DEVELOPING LAND DATA ASSIMILATION SYSTEM BASED ON ENKF, 3DVAR TECHNOLOGY AND COMMUNITY LAND MODEL

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1. INTRODUCTION

Land surface is an important interface that exchanges energy with atmosphere, which controlled by many key factors such as albedo, soil moisture, soil temperature, surface roughness, soil emissivity and more, where albedo and surface emissitivity will contribute to the energy redistribution, soil temperature may directly affect the sensible heat in land-atmosphere exchange and soil moisture controls the partitioning of the latent and sensible heat fluxes to the atmosphere, influencing precipitation recycling.

It is clear that land surface is crucial to weather and climate prediction, however, uncertainties may exist in land data and description on the land surface process. For better describing land surface process, the original bucket-type land surface model (Sellers, et. al., 1997) has been replaced by more physically based representations of the global soil–vegetation–atmosphere transfer system (Bonan, 1996). Now these key factors can be retrieved from the meteorological satellite observed radiation, how to reduce the land data uncertainties and how to better use the retrieved information into the models should be investigated.

On 27 May 2008, China has successfully launched the FY-3A meteorological satellite as a research and development (R&D) satellite, with 11 payloads mounted, which are Visible and InfraRed Radiometer (VIRR), MEdium Resolution Spectral Imager (MERSI), MicroWave Radiation Imager (MWRI), Total Ozone mapping Unit (TOU), InfraRed Atmospheric Sounder (IRAS), MicroWave Temperature Sounder (MWTS), MicroWave Humidity Sounder (MWHS), Solar Backscatter Ultraviolet Sounder (SBUS), Solar Irradiation Monitor (SIM), Earth Radiation Measurer (ERM) and Space Environment Monitor (SEM). FY-3A data and products are open to all users, and with its primary missions as following:
Globally sounding of 3-dimensional thermal and moisture structures of the Earth's atmosphere, its cloud pattern and other key parameters measurements such as precipitation, ozone, etc., to support global numerical weather prediction and environmental services;
Globally imaging of the Earth's surfaces to monitor large scale meteorological and/or hydrological disasters and biosphere environment;
Establish long-term environmental data sets with retrieving important geophysical parameters for climate monitoring and global predication and Earth sciences researches.

FY-3A meteorological satellite contains 3 earth observation instruments: Visible and InfraRed Radiometer (VIRR), MEdium Resolution Spectral Imager (MERSI) and MicroWave Radiation Imager (MWRI) , which will help to improve our understanding in land surface process and forecast skill to land surface temperature and moisture. Thus it is urgent to develop a routine land data assimilation system to combine the information from the observations and the model in an optimum way.

The Chinese Land Data Assimilation System (CLDAS) project aims at the construction and evaluation of a routine system for soil moisture and temperature initialization in NWP applications. It is partially inspired on the NSMC/CMA FY-3 Satellite system Project. This paper will present a brief overview of the structure of the CLDAS project.

Under the comprehensive considerations of observation error and model background error, land data assimilation strives to combine land model simulation and land surface data of different types with different spatial-temporal distributions and different error characteristics. Land data assimilation is a new field to take effort in due to the difficultly-delineated characteristics of land surface processes and land surface parameters, compared to atmosphere and ocean data assimilation, however, the successful concepts and skills in Atmosphere Data Assimilation System (ADAS) and Ocean Data Assimilation System (ODAS) can be applied in LDAS.

Based on its own characteristics of LDAS and the successful experience of ADAS and ODAS, considering data feature of land surface parameters retrieved from the meteorological satellite observation, we design Land Data Assimilation Scheme, introduce design framework and some detailed method and skill of ADAS and ODAS. The 3DVAR data assimilation scheme is adopted to assimilate observed surface temperature, wind speed, precipitation and retrieved FY2 precipitation and solar incident radiance to obtain the land forcing data; The EnKF data assimilation scheme is taken to assimilate observed the soil temperature, soil moister, satellite retrieved surface soil moisture, satellite retrieved surface moisture, Infrared window channel radiance and MWRI radiance data, emissivity etc.

The Chinese Land Data Assimilation Systems (LDAS) based on EnKF, 3Dvar Technology and Community Land Model, has been developed at NSMC/CMA. In the context of numerical weather prediction applications, LDAS can provide optimal estimates of land surface state initial conditions, such soil moisture and soil temperature, by integrating with an ensemble of land surface models, the available atmospheric forcing data, remotely sensed observations of precipitation, radiation and some land surface parameters such as land cover and leaf area index. The validation from Xilinhaote comprehensive experiment site, which was designed to calibrate and validate synchronic observation of FY-3A satellite, not only with the normal meteorological observation, such as, soil temperature, soil moisture, flux etc, but also with the special observation, such radiance observation from the visible spectral to microwave, indicates that the preliminary results obtained are still inspiring. There are still many detailed work to do for the routine operation of CLDAS, such as how to get dynamic P in 3dvar, how to select the spacing interpolation algorithm, etc.

This paper is organized as following, Section 2 provides a summary of model and design frame of data assimilation scheme, in Section 3, the construction of observation operator and other related are discussed, and in Section 4, we demonstrate its validity and usability by a single site test. Finally, the main conclusions are discussed in Section 5.