Research activities at the IDS Combination Center

G. Moreaux, F. Lemoine, L. Soudarin, and all ACs
• What’s new?

• Impact of Jason-2, Cryosat-2, HY2-A and Envisat in terms of Helmert parameters and EOPs

• EOPs evaluation of the single satellite campaign

• What’s next?
What’s new ?

• Introduction of EOPs evaluation (differences wrt IERS C04 series in ITRF2008 ; formal errors) and combination.

• Processing of SINEX weekly solutions:
  1. Inversion of free singular normal equations for ESA and GSC  
     *(new: introduction of inversion error messages in the evaluation report)*
  2. Verification of DORIS station identification (domes # vs acronym, update of acronyms – ex: PATB by PAUB, observation periods)
  3. Rejection of selected stations over the whole time period (never used)
  4. Rejection of selected stations over specific periods (partially used)
  5. Verification/update of position discontinuities
  6. Projection using minimal constraints and rejection of perturbating stations  
     ➔ Combination
     ➔ Evaluation : Helmert parameters and EOPs analysis
What’s new?

Weekly combination process main rules:
1. Rejection of weeks with less than 3 ACs solutions
2. For each week, reject stations observed by less than 3 ACs
3. Reject stations which perturb the combination
4. Internal constraints are applied on origin and scale and minimal constraints are applied on rotations
5. EOPs: Computes only XPO and YPO from all the ACs solutions
## EOPs products per AC (from 2012-001)

<table>
<thead>
<tr>
<th></th>
<th>Pole</th>
<th>Pole rates</th>
<th>UT</th>
<th>LOD</th>
<th>LODR</th>
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</thead>
<tbody>
<tr>
<td>ESA</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>GAU</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<tr>
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<td>No</td>
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<tr>
<td>IGN</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>INA</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>LCA</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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</table>
Example of EOPs evaluation & combination (differences wrt C04)

- Time period = 2009-001 to 2012-085
- Differences wrt CO4 series:
  - std of both XPO and YPO from the multi-ACs combined solution are less than 0.5mas
Example of EOPs evaluation & combination (formal errors)

• Differences wrt CO4 series:
  • std of both XPO and YPO from the multi-ACs combined solution are less than 0.5mas

• Formal errors:
  • Ranges and signals differ from one AC to another – may reflect some internal constraints
  • Range of combined IDS solution is less than 100 micro arcseconds

Time period = 2009-001 to 2012-085

Time period = 2011-001 to 2011-365
Example of EOPs evaluation & combination

Time period = 2008-001 to 2012-085
Red = IDS contribution to ITRF2008
Black = New combined solution

<table>
<thead>
<tr>
<th>AC</th>
<th>serie</th>
<th># days</th>
<th>X pole (um)</th>
<th>Y pole (um)</th>
<th>LDO (um)</th>
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<td>157.509</td>
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<td>02</td>
<td>1183</td>
<td>92.069</td>
<td>285.903</td>
<td>86.517</td>
</tr>
</tbody>
</table>

Time period = 1993-001 to 2011-365
Black = IDS contribution to ITRF2008
Red = New combined solution

<table>
<thead>
<tr>
<th>AC</th>
<th>serie</th>
<th># days</th>
<th>X pole (um)</th>
<th>Y pole (um)</th>
<th>LDO (um)</th>
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<td>1183</td>
<td>92.069</td>
<td>285.903</td>
<td>86.517</td>
</tr>
</tbody>
</table>
Impact of missions in terms of Helmert parameters wrt ITRF2008

- Jason-2 Impact:
  - Tz centered (already known)

- Cryosat-2, HY-2A, Envisat Impact:
  - none

Graph from ESA 06 – Similar results for all the Acs

Time period = 2009-001 to 2012-085/176
Impact of missions in terms of EOPs formal errors (ESA)

- Jason-2 Impact:
  - Reduces formal errors means by nearly 50%
  - Introduces signal of period of 60 days on X and Y pole

- Cryosat-2 Impact:
  - Slightly reduces formal errors means

- HY-2A impact:
  - Slightly reduces formal errors means

- Envisat Impact: none
Impact of missions in terms of EOPs formal errors (GAU)

- Jason-2 Impact: none
- Cryosat-2 Impact: none
- Envisat Impact: none
- Overall: signals of period 173 days
Impact of missions in terms of EOPs formal errors (GOP)

- **Jason-2 Impact:**
  - Reduces formal errors means by 20%
  - Introduces signal of period 60 days

- **Cryosat-2 Impact:**
  - Reduces formal errors means by 20%

- **HY-2A Impact:**
  - Reduces formal errors means by 10%
Impact of missions in terms of EOPs formal errors (GSC)

- Jason-2 Impact:
  - Reduces formal errors means by 20%

- Cryosat-2 Impact:
  - Slightly reduces formal errors means

- Overall: signals of period 173 and 166 days on series 11 and 12 respectively
Impact of missions in terms of EOPs formal errors (IGN)

- Jason-2 Impact:
  - Reduces formal errors means by 25%
  - Introduces signal of period of 60 days

- Cryosat-2 Impact:
  - Slightly reduces formal errors means

- Envisat Impact: none
Impact of missions in terms of EOPs formal errors (INA)

- Jason-2 & Cryosat-2 Impact:
  - Reduces formal errors means by nearly 40%
  - Introduces signal of period of 60 days

- Envisat Impact: none
Impact of missions in terms of EOPs formal errors (LCA)

- Jason-2 Impact:
  - Reduces formal errors means by 40%

- Cryosat-2 Impact:
  - Reduces formal errors means by 10%

- HY-2A impact:
  - Reduces formal errors means by 8%

- Envisat Impact: none

- Overall: no clear periodic signal
EOPs formal errors (LCA26-28 vs 30)

New Jason-2 macromodel
Jason-2 attitude model corrected

LCA 26/28: 60 days signal
LCA 30: no periodic signal
• In terms of differences wrt C04 series: no significant impact

• In terms of formal errors:
  – Positive impact of Jason-2 on the mean
  – Jason-2 induces a signal of period 60 days excepted for LCA
  – Silght impact of Cryosat-2. Less effect than Jason-2 maybe because it was launched after Jason-2
  – No real impact of including HY-2A and loosing Envisat

• No clear impact on the combined solution since mission adding dates differ from one AC to another AC
  ➨ IDS CC propose that all ACs agree for common dates for ITRF2013 reprocessing
- Envisat: no clear periodic signal
- Jason-2: 60 days on X and Y
- Spot-4: no clear periodic signal
- Spot-5: no clear periodic signal
- LOD: no significant periodic signal
IDS Campaign 2010 - EOPs formal errors (GAU 08)

- Envisat: 183 days on X and Y
- Jason-2: 183 days on X
  61 days on Y
- Spot-4: 183 days on X and Y
- Spot-5: 183 days on X and Y
- LOD: no significant periodic signal
• Envisat: no clear periodic signal Y
• Jason-2: 60 days on Y
• Spot-4: no clear periodic signal
• Spot-5: no clear periodic signal
- Envisat: 183 days on X and Y
- Jason-2: 183 days on X, 61 days on Y
- Spot-4: 183 days on X and Y
- Spot-5: 183 days on X and Y
• Envisat : no clear periodic signal
• Jason-2 : 60 days on X and Y
• Spot-4 : no clear periodic signal
• Spot-5 : no clear periodic signal
IDS Campaign 2010 - EOPs formal errors (LCA 26)

- Envisat : 120 days on X and Y
- Jason-2 : 60 days on X and Y
  No more present in the latest series 30/32
- Spot-4  : 90 days on X and Y
- Spot-5  : 90 days on X and Y
IDS campaign 2010 – EOPs - Conclusions

- Jason-2: clear 60 days signal for all the ACs
- GAU and GSC: 180 days signal on Envisat, Spot-4 and Spot-5

List of satellites by decreasing order of mean magnitude:
- Spot-4
- Spot-5 & Envisat
- Jason-2

closely related to the number of DORIS receiver channels
What’s next?

- Tests on combined pole rates and LOD
- Tests on selection criteria for ACs contribution to combined EOPs

- Computation of a new combined series (with EOPs) since 2009-001
- Online STCDs from IDS combined solution

- Computation of a positions/velocities combined solution over time period 2009-001 to 2012-176 for comparisons with IDS-3 and GPS solution at co-located sites (oral presentation at the next AGU fall meeting)

- Online access on IDS web page of a dedicated plottool version to Helmert parameters visualisation