Documentation for LMDZ, Planets version

The vertical discretization

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1 Theoretical aspects

The position of the layers:

- pressure limit between two layers,
- pressure within the layers

The Exner function: $pk = C_p \times (p/preff)^\kappa$. It corresponds to the pressure levels within the layers. Used for the computation of the potential temperature. For the Earth, we use a specific scheme that computes these positions so that it maintains a condition of proportionality between total, internal and potential energy (cf. a note from F. Hourdin).

2 Pratical aspects in the code

- disvert_[no]terre.F[90]: position of the interface pressure levels from an input file (several possibilities). Definition of ap, bp and presnivs. In the planetary version, definition of aps and bps.

  This is done only once, called at the beginning from iniconst.F.

  In the Earth version the vertical coordinates are hybrid (sigma-pressure), and generated automaticaly (or generated from parameters read from file sigma.def, if that file is present in the directory where the gcm is run).

  In the planetary version, the vertical coordinates can be hybrid (default behavior) or sigma (set using parameter "hybrid" in run.def; true implies hybrid coordinate, false implies sigma coordinate). the distribution of model levels is set from file esasig.def or z2sig.def, depending on which is present (in the directory where the gcm is run). The first line of the z2sig.def file should give the value of the reference atmospheric scale height (in km), followed by the (rough estimate) of the altitude (in km) of the atmospheric level (one per line of the file).

  For planetary applications, the usual way to go is to use disvert_noterre.F together with z2sig.def. The sigma levels are computed as:

  - H is the first value in z2sig.def, $zsig$ are the following values in z2sig.def
  - $\sigma(1) = 1$
  - l=2 to llm: $\sigma(l) = 0.5 \times (\exp(-zsig(l)/H) + \exp(-zsig(l-1)/H))$
  - $\sigma(llm+1) = 0$

The ap and bp values, defining the interface pressure levels, are then computed using these sigma values, the reference pressure $preff$, and the transition pressure pa. The values of $preff$ and pa are read in the start.nc file, in the control array.

- Interface pressures: computed in caldyn0.F, caldyn.F, integrd.F, leapfrog.F through the pression.F routine.
- Exner function (and therefore pressure within the layers): computed at three different places in leapfrog.F through the exner_[hyb/milieu].F routine. For the Earth, we use exner_hyb.F, that computes the positions in a specific way to maintain a condition of proportionality between total, internal and potential energy (cf. a note from F. Hourdin). For other planets, we use exner_milieu.F, that computes the positions of these pressure levels exactly in the middle of each layer. Though this fails to maintain the previous condition, there is no evidence of any significant influence on the results, and it makes it a lot easier to define correctly the level positions with the input file.