HARMONIE physics plans

Laura Rontu, FMI

with contributions by
Imanol Guerrero, Timo Vihma and others

ALARO working days
13-15 June 2012 Ljubljana

A FEW STRATEGIC COMMENTS

Towards scale-adaptive, cross-package physical parametrisations in HARMONIE

Towards integrated operational surface modelling: physiography & data assimilation & prognostic parametrisations

Towards full consistency between physics, dynamics, data assimilation and probabilistic forecasting

The key common MF-ALADIN-HIRLAM projects in atmospheric and surface physics for the plan 2012 – 2013 might be sought among the following:

Harmonie radiation comparison

Interfaces and cloud/aerosol input for all radiation schmes in the same framework. Development of the HIRLAM and ALARO radiation schemes, comparison with the ECMWF scheme

GABLS4
preparation and participation

Study of the very stable Antarctic PBL with the (turbulence, radiation, cloud, surface) schemes available in 3D model, MUSC and SURFEX offline.
Work coordinated by the GABLS community.

Renewal of the basic orography

Derivation of parameters for dynamics and parametrisations, based on the highest resolution global digital elevation data

Perestroika of the physics calling routines

Independent improvement and streamlining of aplpar and apl_arome and components called by them, on the way towards a common framework for cross-package comparison and testing

Harmonie radiation comparison

Interfaces and cloud/aerosol input for all radiation schmes in the same framework. Comparison and Development of the HIRLAM and ALARO radiation schemes, comparison with the ECMWF scheme

HARMONIE RADIATION COMPARISON
(First suggested around 2007)

The aim of the model comparison experiment is to compare and validate HIRLAM-ALARO-AROME radiation parametrizations over complex terrain. The experiment should give information to understand the relative importance in mesoscale models of

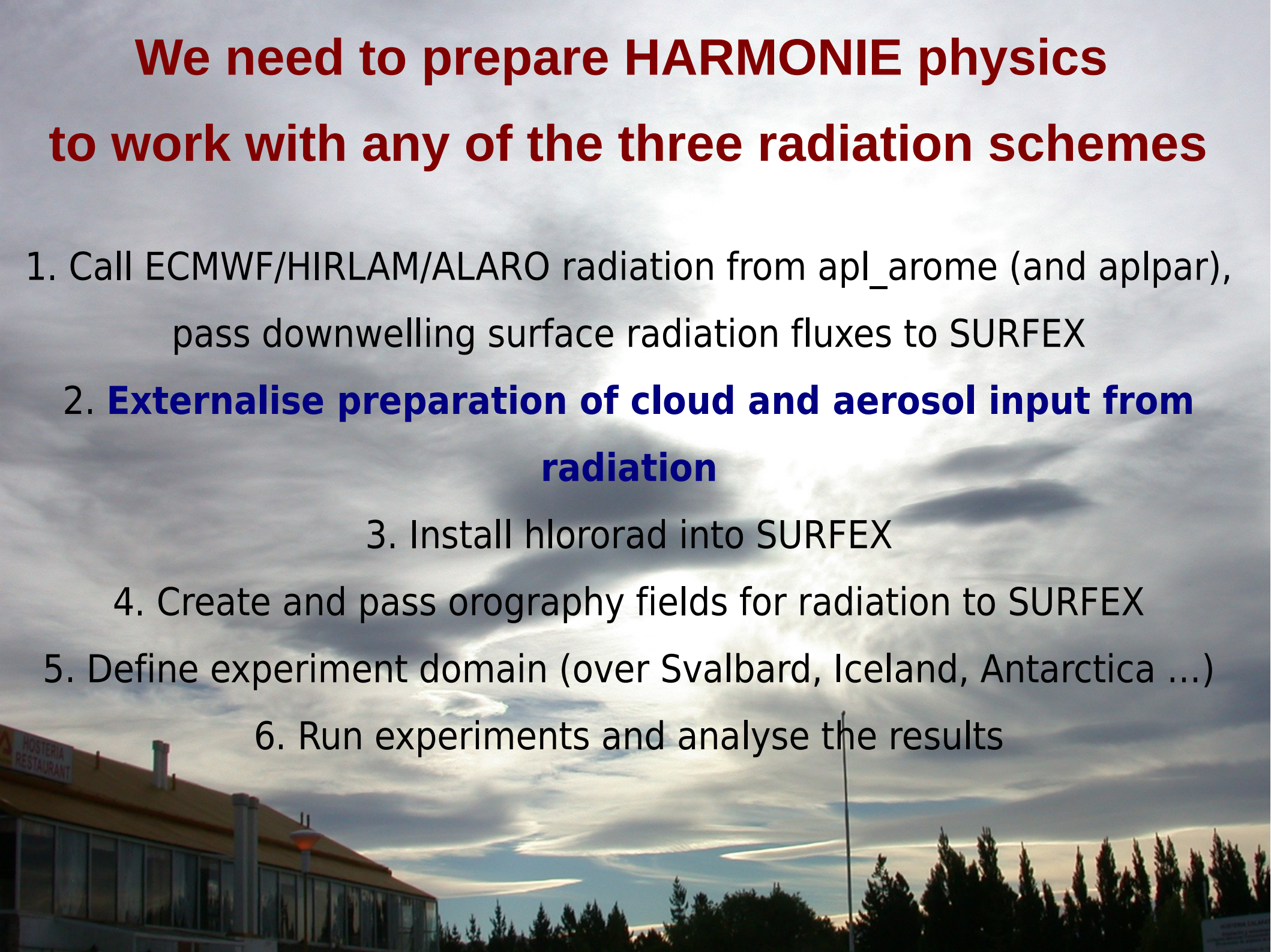
1) **advanced clear-sky radiation** transfer parametrizations (provided by the ECMWF radiation scheme within AROME)

2) accurate handling of **cloud-radiation interactions**, needed time-resolution of radiation calculations

3) improved treatment of **radiation surface-interactions**, including sloping surface parametrizations.

We need to prepare HARMONIE physics to work with any of the three radiation schemes

1. Call ECMWF/HIRLAM/ALARO radiation from apl_arome (and aplpar), pass downwelling surface radiation fluxes to SURFEX
2. **Externalise preparation of cloud and aerosol input from radiation**
3. Install hlororad into SURFEX
4. Create and pass orography fields for radiation to SURFEX
5. Define experiment domain (over Svalbard, Iceland, Antarctica …)
6. Run experiments and analyse the results



First experiences

HIRLAM and ECMWF radiation **interfaces built to apl_arome** first in MUSC framework – quick and easy environment for development

Tried in **1D and 3D (cy37h1) experiments**:

ECMWF every 15th/every timestep, hlradia at every step,

with differenct cloud crystal effective radia

- same amount of computing time required for EC/15 and HL/1
- differences found in cloud droplet/crystal distribution and SW fluxes
- small impact to the near-surface temperatures

ASM/Wk 2012 poster by Kristian Pagh Nielsen et al.

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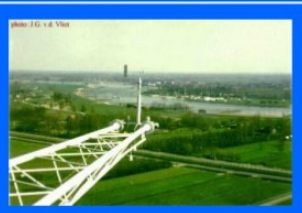
Work coordinated by the GABLS community

GEWEX Atmospheric Boundary Layer Study GABLS - Preparation of the 4th case over Antarctic

GEWEX Atmospheric Boundary Layer Studies (GABLS) provides platform for model intercomparison and development to benefit studies of Climate, Weather, Air Quality and Wind Energy

GABLS1	GABLS2	GABLS3
		
LES as reference	Data (CASES99)	Data (CABAUW)
Academic set up	Idealized forcings	Realistic forcings
Prescribed T_s	Prescribed T_s	Full coupling *(SCM)* Prescribed T_s *(LES)*
No Radiation	No Radiation	Radiation included
Turbulent mixing	Diurnal cycle	Low levet jet + transitions

LES: Large Eddy Simulation; *SCM:* Single Column Model

Slide from presentation by Bert Holtslag in:
http://www.ecmwf.int/newsevents/meetings/workshops/2011/GABLS/

PLANS FOR GABLS4

Pre-GABLS4

Polar WRF, UM, HIRLAM, HARMONIE/AROME 3D experiments for choice of the case and intercomparison

Main GABLS4

Single-column model runs for the chosen case for detailed PBL study and intercomparison

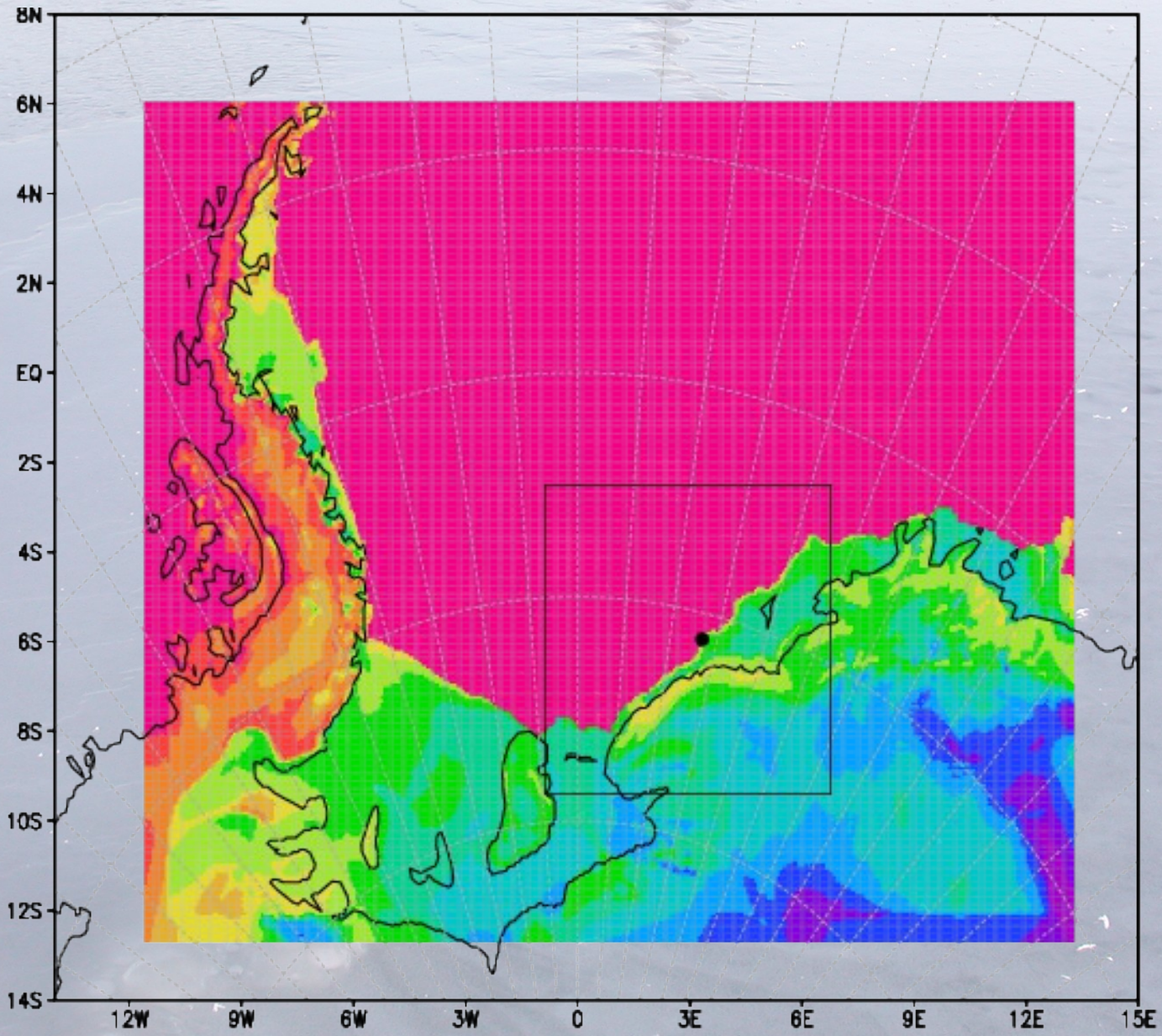
Opportunities for HARMONIE

Learn about very stable Antarctic boundary layer over snow and ice
Enter a strong intercomparison community
Apply 3D models, pick MUSC and SURFEX forcing
Run MUSC and SURFEX experiments, develop parametrisations

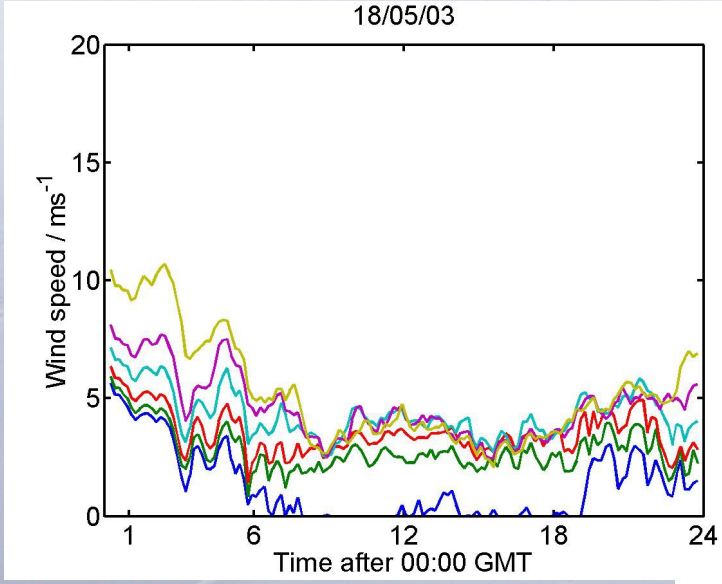
People participating in preparations

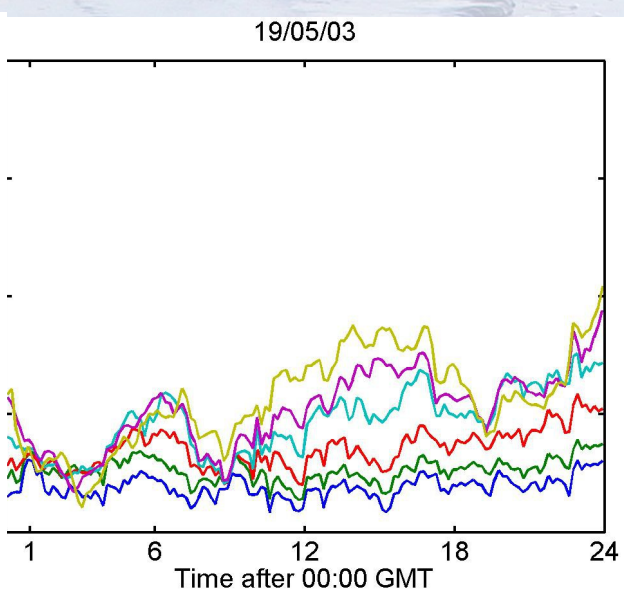
Bert Holtslag, Timo Vihma, Tiina Kilpeläinen, Phil Anderson, Andrew Orr, Klara Finkele and others: YOU are also invited to join!

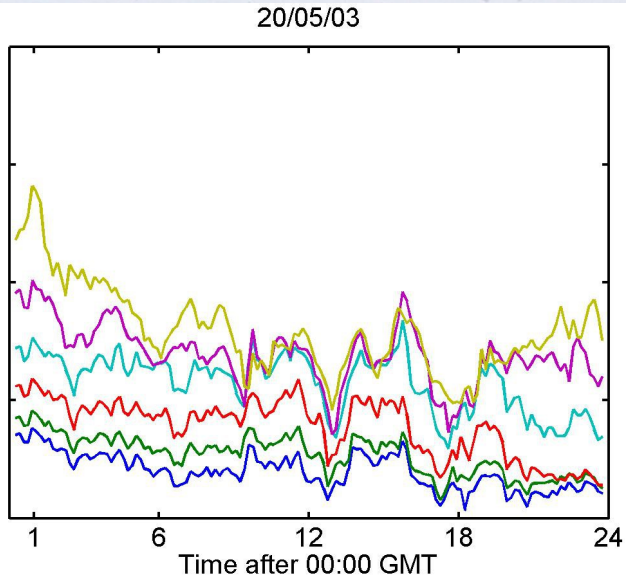
GEWEX Atmospheric Boundary Layer Study GABLS - Preparation of the 4th case over Antarctic

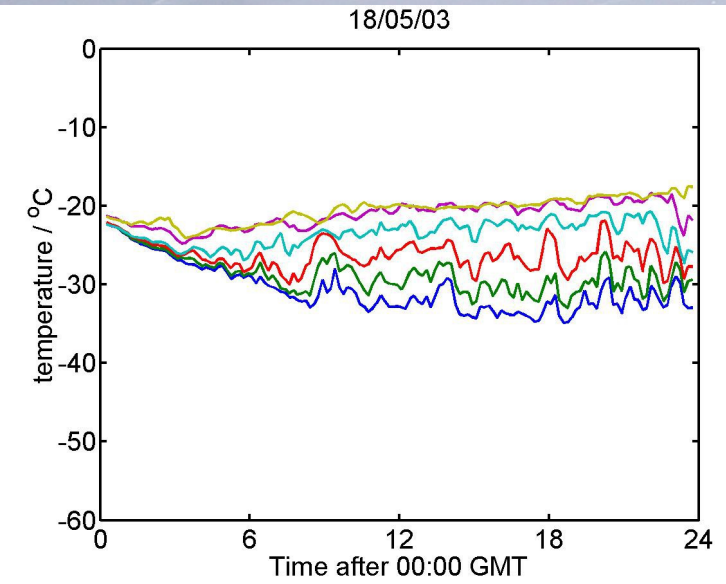


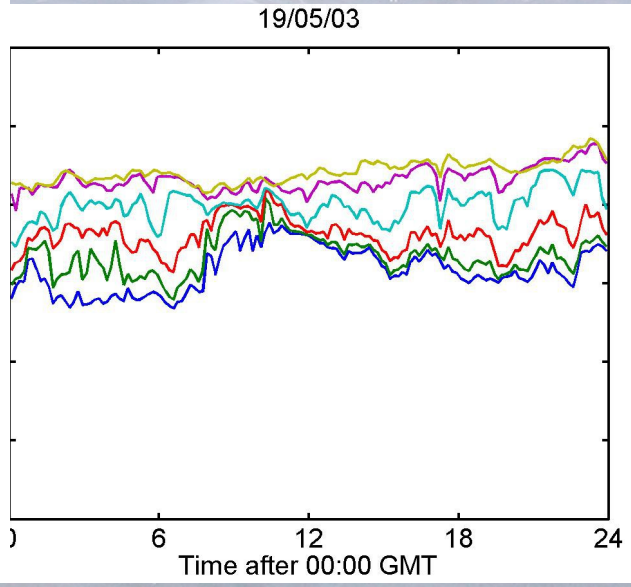
SELECTED WIND SPEED AND TEMPERATURE PROFILES HALLEY (26.57W, 75.58S) MAY 2003 METEO MAST 30M

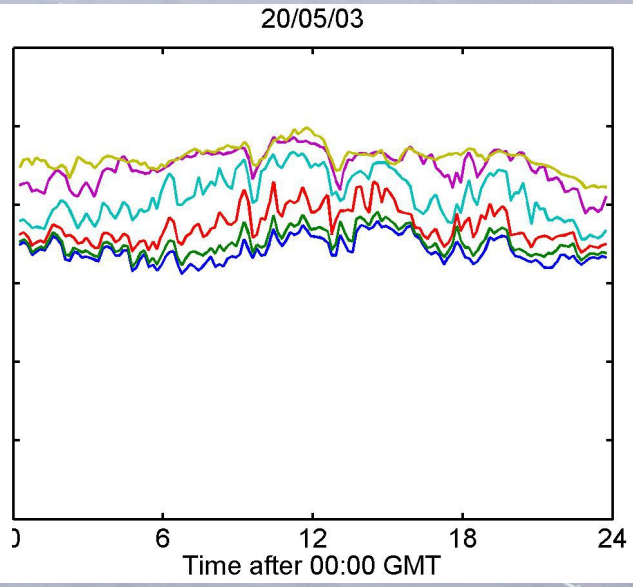




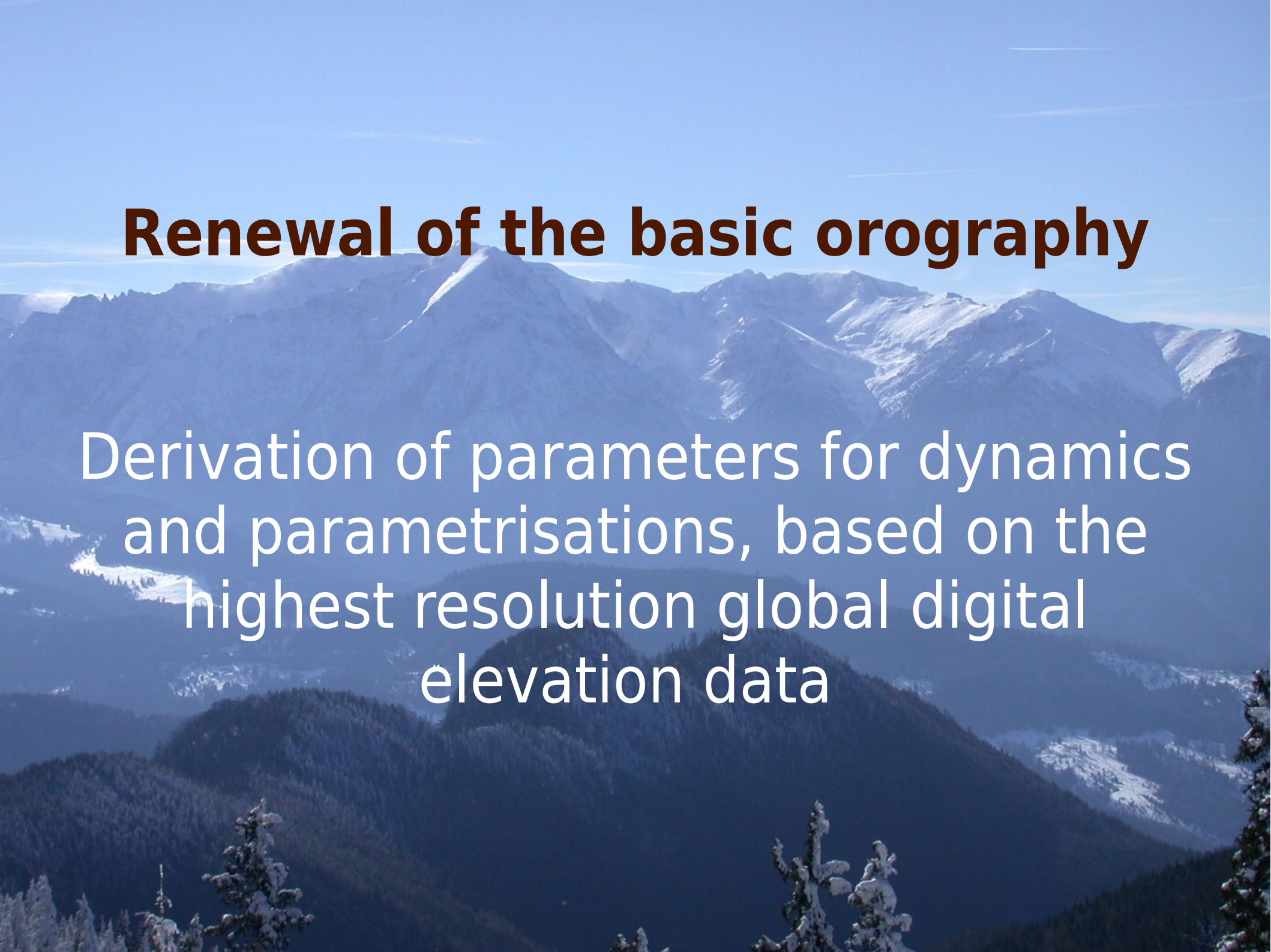








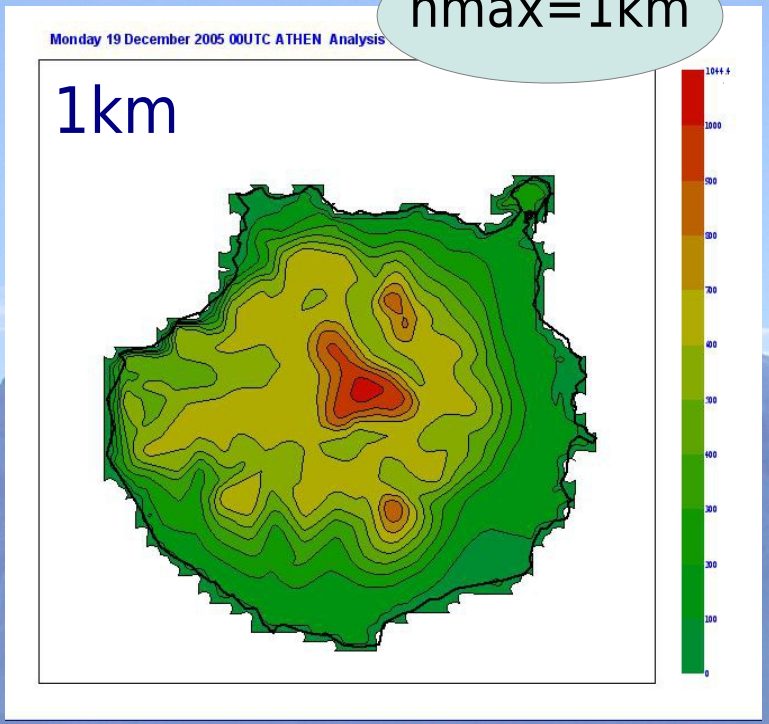
www.antarctica.ac.uk/met/psa/



Renewal of the basic orography

Derivation of parameters for dynamics and parametrisations, based on the highest resolution global digital elevation data

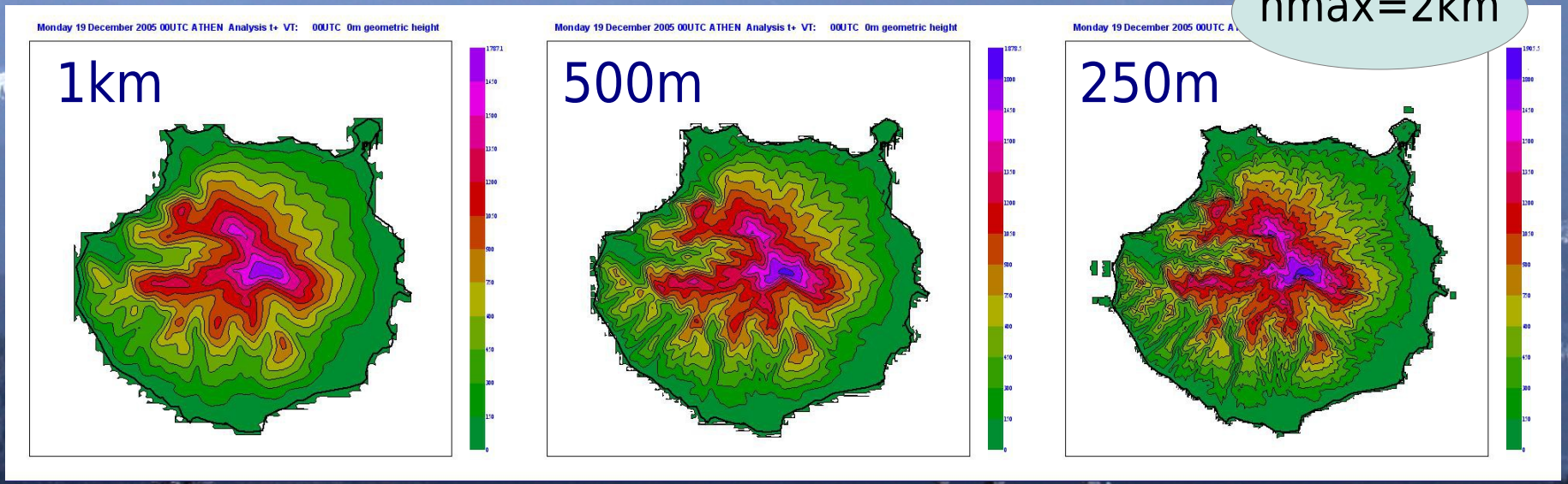
hmax=1km



Mountains of **Gran Canaria** as seen by HARMONIE based on two digital elevation maps

Left: gtopo30”, 1km
Lower panel: MDT-200m averaged to 1km, 500m, 250m

hmax=2km



Maps by Imanol Guerrero, AEMET

Ten-metre wind speed by HARMONIE-AROME with dynamics + default physical parametrisations

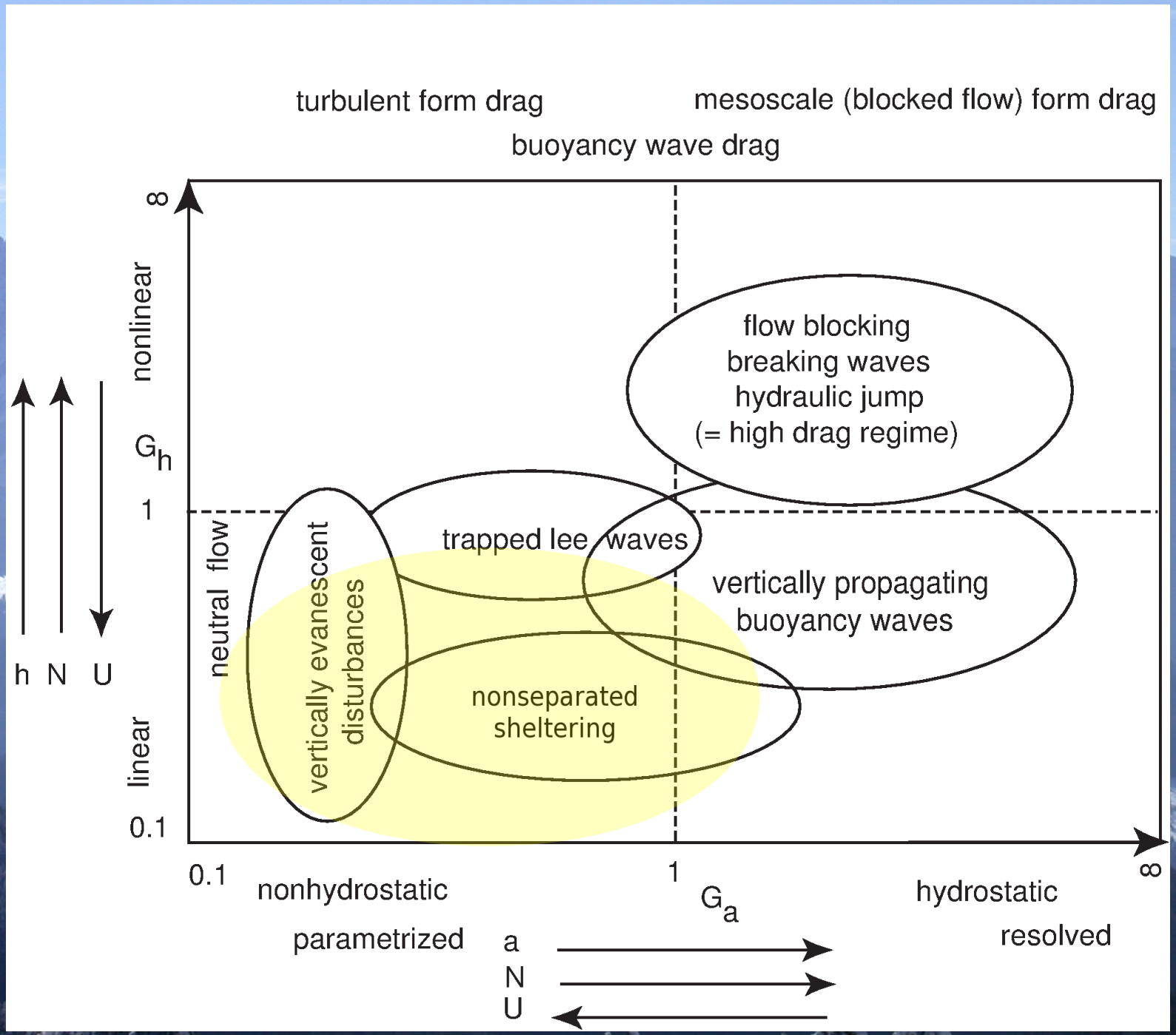
Yellow and green: strong winds, blue: weak

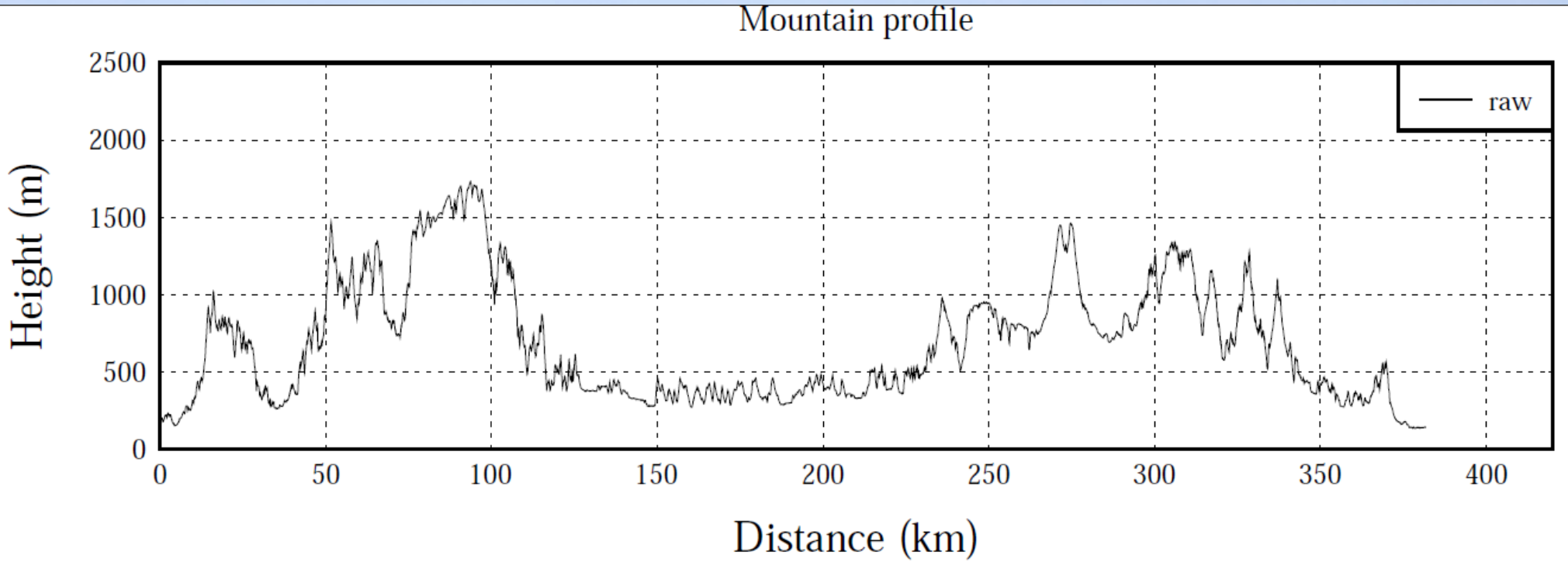
Above: gtopo30”, HARMONIE 500m

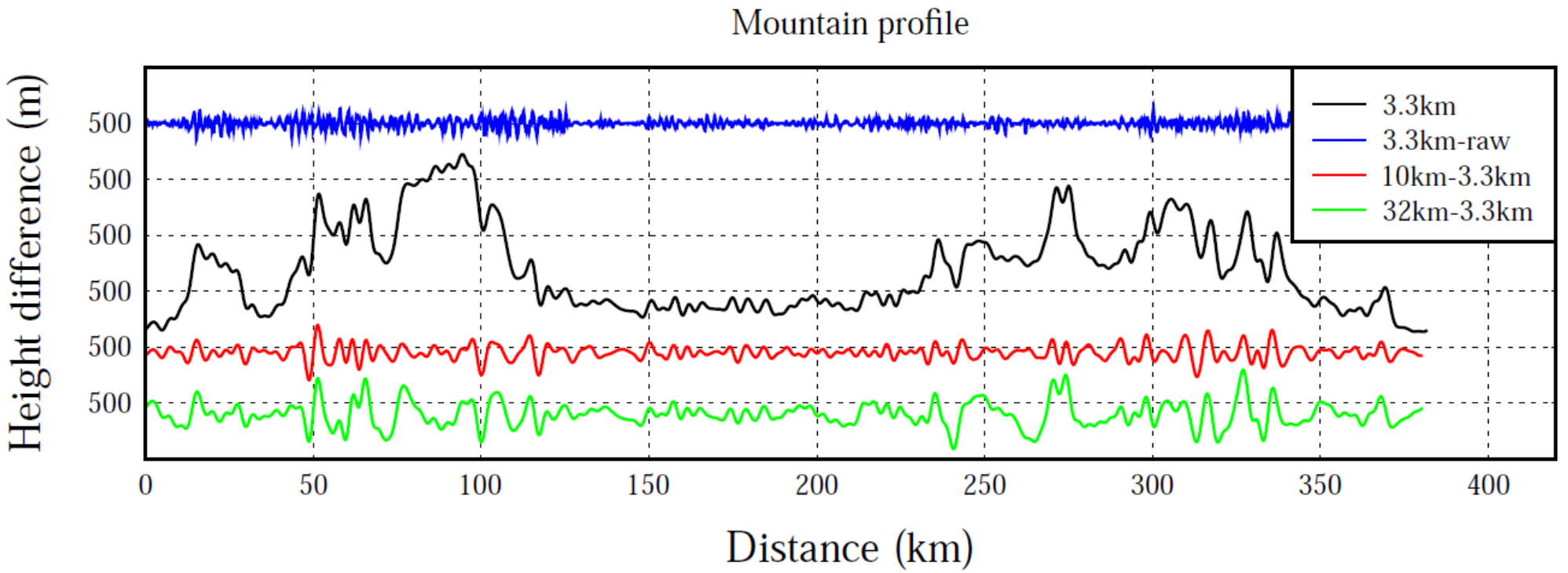
Right : MDT-200m, HARMONIE 500m

Maps by Imanol Guerrero, AEMET

Remarks on orography and a bit of theory




Mountain profile
Height (m)
2500
2000
1500
1000
500
0
0
50
100
150
200
250
300
350
400
Distance (km)
raw


Mountain profile
Height difference (m)
500
500
500
500
500
500
0
50
100
150
200
250
300
350
400
Distance (km)
3.3km
3.3km-raw
10km-3.3km
32km-3.3km

GENERAL PLAN OF OROGRAPHY

Take the most detailed global digital elevation data
(SRTM – ASTER - ?)

Do (spectral) filtering to separate scales
for derivation of variables for

Model dynamics
Orographic buoyancy wave parametrisations
Smallest scale orographic effects on momentum fluxes
Orographic radiation parametrisations

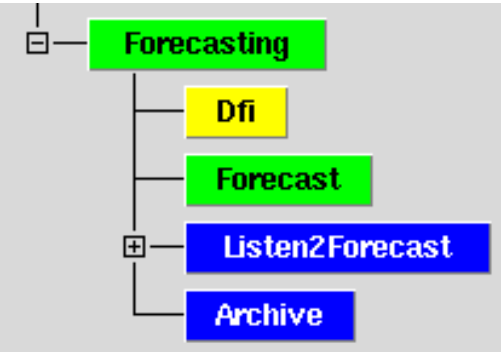
POSSIBLE VARIABLES FOR DIFFERENT PURPOSES (these are from the HIRLAM model)

parameter	description	unit	usage	scale (km)	filtering
s_t	mean maximum small-scale slope	rad	SSO	< 3 km	high-pass
σ_t	mean small-scale standard deviation	m	SSO	< 3 km	high-pass
σ_m	mean mesoscale standard deviation	m	MSO	3 km $\ldots k\Delta x$	band-pass
α	coefficient of anisotropy	-	MSO	3 km $\ldots k\Delta x$	band-pass
θ	x-angle of orography gradient	rad	MSO	3 km $\ldots k\Delta x$	band-pass
$\mathrm{H}_{k\Delta x}$	mean surface elevation	m	dynamics	$> k\Delta x$	low-pass
$\gamma_{m,i}$	mean slope angle in direction i	rad	radiation	full resolution	none
f_i	fraction of slopes in direction i	-	radiation	full resolution	none
$\gamma_{h,i}$	local horizon in direction i	rad	radiation	full resolution	none

Perestroika of the physics calling routines

Independent improvement and streamlining of aplpar and apl_arome and components called by them, on the way towards a common framework for cross-package comparison and testing

Physics source code



src/arp/phys_dmn/**mf_phys.F90**

for AROME-phys

phys_dmn/**apl_arome.F90**

for ALARO/ARPEGE-phys

phys_dmn/**aplpar.F90**

for HIRLAM-phys

phys_dmn/**hl_aplpar.F90**

src/mpa

AROME-phys

src/surfex

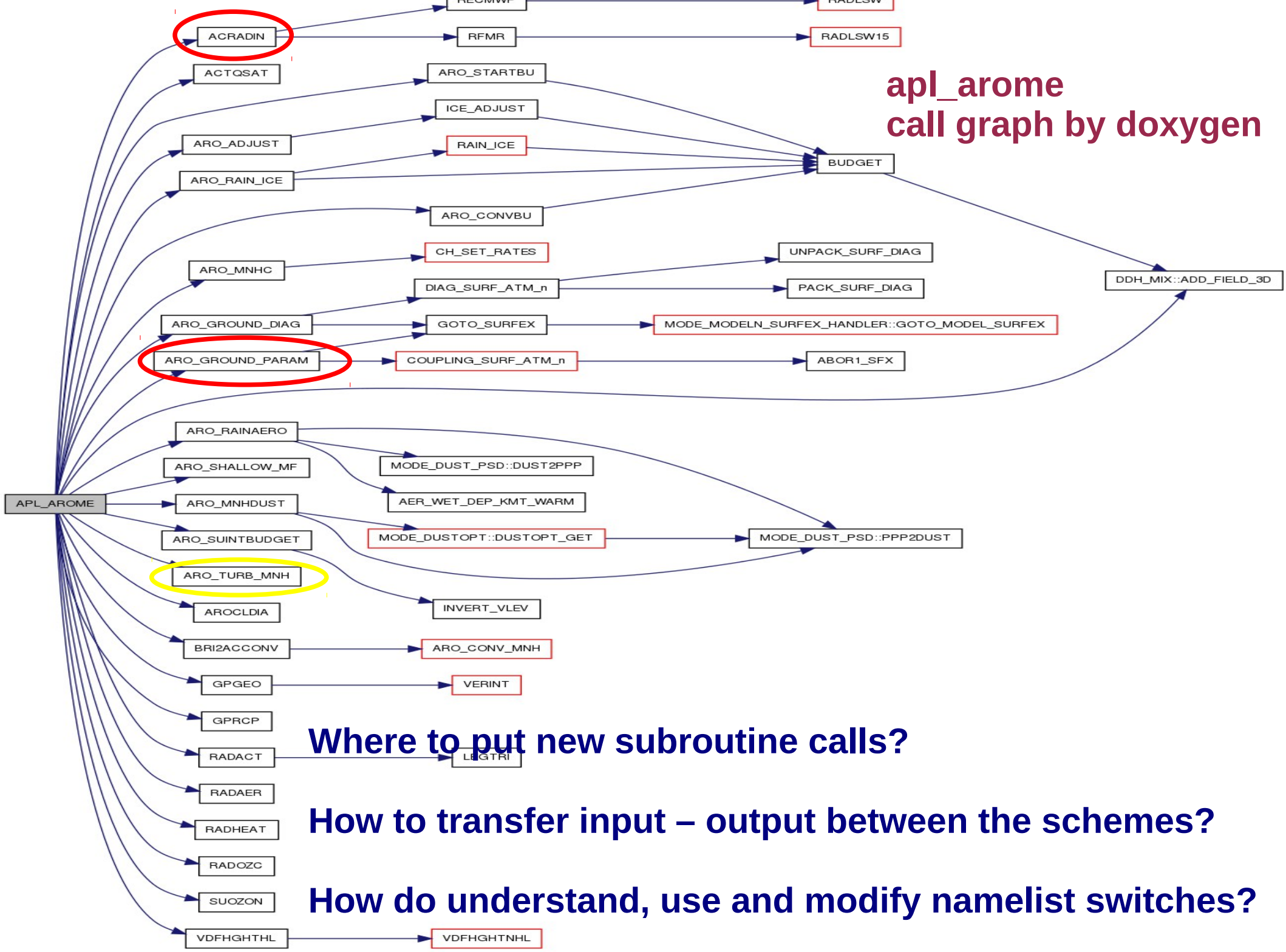
SURFEX

src/arp/phys_ec

ECMWF radiation

src/arp/phys_dmn

Alaro/Aladin/Hirlam-phys



apl_arome
call graph by doxygen

Where to put new subroutine calls?

How to transfer input – output between the schemes?

How do understand, use and modify namelist switches?

Possible ways of the perestroika?

Start streamlining from the existing schemes,
learn how to advance towards more complicated components

Radiation:

Call ECMWF/hlradia/acraneb from apl_arome and aplpar
Clean cloud, aerosol, ozone input from inside the schemes
Pass consistent with microphysics cloud, aerosol, ozone input to the atmospheric radiation

SURFEX:

Check the (already identical) interface and namelists
Pass proper orographic variables (where created?)
Check consistency of radiation fluxes
and parameters (albedo etc) between atmosphere and surface

CBR turbulence and shallow convection mass flux:

Choose one of the existing four (in AROME, ARPEGE, HIRLAM, TOUCANS) CBR schemes for further development
Improve the shallow convection – CBR coordination and coding

norden
MUSCATEN/NordForsk

Third Workshop on

Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling

Sessions on:

- Lake-atmosphere coupling
- External parameters for description of lake properties
- Assimilation of observations on lake surface state
- Model validation and intercomparison
- Processes in fresh-water bodies beyond lake physics

One-day excursion to Lake Sääksjärvi with a workshop session, swimming, sauna, dinner ...

Registration till 30th June, 2012, no registration fee

Finnish Meteorological Insitute, Helsinki
September 18-20 2012
Nordic Network MUSCATEN

Stable boundary layer workshop Helsinki, FMI, 3-5 December 2012

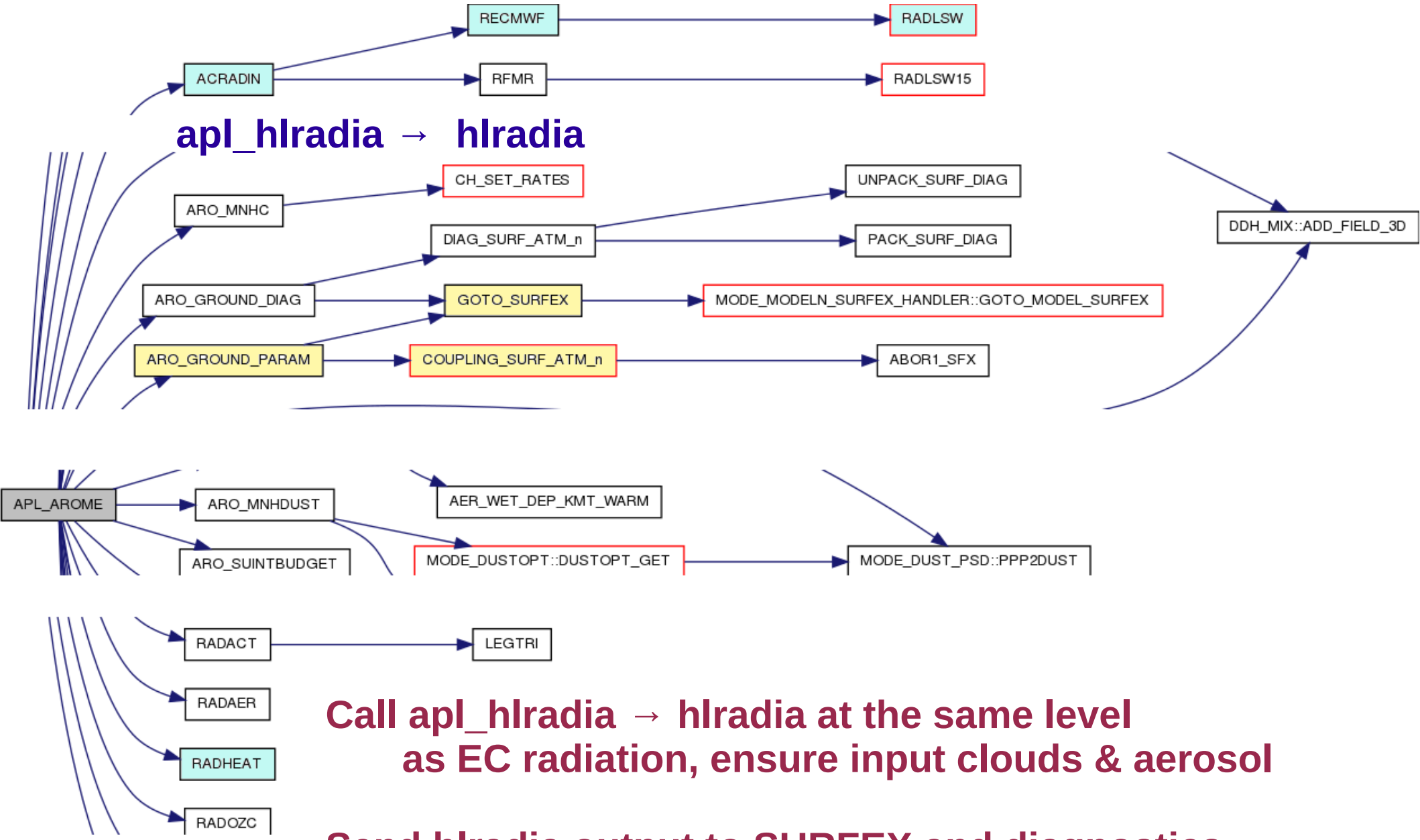
- To discuss how to develop NWP (HARMONIE) parametrisations related to forecast of stable boundary layer conditions
- Bring together researchers, model developers, forecasters
- Three days with presentations and discussions
- Expected outcome: overview of the current problems and ongoing studies, recommendations and coordination of plans

Stable boundary layer workshop Helsinki, FMI, 3-5.12.2012

Suggested topics:

- Models and the Nordic temperature problem
- Forecasting fog, stratus and visibility
- GABLS4 stable boundary layer model intercomparison study over Antarctica
- New developments in turbulence parametrisations

Thank you!

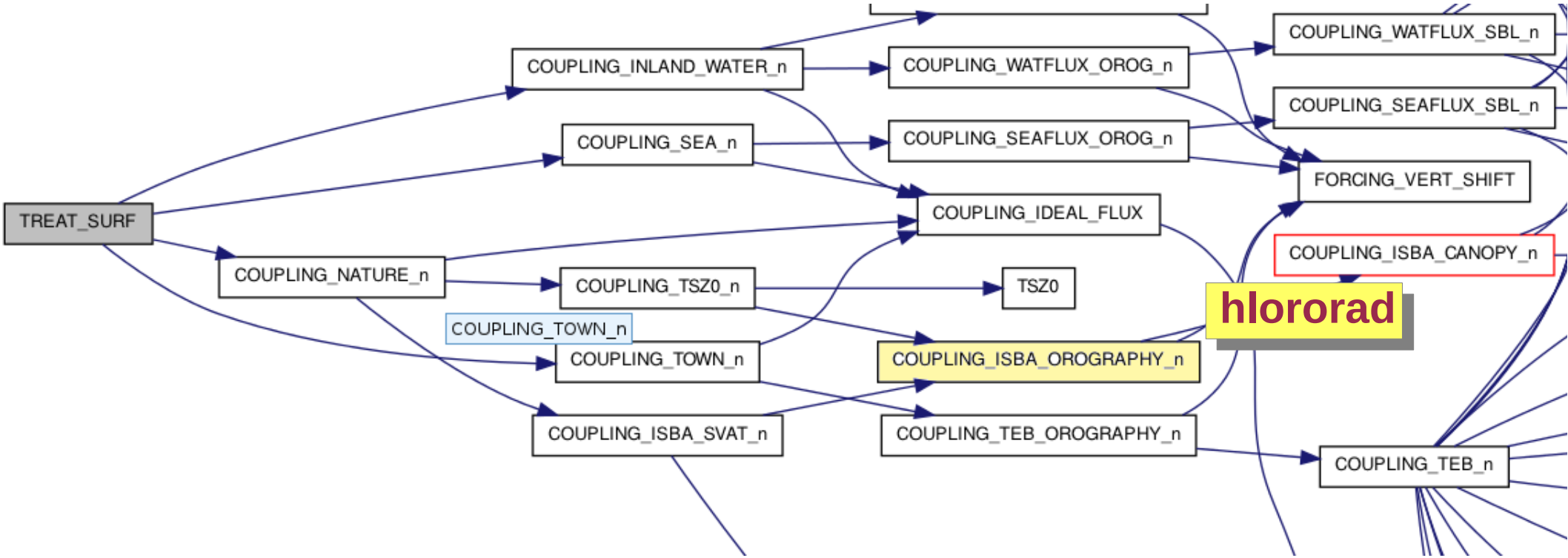


Call apl_hlradia → hlradia at the same level as EC radiation, ensure input clouds & aerosol

Send hlradia output to SURFEX and diagnostics

Call hlororad from coupling_surf_atm → → coupling_isba_orography, ensure orography input

In SURFEX7, slightly different structure:



Call hlororad from coupling_surf_atm → treat_surf → coupling_isba_orography, ensure orography input