

# ARPS Phase Correcting Data Assimilation

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## 1. Introduction

The ADAS phase-correcting assimilation scheme is designed to objectively determine phase or position errors in a forecast field, and apply a position correction to adjust for those errors. The position correction can be done in a single step at the time of the determination of the phase errors or it can be done gradually in a phase-adjustment time window of the ARPS model. The phase correction concept and an application to a simple observing simulation experiment is documented by Brewster (2003a). A demonstration of the position correction in an actual severe thunderstorm outbreak case is presented by Brewster (2003b).

The position offsets are determined by the program, `arpsshift`, which is included in recent versions of the ARPS model file distribution (there is a separate help file for the `arpsshift` program). The `arpsshift` program applies the corrections to the forecast model state and the position-corrected fields are written to an ARPS history file, which may subsequently be used to initialize the ARPS model. The program also writes the vectors describing the offset to a second file, having name `runname.yyyyymmdd.hhmmss.shf`, where `runname` is a name for the model run, and `yyyymmdd.hhmmss` is a date/time string. The shift offset vectors in the `.shf` file can be used to make adjustments to the model over time or used for verification and forecast scoring schemes.

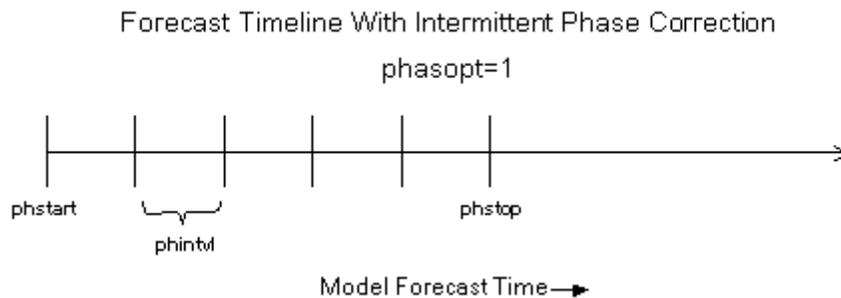
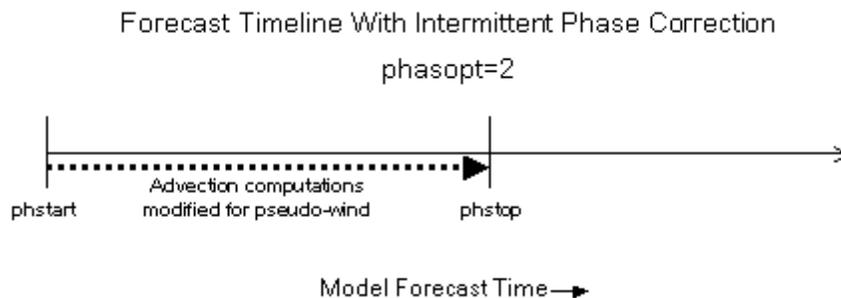


Fig 1. Schematic of application of intermittent phase correction.

In order to apply the position corrections over time, the ARPS model has been modified to read the position offsets and new input namelist variables that specify the phase adjustment time window and the user-selected method for applying the corrections. Position corrections applied gradually may be better accepted by the model, allowing a gradual adjustment of all model fields. Two gradual methods of applying the phase correction are supported. The first method applies a fraction of the phase adjustment at regular intervals during the phase-correction time window (multi-step phase correction). This is illustrated in Fig. 1.

In order to make the each application of the translation small it is good to set the time interval between the adjustments relatively short. However, each application of the transition involves a second-order interpolation process which, implicitly, applies some smoothing to the fields that are being moved. If the total number of adjustments is too large the smoothing may be excessive. Its a reasonable compromise to set *phintvl* so there are 10-20 adjustments applied between *phstart* and *phend*. Typically *phstart* is the first time step after the model begins.



*Fig 2. Schematic of application of phase correction by modification of advection computations to include a pseudo wind.*

The second method of gradual application of the phase correction adjusts for the position errors continuously by means of adjusting the wind speeds in the calculation of the advection terms of the model (i.e., phase correction by pseudo-wind advection). This method is illustrated in Fig. 2.

The wind speed that is used is a function of the total correction and the time interval over which the adjustment is done ( $phend - phstart$ ). The time interval should be sufficiently long that the pseudo-wind speeds are not excessively high. If the time interval is too short the pseudo-wind combined with the actual wind may lead to a violation of the Courant-Friedrichs-Lewy (CFL) condition and cause numerical instability.

It is important that if you are using the multi-step phase correction or the advection by a pseudo-wind adjustment method in the ARPS model that the same initial condition file (namelist input variable *inifile*) is used for both *arpsshift* and ARPS (or the corresponding model restart file may also be used). DO NOT use the output of

`arpsshift` as the input of ARPS if you are also applying the adjustments within ARPS, this would result in duplicate corrections.

It is a good idea to verify that at the end of the phase assimilation period that the result from ARPS is generally matching the fields in the ARPS history dump file from the output of the phase-correction program (verify using the `arpsplt` plotting program). Because of model evolution during the assimilation window the two fields will not match exactly, however.

## **2. References**

- Brewster, K.A., 2003: Phase-correction data assimilation and application to storm-scale numerical weather prediction. Part I: Method description and simulation testing. *Mon. Wea. Rev.*, **131**, 480-492.
- Brewster, K.A., 2003: Phase-correction data assimilation and application to storm-scale numerical weather prediction. Part II: Application to a severe storm outbreak. *Mon. Wea. Rev.*, **131**, 493-507.

### 3. Input Parameters

The table in the following pages details the input parameters for the ARPS numerical forecast model controlling the two options for gradual phase correction within the model. See also Figs. 1 and 2.

#### ARPS Phase Correction Parameters (**namelist & phaseadj in arps.input**)

<u>Parameter</u>	<u>Definition/Purpose</u>	<u>Options/Suggested Values</u>
<i>phasopt</i>	Phase adjustment option.	<i>phasopt</i> = 0: no phase adjustment 1: apply phase adjustment in incremental steps 2: apply phase adjustment in advection routines
<i>phstart</i>	Model time (seconds) to start phase correction.	<i>phstart</i> = <i>dtbig</i>
<i>phstop</i>	Model time (seconds) to stop phase correction.	suggested ( <i>phstop</i> - <i>phstart</i> ) ≥ 600.
<i>phintvl</i>	Phase adjustment time interval (seconds).	<i>phintvl</i> = multiple of <i>dtbig</i>
<i>phfile</i>	Name of position offset vector file, written by <i>arpsshift</i> .	character*132 filename