

Usage of Spectral Nudging in CReSS

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Structure of the directory

```
configure.csh      --- Script to automatically generate Src
compile.conf      --- Configuration file to compile CReSS
compile_radlib.csh --- Compiling script of CReSS
ispack-1.0.4      --- ISPACK (for Fast Fourier Transform; FFT)
SrcOrig, SrcDevelop --- Source codes
```

You have to manually download `ispack-1.0.4.tar.gz`, which is a FFT library, and build the library.

<http://www.gfd-dennou.org/library/ispack/ispack-1.0.4.tar.gz>

Pre-installation

ISPACK (ispack-1.0.4)

```
$ tar zxvf ispack-1.0.4.tar.gz $ cd ispack-1.0.4
```

You have to edit a parameter of FC in Mkinclude, depending on your environment.

```
$ make  
$ ls libisp.a
```

Generation of solver.exe

Setting of compile.conf

```
ISPACK = Directory path of libisp.a  
FC = Fortran compiler name  
FFLAGS = Fortran compiler flags  
LDFLAGS = -L"./" -lrrtmg_kgkgb -L${ISPACK} -lisp
```

Compiling of solver.exe

```
$ ./configure.csh rad  
$ ./compile_radlib.csh radlib compile.conf  
$ ./compile_radlib.csh solver compile.conf
```

Setting of user.conf 1

nggopt	integer(kind=[4bytes]) Nudging option 1 = Traditional, 2 = Spectral.
ngglev	integer(kind=[4bytes]) The lowest level of nudging (grid number). See below for the details.
spnx	integer(kind=[4bytes]) <i>x</i> - direction of truncation wavenumber for the nudging. See below for the details.
spny	integer(kind=[4bytes]) <i>y</i> - direction of truncation wavenumber for the nudging. See below for the details.
spndlt	real(kind=[4bytes]) Updating time interval of the spectral nudging terms [s]. Based on the interval, FFT calculation is performed. See below for the details.

Setting of user.conf 2

```
spgix      1 (Fixed)
spgiy      1 (Fixed)
skpopt     1 (Fixed)
nggvar     character(len=80,kind=[1byte])
           Nudged variables.
           Only 4 variables are available (u, v, pt, qv).
nggcoe     real(kind=[4bytes])
           Nudging coefficient [1/s].
nggdlt     real(kind=[4bytes])
           Nudging time interval [s].
nggstr     real(kind=[4bytes])
           Nudging start time [s].
nggend     real(kind=[4bytes])
           Nudging ending time [s].
nggc20     real(kind=[4bytes])
           Decreasing start time of nudging coefficient [s].
```

Detail of parameters

Nudging formulation

Consider a predicted variable as ψ . The predicted equation is

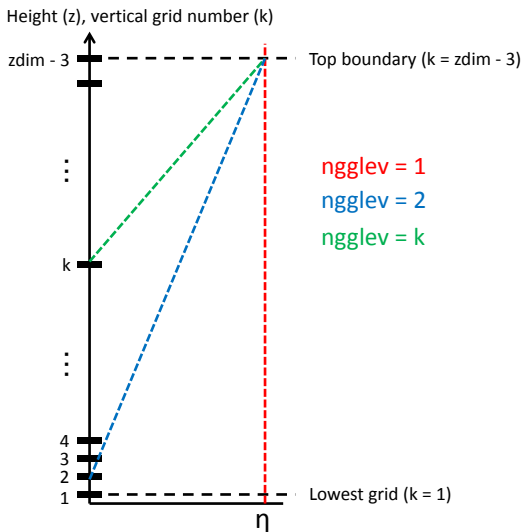
$$\frac{\partial \psi}{\partial t} = L(\psi) + \sum_{k,l}^{K,L} \gamma_{k,l}(z) (\hat{\psi}_{k,l}^a - \hat{\psi}_{k,l}) e^{i(kx+ly)},$$

$$\gamma_{k,l} = \begin{cases} \eta & (k \leq K_T, l \leq L_T), \\ 0 & (\text{otherwise}), \end{cases}$$

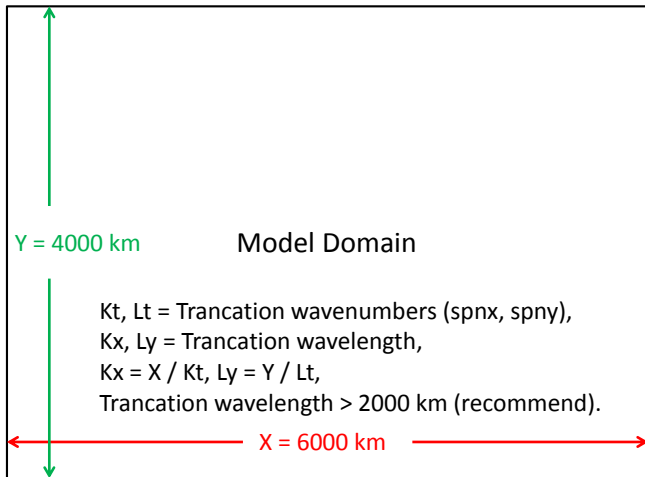
where $\psi = \psi(x, y, z, t)$, k, l are x - and y - directional wavenumbers. $\hat{\psi} = \hat{\psi}_{k,l}(z, t)$ is the Fourier coefficient of k, l . Subscription of a is a reanalysis variable (data of parent model).

- K_T, L_T are truncating wavenumbers (spnx, spny).
- γ is nudging coefficient (nggcoe).

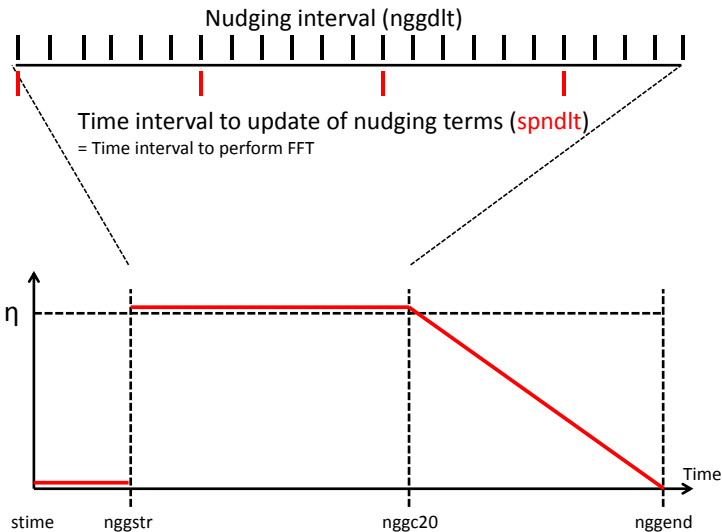
Detail of parameters



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You have to set `xdim` and `ydim` as following for use of the spectral nudging:

$$\text{xdim} - 3, \text{ydim} - 3 = 2^{a+1}3^b5^c, (a, b \text{ and } c \geq 0)$$

You can see a document of NOTE (NOTE.ja) in CReSS directory.
The author hopes that you specify the sentence of the document in your acknowledgement.
If you permit, the author may collabolate with you.