Conclusions & Future Directions

Land surface data assimilation has been demonstrated and has great potential, but many open areas of research remain, including:

(i) Better quantify and use model and observation errors;
(ii) Create model independent data assimilation algorithms that can account for non-linear land models;
(iii) Optimize data assimilation computational efficiency for use in large operational hydrological applications;
(iv) Use forward models to enable the assimilation of remote sensing radiances directly;
(v) Link model calibration and data assimilation to optimally use available observation information;
(vi) Create multivariate hydrologic assimilation methods to use multiple complementary observations;
(vii) Quantify the potential of data assimilation diversifying;
(viii) Create methods to extract the primary information content from redundant/overlapping observations.

Recent advances in understanding of land physical processes, satellite observing systems, and economical computing power, enables us to operationally merge model predictions and observations using data assimilation to address critical hydrologic issues. In the future, we must develop a comprehensive land data assimilation framework using a patch-based, bias-correcting, parameter-optimized local ensemble Kalman filter that is applicable for use in practical large-scale, high-resolution land-surface applications, taking the following steps:

(1) Develop the land data assimilation theory and framework to enable the multi-variate assimilation of relevant remote-sensing observations, using recently developed Kalman filter assimilation tools that allow propagation of subgrid variability in land surface models, while also practically imposing remote-sensing constraints at larger scales in an operational framework.
(2) Implement the framework in off-line setting that will provide value-added assimilated data products for use in satellite removal algorithms, as initial conditions to enable improved earth system model predictions, and that will enable Observing System Experiments (OSEs) and Observing System Simulation Experiments (OPSEs) to guide the development of future observing systems.
(3) Integrate this land assimilation framework into coupled Earth System Models(s). It is well known that the high-resolution time and space complexity of land surface phenomena have significant interaction with atmospheric, biogeochemical, and oceanic processes.

Literature cited


Acknowledgments

I thank the NEWS team and contributors, including Bob Schiffer, Bill Lapenta, Bill Rossow, Adam Schlosser, Eric Njoku, Bing Liu, Debrah Delwiche, Jared Ericks, and Pierre Morel for assistance in producing the graphics and helpful discussions. Funding for this work was provided by the National Aeronautics and Space Administration.