On the ensemble mode in HirLam 7.1

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Introduction

Hirlam-A scientific plan 2006

→ ”As a first step, existing LAM EPS systems in member countries should be the starting point for a careful design of a computational framework for short-range HIRLAM EPS.”

→ “The HIRLAM EPS framework should include probabilistic validation and verification tools that should be applied for evaluation of initial, as well as new when the become available, components of the system”

→ “A possible starting point for HIRLAM EPS could be the `met.no` down-scaling approach combined with INM multi-boundary/multi-model approach and possibly also lagged averaging techniques”

Introduction

Hirlam/Aladin EPS working weeks: Hirlam related work

- Norrköping June 2006
  - LAM EPS scripts from `met.no` as starting point
  - script adaptation to run in downscaling mode from ECMWF-EPS data
  - MARS retrieval of online EPS boundaries
  - 3-member test case
  - SLAF started
- Reading January 2007
  - update to trunk version
  - 3DVAR option for control run
  - random choice of convection scheme for perturbed members
  - GLAMEPS domain defined
  - work on TEPS
  - archiving strategy
- Reading March 2007 on post-processing and SLAF

The current Hirlam EPS system

Main Characteristics

- ⟶ allows for both deterministic and ensemble runs
- ⟶ use of online ECMWF-EPS boundaries
- ⟶ analysis in control run
- ⟶ ensemble member specific environment settings
  - → fixed settings
  - → random settings
  - ⇒ currently implemented: choice of convection/condensation scheme
- ⟶ processing single member or group of members
- ⟶ administration of up to 999 members

The current Hirlam EPS system

Available ensemble methods

- boundary perturbation
  - ensemble downscaling of ECMWF-EPS (12h frequency)
  - norwegian TEPS (24h frequency) to be implemented
- initial perturbation
  - simple perturbed analysis
  - SLAF to be implemented
- model error treatment
  - stochastic choice between KFRK and STRACO scheme

The current Hirlam EPS system

Possible ensemble modes

→ 1 deterministic, using `hireps.tdf` (mSMS for LAM EPS)
or `hirlam.tdf` (standard mSMS)

→ 2 control member only

→ 3 one single perturbed member (e.g. member 5)

→ 4 perturbed ensemble (perturbed members only)

→ 5 full ensemble mode (control and perturbed)

The current Hirlam EPS system

Possible ensemble modes

- → 1 deterministic, using `hireps.tdf` (mSMS for LAM EPS) or `hirlam.tdf` (standard mSMS)
  ENSSIZE = -1
  ENSFIRST = -1
- → 2 control member only
  ENSSIZE = 000
  ENSFIRST = 000
- → 3 one single perturbed member (e.g. member 5)
  ENSSIZE = 001
  ENSFIRST = 005
- → 4 perturbed ensemble (perturbed members only)
  ENSSIZE = xxx
  ENSFIRST = xxx
- → 5 full ensemble mode (control and perturbed)
  ENSSIZE = xxx
  ENSFIRST = 000

The current Hirlam EPS system

Implementation and data flow

- ⟶ build process and climate generation in common for all members
- ⟶ boundary preparation separately for each member
- ⟶ observations processed for each member separately
- ⟶ cycling for each member separately
- ⟶ archiving of ensemble member output in member sub-directory
- ⟶ common post-processing*

*INM ensemble postprocessing to be included still

The current Hirlam EPS system

Relevant code and scripts

⟶ grdy/pertana.F	analysis perturbation
⟶ scripts/EnsInit	initiation of ensemble run (e.g. random lists)
⟶ scripts/Env_domain	GLAMEPS domain definition (0.2^o mesh)
⟶ scripts/Env_ensmbr	ensemble member specific environmet
⟶ scripts/EnsListener.pl	ensemble forecast listener
⟶ scripts/EnsStrategy.pl	boundary strategy process
⟶ scripts/PertAna	analysis perturbation
⟶ scripts/hireps.tdf	mSMS template
⟶ scripts/*	existing scripts include option to process ensemble members

The current Hirlam EPS system

Relevant namelists and tunables

- Env_expdesc
  - ENSSIZE — number of perturbed members (3-digits!)
  - ENSFIRST — number-ID of the first ensemble member (3-digits!)
  - RND_EVENTTYPES — list of random events currently: :con:
  - BDSTRATEGY — boundary strategy currently: eps_ec or teps_no

- Env_ensmbr
  - specification of ensemble member specific environment
  - definition of random event types and usage

The current Hirlam EPS system

scripts/Env_ensmbr 1

```
#========================================================= explicit settings

case $ENSMBR in
  001) COND_SCHEME=KF
       ;;
  002) COND_SCHEME=STRACO
       ;;
    *) COND_SCHEME=STRACO
       ;;
esac
```

The current Hirlam EPS system

scripts/Env_ensmbr 2

```
#============================================================ random settings

for eventtype in 'echo $RND_EVENTTYPES | tr : ' ''; do
  random_list="${HL_DATA}/${CYCLEDIR}/../ensemble/random_${eventtype}_${ENSSIZE}.list"
  if [ -f $random_list ]; then
    case $eventtype in
      con) i='expr $ENSMBR + 0' # choice of convection/condensation scheme
           random_number='cat $random_list | cut -d ' ' -f $i'
           case $random_number in
             0) COND_SCHEME=STRACO
                ;;
             1) COND_SCHEME=KF
                ;;
             ...
           esac
           ...
        ...
      ...
    esac
  fi
done
```

Running a HIRLAM ensemble experiment

An Example: overview

- ⟶ GLAMEPS domain
- ⟶ ECMWF-EPS forecasts boundaries
- ⟶ 10 perturbed Hirlam members plus 1 control
- ⟶ 3DVAR data assimilation in the control
- ⟶ perturbed analysis in the perturbed members
- ⟶ random choice of convection scheme (KFRK $\leftrightarrow$ STRACO) for each perturbed member

Running a HIRLAM ensemble experiment

An Example: specifications and run

Env_expdesc :

⟶ DOMAIN=EPS71	GLAMEPS domain 0.2^o
⟶ ENSSIZE=020	20 perturbed members
⟶ ENSFIRST=000	zero includes control
⟶ RND_EVENTTYPES=:con:	(KFRK ↔ STRACO)
⟶ BDSTRATEGY=eps_ec	ECMWF-EPS boundaries

Running a HIRLAM ensemble experiment

An Example: specifications and run

Env_expdesc :

$\longrightarrow$ DOMAIN=EPS71	GLAMEPS domain 0.2^o
$\longrightarrow$ ENSSIZE=020	20 perturbed members
$\longrightarrow$ ENSFIRST=000	zero includes control
$\longrightarrow$ RND_EVENTTYPES=:con:	(KFRK $\leftrightarrow$ STRACO)
$\longrightarrow$ BDSTRATEGY=eps_ec	ECMWF-EPS boundaries

$\Longrightarrow$ `Hirlam start PLAYFILE=hireps DTG=2007031800 DTGEND=2007032000 LLMAIN=48`

Running a HIRLAM ensemble experiment

EnsInit log

```
.../EnsInit: random list for event type con
.../EnsInit: creating 2-event random list with 020 elements
```

or

```
.../EnsInit: reusing existing random number list in file ↩
  20070318_00/ensemble/random_con_020.list
```

Env_ensmbr log

```
ensemble member 000, no specific setting
```

```
ensemble member 007, specific settings
Mbr007: COND_SCHEME = KF
```

```
ensemble member 011, specific settings
Mbr011: COND_SCHEME = STRACO
```

Running a HIRLAM ensemble experiment

Computational performance and cost

EPS71T_15

⟶ Test domain (GLAMEPS area) with 60x52x40 grid

⟶ 15+1 member ensemble experiment over 7 days with 12h cycling

EPS71_20

⟶ GLAMEPS domain 0.2 degree, 306x250x40 grid

⟶ 20+1 member ensemble experiment over 3 days with 12h cycling

experiment	elapsed time				SBUs			
	forecast	cycle	3 d	7 d	forecast	cycle	3 d	7 d
EPS_71T_15	35 – 47s	≈ 45M		10h	5	80		1200
EPS71_20	550 – 650s	≈ 160M	≈ 15h	1.5d*	60 – 70	1400	8500	20000*

*estimated

Hirlam EPS system documentation

HeXnet wiki pages

⟶ https://hirlam.org/trac/wiki/HirlamSystemDocumentation/Configure/EnsemblePrediction

⟶ https://hirlam.org/trac/wiki/Hirlam_7.1#PerformingexperimentswithHIRLAM7.1

see bullet Ensemble prediction

Hirlam EPS system documentation

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Fine