26TH SESSION
OF THE WORKING GROUP
ON NUMERICAL EXPERIMENTATION (WGNE-26)

Tokyo, Japan, 18-22 October 2010

Prepared by

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Co-Chairs of WGNE

CAS/JSC WGNE NO. 26

The twenty-sixth session of the joint World Climate Research Programme / Commission for Atmospheric Sciences (WCRP/CAS) Working Group on Numerical Experimentation (WGNE) took place from 18-22 October 2010 in Tokyo, Japan. The meeting was hosted by the Japanese Meteorological Agency (JMA), to whom the co-chairs of WGNE, Dr. Andy Brown and Prof. Christian Jakob and the participants express their sincere gratitude for the excellent hospitality the group experienced during the week.

The Terms of Reference for WGNE broadly identify three types of activity, all of which support the overall aim of developing atmospheric models and data assimilation techniques for all space and time scales, these are:

1. provision of advice and liaison
2. co-ordinated numerical experimentation
3. organization and support of meetings, workshops and publications.

Discussions relevant to each of these are now discussed in turn. A full list of decisions and actions can be found in Annex A.

Liaison

WGNE was very pleased to have strong representation from a large number of relevant partners. These included CAS, WCRP, WWRP, THORPEX, and GEWEX and a number of groups and activities within them (e.g. SPARC, YOTC, WGCM, WGSIP, GCSS, GABLS, GLASS, JWGV, and WWRP-mesoscale). This was extremely valuable in helping to place the activities of WGNE in context, and also in helping to identify a number of areas where more active collaborations and activities might emerge. A small number of invitees who were not able to attend gave their presentation via Skype. Whilst inevitably something is lost in the way of personal interaction, this worked very well (hugely better than not having input at all), and its use in future meetings should therefore be seriously considered if someone is unable to attend in person or to avoid travel and costs when a presentation is mainly for information rather than discussion at the meeting.

A number of the presentations emphasized the importance of a seamless approach to atmospheric modelling, with a number of the key science questions cutting across traditional boundaries. There are already several initiatives attempting to address this issue (e.g. YOTC project joint between WWRP-THORPEX and WCRP, and also the forthcoming workshop on sub-seasonal to seasonal prediction). WGNE believes that, with its joint CAS / WCRP parentage, it continues to play a key role in bringing the various communities together. It strongly cautions against setting up new global atmospheric model development efforts, which artificially have a sole climate or weather focus.

WGNE received reports by WWRP and THORPEX and thanked the representatives of these groups for attending the meeting. WGNE was very pleased to once again acknowledge the important role played by the THORPEX DAOS WG, which is the leading expert group for atmospheric data assimilation research in WMO and hence a key partner for WGNE. WGNE strongly endorsed the plan to publish the conclusions on the assessment of the value of observation targeting. WGNE thanked the ConcordIASI project for its leadership and for providing an excellent dataset for model evaluation, and ideas for taking this forward will be pursued. Interactions with the THORPEX-PDP group have also been progressing well (see Workshops).

Following an initiative at WGNE-23 by the then WGNE and GMPP chairs, and the successful establishment at WGNE-24 of an enhanced WGNE membership in the area of model parametrization and development, WGNE again received reports on and welcomed the activities of the three GEWEX parametrization efforts (GCSS, GABLS, and GLASS).

A specific initiative involving WGNE, GCSS and the WWRP mesoscale WG to study parametrization issues in the so-called grey-zone was discussed in great detail (see co-ordinated experiments). It was also suggested that GCSS should consider, in consultation with YOTC, involving the process model community in work relevant to the MJO by assessing at a process level and further improving the recent parametrization developments which have led to significant improvements in the MJO performance of some operational centres.

WGNE welcomed the continued emphasis of GABLS on stable boundary layer issues, which continue to be highly relevant for weather and climate models. It suggested that links between GABLS and the active polar communities in WWRP and WCRP should be strengthened. It also welcomed the planned workshop at ECMWF and requested that WGNE members should have the opportunity to be involved. WGNE also stressed the importance of maintaining its link to the GLASS community, and it was suggested the land surface data assimilation might be a suitable topic for more detailed discussion at a future meeting.

WGNE received reports from WGCM, WGSIP and SPARC and thanked the representatives of these groups for attending the WGNE meeting. It is apparent that links to WGCM are already very active, with, for example, the jointly supported TRANSPOSE-AMIP initiative and the climate metrics panel, and a common interest in work leading to the further improvement of atmospheric models. The links to WGSIP and SPARC are less mature, but have considerable potential and WGNE expressed great interest to see these developed. The ex-officio membership of SPARC on WGNE was seen as a major stepping stone for future collaboration. It was suggested that WGNE and WGSIP could be brought together through a more prominent link between seasonal prediction efforts and atmospheric physics development, which is crucial to alleviate some of the long-standing errors in seasonal prediction systems. Within both SPARC and WGSIP it was noted that there was a lot of expertise on stratospheric modelling, and there may be some potential for better linking that to the NWP community which is increasingly starting to use higher model tops and non-orographic gravity wave schemes. Other possible points of contact of SPARC with WGNE and other groups include modelling of the tropical tropopause layer, and experience in chemistry modelling and in data assimilation. Possibilities for taking these areas forward will be discussed further at the SPARC SSG.

The meeting also received updates on recent progress at the various operational centres. As usual this sharing of information proved valuable, although the chairs had deliberately shortened the reports this year in order to allow more time for discussion of other issues (e.g., project and workshops). The idea of soliciting short-written reports to avoid the need to present some of the technical details in the presentations will be considered next year.

Summary presentations on activities and current issues in numerical methods, data assimilation, high resolution NWP, reanalysis and ensemble prediction were also given. These, along with the other presentations from the meeting, will be made available on the WGNE website in due course.

Co-ordinated Experiments and Projects

As discussed above, the coordination of numerical experiments is one of WGNE's core roles. This section describes briefly the progress made on projects already underway as well as discussions on new efforts.

Transpose-AMIP

The current status of the WGNE/WGCM Transpose-AMIP 2 was presented and discussed. WGNE believes that this project is an excellent example of bringing together climate and weather communities and of the application of seamless prediction ideas as climate models are challenged in NWP mode. Encouragingly a significant number climate centres have signed up to contribute data to the project, and the first submissions are expected soon.

It was noted that the success of the project will depend not just on provision of the data, but in active community efforts to make use of the data. Accordingly, all members of the committee were strongly encouraged to propose further diagnostic subprojects examining model performance and to find volunteers to lead these. Detailed examination of regional performance where individuals or centres can bring local expertise to the analysis would be particularly valuable. It was also noted that provision of results from NWP centres for the Transpose AMIP cases would be valuable to put the performance of the climate models in context. In that context WGNE encourages all its members to contribute to the Transpose AMIP data base.

Potential synergies with the work of THORPEX-PDP (either in terms of work arising from the Zurich workshop on monsoons and cyclones, or more generally in terms of analysis of the TIGGE database were noted). Accordingly the project steering group was requested to approach THORPEX-PDP to further consider the possibility of collaborative work.

The question was raised at to whether any of the climate models submitting data would have a well-resolved stratosphere. It is believed that they will not. However, as previously noted, co-ordinated examination of the representation of the stratosphere in NWP and climate models might for a natural area for combined WGNE-SPARC-WGSIP efforts in the future.

SURFA

The SURFA project has been running for a number of years, with ECMWF and DWD submitting real-time data to the SURFA web-site. In view of the slow uptake of other centres, and limited use of the dataset, it was decided following WGNE-25 to attempt to reinvigorate the project by requesting provision of a fixed two years of data (rather than real-time) from other centres – now provided by JMA and Meteo-France. The SURFA team is expecting to perform an analysis of the NWP data in comparison with buoy and ship data in the coming months.

Grey Zone Project

Over the last year, a number of discussions have taken place with a view to develop a project to examine issues associated with the parametrization of precipitating convection at resolutions where it is partially but not completely resolved (the so-called 'grey zone' from around 1 to 10km). The motivations for this are many-fold – for example global NWP will in a few years be approaching the coarser end of this range. A number of very high resolution global climate simulations have already been performed with resolutions of this sort (e.g. as described to WGNE in a series of interesting science talks on this work and the future Japanese K Computer System). A lot of mesoscale NWP models also already operate at resolutions towards the finer end.

WGNE enthusiastically supported the proposal to take forward co-ordinated work in this area, and discussed options for practical next steps. It was agreed that it was extremely desirable that the first study should be designed to permit relatively easy involvement of many different communities that have an interest in this area (e.g. WWRP-mesoscale, and GCSS as well as global modellers). One attractive proposition therefore is to design an idealized study of a cold-air outbreak. It was noted that this is also of interest to coarser resolution models because of evidence that they typically lack mid-level cloud in these conditions. Once an active community is established, later studies could address confrontation with observations, and the crucial questions relating to the representation of tropical convection.

It was agreed that Martin Miller, Andy Brown, Bill Lapenta, Jeanette Onvlee and Pier Siebesma would form a planning group to take this project forward. WGNE also felt that the involvement of the WWRP Mesoscale WG was so crucial to the success of this initiative, that it requests the inclusion of the chair of the WWRP Mesoscale WG as an ex-officio member of WGNE. The co-chairs will take forward this idea with CAS and WCRP.

Cloudy Radiance Project

A report from Florence Rabier was received on the cloudy radiance project. This project successfully got more NWP centres involved with ISSWG (IASI Sounding Science Working Group) work, and inter-compared the schemes used by different centres (resulting in changes to some). It was found that the scheme agreed best with each other for high clouds amounts. The results will be published in a special issue of QJ. Consideration is now being given as to whether an independent truth can be obtained.

High Resolution AMIP

WGNE remains very supportive of the idea of NWP centres submitting high resolution AMIP runs to the CMIP5 archive, ideally alongside lower resolution runs with the same model, in order to allow a systematic study of the effects of the resolution on the model climate. Peter Gleckler agreed to provide guidance to contributors on the CMIP5 protocol and technical issues associated with large data volumes. A volunteer to champion/co-ordinate the resolution study is still required. WGNE charged the co-chairs to take this forward in discussions with WGCM to identify a potential lead for this activity.

Verification Activities

There are several WGNE-related activities involving verification of forecasts, and a report was received from the Joint Working Group on Verification which continues to be very active in supporting the development and take-up of new techniques, and also in promoting best practice and educational activities. WGNE welcomed the release of the document on precipitation verification, and encouraged continuation of the efforts to produce a similar document for clouds.

The meeting reviewed the encouraging improvements that continue to be made by many centres in standard NWP verification scores, noting some sensitivity to whether the verification was made relative to observations or to analysis. Recent performance for tropical cyclones was reviewed, and thanks are again due to JMA for their work in this area. JMA also proposed a new effort to examine the performance of Limited Area Models for tropical cyclones. A proposal will be sent to all members.

Rainfall verification statistics were presented, with most models continuing to show a positive frequency bias for light rain events. It was agreed that the reasons for this were not clear and that it would be useful in next year's discussions to include any evidence members have (e.g. sensitivity studies to model physics changes) that might point to the root causes.

There are a lot of current activities relevant to polar meteorology (e.g. IPY, WWRP/THORPEX and WCRP workshops), although it was noted that knowledge of the current performance of the operational models in these regions is limited and could usefully be increased. Contact will be made through JWGV with CBS as to the possibility of (and timescales for) carrying out routine verification over the polar regions (standard metrics and/or user-relevant near-surface parameters). In parallel WGNE will consider whether it could usefully carry out any separate activity involving assessment of model performance over the poles (e.g. collation of centre experiences; comparisons with ConcordIASI data).

A report was received from the climate metrics panel summarizing efforts to apply a limited set of metrics to CMIP5. The panel has recently broadened its scope and is now considered a joint WGNE/WGCM activity. WGNE welcomes the progress that has been made and encourages the application of metrics to climate model results, with the proviso that a supporting document on how the metrics should be interpreted is needed. Future work should look to increase the scope of the metrics (e.g. more on variability and process-based evaluation).

Workshops, Publications, Meetings

This section summarizes WGNE's involvement in past and future workshops, a third cornerstone of its activities.

A successful joint WGNE/THORPEX-PDP workshop on diagnosis of model error was held in Zurich in July 2010. This brought together dynamicists, model developers and experts on model error diagnosis. Joint projects are planned to look at the application of advanced diagnostic techniques to try to understand model errors in the representation of the Indian Summer Monsoon and of cyclonic systems.

The second in the series of THORPEX-PDP/WGNE workshops will be held on model uncertainty and error, joint with ECMWF, 20-24 June 2011. Some differences in current ideas regarding the scope of the meeting were noted at WGNE; these have since been addressed. WGNE remains strongly supportive of the meeting.

WGNE-25 had a presentation from the OceanView community, and it was agreed that it would be desirable to organize a joint workshop on the issue of the pros and cons of ocean coupling for short range NWP (with a view to then spinning up some co-ordinated experimentation on this topic). Bill Lapenta agreed to serve as a liaison on this workshop for WGNE. Further ahead there is a desire to spin-up a parallel initiative on the issue of the importance of aerosol/chemistry coupling for NWP, and Andy Brown agreed to take forward preliminary discussions with the GAW community.

Progress with the planning of the conference/workshop led by Dr Joao Teixeira (JPL) on the representation of physical processes in Earth System Models was reported. The committee welcomed these developments, but thought that the proposed date, just a few weeks in advance of the WCRP Open Science Conference, might not attract a number of key participants. Accordingly it was proposed to delay to the first quarter of 2012. The organizing committee (for which a WGNE member is required) were encouraged to make the format of the meeting aim at pathways to solutions to long-standing problems.

A request from Christine Jablonowski for WGNE support for the next NCAR workshop / summer school on dynamical cores was considered. WGNE was supportive, although noted that the requirement for all cores to be ported to NCAR so that tests could be run there was likely to significantly reduce participation and thus reduce the usefulness of the exercise. The organizers were therefore encouraged to consider widening the way the intercomparison is done by, for instance, allowing people to contribute through running the cases on their own machines back home in their own time.

WGNE was pleased to support the forthcoming YOTC Science Symposium (16-18 May 2001, Beijing) and Christian Jakob and Xueshun Shen agreed to serve on the organizing committee.

WGNE has organized a series of workshops on model systematic errors (the most recent being in San Francisco in 2007) and it was agreed that it was timely to start thinking about the next workshop in the series. The idea of combining with a WGCM CMIP5 analysis workshop was discussed, but it was decided against on the grounds that the scope of the CMIP5 workshop is likely to be very broad. Hence the plan will be to hold a WGNE workshop in 2013 (but with the involvement of all interested parties (e.g. WGCM, WWRP, THORPEX-PDP, GEWEX/GCSS). Members were asked to consider whether they could play a role in hosting and/or organizing, and the topic will be revisited at WGNE-27.

In view of a number of common interests, WGNE enthusiastically welcomed the suggestion of co-locating the next meeting with WGCM, including joint sessions between the groups. Tom Hamill agreed to take forward with Jerry Meehl the idea of hosting this meeting at NCAR in the week preceding the WCRP Open Science Conference.

WGNE-26 was the last WGNE-meeting for a number of its members, namely Martin Miller, Pedro Silva Dias, Piere Gauthier, Pier Siebesma and Jim Hack. The committee expresses its sincere thanks to all of them for their many contributions.

The continuing support of Canada in looking after the annual ‘Blue Book’ was gratefully acknowledged.

As evinced by this report, WGNE is involved in and leading many community activities relevant to the development of atmospheric models and data assimilation systems. None if this would be possible without the support of the scientific community both within the major global modelling centres and the academic community. The WGNE co-chairs would like to once again express their sincere gratitude for this support.

Appendix A

WGNE-26 ACTIONS AND DECISIONS

This appendix summarizes the actions and decisions of WGNE-26 in accordance with the full report above. Initials mark the responsible WGNE Co-Chair (AB = Andy Brown, CJ = Christian Jakob)

Liaison

WWRP

WGNE welcomes the new collaboration with the WWRP Mesoscale Working Group and proposes to make its chair an ex-officio member of WGNE (CJ/AB)

WGCM

- Joint 2011 meeting
  - WGNE supports the idea of a co-located meeting with a day of joint sessions
  - T Hamill volunteers to help with the local organization on behalf of WGNE
  - Metrics panel now recognized as a joint WGNE/WGCM effort

- Hi-Resolution AMIP-simulations
  - WGNE encourages all centres to participate by submitting high-resolution simulations to the CMIP5 archive
  - P. Gleckler to provide guidance to contributors on the CMIP5 protocol and technical issues associated with large data volumes
  - WGNE highlighted the need to find someone to champion the effort scientifically in collaboration with WGCM (CJ)
  - If no-one can be found all centres will be again encouraged to submit simulations on an ad-hoc basis (CJ)

WGSIP

- WGNE welcomes a closer collaboration with WGSIP and encourages all involved to identify and propose concrete activities for instance in the area of atmospheric physics and systematic errors (CJ)

GCSS/GABLS

- WGNE supports the proposed reorganization at GCSS/GABLS level

- WGNE encourages the groups to rethink the name change to FAME, as it might cause too much confusion in the community

- GCSS is encouraged to establish a closer collaboration with the MJO Task Force through a joint project

- WGNE suggest that the GABLS activity explores closer links to the WCRP and WWRP efforts in the polar regions – CJ to discuss with relevant groups

- WGNE encourages centres to actively participate in the forthcoming ECMWF/GABLS workshop on the stable PBL in 2011

GLASS

- WGNE supports maintaining the strong current relationship to GLASS through continued ex-officio membership on WGNE

- WGNE encourages GLASS to perhaps send a representative of the land data assimilation efforts to WGNE meetings to strengthen the collaboration in this area

SPARC

- WGNE welcomed the new ex-officio membership of SPARC

- Amongst possible future joint activities discussed were an activity on non-orographic gravity wave drag and the TTL. CJ has been charged to discuss this further at the SPARC SSG.

- WGNE encourage stronger links of the SPARC assimilation and prediction activities with THORPEX

JWGV

- WGNE encouraged the JWGV to continue its activities on cloud verification

- WGNE would like to commission a report by the JWGV on the long-term developments on the verification of weather parameters for its 2011 or 2012 meeting

Proposal by GEWEX for formation of an Atmospheric Processes working group (WGAP)

- WGNE strongly opposes the formation of another WG on the atmosphere.

- WGNE offers to coordinate atmospheric model development activities in collaboration with appropriate partners (e.g., GCSS, WGCM, WGSIP etc.), as it has done for the last 26 years

CORDEX

- WGNE will invite a report on the CORDEX activities for its next meeting (AB)

Atmospheric Chemistry

- In collaboration with the CAS leadership WGNE will identify the most suitable partner in CAS for joint activities (AB)

- The next WGNE meeting will invite a coordinated report on the treatment of aerosols and potentially air quality work from all centres (CJ)

Co-ordinated Experiments and Projects

Focus on Polar work

- WGNE supports a renewed focus on the polar regions and suggests to introduce a unified standard verification for the polar regions. A first step is for the JWGV to contact the CBS to enquire about existing plans (CJ).

- Centres agreed to report verification results over the poles at the next WGNE meeting. F. Rabier volunteers to collate these results.

Grey Zone

- WGNE enthusiastically supports a new effort in this area

- WGNE recommends that the first activity should be designed such that the is maximum likelihood of buy-in from many communities -> WWRP, GCSS, WGNE as a minimum

- WGNE formed a joint planning group consisting of: M Miller, J Onvlee, A Brown, B Lapenta, and P Siebesma. The group was charged to develop a plan and present it at the next WGNE meeting.

Data assimilation

- Antarctic project: Centres to provide Monitoring Statistics -> F Rabier to contact centres with specific requests

- SPARC request for Concordia data (WEB server at Meteo-France) -> F Rabier to contribute to newsletter article

- WGNE received and supported a proposal to make data assimilation incl. other components, e.g., land, sea-ice and chemistry a special topic for the 2012 WGNE meeting

Transpose AMIP

- Operational centre involvement
  - All centres are encouraged to participate or at least provide their operational forecasts to the archive in the right formats
  - All centres are encouraged to contribute diagnostic subprojects

- WGNE encourages the AMIP_T steering committee to talk to THORPEX PDP to explore collaboration on Polar, Monsoon, Cyclones, including diagnostic projects led by the PDP group

Rainfall verification (with JWGV)

- WGNE noted that while annual reports on rainfall verification have been useful, so far there is little knowledge on the causes of the model errors. It is proposed that at the 2011 meeting all centres should provide a report on any knowledge (e.g., sensitivity studies) as to where errors originate

Tropical cyclone verification

- C Muroi to circulate JMA proposal for LAM study

Workshops, Publications, Meetings

Earth System Physics workshop

- WGNE noted that this workshop has been delayed numerous times and expressed its concern about this

- WGNE supported on final delay of the workshop to Q1 of 2012

- WGNE encourages the workshop to take on a format that aims at pathways to solutions rather than providing another list of problems

- CJ/AB will communicate with J Teixeira

Model uncertainty and error workshop

- T Hamill and C Jakob will join the organizing committee of this workshop and report on its outcomes at the next WGNE meeting

Joint GOVST-WGNE workshop on short-term coupled forecasting

- B Lapenta agreed to act as WGNE liaison in the organization of the meeting

- CJ will provide contact details to all involved

Dynamical Core Summer School

- WGNE is very supportive of this activity

- WGNE members found the specific setup too hard for many centres to participate and

- asked the organizers for the option that centres participate through running test cases back home in their own time

- CJ to communicate with organizers

YOTC Science Symposium

- X Shen and C Jakob are proposed to represent WGNE on the workshop committee

Systematic errors workshop

- WGNE discussed ideas for its next systematic errors workshops

- In recognition of many other workshops in the area of model evaluation in 2011 and 2012, it was decided to hold the next workshop in 2013

- All WGNE members are encouraged to propose hosting the meeting and further discussions were deferred to WGNE-27 in 2011

Other

Activity and centre reports/WGNE process

- The new format of centre and activities was judged to work well

- It was decided to trial written centre reports for next year's meeting. CJ and AB will provide a template to members

Next meeting

- The next meeting will be held in Boulder from 17-21 October 2011

- In addition to other items already noted, issues of scalability / future computer architectures was raised as an area to be considered for discussion

Appendix B

MEETING AGENDA

Monday, 18 October

09h00 – 10h30	**Welcome, Adoption of the Agenda, Local Arrangements** (10 min) *C. Jakob, A. Brown, C. Muroi*
	Welcome by JMA (15 min) *Ken-ichi Kuma* *Director, Numerical Prediction Division of JMA*
	Meeting Goals, Actions from last meeting and future WGNE roles and activities (20 min) *C. Jakob, A. Brown*
	CAS matters (45 min) *M. Beland, D. Burridge*
10h30 - 11h00	Coffee break
11h00 - 12h30	**WCRP matters including JSC, New Modeling Strategy, and OSC** (45 min) *G. Asrar*
	GEWEX matters incl. Pan-GEWEX meeting (45 min) *K. Trenberth (via Skype)*
12h30 – 14h00	Lunch
14h00 – 15h30	**WGCM** (30 min) *S. Bony*
	WGSIP (30 min) *D. DeWitt*
	NOAA (30 min) *R. Rosen, J. Huang*
15h30 – 16h00	Coffee
16h00 – 17h30	**WWRP – General** (30 min) *G. Brunet*
	WWRP – Mesoscale Group (30 min) *J. Onvlee-Hooimeyer*
	THORPEX including PDP (30 min) *D. Burridge*

Tuesday, 19 October

09h00 – 10h30	**Recent developments in high-resolution NWP** (30 min) *B. Lapenta*
	The grey-zone project (1 h) *M. Miller, B. Lapenta, J. Onvlee-Hooimeyer*
10h30 – 11h00	Coffee break
11h00 – 12h30	**YOTC** (30 min) *D. Waliser (via Skype)*

Radiance project (30 min)
F. Rabier

A possible project on >15d forecasts (30 min)
P. Silva-Dias

12h30 – 14h00 Lunch

14h00 – 15h30 **Centre reports** (4, 20 min each)
Participants

15h30 – 16h00 Coffee break

16h00 – 18h00 **Science talks** (30 min each)

Projections of the change in tropical cyclone frequency and intensity due to global warming using high resolution AGCMs
Dr Masato Sugi (JAMSTEC)

Projections of the change in future extremes using super-high-resolution atmospheric model
Dr Akio Kitoh (MRI/JMA)

Global cloud-resolving model development (NICAM)
Dr Masaki Satoh (AORI/U, Tokyo)

The Next Generation Supercomputer - The K Computer System
Dr Tadashi Watanabe (RIKEN)

19h00 Reception

Wednesday, 20 October

09h00 – 10h30 **Recent developments in Numerical Methods, incl. report from the PDEs on the Sphere meeting** (30 min)
M. Tolstykh, M. Baldauf

Recent developments in Data assimilation (30 min)
F. Rabier, P. Gauthier

Recent developments in Reanalysis (30 min)
C. Muroi, M. Miller

10h30 – 11h00 Coffee break

11h00 - 12h30 **Transpose AMIP** (30 min)
A. Brown on behalf of K. Williams

Progress with CMIP, Climate Model Metrics, and High Resolution AMIP (30 min)
P. Gleckler

Recent developments in Ensemble Prediction (30 min)
T. Hamill, P. Silva-Dias

12h30 – 14h00 Lunch

14h00 – 15h30 **Climate Services Developments** (30 min)
Participants

Centre reports (3, 20 mins each)
Participants

15h30 – 16h00 Coffee break

16h00 – 17h30 **GABLS report and discussion** (45 min)
B. Holtslag (via Skype)

GLASS report and discussion *(45 min)*
B. van den Hurk (via Skype)

Thursday, 21 October

09h00 – 10h30 **GCSS report and discussion** (45 min)
P. Siebesma

SPARC report and discussion (45 min)
S. Polavarapu

10h30 – 11h00 Coffee break

11h00 – 12h30 **Earth System Physics workshop** (30 min)
J. Teixeira (via Skype)

Stochastic Physics workshop (with PDP) (30 min)
T. Hamill

Potential GOVST workshop (30 min)
C. Jakob

12h30 – 14h00 Lunch

14h00 – 15h30 **Centre reports** (4, 20 min each)
Participants

15h30 – 16h00 Coffee

16h00 – 18h00 **Report of JWGV** (45 min)
L. Wilson

Forecast verification (including typhoons, rainfall etc.) (45 min)
Participants

Friday, 22 October

09h00 – 10h30 **Centre reports** (3, 20 min each)
Participants

Progress with SURFA (15 min)
A. Brown

10h30 – 11h00 Coffee

11h00 – 12h30 **Meeting summary and discussion of future WGNE activities, including workshops and projects**
C. Jakob, A. Brown, Participants

12h30 – 13h00 **Closing Session**

Decisions and Actions
C. Jakob, A. Brown

Appendix C

LIST OF PARTICIPANTS

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Appendix D: Tables of NWP operational models etc

WGNE List of Operational Global Numerical Weather Prediction Systems (as of 01. Jan. 2011)

Forecast Centre (Country)	Computer (Sustained in TFlop/s)	High resolution Model (FC Range in days)	Ensemble Model (FC Range in days)	Type of Data Assimilation
ECMWF (Europe)	IBM p6 575, 2x272 (2x15)	T_L1279 L91 (10)	T_L639 L62; (10) T_L319 L62 (+5)	4D-Var 12h (T_L255)
Met Office (UK)	IBM Power 6 106 nodes x2 (2*6)	~25 km L70 (6)	~60km L70; M24 (15)	4D-Var (~60km)
Météo France (France)	NEC SX9, 2x10 nodes (2x3)	T_L798(C2.4) L70 (4)	T_L538(C2.4) L65; M35 (4)	4D-Var (T_L323)
DWD (Germany)	NEC SX9; 2x14 nodes (2x4.5)	30 km L60 (7)	No global EPS	3D-Var
HMC (Russia)	SGI Altix4700; SGI ICE8200 (1.8; 1.3)	0.72°x0.9° L28 (10) T169 L31 (10)	T85L31,M13+T169L31, M1+0.72x0.9L28,M1 (10)	3D-OI
NCEP (USA)	IBM p655 (Cluster 1600) (2x1.9)	T574 L64 (7.5) T190 L64 (16)	T190L28; M45 (16)	3D-Var (T574)
Navy/FNMOC/NRL (USA)	SGI and IBM (800 proc) (3.2)	T239 L30 (7.5)	T119 L30; M16 (10.5)	3D-Var
CMC (Canada)	IBM p575+, 2X131 nodes (2x6)	0.45°x0.3° L80 (10)	0.9° L28; M20 (16)	Det: 4D-Var (1.5°) EPS: EnKF M96 (0.9°)
CPTEC/INPE (Brazil)	NEC SX6, 12 nodes (0.8) CRAY XT6 30528 cores (16.6)	T299 L64 (7); T126 L28 Coupled (30)	T126 L28; M15 (15)	3D-Var
JMA (Japan)	Hitachi SR11000-K1, 2*80 nodes (2x0.7)	TL959 L60 (9)	TL319 L60; M51 (9)	4D-Var (T159)
CMA (China)	IBM p655/p690 120 nodes	TL639 L60 (10)	T213 L31; M15 (10)	3D-Var(TL639)
KMA (Korea)	Cray X1E-8/1024-L (2x0.7)	T426 L40 (10)	T213 L40; M32 (17/cycle) (10)	3D-Var
NCMRWF (India)	Cray X1E-64 processor (0.1) IBM P6 - 1280 processor (2.4)	T254 L64 (7)	T80 L18; M8 (7)	3D-Var (T254)
BoM (Australia)	SUN Constellation, 576 nodes (2.5)	80km, L50 (10)	No global EPS	4D-VAR (120km)

WGNE Overview of Plans at the NWP Centres with Global Forecasting Systems

Part I: Computer (Sustained Performance in TFlop/s based on main deterministic model)

Forecast Centre (Country)	2011	2012	2013	2014	2015	2016
ECMWF (Europe)	2x15	2x15	2x42	2x42	tbd	
Met Office (UK)	2x6	2*18	tbd	tbd	tbd	
Météo France (France)	2x3	2x3	2x3	tbd	tbd	tbd
DWD (Germany)	2x10	2x10	2x10	2x30	2x30	2x100
HMC (Russia)	1.8+1.3	1.8+1.3	1.8 + 1.3	tbd	tbd	
NCEP (USA)	2x27	2x27	2x27	tbd	tbd	
Navy/FNMOC/NRL (USA)	3	tbd	tbd	tbd	tbd	
CMC (Canada)	2x3.2	tbd	tbd	tbd	tbd	tbd
CPTEC/INPE (Brazil)	16.6	16.6	16.6	16.6	tbd	
JMA (Japan)	2x0.7	2x0.7	2x30	2x30	2x30	2x30
CMA (China)	2.1 5..0	2.1 5	2x20	2x20	2x20 40	tbd
KMA (Korea)	2x17	2x17	2x17	tbd	tbd	
NCMRWF (India)	tbd	tbd	tbd	tbd	tbd	
BoM (Australia)	3	6 - 8	6 - 8	6 - 8	tbd	

WGNE Overview of Plans at NWP Centres with Global Forecasting Systems

Part II: Global Modelling

a) Deterministic Model (Resolution and number of layers)

Forecast Centre (Country)	2011	2012	2013	2014	2015	2016
ECMWF (Europe)	T_L1279 L137	T_L1279 L137	T_L1279 L137	TL1279L137	tbd	tbd
Met Office (UK)	25 km L70	20km L70	20km L70	20km L70	tbd	
Météo France (France)	T_L798c2.4 L70 (10km on W Europe)	T_L798c2.4 L70 (10km on W Europe)	TL798c2.4 L70 (10km on W Europe)	TL1200c2.2 L105 (8km on W Europe)	TL1200c2.2 L105 (8km on W Europe)	tbd
DWD (Germany)	2x10	2x10	2x10	2x30	2x30	2x100
HMC (Russia)	0.72°x0.9° L50 T169 L31	0.37°x0.45° L50 T339 L31	0.19°x0.22° L60 T679L63(10)	tbd	tbd	
NCEP (USA)	T574; L64 (7.5) T190; L64 (16)	T878; L64 (7.5) T382; L64 (16)	T878; L64 (7.5) T382; L64 (16)	T878; L91(7.5) T382; L91 (16)	TBD	
Navy/FNMOC/NRL (USA)	T319 L42	T479 L60	T479 L60	T511 L64	T511 L64	
CMC (Canada)	(0.45°x0.3°) L80	(0.35°x0.23°) L80	(0.35°x0.23°) L90	(0.2°x0.2°) L90	tbd	tbd
CPTEC/INPE (Brazil)	20 km L96	10 km L96	10 km L128	tbd	tbd	
JMA (Japan)	T_L959 L60	T_L959 L60	T_L959 L60	T_L959 L100	T_L959 L100	T_L959 L100
CMA (China)	T_L639 L60 GRAPES 50 km L36	GRAPES 50 km L60	GRAPES 25 km L60	GRAPES 25 km L70	tbd	
KMA (Korea)	25 km L70	25 km L70	20 km L90	tbd	tbd	
NCMRWF (India)	25 km L70	25 km L70	tbd	tbd	tbd	
BoM (Australia)	40 km L70	25 km L70	25 km L70	25 km L70	tbd	

WGNE Overview of Plans at NWP Centres with Global Forecasting Systems

Part II: Global Modelling

b) Global Ensemble Prediction System (Resolution, number of layers, number of members, forecast range in days)

Forecast Centre (Country)	2011	2012	2013	2014	2015	2016
ECMWF (Europe)	T639 to D+10 T319 to D+15 L62	T639 to D+10 T319 to D+15 L90?	T639 to D+10 T319 to D+15 L90?	T639 to D+10 T319 to D+15 L90?	tbd	
Met Office (UK)	60 km L70; M24 15	40km L70; M24;15	40km L70; M24; 15	40km L70; M24; 15	tbd	
Météo France (France)	T538c2.4 L65; M35; 4 days	T538c2.4 L65; M35; 4 days	tbd	tbd	tbd	
DWD (Germany)	nil	nil	nil	40 km L100; M30 3	40 km L100; M30 3	20 km L100; M30 3
HMC (Russia)	T169 L31, 0.72°x0.9°L28; M42; 10	T169 L31, 0.72°x0.9°L28; M42; 14	T169 L63, 0.72°x0.9°L50; M42; 14	tbd	tbd	
NCEP (USA)	T190 L28 M21; 16	T254 L42; M21; 16	T254 L42; M21; 16	T382 L64;M21; 16	T382 L64;M21; 16	tbd
Navy/FNMOC/NRL (USA)	T119L30; M20; 16	T119L30; M20; 16	T239L42; M20; 16	T239L42; M20; 30	T239L42; M20; 30	
CMC (Canada)	GEM (0.6°x0.6°) L40 M20 16	GEM (0.45°x0.45°) L64 M20 16	GEM (0.45°x0.45°) L64 M20 16	GEM (0.45°x0.45°) L64 M20 16	tbd	tbd
CPTEC/INPE (Brazil)	50 km, L42, M50; 15	40 km, L64, M60; 15	40 km, L64, M60; 15	tbd	tbd	
JMA (Japan)	T_L319 L60; M51; 9	T_L319 L60; M51; 9	T_L319 L60; M51; 9	T_L479 L100; M13; 18 T_L479 L100; M14; 9	T_L479 L100; M13; 18 T_L479 L100; M14; 9	T_L479 L100; M13; 18 T_L479 L100; M14; 9
CMA (China)	T213(0.5625°, L31, M30,10)	GRAPES(100 km,L36,M15,10) T213(0.5625°, L31, M30,10)	GRAPES(50 km,L36,M30,10)	GRAPES(50 km,L60,M30,10)	tbd	
KMA (Korea)	40 km L50; M24; 10	40 km L70; M24; 15	40 km L70; M24; 15	tbd	tbd	
NCMRWF (India)	tbd	tbd	tbd	tbd	tbd	
BoM (Australia)	nil	MOGREPS, ~60 km L70; M24; 10	MOGREPS, ~60 km L70; M24; 10	MOGREPS, ~60 km L70; M24; 10	tbd	

WGNE Overview of Plans at NWP Centres with Global Forecasting Systems

Part II: Global Modelling

c) Global Data Assimilation Scheme (Type, resolution, number of layers)

Forecast Centre (Country)	2011	2012	2013	2014	2015	2016
ECMWF (Europe)	4D-Var 12h (EDA); T_L1279 with T_L255 final inner loop; L137	4D-Var 12h (EDA); T_L1279 with T_L399 final inner loop; L137	4D-Var 24h (EDA); T_L1279 with T_L399 final inner loop; L137	4D-Var 24h+ (EDA); T_L1279 with T_L399 final inner loop; L137	tbd	tbd
Met Office (UK)	4D-Var; 60 km; L70	4D-Var (hybrid); 60km; L70	4d-Var (hybrid); 60km; L70	4d-Var (hybrid); 40km; L70	tbd	
Météo France (France)	T538c2.4 L65; M35; 4 days	T538c2.4 L65; M35; 4 days	TL800c3.3 L105 (8km on W Europe)	TL800c3.3 L105 (8km on W Europe)	TL800c3.3 L105 (8km on W Europe)	tbd
DWD (Germany)	3D-Var; 20 km; L60	3D-Var+ensemble; 20 km; L60	3D-Var+ensemble; 20 km; L60	3D-Var+ensemble; 20 km; L100	3D-Var+ensemble; 20 km; L100	3D-Var+ensemble; 10 km; L100
HMC (Russia)	3D-Var 0.72°x0.9° L50	3D-Var + ENKF 0.5°x0.5° L80	3D-Var + ENKF 0.5°x0.5° L80	tbd	tbd	
NCEP (USA)	Advanced-Var; T574; L64	Advanced-Var; T878; L64	Hybrid enkf-3Dvar; T878; L64	Hybrid Enkf-3D-Var T878; L91	Hybrid Enkf-4D-Var T878; L91	
Navy/FNMOC/NRL (USA)	4D-Var T319 L42	4D-Var T479 L60	4D-Var T479 L60	4D-Var T511 L64	4D-Var T511 L64	
CMC (Canada)	Det: 4D-Var (0.9°x0.9°), (0.45°x0.3°) L80 EPS: EnKF M192 (0.9°x0.9°)	Det: 4D-Var (0.9°x0.9°), (0.35°x0.23°) L80 EPS: EnKF M192 (0.6°x0.6°)	Det: 4D-Var (0.6°x0.45°), (0.35°x0.23°) L90 EPS: EnKF M192 (0.6°x0.4°)	Det?: 4D-Var (0.6°x0.45°), (0.3°x0.2°) L90 EPS?: EnKF M192 (0.6°x0.4°)	tbd	tbd
CPTEC/INPE (Brazil)	LETKF; 40 km	LETKF; 20 km	LETKF; 20 km	tbd	tbd	
JMA (Japan)	4D-Var; T_L319; L60	4D-Var; T159; L60	4D-Var; T159; L60	4D-Var; TL319; L100	4D-Var; TL319; L100	4D-Var; TL319; L100
CMA (China)	3DVAR(SSI), TL639,L60 GRAPES_3DVAR, 1.125°, L17	GRAPES_3DVAR, 50 km, L17	GRAPES_3DVAR, 25km,L60	GRAPES_3DVAR, 25km,L60	tbd	
KMA (Korea)	4D-Var; 75km; L70	4D-Var; 75km; L70	tbd	tbd	tbd	
NCMRWF (India)	4D-VAR; 75 km L70	4D-VAR; 75 km L70	tbd	tbd	tbd	
BoM (Australia)	4D-VAR; 80 km L70	4D-VAR; 60 km L70	4D-VAR; 60 km L70	4D-VAR; 60 km L70	tbd	

WGNE Overview of Plans at NWP Centres with Global Forecasting Systems

Part III: Regional Modelling

a) Regional deterministic model (number of gridpoints, resolution, number of layers)

Forecast Centre (Country)	2011	2012	2013	2014	2015	2016
ECMWF (Europe)	-	-	-	-	-	
Met Office (UK)	600*360; 12 km; L70 768*960; 1.5 km; L70	600*360; 12 km; L70 768*960; 1.5 km; L70	768*960; 1.5 km; L70	768*960; 1.5 km; L70	tbd	
Météo France (France)	750x720; 2.5 km; L60	750x720; 2.5 km; L60	750x720; 2.5 km; L60	1.3km L113	1.3km L113	tbd
DWD (Germany)	665x657; 7 km; L40 421x461; 2.8 km; L50	665x657; 7 km; L40 421x461; 2.8 km; L50	665x657; 7 km; L40 421x461; 2.8 km; L50	zooming 5 km; L100 652x702; 2.0 km; L80	zooming 5 km; L100 652x702; 2.0 km; L80	tbd
HMC (Russia)	170x137; 50 km; L30 700x620, 7km, L40 2 dom. 420x470,2.2km,L50	270x230; 25 km; L30 700x620, 7km, L60 2 dom. 420x470,2.2km,L80	270x230; 25 km; L30 700x620, 7km, L60 2 dom. 500x500,2.2km,L80	tbd	tbd	
NCEP (USA)	1371x1100; 4 km; L70 595x625; 6 km; L70 373x561; 3 km; L70 241x241; 3 km; L70	1371x1100; 4 km; L70 595x625; 6 km; L70 373x561; 3 km; L70 241x241; 3 km; L70	1371x1100; 4 km; L70 595x625; 6 km; L70 373x561; 3 km; L70 241x241; 3 km; L70	2193x1760; 2.5 km; L80 1071x1125; 3.33km; L80 559x841; 2 km; L80 361x361; 2 km; L80	2193x1760; 2.5 km; L91 1071x1125; 3.33km; L91 559x841; 2 km; L91 361x361; 2 km; L91	1182x1014; 2.25km; L91 1190x1250; 3 km; L91 621x935; 1.8 km; L91 401x401; 1.8 km; L91
Navy/FNMOC/NR L (USA)	45/15/5; L40	27/9/3 km; L40	27/9/3 km; L50	9/3/1; L50	9/3/1 km; L60	
CMC (Canada)	10 km; L80 LAMs at 2.5km; L58	10 km; L80 LAMs at 2.5km; L58	10 km; L80 LAMs at 2.5km; L58	8km; L80 LAMs at 2.5km; L58	tbd	tbd
CPTEC/INPE (Brazil)	601x1201, 10 km; L50	1001x2101, 5 km; L80	1001x2101, 5 km; L80	tbd	tbd	
JMA (Japan)	721x577; 5 km; L50	721x577; 5 km; L50	817x661; 5 km; L75 800x550, 2km, L60	817x661; 5 km; L75 1581x1301, 2km, L60	817x661; 5 km; L75 1581x1301, 2km, L60	817x661; 5 km; L75 1581x1301, 2km, L60
CMA (China)	GRAPES 502x330,15km; L31	GRAPES 502x330,15km; L31	1506x990, GRAPES-5km; L60	tbd	tbd	
KMA (Korea)	574x514, 10 km, L40 540x432, 12 km, L70	540x432, 12 km, L70 1.5 km, L70	540x432, 12 km, L70 1.5 km, L70	tbd	tbd	
NCMRWF (India	12 km L70	12 km L70	tbd	tbd	tbd	
BoM (Australia)	1090x750; 12km L70 6 LAMs 160x160; 5km L70	1090x750; 12km L70 6 LAMs 530x530; 1.5km L70	1090x750; 12km L70 6 LAMs 530x530; 1.5km L70	1090x750; 12km L70 6 LAMs 530x530; 1.5km L70	tbd	

WGNE Overview of Plans at NWP Centres with Global Forecasting Systems

Part III: Regional Modelling

b) Regional Ensemble Prediction System (Resolution, number of members, forecast range in days)

Forecast Centre (Country)	2011	2012	2013	2014	2015	2016
ECMWF (Europe)	-	-	-	-	-	
Met Office (UK)	18 km; M24 (12hrly); 2	12 km; M12 (6 hrly); 2 1.5 km; M6 (6 hrly); 1	12km: M12 (6hrly); 2 1.5km; M6 (6hrly);1	tbd	tbd	
Météo France (France)	15 km; M35; 4	15 km; M35; 4	15 km; M35; 4	2.4km; M8; 1.5	2.4km; M8; 1.5	tbd
DWD (Germany)	2.8 km; M40; 1	2.8 km; M40; 1	2.8 km; M40; 1	2.0 km; M50; 1	2.0 km; M50; 1	tbd
HMC (Russia)	tbd	14 km; M12; 3	14 km; M12; 3	14 km; M12; 3	14 km; M12; 3	
NCEP (USA)	32 km; M21; 4cyc; 3.625day	22 km; M25; 4cyc; 4day	22 km; M25; 4cyc; 4day	22 km; M25; 4cyc; 4day	10km;M25;4cyc; 4day	3km nested; M6; 24cyc(hrly); 1day
				3 km; M6; 2	3 km; M6; 2	2.5km; M10; 2
Navy/FNMOC/NRL (USA)	45/15 km; M20; 3	27/9 km; M20; 3	27/9 km; M20; 3	tbd	tbd	
CMC (Canada)	33 km L28 M20 2 or 3	22 km L40 M20 3	22 km L40 M20 3	15 km L60 M20 3	tbd	tbd
CPTEC/INPE (Brazil)	20 km; M21; 10	10 km, M21, 10	10 km, M21, 10	tbd	tbd	
JMA (Japan)	T_L319 L60; M11; 4 times/day; 5	T_L319 L60; M11; 4 times/day; 5	T_L319 L60; M11; 4 times/day; 5	T_L479 L100; M25; 4 times/day; 5	T_L479 L100; M25; 4 times/day; 5	tbd
CMA (China)	tbd	tbd	tbd	tbd	tbd	
KMA (Korea)	No regional EPS	12 km; M24; 3	12 km; M24; 3	tbd	tbd	
NCMRWF (India	No regional EPS	No regional EPS	tbd	tbd	tbd	
BoM (Australia)	nil	MOGREPS; 24km L70; M24; 3	MOGREPS; 24km L70; M24; 3	MOGREPS; 24km L70; M24; 3	tbd	

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Part III: Regional Modelling

c) Regional Data Assimilation Scheme (Type and resolution)

Forecast Centre (Country)	2011	2012	2013	2014	2015	2016
ECMWF (Europe)	-	-	-	-	-	
Met Office (UK)	4D-Var, 24 km 3D-Var , 1.5 km	4D-Var, 24 km 3D-Var , 1.5 km	3d-Var, 1.5km	tbd	tbd	
Météo France (France)	3D-Var, 2.5 km	3D-Var, 2.5 km	3D-Var, 2.5km	3D-Var 1.3km	3D-Var 1.3 km	tbd
DWD (Germany)	Nudging; 7 km Nudging, LH-N.; 2.8 km	Nudging; 7 km LETKF; 2.8 km	Nudging; 7 km LETKF; 2.8 km	LETKF; 2.0 km	LETKF; 2.0 km	tbd
HMC (Russia)	none	3D-Var + EnKF 15 km	3D-Var + EnKF 12 km	3D-Var + EnKF 5 km		
NCEP (USA)	Advanced-Var; 12/6/4/3 km	Advanced-Var; 12/6/4/3 km	Hybrid enkf-3dvar; 12/6/4/3 km	Hybrid enkf-3dvar; 10/3.33/2.5/2 km	Hybrid enkf-4dvar; 10/3.33/2.5/2 km	
Navy/FNMOC/NRL (USA)	3D-Var 45/15/5 km	4D-Var 27/9/3 km	4D-Var 27/9/3 km	4D-Var 9/3/1 km	4D-Var 9/3/1 km	
CMC (Canada)	Continental: 3D-Var 55 km L80 Local: 3D-Var 10 km L58	Continental: 3D-Var 55 km L80 Local: 3D-Var 10 km L58	tbd	tbd	tbd	tbd
CPTEC/INPE (Brazil)	LETKF; 20 km	LETKF; 10 km	LETKF; 10 km	tbd tbd	tbd	
JMA (Japan)	4D-Var, 15 km	4D-Var, 15 km	4D-Var, 10 km 3D-Var, 5km	4D-Var, 10 km 3D-Var, 5km	4D-Var, 10 km 3D-Var, 5km	4D-Var, 10 km 3D-Var, 5km
CMA (China)	GRAPES-3DVAR, 15 kmL31	GRAPES-3DVAR, 15 kmL31	tbd	tbd	tbd	
KMA (Korea)	3D-Var, 10 km 4D-Var, 24 km	4D-Var, 24 km 3D-Var, 1.5 km	4D-Var, 24 km 3D-Var, 1.5 km	tbd	tbd	
NCMRWF (India	tbd	tbd	tbd	tbd	tbd	
BoM (Australia)	4D-VAR; 36 km; L70	4D-VAR; 36 km; L70 highest-res systems are forecast-only	4D-VAR; 36 km; L70 3D-VAR; 4 km; L70	4D-VAR; 36 km; L70 3D-VAR; 4 km; L70	tbd	

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Part IV: Atmospheric composition

a) Global atmospheric composition modelling (Type [Aerosols? Chemically reactive gases?] and resolution)

Forecast Centre (Country)	2011	2012	2013	2014	2015	2016
ECMWF (Europe)	aerosol, O3, NO2, SO2, CO, HCHO, CO2, CH4, 4D-Var T255L60, NRT and reanalysis	Pending contract negotiations with EC	Pending contract negotiations with EC	Pending contract negotiations with EC	-	-
Met Office (UK)	Prognostic dust	Prognostic sea-salt, biomass	tbd	tbd	tbd	tbd
Météo France (France)	Resolution: 2°. Gas phase Chemistry : 118 species, over 300 reactions (comprehensive strat+trop scheme). Aerosol : dusts, sea salts, black carbon, sulfate, anthropogenic PM2.5 and PM10-2.5.	Implement a data assimilation step + Finalize comprehensive aerosol scheme (including SOA, ammonia,…)	tbd. CPU permitting, increase gradually to target resolutions : 1°	tbd. CPU permitting, increase gradually to target resolutions : 1°	tbd. CPU permitting, increase gradually to target resolutions : 1°	tbd. CPU permitting, increase gradually to target resolutions : 1°
DWD (Germany)	Nil	Nil	20 km / 5 km ICON-ART; alert system for volcanic ash	20 km / 5 km ICON-ART; alert system for volcanic ash	20 km / 5 km ICON-ART; alert system for volcanic ash	10 km / 5 km ICON-ART; alert system for volcanic ash
HMC (Russia)	Nil	tbd	tbd	tbd	tbd	tbd
NCEP (USA)	Passive dust aerosols 75 km	Passive dust aerosols 75 km	Passive dust and smoke aerosols 75 km	Full aerosol sources (dust, smoke, anthropogenic & Sea-salt) w/ simple sulfate chemistry 50 km	Full aerosols w/ simple sulfate chemistry 50 km	Simple tropospheric gas-phase chem + full aerosols 26 km
Navy/FNMOC/NRL (USA)	Dust, Smoke, Sulfates, Sea Salt 100 km; L36	Dust, Smoke, Sulfates, Sea Salt 50 km; L36	Dust, Smoke, Sulfates, Sea Salt 27 km; L60	Dust, Smoke, Sulfates, Sea Salt 25 km; L64	Dust, Smoke, Sulfates, Sea Salt 25 km; L64	Dust, Smoke, Sulfates, Sea Salt 26 km; L64
CMC (Canada)	tbd	tbd	tbd	tbd	tbd	tbd

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Part IV: Atmospheric composition

a) Global atmospheric composition modelling (Type [Aerosols? Chemically reactive gases?] and resolution)

Forecast Centre						
CPTEC/INPE (Brazil)	T126 L42 volcanoes ash and sulfates, soil dust, black carbon, anthopogenic and sea salt aerosols and gas phase chemistry with RACM/RELACS chemical mechanism.	T256 L68 volcanoes ash and sulfates, soil dust, black carbon, anthopogenic and sea salt aerosols and gas phase chemistry with RACM/RELACS chemical mechanism.	tbd	tbd	tbd	tbd
JMA (Japan)	Stratospheric Ozones 300km; L68, Tropospheric Ozones 120km; L30 Aerosols 120km; L30	Stratospheric Ozones 300km; L68, Tropospheric Ozones 120km; L30 Aerosols 120km; L30	Stratospheric Ozones 300km; L68, Tropospheric Ozones 120km; L30 Aerosols 120km; L30	Stratospheric Ozones 120km; L68 Tropospheric Ozones 60km; L48 Aerosols 60km; L48	Stratospheric Ozones 120km; L68 Tropospheric Ozones 60km; L48 Aerosols 60km; L48	Stratospheric Ozones 120km; L68 Tropospheric Ozones 60km; L48 Aerosols 60km; L48
CMA (China)	Nil	Nil	tbd	tbd	tbd	tbd
KMA (Korea)	tbd					
NCMRWF (India	tbd					
BoM (Australia)	tbd	tbd				

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Part IV: Atmospheric composition

b) Regional atmospheric composition modelling (Type [Aerosols? Chemically reactive gases?] and resolution)

Forecast Centre (Country)	2011	2012	2013	2014	2015	2016
ECMWF (Europe)	MACC European air quality analyses/forecasts from a 7-model ensemble at variable resolution (0.15° - 0.5°)	Pending contract negotiations with EC	Pending contract negotiations with EC	Pending contract negotiations with EC	Pending contract negotiations with EC	
Met Office (UK)	Aerosols+chemistry 12km	Aerosols+chemistry 12km	Aerosols+chemistry 12km	tbd	tbd	
Météo France (France)	increase France domain resolution to 0.025° (for D1 forecast only)	Increase Europe domain resolution to 0.2° by merging with Météo-France MACC forecasts stream + Implement a data assimilation step + Finalize comprehensive aerosol scheme (including SOA, ammonia…)	tbd. CPU permitting, increase gradually to target resolutions : Europe 0.1° and France 0.025° (beyond D1)	tbd. CPU permitting, increase gradually to target resolutions : Europe 0.1° and France 0.025° (beyond D1)	tbd. CPU permitting, increase gradually to target resolutions : Europe 0.1° and France 0.025° (beyond D1)	
DWD (Germany)	7 km COSMO-ART; alert system for volcanic ash	7 km COSMO-ART; alert system for volcanic ash	7 km COSMO-ART; alert system for volcanic ash	tbd	tbd	tbd
HMC (Russia)	Nil	tbd	tbd	tbd	tbd	
NCEP (USA)	Chemically reactive Gas-phase only Passive wild-fire smoke and dust 12	Chemically reactive Gas-phase only Passive wild-fire smoke and dust 4 km	Chemically reactive Gas-phase only Passive wild-fire smoke and dust 4 km	Chemically reactive Gas-phase and full aerosols 2.5 km	Chemically reactive Gas-phase and full aerosols 2.25 km	
Navy/FNMOC/NRL (USA)	Dust 45/15/5 km; L40	Dust, Smoke, Sulfates, Sea Salt 27/9/3 km; L40	Dust, Smoke, Sulfates, Sea Salt 27/9/3 km; L50	Dust, Smoke, Sulfates, Sea Salt 9/3/1 km; L50	Dust, Smoke, Sulfates, Sea Salt 9/3/1 km; L50	
CMC	Continental air quality: GEM-MACH 15 km [aerosols: 2 size bins,8 chemical species; NOx/VOC/O3 oxidant chemistry]	Continental air quality: GEM-MACH 10 km [aerosols: 2 size bins,8 chemical species; NOx/VOC/O3 oxidant chemistry]	Continental air quality: GEM-MACH 10 km [aerosols: 2 size bins,8 chemical species; NOx/VOC/O3 oxidant chemistry]	Continental air quality: GEM-MACH 8 km [aerosols: 2 size bins,8 chemical species; NOx/VOC/O3 oxidant chemistry]	tbd	tbd

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Part IV: Atmospheric composition

b) Regional atmospheric composition modelling (Type [Aerosols? Chemically reactive gases?] and resolution)

(Canada)			GEM-MACH 2.5km [aerosols: 2 size bins,8 chemical species; NOx/VOC/O3 oxidant chemistry] - 1 window	GEM-MACH 2.5km [aerosols: 2 size bins,8 chemical species; NOx/VOC/O3 oxidant chemistry] - 1 window	GEM-MACH 2.5km [aerosols: 2 size bins,8 chemical species; NOx/VOC/O3 oxidant chemistry] - 1 window	
CPTEC/INPE (Brazil)	20 km volcanoes ash and sulfates, soil dust, black carbon, anthopogenic and sea salt aerosols and gas phase chemistry with RACM chemical mechanism.	10 km volcanoes ash and sulfates, soil dust, black carbon, anthopogenic and sea salt aerosols and gas phase chemistry with RACM chemical mechanism. Secondary organic aerosol.	tbd	tbd	tbd	
JMA (Japan)	tbd	tbd	tbd	tbd	tbd	
CMA (China)	tbd	tbd	tbd	tbd	tbd	
KMA (Korea)	tbd					
NCMRWF (India	tbd					
BoM (Australia)	tbd	tbd				