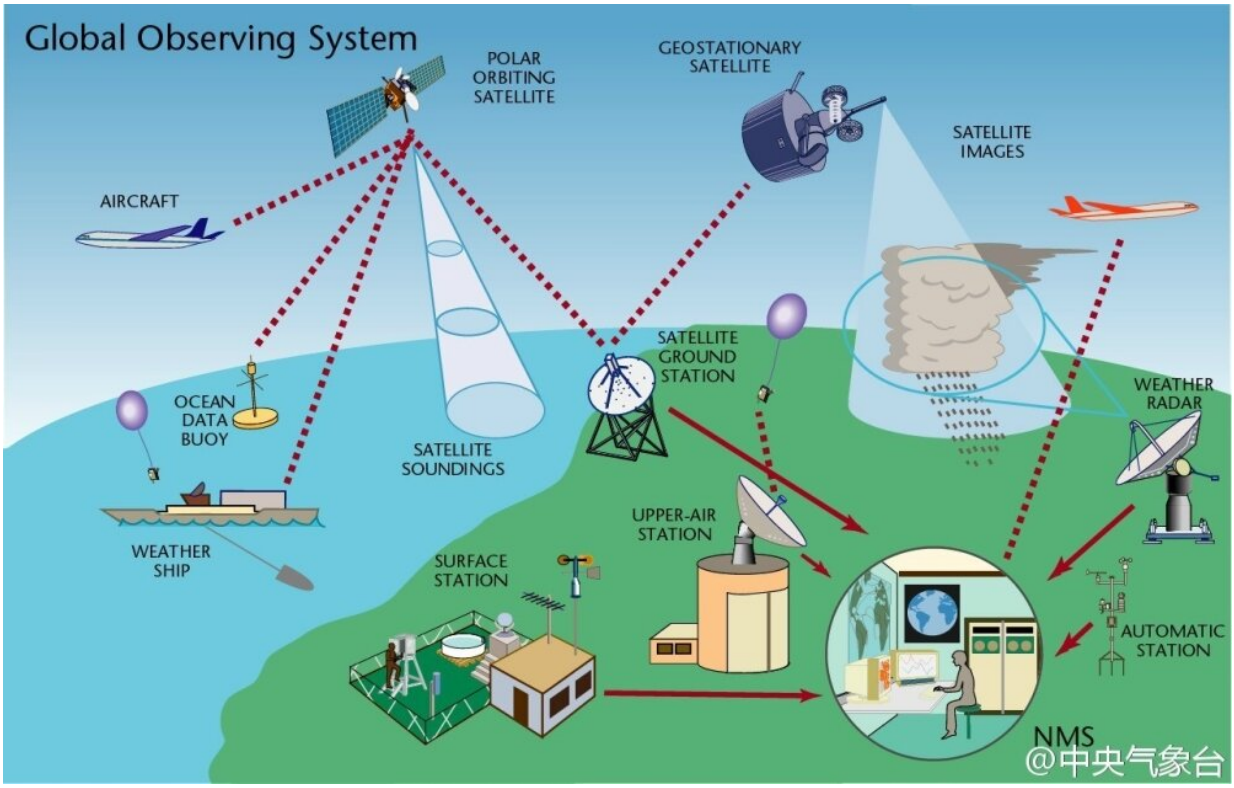
A new data assimilation system to improve precipitation forecast

October 22 2020, by Li Yuan



The global observing system

Data assimilation systems can provide accurate initial fields for further improving numerical weather prediction (NWP). Since 2008, Tian Xiangjun and his team at the Institute of Atmospheric Physics (IAP) of the Chinese Academy of Sciences have been devoted to developing the

nonlinear least-squares 4-D ensemble variational data assimilation method (NLS-4DVar).

NLS-4DVar methods have been used for solving real-world applications including land data assimilation, NWP data assimilation, atmospheric-chemistry data assimilation, and targeted observations.

Recently, TIAN's team has developed a new forecasting system—the System of Multigrid Nonlinear Least-squares Four-dimensional Variational (NLS-4DVar) Data Assimilation for Numerical Weather Prediction (SNAP). The study was published in *Advances in Atmospheric Sciences* on Oct. 9.

SNAP is built upon the multigrid NLS-4DVar data assimilation scheme, the operational Gridpoint Statistical Interpolation (GSI)-based data-processing and observation operators, and the widely used Weather Research and Forecasting numerical model.

The multigrid NLS-4DVar assimilation framework is used for the analysis, which can adequately correct errors from large to small scales and accelerate iteration solutions. The analysis variables are model state variables, rather than the control variables adopted in the conventional 4DVar system.

Currently, the team has achieved the assimilation of conventional and radar observations, and will continue to improve the assimilation of satellite observations in the near future.

"We carefully designed several groups of real experiments, including one case and one-week cycling assimilation experiments, in order to comprehensively evaluate SNAP in this study," the Tian team wrote in their study.

The numerical results demonstrated that, in terms of the precipitation intensity, SNAP could fully absorb observations and improve the initial fields, thereby improving the precipitation forecast. In particular, compared with GSI 4DEnVar, SNAP produces slightly lower forecast root-mean-square errors (RMSEs) and more positive relative percentage improvement (RPI) as a whole.

"The emergence of SNAP provides a promising way with a sound theoretical basis for data assimilation in NWP to significantly improve the forecast skills in an era where the number of observations, especially from remote sensing techniques, is significantly increasing," said Tian. "It is of great importance and practical application to explore more sophisticated data assimilation methods and systems for improving the precision of both weather prediction and climate predictions in the big data era."

More information: Hongqin Zhang et al. System of Multigrid Nonlinear Least-squares Four-dimensional Variational Data Assimilation for Numerical Weather Prediction (SNAP): System Formulation and Preliminary Evaluation, *Advances in Atmospheric Sciences* (2020). DOI: 10.1007/s00376-020-9252-1

Provided by Chinese Academy of Sciences