and 87.5°N. Data are taken from the NCEP–National Center for Atmospheric Research (NCAR) reanalysis dataset (Kalnay et al. 1996) at a horizontal resolution of 2.5° × 2.5° and for the period 1950–2000. Monthly mean anomaly data from all 12 calendar months are pooled together. The spatial patterns, or loading patterns, that define the NAO and PNA are subjectively determined by inspecting the 10 rotated modes. Since the NAO and PNA have the largest variability during the winter season, the loading patterns largely reflect characteristics of the cold season patterns.

The patterns for the NAO and PNA as defined in this study are displayed in Fig. 1. The same patterns will be used for all time scales considered. This may be justified since the spatial patterns derived from daily, monthly, and seasonal data (not shown) are quite similar. Time series of the indices are calculated by projecting the daily, monthly, and seasonal 500-hPa geopotential height anomaly fields onto the patterns of Fig. 1. The correlations between different NAO/PNA indices derived from different techniques (EOFs, REOFs, EOTs, and traditional station based techniques) are very high (see, e.g., Hurrell et al. 2003). For each time scale, the indices are normalized such that the value of one standard deviation is unity.

3. Uncoupled forecasting: Short- to medium-range time scales

In this section we will compare and contrast various aspects related to forecast skill of NAO and PNA in two state-of-the-art high-resolution uncoupled atmospheric models used for operational deterministic (single integration) forecasting in the short to medium range. "Uncoupled" refers to SST being prescribed at the lower boundary.

a. Models and data

The two models chosen are from NCEP and from the ECMWF. Details about the models and model changes can be found in NCEP and ECMWF internal publications as well as at their respective homepages on the Internet. Note that the NCEP model reduces its resolution stepwise in both the horizontal and vertical after a few days into the integration, while the ECMWF model retains the same resolution through its 10-day integration.

Forecast and corresponding verifying analysis data are taken from the archives maintained at NCEP. Instantaneous data on a daily basis at 0000 hour are considered for the extended winter months (1 November–31 March) during the period 22 January 2000–24 March 2005 (819 days). The NCEP model is integrated out to

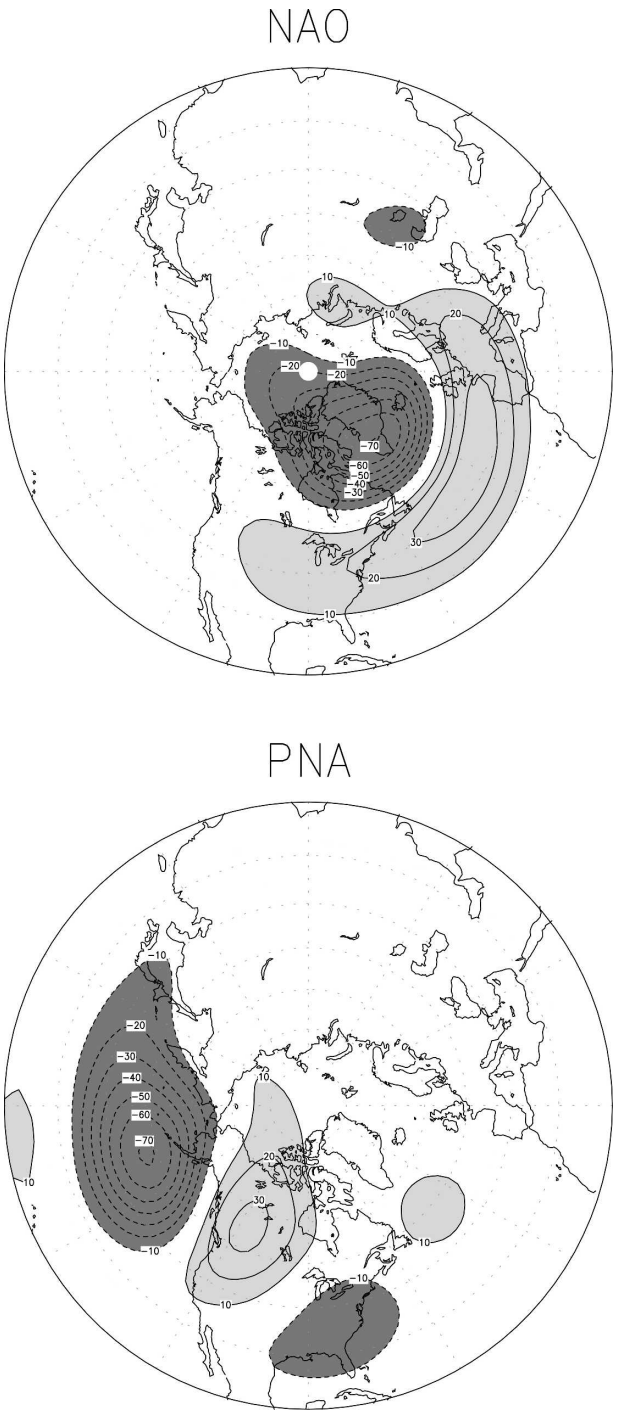

FIG. 1. The NAO and PNA loading patterns used in this study. They are based on a REOF analysis of monthly mean 500-hPa geopotential height data (see text for more details). Unit is m. Contour interval is 10 m with negative contours dashed. Dark (light) shading indicates values <10 m (>10 m).