

Overview

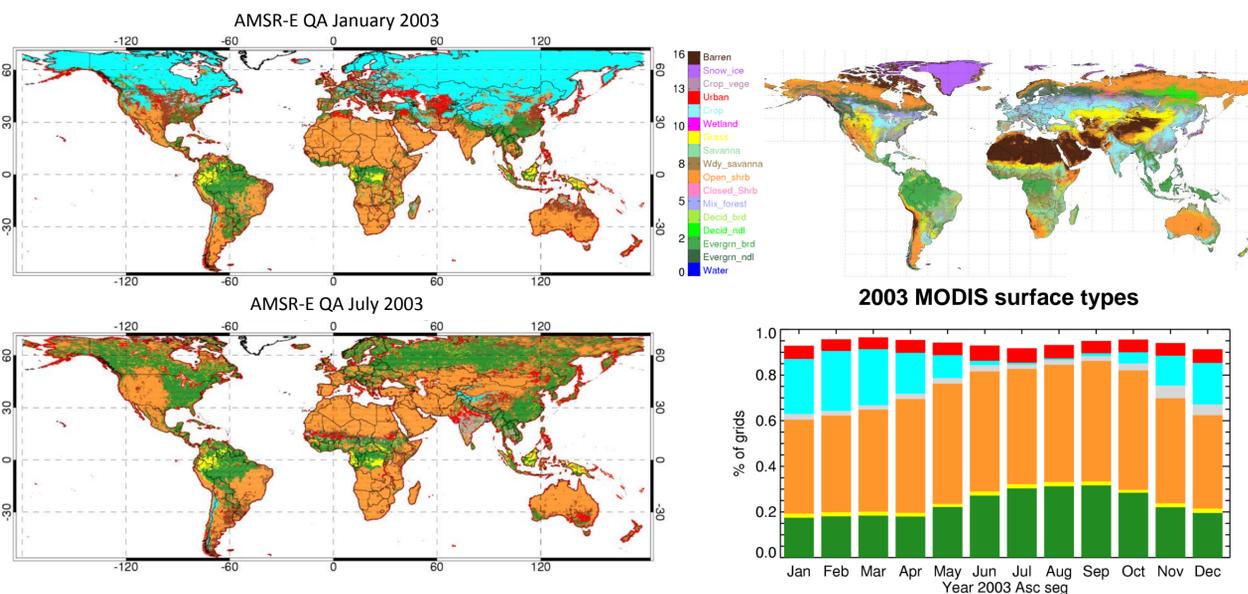
Build on SSM/I heritage from Prigent et al. (1997, 2006) to produce AMSR-E emissivity atlas (Moncet et al., 2011a,b; Galantowicz et al., 2011). Excellent consistency between Aqua/MODIS LST (used in microwave emissivity derivation) and AMSR-E measurements together with improved treatment of penetration effects show that microwave emissivities are more stable than originally thought (based on previous SSM/I experience) over many regions of the globe in snow free conditions.

Targeted applications include surface monitoring, retrieval/ assimilation.

Here we use land surface emissivity database for estimating LST under both clear and cloudy conditions. Monthly mean LST used for LSM evaluation (see Lipton et al., 2011- AMS poster). Comparisons of AMSR-E derived LST with other data sources also serves as validation of emissivity generation process.

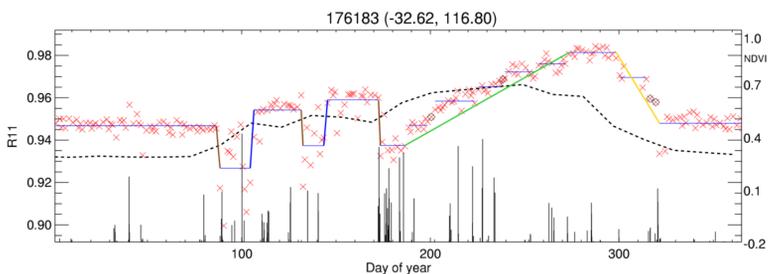
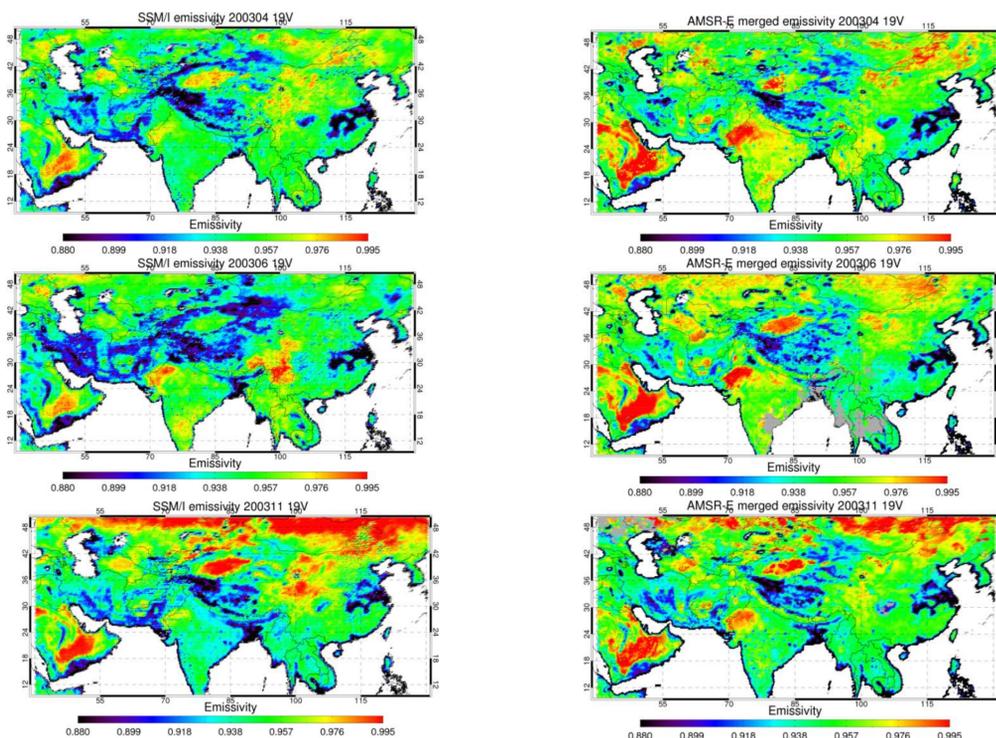
AMSR-E surface emissivity database

- Approach makes use of coincident MODIS information on clouds and LST
- Clear atmospheric correction from NCEP (or AIRS)
- Surface stability monitored using PR11 (=TB11h/TB11v) polarization ratio
- Automatic analysis of PR11 time series isolates time-stable segments at each grid location
- Emissivity derived for each segment using AMSR-E TBs and external data
- Strict QC applied to eliminate outliers due to bad (e.g. cloud contaminated) LST, CLW contaminated AMSR-E measurements
- Penetration effects over arid areas taken into account by estimating thermal model parameters with surface forcing provided by IR Tskin time series (PTS)
- Surface type based substitution (C) used in frequently cloudy areas (e.g. tropics)
- Other QC: daily snow mask/RFI flags
- Final emissivity estimates provided on fixed 28 km sinusoidal Earth grid
- Monthly mean AMSR-E emissivity data for year 2003 posted for open-access downloads at <http://www.aer.com/scienceResearch/mwrs/emis.html>



Fraction of grid points in each QA category year 2003 (bottom right). Color code: NPA (1a), C, PTS (1b), unstable, uncertain (only one valid emissivity estimate for either day or night but not both), snow covered areas. Missing values make up the difference between the total fraction of land points shown in color and 100%. (total number of grid points is 199,525). Geographical distribution of QA categories (left) for January and July 2003.

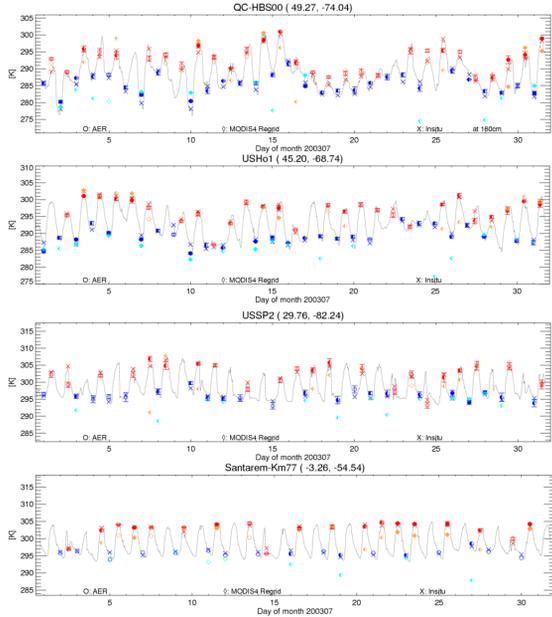
Comparison of monthly mean 19V emissivities from SSM/I heritage (left) and AMSR-E (right) databases over Asia for April, June and November of 2003.



Example of PR11 time series for a grid box located in the wheat growing region of Southwestern Australia. Daily PR11 values are marked by the red crosses, and analysis segments are shown by solid horizontal black lines. Rainfall estimates from Tropical Rainfall Measuring Mission (TRMM) are overlaid on the plot. Dotted line represents the Normalized Difference Vegetative Index (NDVI) from the 16-day MYD13A2 MODIS product. The colored lines correspond to the automated PR11 time series analysis output.

Greater temporal and spatial consistency of AMSR-E emissivities due to better separation of thermal and emissive properties over penetrating areas and higher degree of consistency between microwave measurements and IR T_{skin} .

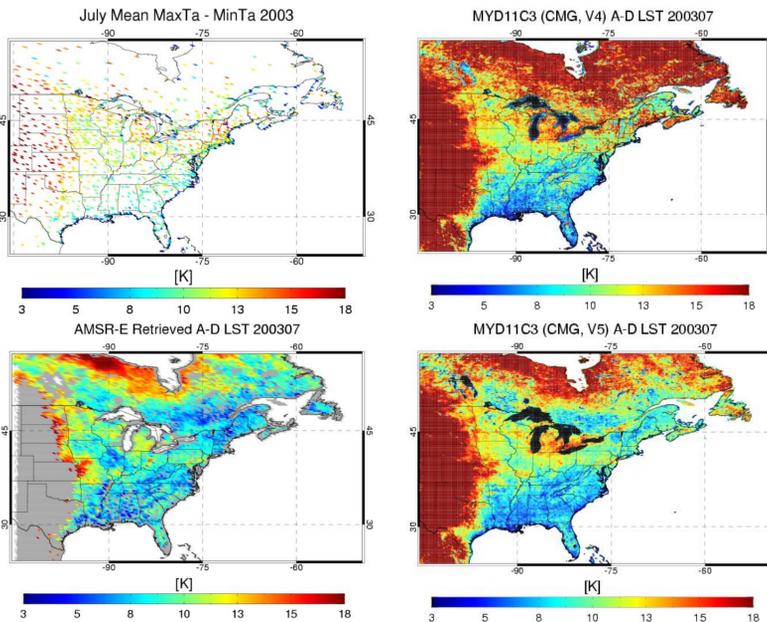
LST/11GHz emissivity validation (vegetated surfaces)



Daily time series for FLUXNET sites in Quebec (QC-HBS00) (a), Maine (USHo1) (b), Florida (USSP2) (c), and in the Amazon basin (Santarem-Km77) (d). The in situ measurements are represented by the continuous line. The red crosses and red circles represent the daytime in situ measurements (at the time of the AMSR-E overpass) and the AMSR-E LST estimates, respectively. The corresponding nighttime data are shown in blue. The nighttime and daytime MODIS V4 data are represented by the orange and light blue diamonds. Filled symbols indicate that the conditions across the 28 km grid were clear at the time of the observations. Open symbols are used for overcast conditions and half filled symbols for partly cloudy.

Good agreement between AMSR-E LSTs and in-situ air temperatures both in clear and cloudy conditions. IR only samples "clear" days. IR LST impacted by under-analyzed cloud cover

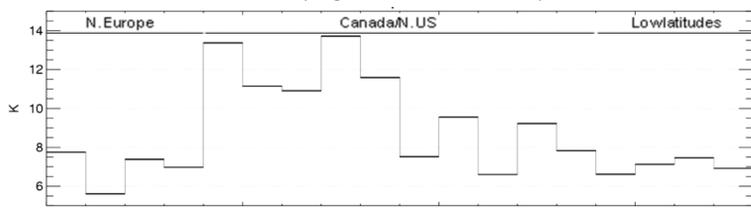
MW vs. IR



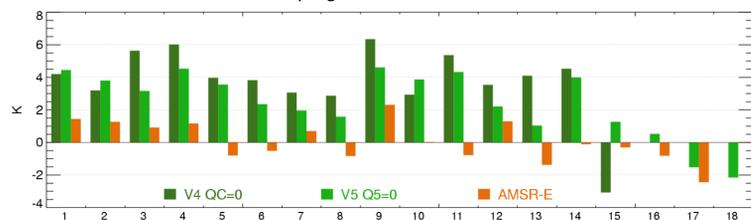
Monthly mean AMSR-E (bottom left) and MODIS MYD11C3 (V4 and V5) (right) day-night LST compared to average daily max - min reported air temperature from surface stations (top left) across the Eastern US and Canada for July 2003. (Gray areas in AMSR-E map correspond to penetrating semi-arid areas or areas where impact of spatial inhomogeneities degrade the quality of the LST retrieval)

Impact of sampling errors on IR monthly mean LST estimates may be significant. Attempt to reduce (as in V5) increases impact of cloud contamination. Better agreement between V5 and in situ mean day-night LST somewhat fortuitous.

Mean day-night in situ surface air temperature

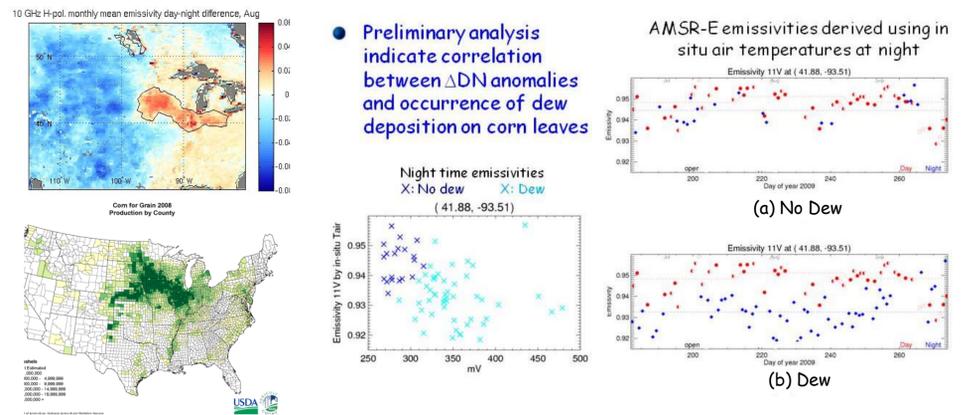


Mean day-night MODIS and AMSR-E LST - in situ

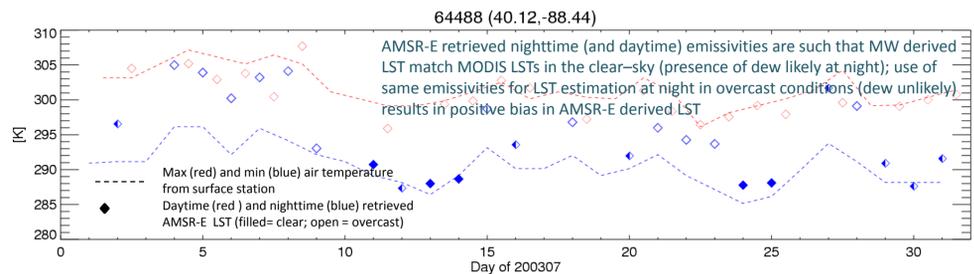


July 2003 mean day-night surface temperature differences from in situ measurements at the 18 FLUXNET sites (upper panel) and differences between day-night temperatures from MODIS (V4 and V5) and AMSR-E, and in situ data (lower panel). Here only the highest quality MODIS data are included.

Impact of dew (?) over Midwestern Corn belt

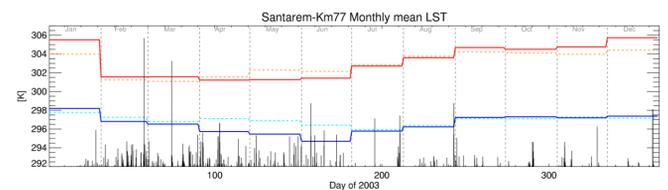


Top left: August 2003 day-night 11 GHz H-pol. month-average emissivity differences. The region where large differences occur in July and August (but not in June or September) is outlined and coincides with corn growing area (bottom left). Right: correlation between negative nighttime emissivity anomaly and leaf wetness (from in situ sensors).

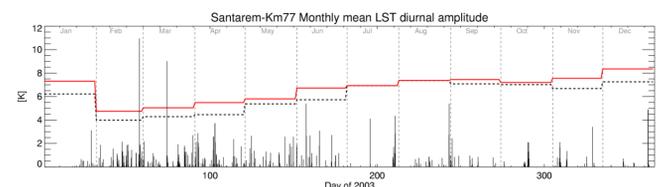


Seasonal emissivity cycle over Amazon forest?

Results below obtained using time invariant emissivity (estimated during dry season)



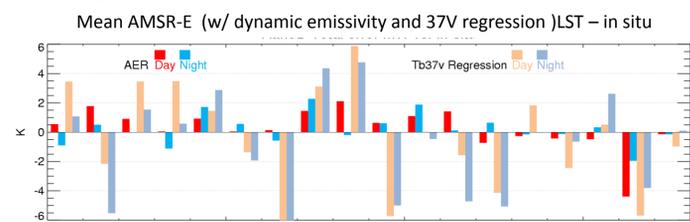
Monthly mean daytime (red) and nighttime (blue) AMSR-E LST (solid) versus 11.3m air temperature measurements (dashed) at the Santarem (Brazil) site for year 2003. Normalized rainfall from TRMM is overlaid to the plot. Maximum reported rain rate (at the end of February) is 20mm/h.



Monthly mean day-night surface temperature from AMSR-E (solid) and in situ measurements (dashed) for year 2003.

Conclusions

- Low frequency microwave more robust than IR with respect to clouds for LST derivation
- Excellent agreement between AMSR-E derived LST and in situ observations achievable over vegetated surfaces
- Requires dynamic emissivity update and strict QC



Monthly mean daytime (red) and nighttime (blue) AER AMSR-E minus in situ surface temperature differences at the 18 FLUXNET sites for July 2003. Also shown in this figure is the daytime and nighttime performance of the Holmes *et al.* (2009) single channel global regression in light brown and light blue, respectively.

- Change detection currently based on PR11