Status of ITRF Development and SLR Contribution

Key Word: Vertical Velocities and GIA

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Warning

- **Preliminary analysis**
- **SLR Analyzed Solutions are not official ILRS products**
- **ILRS reprocessed combined solution not yet available**

Outline

- **Focus on SLR contribution**
  - **Origin & Scale**
  - **Vertical Velocities & GIA model (?)**
- **Analyzed solutions:**
  - **IVS official combined time series**
  - **ASI-12**
  - **GRGS-11**
  - **NCL (Philip Moore): Not yet an Official ILRS AC**
  - **Test SLR solutions (David Coulot):**
    - **Solution per satellite (L1 & L2)**

ITRF and Science Requirement

- **Long-term stable ITRF: 0.1 mm/yr**

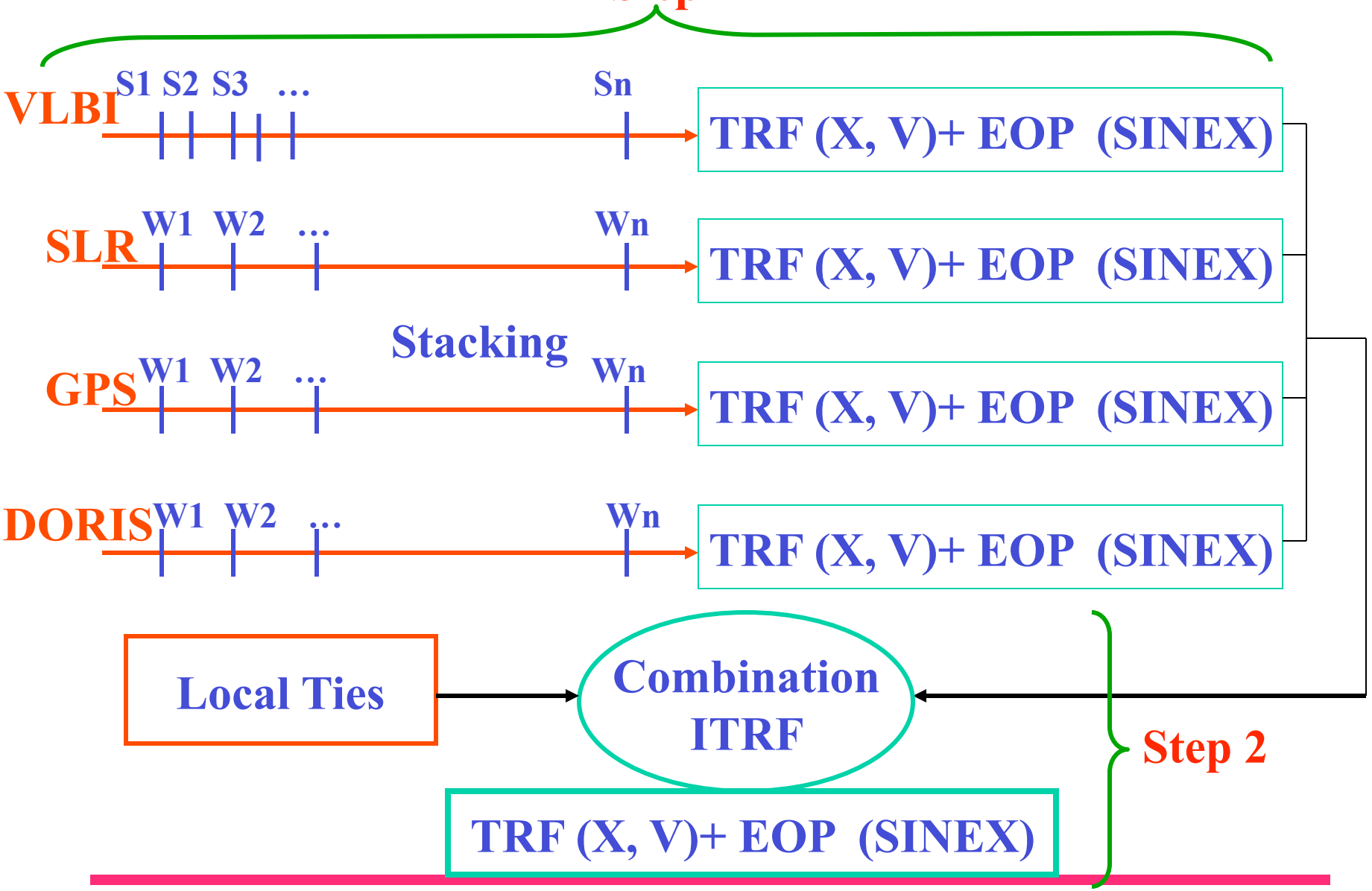
- **Stable: linear behaviour of the TRF parameters, i.e. with no discontinuity :**

  - **Origin Components: 0.1 mm/yr**
  - **Scale 0.01 ppb/yr (0.06 mm/yr)**

- **Current situation: probably not better than 1 mm/yr**

Current ITRF Derivation

Step 1



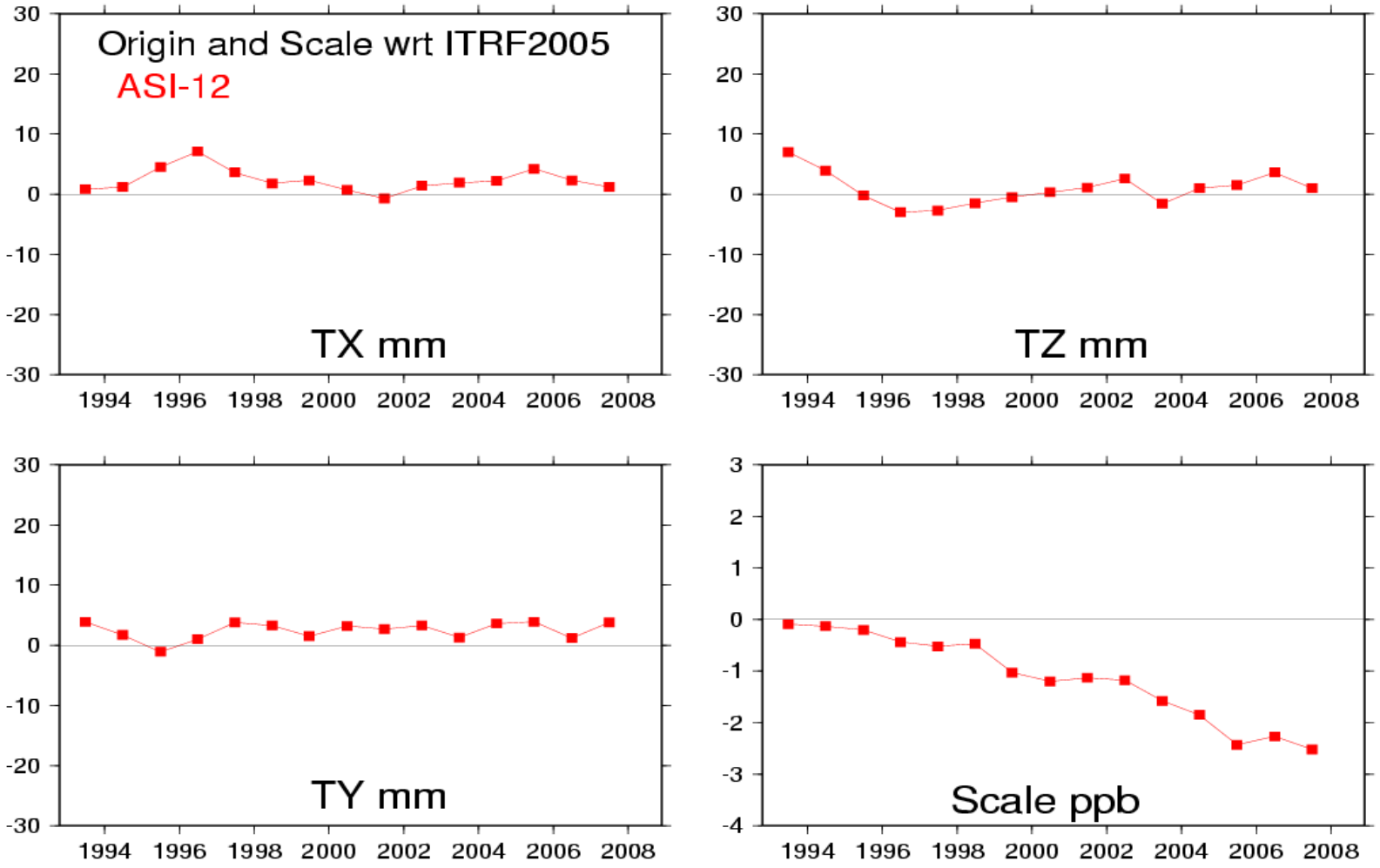
Intrinsic Conditions

$$P(t_0) = 0 \quad \& \quad \dot{P} = 0$$

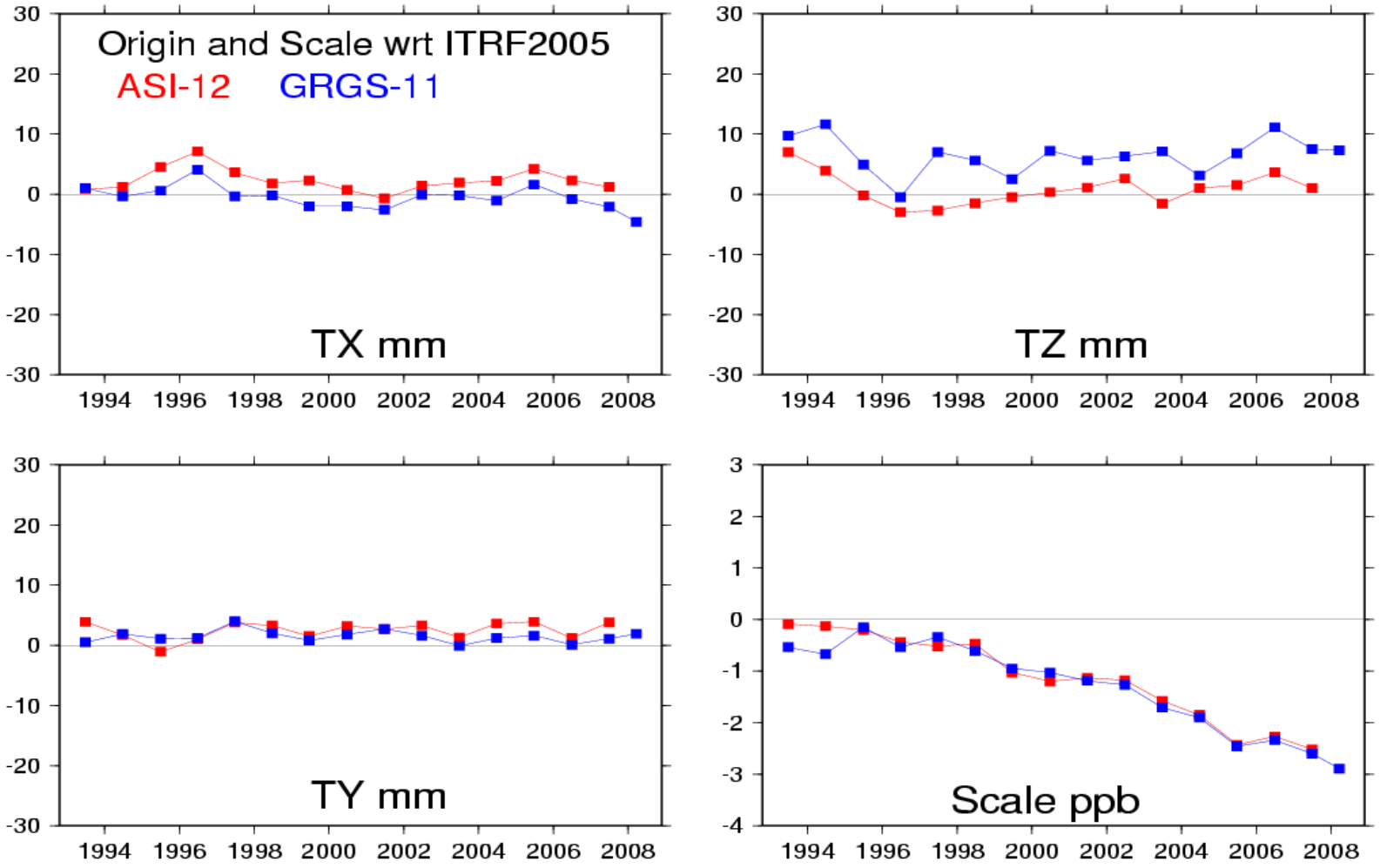
$$\begin{cases} \sum_{k \in K} P_k(t_k) & = & 0 \\ \sum_{k \in K} \dfrac{P_k(t_k)}{(t_k - t_0)^{-1}} & = & 0 \end{cases}$$

- **Preserve the intrinsic origin of SLR**
  - **Seen as No-Net-Translation condition**
  - **Preserve/Realize the long-term CoM as sensed by SLR**
- **Preserve the intrinsic scale of SLR & VLBI**

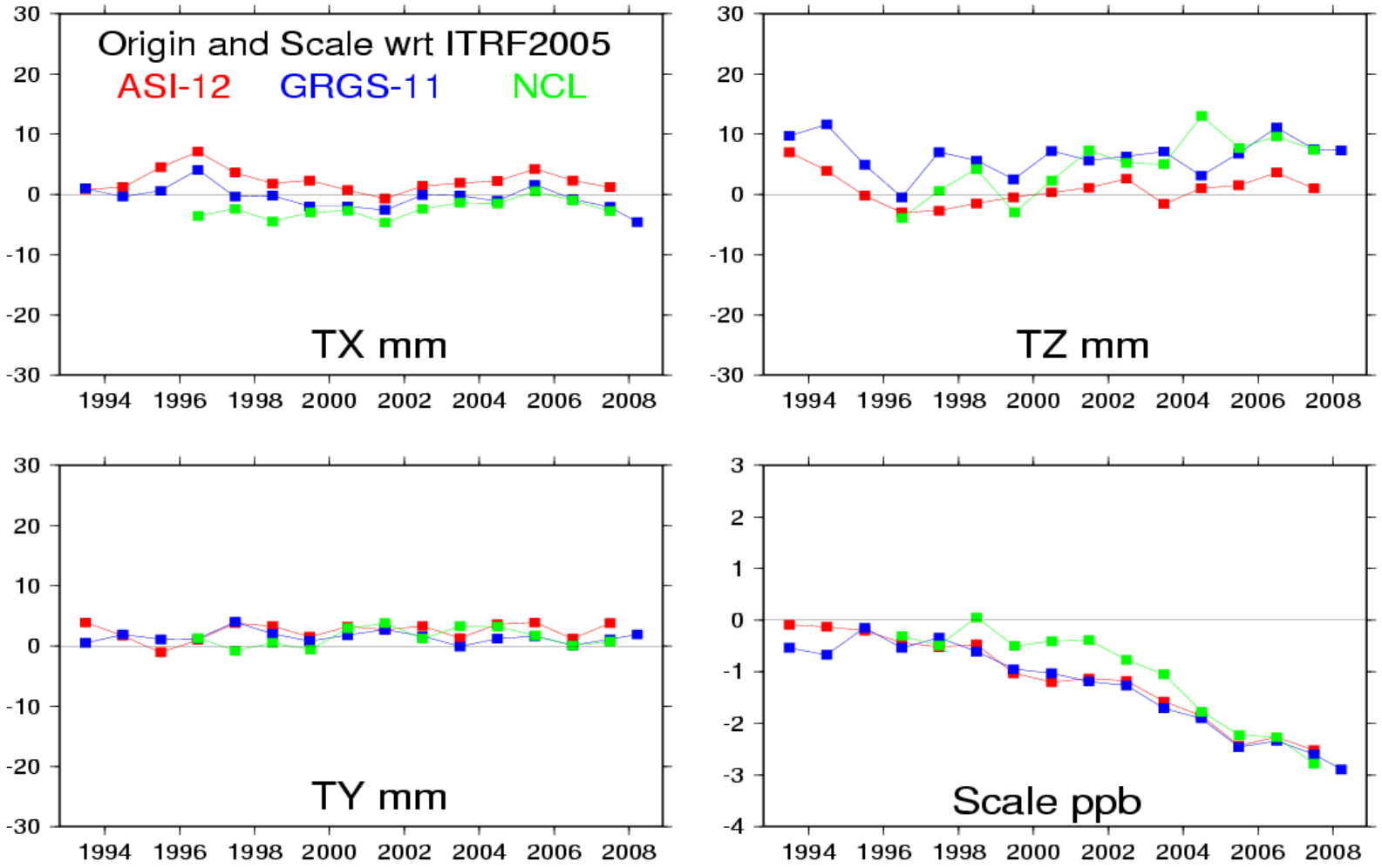
Origin and Scale wrt ITRF2005



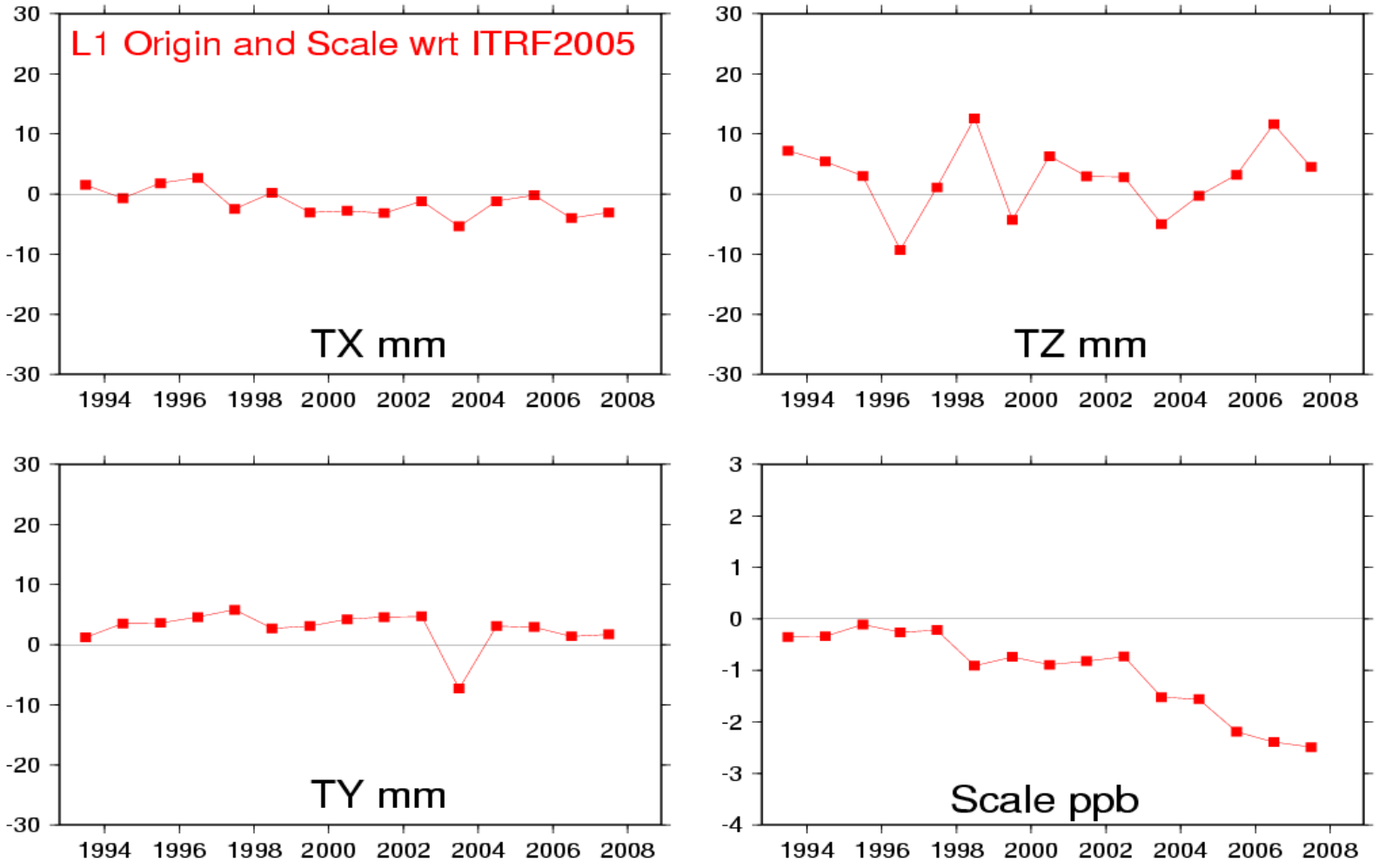
Origin and Scale wrt ITRF2005



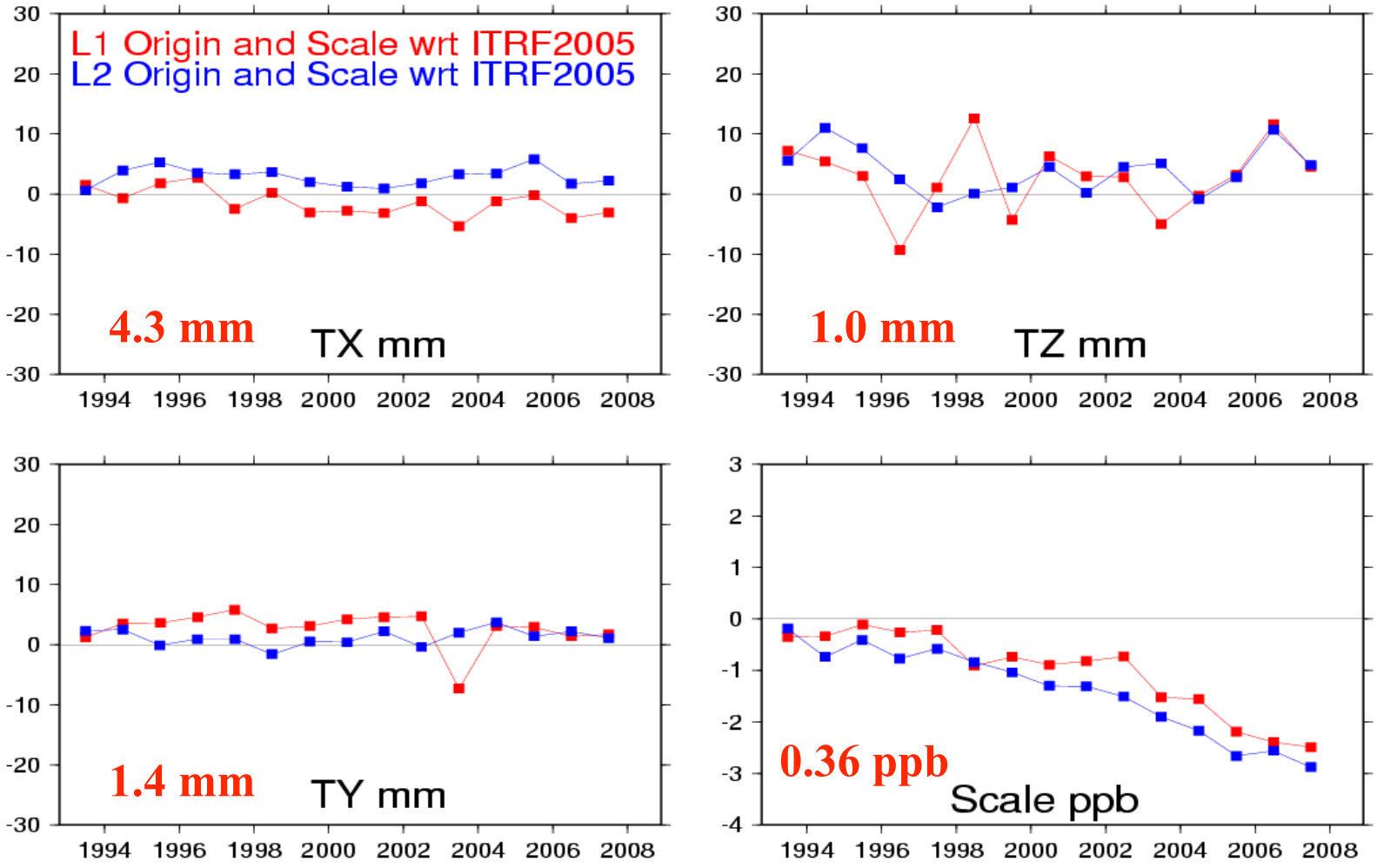
Origin and Scale wrt ITRF2005



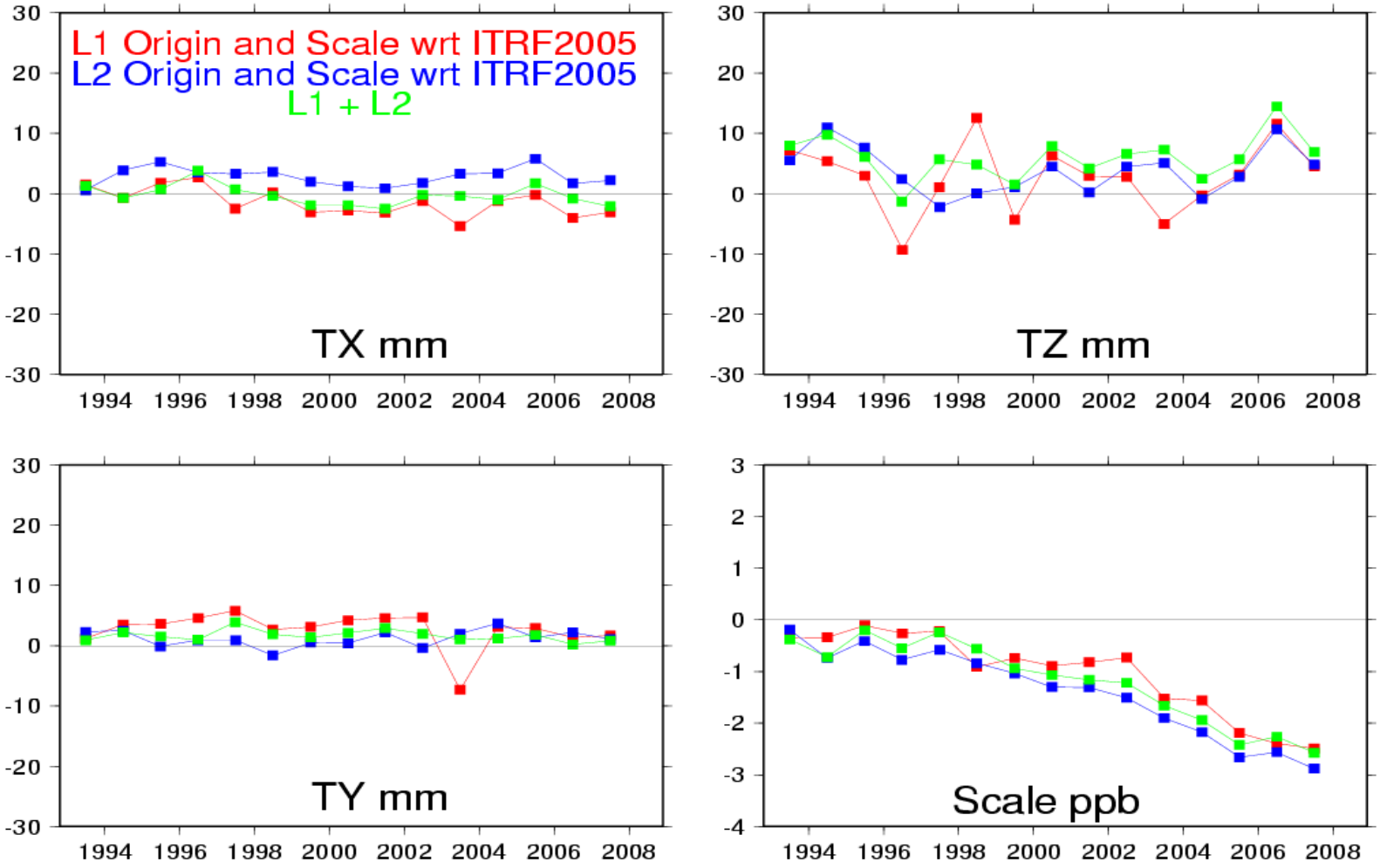
IGN SLR Origin & Scale ITRF2005
Contribution by David Coulot



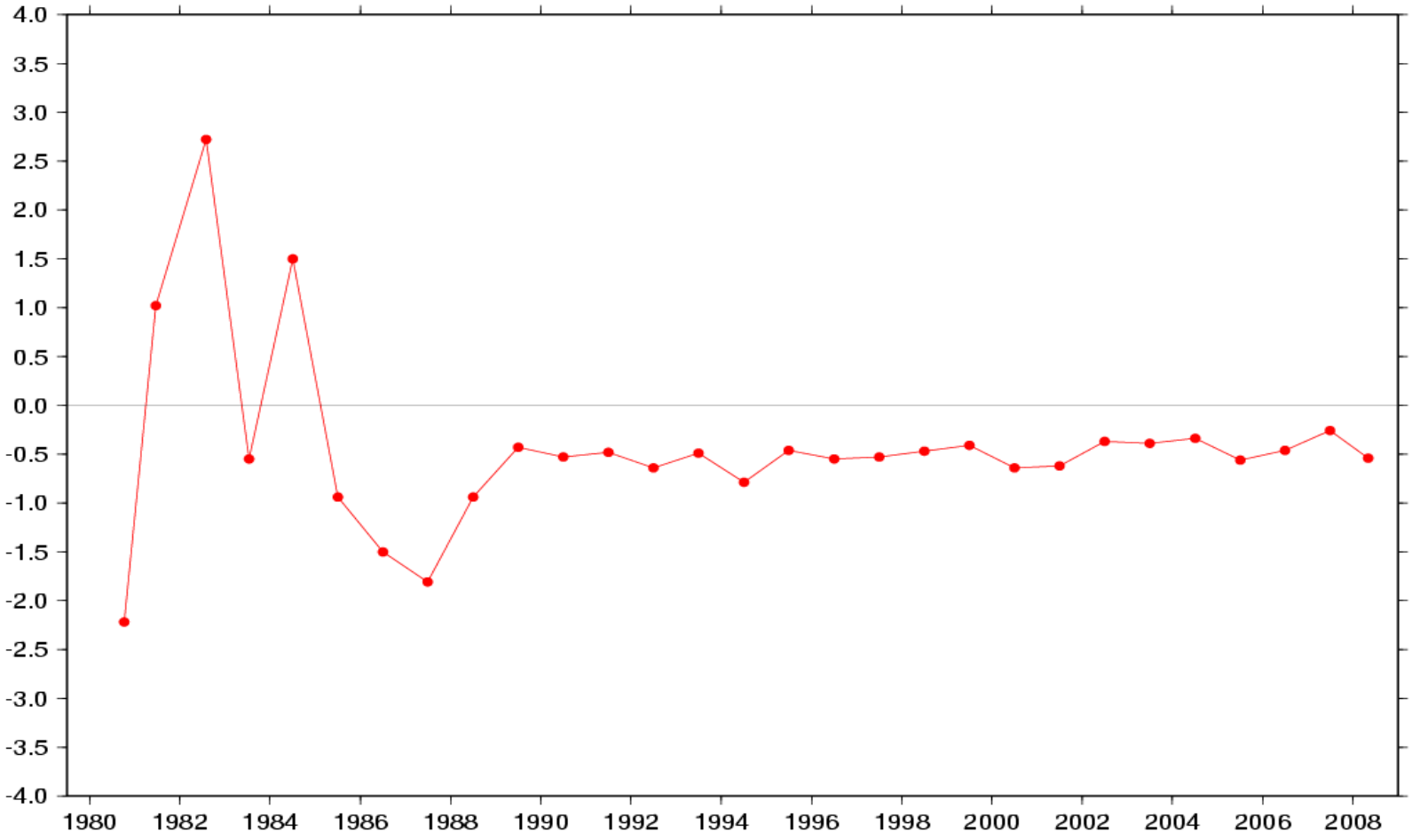
IGN SLR Origin & Scale ITRF2005
Contribution by David Coulot



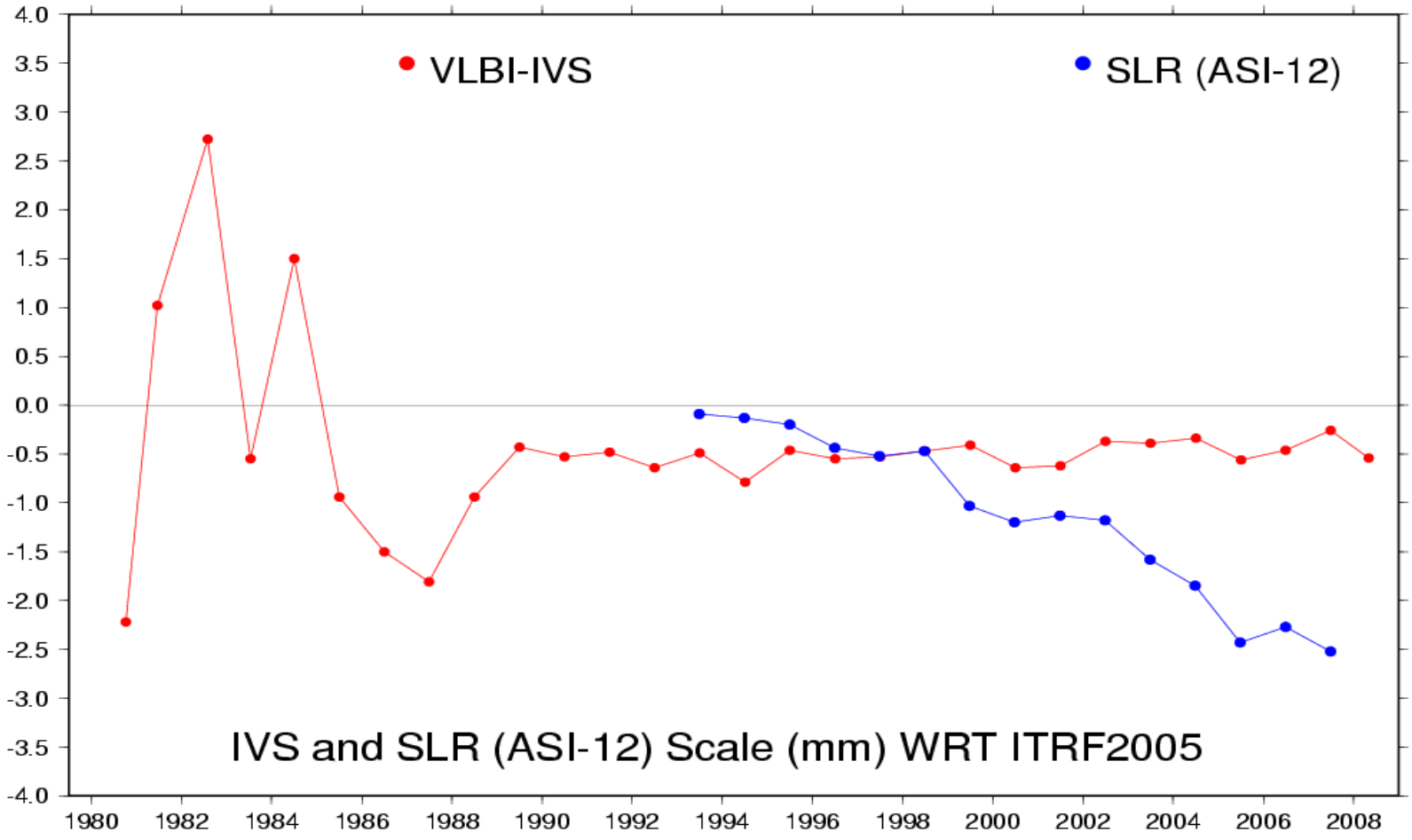
IGN SLR Origin & Scale ITRF2005
Contribution by David Coulot



IVS Scale (ppb) wrt ITRF2005
Mean Pole Tide Corrected



IVS and SLR (ASI-12) Scale (ppb) wrt ITRF2005

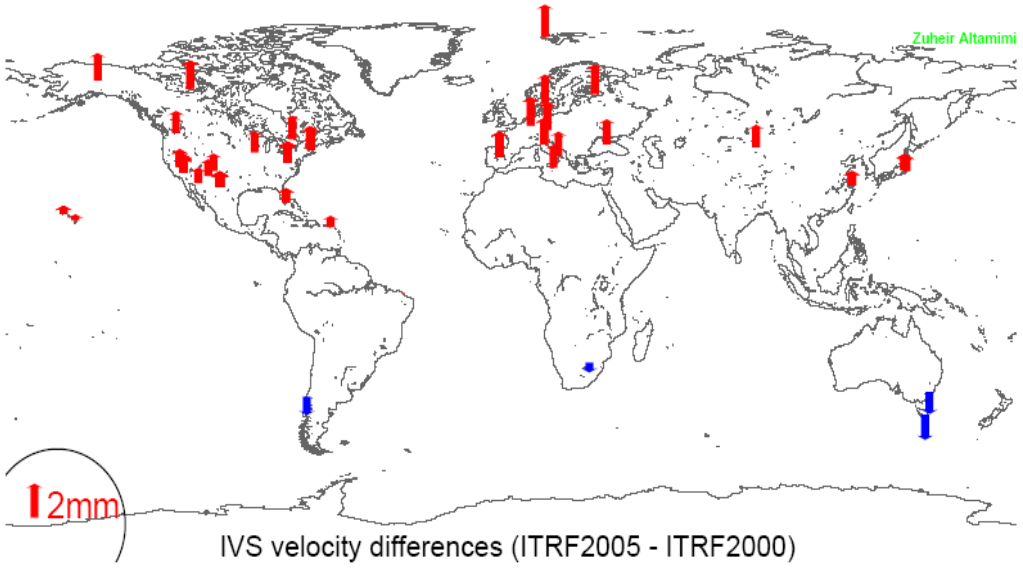


Origin, Scale & Vertical Velocities

- **Vertical velocities depend on**
  - **Z-Translation rate:** $\dot{T}z.\sin(\varphi)$
  - **Scale rate :** **ratio 1 to 1**

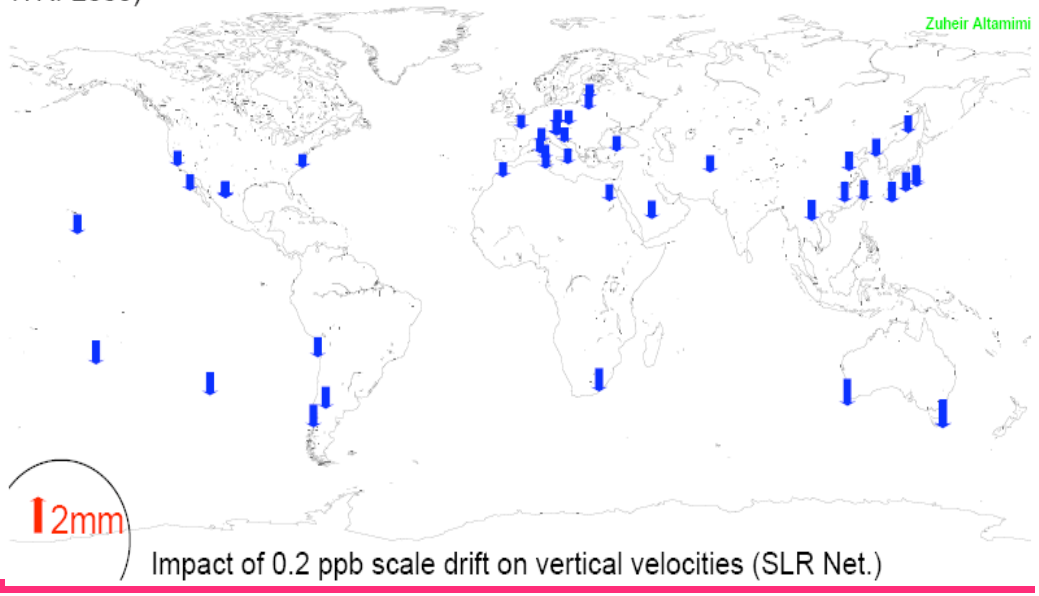
- **But Vertical velocities should reflect geophysics (GIA)**

Illustration of Origin, Scale drift on Vertical Velocities

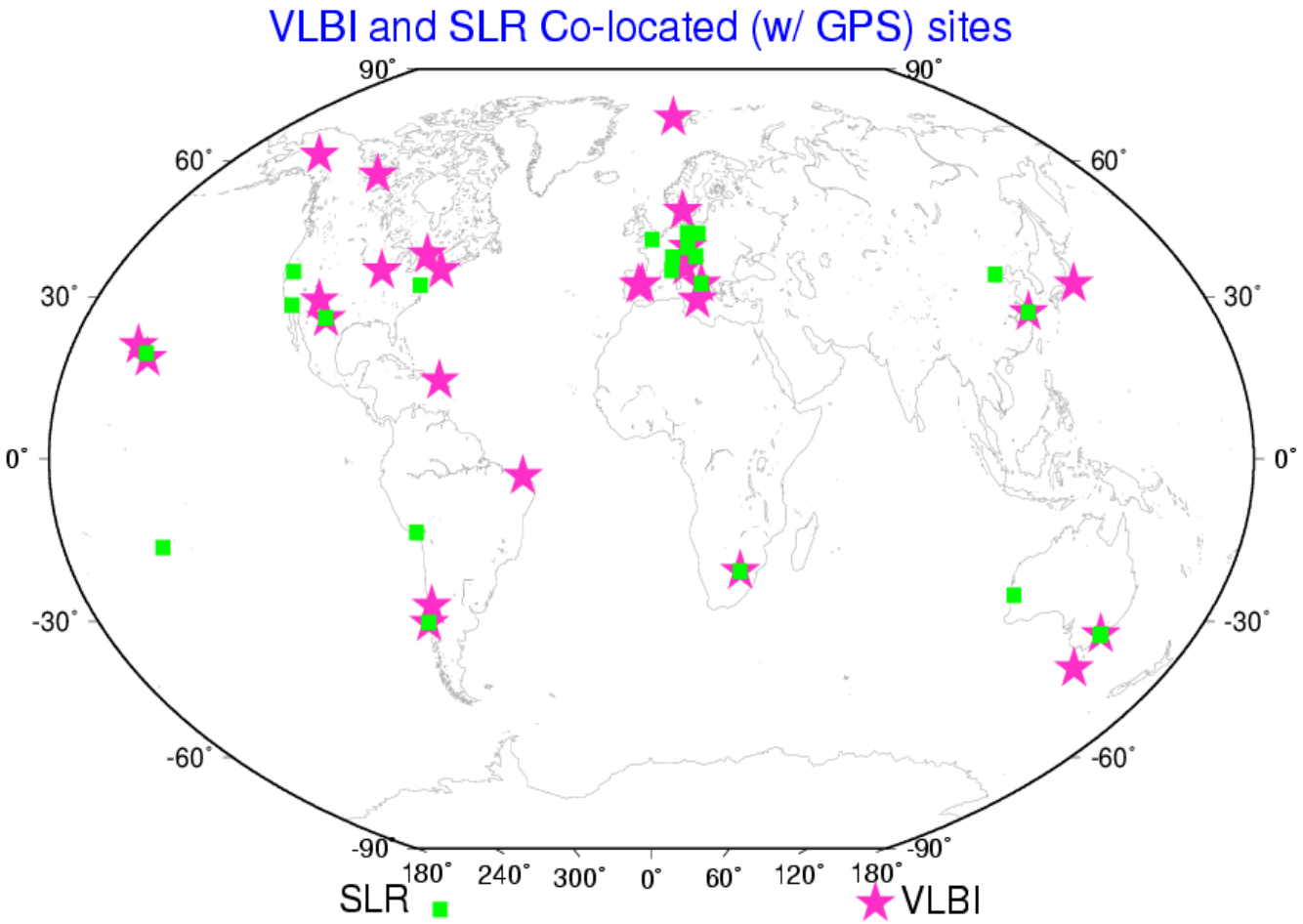


Impact of 1.8 mm/yr
Tz drift
(VLBI Network)

Impact of -0.2 ppb/yr
Scale drift
(SLR Network)

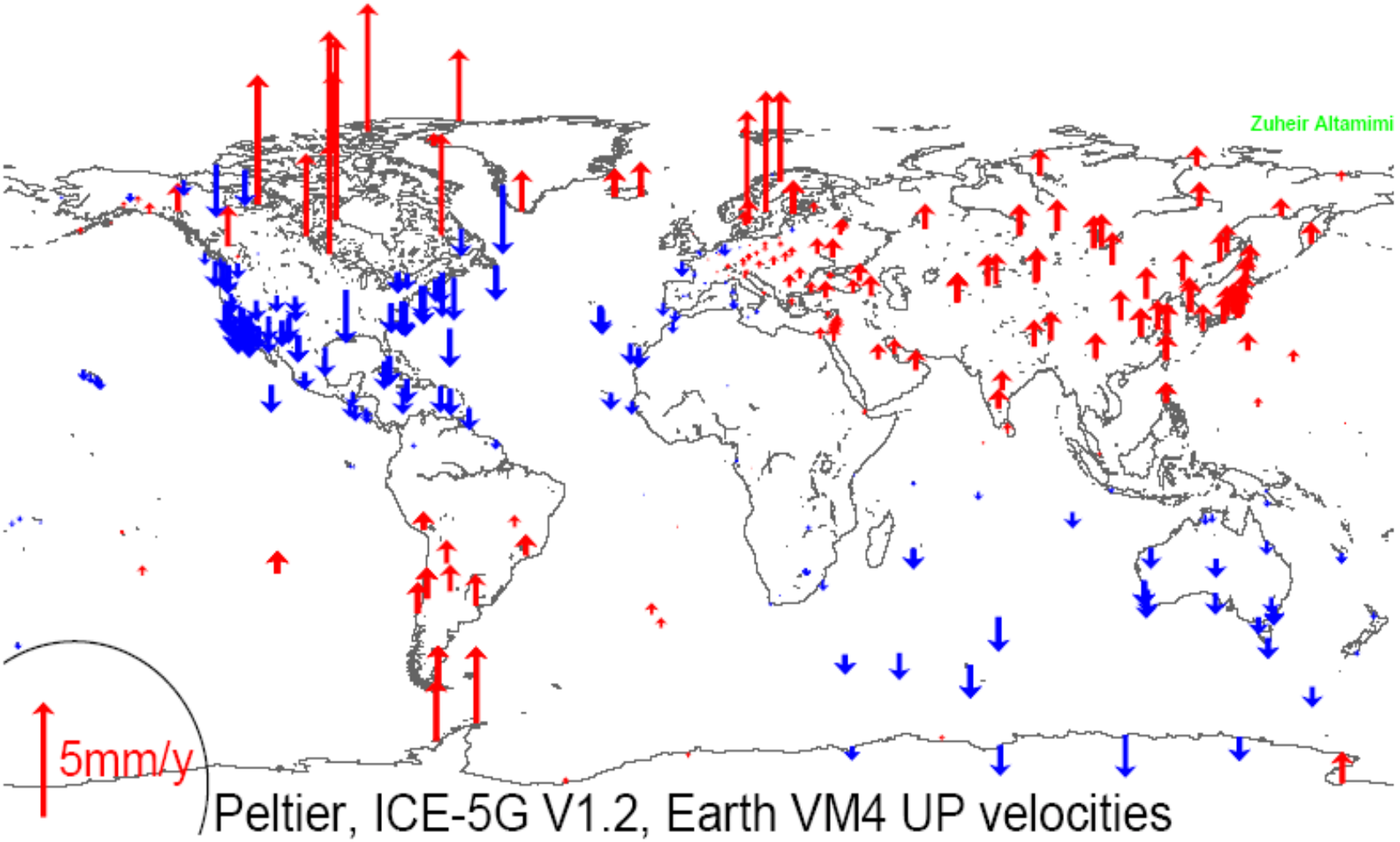


VLBI and SLR Co-located (with GPS) Sites

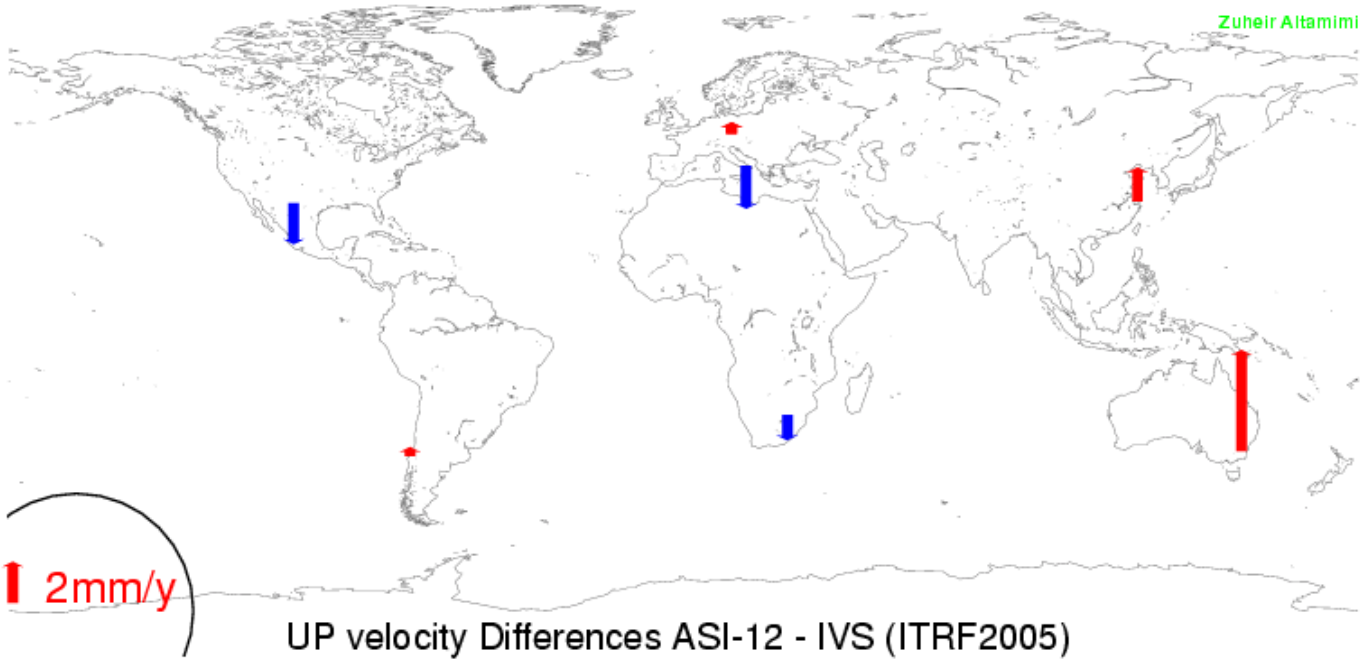


Two different network shapes

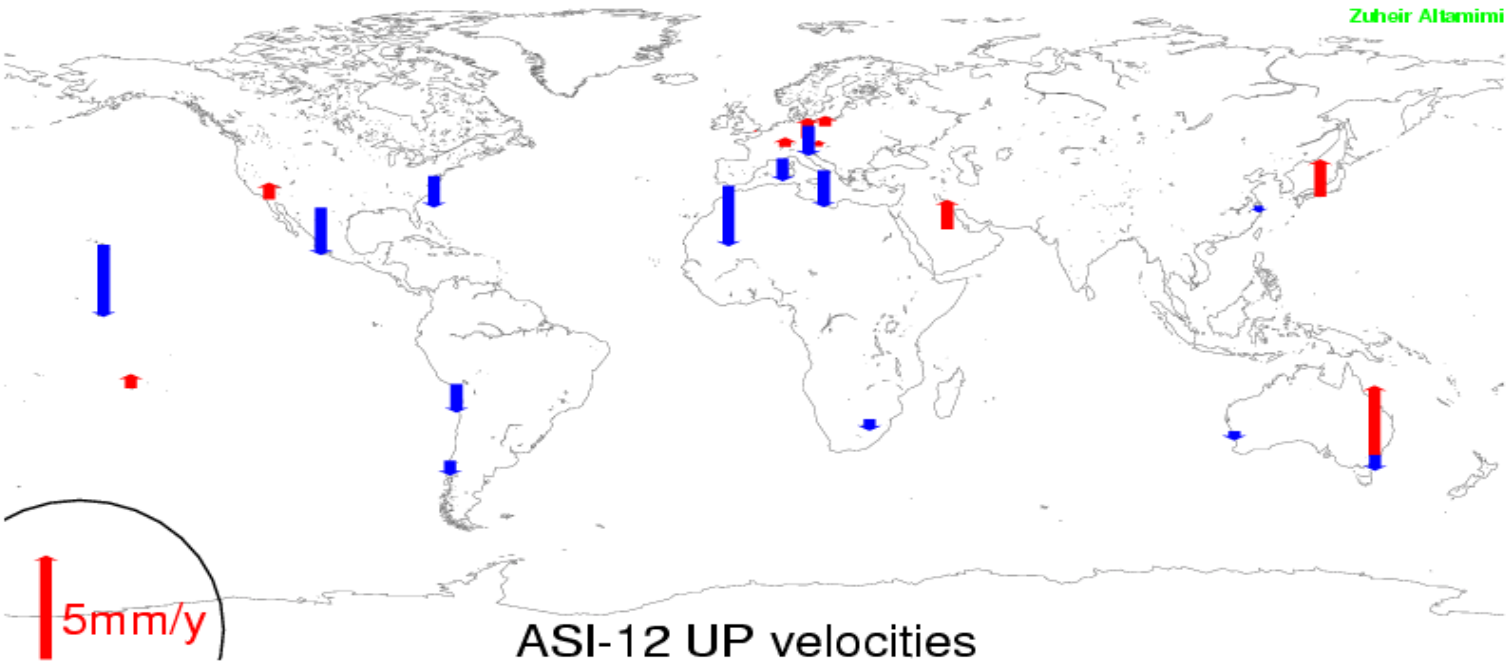
Peltier, ICE-5G V1.2, Earth VM4 UP velocities at ITRF2005 sites



UP Velocity Differences ASI-12 -IVS (ITRF2005 origin)

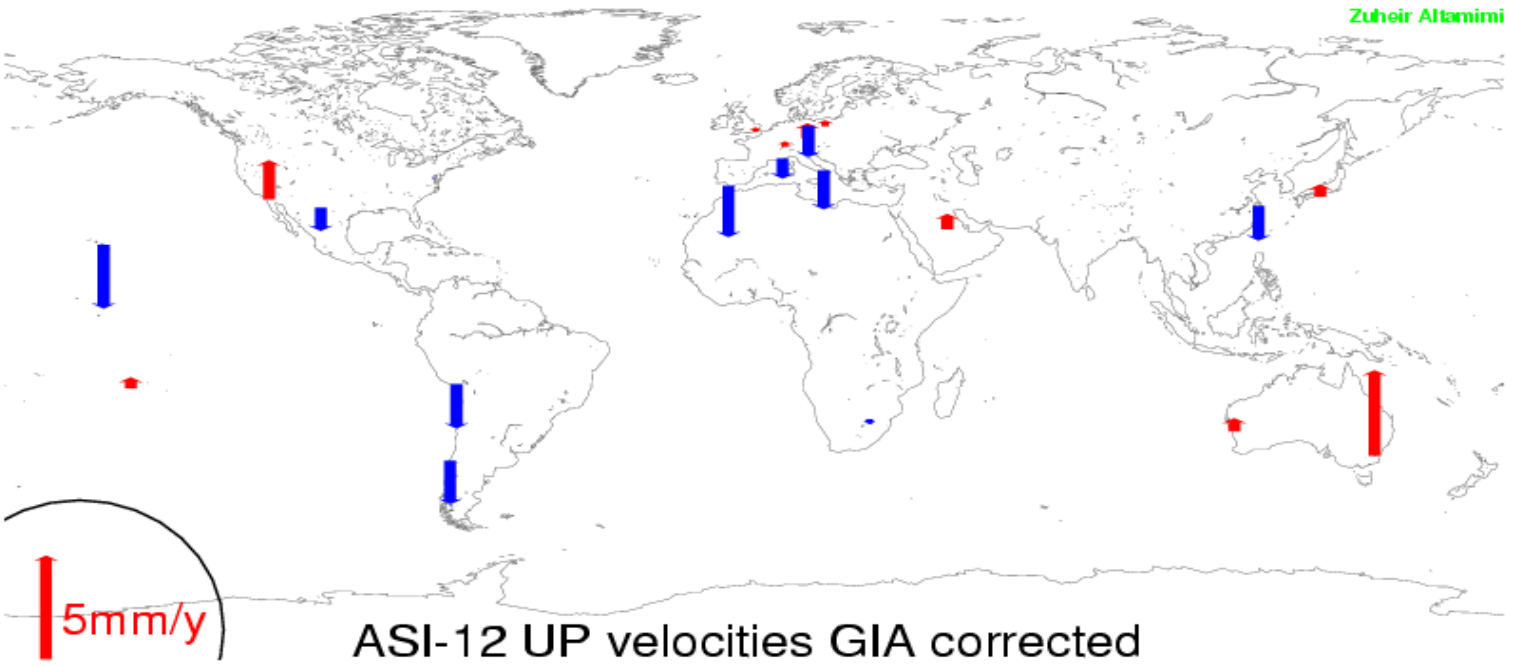


ASI-12 UP velocities at Co-location sites
Intrinsic Origin and Scale



Mean = - 0.36 mm/yr
Weighted Mean = - 0.24

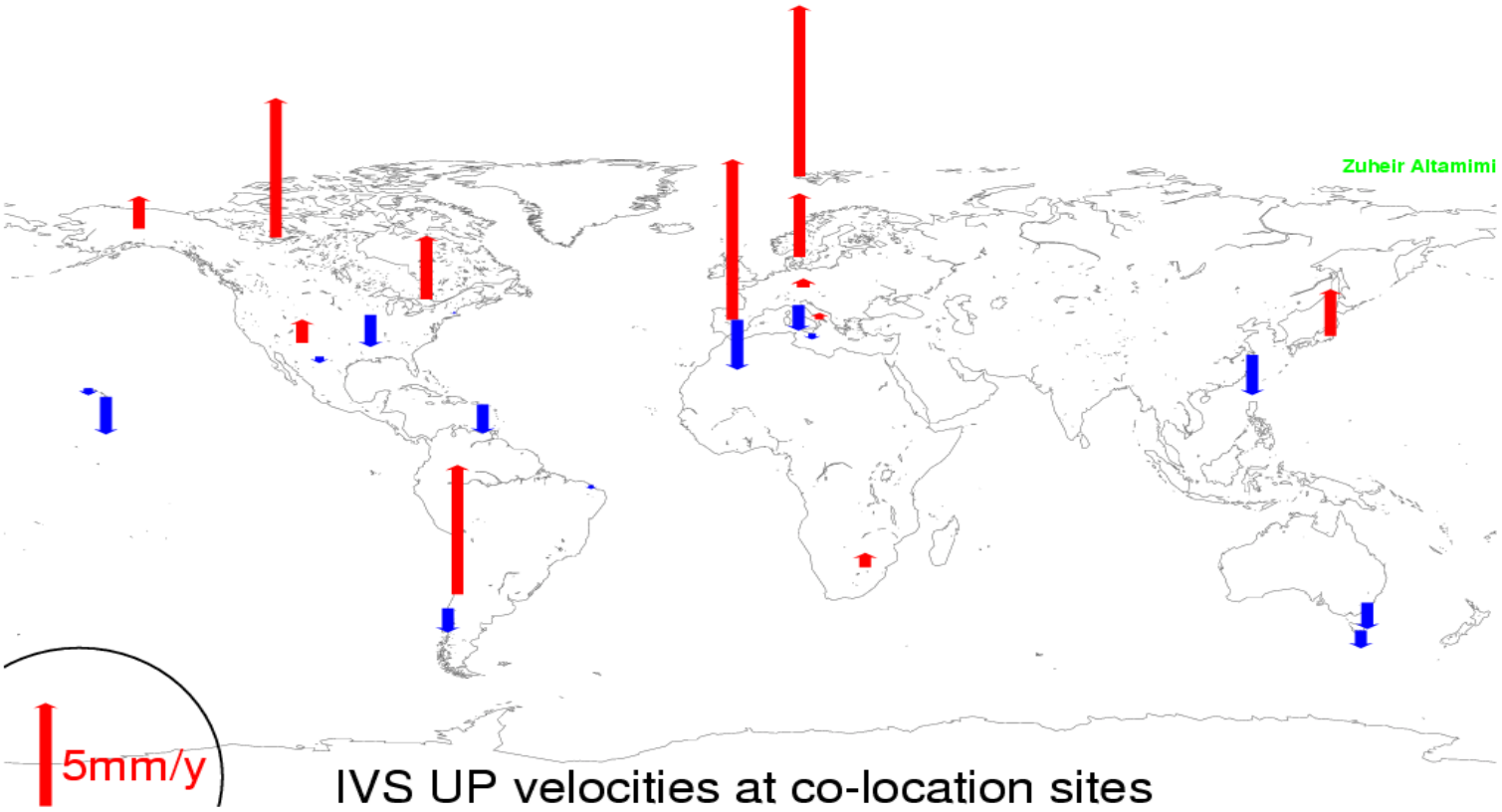
ASI-12 UP velocities & GIA corrected at Co-location Sites (Intrinsic Origin and Scale)



Mean = - 0.32 mm/yr

Weighted Mean = +0.16

IVS UP velocities at Co-location sites
Intrinsic Scale, Origin from SLR(ITRF2005)

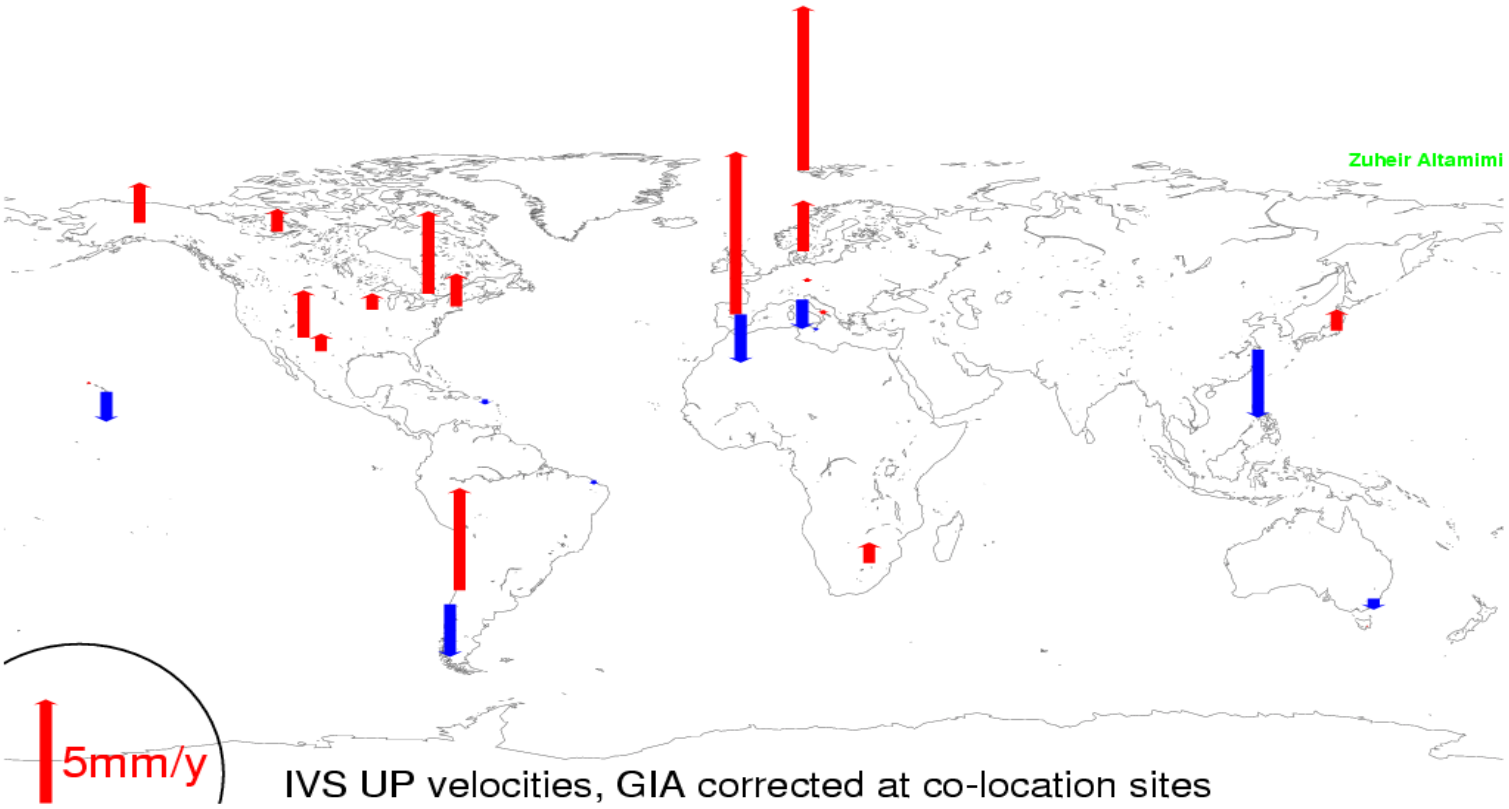


Mean = +0.96 mm/yr

Weighted Mean = +0.89

IVS UP velocities & GIA corrected at Co-location Sites

Intrinsic Scale, Origin from SLR(ITRF2005)

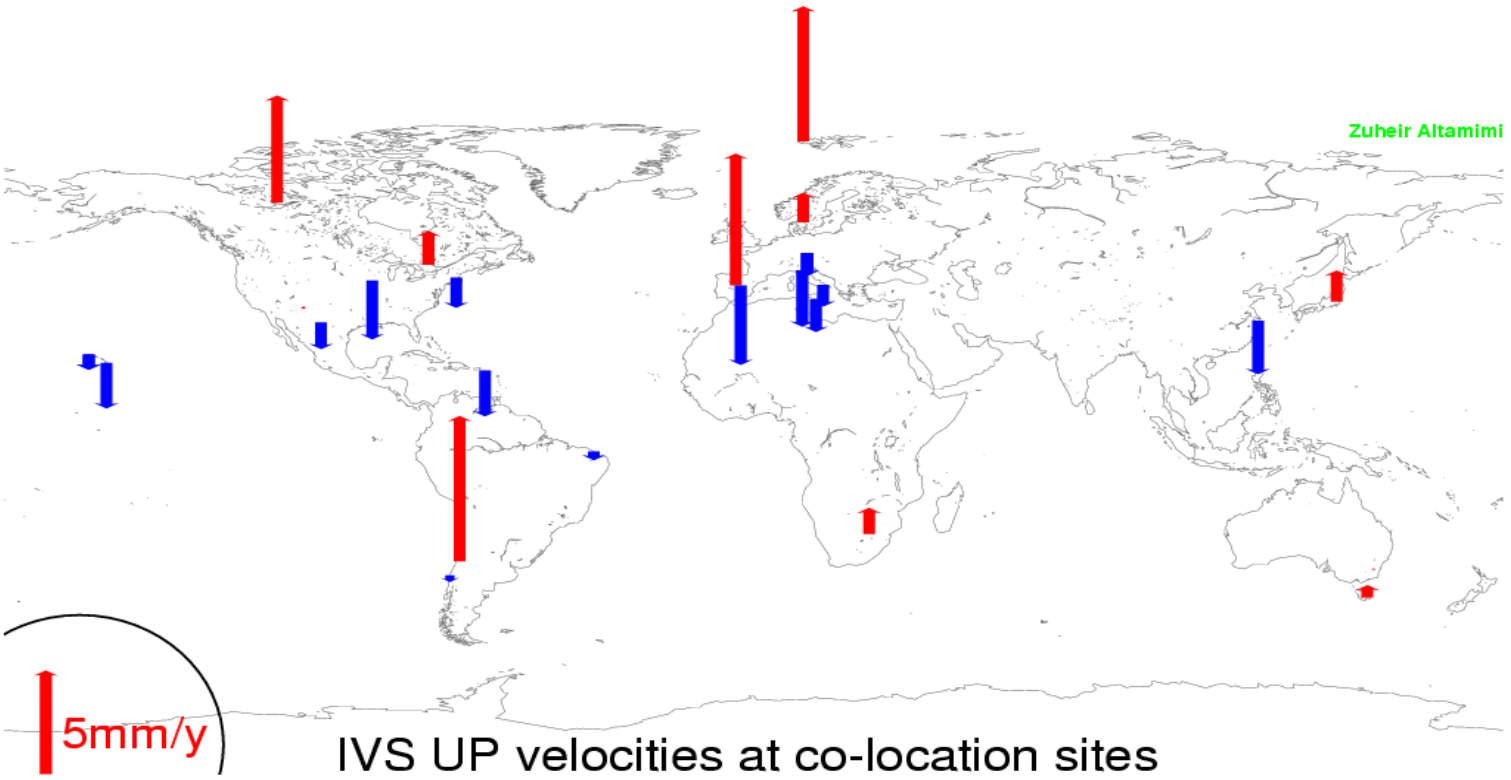


IVS UP velocities, GIA corrected at co-location sites

Mean = +0.94 mm/yr

Weighted Mean = +1.26

IVS UP velocities at Co-location sites
Intrinsic Scale, Origin from SLR(ITRF2000)

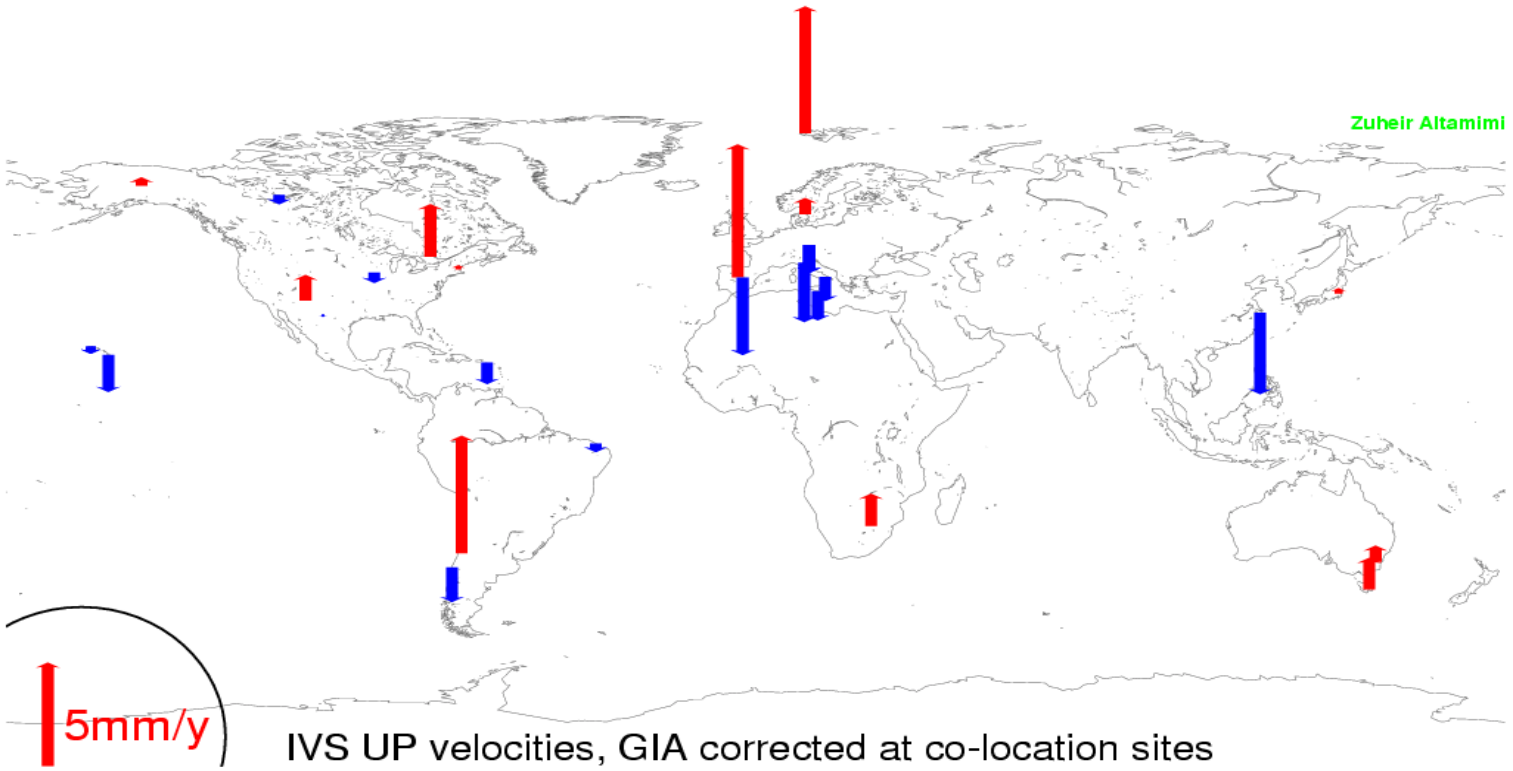


Mean = +0.19 mm/yr

Weighted Mean = -0.24

IVS UP velocities & GIA corrected at Co-location Sites

Intrinsic Scale, Origin from SLR(ITRF2000)



Mean = +0.18 mm/yr

Weighted Mean = +0.13

Concluding Remarks

- **Preliminary analysis: to be repeated with official ILRS reprocessed solution**
- **Vertical velocity differences (and hence scale rate diff.) btw IVS and ASI-12 are most likely due to:**
  - **Different network shapes to infer similar GIA effect**
  - **ITRF origin (ITRF2005 vs ITRF2000 ?)**
- **Accuracy of vertical velocities is probably not better than 1 mm/yr**
- **GPS/IGS dense network is useless without SLR & VLBI**

- **Continuous observations by space techniques are fundamental**
- **Equally fundamental is the improvement of the geodetic infrastructure**