HyMeX

REMEMBER

ANR

Introducing LMDZ physical schemes in WRF

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LMD

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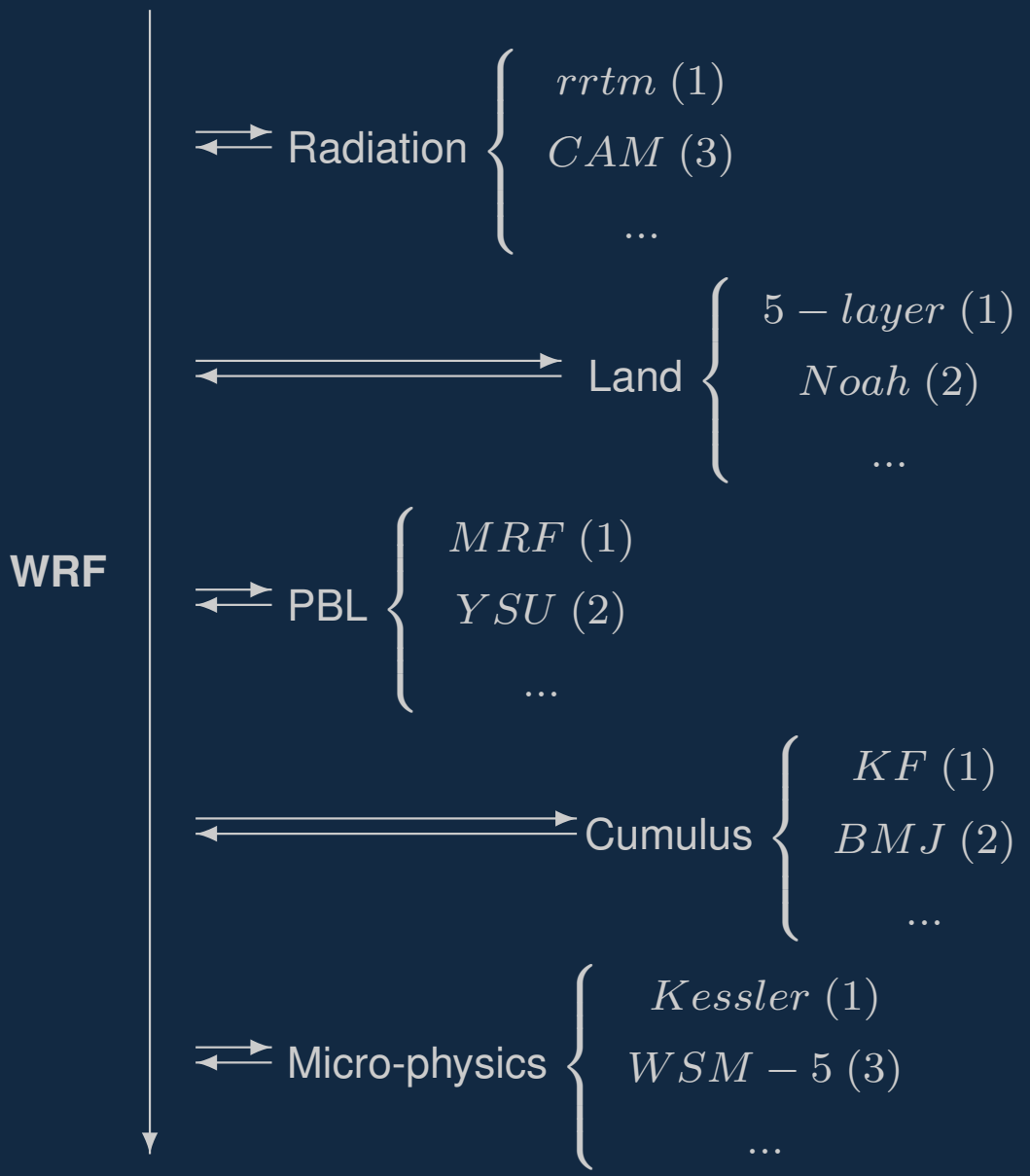
- Include LMDZ physical schemes in WRF in order to:
  - Analyze parameterized/explicitly resolved results with the same platform
  - Analyze the role of a non-hydrostatic dynamics in a GCM/RCM run
  - Analyze the performance of the LMDZ physics at 'high' resolution

Models structure



- Model 'call' each scheme consecutively
- Multiple versions of each scheme
- Flexibility of combination of schemes
- Inconsistent combinations!

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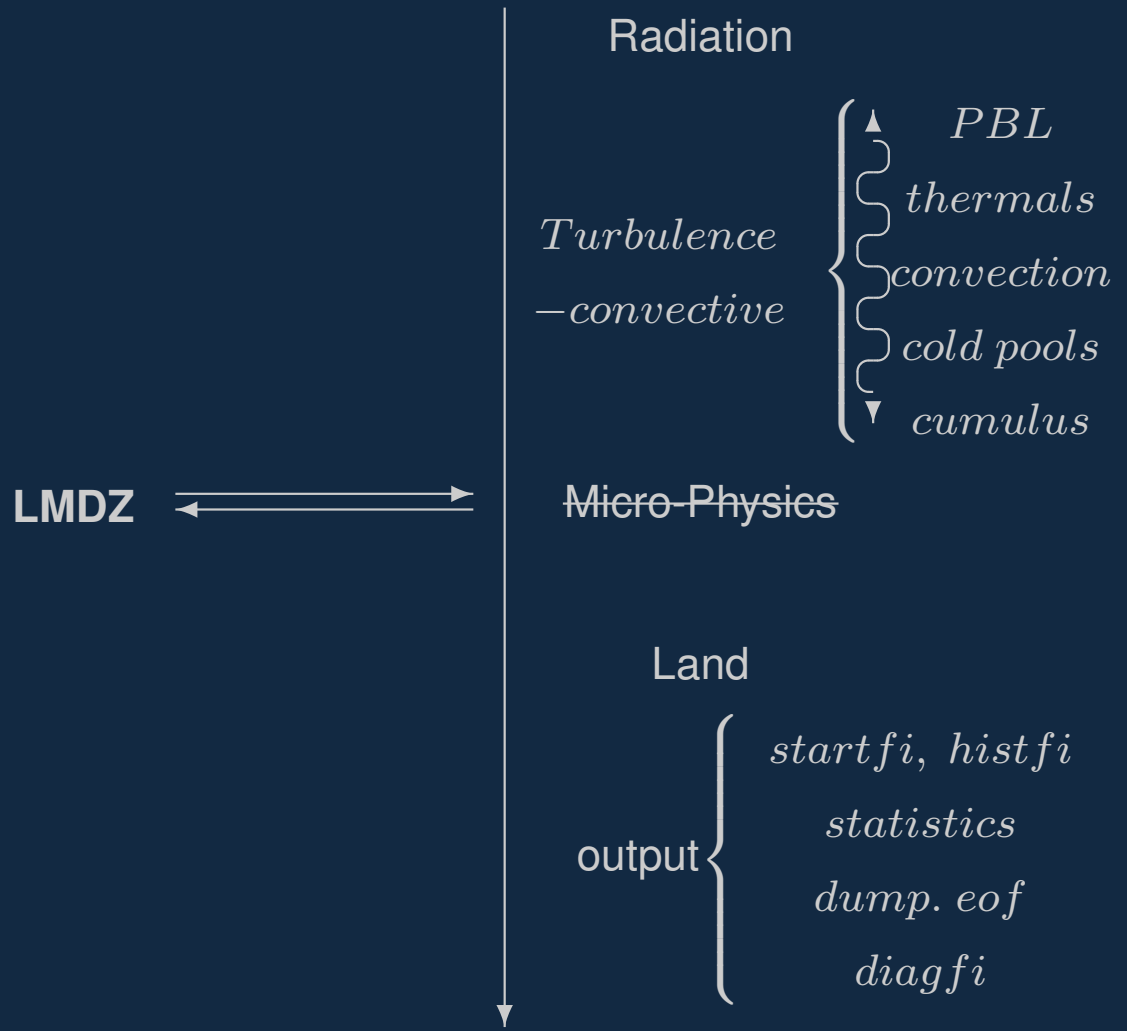

- Robust call of physics schemes
- Computation of climatic values: daily/monthly means
- Single *'turbulence-convective'* scheme

Technical differences

- WRF code is very flexible:
  - fully modular: no mixture of dynamics, physics, i/o
  - fully F90 code: pointer, data-structures, namelist, ...
  - all variables, domain dimensions and data is kept in a Fortran data structure called `grid`, which is managed with an ASCII file called `Registry`

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  - all variables, domain dimensions and data is kept in a Fortran data structure called `grid`, which is managed with an ASCII file called `Registry`
- LMDZ code is less flexible:
  - not fully modular: mixture of physics & i/o
  - F77 & F90 code: static grid dimensions, use of 'SAVE'

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4. Technical aspects:
   - Minimal changes in LMDZ code
   - Use of WRF compilation structure/framework
5. Usability aspects:
   - Use LMDZ physics as a new WRF set of parameterizations
   - Preserve WRF flexibility and capabilities

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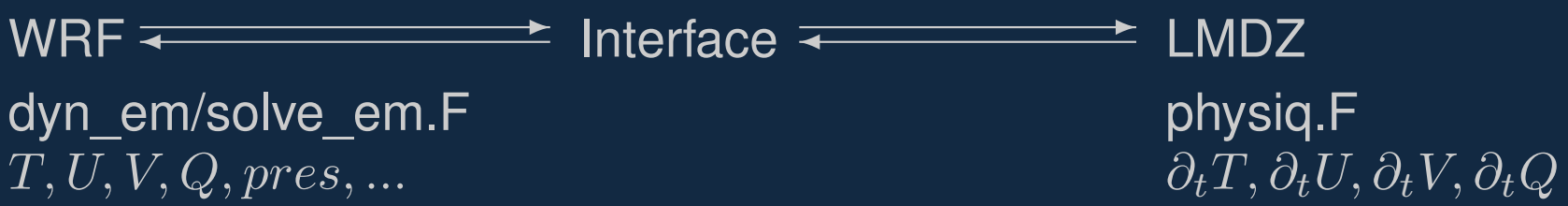

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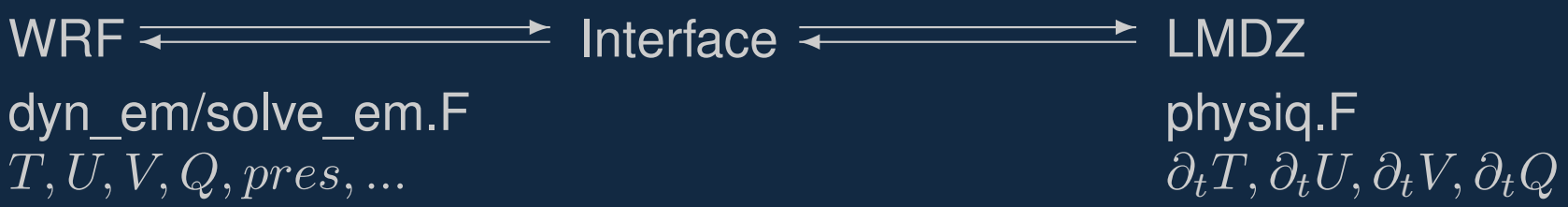

1. Provide WRF variables to LMDZ physics
2. Transform WRF variables (dimx,dimz,dimy) to LMDZ variables (klon,nlev) [klon=dimx*dimy]
3. Initialize LMDZ variables
4. Obtain state variable tendencies from LMDZ physics
5. Pass WRF initial/boundary variables to LMDZ (avoiding LMDZ input)
6. Retrieve all LMDZ diagnostic variables and include them in WRF (avoiding LMDZ output)

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- All the WRF physical schemes have to be switched off: land, surface, pbl, cumulus, micro-physics and sw/lw radiation
- We could use WRF microphysics... for a further step

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- LMDZ `physiq.def` flags: `iflag_pbl`, `lmdz_iflag_con`, `lmdz_iflag_thermals`, `lmdz_iflag_wake`, in order to compute some diagnostic output variables

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- Part of the updating of LMDZ will be simplified once LMDZ code is fully in F90

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- `lmdz/wrf_lmdz_mod.F90`: Is a created module in order to make all the necessary calculations, transformations and actions necessary for the interface

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- WRF variable transformation:
  - WRF θ temperatures to LMDZ T
  - Computation of LMDZ $area, cu, cv$
  - WRF water species to vapour/liquid LMDZ ones
  - WRF base/perturbation p and z variables to LMDZ total p and z
  - Computation of the LMDZ surface geopotential field (z_{sfc})

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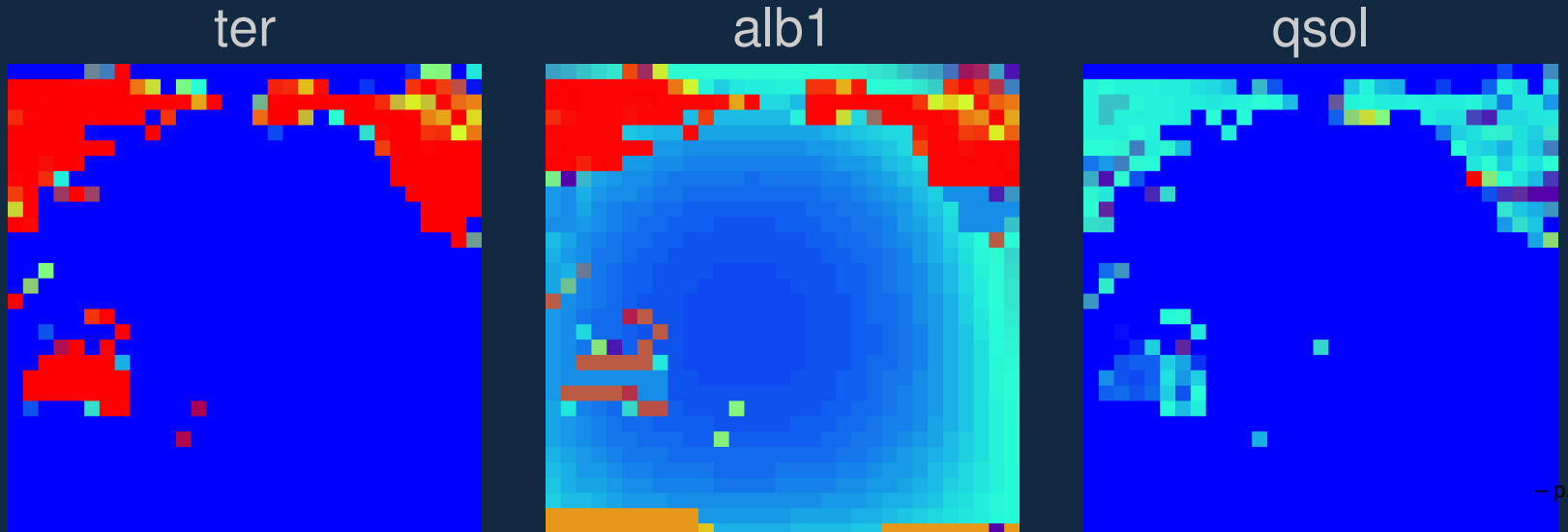

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- `NOread_limit_sub_variables.F90:` Module to create `SAVE` definitions for that variables that were uploaded by `'limit.nc'` or `'startphy.nc'`
- `physiq_limit_variables_mod.F90:` Access restart LMDZ variables in `'physiq'`

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- `output_lmdz_NOmodule.F90` gives the `'SAVE'` attribute and allocate all that output variables which are locally used in `physiq.F90` and they do not appear in the LMDZ modules: `phys_state_var_mod`, `phys_output_var_mod`, `phys_local_var_mod`, `comgeomphy`

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- A series of different subroutines upload the output variables to the WRF `grid` structure: `get_lmdz_out2D_[i/v]`, `get_lmdz_out3D_z_[i/v]`

Boundary & restart variables

- WRF files `wrfbdy_d01` and `wrflopwbdy_d01` provide boundary and updating values for certain variables (usually from the GCMs, at every 6h). An interface to the LMDZ *[var]_lim* variables is needed to be created

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- At the end of the simulation (or at the given time that a restart file is required), LMDZ *[var]_rst* would be updated

Work in progress...

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   - Orography variables for the orographic scheme: not done
   - GHG gases? $ozone, CO_2, CH_4, NO_2, CFC-11, CFC-12$, aerosols?: not done nor thought
   - WRF does not support *p_top = 0*. Add an extra vertical level used only by LMDZ? : not done nor thought

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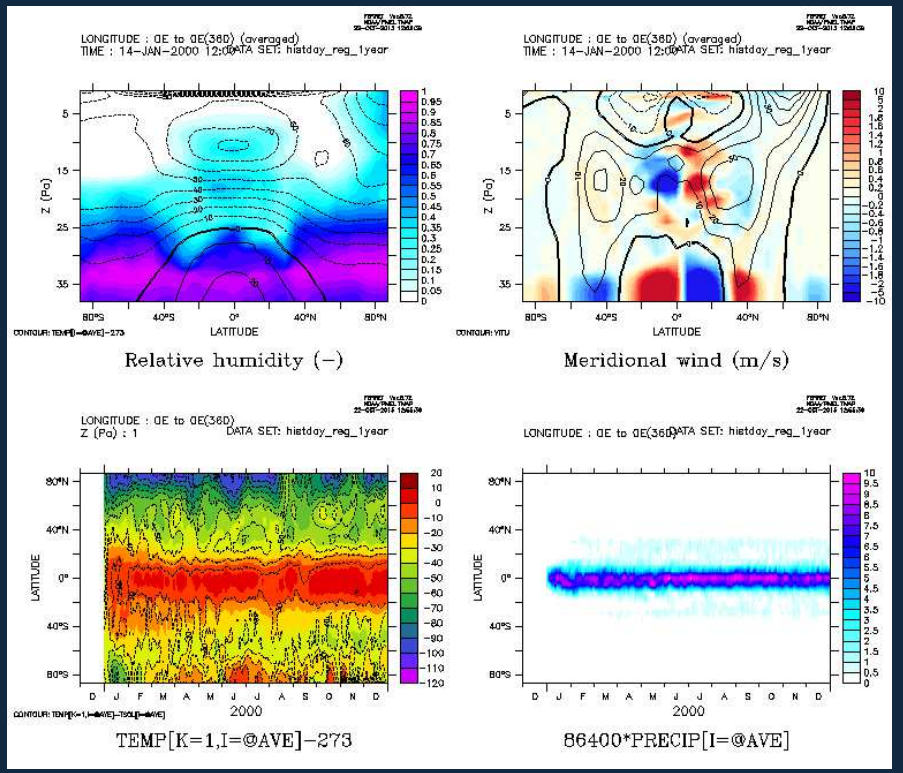
8. couplings with ORCHIDEE, NEMO, INCA: not done nor thought

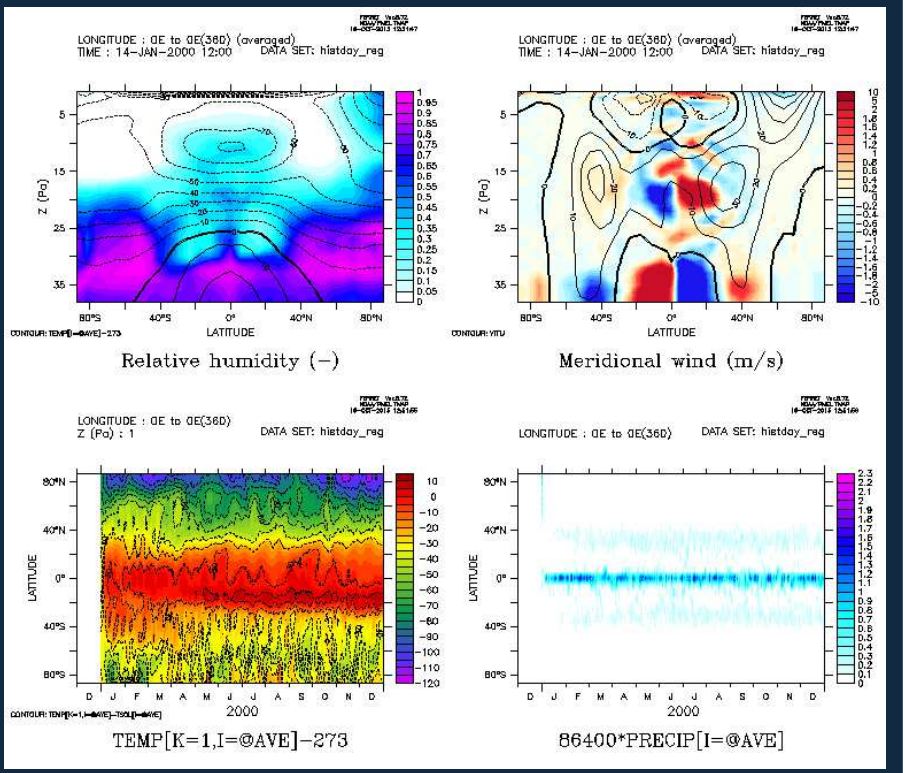
Preliminar results

- Global aqua-planet runs

WRF+LMDZ AR40.0

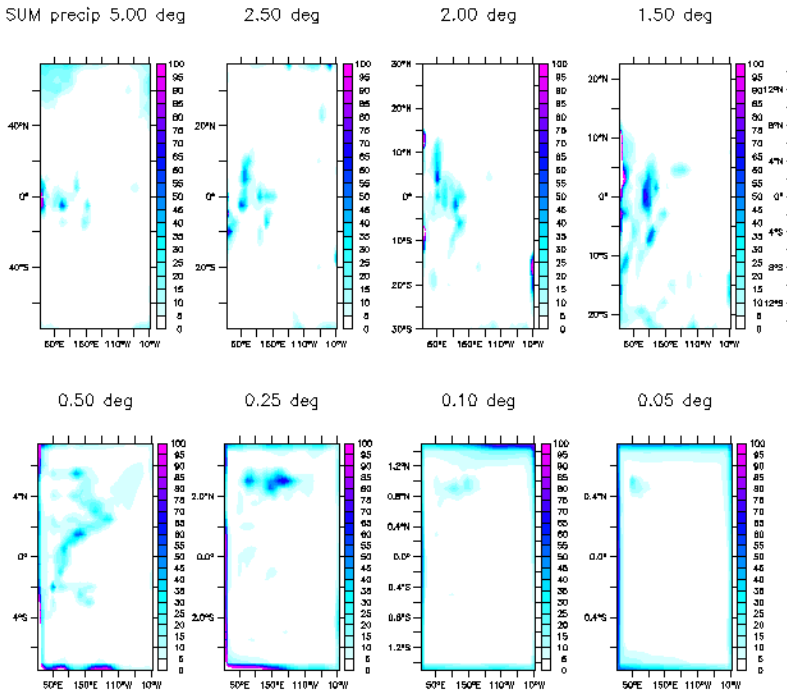


WRF+LMDZ NPv3.0



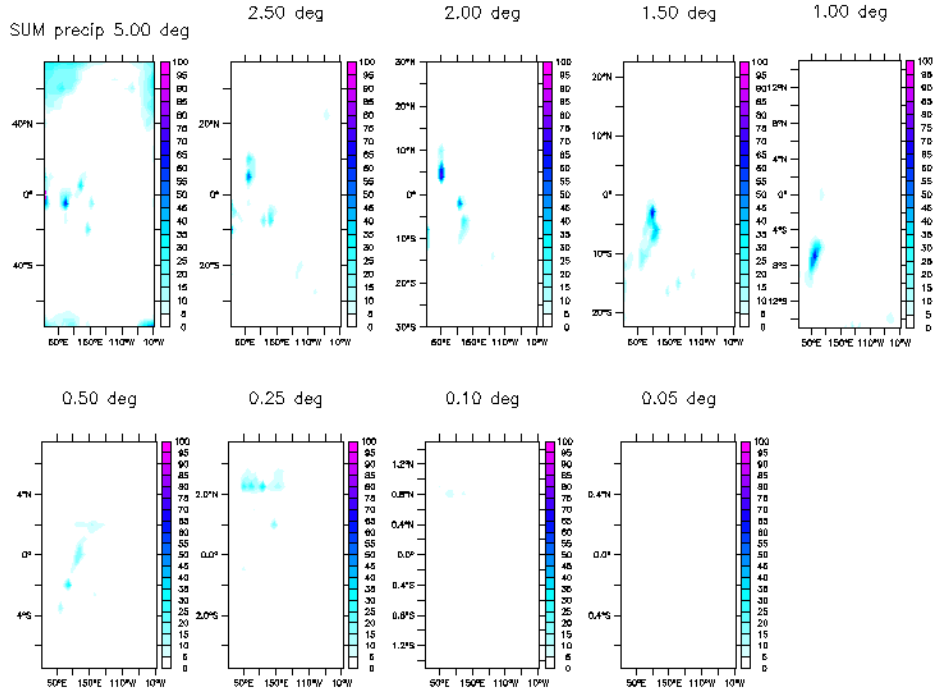
Preliminar results

- Regional aqua-planet runs: Zoom on point $N\ 0°, 171.56°W$



WRF+LMDZ AR40.0

Precipitation



WRF+LMDZ NPv3.0

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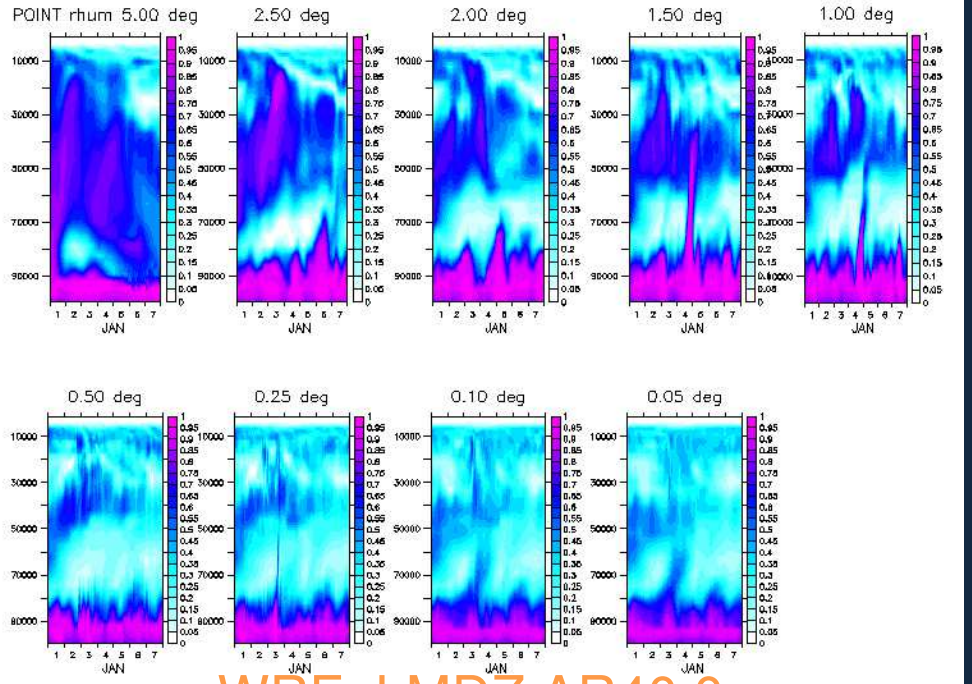
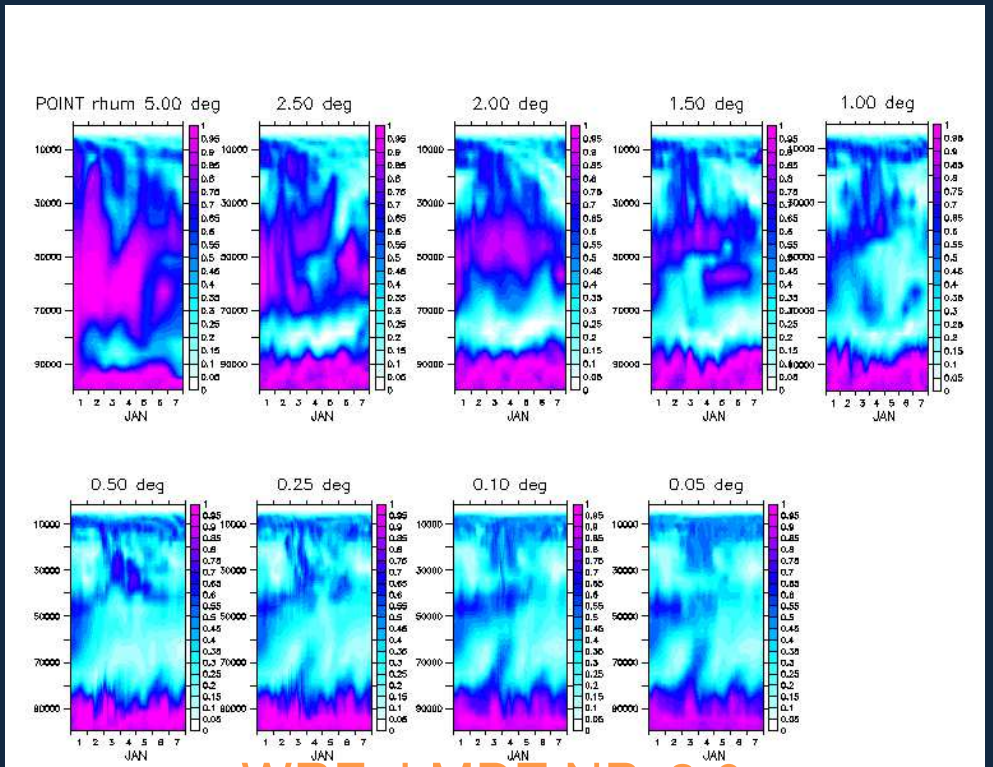


WRF+LMDZ AR40.0

Vertical relative humidity



WRF+LMDZ NPv3.0

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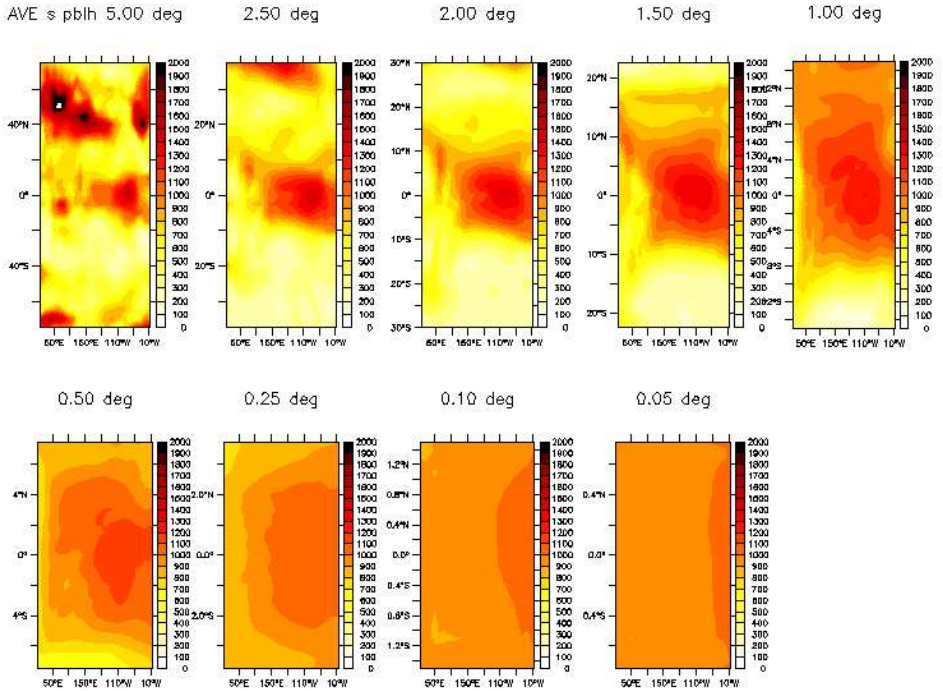
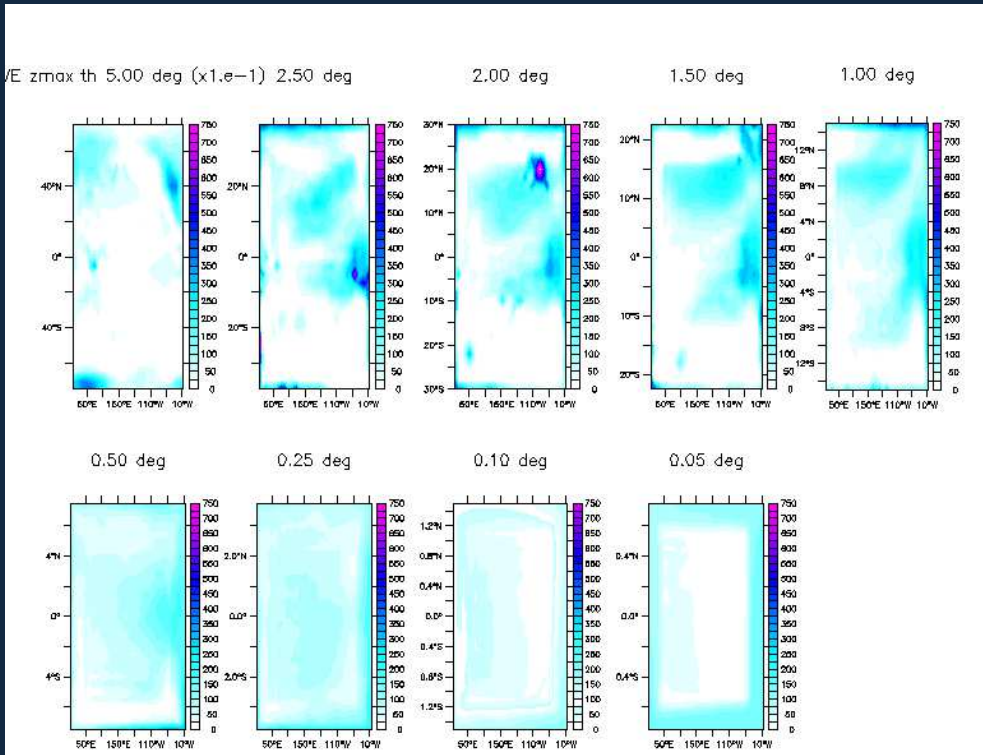


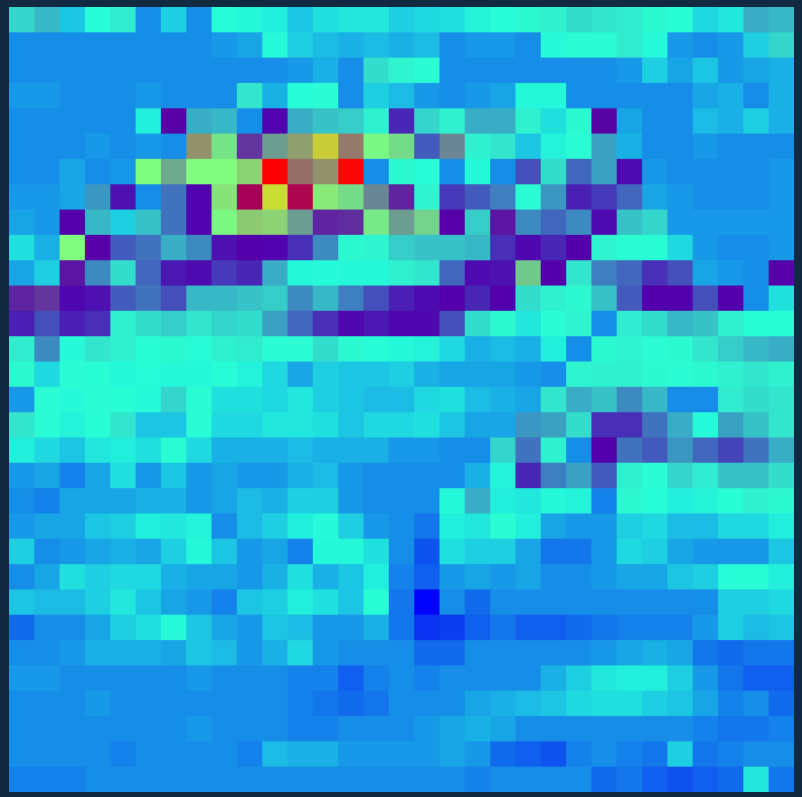
WRF+LMDZ NPv3.0 pbl height



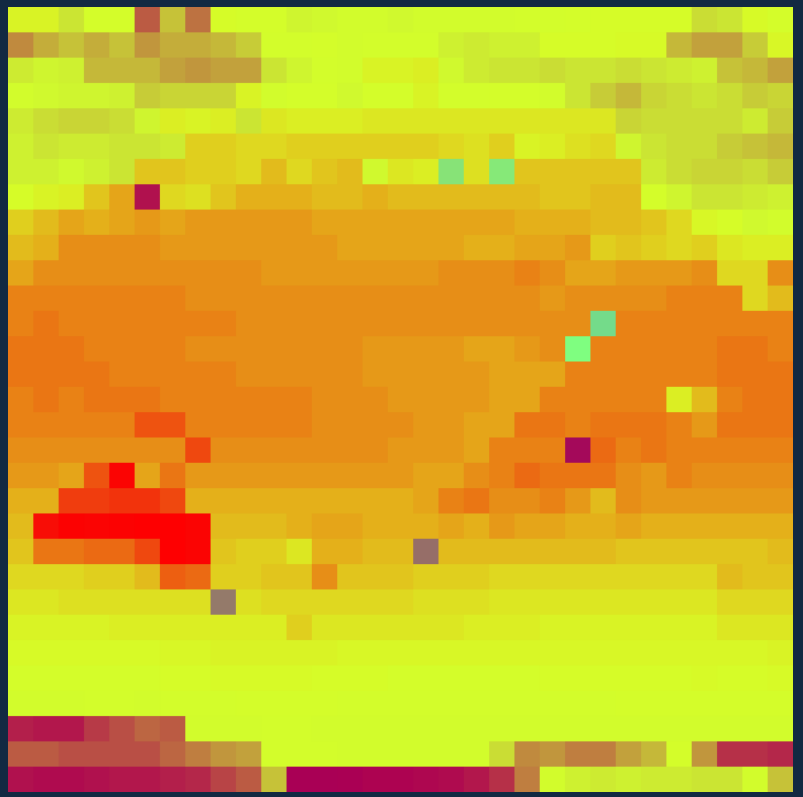
WRF+LMDZ NPv3.0 thermal h_{max}

Preliminar results

- Regional real 6h runs res $5°deg$: Centered on point $N\ 0°, 171.56°W$



Surface evaporation



soil temperature

Preliminar results

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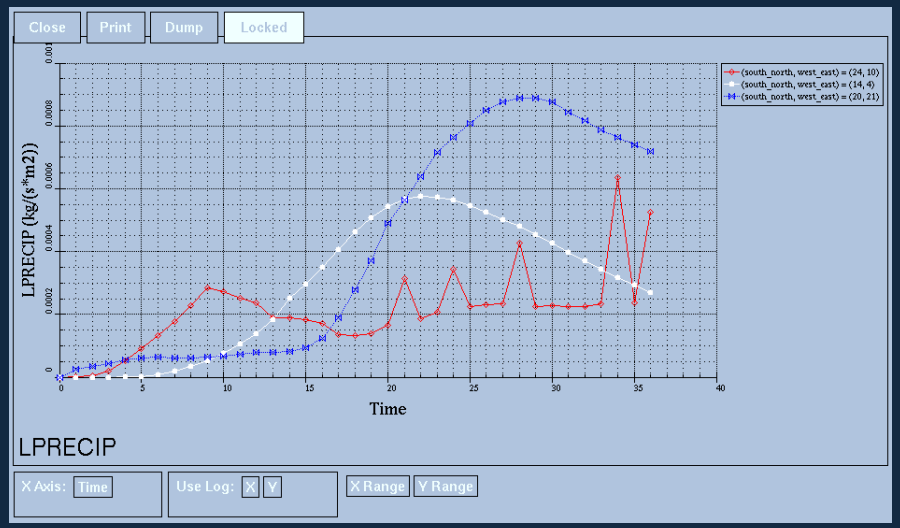
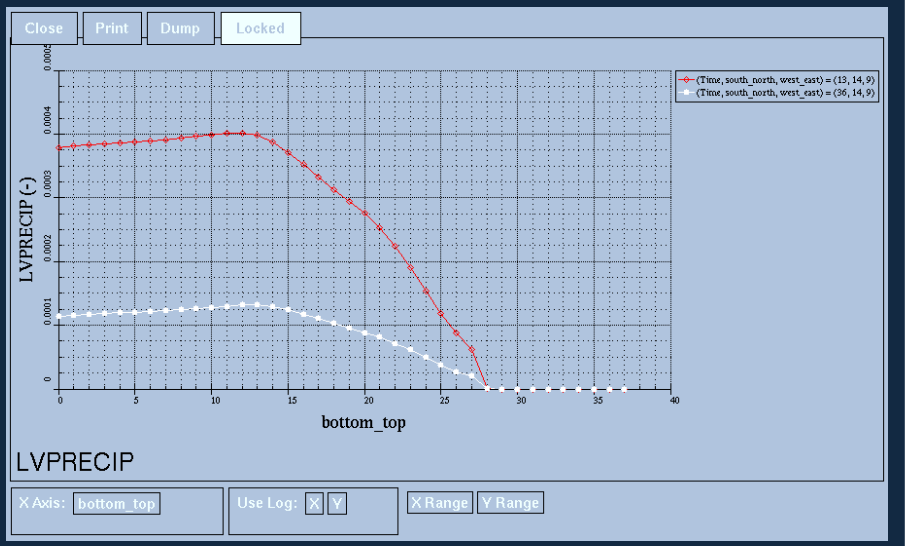


Precipitation evolution at different grid points



Vertical profile of precipitation at different times

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4. WRF does not distinguish between lic/sic, thus taking that WRF ice/glacier types and ter, the equivalents lic/sic are obtained:

$$lic = \sum_{ice}^{glacier} WRF_{soil} \times \frac{ter}{ter + oce}$$

$$sic = \sum_{ice}^{glacier} WRF_{soil} \times \frac{oce}{ter + oce}$$

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6. Taking the soil moistures and soil density at each level, the total soil water content at each grid point is computed as follows:

$$qsol = \sum_{k=1}^{4} \sum_{s=i}^{Nsoil} \delta x \delta y \delta z(k) \rho_s smois(k)$$