COSMO User Seminar 2015 – NWP Model Applications and Case Studies – Poster S03-08

Application of the COSMO Model at the Brazilian Navy
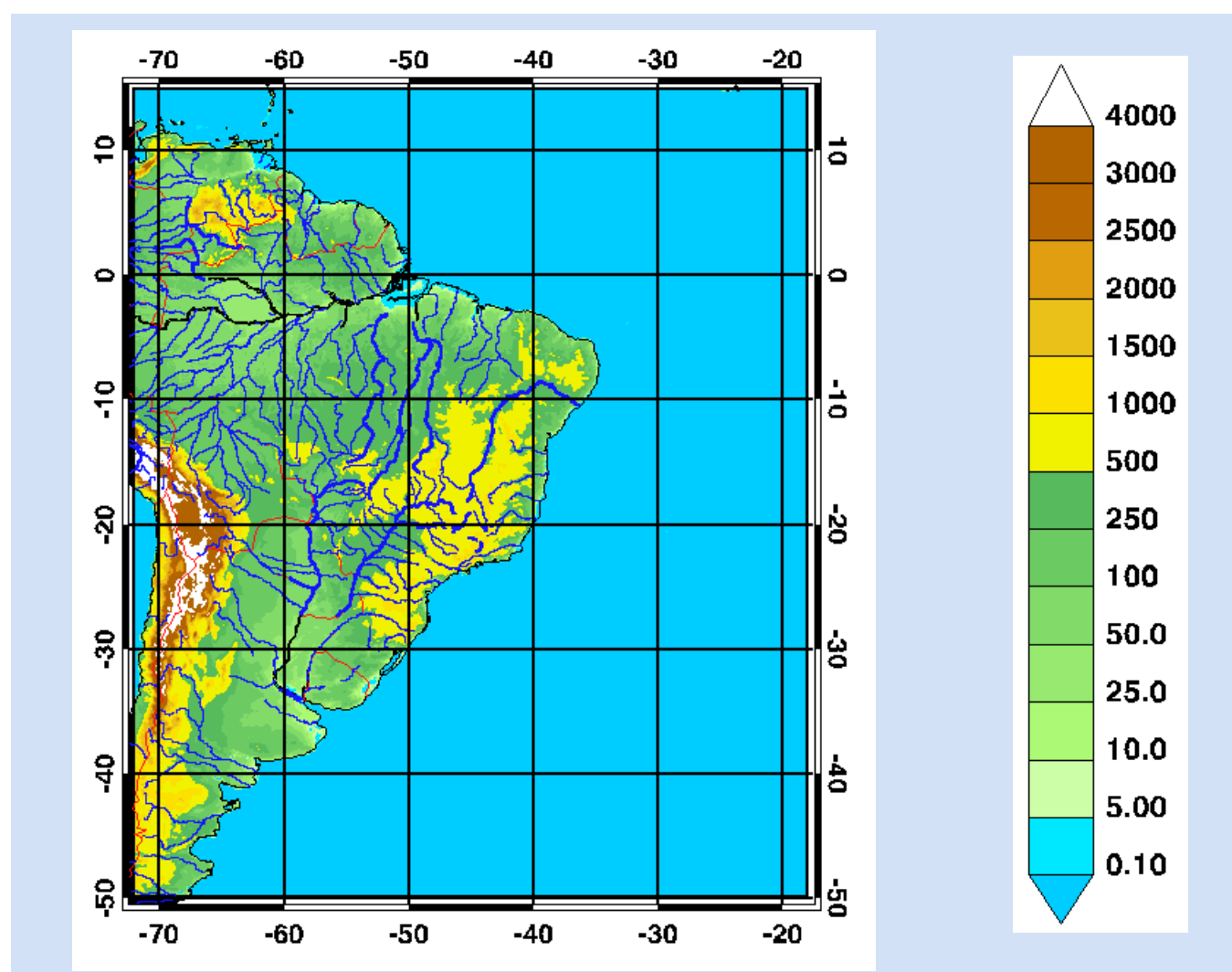
The Brazilian Navy has licensed the COSMO model and uses it for operational forecasts twice a day at 00 and 12 UTC for a domain located along the Brazilian coast and another one in the Antarctic region (Fig. 1) with a horizontal grid size off 10 km respectively. The forecasts are carried out by the Centro de Hidrografia da Marinha (CHM), located in Niterói.

In the framework of the program "Science Without Borders" of the Brazilian government, a cooperation between CHM and DWD was started, aiming to improve the numerical weather prediction in these domains.

Fig. 1: Operational model domains.

Configuration

In the beginning of the cooperation new versions of INT2LM (V2.1) and COSMO (V5.1) were installed on the new SGI Altix ICE X machine (1128 Intel ®Xeon cores) of the Brazilian Navy.

The necessary adjustments to use the new global non-hydrostatic model ICON (operational since 20.01.2015 at DWD) as the driving model were carried out in the model scripts.

Apart from the new binaries new sets of external parameters including for example a satellite (MODIS) retrieved albedo (Fig. 2) and the Tegen et. al (1997) climatology for the optical thickness of different kinds of aerosols were implemented.
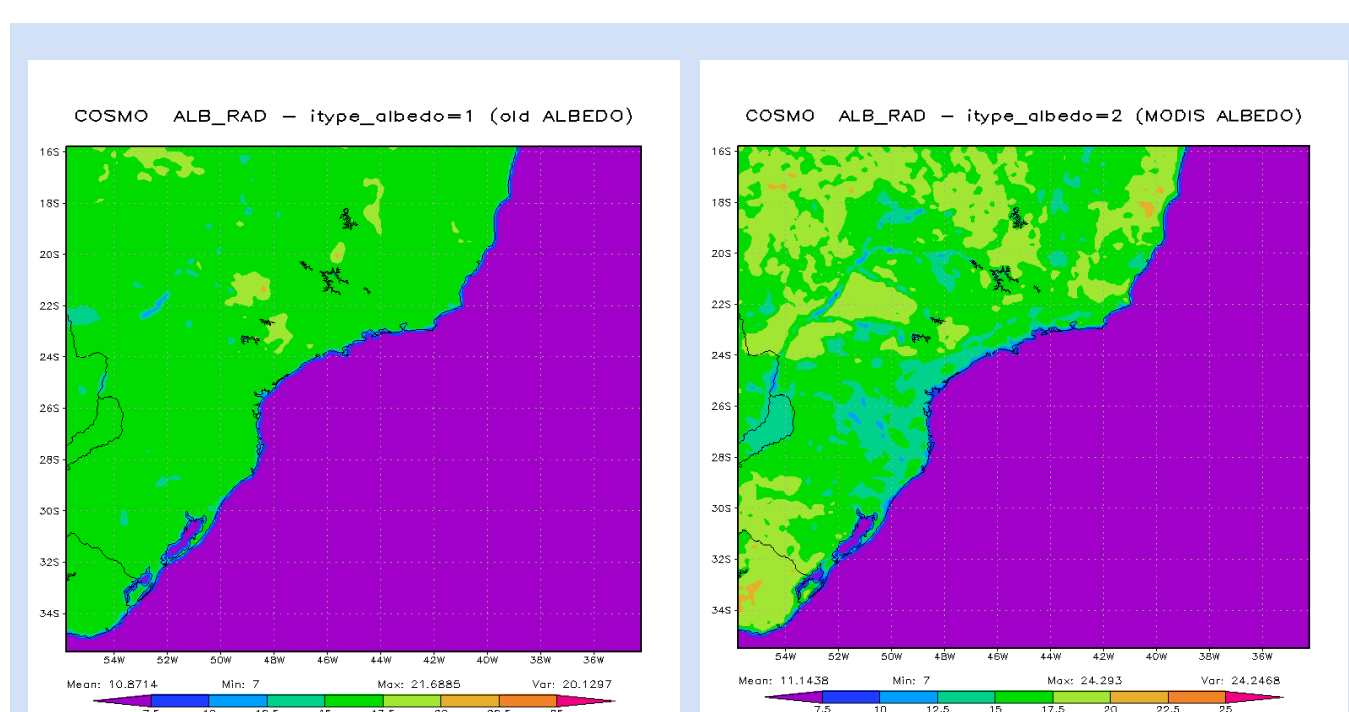

Fig. 2: Albedo – left: old , right: MODIS retrieved.

For the main domain along the Brazilian coast the general configuration was changed to the so called "tropical setup", i.e. a higher model top and Rayleigh damping layer as well as a reference state more representative for low latitudes (Fig. 3).
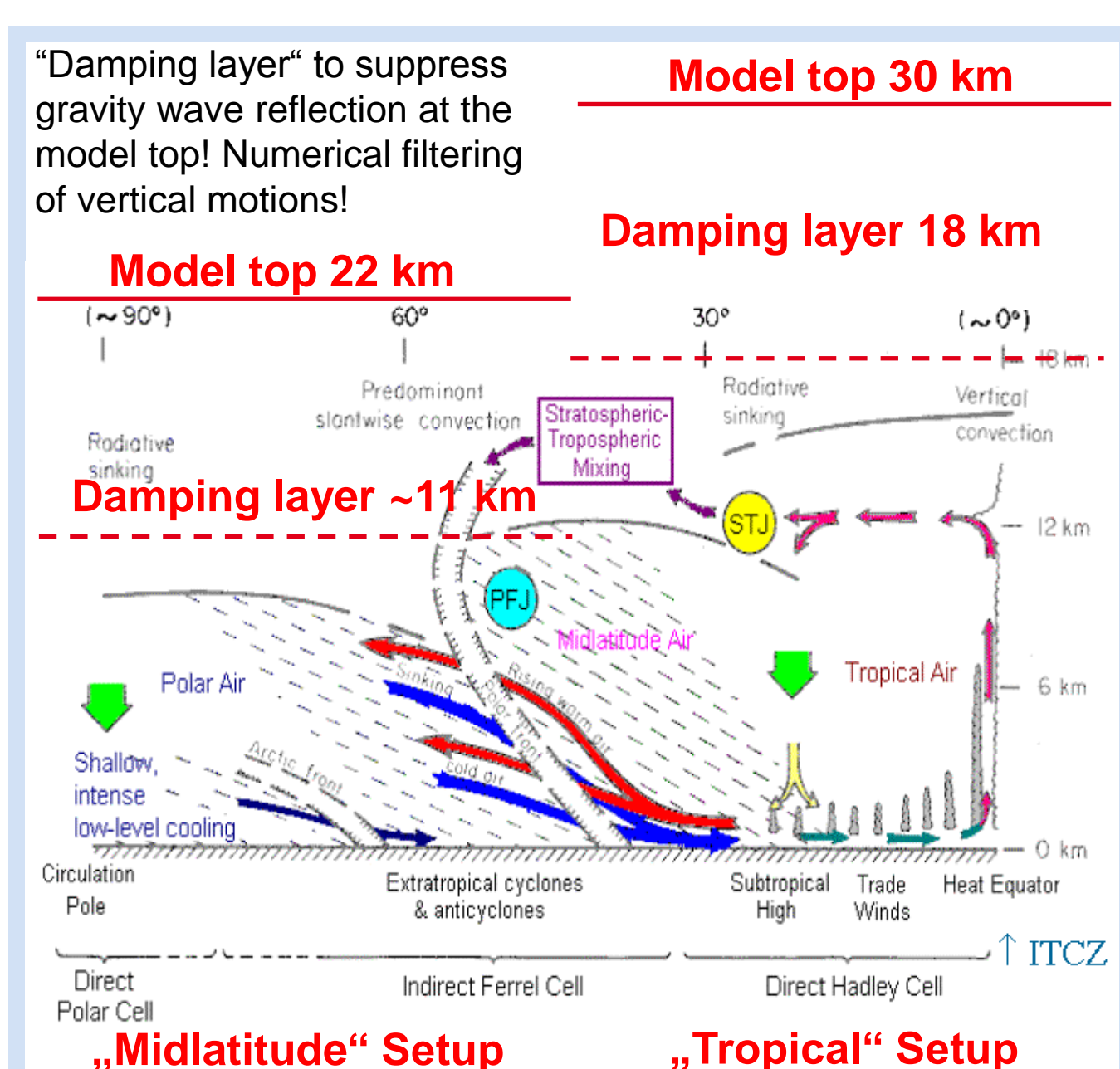

Fig. 3: Model configurations (Graphics from internet).

Coastal Precipitation

One main experience of the forecasters at Brazilian Navy was that COSMO often misses the coastal precipitation in the Rio de Janeiro region. To address this shortcoming a case study was carried out. Selected was the day ahead forecast of the precipitation for 14.11.2014. Mainly the two NAMELIST parameters 'rat_sea' and 'cloud_num' were varied. Basically the parameter 'rat_sea' is a scaling factor for the thickness of the laminar sublayer over sea, which is used in the transfer scheme. I. e. a reduction of the tuning parameter 'rat_sea' selectively increases the heat flux over sea. This already led to an improvement of the forecast.

In a further step, the assumed number concentration of aerosols in the cloud microphysics 'cloud_num' was changed to a ten times lower value, representing a more maritime setting (Fig. 4).
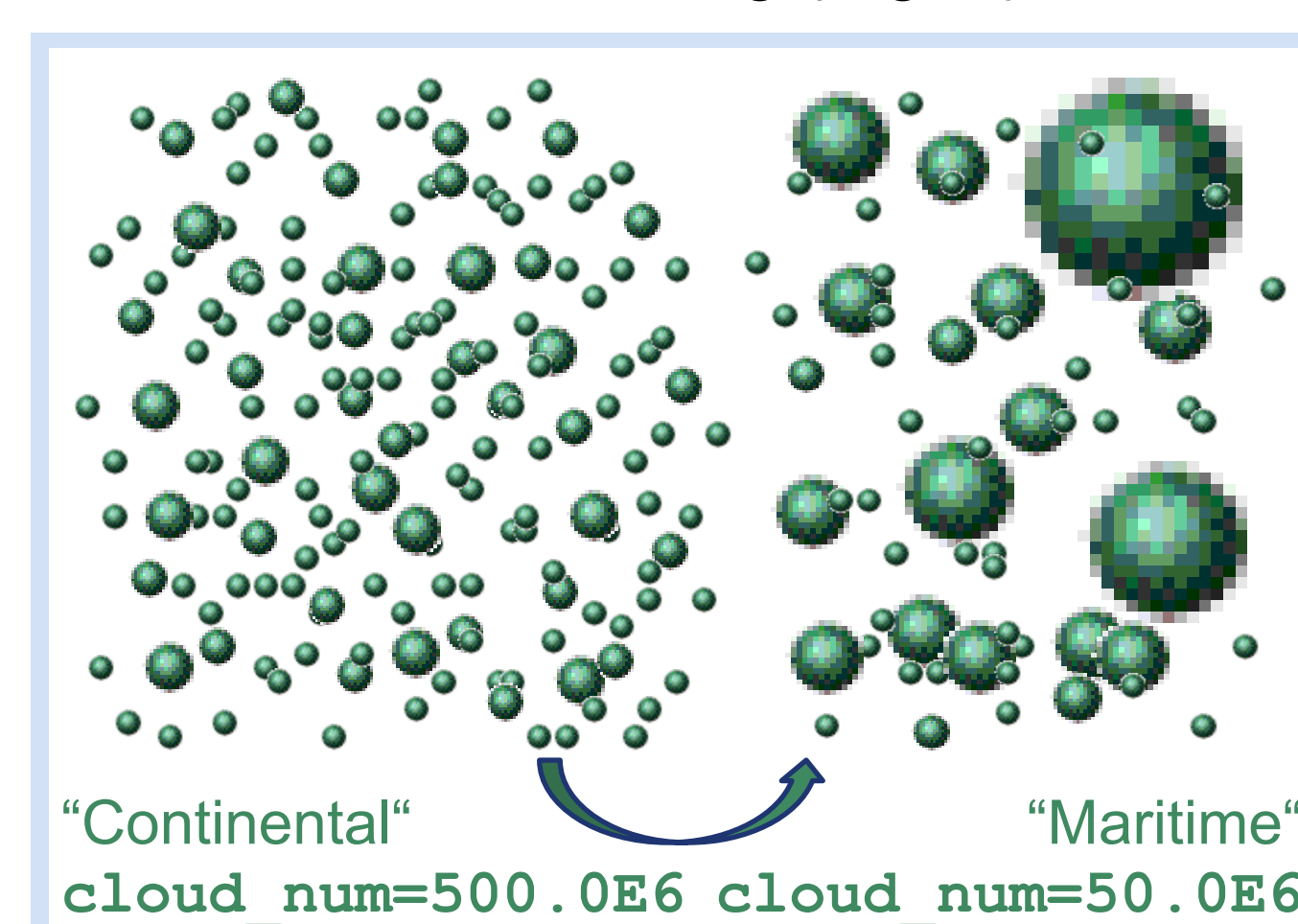

"Continental"
cloud_num=500.0E6

"Maritime"
cloud_num=50.0E6

Fig. 4: Tuning of assumed aerosol number concentration in bulk cloud microphysics.

Results for the 6-hourly accumulated total precipitation are shown in Fig. 5. Halving the value of 'rat_sea' gives already some precipitation in the region of Rio de Janeiro. Changing 'cloud_num' to a "maritime" value further enhances the coastal precipitation. But some precipitation around -25° latitude is still missing. Halving the value of 'rat_sea' a second time, i.e. further reducing the thickness of the lamina sublayer over sea mainly broadens the precipitation patterns and gives some more rain over the sea.

Further investigations and verifications have to show if a value of 'rat_sea' as low as 5.0 is reasonable and does not degrade other forecast variables.

In Fig. 6 the change of the relative humidity field of the latest run with the

a) rat_sea=20.0 cloud_num=500.0E6 (ctrl)

b) rat_sea=10.0

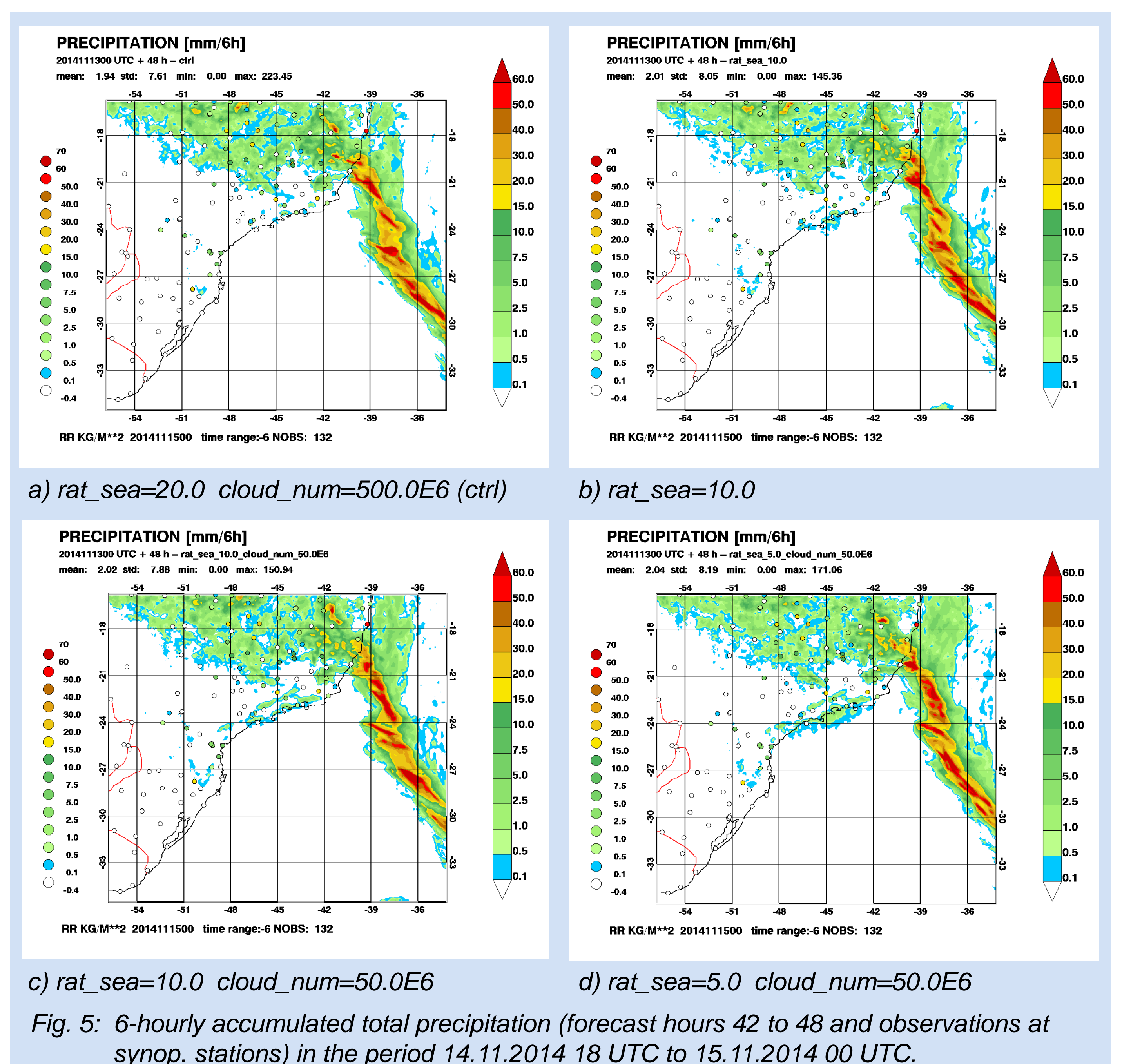c) rat_sea=10.0 cloud_num=50.0E6

d) rat_sea=5.0 cloud_num=50.0E6

Fig. 5: 6-hourly accumulated total precipitation (forecast hours 42 to 48 and observations at synop. stations) in the period 14.11.2014 18 UTC to 15.11.2014 00 UTC.
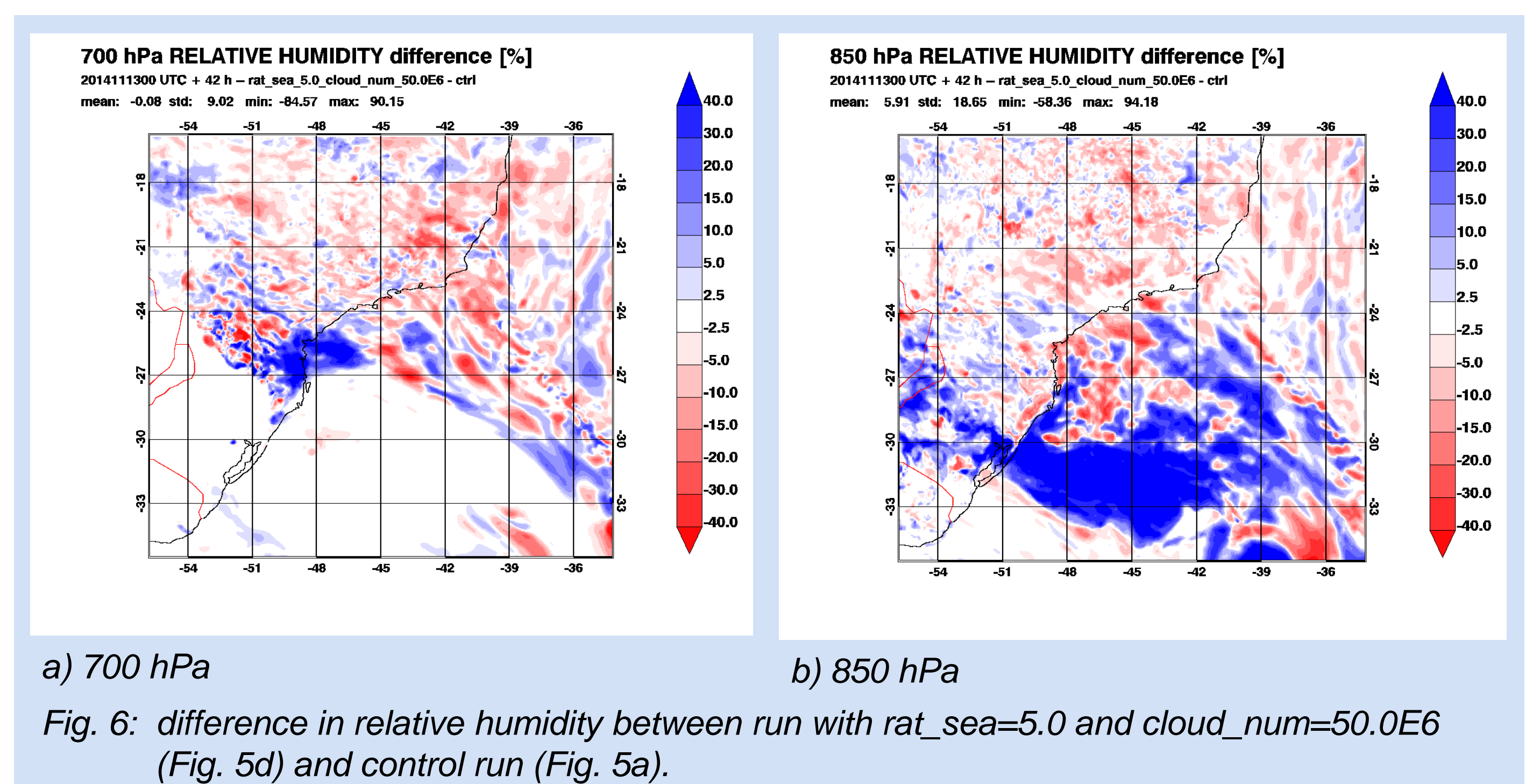

a) 700 hPa

b) 850 hPa

Fig. 6: difference in relative humidity between run with rat_sea=5.0 and cloud_num=50.0E6 (Fig. 5d) and control run (Fig. 5a).

biggest changes compared to the control run is shown. Clearly the changes lead to a moistening of the atmosphere over sea.

Outlook

In the next phase of the project in summer 2015 the Tiedtke-Bechthold scheme (Bechthold et al. 2014) in the version which is currently running in the ICON model will be tested. The hope is that it will outperform the traditional Tiedtke scheme commonly used in the COSMO in the tropical region.

For the Summer Olympics 2016 in Rio de Janerio it is planned to run a high resolution version of COSMO with a grid size of approx. 2 km on the domain shown in the plots above.

It is planned to run this version in a nudging data assimilation cycle.

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