MEPS update to HARMONIE cy43

Introduction

MetCoOp has the role as RCR centre (Regular Cycles with the Reference system) in HIRLAM. This means that we test and evaluate reference versions of Harmonie-AROME tagged by the HIRLAM consortium. HIRLAM tagged harmonie-43h2.1 in late July 2020, after evaluation by MetCoOp and the other RCR centre AEMET. The testing revealed some issues with wind over open land that has since been addressed, and HIRLAM is now about to tag harmonie-43h2.1.1, which should be a more proper candidate for operational implementation. MetCoOp has also performed additional validation runs over 4 seasons with a candidate version including all relevant observation types in assimilation and on our own domain. The internal evaluation and the feedback from the four partner institutes is that the candidate is acceptable as a new operational version. Below we explain in more detail what this update from cycle 40 to cycle 43 means in terms of scientific changes, meteorological impact and technical changes for downstream users (changed parameters in output files).

Scientific changes

A jump of 3 cycles in the common IFS-Aladin-Harmonie system means 2-3 years of development by close to 30 partner institutes, including ECMWF. The list below is therefore far from exhaustive, but includes the changes we think are most relevant for the Harmonie-AROME flavour of the system:

- Physiographic database (ECOCLIMAP) updated to “Second Generation” ECOSG, with 300m resolution (https://opensource.umr-cnrm.fr/projects/ecoclimap-sg/wiki). On top of this, a snow-free albedo data set is used, and there are some additions to account for trees in open land areas. Many aspects of ECOSG in HARMONIE-AROME are documented in Samuelsson et al. (2020), e.g. changes in land-water distribution. In general the land-water distribution is improved by ECOSG which contributes to better scores along the coast. But, it also means that downstream applications from MEPS can be affected by this change if they use hard coded positions with respect to current cy40h land-water distribution.
- SURFEX (http://www.umr-cnrm.fr/spip.php?article145&lang=en) version updated from 7.3 to 8.1.
- Updates to the HARATU turbulence scheme and the EDMF mass-flux scheme, microphysics optimization and tuning.
- More types of satellite-based observations (MWHS-2 instrument from Chinese FY-3D satellite and introduction of ASCAT METOP-C surface winds) used and in an enhanced way (improved data selection to account for recent orbit information and improved cloud detection) for deriving the model initial state. Use of air-traffic control observations produced with an old sub-optimal processing excluded and data from new improved processing underway to be introduced. A positive impact from introduction on MWHS-2 observations on low level moisture forecasts has been demonstrated.
- Technical changes, e.g. the possibility to run forecasts in single precision.
- CY43 changes related to the ensemble aspects of the model were introduced in MetCoOp already in February 2020 in connection with the change to the continuous production setup.

More information can be found in https://hirlam.org/trac/wiki/ReleaseNotes/harmonie-43h2.1

Meteorological impact

It is difficult to concisely describe the meteorological changes between the cycles given the considerable seasonal and regional differences. Nevertheless, a gross summary is attempted below. The reader is strongly encouraged to look at the feedback from each partner institute to get more detailed information.

Deterministic performance

Spring

Finland, Norway and Sweden all report significant improvements in spring, most notably for humidity and temperature, but also neutral to improved wind, clouds and precipitation. Estonia however sees a degradation in spring, in particular for humidity, but also somewhat worsened temperature, wind and precipitation. That being said, cycle 40 was significantly better for Estonia than the nordic countries in the spring. In cycle 43 errors are more evenly distributed.

Summer
All in all, summer scores are fairly neutral compared to cycle 40. Estonia and Sweden see slightly improved temperatures, Estonia also somewhat better humidity, but worsened wind, a problem seen in most seasons unfortunately, in particular over areas dominated by low vegetation.

Autumn
Norway and Sweden both report close to neutral scores for the autumn period. In Finland most parameters see a slight degradation in cycle 43, except for a better cloud base. Estonia sees some improvements in humidity, slightly worse temperature, neutral scores for clouds and precipitation, winds again overestimated (except extreme winds, which tend to be underestimated always).

Winter
Norway sees some small improvements in temperature, the coldest cases in particular. Finland, Sweden and Estonia however regard temperatures as slightly worse in cycle 43. Estonia reports significantly improved humidity, while Finland and Sweden find it slightly worse. Wind is also in general considered degraded in cycle 43, due to a positive bias. Strong winds are improved, however. For clouds and precipitation differences are small, but perhaps slightly in favour of cycle 43.

Ensemble aspects

Due to the high computational cost the ensemble performance of the new version has been validated with a smaller ensemble running 6 members in real time from the second week of January 2021. Compared to the operational setup the new version shows an increase in spread for most surface variables without an increase in the error.

Domain and grid changes

There are no changes to the domain and grid definition.

However, the improved land-water distribution in ECOSG means that downstream applications can be affected by this change if they use hard coded positions with respect to current cy40 land-water distribution.

New and changed parameters

New parameters

Helicopter triggered lightning index

For details see :https://metcoop.smhi.se/dokuwiki/_media/nwp/ops/htl-metcoop-dec2020.pdf

shortName:hti
indicatorOfParameter:148
Level:0
typeOfLevel:entireAtmosphere
Discipline:0
parameterCategory:17
parameterNumber:193
Unit: -

Max wind speed

Maximum of 10m wind speed over the last hour.

shortName:wsmax
indicatorOfParameter:32
Level:10
typeOfLevel:heightAboveGround
Discipline:0
parameterCategory:2
parameterNumber:1
timeRangeIndicator:2
typeOfStatisticalProcessing:2

Unit: m/s

Changed parameters

Direct normal irradiance -> Direct normal exposure

Following
https://www.wmo.int/pages/prog/www/WMOCodes/WMO306_vI2/LatestVERSION/WMO306_vI2_GRIB2_CodeFlag_en.pdf

GRIB key	Current	New
shortName	dni	dne
indicatorOfParameter	140	140
discipline	3	3
parameterCategory	6	6
parameterNumber	2	3

Summary of file content changes

Model state files

fcYYYYMMDDHH+LLLgrib2/fcYYYYMMDDHH+LLLgrib

Removed: cape,cin

Added: hti,wsmax

Fullpos files

fcYYYYMMDDHH+LLLgrib_fp

Removed: cape_old,cin_old

Added: cape,cin

fcYYYYMMDDHH+LLLgrib2_fp

Added: cape,cin

Surfex model state output

The file name convention has changed from
fcYYYYMMDDHH+LLLgrib_full_sfx
to
fcYYYYMMDDHH+LLLgrib_sfx
Where LLL is the forecast lead time

Added fields

IndicatorOfParameter	level	typeOfLevel	unit	Description
15	2	heightAboveGround	K	Grid average max temperature since last output
16	2	heightAboveGround	K	Grid average min temperature since last

				output
15	800	heightAboveGround	K	Nature tile max temperature since last output
16	800	heightAboveGround	K	Nature tile min temperature since last output
15	832	heightAboveGround	K	Open land patch max temperature since last output
16	832	heightAboveGround	K	Open land patch min temperature since last output
15	842	heightAboveGround	K	Forest max temperature since last output
16	842	heightAboveGround	K	Forest min temperature since last output
15	950	heightAboveGround	K	Urban tile max temperature since last output
16	950	heightAboveGround	K	Urban tile min temperature since last output
92	0	meanSea	m	Sea ice thickness

Removed

IndicatorOfParameter	level	typeOfLevel	Description
193	832	heightAboveGround	Open land soil ice level 3
11	833	heightAboveGround	Open land soil temperature level 3
193	842	heightAboveGround	Forest soil ice level 3
11	843	heightAboveGround	Forest soil temperature level 3

Surfex selected output

The file name convention has changed from

fcYYYYMMDDHH+LLLgrib_sfx
to
fcYYYYMMDDHH+LLLgrib_sfxs
Where LLL is the forecast lead time

Added

IndicatorOfParameter	level	typeOfLevel	unit	Description
15	2	heightAboveGround	K	Grid average max temperature since last output
16	2	heightAboveGround	K	Grid average min temperature since last output
15	800	heightAboveGround	K	Nature tile max temperature since last output
16	800	heightAboveGround	K	Nature tile min temperature since last output
15	832	heightAboveGround	K	Open land patch max temperature since last output
16	832	heightAboveGround	K	Open land patch min temperature since last output
15	842	heightAboveGround	K	Forest max temperature since last output
16	842	heightAboveGround	K	Forest min temperature since last output
15	950	heightAboveGround	K	Urban tile max temperature since last output
16	950	heightAboveGround	K	Urban tile min temperature since last output

References

Samuelsson P., Kourzeneva E., de Vries J. and Viana S., 2020: HIRLAM experience with ECOCLIMAP Second Generation. ALADIN-HIRLAM Newsletter no 14, 154-188. https://www.umr-cnrm.fr/aladin/IMG/pdf/nl14.pdf

Feedback from ESTEA:
https://metcoop.smhi.se/dokuwiki/_detail/nwp/ops/estea-scorecard.png

Feedback from FMI:
https://metcoop.smhi.se/dokuwiki/_media/nwp/ops/cy40-to-cy43.pdf

Feedback from MET Norway:
https://docs.google.com/presentation/d/1K-14JJO1B9jNr0Fy6nyFsCeiF_MVp-7bP_k3oQ3WHLI/edit#slide=id.p1

Feedback from SMHI:
https://docs.google.com/presentation/d/1uYAEzApiHH_jGVbBZyD0VnClDQeQd-x1_OzQ7uNRJb8/edit#slide=id.gb8deff9aa2_4_35