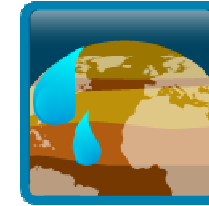




VIENNA
UNIVERSITY OF
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INSTITUTE OF
PHOTOGRAMMETRY
AND REMOTE SENSING



soil moisture
cci

CCI Soil Moisture: Science & Challenges

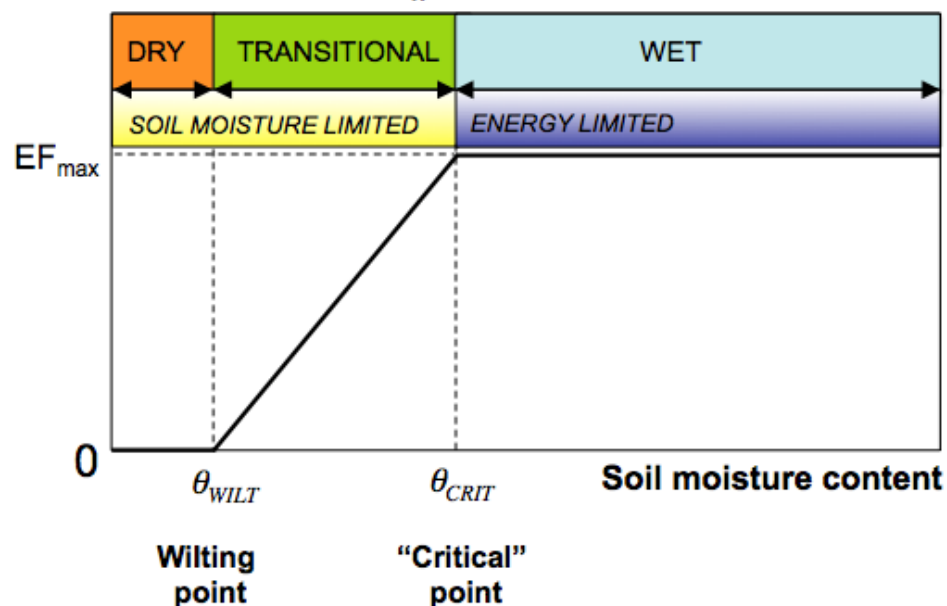
Wolfgang Wagner
ww@ipf.tuwien.ac.at



Importance of Soil Moisture in the Climate System

- Soil-climate interactions are a key aspect of the climate system:
 - Feedbacks to the atmosphere/climate & memory component: Important for weather prediction, seasonal forecasting and climate change
 - Driver for climate variability and extreme events in transitional climate regions
 - Essential link between the energy, water and carbon cycles

Evaporative fraction $EF = \lambda E / R_n$



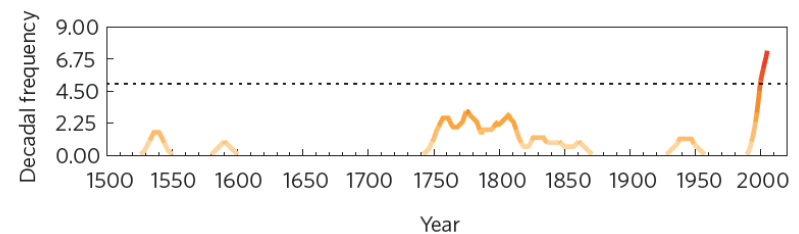
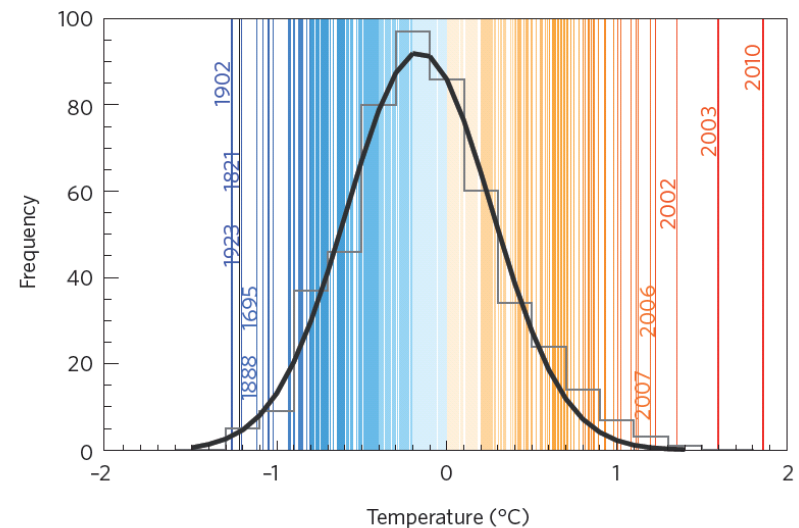
Seneviratne, S.I., Corti, T., Davin, E.L., Hirschi, M., Jaeger, E.B., Lehner, I., Orlowsky, B., & Teuling, A.J. (2010). Investigating soil moisture-climate interactions in a changing climate - a review. *Earth-Science Reviews*, 99, 125-161

Soil Moisture in a Warming Climate

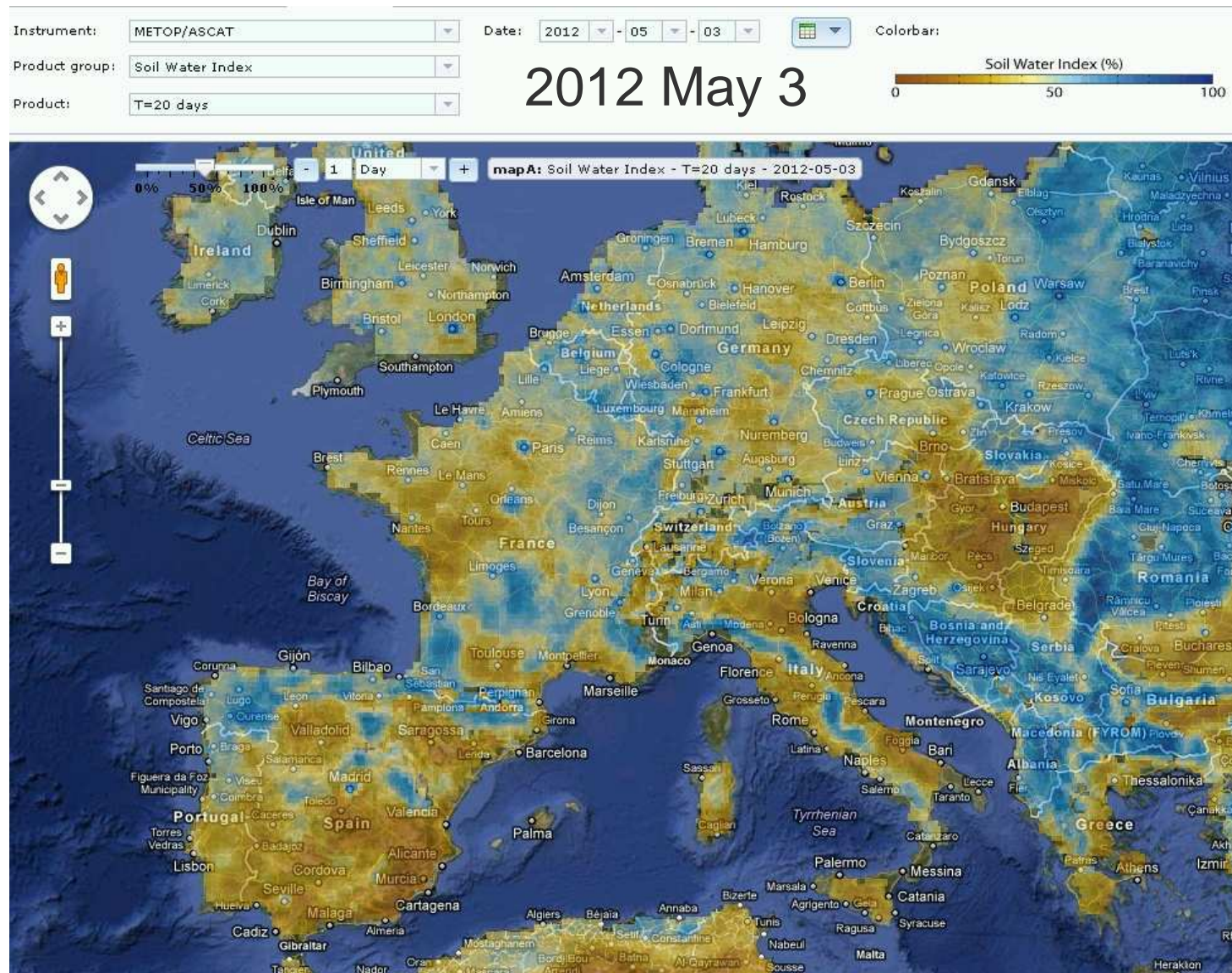
- Higher air temperatures will cause
 - higher evapotranspiration → more severe droughts?
 - higher air humidity → more intense precipitation and floods?
- Feedbacks?
 - Low soil moisture → warmer nights?
 - Low soil moisture → less rain?

“... drought appears to be a pre-requisite to heatwave occurrence in some clusters but not all.” Stefanon et al. 2012

European summer temperatures for 1500–2010. From Coumou & Rahmstorf (2012). A decade of weather extremes. Nature Climate Change.



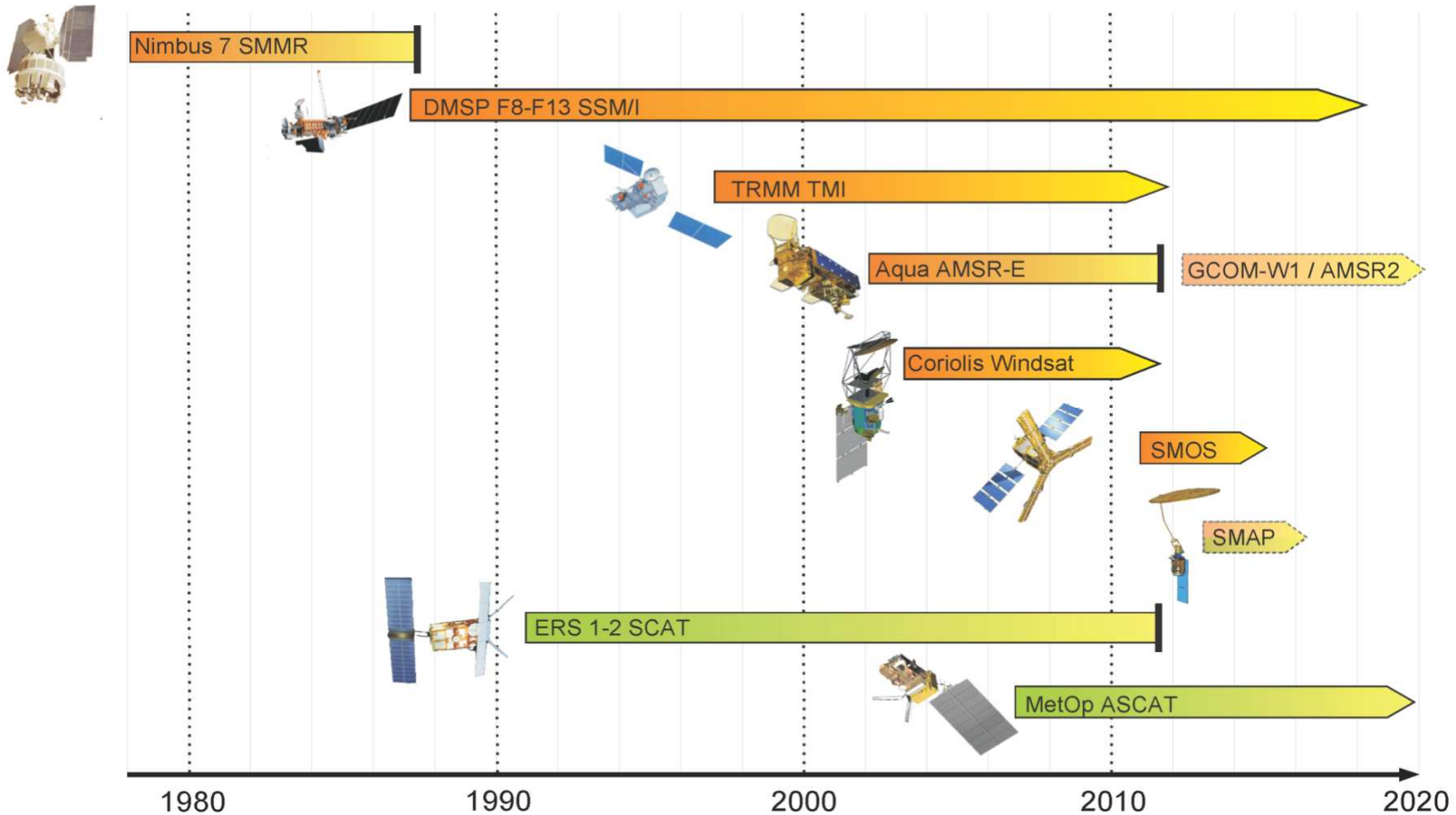
Drought in Parts of Europe in Winter & Spring 2012



Recent and Planned Soil Moisture Missions

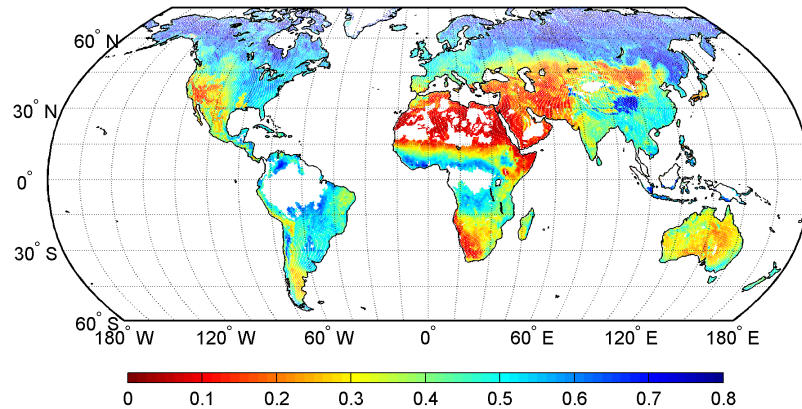


33 Years of Active and Passive Microwave Sensors

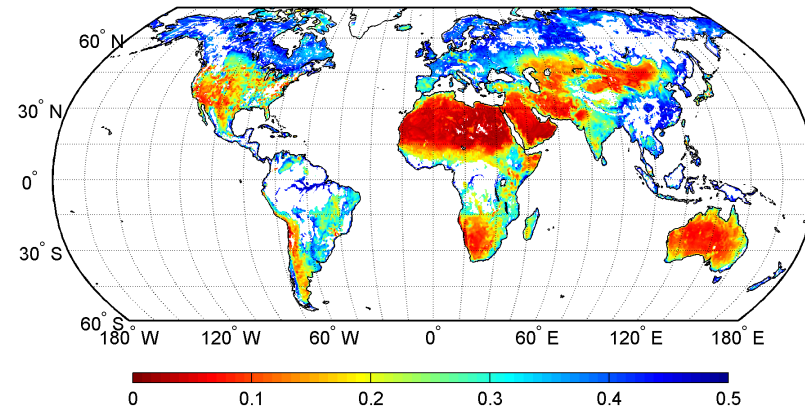


Comparison SCAT and AMSR-E Soil Moisture

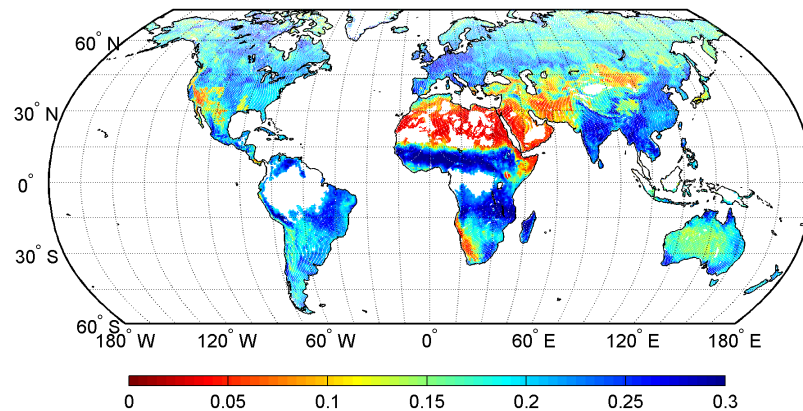
Mean SCAT



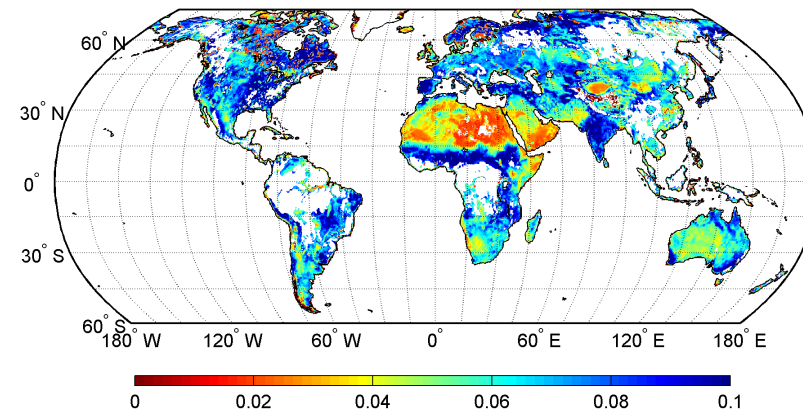
Mean AMSR-E



SCAT Seasonal Dynamics



AMSR-E Seasonal Dynamics



de Jeu, R., Wagner, W., Holmes, T., Dolman, H., van de Giesen, N.C., & Friesen, J. (2008). Global soil moisture patterns observed by space borne microwave radiometers and scatterometers. *Surveys in Geophysics*, 29, 399-420

Producing an ECV Soil Moisture Data Set: Are We Ready?

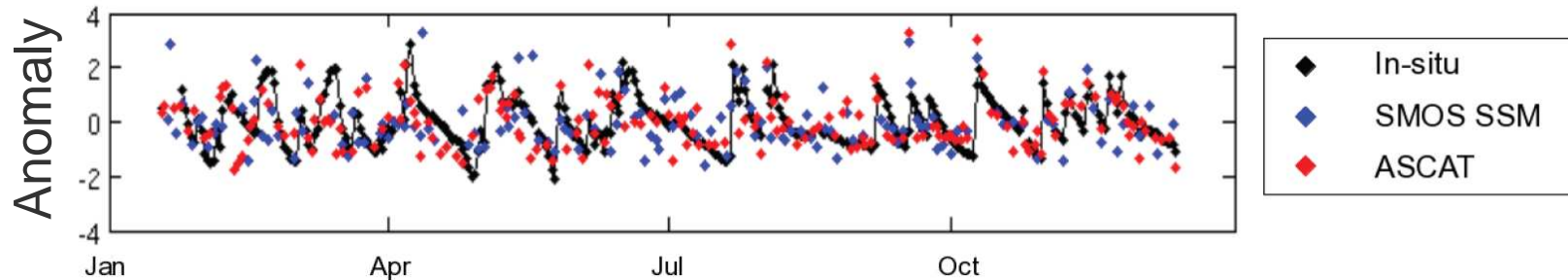
“..., L-band [*soil moisture*] retrievals can be performed and meet the science requirements. In contrast, C- and X-band measurements are representative of the top 1 cm or less of soil. Moderate vegetation (greater than $\sim 3 \text{ kg m}^{-2}$) attenuates the signal sufficiently at these frequencies to make the measurements relatively insensitive to soil moisture.”

SMAP Team (2010)

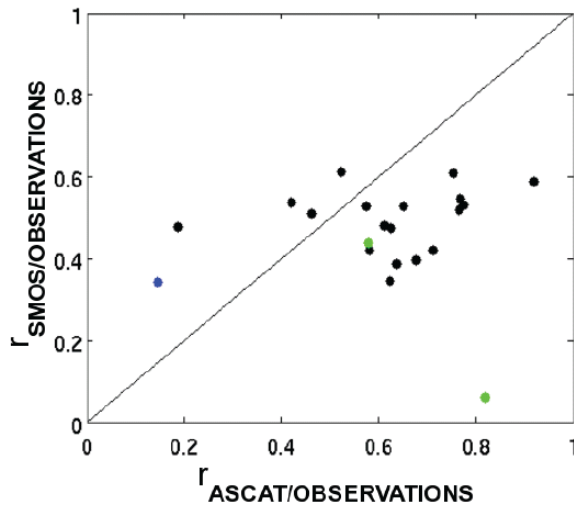
Entekhabi, D., Njoku, E.G., O'Neill, P.E., Kellog, K.H., Crow, W.T., Edelstein, W.N., Entin, J.K., Goodman, S.D., Jackson, T.J., Johnson, J., Kimball, J., Piepmeier, J.R., Koster, R., Martin, N., McDonald, K.C., Moghaddam, M., Moran, S., Reichle, R., Shi, J.C., Spencer, M.W., Thurman, S.W., Tsang, L., & Van Zyl, J. (2010). The Soil Moisture Active Passive (SMAP) mission. Proceedings of the IEEE, 98, 704-716

Validation of SMOS and ASCAT over France

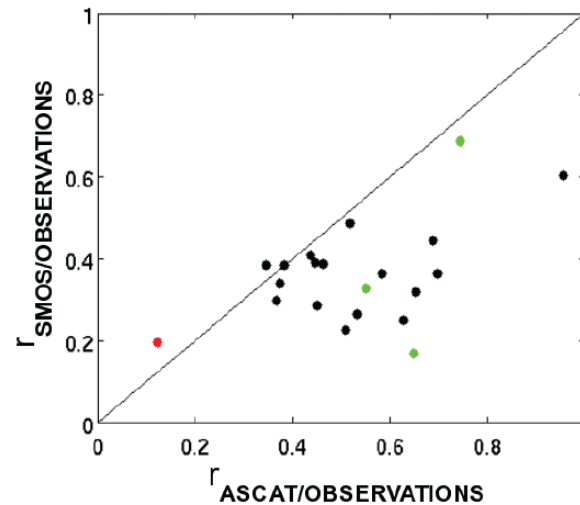
- Validation over SMOSMANIA network



Absolute values



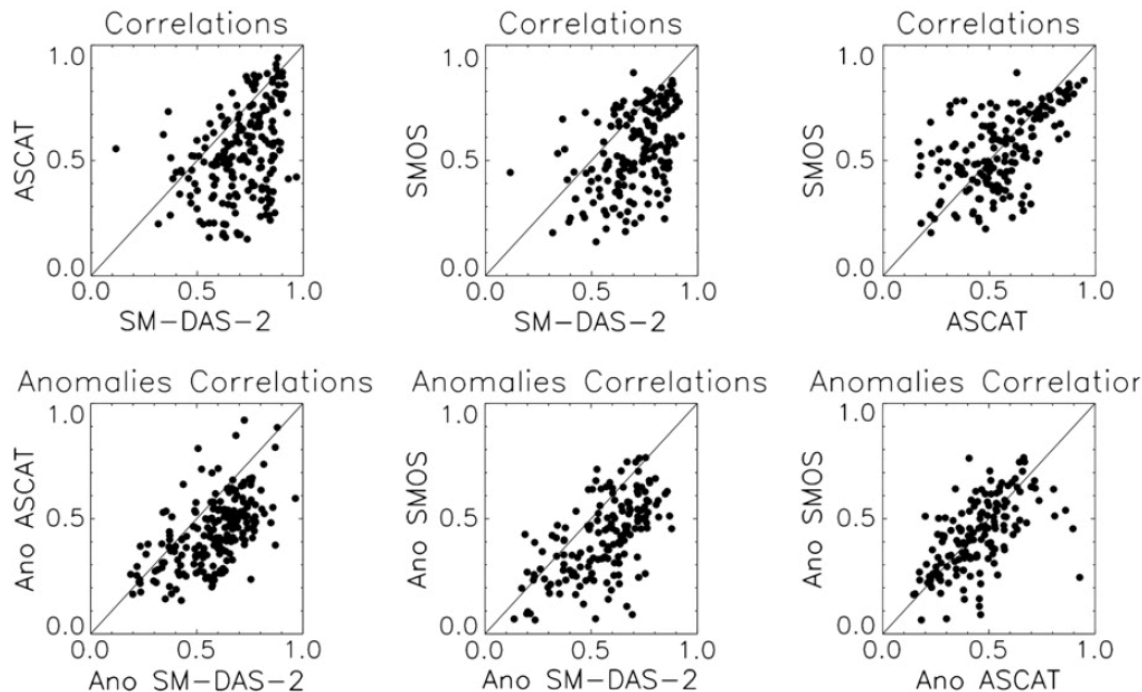
Anomaly values



Parrens, M., E. Zakharova, S. Lafont, J.-C. Calvet, Y. Kerr, W. Wagner, J.-P. Wigneron (2012) Comparing soil moisture retrievals from SMOS and ASCAT over France, *Hydrology and Earth System Sciences*, 16, 423-440.

Validation of SMOS and ASCAT (Operational & Assimilated)

- Validation over networks in the US, Europe and Australia
 - (Initial) operational ASCAT product performs similar to SMOS
 - Assimilation improves correlation to in-situ data



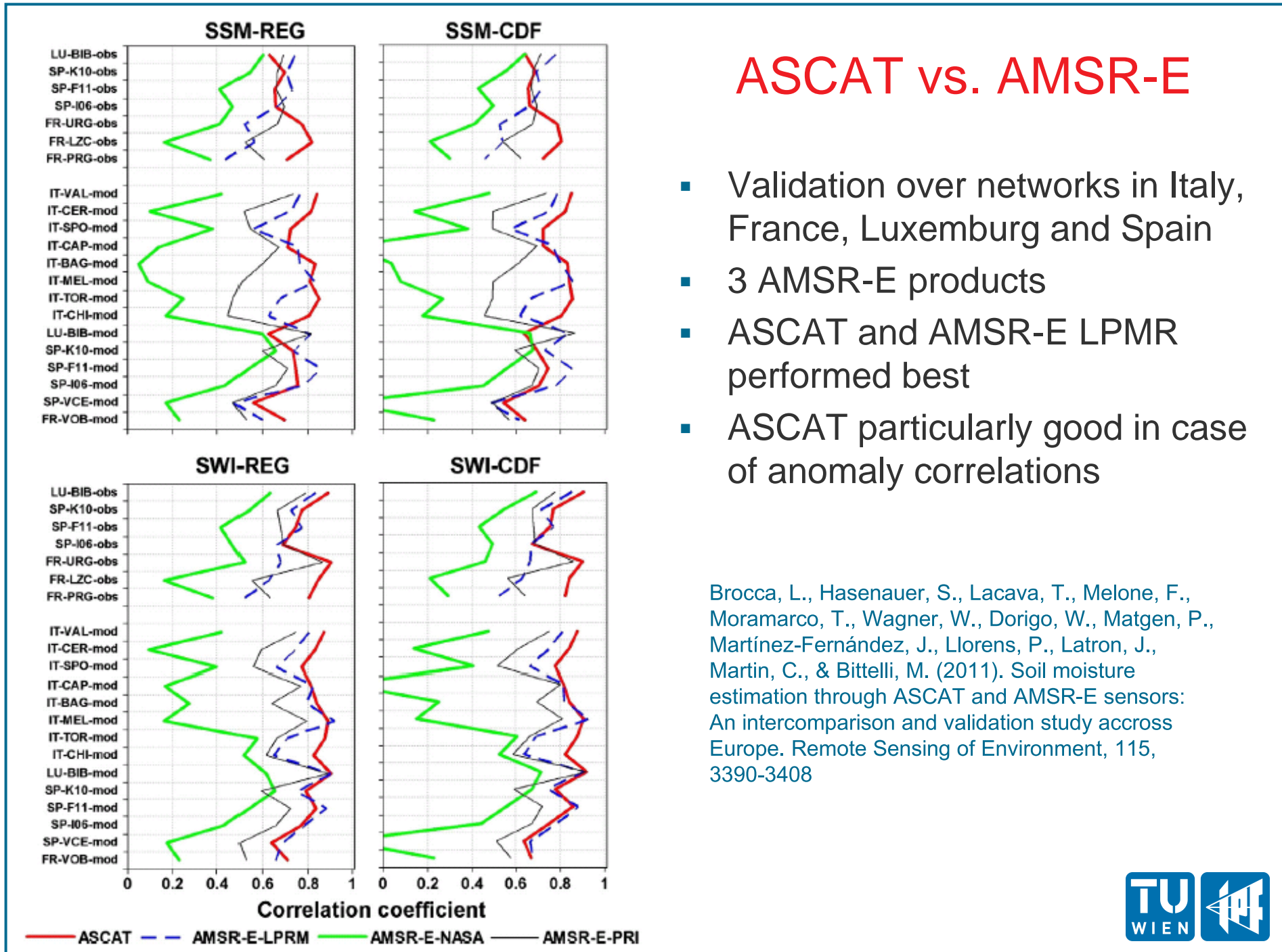
Correlations between ASCAT and in situ data against correlations between ECMWF SM-DAS-2 and in situ data, then same for SMOS and SM-DAS-2, SMOS and ASCAT.

Same as above but for anomaly correlation values instead of normalised time series.

ASCAT vs. AMSR-E

- Validation over networks in Italy, France, Luxemburg and Spain
- 3 AMSR-E products
- ASCAT and AMSR-E LPMR performed best
- ASCAT particularly good in case of anomaly correlations

Brocca, L., Hasenauer, S., Lacava, T., Melone, F., Moramarco, T., Wagner, W., Dorigo, W., Matgen, P., Martínez-Fernández, J., Llorens, P., Latron, J., Martin, C., & Bittelli, M. (2011). Soil moisture estimation through ASCAT and AMSR-E sensors: An intercomparison and validation study across Europe. *Remote Sensing of Environment*, 115, 3390-3408



ECV Production: Level 2 Fusion Approach

■ Fusion of Level 2 soil moisture retrievals

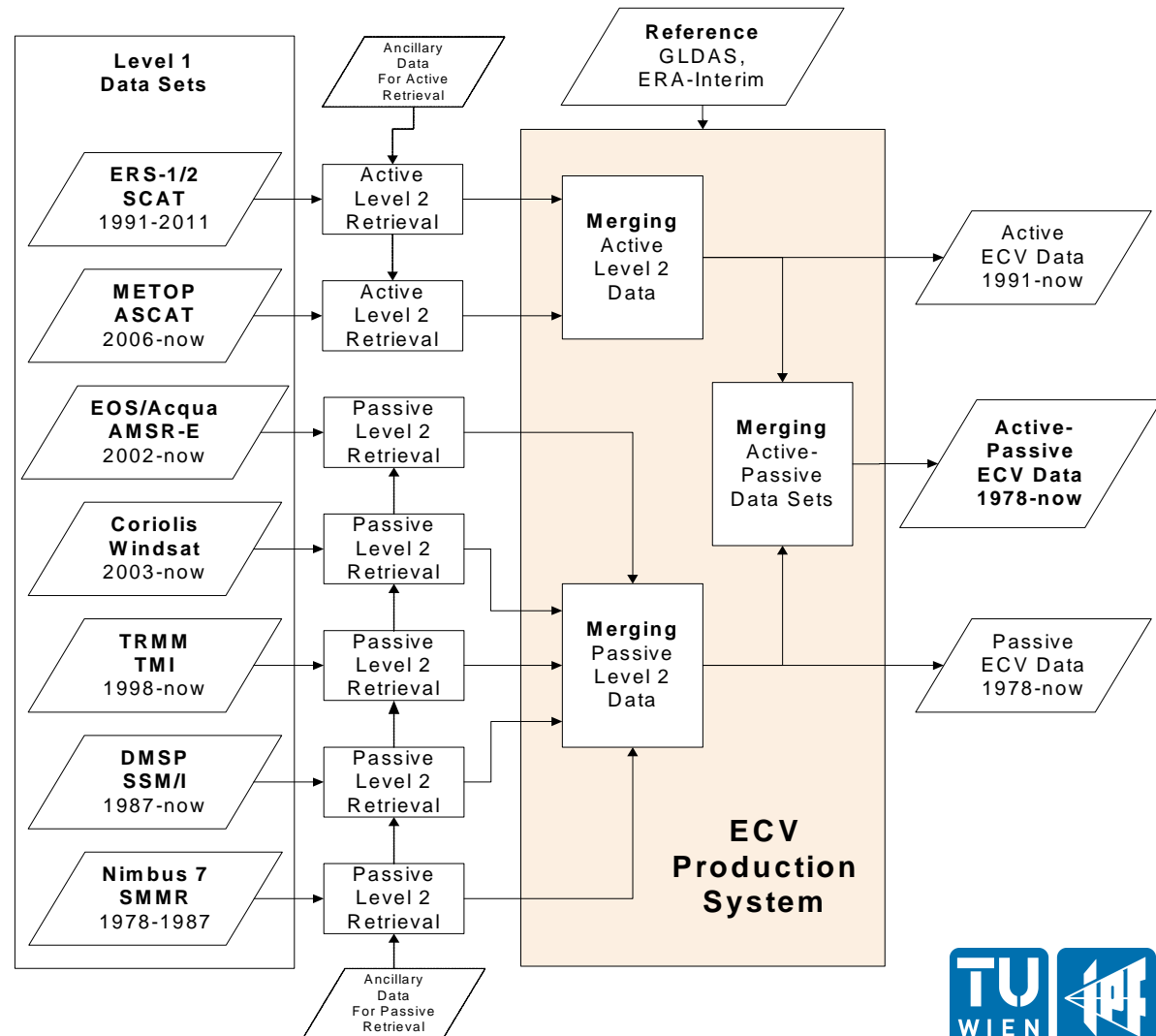
- Error characterisation
- Scaling
- Merging

■ Cons

- Physical consistency?
- Absolute accuracy?

■ Pros

- Modular
- Transparent
- Open to new sensors
- Participation of satellite expert teams



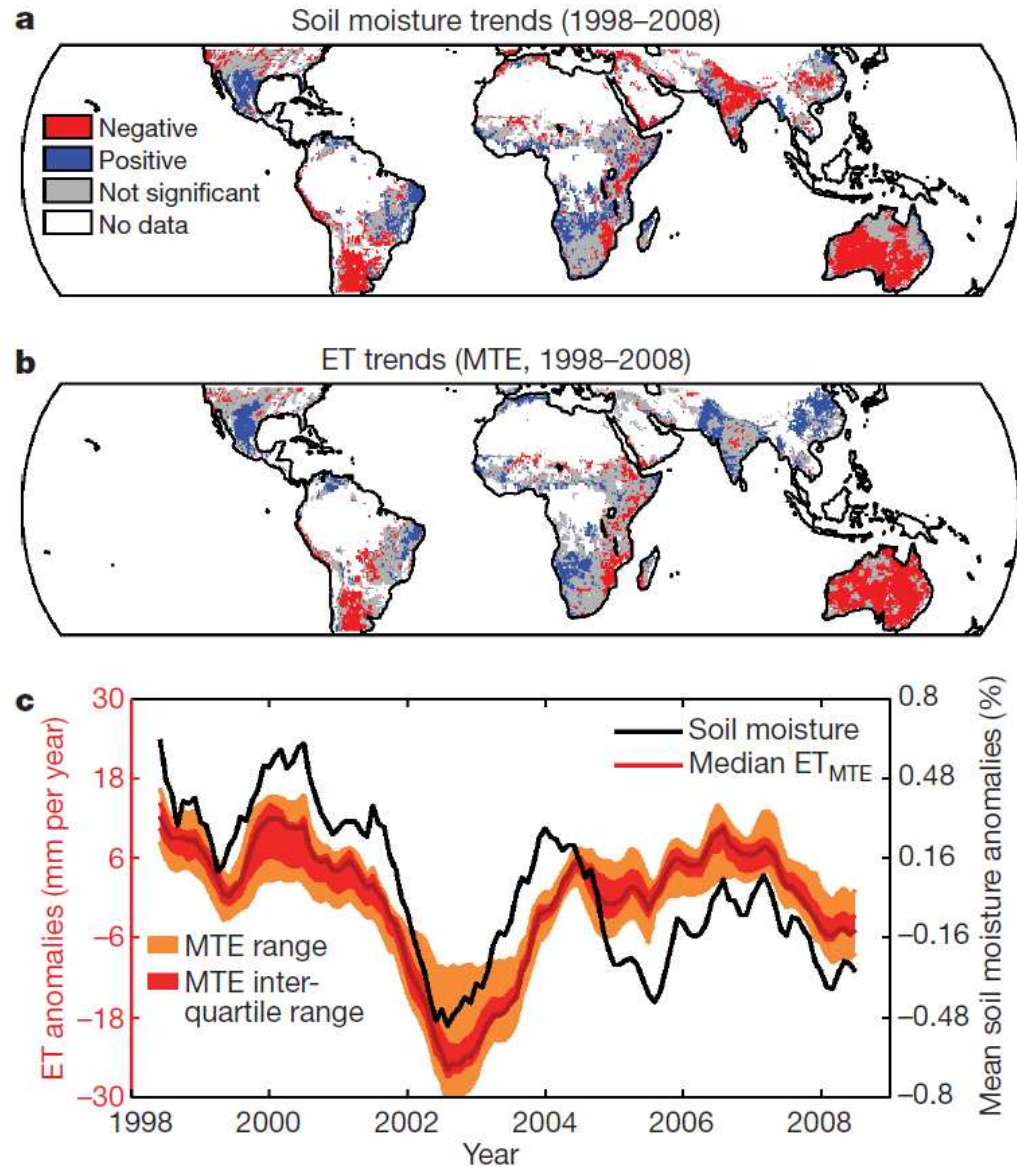
Achievements

- Our fusion approach was recently published
 - Liu, Y.Y., Dorigo, W.A., Parinussa, R.M., de Jeu, R.A.M., Wagner, W., McCabe, M.F., Evans, J.P., & van Dijk, A.I.J.M. (2012). **Trend-preserving blending of passive and active microwave soil moisture retrievals.** *Remote Sensing of Environment*, 123, 280-297

- First ECV soil moisture data set ready
 - Preliminary data viewer is on-line
 - Release of data now planned for 5/6/2012
 - Together with ATBD, CECR, PSD & final version of data viewer

- Round-Robin Protocol published
 - Participants to be informed until 25/5/2012

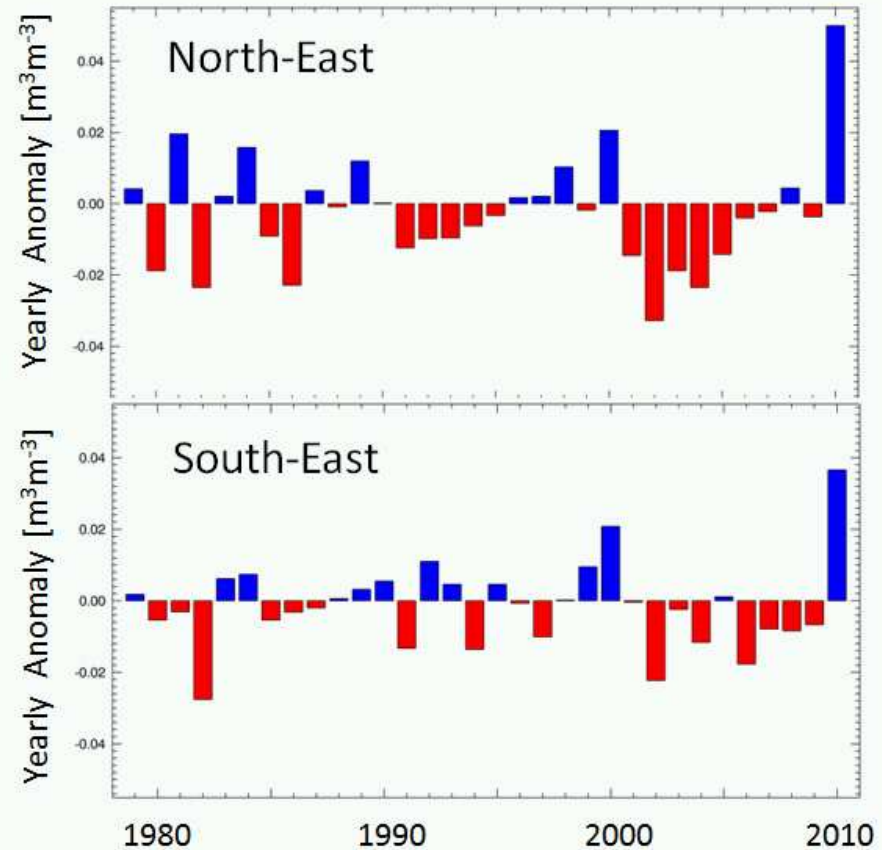
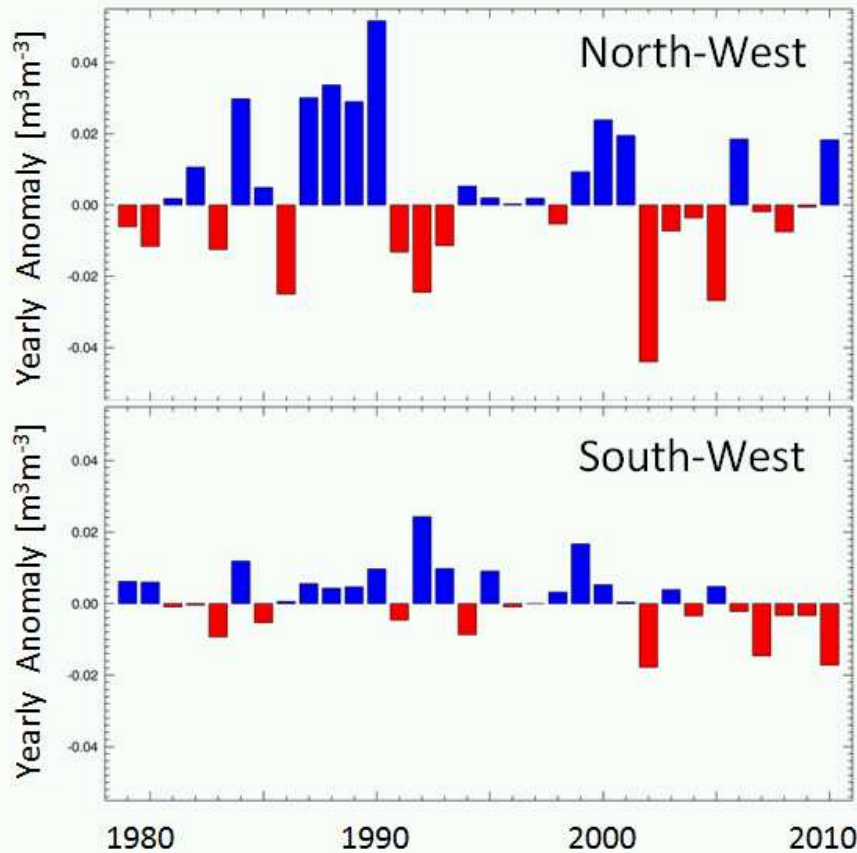
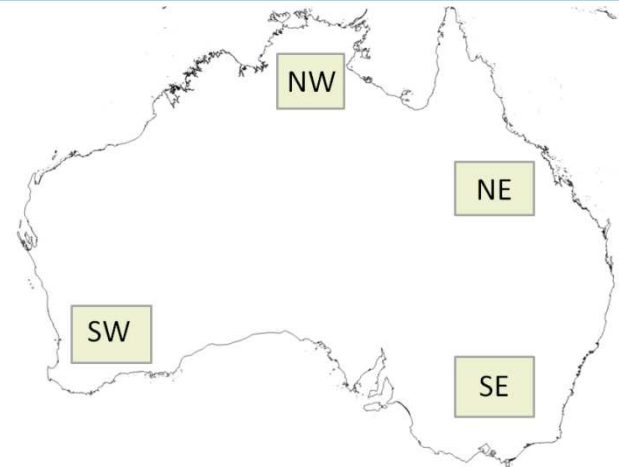
Recent decline in the global land evapotranspiration trend due to limited moisture supply



Jung, M. Et al. (2010). Recent decline in the global land evapotranspiration trend due to limited moisture supply. *Nature*, 467, 951-954

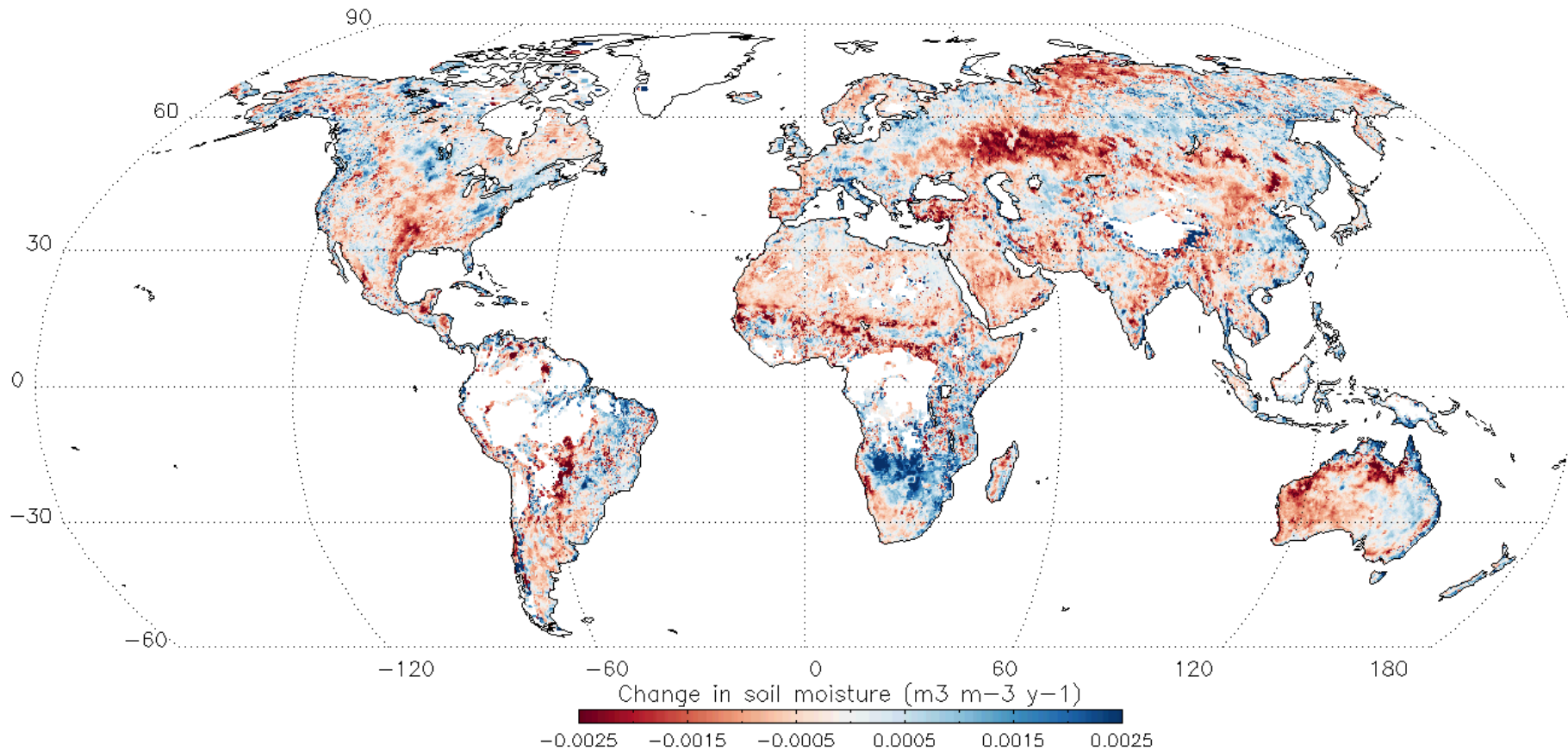
Australia

- Yearly anomalies reveal the great swing from dry to extremely wet conditions in 2010 in the eastern parts of Australia



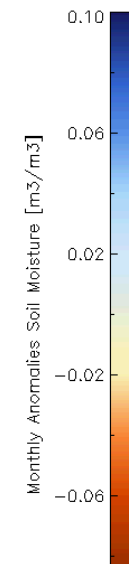
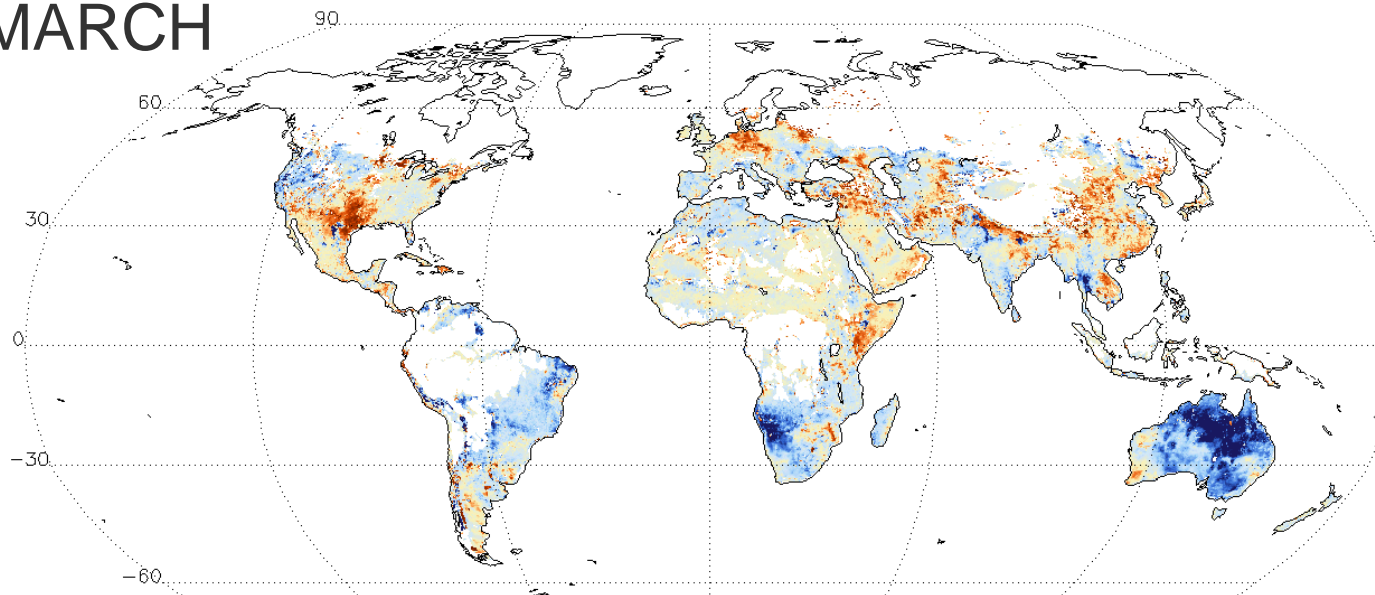
Trends 1988-2010

- Linear regression (including uncertainties) based on yearly averages
- Subtle trends strongly influenced by individual extreme events

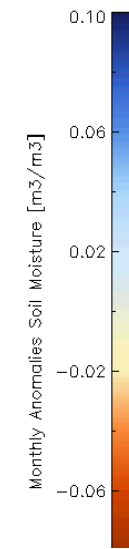
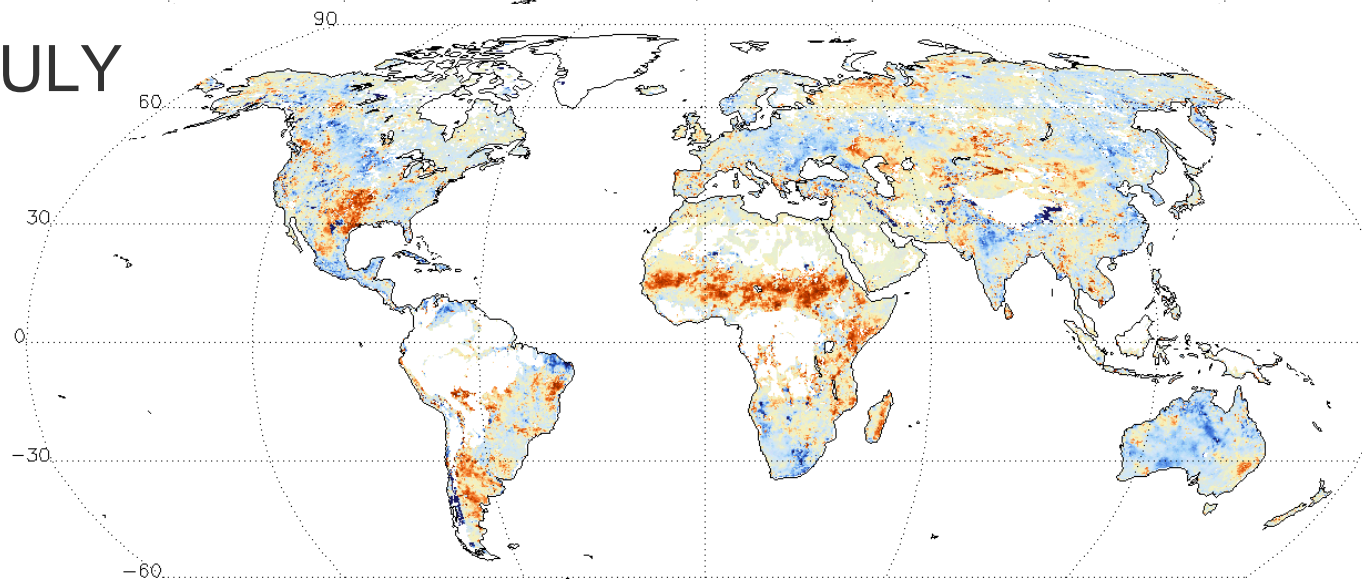


Anomalies 2011

MARCH



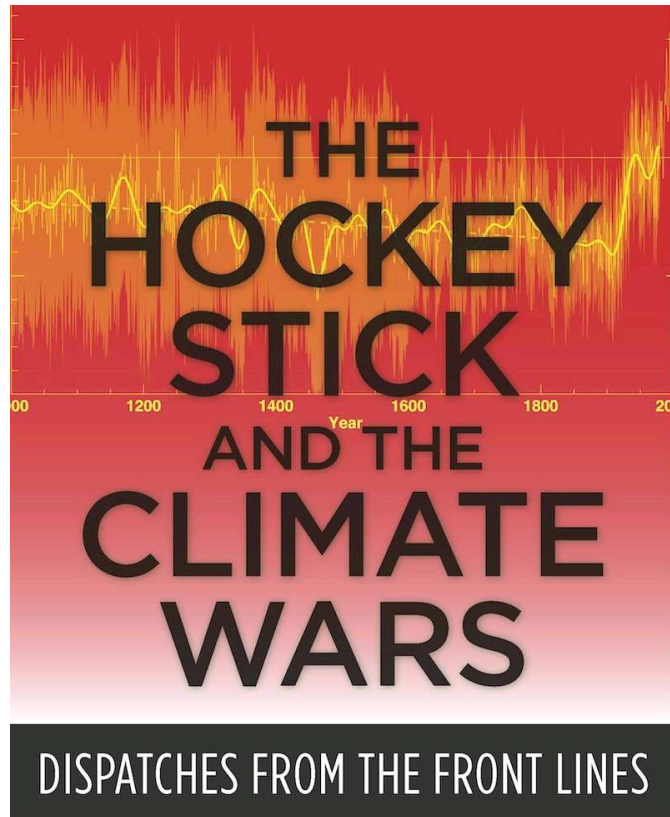
JULY



Outlook

- Next CCI project goals
 - Improve Level 2 retrievals (benefitting from the round robin)
 - Improve merging technique
 - Advance error characterisation
 - How can trend errors be characterised? Can they be linked to the (reasonably well understood) retrieval errors of the individual measurements?
 - Start exploiting the first ECV version for addressing relevant climate change science questions
- Potential scientific questions in common to other CCI projects
 - Can sea level fluctuations be explained by changes in soil moisture?
 - How are SST and soil moisture coupled?
 - What are feedbacks between soil moisture and clouds?
 - Do soil moisture anomalies lead to different land cover classifications?
 - Are there more fires after a wetter than normal wet season in savannah and steppe climates?

The Climate Debate



Michael E. Mann

