Report on my Stay

at Météo-France in Toulouse

06.11. – 15.12.2007

During my stay at Météo-France in Toulouse I was working together with *Pierre Brousseau* on the topic data assimilation in AROME. Since AROME is already a non-hydrostatic model, there have been introduced some more microphysics parameters, therefore, new prognostic variables as well, such as cloud water, ice crystals , rain, snow, graupel, and turbulent kinetic energy. Their use leads to new surface fields, for instance surface albedo, surface emissivity, geopotential (orography) parameters, soil parameters, and vegetation parameters such as the field regarding evapo-transpiration. However, not all of the new surface fields are needed in the data assimilation process. The initial task was to conclude which fields are needed, and where and how to "swich them on".

Data assimilation with 3D-VAR

In order to clarify the difference between the surface fields used by the 3D-VAR data assimilation in ALADIN and AROME, we first ran the following three experiments with the same set of observations:

- `ALADIN`: an ALADIN 3D-VAR data assimilation,
- `AROME0`: an AROME 3D-VAR data assimilation setting the key `larome=.false.`,
- `AROME1`: an AROME 3D-VAR data assimilation setting the key `larome=.true.`.

Comparing the results obtained by the SCREENING in the cases of the above experiments, we could see the differences in the J_o-table, i.e. in the anaysis fields. The biggest differences were found concerning the values of the 2 meter temperature and 2 meter humidity. From now on we concentrated on experiment `AROME1`, and took the result of experiment `AROME0` as a reference. Hence, `AROME1` should have been modified in a way to be able to give back the result of `AROME0`.

To achive this aim, we looked at the setup routine

```
cy32t3_main.01/arp/setup/su0phy.F90
```

where the following keys are set to `false` after the switch containing the key `LAROME`: `LCVRA` (deep convection), `LGWD` (gravity wave drag), `LRAY` (Emerande/Peridot radiation scheme), `LSFHYD` (hyper-simplified soil hydrology), `LSTRA` (classical stratiform precipitation), `LVDIF` (vertical turbulent exchange), `LRRMES` (mesospheric newtonian drag), `LSOLV` (Noilhau-Plauton soil and vegetation scheme), `LFGEL` (freezing with ISBA), `LNEBN` ("stratiform + convection precipitation" cloudiness scheme), `LRAYLU` (Moon radiation), and `LRAYPL` (look for day/night areas).

We ran the following experiments:

- AROME1.alltrue: where we set all the above keys to true,
- AROME1.2true: where we set only the keys LSOLV and LFGEL to true.

At this point we should have compared the surface fields initialized in the SCREENING by the experiments AROME0, AROME1, AROME1.alltrue, and AROME1.2true (see *Table 1*). We remark that for the case of AROME1.2true we obtained the same result as for AROME1.alltrue.

Table 1: Surface fields initialized in the SCREENING by the experiments AROME0, AROME1, and AROME1.alltrue (only the groups with differences). In the case of AROME1.2true we obtained the same result as for AROME1.alltrue.

Group	**Surface field**	AROME0	AROME1	AROME1.alltrue
SOIL B	PROFTEMPERATURE	+	+	+
SOIL B	PROFRESERV.EAU	+	+	+
SOIL B	PROFRESERV.GLACE	+	−	+
SNOWG	SURFRESERV.NEIGE	+	+	+
SNOWG	SURFRESERV.NEIGE	+	−	+
SNOWG	SURFRESERV.NEIGE	+	−	+
SNOWG	SURFALBEDO HISPO	+	−	+
RESVR	SURFTEMPERATURE	+	+	+
RESVR	SURFRESERV.EAU	+	+	+
RESVR	SURFRESERV.INTER	+	−	+
RESVR	SURFRESERV.GLACE	+	−	+
VARSF	SURFIND.TERREMER	+	+	+
VARSF	SURFZ0.FOIS.G	+	+	+
VARSF	SURFALBEDO	+	+	+
VARSF	SURFEMISSIVITIE	+	+	+
VARSF	SURFET.GEOPOTENT	+	−	−
VARSF	SURFPOT.VEGETAT	+	+	+
VARSF	SURFVAR.GEOPOT.ANI	+	−	−
VARSF	SURFVAR.GEOPOT.DIR	+	−	−
VCLIV	SURFPROP.ARGILE	+	−	+
VCLIV	SURFPROP.SABLE	+	−	+
VCLIV	SURFEPAIS.SOL	+	−	+
VCLIV	SURFIND.VEG.DOMI	+	−	+
VCLIV	SURFRESI.STO.MIN	+	−	+
VCLIV	SURFING.FOLIAIRE	+	−	+
VCLIV	SURFRES.EVAPOTRA	+	−	+
VCLIV	SURFGZ0.THERM	+	−	+
VCLIV	SURFALBEDO.SOLNU	+	−	+
VCLIV	SURFALBEDO.VEG	+	−	+

As we can see from *Table 1*, experiment `AROME1.alltrue` nearly gave the same surface fields, except the three geopotential fields

– SURFET.GEOPOTENT: standard deviation of orography,

– SURFVAR.GEO.ANI: anisotrophy of the sub-grid scale orography,

– SURFVAR.GEO.DIR: angle of the direction of orography with the x axis.

Thus, the question arises whether these fields are needed when assimilating the 10 meter wind as well. In order to answer this question we ran the following new experiments:

- `AROME1.2true.geo`: where the three geopotential fields are switched on as well,
- `AROME1.2true.wind`: where the 10 meter wind is assimiated,
- `AROME1.2true.geo.wind`: where the three geopotential fields are switched on, and the 10 meter wind is assimiated.

The three geopotential fields can be switched on in the routine

`cy32t3_main.01/arp/setup/su_surf_flds.F90`,

after the switches containing the key `LAROME`. The assimilation of 10 meter wind can be performed by modifing the namelist NAMOBS and switching `LSLRW10=.FALSE.`. From the results obtained from the above experiments we could see that the lack of the geopotential fields does not effect the assimiltaion of the 10 meter wind, the J_o-tables are the same as in the case of experiment `AROME1.2true`.

To visualise our results we printed some figures from which we present some now. *Figure 1* shows the analysis field obtained by experiment `AROME0` for the sufrace temperature and humidity, respectively, while *Figure 2* shows the difference between the analysis fields of experiments `AROME0` and `AROME1` for the sufrace temperature and humidity, respectively. We note that the results for `AROME1.2true` are the same as for `AROME0`. In *Figure 3* the analysis increments are presented in the cases of experiments `AROME0` and `AROME1.2true` for surface temperature.

Conclusion

Summarizing our work we can say that experiment `AROME1.2true` gives back the results of the reference experiment `AROME0`. This means that it is enough to switch keys `LSOLV` and `LFGEL` to `true` in the setup routine `su0phys.F90` after the switch containing the key `LAROME`. Moreover, the line of this switch should be modified from

```
IF(LAROME.AND..NOT.LFPOS) THEN
```

to

```
IF(LAROME .AND. (LSCREEN .OR. (NCONF == 131))) THEN.
```

Remark: all the compilation tasks were performed by the command

```
gmkpack -r cy32t3 -b main -p aromodb.
```

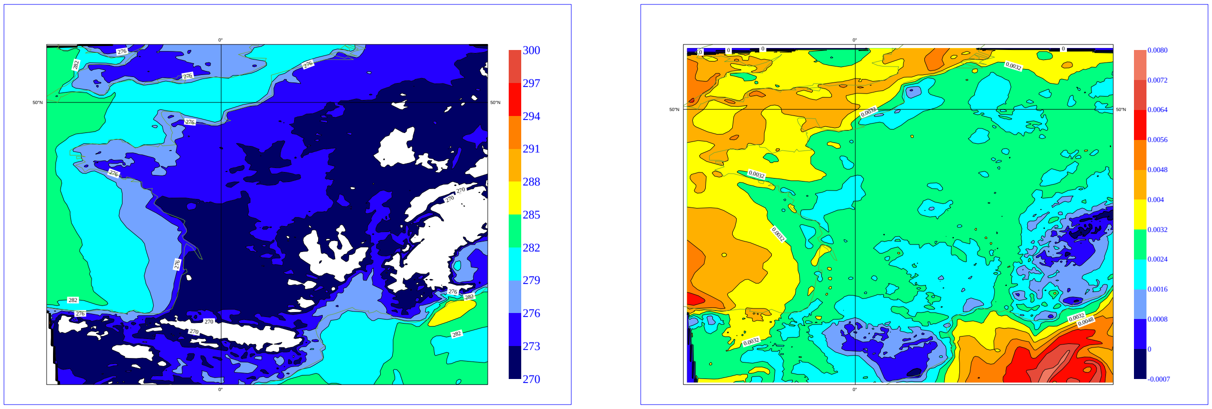

Figure 1: Analysis field obtained by experiment `AROME0` for surface temperature (left panel) and surface humidity (right panel).

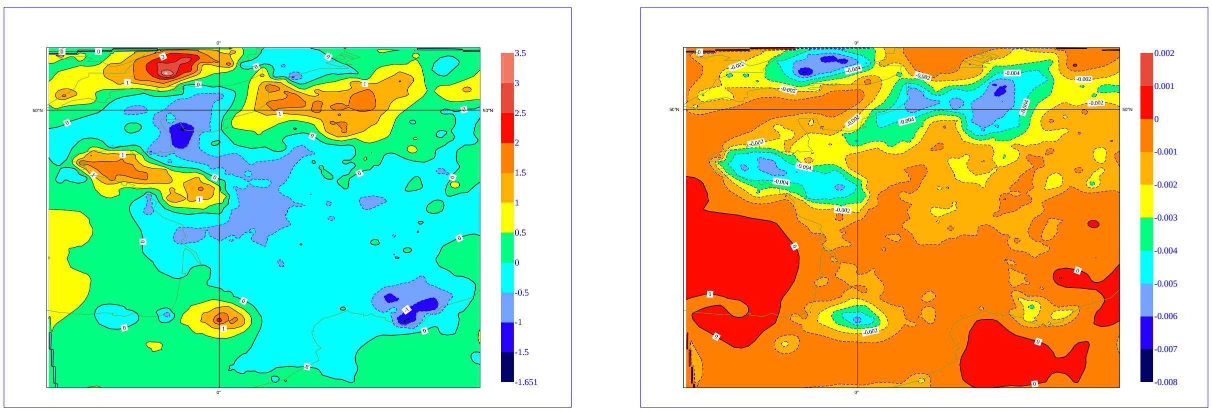

Figure 2: Difference between the analysis fields of experiments `AROME0` and `AROME1.2true` for surface temperature (left panel) and surface humidity (right panel).

Data assimilation with 3D-FGAT

The data assimilation method 3D-FGAT is "half-way" between the variational methods 3D-VAR and 4D-VAR. It uses a forecast during the assimilation, however, it applies time-slots as well, inside which the observations are taken into account as if they were valid only at one time in each time-slot. In order to create an experiment with AROME 3D-FGAT, we should have modified the namelist of the 3D-VAR's SCREENING and insert the informations coming from the fact that a forecast job is supposed to be perfromed inside the SCREENING.

Unfortunatelly, we had some ODB problems, therefore, these results have not been obtained yet.

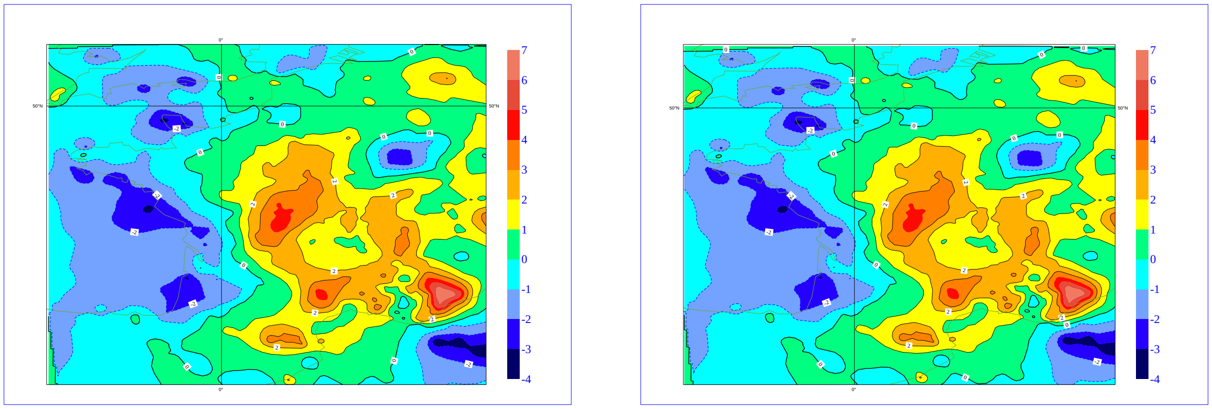

Figure 3: Analysis increments in the cases of experiments `AROME0` (left panel) and `AROME1.2true` (right panel) for surface temperature.

Other scientific activities during my stay

Since my project at Hungarian Meteorological Service is to implement the Ensemble Transform Kalman Filter method, it was a great possibility for me to be able to discuss the related problems with the scientists working on similar fields at Météo-France. First I had a discussion with *Claude Fisher* who proposed his ideas about this project. Then we had a meeting together with *Claude Fisher*, *Gérald Desroziers*, *Bernard Chapnik*, *Loïk Berre*, and *Laure Raynaud*. We discussed the questions of the updated error covariance B matrix, the sampling noise due to the small number of ensemble members, the loss of observations due to the screening and the “intersection” procedure, the adequate coupling files, etc.

Acknowledgement

I thank to all people at Météo-France for their help and hospitality giving me during my stay. I am especially thankful to *Pierre Brousseau* for encouraging and helping me in my work, and *Claude Fischer* for offering me the possibility to come and work here, for organizing the meeting on ETKF, and for his great ideas concerning that project. I also thank *Jean-Antoine Maziejewski* for all his help. And I thank all the “stagiaires” I met here, especially *Filip Váňa*, *Oldřich Španiel*, *Andrey Bogatchev*, *Jure Cedilnik*, and *Alex Deckmyn*, for paving my way here. I kindly acknowledge the financial support of EGIDE.

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