ECV consistency: a data assimilation perspective

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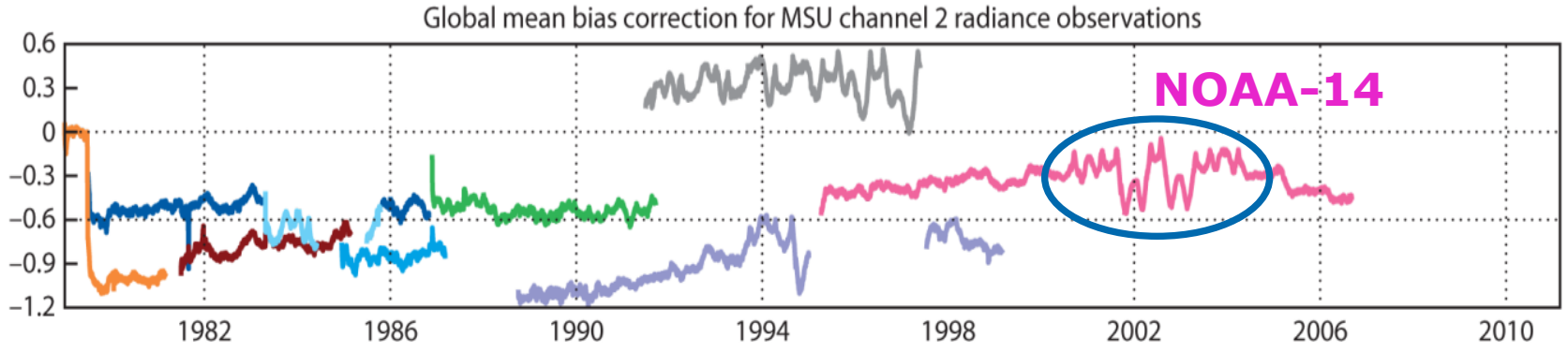
- **Examples on consistency detection within a DAS**
  - ❖ Consistency between datasets of the same ECV
  - ❖ Cross-ECV consistency
- **Beyond consistency**

Something obvious…

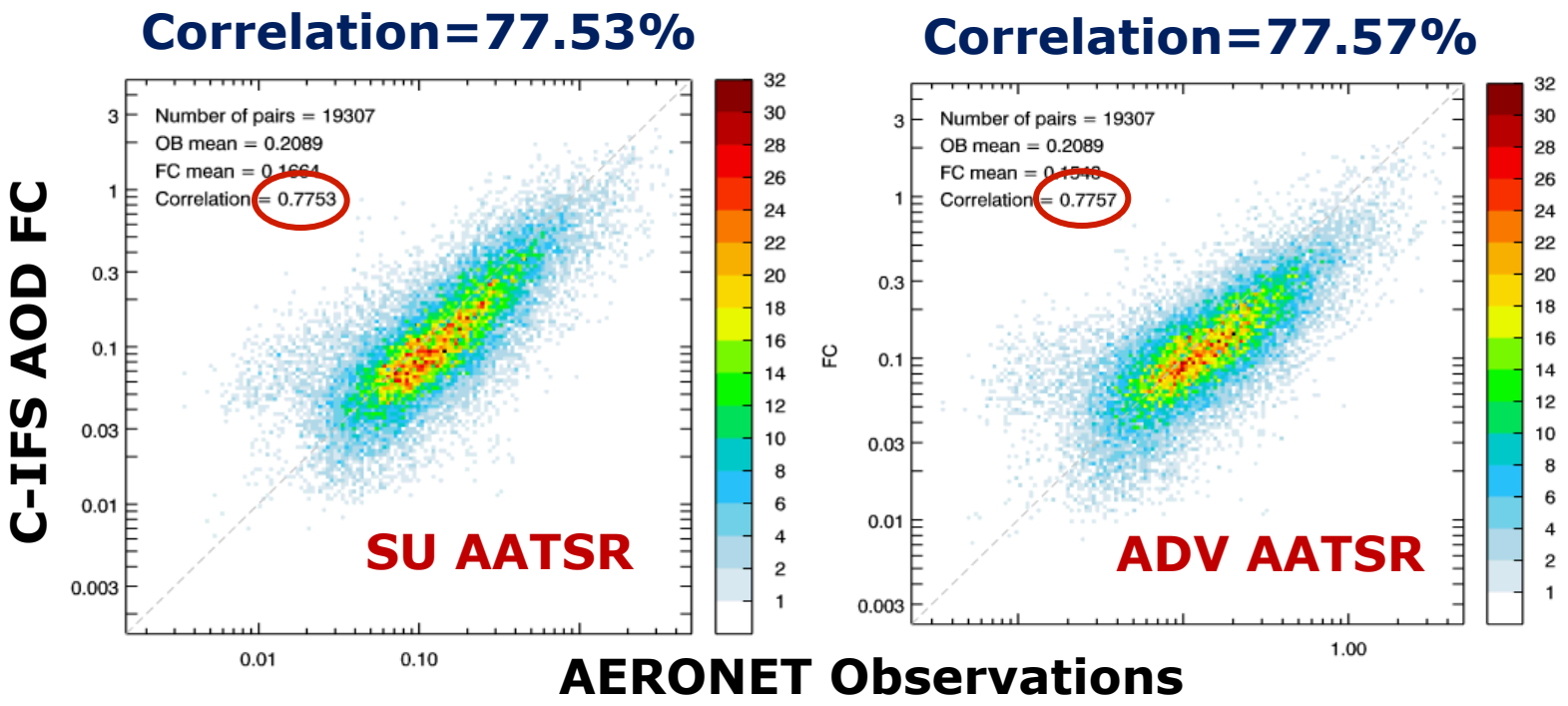
- **We cannot talk about consistency without defining:**
  a. The **property** we require consistency on.
  b. The **reference** with respect to which the consistency is measured.
     ➔ There is not a unique definition of it!

- **Why do we (DA community) care?**



- **A Data Assimilation System (DAS) can be used to assess both the consistency between datasets of the same ECV and that across ECVs**
  ❖ The caveat is that a **DAS can include a large number of interactive variables**.

Consistency between datasets of the same ECV assessed within a DAS



The assimilation of either the SU or the ADV AATSR AOD produces AOD forecasts that show similar level of agreement with independent observations from the AERONET network.

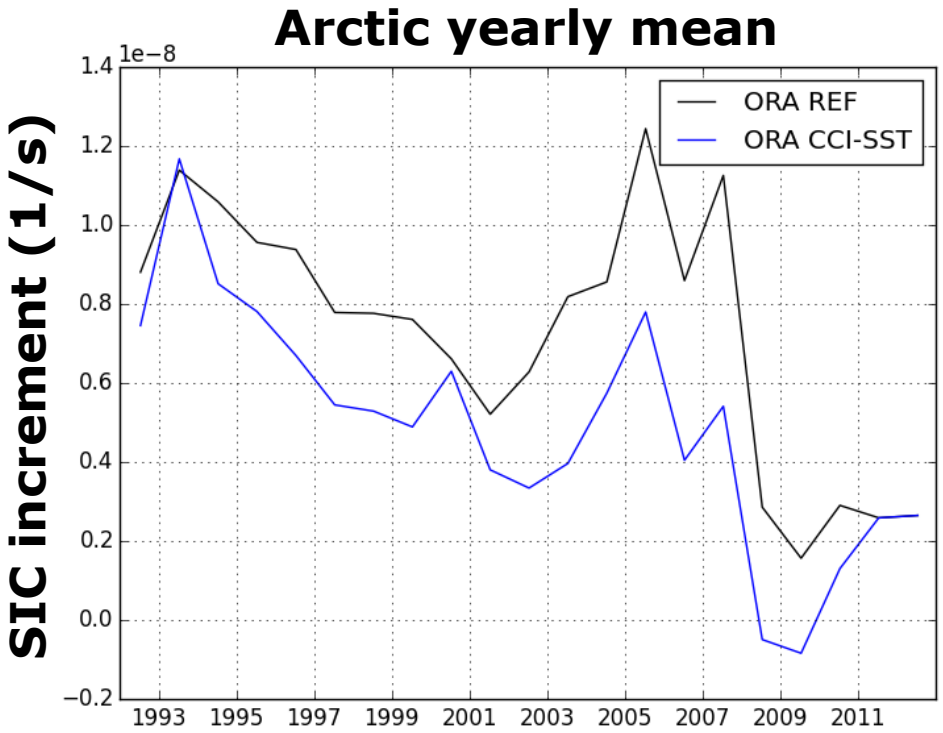
➔ It is a **measure of the level of confidence** we have **in the data**

Cross-ECV consistency through a better internal consistency of the DAS

Experiment	SST	SIC	SL	Start	End
ORA^{REF}	HadISST2	OSI-SAF	Aviso	1975	2014
ORA$^{(CCI-SST)}$	**CCI v1.1**	OSI-SAF	Aviso	1992	2010

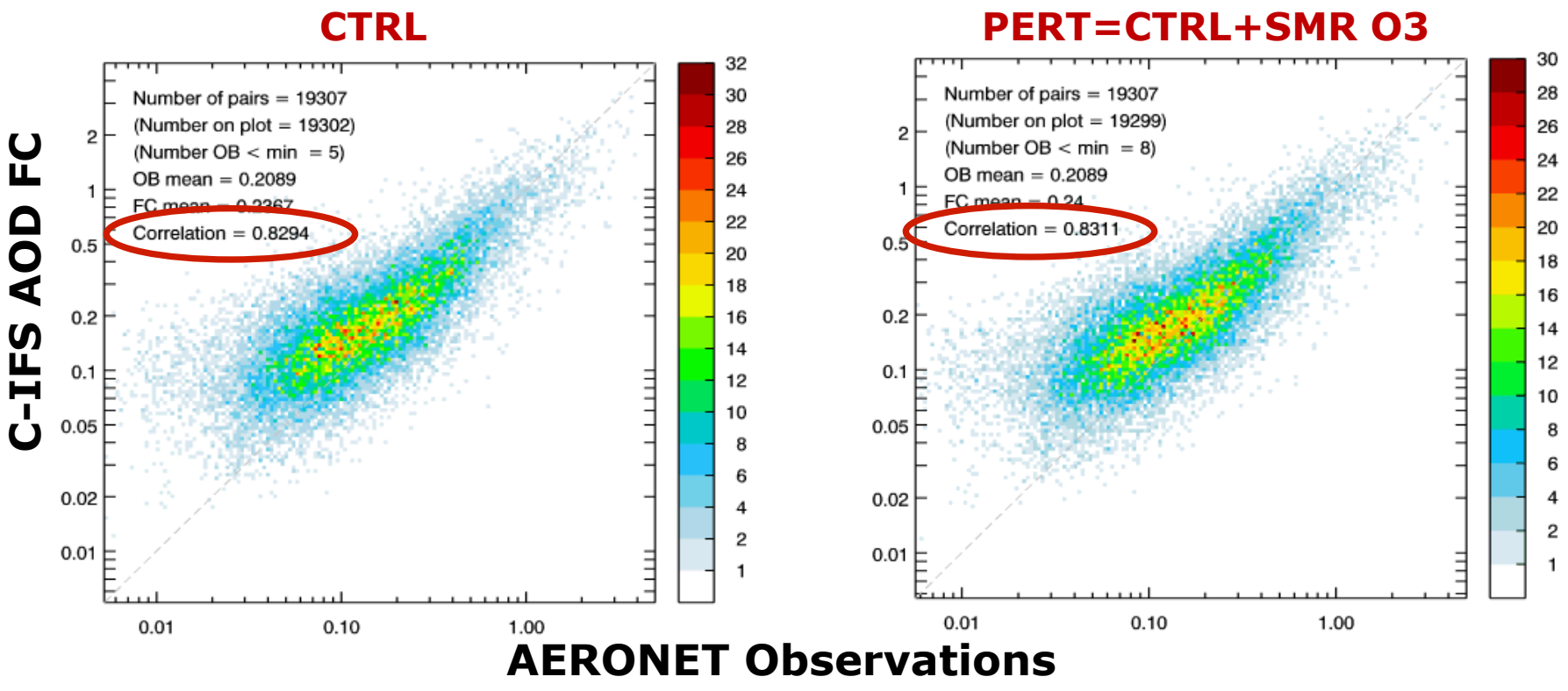
The assimilation of the CCI SST data instead of the HadISST2 reduces the mean sea ice concentration increments.

Greater internal consistency.



Credit: S. Tietsche (ECMWF)

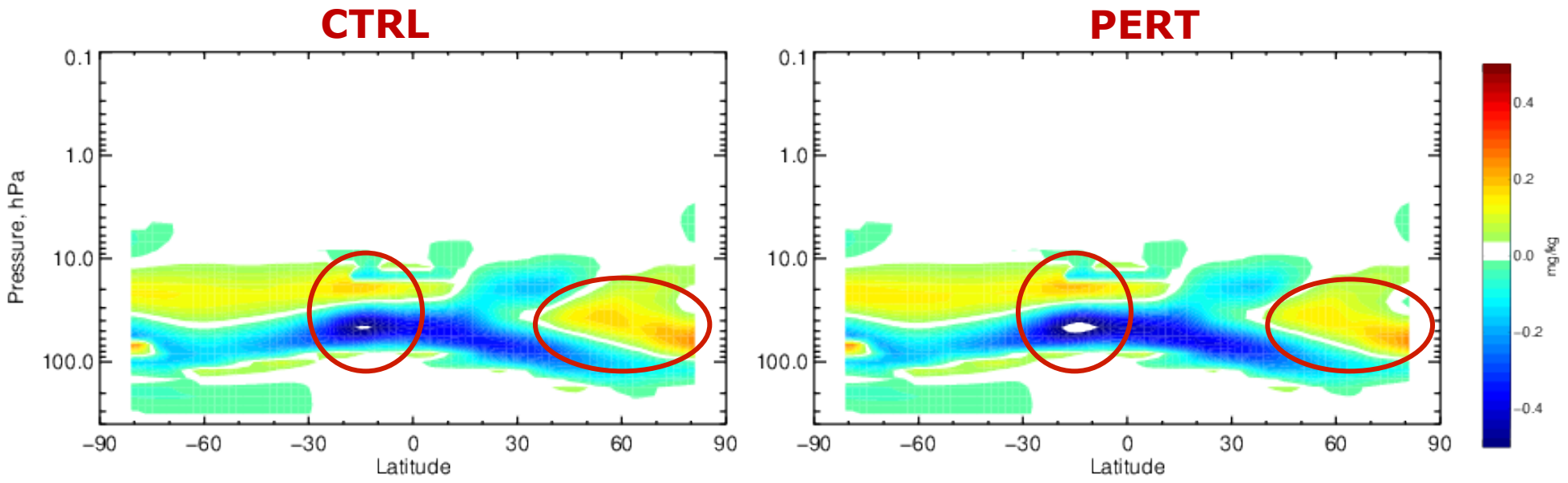
Cross-ECV consistency for improved analyses/forecasts: O_3 impact on AOD



Active	OZONE	AEROSOLS	GHG	
			CO2	CH4
CTRL	SBUV SCIA TCO3	MODIS	IASI	IASI
PERT	SBUV SCIA TCO3 **SMR**	MODIS	IASI	IASI

- **The assimilation of SMR O_3 impacts the quality of the AOD FC.**
- **Improved agreement with AERONET data (+0.17%).**

Cross-ECV consistency for improved analyses/ forecasts : AOD and GHG impact on O_3



	OZONE	AEROSOLS	GHG	
			CO2	CH4
CTRL	SBUV SCIA TCO3 **OSIRIS**	**ADV AATSR**	IASI **BESD SCIA**	**SRFP TANSO**
PERT	SBUV SCIA TCO3 **OSIRIS**	**MODIS** **ADV AATSR**	IASI **BESD SCIA** **SRFP TANSO**	**SRPR TANSO**

$$\Delta = \left|\overline{MLS - An_{O_3}^{(PERT)}}\right| - \left|\overline{MLS - An_{O_3}^{(CTRL)}}\right|$$

$$\Delta = \begin{cases} > 0 \rightarrow \text{-ve impact} \\ < 0 \rightarrow \text{+ve impact} \end{cases}$$

Bold=CCI / **Bold**=Difference between experiments

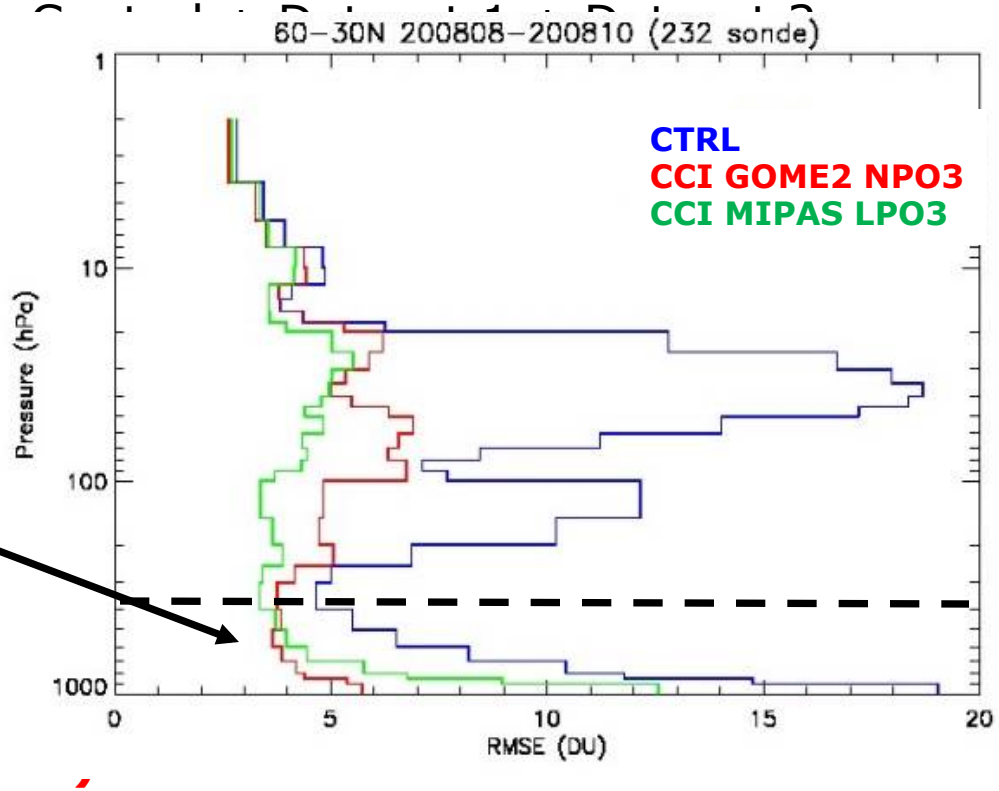
Consistency, complementarity and synergy

Dataset 1
Dataset 2

Control
Exp1 = Control + Dataset 1
Exp2 = Control + Dataset 2
Exp3 = Control + Dataset 1 + Dataset 2

$$\Sigma = \frac{|\text{Exp3} - \text{Control}| - |(\text{Exp2-}}{\text{Contro}}$$

Σ { >0 Synergistic
=0 Complementary
<0 Consistent information → **No impa (redund**



Consistency, complementarity and synergy

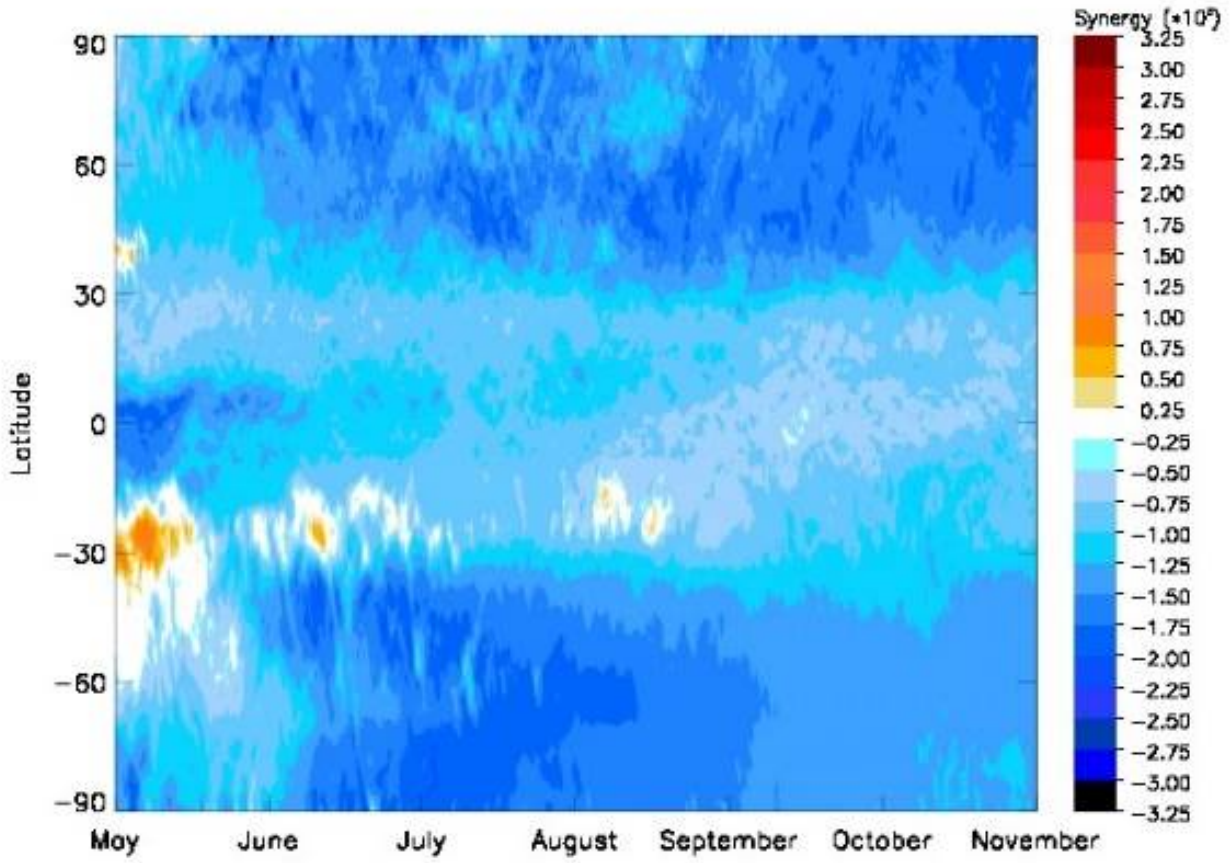
$$\Sigma = \frac{\left|\text{Exp3} - \text{Control}\right| - \left|\ (\text{Exp2-Control}) + (\text{Exp1-Control})\ \right|}{\text{Control}}$$

>0 ➔ Synergy

=0 ➔ Complementarity

<0 ➔ Consistency

(➔ redundancy)

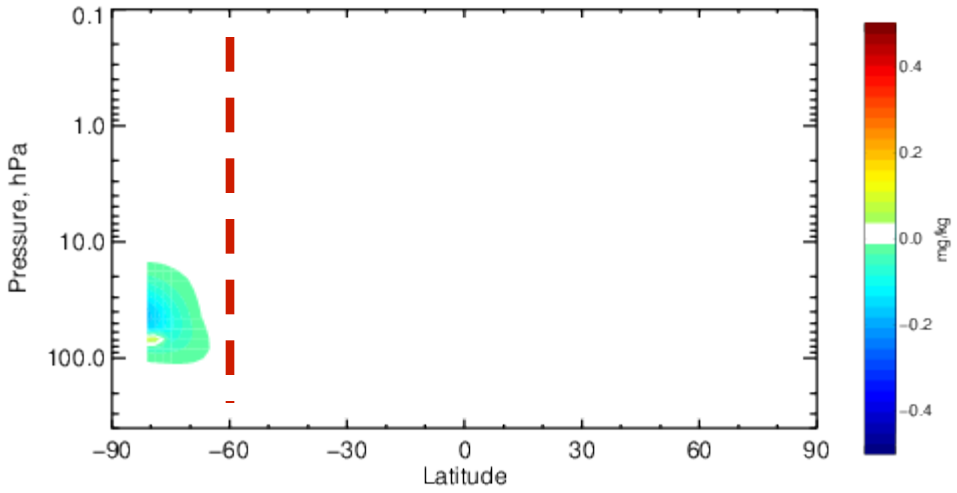


	GHG CO2
CTRL	IASI
EXP 1	IASI **SRFP TANSO**
EXP 2	IASI **BESD SCIA**
EXP 3	IASI **BESD SCIA** **SRFP TANSO**

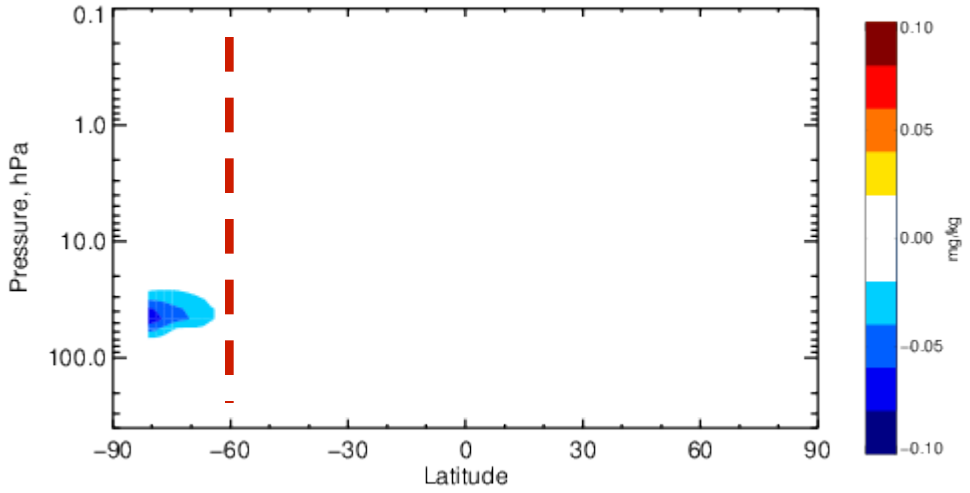
Bold=CCI datasets

Consistency → redundancy → robustness of DAS

MEAN



STD DEV



$$\Delta = \left|\overline{MLS - An_{O_3}^{(PERT)}}\right| - \left|\overline{MLS - An_{O_3}^{(CTRL)}}\right|$$

> 0 → -ve impact

< 0 → +ve impact

Assimilation of the CCI SMR O_3 profiles (May-Jul) has neutral impact except at high latitudes in the SH → redundancy in the information (data + error) w.r.t. what already available in the DAS

Final considerations

- **Consistency does not have a unique definition, but it depends on the property we are interested in and on the reference w.r.t. it is evaluated.**
- **Assessing what consistency is in a DAS is not trivial ➔ largely because of the size of the problem (e.g. 100+ fields)**
- **Examples:**
  - Consistency between two or more datasets representing the same ECV
  - Cross-ECV consistency
  - Internal consistency of the DAS
- **In DA, we are also interested in synergy.**
- **Consistency in the information provided by two datasets can eventually translate in redundancy within a DAS ➔**

~~**data is useless**~~ **robustness of the DAS!**