AMSR-E Ecological Applications: Legacy and Future Directions

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Then…

- Original project: Investigate boreal-arctic land-atmosphere CO_2 exchange using model driven by freeze-thaw, soil moisture and temperature from AMSR-E and vegetation information from MODIS.

- Land temperature retrieval algorithms did not exist at the time and most experience with soil moisture retrievals was for mid-latitude crop and grasslands, not tundra.

Now…

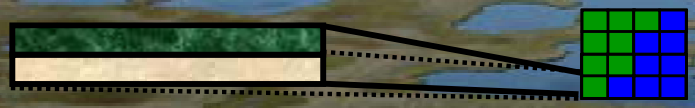
- Full suite of AMSR-E validated[1] land-parameters.
- New validation approaches, algorithm inter-comparisons, field campaigns, and data assimilation are allowing robust error estimation, dataset merging, and error tracking.

- Enables a wide variety of ecological monitoring and modeling activities and that inform development of future missions (SMAP L4C, and L3FT products).
- Other interesting, unforeseen applications.

[1]In NASA Technology Readiness Levels (TRL): Level 7 (Temperature), Level 6 (Water Fraction, Vegetation Optical Depth); Level 5 (Soil Moisture); Level 4 (Atmospheric Water Vapor)

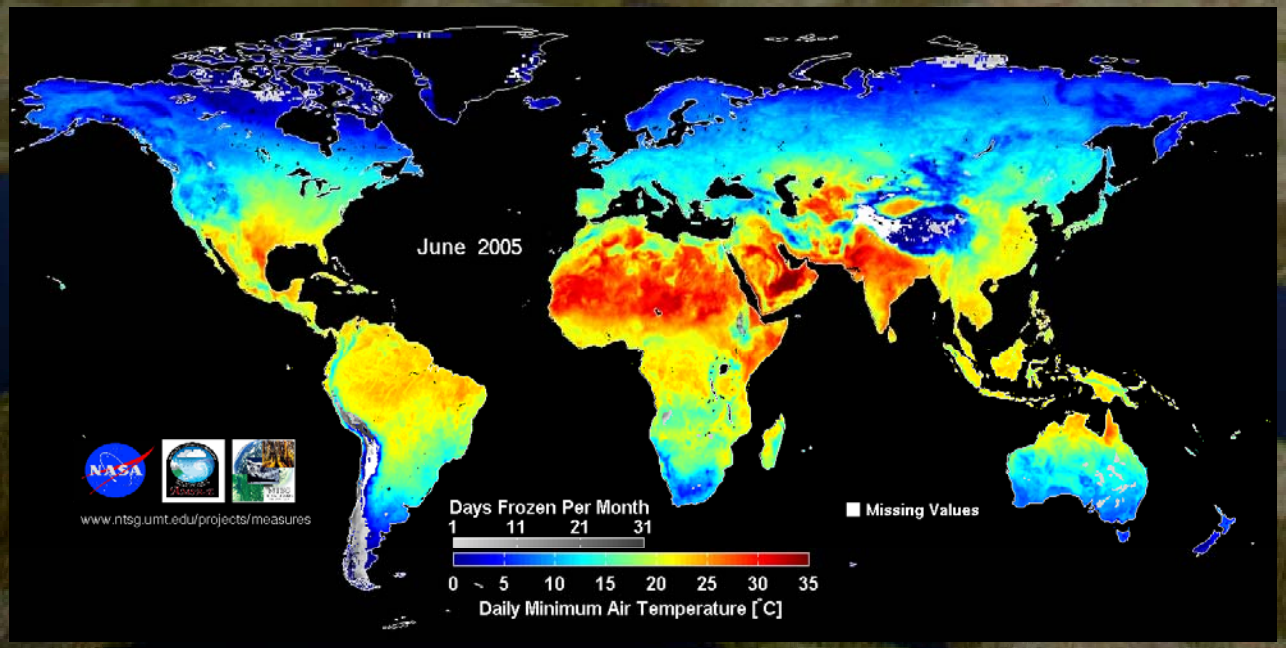
Land Parameter Retrieval

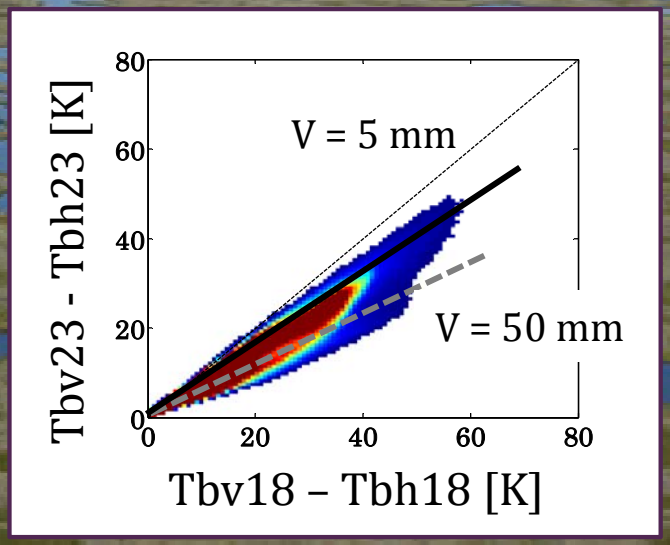
Vertical (Profile) **Horizontal (footprint)**

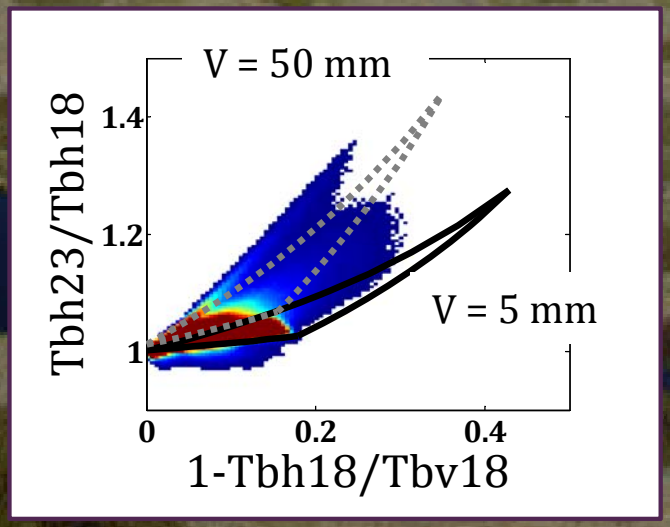


Visualizations:
http://freezethaw.ntsg.umt.edu/visualization.htm

Data: http://nsidc.org/data/nsidc-0451.html



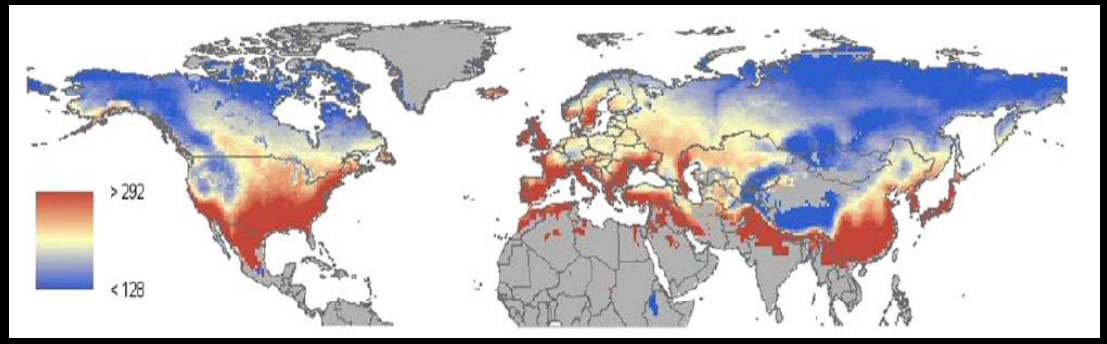




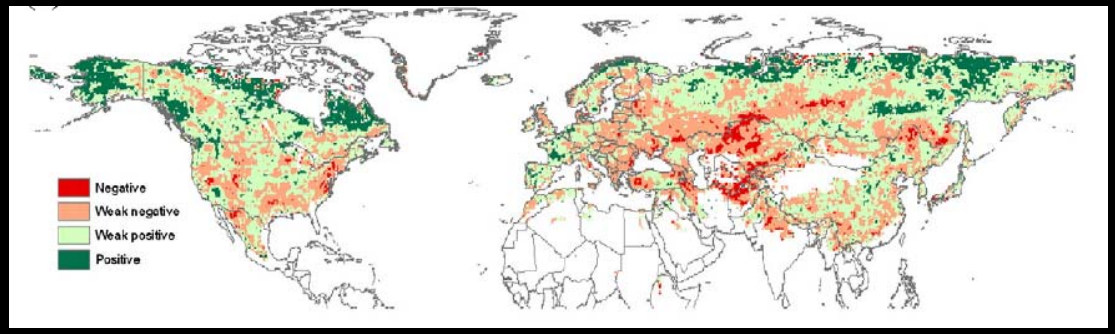
Jones, L. A. et al. (2010), *IEEE J-STARS;* Jones, L. A. et al. (2009) *IEEE IGARSS'09 Proc.*

Freeze-thaw control of high latitude vegetation growth

Mean annual non-frozen period [days]
FT ESDR (SMMR/SSMI) Record[1] (1979-2008)



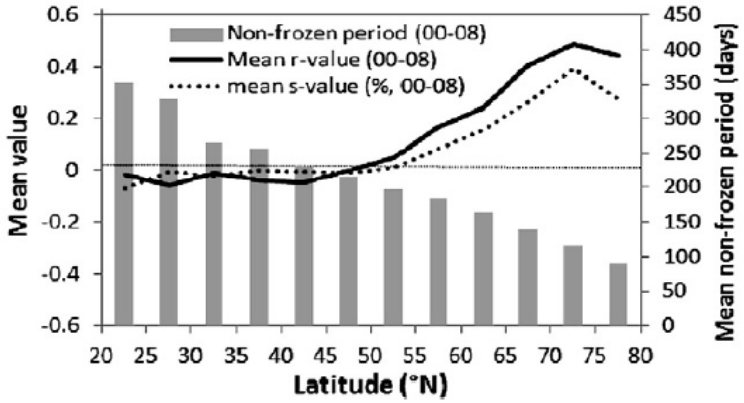
Correlation of non-frozen period anomalies
vs. MODIS mean summer NDVI (2000-2008)



[1]All freeze-thaw data (includes AMSR-E) available at:
http://freezethaw.ntsg.umt.edu/dataholdings.htm

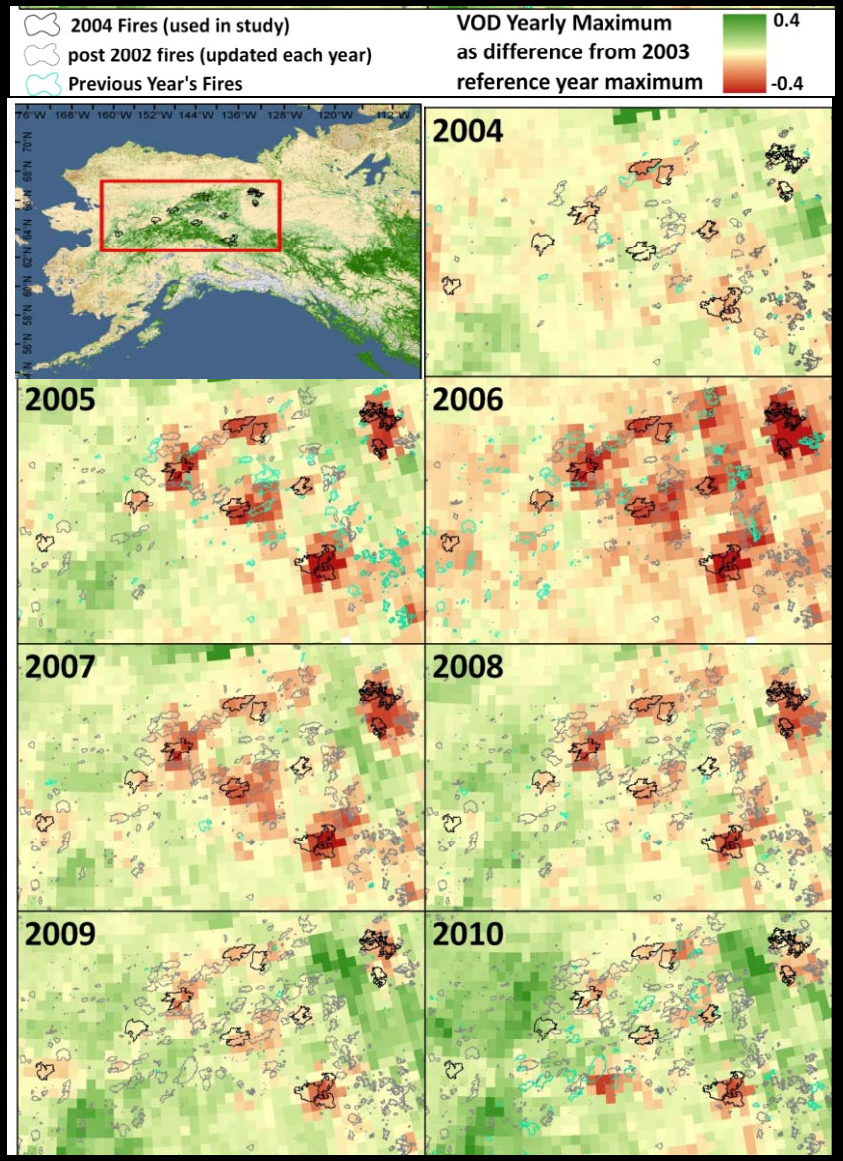
- AMSR-E used for cal/val of longer-term freeze-thaw ESDR from SMMR/SSMI.
- Record reveals lengthening growing season contributing to an increase in plant growth detected by MODIS.

Latitudinal Summary

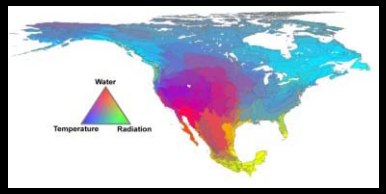


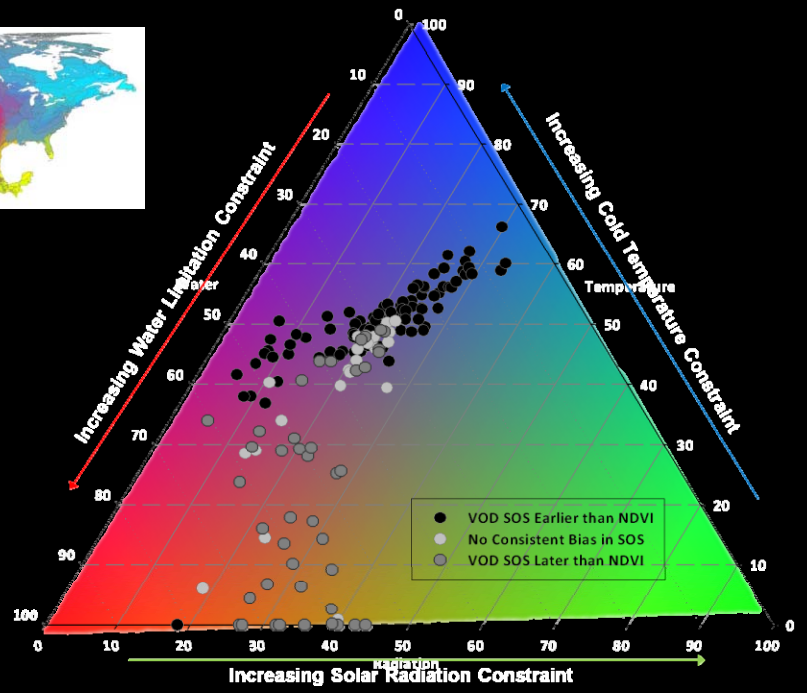
Kim, Y. et al. (2012), *Rem. Sens. Environ.*

AMSR-E vegetation optical depth (VOD) for phenology and disturbance



- VOD responds to biomass loss from fire disturbance.
- VOD seasonal cycle tends to lead NDVI in lower-biomass northern locations, and lag NDVI in higher-biomass sub-tropical locations.

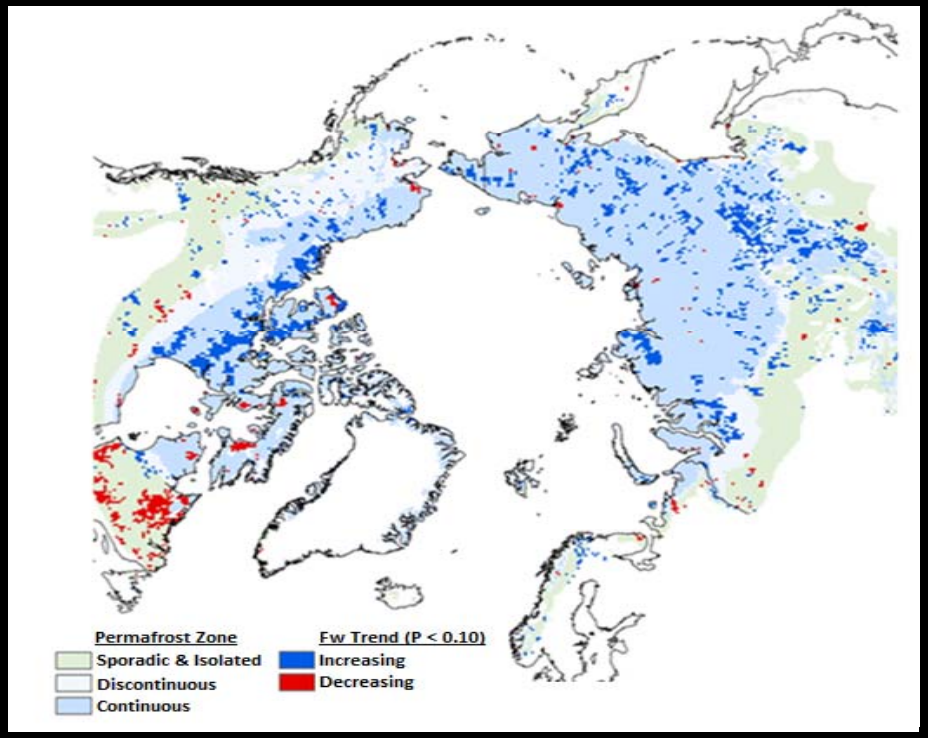




Jones, M. O. et al. (2012), *Rem. Sens. Environ.*

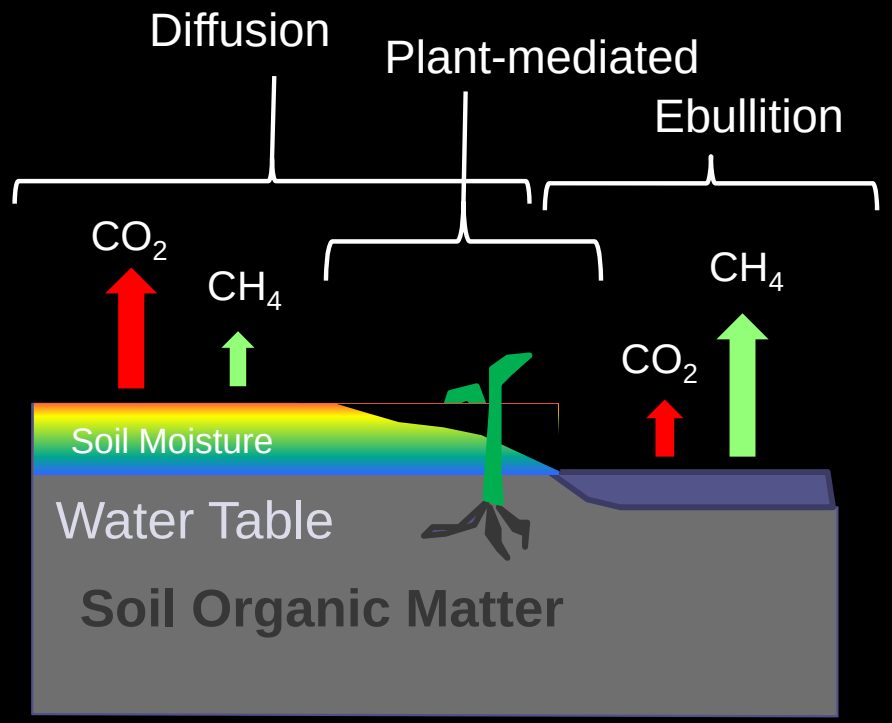
AMSR-E Open Water Inundation Dynamics

- Daily repeat of AMSR-E allows monitoring of seasonal inundation at high latitudes .
- Significant trends over the 9-year AMSR-E record correspond with major permafrost zones.



Watts, J. et al. (in press), *Rem. Sens. Environ.*

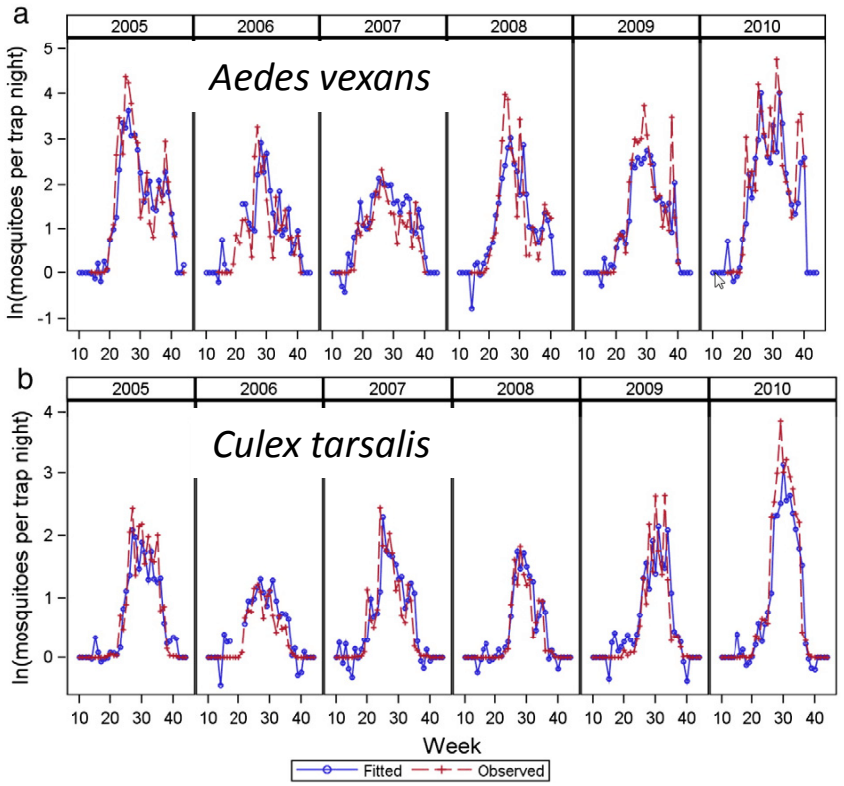
CH_4 Transport Pathways

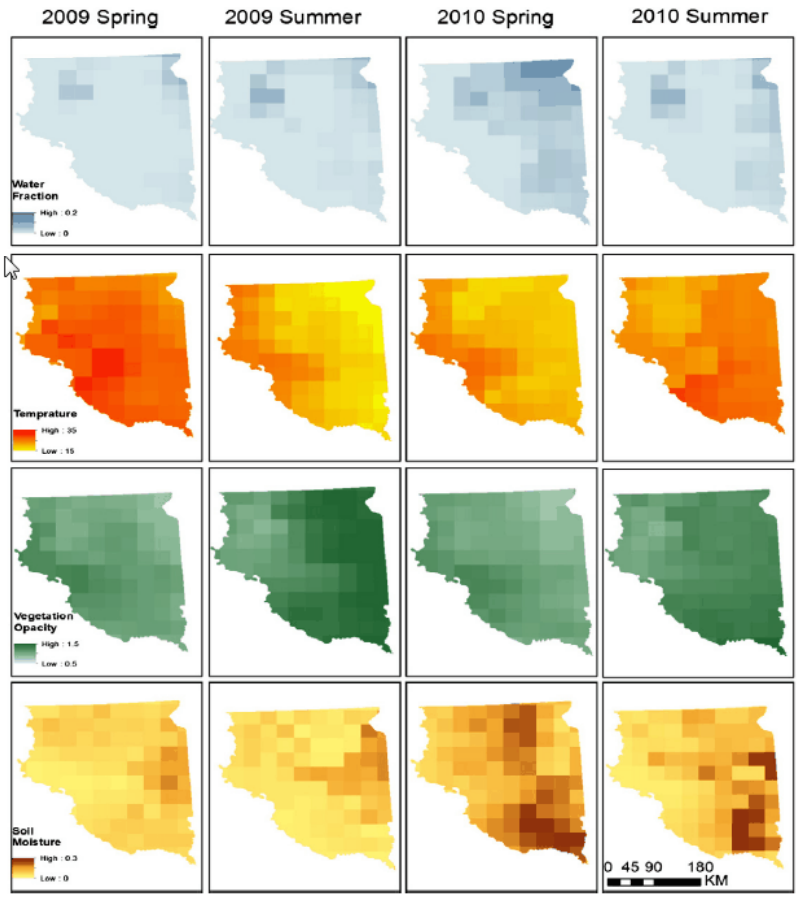


- Are soils inundated, saturated, or merely wet?
- Is the inundated area wetlands or lakes?
- It matters for biogenic trace gas emissions!

Improved Estimation of Mosquito Population Dynamics from AMSR-E

- **Mosquito abundance (*Aedes vexans* & *Culex tarsalis*) modeled using AMSR-E (UMT) land parameter record over South Dakota**
- **AMSR-E predictions more accurate than standard models from weather station data**
- **AMSR-E provides better measures of habitat conditions & accurate regional forecasts of mosquito abundance & disease risk**

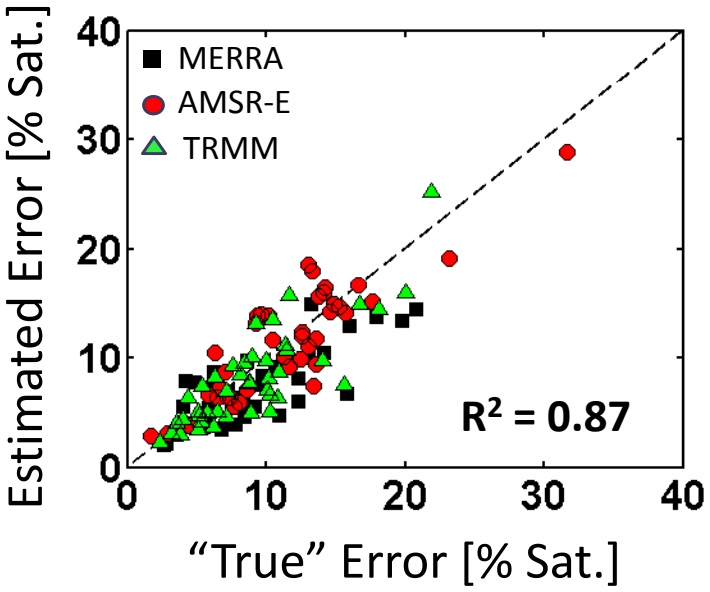




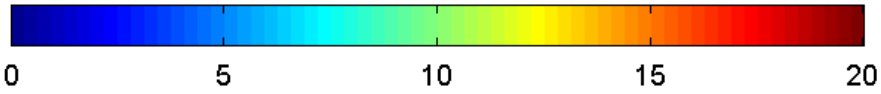
Chuang, T. W. et al. 2012 *Rem. Sens. Environ.* 125

Improving soil moisture accuracy and Assessing uncertainty with multiple datasets

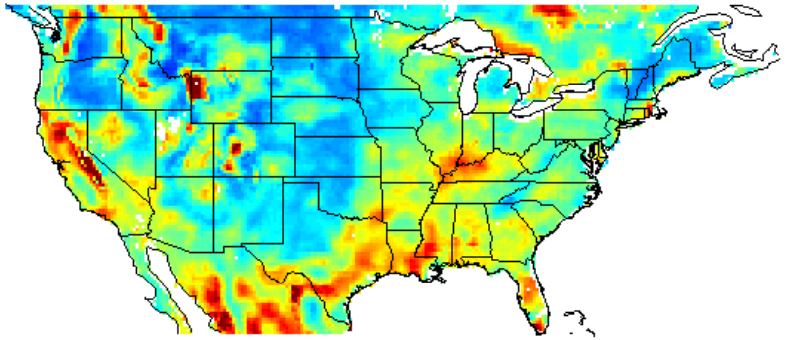
Estimated Errors (vs. ground obs. @ 42 sites)



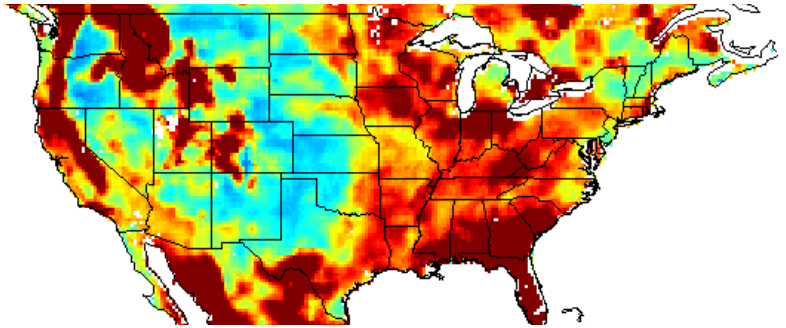
Soil Moisture RMS Error [% of Sat.]



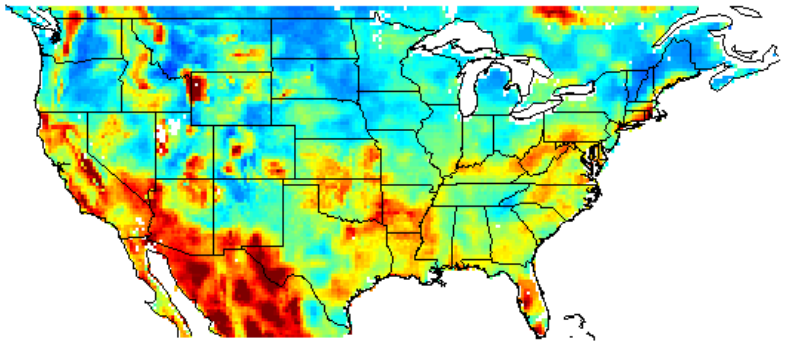
MERRA (Model)



AMSR-E



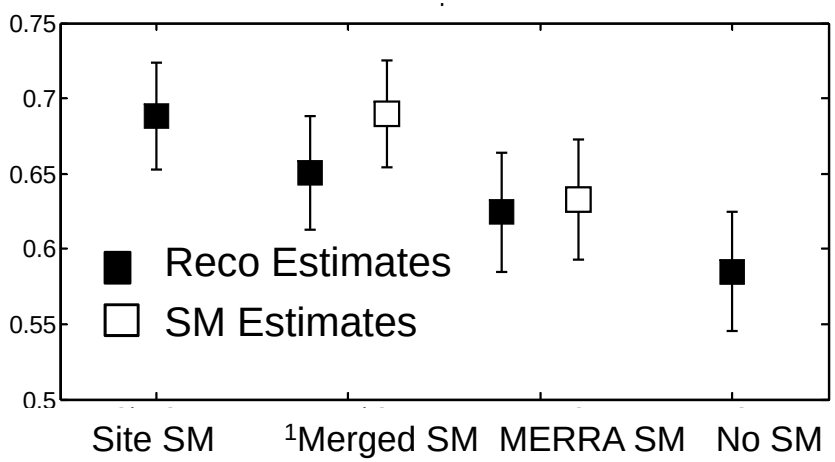
TRMM/ET

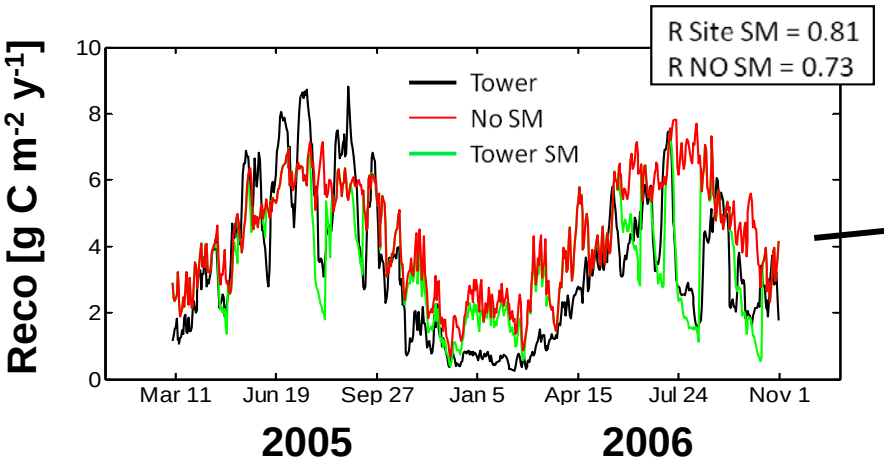


Jones, L. A. et. al. *J. Hydrometeorology* (in prep.)

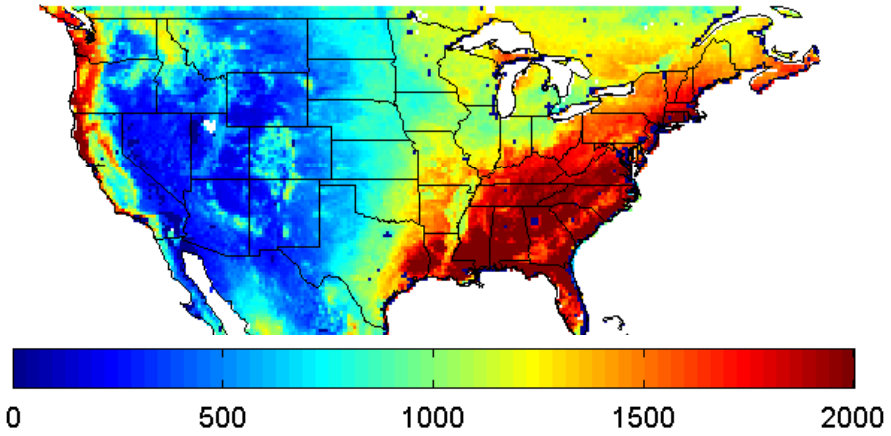
Impact of more accurate soil moisture information on Ecosystem Respiration CO_2 flux (Reco) estimates

Timeseries Correlations (vs. ground obs. @ 28 sites)

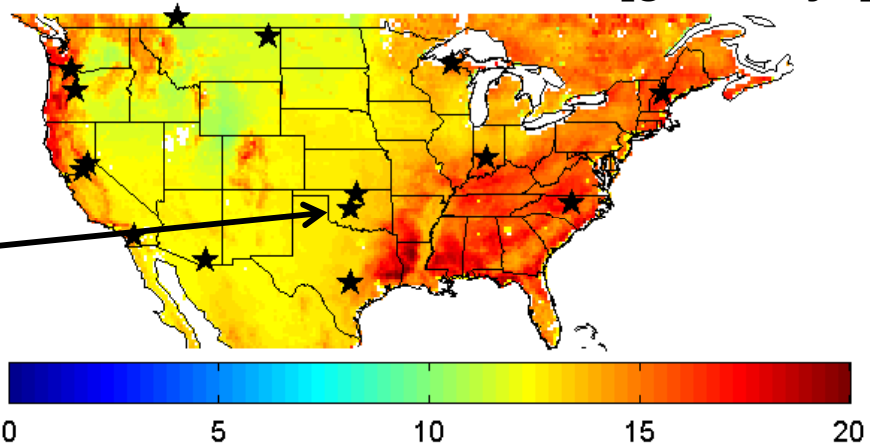




Mean Annual Reco [g C m^{-2} y^{-1}]



Annual Reco Random Error [g C m^{-2} y^{-1}]

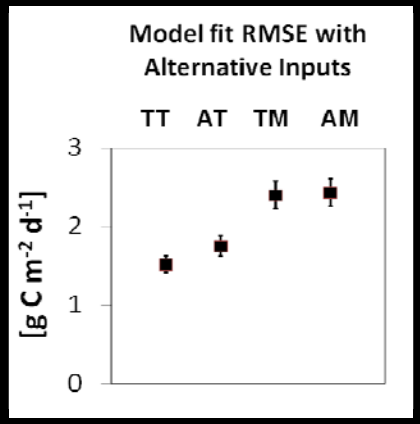


[1]Merged dataset includes AMSR-E, TRMM-PET, and MERRA.

Value of AMSR-E to SMAP L4C and L3FT Mission Preparations

AMSR-E provides ancillary inputs for:

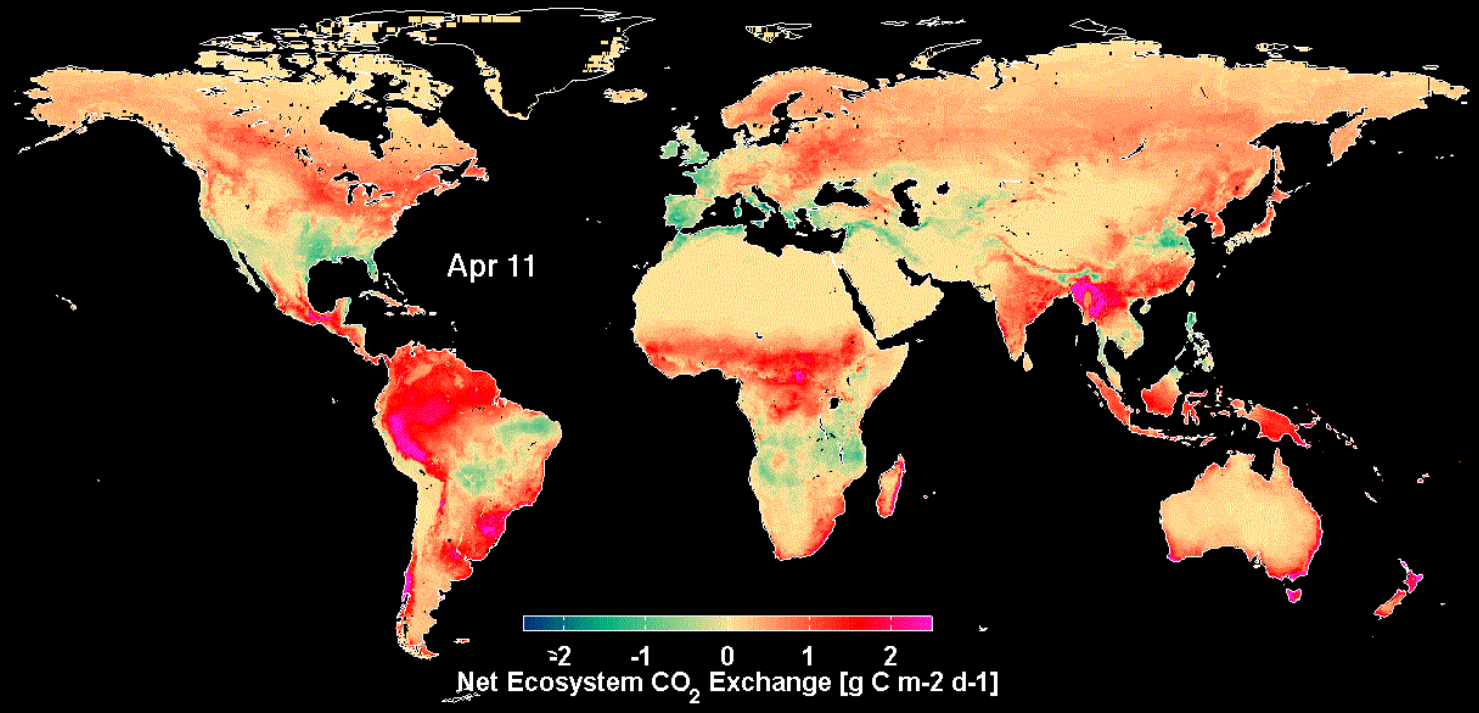
- Algorithm development, calibration, and testing.
- Input error fields for model error propagation and sensitivity analyses.



Flux tower model calibration
Tonzi Ranch, CA,
(Dennis Baldocchi, PI)

Input Key

TT: Tower Met. + MODIS GPP
AT: AMSR-E Met. + Tower GPP
TM: Tower Met. + MODIS GPP
AM: AMSR-E Met. + MODIS GPP



Then… Now…Tomorrow

Bottom Line:

- AMSR-E provides a spectrum of land surface information (not just soil moisture) relevant to ecological processes.
- The value of these products to carbon cycle research is becoming realized.
- Not bad for a sensor that was not designed to do any of these things.
- However, the land signals are noisy and many problems remain, requiring vigilance towards error quantification and tracking.

Looking Forward:

- Reprocessing of the AMSR-E record with the new RSS 18.7 GHz land bias-corrected dataset.
- Algorithm transfer to GCOM-W and WindSAT.
- WindSAT will be crucial for bridging the short data gap between AMSR-E and GCOM-W.
- Finally, the algorithms are due for an overhaul based on lessons learned from the first full version.

Papers published since last year

Chuang, T. W., G. M. Henebry **J.S. Kimball**, D. L. VanRoekel-Patton, M.B. Hildreth, M.C. Wimberly. 2012. Satellite microwave remote sensing for environmental modeling of mosquito population dynamics, *Rem. Sens. Environ.,* 125: 147-156.

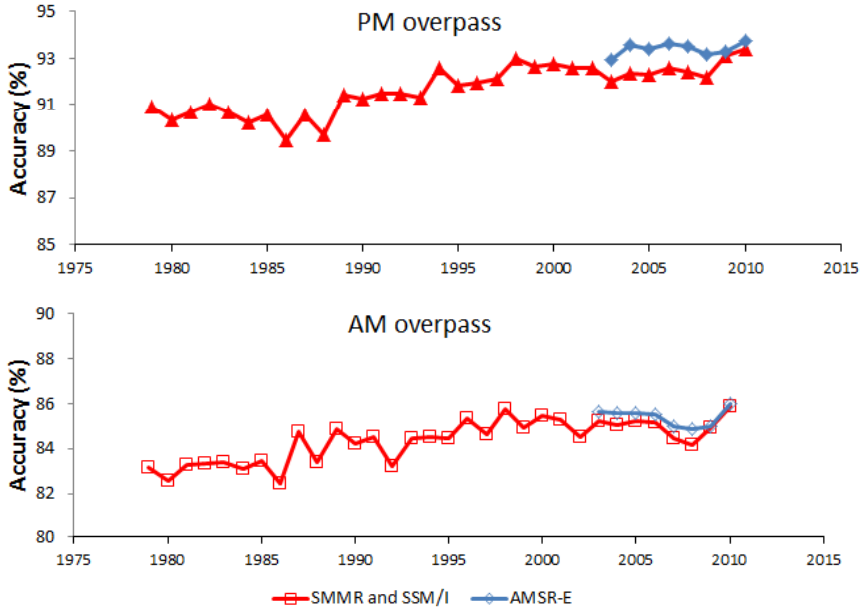
Jones, M. O., J. S. Kimball, L.A. Jones, K. C. McDonald. 2012. Satellite passive microwave detection of North America start of season, *Rem. Sens. Environ.,* 123: 324-333.

Kim, Y., J. S. Kimball, K. Zhang, K. C. McDonald. 2012. Satellite detection of increasing Northern Hemisphere non-frozen seasons from 1979 to 2008: Implications for regional vegetation growth, *Rem. Sens. Environ.,* 121: 472-487.

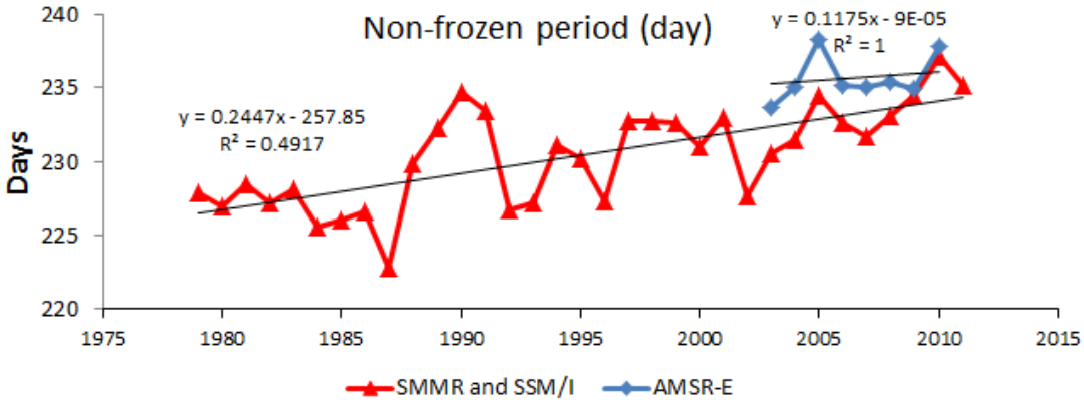
Watts, J., J. S. Kimball, L. A. Jones, R. Shroeder, K. C. McDonald. 2012. Satellite microwave remote sensing of contrasting surface water inundation changes within pan-Arctic permafrost zones. *Rem. Sens. Environ.*

Extras

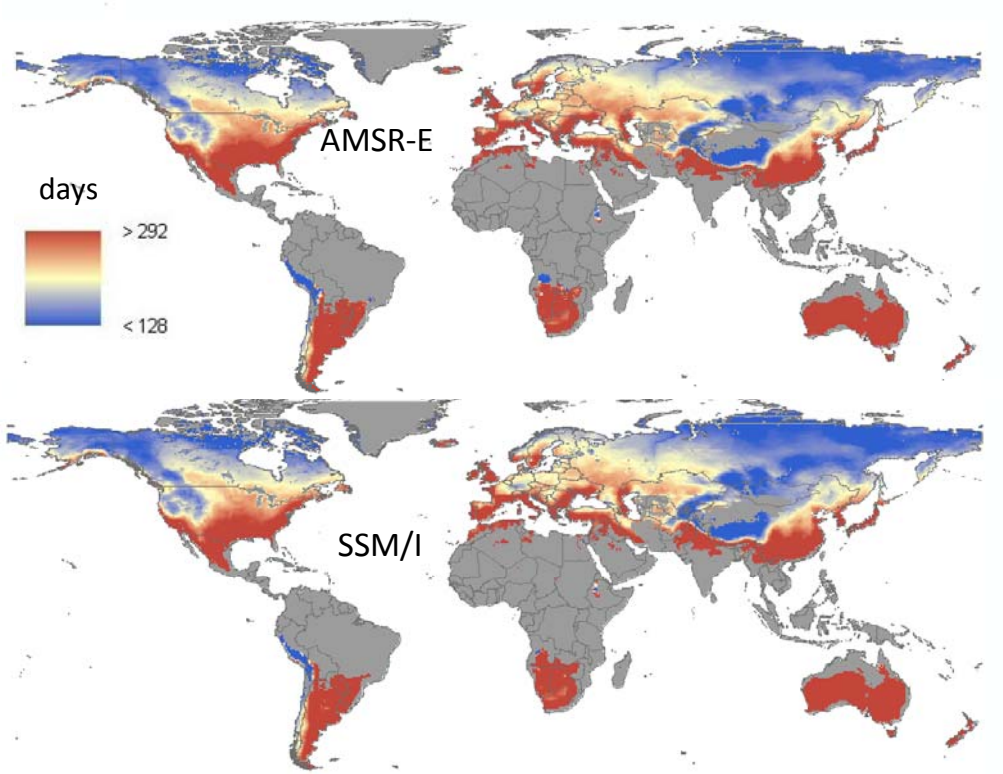
Mean annual FT classification accuracy, 1979-2010



Mean annual non-frozen period trend, 1979-2010



Mean annual non-frozen period (days), 2003-2010



Difference of mean annual non-frozen period (days) 2003-2010