ACE-Asia Science Team Meeting Report

Honolulu, Hawaii, October 2-4, 2000

27 December 2000

[Some post-meeting updates have been added in square brackets]

The ACE-Asia Science Team met in Honolulu, Hawaii from 2-4 October 2000 at the East-West Center on the University of Hawaii Campus. The overall goal of the meeting was to discuss very specific details of each aspect of ACE-Asia. This was a very productive meeting in part because many of the ACE-Asia scientists now know their funding status and can be more concrete about their intended observations. Much of our time was spent in working groups, discussing the details of various measurements and how they can best be co-ordinated. The hope is that most of the results of this meeting will shortly be incorporated into our web-based Science and Implementation Plan.

A. Reports

As usual, the meeting began with a series of reports from National Committee Chairs, updating the status of each nation's plans. What resources (platforms, people, equipment) will each country contribute to the experiment?

A.1. The **Australian** contribution will take three forms. Zaharowski's group will uses Rn to do real-time air mass characterisation at six ground sites (Haiphong, Hong Kong, Manila, Kosan, Sado Island, and Mauna Loa) and on the NOAA ship Ron Brown. Hilton Swan will make DMS measurements at the Kosan site. Steve Siems reported that the ARA Kingair is still not fully funded, but they hope it will be available both to study frontal structure and to do radiation measurements with Teriyuku Nakajima. [Since the meeting we have learned that the Kingair will participate, with about 40 research flight hours. –BJH, 12/27/00] He also reported on plans to participate in a hill cloud study on Cheju Island with Tom Choularton, if Tom receives **United Kingdom** funding.

A. 2. Kimitaka Kawamura reported on the **Japanese** plans, based on a June/July 2000 Pre-ACE-Asia cruise and a September national committee meeting. These include basic measurements at surface sites from 2000 to 2003 and enhanced measurements (at Hachijo and Chichijima Islands) in March through May of 2001. Radiative properties will be measured at Fukue and Amami Ojima, as a part of the APEX experiment. Shipboard measurements will be conducted on the R/V Mirai during the last two weeks of May, 2001. Airborne measurements will be made both in December, 2000 as a part of APEX and in May, 2001 as a part of the PEACE experiment that is co-ordinated with TRACE-P. An extensive semi-real time support system involving satellites and models will be co-ordinated by Terry Nakajima at Tokyo University. The lidar network is making plans to participate in real-time mission planning and overflights by the NCAR C-130. Finally, a group with Prof. Uno will be running an aerosol forecast model to assist in the planning of the Spring, 2001 intensive observations.

A.3. Young J Kim reported on the **Korean** plans, which also include continuous measurements (from 2001.1 through 2003.12) and intensive operations in March and April of 2001. His group at K-JIST will make surface measurements at both Kwangju and Kosan, where they are planning to put a very advanced 8-channel Raman lidar. Sung-Nam Oh's METRI group will be working at Anmyundo (a GAW site) in addition to co-ordinating the many surface measurements and visitors to the Kosan site. While a group from NIER is planning aircraft measurements over the Yellow Sea, it is not yet clear whether their observations will be closely co-ordinated with other ACE-Asia platforms. There is still the possibility of a cruise by a KORDI ship.

A.4. Tai Chen reported on the **Chinese Taipei** plans, which include surface sites at Mt. Bamboo and Wan Li on the north tip of Taipei, and Lan Yu, and island to the Southeast. His group will also make the hydrocarbon and halocarbon measurements from the NCAR-C-130 and the Ron Brown, using technology very much like that which the Irvine group will use on the TRACE-P aircraft. This will enable very useful comparisons with the TRACE-P sampling.

A.5. Ali Wiedensohler described the plans of his **German** group to measure wet and dry size distributions and measure hygroscopic growth on the R/V Ron Brown.

A.6. Laurent Gomes discussed **French** plans to study the direct radiative impact of Asian dust, using measurements near source regions (Zhenbeitai), polluted areas (Xi'an and Beijing), and marine areas (Chinese Taipei). These observations will be tied to a RAMS model of dust transport (validated against satellites) to compute direct radiative impact. [It has since become clear that Celine Mari will do forecast modeling through the ACE-Asia intensive, working also with TRACE-P. –BJH, 12/27/00]

A.7. The **US** report included four sections. Tim Bates reported on the planning for the R/V Ron Brown. The current plan is to leave Hawaii for Asian waters on 14 March, and not put into port for 39 days, at which time it will dock near Tokyo. Barry Huebert reported that the C-130 schedule may be moved up a week so that it can be operating from Iwakuni, Japan from 20 March to 23 April. This would double the time when joint operations with the NASA TRACE-P aircraft would be possible; they will leave Japan on 3 April. [Update: the current plan is that the C-130 will depart Colorado on 16 March, ferry rapidly to Japan, and be ready for its first research flight about 23 March, 2001. This may allow for 4 joint flights with TRACE-P. –BJH, 12/27/00] The July tests of a new low-turbulence inlet (LTI) were successful, so NSF is recommending that the C-130 be allowed to participate in ACE-Asia. John Seinfeld outlined the Twin Otter plans, which involve parallel operations with the NCAR aircraft from Iwakuni. The timing and number of flights are the same, and the hope is that most flight operations will be done in concert.

A.8. Rich Arimoto reported on site visits to **network** sites at Hachijo, Cheju, Beijing, Hong Kong, Bamboo Mt., Wan Li and Lan Yu. He collected detailed site information and is asking surface PIs to complete information forms on the web site, so that a complete picture of the surface network operations can be assembled. There will be up to 30 Improve samplers throughout Asia by next spring. Tom Cahill is looking into the possibility of reducing their cut sizes to 1.0 um from 2.5 um.

A.9. At least two related projects will work closely with ACE-Asia. Vickie Connors reported on NASA's **TRACE-P** program, which will involve both the DC-8 and P-3 aircraft. They will operate first out of Hong Kong, then move to Yokota near Tokyo for the last half of their flights.

The primary objectives of TRACE-P are to determine the chemical composition of Asian outflow and to study its evolution, with an emphasis on photochemical processes. The aircraft will depart for Asia on 24 February, 2001 and return to the US on 7 April. The TRACE-P Science Team is very interested in conducting joint flight operations with ACE-Asia. [Since the HNL meeting, we conducting joint flight planning operations with TRACE-P in Boulder. We hope to have 4 joint flights. –BJH, 12/27/00]

A.10. Mitsuo Uematsu described the **APEX** program, a Japanese-led effort to measure the effects of aerosols on the radiative and microphysical properties of water clouds. Teriyuku Nakajima, the Lead Scientist for APEX, has arranged to compare satellite and radiometric observations with in situ aerosol measurements in four different campaigns, from December, 2000 through May, 2001. The ACE-Asia satellite plan is closely tied to the APEX program. Uematsu-san also reported on a program, "Long-range Transboundary Air Pollutants in Northeast Asia," which is being organized jointly by Japan, Korea and China. Dr. Shiro Hatakeyama of NIES is organizing the monitoring network (8 sites) and planning intensive monitoring during the period of November 10-20, 2000, April10-20 and August 5-15, 2001.

A.11. Bob Bergstrom presented an overview of **cloud conditions** we are likely to encounter during ACE-Asia, with an eye toward finding clear regions for column-closure experiments. The frequency of cloudiness is about 70% in the region that will be accessible to the C-130 in April, with holes in clouds making up some of that. NW of Japan (the Yellow and South China Seas) has the lowest cloudiness, with the highest fractions to the SE. Holes of at least 100 km on a side will be needed for column closure experiments; they occur frequently but it may be a challenge to find them as they move, appear, and disappear. Clear skies tend to follow low pressure systems, as do dust events. A movie of clouds in the spring of 1999 showed at least two extended clear periods behind frontal systems. It is clear, though, that we will have to be alert to these opportunities and take them when we can.

A.12. Nobuo Sugimoto updated the group on the **lidar network**. At least two of the sites will provide continuous web-based quick-look images: Tsukuba and Nagasaki. The latter is roughly between Iwakuni and Cheju, so there may be several opportunities to overfly it when ferrying to and from missions. Data will be distributed as netCDF files with a 15 minute resolution and plots of extinction coefficient, range-corrected backscatter, and category (e.g., dust, ice, cloud, spherical, etc.) The KOSA lidar network will also be operating from March through May 2001.

A.13. Tony Clarke reported on the INDOEX experiment's "**harmony**" effort to reconcile observations from multiple platforms. More side-by-side comparisons of platforms would have been extremely useful, since the lack of these exercises has made it hard to compare surface and airborne observations. The conclusion is that we need to devote significant amounts of time to intercomparing platforms and to ensuring the comparability of various measurement systems. Otherwise, much of the benefit from simultaneous observations is lost.

B. Platform Breakout Meetings

Several groups met to discuss logistics and preparations for their individual platforms.

B.1. The **C-130** group met (with Twin Otter and Kingair personnel, who will also be based at Iwakuni) to discuss details of the C-130 layout schedule, and inlets. If the C-130 inspection is finished by the end of this year, it should be possible to move the departure from Colorado up from 16 to 9 March. Integration of user equipment on the plane would begin in the middle of January, 2001. A new floor plan was prepared that would optimise the inlets, some of which will be LTIs and some solid diffusers (for submicron aerosol measurements). [It is now thought that the C-130 will not return to Jeffco until 31 January, but a new integration schedule should still permit a departure for Japan on 16 March. –BJH, 12/27/00]

B.2. The **Ron Brown** group talked about space allocation and sampling from their newly-tested common inlet.

B. 3. The **Network Sites** group used this opportunity to clarify issues about participants, space, and power at all sites, with an emphasis on the Kosan site. They discussed the issue of a Kosan sampling tower, the costs involved, and the potential for it to interfere with routine radiosonde launches. Of particular concern was the possibility that a summit meeting between North and South Korea might be held on Cheju Island during the Spring 2001 intensive period. If this materialises, the need for heightened security could limit the mobility of personnel working at the Kosan site. The meeting would probably be held in the hotel district on the south side of the island, however, which may mean fewer restrictions at Kosan. It was also noted that the AERONET network will have more Asian sites operating by the spring of 2001.

B. 4. A **forecasting** group began formulating a plan for the exchange of information between meteorologists and the chemical forecast modelers. There is a need for more regional forecasters to participate in the Operations Center. China, Japan, Korea, and Chinese Taipei have all been asked to identify experienced forecasters who could come to the Operations Center for all or part of the period 20 March – 30 April, 2001. Their travel expenses would be paid by the project.

C. Working group meetings

C.1. Satellites & Radiation, Phil Russell & Phil Durkee

This material overlaps with that in other reports: please see Sections D.4. and E.1.

C.2. Modeling, Greg Carmichael

This group discussed plans for operational modeling support in the field. The only chemical forecst model with aerosols that is committed now is the RAMS model, being run by Carmichael and Uno. There are plans to run an MM5 model of the Cheju area, a secondary organic aerosol model from Cal Tech, and the French group running RAMS in the dust source region. There were also discussions of the type of post-mission modeling that will be used to interpret the ACE-Asia observations. [At the Boulder Mission Simulation Exercise, we benefited from forecast models run by Uno/Carmichael, Mian Chin, Rasch/Collins, and Doug Westphal. The number of funded forecast chemical models is growing. –BJH, 12/27/00]

C.3. Measurement intercomparisons between instruments and platforms

This group broke into three different groups, one discussing the comparison of physical sizing devices, one discussing chemical intercomparisons, and one discussing nephelometers. These intercomparison activities are particularly important, because they are our only method for putting error-bars on comparisons between measurements on different platforms. Data from groups that have participated in these activities will be flagged as "quality control checked" in the final database, to allow users of the data to know which are the most reliable values.

C.3.a. Physical sizing, Steve Howell

The issue that emerged as the most critical for successful intercomparisons is that the relative humidity (RH) within the sampling volume of the sizing instrument should be known. Several instruments will have to be modified to accomplish this. In some cases it may be sufficient to merely measure temperature in (or near) the sampling volume if humidity is accurately measured elsewhere in the sampling line.

Sizing instruments need to determine both size and concentration. In most cases, the sizing is easily tested by introducing particles of known size. It is much more difficult to prepare known concentrations of particles. One development that promises to help with this issue is a system being developed at Caltech by Rick Flagan and John Seinfeld that should produce an airstream containing known sizes and concentrations of particles. This instrument will apparently be available at Iwakune, and perhaps at other locations as well. We hope that many groups will be able to use this.

Most sampling platforms will have a variety of instruments that use different principles to measure particle size. This means that even if the equipment works perfectly, the size distributions produced can be quite different. This makes intercomparisons difficult, but also produces more information about the aerosol. For example, the difference between mobility size (DMA) and aerodynamic size (APS) is primarily due to particle density.

Physical Sizing Intercomparison Group Recommendations

Recommendations for operation, calibration, and intercomparisons of
specific types of instruments:

C.3.a.1.Aerodynamic Particle Sizers (APS)

It appears that most of the sampling platforms will have one of these. The most notable exception is the Cheju Island ground station. Efforts will be made to obtain one for use there.

APSs are simple to operate and in theory span the range of sizes responsible for much light scattering. Their use of aerodynamic diameter side-steps the biggest difficulty in calibrating optical particle counters, which is the complex shape of the Mie scattering curves. (OPCs are the only other common sizing instruments for that size range.)

Unfortunately, recent experience suggests that APSs can malfunction in subtle ways not evident until they are directly compared. Since the latest generation of APSs (TSI 3320) is relatively new, the groups using them have not yet learned all of the failure modes and how to deal with them. Therefore, we highly recommend that all groups using APSs send their machine and ideally a technician to a calibration/intercomparison/troubleshooting workshop that TSI has offered to host the last two weeks of January, 2001. Contact Dave Covert (dcovert@u.washington.edu) for information about participating.

Other recommendations for APS users:

Measure RH and temperature of air exiting the sensing chamber.

For systems with controlled inlet RH, it may be necessary to cool the sheath air by bringing it out of the APS and through a heat exchanger. Otherwise, T may be higher than intended, thus lowering RH.

Target 0.8 um particles and larger. While the 3320 can in theory size accurately to 0.5 um, it appears that performance for larger particles suffers when the APS is tuned to sense the smallest particles.

Calibrate regularly with latex spheres.

Make use of the Flagan/Seinfeld aerosol calibration system if at all possible.

C.3.a.2. Forward Scattering Spectrometer Probes (FSSP)

These will be present on all aircraft. Unfortunately, they require flow rates much too high for the Flagan/Seinfeld aerosol calibrator, so the only real calibrations that can be done are for particle size rather than concentration. This makes intercalibrations more critical for evaluating performance.

Therefore, we should do some formation flying early in the experiment so we can get a handle on the relative performance of the FSSPs.

Jeff Stith pointed out that the NCAR C-130 has several mounting points for FSSPs. If other planes' FSSPs are mounted on the C-130 for a flight or two (presumably on down days for the other aircraft), we can get much more extensive intercomparisons.

Regular calibrations with latex spheres or glass beads are also recommended.

C.3.a.3. Differential Mobility Analyzer (DMA, aka SMPS, DMPS)

As with the APSs, it is vital to measure RH. A sensor in the excess air outlet should do. This will require modification of stock TSI DMAs for groups using them.

It would be valuable to monitor the integrated number distribution from the DMA and compare with CN counter output. This is a good check of the counting efficiency and should be done frequently.

Make use of the Flagan/Seinfeld aerosol calibrator if possible.

Calibrations with latex spheres are useful here as well.

C.3.a.4. Optical particle counters (OPC, PCASP, etc.)

Measurement of sample RH is vital. This may be a challenge for the PCASP.

Calibration with latex spheres is important, but insufficient. Materials with different indices of refraction should also be used.

C.3.b. Chemical intercomparisons, Trish Quinn

Major chemical species will be targeted for intercomparisons. Tom Cahill has NIST SRMs that can be used for trace element determinations. These will be supplied to Cahill, Quinn, Anderson, and Kasahara. Trish Quinn will prepare standard solutions and spiked filters to intercompare ionic analysis systems. Analytical groups include Quinn, Huebert, Schauer, and Weber, and probably several others that were not represented in the working group. TC/EC/OC comparisons will be done using hi-vol quartz filters that Yin-nan Lee will expose. Barb Turpin will evaluate several punches to assure uniformity, after which punches will be sent out to Quinn, Huebert, Turpin, Cahill, Schauer, Jiam Yu, and Kasahara. Any additional groups wishing to participate in these intercomparisons should identify themselves to Trish Quinn at PMEL. [The organic aerosol group has had an active discussion since the meeting. Among other things they have agreed to use identical procedures from Jamie Schauer for baking, storing, and handling quartz filters. It is particularly important that state parameters (T, P, RH) be measured at every step in OC samplers, to allow assessment of possible aerosol/vapor artifacts. – BJH, 12/27/00]

C.3.c. Nephelometers, Anne Jefferson

This group concluded that all nephelometers should be calibrated with particle free air (hourly) and CO_2 (weekly), and that the T, P, and RH should be recorded for all measurements to allow for humidity corrections. Inlet cut points of 1 and 10 um are recommended, as is frequent leak-checking with a CPC. Data are to be reported at STP (0 C and 1 Atm).

C.4. Database Management WG, Dirks

This group discussed the data archive and distribution strategy. Each country should plan for its own archive (UCAR/JOSS in the US, YJ Kim in Korea, etc.) Data policies need to be established for sharing with related projects such as TRACE-P and APEX.

D. Breakout groups to plan for specific scientific questions

D.1: How does the size and composition of **mineral aerosol** change with altitude and distance from the source? (Spatial characterization) **–** Uematsu & Huebert

This working group discussed strategies for studying changes in dust over time and space. The working hypothesis was that larger particles would be less common farther from sources, as settling preferentially removed them. Larger particles might also be more concentrated at the bottom of layers than the top, for the same reason. The sky radiometer networks might give some information on the spatial variation, since inverting the aureole data can be used to derive a column-effective size distribution. Data from subsequent days could then be used to estimate changes in the dust size distribution during transport.

Airborne in situ measurements of the dust at various altitudes and distances is the most direct strategy for studying the changes during transport of dust. One difficulty is our inability to sample dust aloft near its source. By the time a dust plume reaches the coast where the aircraft can reach it, it will have lost its largest particles already and may have begun to react with pollutant gases such as sulfur dioxide. Given the large concentrations of SO2 offshore, however, reactions on the mineral particles will not have reached completion. The fact that many layers slope makes it more difficult to sample them; a scanning lidar is essential to position the aircraft relative to the layer being sampled. In some cases it may be wise to use two aircraft, so that one can map a layer from a different altitude and help to direct the plane inside the layer. Since dust is often found on the backside of frontal passages, it will be important to use the fast SO2 and particle measurements to determine the extent to which the SO2 and dust are in the same airmass (proximity may limit their ability to react).

D.2: What is the relationship between aerosol {composition, shape, and mixing state} and its **optical properties**? (Local closure) **–** Quinn and Wiedensohler

The working group discussed several issues relevant to optical closure and came up with the following recommendations.

<u>Particle shape</u>

1) Single particle analysis by SEM/TEM can reveal particle shape for those particles not affected by a vacuum.

2) Each platform should have several different measures of the number size distribution (optical, aerodynamic, and geometric).

Fred Brechtel will work on getting an APS for Cheju.

3) The majority of research groups involved will use Mie theory for calculating optical parameters since that is the tool available to them. Therefore, all calculated optical parameters should be reported with an uncertainty that considers shape effects that are not accounted for in the calculations.

<u>Mineralogy</u> (for determining particle refractive index, density, and water uptake)

1) Samples should be collected for single particle analysis by TEM at all platforms undertaking optical closure (C130, Cheju, Ron Brown).

Water Uptake

1) Where possible (Cheju and the Ron Brown) measurements with an ambient RH nephelometer should be made.
2) Closure studies involving measured and predicted water uptake are required to identify and quantify uncertainties.
3) The Twin Otter, Ron Brown, and Cheju will have the ability to do water uptake closure with a mix of chemical, HTDMA, and gravimetric measurements.

EC/OC Split

1) The EC/OC split can not be determined on the aluminum foils used in impactors. To get size segregated EC/OC splits, it was suggested that quartz filter samples for the sub-1, sub-2.5, and sub-10 (m size ranges be collected.

D.3: What **fraction of the Asian aerosol is organic**, and how does this influence its hygroscopic properties? (RH growth and impact on clouds) - Kawamura and Seinfeld

The Organic Aerosol Working Group discussed the measurement of organic aerosols in ACE-Asia. Measurements are being planned for OC/EC on the C-130, the Twin Otter, the Ron Brown, and the ground site at Kosan. Tom Cahill offered to host an organic intercomparison at Kyoto University. No specific action was taken on his proposal. It was recognised that performing molecular speciation on atmospheric organic aerosols is a challenging task, and that historically only a small fraction of the organic aerosol has been identified on a molecular level. It was suggested that an ad hoc working group on organic speciation techniques be formed. One role of such a group would be to evaluate the different techniques planned to be used for organic speciation. Another would be to synthesise a molecular picture of the organic aerosol after the field deployment, based on the different techniques that will be used. The breakout group was useful in identifying who is planning to do what and what the challenges will be.

D.4: Can we account for all the **extinction in a column** using in situ measurements? (Column closure, satellite comparisons, radiative climate forcing)
Moderator: Phil Russell. Recorder: Phil Durkee

Discussions in this group centered on four subsidiary questions:

4a. What strategies are needed to understand the above question (i.e., what measurements, sites, platforms, and ultimately, what flight plans)?
4b. What has been accomplished in previous experiments?
4c. What were the largest uncertainties? (What needs more work?)
4d. How can we best use models to improve chances of success? (This includes using models for forecasts and for integration of observations.)

A brief review of previous experiments noted that acceptable closure among aerosol optical depths from (1) solar transmission, (2) in situ scattering and absorption, and (3) in situ size distribution and composition was achieved only when all measurements were made from the same aircraft. And even in those cases where closure was “acceptable”, there was a persistent tendency for aerosol optical depth derived from solar transmission to exceed that derived by vertically integrating in situ measurements. This persistent discrepancy suggests (1) particle losses in previous in situ measurements, (2) gas absorption not properly accounted for in previous transmission analyses, or both. In ACE-Asia we expect to reduce uncertainties through several instrument advances or additions, including improved aerosol inlets and improved spectral resolution in solar flux measurements. Although spectral solar flux measurements on the C-130 have been selected for funding, spectral solar flux measurements on the Twin Otter have not yet been confirmed.

We need improved knowledge of particle absorption, including better wavelength coverage and better knowledge of humidification effects. Improved wavelength coverage may be provided in ACE-Asia by post-analysis of PSAP-collected samples, albeit at the sample humidity. Multiwavelength retrievals from extinction and sky radiance (e.g., by AERONET) can help characterize absorption wavelength dependence at ambient humidities. An externally mounted polar nephelometer (i.e., without an inlet) would avoid the inlet limitations common to previous airborne integrating nephelometer measurements. However, airborne polar nephelometer measurements are currently unfunded. We also need better particle shape information, especially for Asian dust. Lidar intercomparisons and polar nephelometry were both mentioned as ways to characterize shape effects.

Discussion addressed what could be done with the Carmichael model planned for ACE-Asia relative to what was done with the Rasch and Collins model in INDOEX. The R&C model assimilated optical depth fields from AVHRR, lidar data, etc. and combined them with meteorological fields to predict fields of optical depth, which were used in flight planning. In post-analysis studies, the R&C model products also permitted studying the interaction between aerosol and climate variability. In ACE-Asia the Carmichael model will combine emission source strength with meteorological fields to predict fields of particle mass, composition, and size. Initial efforts to convert these to an optical depth product available in the field were discussed.

Forecast products must include cloud cover analysis, because flights to determine aerosol effects on radiative flux are strongly dependent on finding cloud-free areas.

The following flight table, from the Implementation Section of the S&I Plan was discussed.

Flight Type	Tentative Number Planned	Brief Description	Objectives Addressed
A	3	Column closure flights (coordinated with satellite scenes, other aircraft, and Ron Brown)	a, b, d
B	2	Sea salt aerosol/ flights (with Twin Otter and Ron Brown)	c
C	4	Aerosol variation flights (coordinated with Twin Otter, Ron Brown, and TRACE-P, if possible)	a, b, c, d
D	2	Frontal passage flights (coord with ARA Kingair)	a, b, c, d
E	2	Up/Down-wind plume flights (across Japan and Korea, the latter coordinated with Korean platforms)	a, b, c, d
F	3	Dust plume (east, southeast) flights (starting near Qingdao, hopefully with Twin Otter)	a, b, c, d

G	3	Urban/industrial plume flights (starting near Lin'an, Shanghai, and Tokyo, with Twin Otter and Ron Brown)	a, b, c, d
Total flights	19		

[The revised version of this table has been added to Section E.2. -BJH, 12/27/00]

It was emphasized that the utility of Plans C-G for radiative closure and forcing depends strongly on details of flight design, including relationship to clouds, satellite overpasses, and lidars, plus aircraft attitude. The need was highlighted to design flight plans, analogous to those in the above table and associated drawings and text, that are tailored specifically to the needs of the radiative-effects objective.

These radiative-effects flight plans are of two basic types: (1) Vertically oriented (to combine column closure with radiative forcing) and (2) Horizontally oriented (to use horizontal gradients in the aerosol column to document forcing). Vertically oriented flights must include some short horizontal legs optimized for the flux radiometers; such legs are also advantageous for some inlets and for instruments that must integrate or scan to characterize a flight level (e.g., filter samplers, humidity scanners). However, the need for these horizontal legs must be balanced with the need to span an aerosol layer in a short time, so that temporal variations are not confused with vertical variations. Hence a combination of stepped descent with spiral ascent, or vice versa, might be optimal. The need to be at minimum altitude at satellite overpass time was emphasized for all radiation-effects flights. Horizontally oriented flights across aerosol column gradients can be aided by use of a second aircraft to sample the aerosol layer core while the first underflies the layer. When such two-aircraft coordination is not possible, the single aircraft could sample the layer immediately after underflying it. Explicit flight plans that embody these concepts are in preparation and will be iterated before the December mission selection exercise.

D.5: How accurately can models represent the spatial impact of urban and industrial emissions? (**Model/observation comparisons**) Chen and Carmichael

This group discussed plans for operational modeling support in the field. The only chemical forecst model with aerosols that is committed now is the RAMS model, being run by Carmichael and Uno. They will produce a suite of forecasted 3-d fields that includes aerosol loadings (mineral, bc, sea salt, sulfate) and air mass markers. There are also plans to run an MM5 model of the Cheju area, and the French group running RAMS in the dust source region. The NASA Goddard/GIT global aerosol model may also be run in the forecast mode in support of Ace-Asia. There were also discussions of the type of post-mission modeling that will be used to interpret the ACE-Asia observations. One planned activity is the use of a secondary organic aerosol model from Cal Tech. Another important discussion point involved the use of models in the forecasting and post analysis of radiative quantities (e.g., optical properties, radiances, etc.). The point being that a wide variety of such measurements will be taken during Ace-Asia. The models will be providing 3-d fields of aerosol composition, mass and size. Converting these to radiative quantities requires information on optical properties (which for mineral aerosol are complicated by the fact that the particle shapes may not be spherical and the optical properties depend strongly on the particle mineralogy). The need for further work on the optical properties of mineral aerosol and a closer coordination of effort with the satellite & radiation group on these issues was recommended.

E. Implementation

E.1 Co-ordination with satellites

Working Group on Satellites and Radiation
Moderators: Phil Russell, Phil Durkee
Rapporteur: Phil Durkee*

The discussion began with a consideration of cross-platform issues (e.g. satellite-aircraft, aircraft-ship, etc.) The first question considered was whether we have all the measurements we need to complete Objective 2 - Aerosol-Radiation Interactions. The group prepared a table that lists the measurement categories, the parameters that must be measured and whether measurement capability resides on the various platforms. (See the S&IP for this table.) Some questions remain. Spectral flux measurements are not assured on the Twin Otter. [Peter Pilewski has since been funded to do them. –BJH, 12/27/00] All the measurement groups confirmed the importance of calibration. In particular, all radiation instruments were encouraged to participate, when possible, in collaborative calibration activities before and after the field campaign (e.g. MLO). Extensive and repetitive intercomparisons of instruments are also required in the field. These include aircraft overflights of the ship and accessible surface sites, underflights of critical satellites, and ship operations in the vicinity of Cheju Island. When aircraft are flying intercomparison legs, it is important they are flown in regions and conditions relevant to radiation measurements.

The importance of radiation measurement strategies in flight planning was discussed at length. Aerosol gradient flights are considered to be a high priority since they can provide a direct assessment of direct radiative forcing (i.e., dF/dAOT, where F is radiative flux and AOT is aerosol optical thickness). It is very useful during aircraft operations, if possible, to have the aircraft near the surface at the time of a satellite overpass so that upward looking radiometers and lidars can assess the same column the satellite is sensing. Vertically oriented column closure flights immediately before and/or after the satellite overpass can provide for a more complete test of closure, including measurements by airborne in situ, airborne and surface radiometric, and satellite instruments. Such vertically oriented flights must include some horizontal legs, as required by flux radiometers and integrating or scanning in situ instruments (see also Group 4 report). Such flights can also measure dF/dAOT, providing another approach to measuring radiative forcing. It is important that whenever possible, Column Closure missions include the R/V Brown at the base of the column.

The cloud conditions expected during ACE-Asia will challenge our ability to observe direct aerosol radiative effects. The planning process must account for this so that the platforms are ready for every possible cloud-free condition that presents itself. Finally, every effort must be made to coordinate the use of numerical models with satellite and radiation measurements to understand the influence of aerosol on climate variability.

E.2. What flight plans should we fly?

We had a very active discussion of the kinds of flight plans that would most effectively meet our objectives. Barry Huebert presented a series of potential flights that would be used to characterize the aerosol. Eric Saltzman argued that the flight descriptions should be re-ordered by objective, rather than by type of flight, to ensure that the highest priority objectives are met. He objected to flights that are designed to watch the evolution of aerosol with time. The flight descriptions in the S&IP will be redone with these comments in mind.

Phil Russell described radiation flights, noting that some objectives require vertical flights while others require long horizontal legs. Column closure flights need to have measurements of aerosols, optical properties, and radiation from many layers at essentially one point in a satellite scene. By contrast, a horizontal flight at low altitude that measures both the aerosol optical depth and the radiative flux when passing under changing plumes of aerosols can give a direct measure of the aerosol forcing due to those aerosols. The radiation group will prepare a new set of flight plans for incorporation into the S&IP.

Steve Siems noted that the intent of the ARA Kingair was to fly with the C-130 near fronts, with the Kingair studying the dynamics of the front and the C-130 characterising the aerosol on both sides of it.

[BJH, 12/27/00 - The re-ordered table of flights is as follows:

[Objective 1: Characterization
A. **3** Urban/Industrial plume flights (1 vertical detail and 2 walls vs distance)
B. **3** Dust plume flights
C. **2** Upwind/Downwind flights (1 Japan, 1 Korea)

Objective 2: Radiation
D. **3** Column closure flights
E. **2** Radiation gradient flights

Objective 3: Processes
F. **2** Frontal passage flights

Objective 4: Modeling
G,H **4** Spatial variation flights (2 horizontal, 2 vertical)

Of course, these are not exclusive: radiation goals will be achieved on spatial variation flights and vice-versa. The listing above is meant to ensure that enough attention is focused on each objective that it can be achieved.]

F. Operations

Dick Dirks lead a series of discussions of operational aspects of ACE-Asia. He began with a timeline, which he used to discuss when various preparations need to be completed. Many tasks, such as planning for shipping of material into the field, need to be completed very soon. Details on many of these operational issues can be found in Bulletins posted by JOSS to their web site, http://www.joss.ucar.edu/ace-asia/. He then discussed the operations process, including the Operations Center staff & their functions, the decision making process, daily timeline, notification procedures, facility coordination procedures, resource allocation, and the operations center space & setup.

Greg Stossmeister described the JOSS field catalogue, a web-based system that gives participants in the field and anyone else and easy way to access status reports, weather summaries, operations summaries, and preliminary data sets. This is an incredibly valuable tool that has been refined in numerous earlier programs.

John Merrill discussed the plans for providing forecasting support. This will involve the collection of many products, including satellite images, numerical forecasts, and forecast trajectories. The forecaster team will conduct daily weather briefings, arrange for the availability of the necessary data & products, and prepare special forecasts as needed for specific conditions or operations. He issued a plea for help by regional forecasters, whose experience is invaluable. Working as a part of this team would be both exciting and a unique experience that would sharpen the skills of any forecasters who elect to work in the Operations Center.

For the RAMS aerosol forecast model being run by Carmichael and Uno to provide timely forecasts of aerosol plume locations, it has to get dynamic forecast products as soon as they are available. They also need event-specific emission terms, such as fires and volcanic activity, to be current. From this information RAMS will predict the vertical and horizontal distribution of sulfate, sea salt, BC, dust, etc. One limitation to their efforts is the narrow bandwidth of the main internet backbone in southern Kyushu where the model is being run, since the dynamic model output they use are in extremely large files.

As Phil Durkee explained, one factor that will impact the timing of operational decision-making is the availability of first-light satellite images. The Operations Center will have two receiving stations to download the most critical products, while others will be delivered via the web and Tokyo University. AVHRR, SeaWiFS, DMSP, and GMS will be the most heavily used for operational decision-making. Some of the other satellite-derived aerosol products (as from TOMS and MISR) will not be available in real-time.

Jim Moore outlined the communications strategies for keeping the Operations Center in contact with all the outlying platforms, surface sites, and sources of data. The plan involves satellite downlinks, a high-bandwidth connection to the internet, phone and fax lines, and both satcom phone and HF radio communications to the ship and aircraft. The LAN at Iwakuni will support only the TCP/IP protocol and will employ 10 base T RJ-45 connectors. JOSS and MCAS will assign IP addresses to all computers brought to the Ops Center and connected to the LAN. The base has 110v/60Hz power, but power conditioners are recommended for most computers. The phone system is very flexible, so that each group will have its own calls billed separately to its own account.

Jeff Stith described the capabilities of the NCAR C-130 and discussed a variety of operational considerations. Among these are the pilot duty limits, that constrain how many hours per day, week, and month a pilot can fly. RAF is considering having a third pilot in the field, since the number of flight hours and days may make it hard to utilize all the hours within those rules.

John Seinfeld discussed the Twin Otter's capabilities, which include an airspeed half that of the C-130 (50 m/s), 7 1/2 hour flights, and a ceiling of 4500 m. Their intention is to fly the same number of flights as the C-130. Obviously, because of their limited range they will benefit most from operations close to Iwakuni, which argues for having the Ron Brown spend some of its time nearby.

If the ARA Kingair is able to find full funding, it will operate 1-2 weeks from Cheju Island and 2-3 weeks from Iwakuni. Their flights will be between 4 and 4.5 hours, and will focus on clouds and radiation. They want to conduct joint operations with the C-130 in addition to their APEX related work.

Greg Stossmeister outlined a mission simulation exercise that will take place at NCAR from 4 to 6 December, 2000. The purpose of this small gathering is to practise and refine the decision-making process by simulating as accurately as possible conditions we will encounter in the field. The participants will be presented with case studies from 2000, as if they were seeing each situation for the first time at Iwakuni. Satellite images, synoptic forecasts, and aerosol model runs will be used to decide among possible flights and ship locations. This ACE-Asia exercise will be run in parallel with a similar TRACE-P exercise, so that we can also work out methods for jointly planning operations while all three aircraft are in Japan. To keep the travel costs down, just one representative of each platform will take part in the simulation. It is desirable, however, to have all likely forecast model products running and represented, so the decision-making process is as realistic as possible.

Tim Bates discussed the operations of the R/V Ron Brown. The ship will spend 39 days at sea after leaving Hawaii. They will frequently stop and position the ship to make radiation measurements during satellite overpasses. NOAA is requesting permission to operate in Japanese, Korean, and Chinese territorial waters, to support studies of the interaction between continental aerosols. Mitsuo Uematsu similarly described the many radiation and chemical measurements that will be made from the R/V Mirai during its cruise in May, 2001.

Rich Arimoto described some operational aspects of the surface network. The Kosan site will probably be the most heavily instrumented surface site, with PIs from several countries. The Network web page contains details of many of these sites, but site operators need to send in details of measurements to be made. It was concluded that a UCAR Integrated Sounding System was not needed at the Kosan site.

Gene Martin outlined a series of administrative and logistical issues, many relating to getting equipment and personnel to the field. It is essential that anyone planning to work at Iwakuni or needing to have JOSS help with logistics needs to immediately fill out a logistics questionnaire at www.joss.ucar.edu/ace-asia/. This is the only way JOSS has to tabulate the needs they have to meet. It is also important that non-US nationals who will be working at the Operations Center contact JOSS soon to begin the clearance process. It is our hope that there will be a rich mixture of nationalities at the Ops Center (and the base is fine with that), but the base clearance paperwork takes about 30 days or more to clear. JOSS will also produce an ACE-Asia email newsletter that can be used for announcements and notices.

Steve Williams discussed the ACE-Asia data management system, that will include data archive and analysis centers in each country. The data catalogue at JOSS will have links to all these centers, so that participants can download data from any of the archive sites. The philosophy of ACE-Asia is to make data as widely available as possible, while ensuring that the PI who generated the data is given the chance to participate in publications that use that data. Protocols will be established for submitting data, so that confusion about units and time conventions is minimized.

G. Project Schedule

G.1. Operations

Mission Simulation Exercise, Dec. 4-6, 2000 Boulder
Intensive Field Operations March-May 2001
Network Observations, 2001-2003

G.2. Data Workshops

November 2001, Seattle?
Surface site workshop, Fall 2001 Taipei?
Smaller focused integrating workshops, Summer, 2002?
[A joint ACE-Asia/TRACE-P workshop at NCAR has been suggested for some time in 2002. – BJH, 12/27/00]

G.3. Presentations at Meetings

Initial data presentations, AGU, Dec. 10-14, 2001 San Francisco
Major data presentations
International Aerosol Conference, 8-13 Sept, 2002 Taipei
IGAC/CACGP meeting, 19-25 Sept, 2002 Crete
Other meetings:
Asian Aerosol Conference, July 2001 Pusan
Clean Air Congress, Aug 2001 Seoul
Fall 2002 AGU

G.4. JGR special section manuscript deadline, Nov 2002?

Appendix A. Participants

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Blomquist, Byron	University of Hawaii	USA
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