An overview of the ERA-40 analyses

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Humidity analyses and ITCZ precipitation.

The early diagnostics indicate an unrealistic increase in humidity and precipitation, primarily over the tropical oceans. (fig.1)

To investigate, two simple Observing System Experiments were run by re-analyzing January 1993 with

1) SSM/I data removed (exp. 0259)

2) All satellite radiance data removed (exp. 0261)

These two assimilations were compared with the production assimilation 0018.

The zonal mean analysis increments (analysis - background forecasts) averaged for all analysis cycles in January 1993 for the three experiments are shown in figures 2, 3 & 4 and the zonal means of the precipitable water content (PWC) in fig.5. The map in figure 6 shows the geographical distribution of the 'wetting' from the satellite radiances (SSM/I and HIRS)

In fig. 7 the zonal means of the total precipitation from the three assimilations, at +6h and +24h, are compared. Independent estimates from 'GPCP', 'CMAP' and the NCEP/NCAR reanalysis are also included.

Conclusion:

It is seen that removal of the SSM/I had very little impact on the humidity analyses and the monthly mean PWC PWC. The removal of all satellite radiances had a much bigger effect, both in PWC which is now closer to the NASA NVAP estimates, and in the total precipitation, particularly on the southern (summer) side of the ITCZ.

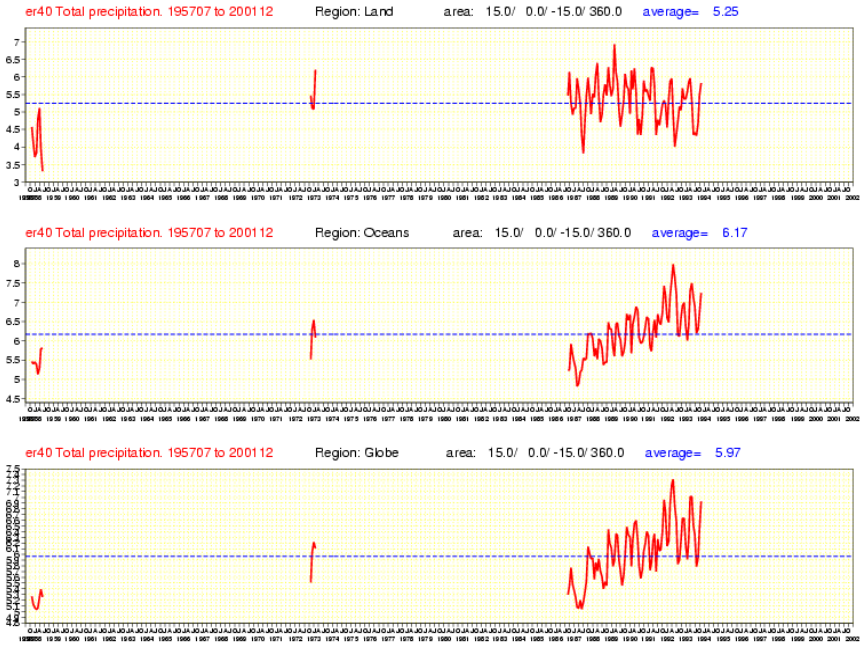


Fig.1

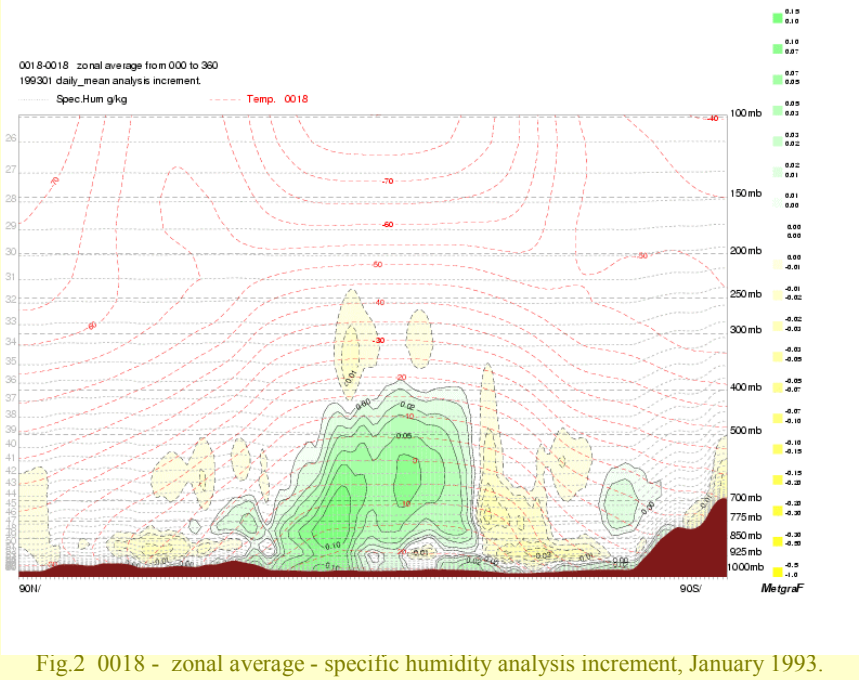


Fig.2 0018 - zonal average - specific humidity analysis increment, January 1993. Both HIRS and SSM/I

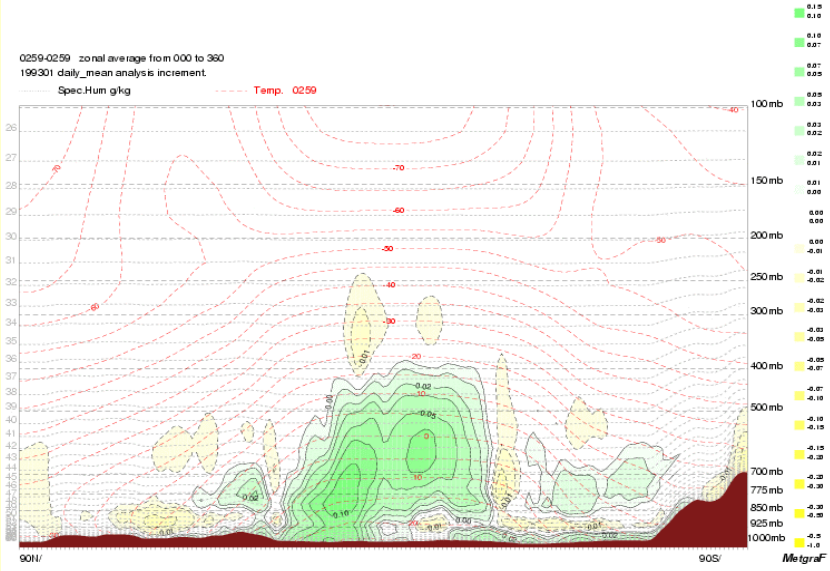


Fig.3 0259 - zonal average - specific humidity analysis increment, January 1993. HIRS but no SSM/I

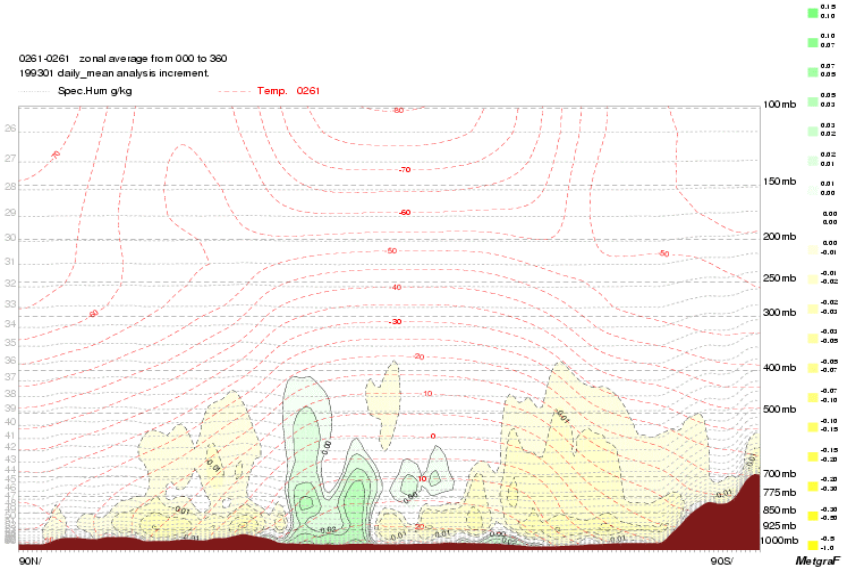
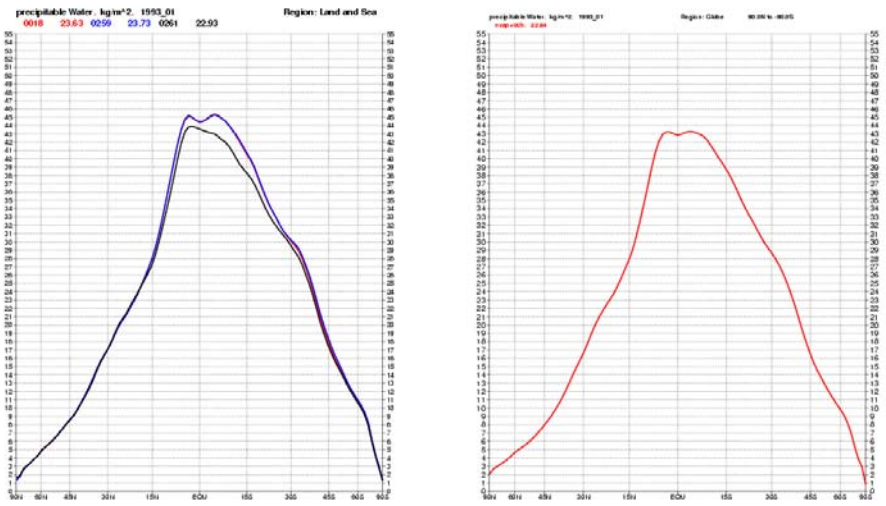


Fig.4 0261 - zonal average - specific humidity analysis increment, January 1993.
no HIRS, no SSM/I



0018 0259 0261 fig.5 NVAP

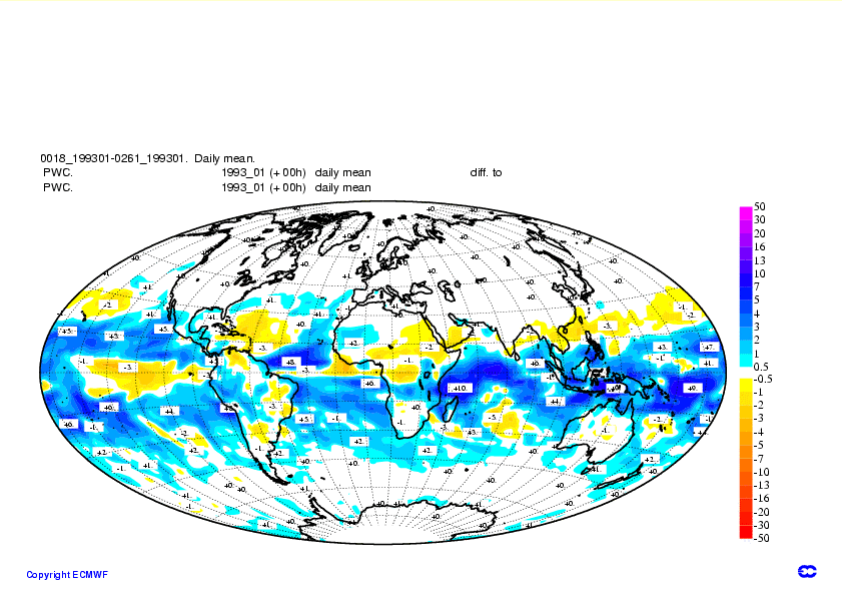


Fig.6 The difference 0018-0261 in monthly/daily mean PWC. January 1993

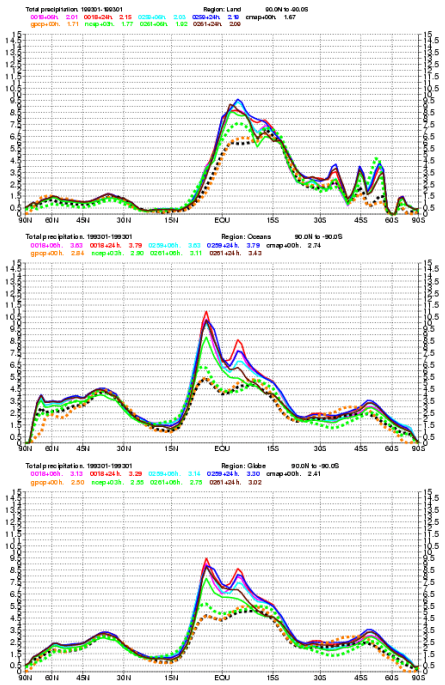


Fig.7

Zonal averages of total precipitation

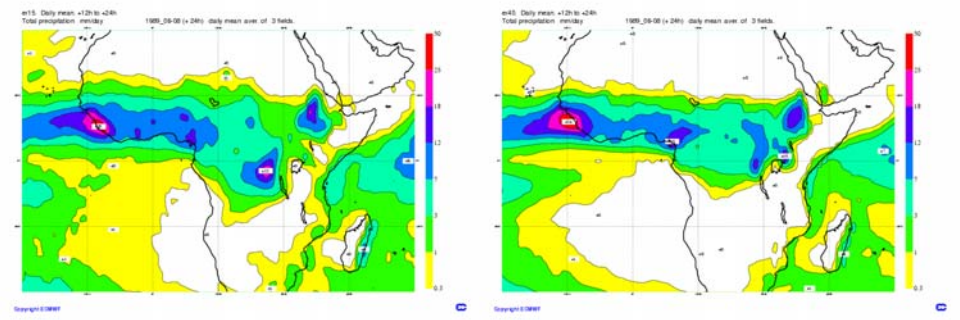
stream1 (0018)	+06h
stream1 (0018)	+24h
no SSM/I (0259)	+06h
no SSM/I (0259)	+24h
no sat.radiance (0261)	+06h
no sat.radiance (0261)	+24h
ncep/ncar reanalysis	
cmap	
gpcp	

African 'rain problem'

In Africa between 1988 and 1992 'the position of the ITCZ shifts by 10º to the south … being less reasonable' (Stendel & Arpe in ERA-15 Project Report Series #6)

The top left map in figure 9 shows an unrealistic precipitation maximum to the northwest of Lake Tanganyika in ERA-15. This feature is not seen in the DWD GPCC gauge measurement analysis in the bottom map.

ERA-40 does also does not show this, as seen in the top right map.



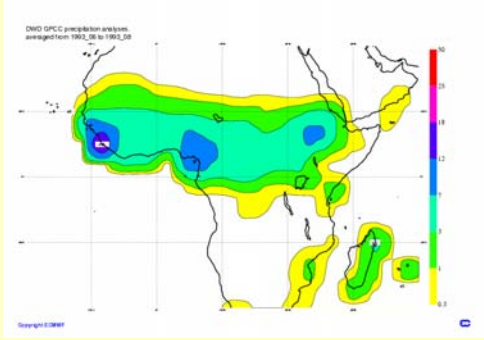


Figure 9

Rain over Africa, June-August 1989

ERA-15 (top left)

ERA-40 (top right)

DWD GPCC (bottom right)

the hydrological balance

There was some concern about spin-up in ERA-15.

Has it changed in ERA-40 ?

Compare 7 years of the of the spin-up from +6h to +24h in ERA-15 (top left maps) and ERA-40 (bottom right maps)

The stratiform precipitation (in fig.8) spins up in both reanalyses; in the ITCZ and in mid-latitude stormtracks

The considerable spin-up of the convective precipitation in ERA-15 (in fig.9) has been much reduced in ERA-40.

In ERA-15 the evaporation (in fig. 10) increased considerably during the short forecasts. Much less so in ERA-40.

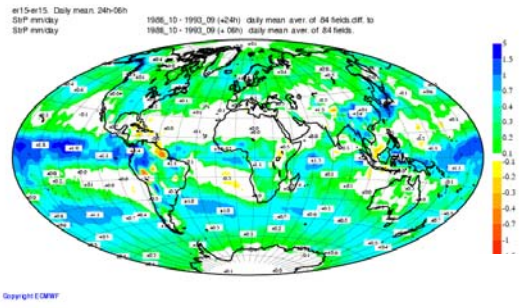
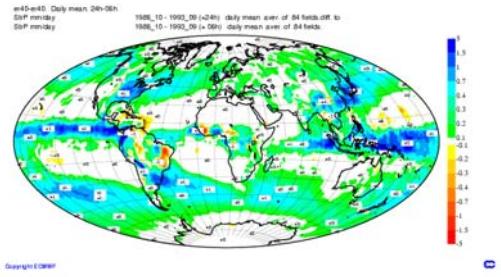


Fig.8

stratiform precipitation

+24h difference to +06h

ERA-15 (top)
ERA-40 (right)



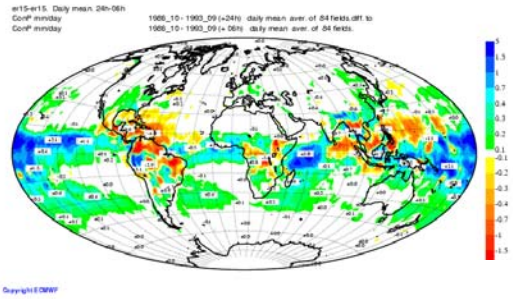
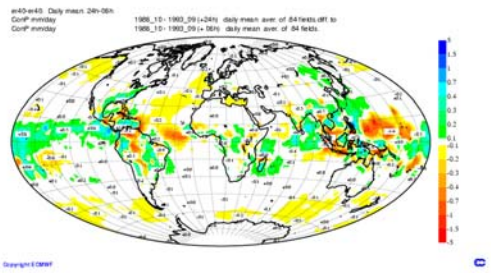


Fig.9

convective precipitation

+24h difference to +06h

ERA-15 (above)
ERA-40 (right)



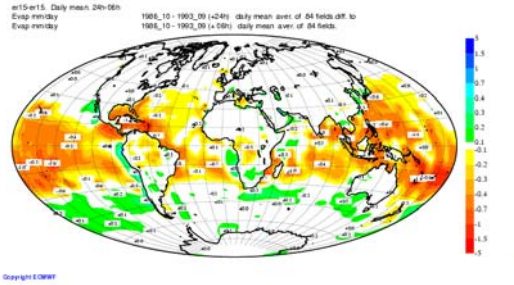
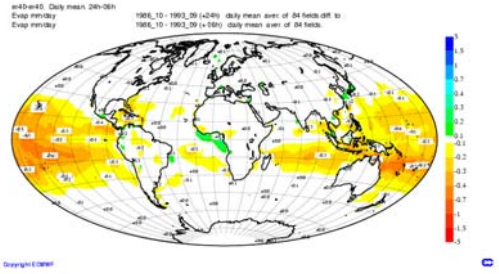


Fig. 10

evaporation

+24h difference to +06h

ERA-15 (above)
ERA-40 (right)



Conclusions.

In ERA-15 the ocean evaporation increased considerably during the short forecasts. This was attributed to the use (by mistake) of non-representative 10-metre wind observations from isolated island stations. The increasing evaporation lead to spin-up in the tropical ocean convection. This problem has been removed in ERA-40.

'Excess' water, added primarily in the tropics by the use of satellite radiances in ERA-40, rains out during the first 24 hours of the forecasts. This is primarily taken care of by the stratiform processes.

The intermittent nature of the 3D-Var assimilation has a tendency to suppresses the development of mid-latitude baroclinic disturbances.

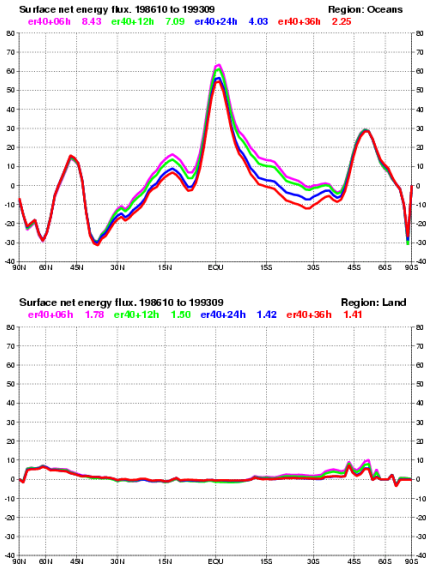


Fig.11

The net energy exchange at the surface in ERA-40

7 year mean including the 'preliminary' assimilation of 1987-1988

The best balance over the oceans is at +36h

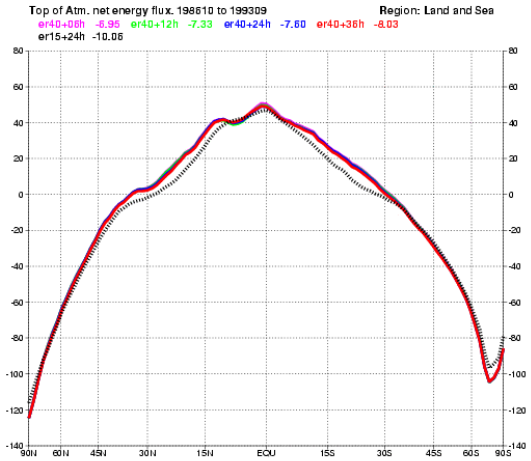


Fig. 12

7-year mean of
the net energy exchange
at the top of the atmosphere

ERA-40 and ERA-15

net energy exchanges

conclusions

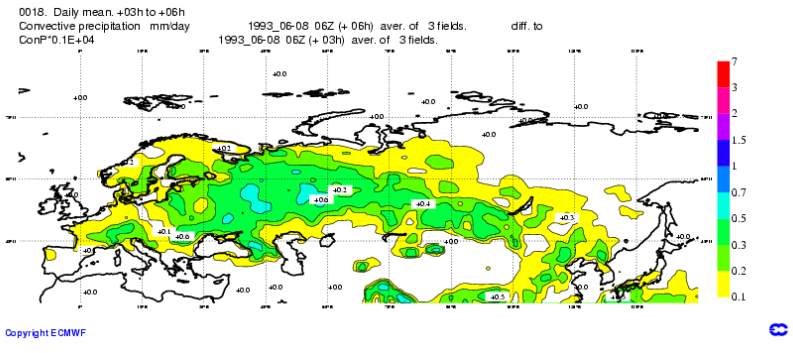
- net surface energy flux
  - best balance over sea at +36 hours (2.25 W/m²)
  - corresponding to a net energy flux ~0.7 PW into the ocean
  - dominating contributor: evaporation

- net T.O.A. energy flux
  - net cooling of the earth which increases slowly - to ~8 W/m² at +36h
  - it was ~10 W/m² in ERA-15 (+24h)

diurnal phase of the convection

The map in figure 13 shows the 3-hour convective rain from forecasts starting at 06UTC, averaged for June-August 1993

The convective precipitation has its maximum at, or even before, noon, which is unrealistic.



09 Y 12 local sun

12 Y 15 local sun time

15 Y 18 local sun

Fig 13.
ERA-40 convective rain (mm/3h) from 06UTC+03h to 06UTC+06h June-August 1993