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2 **Cumulative influence of summer sub-surface soil temperature on**  
3 **North America surface temperature in NCEP CFSv2**

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## 38 **Figures Caption:**

39 **Figure S1.** The spatial distributions of climatological seasonal mean of March to May (MAM) of  
40 H850 in (a) CFSR, (b) CFSv2 simulation and (c) climatological H850 biases relative to CFSR over  
41 the North America region. The scale for the magnitude for climatology (bias; gpm) of H850 is  
42 shown below these panels. (d)-(f) as in (a)-(c) but for MAM 850hPa-winds (m/s). The scale for the  
43 magnitude for climatology (bias) of 850hPa-winds is shown at left (right) of these panels. Spatial  
44 distributions of climatological MAM rainfall (mm/day) in (g) CMAP, (h) CFSv2 simulation and (i)  
45 climatological rainfall biases relative to CMAP. The scale for the magnitude for climatology (bias)  
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47 **Figure S2.** The spatial distributions of climatological seasonal mean of July to September (JAS) of  
48 H850 in (a) CFSR, (b) CFSv2 simulation and (c) climatological H850 biases relative to CFSR over  
49 the North America. The scale for the magnitude for climatology (bias; gpm) of H850 is shown  
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53 rainfall biases relative to CMAP. The scale for the magnitude for climatology (bias) of rainfall is  
54 shown at left (right) of these panels.

55 **Figure S3.** (a) Spatial distribution of seasonal mean July to September (JAS) climatological ERA-  
56 Interim surface sensible heat flux (SSHF;  $W/m^2$ ) over the North America. The scale for the  
57 magnitude for climatology of SSHF is shown at left of this figure. (b) The spatial distribution of  
58 climatological biases relative to SSHF ERA-Interim in model simulation during JAS. The scale for  
59 the magnitude for climatological bias of SSHF is shown at right of this figure. (c) as in (a) but for  
60 ERA-Interim surface latent heat flux (SLHF;  $W/m^2$ ). (d) as in (b) but for SLHF in model simulation.

61 **Figure S4.** Spatial distribution of the climatological observed CERES-EBAF SCF SCF [%] in (a)  
62 Oct, (b) Nov, (c) Dec, (d) FEB, (e) MAR, (f) APR, (g) May and (h) Jun over the North America  
63 continent. The scale for the magnitude of SCF in “%” is shown below these panels. (i)-(p) as in (a)-  
64 (h) but for GLDAS-2.0 SWE [ $kg/m^2$ ]. The scale for the magnitude of SWE in “ $kg/m^2$ ” is shown right  
65 of these panels (1<sup>st</sup>). (q)-(x) as in (a)-(h) but for CERES-EBAF Surface Albedo (SA). The scale for  
66 the magnitude of bias for SA in “%” is shown at right of these panels (2<sup>nd</sup>).

67 **Figure S5.** Spatial distributions of monthly SWE [ $kg/m^2$ ] climatological biases relative to reanalysis  
68 (GLDAS-2.0) in CFSv2 simulation for (a) Oct, (b) Nov, (c) Dec, (d) Feb, (e) Mar, (f) Apr, (g) May  
69 and (h) Jun over the North America continent. Monthly SCF climatological biases relative to  
70 observation in FIR for (i) Feb, (j) Mar, (k) Apr, (l) May and (m) Jun. Monthly SCF climatological  
71 biases relative to observation in MIR for (n) May and (o) June.

72 **Figure S6.** Spatial distributions of monthly Surface Albedo climatological biases relative to  
73 CERES-EBAF Surface Albedo (SA) in CFSv2 simulation for (a) Oct, (b) Nov, (c) Dec, (d) Feb, (e)  
74 Mar, (f) Apr, (g) May and (h) Jun. Monthly SA climatological biases relative to observation in FIR  
75 for (i) Feb, (j) Mar, (k) Apr, (l) May and (m) Jun. Monthly SA climatological biases relative to  
76 CERES-EBAF SA in MIR for (n) May and (o) June.

77 **Figure S7.** Spatial distribution of the climatological NOAA OISST v2 [ $^{\circ}C$ ] in (a) SEP, (b) OCT, (c)  
78 NOV, (d) DEC, (e) FEB, (f) MAR, (g) APR and (h) MAY over the Northern Atlantic Ocean. The

79 red lines in all the panels depict 0 °C (freezing temperature) in NOAA OISST v2. **(i)-(p)** as in (a)-(h)  
80 but for model simulation. (q)-(t) as in (e)-(h) but for FIR. The black line in all the panels depicts  
81 freezing temperature in simulation and reforecasts.

82 **Figure S8.** Spatial distribution of monthly climatological CFSR SUBT at 0-10cm [°K] in **(a)** Jul, **(b)**  
83 Aug and **(c)** Sep. The scale for the magnitude for SUBT in °K is shown at right of these panels. Both  
84 red and black lines in all the panels depict 273.15 °K for CFSR (red line) and CFSv2 (black line).  
85 **(d)-(f)** as in (a)-(c) but for SUBT at 10-40cm. **(g)-(i)** as in (a)-(c) but for SUBT at 40-100cm. **(j)-(l)**  
86 as in (a)-(c) but for SUBT at 100-200cm.

87 **Figure S9.** Spatial distributions of monthly climatological LST biases relative to CFSR in CFSv2  
88 simulation over the North America continent for **(a)** Apr, **(b)** May and **(c)** Jun. Both red and black  
89 lines in all the panels depict 273.15 °K (freezing temperature) for CFSR (red line) and CFSv2  
90 simulation (black line). **(d)-(e)** as in (a)-(c) but for SUBT at 0-10cm. **(d)-(e)** as in (a)-(c) but for  
91 SUBT at 10-40cm. **(d)-(e)** as in (a)-(c) but for SUBT at 40-100cm. **(d)-(e)** as in (a)-(c) but for SUBT  
92 at 100-200cm.

93 **Figure S10.** Difference between mean of five cold years and warm years of SUBT at 100-200cm  
94 over the America (outlined by green box in Figure 9; 44°N-58°N, 275°E-298°E) during July to  
95 September mean (JAS) in the CFSv2 simulation. **(b)** as in (a) SUBT at 0-10cm during October. The  
96 red line (black line) denotes 273.15°K in cold year (warm year) in CFSv2. **(c)** as in (a) but for LST  
97 during October. **(d)** as in (a) but for SCF during October. **(e)-(h)** as in (a)-(d) but for CFSR  
98 reanalysis respectively.

99 **Figure S11.** **(a-e)** Spatial distribution of climatological bias for difference between subsurface  
100 SUBT at 100-200cm and SUBT 0-10cm relative to CFSR in FIR. **(f-i)** as in (a-e) but for MIR.

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102 **Figure S12.** **(a-f)** Spatial distributions of monthly surface sensible heat flux (SSHF; W/m<sup>2</sup>)  
103 climatological biases relative to reanalysis in model simulation during May to October over North  
104 America. **(g-l)** as in (a-f) but for net long wave radiation (LWR; W/m<sup>2</sup>). The net LWR is defined as  
105 difference between downward LWR and upward LWR. **(m-r)** as in (a-f) but for net short wave  
106 radiation (SWR; W/m<sup>2</sup>). The net SWR is defined as difference between downward SWR and upward  
107 SWR.

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109 **Figure S13:** **(a-f)** Spatial distributions of monthly LST climatological biases (February to July) of  
110 the NCEP CFSv2 February initialized reforecast (FIR; 1982-2009) relative to CRU 3.21 (1979-  
111 2008) over the North America continent, monthly means based on the daily average of 6-hourly  
112 instantaneous values (i.e., 00Z, 06Z, 12Z, and 18Z) in NCEP CFSv2 FIR. **(g-l)** Spatial distributions  
113 of monthly mean LST climatological biases of NCEP CFSv2 FIR relative to CFSR (1979-2008),  
114 monthly means based on the daily average of 6-hourly instantaneous values (i.e., 00Z, 06Z, 12Z, and  
115 18Z) in both reforecasts and reanalysis. **(m-r)** Spatial distributions of monthly LST climatological  
116 biases of CFSv2 FIR (1979-2008) relative to CFSR, monthly means based on the *instantaneous*  
117 fields at 00Z in both the CFSv2 FIR reforecasts and reanalysis.

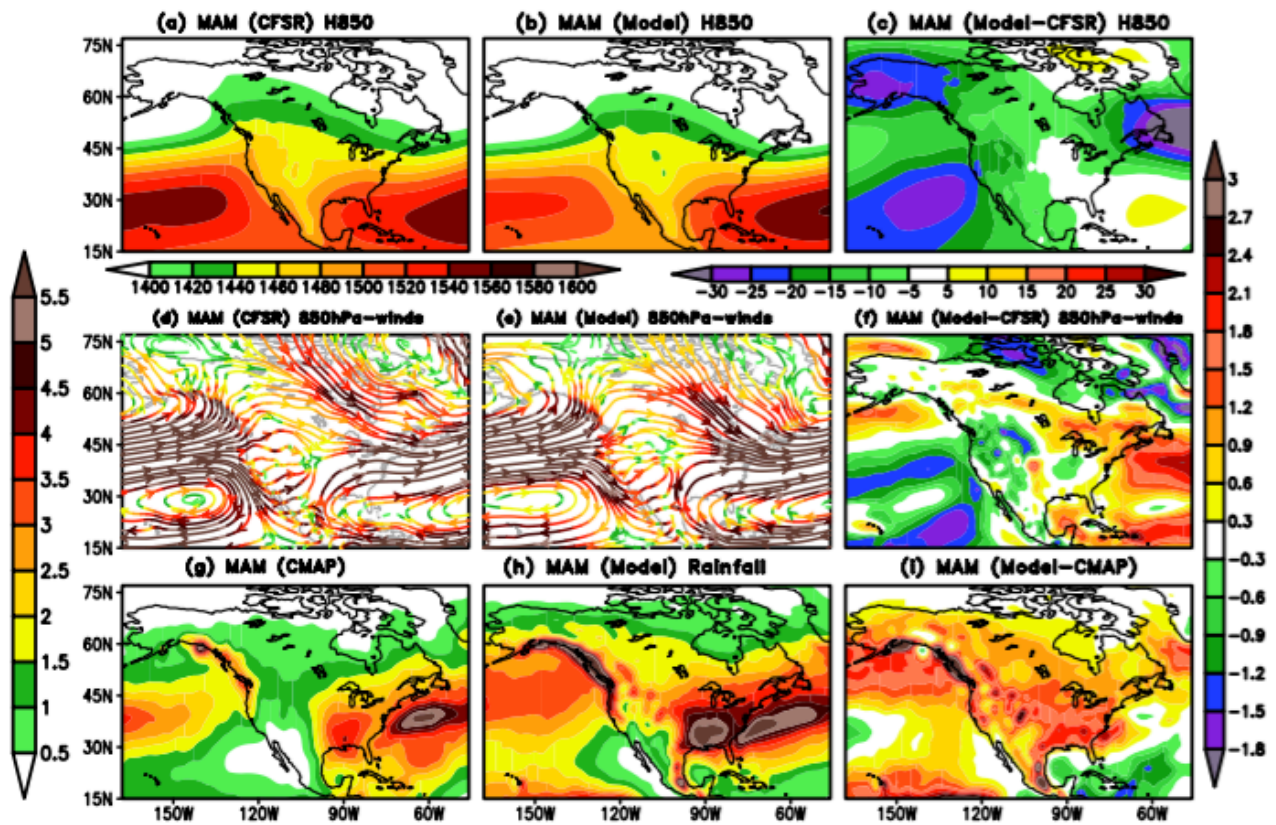
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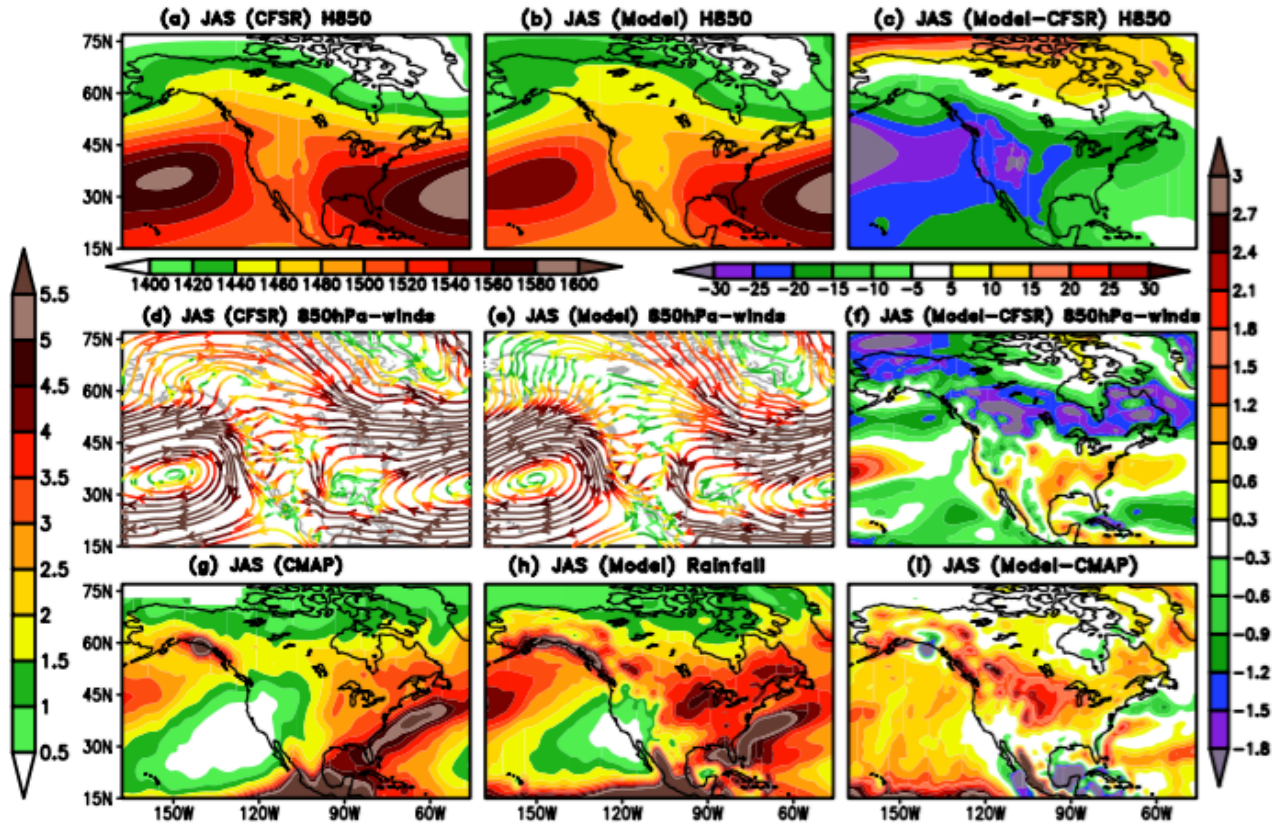
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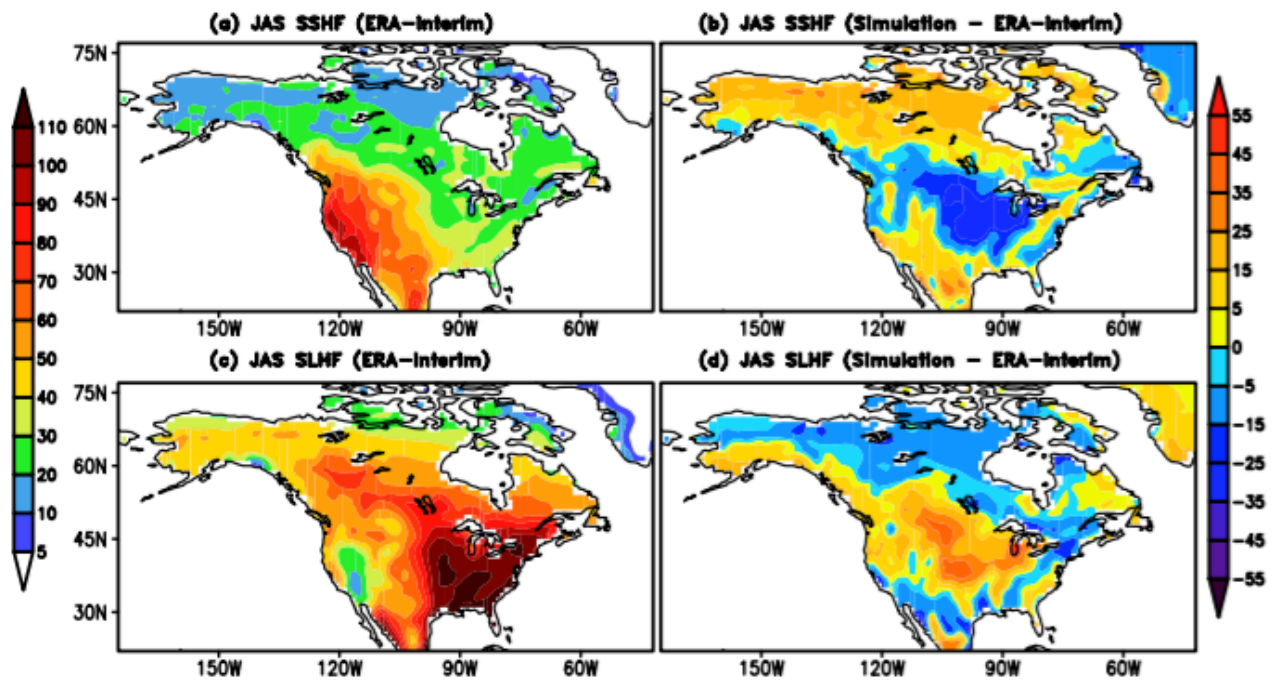


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143 **Figure S2.** The spatial distributions of climatological seasonal mean of July to September (JAS) of  
144 H850 in (a) CFSR, (b) CFSv2 simulation and (c) climatological H850 biases relative to CFSR over  
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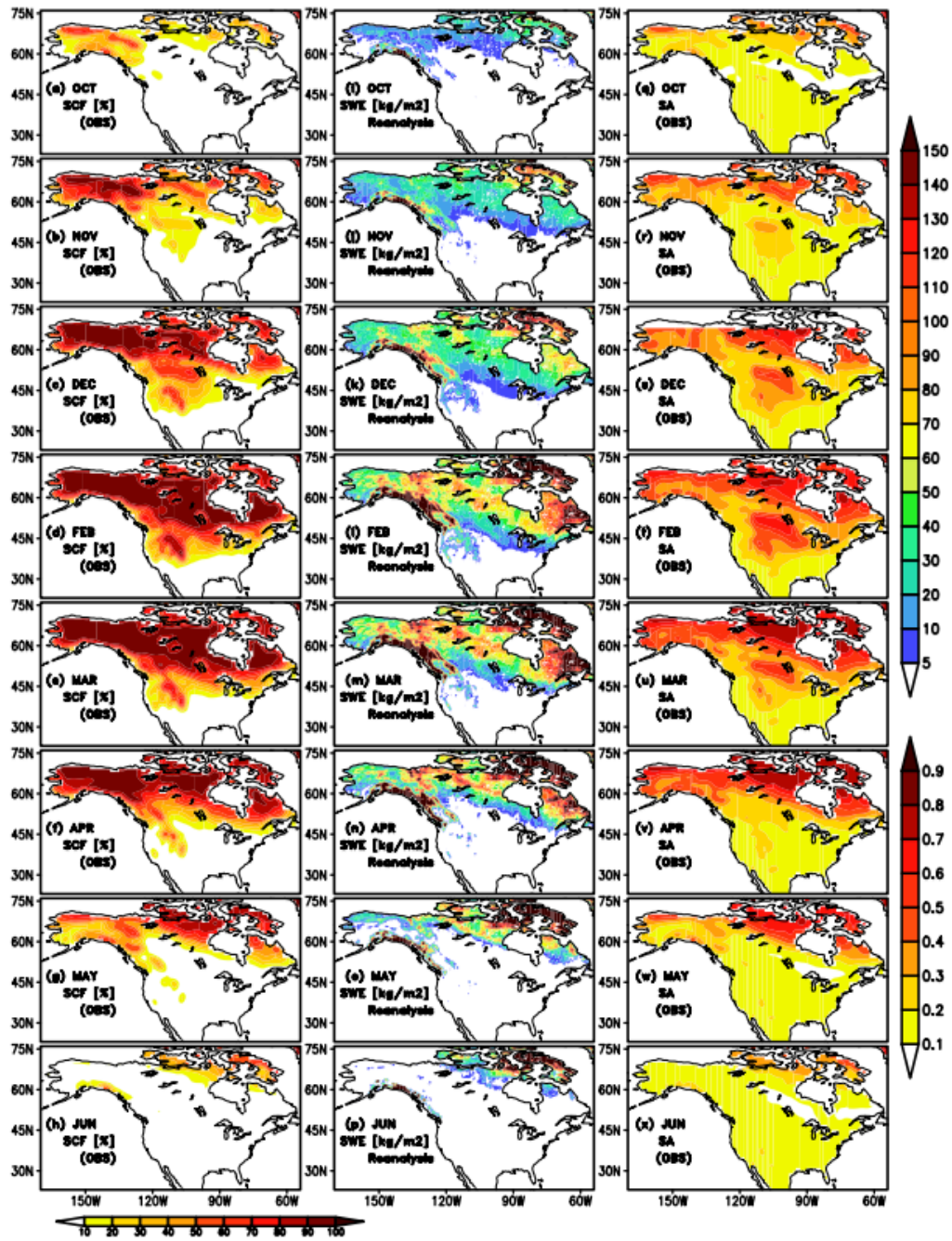
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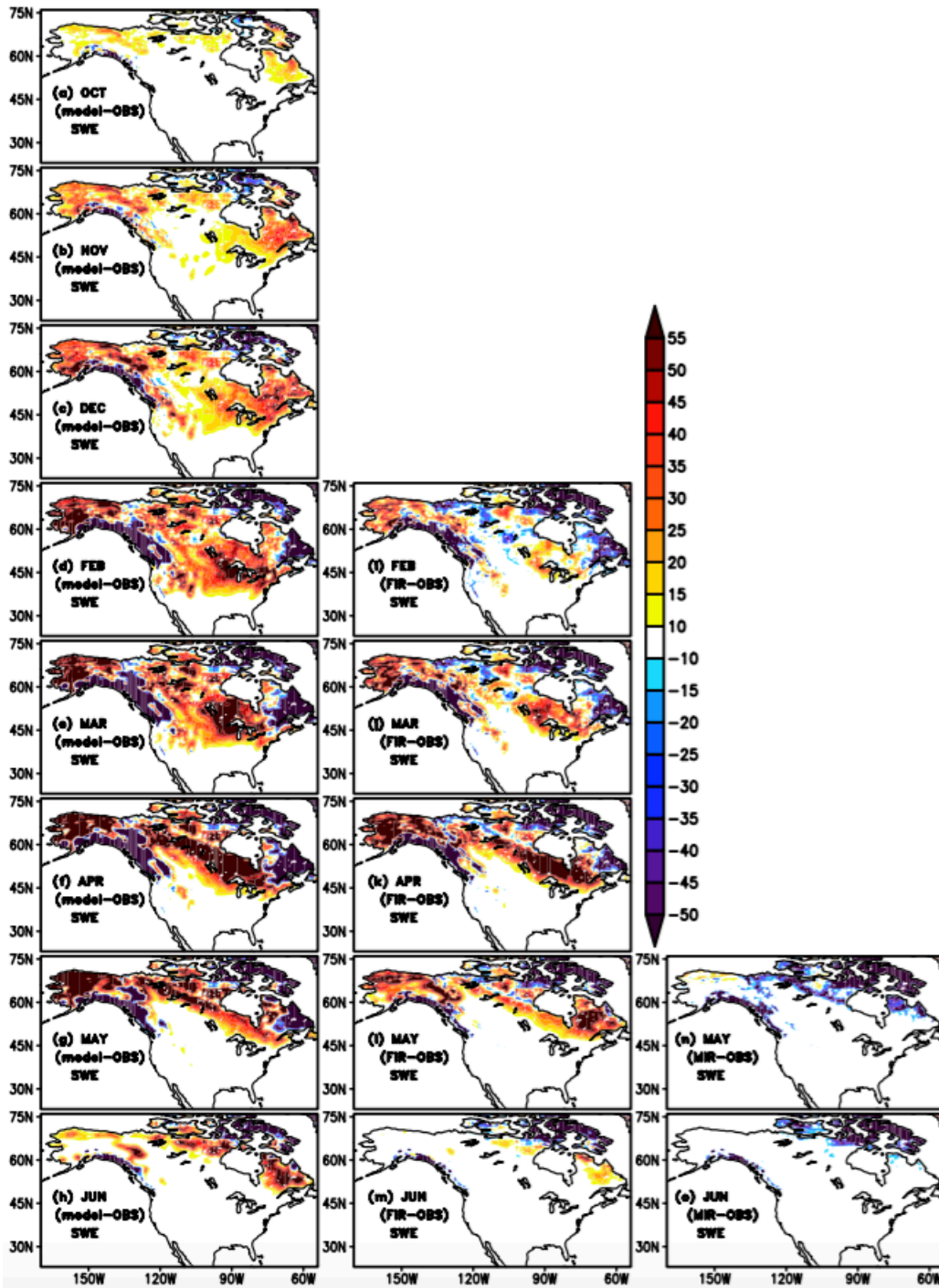


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175 **Figure S4.** Spatial distribution of the climatological observed CERES-EBAF SCF SCF [%] in (a)  
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 180 the magnitude of bias for SA in “%” is shown at right of these panels (2<sup>nd</sup>).

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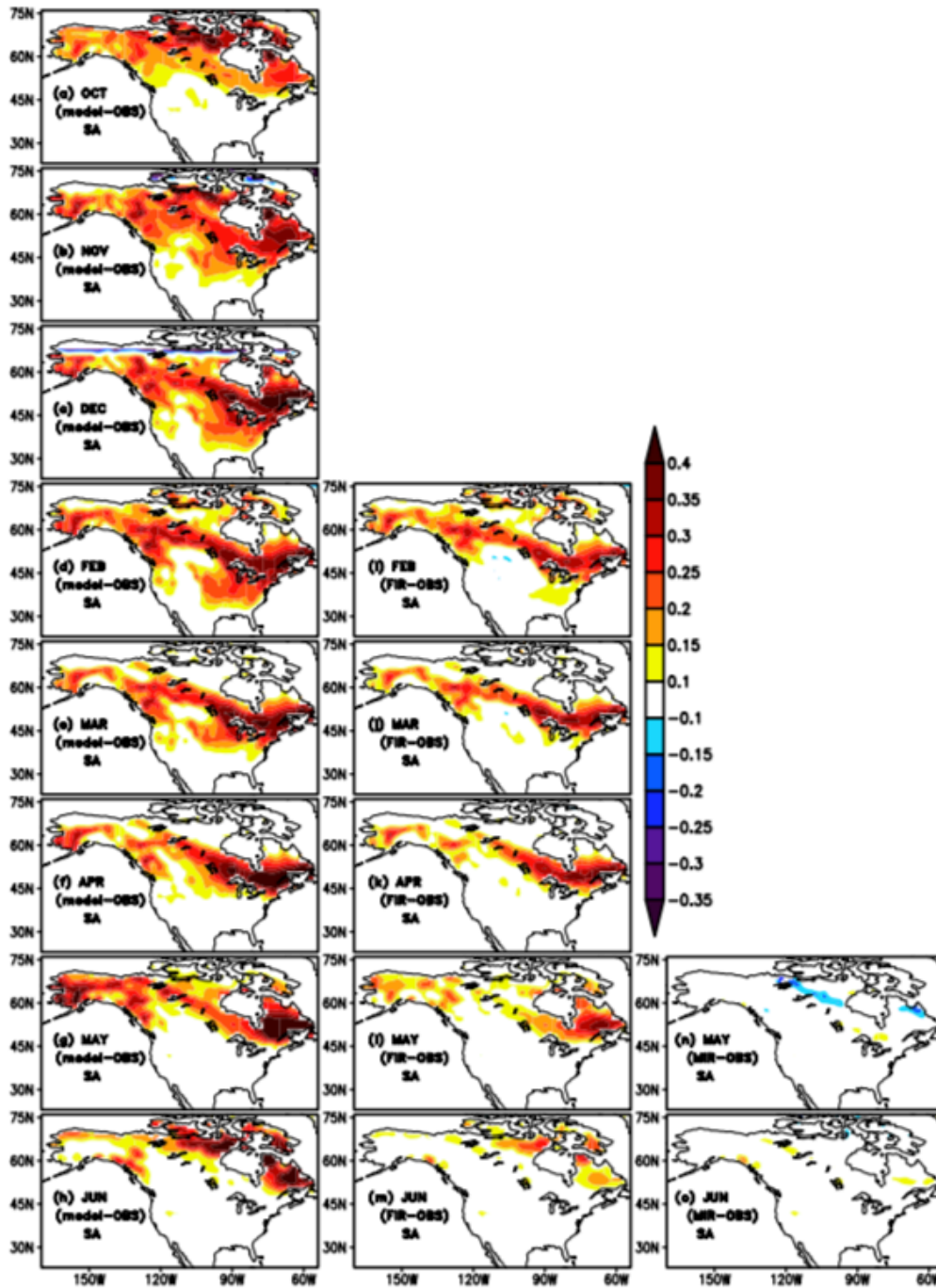
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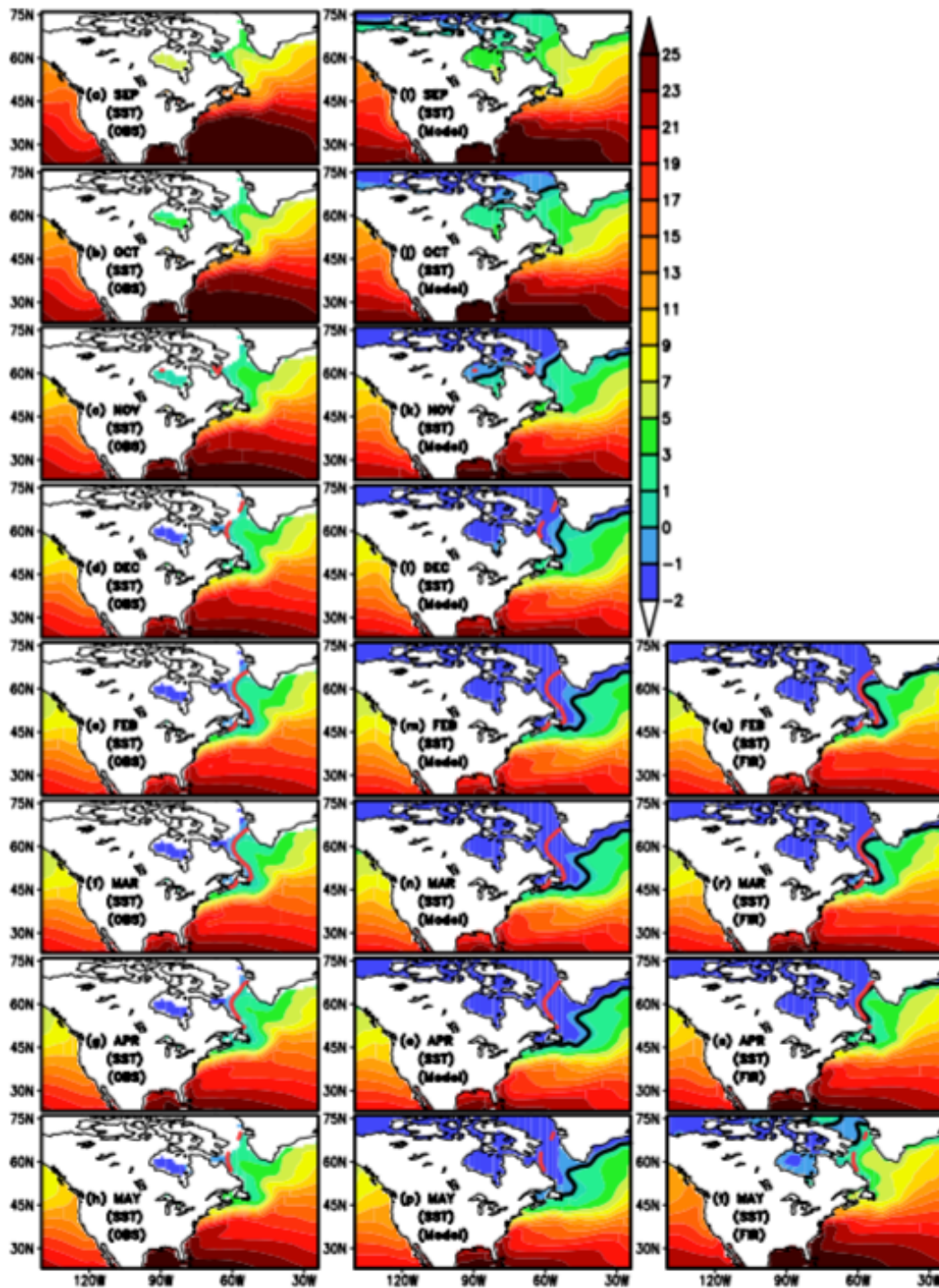
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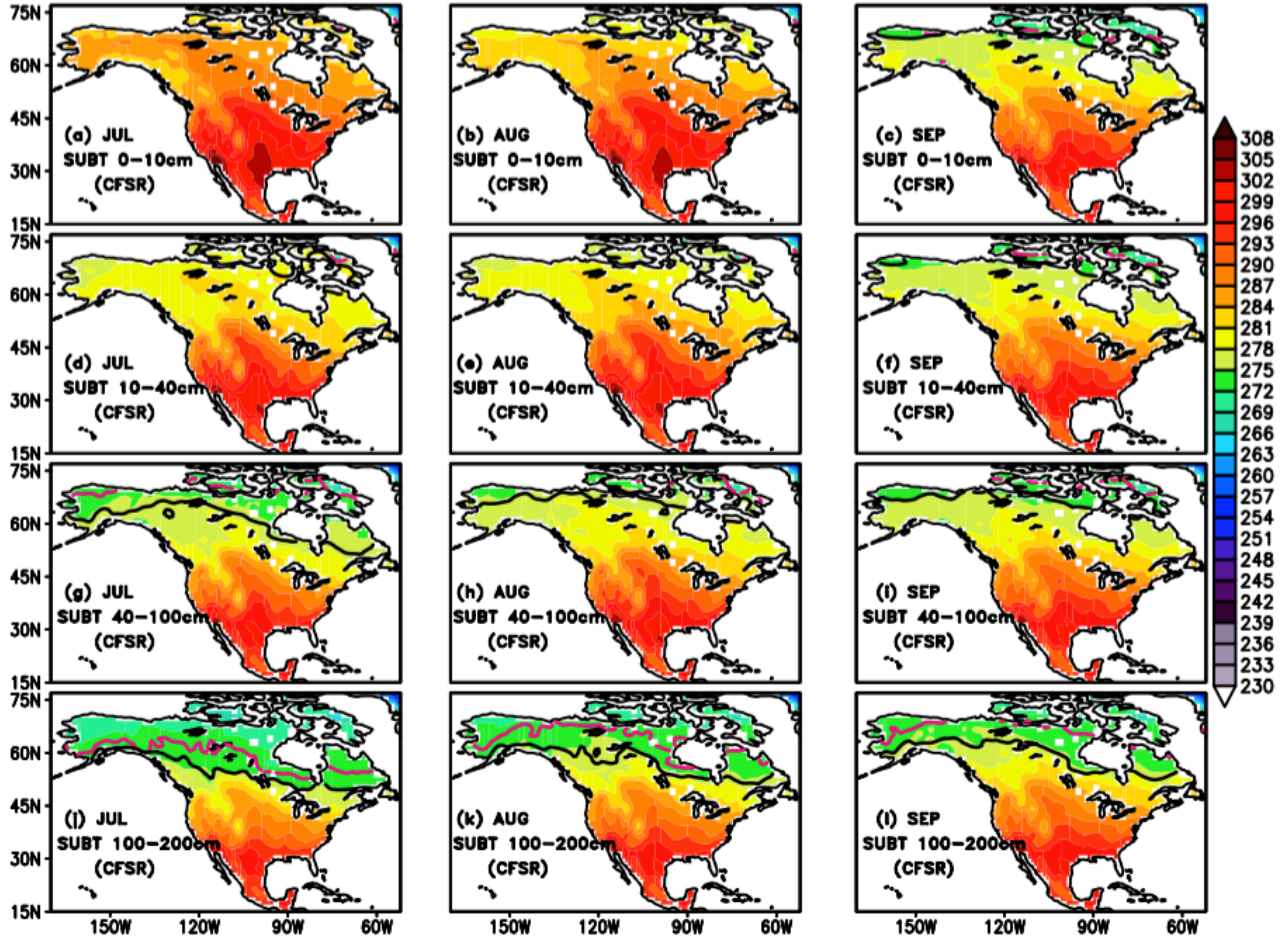
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196 CERES-EBAF SA in MIR for (n) May and (o) June.



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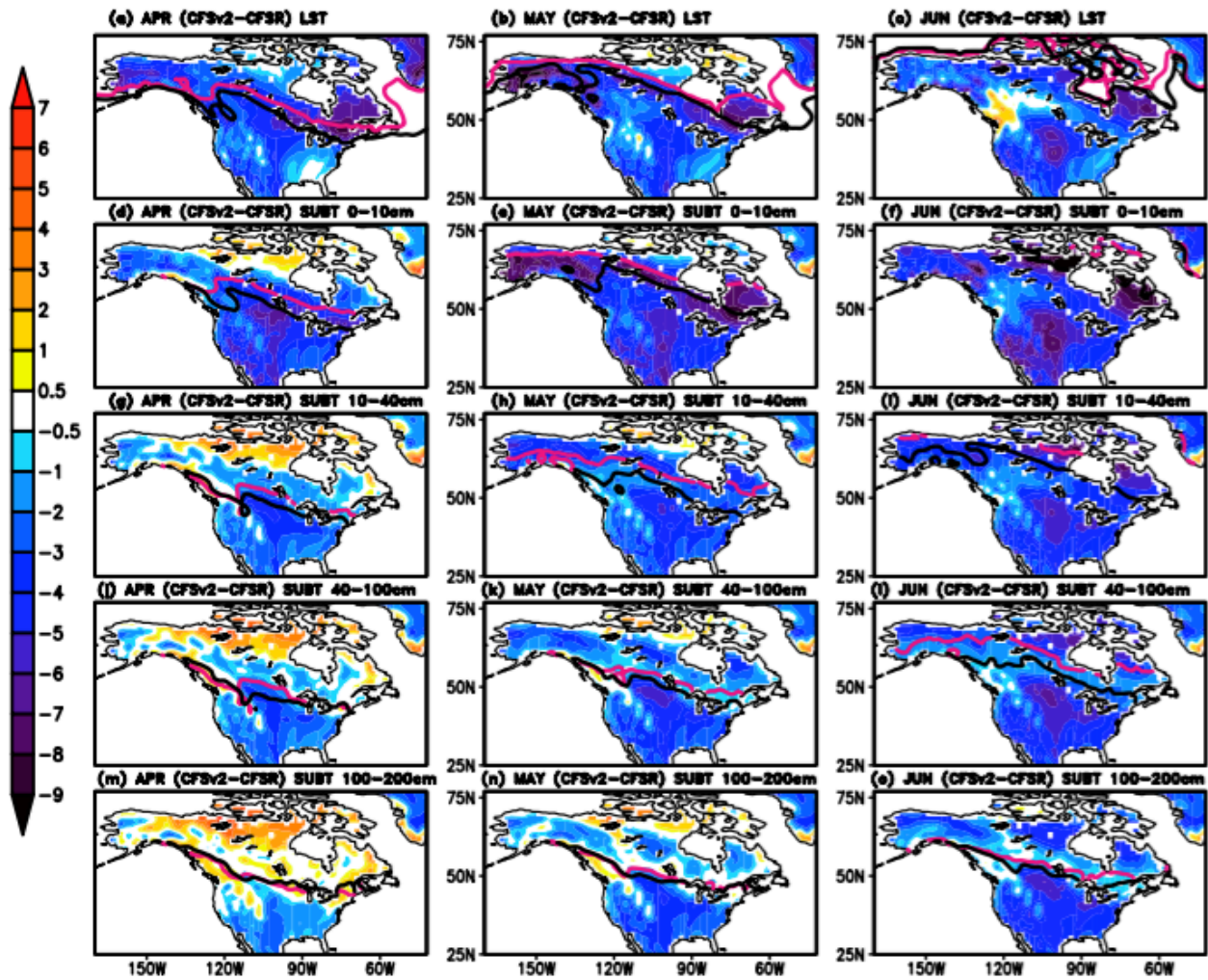
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221 **Figure S9.** Spatial distributions of monthly climatological LST biases relative to CFSR in CFSv2  
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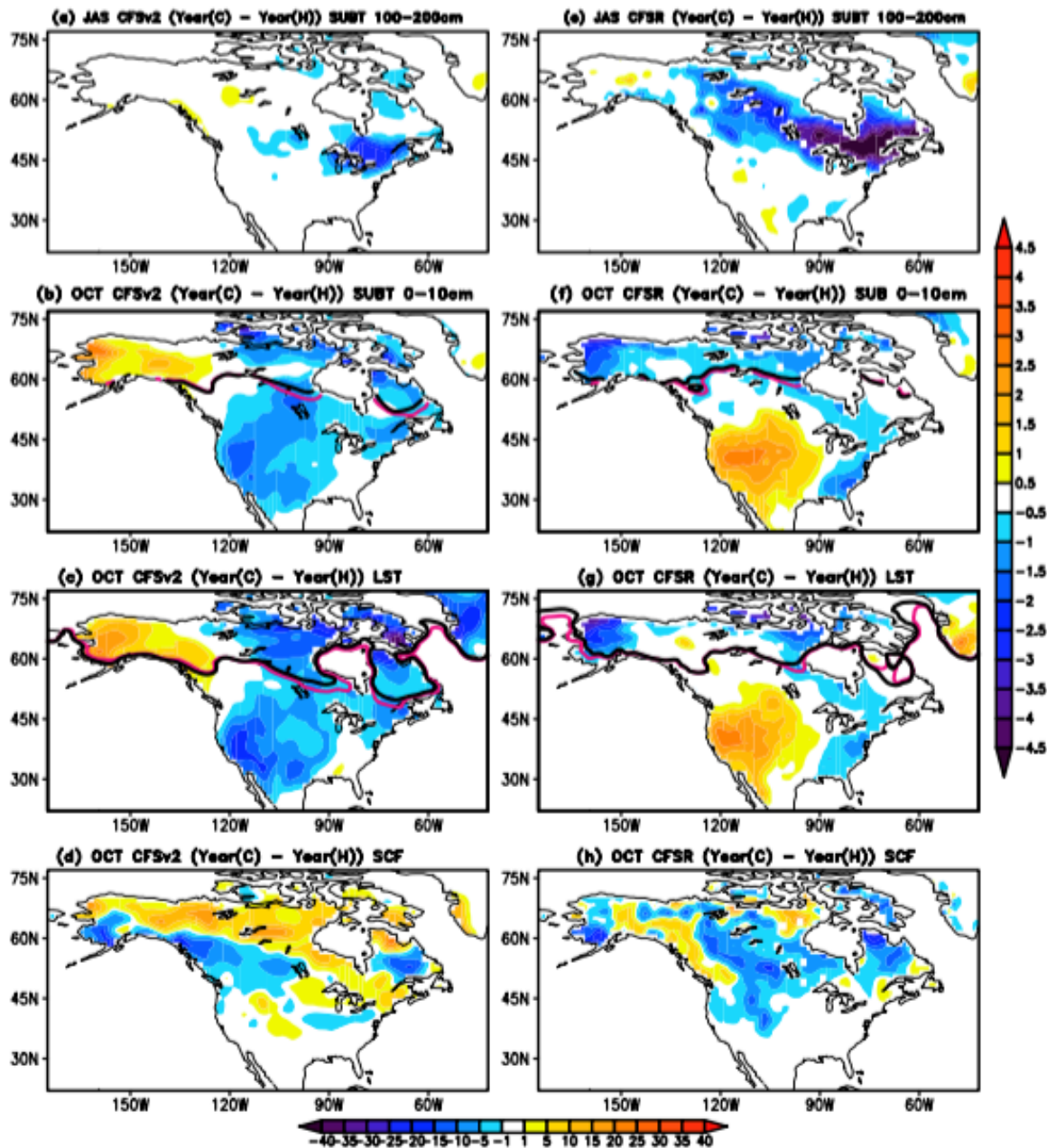
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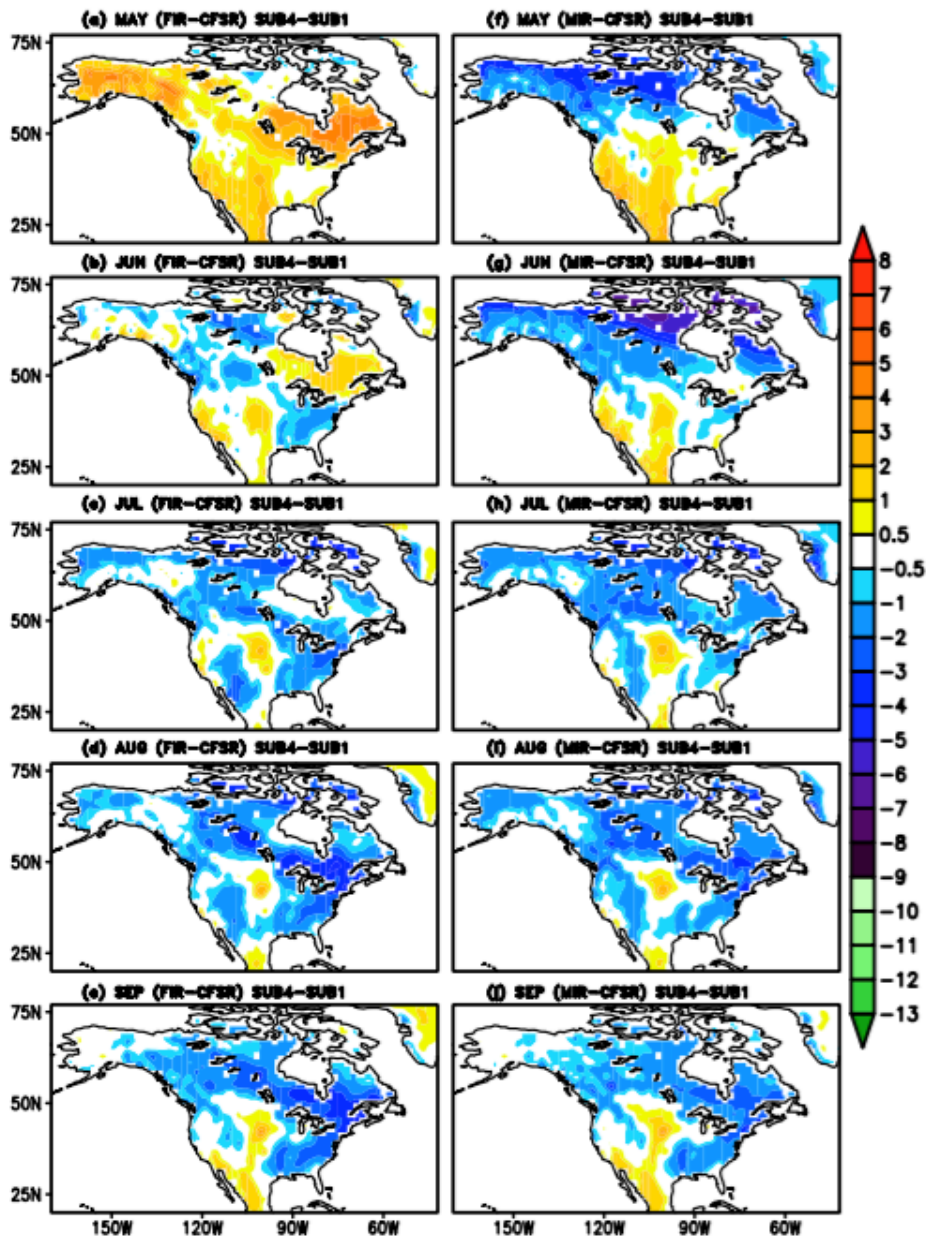


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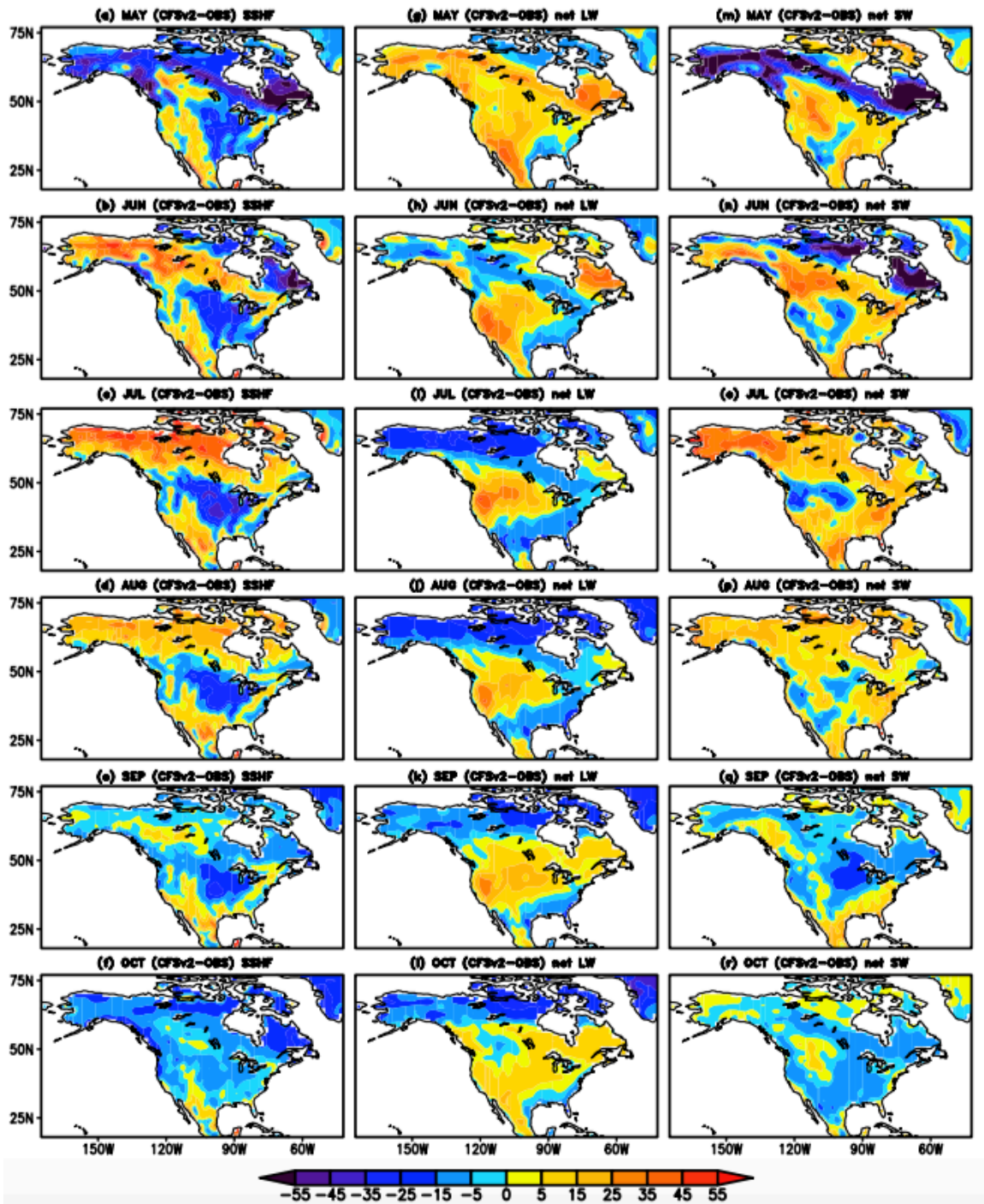
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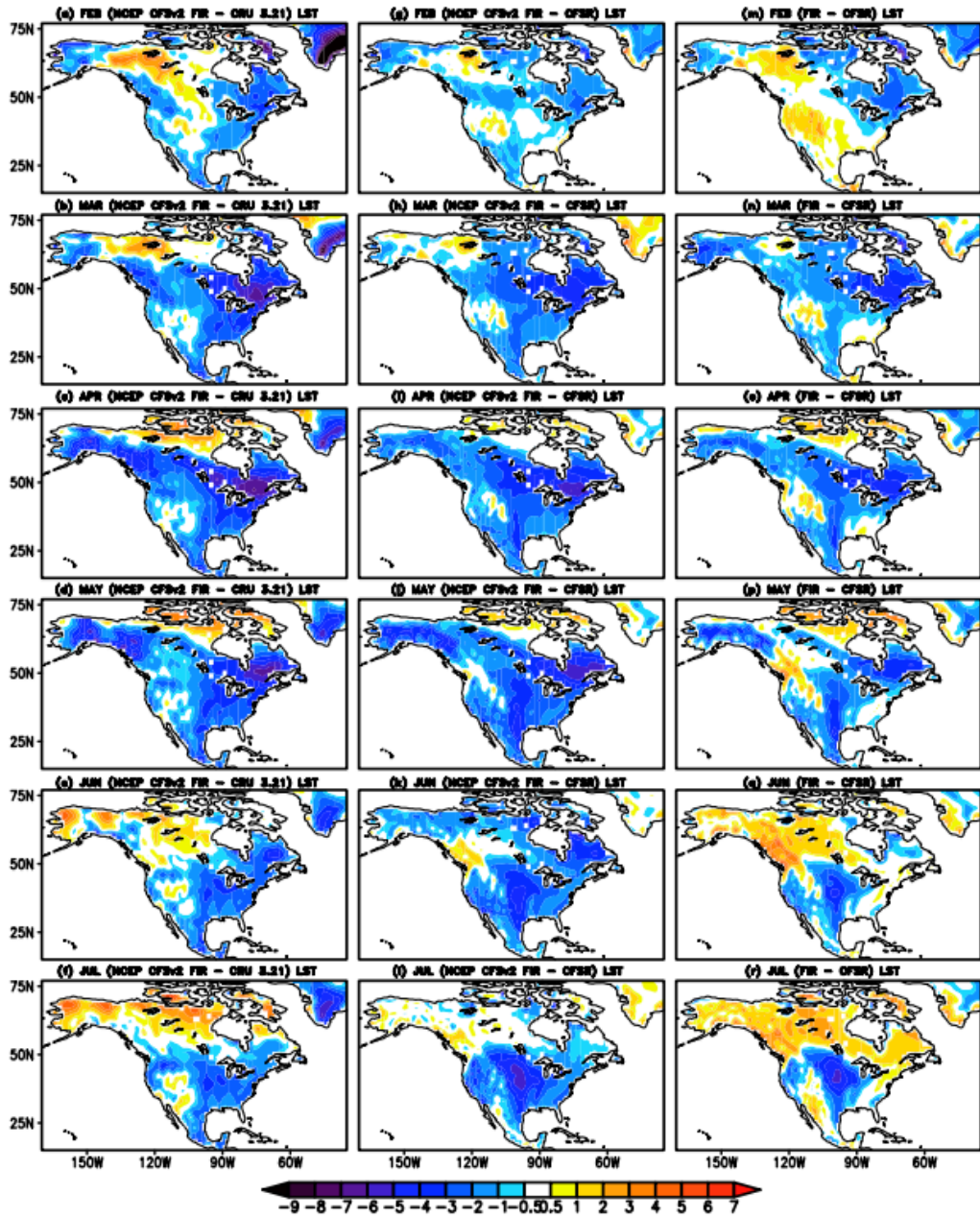


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 255 radiation (SWR;  $W/m^2$ ). The net SWR is defined as difference between downward SWR and upward  
 256 SWR.

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 261 2008) over the North America continent, monthly means based on the daily average of 6-hourly instantaneous values (i.e., 00Z, 06Z, 12Z, and 18Z) in NCEP CFSv2 FIR. (g-l) Spatial distributions  
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