Development of a New Land-surface Model for JMA-GSM

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In 1989, a SiB (Simple Biosphere) model was developed as a land-surface scheme for JMA's operational global NWP model (JMA-GSM). However, the SiB model has not been modified substantially after that. Recently, problems considered to be relevant to the land-surface process were pointed out as follows:

* Snow-melting is overestimated in spring. In the Northern Hemisphere, the southern edge of the snow cover area retreats faster comparing with an analysis or observations.
* Warming bias in the lower troposphere on ice sheet area in summer.

In order to solve such problems, we have developed a new land-surface model, which treats soil and snow processes more accurately. Major changes are as follows:

* A conventional force restore method for predicting soil temperature is abandoned and heat conductivity among multiplied soil layers is explicitly calculated.
* Phase change of soil water is considered.
* Multiplied snow layers are introduced and phase change of snow water is considered.
* Snow cover is classified into two categories, "partial snow cover" and "full snow cover".
* A sophisticated snow process is introduced. (Aging of snow albedo, temporal changes of snow density and heat conductivity, keeping water in snow layers and so on.)

We carried out preliminary forecast experiments for April 2002 with JMA-GSM T213L40. Initial condition of soil water for the experiments is set to a model-climate state obtained from a long-term integration of the model, while the operational SiB uses a climate state by Willmott et al. (1985).

The snow cover area for 72 hour forecast (FT72) initiated at 12 UTC April 15, 2002 (validtime is 12UTC April 18, 2002) is shown in Fig. 1. A snow cover area at the Tibetan Plateau is well predicted by the new land-surface model, while not by the operational one. Comparing with the snow cover area estimated from the brightness temperature of SSM/I (See Fig. 2.), the new land-surface model simulates better than the operational one in this region.

Time series of forecast results of sensible and latent heat fluxes and snow depth at a point in the Tibetan Plateau (35N, 90E) are shown in Fig. 3. The new land-surface model well simulates that sensible heat flux decreases reasonably after snow cover forms on the day 2. Instead, latent heat flux increases because of snow sublimation. Net short-wave radiation decreases about 150 W/m^2 and net long-wave radiation increases due to snow cover (not shown).

As a result, it is shown that the new land-surface model properly represents snow process. However, southern edge of the snow cover area still retreats faster than an analysis or observations. Moreover, RMSE (Root Mean Square Error) of the temperature at 850 hPa in the Northern Hemisphere is not improved and a distinct negative bias appears by the new land-surface model.

We go on with development of the land-surface model, planing to put it into operation within a few years.

References

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Willmott, C. J., C. M. Rowe, and Y. Mintz, 1985: Climatology of the terrestrial seasonal water cycle. *J. Climatology*, **5**, 589-606.

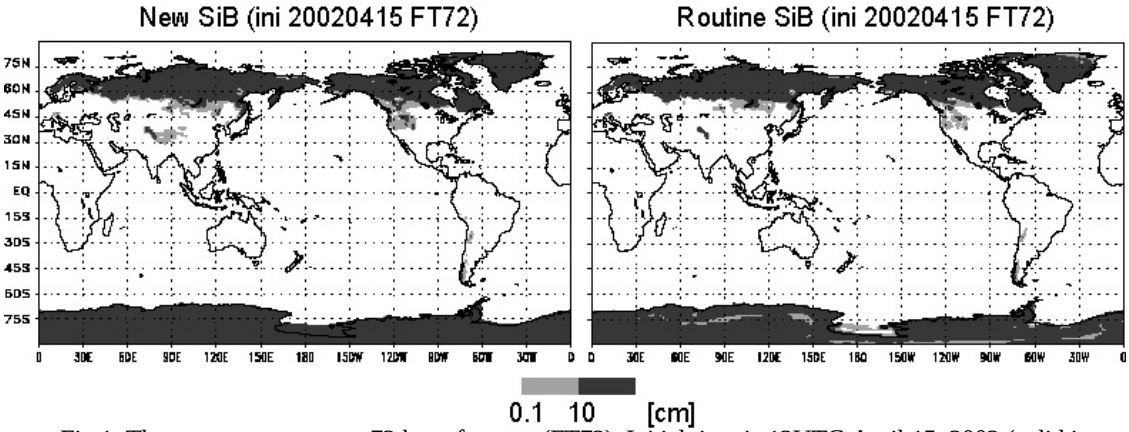

Fig 1. The snow cover area at 72 hour forecast (FT72). Initial time is 12UTC April 15, 2002 (validtime is 12UTC April 18, 2002). The left figure shows a result from the new land-surface model, and right one shows that from the operational one.

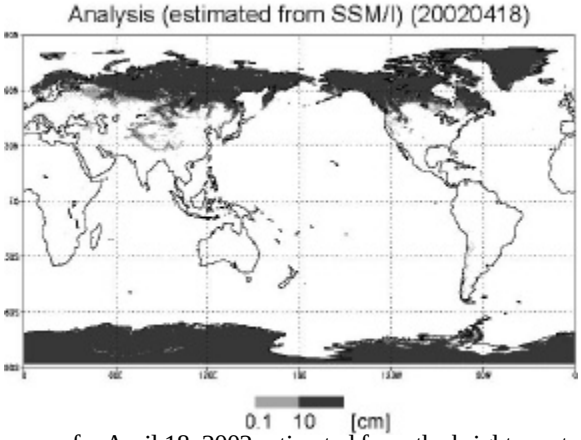

Fig 2. The snow cover area for April 18, 2002 estimated from the brightness temperature of SSM/I.

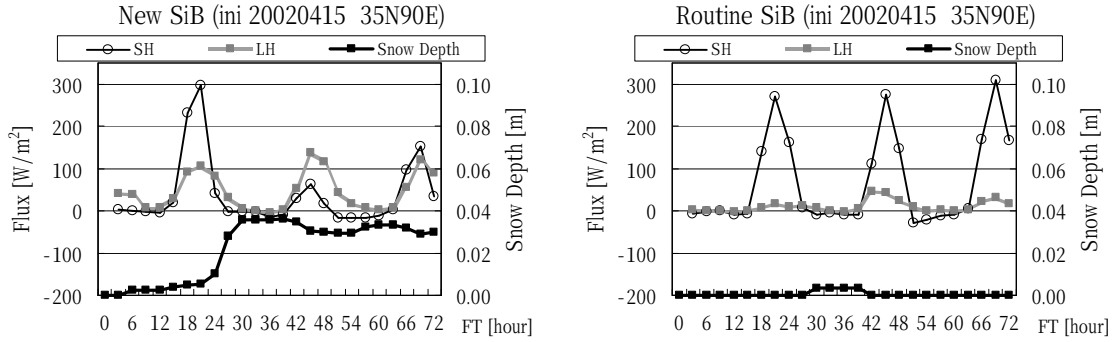

Fig 3. The time series of sensible and latent heat fluxes and snow depth at a point in the Tibetan Plateau (35N, 90E). The result from the new land-surface model is shown in left, and the operational model is in right.