SUPPLEMENT

THE IITM EARTH SYSTEM MODEL

Transformation of a Seasonal Prediction Model to a Long-Term Climate Model

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ANNEX. The ocean module in Indian Institute of Tropical Meteorology (IITM) Earth System Model (ESMv1) uses the rescaled geopotential vertical coordinate (z^*; Stacey et al. 1995; Adcroft and Campin 2004) in comparison with the geopotential coordinate used in CFSv2. The tracer advection in IITM-ESMv1 uses the conservative, minimally diffusive, monotonic, multidimensional piecewise method (MDPPM) while CFSv2 used Sweby's tracer advection (Sweby 1984).

IITM ESMv1 does not use a parameterization for the effects of mesoscale eddies [in contrast to CFSv2, which uses a parameterization as described in Griffies et al. (2004) and Gnanadesikan et al. (2006)]. IITM ESMv1 uses a parameterization for the effects of submesoscale, mixed layer eddies (Fox-Kemper et al. 2011), which allows mixed layer depths to avoid becoming excessively deep (Hallberg 2003).

For eddy parameterization, IITM ESMv1 uses the skew flux approach of Griffies (1998) but computes the quasi-Stokes streamfunction via a boundary value problem extending across the full column, after Ferrari et al. (2010), rather than locally (Gent and McWillams 1990), as in CFSv2.

Instead of prescribed vertical diffusivity for interior mixing (Bryan and Lewis 1979) as in CFSv2, IITM ESMv1 uses Simmons et al.'s (2004) scheme.

Shortwave radiation penetration into the ocean is prescribed according to the approach of Manizaa et al. (2005) in IITM ESMv1, while CFSv2 uses Morel and Antoine's (1994) approach.

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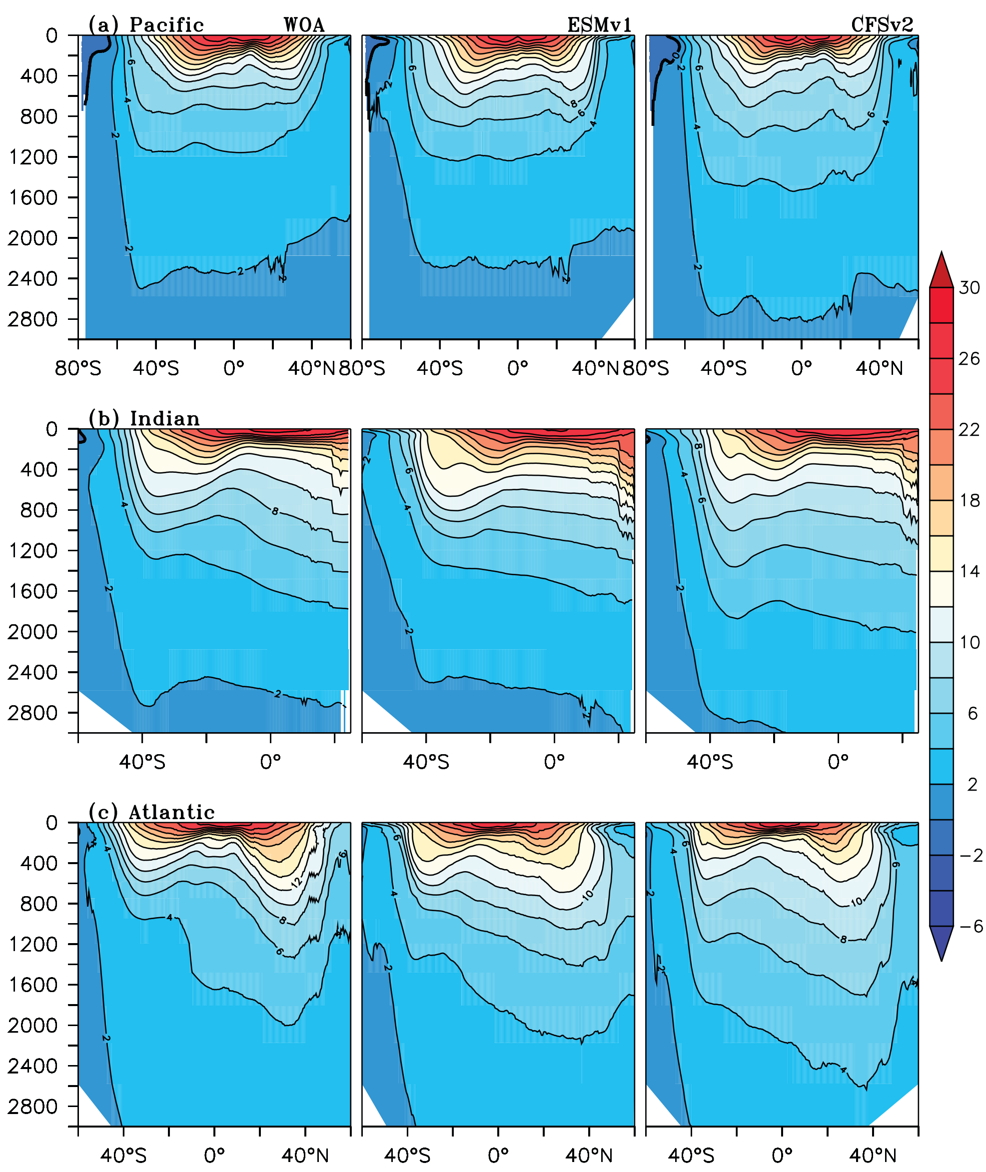

Fig. S1. Vertical distribution of the global ocean zonal mean temperature (°C) for individual ocean basins [(top) Pacific, (middle) Indian, and (bottom) Atlantic] from (a) WOA, (b) ESMv1, and (c) CFSv2.

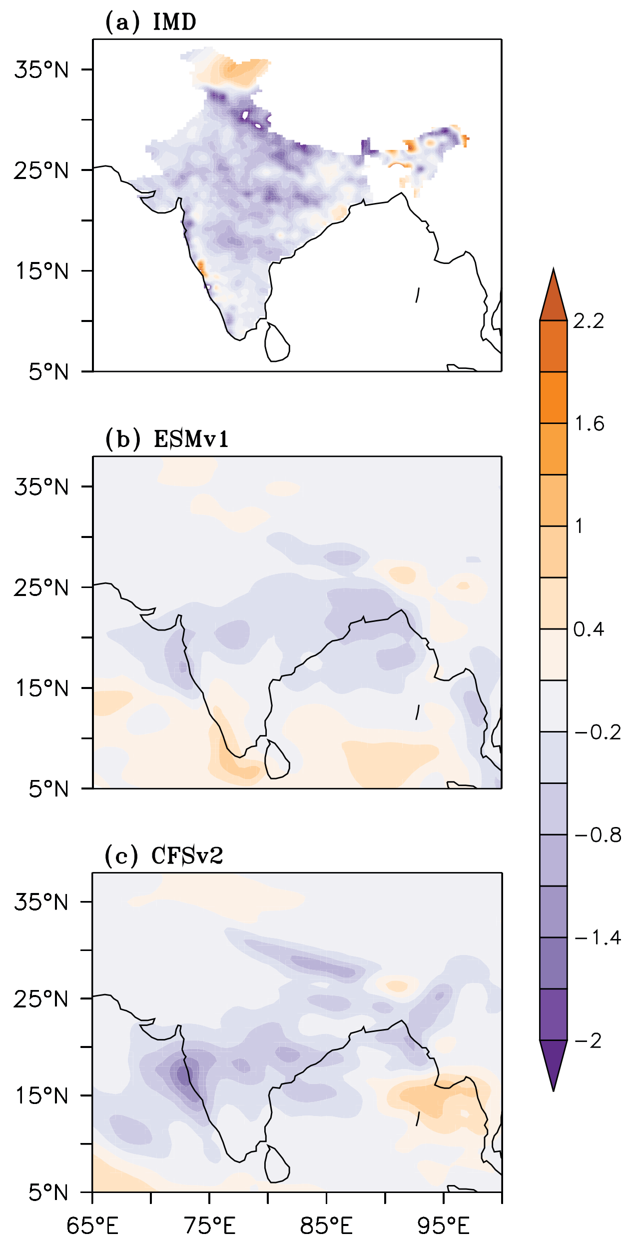

Fig. S2. Spatial map of JJAS rainfall anomalies (mm day⁻¹) regressed onto the gravest principal component from EOF analysis of the Pacific SST (60°N–60°S, 120°E–80°W; see Fig. 6) from (a) observations (for the period 1935–2010), (b) ESMv1, and (c) CFSv2. The model results are computed over the last 75 yr of simulation.

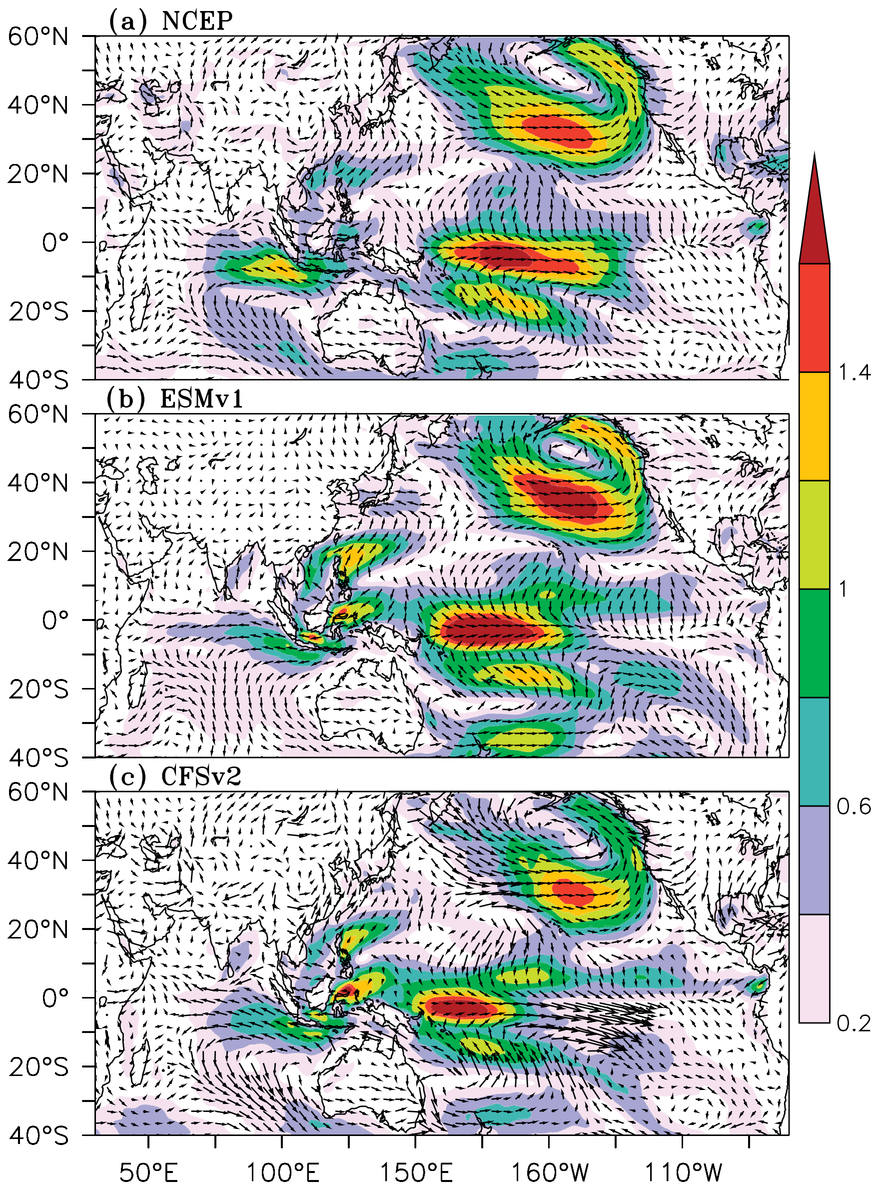

Fig. S3. Spatial map of DJF surface wind anomalies (m s^{-1}) regressed on to the gravest principal component from EOF analysis of the Pacific SST(20°–60°N, 120°E–120°W; see Fig. 9) from upon the wind anomalies from (a) observations (NCEP–NCAR reanalysis), (b) ESMv1, and (c) CFSv2.

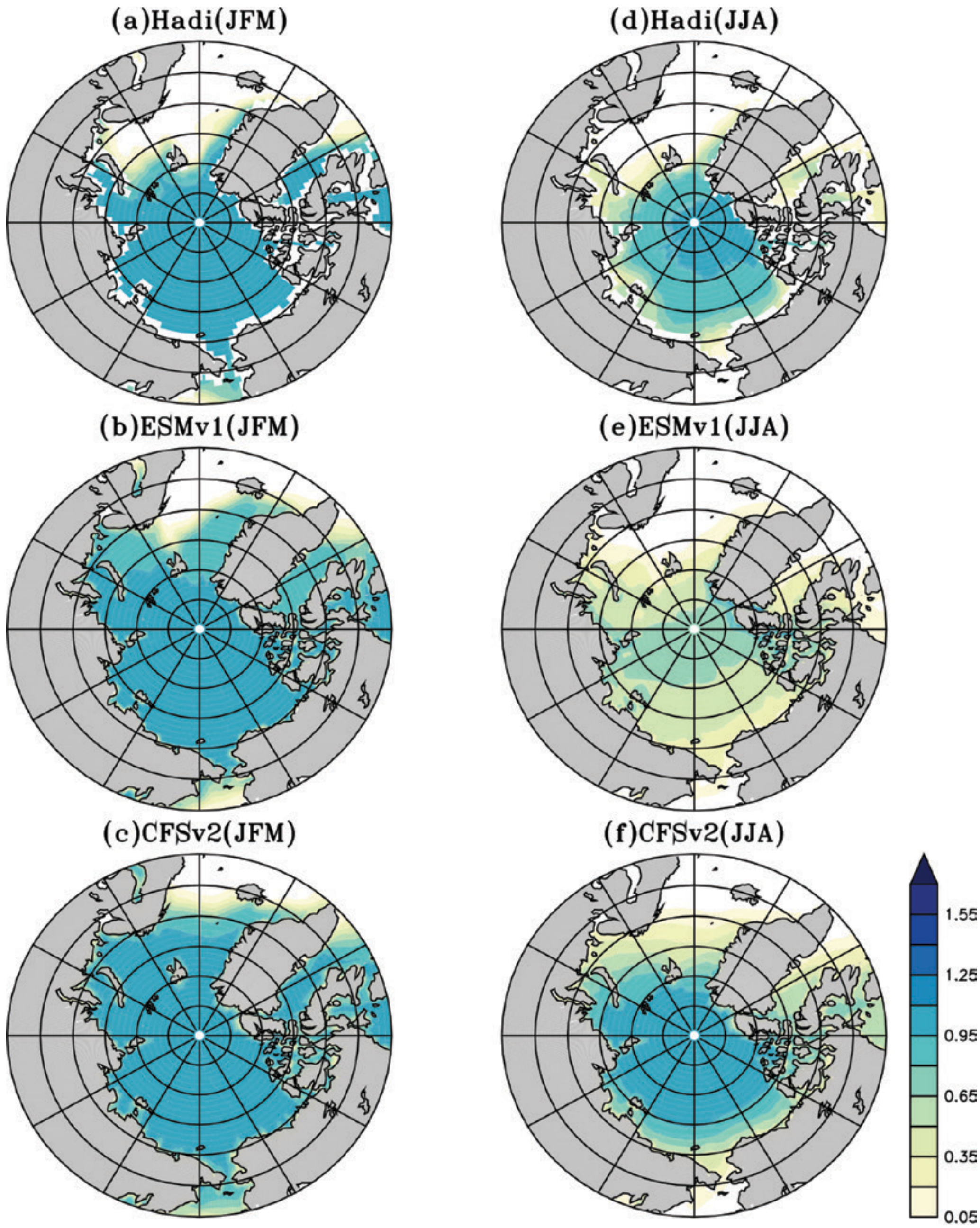

Fig. S4. Sea ice concentration in the Northern Hemisphere north of 60°N during January–March (JFM) from (a) HadISST, (b) ESMv1, and (c) CFSv2. (d)–(f) As in (a)–(c), but during June–September (JJAS).