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Seasonal Temperature Trends in forced CLIMBER-2 Simulations of the past Millennium

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CLIMBER-2 simulations forced by natural and anthropogenic factors (Milankovitch forcing, solar variability, volcanism, atmospheric CO_2 concentration, deforestation) generate seasonal differing responses. The temperature responses differ most clearly for Northern Hemisphere land areas. The Milankovitch forcing involves progressive warming in spring and progressive cooling in autumn. Annual-mean solar irradiance changes from volcanic and solar activity produce annual to centennial temperature changes which are slightly larger in summer than in winter. The anthropogenic CO_2 increase leads to larger warming in winter than in summer. The cooling effect from deforestation is largest in spring and autumn and larger in summer than in winter. The effect of the anthropogenic factors is reinforced by feedback mechanisms related to albedo changes from changing sea-ice and snow cover. The factors together generate a decline in the seasonal temperature spread at the end of the millennium which is in agreement with temperature observations. However, the observations from the Northern Hemisphere after 1861 show an even larger decline in the seasonal temperature spread than the simulations. Potential reasons for the underestimation of the simulated decline are discussed in respect of our simplified treatment of volcanic activity on the atmospheric dynamic and the neglect of the anthropogenic aerosol forcing.