RECONSTRUCTION OF 2D AND 3D OCEAN CIRCULATION FROM SWOT: ADVANCES OF THE 2016-2019 SCIENCE TEAM, AND REMAINING ISSUES

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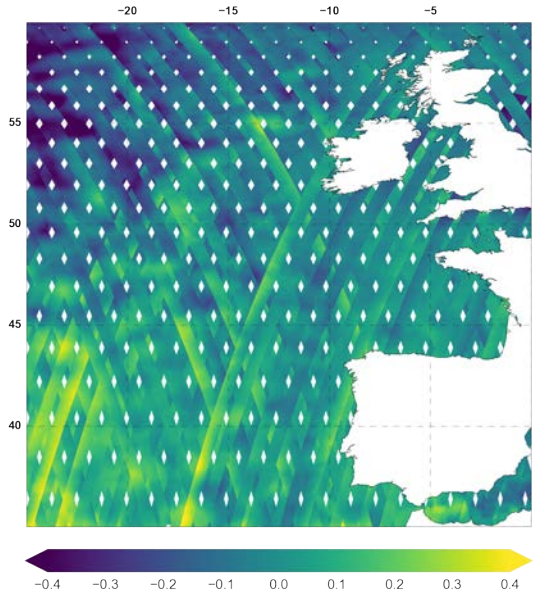
(coordinators of the reconstruction session and contact points if you think we missed something)

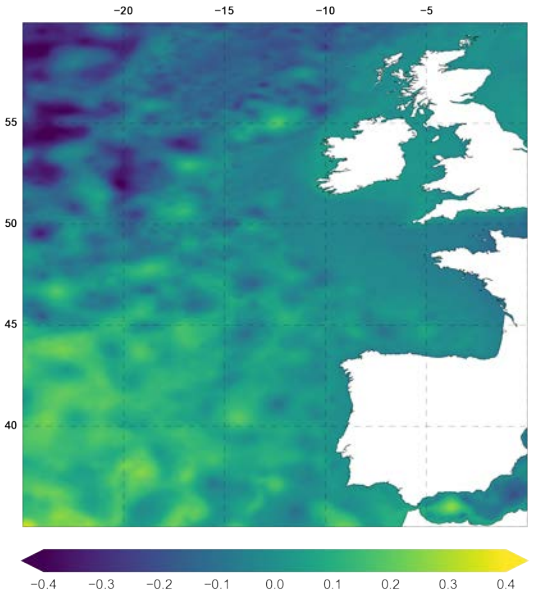
SWOT ST meeting, 17-20 June 2019, Bordeaux

Reconstruction steps: contributions

SWOT (Balanced dyn., Internal tides)



21 days of SWOT SSH data



Daily SSH field

Surface fields (SSH, U, V)

Interior fields (w, PV)

Reconstruction steps: contributions

SWOT (Balanced dyn., Internal tides)

Reconstruction-from-SWOT main issues:

- Presence of small-scale and large-scale, structured noise
- Presence of HF signal from internal tides
- High spatial resolution vs low temporal resolution

Resulting to:

- A large diversity of challenges and sub-challenges
- A large diversity of approaches and methods
- Remaining open questions

Surface fields (SSH, U, V)

Interior fields (w, PV)

Reconstruction steps: contributions

SWOT (Balanced dyn., Internal tides)

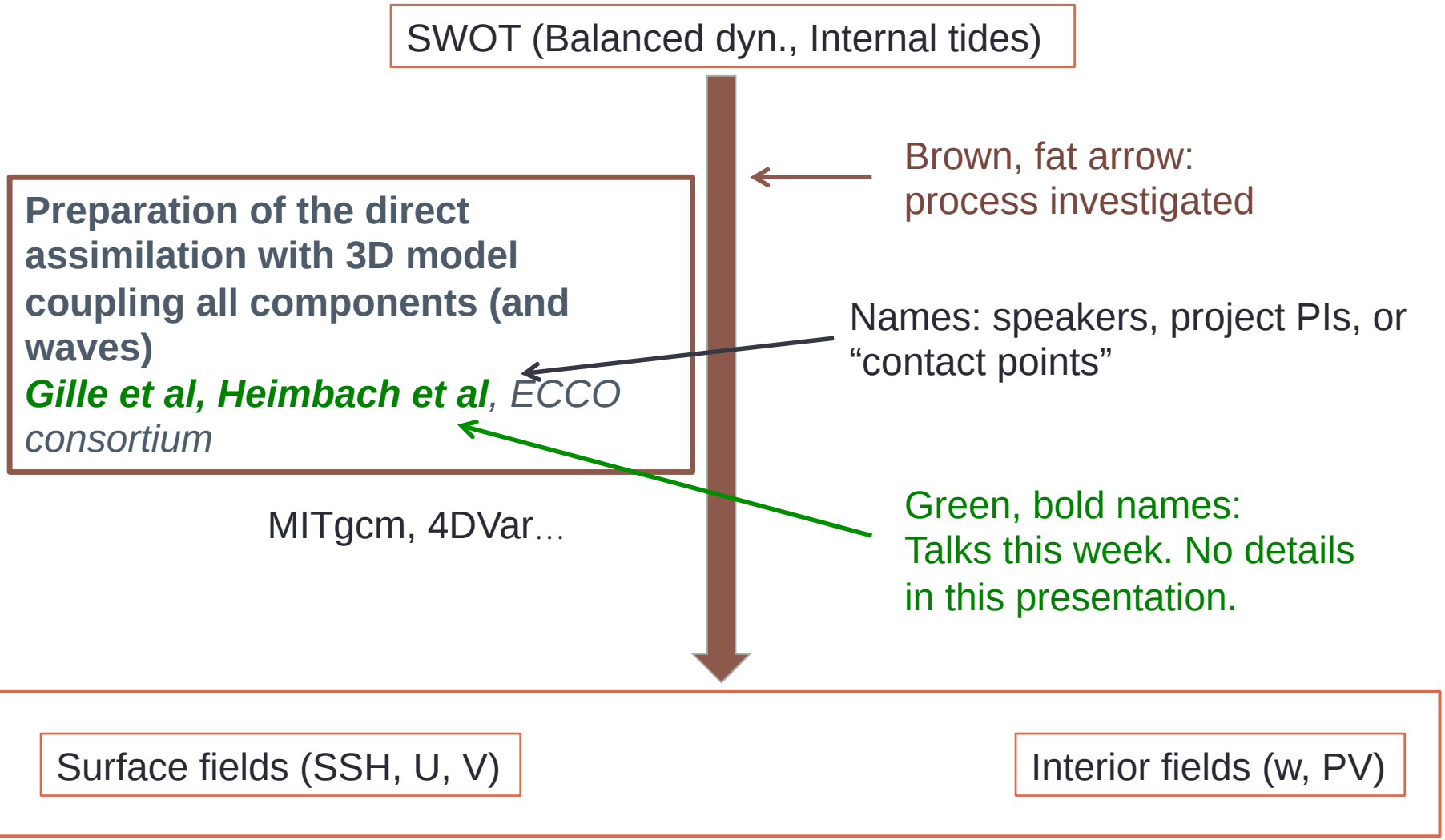
Preparation of the direct assimilation with 3D model coupling all components (and waves)
***Gille et al, Heimbach et al**, ECCO consortium*

MITgcm, 4DVar…

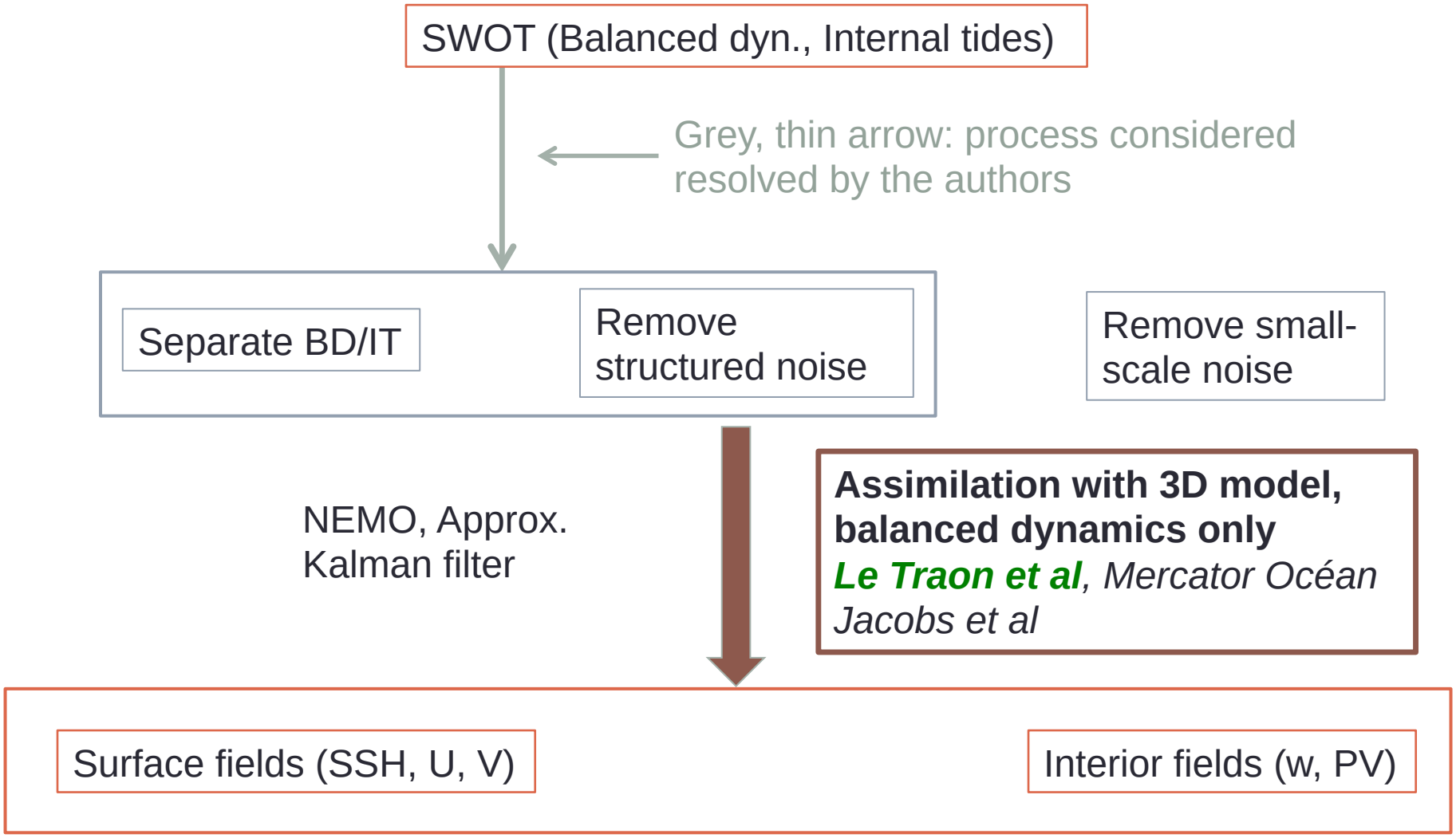
Surface fields (SSH, U, V)

Interior fields (w, PV)

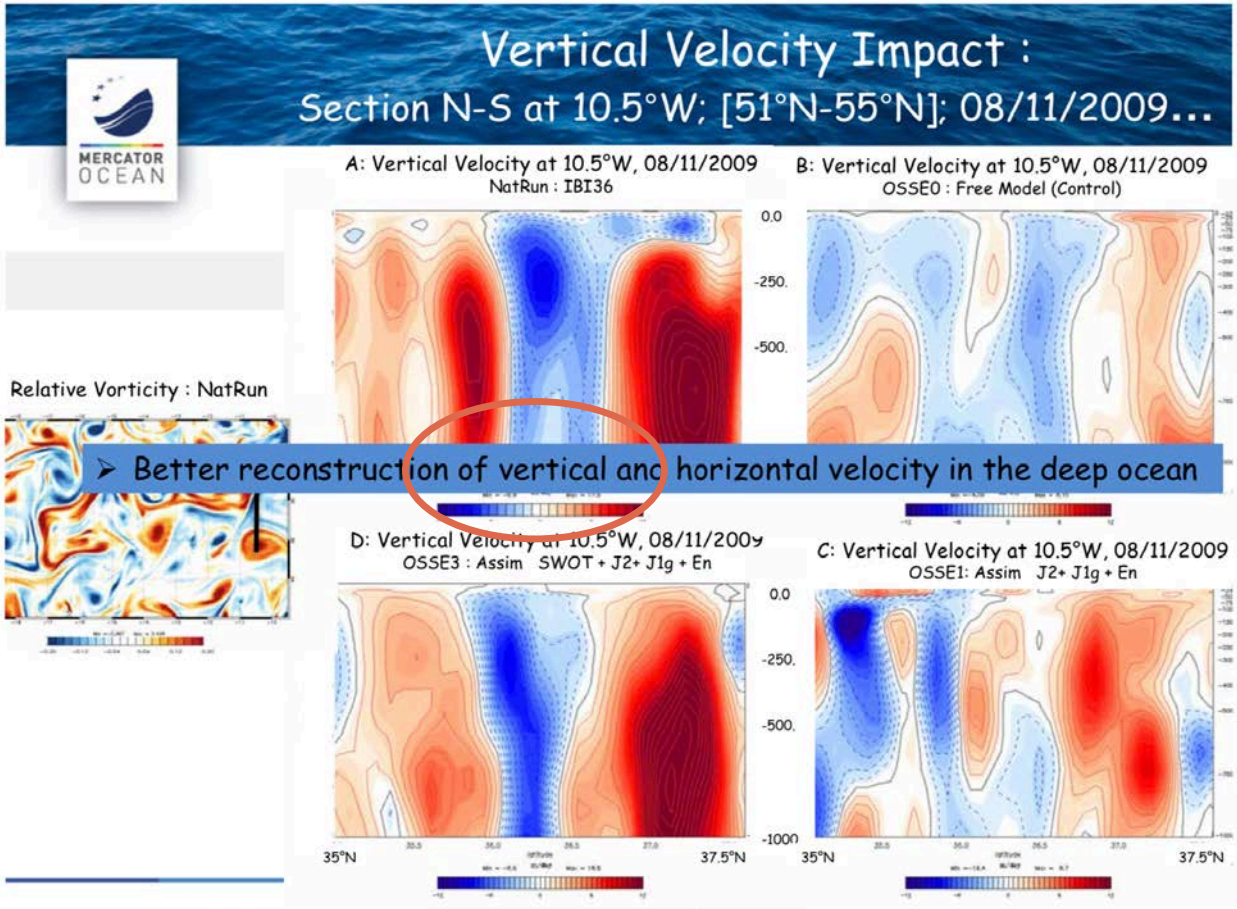
Reconstruction steps: contributions



Reconstruction steps: contributions



Reconstruction steps: contributions



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Remove small-scale noise

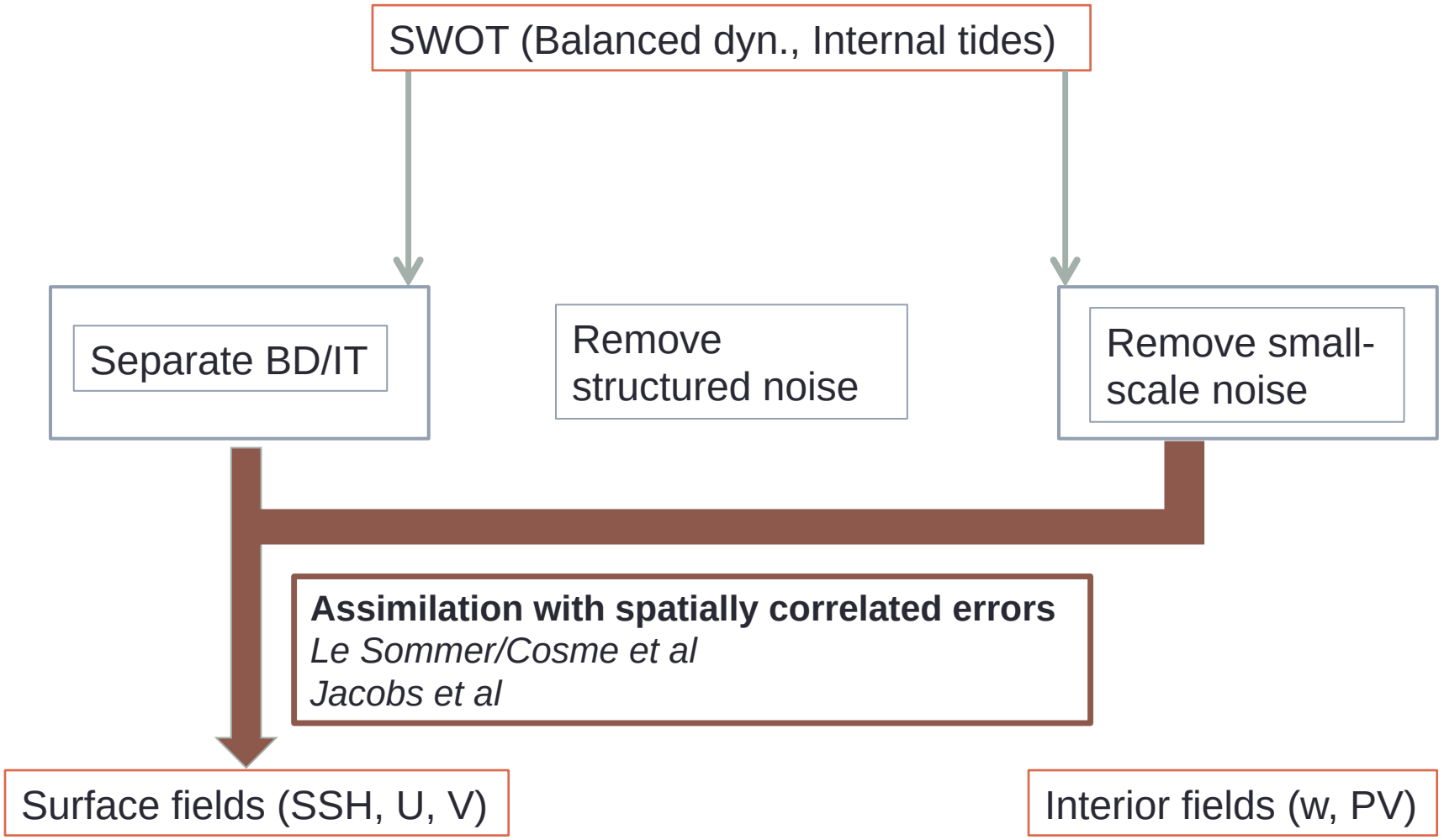
ion with 3D model, dynamics only

et al, *Mercator Océan al*

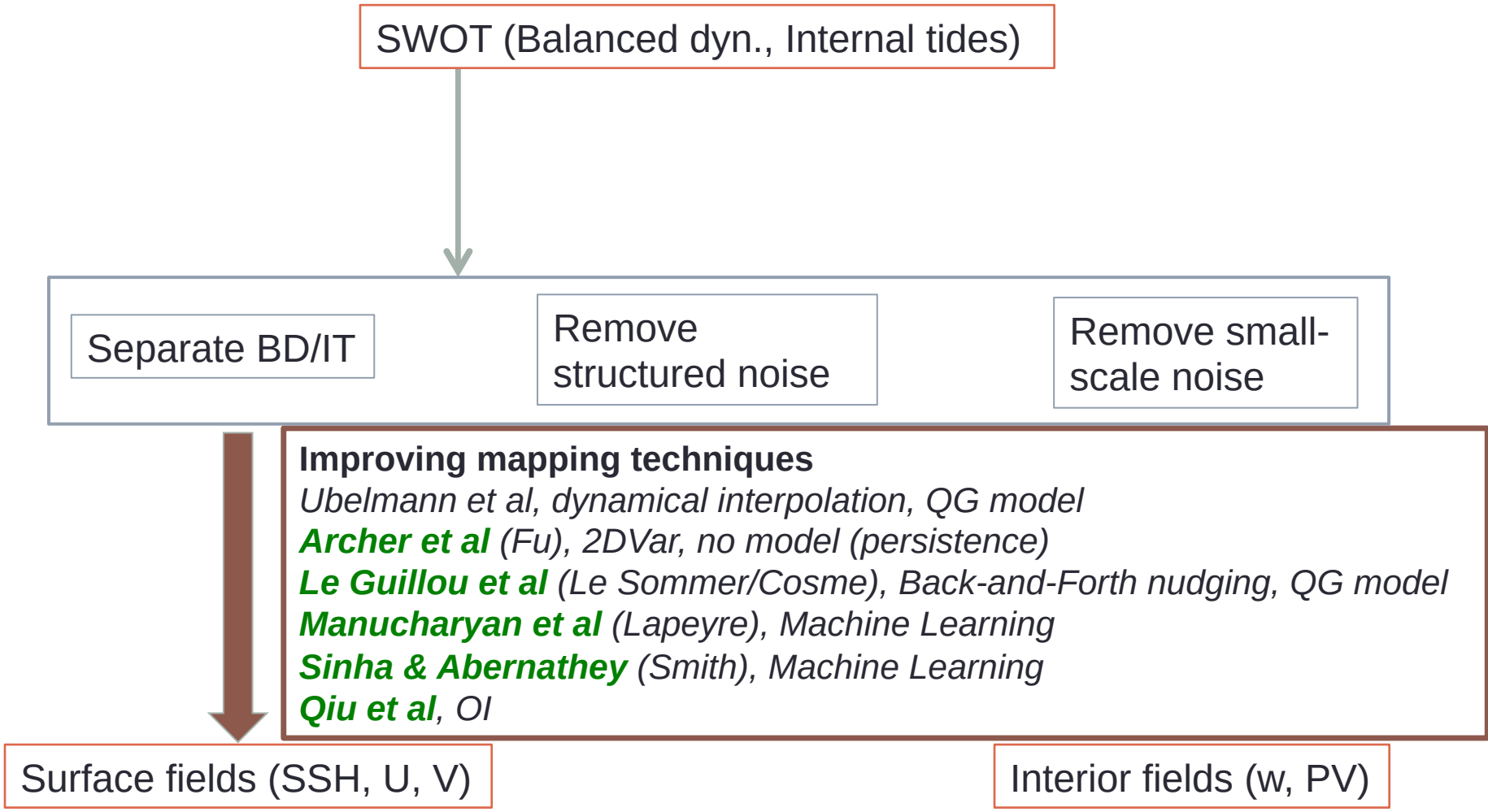
Surface fields (SSH, U, V)

Interior fields (w, PV)

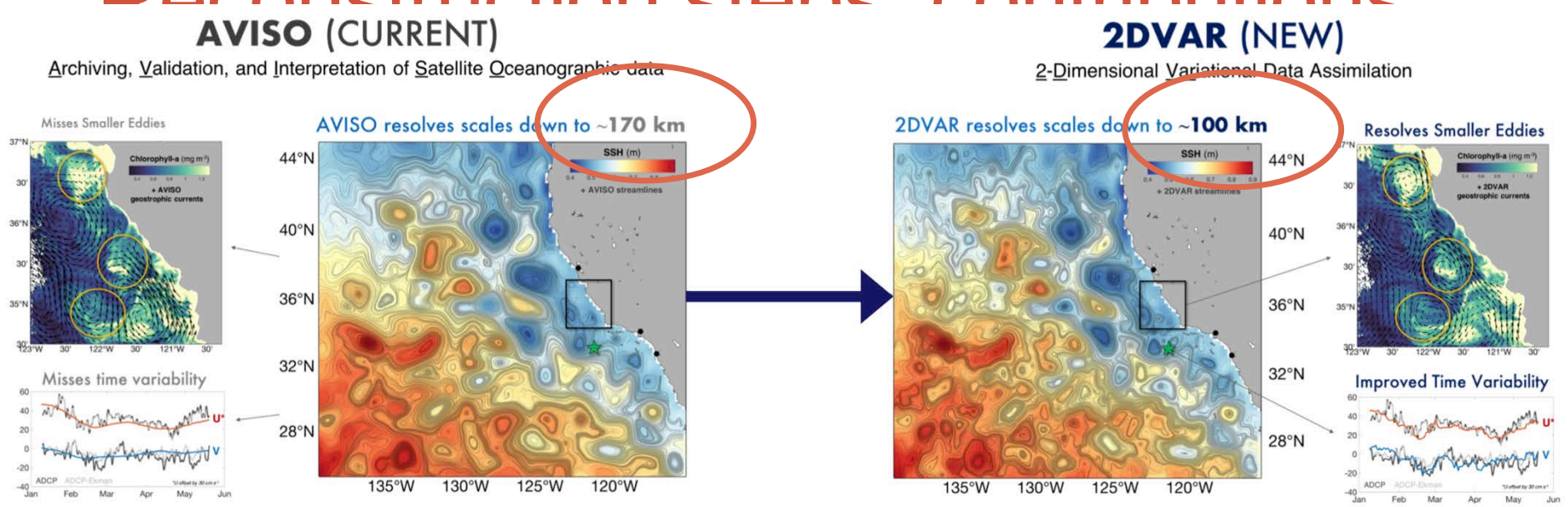
Reconstruction steps: contributions



Reconstruction steps: contributions



Reconstruction steps: contributions



Improving mapping techniques

Ubelmann et al, dynamical interpolation, QG model

Archer et al *(Fu), 2DVar, no model (persistence)*

Le Guillou et al *(Le Sommer/Cosme), Back-and-Forth nudging, QG model*

Manucharyan et al *(Lapeyre), Machine Learning*

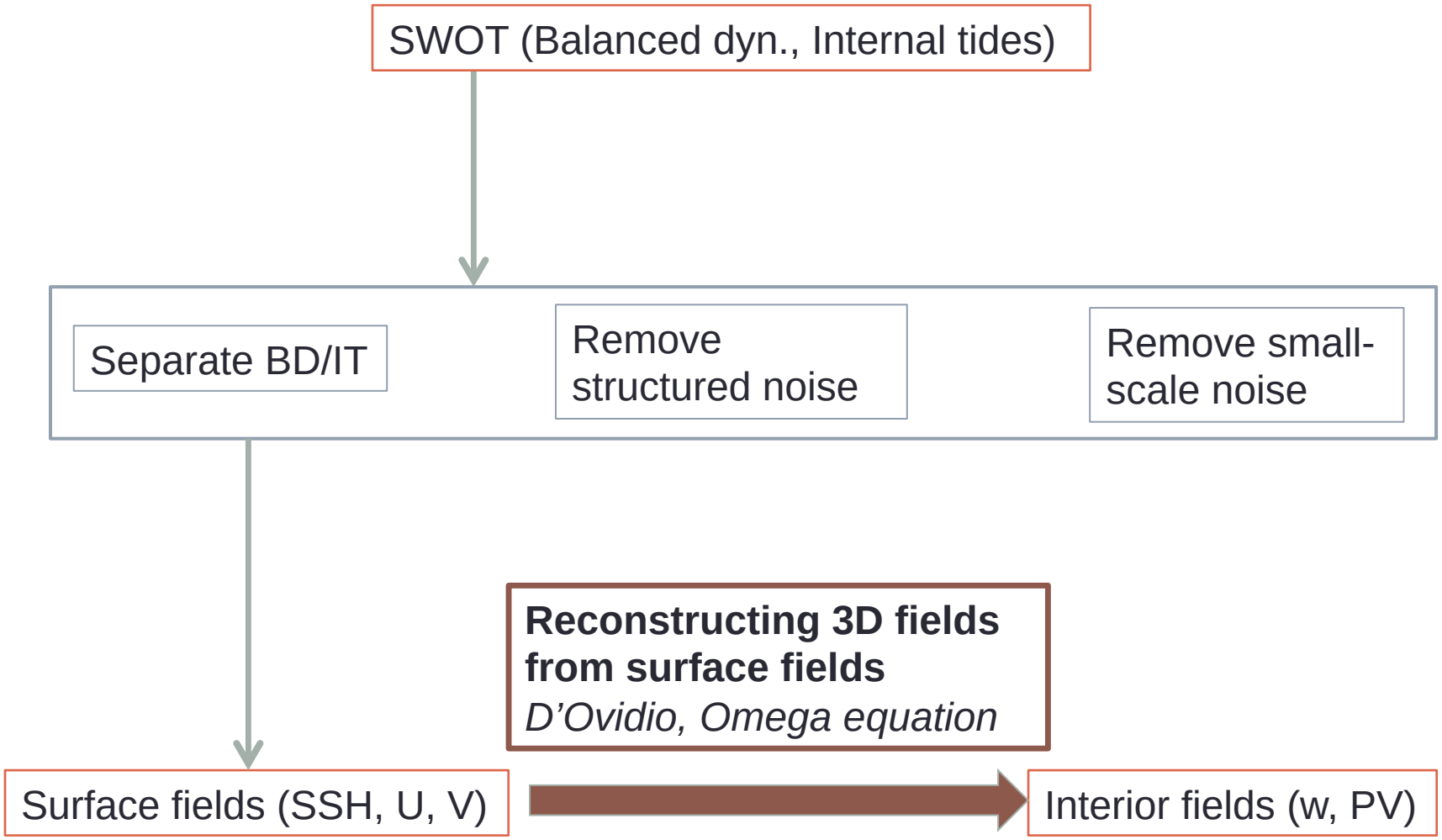
Sinha & Abernathey *(Smith), Machine Learning*

Qiu et al*, OI*

Surface fields (SSH, U, V)

Interior fields (w, PV)

Reconstruction steps: contributions



Reconstruction steps: contributions

Conclusions

Is the Omega equation the good framework for the experimental calculation of vertical velocities ?

- ***Not really !***

→ *The omega equation doesn't reproduce well the submesoscale vertical velocity (below few tens of kilometers) in any dynamical regime.*

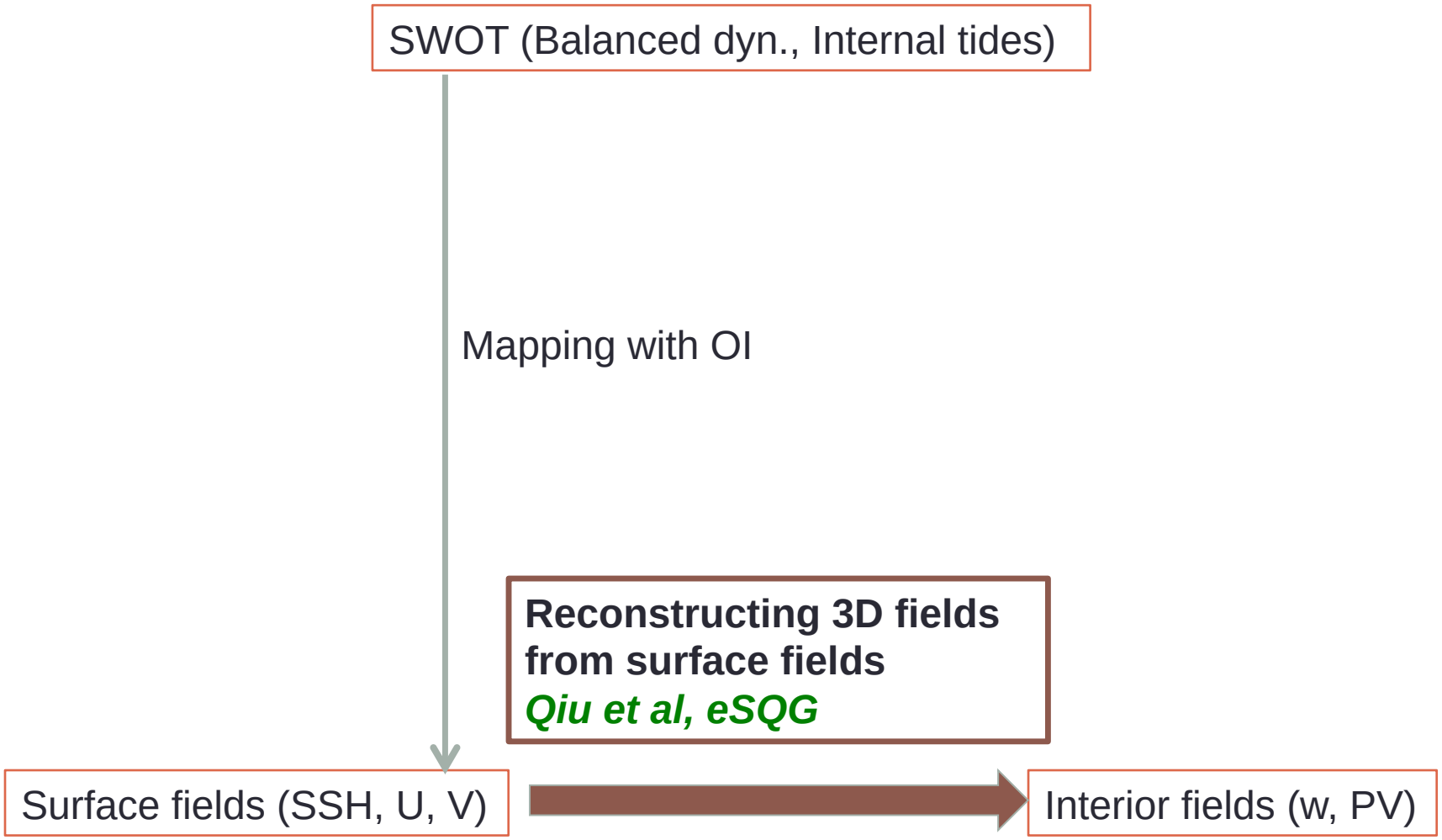
→ *In some regimes these small mesoscale and submesoscale (below 40 km) features account for up to 30 % of the variance of the field.*

→ The vertical velocity inferred from the omega equation represents well the mesoscale energetic patterns. Structures larger than 40 km tend to have a spectral coherence above 0.6

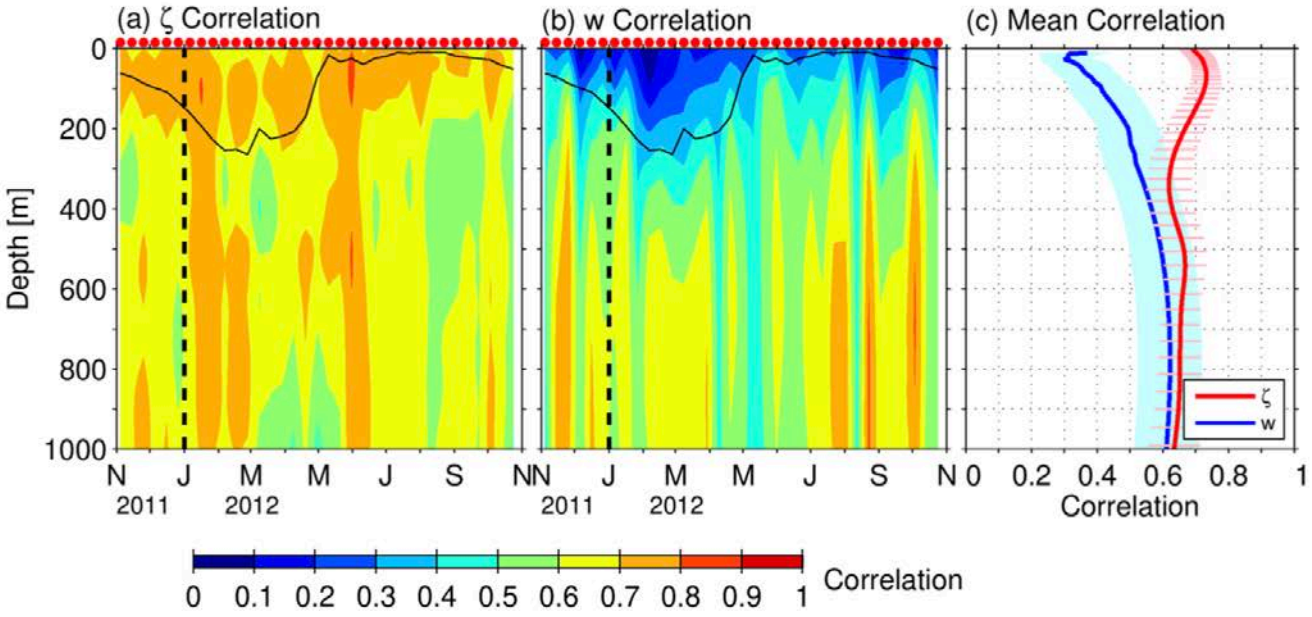
Reconstructing 3D fields from surface fields
D'Ovidio, Omega equation

Surface fields (SSH, U, V) → Interior fields (w, PV)

Reconstruction steps: contributions



Reconstructed w & ζ correlations as a function of time

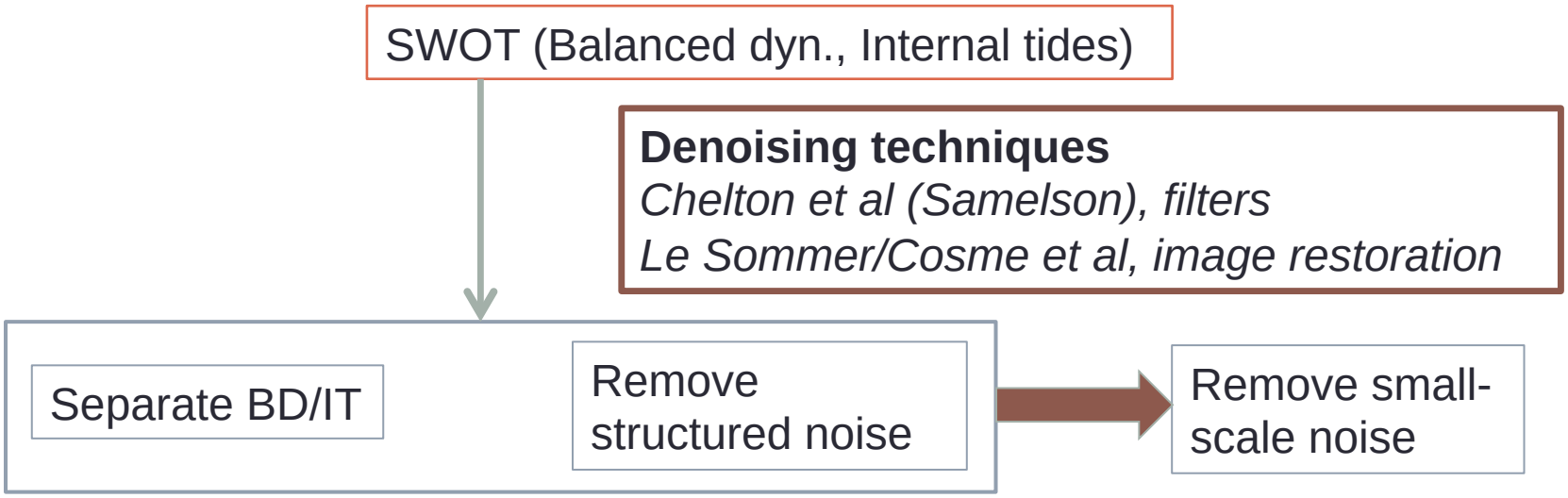


eSQG reconstruct using SWOT-measured η

Reconstructing 3D fields from surface fields
Qiu et al, eSQG

Surface fields (SSH, U, V) → Interior fields (w, PV)

Reconstruction steps: contributions



Surface fields (SSH, U, V)

Interior fields (w, PV)

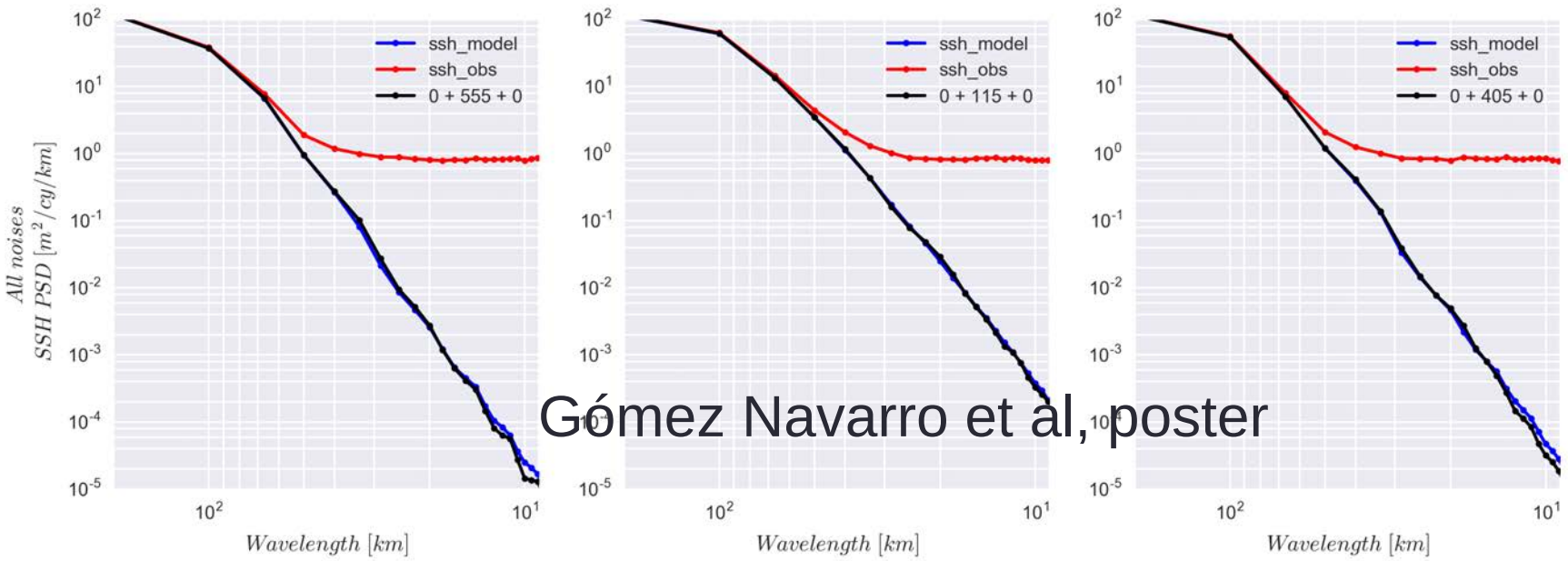
Reconstruction steps: contributions

SWOT (Balanced dyn., Internal tides)

Denoising techniques
Chelton et al (Samelson), filters
Le Sommer/Cosme et al, image restoration

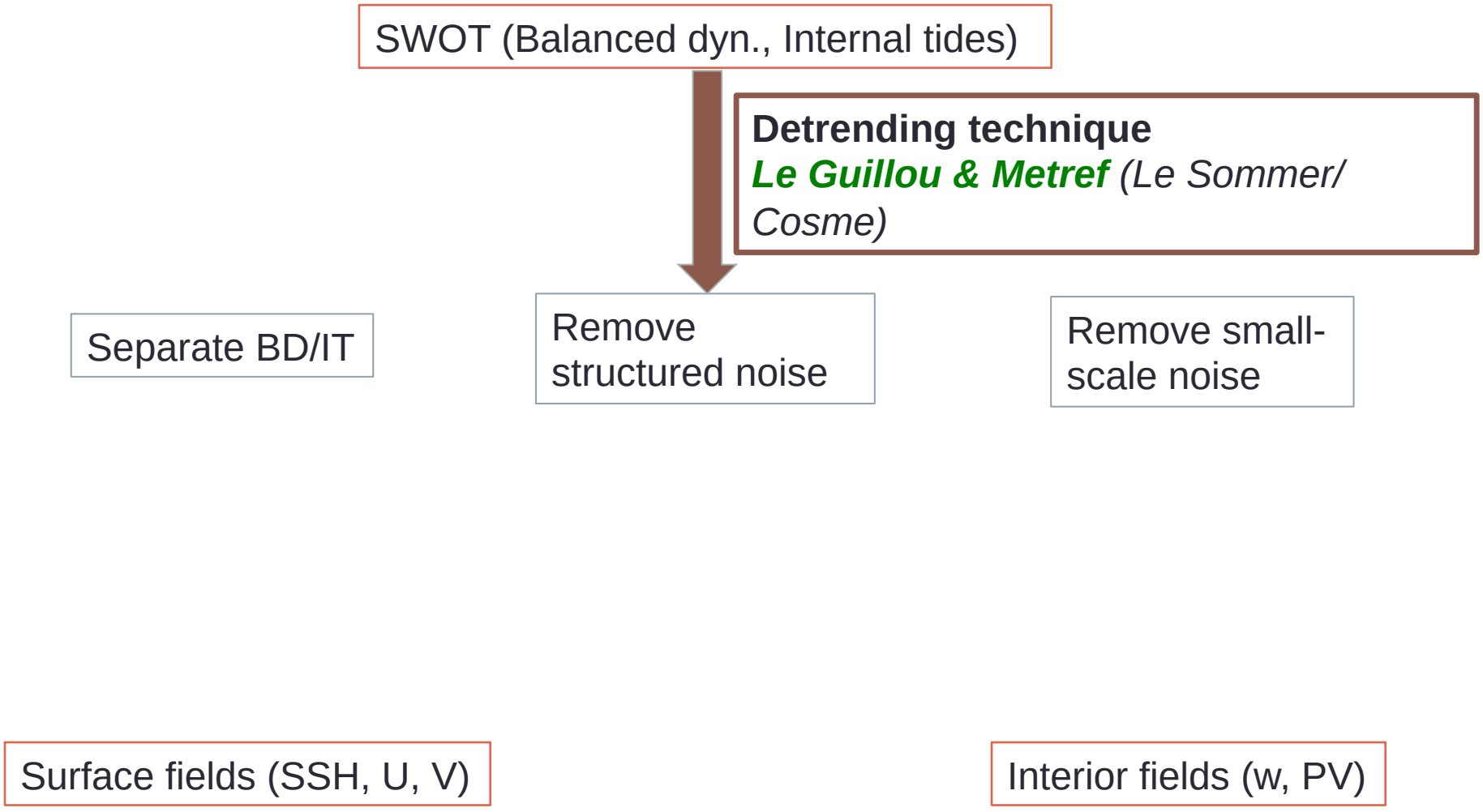
Remove

Remove small-

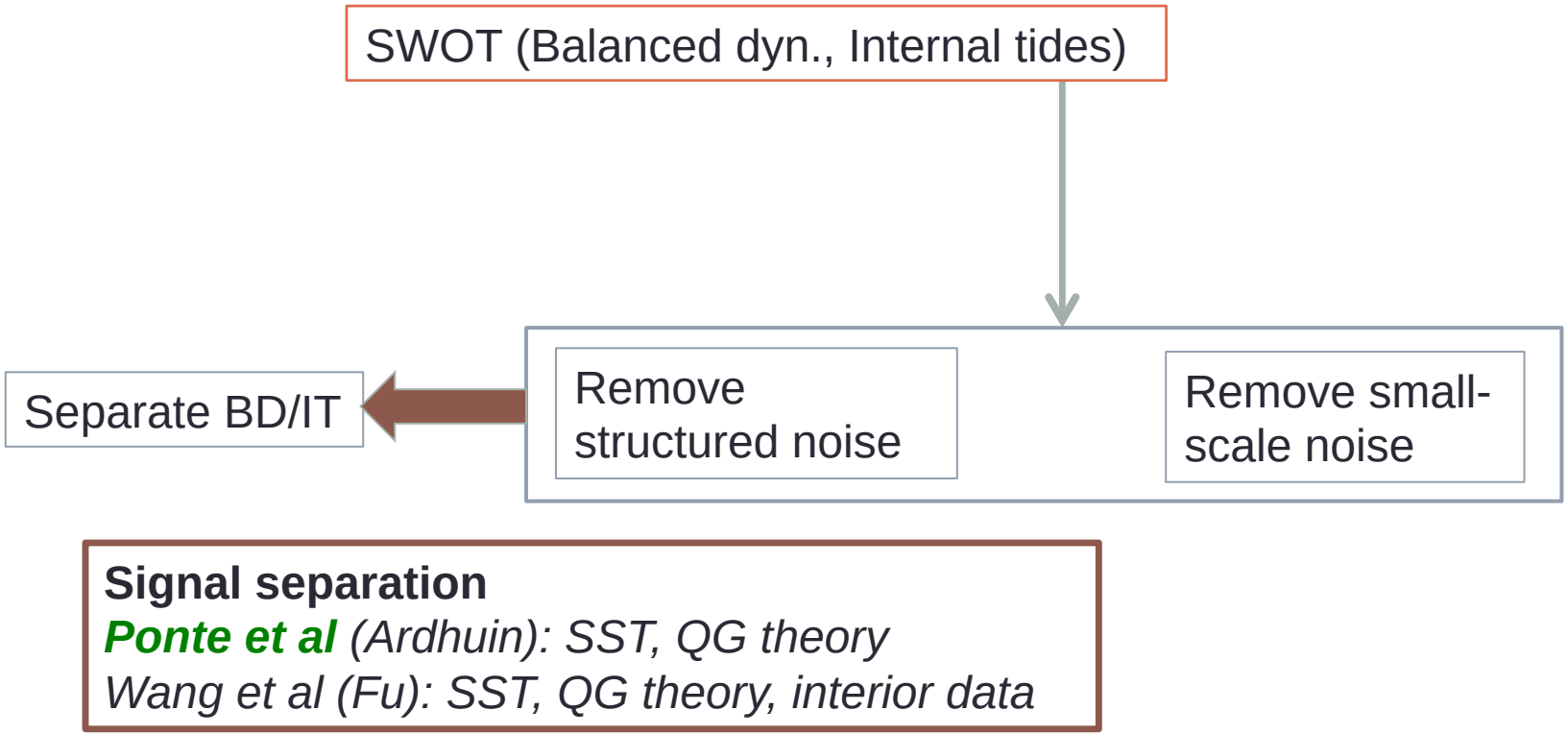


Gómez Navarro et al, poster

Reconstruction steps: contributions



Reconstruction steps: contributions



Reconstruction steps: contributions

SWOT (Balanced dyn., Internal tides)

A big remaining issue.
Splinter session 4 dedicated to it.
Talk by A. Ponte on the state of the art.

Remove small-scale noise

Signal separation
Ponte et al *(Ardhuin): SST, QG theory*
Wang et al (Fu): SST, QG theory, interior data

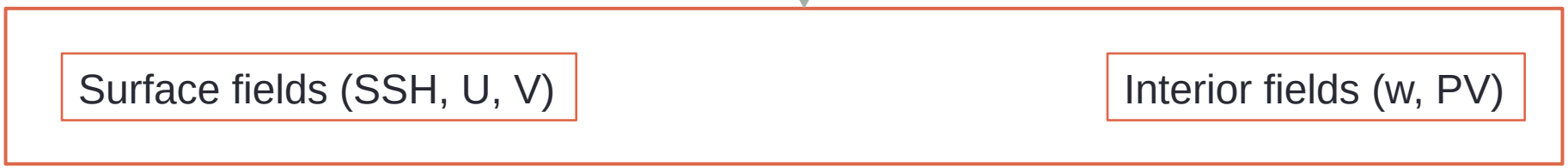
Surface fields (SSH, U, V)

Interior fields (w, PV)

Reconstruction steps: contributions

SWOT (Balanced dyn., Internal tides)

Multi-sensor approaches:
Considered by many authors
Essential!



Conclusions

- All issues and related smaller challenges have been/are being tackled. Significant progress have been made on all items
- Mapping: many approaches tested, no consensus yet. Need to compare methods at some point. Explore coastal and low-lat regions.
- The Internal Tide separation problem still remains a particularly open issue
- The BD+IT Assimilation has not yet been implemented
- No clear end-to-end demonstration of reconstruction so far (i.e., from SWOT data made from a recent version of the simulator and with tides, to 3D datasets)