COSMO Overview

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Consortium in Transition

No further development of the COSMO model, the model will soon be “frozen”. The Consortium members switch to ICON-LAM (limited-area version of the ICON modelling framework).

- PP C2I (lead by Daniel Rieger) is launched to ensure a smooth transition from COSMO to ICON-LAM; at the end of PP C2I, each participating institution is free to choose when ICON-LAM replaces the COSMO model in their operational system.

In March 2022, all COSMO members should be able to perform deterministic forecast with ICON-LAM

- Numerous tricky issues, e.g. with data assimilation

COSMO-Model Timeline

Version 6.0,
a unified version for NWP and climate modelling,
is going to be the latest release of the COSMO model

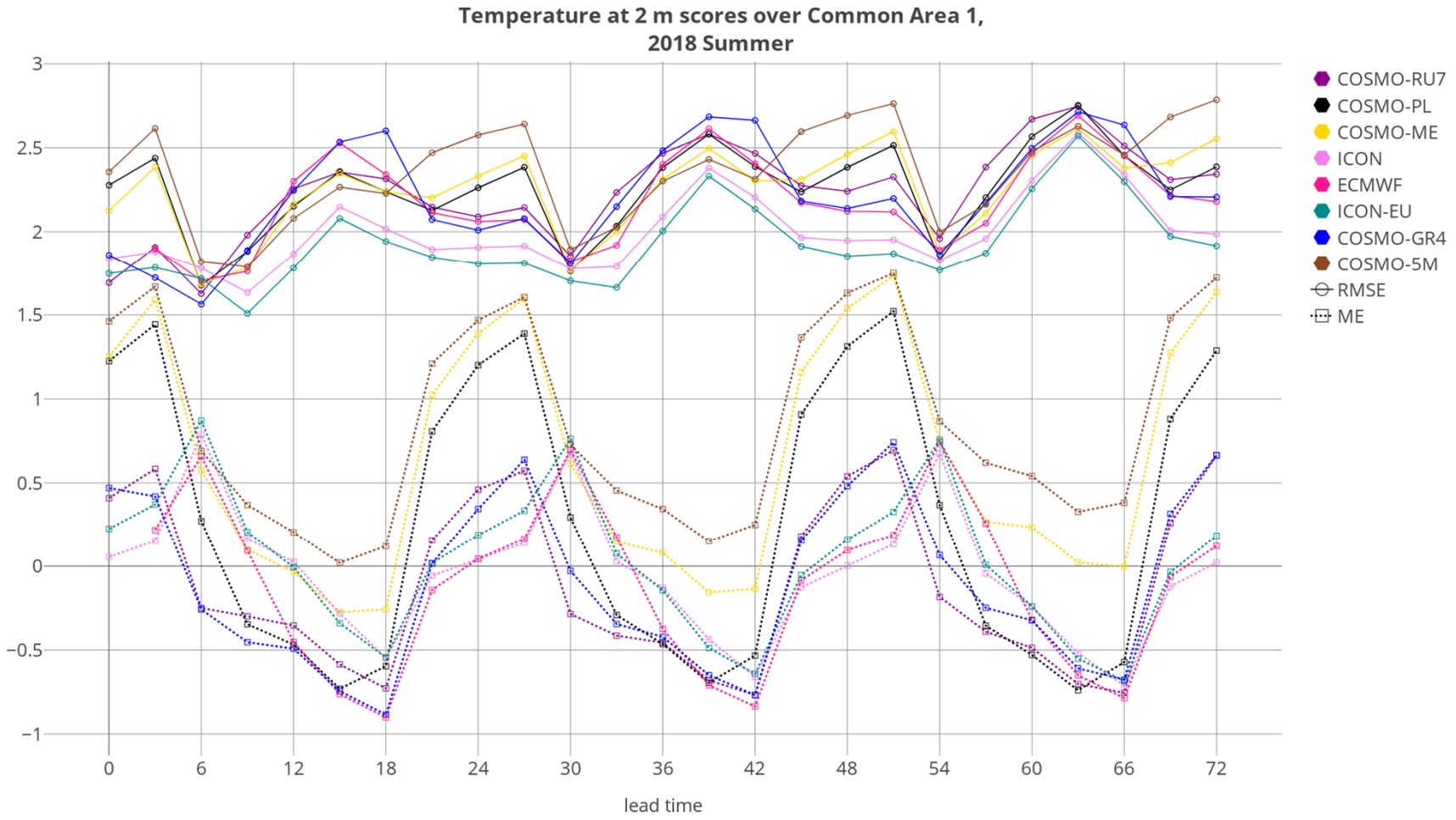
The release of 6.0 is expected in **March 2020**

Beyond that point in time

- the COSMO code is frozen
- only maintenance is provided, incl. bug fixes (in exceptional cases, results of long-lasting development efforts are incorporated)

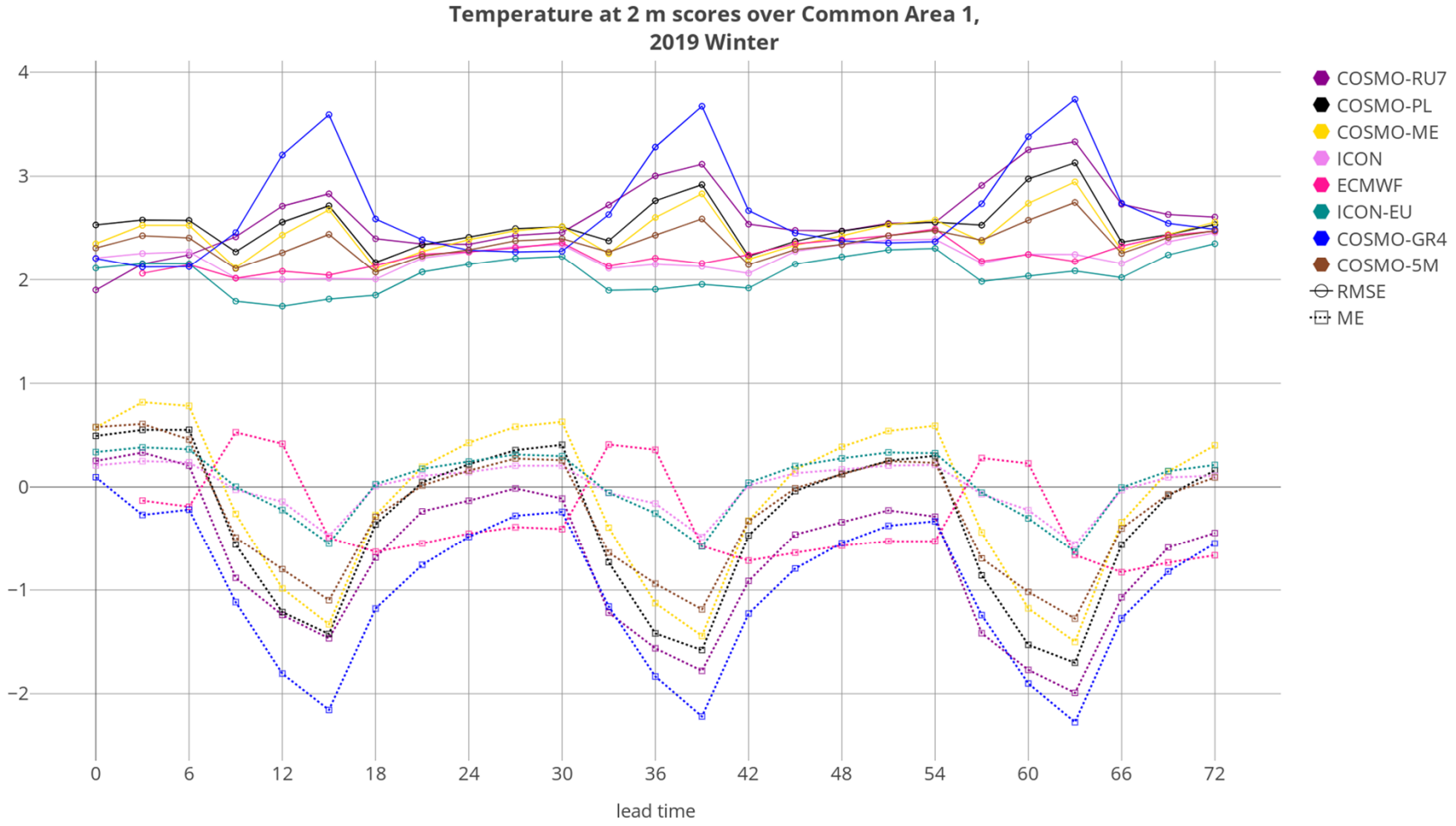
Taste of ICON

ME and RMSE of T2m, JJA 2018



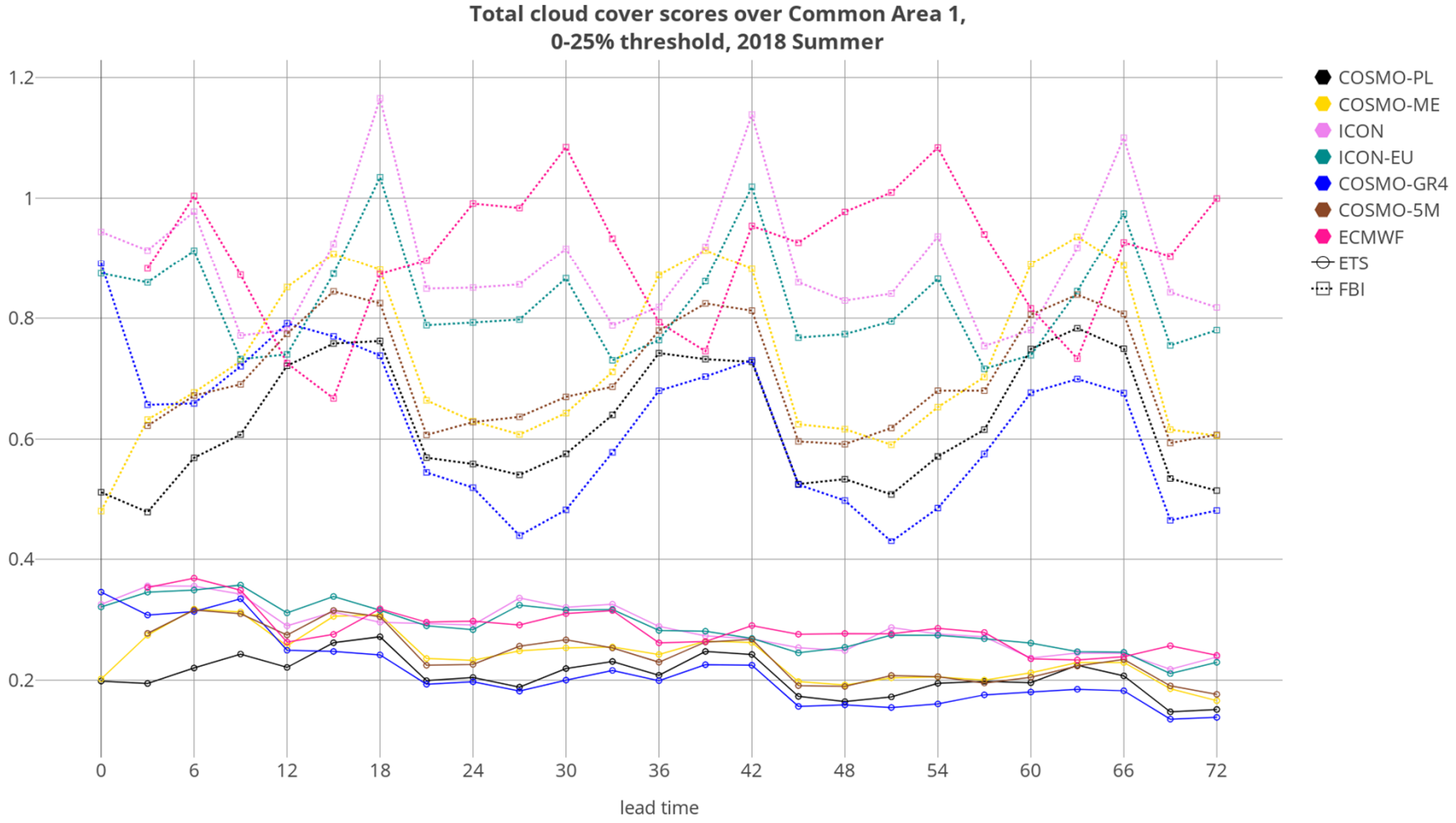
Taste of ICON (cont'd)

ME and RMSE of T2m, DJF 2018-2019



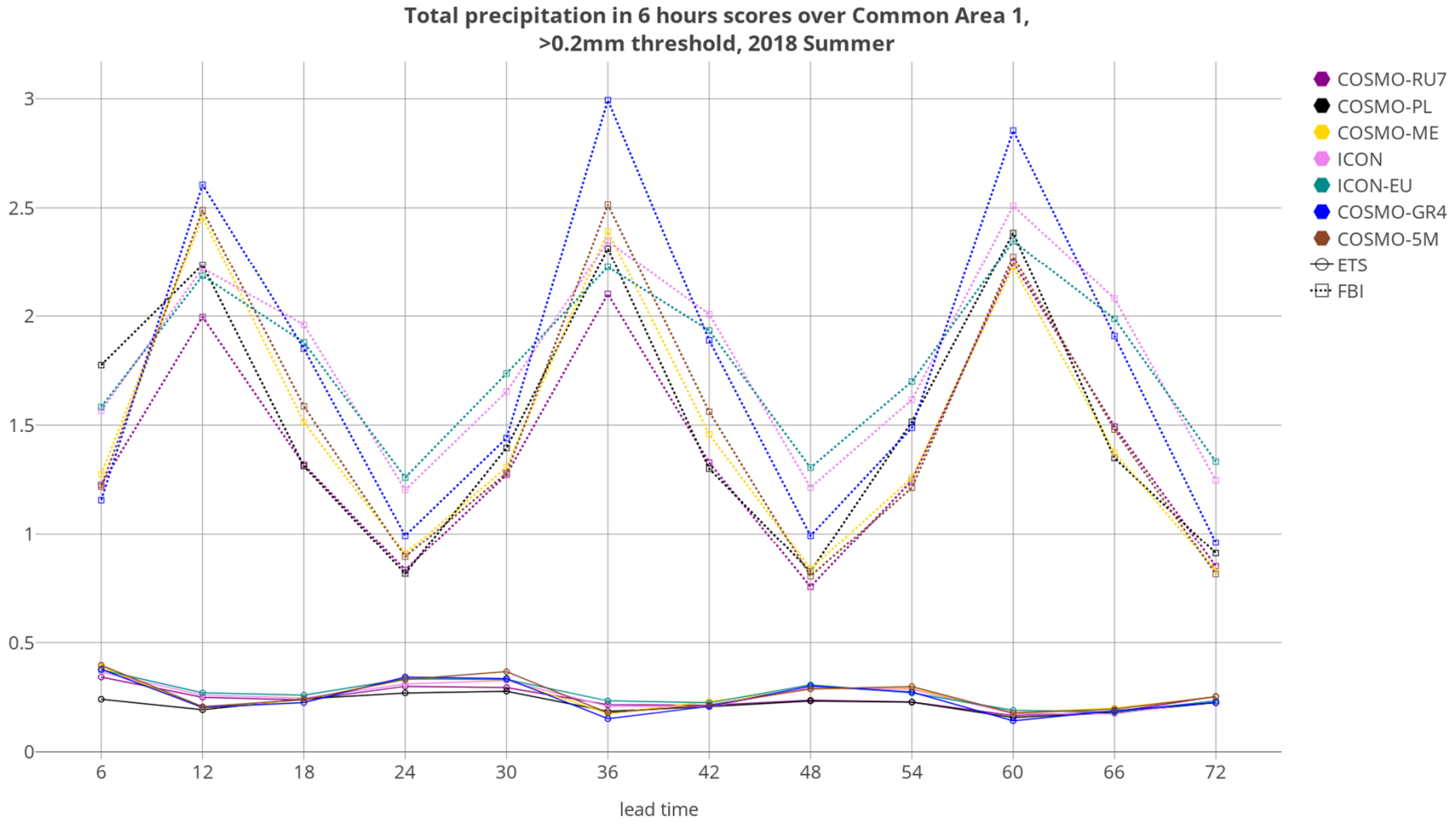
Taste of ICON (cont'd)

ETS and FBI for Total Cloud Cover, JJA 2018

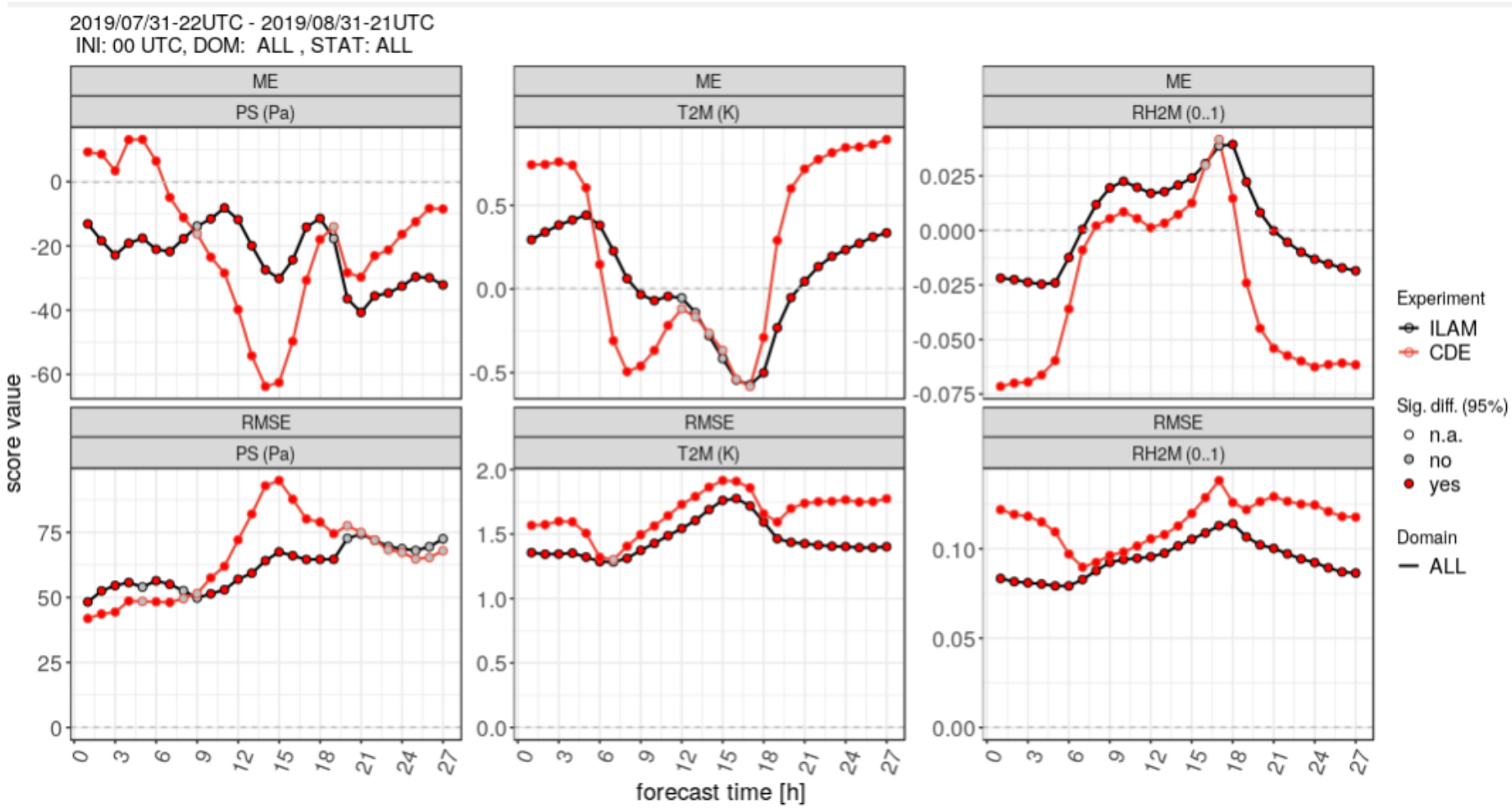


Taste of ICON (cont'd)

ETS and FBI for Total Precip, JJA 2018

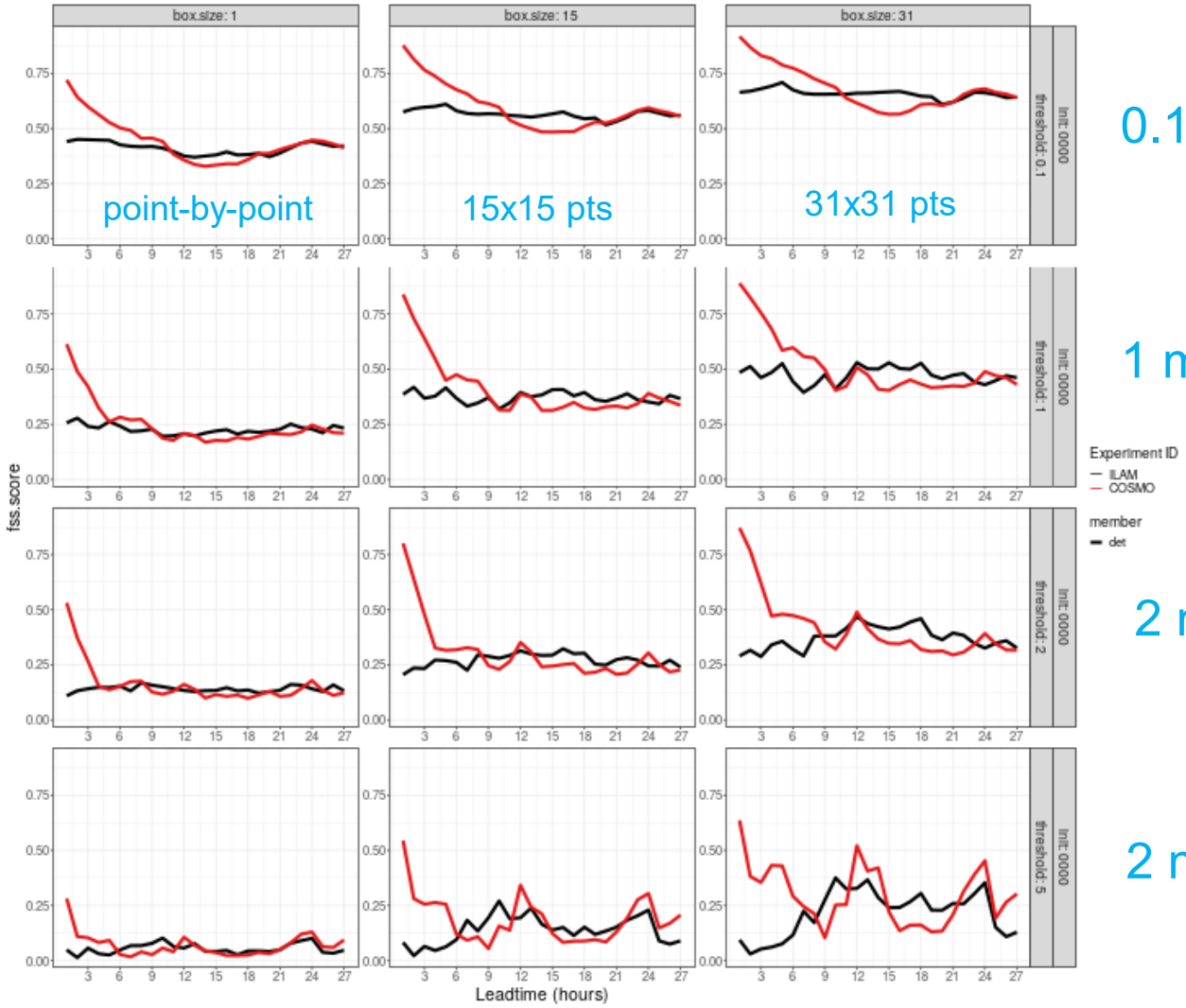


ICON-D2 vs. COSMO-D2 (Günther Zängl)



surface pressure 2m temperature 2m rel. humidity

ICON-D2 vs. COSMO-D2 (Günther Zängl)



0.1 mm/h

1 mm/h

2 mm/h

2 mm/h

Radar verification for August 2019, FSS, 00-UTC runs. ICON-D2 vs. COSMO-D2

Quo vadis? (a few buzz words)

Data Assimilation

- Further development of LETKF (PP KENDA-O, Christoph Schraff)
- Adaptation to ICON-LAM

- ICON comes without nudging, only 3D-Var and KENDA
- We explore a number of options for NWP centres that do not perform their own ensemble data assimilation

More in the talks of Christoph Schraff and Michael Tsyrulnikov on Tu

Numerical Aspects

- Complete COSMO-related work (e.g. high-order scheme)
- Consolidate COSMO-EULAG development (PPs EX-CELO and CEL-ACCEL, Zbigniew Piotrowski)

- Discontinuous Galerkin discretization as a potential new dynamical core for ICON (medium-term to long-term prospect, at least 5 years)

More in the talk of Michael Baldauf on We

Physics: Soil and Surface

- Complete ongoing work on urban parameterization (PT AEVUS2, Paola Mercogliano), multi-layer snow model (PT SAINT, Sascha Bellaire), phenology, and objective model calibration (PP CALMO-MAX, Antigoni Voudouri)
- Consolidate mire parameterization, (hopefully) go operational
- Reformulate surface transfer processes in terms of an implicit treatment of surface temperatures (PT ConSAT, Matthias Raschendorfer)
- Use COSMO experience to implement new parameterizations into ICON, e.g. mire, TERRA_URB, and multi-layer snow
- Much attention to external parameters, incl. unified COSMO-ICON carefully maintained software, new raw data sets (inter-consortium co-operation seems promising!)

More in the talks of Jürgen Helmert on Tu and We and Massimo Milelli on We

Physics: Upper Air

- Further development of the surface-to-atmosphere transfer scheme; better coupling of soil, surface, and the PBL; parameterization of SGS kata- and anabatic circulations forced by SSO and their interaction with near-surface turbulence (PT ConSAT, Matthias Raschendorfer); major development within the framework of ICON
- Improvement of the cloud-radiation coupling, incl. implementation and testing of new ice and water droplets optical properties and of ICON-ART and CAMS prognostic aerosols, and improved parameterization of shallow cumuli [PP T2(RC)2, Harel Muskatel]
- New PP CAIIR (Harel Muskatel) aimed at improving the ecRAD radiation scheme recently implemented into ICON

Physics: Upper Air (cont'd)

ecRad modular radiation scheme (Hogan and Bozzo 2018) is implemented into ICON, capable of approximating SGS 3D effects. Further efforts to

- extend ice microphysics to larger ice particles in the snow or graupel range,
- couple ecRad to 2-moment microphysics and to various aerosol climatologies and prognostic aerosol in ICON-ART,
- generalise ecRad to user-defined number of cloud particles,
- testing new cloud nucleation schemes

Ongoing DWD project (Sophia Schäfer), PP CAIIR

Physics: Upper Air (cont'd)

ICON-ART is run quasi-operationally at DWD twice a day to forecast mineral dust incl. radiation interaction (RRTM scheme). Further efforts to

- include more prognostic aerosol components, e.g. seasalt and wild fire generated particles,
- incorporate aerosol-cloud interaction processes,
- start global and LAM ensemble forecasts with at least a few ICON-ART members

DWD+KIT project PerduS, new project proposal "PermaStrom" is submitted (Vanessa Bachmann, Jochen Förstner, Axel Seifert, Bernhard Vogel, staff of meteocontrol GmbH)

Physics: Upper Air (cont'd)

- 2-moment microphysics scheme (ICON-D2 SYNFONY, Alberto de Lozar), particle-based microphysics „McSnow" [part of HD(CP2) Christoph Siewert]
- Stochastic mass-flux shallow convection scheme (as an option, e.g. Sakradzija et al. 2015), or using stochastic DEs approach (Machulskaya 2019); but at the end of the day, shallow convection and turbulence within a high-order closer, TKESV scheme, with stochastic components (Maike Ahlgrimm)
- Coupling with 1D upper-ocean model (FLake-like scheme, no 3D ocean, we would not like to use a sledgehammer to crack a nut)
- Implementation of TOFD scheme, canopy layer for TERRA

Interpretation and Applications

- More attention to challenging weather and high impact weather
- Analysis of cases of notorious failure of the COSMO model (most notably the cases for which the model is specifically tailored)
- Development of methods for automatic assessment of poor forecasts
- In the future, similar analyses for ICON-LAM

More in the talk of Anastasia Bundel and Inna Rozinkina on Th

Verification and Case Studies

- Much work (incl. technical work) because of the advent of ICON-LAM, e.g. new verification software (PP CARMA, Amalia Iriza-Burca)

- Verification activities extended to include ICON results, e.g. “common verification plots”
- Focus on challenging weather and high impact weather verification incl. ICON (new PP AWARE, Flora Gofa and Anastasia Bundel)

More in the talk of Flora Gofa on Tu

Reference Version and Implementation

- Much work of technical order because of the advent of ICON-LAM, e.g. NWP test suite (hindcast, free running soil, etc.), LEPS, model docu, and COSMO web site
- Common COSMO-ICON physics (see table)
- Strenuous effort to make our NWP models GPU-capable

- New PP IMPACT (Carlos Osuna) “ICON on massively parallel architectures”

Common COSMO-ICON Physics

Scheme	COSMO	ICON
Microphysics	gscp_hydro	
	gscp_kessler, gscp_cloudice, gscp_graupel	
Subgrid scale orography	sso_lottmiller	
		mo_sso_ifs
Turbulence	turb_[data|diffusion|transfer|utilities|vertdiff]	
Surface Schemes	sfc_terra_data, sfc_terra_init, sfc_terra sfc_flake_data, sfc_flake, sfc_seaice	
Convection (Tiedtke-Bechtold)	conv_[many files]	

N.B. ICON utilizes tile approach to compute surface fluxes!

Predictability and Ensemble Methods

- Work on maintenance and improvement of EPSs, methodologies for initial and boundary perturbations (e.g. better use of KENDA analyses of IC and BC), model error description, product interpretation and verification, post-processing (PP APSU, Chiara Marsigli)
- Parallel (and collaborative) developments at DWD and RHM on the development of models for model error

- Transition to ICON-LAM

More in the talk of Chiara Marsigli on We

Some Valuable Lessons

- Try to avoid too much tuning (scores are improved here and now, but overtuning is a bad practice as it deprives NWP models of their predictive capacity)
- If you develop something new, do not worry if it takes longer than you originally planned and even longer than you dare to admit (even though analytical work and coding of e.g. a new parameterization can be done reasonably fast, testing likely takes a lot of time and is intellectually difficult)

Modern NWP systems are complex and advanced…
Think deeper, quick fixes do not work in the long run!

CONSORTIUM FOR SMALL SCALE MODELING

COSMO

Thank you for your kind attention!

41st EWGLAM and 26th SRNWP Workshop, 30 September – 3 October 2019, Sofia, Bulgaria

Unused

Recall… Our Overall Goals

- **Convection-permitting high-resolution weather forecast**

- **Ensemble prediction and nowcasting, incl. ensemble data assimilation**

COSMO in a Nutshell

Consortium members (national services)

- Germany (DWD) Deutscher Wetterdienst
- Greece (HNMS) Hellenic National Meteorological Service
- Israel (IMS) Israel Meteorological Service
- Italy (ReMet) Aeronautica Militare-Reparto per la Meteorologia
- Poland (IMGW) Institute of Meteorology and Water Management
- Romania (NMA) National Meteorological Administration
- Russia (RHM) Federal Service for Hydrometeorology and Environmental Monitoring
- Switzerland (MCH) MeteoSchweiz

COSMO in a Nutshell (cont'd)

Consortium members

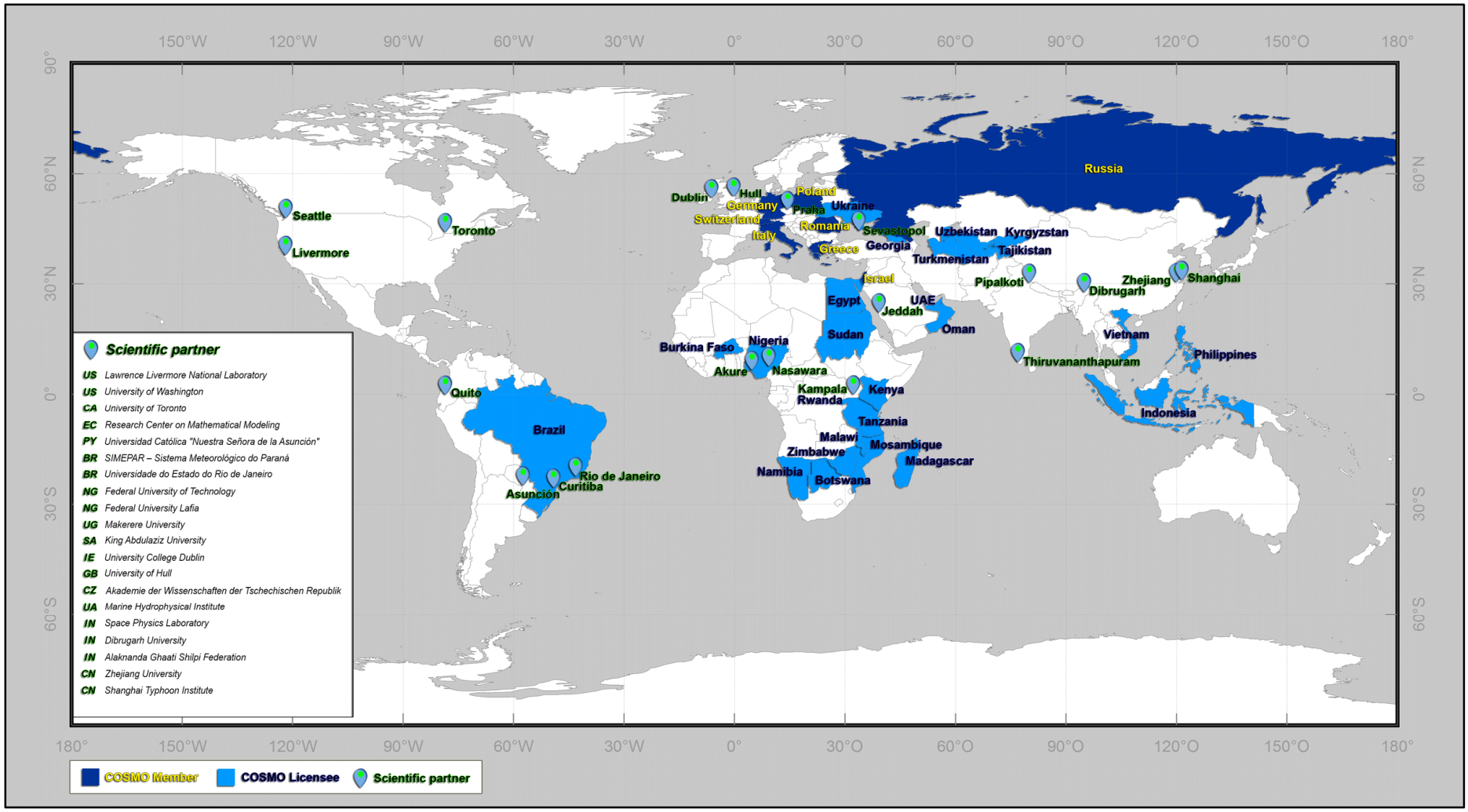
Regional and military services

- Germany (ZGeoBw) Zentrum für GeoInformationswesen der Bundeswehr
- Italy (CIRA) Centro Italiano Ricerche Aerospaziali
- Italy (ARPAE) Agenzia Regionale per la Prevenzione, l´ Ambiente e l´Energia Emilia Romagna
- Italy (ARPA) Agenzia Regionale per la Protezione Ambientale Piemonte

Academic Communities

- CLM Climate Limited-Area Modeling
- COSMO ART COSMO Aerosols and Reactive Trace gases

COSMO in a Nutshell (cont'd)



COSMO in a Nutshell (cont'd)

Working Groups

- WG1 Data assimilation (Christoph Schraff)
- WG2 Numerical aspects (Michael Baldauf)
- WG3a Physical aspects, Upper Air (Matthias Raschendorfer)
- WG3b Physical aspects, Soil and Surface (Jean-Marie Bettems)
- WG4 Interpretation and Applications (Anastasia Bundel)
- WG5 Verification and case studies (Flora Gofa)
- WG6 Reference Version and Implementation (Massimo Milelli)
- WG7 Predictability and Ensemble Methods (Chiara Marsigli)

COSMO in a Nutshell (cont'd)

A number of **Priority Projects** (PP) and **Priority Tasks** (PT)

Governing bodies

- Steering Committee (STC)
- Scientific Management Committee (SMC)
- Technical Advisory Group (TAG)