Regional coupled modeling to improve understanding of the Southeast Asian Climate

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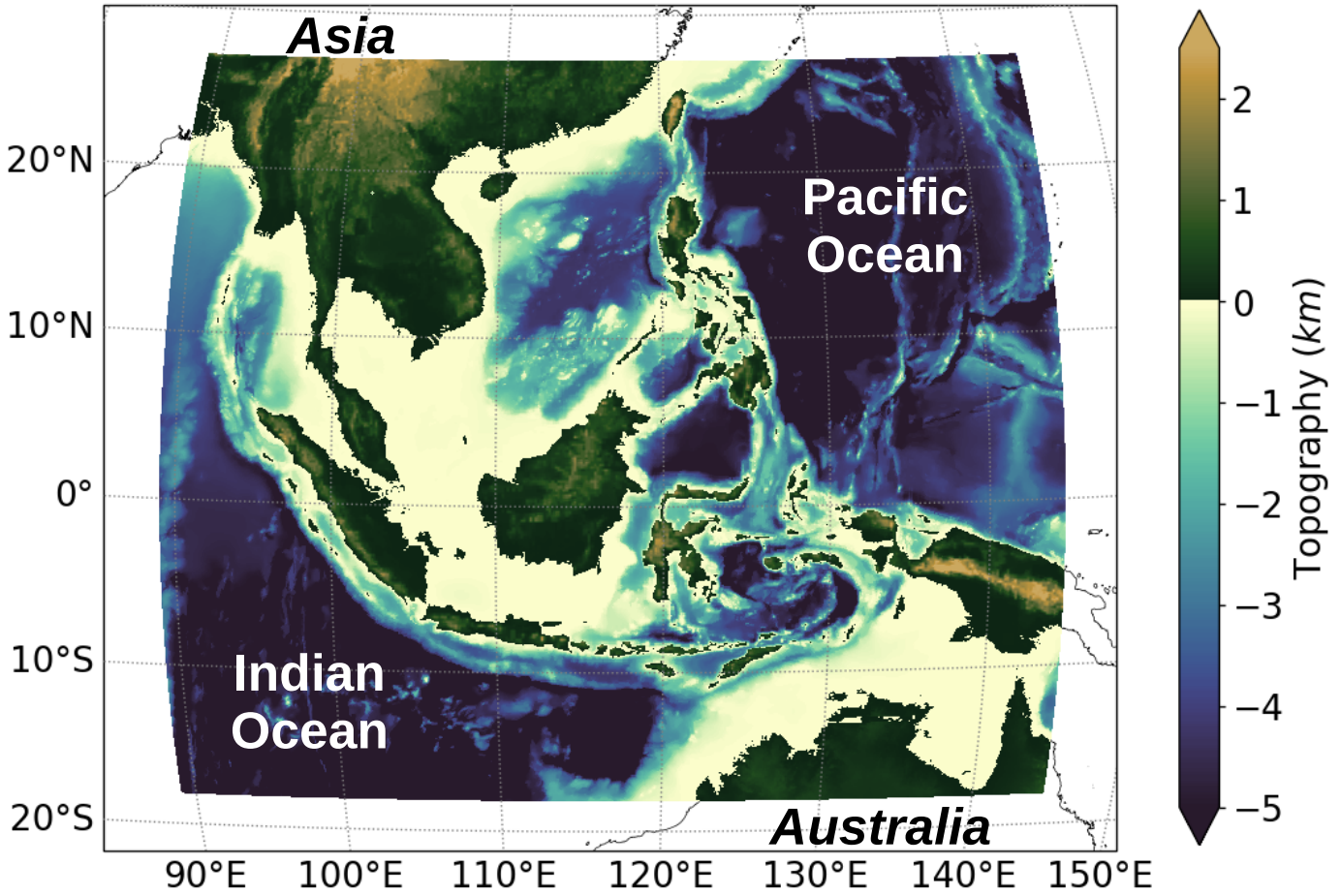
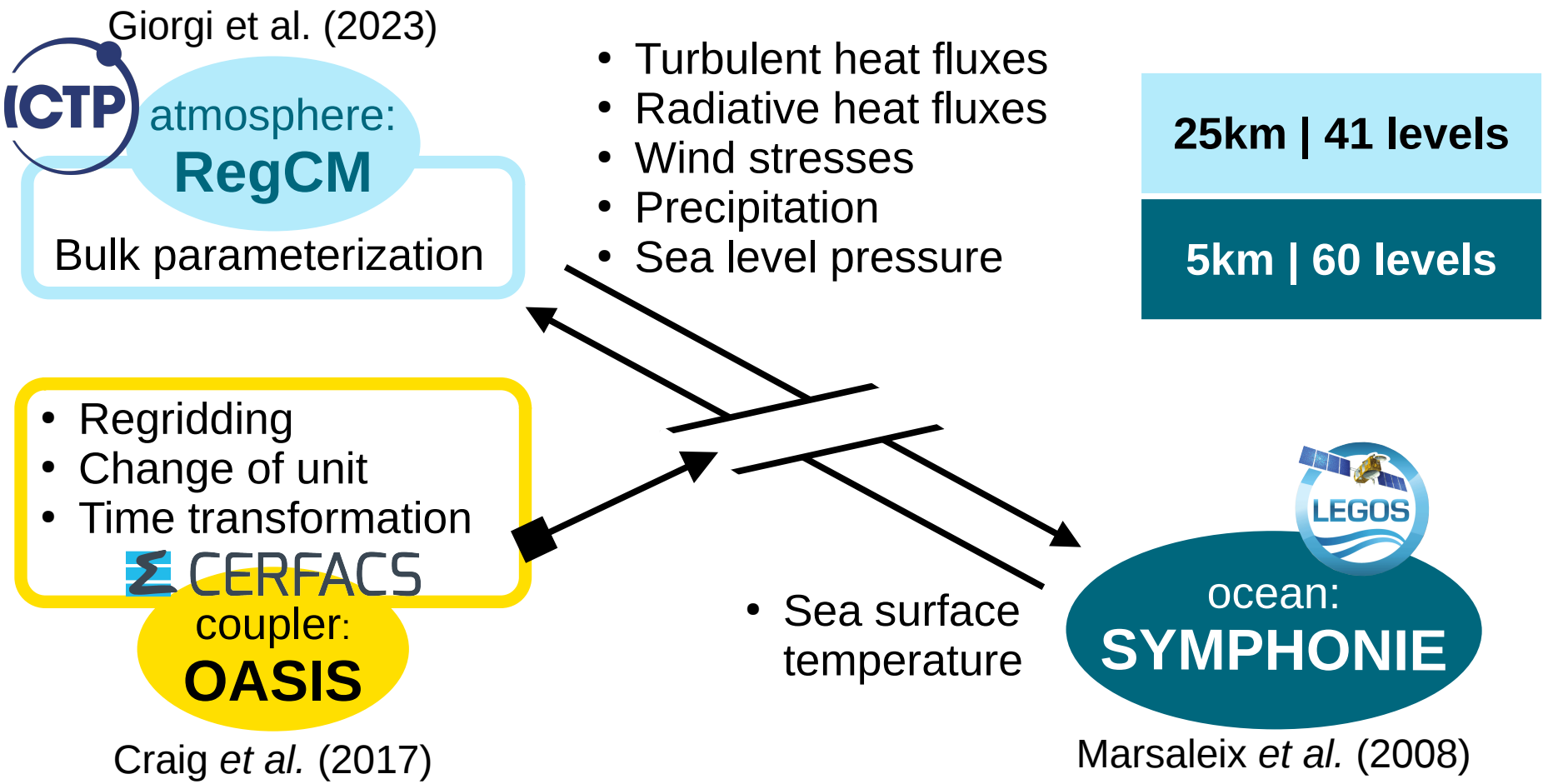
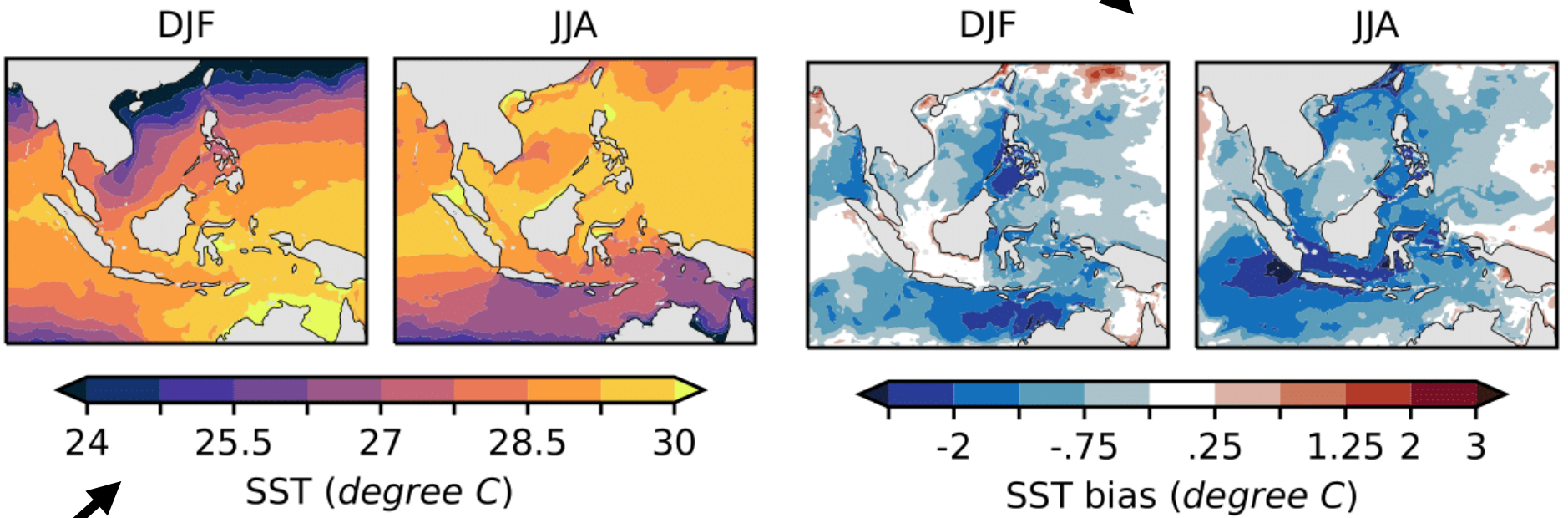
Introduction: study area



Introduction: technical setup



Introduction: first coupled simulation



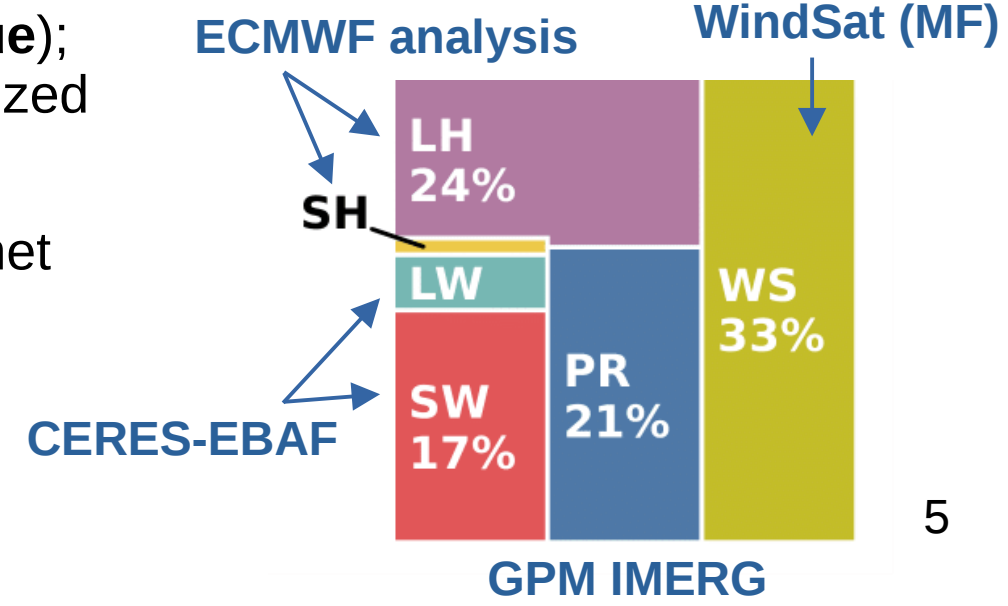
OSTIA reanalysis

+ many other problems…

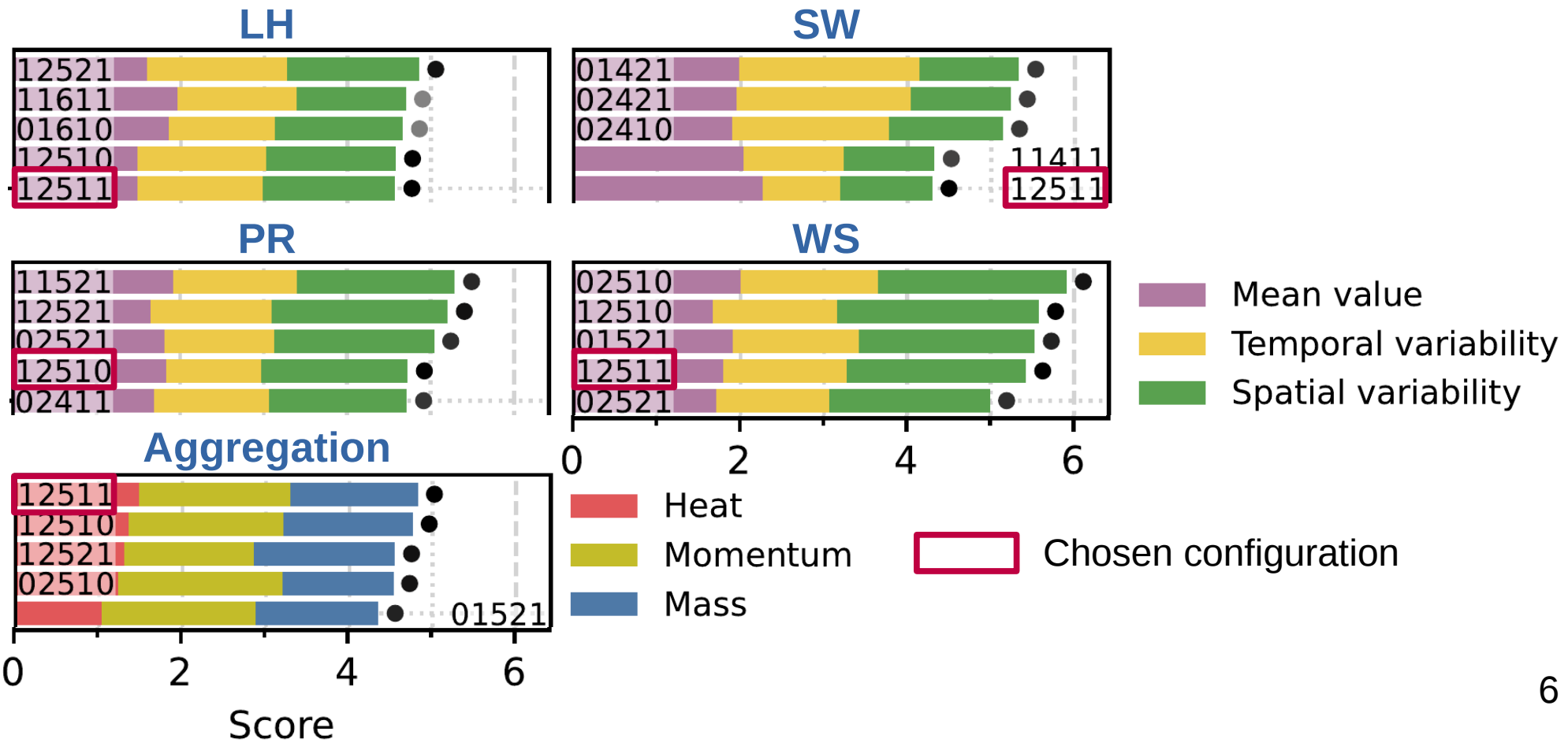
→ **Need** for uncoupled parameterization of RegCM

Uncoupled configuration: method

- **36 simulations** with various combinations of RegCM's physics options
- Validation targets: good ocean-surface fluxes
- 2 types of patterns: **subregional** annual cycles + **seasonal** spatial patterns
- 3 base metrics: mean bias (**mean value**); correlation coefficient (**phase**); normalized standard deviation (**amplitude**).
- Continuous **scoring function** of Desmet and Ngo-Duc (2021) to **aggregate** all statistics and deduct a final ranking



Uncoupled configuration: results

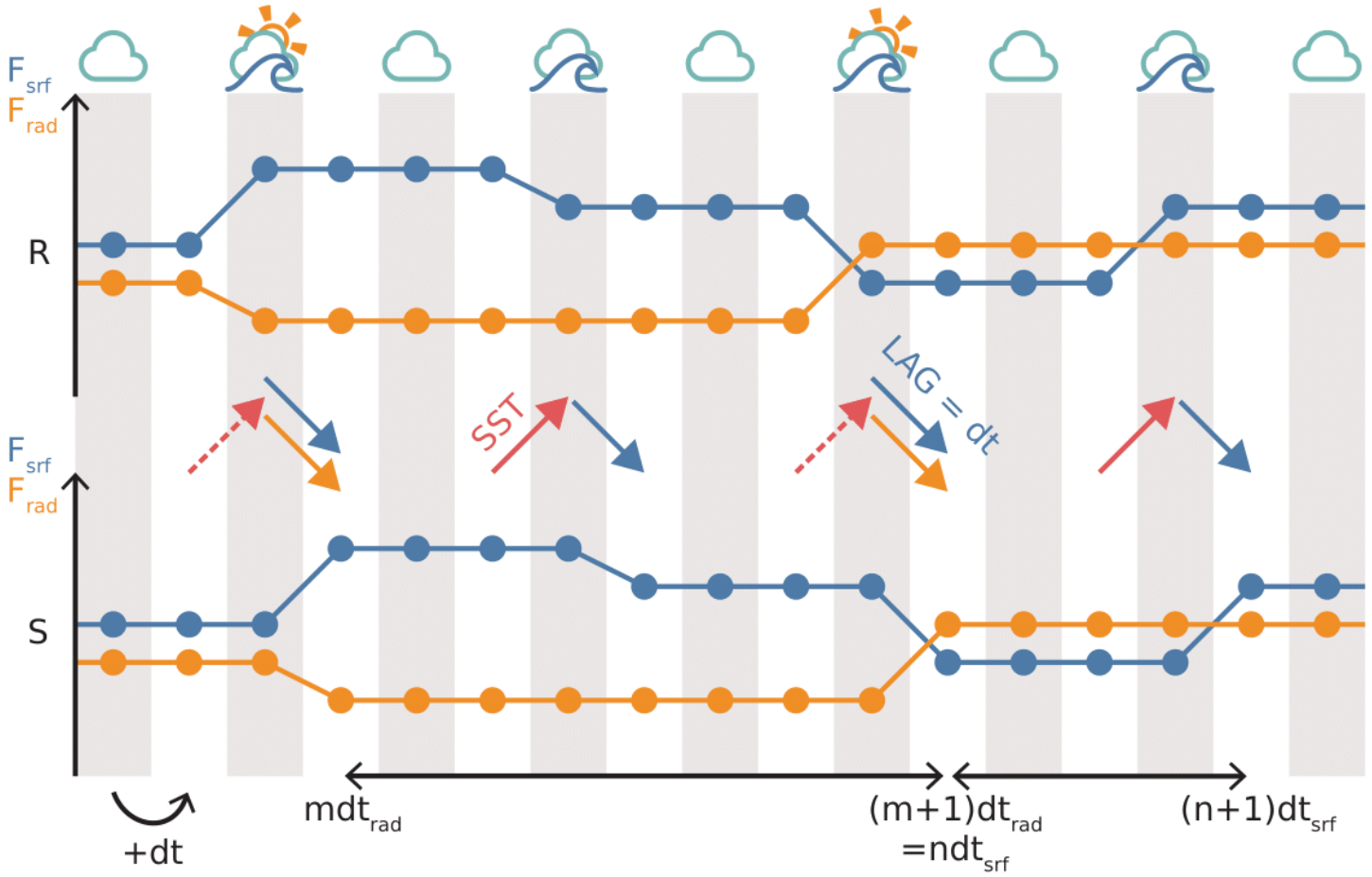


Coupling algorithm: the challenge

- Standard averaging parallel algorithm:
  - **conservation: OK** (averaged fluxes)
  - **synchronicity: not OK** (1 coupling period lag)

- Errors estimated by comparison with solutions from Schwarz iterations (Marti et al., 2021) are not small

Coupling algorithm: a solution?

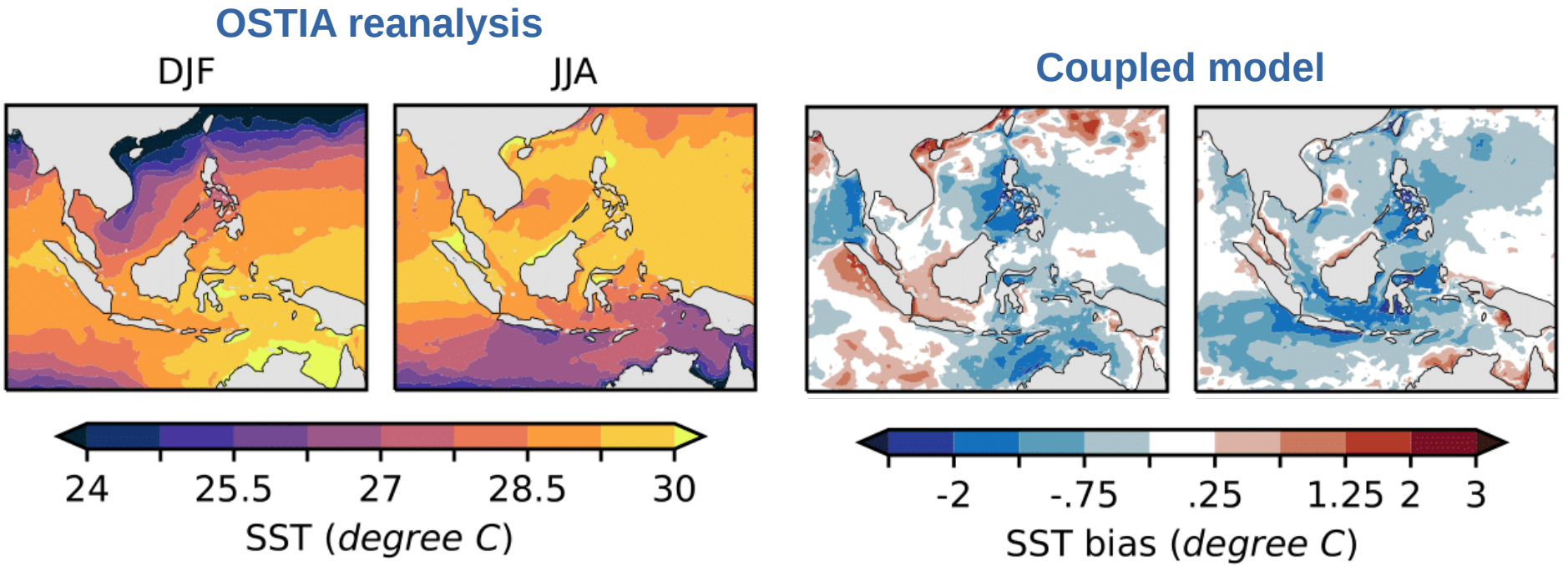


Computation of ...

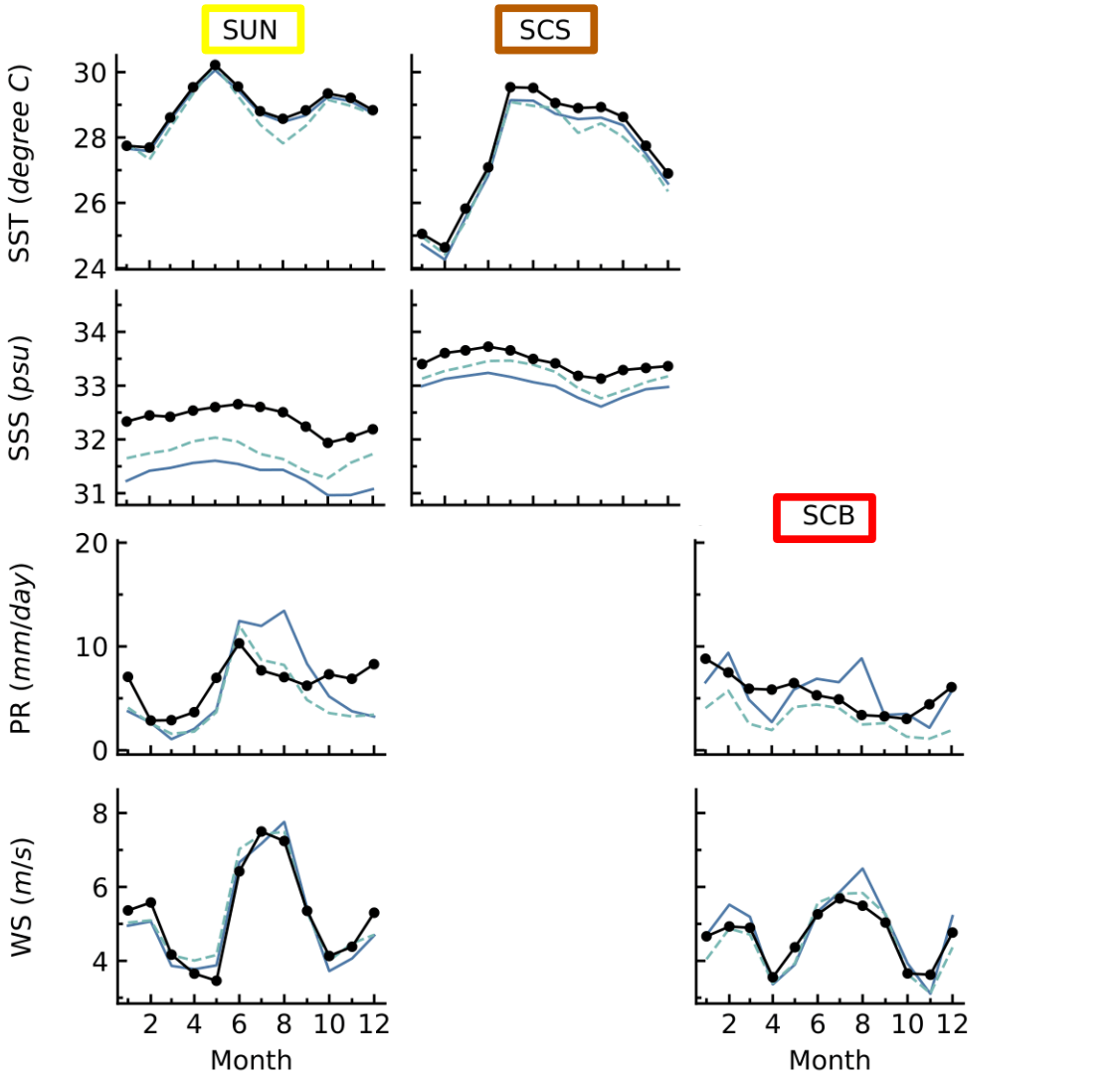
- Cumulus convection
- Radiative transfer
- Surface module

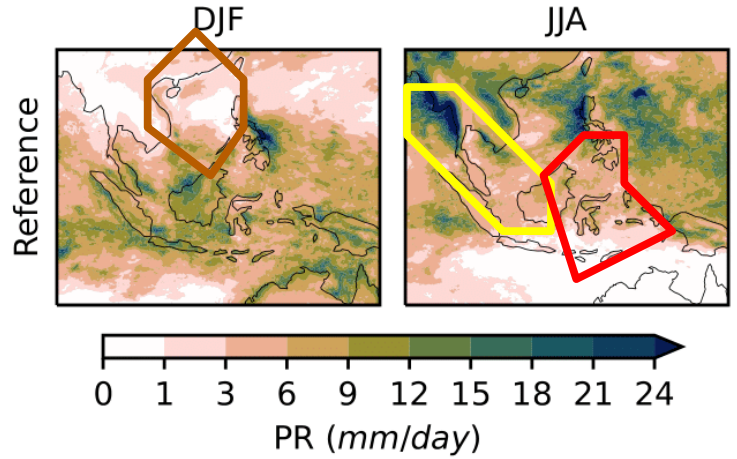
- **Conservation: OK** (instantaneous fluxes at each update)
- **Synchronicity: almost OK** (residual dt lag)
- **Cost: 10%**

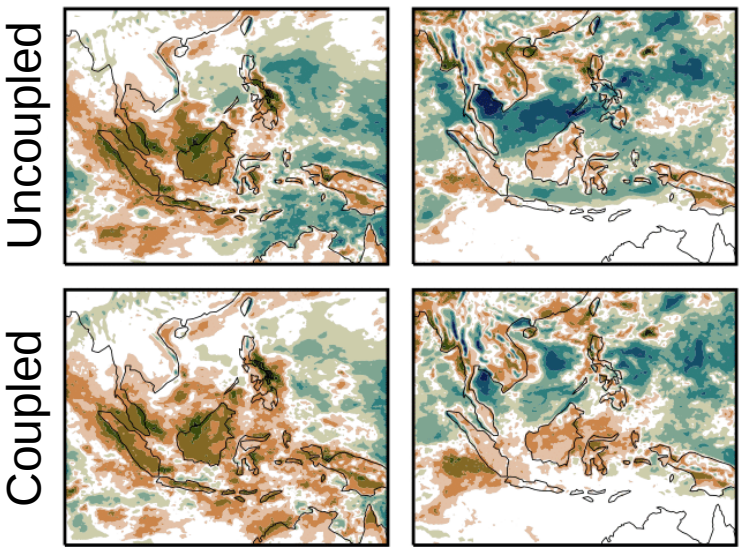
Coupled simulation: validation



ESA CCI







Reference Uncoupled Coupled

Coupled simulation: what’s next?

Now we can serenely use it to study air-sea interactions in the region

- Impact of the coupling algorithm?
- Impact of the air-sea bulk formula?
- Improvement for land variables?

Key highlights

1) With an adequate method, it can be **convenient and affordable** to **aggregate many comparison statistics** in order to select / eliminate a subset of members within an ensemble.

2) Identify and focus on **core variables that condition the success** of your coupled experiment is worth-it.

3) It is very **affordable to couple at a high frequency** and **eliminate the synchronicity issue** of the state-of-the-art standard averaging parallel coupling algorithms.

Thank you for your attention.

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Appendix A

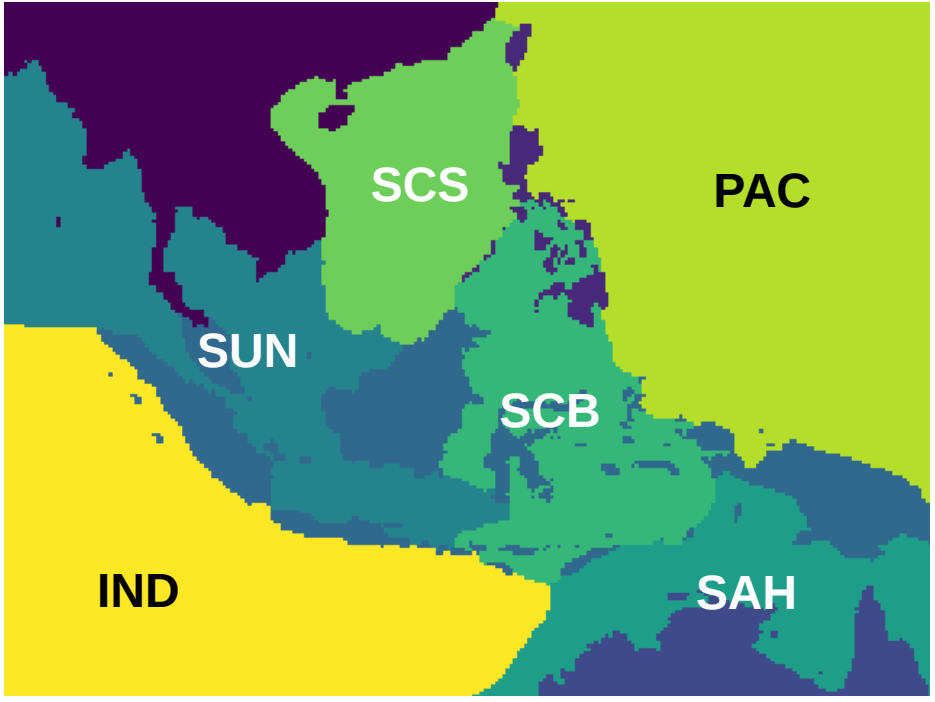
Physics options used in the uncoupled parameterization of RegCM.

Radiative transfer	Planetary boundary layer	Cumulus convection	Resolved scale microphysics	Cloud fraction
0: Modified **CCM3** (Kiehl et al., 1996)	1: Modified **Holtslag** (Holtslag et al., 1990)	4: **MIT** (Emanuel and Zivkovic-Rothman, 1999)	1: **SUBEX** (Pal et al., 2000)	0: **Sundqvist** (Sundqvist, 1988)
1: **RRTM** (Mlawer and Clough, 1997; Mlawer et al., 1997)	2: **UW-PBL** (Bretherton et al., 2004)	5: **Tiedtke** (Tiedtke, 1989)	2: Nogherotto-Tompkins (**NoTo**; Nogherotto et al., 2016)	1: **Xu-Randall** (Xu and Randall, 1996)
		6: **Kain-Fritsch** (Kain, 2004)		

36 simulations and not 48 because the combinations featuring both the NoTo explicit moisture scheme and the Sundqvist cloud fraction algorithm tend to produce spurious high cloud amounts which seriously impact the surface shortwave radiation fluxes: these 12 configurations are excluded from the protocol.

Appendix B

Exact oceanic subregions used for the annual cycles and in the ranking method.



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