SLOOP: Toward A New Methodology For Handling S1 And S2 Tidal Waves In DAC For Altimetry Products

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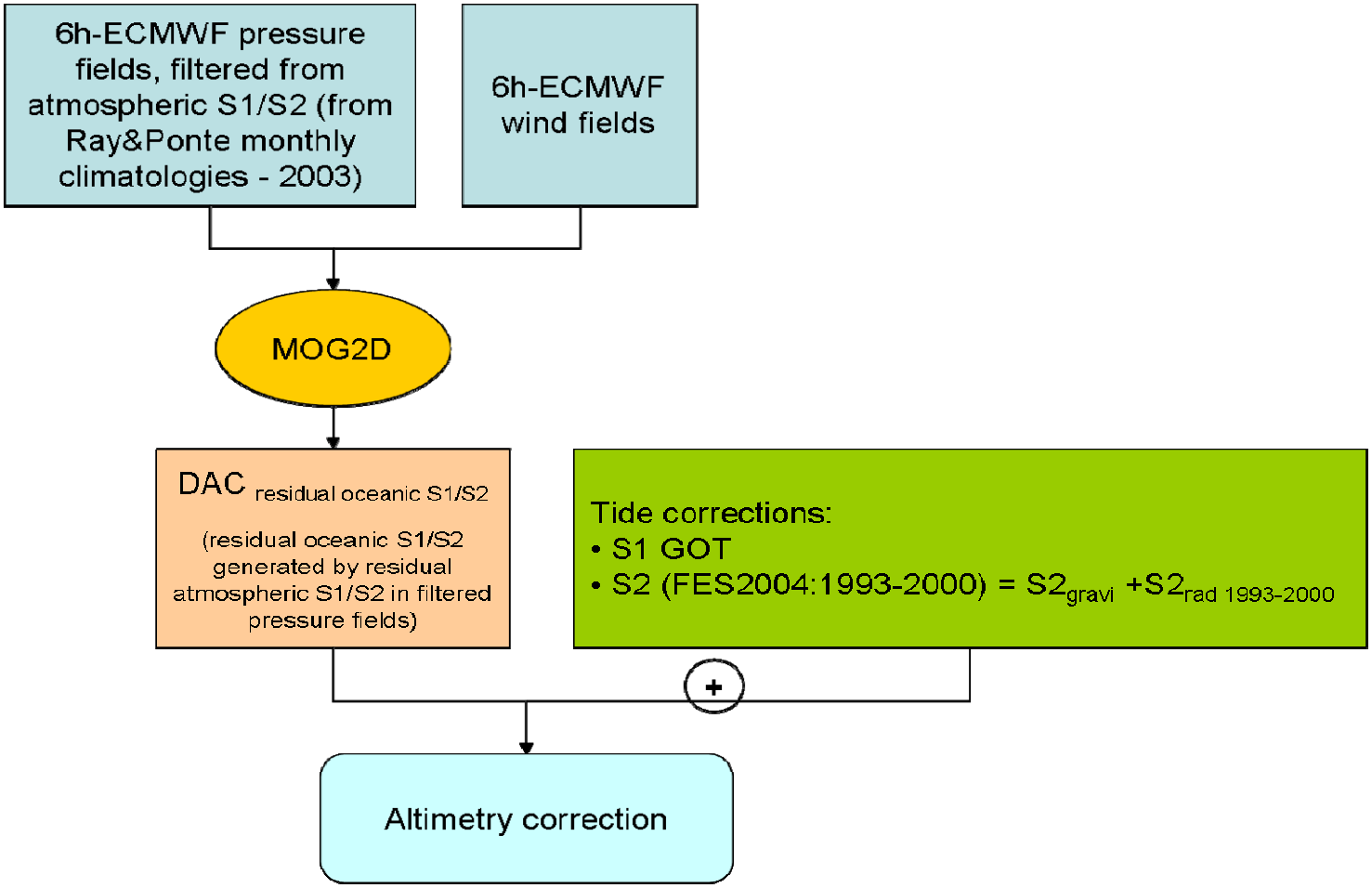
Outlines

- ✓ Oceanic S1/S2 correction strategy in DAC: state of the art
  - ➢ Current strategy
  - ➢ Issues relative to this strategy
  - ➢ Proposition of a new strategy
- ✓ Variability study of radiational oceanic S1 and S2
- ✓ New S1/S2 correction strategy in DAC: implementation and validation

- Oceanic S1/S2 correction strategy in DAC: state of the art
  - ✓ Current AVISO correction strategy for DAC



S1/S2 correction strategy : State of the art

✓ Problematic of the current study

➢ Oceanic S1

- Mostly driven by atmospheric S1
- Oceanic S1 variability essentially depends on atmospheric S1 one, which is significant

So, which strategy for S1 correction in DAC ?

– Use climatologic S1 ?

– Use natural radiational S1 in DAC ?

Issues relative to current AVISO strategy:

– questionable use of 6h-ECMWF forcing for atmospheric S1 retrieval

– questionable use of a unique climatologic S1 GOT for correction

Proposition: S1 is *a priori* not stable in time ➔ use natural radiational S1 in DAC as correction (*i.e.* no external correction)

➔ Object of the current study: confirm S1 variability (seasonal, interannual) from 3h-ECMWF driven TUGO simulations

Oceanic S2

- Tricky point …
- Radiational S2 is already present in global atlas through data assimilation process, but only coherent with the period of assimilation (*e.g.* 1993-2000 for FES2004)
- S2 Nyquist frequency = 6h …

Issues relative to current AVISO strategy:

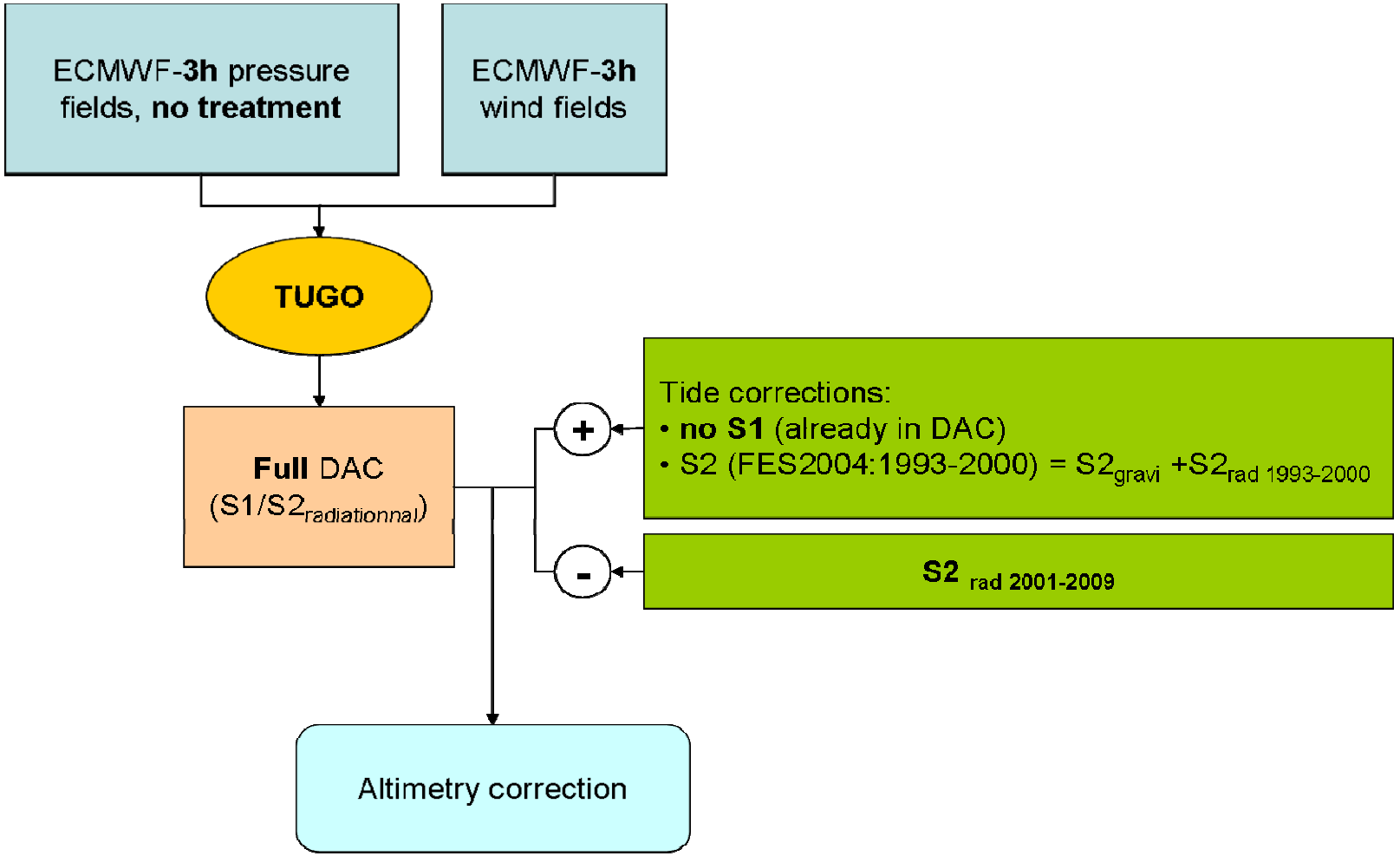
- questionable use of 6h-ECMWF forcing for atmospheric S2 retrieval
- probable remaining radiational oceanic S2 signal in filtered-DAC
- questionable use of S2-FES2004 for current corrections

Solution:

- use natural radiational S2 in DAC as correction
- Subtract an equivalent multiannual radiational S2 analysis, over a period on which 3h-ECMWF forcings are available, to S2-FES2004

➔ Object of the current study: verification that S2 interannual variability is lower than seasonal variability

Proposed strategy



Proposed strategy

✓ Assumptions relative to this new strategy

Issue	Solution	Assumption
questionable use of a **unique climatologic S1 GOT** for correction	**full S1 in DAC signal**, no S1 correction from extern atlas	**intra-annual and interannual variabilities of radiational S1 are significant**
questionable use of **$S2_{FES2004}$** for current corrections (**containing $S2_{radiational\ 1993\text{-}2000}$**)	S2 correction = **$S2_{FES2004} - S2_{radiational\ 2001\text{-}2009}$**	**variability of S2 at interannual scale is lower than at seasonal scale**

✓ Validation process

- Comparison of variance reduction of tide-gauge time-series corrected with either new proposed correction, or current AVISO's one

- Variability study of radiational oceanic S1 and S2

  - ✓ protocol:

    - 7 years of 3h-ECMWF global atmosphere driven TUGO simulation (2002-2008)

    - Harmonic analysis ➔ extraction of S1,S2
      - over each month = "monthly S1,S2"
      - over each year = "annual S1,S2"

    - Variability diagnostics:

      - "annual variability" = complex mean and standard-deviation of monthly S1,S2 for a given year

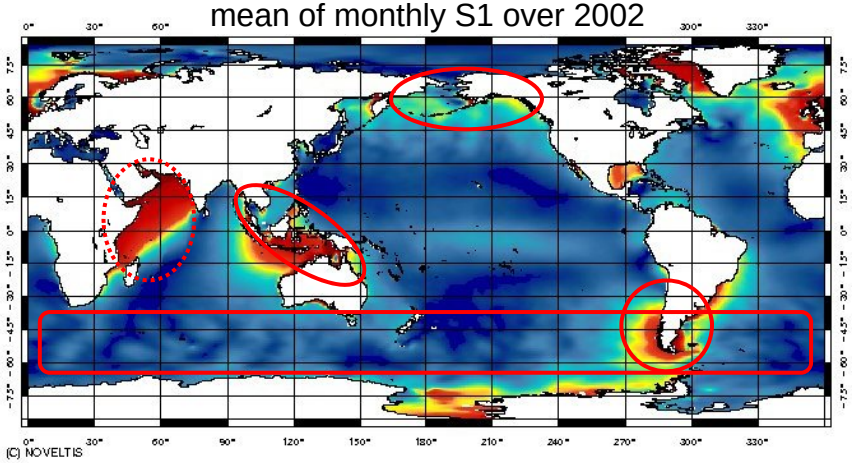
      - "interannual variability" = complex mean and standard-deviation of annual S1,S2

      - "seasonal variability" = for a given month, complex mean and standard-deviation of monthly S1,S2 over the whole period (Ponte and Ray, 2003)

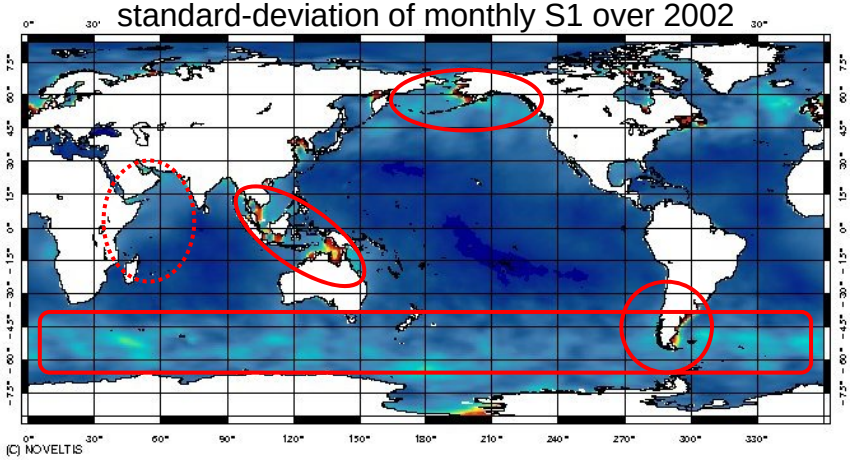
Variability study of S1

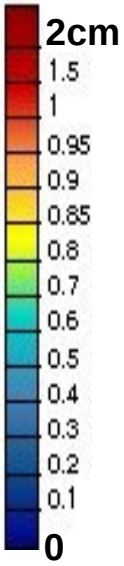
- **Stability of S1 monthly analysis over 2002 (seasonal variability)**

mean of monthly S1 over 2002



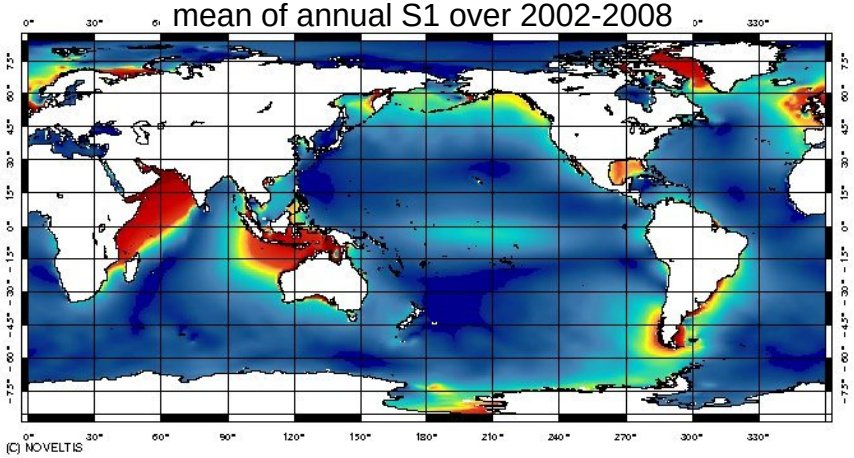
standard-deviation of monthly S1 over 2002



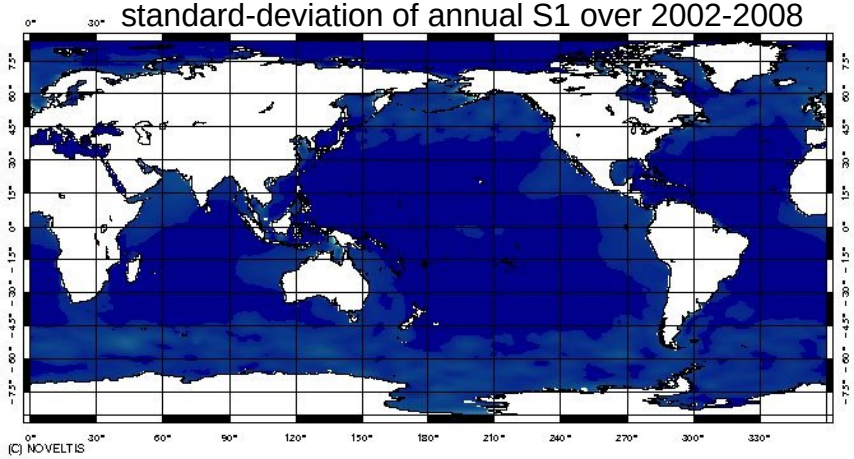


- **Stability of S1 annual analysis over 2002-2008 (interannual variability)**

mean of annual S1 over 2002-2008



standard-deviation of annual S1 over 2002-2008



variability >75%

variability ~50%

➔ **Interannual variability ~ 30% of seasonal variability**

Variability study of S1

- **Stability of S1 monthly analysis over 2002-2008**

Equator:
Mean S1: maximum in march and oct/nov
minimum in june/july

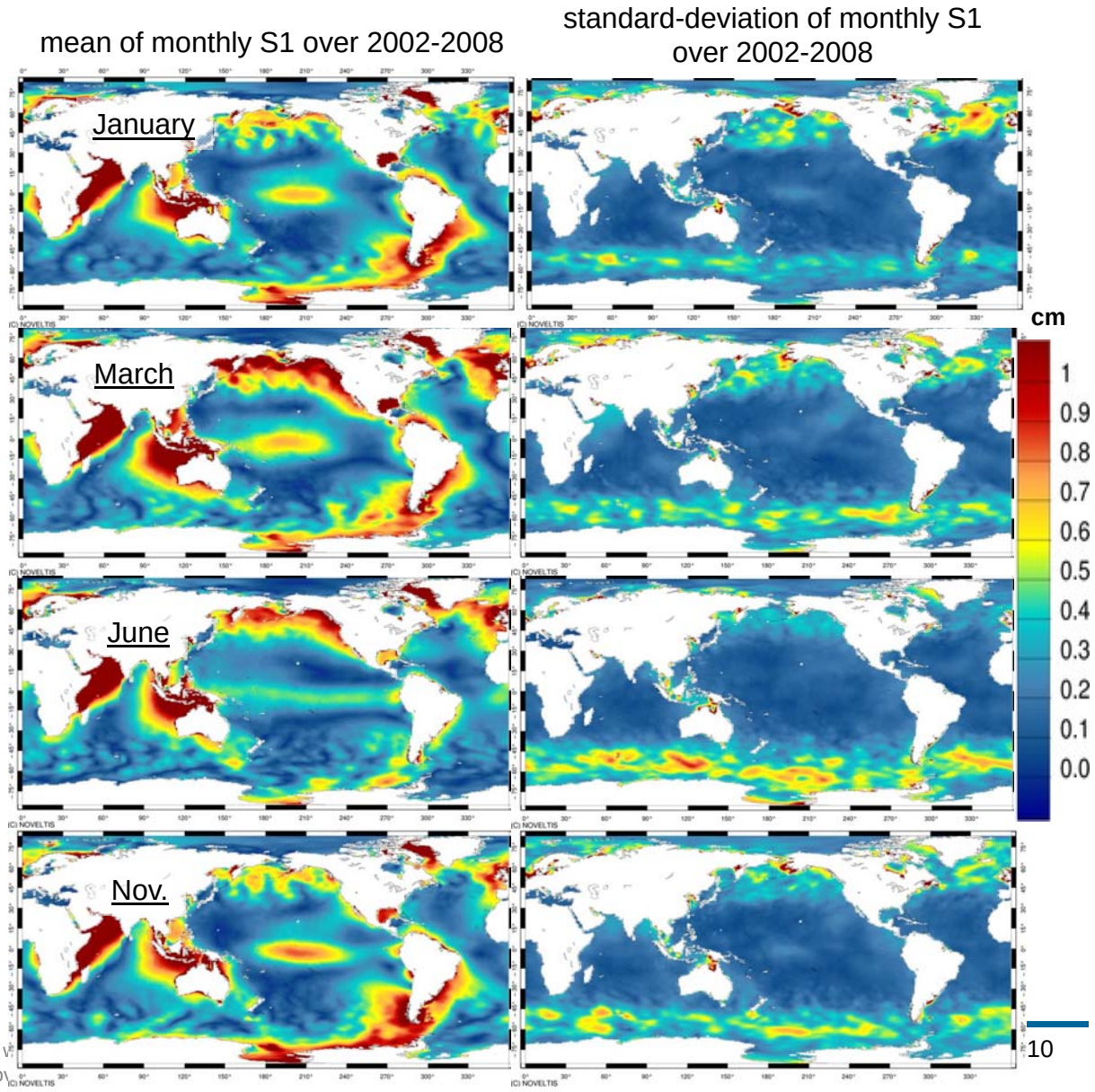
At Globe scale:
Maximum S1: march/april (North Hemisphere) et sept/oct (South Hemisphere)

Minimum: june/july

Coherent with Ponte and Ray (2003) variability analysis of barometric S1

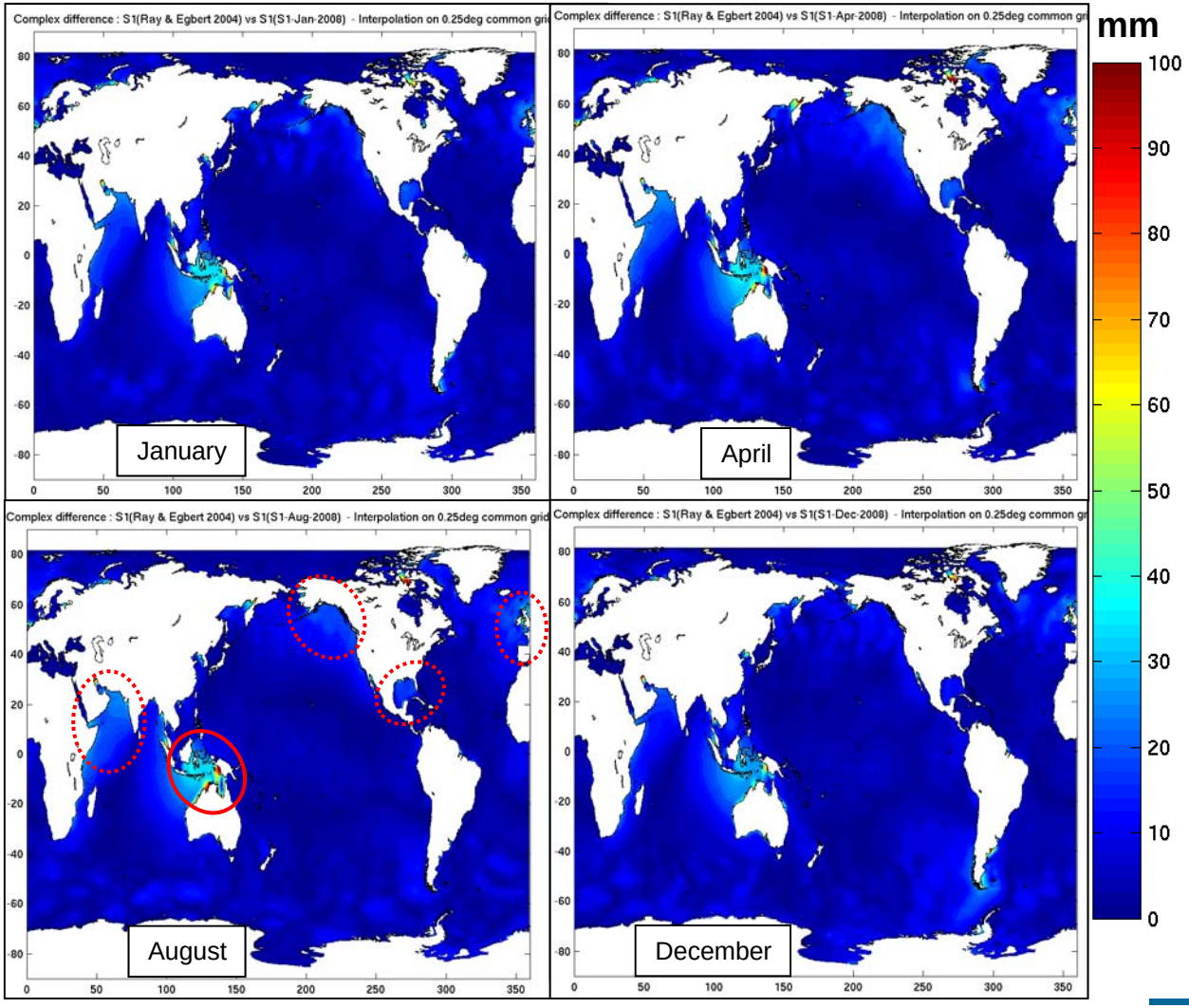
NB: interannual variability of monthly analysis
➔ Using an S1 monthly climatology can be problematic

➔ Significant seasonal variability



Variability study of S1

- Comparisons of AVISO S1-GOT00 and monthly S1 analysis over year 2008



Differences > 5cm

Differences in [2-4cm]

➔ Significant differences over one year

- Variability study of S1: conclusions

  - ✓ S1 annual analysis: quite stable in time
  - ✓ S1 monthly analysis: significant seasonal and interannual variability

  ➔ questionable use of a unique radiational S1 climatology (whether from GOT or computed from another model)

Variability study of S2: reminder

- ✓ Tricky point …
- ✓ Radiational S2 is already present in global atlas through data assimilation process, but only coherent with the period of assimilation (*e.g.* 1993-2000 for FES2004)
- ✓ questionable use of S2-FES2004 for current corrections

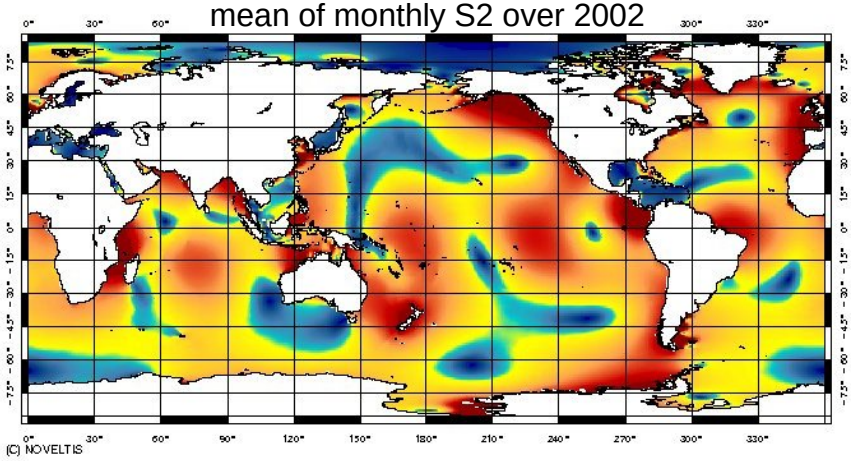
➔ Solution: subtract an equivalent multiannual radiational S2 analysis, over a period on which 3h-ECMWF forcings are available, to S2-FES2004

➔ Object of the current study: verification that S2 interannual variability is lower than seasonal variability

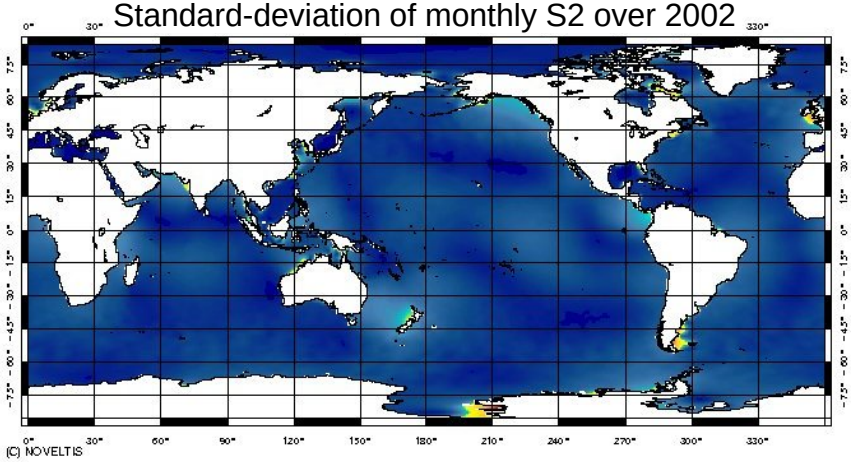
Variability study of S2

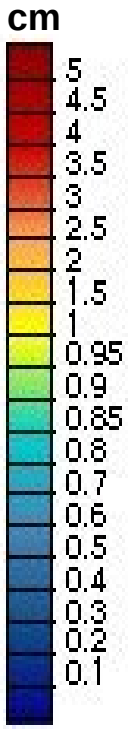
- **Stability of S2 monthly analysis over 2002 (seasonal variability)**

mean of monthly S2 over 2002



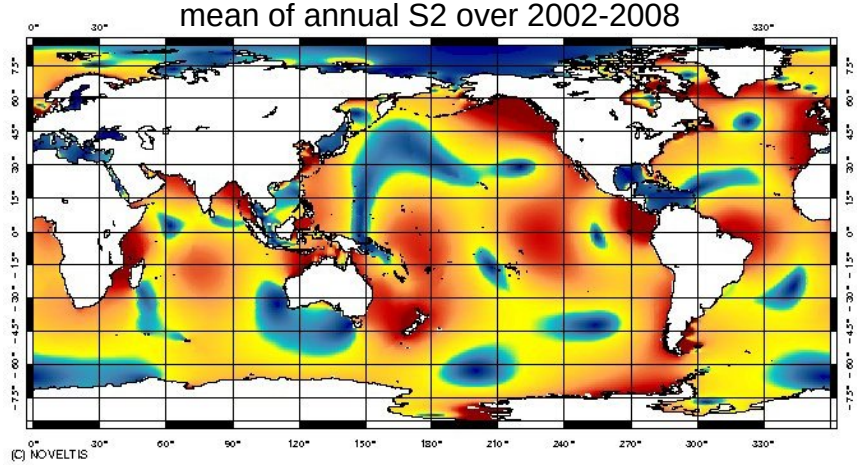
Standard-deviation of monthly S2 over 2002



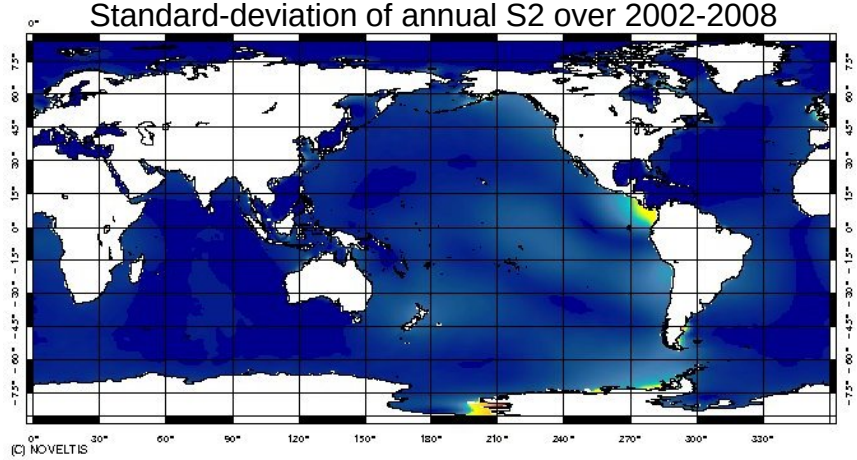


- **Stability of S1 annual analysis over 2002-2008 (interannual variability)**

mean of annual S2 over 2002-2008



Standard-deviation of annual S2 over 2002-2008



Variability study of S2

- **Stability of S2 monthly analysis over 2002-2008**

Important seasonal variability

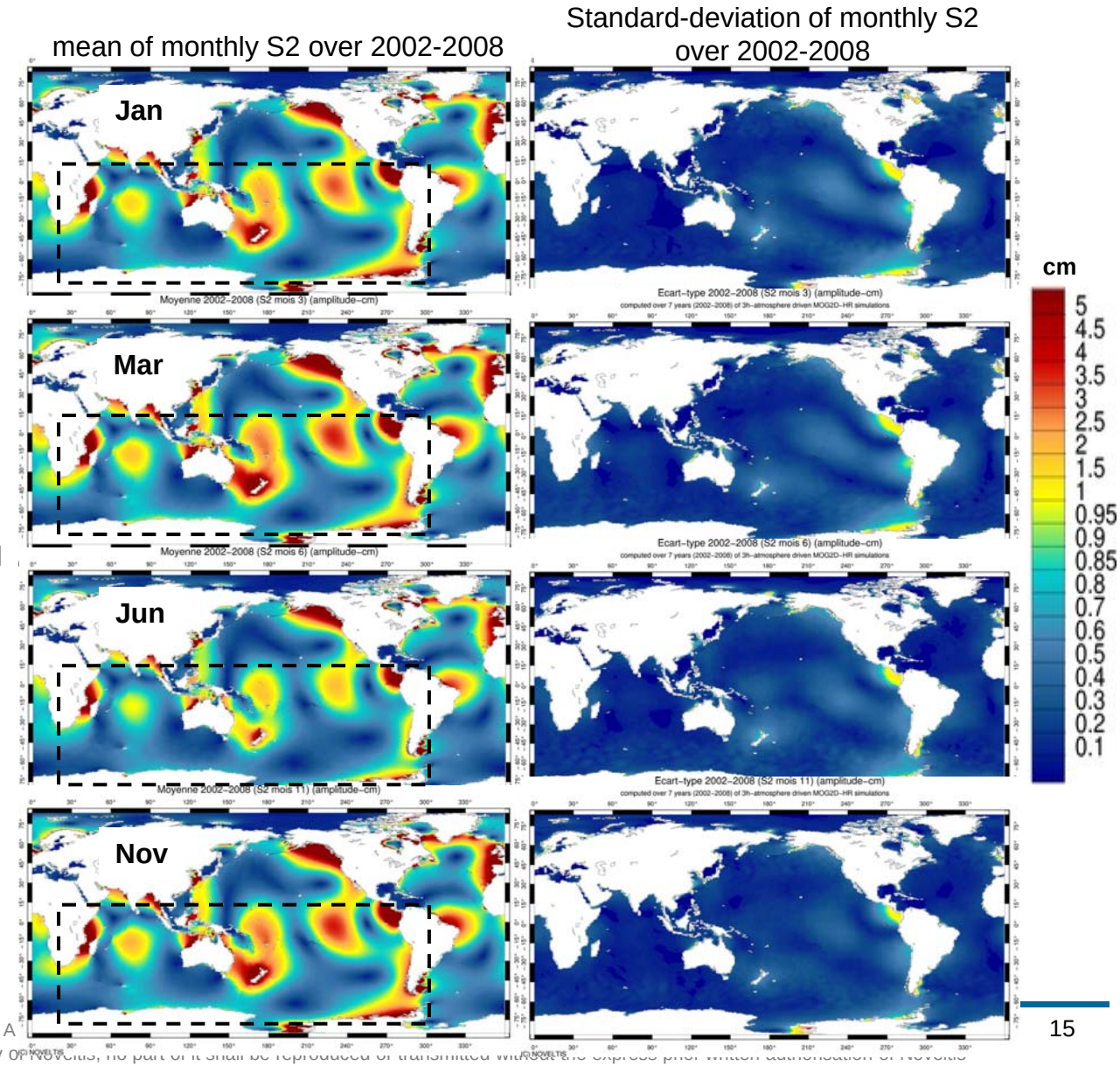
Mean of monthly S2:
maximum in march/april and
october/november
minimum in june/july

Decrease of amplitude between march and july: *O*(10-40%)

Coherent with Ponte and Ray (2003) analysis of mean barometric S2 at seasonal scale

Standard-deviation of monthly S2 is quite stable over 2002-2008

➔ variability of S2 at interannual scale is lower than at seasonal scale



Variability study of S2: conclusions

- ✓ Interannual variability significantly lower than seasonal variability
- ✓ Strong annual evolution of S2 signal, while interannual variability remains stable and limited

➔ interannual variability is not "negligible" with regard to seasonal variability, but still significantly less important.

➔ coherent assumption: $S2_{\text{radiational 1993-2000}} \sim S2_{\text{radiational 2001-2009}}$

note: another possible solution would be to subtract the radiational S2 signal in DAC, using an annual S2 analysed from DAC signal

Validation of new correction strategy

✓ Protocol

➢ S1 correction

- 13 tidegauges time-series: **detided**, **excepted for S1 signal**
- S1 AVISO correction=$DAC_{\textbf{residual S1/S2}}$ **+** S1GOT00 (*i.e.* classical correction **without S2 contribution**)
- **New correction = TUGO DAC, filtered from S2 signal**

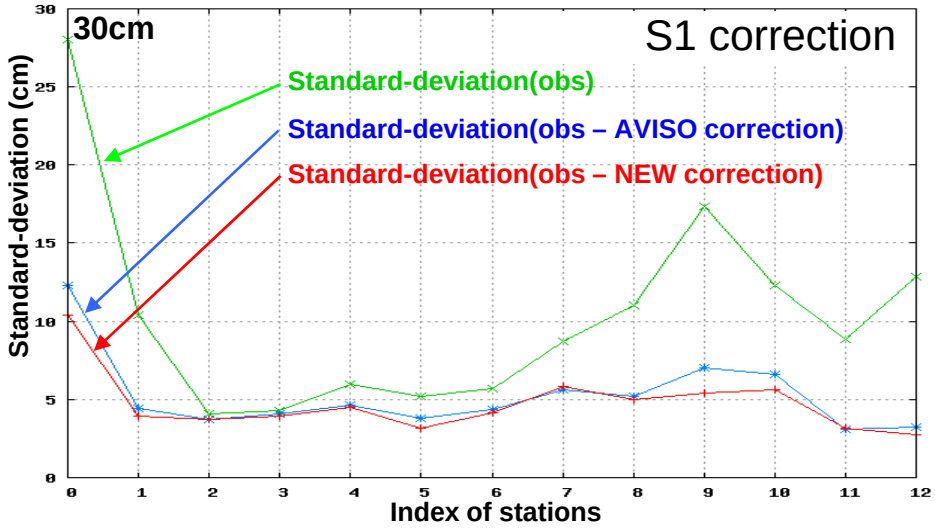
➢ S2 correction

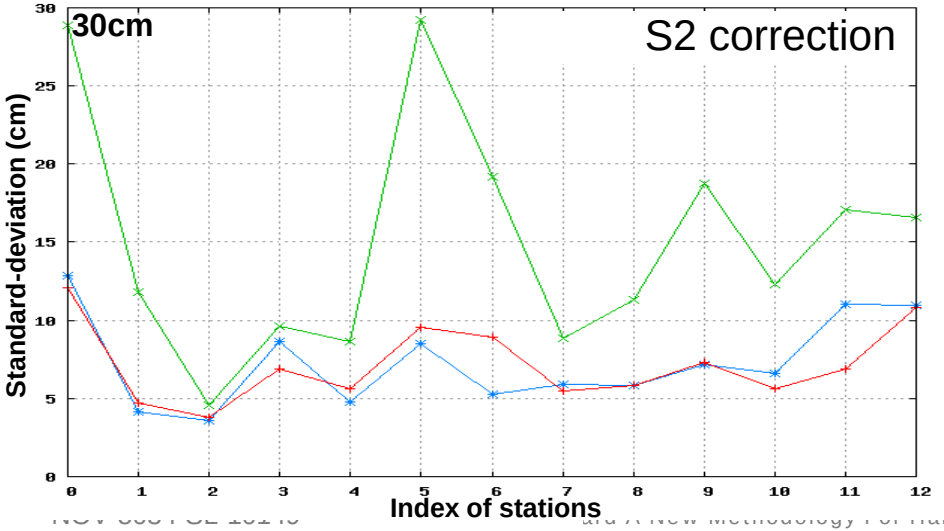
- 13 tidegauges time-series: **detided**, **excepted for S2 signal**
- S2 AVISO correction=$DAC_{\textbf{residual S1/S2}}$ **+** S2FES04 (*i.e.* classical correction **without S1 contribution**)
- **New correction = TUGO DAC, filtered from S1 signal + S2FES04 - $S2_{\textbf{radiational 2001-2009}}$**

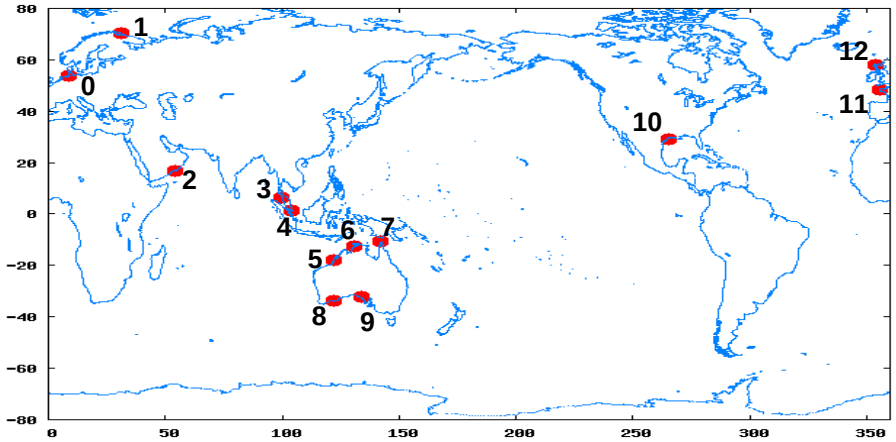
➢ Variance reduction of tidegauges time-series corrected with either AVISO or new correction (focus on [0.5-20 days] frequencies)

Validation of new correction strategy

Results







S1 correction

globally, stronger variance reduction with new correction strategy; gain=*O*(1-2cm), *i.e.* 5-20% with regard to natural variance levels

S2 correction

New correction:

- less efficient for 5 stations, with negative gain *O*(-1,-4cm)
- better or at least similar for the 8 others, with gain *O*(1-5cm), *i.e.* 3-25% with regard to natural variance levels

➔ **New S2 correction gain less significant than new S1 correction gain**

➔ **But promising global results**

➔ **Should be now validated over a larger database**

Thank you for your attention

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