PALM Ocean Version

PALM group

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last update: 21st September 2015

PALM - Ocean Version - General Features

- Ocean and atmosphere version are sharing the same code.
- The ocean version is switched on by setting the +inipar - parameter:

```
ocean = .TRUE.
```

- There are only few parts in the code which differ between both versions. In the ocean version:
  - an additional prognostic equation for salinity is solved,
  - in the buoyancy term (w-equation) and the stability-related terms (SGS-TKE-equation), potential temperature is replaced by potential density,
  - density is calculated from the nonlinear equation of state for seawater. So far, only the initial hydrostatic pressure is entered into this equation.

PALM - Ocean Version - Equations

Momentum:

$$\frac{\partial \bar{u}_i}{\partial t} = - \frac{\partial \bar{u}_k \bar{u}_i}{\partial x_k} - \frac{1}{\rho_0} \frac{\partial \bar{p}^*}{\partial x_i} - \varepsilon_{ijk} f_j (\bar{u}_k - \bar{u}_{k_g}) - \delta_{i3} g \frac{\bar{\rho} - \tilde{\bar{\rho}}}{\rho_{ref}} - \frac{\partial \overline{u'_k u'_i}}{\partial x_k}$$

Potential Temperature:

$$\frac{\partial \bar{\theta}}{\partial t} = - \frac{\partial \bar{u}_k \bar{\theta}}{\partial x_k} - \frac{\partial \overline{u'_k \theta'}}{\partial x_k}$$

Density r = r(S,q,ph) is calculated from the equation of state for seawater using the algorithm from Jackett et al. (2006)

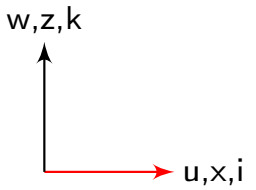
Salinity:

$$\frac{\partial \bar{S}}{\partial t} = - \frac{\partial \bar{u}_k \bar{S}}{\partial x_k} - \frac{\partial \overline{u'_k S'}}{\partial x_k}$$

$$\frac{\partial \bar{u}_k}{\partial x_k} = 0$$

$$\frac{\partial^2 \bar{p}^*}{\partial x_k^2} = \frac{\rho_0}{\Delta t} \frac{\partial \hat{\bar{u}}_k}{\partial x_k}$$

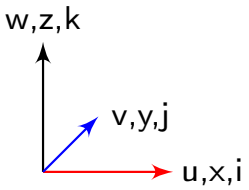
PALM - Ocean Version - Grid Structure and Conventions

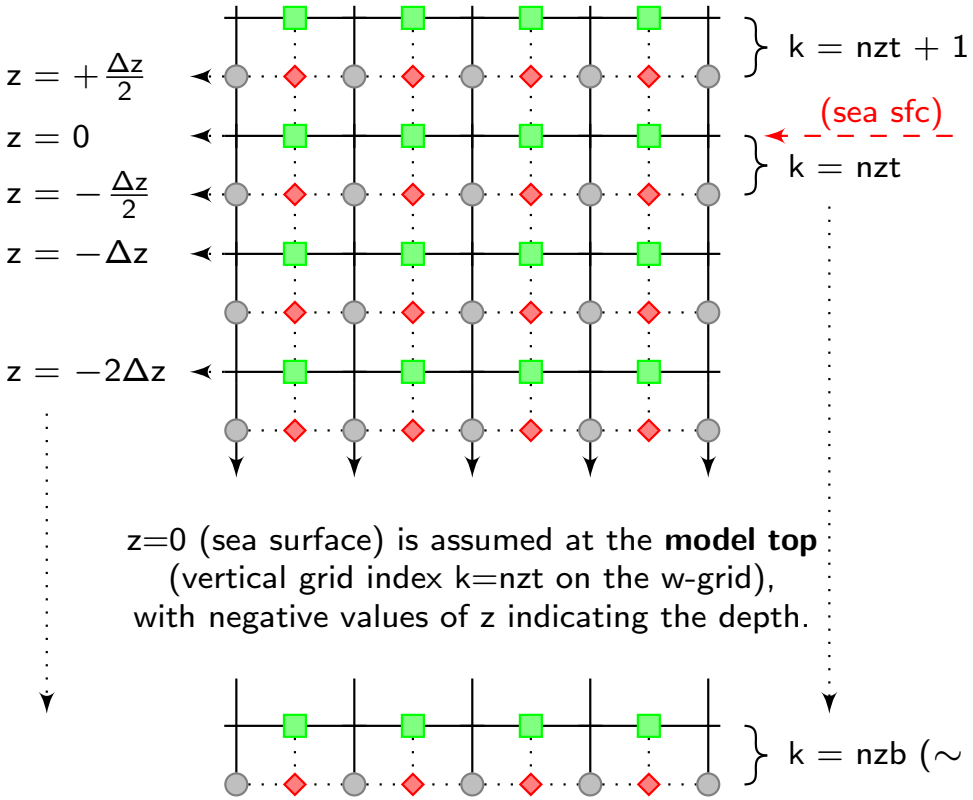


: w

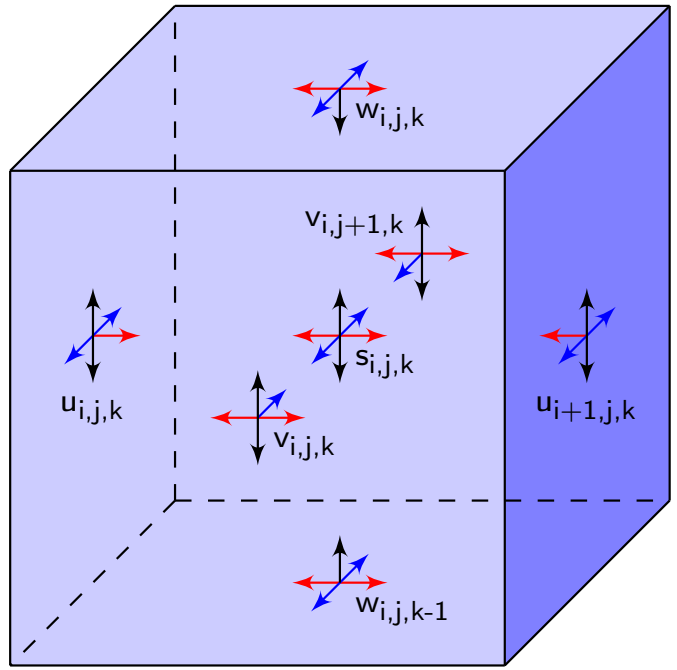
: u

: scalar (e.g. pt)





z=0 (sea surface) is assumed at the **model top**
(vertical grid index k=nzt on the w-grid),
with negative values of z indicating the depth.



PALM - Ocean Version - Boundary Conditions

The following boundary conditions should be used for the ocean version. Some of them are not set by default, so please set them manually.

- Ocean surface (z=0):
  - Fluxes should be given at the ocean surface for all quantities. This requires parameter

    ```
    top_momentum_flux_u = ..., top_momentum_flux_v = ..., bc_uv_t = 'neumann'
    ```

  - Momentum:

    ```
    use_top_fluxes = .TRUE.
    ```

  - Temperature:

    ```
    top_heatflux = ..., bc_pt_t = 'neumann'
    ```

  - Salinity:

    ```
    top_salinityflux = ..., bc_sa_t = 'neumann'
    ```

- Ocean bottom (z=-...)
  - A Prandtl-layer should be used at the bottom:

    ```
    prandtl_layer = .TRUE.
    ```

PALM - Ocean Version - Further Settings

- Initial profiles:
  - The ocean version can only use:

    ```
    initializing_actions = 'set_constant_profiles'
    ```

  - Profiles are constructed piecewise linear from the top (surface), using parameters (e.g.):

    ```
    pt_surface = ..., pt_initial_gradient = ..., pt_initial_gradient_level = ...
    ```

- Random perturbations:
  - Random perturbations are by default applied to the upper third of the model domain!

PALM - Ocean Version - Final Remarks

- The ocean version of PALM has not been tested sufficiently so far! Only some plausibility checks have been done.
- Please carefully check the results and please also check the code.
- Effects of surface waves (Langmuir circulation, wave breaking) are not included in the standard code.