VIENNA UNIVERSITY OF TECHNOLOGY
DEPARTMENT FOR GEODESY AND GEOINFORMATION
RESEARCH GROUPS PHOTOGRAMMETRY & REMOTE SENSING

Microwave remote sensing of soil moisture and surface state

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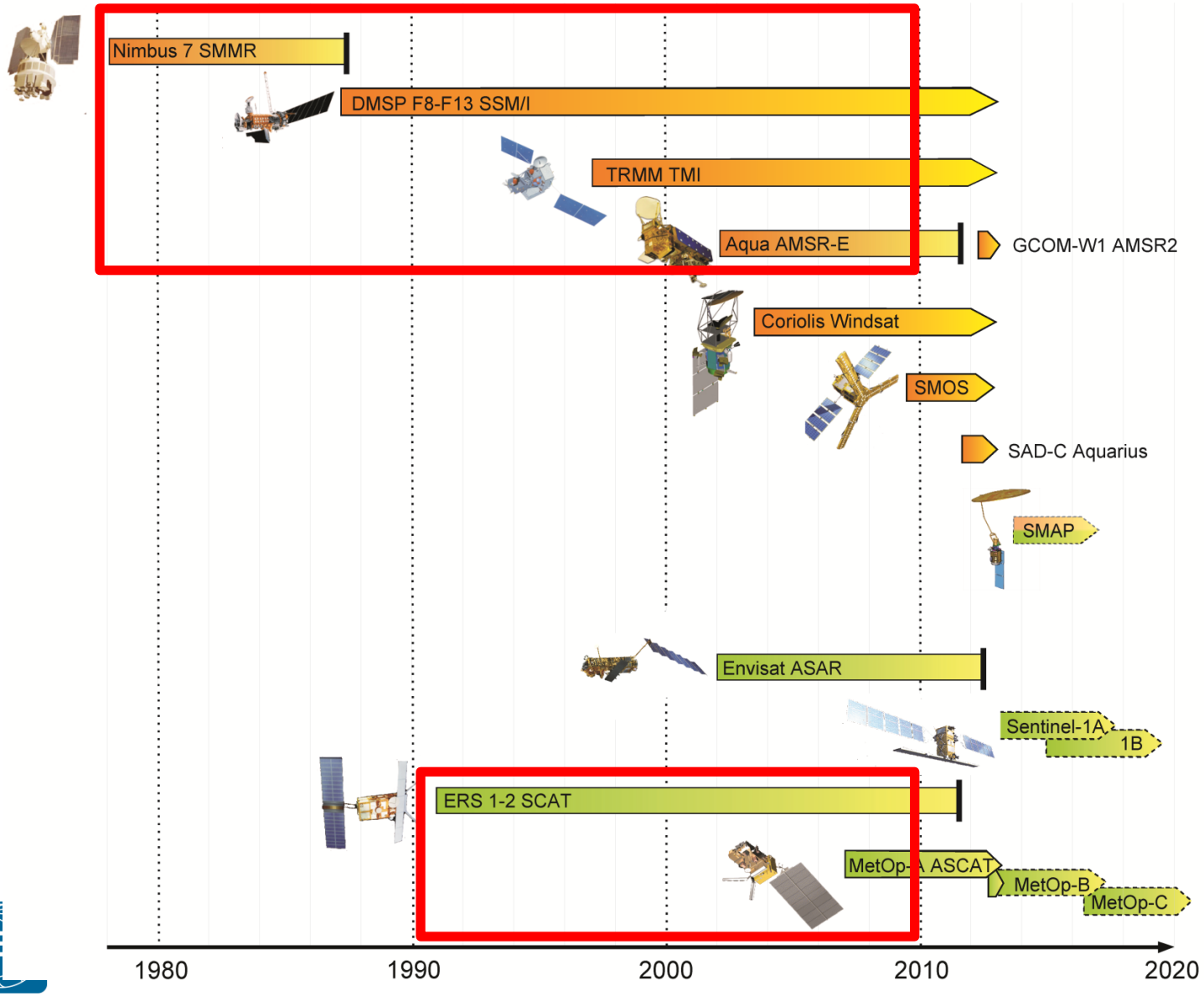
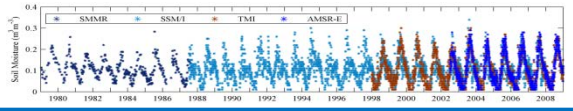
Microwave missions for soil moisture

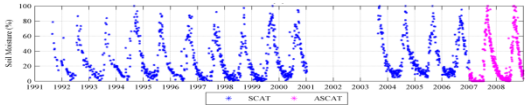


WACMOS/CCI merging methodology

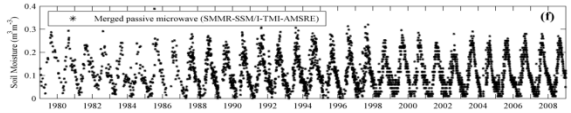
1. Individual radiometer products



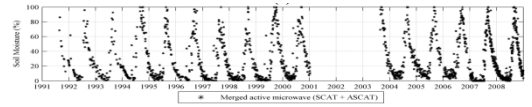
2. Individual scatterometer products



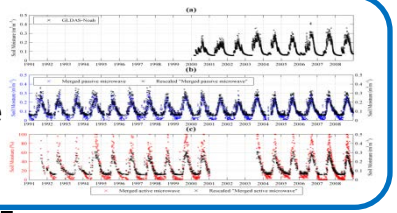
3. Scaling and merging passive products to climatology AMSR-E



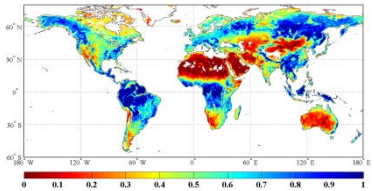
4. Scaling and merging active products to climatology ASCAT



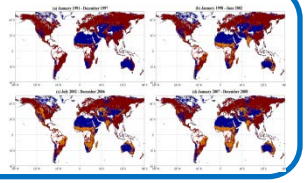
5. Rescale active and passive to GLDAS-NoahSSM reference



6. Test sensitivity to vegetation density

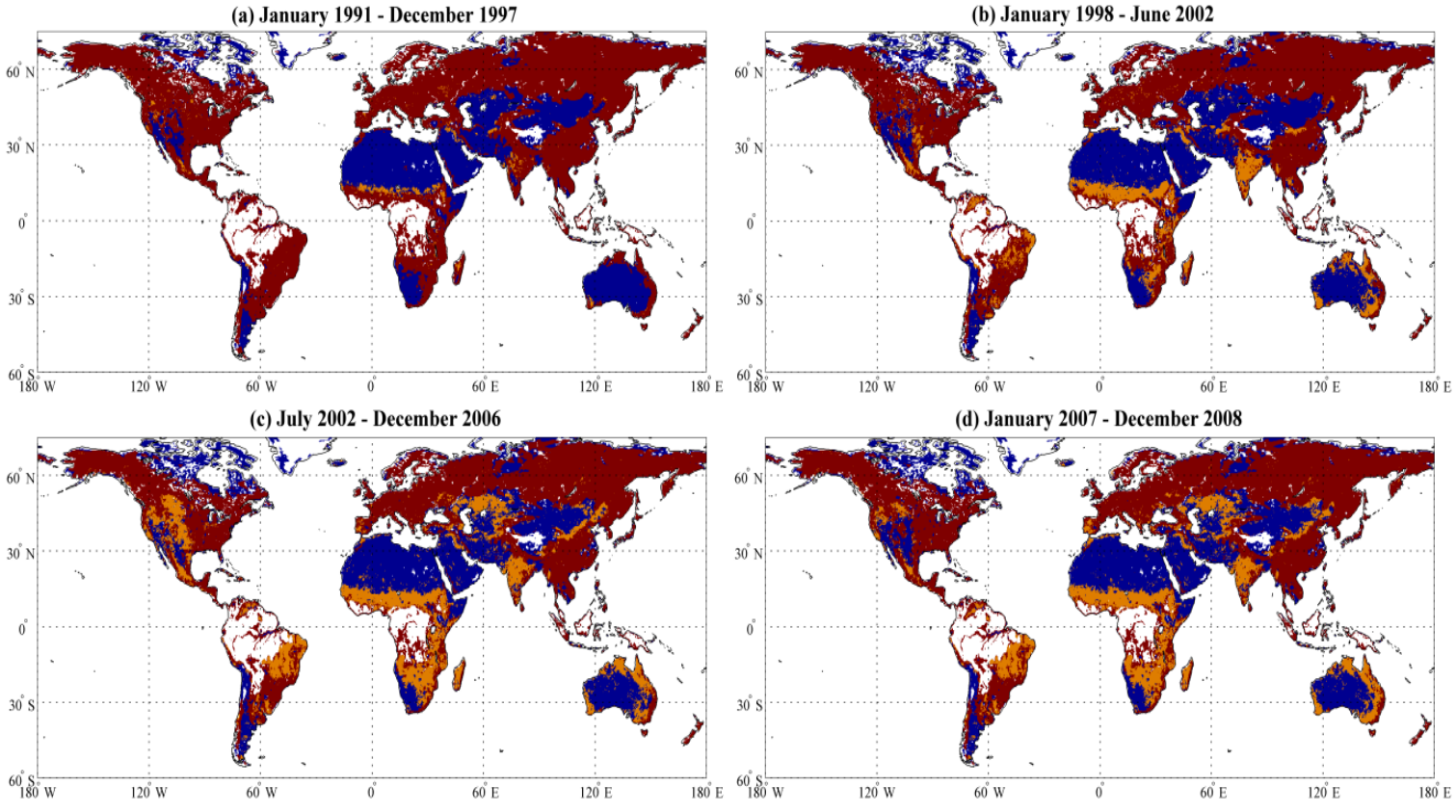


7. Blend rescaled active and passive datasets

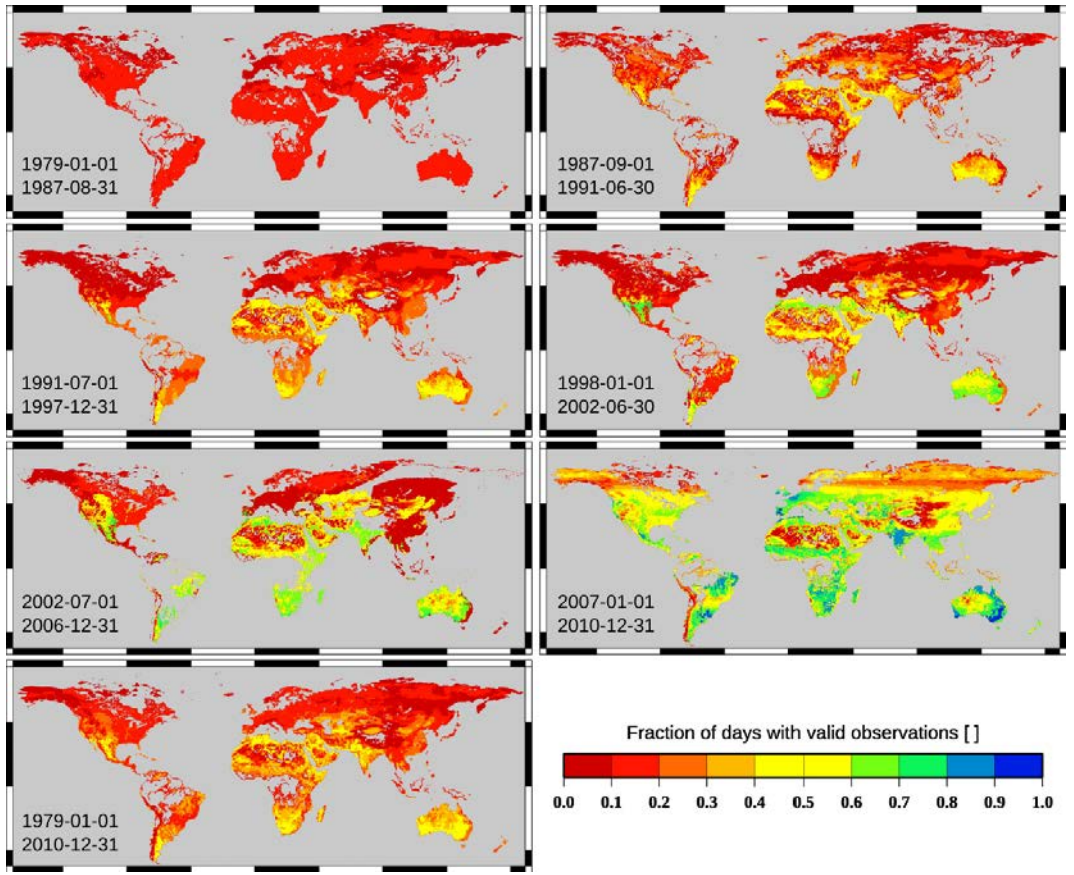


WACMOS/CCI merging methodology

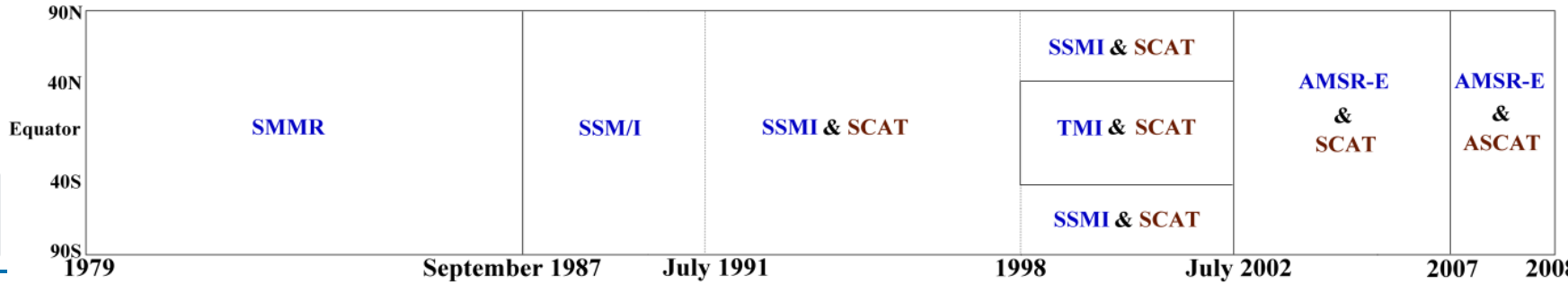
- For areas with moderate to dense vegetation we use active
- For (semi-)arid areas we use passive
- In transition zones we use both by averaging
- Ranking maps are dynamic over time, depending on available sensors



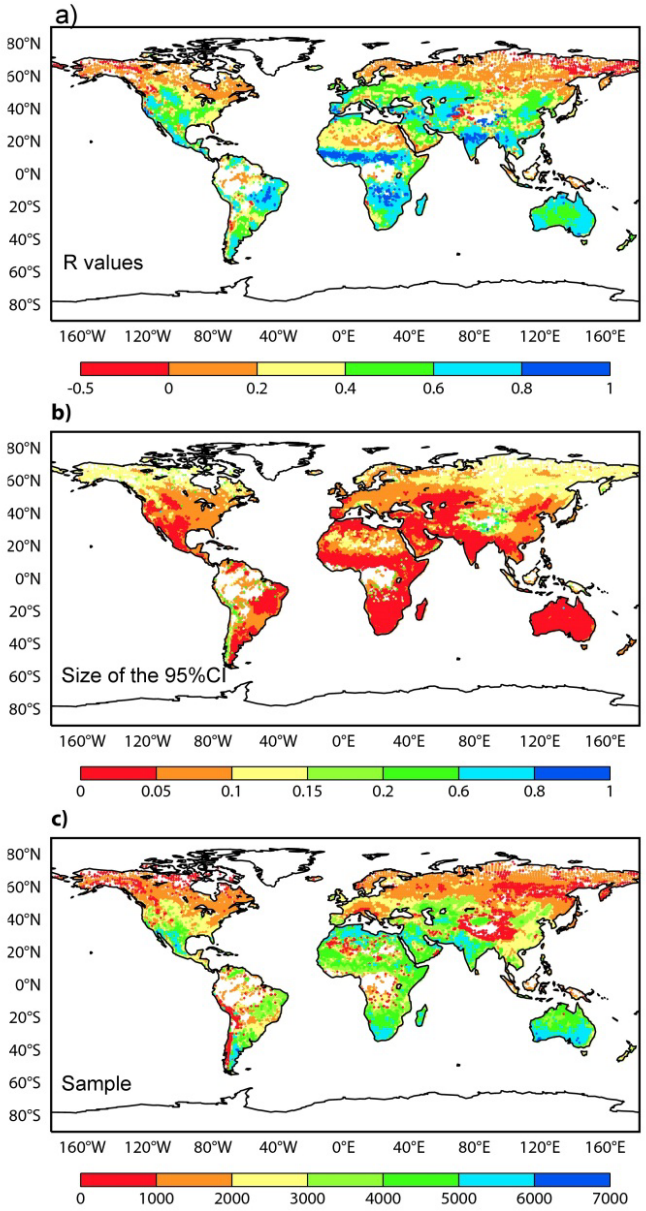
Data density over time



Dorigo et al., 2013, RSE



Validation using ERA-Land SM estimates

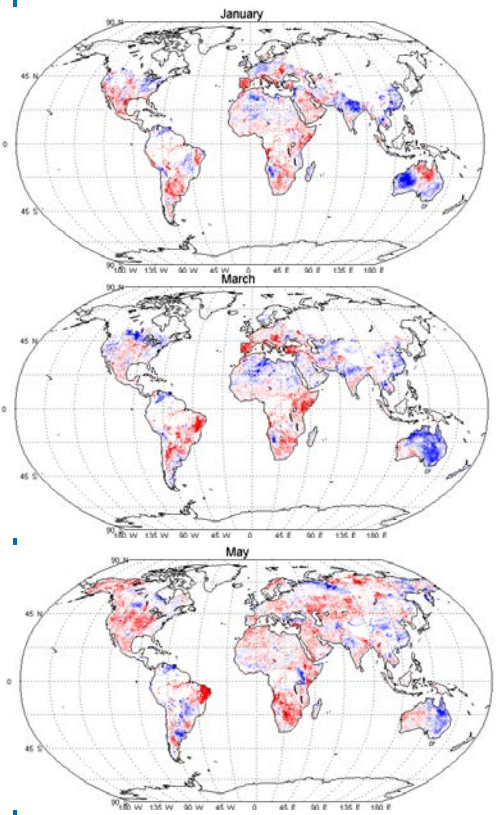


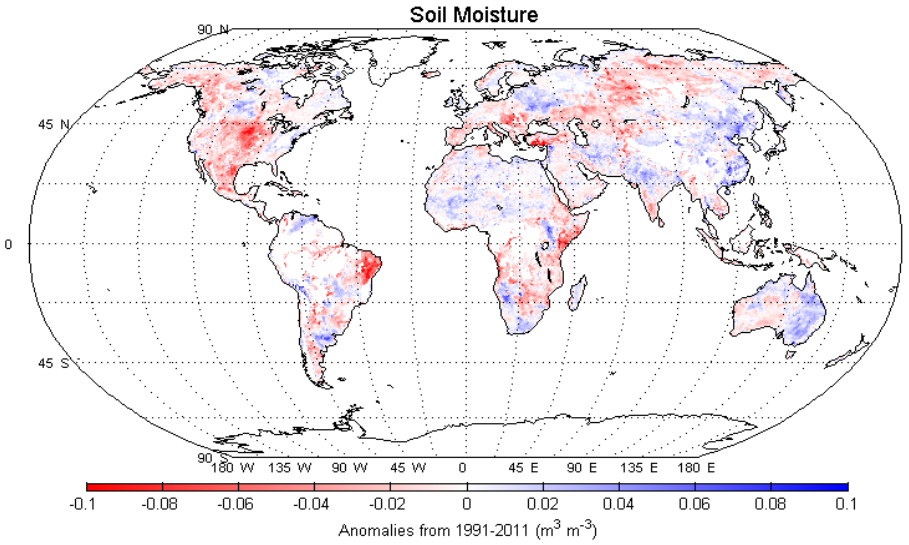
poor scores at high latitudes, altitude and in arid areas, good scores obtained in the tropics and close to the Equator, and over Australia (strong seasonal cycle)

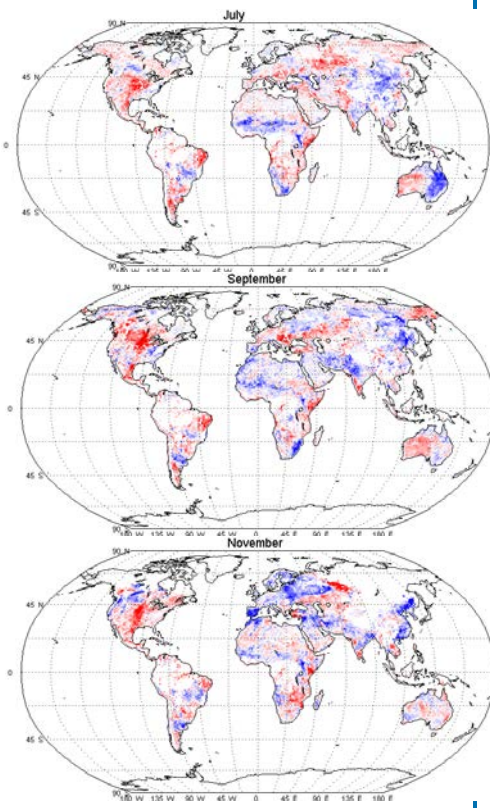
a) Correlation values between ECV_SM and ERA-Land over 1980-2010 (p-value<0.05),
b) size of the 95% confidence interval
c) number of observations used for the comparison

Global anomalies

- Anomalies 2012 wrt ECV_SM climatology 1991-2011



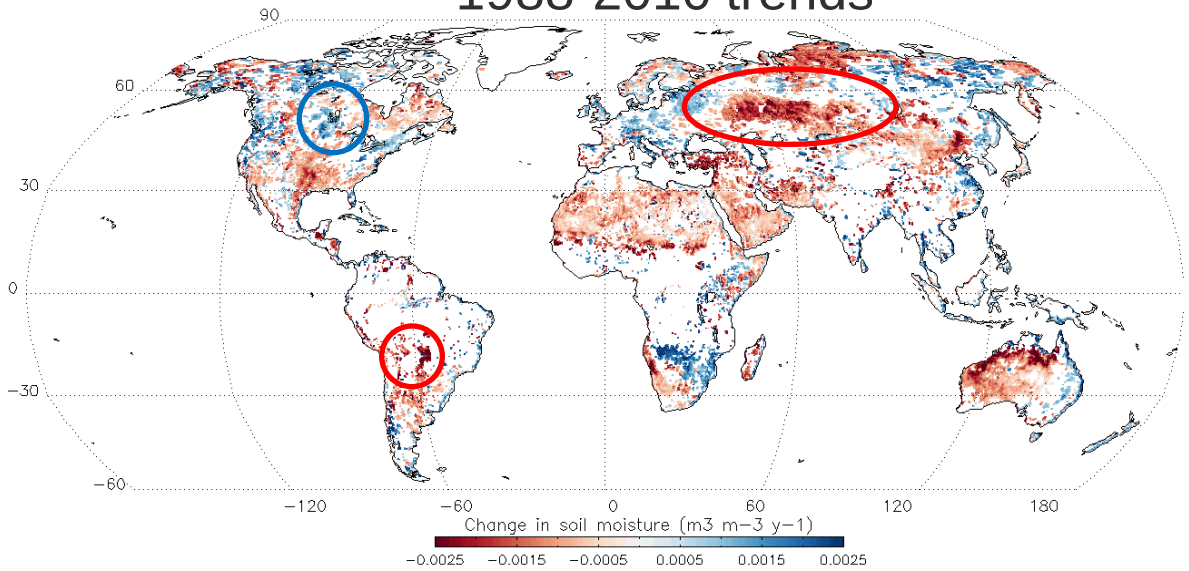




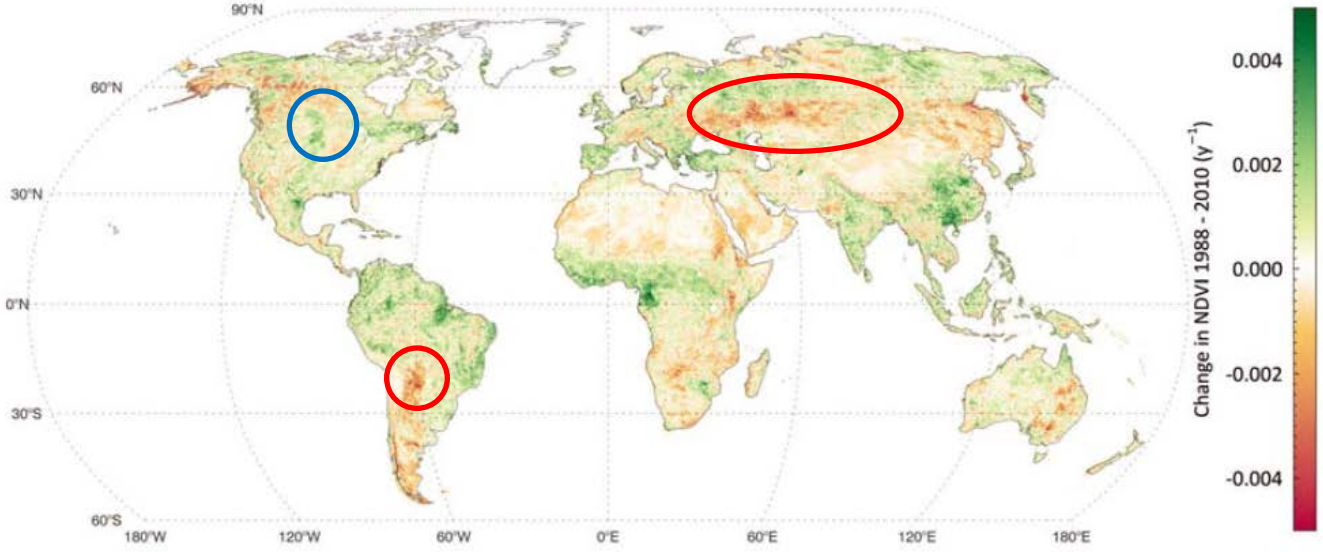
Parinussa et al., 2013, BAMS

Is ECV_SM good enough to capture trends?

1988-2010 trends



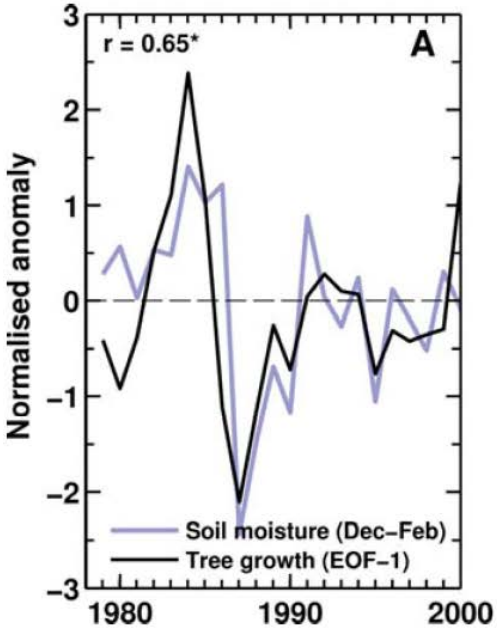
CCI ECV_SM

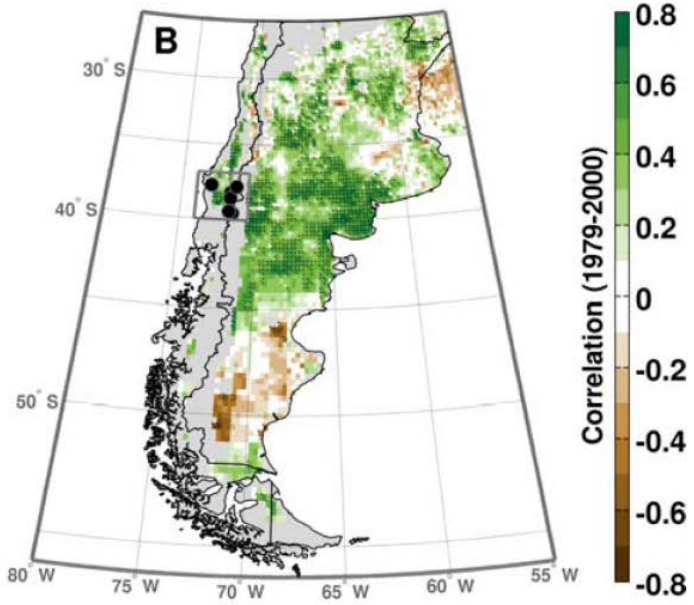


NDVI GIMMS 3g

Dorigo, et al. (2012), GRL

Linking MW soil moisture with tree growth





Muñoz et al. (2013), Austral Ecology

Comparison of the leading Empirical Orthogonal Function (EOF) of six updated tree-ring chronologies of Araucaria with (A) regional satellite-observed summer (Dec–Feb) soil moisture and (B) correlation field between this EOF and summer soil moisture variability across southern South America from 1979 to 2000.

MW soil moisture for better understanding of land atmosphere interaction

Dark red = rain falls most likely over drier soils

Pink = rain falls likely over drier soils

Blue = rain falls likely over wetter soils

Dark blue = rain most falls likely over wetter soils

	Observations								Models					
	AMSR-E CMORPH	ASCAT CMORPH	AMSR-E TRMM	ASCAT TRMM	AMSR-E PERSIANN	ASCAT PERSIANN	AMSR-E CMORPH 1°	ASCAT CMORPH 1°	HadGEM2	CNRM-CM5	MRI-AGCM3_2H	INMCM4	MERRA	ERA-Interim
Moist tropics	89.5 (587)	19.8 (196)	93.5 (911)	18.1 (304)	27.2 (777)	18.1 (255)	-	-	>99 (7852)	>99 (20457)	>99 (28578)	>99 (1154)	>99 (3514)	>99 (25462)
Savanna	1.13 (12937)	<0.01 (6666)	<0.1 (17698)	<0.1 (8243)	<0.1 (12496)	1.1 (6248)	0.03 (632)	1.61 (451)	>99 (12021)	>99 (23777)	>99 (26422)	>99 (3256)	>99 (9612)	>99 (33595)
Semi-arid	<0.1 (23453)	<0.1 (7880)	<0.1 (33668)	<0.1 (8302)	1.1 (19539)	0.3 (5773)	0.39 (1872)	0.3 (821)	>99 (3438)	>99 (9517)	>99 (8284)	>99 (643)	86 (4467)	>99 (9761)
Arid	<0.1 (18810)	<0.1 (3752)	<0.1 (23450)	<0.1 (2926)	<0.1 (13952)	<0.1 (2216)	<0.01 (2613)	0.67 (620)	>99 (907)	<1 (6931)	84 (2957)	>99 (186)	97 (2401)	>99 (2496)
Temperate	58.1 (6224)	0.12 (4721)	13.1 (7917)	<0.1 (4858)	50.5 (5565)	54.5 (3844)	38.69 (474)	10.02 (455)	>99 (1844)	>99 (7151)	>99 (7174)	>99 (376)	1 (4811)	>99 (6092)
Continental	9.5 (11612)	<0.01 (6514)	78.4 (5009)	<0.1 (1774)	64.3 (9617)	49.0 (4304)	32.79 (485)	34.17 (485)	45 (2981)	61 (5949)	>99 (10377)	>99 (206)	<1 (3692)	>99 (5963)

Taylor, C.M., de Jeu, R.A.M., Guichard, F., Harris, P.P., & Dorigo, W.A. (2012). Afternoon rain more likely over drier soils. Nature, 489, 423-426.

Microwave Remote Sensing of Surface State

- Mirror reflection makes MW a potential water body detector

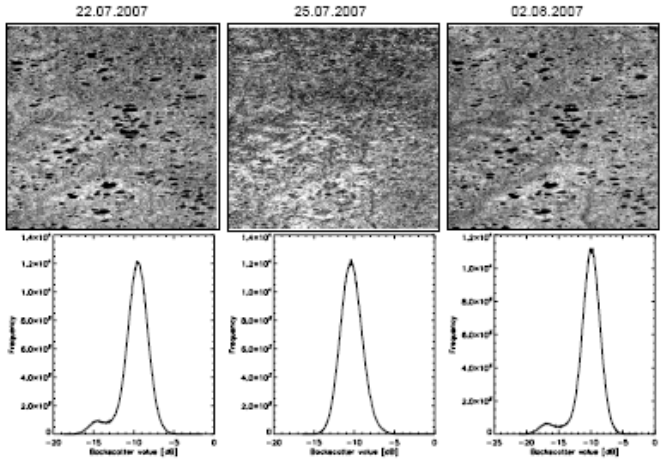
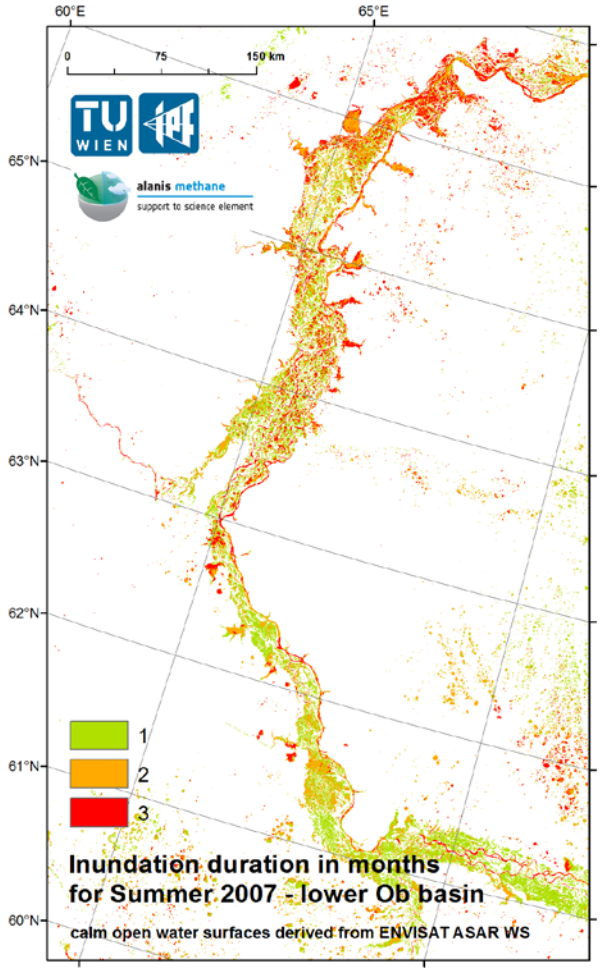


Fig. 3. Backscatter time series example for loss of bimodal distribution over tundra: top normalized backscatter images, bottom: histograms of backscatter distribution [dB].

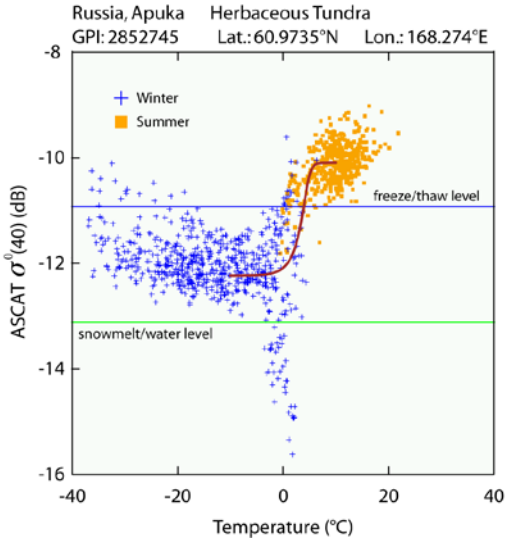
- ENVISAT ASAR Wide swath
  - 150 m resolution
  - ~10 day revisit time
  - C-Band – sensitivity to weather in case of this specific application – more than 50% affected
- Continuity with Sentinel 1



Bartsch et al., 2012

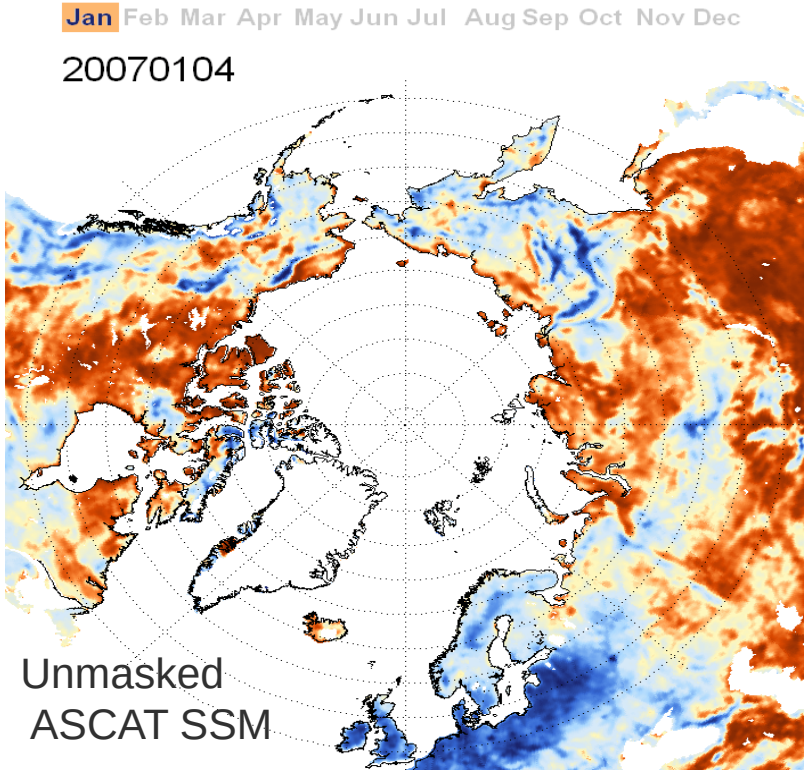
Microwave Remote Sensing of Surface State

- Dielectric conductivity of ice much lower than for water → makes MW a good “frost detector”



frozen/dry/inundated

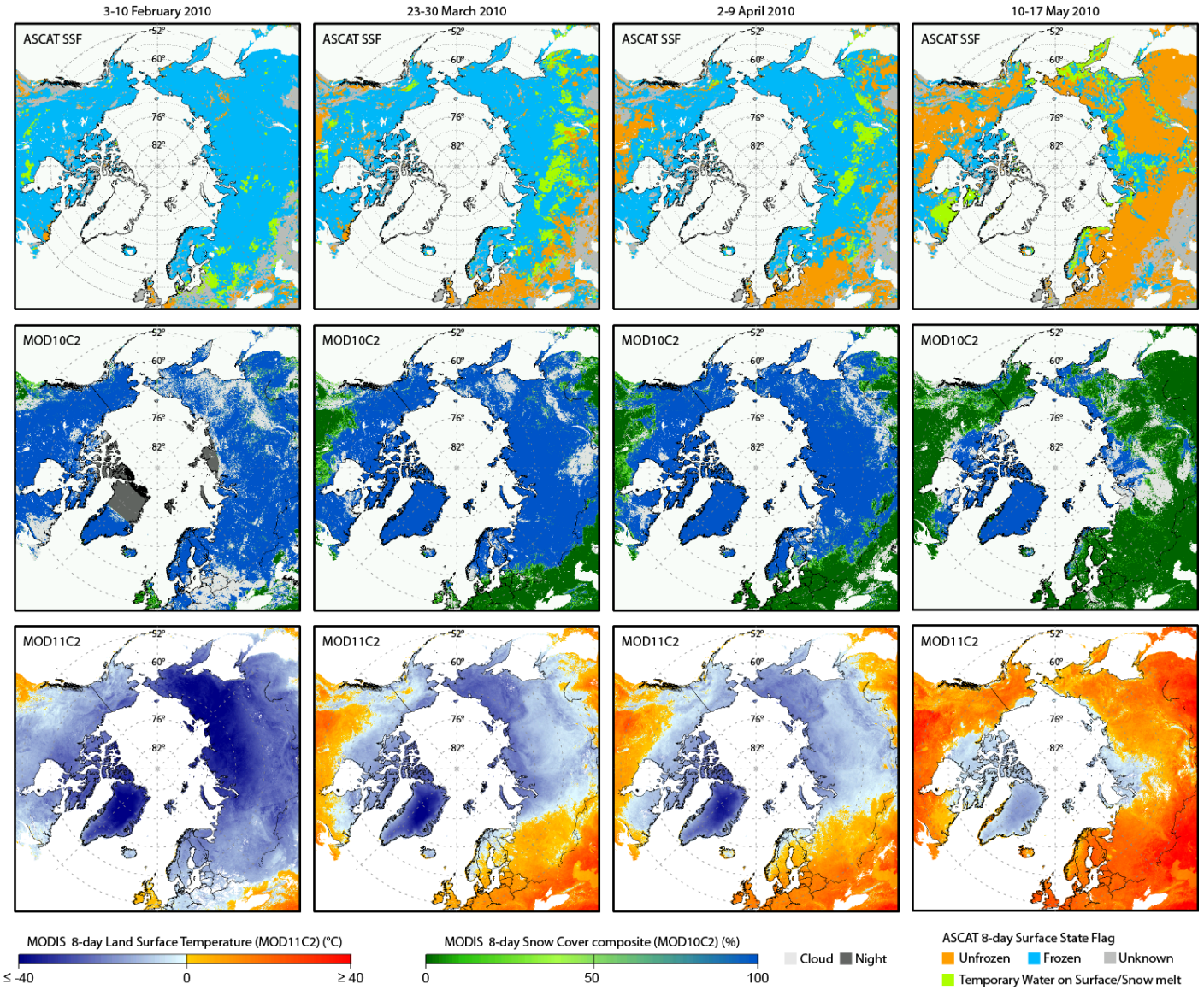
Saturated



Unmasked ASCAT SSM

Microwave Remote Sensing of Surface State

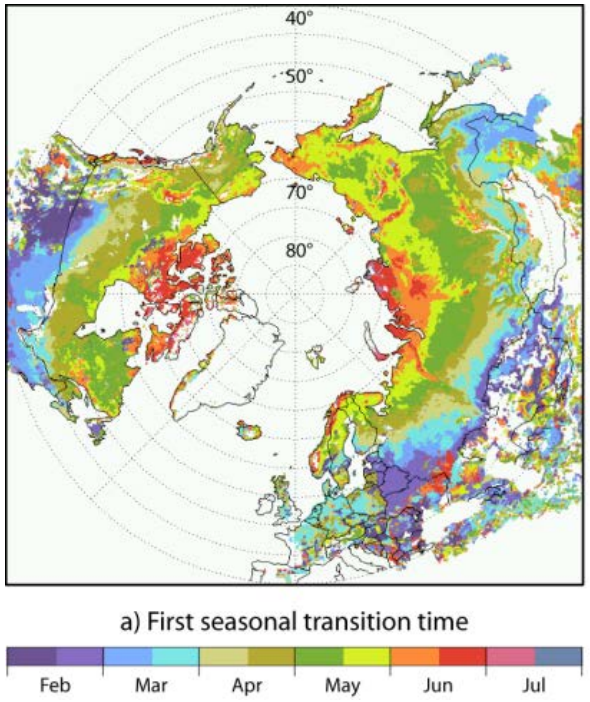
- ASCAT Surface State Flag product

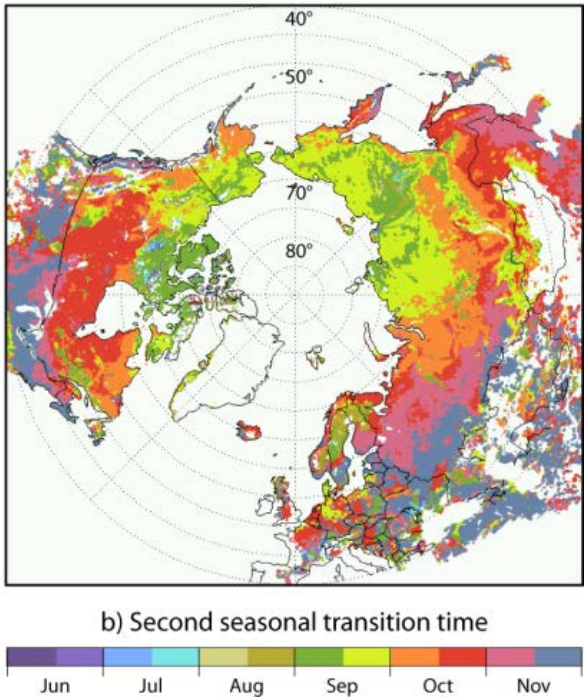


Naeimi et al., 2012

Microwave Remote Sensing of Surface State

- Start/end of the season





Naeimi et al., 2012

Thank you for your attention

- Albergel, C, Dorigo W., Balsamo G., Muñoz- Sabater J., de Rosnay P., Isaksen L., Brocca L., de Jeu R. & Wagner W.: Monitoring the consistency of earth observation soil moisture data through land surface modelling: An example for multi-decadal soil moisture, *Remote Sensing of Environment*, in rev.
- Dorigo, W.A., De Jeu, R.A.M., Chung, D., Parinussa, R.M., Liu, Y.Y., Wagner, W., Fernández-Prieto, D. (2012). Evaluating global trends (1988-2010) in harmonized multi-satellite surface soil moisture. Geophysical Research Letters, 39, L18405. doi:10.1029/2012GL052988
- Dorigo, W.A., Gruber, A., De Jeu, R.A.M., Wagner, W., Stacke, T., Loew, A., Albergel, C., Brocca, L., Chung, D., Parinussa, R.M., & Kidd, R.. Evaluation of the ESA CCI soil moisture product using ground-based observations. *Remote Sensing of Environment*, in rev.
- Muñoz, A. A., Barichivich, J., Christie, D. A., Dorigo, W., González-Reyes, A., González, M. E., Lara, A., Sauchyn, D., Villalba, R. (2013). Patterns and drivers of Araucaria araucana forest growth along a biophysical gradient in the northern Patagonian Andes: linking tree rings with satellite observations of soil moisture. *Austral Ecology*, in press
- Naeimi, V., Paulik, C. Bartsch, A., Wagner, W., Kidd, R. & Boike, J. 2012. Extracting information on surface freeze/thaw conditions from backscatter data using an empirical threshold-analysis algorithm. IEEE Transactions on Geoscience and Remote Sensing 99, 1-17.
- Parinussa, R.M., De Jeu, R., Wagner, W., Dorigo, W., Fang, F., Teng, W., & Liu, Y.Y. (2013). [Global Climate] Soil Moisture [in: State of the Climate in 2012]. *Bulletin of the American Meteorological Society*, accepted