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

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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.
What is a jitter?

Fixed trajectory models

Solution Polyhedron

Missing station
What is a jitter?

Fixed trajectory models
Solution Polyhedron

H7

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Fixed trajectory models
Solution Polyhedron

H7

Solution Polyhedron
Et voilà!
A jitter!

No missing station
With missing station
Back to keeping conventional epoch coordinates: POSGAR07

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Frame Change</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998.0</td>
<td>2006.632</td>
<td>POSGAR07c (IGS20)</td>
<td>2022.0</td>
</tr>
<tr>
<td>1998.0</td>
<td>2006.632</td>
<td>POSGAR07b (IGS14)</td>
<td>2019.5</td>
</tr>
</tbody>
</table>

- 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 lifecycle

ITRF14

Reprocess

POSGAR07b (ITRF14)

Change in scale or orientation?

ITRF20

POSGAR07c (ITRF20)
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)
Muito obrigado!
Muchas gracias!
Thank you!