SIRGAS
www.sirgas.org

IGN
Instituto Geográfico Nacional
REPÚBLICA ARGENTINA

THE OHIO STATE UNIVERSITY

Towards a Kinematic Geodetic Reference Frame: The Challenges of the Implementation of the SIRGAS Frame and ITRF in Argentina

Demián D. Gómez, Michael Bevis, Diego Piñón and Sergio Cimbaro

Presentation Outline

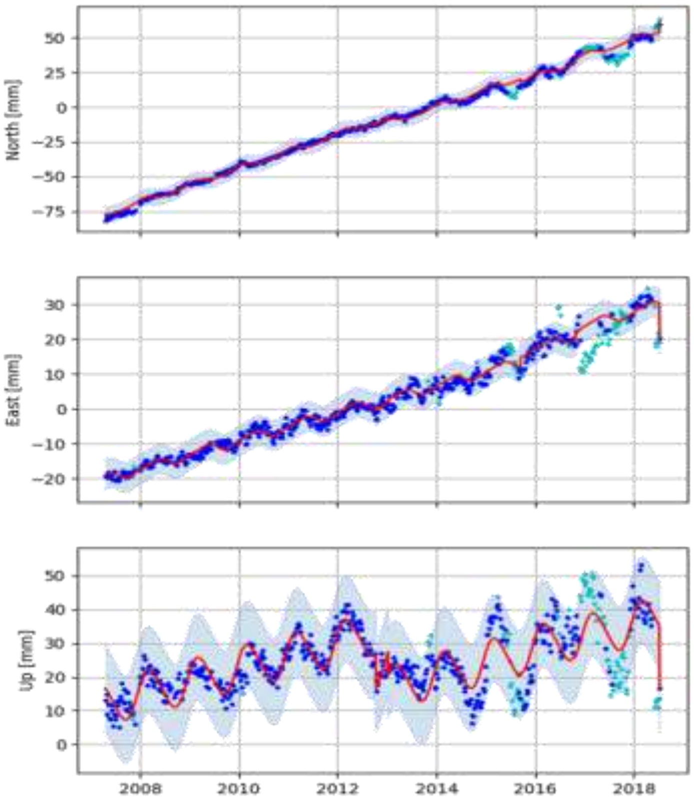
- Geodetic RFs at mapping agencies
- What is a jitter?
- Keeping conventional epoch coordinates
- ISO geodetic standards
- Kinematic Reference Frames
- Reprocessing strategy

Geodetic RFs at national mapping agencies: what do we need?

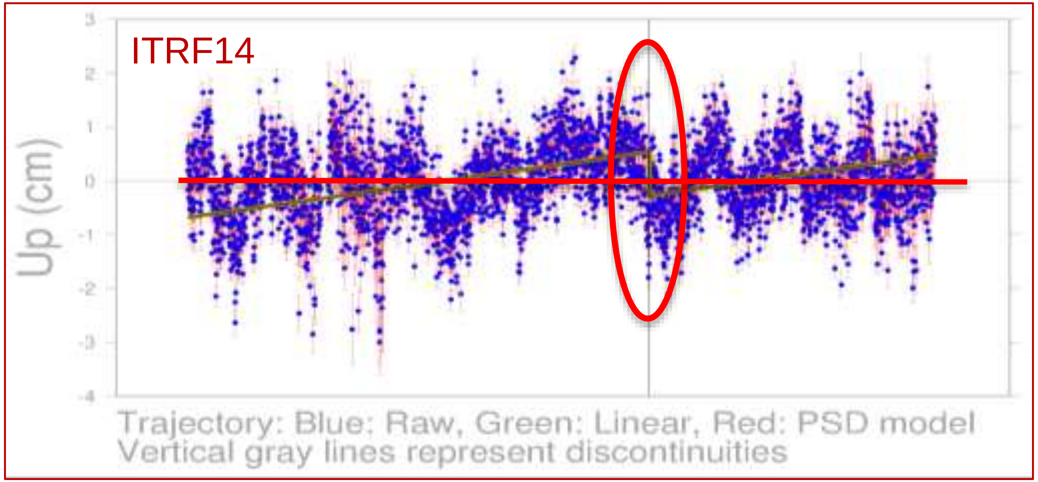
- **Single conventional epoch**, accessible to all users at any point in time, to promote homogeneity within the nation
- **Adequate models** to access the **conventional epoch**, even after earthquakes (whenever possible)
- Due to current lack of capacity, **changes in conventional epoch or RF realization** can generate discontinuities across boundaries (provincial, municipal, etc) → we try to avoid changes

    In Argentina, 10 years after the publication of POSGAR07 (current official frame), there are still provinces using POSGAR94!

PROBLEM: trying to keep POSGAR07 for too long



- **BUT WHY?** → mostly jitters
- With time, the station velocities of a specific ITRF realization start decaying
- Variations in station velocities generate biases in coordinates

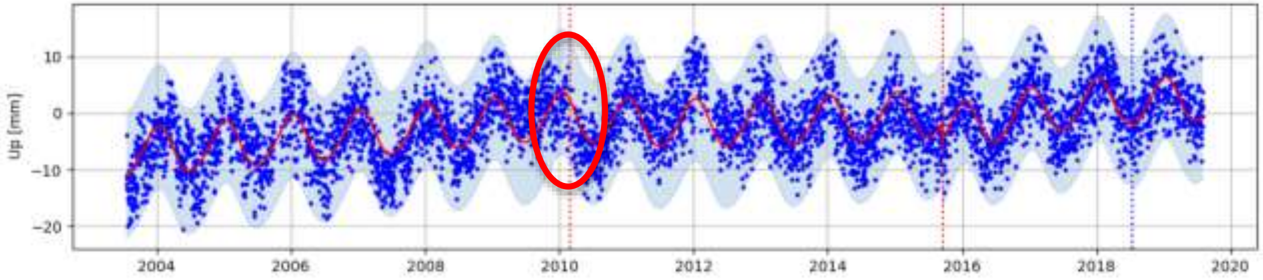


Example: IGM1

ITRF jump of the Maule earthquake in the vertical component is over-estimated

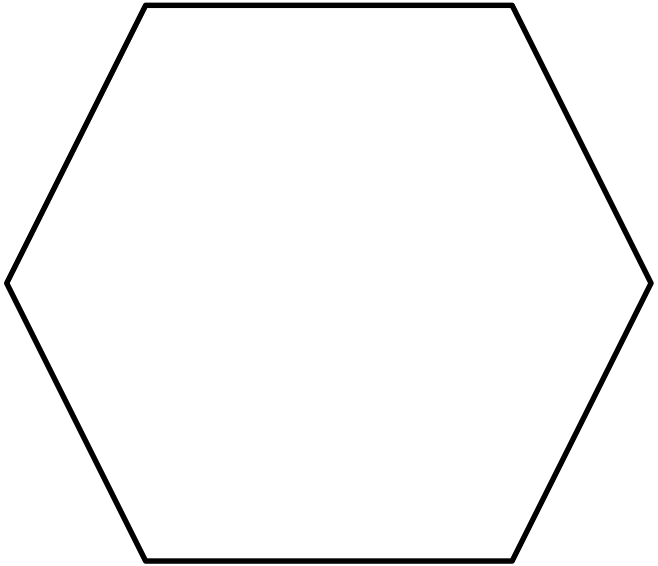
Bias in the vertical velocity of the station of ~0.9 mm/yr

In 5 years, this is equal to a position bias of 5 mm.

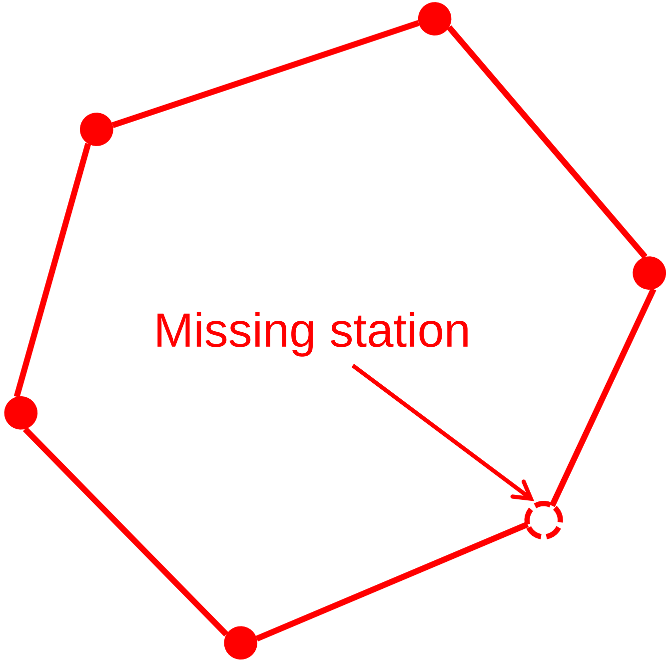


JITTER!

What is a jitter?

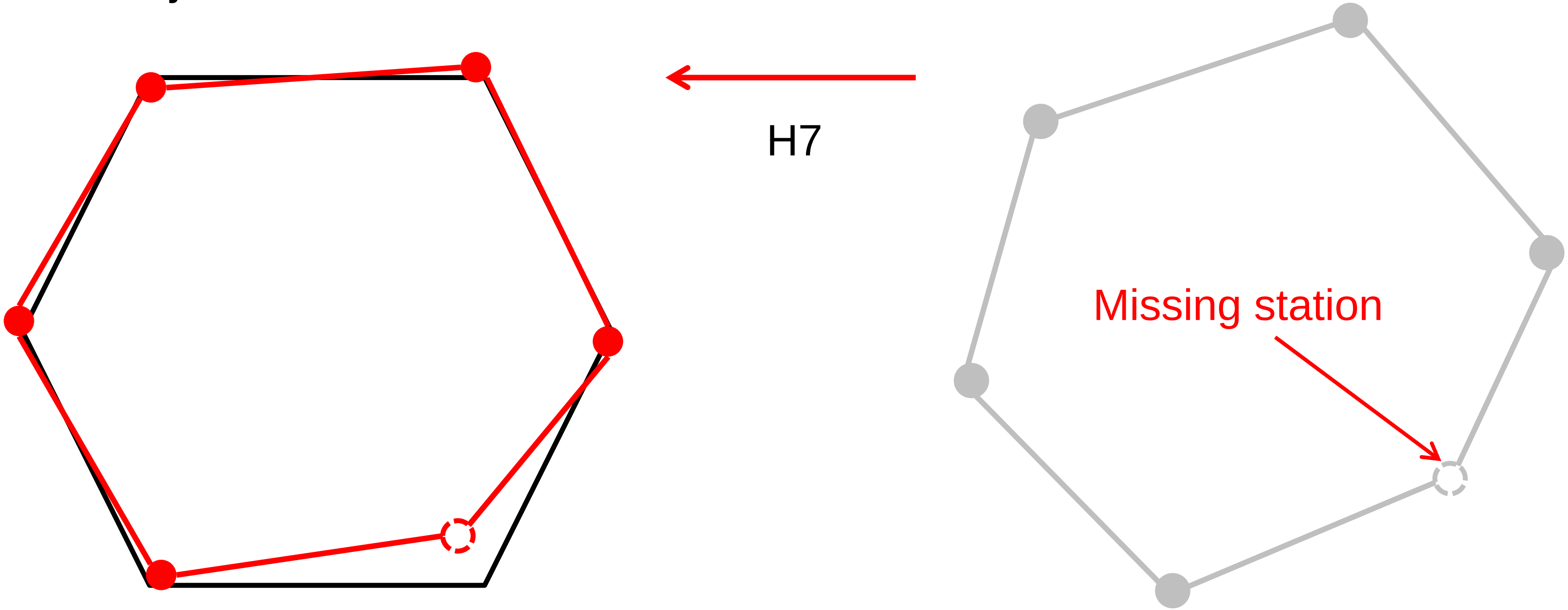


Fixed trajectory models



Solution Polyhedron

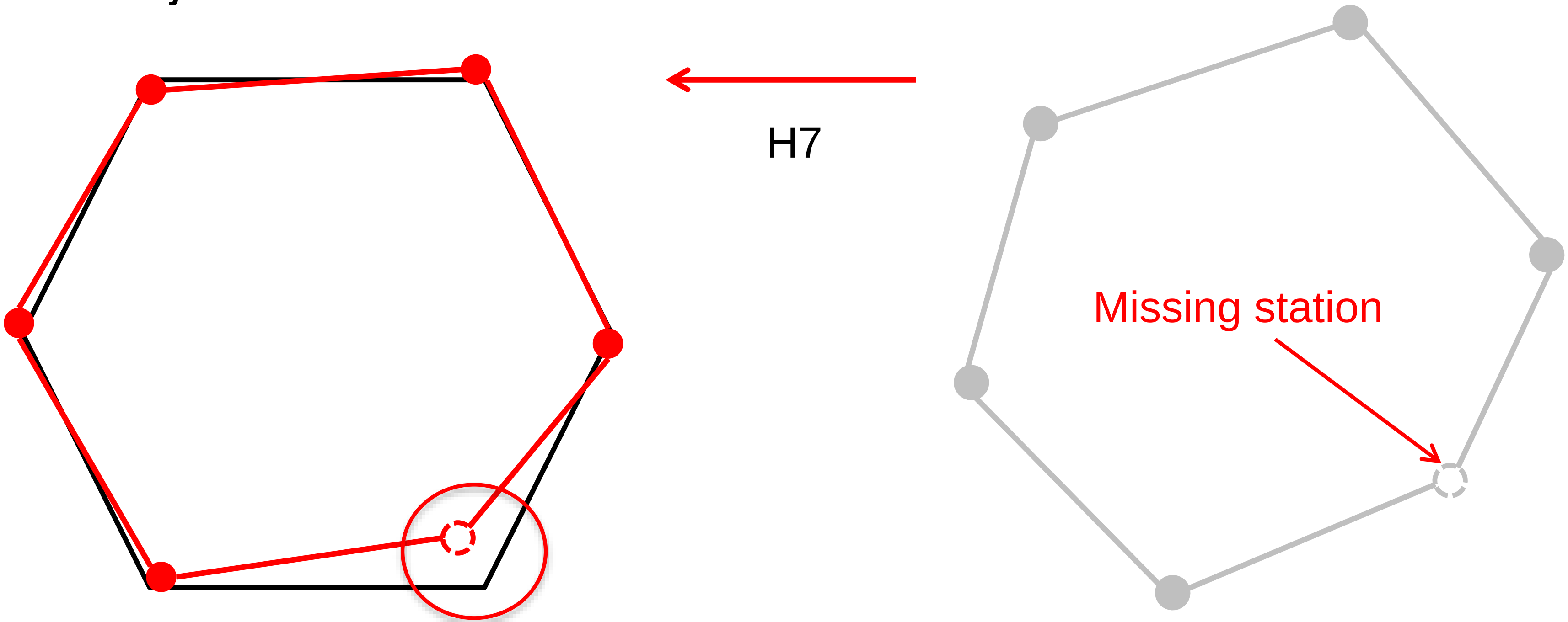
What is a jitter?



Fixed trajectory models

Solution Polyhedron

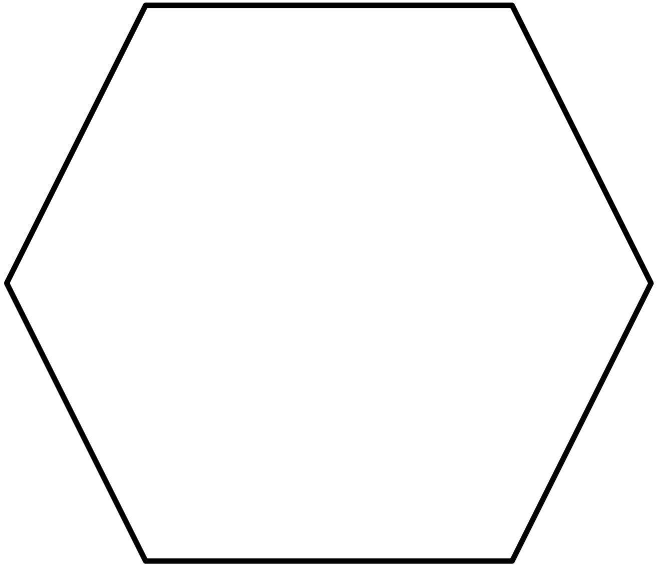
What is a jitter?



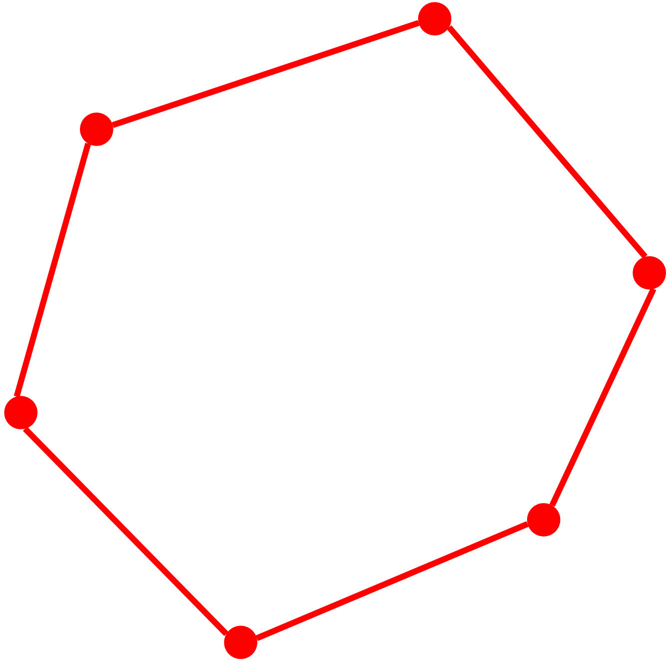
Fixed trajectory models

Solution Polyhedron

What is a jitter?

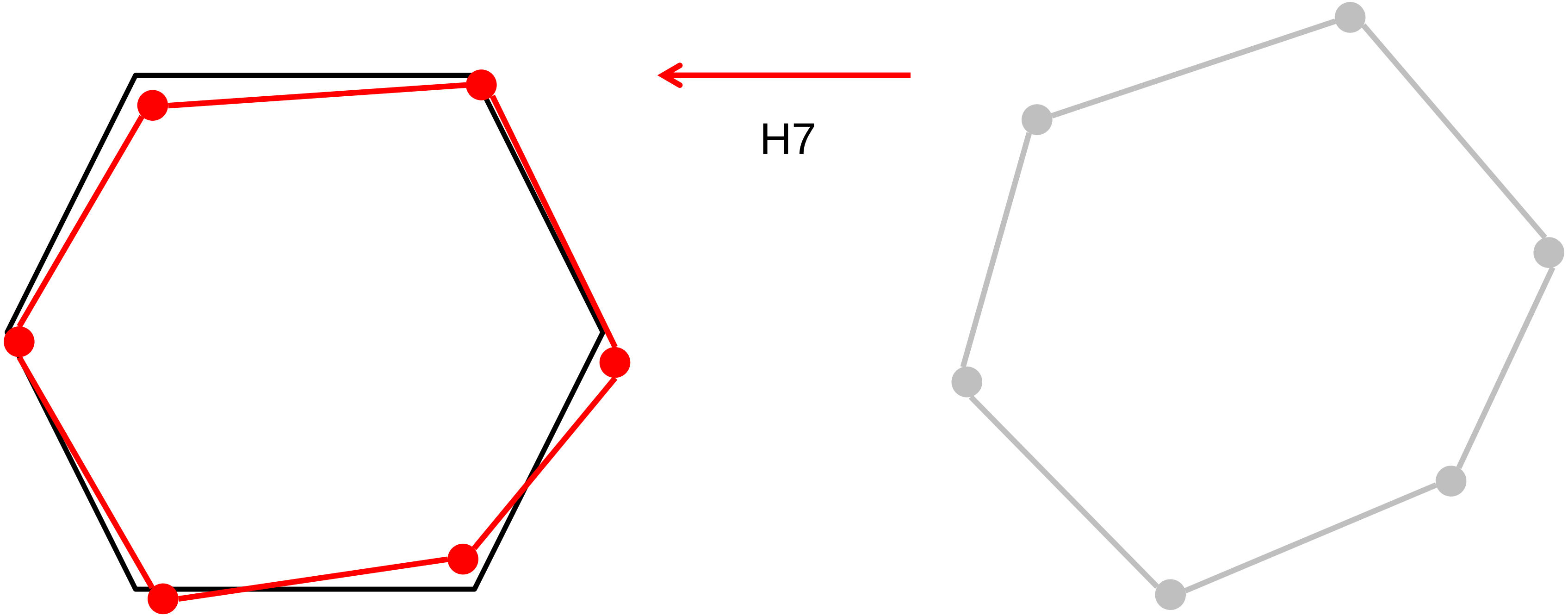


Fixed trajectory models



Solution Polyhedron

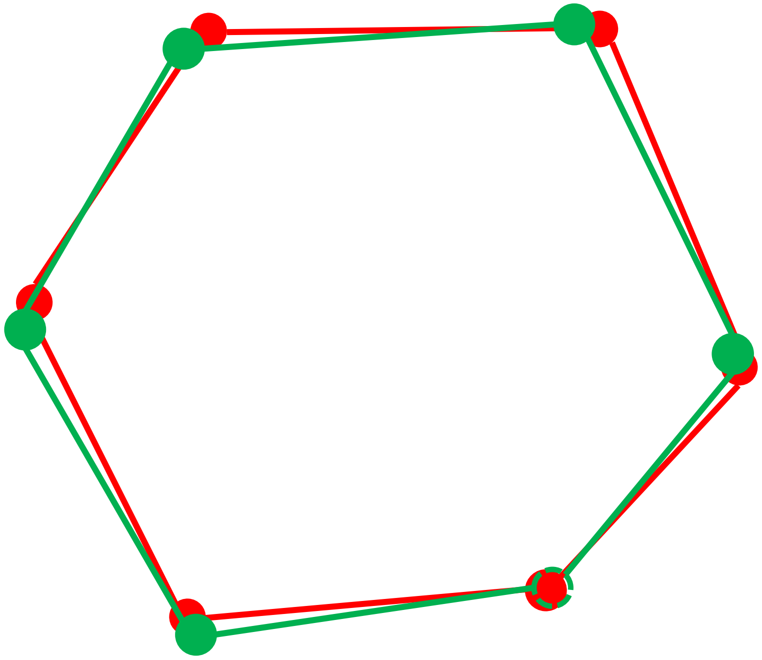
What is a jitter?



Fixed trajectory models

Solution Polyhedron

Solution Polyhedron



Et voilà!
A jitter!

No missing station
With missing station

Back to keeping conventional epoch coordinates: POSGAR07

1998.0 2006.632 POSGAR07c (IGS20) 2022.0

1998.0 2006.632 POSGAR07b (IGS14) 2019.5

2006.632 POSGAR07 (IGS05)

- At some point, a frame change is inevitable!
- But we have time to prepare people and institutions

Towards an ISO standard for geodetic reference frames

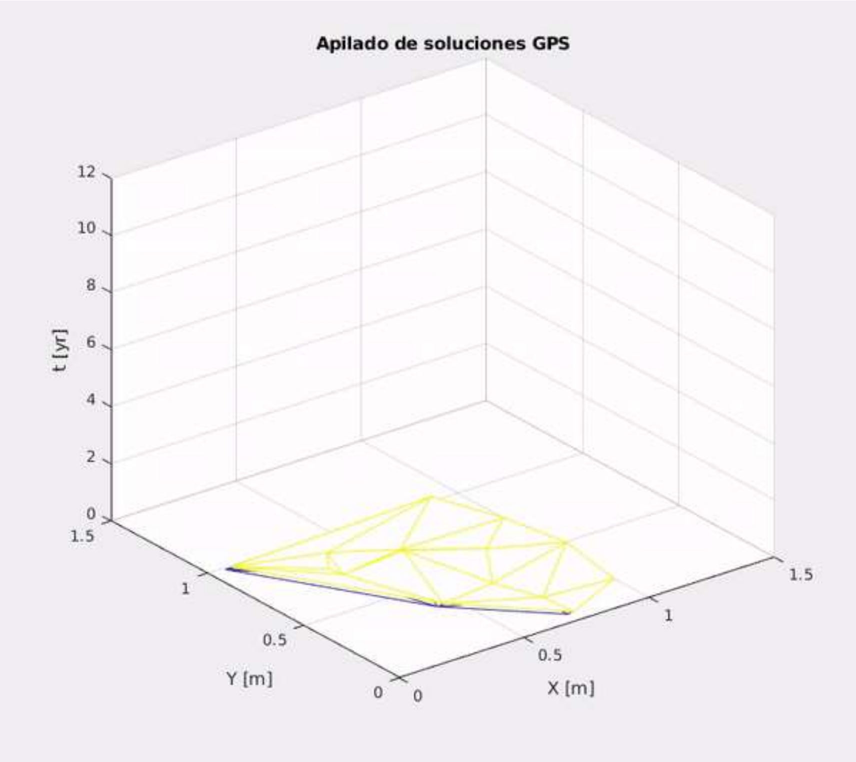
- ITRS is the **adopted standard for geospatial and scientific positioning** (ITRF is the numerical realization of the ITRS)
- This standard can be achieved by **closely aligning to ITRF**, as defined by ISO 19161-1 (under development and in approval stage)
- Dynamic (or kinematic) realizations are also being included in this standard (temporal variations of the parameters)

Subcommittee on Geodesy Report at the UN-GGIM 9th session (New York Aug 2019)

POSGAR07b: the first operative **Kinematic Reference Frame (KRF)** in the Americas

- In traditional RFs, trajectory parameters for the stations are kept constant
- In a KRF, trajectory parameters change every time new solutions are added
- A KRF is defined using kinematic trajectory models, using all the available components (Extended Trajectory Model, ETM)
- We prefer the term “kinematic” because these RFs do not include any physics or causal models to define them (although this would be possible)

Kinematic Reference Frame Stacking

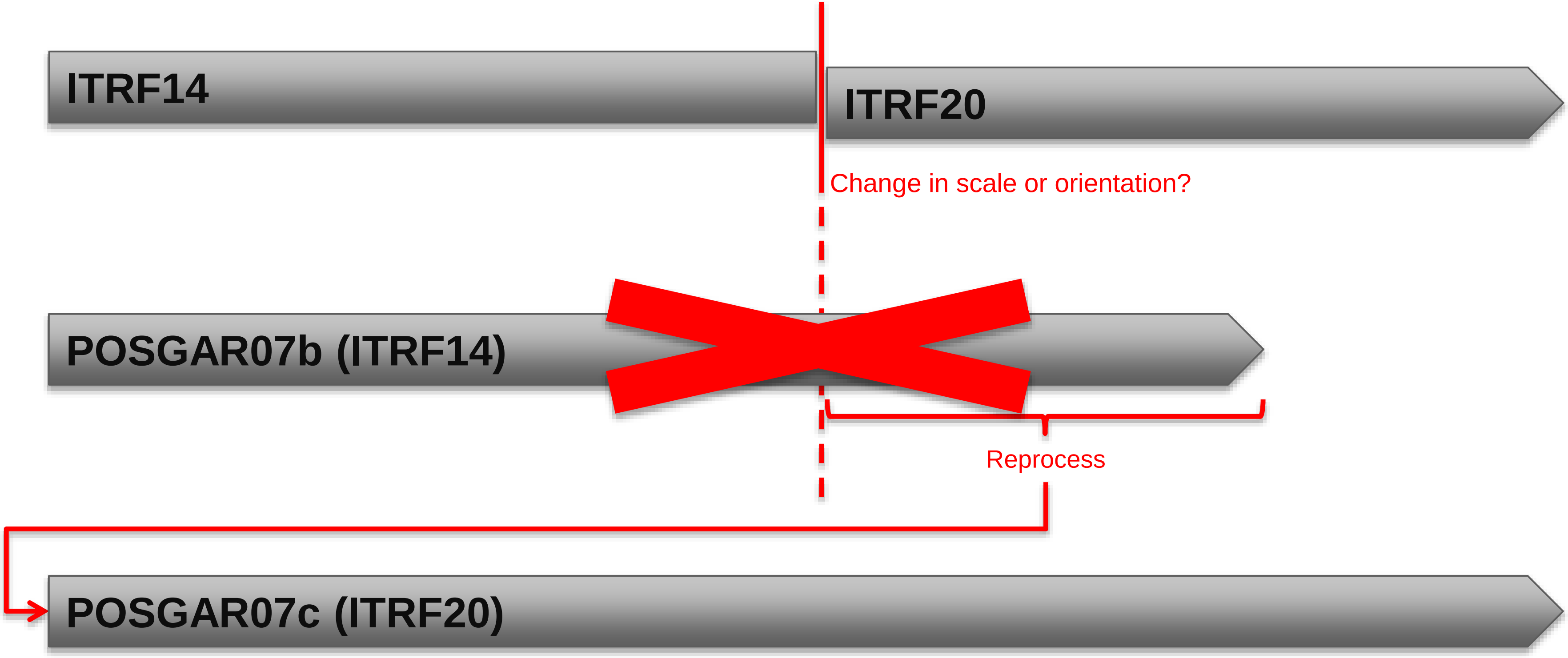


- Very fast realization using iterative technique
- Past solutions don't change, they stay static (unless there's a new ITRF / IGS frame)
- Parameters change as solutions are added to the stack
- Can be done both for global or regional stacks, as we have shown

What is the advantage of KRF stacking?

- **The stack can last longer** because trajectories are recomputed every time new solutions are added
- The **temporal change in trajectory parameters** could be modeled (?)
- **No more jitters** due to incorrect models
- **Stations are not “lost”** after large trajectory changes (e.g. earthquakes)
- New stations can be incorporated into the stack at any time

The ITRF / POSGAR lifecyle



Conclusions

- We have shown how **constant trajectory parameters** can introduce **jitters** and other **biases** in station coordinates
- We presented the notion of **kinematic reference frames**
- **POSGAR** has embraced the **temporal change of parameters**, leading the next generation of geodetic (geometric) reference frames
- We have presented a suggested **workflow** that accounts for ITRF changes without perturbing the RF users
- All the code to do this is available through GitHub (Parallel.GAMIT)

The Ohio State University

Muito obrigado!

Muchas gracias!

Thank you!