The COSMO software for processing geospatial data (EXTPAR)

Status March 2020

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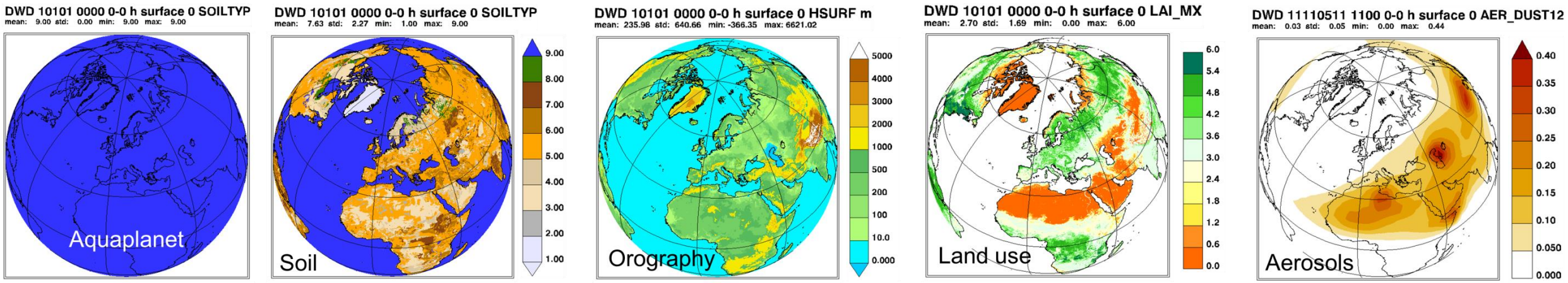
EXTPAR - Background



- Geospatial data are retrieved from high-resolution satellite information or land registers and are aggregated to the model's global or limited-area grid.
- In a final processing step all available data are cross-checked for consistency (e.g., to exclude vegetation on glaciers).
- The required model parameters are very similar for NWP models, but the used data sources and the applied tools vary between different models – i.e. different mapping of geospatial information (Onvlee et al, 2014).

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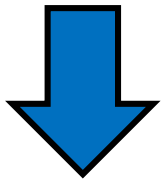
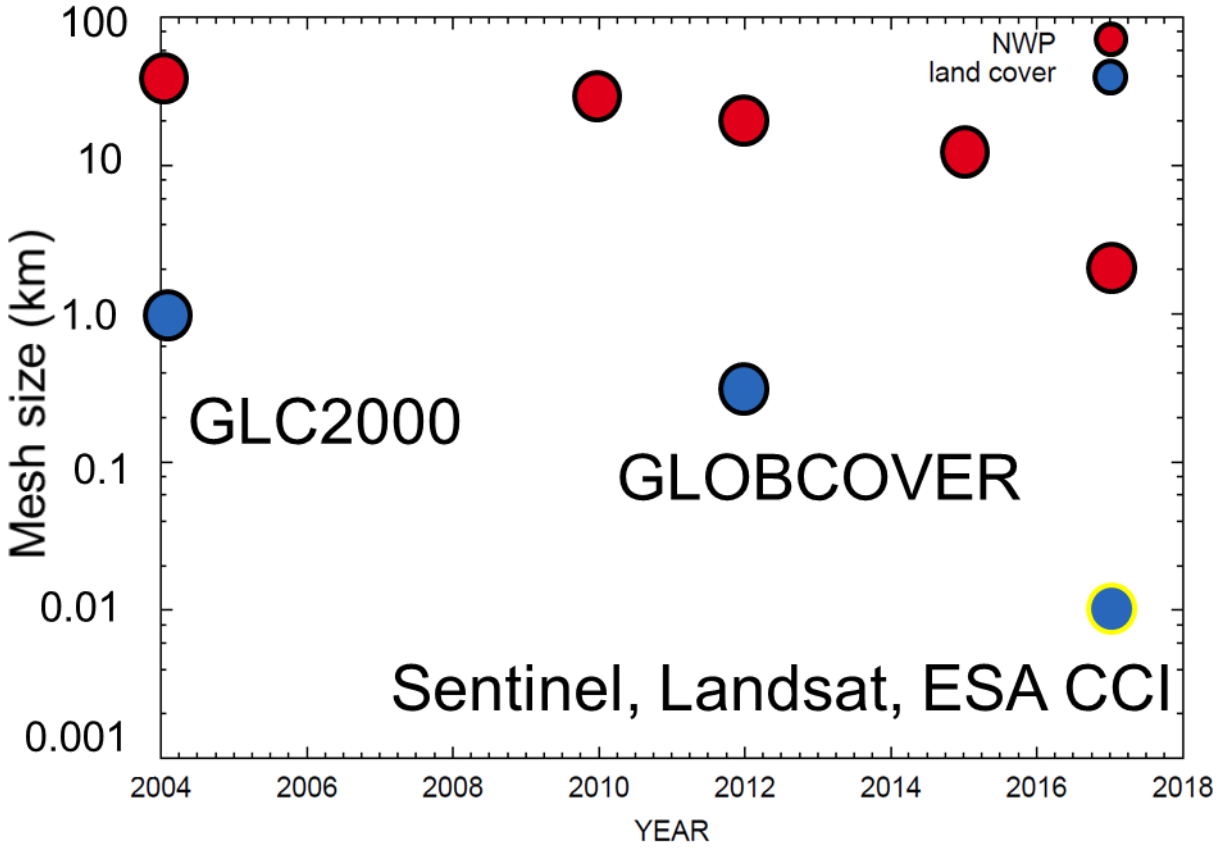
EXTPAR - Challenges

1. Demand for high-resolution remote sensing data to be used for:
2. convection permitting global NWP or LES-type limited-area models.
3. Increasing number of users for aggregated data on model's grid all over the world

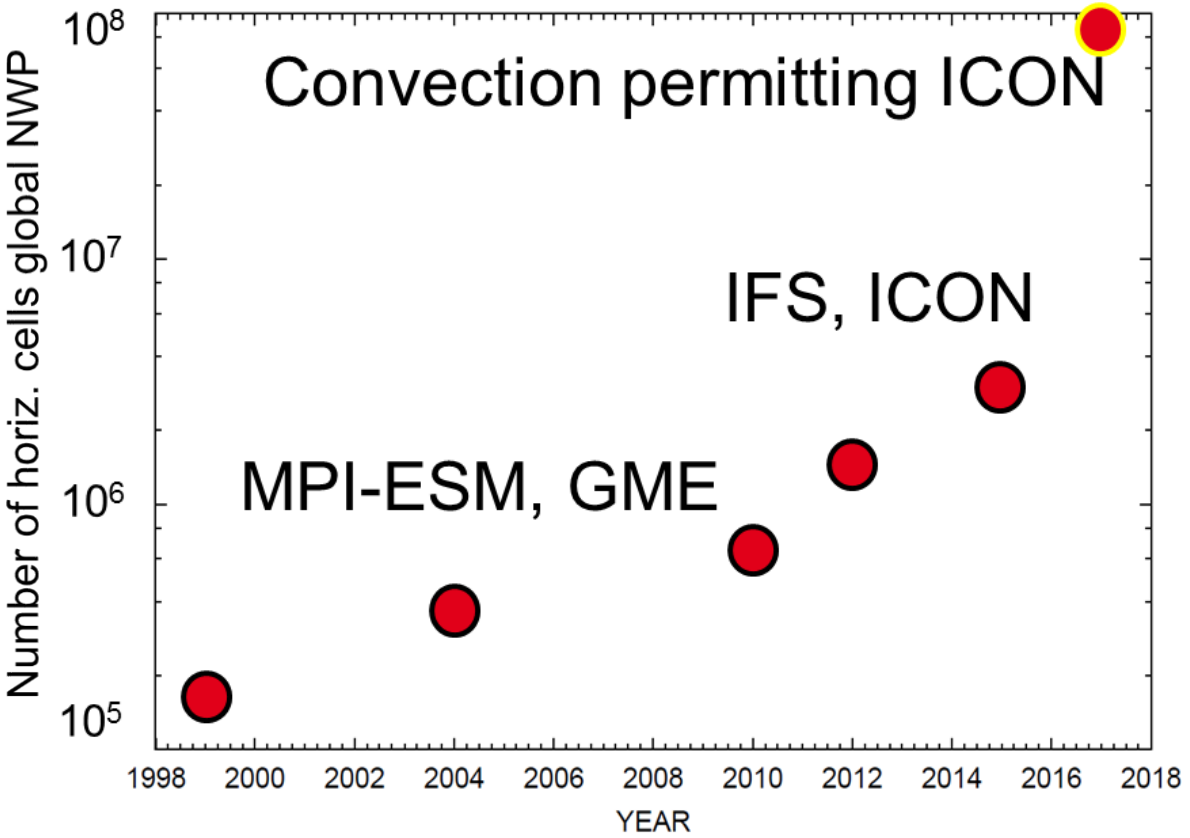


- Increase in storage costs
- Increase in I/O costs
- Demand for improved approaches for data aggregation
- Need for parallelization
- Need for user-friendly, low maintenance front ends

EXTPAR - Challenges



Evolution of the mesh size in global NWP models and land use remote sensing products



Evolution of number of grid points in global NWP models

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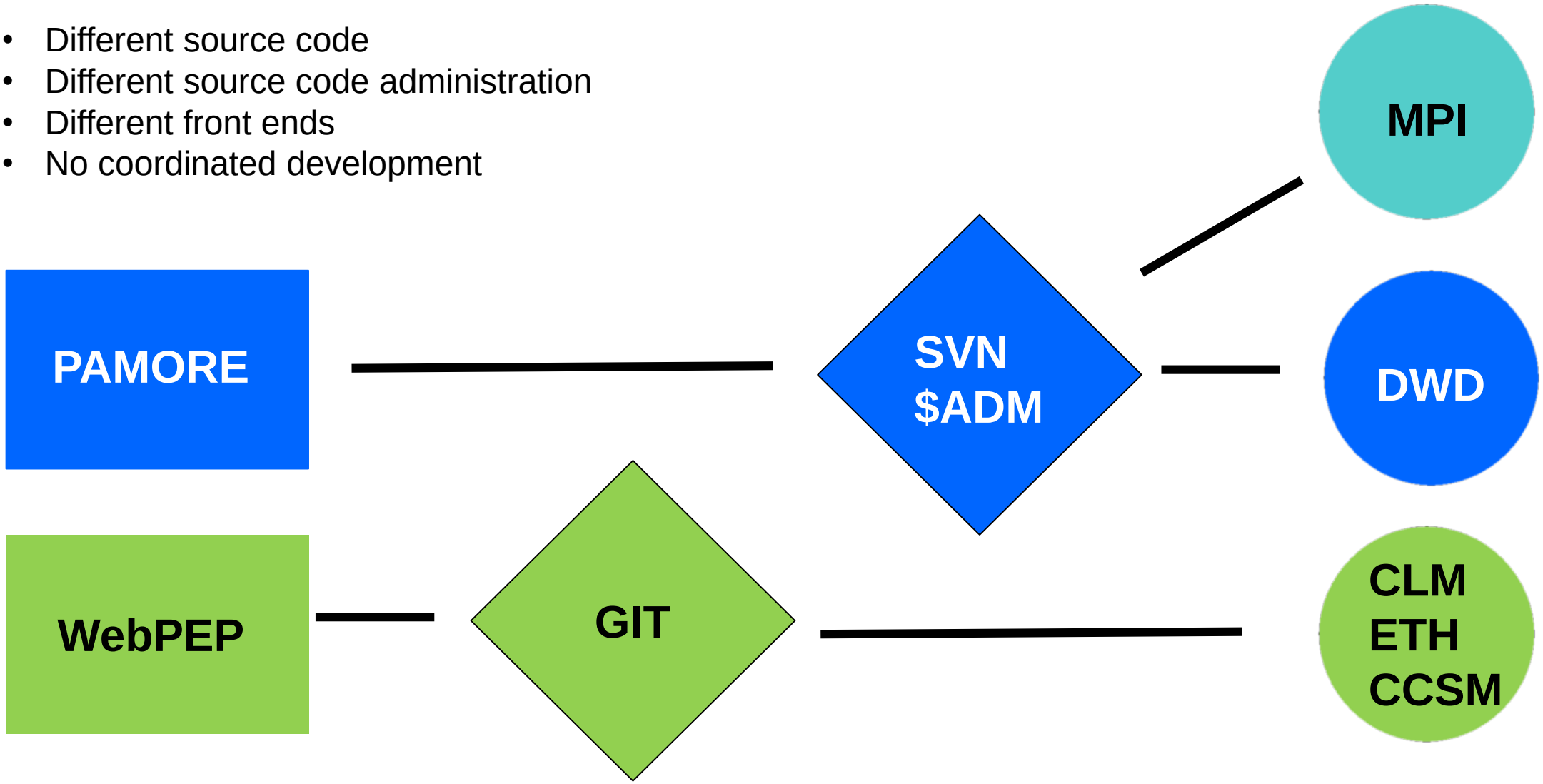
EXTPAR - 2017

- Different source code
- Different source code administration
- Different front ends
- No coordinated development



*http://www.cosmo-model.org/content/tasks/workGroups/wg3b/default.htm#EXTPAR

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EXTPAR - 2017

- Different source code
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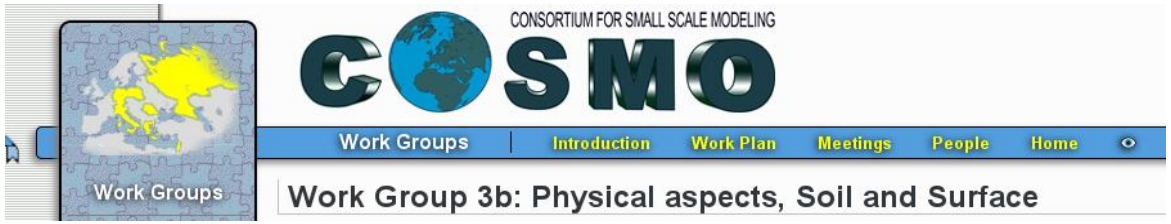
PAMOR

WebPE



- Limitations of the situation recognized in COSMO WG3b (J.M. Bettems)
- Ressources invested in COSMO-CH (D. Luethi, M. Messmer, A. Roches)
- Nomination of new COSMO SCA for EXTPAR
- Impetus for unified EXTPAR version
- Progress documented at COSMO WG3b website*

MPI

DWD

CLM
ETH
CCSM

*http://www.cosmo-model.org/content/tasks/workGroups/wg3b/default.htm#EXTPAR

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EXTPAR – Kick off 2107

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27 June 2017 ICON EXTPAR Meeting

Meeting

- **Offenbach**
- Time: **14:00-18:00 (ca.)**
- **Room: DWD, OF, F135, conference area GREE**

Participants

Jürgen Helmert	DWD
Marco Giorgetta	MPI-M
Reinhard Budich	MPI-M
Christian Steger	DWD
Luis Kornblueh	MPI-M
Reiner Schnur	MPI-M
Michael Weimer	KIT
Günther Zängl	DWD
Astrid Schöne	DWD
Katherine Osterried	ETH

Agenda

14:00 Welcome
14:15 - 14:45 J. Helmert et al.: COSMO/ICON physiogr
14:45 - 15:00 A. Schöne: Informationen zu Geodaten

15:15 - 15:45 Coffee Break

15:45 - 17:30 Discussion
17:30 Summary and closing

Notes from Luis:

extpar

Basic: github, test suite, fork - pull model, agreement on working together on the github account: expect some work initially to get a single version, Jenkins (get an account for Katherine Osterried on mistral)

Optimization: LAM data generation and date line handling

Usability: Pick-up the web-frontend for extpar from Florian later

Long-term project: Open-up license from COSMO institutional license

Till September (ICON meeting) target

Github handling, Jenkins, and merging of available modifications (without MPI version of consistency checking)

- Jürgen 1: merge DWD changes into **in preparation**
- Jürgen et al.: evaluation of MPI implemtion with respect to necessary man-power requirements to clean-up **in preparation**
- Luis 1: add the cmake build
- Luis 2: netcdf4 support
- Luis 3: add the additional SSO parameters
- Luis 4: the compile checks with NAG (assuming the bugs submitted to Jürgen are resolved)
- Michael: add some KIT extras
- Luis 5: send Katherine the 'versioning best practice of ICON'
- Jürgen 2: DLR/AIRBUS DEM request by ICON community to DLR for scientific/non-commercial **commissioned**

Features required

- DWD: Cleanup of code planning of necessary steps: Günther et al. (Reiner und Luis @MPI)
- MPI 1: slm, frland re-proccesing for the coupled model
- LES 1: Land data processing for JSBACH: Reiner-Luis
- DWD/MPI: SSO parameter problem (first solve DWD 1: it might support this); idea by Günther: Average the subgrid-scale slopes?, and more ... Target: ssotheta **solved**

Immediate action:

- Kathy: Pass around information to get access to ...

Topics for discussion:

- Status of EXTPAR
- Deficiencies of the current solution
- New developments - MPI parallelization
- New HiRes data (e.g. COPERNICUS-Sentinels) - challenges for EXTPAR
- Efficient code structure
- others?

Summary:

- Presentations by J. Helmert and A. Schöne: EXTPAR and ArcGIS
- ArcGIS not as production tool but offers features for preprocessing and validation
- Merging Code in github, managing feature requests, wiki - Sept. 2017
- MPI-Parallel version of EXTPAR after Sept. 2017, Evaluation of the code required
- Roadmap of future developments, Release plan
- Decision: COSMO STC, ICON-PI
- Legal issues for EXTPAR: GPL?
- Frequency of Meetings: Min. 2x per year
- Building a test-suite at CSCS and DWD, MPI (CLIM to HiRes HDCP2)
- Web-Interface: Evaluate existing versions, hosting a common interface
- New features from MPI (MIN, MAX of gridpoint values), Ocean related land-mask
- General module for reading new data as demand
- NetCDF-Issues (NetCDF-4)
- Solve SSO problems – background: orientation of mountains in high lat.
  - *alternative data set from DLR/Airbus – area based, legal questions*
  - *slope of the icon grid (averaging sso-slope)*

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EXTPAR - 2020

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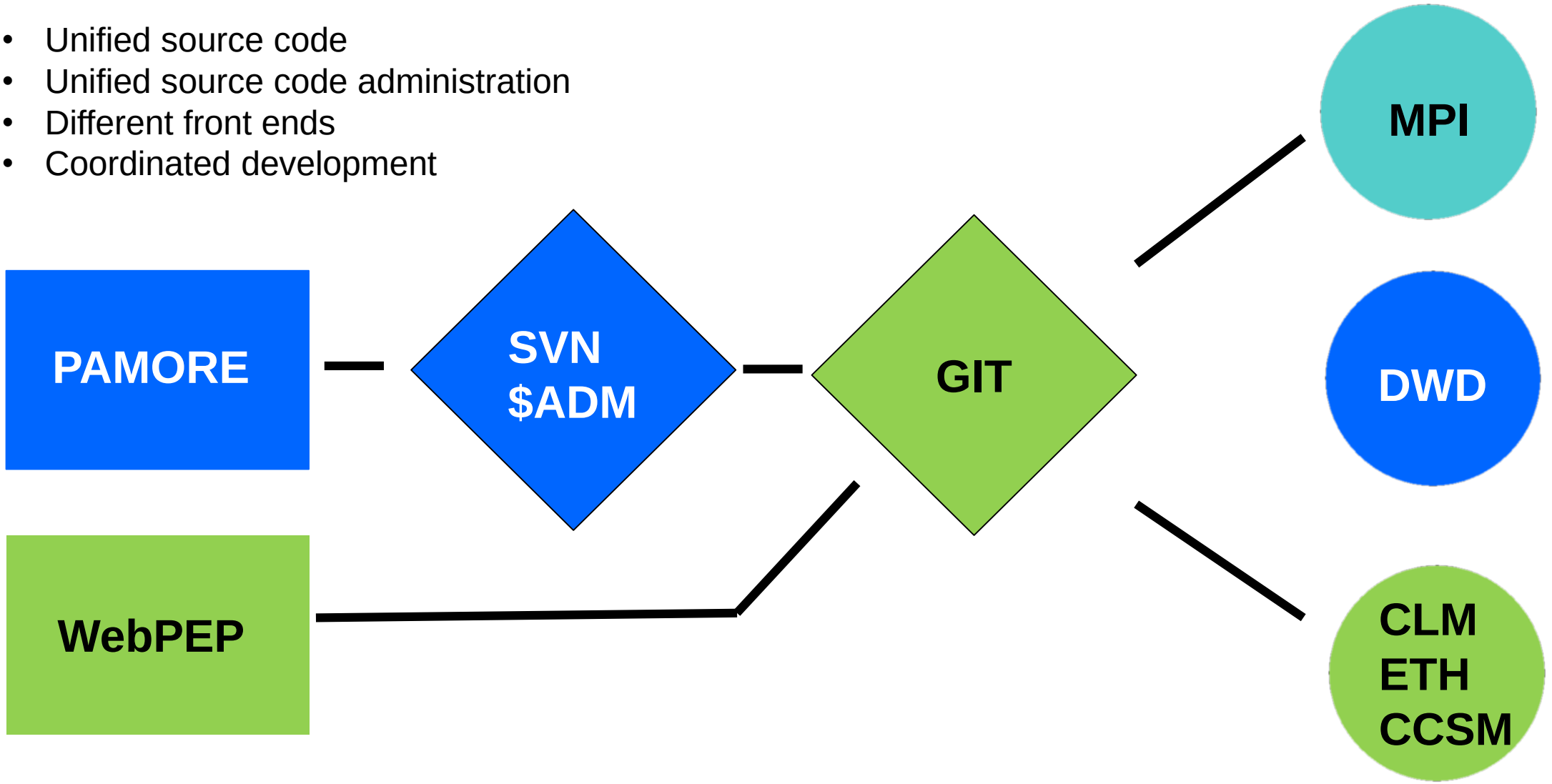
- Unified source code
- Unified source code administration
- Different front ends
- Coordinated development



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EXTPAR – Results 2020

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Features	2017	2020	Results
Development requests	pers. communication, E-Mail	GitHub Issue List	Better overview, avoid work duplication
Source code handling	$ADM/workbench @DWD GitHub (CLM)	Github handling, Jenkins, and merging of available modifications	robust and stable environment Parallelization: fast CDO with OMP support
Software Test Suite	Own tests @ DWD, CSCS, MPI	TestSuite with Jenkins including ICON @GitHub	Improved Quality management
Web-Interface: Evaluate existing versions, hosting a common interface	PAMORE (DWD), WebPEP (CLM)	PAMORE (DWD), WebPEP (CLM)	Actually PAMORE and WebPEP
General module for reading new data as demand	Own F90 module for new data	Easy implementation by simple CDO scripts	Faster implementation of new data
Compiler support	Intel, Cray	Intel, Cray, NAG, PGI	More robust and clean code
Integration of developments for SSO, glacier points, emissivity	Available only @DWD, or MPI, ETH	Available for all users @GitHub EXTPAR	Share ressources for new developments

EXTPAR@DWD - PAMORE WebService

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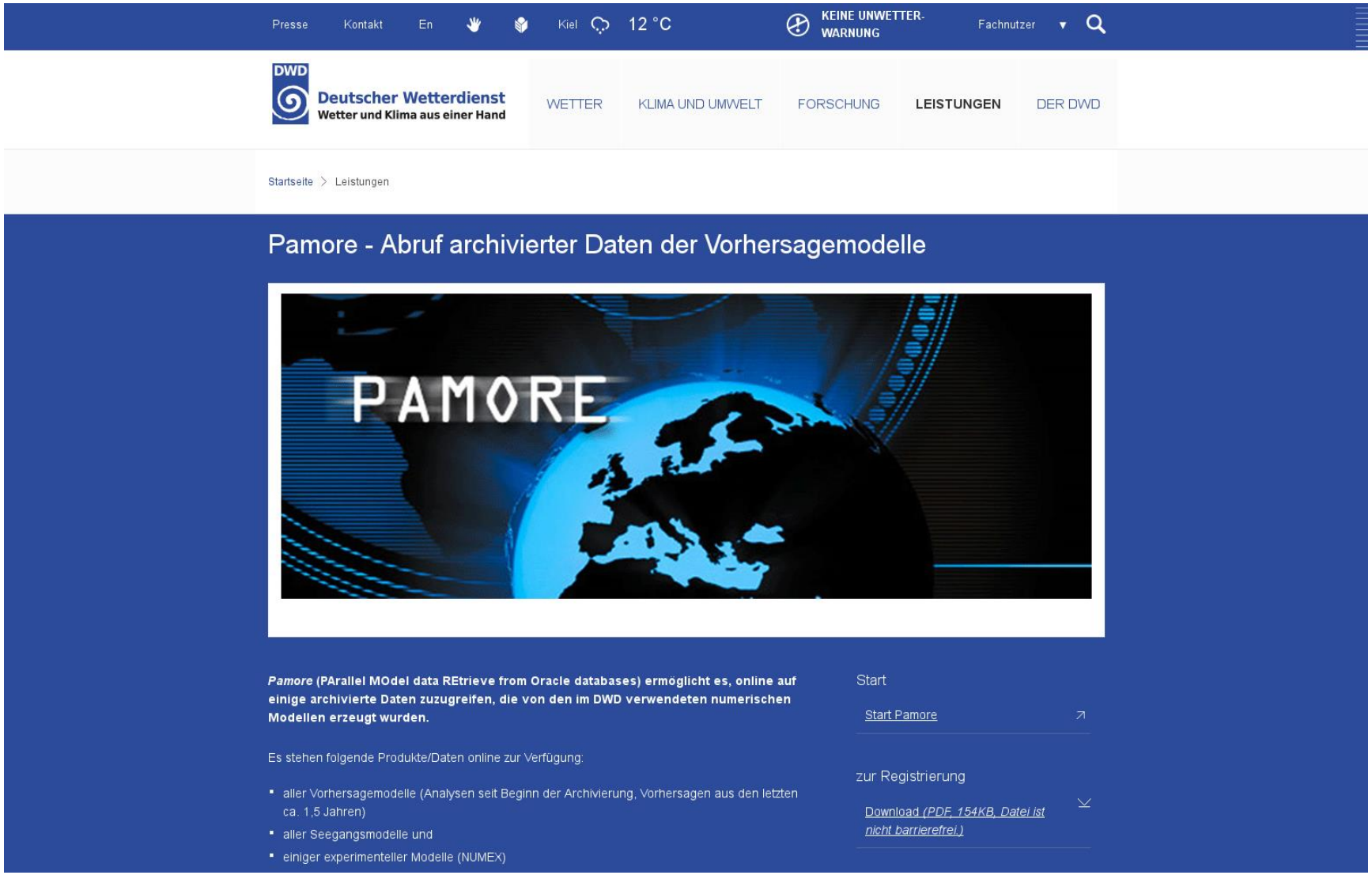

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EXTPAR@DWD

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Production (PAMORE)

- Web- Frontend
- Grid- Generator
- Namelist-Control
- ERA-I SST
- ERA-I T2M
- EXTPAR-F90
- OUTPUT, FTP, MAIL

SVN
$ADM

GIT

Development

- Namelist-Control
- ERA-I SST
- ERA-I T2M
- EXTPAR-F90

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EXTPAR@DWD - Results

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Feature	Result
GIT	• Exchange with GIT and DWD SVN svn://xceh.dwd.de ($ADM) • Version Tagging for head of GIT DWD branch
Scripts	• Uniform and complete job output • Clean error codes • Ex post modification of name lists
Orography	• Automatic determination of model resolution • Automatic determination of required ASTER files • Switch of orography in ASTER non-covered regions
Grid	• Improved compatibility with grids from MPI HH
Executables	• Implementation of CDO versions for improved performance (albedo) • Optional treatment of new fields (emissivity, soil,…)
GRIB	• Automatic detection of required value for **`generatingProcessIdentifier`** • ICON-GRIB2: grib_filter from NetCDF, libCDI and Fieldextra in future • COSMO-GRIB2: Fieldextra

EXTPAR – Summary

- Joint project with COSMO-(CLM), MPI-HH, DWD
- Project partners with long experience in geospatial data for NWP and climate models
- Now unified, robust, and stable code of EXTPAR available for project partners
- Special adaptions for application in DWD (PAMORE)
- Possible to run EXTPAR on different platforms (compilers)
- Allow automatic tests of modified code (compilers and output)
- Benefit from developments in CLM/DWD/MPI, e.g. fast CDO with OpenMP support – easy implementation of new data
- Work share on open issues in GitHub (TANDEM-X, technical issues, etc.)

EXTPAR – Outlook

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DWD

- Further improve quality management – provide figures for EXTPAR fields
- Replace F90 code with CDO for modules, which only interpolate to model grid (e.g., Albedo, CRU, NDVI) – further reduce of maintenance costs
- Pre-processing of hi-res satellite data for usage in EXTPAR will be an issue (support GIS solution?)
- Management of memory demanding grids – special attention to consistency check
- Common Web-Interface after COSMO expires for CLM - EXTPAR^{CLOUD}
- Intensify collaboration with NWP and climate consortia – formulate requests to ESA
- EXTPAR-HACKATHON End of March

EXTPAR – Outlook

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EXTPAR work packages

Code

- A1 Disk cache approach
- A2 fast topo processing
- A3 register raw, buffer?, grib
- A4 code replacement- cdo

Content

- B1 ESA CCI LandCover
- B2 SoilGrids
- B3 Pollen
- B4 global hires orography

Infrastructure

- C1 raw data processing
- C2 cmake environment
- C3 Repository @DKRZ
- C4 Input data maintenance
- C5 Unified web interface

#	Work package	Start	End	Q2/20	Q3/20	Q4/20	Q1/21	Q2/21	Q3/21
A1	Disk cache approach	Q2/20	Q3/20						
A2	fast topo processing	Q2/20	Q3/20						
A3	register raw, buffer?, grib	Q2/20	Q2/20						
A4	code replacement- cdo	Q2/20	Q2/20						
B1	ESA CCI LandCover	Q2/20	Q4/20						
B2	SoilGrids	Q2/20	Q4/20						
B3	Pollen	Q3/20	Q1/21						
B4	global hires orography	Q3/20	Q4/20						
C1	raw data processing	Q2/20	Q2/20						
C2	cmake environment	Q2/20	Q2/20						
C3	Repository @DKRZ	Q3/20	Q3/20						
C4	Input data maintanance ICDC	Q3/20	Q3/20						
C5	Unified web interface	Q1/21	Q3/21