Overview of NWP systems used in ALADIN / HIRLAM

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Outline

- ECMWF and SRNWP Consortia in Europe
- IFS/ARPEGE and Meso-Nh software
- Current resolutions of operational NWP systems
- Physical parameterizations development

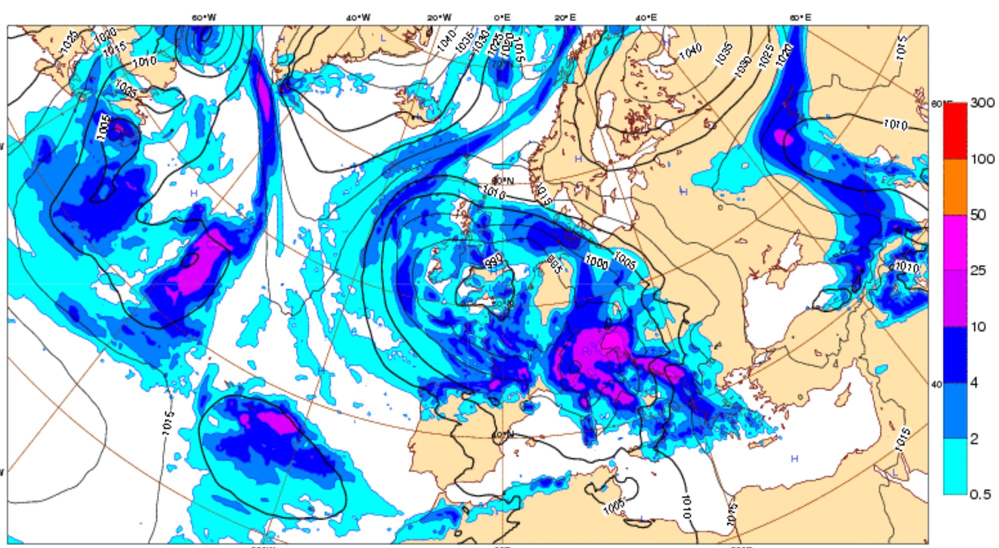
European Centre for Medium-Range Weather Forecasts (ECMWF)

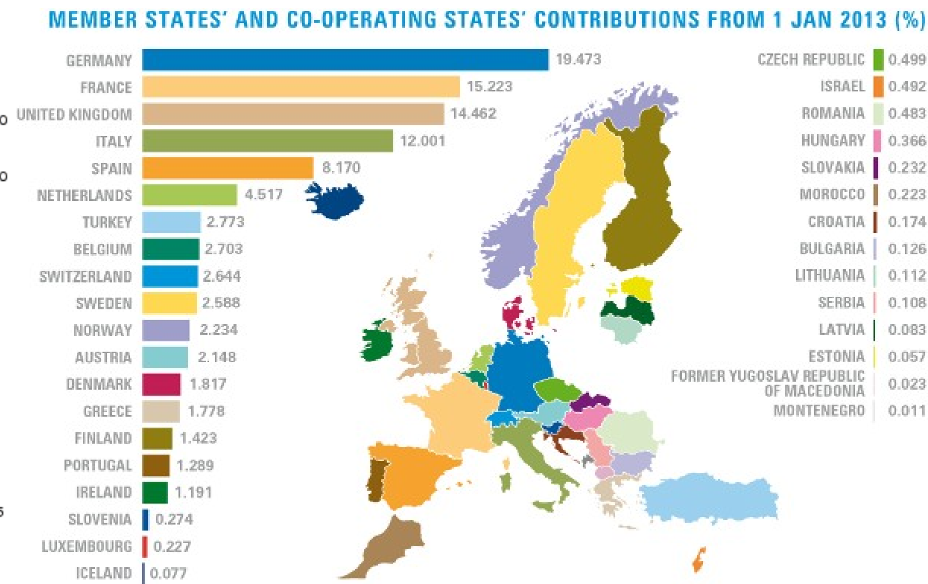
- Independent intergovernmental organization supported by 34 States (20 member states and co-operation agreements with 14 States).

- Development and operation of global models and data-assimilation systems for the dynamics, thermodynamics and composition of the Earth's fluid envelope and interacting parts of the Earth-system.

- IFS/ARPEGE NWP software conceived, developed and maintained in collaboration with Météo-France since 1988.

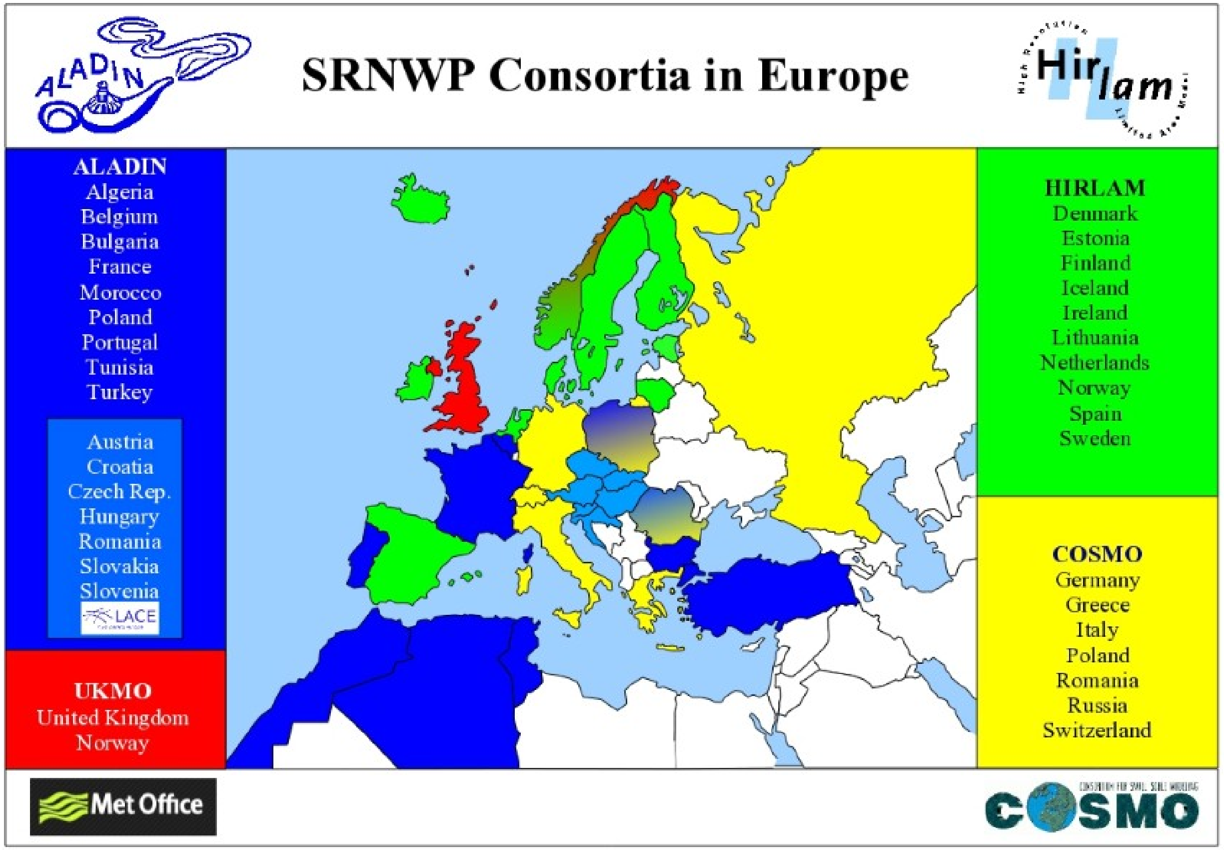
Sunday 17 March 2013 00UTC ©ECMWF Forecast t+036 VT: Monday 18 March 2013 12UTC
Surface: Mean sea level pressure / 12hr Accumulated precipitation (VT-6h/VT+6h)





Short range NWP Consortia in Europe

- Short-range forecasts (a few hours to a few days) rely on very high-resolution limited-area models operated by the National Meteorological Services (NMS), using boundary condition data from European global models (IFS, ARPEGE, UM, GME). Such systems are mainly developed as cooperative projects under three large European consortia (ALADIN, HIRLAM and COSMO).



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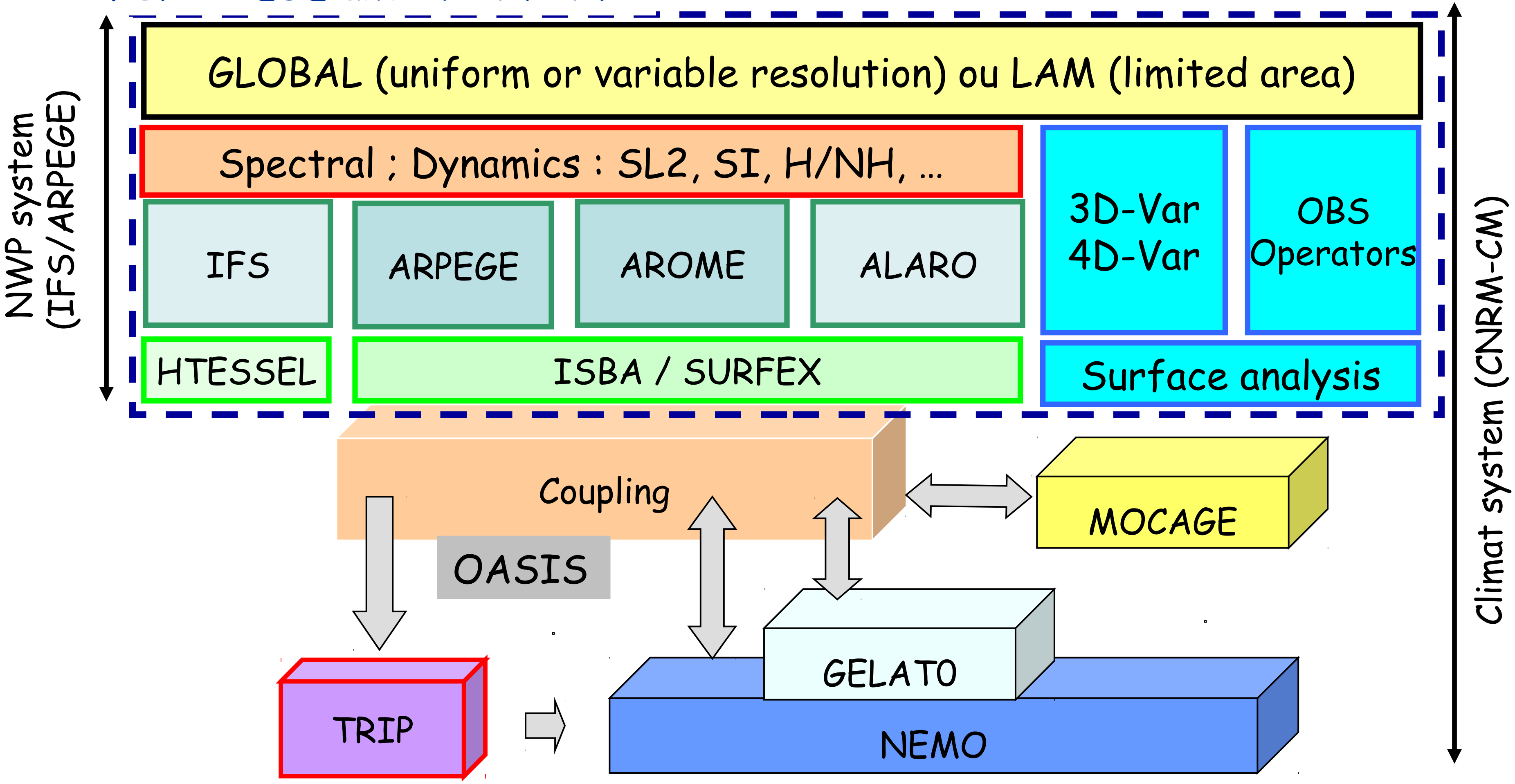
Numerical codes

✓IFS/ARPEGE and CNRM-CM



✓MESO-NH : research model for meso-alpha scale to micro-scale, anelastic system, two way nesting, advanced physical parameterizations for kilometric scales, process studies, tracers, more diagnostics, 1D, 2D

Characteristics of some current NWP systems in Europe as of Oct. 2012

I) Deterministic Systems

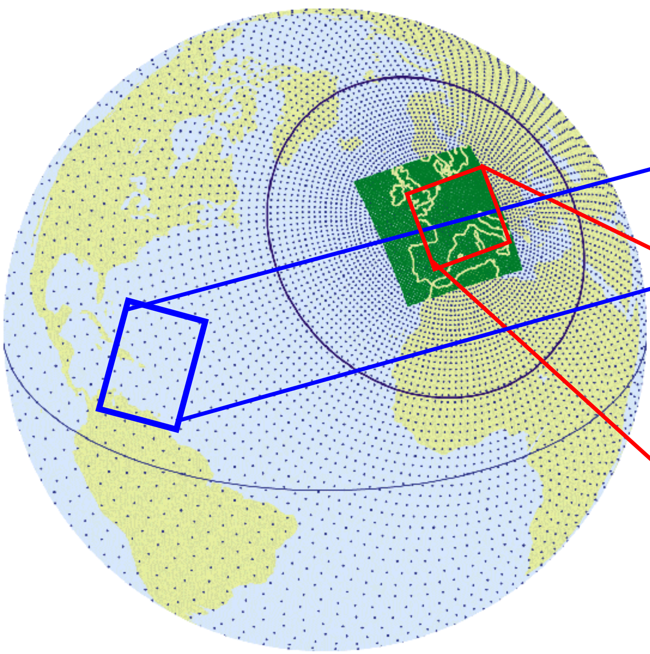
Country	Model	Mesh size (km)	Nb of gridpoints	Nb of levels	Initial times & Forecast ranges (h)	Type of data assimi-lation	Model providing LBC data	LBC update interval (h)	Computer
ECMWF	IFS	16	global	91	00/06/12/18 +240h/+90h	4D-Var & EDA	-	-	IBM P6+ 575
France	ARPEGE	10-60	global	70	00/06/12/18 +102h/72/84/60	4D-Var & EDA	-	-	NEC SX-9
	AROME France	2.5	739 × 709	60	00/06/12/18 +36h	3D-Var	ARPEGE	1h	
	ALADIN Réunion	7.5	489 × 799	70	00/12 +84h	3D-Var	ARPEGE	3h	
	ALADIN Polynesia	7.5	475 × 529	70	06/18 +54h	3D-Var	IFS	3h	
	ALADIN Caledonia	7.5	349 × 277	70	06/18 +54h	3D-Var	IFS	3h	
	ALADIN Ant. Guayana	7.5	501 × 439	70	06/18 +54h	3D-Var	IFS	3h	
Finland	HIRLAM	7.5	1030 × 816	65	00/06/12/18 +54h	4D-VAR	IFS	3h	Cray XT5m
	HARMONIE	2.5	300 × 600	65	00/06/12/18 +36h	3D-VAR	IFS	3h	
Czech Rep.	ALARO	4.7	529 × 421	87	00/06/12/18 +54h	OI + DFI Blending	ARPEGE	3h	NEC SX-9

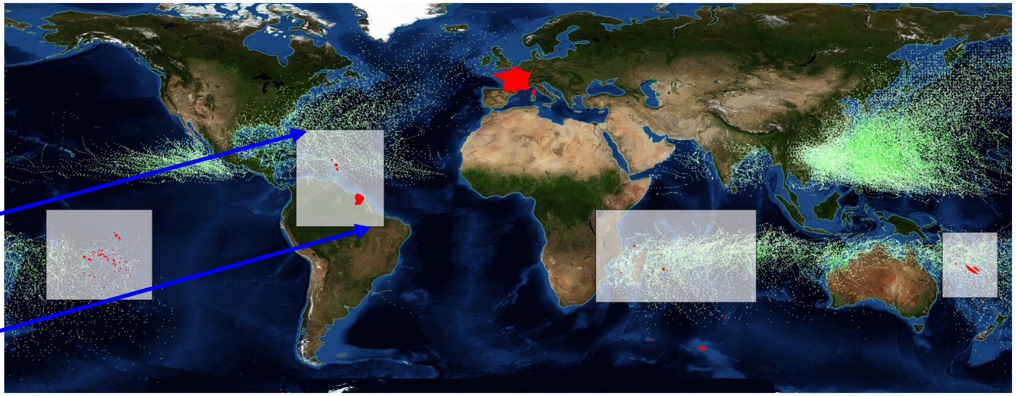
Characteristics of some current NWP systems in Europe as of Oct. 2012

II) Ensemble Prediction Systems

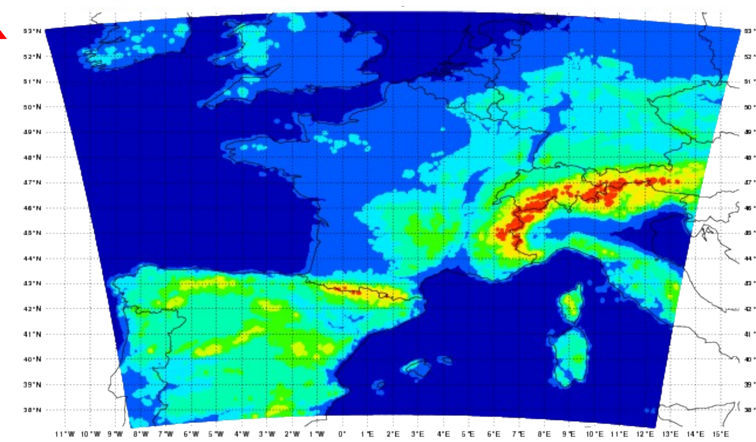
Country	Model	Mesh size (km)	Nb of gridpoints	Nb of levels	Initial times & Forecast ranges (h)	Type of data assimi-lation	Model providing LBC data	LBC update interval (h)	Number of EPS members
ECMWF	IFS-EPS	31	global	62	00/12 +360h	SV initial pert. + coupling with global EDA	-	-	50+1
France	PEARP (ARPEGE-EPS)	15-80	global	65	06/18 +72/+108h	SV initial pert + coupling with global EDA	-	-	35
Norway	LAMEPS / HIRLAM	12	232 × 371	60	06/18 +60h	EDA pert initial ECMWF EPS SVs	ECMWF EPS	3h	20+1
Austria (for LACE)	ALADIN-LAEF	11	324 × 225	45	00/12 +72h	Blending ECMWF SV ALADIN Breeding Ens. LSA	ECMWF EPS	6h	16+1

NWP deterministic systems with assim at MF





LAM ALADIN : ~3-days forecasts, dx~8km, 70 vertical levels, dt=450s - *3DVar Data Assimilation*



Global ARPEGE : T798c2.4L70

~4-days forecasts every 6 hours

dx~10km over France, ~60km over antipodes,

dt~514mn, 70 vertical levels

4DVar incremental Data Assimilation

Low resolutions :

T107c1L70 (~180km) dt=1800s

and T323c1L70 (~60km) dt=1350s

LAM Cloud Resolving Model AROME

30 h forecasts every 6h

dx=2.5km, 60 vertical levels, dt=60s

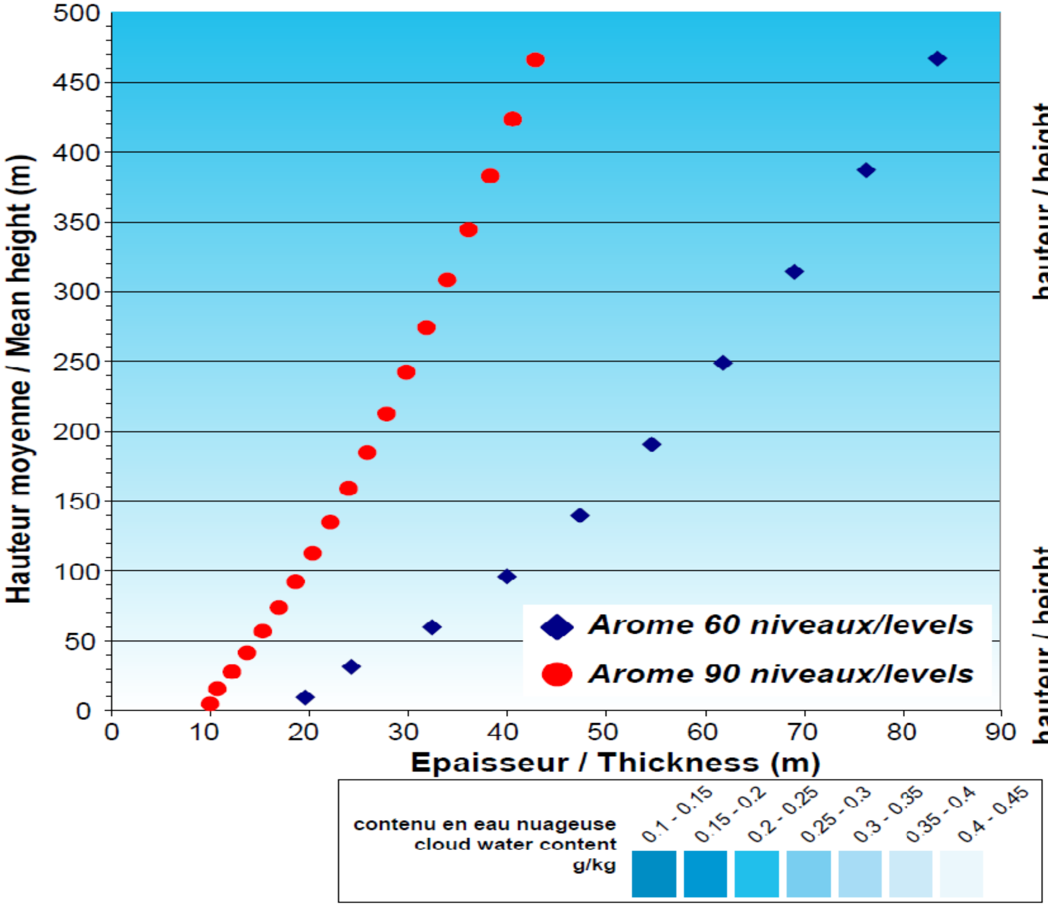
3DVar Data Assimilation (RUC3h)

Future ARPEGE and AROME configurations planned on the new computer

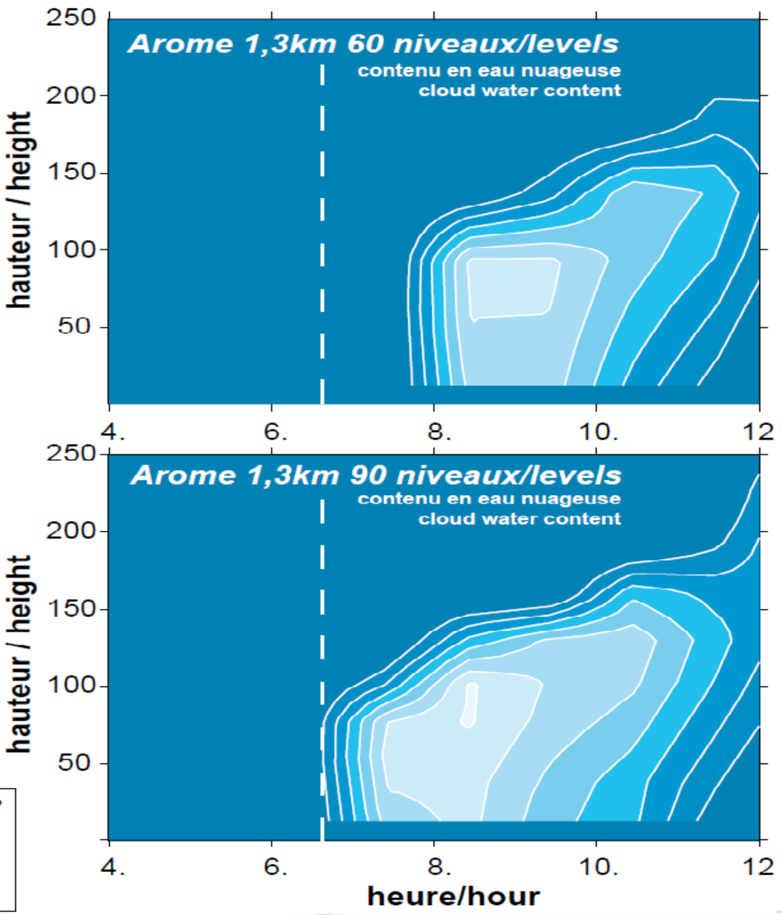
- Increase of spatial resolution planned for ARPEGE NWP system : 7km<Δx<40km and ~105 vertical levels.
- Increase of spatial resolution planned for PEARP ensemble prediction system : 10km<Δx<70km and ~95 vertical levels.
- Increase of spatial resolution planned for AROME-France NWP system : ~1.3 km and ~90 vertical levels.
- Development of a convective scale ensemble forecasting system PEARO based on AROME NWP model at 2.5km
- Development of a nowcasting system ARO-PI based on AROME NWP model with hourly assimilations and short range forecasts (few hours)
- Evaluation of AROME-500m over dedicated areas (airports, mountains, ...)

AROME vertical resolution

Vertical resolution near the surface



Arome forecasts over Roissy from operational analysis 20101115r18



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Constraints on physical parameterizations

Linked to operational context and multiplicity of NWP applications :

- Suitable for the entire globe and atmosphere
- Multi-scales (wide range of time-steps and spatial resolutions)
- Robustness
- Efficiency

Linked to assimilation :

- Modeling high stratosphere and low mesosphere for assimilating satellite observations
- 4D-Var : Model integration at lower spatial resolution (in Arpege: Dx~200km, Dt~30min)

Physical parameterizations

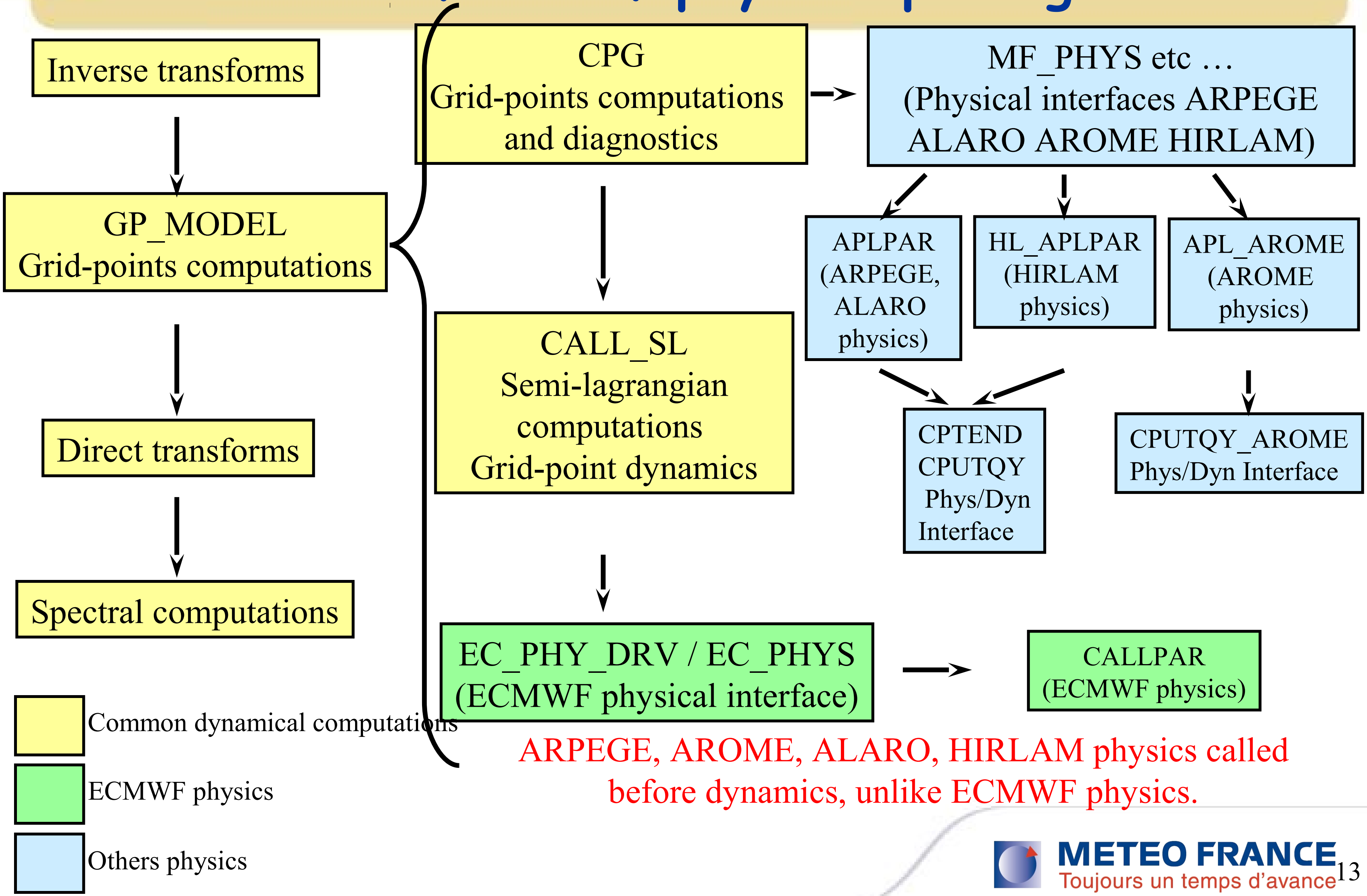
Prognostic variables : U, V, T, Qv, Ql, Qi, Qr, Qs, Qg, TKE, others for surface

Still 1D physical parameterizations

Physical schemes :

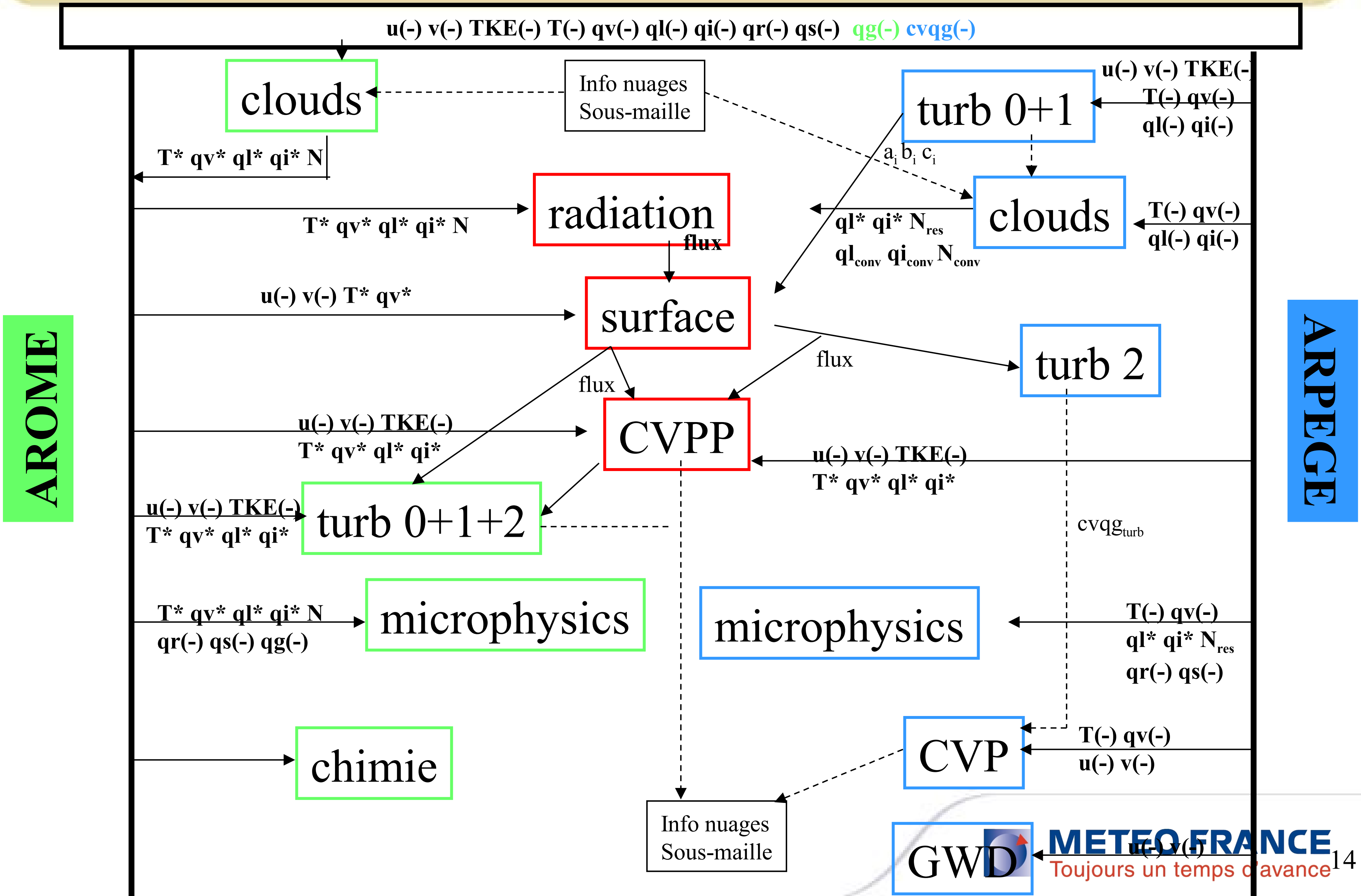
- Turbulence
- Thermals
- Deep convection (supposed resolved at kilometric scale, like in Arome)
- Microphysics
- Clouds
- Radiation
- Subgrid orographical effects
- Surface processes (soil, vegetation, snow, town, sea, sea-ice, lake, etc.)

Interfaces of physical packages



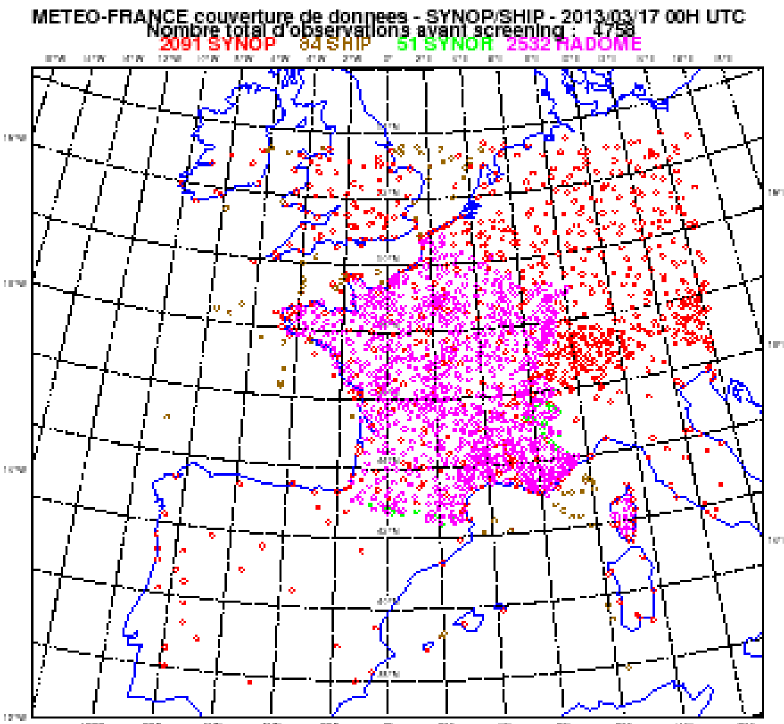
ARPEGE, AROME, ALARO, HIRLAM physics called before dynamics, unlike ECMWF physics.

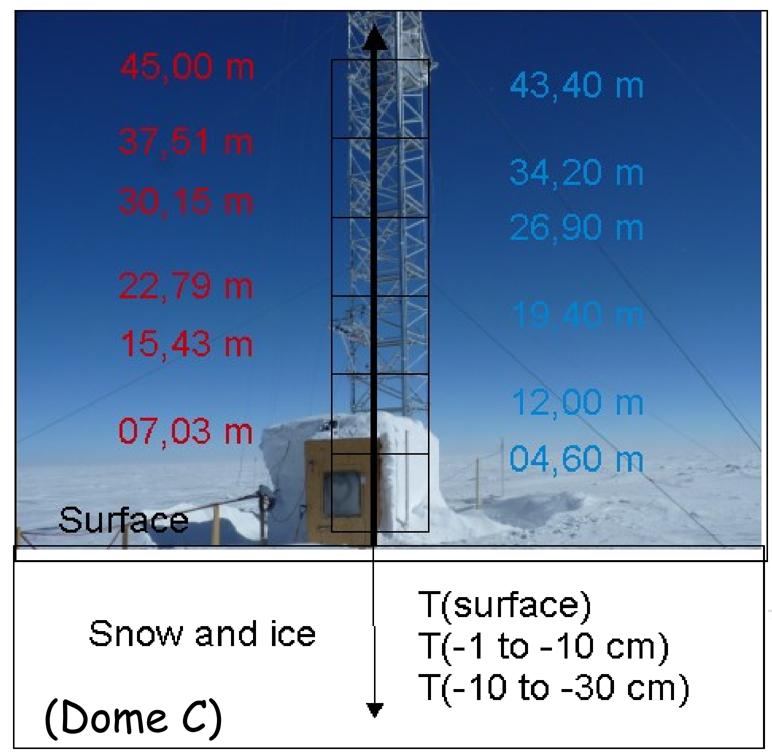
Physical parameterizations



Validation methods

- Locally on highly instrumented sites (Cabauw, Sodankyla, ARM, etc.)
- "Locally" against explicit simulations (CSRM, LES, DNS) -> Meso-Nh
- 1D model (intercomparison case studies : GABLS, GCSS, …)
- 3D : Objective scores against observations (SYNOP, TEMP, ...) and analyses
- 3D : Subjective validation by forecasters (continuous validation)





Motivations for improving turbulence parameterization in stable stratification

- Total decay of turbulence which occurs at moderately stable stratification in current operational turbulence parameterizations is not realistic.
- Very stable conditions are quite common in the atmosphere : polar regions, mid-latitudes in winter, top of PBL, free atmosphere, etc.
- Improving their representation is important for short-range weather forecasts (diurnal cycle of temperature and wind, low level clouds, air quality, clear air turbulence, etc.), but probably also for medium range weather forecasts (synoptic evolution) and climate simulations.