Development of global hydrological monitoring system using GCOM-W retrievals

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Coupled data assimilation
Suzuki and Zupanski (2018)

Open loop (OPNL)

- Model simulation without data assimilation

Weakly coupled data assimilation (WCDA)

- To enable interaction between model components (e.g., atmosphere and land).
- In such cases, data assimilation is still performed independently for each component, as in the analysis step of uncoupled data assimilation

Strongly coupled data assimilation (SCDA)

- To refer to the use of a single system that combines information from all components to perform coupled forecasting and coupled data assimilation for all components.
- Cross-component error covariance is used, forecasts and observations of each individual component have the potential to affect all other components.

Land-atmosphere WCDA & SCDA Lin and Pu (2019)

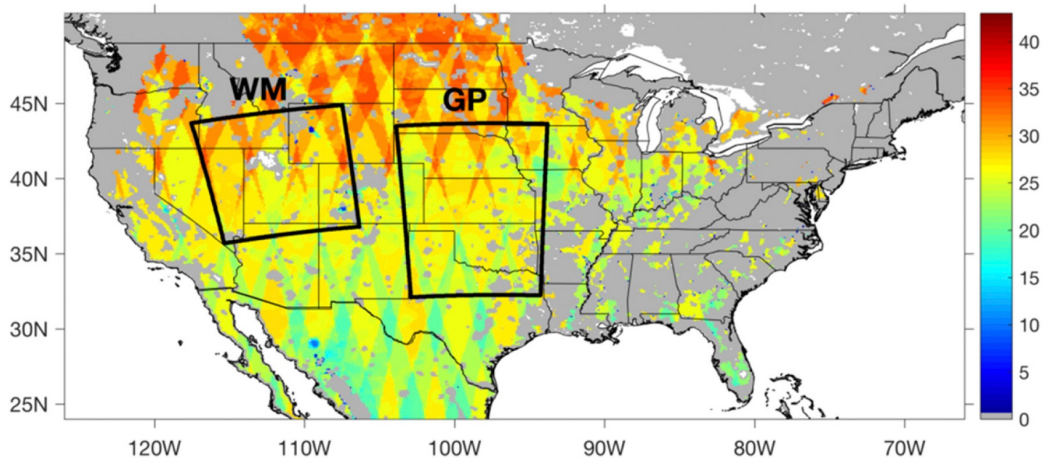
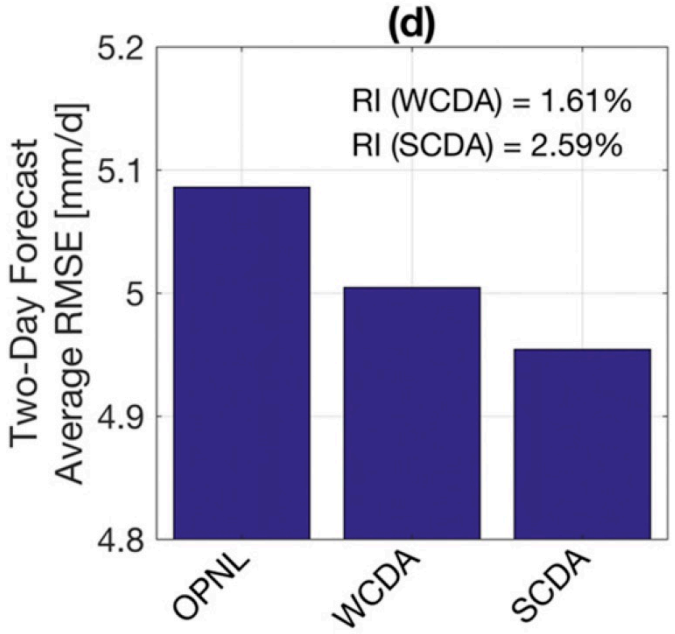


FIG. 2. The sample size of assimilated SMAP soil moisture retrievals during the study period from 1 to 27 Jul 2016. The gray pixels show areas without SMAP data being assimilated, primarily due to the quality control of data with quality flags.

Changes in Reproducibility of Precipitation Estimation by Data Assimilation of SMAP Soil Moisture



MLEF-GWRF data assimilation system

Two components:

(1) Maximum Likelihood Ensemble Filter (MLEF)
(2) Global WRF (GWRF) model

MLEF

- Hybrid variational-ensemble data assimilation (DA) system
- Successfully used in coupled land surface –atmosphere data assimilation with regional WRF model
- Well-suited for strongly nonlinear and for coupled DA applications

GWRF

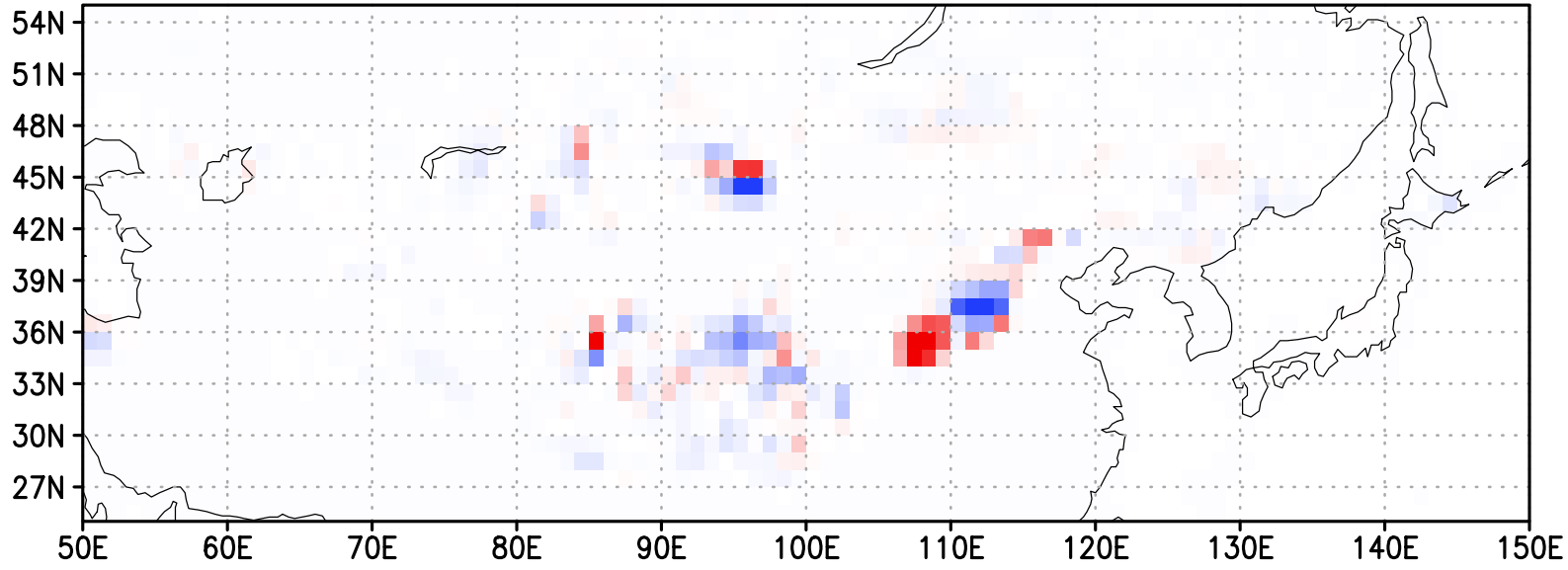
- Essentially same as regional WRF model, except defined in Gaussian latitude-longitude grid
- Originally developed for applications to other planets

MLEF-GWRF performance evaluation

- **Data assimilation set up**
  - 6 hours data assimilation cycle **PrepBUFR**
  - **10 data assimilation cycle （2.5 days）**
  - 1800 UTC March 14, 2018 –1200 UTC March 17, 2018
  - 32 Ensemble data assimilation
  - Localization horizontal 600 km
  - **Control variables**: perturbed dry air mass in column, perturbed potential temperature, specific humidity, horizontal winds
- **Experiment**
  1. WCDA
  2. SCDA ＋ Control variables: Snow depth

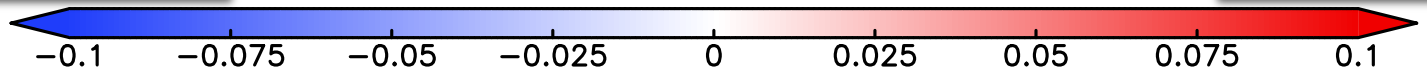
SCDA &WCDA (1200 UTC March 17, 2018) Snow cover fraction

Abs(SCDA Bias)-Abs(WCDA Bias)



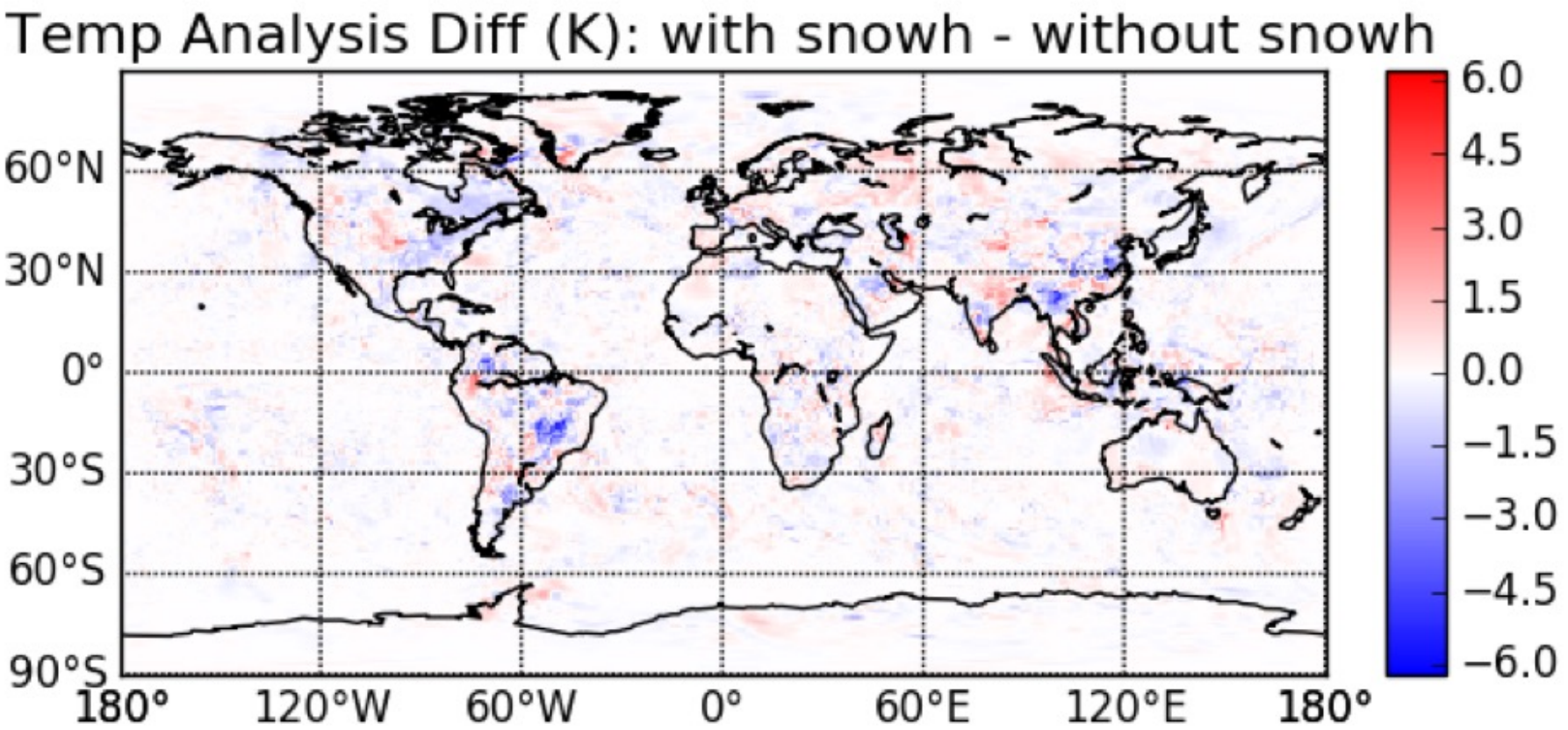
Improved

Degraded



SCDA vs. WCDA (1200 UTC March 17, 2018)
2m surface temp. (K)

2m air temp. (SCDA –WCDA)



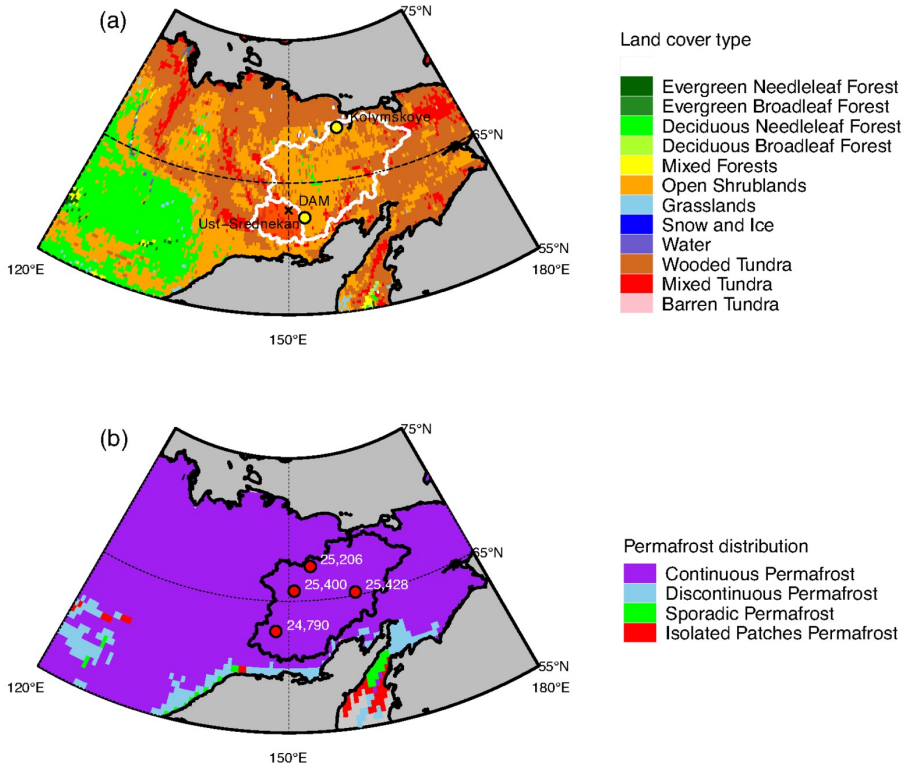
remote sensing

MDPI

Article

Effect of Permafrost Thawing on Discharge of the Kolyma River, Northeastern Siberia

Kazuyoshi Suzuki [1,*], Hotaek Park [2], Olga Makarieva [3,4], Hironari Kanamori [5], Masahiro Hori [6], Koji Matsuo [7], Shinji Matsumura [8], Nataliia Nesterova [3,4] and Tetsuya Hiyama [5]



Model

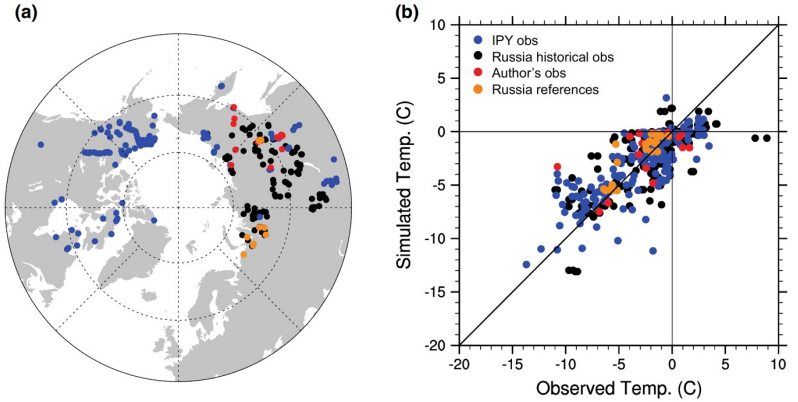
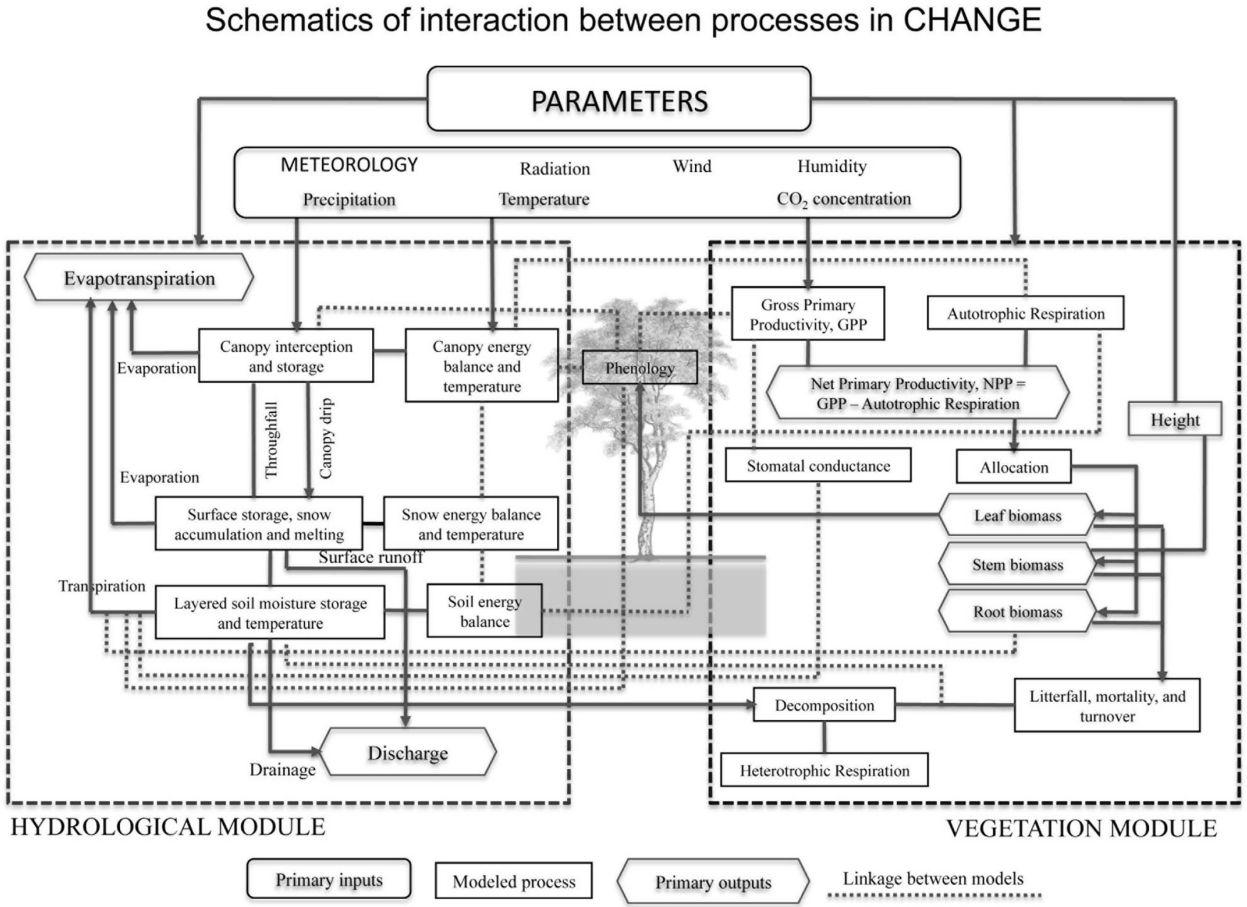


Fig. 4 **a** A map showing the locations of borehole sites used for **b** the comparison between borehole observations and simulated temperatures at depths deeper than 10 m

Park et al. (2015)



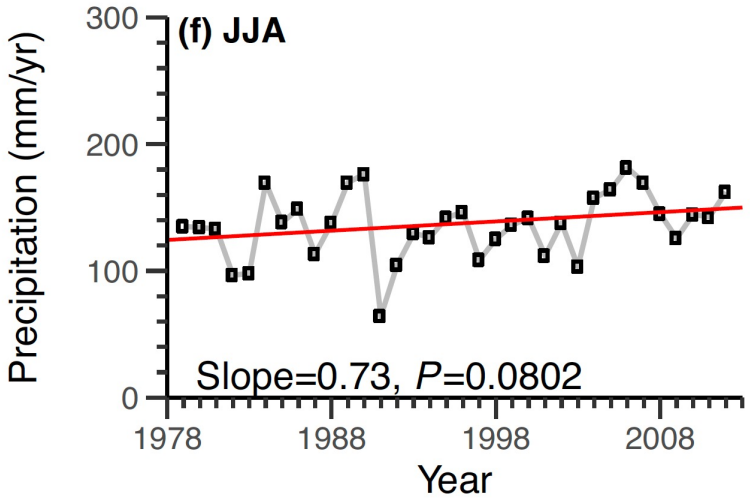
Park et al. (2011)

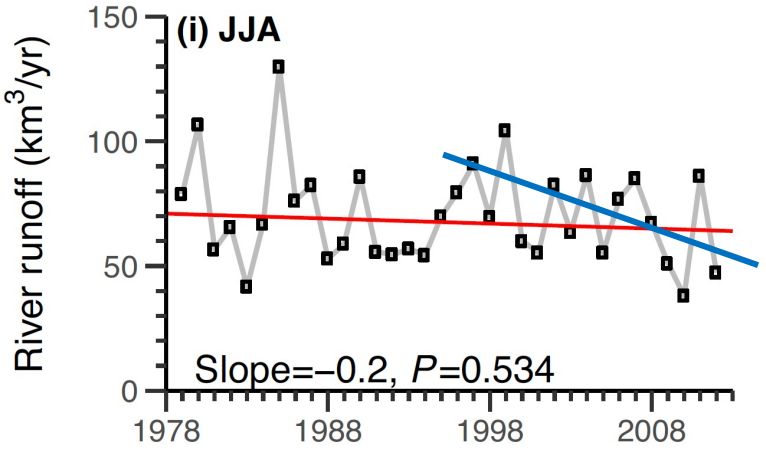
Model validation

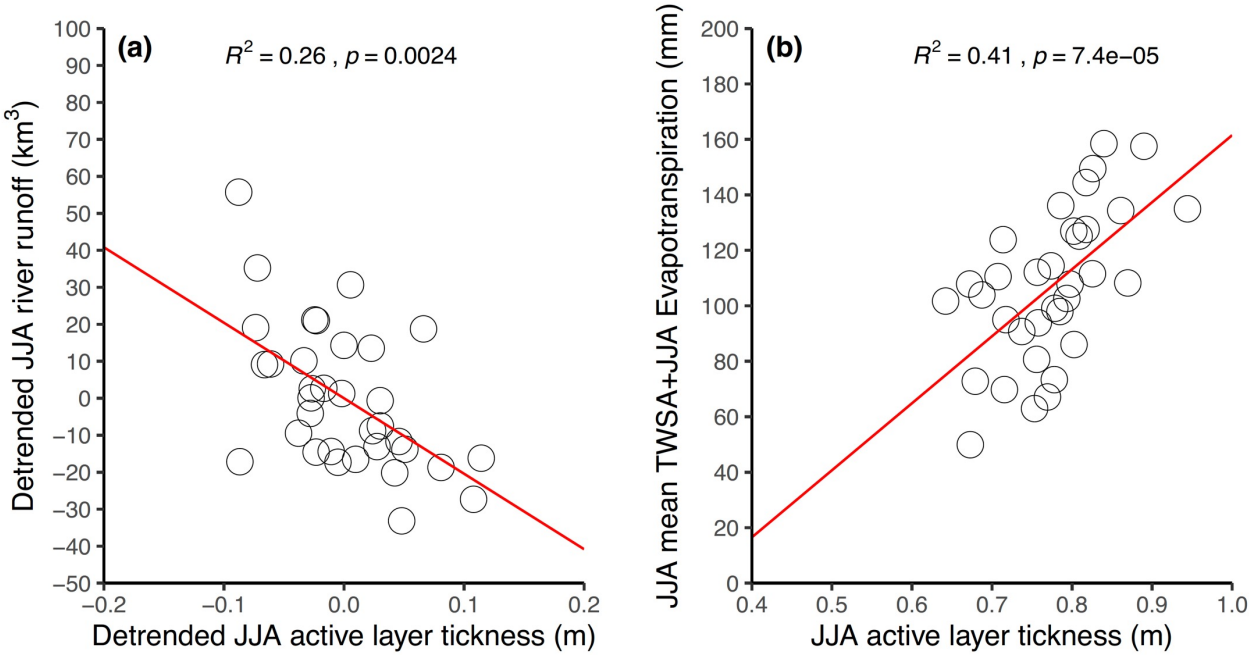
Table 2. List of long-term monthly model performance against satellite-based observation datasets.

Model	TWSA April 2002 to December 2012			Snow Cover Fraction January 1979 to December 2012		
	Root Mean Square Error (mm)	Nash–Sutcliffe Efficiency	R^2	Root Mean Square Error	Nash–Sutcliffe Efficiency	R^2
CHANGE	37.3	0.35	0.66	0.19	0.81	0.84

Summer river runoff



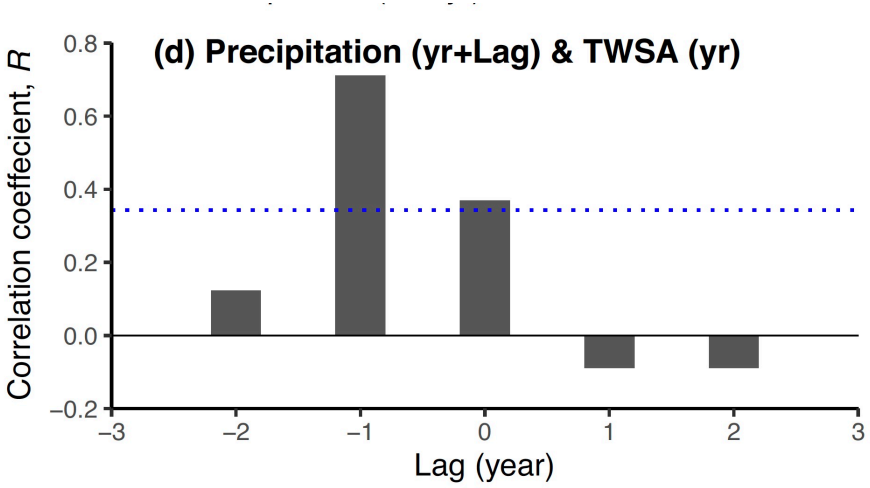


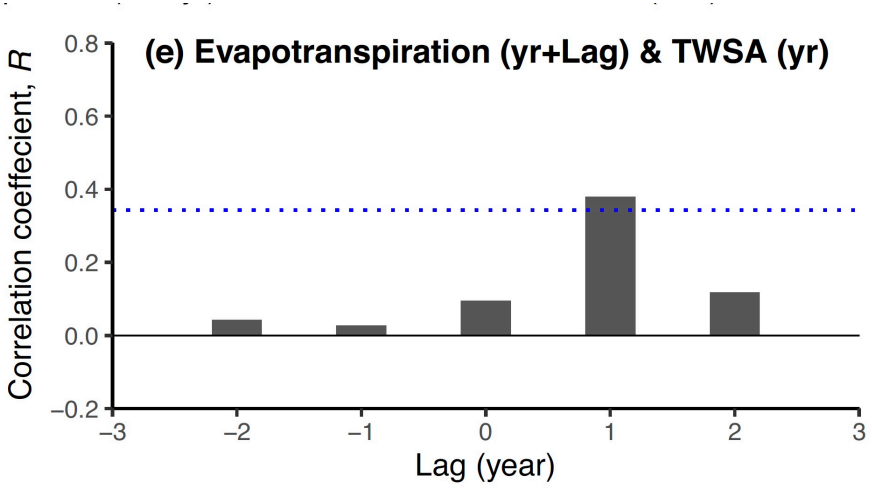


P=R+E+ΔTWSA
R=P–(E+ΔTWSA)

Figure 14. Relationship between (**a**) detrended June–August (JJA) river runoff and detrended JJA ALT and (**b**) Relationship between JJA TWSA and JJA evapotranspiration and JJA active layer thickness (ALT).

2 years' lag correlation Precipitation-Evapotranspiration





Conclusions

- We revealed that the Kolyma River basin experiences a decrease in river runoff, particularly during the summer. As the active layer thickens, the water storage capacity of the basin increases, which contributes to the increase in evapotranspiration, thereby reducing soil water stress to plants. By increasing TWSA and E, the runoff volume has slightly decreased despite the increase in precipitation.
- We identified a two-year lag between precipitation and evapotranspiration via TWSA. There was one-year lag correlation between the preceding year's precipitation and the target year's TWSA, whereas another one-year lag existed between the preceding year's TWSA and the target year's evapotranspiration.

Development of global hydrological monitoring system using GCOM-W retrievals 3 years' summary

- ✓Development of a coupled global atmosphere-land surface data assimilation system (mlef-GWRF) (completed) *To be submitted*
- ✓Comparison and validation of AMSR2 retrieval with land surface model estimation (completed) *Published*
- ➢Data assimilation of AMSR2 brightness temperature using the JAXA Joint-simulator microwave radiative transfer model (ongoing)
- ➢Data assimilation of AMSR2 retrieval products (snow depth, soil moisture and total precipitable water) (ongoing)