

Clouds

The IFS predicts the three-dimensional cloud field with three variables for each grid box; cloud fraction, cloud liquid water and cloud ice. Cloud processes such as condensation, evaporation, glaciation and precipitation formation in convective and stratiform clouds are all taken into account with physically-based equations.

Cloud is parameterised within a grid box as stratiform or convective according to the stability or instability of the IFS model atmosphere but it is possible to have both types where convection does not extend throughout the IFS model troposphere (e.g. convection limited to lower troposphere with stable moist layer above). Only rain or snow is produced by the precipitation scheme and hail is not considered nor developed in the IFS model convection scheme, no matter how unstable is the IFS model atmosphere.

There are some meteorological situations that are more challenging to forecast than others. One of these is stratiform cloud beneath an inversion, especially subsidence inversions in high pressure situations, which can be difficult for atmospheric models to both analyse and forecast. Often there is uncertainty regarding the cloud extent, phase, thickness or persistence. This has a corresponding effect on radiation balance at the surface and consequently also upon near-surface temperatures. Users should check the analysed cloud against observations as far as possible in these circumstances (see also [model boundary layer](#)).

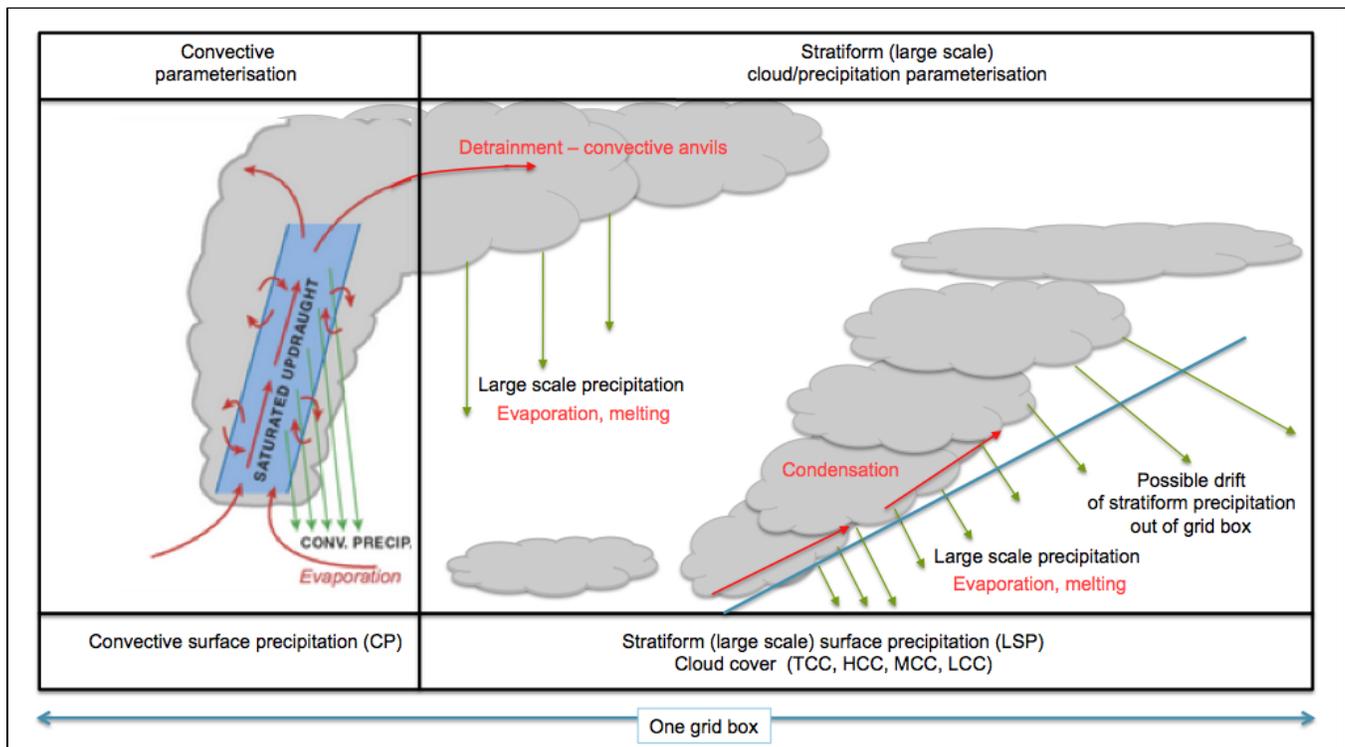


Fig2.1.20: Schematic diagram to illustrate the parameterised processes for precipitation and clouds within a single grid box. A cloud-overlap algorithm calculates the relative placement of clouds across IFS model levels. This is important for the "life history" of falling precipitation (from level-with-cloud to level-with-clear-sky and vice-versa) and this process may occur several times during the descent of the IFS model precipitation.

Convection processes (due to subgrid-scale convective updraughts) are calculated separately from larger scale cloud processes (e.g. due to large-scale ascent or radiative cooling), but the two schemes are connected and represent different parts of the cloud and precipitation in a grid column. The convection "detrain" cloud and precipitation to the large-scale cloud scheme, representing convective anvils and the precipitation associated with the more stratiform part of the convective cell. However, the main part of the precipitation from the core of the updraught is treated diagnostically in the convection scheme, with the assumption that all the precipitation falls out within the grid column in a timescale less than the model timestep.

In contrast, the precipitation from the large scale cloud scheme has a finite fall speed and can be blown laterally by the wind across grid boxes during descent.

The low, medium and high and total cloud cover for each grid column are calculated from the profile of the predicted cloud fraction using assumptions about the overlap between the subgrid clouds in the vertical (whether the layers of cloud are stacked above one another in the vertical, or whether they are displaced relative to one another).

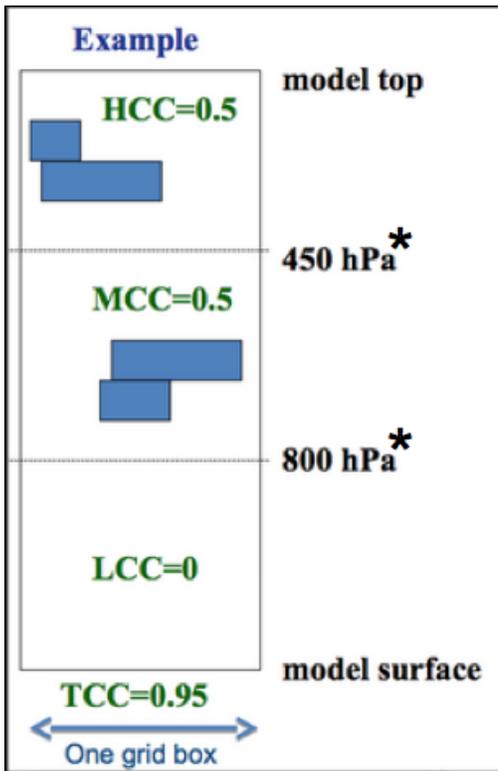


Fig2.1.21: *Example of Assessment of Cloud Cover.*
IFS model cloud layers are assigned as:

- High-level cloud cover (HCC). - Cloud integrated from top of the atmosphere down to 450hPa*.
 - Medium-level cloud cover (MCC). - Cloud integrated from 450hPa* down to 800hPa*.
 - Low-level cloud cover (LCC). - Cloud integrated from 800hPa* down to the surface.
- But note: the Total Cloud Cover (TCC) is cloud layers integrated from the top of the atmosphere down to the surface with overlap assumptions based upon global observations. The degree of randomness in the overlap is dependant upon distance between layers. Hence **TCC = HCC + MCC + LCC.**

* strictly pressure levels are not used, but actually the IFS model levels that correspond to the given pressure levels in a standard atmosphere. This means that one can get low cloud over the Tibetan plateau, for example, because we are using there the same IFS model levels to divide up cloud layers that we use the over open ocean.