

IAG JWG 4.3.8 “GNSS tropospheric products for Climate”:

Objectives and Future Plans

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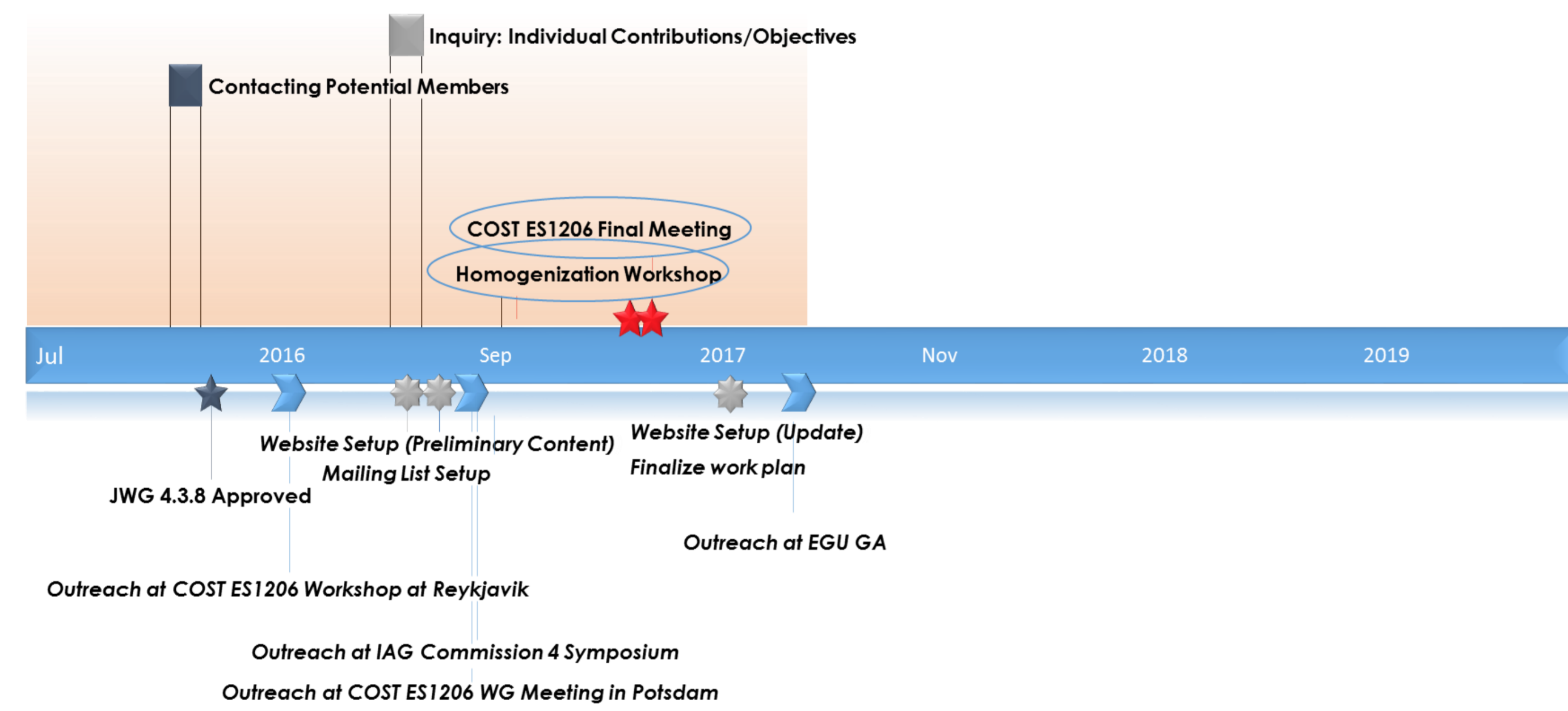
Abstract

The Joint Working Group ‘GNSS tropospheric products for Climate’ is part of the IAG Sub-Commission 4.3 ‘Atmosphere Remote Sensing’, which is embedded in the IAG Commission 4 ‘Positioning and Applications’. The main objective of the working group is to assess existing reprocessed GNSS tropospheric products, foster the development of forthcoming reprocessing activities, review and update GNSS-based product requirements and exchange format for climate and promote their use for climate research, including a possible data assimilation of GNSS troposphere products in climate models.

Introduction

In many parts of the world, huge efforts are ongoing for providing homogeneously reprocessed GNSS solutions that are the basis for deriving very precise coordinates, velocities and troposphere parameters (namely Zenith Total tropospheric Delays and Horizontal Gradients). These regional and global reprocessing campaigns are possible thanks to the availability of of nearly two decades of observations from permanently observing GNSS stations located worldwide (e.g. the IGS network), their regional densifications (e.g. the EPN network), and of reprocessed global orbit and clock products (e.g. those provided by the IGS Analysis Centers). These long-term time series of homogeneously reprocessed troposphere parameters will provide a GNSS climate data record with high potential for climate monitoring. Unfortunately, these time series still suffer from inhomogeneities (for example instrumental changes, changes in the station environment) which can affect the analysis of the long-term variabilities.

Timeline and Achievements



<http://iag-gnssclimate.oma.be/index.php>

Name	Institute	Country	Membership
R. Pacione	E-GEOS S.p.A ASI/CGS	Italy	Chair
E. Pottiaux	RDB, Royal Observatory of Belgium	Belgium	Vice-Chair
A. Araszkiewicz	Military University of Technology	Poland	Full Member
F. Alshawaf	GFZ, GeoforschungszentrumPotsdam	Germany	Full Member
F. N. Tellerie	University of Luxembourg	Luxembourg	Full Member
G. Dick	GFZ, GeoforschungszentrumPotsdam	Germany	Full Member
G. Halloran	Met Office UK	United Kingdom	Full Member
G. Liu Zhihao	Hong Kong Polytechnic University	Hong Kong	Full Member
J. Douša	GOP, Geodetic Observatory Pecny, RIGTC	Czech Republic	Full Member
J. Wang	Department of Atmospheric and Environmental Sciences, University at Albany	United States	Full Member
K. Stepiak	University of Warmia and Mazury Olsztyn	Poland	Full Member
M. Santos	UNB, University of New Brunswick	Canada	Full Member
O. Bock	IGN LAREG, Univ Paris Diderot	France	Full Member
R. Heinkelmann	GFZ, GeoforschungszentrumPotsdam	Germany	Full Member
R. Van Malderen	Royal Meteorological Institute of Belgium	Belgium	Full Member
S. Vey	GFZ, Geoforschungszentrum, Potsdam	Germany	Full Member
T. Ning	Lantmateriet, Swedish Mapping, Cadastre and Land Registration Authority	Sweden	Full Member
Y. Shoji	Meteorological Research Institute	Japan	Full Member
A. Klos	Military University of Technology	Poland	Correspondent member
S. Zengin Kazanci	Karadeniz Technical University, Trabzon	Turkey	Correspondent member

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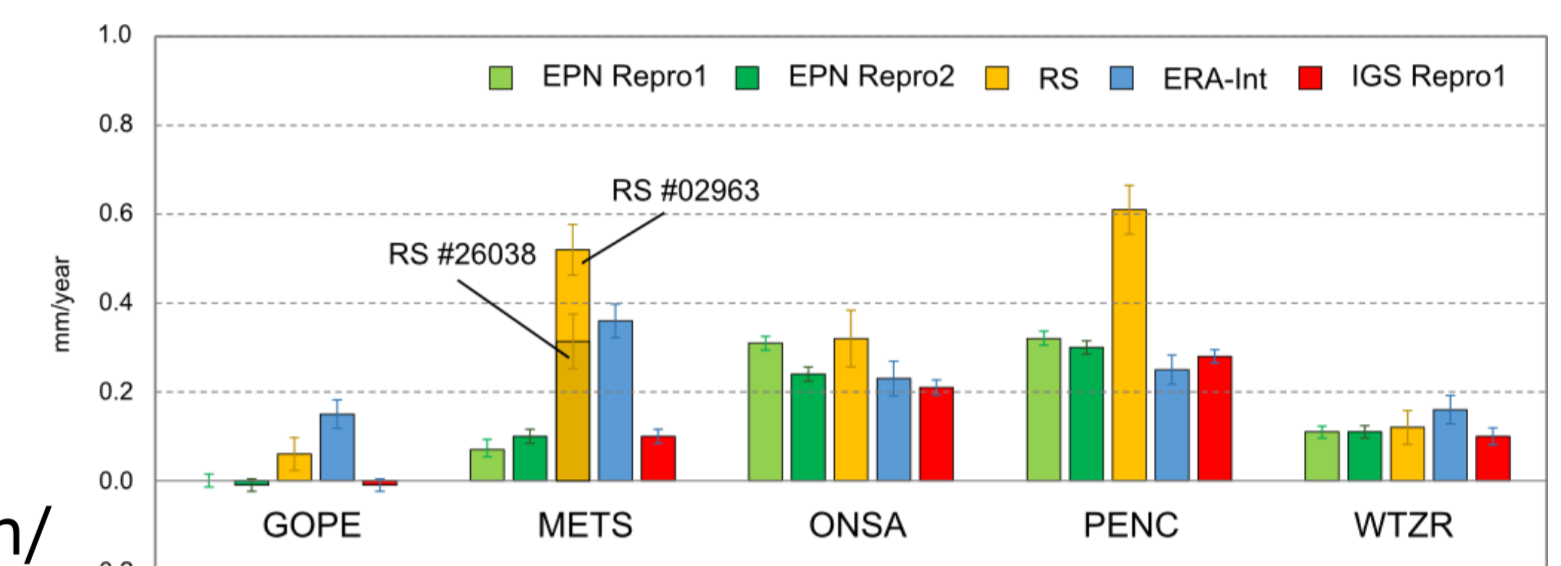
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Main Scientific Objectives

Objective 1 REPRO: Assess existing reprocessed troposphere solutions and provide recommendations for the forthcoming reprocessing activities

Major Tasks and Deliverables:

- Inventory: list major reprocessed time series and their characteristics available for climate studies along the lines of what has been done during the WG3 of the COST Action ES1206. This will serve to fill the common database mentioned in the objective 2 on homogenisation. Other datasets necessary for the evaluation/assessment framework (radiosonde, WVR, models...) should be identified as well.
- Evaluation/assessment framework: propose a complete strategy for the assessment of any reprocessed time series and apply this framework to at least one of the identified datasets.
- Recommendations: propose recommendations for further reprocessing activities and their assessments.



Courtesy of A. Araszkiewicz. ZTD trend comparisons at five EPN stations for 5 different ZTD datasets. The error bars are the formal errors of the estimated trend values.

International Reprocessing Activities

- EUREF Tropospheric 2nd Reprocessing Campaign http://www.epncb.oma.be/_productservices/troposphere/
- TIGA Reprocessing Campaign http://adsc.gfz-potsdam.de/tiga/index_TIGA.html
- GRUAN Reprocessing Campaign <http://www.gfz-potsdam.de/en/section/space-geodetic-techniques/projects/gruan/>

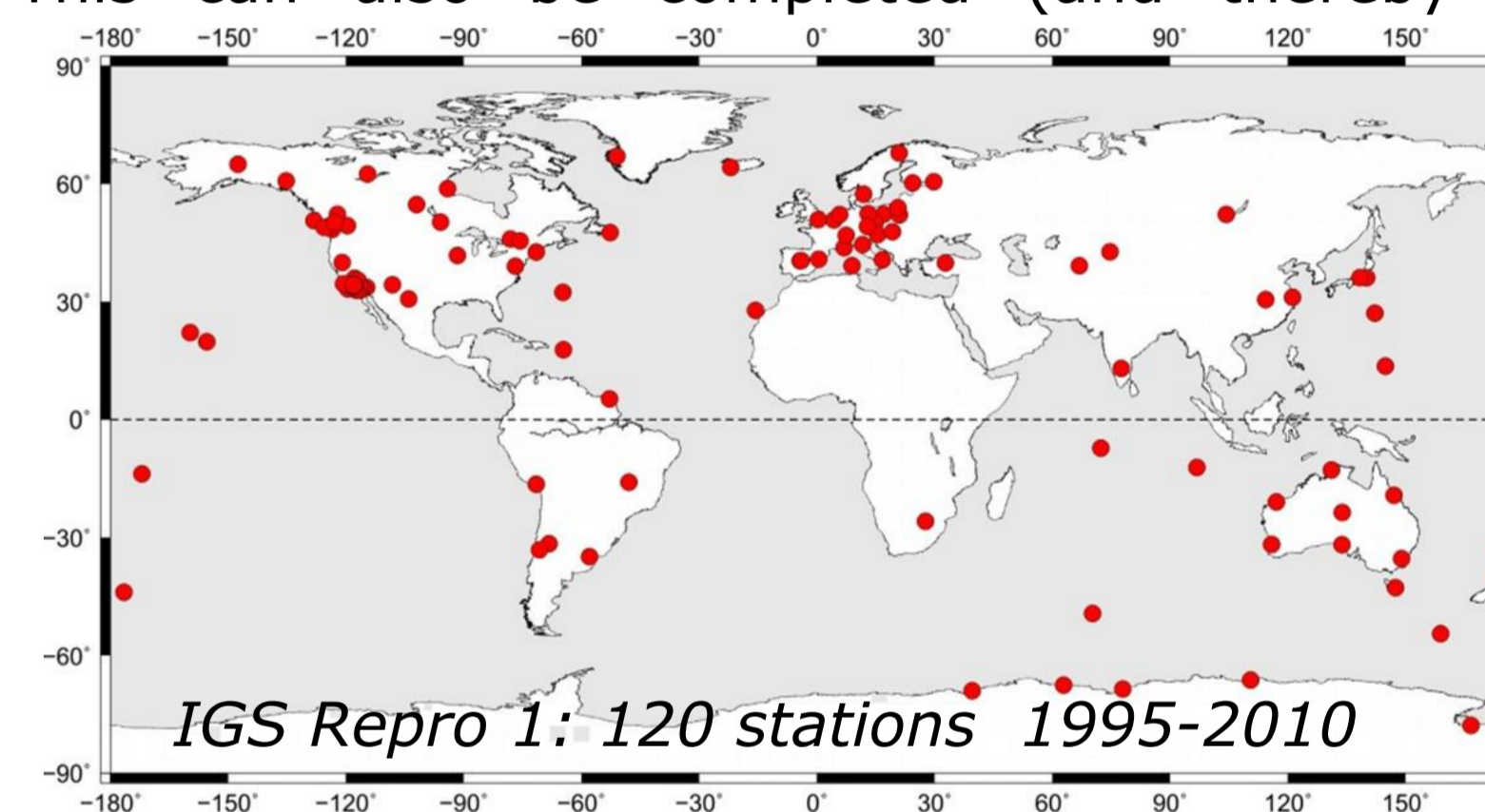
National Reprocessing Activities

- CORDEX.be Reprocessing Campaign
- Historical Reprocessing of the German Network (SAPOS)

Objective 2 HOMO: Set-up a common GNSS climate dataset on which different homogenisation methodologies can be tested. The homogenised common long-term dataset can then be re-used for climate trends and variability studies within the community.

Major Tasks and Deliverables:

- Datasets: establish at least one common GNSS climate dataset, which can be homogenised and then used for climate trends and time variability studies. These datasets can then be completed with other datasets necessary for the evaluation/assessment framework (radiosonde, WVR, models...).
- Homogenisation methods: apply and assess different homogenisation methods on selected tropospheric datasets.
- Homogenised datasets: Come up with a homogenised version of the selected datasets suitable for climate studies.
- Applications: use the homogenised long-term datasets for climate trend and time variability studies. This can also be completed (and thereby validated/invalidated) with similar studies based on satellite observations and climate model outputs.
- Recommendations: propose recommendations for forthcoming homogenisation activities.



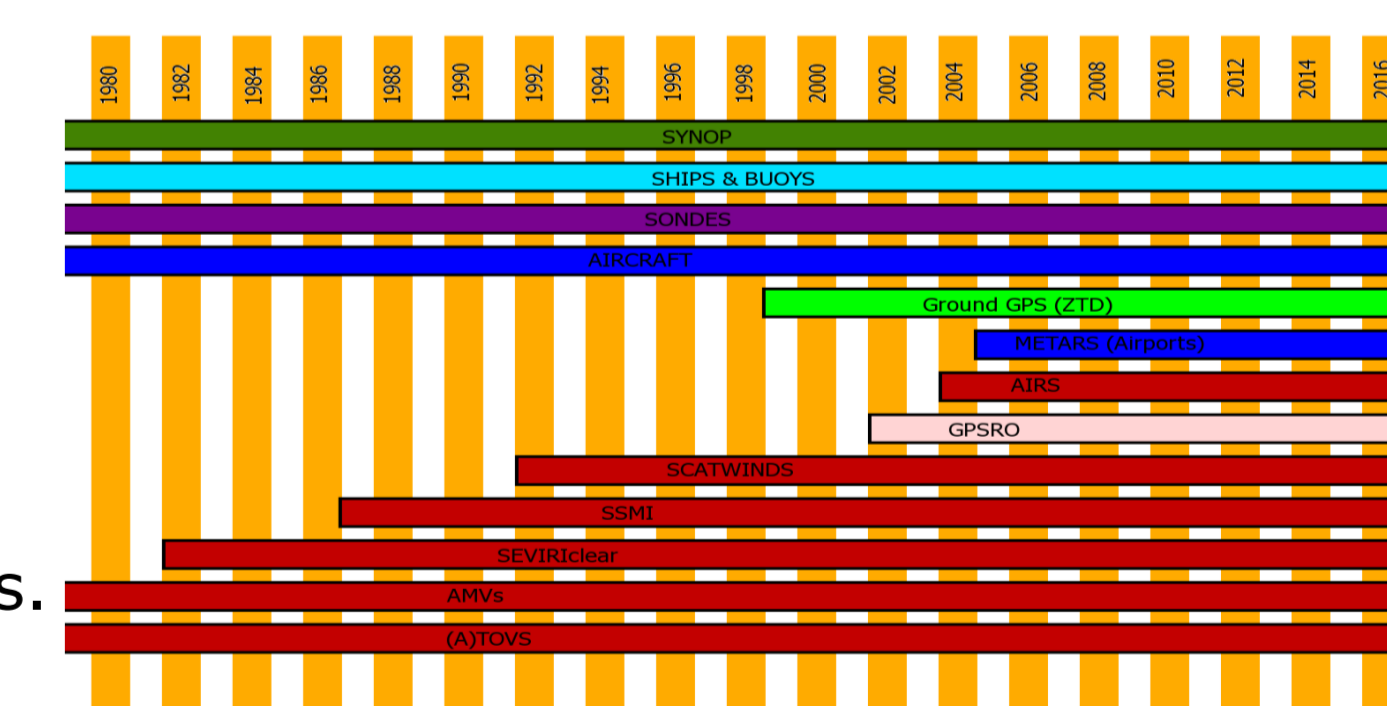
On-going activities follow on of GNSS4SWEC Sub-WG on data homogenisation

- Work on one or two long-term reference datasets.
First Reference dataset: IGS-Repro1 screened and converted to IWV by O. Bock.
Second reference dataset: EPN repro 2.
- Work with different homogenisation methods/algorithms:
- Inter-compare their results, advantages, drawbacks...
- Build a list of commonly identified inhomogeneities (instrumental change, break points, auxiliary data jumps...).
- Come up with an homogenized version of the reference dataset that can be re-used to study climate trends and time variability by the community.

Objective 3 ASSIM: Advocate the data assimilation of GNSS troposphere products in Climate Re-Analysis.

Major Tasks and Deliverables:

- Establish a strong link with the European Reanalysis project and other similar existing projects.
- Promote the data assimilation of ZTDs/IWVs in climate re-analysis.
- Investigate if other tropospheric products, such as horizontal gradients and slant delays, can be assimilated as well.
- Recommendations: propose recommendations for producing tropospheric delays for data assimilation in climate models.



Courtesy of G. Halloran. UERRA Observations

On-going activities

- At University at Albany, use GNSS PW data to develop PW diurnal matrices and validate climate models.
- At the Met Office, in the framework of the European FP7 project UERRA (Uncertainties in Ensembles of Regional Re-analysis, <http://www.uerra.eu/>), assimilation trials of reprocessed ZTD into a 12 km European climate reanalysis beginning in 1979 are ongoing. To account for any systematic bias or bias change, the reprocessed ZTDs will have a bias correction applied before assimilation.
- At Hong Kong Polytechnic University, collaboration with the China Meteorological Administration (CMA) scientists to evaluate PW accuracy of CMA's weather satellites' various PW products, using GNSS-derived and other PW data (such as WVR, etc) as a reference.

Objective 5 COOP: Strengthen the cooperation between geodesists and climatologists.

Objective 4 FORMAT: Review and update GNSS-based product requirements and exchange format for climate

Major Tasks and Deliverables:

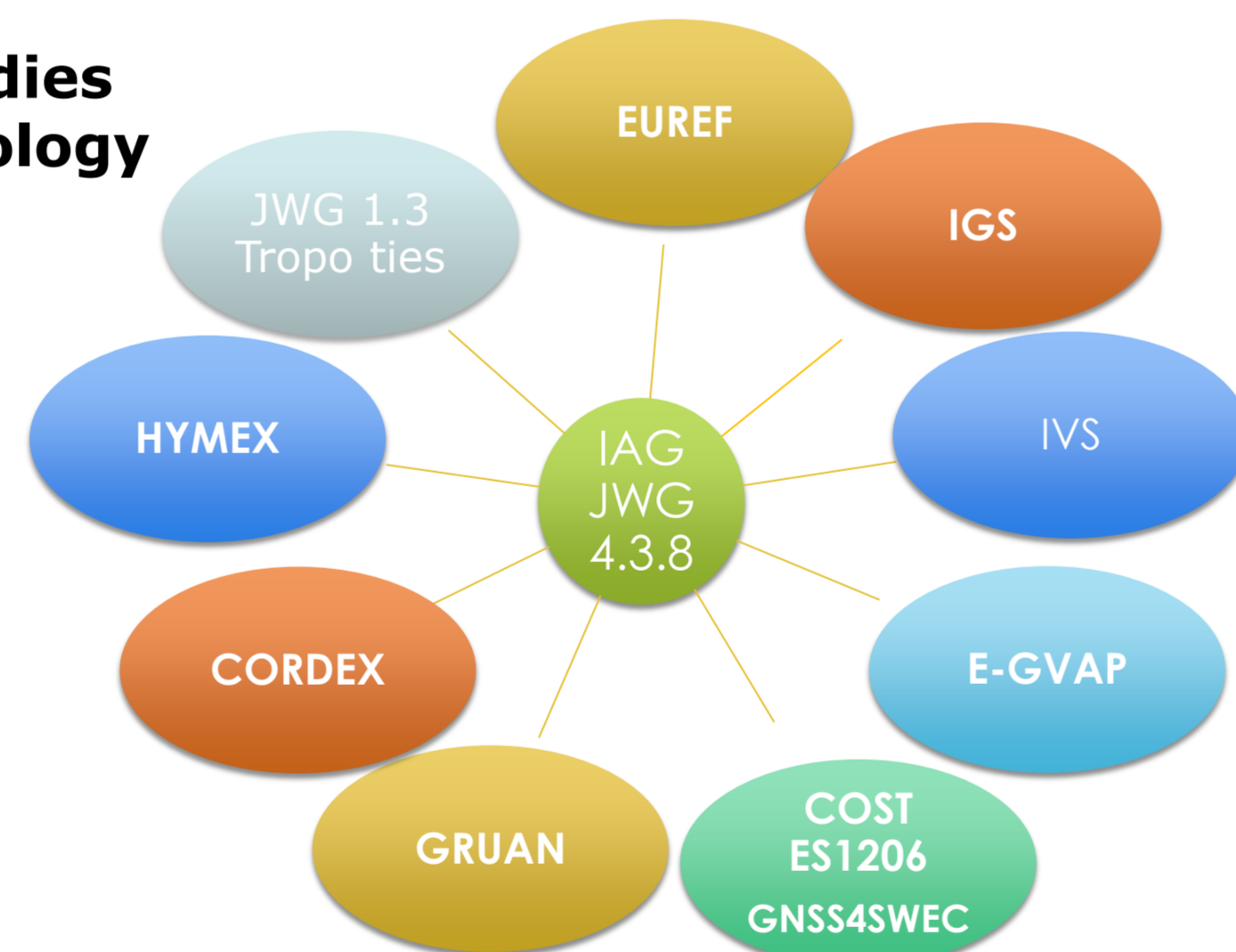
- Finalise the standardisation of the SINEX-TRO exchange format.
- Finalise the standardisation of the meta-data exchange format if necessary.
- Develop and share the necessary conversion tools.

Major Tasks and Deliverables:

- Setup a dedicated website.
- Scientific Outreach (papers, presentations...).
- Technical documents Share common tools.
- Establish a two-way communication channel between geodesists and climatologists.
- Introduce the topic “use of GNSS for climate sciences” in Geodesy and Geophysics programmes at universities.

Link to other bodies

9 international bodies (geodesy, meteorology and climate)



Member Geographical Distribution



- 18 countries worldwide
- 18 full members
- 2 corresponding members