Dynamic Land Surface Animations from AMSR-E

Summary:
This directory contains animation files (MP4 Video format) of satellite passive microwave remote sensing retrievals of selected land parameters from the Advanced Microwave Scanning Radiometer for EOS (AMSR-E) on-board NASA's Aqua satellite. These parameters are derived using retrieval algorithms developed at the University of Montana (Jones and Kimball 2010) and extend over the AMSR-E operational record from 2002 to 2011. AMSR-E observes the Earth at microwave frequencies that are largely insensitive to solar illumination, clouds, smoke & other atmosphere effects, enabling continuous near-daily global observations of dynamic land surface processes. The satellite retrievals include landscape freeze/thaw (FT) status, maximum & minimum air temperature (Tmax, Tmin), open water inundation (Fw), vegetation optical depth (VOD) & surface soil moisture (mv) parameters. Together these visualizations capture the dynamic Earth, & the spatial patterns & seasonal to annual variability of surface temperature, moisture & vegetation processes.

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File description:

Tmn_monthly.mp4: Monthly mean minimum daily air temperature & frozen period. Land surface (~2m height) minimum daily air temperatures were derived from daily (1:30 AM equatorial overpass) multi-frequency brightness temperature (Tb) measurements from AMSR-E. The animation (at right) also shows the estimated monthly frozen period (days) derived using a temporal change classification of daily Tb (36V GHz) series to determine landscape freeze/thaw (FT) status. The FT retrievals are used as a prerequisite frozen area flag for obtaining air temperature retrievals under classified non-frozen conditions. Data retrieval gaps due to missing or screened Tb observations are shown in white. The animation shows the characteristic global seasonality of frozen conditions & air temperatures ranging from maximum warming in summer to seasonal minimum temperatures & widespread frozen conditions in winter. The fall & winter periods coincide with an expansion of cooling & frozen area from the poles to lower latitudes & from high to low elevations, & a return to warmer conditions & poleward retreat of frozen conditions in spring & summer.

Tmx_monthly.mp4: Monthly mean daily maximum air temperature & frozen period. The land surface (~2m height) maximum daily air temperature retrievals were derived from daily multi-frequency Tb measurements. The animation (right) also shows the estimated monthly frozen period derived using a temporal change classification of daily Tb (36V GHz) series to determine landscape FT status used as a frozen area flag for obtaining air temperature retrievals under classified non-frozen conditions. These results

are similar to the above temperature animations, except that the maximum daily air temperature retrievals are derived from sensor PM (1:30 PM equatorial crossing) Tb overpass observations. AMSR-E provides approximately global, twice daily (ascending & descending orbit) observations enabling retrievals of diurnal air temperature changes. Data gaps due to missing or screened Tb observations are shown in white.

VOD10_monthly.mp4: Monthly mean daily vegetation canopy optical depth & frozen period. Mean vegetation canopy optical depth (VOD) retrievals from AMSR-E 10.7 GHz (X-band) Tb records. The VOD parameter indicates the degree of vegetation opacity to soil microwave emissions & is strongly sensitive to spatial/temporal variability in canopy biomass & water content. In the animation (right), higher VOD areas coincide with higher biomass forests (e.g. tropical rain forest), while lower VOD areas reflect lower biomass (e.g. shrubland, grassland) areas. Relatively large VOD seasonal variability is shown in tropical wet/dry climate (e.g. African Sahel, SW USA) & temperate deciduous forest areas (e.g. eastern USA) coinciding with seasonal canopy growth & senescence. The animation also shows the estimated monthly frozen period derived through temporal change classification of daily Tb (36V GHz) series to determine landscape FT status used to obtain VOD & other land parameter retrievals under classified non-frozen conditions.

Fw_monthly.mp4: Monthly mean fractional open water inundation. Mean monthly fractional open water (Fw) inundation derived from AMSR-E 18.7 & 23.8 GHz Tb records. The Tb data are strongly sensitive to land surface wetness, while the Fw parameter quantifies the proportional (%) coverage of open water inundation within each ~25-km grid cell. The Fw animation (right) shows the characteristic large seasonal inundation variation for many wetlands (e.g. Amazon, tropical monsoon & northern tundra) & other prominant Fw areas including large river floodplains (e.g. Mississippi, Amazon, Ganges, Yangtze). These results also provide a metric of dynamic surface water storage changes over the globe. The animation also shows the estimated monthly frozen period derived through temporal FT classification of daily Tb (36V GHz) series, & used as a flag for obtaining Fw & other land parameter retrievals under classified non-frozen conditions.

Mv_monthly.mp4: Monthly mean surface soil moisture & frozen period. Land surface monthly mean daily soil moisture (% volumetric) retrievals derived from AMSR-E daily (AM & PM overpass) multi-frequency Tb measurements. The animation (right) also shows the estimated monthly frozen period (days) derived from FT classification of daily Tb (36V GHz) series and used as a flag for obtaining soil moisture retrievals under classified non-frozen conditions. The soil moisture retrievals are derived from X/C-band (10.7/6.9 GHz) Tb data & reflect surface (~1-2 cm depth) soil conditions under relatively low vegetation biomass cover. The soil moisture conditions are obscured under dense vegetation (in green) indicated by the VOD retrievals above. These results show the characteristic N-S seasonal changes in frozen period, as well as dynamic soil moisture changes in response to wetting & drying events. Dynamic spatial/temporal variability in the dense vegetation (VOD) areas reflect vegetation phenology cycles of seasonal canopy biomass growth & senescence, which influence the corresponding soil moisture retrievals. Other retrieval gaps due to missing or screened Tb observations are shown in

white. Similar products are planned for the NASA Soil Moisture Active Passive (SMAP) mission (mid-2014 launch), which will provide enhanced (L-band) sensitivity to soil moisture & freeze/thaw processes.

Mv_5day.mp4: This is the same format as the soil moisture (mv) file above except that the daily mv retrievals are composited to a finer 5-day temporal repeat. The resulting animations show greater occurrence of spatial gaps at 5-day intervals relative to the monthly mv animations due to sensor orbital swath gaps and screening of unfavorable retrieval conditions including RFI, snow and heavy precipitation. These results also show greater spatial & temporal variability in surface soil moisture & FT dynamics that get washed out at coarser monthly time scales.

References:

Jones, L.A., and J.S. Kimball, 2010. Daily Global Land Surface Parameters Derived from AMSR-E. Boulder Colorado USA: National Snow and Ice Data Center. Digital media (http://nsidc.org/data/nsidc-0451.html).