II. Conventions for DATAGRID, RAWINS, and the forecast model

This section presents a few specifications of the forecast model as background to the discussion of programs DATAGRID and RAWINS. It also defines several terms used throughout this document.

The forecast model uses a terrain-following vertical coordinate, σ, defined by

$$\sigma \;=\; \frac{p - p_t}{p_s - p_t}\ , \tag{2.1}$$

where p is pressure, p_t is the constant pressure which defines the top of the model, and p_s is the surface pressure.

The forecast variables are u and v, the horizontal wind components in the x and y directions; T, the temperature; q, the specific humidity; q_c, the cloud water specific humidity; q_r, the rain water specific humidity; T_g, the ground temperature; and p^*, defined as $p^* = p_s - p_t$. Geopotential, ϕ, is diagnosed from the hydrostatic equation. Vertical velocity, $\dot{\sigma} = \frac{d\sigma}{dt}$ (where t is time), is diagnosed from the continuity equation.

Although the forecast model uses σ as its vertical coordinate, DATAGRID and RAWINS use pressure as the vertical coordinate. Additionally, DATAGRID and RAWINS use relative humidity RH as the moisture variable, whereas the model uses specific humidity q. Program INTERP later interpolates the pressure-level data to σ levels, and converts relative humidity to specific humidity, thus creating fields suitable for the forecast model.

The two-dimensional variables T_g and sea-level pressure p_o are supplemented in DATAGRID and RAWINS by additional two-dimensional fields describing terrain height (z_s), Coriolis parameter, map-scale factor, sea-surface temperature, land-use categories, snow cover, latitude, and longitude for the appropriate map projection of the mesoscale grid.

The forecast model has the capability to perform four-dimensional data assimilation (FDDA). In the PSU/NCAR Modeling System, this capability requires surface analyses at either 3 or 6 h intervals. The analyses for FDDA are created in RAWINS. The time periods at which these analyses used for FDDA are created are referred to in this document as *FDDA times*. Generally, the FDDA times will include 0000 and 1200 UTC (referred to as *standard times* or *standard upper-air times*), as well as additional times at either 3 or 6 h intervals (referred to as *intermediate times* or *intermediate FDDA times*). For example, in a 12 h time period, there will be either three or five FDDA times (*e.g.*, 0000, 0600, and 1200; or 0000, 0300, 0600, 0900, and 1200 UTC) and either one or three intermediate FDDA times (*e.g.*, 0600; or 0300, 0600, and 0900 UTC).

The horizontal grid of the model domain is the staggered "Arakawa B grid" (Arakawa and Lamb, 1977). The wind components u and v are defined at one set of points (called *dot points*) while the variables T, q (RH in DATAGRID and RAWINS), q_c, q_r, and p^* are defined at the other points (called *cross points*). Geopotential height ϕ is defined at dot points in DATAGRID and RAWINS, but is diagnosed at cross points in the forecast model. The staggered grid used in the PSU/NCAR modeling system is illustrated in Fig. 2.1. The x and y dimensions for all components of the modeling system are labeled in the code and output as J and I, respectively. This is the reverse of normal conventions.

In DATAGRID and RAWINS, calculations may be performed on a grid larger than the user-defined mesoscale coarse-mesh grid. This expansion is performed to improve the analyses near the boundaries of the defined grid. The larger grid is referred to in this document as the *expanded grid*. The original coarse-mesh grid is referred to as the *unexpanded grid*.

Data from the entire horizontal domain (either the expanded or unexpanded grid) is referred to as a *slab* of data. In the original configuration of RAWINS, each slab of data could be divided into several *slices*, in order to reduce in-core memory requirements. In the current configuration of RAWINS, the division of slabs into slices is no longer performed, so one slice of data is the same as one slab of data.

DATAGRID and RAWINS have been designed to access both historical data (*i.e.*, data that have been taken some time in the past) for historical simulations and real-time data (*i.e.*, data taken quite recently, within a few hours of program execution) for real-time forecasts. For historical simulations, analyses and observations are generally accessed from a period encompassing up to several days. These observations are used for an optional

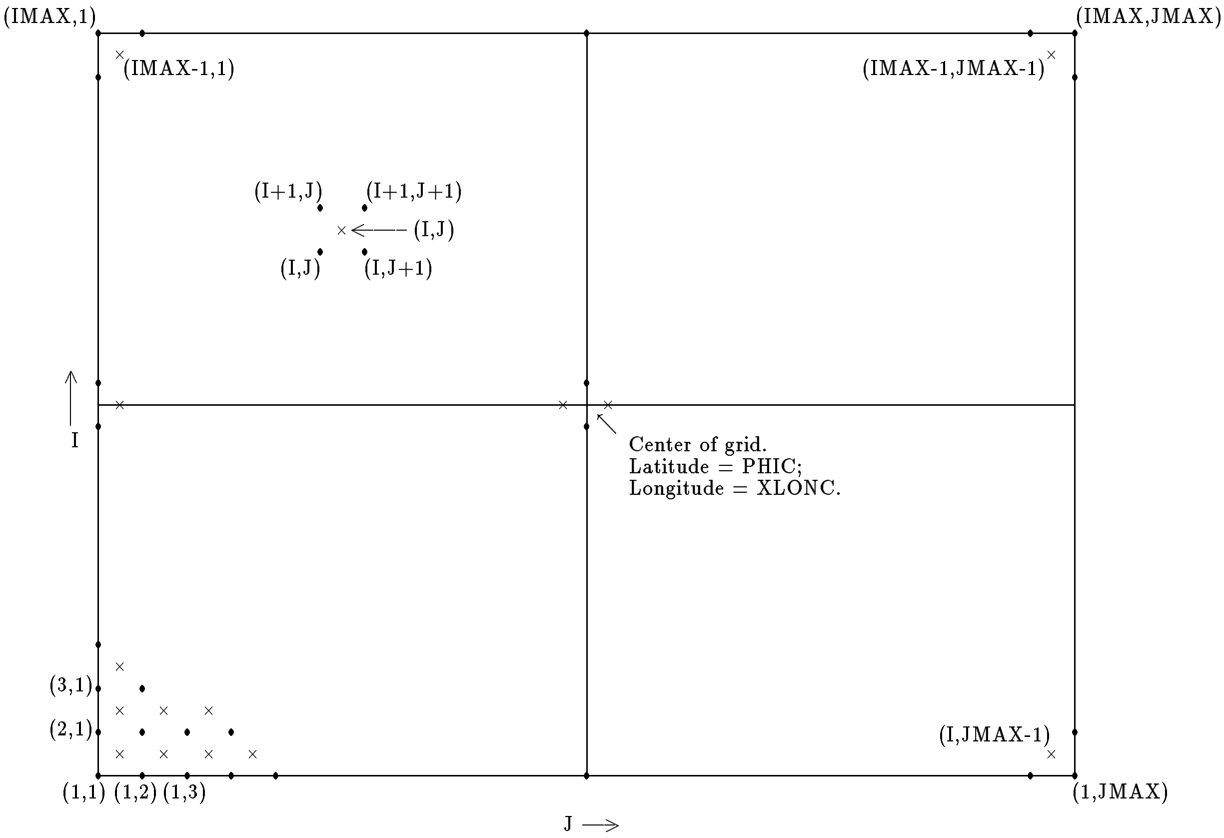

Fig. 2.1 Horizontal grid structure of the model for a domain dimensioned by (IMAX, JMAX) and centered at latitude PHIC and longitude XLONC. Variables u and v are defined at dot points. All other variables are defined at cross points.

period of FDDA before the simulation period, to create fields for the initial conditions of the model, and to create fields to be used as boundary conditions during the simulation. For real-time forecasts on the other hand, observations are generally not accessed for more than one time period, as much of the period of the forecast is in the future. The observations that are available are used for an optional period of FDDA, and to create fields for the initial conditions. Forecast analyses are used as boundary conditions of the model. In this text, the term *analysis* in the context of input to DATAGRID will refer to both historical analyses and real-time forecasts.

In DATAGRID, analyses are generally accessed at *mandatory levels* (which include the 1000, 850, 700, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, and 10 mb levels). Upper-air data accessed by RAWINS are generally available at mandatory levels, as well as *significant levels* (pressure levels at which observations are reported, but which are not mandatory levels). The significant levels differ for each rawinsonde report. Thus, in order to make use of the high vertical resolution of the rawinsonde data, RAWINS can interpolate the rawinsonde data to a number of user-specified levels. These pressure levels are referred to in this document as the *nonmandatory levels* (or *new nonmandatory levels*).

In this document, FORTRAN statements and variables are printed with ALL CAPITALS. Shell script statements and variables are printed in `typewriter` font.