth Observation Research and Education Sites

The Role of the Tibetan Plateau in Global Climate

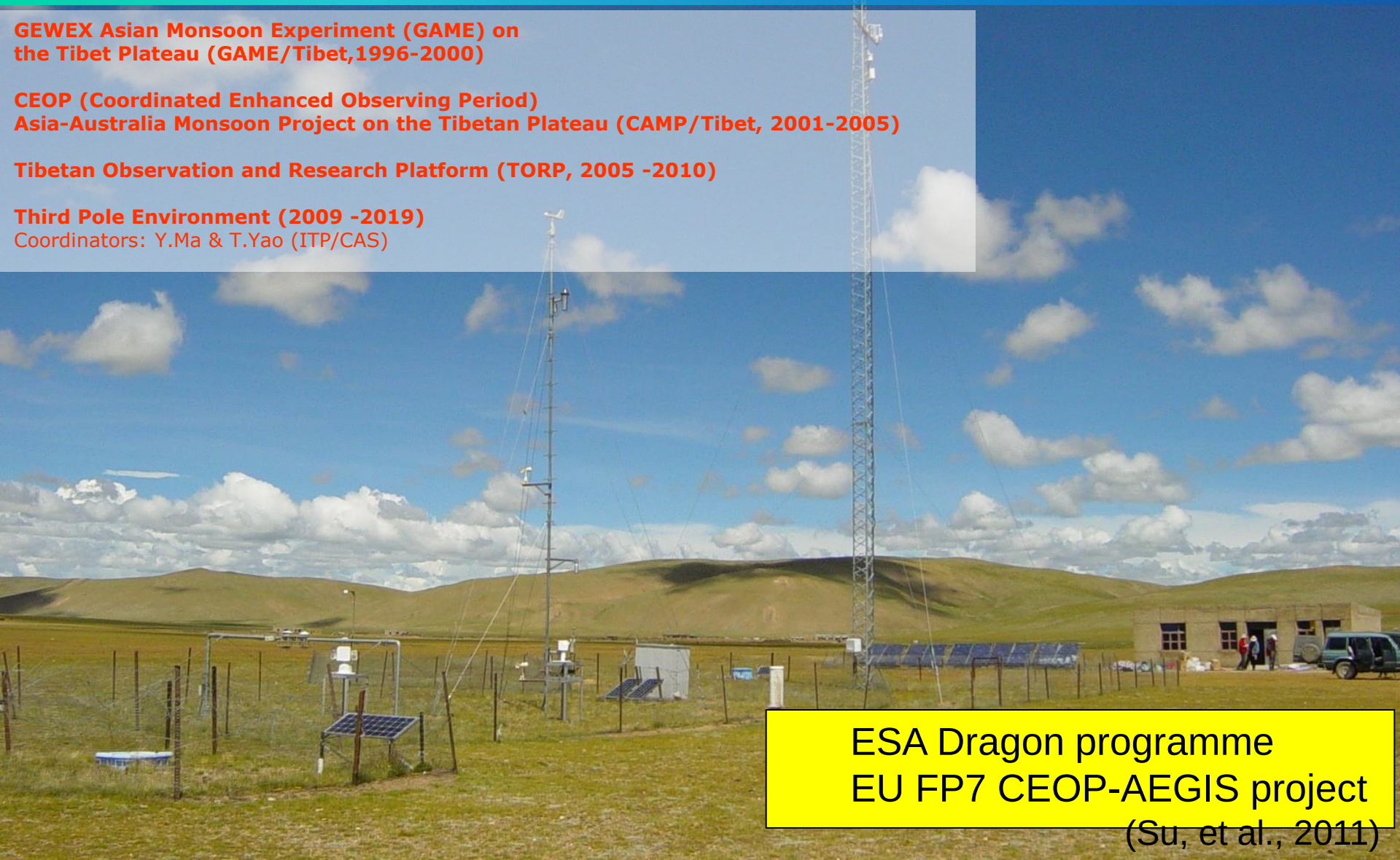
(Collaboration with Chinese Academy of Sciences)

GEWEX Asian Monsoon Experiment (GAME) on the Tibet Plateau (GAME/Tibet,1996-2000)

CEOP (Coordinated Enhanced Observing Period)
Asia-Australia Monsoon Project on the Tibetan Plateau (CAMP/Tibet, 2001-2005)

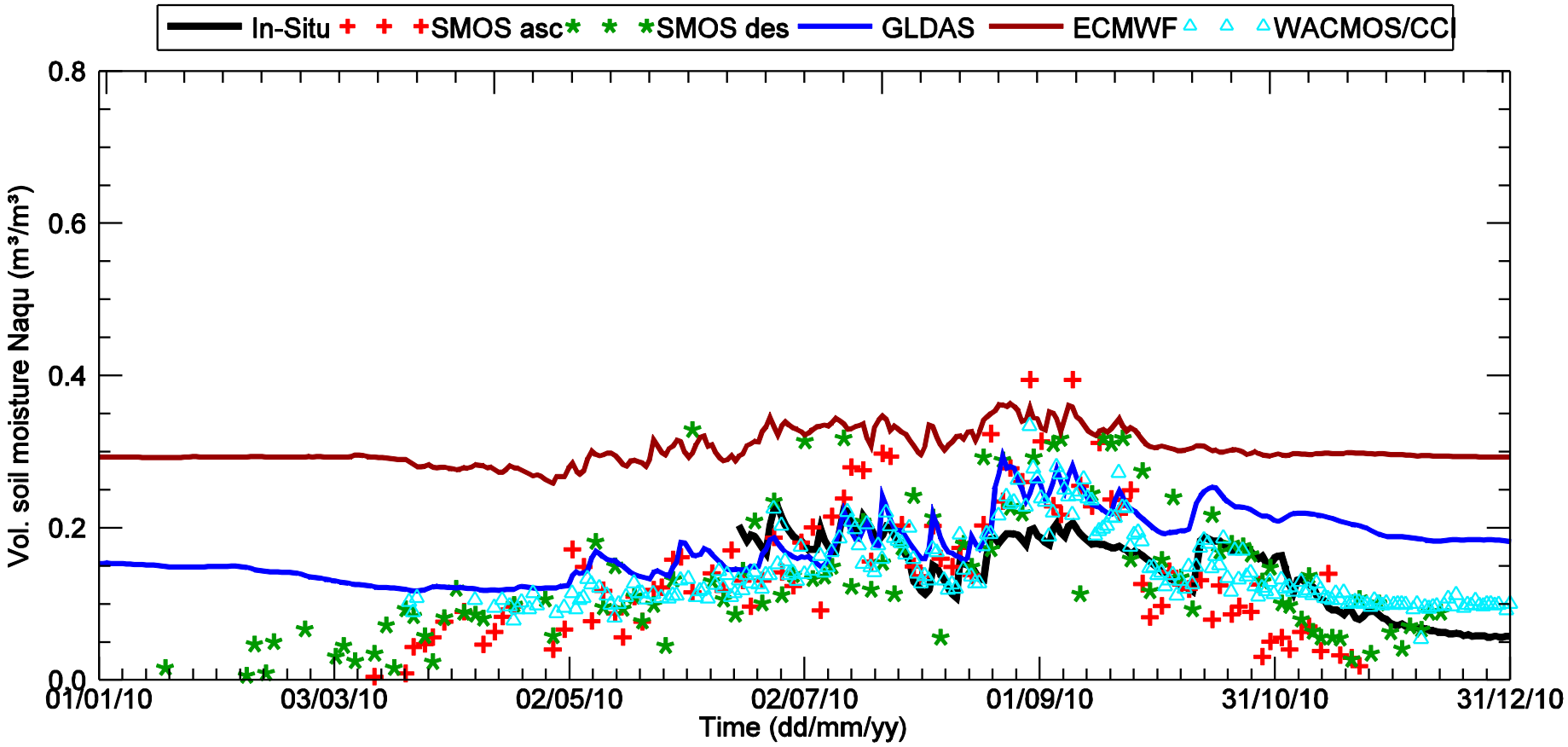
Tibetan Observation and Research Platform (TORP, 2005 -2010)

Third Pole Environment (2009 -2019)
Coordinators: Y.Ma & T.Yao (ITP/CAS)

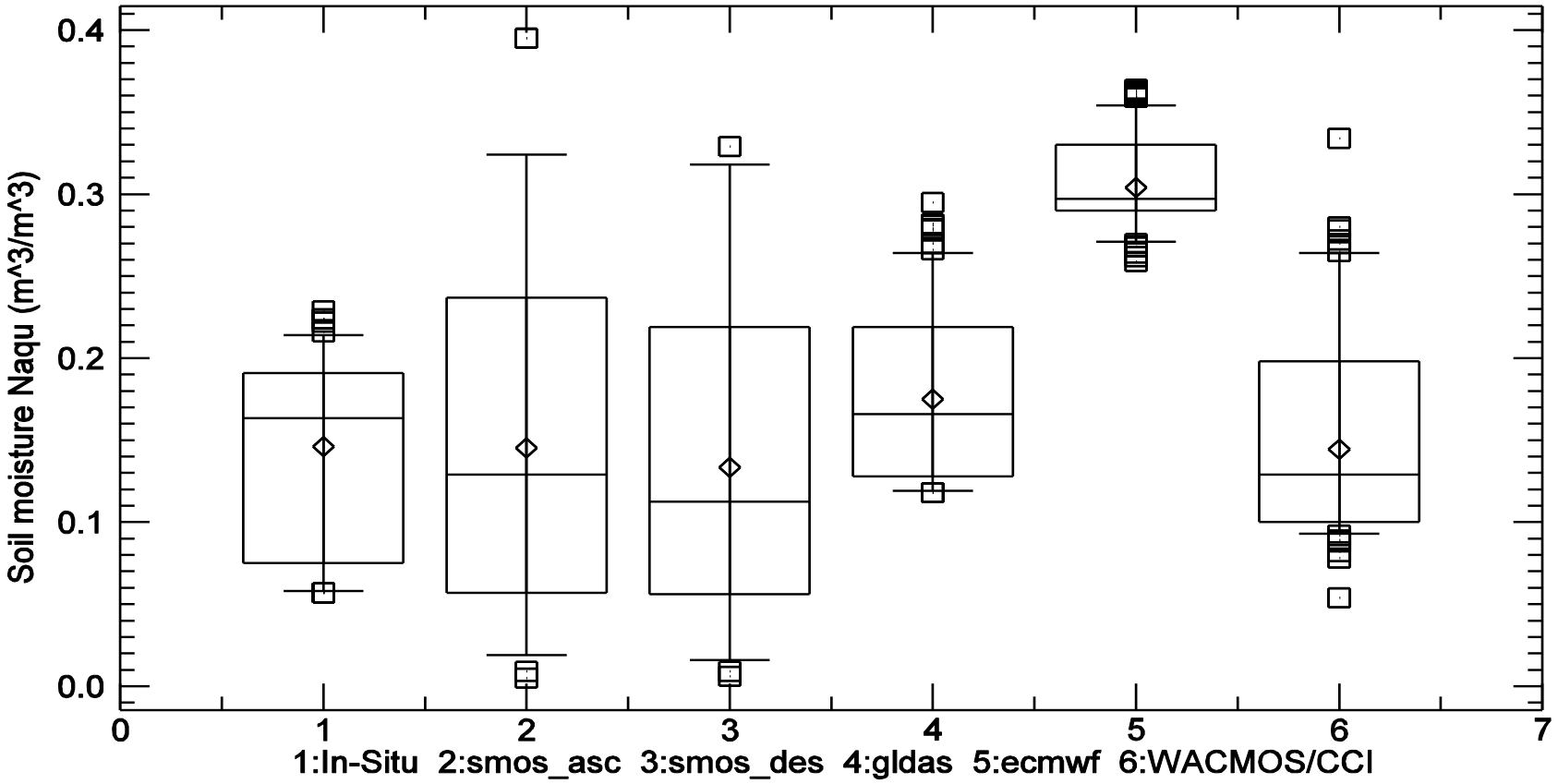


ESA Dragon programme
EU FP7 CEOP-AEGIS project
(Su, et al., 2011)

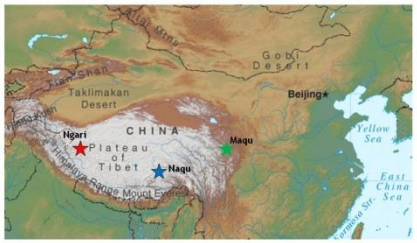
Naqu SMST Network – validation results



Naqu SMST Network – validation results



Tibetan Plateau soil moisture and soil temperature Observatory (Tibet-Obs)



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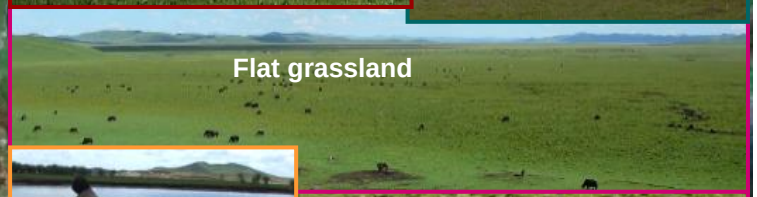
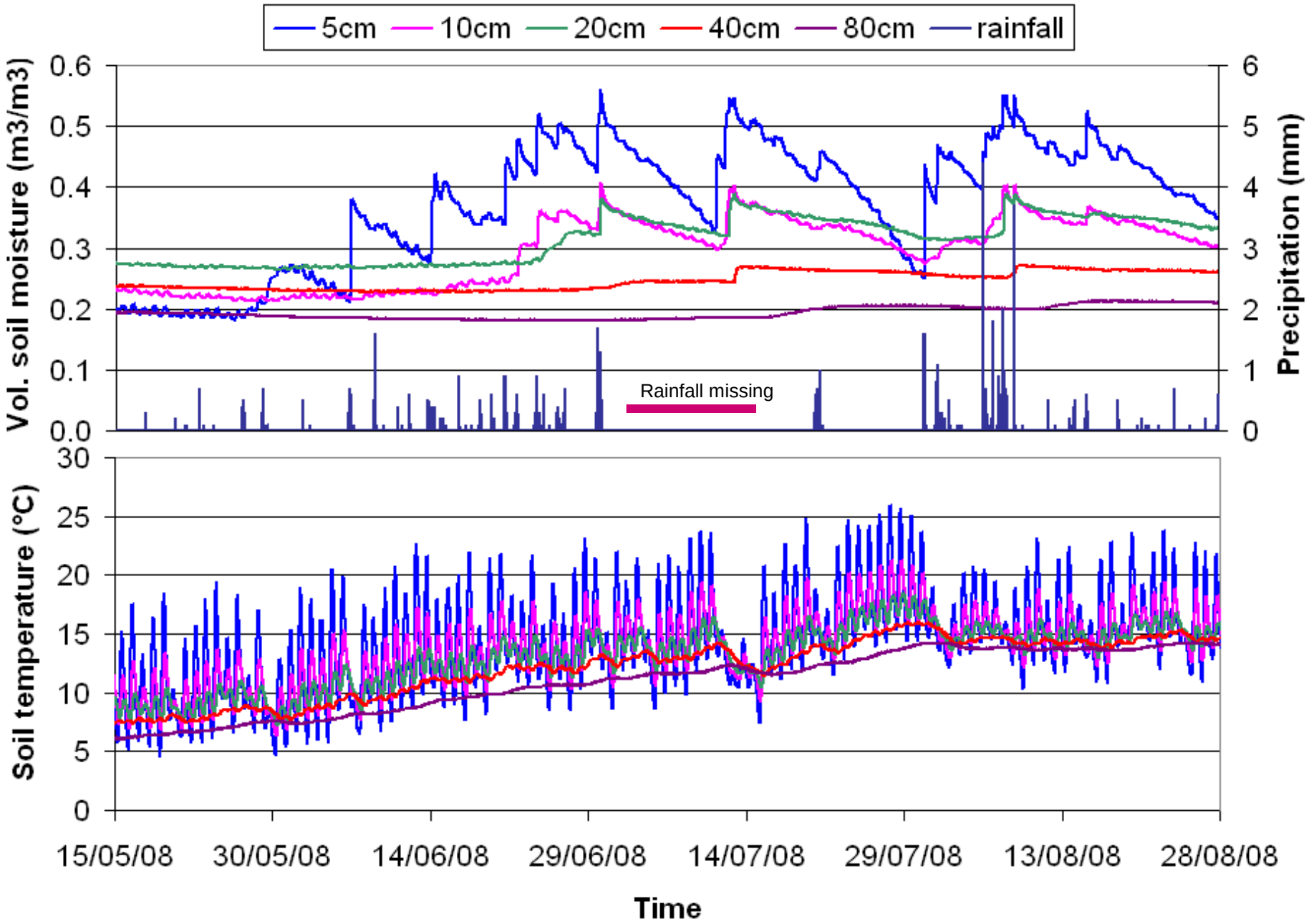
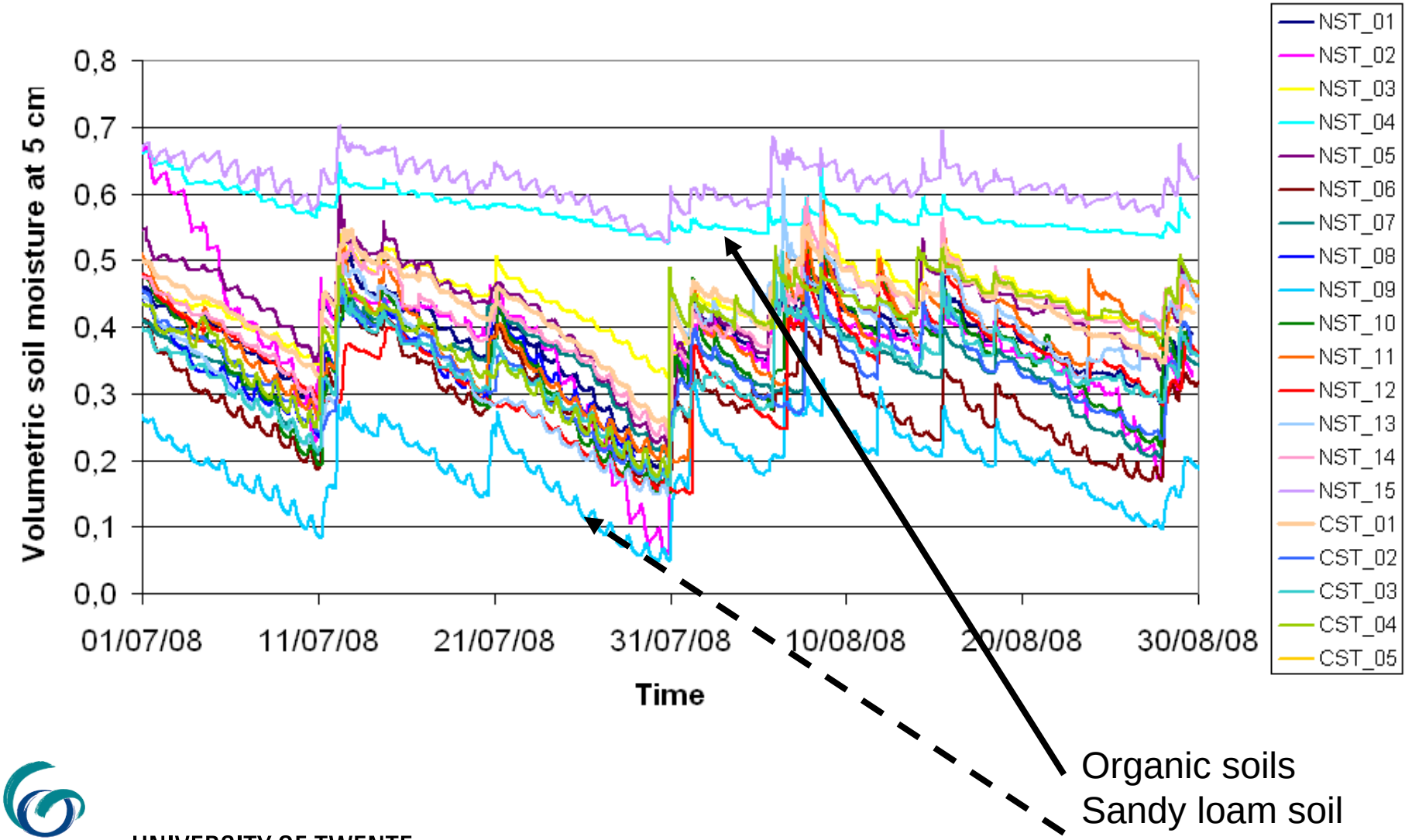


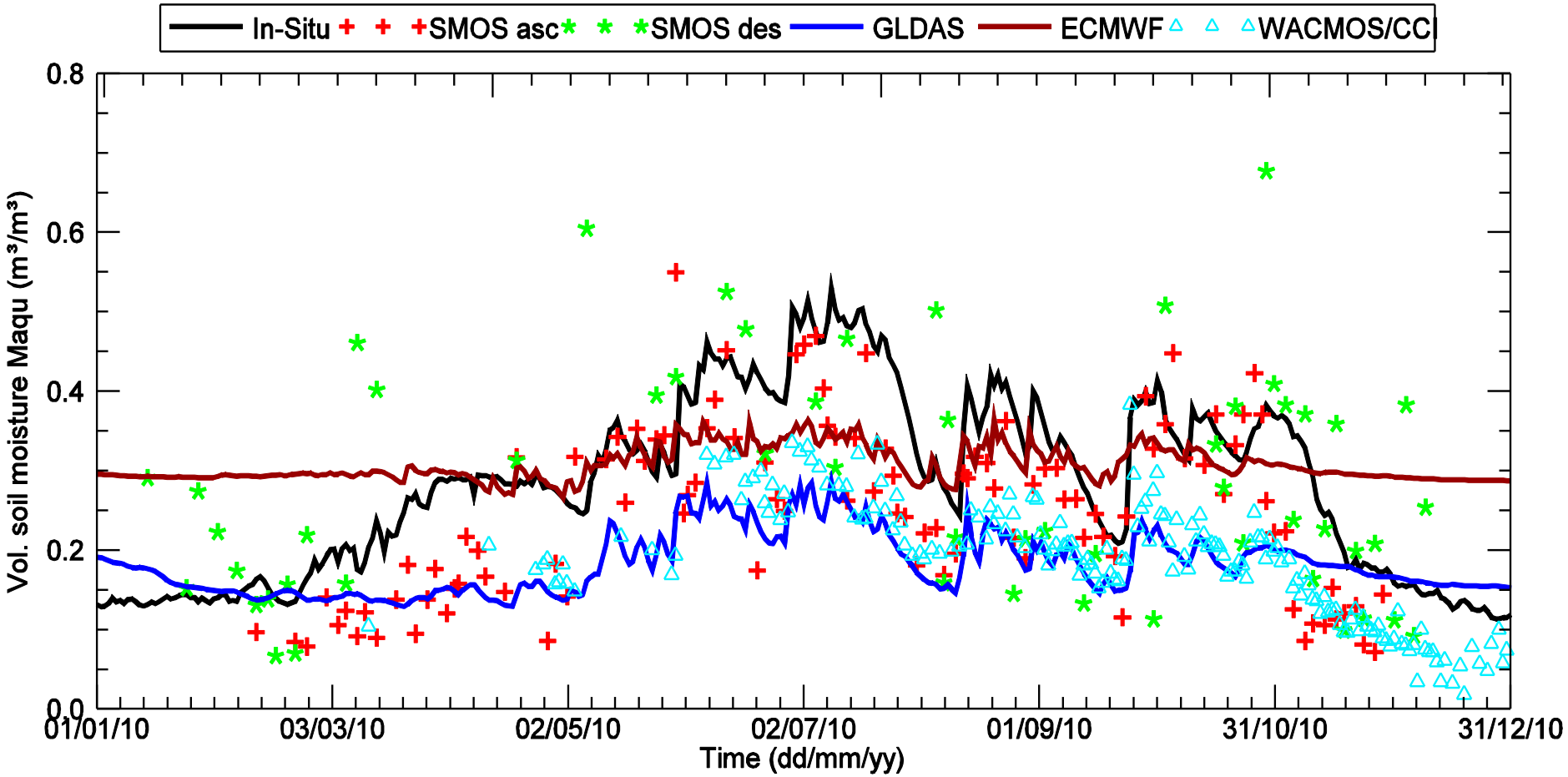
Maqu Network: SMST at different depths (station: *CST_01)*



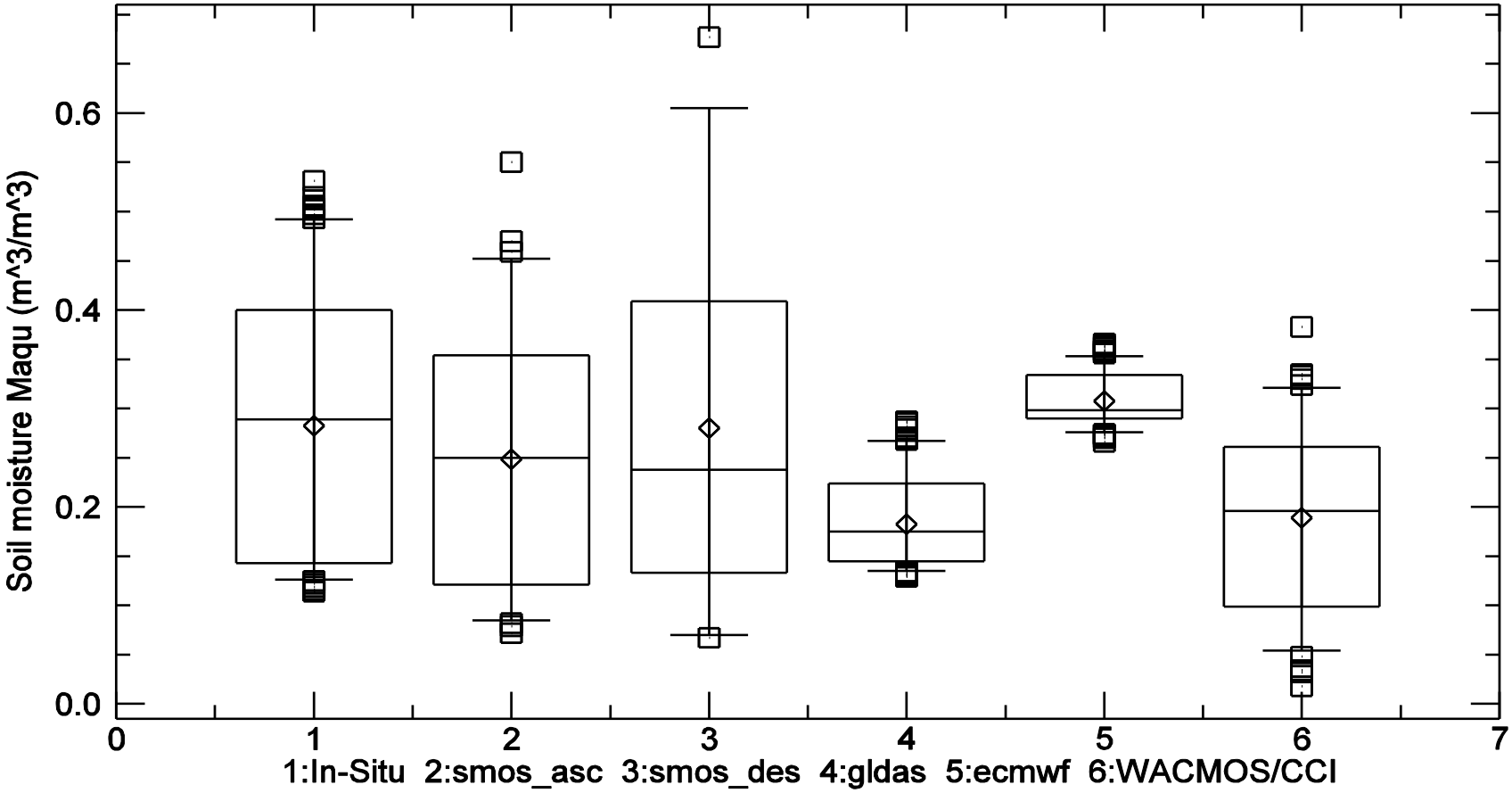
Maqu Network: Soil moisture at 5 cm depth of all the stations



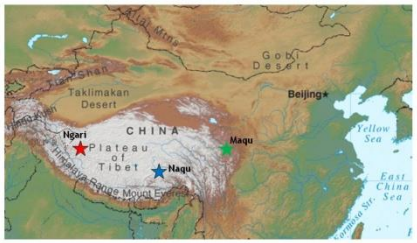
Maqu SMST Network – validation results



Maqu SMST Network – validation results



Tibetan Plateau soil moisture and soil temperature Observatory (Tibet-Obs)



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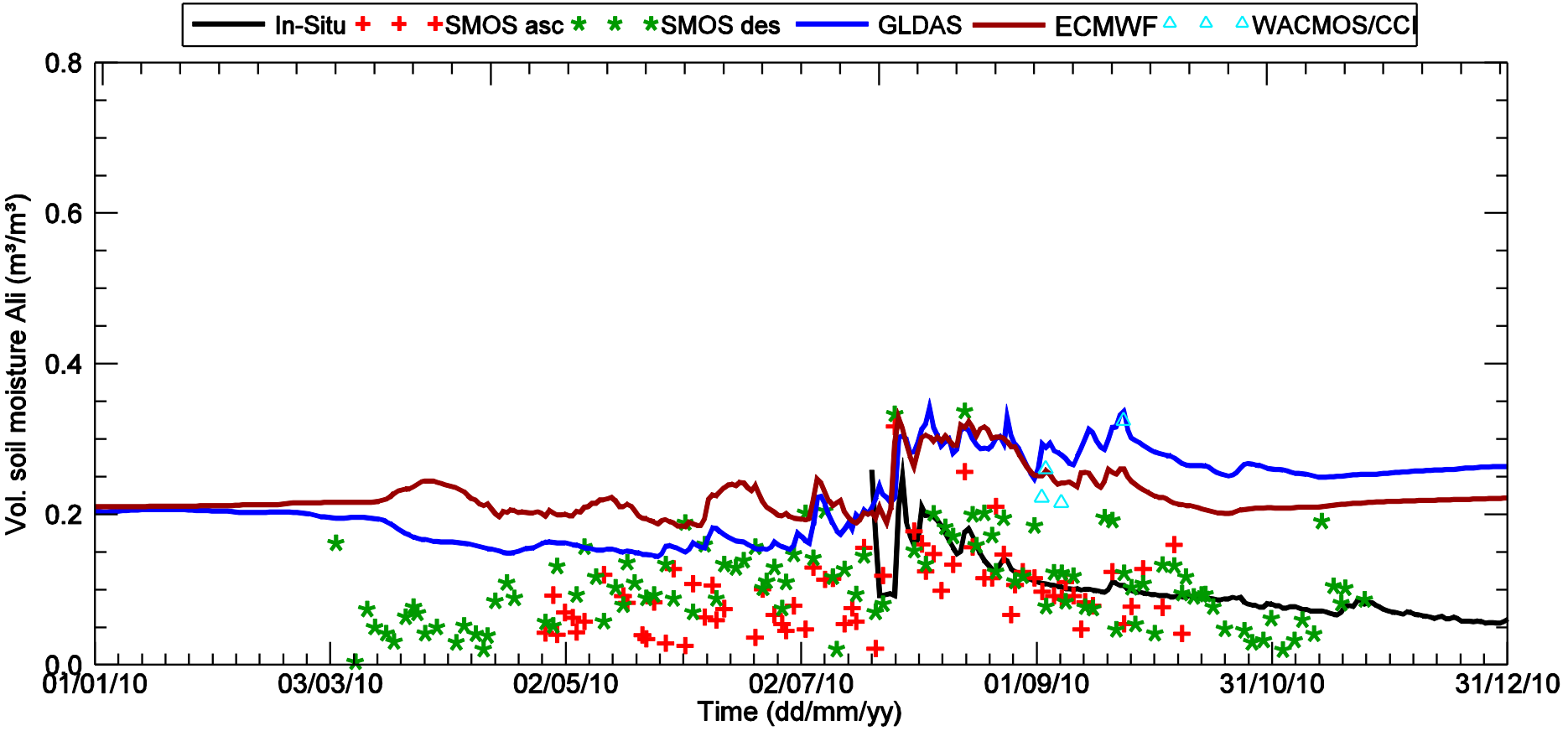
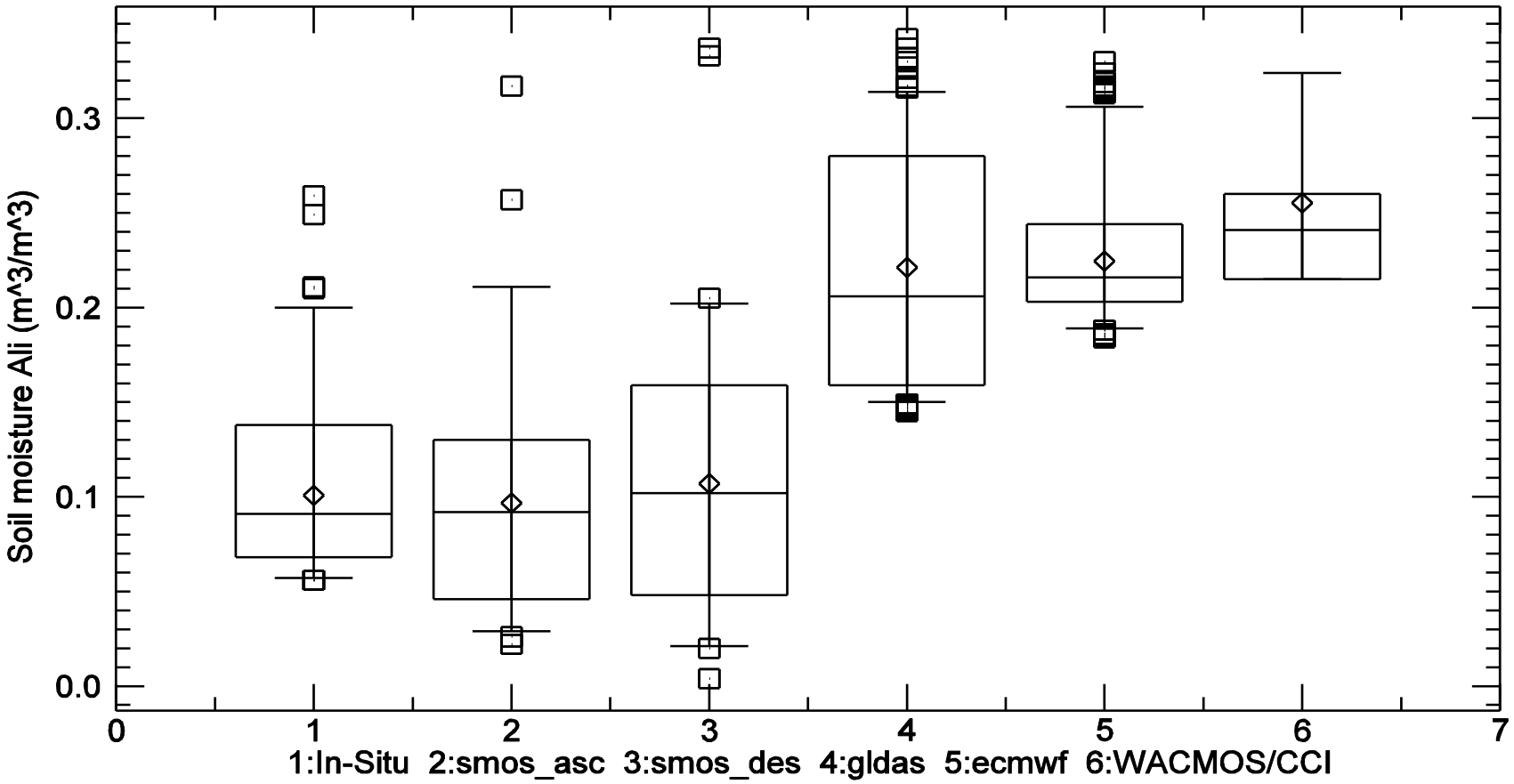
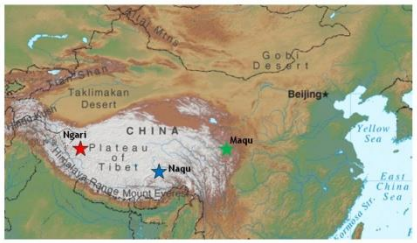
Ali SMST Network – validation results



Ali SMST Network – validation results



Tibetan Plateau soil moisture and soil temperature Observatory (Tibet-Obs)



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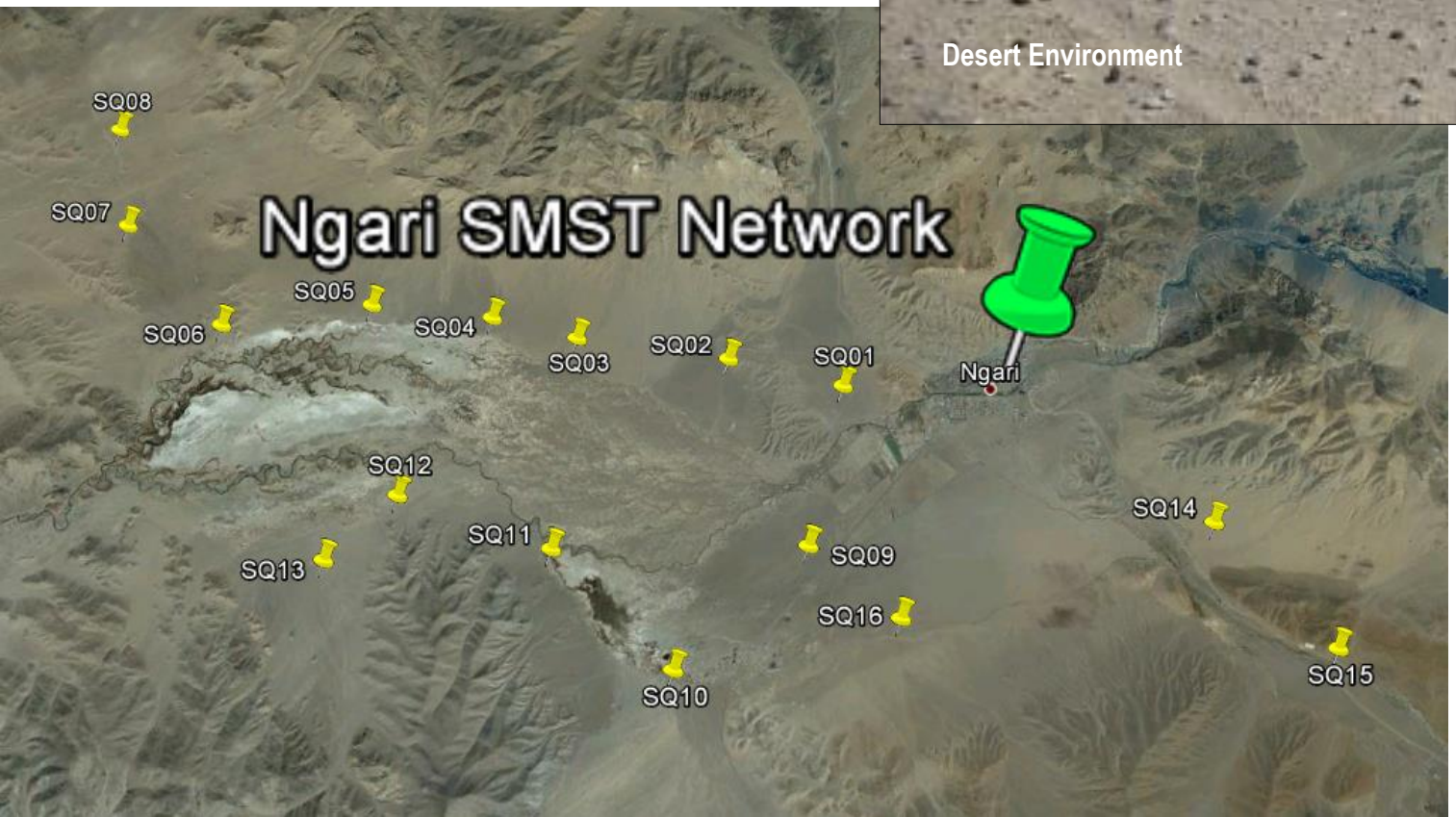
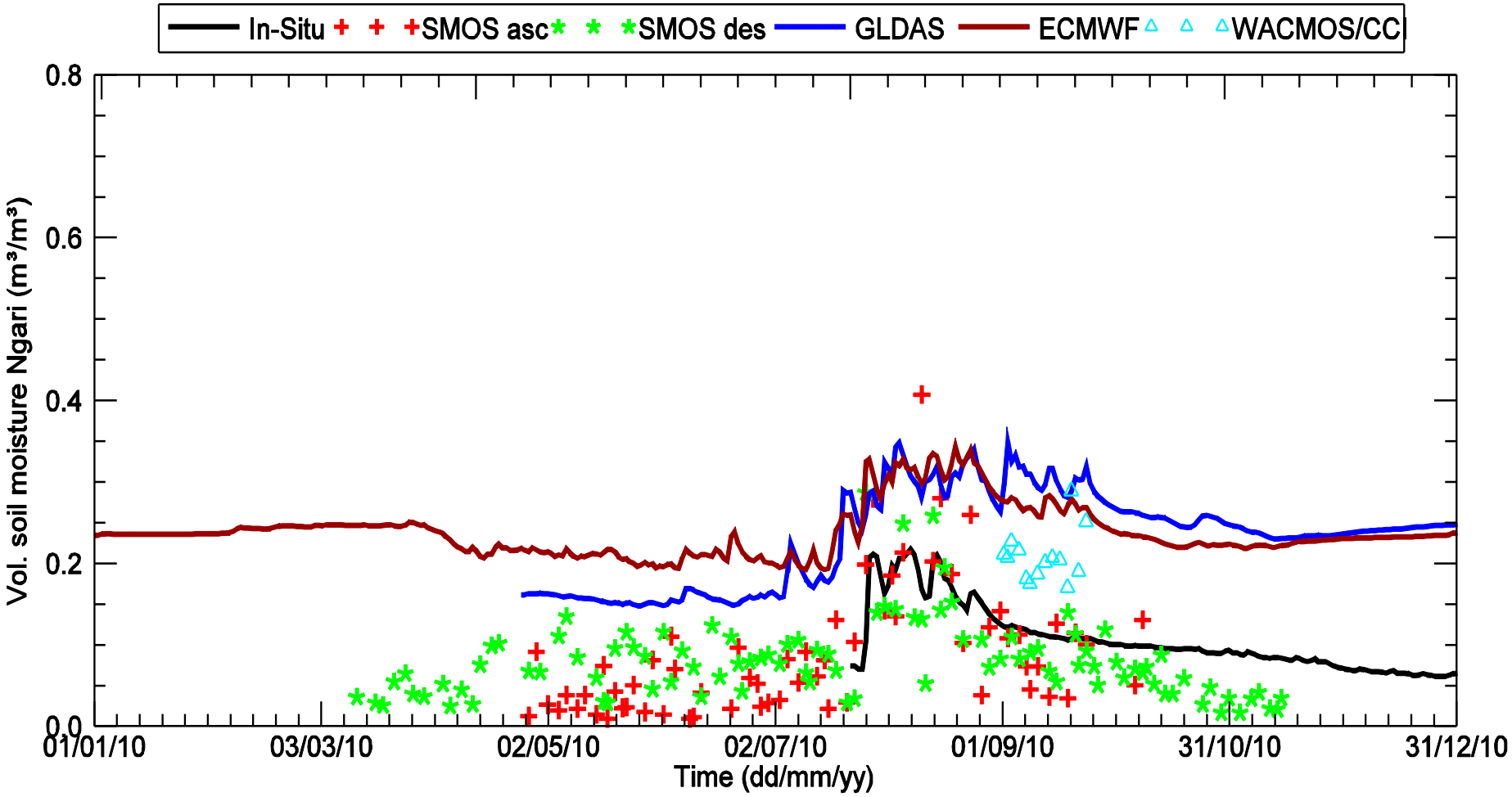
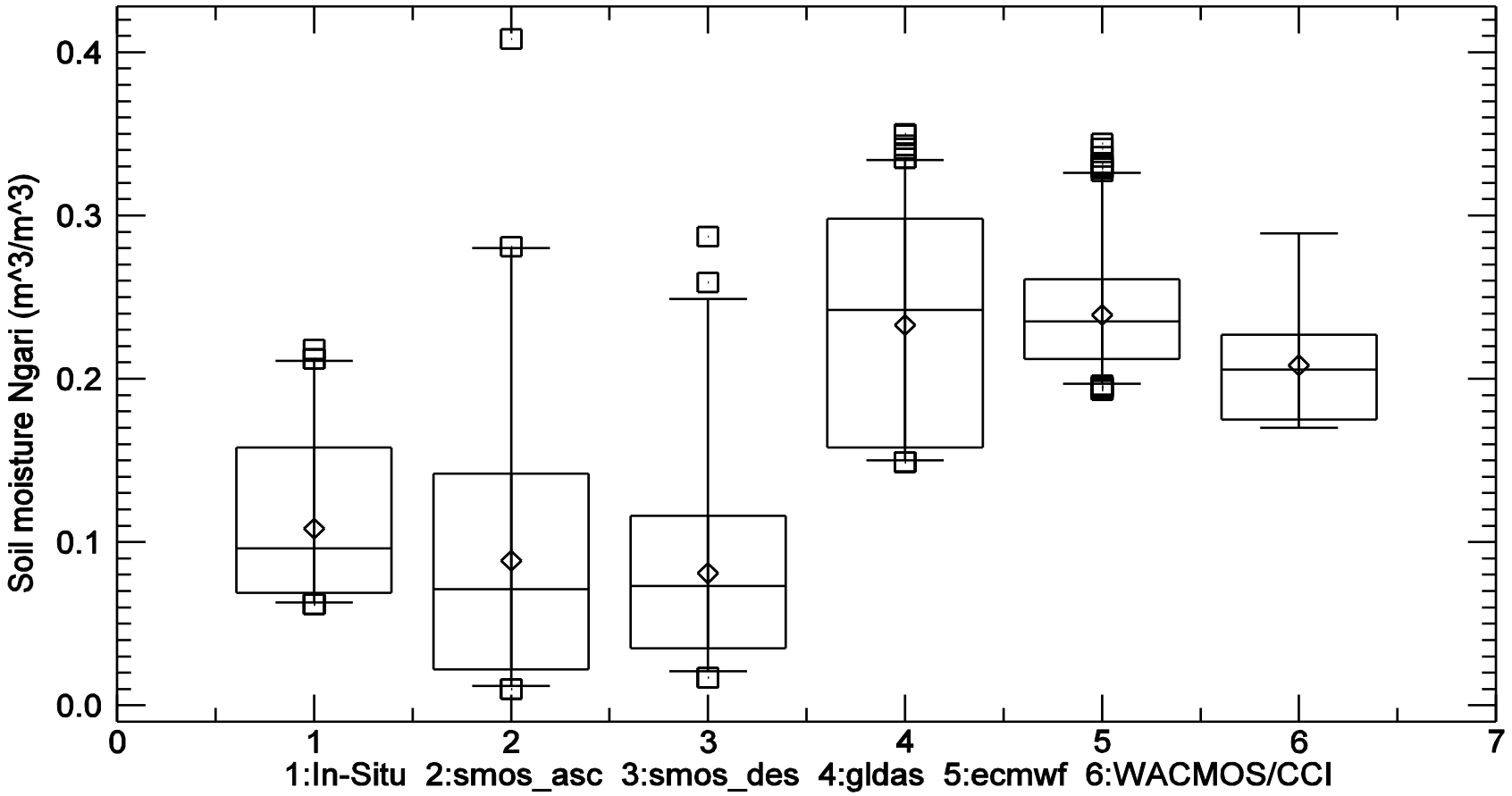


Ngari SMST Network – validation results



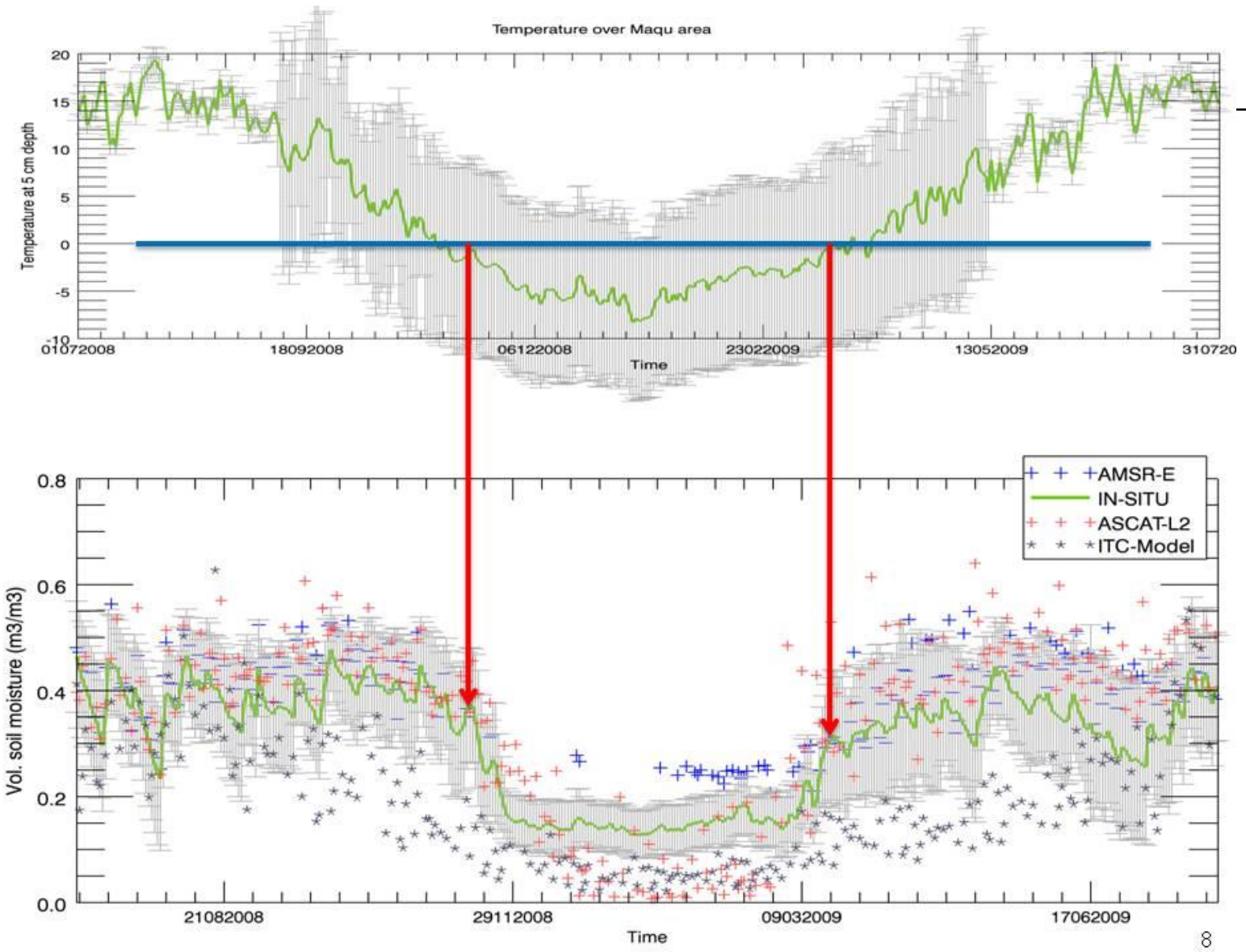
Ngari SMST Network – validation results



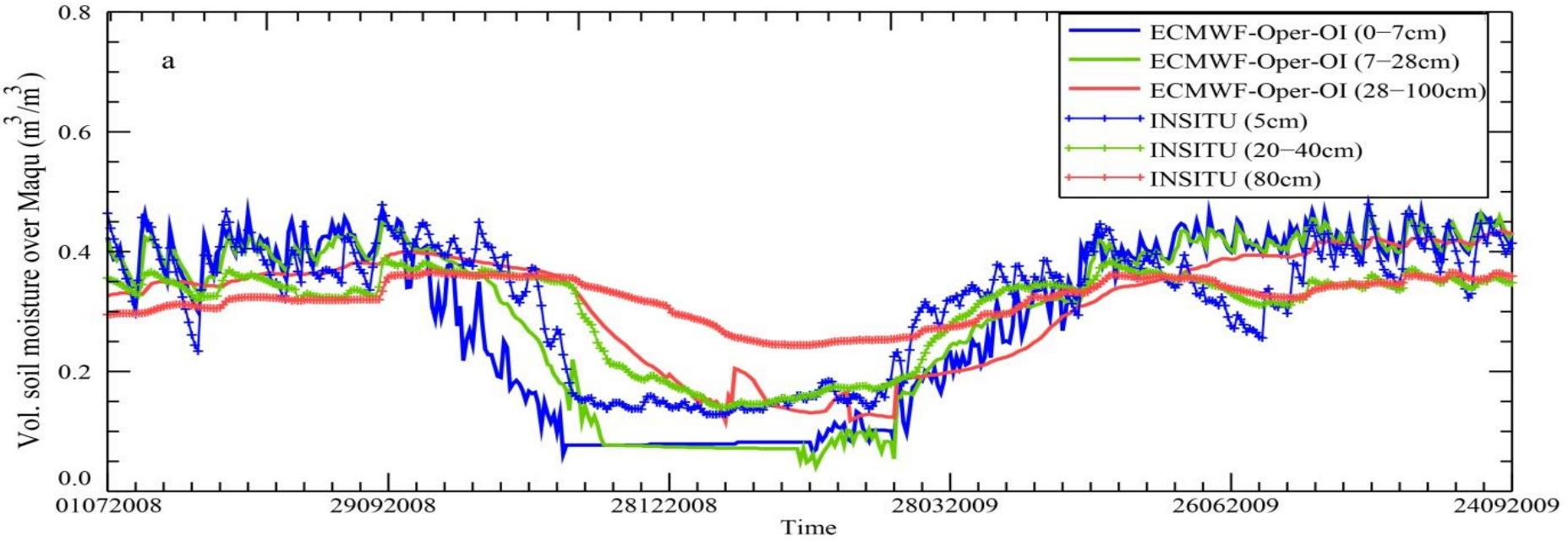
Some other research examples

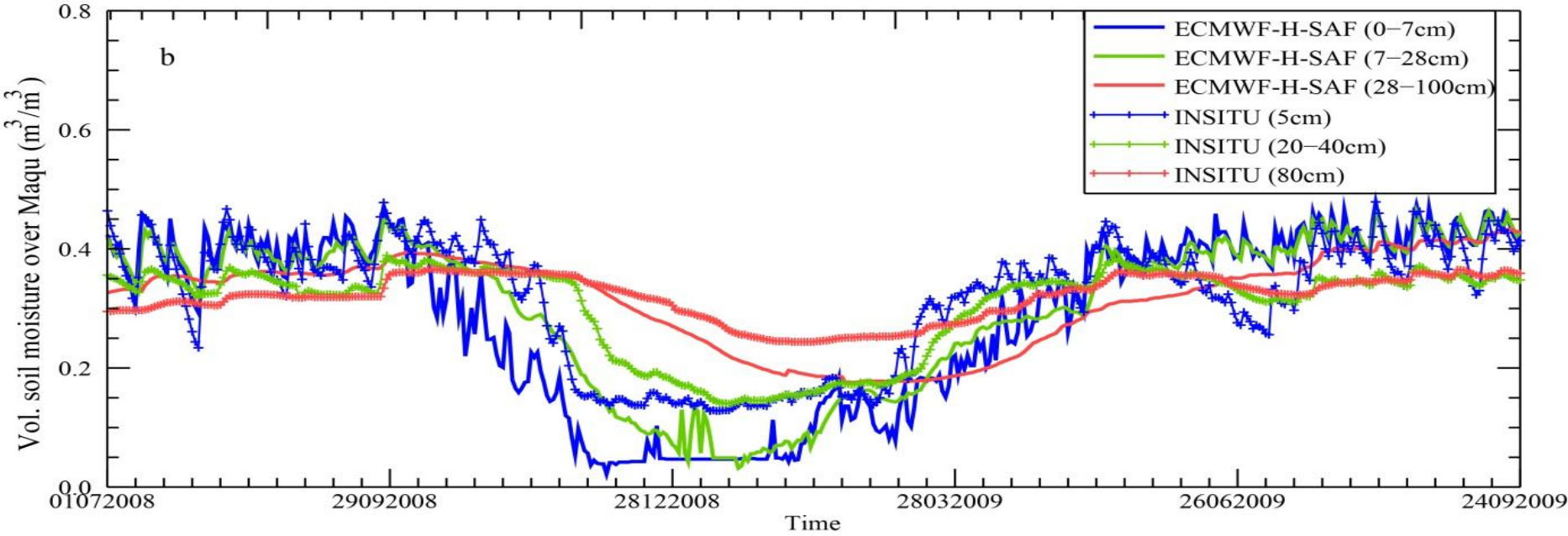
Quantification of uncertainties in global products

(Su, et al., 2011)



How good is soil moisture analysis/assimilation? (Su & de Rosnay, et al. 2013)





An Improved Two-layer Algorithm for Estimating Effective Soil Temperature using L-band Radiometry (Lv et al., 2013, RSE, in review)

$$T_B = \varepsilon T_{eff}$$

$$T_{eff} = \int_0^{\infty} T(x)\alpha(x)\exp\left[-\int_0^{x} a(x')dx'\right]dx$$ (Ulaby et al. 1978; 1979)

$$\alpha(x) = \frac{4\pi}{\lambda}\varepsilon''(x) \Big/ 2\left[\varepsilon'(x)\right]^{\frac{1}{2}}$$ (Wilheit 1978)

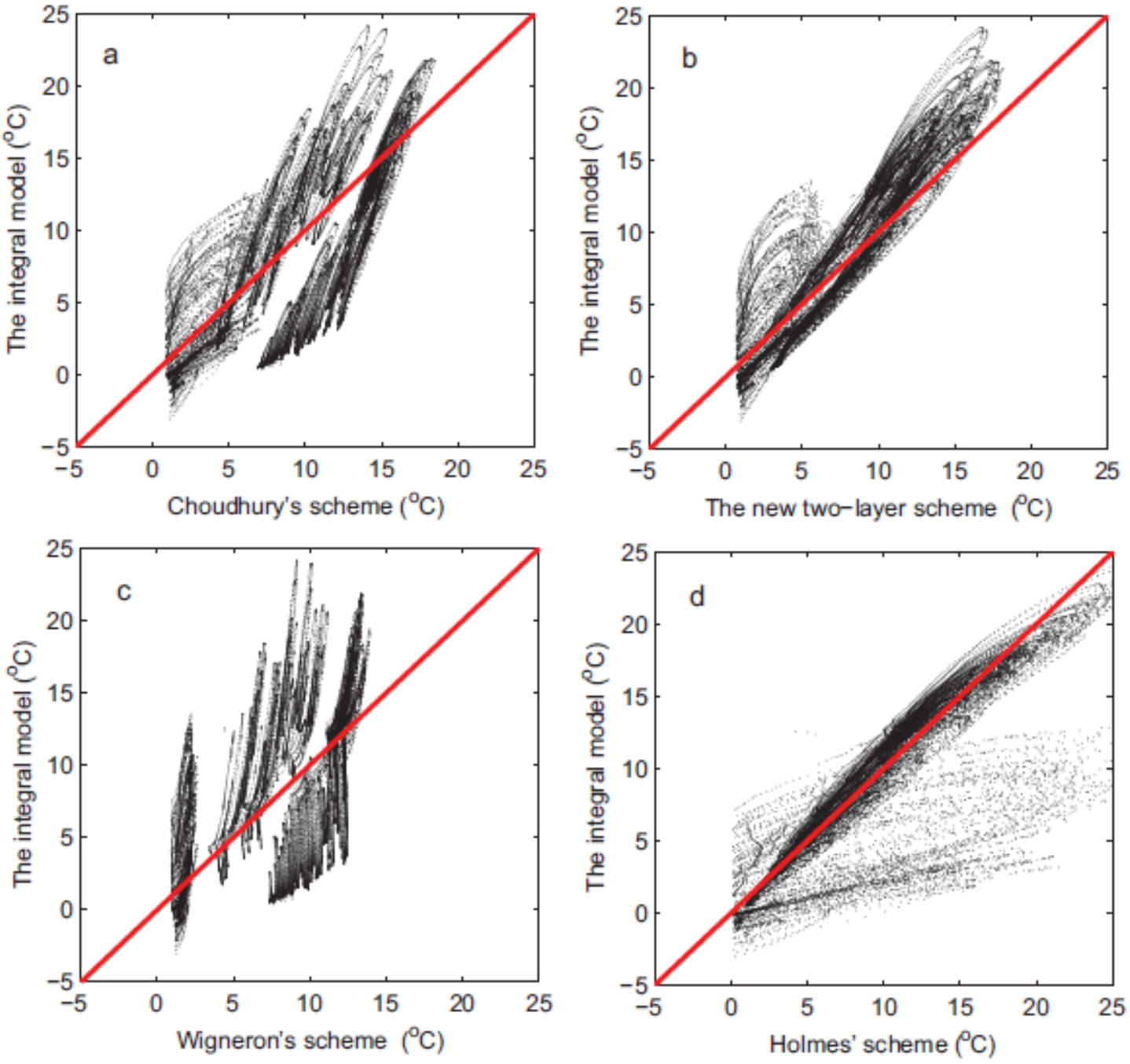
A two-layer system:

$$T_{eff} = T_0\left(1 - e^{-B_0}\right) + T_{\infty}e^{-B_0}$$

$$B_0 = \alpha_1 x_1$$

$$B_0 = \Delta x \cdot \frac{4\pi}{\lambda} \cdot \frac{\varepsilon''}{2\sqrt{\varepsilon'}}$$

$$C = 1 - e^{-B_0}$$
$$= 1 - \exp\left(-\Delta x \alpha_1\right)$$
$$= 1 - \exp\left(-\Delta x \cdot \frac{4\pi}{\lambda} \cdot \frac{\varepsilon''}{2\sqrt{\varepsilon'}}\right)$$


a
b
c
d
The integral model (°C)
Choudhury's scheme (°C)
The new two−layer scheme (°C)
Wigneron's scheme (°C)
Holmes' scheme (°C)
−5
0
5
10
15
20
25

Tor Vergata Model – Simultaneous Modeling Of Active And Passive Microwave Signatures

- To use a single discrete scattering model to simulate both emission and backscattering, with a unique set of input parameters
- To combine the use of active and passive microwave satellite signatures to constrain the model
- To improve the modelling and understanding of microwave emissivity and backscattering coefficient over grassland with litter
- To contribute to an optimal use of SMAP-like data
- To improve the soil moisture retrieval

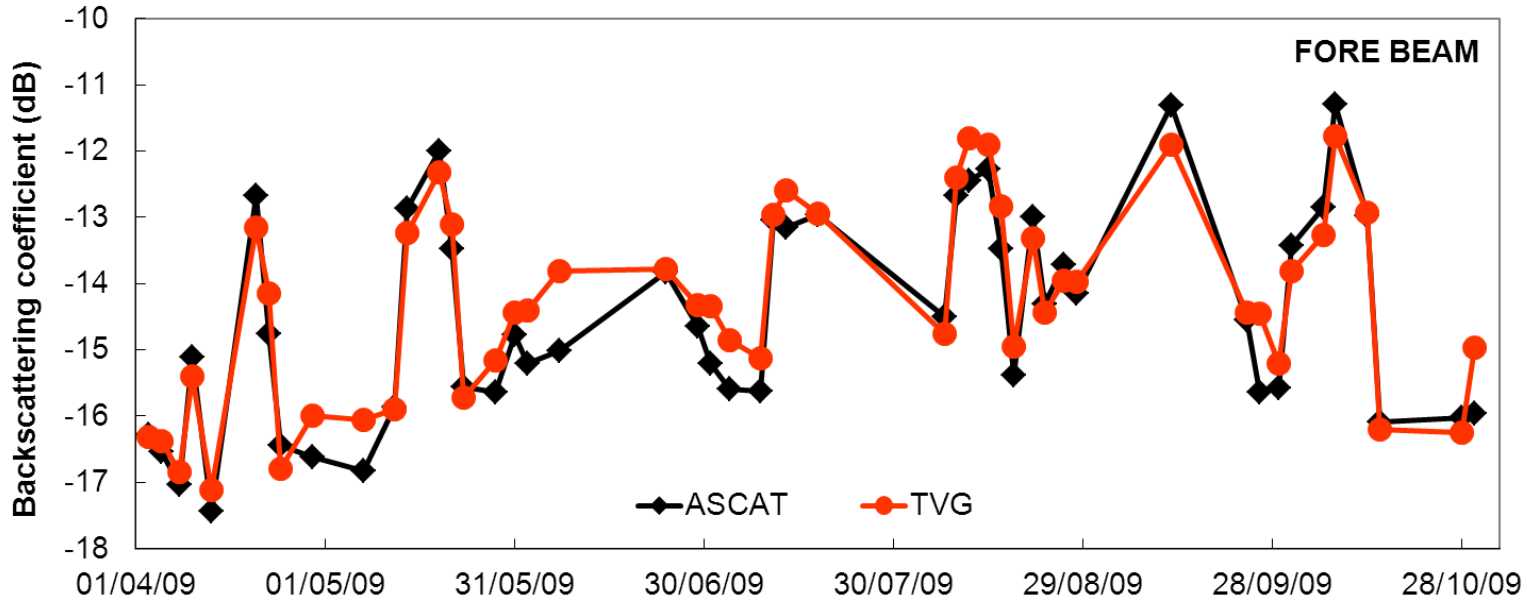
L. Dente, P. Ferrazzoli, Z. Su, R. van de Velde, L. Guerriero, 2013, Combined use of active and passive microwave satellite data to constrain a discrete scattering model, RSE, In review.

PRELIMINARY ANALYSIS:
Model sensitivity to unavailable variables

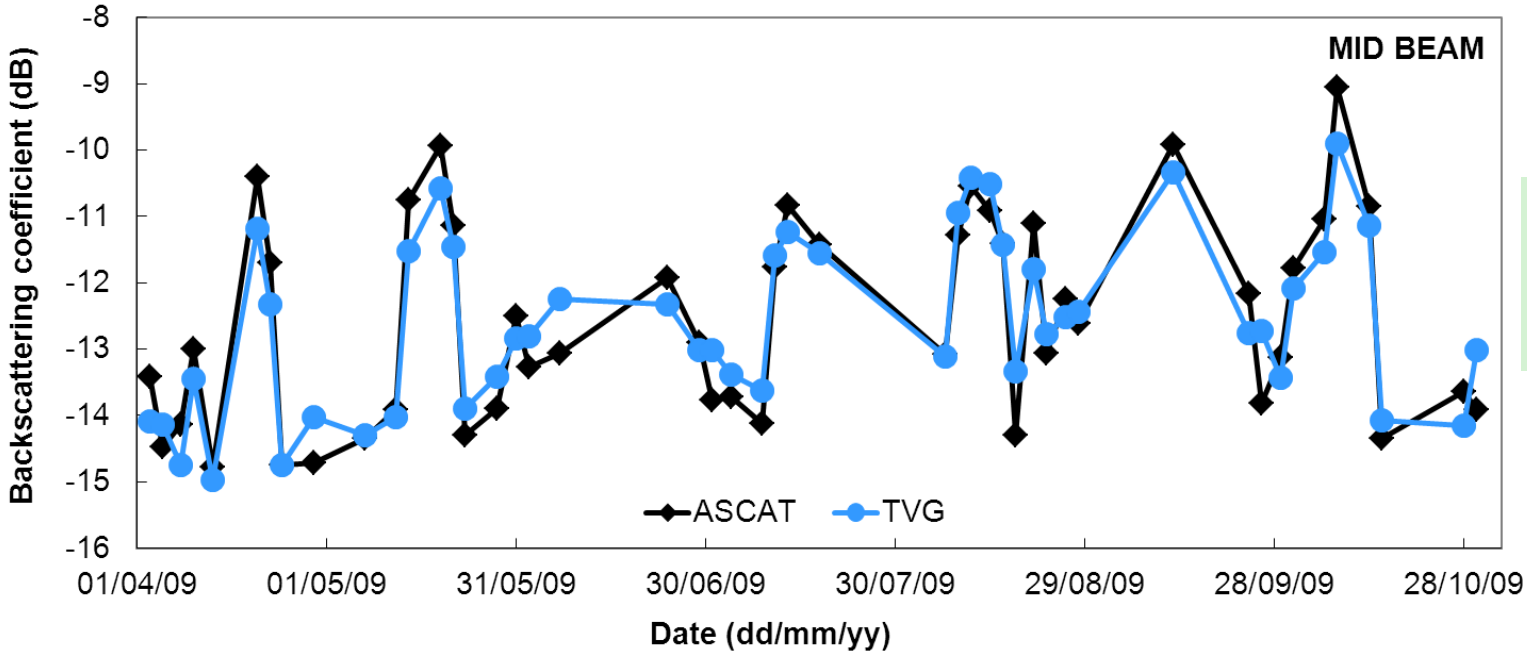
RESULTS:
Soil moisture and LAI (i.e. the measured variables) are the most important model inputs to simulate the temporal variability of emission and backscattering.
The unavailability of several model inputs can be managed by a proper parameter tuning.

height standard deviation	Calibrated
correlation length	Calibrated
autocorrelation function	Exponential
▪ Litter moisture content	Related to soil moisture, calibrated
▪ Litter biomass	Calibrated
▪ Leaf Area Index	MODIS/Terra+Aqua LAI 8-day
▪ Leaves: disc radius	Calibrated
▪ Leaves: disc thickness	0.02 cm
▪ Leaves: disc angular distribution	Random
▪ Plant moisture content	Calibrated

RESULTS: MODEL CALIBRATION (2009) – ACTIVE CASE

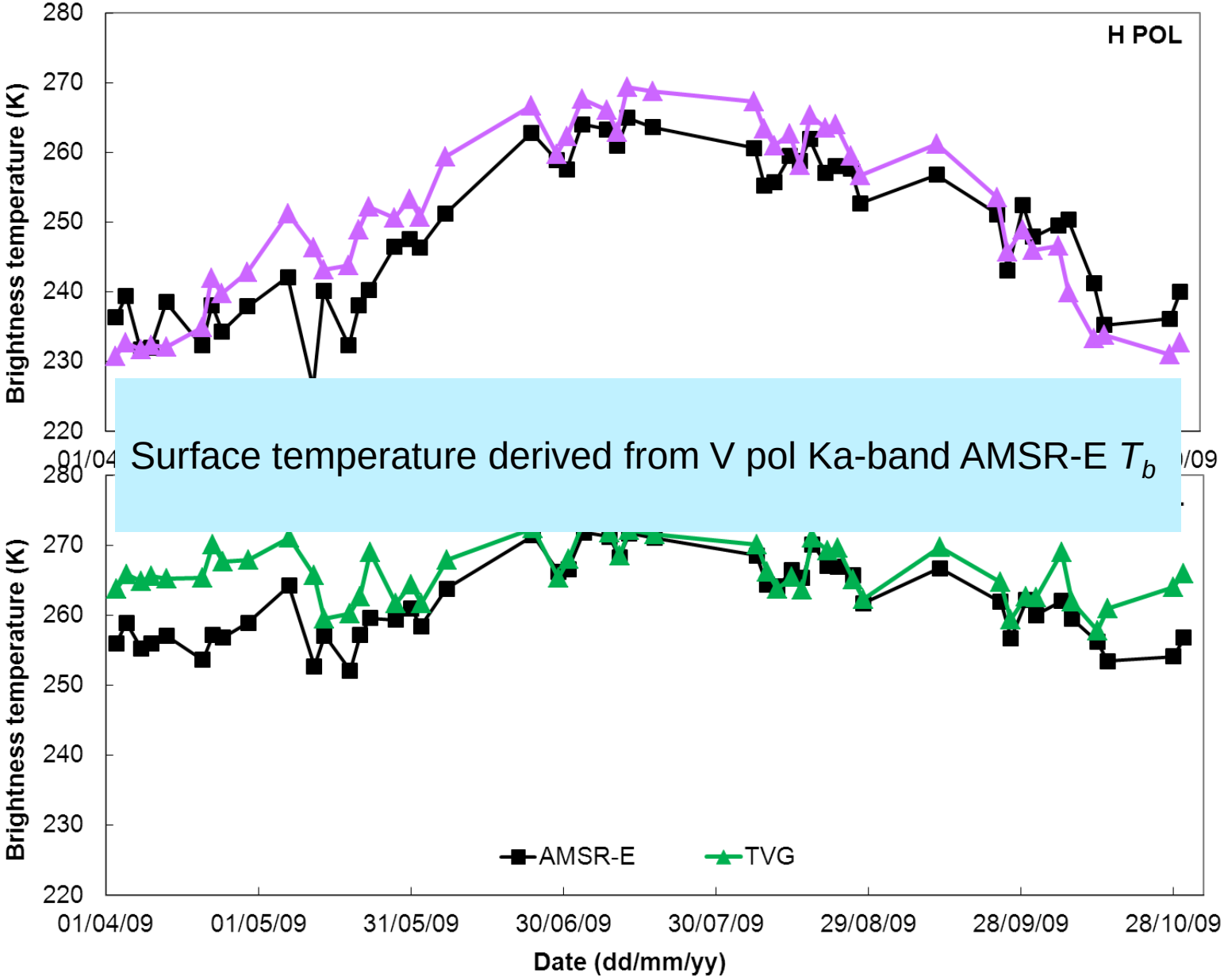


R^2 = 0.9
rmse = 0.5 dB
bias = 0.2 dB



R^2 = 0.9
rmse = 0.5 dB
bias = -0.04 dB

RESULTS: MODEL CALIBRATION (2009) – PASSIVE CASE (1)

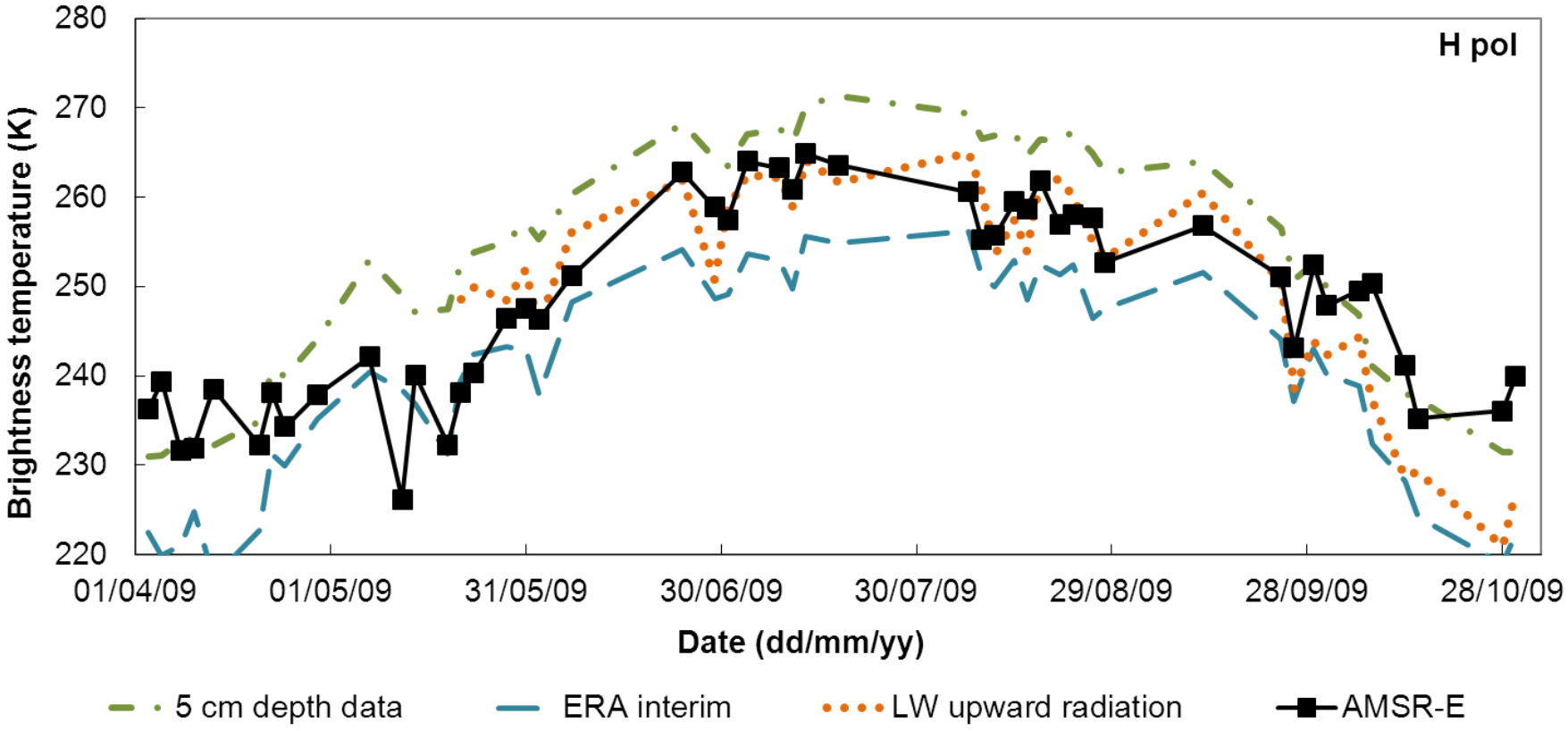


R^2 = 0.8
rmse = 6.3 K
bias = 2.7 K

R^2 = 0.5
rmse = 5.9 K
bias = 4.3 K

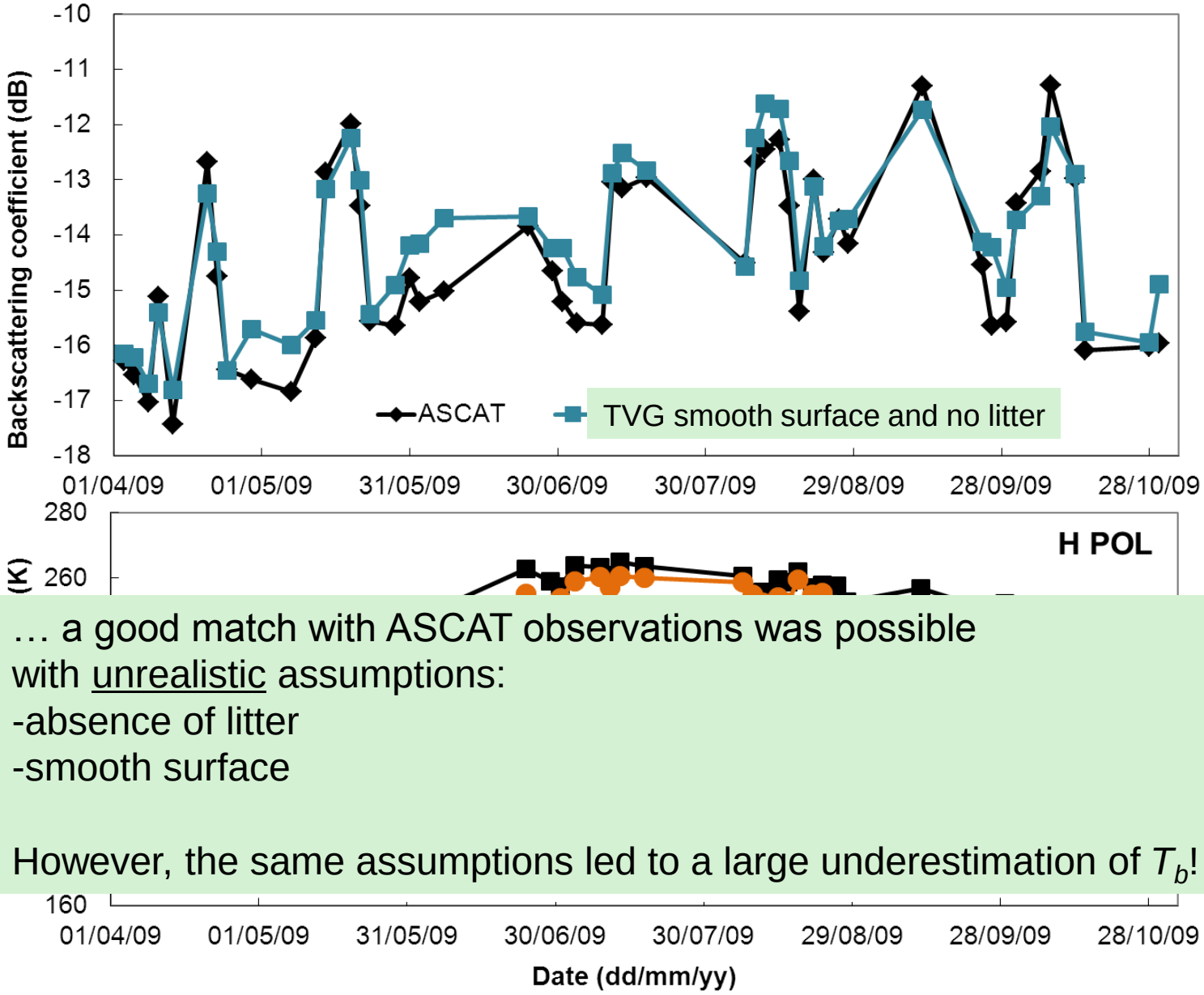
RESULTS: MODEL CALIBRATION (2009) – PASSIVE CASE (2)

… when a different surface temperature is used.



5 cm depth data	ERA interim	LW upward radiation
R^2 = 0.8	R^2 = 0.8	R^2 = 0.7
rmse = 8.2 K	*rmse* = 9.7 K	*rmse* = 6.2 K
bias = 5.1 K	*bias* = -7.8 K	*bias* = -1.7 K

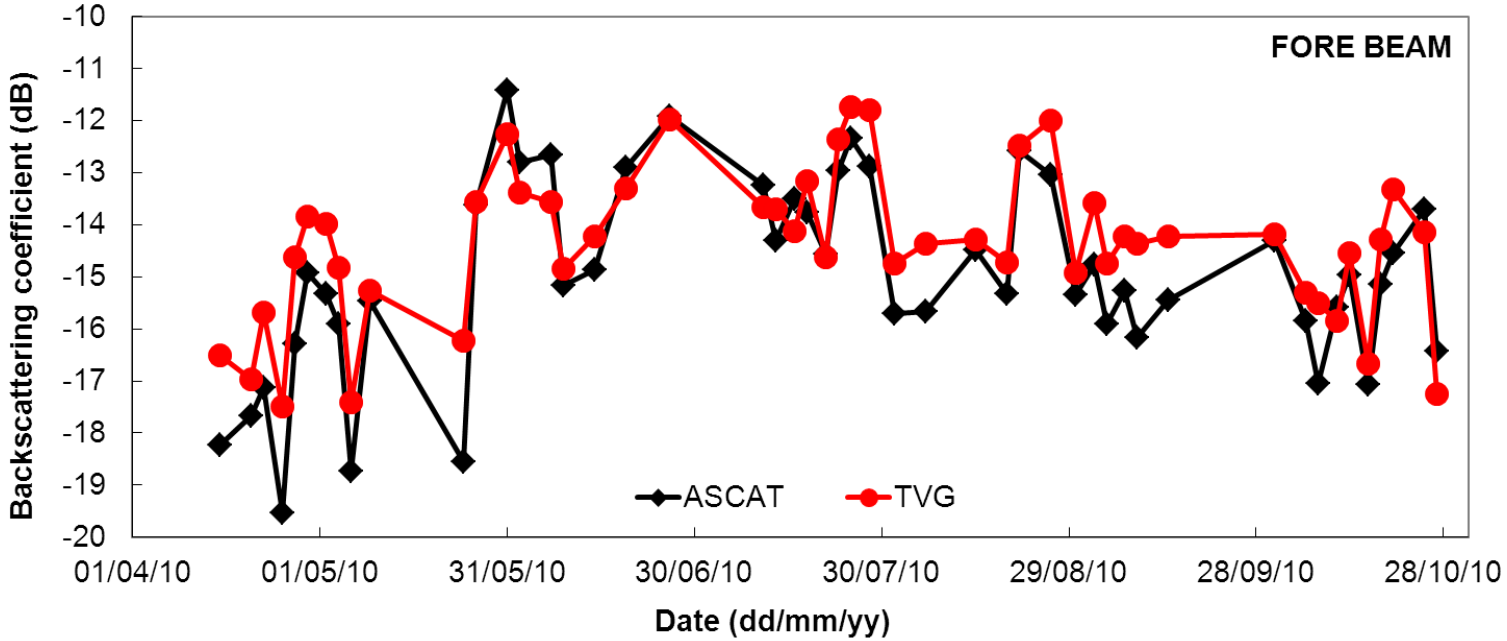
IF ONLY THE ACTIVE MICROWAVE DATA WERE USED …



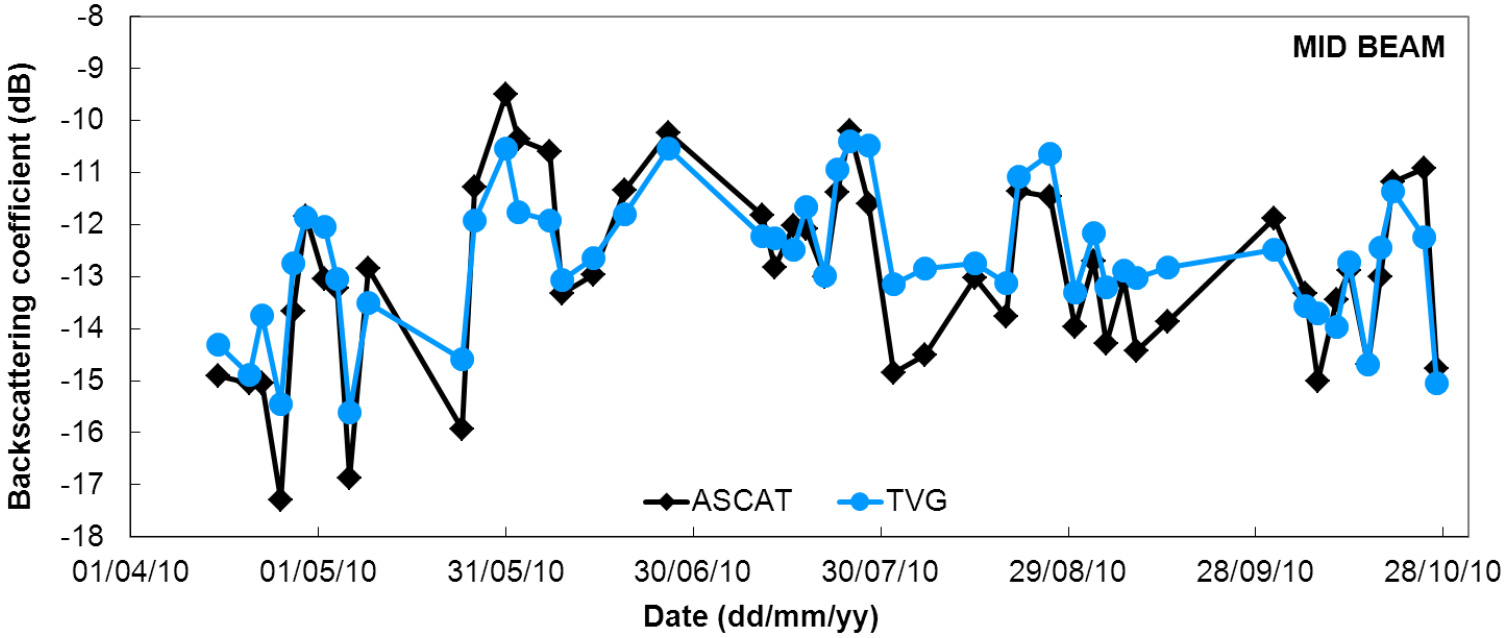
… a good match with ASCAT observations was possible with <u>unrealistic</u> assumptions:
-absence of litter
-smooth surface

However, the same assumptions led to a large underestimation of T_b!

RESULTS: MODEL VALIDATION (2010) – ACTIVE CASE

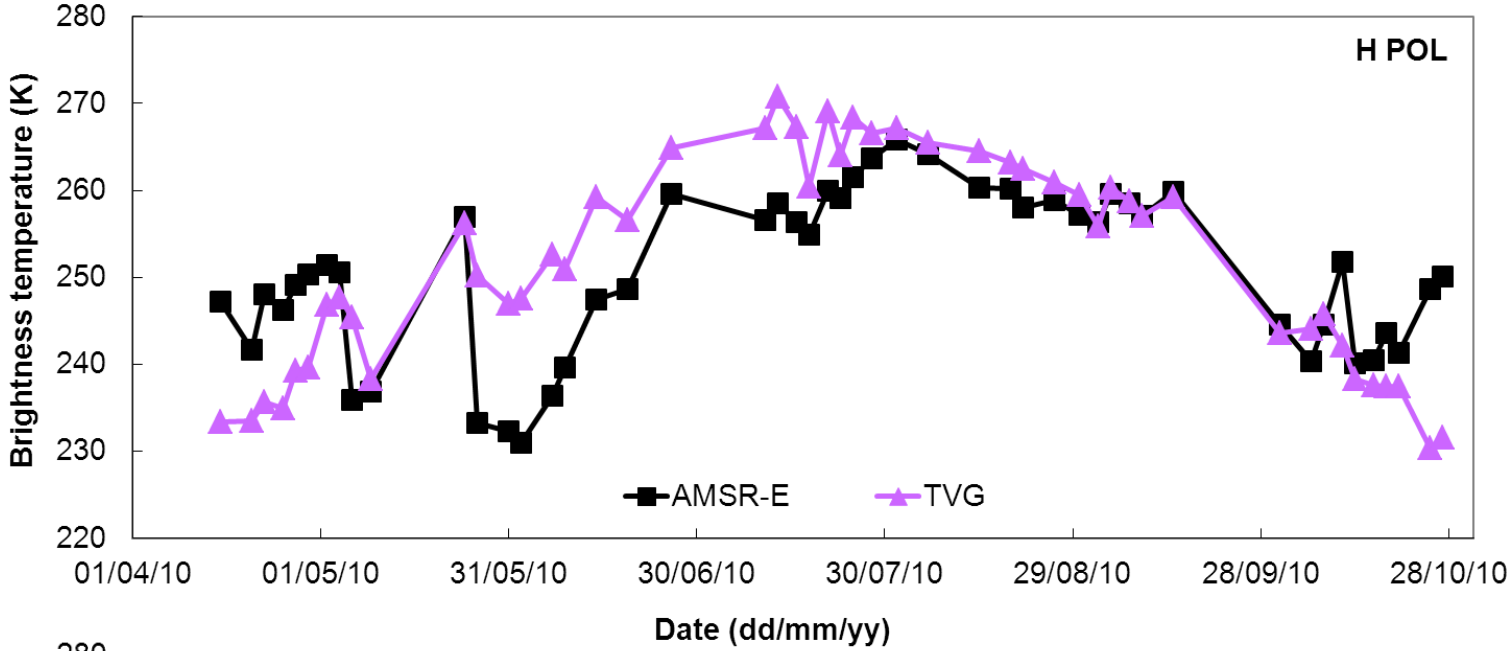


R^2 = 0.8
rmse = 1 dB
bias = 0.6 dB

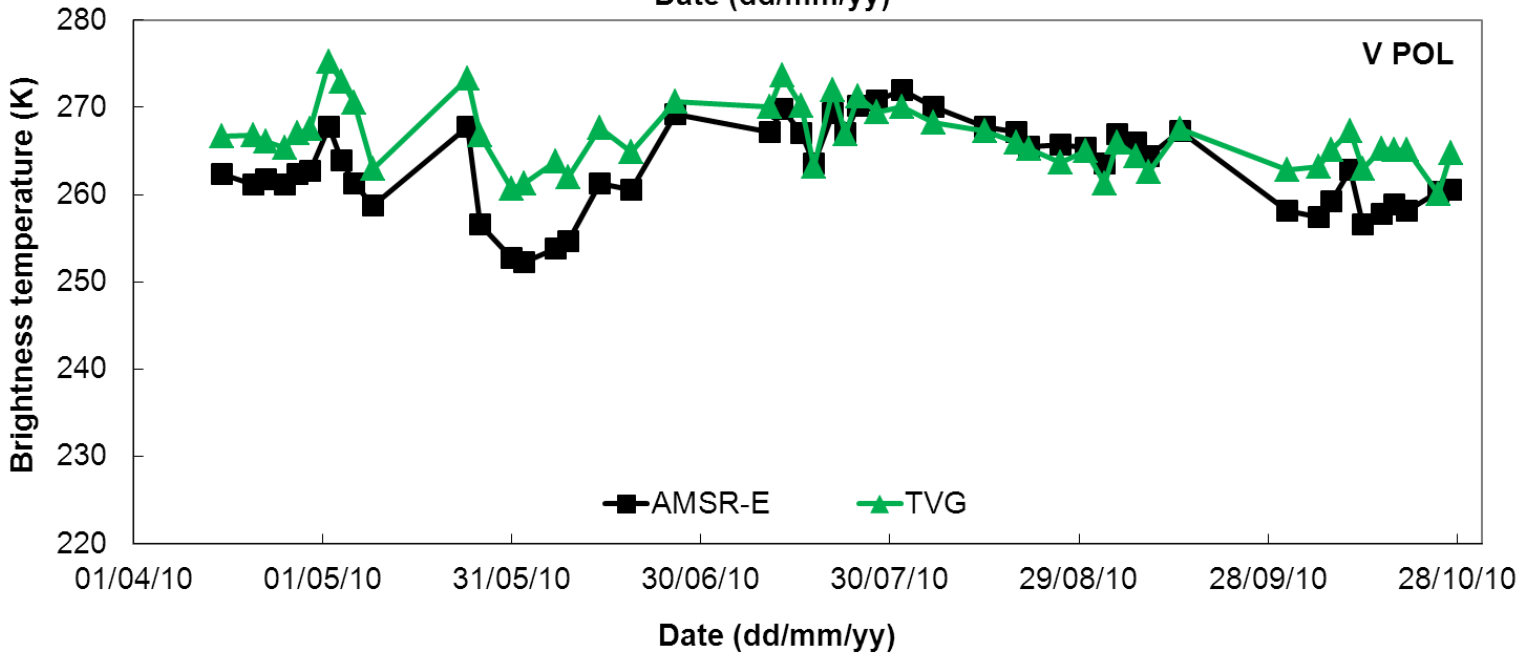


R^2 = 0.8
rmse = 0.8 dB
bias = 0.3 dB

RESULTS: MODEL VALIDATION (2010) – PASSIVE CASE



R^2 = 0.5
rmse = 8.7 K
bias = 1.3 K



R^2 = 0.5
rmse = 5.0 K
bias = 3.4 K

Referances/Further Readings

Su, Z., Wen, J., Dente, L., van der Velde, R., Wang, L., Ma, Y., Yang, K., and Hu, Z. 2011, The Tibetan Plateau observatory of plateau scale soil moisture and soil temperature (Tibet-Obs) for quantifying uncertainties in coarse resolution satellite and model products, Hydrol. Earth Syst. Sci., 15, 2303–2316, 2011, www.hydrol-earth-syst-sci.net/15/2303/2011/, doi:10.5194/hess-15-2303-2011.

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Dente, L., P. Ferrazzoli, Z. Su, R. van de Velde, L. Guerriero, 2013, Combined use of active and passive microwave satellite data to constrain a discrete scattering model, RSE, In review.

Lv, S., J. WEN, Y. Zeng, H.Tian, Z.Su, 2013, An Improved Two-layer Algorithm for Estimating Effective Soil Temperature in Microwave Radiometry using In Situ Temperature and Soil Moisture Measurements, RSE, in revision.